Institute of Applied Physics

Friedrich-Schiller-Universität Jena

Annual Report
2011

Imprint

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PHOTOS/GRAFICS	IAP and Friedrich Schiller University Jena [J.-P. Kasper] S.53: aboutpixel.de/Lektüre©marshi

Content

PREFACE

The German optics and photonics industry has weathered the financial and economic crisis well, reported the Association SPECTARIS. The essential factor for growth is the continuing strength of exports, which is impressively demonstrated by the competitiveness of German products. Thus German companies are currently looking optimistically to the year 2012.

This is also reflected in the research contracts and topics at the Institute of Applied Physics at the Friedrich Schiller University, where "Green Photonics," or the sustainable use of light, is a focus of research. In various partnerships with other institutes, and especially with the Fraunhofer Institute for Applied Optics and Precision Engineering IOF, solutions with light are developed here for the research fields of the future, energy and the environment. Examples of research work include the development of high- efficiency solar cells or powerful and efficient EUV Coherent Light Sources (PECS).

Under the name "Green Photonics" and with the support of the Thuringian Ministry of Culture, a scholarship program was also set up, which is based on the excellent methodological state of the Graduate School Optical Microsystem Technology OMiTec (funded by the ProExzellenz program of Thuringia). While the Graduate School has so far mainly been active nationally, and with a strong orientation towards technology, in the future it will become more international and application-oriented.

That the Institute's efforts here are on the right track is illustrated, not only by the ever-increasing research funds, which have gone up by more than half in comparison to 2010, but also the constantly-growing number of employees and not least the establishment of a new Junior Professorship of Diamond / Carbon-based Optical Systems but also the installation of two Junior Research Groups *Multiphoton Microscopy* and *Atomic Layer Deposition*. At the institute, the results of advanced research work at the Center for Innovation Competence (ZIK) ultra optics, which takes new paths for optical microscopy and nano-systems and technologies based on diamond and carbon materials, are combined with a sound basic education at the Friedrich Schiller University in Jena.

I would like to express my gratitude to our partners in industry and science for the excellent cooperation we have enjoyed, and also the Federal Ministry of Education and Research (BMBF), the Ministries of Culture and Business, Labor and Technology in Thuringia as well as the German Research Community (DFG) for their continuous support. I would particularly like to thank and pay tribute to my co-workers for the commitment they have shown. Their outstanding performance and creativeness has made it possible to cooperate on solutions for socially relevant issues.

Prof. Dr. Andreas Tünnermann

Prof. Andreas Tünnermann,
Director of the Institute of
Applied Physics at the
Friedrich Schiller Universtity

THE INSTITUTE

The Institute of Applied Physics at the Friedrich Schiller University Jena has a longstanding tradition and competence in design, fabrication and application of active and passive optical photonic elements for both, optical and optoelectronical 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 110 scientists - concern function, design and production of micro-and nano-optical elements. Those are e.g. resonant grating structures, metallic and dielectric polarizers, opto-optical switching processes in integrated optics and effective media to reduce reflection of surfaces. Also light propagation and nonlinear light-matter interaction in micro- and nano-structures, optical meta materials and photonic crystals are fundamentally examined. Further research fields are application of femtosecond laser pulses, e.g. for material processing and micro- and nano-structuring, development of new concepts for solid-state lasers such as fiber lasers, fiber-optic pulse shaping and amplification of ultrashort laser pulses.

With these skills and supported by cooperating institutions (strong connection to the Fraunhofer IOF) and companies the IAP covers far parts of the innovation chain - from interdisciplinary basic 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 confirms the establishment of the Competence Center ultra optics (www.ultra-optics.de) as a driver of innovation in the interdisciplinary research field of laser physics and nano-optics, the research initiative on Photonic Nanomaterials PhoNa (www.phona.uni-jena.de) and also the project “KD OptiMi” (www.optimi.uni-jena.de), which combines basic and applied research in a unique way.

But not only excellent research makes the Institute conspicuous, also outstanding laboratory equipment, an excellentstaff and a high commitment in the training of students and scientists belongs to the self understanding of the IAP.

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ZIK
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ForMaT
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Junior research group
multiphoton microscopy
Rachel Granche
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Junior research group
atomic layer deposition
Adriana Szeghalmi
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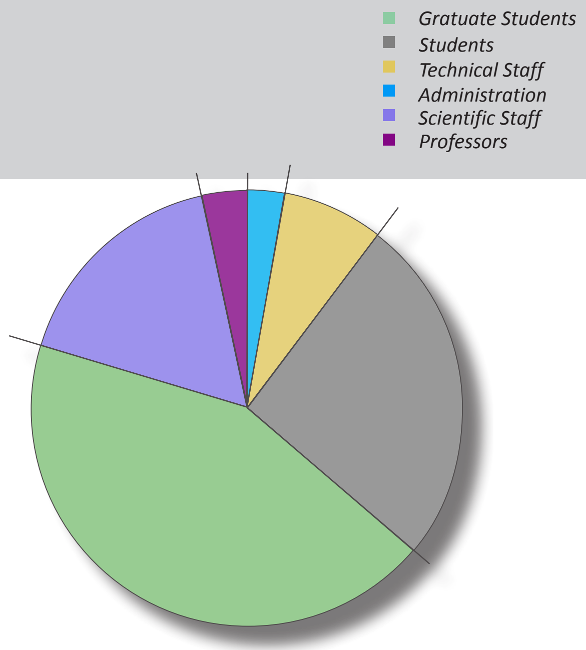
Research Facilities / Resources

Excellency in research requires high quality equipment for experimental questions and analysis. The high standard technical infrastructure will be driven constantly foreward by aquired adaptions for scientific questions.

- Clean room
- Electron beam and Laser Lithography
- Dry etching
- Cross beam, scanning electron microscopy
- Photolitography
- Interference optical surface profilometry
- 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 technics
- Helium ion microscopy

Staff

budgetarily financed:	4	university professors
	3	scientific staff
	10	technical /admin. staff
externally funded:	1,25	junior professor
	76,46	scientific staff
	6,16	technical /admin. staff



ABBE Sylvia
ACKERMANN Roland
APPELFELDER Michael
BAUMGARTL Martin
BECKER Ria
BLUMRÖDER Ulrike
BOURGIN Yannick
BRAIG Christoph
BRAM Anika
BRANDT Juliane
BROWN Alexander
BRUCHMANN Claudia
BRÜCKNER Andreas
BRÜCKNER Frank
BURKHARDT Thomas
BURMEISTER Frank
CHIPOULINE Arkadi
Demmler Stefan
DIETRICH Kay
DIZIAIN Séverine
DÖRING Sven
DREISOW Felix
EIDAM Tino
EILENBERGER Falk
FALKNER Matthias
FASOLD Stefan
FLÄMMICH Michael
FREESE Wiebke
FUCHS Hans-Jörg
FÜCHSEL Kevin
GEISS Reinhard
GHAZARYAN Lilit
GOTTSCHALL Thomas
GRÄF Waltraud
GRÄFE Markus
GRANGE Rachel
HÄDRICH Steffen
HARTUNG Holger
HEILMANN René
HEINRICH Matthias
HELGERT Christian
HOLZ Manuela
JANSEN Florian
JANUNTS Norik
JAUREGUI MISAS Cesar
JOCHER Christoph
JOSWIG Andreas
KAISER Thomas
KAMMEL Robert
KÄSEBIER Thomas
KEIL Robert
KLEIN Andreas
KLEIN Angela
KLEY Ernst-Bernhard
KLUGE Anja
KREBS Manuel
KROKER Stefanie
KROLL Matthias
LANGE Nicolas
LEHNEIS Reinhold
LEHR Dennis
LIMPERT Jens
MARTIN Bodo
MATTHÄUS Gabor
MEYER Julia
MINARDI Stefano
MUNDUS Markus
NARANTSATSRALT Bayarjargal
NODOP Dirk
NOLTE Stefan
OTTO Christiane
OTTO Hans-Jürgen
PABST Oliver
PABST Reinhold
PERTSCH Thomas
PETSCHULAT Jörg
PRATER Karin
PFEIFER Beate
PSHENAY-SEVERIN Ekaterina
RATZSCH Stephan
REINHOLD Jörg
RICHTER Daniel
RICHTER Jessica
RICHTER Sören
ROCKSTROH Sabine
ROCKSTROH Werner
ROTHHARDT Jan
SARAVI Sina
SAUERBREY Philip
SCHAMBACH Doreen
SCHELLE Detlef
SCHMIDT Carsten
SCHMIDT Holger
SCHREMPEL Frank
SCHULZE Marcel
SEISE Enrico
SERGEEYEV Anton
SETZPFANDT Frank
STEGLICH Martin
STEINBERG Carola
STEINER Stefan
STEINERT Michael
STEINMETZ Alexander
STOCK Katrin
STUTZKI Fabian
STÜTZER Simon
SZAMEIT Alexander
SZEGHALMI Adriana
THOMAS Jens
TÜNNERMANN Andreas
ULLSPERGER Tobias
VETTER Julia
VOIGT Daniel
VOIGTLÄNDER Christian
WACHS Rico
WALTHER Benny
WEBER Thomas
WEBER Christin
WINKLER Ira
WIRTH Chirstian
WITSCHAS Benjamin
WYROWSKI Frank
ZAPFE Annelie
ZEITNER Uwe
ZIMMERMAN Felix

Guests

Guests indicate the national and international visibility of research results and enrich the structures of the IAP 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.

ALKESKJOLD Thomas Tanggaard	NKT Photonics, Birkeroed, Denmark
ANDERSEN Thomas Vestergaard	NKT Photonics, Birkeroed, Denmark
BRENET Gilles	PHELMA , Grenoble, France
DONDAPATI Srujan	Kumar University Freiburg, Germany
HERRICK Nicholas	Brigham Young University, Provo, USA
HIDEUR Ammar	CORIA, Université Rouen, St. Etienne du Rouvray, France
HINGERL Kurt	University of Linz, Austria
HSIEH Chia-Lung	EPFL, Switzerland
LAURILA Marco	NKT Photonics, Birkeroed, Denmark
LECAPLAIN Caroline	CORIA, Universität Rouen, St. Etienne du Rouvray, France
LÓPEZ-HIGUERA José Miguel	University of Cantabria, Santander, Spanien
MINOVICH Alexander	Australian National University, Canberra, Australia
NAETHER Uta	Universidad de Chile, Santiago, Chile
NESHEV Dragomir	Australian National University, Canberra, Australia
RASCHKE Markus	University of Colorado, Boulder, USA
SHCHERBAKOV Maxim	Moscow State University, Moscow, Russia
SOLNTSEV Alexander	Australian National University, Canberra, Australia
SUKHORUKOV Andrey	Australian National University, Canberra, Australia
SURAKKA Minna	University of Eastern Finland, Joensuu, Finland
WILLIAMS Robert	Cudos, University of Sydney, Australien
ZAIR Amelle	Imperial College, London, England
ZENG Hao	Nankai University, China

Research Stay

GEISS Reinhard	National Central University, Taiwan
PERTSCH Thomas	Australien National University, Canberra, Australia
ROTHHARDT Jan	CEA-Saclay, Gif-sur-Yvette, France
SETZPFANDT Frank	Australien National University, Canberra, Australia
SZAMEIT Alexander	Physics Department, Technion, Haifa, Israel

Cooperations

The IAP is cooperating with all institutions of the Physical-Astronomical Faculty at Friedrich Schiller University in context of research projects. Strategic collaborations that go far beyond the project work are, in particular with the Institute of Solid State Theory and Optics, and the Institute of Optics and Quantum Electronics. Cooperative relations within the FSU exist in particular to individual departments within the Chemical - Geoscientific Faculty. Moreover, there are more than 100 external partners in science and industry. Of special importance are regional co-operations with the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) and the Institute of Photonic Technology Jena (IPHT).

Here, for the development of the IAP cooperation with the Fraunhofer Institute is of fundamental importance. Objective is to develop an outstanding international center of excellence for micro- and nano-structured optics as well as optical systems on basis of a close intermeshing of the two institutes.

Within Thuringia the Competence Network for Optical Microsystems (OptiMi) could be established, which focused on a close interdisciplinary integration of research groups from the IAP, IOF, the CiS Foschungsinstitut Erfurt and Ilmenau University of Technology in the first phase. OptiMi has been mainly expanded in 2011 by other scientists from the Karlsruhe Institute of Technology (KIT), University of Tübingen 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 on the competence in Garching regarding cavity enhancement and the generation of high harmonics (HHG).

The competence in Jena 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.

Together with the LightTrans GmbH, the theoretical models of Field Tracing were developed. A long-term cooperation exists with the University of Eastern Finland. In 2011 the focus was on the source modeling and coherence theory. About the EU project SMETHODS (project for optics training) the cooperation with the optics group at the University of Delft in 2011 has been deepened considerably.

Major international collaborations have existed for years 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 Imperial College, Warsaw University, the Delft University and the Institut d‘Optique (Orsay-Palaiseau, Paris) 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: International Master in Lasers, Materials Science and Interactions“ in context of the EU-US Atlantis program.

Outline of Cooperations with common Research Topics

State University of Information, Mechanics and Optics (ITMO)
St. Petersburg, Russia
Enginieering Center OPTICA
(Prof. I. Livshits)

University Paris Sud (UPS)
Paris, France
Institute d‘Optique Graduate School IOGS
(Prof. P. Chavel)

Universidad Politecnico de Madrid (UPM)
Madrid, Spain
Optical Engineering Group (OEG)
(Prof. P. Benitez)

Delft University of Technology (TUD)
Delft, The Netherlands
Optics Research Group
(Prof. P. Urbach)

Universität Bordeaux
Bordeaux, France
CELIA (Eric Cormier)

U.O.S. Bari
Bari, Italy
Institute for Photonics and Nanotechnologies
(Antonio Ancona)

Vrije Universiteit Brussel (VUB)
Brussel, Belgium
Brussels Photonics Team
(Prof. H. Thienpont)

University of Eastern Finland (UEF)
Joensuu, Finland
Department of Physics and Mathematics
(Prof. J. Turunen)

Australian National University
Canberra, Australia
Nonlinear Physics Center
(Yuri Kivshar, Dragomir Neshev)

Castelldefels, Spain
ICFO-Institute of Photonic Sciences
(Lluis Torner)

National Central University, Taiwan
(Yen-Hung Chen)

Max-Planck Gesellschaft
Garching, Deutschland
Max-Planck Institut für Quantenoptik
(Ioachim Pupeza)

DESY
Hamburg, Deutschland
(Franz Tavella)

GSI Helmholtzzentrum für Schwerionenforschung
Darmstadt, Deutschland
(Vincent Bagnoud)

Institute of Photonic Technology IPHT
Jena, Deutschland
(Benjamin Dietzek)

Project introduction for pupils

TEACHING

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

Lectures

Courses (L- Lectures, S- Seminars, T- Training)

L/S: Atom- und Molekülphysik
Atom- und Molekülphysik für Lehramt
Computational Physics I
Laser Physics
Optical Modelling and Design I

L: Miniaturisierte Optik (FH Jena)
S: Fundamentals of modern optics

T: Physikalisches Grundpraktikum
Labwork Optics

Elective Courses

L/S: Grundlagen der Laserphysik
Optical Modelling and Design II
Optical Modelling and Design III
Optics in Nanostructures
Ultrafast optics

L/S: Astrophotonics
Computiational Photonics
Introduction to Nanooptics
Theoretical Nanooptics
Thin Film Optics

Tutorials

Department: Microstructure Technologies - Microoptics
Nano optics
Ultrafast Optics
Fibre lasers
Field Tracing

Institute: Angewandte Physik
Super tutorials: Abbe School of Photonics

Bachelor Theses

Juliane Brandt
Ätzen von ionenbestrahltem Lithiumniobat in KOH zur Herstellung von Mikro- und Nanostrukturen

Christian Gaida
Anwendbarkeit von Wellenfrontsensoren zur Modenzerlegung

Alexander Grimm
Stabilisierung einer Diodenlasers mittels Pound-Drever-Hall-Technik

Erik Hebestreit
Development of a Cryogenic Scattering type scanning near-field optical microscope

Tassilo Jacobitz
Bestimmung von Ätzraten an SiO_2-Schichten zur Herstellung von resonanten Wellenleitergittern

Heiko Knopf
Analyse der numerischen Apertur von Luftmantelfasern

Jürgen Reiter
Modenaufgelöste Biegung einer optischen Faser durch räumlich und spektral aufgelöste Interferometrie

Master Theses

Nadezda Chakrova
Micro-chip electrically-pumped vertical cavity surface emitting lasers with external feedback

Bing Han
Investigation of a novel q-switched high power CO_2 laser

Fei Jia
Investigation of Nanogratings Formation in Fused Silicia

Hui-Wen Lu
An Artificial Eye Model for Investigating the Light Scattering Properties of fs-Laser Structures

Andreas Martin
Parametervariation und thermische Untersuchung gütegeschalteter Kurzpulslaser (Mikrochiplaser)

Markus Mundus
Transversal mode analysis of ultrashort pulse written Bragg gratings

Aude Sagnier
Synchronized femto- and picosecond fiber laser system and its application to the characterization of complex picosecond pulse shapes

Anshuman Singh
Inscription of chirped fiber Bragg gratings applying wavefront-shaped ultrashort pulses

Srikant Sugavanam
Extension of the multipole approach for metamaterials to interacting meta-atoms in regular and random lattices

Haiyue Yang
Guided Mode Resonance Gratings Produced by Atomic Layer Deposition and their Application for Monitoring Nucleation of Al_2O_3 and TiO_2

Diploma Theses

Sven Breitkopf
Untersuchung von aktiv stabilisierten Interferometern als Skalierungskonzept für Ultrakurzpulslaser

Henning Carstens
Hohlkernfaserkompression bei hohen Durchschnittsleistungen

Mario Chemnitz
Optisch-parametrische Pikosekunden Faserlaserquelle für die kohärente Anti-Stokes-Raman-Mikroskopie

Matthias Falkner
Methoden zur Charakterisierung effektiver Parameter nanostrukturierter optischer Materialien

Carsten Klein
Erzeugung optischer Nanostrukturen mit Zwei-Photonen-Polymerisation (2PP)

René Siegmund
Realisierung und Charakterisierung eines fasergekoppelten 2D Terahertz-Zeitbereich-Spektrometers

Alexander Weigel
Untersuchungen zur Profil- und Schichtdickenanalyse mit gepulster Terahertz-Strahlung

Felix Zimmermann
Ultrakurzpuls-induzierte Volumenmodifikation transparenter Materialien zum lokalen Laserbonden

Examination Theses

Stefan Völker
Strahlformung mittels adaptiver Optik

Doctoral Theses

Andreas Brückner
Microoptical Multi-Aperture Imaging Systems

Frank Brückner
Advanced mirror concepts for high-precision metrology

Michael Flämmich
Optical Characterization of OLED Emitter Properties by Radiation Pattern Analyses

Matthias Heinrich
Nonlinear Localization of Light in Two-dimensional Photonic Lattices with Perturbed Periodicity

Christian Helgert
Symmetry-related effects of optical metamaterials

Christoph Munkelt
Aktive daten- und modellbasierte Sensorpositionierung zur 3-D Vermessung

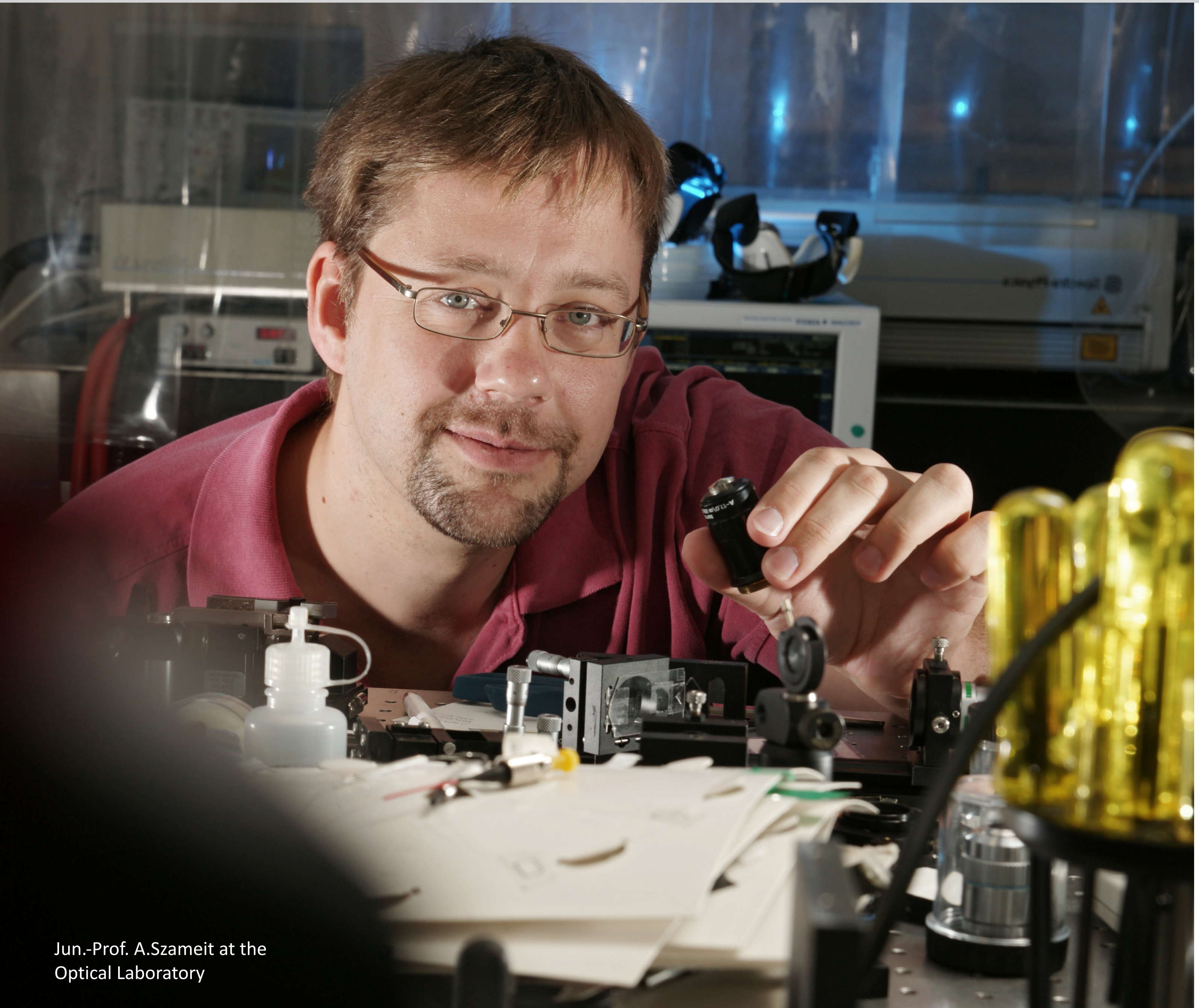
Dirk Nodop
Langperiodische Gitter zur Kontrolle nichtlinearer Effekte in Glasfasern

Jörg Petschulat
The multipole description of complex plasmonic nanostructures

Ekatherina Pshenay-Severin
Design, realization, and characterization of optical negative index metamaterials

Christian Wirth
Skalierung von Leistung und Brillianz schmalbandiger cw-Hochleistungsfaserverstärker

Benjamin Witschas
Experiments on spontaneous Rayleigh-Brillouin scattering in air



Jun.-Prof. A.Szameit at the
Optical Laboratory

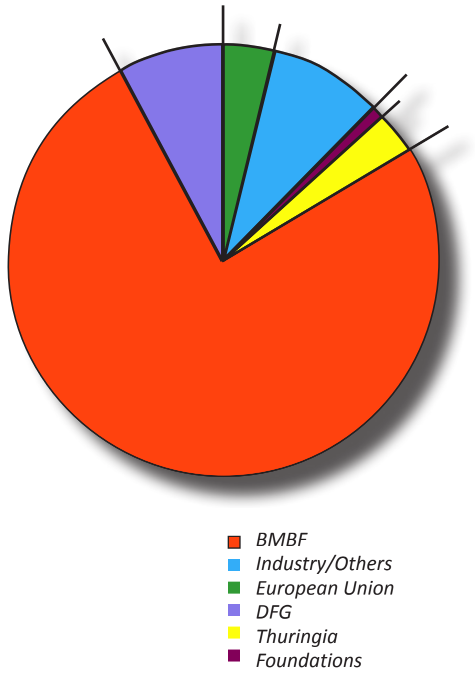
PROJECTS

„Applied Physics" is implemented in numerous projects that contain basic 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 products.

Statistics

External Funds (Revenues 2011):

DFG (German Resarch Society)	854 TSD €
BMBF (Federal Ministry of Education and Research)	8,098 TSD €
Thuringian Ministries	390 TSD €
Foundations	86 TSD €
Industry/Others	884 TSD €
Europian Union	413 TSD €
Total:	**10,725 TSD €**



PROJECTS Selection

DFG- German Research Society

Leibniz Preis: „Nanophotonik - Künstliche Medien für die Optik,
Design-Herstellung-Applikation“
Duration: 11/05 - 10/12

„Optische Beschichtung mittels Atomic Layer Deposition. Beschichtung nanostrukturierter Substrate und Adsorption von Flüssigkristallen an dünnen Schichten“
(Emmy Noether-Programm)
Duration: 05/10 - 04/13

Forschergruppe Teilprojekt F: „Discrete spatio-temporal dynamics in waveguide arrays with quadratic nonlinearity“
Duration: 12/07 – 3/11

„Aktive Mikrooptik“
Duration: 10/08 - 09/11

„Strukturierungsverfahren für mikro- und nanooptische Elemente in $LiNbO_3$“
Duration: 01/11 - 12/12

„Optisch erzeugte Sub-100-nm-Strukturen für biomedizinische und technische Zwecke“
Duration: 02/09 - 01/12

„Optisch erzeugte Sub-100-nm-Strukturen für biomedizinische und technische Zwecke - Ultrakurz-puls-induzierte Erzeugung periodischer Nanostrukturen im Volumen transparenter Festkörper“
Duration: 01/09 - 12/11

„Ultrafast Nanooptics – Nonlinear optics in metallic nanowaveguides in Lithium Niobate“
Duration: 04/10 – 03/13

„Untersuchung der Kopplung dielektrischer und plasmonischer Resonanzen an optischen Metamaterialien in Wellenleitergeometrien“
Duration: 04/09 - 03/12

European Union

„Powerful and Efficient EUV Coherent Light Sources (PECS)“
Duration: 11/09 - 10/13

Erasmus Mundus Programm: „Optics in Science and Technology (OpSciTech)“

„Large Area Fabrication of 3D Negative Index Materials by Nanoimprint Lithography (NIM-NIL)“
Duration: 12/09 - 1/13

BMBF-Projects

Federal Ministry of Educaion and Research

Ultra Optics 2015 - „Strategische Investitionen für das Zentrum für Innovations-kompetenz“
Duration: 07/08 - 03/11

Ultra Optics 2015 – Forschergruppe „Fertigungstechnologien für hoch entwickelte Mikro- und Nano-Optiken“
Duration: 05/11 - 04/16

„Nanostrukturierte Siliziumgrenzflächen - Black Silicon - NanoSIS (Programm ForMaT)“
Duration: 03/11 - 02/13

Verbundprojekt: „Kompetenzdreieck Optische Mikrosysteme (KD OptiMi)“
Duration: 01/11 - 09/13

Verbundprojekt: „onCOOPtics - Teilvorhaben: Physikalisch-technische Grundlagen von Hochintensitätslasern für die Radioonkologie und Aufbau eines Charakterisierungs- und Herstellungslabors für Hochleistungskomponenten“
Duration: 04/07 - 03/12

Ultra Optics 2015 – Nachwuchsgruppe „Design und Realisierung komplexer mikro- und nanostrukturierter photonischer Systeme basierend auf Diamant- u. Kohlenstoffoptiken“
Duration: 07/11 - 06/16

„Photonische Nanomaterialien“
Duration: 12/09 - 11/14

Grundlagen der CARS-Mikroskopie in der Neurochirurgie (MEDICARS) – Teilvorhaben: „Grundlagen faser-integrierter Lasersysteme für die CARS-Mikroskopie“
Duration: 09/09 - 08/12

Verbundprojekt: „Effektive Medien für die Mikrooptik (EFFET)“ - Teilvorhaben: „Elektronenstrahl-Lithographie und anisotrope Ätztechniken zur Herstellung effektiver optischer Medien“
Duration: 04/08 - 03/11

Forscherverbund: „Photonmanagement durch gezielte Interfacemodifizierung in optoelektronischen Bauelementen (PHIOBE)“ - Teilvorhaben: „Kontrolle optischer und elektronischer Eigenschaften nanostrukturierter Interfaces (NANOFACES)“
Duration: 05/08 - 12/11

Verbundprojekt: „Verbesserte Herstellungstechniken für tageslichttaugliche Bildschirmhologramme (VHTB)“ - Teilvorhaben: „Herstellungstechnologien für Masterhologramme“
Duration: 07/08 - 12/11

Schonendes Operieren mit innovativer Technik (SOMIT) - Kopfchirurgisches Zentrum – (CoHS), Teilvorhaben: „Minimalinvasive Femtosekunden-Laserchirurgie an der Augenlinse“
Duration: 09/05 - 08/11

Verbundprojekt: „METAMAT: Photonische Metamaterialien“ - Teilvorhaben „Gestapelte Metamaterialien“
Duration: 10/08 - 09/11

Optische Mikrosysteme für ultrakompakte hyperspektrale Sensorik - Teilprojekt: Mikrostrukturierte Filter (OpMiSen)
Duration: 08/11 - 01/14

Infrarot-optische Nanostrukturen für die Photovoltaik (InfraVolt), Teilvorhaben: „Photonmanagment im infraroten Spektralbereich“
Duration: 04/11 - 03/14

„HypoSolar-Hybridsolarzelle aus halbleitenden Polymeren und Si-Nanowirestrukturen, Simulation und Optimierung der Light-trapping-Eigenschaften von Hybridsolarzellen mit Si-Nanowire¬strukturen“
Duration: 08/08 - 07/11

Neue Bonding- u. Integrationsverfahren für einen Pikosekunden-Mikrochiplaser mit integriertem Faserverstärker und Hochleistungsfrequenzkonversion (BIVMIFF) - Teilvorhaben: „Faserbasierte Verstärkung von Pikosekunden Mikrochip-Lasern“
Duration: 05/08 - 04/11

„Montagegerechte Fertigungstechnologie für gefasste Optik (Justierfräsen)“
Duration: 08/11 - 01/14

Thuringian Projects

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

„Ultra Optics 2015“, Infrastrukturelles Investitionsprojekt – Anschaffung eines Helium-Ionen-Mikroskops (HIM) und einer Laserbearbeitungsstation zur 3D Volumenstrukturierung
Duration: 06/10 - 12/12

„OptiMi 2020“ – Ausbau der Forschungsinfrastruktur
Duration: 01/11 - 12/12

Optische Technologien für die nächste Generation Silizium Dünnschicht Photovoltaik Sol-Lux - Teilthema: „Untersuchungen zum Photonmanagement in Dünnschichtsolarzellen“
Duration: 02/09 - 02/12

Koordination der Initiative „PhoNa – Photonische NanoMaterialien“ im Bundesprogramm „Spitzenforschung und Innovation in den Neuen Ländern“
Duration: 10/09 - 12/13

OptiMi 2020-Graduate Research School „Green Photonics“
Duration: 07/11 - 12/13

PROJECTS Selection

„Entwicklung eines Verfahrens zum Laserbohren von Mikrofunktionsbohrungen für die Aktiventlüf-tung und Ausformunterstützung in komplexen Spritzgießwerkzeugen für die Verarbeitung von Kunststoffen, Keramiken und Verbundstoffen, TP: Erzeugung von Entlüftungsbohrungen in Spritzgußwerkzeugen mit ultrakurzen Laserpulsen“
Duration: 12/08 - 03/11

„Innovative nanostrukturierte Materialien für die Optik – Basisinnovation für den Cluster CoOPTICS (MeMa)“ (Landesprogramm ProExzellenz)
Duration: 01/09 - 12/13

„Modenfeldstabilisierung in Hochleistungsfaserlaser und –verstärkersystemen (MOFA)“ (Landesprogramm ProExzellenz)
Duration: 07/09 - 05/12

Foundations

Carl-Zeiss-Scholarships

Scholarships of the Merkle-Foundation

Contract Research

Entwicklung und Aufbau eines fs Faserlasers mit hoher mittlerer Leistung (Kurzpulsfaserlaser, MPG Garching)

Breitbandige FBG bei 2 µm für MM Fasern im Rahmen des BMBF Vorhabens (one2FEL)

Untersuchungen zum Laserstrahllötprozess

Charakterisierung der Benetzungs- und Rauheitseigenschaften funktionaler Oberflächen

Streulichtcharakterisierung optischer Oberflächen und Materialien

Entwicklung keramischer Gasführungen für Atmosphären- und Vakuumanwendungen

Theoretische und experimentelle Untersuchung zur Mikro- und Nanostrukturierung gekrümmter Oberflächen

Streulichtmechanismen an optischen Oberflächen

Faserlaser

Theoretische und experimentelle Untersuchungen zum plasmaaktivierten zwischenschichtfreien Bonden von Glas und optischen Kristallen

Funktionalisierung von Kunststoffoberflächen durch Ionenätzen und Beschichtung

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

Entwicklung und Analyse einer athermalen Werkstoffkombination für formstabile Metalloptiken auf Basis von amorphen chemisch abgeschiedenen Nickel-Phosphor-Schichten

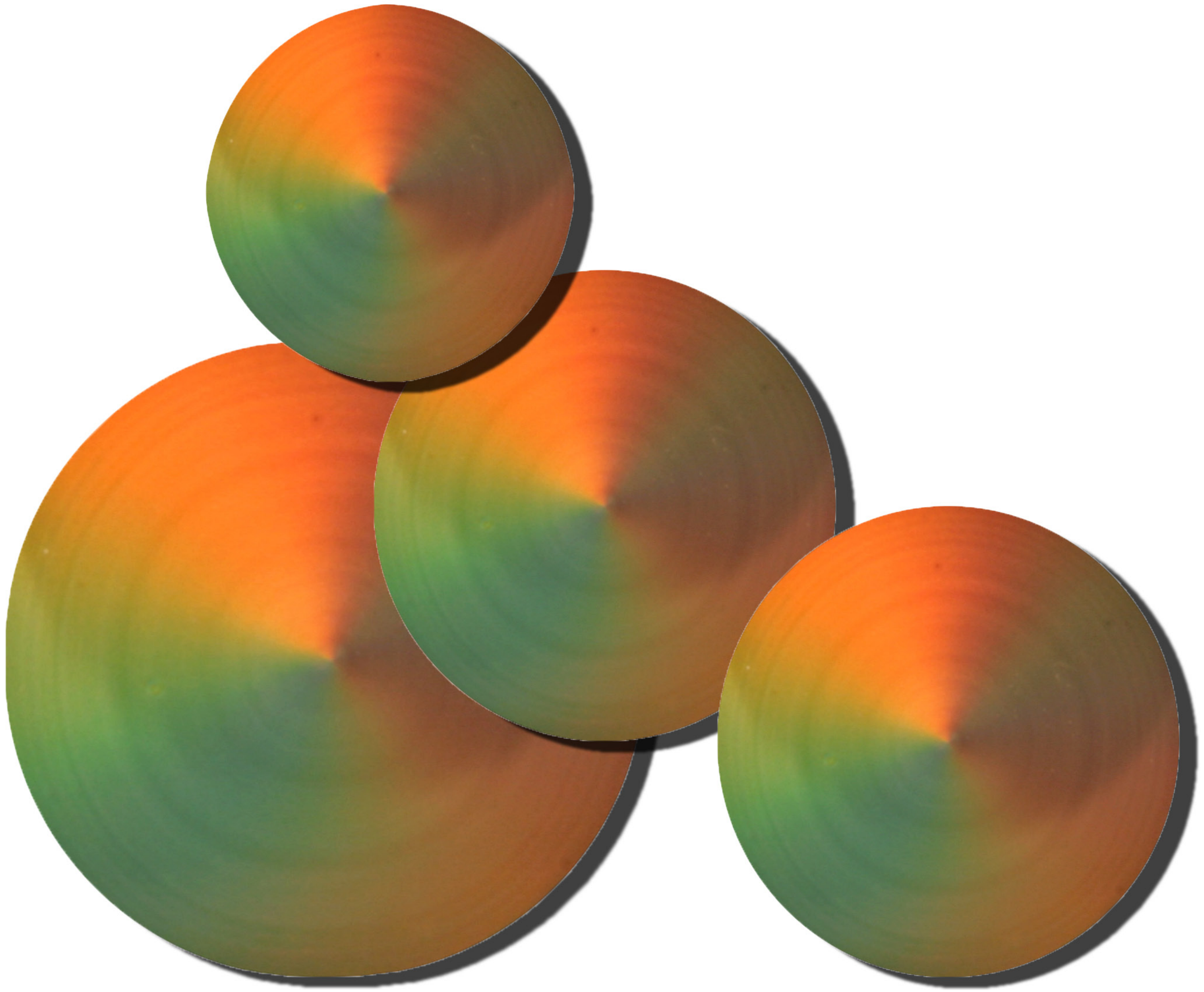
Theoretische und experimentelle Untersuchung zur Entwicklung einer Leichtgewichtsausführung von Metallspiegeln für weltraumtaugliche Teleskope

Entwicklung von THz-Tomographiesystemen

Entwicklung und Untersuchung eines Aktuators mitsamt Fertigungsprozess für direkt in Schicht-technologien integrierbare elektrostatische Aktorik zur Verstellung von Mikrolinsen in einem geschlossenen und volumenminimierten Optiksystem

Neuartige Hochleistungskomponenten für Faserlasersysteme

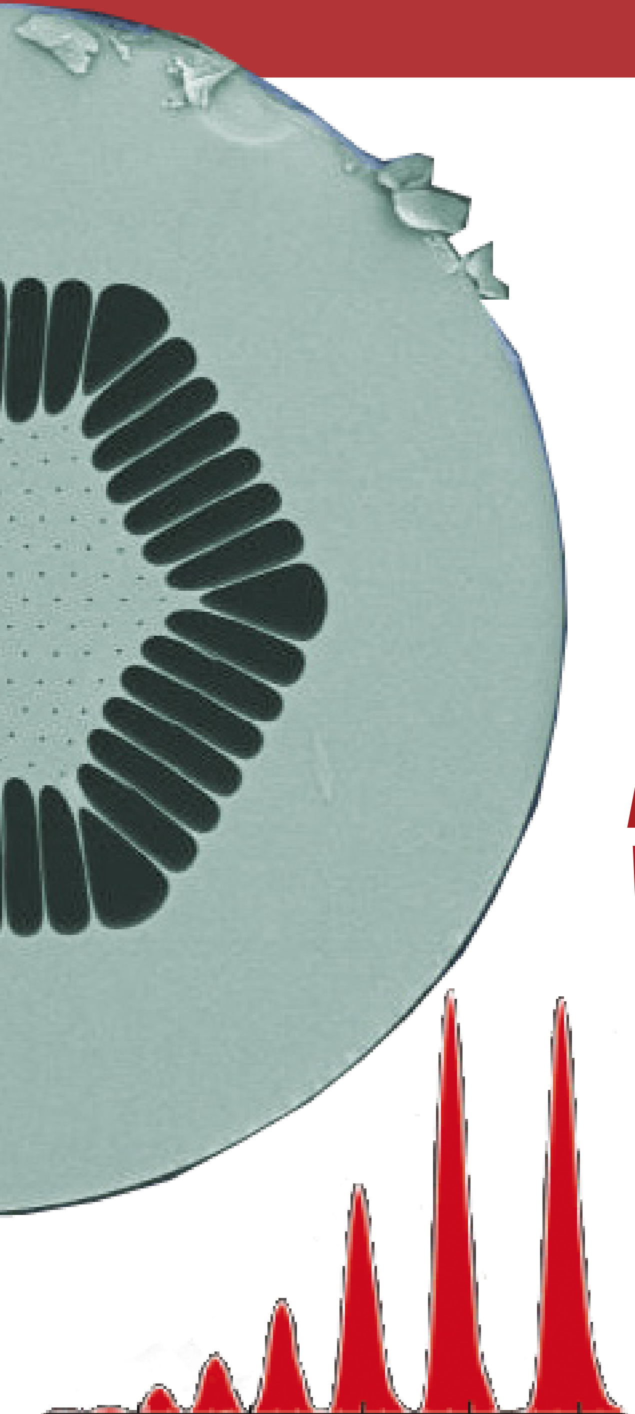
Streulichtmechanismen an optischen Oberflächen



Wave-plates in fused silica to generate radial polarisation
(manipulated image)

RESEARCH - Achievements & Results

Evidence of intensive engagement with research topics of the institute is the spezialization of the seperate research groups on key problems. 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

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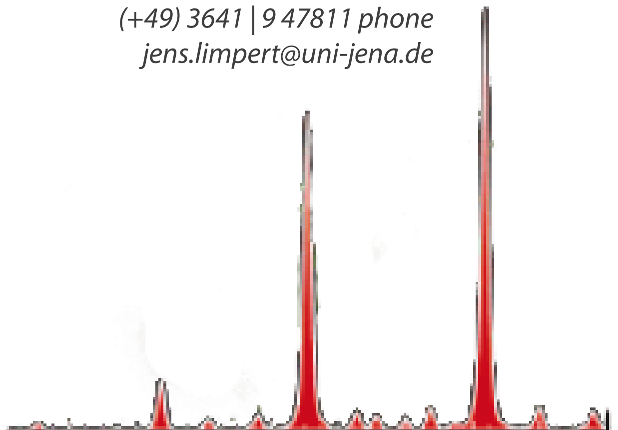

This research group is working on the development of new concepts for solid-state lasers with focus on fiber laser technology. Research emphasis lies on fiber-optical amplification of ultrashort laser pulses, ultrashort pulse oscillators, few-cycle pulse generation and amplification, the design of new large core fibers, the simulation of nonlinear effects and the amplifier dynamics in active fibers, fiber-optical frequency conversion, picosecond µchip laser and the generation of high harmonics.

Scientific focus lies on:

- Combination of pulsed laser radiation
- Fiber optical enhancement of ultra-short laser pulses
- Fiber laser - pumped parametric short-pulse amplification
- Conception of novel large core diameter fibers
- Suppression of non-linear effects in high-performance fiber lasers
- Pulse shaping in fiber amplifiers
- pico-second µchip-lasers
- Generation of Harmonics with fiber lasers
- Design of actively doped large mode area fibers
- Generation of high gas harmonics with high pulse frequency

High Harmonic Generation at High Repetition Rate

Coherent, pulsed and short-wavelength radiation has the potential to help answering fundamental questions in physics, biology and chemistry. Typically, such radiation is generated at large-scale facilities. Laser-based generation by means of high gas harmonics is an interesting alternative. In the process a high intensity laser pulse interacts with a gas, which is why only kHz repetition rates can be achieved. The constant development of fiber laser technology has now enabled to significantly increase the repetition rate.
Nonlinear compression of a fiber amplifier system in hollow core fibers leads to 40 fs pulses with an energy of more than 0.5 mJ and a pulse peak power higher than 7 GW [1]. An average power of 3.2 µW in a single harmonic could be generated at 50 kHz with such a system, which already constitutes a record value for direct generation. Usually, similar power levels can only be achieved by enhancement in an external resonator [2]. A further increase to 1 MHz became possible by the use of a novel large pitch fiber design. Therewith, the laser system provided an average power of 200 W, which could be converted to several µW of power in a single harmonic.

This work is supported by the European Research Council under the European Union's Seventh Framework Program (FP7/2007-2013)/ERC Grant agreement no [240460].

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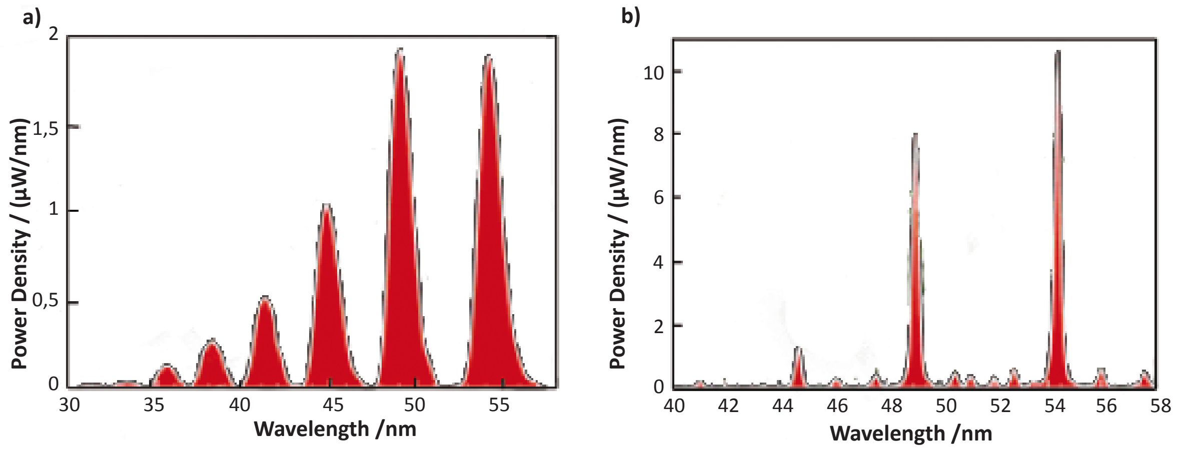
Jens Limpert

[1] S. Hädrich, M. Krebs, J. Rothhardt, H. Carstens, S. Demmler, J. Limpert, A. Tünnermann: "Generation of µW level plateau harmonics at high repetition rate" Opt. Express 19, 19374 (2011).

[2] J. Johns: "Intracavity high harmonic generation with fs frequency combs" in High Intensity Lasers and High Field Phenomena, OSA, technical Digest (CD) paper HFB5 (2011).

Figure 1: Spectrum of high gas harmonics generated at 50 kHz (left) and 1 MHz (right), respectively.



Designing actively doped large mode area fibers

[3] F. Stutzki, F. Jansen, T. Eidam, A. Steinmetz, C. Jauregui, J. Limpert, A. Tünnermann: "High average power large-pitch fiber amplifier with robust single-mode operation" Opt. Lett. 36, 689-691 (2011).

[4] T. Eidam, J. Rothhardt, F. Stutzki, F. Jansen, S. Hädrich, H. Carstens, C. Jauregui, J. Limpert, A. Tünnermann: "Fiber chirped-pulse amplification system emitting 3.8 GW peak power" Opt. Express 19, 255-260 (2011).

Fiber laser systems are characterized by their excellent beam quality and high efficiency. However, parasitic nonlinear effects are challenging for pulsed high power laser systems. Therefore, actively doped fibers with very large mode areas are required. Herein, it is most important to ensure single-mode operation and, therewith, excellent beam quality. The novel large-pitch fibers employ a photonic structure consisting of few hexagonally arranged air holes with large hole-to-hole distances (Fig. 2) to achieve a delocalization of higher order modes. The delocalization reduces the excitation of these modes by the seed signal and minimizes their overlap with the actively doped region. Therefore, the fundamental mode experiences an improved excitation at the fiber input and a preferential amplification. The simplicity of the fiber design ensures an excellent reproducibility. As the fiber design is not based on resonant effects, it is easily scalable by increasing the hole-to-hole distance. Values between 30 µm and 75 µm have been realized. These fibers raised the bar for highest average output power at largest mode field areas under single-mode operation. At mode field diameters of up to 62 µm up to 300 W of average output power were demonstrated in [3] maintaining nearly diffraction limited beam quality of $M^2 < 1.4$. Finally, even a mode field diameter of 100 µm in the single-mode regime could be exceeded and enabled pulse energies of 2.2 mJ at pulse peak powers of 3.8 GW and pulse durations below 500 fs [4]. Hence, large-pitch fibers will serve as the backbone of future fiber laser systems with highest pulse energies.

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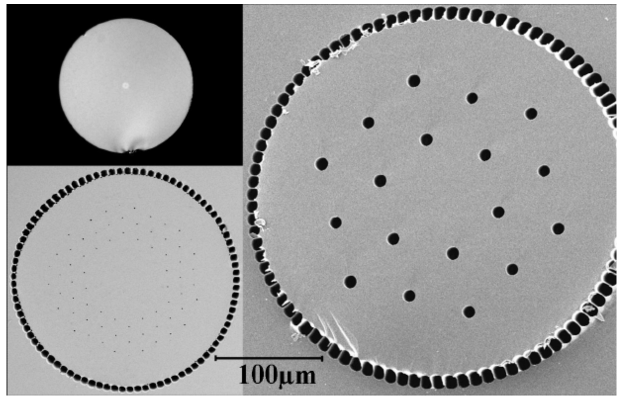
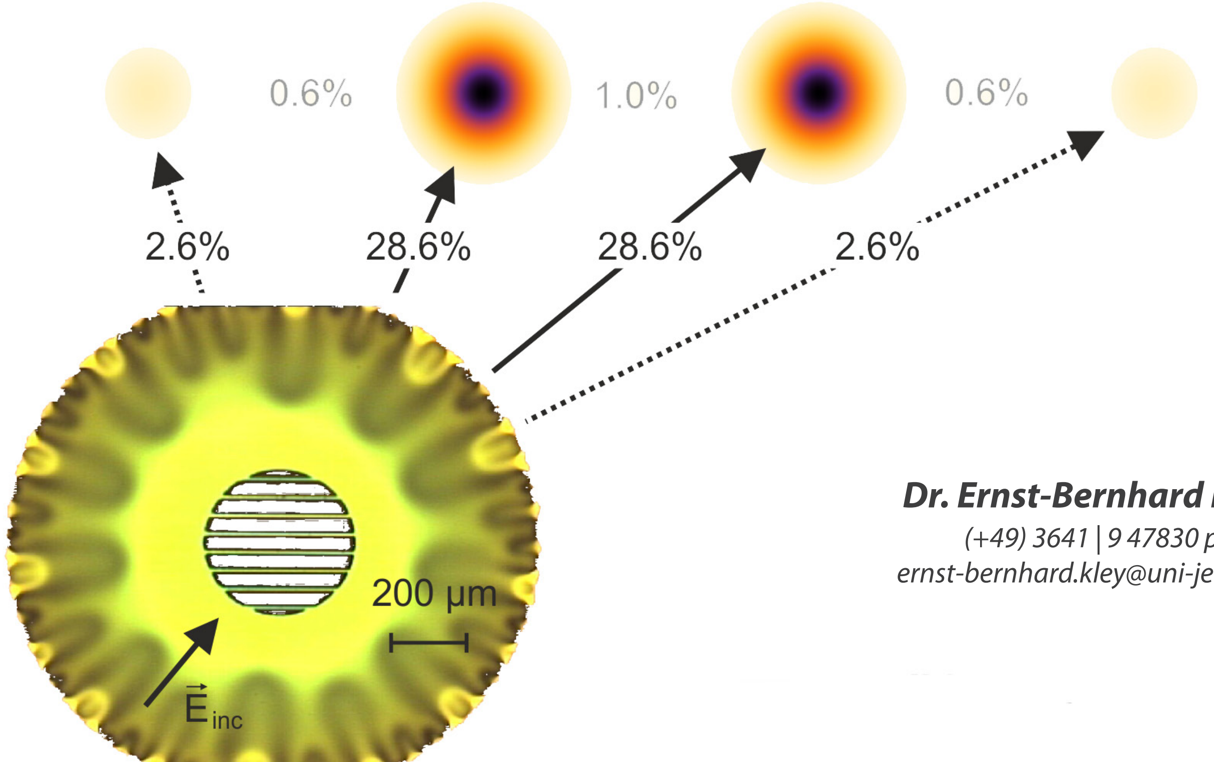
Figure 2: Microscope images (all at the same scale) of [A] standard step index fiber with 6 µm core and 125 µm outer diameter, [B] 85 µm core rod type photonic crystal fiber with 200 µm air-clad diameter, and [C] 108 µm core large-pitch fiber with 340 µm airclad diameter.



The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC Grant agreement n° [240460] „PECS".

Microstructure Technology & Microoptics



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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.

2011 the following research priorities have been edited:

- Plasmonic nanostructures and 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 rage
- 3D nano-structuring of crystals with ion beam enhanced etchings
- Effective media for reflection reduction of smooth and micro-structured surfaces
- Material-scientific aspects
- Silicon-photodiodes for IR and antireflective surfaces
- Membrane and thinfilm bonding
- Atomic Layer Deposition

High efficient EUV and X-ray gratings for plasma diagnostics

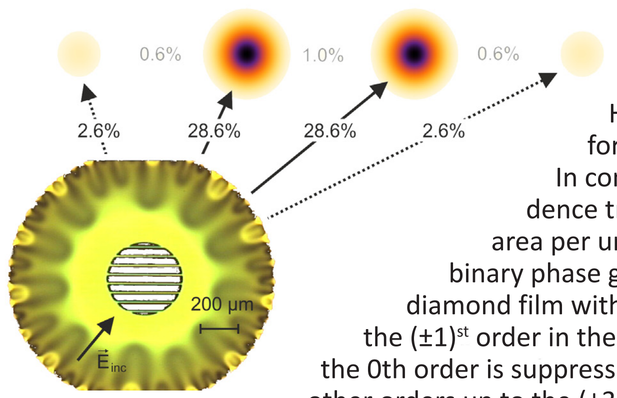

Figure 1: Diffraction by a stand-alone phase transmission grating made of an ultrathin diamond membrane [λ = 6.25 nm].

High throughput diffractive optics are of crucial interest for low-signal applications, in astronomy for instance [1]. In contrast to reflective components, lightweight normal-incidence transmission gratings provide an unprecedented effective area per unit mass. Without any substrate layer, true stand-alone binary phase grating membranes made of an ultra-nanocrystalline diamond film with a thickness of 0.3 µm reach an efficiency up to 28% in the $(\pm1)^{st}$ order in the wavelength range between 5 nm and 7.5 nm, whereas the 0th order is suppressed down to 1% near 6.8 nm [2]. Diffraction losses into other orders up to the $(\pm3)^{rd}$ one amount to ~7%. The non-negligible compressive stress of the membrane sets an upper limit to feasible grating diameters of ~400 µm currently. An extension to dimensions of practical interest, i.e. several $(10^{-3}$-$10^{-2})$ m, is thus planned for future [Fig.1].

In – ground based – laboratories however, the complex plasma emission is often investigated using interferometry. Conventional grating beamsplitters, essential for Mach-Zehnder like setups, suffer from severe difficulties in balancing the diffraction efficiencies. An alternative design, based on conical grazing incidence diffraction, so appears to be straightforward: The symmetry of binary profiles, now operated in total external reflection, permits a natural equalization of the $(\pm1)^{st}$ order efficiency which is found as high as 33% in each of them for an initial sample made of Si and SiO_2 [3]. On the other hand, the 0th order is almost eliminated to 0.12% by means of destructive interference from the binary groove pattern. Higher orders beyond the $(\pm1)^{st}$ one are even evanescent and cannot propagate. With an absolute intensity difference of 0.01% between the $(-1)^{st}$ and the $(+1)^{st}$ order, a nearly perfect interference contrast of 1-ε with $\varepsilon \sim 10^{-7}$ might be obtained [Fig.2].

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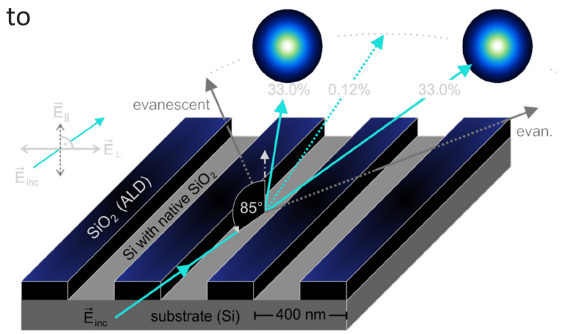


Figure 2: Diffraction by an EUV beamsplitter in conical grazing incidence. Propagating orders are drawn in turquois [λ = 25.0 nm].

Light Propagation in Lithium Niobate Photonic Crystals

The growing need to miniaturize functional optical elements led to the objective to combine the fields of nonlinear and integrated optics. The efficiency of nonlinear optical effects, e.g. optic parametric oscillation, is enhanced by decreasing the interaction volume of light and nonlinear medium. One way to implement this concept is the use of photonic crystals formed by a hexagonal lattice of air holes in a 500 nm thick membrane. By omitting single holes or complete lines of holes light can be localized to those point or line defects. As a optically nonlinear material system lithium niobate was chosen. For the patterning of lithium niobate the ion-beam enhanced etching has been developed allowing for the transfer of arbitrary geometries, defined by electron beam lithography, into suspended membranes [1]. A photonic crystal with line defect was characterized optically by scanning near-field microscopy (Fig.3). Exemplarily depicted in Fig.4, the desired localization of light coupled to the structure along the waveguide can be seen clearly [2]. Now, those results enable us to realize more complex structure for the application in nonlinear optics.

[1] H. Hartung, et al.: "Ultra thin high index contrast photonic crystal slabs in lithium niobate"
Opt. Mat. 33, 19 (2010).

[2] R. Geiss, et al.: "Light propagation in a free-standing lithium niobate photonic crystal waveguide"
Appl. Phys. Lett. 97, 131109 (2010).

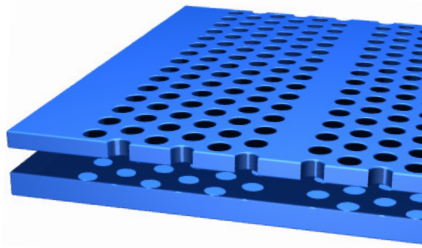
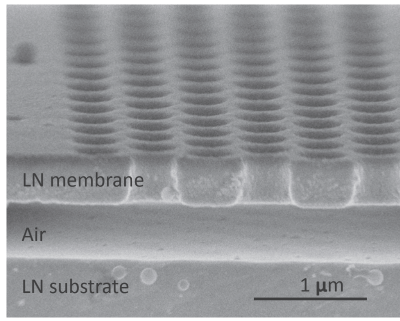


Figure 3: Shematic Structure (top) and REM image (bottom) of a photonic crystal with line defect in lithium niobate(LN) [2].



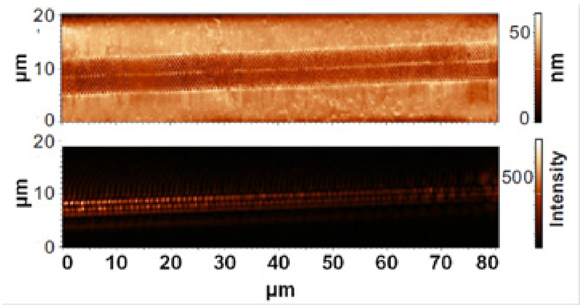


Figure 4: Topography (top) and optical near-field (bottom) of a photonic crystal with line defect at 1400 nm [2].

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Nano Optics

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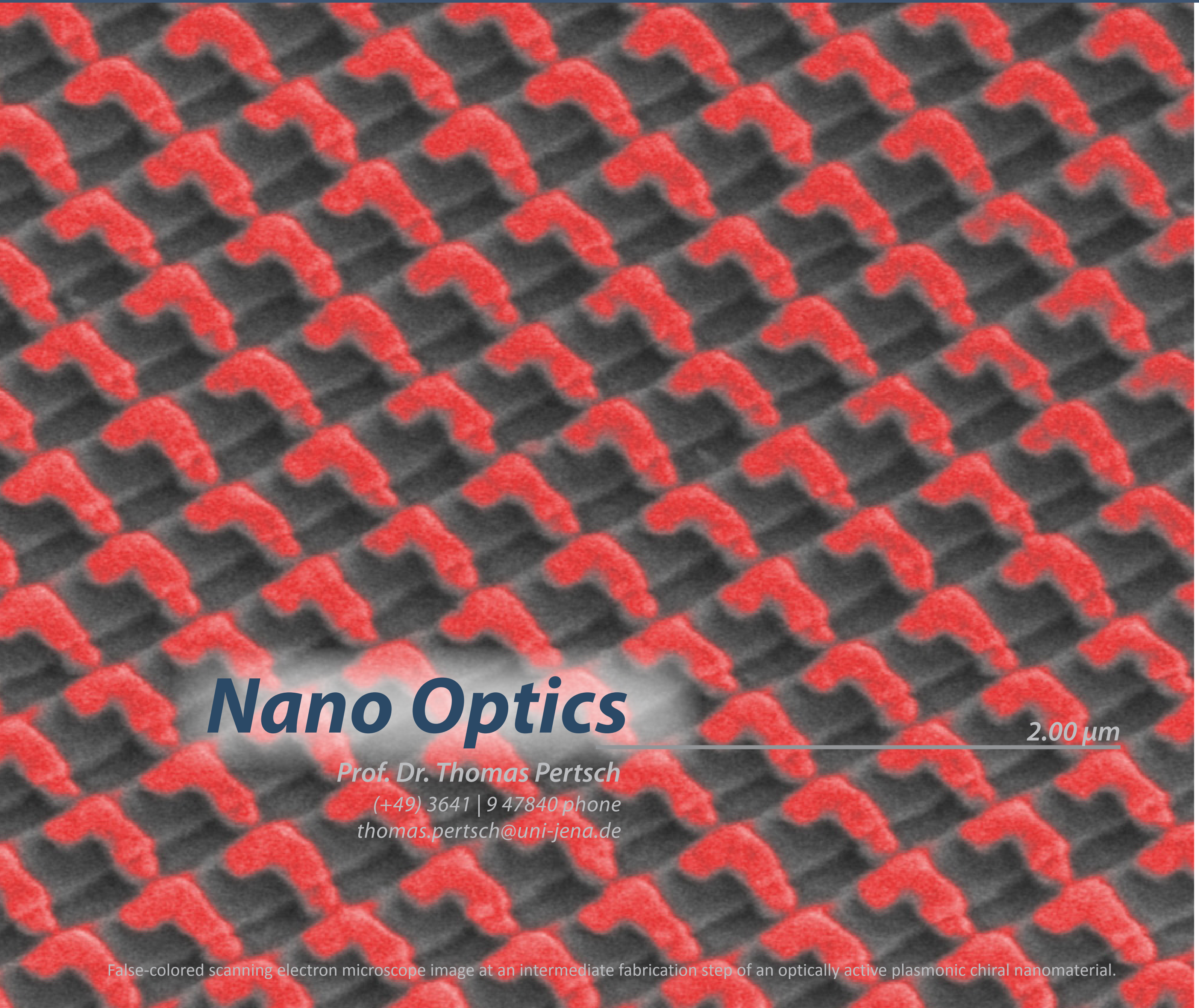

False-colored scanning electron microscope image at an intermediate fabrication step of an optically active plasmonic chiral nanomaterial.

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

2011 the scientific emphasis was 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
- Optical micro resonator of high quality
- Nonlinear nano marker for maxium-resolution microscopy
- Opto-optical switching processes in integrated optics
- New optical technologies for astronomical instruments
- Application of nanostructures to enhance efficiency of photovoltaic elements

Some outstanding results are: three-dimensional chiral meta material with highly optical activity • experimental proof of non-defrative plasmonic beams as Airy-Surface-Plasmons • solution of the lifecycle of optical Light Bullets and demonstration of the acceleration of nonlinear space-time localizations at the decay process • realization of strong dispersive computer generated holograms (CGH) with nanostructured meta materials • realization of large-scale meta materials with Nanoimprint Lithography • generation of interlaced photon pairs in optical waveguide arrays • fusion of some interferometer-arms in an intergrated-optical 3D beam combiner for astronomical interferometry.

Three-Dimensional Chiral Metamaterial with Giant Optical Activity

Artificial nanomaterials may exhibit a topology far off the thermodynamic equilibrium which is their primary difference to natural materials. This has been impressively demonstrated by optical metamaterials which consist of nanoscale structures. By deliberately breaking their spatial symmetries new effects occur, such as a directional asymmetry in the transmission [1].

Likewise, natural effects are extraordinarily enhanced, such as the manipulation of the polarization state of light, commonly referred to as optical activity. In this context we investigated an optical metamaterial (Fig.1) composed of three-dimensional, chiral unit cells [2]. Exemplarily we measured all entries of its broadband complex Jones matrix, obtaining a complete data set that comprises all transmission properties of the metamaterials for visible and near-infrared light (Fig. 2).

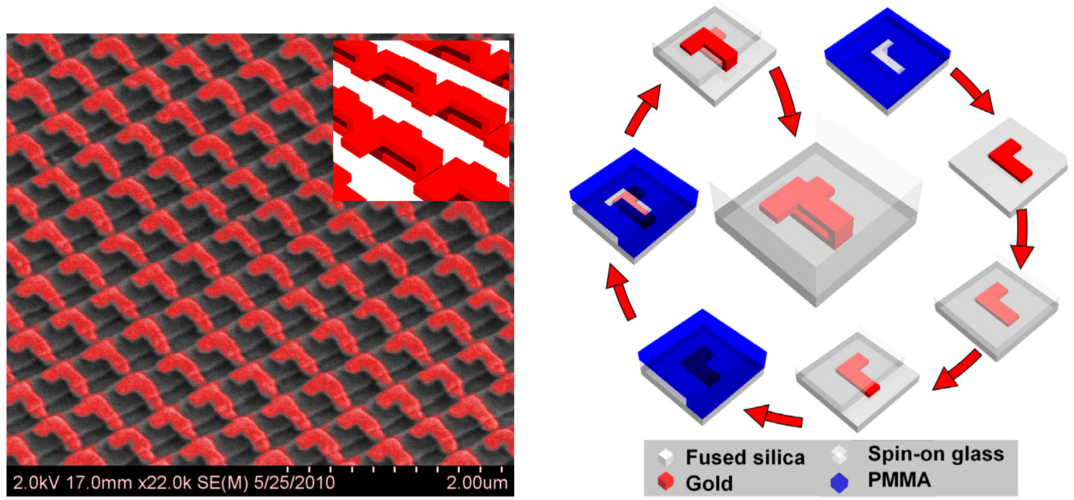

Figure 1: Fabrication procedure of the optically active plasmonic chiral nanomaterial (right) and a false-colored scanning electron microscope image at an intermediate fabrication step (left). Adapted with permission from [2]. Copyright 2011 American Chemical Society

[1] C. Menzel, C. Helgert, C. Rockstuhl, E.-B. Kley, A. Tünnermann, T. Pertsch, F. Lederer: „Asymmetric transmission of linearly polarized light at optical metamaterials“ Phys. Rev. Lett. 104, 253902 (2010).

[2] C. Helgert, E. Pshenay-Severin, M. Falkner, C. Menzel, C. Rockstuhl, E.-B. Kley, A. Tünnermann, F. Lederer, T. Pertsch: „Chiral metamaterial composed of threedimensional plasmonic nanostructures“ Nano Lett. 11, 4400–4404 (2011).

Amongst them, a peak polarization azimuth rotation of linearly polarized light exceeding 50° was found for a wavelength of 1.08 µm. Normalizing this record-breaking value, based on entirely experimental means, to the light propagation path, it exceeds comparable criteria of any known passive and reciprocal optical media by orders of magnitude.

This proof constitutes a substantial advancement in the current state of optical metamaterials. Our applied methods open the way to the complex far field characterization of a very general class of dispersive media and will have important implications for their design, realization and experimental evaluation. Moreover the reported concepts and methods can be straightforwardly applied to the realization of miniaturized optical systems based on optically active media.

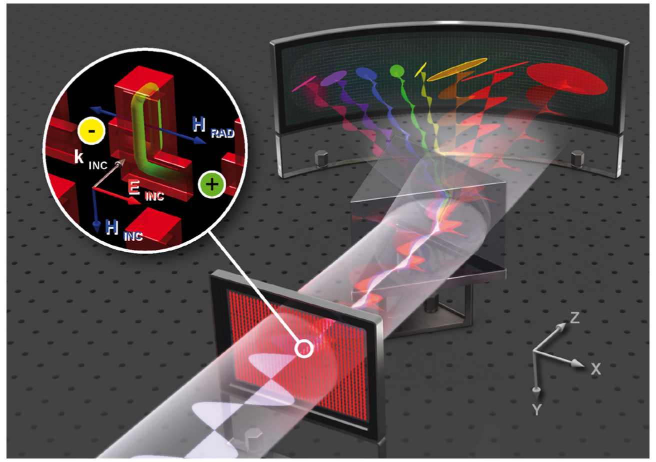

Figure 2: The optically active nanomaterial converts a linearly polarized input spectrum into wavelength dependent elliptical polarization states. Reprinted with permission from [2]. Copyright 2011 American Chemical Society

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Christoph Menzel
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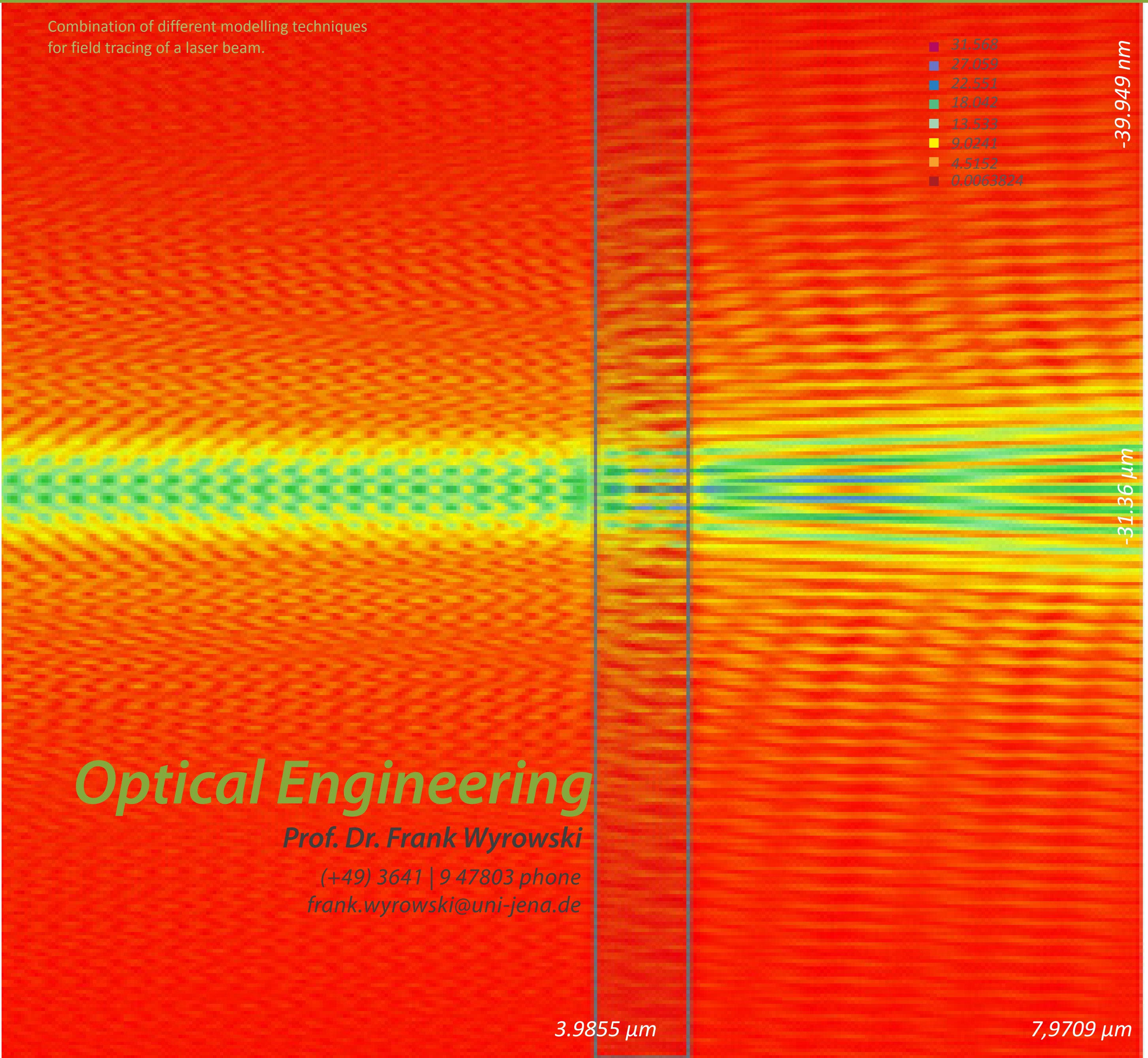
Falk Lederer

Combination of different modelling techniques for field tracing of a laser beam.



Optical Engineering

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The group Optical Engineering deals with the development of novel approaches for modeling and design of optical systems. Our approach is based on field tracing, in which not ray bundles but electromagnetic harmonic fields are propagated through the system. That enables unified optical modeling which reaches from source modeling to a suitable simulation of optical detectors.

In 2011 we were particularly interested in:

- Non-sequential field tracing
- Electromagnetic modeling of partially coherent light
- Geometrical optics field tracing technology
- Propagation of non-paraxial harmonic fields
- Rigorous and efficient propagation of general fields through plane interfaces
- Propagation of fields between tilted planes
- Design of light-shaping elements

2011 was a very productive year. Together with our colleagues at LightTrans GmbH we were able to combine the mathematical concept of sparse tearing and interconnecting with our idea of non-sequential field tracing. That constitutes the basis of a new type of Maxwell's solver with high efficiency and numerical stability. We also introduced parabasal field decomposition. This technique solves various problems in optical modeling, e.g., efficient propagation of non-paraxial harmonic fields, tracing scattered light through lens systems and tolerancing of optical systems.

Non-Sequential Field Tracing

Together with colleagues from the LightTrans GmbH, a mathematical concept for a non-sequential tracing field was developed. It could be shown that this method represents a novel method for solving the Maxwell‘s equations for general optical systems. Mathematically, the concept belongs to the concept of „Sparce Tearing and Interconnecting". The numerical efficiency of the method is essentially based on two concepts: (1) One Light Path Tree allows a quick analysis of all contributing light paths within the system. (2) The Field tracing allows the use of adapted modeling methods in different regions within the system. „Non-Sequential Optical Field Tracing by SparseTearing and Interconnecting" discribes a theoretical breakthrough for the optical system modeling . Based on this corresponding algorithms will be implemented in cooperation with LightTrans GmbH in future.

Parabasal Field decomposition and Propagation

The propagation of non-paraxial fields is a hitherto unsolved problem in optics modeling. Although there are physical models, such as the Spectrum of Plane Waves (SPW) operator, but these non-paraxial fields lead to very high numerical effort, which makes it impossible to model with PC technology. The fundamental problem lies in the sampling of strong smooth phase terms, such as spherical and cylindrical waves or astigmatic fields. In 2011, we were able to solve this problem by parabasal decompositions of non-paraxial fields. It is particularly used that locally linear phase fractions were separated from the field and can then treated without further sampling. In combination with a newly developed SPW operator for parabasal fields non-paraxial fields now can propagated with significantly reduced numerical effort.

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Frank Wyrowski

Rigorous Method for Field Rotation

Typically, fields between parallel planes are propagated. In the practice of optical modeling, however, there are many reasons to overcome this limitation. In 2011, we have therefore developed a rigorous and effective operator for the 3D rotation of harmonic fields . It solves a known problem of interpolation of other methods. In particular, the method allows a very efficient rotation of parabasale fields and can therefore be used in conjunction with the parabasal field decomposition. We have used this method to propagate general fields rigorously through planar interfaces.

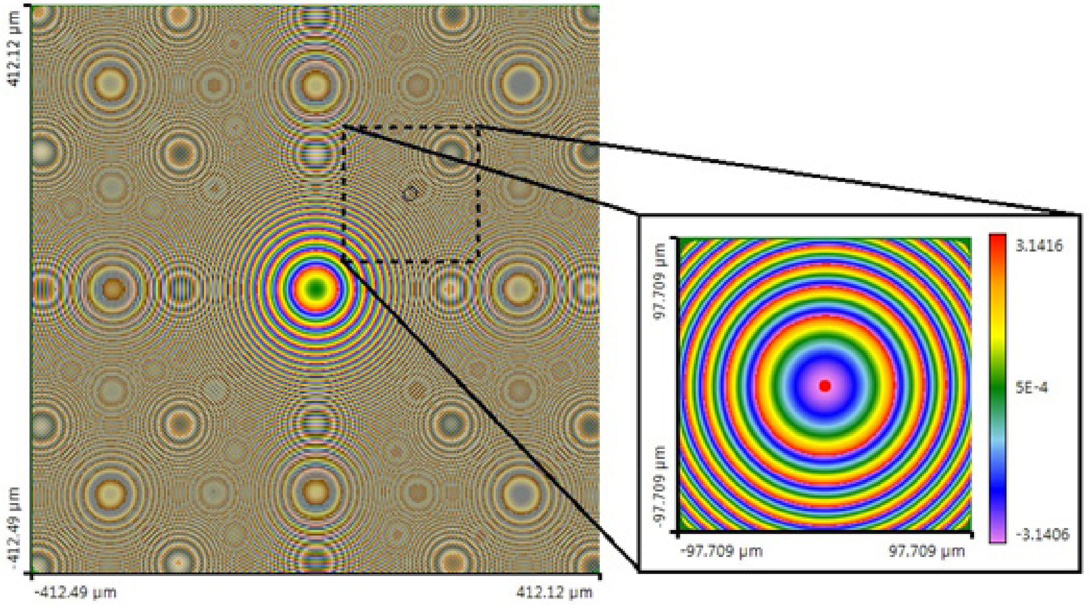
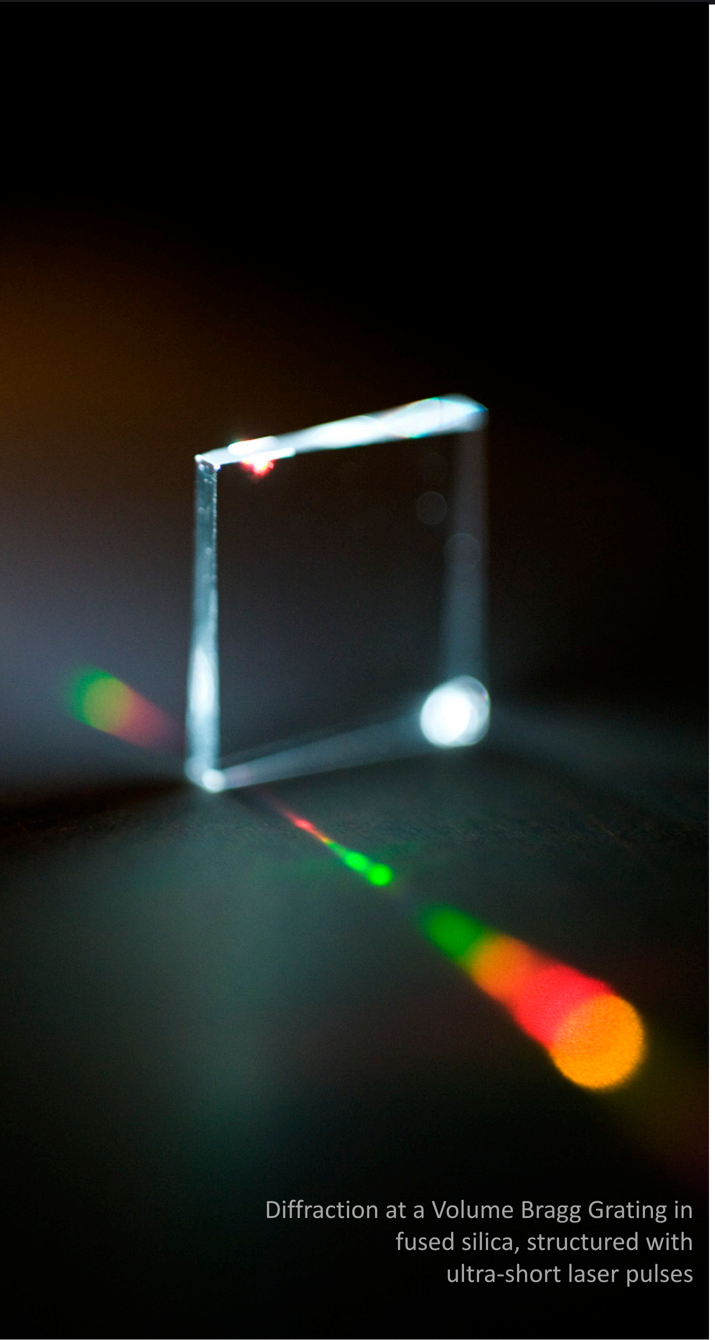


Figure 1:
Left, a sampled version of a spherical wave can be seen. The necessary very fine sampling ¬ scanning leads in conjunction with the much coarser resolution of the screen on which the phase is displayed to Moiré patterns. The main effect of the newly developed parabasal field decomposition is shown in the dashed square labeled. Obviously, the phase is then substantially linear. If one extracts these linear part, it only remains the local phase shown to the right , which is substantially parabolic . Obviously, one can reduce drastically the remaining sampling effort by local extraction of the linear phases.



Diffraction at a Volume Bragg Grating in fused silica, structured with ultra-short laser pulses

Ultrafast Optics

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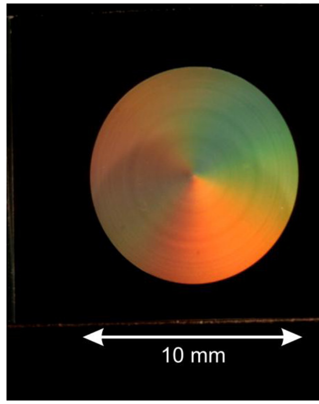
The group Ultrafast Optics works on applications of femtosecond laser pulses, such as materials processing and micro/nano structuring of optical materials.

The scientific topics in 2011 were:

- Micro- and nanostructuring with ultrashort laser pulses
- 3D volume structuring inside glasses and crystals
- Linear and nonlinear optics in discrete systems
- Fiber Bragg Gratings
- Medical laser applications in ophthalmology
- Ultra-short pulse laser technology
- THz technology



Wave-plate in fused silica to generate radial polarisation. The optcial function is realized by nano grating structures, which have been created by ultra-short laser pulses.

In 2011, some outstanding results were: direct visualization of the hole drilling of opaque materials with ultrashort laser pulses • realization of high-strength bonds in glass by local laser welding with ultrashort pulses • realization of Fiber Bragg gratings in multimode fibers with ultrashort laser pulses • realization of volume Bragg gratings in fused silica with ultrashort laser pulses • investigation of discrete optical effects in fs written two-dimensional waveguide arrays • analysis of photon correlations in two-dimensional waveguide arrays • optimization of cutting geometry in eye surgery with ultrashort laser pulses.

Advanced Phase Elements based on fs Laser Induced Nanogratings

The internal structuring of transparent materials with femtosecond laser pulses has been the subject of intense research in recent years. Fused silica has proven to be a particularly versatile platform for this type of micro-machining. In a certain range of fabrication parameters, self-organized periodic structures emerge upon exposure to multiple femtosecond laser pulses [1]. The structural properties of these so-called nanogratings can be tuned by the exposure parameters. This enables a precise control of both strength and orientation of the induced form birefringence [2]. In combination with the degrees of freedom provided by the inscription technique, nanogratings can be used to realize e.g. complex three-dimensional phase elements for polarization control.

Our investigations of the formation process reveal that nanogratings grow from intrinsic nanometer-scale inhomogeneities which are randomly distributed in the host material. The collaborative action mediated by the interplay of field enhancement and transient defects [3] results in uniform nanogratings after several hundreds of laser pulses (Fig. 1a). Until recently, nanogratings had only been demonstrated with high pulse energy Ti:sapphire CPA laser systems. Due to the substantial number of pulses per spot required, the low repetition rate of such lasers (typically 1-100 kHz) severely restricts the processing speed. We were able to overcome this limitation by utilizing a high power femtosecond oscillator with a repetition rate of 9.4 MHz [4] (Fig. 1b).

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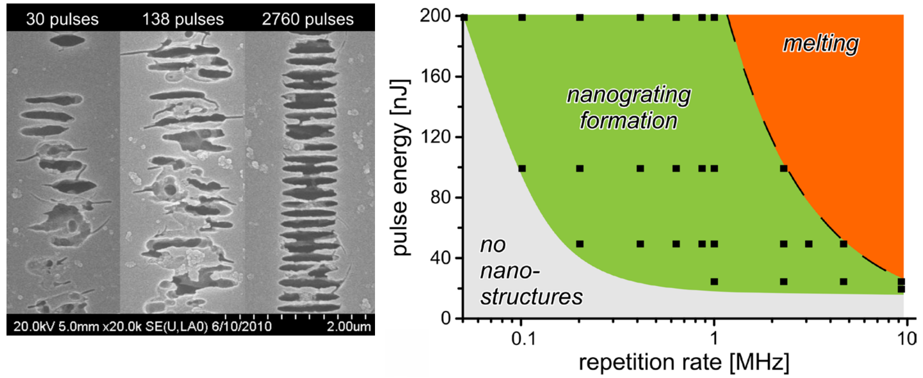

Figure 1: (a) Growth stages of femtosecond laser-induced nanogratings [3]. The grating planes are oriented perpendicular to the writing polarization and introduce localized form birefringence within the isotropic host material. (b) Parameter window for nanograting inscription [3]. Optimized parameters allow inscription at high repetition rates yielding high processing speeds.

In order to demonstrate the versatility of our technique, we realized a wave plate which converts circularly polarized input light into a radially polarized beam. The inscribed nanograting pattern features a retardation of λ/4 with spatially varying orientation, thus locally converting the circularly polarized input beam into linearly polarized light with radial orientation (Fig. 2a). In contrast to other techniques, our approach naturally allows a continuously varying orientation of the birefringence. Figure 2b shows the intensity profile of the output beam in the far field with its characteristic doughnut shape.

In conclusion, the use of high repetition rate lasers allows for nanogratings to be utilized as building blocks of intricate three-dimensional phase elements. The combination of the high damage threshold and broad transparency range of the host material fused silica as well as the thermal stability of the inscribed structures paves the way for a multitude of applications ranging from beam shaping to high resolution microscopy.

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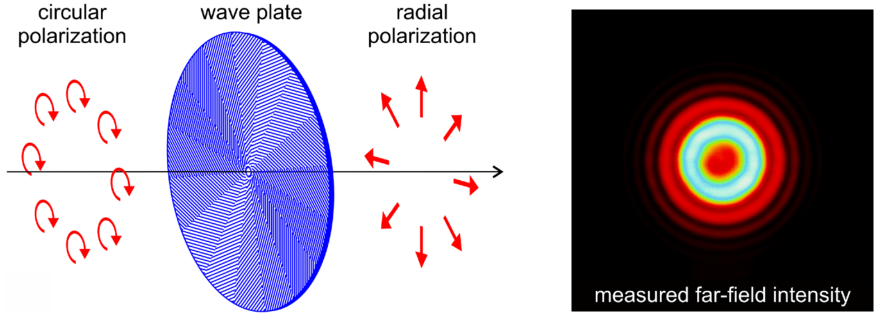

Figure 2: Generation of a radially polarized doughnut beam. (a) Schematic setup: The wave plate introduces a retardation of λ/4 with spatially varying orientation, thus converting the circularly polarized input beam into radially polarized light. (b) Measured far-field beam profile. The characteristic doughnut shape emerges upon propagation as opposing polarizations interfere destructively in the central region.

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Centre for Innovation Competence ZIK ultra optics

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.

Diamond-/Carbon-based Optical Systems

Intension
- In addition to the currently dominant silicon-based optics, the research group will establish organic and inorganic carbon-based materials optics/photonics, and thereby implement new optical, opto-electronic and mechanical functions. The wide variety of structural forms of carbon and its compounds offers an exceptionally high degree of flexibility, since the physical properties of the material can be set over a wide area. Carbon exists as single-crystal line diamond, polycrystalline and nanocrystalline form, as amorphous carbon in the form of DLC (diamond like carbon), graphite and graphene, fullerenes and carbon nano-tubes, and in the form of carbon-mixed crystals.

Aim
- The focus of the research group lies on the fundamental theoretical and experimental understanding of the propagation of optical waves in different systems, whose material parameters and structure base on the different macroscopic manifestations of carbon. Using these basic results, a series of highly innovative applications in the optical micro- and nanotechnology can be realized.

Research areas
- Optical Graphene
- Complex Fluids
- Super Oscillation
- Algorithmical Subwavelength Microscopy

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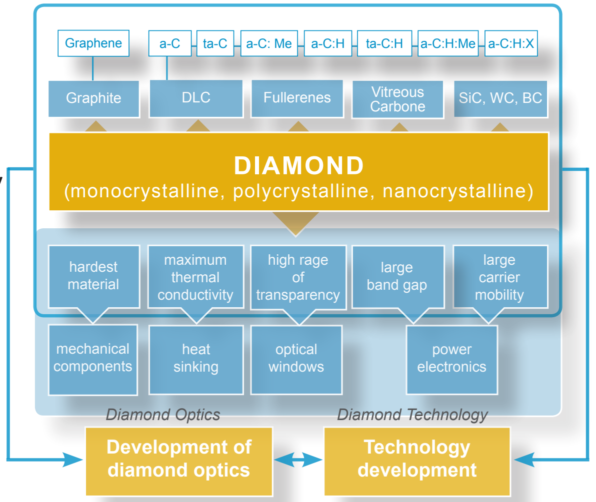

Manufacturing Technologies for Advanced Micro-and Nano-Optics

Intension
- Over the last years, the micro-and nano-structured optics has undergone an enormous upswing with the development of new physical effects for the targeted control of light. Despite intensive efforts, there is still a gap in the transfer of basic findings into practical applications. This is significantly due to a lack of industry-standard fabrication technology for the highly sophisticated nanostructures.
Part of this project will be to build a bridge between the basic research-oriented focus of the center and specific applications. The key to this is the development of a new technological base for the flexible production of optical micro-and nano-structures with economical procedures of high industrial spreading. The project deals with both major work on the expansion of available process technologies as well as the development of new materials for micro-structured optical elements.
The potential of new technological possibilities will be demonstrated in concrete examples.

Aim
- The production of optical nano-structures requires particularly adapted manufacturing approaches, which permit a flexible realization of high-dissolved structures in an industrial environment. Diffraction effects seem to open this way: the use of new diffraction-optical approaches for the production of micro and nano-structures for optical applications. The project aims at the development of scientific and technical bases and the consistent evolution of the technological possibilities for the precise production of smallest optical structures.

Research areas
- New Patterning Technologies
- Treatment of New Materials
- Development of Sample Applications

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ForMaT Initiative Nano-SIS

Black Silicon Solutions

Aim
- Development of innovative photodiodes and efficient and cost effective solar cells based on crystalline and polycrystalline silicon.

Nanostructured Silicon
- A requirement for high efficient solar cells and enhanced silicon photodiodes is an effective coupling of the incident radiation into the absorber material. Nanostructured silicon surfaces are a known solution for the generation of broadband anti-reflection properties as well as a direct photon management.

SIS Solar Cells
- To implement a semiconductor-insulator-semiconductor system, a thin film of an insulating material is deposited on silicon followed by the overcoating of a transparent conductive oxide (TCO). Therefore indium tin oxide or aluminum doped zinc oxide can be used. The combination of nanostructured silicon interfaces and low cost SIS systems create an innovative solar cell concept with the potential of high efficiency at low production costs. Front side contacts are realized by inkjet-printing metal layers. The connection of several cells using laser-based soldering is planned.

Enhanced Silicon Photodiodes
- Due to the unique optical properties of nanostructured silicon it is possible to improve the response of sensors in the near infrared (NIR) range. By using bivalent doping technologies the usability of silicon can be extended up to 1.5 µm.

The Initiative is funded by the Federal Ministry of Education and Research (BMBF) under the project "Nano-SIS" (FKZ 03FO3291).

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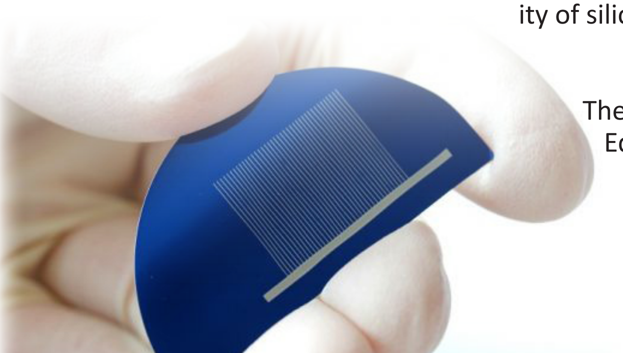

SIS solar cell with inkjet-printed front side contact

Junior Research Groups

Multiphoton Microscopy
- junior research group -

Research areas
- 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

Funding
- Carl Zeiss Stiftung, JSMC, Pro Chance

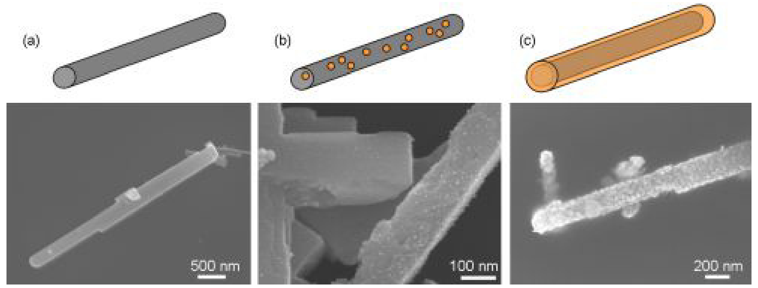

Figure 1: Bottom-up synthesized $KNbO_3$ nanowire with gold nanoshell

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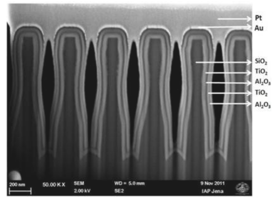
Atomic Layer Deposition
- Emmy-Noether junior research group -

Research areas
- Fabrication of resonant wave-guides with high sensitivity by atomic layer deposition (ALD)
- In-situ analysis of the nucleation in ALD-processes

Funding
- Deutsche Forschungsgemeinschaft, Project SZ253/1-1



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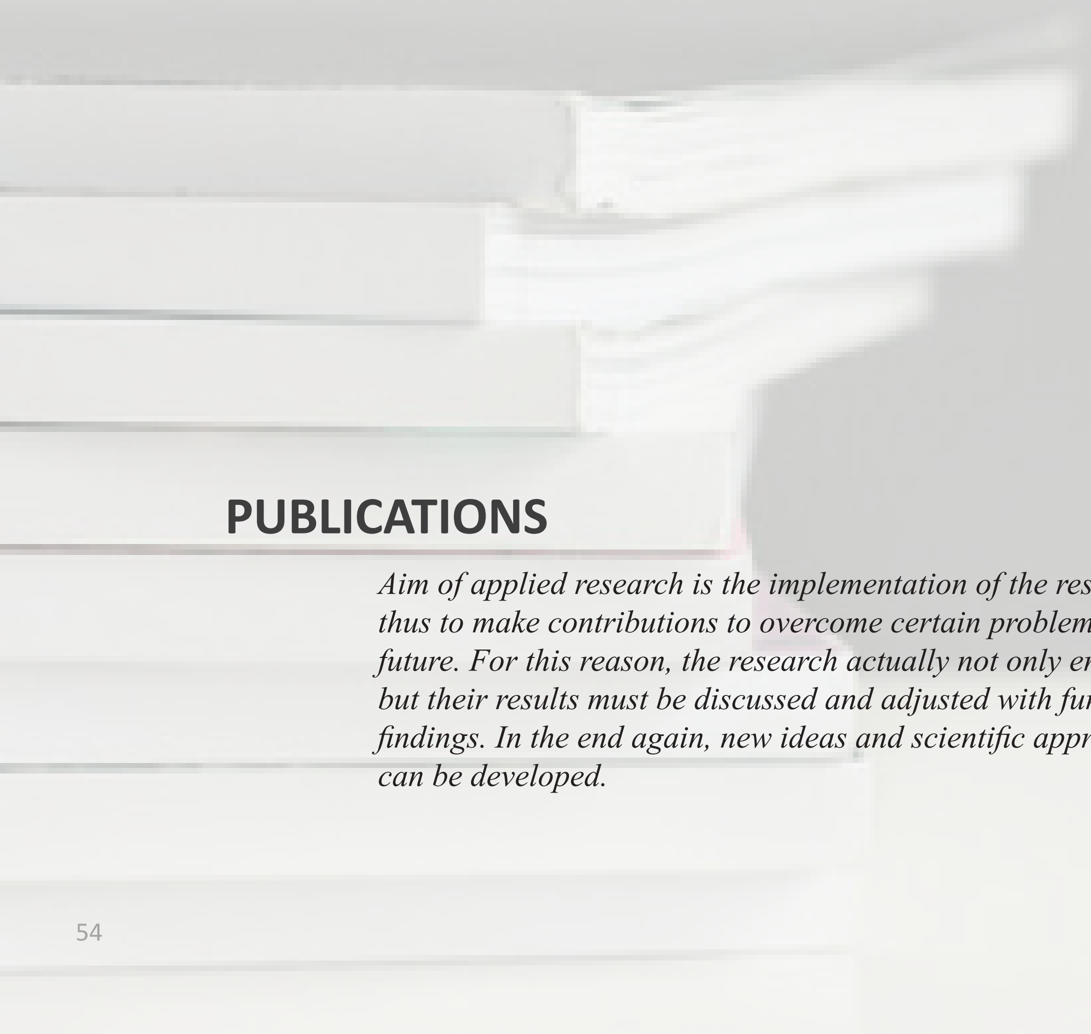

PUBLICATIONS

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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Conference Contributions

Invited Talks

R. Keil, F. Dreisow, M. Heinrich, A. Tünnermann, S. Nolte, A. Szameit: Classical characterisation of correlated biphotons in waveguide lattices, 2nd German-French-Russian Laser Symposium, Gößweinstein, Germany, 15. - 17. Apr 2011.

A. Szameit, M. Heinrich, S. Minardi, F. Dreisow, R. Keil, A. Tünnermann, S. Nolte: Two-dimensional X-waves in waveguide arrays, International Workshop of Nonlinear Photonics: Theory, Materials, Applications, St. Petersburg, Russia, 25. - 27. Aug 2011.

S. Döring, S. Richter, S. Nolte, and A. Tünnermann: In-situ observation of the hole formation during deep drilling with ultrashort laser pulses, SPIE Photonics West, San Francisco, USA, 22. - 27. Jan 2011.

M. Segev, E. Greenfield, Y. Lamhot, C. Rotschild, A. Szameit, Y. Nemirovsky, E. Lifshitz, and D. Christodoulides: Complex nonlinear opto-fluidics: controlling flow with light and vice-versa, IEEE Topical Meeting on Optofluidics, Acapulco, Mexico, 21. - 23. Jul 2011.

F. Eilenberger, S. Minardi, E. Pshenay-Severin, Y. Kartashov, A. Szameit, U. Roepke, J. Kobelke, K. Schuster, L. Torner, S. Nolte, F. Lederer, A. Tünnermann, and T. Pertsch: Observation of nonlinear light bullets in waveguide arrays, Conference on Lasers and Electro Optics (CLEO), Baltimore, USA, 1. - 6. May 2011.

R. Keil, F. Dreisow, M. Heinrich, S. Nolte, and A. Szameit: Correlated quantum random walks in non-uniform photonic lattices, 20th International Laser Physics Workshop, Sarajevo, Bosnia-Herzegowina, 11. - 15. Jul 2011.

C. Schmidt, M. Liebsch, A. Chipouline, N. Janunts, T. Käsebier, E.-B. Kley, A. Tünnermann, and T. Pertsch: Coupled disk microresonators, International Conference on Transparent Optical Networks, Stockholm, Sweden, 26. - 30. Jun 2011.

T. Pertsch, F. Eilenberger, S. Minardi, Y. Kartashov, A. Szameit, U. Röpke, J. Kobelke, K. Schuster, L. Torner, H. Bartelt, S. Nolte, F. Lederer, and A. Tünnermann: Light Bullets, CLEO Pacific Rim, Sydney, Australia, 28. - 1. Sep 2011.

K. Füchsel, M. Kroll, T. Käsebier, M. Otto, T. Pertsch, E.-B. Kley, R. B. Wehrspohn, and A. Tünnermann: Black silicon photovoltaics, SPIE Photonics Europe, Brussels, Belgium, 16. - 19. Apr 2011.

M. Rechtsman, A. Szameit, and M. Segev: Magnetic Field Effects and Landau Solitons in Strained Photonic Graphene, Information Photonics conference, Canada, Ottawa, 18. - 20. May 2011.

M. Segev, E. Greenfield, Y. Lamhot, C. Rotschild, A. Szameit, Y. Nemirovsky, E. Lifshitz, and D. Christodoulides: Complex Nonlinear Opto-Fluidity, 1st EOS Conference on Optofluidics, München, Germany, 23. - 25. May 2011.

S. Nolte, J. Limpert, A. Tünnermann: Faserlaserkonzepte für UKP-Strahlquellen, 1. Aachener Ultrakurzpulslaser-Workshop, Vaals, NL, 13. - 14. Apr 2011.

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M. C. Rechtsman, A. Szameit, and M. Segev: Tachyons and Landau Solitons in Photonic Graphene, 7th IMACS international conference on nonlinear evolution equations and wave phenomena: computation and theory, Athens, USA, 4. - 7. Apr 2011.

J. Limpert: High Power Ultrafast Fiber Lasers and Amplifiers: Design, Performance and Potential, CLEO/ Europe-EQEC Conference 2011, München, Germany, 22. - 26. May 2011.

S. Nolte, S. Döring, A. Ancona, J. Limpert, and A. Tünnermann: High Repetition Rate Ultrashort Pulse Micromachining with Fiber Lasers, Fiber Lasers and Applications (FILAS), Istanbul, Turkey, 16. - 17. Feb 2011.

A. Szameit, F. Dreisow, M. Heinrich, R. Keil, S. Nolte, and S. Longhi: Modelling quantum mechanics in optical waveguiding structures, Quantum Simulations conference, Benasque, Spain, 28. - 5. March 2011.

S. Nolte, J. Thomas, C. Voigtländer, R. G. Becker, D. Richter, M. Mundus, and A. Tünnermann: Femtosecond Laser Induced Bragg Gratings – Status and Prospects, International Symposium on Optomechatronic Technologies ISOT 2011, Hong Kong, China, 1. - 3. Nov 2011.

A. Szameit, Y. Shechtman, H. Dana, S. Hechler, S. Gazit, T. Cohen-Hyams, Y. Eldar, S. Shoham, E.-B. Kley, and M. Segev: Sparsity-based subwavelength optical imaging, 3rd International Topical Meeting on Nanophotonics and Metamaterials NANOMETA, Seefeld, Austria, 3. - 6. Jan 2011.

M. Krebs, S. Hädrich, J. Rothhardt, H. Carstens, S. Demmler, J. Limpert, and A. Tünnermann: µW level high-order harmonic generation at high repetition rate, Ultrafast Optics VIII, Montery, USA, 26. - 28. Sep 2011.

T. Pertsch and F. Setzpfandt: Spatial nonlinear effects with higher order modes in LiNbO3 waveguide arrays, NLP 2011 - International Workshop on Nonlinear Photonics, Kharkov, Ukraine, 4. - 8. Sep 2011.

A. Szameit, R. Keil, F. Dreisow, M. Heinrich, A. Tünnermann, and S. Nolte, “Two-dimensional all-optical routing and switching in laser-written waveguide arrays: Two-dimensional all-optical routing and switching in laser-written waveguide arrays, CLEO PacificRim, Sydney, Australia, 28. - 1. Sep 2011.

C. Helgert, E. Pschenay-Severin, M. Falkner, C. Menzel, E.-B. Kley, C. Rockstuhl, F. Lederer, and T. Pertsch: Top-down fabricated 3D plasmonic structures for nano-optics, Annual World Congress of Nano-S&T, Dalian, China, 23. - 26. Okt 2011.

A. Szameit, M. Rechtsman, M. Heinrich, F. Dreisow, R. Keil, A. Tünnermann, S. Nolte, and M. Segev: Amorphous Photonic Lattices, 3rd International Topical Meeting on Nanophotonics and Metamaterials (NANOMETA), Seefeld, Austria, 3. - 6. Jan 2011.

J. Hönig, G. Brenet, A. Sergeyev, N. Janunts,T. Pertsch, A. Tünnerman and R. Grange: Core-shell nanowires for enhanced-second harmonic generation, 2nd German French Workshop on NanoScience, Landau, Germany, 31. Aug - 2. Sep 2011.

T. Pertsch, C. Menzel, C. Helgert, T. Paul, C. Rockstuhl, and F. Lederer: Deriving meaningful design guidelines for optical cloaking metamaterials, CLEO PacificRim, Sydney, Australia, 28. Aug - 1. Sep 2011.

T. Pertsch, C. Schmidt, M. Liebsch, A. Klein, N. Janunts, A. Chipouline, T. Käsebier, E.-B. Kley, and A. Tünnermann: Mode dynamics in coupled disk microresonators, Heraeus-Seminar Micro and macro-cavities in classical and non-classical light, Bad Honnef, Germany, 30. Okt - 4. Nov 2011.

K. Hoeflich, M. Becker, J. Petschulat, N. Janunts, T. Pertsch, G. Leuchs, and S. Christiansen: The direct writing of plasmonic nanostructures and metamaterials, 3rd International Topical Meeting on Nanophotonics and Metamaterials NANOMETA, Seefeld, Austria, 3. - 6. Jan 2011.

T. Pertsch, E. Pshenay-Severin, C. Helgert, A. Chipouline, E.-B. Kley, C. Menzel, C. Rockstuhl, and F. Lederer: Characterization of the complex transfer matrix of metamaterials, 3rd International Topical Meeting on Nanophotonics and Metamaterials NANOMETA, Seefeld, Austria, 3. - 6. Jan 2011.

S. Nolte: Ultrashort pulse laser materials processing at high repetition rates: Status and perspectives, 11th International SAOT Workshop on "Laser Based Micromanufacturing - From Surface Structuring to Metamaterials", Erlangen, Germany, 10. - 11. Jan 2011.

Selected Talks and Posters

M. Chemnitz, M. Baumgartl, C. Jauregui, J. Limpert, A. Tünnermann: Justagefreie ps-Faserlaserquelle auf Basis von Vierwellenmischung für kohärente Raman-Mikroskopie, DPG Frühjahrstagung, Dresden, Germany, 13. - 18. March 2011.

R. Keil, F. Dreisow, M. Heinrich, S. Nolte, A. Szameit: Correlated Quantum Walks in Two-Dimensional Photonic Lattices, DokDok 2011, Naumburg, Germany, 21. - 25. March 2011.

C. Voigtländer, P. Zeil, J. Thomas, D. Richter, A. Tünnermann, S. Nolte: Inscription of apodised Bragg grating devices with ultrashort laser pulses, DoKDoK 2011, Naumburg, Germany, 21. - 25. March 2011.

F. Dreisow, A. Szameit, M. Heinrich, R. Keil, S. Nolte, A. Tünnermann, S. Longhi: Quantum analogies in optical waveguide systems, DokDok 2011, Naumburg, Germany, 21. - 25. March 2011.

F. Zimmermann, S. Richter, S. Döring, S. Nolte, A. Tünnermann: Lokales Schweißen von Gläsern mit ultrakurzen Pulsen bei hohen Repetitionsraten, DPG Frühjahrstagung, Kiel, Germany, 28. - 31. March 2011.

Y. Shechtman, A. Szameit, S. Gazit, P. Sidorenko, E. Bullkich, Y. C. Eldar, O. Cohen, and M. Segev: Sparsity-based sub-wavelength imaging and super-resolution in time and frequency, French-Israeli Symposium on Nonlinear and Quantum Optics, Rehovot, Israel, 28. - 1. Apr 2011.

A. Perez-Leija, R. Keil, H. Moya-Cessa, D. Christodoulides, and A. Szameit: Observation of Glauber-Fock dynamics in photonic lattices, Conference on Lasers and Electro Optics (CLEO), Baltimore, USA, 1. - 6. May 2011.

L. Martin, G. Di Giuseppe, A. Perez-Leija, R. Keil, A. Szameit, A. Abouraddy, D. Christodoulides, B. E. Saleh: Anderson localization in optical waveguide arrays with off-diagonal coupling disorder, Conference on Lasers and Electro Optics (CLEO), Baltimore, USA, 1. - 6. May 2011.

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A. Szameit, Y. Nemirovski, M. Segev: Nonlinear dynamics through radiation pressure of light, fluid, and nano-particles: light-induced flow and beam collapse, Conference on Lasers and Electro Optics (CLEO), Baltimore, USA, 1. - 6. May 2011.

C. C. C. Willis, J. D. Bradford, R. A. Sims, L. Shah, M. Richardson, J. Thomas, R. G. Becker, C. Voigtländer, A. Tünnermann, S. Nolte: Monolithic narrow linewidth polarization-Mayntaining thulium fiber laser using femtosecond laser written fiber Bragg gratings, SPIE Defense, Security + Sensing, Orlando, USA, 25. - 27. Apr 2011.

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S. Döring, S. Richter, A. Tünnermann, S. Nolte: In-situ observation of ultrashort pulse deep drilling in silicon at 1030 nm and 515 nm, CLEO/Europe-EQEC Conference 2011, München, Germany, 22. - 26. May 2011.

A. Hideur, C. Lecaplain, B. Ortaç, G. Machinet, J. Boullet, E. Cormier, M. Baumgartl, T. Schreiber: Femtosecond Microjoule-Class Ytterbium Fiber Lasers, Advanced Solid-State Photonics, Istanbul, Turkey, 13. - 16. Feb 2011.

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R. G. Becker, C. Voigtländer, D. Richter, J. Thomas, A. Tünnermann, S. Nolte: Tailored fiber Bragg gratings inscribed with a phase mask and a deformed wave front of femtosecond laser pulses, DokDok 2011, Naumburg, Germany, 21. - 25. March 2011.

S. Richter, S. Döring, F. Zimmermann, S. Nolte, A. Tünnermann: Welding of glass with femtosecond laser pulses at high repetition rates, DokDok 2011, Naumburg, Germany, 21. - 25. March 2011.

F. Stutzki, F. Jansen, T. Eidam, C. Jauregui, J. Limpert, A. Tünnermann: Robust Single-Mode High Average Power Very Large Mode Area Fiber Amplifiers, Advanced Solid-State Photonics (ASSP), Istanbul, Turkey, 13. - 16. Feb 2011.

C. Voigtländer, R. G. Becker, J. Thomas, D. Richter, A. Tünnermann, S. Nolte: Variable ultrafast Fiber Bragg grating inscription with a phase mask and a deformed wave front, CLEO/Europe-EQEC Conference, München, Germany, 22. - 26. May 2011.

F. Stutzki, F. Jansen, C. Jauregui, J. Limpert, A. Tünnermann: Breaking the symmetry: enhanced transverse mode discrimination in large pitch photonic crystal fibers, SPIE Photonics West, San Francisco, USA, 22. - 27. Jan 2011.

Patent Applications

E. Beckert, O. Pabst:
Mikropumpe (DE 10 2011 107 046.3)

G. Kalkowski, C. Rothhardt, R. Eberhardt, M. Rhode:
Direktes Bonden massiver Substrate/auch mit Beschichtung (DE 10 2011 012 835.2)

J. Limpert, C. Jocher, C. Jauregui, A. Tünnermann:
Verfahren zur Erzeugung von azimutal und radial polarisierter Strahlung in optischen Wellenleiter (PCT/EP2011/001881)

J. Limpert, A. Tünnermann, C. Jauregui, F. Stutzki, F. Jansen:
Large-mode-area-double-clad-multimode optical fibers with reduced overlap of higher-order modes (EP 10 192 190.6)

M. Schulze, E.-B. Kley:
Optisches Element mit einer Antireflexionsbeschichtung (DE 10 2011 107 192.3)

S. Steiner, E.-B. Kley:
Optischer Filter mit einem resonanten Wellenleitergitter (DE 10 2011 084 055.9)

C. Voigtländer, S. Nolte, J. U. Thomas, A. Tünnermann, R. Williams:
Herstellung eines Modenfilters in multimodigen Fasern (DE 10 2011 114 586.2)

A. von Finck, M. Trost, G. Notni, A. Duparré:
Vorrichtung und Verfahren zur Streulichtmessung mit mehreren parallelen Messkanälen (DE 10 2011 113 134.9)

T. Weber, E.-B. Kley:
Polarisator und Verfahren zur Herstellung eines Polarisators (DE 10 2011 079 030.6)

T. Weber, E.-B. Kley:
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C. Bruchmann, E. Beckert, T. Peschel, C. Damm:
Adaptiver deformierbarer Spiegel zur Kompensation von Fehlern einer Wellenfront (DE 10 2008 014 619 B4)

K. Füchsel, E.-B. Kley, T. Käsebier, M. Kroll, T. Pertsch:
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J. Limpert, A. Tünnermann, D. Schimpf:
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J. Limpert, A. Tünnermann, A. Steinmetz, D. Nodop:
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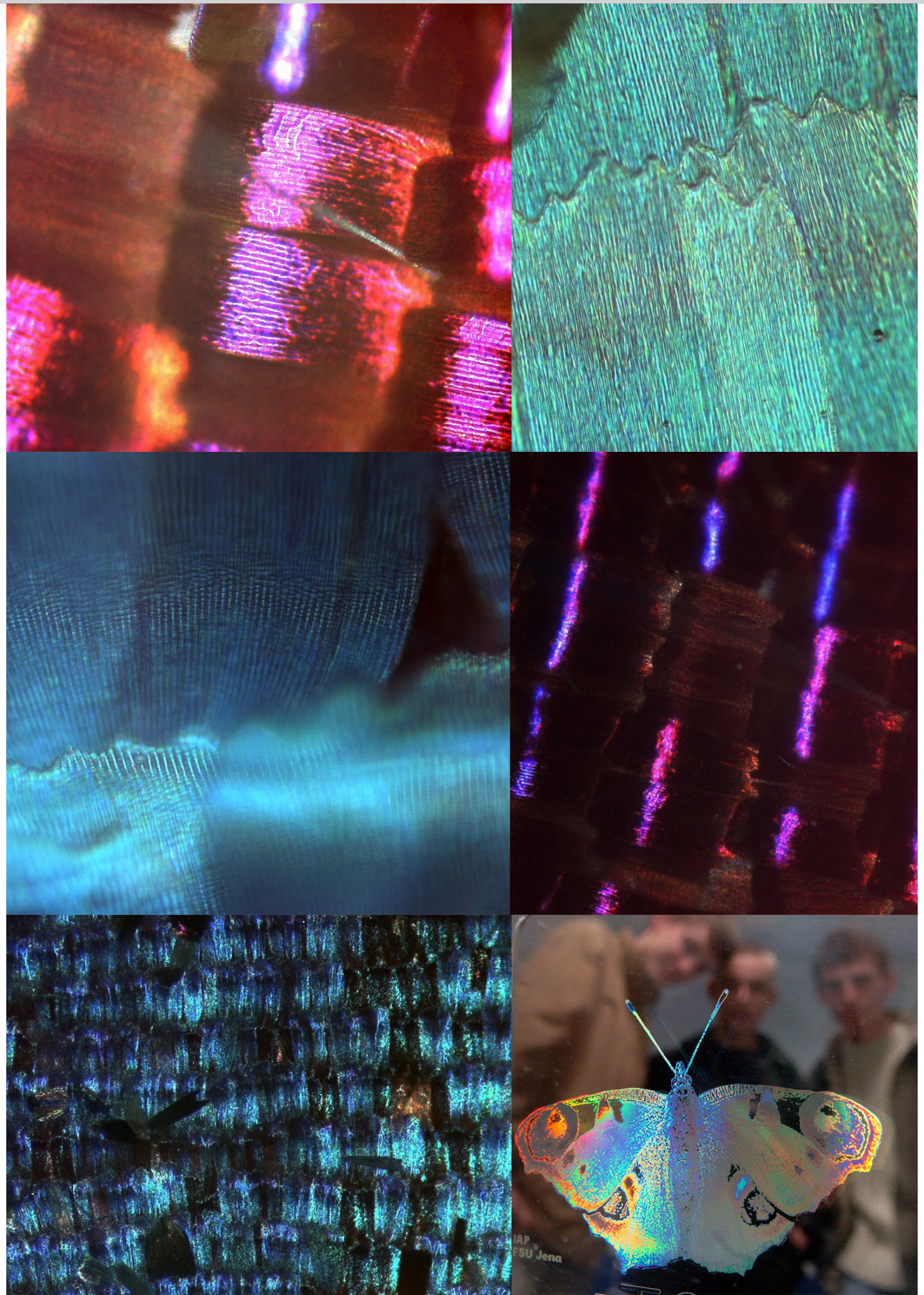
C. Munkelt, I. Schmidt, P. Kühnstedt, G. Notni:
Vorrichtung und Verfahren zum berührungslosen Erfassen räumlicher Koordinaten einer Oberfläche (EP 2 156 139 B1)

D. Nopod, A. Steinmetz, J. Limpert, A. Tünnermnn:
Lasersystem mit nichtlinearer Kompression (DE 20 2010 017 367 U1)

A. Tünnermann, J. Limpert, B. Ortac, T. Schreiber, C. K. Nielsen:
Faserlaser (EP 1 929 594 B1)

T. Weber, E.-B. Kley:
Metallstreifenpolarisator (DE 20 2011 102 876 U1)

T. Weber, E.-B. Kley:
Metallstreifenpolarisator (DE 20 2011 102 885 U1)



Microscopic images of butterfly
wings,
down right: holografic structure

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 - at the participation at conferences and at co-operation 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.

ACTIVITIES

Awards

Ria Becker
Emil Wolf Outstanding Student Paper Competition in „Fiber optics and optical communication“
International Conference „Frontiers in Optics 2011“, San Jose
„Observation of Spectral Gouy Shift in Large Cross-Section Fiber Bragg Gratings“

Constanze Grossmann
Student Award
Middle European Spring Conference of the Society for Information Display, Darmstadt
„OLED-based System“

Fabian Stutzki
Best Student Poster
Advanced Solid State Photonics (ASSP)
„Robust Single-Mode High Average Power Very Large Mode Area Fiber Amplifiers“

Thomas Weber
Student Poster Presentation Award
Conference on Manufacturing of Optical Components (EOSMOC)
„Iridium metallic strip polarizer for UV applications“

Sören Richter
Best Student Paper, 1st Place
SPIE Photonics West - Frontiers in Ultrafast Optics: Biomedical, Scientific and Industrial Applications XI, San Francisco
„Breaking stress of glass welded with femtosecond laser pulses at high repetition rates“

Sven Döring
Best Student Paper
SPIE Photonics West - Frontiers in Ultrafast Optics: Biomedical, Scientific and Industrial Applications XI, San Francisco
„In-situ observation of the hole formation during deep-drilling with ultrashort laser pulses“

Christian Voigtländer
Best Student Paper
SPIE Photonics West - Frontiers in Ultrafast Optics: Biomedical, Scientific and Industrial Applications XI, San Francisco
„Fs-induced apodised Bragg waveguides in fused silica“

Florian Jansen
Best Student Presentation
SPIE Photonics West in Fiber Lasers VII, San Francisco
„Robust single-mode ytterbium-doped large pitch fiber emitting 294 W“

Enrico Seise
Best Student Presentation
SPIE Photonics West in Fiber Lasers VII, San Francisco
„Coherent combining of ultrashort fiber-amplified laser pulses”

Alexander Steinmetz
Best Student Presentation
SPIE Photonics West in Fiber Lasers VII, San Francisco
„Simple and robust Laser system for precise micro material processing with pulse amplification of a microchip laser“

Anika Brahm
Hugo Geiger Preis of the Fraunhofer-Society
„Design of a Terahertz measuring system for simultaneous measurments of transmission and reflection“

Jan Rothhardt
STIFT Award 2011 for outstanding application-oriented theses at universities in Thuringia
„Hochleistungs-Ultrakurzpulslaser auf Basis Faserlasergetriebener optisch parametrischer Verstärkung“

Alexander Szameit
WLT Award at International Congress World of Photonics, Munich

Falk Eilenberger
HEPTAGON – Sven Bühling – Award
„Raumzeitliche Dynamik von Lichtpulsen in diskreten Systemen“

Andreas Tünnermann,
Member of National Academy of Science and Engineering (acatech)
Thuringian Oder of Merit

Ceremony at the State Chancellery, Presentation of the Thuringian Order of Merit
right: Prime Minister of Thuringia Christine Lieberknecht
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ACTIVITIES

Organizing Activities

Prof. Dr. Tünnermann

Council member of the Faculty

Member of program committee „Optische Technologien“, BMBF

Board of trustees MPA, Heidelberg

Board of trustees MPQ, Garching

Board of trustees IOM, Leipzig

Chairman „AG Naturwissenschaften“, Wissenschaftliche Gesellschaft Lasertechnik

Spokesman Abbe-Center of Photonics, FSU Jena

Editor Applied Physics B

Stakeholder Photonics 21-Plattform

Member of the seering committee Fraunhofer Gesellschaft

Member of the executive Board OptoNet e. V.

Referee for several scientific journals

Prof. Dr. Nolte

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

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)

Member Optical Society of America, Deutsche Physikalische Gesellschaft

Referee for several scientific journals

Member of program committee : CLEO Pacific Rim 2011 (Laser Processing, Laser Microfabrication, and Industrial Applications)

Conference Chair: Photonics West/ LASE (Frontiers in Ultrafast Optics: Biomedical, Scientific and Industrial Applications)

Prof. Dr. Pertsch

Member of the Faculty Board since October 2010

Member of the Technical Program Committee of CLEO/Europe 2009, 2011 (Conference on Lasers and Electro-Optics Europe) Person in charge for course of studies „Master of Science in Photonics“

Vice-Speaker Abbe School of Photonics, Jena

Person in charge for course of studies „Master of Science in Photonics“

Referee for several international journals

Referee of German Research Society DFG

Member of the Technical Program Committee of Metamaterials 2011

Member of the Technical Program Committee of CLEO Pacific Rim 2011

Program Committee NLP 2011 - Nonlinear Photonics, Kharkov, Ukraine, 2011

Program Committee CLEO 2012 - Laser Science to Photonic Applications, San Jose, USA, 2012

Program Committee OSA topical Advanced Photonics Congress 2012, Colorado Springs, USA, 2012 - Nonlinear Photonics subcommittee chair

Jun.-Prof. Dr. Limpert

Referee for several scientific journals

Program chair Europhoton 2010 - 2012

Dr. Schrempel

Member of the Faculty Board

Referee for several scientific journals

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

ACTIVITIES

Prof. Dr. Wyrowski

Visiting Professor at the Jiangsu University, Zhenjiang, China

Conference Co-Chair: SPIE Conference on Optical Modelling and Design

Conference Co-Chair: SPIE Conference on Physical Optics

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

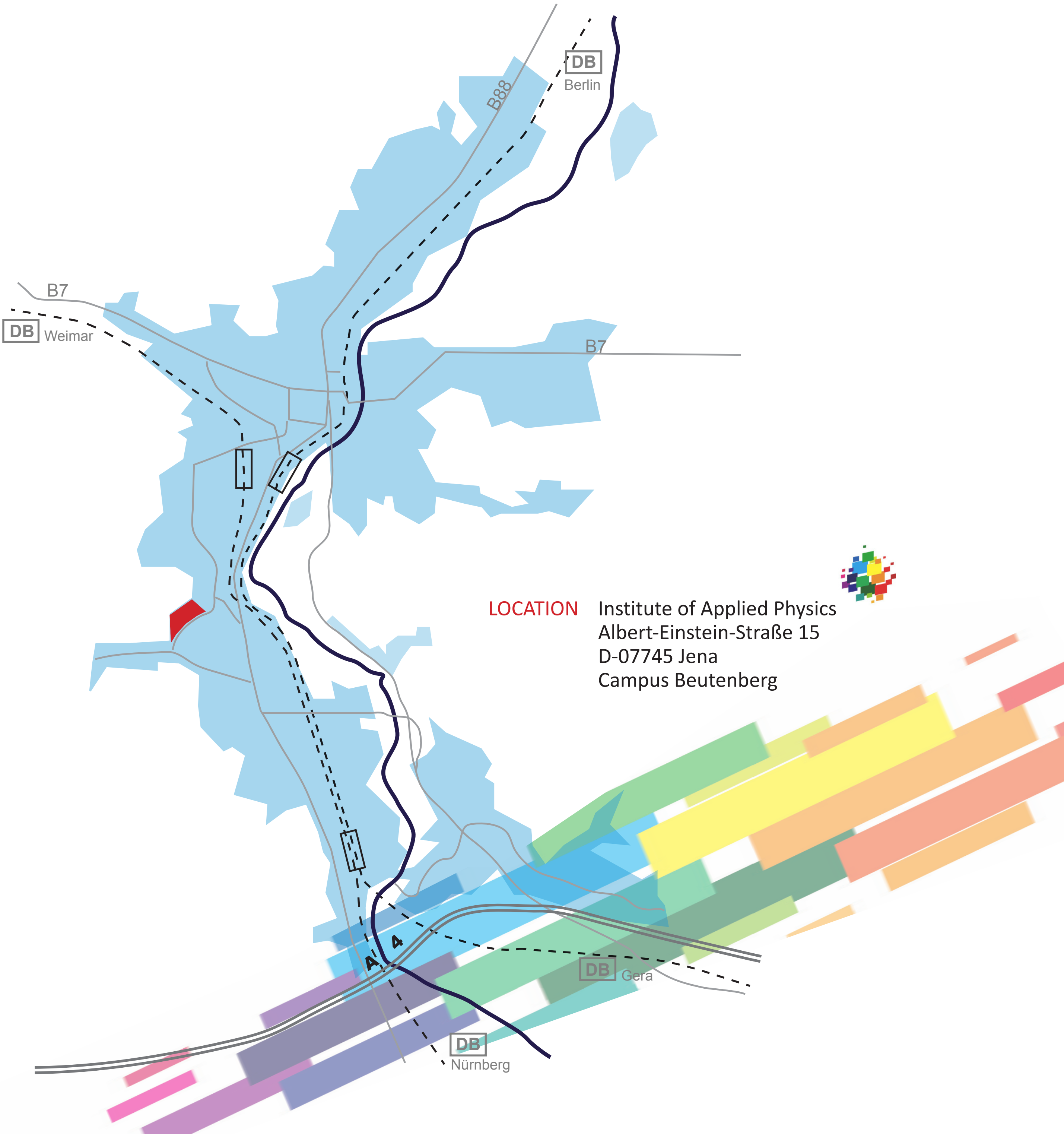
Member of the International Program Committee: IPC 10th IMEKO Symposium Lasermetrology in Production 2011

Editor, Special Issue on Computational Optics and Photonics of the JMO

Referee for several scientific journals

Study Advisor of the Fakulty od Physics and Astronomy

President of the LightTrans GmbH



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