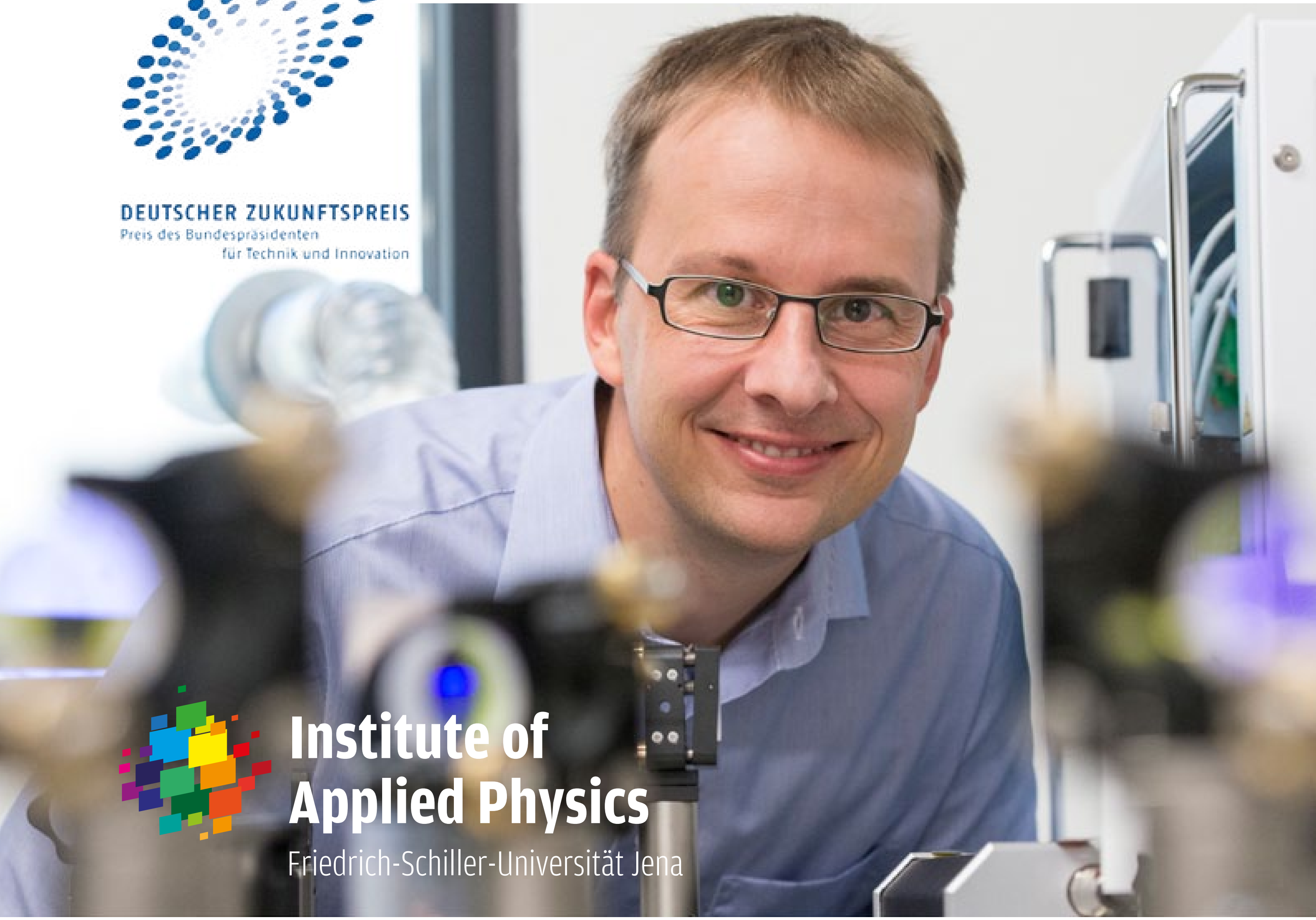
DEUTSCHER ZUKUNFTSPREIS
Preis des Bundespräsidenten
für Technik und Innovation



Institute of Applied Physics
Friedrich-Schiller-Universität Jena

2013
Annual Report

Imprint

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EDITORIAL
Dr. Frank Schrempel
Dipl.-Ing. Ira Winkler M.Sc., Pat.-Ing.

PHOTOS/GRAFICS
Institute of Applied Physics (IAP), Fraunhofer IOF and Friedrich Schiller University Jena [J.-P. Kasper]
front cover & p.54: Deutscher Zukunftspreis
p.50 Simon Stützer, p.64: aboutpixel.de/Lektüre©marshi

Content

PREFACE

The year 2013 was an outstanding year in which our Institute of Applied Physics could maintain and consolidate its top spot in the research landscape: so the first thing I want to mention is the award of this year's Future Award “Deutscher Zukunftspreis” for Technology and Innovation of the Federal President to Stefan Nolte. Awarded were the studies of basic physical effects about the use of ultra -short pulse lasers in precision machining, which were transferred jointly with TRUMPF GmbH and Robert Bosch GmbH in wide application fields. Behind this success lay twenty years of research - twenty years of always new ideas to solve theoretical and practical questions and twenty years of firm belief in the possibilities, but finally, also their financing. However, the Future Award is not the end of the research in this area - now other interesting areas will open up; such as diamond-based optics, since now we will have an available tool for processing such rough materials.

But mentioned at this point, the Future Award is only representative for all the other awards in 2013.

In addition, the Thuringian Research Award for Applied Research about “Multi-contrast microscopy for the clinical application", cooperatively won with our partners, shows also how strong reinforces basic research and industrial implementation mutually, and that we do well as an institution to forge and maintain alliances with the industry. These successes and the focusing on issues with ecological and economical relevance are also reflected in the successful acquisition of project financing in 2013, whereby the two big science- and economic- alliances “freeform optics fo+“ with support under the initiative " Innovative regionale Wachstumskerne " and “3Dsensation” as winner of the program “Zwanzig20 Partnerschaft für Innovation“ starting in 2014 should be named representatively.

Future compliant is also our commitment in teaching: the good cooperation with the Abbe School of Photonics (ASP), the active forming of content in the Atlantic MILMI program as well as the adaptation of old teaching concepts and content to new conditions such as specialization or interdisciplinarity, further training and associated to demographical trends an international orientation. Such activities have led to a repeated leading position of the University and especially of our Faculty in the CHE ranking and students surveys. The realization of the this year's VDI Photonics Academy was certainly a highlight - another the awarding of the Teaching Award of the Faculty of Physics and Astronomy (PAF) to Herbert Gross.

So I would like to thank all active participants; thanks to the technicians, scientists and employees who have contributed to these successes, not to forget the numerous partners from industry and research as well as the ministries of the Federation and the State of Thuringia for their support in implementing our research objectives for future solutions with light.

Prof. Dr. Andreas Tünnermann

The Institute of Applied Physics (IAP) at the Friedrich Schiller University Jena (FSU Jena) has a long-standing tradition and competence in design, fabrication and application of active and passive optical photonic elements for both optical and opto-electronical devices. Collaborative projects with companies ensure practical relevance and feasibility.

Research Profile

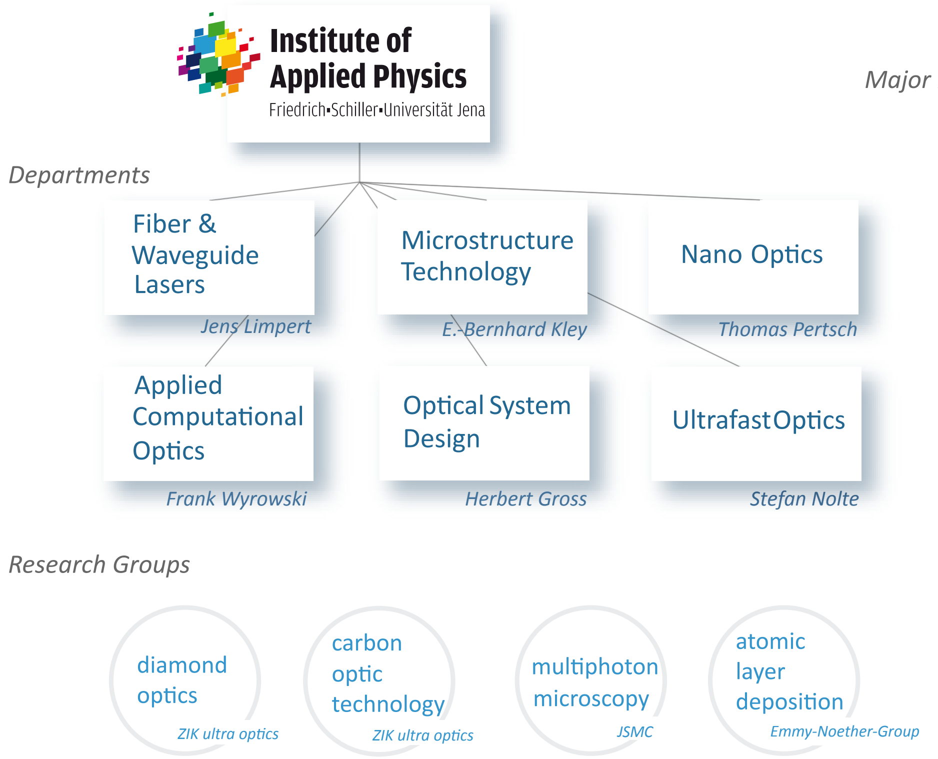
The Institute practices fundamental and applied research in the fields of micro- and nano-optics, fiber and waveguide optics and ultrafast optics. It develops novel optical materials, elements and concepts for information and communication technology, life science and medicine, security and mobility,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

Current research topics - treated by over 160 scientists - concern design of optical systems, as well as function, design and production of micro-and nano-optical elements. Those are e.g. resonant grating structures, metallic and dielectric polarizers, all-optical switching processes in integrated photonic elements and effective media for reduced reflection losses of surfaces. Also light propagation and nonlinear light-matter interaction in micro- and nano-structures, optical metamaterials and photonic crystals are investigated for their inherently novel fundamental physics. Further research fields are the application of femtosecond laser pulses, e.g. for material processing and micro- and nano-structuring, the development of new concepts for solid-state lasers such as fiber lasers, fiber-optic pulse shaping and the amplification of ultrashort laser pulses.

By investigating these fields of research, particularly in close cooperation with the Fraunhofer Institute of Applied Physics and Precision Engineering (IOF) as well as many partner companies, the IAP covers numerous parts of the innovation chain - from interdisciplinary fundamental research to the presentation of prototypes. This expertise offers remarkable contributions to solve issues in emerging fields like energy, environment, health and communication.

Excellence in research is confirmed by the establishment of the Competence Centre ultra optics (www.ultra-optics.de) as a driver of innovation in the research field of laser physics and nano-optics, the research initiative on Photonic Nanomaterials PhoNa (www.phona.uni-jena.de) and also the local competence inititative KD OptiMi (www.optimi.uni-jena.de), which combines fundamental and applied research in a unique way.

But not only excellent research makes the Institute splendid, also outstanding laboratory equipment, an excellent staff and a high commitment in the training of students and scientists in cooperation with the Abbe School of Photonics (www.asp.uni-jena.de) belongs to the self understanding of the IAP.



Major Projects

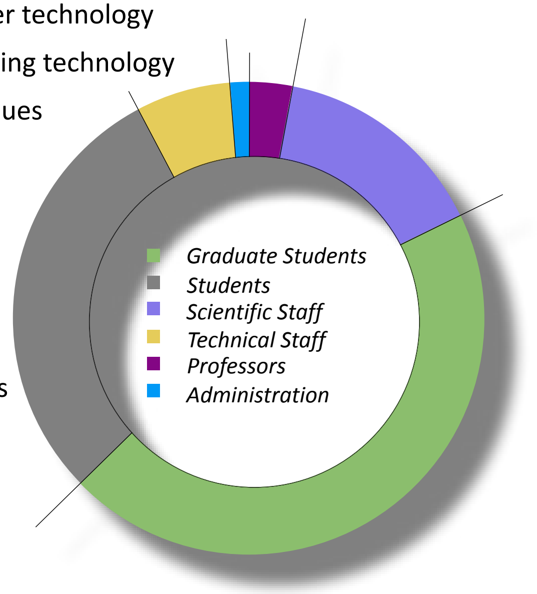
Research Facilities / Resources

Excellence in research requires high quality equipment for experimental questions and analysis. The state-of-the-art technical infrastructure is driven constantly forward by acquired adaptions for scientific questions.

- 860 m² class 10,000 to 10 clean room area
- Electron beam and laser lithography
- Dry etching facilities
- Electron and ion beam microscopy, scanning electron microscopy
- Photolithography
- Helium ion microscopy
- Interference optical surface profilometry
- Photoemission electron microscopy
- Scanning nearfield optical microscopy
- Nonlinear optical waveguide characterization
- UV-VIS spectrometry
- FTIR spectrometry
- Rigorous optical simulation
- Ultrashort pulse laser technology
- Laser micro-structuring technology
- Field tracing techniques

Staff

budgetarily financed:	4	university professors
	4.6	scientific staff
	10.3	technical / administrative staff
externally funded:	1	endowed professor
	2	junior professors
	91.6	scientific staff
	5.0	technical /administrative staff



ABBE Sylvia
ACKERMANN Roland
AHMAD Muhammad
APPELFELDER Michael
ASOUBAR Daniel
BAUMGARTL Martin
BECKER Ria
BEIER Franz
BEIER Matthias
BERGNER Klaus
BERNERT Jan
BINGEL Astrid
BLUMRÖDER Ulrike
BOURGIN Yannick
BRAHM Anika
BRAIG Christoph
BRANDT Juliane
BREITBARTH Andreas
BREITKOPF Sven
BURKHARDT Thomas
BURMEISTER Frank
CHEMNITZ Mario
CHIPOULINE Arkadi
CORIAND Luisa
DECKER Manuel
DEMMLER Stefan
DIETRICH Kay
DIZIAIN Séverine
DÖRING Sven
DREISOW Felix
DUNKEL Jens
ECKSTEIN Wiebke
EICHELKRAUT Toni
EIDAM Tino
EILENBERGER Falk
FALKNER Matthias
FASOLD Stefan
FLOC´H Kevin
FRANKE Christian
FUCHS Hans-Jörg
FUCHS Benjamin
FÜCHSEL Kevin
FÜSSEL Daniel
GAIDA Christian
GEISS Reinhard
GENEVÉE Pascal
GEROLD Marcel
GHAZARYAN Lilit
GIREE Achut
GÖDEKER Christoph
GOTTSCHALL Thomas
GRÄF Waltraud
GRÄFE Markus
GRANGE Rachel
GROSS Herbert
HÄDRICH Steffen
HARTUNG Holger
HEIDLER Nils
HEILEMANN Martin
HEILMANN René
HEIST Stefan
HELGERT Christian
HERFFURTH Tobias
HEUSINGER Martin
HOFFMANN Armin
HOLLAND-MORITZ Henry
JANSEN Florian
JANUNTS Norik
JAUREGUI MISAS Cesar
JOBST Paul-Johannes
JOCHER Christoph
JOSWIG Andreas
KAISER Thomas
KAMMEL Robert
KÄMMER Helena
KÄSEBIER Thomas
KEIL Robert
KEMPER Falk
KHANUKAEVA Yuliya
KIENEL Marco
KIM Eugene
KINAST Jan
KLEIN Angela
KLENKE Arno
KLEY Ernst-Bernhard
KLUGE Anja
KNETSCH Ricarda
KNOPF Heiko
KNOTH Roberto
KRÄMER Ria
KRAUSE Sylvio
KREBS Manuel
KROKER Stefanie
LANGE Nicolas
LEHNEIS Reinhold
LEHR Dennis
LIMPERT Jens
LUDWIG Henning
LUTZKE Peter
MARTIN Bodo
MATTHÄUS Gabor
MENZEL Christoph
MINARDI Stefano
MODSCHING Norbert
NARANTSATSRALT Bayarjargal
NATHANAEL Anne
NOLTE Stefan
OTTO Christiane
OTTO Hans-Jürgen
PABST Oliver
PABST Reinhold
PEREZ LEIJA Armando
PERTSCH Thomas
PEUKER Ralf
PFEIFER Kristin
PLÖTNER Marco
POL RIBES Pleguezuelo
PRATER Karin
PREUßER Henry
PSHENAY-SEVERIN Ekaterina
PUFFKY Oliver
PULSACK Julian
RATZSCH Stephan
REINHOLD Jörg
REITER Jürgen
RICHARDT Tim
RICHTER Daniel
RICHTER Jessica
RICHTER Sören
ROCKSTROH Sabine
ROCKSTROH Werner
ROSENSTENGEL Diana
ROTHHARDT Carolin
ROTHHARDT Jan
SARAVI Sina
SCHEIDING Sebastian
SCHELLE Detlef
SCHIEK Roland
SCHMIDT Carsten
SCHMIDT Dorit
SCHMIDT Holger
SCHREMPEL Frank
SCHULZE Marcel
SCHWINDE Stefan
SEISE Enrico
SERGEEV Natali
SERGEEYEV Anton
SETZPFANDT Frank
SHI Rui
SIEFKE Thomas
SIMON Gitta
SISON Miguel
SIVUN Dimitry
SPREER Simone
STEGLICH Martin
STEINBERG Carola
STEINBRÜCK Andrea
STEINER Stefan
STEINERT Michael
STEINMETZ Alexander
STÜRZEBECHER Lorenz
STÜTZER Simon
STUTZKI Fabian
SZAMEIT Alexander
SZEGHALMI Adriana
TESSMER Manuel
THOMAS Jens
TISCHNER Katrin
TROST Marcus
TÜNNERMANN Andreas
ULLSPERGER Tobias
VETTER Christian
VETTER Julia
VOIGT Daniel
VOIGTLÄNDER Christian
VON GRAFENSTEIN Lorenz
WALTER Benni
WANG Xiaolong
WARZESCHKA Sandra
WEBER Christin
WEBER Thomas
WEICHELT Tina
WEIMANN Steffen
WINKLER Ira
WUNDERLICH Stefano
WYROWSKI Frank
XUEKAI Ma
ZEITNER Uwe
ZEUNER Julia
ZHANG Site
ZHANG Xu
ZHONG Huiying
ZHONG Minyi
ZILK Matthias
ZIMMERMANN Felix

Guests

Guests indicate the national and international visibility of research results and enrich the structures of the Institute of Applied Physics with new thinking and perspectives - not only in research and teaching, but also open eyes to other cultures and strengthen the network by personal relations.

ABREU AFONSO Javier	Universidad de Valencia, Valencia, Spain
BARAD Shimshon	Tel Aviv University, Tel Aviv, Israel
BUSE Karsten	Fraunhofer-Institut für Physikalische Messtechnik IPM, Freiburg, Germany
CHANG Wei-Kun	National Central University, Jhongli, Taiwan
DECKER Manuel	Australian National University, Canberra, Australia
EISFELD Alexander	MPI-PKS, Dresden, Germany
FARBEROVICH Oleg	Tel Aviv University, Tel Aviv, Israel
FEDRIZZI Alessandro	University of Queensland, Brisbane, Australia
GOLSHANI Mojtaba	Sharif University of Technology, Teheran, Iran
HAROYAN Hovhannes	Yerevan State University, Yerevan, Armenia
KAZANTSEV Dimitry	Fraunhofer IISB, Erlangen, Germany
KRUK Sergey	Australian National University, Canberra, Australia
KWEK Leong Chuan	Singapore Technical University, Singapore
LANGARI Abdollah	Sharif University of Technology, Teheran, Iran
MINOVICH Alexander	Australian National University, Canberra, Australia
MÜHLKEN Oliver	Universität Freiburg, Freiburg, Germany
NESHEV Dragomir	Australian National University, Canberra, Australia
PRANDOLINI Mark	Helmholtz-Gemeinschaft, DESY Hamburg, Germany
PULIDO MANCERA Laura	National University of Colombia, Colombia
SKIRLO Scott	Massachusetts Institute of Technology, Cambridge, USA
SQUIER Jeff	Colorado School of Mines, Golden, USA
STAUDE Isabelle	Australian National University, Canberra, Australia
VICENCIO Rodrigo	University of Chile, Santiago, Chile
WEIHS Gregor	Innsbruck University, Innsbruck, Austria
WU Xiaofei	Universität Würzburg, Würzburg, Germany

Research Stay

BREITKOPF Sven	CERN, Geneva, Switzerland
DREISOW Felix	Instituto di Fotonica e Nanotecnologie, Bari, Italy
EIDAM Tino	DESY, Hamburg, Germany& CERN, Geneva, Switzerland
GOTTSCHALL Thomas	DESY, Hamburg, Germany
GROSS Herbert	Australian National University, Canberra, Australia
HEILMANN René	University of Queensland, Brisbane, Australia
HEINRICH Matthias	College of Optics & Photonics CREOL, University of Central Florida, USA
KIENEL Marco	CERN, Geneva, Switzerland
KRÄMER Ria	Australian National University, Canberra, Australia
LIMPERT Jens	CERN, Geneva, Switzerland
THOMAS Jens	Colorado School of Mines, Golden, USA
ZEUNER Julia	Technion, Haifa, Israel

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 cooperations 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 centre of excellence for micro- and nano-structured optics as well as optical systems.

Within Thuringia, the Competence Network for Optical Microsystems (OptiMi) is established, which focuses on a close interdisciplinary integration of research groups from the IAP, IOF, the CiS Foschungsinstitut Erfurt and Ilmenau University of Technology. Now, OptiMi has been mainly expanded above the regional frontier through collaborations with scientists, e.g. from the Karlsruhe Institute of Technology (KIT), University of Freiburg and industrial holdings.

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 optcis modeling software (VirtualLab ™) have been developed. A long-standing cooperation exists with the University of Eastern Finland and the University of Delft. Also 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.

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.

Delegation, supported by the BMBF, at the Laval University (Quebec) in Canada visited the facilities, here: a fiber-drawing tower.

Outline of Cooperations with Joint Research Topics

Centre d'Optique, Photonique et Laser
Université Laval
Québec, Canada
Réal Vallée

Centre for Quantum Optics
Bristol University
Bristol, UK
Jeremy O'Brien

Centre of Ultrahigh Bandwidth
Devices for Optical Systems (CUDOS)
MQ Photonics Research Centre
Department of Physics and
Astronomy Macquarie University
Sydney, Australia
Prof. Michael Withford

Classical Optics Group
Politecnico Milano
Milano, Italy
Stefano Longhi

College of Optics and Photonics, CREOL
University of Central Florida
Orlando, USA
Demetrios Christodoulides &
Martin Richardson

Department of Electrical & Computer
Engineering
University of Toronto
Toronto, Canada
Peter Herman

Department of Microsystems Engineering
University of Freiburg
Freiburg, Germany
Karsten Buse

Department of Physics
Colorado School of Mines
Golden, USA
Jeff Squier

DESY
Helmholtz Association
Hamburg, Germany
Franz Tavella

Devision Attosecond Physics
Max Planck Institute of Quantum Optics
Garching, Germany
Joachim Pupeza

Devision Molecular Imaging
Leibnitz Institute of Photonic Technology
Jena, Germany
Tobias Meyer

Ecole Polytechnique Federal Lausanne
Laboratoire d'Optique Biomedicale
Lausanne, Swiss
Theo Lasser

Énergie, Matériaux et Télécommunica-
tions
Research Center
Institut National de la Recherche
Scientifique (INRS)
Varennes, Canada
Roberto Morandotti

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

Institute for Optics and Quantum
Electronics
Friedrich Schiller University Jena
Jena, Germany
Michael Zürch

Institute of Optics, Information
and Photonics
Friedrich Alexander University
Erlangen-Nürnberg, Germany
Prof. Ulf Peschel

Massachusetts Institute of Technology
Cambridge, USA
Scott Skirlo

Material Science Division
Clemson University, Florida, USA
Prof. Kathleen Richardson

Nonlinear Optics Group
Institute of Photonic Sciences (ICFO)
Barcelona, Spain
Yaroslav Kartashov

Nonlinear Optics Group
Universidad de las Americas
Puebla, Mexico
Victor Vysloukh

Nonlinear Optics Group
Wesleyan University
Middletown, USA
Dr. Tsampikos Kottos

Nonlinear Physics Centre
Australian National University
Canberra , Australia
Yuri Kivshar, Dragomir Neshev

Nonlinear Solid-State
Optics Group
Technion
Haifa, Israel
Mordechai Segev

Optical Physics Group
University of Santiago
Santiago, Chile
Mario I. Molina

Optical Sciences Center
National Central University
Jhongli, Taiwan
Wei-Kun Chang

Optical Solitons Group
Crete University
Heraklion, Greece
Prof. Nikolaos Efremidis

Photonics Group, XLIM
Limoges, France
Frederic Louradour

Physics Department
Sharif University of Technology
Teheran, Iran
Abdollah Langari

Physics Department
Tel Aviv University
Tel Aviv, Israel
Victor Fleurov

Institut für Quantenoptik
Universität Wien
Vienna, Austria
Prof. Philip Walther

Quantum Optics Group
Instituto Nacional de Astrofísica
Óptica y Electrónica
Puebla, Mexico
Hector Moya-Cessa

Quantum Optics Group
Singapore University
Singapore
Kwek Chuang

University Bordeaux 1
Bordeaux, France
Prof. Bruno Bousquet

Yerevan State University
Yerevan, Armenia
Hovhannes Haroyan

TEACHING

An essential part of the IAP is the training of young scientists at the interface of physics, chemistry and material science. Additively to this purpose, interdisciplinary international Master´s degree and graduation programs, like Master International in Laser, Material science and Interation (MILMI) and Optical Microsystem Technology (OMiTec) as well as Green Photonics, have been integrated into the Abbe School of Photonics (ASP).

Lectures

Elective Courses (Lectures & Seminars)

- Advanced Optical Microscopy
- Astrophotonics
- Computational Photonics
- Design and Correction of Optical Systems
- Experimental Methods of Optical Spectroscopy
- Fourier Transformation and Sampling Theory
- Fundamentals in Laser Physics
- Fundamentals of Microscopic Imaging
- Fundamentals of Modern Optics
- Imaging and Aberration Theory
- Introduction to Nanooptics
- Introduction to Optical Modeling
- Micro/Nanotechnology
- Nanomaterials for Photonics
- Optical Design with Zemax
- Optical Modeling & Design I
- Optical Modeling & Design II
- Solid Analysis with Ion Beams
- Thin Film Optics
- Ultrafast Optics

Tutorials

Department:
- Diamond Optics
- Fiber Lasers
- Field Tracing
- Microstructure Technologies - Microoptics
- Nano Optics
- Optical System Design
- Ultrafast Optics

Institute: Applied Physics

Super tutorial: Optics

ASP interinstitutional seminar

Optical Modeling of the Do-IT-Yourself telescope together with participants of the BMBF Photonik Akademie 2013, held at Fraunhofer IOF and IAP.
Herbert Gross was honored by the this year's Teaching Award of the Fakulty for his courses.

Bachelor Theses

Nils Becker
Nichtdispersive, ultrakurze Pulse

Marina Merker
Experimentelle Untersuchungen zur Durchtrennung des Glaskörpers mittels Femtosekundenlaser

Lukas Stein
Two-dimensional optical tweezing in a fluid environment for emulating statistical mechanics

Yera Ussembayev
Design and fabrication of different plasmonic gold nanostructures for the laser-based cell manipulation

Thomas Witt
Untersuchung und Korrektur von Aberrationen der intraokularen Femtosekundenlaser-Chirurgie mittels adaptiver Optik

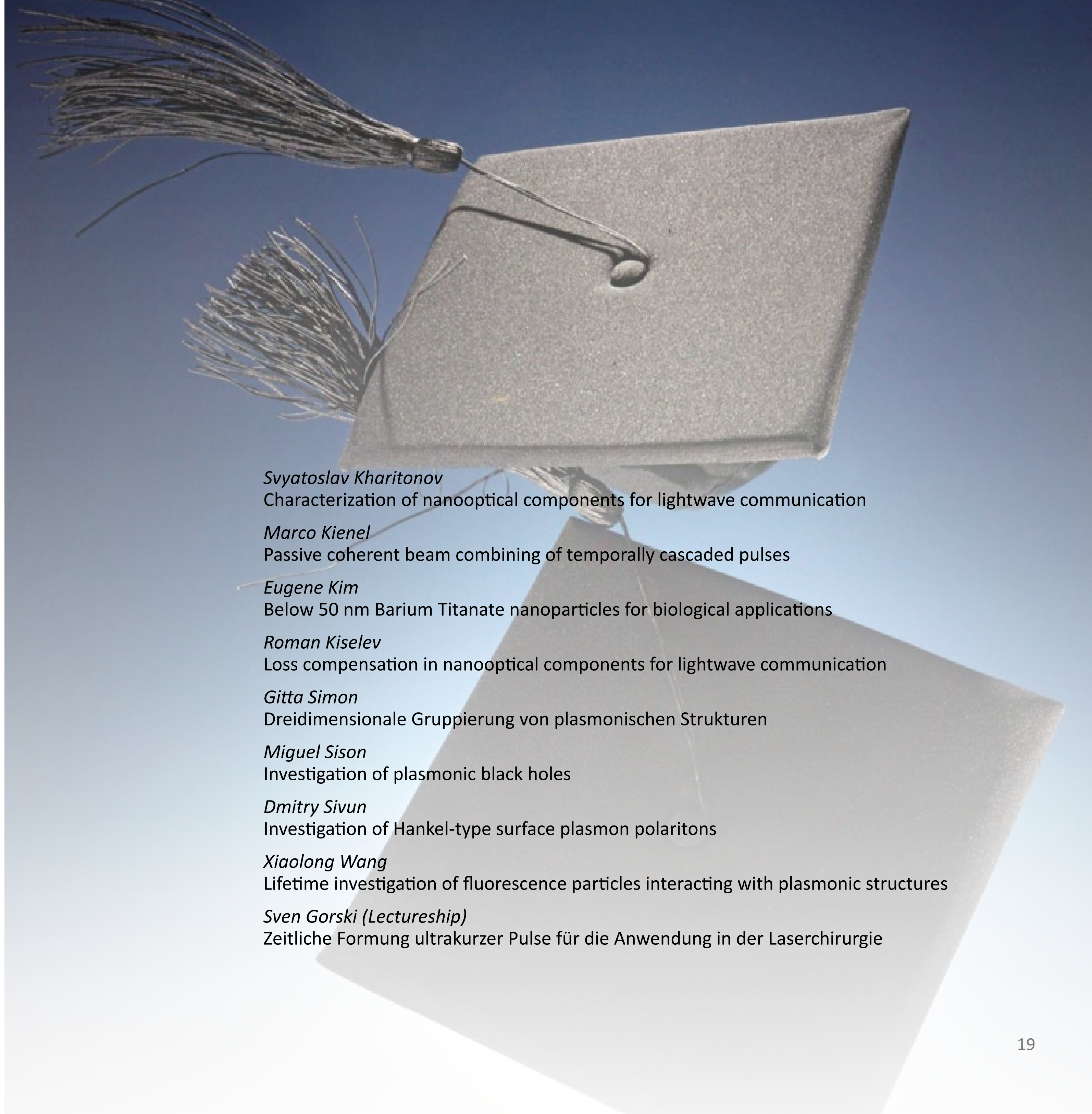
Diploma Theses

Jan Bernert
Verbesserung der plasmonischen Eigenschaft polykristalliner Goldschichten

Master Theses

Armin Hoffmann
Zeitliche Pulskompression hochenergetischer Ultrakurzpulsfaserlaser

Yuliya Khanukaeva
All-fiber narrowband tunable laser source for coherent anti-Stokes Raman scattering microscopy



Svyatoslav Kharitonov
Characterization of nanooptical components for lightwave communication

Marco Kienel
Passive coherent beam combining of temporally cascaded pulses

Eugene Kim
Below 50 nm Barium Titanate nanoparticles for biological applications

Roman Kiselev
Loss compensation in nanooptical components for lightwave communication

Gitta Simon
Dreidimensionale Gruppierung von plasmonischen Strukturen

Miguel Sison
Investigation of plasmonic black holes

Dmitry Sivun
Investigation of Hankel-type surface plasmon polaritons

Xiaolong Wang
Lifetime investigation of fluorescence particles interacting with plasmonic structures

Sven Gorski (Lectureship)
Zeitliche Formung ultrakurzer Pulse für die Anwendung in der Laserchirurgie

Doctoral Theses

Luisa Coriand
Roughness, wetting, and optical properties of functional surfaces

Kevin Füchsel
Nanostrukturierte Halbleiter-Isolator-Halbleiter Solarzellen

Christoph Gödeker
Schichtdesign unter Berücksichtigung von optischen und mechanischen Eigenschaften

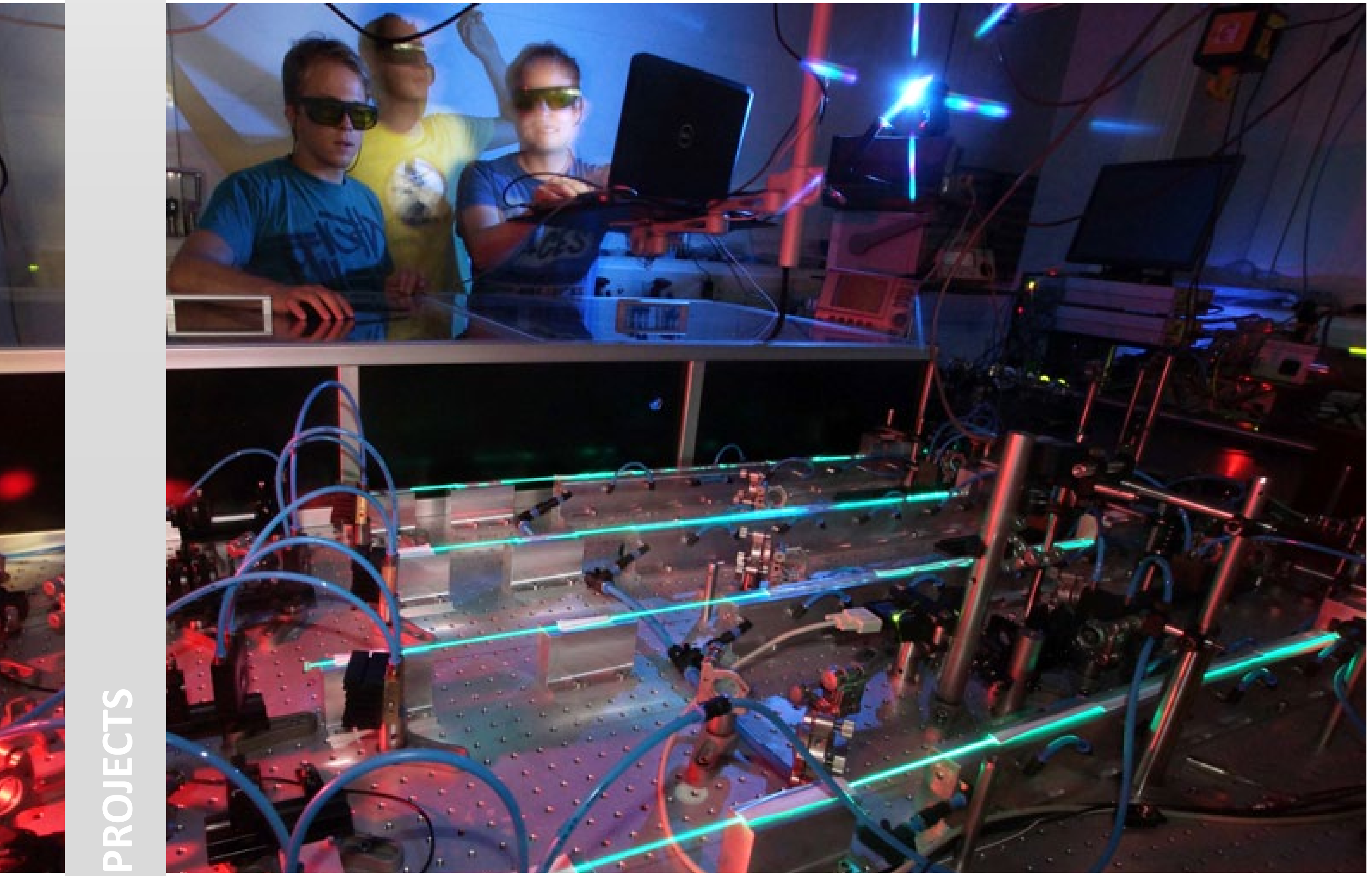
Robert Keil
Quantum random walks in waveguide lattices

Christiane Präfke
Vakuumgedampfte organisch-anorganische Hybridschichten für den UV-Schutz von Bisphenol-A-Polycarbonat

Carsten Schmidt
Mode dynamics in coupled disk optical microresonators

Enrico Seise
Coherent combining of ultrashort laser pulses

Alexander Steinmetz
Short and ultrashort pulses from fiber-amplified and passively Q-switched microchip lasers



High performance femtosecond fiber laser system consisting of four parallel amplifiers in operation.

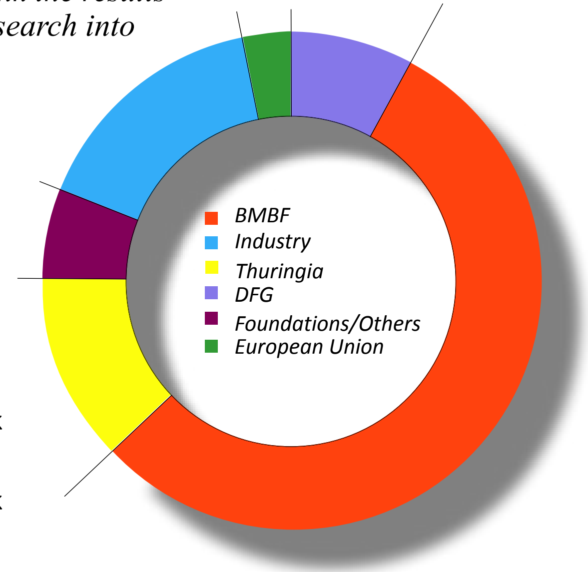
PROJECTS

"Applied Physics" is implemented in numerous projects in different application fields that contain fundamental research as well as application specifics. Accordingly, strong partners were explored and cooperations expanded. Thus, the IAP can continuously link the results at the value chain and transfer these results from basic research into innovative and novel demonstrators.

Statistics

External funding (turn-over 2013):

DFG (German Research Society)	€	868 k
BMBF (Federal Ministry of Education and Research)	€	6,074 k
State of Thuringia	€	1,353 k
Foundations	€	633 k
Industry/Others	€	1,768 k
European Union	€	338 k
Total:	**€**	**11,034 k**



DFG - German Research Foundation

„Optisch erzeugte Sub-100-nm-Strukturen für biomedizinische und technische Zwecke“

„Nonlinear optics in metallic nanowaveguides in Lithium Niobate”

„Optische Beschichtung mittels Atomic Layer Deposition. Beschichtung nanostrukturierter Substrate und Adsorption von Flüssigkristallen an dünnen Schichten“ (Emmy Noether-Programm)

„Strukturierungsverfahren für mikro- und nanooptische Elemente in $LiNbO_3$“

SFB Transregio "Gravitationswellenastronomie"

„Lineare und nichtlineare Lichtausbreitung in Wellenleiterarrays bei komplexen Anregungsprofilen“

„Ultrakurzpuls–induzierte Erzeugung periodischer Nanostrukturen im Volumen transparenter Festkörper“

„Aktive Mikrooptik: Adaptierbare plenoptische Kameras: Design, Herstellung, Integration“

"Untersuchung der Kopplung dielektrischer und plasmonischer Resonanzen an optischen Metamaterialien in Wellenleitergeometrien"

"Design und Herstellung nanostrukturierter optischer Schichtsysteme zur Optimierung des Wirkungsgrades photovoltaischer Elemente"

European Union

„Powerful and Efficient EUV Coherent Light Sources (PECS)“

„Large Area Fabrication of 3D Negative Index Materials by Nanoimprint Lithography (NIM-NIL)“

Master in Lasers Materials Interactions - Student Exchange Program with Université Bordeaux, the College of Optics and Photonics CREOL & FPCE and Clemson University

BMBF-Projects

Federal Ministry of Educaion and Research

Verbundprojekt: onCOOPtics - Teilvorhaben: „Physikalisch-technische Grundlagen von Hochintensitätslasern für die Radioonkologie und Aufbau eines Charakterisierungs- und Herstellungslabors für Hochleistungskomponenten“

„Grundlagen der CARS-Mikroskopie in der Neurochirurgie (MEDICARS) –
Teilvorhaben: Grundlagen faser-integrierter Lasersysteme für die CARS-Mikroskopie“

„Photonische Nanomaterialien“- project part ZIK and project part IAP & strategical investitions"

Kompetenzdreieck "Optische Mikrosysteme" (KD OptiMi)

„Nanostrukturierte Siliziumgrenzflächen - Black Silicon“ NanoSIS (Program ForMaT)

„Infrarot-optische Nanostrukturen für die Photovoltaik (InfraVolt) -
Teilvorhaben: Photonmanagment im infraroten Spektralbereich“

Ultra Optics 2015 – research group „Fertigungstechnologien für hoch entwickelte Mikro- und Nano-Optiken“

Ultra Optics 2015 – junior research group „Design und Realisierung komplexer mikro- und nanostrukturierter photonischer Systeme basierend auf Diamant- und Kohlenstoffoptiken“

Optische Mikrosysteme für ultrakompakte hyperspektrale Sensorik (OpMiSen) -
Teilprojekt: „Mikrostrukturierte Filter“

„Tailored for next PV (T4nPV), UKP-Laserstrukturierung von dünnen Schichten für PV-Anwendungen“

„Grundlegende Untersuchung zur zeitlichen Kompression passiv gütegeschalteter Laser im sub-10 ps Bereich“

„Kompakte Ultrakurzpulslaser basierend auf kohärenter Kombination“

„Montagegerechte Fertigungstechnologie für gefasste Optik"

Thuringian Projects

Thuringian Ministry of Education, Science and Culture (TMBWK) & Thuringian Ministry of Economics, Labour and Technology (TMWAT)

„Burst-Überhöhungsresonatoren zur Darstellung von Hochenergiepulsen“

„Nichtlineare Raum-Zeit-Dynamik in nanostrukturierten optischen Systemen“

OptiMi 2020-Graduate Research School „Green Photonics“

Koordination der Initiative „PhoNa – Photonische NanoMaterialien“ im Bundesprogramm „Spitzenforschung und Innovation in den Neuen Ländern“

„Innovative nanostrukturierte Materialien für die Optik“ – Basisinnovation für den Cluster CoOPTICS (MeMa) (Landesprogramm ProExzellenz)

Foundations/Other Sources

Carl-Zeiss-Scholarships

Scholarships of the Merkle-Foundation

Nanostrukturierte Semiconductor-Insulator-Semiconductor-Bauelemente

Luminous fluid flow in 2d structures: experiment and theory

Contract Research

Grundlegende Untersuchungen zu Hochleistungsfaserlasern

Herstellung hochpräziser optischer Schichten mittels Magnetronsputtern

Entwicklung und Aufbau eines fs Faserlasers mit hoher mittlerer Leistung

Streulichtmechanismen an optischen Oberflächen

Untersuchungen zum Laserstrahllötprozess

Charakterisierung der Benetzungs- und Rauheitseigenschaften funktionaler Oberflächen

Synchronisiertes Ultrakurzpuls-Faserverstärkersystem

Theoretische und experimentelle Untersuchung zur Entwicklung einer Leichtgewichtsausführung von Metallspiegeln für weltraumtaugliche Teleskope

Entwicklung von Kurzpulsseedquellen

Verfahren für hochdynamische 3D-Messungen mittels Arrayprojektion

Entwicklung von Methoden für das 3D-Messen mit strukturierter Beleuchtung in Bewegung

Ultrakurzpulsstrukturierung von elektronischen Komponenten auf hochelastischen metallisierten Polymerfasern

Entwicklung von Methoden zur Kompensation des Fehlereinflusses bei der 3D-Vermessung transluzenter Objekte

Faserlaser: Entwicklung, Test u. Optimierung des High Harmonic (HHG) Seeding

Ultrakurzpulsstrukturierung von Siliziumsolarzellen auf textilen Substraten

Experimentalstudie zur Herstellung von DUV-Drahgitterpolarisatoren

Entwicklung keramischer Gasführungen für Atmosphären- und Vakuumanwendungen

Theoretische und experimentelle Untersuchungen zum plasmaaktivierten zwischenschicht-freien Bonden von Glas und optischen Kristallen

Talbot-Lithographie für PSS-Strukturen

Einfluss der Plasmachemie und -energetik auf die Zusammensetzung und Kristallstruktur gesputterter Metall-Dielektrischer Schichten

Anorganisch-organische Hybridschichten für die Optik

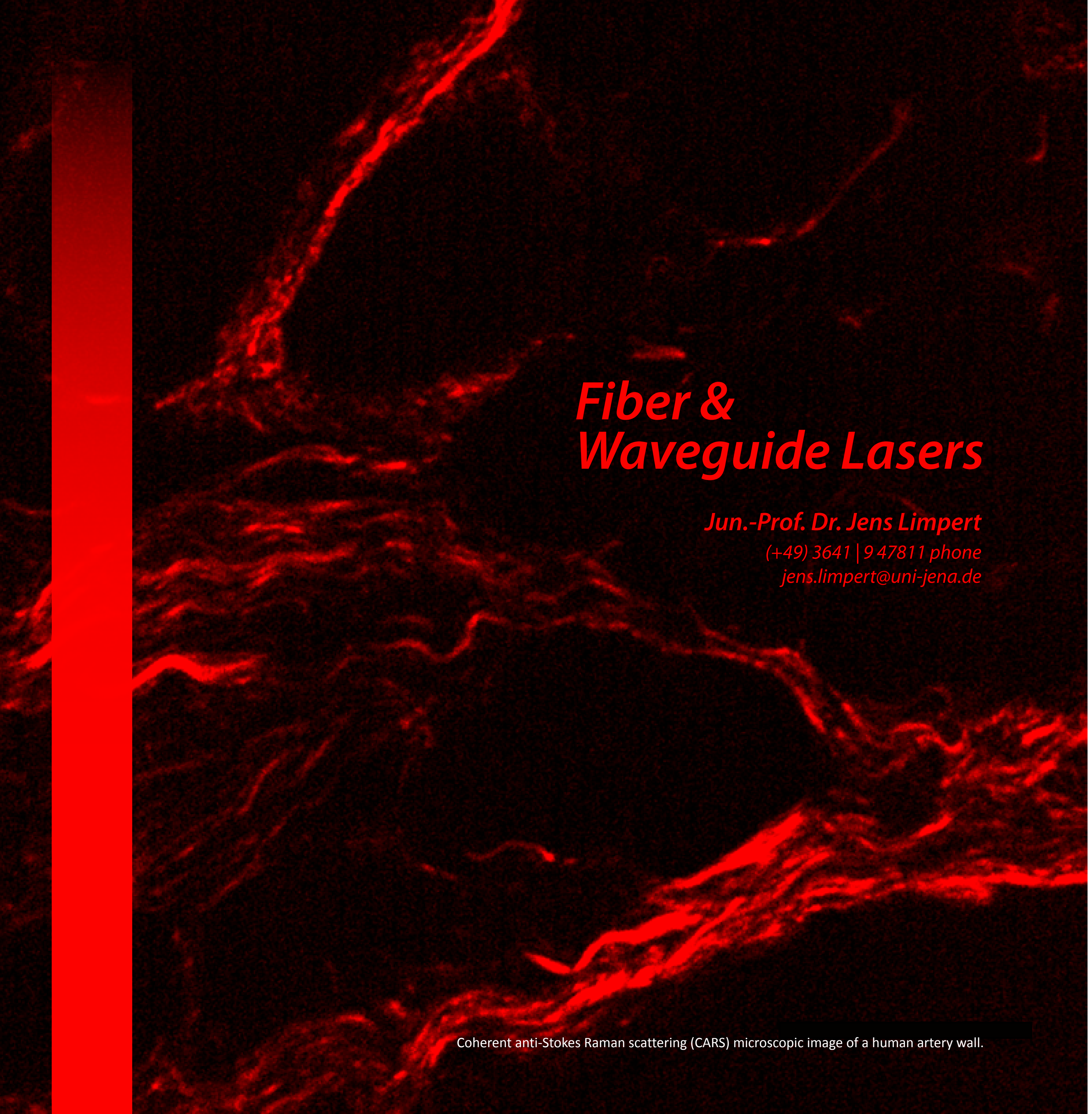
Entwicklung von THz-Tomographiesystemen

Entwicklung eines synchronisierten OPA Systems

A novel high-harmonic generation experiment developed by Manuel Krebs and his colleagues enables the production of isolated attosecond pulses at unprecedented repetition rates.

RESEARCH - Achievements & Results

Evidence of intense engagement with research topics of the institute is the spezialization of the separate research groups on key challenges. In turn, these groups contribute with their results to the solution of partial tasks of the other work groups. This constantly self-fertilising approach itself leads to remarkable results. Measurably honored are such results by success in granting research contracts, the strong interest in cooperation with the IAP and the number of scientists and students who would like to work at IAP scientifically.



Fiber & Waveguide Lasers

Jun.-Prof. Dr. Jens Limpert

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

This 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.

Scientific focus lies on:

- 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

Authors:
Manuel Krebs, Steffen Hädrich, Stefan Demmler, Jan Rothhardt, Amelle Zaïr, Luke Chipperfield,
Jens Limpert and Andreas Tünnermann

Isolated attosecond pulses at high repetition rates

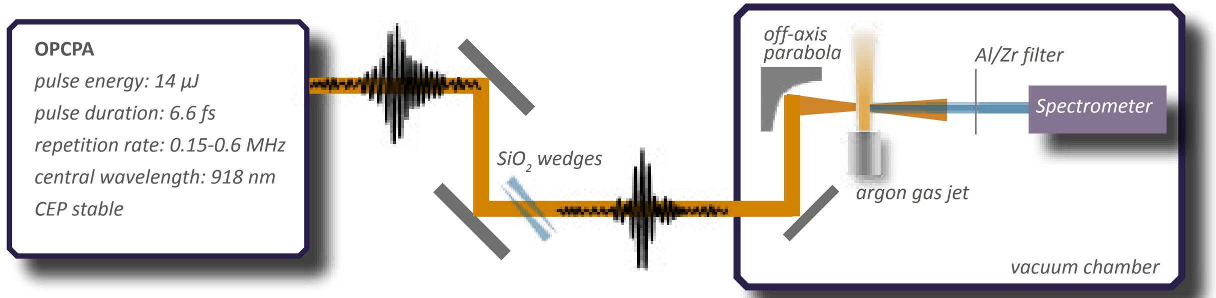

Figure 1: Experimental setup. Pulses of an optical parametric amplifier are focused onto a noble gas jet.

The research on atomic and molecular processes demands for sophisticated measurement schemes. A key role in this regard is taken on by the process of high harmonic generation (HHG), which, for the first time, provides access to the ultrashort timescale of electronic motion. Intensive few-cycle infrared pulses are focused into a noble gas jet. This leads to nonlinear conversion of part of the energy to isolated attosecond pulses in the extreme ultraviolet (XUV) spectral range. These pulses are then used as a tool for the study of electron dynamics in atoms and molecules.

However, due to the low repetition rates of current sources up to a maximum of 3 kHz, measurements with a high signal-to-noise ratio and multi-dimensional acquisition schemes are not possible within reasonable time frames. A major milestone to overcome this limitation is the generation of isolated attosecond pulses using HHG driven by a novel high repetition rate optical parametric amplifier for the first time [1]. This source delivers attosecond pulses at megahertz-level repetition rates and enables unprecedented opportunities for the further evolution of attosecond physics.

This development is built upon the foundation of a high repetition rate, high average power state-of-the-art ultrashort pulse fiber laser system used as pump source for a two-stage, octave-spanning optical-parametric amplifier system [2]. 6.6 fs infrared pulses are generated by this system at up to 1 MHz repetition rate. The carrier-envelope phase (CEP) is actively stabilized [3]. By focusing these pulses into an argon gas jet in vacuum (fig. 1) at up to 600 kHz repetition rate, coherent XUV radiation has been generated and part of the spectrum has been selected by means of filters.

Characterization of this radiation has been carried out for different settings of the CEP using an XUV grating spectrometer connected to a charge-coupled device (CCD) sensor (fig. 2a). For a certain setting of the carrier envelope phase, a spectral continuum in the XUV is obtained. This is evidence for the generation of isolated attosecond pulses. A numerical simulation by solving the time-dependent Schrödinger equation and the propagation of the beam according to the Maxwell equations reproduced the experimental results very well (fig. 2b). Parameters of the generated pulses, not accessible directly in the experiment, can thus be estimated within sufficient accuracy. According to the simulation, a pulse duration on the order of 340 as and a contrast of about 6 : 1 is reached (fig. 2c, inset).

The generation of isolated attosecond pulses imposes highest requirements on stability of the laser systems and control of the electrical field, which has been enabled at unprecedented laser parameters due to continuous developments in ultrashort-pulse laser technology at the IOF and IAP. The presented approach is a promising foundation for the extension of current applications like spatially or angular resolved photoemission spectroscopy and coincidence experiments to attosecond time resolution. This will enable an unprecedented insight into the electron dynamics, and thus, the inner workings of atoms and molecules.

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[2] J. Rothhardt, S. Demmler, S. Hädrich, J. Limpert, A. Tünnermann:
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Opt. Express 20, 10870–8 (2012).

[3] S. Hädrich et al.:
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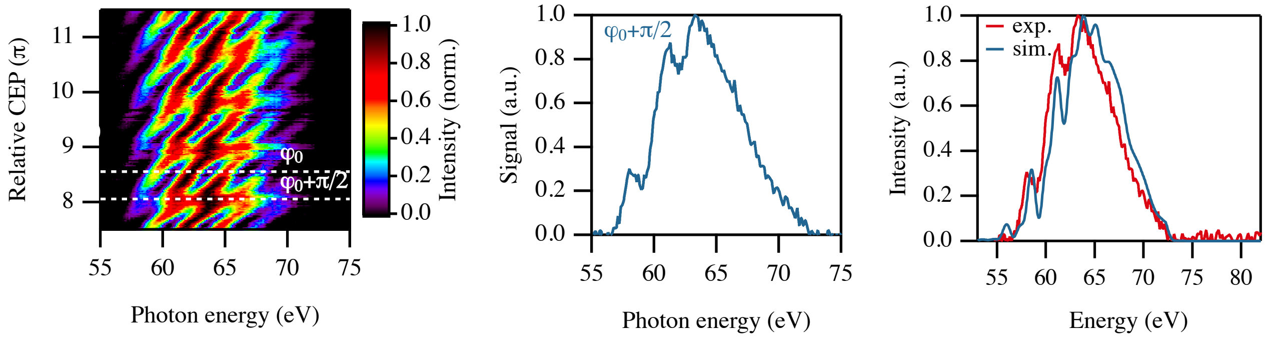

Figure 2:
Measured XUV spectra. a) XUV spectra scanned for different CEPs. b) continuous spectrum corresponding to isolated attosecond pulse c) simulation results (blue) compared to experimental results. inset: simulated temporal pulse shape.

Microstructure Technology & Microoptics

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

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

The following research priorities have been edited:

- Plasmonic resonant nanometric metal rings
- Resonant reflective monolithic grating structures
- 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
- Effective media for reflection reduction of smooth and micro-structured surfaces
- Material-scientific aspects

Authors:
Stefanie Kroker, Thomas Käsebier, Ernst-Bernhard Kley and Andreas Tünnermann

Monolithic gratings for high-precision optical metrology

The sensitivity of many experiments in the field of high-precision optical metrology, such as the realization of frequency stabilized lasers or optical clocks as well as the detection of gravitational waves, are limited by the thermal noise of the optical components. These thermal fluctuations impose random phases onto the light which can interfere with the length changes to be detected. As an important source for thermal noise amorphous coating stacks which are widely used for conventional optical mirrors have been identified. Additionally, transmissive optics can give rise to undesirable effects such as heating due to light absorption or thermal lensing. Thus, grating concepts for reflective optical components such as mirrors or beam splitters with low thermal noise are developed.

To reduce browinan coating thermal noise beside a reduction of temperature use of crystalline materials can be made.
One possibility for the realization of highly-reflective optical components is to apply resonant waveguide gratings.

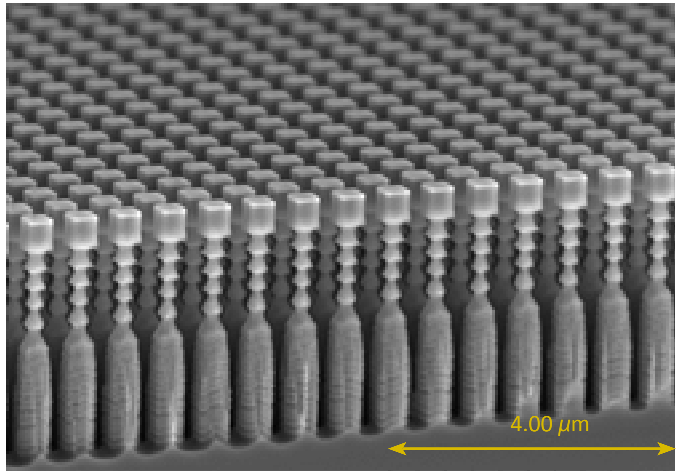

Figure 1:
Scanning electron microscope image of a high reflectivity monolithic grating structure made of silicon. [2]

Here, a reflectance of theoretically 100% with only one stuctured layer embedded in a low-index environment instead can be achieved. Due to their specific grating profile, particularly, monolithic T-shape structures made of crystalline silicon are a promising approach in order to avoid amorphous materials and thereby reduce thermal noise. For example, with these structures, thermal noise in future gravitational wave detectors can be decreased up to one order of magnitude which results in a gain of detection sensitivity of a factor of 1000 [2]. For the realization of beam splitters it is necessary to combine the high reflectance of resonant waveguide gratings with diffractive properties requiring a high angular tolerance of reflectance. Waveguide gratings with one-dimensional periodicity do not provide such a tolerant performance. Therefore, mirrors based on stacked gratings [3] as well as gratings with a periodicity in two dimensions are developed [2] showing a high reflectance in the entire angular spectrum.

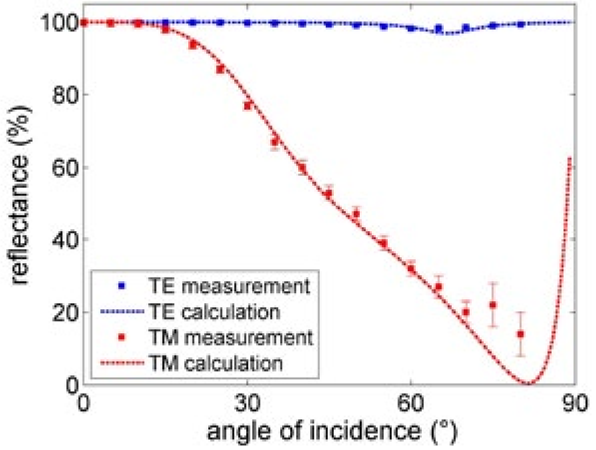

Figure 2:
Angle dependent reflectance of monolithic resonant waveguide grating made of silicon. [2]

The latter for instance exhibits a nearly angular independent reflection behavior for transversal-electric light (see Fig. XXX). By means of an additional modulation, e.g. of the grating depth, the reflective properties of these structures can be combined with an additional diffracting function allowing for reflective beam splitting gratings with low thermal noise.

This research is supported by the German Science Foundation (DFG) within project Transregio 7 „Gravitational waves. Sources. Methods. Observation".

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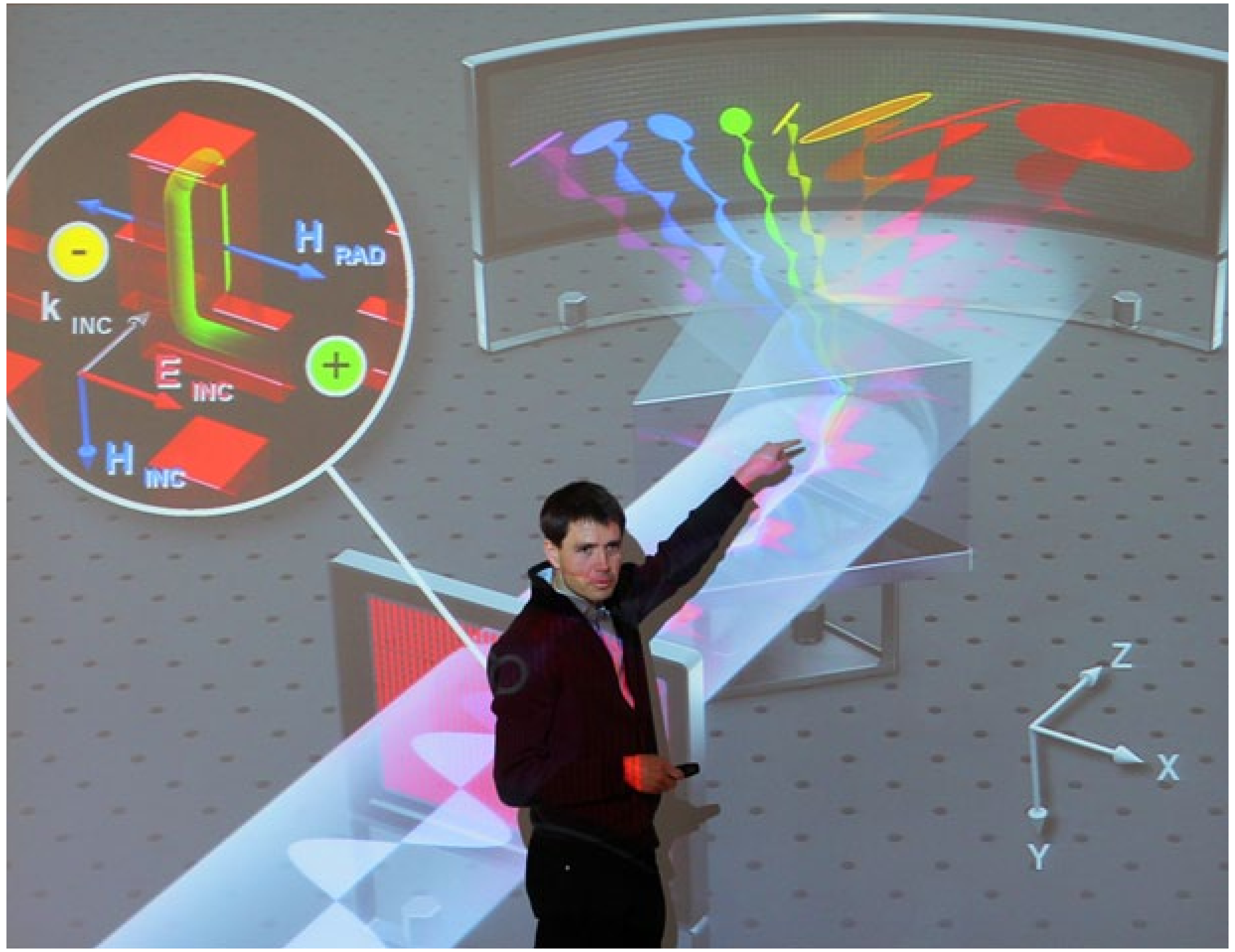
[4] S. Kroker, T. Käsebier, S. Steiner, E.-B. Kley, A. Tünnermann: "High efficiency two-dimensional grating reflectors with angularly tunable polarization efficiency", Applied Physics Letters 102 (2013) 161111.

Nano Optics



Prof. Dr. Thomas Pertsch
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Prof. Pertsch explains the working principle of a photonic nanomaterial, which consists of nanoscopic omega-shaped particles made from gold, which can shape the polarization state of light with an efficiency exceeding any natural material by many orders of magnitude.

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

The scientific emphasis lies on:

- 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 are: realization of polychrome computer-generated holograms (CGH) by nanostructured meta materials • plasmonic core-shell-nano wire with intensified generation of the second harmonics • stimulation and monitoring of multiple Airy-plasmons for generation of a plasmonic focus • direct measurement of near field distribution of whispering gallery modes in micro resonators • quasi-crystalline metamaterials with isotropic material response • multi-pole description for random optical meta materials • modeling of transient dynamics in optical micro resonators.

Authors:
Matthias Falker, Ekaterina Pshenay-Severin, Christian Helgert and Thomas Pertsch

White light interferometry for the characterization of photonic nanomaterials

The design and creation of two-dimensional nanostructured materials have created a new paradigm in material science: so-called metasurfaces have emerged as a new class of integrated photonic elements featuring only a single or few surface layers composed of subwavelength plasmonic nanostructures. Recently, significant breakthroughs in the wavefront manipulation, such as abnormal and out-of-plane refraction and reflection, have been achieved by laterally inhomogeneous metasurfaces. Another prominent example is the spectrally selective image formation demonstrated by computationally encoded metasurfaces using the principles of digital holography [1]. In the view of the growing structural complexity of contemporary metasurfaces, the lack of comprehensive experimental methods to assess and characterize their performance becomes a critical issue, hampering the development of this field towards real-world applications. In particular, the accurate measurements of absolute phase delays exhibited unclaimed territory in this field of research so far.

As a prerequisite to assess the broadband optical performance of metasurfaces, we introduce a versatile experimental technique, thus providing experimental access to the complex transmission and reflection coefficients of optical metasurfaces. Therefore, we significantly improved and extended our original approach exploiting the principles of white light Fourier-transform spectral interferometry [2]. Our interferometric setup presented in Figure 1 is a polarization interferometer upgraded for simultaneous measurements in transmission and reflection. The two arms of the interferometer are formed in the calcite beam displacer B1. The second displacer B2 serves to recombine the two beams and is followed by a linear polarizer P2, providing interference of the sample and reference beams. The recombined beam is coupled into an endlessly single-mode photonic crystal fiber and delivered to an optical spectrum analyzer. The retrieval of the phase delay between two arms requires transforming the measured data into

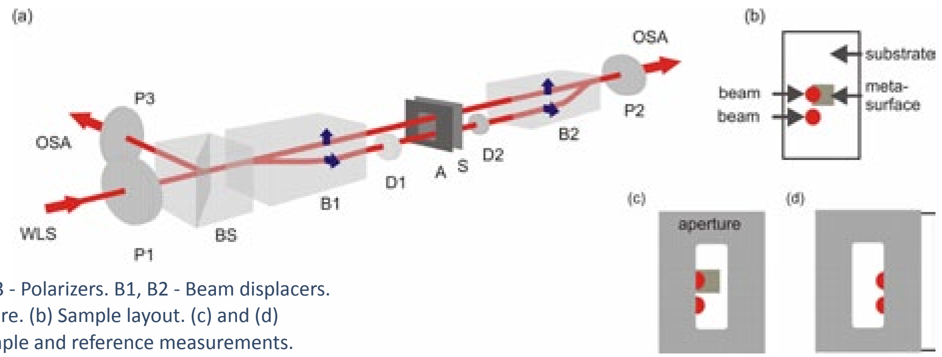

Figure 1:
(a) Interferometric setup. P1, P2, P3 - Polarizers. B1, B2 - Beam displacers. D1, D2 - Delay elements. A - Aperture. (b) Sample layout. (c) and (d) Position of the aperture during sample and reference measurements.

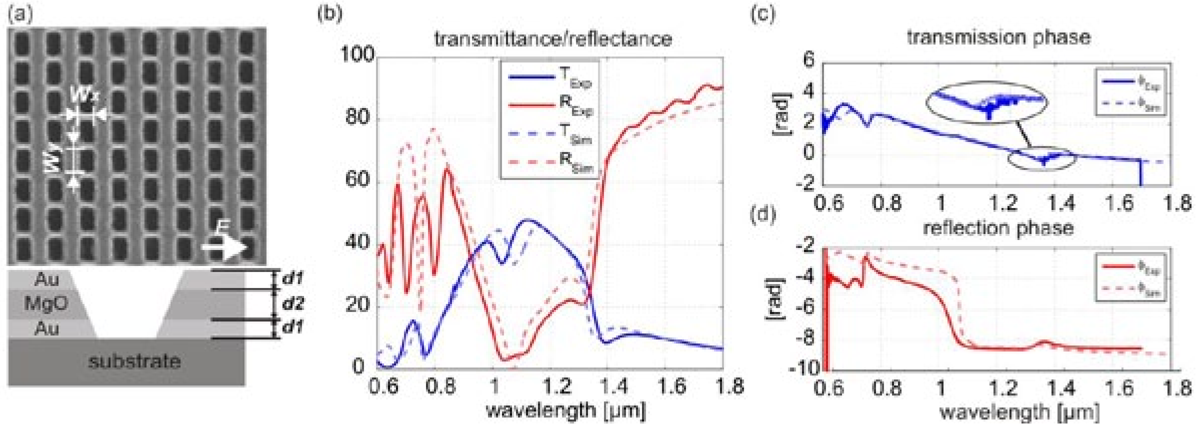

Figure 2:
(a) Electron microscopy image of a metasurface with a fishnet topology whose geometrical parameters are: P_x=P_y= 500 nm, W_x= 180 nm, W_y= 380 nm, d_1= 20 nm, d_2= 40 nm. (b), (c), (d) The measured and simulated transmittance and reflectance, the phase of transmission and the phase of reflection coefficients, respectively. The measured and simulated curves are labeled with "Exp" and "Sim", respectively.

the time domain, to filter an interference term, to back-Fourier transform the filtered term into the wavelength domain, and to finally extract its argument. In order to extract the absolute phase delay accumulated by an unknown specimen, e.g. a metasurface, a second measurement using an object with well-known optical properties in the sample arm is required. In classical interferometric schemes, this meant that the sample containing the metasurface had to be removed and physically substituted by such a referential object. However, since state-of-the-art metasurfaces have typical thicknesses of the order of 100 nm, any misalignment or tilt on the nanometer scale of either object will cause a critical error in the resulting absolute phase. We have solved this challenge by enabling the first and the second measurement in a consecutive way without even moving the sample but using the movable aperture placed in front of it. The accuracy of the method is determined by the signal to noise ratio of the interference signal acquisition, which depends on the transmission and reflection properties of a metasurface and is better than 0.02 rad for transmittance (reflectance) of at least 5%.

In Figure 2 an example of measured phases in transmission and reflection on a fishnet-metasurface used as a basic element in multicolor metasurface based hologram [1] is presented. In terms of reliability and accuracy, this performance benchmark was shown to be superior to common numerical modeling of complex nanostructures and is applicable for a wide range of almost arbitrary optical media. Further extensions of our method, e.g. to address polarization-rotating metasurfaces or oblique incidence amplitude and phase measurements, can be implemented straightforward [3].

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Applied Computational Optics

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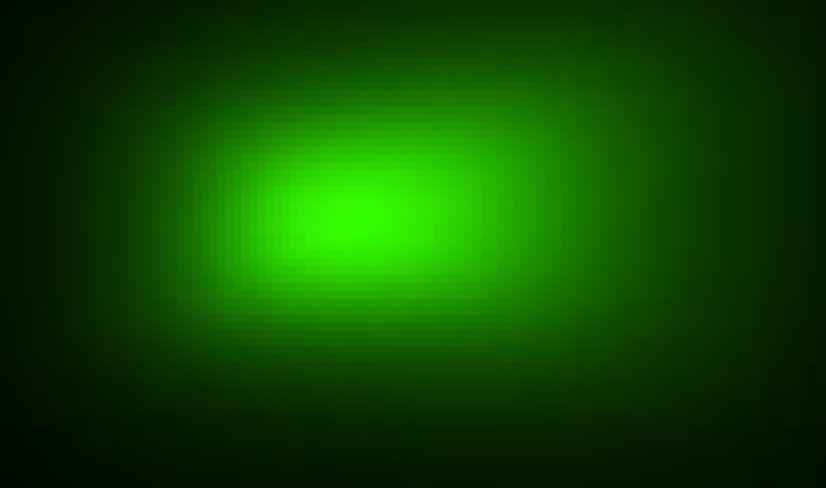

Propagated non-paraxial field after strong-aberrated high-NA Gaussian-to-Top-Heat-beam-shaper.

In 2013, the Optical Engineering Group was renamed into Applied Computional Optics and found a new domicile in the city of Jena, the Jentower.

The Group develops new optical modeling techniques and combines them with established ones in a unified optical modeling concept. To this end we represent light by electromagnetic fields and trace them by a combination of different propagation techniques through optical systems. The modeling methods range from geometrical optics to rigorous solutions of Maxwell's equations. In each region of the system a technique is chosen in such a way, that the best compromise between modeling accuracy and speed for the complete system simulation is obtained.

The following topics were focused in 2013:

- Efficient and rigorous free-space propagation for non-paraxial beams
- Generalization of the Thin Element Approximation (TEA) in order to allow parabasal incident fields
- Rigorous propagation of general electromagnetic fields through prisms and gratings
- Extending field tracing to x-ray sources
- Ultrashort pulse modeling
- Laser resonator analysis
- Planar waveguide modeling for display applications
- Generalized iterative projection type algorithm for DOE design
- Mask design for proximity printing

Author:
Frank Wyrowski

Research fields of Applied Computational Optics

Also in 2013 we worked closely together with LightTrans GmbH and contributed to the development of the optics modeling software VirtualLab™. We also organized three SMETHODS (www.smethods.eu) trainings in Jena on Diffractive Optics and Laser Optics. In 2013 we have intensified our cooperation with the Shanghai Institute (SIOM) in the modeling of lithographic illumination systems as well as with the Harbin Institute of Technology (HIT) in the field of diffractive optics.
In what follows some more detailed information on two selected R&D topics is given.

Analysis on pulse front tilt in simultaneous spatial and temporal focusing

The spatial and temporal behavior of ultrashort pulses has drawn more and more attention. Especially in laser material processing such spatio-temporal behavior has significant influence. We did a detailed analysis of the pulse front tilt (PFT) in simultaneous spatial and temporal focusing (SSTF) mathematically and in simulations. See Figure 1 for the illustration of the setup to be modeled. We applied paraxial field tracing based on the Collins integral for modeling the spatio-temporal focusing process. Using the shift theorem of the Fourier transformation, we provided an explanation of the PFT in focus for general input pulses. By assuming a Gaussian lateral and temporal pulse shape an analytical solution for the field distribution at any position in the focal region was obtained. In the R&D we took the influence of an initial PFT before focusing into considerations as well and found a potential way to control the PFT during the focusing process. With the optical modeling software VirtualLab we performed rigorous simulations of the SSTF to verify our mathematical conclusions. This work was done together with the group Ultrafast Optics of Prof. S. Nolte.

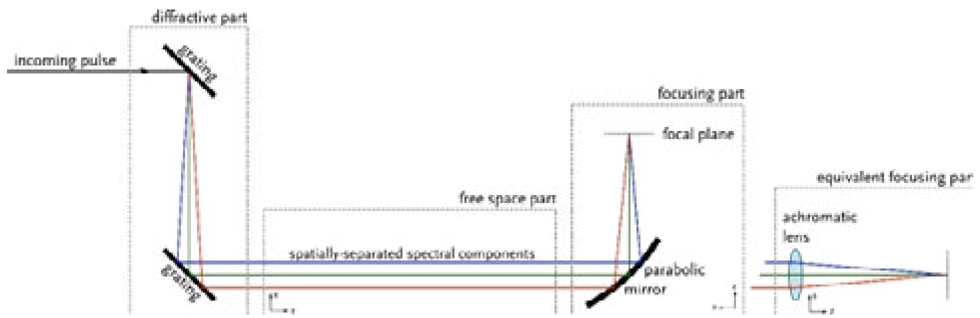

Figure 1:
Optics setup for the SSTF technique.

Resonator modeling by field tracing – a flexible approach for fully vectorial laser resonator modeling

Nowadays lasers cover a broad spectrum of applications, like laser material processing, metrology and communications. Therefore a broad variety of different lasers containing various active media and resonator setups with optical components like aspherical or graded-phase mirrors and lenses, diffractive optical elements, thin film coatings and nonlinear optical components are used to provide high design flexibility. The optimization of such multi-parameter laser setups requires powerful simulation techniques. In literature mainly three practical resonator modeling techniques can be found: Rigorous techniques, e.g. the finite element method (FEM), which are based on the solution of Maxwell's equations with periodic boundary conditions at the cavity edges. These techniques suffer from high numerical effort, resulting in a very restricted computational volume of the resonator cavities. Approximated solutions are based on paraxial Gaussian beam tracing by ABCD matrices, which can simulate optical components introducing quadratic phase terms only. Furthermore the beam propagation technique (BPM) is used to analyze transversal resonator modes. This approach is restricted by the computational effort and the flexibility to simulate a large variety of different optical components. All of these existing approaches have in common, that only a single simulation technique is used for the whole resonator. In contrast we have introduced a combination of different field tracing techniques within the Fox & Li algorithm to fulfill nowadays requirements in the flexible simulation of complex multi-parameter resonators. In field tracing we use a fully vectorial field representation. With this technique we allow the calculation of vectorial, transversal eigenmodes of stable and unstable resonators.

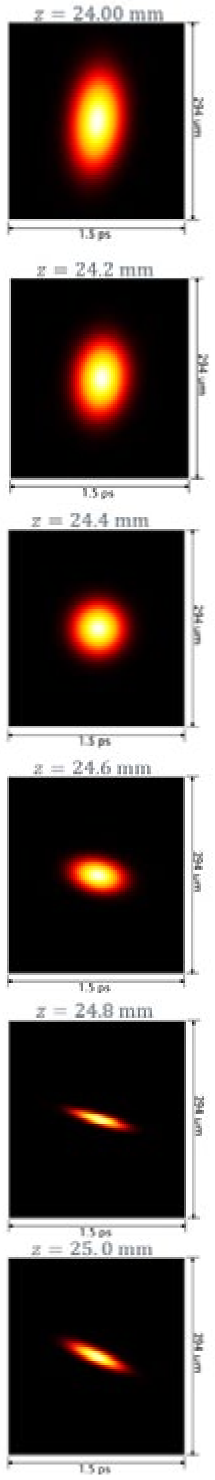

Figure 2:
Pulse propagation into the focal plane at z =25 mm for a SSTF system.

Optical System Design

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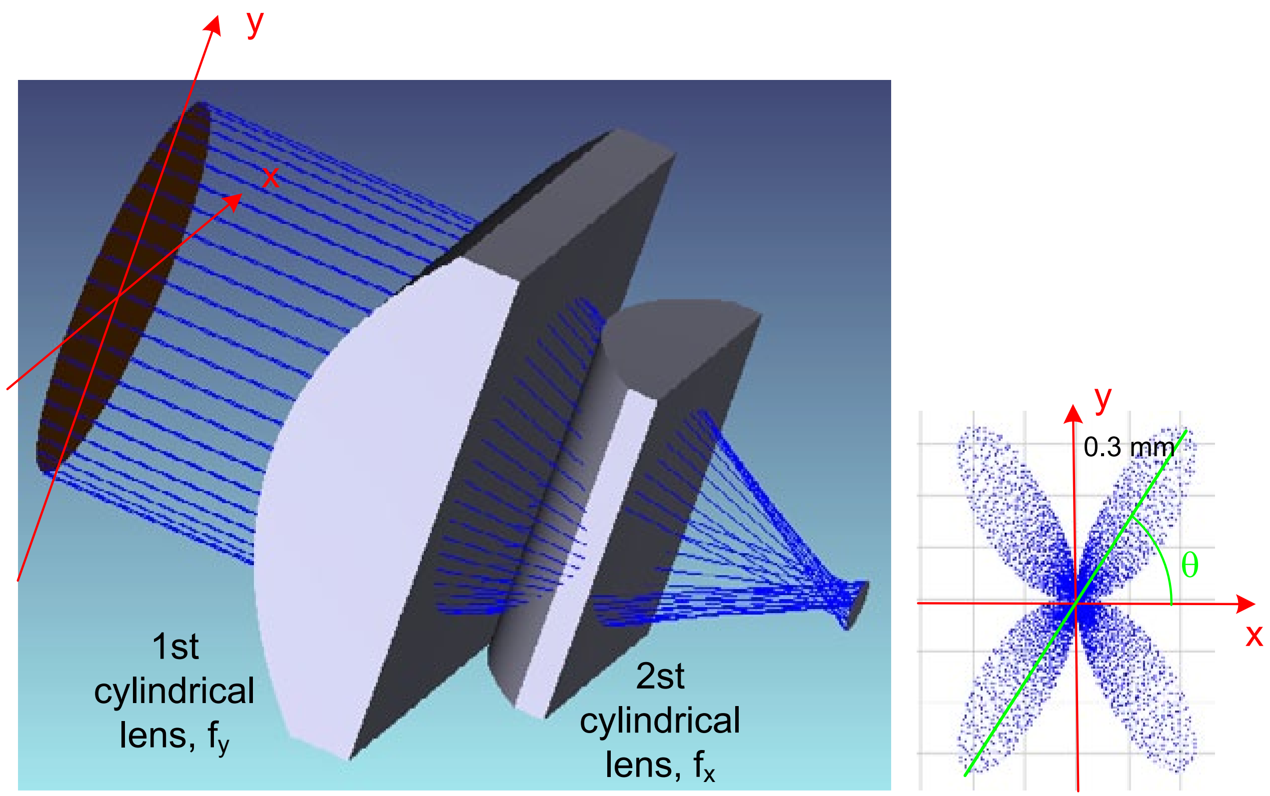

Figure 1:
Layout of a test system with two crossed cylindrical lenses and corresponding spot diagram

Since April 2012, the new endowed professorship Theory of Optical Systems could be assigned by Prof. Herbert Gross. Thirteen companies of the region have launched this facility along with the STIFT Thuringia and the Ernst Abbe Foundation. It is thought to extend this facility to a reseach group with the aim to support small and medium-sized optical companies of the region around Jena in their development and training.

The research priorities of this working group can be divided into two main areas. In classical optics design, especially the following topics will be adressed:

- 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
- 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.

Author:
Herbert Gross, Chang Liu and Olga Rodenko

Extended performance analysis of optical systems free of symmetry

In conventional optical systems, there are many possibilities to evaluate and assess the functional performance. The most prominant examples are geometrical aberrations, wave aberrations, point spread function or the optical transfer function. In the concept phase and the design of optical systems, an understanding of the structure, the effect of the individual components and their contribution to the total quality is quite important. This is supported by the famous idea of the Seidel aberrations, which give additive surface contributions and allow for a detailed analysis of the system. This old fashion approach has two severy restrictions, it is only valid in 3rd order of the perturbation theory of aberrations and it is only defined for circular symmetric systems. Nowadays, more general geometries of the system layout as well as free shaped surfaces without any symmetry are of great interest. The miniaturization of systems, the progress of the manufacturing technology in this field and the development of compact systems with high performance needs for more general tools and concepts to assess the quality and internal structure of the setup. As a first step towards this goal, a proposed theorem according to Aldis [1,2] and a famous generalization following Brewer [3] is used and extended to be able to calculate the surface contributions in a more general system. The basic idea of these approaches is to calculate a finite exact ray and compare the transverse aberration results with the corresponding ideal reference results. In the general case of 3D geometry and surfaces free of symmetry, the reference must be determined by quasi-paraxial neighboring rays in several azimuthal directions. Therefore it is necessary to define a pilot ray which serves as a reference and new optical axis. The application of this concept is first restricted to an anamorphotic system of two crossed aspherical cylindrical lenses and the results are promising and are able to indicate the problems, that are known for these types of systems. One restriction, which is still valid is the consideration of single rays, but corresponding generalizations to have a more integral criterion of performance evaluation are in preparation.

For a generalization of the Brewer formula, the field should be allowed to have an x and a y-component. For this, the paraxial marginal and chief rays must be distinguished in x and y. Therefore as a consequence of the more general geometry, now 4 quasi paraxial rays must be calculated, a marginal and a chief ray in x and y-section respectively. With the following notations:

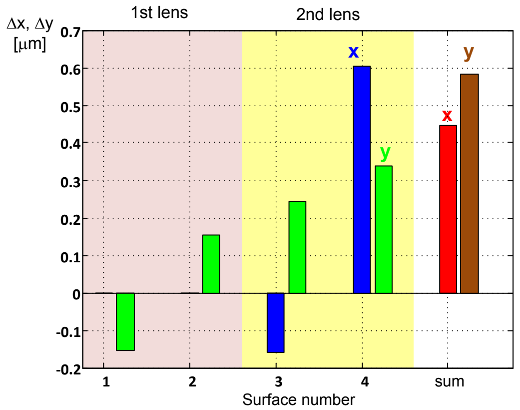

Figure 2:
Contributions of the surfaces of the system to the transverse aberrations in the x- and y-section together with the total values.

x_{pmj} ,y_{pmj}	the paraxial marginal ray height at the surface no. j in x- and y-direction
x_{pN} , y_{pN}	paraxial image height in x and y-direction
u_j , v_j	ray angle of the paraxial marginal ray in the x- and y-section at surface no. j
n_j	refractive index
s_{xj}, s_{yj}, s_{zj}	optical direction cosine, regular cosine multiplied with the refractive index in x, y, z

where Δ indicates the difference of a quantity after and before a surface, the generalized formulas read

$$\Delta x' = \frac{1}{n_N u_N s_{zN}} \sum_{j=1}^{N} \begin{bmatrix} x_j \cdot \left(n_j u_j s_{zj} - n_{j-1} u_{j-1} s_{zj-1}\right) - z_j \cdot \left(n_j u_j s_{xj} - n_{j-1} u_{j-1} s_{xj-1}\right) \\ - x_{pmj} \cdot \left(n_j s_{xj} - n_{j-1} s_{xj}\right) - n_N u_N x_{pN} \cdot \left(s_{zj} - s_{zj-1}\right) \end{bmatrix}$$

$$= \frac{1}{n_N u_N s_{zN}} \sum_{j=1}^{N} x_j \cdot \Delta\left(n_j u_j s_{zj}\right) - z_j \cdot \Delta\left(n_j u_j s_{xj}\right) - x_{pmj} \cdot \Delta\left(n_j s_{xj}\right) - n_N u_N x_{pN} \cdot \Delta\left(s_{zj}\right)$$

$$\Delta y' = \frac{1}{n_N v_N s_{zN}} \sum_{j=1}^{N} \begin{bmatrix} y_j \cdot \left(n_j v_j s_{zj} - v_{j-1} s_{zj-1}\right) - z_j \cdot \left(n_j v_j s_{yj} - n_{j-1} v_{j-1} s_{yj-1}\right) \\ - y_{pmj} \cdot \left(n_j s_{yj} - n_{j-1} s_{yj}\right) - n_N v_N y_{pN} \cdot \left(s_{zj} - s_{zj-1}\right) \end{bmatrix}$$

$$= \frac{1}{n_N u_N s_{zN}} \sum_{j=1}^{N} y_j \cdot \Delta\left(n_j u_j s_{zj}\right) - z_j \cdot \Delta\left(n_j u_j s_{yj}\right) - y_{pmj} \cdot \Delta\left(n_j s_{yj}\right) - n_N u_N y_{pN} \cdot \Delta\left(s_{zj}\right)$$

In the case of an anamorphotic system independent gaussian image locations must be distinguished in the formulation of the transverse aberration. Figure 1 shows the geometry of the system considered consisting of two crossed aspherical cylindrical lenses with focal lengths of 40 mm and 30 mm together with the spot diagram of the system performance on axis. The strange shape of the pattern can be understood by the non-separability of non-paraxial phase functions of the components in x and y. The mixed x-y-terms of the phase produce corresponding deviations along the 45° diagonal directions. Figure 2 shows the surface contributions of the system to the transverse aberrations and the total value. It is seen, that the first lens as a components works perfectly, while the second lens produces residual aberrations. Corresponding representations under 45° shows the dominant contributions of the aspheres to the wings, which are observed in Figure 1.

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"A System of Optical Design"
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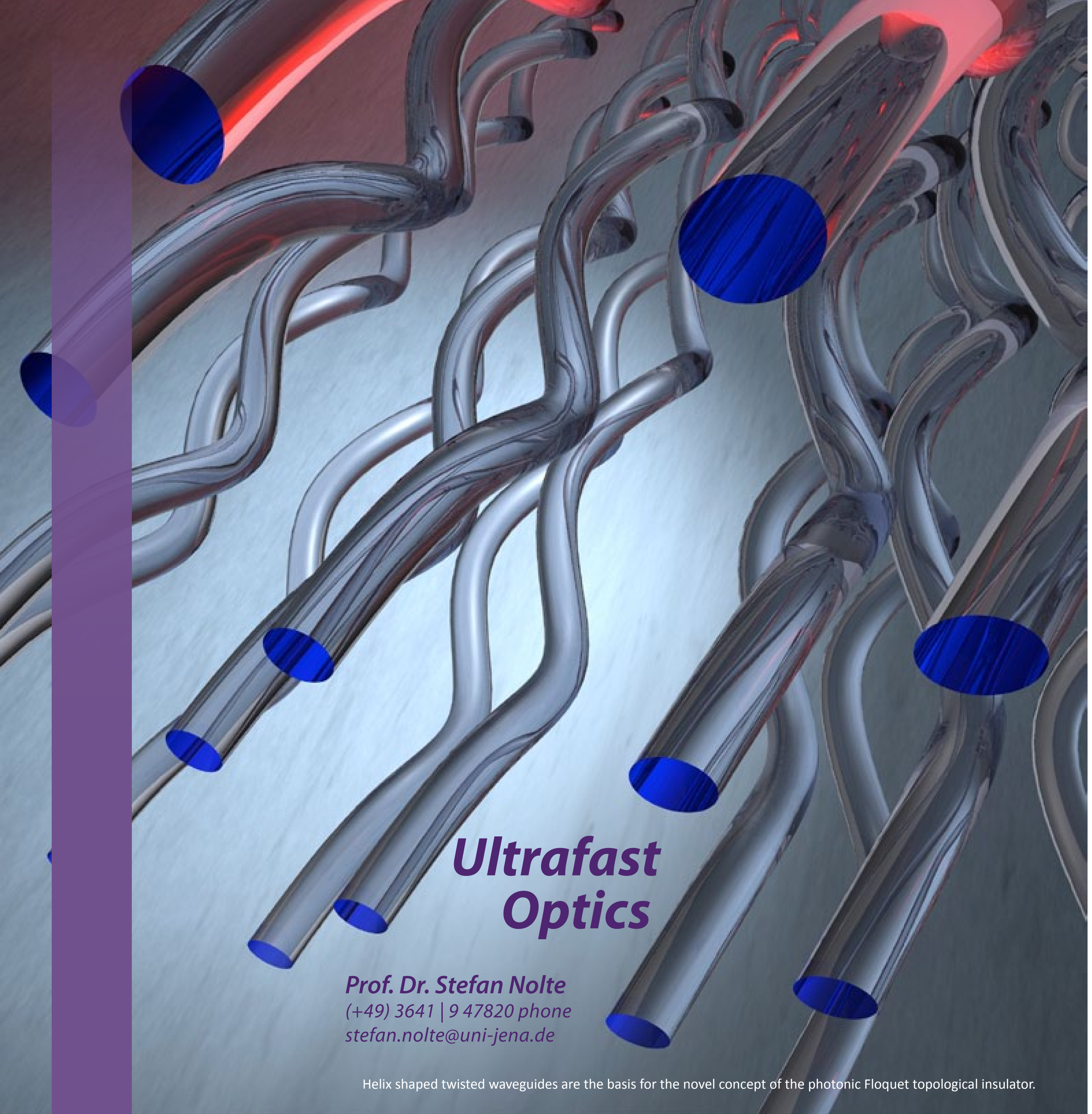

Ultrafast Optics

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Helix shaped twisted waveguides are the basis for the novel concept of the photonic Floquet topological insulator.

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

The scientific topics are:

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

In 2013, some outstanding results were: • realization of low-loss fiber Bragg gratings by femtosecond direct-writing • realization of narrow-linewidth fiber laser using fs-written FBG • femtosecond laser-induced apodized Bragg grating waveguides • time-resolved studies of ultrashort-pulse thin-film ablation • ultrastable bonding of glasses using adapted laser bursts • demonstration of a photonic Floquet topological insulator • observation of edge states in photonic grapheme • experimental boson sampling in fs-written integrated quantum networks • demonstration of strain-induced pseudomagnetic field and photonic Landau levels • realization of fs-induced nanogratings with sub 100 nm period • analysis of structural evolution of nanograting formation after fs irradiation • in vitro study on focusing fs-laser pulses into ocular media for ophthalmic surgery

Authors:
Gabor Matthäus, Thomas Peschel, Stefan Nolte and Andreas Tünnermann

Ultrashort – Pulse Laser Structuring of Thin-Film Solar Modules

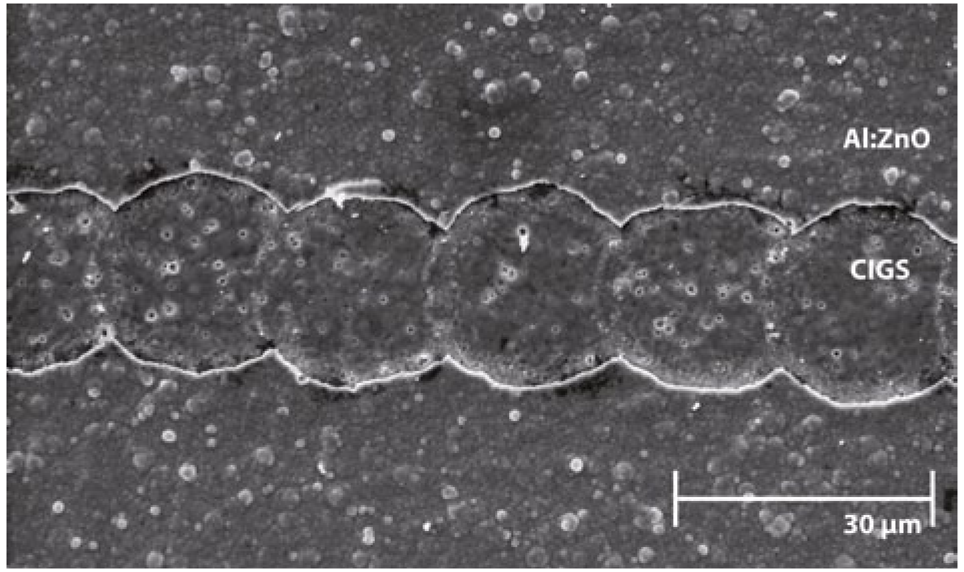

Figure 1:
Generated P3 trench using ultrashort laser pulses.

[1] P. Jackson et al., Prog. Photovolt, Res. Appl. 19, 894-897 (2011).

[2] A. Letsch et al., Laser Technik Journal 10, 16-19 (2013).

Solar technology in particular thin-film solar technology is considered to be one of the cornerstones of future renewable energy concepts. Among currently used materials copper indium gallium diselenide (CIGS) is one of the most promising candidates. Using this semiconductor compound conversion efficiencies higher than 20 % could already be demonstrated on cell level [1]. CIGS solar modules are based on a one to two microns thick multi-layer system. During deposition, trenches are inserted that divide the layers into separated cells and interconnect them in series (Fig. 1). This series connection allows high module voltages at low module currents and therefore reduces resistance losses. The interconnection zone cannot contribute to energy generation and is for that reason called "dead zone". Today mainly mechanical abrasion and thus wearing tools are used for interconnection, which causes very broad and irregular trenches.

As part of the German Federal Ministry of Education and Research (BMBF) funded collaborative project "Tailored for next PV (T4nPV)" ultrashort laser pulses were used as an alternative to mechanical processing. Within these studies CIGS thin-film modules have been structured in a fraction of the previously required time and with significantly increased precision [2]. Using laser pulses with less than 10 ps duration and a wavelength at 515 nm layer thicknesses of about a few 100 nm can be removed selectively without thermal damaging nearby areas.

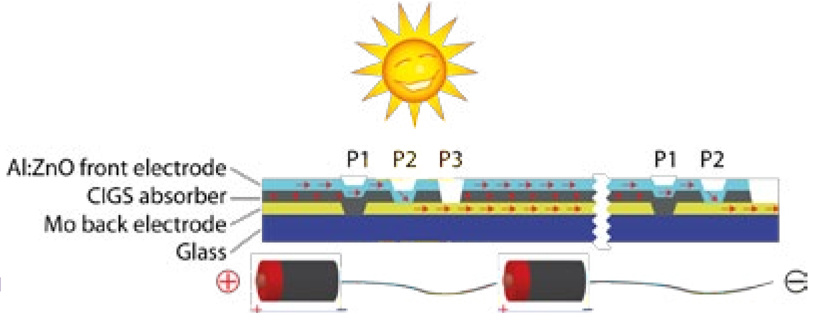

Figure 2:
Schematic that illustrates the connected CIGS thin-film cells within the module.

Due to the increased precision, microscopic cuts inside the CIGS layer system can be provided which match the mechanical references in their electrical properties and allow further miniaturization of the "dead zone" (Fig. 2). In parallel to the experiments a theoretical model was carried out which describes the underlying physical processes. Regarding the specific material system, this model allows a prediction of the optimum laser parameters.

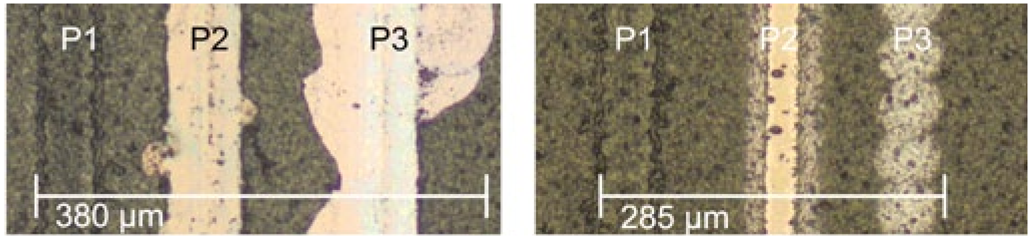

Figure 3:
Conventionally fabricated P2 and P3 trenches (left) in comparison to the completely laser-structured interconnection zone (right).

Author:
Stefan Nolte

Ultrashort laser pulses for effective series-production

Figure 1:
Award ceremony of the German Future prize 2013. From left to right: Jens König (Bosch), German Federal President Joachim Gauck, Dirk Sutter (Trumpf), and Stefan Nolte.
(Foto: Stephanie Pilick)

Ultrashort laser pulses with a duration of a few picoseconds (10^{-12} s) or below provide an efficient way of precisely processing a wide range of materials. By cleverly selecting the right pulse duration, pulse energy and focusing, the material is heated so quickly and forcefully that it is instantly vaporized. Gradually every pulse ablates tiny regions just few nanometers in depth. This enables a melt-free, “cold” ablation without thermal or mechanical damage to the surrounding. While the principle advantages of ultrashort laser pulses for precise materials processing have been impressively demonstrated already about 20 years ago, an economical, industrial use has been impossible in most cases. On the one hand robust, reliable and powerful ultrashort pulse laser systems were missing, on the other hand adapted processes exploiting the full potential of high average power and high repetition rate laser systems had to be developed.

In a joined research approach Bosch, Trumpf, the Friedrich Schiller University Jena and the Fraunhofer IOF succeeded in turning the ultrashort pulse laser into an effective series-production tool. For their collective effort they were awarded the German Future Prize 2013 by German President Joachim Gauck.

The application potential of this technology is enormous. From diamond, glasses and steel, to semiconductors, ceramics and sensitive plastics – virtually any material can be structured with highest precision. This allows to manufacture new products which so far had proved exceedingly difficult – or impossible – to produce. Current application examples include the drilling of extremely fine nozzles for gasoline injection valves, the cutting of strengthened glass for smartphone displays, as well as the structuring of better-tolerated stents.

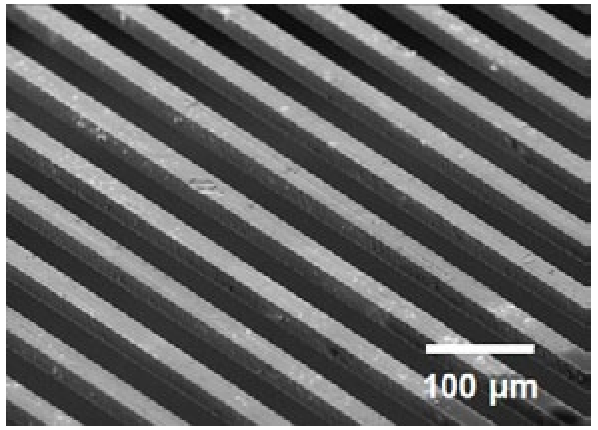

Figure 2:
Metal grid structured in a stainless steel foil.

Presently various potential new applications are investigated at the IOF and the IAP. These span from photovoltaics to laser surgery in ophthalmology. Additionally, the refractive index can be precisely modified within the bulk of glasses and crystals to implement optical functionalities – even highly spatially resolved artificial birefringence can be generated. Efficient Fiber-Bragg gratings can be inscribed for applications as high-power filters or mirrors or as highly sensitive sensing elements. However, even the local bonding of transparent glasses and crystals becomes possible using ultrashort laser pulses. Here, the heat accumulation of successive laser pulses is used to obtain ultimate breaking strengths in the order of the bulk material itself. Even the bonding of dissimilar materials with different thermal expansion coefficients is feasible.

The Centre for Innovation Competence ultra optics makes fundamental contributions to understand the physical and technological possibilities and limitations of monitoring and controlling the properties of light that form the basis for the representation of future optical systems. It will create the requirements for basic elements of an optical system technology which allows the step from discrete components to fully integrated functional units.

Manufacturing Technologies for Advanced Micro-and Nano-Optics

In 2013 the work of the research group Advanced Fabrication Technologies for Micro- and Nano-Optics was concerned with different topics in the fields of electron-beam lithography and diffractive mask-aligner lithography. In a close collaboration with the Company Vistec the electron column of the e-beam writer SB350 OS was extended by a specially developed computer controlled reticle stage for an advanced cell-projection exposure regime. The new stage allows for the use of currently more than 250 different exposure shapes which can be combined in a single exposure. As the exposed pattern defined within a single cell can have a comparable complex shape the exposure speed especially for high resolution pattern as needed e.g. for optical meta-material- or plasmonic-structures increases by up to 3 orders of magnitude. This opens the option to fabricate such structures on application relevant areas.

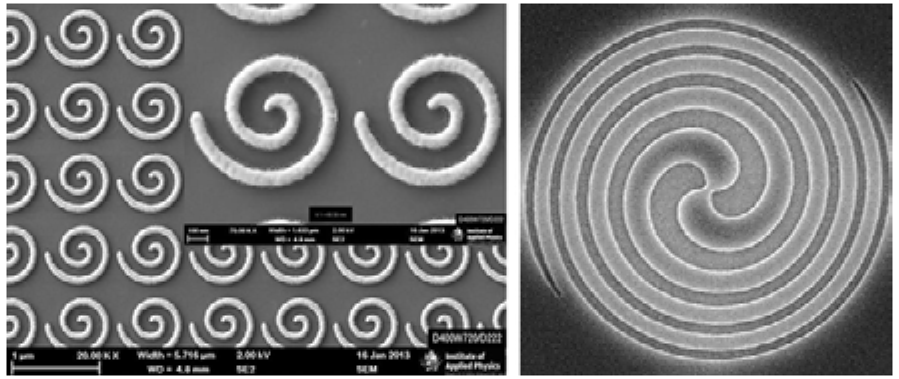

Figure 1:
High resolution pattern with sub-100nm feature size generated by the new cell-projection capability of the SB350 OS e-beam writer.

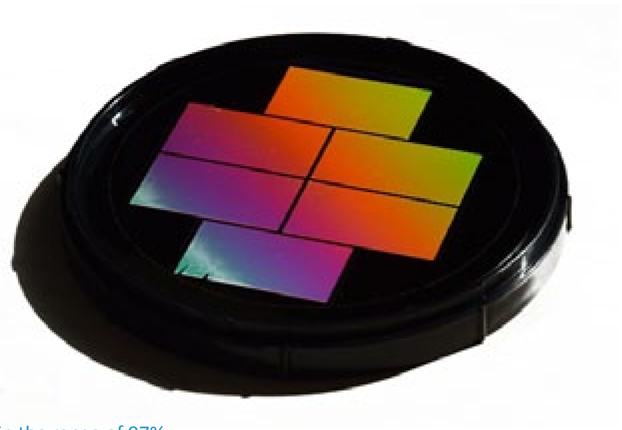

Figure 2:
Gratings for ultra-short pulse compression applications realized by diffractive mask-aligner lithography in a wafer scale technology.
The grating period is 800nm and the achieved diffraction efficiency is in the range of 97%.

Besides the tremendous improvement of exposure speed also the structure quality is significantly improved as a complex pattern does not need to be composed of single primitives anymore.

In a second focus of the work significant advancements of the mask-aligner based diffraction lithography has been achieved. By using multi-level diffractive photo-masks and a specially designed illumination configuration it became possible to realize sub-micrometer period gratings on a wafer scale. The principle was used to fabricate 800 nm period transmissive pulse compression gratings with diffraction efficiencies of 97 %, corresponding to the theoretical limit of the grating design. Before this successful demonstration the fabrication of such gratings required a high-resolution direct write technique like e-beam lithography. In another experiment we used a high-refractive index photo-mask for the realization of a high resolution grating with only 250 nm period, approaching the theoretical resolution limit of the diffractive mask-aligner lithography with an exposure wavelength of 365 nm.

To further promote the diffraction lithography a new specially developed Mask-Aligner has been purchased from the company Suss MicroTec. This recently installed tool offers a shorter exposure wavelength of 250 nm, a special gap-setting module allowing for a highly precise control of the mask-to-wafer distance, and an option for multiple exposures with a highly precise mask shift in between the exposures. These advanced features will allow for high resolution pattern generation with a mask-aligner far beyond current state of the art.

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Diamond-/Carbon-based Optical Systems

Integrated Photonic Quantum Computing

Quantum information science addresses various fundamental questions on how to harness quantum mechanical phenomena for storing, processing and transmitting information. Therefore, quantum information is both fundamental science and a progenitor for new technologies. One of the most intricate future technologies is the quantum computer which promises exponentially faster operation for particular tasks such as factorizing and searching databases. Systems involving photonic quantum states seem likely to play a central role as light is a logical choice when dealing with quantum communication, metrology and lithography. A promising approach to miniaturizing and scaling optical quantum circuits is to use on-chip integrated photonic waveguides, which show strong improvements in performance due to high stability and low noise – crucial aspects for high-fidelity classical and quantum interference.

In one of our latest works, in such a glass chip we realized for the first time the so-called "boson sampling computation". In recent years, several intermediate models of quantum computation have been proposed. Although they do not enable universal quantum computation, these models still provide a dramatic increase in computational speed for particular tasks. In contrast to purely linear computation schemes, these models need neither entangling gate operations, adaptive measurements, nor ancilla photons, and are thus technically more feasible. The intermediate quantum computation model proposed by Aaronson and Arkhipov seems to be extremely resource-efficient, as it utilizes the unique advantages of the mobility and bosonic nature of photons to solve the so-called sampling problems that are believed to be classically hard. In our work, we experimentally solved small instances of the boson sampling problem by implementing Aaronson and Arkhipov's model of computation with non-interacting bosons (in our case photons).

[1] M. Tillmann, B. Dakic, R. Heilmann, S. Nolte, A. Szameit, P. Walther: "Experimental Boson Sampling," Nature Photonics 7(7), 540-544 (2013).

Randomly chosen instances of this problem are strongly believed to be hard to solve by classical means. Instances of boson sampling can be realized with quantum systems composed of non-interacting photons that are processed through randomly chosen networks of physical modes. The bosonic nature of the photons leads to non-classical interference, producing an output probability distribution for which there is no known efficient classical sampling algorithm.

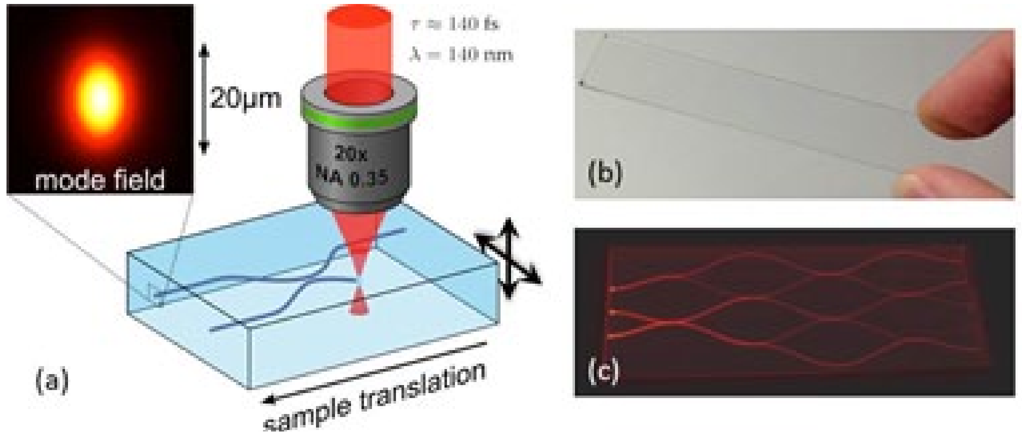

Figure 1:
(a) Setup for writing waveguides using ultrashort laser pulses. The inset shows a typical waveguide mode. (b) An optical chip with a waveguide network. Typical lengths are a few centimeter. (c) Fluorescence microscopy image of a waveguide network that was used for the bosonic sampling computation. (d) Results of the bosonic sampling computation. Shown is the probability for all possibilities that the three input photons occupy three different output modes. The red bars indicate the measured probabilities, whereas the blue bars display the output probabilities from the reconstructed unitary matrix.

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Junior Research Group: Multiphoton Microscopy

Research Areas

Research focuses on the synthesis, characterization and manipulation of semiconductor and oxide-nanomaterials for bioimaging applications, and their combination with plasmonic structures to enhance their optical properties.

Main scientific areas include:

- Bottom-up chemical synthesis of oxide core and gold shell nanowires for imaging and lab-on-a-chip applications
- Top-down fabrication of oxide nanowaveguides for nonlinear ultrafast photonic devices
- Nonlinear imaging of semiconductor and oxide nanomaterials
- Plasmonic nanoparticles integrated in optofluidic devices

Research Methodes

The key facilities are femtosecond lasers ranging from the visible to the near- infrared, coupled to home-built wide illumination microscopes with sensitive electron-magnified charge-coupled device (CCD) cameras. Furthermore, chemicals for the bottom-up synthesis of nanomaterials and soft lithography for optofluidic chip fabrication are utilized. The nanomaterial research involves access to electron-beam lithography, high-resolution microscopy (AFM, SEM, TEM), powder x-ray diffraction and dynamic light-scattering.

Funding

Carl Zeiss Stiftung, JSMC,
Pro Chance

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Highlights in 2013

The nonlinear optical properties of $LiNbO_3$ nanowires (NWs) fabricated by a top-down ion beam enhanced etching method (Fig. 1a) were studied. First, we demonstrated generation and propagation of the second-harmonic (SH) light in $LiNbO_3$ NWs (Fig. 1b). Then, we showed local fluorescence excitation of dye with the propagated SH signal in standard concentrations as used for biological applications [1]. Thus, such NWs have a great potential in localized delivery of light for biological applications.

Besides NWs, our research focuses on the nonlinear optical properties of barium titanate ($BaTiO_3$) nanocrystals down to a size that was never investigated before [2]. To do so, we developed a second-harmonic generation (SHG) optical measurement setup based on a home-built transmission microscope with a large excitation spot to avoid scanning. Based on power and polarization dependent experiments of the SHG signals, we discussed the crystallographic properties of $BaTiO_3$ nanoparticles with diameters from 22 to 70 nm (Fig. 1c). We are convinced that nonlinear optics can help to determine material's crucial changes at very small sizes.

[1] A. Sergeyev, R. Geiss, A. S. Solntsev, A. Steinbrück, F. Schrempel, E.-B. Kley, T. Pertsch, R. Grange: "Second-harmonic generation in lithium niobate nanowires for local fluorescence excitation" Opt. Express 21, 19012–21 (2013).

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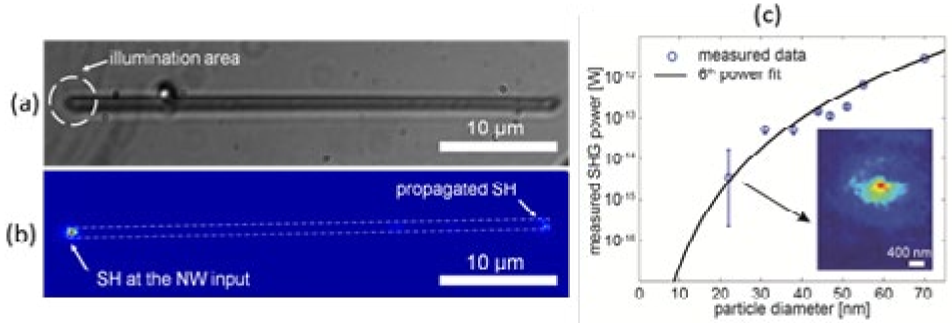

Figure 1:
(a) Bright field image and (b) SH image of a $LiNbO_3$ NW. (c) $BaTiO_3$ nanoparticle diameters versus the SHG logarithm power and the 6th power fit (solid line). Inset: SHG image from the 22 nm particle.

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Junior Research Group: Atomic Layer Deposition

- Emmy-Noether group -

Research Areas

The group Atomic Layer Deposition of Optical Coatings aims to establish this coating technology in the development of novel and improved optical elements.
They currently focus on ALD coatings for:

- Low refractive index/ porous materials
- Monitoring nucleation and ALD growth
- Advanced nano structuring technologies
- Metal wire grid polarizers
- High efficiency compressor gratings
- Guided mode resonance gratings

Research Methodes

Two plasma-enhanced atomic layer deposition reactors are available.
These are located in the clean room and are equipped with in situ monitoring techniques for experimental characterization by means of spectroscopic ellipsometry in the 245 nm - 1700 nm spectral range. The equipment comprises:

- OpAL PEALD, Oxford Plasma Technologies
- Sunale R200, Picosun Oy
- J. A. Woollam spectroscopic ellipsometer

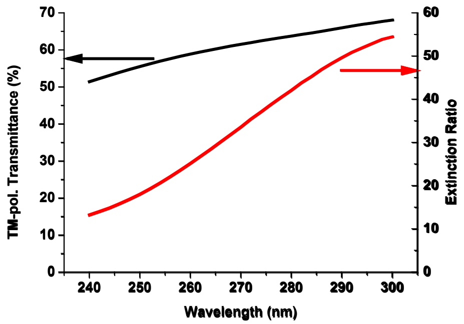

Figure 2:
TM-polarized transmittance and extinction ratio of the iridium wire grid polarizer.

Highlights in 2013

Iridium polarizers

Polarizer diffractive optical elements for the UV spectral range are difficult to realize due to stringent requirements on their structural parameters (period < 100 nm, grating width ca. 20 nm, and grating height ca. 100 nm). Here, we apply a frequency doubling technique to realize metal wire polarizer gratings whereby a template photoresist grating is coated with iridium (Ir) by atomic layer deposition (ALD). Then, etching of the top and bottom horizontal parts of the Ir is performed by ion beam etching under normal incidence and the photoresist is removed by inductively coupled plasma O_2 etching. Figure 1 shows the advantage of ALD to produce highly uniform, conformal coatings on the nanostructured substrates and the high quality of the iridium wire polarizer.

The polarizer element allows TM-polarized light to be transmitted, whereas TE-polarized light is blocked. The optical performance of an Ir polarizer is depicted in Fig. 2.

Funding by the German Research Society (DFG), the Thuringian Ministry of Education, Science and Culture (TMBWK) and ProChance is highly acknowledged.

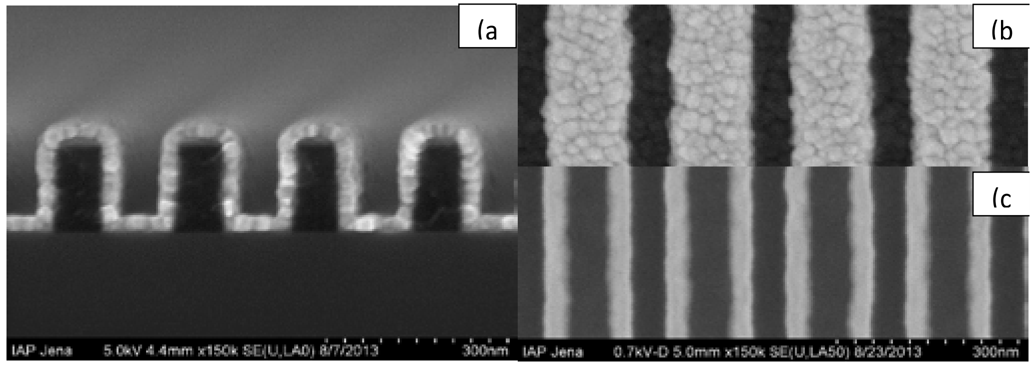

Figure 1:
Scanning electron microscopy images of iridium ALD coating on photoresist grating structure (cross section (a), top view (b)), and of the iridium polarizer (c) designed by frequency doubling.

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PUBLICATIONS

Aim of applied research is the implementation of the results and thus to make contributions to overcome certain problems of the future. For this reason, the research actually not only ends in itself, but their results must be discussed and adjusted with further findings. In the end again, new ideas and scientific approaches can be developed.

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C. Helgert, T. Pertsch: Deterministic amorphous metamaterials and their optical far-field response, C. Rockstuhl and T. Scharf, Amorphous Nanophotonics, Springer Verlag, Berlin 2013.

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Conference Contributions

Invited Talks

A. Brückner, R. Berlich, R. Leitel, P. Dannberg, B. Höfer, F. Wippermann, A. Bräuer, A. Tünnermann: Sehen mit den Augen der Insekten: Neue Ansätze für die Mikroskopie, OSTEOLOGIE 2013, Weimar, Germany, 6. - 9. March 2013.

A. Chipouline: Optical metamaterials: scientific and educational aspects, META`13, Sharjah, UAE, 17. - 22. March 2013.

A. Chipouline: Optical metamaterials for biosensing, Light and matter interaction, AFM technique, Potsdam, Germany, 13. - 15. Feb. 2013.

A. Chipouline: Optical metamaterials: scientific and educational aspects, METAMORPHOSE VI Kongress, London, UK, 3. - 5. Apr. 2013.

A. Chipouline: Optical quantum metamaterials, Days of Diffraction, St. Petersburg, Russia, 26. - 31. May 2013.

A. Chipouline: Optical metamaterials: scientific and educational aspects, Nanostructures, nanoparticles, and nanocontainers, Golm, Germany, 5. - 9. May 2013.

A. Chipouline: Optical metamaterials: scientific and educational aspects, Innovative Lehrmittel für das Erlernen physikalischer Konzepte, Garching, Germany, 3. - 4. Jul. 2013.

A. Chipouline: Optical metamaterials: scientific and educational aspects, METAMATERIALS'13, Bordeaux, France, 3. - 4. Jul. 2013.

A. Nathanael, D. Lehr, H. Hartung, F. Schrempel: Analysis and Nanopatterning for Photonics, ZEISS ORION User Meeting, Dresden, Germany, 10. - 11. Dez. 2013.

A. Szameit: Superballistic transport and anomalous diffusion in inhomogeneous lattices, 546. WE-Heraeus-Seminar on "Light in disordered Photonic Media", Bad Honnef, Germany, 2. - 4. Dez. 2013.

A. Szameit: Photonic graphene - The physics of honeycomb waveguide arrays, Advances in Quantum Chaotic Scattering conference, Dresden, Germany, 9. - 13. Sep. 2013.

A. Szameit, J. M. Zeuner, S. Nolte, M. C. Rechtsman, Y. Plotnik, M. Segev: Photonic Graphene: Ultrastrong magnetic fields and Floquet topological insulators, Quantum Simulations conference, Benasque, Spain, 28. Feb. - 5. March. 2013.

A. Szameit, S. Nolte: Nonlinear light propagation in fs laser-written waveguide arrays, Progress in Ultrafast Laser Modifications of Materials workshop, Cargesé, Corsica, France, 14. - 19. Apr. 2013.

A. Tünnermann: Technical advances and future prospects of fiber lasers and amplifiers, International Symposium on Photoelectronic Detection and Imaging, Beijing, China, 25. - 27. Jun. 2013.

A. Tünnermann: Towards isolated attosecond pulses at Megahertz Repetition rates, Sino-German Symposium on Attosecond Pulse Generation and Application, Beijing, China, 27. Jun. 2013.

A. Tünnermann: Advanced solid state lasers and fiber lasers – Trends and Markets, LASER World of Photonics 2013, Munich, Germany, 13. - 16. May 2013.

A. Tünnermann, J. Limpert: High peak and average power ultrafast fiber lasers, Frontiers in Optics, Orlando, USA, 6. - 10. Okt. 2013.

C. Jauregui, H.-J. Otto, F. Stutzki, F. Jansen, J. Limpert, A. Tünnermann: Recent Progress in the Understanding and Mitigation of Mode Instabilities, Frontiers in Optics, Orlando, USA, 6. - 10. Okt. 2013.

C. Menzel, B. Walther, M. Falkner, T. Pertsch: Metasurfaces for polarization and diffraction control, Photonica 2013, Belgrad, Serbia, 25. - 31. Aug. 2013.

C. Menzel, E. Hebestreit, S. Mühlig, S. Burger, C. Rockstuhl, F. Lederer, T. Pertsch: Towards homogeneous magnetic metamaterials - a comprehensive multipole analysis, META'14, Sharjah, VAE, 16. - 23. March 2013.

C. Rockstuhl, R. Alaee, C. Menzel, U. Huebner, E. Pshenay-Severin, S. Bin Hasan, T. Pertsch, F. Lederer: Exploiting extreme coupling in nanoplasmonic elements, NOMA, Cetraro, Italy, 10. - 15. Jun. 2013.

E.-B. Kley: , ISMOA 2013, Bandung, India, 22. Jun. - 1. Jul. 2013.

F. Dreisow, S. Richter, F. Zimmermann, R. Keil, M. Heinrich, R. Heilmann, A. Szameit, S. Nolte: Ultrafast Laser Proceeding of Transparant Materials, EuroMAT 2013, Sevilla, Spain, 9. - 13. Sep. 2013.

F. Eilenberger, K. Prater, S. Minardi, T. Pertsch: Discrete Light Bullet Vortices, Workshop on Nonlinear Photonics, Sudak, Ukraine, 10. - 11. Sep. 2013.

F. Eilenberger, S. Minardi, F. Lederer, J. Kobelke, K. Schuster, Y. Kartashov, L. Torner, U. Peschel, T. Pertsch: Nonlinear spatio-temporal dynamics in microstructured fibers, Nonlinear Schrödinger Equation: Theory and Applications, Heraklion, Greece, 20. - 24. May 2013.

F. Lederer, S. Mühlig, C. Rockstuhl, R. Alaee, C. Menzel: Tailoring meta-atoms for specific metamaterial applications, OWTNM, Twente, Netherlands, 19. - 20. Apr. 2013.

F. Schrempel, A. Nathanael, D. Lehr, H. Hartung: Material- und Strukturanalyse sowie Nanostrukturierung mit dem Helium-Ionenmikroskop, 47. Metallographie-Tagung mit Ausstellung, Friedrichshaven, Germany, 18. - 20. Sep. 2013.

H.-J. Otto, C. Jauregui, F. Stutzki, F. Jansen, J. Limpert, A. Tünnermann: Mitigation Strategies for Mode Instabilities in High-Power Fiber-Laser Systems, CLEO. Europe and EQEC 2013 Conference Digest, München, Germany, 12. - 16. May 2013.

J. Limpert: Faserlaser - Stand und Perspektiven, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

J. Limpert: High repetition rate technology, Heraeus DPG Physics School, Bad Honnef, Germany, 15. - 20. Sep. 2013.

J. Limpert, C. Jauregui, H.-J. Otto, F. Stutzki, F. Jansen, T. Eidam, A. Tünnermann: Understanding and Mitigation of Modal Instabilities in High Power Fiber Laser and Amplifiers, Advanced Solid-State Lasers Congress, Paris, France, 27. Okt. - 1. Nov. 2013.

J. Limpert, T. Gottschall, J. Rothhardt, S. Breitkopf, S. Hädrich, C. Jauregui, M. Kienel, A. Klenke, M. Baumgartl, M. Krebs, R. Lehneis, H.-J. Otto, F. Jansen, T. Eidam, A. Steinmetz, F. Stutzki, S. Demmler, C. Jocher, A. Tünnermann: High repetition rate ultrafast fiber lasers and their use in high-field science, TOWNES WINTER SYMPOSIUM, Townes, USA, 11. - 15. March 2013.

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J. M. Zeuner, M. C. Rechtsman, R. Keil, M. Segev, A. Szameit: Strain-induced magnetic field in photonic graphene, Artificial Graphene Meeting, Cuernavaca, Mexico, 25. Nov. - 6. Dez. 2013.

J. Rothhardt, S. Hädrich, M. Krebs, S. Demmler, J. Limpert, A. Tünnermann: Coherent soft x-ray sources for spectroscopic applications, 10th Topical Workshop of the SPARC Collaboration, Jena, Germany, 28. - 30. Okt. 2013.

M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, D. Podolsky, Y. Lumer, A. Szameit, M. Segev: Photonic Floquet Topological Insulators, Workshop on Nonlinear Schrödinger Equation: Theory and Applications, Heraklion, Greece, 20. - 24. May. 2013.

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M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, Y. Lumer, S. Nolte, M. Segev, A. Szameit: Photonic Floquet Topological Insulators, Topological Phenomena in Quantum Dynamics and Disordered Systems conference, Banff, Canada, 3. - 8. Feb. 2013.

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M. C. Rechtsman, Y. Plotnik, J. M. Zeuner, D. Podolsky, Y. Lumer, M. Segev, A. Szameit: Artificial gauge fields and topological protection in photonic lattices, Workshop on Synthetic Gauge Fields with Atoms and Photons, Trento, Italy, 1. - 7. Jul. 2013.

R. Keil: Quantum random walks in waveguide lattices, Artificial Graphene Meeting, Cuernavaca, Mexico, 25. Nov. - 6. Dez. 2013.

R. Keil, K. Poulios, D. Fry, J. D. A. Meinecke, J. C. F. Matthews, A. Politi, M. Gräfe, M. Heinrich, S. Nolte, J. L. O'Brien, A. Szameit: Two-dimensional integrated quantum walks of correlated photon pairs, 22nd International Laser Physics Workshop, Prague, Czech Republic, 15. - 19. Jul. 2013.

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S. Kroker, S. Steiner, T. Käsebier, E.-B. Kley, A. Tünnermann: High contrast gratings for high precision metrology, SPIE Photonics West, OPTO, San Francisco, USA, 2. - 7. Feb. 2013.

S. Schröder, M. Trost, A. Duparré: Angle resolved scattering at 193 nm and 13,5 nm, 273. PTB-Seminar: VUV and EUV Metrology, Berlin, Germany, 24. - 25. Okt. 2013.

T. Eidam, C. Jauregui, H.-J. Otto, F. Jansen, F. Stutzki, J. Limpert, A. Tünnermann: Mode instabilities in large-mode-area fiber amplifiers, CLEO.Europe and EQEC 2013 Conference Digest, München, Germany, 12. - 16. May 2013.

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U. Zeitner, F. Fuchs, M. Oliva, E.-B. Kley: Recent Advancements of High-Performance Gratings for Spectroscopic- and Laser-Applications, 3rd EOS Conference on Manufacturing of Optical Components (EOSMOC 2013), Munich, Germany, 13. - 15. May 2013.

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Posters

A. Sergeyev, R. Geiss, E.-B. Kley, T. Pertsch, R. Grange: Generation and propagation of the second-harmonic in lithium niobate nanowires, 30th Course NANO-STRUCTURES FOR OPTICS AND PHOTONICS, Erice, Italy, 4. - 19. Jul. 2013.

C. Jauregui, F. Stutzki, F. Jansen, J. Limpert, A. Tünnermann: Laser-Induced Efficiency Improvement for Thulium-doped Fiber Laser Systems, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

C. Vetter, T. Eichelkraut, A. Szameit: Optical Solenoid Beams: A new avenue of particle manipulation, 546. WE-Heraeus-Seminar on "Light in disordered Photonic Media", Bad Honnef, Germany, 2. - 4. Dec. 2013.

C. Voigtländer, R. G. Krämer, J. U. Thomas, D. Richter, A. Tünnermann, S. Nolte: Variable period change of femtosecond written fiber Bragg gratings with a deformed wavefront, Progress in Ultrafast Laser Modifications of Materials, Cargesé, Corsica, France, 14. - 19. Apr. 2013.

D. Richter, C. Voigtländer, R. G. Krämer, J. U. Thomas, A. Tünnermann, S. Nolte: Femtosecond laser pulse written Volume Bragg Gratings, Progress in Ultrafast Laser Modifications of Materials, Cargesé, Corsica, France, 14. - 19. Apr. 2013.

F. Eilenberger, M. Bache, S. Minardi, T. Pertsch: Pressure tunable cascaded third order nonlinearity and temporal pulse switching, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

F. Hashimoto, S. Richter, S. Nolte, Y. Ozeki, K. Itoh: Measurement of temperature dynamics by time-resolved micro-Raman spectroscopy during high repetition rate ultrafast laser microprocessing, Japan Spring Meeting, Kanagawa, Japan, 27. - 30. March 2013.

F. Jansen, F. Stutzki, C. Jauregui, J. Limpert, A. Tünnermann: Improved Delocalization of Higher-Order Modes in Large-Pitch Fibers by Breaking the Symmetry, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

F. Stutzki, H.-J. Otto, F. Jansen, C. Jauregui, J. Limpert, A. Tünnermann: High Power Ytterbium-doped Ge-pedestal Large-Pitch Fiber, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

H.-J. Otto, C. Jauregui, F. Stutzki, J. Limpert, A. Tünnermann: Dependence of Mode Instabilities on the Extracted Power of Fiber Laser Systems, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

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L. von Grafenstein, S. Breitkopf, A. Klenke, T. Eidam, I. Pupeza, H. Carstens, S. Holzberger, E. Fill, J. Limpert, A. Tünnermann: Ultra-long enhancement cavities as a promising approach to raise femtosecond lasers to a new level of output parameters, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

M. Bache, F. Eilenberger, S. Minardi: Higher order Kerr effect and Harmonic cascading in gases, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

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M. Gräfe, A. S. Solntsev, R. Keil, A. Tünnermann, S. Nolte, A. A. Sukhorukov, Y. S. Kivshar, A. Szameit: Photon pair generation in quadratic waveguide arrays: A classical optical simulation, CLEO Europe, München, Germany, 12. - 16. May 2013.

M. Gräfe, R. Heilmann, R. Keil, T. Eichelkraut, M. Heinrich, S. Nolte, A. Szameit: Indistinguishable particles and their correlations in non-Hermitian lattices, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

M. Gräfe, R. Heilmann, R. Keil, T. Eichelkraut, M. Heinrich, S. Nolte, A. Szameit: Indistinguishable particles in non-Hermitian lattices and their correlations, CLEO Europe, München, Germany, 12. - 16. May 2013.

M. Kienel, A. Klenke, S. Hädrich, T. Eidam, J. Limpert, A. Tünnermann: Divided-Pulse Amplification for High Energy Extraction, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

M. Kienel, A. Klenke, T. Eidam, C. Jauregui, J. Limpert, A. Tünnermann: Divided-Pulse Amplification for multi-mJ Extraction, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

M. Kienel, T. Eidam, A. Klenke, C. Jauregui, J. Limpert, A. Tünnermann: Analysis of Energy-Scaling Capability of Ultrashort Pulses via Passively Combined Divided-Pulse Amplification, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

N. Modsching, F. Stutzki, F. Jansen, C. Jauregui, J. Limpert, A. Tünnermann: High power very large mode area fiber designs for fiber CPA systems around 2 micron, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

R. Heilmann, R. Keil, S. Nolte, A. Szameit: Generalized directional coupling for high-precision manipulation of the optical phase for classical and quantum light, CLEO Europe, München, Germany, 12. - 16. May 2013.

R. Keil, J. M. Zeuner, F. Dreisow, M. Heinrich, A. Tünnermann, S. Nolte, A. Szameit: Long-range correlations and the random mass Dirac model on an integrated optical platform, CLEO Europe, München, Germany, 12. - 16. May 2013.

R. Lehneis, A. Steinmetz, J. Limpert, A. Tünnermann: Ultrashort pulses from a passively Q-switched microchip laser, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

S. Kroker, T. Käsebier, E.-B. Kley, A. Tünnermann: Silicon Grating Optics for Future Gravitational Wave Detectors, Einstein Telescope Symposium, Hannover, Germany, 22. - 23. Oct. 2013.

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S. Weimann, A. Kay, R. Keil, S. Nolte, A. Szameit: State transfer with time-dependent Hamiltonians in waveguide arrays, CLEO Europe, München, Germany, 12. - 16. May 2013.

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T. Gottschall, T. Meyer, M. Baumgartl, B. Dietzek, J. Popp, J. Limpert, A. Tünnermann: Fiber based optical parametric oscillator for high fidelity coherent anti-stokes Raman (CARS) microscopy, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

T. Siefke, T. Weber, H. J. Fuchs, D. Voigt, E.-B. Kley, A. Tünnermann: Wire grid polarizers for UV applications, PTB-Seminar VUV and EUV Metrology, Berlin, Germany, 24. - 25. Oct. 2013.

A. Brahm, F. Wichmann, C. Gerth, G. Notni, A. Tünnermann: Development of a Recognition Algorithm for THz Spectra, IRMMW-THz 2013, Mainz, Germany, 1. - 6. Sep. 2013.

A. Breitbarth: Hochdynamische 3D-Verfahren, Fraunhofer-Allianz VISION Seminar mit Praktikum, Magdeburg, Germany, 20. - 21. Nov. 2013.

A. Breitbarth, P. Kühmstedt, G. Notni, J. Denzler: Lighting estimation in fringe images during motion compensation for 3D measurements, SPIE Optical Metrology 2013, Munich, Germany, 13. - 16. May 2013.

A. von Finck, T. Herffurth, S. Schröder, A. Duparré: Compact light scatter techniques for optical coatings, Optical Interference Coatings (OIC, Whistler, Canada, 16. - 21. Jun. 2013.

C. Bräuer-Burchardt, S. Heist, P. Kühmstedt, G. Notni: Comparison of unwrapping strategies for a 3D measurement system based on a tailored free-form mirror for fringe generation, Fringe 2013, 7th International Workshop on Advanced Optical Imaging & Metrology, Nürtingen, Germany, 8. - 11. Sep. 2013.

C. Bräuer-Burchardt, S. Heist, P. Kühmstedt, G. Notni, S. Zwick: Calibration of a Free-Form Mirror for Optical 3D Measurements Using a Generalized Camera Model, 8th International Symposium on Image and Signal Processing and Analysis (ISPA 2013), Trieste, Italy, 4. - 6. Sep. 2013.

C. Gerth, R. Dietz, A. Brahm, G. Notni, A. Tünnermann: Highly efficient terahertz photoconductive switch at 1060nm excitation wavelength for multichannel THz system, IRMMW-THz 2013 – 38th International Conference on Infrared, Millimeter and Terahertz Waves, Mainz, Germany, 1. - 6. Sep. 2013.

PUBLICATIONS

C. Großmann, M. Pertenais, G. Notni, A. Tünnermann: A novel concept of a vein viewer based on a bidirectional OLED microdisplay, SID Display Week 2013, Vancouver, Canada, 19. - 24. May 2013.

C. Reinlein, M. Appelfelder, M. Goy: Results on the high power testing of screen-printed deformable mirrors, 9th International Workshop on Adaptive Optics for Industry & Medicine, Stellenbosch, South Africa, 2. - 6. Sep. 2013.

C. Richter, F. Burmeister, F. Zimmermann, S. Döring, A. Tünnermann, S. Nolte: Formation of disruptions in molten fused silica induced by heat accumulation of ultrashort laser pulses at high repetition rates, CLEO. EUROPE – IQEC 2013, Munich, Germany, 12. - 16. May 2013.

D.A. Guilhot, M. Gilaberte, S. Ferrando, P. Pol-Ribes, D. Montes, M. Galan, T. Burkhardt, E. Beckert, M. Hornaff: Miniaturized frequency doubled DPSS assembled using solderjet bumping technology, Smart Systems Integration Conference (SSI 2013), Amsterdam, The Netherlands, 13. - 14. March 2013.

E. Beckert, O. Pabst, Z. Shu, J. Perelaer, R. Eberhardt, A. Tünnermann, U. Schubert, H. Becker: Inkjet-printed functionalities for microfluidic Lab-on-a-Chip systems, Smart Systems Integration Conference (SSI 2013), Amsterdam, The Netherlands, 13. - 14. March 2013.

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M. Kienel, A. Klenke, S. Breitkopf, M. Baumgartl, T. Eidam, J. Limpert, A. Tünnermann: Passive Coherent Beam Combining of Temporally Cascaded Pulses, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

M. Kienel, A. Klenke, S. Breitkopf, T. Eidam, C. Jauregui, J. Limpert, A. Tünnermann: Fiber Amplifier CPA System using Divided-Pulse Amplification for multi-mJ Extraction, CLEO.Europe and EQEC 2013 Conference Digest, Munich, Germany, 12. - 16. May 2013.

M. Krebs, S. Hädrich, S. Demmler, J. Rothhardt, A. Zaïr, L. Chipperfield, J. Limpert, A. Tünnermann: Attosekundenpulserzeugung mit Pulswiederholraten im Megahertzbereich, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

M. Zhong, H. Gross: Design and Simulation of the Hyperchromatic Confocal System in Metrology, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

N. Becker, F. Eilenberger, T. Pertsch: Airy pulses and pulses with arbitrary temporal trajectories, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

N. Haarlammert, M. Rekas, O. de Vries, A. Kliner, A. Liem, T. Schreiber, R. Eberhardt, A. Tünnermann,: Polarization dependent nonlinear limitations in continuous-wave high power fi ber amplifi ers, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

N. Lange, F.C. Wippermann, E. Beckert, R. Eberhardt, A. Tünnermann: Innovative approach to high stroke electrostatic actuators, SPIE Photonics West, MOEMS-MEMS, San Francisco, USA, 2. - 7. Feb. 2013.

R. G. Krämer, A. Liem, C. Voigtländer, J. U. Thomas, D. Richter, T. Schreiber, A. Tünnermann, S. Nolte: 514 monolithic fiber laser with a femtosecond inscribed fiber Bragg grating, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

R. G. Krämer, A. Liem, C. Voigtländer, J. U. Thomas, D. Richter, T. Schreiber, A. Tünnermann, S. Nolte: High power 1.2 kW monolithic fiber laser with a femtosecond inscribed fiber Bragg grating, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

R. G. Krämer, C. Voigtländer, E. Freier, A. Liem, J. U. Thomas, D. Richter, T. Schreiber, A. Tünnermann, S. Nolte: Femtosecond pulse inscription of a selective mode filter in large mode area fibers, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

R. G. Krämer, C. Voigtländer, J. U. Thomas, D. Richter, A. Tünnermann, S. Nolte: Selective mode filter in a large mode area fiber inscribed by ultrashort laser pulses, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

R. G. Krämer, R. J. Williams, A. Tünnermann, S. Nolte, M. J. Withford: Core-scanned fibre Bragg gratings inscribed using ultrashort pulses and a point by point setup, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

R. Geiss, H. Hartung, S. Diziain, M. Steinert, F. Schrempel, E. B. Kley, T. Pertsch, A.Tünnermann: Freestanding Photonic Crystals in Lithium Niobate, Conference on electron, ion, and photon beam technology and nanofabrication (EIPBN), Nashville, USA, 28. - 31. May 2013.

R. Geiss, H. Hartung, S. Diziain, M. Steinert, F. Schrempel, E.-B. Kley, T. Pertsch, A. Tünnermann: Fabrication of Freestanding Photonic Crystals in Lithium Niobate by Combining Focused Ion-Beam Writing and Ion-Beam Enhanced Etching, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

R. Kammel, R. Ackermann, A. Tünnermann, S. Nolte: Pump-probe investigation of fs-LIOB in water by simultaneous spatial and temporal focusing, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

R. Keil, A. Perez-Leija, A. Kay, H. Moya-Cessa, S. Nolte, L.-C. Kwek, B. M. Rodriguez-Lara, A. Szameit, D. N. Christodoulides: Coherent quantum transport in waveguide lattices, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

PUBLICATIONS

R. Krämer, A. Liem, E. Freier, C. Voigtländer, J.U. Thomas, D. Richter, T. Schreiber, A. Tünnermann, S. Nolte: High power 1.2 kW monolithic fiber laser with a femtosecond inscribed fiber Bragg grating, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

R. Lehneis, A. Steinmetz, J. Limpert, A. Tünnermann: All-fiber 170 fs pulses from a passively Q-switched microchip laser system, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

R. Lehneis, A. Steinmetz, J. Limpert, A. Tünnermann: 650fs pulses at 1045nm from a passively Q-switched Nd:YVO_4 microchip laser system, CLEO.Europe and EQEC 2013 Conference Digest, Munich, Germany, 12. - 16. May 2013.

R. Lehneis, A. Steinmetz, J. Limpert, A. Tünnermann: 550fs Laserpulse bei 1038nm mit einem passiv gütege- schalteten Nd:YVO_4 Mikrochiplasersystem, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

R. Lehneis, A. Steinmetz, J. Limpert, A. Tünnermann: 900fs pulses from a passively Q-switched microchip laser, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

S. Breitkopf, A. Klenke, T. Gottschall, H.-J. Otto, C. Jauregui, J. Limpert, and A. Tünnermann: 58 mJ burst containing ultra-short pulses with homogenous energy level from an Yb-doped fiber amplifier, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

S. Breitkopf, H. Carstens, S. Holzberger, I. Pupeza, T. Eidam, A. Klenke, E. Fill, J. Limpert, A. Tünnermann: 10MHz-Überhöhungsresonator zur Skalierung der Pulsspitzenleistung von Ultrakurzpuls-Lasersystemen, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

S. Breitkopf, T. Eidam, A. Klenke, M. Kienel, L. von Grafenstein, J. Limpert, I. Pupeza, A. Tünnermann: Fiber laser based multi-dimensional combining scheme for the next generation of particle accelerators, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

S. Breitkopf, T. Eidam, L. von Grafenstein, A. Klenke, H. Carstens, S. Holzberger, I. Pupeza, T. Schreiber, E. Fill, J. Limpert, F. Krausz, A. Tünnermann: Non-steady-state enhancement cavities using pulse-dumping as power scaling concept of femtosecond lasers, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

S. Demmler, J. Rothhardt, S. Hädrich, M. Krebs, A. Zaïr, L. Chipperfield, J. Limpert, A. Tünnermann: High repetition rate source of isolated attosecond pulses and coherent soft x-rays, 4th International Conference on Attosecond Physics, Paris, France, 8. - 12. Jul. 2013.

S. Demmler, J. Rothhardt, S. Hädrich, M. Krebs, J. Limpert, A. Tünnermann: Generation of High Photon Flux Coherent Soft X-rays, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

S. Demmler, J. Rothhardt, S. Hädrich, T. Peschel, J. Limpert, A. Tünnermann: Thermal challenges in high power optical parametric amplifiers, CLEO.Europe and EQEC 2013 Conference Digest, Munich, Germany, 12. - 16. May 2013.

S. Demmler, S. Hädrich, J. Rothhardt, M. Krebs, J. Limpert, A. Tünnermann: Control of timing jitter in high power optical parametric chirped-pulse amplifiers, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

S. Diziain, R. Geiss, M. Zilk, F. Schrempel, E. B. Kley, A. Tünnermann, T. Pertsch: Freestanding lithium niobate photonic crystal cavities for nonlinear optics applications, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

S. Döring, S. Richter, T. Ullsperger, A. Tünnermann, S. Nolte: Influence of ambient pressure on the hole formation process in ultrashort pulse laser deep drilling, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

S. Döring, T. Ullsperger, F. Heisler, S. Richter, A. Tünnermann, S. Nolte: Hole formation process in ultrashort pulse laser percussion drilling, Lasers in Manufacturing conference, Munich, Germany, 12. - 16. May 2013.

S. Döring, T. Ullsperger, S. Richter, A. Tünnermann, S. Nolte: Analysis of the hole formation in ultrashort pulse laser deep drilling. DPG, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

S. Fasold, T. Paul, T. Pertsch: Plasmonic Moire Magnifier, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

S. Hädrich, A. Klenke, A. Hoffmann, T. Eidam, T. Gottschall, J. Rothhardt, J. Limpert, A. Tünnermann: 135 W, 0.5 mJ, sub-30 fs Pulses Obtained by Nonlinear Compression of Coherently Combined Fiber CPA, Advanced Solid-State Lasers Congress, Paris, France, 27. Oct. - 1. Nov. 2013.

S. Hädrich, J. Rothhardt, M. Krebs, S. Demmler, J. Limpert, A. Tünnermann: Signatures of atomic resonances in atomic gas high harmonic generation, 4th International Conference on Attosecond Physics, Paris, France, 8. - 12. Jul. 2013.

S. Hädrich, J. Rothhardt, S. Demmler, M. Krebs, J. Limpert, A. Tünnermann: High Repetition Rate Carrier-envelope Phase Stable Few-cycle OPCPA for Strong Field Physics, CLEO.Europe and EQEC 2013 Conference Digest, Munich, Germany, 12. - 16. May 2013.

S. Hädrich, M. Krebs, J. Rothhardt, S. Demmler, L. Chipperfield, A. Zaïr, J. Limpert, A. Tünnermann: Megahertz repetition rate isolated attosecond pulse generation, Ultrafast Optics IX, Davos, Switzerland, 4. - 11. March 2013.

S. Kroker, T. Käsebier, S. Steiner, E.-B. Kley, A. Tünnermann: Optical grating concepts for future gravitational wave detection, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

S. Kruk, C. Helgert, M.l Decker, I. Staude, C. Menzel, D. Powell, C. Etrich, C. Rockstuhl, T. Pertsch, D. Neshev, Y. Kivshar: Symmetry Properties of Metamaterials at Oblique Incidence, Metamaterials 2013, Bordeaux, France, 16. - 21. Sep. 2013.

S. Richter, F. Burmeister, F. Zimmermann, S. Döring, A. Tünnermann, and S. Nolte: Formation of disruptions in molten fused silica induced by heat accumulation of ultrashort laser pulses at high repetition rates, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

S. Richter, F. Zimmermann, S. Döring, A. Tünnermann, S. Nolte: Ultrashort high repetition rate exposure of dielectirc materials: Laser bonding of glass, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

S. Richter, F. Zimmermann, S. Döring, A. Tünnermann, S. Nolte: Ultrastable Bonding of glass with femtosecond laser bursts, SPIE Photonics West, LASE, San Francisco, USA, 2. - 7. Feb. 2013.

S. Saravi, S. Diziain, R. Geiss, F.Setzpfandt, C. Etrich, T. Pertsch: Spontaneous Parametric Down Conversion in Slow Light Lithium Niobate Photonic Crystal Slab Waveguides, Summer school "Quantum Optics and nanophotonics", Les Houches, France, 5. - 30. Aug. 2013.

S. Steiner, S. Kroker, T. Käsebier, E.-B. Kley, and A. Tünnermann: Asymmetric direction selective filter elements based on high-contrast gratings, SPIE Photonics West, OPTO, San Francisco, USA, 2. - 7. Feb. 2013.

S. Stützer, T. Kottos, A. Tünnermann, S. Nolte, D.N. Christodoulides, A. Szameit: Superballistic transport in hybrid photonic lattices, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

S. Stützer, U. Naether,T. Kottos, R.A. Vicencio,M.I. Molina, A. Tünnermann, S. Nolte, D.N. Christodoulides, A. Szameit: Anomalous diffusion of light in 1D random dimer waveguide arrays, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

S. Stützer, Y. Kartashov, V. Vysloukh, V. Konotop, S. Nolte, L. Torner, A. Szameit: Hybrid Bloch-Anderson localization of light, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

S. Stützer, Y.V. Kartashov, V.A. Vysloukh, A. Tünnermann, V.V. Konotop, S. Nolte, L. Torner, A. Szameit: A new transport regime: Hybrid Bloch-Anderson localization of light, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

S. Stützer,U. Naether,T. Kottos,R.A. Vicencio, M.I. Molina, A. Tünnermann, S. Nolte, D.N. Christodoulides, A. Szameit: Observation of anomalous diffusion in a 1D optical random dimer, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

S. Weimann, Y. Xu, R. Keil, A. E. Miroshnichenko, A. Tünnermann, S. Nolte, A. A. Sukhorukov, A. Szameit, Y. S. Kivshar: Compact Surface Fano States Embedded in the Continuum of Waveguide Arrays, CLEO.QELS Conference, San Jose, USA, 9. - 14. Jun. 2013.

S. Weimann, Y. Xu, R. Keil, A. E. Miroshnichenko, S. Nolte, A. A. Sukhorukov, Y. S. Kivshar, A. Szameit: Compact Fano states embedded in the continuum of waveguide arrays, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

T. Eichelkraut, R. Heilmann, S. Stützer, S. Nolte, A. Szameit: Sharp Transition between ballistic and diffusive Transport in PT-symmetric Media, CLEO Europe, Munich, Germany, 12. - 16. May 2013.

T. Eichelkraut, R. Heilmann, S. Weimann, S. Stützer, S. Nolte, A. Szameit: Diffusion and ballistic transport in non-Hermitian systems, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

T. Eidam, C. Jauregui, F. Jansen, F. Stutzki, H.-J. Otto, J. Limpert, A. Tünnermann: High-power fiber designs, 540. WE-Heraeus-Seminar: Modern Concepts of Continuous Wave and Pulsed High Power Lasers, Bad Honnef, Germany, 15. - 17. Jul. 2013.

T. Gottschall, M. Baumgartl, M. Chemnitz, J. Abreu-Afonso, T. Meyer, B. Dietzek, J. Popp, J. Limpert, A. Tünnermann: All-fiber laser source for CARS-Microscopy, CLEO.Europe and EQEC 2013 Conference Digest, Munich, Germany, 12. May - 16. May 2013.

T. Kaiser, C. Rockstuhl, T. Pertsch: Effective photonic parameters from an eigenmode perspective, DoKDoK, Suhl, Germany, 6. - 10. Oct. 2013.

T. Kaiser, S. Diziain, C. Helgert, C. Rockstuhl, T.Pertsch: Plasmonic nanoparticle interaction in hybrid plasmonic-dielectric waveguides, CLEO US, San Jose, USA, 9. - 14. Jun. 2013.

U. Blumröder, P. Hoyer, G. Matthäus, K. Füchsel, A. Tünnermann, S. Nolte: THz emission as a probe für silicon-based multilyer systems, SPIE Photonics West, OPTO, San Francisco, USA, 2. - 7. Feb. 2013.

U. Blumröder, S. Nolte, P.Hoyer, A. Tünnermann: Influence of surface treatment of silicon observed with THz emission spectroscopy, 10th International Conference on Optics of Surfaces and Interfaces OSI 2013, Chemnitz, Germany, 8. - 13. Sep. 2013.

U. Blumröder, S. Nolte, P.Hoyer, A. Tünnermann: Observing surface charges in oxide coatings on silicon surfaces with THz emission spectroscopy, DPG Spring Meeting, Jena, Germany, 25. Feb. - 1. March 2013.

Y. Plotnik, J. M. Zeuner, M. C. Rechtsman, Y. Lumer, M. Segev, A. Szameit: Experimental Observation of Photonic Floquet Topological Insulators, French-Israeli Symposium on Nonlinear and Quantum Optics, Ein Gedi, Israel, 24. Feb. - 1. March 2013.

Patents

Applications

C. Jauregui, F. Jansen, F. Stutzki, H.-J. Otto, T. Eidam:
Verfahren und Vorrichtung zur Reduktion von Modeninstabilität in einem Lichtwellenleiter
(PCT/EP 2013/001071)

E.-B. Kley, U.-D. Zeitner:
Beugungsgitter und Verfahren zu dessen Herstellung
(PCT/EP 2013/053715)

H. Ludwig:
Verfahren zur Herstellung einer Entspiegelungsschicht mit organischen Strukturtemplaten
(DE 10 2013 103 075.0)

M. Gräfe, R. Heilmann, A. Perez-Leija, S. Nolte, A. Szameit:
Verfahren und Vorrichtung zum Entspiegeln eines optischen Elementes
(DE 10 2014200 742.9)

M. Steglich, E.-B. Kley, T. Käsebier:
Strahlungsabsorber auf Siliziumbasis
(DE 10 2013 108 288.2)

P. Kühmstedt, G. Notni, S. Heist:
Verfahren zur dreidimensionalen Vermessung einer Oberfläche
(DE 10 2013 013 791.8)

S. Breitkopf, T. Eidam:
Lichtauskopplung aus optischen Resonatoren
(PCT/EP 2013/071068)

S. Gazit, Y. Schechtman, A. Szameit, Y. Eldar, M. Segev:
Reconstruction of sparse sub-wavelength images
(EP 2 452 311 A1, CN 102473286A, US 20120188368, WO 2011004378A1)

S. Nolte, M. Gabor, K. Bergner:
Verfahren und System zum Bearbeiten eines Objekts mit einem Laserstrahl
(DE 10 2013 204 222.1)

T. Eidam, S. Hädrich, E. Seise:
Vorrichtung zur Erzeugung von Lichtpulsen
(PCT/EP 2013/051585)

T. Gottschall, J. Limpert, A. Tünnermann, M. Baumgartl:
Vorrichtung und Verfahren zur Erzeugung von ultrakurzen Strahlungspulsen
(DE 10 2013 017 755.3)

U. Schulz, N. Kaiser, P. Munzert, H. Ludwig:
Verfahren zur Herstellung einer Entspiegelungsschicht auf einem Substrat und Substrat mit einer Entspiegelungsschicht
(DE 10 2013 103 075.0)

Issuances

A. Tünnermann, G. Kalkowski, R. Eberhardt, S. Nolte, M. Borchardt:
Verfahren zum Lasergestützten Bonden, derart gebondete Substrate und deren Verwendung
(JP 5 342 460)

B. Pradarutti, G. Notni, S. Riehemann:
Verfahren und Vorrichtung zum schnellen Messen von Proben mit geringem optischem Wegunterschied mittels elektromagnetischer Strahlung im Terahertz-Bereich
(DE 10 2007 011 820)

E.-B. Kley, U.-D. Zeitner, F. Fuchs:
Beugungsgitter und Verfahren zu dessen Herstellung
(DE 10 2012 101 555)

J. Limpert, A. Tünnermann, A. Steinmetz, D. Nodop:
Gütegeschalteter Laser
(US Erteilungsbeschluss 2013)

J. Limpert, A. Tünnermann, D. Schimpf:
Vorrichtung zum Verstärken von Lichtimpulsen
(DE 10 2008 047 226)

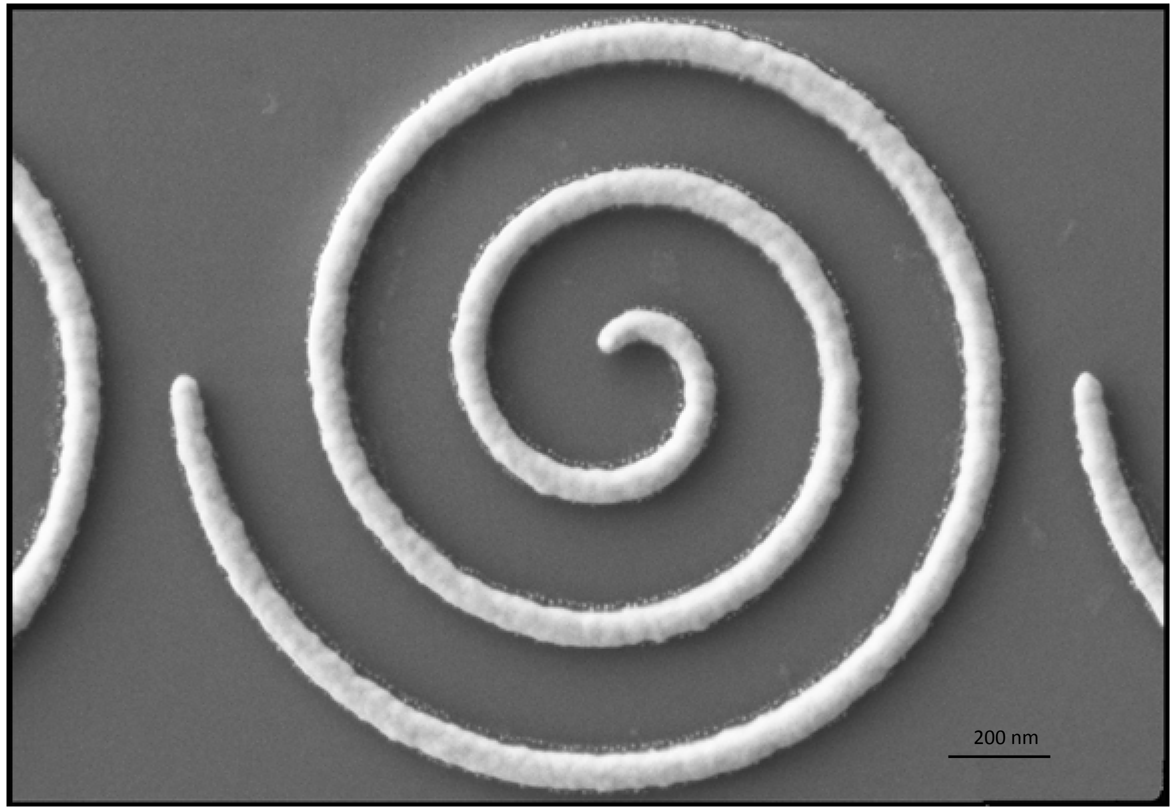
J. Limpert, A. Tünnermann, D. Schimpf, F. Röser, E. Seise:
Vorrichtung und Verfahren zum Verstärken von Lichtimpulsen
(EP 2 384 526WO 2010/075999)

K. Füchsel, S. Schröder, J. Pulsack:
Schichtsystem für eine transparente Elektrode und Verfahren zu dessen Herstellung
(DE 10 2012 015 457 B3)

M. Trost, S. Schröder, G. Notni, A. Duparre, T. Feigl, M. Hauptvogel:
Vorrichtung und Verfahren zur winkelaufgelösten Streulichtmessung
(DE 10 2012 005 417)

S. Nolte, A. Tünnermann, R. Eberhardt, G. Kalkowski, M. Borchardt:
Verfahren zum Laser-gestützten Bonden, derart gebondete Substrate und deren Verwendung
(DE 10 2007 008 540.2)

S. Schröder, M. Trost, T. Herffurth:
Verfahren zur hochempfindlichen Streulichtmessung
(DE 10 2012 106 322)



Chiral nanostructures for realization of circular dichroism, project " Photonische Nanomaterialien - PhoNa ".

Good teamwork is one success factor of the IAP. Not only on scientific issues the staff work closely together, but also maintain friendly relations with each other. So, among others, an annually common summer party with the Fraunhofer IOF colleagues takes place.

ACTIVITIES

A key feature of the IAP is the active and engaged exchange of its employees within the scientific community. This commitment can be measured in both the participation at conferences and at cooperation in projects with other institutions. Such community projects are the fruits of compulsory networking and strengthen the reputation of the Institute within the research society and industrial associations. Appreciation of these efforts are also the call-ups of particular scientists in committees and editorial positions of academically approved journals.

Awards

Prof. Stefan Nolte
Deutscher Zukunftspreis des Bundespräsidenten
„Ultrakurzpulslaser für die industrielle Massenfertigung - produzieren mit Lichtblitzen“

Martin Baumgartl
2nd Place Best Student Paper
SPIE Photonic West Conference – Frontiers in Ultrafast Optics: Biomedical, Scientific, and Industrial Applications
„Compact fiber laser for nonlinear microscopy methods such as coherent anti-Stokes Raman scattering (CARS)”

Franz Beier
Idea Competition of Fraunhofer Symposium »Netzwert«
„Biomonitoring durch Glasfasersensorik in Völkern der westlichen Honigbiene“

Sven Breitkopf
3rd Place Best Student Paper
SPIE Photonic West Conference – Fiber Lasers
„High-energy ultrashort laser pulse trains from a fiber amplifier at high pulse repetition rates”

Felix Dreisow
Friedrich Schiller University Program to encourage the ability of third-party funding

Tino Eidam
Postdoc Scholarship, Carl-Zeiss- Foundation
„Energieskalierung von Ultrakurzpulslasern durch kohärente Überlagerung von zeitlich separierten Pulsen“

Christian Gaida
PhD Scholarship, Carl-Zeiss-Foundation
„Entwicklung von hochleistungstauglichen Großkernfaserdesigns“

Herbert Gross
Teaching Award of Faculty of Physics and Astronomy (PAF)

Christoph Jocher
2nd Place Best Student Paper
SPIE Photonic West Conference – Fiber Lasers
„Demonstration of a pulsed 250-MHz high-power laser system with 23 fs pulse duration at 250 W average power”

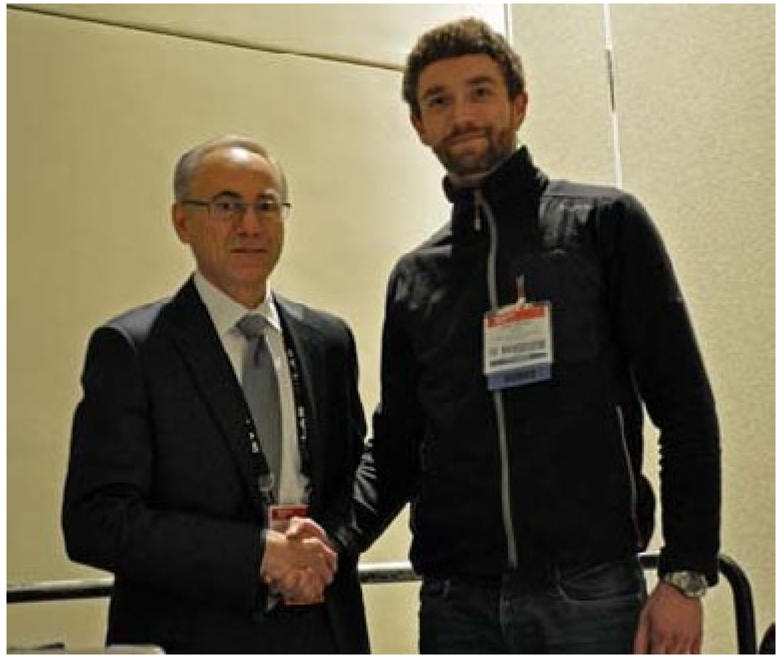
Robert Kammel
3rd Place Best Student Paper
SPIE Photonic West Conference - Frontiers in Ultrafast Optics: Biomedical, Scientific, and Industrial Applications
„New focus concept for ophthalmic laser surgery - simultaneous spatial and temporal focusing (SSTF)”

Peter Lutzke
Idea Competition of Fraunhofer Symposium »Netzwert«
„Scannen statt Knipsen - 3D-Datengewinnung für Jedermann“

Christoph Menzel
Postdoc Scholarship, Carl-Zeiss- Foundation
„Homogenisierung nanoskaliger Licht-Materie Wechselwirkung“

Hans-Jürgen Otto
1st Place Best Student Paper
SPIE Photonic West Conference – Fiber Lasers
„Mitigation of mode instabilities by dynamic excitation of fiber modes”

Sören Richter
3rd Place Best Student Paper
SPIE Photonic West Conference - Frontiers in Ultrafast Optics: Biomedical, Scientific, and Industrial Applications
„Demonstration of a firmer break resistance due to laser bonding of glass by ultrashort laser pulses”



Winner Hans-Jürgen Otto at Photonics West Conference in 2013 (Rights at SPIE)

Sina Saravi
Best Master's Thesis Examination Award of the Faculty (PAF)
„Trapping and slowing down light in lithium niobate photonic crystals“

Alexander Szameit
- Hershel Rich Technion Innovation Award, Israel
- Outstanding Young Researchers in Life Science and Physics Award of Beutenberg Campus e.V.
  „Diamant-/Kohlenstoffbasierte optische Systeme“

Jens Thomas
Best Doctorate in the Field of Optical Metrology, Dr.-Ing. Siegfried Werth Stiftung
„Mode control with ultra-short pulse written fiber Bragg gratings“

Andreas Tünnermann
Member of Honor „International Society of Optics and Photonics SPIE”

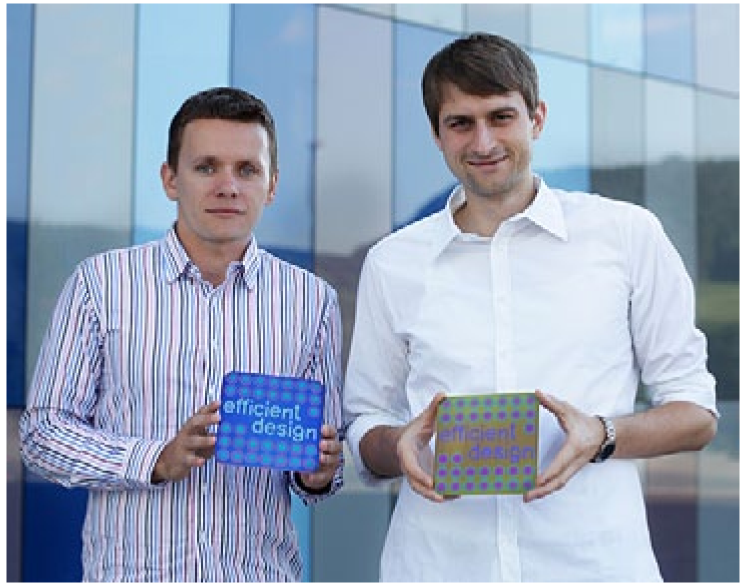
Tobias Ullsperger
Green Photonics Exceptional Award of Sonderpreis oft the Foundation for Technology, Innovation and Research Thuringia (STIFT)
„Räumlich und zeitlich hochaufgelöste Untersuchung des ultrakurzpuls-induzierten Plasmas bei der Tiefenablation von Silizium und ionengefärbtem Glas“

Julia Zeuner
- 1st Place Student Poster Award, 546. WE-Heraeus-Seminar on “Light in disordered Photonic Media”
- Heptagon - Sven Bühling – Forschungsförderpreis

Research Group Fiber & Waveguide Lasers (Jun.-Prof. Jens Limpert)
Biophotonic Solutions Outstanding Research Award
SPIE Photonic West Conference
„Coherent high performance XUV sources"

„efficient design"
Ausgezeichneter Ort im Land der Ideen
„Individuelle Gestaltungsmöglichkeiten von Solarzellen zur Realisierung gestalterischer Elemente"

Interdisciplinary Research Project „Multikontrast-Mikroskopie für den klinischen Einsatz"
Thüringian Research Award for Applied Research 2012, awarded 2013



Reinhold Pabst and Kevin Füchsel with »efficient design« solar cells.

Organizing Activities

Herbert Gross

Reviewer of the Baden-Württemberg Foundation

Board of Trustees of Physics Journals

Referee for several international journals

E.-Bernhard Kley

Member of the Program Committee SPIE Photonics West Conference "Advanced Fabrication Technologies for Micro / Nano Optics and Photonics"

Referee for several scientific journals

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

Jens Limpert

Member of the Program Committee SPIE Photonics West Conference "LASE 2014"

Referee for several scientific journals

Stefan Nolte

Chair of the Faculty´s Budget Commission and member of the Budget Board of the Senate

Member Optical Society of America

Member of Deutsche Physikalische Gesellschaft

Coordinator of the BMBF Association "Ultrashort Pulse Laser for High-precision Machining"

Referee for several scientific journals

Member of program committee: "ASSL 2013 (Advanced Solid State Lasers)"

Member of program committee: "PR’ 2013 (International Conference on photorefractive effects, materials and devices)"

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)

Thomas Pertsch

Vice Dean of the Faculty

Council member of the Faculty

Member of the Executive Board of the Abbe Center of Photonics

Spokesman of the Abbe School of Photonics

Spokesman of the research initiative "Photonic Nanomaterials PhoNa"

Coordinator of the study progam "Master of Science in Photonics"

Referee for several international journals

Member of conference program committees: CLEO/QELS, San Jose, USA, 2013 / NLP - Nonlinear Photonics, Kharkov/Sudak, Ukraine, 2013 / ICONO/LAT - Conferences on Coherent and Nonlinear Optics, Moscow, 2013 / OPTICS – Optics and Photonics Taiwan, International Conference, 2013

Andreas Tünnermann

Council member of the Faculty

Member of program committee „Optische Technologien“, BMBF

Member of the technical council Fraunhofer Gesellschaft

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 IOM, Leipzig

Board of trustees MPQ, Garching

Chairman „AG Naturwissenschaften“, Wissenschaftliche Gesellschaft Lasertechnik

Member of acatech „Deutsche Akademie der Technikwissenschaften“

Editor Applied Physics B

Member of Honor „International Society of Optics and Photonics SPIE“

Stakeholder Photonics 21-Plattform

Spokesman Abbe Center of Photonics, FSU Jena

Member of the executive Board OptoNet e. V.

Referee for several scientific journals

Frank Schrempel

Coordinator of the IAP at the Beutenberg Campus e.V.

Member of the Faculty Board

Referee for several scientific journals

Alexander Szameit

Member of the Program Committee SPIE Photonics West Conference "LASE 2014"

Referee for several scientific journals

Member Optical Society of America

Member of Deutsche Physikalische Gesellschaft

Member of the Program Committee CLEO 2013 / 2014

Member of the Faculty Committee for the Landesgraduiertenstipendium

Frank Wyrowski

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 Modelling Aspects in Optical Metrology

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

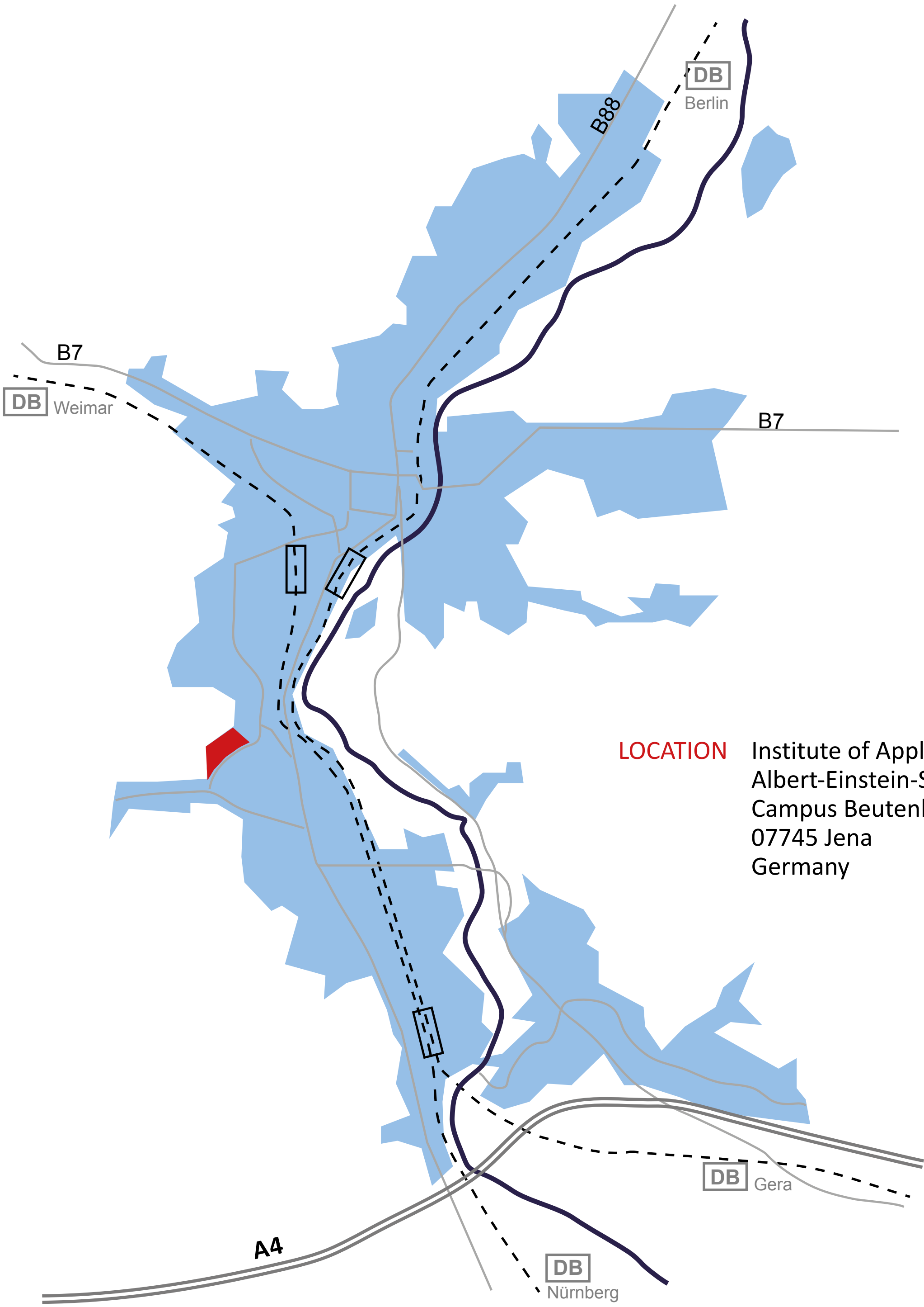
Study Advisor of the Fakulty od Physics and Astronomy

President of the LightTrans GmbH

Uwe D. Zeitner

Member of the Program Committee EOS Topical Meetings "Diffractive Optics"

Referee for several scientific journals



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