Faculty of Physics and Astronomy of the Friedrich Schiller University Jena

Annual Report 2014

On January 27th 2014 the Thuringian Minister for Education and Research, Christoph Matschie, awards the Thuringian Research Prize for Applied Research 2013 to Prof. Dr. Richard Kowarschik (right) together with Dr. Gunther Notni and Dr. Kühmstedt (both Fraunhofer IOF) for fast 3D-shape sensors.

Editors: Prof. Dr. Gerhard Paulus
Prof. Dr. Thomas Pertsch
Prof. Dr. Karl-Heinz Lotze
Dr. Angela Unkroth

Directory

1.	The Faculty of Physics and Astronomy of the Friedrich Schiller University Jena	3
2.	The Development of the Faculty of Physics and Astronomy in 2014	5
3.	Recently appointed professors	8
3.1.	Professor for Theoretical Physics (W3) / Solid State Physics	8
3.2.	Professor for Theoretical Physics (W3) / Solid State Optics	9
4.	General Information	10
4.1.	Contact and Structure of the Faculty	10
4.2.	Staff	18
4.3.	Publications and Patents	21
4.4.	Third -party Funding	23
5.	Teaching	24
5.1.	Teaching report of the Faculty of Physics and Astronomy	24
5.2.	Abbe School of Photonics	33
5.2.1.	Master's degree program	33
5.2.2.	Doctoral program	37
5.3.	Compulsory Courses	40
5.4.	Optional and special courses	42
5.5.	Seminars of the institutes and research groups	45
5.6.	Postgraduate Training	46
5.7.	Public Saturday Morning Lectures	48
5.8.	Physical Colloquia	50
5.9.	Physics Day	51
6.	Student research projects; Bachelor, Diploma and Master thesis, thesis for the state examination, dissertations	52
7.	Research Activities	64
7.1.	Institute of Astrophysics and University Observatory	64
7.2.	Institute of Applied Optics	65
7.3.	Institute of Applied Physics	70
7.4.	Institute of Solid State Physics	81
7.5.	Institute of Solid State Theory and Optics	86
7.6.	Otto Schott Institute of Materials Research	87
7.7.	Institute of Optics and Quantum Electronics	97
7.8.	Institute of Theoretical Physics	116
7.9.	Collaborative Research Center/Transregio 7 „Gravitational Wave Astronomy“	120
7.10.	Research Training Groupe GRK 1523/1 „Quantum- and Gravitational Fields"	121
7.11.	Abbe Center of Photonics (ACP)	124
7.12.	Research School of Advanced Photon Science of the Helmholtz Institute Jena	129
8.	Visible results of the research and teaching activities	131
8.1.	Guest professor program of the Abbe School of Photonics	131
8.2.	Awards	133
8.2.1.	Awards for the best doctoral thesis and Master thesis	133
8.2.2.	Prize for exceptional commitment to the benefit of the faculty	135
8.2.3.	Teaching Awards	136

8.2.4.	Performance bonuses	138
8.3.	Institute of Astrophysics and University Observatory	139
8.4.	Institute of Applied Optics	141
8.5.	Institute of Applied Physics	143
8.6.	Institute of Solid State Physics	151
8.7.	Institut of Solid State Theory and Optics	156
8.8.	Otto Schott Institute of Materials Research	159
8.9.	Institute of Optics and Quantum Electronics	163
8.10.	Institute of Theoretical Physics	169
8.11.	Research Group - Teaching Methodology in Physics and Astronomy	173
9.	International Relationships	175
9.1.	Common Publications with international partners	175
9.2.	Institute of Astrophysics and University Observatory	176
9.3.	Institute of Applied Optics	177
9.4.	Institute of Applied Physics	178
9.5.	Institute of Solid State Physics	179
9.6.	Institut of Solid State Theory and Optics	182
9.7.	Otto Schott Institute of Materials Research	183
9.8.	Institute of Optics and Quantum Electronics	184
9.9.	Institute of Theoretical Physics	185
9.10.	Research Group - Teaching Methodology in Physics and Astronomy	186
10.	Academic Organization and Bodies	187
10.1.	Scientific Advisory Board of the Faculty of Physics and Astronomy	187
10.2.	Institute of Astrophysics and University Observatory	188
10.3.	Institute of Applied Optics	189
10.4.	Institute of Applied Physics	190
10.5.	Institute of Solid State Physics	192
10.6.	Institut of Solid State Theory and Optics	195
10.7.	Otto Schott Institute of Materials Research	196
10.8.	Institute of Optics and Quantum Electronics	198
10.9.	Institute of Theoretical Physics	198
10.10.	Research Group - Teaching Methodology in Physics and Astronomy	200
11.	Central Institutions of the Faculty of Physics and Astronomy	201
11.1.	Branch Library Physics of the Thüringer Universitäts- und Landesbibliothek (ThULB)	201
11.2.	Scientific Workshops of the Faculty of Physics and Astronomy	202
11.3.	Student Council of the Faculty of Physics and Astronomy	207
11.4.	Alumni Association of the Faculty of Physics and Astronomy	212
12.	Outlook	213

1. The Faculty of Physics and Astronomy of the Friedrich Schiller University Jena

The eye of anyone entering the main building of the Faculty will be caught by a large painting opposite the portal. It depicts Otto von Guericke's famous demonstration of the existence of a vacuum. Viewers will be amused by the hardly flattering representation of the clergyman present at the event – a clue to the period of origin of the painting as well as of the building. Just as interesting, though, is the question why Guericke, with the town of Magdeburg (of which he was Mayor) as a backdrop, was honoured in this way in Jena, of all places. Arguably, this relates to the fact that Guericke (who then spelled himself Gericke) studied in Jena from 1621 to 1623, when the alma mater jenensis, just over 60 years old, was still in its budding years. Of course, Gericke did not study physics here, nor even philosophy, but law.

A few decades later, Jena's university (known as the „Salana" after the nearby Saale river) boasted its first distinguished scientist, Erhard Weigel. Though not a physicist, Weigel was a notable astronomer and mathematician. One of his students was Gottfried Wilhelm Leibniz. Weigel played a crucial role in the adoption of the Gregorian calendar in the protestant territories; moreover, he was one of the early educationalists and established a tradition in Jena in this field, too.

A man of outstanding importance for Jena and its university was Johann Wolfgang von Goethe. First as the Duke of Saxe-Weimar's chief minister, he was specially charged in 1782 with overseeing the university, which he kept promoting with enduring effect. 200 years ago, on 3 September 1813, Goethe founded the Jena observatory, thus laying the foundations for astronomy as a part of our faculty.

Physics owes its status at the Jena University to two personalities of unique and lasting significance: Carl Zeiss and Ernst Abbe. The latter was, and still is Jena's most notable physicist. Moreover, by establishing the Carl Zeiss Foundation he safeguarded the continued existence of the university. He personally took over the direction of the observatory, and it was in his time that the Institute of Physics was founded. A Faculty of Physics did not come into being until after World War One.

One might assume that the paramount role of optics in Jena would promptly lead to a comparable dominance of optics at the Institute of Physics. Interestingly, this was not the case. From the late 19th century up to the end of the war in 1945, optics indeed acquired great industrial importance, but after Abbe's fundamental contributions to the theory of optical imaging and the correction of aberrations, optics largely became a subject of industrial research in the secluded laboratories of the Zeiss company.

In 1883, Leonhard Sohnke was made the first director of the Institute of Physics. While he did some work on optical effects, his research efforts were focussed mainly on solid-state physics. His investigations into the structure of crystals made him one of the forefathers of present-day solid-state physics in Jena.

Throughout the first half of the 20th century, however, the main area of interest was electrical engineering (then a very young field), with special emphasis on wireless telecommunications. Max Wien, cousin of Nobel laureate Wilhelm Wien, invented, among other things, the quenched-spark gap, which made possible dependable intercontinental radio links for the first time. Given British control of the submarine cables and the interception practice common even then, this was of vital strategic importance for the ambitions of the German empire.

After World War One, the pioneering achievements of the Jena physicists were followed by ad-

vancements in the field of short waves. In 1924, Erich Habann invented the magnetron, and Abraham Esau accomplished the first VHF radio communication between Kahla and Jena in 1925. Esau was the supervisor of the doctoral theses of Lothar Rohde and Hermann Schwarz. It may be mentioned in passing that at the same time, Hans Busch discovered electron optics, but the experts in Jena failed to realize its importance.

Nevertheless, Jena's outstanding competence in high-frequency engineering – despite the emigration of notable specialists to the West in divided Germany – paved the way to laser technology and, thus, the rise of optics to the most important field of research at the Faculty of Physics and Astronomy. This competence also gave rise to a flowering of NMR spectroscopy in all of those developments a number of notable theoreticians who taught and did research in Jena were of great importance. Examples are Felix Auerbach, Georg Joos and Friedrich Hund. Schrödinger, too, dwelt at Jena for some time. These, arguably, are the roots of the Faculty's continuously leading position in the theory of relativity. The NMR department survived at the faculty until after the political upheaval.

The development of laser physics was decisively stimulated by Wilhelm Schütz and Paul Görlich. For this purpose, research was organized strategically and coordinated with the interests of the Zeiss company. The first lasers became functional in the late summer of 1962. A few months later, on 3 December 1962, they were presented to an amazed public during the Physical Colloquium. Later, under the direction of Max Schubert and Bernd Wilhelmi, Jena became a centre of ultrashort-pulse laser physics.

After the reunification of Germany, the Faculty of Physics and Astronomy, which had been dissolved in 1968, was re-established. Based on the existing fields of competence, the Faculty was given its present structure comprising four divisions: optics and photonics, solid-state physics and materials science, quantum and gravitational theory, and astronomy.

Although one of the smallest, the Faculty has since grown into a key performer of the Friedrich Schiller University. It can boast great accomplishments in research, ample third-party funds, good rankings, teaching achievements far above the average and, last but not least, highly committed students who identify themselves with their Faculty. With its English-language Master Course in Photonics, the Faculty has adopted a role as trailblazer in the University's efforts towards a higher degree of internationalization. More of all this will be found elsewhere in this Annual Report.

The present report hardly deals with the challenges the Faculty of Physics and Astronomy is presently facing, irrespective of its successes: The number of first-year students of physics has dropped in 2014 to one third of those in the year before. The Faculty is trying to counter this with a package of measures such as enrolment for the summer semester, intensified co-operation with schools and increasing the attractiveness of the programmes for foreign students.

A number of retirements and appointments to other institutions as well as the economies decreed by the Thuringian government make it necessary to draw up and implement a structural and development plan. This will especially affect the Institute of Applied Optics and the cryophysics professorship. Confident that new chances and opportunities will arise, the Faculty, in close co-operation with its scientific advisory board, is prepared to take up the challenge with new ideas and concepts.

Prof. Dr. Gerhard G. Paulus
Dean

2. The Development of the Faculty of Physics and Astronomy in 2014

In 2014, the developments initiated in the years before were successfully continued. This applies to important content-related and organizational issues of teaching as well as the procedures for appointing chairs and professors. Great efforts were put forth to land large promoted projects on the national and international levels.

The *Abbe Centre of Photonics* (ACP) founded in December 2010 will play an important part in the further successful development of close collaboration between academic and non-academic research institutions and the optical industry, in the advancement of junior scientists and in improving permeability between the University and the industry.

The center and its members commit themselves to Jena's tradition of excellence in research and teaching in the field of optics and photonics and thus form the core of the key research area "Light" regarding the University's institutional strategy "Light – Life – Liberty". ACP's main mission is to promote and to coordinate interdisciplinary research jointly performed by scientists from different subject areas and to contribute sustainably both in fundamental and applied optical sciences. While encompassing a broad variety of research fields, ACP concentrates on expertise development in its three strategic domains **ultra optics, strong field physics and biophotonics**. Besides ACP's research efforts, the education of young research scientists, represented by its integrated **Abbe School of Photonics (ASP)**, exhibits its fourth profile cornerstone and cross-connects all research areas.

The Jena Helmholtz Institute founded on 1 July 2009 was successfully evaluated and integrated into the regular funding scheme of the Helmholtz Association in 2014. Within the short period since its foundation, the institute managed to attain good research results in the fields of petawatt lasers, fibre lasers, X-ray optics, laser particle acceleration and strong-field QED and to set up new working groups. This also backs up innovative research fields of our Faculty as well as our collaboration both within the Faculty and especially with GSI Darmstadt, DESY Hamburg and the Helmholtz Centre at Dresden–Rossendorf. The appointment procedure in 2014 for the professorship of Laser Particle Acceleration was successfully completed with the appointment of Prof. Matt Zepf.

The targeted promotion of junior scientists in the research field of intensive photon and particle radiation takes place at the Research School of Advanced Photon Science founded at the Jena Helmholtz Institute early in 2013 (see chapter 7.12).

The Collaborative Research Centre/Transregio (SFB/TR 7) „Gravitational Wave Astronomy" successfully completed its third (and last possible) period of grant in 2014. The participants in this SFB were the Institute of Theoretical Physics (TPI), which provided the speaker, Prof. Brügmann, the Institute of Applied Physics (IAP), the Institute of Solid State Physics (IFK) and the Institute of Astrophysics and University Observatory (AIU).

The SFB/TR 18 "Relativistic Laser Plasma Physics", successfully evaluated in Jena in 2012, is still active. The funds granted amount to €6.6 million for the period from 2013 to 2016, about 30% of which go to Jena. Participants include the Institute of Optics and Quantum Electronics (IOQ) and the TPI. Prof. Paulus is the deputy speaker.

The Postgraduate College GRK 1523 "Quantum and Gravitational Fields", which forges a link between the Institute of Theoretical Physics and the Institute of Mathematics of the Faculty of Mathematics and Computer Sciences, was confirmed in 2013 and thus enjoys its second period of grant lasting till March 2018.

In 2014, Prof. Stephan Fritzsche of the Jena Helmholtz Institute (HI Jena) and Prof. Markus Schmidt of the Leibniz Institute of Photonic Technology (IPHT) held their inaugural lectures in the assembly hall of our University.

In 2014, again, we followed the decision of the Faculty Council that about 40% of the funds due to the institutes be allocated on an achievement basis. In keeping with the CHE criteria, about 0.3% of

the third-party funds granted, a fixed sum for each doctorate conferred and approximately 6% of the allocated budget are directly passed on to the institutes according to their impact factors achieved.

It is a matter of importance for our Faculty to develop meaningful assessment factors also for teaching. The awarding of teaching prizes every semester has proved an effective means of recognizing good results in teaching. This year's prizewinners were Prof. Dr. Frank Schmidl and Dr. Claudia Schnohr. In addition, the Dean's teaching prize this year was awarded to M.Sc. Tobias Ehmke in appreciation of his extraordinary commitment as tutor of practical courses in experimental physics.

In 2014, again, the Faculty had the possibility to pay bonuses to 14 meritorious colleagues in recognition of their continuously outstanding performance.

The state of research at the Faculty in 2014 is shown by the following indicators: In 2014, third-party funds (not counting those granted by the State of Thuringia) amounted to approximately €18 million. Compared to the previous year, especially the share of funds granted by the German Research Foundation (DFG), amounting to €5.4 million, decreased by about 12%. The front runner in successful applications for third-party grants is the IAP (ca. 49%); other main contributors to the good third-party funds account are TPI (with SFB and the Postgraduate College), IOQ, the Otto Schott Institute of Materials Research (OSIM), IFK and the Abbe School of Photonics. The number of publications in 2014 totalled 465 (an increase by ca. 12%); the accumulated impact factor rose by 16% and the average number of publications per scientist went up from 1.68 to 2.39, i.e. by more than 40%. The top position in the number of publications and the accumulated impact factor is held by the IAP (98 / impact factor 487), followed by the IOQ (85.5 / impact 317) and the IFK (80 / Impact 245). In 2014, 36 doctoral proceedings at the Faculty of Physics and Astronomy were successfully completed, an increase by 44% compared to 2013. The rise in the number of patent applications (15) and patents granted (13) in 2014 is encouraging, too.

Since the allocation of funds by the University is not only a function of the number of students enrolled but mainly, and to a growing extent, of the third-party funds granted, and since the result in CHE rankings will have a strong influence on the standing of the Faculty, we will continue to pay close attention to these criteria.

The staff of the Faculty – professors and others – serve on many national and international specialist panels and as peer reviewers for all relevant professional journals, the DFG, the Federal Ministry of Education and Research and the European Commission.

Public awareness of the Faculty has been enhanced by high honours conferred upon our professors and other staff. The Thuringian Research Prize in the category of Applied Research was awarded to Prof. Dr. Richard Kowarschik and co-workers Dr. Gunther Notni and Dr. Kühmstedt (both of the Fraunhofer IOF) for their project "Fast 3D shape sensors". Jun.-Prof. Dr. Alexander Szameit was honoured with two high-level prizes: the Adolph Lomb Medal of the Optical Society of America (OSA) and the 2014 Rudolf Kaiser Prize.

Notwithstanding these successes in research, it will be of vital importance in the next few years for us to develop a distinctive profile at Jena within the German research landscape, which is about to get more sharply structured in the context of the German universities' Excellence Initiative. Greater efforts will be needed to integrate such fields as photonics, nanotechnology, solid-state physics, materials and life sciences in a wide-scope research alliance in order to maintain access to DFG-funded collaborative research.

An important building project in this connection is the Abbe Centre of Photonics, which had its topping-out ceremony in 2014.

In 2014, the number of first-year students in the basic courses dropped drastically, with the exception of those studying for the teaching profession. Whereas the 26 freshmen in physics teacher training meant a reduction by a mere 10% , the bachelor programmes in physics and materials sciences notched up only 33 and 14 freshers, respectively – no more than respectively 37% and 56% of the

2013 figures. To counteract this trend, we need to increase our efforts in winning over young people to study – the more so as the numbers of secondary school (high school) graduates in the eastern states of Germany continue to shrink dramatically. As a first measure, enrolment of students for bachelor programmes in physics at the start of the summer semester was re-introduced in 2014. Unfortunately, of the seven students that earnestly started a physics study in the summer 2014 semester (out of 26 who had enrolled), only one still participates in the standard curriculum. Other canvassing measures are the improvement of our website, presence at Facebook and a great number of outreach activities such as "Rent a Prof", the school holiday workshop "Physics for school girls", the setting up of a school student lab and a first “Day of Physics”.

The number of graduates in physics (6 diplomas and 24 M.Sc.) is further decreasing (about 40% in relation to 2013, whereas the number of graduates in materials sciences (3 diplomas and 22 M.Sc.) remains constant. Fortunately, the number of graduates in physics as a teaching profession (21) has increased by 60% compared to 2013. The number of graduates in photonics has also decreased by 26%.

We are grateful to the local industry which continued to support our education tasks in many ways. Besides the measures already mentioned, e.g. those within the scope of the ASP, we were again able to award the Dr.-Ing. Siegfried Werth Prize for the best doctoral thesis in the field of optical measurement; in 2014, it went to Dr. Marcus Grosse of the Institute of Applied Optics. Since as early as 1991, the company of Rohde & Schwarz (Munich) has annually donated a prize each for the best diploma or master thesis and the best doctoral thesis at the Faculty. The Carl Zeiss Foundation generously grants scholarships to several doctors and doctoral candidates. Last but not least, the Carl Zeiss AG finances a professorship for the theory of optical systems and a junior professorship for attosecond laser physics.

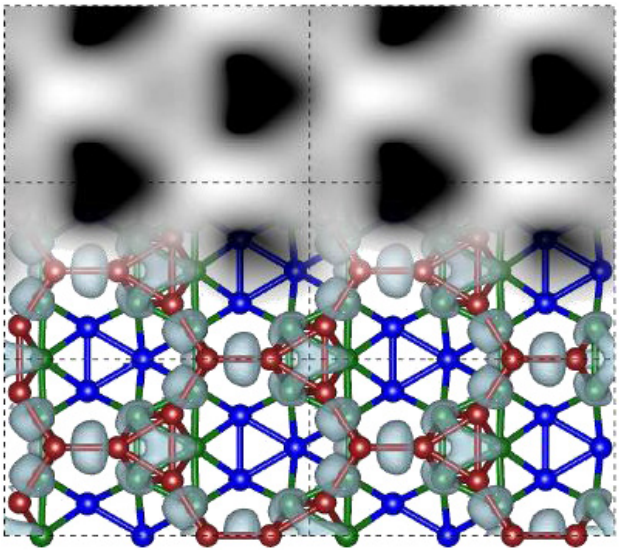
In retrospect, 2014 was another particularly active year of the Faculty of Physics and Astronomy, in which national and international awareness of its teaching and research accomplishments heightened. Moreover, we have mapped out the path to continued success in 2015, aiming for qualitative growth despite the inevitable austerity measures.

3. Recently appointed professors

3.1. Professor for Theoretical Physics (W3) /Solid State Physics

Prof. Dr. Silvana Botti
Professor of Theoretical Physics / Solid State Physics
Institute of Solid State Theory and Optics
Appointed in October 2014

The research activities of Silvana Botti belong to the field of theoretical condensed matter physics. She works on the theoretical development and numerical implementation of many-body approaches for the description of electronic excitations in materials. The tools used are based on density functional theory and many-body perturbation theory. Examples of applications are the simulation of spectroscopy of "real" materials of technological interest. The materials studied can range from simple pure crystals to non-stoichiometric, doped, alloyed compounds, or to nanostructured materials and interfaces. At the same time, a "materials by design" approach based on global structural prediction and high-throughput calculations is followed to propose “new” materials for specific applications, that are then further characterized with the same techniques used for “old” materials.

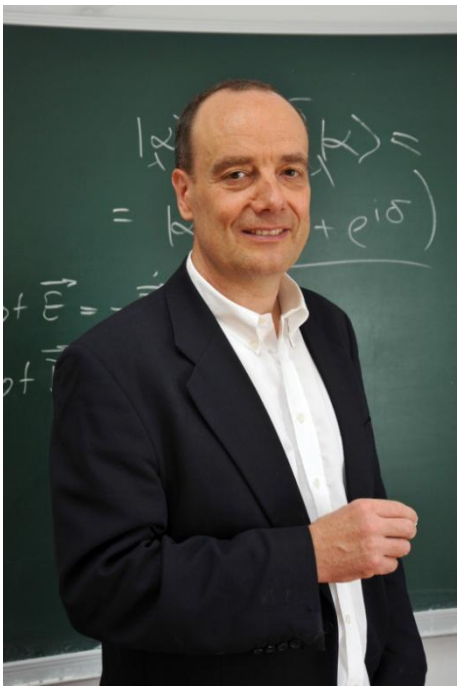


Her most recent studies have focused on the understanding of light absorption and energy conversion in materials for solar cells, and more in general on the search of new candidate materials for applications in the domain of energy production, storage and saving.
Silvana Botti obtained her PhD from the University of Pavia in Italy. She worked then at the Ecole Polytechnique in Paris, first as a Marie Curie Fellow and then, since 2004, as a Research Scientist of the French National Center for Research (CNRS). In 2008 she moved to the University of Lyon, where she habilitated in 2010. Since October 2014, she holds the Chair of Theoretical Physics/Solid State Physics at the Friedrich-Schiller University of Jena. She is member of the European Theoretical Spectroscopy Facility (ETSF) (www.etsf.eu) and she has a network of theoretical and experimental collaborators in Germany and outside Germany.

www.ico.uni-jena.de/condensed_matter_theory.html

3.2. Professor for Theoretical Physics(W3)/ Solid State Optics

Prof. Dr. Ulf Peschel
Professor of Theoretical Physics / Solid StateOptics
Institute of Solid State Theory and Optics
Appointed in October 2014



Ulf Peschel has been working in the field of optics for more than 20 years, both theoretically and experimentally with a focus on classical and integrated optics, nanophotonics, nonlinear dynamics and electromagnetic modelling. He successfully transferred many concepts of solid-state physics to optics and contributed to the first experimental realization of one- and two-dimensional optical Bloch-oscillations and of Zener tunneling in waveguide arrays. Together with his group "Nonlinear Optics and Nanophotonics (NONA)" he for the first time realized a discrete system in the time domain and observed discrete temporal solitons in an optical transmission line. A recent effect, which he predicted and his group finally experimentally observed, is the so-called diametric drive. It consists of a nonlinear bound state formed by normal and anomalous dispersive waves, which self-accelerates and constantly shifts in frequency. Ulf Peschel's current activities focus on optical systems with balanced gain and loss with parity-time (PT) symmetry. His group realized the first PT-symmetric optical system with transverse degrees of freedom thus allowing for the investigation of unidirectional invisibility and of soliton formation in the presence of gain and loss. Ulf Peschel's research in the field of nanophotonics is concentrated on metamaterials, photonic crystals and plasmonic structures. Together with his co-workers he developed new methods to characterize highly focused beams and explored the optical response of dielectric-plasmonic crystals. For the first time his group realized the excitation of sub wavelength plasmonic gap-waveguides and of plasmonic nano-circuitries via nanoantennas.

Ulf Peschel studied physics at the Friedrich-Schiller-University Jena and finished his PhD thesis entitled "Nonlinear Optics in Highly Resonant Semiconductor Structures" in 1994. From 1998 to 1999, he stayed as an Honorary Research Fellow at the University of Glasgow, where he investigated the dynamics and nonlinear response of optical discrete systems while closely cooperating with experimentalists. After returning to Jena he finished his habilitation entitled "Localized Structures in Nonlinear Optics" in 2001. In 2005 he moved to Erlangen, where he was appointed to a W2 Professor for Experimental Physics at the Friedrich-Alexander-University Erlangen-Nuremberg. Together with his group "Nonlinear Optics and Nanophotonics (NONA)" he dealt with various experimental and theoretical problems of nanophotonics, plasmonics, optical communication and electromagnetic modelling. He finally moved back to the Friedrich-Schiller-University of Jena in 2014, where he became a Chair holder at the Institute of Solid State Theory and Optics (W3).

4. General Information

4. 1. Contact and Structure of the Faculty

Mailing address:

Friedrich-Schiller-Universität Jena
Faculty of Physics and Astronomy
Max-Wien-Platz 1
07743 Jena

Tel.: (03641) 9 47000
Fax: (03641) 9 47002
Mail: dekanat-paf@uni-jena.de
http://www.physik.uni-jena.de

Dean's Office

Dean: Prof. Dr. Gerhard G. Paulus
Institute of Optics and Quantum Electronics
Chair for Nonlinear Optics
Tel. 03641/ 947000 or 947200

Vice Dean: Prof. Dr. Thomas Pertsch
Institute of Applied Physics
Professor for Applied Physics/Nanooptics
Tel. 03641/ 9 47000 or 9 47840

Dean of Students: Prof. Dr. Karl-Heinz Lotze
Research Group -Teaching Methodology in Physics and Astronomy
Docentship for Teaching Methodology in Physics and Astronomy
Tel. 03641/ 9 47010 or 9 47490

Faculty of Physics and Astronomy

Dean's Office

Dean: Prof. Paulus
Vice Dean: Prof. Pertsch
Dean of Students: Prof. Lotze

Scientific Workshops

Director: A. Winnefeld
Assistent: H. Wöhl

Workshops

Elektronics Workshop:	R. Bark
Equipment Service:	P. Engelhardt
Electrical Workshop:	A. Rose
Precision Engineering 1:	B. Klumbies
Precision Engineering 2:	P. Hanse
Metal Working/Welding:	M. Krauspe
Construction:	S. Laukner

Institute of Astrophysics and University Observatory
Director: Prof. Neuhäuser

Institute of Applied Optics
Director: Prof. Kowarschik

Institute of Applied Physics
Director: Prof. Tünnermann

Institute of Solid State Physics
Director: Prof. Fritz

Institute of Solid State Theory and Optics
Interim Director: Prof. Peschel

Otto Schott Institute of Materials Research
Director: Prof. Rettenmayr

Institute of Optics and Quantum Electronics
Director: Prof. Spielmann

Institute of Theoretical Physics
Director: Prof. Wipf

Research Group - Teaching Methodology in Physics and Astronomy
Director: Prof. Lotze

CFC/TR 7 Gravitational Wave Astronomy
Spokesman: Prof. Brügmann

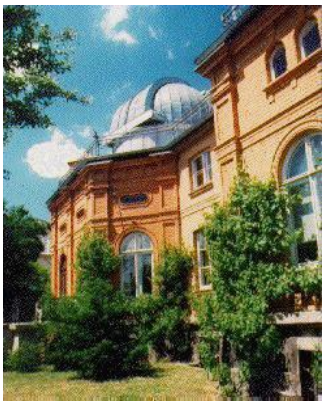
Post Graduate Research Training Group - Quantum- and Gravitational Fields
Spokesman: Prof. Wipf

Abbe Center of Photonics
Spokesman: Prof. Pertsch

Abbe School of Photonics
Spokesman: Prof. Pertsch

Institutes

Astrophysical Institute and University Observatory



Director: Prof. Dr. Ralph Neuhäuser

Mailing address and location:
Friedrich-Schiller-Universität Jena
Astrophysikalisches Institut und Universitätssternwarte
Schillergässchen 2
07745 Jena

Tel.: (03641) 947501
Fax: (03641) 947502
e-mail: moni@astro.uni-jena.de
http://www.astro.uni-jena.de

Institute of Applied Optics

Director: Prof. Dr. Richard Kowarschik

Mailing address:
Friedrich-Schiller-Universität Jena
Institut für Angewandte Optik
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Institut für Angewandte Optik
Fröbelstieg 1
07743 Jena

Tel.: (03641) 947651
Fax: (03641) 947652
e-mail: iao.physik@uni-jena.de
http://www.iao.uni-jena.de

Institute of Applied Physics

Director: Prof. Dr. Andreas Tünnermann

Mailing address:
Friedrich-Schiller-Universität Jena
Institut für Angewandte Physik
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Institut für Angewandte Physik
Albert-Einstein-Str. 15
07745 Jena

Tel.: (03641) 94 78 00
Fax: (03641) 94 78 02
e-mail: sabine.rockstroh@uni-jena.de
http://www.iap.uni-jena.de

Institute of Solid State Physics

DIrector: Prof. Dr. Torsten Fritz

Mailing address:
Friedrich-Schiller-Universität Jena
Institut für Festkörperphysik
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Institut für Festkörperphysik
Helmholtzweg 3 / 5
07743 Jena

Tel.: (03641) 94 7400
Fax: (03641) 94 7402
e-mail: torsten.fritz@uni-jena.de
http://www.ifk.uni-jena.de/

Institute of Solid State Theory and Optics

Interim Director: Prof. Dr. Ulf Peschel

Mailing address:
Friedrich-Schiller-Universität Jena
Institut für Festkörpertheorie und -optik
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Institut für Festkörpertheorie und -optik
Fröbelstieg 1
07743 Jena

Tel.: (03641) 9 47150
Fax: (03641) 9 47152
e-mail: ulf.peschel@uni-jena.de
http://www.ico.uni-jena.de

Otto Schott Institute of Materials Research
(interdepartmental Institute, section Löbdergraben 32)

Director: Prof. Dr. Markus Rettenmayr

Mailing address and location:
Friedrich-Schiller-Universität Jena
Otto-Schott-Institut für Materialforschung (OSIM)
Löbdergraben 32
07743 Jena

Tel.: (03641) 947 790
Fax: (03641) 947 792
e-mail: m.rettenmayr@uni-jena.de
http://www.osim.uni-jena.de

Institute of Optics and Quantum Electronics

Director: Prof. Dr. Christian Spielmann

Mailing address and location:
Friedrich-Schiller-Universität Jena
Institut für Optik und Quantenelektronik
Max-Wien-Platz 1
07743 Jena

Tel.: (03641) 947201
Fax: (03641) 947202
e-mail: sekretariat-ioq@uni-jena.de
http://www.ioq.uni-jena.de

Institute of Theoretical Physics

Director: Prof. Dr. Andreas Wipf

Mailing address:
Friedrich-Schiller-Universität Jena
Theoretisch-Physikalisches Institut
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Theoretisch-Physikalisches Institut
Fröbelstieg 1
07743 Jena

Tel.: (03641) 94 71 00
Fax: (03641) 94 71 02
e-mail: lisann.schmidt@uni-jena.de
http://www.tpi.uni-jena.de/

Research Group - Teaching Methodology in Physics and Astronomy

Director: Prof. Dr. Karl-Heinz Lotze

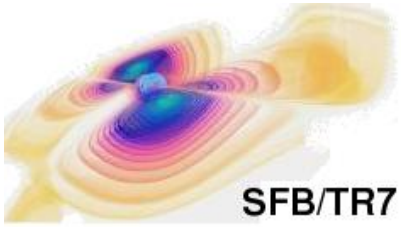
Mailing address:
Friedrich-Schiller-Universität Jena
AG Fachdidaktik der Physik & Astronomie
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
AG Fachdidaktik der Physik & Astronomie
August-Bebel-Str. 4
07743 Jena

Tel.: (03641) 947491
Fax: (03641) 947492
e-mail: kh.lotze@uni-jena.de
http:// www.uni-jena.de/didaktik_physik.html

Collaborative Research Centre /Transregio 7 „Gravitational Wave Astronomy “

Spokesman: Prof. Dr. Bernd Brügmann



Mailing address:
SFB/TR 7 Gravitationswellenastronomie
Zentrale Verwaltung
an der Friedrich-Schiller-Universität Jena
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Theoretisch-Physikalisches Institut
Fröbelstieg 1
07743 Jena

Tel.: (03641) 947111
Fax: (03641) 947102
e-mail: renate.wagner@uni-jena.de
http://wwwsfb.tpi.uni-jena.de/

Abbe Center of Photonics

Director: Prof. Dr. Thomas Pertsch

Mailing address:
Abbe Center of Photonics
Physikalisch-Astronomische Fakultät
07743 Jena

Location:
Abbe Center Beutenberg
Hans-Knöll-Str. 1
07745 Jena

Tel.: +49 3641 947 963
Fax: +49 3641 947 962
e-mail: christian.helgert@uni-jena.de
http://www.acp.uni-jena.de

Abbe School of Photonics

Spokesman: Prof. Dr. Thomas Pertsch

Mailing address:
Abbe School of Photonics
Physikalisch-Astronomische Fakultät
Max-Wien-Platz 1
07743 Jena
Germany

Location:
Abbe School of Photonics
Helmholtzweg 4
07743 Jena

Tel.: +49 3641 947 960
Fax: +49 3641 947 962
e-mail: master-asp@uni-jena.de
http://www.asp.uni-jena.de

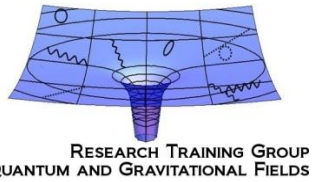
Research Training Group GRK 1523/1 „Quantum and Gravitational Fields"

Spokesman: Prof. Dr. Andreas Wipf

Mailing address:
GRK 1523/1 Quanten- und Gravitationsfelder
Max-Wien-Platz 1
07743 Jena

Location:
Friedrich-Schiller-Universität Jena
Theoretisch-Physikalisches Institut
Fröbelstieg 1
07743 Jena

Tel.: (03641) 947101
Fax: (03641) 947102
e-mail: lisann.schmidt@tpi.uni-jena.de
http://www.qgf@uni-jena.de



Non-university institutes with shared appointed professors at our faculty

Leibniz Institute of Photonic Technology

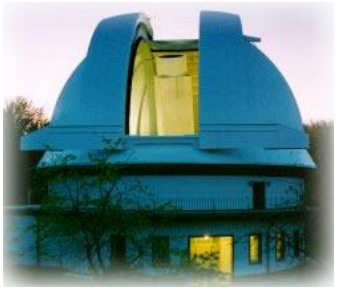
Director: Prof. Dr. Jürgen Popp

Albert-Einstein-Str. 9
07745 Jena
Tel.: (03641) 206 020
Fax: (03641) 206 099
e-mail: juergen.popp@ipht-jena.de
http://www.ipht-jena.de

Thüringer Landessternwarte Tautenburg (Observatory)

Director: Prof. Dr. Artie Hatzes

Sternwarte 5
07778 Tautenburg
Tel.: (036427) 863-0
Fax: (036427) 863-29
e-mail: artie@tls-tautenburg.de
http://www.tls-tautenburg.de

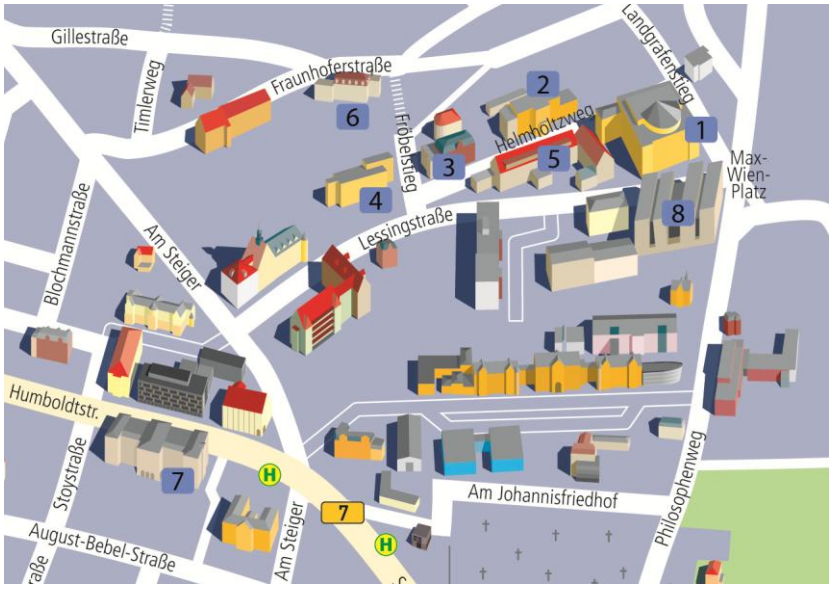


Helmholtz Institute Jena

Director: Prof. Dr. Thomas Stöhlker

Fröbelstieg 3
07743 Jena
Tel.: (03641) 947601
Fax: (03641) 947602
e-mail: sekretariat-hi-jena@gsi.de
http://www.hi-jena.de

General view of the physical institutes and laboratories near Max-Wien-Platz



1 Max-Wien-Platz 1
- Dean's office
- Office for Student Affairs
- Institute of Optics and Quantum Electronics

2 Helmholtzweg 5
- Institute of Solid State Physics

3 Helmholtzweg 3
- Institute of Solid State Physics
- Max Planck Research group Laboratory Astrophysics

4 Fröbelstieg 1
- Institute of Applied Optics
- Institute of Solid State Theory and Optics (Chair Condensed Matter Theory)
- Institute of Theoretical Physics

5 Helmholtzweg 4
- Institute of Theoretical Physics
- Computer pool of the faculty
- Institute of Solid State Theory and Optics (Chair Solid State Optics)
- Abbe School of Photonics

6 Fröbelstieg 3
- Institute of Optics and Quantum Electronics / POLARIS - Labs
- Helmholtz Institute Jena

7 August-Bebel-Str. 4
- Research Group - Teaching Methodology of Physics and Astronomy

8 Philosophenweg 7
- Institute of Solid State Physics

4. 2. Staff

Faculty of Physics and Astronomy (altogether)*

* all data are given in full-time equivalents per annum

Public budget funded:	**21.955**	**university professors**
	5.75	**university professors at external institutes**
	1	**assistant professor**
	4	**docents/adjunct professors**
	47.735	**research associates**
	105.852	**technical staff members**
Third-party funded:	**2**	**university professors**
	3.083	**assistant professors**
	195.685	**research associates (including fellowship holders)**
	18.53	**technical staff members**

Astrophysical Institute and University Observatory

public budget funded:	2	university professors	Prof. Dr. Ralph Neuhäuser Prof. Dr. Alexander Krivov
	4.75	research associates	
	3.25	technical staff members	
third-party funded:	4.5	research associates	
	0.25	technical staff members	

Institute of Applied Optics

public budget funded:	1.08	university professors	Prof. Dr. Richard Kowarschik Prof. Dr. Alexander Heisterkamp (up to 2/2014)
	3.6	research associates	
	5.25	technical staff members (thereof 0.75 in Advanced practical training)	
third-party funded:	1.6	research associates	

Institute of Applied Physics

Public budget funded:	3.0	university professors	Prof. Thomas Pertsch Prof. Andreas Tünnermann Prof. Frank Wyrowski
	5.2	research associates	
	9.6	technical staff members	
Third-party funded:	1.0	university professors	Prof. Stefan Nolte
	1.0	endowed professorship	Prof. Herbert Gross
	2.0	assistant professors	Jun.-Prof. Jens Limpert Jun.-Prof. Alexander Szameit
	98.0	research associates incl. fellowship holders	
	4.8	technical staff members	

Institute of Solid State Physics

public budget funded:	3	university professors	Prof. Dr. Carsten Ronning Prof. Dr. Torsten Fritz Prof. Dr. Paul Seidel
	2	adjunct professors	Prof. Dr. Frank Schmidl Prof. Dr. Elke Wendler
	5.19	research associates	
	1	research associate only for teaching	
	12.9	technical staff members	
	2	technical staff members university funded (He liquifier)	
third-party funded:	16.53	research associates	
	0.6	technical staff members	

Institute of Solid State Theory and Optics

public budget funded:	1.75	university professors	Prof. Dr. Friedhelm Bechstedt (up to 9/2014) Prof. Dr. Falk Lederer (0,25 up to 9/2014) Prof. Dr. Silvana Botti Prof. Dr. Ulf Peschel (both since 9/2014)
	2.18	research associates	
	2.75	technical staff members (incl. computer pool)	
third-party funded:	0.083	assistant professors	Prof. Dr. Stefan Skupin
	8.375	research associates and Ph.D. students	

Otto Schott Institute of Materials Research, section Löbdergraben 32

public budget funded:	4.125	university professors	Prof. Dr. Markus Rettenmayr Prof. Dr. Klaus D. Jandt Prof. Dr. Frank A. Müller Prof. Dr. Olivier Guillon (up to 2/2014) Prof. Dr. Marek Sierka
	8.48	research associates	
	11.75	technical staff members	
third-party funded:	19.38	research associates incl. fellowship holders	
	0.5	technical staff members	

Institute of Optics and Quantum Electronics

public budget funded:	3	university professors	Prof. Dr. Gerhard Paulus Prof. Dr. Christian Spielmann Prof. Dr. Malte Kaluza
	7.85	research associates	
	12.18	technical staff members	
	4.75	technical staff members for teaching	

third-party funded:	1.75	university professors at HI Jena	Prof. Dr. Thomas Stöhlker Prof. Dr. Matt Zepf (since 4/2014)
	1	Carl Zeiss assistent professor	Jun.-Prof. Dr. Adrian Pfeiffer
	32.41	research associates incl. fellowship holders	
	3.63	technical staff members	

Institute of Theoretical Physics

public budget funded:	4	university professors	Prof. Dr. Marcus Ansorg Prof. Dr. Bernd Brügmann Prof. Dr. Holger Gies Prof. Dr. Andreas Wipf
	1	assistent professor	Prof. Dr. Martin Ammon
	1	docent	apl. Prof. Dr. Reinhard Meinel
	5,66	research associates	
	2	technical staff members	
third-party funded:	1	university professors at HI Jena	Prof. Dr. Stephan Fritzsche
	13.89	research associates (thereof 6.21 SFB/TR 7 and 6.21 GRK 1523/1)	
	1.5	technical staff (1 SFB/TR 7 and 0,5 GRK 1523/1)	

Research Group - Teaching Methodology in Physics and Astronomy

public budget funded:	1	docent	apl. Prof. Dr. Karl-Heinz Lotze
	1.5	research associates	
	0.75	technical staff members	

Scientific Workshops, Teaching Areas and Dean's Office

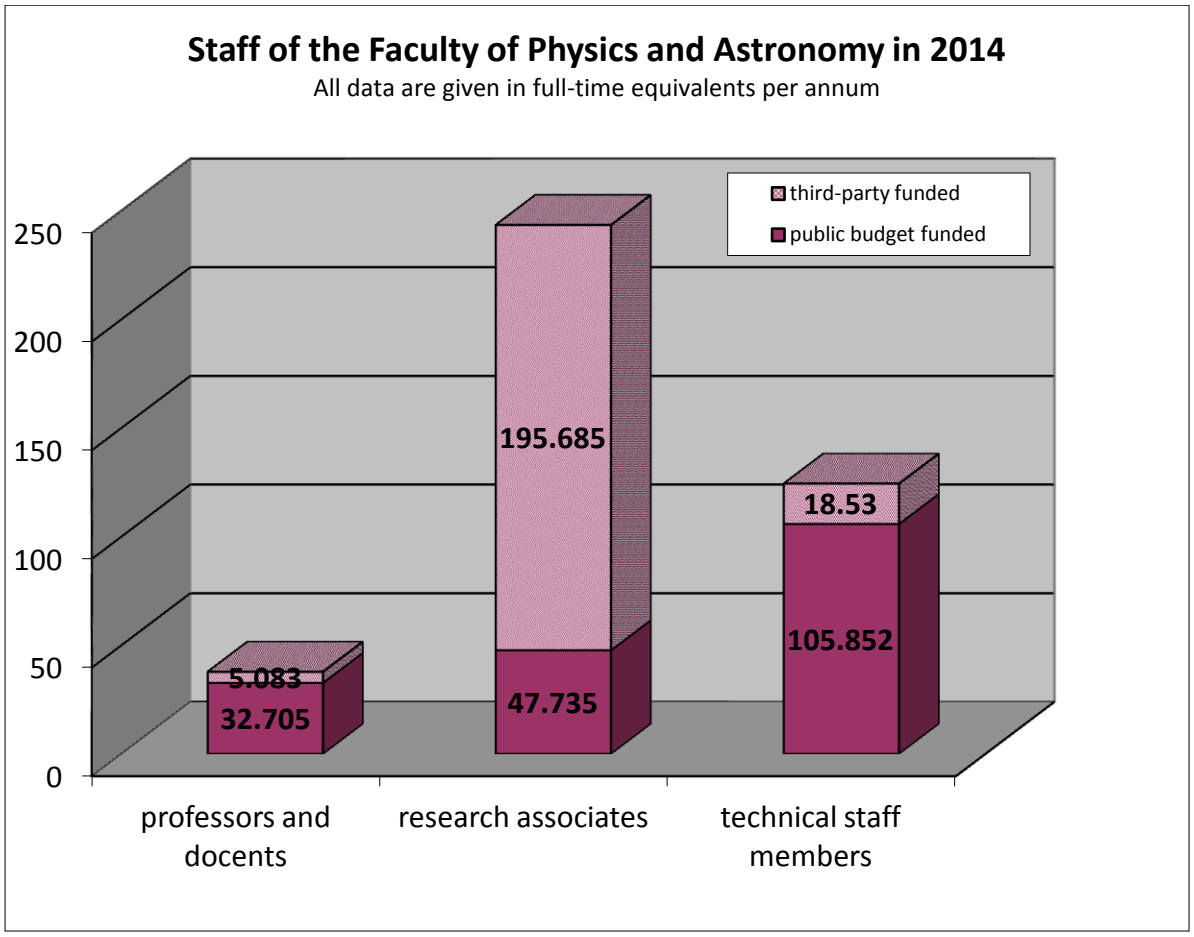
public budget funded:	2.225	research associates (functional positions)
	38.6725	technical staff members
third-party funded:	1	research associates (ProQualität Lehre)
	1.25	technical staff members

Leibniz Institute of Photonic Technology

public budget funded: (by university)	2	university professors (with reduced teaching responsibilities)	Prof. Dr. Hartmut Bartelt Prof. Dr. Markus Schmidt

Thüringer Landessternwarte Tautenburg (Karl-Schwarzschild-Observatorium)

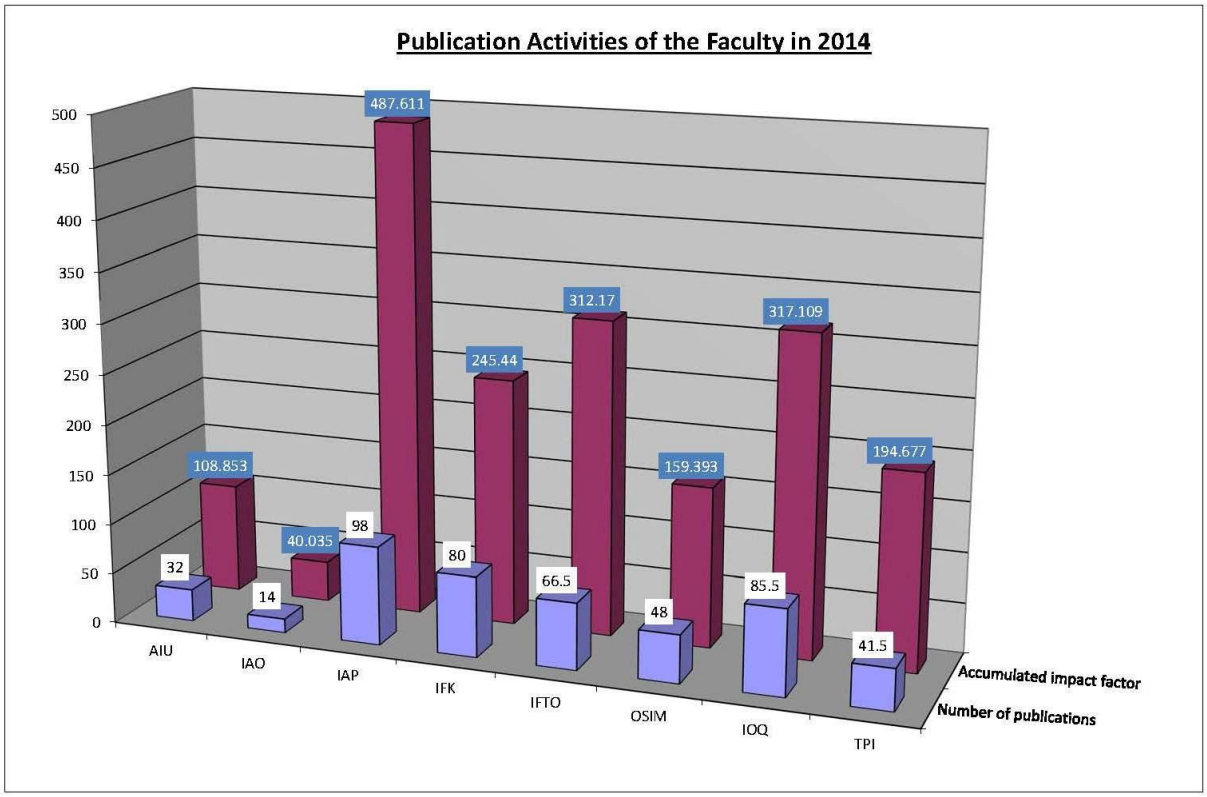
public budget funded: (by university)	1	university professors (with reduced teaching responsibilities)	Prof. Dr. Artie Hatzes

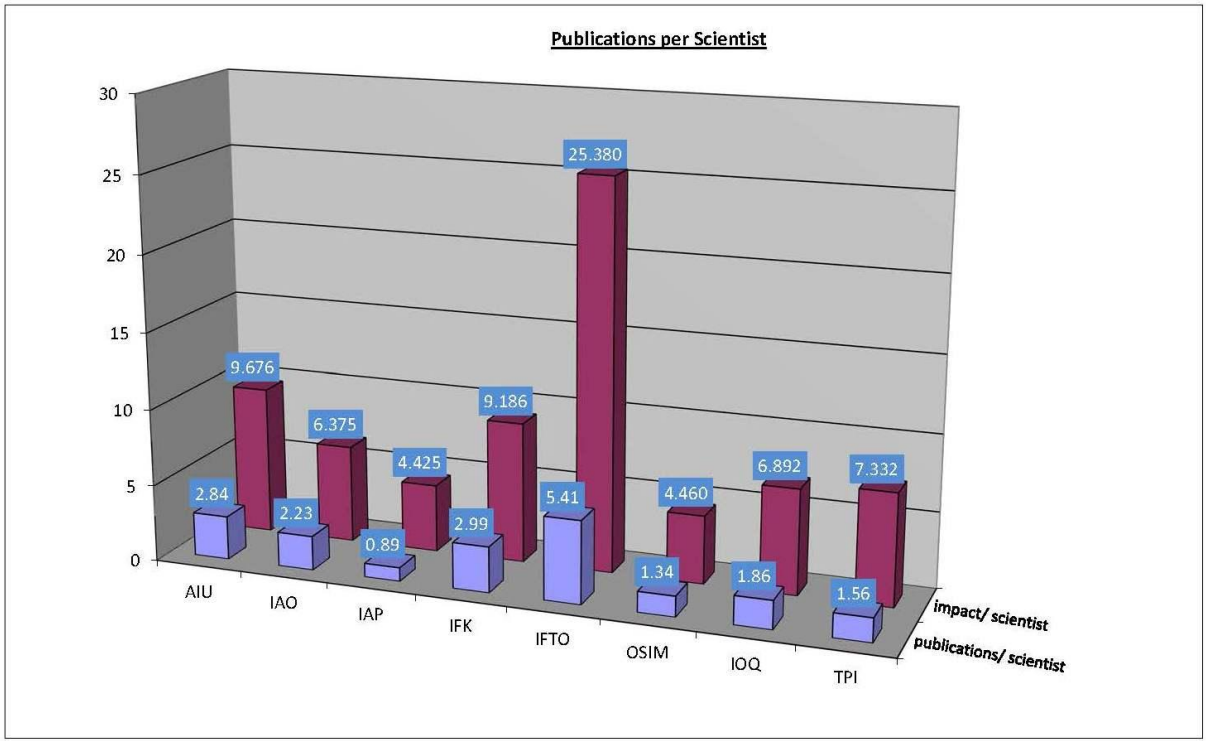


4. 3. Publications and Patents

Some publications were written by scientists from different institutes of the faculty. For this reason a fractional number of publications can arise.

Institute	**Number of Publications**	**Accumulated Impact Factor**	**Publications per Scientist**	**Impact per Scientist**
Institute of Astrophysics & University Observatory (AIU)	32	108.853	2.84	9.676
Institute of Applied Optics (IAO)	14	40.035	2.23	6.375
Institute of Applied Physics (IAP)	98	487.611	0.93	4.399
Institute of Solid State Physics (IFK)	80	245.44	2.99	9.186
Institute of Solid State Theory and Optics (IFTO)	66.5	312.17	5.41	25.38
Otto Schott Institute of Materials Research (OSIM)	48	159.393	1.34	4.460
Institute of Optics & Quantum Electronics (IOQ)	85.5	317.109	1.86	6.892
Institute of Theoretical Physics (TPI)	41.5	194.677	1.56	7.332
Faculty as a whole	**465.5**	**1865.288**	**2.39**	**9.216**



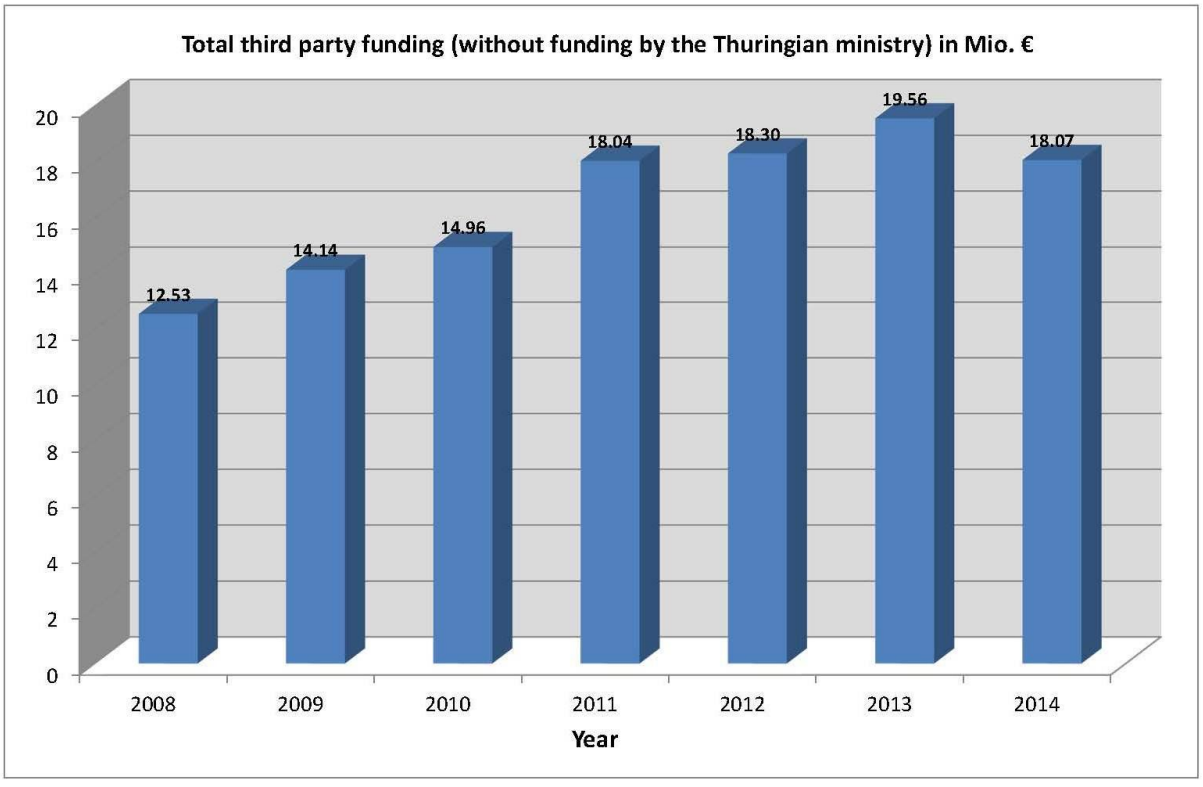


Furthermore, the number of 15 patent applications and 13 patent assignations in 2014 is remarkably. Most of the patent applications (11) were filed by the Institute of Applied Physics.

4. 4. *Third-party funding*

The following table shows the financial means collected by third-party funding in 2014. The real value of third-party funded means according to the data of the intitutes is higher, because not all of the means were covered by accounts of the university (i.e. nonmonetary benefits, counting and measurement time in largescale Data Centers or large research establishments, personal grants for travelling and others).

Institute	DFG	EU	others	Thuringian Ministry (TMBJS)	Sum of the institution
Deans Office			103.286 €		103.286 €
Abbe School of Photonics			1.142.999 €		1.142.999 €
AIU	440.707 €		12.849 €		453.556 €
IAO	977 €		86.985 €	16.577 €	104.539 €
IAP	687.240 €	527.948 €	7.586.027 €	156.112 €	8.957.327 €
IFK	737.338 €	49.107 €	453.088 €		1.239.533 €
IFTO	295.956 €		198.867 €		494.823 €
OSIM	303.071 €	133.501 €	1.250.181 €	324 €	1.687.077 €
IOQ	1.184.426 €		1.042.739 €		2.227.165 €
TPI	1.793.024 €		37.276 €		1.830.300 €
PAD			2.450 €		2.450 €
Faculty as a whole	**5.442.739 €**	**710.556 €**	**11.916.747 €**	**173.013 €**	**18.243.055 €**



5. Teaching

5. 1. Teaching report of the Faculty of Physics and Astronomy

The range of courses offered by the Faculty clearly reflects its main research areas and lines of tradition. A higher-than-average breadth of high-quality optics and astronomy courses are offered. Theoretical physics is focused on gravitation and quantum theory and participates in both theoretical and experimental projects related to basics-oriented research and teaching, as evidenced by the programmes of the Postgraduate College GRK 1523 „Quantum and gravitational fields“ and the SFB/TR 7 „Gravitational wave astronomy“. In spite of this specialized profile, the Faculty guarantees every student a sound fundamental training throughout the breadth of physics.

The study of physics in Jena is well reputed for both the quality of its courses and for its study conditions; secondary school graduates and first-year students frequently refer to the relevant rankings. Still, the number of first-year students in the bachelor of physics programme (about 33) did not attain the high level of the years 2010 and 2011; rather, it corroborated the trend of the previous year. The decline is mainly due to two three reasons:

1. The abolition of tuition fees in most German federal states has induced more students, especially from the former western states, to study just there. Thuringia has lost its (almost) unique selling proposition of „no tuition fees“.

2. The increasingly deteriorating preparation of secondary school students for studying science subjects has led to school leavers feeling insufficiently qualified and lacking confidence in their capabilities for a study of physics. This is due not only to the reduction in science lessons but also to the uncomprehending, mechanical solving of problems with programmed pocket calculators in mathematics.

3. Taking into account that circa 50 percent of the students who enrol at our faculty come from the nearby regions of Thuringia, Saxonia and Saxonia Anhalt, the trend of the last years clearly reflects the demographic develeopment 18 or 19 years ago. As a consequence of that develeopment the number of secondary-school öeavers continuously decreased during the last years.

Finally, the expectations regarding first-year student figures should not be measured with the yardstick of the years 2010 and 2011, as then, the reduction of secondary school years from nine to eight in some German states led to two age groups leaving school simultaneously; moreover, military service was suspended.

Student figures in the “Materials sciences” bachelor programme, mainly carried out by the Otto Schott Institute of Materials Research jointly with the Ilmenau University of Technology, have evened out at 25 on average.

Besides the Bachelor programme in physics there is, traditionally, a programme for physics as a teaching profession. Here, astronomy can be selected as a minor or supplementary subject. The programme for training physics teachers enjoys persistent popularity, as evidenced by 26 enrolments in the winter 2014/2015 semester. Experience shows that not all students who enrolled actually turn up for the studies, so that one can assume a first-year student number between 25 and 30 for 40 enrolments. In designing the teacher training programme, the beginning modularization and the Jena model of teacher training led to substantial changes, which we have taken into account by revising and modifying the training in physics as well as in teaching methodology. According to the Jena model, the teacher training programme includes a practical semester as an essential constituent, which is of vital importance for gaining experience and a realistic idea of everyday school life. Together with other influences, however, it does not motivate students for their further physics courses. Not seldom, it creates doubts among students about the right amount of scientific knowledge to be imparted in a teacher training programme. It becomes increasingly apparent how prob-

lematic it is to let students in the teacher training programme freely decide upon the combination of subjects. Whoever studies physics for the teaching profession is urgently advised to combine their major subject with mathematics.

Together with the Faculty of Mathematics and Computer Sciences, we have managed training in mathematics to be better tailored to the requirements of the study of physics. Now, topics important for the basic physics courses (e.g., differential equations, theory of functions) are treated early in the mathematics courses. In addition to the mathematics courses run by the Faculty of Mathematics and Computer Sciences, first-year students of physics also attend a preparatory course in mathematics and a course on mathematical methods in physics, both held by the Faculty of Physics and Astronomy. For a number of years, such courses have been attended successfully and with keen commitment by students in their senior years; they are a striking example of how students of different semesters work together and learn from each other. The same can fortunately be said also of the tutorials in many subjects, which are led by senior students and are very popular as well as effective, so that they ought to be made a permanent form of learning.

In preparing the documents for the accreditation of the physics and materials science programmes, which was granted in 2009 for five years, we attached special importance to keeping the programmes attractive with updated, modern contents, while maintaining the high level of training. This is evident, e.g., by the greater weight lent to the Faculty's research focuses in the Master programme, both in the compulsory and optional courses, and by better coordination of the courses of a module with regard to contents and time. In the teacher training programmes we particularly saw to it that the modules were better adapted to the requirements of the teaching profession, such as by bringing the start of the methodology training forward to the third semester and adding another methodology semester in preparation to the state examination. Thus, the share of methodology training relative to the science studies is now in agreement with the guidelines recommended by the German Physical Society. Finally, we upgraded the practical seminar „School experiments in physics" by increasing the number of credit points awarded to this course. Nevertheless, in late 2014 we started, together with representatives of the teacher students, a discussion in working groups, aimed at a further improvement of their studies. In particular there is a need for more time to be devoted to optics and thermodynamics as part of experimental-physics courses. Another topic are the specific needs and interests of middle-school-teacher students as compared to those of high-school-teacher students. First decisions in this direction will be made in 2015.

Now as before we believe that the Bachelor is not a degree that really qualifies for a profession in physics or materials science. Rather, we regard it as a first stage on the way to a Master of Science, which all students should aim at, disregarding rare exceptions. The Faculty first matriculated students in a Master programme for the winter 2010/11 semester. The development of the number of students transferred to the Master programme in the years after can be seen in the diagrams attached. None of the Bachelor graduates finished their studies with the degree of a Bachelor of Science in Physics, although part of our Bachelor graduates started their Master studies at other universities. This was compensated by about as many Bachelor graduates who came to Jena. The specialization subjects of astronomy/astrophysics and gravitational and quantum theory have proved particularly attractive, followed by (nano-)optics. For the subject of Materials Science, too, a Master programme jointly run by the Universities of Jena and Ilmenau was first started in the winter 2010/11 semester. It is to be expected that the Otto Schott Institute of Materials Research founded in October 2013 will add further impetus to this programme.

The experience gathered so far with modularization and the introduction of the Bachelor programmes clearly shows that, compared to the classical diplom programme, the amount of bureaucratic paperwork needed to control the modular system has increased dramatically and would not have been manageable without the provision of added administration capacities. Regrettably, this has boosted the tendency among many students to judge their study by formal rather than content-related aspects, which is not least due to the increased examination burden. For example, it is very

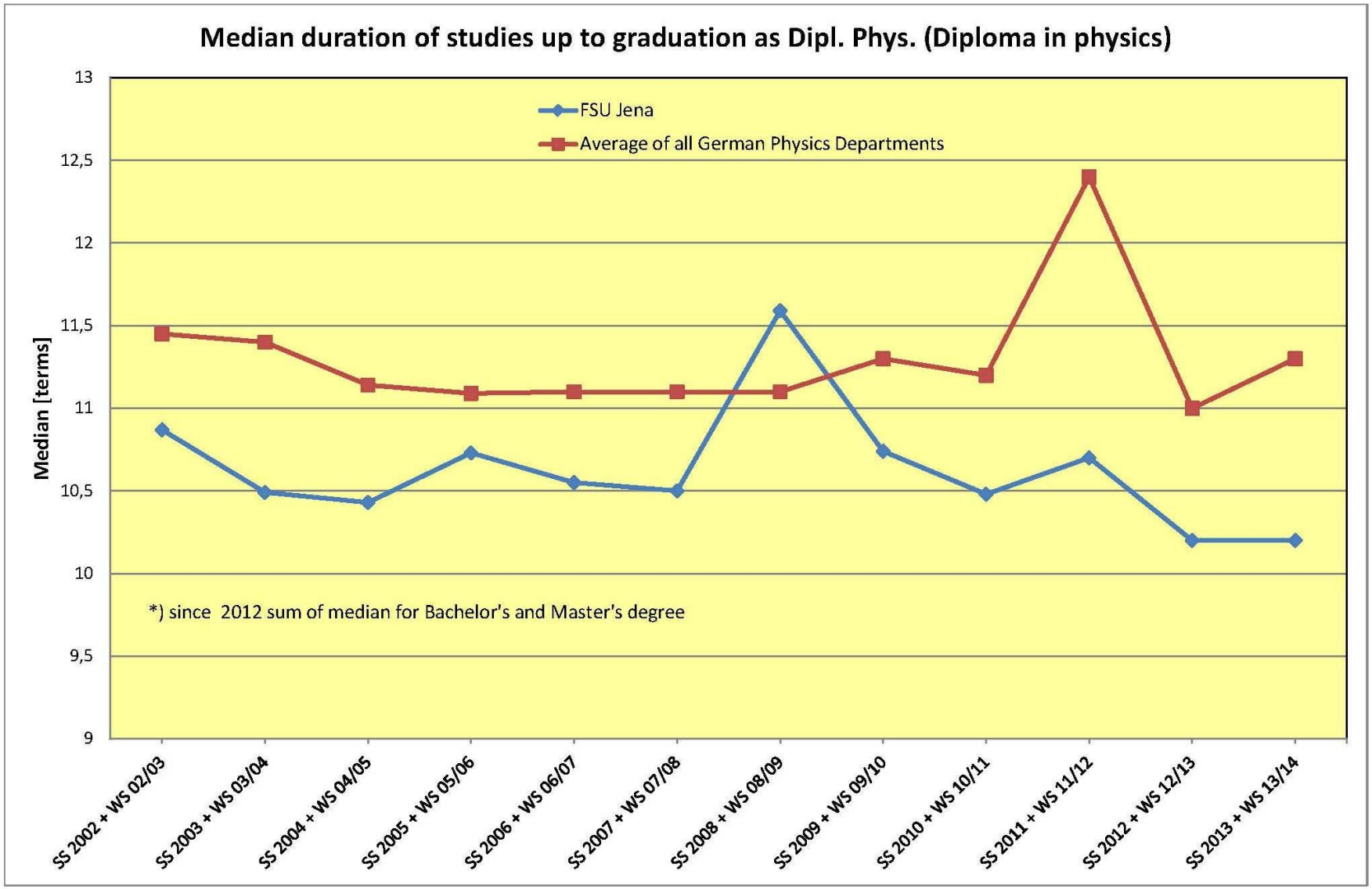
difficult to bring students to attend courses that would enhance their general education, unless they can earn credits by attending. Further, we have to see that students changing to another university face difficulties in getting their achievements at University A acknowledged by University B, because it turns out that study programs are not really comparable on a national level, with regard to contents as well as credits earned. On the other hand, study semesters abroad have got under way, with North European countries (Norway and Sweden) and Spain being particularly popular. Recognition of achievements across borders, although possible almost without exception, is by no means easier than within Germany. In addition to the continuation of one's study of physics, encounter with the language, culture and the political conditions in the host country is a material motivation.

Even before the system accreditation forthcoming in 2014, revising the curricula and the study and exam regulations was an ongoing task. For example, on the students' request, the share of oral examinations relative to the proctored written ones was increased. Also, the Bachelor of Science and Master of Science in Physics programmes were revised to offer more elective courses and reduce redundancy in the compulsory part.

One of the important activities of the Faculty in the realm of teaching since the end of 2013 was the preparation for student enrolment for the summer 2014 semester. Over a number of years, it will be examined whether an appreciable number of students will register for the summer semester. They will be offered a full-scale, independent Bachelor of Science in Physics programme (transfer to the Master programme is possible even in the current summer semester). This programme provides for the students to get their own, independent course in experimental physics. Their integration in the basic practical course is no problem as far as contents are concerned. The students attend theoretical physics lectures together with those studying for the teaching profession, whose theoretical lectures are shifted by one semester relative to the regular Bachelor program. With the colleagues of the Faculty of Mathematics and Computer Sciences we agreed, at least for 2014, on how the said students can be offered adequate training in mathematics.

Table: Median duration of studies up to graduation as Dipl.Phys. (Diploma in physics)

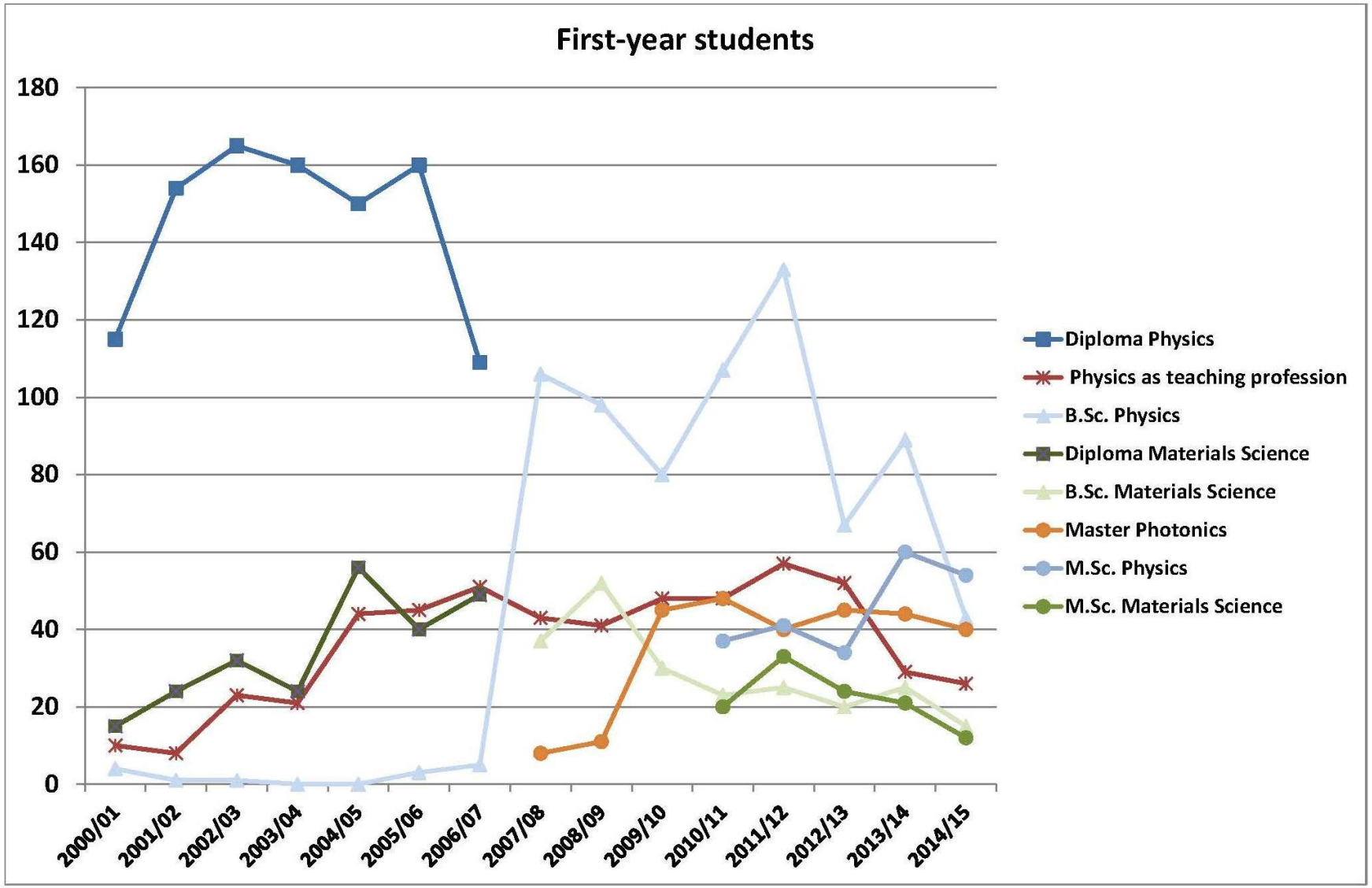
Period	Median	Average Grade
SS 2002 + WS 2002/2003	10.87	1.49
SS 2003 + WS 2003/2004	10.49	1.58
SS 2004 + WS 2004/2005	10.43	1.43
SS 2005 + WS 2005/2006	10.73	1.51
SS 2006 + WS 2006/2007	10.55	1.67
SS 2007 + WS 2007/2008	10.50	1.46
SS 2008 + WS 2008/2009	11.59	1.58
SS 2009 + WS 2009/2010	10.74	1.92
SS 2010 + WS 2010/2011	10.48	1.50 1.60 (modularized)
SS 2011 + WS 2011/12	10.70	1.50 1.37 (modularized)
SS 2012 + WS 2012/13	11.4 6.00 (B.Sc.) 4.20 (M.Sc.)	1.40 2.09 (B.Sc.)
SS 2013 + WS 2013/14	15.92 6.00 (B.Sc.) 4.20 (M.Sc.)	2.1 2.1 (B.Sc.) 1.5 (M.Sc.)


Median duration of studies up to graduation as Dipl. Phys. (Diploma in physics)
Median [terms]
13
12,5
12
11,5
11
10,5
10
9,5
9
FSU Jena
Average of all German Physics Departments
*) since 2012 sum of median for Bachelor's and Master's degree
SS 2002 + WS 02/03
SS 2003 + WS 03/04
SS 2004 + WS 04/05
SS 2005 + WS 05/06
SS 2006 + WS 06/07
SS 2007 + WS 07/08
SS 2008 + WS 08/09
SS 2009 + WS 09/10
SS 2010 + WS 10/11
SS 2011 + WS 11/12
SS 2012 + WS 12/13
SS 2013 + WS 13/14

First-year students in the period 2000 – 2014

Study courses Physics, Physics as teaching profession, Materials Science and Master Photonics

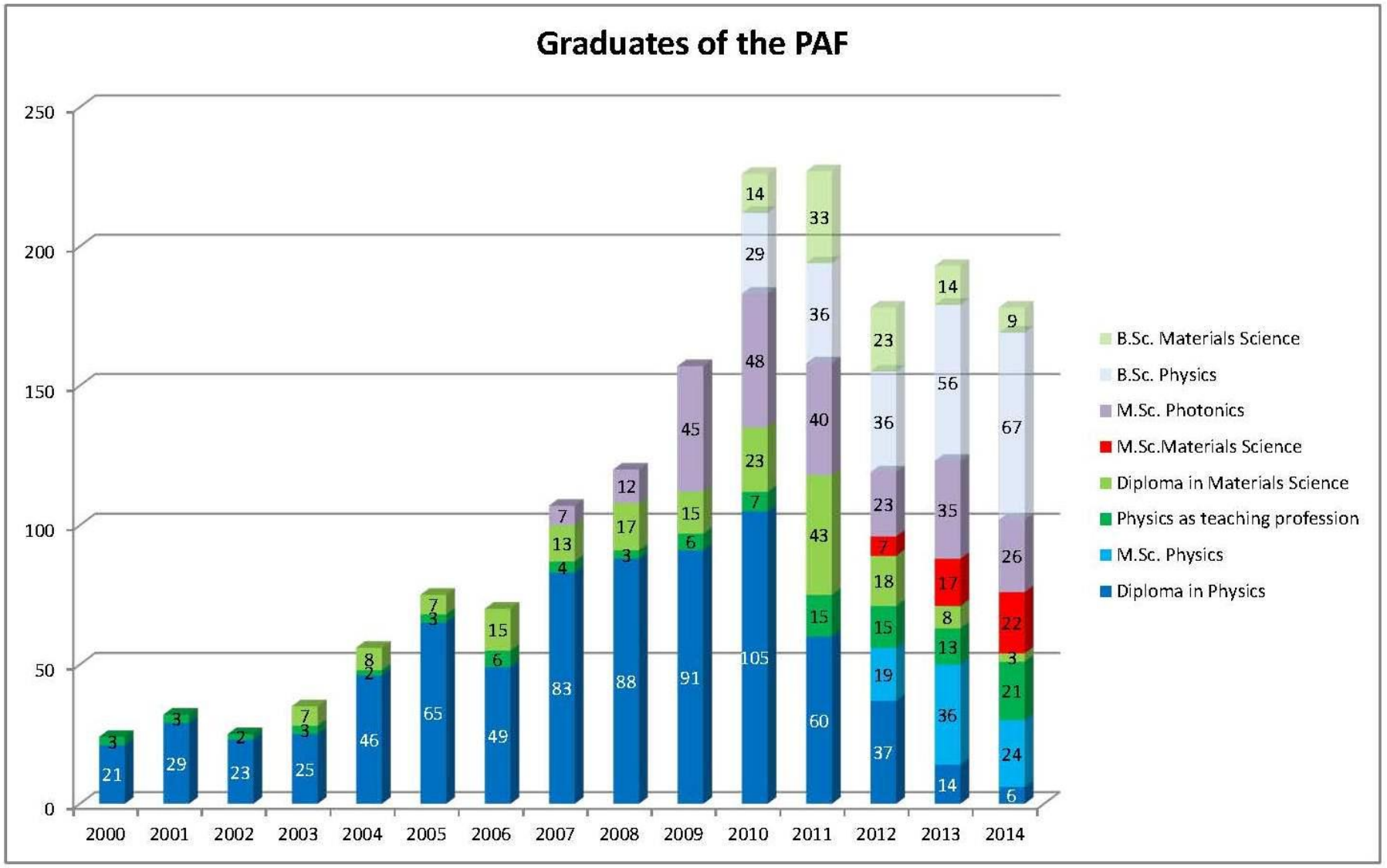
Period	Physics				Materials Science			M.Sc. Photonics
	Diplom	B. Sc. (ab WS 07/08)	M.Sc. (ab WS 10/11)	as teaching profession	Diplom	B. Sc. (ab WS 07/08)	M.Sc. (ab WS 10/11)	
WS 2000/01 + SS 2001	103 + 12 = 115	4		6 + 4 = 10	15			
WS 2001/02 + SS 2002	135 + 19 = 154	1		6 + 2 = 8	24			
WS 2002/03 + SS 2003	130 + 35 = 165	1		19 + 4 = 23	32			
WS 2003/04 + SS 2004	126 + 34 = 160			19 + 2 = 21	24			
WS 2004/05 + SS 2005	105 + 45 = 150			32 + 12 = 44	56			
WS 2005/06 + SS 2006	117 + 43 = 160	3		37 + 8 = 45	39 + 1			
WS 2006/07 + SS 2007	82 + 27 = 109	5		39 + 12 = 51	49			
WS 2007/08 + SS 2008	-	79 + 27 = 106		43	-	37		7 + 1
WS 2008/09 + SS 2009	-	84 + 14 = 98		41	-	52		11
WS 2009/10 + SS 2010	-	80		48	-	30		45
WS 2010/11 + SS 2011	-	107	31+ 6	48	-	23	20	48
WS 2011/12 + SS 2012	-	133	31+11	57	-	25	33	40
WS 2012/13 + SS 2013	-	66	27 + 14	39	-	23	22 + 2	44 + 4
WS 2013/14 + SS 2014	-	60 + 29	49 + 13	29	-	25	17 + 4	44
WS 2014/15 + SS 2015	-	33	55	26	-	15	12	40


First-year students
180
160
140
120
100
80
60
40
20
0
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
Diploma Physics
Physics as teaching profession
B.Sc. Physics
Diploma Materials Science
B.Sc. Materials Science
Master Photonics
M.Sc. Physics
M.Sc. Materials Science

The following table shows the devolepment of the number of graduations in physics and physics as teaching profession.

Number of graduations in physics, Period 2005 – 2014

Year	Prediploma (Vordiplome) in Physics since 2010 B.Sc. in Physics	Diploms in Physics Since 2012 M.Sc. in Physik	Intermediate examinations for physics as teaching profession Since 2011 1. State examination
2005	92	65 (9 A) + 1 Bakkalaureat	7
2006	78 (1 xdefinitely failed)	49 (6 x with distinction)	2
2007	69 (37 of it in the modularized study course)	83 (6 x with distinction)	13
2008	77 (73 of it in the modularized study course)	76 (7 x with distinction)	20 (18 of it in the modularized study course)
2009	21 (all modularized)	99 (11 x with distinction)	5
2010	4 (3 of it in the modularized study course) 29 B.Sc. (1 x with distinction)	80 (19 x with distinction) 34 (14 x with distinction) of it modularized	2
2011	36 B.Sc.	60 (14 x with distinction) 45 (14 x with distinction) of it modularized	15
2012	36 B.Sc.	37 34 (10 x with distinction) of it modularized, 19 M.Sc.	15 8 of it according to Jena model
2013	56 B.Sc.	14 10 of it modularized, 36 M.Sc.	13 according to Jena model
2014	67 B.Sc.	6 modularized 24 M.Sc.	21 according to Jena model


Graduates of the PAF
250
200
150
100
50
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
21
3
29
3
23
2
25
3
7
46
2
8
65
3
7
49
6
15
83
4
13
7
88
3
17
12
91
6
15
45
105
7
23
48
29
14
60
15
43
40
36
33
37
19
15
18
7
23
36
23
14
36
13
8
17
35
56
14
6
24
21
3
22
26
67
9
B.Sc. Materials Science
B.Sc. Physics
M.Sc. Photonics
M.Sc.Materials Science
Diploma in Materials Science
Physics as teaching profession
M.Sc. Physics
Diploma in Physics

Graduations in Materials Science

(D =with distinction)

Year	Prediploma ab 2010 B.Sc.	Diplom ab 2012 M.Sc.	Average Grade
2002		1	
2003		6	
2004	25	8	1.67
2005	12	7 (3 D)	1.38
2006	29	15 (2 D)	1.73
2007	24	13 (2 D)	1.61
2008	49	15	1.60
2009	14	12	1.55
2010	1 20 (1 D)	18 (6 D)	1.45 1.7 (B.Sc.)
2011	33	43 (5 D)	1.7
2012	23	18 (1 D) 7 M.Sc.	1.68
2013	14	8 + 17 M.Sc.	1.8
2014	9	22	2.1 (B.Sc.) 1.8 (M.Sc.)

Since 1995, the Faculty offers a four-semester post-graduate training **correspondence course in laser technology**, with the Otto Schott Institute of Materials Research as the leading partner. The table below gives the development of student figures.

Correspondence course in laser technology, 2004 – 2014

Year	Enrolments	Graduates
2004	16	13
2005	9	14
2006	8	7
2007	16	8
2008	11	6
2009	10	8
2010	6	4
2011	12	4
2012	7	4
2013	10	8
2014	No enrolment possible	7

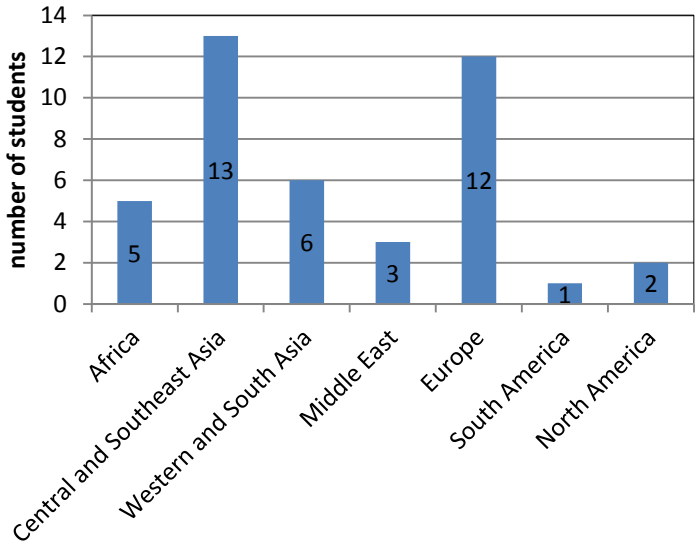
5. 2. Abbe School of Photonics

The Abbe School of Photonics (ASP) forms the central education constituent of the Abbe Center of Photonics by crosslinking its three key research areas – ultra optics, strong field physics and biophotonics (see figure on page 124). In a nutshell, ASP offers a full-scale higher education program on the Master and doctoral level with special focus on optics and photonics. Enrolled students are trained for technical industry positions or scientific research positions in academia. Although deeply rooted in the Faculty of Physics and Astronomy, ASP clearly has a cross-institutional and interfaculty character by involving teaching staff and students also from the Faculties of Chemistry and Earth Sciences, Biology and Pharmacy, and Medicine, respectively.

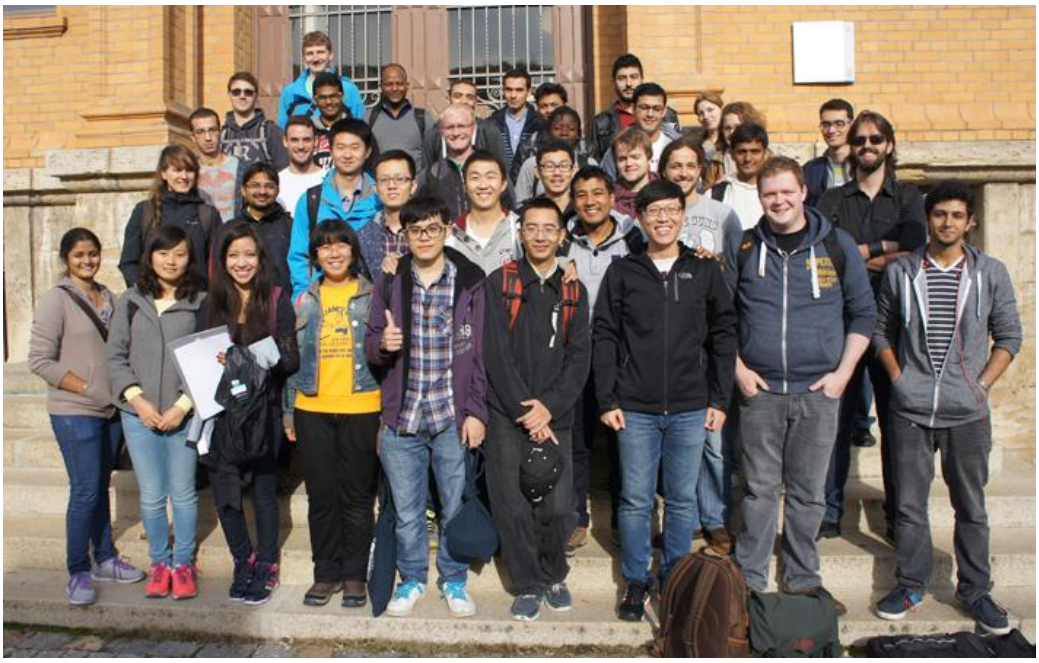
ASP' curriculum is divided into an international Master's degree program as well as a structured PhD/doctoral program. The former's core area is the international **Master's degree program M.Sc. Photonics**, which is funded in a public-private partnership by the federal government, the Thuringian government and the German optics industry. From this funding, e.g. 2-years Master scholarships are regularly given to the most excellent foreign applicants. The studies are completed by intercultural trainings, language and block courses. The **structured doctoral program** offers its doctoral candidates outstanding research possibilities in a multidisciplinary surrounding and also exhibits an umbrella organization for all active doctoral students and postdocs in the optics and photonics research environment of the University. Both, Master's degree and doctoral program, are complemented and fueled by a renowned guest professor program with international top-ranking scientists.

5.2.1. Master's degree program

Internationality, excellent training, research within an international top level as well as a close collaboration with industry – all this is made available for Master students of the Abbe School of Photonics. While about 40 students are expected to finish their biennial M.Sc. Photonics during the winter term 2014/2015, an equal share of students with geographic roots from all over the world has been enrolled in October 2014.



Geographic origins of M.Sc. Photonics students enrolled in 2014.



Group picture of M.Sc. Photonics students enrolled in 2014.

Within the M.Sc. Photonics course, during the last years ASP was engaged in two other international Master's degree programs. The Erasmus Mundus program **"Optics in Science and Technology - OpSciTech"**, supported by the European Union, is an international study course, offered by six well-respected European universities and institutions: Technical Universities Delft and Warsaw, Imperial College London, Institute d´Optique of the Université Paris Sud, University of Eastern Finland, and, of course, Friedrich Schiller University Jena. Within the scope of this program the participants studied in two different countries and change from the first to the second university after the first academic year. The possibility for issuing a double degree had been confirmed by OpSciTech- pool/consortium and the corresponding committees. Moreover, ASP enabled French, American and German students to take part in the Atlantis-MILMI-program with external partners from the Université Bordeaux, the University of Central Florida and the Clemson University, South Carolina. In 2014, all enrolled students successfully finished these programs.

The 2014´s graduates of the Erasmus Mundus program within the staff members in the Institute d´ Optique, Université Paris Sud.

Due to its success, the partners of the Erasmus program OpSciTech agreed on its continuation based on bilateral contracts, albeit without additional European funding. With the appointment of the former Erasmus Mundus Coordinator Prof. Carsten Rockstuhl at the Karlsruhe Institute of Technology, in 2014 this position was taken over by Jun. Prof. Adrian Pfeiffer. In August 2014, all OpSciTech students had been invited to a Summer School at the Institut d´Optique in Palaiseau (Paris), France. Besides attending special lectures from Erasmus Mundus Visiting Scholars, the students were able to present their research work. Traditionally the certificates were solemnly handed over to the graduates at the end of the Summer School.

Jena´s new Erasmus Mundus Coordinator, Prof. Adrian Pfeiffer (3rd from the left) surrounded by the Erasmus Mundus Consortium during the graduation ceremony.

Since 2009 already, funded to the ProExcellence initiative of the State of Thuringia, additional educational elements within the M.Sc. Photonics were implemented. Special emphasis has been put on hands-on training at a **research-grade optics training laboratory** as well as a supporting **tutor program**. In the latter, ASP entrusts qualified young scientists at the postdoc level with the great responsibility of continuously teaching and supervising Master's degree students. The tutors act as contact persons for each individual Master's degree student with regard to all questions concerning seminars, tutorials, lectures and practical labs. Thereby, not only an individual advancement of the students is guaranteed, but also an accurately fitting support, e.g. when writing scientific manuscripts. Due to the great and measurable benefit for the students, both the optics training laboratory and the tutor program will be continued beyond 2015.

In order to reward excellent course achievements with financial reliefs, the Federal Government issued **scholarships for excellent German students ("Deutschlandstipendien")**, whereby high-performing students are supported with EUR 300 per month. In 2014, with the help of industrial partners, two of these prestigious scholarships had been allocated again by two M.Sc. Photonics students.

A special and by now quite traditional feature of ASP's Master's degree program master program is exhibited by the close integration of industrial partners concerning the technical training. Many students complete their practical trainings and Master's degree theses in regional and national optics companies. Furthermore, study trips to industry partners and research institutions provide the opportunity to gain insight into research and career possibilities. A dedicated application training has been established for the increasing amount of graduates. By visits of fairs, like the visit of the "Light and Building 2014" in Frankfurt, and the organized participation in job exchange fairs of the Friedrich Schiller University and the University of Applied Sciences in Jena, Master as well as doctoral students got the chance to apply for job vacancies, traineeships or research topics in well-respected companies of the optics industry and in non-university research institutions. In 2014 and for the first time,

the job fair of the Faculty of Physics and Astronomy ("Jobbörse der PAF") and ASP's Photonics Career Day where merged and held jointly together. Students had the possibility to get in touch with future employees and could even book a private speed dating session with the company´s representatives. The synergetic merging of two formerly separated recruitment events was regarded a full success by everybody involved, and thus will be continued in this way.

ASP students were invited by the OSRAM to Frankfurt to attend the fair „Light and Building 2014".



Impressions from the 2014 edition of the job fair jointly organized by the Faculty of Physics and Astronomy and the Abbe School of Photonics.

As another highlight of lively student life in 2014, M.Sc. Photonic students were invited by ASP's partner **Carl Zeiss to visit the lab and production site in Oberkochen**. The participating students had the chance not only to get in touch with HR-managers, but also to ask questions to the co-workers in the Research and Development department. The visit to Carl Zeiss in Oberkochen was a full success for both parties.

By the end of 2014, already 27 of 48 students, who started their studies in winter term 2012/13, have successfully completed their M.Sc. Photonics, while more students are very close to their graduation. The achieved graduation marks are very good and good. Most of the graduates are aiming at a start of a doctoral research position after the Master´s degree program.

ASP students visiting Carl Zeiss in Oberkochen.

5.2.2. Doctoral program

Based on the experiences of the Master's degree program and the increasing demand of foreign graduates to sustain research, from 2011 on ASP has launched a consequent internationalization process also with regard to its doctoral program. During the last years, this strategic aim was supported by successful acquired third-party funding and scholarships from the German Academic Exchange Service (DAAD), from Thuringian's ProExzellenz programs "Graduate Research School Photonics" and "Graduate Research School - Optical Microsystem Technologies" and from the federally funded Graduate Research School "Green Photonics". Currently, ten ASP doctoral students are working on their research topics under the support of scholarships from the Carl Zeiss Foundation. A close cooperation between ASP and the Advanced Photon Science Graduate School of the Helmholtz Institute Jena is carried out since its inception in 2012. In 2014, ASP's doctoral program has again received a constantly growing input of graduates of the M.Sc. Photonics. Currently, 39 out of 145 doctoral students are of foreign origin. Since its foundation, at least 71 ASP doctoral students have completed their doctorate on a subject in optics and photonics. Only in 2014, **25 doctoral theses within ASP's auspices were finished**. This year's dissertation prize in physics of the Friedrich Schiller University was awarded to former ASP doctoral student Dr. Robert Keil.

The dissertation price in physics 2014 was awarded to Dr. Robert Keil by the vice-rector for teaching and structure Prof. Jens Haustein.

A central component of the doctoral program is the interdisciplinary, cross-faculty **ASP seminar**. This seminar takes place on Friday afternoon every two weeks at the Carl Zeiss seminar room of the

Fraunhofer Institute of Applied Optics and Precision Engineering (IOF). It provides an excellent platform on which the students may present their research results at a broader audience. At the same time, the seminar provides a vivid forum for scientific discussion between academics and graduate students, both within the University and in exchange for the non-university institutions. The language of the ASP seminar is English. It is again worth to point out here that **all staff and student members of the Faculty of Physics and Astronomy are cordially invited to join the ASP seminar and discuss pertinent trends of doctoral research**. In 2014, the following presentations were given within the ASP seminar edition:

- Aurélie Jost (IPC), "Advances in Structured Illumination Microscopy (SIM): Blind Reconstruction and Simultaneous Multi-Focus Acquisition"
- Matthew Schwab (IOQ), "Optical Probing of Laser Wakefield Acceleration Experiments"
- Matthias Falkner (IAP), "Characterization of Ultrafast Spatio-Temporal Excitation Dynamics of Plasmonic Nanostructures by Photoemission Electron Microscopy (PEEM"
- Sören Schmidt (IAP), "Simulation with the Wave Propagation Method"
- Rossa McCiarnain (IOF), "Emitter Orientation Analysis in Multi-Color Organic Light-Emitting Diodes"
- Dragana Kusić (IPC), "Raman Microspectroscopic Characterization of Pathogens in Planktonic and Biofilms State"
- Stefan Heist (IOF), "Array Projection of Aperiodic Sinusoidal Fringes for High-Speed 3D Shape Measurement"
- Per-Christian Heisel (IPHT), "Electric Field Induced Second Harmonic-New approaches with Si/SiO2 interfaces"
- Vinzenz Hilbert (IOQ), "Coherence Measurements at the Free Electron Laser in Hamburg (FLASH)"
- Stefan Fasold (IAP), "Near-Field Imaging by Plasmonic Moiré Magnification"
- Christian Karras (IPHT), "Optical - optical gating in the sub picosecond regime"
- Andrea Kliner (IOF), "Long-period gratings in high-power fiber lasers: physical background, fabrication, and applications"
- Marie Walde (IPC), "Holoscopy - a holographic approach to Optical Coherence Tomography"
- Andreas Hoffmann (IOQ), "High-power nonlinear optics with Bessel beams"
- Hans-Jürgen Otto (IAP), "Mode instabilities in high-power-fiber lasers and amplifiers"
- Susanne Pahlow (IPC), "Chip-based Isolation of Pathogens for Raman Spectroscopic Applications"
- Tino Elsmann (IPHT), "Fiber-Bragg-Gratings in Sapphire Fibers"
- Jan Kinast (IOF), "Amorphous Nickel-Phosphorus alloy - material for unique metal optics"
- Daniel Richter (IAP), "Ultrashort Pulse written Volume Bragg Gratings - fundamentals and applications"
- Ron Spittel (IPHT), "Optical properties of metal-filled photonic crystal fibers"
- Thomas Zeuner (IPHT), "Selected defects in mono crystalline CaF2 investigated by optical methods"
- Matthias Zilk (IAP), "Silicon Nanostructures for Photovoltaic Applications"

For evaluation and constant improvement of the seminar's quality, regular feedback from the auditorium is utilized. For this purpose, a feedback form was developed in collaboration with the University's teaching evaluation project (ULE) and allows the speakers for a differentiated and personalized feedback. Upon, one-year evaluation, outstanding seminar contributions are awarded. In 2014, all

together four "**Best Talk Awards**" were awarded. In the first term, Marie Walde was awarded for her talk "Holoscopy - a holographic approach to Optical Coherence Tomography", while Hans-Jürgen Otto won the second prize for his talk "Mode instabilities in high-power-fiber lasers and amplifiers". In the second term, the first price was given to Matthias Zilk and his talk "Silicon Nanostructures for Photovoltaic Applications", while Daniel Richter won the second prize for his talk "Ultrashort Pulse written Volume Bragg Gratings - fundamentals and applications".

The winners of the 2014 edition of ASP seminar's „Best Talk Awards". Left-hand side: Marie Walde (IPC, on the left) and Hans-Jürgen Otto (IAP, center) flanked by the ASP seminar's responsible Prof. Christian Spielmann. Right-hand side: Matthias Zilk (IAP, on the left) and Daniel Richter (IAP, on the right).

Again, 2014 was enriched by a branch of optional qualification courses which were open to all ASP doctoral students. As an outstanding element, the weekly course "Zemax for doctoral students" taught by Prof. Herbert Gross was highly appreciated by all participants. A notable highlight was also the "ACP Photonics and Physics Alumni Workshop" in November, where many doctoral students in their final phase of their doctorate were able to get answers on pertinent questions concerning job perspectives from experienced individuals. Further details on this workshop are given within this annual report in the section on the Abbe Center of Photonics. Likewise, the job fair of the Faculty of Physics and Astronomy, the excursion to Carl Zeiss in Oberkochen and a visit of the industrial fair in Hannover were additional opportunities for ASP's doctoral students to learn about career prospects and to establish their own networks. Very strong topical and organizational support from the ASP was given to the Doctoral School on Photonic Nanomaterials and Metamaterials, co-organized by the Virtual Institute for Artificial Electromagnetic Materials and Metamaterials (METAMORPHOSE VI) in November 2014. In a long series of doctoral schools within this edition, the Jena School was attended by a record number of 45 international doctoral students.

From an ASP's doctoral student's point of view, the year 2014 was coined by very ambitious and fruitful activities of the elected doctoral representatives Thomas Kaiser (IAP, speaker), Ria Krämer (IAP, deputy speaker), Katharina Bräutigam (IPC, officer for gender equality) and Minyi Zhong (IAP, officer for special issues of international doctoral students). The representatives hosted several events to provide information and receive feedback from their doctoral. As an initial activity, the members introduced themselves by hosting a New Year's Reception in January 2014 where they informed about their plans and initiatives and received helpful suggestions. Throughout the year, Minyi Zhong put up a frequent "International Lunch" where non-German ASP students came together and discussed the everyday life issues such as insurance or residence permit. The members also helped the organizing team for next year's ASP doctoral student's conference DoKDoK, which will be led by Marie Walde (IPC), with their experiences. By the beginning of 2015, the annual election of the doctoral students' representatives and thus a replacement of the current team are planned.

Meeting of ASP's doctoral students' representatives in 2014.

Concerning public outreach, a selected number of ASP doctoral students presented their research to the lay public at the Carl Zeiss open house. More than 25,000 visitors took the opportunity to explore optical technologies on the tour comprising nearly 100 booths. For the first time, a science theme park was incorporated, where Carl Zeiss research partners such as ASP and industry presented their work. Also in 2014, the Friedrich Schiller University has considerably strengthened its marketing efforts to attract new students. For this purpose, a series of topical video clips to present different aspects of students' life in Jena (University, City, Culture, Social Life, and Sports) were co-produced by the University's central marketing department and ASP. Likewise, three out of five protagonists were current or former ASP students. By the end of 2014, these video clips have become extremely popular within the whole University, and have been watched by more than 20,000 people on the University's Youtube channel at www.youtube.com/user/UniJena.

Left: impressions from ASP's booth at the Carl Zeiss open house, where ASP doctoral students Aleksandar Lukic, Sebastian Dochow and Katharina Eberhardt explained the experimental setups. Right: Protagonists of Friedrich Schiller University's image videos. From left to right: Franck E. Gounou, Rossá Mc Kiernan, Kathrin Rieken (all ASP), Angela Klinger, and Jordy Pacheo.

5. 3. Compulsory Courses

The responsibility for the compulsory courses was divided between the institutes according to their competences.

Klassische Experimentalphysik I+II
Institute of Optics and Quantum Electronics, Institute of Solid State Physics, Institute of Applied Optics (seminares)

Vorkurs Mathematik und Mathematische Methoden der Physik I
Research Group - Teaching Methodology in Physics and Astronomy

Struktur der Materie I +II
Institute of Solid State Physics

Elektronik, Messtechnik, Kern- und Elementarteilchenphysik (auch für Lehramt)
Institute of Solid State Physics

Physikalisches Grundpraktikum
Institute of Optics and Quantum Electronics with assistants from all experimental institutes

Elektrodynamik
Institute of Theoretical Physics

Theoretische Mechanik, Quantenmechanik I+II, Thermodynamik / Statistische Physik (auch für Lehramt)
Institute of Theoretical Physics, Research Group - Teaching Methodology in Physics and Astronomy

Kontinuumsmechanik (Lehramt), Elektrodynamik (Lehramt), Quantentheorie für Lehramt
Institute of Theoretical Physics, Research Group - Teaching Methodology in Physics and Astronomy

Grundkonzepte der Optik
Institute of Applied Physics

Fundamentals of Modern Optics (degree program M.Sc. Photonics)
Institute of Applied Physics

Optical Metrology and Sensing, Coherence Theory and Applications (degree programme M.Sc. Photonics)
Institute of Applied Optics

Laser Physics (degree program M.Sc. Photonics)
Institute of Applied Physics

Computational Physics I und II
Institute of Applied Physics, Institute of Solid State Theory and Optics

Atom- und Molekülphysik (auch für Lehramt)
Institute of Applied Physics, Institute of Optics and Quantum Electronics

Festkörperphysik I und II (auch für Lehramt und Werkstoffwissenschaft)
Institute of Solid State Physics, Institute of Condensed Matter Theory and Solid State Optics

Structure of Matter (degree program M.Sc. Photonics)
Institute of Solid State Theory and Optics

Physikalisches Fortgeschrittenen-Praktikum, Proseminar und Zusatzversuche
Institute of Solid State Physics with assistants from the Institute of Optics and Quantum Electronics, Institute of Applied Optics, Institute of Applied Physics and the Astrophysical Institute

Technische Mechanik, Grundlagen der Fertigungstechnik, Grundlagen der Werkstoffwissenschaft, Metalle, Polymere, Materialprüfung, Stochastik und Versuchsplanung, Innovative Verfahren in der Fertigungstechnik, Modellieren und Simulation, Materialkundliches Praktikum, Kommunikation und Präsentation, Verbundwerkstoffe, Materialcharakterisierung
Otto Schott Institute of Materials Research

Physik als Nebenfach

V Physik für Mediziner, Zahnmediziner und Biochemiker
Institute of Solid State Physics

V/Ü Physik für Biologen, Ernährungswissenschaftler, Pharmazeuten, Chemiker, Biogeowissenschaftler
Institute of Solid State Physics

V/Ü Experimentalphysik für Werkstoffwissenschaftler, Geologen, Mineralogen
Institute of Applied Optics, Institute of Optics and Quantum Electronics

P Physikalisches Grundpraktikum für Mediziner, Zahnmediziner
Institute of Solid State Physics with assistants from all experimental institutes

P Physikalisches Grundpraktikum für Nebenfächler (Biologie, Chemie, Ernährungswissenschaft)
Institute of Solid State Physics with assistants from all experimental institutes

P Physikalisches Grundpraktikum für Pharmazie
Institute of Optics and Quantum Electronics with assistants from all experimental institutes

Didaktik der Physik, Didaktik der Astronomie, Physikalische Schulexperimente, Begleitseminar zum Praxissemester, Vorbereitungsmodul für die Staatsprüfung Fachdidaktik der Physik
Research Group - Teaching Methodology in Physics and Astronomy

Vorbereitungsmodul für die Staatsprüfung Theoretische Physik
Institute of Theoretical Physics, Research Group - Teaching Methodology in Physics and Astronomy

Vorbereitungsmodul für die Staatsprüfung Experimentalphysik (Lehramt)
Institute of Optics and Quantum Electronics, Institute of Solid State Physics

Laborpraktikum für Masterstudiengang Photonics
Institute of Applied Optics, Institute of Applied Physics, Institute of Optics and Quantum Electronics

Oberseminar Optik
Institute of Applied Optics, Institute of Applied Physics, Institute of Optics and Quantum Electronics, Institute of Solid State Theory and Optics

Oberseminar Festkörperphysik
Institute of Solid State Theory and Optics, Institute of Solid State Physics

Oberseminar Gravitations- und Quantentheorie
Institute of Theoretical Physics

5. 4. Optional and special courses

Astrophysical Institute and University Observatory

L/E/P Astronomische Beobachtungstechnik
L/E Einführung in die Astronomie
L/E Celestial mechanics (in English language)
L/E Laborastrophysik
L/E Neutronensterne
L/E Physics of planetary systems (in English language)
L/E Physik der Sterne
L/E Radioastronomie
P Astronomisches Praktikum
AS Beobachtende Astrophysik: Historische Supernovae
AS Beobachtende Astrophysik: Sonnenaktivität
AS Theoretische Astrophysik
S Aktivität von Sternen
S Junge Sterne
S Labor-Astrophysik
S Neutronensterne

S Staub, Kleinkörper und Planeten

Institute of Applied Optics

L Optical metrology and sensing
L Coherence theory and applications
L Experimentalphysik für Geo- und Werkstoffwissenschaftler
EL Holographie – Grundlagen und Anwendungen
EL Laser in Medicine and Ophthalmology
EL Holography

Institute of Applied Physics

L/E Advanced lens design
L/E Astrophotonics
L/E Computational Photonics
L/E Design and correction of optical systems
L/E Diffractive Optics
L/E Experimentelle Methoden der Optischen Spektroskopie
L/E Fundamentals of microscopic imaging
L/E Fundamentals of Quantum Optics
V/S Grundlagen der Laserphysik
L/E Imaging and aberration theory
L/E Introduction to optical modeling
L/E Micro/nanotechnology
L/E Nanomaterials for photonics
L/E Optical design with Zemax
L/E Optical Modelling and Design II + III
L/E Physical optics simulation with Virtual Lab
L/E Thin Film Optics
L/E Ultrafast Optics

Institute of Solid State Physics

L Nuclear solid state physics
L Optoelectronics
L Nanomaterials and nanotechnology
V Supraleitende Materialien
L Nuclear and particle physics
L Ion beam modification of materials
L Optical properties of solid and thin films
V Vakuum- und Dünnschichtphysik
L Gravitational Wave Detection
V Einführung in die Elektronik
V Tieftemperaturphysik
L Laboratory Astrophysics (together with Dr. Mutschke, AIU)

Institute of Solid State Theory and Optics

L/S Solid State Theory
L/S Introduction to Quantum Optics
L/S Waveguide Theory
L/S Nonlinear Optics

Otto Schott Institute of Materials Research

V/S Biomaterialien und Medizintechnik
V Legierungen - Anwendungen und Eigenschaften
V Präzisionsbearbeitung und Oberflächenmesstechnik
V Lasertechnik für Materialwissenschaftler
V Lasertechnik - Grundlagen und Anwendungen I + II
V/S Polymerphysik
V Abfallverwertung - werkstoffkundliche Aspekte des Recycling
V/S Materialwissenschaft für Physiker
V/S Keramische Werkstoffe in der Medizin
V Biomimetische Materialsynthese
V Phasenumwandlungen
V/S Nanostrukturierte Oberflächen und Nanomaterialien
V Archäometallurgie
V/S Sintern
V Mechanische Eigenschaften keramischer Werkstoffe
V/Ü Advanced Computational Materials Science
V Theoretisch-chemische Grundlagen der Materialwissenschaft
V/Ü Algorithmen des Wissenschaftlichen Rechnens

Institute of Optics and Quantum Electronics

L/S Biomedical Imaging I,II
L/S Plasma physics
V/Ü Grundlagen der Photonik
L Nonlinear Optics
L High-intensity /Relativistic optics
L/S XUV and X-ray optics
V Physikalische Grundlagen regenerativer Energiequellen
S Zeitaufgelöste Röntgenspektroskopie
S Lektürekurs: Journal Club
S Spezielle und aktuelle Themen der Relativistischen Laser-Plasma-Physik
L/S Physics of the Free Electron Laser
L/E Interaction of high-energy radiation with matter
L/E New Trends in Strong Fields Physics – Experiment and Theory
L/E Strong Field Laser Physics
V/Ü Moderne Methoden der Spektroskopie
L/E Attosecond laser physics
L/E Physics of ulftrafast optical discharge and filamentation
V Modern Atomic Physics
OS Oberseminar Optik
S of the Research School for Advanced Photon Science of the Helmholtz Institute Jena
L/S Fundamentals of X-ray Physics
L Introduction to accelerator physics/Beschleunigerphysik

Institute of Theoretical Physics

V/S Allgemeine Relativitätstheorie
V/S Quantenfeldtheorie I+II
V/S Relativistische Physik
V/S Numerische Relativitätstheorie
L/S Introduction to String Theory and AdS/CFT

V/S Mathematische Methoden für Fortgeschrittene
L/S Gravitationswellen/Gravitational Waves
OS Twisted light – Drehimpuls von Licht- und Teilchenstrahlen
OS Quanteneffekte in gekrümmten Raumzeiten
L Physics of Scales
V/S Solitonen
L Theoretical Particle Physics

Research Group -Teaching Methodoly in Physics and Astronomy
V Mathematische Methoden der Physik II + III
V Gastvorlesung Kosmologie (Lehramt) an der Martin-Luther-Universität Halle -Wittenberg
V/S Kosmologie (Lehramt)
V Relativitätstheorie und Relativistische Astrophysik (Lehramt)

5. 5. Seminars of the institutes and research groups

Institute of Astrophysics and University Observatory

Astrophysical colloquium (in cooperation with TLS Tautenburg)
Institute seminar "Astrophysics"
Institute of Applied Optics

Institute colloquium Applied Optics
Seminar Applied Optics for students and postgraduates
Working Group Seminar Optical Measurement Techniques

Institute of Applied Physics

ASP-seminar Applied photonics (together with IFTO and FhG-IOF)
Applied physics (Prof. Tünnermann, Prof. Nolte, Prof. Pertsch, Jun.-Prof. Limpert)
Design of optical systems (Prof. Gross)
Fiber lasers (Jun.-Prof. Limpert)
Field tracing (Prof. Wyrowski)
Diamond optics (Jun.-Prof. Szameit)
Microstructure technologies - Microoptics (Dr. Kley, Dr. Schrempel)
Nano optics (Prof. Pertsch)
Ultrafast optics (Prof. Nolte)

Institute of Solid State Physics

Seminar of the Institute of Solid State Physics
Group Seminars: Applied Solid State Physics / Surface Science
Ion beam physics
Nanostructures
Photovoltaics
Low Temperature Physics and Superconductivity
Laboratory Astrophysics (together with Dr. Mutschke, AIU)

Institute of Solid State Theory and Optics

Group Seminar Solid State Theory
Group Seminar Photonics

Otto Schott Institute of Materials Research

OSIM seminar: Materialwissenschaftliches Kolloquium des OSIM

Group seminars: Materials Science Research
Metallic Materials
Colloids, Surfaces and Interfaces
Computational Materials Science

Institute of Optics and Quantum Electronics

Seminar of the Institute
Mitarbeiterseminar des IOQ

Group seminars: Quantum electronics
Nonlinear Optics
Relativistic Laser Physics
X-ray Optics

Seminar of the Helmholtz Institute Jena

Institute of Theoretical Physics

Institutsseminar Theoretische Physik
Bereichsseminar Quantentheorie
Bereichsseminar Relativitätstheorie
GRK 1523/1: Kollegiatenseminar Quanten- und Gravitationsfelder
SFB/TR 7: Videoseminar
Group seminar Quantum Dynamics in Strong Fields

5. 6. Postgraduate Training

Institute of Astrophysics and University Observatory together with the Research Group -Teaching Methodoly in Physics and Astronomy

Organised part-time postgraduate training in astronomy to achieve the teaching qualification in a further subject at secondary schools according to the Thuringian Regulations (Astronomy as third school subject)

Research Group -Teaching Methodoly in Physics and Astronomy

Nation wide further teacher training in Astronomy in Jena from July 21st to July 23rd, 2014 (160 participants, including referents) including the 1st Colloquium for Doctoral Students on Teaching Methodology in Astronomy

The organizing team of the nation wide further teaching training

17 public lectures (most of them for further education of teachers) par example at the universities of Padua, Marburg and Dresden as well as in Bad Honnef:

- Das Äquivalenzprinzip als Zugang zur Allgemeinen Relativitätstheorie
- Kosmologie
- Gravitationslinsen
- Galilei, Kepler und der Übergang vom geozentrischen zum heliozentrischen Weltbild

Hereaus Sommer School from 4 Perspectives, second meeting:
Padua, 1.-6. September 2014, Theme „ActiveGalactic Centres“
Vorbereitungsmodul „Relativistische Astrophysik (Lehramt)“ (see above) in sommer term 2014, student's reports, 16 participants (students and practising teachers)

Further teacher training in astronomy for elementary school teachers "How astronomical phenomena influence daily life"

Colloquia in teaching methodology of the central German universities Halle-Leipzig -Jena (colloquia series 36 -38)

Two Workshops on "Optics with LEGO®" within the program "Schule MIT Wissenschaft" of the MIT Club of Germany, Erfurt 21.-23.11.2014, together with Dr. Walter (Witelo)

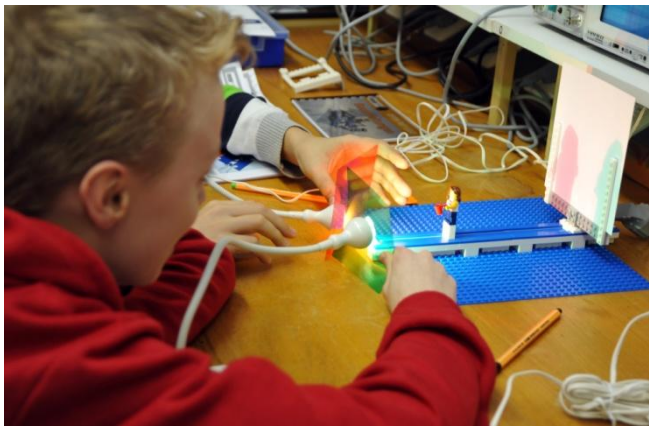


Foto: Annegret Günther (FSU)

Institute of Applied Optics

Prof. Kowarschik - Chairman of the JENA-Carl Zeiss Optics Colloquium

Otto-Schott-Institut für Materialforschung

Correspondence course „Lasertechnik“ (including other institutes of optics for labwork)

Institute of Theoretical Physics

Spring School for Bachelor students: Perlen der theoretischen Physik
Jena, 21 – 25 March 2014;
Organizers: Professors of the Institute of Theoretical Physics, Jena

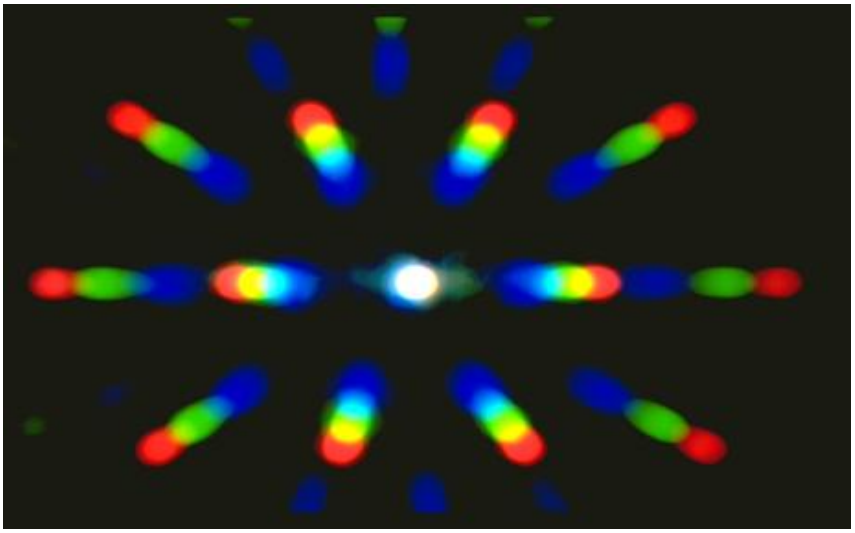
Participants of Spring School for Bachelor students at TPI

DPG Physics School: General Relativity @ 99
Bad Honnef, 14 – 19 September 2014
Organizers: G. Schäfer and C. M. Will (Florida)

20. Saalburg summer school for PhD-Students of Theoretical Physics in Wolfersdorf
"Foundations and new Methods in Theoretical Physics", Wolfersdorf, 1. - 12. September 2014
Speakers: A. Van Proeyen (Katholieke Universiteit Leuven), M. Sasaki (Yukawa Institute, Kyoto University), C. Gattringer (University Graz), K. Sundermeyer (Free University Berlin), G. Semenoff (UBC Vancouver)
Organizers: A. Hebecker (Heidelberg), O. Lechtenfeld (Hannover), I. Sachs (Munich), S. Theisen (Potsdam), A. Wipf (Jena)

9th International Conference on Atomic and Molecular Data and Their Applications (ICAMDATA 2014)
Jena, 21 – 25 September 2014
Organizers: S. Fritzsche, S. Schippers and A. Surzhykov

5. 7. Public Saturday Morning Lectures



19.01.2014 Prof. Dr. Olivier Guillon (Otto Schott Institute of Materials Science)
Hochleistungskeramiken: Überall vorhanden, trotzdem unsichtbar

01.02.2014 Prof. Dr. Marek Sierka (Otto Schott Institute of Materials Science)
Hochleistungsrechner – Das virtuelle Labor

15.02.2014 Prof. Dr. Stefan Nolte (Institute of Applied Physics)
Ultrakurzpulslaser für die industrielle Massenfertigung – Wieso gewinnt man mit Lasermaterialbearbeitung den Deutschen Zukunftspreis?

25.10.2014 Prof. Dr. Ute Kaiser (AG Materialwissenschaftliche Elektronenmikroskopie der Universität Ulm)
Elektronenoptik - das Tor zum Nanokosmos

15.11.2014 Prof. Dr. Paul Seidel (Institut für Festkörperphysik)
Wozu eigentlich Tieftemperaturphysik ? - Vortrag mit coolen Experimenten

13.12.2014 Dr. Dörte Hansen (Abbe School of Photonics)
Steinschleuder und Co. – Physik und Technik im Mittelalter

5. 8. Physical Colloquia

Organizers: Prof. Dr. M. Ansorg, Prof. Dr. G. Paulus and Prof. Dr. C. Ronning (up to March 2014)
Prof. Dr. M. Ansorg, Prof. Fritz, Prof. Szameit (since April 2014)

06.01.2014	**Prof. Dr. Harald Lesch** LMU München	Entstehung und Entwicklung von Magnetfeldern in Galaxien und Galaxienhaufen
13.01.2014	**Jun.-Prof. Dr. Alexander Szameit** Institut für Angewandte Physik	Integrierte optische Schaltkreise für klassisches und nichtklassisches Licht
20.01.2014	**Prof. Dr. Stephan Fritzsche** Helmholtz-Institut Jena	**Inaugural Lecture** Elektronendynamik in starken Feldern
03.02.2014	**Dr. Claudia Schnohr** Institut für Festkörperphysik	Komplexe Verbindungshalbleiter: Von der atomaren Struktur zur Bandlücke
28.04.2014	**Dr. Christian Graeff** Helmholtzzentrum für Schwerionenforschung GmbH	Tumor therapy with scanned carbon ion beams
05.05.2014	**Prof. Dr. Detlef Dürr** Ludwig-Maximilians-Universität München	Was heißt und zu welchem Ende studiert man Bohmsche Mechanik?
12.05.2014	**Prof. Dr. Rainer Blatt** Universität Innsbruck	The Quantum Way of Doing Computations
26.05.2014	**Prof. Dr. Ute Kraus** Universität Hildesheim	Relativitätstheorie relativ anschaulich – Visualisierungen und Modellexperimente
16.06.2014	**Dr. Ronny Nawrodt** Institut für Festkörperphysik, FSU Jena	Optische Interferometer mit sub-Attometer Auflösung – Wege zur Gravitationswellenastronomie
23.06.2014	**Prof. Dr. Markus Schmidt** Leibniz-Institut für Photonische Technologien	**Inaugural Lecture** Optische Glasfasern – eine Plattform für die Photonik
07.07.2014	**Dr. Silke Weinfurtner** University of Nottingham	Black hole physics in the laboratory
10.11.2014	**Dr. Stefano Minardi** Institut für Angewandte Physik, FSU Jena	Photonics for astronomical interferometry
17.11.2014	**Prof. Dr. Rainer Heintzmann** Institut für Physikalische Chemie, FSU Jena	Novel approaches in optical imaging
24.11.2014	**Dr. Ulf Zastrau** Inst. für Optik und Quantenelektronik, FSU Jena	XFEL-basierte Röntgenspektroskopie zum Studium dichter Plasmen
08.12.2014	**Prof. Dr. Kurt Kremer** MPI für Polymerforschung, Mainz	Adaptive Resolution Simulations for Soft Matter: Applications and New Developments
15.12.2014	**Prof. Dr. Martin Reuter** Johannes-Gutenberg Universität Mainz, Institut für Physik	QEG: Eine „asymptotisch sichere“ Quantentheorie der Gravitation

5. 9. Physics day

At the suggestion of the Alumni Association and as a measure of winning students, a first Physics Day was held on Saturday, 25 October 2014. An attractive programme was intended to give school students, parents, teachers, alumni and the interested public an insight into physics and its exploration.

For a whole day, information stalls and hands-on experiments were set up in the building at Max-Wien-Platz. Individual consulting on studying physics was also offered.

Demonstration experiment: (Negative) pressure effects in a vacuum
Photo: Jan-Peter Kasper (FSU)

The first Saturday Lecture of the winter 2014/2015 semester series was integrated in the Physics Day. By her lecture "Electron optics – the gate to the nanocosmos", Prof. Dr. Ute Kaiser, an FSU alumna now teaching at the University of Ulm, paid tribute to Prof. Hans Busch, the pioneer of electron optics. After the lecture a commemorative plaque for Prof. Hans Busch, who worked at the Friedrich Schiller University from 1922 up to 1929, was uncovered. The encovering ceremony was attended by his grandchildren and great-grandchildren.

The Dean among the grandchildren of Prof. Hans Busch: Prof. Dietrich Kabelitz of Kiel (2nd from right) and Anne Köhn of Konstanz (3rd from left).
Photos: Erich Greger (Alumni Association)

Another highlight was the experimental show by the winner of the DPG Science Slam, Dipl.-Phys. Reinhardt Remfort of the University of Duisburg-Essen. Entitled "Of Schnapps Rockets and Cucumber Lanterns – Stories from the Life of a Physicist", the show delighted especially the youngsters.

Between the lectures, the visitors were offered guided tours of selected labs of the Faculty, such as the new laboratories for electron spectroscopy at the Centre of Applied Research, which attracted much interest.

To prevent visitors getting hungry at lunchtime, our workshops furnished roast sausages, funded by the Alumni Association.

6. Student research projects; Bachelor, Diploma and Master thesis, exam thesis in educational physics, dissertations

Institute of Astrophysics and University Observatory

Bachelor Thesis

Markus Drüke
Untersuchung der Sonnenaktivität anhand der 14C-Messkurve

Franz Eysoldt
Elektromagnetische Analyse von O- und B-Sternspektren

Aljoscha Ide
Variabilität der jungen Sterne in IC348

Henriette Wirth
Das Chamberskriterium für Zweiplanetensysteme

Tamara Zehe
Bestimmung der Lage des geomagnetischen Nordpols von 400 AD bis 1700 AD anhand historischer Aurorabeobachtungen

Roy Zitzmann
Oberflächenhelligkeitsprofile ausgedehnter Trümmerscheiben

Institute of Applied Optics

Bachelor Thesis

Adrian Bubholz
Auflösungssteigerung in der Mikroskopie mittels digital-holografischer Interferometrie

Richard Wiedenhöft
Punktwolkenregistrierung mit dem ICP-Algorithmus

Johannes Wilde
Examination of model excitation in few mode fibers

Master Thesis

Franck Emmanuel Gounou
Charakterisierung einer Adaptiven Optik für die Nichtlineare Lasermikroskopie

Andreas Knebl
Characteristics of Nonlinear Signal Formation in Biological Tissue and Applications in Nonlinear Microscopy

Thomas Mittag
Nonlinear microscopy of porcine cornea

Undine Richter
Intracellular laser-based cell manipulation by endosomal uptaken gold nanoparticles

Doctoral Thesis

Martin Schaffer
Stereophotogrammetrie mit strukturierter Beleuchtung für die schnelle 3D-Vermessung

Christian Schulze
Laser beam characterization with holographic tools

Institute of Applied Physics

Bachelor Theses

Thorsten Albert Goebel
Femtosekundenpuls-Laser geschriebene Faser-Bragg-Gitter

Simon Grosche
Goos-Hänchen and Imbert-Fedorov shifts in photonic graphene

Robert Hecht
Untersuchung der Temperaturverteilung in Festkörpern bei Bestrahlung mit Femtosekunden-Laserpulsen

Tobias Heuermann
Aufbau eines Experiments zur kohärenten Anti-Stokes-Raman-Spektroskopie mittels ultrakurzer Pulse

Friedrich Horschig
Untersuchung zur Optimierung des optischen Durchbruchs in Wasser mittels zeitlicher Formung ultrakurzer Laserpulse

Mark Kremer
Topological Bound States in Non-Hermitian Systems

Annika Tamara Schmitt
Ramanspektroskopie von ultrakurzpuls-induzierten Nanostrukturen in transparenten Materialien

Stephan Schuhmann
Spektrale Verbreitung und zeitliche Kompression ultrakurzer Pulse hoher Leistung

Master Theses

Muhammad Ahmad
Design of diffractive optical elements using iterative projection type algorithm (IPTA)

Shan Du
Optical properties of aluminia-aluminium fluoride mixture coatings prepared by evaporation

Rui Fan
The AC-method for finding initial system setups

Gashaw Fente
Optimization of segmented components in illumination systems

Martin Gebhardt
Peak power scaling of ultrafast, thulium-doped fiber lasers

Marcel Gerold
Ion beam correction of lithography substrates for high precision optical components

Lorenz von Grafenstein
Stacking of Chirped Femtosecond Pulses with an Ultra-long Enhancement Cavity

Selam Wondimu Habtegiorgis
Investigation of human adpatation to distortion of provided optical information

Martin Heilemann
Siliziumoberflächenmodifikation durch Laserstrukturierung zur Realisierung hochempfindlicher Photodetektoren

Egor Khaidarov
Narrowband plasmonic resonances and their applications

Eric Ofosu Kissi
Characterization of femtosecond laser induced nanogratings

Soumera Kousar
Highly Precise Soldering of End Mirrors of a Miniature Diode-Pumped Solid State Laser for European Space Agency ExoMars Mission

Norbert Modsching
Wavelenght dependence of Mode Instabilities in Ytterbium-doped High-power Fiber Amplifier

Sergii Morozov
Relaxation dynamics of quantum systems in the vicinity of plasmonic structures

Michael Müller
Multidimensional coherent pulse addition of ultrashort laser pulses

Mateusz Oleszko
Simulation of the Stress induced birefringence in mounted optical elements

Ivan Fernandez de Jauregui Ruiz
DSP based mitigation of fiber non-linearity in fiber optic coherent communication systems

Kristin Pfeiffer
Atomlagenabscheidung von Vanadiumdioxid mit thermochromem optischem Effekt

Illia Thiele
Investigation of nonlinear effects in plasmonic nanostructures by finite difference time domain simulations

Qian Xu
Characterization of magnetron-sputtered amorphous silicon layers

Huiying Zhong
Modelling of surface scattering by ray tracing and field tracing

Yi Zhong
Imaging with Scheimpflug setup

ExamTheses in Educational Physics

Stefanie Böttcher
Entwicklung einer Experimentierreihe zum Thema Optik in der Sekundarstufe I

Diploma Theses

Benjamin Fuchs
Schattenfotographische Untersuchung an Doppelpuls-Laserinduzierten optischen Durchbrüchen in Wasser

Soheil Mehrabkhnai
Solving transport of intensity equation using Fourier method

Doctoral Theses

Dominik Bartl (Abbe School of Photonics)
Indirekte Ablationsprozesse mit ultrakurzen Laserpulsen am Beispiel des Dünnschichtsystems Glas-Molybdän

Lars Dick
Spritzgießen hochpräziser freiformoptischer Komponenten

Sven Döring (Abbe School of Photonics)
Untersuchungen zur Bohrlochentwicklung beim Ultrakurzpulslaserbohren

Hans-Christoph Eckstein (Abbe School of Photonics)
Modenkontrolle in Halbleiterlasern durch monolithisch integrierte mikrooptische Elemente

Falk Eilenberger (Abbe School of Photonics)
Raumzeitlich-nichtlineare Optik und die Untersuchung diskreter Light Bullets

Florian Jansen (Abbe School of Photonics)
Very-Large-Mode-Area Fibers for High-Power Laser Operation

Stefanie Kroker
Siliziumbasierte resonante Wellenleitergitter für rauscharme Resonatorkomponenten

Maria Oliva (Abbe School of Photonics)
High efficiency blazed gratings in resonance domain

Oliver Pabst (Abbe School of Photonics)
All Inkjet Printed Piezoelectric Polymer Actuators for Microfluidic Lab-on-a-Chip Systems

Miroslaw Rekas (Abbe School of Photonics)
High power scaling of optical amplifiers on the basis of the Stimulated Raman Scattering in optical fibers

Sören Richter (Abbe School of Photonics)
Direct laser bonding of transparent materials using ultrashort laser pulses at high repetition rates

Marcel Schulze
Stochastische Antireflexstrukturen in Kieselglas

Thomas Weber
Drahtgitterpolarisatoren für Anwendungen im UV-Spektralbereich

Institute of Solid State Physics

Bachelor Thesis

Andreas Masek
Optische Spektroskopie und LEED an Blei-Phthalocyanin auf Graphen

Josua Kottke
Gradientensublimation und Quadrupol-Massenspektroskopie

Susanne Fuchs
Schalten von Molekülen in einer SnPc/PTCDA-Heterostruktur

Tino Morgenroth
Strukturbestimmung von hoch geordneten DBP Filmen auf Au(111)

Sascha Creutzburg
Untersuchung der elektrischen Eigenschaften von funktionalisierten ZnO-Nanodrähten

Maximilian Zapf
Oberflächenmodifikation von ZnO-Halbleiternanodrähten für sensorische Anwendungen und die UV-Photodetektion

Kevin Murray
UV-VIS Spektroskopie an ZnO Nanodrähten

Torsten Lindemann
Kathodo- und Photolumineszenz-Untersuchungen an CIGSe-Hochtemperaturabsorbern

Walter Dickmann
Elektrische Charakterisierung von CIGS-Solarzellen

Julia Baldauf
Charakterisierung von Struktur und Eigenschaften von ß-Ga_2O_3 Einkristallen

Philipp Lorenz
Gallium-, Stickstoff- und Europium-Ionenimplantation zur optischen Dotierung von SiO_2

Florian Wittkämper
Ionometrische Untersuchungen an homoepitaktischen ZnO-Schichten

Jari Domke
Nachweis von Fremdatomen in Glas mittels RBS

Leonie Kaczmarek
Transmissionselektronenmikroskopie von Siliziumkarbid nach Ionenimplantation bei 625 K

Malte Per Siems
Bestimmung der Absorption in Silizium bei 1550 nm

Brian Seyfarth
Messungen der thermo-optischen Koeffizienten von Saphir von 10 bis 410 K

Christian Hopf
Charakterisierung eines Großhub-SQUID mit intrinsischer Rückkopplung

Jessica Golm
Messverfahren zur Bestimmung supraleitender Materialparameter

Sabine Stück
Modifikation von YBCO-Schichten mit Au-Nanopartikeln

Diploma, Master and state examination theses

Christian Zwick
Dotierung hochgeordneter, ultradünner Schichten organischer Moleküle - Das System PTCDA+nK/Ag(111)

Julia Peuker
Epitaktisches Wachstum von organisch-organischen Heterosystemen

Tino Kirchhubel
Wachstum und Dotierung ultradünner DBP-Schichten auf Metalleinkristallen und Glimmer

Tobias Hümpfner
Wachstum und Dotierung von Coronen

Tesfaye Belete
Thinning of thin-film Cu(In,Ga)Se_2 solar cell absorber layer

Martin Salge
Herstellung und elektrische Charakterisierung von dotierten CdTe-Dünnschichtsolarzellen

Martin Krauße
Elektrooptische Untersuchungen an ionenimplantierten InS-Dünnschichten

Alexander Kusch
Elektrische und strukturelle Untersuchungen an sequenziell prozessierten Cu(In,Ga)Se2-Solarzellen

Marcel Hopfe
Ionenimplantation und thermische Ausheilung von Vanadiumdioxid-Dünnschichten

Alexander von Müller
Investigations of ion beam induced nanoscale ripple patterns and their effect on protein-surface adsorption

Sebastian Vatterodt
Elektrische und optische Charakterisierung von undotierten und dotierten Vanadium (IV)-oxid-Dünnschichten

Stefan Noack
Sputter effects of silicon nanowires under ion bombardement

Romina Diener
Modifikation der supraleitenden Schichteigenschaften von YBCO durch Nanopartikelwachstum

Falk Wyrwa
Strukturelle Untersuchungen an dünnen YBCO-Schichten mit Au Nanopartikeln

Bastian Walter
Verlustuntersuchungen an dielektrischen Materialien

Robert Müller
Entwicklung und Realisierung reaktive Multischichtsysteme für laserinduzierte Bondverfahren

David Reifert
Elektrische Untersuchungen an Pniktid-Einkristallen

Dissertations

Michael Kozlik (Abbe School of Photonics)
Hybrid Solar Cells

Jana Sommerfeld
Ion beam modification of surfaces for biomedical applications

Ivo Zunke
Erzeugung von halbleitenden transparenten Zinkoxid-Nanoschichten unter Atmosphärendruckverhältnissen durch flammenpyrolytische Abscheidung

Institute of Solid State Theory and Optics

Master thesis

P. Pflugradt
Silicene on metallic surfaces

M. Laubscher
Elektronische und optische Eigenschaften von amorphen Germaniumnanokristallen eingebettet in eine kristalline Siliziummatrix

M. Fitzner
Topological quantum states in a tight-binding framework including nearest-neighbor spin-orbit interactions

He Zhi
Directional scattering by multimode interference for nano-antennas

Renwen Yu
Controlling the Interaction Between Localized and Delocalized Surface Plasmon Polariton Modes in Graphene

Diploma thesis

Jakob Straubel
Beschreibung der starken Kopplung in quantenplasmonischen Systemen

Dissertations

Shakeeb bin Hasan (Abbe School of Photonics)
Waveguide Approach to Plasmonic Antennas

Stefan Mühlig (Abbe School of Photonics)
Towards Self-Assembled Metamaterials

Habilitation

Stefan Skupin
Nonlinear Dynamics

Otto Schott Institute of Materials Research

Bachelor theses

Tobias Büttner
Kinetische Untersuchung der Verdickung kristalliner Lamellen eines semikristallinen Diblockcopolymers im Soft-Confinement

Dorothea Mey
Optimierung von Tröpfchendichte und -größe beim partiellen Aufschmelzen im Temperaturgradienten

Björn Naumann
Modellierung und Vorhersage der Steifigkeit laminierter Spread-Tow-Faserhalbzeuge

Elard Niemöller
Untersuchungen zur Oberflächenstruktur und Stabilität von Farbdekor auf Porzellan

Christoph Otzen
Moleküldynamiksimulationen zur Untersuchung der Kompatibilität zwischen organischen Molekülen und statistischen Copolymeren

Henriette Tetzner
Virtuelle Gold-Substrate auf Silizium-Wafern: ein oxid-basierter Pufferansatz

Master theses

Anne Veronika Boehm
Experimental and theoretical examination of the solubility of different dyes in the hydrophobic core of block copolymer micelles

Marcel Ehrhardt
Untersuchungen zur Wärmeleitfähigkeit und Viskosität gefüllter Epoxidharze

Karl Gehre
Schmelzelektrospinnen von Hydroxylapatit-Polycaprolacton-Kompositen

Carolin Hühn
Struktur und Eigenschaften von Gold auf SiO2-Oberflächen

Suraju Olawale Kasali
Fabrication and Optical Characterization of 3D Photonic Crystals

Maher Kouli
Vorhersage der Laminatsteifigkeit für Faservolumenanteile größer 40 vol% - Modellierung verschachtelter Faserhalbzeuge zur Vorhersage der Laminatsteifigkeit

Sebastian Matthes
Untersuchungen zum Prozessgaseinfluss beim selektiven Laserstrahlschmelzen von Nickelbasis-Superlegierungen

Jan Reimann
Experimentelle und theoretische Untersuchungen zum simultanen Laserumfangsschweißen rotationssymmetrischer Kunststoffbauteile mittels frei strahlenden Diodenlasern

Janine Reuschel
Mechanische Eigenschaften und Bearbeitbarkeit von feinstdispersen Zirkoniumoxid- und Dispersionskeramiken

Stephan Richard
Untersuchung der technischen Voraussetzungen für die Mikrobearbeitung akusto-optischer Komponenten

Stefan Szemkus
Studie zum Schmelzen und Erstarren im Powder Bed Fusion-Prozess

Caroline Tschirpke
Einfluss der Korngröße und hydrothermale Alterung auf die mikrostrukturellen und mechanischen Oberflächeneigenschaften von Y-TZP/Al2O3 Dispersionskeramiken

Christoph Wenisch
Untersuchungen zum Einfluss optischer Anregung auf das photoakustische Verhalten optisch aktiver Gläser

Doctoral theses

Marcel Fink
Thermodynamik der fest-flüssig-Phasengrenze beim Schmelzen von metallischen Legierungen

Robert Schulze
Erzeugung von Oberflächennanostrukturen mittels kristallisierbarer Diblockcopolymere

Martin Seyring
Charakterisierung von Korngrenzen und Phasen in nanokristallinen Materialien mit Transmissionselektronenmikroskopie

Claudia Lüdecke-Beyer (in Faculty of Biology and Pharmacy)
Investigation of bacterial adhesion mechanisms on nanorough biomaterials surfaces using a novel in vitro testing device

Institute of Optics and Quantum Electronics

Bachelor thesis

Lennart Bock
Erzeugung und Charakterisierung frequenzverdoppelter Pulse am POLARIS-Lasersystem

Justus Bohn
Untersuchungen zur Laserelektronenbeschleunigung mit Hochintensitätslasern

Joachim Buldt
Charakterisierung Yb^{3+}-dotierter Alumosilikatgläser im Laserbetrieb

Moritz Förster
Effiziente Erzeugung von Hohen Harmonischen an relativistischen Plasmaoberflächen durch die Kontrolle der Plasmaskalenlänge

Richard Hollinger
Zusätzliche Optimierungsmaßnahmen zur Erzeugung von Few-Optical-Cycle Laserpulsen

Alexander Kirsche
Vollständige Charakterisierung eines breitbandigen Röntgendetektors

Tilman Lühders
Messung thermooptischer Eigenschaften von Lasermaterialien

Johann Müller
Fokusoptimierung an einem Hochintensitätslaser mit Hilfe einer adaptiven Optik unter Verwendung der Programmiersprache LabVIEW

Sebastian Pumpe
Pulse shaper for contrast improvement in few-optical-cycle laser pulse generation

Carsten Stock
Ionisation von Molekülen mit hohen Harmonischen und deren Untersuchungen mit einem Massen-Flugzeitspektrometer

Frederik Tuitje
Linsenloses Abbilden mittels optischer Vortexstrahlen

Carola Wirth
Charakterisierung von JETI-100 Laserpulsen

Master thesis

Adee Amjad
Characterization of Quality Parameters of Multiple Laser Beams

Georg Becker
Untersuchung des Einflusses von Targetmaterial, Foliendicken und Intensitätskontrast bei der Optimierung der Laser-Protonen-Beschleunigung

Frank Meyer
Generation and Application of Intense, Few-Cycle Pulses at 1.8 um

Abel Hailu Woldegeorgis
X-ray spectropolarimetry of electron excited atoms

Daniel Würzler
Untersuchung der Ionisationsdynamik nichtsequentieller Mehrfachionisationen in Edelgasen im Sub-Femtosekundenbereich

Philipp Wustelt
Ionisation atomarer Ionen in intensiven Laserfeldern

Dissertationen

Sebastian Höfer (Abbe School of Photonics)
Zeitaufgelöste Röntgenbeugung an einkristallinem Indiumantimonid

Christian Kern (Abbe School of Photonics)
Extreme Nonlinear Optics with Spatially Controlled Light Fields

Thomas Kiefer (Abbe School of Photonics)
Investigation of the laser-based Target Normal Sheath Acceleration (TNSA) process for high-energy ions — an analytical and numerical study

Jörg Körner
Effizienzsteigerung Yb^{3+} - basierter Kurzpuls-Laserverstärker

Christian Rödel (Abbe School of Photonics)
Synthese von extrem ultravioletter Strahlung an relativistischen Plasmaoberflächen

Michael Schnell (Abbe School of Photonics)
Betatron Radiation from a Laser-Plasma Accelerator

Michael Zürch (Abbe School of Photonics)
Coherent High-Resolution Imaging of Artificial and Biological Specimens using Compact Ultrafast Extreme Ultraviolet Sources

Institute of Theoretical Physics

Bachelor thesis

Jacob Abel
Tomographic reconstruction of density matrices from informational complete and incomplete measurements: Implementation and comparison of entanglement measures for different methods

Tobias Bucher
Implementation and simulation of discrete time quantum walks on regular graphs within the Feynman tools

Markus Gardemann
Höhere Spin-Gravitation in AdS/CFT

Sebastian Grieninger
Anwendung von AdS/CFT auf Systeme der kondensierten Materie

Piet Hessenius
Orbital dynamics in post-Newtonian mechanics

Sabrina Kaack
Das Newtonsche Gravitationsfeld eines Systems aus zentraler Punktmasse und umgebenden Staubring: Eine Integralgleichungs-Methode

Daniel Reiche
Einfluss von Higgsbindungszuständen auf W/Z-Streuung am Large Hadron Collider

Jan Schumm
Lichtablenkung in der Kerr-Raumzeit

Marc Steinhauser:
Spektralmethoden zur Lösung von Flussgleichungen

Sebastian Stock
Berechnung der Winkelverteilung und Polarisation Thomson-gestreuter Photonen:
Vergleich zwischen ebenen Wellen und Twisted Light

Chantal Sundqvist
Exakte Lösungen des anharmonischen Oszillators sowie des Doppel-Mulden-Potentials im Limes großer Dimensionen

Dorothee Tell
Geodäten in der Raumzeit eines geladenen Schwarzen Loches

Sebastian Ulbricht
Geometrische Eigenschaften der Reissner-Nordström-Raumzeit

Julian Weigt
Oppenheimer-Snyder Collapse

Master thesis

Dvin Galstain
Kritisches Verhalten des dreidimensionalen Gross-Neveu- und Thirring-Models

Suraj Krishnamurthy
Simulation of a two-dimensional, N=2 supersymmetric lattice gauge theory

Doctoral thesis

Daniel Körner
Supersymmetric Lattice Models

Lars Rößler (Abbe School of Photonics)
Quanteneffekte in starken Feldern

Appointments of scientists of the Institute

Axel Maas
Full Professor, University of Graz, Austria (10/2014)

Research Group - Teaching Methodology in Physics and Astronomy

State examination thesis

Stefanie Böttcher
Entwicklung einer Experimentierreihe zum Thema Optik in der Sekundarstufe I

Florian Gausche
Ein Vergleich der Bohmschen und der Kopenhagener Interpretation der Quantenmechanik hinsichtlich ihres didaktischen Nutzens

David Hagedorn
Das Verhältnis von Physik und Religion in der heutigen Zeit: Konzepte eines konstruktiven Dialogs

Daniel Reichelt
Die Integration des heliozentrischen Weltbildes in den Schulunterricht im 16. und 17. Jahrhundert

Katrin Ruhner
Die Geschichte der Entwicklung von Größenvorstellungen und des Evolutionsgedankens in der Astrophysik

Bachelor thesis

Marlene Götz
Maßstäbe, Geodäten und Horizonte in Friedmann-Lemaitre-Weltmodellen

Abbe School of Photonics

Doctoral thesis (in other faculties only)

Melanie Becker-Puts
Untersuchungen an ausgewählten Brustkrebszelllinien mittels Raman-Mikrospektroskopie und chemometrischer Methoden

Barbara Seise
Moderne Nukeinsäure-basierte verfahren für den Pathiogennachweis

Ina Anja Weißflog
Application of Raman Spectroscopic Methods for the Elucidation of Defense Mechanisms in Plants

Linda Zedler
(Resonanz)Raman- und Redox-sensitive Spektroskopie zur Prozessaufklärung in funktionellen Molekülen

Ute Münchberg
Monitoring the signaling state of bacteria by means of optical spectroscopic technologies

Frank Theil
Synthese und Charakterisierung artifizieller Reaktionszentren

The Graduates of the cohort 2013/14

7. Research Activities

7.1. Institute of Astrophysics and University Observatory

a) Fields of research and results

Observational Astrophysics:

In our projects on transiting planets, we continued photometric monitoring of young clusters in the YETI program (Young Exoplanet Transit Initiative), a worldwide collaboration led by us. The first transit planet candidate found by us in the cluster Tr-37 was identified to be a low-mass binary star (Errmann et al.). Follow-up observations of two further candidates in Tr-37 and 25 Ori are underway. We also contributed observations for transit timing variations, i.e. perturbations of orbits of known transiting planets, which would be indications for a further planet. Monitoring of several targets with our telescope and several other world-wide telescopes of the YETI network did not reveal new variations (e.g. Seeliger et al., MNRAS 441). With many transits of TrES-2 observed with the Kepler satellite, we could not confirm other claims about small variations (Raetz et al.).

In the projects on directly imaged sub-stellar companions to young stars, we published our infrared spectra of PZ Tel B, taken with Sinfoni at the VLT, so that we could constrain its mass better than before. Our result places the companion in the low-mass brown dwarf regime (Schmidt et al.). Astrometric follow-up observations of additional previously found brown dwarf companions could constrain their orbits (Ginski et al., MNRAS 444). Furthermore, a close companion was found to an early-type binary star in a planetary nebula (Adam & Mugrauer, MNRAS 444).

In our participation in the SFB TR on gravitational waves, we published first results on the compactness of two further neutron stars obtained with rotational phase-resolved X-ray spectroscopy (Hambaryan et al., JPCS 496) and also finished our large population synthesis program on OB stars, in order to predict best places for detection of young neutron stars and gravitational waves in the Galaxy (Schmidt et al., AN 335).

Further investigations of the strong short-term radiocarbon variation around AD 774/5 have been carried out to show (i) that the Chinese comet in January AD 773 did not collide with Earth, as was claimed, so that it did not deliver radioisotopes (Chapman et al.), and (ii) that an observation of a transient celestial event in AD 775 found be us in the Arabic chronology of al-Tabari was not a nova, supernova, nor kilonova, so that it is not related to the AD 774/5 radiocarbon variation, but that it was a bolide (Neuhäuser & Kunitzsch, AN 335). Furthermore, we summarized all doubts and problems related to a solar super-flare (Neuhäuser & Hambaryan). We studied in detail the Kepler data of the two largest, presumably solar-like super-flare stars and found that in at least one of the two cases, the single super-flare did not happen on the presumably solar-like star, but on a star nearby, either a companion or a background source, which cannot be assumed to be solar-like (Kitze et al.).

The individual instruments, which are operated at the university observatory in Großschwabhausen, were used in 2014 in total in 131 nights for astronomical research, as well as for teaching activities, in practical courses of the lecture “Astronomical Observational Techniques” and in the “Astronomical lab”.

The Echelle spectrograph FLECHAS was used in 2014 during 83 nights to study the Lithium abundance of candidates of runaway-stars, as well as for the spectral classification of young and massive stars.
(Neuhäuser, Mugrauer, Hambaryan, et al.)

Theoretical Astrophysics:

Based on data from several programmes of the Herschel Space Observatory, we studied a sample of 34 spatially resolved debris discs, the largest sample of its kind to date. We identified new statistical trends and proposed conceivable explanations (Pawellek et al. 2014). For the debris disc around the nearby K2 star HIP 17439, which was imaged by the Herschel Open Time Key Programme (OTKP) “DUNES” (PI: C. Eiroa, Spain), we set up detailed theoretical models through multi-parameter fitting (Ertel et al., A&A 561) and performed in-depth collisional modelling with our ACE code (Schüppler et

al., A&A 567). We also studied young debris discs around members of the "Beta Pictoris Moving Group" (Riviere-Marichalar et al., A&A 565), observed in the framework of the Herschel OTKP "GASPS" (PI: W. R. F. Dent, Chile). In another project, we aimed to improve our understanding of the transition from the protoplanetary phase to the debris disc phase (Kobayashi & Löhne, MNRAS 442). Our investigation of the outer debris disc of the solar system, the Kuiper belt, was continued with a model of its asymmetric dust distribution and the detectability thereof by means of the dust detector aboard the New Horizons space probe (Vitense et al., AJ 147). Further, we took part in an ongoing investigation of the properties of planet and debris disc host stars. Already in 2013, we proved observationally that a temperature minimum exists in the chromosphere of alpha Cen A (Liseau et al., A&A 549); now, the same phenomenon has been shown to exist for alpha Cen B (Wiegert et al., A&A 563).
(Krivov, Löhne, Vitense, Schüppler, Pawellek; in collaboration with the Herschel/DUNES and GASPS teams and other groups in Europe, USA, and Japan; with funds granted by the DFG)

Laboratory Astrophysics I – Astromineralogy:

In the laboratory group of the AIU, the DFG-funded research project "Measurements of the far-infrared to millimeter dust opacity at low temperatures" has been continued (P. Mohr, H. Mutschke, G. Born, DFG Priority Programme 1573 – "Physics of the Interstellar Medium"). Amorphous silicates have been synthesized and their absorption depending on iron content and temperature has been measured in the wavelength range 100 micrometers to 4 millimeters in collaboration with the 1. Phys. Institut der Universität Köln. A relation with the distribution of the two iron oxidation states, which has been determined by Mößbauer spectroscopy (collaboration IFK, U. Reislöhner), has been established. The millimeter wave spectroscopy setup developed in Cologne for these measurements has led to a publication in Rev. Sci. Instrum. (Potapov, Lewen, Mutschke, Mohr, Schlemmer). The proposal for a second project period, in which we will focus on spectroscopy of carbonaceous materials in the same long-wavelength range, has been successfully defended and funding was confirmed by DFG.
At shorter infrared wavelengths, minerals from meteorites have been spectroscopically investigated, in particular constituents of chondrules and Ca-Al-rich inclusions (CAIs) which have been isolated from a number of different meteorites. These minerals are likely to be abundant in the dust of debris disks of other stars as well. The results were presented at the meeting of the Deutsche Mineralogische Gesellschaft in Jena (P. Mohr).
In cooperation with the theory group (A. Krivov, T. Löhne), we developed a temperature-dependent model of the opacity of crystalline water ice particles, based on spectroscopic measurements in the wavelength range up to 400 micrometers (C. Reinert, H. Mutschke, P. Mohr).

7.2. Institute of Applied Optics

a) Fields of research and results

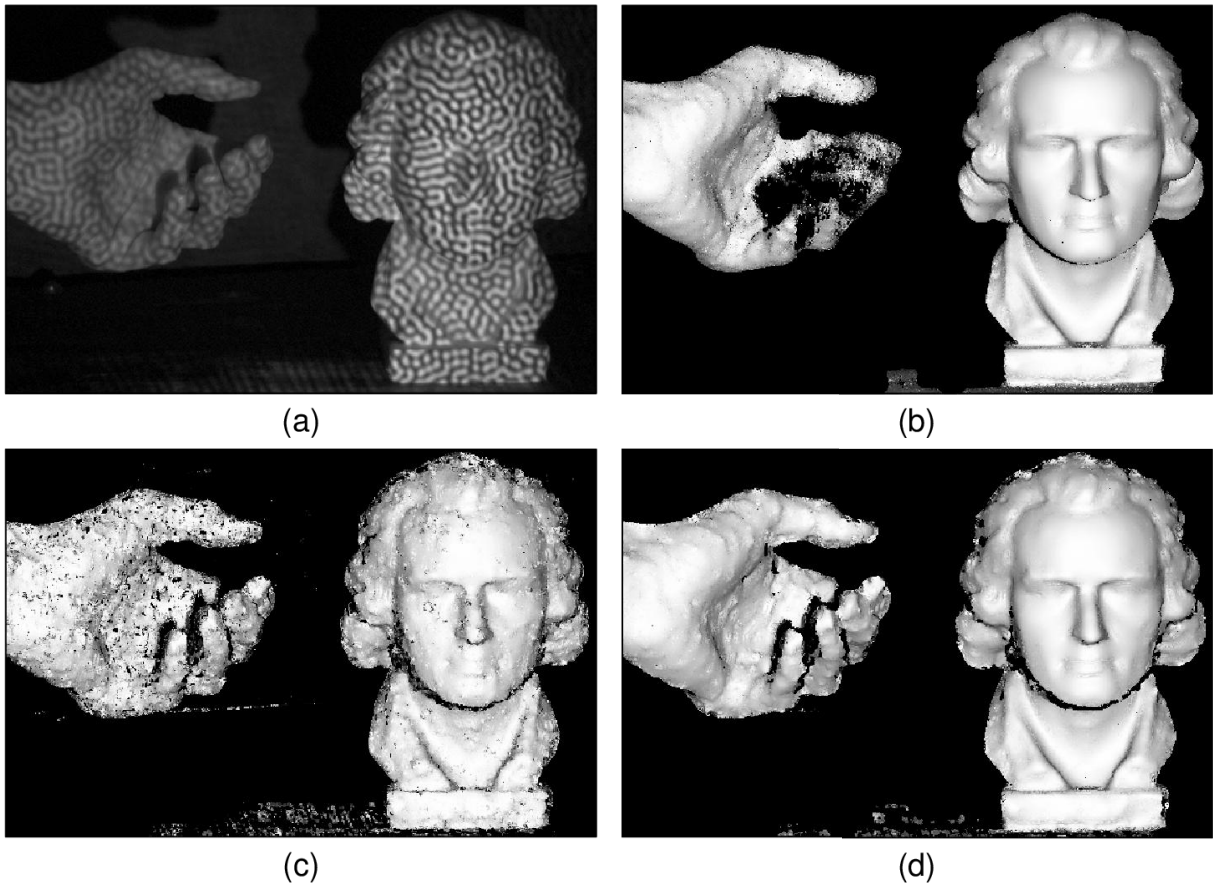
The main fields of research at the IAO are

- Optical measurement techniques
- Optical information storage and processing
- Interaction of optical wave fields with materials and surfaces
- Synthesis, analysis and transformation of laser modes and laser beam forming with diffractive optical elements (DOE)
- Linear and nonlinear laser-based imaging techniques
- Cell and tissue manipulation by ultrashort laser pulses
- Applications of lasers and optics in ophthalmology

Following a long tradition at the IAO, works in the field of optical metrology at the institute are highly focused on possible applications. Corresponding techniques are the optical acquisition of three-dimensional shapes and changes of shapes (structured illumination, holography and interferometry) as well as wavefront sensing and the analyzing of laser beams.

In the field of 3D-metrology using stereophotogrammetry several new developments and advancements have been done. Based on the high-speed techniques that were developed over the last years, as the translation of statistical patterns or the ultra-fast switching of speckle patterns with and without acousto-optical deflectors, physical limits of such systems have been determined underpinned by numerical simulations.

In this context, a new camera calibration (vision ray calibration) has been implemented and compared in simulation with the standard Zhang calibration to gain advantages at the calibration of optical systems with strong aberrations. In this range, e. g. the accuracy of the correlation of points depending on different classes of patterns, the signal-to-noise ratio (SNR) as well as special weighting functions have been investigated and equations have been derived to evaluate 3D-setups based on stereophotogrammetry with structured illumination. Additionally, work on the registration of point-clouds with the ICP-algorithm has been done as a first step to implement all-around measurements of objects within the current software.
A speckle illumination with a linear shape has been developed and it's optical and stereophotogrammetric properties have been evolved. Additionally different possibilities to create variable objective speckle patterns have been tested.



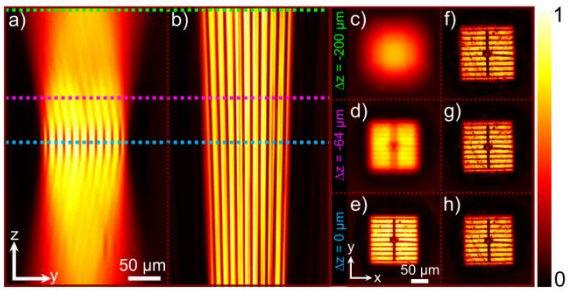
(a) A camera frame of a dynamic scene that contains a static white bust and a comparatively dark hand that opens up. Corresponding point clouds that were reconstructed using (b) temporal, (c) spatial, and (d) adaptive spatiotemporal correlation.
(B. Harendt, M. Große, M. Schaffer, and R. Kowarschik, "3D shape measurement of static and moving objects with adaptive spatiotemporal correlation," Appl. Opt. 53, 7507-7515 (2014))

Besides fast measurement techniques, there are different possibilities to measure moving objects. Another method uses an adaptive spatiotemporal correlation method that adopts its temporal and spatial support to motion and further applies motion compensation. This makes the measurement system robust on movements of the measured objects. First experimental and simulated results could verify that this adaptive correlation (see (d) of the following figure) is less sensitive to motion than the common temporal correlation (see (b)) but more precise than the common spatial correlation (see (c)).

The partnership with the Fraunhofer IOF, Jena, several companies and academic institutions in the field of 3D-measurement was intensified within the strategic alliance 3dsensation. Common joint projects are now in preparation. The development of fast 3D-sensors at IAO and IOF were honored with the Thuringian research award 2013 for Prof. Kowarschik and the IOF-colleagues Dr. Notni und Dr. Kühmstedt.

The research in digital holography using high resolution CCD-chips was continued. The Moiré-effect was used to increase the angular size of objects to be recorded and to increase the resolution of objects in image field holography. Work in the field of a holographic version of an image inverting interferometer has been continued as well characterizing the setup and exploring characteristics of the technique.

In 2014 simulations have been done to demonstrate the imaging properties of different microscopic techniques in combination with an image inverting interferometer. The work on measuring the complex coherence function using an image inverting interferometer has been continued. E. g. in theory an infinite depth-of-field can be gained by this method. The theoretical predictions have been compared to measurements. Additionally, the technique yields a suppression of different aberrations as well as an increased lateral resolution. The figure contains the cross section of an imaged LED demonstrating the extended depth-of field of the image inversion technique (b, f-h) compared a conventional incoherent image (a, c-e).



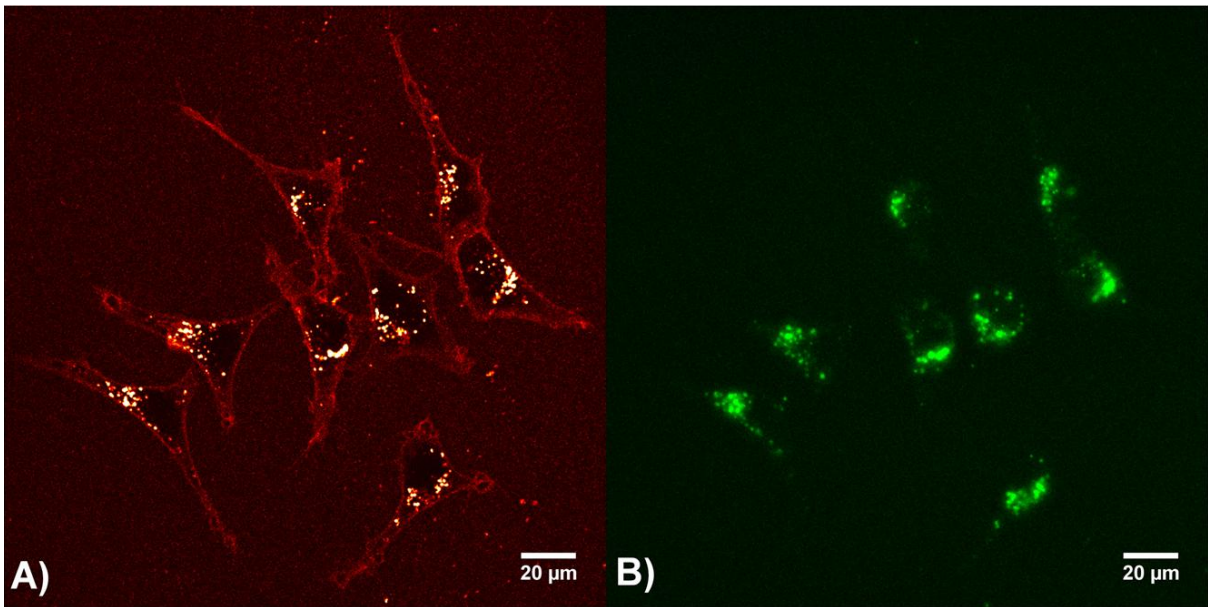
Cross section of an imaged LED demonstrating the extended depth-of field of the image inversion technique (b, f-h) compared a conventional incoherent image (a, c-e) (D. Weigel, H. Babovsky, A. Kiessling, and R. Kowarschik, "Widefield microscopy with infinite depth of field and enhanced lateral resolution based on an image inverting interferometer," Opt. Comm. 342, 102-108).

Works on the "adaptive optical real-time phoropter" have been continued in 2014 in cooperation with the hospital ophthalmology at the Johann-Wolfgang-Goethe University Frankfurt (Main). Preparations have been done to extend the system into a binocular setup.

In collaboration with a Jena company an improved technology of the fine polishing of optical glasses was developed and successfully applied. The concept is based on the polishing with CeO2-slurries and chemical ultrasonic cleaning, and a final roughness of the optical surfaces 0.1 nm was achieved.

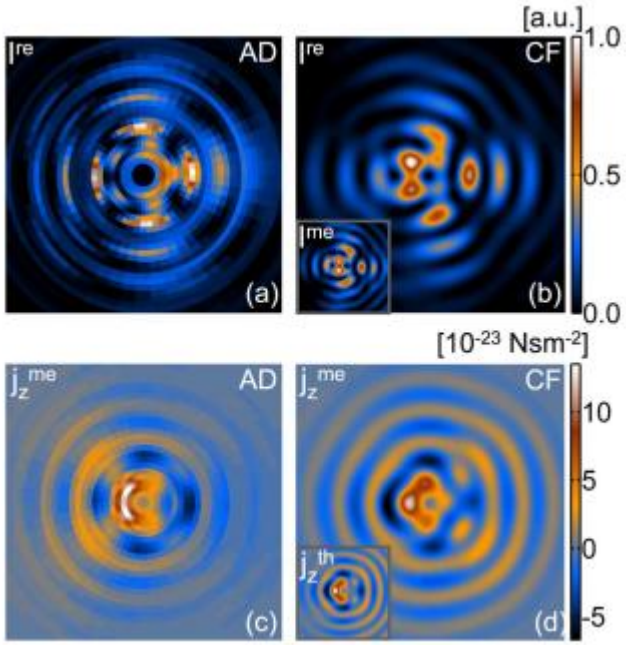
In the area of biomedical optics and biophotonics (RG Heisterkamp) several works have been conducted in 2014, although however, Prof. Heisterkamp left the FSU to accept a professorship at Leibniz University, Hannover.
In the field of cellular manipulation, ns-lasers have been employed to achieve and intracellular release of model drugs into the cytoplasm, in close collaboration with the RG of Prof Barcikowski, Duisburg Essen University.
In the field of nonlinear optics, imaging of several structures of the eye (neuropathology, distribution of Riboflavin in the cornea etc.) could be performed by two photon imaging and integrating further

modalities like third harmonic generation and four wave mixing. Furthermore, an adaptive optics setup was implemented into this nonlinear microscope, allowing the compensation of aberrations in deep tissue imaging.



Multiphoton-microscopy images of cells with AuNP−CWR_{10} conjugates: (A) Excitation at 1050 nm shows the cell membrane stained with CellMask Orange and the conjugates luminescence. (B) AuNP−CWR_{10} conjugates luminescence excited at 720 nm, where the cell membrane cannot be detected, Gamradt et al., J. Phys. Chem C., 2014

A further area of research of the institute is connected with the synthesis, analysis, and transformation of laser modes respectively laser beams, as well as laser beam shaping, mainly by means of diffractive-optical elements (DOEs). In 2014 the focus was on on-line laser beam analysis, which is not only of fundamental physical interest, but represents an essential precondition for the industrial application of certain laser systems. Especially in connection with the investigation of transversal modes in so called optical passive fibers, intended for lossless transportation of brilliant laser radiation from its origin (fiber laser respectively solid state laser) to the point of application, but furthermore in the case of active optical fibers, the concept of modal analysis by correlation filter method delivers valuable information about the laser beam. This concerns (relative) modal strengths, intermodal phase differences as well as mode-resolved polarization states – parameters of the laser beam hard or even impossible to access by “standard” measurement procedures.
A specific key point in 2014 was the application of dynamically programmable DOEs, realized as Spatial Light Modulators (SLM), which enables a much higher flexibility compared to earlier approaches. Well-defined selective excitation of specific modal superpositions at the input of few-mode-fibers in combination with high precision measurement of the modal distribution of the optical field at the fiber output, allows to determine the so called “Modal Transfer Function” of the waveguide under test. This approach will enable promising applications for the future.
A further, very sophisticated approach of mode analyzing by means of DOEs is the application to synthesis and recognition of laser beams carrying specific Optical Angular Moments (OAM). OAM represents an additional degree of freedom for information transfer in fiber bound respectively free space communication lines, additionally to the actually used parameters wavelength and polarization state.



Decomposition of a nonsymmetrical superposition of three Bessel beams, $\mathbf{J}_{-3}(\mathbf{q}_1\mathbf{r})\exp(-3\mathbf{i}\phi)+\mathbf{J}_2(\mathbf{q}_2\mathbf{r})\exp(2\mathbf{i}\phi)+\mathbf{J}_1(\mathbf{q}_3\mathbf{r})\exp(\mathbf{i}\phi)$. (a), (b) Reconstructed beam intensity from azimuthal decomposition (AD) and from modal decomposition using a correlation filter (CF); (c), (d) reconstructed OAM density from azimuthal decomposition (AD) and from using a correlation filter (CF). The insets depict the directly measured beam intensity and theoretical OAM density. The depicted section is 2.4 mm × 2.4 mm. Exemplary result, taken from Applied Optics, Vol. 53, Issue 26, pp. 5924-5933 (2014) http://dx.doi.org/10.1364/AO.53.005924 "Measurement of the orbital angular momentum density of Bessel beams by projection into a Laguerre – Gaussian basis".

b) National Cooperations

In the field of optical measurement techniques we have collaborations with several institutes of our Faculty and German companies. Long-term cooperation and relationships exist with the Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF, Jena, on the subject of optical 3D-shape measurement with structured illumination.

In the area of nonlinear imaging several collaborations with research groups in Hannover are presented, especially since Prof. Heisterkamp accepted an offer from Hannover University in February 2014 for a W3 position. He is a member of the research cluster REBIRTH and the German Center for Lung Research (DZL), collaborations especially with Prof. Ochs, MHH, in the field of lung imaging.

With the group of Prof. Barcikowski, the works on gold nanoparticles and cell manipulation are continued. With the RG Stachs (Rostock) a joint abstract was presented at the ISER conference, San Francisco and further studies in the field of ophthalmology have been conducted.

Concerning the spatial characterization of laser beams respectively of modal properties of waveguides, both by means of Diffractive Optical Elements, we cooperate with the Leibnitz Institute of Photonic Technology, Jena, and with a major German laser manufacturer.

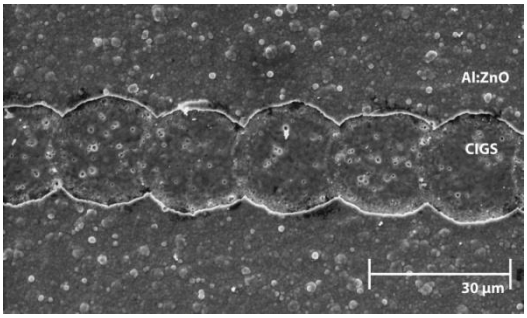
7.3. Institute of Applied Physics

a) Research areas and results

The Institute of Applied Physics practices fundamental and applied research in the fields of micro- and nano-optics, fiber and waveguide optics, ultrafast optics as well as optical engineering. It develops novel optical materials, elements and concepts for information and communication technology, life science and medicine, security and mobility, environment and energy as well as process technology including material processing and optical measurement techniques.

Ultrafast Optics (Prof. Stefan Nolte)

The research group works on various applications of femtosecond laser pulses, such as materials processing and micro / nano structuring of optical materials.



P3 trench generated by ultrashort laser pulses.

- Linear and nonlinear interaction processes between light and matter
- Micro- and nanostructuring with ultrashort laser pulses
- Sub-wavelengths structuring
- Fiber Bragg Gratings (FBG), Volume Bragg Gratings (VBG)
- Linear and nonlinear optics in discrete systems
- Medical laser applications in ophthalmology
- THz technology

In 2014, some outstanding results were: simultaneous spatial and temporal focusing for improved precision in medical and materials processing applications • spatial and temporal resolved measurement of temperature evolution inside bulk glass after fs-pulse irradiation • demonstration of narrow-linewidth stabilization of diode lasers with fs-written VBGs in fused silica • realization of a fiber mode modulator by femtosecond direct-writing • ultrastable bonding of dissimilar glasses • structural analysis of laser induced nanogratings • realization of broadband THz antireflection structures by fs processing • laser shock experiments simulating impact events in debris disks in space • realization of fs-laser written integrated photonic quantum circuits • demonstration of arbitrary photonic wave plate operations on chip for polarization qubits • demonstration of supersymmetric mode converters • analysis of unconventional edge states in photonic graphene

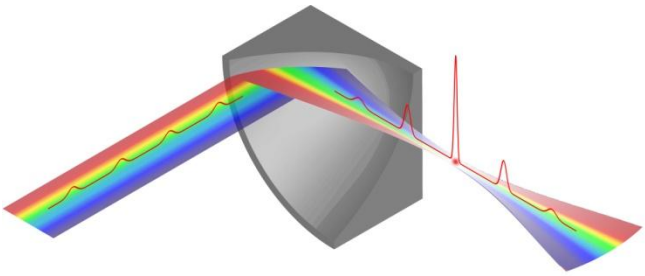
<u>Enhanced Material processing using spatiotemporal pulse shaping</u>

Precise processing of transparent materials using ultrashort laser pulses has enabled various applications ranging from the processing of glass to ophthalmology. While in the past mainly bandwidth-limited pulses were applied, innovative treatment strategies aim at tailoring the nonlinear modification processes using spatiotemporally shaped pulses.

For laser processing deep within the bulk material, the limited numerical aperture of the focusing optics results in high intensities and detrimental nonlinear pulse-material interactions already far in front of the geometrical focus [1]. Simultaneous spatial and temporal focusing (SSTF) was applied to strongly confine the extreme intensities to the focal region. In SSTF the laser pulse possesses its ultrashort duration only in the vicinity of the focal plane [2]. Outside of the focal region, the intensity dramatically drops owing to both the geometrical divergence and temporal prolongation of the pulse.

To investigate the laser-induced optical breakdown, the formation of the plasma and the subsequent evolution of the shock waves were studied in water as a model system. SSTF and conventional focusing were compared using focusing conditions typical for intraocular surgery. Moreover, detailed sim-

ulations have been realized in corporation with the 'Max Planck Institute for the Physics of Complex Systems', Dresden, Germany.
In excellent agreement with the theoretical investigations, the experimentally detected length of the plasma channels induced with SSTF was reduced by a factor of 2 compared to conventional focusing [3]. Moreover, the enhanced intensity confinement of SSTF prevented the formation of extended plasma filaments and sprawling plasma side-lobes observed with conventional focusing, which strongly reduced the precision of the applied modifications. In addition, while the long propagation of conventionally focused pulses within the transparent media resulted in intense white-light generation, the localization of the nonlinear interaction by SSTF nearly entirely suppressed spectral broadening. Significant advantages for eye surgery and precision processing of glasses and crystals result from the more precise localization of the induced modifications.

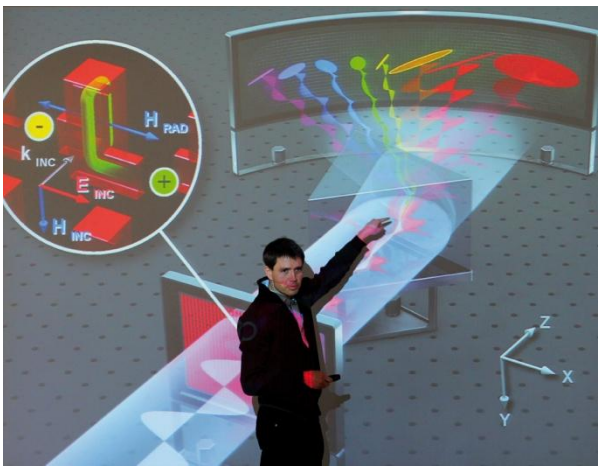


Schematic illustration of simultaneous spatial and temporal focusing (SSTF)

[1] Bergé et al.: Reports on Progress in Physics 70, 10, 1633-1713 (2007)
[2] Zhu et al.: Optics Express 13, 6, 2153-2159 (2005)
[3] Kammel et al.: Light: Science & Applications 3, 5, e169 (2014)

Nano Optics (Prof. Thomas Pertsch)

The research group deals with light propagation and nonlinear light-matter interaction in micro and nano structures, optical metamaterials as well as photonic crystals.



Prof. Pertsch explains the working principle of a photonic nanomaterial.

- Plasmonics and near-field optics, scanning optical nearfield microscopy (SNOM)
- Nanostructured optical metamaterials
- Nonlinear light-matter interaction at high optical intensities in micro- and nanostructures, nonlinear space-time-dynamics
- Nonlinear optical micro resonators
- Nonlinear nano markers for high-resolution microscopy
- Opto-optical switching processes in integrated optics
- New optical technologies for astronomical instruments
- Application of nanostructures to the enhance efficiency of photovoltaic elements

Important results in 2014 are: generation of nonclassical biphoton states through cascaded quantum walks on a nonlinear chip • plasmonic nanoparticle clusters with tunable plasmonic resonances in the visible spectral region • polarization-resolved near-field mapping of plasmonic aperture emission by

a dual-SNOM system • ultra broadband phase measurements on nanostructured metasurfaces • demonstrating extreme plasmonic coupling: a route towards local magnetic metamaterials • highly resonant and directional optical nanoantennas • data transmission in long-range dielectric-loaded surface plasmon polariton waveguides • realization of photonic crystals in lithium niobate by combining focused ion beam writing and ion-beam enhanced etching • new understanding of the energy deposition dynamics of femtosecond pulses in water

Dual-SNOM characterization of nanooptical devices

In photonic circuits, information can potentially be processed faster than in current electronic microchips. Nanooptical plasmonic devices are the building blocks of compact photonic circuits due to their ability to localize light within small volumes.

To microscopically characterize such devices, a method is necessary which can map the near-fields which are localized at the sample surface and which surpasses the diffraction limit of resolution.

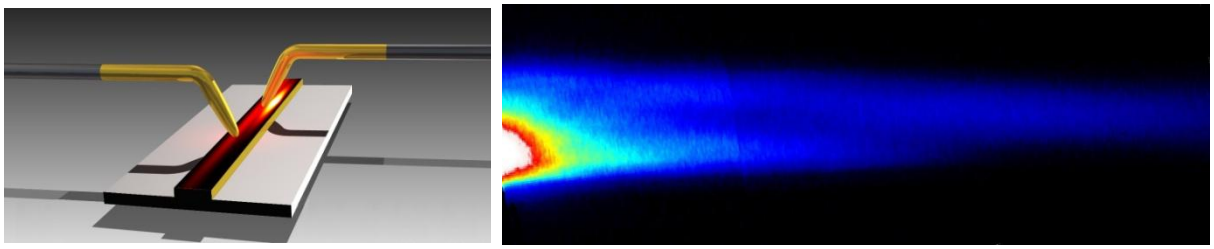
In scanning near-field optical microscopy (SNOM), a sharp, metal-coated tip fabricated from a tapered optical fiber is scanned along the sample surface. The metal coating features a small aperture at the apex. The aperture diameter is chosen between 50 nm and 200 nm in most cases. The sample can either be locally excited by the aperture's near-field, or the sample is illuminated from the far-field while the tip serves to locally collect light.

Usually either the illumination or the collection is done in the far field and with diffraction-limited resolution, thus hampering the characterization of plasmonic devices.

We succeeded in combining two SNOMs with fiber tips into a Dual-SNOM setup. With this setup, the samples can be near-field illuminated at a freely chosen position by the first tip, while the second tip scans the sample surface and maps the optical near-fields [1]. A specially developed approach-warning mechanism serves to prevent collisions [2].

The Dual-SNOM was used to investigate plasmonic leaky modes in gold strip waveguides. In waveguides which support several leaky modes, mode beating patterns were observed. By varying the excitation position, the relative excitation strengths of the different modes could be finely tuned.

The capability to selectively and locally excite modes and to map their optical near-fields at the same time makes the Dual-SNOM a valuable and versatile tool for the characterization of a wide range of micro- and nanooptical devices and structures. In particular, coupling and transport phenomena can advantageously investigated via simultaneous near-field excitation and near-field detection with subwavelength resolution.



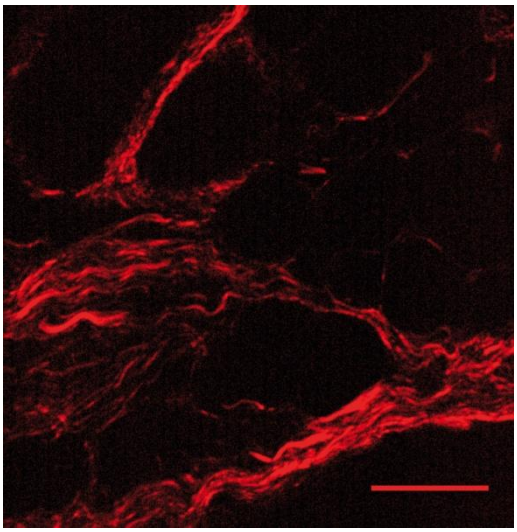
The two tips of a Dual-SNOM on a gold stripe waveguide (artist's view) and image of a gold strip waveguide (width: 2.5µm, light wavelength: 663 nm). The illumination tip is near the left edge of the image.

[1] A. E. Klein, N. Janunts, M. Steinert, A. Tünnermann, and T. Pertsch, Nano Lett. 14, 5010 (2014).
[2] A. E. Klein, N. Janunts, A. Tünnermann, and T. Pertsch, Appl. Phys. B 108, 737 (2012).

Fiber & Waveguide Lasers (Jun.-Prof. Jens Limpert)

The research group is working on the development of new concepts for solid-state lasers with focus on fiber laser technology. Research emphasis lies on fiber-optical amplification of ultrashort laser pulses, ultrashort pulse oscillators, few-cycle pulse generation and amplification, the design of new

large core fibers, the simulation of nonlinear effects and the amplifier dynamics in active fibers, fiber-optical frequency conversion, picosecond µ-chip laser and the generation of high harmonics.



Coherent anti-Stokes Raman scattering microscopic image of a human artery wall.

- Fiber optical amplification of ultra-short laser pulses
- Ultra-short pulse oscillators, few-cycle pulse generation and amplification
- Conception of novel large core diameter fibers
- Simulation of non-linear effects and amplification dynamics in active fibers
- Fiber optical frequency conversion
- Picosecond µ-chip-lasers
- Generation of high harmonics

Coherent Addition of ultrashort pulses

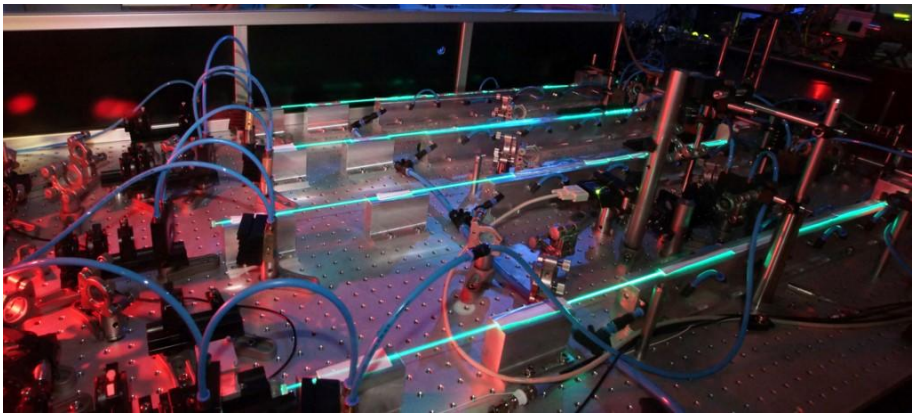
Fiber-laser systems emitting ultrashort pulses have proven to be an indispensible tool for a large number of applications. These systems are distinguished by their excellent beam-quality, efficient operation, compact footprint and high average power. Additionally, in recent years outstanding progress has been made in increasing the maximum peak-power. Thus, today's fiber lasers are able to compete with any other architecture. However, although further power scaling is still possible, it becomes more and more demanding due to fundamental physical limitations. One solution is to use parallelization, i.e. the coherent addition of multiple laser amplifiers [1]. Thus, laser power is not limited by physics any more, but only by size and cost of the envisioned system.

In the setup, the output beam of the last pre-amplifier in a high-power laser system is split into four parallel channels. Large-mode-area fiber amplifiers employing large-pitch fibers developed at IAP/IOF [2] are located in each of the channels. Afterwards, the output beams of all the channels are recombined into a single beam. The combination requires a high-precision temporal overlap of the corresponding laser pulses with a variation of less than an optical cycle and employs, therefore, an active optical-path-length stabilization.

The properties of the combined laser pulses are comparable in beam quality and duration to a single-channel system. However, dramatically higher pulse energies and average powers are achievable. In experimental conditions, 200 fs pulses with an energy of 5.7 mJ, a peak-power of 22 GW and an average power of 230 W were realized, which represents a new record for fiber laser systems [3].

There are a large number of applications for such laser sources. For example, coherent light pulses in the XUV wavelength range can be produced. In a first experiment, an average power for these short wavelengths comparable to a synchrotron has been achieved [4]. With additional power scaling, e.g. by increasing the number of parallel channels, these systems might even be used for applications like laser particle acceleration.

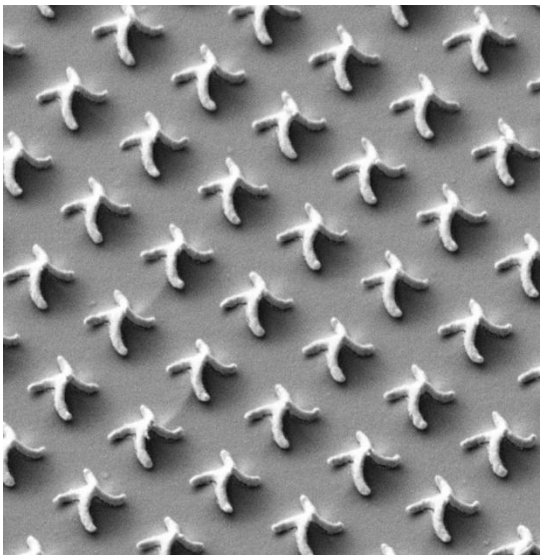
[1] J. Limpert et al., IEEE J. Sel. Top. Quantum Electron. 20, 1–10 (2014).
[2] J. Limpert et al., Light Sci. Appl. 1, e8 (2012).
[3] A. Klenke et al., to be published in Optics Letters
[4] S. Hädrich et al., Nat. Photonics 8, 779–783 (2014).



Main amplifier of an ultrashort-pulse fiber-laser system employing four parallel channels.

Microstructure Technology & Microoptics (Dr. E.-B. Kley)

The research group concentrates fundamentally on function and design of micro- and nano-optical elements as well as applications and technology developments for micro structuring.



In the project "Photonische Nanomaterialien - PhoNa "developed chiral nanostructures for realization of circular dichroism.

- Plasmonic resonant nanometric structures
- Resonant reflective monolithic gratings
- Transmissive, reflective and diffractive elements based on effective media
- Metallic and dielectric polarizers from IR to DUV range
- 3D nano-structuring of crystals with ion beam
- Optical and opto-electronic applications of anti-reflective fused silica and silicon surfaces
- Material-scientific aspects

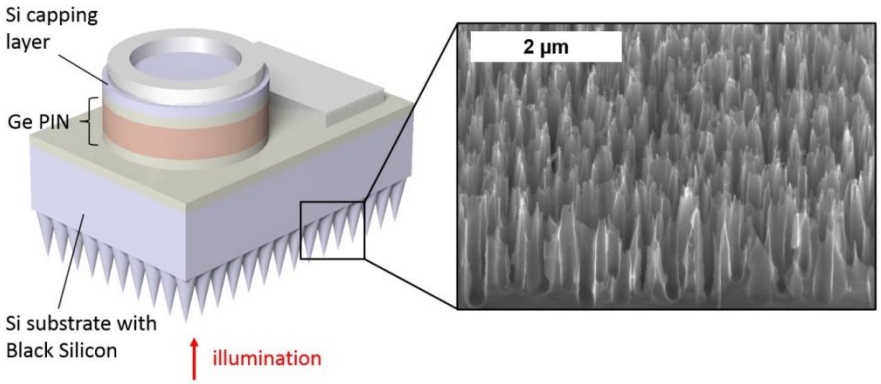
Black Silicon enhanced Ge-on-Si photodiodes

Fast internet access is a crucial economic factor in the modern knowledge society. An even more rapid development of the persistent telecommunication infrastructure fails due to the prohibitively high investments costs. Cheaper photodiodes for the conversion of fiber-delivered light signals into electrical signals would significantly contribute to their reduction.

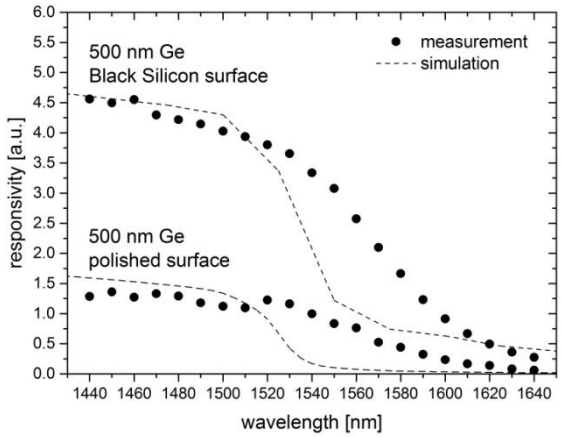
A promising detector concept is represented by Germanium photodiodes being epitaxially integrated on a silicon chip. However, Germanium is only weakly absorbing in the relevant spectral range from 1300 nm to 1700 nm, thus necessitating high layer thicknesses of a few µm for a sufficient photocurrent yield. On the other hand, application in fast telecommunication systems requires very high detector bandwidths (> 10 GHz). This, in turn, can only be achieved by application of thin Germanium layers of a few 100 nm thickness because of the truncated photocarrier transit time.

Application of Black Silicon, a needle-like, self-organized and thus cost-efficiently manufacturable silicon nanostructure, can solve this problem. Placed on the rear of the silicon chip – which is transparent in this wavelength range – a light-trap is implemented that strongly increases light absorptance in

thin Germanium. By that, the responsivity of ultrafast Ge-on-Si detectors with bandwidths of up to 100 GHz can be increased by a factor of 3 to 10.
In particular, common problems that are related to the application of silicon nanostructures are circumvented with this approach. Since photocurrent generation takes place in the Germanium, the raised surface recombination velocity of the silicon nanostructures imposes no drawback. Thus, theoretically predicted absorptance enhancements through the applied Black Silicon light-trapping can be directly transferred into equivalent responsivity enhancements. Furthermore, the fabrication of Black Silicon can be carried out uncomplicated on the chip's rear during back-end processing.



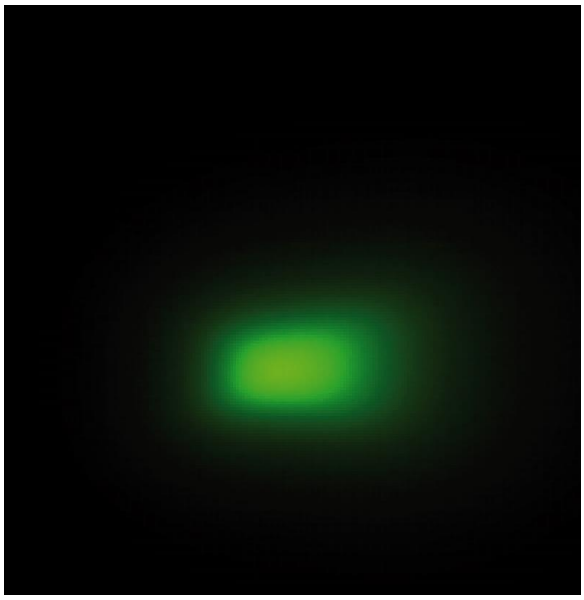
Ge-on-Si detector concept with Black Silicon light-trapping for enhancement of intrinsic Ge absorptance. An epitaxial Ge PIN photodiode is arranged on the silicon substrate. Illumination is performed over the Black Silicon structured rear side of the device.



Theoretically predicted absorptance increase due to rear Black Silicon light-trapping for an absorber thickness of 500 nm (dashed lines) and corresponding responsivity increase proven at the device (dots). Deviations in the vicinity of the Ge bandgap around 1550 nm can be ascribed to strain in the epitaxial Ge layer.

Applied Computational Optics (Prof. Frank Wyrowski)

The Group deals with various optical modeling techniques, ranging from geometrical optics to rigorous solutions like the Fourier modal method. By combining different techniques, a unified modeling concept -field tracing- is established.



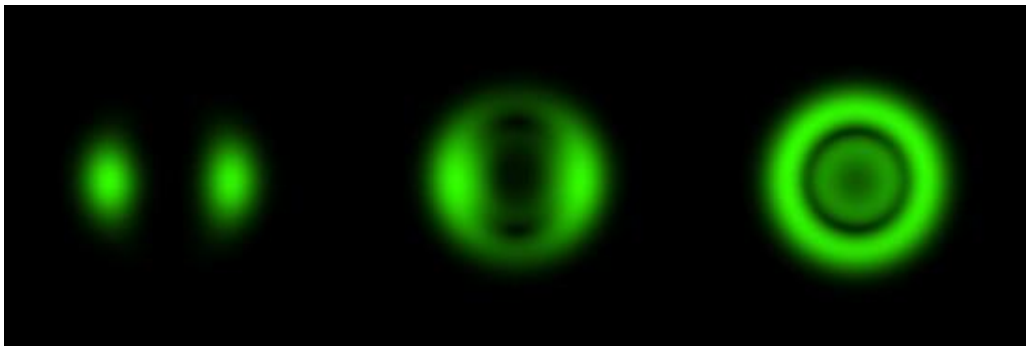
Propagated non-paraxial field after strong-aberrated high-NA Gaussian-to-Top-Heat-beam-shaper.

- Spatio-temporal simulations of ultrashort pulses
- Light propagation through anisotropic media
- Fully vectorial laser resonator analysis and its acceleration with vector extrapolation
- Generalized iterative projection type algorithm for DOE design
- Rigorous solution for general field interaction with periodic/aperiodic microstructures
- Rigorous simulation of optical prisms, plates, and Etalons
- Thin Element Approximation (TEA) used for parabasal incident fields
- Geometrical optics modeling of freeform surfaces
- Ray-tracing in inhomogeneous media
- Numerical representation of smooth functions in modeling
- Efficient light propagation techniques by using smooth decompositions
- Semi-analytical handling of smooth phase terms in modeling with N log N operators

Several topics have been developed in cooperation with LightTrans GmbH using the optics software VirtualLab. The cooperation with Shanghai Institute of Optics (SIOM) and Harbin Institute of Technology (HIT) has been strengthened. In addition, we hosted two visiting scholars, one from Harbin Engineering University (HAREU) and the other from the University of Eastern Finland (UEF).
What follows is an example, involving two selected topics from above and explaining them in more detail.

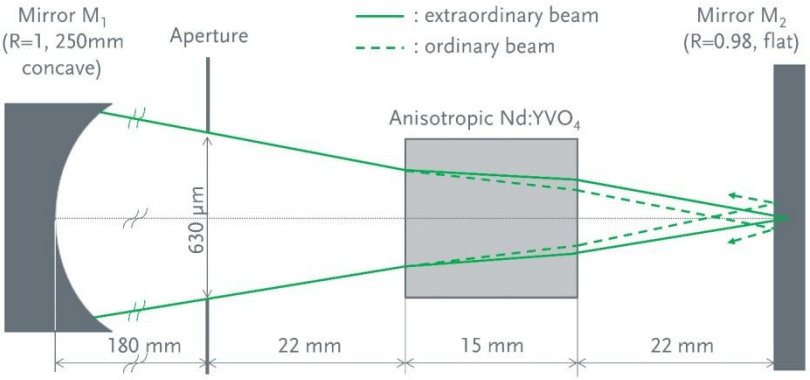
<u>Laser resonator modeling by field tracing – including birefringence effects caused by anisotropic crystals</u>

To fulfill the tasks of various laser applications, a wide range of optical components are used inside laser cavities. Anisotropic crystals, as an important group of intracavity components, show significant influence on the transversal mode and polarization-state of the light.
We developed a generalized Fox and Li approach, which takes the vector nature of light fully into account. In this manner, a round trip operator could be used to describe a single pass through the cavity and by repeatingly applying such an operator, the multiple-reflection process inside the cavity is included. Within the framework of field tracing, a round trip can be described as a sequence of optical component operators and propagation operators for the space between components.
To simulate birefringence effects, a fast Fourier transformation (FFT)-based angular-spectrum-of-plane-waves approach is developed to deal with light propagation through an anisotropic crystal, as a component operator. Such an operator handles both the refraction at isotropic-anisotropic interfaces and the propagation inside anisotropic crystals. It should be emphasized, that this technique is valid for general anisotropic media, including biaxial crystals. From experiments it is known that when the light comes along the optical axis of a biaxial crystal, the conical refraction effect happens. The related simulation obtained by our crystal modeling technique is shown in the figure.



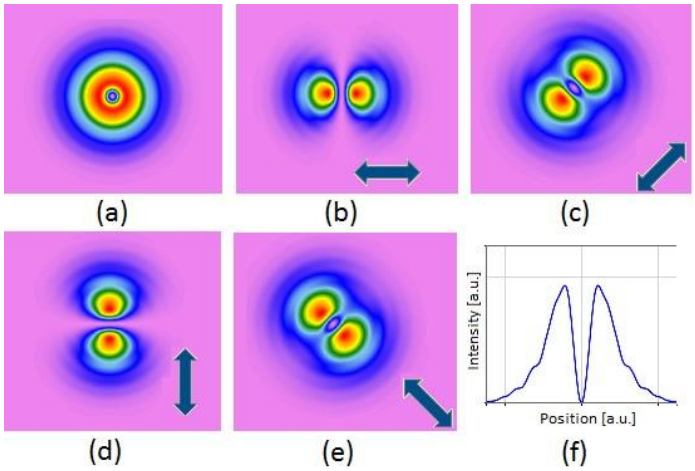
Transition from normal double refraction into conical refraction when incident light gradually goes in parallel with the optical axis of a biaxial crystal.

In 2006, Yonezawa *et al*. introduced a way to generate radially polarized light by using a c-cut Nd:YVO_4 crystal (uniaxial). A difference in the optical paths of the extraordinary wave and the ordinary wave appears. When the length of the cavity is properly chosen, the round trip loss for one wave is higher than for the other. By choosing the ordinary wave to have higher loss, the extraordinary wave, which corresponds to radial polarization, remains as the output.



A laser resonator used to generate radially polarized light.

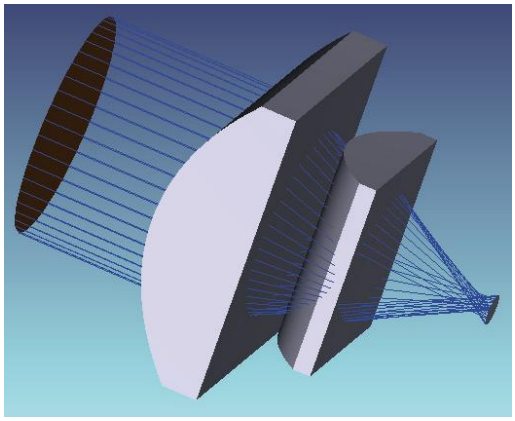
With the generalized Fox and Li approach and the propagation technique through anisotropic media, the cavity in the figure can be well described and then an eigenvalue problem can be formulated. We use a vector extrapolation method – minimal polynomial extrapolation (MPE) – to solve it and a much faster convergence is achieved in comparison to the power method. Simulation results of the dominant resonator mode are shown in in the figure below and they are in good agreement to the measurements found in literature.



Intensity distribution of the dominant transversal resonator mode at the output. (a) Overall intensity distribution. (b)-(e) Intensity distributions after a linear polarizer with different directions, with the arrows indicating the polarizer directions. (f) Intensity profile along the vertical line through the center of (a).

Theory of Optical Systems (Prof. Herbert Gross)

Thirteen companies of the region have launched this endowed professorship along with the STIFT Thuringia and the Ernst Abbe Foundation. It is thought to extend this facility to a research group with the aim to support small and medium-sized optical companies of the region around Jena in their development and training. The group has now reached a size of 10 co-workers.



Layout of a test system with two crossed cylindrical lenses.

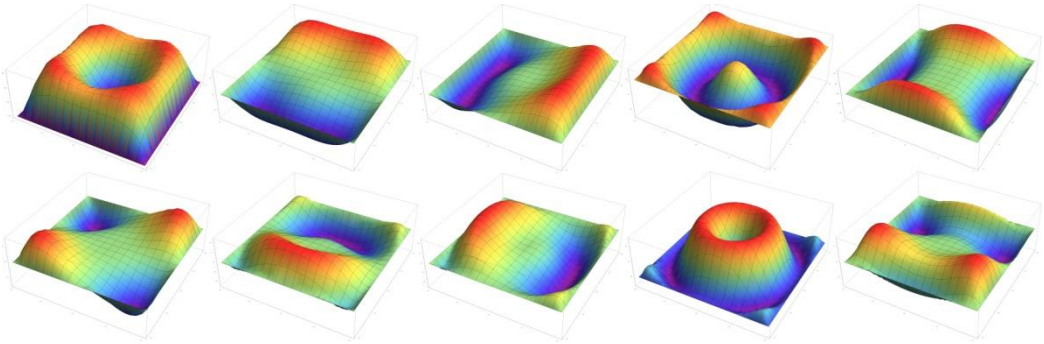
- Design of modern optical system
- Aberration theory
- Quality evaluation of optical systems
- Measurement of the performance of optical systems
- Design of laser and delivery systems
- Design and evaluation of freeform optical systems for imaging and illumination
- Optimization methods in optical design
- Tolerancing of optical systems.

In somewhat more general physical issues relating to optical systems, in particular the following topics of interest are:

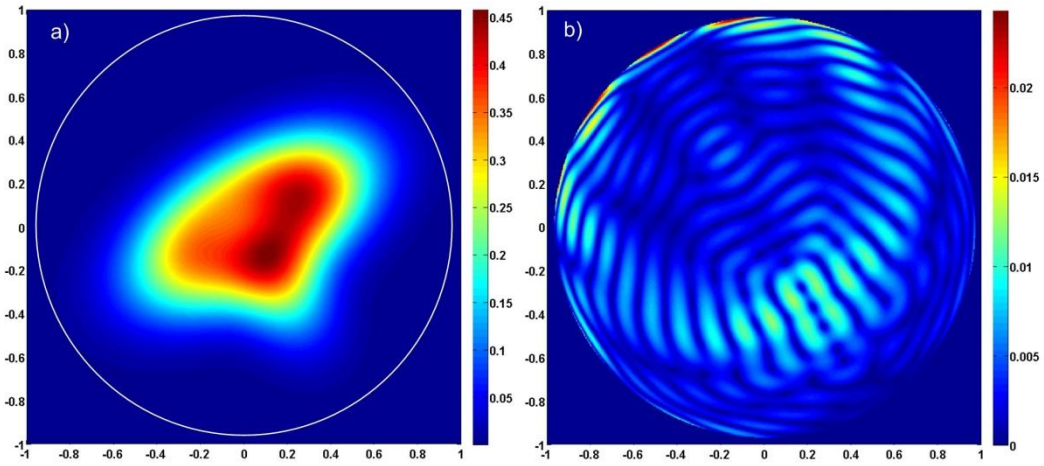
- Simulation of diffraction effects
- Microscopic image formation
- Calculation algorithms of wave propagation
- Straylight and scattering in optical systems
- Modelling of illuminations systems
- Partial coherent imaging and beam propagation
- Point spread function engineering and Fourier optics.

<u>New Descriptions of Optical Freeform Surfaces</u>

Historically optical surfaces are plane, spherical or circular symmetric aspherical in shape. In recent years, more general freeform shapes are investigated to be able to control the quality of very compact optical systems without any symmetry or to generate very special functionalities. Especially arbitrary shaped smooth surfaces are of growing interest for applications with high quality requirements in imaging. But there are many unsolved problems in the development of these components. One of the challenges is the mathematical description of the surface. In mechanical design freeform surfaces typically are described by Splines of the NURBS type. In optical applications there are several requirements on the representation, in particular a good performance and fast convergence in optimization, a fast raytracing and a good manufacturability. Considering these goals splines have proven to be unsuitable and alternative solutions are necessary. Expansions into orthogonal basis functions have some advantages. They allow a reduced number of parameters in optimization. Due to the special properties of the light deflection it is feasible to use functional systems, which are orthogonal in slope. This gives quite faster convergence in optimization and better final results. On the other hand, the problems of manufactured surfaces with local errors typically cannot be described well with expansions of global support with high accuracy. Thus several representations are necessary in practice. Depending on the remaining symmetry and the shape of the boundary several new types of surface descriptions are developed.
For an objective assessment of the various properties a benchmark with different options is defined and the performance of several formulations is tested under different aspects.

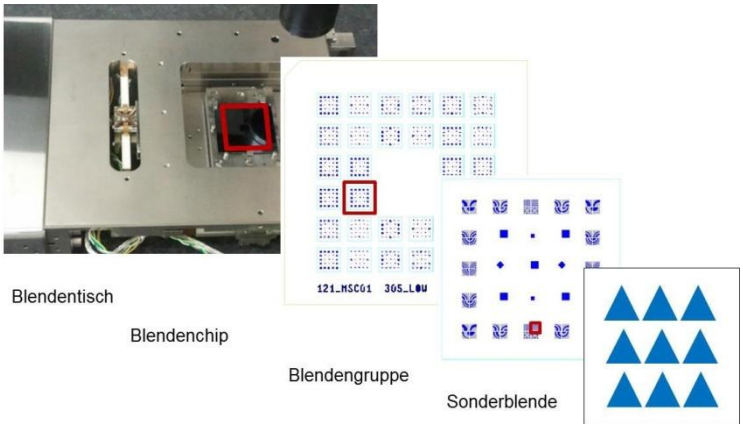


Low order shapes of a new developed expansion description for freeform surfaces for rectangular boundaries.

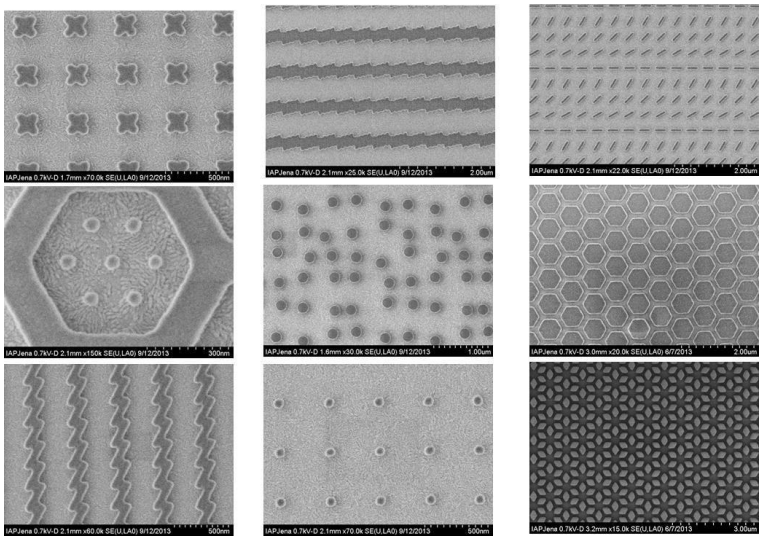


Typical result of a benchmark test calculation. a) given shape on a normalized quadratic area, b) result of the residual slope deviations after a fitting procedure with 225 Zernike polynomials.

In 2014, the two research groups of the **Center for Innovation Competence (ZIK) ultra optics** achieved the following results:
Due to the scheduled upgrade of the electron beam lithography the research group Manufacturing Technologies for Advanced Micro-and Nano-Optics (Dr. U.D. Zeitner) is now able to a flexible exposure of high-resolution structures with the highest efficiency. For the diffractive mask aligner lithography a special technology was developed for the realization of double-sided masks. Various strategies for highly accurate positioning of the front and back side structures to each other have been developed and successfully demonstrated. Furthermore, very good results in improving the resolution limit could be achieved. Thus, inter alia, the exposure of gratings with 250nm period has been shown with a mask aligner.
New imaging strategies with diffractive photomasks for the generation of three-dimensional light distributions were also developed as part of the development of the diffraction lithography.
In the field of the transmission technologies the work has been started for structuring diamond films. First high-resolution structures with dimensions evident <500 nm have already been demonstrated. For the first time also so called "Black Diamond" structures for broadband reflection suppression on silicon have been demonstrated.
A number of sample applications have been also already successfully implemented. This includes diffractive masks for photonic crystal structures for the light extraction from LEDs, high-efficiency submicron gratings for laser pulse compression, double-sided masks for metallic strip polarizer and structure template for plasmonic absorber.



Picture of one of the new aperture module. Right: hierarchical subdivision of the structures on the moveable aperture chip down to the specific special aperture geometry.



Examples of optical nanostructures that were exposed to the new special aperture.

In the research group Diamond-/Carbon-based Optical Systems (Jun.-Prof. A. Szameit) one of the outstanding results in 2014 is the first demonstration of the Floquet topological insulator. On the basis of coupled photonic waveguides, we managed to realize a new type of material in which the light is guided only along the edge using so-called "one-way edge states". With the aid of such a medium, which can also be regarded as a superconductor for light, the basis for a number of new applications of photonic is defined in which light has to be controlled and influenced specifically [1].
Furthermore, we have succeeded in to produce photonic structures on a glass chip, whereby the electronic properties, particularly in the edge structures of graphene crystal, could be simulated accurately. In this way the first time ever, surface states at the beard shaped graphene edge could be verified. In addition, it was possible to demonstrate a heretofore completely unknown surface condition. This means that the previous theoretical description of the electron motion along the edges of the graphene crystal was incomplete and we could now closed this gap [2].

[1] Nature 496, 196-200 (2013).
[2] Nature Materials 13, 57-62 (2014).

b) Cooperations

The IAP is cooperating with all departments of the Faculty of Physics and Astronomy at Friedrich Schiller University, in particular with the Institute of Solid State Theory and Condensed Matter Optics,

the Institute of Optics and Quantum Electronics and also with individual departments within the Faculty of Chemistry and Earth Sciences.
In addition, for special research projects more than 100 external partners in science and industry are standing by. Of special importance are regional cooperation's with the Leibniz Institute of Photonic Technology Jena (IPHT) and the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF). On the basis of the close intermeshing between IOF and IAP, one major goal is to develop an outstanding international center of excellence for micro- and nano-structured optics as well as optical systems.
Within the Collaborative Research Center (SFB) „Gravitational Wave Astronomy" the IAP works together with groups from Hannover, Tübingen, Garching, Potsdam and Jena on issues of reflective optical components for interferometer-based gravitational wave detectors.
The collaboration with the Max-Planck-Institute for Quantum Optics in Garching and the Ludwig-Maximilian University in Munich combines the expertise in Jena in the generation of femtosecond pulses with high average power with the competence in Garching regarding cavity enhancement and the generation of high harmonics (HHG).
The Institute's competence for the production of high-energy few-cycle pulses with high repetition rates is linked with the possibility of the application of these pulses at the free electron laser (FEL) in Hamburg (FLASH) in cooperation with the German Electron Synchrotron (DESY). The aim of that cooperation is to develop laser systems for seeding of the FEL.
The IAP research group Applied Computational Optics cooperates with different national and international institutions, but the collaboration with LightTrans GmbH is of particular importance. Together, new theoretical models of Field Tracing and an optics modeling software (VirtualLab™) have been developed. A long-standing cooperation exists with the University of Eastern Finland and the University of Delft and Brussel. In addition, cooperation with the Shanghai Institute of Optics (SIOM) in the modeling of lithographic lighting systems as well as the Harbin Institute of Technology (HIT) in the field of diffractive optics has been strengthened. Within the project "Advanced Optical System Design" (ADOPSYS) the group is working together amongst others with OSRAM GmbH, Carl Zeiss AG, University ITMO, Russia and CNRS, France.
For years, major international collaborations exist with the College of Optics and Photonics, CREOL & FPCE, Florida, United States, the ICFO-Institute of Photonic Sciences in Barcelona, Spain, and the Australian Research Council Centre of Excellence for Ultrahigh-Bandwidth Devices for Optical Systems (CUDOS) and the Nonlinear Physics Centre, Australian National University in Canberra, Australia.
Other important partners in education include the Imperial College, UK, Warsaw University, Poland, the Delft University, The Netherlands, and the Institut d'Optique (Orsay-Palaiseau, Paris), France, in the international Erasmus Mundus Master's program OpSciTech as well as the University of Bordeaux, the College of Optics and Photonics , CREOL & FPCE, Florida and Clemson University in South Carolina in the international master program „MILMI: Master International in Lasers, Materials Science and Interactions" in context of the EU-US Atlantis program together with the Abbe School of Photonics here in Jena.

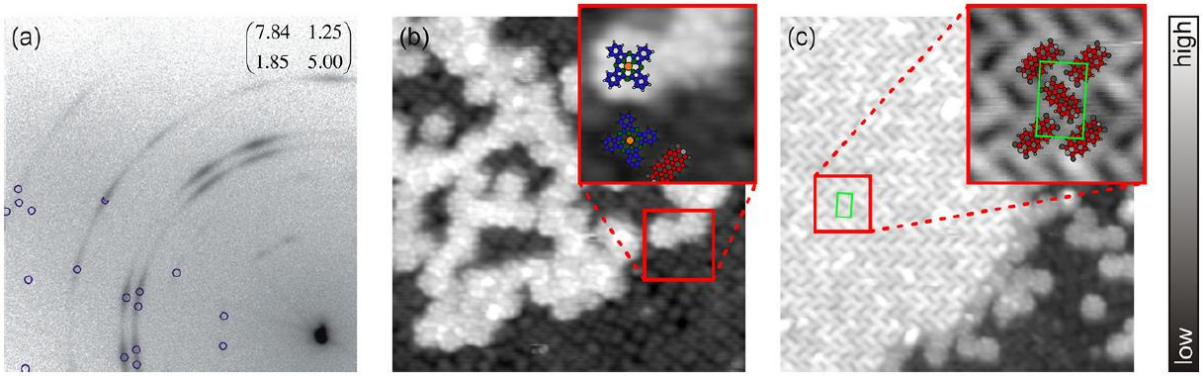
7.4. Institute of Solid State Physics

a) Research areas and important results

The research group of **Prof. Dr. Torsten Fritz** is engaged in the research on nanostructures, surfaces of solids, and thin films of both organic and inorganic semiconductor materials.
Our main research interest lays in the discovery of structure-property-relations of structurally well-defined ultrathin epitaxial layers, organic quantum wells, K-doped organic super conductors, and carbon nanotubes. The main target of our research is the development of basic principles for the use of nano materials in prospective devices. For the analyses of the chemical composition and bonding at surfaces and in thin films we use surface analysis methods like photoelectron spectroscopy (XPS,

UPS) and Auger electron spectroscopy (AES). The crystalline structure can be determined by electron diffraction (LEED, RHEED, XPD, and electron channeling). Scanning tunneling microscopy (STM) and atomic force microscopy (AFM) at ultra-low temperatures (T = 1.1 K) are used for high-resolution imaging of nanostructures and surfaces.
Our *in situ* optical spectroscopy, namely differential reflectance spectroscopy (DRS) is used to study organic (sub-)monolayers and heterostructures in terms of absorption spectroscopy to analyze the optical interaction between either the molecules itself, organic adsorbates and inorganic substrates, or molecules and dopants.

Important results obtained in 2014:
- Discovery of the molecular exchange in a heteromolecular PTCDA/CuPc bilayer film on Ag(111)
- Elucidation of the complex polymorphism and thermodynamic behavior of naphthalene on Cu(111)
- Implementation of a new STM technique: the Scanning Tunneling Hydrogen Microscopy (STHM)
- Direct imaging of dopant atoms in a potassium doped organic thin film
- Detailed optical investigation of ultrathin DBP films on a variety of substrates

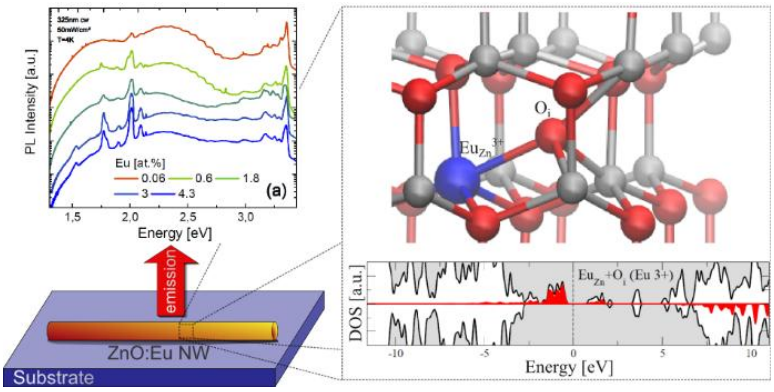


(a) SPA-LEED pattern of 0.70 ML PTCDA on CuPc/Ag(111) recorded at room temperature (E_{kin} = 27.2 eV). In the lower left part of the diffraction image, simulated diffraction spots are shown as blue circles. The corresponding superstructure matrix is also given in the upper right corner. Panels (b) and (c) show LT-STM images of 0.6 ML PTCDA deposited onto 0.9 ML CuPc on Ag(111), V_s = 1.5 V, I_t = 1.5 pA. (b) 16.5 × 16.5 nm^2 scan with CuPc molecules floating on top of the first layer composed of CuPc with PTCDA inclusions in a disordered arrangement. (c) 20.6 × 20.6 nm^2 scan with CuPc and PTCDA molecules in the second layer, the latter forming the typical herringbone pattern. Both insets depict selected areas measuring 3.2 × 3.2 nm^2 superimposed by structural models of the molecules. PTCDA appears dark in the center with bright lobes on either side of the aromatic framework's long axis. The green rectangle denotes the PTCDA unit cell derived from LEED.

The focus areas of the research of the solid state physics group of **Prof. Dr. Carsten Ronning** are:
- Synthesis, doping, characterization, and functionalization of semiconductor nanowires
- Structural analysis of complex semiconductors in relation to their electronic properties
- Modification and characterization of phase change materials
- Synthesis of diamond-like materials for bio-medical applications
- Semiconductor physics: optical, electrical, and magnetic doping via ion implantation
- Synthesis and characterization of CIGS and CdTe thin film solar cells
- Ion beam synthesis of nanoclusters

Important results obtained in 2014:
- Development of ultrafast plasmonic nanowire lasers near the surface plasmon frequency
- Observation of intense intra-shell luminescence of Eu-doped single ZnO nanowires at room Temperature by ion implantation created Eu-O_i complexes

- Realization of phonon-assisted lasing in ZnO microwires at room temperature
- Observation of the amphoteric nature of Sn in CdS nanowires
- Realization of local ion irradiation-induced resistive threshold and memory switching in Nb_2O_5/NbO_x films
- Investigation of the local and global electronic properties of chalcopyrite alloys by X-ray absorption spectroscopy and ab initio calculations



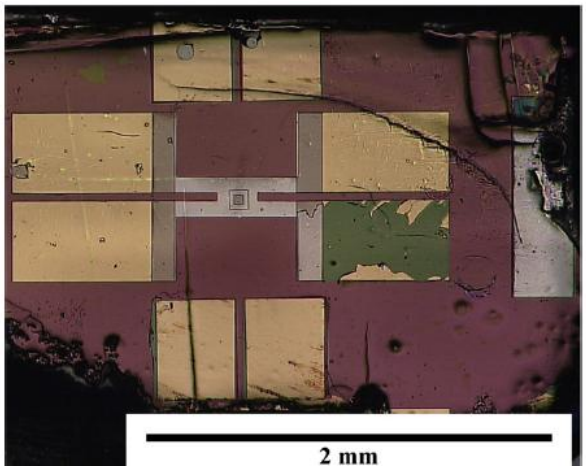
Successful doping and excellent optical activation of Eu^{3+} ions in ZnO nanowires were achieved by ion implantation. We identified and assigned the origin of the intra-4f luminescence of Eu^{3+} ions in ZnO by first-principles calculations to Eu–Oi complexes, which are formed during the non-equilibrium ion implantation process and subsequent annealing at 700 °C in air. Our targeted defect engineering resulted in intense intrashell luminescence of single ZnO:Eu nanowires dominating the photoluminescence spectrum even at room temperature. The high intensity enabled us to study the luminescence of single ZnO nanowires in detail, their behavior as a function of excitation power, waveguiding properties, and the decay time of the transition.

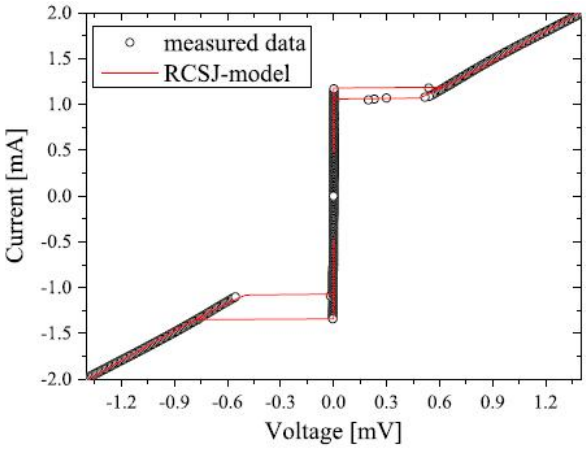
The **Low Temperature Physics** group (Prof. Dr. Paul Seidel) focuses on the following topics:

- Modelling, fabrication, characterization and application of Josephson junctions and superconducting quantum interference devices (SQUIDs) including novel superconductors such as pnictides
- Cryogenic engineering and low temperature physics (e.g. design and optimization of cryostats)
- Experimental aspects of gravitational wave detection including the study of mechanical losses in crystalline and amorphous materials, modelling of thermal noise processes in precision instrumentation, study of thermo-mechanical and thermo-optical properties of matter at low temperatures
- Instrumentation for particle accelerators (e.g. cryogenic current comparators)
- Thin film physics and their applications in optical and electronic components

<u>Important results obtained in 2014:</u>

- Modelling of a new noise process occurring in silicon if used as transmissive optical component based on the correlation between refractive index and density of free carriers
- Different kinds of Josephson junctions with one or two pnictide electrodes in thin film technology as well as using a pnictide single crystal for basis electrode
- Modification of structural and superconducting properties of thin high-T_c films with selforganised grown Au-nanoparticles





Left: Optical micrograph of a Josephson junction on a pnictide single crystal with a lead counterelectrode and an Au/TiOx barrier. Right: Measured I–V characteristic of such a Josephson junction at T = 4.2 K compared to a fit within the RCSJ model demonstrating a remarkable high I_cR_n product [Superconductor Science and Technology 27 (2014) 085003].

The **Ion Beam Physics group** of Prof. Dr. Elke Wendler applies ion beams for analyzing and modifying solids. The main fields of work are:

- Ion-beam induced damage formation in covalent-ionic crystals
- Formation of nano-crystals by high-fluence ion implantation and annealing
- Combination of various ion-beam techniques for compositional analysis of solids and thin films
- Defect analysis in covalent-ionic crystals by ion channeling
- Investigation of relations between structure and physical properties in defective crystals

<u>Important results obtained in 2014:</u>

- Prove of validity of empirical formula of damage formation in ion implanted III-V compounds for ion implanted SiC
- Evidence of crucial role of atomic species for defect formation in ion implanted ZnO
- Formation of GaN nanocrystals in SiO_2
- Simultaneous profiling of fluorine and heavy elements in doped SiO_2 glasses by ion beam analysis

The working group **Laboratory Astrophysics and Cluster Physics** (Dr. Cornelia Jäger and Prof. Dr. Thomas Henning, MPIA Heidelberg) dealt with the following priority projects in the year 2014:

- High-temperature, gas-phase condensation experiments of carbonaceous and siliceous cosmic dust analogs and their morphological, structural, and spectral characterization from the VUV to the IR spectral range
- Experimental studies on astrophysically relevant processing of carbonaceous solids and silicates by UV photons, ion bombardment, and X-ray irradiation
- Laboratory experiments to study the formation of astrophysically important molecules such as H_2, CO, und CO_2 on dust grain surfaces
- Stability studies of polycyclic aromatic hydrocarbons (PAHs) under astrophysical conditions
- Chemical reactions of atoms and molecules in He clusters at low temperatures
- Experimental studies on the condensation and growth of astrophysically relevant dust particles at low temperature and pressure in the interstellar medium and identification of the molecular precursors for the low-temperature formation and growth of cosmic dust particles in the ISM by matrix-isolation spectroscopy
- Interaction of fullerenes with PAHs

Outstanding results 2014:

- We have experimentally demonstrated that complex magnesium iron silicates can be efficiently formed at temperatures prevailing in the dense interstellar medium. This has been shown by in situ IR spectroscopy of the formed silicates at temperatures around 10 K. The formed silicates show a good agreement with the spectral signature of interstellar silicates in the IR range. In addition, the formation of carbonaceous solids at temperatures of around 10 K without an energy barrier has also been confirmed. The experimental results have a strong impact on the understanding of dust formation and growth processes in dense molecular clouds.
- The reaction of atomic carbon with benzene molecules has been investigated in liquid helium droplets at ultra-low temperature. The reaction between the two species was found to have no barrier in the entrance channel. Such barrierless reaction between benzene molecules and atomic carbon, which belongs to the four most abundant species in the ISM, is of great interest for the discussion of the stability and formation of PAH molecules in the ISM.

b) Collaborations

The Surface Science group of **Prof. Dr. T. Fritz** strengthened their international cooperations in 2014. While the ongoing collaboration with the group of Prof. Dr. T. Munakata (University of Osaka) was continued and even intensified by numerous exchange visits (founded via a PaJaKo project of the DAAD) between German and Japanese Scientist new collaborations were started with the groups of Prof. Dr. N. Ueno (University of Chiba) and Prof. Dr. S. Kera (Institute of Molecular Science, Okazaki). In the USA we cooperate with the group of Prof. Dr. O. Monti (University of Arizona). Within Europe we have intensive collaborations with the theory groups of Prof. Dr. E. Zojer (Graz University of Technology) and Prof. Dr. G.-P. Brivio (Universita` di Milano-Bicocca). In Germany our collaborations included the group of Prof. Dr. C. Kumpf (Forschungszentrum Jülich GmbH) and Prof. Dr. J. Kröger (TU Ilmenau).

The group of **Prof. Dr. C. Ronning** collaborated in 2014 with various international groups. Special situations have been established with the groups of Prof. Dr. F. Capasso (U Harvard), Prof. A. Lugstein (TU Vienna), Prof. A. Fontcuberta i Moral (EPF Lausanne), and Prof. K. Bharuth-Ram (iThemba Labs, South Africa), which have been founded either by the DAAD or DFG. Further collaborations have been conducted with the groups at the University of Lund (Sweden, Prof. L. Samuelson), Australian National University Canberra (Australia, Prof. M. Ridgway), University of Southern California (USA, Prof. J.G. Lu), University of Florence (Italy, Dr. F. di Benedetto), University of the Basque Country (Spain, Prof. A. Rubio), Institute of Light and Matter (France, Dr. S. Botti), ERSF Grenoble (France, Dr. G. Martinez-Criado & Dr. F. d'Acapito) and Imperial College (UK, Dr. R. Oulton & Prof. O. Hess). National collaborations involve partners from Bremen, Duisburg, Mainz, Leipzig, Braunschweig, and Erlangen within the frame of the DFG research unit FOR1616. However, collaborations have been also established to groups at the HZ Berlin, FHI Berlin and ZSW Stuttgart on photovoltaics.

The Low Temperature Physics group of **Prof. Dr. Paul Seidel** is collaborating with Thuringian research institutions (TU Ilmenau, IPHT Jena, SUPRACON Jena, Innovent e.V. Jena, Helmholtzinstitut Jena, Universitätsklinikum Jena). Within funded research projects joint research is carried out with the IFW Dresden, the GSI Darmstadt, the DESY Hamburg, the MPI Heidelberg and the CERN Genf. Long-term collaborations exist to the Karlsruhe Institute of Technology KIT and the research groups at the universities in Erlangen-Nürnberg, Hannover, Dresden, Gießen, Heidelberg, Tübingen as well as the Universities of Applied Science in Aalen and Jena.

Within the German Collaborative Research Center (SFB TR7) scientific results have been obtained in close collaboration with national (Hannover, Tübingen, Golm, Garching) as well as international partners, such as the universities of Glasgow, Padova, Lyon, Tokyo, Pisa, Salerno, Roma, Moscow and

others. Additional international partners in the field of superconducting materials and its application are the universities of Bratislava, Poznan, Twente, Donetsk, Kharkov, Osaka, Nagoya and Tokyo.

The **Ion Beam Physics group** cooperated in 2014 with Prof. Dr. Fadei F. Komarov (BGU Minsk), Prof. Dr. Maria Katsikini (U Thessaloniki), Dr. Katharina Lorenz (IST, U Lissabon), Prof. Dr. Johan B. Malberbe (U Pretoria), Dr. Alexander Yu. Azarov (U Oslo) and Dr. Albert Juma (now U Gaborone, Botswana). National cooperations exist with Dr. Klaus Ellmer and Dr. Thomas Dittrich (HZ Berlin), Dr. Jürgen Vogt (U Leipzig), Dr. Stefan Grimm (IPHT Jena) and Robert Hanf (j-fiber Jena).

The working group **Laboratory Astrophysics and Cluster Physics** collaborates with a number of institutes both at home and abroad. Experimental studies of molecular hydrogen formation on the surface of silicate dust grains under astrophysical conditions have been performed in collaboration with Prof. J.-L. Lemaire and Prof. Dr.Gianni Vidali from the Observatoire de Paris and Université de Cergy-Pontoise). In the field of UV-induced reactions of astrophysically relevant molecules in cryogenic matrices, close collaborations exist with Prof. Harold Linnartz from the Raymond and Beverly Sackler Laboratory for Astrophysics, Leiden Observatory (Netherlands), and Prof. Stephen Price at the Chemistry Department of the University College London. The formation of molecules in interstellar ices and the erosion of carbonaceous solids in the dense interstellar medium by proton bombardment are the topics of a joint project with the Laboratory Astrophysics Group at INAF–Osservatorio Astrofisico di Catania, Italy. These scientific connections were mainly built during the Marie Curie ITN network "LASSIE- Laboratory Astrophysics Surface Science in Europe'' that was working between 2010 and 2014. Intensive collaboration with Dr. Akos Keszturi and Prof. Peter Abraham, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary, has been established in the last years. Here, we focus on joint laboratory work including condensation experiments and spectroscopy of condensates at low temperature. With Prof. Stephan Schlemmer, Cologne Laboratory Astrophysics Group, Prof. Thomas Giesen, Laboratory Astrophysics Group at the University Kassel, and Dr. Holger Kreckel, Max Planck Institute for Nuclear Physics in Heidelberg, long-standing collaborations in the field of laboratory astrophysics, structure, dynamic, and properties of molecules and dust grains in astrophysical environments have been existing for more than 10 years.

7.5. Institute of Solid State Theory and Optics

a) Research areas and results

Research activities of the institute cover the theoretical investigation of new materials and structures as well as the simulation of light propagation and localization in micro- and nanostructures and nonlinearly driven self-organization of light for high intensities. One of the central topics is the deeper understanding of all the aspects of light matter interaction including the investigation of resonant phenomena as e.g. the formation of exciton polariton condensates. We are interested in how new effective optical materials properties can be created by nanostructuring and how molecular structures or the combination of different materials influence electronic and optical properties. All theoretical investigations were closely linked with or even based on high performance computing. Respective tools and software has been developed further. Theoretical studies were based on realistic and experimentally accessible parameters and respective results have often been checked in experiments.

The Institute has recently undergone major changes due to the retirement of both Professors at the head of the two groups. The following recruitment procedure came to a successful end with the appointment of two new chair holders on October 1 2014: Prof. Silvana Botti, a well-known scientist in the field of theoretical solid state physics and Prof. Ulf Peschel, who is known for his contributions to nonlinear optics, wave dynamics and nanophotonics.

In the Condensed Matter Theory group (Prof. Botti) research is now focused on the theoretical development and numerical implementation of many-body approaches for the description of electronic excitations. The tools used are based on density functional theory and many-body

perturbation theory. A special focus is on the simulation of spectroscopic properties of "real" materials for energy conversion, storage and saving. The studied systems can range from simple bulk crystals to non-stoichiometric, doped, alloyed compounds, or to nanostructured materials and interfaces. At the same time, a "materials by design" approach based on global structural prediction and high-throughput calculations is followed to propose novel materials that are then further characterized with the same theoretical spectroscopy techniques.

In the Solid State Optics group (Prof. Peschel) research activities will cover all aspects of wave optics with a special focus on the nonlinearly induced self-organization of light in the presence of nonlinearities, on the interaction of electromagnetic waves with nanostructures and on the efficient modeling of electromagnetic problems. Research activities comprise not only fundamental questions of theoretical physics as e.g. the existence and dynamics of localized nonlinear states, but will also cover rather applied issues as light harvesting in solar cells. Other research activities are focused on the simultaneous numerical description of electromagnetic fields and of the excited optical material using large scale parallel computing.

b) National Collaborations

- IAP FSU Jena
- IPHT Jena
- FhG IOF Jena
- HI Jena
- Forschungszentrum Jülich
- Max-Planck-Institut für Festkörperforschung Stuttgart
- Max-Planck-Institut für Intelligente Systeme Stuttgart
- Universität Paderborn
- Martin-Luther-Universität Halle-Wittenberg
- TU Magdeburg
- Institut für Spektrochemie und Angewandte Spektroskopie Berlin
- Fritz-Haber-Institut Berlin der MPG
- Paul-Drude-Institut Berlin
- Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Berlin
- Max-Planck-Institut für Physik komplexer Systeme, Dresden
- Universität Hannover
- Universität Gießen
- TU Berlin
- Jacobs University Bremen

International cooperations see chapter 10.5.

7.6. Otto Schott Institute of Materials Research

a) Research areas and results

Chair of Metallic Materials

Alloy Development

Alloys are newly developed or alloy compositions and processing conditions varied for particular applications so that simultaneously a series of properties is adjusted to the required property profiles. In 2014 brazes and active brazes for joining metallic or ceramic parts were in the focus of interest. Alloy compositions are selected with the aid of thermodynamic data bases and the corresponding software. A high temperature levitation furnace with cold wall crucible is used to melt the alloys from the pure elements at temperatures of up to 2500°C. The alloys are then modified by thermomecha-

nical treatment. Characterization of the alloys is performed with respect to static and dynamic mechanical properties (yield strength, tensile strength, deformability, hardness, fatigue strength), thermodynamic/thermophysical properties (heat capacities, heat conductivities) and functional properties such as wettability.

Thermodynamics of interfaces

The ”contact conditions” and the thermodynamic state at migrating solid/liquid interfaces are investigated experimentally employing solute driven melting. The experiments are accompanied by further developing interface thermodynamics models that are coupled with kinetics (trans-interface diffusion, solute redistribution) at the interface. The models are valid for all kinds of migrating solid/liquid interfaces. The models aim for a better understanding of microstructural evolution in metal alloys that are processed under extreme conditions and under conditions that are far off equilibrium such as additive manufacturing (selective laser melting).

Microstructural evolution

The microstructure of materials as it forms by solidification from the melt and during thermomechanical treatment is crucial for the properties of the respective part. Precise, and generalized prediction of microstructural parameters and concentration distributions is nowadays in a state that it can more and more be applied during materials’ development in combination with experiments. Models for microstructural evolution include microsegregation models for technical alloys, dendritic growth models that are free of numerical artifacts (see figure below), different types of rapid solidification models and recrystallization models.

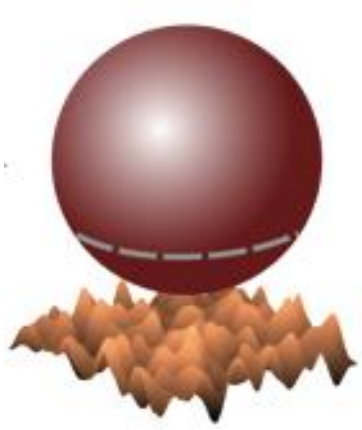
Simulated 2D dendrite calculated on an unstructured amourphous grid with our Meshless Front Tracking method.

Experimental microstructures are characterized using optical microscopy, scanning electron microscopy and transmission electron microscopy. The materials under investigation include laboratory materials produced from highly pure elements, but also technical multicomponent alloys that are further developed with industrial partners. In 2014, in addition to long term alloy development projects investigations on thermoelectric materials were in the focus. These materials are promising candidates for energy conversion and ”harvesting” of waste energy.

Implant materials

Nickel-Titanium shape memory alloys are, among others, applied cardio vascular (stents, occluders) or other implants (dental braces) that are supposed to remain in the human body for time spans of months or years, and partly without any temporal restriction. We investigate the thermomechanical treatment with the purpose to optimize on the one hand structural properties such as superelasticity or phase transformation temperatures, and on the other hand functional properties such as bio- and hemocompatibility. In 2014 the focus was on the formation of surface oxide layers and their mechan-

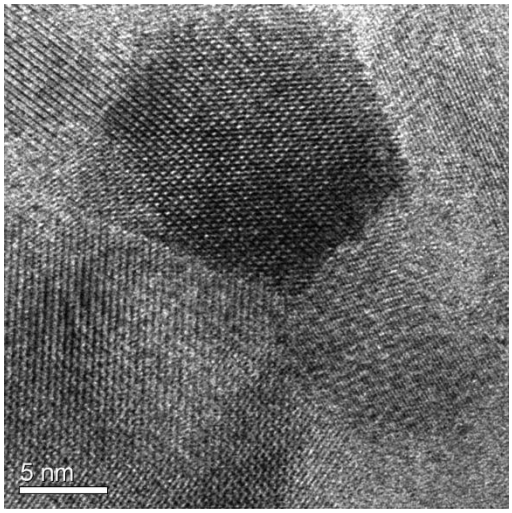
ical behavior, the adsorption of proteins, bacteria and cells, and the release of ions into body fluids. All these features need to be known if an infection free implantation is to be carried out. In the figure below, a schematic representation of our model for describing the interaction of a bacterium with the surface of a biomaterial in dependence of the surface roughness.



Schematic of a spherical bacterium (e.g. staphylococcus aureus) in interaction with a rough biomaterial surface.

Structure of nanomaterials with ultrafine grains

Continuous minimization of structural features over the past decades has lead to the discovery of qualitatively new materials properties in different classes of alloys. Until present it is challenging to characterize such structures to an extent that the mechanisms of their formation and their stability can be modeled and understood. In the past we developed methods to determine grain size distributions and grain orientation distributions in the transmission electron microscope. Bright field and dark field images are considered with a variety of methods using high resolution imaging and electron diffraction. In 2014 we made progress in clarifying phase transformation mechanisms in complex alloys with high temperature and low temperature phases, where the latter ones are stabilized by nanostructuring.



Nanocrystalline structure of a Co-Sm alloy that is a candidate material for hard magnets with high energy density and pronounced stability at high temperatures (high resolution transmission electon microscopy image).

Chair of Materials Science

Correlation between materials' structures and properties and their biological behavior – materials for healthcare/biomaterials

In this basic science field, new materials for biomedical applications with defined properties (e.g. nano and micro structured titanium thin films, ceramic nanomaterials, polymer multilayers, biopolymer nanofibers, bone cements with advanced mechanical properties) were developed, and their structure and properties were characterized. In the next step, the biological properties of the new materials are investigated (e.g. protein adsorption, cell proliferation, bacterial adhesion and biofilm formation). In addition, the interactions between the proteins and the materials surfaces were simulated. The research also focuses on transferring the scientific results into practical applications.
The most significant results in 2014 are:

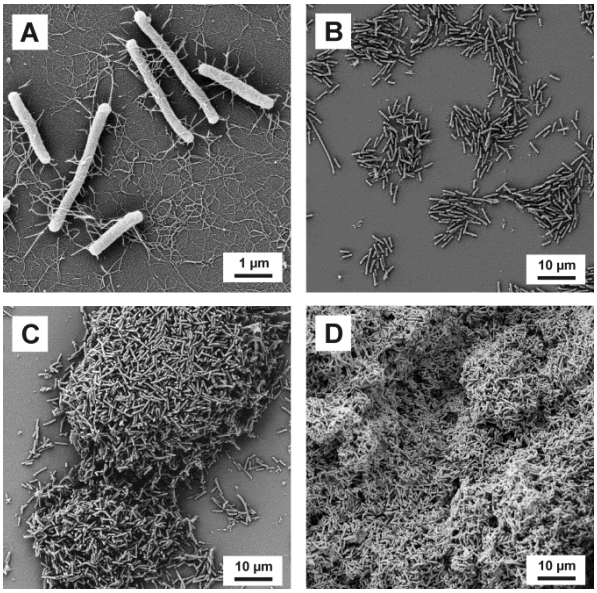
- Delivery of drugs from silica and graphene-based nanoreservoirs
- Control of the adhesion of bacteria on nanostructured titanium and dental materials
- Functionalization of biomaterials surfaces by microcontact printing (µCP)
- Control of the protein adsorption on polymer surfaces
- Fabrication and understanding of protein nanofibers
- Development of fiber-reinforced, calcium phosphate cements
- Confirmation of the biocompatibility of fiber-reinforced, calcium phosphate cements
- Control of platelet adhesion on artificial materials by biomimetic surface structuring

Antimicrobial biomaterials

The focus of the research group in the area of antimicrobial biomaterials is to use or to create properties of materials, used as biomaterials for example in form of implants that inhibit the adhesion of microorganisms and, thus, lower the risk of implant-associated infections. Passive and active approaches of anti microbial action were pursued.
One passive approach is the physical structuring of titanium surfaces on the nanometer scale (creation of defined surface roughnesses). In this way, the adhesion of the clinically relevant pathogenic microorganisms Escherichia coli and Staphylococcus aureus have been reduced by up to 50 % after 11 h. Using innovative techniques, such as scanning electron microscopy in combination with a focused ion beam (FIB) led to the successful identification of primary mechanisms. This project was a cooperation with the Leibniz Institut for Natural Product Research and Infection Biology (Hans Knöll Institute), Jena.
In a Ph.D. project (anticipated duration three years) started this year, physical nanostructures will be created using nanoparticles. By modification of these nanoparticles, e.g. with quaternary ammonium compounds, the surface will be chemically nanostructured.

In a further research project, the microbial load in polluted liquids was reduced by electrolytic processes. The primary aim was to develop longtime-stable, corrosion-resistant electrodes made from titanium oxide. Although the project officially ended 2012, in 2013/14, in a further cooperation with the project partner, the electrochemical removal of microbial loads in polluted liquids on these electrodes was investigated under industrial conditions.
In cooperation with the university hospital in Jena and industrial partners, functional antibiotics-loaded coatings on implants surfaces were created using a layer-by-layer technique (active approach) and tested in vivo in a rat animal model. A statistically significant reduction of inflammation and the number of microorganisms was found.
Crosslinked copolymer hollow spheres were synthesized by a precipitation polymerization method with a self-core-removing process. These polymer spheres work as a noble metal (e.g. silver) carrier and may prevent nanoparticles from aggregation. The polymer-metal nanocomposite will be used as antibacterial coating on implant surfaces. First in vitro investigations concerning their antimicrobial activity have been carried out.
Main results of the research group *Antimicrobial Biomaterials* in 2014:

- Creation of nanorough titanium surfaces that significantly reduced microbial adhesion
- The creation of antibiotic-loaded polyelectrolyte multilayers on biomaterials surfaces and the successful in vivo-investigation of the antibacterial activity against Staphylococcus aureus
- The synthesis of hollow copolymer spheres as an innovative carrier system for silver nanoparticles



Bacterial adhesion and biofilm formation of Escherichia coli on nanorough titanium surface (A: 24 h, B: 48 h, C: 72 h, D: 144 h). Figure modified according to Lüdecke et al. 2014 (doi:10.1371/journal.pone.0084837.g005). © 2014 Lüdecke et al.

Materials for tissue engineering

The project Novel functional materials based on self-assembled protein nanofibers funded by the German Science Foundation (DFG) started this year. The aim is to create/develop a new generation of plasma protein based nanofibers biomaterials by combining different proteins. Investigations of their assembly mechanisms, structure and properties should lay the foundation for their further application. In first experiments, nanofibers have been created by mixing the plasma proteins hemoglobin and fibrinogen.

Soft matter physics

The aim of this research field is to find new approaches for the nanostructuring of functional polymers by applying methods of polymer physics and especially polymer thermodynamics. The research focuses on polymer surfaces as well as the polymer bulk. Furthermore, polymer surfaces are functionalized to control and create new surface properties. The investigated polymers are synthetic polymers (thermoplastic, homo- and copolymers) and biopolymers (proteins and polysaccharides). In addition, these polymers are used for the preparation of carbon nanotube/polymer nanocomposites, which establishes close ties to the group's expertise in long-fiber-reinforced composites. We are mostly interested in the interactions of carbon nanotubes with different polymer matrices (semicrystalline homopolymers and block copolymers) and to control them (crystallization, templating). The main results in the research field soft matter physics in 2014 were:

- kinetic investigation of lamellar thickening in amphiphilic block copolymers by controlled crystallization in the range of 15 – 30 nm using DSC and SAXS
- co-crystallization of crystalline block copolymers and their corresponding homopolymers with varying molecular masses
- investigation of double crystalline block copolymers in bulk and thin film to control their nanostructures

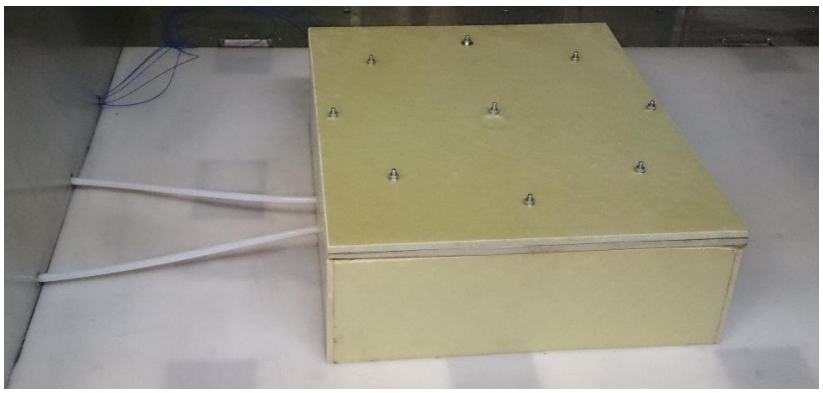
- orientation of block copolymer lamellae by external thermal fields
- fabrication of polymer nanospheres and hollow nanospheres by biological and synthetic polymers and to test their suitability for drug-delivery
- fabrication of graphene coated polymeric hollow spheres for catalysis
- orientation and quasi-epitaxy of proteins on uniaxial highly oriented polymer surfaces and polymer single crystals
- investigation of the crystallization of polycaprolactone on carbon nanotubes
- investigation of the dispersing mechanism of carbon nanotubes in different block copolymers
- alignment of carbon nanotubes in melt drawn block copolymer films

Investigation of the concentration dependent dispersibility of carbon nanotubes in block copolymer solutions. The concentration of carbon nanotubes rises from left to right while the amount of solvent and block copolymer is kept constant. The third sample from the right side depicts the saturated concentration where the carbon nanotubes aggregate and flocculate.

<u>Fiber-reinforced composites – enhancement of the resource efficiency and manufacturing efficiency of the fiber-reinforced composite production process</u>

This application based research field aims to enhance the possible applications of high-performance fiber-reinforced composites, in particular for Thuringian SMEs. For this purpose, microwave induced curing was selected to reduce the process time and the total process energy consumption. By optimizing the mold material, the durability/mold resistance shall be improved, and the process time shall be reduced. In addition, simulations and measurements of the anisotropic materials properties serve as a basis for a materials based design to exploit the full lightweight potential. Major findings in this research field in 2014 are:

- enhancement of the durability/mold resistance of molds
- optimization of the thermal properties of molds that were used in the microwave induced curing process of epoxy resins
- establishment of a research partnership for an enhancement of the resource efficiency and manufacturing efficiency of the fiber-reinforced composite production process



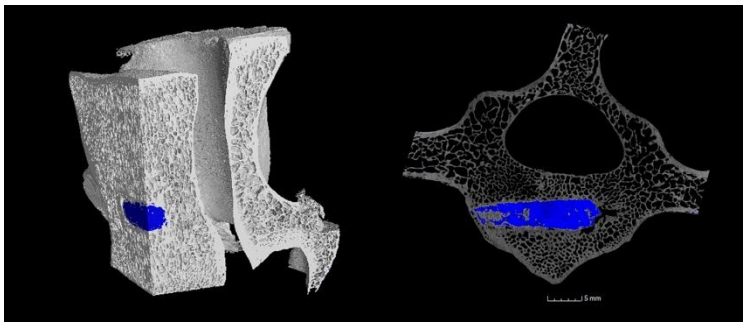
Resin transfer molding (RTM) process in the industrial microwave oven at the FSU Jena, USIM, CMS. RTM mold with an infiltration pipe and a raiser pipe.

3D characterization of materials and interfaces with tomographic methods

The 3D characterization of materials and interfaces is carried out from the nanometer level to the micrometer level and can be performed with tomographic methods, e.g. X-ray tomography, confocal laser scanning microscopy, and FIB-SEM. The raw data obtained by different methods can be visualized and processed for 3D evaluation. By identifying and quantifying the 3D structure, it was possible to determine the structure-property relationships of multiphase materials.

The most important results of the work in 2014 were:

- Fabrication of 3D macroporous ceramics with interconnected pores
- Preparation of 3D-macroporous ceramic coatings with osseointegrative properties on dense ceramic substrates for orthopedic applications
- 3D-characterization and visualization of the macroporous ceramics and coatings with tomographic methods
- 3-D characterization of bone formation after implantation of fiber-reinforced calcium phosphate cements in a sheep animal model
- 3-D characterization of bone formation after implantation of coated titanium implants in a rat animal model
- 3-D characterization of bone remodeling in an arthritic mice model
- 3-D reconstruction of data sets achieved by FIB-SEM



CT image of a vertebral body (sheep) after implantation of calcium phosphate cement; left: 3-D reconstruction; right: cross section.

Colloids, Surfaces and Interfaces

Laser materials processing

Nanoparticles: Functional nanoparticles are of increasing importance in the development of hybrid materials for energy and environmental technology and biomedical applications. Our research focuses on the synthesis of functional ceramic nanoparticles using the CO2 laser vaporization (LAVA) process. The highly flexible LAVA method offers the possibility to convert almost any oxidic ceramic compound into nanoparticles and nanopowders. Thus, phase-pure oxides, defined adjustable mixed oxide crystals (e.g. perovskites, spinels) and defect structures (e.g. doped semiconductors) as well as intra-particle dispersion ceramics (e.g. Al2O3-ZrO2) and inclusions of nanocrystallites (e.g. FexOy) in nanostructured glass matrices can be prepared as nanoparticles. The obtained spherical nanoparticles can be integrated into high-performance composites and hybrid systems by technological production processes. Here, besides conventional and generative processes for the fabrication of nanoporous or dense sintered structures in particular Mother Nature serves as an inspiration for innovative approaches for the synthesis of biomimetic composite structures. The targeted control of material properties combined with the various ways of processing the nanopowders thus opens up completely new possibilities to develop innovative functional and hybrid materials. Their fields of applications include energy technology (e.g. nanoporous electrode materials for lithium-ion batteries or novel semiconductor materials for dye sensitized solar cells), environmental technology (e.g. porous hybrid structures for the photocatalytic purification of water and air in the visible part of the elec-

tromagnetic spectrum), and biomedical applications (e.g. piezoelectric materials for bone regeneration, magnetic nanoparticles which can be functionalized with drugs for tumor therapy and diagnostics, or novel functional ceramics for artificial joints).

Surface modification: Due to the high energy absorption of ceramic materials in the IR region, CO2 laser radiation (λ = 10.59 µm) offers an effective way for the defined structuring of ceramic surfaces. The generated structures can be further modified by chemical modification or laser-induced coating (pulsed laser deposition - PLD). The PLD method offers the possibility to provide substrate materials with functional ceramic coatings by evaporating a ceramic target. This can be carried out on both smooth and textured surfaces as well as on textiles. Thus, the PLD method enables new approaches for the development of textile dye solar cells or catalytically active textile structures.
Furthermore, the use of fs-pulsed lasers offers the possibility to functionalize existing structures by additive structuring in the sub-µm range (2-photon polymerization) at another hierarchical level.

Rapid prototyping: The setting reaction of calcium phosphate cements was used to prepare porous scaffolds via 3D powder printing. Due to the low processing temperatures a simultaneous incorporation of pharmaceutical drugs was possible. The mechanical properties of calcium phosphate cements was significantly increased by mixing the cement powder with hydroxy apatite whiskers.
Furthermore, the potential of the CO2 laser for materials processing is used to fabricate ceramic/metal or ceramic/polymer laminates by selective laser sintering (SLS). The primary goal is to optimize the mechanical properties of the laminate by the selective combination of different materials. In contrast to conventional sintering methods in which diffusion processes are responsible for the densification, the densification during SLS is initiated by totally or partially melting of the particles. Therefore, the main focus is on fundamental studies on the influence of the laser parameters (intensity and time) on the heat input and heat conduction.

Bioinspired Materials

Surfaces: Morphological, physico-chemical, or bioorganic surface modifications of biomaterials were realised to affect the interaction between the living body and an implanted material, resulting in bioactive, osteoconductive surfaces or in porous scaffolds for tissue engineering. Furthermore, surface treatments are of interest in dental restoration, where the materials surface has to adhere effectively to the tooth.

Biomineralisation: Simulated body fluids (SBF) with a composition similar to the inorganic part of the human blood plasma were used for in vitro bioactivity tests. Beyond that, SBF was used to precipitate biomimetic apatite with a composition, morphology, and growth orientation equal to the mineral part of the vertebrate bone. The photoluminescence of annealed biomimetic apatite might be of specific interest for histological probing and monitoring of bone re-modelling. SBF solutions with modified ion concentrations and increased supersaturation were used to accelerate the formation of apatite and to coat various materials with bioactive calcium phosphate.
The wet-chemical synthesis of nano-sized, bioactive or resorbable calcium phosphate powders is of particular interest for the development of load-bearing orthopedical implants. Ionic substitutions were performed to affect the solubility of the material and to enhance its bio-acceptance. The mechanical properties of sintered calcium phosphates were significantly increased by vacuum synthesis technologies. Biomimetic techniques were used to synthesise hydroxy apatite powders with a bone-like composition. Sol-gel processes were used to prepare bioactive sodium titanate ceramics and SiO2-CaO-glasses, respectively.

Hybride structures: Cellulose is the world´s most abundant biopolymer. Langmuir-Blodgett monolayers, fibres and knits made of cellulose were used to prepare scaffolds and drug delivery systems for the regeneration of bone and cartilage. The coagulation and co-extrusion of cellulose/hydroxy apatite solutions were used to prepare composite tapes and fibres, respectively.

Photocatalytically active hybrids consisting of anatase nanoparticles (NP) and bacterial nanocellulose were prepared by dispersing the NP into the Hestrin-Schramm culture medium. In contact with air the bacteria produce cellulose from glucose and simultaneously integrate the NP homogeneously in the BNC hydrogel. The antibacterial activity of such kind of materials was demonstrated by methanol conversion (MC) under UV irradiation. Thus, the in situ integration of NPs into BNC represents an attractive possibility to extend its use to novel innovative fields of application.
Ice templating represents a process to prepare ceramic scaffolds with an aligned and open porosity. In this process ceramic slurries are frozen directionally from a temperature controlled cooling finger. Adjusting the velocity of the ice front to a certain level leads to lamellar ice crystal growth. The ceramic particles are repelled at the tip of the growing ice crystals and they are enriched between them. Subsequent sublimation of the ice leads to a structured green body that finally has to be sintered.

Structural sizes and mechanical properties of the sintered TCP scaffolds depend on the solid content of the suspensions and on the applied ice front velocity. With increasing solid content the porosity decreases from 80% for 10 vol-% suspensions to 50% for 30 vol-% suspensions. This porosity is independent on the applied ice front velocity. For a given porosity the onset ice front velocity influences the pore widths and ceramic lamella thicknesses. With increasing velocity the structural sizes decrease. Simultaneously, the compression strength of scaffolds increases by more than twofold due to the reduced amount of critical size defects.

Sintered TCP scaffolds were impregnated with the biodegradable biopolymer PCL. Only a small amount of polymer was used to solely infiltrate the micro pores and to coat the ceramic lamellae with a thin polymer film. The infiltrated samples show a damage tolerant non-catastrophic failure mechanism which can be explained by the formation of cold drawn PCL fibers bridging micro- and macrocracks. Moreover, the compressive and flexural strength of the impregnated samples increases by approximately 100%.

Surface machining / Surface metrology

- Analyses of materials removal principles, subsurface damage, surface generation (micro geometry, shape and dimensional accuracy) for different machining processes
- Precision machining (especially brittle materials: ceramic materials, glass materials, crystalline materials) by grinding / ultrasonic assisted grinding, lapping / ultrasonic machining and polishing
- Surface measurement with tactile and optical methods (Multisensor-Coordinate measuring machine, tactile profilometer, Coherence correlation interferometry, scattering light sensor)

Computational Materials Science

Development of simulation methods

This research area of the Sierka group focuses on the development and applications of computational methods for investigating structure, properties and reactivity of complex materials – nanoparticles, thin films, surfaces and interfaces. Many chemical and physical properties of these materials arise from processes and features at multiple scales, both spatial and temporal. Therefore, our work involves simulations of material properties using information or models from different levels of theory: quantum mechanics, molecular mechanics and dynamics, mesoscale and continuum mechanics levels. The spectrum of the methods currently developed in the group ranges from quantum chemical methods for extended systems and hybrid methods through to global structure optimization algorithms. These methodological developments are applied within research projects conducted in close collaboration with experimental groups from different disciplines of chemistry and physics.

Simulation methods for large molecules, surfaces and solids: The basis for research projects within this area is the TURBOMOLE quantum chemical program package, initially developed in the group of Reinhart Ahlrichs at the University of Karlsruhe and at the Forschungszentrum Karlsruhe. With almost

20 years of continuous development TURBOMOLE has become a valuable tool used by academic and industrial researchers. It is used in research areas ranging from materials science, inorganic and organic chemistry to various types of spectroscopy, and biochemistry.
Our research in this area is devoted to the extension of the methods available within the TURBOMOLE program to periodic systems such as surfaces, interfaces and bulk solids. The main features of this new implementation are sparse storage of real space integrals and density matrices, the use of resolution of identity (RI) approximation and hierarchical approaches for numerical integration of exchange-correlation terms within density functional theory methods. The key component is the new formulation of RI approximation for the Coulomb term, which treats molecular and periodic systems of any dimensionality on an equal footing. This project plays a crucial role in future developments and applications of the TURBOMOLE program package to surfaces, interfaces and bulk systems.
Global structure optimization methods: This research area is devoted to the development of global optimization methods and their application for design of novel materials. In general, efficient structure optimization methods are important prerequisite for computational studies of structure and properties of materials. Local optimization methods locate the nearest local minimum or a saddle point and need a reasonable initial starting point. Global optimization methods are able to locate the global energy minimum independent of the initial structure. Therefore, such methods are well suited for the design of novel materials and for structure determination of systems, which are difficult to access experimentally. The DoDo program package developed within this project uses genetic algorithm (GA) as the global optimization method. It proved efficient for automatic structure resolution of both molecular systems, surfaces and interfaces. The current application area within this project is the design and structure determination of novel low-dimensional materials by a combination of calculations and experiments.

Structure and properties of low-dimensional materials

Low-dimensional materials can be defined as compounds of unusual structure that extend to less than three dimensions. Examples are two-dimensional surfaces, thin films and interfaces, one-dimensional nanotubes and nanowires as well as zero-dimensional nanoparticles, large molecules and clusters. Interests in such materials range from material science and nanotechnology through to astrophysics.

The key prerequisite for understanding the chemical and physical properties of existing low-dimensional materials and for designing new ones is a detailed knowledge of their atomic structure. However, such materials frequently present complex structures to solve. This is because on one hand the structural information is difficult to access experimentally and on the other hand the accuracy of theoretical tools that can be applied to extended systems is often limited. The results of our research show that often only a close collaboration between theory and experiment makes possible the successful atomic structure determination of low-dimensional materials. In particular, the application of global optimization methods at an ab initio level of theory has proved very useful in an automatic structure resolution of such systems.

Nanoparticles and clusters

Nanoparticles are of great scientific interest as they often display properties intermediate between bulk materials and atomic or molecular structures. In addition, one of the fundamental issues of materials science is how the structure, properties and reactivity of a material change with its increasing aggregation state – from small molecules and clusters through nanostructures to the three-dimensional bulk phase.

In this research area studies of nanostructured metal oxides aggregates are carried out using atomistic modeling tools. The use of global optimization methods is essential for the determination of atomic structures of such nanoparticles, since their structures often differ fundamentally from their bulk counterparts.

Thin films, surfaces and interfaces

Two-dimensional thin films, surface layers and interfaces play a crucial role in many modern technologies, e.g., electronic semiconductor devices, optical coatings, solar cells and batteries. The knowledge of the atomic structure of such materials is of great importance for their successful applications and for improving their functionality. Our results within this project demonstrate that a successful structure resolution of two-dimensional materials can often only be achieved by a combination of theory and experiment.

Nanostructured coordination compounds

This project involves scientific collaboration with the group of M. Scheer at the Institute of Inorganic Chemistry, University of Regensburg. Here, the focus is on exploration of possible synthetic routes and structural characterization of coordination compounds with unusual main group elements ligands. Particularly important is the ligand-induced stabilization of otherwise unstable species. Our contribution is the computational support and theoretical interpretation of experimental data. The development of efficient computational methods is of particular importance since the chemical compounds investigated within this project usually contain several hundred atoms.

7.7. Institute of Optics and Quantum Electronics

Preface

The Institute of Optics and Quantum Electronics (IOQ) is one of the major optics institutes of the Department of Physics and Astronomy of Friedrich Schiller University in Jena. The mission of the institute is typical for university institutes and consists of the two pillars teaching and research. However, the faculty of IOQ shares also numerous administrative responsibilities within the department, the university, and at extra-university institutes.

IOQ consists of five professorships: Nonlinear Optics (Prof. G. G. Paulus), Quantum Electronics (Prof. C. Spielmann), Relativistic Laser Physics (Prof. M. C. Kaluza), Atomic Physics of Highly Charged Ions (Prof. T. Stöhlker), and Laser Based Particle Acceleration (Prof. M. Zepf). In addition, there is the X-ray group of emeritus Professor E. Förster. Furthermore, the institute hosts a junior professor in the field of Experimental Attosecond Laser Physics (Jun.-Prof. A. Pfeifer) supported by the Carl Zeiss Foundation.

The central theme of research is the interaction of extremely intense laser radiation with matter. The laser intensities covered extend over more than seven orders of magnitude from extremely non-perturbative to relativistic strong-field laser physics. Accordingly, the institute is home of several high-power lasers that range from few-cycle laser pulses at kilohertz repetition rates to 100-TW pulses. Unique is the Polaris laser system, the worldwide first all diode-pumped solid-state PW-class femtosecond laser. Characteristic projects are the generation, investigation, and application of XUV and soft-X-ray radiation, the acceleration of electrons and ions, and strong-field QED and ionization dynamics.

IOQ has a strong partnership with the Helmholtz Institute Jena, an institute of the Helmholtz Association (HGF) on the campus of Friedrich Schiller University and directed by Prof. T. Stöhlker. Both institutes jointly operate some of the large-scale facilities mentioned above. The Helmholtz Institute Jena is also instrumental for establishing and supporting collaborations with the national laboratories run by HGF, in particular DESY, GSI and HZDR.

Concerning teaching, the institute contributes to the course program at the undergraduate and graduate level. Besides physics majors, this includes the education of prospective teachers and students with physics as a minor subject. At the graduate level, IOQ contributes to the department masters programs in physics and photonics. Most of our graduate courses are taught in English and service also the department's International Masters in Photonics in the framework of the Abbe School of

Photonics. In addition, the scientific staff of the institute and the research assistants offers recitations and lab courses. IOQ has significant outreach activities. Examples are public lectures and support for high-school research projects.

The IOQ is active in a number of national and international networks. In Jena these are the university centers Abbe Center of Photonics and the Center of Medical Optics and Photonics. A formative role has played the Collaborative Research Center SFB/TR-18 funded by the German Science Foundation. This center ties the institute's research activities in relativistic laser plasma physics. The renewal of this project in 2012 has been a major milestone. On the European level, the institute is a member of LaserLab Europe and contributes to the large-scale projects Extreme Light Infrastructure (ELI) and High Power Laser Energy Research (HiPER).

Research Projects at the Chair Nonlinear Optics

Strong-field and attosecond laser physics is a central theme of the research activities of the Chair Nonlinear Optics. The central research infrastructure for these activities is a laser system capable of producing laser pulses with a duration of less than two optical cycles. One characteristic research method of the lab is to exploit the dependence of the evolution of the electric field of such pulses on the absolute phase, which is also known as carrier-envelope phase. The ability to shape laser pulses on the sub-cycle timescale allows for the investigation of the ionization- and dissociation dynamics of atoms and molecules with attosecond time resolution. To this end, we have developed the currently leading approach of absolute-phase measurement and we hold several respective patents. The other large research thread in this context is relativistic nonlinear optics, in particular the generation of attosecond XUV pulses at relativistic laser surface plasmas. For these experiments, we mainly use the 40-TW laser system JETI which is commonly operated by the research groups of the Institute of Optics and Quantum Electronics.

These projects, which are entirely in the realm of basic research, have been the root of several applications. Particularly important in this respect is coherence tomography in the extreme UV and soft X-ray regime. A few years ago, we succeeded to demonstrate axial resolutions on the nanometer scale. This has enabled the acquisition of a large BMBF project that has the goal to validate the method for industrial applications.

A similar achievement has been obtained in X-ray polarimetry. Together with the X-ray group of the institute, we established the procedures for producing and operating X-ray polarimeters that achieve a polarization purity on the order of 10^{10}, an unprecedented value. This has resulted in several application in X-ray polarimetry far beyond our previous research interests. In fact, the new PETRA-3 synchrotron at DESY (Hamburg) will equip their corresponding beam line with some of our polarimeters. The respective funding comes from BMBF.

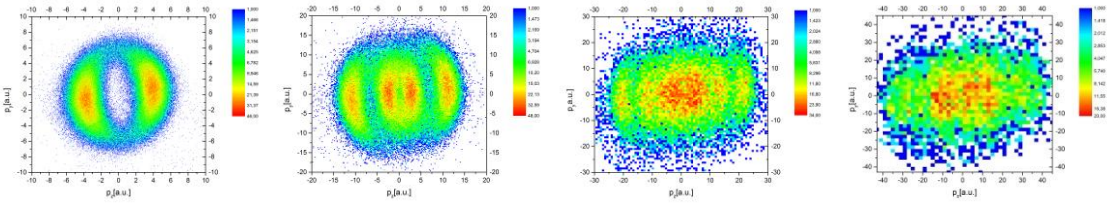
Many, in fact most of the research projects of our group are carried out in collaboration with colleagues from other research institutes in Germany and abroad. This is evident from the names of our coauthors on more than a dozen peer-reviewed papers in international research journals. In addition, we were invited to about half a dozen talks at international conferences.

Progress report of selected research projects

<u>Ionization dynamics of ions in intense laser fields</u>

The interaction of atoms and molecules with intense laser pulses in the visible or near-infrared (NIR) spectral region can result in the removal of many electrons and is an extremely nonlinear process. The latter implies that the electrons are ionized close to the very brief time intervals where the electric field of the laser assumes extremal values. This in term implies that the instant of the ionization events depends on the temporal evolution of the laser field, in particular on its absolute phase. The theoretical description of multi-electron, multi-photon ionization is a formidable problem. However,

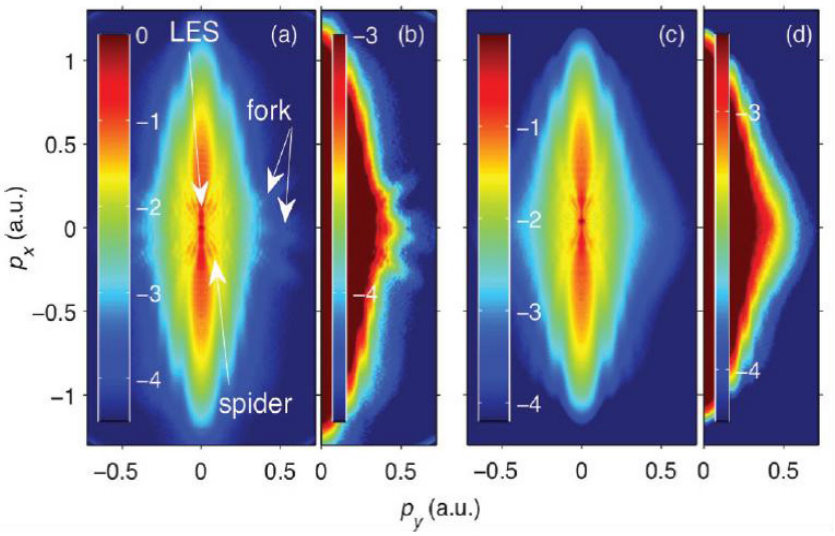
it is also a very timely problem considering the abundance of applications of intense femtosecond lasers in science and, increasingly, industry.
We have developed an ion beam apparatus for investigating the ionization dynamics up to considerable charge states with unprecedented detail. The apparatus can also be used to investigate the interaction of ultrashort laser pulses with exotic but fundamentally important molecules such as H_2^+ as reported last year. We measure the momenta of each and every ion in addition to their charge states. This can be used to determine the instant of ionization and the corresponding amplitude of the laser field.



The figure displays the momentum spectra of one- to four-fold ionization of Ne+ by nearly circularly polarized laser pulses. The outer crescent-shaped structures of the Ne^{3+} spectra, e.g., correspond to the situation where both photoelectrons are emitted in the same direction, while the inner ones correspond to the process where the first electron is ionized at a certain intensity in one direction and the second electron at higher intensity in opposite direction. This can be used for detailed tests of strong-field ionization theories.

Strong-field ionization at mid-infrared wavelengths

Ultrashort mid-infrared (MIR) laser pulses will play a pivotal role for the future of strong-field and attosecond laser physics. This calls for investigating the ionization dynamics for such laser sources. The widely accepted semi-classical model of strong-field ionization explains ionization as a three-step process that takes place within less than one optical cycle, i.e. on a time scale in the attosecond range. First, the electron leaves the atom close to a maximum of the laser's electric field. Second, the electron makes a trajectory which is governed by the laser field. The trajectory either moves the electron away from the parent ion or it leads back to it shortly after the time of initial ionization. If the electron returns, it might elastically scatter off the potential of the parent ion in the third step. Modern attosecond and strong-field laser physics exploit this in order to gain structural information on atoms and molecules with temporal resolutions of a few femtoseconds and even attoseconds. Accordingly, understanding and controlling the electron dynamics is a key issue.

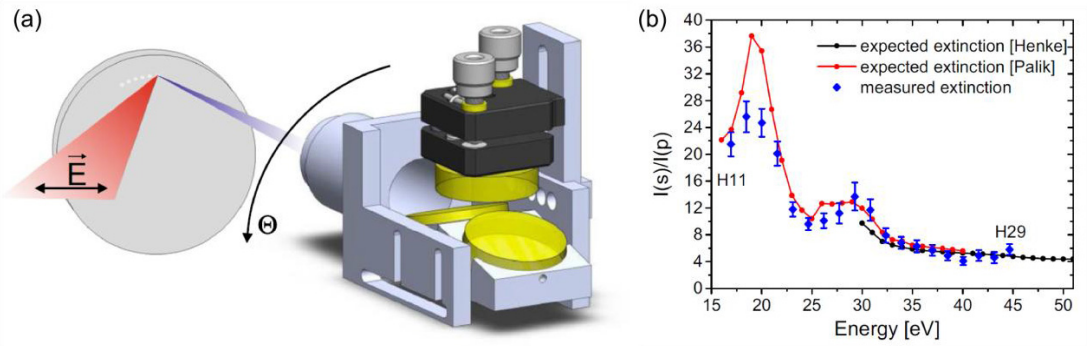


The generally hold view had been that the established approximations used in strong-field laser physics should hold the better the longer the wavelength. A few years ago, however, we contributed to a discovery that revealed a large effect on odds with expectations. In a recent paper, we analyzed the photoelectrons emitted perpendicular to the laser polarization — in contrast to the preceding work that concentrated on emission in parallel emission. The experiments revealed a so-far not discussed structure in the electron distribution which shows strong sensitivity to the pulse duration. Based on these experiments, it was possible to refine the understanding of the ionization mechanism and particularly the underlying electron dynamics. A surprising conclusion has been that forward scattering leaves a prominent imprint on photoelectrons emitted in perpendicular direction.

[1] M. Möller, F. Meyer et al., Physical Review A **90**, 023412 (2014).
[2] W. Becker et al., Journal of Physics B **47**, 204022 (2014).

Relativistic surface high-harmonic generation

High-order harmonic generation (HHG) from relativistic plasma surfaces has proven itself as an efficient mechanism to convert high-intensity laser pulses (> 10^{18} W/cm^2) into coherent extreme ultraviolet (XUV) radiation. The broad bandwidth produced in HHG processes facilitates the generation of attosecond pulses which open the way to new areas of research and technologies. Such applications require, among other things, the measurement and control of the harmonics' polarization properties. For high harmonics generated at relativistic plasma surfaces, simulations and analytic theory predict selection rules for the polarization state depending on the angle of incidence and polarization of the driving laser pulse.



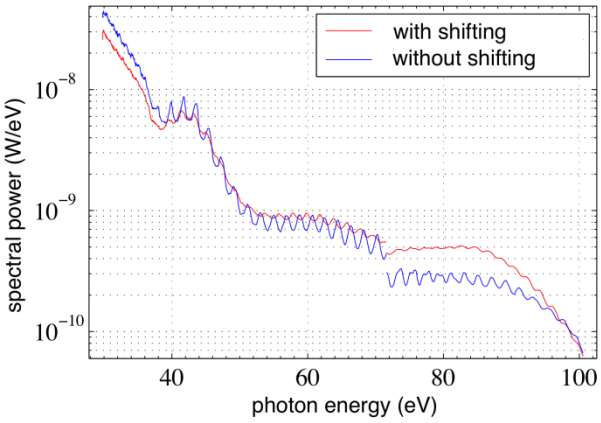
Within a collaboration with colleagues from the Heinrich Heine University Düsseldorf in the framework of the DFG TR18 research center, we performed experiments at our 40-TW laser system "JETI" in order to investigate the polarization state of relativistic surface high-harmonic generation for the most efficient conditions, i.e. the laser pulses are focused in p-polarization and under oblique (45°) incidence. For this purpose we designed a broadband XUV polarimeter based on multiple Fresnel reflections from gold-coated mirrors. The rotation of the polarimeter setup, as depicted in panel (a) of the figure, alters the XUV beams plane of incidence with respect to its polarization. Therefore, a measurement of the transmitted signal of the polarimeter for different rotation angles reveals the XUV lights polarization state and axis. Panel (b) shows that the extinction rates of our experimental data are in good agreement with the expectations for linear p-polarization. Hence, our measurements present the first experimental confirmation that linear p-polarization of a driving laser pulse is transferred to surface high-order harmonics as predicted from theory. The efficient generation and polarization control of high-harmonics from relativistic plasma surfaces pave the way for a series of experiments and applications such as time-resolved XUV spectroscopy of electronic transitions or the seeding of free-electron lasers.

[1] T. Hahn, J. Bierbach et al.: Broadband XUV polarimetry of high harmonics from plasma surfaces using multiple Fresnel reflections, Appl. Phys. B, DOI 10.1007/s00340-014-5977-9 (2014).

Towards nano-scale imaging with soft-X-ray coherence tomography

Optical coherence tomography (OCT) is a well-established method to retrieve three-dimensional, cross-sectional images of biological samples in a non-invasive way using near-infrared radiation. The axial resolution of OCT with broadband visible and near-infrared sources typically reaches axial (depth) resolutions in the order of a few micrometers.
We developed soft-X-ray coherence tomography (XCT), which takes advantage of the fact that the coherence length can be significantly reduced if broadband extreme UV (XUV) and soft X-ray (SXR) radiation is used. XCT can display its full capabilities when used in the spectral transmission windows of the sample materials. For instance, the silicon transmission window (30-99 eV) corresponds to a coherence length of about 12 nm, thus suggesting applications for semiconductor inspection. In the water window at 280-530 eV, a coherence length as short as 3 nm can be achieved and highlights possible applications of XCT for life sciences.

Our setup utilizes a variant of a Fourier-domain OCT setup that completely avoids a beamsplitter. Broadband XUV light is focused on the surface of the sample. The reflected spectrum is measured either with a grating spectrometer, consisting of a gold transmission grating and a toroidal mirror (spectrometer-based OCT), or with a photo diode (swept-source OCT) and a tunable source. The top layer reflection assumes the role of a reference beam. A Fourier transform including dispersion correction of the reflected spectrum needs to be computed for retrieving the structural information. A 3D-image can be captured by scanning the focus over the sample. A proof-of-principle experiment has been performed at synchrotron sources successfully.



Since XCT exploits the spectral broadness of the light source to achieve axial resolution it can be regarded as a perfect application for laser-driven high-harmonic generation sources due to their intrinsic broad bandwidths. In fact, the bandwidth of HHG would have disadvantages for other imaging methods such as confocal microscopy or coherent diffraction imaging. In addition, HHG enables XCT to become a table top nanometer imaging technique. Thus we developed a suitable HHG source in the energy range of the silicon transmission window (30-99eV) with sufficient flux by using laser pulses with an energy of 1.8mW, a pulse duration of 50fs, and a wavelength of 1300nm driven by an OPA. In XCT, the depth information is contained in spectral modulations of the reflected light. Thus, the harmonic structure of HHG with multi-cycle laser pulses superimposes and therefore weakens the modulations of the XCT signal. Hence, it is necessary to flatten the HHG spectrum. Therefore we used the ability of the OPA to shift the wavelength of the driving laser rather quickly. We changed the driving laser wavelength during a single CCD exposure time in such a way that the HHG structure in the time-averaged spectrum on the CCD almost vanished (from 1250nm to 1310nm). The figure shows the difference between harmonic spectra with and without shifting the wavelength. In 2015 we will use this XUV source to drive XCT.

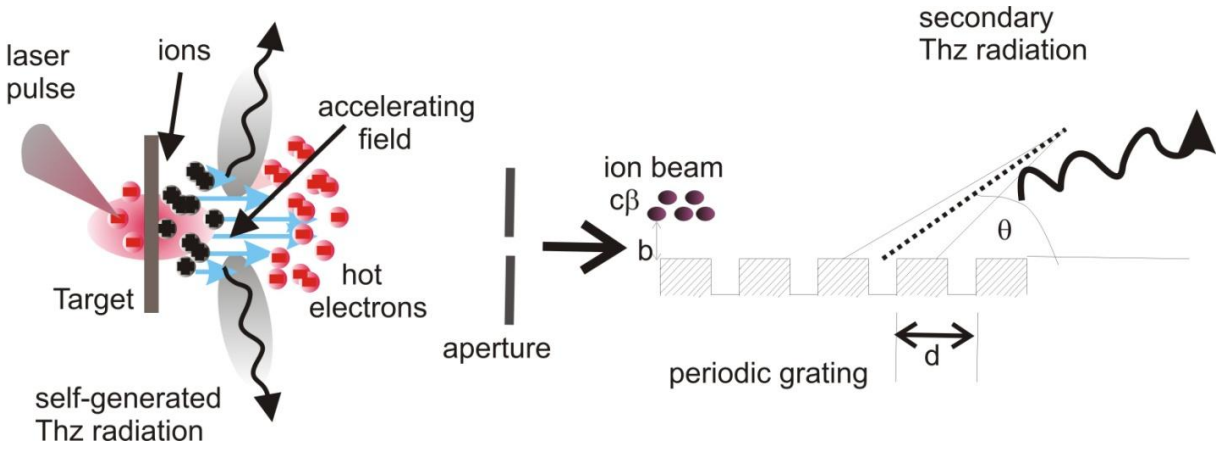
Generation of secondary terahertz radiation via the Smith-Purcell effect

A MeV ion beam generated by a laser-driven ion accelerator was sent in close proximity to a periodic structure to generate Smith-Purcell radiation in the terahertz regime. Sub-microjoule terahertz radiation was detected using a pyroelectric detector. The distance between the grating and the ion beam

was varied to distinguish the Smith-Purcell radiation from the background radiation. The Simultaneous measurement of the ion spectrum allowed us to estimate the radiated power and a detailed analysis of the radiation can be used to characterize the ion beam.
High-energy particle beams traveling close to a periodic structure emits electromagnetic radiation. The concept was initially proposed by Frank[1] and was first observed by Smith and Purcell[2]. In their studies, a 250-300 keV electron beam was used to generate electromagnetic radiation in the visible range. The radiation was strongly polarized and the wavelength of the radiation was defined by the dispersion relation,

$$\lambda = \frac{d}{|n|}\left({}^{1}/_{\beta} - cos\theta\right)$$

where λ is the wavelength of the emitted radiation, d is the grating period, n the diffraction order, $\beta = v/c$ and θ is the emission angle.



Schematic layout of the experiment

Previous experimental observations of Smith-Purcell radiation employed high-energy electron beams. In our experiment, proton and ion beams are used for the first time to generate Smith-Purcell radiation in the terahertz regime. The experiment was performed at the JETI laser system. TW laser pulses were focused onto a thin metal foil placed inside a vacuum chamber. MeV energy ions and protons were generated by the target normal sheath acceleration process. The accelerated proton beam from the laser-driven accelerator was collected and sent in close proximity to an optical grating. Gratings with 70 lines/mm and 300 lines/mm were used to generate the terahertz beam. Beam blocks were used to isolate the background radiation from the plasma. Additionally, the distance between the grating and the ion beam was varied: As the distance increases, the observed radiation decreases exponentially. The maximum detected energy of the terahertz radiation was 200 nJ.
Future studies will focus on the optimization of the process by careful beam placing above the grating structure and optimal collection of the radiation. Spatio-temporal analysis of the radiation will be carried out to characterize the particle beam.

[1] I. M. Frank, Izv. Akad. Nauk SSSR, Ser. Fiz. **6**, 3 (1942).
[2] S.J. Smith, E.M. Purcell, Phys. Rev. **92** 1069 (1953).

Research Projects at the Chair Quantum Electronics

The research of the Quantum Electronics group is focused on the generation and application of ultrashort laser pulses in a wide spectral range, from the near infrared to the x-ray. The ultrashort laser pulses are in the visible range are mainly employed to study the dynamics of molecules in the gas phase, stimulated Raman back scattering in a plasma, the nonlinear response of nanostructured samples, and demonstrate remote lasing in air. Major emphasis is also put on the development of new methods to increase the conversion efficiency and/or flux of laser driven XUV sources based on high harmonic generation and their application in high resolution imaging. In the following the most important results and findings achieved in the last two years are briefly described.

Molecular nonlinear optics

Noble gases are used for many applications in nonlinear optics, e.g. spectral broadening due to self-phase modulation and generation of XUV radiation using high-order harmonics. Instead of monoatomic nobles gases also molecular gases can be used, offering additional degrees of freedom, e.g. rotations or vibrations, which can be beneficially used to for spectral broadening and compression in hollow-core fibers (HCF). Our experiments with SF_6-filled HCFs showed that pulses longer compared to the Raman period could be efficiently compressed. We obtained a compression of a factor of 3 for pulses at either 800 nm or 400 nm resulting in an increased peak power in both cases. The major advantage of a molecular gas compared to e.g. argon is the same broadening for either a lower gas pressure or reduced input peak intensity. The latter offers the possibility to efficiently compress pulses from Yb doped thin disk or fiber lasers delivering sub-100 µJ and sub-500 fs laser pulses at very high repetition rates which can be found in an increasing number of non-laserlab, medical or industrial environments.

Stimulated Raman Backscattering

In the last few years we have witnessed a tremendous progress in the field of generation of ultra-intense ultrashort laser pulses and their application e.g. particle acceleration. To fulfil the increasing demand for higher peak power we have to develop a new class of amplifiers based on stimulated Raman backscattering (SRBS) in a plasma. This novel approach has the potential for realizing pulses on the petawatt level and above. Amplification by SRBS is a three wave interaction where a plasma density wave is resonantly excited by the ponderomotive force of the beat wave produced by counter-propagating pump and probe laser beams. The Manley-Rowe relations require that the seed frequency is lower than the pump frequency for amplification to occur. Several possible processes for this frequency shifter have been considered, but most of them have either a low conversion efficiency or are not stable enough to be implemented in high-power petawatt systems like PHELIX at GSI. A promising candidate –molecular Raman scattering- was studied first at JETI-40 and in fall 2014 also at PHELIX. To increase the interaction length and drive a parametric conversion processes axicons with different apex angles as well as different Raman active media were systematically studied. As a result redshifts we were able to generate 50-500 nm redshifted pulses with an excellent beam quality and stability. Based on our previous experimental and theoretical work we have designed a high energy experiment, which will take place at the GSI Darmstadt in 2015.

Second harmonic generation from nanostructured dielectric surfaces

In collaboration with the Institute for Solid State Physics (FSU Jena) we have investigated experimentally interaction of intense femtosecond laser pulses with ZnO nanostructured surfaces at the intensity level close to the optical breakdown and ablation threshold. Two types of nanostructures – an array of nano-pillars and a pile of nanowires chaotically arranged along the surface – were used in the experiments. An intense second harmonic emission was observed from both samples with the total yield several orders of magnitude higher than from the polished ZnO surface. The yield demonstrates sharp dependence on the laser pulse energy which is beyond quadratic law reported in similar experiments so far and which results in saturation and even drop in the efficiency with the laser energy in-

crease. As the next steps, we will investigate this phenomenon for different size and surface density of the nanostructures and develop physical model describing second harmonic generation from transparent nanostructured surfaces under critical intensities of the femtosecond laser radiation.

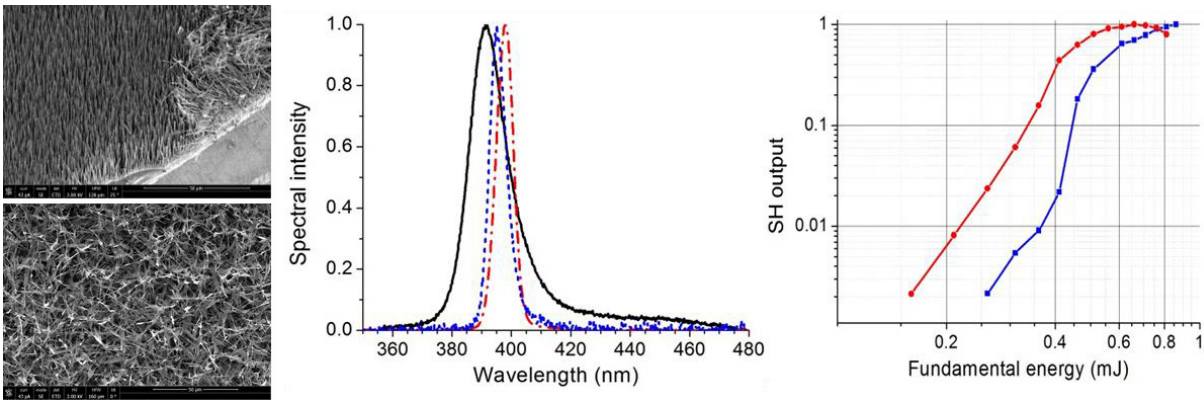


Figure 1 From left to right – SEM images of the "nanograss" and "nano-spaghetti" ZnO, the spectra of SHG from the polished ZnO surface (black), "grass" (blue) and "spaghetti" (red) samples, and the normalized SHG yield as a function of the pump energy.

Standoff lasing in nitrogen and air initiated by femtosecond laser filaments

In collaboration with Prof. M. Shneider from the Princeton University, USA, we have developed theoretical and numerical model of a time-dependent plasma-chemical dynamics in laser filaments generated by a high power femtosecond laser source in nitrogen gas or air. The model is based on self-consistent solution of Boltzmann kinetic equation for the electron energy distribution function, rate equations for electronic excitations in molecular nitrogen and different atomic and molecular species and laser equations describing evolution of a spontaneous and stimulated emission. We have identified different mechanisms of pumping electronic excited states in molecular nitrogen and conditions when single-pass lasing from femtosecond filaments can be realized. We have shown that the filamentation laser wavelength and polarization are the key parameters which determine the possibility to realize a standoff single pass nitrogen laser in the atmosphere.

Cancer Cell Classification using an Extreme Ultraviolet Laser Source

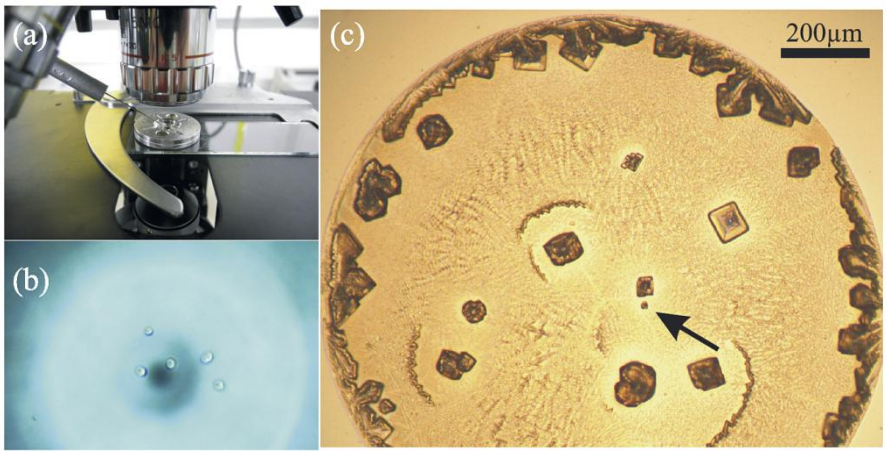
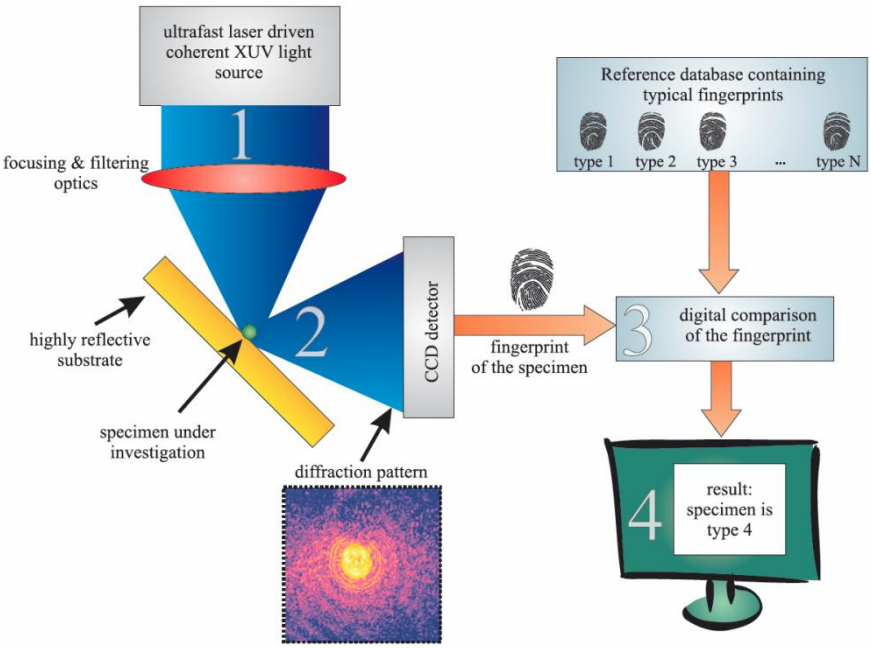


Figure (a) Preparing the samples, cells in a liquid are applied with a nanopipette under a microscope. (b) Example of 5 cells placed on a wafer still in their liquid environment. After evaporation of the PBS buffer salt remains of the droplet are found on the substrate (c) while in this example a single MCF7 cell can be found ready for illumination.

In modern cancer treatment it is highly desirable to identify and /or classify individual cancer cells in real time and without special preparation of the cells, e.g., like staining. The current standard method is polymerase chain reaction (PCR) which is costly and time-consuming due to the multifold amplification of the DNA structure. Recently we endeavored a novel approach for rapidly classifying cell types: we measure the pattern of coherently diffracted extreme ultraviolet radiation (XUV radiation at 38nm wavelength) and demonstrated that it is possible to distinguish different single breast cancer cell types. To achieve this, we focus the output of our laser driven XUV light source onto a single unstained and unlabeled cancer cell, and the resulting diffraction pattern is measured in reflection geometry.

For a proof-of-principle experiment several MCF7 and SKBR3 breast cancer cells were pipetted on gold-coated silica slides (Fig. 1) and subsequently illuminated with our XUV source operating at 38 nm wavelength. It was possible to retrieve the outer shape of the object from the diffraction pattern with sub-micron resolution. However, we found that for classification it is often not necessary to retrieve the image, it is only necessary to compare the diffraction patterns which can be regarded as a spatial fingerprint of the specimen (Fig. 2). By measuring a characteristic diffraction pattern we could distinguish between them. Using a more powerful laser, even classifying circulating tumor cells (CTC) at a high throughput seems possible and shall be a topic for the coming years. Further improvement of the setup and the source may allow for fast classification of any kind of cells, bacteria or even viruses in the near future.



Scheme for cancer cell classification using an ultrafast extreme ultraviolet source. Coherent XUV light is scattered on a single cancer cell. A characteristic diffraction pattern is captured by a camera and subsequently compared to a database of known fingerprints.

Sub-Wavelength Imaging using a High-Average Power Extreme Ultraviolet Laser Source

During the recent years tremendous progress in the development of high-average power high harmonic sources (HHG) opens was witnessed. This opens possibilities for novel applications in the soft X-ray and extreme ultraviolet (XUV) spectral range. Especially photon-hungry applications such as imaging benefit from the high photon flux that is available from these sources. One prerequisite for high-resolution imaging is further a high temporal coherence, i.e., a narrow line width. This can be achieved by relatively long driving pulses of the high harmonic source.

Using such a high power HHG source at the Institute of Applied Physics at Jena University, which is driven by a ytterbium-doped fiber CPA system operating at 1030 nm central wavelength, we performed coherent diffraction imaging (Fig. 1a & c) experiments and demonstrated a spatial resolution below the wavelength of the illuminating light at a high numerical aperture of 0.8 [3]. One should note that such high numerical apertures are especially challenging in the XUV and soft X-ray spectral domain. As sample (Fig. 1b) we used a thin silicon nitride substrate coated with a 200 nm thick gold layer and the institute's logo written as aperture using a focused ion beam. Cooperation with the Institute of Solid State Physics at Jena University is acknowledged for sample production. The coherent diffraction imaging setup we used consists of two multilayer coated focusing mirrors that refocus the XUV light onto the sample. At the same time the mirrors spectrally select the 31st harmonic at 33.2 nm wavelength. The achieved resolution is 26 nm and thus compares to less than one wavelength, which is in good agreement with the Abbe limit for the NA used. Further it compares well to the achievable resolution induced by the relative bandwidth of the harmonic line ($\Delta\lambda/\lambda=1/220$). Further we could demonstrate real-time imaging, which we define as one frame per second, at a resolution of 65 nm. The achieved relative resolution marks a new record for any coherent diffraction imaging experiment for any coherent XUV source reported in literature.

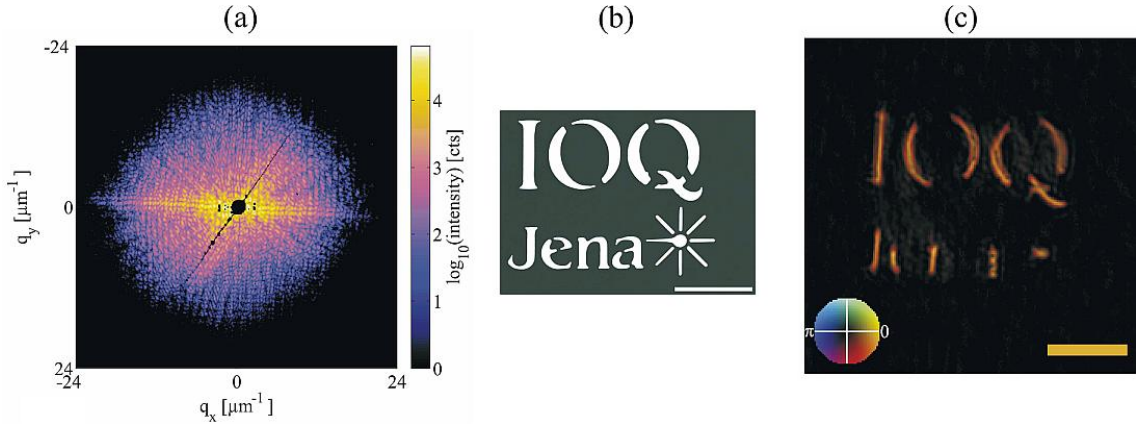


Figure (a) Measured diffraction pattern at 33.2 nm wavelength and a numerical aperture of 0.8. (b) STEM image of the sample used. (c) Reconstruction of the sample with 26 nm spatial resolution. The scale bars in (b) and (c) are 1µm.

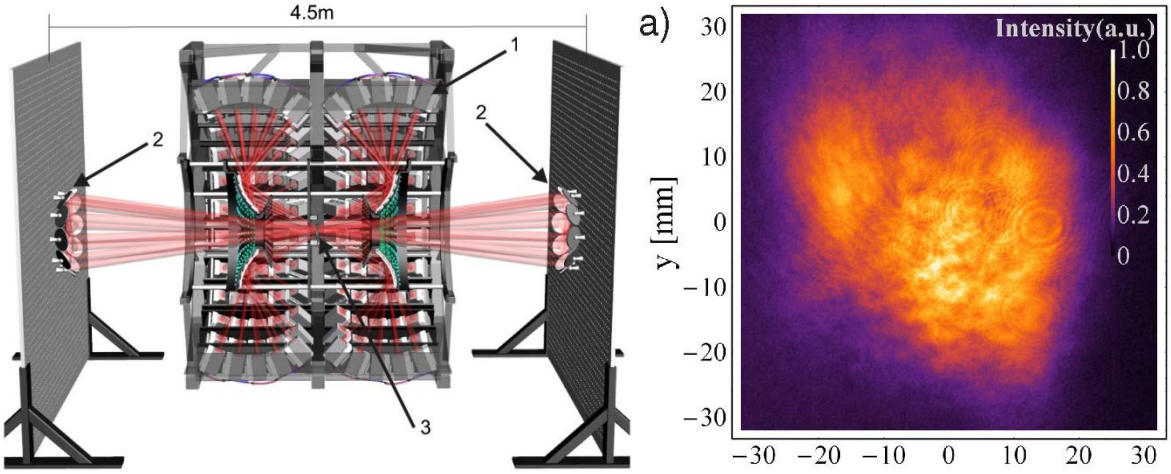
Research Projects at the Chair for Relativistic Laser Physics

The research at the chair for relativistic laser physics is aiming at the development and optimization of novel laser systems, both reaching ultra-high average and peak powers. Furthermore, these laser systems are applied for fundamental and applied research towards the realization of novel concepts for the acceleration of particles and the generation of ultra-short radiation pulses. Hence, generating and applying laser pulses suitable for driving high-intensity, relativistic interactions is a central goal of our research. Furthermore, our group has pioneered a number of ground-breaking experiments enabling the visualization of the interaction of high-power laser pulses with plasmas with unprecedented spatial and temporal resolution. By the end of 2014, a total of 25 scientists, students, and engineering staff were working in this group.

<u>Development of High-Power Laser Systems</u>

The laser system POLARIS, which has been developed entirely within our group, is one of the large-scale research infrastructures at the Institute of Optics and Quantum Electronics and at the Faculty of Astronomy and Physics. It is also embedded within the Helmholtz-Institute Jena. Delivering laser pulses of less than 150 fs duration with peak powers in excess of 100 TW, POLARIS is currently the fully diode pumped laser system reaching the highest peak power worldwide [1]. Significant im-

provement of the laser's performance has been possible using high-quality amplifier crystals made of Yb:CaF_2 in combination with specially designed, high-power laser diodes.



Schematic illustration of the last amplifier of POLARIS (left) and beam profile of the POLARIS pulses after this amplifier having a total energy of 16.6 J [1].

In collaboration with the Max-Planck-Institute for Quantum Optics (MPQ) in Garching, an additional power amplifier for POLARIS with a novel geometry has been designed and realized, which will replace two of the existing amplifiers in the POLARIS chain in the future [2]. This will help both to improve the performance parameters of the laser (in particular the pulses' energy and the beam profile) and to relax the alignment requirements for the daily operation.

Over the last years, a particular emphasis has been the improvement of the temporal contrast of the laser system, a parameter, which is of utmost importance for experiments for particle acceleration employing sophisticated or nm-thin targets. In addition to suppressing or avoiding sources of prepulses in the laser chain, a large-diameter KDP-crystal could be installed to provide ultra-short laser pulses at the second harmonic of POLARIS. Using these pulses helped to further improve the temporal intensity contrast by several orders of magnitude. A number of particle-acceleration experiments have been carried out successfully with this ultra-high contrast pulses.

In collaboration with the Otto-Schott-Institute of Materials Research (OSIM), new laser materials suitable for the application as the active medium in diode-pumped laser systems have been developed. At IOQ, their performance with respect to laser operation has been investigated and characterized. As one of the final results of the research group ALASKA, in which IOQ and OSIM have closely collaborated, a novel Yb-doped laser glass has been developed and large-scale glass melt on the basis of this material have been realized in collaboration with Vitron Spezialwerkstoffe GmbH.

Laser-Driven Particle Accleration

Using both the 30 TW Ti:Sapphire laser system JETI and the 100 TW Yb:glass laser system POLARIS, a number of experiments on laser-driven particle acceleration have been carried out.

At the JETI system, several campaigns investigating the acceleration and application of ultra-short electron pulses have been carried out. Here, novel targets based on gas-cells have been used and the interaction has been monitored using the worldwide unique few-cycle probe pulse capability, which has been developed in our group. Here, the formation and evolution of the plasma wave, the "heart" of a laser-driven electron accelerator could be studied when using different target gases and density distributions which gave insights of unprecedented resolution into the interaction.

The further application of electron pulses, e.g. the generation of ultra-short pulses of secondary radiation in external undulators structures relies on the transport of these pulses from the plasma to the undulators over meter-distances. For this purpose, a novel electron beam line has been designed,

setup and characterized in collaboration with the Karlsruhe Institute of Technology. Here, we could show that the transport of relativistic electrons of variable kinetic energy could be realized using several electro-magnetic multi-pole magnets. In a next step, these electron pulses will be fed into a super-conducting undulators which – using a specially designed magnetic field distribution – will generate narrow-band undulator radiation.

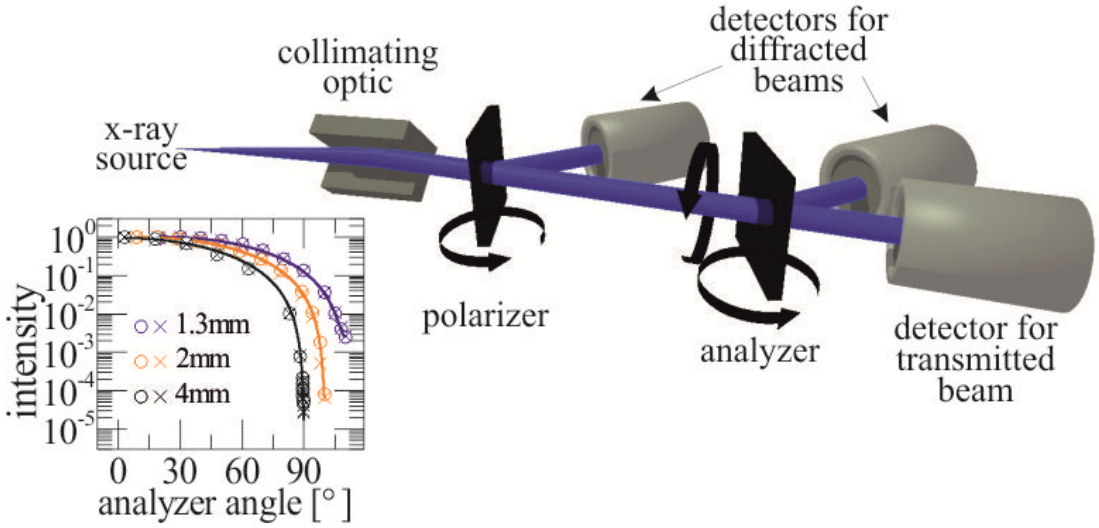
At the POLARIS laser systems, pulses of 50 to 100 TW could be used for the first time to generate narrow-band electron pulses from a gas jet or a gas cell with kinetic energies up to 0.5 GeV. Here, a special long-focal length parabola was used for the focusing of the laser pulses into the gas targets. Furthermore, experiments using the second harmonic of POLARIS were carried out in collaboration with MPQ Garching, LMU Munich and HZDR Dresden to investigate the acceleration of ions from target foils with thicknesses down to a few nm only. Furthermore, special mass-limted targets were employed which help to concentrate the laser energy to a much smaller volume significantly enhancing the efficiency of the acceleration process.

[1] Alexander Kessler, Marco Hornung, Sebastian Keppler, Frank Schorcht, Marco Hellwing, Hartmut Liebetrau, Jörg Körner, Alexander Sävert, Mathias Siebold, Matthias Schnepp, Joachim Hein, and Malte C. Kaluza, *16.6 J chirped femtosecond laser pulses from a diode pumped Yb:CaF_2 amplifier,* Optics Letters **39,** 1333 (2014).
[2] Christoph Wandt, Sandro Klingebiel, Sebastian Keppler, Marco Hornung, Christoph Skrobol, Alexander Kessel, Sergei A. Trushin, Zsuzsanna Major, Joachim Hein, Malte C. Kaluza, Ferenc Krausz, and Stefan Karsch, *Development of a Joule-class Yb:YAG amplifier and its implementation in a CPA system generating 1TW pulses,* Laser & Photonics Reviews DOI 10.1002/lpor.201400040 (2014).

Research Projects at the ray optics group

<u>High Purity X-ray Polarimetry</u>
Besides intensity and direction, the polarization of an electromagnetic wave provides characteristic information on the crossed medium.
X-ray polarimetry is a standard method at 3rd generation synchrotrons to study magnetic and electronic ordered structures of solids. The method uses the property of undulator radiation that the emitted radiation has already a highly defined linear polarization state. The sensitivity of such investigations depends on the polarization purity of such sources which are usually not well characterized. We have measured the polarization purity of undulator radiation at 12.9 keV, with the best x-ray polarizer existing at present in the world. We could measure a polarization purity of 1.8×10^{-4} by using a silicon channel-cut crystal with six Bragg reflections at Brewster angle which is 45° for x-rays as an analyzer. This value is the best purity measured for any x-ray sources up to now. By comparison of this data with simulation of synchrotron radiation emitted by an undulator we could understand the achieved result by assuming an off axis shift of our instrument to the center of the x-ray beam. A new X-ray polarimeter was developed based on the effect that anomalous transmission (Borrmann effect) of an x-ray wave in a perfect crystal is providing a linear polarized state. Using a polarizer-analyzer setup, we have measured a polarization purity of less than 1.5×10^{-5}, three orders of magnitude better than obtained in earlier work. Using the analyzer crystal in multiple-beam case with slightly detuned azimuth, we show how the first three Stokes parameters can be determined with a single angular scan. Thus, polarization analyzers based on anomalous transmission make it possible to detect changes of the polarization in a range from degrees down to arcseconds. The detection limits can be reduced considerably. At synchrotron sources, much better polarization purity is expected. Thus, polarization changing effects can be investigated precisely at arbitrary photon energies in a range from 4 to 10 keV. The advantage of this new polarimeter is that the polarizing effect is independent on the Brewster angle, which amounts 45 degree for x-rays and which fixes the diffracted wavelength by using Bragg reflection. Compared to previous x-ray polarimeters the wavelength can be detuned by a

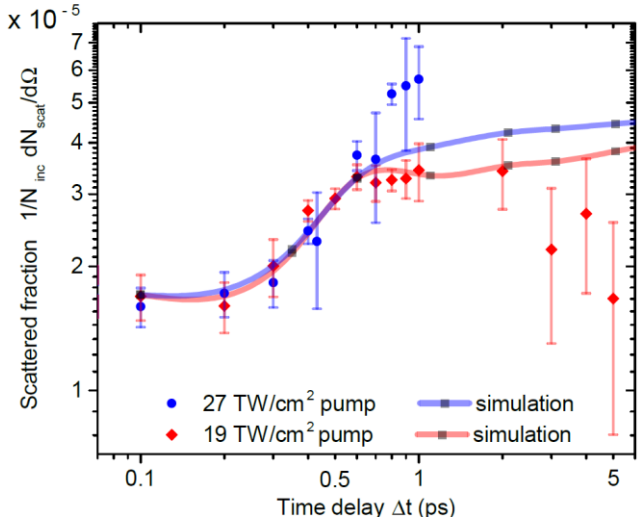
wide range using the new polarimeter. Since the L-edges of rare earth metals are in this range, polarizers based on the Borrmann effect are suitable for future investigation of electric and magnetic properties of these materials.



A new X-ray polarimeter based on anomalous X-ray transmission and its measured polarization purity for three crystal thicknesses.

X-ray laser FLASH spies deep into giant gas planets

Knowledge of thermodynamic properties of matter under extreme conditions is critical for modelling stellar and planetary interiors [1]. Of central importance are the electron-ion collision and equilibration times that determine the microscopic properties of matter related to reflectivity and thermal conductivity. On a macroscopic scale, they affect the depth of mixing layers in Jovian planets.



Temporal evolution of measured and simulated x-ray scattering. For the blue data points, ranging from Δt = 0 ps to 1 ps only, the more intense 27 TW/cm² pulse pumps the target, while it is probed by the 19 TW/cm² pulse. The red data points, ranging from 0 to 5 ps, resemble the inverse case.

The split-and-delay capability of FLASH is used to measure ultrafast heating of dense matter. We produce two FEL pulses of comparable intensity to volumetrically heat dense cryogenic hydrogen and probe it by soft x-ray scattering.

We employ 92 eV soft x-ray radiation to be in a regime where the photon energy is well above the plasma frequency for hydrogen at liquid density. The generated photo-electrons with kinetic energies of 78 eV are capable of impact-ionizing several molecules and atoms within the FEL pulse duration. This leads to further ionization, molecular heating, and expansion, as well as breaking of the covalent H-H bond (dissociation).

To describe the temporal variation of the measured scattering intensity, we compare one-dimensional Lagrangian radiation-hydrodynamic simulations with the code HELIOS using two different equations of state (EOS) models: one model calculates the ionization via a Saha model, while the second one uses a Thomas-Fermi model as implemented in the quotidian EOS (QEOS). We evaluated ionization models for the

equation of state data and showed that a Saha-like model is superior to a Thomas-Fermi approach as implemented in the QEOS. The latter predicts about one order of magnitude too short equilibration times. Hence, a pump-probe delay dependence for *S(0)* is not predicted using the QEOS.

The figure shows the experimental data in comparison with the different simulations. The total scattered fraction of FEL photons raises to a peak value of $4*10^{-6}$ within 0.9 ps, remaining constant for delays up to 2 ps. We show that this dynamic behaviour is reproduced with the Saha model for ionization.

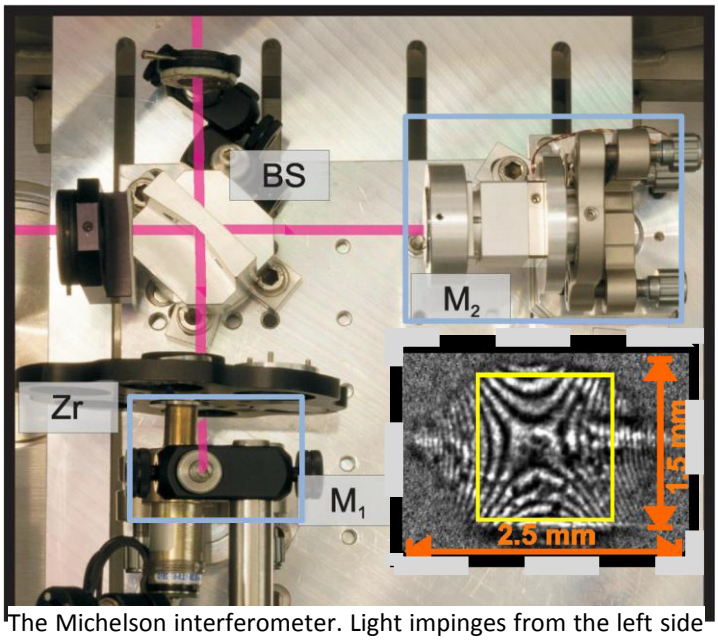
In summary, our experimental results have provided important insights on transport effects which lead to a better understanding of dense plasmas.

Assistance by the BMBF (FSP 302) and the VolkswagenStiftung is acknowledged.

[1] Phys. Rev. Lett. 112, 105002 (2014), DOI: 10.1103/PhysRevLett.112.105002

Coherence of free-electron laser radiation

Within this project we performed an experiment at the XUV free-electron laser facility (FLASH) at DESY (Hamburg) where we address the issue of temporal and spatial coherence. This experiment uses an XUV Michelson interferometer to determine the coherence properties of the FEL. Since the experiment is performed at the monochromator beam line PG2 at FLASH we have precise control over the spectral properties of the FEL pulses. Moreover, we are able to predict temporal coherence properties from the spectral distribution and compare them to our measurements.
We present a different approach to the analysis of the data by using the standard deviation of the recorded images instead of their visibility. This way, fluctuations are strongly reduced due to improved statistics.



The Michelson interferometer. Light impinges from the left side onto the beam splitter (BS) and then in the mirrors M1 and M2. Beams are recombined at the BS and proceed in upper direction. The inset shows a typical interferogram.

The measured spatial coherence lies well within the range of reported values and can be explained via recently published theoretical conclusions. In this framework our measurement represents an important contribution to the understanding of the self-amplified spontaneous emission (SASE) nature of FEL radiation and its impact on the spatio-temporal coherence properties.

This work was carried out by researchers from the universities of Jena and Rostock in close collaboration with DESY / FLASH and the European XFEL, as well as the Hamburg Center for Ultrafast Imaging (CUI). Experimental and theoretical work was performed by researchers from the US research centers SLAC and Lawrence Livermore Lab, the Helmholtz Institute Jena, and University of Oxford.

[1] Appl. Phys. Lett. **105**, 101102 on 9 September 2014.

Research Projects Related to the Professorship Atomic Physics with Highly-Charged Ions

Experimental studies on elastic X-ray scattering

The physics of strong electromagnetic fields has been studied in an experiment where hard X-rays (175 keV) were elastically scattered by a high-Z (gold) target. In the last decades, numerous elastic photon scattering studies were carried out covering a broad range of photon energies and target materials [1,2]. While in most experiments the differential scattering cross section was studied, we aimed to investigate the photon polarization properties in addition. In the hard X-ray regime, such experiments were limited by the lack of polarized photon sources as well as suitable polarization detectors. Nowadays, synchrotron radiation sources provide intense beams of highly linearly polarized photons, even in the hard X-ray regime. On the other hand, large-volume, segmented solid state detectors are available that can act as efficient Compton polarimeters.

The incident 175-keV photon beam was provided by the High Energy Material Science Beamline P07 [3] at the synchrotron radiation source PETRA III at DESY, Hamburg. It was scattered by a thin solid gold target and the scattered radiation was detected by a 2D Si(Li) strip polarimeter [4] and a standard high-purity germanium detector. This setup allowed the parallel measurement of the differential cross section and the polarization. While for the linear polarization measurement data analysis is still ongoing, we can already present preliminary values for the angular differential cross section of the elastically scattered x-rays. Figure 1 (a) shows the energy spectrum of the germanium detector mounted under a scattering angle θ = 30°.

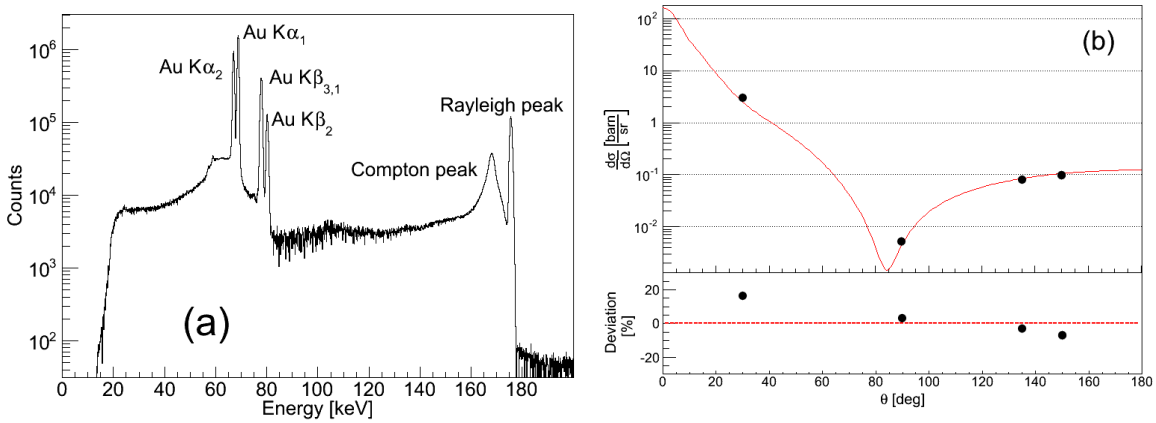


Figure 1: Preliminary results: (a) Photon energy spectrum of a Ge(i) detector at θ = 30°; (b) Differential cross section, normalized to $K\alpha_1$ peak (solid circles) and to Compton peak (open triangles). The solid line denotes theory values by A. Surzhykov, V. Yerokhin and S. Fritzsche [5]. Statistical errors are smaller than the point size, systematic errors are not yet included.

The main features are the Rayleigh peak (elastically scattered photons), the Compton peak (inelastically scattered photons) and the Au K_α and K_β lines (fluorescence from the target). The differential cross section is obtained by determining the intensity of the Rayleigh peak and normalizing it (i) to the Au-$K\alpha_1$ cross section and (ii) the Compton cross section, which are believed to be well-known. This procedure allows canceling uncertainties from the experimental geometry and fluctuations in the incident beam intensity. Preliminary results are shown in figure 1 (b). We want to stress that here we successfully studies a variation in the absolute cross section over three orders of magnitude.

[1] P. P. Kane et al., Phys. Rep. **140**, 75-159 (1986).
[2] D. A. Bradley et al., Radiat. Phys. Chem. **56**, 125-150 (1999).
[3] N. Schell et al., Mater. Sci. Forum **772**, 57-61 (2014).
[4] D. Protic et al., IEEE Trans. Nucl. Sci. **53**, 3181-3185 (2005).
[5] A. Surzhykov, priv. comm. (2014).

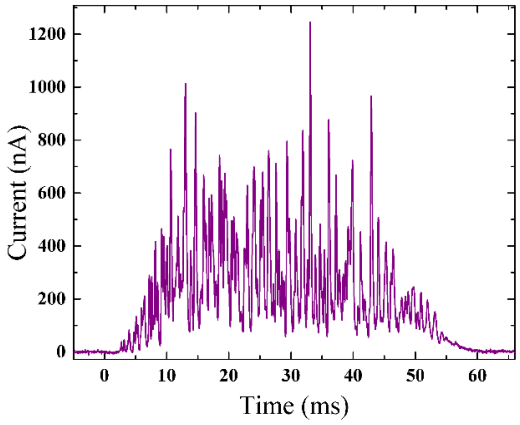
Cryogenic Current Comparator for Particle Diagnostics at an Ion Beam Line

A non-destructive online beam current monitor, based on the Cryogenic Current Comparator principle (CCC), was developed in cooperation with the Institute of Solid State Physics, the Helmholtz Institute Jena, and the GSI Helmholtzzentrum für Schwerionenforschung.

This SQUID-based detector will be able to monitor expected beam currents in the range of few nA up to several µA for continuous as well as bunched beams with a low detection threshold, a high resolution, and as well as high bandwidth from DC to several kHz [1, 2].

Therefore the focus of the research was on the low temperature properties of ferromagnetic core materials and state-of-the-art SQUID sensors, regarding a low noise contribution and high bandwidths [3].

A CCC was installed in the extraction line of the GSI synchrotron SIS18 to monitor the extracted beam current and was showing very promising results. A 600 MeV/u beam of slowly extracted Ni^{26+} ions was measured by the GSI-CCC. An example of the measured current signal is shown in the figure . The bandwidth of the GSI-CCC was limited to 10 kHz by a switchable low pass filter at the Connector Box of the Magnicon readout electronics to reduce the rf-noise. The spill structure of the extracted beam signal shows a large number of spikes with peak currents of up to 1.2 µA while the average current of the spill is 211 nA.



Spill structure of a 600 MeV/u slowly extracted beam of Ni^{26+} extracted over 64 ms measured with the GSI-CCC.

An improved version of the CCC with nA resolution and approximately 200 kHz bandwidth was developed and will be tested at AD at CERN and later on at CRYRING [4].

[1] Peters A, Vodel W, Koch H, Neubert R, Reeg H and Schroeder C H 1998 AIP Conf. Proc. 451 163-180.

[2] Geithner R, Neubert R, Vodel W, Seidel P, Knaack K, Vilcins S, Wittenburg K, Kugeler O and Knobloch J 2011 Rev. Sci. Instrum. 82 013302.

[3] Geithner R, Heinert D, Neubert R, Vodel W and Seidel P 2013 Cryogenics 54 pp. 16-19.

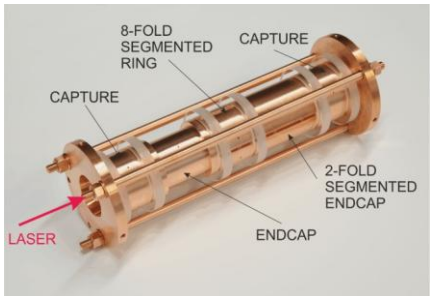
[4] Geithner R, Neubert R, Seidel P, Kurian F, Reeg H, Schwickert M and Stöhlker T 2014 Proc. of IBIC 2014, Monterey, USA, WECZB1.

HILITE - trapped ions in intense photon fields

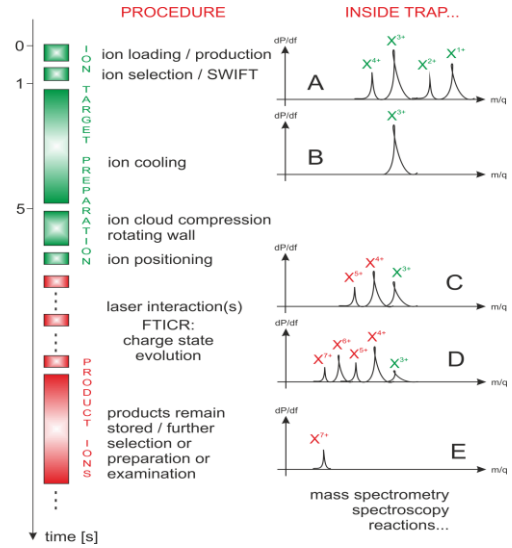
Recent experiments on laser-ionization of atoms [1] made it necessary to use an ion storage tool to provide well defined ion target to investigate ionization dynamics of field-ionization and multiphoton ionization. Due to its strong trapping force we decided to build a Penning trap for experiments with ions and intense laser radiation in collaboration with the GSI in Darmstadt [2]. The Penning trap is designed to support the preparation of well-defined ion targets concerning ion shape, ion species and charge state with the Rotation Wall mechanism[3]. Applying recent developed and investigated in-trap ion-cooling technologies[4] we will cool down the ions to cryogenic temperatures to assure a well confinement of the ion cloud. Using the FT-ICR method the Penning trap also will be used to

measure the stored number of particles precisely for every single charge state non-destructively and simultaneously before and after laser interaction. Therefore we will be able to measure ionization cross sections of all ionization channels to achieve a better knowledge of ionization mechanisms. Due to the well-defined target we plan to use the ion target as a probe to determine the shape of the laser pulse varying will also be able to determine the shape of the laser-focus.

The whole setup is designed in a flexible fashion and can therefore be transferred easily to different laser-facilities such as PHELIX, POLARIS, JETI and FLASH. So we will cover a wide range of ionization parameters.



Photograph of the Penning trap.



Experimental procedure of one Measurement cycle.

[1] Richter, M. et al. 2009. *Extreme Ultraviolet Laser Excites Atomic Giant Resonance*. Physical Review Letters, 102(16), S.163002.
[2] Vogel, M. et al., 2012. *A Penning trap for advanced studies with particles in extreme laser fields.* Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 285, S.65–71.
[3] Bharadia, S. et al., 2012. *Dynamics of laser-cooled Ca+ ions in a Penning trap with a rotating wall*. Applied Physics B, 107(4), S.1105–1115.
[4] Vogel, M. et al., 2014. *Resistive and sympathetic cooling of highly-charged-ion clouds in a Penning trap.* Physical Review A, 90(4), S.043412.

The Ion Storage Ring CRYRING for GSI/FAIR

CRYRING@ESR (an contribution of Sweden to FAIR)[1] is one of the first storage ring installations of the FAIR facility in Darmstadt. The installations are ongoing (see. Fig. 1) and the beginning of commissioning is expected already as soon as 2015. The ring is dedicated to low-energy experiments on highly-charged heavy ions up to bare uranium (Z=92). The research program has its focus on two research topics made possible by the unique in-ring capabilities offered at GSI/FAIR [2]: 1) Precision studies of cooled highly charged ions at rest and at low velocities as test of QED theory at extreme fields (e.g. Hyperfine Structure, 1s Lamb-Shift); 2) Study of the interaction of highly charged ions with matter by using atomic targets or cold electrons (e.g. di-electronic recombination experiments).
Key features of CRYRING are long storage times at low ion energies, a wide range of fast ramping capability for ion energies 300 keV/u < E < 15 MeV=u, an electron cooler, a “free” experiment section, and slow or ion fast extraction for downstream experiments. The installation and commissioning of CRYRING is pursued in collaboration between Stockholm University, SPARC@GSI, University of Cracow, University of Stockholm, IOQ at University of Jena, and HI-Jena.

Figure 1: Left side: Construction site for the installation of CRYRING (Foto: December 2014). Right side: The injector for CRYRING at the construction site (Foto: December 2014).

[1] M Lestinsky et al. CRYRING@ESR: A study group report. Project Study. Darmstadt: GSI, 2012. URL: http://www.flairatfair.eu/typo3/fileadmin/files/documents/reports/ReportCryring_40ESR.pdf.

[2] Thomas Stöhlker et al., Hyperfine Interact., 1-9 (2014).

Research projects in the attosecond physics group

The research field of the attosecond physics group is physics on extremely short time scales. There are many important processes in atoms, molecules and in condensed matter that occur within a timespan on the order of attoseconds. Prominent examples include coherent charge migration in atoms and molecules, decay of atoms with inner-shell vacancies, and photoionization.

The most important experimental tools both for the preparation of these processes and for their observation are intense laser pulses that consist of only a few optical cycles. The field strengths of these laser pulses are comparable to the inner-atomic Coulomb fields, and hence allow to liberate electrons from their parent ions and thereafter steer them by means of the laser field. Demanding requirements to the laser source are not only very short pulse durations and very high intensities, but also stability of the carrier-envelope phase of the laser pulses, meaning that the electric waveform of the pulses is identical to one another. A well-suited laser source is available in collaboration with the group for non-linear optics.

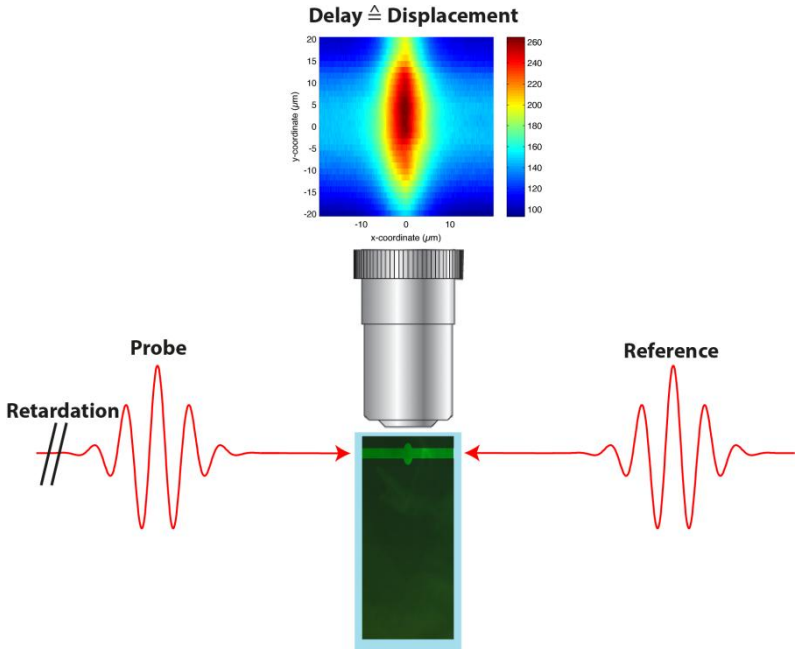
The interest of the research group focuses also on new directions in attosecond science, such as fast processes in bulk dielectrics. Attosecond metrology of condensed matter and signal processing are very exciting new directions in attosecond science, because there is the potential to produce great discoveries of both fundamental importance and great technological relevance. Most methods of attosecond science (especially those based on photoelectron detection) are not applicable to bulk solids. Therefore, new methods need to be developed.

<u>Sub-cycle resolved probe retardation in strong-field pumped dielectrics</u>

Since very recently, it is known that a strong few-cycle laser can populate conduction band levels in a bulk dielectric transiently at the crests of the laser field, thereby switching the dielectric from an insulator into a conductor and back into an insulator within one optical cycle. This extremely fast electronic response, footed on the wide band gap of dielectrics and the high nonlinearity of the process, could in the future circumvent fundamental limits of semiconductor electronics.

A new method was developed which delivers time-resolved information about strong-field processes that occur in dielectric solids during one laser cycle. The method is based on the well-known retardation of a probe pulse in the presence of a strong pump pulse. The retardation of a probe pulse in a strong-field pumped, bulk dielectric is measured with sub-cycle resolution in the pump-probe delay. A close-to-collinear alignment of pump and probe beams facilitates the detection of sub-cycle dynamics.

After the interaction in the bulk sample, the probe and the reference pulses are focused head-on into a custom cuvette containing a fluorescent solution (Fluorescein). The fluorescence is imaged with a microscope objective onto a CCD camera. Through two-photon fluorescence, the temporal overlap of the probe and the reference pulses is mapped to the spatial domain: the spatial location of the maximum fluorescence shifts in space upon temporal retardation of the probe pulse (see figure).



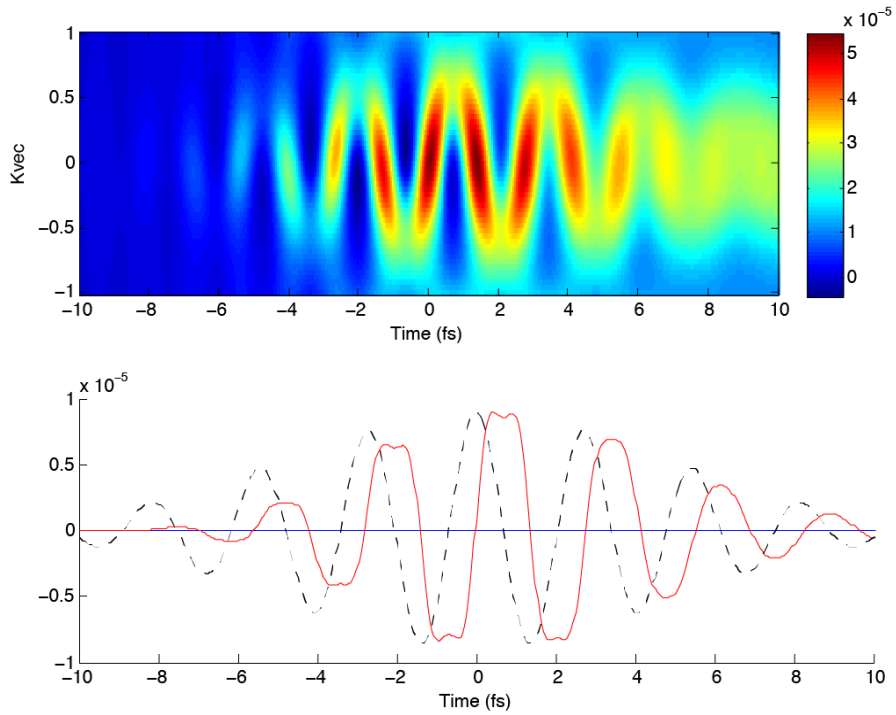
The electronic contribution to the nonlinear material response is revealed both through the interband polarization and through transient excitations in the conduction band that gives rise to the intraband polarization. By comparison with model calculations, the interband dephasing time, which determines the coherence of the transient excitations in the conduction band, can be measured. The method stands out in two points:

1) The coherence properties, characterized by the dephasing time, are accessible to our measurement.

2) The method is very versatile (it can be applied to all transparent dielectrics) and sufficiently easy to implement.

Generation of isolated pulses in the deep UV

The most important tools of attosecond physics are light pulses with the duration of attoseconds. Typically, the attosecond pulses are generated through the process of high-harmonic generation in gases, where the collision of a liberated electron with the parent ion after strong-field ionization generates light in the extreme ultraviolet regime. To date, this scheme for generation of attosecond pulses is limited to pulse energies below micro Joules.
High-harmonic radiation can also be generated from bulk crystals with hope for new schemes for attosecond pulse generation. The process is fundamentally different compared to high-harmonic generation in gases. Conduction band levels are populated transiently and accelerated (see figure below). The upper panel shows the population of conduction band levels in k-space. The lower panel shows the electric field of the laser (blue) and the resulting electric current (red). The electric current contains frequency components of higher orders than the laser field, which in turn generates light at high-order frequencies.



The generated high-order frequency light has been detected with the same experimental setup that is in use for sub-cycle resolved probe retardation measurements in strong-field pumped dielectrics. It was investigated by calculations how the phenomenon of wave-front rotation can be used to isolate pulses from this light. Experiments are in preparation to demonstrate this effect.

7.8. Institute of Theoretical Physics

a) Fields of research and results

Gravitational Theory

1. Soliton-theoretic methods for rigorously solving initial and boundary value problems of the Einstein- and Einstein-Maxwell equations have been further developed and applied to problems of colliding plane gravitational waves, black holes and rotating discs.

2. The research group "Conformal Methods" studies field equations in conformally compactified coordinates. The main emphasis is put on the development of novel numerical techniques based upon pseudo-spectral methods in order to achieve extremely high accuracy of the resulting numerical solutions. In 2014, the fully pseudo-spectral time integration scheme written in 2012/13, was further improved to include the treatment of unknown free boundaries. Furthermore, through an extensive stability analysis of the code it has become apparent that the equations are to be formulated as systems of first order in time. By the introduction of specifically designed coordinates, the late time behavior of solutions to wave equations in given black-hole spacetimes was determined to a previously inaccessible numerical accuracy. Finally, mathematical techniques were developed in order to filter quasi normal modes from given initial data of the Teukolsky-equation.

Marcus Bugner and Niclas Moldenhauer from the Gravity group present the picture of a Black Hole as seen by a webcam in real time.

3. The focus area of Numerical Relativity is the solution of the classical field equations of general relativity for astrophysical systems. Topics were black holes and neutron stars, as well as gravitational waves generated in various binary and collapse scenarios. Newly studied were systems with significant eccentricity, as well as systems with spinning neutron stars which had not been accessible before. A new numerical infrastructure for the evolution of extreme gravitational fields with pseudospectral methods was developed.

Quantum Theory

1. Investigation of quantum vacuum effects in strong electromagnetic fields. Prediction of photon merging rates of laser photons in inhomogeneous backgrounds. Verification of photon quantum reflection rates in inhomogeneous fields by numerical simulations.

2. Nonequilibrium evolution of electron-positron quantum fields in time-varying electric fields. Numerical evaluation of Wigner functions and prediction of signatures of pair production in rotating electric fields.

3. Investigation of mass bounds for the Higgs bounds and stability properties of the standard model effective potential. Derivation of new consistency bounds for the mass spectrum of the standard model of particle physics accounting for the sensitivity to new high-scale physics. Development of new numerical algorithms for the renormalization group evolution of effective potentials.

4. Exploration of the concept of asymptotic safety in quantum field theory and quantum gravity. Construction of new asymptotically free gauged Higgs and Higgs-Yukawa models. Studies of the high energy behavior of quantum gravity including fermionic matter degrees of freedom. Analysis of the spin-base invariant formulation of fermions in curved spacetime.

5. With the help of Monte-Carlo-Simualtions we determined the flow of the couplings in nonlinear O(N) lattice models for various values of N. We localized the nontrivial fixed points and the relevant critical exponents. The results unambiguously show that these models realize the asymptotic safety scenario.

Members of the Doktoratskolleg Graz and of the Quantum Field Theory group at TPI meet regularly in Graz and Jena to discuss their recent results

6. QCD phase diagram: We have continued the investigation of QCD and QCD-like theories both at finite density and finite temperature. We have uncovered several aspects of the interaction for gluons, especially in form of their vertices.

7. Higgs physics: We have established the Fröhlich-Morchio-Strocchi mechanism is the way how in the Higgs sector of the standard model a bridge is created between a perturbative language in terms of the elementary particles, and experimentally observable states. Our first investigations beyond the standard model hint that this could be a powerful constraint to eliminate many of current scenarios for new physics.

8. Studies on the relativistic dynamics of highly-charged and finite quantum systems, based on Dirac's relativistic equation and the density matrix theory. Analysis of angular and polarization correlations of emitted electron and photons in collisions with ions, atoms and molecules. Comparison and support of ongoing experiments at synchrotrons, FEL and strong laser facilities.

9. Investigations of new dualities between quantum gravity theories and ordinary quantum field theories, which are referred to as gauge/gravity dualities. Gauge/gravity dualities may be motivated within string theory and give rise to deep insights into quantum gravity in asymptotically AdS spacetimes such as black hole evaporation. Moreover gauge/gravity dualities provide a new tool for describing dynamical processes in strongly coupled quantum field theories, for which a description by conventional means is often difficult or even impossible. Both aspects of gauge/gravity dualities are explored in the working group of Juniorprofessor Martin Ammon.

b) Cooperations (national)

Within Project A07 of SFB-TR7 cooperation with C. Lubich (University of Tübingen). Exchange and scientific overlap with L. Andersson (Max Planck Institute for Gravitational Physics, Potsdam)

Within Project G1 of GRK 1523 strong cooperation with J. Kunz-Drolshagen (University of Oldenburg).

In the framework of the SFB/TR18, TPI cooperates closely with IOQ (group of Prof. Paulus) at FSU.

In the framework of the DFG research unit FOR 723, there exist an ongoing collaborations with ITP Heidelberg U. (groups of Profs. Pawlowski and Wetterich), ITP Frankfurt U. (group of Prof. Kopietz) and MPI-FK Stuttgart (group of Prof. Metzner).

On Higgs mass bounds and vacuum stability, there is a larger collaboration also involving ITP Heidelberg (groups of Profs. Jaeckel and Plehn, Dr. Scherer) as well as ITP Freiburg (Dr. Gneiting).

Collaboration with IKP at TU Darmstadt (group of Prof. Braun) on relativistic fermion systems and in condensed matter systems and inhomogeneous phases in fermionic models.

Collaboration with Prof. Dr. Marc Wagner, ITP Frankfurt U., on the quark-antiquark static potential.

There is a collaboration with Prof. Pawlowski (U. Heidelberg) on gluons, and with Prof. von Smekal (U. Darmstadt and Giessen) and Prof. Skullerud (U. Maynooth, Ireland) on the QCD phase diagram.

A tight collaboration exists for many years with the Atomic Physics Division at GSI Darmstadt on excitation, ionization and decay processes in strong Coulomb fields (Thomas Stöhlker, Alexandre Gumberidze).

The study of multi-electron photoionization processes at noble gases is in the focus of a collaboration with the groups of Alfred Müller & Stefan Schippers at the Justus Liebig University of Giessen.

The lifetime of the metastable 2s 2p ^3P_0 level of beryllium-like ions has been investigated with a relativistic and quantum-electrodynamical framework together with Andrey Volotka from the Technical University of Dresden.

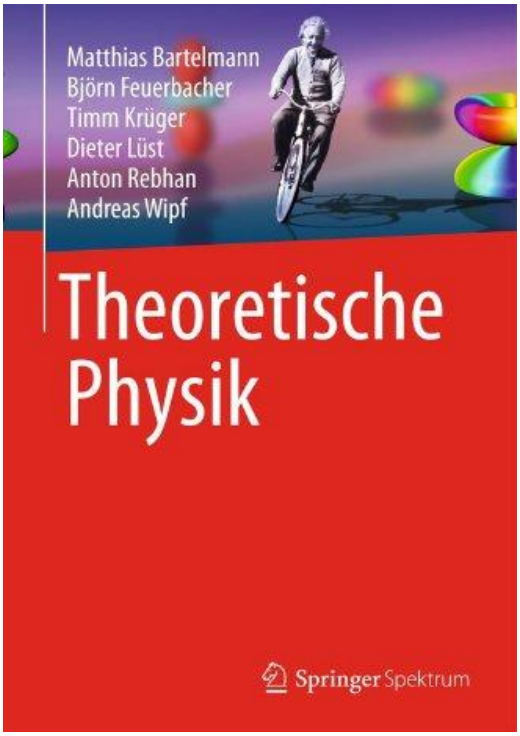
Multi-photon ionization and subsequent Auger processes are currently investigated together with Michael Meyer and Nikolay Kabachnik from XFEL Hamburg, Germany.

Angle- and polarization studies are performed together with the Emmy-Noether group of Stanislav Tashenov from Heidelberg University.

Book „Theoretische Physik“

The complete curriculum in Theoretical Physics for Bachelor students.

The book with 1300 pages, written by physicists from Edinburgh, Heidelberg, Jena, Munich and Vienna, presents classical mechanics, electrodynamics, quantum mechanics and thermodynamics/ statistical physics in one volume.



7.9. *Collaborative Research Center/Transregio 7 "Gravitational Wave Astronomy"*

SFB structure and financing

The Transregional Collaborative Research Center *SFB/TR 7 Gravitational Wave Astronomy* comprised research staff of the following universities

- Friedrich Schiller University, Jena
- Eberhard Karls University, Tübingen
- Leibniz University, Hannover

as well as of the Max Planck Institutes

- Potsdam and Hannover (Albert Einstein Institutes)
- Garching (Max Planck Institute for Astrophysics).

The University of Jena was the lead institution of the SFB/TR 7, with Professor Bernd Brügmann acting as lead investigator (speaker).

At the end of 2014 the SFB/TR 7 finished its third funding period. Thus, it had been active for the maximum funding period, ranging from 2003 to 2014.

In 2014 the SFB/TR 7 researchers worked in 3 project areas on 20 projects (including the central administration project, Z). In part, these projects were jointly dealt with by investigators from diverse institutes and sites. The principal investigators in Jena (M. Ansorg, B. Brügmann, R. Nawrodt, R. Neuhäuser, P. Seidel, A. Tünnermann, and G. Zumbusch) worked on 12 projects.

The SFB/TR 7's public outreach project (which started in fall 2008) was funded by the Deutsche Forschungsgesellschaft (DFG) with 148.600 Euro. During the funding period 2011-2014 a total of 593.200 Euro were granted. The public outreach project's activities include exhibitions, workshops, a so-called Einstein-Wellen-Mobil (to be shown in schools), a project website, and the public presentation of results achieved in gravitational wave research.

In 2014 the DFG funded the SFB/TR 7 with about 2.38 million Euro, with 1.42 million Euro being allotted to the institutes in Jena. The Transregional Collaborative Research Center *SFB/TR 7* funded more than 50 researchers.

Content and goals of the research programme

With his Theory of General Relativity providing the insight that the effect of gravitation between masses can only be understood as geometry of spacetime, Albert Einstein has radically changed our physical view of the world. Whereas at the beginning of research the main focus was on the experimental verification of theoretical results and on the interpretation of new concepts, it is now placed on the astrophysical application of Einstein's theory.

The research of SFB/TR 7 focuses on the theoretical modelling of cosmic sources of gravitational radiation, on the improvement of detector concepts, and on the evaluation of the gravitational wave signals visualized.

Activities

In addition to continuous communication (e-mail) and cooperative visits of researchers, the following cooperative events of the SFB/TR 7 deserve to be highlighted:

1) Semi-annual Meeting, Tübingen, 26 - 27 February 2014

2) Video Seminar *Numerical Relativity*, Jena; weekly video conference with researchers at Garching, Hannover, Potsdam, and Tübingen

3) Symposium for Bachelor and Master students (Spring School), Jena, 25 - 28 March 2014

4) SFB/TR 7 Conclusion Workshop, Jena, 1 - 5 December 2014

7.10. Research Training Group (RTG) GRK 1523/2 "Quantum and Gravitational Fields"

a) Research

Quantum Field Theory:
The Theory of Quantum Fields is of great importance for gaining deeper insights into the fundamental laws of nature and has an increasing impact on novel applications. Quantum fields successfully describe the fundamental interactions in elementary particle physics and are of utmost importance for theories beyond the standard model. At the same time the theory of quantum fields plays an increasingly important role in laser, atom, and molecular physics, and is an indispensable tool to study phase transitions in many-body systems.

Gravity:
On large scales the universal gravitational force described by the gravitational field dominates. Through the burgeoning field of gravitational wave astronomy with its far reaching implications for astrophysics and cosmology, a deeper knowledge, and in particular realistic solutions of the Einstein field equations are urgently needed.

Mathematical Methods:
Research in Field Theory profits considerably from mathematical methods and the fruitful interplay of physics and mathematics. For example, the methods of modern differential geometry are needed for investigating symmetries and solutions of nonlinear field equations - in particular of Einstein's equations, and the emerging integrable structures. Structural insights and rigorous results about interesting states in quantum (field) theories are obtained with powerful methods of functional analysis. Moreover, for efficient and controlled simulations of quantum field theories optimized numerical and stochastic methods become increasingly important.

b) Cooperations

national:
With research groups in University Oldenburg (J. Kunz-Drolshaben), MPI Potsdam (L. Anderson), Tübingen (of K. Kokkotas und C. Lubich), MPI in Garching (E. Müller), MPI in Potsdam (B. Schutz and G. Huisken), University Frankfurt (P. Kopietz and M. Wagner), Technical University Darmstadt (L. von Smekal, J. Braun), University Giessen (C. Fischer), University Jena (G. Paulus), University Heidelberg (C. Wetterich, J. Pawlowski, J. Jaeckel, M. Scherer and V. Plehn), ITP Freiburg (Dr. Gneiting), MPI-FK Stuttgart (W. Metzner), DESY Hamburg (A. Ringwald).

international:
With A. Castro (Amsterdam, Netherland), N. Iqbal (UC Santa Barbara, USA), M. Gutperle (UC Los Angeles, USA), A. O'Bannon (U of Oxford, UK), W. Tichy (U Florida, USA), A. Nagar (Bures-sur Yvette, France), T. Damour (Bures-sur-Yvette, France), G. Dunne (U Connecticut, USA), C. Schubert (U Morelio, Mexico), A. Eichhorn (Waterloo, Canada), F. Saueressig (U Nijmegen, Netherland), A. Codello (U Odense, Denmark), G.P. Vacca (U Bologna, Italy), J. Skullerud (U Maynooth, Ireland), O. Cruciel (Wien, Austria), R. Alkofer (Graz, Austria), K. Langfeld (Plymouth, UK), I. Shapiro (Juis de Fora, Brazil), E. Mottola (Los Alamos, USA), D. Litim (Sussex, UK), M. Plyushchay (Santiago, Chile).

c) Structure and financing of GRK

Members of the RTG „Quantum and Gravitational Fields" are at the same time members of the

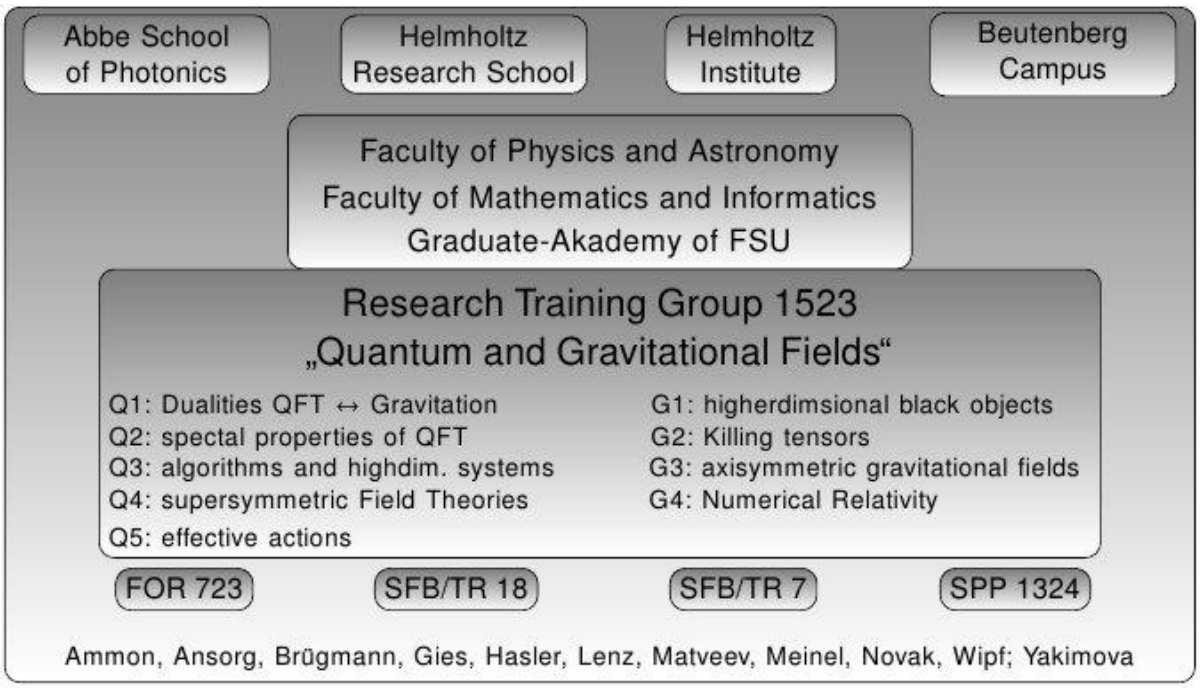
- Institute for Theoretical Physics (Theoretisch-Physikalisches Institut TPI)
- Institute for Mathematics (Mathematisches Institut MI)

Speaker is Prof. Dr. Andreas Wipf (TPI).

The RTG exists since October 2009 and the first funding period ended in September 2013. After a very successful evaluation the group is now in its second funding period which ends in April 2018.

15 PhD students and one postoc are funded directly by the DFG. Another 15 PhD students and five postdocs, which are funded by the university or other sources, are associated members of the RTG. Principal investigators are the Professors M. Ammon (TPI), M. Ansorg (TPI), B. Brügmann (TPI), H. Gies (TPI), D. Hasler (MI), D. Lenz (MI), V. Matveev (MI), R. Meinel (TPI), E. Novak (MI) und A. Wipf (TPI). In addition, Professor O. Yakimova (MI) is associated to the RTG.

The RTG 1523 is divided into two research areas: Quantum Field Theory and Gravitation. It consists of 9 projects dealing with research problems in fundamental theoretical physics and mathematical physics.



Structure of the Research Training Group “Quantum and Gravitational Fields”

Content and objectives of the program:

The first focus of the college deals with the quantum field theoretical description of fermionic many-body systems and their coupling to bosonsic fields

Project Q1 of the RTG deals with quantum critical phenomena in strongly coupled quantum systems. They are studied with the help of dualities between quantum field theories and gravity. For example, with the well-established AdS/CFT correspondence physically relevant phases and states are classified. Thereby non-equilibrium quantities such as relaxation times of observables and transport coefficients are calculated. A key feature of this project is the cross-fertilization of quantum field theory and gravity. In the second project Q2 analytical methods are applied to investigate spectral and dynamical properties of quantum matter in interaction with quantum fields. Of particular interest are the properties of the ground state and of excited states, for example in non-relativistic quantum electrodynamics. In addition, decoherence properties of quantum fields at finite temperature are characterized and the existence of phase transitions in long-range spin models are proved. An extension of the analysis based on renormalization is under way. In several projects of the RTG stochastic methods are used. Thus randomized algorithms for approximating high-dimensional integrals are examined, further developed and optimized in project Q3. The important conductivity of local and global algorithms is estimated and compared for spin models and nonlinear sigma models. In project

Q4 stochastic algorithms are used in the simulation of quantum field theories with fermions and in particular supersymmetric lattice theories. Supersymmetry is part of many attempts to construct a unified theory beyond the Standard Model of particle physics. In the project nonperturbative effects such as symmetries of the ground state (or ground states), the emergence of condensates, the mass spectra, phase transitions or the breaking of supersymmetry are investigated. Here sophisticated analytical and numerical methods such as the functional renormalization group or state of the art simulation algorithms for lattice theories with dynamical fermions play an important role. Many studies of classical or quantum systems aim at the calculation of the effective action for macroscopic degrees of freedom. The project Q5 is dedicated to the functional renormalization group. In the past it has been successfully applied (and further developed in Jena) in order to answer several important questions, examples include the non-perturbative study of the Higgs mass bounds, the calculation of condensates and symmetry-breaking phase transitions. It also is used to investigate the quantum-induced energy-momentum tensor in curved spacetimes.

The second focus of the RTG is on gravitational fields in the vicinity of compact astrophysical objects.

In project G1 so-called black objects, such as black holes or black strings in higher dimensions, are constructed and investigated for their physical and geometric properties. Such solutions of the gravitational field equations in higher dimensions with an event horizon are of great importance in the string-inspired correspondence between quantum field theories and gravity. Especially sought are solutions with de Sitter or anti-de Sitter asymptotics. The solutions will be constructed with the pseudo-spectral methods developed in Jena. When one solves Einstein's field equations and describes geodesic motions in the gravitational field symmetries and conserved quantities play a major role. These are closely connected with the existence of Killing tensors. The theory of Killing tensors and their relationship with curvature invariants are studied in the project G2. Here the question will be investigated when a stationary and axially symmetric vacuum solution admits Killing tensors. One can interpret the Killing equations as field equations for the Killing-connection and may construct curvature invariants with field theoretic methods. This also leads to he Ernst equation, which has been carefully studied by the gravity group in Jena. Hence there is a close relation of project G2 to other projects in the RTG dealing with gravitational fields. In the project G3 stationary and axially symmetric solutions of the Einstein-Maxwell equations will be constructed. As a concrete application a rigidly rotating disk of dust with constant specific charge will be investigated. Here a parametric transition to black holes is possible. The emerging system of coupled integrable Ernst equations will be treated with soliton theoretic methods. Thereby methods developed in Jena for the treatment of boundary value problems of the Ernst equation are used. In parallel, a hyperbolic version of the Ernst equation should be investigated. It describes the propagation of (nonlinear) gravitational waves. Project G4 deals with the numerical treatment of black holes and neutron stars - as single objects or bound in binary systems. In the numerical calculation of gravitational two-body systems, there exist several renowned contributions of the relativity group in Jena. The goal is the detection and analysis of gravitational waves in the final stages of binary systems and the creation of a complete catalog of wave templates in the phase space of compact objects. With different approaches initial data for eccentric neutron star binaries will be calculated. These will be used to compute the time-evolution of these systems. Here the influence of strong magnetic fields of neutron stars is of particular interest.

Activities during the reporting period

In addition to the contact interaction between the PhD-students and principal investigators, the students profit from attending schools and conferences and the chance to come in contact with renowned guest scientists invited by the RTG. The following events have been organized by the RTG or co-organized by principal investigators of the RTG:

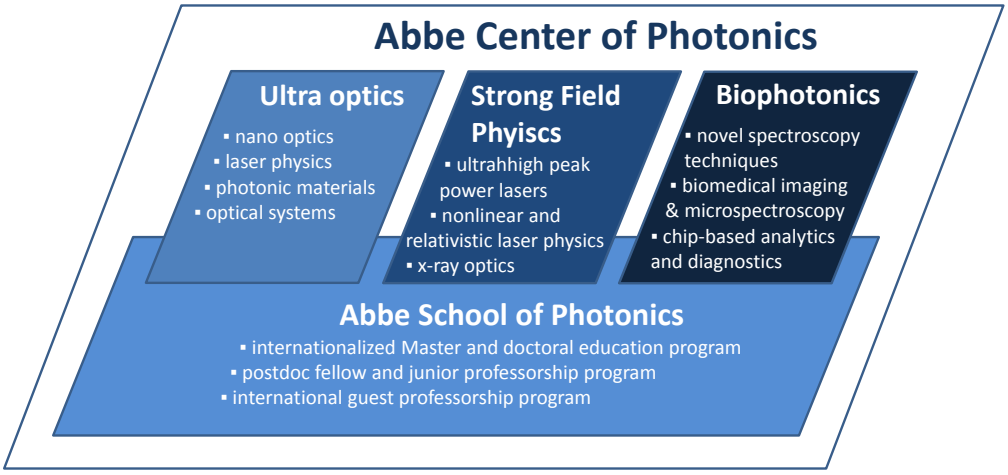
- Weekly seminar organized by the PhD-students
- Annual Meeting, 24.-25. February 2014 in Oppurg

- 20th Heraeus Summer School for graduate students on ,,Foundations and New Methods in Theoretical Physics", 1.- 12. September 2014 in Wolfersdorf
- Workshop on "Programming of Heterogeneous Systems in Physics", 14.-15. July 2014 in Jena
- Workshop Mathematical Physics, 16.-19. September 2014 in Jena
- Workshop: Gravitational Wave Astronomy, 01. - 05. December 2014 in Jena
- Monitoring-Workshop of the RTG's of Graz and Jena, 24.-26. October 2014 in Graz

In the year 2014, the Research Training Group supported about 90 trips of PhD-students and post-docs to conferences, workshops, annual meetings, summer schools and research visits, including some longer-term visits of institutions abroad.

7.11. Abbe Center of Photonics (ACP)

The Abbe Center of Photonics (ACP) is an interfaculty center within the Friedrich Schiller University Jena. Its members are dedicated to the optics and photonics research and education. By the end of 2014, ACP is comprised of 40 principal scientists, among them 31 full professors, five junior professors and four group leaders. The majority of the center's members is affiliated with the Faculty of Physics and Astronomy, others with the Faculties of Chemistry and Earth Sciences, Biology and Pharmacy, and Medicine, respectively. The center and its members commit themselves to Jena's tradition of excellent research and teaching in the field of optics and photonics and thus form the core of the key research area "Light" regarding the University's institutional strategy "Light – Life – Liberty". ACP's main mission is to promote and to coordinate interdisciplinary research jointly performed by scientists from different subject areas and to contribute sustainably both in fundamental and applied optical sciences. While encompassing a broad variety of research fields, ACP concentrates on expertise development in its three strategic domains **ultra optics, strong field physics and biophotonics**. Besides ACP's research efforts, the education of young research scientists, represented by its integrated **Abbe School of Photonics (ASP)**, exhibits its fourth profile cornerstone and cross-connects all research areas.



ACP's structure, research and education foci.

Since its foundation in 2010, ACP is supported by a concept for structural measures funded by the Carl Zeiss foundation. Its integrated **Abbe School of Photonics (ASP)** sustains strategic cooperations with more than 20 industrial partners. The Carl Zeiss AG is particularly worth to note as a premium partner concerning sustainable funding and strategic development of ASP's educational programs. Moreover, ACP's principal scientists are involved in a high number of structured research projects in optics and photonics, but also in adjacent fields like the life sciences, where photonic technologies are widely applied.

2014 was quiet an eventful year for theACP. For the sake of brevity, only a selection of highlights will be mentioned here. On June 1, Prof. Jürgen Popp from the Faculty of Chemistry and Earth Sciences has regularly resigned from his one-year position as executive director of the Abbe Center of Photonics. According to ACP's statute, the executive director is annually elected by the board of directors and commissioned by the rector of the Friedrich Schiller University. Prof. Thomas Pertsch was unanimously elected by the board and will fill this position, with Prof. Stefanie Gräfe from the Faculty of Chemistry and Earth Sciences being the new deputy director.

The most publicly visible steps in 2014 were certainly achieved with regard to the **new research building "Abbe Center of Photonics"**. This multifunctional research and teaching building will offer 2600 m² space for functionalized optical, biological and chemical labs, seminar rooms, offices and an auditorium. In particular, the new research site is supposed to give an integrative stage for interdisciplinary exchange within ACP's main research areas by hosting laboratories for joint research performed by ACP's principal scientists. Furthermore, the new building will allow for the enhanced integration of ACP's photonics educational programs into its research program. The construction works are being funded by the State of Thuringia and the German federal government with more than EUR 25 million.

Already on May 15, the former minister of state Christoph Matschie was a guest of honor at the Beutenberg campus in Jena to witness the construction progress. Matschie emphasized that the upgrading of Thuringia's research infrastructure is a key element to maintain its international competitiveness in this sector: "The Abbe Center of Photonics will strengthen Jena's research and its recognition on a national and international scale."

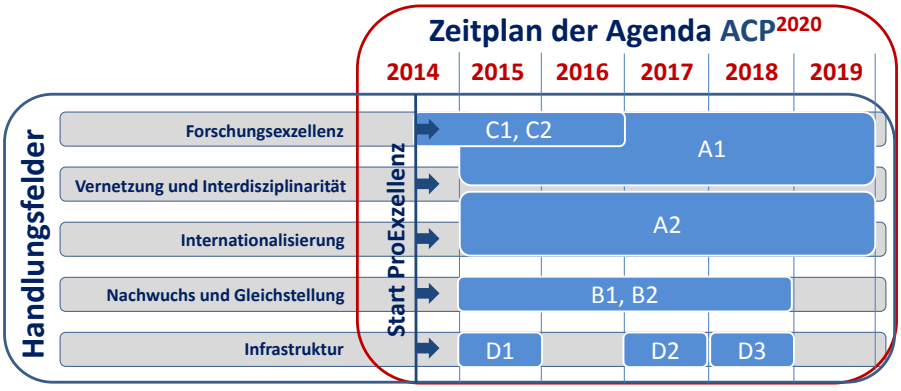
In May the construction of ACP's new research building was witnessed by the former minister of state Matschie.

On September 25, the time had finally come to celebrate the **topping-out ceremony ("Richtfest")** of the new building. The ceremony was witnessed by more than 100 high-profile guests from science, society and politics, among the two former ministers of state Reinhard Carius and Christoph Matschie. By the time of writing this report, the construction works at the Beutenberg campus were still ongoing, but the completion and handing-over to the Friedrich Schiller University are in sight and projected for autumn 2015.

One major milestone concerning the acquisition of third-party funding in 2014 was the successful defense of the **International Research Training Group (IRTG/IGK 2101) "Guided light, tightly packed: novel concepts, components and applications"** on September 5, 2014 in front of the German Research Foundation (DFG). This education program will be structurally embedded in the research and teaching environment of the Abbe Center and the Abbe School of Photonics. The IRTG will be lead by its German and Canadian spokespersons Prof. Andreas Tünnermann and Prof. Peter Herman (University of Toronto), respectively. The external cooperation partners are nine additional principal investigators from Canadian universities and research institutions in Toronto, Québec and Montréal. At the time of writing of this report, the final decision of the Canadian funding agency (NSERC) was still due, while the German Research Foundation (DFG) had already and publicly confirmed funding starting possibly by April 2015.

Last year's progress in the construction of the new research building Abbe Center of Photonics.

Another important milestone was the confirmation by the state of Thuringia to fund **ACP's strategic roadmap "ACP^{2020} – agenda for excellent photonics"** EUR 3.9 million within the second phase of the **ProExcellence program**. In total, 21 project proposals from Thuringian universities competed in this funding scheme. Based on external peer-reviews, the former Thuringian Ministry for Education, Science and Culture (TMBWK) selected ACP's as one out of seven projects funded from 2015 until 2019. With the ProExcellence program, the federal state government supports scientific centers and strategies of national interest and with an extraordinary potential in the academic areas of research, innovation and education. By virtue of its roadmap, ACP has formulated and substantiated its vision to establish itself as a leading European center for research and education in optics and photonics and to foster the development and transfer of photonic technologies. A pivotal element of this vision is the strengthening of the already existing interdisciplinary cooperations between ACP's key research areas ultra optics, strong field physics and biophotonics. These scientific prospects in APC's roadmap are complemented by an adequate support of excellent early-career scientists, gender equality, research infrastructure and science management to ensure ACP's sustainable and internationally competitive development.



Excerpt from the roadmap document „ACP 2020 – agenda for excellent photonics", funded with EUR 3.9 million.

The strengthening of existing and the establishing of new links inside the ACP community were also at the focus on **ACP's 2-day-retreat** on September 29/30. For the first time, about 20 ACP principal scientists gathered outside of Jena at the Ringberghotel in Suhl. The participants discussed novel approaches to pertinent research and educational questions in optics and photonics with special regard to the scientific landscape and perspective of Jena. To this end and for the next five years, a major part of the Thuringian ProExcellence funding will be invested into so-called **"ACP Explore projects"** operated by at least two ACP principal scientists. In this newly established scheme, ACP's scientists are invited to submit short proposals of collaborative research projects upon regular calls and at least twice per year. These ACP Explore projects are supposed to fulfill several selection criteria such as scientific excellence, ACP networking and improvement of local collaboration structures and interdisciplinarity. During the Suhl retreat, a notable number of potential ACP Explore project ideas, co-operated by at least two ACP principal scientists with different topical backgrounds, were designed and refined.

Impressions from the first ACP retreat 2014 hold in Suhl.

The first call for ACP Explore projects was open until November 31. All together eight respective proposals were competitively reviewed by ACP's board of directors and evaluated as strategic elements to strengthen the center's efforts in the acquisition of competitive structured research programs, particularly from the DFG and from the European Union. As an outcome, two projects headed by Alexander Szameit /Holger Gies and Jürgen Popp/Herbert Gross and each designed for a 2-year-period will be funded with EUR 100,000 starting from February 2015. The next call within ACP Explore will be issued in March 2015.

Another highlight in 2014 was a dedicated **German-Australian workshop** with contributions both from ACP scientists as well as three members of CUDOS (see figure on next page). The acronym CUDOS stands for "**Centre for Ultrahigh bandwidth Devices for Optical Systems**" and is a Centre of Excellence of the Australian Research Council (ARC), merging seven Australian Universities, among them universities from Canberra, Sydney and Melbourne. The CUDOS mission focuses on integrated nanophotonics for all-optical information processing as well as on signal processing applications with excellent power efficiency. By going to single photon power levels, CUDOS scientists also aim at opening up a host of applications on the quantum scale. These exciting research opportunities will be explored by CUDOS over the coming years to develop ultrafast signal processors, quantum photonic processors, and integrated photonic devices for the mid infrared.

The one-day ACP-CUDOS workshop was open to the public and covered subjects on optical materials, photonic devices and nonlinear optics. On this occasion, a Memorandum of Understanding (MoU) was signed by ACP director Prof. Thomas Pertsch and **CUDOS director Prof. Benjamin Eggleton**. Close interconnections and collaborative schemes with partners in science and industry have always contributed to ACP´s internationalization claims. The partnership of the two centers is an exciting match with a trans-continental reach - both centers expect that their complementary expertise will create an added value along the whole chain of research and development of future photonic components. "This MoU is a great foundation for future collaboration and partnership. It was wonderful to see the laboratories and facilities in Jena which is an amazing optics ecosystem and certainly unique," CUDOS

director Eggleton stated after his visit. Starting from 2015, ACP and CUDOS will further try to substantiate common research goals and potential collaboration schemes.

Impressions from the CUDOS-ACP workshop on optical materials, photonic devices and nonlinear optics.

Another highlight in 2014 was the **"ACP Photonics and Physics Alumni Workshop"** on November 26. This workshop was part of an initiative on Research Alumni Strategies, supported by the Alexander von Humboldt Foundation and the Federal Ministry of Education and Research (BMBF). Already in 2013, ACP and the Friedrich Schiller University of Jena were among the eight winners of the first round of the competition "Research Alumni Strategies". The alumni workshop, at which the newly elected president of the University **Prof. Walther Rosenthal** hold the welcome speech, was attended by about 80 participants – Master students, doctoral students, scientists and alumni from academia and industry. In sum, five distinguished guest speakers from academia and industry (e.g. Carl Zeiss and Osram) took the liberty to share their very personal perspectives on science and industry with the audience. Along with the philosophy of the University and as also pointed out by Prof. Rosenthal, it was shown again that alumni can be powerful multipliers who can inform junior researchers in their specialist networks about the opportunities and potential for future career options in Germany or abroad. Moreover, it became clear that in the future research and teaching on an international level will only be sustainable if also staff and network are internationally oriented. ACP and the Abbe School of Photonics will take the impetus of this workshop to establish a long-term and international alumni concept together with existing structures at the University.

Impressions from the first „ACP Photonics and Physics Alumni Workshop", funded by the Alexander von Humboldt-Foundation.

The Photonics and Physics Alumni Workshop was part of a whole conference week from September 24 to 28. As such, the alumni workshop was collocated with an **International Symposium on Nanophotonics and with a Doctoral School on Photonic Nanomaterials and Metamaterials**. Symposium and School were organized by our former colleague Carsten Rockstuhl (Karlsruhe Institute of Technology) and ACP director Prof. Thomas Pertsch on behalf of the ACP and the Abbe School of Photonics. During this week, many leading experts in the field contributed to the success of the symposium and the doctoral school by invited talks and lectures, among them Ari Sihvola (Aalto University), Thomas Philbin (University of Exeter), Philippe Lalanne (Centre national de la recherche scientifique, Bordeaux), Sergei Tretyakov (Aalto University), Andrea Alù (University of Austin, Texas), Javier Aizpurua (Donostia International Physics Center, San Sebastian), Thomas F. Krauss (University of York). More than 80 participants, both from industrial R&D as well as from academia gathered to learn about the latest trends and developments in the field.

Selection of impressions from the International Symposium on Nanophotonics and the Doctoral School on Photonic Nanomaterials and Metamaterials.

7.12. Research School of Advanced Photon Science of the Helmholtz Institute Jena

Among the most important tasks of the Helmholtz Institute Jena is the education and support of young scientists. The Research School of Advanced Photon Science (RS-APS) provides structured PhD education adapted to the research profile and organizational structure of the HI Jena. Emphasis is given to research being relevant for the international FAIR project in Darmstadt and the European XFEL facility in Hamburg, both being currently in the construction phase.

In 2014 about 25 PhD students were participating in the program of the research school. They were supervised by 14 principal investigators belonging directly to the Helmholtz Institute Jena or to institutes of the cooperating University Jena. Besides their doctoral work the students have the possibility to participate in the academic program which is offered directly by the Helmholtz Institute Jena and moreover they have access to the broad spectrum of courses provided by the cooperating graduate programs. More specifically, RS-APS is member of the graduate academy of the Jena university and additionally, the school is in close cooperation with both the Abbe School of Photonics, which resides at the Department for Physics and Astronomy (PAF), and the DFG graduate college “Quantum and Gravitational Fields”. Moreover since 2013 the RS-APS is member of the Helmholtz Graduate School for Hadron and Ion Research (HGS-HIRe) which promotes structured PhD education for research associated with FAIR and GSI.

The regular on-site seminars of the Research School provide the students either a platform for presenting their recent results or meeting distinguished researchers in the field. Additionally in 2014 almost half of the students of the HI Jena participated in dedicated soft skill block courses offered by HGS-HIRe focusing on the strengthening the core competencies of young researchers. Furthermore students of the Helmholtz Institute attended so-called Power Weeks by HGS-HIRe. A Power Week is focused on a particular science topic. In contrast to a lecture week it is not interdisciplinary and therefore allows discussions on a much deeper level. In addition transferable skill courses offered on site by the graduate academy Jena have been visited, e.g. qualification in academic teaching.

One major event in 2014 was the second joint HGS-HIRe and RS-APS Lecture Week which took place in Buchenau Manor from November 16th to 20th. The whole week 25 students from RS-APS and HGS-HIRe dealt intensively with “X-ray spectroscopy as diagnostic tool in atomic and plasma physics”. The PhD students have been supervised by the lecturers Alexander Gumberidze (EMMI and GSI), Paul Neumayer (GSI), Daniel Seipt (HI Jena) and Ulf Zastrau (University of Jena and LCLS, Stanford)

Participants of the joint lecture week at Buchenau Manor

The Research School of the HI Jena is not only supporting its students financially through scholarships but also every student has its own annual travel budget which he can spend individually. In 2014 more than two third of the doctoral candidates took use of this money for visiting international workshops and conferences to present their research results.

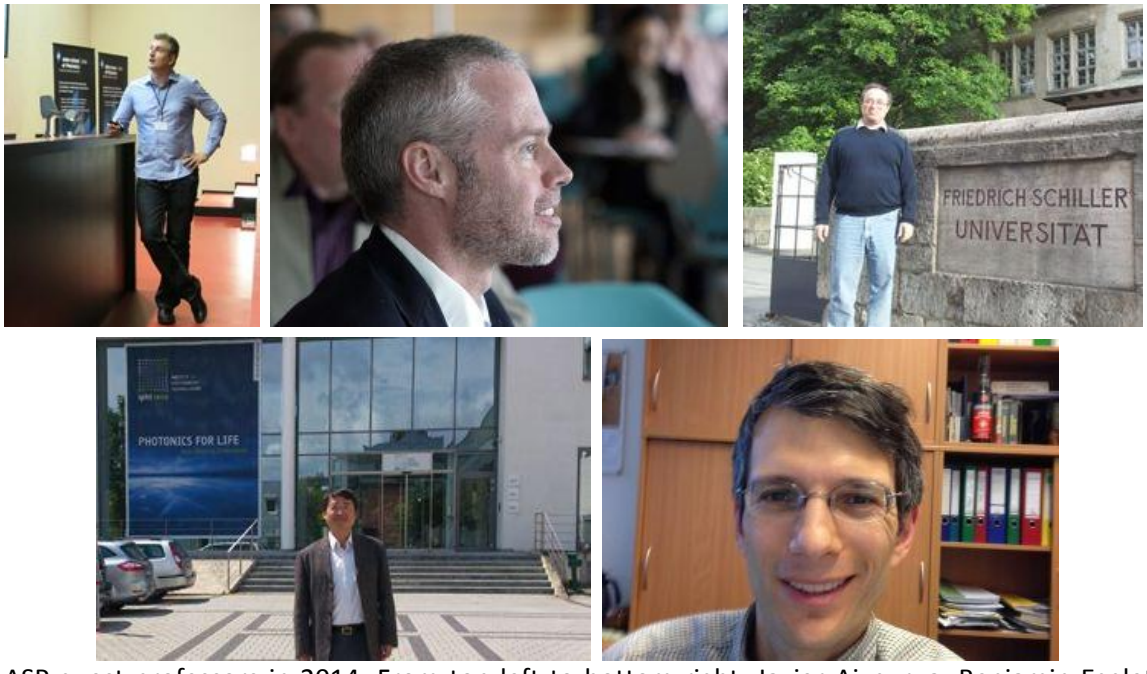
From the administrative point of view, the year 2014 brought a major improvement as all data of the students is now managed by a web-based system. Now the students can view and update their personal and academic data via the internet. Final adjustments of the new management system will take place in the upcoming months. We expect a significant gain in productivity and convenience compared to the old ‘paper sheet based’ system.

8. Visible Results of the Research and Teaching Avtivities

8. 1. Abbe School of Photonics guest professor and visiting scholar program

The ASP guest program has become a truly international brand. Besides its research focus, it emphasizes the involvement of world-class international scientists as guest professors in ASP's education program. Renowned scientists from all over the world are invited to join the local optis and photonics community for several weeks in challenging research collaborations and teaching activities in the Master's degree and doctoral programs. In 2014, five guest professors were our guests:

- **Prof. Javier AIZPURUA (**University of the Basque Country, the Basque Country, Spain) Lectures given: "Basics of the optical response in metals and metallic surfaces," "Basics of nanoplasmonics," "Plasmons in Field-enhanced spectroscopy and microscopy," "Quantum effects in plasmonics"
- **Prof. Benjamin EGGLETON (**University of Sydney, Australia)
  Lectures given within the ACP-CUDOS-Workshop: "The ARC Centre for Ultrahigh-Bandwidth Devices for Optical Systems (CUDOS) and Photonics research in Australia," "New frontiers in chip-based nonlinear optics"
- **Prof. Mikhail N. SHNEIDER** (Princeton University, Princeton, USA)
  Lectures given: "Weakly-ionized plasma processes in upper atmosphere," "Molecular Ensembles in Non-Resonant Optical Lattices"
- **Prof. Sheng-Lung HUANG (**National Taiwan University)
  Lectures given: "Cellular-resolution optical coherence tomography," "Crystal fiber based broadband light sources"
- **Prof. Andrew BERGER (**University of Rochester in Rochester, NY, USA)
  Lectures given: "Medical adventures in the near-infrared," "Turbid tissue optics I: Introduction," "Turbid tissue optics II: Instrumentation and measurements," "Turbid tissue optics III: Applications," "A different view of turbidity: elastic scattering analysis"



ASP guest professors in 2014: From top left to bottom right: Javier Aizpurua, Benjamin Eggleton, Mikhail Shneider, Sheng-Lung Huang, and Andrew Berger.

With their vast experience and their cosmopolitan background in science, ASP visiting scholars regularly offer valuable feedback on our curriculum based on their personal perspectives. Excerpts from the impressions of our guest in 2014 are as follows:

- **Prof. Javier AIZPURUA:** "My stay in Jena at the Abbe Center of Photonics has been a really enlightening one. It is really encouraging to be immersed in an atmosphere of cooperation and collaboration within optics, being exposed to a multidisciplinary effort that covers aspects of biochemistry, optical signaling, image formation, or chemical physics, at a very high level. I valued enormously during my stay the double aspect of the visiting professorship: on the one hand, the interaction with the students who were attending my lectures was really intense and full of nice feedback. On the other hand, from a scientific perspective, the interaction and visits to many state-of-the-art research groups associated to the sister Institutes of the ACP has been really fulfilling in terms of scientific content and sharing attitude. It has been a privilege to visit this pole of optics and to be hosted by Prof. Deckert, as a fantastic representative of this exemplary scientific community."
- **Prof. Benjamin EGGLETON: "**My stay at ACP was very enjoyable and stimulating and a great foundation for future collaboration and partnership. It was wonderful to see the laboratories and facilities in Jena. It is an amazing optics ecosystem and certainly unique."
- **Prof. Mikhail N. SHNEIDER:** "I believe that Abbe Center of Photonics at Friedrich Schiller University in Jena is one of the world leaders in modern optics, photonics and their applications, which not only provides a unique educational center for students - future scientists and engineers, but also a modern research organization, conducting the most advanced researches on a highest scientific level in close connection with industry and other research institutions."
- **Prof. Sheng-Lung HUANG:** "The long history of optics in Jena has really inscribed into the daily lives of this university town. From the street names, and the giant optics centers and factories, no one can ignore the existence of optics here. The gapless linkage between the University faculty/students and the scientists at Beutenberg campus really creates a huge amount of synergy for idea and vision burst in photonics for life. I was amazed by the vibrant activities here, all kinds of intra-institute, inter-institute, as well as international collaborations make the photonic researches at the ACP a truly world class hub."
- **Prof. Andrew BERGER:** "My home city is Rochester, New York, the home of Kodak, Xerox, and many other optical companies and university research groups. I could not have picked a more appropriate place than Jena to spend a sabbatical year. Both Rochester and Jena embrace their rich tradition of optical innovation and make it a central part of the region's identity. Even when I am not at work, I am aware of the huge cultural contributions of Ernst Abbe to Jena, or I am watching my son play football in one of the many Schott youth teams. I think that the city's pride in optics truly strengthens the research and education programs. As a guest researcher, I have directly benefitted from the interplay between the Leibniz Institute of Photonic Technology, the Abbe School of Photonics, the Institute of Applied Physics, and several other entities on the Beutenberg campus. The Abbe School in particular gave me the chance to interact with a wide range of people through guest lectures and conference activities. Jena is a world-class hub for optics, and I will certainly be spreading the word back in Rochester and across the USA that this is a place for collaborations, visits, and student exchange."

8. 2. Awards

8. 2. 1. Awards for the best doctoral thesis and Master's thesis

Since 1991 the Rohde & Schwarz Company, Munich, is endowing an annual prize for the best thesis (1,500 €) and the best diploma or Master's thesis (1,000 €) of the faculty of Physics and Astronomy. The company founders Dr. Lothar Rohde and Dr. Hermann Schwarz endowed this prize to honour the university where they in 1931 did their doctorate in the Physical Technical Institute. The Prize should honour outstanding scientific paper whereby the award winners were selected by the faculty alone. Rohde & Schwarz demonstrates with the endowed prize its interest in highly qualified engineers and physicists.

In 2014 the prize for the best Master's thesis went to **M.Sc. Christian Gaida** from the Institute of Applied Physics for his Master's thesis entitled "Peak power scaling of nanosecond pulses in thulium based fiber lasers". Christian Gaida prepared his Master's thesis within new internationally Master of Sciences (M.Sc.) degree program in Photonics at the College for Optics and Photonics (CREOL) of the University of Central Florida in Orlando. He finished his study with the overall grade 1.2 and therefore belongs to the best students of this course of study. In his work which was co-supported by Prof. Limpert from the Institute of Applied Physics he made an essential contribution in the field of fiber lasers. Especially he worked out new concepts for high-power fiber lasers in the wavelength range about 2 µm and therefore enlarged the maximum peak power to one order of magnitude.

In 2014 the prizes endowed by the Rohde & Schwarz company were awarded to M.Sc. Christian Gaida (left) for his Master's thesis and to Dr. Sebastian Geburt (right) for his doctoral thesis. The prizes were presented by Dr. Hendrik Bartko from Rohde & Schwarz (always left) and the dean of the faculty, Prof. Dr. Gerhard Paulus, (always right).
Photos: Simon Stützer

The prize for the best doctoral thesis went to **Dr. Sebastian Geburt** from the Institute of Solid State Physics for his thesis entitled "Lasing and ion beam doping of semiconductor nanowires". In his work Dr. Geburt investigated optical and "lasing" properties of semiconductor nanowires by doping with rare earth and transition metals. He gave answers to such questions as "What is the minimum size of a laser? What is its physically minimum dimension?" He was the first who measured the emission characteristics of such a nanolaser on the basis of CdS or ZnO nano wires.

Further prizes were awarded by the Friedrich Schiller University respectively its society of friends and supporters. Each faculty can award one prize for the best doctoral thesis the so-called *Promotionspreis* and one prize for the best degree thesis (diploma, examina or Master's thesis), the *Examenspreis*.

The Promotionspreis for the Faculty of Physics and Astronomy went in 2014 to **Dr. Robert Keil** from the Institut of Applied Physics. In his thesis "Quantum random walks in waveguide lattices" he gives a fundamental view on the behaviour of bosonic multiparticle systems. On the basis of his results a broader research of quantum effects in waveguide systems is possible.

On the occasion of the annual matriculation ceremony the Examenspreis 2014 was awarded to **M.Sc. Stefanie Eckner** from the Institute of Solid State Physics. In her Master's thesis she investigated the atomare structure of $Cu(In,Ga)S_2$ - an important absorber material for the production of thin layer solar

cells - by X-ray absorption spectroscopy. Furthermore she investigated the influence of these structural parmeters on the band cap.

The award of the prize for the best doctoral thesis to Dr. Robert Keil on the ocassion of the Schiller day.

(Photos: Jan-Peter Kasper)

M.Sc. Stefanie Eckner was awarded with the Examenspreis for her Master's thesis.

Dr.-Ing. Siegfried Werth Prize

The Dr.-Ing. Siegfried Werth Foundation, established in memory of the pioneer of optical coordinate measurement and founder of the company of Werth Messtechnik GmbH in Giessen, has made it its aim to sponsor junior scientists in the field of optoelectronic coordinate measurement. On an initiative of Dr.-Ing. habil. Ralf Christoph, today's managing director of the company and an alumnus of our Faculty, the Foundation has since 2010 been donating an annual price for the best doctoral, Diplom or Master's thesis in the field of optical measurement, to be awarded by the Faculty of Physics and Astronomy.

In 2014, the prize of the Dr.-Ing Siegfried Werth Foundation was awarded to **Dr. Marcus Große** of the Institute of Applied Optics, for his doctoral thesis on "Investigations into correlation-based point assignment in the stereophotogrammetric measurement of 3D objects, using sequences of structured illumination".

Arno Fink , Chairman of the Board of Trustees of the Dr.-Ing. Siegfried Werth Foundation (right), during presentation of the prize to Dr. Marcus Große (centre).

Photo: Simon Stützer

8.2.2. Prize for Exceptional Commitment to the Benefit of the Faculty of Physics and Astronomy

This prize was first awarded in 2013 on the ceremonial occasion of handing out the graduation certificates. It is endowed by the financial services company MLP AG with the aim of promoting charitable commitment to the benefit of the Faculty. The prize money of 250 € can be split between several persons.

In 2014, this prize went to the team of the schoolchildren's laboratory. This lab, run by the Physics and Astronomy Methodology working group, serves two purposes. Firstly, it is an extramural place of learning for more than 200 pupils of all age groups. Secondly, it is an experimental lab for physics students in teacher training courses, where they get into early contact with schoolchildren, gaining practical experience, routine and self-confidence in teaching, long before their practical semester as student teachers.

Every student in their second year has to attend to a group of schoolchildren as part of his or her training in the methodology of teaching physics. Luckily, many of them remain devoted to the children's lab thereafter. One example is Lukas Maczewsky, whose extraordinary commitment won him the prize together with doctoral candidate Stefan Völker on behalf of the entire team of the methodology working group.

Jens Trinter, director of the Jena branch of MLP, awarded the Prize for Exceptional Commitment to the Benefit of the Faculty of Physics and Astronomy to the schoolchildren's lab. Lukas Maczewsky (left) and Stefan Völker (right) accepted the prize on behalf of the whole team.

Photo: Simon Stützer

8. 2. 3. Teaching awards

The student body of the Faculty of Physics and Astronomy annually evaluates all courses held at the Faculty and awards a teaching award (without prize money) in the form of a challenge cup. In the context of the achievement-oriented distribution of funds within the Faculty, the Faculty Council has come out in favour of including teaching into the achievement criteria and therefore decided to endow the student body's teaching award with a prize money out of the Faculty's budget. In addition, the Council has earmarked prize money for another award conferred by the Dean to faculty members of merit in teaching who are regularly disregarded by the student body.

On basis of the evaluation the student body teaching award in winter semester 2013/14 went to **Prof. Frank Schmidl** for his physics lecture and practical physical training for medical and dentistry students.

Because he couldn't take part in the traditional student-professors - meeting on June 26th he was later awarded in the Dean's office.

Additional acknowledgements for exceptionally good teaching were given to **Jun.-Prof. Alexander Szameit** (left) and **Dr. Andreas Undisz** (right).

Photo: A. Unkroth

In summer semester 2014 the award was given to **Dr. Claudia Schnohr**, whose lectures in nuclear physics ("Kernphysik"), as well as her seminars in experimental physics for biologists, chemists, … ("Experimentalphysik für Biologen, Chemiker, ...") achieved marvellous ratings.

The Dean's teaching award went to **M. Sc. Tobias Ehmke** for his extraordinary involvement and talent as an exercise course trainer in experimental physics. He regrettably failed to receive the teaching award of the Friedrich Schiller University, for which the Faculty's student body had recommended him because of his stimulating manner in guiding the exercises. The students underline that he is always prepared to listen to their questions, even by e-mail at late hours.

8. 2. 4. Performance bonuses

The University has made it possible to pay bonuses to employees who perform exceptionally well. Proposed by the institutes and the Faculty Board, the following employees of the Faculty of Physics and Astronomy were paid performance bonuses in 2014:

- **Bodo Martin**, charged with the technical management of the Institute of Applied Physics, is responsible for all infrastructural measures concerning the buildings and most of the equipment. He is the institute's safety, laser protection and stocktaking officer and attends to its extensive computer systems. The smooth function of the IAP's infrastructure is, to a decisive extent, due to his exceptional commitment, even after regular working hours.

- **Dr. Hans-Jörg Fuchs** and **Thomas Käsebier** attend to the IAP's six etching plants. They put a lot of effort and initiative into the improvement of the equipment and processes. Both are always ready to adapt their working hours to urgent requirements.

- **Dieter Wostl** received a bonus for his more than 25 years of dependable work at the Institute of Applied Optics. His scope of duties comprises assistance in setting up equipment for various optical measurement techniques in the laboratories as well as for experiments during special lectures. He takes care of the IAO's collection of apparatus for use in lecture theatres and is responsible for the acquisition, inventory-taking and disposal of equipment.

- **Renate Wagner** has been running the administration office of the collaborative research centre SFB/TR 7 since 2003. Always reliable and exceptionally committed, she has carried out a great diversity of tasks, which clearly exceed the demands normally made on a secretary. She deserves special credit for handling the entire financial accounts of the SFB and for her commitment in caring for our foreign co-workers.

- The Institute of Solid-State Physics (IFK) proposed **Holger Mühlig** and **Matthias Thürk** for performance bonuses. *Holger Mühlig* has been working in the technical realm of the IFK for many years. Thanks to his knowledgeable and reliable work – usually on his own initiative – on the new large instrument supplied by the Fritz Work Group, he has a decisive part in the success of the institute's research and qualification efforts. For a number of years, he has been extremely active in teaching, especially in the practical electronics course. Also, he is the systems administrator for the "Yellow House" at Helmholtzweg 5. *Matthias Thürk* is responsible for the Faculty's cryogenic service; as such, he has always excelled by his professional competence as well as his cooperativeness. Showing commitment even beyond the bounds of the Faculty, he actively contributed to solving the problems of refrigerant supply for the new Centre of Applied Research (ZAF). In addition, he performs his tasks in the Cryophysics working group in an exemplary manner, participates in contracting for various industry-related research projects and has been involved in lecturing and practical courses.

- The Scientific Workshops rewarded Peter **Hanse** and **Dieter Skala** with performance bonuses in 2014. *Peter Hanse* supervises the workshop of the Precision Engineering unit 2. He was one of the first employees to qualify for the key technology of CNC machining and dedicates himself to passing on his expertise to his colleagues. Recently he involved himself creatively and successfully in the installation and start-up of a CAM system in the workshop; thanks to his commitment, the highly demanding CAD-CAM combination was made operable in mechanical parts machining in next to no time. *Dieter Skala* has been employed with the Faculty as a mechatronic and electronic worker since 2010. After a short settling-in period, he had acquired the competence to handle all operations that came up. In 2013, he started a qualification course to become a master craftsman/foreman; with exemplary commitment, he has familiarized himself with the programming of stored-program controls, thus making this technology available to the Faculty.

- Lecture-hall assistant **Petra Richter** shows exceptional involvement in lectures on experimental physics, including those outside the programmes for students. Whenever lectures are requested, e.g., for schoolchildren, she is exceedingly ready to help, even at weekends or in the evening.

- The Institute of Solid-State Theory and Optics recommended **Marion Fiedler** and **Sylvia Hennig** for performance bonuses. *Marion Fiedler* has been employed as a technical assistant to Prof. Bechstedt

since 1987. She takes care of the hardware and software belonging to the chair. Together with Dr. Leine, she also looks after the computer pool of the Faculty. For the Computational Physics II and Computational Materials I and II courses, she ensures that operable hardware and software for the practical exercises is available to every student. Moreover, she is in charge of those units of the University's parallel computer that are used by the Faculty. When the head of the University Computing Centre is on vacation, Marion Fiedler takes over full responsibility. *Sylvia Hennig* handles the financial and administrative side of the completed and ongoing third-party-funded projects. Her reliable activity in the institute's administration, third-party funds management and technical assistance to teaching and research by far exceeds the job description of an institute secretary. Her tasks also include the production of lecture scripts for the students in the LaTex format as well as all Powerpoint presentations for Prof. Bechstedt's lectures and discourses.

- **Dr. Ingo Uschmann**, an X-ray physicist of high international repute, has been a member of the X-ray physics working group since 1991. For many years a non-professorial co-researcher, he has a leading role in many cooperative projects. In recent years, he has written contributions to high-ranking publications. Dr. Uschmann has a major part in the strategy of the Jena Helmholtz Institute, which aims at continuing and extending X-ray optics in Jena. He is the contact person for access to all X-ray instruments at the Institute of Optics and Quantum Electronics IOQ). He not only handles administrative matters involved but is also much in demand as a contact in scientific and technical issues. Last but not least, he is intensively involved in the advanced practical courses, where he does an excellent job.
- **Reinhard Kind** has been working at the IOQ since 1987. With great commitment and outstanding success, he has solved many problems in the field of electronic measurement and control during this time. In the last ten or more years, in particular, he has had a major share in developing the entire electronic circuitry of the POLARIS laser system.

The employees who were awarded performance bonuses in 2014

8. 3. Astrophysical Institute and University Observatory

10 most important publications (in alphabetical order)

Chapman J., Csikszentmihalyi M., Neuhäuser R.: The Chinese comet observation in AD 773 January, Astron. Nachr. 335 (2014), 964–967

Errmann R., Torres G., Schmidt T.O.B., Seeliger M., Howard A.W., Maciejewski G., Neuhäuser R., Meibom S., Kellerer A., Dimitrov D.P., Dincel B., Marka C., Mugrauer M., Ginski C., Adam C., St. Raetz, Schmidt J.G., Hohle M.M., Berndt A., Kitze M., Trepl L., Moualla M., Eisenbeiß T., Fiedler S., Dathe A., Graefe C., Pawellek N., Schreyer K., Kjurkchieva D.P., Radeva V.S., Yotov V., Chen W.P., Hu S.-L., Wu Z.-Y., Zhou X., Pribulla T., Budaj J., Vaňko M., Kundra E., Hambálek Ľ., Krushevska V., Bukowiecki Ł., Nowak G., Marschall L., Terada H., Tomono D., Fernandez M., Sota A., Takahashi H., Oasa Y., Briceño C., Chini R., Broeg C.H.: Investigation of a transiting planet candidate in Trumpler 37: An astro-physical false positive eclipsing spectroscopic binary star, Astron. Nachr. 335 (2014), 345–356

Kitze M., Neuhäuser R., Hambaryan V., Ginski C.: Superflares on the slowly rotating solar-type stars KIC10524994 and KIC07133671?, Mon. Not. R. Astron. Soc. 442 (2014), 3769–3776

Matthews B.C., Krivov A.V., Wyatt M.C., Bryden G., Eiroa C.: Observations, Modeling, and Theory of Debris Disks. In: Beuther, H., Klessen, R.S., Dullemond, C.P., Henning, T. (eds.): Protostars and Planets VI (2014). University of Arizona Press, Tucson, USA, 521–544

Mugrauer M., Ginski C., Seeliger M.: New wide stellar companions of exoplanet host stars, Mon. Not. R. Astron. Soc. 439 (2014), 1063–1070

Neuhäuser R., Hambaryan V.V.: A solar super-flare as cause for the ^{14}C variation in AD 774/5 ?, Astron. Nachr. 335 (2014), 949–963

Özsükan G., Ekşi K.Y., Hambaryan V., Neuhäuser R., Hohle M.M., Ginski C., Werner K.: The Vela Pulsar with an Active Fallback Disk, Astrophys. J. 796 (2014), 46

Pawellek N., Krivov A.V., Marshall J.P., Montesinos B., Ábrahám P., Moór A., Bryden G., Eiroa C.: Disk Radii and Grain Sizes in *Herschel*-resolved Debris Disks, Astrophys. J. 792 (2014), 65

Raetz S., Maciejewski G., Ginski C., Mugrauer M., Berndt A., Eisenbeiss T., Adam C., Raetz M., Roell T., Seeliger M., Marka C., Vaňko M., Bukowiecki Ł., Errmann R., Kitze M., Ohlert J., Pribulla T., Schmidt J.G., Sebastian D., Puchalski D., Tetzlaff N., Hohle M.M., Schmidt T.O.B., Neuhäuser R.: Transit timing of TrES-2: a combined analysis of ground- and space-based photometry, Mon. Not. R. Astron. Soc. 444 (2014), 1351–1368

Schmidt T.O.B., Mugrauer M., Neuhäuser R., Vogt N., Witte S., Hauschildt P.H., Helling C., Seifahrt A.: First spectroscopic observations of the substellar companion of the young debris disk star PZ Telescopii, Astron. Astrophys. 566 (2014), A85

Invited talks and tutorials at international conferences

Alexander Krivov
Invited talk: Debris disks – Lessons from Herschel, International Conference “Planet Formation and Evolution”, Kiel (8th–10th September)

Ralph Neuhäuser
Invited talk: Studying past solar activity and supernovae with historic Arabic reports, Second International Conference on Arabs' and Muslims' History of Science, Sharjah, UAE (8th–11th December)

Major extra-budgetary projects

DFG:

KR 2164 / 10-1
Interpretation of Herschel´s “cold” debris disks
Total: 126,000 € (plus 25,200 € program lump sum), for 2 full-time employees
Receipts 2014: 52,500 €

LO 1715 / 1-1
Statistical study of extrasolar Kuiper belts with Herschel/DUNES
Total: 128,500 € (plus 25,700 € program lump sum), for 2 full-time employees
Receipts 2014: 24,200 €

MU 1164 /7-2, SPP 1385
Measurements of high-temperature optical constants of solar-nebula minerals
Total: 76,850 € (plus 15,400 € program lump sum), for 1 full-time employee
Receipts 2014: 14,440 €

MU 1164 /8-1, SPP 1573
Laboratory measurements of the far-infrared to millimeter dust opacity at low temperatures
Total: 104,004 € (plus 20,800 € program lump sum), for 1.5 full-time employees
Receipts 2014: 40,800 €

MU 2695 / 13-1
Search for sub-stellar companions of T-Tauri stars in the Lupus star-forming region
Total: 145,200 € (plus 24,200 € program lump sum), for 2 full-time employees
Receipts 2014: 49,881 €

NE 515 / 34-1, SPP 1385
Young transiting planets
Total: approx. 59,000 € (plus 11,800 € program lump sum), for 1 full-time employee
Receipts 2014: none

NE 515 / 34-2, SPP 1385
Young transiting planets
Total: 64,700 € (plus 12,900 € program lump sum), for 1 full-time employee
Receipts 2014: 35,100 €

NE 515 / 35-2, SPP 1385
Direct detection of Jovian planets around young solar analogs and their atmospheres
Total: 30,650 € (plus 6,100 € program lump sum), for 0.5 full-time employees
Receipts 2014: 11,518 €

NE 515 / 36-1
Architecture of Selected Planetary Systems: III. Direct Imaging Search for Outer Planets
Total: approx. 128,000 € (plus 25,600 € program lump sum), for 2 full-time employees
Receipts 2014: 18,600 €

SCHR 665 / 7-1
Exposure of details of the formation of massive stars
Total: 120,500 € (plus 24,100 € program lump sum), for 2 full-time employees
Receipts 2014: 5,405 €

SFB/Transregio 7 Teilprojekt B9
Gravitationswellenastronomie Methoden-Quellen-Beobachtungen
for 3 full-time employees Jena, Tübingen, Hannover
Grant personnel 2014: 44,100 €

SFB/Transregio 7 Teilprojekt C2
Gravitationswellenastronomie Methoden-Quellen-Beobachtungen
for 3 full-time employees Jena, Tübingen, Hannover
Grant personnel 2014: 44,100 €

SFB/Transregio 7 Teilprojekt C7
Gravitationswellenastronomie Methoden-Quellen-Beobachtungen
for 4 full-time employees Jena, Tübingen, Hannover
Grant personnel 2014: 63,600 €

MPI für Astronomie Heidelberg:

Total: 25% tariff part E9, 4+, TV-L
Receipts 2014: 12,849 €

8. 4. Institute of Applied Optics

10 most important publications

Gamrad, L.; Rehbock, C.; Krawinkel, J.; Tumursukh, B.; Heisterkamp, A. and Barcikowski, S.: "Charge Balancing of Model Gold-Nanoparticle-Peptide Conjugates Controlled by the Peptide's Net Charge and the Ligand to Nanoparticle Ratio", J. Phys. Chem. C, 118 (19), 10302–10313, 2014

Kalies, S.; Birr, T.; Heinemann, D.; Schomaker, M.; Ripken, T.; Heisterkamp, A.; Meyer, H.: "Enhancement of extracellular molecule uptake in plasmonic laser perforation", J. Biophotonics, 7, 7, 474-482, 2014

Eberhard, J.; Loewen, H.; Krueger, A.; Donner, S.; Stumpp, N.; Partzlaff, M.; Stachs, O.; Reichard, M.; Ripken, T.; Heisterkamp, A.; Stiesch, M.: "Non-invasive in vivo imaging by confocal laser scanning microscopy of gingival tissues following natural plaque deposition", J. Clin. Periodontol., 41, 4, 321-326, 2014

Jollivet, C.; Mafi, A.; Flamm, D.; Duparré, M.; Schuster, K.; Grimm; S.; Schülzgen, A.; "Mode-resolved gain analysis and lasing in multi-supermode multi-core fiber laser"; Opt. Exp. 22, 30377 – 30386 (2014)

Ehmke, T.; Nitzsche, T.H.; Knebl, A. and Heisterkamp, A.: "Molecular orientation sensitive second harmonic microscopy by radially and azimuthally polarized light," Biomedical Optics Express, Vol. 5, No. 7, pp. 2231-2246, 2014

Schulze, Ch.; Wilde, J.; Brüning, R.; Schröter, S.; Duparré, M.: "Measurement of effective refractive index differences in multimode optical fibers based on modal decomposition", Opt. Lett. 39, 5810 – 5813 (2014)

Schulze, Ch.; Dudley, A.; Brüning, R.; Duparré, M.; Forbes, A.: "Measurement of the orbital angular momentum density of Bessel beams by projection into a Laguerre-Gaussian basis"; Appl. Opt. 53, 5924 – 5933 (2014)

Harendt, B.; Große, M.; Schaffer, M. and Kowarschik, R.: "3D shape measurement of static and moving objects with adaptive spatiotemporal correlation," Appl. Opt. 53, 7507-7515 (2014)

Weigel, D.; Babovsky, H.; Kiessling, A.; Kowarschik, R.: "Imaging properties of different types of microscopes in combination with an image inversion interferometer"; Optics Communications, Volume 332 , Pages 301-310

Weigel, D.; Babovsky, H.; Kiessling, A.; Kowarschik, R.: „Widefield microscopy with infinite depth of field and enhanced lateral resolution based on an image inverting interferometer"; Optics Communications, Volume 342 , Pages 102-108

Invited papers and tutorials on international conferences

A. Heisterkamp

ILT Kolloquium, Fraunhofer ILT Aachen, Laser in Medizin und Biotechnologie, 13.02.2014

LALS Conference, Ulm, Plasmonics and ultrashort pulses for selective cell manipulation, 30.06.2014

St. Petersburg Symposium, REBIRTH, Lasers in regenerative science,

ISER conference, San Francisco, Modalities for Multiphoton Imaging in Vivo, 24.07.2014

ICO Conference, Havana, Cuba, Laser in regenerative sciences, 17.10.2014

Third-party projects (title, duration, source, amount in 2014)

DFG:

„Untersuchung selbstinduzierter wellenleitender Strukturen in Photopolymeren auf Plexiglasbasis“
Duration: 12/2010 – 02/2013
2014: 1,100 €

Industry:

2014: 59,200 €

Foundations:

2014: 12,600 €

TMWFK:
2014: 19,800 €

Patents

R. Kowarschik, E. Tolstik, V. Matusevich, „Verfahren zur Erzeugung einer Lichtkopplung in optischen Fasern durch selbstorganisierendes Polymer“, DE 10 2014 006 716.5

Prizes and Awards

Prof. Kowarschik

Thuringian Research Award for Applied Research 2013 together with Dr. Notni and Dr. Kühmstedt (both with IOF) for fast 3D-shape sensors

Dr. Marcus Große

Award of the Dr.-Ing. Siegfried Werth Foundation for the best doctoral thesis 2013 on the field of optical measurement techniques

8. 5. Institute of Applied Physics

10 most important publications

Y. Plotnik, M. C. Rechtsman, D. Song, M. Heinrich, J. M. Zeuner, S. Nolte, Y. Lumer, N. Malkova, J. Xu, A. Szameit, Z. Chen, M. Segev, Observation of unconventional edge states in 'photonic graphene', NATURE MATERIALS 13 (1), 57-62 (2014).

F. Eilenberger, K. Prater, S. Minardi, R. Geiss, U. Röpke, J. Kobelke, K. Schuster, H. Bartelt, S. Nolte, A. Tünnermann, T. Pertsch, A twister of light bullets, Nature Photonics 8, 169 (2014).

M. Gräfe, R. Heilmann, A. Perez-Leija, R. Keil, F. Dreisow, M. Heinrich, H. Moya-Cessa, S. Nolte, D. N. Christodoulides, A. Szameit, On-chip generation of high-order single-photon W-states, Nature Photonics 8(10), 791-795 (2014).

S. Hädrich, A. Klenke, J. Rothhardt, M. Krebs, A. Hoffmann, O. Pronin, V. Pervak, J. Limpert, A. Tünnermann, High photon flux table-top coherent extreme-ultraviolet source, Nature Photonics 8 (10) (2014).

A. E. Klein, N. Janunts, M. Steinert, A. Tünnermann, T. Pertsch, Polarization-Resolved Near-Field Mapping of Plasmonic Aperture Emission by a Dual-SNOM System, Nano Letters 14 (9), 5010-5015 (2014).

M. Heinrich, M.-A. Miri, S. Stutzer, R. El-Ganainy, S. Nolte, A. Szameit, D. N. Christodoulides, Supersymmetric mode converters, Nature Communications 5, 3698 (2014).

A. E. Minovich, A. E. Klein, D. N. Neshev, T. Pertsch, Y. S. Kivshar, D. N. Christodoulides, Airy plasmons: non-diffracting optical surface waves, Laser & Photonics Reviews 8 (2), 221-232 (2014).

M. Steglich, D. Lehr, S. Ratzsch, T. Käsebier, F. Schrempel, E.-B. Kley, A. Tünnermann, An ultra-black silicon absorber, Laser & Photonics Reviews 8 (2), L13-L17 (2014).

A. S. Solntsev, F. Setzpfandt, A. S. Clark, C. Wen Wu, M. J. Collins, C. Xiong, A. Schreiber, F. Katzschmann, F. Eilenberger, R. Schiek, W. Sohler, A. Mitchell, C. Silberhorn, B. J. Eggleton, T. Pertsch, A. A. Sukhorukov, D. N. Neshev, Y. S. Kivshar , Generation of nonclassical biphoton states through cascaded quantum walks on a nonlinear chip, Physical Review X 4, 031007 (2014).

C. Vetter, T. Eichelkraut, M. Ornigotti, A. Szameit, Generalized Radially Self-Accelerating Helicon Beams, Physical Review Letters 113 (18), 183901 (2014).

Invited talks und tutorials

J. Limpert

Performance scaling of femtosecond fiber-laser systems, Advanced Lasers and Their Applications (ALTA), Jeju, Korea, 24. - 31. May 2014.

A path towards Joule-class high repetition rate ultrafast fiber laser systems, Europhoton, Neuchatel, Switzerland, 24. - 29. Aug. 2014.

Performance Scaling of Ultrafast Fiber Laser Systems, IMPRS monthly meeting, Erlangen, Germany, 1. - 30. Nov. 2014.

S. Nolte

Ultrashort pulse laser materials processing, Arbeitskreis Produktionstechnik (Optonet), Jena, Germany, 3. Jun. 2014.

Ultrakurze Laserpulse – neue Möglichkeiten für hochpräzise Mikrostrukturierung, Sommerschule der Chemisch-Geowissenschaftlichen Fakultät, Friedrich-Schiller-Universität Jena, Jena, Germany, 14. Jul. 2014.

Ultrashort pulse laser processing: physics and technological applications, Internationales Kolloquium zum fünfjährigen Bestehen des Zentrum für Innovationskompetenz (ZIK) SiLi-nano, Halle, Germany, 17. Jul. 2014.

Ultrashort laser pulses for industrial mass production - manufacturing with laser flashes, Festvortrag LANE, Bamberg, Germany, 9. Sep. 2014.

Ultrakurzpulslaser – ein universelles Werkzeug für die hochpräzise Mikromaterialbearbeitung, Industriegespräche Jena - Chemnitz, Jena, Germany, 24. Sep. 2014.

Ultrakurzpulslaser – universelles Werkzeug in der hochpräzisen Mikromaterialbearbeitung, 60 Jahre Fertigungstechnik Dresden, Dresden, Germany, 20. Nov. 2014.

Ultrashort pulse lasers for precise processing: overview on a current German research initiative, SPIE Photonics West, San Francisco, USA, 1. - 6. Feb. 2014.

S. Döring, S. Richter, F. Zimmermann, A. Tünnermann S. Nolte, Lokales Fügen transparenter Werkstoffe mit ultrakurzen Laserpulsen, 2. Innovationsforum MikroLas, Rostock, Germany, 4. - 5. March 2014.

M. Kumkar, M. Kaiser, J. Kleiner, D. Grossmann, D. Flamm, K. Bergner, S. Nolte, Cutting of Transparent Materials by Tailored Absorption, Advanced Solid State Lasers (ASSL), Shanghai, China, 16. - 21. Nov 2014.

S. Nolte, F. Zimmermann, S. Richter, A. Plech, Ultrashort pulse induced nanogratings inside glass – fundamentals and applications, ALT'14, Cassis, France, 5. - 10. Oct 2014.

F. Dreisow, S. Döring, S. Richter, F. Zimmermann, A. Tünnermann and S. Nolte, Lokales Fügen transparenter Werkstoffe mit ultrakurzen Laserpulsen, Bearbeitung von Glaswerkstoffen mit innovativen Verfahren, Düsseldorf, Germany, 20. Oct. 2014.

S. Nolte, S. Richter, A. Tünnermann, Ultrastable Bonding of Glass with Femtosecond Laser Pulses, Classical Optics Conference, Kohala Coast, Hawaii, USA, 22. - 27. Jun. 2014.

G. Kalkowski, C. Rothhardt, S. Risse, S. Richter, F. Zimmermann, R. Eberhardt, S. Nolte, Integriert-Optische Module durch neue Bondtechnologien (Opti-Bond), F.O.M.-Konferenz 2014: „Gemeinsam Zukunftstechnologien gestalten“, Berlin, Germany, 4. Nov. 2014.

R. Heilmann, M. Gräfe, A. Perez-Leija, S. Nolte, A. Szameit, Laser-written integrated photonic quantum circuits, Frontiers in Optics, Tucson , USA, 19. - 23. Oct 2014.

R. Heilmann, M. Gräfe, S. Nolte, A. Szameit, Integrated laser-written photonic quantum circuits, Photonics North conference, Montreal, Canada, 28. - 30. May 2014.

F. Dreisow, S. Nolte, Volumenbearbeitung von Gläsern mit hochrepetierenden UKP-Lasern, Spectaris - Ultrakurzpuls-Laser zur industriellen Präzisionsbearbeitung von transparenten und sprödharten Materialien, Kaiserslautern, Germany, 17. Sep. 2014.

M. Richardson, I. Mingareev, S. Nolte, A. Tünnermann, I. Kelbassa, R. Poprawe, From Femtosecond Laser-Materials Processing to 3D Printing – Laser-Based Technologies that Will Transform Manufacturing, The 15th International Symposium on Laser Precision Microfabrication (LPM), Vilnius, Lithuania.

S. Nolte, F. Zimmermann, S. Richter, A. Plech, U. Peschel, and A. Tünnermann, Ultrashort pulse induced nanogratings – fundamentals and applications, The Nonlinear Meeting, Edinburgh, UK, 17. - 22. May 2014.

F. Dreisow, S. Nolte, Recent developments and applications of ultra short pulse-lasers, Trends and new developments in Laser Technology 2014, Dresden, Germany, 25. - 29. Aug. 2014.

S. Weimann, M. Heinrich, F. Dreisow, R. Keil, S. Nolte, A. Szameit, Nonlinear spatial photonics in laser-written photonic structures, Workshop on the cutting edge problems on nonlinear photonics, Castelldefels, Spain, 25. Jul. 2014.

A. Szameit
Photonic Graphene: Ultrastrong magnetic fields and Floquet topological insulators, Bose-Einstein Condensates in Waveguide - Curvature meets Nonlinearity workshop, Hamburg, Germany, 14. - 16. May 2014.

Photonic Floquet Topological Insulators, Coherent Control of Complex Quantum Systems conference, Okinawa, Japan, 14. - 17. Apr. 2014.

Photonic Graphene - the physics of honeycomb photonic lattices, Chalmers University of Technology Gothenburg, Gothenburg, Sweden, 2014.

Photonic Graphene - the physics of honeycomb photonic lattices, Universität Regensburg, Regensburg, Germany, 2014.

Symmetries in photonic waveguide lattices, Friedrich-Schiller-Universität Jena, Jena, Germany, 2014.
Light evolution in photonic waveguide arrays, Geometric Methods in Classical and Quantum Lattice Systems workshop, Caputh, Germany, 29. Sep. 2014.

Photonic Floquet Topological Insulators, SINOGFOS conference, Kunming, China, 20. - 23. March 2014.

Photonic Floquet topological insulators , Topological Matter Out of Equilibrium workshop, Dresden, Germany, 27. - 29. March 2014.

Photonic Topological Insulators, Status Seminar, Jena, Germany, 27. March 2014.

A. Szameit, J. M. Zeuner, M. C. Rechtsman, Y. Plotnik, S. Nolte, M. Segev, Photonic Floquet Topological Insulators in Discrete and Analogue Quantum Simulators, Heraeus Seminar, Bad Honnef, Germany, 10. - 12. Feb. 2014.

A. Szameit, J. M. Zeuner, M. C. Rechtsman, Y. Plotnik, S. Nolte, M. Segev, Photonic Floquet Topological Insulators, The Nonlinear Meeting 2014, Edinburgh, UK, 17. - 22. May 2014.

M. Segev, Y. Plotnik, M. Rechtsman, Y. Lumer, M. A. Bandres, J. M. Zeuner, A. Szameit, Photonic Topological Insulators, Conference on Lasers and Electro Optics (CLEO), San José, USA, 8. - 13. Jun. 2014.

M. Gräfe, R. Heilmann, A. Perez-Leija, S. Nolte, A. Szameit, Fs-laser-written integrated photonic quantum circuits, Congress of the International Commission for Optics, Santiago de Compostela, Spain, 26. - 29. Aug. 2014.

M. Segev, M. C. Rechtsman, Y. Plotnik, Y. Lumer, J. M. Zeuner, A. Szameit, Photonic topological insulators, International Conference on Metamaterials, Photonic Crystals and Plasmonics (META), Singapur, Singapur, 20. - 23. May 2014.

M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, Y. Lumer, M. Segev, A. Szameit, Aspects of photonic topological insulators, OSA Incubator Meeting on Topological Order with Photons, Washington DC, USA, 2. - 4. Apr. 2014.

M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, Y. Lumer, M. Segev, A. Szameit, Aspects of photonic topological insulators, Photonics North conference, Montreal, Canada, 28. - 30. May 2014.

M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, Y. Lumer, M. Segev, A. Szameit, Photonic Topological Insulators, SPIE Photonics Europe, Brussels, Belgium, 14. - 17. Apr. 2014.

A. Chipouline

Narrowband plasmonic structures for biosensors, Days on Diffraction, St. Petersburg, Russia, 26. - 30. May 2014.

Narrowband resonances for biosensing applications, Days on Diffraction, St. Petersburg, Russia, 26. - 30. May 2014.

Qualitative models in nanophotonics, International Conference on Metamaterials, Photonic Crystals and Plasmonics (META), Singapur, 20. - 23. May 2014.

A. Veltri, A. Chipouline, A. Aradian, Time-dynamical model for the optical response of a plasmonic nanoparticle immersed in an active gain medium, International Conference on Metamaterials, Photonic Crystals and Plasmonics (META), Singapur, 20. - 23. May 2014.

A. Zagoskin, A. Chipouline, E. Il'ichev, R. Johansson, F. Nori, Electromagnetic wave propagation and lasing in a toroidal quantum metamaterial, International Conference on Metamaterials, Photonic Crystals and Plasmonics (META), Singapur, 20. - 23. May 2014.

V. Pustovit, A. Chipouline, D. Brown, T. Shahbazyan, A. Urbas, A loss compensation condition and SPASER frequency for plasmonic nanoshell assisted by optical gain media, International Conference on Metamaterials, Photonic Crystals and Plasmonics (META), Singapur, 20. - 23. May 2014.

R. Grange

Coherent nanoprobes for new multiphoton imaging modalities, International Workshop on New Frontiers in Nonlinear Raman Microscopy, Heidelberg, Germany, 8. - 9. Aug. 2014.

S. Minardi

3D photonics for astronomy: a tutorial, LFIB Workshop, Nizza, France, 23. - 24. Jun. 2014.

Advanced photonics for nulling techniques, Workshop "Photonics for planets" Convitto della Calza, Firenze, Italy, 6. - 7. Nov. 2014.

S. Minardi, F. Eilenberger, K. Prater, T. Pertsch, Three-dimensional spatiotemporal solitary waves in multicore fibers, Workshop "Rogue waves, dissipative solitons, plasmonics, supercontinuum and special fibres" ICFO-The Institute of Photonics Science, Castelldefels, Spain, 25. - 26. Jul. 2014.

U.D. Zeitner, F. Fuchs, E.-B. Kley, A. Tünnermann, High-refractive-index gratings for spectroscopic and laser applications, High Contrast Metastructure III, San Francisco, USA, 1. - 7. Feb. 2014.

U.D. Zeitner, T. Harzendorf, T. Paul, D. Michaelis, F. Fuchs, E.-B. Kley, Bringing Photonic Sub-Wavelength Structures to Application, Topical Meeting on Metamaterials, Photonic Crystals and Plasmonics, Berlin, Germany, 16. - 18. Sep. 2014.

S. Diziain, R. Geiss, M. Zilk, F. Schrempel, E.-B. Kley, A. Tünnermann, T. Pertsch, Enhancement of second harmonic generation in self-suspended lithium niobate photonic crystal cavites, ICTON, Graz, Austria, 6. - 10. Jul. 2014.

S. Kroker, E.-B. Kley, A. Tünnermann, Thermal noise of silicon based grating reflectors for high-precision metrology, IEEE Metrology for Aerospace, Benevento, Italy, 30. May - 1. Jun. 2014.

S. Kroker,R. Nawrodt on behalf of the Einstein Telescop Science Team, The Einstein Telescope, IEEE Metrology for Aerospace, Benevento, Italy, 30. May - 1. Jun. 2014.

J. A. Squier, J. U. Thomas, E. K. Block, C. G. Durfee III, S. J. Backus, Spatial and temporally focused femtosecond laser pulses for material processing, SPIE Photonics West, San Francisco, USA, 1. - 7. Feb. 2014.

F. Wyrowski, C. Hellmann, Field tracing for simulation of locally-polarized light fields and fs pulses, SPIE Photonics West , San Francisco, USA, 1. - 6. Feb. 2014.

Hans-Jürgen Otto, Mode instabilities in high-power fiber laser, Abbe School of Photonics, FSU, Jena, Germany, 2014.

J. A. Squier, E. Block, M. Greco, M. Young, C. G. Durfee, J.Thomas, J. Field, R. Bartels, Multiphoton imaging and manipulation of biological systems, CLEO: Applications and Technology (CLEO-AT), San José, USA, 8. - 13. Jun. 2014.

Third-party funded projects >30T € (expenses 2014)

DFG - German Research Society (expenses in 2014: 560,000 €)

- Design und Herstellung nanostrukturierter optischer Schichtsysteme zur Optimierung des Wirkungsgrades photovoltaischer Elemente (152,000 €)
- Optische Beschichtung mittels ALD - Beschichtung nanostrukturierter Substrate und Adsorption von Flüssigkristallen an dünnen Schichten (Emmy Noether-Programm) (140,000 €)
- SFB Transregio „Gravitationswellenastronomie“ (131,000 €)
- Aktive Mikrooptik: Adaptierbare plenoptische Kameras: Design, Herstellung, Integration (85,000 €)
- Ultrakurzpuls–induzierte Erzeugung periodischer Nanostrukturen im Volumen transparenter Festkörper (70,000 €)
- Optisch erzeugte Sub-100-nm-Strukturen für biomedizinische und technische Zwecke (56,000 €)
- Lin. und nichtlin. Lichtausbreitung in Wellenleiterarrays bei komplexen Anregungsprofilen (33,000 €)

EU - European Union (expenses in 2014: 701,000 €)

- ACOPS - Program „Ideas“, ERC Consolidator Grant; Advanced coherent ultrafast laser pulse stacking (281,000 €)
- PECS - Program „Ideas“, ERC Starting Grant; Powerful and Efficient EUV Coherent Light (165,000 €)
- NimNil - Large Area Fabrication of 3D Negative Index Materials by Nanoimprint Lithography (100,000 €)
- PICQUE - Marie Curie Initial Training Network; Photonic Integrated Compound Quantum Encoding (94,000 €)
- ADOPSYS - Advanced Optical System Design (56,000 €)

BMBF/BMWI – Federal ministries (expenses in 2014: 4,384,000 €)

- ZIK Ultra Optics 2015 – Forschergruppe Fertigungstechnologien für hoch entwickelte Mikro- und Nano-Optiken (770,000 €)
- ZIK Ultra Optics 2015 – Nachwuchsgruppe Design und Realisierung komplexer mikro- u. nanostrukturierter photonischer Systeme basierend auf Diamant- u. Kohlenstoffoptiken (712,000 €)

- Verbund-ZIK Hitecom - Verbundprojekt Spektroskopietechniken zur Untersuchung der Vergasung von Kokspartikeln in einer strömenden, heißen Gasatmosphäre (679,000 €)
- PhoNa- Photonische Nanomaterialien (570,000 €)
- Wachstumskern fo+ - Untersuchung ultrapräziser Freiformsysteme (513,000 €)
- T4nPV - UKP-Laserstrukturierung von dünnen Schichten für PV-Anwendungen (359,000 €)
- NEXUS - Kompakte Ultrakurzpulslaser basierend auf kohärenter Kombination (162,000 €)
- iPLASE - Grundlegende Untersuchung zur zeitlichen Kompression passiv gütegeschalteter Laser in den sub-10 ps Bereich (107,000 €)
- MEDUSA - Mehrdimesionale Ultrakurzpulssynthese für Faserlaser der TW-Klasse (106,000 €)
- Einführung von Field Tracing Verfahren für anisotrope und nichtlineare Medien (72,000 €)
- NanoInt - Verbundprojekt Integrierte Nanooptik (67,000 €)
- OpMiSen - Optische Mikrosysteme für ultrakompakte hyperspektrale Sensorik (66,000 €)
- ALSI - Advanced Laser-writing for Stellar Interferometry (45,000 €)
- SITARA - Selbstadaptierende intelligente Multiaperturkamera-Module (44,000 €)
- InfraVolt - Infrarot-optische Nanostrukturen für die Photovoltaik (43T,000 €)
- Montagegerechte Fertigungstechnologie für gefasste Optik (Justierfräsen) (38,000 €)

State of Thuringia (expenses in 2014: 163,000 €)

- PhoNa- Photonische Nanomaterialien (66,000 €)
- SpaceTime - Nichtlineare Raum-Zeit-Dynamik in nanostrukturierten optischen Systemen (62,000 €)
- OptiMi 2020-Graduate Research School „Green Photonics“ (43,000 €)

Foundations/Others (expenses in 2014: 496,000 €)

- Stiftungsprofessur (endowed professorship) (126,000 €)
- Carl-Zeiss-Scholarships (302,000 €)

Contract research (expenses in 2014: 2,461,000 €)

- Anorganisch-organische Hybridschichten für die Optik
- Design, Verschaltung und Charakterisierung von photosensorischen Elementen
- Einfluss der Abscheidebedingungen auf die optischen und mechanischen Eigenschaften amorpher Funktionsschichten
- Einfluss der Plasmachemie und -energetik auf die Zusammensetzung und Kristallstruktur gesputterter Metall-Dielektrischer Schichten
- Entspiegelung von SiON-Schichten
- Entwicklung eines synchronisierten OPA Systems
- Entwicklung keramischer Gasdurchführungen für Atmosphären- und Vakuumanwendungen
- Entwicklung und Analyse einer athermalen Werkstoffkombination für formstabile Metalloptiken
- Entwicklung und Untersuchung eines Aktuators mitsamt Fertigungsprozess für direkt in Schichttechnologien integrierbare elektrostatische Aktorik zur Verstellung von Mikrolinsen in einem abgeschlossenen und volumenminimierten Optiksystem
- Entwicklung von Methoden für das 3D-Messen mit strukturierter Beleuchtung in Bewegung
- Entwicklung von THz-Tomographiesystemen
- Erforschung der Möglichkeiten und Grenzen von Strukturen in kombinierten dieelektrischen / metallischen Schichten bezüglich deren polarisierenden Wirkung
- Funktionale Oberflächen mit spezifischen optischen, haptischen und Benetzungseigenschaften
- Grundlegende Untersuchungen zu Hochleistungsfaserlasern
- Herstellung hochpräziser optischer Schichten mittels Magnetronsputtern
- Herstellung von ultraleichten Metalloptiken auf der Basis additiver Fertigungsverfahren
- Magnetorheological Finishing (MRF) als Formkorrekturverfahren für metallische Freiformspiegel
- Neuartige Laserquellen für schmalbandige faserbasierte Verstärkung im nahen IR

- Optimization of a laser beam soldering process for optical components with respect to precision and stability
- Streulichtcharakterisierung Optischer Oberflächen und Materialien
- Streulichtmechanismen an optischen Oberflächen
- Steigerung des Wirkungsgrades von Nano-SIS Solarzellen sowie Entwicklung und Anpassung von TCO-Materialien für nano-SIS Bauelemente
- Synchronisiertes Ultrakurzpuls-Faserverstärkersystem
- Theoretische und experimentelle Untersuchung zur Entwicklung einer Leichtgewichtsausführung von Metallspiegeln für weltraumtaugliche Teleskope
- Ultrakurzpulsstrukturierung von elektronischen Komponenten auf hochelastischen metallisierten Polymerfasern
- Ultrakurzpulsstrukturierung von Siliziumsolarzellen auf textilen Substraten
- Unterstützung bei der Entwicklung kohärent kombinierter Ultrakurzpuls-Laser
- Verfahren für hochdynamische 3D-Messungen mittels Arrayprojektion

Awards

Alexander Szameit
Rudolf-Kaiser-Preis 2014

Alexander Szameit
OSA Adolph Lomb Medal

Sven Breitkopf
Best Student Talk Award, OSA Confernce Advanced Solid State Lasers (ASSL) in Paris, France
“Non-steady-state enhancement cavities using pulse-dumping as power scaling concept of femtosecond lasers”

Sven Breitkopf
Student Award ICUIL Conference 2014 in Goa, India
“Approaching TW-Peak Powers at >10 kHz Repetition Rate by Temporal Combining of Femtosecond Fiber Lasers in a Stack and Dump Cavity”

Arno Klenke
Best Student Paper (1st Place), Photonics West 2014: “Fiber Lasers XI: Technology, Systems, and Applications (LASE)”
“2.1mJ, 210W femtosecond fiber CPA system”

Christian Gaida
Best Student Talk (1st Place), Photonics West 2014: “Fiber Lasers XI: Technology, Systems, and Applications (LASE)”
“Short-length Ge-pedestal large-pitch fiber”

César Jáuregui Misas
ACP Fellow for Teaching of Research
"Herausragendes persönliches Engagement als Tutor für die Studierenden des Masterprogramms Photonik"

Sören Richter
Wissenschaftspreis für anwendungsorientierte Abschlussarbeiten der FSU in der Kategorie Dissertation
„Fügen transparenter Werkstoffe mit ultrakurzen Pulsen“

Luisa Coriand
Stiftung für Technologie, Innovation und Forschung Thüringen (STIFT) Green Photonics-Sonderpreis Thüringen für die beste eingereichte Dissertation
„Entwicklung einer Mess- und Auswertemethodologie zur komplexen Charakterisierung der Struktur-Eigenschaftsbeziehung hydrophober und hydrophiler Funktionsflächen bis hin zur Superhydrophobie und zu Anti-Beschlageffekten“

Marina Merker
Stiftung für Technologie, Innovation und Forschung Thüringen (STIFT) Green Photonics-Sonderpreis Thüringen für die beste eingereichte Bachelorarbeit
„Experimentelle Untersuchungen zur Durchtrennung des Glaskörpers mittels Femtosekundenlaser“

Patents

Applications

Beier, M.; Stumpf, D.; Gebhardt, A.; Risse, S.; Zeitner, U.
Verfahren und Anordnung zur interferometrischen Form- und Lageprüfung mehrerer funktionsrelevanter Optikflächen in einer gemeinsamen Anordnung (DE 10 2014 117 511.5)

Coriand, L.; Duparré, A.; Notni, G.; Felde, N.
Beschichtung für Glasoberfläche, Verfahren zu deren Herstellung und Glaselemente (DE 10 2014 112 133.3)

Felde, N.; Coriand, L.; Duparré, A.; Dannberg, P.; Notni, G.
Mikrostrukturierte Oberfläche mit nanorauer Beschichtung für mechanisch stabile Funktionsflächen (DE 10 2014 112 133.3)

Gottschall, T.; Baumgartl, M.
Vorrichtung und Verfahren zur Erzeugung von kurzen Strahlungspulsen (PCT/EP 2014/073079)

Jáuregui, C.; Tünnermann, A.; Limpert, J.; Gaida, C.
Multicore crystalline waveguides for high power laser systems (DE 10 2014 014 315.5)

Klenke, A.; Otto, H.-J.; Limpert, J.; Tünnermann, A.
Optische Anordnung mit Strahlaufteilung (DE 10 2014 001 252.2)

Kley, E.-B.; Zeitner, U.
Beugungsgitter und Verfahren zu dessen Herstellung (EP 13 70 8714.4)

Nolte, S.; Döring, S.; Brahm, A.; Willms, A.; Notni, G.
Verfahren und System zur Erzeugung von breitbandigen Antireflexstrukturen für den Terahertz-Frequenz-Bereich (DE 10 2014 200 742.9)

Schwinde, S.; Schürmann, M.; Kaiser, N.
Optisches Element mit einer reflektierenden Beschichtung (DE 10 2014 108 679.1)

Szameit, A.; Gräfe, M.; Heilmann, R.; Perez-Leija, A.; Nolte, S.
Verfahren und Vorrichtung zur Generierung von Zufallszahlen (DE 10 2014 202 312.2)

Tünnermann, A.; Szeghalmi, A.; Kley, E.B.; Ratzsch, S.
Gedeckelte Gitter (DE 10 2014 218 016.3)

Assignations

Böhme, S; Peschel, T.; Eberhardt, R.; Tünnermann, A.; Limpert, J.
Vorrichtung zum Bearbeiten von zylindrischen Werkstücken (JP-5596021)

Bruchmann, C.; Beckert, E.; Peschel, T.; Damm, C.
Adaptiver deformierbarer Spiegel zur Kompensation von Fehlern einer Wellenfront (US 8,708,508 B2)

Eckstein, C.; Zeitner, U.; Schmid, W.
Kantenemittierender Halbleiterlaser (JP 5529151)

Fuchs, F.; Zeitner, U.
Reflexionsbeugungsgitter und Verfahren zu dessen Herstellung (DE 10 2012 103 443 B4)

Kley, E.-B.; Kämpfe, T.; Tünnermann, A.
Ortsfrequenzfiltervorrichtung und Verfahren zur Ortsfrequenzfilterung von Laserstrahlen (DE 10 2004 058 044)

Kley, E.-B.; Brückner, F.; Clausnitzer, T.
Monolithischer dielektrischer Spiegel (DE 10 2007 047 681)

Kühmstedt, P.; Bräuer-Burchardt, C.; Zwick, S.; Gebhardt, A.; Beier, M.
Verfahren und Vorrichtung zur Messung der Position und Justage eines asphärischen Körpers (DE 10 2012 023 377 B3)

Limpert, J.; Tünnermann, A.; Schimpf, D.
Vorrichtung zum Verstärken von Lichtimpulsen (EP 2 324 543 B1; US 8,659,821B2)

Limpert,J.; Tünnermann, A.; Schimpf, D.; Seise, E.; Röser, F.
Vorrichtung und Verfahren zum Verstärken von Lichtimpulsen (US 8,760,753 B2)

Nodop, D.; Limpert, J; Tünnermann, A.
Faserverstärkersystem (US 2014/0002893)

Tünnermann, A.; Kalkowski, G.; Eberhardt, R.; Nolte, S.
Verfahren zum Lasergestützten Bonden, derart gebondete Substrate und deren Verwendung (US 8,778,121 B2)

Tünnermann, A.; Kämpfe, T.; Kley, E.B.
Dielektrische Pinhole zur Ortsfrequenzfilterung von Laserstrahlen (DE 10 2004 058 044 B4)

Weber, T.; Kley, E.B.
Polarisator und Verfahren zur Herstellung eines Polarisators (DE 10 2011 079 030 B4)

8. 6. Institute of Solid State Physics

10 most important publications published in 2014

Ultrafast plasmonic nanowire lasers near the surface plasmon frequency
T.P.H. Sidiropoulos, R. Röder, S. Geburt, O. Hess, S.A. Maier, C. Ronning, R.F. Oulton
Nature Physics **10***, 870 (2014)*

Intense Intrashell Luminescence of Eu-Doped Single ZnO Nanowires at Room Temperature by Implantation Created Eu-O_i Complexes
S. Geburt, M. Lorke, A. L. da Rosa, T. Frauenheim, R. Röder, T. Voss, U. Kaiser, W. Heimbrodt, C. Ronning
Nano Letters **14**, 4523 (2014)

Local versus global electronic properties of chalcopyrite alloys: X-ray absorption spectroscopy and ab initio calculations
R. Sarmiento-Pérez, S. Botti, C. S. Schnohr, I. Lauermann, A. Rubio, B. Johnson
Journal of Applied Physics **116**, 093703 (2014)

Crucial role of implanted atoms on dynamic defect annealing in ZnO
A.Yu. Azarov, E. Wendler, A.Yu. Kuznetsov, B.G. Svenson
Applied Physics Letters **104**, 052101 (2014)

Molecular exchange in a heteromolecular PTCDA/CuPc bilayer film on Ag(111),
B. Stadtmüller, M. Gruenewald, J. Peuker, R. Forker, T. Fritz, and C. Kumpf,
J. Phys. Chem. C **118**, 28592 (2014).

The complex polymorphism and thermodynamic behavior of a seemingly simple system: naphthalene on Cu(111),
R. Forker, J. Peuker, M. Meissner, F. Sojka, T. Ueba, T. Yamada, H. S. Kato, T. Munakata, and T. Fritz,
Langmuir **30**, 14163 (2014).

Measurement of the optical absorption of bulk silicon at cryogenic temperature and the implication for the Einstein Telescope
J. Degallaix, J. Komma, D. Forest, G. Hofmann, M. Granata, D. Heinert, C. Schwarz, R. Nawrodt, L. Pinard, C. Michel, R. Flaminio and G. Cagnoli
Class. Quantum Grav. **31** (2014) 185010

Investigation of TiOx barriers for their use in hybrid Josephson and tunneling junctions based on pnictide thin films
S. Döring, M. Monecke, S. Schmidt, F. Schmidl, V. Tympel, J. Engelmann, F. Kurth, K. Iida, S. Haindl, I. Mönch, B. Holzapfel and P. Seidel
J. Appl. Phys. **115** (2014) 083901

Modifications of the Meissner screening profile in $YBa_2Cu_3O_{7-\delta}$ thin films by gold nanoparticles
E. Stilp, A. Suter, T. Prokscha, Z. Salman, E. Morenzoni, H. Keller, C. Katzer, F. Schmidl and M. Döbeli
Phys. Rev. B **89** (2014) 020510(R)

Formation of silicon oxide grains at low temperature S. A. Krasnokutski, G. Rouillé, C. Jäger, F. Huisken, S. Zhukovska, and Th. Henning
Astrophys. J. **782**, 15/1-15/10 (2014).

Invited Talks at Conferences and Colloquia

T. Fritz:

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties, (2 Lectures),
PCAM – Physics and Chemistry of Advanced Materials; European Doctorate,
Mailand (Italy), 14.-15.10.2014.

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties,
Department of Photo-Molecular Science, Institute of Molecular Science,Okazaki (Japan), 12.09.2014.

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties – Recent Results,
Department of Chemistry, Kyoto University, Kyoto (Japan), 04.09.2014.

Recent Results on Organic-Organic Heterostructures and on Doping of Molecular Films,
Department of Chemistry, Osaka University, Osaka (Japan), 02.09.2014.

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties",
Department of Electronics and Mechanical Engineering, Chiba University, Chiba (Japan), 26.08.2014.

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties,
Kolloquium am Institut für Physik, Technische Universität Ilmenau, Ilmenau, 29.04.2014.

Structure and Physical Properties of Epitaxial Molecular Layers - The Influence of K-Doping,
Kolloquium am Institute of Solid State Physics, Graz University of Technology, Graz (Österreich), 23.04.2014.

Epitaxial Organic Thin Films of Large Aromatic Hydrocarbons - Structure and Physical Properties,
SPERC Seminar, King Abdullah University of Science and Technology, Thuwal (Saudi Arabien), 12.03.2014.

C. Ronning:

Ion beam doping of semiconductor nanowires
Inter. Conf. on Ion beam Modification of Materials (IBMM) 2014, Leuven, Belgium, 19.09.2014

Semiconductor nanowire photonics
Nanowire back2back workshop, Eindhoven, Netherlands, 28.08.2014

Ion beam doping of ZnO nanowires
CECAM workshop “Nanostructured ZnO and related materials”, Bremen, 24.06.2014

Ion beam doping of GaN and related nanostructures
E-MRS spring meeting, Lille, France, 29.06.2014

Lasing in Semiconductor nanowires
Physics Colloquium, University of KwaZulu-Natal, Durban, South Africa, 27.02.2014

Lasing in Semiconductor nanowires
Physics Colloquium, University of Stellenbosch, South Africa, 20.02.2014

P. Seidel:

Present Status of Research Projects on Iron-based Superconductors in Germany
ISS'2014, Tokio, Japan, November 25-27, 2014

Modelling different kinds of Josephson junctions an circuits for interpretation of their electrical characteristics
9th Int Symp Intrinsic Josephson Effects and THz Plasma Oscillations in High-Tc superconductors, Kyoto, Japan, November 30 - December 3, 2014

E. Wendler:

Application of ion beams in material science
Master Program at School of Physics, Aristotle University of Thessaloniki, Greece, 08.12.2014

C.S. Schnohr:

Irradiation effects in compound semiconductors studied by X-ray absorption spectroscopy
MRS spring meeting, San Francisco, USA, 23.04.2014

Chalcopyrite semiconductors: Atomic-scale structure and band gap bowing
DPG spring meeting, Dresden, Germany, 01.04.2014

R. Nawrodt:

Materials for the Einstein Telescope – Overview
6th Einstein Telescope Symposium Lyon, France, November 19-20, 2014

C. Jäger:

Cold condensation of dust in the ISM
Faraday Discussion 168 – Astrochemistry of Dust, Ice and Gas, Leiden, 7-9 April 2014

Cosmic dust in the laboratory: From Molecules to Solids
International Workshop on Astromineralogy II, Research Center for Astronomy and Earth Sciences, Budapest, 29 -30 September 2014

Synthesis of cosmic dust analogs and *Processing of grains*
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October

Processing of grains
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October

Ion-induced erosion of carbon grains: Astrochemistry at the interface grains/ice in molecular clouds and protoplanetary disks
Planet and star-formation workshop of the Max Planck Institute for Astronomy, Kloster Schöntal, Germany, 12-14 November 2014

G. Rouillé:

Formation of silicates in the interstellar medium: Laboratory experiments
Seminaires du Laboratoire d'Astrophysique de Bordeaux, Observatoire de Bordeaux, France, April 30, 2014

Molecules and UV/vis Photons - From the ISM to the Laboratory
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October

Growth of silicate grains in the ISM: An experimental study
Planet and Star Formation Workshop 2014, Kloster Schöntal, Germany, 12-14 November 2014

S. Krasnokutski:

Cryochemistry in the Inert and Interstellar Media
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October

Reactions in He clusters
Planet and star-formation workshop of the Max Planck Institute for Astronomy, Kloster Schöntal, Germany, 12-14 November 2014

D. Fulvio:

Radiation-Induced Processing at the Interface Ice/Dust Grains
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October, 2014

The conundrum of the missing silicon carbide (SiC)
Invited Talk at the Laboratory for Experimental Astrophysics Group in Catania, INAF - OACT, Italy, 3 Sept. 2014

A straightforward method for VUV flux measurements: The case of the H_2 discharge lamp and implications for solid-phase actinometry
Invited Talk at the Laboratory for Experimental Astrophysics Group in Catania, INAF - OACT, Italy, 1 Sept. 2014;

Radiation-Induced Processing at the Interface Ice/Dust Grains
Tutorial at the summer school ''Laboratory Astrophysics'', Tabarz, 13 – 16 October

Third party funding

DFG projects

Dotierte aromatische Dünnfilme mit supraleitenden Eigenschaften
(FO 770/2-1)
Time span: 09/14 – 08/17

Optische Spektroskopie an ultradünnen Molekülschichten
(FR 875/9-3)
Time span: 02/12 – 02/15

Großgeräteantrag UHV-Analysesystem für XPS/UPS/AES
(INST 275/267-1)
Time span: 06/12 – 05/14

Formation and shaping of magnetic nanoclusters in oxides, using ion implantation
Time span: 03/11 – 02/15

Wiring quantum dots – phase separation inducing new functionality
Time span: 08/11 – 07/14

Dynamics and Interactions of Semiconductor Nanowires for Optoelectronics
Time span: 03/12 – 06/15

Teilprojekt P4: Light-matter interaction in optically doped nanowire LEDs and nano lasers
Time span: 03/12 – 11/15

Gütemessungen bei kryogenen Temperaturen
Project C4 within the Collaborative Research Center SFB/TR7 „Gravitationswellenastronomie“
Time span: 01/03 – 12/14

Optische Eigenschaften siliziumbasierter Testmassen
Project C9 within the Collaborative Research Center SFB/TR 7 „Gravitationswellenastronomie“
Time span: 01/11 – 12/14

Josephson effects at iron pnicides - phase-sensivitve experiments
Time span: 10/13 – 09/16

Experimental and theoretical studies of charge transport in heterostructures based on two-band superconductors and/or ferromagnetic metals
Time span: 11/13 – 06/15

Experimental studies of the low-temperature condensation of cosmic dust in the interstellar medium (HE 1935/26-1) (1. Tranche of the SPP 1378) (financial management by the MPIA)
Time span: 02/12 – 01/15

Experimental studies of the low-temperature condensation of cosmic dust in the interstellar medium (JA 2107/2-2) (2. Tranche of the SPP 1378)
Time span: 10/14 – 09/17

Kohlenwasserstoff-Chemie bei ultratiefen Temperaturen in flüssigen Helium-Tröpfchen
(HU 474/22-3)
Time span: 05/12 – 05/15

<u>*BMBF-, BMU- and BMWi-projects*</u>

Spitzenforschung und Innovation in den Neuen Ländern – PhoNa: Photonische Nanomaterialien
Time span: 12/09 – 11/14

Verbundvorhaben: Grenzflächen und Defekte – Rechnerunterstützte Optimierung des Wirkungsgrades von CIGS Dünnschichtsolarzellen in der industriellen Umsetzung
Teilvorhaben: Ermittlung von Struktur-Eigenschaftsbeziehungen und ihre Beeinflussung durch Variation der Prozessparameter
Time span: 08/12 – 07/15

Neuartige Verbundmaterialien u. Fertigungstechnologien für Kryostate zur see- u. luftgestützten Rohstoff- und Umwelterkundung (MAKSEL)
Time span: 09/14 – 12/17

Microwave response of intrinsic Josephson junctions and SQUIDs (Heisenberg-Landau Programm)
Time span: 01/14 – 12/14

ET R&D – Networking and R&D for the Einstein Telescope (3rd common ASPERA call)
Time span: 03/13 – 02/16

<u>*Other projects*</u>

Nanoscale Interfaces for Organic Electronics (DAAD PaJaKo Project Japan, ID 56264880)
Time span: 01/13 – 12/15

Marie-Curie ITN network “Nanowiring” (EU Projekt)
Time span: 11/10 – 10/14

Virtuelles Institut „MEMRIOX“ (HZDR Dresden-Rossendorf)
Memory Effects in Resistive Ion-beam Modified Oxides
Time span: 10/11 – 09/16

GaN Nanokristalle dotiert mit seltenen Erden (DAAD/PPP Griechenland)
Time span: 01/13 – 12/14

Switchable and tunable infrared devices by controlled manipulation of the insulator-to-metal transition in Vanadium dioxide (DAAD/PPP USA)
Time span: 01/14 – 12/15

Schwingungsdynamik in komplexen Verbindungshalbleitern (ProChance, FSU Jena)
Time span: 03/13 – 03/16

IRON-SEA - Establishing the basic science and technology for Iron-based superconducting electronics applications (EU Projekt)
Time span: 10/11 – 09/14

FP7-PEOPLE-IRSES Scientist Exchange Program „ELiTES“
Time span: 03/12 – 02/16

8. 7. Institute of Solid State Theory and Optics

10 most important publications

1. H. W. Lee, G. Papadakis, S. P. Burgos, K. Chander, A. Kriesch, R. Pala, U. Peschel, and H. A. Atwater, “Nanoscale Conducting Oxide PlasMOStor”, Nano Letters (2014).
2. T. Bauer, S. Orlov, U. Peschel, P. Banzer, and G. Leuchs, “Nanointerferometric amplitude and phase reconstruction of tightly focused vector beams”, Nature Photonics 8, 23–27 (2014).
3. I. Al-Naib, E. Hebestreit, C. Rockstuhl, et al. “Conductive Coupling of Split Ring Resonators: A Path to THz Metamaterials with Ultrasharp Resonances”, Phys. Rev. Lett. 112, 183903 (2014).
4. R. Yu, R. Alaee, F. Lederer, et al. “Manipulating the interaction between localized and delocalized surface plasmon-polaritons in graphene”, Phys. Rev. B 90, 085409 (2014).
5. A. Werner, O. Egorov, F. Lederer, “Exciton-polariton patterns in coherently pumped semiconductor microcavities”, Phys. Rev. B 89, 245307 (2014)
6. L. Matthes and F. Bechstedt, “Influence of edge and field effects on topological states of germanene nanoribbons from self-consistent calculations”, Phys. Rev. B 90, 165431 (2014)
7. L. Matthes, O. Pulci, and F. Bechstedt, “Optical properties of two-dimensional honeycomb crystals graphene, silicene, germanene, and tinene from first principles”, New J. Phys. 16, 105007 (2014)
8. S. Küfner, M. Fitzner, and F. Bechstedt, “Toplogical a-Sn surface states versus film thickness and strain”, Phys. Rev. B 90, 125312 (2014)
9. P. Pflugradt, L. Matthes, and F. Bechstedt, “Silicene on metal and metallized surfaces: ab initio studies”, New J. Phys. 16, 075004 (2014)
10. S. Küfner and F. Bechstedt, “Topological transition and edge states in HgTe quantum wells from first principles”, Phys. Rev. B 89, 195312 (2014)

Invited talks and tutorials at international conferences

O.A. Egorov

“Sponateous motion of polariton quantum fluids with spin-orbit interaction”
III Dynamics Days South America, Valparaiso, Chile 2014

O.A. Egorov and F. Lederer
“Hybrid Parameteric Cavity Polariaton Solitons”
International Conference on Metamaterials and Nanophysics, Varadero, Cuba 2014

L. Matthes, S. Kokott, O. Pulci, P. Gori and F. Bechstedt
“Modeling of silicene and its applications”
Invited Talk; EPIOPTICS-14; Erice (Italy); July/August 2014

C. Rockstuhl, J. Straubel, J. Hou, C. Bosel, K. Slowik, and R. Filter
“Weak and strong coupling of quantum emitters with optical nanoantennas”
META 14, Singapore

C. Rockstuhl, R. Filter, K. Slowik, J. Straubel, and G. Toscano
“Quantum optical properties of hybrid photonic nanostructures”
International Symposium on Nanophotonics, Jena, Germany2014

C. Yu, B. Tang, C. Schubert, M. Tamba, C. Welch, O. Amos, X. Zeng, X. Mang, F. Liu, G. Ungar, J. Dintinger, T. Scharf, T. Kienzler, C. Rockstuhl, and G. Mehl
“Design and control of liquid crystal superlattice forming gold nanoparticles - a route to plasmonic metamaterials”
META 14, Singapore

R. Alaee, M. Albooyeh, C. Simovski, F. Lederer, and C. Rockstuhl
“Novel optical features in asymmetric nanoparticle systems”
META 14, Singapore

F. Bechstedt
“Parameterfree calculations of excitations and spectra: Fiction or reality for semiconductors?”
Frühjahrstagung DPG, Dresden 2014

“ZnO and other transparent conducting oxides: Electronic states, optical properties and band time-ups”
CECAM Workshop “Nanostructures Zinc Oxide and related materials”, Bremen 2014

“Silicene, germanene and tinene: Modeling of IR absorbance and topological states”
3rd Int. Conf. Mathematical Modeling in Physical Sciences, Madrid 2014

“Silicene and other 2D honeycomb crystals from first principles”
17th Int. Conf. Solid Films and Surfaces, Rio de Janeiro 2014

“Transparent conducting oxides: Electronic states and band line-ups from first principles”
Workshop `Transparent Conductive Oxides – Fundamentals and Applications´, Leipzig 2014

“Silicene, germanene and stanene: Novel 2D honeycomb crystals from first principles”
8th EMN Fall Meeting, Orlando 2014

F. Bechstedt, P. Gori, S. Kokott, L. Matthes, P. Pflugradt, O. Pulci
“Modeling of structure and properties of silicene and related novel materials”
10th Int. Conf. Computational Methods in Sciences and Engineering, Athens 2014

A. Regensburger, M. Wimmer, C. Bersch, S. Batz, G. Onishchukov, M.-A. Miri, D. N. Christodoulides, and U. Peschel
Optical Mesh Lattices: From Discrete Temporal Solitons to PT Symmetric Systems and Self-Accelerating Pulses”
3rd International Workshop on Light-Matter Interaction, Recife, Brazil 2014

M. Wimmer, A. Regensburger, C. Bersch, M.-A. Miri, S. Batz, G. Onishchukov, D. N. Christodoulides and U. Peschel
“Optical Mesh Lattices: From Discrete Solitons to the Optical Diametric Drive”
Photonics North 2014, Montreal, Canada 2014

M. Wimmer, A. Regensburger, C. Bersch, S. Batz, G. Onishchukov, M.-A. Miri, D. N. Christodoulides, and U. Peschel
"Double Discrete Solitons, Self-Accelerating Pulses and PT Symmetric Lattices in Time"
The Nonlinear Meeting 2014 – Nonlinear Physics, Solitons & Instabilities, Marriott Dalmahoy, Edinburgh, Scotland, U.K. 2014

U. Peschel, A. Kriesch, D. Ploß, H. Lee, S. Burgos and H. Atwater
"Experiments on Plasmonic Nano-Circuits"
Workshop Ultraoptics, Jena 2014

A. Regensburger, M. Wimmer, C. Bersch, S. Batz, G. Onishchukov, M.-A. Miri, D. N. Christodoulides, and U. Peschel
"Optical mesh lattices: from self-accelerating pulses to Pt-symmetric temporal systems"
University of Strathclyde, Glasgow, Scotland, U.K. 2014

S. Botti

"Understanding and designing novel materials for energy"
Royal Institute for Technology KTH, Stockholm, Sweden

"Ab initio identification of novel phases of CZTSe"
2èmes rencontres francaises sur les kesterites pour applications photoaiques", Grenoble, France 2014

"Applications of Many-body-perturbation theory to new materials for photovoltaics"
Hands-on Workshop on Excitations in Solids, Berlin 2014

Third party funded projects (name, duration, funding agency, financial volume in 2014)

DFG:

Nano-Waveguide: Untersuchung der Kopplung dielektrischer und plasmonischer Resonanzen an opt. Metamaterialien in Wellenleiter Geometrien
(duration: 05/2008-09/14)
2014: 9.800 €

Nanosun 2: Design und Herstellung nanostrukturierter optischer Schichtsysteme zur Optimierung des Wirkungsgrades photovoltaischer Elemente (mit Prof. Pertsch, IAP)
(duration: 12/09 – 06/14)
2014: 22.800 €

Nonlinear Optics in metallic nanowaveguides in Lithium Niobate (with Prof. Pertsch, IAP)
(duration: 12/09 – 06/14)
2014: 28.400 €

Nichtlineare Dynamik von Polaritonen in photonischen Halbleiterstrukturen
(duration: 05/14-04/16)
2014: 50.200 €

Interregio Forschergruppe FOR 1700 „Metallic nanowires"
(duration: 12/12 – 11/15)
2014: 40.000 €

BMBF:

Verbundprojekt 03IS2101A PhoNa: Photonische Nanomaterialien
(duration 10/09 – 11/14)
2014: 72.900 €

Verbundprojekt Infrarot-Optische Nanostrukturen für die Photovoltaik: InfraVolt FKZ03FS0401D
(duration 04/11-12/14)
2014: 32.700 €

EU

LIMACONA
(duration 11/13 – 09/16)
2014: 5.800 €

Industry

Schott AG: Simulations
duration: 01.11.2012-15.02.2014)
2014: 13.800 €

Austrian Research Funds (FFW)

SFB F25 „InfraRed Optical Nanostructures (IR-ON)“
(duration: 04/05 – 03/09 + 04/09 – 03/12 + 04/12 – 03/15)
2014: 73.500 €

French National Research Agency (ANR) Programme Blanc.

“Photovoltaics with Ab initio Novel Electronic-Structure Simulations”
(duration: 01/12 – 12/15)
2014: 112.000 €

Stipends

Carl-Zeiss-Stiftungsprofessur Prof. Stefan Skupin
(Projektlaufzeit 04/2009 – 04/2014)
2014: 52.800 €

Carl-Zeiss Stipend Lars Matthes
(Projektlaufzeit: 02/12 – 10/14)
2014: 15.000 €

High performance computing

(i) National high performance computing center J. v. Neumann Jülich

Structures and properties of noble metal nanowries on semiconductors
(duration: 11/13 – 10/14)
2014: 37.000 €

8. 8. Otto-Schott-Institute of Materials Research

10 most important publications

1. “Turbomole”, F Furche, R Ahlrichs, C Hättig, W Klopper, M Sierka, . Weigend, WIREs Comput. Mol. Sci. 2014, 4, 91–100; impact factor: 9.014

2. “Cage-Like Nanoclusters of ZnO Probed by Time-Resolved Photoelectron Spectroscopy and Theory”, J Heinzelmann, A Koop, S Proch, G Gantefoer, R Łazarski, M Sierka, J Phys Chem Lett 2014, 5, 2642–2648; impact factor: 6.687

3. "How the Calorimetric Properties of a Crystalline Copolymer Correlate to Its Surface Nanostructures" R Schulze, MML Arras, C Helbing, S Hölzer, US Schubert, TF Keller, KD Jandt, Macromolecules 47 (2014) 1705–1714; Impact Factor: 5.927

4. ”Ultrathin Silica Films: The Atomic Structure of Two-dimensional Crystals and Glasses“, C Büchner, L Lichtenstein, X Yu, JA Boscoboinik, B Yang, W Kaden, M Heyde, SK Shaikhutdinov, R Włodarczyk, M Sierka, J Sauer, H-J Freund, Chem. Eur. J. 2014, 20, 9176–9183; impact factor: 5.696

5. ”Complexes of Monocationic Group 13 Elements with Pentaphospha- and Pentaarsaferrocene“, M Fleischmann, S Welsch, H Krauss, M Schmidt, M Bodensteiner, EV Peresypkina, M Sierka, C Gröger, M Scheer, Chem. Eur. J. 2014, 20, 3759–3768; impact factor: 5.696

6. “Quantification of the Interaction of Biomaterial Surfaces and Bacterial Pathogens by 3D Modeling “, D. Siegismund, A. Undisz, S. Germerodt, S. Schuster, M. Rettenmayr, Acta Biomaterialia 10 (2014) 267-275; impact Factor: 5,684

7. ”Structure and mechanical properties of β-TCP scaffolds prepared by ice-templating with preset ice front velocities”, S Flauder, U Gbureck, FA Müller, Acta Biomater. 10 (2014) 5148-5155; impact factor: 5.684

8. “Effect of Thermo-Mechanical Pre-Treatment on Short- and Long-Term Ni Release of Biomedical NiTi”, K. Freiberg, S. Bremer-Streck, M. Kiehntopf, M. Rettenmayr, A. Undisz, Acta Biomaterialia 10 (2014) 2290-2295; impact factor: 5.684

9. “The Effect of Heating Rate on The Surface Chemistry of NiTi”, A. Undisz, R. Hanke, K.E. Freiberg, V. Hoffmann, M. Rettenmayr, Acta Biomaterialia 10 (2014) 4919-4923; impact factor: 5.684

10. “Enveloping Self-Assembly of Carbon Nanotubes at Copolymer Micelle Cores”, MML Arras, C Schillai, KD Jandt, Langmuir 30 (2014) 14263-14269; impact factor: 4.384

Invited talks and tutorials at international conferences

Markus Rettenmayr
Growth of oriented thermoelectric Bi-In-Te alloys by seeding zone melting for the enhancement of chemical homogeneity, invited talk, ICASP-4, Old Windsor, July 7-11, 2014

Klaus D. Jandt
International conference „BIOMUT 2014“, Istanbul, Turkey, 16.-17. October 2014

Frank Müller
Bioinspired Biomaterials, invited talk, 1st Sino-German Symposium „Bioinspired Materials and Engineering“ Workshop, May 2014, Wuhan, China

Stephan Gräf
Laser Assisted Processing of Bioinspired Surfaces, invited talk, 1st Sino-German Symposium „Bioinspired Materials and Engineering“ Workshop, May 2014, Wuhan, China

External funding

EU:
European Commission - 7th Framework Program
Smart nano-structured devices hierarchically assembled by bio-mineralization processes - SMILEY
Projektdauer: 12/2012 – 11/2015
2014: 148.300 €

DFG:
Critical Solidification Experiments for a New Quality of Thermodynamic Key Data
Duration: 3/2010 – 05/2015
2014: 56.000 €

Phase stability of alloy-type lithium storage anode materials
Duration: 08/2010 – 07/2016
2014: 85.000 €

Thermodynamics and interdiffusion at interfaces with potential jumps
Duration: 11/2014 – 10/2016
2014: 8.000 €

Novel functional materials based on self-assembled protein nanofibers: creating and understanding nanofibers
Duration: 01.07.2014 - 30.06.2016
2014: 29.794 €

Influence of a pressure induced piezoelectric field on the recombination processes in photocatalytically active nanoparticles
Duration: 03/2014 – 02/2017
2014: 79.100 €

Self-healing capacity of damage tolerant calcium phosphate biocements
Duration: 11/2014 – 10/2017
2014: 10.800 €

BMBF
Wachstumskern "BioAnalytics and Surfaces for Integrations in Systems" (BASIS): Entwicklung des µCP-Verfahrens zur Strukturierung von Hydrogelen
Duration: 01.06.2011-31.05.2014
2014: 47.842 €

KMU-Innovativ Biotechnologisch modifizierter Calcium-Phosphat-Zement zur Stabilisierung osteoporotischer Wirbelkörper-Frakturen
Duration: 01.03.2012 – 31.03.2015
2014: 94.000 €

Wachstumskern PADES: Funktionalisierung von Partikeln für Hochleistungskeramiken
Duration: 01.10.2014 – 30.09.2017
2014: 34.987 €

Wachstumskern PADES: Kompositwerkstoffe mit hoher Additivbeladung
Duration: 01.10.2014 – 30.09.2017
2014: 13.480 €

Ostseenetzwerk für Biomaterialverbunde
Duration: 01.10.2014 – 31.08.2016
2014: 0 €

AkMiArray – Akustooptische Systeme für die hochauflösende Ultraschallmikroskopie und Materialprüfung
Duration: 09/2013 – 08/2016
2014: 139.700 €

AiF:
Duration: 01.08.2014- 13.07.2017
2014: 6.166 €

Entwicklung eines neuartigen CO2-Lasers auf Basis innovativer Güteschaltungstechniken und Untersuchung des Potentials der erzeugten Hochleistungs-Strahlungsimpulse für eine effiziente Materialbearbeitung
Duration: 03/2012 – 02/2014
2014: 11.800 €

Entwicklung einer industrietauglichen Lösung zur präzisen und effizienten Laserstrukturierung von Bipolarelementen
Duration: 07/2012 – 06/2014
2014: 41.500 €

Carl Zeiss Foundation
Postdoctoral research funding (Robert Schulze)
Duration: 01.01.2014 - 31.12.2015
2014: 106.359 €

Direct Industry funding:
Entwicklung von Aktivloten
Duration: 06/2011 – 05/2014
2014: 55.000 €

Ermüdungsfestigkeit von NiTi-Implantaten
Duration: 06/2012-09/2014
2014: 45.000 €

Entwicklung von Hartloten
Duration: 04/2014-03/2017
2014: 62.000 €

Implementation of a Low-Memory Iterative Density Fitting method
Duration: 04/2014-09/2014
2014: 71.400 €

DAAD
Design of ceramic-metal nanocomposites
Duration: 01/2014 – 12/2015
2014: 6.700 €

Thüringer Aufbaubank:
2012 FE 9009: OSCELA - Charakterisierung und Herstellung von osteointegrativen keramischen 3-D Schichten auf Dispersionskeramiken im System Zirkonoxid-Aluminiumoxid durch Porosierungsmittel
Duration: 01.09.2012 – 31.10.2014
2014: 150.829 €

2012 FE 9031: ERFEFA - Mikrowellenunterstütztes RTM-Verfahren
Duration: 01.04.2013 – 31.12.2014
2014: 154.186 €

TKM/TMBWK:
Nanosorb – Wissensbasierte Design mikro- und nanostrukturierter Sorptionsgradienten auf anorganischen Werkstoffoberflächen
Duration of the project: 12/2013 – 11/2015
2014: 56.500 €

Prices and awards

Dipl.-Phys. Matthias M. L. Arras, Chair of Materials Science, poster prize, ”Thüringer Werkstofftag 2014”, 19. March, Jena, Germany

Public visibility

Press releases:

Krankenhauskeime mögen keine nanorauen Oberflächen: Neues Testsystem beim Kampf gegen Bakterien entwickelt
idw - Informationsdienst Wissenschaft (07.01.2014)

Das ist Thüringen - Echt clever: Hilfe für gebrochene Wirbel
idw - Informationsdienst Wissenschaft (25.02.2014)

Optisches Museum stellt nun Entwicklung von Materialforschern der Universität Jena aus: Mit LED-Blaulicht die Zahnfüllungen aushärten
http://www.uni-jena.de/Mitteilungen/PM140522_LED_Blaulicht.html (23.05.2014)

Jenaer Nachwuchs vernetzt sich
Universität Jena, http://www.uni-jena.de/Mitteilungen/PM140627_DGM_Nachwuchs.html (27.06.2014)

Eiweiß-Nanofasern als Bausteine für innovative Materialien
idw - Informationsdienst Wissenschaft (27.09.2014)

bdw berichtet über CMS Forschung
„bild der wissenschaft“ 10-2014, S. 101 (22.09.2014)

Kleine Partikel machen Kunststoff zum Wärmeleiter, Materialwissenschaftler der Universität Jena präsentieren vom 7. bis 9. Oktober auf der Messe „Composites Europe 2014“ wärmeleitfähige Verbundstoffe
http://www.uni-jena.de/Mitteilungen/PM141002_Composites.html (02.10.2014)

Klaus Jandt: Vom Blutprotein zum Hightech-Material; Prof. Jandt im Interview mit biotechnologie.de
biotechnologie.de (02.10.2014)

Jena und der Physik-Nobelpreis: Forscher arbeiten mit blauen LED
Thüringische Landeszeitung (09.10.2014)

8. 9. Institute of Optics and Quantum Electronics

10 most important publications

Development of a Joule-class Yb:YAG amplifier and its implementation in a CPA system generating 1 TW pulses
C. Wandt, S. Klingebiel, **S. Keppler, M. Hornung**, M. Loeser, M. Siebold, C. Skrobol , A. Kessel, S. A. Trushin, Z. Major, **J. Hein, M. C. Kaluza**, F. Krausz, S. Karsch
Laser & Photonics Reviews **8**, DOI: 10.1002/lpor.201400040 (Nov. 2014)

What will it take to observe processes in '*real time*'?
S. E. Leone, C. W. McCurdy, J. Burgdoerfer, L. S. Cederbaum, Z. Chang, N. Dudovich, J. Feist, C. H. Greene, M. Ivanov, R. Kienberger, U. Keller, M. F. Kling, Z. H. Loh, T. Pfeifer, **A. N. Pfeiffer**, R. Santra, K. Schafer, A. Stolow, U. Thumm, M. J. J. Vrakking
Nature Photonics **8**, DOI: 10.1038/nphoton.2014.48 (Mar. 2014)

Structure and fluorescence properties of ternary aluminosilicate glasses doped with samarium and europium
A. Herrmann, S. Kuhn, M. Tiegel, C. Russel, **J. Körner, D. Klöpfel, J. Hein, M. C. Kaluza**
Journal of Materials Chemistry C **2**, DOI: 10.1039/c4tc00036f (Mar. 2014)

Electrons take the fast track through silicon
C. Spielmann
Science **346**, DOI: 10.1126/science.aaa1211 (Dec. 2014)

Resolving Ultrafast Heating of Dense Cryogenic Hydrogen
U. Zastrau, P. Sperling, M. Harmand, A. Becker, T. Bornath, R. Bredow, S. Dziarzhytski, T. Fennel, L. B. Fletcher, **E. Förster**, S. God, G. Gregori, **V. Hilbert**, D. Hochhaus, B. Holst, T. Laarmann, H. J. Lee, T. Ma, J. P. Mithen, R. Mitzner, C. D. Murphy, M. Nakatsutsumi, P. Neumayer, A. Przystawik, S. Roling, M. Schulz, B. Siemer, S. Skruszewicz, J. Tiggesbaumker, S. Toleikis, T. Tschentscher, T. White, M. Wostmann, H. Zacharias, T. Doppner, S. H. Glenzer, R. Redmer
Physical Review Letters **112**, 105002, DOI: 10.1103/PhysRevLett.112.105002 (Mar. 2014)

Dependence of Laser-Driven Coherent Synchrotron Emission Efficiency on Pulse Ellipticity and Implications for Polarization Gating
M. Yeung, B. Dromey, S. Cousens, T. Dzelzainis, D. Kiefer, J. Schreiber, J. H. Bin, W. Ma, C. Kreuzer, J. Meyer-ter-Vehn, M. J. V. Streeter, P. S. Foster, S. Rykovanov, **M. Zepf**
Physical Review Letters **112**, 123902, DOI: 10.1103/PhysRevLett.112.123902 (Mar. 2014)

Electron-Ion Equilibration in Ultrafast Heated Graphite
T. G. White, N. J. Hartley, B. Borm, B. J. B. Crowley, J. W. O. Harris, D. C. Hochhaus, **T. Kaempfer**, K. Li, P. Neumayer, L. K. Pattison, F. Pfeifer, S. Richardson, A. P. L. Robinson, **I. Uschmann,** G. Gregori,
Physical Review Letters **112**, 145005, DOI: 10.1103/PhysRevLett.112.145005 (Apr. 2014)

Selective Control over Fragmentation Reactions in Polyatomic Molecules Using Impulsive Laser Alignment
X. H. Xie, K. Doblhoff-Dier, H. Xu, S. Roither, M.S. Schffler, **D. Kartashov**, S. Erattupuzha, **T. Rathje, G. G. Paulus,** K. Yamanouchi, A. Baltuska, S. Grafe, M. Kitzler
Physical Review Letters **112**, 163003, DOI: 10.1103/PhysRevLett.112.163003 (Apr. 2014)

Test of Time Dilation Using Stored Li+ Ions as Clocks at Relativistic Speed
B. Botermann, D. Bing, C. Geppert, G. Gwinner, T. W. Hansch, G. Huber, S. Karpuk, A. Krieger, T. Kuhl, W. Nortershauser, C. Novotny, S. Reinhardt, R. Sanchez, D. Schwalm, **T. Stöhlker**, A. Wolf, G. Saathoff
Physical Review Letters **113**, 120405, DOI: 10.1103/PhysRevLett.113.120405 (Sept. 2014)

Vortex algebra by multiply cascaded four-wave mixing of femtosecond optical beams
P. Hansinger, G. Maleshkov,I.L. Garanovich,D.V. Skryabin, D.N. Neshev,A. Dreischuh, **G. G. Paulus**
Opt Express. 2014 **22**, DOI: 10.1364/OE.22.011079 (May 2014)

Invited talks and tutorials at international conferences

Gerhard Paulus

Röntgenworkshop Jena
24.02.-26.02.2014, organizer

Observation of gigawatt-class THz pulses from a compact laser-driven particle accelerator
8th International West Lake Symposium – Laser Plasma Interactions, Hangzhou, China,
21.04.-25.04.2014

Relativistic surface high-harmonic generation
The atto clock applied to highly charged ions
LPHYS14, Sofia, Bulgarien, 14.07.-18.07.2014

Frontiers in attosecond science II
International Symposium on Ultrafast Intense Laser Science 13 (ISUILS13), Jodhpur, Indien,
04.10.-11.10.2014

Ionization and harmonic generation at weakly relativistic and relativistic intensities
13th International Conference on Multiphoton Processes (ICOMP13), Shanghai, China,
06.12.-11.12.2014

Christian Spielmann

Novel concepts for amplification of laser pulses with extreme parameters
LPHYS'14 Conference, Sofia, Bulgarien, 16.07.-19.07.2014

C. Spielmann, M. Zürch, C. Kern, P. Hansinger, A. Dreischuh
Extreme nonlinear optical processes mit beams carrying orbital angular momentum
SPIE Photonics West-Ultrafast Phenomena and Nanophotonics XVIII, San Francisco, USA, 05.02.2014

M. Zürch, S. Foertsch, M. Matzas, K. Pachmann, R. Kuth, C. Spielmann
Apparatus and fast method for cancer cell classification based on high harmonic coherent diffraction imaging in reflection geometry
SPIE Medical Imaging 2014, San Diego, USA, 20.02.2014

M. Zürch, J. Rothhardt, S. Hädrich, S. Demmler, M. Krebs, J. Limpert, A. Tünnermann, A. Guggenmos, U. Kleineberg, C. Spielmann
High Average Power quasi-monochromatic XUV Source for Coherent Imaging Applications, High-Intensity Lasers and High-Field Phenomena, Berlin, 20.03.2014

M. Zürch, C. Spielmann
Coherent diffraction Imaging and Digital In-line Holography using Table-top HHG Sources
Group-Seminar, Clarendon Labs at University of Oxford, UK, 21.05.2014

C. Kern, M. Zürch, P. Hansinger, A. Dreischuh, C. Spielmann
Extreme Nonlinear Optics with Beams Carrying Orbital Angular Momentum
Conference on "Light induced dynamics and control of correlated quantum systems", Hohwacht, 25.06.-27.06.2014

J. Rothhardt, M. Zürch, S. Hädrich, S. Demmler, M. Krebs, A. Guggenmos, U. Kleineberg, C. Spielmann, J. Limpert, A. Tünnermann
CDI with high photon flux table-top XUV and soft X-ray sources, Coherence
Argonne, USA, 04.09.2014

M. Zürch, C. Spielmann
Nanoscale diffraction imaging and holography using Table-top HHG sources
Seminar, Lund University, Sweden, 06.10.2014

Daniil Kartashov
Filament initiated standoff nitrogen laser: theory and experiment
COFIL 2014, Shanghai, China, 18.09.-24.09.2014

Compression of high energy laser pulses by Stimulated Backward Raman Scattering in plasmas
Plasma Physics Seminar GSI, Darmstadt, 28.10.2014

Malte Kaluza

Optical Diagnostics for Laser-Driven Plasma Accelerators
LA3NET-workshop, Dresden, 29.04.2014

Advanced Characterization of Wakefield Accelerators
EPS conference on plasma physics, Berlin, 23.06.-24.06.2014

Advanced Characterization of Laser-Wakefield Accelerators
AAC 2014 San Jose, CA, USA, 14.07.-19.07.2014

Laser-driven ion acceleration: from thin toils to truly mass-limited targets
ECLIM 2014, Paris, 31.08.-03.09.2014

Diagnostic Tools for Laser-Driven Plasma-Accelerators
CERN Accelerator School on Plasma Wake Acceleration, Genf, Brüssel, 25.11.-28.11.2014

M. Schnell, A. Sävert, I. Uschmann, M. Reuter, M. Nicolai, T. Kämpfer, B. Landgraf, O. Jansen, A. Pukhov, M. C. Kaluza
Characterizing Laser Plasma Electron Accelerators with Betatron Radiation
High Intensity Lasers and High Field Phenomena, HTh2B. 1, Berlin, 20.03.2014

Eckhart Förster

Modern Applications of X-ray Crystal Optics
XIX PSC Conference on Wave and Quantum Optics, Wojanow, Poland, 10.09.2014

X-Ray Crystal Optics for use at Brilliant X-ray Sources
General Assembly of the European Cooperation in Science and Technology (COST), Dubrovnik, Croatia, 02.10.2014

X-Ray Crystal Optics and Spectroscopy
Erasmus Mundus Joint Doctoral Programme of the European Union (EXTATIC), Warsaw, Poland, 22.10.2014

Ulf Zastrau
X-ray spectroscopy to explore extreme states of dense matter
Institutsseminar für Strukturphysik, TU Dresden, Dresden, 16.12.2014

Thomas Stöhlker

Der Experimentierspeicherring ESR: Paul Kienles großartiges Geschenk für die Atomphysik
GSI Darmstadt, 14.02.2014

Quantum Electrodynamics in Strong Coulomb and Intense Photon Fields
the PEARL2014, Shanghai, China, 05.05.2014

FAIR: Facility for Antiproton and Ion Research
SPARC: Experiments at the HESR
CAARI 2014, San Antonio, USA, 25.05.-30.05.2014

FAIR: Facility for Antiproton and Ion Research / The APPA Pillar
3rd International Conference on New Frontiers in Physic, Kolymbari, Crete, Greece,28.07.-06.08.2014

Radiative processes and particle production phenomena in relativistic heavy ion collisions
Academy of Sciences of Ukraine, Kharkiv, Ukraine, 26.09.2014

The Physics of FAIR: Exploring Matter in Extreme Electromagnetic Fields
DESY, Hamburg, 7.10.2014 & DESY, Zeuthen, 08.10.2014

New Developments for SPARC at FAIR
11th Topical SPARC Workshop, Worms, 16.10.-17.10.2014

Exploring Matter in Extreme Electromagnetic Fields
IMP, Lanzhou, China, 20.11.2014

Status and Progress report for APPA
3rd EMMI Workshop on, Plasma Physics, Moscow, 09.-10.12.2014

K.-H. Blumenhagen
Characterization of a double-sided Si(Li) strip Compton polarimeter - SPARC@FAIR development
HCI2014, San Carlos de Bariloche, Argentina, 05.09.2014

Characterization of a double-sided Si(Li) strip Compton polarimeter - SPARC@FAIR development
Deutsche Tagung für Forschung mit Synchrotronstrahlung, Neutronen und Ionenstrahlen an Großgeräten 2014, 21.09.2014

René Geithner

A SQUID-Based Beam Current Monitor for FAIR/CRYRINGInternational Beam Instrumentation Conference 2014 (IBIC14), 17.09.2014

A SQUID-Based Beam Current Monitor for FAIR/CRYRING
9th International Conference on Nuclear Physics at Storage Rings (STORI'14), 03.10.2014
A SQUID-Based Beam Current Monitor for FAIR/CRYRING
Atomphysik-Seminar der GSI, 18.11.2014

Third -party projects

DFG

TRANSREGIO / TR18-04 „Relativistische Laser-Plasma-Dynamik“
Düsseldorf/Jena/München Teilprojekte A5, A7, A12, B7, B9
2013 -2016
2014: 493.700 €

Phase-dependent Strong-field Laser Physics
PA 730/4-2
2012 - 15
2014: 23.500 €

Investigation of relativistic plasmas produced by irradiating micrometer-sized solid-density hydrogen and argon droplets with ultraintense laser pulses
KA 2869/2-1
2012 – 15
2014: 61.300 €

Induzierte Terahertz-Strahlung und relativistische Optik - ein neues Charakterisierungsverfahren für laser-basierte Teilchenbeschleuniger
GO 1998/3-1
2013 - 2016
2014: 35.500 €

Erste Schritte in Richtung der Atomphysik von Stößen schneller Ionen mit langsamen Ionen
STO 346/4-1
2013 – 2016
2014: 24.400 €

BMBF

BMBF/ Zentren für Innovationskompetenz-Verbundprojekt "onCOOPtics - Hochintensitätslaser für die Radioonkologie, Teilvorhaben B: "Laser- und Targettechnologieentwicklung für therapierelevante Teilchenstrahlen" 03Z1H531
2012 - 2017
2014: 323.500 €

BMBF/DESY, FAIR-APPA: „Effiziente Röntgenoptik mit gebogenen Mosaikkristallen für die Röntgenspektroskopie“, 06JY7149
2012 – 2015
2014: 51.600 €

BMBF/DESY, „FEL-Spezifische Röntgendiagnostik zum Studium dichter Plasmen (XFEL)“, 05K13SJA
2013 – 2016
2014: 77.700 €

BMBF/DESY, Verbundprojekt 05K2013 „PolarX: Präzisions-Röntgen-Spektroskopie und -Polarimetrie. Teilprojekt 3: Röntgenpolarimetrie mit extrem hoher Reinheit“, 05 K 13SJ1
2013 – 2016
2014: 655.700 €

BMBF/DESY, Verbundprojekt 05K2013 „PolarX: Präzisions-Röntgen-Spektroskopie und Polarimetrie - Neue Röntgenstandards für Synchrotrone“ , 05K13SJ2
2013 – 2016
2014: 76.300 €

BMBF/Jülich, "XUV Kohärenztomografie zur zerstörungsfreien, dreidimensionalen Bildgebung von Nanostrukturen" XCT, VIP0515 03 V0690
2013 – 2016
2014: 416.300 €

GSI - Helmholtz-Institut Jena
2014: 539.800 € (Uni-Konto)

Stae of Thuringia (TKM)

Angepasste Laser- und Konvertgläser – ALASKA(TMWAT)
2011 FGR 0122
2011 – 2014
2014: 88.400 €

VW-Foundation

Peter Paul Ewald-Fellowship: Exploring extreme states of matter by time-resolved X-ray spectroscopy
2012 – 15
2014: 92.900 €

Peter Paul Ewald-Fellowship: Exploring Relativistic Plasmas with free-Electron- Lasers
2014 – 2017
2014: 26.400 €

Patents

„Verfahren und Vorrichtung zur Bestimmung der ein- oder mehrdimensionalen Struktur von Objekten mittels Strahlung kurzer Wellenlänge“, AZ: 10 2014 007 106.5, Hausakte 12-25

„Verfahren und Vorrichtung zur Erzeugung von Laserlicht mit definierten Spektraleigenschaften“,
AZ: 10 2014 018 511.7, Hausakte 14-31

8. 10. Institute of Theoretical Physics

10 most important publications

S. Bernuzzi, A. Nagar, S. Balmelli, T. Dietrich and M. Ujevic;
Quasi-universal properties of neutron star mergers;
Phys. Rev. Lett. 112, 201101 (2014).

S. Bernuzzi, T. Dietrich, W. Tichy and B. Brügmann;
Mergers of binary neutron stars with realistic spin;
Phys. Rev. D 89, 104021 (2014).

T. Damour, P. Jaranowski and G. Schäfer;
Nonlocal-in-time action for the fourth post-Newtonian conservative dynamics of two-body systems;
Phys. Rev. D 89, 064058 (2014).]

H. Gies, C. Gneiting and R. Sondenheimer;
Higgs Mass Bounds from Renormalization Flow for a simple Yukawa model;
Phys.Rev. D 89, 045012 (2014).

A. G. Hayrapetyan, O. Matula, A. Aiello, A. Surzhykov and S. Fritzsche;
Interaction of relativistic electron-vortex beams with few-cycle laser pulses;
Phys. Rev. Lett. 112, 134801 (2014).

C. Kohlfürst, H. Gies and R. Alkofer;
Effective mass signatures in multiphoton pair production;
Phys.Rev.Lett. 112, 050402 (2014).

Björn Wellegehausen, Daniel Körner and A. Wipf;
Asymptotic safety on the lattice: The nonlinear O(N) Sigma-Model
Annals of Physics 349 (2014) 374

A. Maas and T. Mufti;
Two- and three-point functions in Landau gauge Yang-Mills-Higgs theory;
JHEP 1404, 006 (2014).

R. Panosso Macedo and M. Ansorg;
Axisymmetric fully spectral code for hyperbolic equations;
Journal of Computational Physics 276, 357 (2014).

J. Rothhardt, S. Hädrich, S. Demmler, M. Krebs, S. Fritzsche, J. Limpert and A. Tünnermann;
Enhancing the macroscopic yield of narrow-band high-order generation by Fano resonances;
Phys. Rev. Lett. 112, 233002 (2014).

Invited talks and tutorials

M. Ammon

Introduction to AdS/CFT
Three talks at University of Leipzig, Joint Seminar of the condensed matter group and particle theory, 20.11.2014, 04.12.2014 and 11.12.2014

Quantum Effects in black holes
Workshop “Black Holes and their environment'”, Hanse-Wissenschaftskolleg Delmenhorst, 02.2014

Higher Spin Gravity and black holes
Overview talk at workshop “Beyond the Standard model” , Bad Honnef, 03.2014

Introduction to Higher Spin gravity
Four lectures / Seminar at Arnold Sommerfeld Summer School 2014, Munich, 08.2014

Recent progress in higher spin AdS/CFT correspondence – Exploring the symmetries and spacetime notion of string theory
Workshop String theory and its applications, Mainz, with title, 09.2014

Recent progress in higher spin gravity
Workshop Recent theoretical developments in gravity and cosmology, Hannover, 10.2014

A. Blinne

Electron-positron pair production with circular or elliptical polarization
Advances in Strong-Field Electrodynamics, Budapest, 02.2014

Julia Borchardt

Universality in 3d relativistic fermionic models
Functional Renormalization Group for Correlated Fermion Systems (Vienna), 07.2014

B. Brügmann

Black Holes in Numerical Relativity
558. WE-Heraeus-Seminar "The Strong Gravity Regime of Black Holes and Neutron Stars", Bad Honnef, 04.2014

Numerical Relativity: Computer Simulations of Black Holes and Neutron Stars
Workshop Einstein@99, Bad Honnef, 09.2014

Black Holes on the Computer, Colloqium, Leipzig, 10.2014

S. Fritzsche

Photoionization and electron capture with “twisted particles”
Halle University, Seminar, 05.2014.

Photoabsorption and photoionization with “twisted ligt”
CEPAS 2014, 6th Conference on EElementary Processes in Atomic Systems, Bratislava, Slovakia, 07.2014.

Quanten-Twist: Verdrehte Teilchen und Strahlen
Kassel University, Colloquium, 11.2014.

H. Gies

Renormalization flow of the Higgs potential
Teilchentee, ITP Heidelberg, 01.2014

38th Johns-Hopkins-Workshop 2014, Heidelberg U, 07.2014

7th International Conference on the Exact Renormalization Group,
Lefkada Island, Greece, 09.2014

Strong interactions in the LHC era, Bad Honnef, 11.2014

Higgs mass bounds from the functional RG
Group seminar, LPTMC, UPMC Paris, France, 02.2014

Physics of the Quantum Vacuum
Physics Colloquium, Wuppertal, 05.2014

F. Karbstein

Towards an all-optical probe of quantum vacuum nonlinearity
Semiannual Palaver of the Helmholtz-Institute Jena, Jena, 07.2014

S. Lippoldt

Fermions in gravity with local spin-base invariance
Seminar, University of Mainz, 01.2014

Quantum Gravity Group Meeting, Perimeter Institute, Canada, 04.2014

Workshop of the DFG Research Group FOR 723, Vienna, Austria 07.2014

Conceptual and Technical Challenges for Quantum Gravity 2014, Rome, Italy, 09.2014;

7th International Conference on the Exact Renormalization Group, Lefkada Island, Greece, 09.2014

Cold Quantum Coffee, Heidelberg, 11.2014

Why we don't need a vierbein
Renormalization Group Approaches to Quantum Gravity, Perimeter Institute, Canada, 04.2014

A. Maas

The physics of Yang-Mills-Higgs theories
University of Heidelberg, Heidelberg, Germany, 01.2014

32nd international symposium on lattice field theory, New York, U.S.A., 06.2014

Darmstadt University of Technology, Darmstadt, Germany, 08.2014

Observables in Higgsed Theories, After the Discovery: Hunting for a non-standard Higgs sector Benasque, Spain, 04.2014

Observables in Higgsed Theories
37th international conference on high-energy physics, Valencia, Spain

Non-Perturbative Methods in Quantum Field Theory, Balatonfüred, Hungary, 07.2014 and 10.2014

571. WE-Heraeus-Seminar: New Physics Within and Beyond the Standard Model, Oberwöz, Austria, 09.2014

C. Markakis

Existence & uniqueness of constants of motion in stationary axisymmetric gravitational fields
NEB XVI Conference - Recent Developments in Gravity, Mykonos, Greece, 09.2014

A discontinuous method for time-domain gravitational self-force computation
17th CapraMeeting on Radiation Reaction in General Relativity, Caltech, Pasadena, California, USA, 06.2014

Initial Data for Eccentric Neutron-Star Binaries
14th British Gravity Meeting, University of Cambridge, Cambridge, UK, 04.2104

R. Meinel

Constructive proof of the no-hair theorem
558. WE-Heraeus-Seminar "The Strong Gravity Regime of Black Holes and Neutron Stars", Bad Honnef, 04.2014

A. Wipf

Asymptotic safety on the lattice: the nonlinear O(N) sigma-models
University Graz, 4.2014; University of Plymouth (UK), 06.2014

G2-QCD at finite temperature
Universität Heidelberg, 02.2014
HIC for FAIR, Gießen, 05.2014
Swansea University, Swanse, UK, 07.2014

Asymptotic safety of nonlinear O(N) models
Universidade Federal de *Juiz de Fora* (Brazil), 07.2014
7th International Conference on the Exact Renormalization Group, Lefkada Island, Greece, 09.2014

The functional renormalization group method – an introduction
Universidad Nacional de La *Plata* (Argentina), 07.2014

Asymptotic safety of O(N) lattice models
University of Mainz, 05.2014

G. Schäfer

Hamiltonian treatment of spinning compact binaries in general relativity
558. WE-Heraeus-Seminar "The Strong Gravity Regime of Black Holes and Neutron Stars", Bad Honnef, 04.2014

Spinning compact binaries in general relativity through higher post-Newtonian orders (Hamiltonian treatment)
The first Conference of the Polish Society on General Relativity, Spala, Poland, 07.2014

Highest order post-Newtonian dynamics of non-spinning and spinning compact binaries in general relativity,
Conclusion Workshop of SFB/TR7 “Gravitational Wave Astronomy”, Jena, 12.2014

N. Seegert

Quantum Reflection as a Signature of the Quantum Vacuum Nonlinearity
Lecture Series on Advances in Strong-Field Electrodynamics, Budapest, 20.2014

Probing the quantum vacuum: Quantum reflection
Helmholtz Graduate Days 2014, Gründau-Gettenbach, 10.2014

R. Sondenheimer

Higgs mass bounds in Yukawa systems from the functional RG
Schladming Winter School 2014 Physics Beyond the Higgs, Schladming, Austria, 03.2014

Workshop of the DFG Research Group FOR 723, Functional Renormalization Group for Correlated Fermion Systems, Vienna, Austria, 07.2014

Higgs mass bounds from the functional renormalization group
7th International Conference on the Exact Renormalization Group,
Lefkasa Island, Greece, 09.2014
Cold Quantum Coffee, Heidelberg, Germany, 11.2014
574. Heraeus Seminar, Strong Interactions in the LHC Era, Bad Honnef, Germany, 11.2014

L. Zambelli

A Hamiltonian formulation of functional renormalization group equations
Cold Quantum Coffee Graduate Seminars, Heidelberg, 01.2014

A UV completion for gauged chiral Higgs Yukawa models
Schladming Winter School, Schladming, Austria, 03.2014

Higher spins, momenta expansion and the FRG
7th International Conference on the Exact Renormalization Group, Lefkada, Greece, 09.2014

O. Zanusso

Functional renormalization group and statistical mechanics of membranes.
7th International Conference on the Exact Renormalization Group, Lefkada, Greece, 09.2014

Third party funding

DFG-projects

SFB/TR7: Gravitational wave astronomy
(Project term: 01/2003 - 12/2014)
2014: 463.251 €

GRK 1523: Quantum and gravitational fields
(Project term: 04/2009 – 03/2018)
2014: 429,234 €

SFB/TR18/2: Relativistic Laser-Plasma-Dynamics
Projekt B7 *From Compton Scattering to Strong Field Electrodynamics*
(Project term: 12/2005 - 06/2016)
2014: 40,694 €

Wi 777/11-1: *Supersymmetrische Yang-Mills Theorien im Kontinuum und auf dem Gitter*
(Project term: 2011 - 2014)
2014:. 27,703 €

MA 3935/5-1: *Matter under the influence of strong and weak interactions*
(Project term: 1/2011 - 07/2014)
2014: 16,049 €

MA 3935/8-1: *Non-perturbative particle physics* (Heisenberg program)
(Project term: 01/2014-09/2014 (granted until 12/2016)
2014: 41,400 €

Other Projects

BMBF Project: 05K2013 - PolarX: Präzisions-Röntgen-Spektroskopie und -Polarimetrie.

Teilprojekt 4: Polarisationskorrelation für die elastische Photonenstreuung" (Förderkennzeichen 05K13VHA)

Helmholtz-Institut Jena: Cluster Extension: 19,500 €

Numerical simulations of G2-QCD at finite densities and tempertur at the Center for Scientific Computing in Frankfurt, approx. 20.000.000 CPU-hours between 2011 and 2014

The TPI invested approx. 33 000 EUR to buy and maintain servers and clusters, approx 26 000 EUR to buy new desktop computers and further computer equipment and approx. 12 000 Euro for notebooks and printers.

8. 11. Research group - Teaching Methodology in Physics and Astronomy

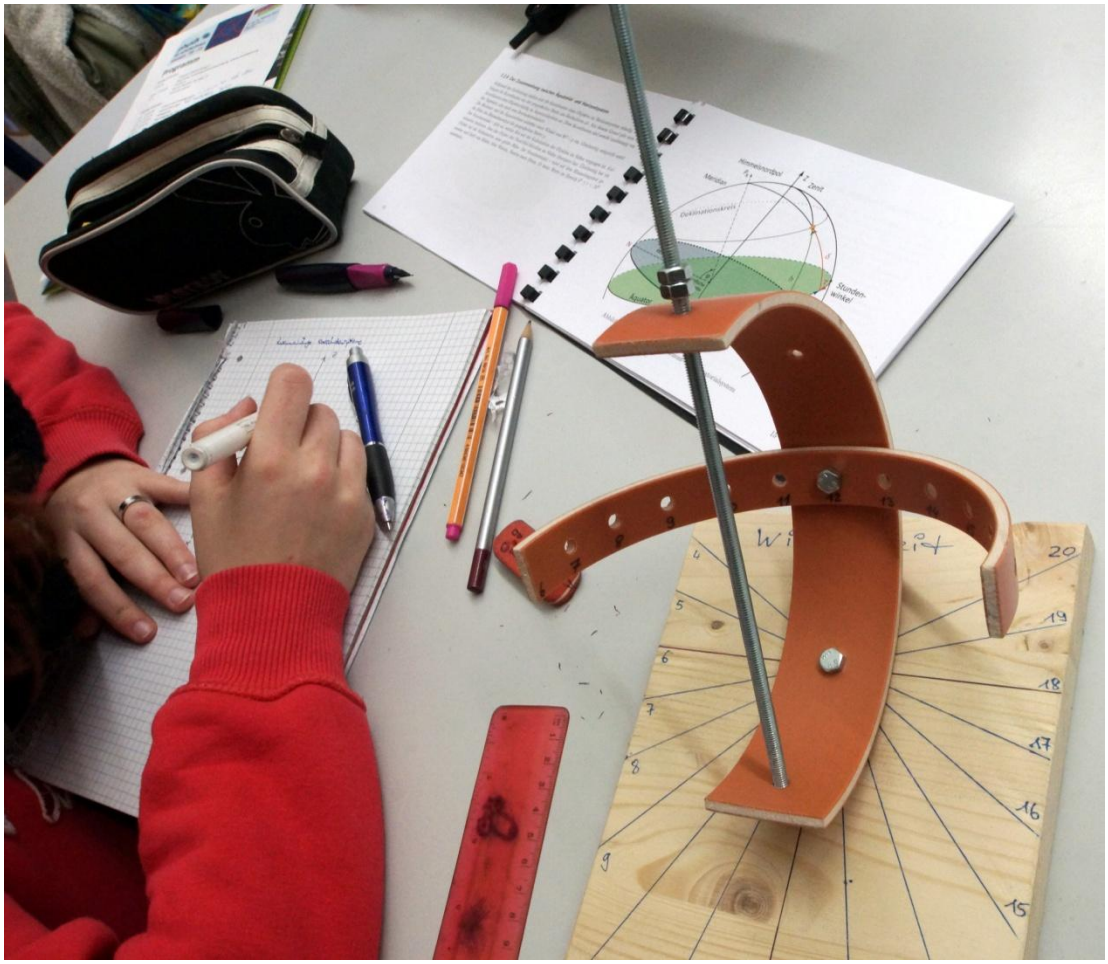
Publications

- Lotze, K.-H.: „Astronomie – Jena 2013“, Astronomie+Raumfahrt im Unterricht, 51(2014)(5)
- Lotze, K.-H.: „Die Expansions-Geschichte des Universums“, Interview Gustav A. Tammann, Astronomie+Raumfahrt im Unterricht, 51(2014)(5) 15-22, (6) 20-25
- Völker, S.: „Wie man einen Stern auf die Waage legt – stellare Zustandsgrößen bestimmen (Teil I)“Beitrag II/H, Reihe 3 in RAAbits Physik; Dr. Josef Raabe Verlag

Talks and Workshops:

<u>Stefan Völker:</u>

- Report at the Annual Meting of the Astronomicl
  "The mass of 70 Ophiuchi – how to weigh a star in the classroom"
- Report at the 1st Colloquium for Doctoral Students on Teaching Methodology in Astronomy „Wie man im Klassenzimmer einen Stern auf die Waage legt – Die Bestimmung der Masse von 70 Ophiuchi"
- Workshop at the jun.iversity-Camps
  "Vom Fallgesetz zur Schwerelosigkeit "
- Supervisor of the Project "Vom Schatten zur Sonnenuhr - Sonnenuhren aus dem Baumarkt" within the Workshop "Physics for School Girls"



Third-party funding

DPG 3.173 €

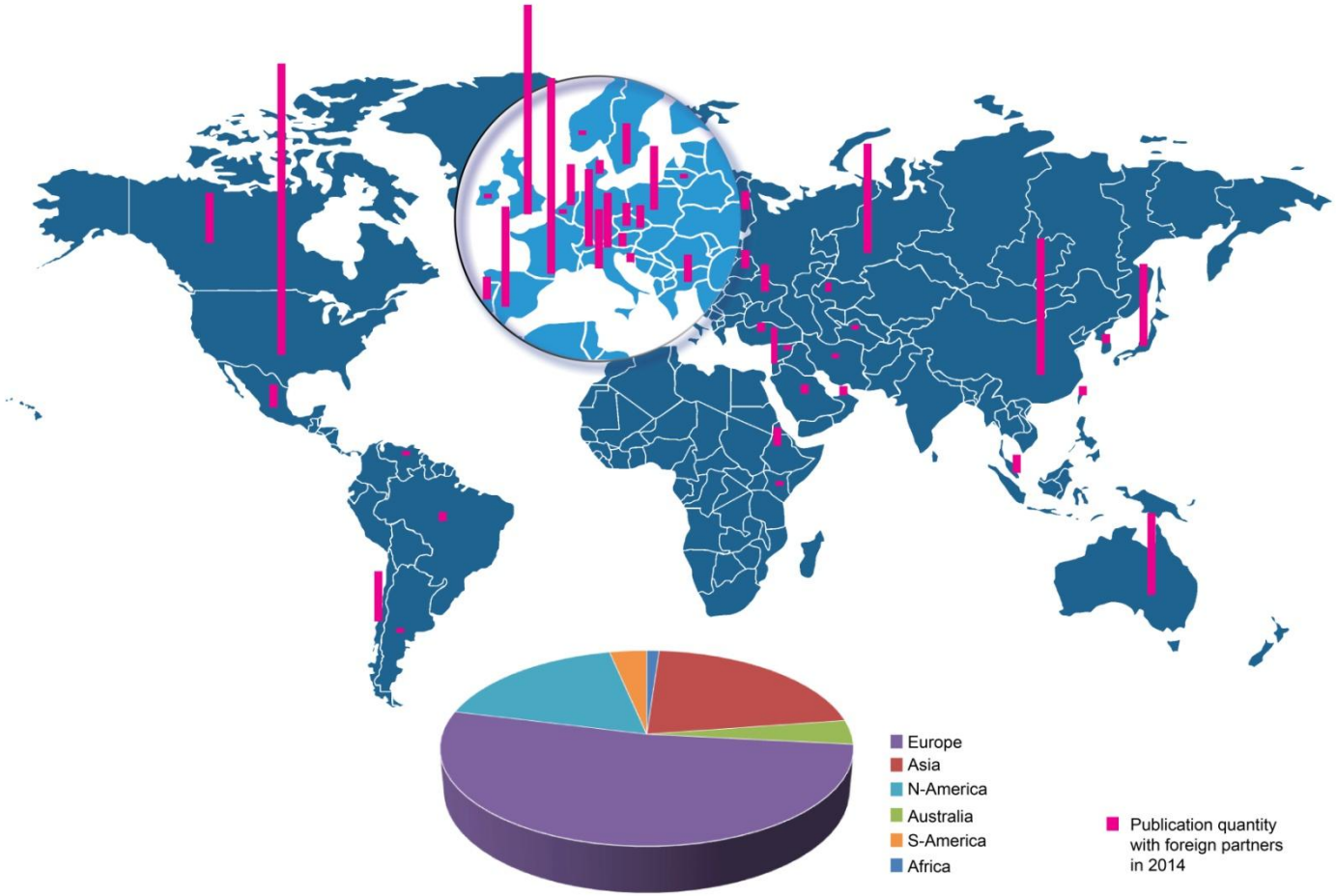
Meade 1.000 €

Wilhelm- und Else-Heraeus-Stiftung
Heraeus Summer Course "Kosmology" for teachers together with Heidelberg, Padua, Florenz,
duration: 2013 -2016
2014: 11.875 €

9. International Relationships

9. 1. Common Publications with International Partners

The cooperation with partners in foreign institutions in most of the cases leads to common publications in peer-reviewed journals. More than 58 % of the publications of the Faculty of Physics and Astronomy are together with authors from foreign institutes. The authors are located in 49 countries. Most of the 243 common publications in 2014 were made with authors from the United States (64), the United Kingdom (46) and France (43). The figure below shows the distribution of the common publications with partners all over the world.



9. 2. Astrophysical Institute and University Observatory

a) Collaborations, shared research projects

The institute participates in numerous national and international collaborations many of which have been mentioned above. A short list of currently active ones follows:

- Direct detection and infrared spectroscopy of sub-stellar companions of young stars and their orbital movement and mass determination for analyzing their formation, Ralph Neuhäuser, Markus Mugrauer, Tobias Schmidt, Christian Ginski, Christian Adam together with N. Vogt, U Valparaiso, Chile, A. Seifahrt, U Chicago, USA, T. Mazeh, S. Zucker, U Tel Aviv, Israel, and others.
- Project YETI (Young Exoplanet Transit Initiative): photometric monitoring of young star clusters for analysis of very young transiting planets and other variability phenomena, Ralph Neuhäuser, Ronny Errmann, Markus Mugrauer et al. together with G. Maciejewski, A. Niedzielski, U Torun, Poland, W.P. Chen, National Central U, Taiwan, R. Redmer, N. Nettelmann, U. Kramm, U Rostock, D.P. Dimitrov, Inst. Astronomy, Bulgar. Aca. Sci., T. Pribulla, M. Vaňko, A. Budaj, Astron. Inst., Slov. Aca. Sci., G. Torres, D. Latham, CfA U Harvard, USA, St. Rätz, ESA ESTEC, and others.
- Search for additional companions of stars with transiting planets by means of the transit-time-variation method, Martin Seeliger, Manfred Kitze, Ralph Neuhäuser, Markus Mugrauer together with St. Rätz, ESA ESTEC, G. Maciejewski, U Torun, Poland, D.P. Dimitrov, Inst. Astronomy, Bulgar. Aca. Sci., and others.
- Investigation of young nearby neutron stars, particularly optical and X-ray observations to constrain the equation-of-state of neutron stars, Valeri Hambaryan, Nina Tetzlaff, János Schmidt, Ralph Neuhäuser together with K. Kokkotas, K. Werner, V. Suleimanov, U Tübingen, F. Haberl, R. Diehl, MPE Garching, F. Walter, SUNYSB, USA, and others.
- Investigation of runaway stars inside of supernova remnants, Baha Dinçel, Anna Pannicke, Ralph Neuhäuser together with Dr. Ankay (Boğaziçi U Istanbul), Dr. Yerli (METU Ankara), Turkey, and G. Torres (Harvard).
- Investigation of fallback discs of neutron stars, together with Dr. Ekşi, TU Istanbul, Turkey.
- Interpretation of historic reports on astronomical observations to study solar activity and (super-)novae, Ralph Neuhäuser et al. in collaboration with M. Csikszentmihalyi, J. Chapman UC Berkeley, USA, P. Kunitzsch, LMU München, and others
- Participation in the Herschel Open Time Key Project DUNES (“Dust around Nearby Stars”, PI: C. Eiroa, Spain), Alexander Krivov, Torsten Löhne, Harald Mutschke, together with the DUNES-consortium.
- Participation in the Herschel Open Time Key Project GASPS (“Gas in Protoplanetary Systems”, PI: W.R.F. Dent, UK), Alexander Krivov, together with the GASPS-consortium.
- Investigation of spatially resolved debris discs, Nicolle Pawellek, Alexander Krivov, together with P. Abraham und A. Moor, Konkoly Observatory, Budapest, Hungary.
- Investigations on the formation of debris discs during planetesimal growth, Torsten Löhne, together with H. Kobayashi, Nagoya University, Japan.
- Mineralogy and infrared spectroscopy of silicate and oxide dust particles in star surroundings, Harald Mutschke together with S. Zeidler, NAOJ Tokio, Japan, and T. Posch, U Vienna, Austria.

b) Guests in 2014 (for several days):

Aşkin Ankay, Boğaziçi University, Turkey
Kazim Yavuz Ekşi, Istanbul Technical University, Turkey
Steve Ertel, ESO, Chile
Virginie Faramaz, IPAG Grenoble, France
Nader Haghighipour, University of Hawaii-Manoa, USA
Quentin Kral, LESIA-Observatoire de Paris, France

Thomas Posch, Institut für Astronomie, Universität Wien, Austria
Thorsten Ratzka, Karl-Franzens-Universität Graz, Austria
Sinan Yerli, METU, Turkey

9. 3. Institute of Applied Optics

a) Cooperation & joint projects

Harvard University, USA

- Plasmon resonances at gold surfaces, former member of the lab (Marinus Huber, bachelor student) is staying abroad at Harvard for his master thesis.

Dr. Theo Seiler Jr., IROC, Zürich, Switzerland,

- Studies on corneal cross linking.

Image Processing Systems Institute (IPSI) of the Russian Academy of Sciences, Samara, Russia & Korolyov Samara State Aerospace University, Samara, Russia

- Selective excitation and quantitative detection of transversal modes of higher order in Few-Mode-Fibers by means of monolithic phase plates

National Laser Centre South Africa CISR, Pretoria

- Application of static and dynamic DOEs for the characterization of “classical” and “exotic” laser beams, of waveguides and fibers and for non-interferometric measurement of wave fronts

CREOL, Orlando, USA

- Comparison of different mode analyzing methods for sophisticated active and passive waveguides as well as for laser beams

Optical Research Center (ORC) of Tampere University, Tampere, Finland

- Modal description of new types of (tapered) waveguides
- Modal characterization of novel semiconductor disc lasers (cw and pulsed)

University Minsk, Belorussia

- Development and characterization of new photopolymers for holographic storage

Pedagogical University Mozyr, Belorussia

- Spatial solitons in photorefractive crystals

University Dublin

- Focusing and defocusing of laser beams in polymers

b) Guest scientists

Dr. Melnikova, State University Minsk, Belorussia
Dr. Timofeeva, State University Minsk, Belorussia
Prof. Dr. Alexej Tolstik, State University Minsk, Belorussia
Prof. Dr. Mahilny, State University Minsk, Belorussia
Dr. O. Romanov, State University Minsk, Belorussia
Tatiana Kornienko, State University Minsk, Belorussia

9. 4. Institute of Applied Physics

a) Cooperations

- Australian National University, Nonlinear Physics Center, Canberra , Australia (Dragomir Neshev)
- Centre d'optique, photonique et laser (COPL), Université Laval, Québec, Canada (Réal Vallée)
- Centre of Ultrahigh bandwidth Devices for Optical Systems (CUDOS), MQPhotonics Research Centre, Department of Physics and Astronomy, Macquarie University, Sydney, Australia (Michael Withford)
- College of Optics and Photonics, CREOL & FPCE, University of Central Florida, Orlando, USA (Kathleen Richardson, Martin Richardson)
- Department of Electrical and Computer Engineering, University of Toronto, Toronto, Canada (Peter Herman)
- Department of Physics, Colorado School of Mines, Golden, USA (Jeff Squier)
- Department of Physics, Oxford University, Oxford, UK (Simon Cooker)
- Énergie, Matériaux et Télécommunications Research Center, Institut national de la recherche scientifique (INRS), Varennes, Canada (Roberto Morandotti)
- ICFO-Institute of Photonic Sciences, Castelldefels, Spain (Lluis Torner)
- INAOUE, INAOUE, Puebla, Mexico (Hector Moya-Cessa)
- Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO), Laboratoire de Physico-Chimie de L'Etat Solide (LPCES), Université de Paris Sud 11, Orsay, France (Matthieu Lancry)
- ICFO, ICFO, Barcelona, Spain (Yaroslav Kartashov)
- IZEST, Ecole Polytechnique, Paris, France (Gerard Mourou)
- Laboratoire Ondes et Matière d'aquitaine (LOMA), University Bordeaux, Bordeaux, France (Lionel Canioni)
- National Central University, Optical Sciences Center, Jhongli , Taiwan (Wei-Kun Chang)
- Physics Department, University of Queensland, Brisbane, Australia (Andrew White)
- Physikalisches Institut, Universität Wien, Wien, Österreich (Philip Walter)
- Solid State Institute, Technion, Haifa, Israel (Moti Segev)

b) Guests

- Akhmediev, Nail, Australian National University Canberra, Australia
- Ancona, Antonio, CNR-IFN U.O.S. Bari, Bari, Italy
- Camper, Antoine, Ohio State University, Ohio, USA
- Chan, Chia-Hua, National Central University, Jhongli, Taiwan
- Chen, Yen-Hung, National Central University, Jhongli, Taiwan
- Clube, Francis, Eulitha AG, Althau, Suisse
- Conti, Claudio, University Sapienza, Roma, Italy
- Dai, Qiang, College of Science, Harbin Engineering University Harbin, China
- Eggleton, Benjamin, University of Sydney Sydney, Australia
- Fleurov, Victor, Tel Aviv University, Tel Aviv, Israel
- Gaudioso, Caterina, CNR-IFN U.O.S. Bari, Bari, Italy
- Hendricks, Nicholas, University of Massachusetts, Amherst, USA
- Herman, Peter, University of Toronto, Toronto, Canada
- Jourlin, Yves, Université Jean Monnet, Saint-Etienne, France
- Laude, Vincent, FEMTO-ST Institute Besancon, France
- Mitchell, Arnan, RMIT University Melbourne, Australia
- Morandotti, Roberto, Institut national de la recherche scientifique (INRS), Énergie, Matériaux et Télécommunications Research Center, Varennes, Canada
- Mortensem, Asger, Technical University of Denmark Lyngby, Denmark

- Neuenschwander, Beate, Bern University of Applied Sciences, Department of Electrical and Computer Engineering Bern, Suisse
- Partanen, Henri, University of Eastern Finland Joensuu, Finland
- Partel, Stefan, FH Vorarlberg, Dornbirn, Austria
- Rechtsman, Mikael, Technion, Haifa, Israel
- Solntsev, Alexander, Australian National University Canberra, Australia
- Staude, Isabelle, Australian National University Canberra, Australia
- Timoffeeva, Maria, Sankt-Petersburg Academic University, St. Petersburg, Russia
- Vahimaa, Pasi, University of Eastern Finland, Joensuu, Finland
- Vallée, Réal, Université Laval, Centre d'optique, photonique et laser (COPL), Québec, Canada
- Walter, Philip, Universität Wien, Vienna, Austria
- Weinfurtner, Silke, University of Nottingham, UK

c) Visits

- University of Sydney, Institute of Photonics and Optical Science/CUDOS, Sydney, Australia (Martin Steglich)
- Australian National University (ANU), RSPE, Department EME, Canberra, Australia (Dennis Lehr, Martin Steglich)
- Australian National University (ANU), Canberra, Australia (Ekaterina Pshenay-Severin, Frank Setzpfand)
- CSIRO, Clayton Laboratories, CMSE/CCEF, Melbourne, Australia (Dennis Lehr, Martin Steglich)
- University of Melbourne, Department Optical Physics, Melbourne, Australia (Dennis Lehr, Martin Steglich)
- Department of Physics, Colorado School of Mines, Golden, USA (Jens Thomas)
- Centre of Ultrahigh bandwidth Devices for Optical Systems (CUDOS), MQ Photonics Research Centre, Department of Physics and Astronomy, Sydney, Australia (Felix Dreisow)
- University of Eastern Finland, Joensuu, Finland (Olga Baladron-Zorita)
- Universidad Politecnica de Madrid, Madrid, Spain (Olga Baladron-Zorita)
- Institute for Cosmic Ray Research, Tokyo, Japan (Stefani Kroker)
- Tokyo Institute of Technology, Tokyo, Japan (Stefanie Kroker)
- Università di Brescia, Brescia, Italy (Thomas Pertsch)
- National Central University, Jhongli, Taiwan (Reinhard Geiß, Mohammad Tollabi Mazraehno)

9. 5. Institute of Solid State Physics

a) Collaborations

The Surface Science group of **Prof. Dr. T. Fritz** strengthened their international cooperations in 2014. While the ongoing collaboration with the group of Prof. Dr. T. Munakata (University of Osaka) was continued and even intensified by numerous exchange visits (founded via a PaJaKo project of the DAAD) between German and Japanese Scientist new collaborations were started with the groups of Prof. Dr. N. Ueno (University of Chiba) and Prof. Dr. S. Kera (Institute of Molecular Science, Okazaki). In the USA we cooperate with the group of Prof. Dr. O. Monti (University of Arizona). Within Europe we have intensive collaborations with the theory groups of Prof. Dr. E. Zojer (Graz University of Technology) and Prof. Dr. G.-P. Brivio (Universita` di Milano-Bicocca). In Germany our collaborations included the group of Prof. Dr. C. Kumpf (Forschungszentrum Jülich GmbH) and Prof. Dr. J. Kröger (TU Ilmenau).

The group of **Prof. C. Ronning** collaborated in 2014 with various international groups. Special situations have been established with the groups of Prof. Dr. F. Capasso (U Harvard), Prof. A. Lugstein (TU Vienna), Prof. A. Fontcuberta i Moral (EPF Lausanne), and Prof. K. Bharuth-Ram (iThemba Labs, South Africa), which have been founded either by the DAAD or DFG. Further collaborations have been conducted with the groups at the University of Lund (Sweden, Prof. L. Samuelson), Australian National University Canberra

(Australia, Prof. M. Ridgway), University of Southern California (USA, Prof. J.G. Lu), University of Florence (Italy, Dr. F. di Benedetto), University of the Basque Country (Spain, Prof. A. Rubio), Institute of Light and Matter (France, Dr. S. Botti), ERSF Grenoble (France, Dr. G. Martinez-Criado & Dr. F. d'Acapito) and Imperial College (UK, Dr. R. Oulton & Prof. O. Hess).

The Low Temperature Physics group of **Prof. Dr. Paul Seidel** is collaborating in the field of superconducting materials and its application are the universities of Bratislawa, Poznan, Twente, Donetsk, Kharkov, Osaka, Nagoya and Berkeley. Within the German Collaborative Research Center (SFB TR7) scientific results have been obtained in close collaboration with international partners, such as the universities of Glasgow, Padova, Lyon, Tokyo, Pisa, Salerno, Roma, Moscow and others.

The Ion Beam Physics group of **Prof. Dr. Elke Wendler** cooperated in 2014 with Prof. Dr. Fadei F. Komarov (BGU Minsk), Prof. Dr. Maria Katsikini (U Thessaloniki), Dr. Katharina Lorenz (IST, U Lissabon), Prof. Dr. Johan B. Malberbe (U Pretoria), Dr. Alexander Azarov (U Oslo) and Dr. Albert Juma (now U Gaborone, Botswana).

The working group ***Laboratory Astrophysics and Cluster Physics*** collaborates with a number of institutes both at home and abroad. Experimental studies of molecular hydrogen formation on the surface of silicate dust grains under astrophysical conditions have been performed in collaboration with Prof. J.-L. Lemaire and Prof. Dr.Gianni Vidali from the Observatoire de Paris and Université de Cergy-Pontoise). In the field of UV-induced reactions of astrophysically relevant molecules in cryogenic matrices, close collaborations exist with Prof. Harold Linnartz from the Raymond and Beverly Sackler Laboratory for Astrophysics, Leiden Observatory (Netherlands), and Prof. Stephen Price at the Chemistry Department of the University College London. The formation of molecules in interstellar ices and the erosion of carbonaceous solids in the dense interstellar medium by proton bombardment are the topics of a joint project with the Laboratory Astrophysics Group at INAF–Osservatorio Astrofisico di Catania, Italy. These scientific connections were mainly built during the Marie Curie ITN network "LASSIE- Laboratory Astrophysics Surface Science in Europe'' that was working between 2010 and 2014. Intensive collaboration with Dr. Akos Keszturi and Prof. Peter Abraham, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary, has been established in the last years. Here, we focus on joint laboratory work including condensation experiments and spectroscopy of condensates at low temperature. With Prof. Stephan Schlemmer, Cologne Laboratory Astrophysics Group, Prof. Thomas Giesen, Laboratory Astrophysics Group at the University Kassel, and Dr. Holger Kreckel, Max Planck Institute for Nuclear Physics in Heidelberg, long-standing collaborations in the field of laboratory astrophysics, structure, dynamic, and properties of molecules and dust grains in astrophysical environments have been existing for more than 10 years.

b) Joint research projects

Nanoscale Interfaces for Organic Electronics (DAAD PaJaKo Project Japan, ID 56264880)
Time span: 01/13 – 12/15
With Prof. Dr. T. Munakata (Osaka University)

Formation and shaping of magnetic nanoclusters in oxides, using ion implantation
Time span: 03/11 – 02/15
With Prof. K. Bharuth-Ram (iThemba Labs, Cape Town, South Africa)

Wiring quantum dots – phase separation inducing new functionality
Time span: 08/11 – 07/14
With Prof. A. Lugstein (TU Vienna, Austria) & Prof. A. Fontcuberta i Moral (EPF Lausanne, Switzerland)

Switchable and tunable infrared devices by controlled manipulation of the insulator-to-metal transition in Vanadium dioxide (DAAD/PPP USA)
Time span: 01/14 – 12/15
With Prof. F. Capasso & Prof. S. Ramanathan (U Harvard, USA)

Marie-Curie ITN network "Nanowiring" (EU Project)
Time span: 11/10 – 10/14
With 9 partners within the EU

Virtuelles Institut „MEMRIOX“ (HZDR Dresden-Rossendorf)
Memory Effects in Resistive Ion-beam Modified Oxides
Time span: 10/11 – 09/16
With Prof. D. Basov (U of California @ San Diego, USA)

Ion implantation synthesis and characterization of rare earth doped nanocrystalline GaN (DAAD/PPP Greece)
Time-span: 01/13 – 12/14
With Prof. Dr. Maria Katsiki (Aristotle U Thessaloniki, Greece)

Formation of semiconductor nanocrystals in silicon-based dielectrica (DAAD/Osteuropapartnerschaften)
Time-span: 01/13 – 12/16
With Prof. Dr. Fadei F. Komarov (BGU Minsk, Belarus)

EU-Project IRON-SEA: *Establishing the basic science and technology for Iron-based superconducting films for electronics applications* and Japanese partners:
With Prof. Dr. Plecenik, Comenius-University Bratislava
Dr. A. Golubov, Univ. Twente
Dr. G. Pepe, Dr. S. Pagano CNR Italy
Dr. S. Gonelli, Dr. D. Dario, Politechnico Torino
Prof. H. Ikuta, Prof. Y. Tanaka University Nagoya
Prof. S. Tajikma, University Osaka
Prof. A. Maeda, Prof. M. Naito, University Tokyo

Heisenberg-Landau Program: *Microwave response of intrinsic Josephson junctions and SQUIDs:*
With Dr. Yu. Shukrinov, JINR Dubna

EU-Projekt ELiTES: *International Exchange Scheme*, Marie Curie Actions:
With FSU Jena (Dr. R. Nawrodt, coordinating workpackage 2 „Mirror thermal noise and cryogenics“
Institute for Cosmic Ray Research, The University of Tokyo (Prof. K. Kuroda)
Tokyo Institute of Technology (Prof. K. Somiya)
European Gravitational Observatory EGO (Dr. M. Punturo)
Rome University „La Sapienza“ (Prof. F. Ricci)
University of Glasgow (Prof. S. Rowan)
FOM/NIKHEF, Amsterdam (Prof. J. van den Brand)
Max-Planck-Gesellschaft zur Förderung der Wissenschaft (AEI Hannover, Dr. H. Lück)
University of Sannio at Benevento (Prof. I. Pinto)
The University of the West of Scotland (Dr. S. Reid)

EU/BMBF-Projekt: *ET R&D – Networking and R&D for the Einstein Telescope* (ERA-NET FT7 + ASPERA):
With FSU Jena (Dr. R. Nawrodt, coordinating working group 3 „Optical properties of silicon at cryogenic temperatures)
NIKHEF, Amsterdam (Prof. K. Kuroda)
Leibniz Universität Hannover (Dr. H. Lück)
Moscow State University (Prof. V. Rudenko – Sternberg Institute, Prof. S. Vyatchanin - Physics Department), Institute of Nuclear Research, Russian Academy of Science (Prof. L. Bezrukov)
University of Warsaw (Prof. T. Bulik), University of Zielona Gora, University of Bialystok, Warsaw University of Technology, Polish Academy of Science
University of Birmingham (Prof. A. Freise)
University of Glasgow (Dr. I. Martin)
University of Cardiff (Prof. B. S. Sathyaprakash)
University of the West of Scotland (Dr. S. Reid)

c) Guests

Prof. Dr. Puxian Gao	U Connecticut, USA – **Humboldt-Professor for 1 year**
Prof. Dr. T. Munakata	Osaka University, Japan
Prof. Dr. H. Kato	Osaka University, Japan
MSc N. Kawakita	Osaka University, Japan

Prof. Dr. K. Baruth-Ram	iThemba Labs, Cape Town, South Africa
Prof. Dr. J. Grace Lu	University of Southern California, USA
M. Glaser	TU Wien, Austria
Dr. G. Martinez-Criado	ESRF Grenoble, France
M. Geelen	U Hasselt, Belgium
Prof. Dr. M. Katsikini	Aristotle U Thessaloniki, Greece
Prof. Dr. J. B. Malherbe	U Pretoria, South Africa
Prof. Dr. K. Somiya	Tokyo Institute of Technology, Japan
Prof. Dr. T. Tomaru	KEK Tsukuba, Japan
Dr. M. Belogolovskii	Donetsk Institute for Physics and Engineering, Ukraine
Dr. K. Kulikov	Joint Institute for Nuclear Research Dubna, Russia
Dr. A. Bell	University of Glasgow, UK
T. Kawaguchi	Nagoya University, Japan
R. Douglas	University of Glasgow, UK
D. Chen	University of Tokyo, Japan
Dr. A. Gucsik	Konkoly Thege Miklos Astronomical Institute, Astrophysical and Geochemical Laboratory, Budapest, Hungary and Department of Geology, University of Johannesburg
S. Gobi	Konkoly Thege Miklos Astronomical Institute, Astrophysical and Geochemical Laboratory, Budapest, Hungary
S. Cuylle	Raymond and Beverly Sackler Laboratory for Astrophysics, Leiden, NL
H. Kimber	Department of Chemistry, University College London, UK
A. Nanni	Astrophysics, University of Keele, Staffordshire, UK

9. 6. Institute of Solid State Theory and Optics

a) Collaborating Institutions

- Université Geneva
- CEA Paris
- Ecole Polytechnique Palaiseau
- Universita degli Studi di Roma
- TU Eindhoven
- DIPC San Sebastian
- University of Arlington (Texas)
- Universität Linz
- Universita di Milano
- Universität Wien
- University of California, Santa Barbara
- Lawrence Livermore National Laboratory
- CEA-DAM Arpajon, France
- CELIA, Bordeaux, France
- University of Wisconsin, USA
- Tampere University of Technology, Finland
- Universidad Complutense de Madrid, Spanien
- Ecole Polytechnique Fédérale de Lausanne
- Helsinki University of Technology

b) Joint Scientific Projects

Spezialforschungsbereich F25 Österreich: InfraRed Optical Nanostructures (IR-ON)

EU I3 European Theoretical Spectroscopy Facility (ETSF)

c) Guests

Prof. Dr. Giancarlo Cappellini (Cagliari)
Dr. Silvana Botti (Lyon)
Prof. André Schleife (Urbana-Champaign)
Prof. Olivia Pulci (Rom)

9. 7. Otto Schott Institute of Materials Research

a) Cooperations (joint projects or publications)

Chair of Metallic Materials

- Université de Lorraine, Nancy
- Clausthal University of Technology
- Max-Planck-Institute of Iron Research
- RWTH Aachen University
- Karlsruhe Institute of Technology, IAM
- German Aerospace Center DKR
- Harbin Institute of Technology
- Southeast University Nanjing
- Beijing University of Technology
- Montanuniversität Leoben

Chair of Materials Science

- Beijing University of Chemical Technology, Beijing, China
- Boğaziçi University, Istanbul, Turkey
- Chongqing University, Chongqing, China
- Faculty of Chemical and Process Engineering, Warsaw University of Technology, Warsaw, Poland
- Institute for Clinical Dentistry, University of Oslo, Oslo, Norway
- Institute of Interdisciplinary Studies, Belgrade, Serbia
- Jilin University, Changchun, China
- Medical University of Vienna, Vienna, Austria
- Prince of Songkla University, Hat Yai, Songkhla, Thailand
- Rudolfs Cimdins Riga Biomaterials Innovation and Development Centre, Riga Technical University, Latvia
- Tribology Centre, Danish Technological Institute, Aarhus, Denmark
- Universität St. Cyril and Methodius, Skopje, Macedonia
- University of Catania, Italy
- University of Colorado Boulder, Boulder, Colorado, United States
- University of Lyon, Lyon, France
- University of Manchester, Manchester, United Kingdom
- University of Minho, Portugal
- University of South Carolina, Columbia, South Carolina, United States
- University of Strasbourg, Strasbourg, France
- Wuhan University, Wuhan, Hubei Province, China
- Yerevan State University, Armenia

Colloids, Surfaces and Interfaces

- CSIC-ICMM, Madrid, Spain
- McGill University, Montreal, Canada
- University of Birmingham, UK
- ISTEC-CNR, Faenza, Italy
- INIQUI–CONICET, University of Salta, Argentina

- Shanghai Institute of Ceramics, Chinese Academy of Sciences, China
- University of Würzburg, Department for functional materials in medicine and dentistry
- Federal Institute of Materials Research and Testing, BAM Berlin
- TU München – Biogenic Polymers
- Clausthal University of Technology, Institute of Non-Metallic Materials

Computational Materials Science
- University of California, Irvine, USA
- Nikolaev Institute of Inorganic Chemistry, Russia

b) Guests
- Prof. Xinzhong Li, Harbin University of Technology
- Prof. Dmitry Alexandrov, Jekaterinburg University
- Prof. Dr. Wang Xin, Jilin University, China
- Dr. Robin W. Mills, University of Bristol, United Kingdom
- Prof. Dr. David Watts, University of Manchester, United Kingdom
- Prof. Dr. Janis Locs, Riga Technical University, Latvia
- Prof. Dr. Bora Garipcan, Boğaziçi University, Istanbul, Turkey
- Jialu Chen, Wuhan University, Hubei Province, China
- Tanatchaporn Sangfai, Prince of Songkla University, Hat Yai, Songkhla, Thailand
- Joseph Andrews, University of South Carolina, United States of America

9. 8. Institute of Optics and Quantum Electronics

a) Cooperations

Pengfei Lan, Katsumi Midorikawa (RIKEN Center for Advanced Photonics)

Stephen R. Leone, Daniel M. Neumark (UC Berkeley)

Dr. Alexander P. L. Robinson (Rutherford Appleton Laboratory, UK)
Prof. Dr. Z. Najmudin, Dr. Stuart P. D. Mangles (Imperial College London)

C. Detlefs, R. Rüffer, J. Härtwig (European Synchrotron Radiation Facility) – High purity X-ray polarimetry

Dr. E. Kroupp and E. Stambulchik (Weizmann Institute of Science) – Investigation of highly charged ions in high electromagnetic fields

G. Gregori, Dr. A. Robinson (Rutherford Appleton Laboratory/Oxford University) – Hot electron production in laser solid interactions

S. A. Pikuz (Joint Institute of High Temperature, Russian Academy of Science) – Physics of hollow atoms

High Energy Density Group, SLAC SIMES, Stanford University, CA, USA
X-ray scattering from solid and liquid density plasmas

Nevada Terawatt Facility (NTF), Reno, NV, USA
Spatially resolved Ti K-spectroscopy of laser-produced plasmas

b) Visitors

Prof. Alexey Balakin	Institute of Applied Physics RAS, Nizhny Novgorod, Russia
Prof. Christoph Hauri	Paul Scherrer Institut, Villigen, Schweiz
Dr. Hong He	Chief Representative, Helmholtz Association of German Research Centres, Beijing und Berlin
Dr. Eyal Kroupp	Weizmann Institute of Science, Rehovot, Israel
Dr. Alexander Robinson	Rutherford Appleton Laboratory, UK
Prof. Frank Rosmej	Pierre Marie Curie University Paris, Frankreich
Prof. Mikhail Shneider	Princeton University, USA

Evgeny Stambulchik	Weizmann Institute of Science, Rehovot, Israel
Dr. Sven Steinke	Lawrence Berkeley National Laboratory California
Dr. Ando Toshiaki	University of Tokyo, Japan
Dr. Daniel Ursescu	THE ELI – Nuclear Physics Facility
Prof. Claes-Göran Wahlström	Deparment of Physics and Lund Laser Centre, Lund University, Sweden
Prof. Quan Wei	Wuhan, China
Dr. Philippe Zeitoun	Le Laboratoire d'Optique Appliquee (LOA), Palaiseau, Frankreich

9. 9. Institute of Theroretical Physics

a) Cooperations on common research projects

Prof. M. Ammon

Cooperation with Prof. Alejandra Castro (Amsterdam), Dr. Nabil Iqbal (US Santa Barbara), Prof. Michael Gutperle (UC Los Angeles) and Dr. Andrew O'Bannon (University of Oxford)

Prof. B. Brügmann

Cooperation with Prof. W. Tichy, Florida Atlantic University (USA) on black holes and Dr. Alessandro Nagar, IHES, Bures-sur-Yvette (France) on gravitational waves

Prof. S. Fritzsche

Collaboration and regular exchange exists with the groups of professors Michel Godefroid (Brüssels, Belgium), Raimund Feifel (Goeteborg, Sweden), Jacek Bieron (Krakow, Poland), Chenzhong Dong (Lanzhou, China), Alexei Grum-Grzhimailo (Moscow, Russia), Velerij Serbo (Novosibirsk, Russia) and Vladimir Shabaev (St. Petersburg, Russia).

Prof. H. Gies

Collaboration with Prof. Gerald Dunne, University of Connecticut (USA) and Prof. C. Schubert (Morelia, Mexico) an effective actions in quantum field theory. Collaboration with Prof. Reinhard Alkofer, Graz U. (Austria) on quantum electrodynamics far from equilibrium. Collaboration with Dr. Astrid Eichhorn, Perimeter Institute (Waterloo, Canada) and Imperial College London (UK) on Higgs boson mass bounds and vacuum stability. Collaboration with Dr. Lukas Janssen, SFU Burnaby/Vancouver (Canada) on relativistic fermion systems in condensed matter systems. Collaboration with Dr. Rashid Shaisultanov, Nazarbayev U. Astana (Kazachstan) on strong-field quantum electrodynamics.

Dr. F. Karbstein

Collaboration with Dr. Rashid Shaisultanov, Nazarbayev University, Republic of Kazakhstan, on strong field QED

Dr. O. Zanusso

Collaboration with Dr. A. Codello (CP3-Origins, Odense, Denmark) and Prof. D. Mouhanna (LPTMC, Paris, France) on critical properties of membranes. Project with Prof. F. Saueressig (Radboud University Nijmegen, The Netherlands) on quantum gravity, quantum geometry and asymptotic safety.

Dr. L. Zambelli

Collaboration with Dr. G. P. Vacca, Bologna U., Italy, on the role of the multiple exchange of mesons in simple Yukawa systems at criticality

Dr. A. Maas

Project with J. Skullerud (Univ. Maynooth) on two-color QCD at finite density. Cooperation with L. Fister (Univ. Saclay) on vertices at finite temperature

Prof. R. Meinel

Collaboration with Prof. P. Chruściel, University of Vienna, in the area of Ernst equation.

Prof. G. Schäfer (retd.)

Collaboration with Prof. P. Jaranowski. University of Bialystok, Bialystok, Poland, and Prof. T. Damour, IHES, Bures-sur-Yvette, France, on the problem of motion in general relativity.

Prof. A. Wipf

Collaboration with Prof. Ilya Shapiro (Luiz de Fora, Brazil) on quantum induced effects in curved spacetimes. On simulations of strongly coupled lattice system there exists and ongoing collaboration with Prof. Kurt Langeld (University Plymouth). Collaboration with Mikhail Plyushschay (Universidad de Santiago de Chile, Chile) on particles in self-dual backgrounds and exotic symmetries.

b) Guests from abroad *(including SFB/TR7 and GRK 1523)*

Prof. C. Bambi, Shanghai, PR China
Dr. Georg Bergner, University Bern, Switzerland
Prof. Dr. Keith Burns, University of Warwick, UK
Robert Dabrowski, University of Connecticut, USA
Prof. Dr. Chenzhong Dong, Northwest University Lanzhou, China
Prof. Dr. Alexei Grum-Grzhimailo, Moscow State University, Russia
Prof. P. Freire, Bonn (for the time being)
Dr. M. Hannam, Cardiff, UK
Dr. Jonathan Kress, University of New South Wales, Australia
Prof. Dr. Robert Milson, Dalhousie University Halifax, Canada
Prof. Dr. Andrea Posilicano, University of Insubria, Italy
Prof. Dr. Stephan Rosswog, Stockholm University, Sweden
Prof. D. Shoemaker, Acton, USA
Dr. Marco Schreck, Indiana University, USA
Dr. Vsevolod Shevchishin, National Research University Higher School of Economics, Russia
Prof. M. Shibata, Kyoto, Japan
Dr. N. Stergioulas, Thessaloniki, Greece
Prof. Dr. Norbert Straumann, University Zürich, Switzerland
Prof. Dr. Urs Wenger, University Bern, Switzerland
Dr. Vladimir Yerokhin, St. Petersburg State Polytechnical University, Russia
Dr. Omar Zanusso, Radboud Universiteit Nijmengen, Netherlands

<u>longer-term guests:</u>
M.Sc. Greger Torgrimsson (Chalmers U., Göteborg, Sweden)
M.Sc. Anabel Maria Trejo (Michoacan University, Morelia, Mexico)
Prof. Maximiliano Ujevic Tonino (Universidade Federal do ABC, Brasilien)

<u>Special guests:</u>
Prof. Dr. Gerald Dunne, University of Connecticut, USA (Mercator GRK)

9. 10. Research Group - Teaching Methodoly in Physics and Astronomy

Cooperations

Within the Heraeus Summer School "Kosmology from 4 perspectives" we work together with the University in Padua (Italy).

10. Academic Organization and Bodies

10. 1. Scientific Advisory Board of the Faculty of Physics and Astronomy

The Scientific Advisory Board of the Faculty of Physics and Astronomy was set up by the Rector in 2005, on suggestion of the Faculty Council and the Structural Committee.

The Scientific Advisory Board is a panel consulted by the Dean and the Faculty Council with regard to the further development of the Faculty. This includes the Faculty's overall concept, but also the content orientation of the various chairs in case of vacant positions advertised. The Advisory Board offers suggestions about the scientific equipment, staff and space required by the Faculty and its institutes, and about the organizational structures most favourable for fulfilling the tasks in research and teaching. In selected cases, the Dean will ask the Advisory Board to participate in outlining the contents of chair position advertisements and in deciding on who is given the chair.

At its 3rd meeting in April 2012, the Scientific Advisory Board discussed the implementation of the Faculty's strategy for the period until 2020.

According to its statute, the board comprises at least seven members, viz. two each from the departments of Solid-State Physics/Materials Science, Optics/Quantum Electronics and Theory, plus one from Astrophysics. The members are appointed by the Rector for a four-year term. On suggestions of the Institutes, the following persons were appointed to the Scientific Advisory Board of the Faculty of Physics and Astronomy for another four years:

- for Optics/Quantum Electronics:

Prof. Dr. Gerd Leuchs,
Institute of Optics, Information and Photonics , University of Erlangen - Nürnberg
He was the Chairman of the Advisory Board up to 2014.

Prof. Dr. Günter Huber,
Department of Physics, University of Hamburg

- for Soolid State Physics /Materials Science:

Prof. Dr. Paul Müller,
Institute of Physics, University of Erlangen-Nürnberg

Prof. Dr. Ludwig Schultz,
Scientific Director of the Leibniz Institute of Solid-State and Materials Research, Dresden

- for Quantum Theory and Theory of Gravity:

Prof. Dr. Friedrich W. Hehl,
Faculty of Mathematics and Natural Sciences, University of Cologne

Prof. Dr. Olaf Lechtenfeld,
Institute of Theoretical Physics, Gottfried Wilhelm Leibniz University of Hannover
He is the Chairman of the Advisory Board since 2015.

- for Astrophysics:

Prof. Dr. Rolf Chini,
Faculty of Physics and Astronomy, Ruhr-Universität Bochum

With respect to the particular importance of the questions the scientific advisory board would have to deal with in the next years the Faculty of Physics and Astronomy plans to renew it gradually. Therefore since 2015 two new members have been appointed:

Prof. Dr. Jan-Michael Rost
Max Planck Institute for the Physics of Complex Systems,
Dresden

Prof. Dr. Jörg Neugebauer
Director of the Max-Planck- Institut für Eisenforschung,
Düsseldorf

10. 2. Astrophysical Institute and University Observatory

Providing of expertise, activities in committees, participation in program committees of international conferences

C. Ginski

- Referee for several journals
- Referee for the Time Allocation Committee of the CFHT telescope on Mauna Kea

Prof. Dr. Alexander Krivov

- Deputy member of the Academic Commission of the senate of the FSU
- Acting member of the Faculty Council of the FSU
- Member of the Evaluation Commission of the faculty

- Member of the Scrutiny Committee of the FSU
- Member in several dissertation and habilitation commissions of the faculty
- Examiner for the First State Examination (teaching degree for astronomy)
- Referee of several PhD, Master, and Bachelor theses (FSU)
- External examiner for the defense of the doctor's thesis of Quentin Kral (Observatoire de Paris)
- Major and minor subject examiner in several dissertation procedures (FSU)
- Referee of the Alexander-von-Humboldt-Foundation
- Referee for several journals

Dr. Torsten Löhne

- Referee for several journals

Dr. Markus Mugrauer

- Referee for several journals

Dr. Harald Mutschke

- Referee for *Mon. Not. R. Astron. Soc.*
- Referee for DFG

Prof. Dr. Ralph Neuhäuser

- Director of AIU
- Faculty's astrophysics lecturer in charge
- Member of the Structural Commission of the faculty
- Advisor for a tenure track process at Tel Aviv University
- Referee for several journals
- Examiner for the First State Examination (teaching degree for astronomy)
- Referee for PhD thesis at University of Potsdam
- External referee for the DFG, Humboldt-Foundation, and Wrangell Habilitation Program for Women
- Consulting member of the commission *Sterne und Galaxien* of the Academy of Sciences of North Rhine-Westphalia
- Member of a professorship search commission at University of Göttingen

Ch. Vitense

- Referee for several journals

10. 3. Institute of Applied Optics

Peer review work, memberships

Prof. Kowarschik

- Member of the board of directors of the Center of Medical Optics and Photonics (CeMOP)
- Member of the DFG Review Board „Optics, Quantum Optics, Atoms, Molecules, Plasmas" and of the DFG Review Panel "Medical Technology"
- Reviewer of international journals publics institutions BMWT, TMWFK and Research Societies (DFG, DAAD, Foundations)
- Member of the Advisory Board MedWays e.V.
- Vice-chairman of the scientific Advisory Board of the IPHT Jena

Prof. Heisterkamp

- Reviewer for the young researcher contest, January/&February 2014, contest on 27.02.2014
- Conference Chair LASE Conference „Frontiers of Ultrafast Optics", Photonics West 2014, 01.-06.02.2014, San Francisco, USA
- PI in Excellence cluster Hearing for All, Oldenburg-Hannover
- Editor in Chief Medical Photonics, journal in preparation, Elsevier Verlag
- Section Editor of JEOS, Journal of the European Optical Society

- Member of Steering Committee REBIRTH Excellencecluster
- PI in the German Center for lung research
- Member of the scientific directorate of the Laser Zentrum Hannover
- several reviewer tasks for Journals and Research Societies
- Chair and member of the planning committee Annual Meeting der EOS, Berlin 2014

Dr. Duparré

- Accredited member in the National Standardization Committees AA O 18 „Laser“ and AA O 18 AK1 „Begriffe, Prüfgeräte und Prüfverfahren“
- Accredited member in the International Standardization Committee ISO/TC 172/SC9/WG 1 & ISO/TC 172/SC9/JWG 1
- Regular member of the “Main Staff Council for Civil Servants” at Thuringian Ministry for Education, Science and Culture (HPR TMBWK), till May 31st (end of previous electoral period)
- Participation in program committees for the conferences „Laser Beam Shaping XV“ / SPIE’s International Symposium on Optics and Photonics 2014 San Diego/USA as well as „Laser Beam Shaping XVI“ / SPIE’s International Symposium on Optics and Photonics 2015 San Diego/USA
- Active in peer-review for „Applied Optics“, “JOSA A”, “Optics Letters” “Optics Express” and “Journal of Pure and Applied Optics”
- Reviewer for „National Research Foundation South Africa“

10. 4. Institute of Applied Physics

Peer review work, memberships

Prof. Dr. A. Tünnermann

- Council member of the Faculty
- Member of program committee „Optische Technologien“, BMBF
- Member of the VDI / VDE-GMA Advisory Board FB 8 "Optical Technologies of the Society for Measurement and Automation"
- Board of trustees MPA, Heidelberg
- Board of trustees MPQ, Garching
- Board of trustees IOM, Leipzig
- Chairman „AG Naturwissenschaften“, Wissenschaftliche Gesellschaft Lasertechnik
- Spokesman Abbe Center of Photonics, FSU Jena
- Editor Applied Physics B
- Stakeholder Photonics 21-Plattform
- Member of the steering committee Fraunhofer Gesellschaft
- Member of the technical council Fraunhofer Gesellschaft
- Member of the executive Board OptoNet e. V.
- Referee for several scientific journals

Prof. Dr. S. Nolte

- Conference Chair of the SPIE Photonics West Conference "Frontiers in Ultrafast Optics: Biomedical, Scientific and Industrial Applications (LASE)"
- Person responsible for EU-US Atlantis Program, Cooperation in higher Education and Training, „MILMI“ - International Master Degree in Laser, Material Science and Interaction, Univ. BORDEAUX (France), FSU Jena, Univ. Central Florida und Clemson Univ. (USA)
- Chair of the Faculty´s Budget Commission and member of the Budget Board of the Senate
- Member Optical Society of America (OSA)
- Member of Deutsche Physikalische Gesellschaft (DPG)
- Member of Scientific Committee “Lasers in Manufacturing (LIM)”, 2015

- Member of SPIE
- Coordinator of the BMBF Association "Ultrashort Pulse Laser for High Precision Machining"
- Referee for several scientific journals
- Member of jury “Jugend forscht”

Prof. Dr. T. Pertsch

- Vice Dean of the Faculty
- Council member of the Faculty
- Director of the Abbe Center of Photonics and member of its Executive Board
- Spokesman of the Abbe School of Photonics
- Spokesman of the research initiative "Photonic Nanomaterials PhoNa"
- Coordinator of the study program "Master of Science in Photonics"
- Fellow of the Optical Society of America
- Referee for several international journals
- Member of conference program committees: EUPROMETA doctoral school on "Photonic nanostructures and metamaterials," Jena, Germany, 2014 / OSA Optics & Photonics Congress: Advanced Photonics, Barcelona, 2014
- Local coordinator of Erasmus Mundus Program – NANOPHI – Nonlinear Nanophotonics

Prof. Dr. H. Gross

- Reviewer of the Baden-Württemberg Foundation
- Reviewer for Carl Zeiss Foundation
- Board of Trustees of Physics Journals
- Referee for several international journals
- Program committee for SPIE conference Optical Systems Design in Jena 2015

Prof. Dr. F. Wyrowski

- Member of the Technical Program Committee: OSA Conference on Digital Holography and Three-Dimensional Imaging
- Member of the Technical Program Committee: EOS Topical Meeting on Diffractive Optics
- Referee for several scientific journals
- Study Advisor of the Faculty of Physics and Astronomy
- President of the Light Trans GmbH
- President of Wyrowski Photonics UG
- Visiting Professor at the Chinese Academy of Science, China
- Visiting Professor at the Institute of Technology (HIT), China
- Conference Co-Chair: SPIE Conference on Optical Modelling and Design
- Member of the Technical Program Committee SPIE Conference on Optics and Photonics for Information Processing
- Member of the Technical Program Committee: SPIE Conference on Modeling Aspects in Optical Metrology

Jun.-Prof. Dr. J. Limpert

- Member of the Program Committee SPIE Photonics West Conference "LASE 2014"
- Referee for several scientific journals
- Member of the Program Committee High-Power, High-Energy, and High-
- Intensity Laser Technology
- Member of the Program Committee International Ultrafast Optics Conference

Jun.-Prof. Dr. A. Szameit

- Program committee for CLEO/QELS conference FS5: Nonlinear optics and novel phenomena
- Member Optical Society of America (OSA)
- Member of Deutsche Physikalische Gesellschaft (DPG)
- Referee for several scientific journals, including Nature, Nature Photonics, and Nature Physics

Dr. E.-Bernhard Kley

- Member of the Program Committee SPIE Photonics West Conference "Advanced Fabrication Technologies for Micro / Nano Optics and Photonics"
- Member of the Program Committee SPIE Photonics West Conference "High Contrast Metastructures"
- Member of the GMM-Technical Committee meeting FA 4.7 Micro-Nano Integration
- Referee for several scientific journals

Dr. U. Zeitner

- Workshop “Centre for Innovation Competence ultra optics”, March 2014 (Organizer)
- Member of the Program Committee EOS Topical Meeting “Diffractive Optics”, part of EOS Annual Meeting 2014
- Referee for several scientific journals

Dr. F. Schrempel

- Council member of the Faculty
- Coordination of the Institute of Applied Physics at the Beutenberg Campus e.V.
- Referee for several scientific journals

10. 5. Institute of Solid State Physics

Reviewer duties, membership in committees, etc.

Prof. Dr. Torsten Fritz

- Director of the Institute of Solid State Physics
- Deputy member of the faculty board
- Reviewer for several scientific journals (Nature Materials, Phys. Rev. Lett., Phys. Rev. B, Appl. Phys. Lett., Organic Electronics, Advanced Materials, etc.)
- Reviewer for the Fonds zur Förderung der wissenschaftlichen Forschung (FWF), Österreich
- Reviewer for the Deutsche Forschungsgemeinschaft (DFG), the Deutschen Akademischen Austauschdienst (DAAD), for the Studienstiftung des deutschen Volkes e.V., and for the Friedrich-Ebert-Stiftung e.V.
- Editor of "Datasets in Physics"
- Member of scientific societies: Deutsche Physikalische Gesellschaft (DPG), Deutscher Hochschulverband (DHV)

Prof. Dr. Carsten Ronning

- Speaker of the DFG research unit FOR1616
- Member of the faculty board
- Member of the committee for student issues
- Member of hiring committees
- Reviewer for scientific journals (Nature Communication, Nano Letters, Phys. Rev. Lett. , Appl. Phys. Lett., Nanotechnology, Thin Solid Films, etc.)
- Reviewer for funding agencies: Deutsche Forschungsgemeinschaft (DFG), Deutscher Wissenschaftsrat, National Science Foundation (NSF, USA), Humboldt Stiftung, etc.

- Member of scientific societies: Deutsche Physikalische Gesellschaft (DPG), Materials Research Society, USA (MRS)

Prof. Dr. Paul Seidel

- Member of the „Studienkommission Physik“, the „Prüfungsausschuss Materialwissenschaft“ and the teacher educational board
- Referee for Supercond. Sci. Technol., Physical Review, Appl. Phys. Lett. , J. Appl. Phys.
- Referee for different organizations, e.g. DFG, DAAD, AvH Stiftung, Carl Zeiss Stiftung, BMWT, EURONORM
- Board member of the European Society of Applied Superconductivity
- Co-editor of „Jenaer Beiträge zur Geschichte der Physik“
- Deputy head of the Alumni association of the PAF
- Board member of international conferences (ISS 2014 in Tokyo, KRYO 2014 in Berlin)
- Member of scientific societies: Deutsche Physikalische Gesellschaft (DPG), Materials Research Society, USA (MRS)

Prof. Dr. Elke Wendler

- Member of International Committee of „Radiation Effects in Insulators“ (REI)
- Member of International Committee of “Ion Beam Modifications of Materials” (IBMM)
- Member of Advisory Board of journal Nuclear Instruments and Methods in Physical research (B)
- Referee for Nucl. Instr. and Methods, Physical Chemistry Chemical Physics, Physica Status Solidi B, Vacuum
- Reviewer for National Research Foundation of South Africa (one project, one person)

Prof. Dr. Frank Schmidl

- Member of the teacher educational board
- Deputy head of the panel steering the natural science education of medical students (dentists)

Dr. Claudia S. Schnohr

- Member of the council of the institute
- Member of the committee *Career paths for postdocs*
- Reviewer for scientific journals (European Physical Journal B, Thin Solid Films, Vacuum)
- Member of scientific societies: Deutsche Physikalische Gesellschaft (DPG), Komitee Forschung mit Synchrotronstrahlung (KFS), International X-Ray Absorption Society (IXAS), Materials Research Society, USA (MRS)

Dr. Ronny Nawrodt

- Member of the faculty board
- Member of the evaluation committee
- Member of the exam committee for medical students (dentists)
- Referee for scientific journals (e.g. Cryogenics, Class. Quantum Grav., J. Appl. Phys., New J. Phys., Appl. Phys. Lett., Optics Letters, Optics Express)

Dr. Cornelia Jäger

- Reviewer for the Deutsche Forschungsgemeinschaft (DFG)
- Reviewer for various professional journals (such as Astrophysical Journal, Astronomy and Astrophysics)
- Guest editor for Planetary and Space Science
- Member of the program board of the DFG priority program “The Physics of the Interstellar Medium”
- Member of the scientific organization committee of the ‘’The 7th meeting on Cosmic Dust‘‘, Osaka, August 2014)

Matthias Thürk

- Referee for DFG, DKV, Cryogenics

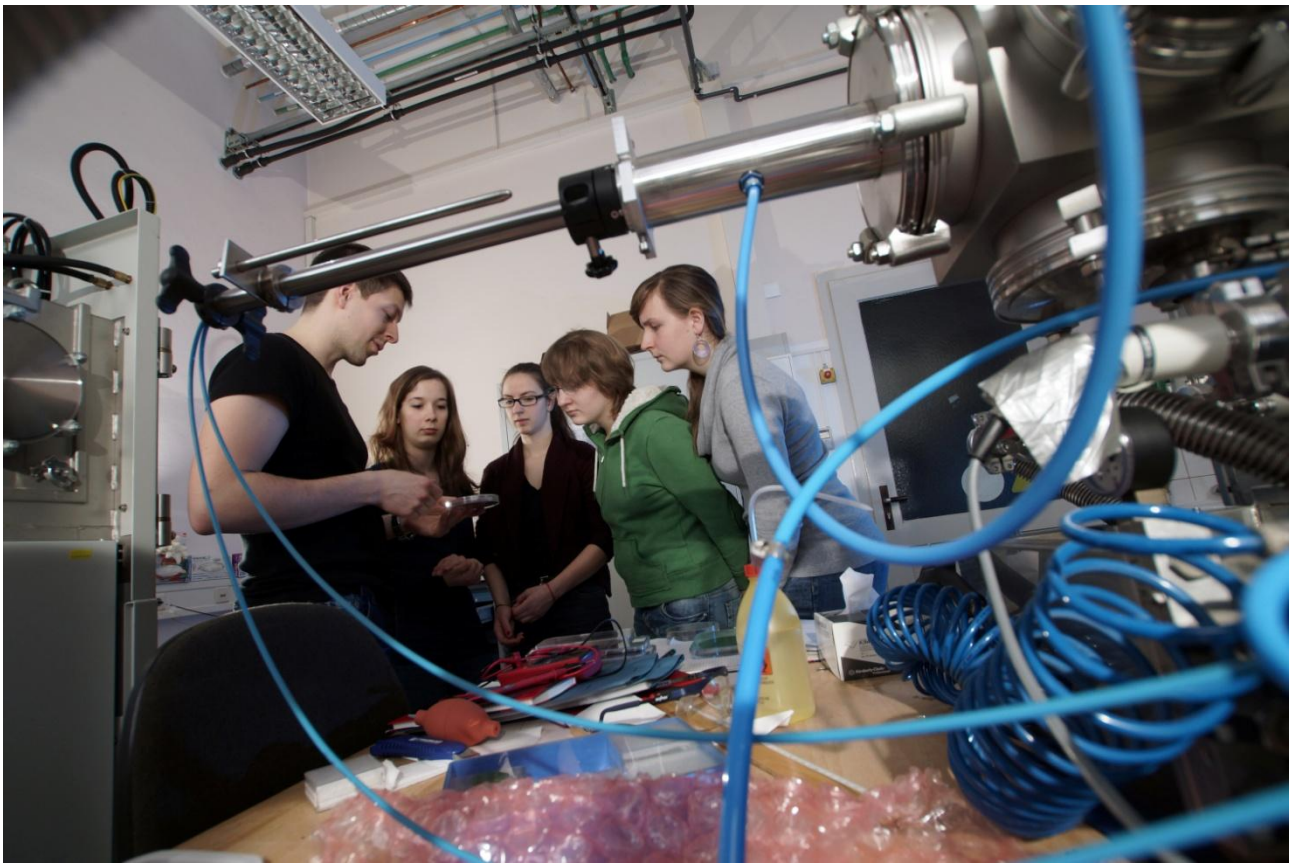
Ralf Neubert

- Deputy member of the faculty board

Support of schools and girls

Prof. Dr. Elke Wendler

- Workshop „Physik für Schülerinnen“ 17. - 20. February 2014,
  concept and organisation with Dr. Angela Unkroth
- GirlsLab – project for school girls from grade 5 forcing natural sciences and technics,
  Abbe-Gymnasium Jena-Winzerla, concept and organization with Dr. Silvana Fischer



During the workshop "Physik für Schülerinnen" the supervisor of the project "Wie kommt die Sonnenenergie in die Steckdose?", Sven Schönherr, shows schoolgirls the laboratory of the photovoltaic group.

Dr. R. Nawrodt, Dr. C. Schwarz

- Introductory lecture „Low Temperatures“ at the Gymnasium Lauterbach
- Lab tours dedicated to school classes

Dr. D. Heinert

- Physics labs for pupils from the Carl-Zeiss-Gymnasium Jena

Prof. Dr. P. Seidel

- Referee of a „Seminarfacharbeit“ at the Carl-Zeiss-Gymnasium Jena

R. Neubert

- Girls Day 2014
- Experiments at the open day at the Talschule/Jena

Prof. Dr. F. Schmidl

- Introductory lecture „Superconductivity - research and application“ at the Gymnasium Sondershausen
- Introductory lecture „Superconductivity” 50years Carl Zeiss Gymnasium Jena
- Introductory lecture „Superconductors – from basics to application“ 20 year Osterlandgymnasium Gera

10. 6. Institute of Solid State Theory and Optics

Engagement in institutions of academic self-administration

Prof. Dr. Falk Lederer:	Speaker of the Abbe School of Photonics, member of the board of the Abbe Center of Photonics, speaker of the priority program Optics and Photonics of the FSU
Prof. Dr. Friedhelm Bechstedt:	Director of the institute
Prof. Dr. Ulf Peschel	Director of the institute, member of the board of the Erlangen Cluster of Excellence Engineering of Materials (EAM), member of the board of the Erlangen Graduate School of Applied Optical Technologies (SAOT).
Prof. Dr. Silvana Botti	Editor for European Physics Journal B, Member of the committee of experts of GENCI (Grand Équipement National de Calcul Intensif), Member of the evaluation committee of the FRQNT “Fonds de recherche du Québec – Nature et Technologie” (Comité 918C Physique Matériaux C), Co-chair of the management board of the European Theoretical Spectroscopy Facility (ETSF) infrastructure

Other activities (referee, committee memberships,…)

Prof. Friedhelm Bechstedt

- Referee for different science organisations DFG, NSF, MIUR, ANR, etc
- Referee for many journals (z.B. PRL, PRB, Nature Materials)
- Advisory Committee 12th Int. Conf. Atomically Controlled Surfaces, Interfaces and Nanostructures, Tsukuba, 2013
- Organizer CECAM Workshop “Calculation of Optical Properties of Nanostructures”, Lausanne, 2013
- Steering Committee 14th Int. Conf. Formation of Semiconductor Interfaces, Gyeongiu 2013
- Organization Committee of 10th Int. Conf. on Optics of Surfaces and Interfaces, Chemnitz 2013
- Member of Advisory Board FHI-MPG Berlin
- Member of Advisory Board Int. Max Planck Research School of Surface Science
- Beamline Review Panel of BESSY II

Prof. Falk Lederer

- Topical Editor Optics Letters
- Referee for different scientific journals (e.g. Nature, Nature Physics, Nature Photonics, Nature Materials, Physical Review Letters)
- Referee for different science organisations (DFG, Humboldt foundation, EPSRC, NRC, FOM Netherlands)
- Member of the advisory board of the Fraunhofer IOF Jena

Prof. Ulf Peschel

- Referee for different scientific journals (e.g. Nature Physics, Nature Photonics, Physical Review Letters)
- Referee for different science organizations (DFG, GIF, EPSRC)

Prof. Silvana Botti

- Referee for different scientific journals (e.g. Physical Review Letters, Physical Review B, Journal of the American Chemical Society, Journal fo Chemical Physics, Applied Physics Letters, Journal of Applied Physics, ACS Nano)
- Referee for different science organizations (Research National Agency (ANR) of France ,DFG, Fund for Scientific Research of Belgium)

Prof. Stefan Skupin

- Referee for international journals Phys. Rev. Lett., Phys. Rev. A, Opt. Lett., Opt. Express, J. Opt. Soc. Am. B
- Referee for EPSRC

Dr. Jürgen Furthmüller

- Referee for Phys. Rev. Lett., Phys. Rev. B, APL

Dr. Oleg Egorov

- Referee for international journals Opt. Express, Opt. Lett.

10. 7. Otto Schott Institute of Materials Research

Reviewing activities, Committee work , Collaboration in program committees of international conferences

Prof. Dr. M. Rettenmayr

- Member of faculty council
- Editor: Journal of Crystal Growth
- Editorial Board: Practical Metallography
- Member of the DFG-funded excellence graduate school Jena School for Microbial Communications (JSMC)
- Chairman of the panel of experts of DGM ”Materialography“
- Reviewer: Acta Materialia, Surface Science, Journal of Crystal Growth, Materials Science and Engineering, Materials and Metallurgical Transactions, International Journal of Materials Reserach, Journal of Materials, etc.
- Reviewer: DFG, DAAD, further national research associations (Austria, Czech Republik)

Prof. Dr. K. D. Jandt

- Deputy member of the faculty council of the Faculty of Physics and Astronomy, FSU Jena
- Editorial boards: Colloids and Surfaces B: Biointerfaces, Elsevier; Acta Biomaterialia, Elsevier; Dental Materials, Elsevier; Advanced Healthcare Materials, Wiley-VCH; Advanced Engineering Materials, Wiley-VCH; Hacettepe Journal of Biology and Chemistry
- Member of the board of the German Materials Society (DGM) Executive Committee
- Scientific spokesman for all DGM-Panels of Experts
- Member of the advisory board of the German Materials Society (DGM)
- Member of the DFG-funded excellence graduate school Jena School for Microbial Communications (JSMC)
- Founder and chairman of the panel of experts "Biomaterials" of the German Materials Society (DFG)
- Founder and chairman of the "Jena Organization for Biomaterials (JOB)"
- Reviewer for Nature Materials; ACS Nano; Journal of Materials Science; Journal of Materials Science - Materials in Medicine; Macromolecules; Biomacromolecules; Chemistry of Materials; Biomaterials; Dental Materials; Advanced Engineering Materials; Langmuir; Journal of Applied Polymer Science; etc.
- Reviewer for the German Research Foundation (DFG); European Social Fund (ESF); European Research Council (ERC); Alexander-von-Humboldt-Foundation; European Science Foundation; European Commission; Engineering and Physical Sciences Research Council (EPSRC), GB; Biotechnology and Biological Sciences Research Council (BBSRC), GB; Medical Research Council (MRC), GB; National Institutes of Health (NIH), USA; etc.

Prof. Dr. Frank A. Müller

- Member of the Faculty Council of the Faculty of Physics and Astronomy
- Chair of the examination committee (Materials Science)
- Reviewer: DFG
- Reviewer: ACS Appl. Mater. Inter., Acta Biomater., Ceram. Int., Cryst. Growth Des.,
- Editorial Board Member: Journal of Biomaterials Applications
- Organizer of the 3rd International MPSL Symposium, April 2014, Berlin, Germany

Prof. Dr. M. Sierka

- Deputy member of the academic Senate of Friedrich Schiller University Jena
- Chair of the examination committee (Materials Science)
- Coordinator of the study program (Materials Science)
- External member of the Center of Computational Sciences Adlershof in Berlin
- Reviewer: Angewandte Chemie International Edition, Journal of Chemical Physics, Journal of Physical Chemistry, Physical Chemistry Chemical Physics, Journal of Computational Chemistry, Nanoscale, Physical Review B, Nature Communications

AOR PD Dr. J. Bossert

- Reviewer for Acta Biomaterialia; Advanced Engineering Materials; Journal of the American Ceramic Society; Fuel; Surface Science; Journal of the European Ceramic Society, Composites Part A: Applied Science and Manufacturing; Materials Letters
- Reviewer for the Latvian Science Council
- Head of the group „Antimicrobial Materials" of the DGM-technical committee biomaterials

Work with high school students

- „jun.iversity" summer school for talented high school students, age range 10-17 years, Otto Schott Institute of Materials Research, Jena, Germany (01.08.2014)
- Introduction to materials science at the fair „Composites Europe 2014, Gemeinschaftsstand Forschung für die Zukunft", Düsseldorf, Germany (7-9.10.2014)

- A talk “Funktionelle Polymere: Eigenschaften nach Wunsch“ during the school festival for high school students of all grade levels at the “Osterlandgymnasium Gera”, Germany (02.10.2014)
- Orientation workshop for high school students in the study orientation of the central student counseling (08.10.2014)

10. 8. Institute of Optics and Quantum Electronics

Reviewing activities, Committee work , Collaboration in program committees of international conferences

Prof. Dr. G. G. Paulus

- Member of the board of directors of HI Jena
- Member of the Scientific Advisory Committees of
  CILEX-APOLLON, Frankreich
  ELI-ALPS, Ungarn
  CLPU, Spanien
- Member of the Visiting Committee of Laser MegaJoule, APPOLLON and Atto
- Member of the Program Committees of the conferences ATTO and ISUILS

Prof. Dr. Ch. Spielmann

- Member of the board of Abbe Center of Photonics
- deputy speaker of the Abbe School of Photonics
- Speaker of the Graduiertenkolleg “Advanced Photon Science”, HI Jena
- Member of the curatorship of the Fraunhofer Institute IOF
- Member of the advisory committee of the Leibnitz Institut für Photonische Technologien
- Chair of the Ultrafast Optical Phenomena Technical Group in the Optical Interaction Science Division of the Optical Society of America (OSA)
- Member of the Editorial Board of the following international Journals: Nature Scientific Reports (Nature Publishing Group), Dataset Papers in Optics (open access), Conference Papers in Physics (open access)
- Reviewer for international Journals and research funding organisations

Prof. Dr. M. C. Kaluza

- Reviewer for the following Journals:
  Physical Review Letters
  Physical Review E
  Physics of Plasmas
  New Journal of Physics
  Physical Review Special Topics – Accelerators and Beams
  Nature Physics

Prof. Dr. Th. Stöhlker

- Director of the Helmholtz Institute Jena, deputy research director GSI Darmstadt, speaker of the program topic of the Helmholtz programme “Matter and Materials and Life”
- Science Council IMP, Lanzhou, China; Science Council Extreme Matter Institute, Darmstadt, Germany
- International advisory board of the ICPEAC 2013 conference; international advisory board of the HCI 2014 conference, international advisory board of the STORI 2014 conference, advisory board of EBIST conference 2014
- Member of the international board of the SPARC collaboration
- Member of the international board of the FLAIR collaboration
- Member of the Board of Editors of the *European Physical Journal D*

Prof. Dr. E. Förster

- Reviewer for international Journals

Prof. Dr. A. Pfeiffer

- Reviewer for the following Journals:
  Scientific Reports
  Journal of Physics B: Atomic, Molecular and Optical Physics
  Physical Review Letters
  Nature Physics

10. 9. Institute of Theoretical Physics

Expert activities, commitee works, participation in the program committees of international conferences

Prof. M. Ammon

- Referee for various international journals
- Referee for Alexander-von-Humboldt foundation, for Studienstiftung des deutschen Volkes and for Swiss National Science Foundation
- Organisation of the spring school "Perlen der theoretischen Physik"

Prof. M. Ansorg

- Member of Councel of the DPG (since Oct. 2012)
- Board Member of the FV Gravitation und Relativitätstheorie of DPG
- Reviewer for international journals.

Prof. B. Brügmann

- Board Member of the FV Gravitation und Relativitätstheorie of DPG
- Board Member of the Committee of the International Society of General Relativity and Gravitation
- Editorial Board of Living Reviews in Relativity
- Counsel of the Faculty
- Referee for international science foundations and international scientific journals and publishers
- Organizing Committee: Workshop Programming of Heterogeneous Systems in Physics, Jena, 14-15 July 2014
- Chair of Organizing Committee: Conclusion Workshop of SFB/TR7 "Gravitational Wave Astronomy" Jena, Germany, December 1 - 5, 2014.

Prof. S. Fritzsche

- Principal Editor of Computer Physics Communications
- Board Member of the International Program Committee of the Int. Conference on Atomic & Molecular Data and Their Applications
- Reviewer for Science Organizations and international journals
- Reviewer of the Project Review Panel PRP1 "VUV- and soft X-ray" at PETRA III at DESY, Hamburg.

Prof. H. Gies

- Member of the extended Directorate Helmholtz Institute Jena (HI Jena)
- Counsel of the Faculty
- Senate of FSU Jena
- Referee for international science foundations and international scientific journals and publishers.

Dr. A. Maas

- Organization "Bound states in and beyond the standard model“ 2015 in St. Goar (together with Profs. Fischer, Univ. Giessen, and Ryan, Univ. Dublin)
- Reviewer for Mathematical Reviews
- Reviewer for Science Organizations and international journals

Prof. R. Meinel

- Deputy Member of Counsel of the Faculty
- Reviewer for Science Organizations and international journals.

Prof. Schäfer (retd.)

- Director of DPG Physics School on General Relativity @ 99, Bad Honnef
- Chairman Scientific Advisory Board of Physikzentrum Bad Honnef.

Prof. Wipf

- Director of the TPI
- Speaker of the Research Training Group “Quantum and Gravitational Fields”, GRK 1523
- Member of Council of the Faculty
- Board Member of the FV Theoretische und Mathematische Grundlagen der Physik of the DPG
- Board member of Graduate Academy at FSU Jena
- Member of Honorably Advisory Board of Annalen der Physik
- Co-Organisator of the W.E. Heraeus Summer School "Saalburg" for Graduate Students on "Foundations and New Methods in Theoretical Physics", 2 weeks in September
- Reviewer for Science Organizations and international journals.

10. 10. Research Group - Teaching Methodology in Physics and Astronomy

Expert activities, commitee works, participation in the program committees of international conferences

Prof. Dr. K.-H. Lotze

- Dean of Students
- Member of the editorial board of the Journal „Astronomie + Raumfahrt im Unterricht"
- Board Member of the "Studium Generale" at FSU Jena
- Coordinator of the project „Schüler an der Universität“ of the MINT faculties of the FSU Jena

Dr. Silvana Fischer

- Member of the Study Commission of the PAF
- Deputy equal opportunities representative of the PAF
- Member of the working group "Physical Laboratory" (DPG) and its comission for teaching materials
- Working group "Praxissemester"

Stefan Völker

- Member of the Board of education of the Astronomical Society

Support of schools and school students

- Experiment days with school classes (mostly grade level 10-12), more than 290 school students
- Future Day (Girls Day) at FSU Jena
- Girls Lab at the Ernst-Abbe Gymnasium Jena (supervised exclusively by student teachers, project on criminology)
- Preliminary works for the setup of a school student lab: build up a large database of experimental setups for schools
- Workshop within the jun.iversity program „Vom Fallgesetz zur Schwerelosigkeit“
- Station with experiments at the "Long Night of Sciences" in the Talschule Jena
- Presentation of the school students lab and other support for school students at the WITELO marketplace (June 5th, 2014)

Girls Lab: Project on Criminology

11. Central Institutions of the Faculty of Physics and Astronomy

11. 1. Branch Library Physics of the Thüringer Universitäts- und Landesbibliothek

Although the library budget was not adequate to compensate the annual rise in prices, it was possible to keep up the good offer of information of the Faculty of Physics and Astronomy.
It was possible to avoid cancellation of journals or data base. However, because of the difficult financial situation, it was not possible to license the Springer E-Book Collection in 2014.

With the start of fall semester 2014 the new "ThULB Suche" was activated. By using the query mask at ThULB homepage (http://www.thulb.uni-jena.de/), it is now possible to search simultaneously in the library holdings (OPAC) and in numerous data bases and E-journals licensed by the library as well as in open access sources.

To impart information literacy, the ability to know when there is a need for information, to be able to identify, locate, evaluate, and effectively use that information for the issue or problem, several training courses were carried out. For new enrolled students seven introductory courses for using the library with altogether 89 people were realized.
The course "Vom Thema zur Literatur" is still an integral part of the course "Biomaterialien und Medizintechnik" for students in the field of materials science (5th semester).

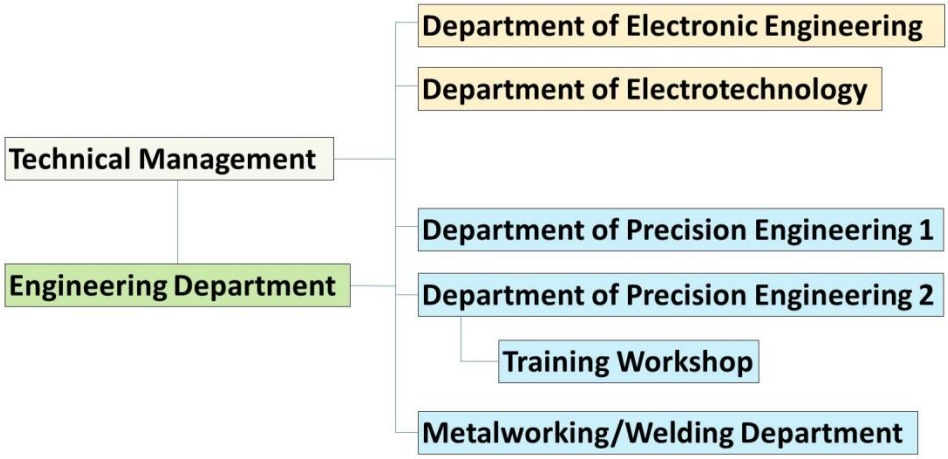
In the Departmental Library Physik 4073 borrowing and 6184 users of the library were registered.

Reading room of the branch library physics

11.2. Scientific Workshops of the Faculty of Physics and Astronomy

The Scientific Workshops of the Faculty of Physics and Astronomy fulfill a central function as technical backup for research and teaching of the institutes and for central service units. The workshops are organized in a separate entity. They are headed by the Technical Manager who is directly responsible to the Dean.

Structure:



Their responsibilities range from planning, development, and construction of devices and equipment , teaching and demonstration models to installation of experimental facilities for research, including commissioning, maintenance, and repair. This requires to work not only service-oriented, but also to be involved directly in research and teaching. These activities are accompanied by an own internal cash flow, inventory management, cooperation with external contractors, and vocational training.

In addition, there will be provided service to other faculties and institutions of the university according to the available capacity.

Getting a new order, the technological procedure is fixed after consultation with the Technical Management, the Engineering Department, and the managers of the departments.
In case of extensive projects, cost estimate is submitted to the sponsor, cooperation alternatives are compared and first quotations on necessary material and standard parts are requested.
The orders are settled according to a system that distinguishes between costs incurred in teaching or research (financed by budget or third party funded).
The cost-effectiveness of each order is checked.

Stuff 2014

January 2014: in total 35 employees, in which 8 engineers, 7 masters, 20 skilled workers
December 2014: in total 34 employees, in which 8 engineers, 7 masters, 19 skilled workers

This stuff development is a result of termination of 4 employment contracts (1 skilled worker, 1 engineer - retirement, 1 skilled worker – end of the contract, 1 skilled worker – cancellation agreement) and conclusion of 3 new employment contracts (2 skilled workers –in-house training, 1 skilled worker – external advertisement). It is very enjoyable that one skilled worker received qualification for engineer.

The number of employees includes also 6-8 apprentices who get their training in the Training Workshop for industrial mechanics 2.

Departments of the Scientific Workshops

Department of Precision Engineering 1 and 2 (17 coworkers, in which 1,25 third party funded)

The tasks of the Departments of Precision Engineering include planning, development, construction, maintenance and repair of devices and experimental equipment for teaching and research. Depending on

the scale and complexity, the drawing and engineering documents are prepared by the Engineering Department or the managers respectively coworkers of the other departments.
Among conventional manufacturing methods (turning, milling, grinding, drilling, sawing, etc.) 4 universal-purpose CNC milling machine, 1 CNC lathe and 3 digitally controlled screw cutting and bar lathes are available. A cycle controlled lathe was financed by the Helmholtz Institute Jena. Furthermore, 6 conventional lathes were overhauled financed by central funds of the faculty.
These investments provide possibilities for an excellent manufacturing and the basis for creation of complicated shapes.

Dimensions able to be machined are:

- Turning operations up to Ø 500 x 1000 mm
- Milling operations up to 600 x 400 mm
- Honing operations up to 400 x 300 mm
- Drilling operations up to Ø 40 mm
- Engraving works, as well as laser engraving up to 18 mm

For the construction of equipment for application in laser, low temperatures and astrophysics requires essentially the use of non-ferrous metals, Cr-Ni metals, special materials (molybdenum, tantalum, titanium, tungsten, and ceramics) and all kinds of substitute materials.
The CNC milling machines FP 2a, MH 600, DMU 50T, DMC 635, the CNC turning machine CTX alpha 300 and the cycle controlled lathe Weiler C30 allow to meet the increasing requirements in the physics research and to manufacture not only complicated individual parts but also small series of high precision.


Department of Precision Engineering 1


Department of Precision Engineering 1

Metalworking/Welding Department (3 coworkers)

Coworkers of this department carry out especially works on the production of systems with high vacuum and ultrahigh vacuum vessels, on the construction of equipment systems and large parts (turned parts Ø 500 x 1000, sheet metal parts 1000 x 2000). Therefore, modern welding technology and equipment (tungsten inert gas (TIG), CO2 and electric welding) are applied. There are 2 working areas with transportable extraction unit to carry out welding operations. Steels of all grades, stainless steels (CrNi), non-ferrous metals and plastic materials are machined. Procedures for thermal and surface treatment (Glass bead and sand blasting) are also used. Manufacturing of vacuum and ultrahigh vacuum welded joints by TIG welding technology up to 250A is essential for the research.

Training Workshop (1 trainer, 6 apprentices at present)

The practical part of the three-and-a-half years' vocational training is carried out at the Department of Precision Engineering 2, the theoretical part at the Vocational Training Centre Jena Göschwitz. In addition, the apprentices follow training courses: CNC basic course, basics of welding technology, pneumatics basic level.

The training comprises construction and maintenance of precision mechanical devices (adjustment, measuring, weighing, counting devices), as well as of optical and medical equipment.

After 6 months of initial training, the apprentices carry out parts of current orders for teaching and research. The knowledge gained by this way enter the training.

Metalworking/Welding Department

Training Workshop

Department of Electronic Engineering (8 coworkers)

The main tasks of this department consist of development and construction of commercially unavailable special electronic devices and equipment using analogue, digital, high voltage or measurement, engineering, control technology. The spectrum ranges from small additional devices, high precision positioning and drive systems, special measuring instruments, power supplies for high power to completely computer-controlled systems. These works range from development of a concept in cooperation with the scientists, a circuit, and PCB layouts at modern CAD workplaces to the configuration of modules, as well as the completion, commissioning and testing of the devices.

The tasks of the department include also repair work on electronic devises and equipment, as well as on computer hardware.
Furthermore, the department takes over the technical assistance in the context of research and examination projects. Its tasks include the maintenance and extension of existing data networks in the buildings of the faculty, as well as the procurement and storage of electronic components.

Department of Electronic Engineering

Department of Electrotechnology (4 coworkers)

The tasks of the department include the development and configuration of special electrical components and experimental facilities, as well as the conversion of electrical equipment in research laboratories and for practical courses. Furthermore, the department carries out planning and technical realization of new and extension installations of entire laboratory areas and areas for practical courses. In addition, it is responsible for the mandatory inspection of all electrical devices and equipment according to DIN VDE.

Department of Electrotechnology

Engineering Department with new printing technology

Engineering Department (2 coworkers)

The tasks of the department consists of development and engineering of different components up to large-scale experiments. The documentation is prepared in close contact with the scientists up to production stage and is passed on to manufacturing at the faculty's workshops or to cooperation partners. This procedure covers also the determination of the input of material, components and standard parts, including offer, order und procurement.

Issues and projects

It would go beyond the scope to list all issues and projects whose technical basis was provided by the Scientific Workshops. The examples here are just a small selection of research projects in 2014:

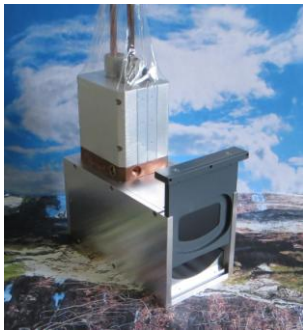
Camera splitter

Ion beam source

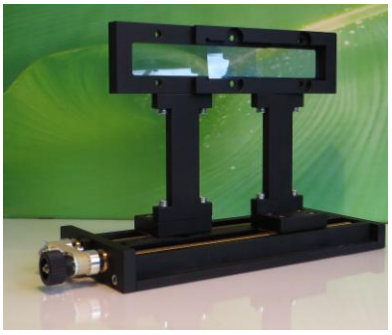
Peltier Controller

Shutter Controller

Steerer Controller

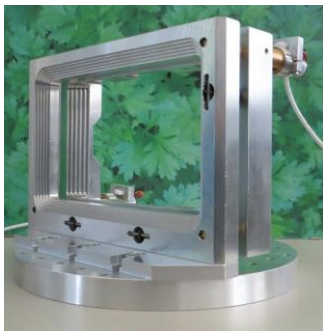


Cool camera body

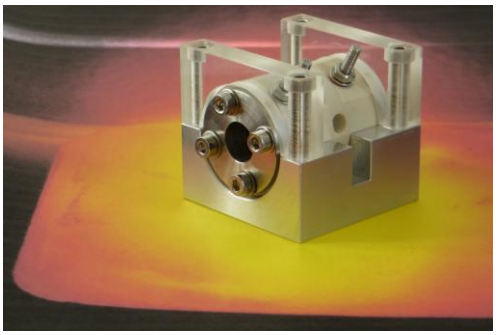


Peltier Controller

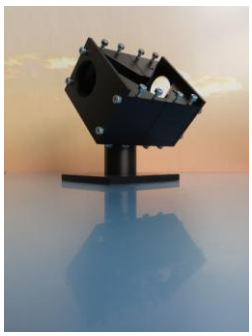
Mirror bender



Mirror support

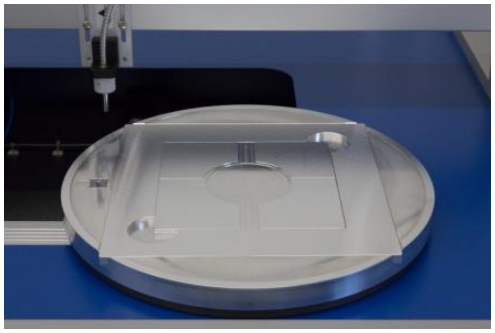


Steerer Controller



Polarization rotator

VMI device



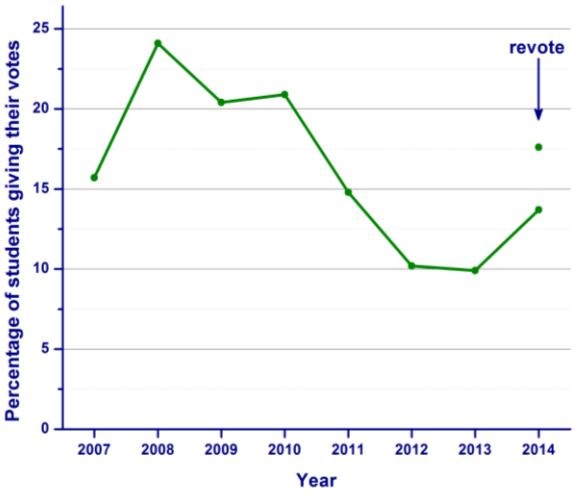
Layer thickness measuring station

Layer thickness measuring station

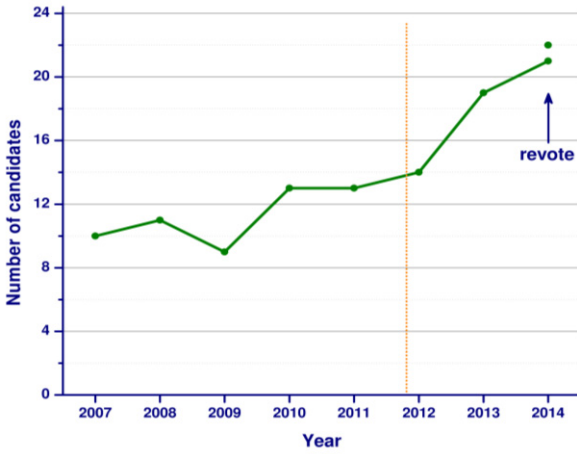
11. 3. Student Council (Fachschaftsrat, FSR) of the Faculty of Physics and Astronomy

The FSR and what we do

The student council of the Faculty of Physics and Astronomy – referred to as FSR (for "Fachschaftsrat") – is a group of 15 students, elected each year. There were 21 students standing for election in 2014, and about 14% of the PAF student body were giving their vote. As one can see in the two graphs below, the relative number of voters slightly increased in comparison to the past two years. Besides, we notice the strictly rising number of candidates, giving us hope for the future to achieve a larger recognition of our work among the student body.



Percentage of students giving their votes in FSR election over the past eight years.



Number of candidates over the past eight years. In 2012 (orange dashed line) we set the number of members from nine to fifteen.

Because of some contradictions between our electoral rules, determined by the student body in December 2013, and the regulations of the university student council we had to repeat 2014's election, and the constitution of the new FSR had to be shifted to January 2015. Unfortunately, it is not possible to include a quotation for teaching degree, material science and B.Sc. students. In the following we list the names of old and newly elected members of the PAF student council.

Members in 2013/14:

- Eric Abraham
- Tim Barth (until Nov. '14)
- Nils Becker
- Eduard Betko
- Julius Biedermann (until Nov. '14)
- Sven Buder
- Hannes Damm (treasurer)
- Mark Kremer
- Hoàng Lê (until Nov. '14)
- Amadeus Müller
- Michel Pannier (chairman)
- Kevin Prast (until Nov. '14)
- Stephan Siewert (budget official)
- Sebastian Ulbricht
- Richard Wiedenhöft

Members since January 2015:

- Eric Abraham
- Nils Becker
- Eduard Betko
- Sven Buder
- Hannes Damm (treasurer)
- Annika Gambke
- Maximilian Keller
- Mark Kremer
- Silvia Kunz
- Lukas Jonas Maczewsky
- Michel Pannier (chairman)
- Stephan Siewert (budget official)
- Sebastian Ulbricht
- Richard Wiedenhöft
- Anna Katharina Wölfl

We are facing a large spectrum of responsibilities. A small overview of tasks is shown below:

A huge part of our work consists of communication with institutions of the faculty (such as the Dean's office, the Office for Student Affairs or "ProQualität Lehre" – especially the regular talks with the Dean have shown to be very fruitful for both of us) and sending student representatives to other councils (such as the university student council *StuRa*, the *FSR-Kom*, the council of the faculty or the committee for lecture evaluation). During the lecture period we coordinate our work in weekly sessions, open to public. Furthermore we offer two or more visiting times per week for students looking for advices or searching for old exams.

For further information (e.g. about our meeting and visiting times or upcoming events), questions or help, please contact us:

Mail	*fsr@paf.uni-jena.de*
Phone	*03641/9-47095*
Web	*www.fsr.uni-jena.de*
Facebook	*Physikalisch-Astronomische Fachschaft Jena*

Lecture evaluation

Each semester the FSR organizes an evaluation of all lectures at the PAF (including several service courses of other faculties) in cooperation with the "Universitätsprojekt Lehrevaluation (ULe)". The evaluation aims the assessment of quality and professional level of the lectures seen by the viewpoint of students and gives rise for the lecturers to take a critical review of their teaching. At the same time it gives an orientation for students, for instance when choosing physical elective courses.

On basis of the evaluation the FSR gave the **student body teaching award** in winter semester 2013/14 to Prof. Frank Schmidl for his lecture in physics for medical and dentistry students ("Physik für Human- und Zahnmediziner"); additional acknowledgements for exceptionally good teaching were given to Jun.-Prof. Szameit and Dr. Undisz. In summer semester the award was given to Dr. Claudia Schnohr, whose lectures in nuclear physics ("Kernphysik"), as well as her seminars in experimental physics for biologists, chemists, … ("Experimentalphysik für Biologen, Chemiker, ...") achieved marvellous ratings.

The complete evaluation can be found at the Dean's Office, the physics library and the FSR office; moreover you will find it online via our website.

Orientation days for new students and "Ersti-Fahrt"

As every semester the FSR organized orientation days for new physics students (1st/2nd April & 1st-3rd October), offering introductions to study regulations, university life and *Friedolin,* as well as a city tour and visits of the institutes of the PAF. Unfortunately, we recognized an alarming small number of first semester students: 7 *B.Sc. in Physics* students in summer term (who actually appeared to the lectures – in fact there were 26 matriculations) as well as 33 *B.Sc. in Physics*, 27 *Teaching degree* and 14 *B.Sc. in Material Science* students in winter term. The reasons for this unexpected decrease might be the elimination of tuition fees in the western states, the results of the last CHE ranking, the decline of the birth rate or an insufficient marketing of our faculty.

New features since last winter semester are for one thing our own introduction course to *Friedolin,* and for another thing the brochure "Studienführer der Fachschaft Physik", which summarises most important information for the newcomers.

As every year, we also invited our new students for a weekend trip to Niederkrossen, called "Ersti-Fahrt", this year from 7th to 9th November.

ZaPF and BuFaTa MatWerk

The **meeting of all physics student bodies** (referred to as ZaPF for "Zusammenkunft aller Physik-Fachschaften") takes place every semester; this year the physics student bodies of Düsseldorf and Bremen organized the conferences in May and November. Of course we participated in both of them and joined work groups dealing with B.Sc. and Teaching degree programs of study, CHE ranking, budget cutbacks, system accreditation, communication to other student bodies, female quota and many other topics. Especially there was a discussion, initiated by members of our delegation, about the lowering of mathematical learning in the German Abitur and it's consequences for beginning physics students; it might be continued at the next ZaPF in May 2015 in Aachen.

Furthermore, we hosted the **meeting of all materials science and engineering technology student bodies** (referred to as BuFaTa MatWerk for "Bundesfachschaftentagung der Fachbereiche Materialwissenschaft/Werkstofftechnologie") from 27th to 30th November in Jena. Here public relations work and recruitment of new materials science students were crucial topics, especially concerning the work of the *jDGM* ("junge Deutsche Gesellschaft für Materialkunde"). Other issues, such as system and program accreditation or how to organize such a meeting, have been talked over, too. The next BuFaTa MatWerk will be in Karlsruhe.

Excursions, tournaments and events

This year the FSR organized two excursions. The **two-day trip to Frankfurt a. M.** from the 19th to 20th May included visits of the *Gesellschaft für Schwerionenforschung* (*GSI)* in Darmstadt, as well as the *European Space Operations Centre*; in Frankfurt there were guiding tours at *Evonik Industries*, the experimental hall of the university (where they do astrophysical experiments with neutron sources and develop particle accelerators) and *Continental AG* (including cruising on their test route). On the 5th December there was a **tour to Dresden** with the opportunity to visit the *Helmholtz-Zentrum Dresden-Rossendorf* (seeing their radiation source "ELBE" and some particle accelerators), as well as the *Leibniz-Institut für Festkörper- und Materialforschung*, including a ride on their magnetic levitation train. We are grateful for the financial help, coming from the *Alumni-Verein* and the *Deutsche Gesellschaft für Materialkunde (DGM)*!

The participants of the excursion on the Main Tower

We usually try to organize at least one sport tournament each semester, where the teams can compete with each other in either football or volleyball. On the 21st June we arranged a **football and table football tournament** in cooperation with the Math student council; of course the winner teams were happy to get some nice prices. Unfortunately, we were not able to find a sports hall for tournaments in winter 2014/15. However, finding a location for our **skat tournaments** was quite easy – the Quergasse No. 1 is always ready for us reserving a whole floor –, so we arranged two of them in January and June. Although the **"Bierathlon"** we set up for July was not well-attended, we might give it another try next summer.

A real highlight in 2014 was the **student-professors-meeting** on 26th June, where besides the usual culinary offerings (nitrogen-ice, sausages, beer, …) and the handover of the student body's teaching award, there was a public viewing of the world football championship match USA versus Germany in the Jenoptik lecture hall.

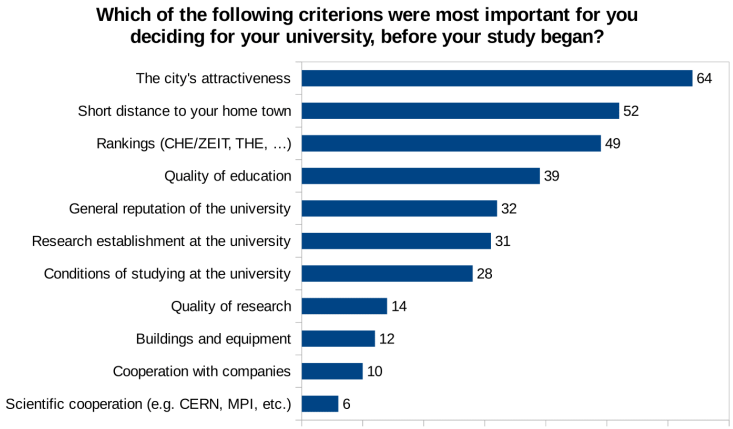
On the very beginning of the year, more precisely on 6th January, we had a famous guest for the **physical colloquium**: Prof. Dr. Harald Lesch talked about magnetic fields in galaxies and galaxy clusters ("Entstehung und Entwicklung von Magnetfeldern in Galaxien und Galaxienhaufen"). Following our suggestion to invite Prof. Lesch, the faculty had more guests than the lecture hall could hold.

At the end of the year we decided to enlarge our traditional **Christmas session**, combining it with the Christmas parties of the *OSA Student Chapter* and the *Abbe School of Photonics*. We look forward to stay in contact with both of them.

Of course there were some other parties this year in cooperation with the student councils of maths, chemists, biologists and SciTec (from the EAH), located in the *Rosenkeller* or the *F-Haus*.

Other matters

This year, thanks to financial help of the faculty, we were able to hire a student assistant to establish an **online library for lecture notes and old exams**. We are looking forward for the programming work to be finished during the current year.



An important matter was the ranking of the *B.Sc. in Physics* and *Teaching degree* programs of study by the *Centrum für Hochschulentwicklung (CHE)* in November 2014. The significance of the **CHE ranking** for the decision of beginning physics students, which university to take, is illustrated in the graphic on the right: In the underlying survey of ZaPF and jDPG, which was carried out by us and partly analysed before waiting for the final results coming up 2015, rankings were found to be the third most important reason to come to Jena (100 *B.Sc. in Physics* students were participating). Hence we worked out a presentation and visited some lectures to inform the involved students and motivate them to participate in the ranking. The results are planned to be published by the CHE in May 2015.

During winter term we had to face the results of a university-wide survey (“Zwischenbefragung”), revealing profound problems in our faculty's **teaching program of study**, especially an alarming dissatisfaction of the students with their workload. As a consequence work groups were established, dealing with the balance of theoretical and experimental physics, the quality and quantity of teaching methodology and practical matters, as well as the special role of the teaching program for regular school. Anyway, there is still a lot of work to do for next year.

Again, this year we arranged some **tutorials** for learning the proper handling of *LaTeX*, *Mathematica* and, for the first time, also *Python*. As usual these courses were well-attended and will be offered each year (at least the first two). Of course we also supported *ProQualität Lehre* in getting up tutorials for theoretical and mathematical lectures.

Keeping an eye on the decrease of mathematical knowledge of beginning physics students, we suggested to offer another course of about two weeks, starting in September, even before the actual mathematical course – so to say a **pre-course** for the pre-course. We assured the Research Group for Teaching Methodology of our help designing a proper table of content for this pre-pre-course.

To improve the effectiveness of the **lecture evaluation,** we finally re-designed our questionnaires, removing some less useful points, adding a few indicators, and formulating them as statements rather than questions. We are planning to make use of the new forms for the evaluation in the upcoming summer semester.

In 2014 we also did some work on our **office and the student's common room**. Now our walls appear to shine white again, the PAF logo decorates our office, and we added some kind of counter as well as a comfortable sofa to the common room.

Besides all this there were some other events, we supported this year. We would like to briefly mention the theoretical physics spring school (“Perlen der Physik”) in March, the “Hochschulinformationstag” and “Tag der Physik”.

11. 4. Alumni Association of the Faculty of Physics and Astronomy

The object of the association is to maintain and strengthen contacts between our graduates and former Faculty members and the Faculty, and to lend spiritual and financial support to the Faculty in the fields of teaching, science, research and the union of theory and practice. The association encourages contacts between present students and former graduates as well as students' visits to industrial enterprises, research labs and institutes in order to point out possible job placements after their studies. Our activities also keep alumni informed about new fields of research and priorities of the Faculty.

The association's affairs are governed by a set of rules. The annual general meeting on 12 December 2014 approved the committee's report and adopted the action programme for 2015. The meeting elected a new committee for the term until 2016.

As the association does not charge any regular membership fees, its activities are funded mainly by sponsors and donations. In particular, we wish to mention the sponsorship agreements with JENOPTIK AG and MLP and the longstanding patronage by Rohde & Schwarz of Munich. A new sponsorship agreement has been entered with PCE Instruments, covering the supply of measuring instruments for the Faculty's practical courses. Further incomes in 2014 resulted from the Job Fair organized by the association and from many individual donations. The association is an officially recognized non-profit organization and is entitled to write out receipts for donations.

A highlight in 2014 was the Alumni Day on 23 May. In a festive ceremony, graduates and newly qualified doctors received their certificates, and students and doctoral candidates were awarded the Faculty prizes donated by Rohde & Schwarz. The ceremonial address was given by alumnus Prof. Dr. Michael Kaschke, chairman of the Executive Board of Carl Zeiss AG.

The day before, a plaque was unveiled honouring Dr. Lothar Rohde and Dr. Hermann Schwarz, two famous alumni of the Faculty. In his speech, the latter's son Friedrich Schwarz reported on how the foundation of today's global player Rohde & Schwarz in Munich came about.

In 2014, the first Physics Day was held with the association's active help and financial support.

Hands-on experiments on the Physics Days

Our funds also went into supporting the workshop „Physics for schoolgirls", the annual student-professor dialogue, the event known as „The Dean informs" and into advertising the Faculty's public Saturday lecture, among other events. A substantial amount was spent to support a two-day student excursion to Darmstadt and Frankfurt.

12. Outlook

We hope that our "Annual Report 2014" documented the continuation of the positive general development of our faculty in the last year. Based on the many achievements in the structure of our faculty and its staff, the quality of our teaching program and our students, as well as our competitive research program and the subsequently attracted funding, we hope that this positive development will continue also in the future.

However, particularly because of our success in the past we are also facing major challenges in the future. Over the last years it became quite clear that the attained substantial growth of our faculty cannot be matched by an adequate increase of basic central resources of the university. Thus many new activities in research and teaching which we have established successfully based on the attraction of external third-party funding leave us with the problem of their sustainability. Consequently, the next years might require a process of strategic consolidation and concentration. Nevertheless, we are looking optimistically into the future and would like to sketch some of the specific developments which we anticipate for 2015.

First and most importantly, our faculty live is strongly connected to the development of the faculty's body, i.e. the opportunities arising from new appointments and the connected challenges resulting from the retirement or leave of precious colleagues. In 2014 we had been very successful in a number of important appointments: Silvana Botti (Professor for Theoretical Physics / Solid State Physics at the Institute of Solid State Theory and Optics), Ulf Peschel (Professor of Theoretical Physics / Solid State Optics at the Institute of Solid State Theory and Optics), and Matt Zepf (Professor for Laser Particle Acceleration at the Helmholtz-Institute Jena and the Institute of Optics and Quantum Electronics). Thus, for 2015 there remains the challenge for all of us to integrate these new colleagues smoothly into the faculty and to realize the opportunities which arise from their new input to our research and teaching. This is of particular significance since Silvana Botti and Ulf Peschel are forming the entirely new faculty body of the Institute of Solid State Theory and Optics which was left empty after the retirement of our valuable colleagues Friedhelm Bechstedt and Falk Lederer. Thus, we are looking forward to a fresh start of this institute which was always a cornerstone of important developments in the past.

Likewise, we are looking forward to fill open faculty positions successfully by similarly promising candidates in 2015, as e.g. the professorship for "Mechanics of Functional Materials" at the Otto Schott Institute of Materials Research and the junior professorship for "EUV and X-Ray Sources" at the Institute of Applied Physics.

While from these new professors fresh opportunities will arise, soon we will face the challenges connected to the reappointment of the Professorship for "Teaching Methodology in Physics and Astronomy", which is currently held by Karl-Heinz Lotze, who provided a substantial and very reliable basis of our teaching program over the last years. A similarly difficult task will arise in the near future connected to the close retirement of Richard Kowarschik (Professor for Experimental Physics / Coherence Optics at the Institute of Applied Optics). Combined with the recent leave of Alexander Heisterkamp (Professor for Applied Physics / Optics for Ophthalmology) from the same institute, the faculty has to develop a strategy to sustain the profile of the institute, which was particularly important for the faculty's connection to the fields of life science and medicine and therefore to other faculties of the university.

The appointment process at the faculty in 2014 marks a true milestone. With Silvana Botti, we could appoint the first female full professor to the Faculty of Physics and Astronomy. Thus our gender equality measures, which we had strengthened continuously during the last years, finally payed off. Similarly our gender measures on the junior level had also been fruitful. After the successful appointment of Rachel Grange to the position of a Junior Research Group Leader at our faculty, she could advance to a professor position at ETH Zurich. Following this model we opened a new position of a Junior Research Group Leader for which we could again find a very talented female scientist. As a result, we are looking forward to the start of Isabelle Staude from the Aus-

tralian National University in Canberra at our faculty in 2015. While we will continue to increase our efforts on gender equality, we hope that our already demonstrated success-cases will act as a seed for further appointments of female professors in the future.

Another challenge which we will face in the next years will be the reappointment of a number of positions at the mid-level faculty, i.e. scientific assistants connected to the individual professorships. While historically we had a high number and quality of staff members at this level, the shrinking process, which was initiated after the reunification in the early 90's, resulted in the situation that this sector is underrepresented today. Thus together with the university's leadership we must find ways to counteract this development in order to maintain the high quality level in teaching and research.

Looking at our annual report, we hope that it became clear that teaching enthusiastic students is truly at the heart of our faculty. Thus the continuous development of the quality of our teaching programs will be important for us also in the future. Moreover after the successful completion of the reaccreditation of our course program as part of the system accreditation of the university, we are now looking forward to concentrate again on working more intensively directly with the students again.

In contradiction to the proud, which we take in our teaching, the entire faculty is scared by the drastic decrease of the numbers of freshly starting students. While this trend was to be expected from the simple correlation to the negative development of the local population, its harshness wasn't expected and left us puzzled and searching for possible internal reasons. Even though the drop of the number of beginning students is consistent with the birth rate in Thuringia 19 years ago, it also shows that we are not sufficiently successful in attracting students from the western part of Germany – despite of the student-friendly conditions in Jena. Our faculty takes up the challenge to counteract this truly dangerous development. Based on the success in international recruitment for our Master program in Photonics we are planning to expand the international scope of our teaching also to other programs. Furthermore, we already started to pay more attention to communication of our teaching programs to the public. First successful activities in this direction are the outstanding results in the recent CHE ranking and our first positive encounter with New Media by the new Facebook entry of our faculty. We are in close contact with our student council in order to optimize the learning experience from the CHE ranking and to get the message across.

Other important activities in the area of student recruitment are outreach measures. Again we build on longstanding experience which includes the Saturday morning lectures, the Girls' Lab, lectures for pupils at their schools or in our lecture hall, etc. We have added the Physics Day to the suite of activities.

It is clear that these outreach and public relation activities have to be strengthened even further in the future if we want to avoid the risk that the positive general development of our faculty is suffering from the low number of students.

During the last years we had constantly encountered limitations of our research and teaching by the insufficiency of rooms and infrastructures. This problem was addressed and many buildings had been renovated. In 2015 we are looking forward to another important development, since the new research building of the Abbe Center of Photonics is planned to be finished by the end of the year. This will provide high quality laboratories for photonics at the interface to life science, medicine, and chemistry and will therefore strengthen our interaction with partners at these faculties.

The positive development of our faculty, which is documented in the present annual report, is closely connected to our success in attracting external third-party funding for our research. Hence it will be an important part of our activities to maintain and possibly increase our impact in this direction also in the future. Therefore the positive evaluation of our proposal for an International Research Training School with Canadian partners was very important and we are looking forward

to a successful start of the funding of IRTG 2101 (speaker: Andreas Tünnermann) by the German Research Foundation in September 2015. After this success we have now focused our activities to establish a Collaborative Research Center in the field of optical sciences in the near future.

Eventually our persistent ambitions to improve the quality of our research and teaching follow a strategy for excellence, which is constantly coordinated with the leadership of the university and the Free State of Thuringia. Having received substantial funding within Thuringia's Pro-Excellence Program, we are looking forward to the future of the Excellence Initiative in Germany. Successful participation in the Excellence Initiative 3 has to be achieved despite the Plan for Structure and Development (StEP) of the Free State of Thuringia, which severely limits the resources of the university for new strategic developments. Our general strategy to cope with this situation will be to continue along the lines that have become the basis of our present success: Increase collaboration across different faculties and with extra-university institutes. For the latter, the exemplary close links of the Faculty with the Fraunhofer Institute, the Helmholtz Institute and the Leibniz Institute of Photonic Technology have created a remarkably profound win-win situation without which the faculty would be a completely different one. Therefore, it is obvious to seek for and create even more of such opportunities. For this we can rely on established structures, in particular the Abbe Center of Photonics, which already received a strong commitment of the university. Hence the strengthening of the center's research, which is closely connected to the faculty's associated extra-university research institutes, as well as its education, established as the Abbe School of Photonics, will be important not only for our faculty. Therefore the strategy for the future development of our faculty in coherence with the Abbe Center of Photonics will include the strengthening of the connection to life science and medicine, which we consider important to reinforce the profile of the university. A lot of effort has been put in this already and respective university structures – the Center of Medical Optics and Photonics in particular – were created. One of the next steps will be the establishment of an international masters course in medical photonics.

However the limited central resources will also require to set priorities on the most important subjects. The Faculty of Physics and Astronomy together with its Scientific Advisory Board will take up this challenge.

At the end we would like to make aware of a number of specific events in 2015, which we are particularly looking forward to. Many activities in 2015 will be guided by the spirit of UNESCO's International Year of Light 2015. Accordingly, the year 2015 has already started with a public opening event in January, to which our faculty proudly contributed. With the "Day of Physics" in spring 2015 we will continue this series of outreach events, which we have started successfully in 2014. In 2015 we put the partial eclipse on March 20th in the focus of the event together with a lecture on the Rosetta mission. In July we are looking forward to a fruitful meeting with our Scientific Advisory Board, during which we would like to discuss many of the issues arising from the developments sketched in this annual report. Last but not least the festival "Highlights of Physics will be a true highlight for us in 2015.

At the very end we would like to thank those who read our annual report for their interest in our work. Despite being a report, we hope that it also inspires discussions for new successful activities.