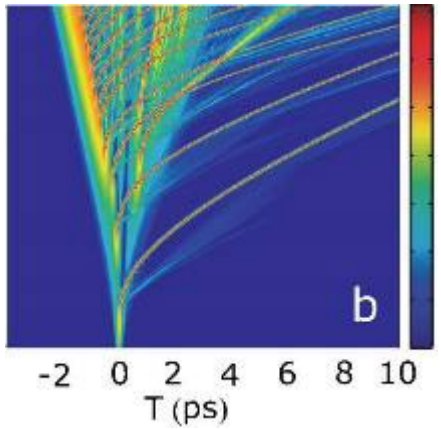
Optics Faculty Research Overview

	Agrawal, Govind	Alonso, Miguel	Baran, Timothy	Bauer, Aaron	Bentley, Julie	Berger, Andrew	Boyd, Bob	Bromage, Jake	Brown, Tom	Cardenas, Jaime	Carney, P. Scott	Fienup, James	Guo, Chunlei	Huo, Frank	Huxlin, Krystel	Knox, Wayne	Krauss, Todd	Kruschwitz, Brian	Kruschwitz, Jennifer	Lin, Qiang	Lukishova, Svetlana	Marciante, John	Marcos, Susana	McIntyre, Brian	Miller, Benjamin	Moore, Duncan	Palastro, John	Postigo Resa, Pablo	Renninger, Will	Rolland, Jannick	Schmidt, Greg	Vamivakas, Nick	Visser, Taco	Wicks, Gary	Williams, David	Zavislan, James	Zhang, Xi-Cheng	Zuegel, Jon	
AR/VR																		x							x				x	x	x								5
Biomedical Imaging			x			x										x						x							x						x				6
Biomedical Optics			x	x		x								x	x							x			x		x	x	x						x				11
Coatings																		x																					1
Coherence		x							x																						x	x			x				5
Color																		x																	x				2
Detectors																																	x						1
Fiber Optics	x		x							x											x						x											5
Freeform Optics				x																					x				x	x									4
Geometrical Optics		x		x	x																				x				x						x				6
Illumination																													x	x					x				3
Imaging		x			x						x									x					x			x	x		x			x	x				10
Integrated Photonics									x	x														x							x								4
Laser Machining															x						x	x																	3
Laser Matter Interaction												x								x																			2
Lasers								x		x		x			x		x			x	x						x	x					x			x	x		12
Lens Design				x	x																	x			x				x	x									6
Liqued Crystals																				x																			1
Microscopy		x				x					x									x			x						x		x				x				8
Nanophotonics									x	x				x		x			x	x			x	x			x		x		x		x						12
Neuroscience												x			x																									2
Nonlinear Optics	x						x	x		x							x			x	x	x				x		x			x					x	x		13
Optical Materials							x	x		x										x			x				x			x	x						x		9
Optical Metrology								x				x					x						x		x				x	x	x				x				9
Optics of the Eye																						x			x										x	x				4
Phase Retrieval								x			x	x					x																							4
Physical Optics	x						x			x		x																				x	x			x			7
Plasma Optics								x																		x											x			3
Polarization		x				x			x																						x					x			5
Quantum Dots																x										x				x		x							4
Quantum Optics							x			x				x			x			x	x						x	x			x									9
Solar Concentrators																									x		x			x										3
Sources																				x								x				x			x	x			5
Space Optics				x						x		x																	x											4
Spectroscopy			x			x				x	x					x				x			x								x								8
Structured Light		x							x																	x					x				x				5
Surface Plasmons																				x												x							2
TeraHerz Optics																																				x			1
Theoretical Chemistry														x																									1
Ultrafast Optics								x				x				x															x					x			5
Vision															x							x							x					x	x				5

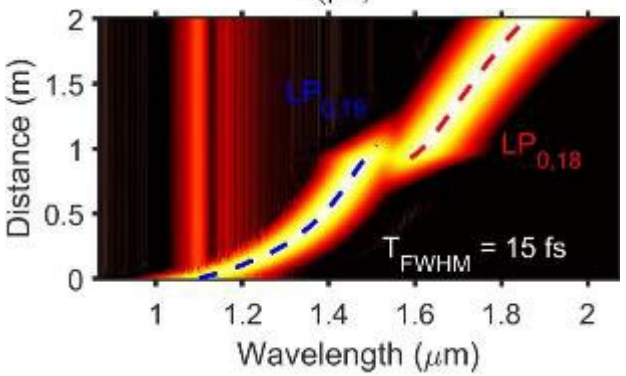
Govind P. Agrawal | James C. Wyant Professor

Department: The Institute of Optics
Focus: Nonlinear fiber optics, Optical communications, Nonlinear silicon photonics, Quantum optics
Courses: OPT462 – Electromagnetic Theory | OPT428 – Optical Communication Systems
OPT468 – Optical Waveguides | OPT511 – Advanced Mathematics
Email: Govind.Agrawal@rochester.edu

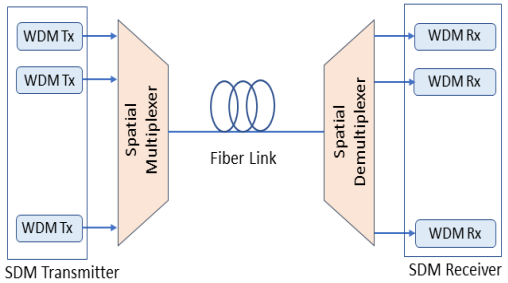
RESEARCH TOPICS:



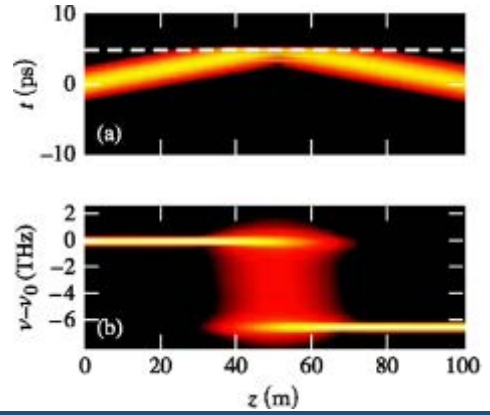
Nonlinear fiber optics
- Solitons and similaritons
- Supercontinuum generation
- Stimulated Raman scattering
- Ultrashort pulse propagation



Multimode nonlinear optics
- Graded-index fibers
- Fibers with multiple cores
- Intermodal nonlinear effects
- Spatio-temporal effects



Optical communications
- Space-division multiplexing
- Quantum communication
- Intermodal coupling effects
- Coherent communication systems

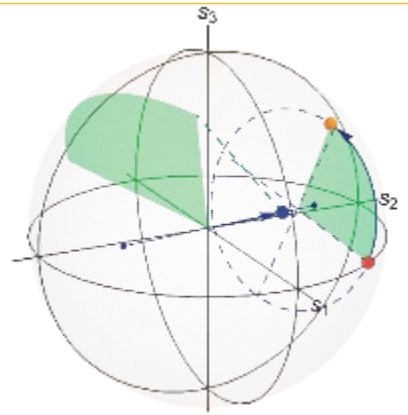


Physical optics
- Applications of space-time duality
- Partial coherence and polarization
- Metamaterials and plasmonics
- Nanoscale device physics

Miguel A. Alonso| Professor

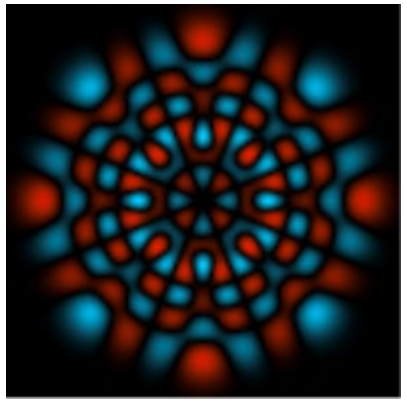
Department: The Institute of Optics
Focus: Theory of wave propagation, optical modeling, polarization-based measurements
Courses:
Email: miguel.alonso@rochester.edu

RESEARCH TOPICS:



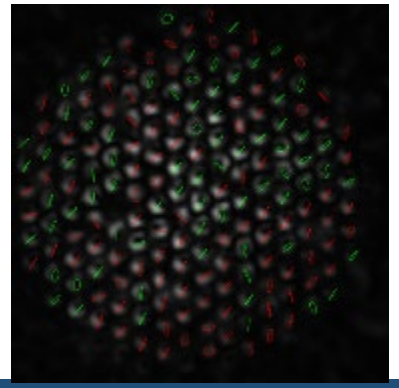
Mathematics of wave propagation

- Abstract representations for optical polarization, beam structure, and birefringence
- Connections between the ray and wave models of light
- Analogies with quantum entanglement
- Geometric phases



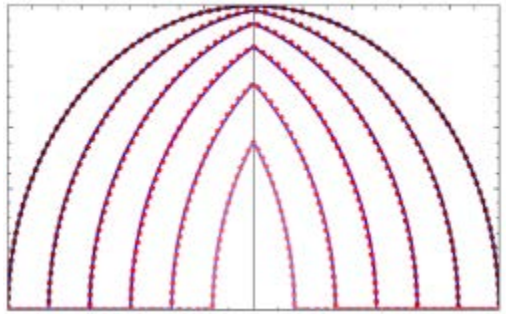
Structured light and physical analogies

- Optical beams with interesting spatial and temporal distributions
- Physical analogies between optical beams and quantum systems
- Forces and torques exerted by beams on particles



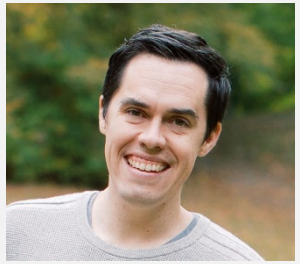
Polarization microscopy and metrology

- Superresolution techniques for determining 3D position and orientation of fluorescing molecules
- Metrology of periodic nanostructures based on tailored polarization
- Imaging polarimetry
- 3D polarization measurements



Modeling of imaging systems

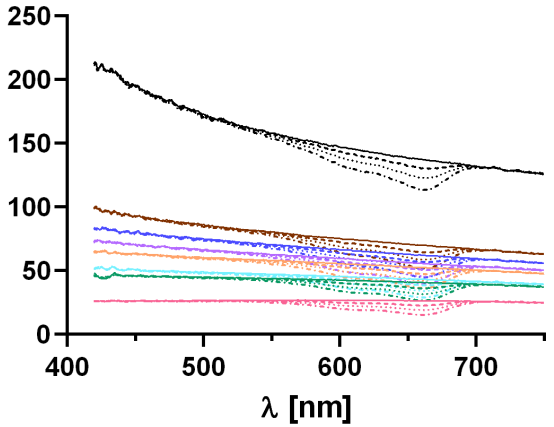
- Models for the effect of surface errors on image quality
- Validity of approximations used in optical modeling
- New mathematical techniques for understanding illumination systems



Timothy Baran| Assistant Professor

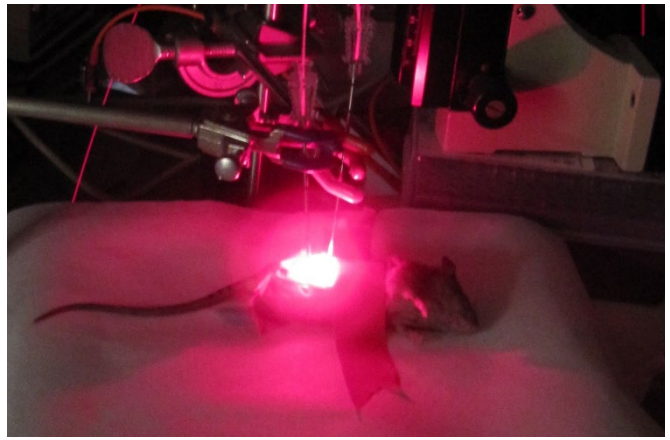
Department: Imaging Sciences, Biomedical Engineering, and The Institute of Optics
Focus: Diffuse optical spectroscopy, photodynamic therapy, medical image processing
Email: timothy.baran@rochester.edu

RESEARCH TOPICS:



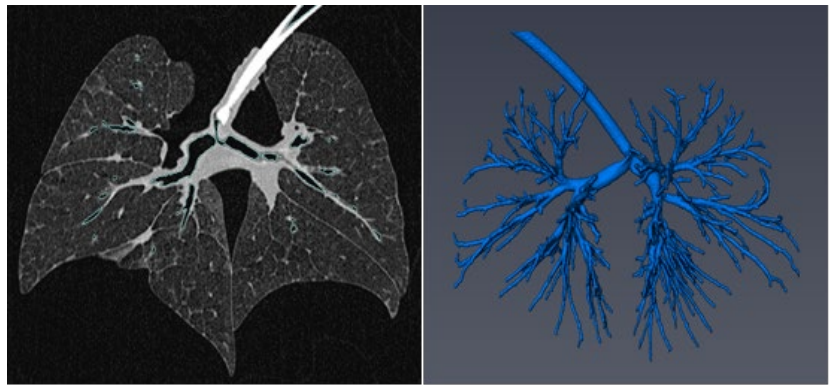
Diffuse Optical Spectroscopy

- Spatially-resolved diffuse reflectance
- Quantitative fluorescence spectroscopy
- Monte Carlo simulation



Photodynamic Therapy

- Therapy that generates reactive oxygen species upon excitation by visible red light
- Pre-clinical applications in cancer and infectious disease
- Clinical trial in human abscesses



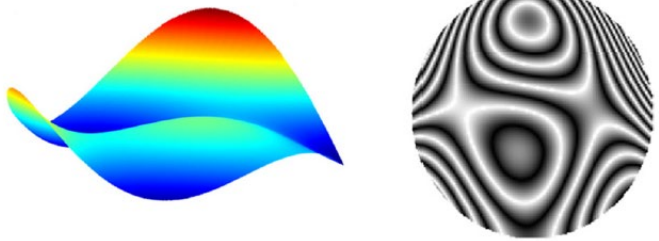
Medical Image Processing

- Lung development in neonates
- Neuroimaging of cognitive aging
- Soft-tissue segmentation

Aaron Bauer| Research Assistant Professor

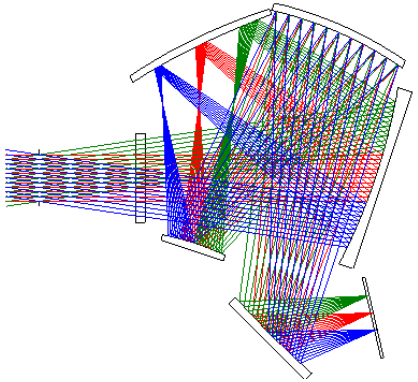
Department: The Institute of Optics
Focus: Freeform optics, optical design, optical instrumentation
Email: aaron.bauer@rochester.edu

RESEARCH TOPICS:



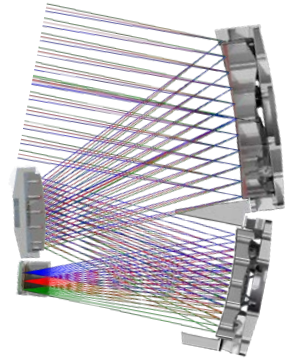
Freeform optics

- Mathematical description
- Optical design methods with a focus on manufacturability
- Tolerancing of optical systems with freeform surfaces



Optical design

- Using novel surface types to improve optical systems
- Aberration theory to complement optimization



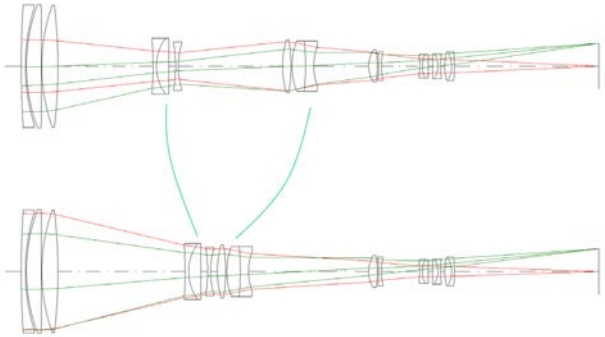
Optical instrumentation

- Telescopes
- Microscope objectives
- Visual systems
  - Eyepieces
  - AR/VR optics
- Spectrometers

Julie Bentley | Professor

Department: The Institute of Optics
Focus: Optical Design & Engineering
Courses: OPT241 – Geometrical Optics | OPT244/444 – Introduction to Lens Design | OPT544 – Advanced Lens Design
Email: bentley@optics.rochester.edu

RESEARCH TOPICS:

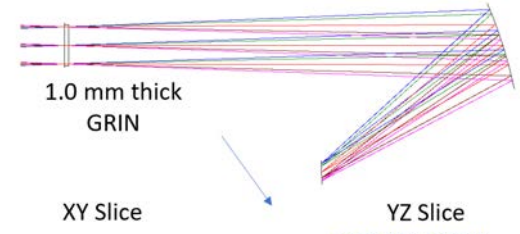


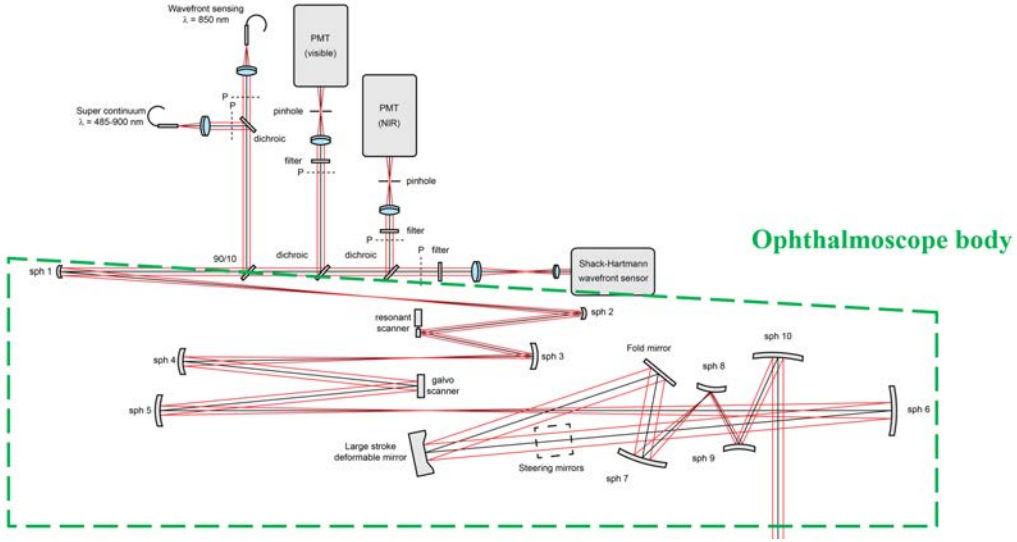
Optical Design

- High resolution objectives
- Biomedical instruments
- AR/VR systems
- Lithography lenses
- Reflective/freeform systems
- Infrared optics
- Zoom lenses

Gradient Index Materials

- Ion exchange
- 3-d printed polymers
- Freeform index distributions
- Improvements in optimization





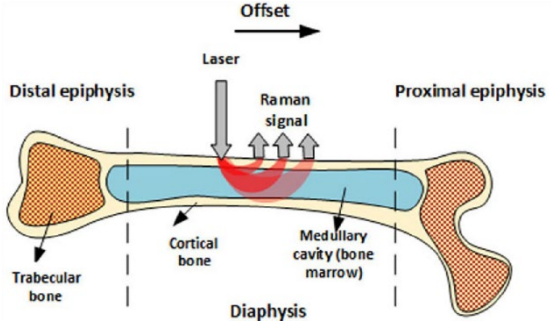
Retinal Imaging/adaptive optics ophthalmoscopes (in collaboration with A. Dubra @Stanford)

- Broadband AOSLO design with nodal aberration theory
- Wide-field fundus camera and fixation target
- Reflective image rotator
- Tunable chromatic lens

Andrew Berger| Professor

Department: The Institute of Optics
Focus: Biomedical Optics, Optics Education
Courses: OPT 262 – Electromagnetic Theory| OPT 276/476 – Biomedical Optics| OPT 223 – Quantum Theory
Email: andrew.berger@rochester.edu

RESEARCH TOPICS:

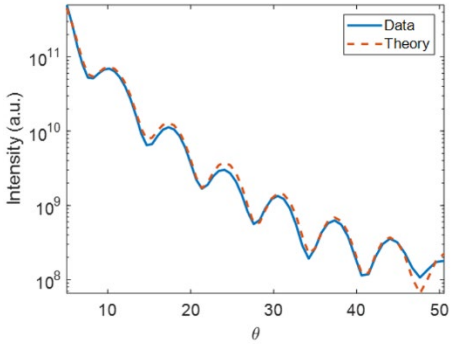


Noninvasive detection of bone fracture risk

- transcutaneous, near-infrared Raman spectroscopy
- alternative prediction of parameters typically measured by X-ray exposure or destructive mechanical tests

Equitable documentation of bruising in victims of violence

- improve bruise contrast in darker-skinned individuals
- quantitative reflectance measured in visible, UV, and IR
- empower victims to trust their memories and pursue protection orders



Tracking organelle size changes in single immune cells

- angularly-resolved elastic scattering
- calculated using quantitative phase imaging
- size estimates from comparison with Mie theory (5 micron bead example shown)

Optics Education

- strengthening connections between Optics educators in greater Rochester and beyond
- flipped classroom techniques to increase focus on conceptual learning
- Photonics REU program (NSF)

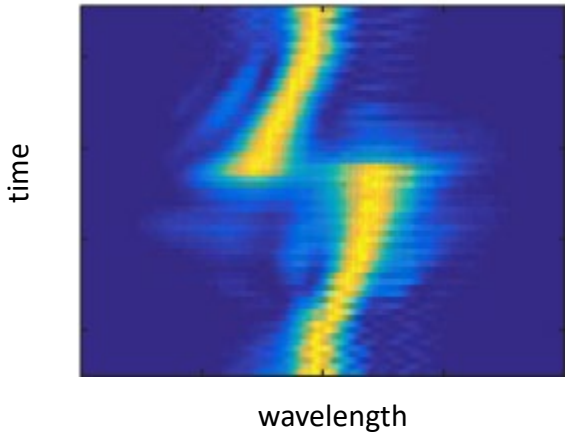
Robert W. Boyd | Professor

Department: Institute of Optics
Focus: Nonlinear Optics, Quantum Optics, Quantum imaging
Courses: Opt 467 Nonlinear Optics
Email rboyd@UR.rochester.edu

RESEARCH TOPICS:

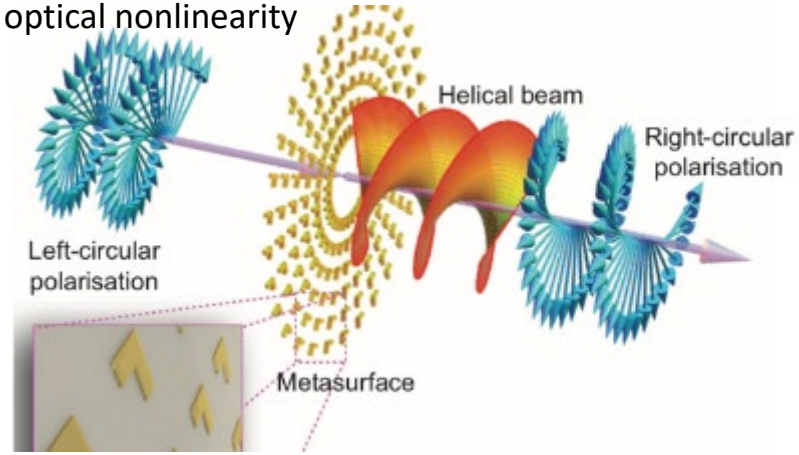
NONLINEAR OPTICS

- Search for optical materials with a ultra-strong nonlinear response
- Devise means to control the process of beam filamentation
- Shift frequency of light beam via a a time lens



EPSILON-NEAR-ZERO MATERIALS

- Devise means for creating ENZ metamaterials
- Studies of light propagation in materials with a small refractive index
- Explore the relation between ENZ and enhanced optical nonlinearity

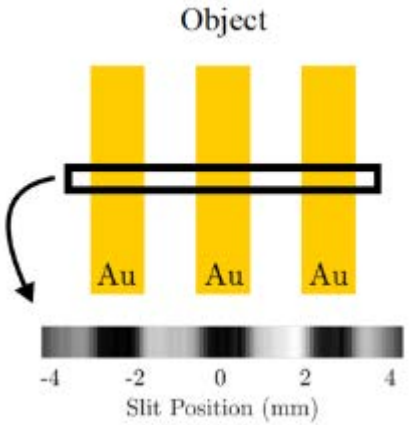


NANOPHOTONICS

- Fabrication of photonic devices with nanoscale features
- Perform laser mode conversion by scattering from a metasurface
- Fabrication of miniature (chip-scale) spectrometers

QUANTUM INFORMATION

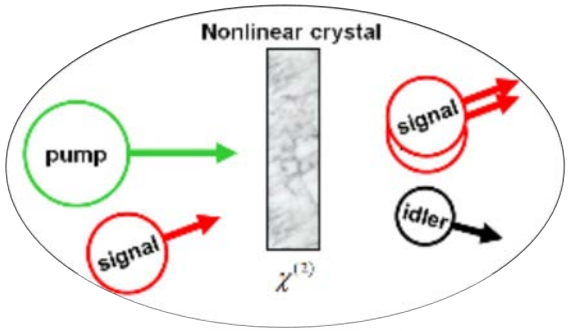
- Secure communication via quantum key distribution
- Nonlocal aberration correction
- Quantum radiometry for calibration of spectrophotometers



Jake Bromage | Associate Professor

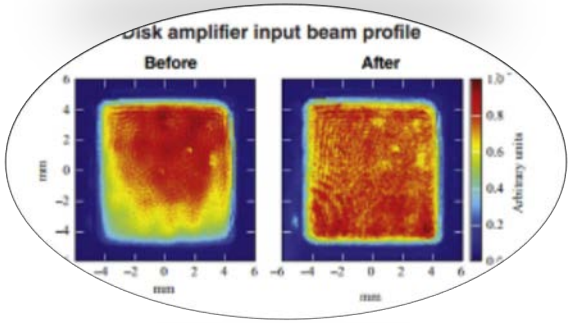
Department: Laboratory for Laser Energetics
Focus: Laser science & engineering, ultrafast pulse generation & characterization
Email: jbro@lle.rochester.edu

RESEARCH TOPICS:



Fundamental Research

- Advanced nonlinear crystals
- Nonlinear pulse propagation
- Spatiotemporal coupling in ultrafast pulses
- Plasma amplifiers
- Plasma optics



Applied Research

- Chirped-pulse amplification
- Ultra-broadband optical parametric amplifiers
- High-energy Nd:glass lasers
- High-power Yb:YAG lasers
- Temporal contrast improvement

Capabilities & Facilities

- Group built and operates a Multi-TeraWatt laser (MTW) for hands-on mid-scale research
- Adding new mid-scale petawatt (PW) facility – MTW-OPAL.
- Interacts with professional staff in National-lab-style environment

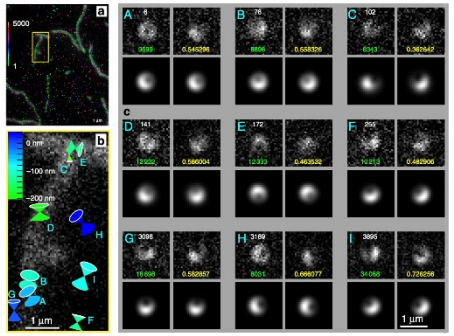
Laboratory for Laser Energetics

- World-class facility with two large-scale lasers for fusion research
- ~300 staff providing expertise in material science, laser engineering, plasma physics and advanced diagnostics
- 2018 Nobel Prize in Physics

Thomas Brown| Director and Professor

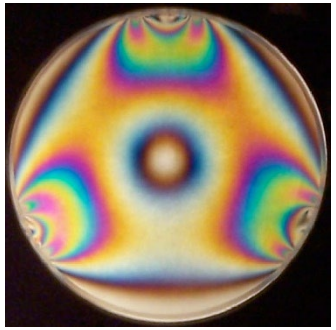
Department: The Institute of Optics
Focus: **Polarization, Metrology and Photonic Integrated Circuits**
Courses: Optics 101 Introduction to Optics | Optics 450, Polarization | Optics 442, Instrumental Optics

RESEARCH TOPICS:



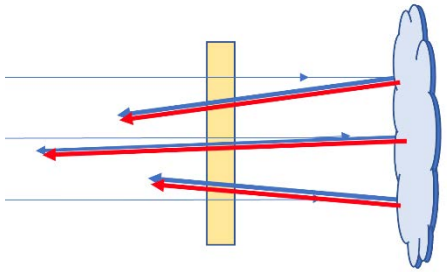
Polarization & Microscopy

Polarization yields important orientation information in single molecule microscopy. This work is a collaboration with Miguel Alonso and Sophie Brasselet at Instut Fresnel (Marseilles).



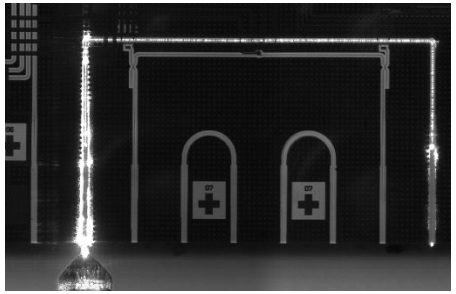
Stress-engineered Optics

Inhomogeneous stress can yield to important and potentially useful pupil and point spread function engineering. The current challenge is to create computer controlled stress optics for adaptive control of birefringence distributions in glass.



Holographic Freeform Metrology

This work poses alternatives to CGH technology by exploring self-aligning nulling using a high quality photopolymer reflection hologram as the reference surface on a Fizeau. .



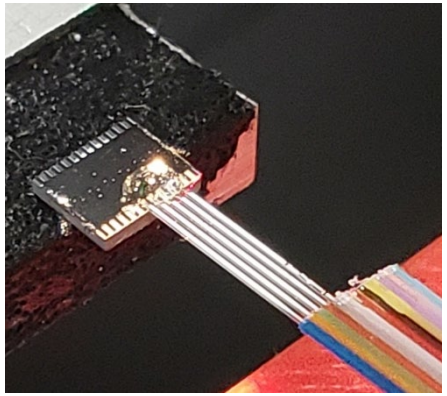
Integrated Photonics Metrology

The Test Assembly and Packaging division of AIM Photonics is tasked with new manufacturing technologies for integrated photonic package design, assembly and metrology. .

Jaime Cardenas| Assistant Professor

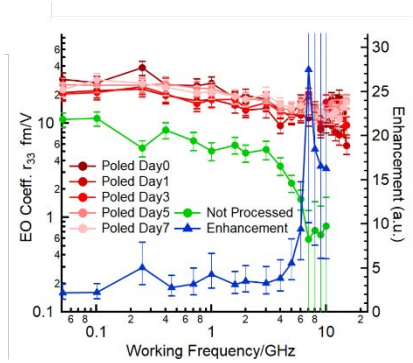
Department: The Institute of Optics
Focus: Silicon Photonics, Fiber Packaging, 2D Materials, Quantum Photonics, Interferometry, Nonlinear Photonics
Courses: OPT468, Integrated Photonics| OPT225, Sources and Detectors
Email: jaime.cardenas@rochester.edu

RESEARCH TOPICS:



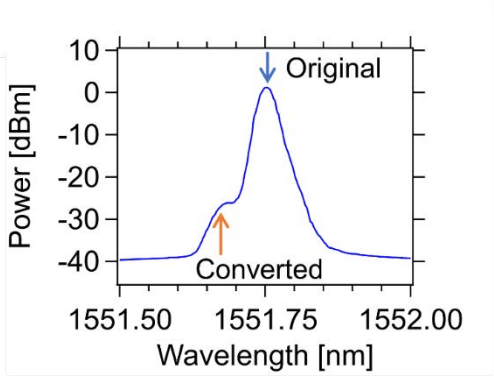
High Efficiency/High Volume Photonic Packaging

- Fiber attach
- Co-packaged optics
- Pluggable photonics
- 3D PIC packaging
- AI driven photonic packaging



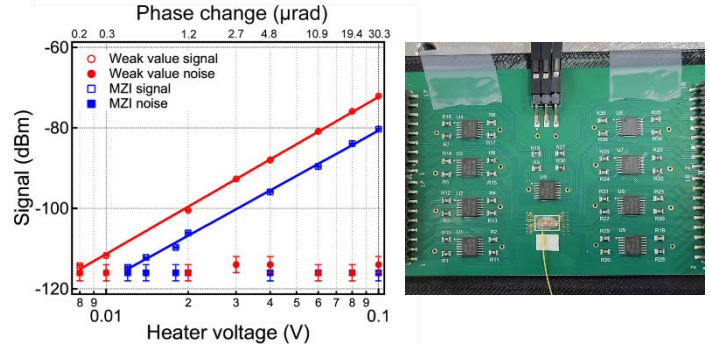
Novel Optical Materials for Photonics

- 2D materials
- Engineered $\chi^{(2)}$ silicon nitride
- UV photonics



Nonlinear Devices and Nonlinear Optics

- Electrically induced adiabatic frequency conversion
- Normal dispersion frequency combs
- High energy soliton generation



Quantum Photonics and Sensing

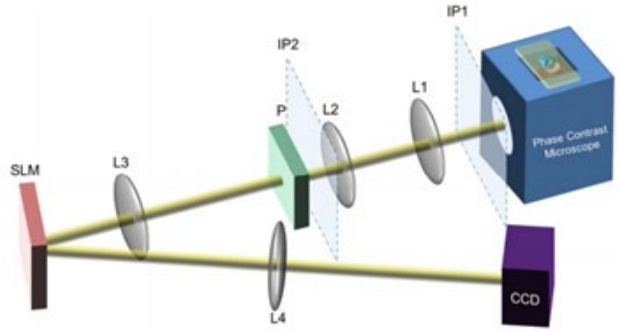
- On-chip weak value amplification
- Compressed sensing spectroscopy
- Hyperentangled photons
- Single photon frequency conversion
- Sensing beyond the standard quantum limit

P. Scott Carney| Director and Professor of Optics

Department: The Institute of Optics
Focus: Signal, Data, and Imaging Sciences
Courses: Mathematical Optics, Electrical Engineering, and Physics
Email: scott.carney@rochester.edu

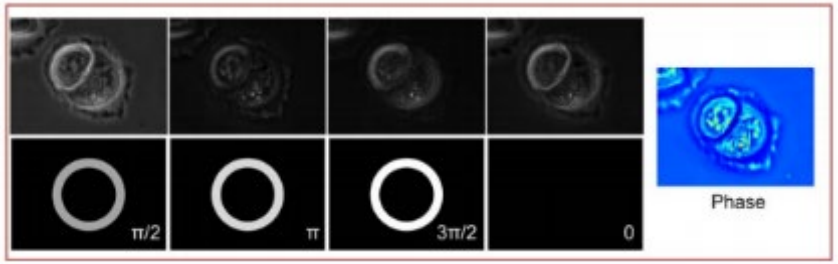
RESEARCH TOPICS:

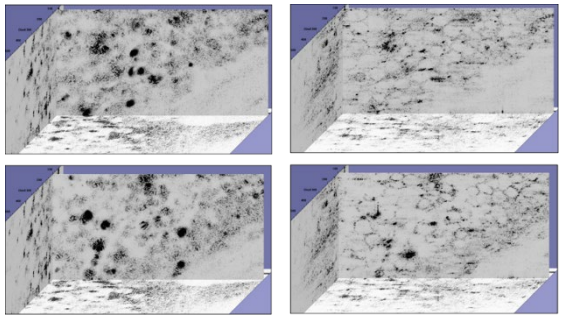
- Applied Theorist
- Computational imaging, spectroscopy and coherence theory
- Nearfield microscopy



OUTREACH:

- Professional Societies: OSA; Fellow, Editor-in-Chief of JOSA-A, FiO Chair 2016
- Co-founder Diagnostic Photonics, Inc.

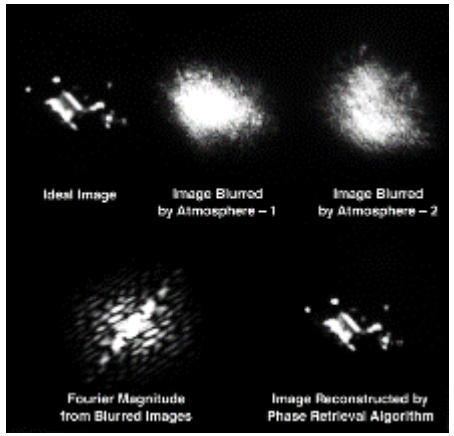




James R. Fienup| Robert E. Hopkins Professor of Optics

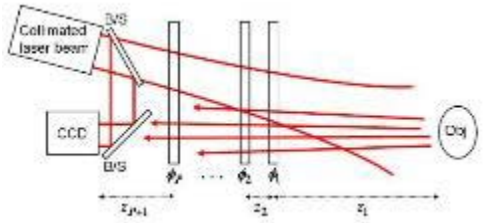
Department: The Institute of Optics, & secondary in: the Center for Visual Science, in Electrical and Computer Eng., and Distinguished Scientist in the Laboratory for Laser Energetics
Focus: Unconventional Imaging, Wavefront Sensing, Image Reconstruction and Restoration
Courses: OPT461 – Fourier Optics | OPT561 – Advanced Imaging | OPT261 – Interference and Diffraction
Email: fienup@optics.rochester.edu

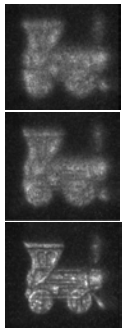
RESEARCH TOPICS:

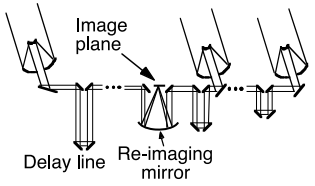


Unconventional Imaging & Image Reconstruction

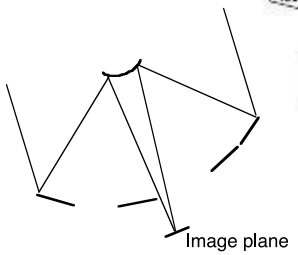
- Through atmospheric turbulence
- Sparse & segmented telescopes
- Interferometric imaging
- Lensless imaging



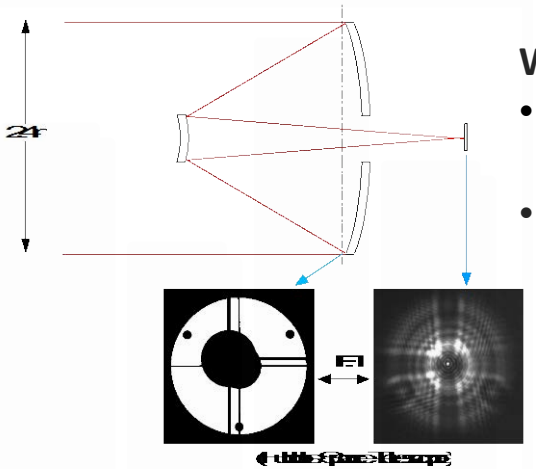


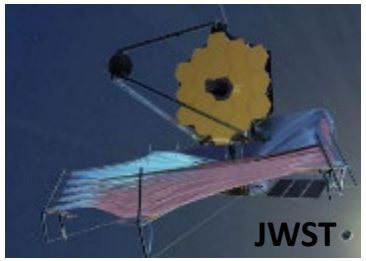


Multiple-Telescope Interferometer



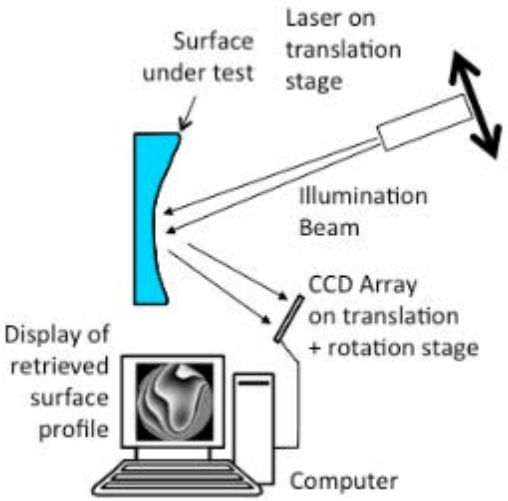
Sparse-Aperture Telescope

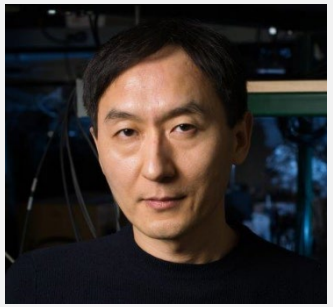




Wavefront Sensing

- Aberration correction for HST, JWST, Roman telescope, etc.
- Optical metrology for freeform surfaces

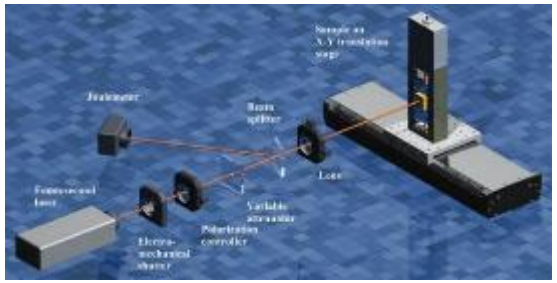




Chunlei Guo | Professor

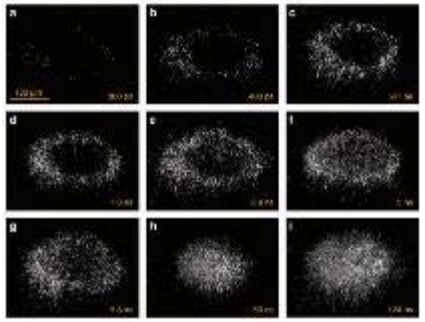
Department: The Institute of Optics
Focus: Femtosecond laser structuring, Ultrafast dynamics & imaging, Ultrafast metrology, Nanophotonics
Courses: OPT225 – Sources and Detectors | OPT465 – Lasers
Email: guo@optics.rochester.edu

RESEARCH TOPICS:



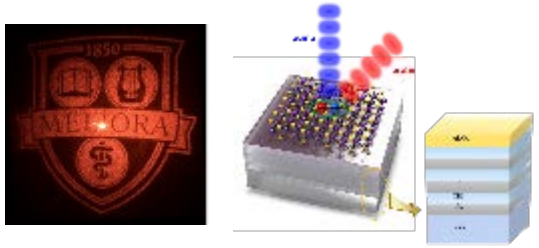
Femtosecond laser structuring

- Black & colored metals
- Superhydrophilic & superhydrophobic surfaces
- Maskless nano-lithography
- Energy based on laser treated materials



Ultrafast dynamics & imaging

- Direct imaging of laser-induced surface structure dynamics
- Nonlinear monitoring of laser-induced surface structure dynamics
- Pump-probe spectroscopy
- Time-resolved photoluminescence



Nanophotonics

- Metasurfaces
- Plasmonics
- 2D materials incorporating nanophotonic structures
- Thin-films nanophotonics

Ultrafast metrology

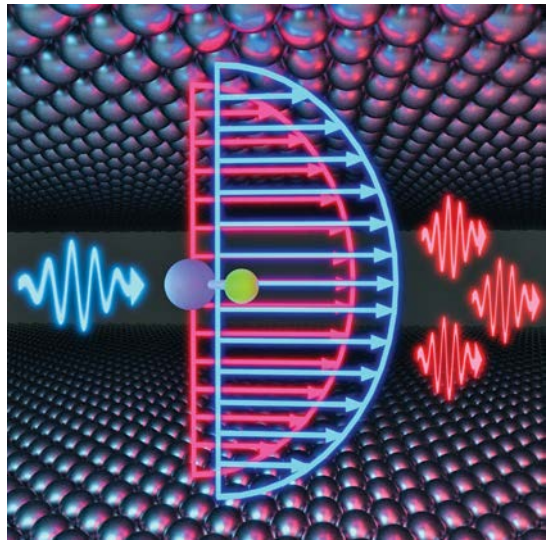
- Shear interferometer for ultrafast optical pulses (see left)
- Spatial and temporal characterization of ultrafast optical pulses

Pengfei Huo| Associate Professor (Chemistry)

Department: Chemistry and The Institute of Optics
Focus: Quantum optics, Polariton Chemistry, Quantum Dynamics of Light-matter Interactions
Courses:
Email: huo@chem.rochester.edu

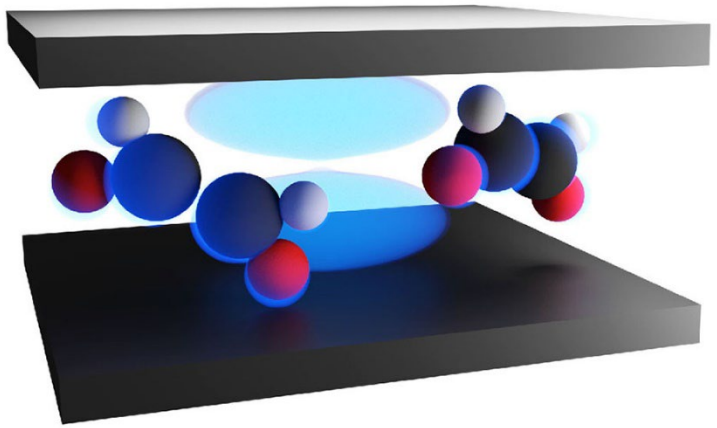
RESEARCH TOPICS:

Quantum Optics



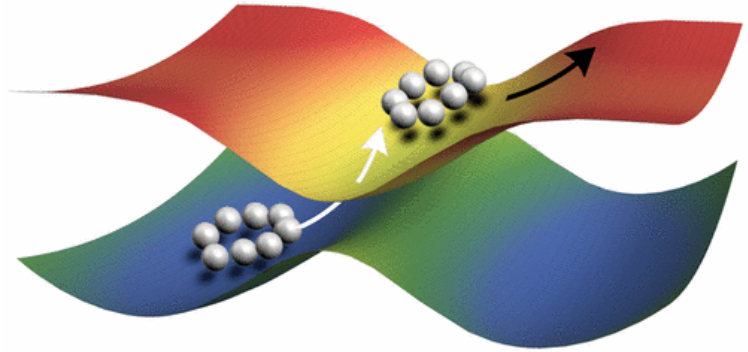
- Cavity Quantum Electrodynamics
- Fundamental Quantum Optical Theory
- Dynamical Casimir Effects
- Polariton Photo-physics and Spectroscopy

Polariton Chemistry



- New chemical Reactivities enabled by forming molecular polaritons
- Polariton Photochemistry
- Vibrational Strong Couplings

Quantum Dynamics

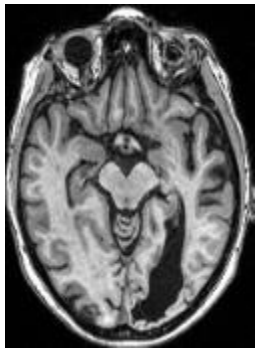


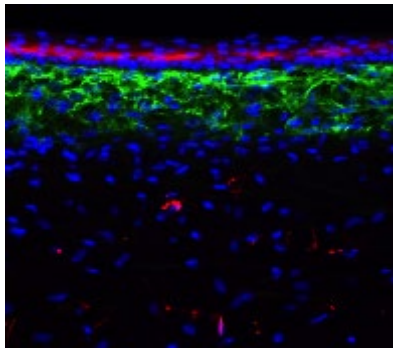
- Quantum Dynamics for coupled electrons and nuclei
- Non-adiabatic dynamics with nuclear quantum effects
- Now theory for light-matter interactions

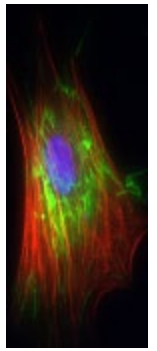
Krystel R. Huxlin | James V. Aquavella Professor of Ophthalmology

Department: Ophthalmology | Flaum Eye Institute | Center for Visual Science
Focus: Applied Vision Research and Rehabilitation
Courses: Topics in Research (Ophthalmology Residency Program)
Email: khuxlin@ur.rochester.edu

RESEARCH TOPICS:







Manipulating plasticity to improve/recover vision

- Customized, psychophysical training
- Eye tracking
- Multisensory integration
- Electrical brain stimulation
- fMRI to assess neural substrates of recovery
- Virtual reality to study visually-guided actions

Laser-Induced Refractive Index Change (LIRIC)

- Novel non-surgical, non-ablative procedure for correcting ocular refractive error
- Multiphoton laser-tissue interactions
- Applications to living cornea, lens and hydrogel materials (contact lenses and IOLs)
- Biological substrates and consequences of LIRIC in animal models

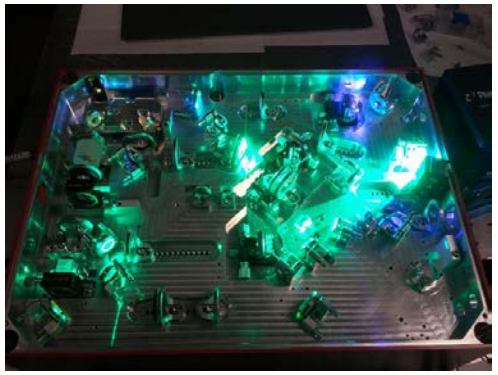
Corneal wound healing: biology & optics

- Molecular substrates of corneal fibrosis
- Optical coherence tomography
- Nerve regeneration in wounds
- Metabolic plasticity as a key regulator of wound healing & nerve regeneration

Wayne H. Knox| Professor

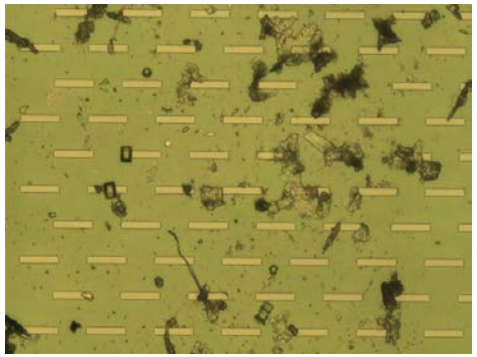
Department: The Institute of Optics
Focus: Femtosecond lasers and nonlinear optics, applications in vision correction, microplastics and medical imaging
Courses: Optical Engineering Senior Design and Optics Senior Thesis
Email: wknox@optics.rochester.edu

RESEARCH TOPICS:



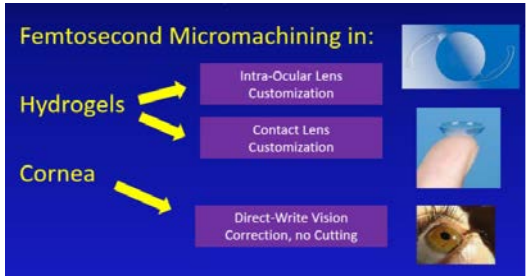
Femtosecond lasers and nonlinear optics

- Fiber lasers and photonic crystal fibers
- Nonlinear wavelength conversion
- Limits of pulse compression
- Femtosecond optical systems



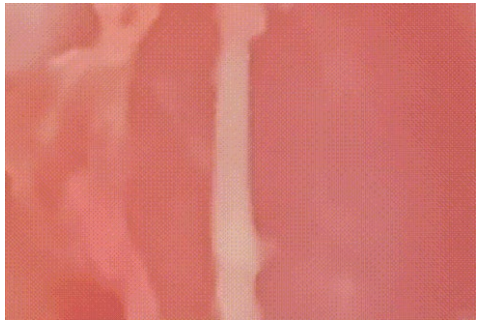
Microplastics in water and air

- Quantitative birefringence microscopy of microplastics
- Multispectral detection of plastics
- Automatic recognition systems for high speed assay of microplastics in air and water



Noninvasive Vision Correction

- 3D writing refractive index microstructures in hydrogels for custom contact lenses
- Adjustable intra-ocular lens in-vivo
- Direct write refractive correction in cornea
- Metrology of refractive structures



Real-time imaging of nerves

- Multispectral polarimetric imaging of nerves during surgery
- Strong differential of nerves vs other common tissues
- Development of prototype surgical demonstrator

Todd Krauss| Professor (Chemistry)

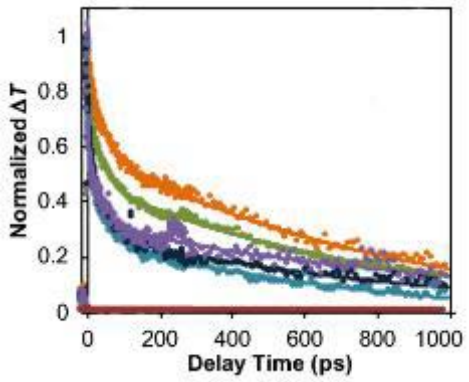
Department: Chemistry and The Institute of Optics
Focus: Nanoscience, ultrafast optical science, Quantum optics, Optical materials, Biomedical optics
Courses: OPT429 – Chemical Bonds: From Molecules to Materials
Email: krauss@chem.rochester.edu

@KrausslabUR

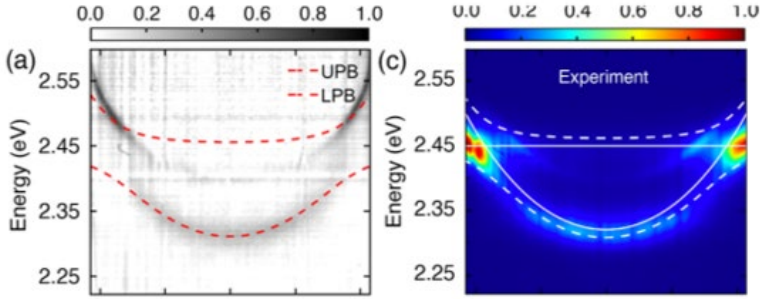
Krausslab.com

RESEARCH TOPICS:

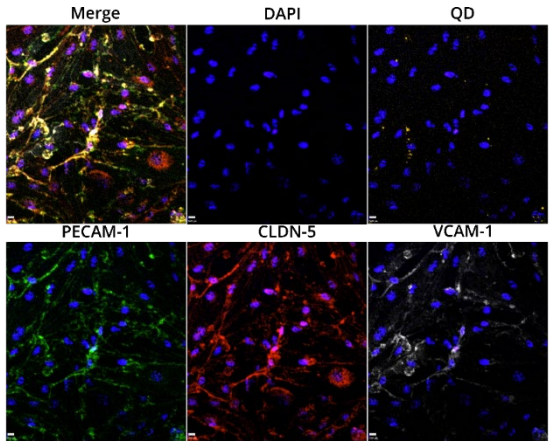
Optical materials
- Colloidal nanocrystals/ quantum dots
- Carbon nanotubes



Ultrafast optical physics
- Optical coherence
- Multi-dimensional spectroscopy



Quantum optics
- quantum communication/single photon sources
- novel materials
- strong light-matter interactions



Biomedical optics
- Super-resolution imaging
- Single-cell spectroscopy

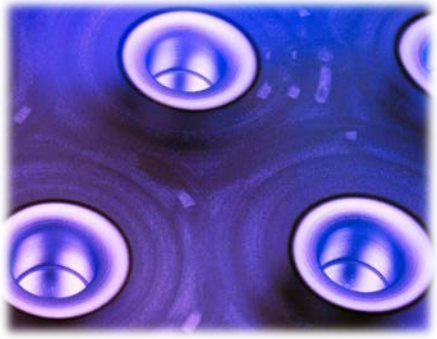
Brian Kruschwitz | Sr. Scientist & Assoc. Professor

Department: Laboratory for Laser Energetics & The Institute of Optics
Focus: **Laser System Science, High-Energy Laser Systems**
Courses: Optics 242 Aberrations, Interferometry, Optical Testing | Optics 442, Instrumental Optics

RESEARCH TOPICS:

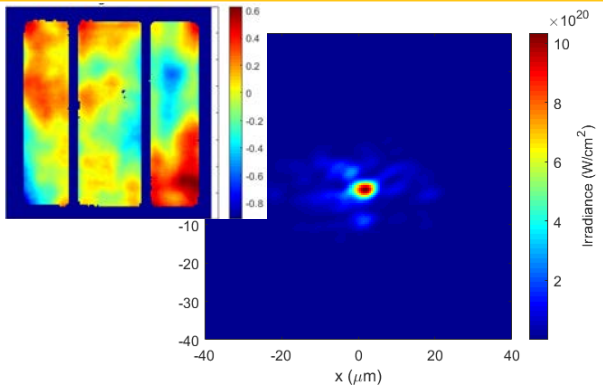
Omega Laser Facility Operations

The Laser System Science group is charged with characterizing and optimizing the performance of the world-class OMEGA and OMEGA EP high-energy laser facilities at the Laboratory for Laser Energetics.



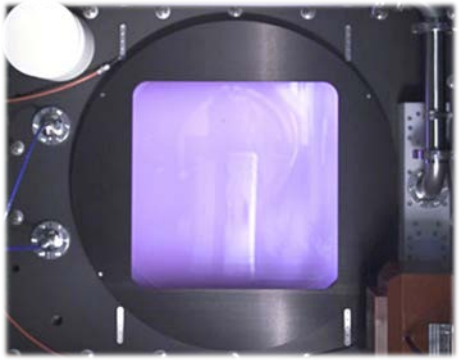
Adaptive Optics and Wavefront Correction

In order to maximize on-target focal spot intensity and minimize threat of pinhole closure on the petawatt-class OMEGA EP laser, Adaptive Optics systems, comprising two deformable mirrors and Shack-Hartmann sensors, were developed in conjunction with static phase correction.



Focal Spot Diagnostics

Accurate target-plane irradiance measurements at the >10^{20} W/cm^2 level are provided to users of the OMEGA EP petawatt laser based on a hybrid wavefront sensing approach utilizing high-resolution Shack-Hartmann sensors and phase retrieval.



Plasma-Electrode Pockels Cells (PEPC)

LLE has adapted Plasma-Electrode Pockels Cell (PEPC) technology to provide large-aperture high-contrast optical switching for target retro isolation in OMEGA EP and for fast, midscale switching in emerging laser systems.

Photo credits: Eugene Kowaluk, LLE

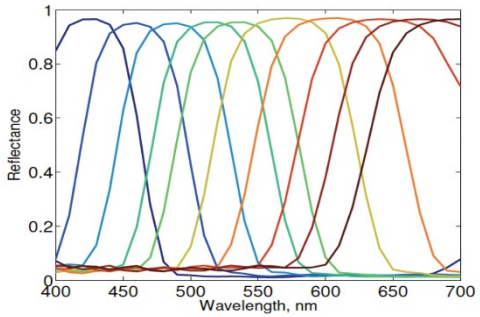
Jennifer Kruschwitz| Associate Professor / Senior Scientist

Department: Institute of Optics / Laboratory for Laser Energetics
Focus: Color Science, Optical Interference Coatings
Courses: OPT422 Color Technology, OPT446 Optical Coating Design, OPT447 Advanced Optical Coating Design, OPT456 MS Laboratory, OPT463 Wave Optics, OPT 203 Instrumentation Laboratory

RESEARCH TOPICS:

LASER PROJECTION DISPLAY

Developed phase compensating optical interference coatings for within RGB laser cinema projectors. Traditionally the phase change on reflectance or transmittance of the color splitting or combining optics have not been taken into consideration. Phase compensation increases overall light output and contrast in 3D systems that either use traditional polarizing filters or dual RGB narrow band filter glasses (Dolby). VR/AR systems can also benefit from increased light output and contrast regardless of the RGB sources.

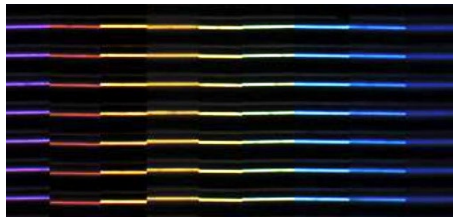


LASER BLOCKING EYEWEAR

Developed design to block RGB lasers and still allow airline pilots to distinguish colors on their electronic tablets. Same technique could be used for AR glasses that allow the pilots to view charts and controls.

MULTI-SPECTRAL IMAGING

Developing narrow-band reflection mirrors or transmission filters to enable imaging of visible and near IR wavelength regions on a single CMOS sensor array.



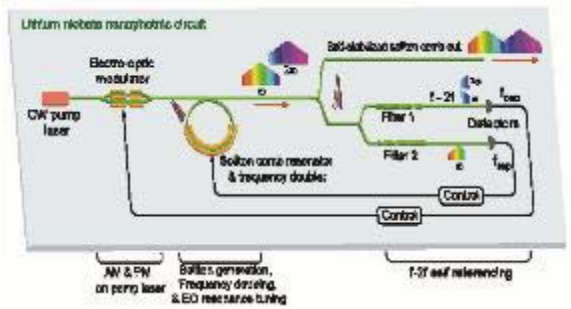
MICROSCOPIC COLOR TARGETS

Developed the ideal color targets for reflectance that can be used to determine the spectral reflected color of objects by simply using two RAW camera images. The targets help to remove the spectral light component from the color images (flat fielding) such that a transformation from camera RGB data to spectral reflectance can be created per image pixel. This technology can also be used to determine the spectral color of the light incident on objects to adjust AR glasses color gamut due to chromatic adaptation of the user.

Qiang Lin | Associate Professor

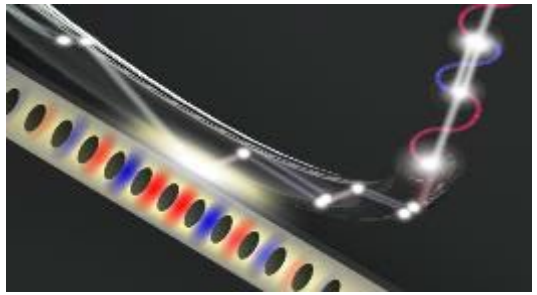
Department: Electrical and Computer Engineering
Focus: Nanophotonic Devices; Physics and Applications
Courses: OPT464/ECE436 – Nanophotonic and nanomechanical devices
Group webpage: http://photonlab.hajim.rochester.edu/
Email: qiang.lin@rochester.edu

RESEARCH TOPICS:



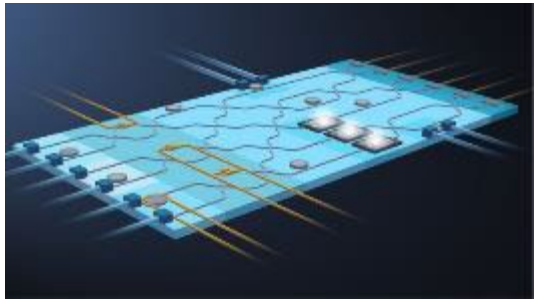
Nonlinear nanophotonics

- Optical Kerr frequency combs
- Broadband coherent light sources
- Energy efficiency nonlinear photonics
- Coherent light conversion
- Nano-optomechanics



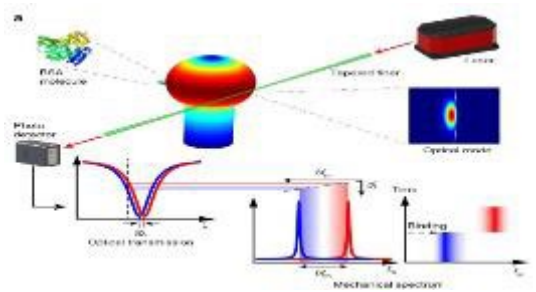
Nanophotonic signal processing

- High-speed optical modulation
- Electro-optic and all optical signal processing
- Integrated microwave photonics
- Integrated photonic wavefront engineering



Integrated quantum photonics

- Chip-scale single photon and entangled photon pair sources
- Quantum photonic integrated circuits
- Quantum enhanced computing, communication, and sensing



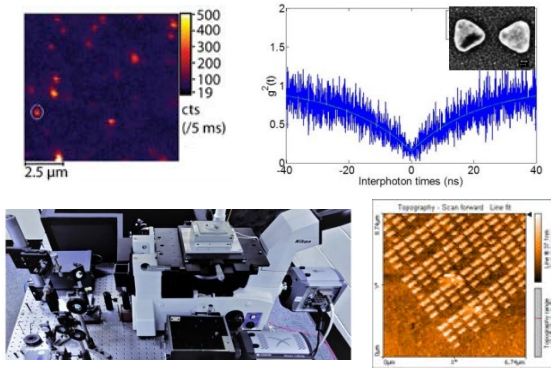
Integrated photonic sensing

- Position and inertial sensing
- Spectroscopic sensing
- Acoustic sensing
- Biomolecule sensing

Svetlana Lukishova | Group Leader, Adjunct Professor

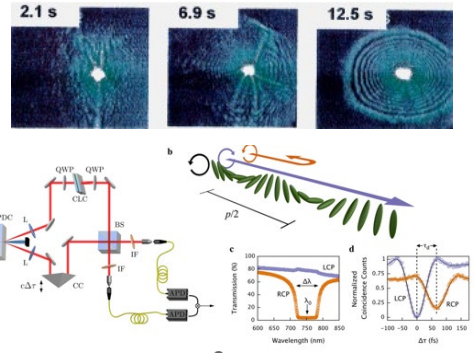
Department: The Institute of Optics
Focus: Quantum Nanophotonics, Liquid Crystals, Interaction of Laser Radiation with Matter, High Damage Threshold Apodizers
Courses: OPT204– Sources and Detectors, Labs and Lab Lectures | OPT253 – Quantum and Nano-optics Laboratory | OPT453/PHY 434– Advanced Quantum and Nano-Optics Laboratory| OPT254 – Nanometrology Laboratory
Email: lukishov@optics.rochester.edu

RESEARCH TOPICS:



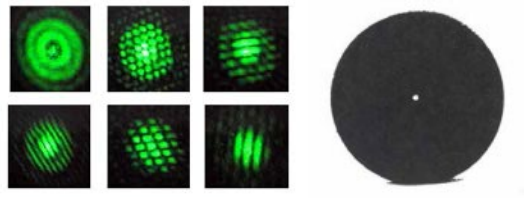
QUANTUM NANOPHOTONICS

- single-emitter fluorescence microscopy and spectroscopy
- single-photon sources
- plasmonic nanoantennas and metasurfaces
- tailoring spontaneous emission
- novel single emitters



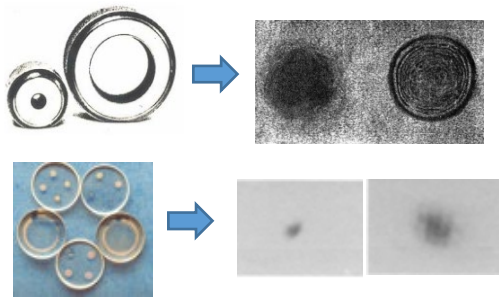
LIQUID CRYSTALS

- nonlinear optical response to high-power laser irradiation
- single-photon sources with definite linear and circular polarizations, cholesteric microcavity resonances
- cholesteric lasers
- modeling quantum mechanical tunneling phenomena



INTERACTION OF LASER RADIATION WITH MATTER

- self-focusing
- feedback-free pattern formation in dye-doped liquids and liquid crystals
- creation and transformation of color centers under high-power laser irradiation



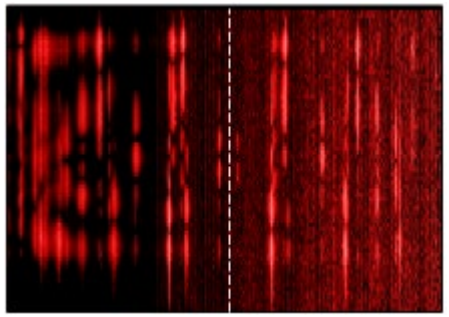
HIGH LASER DAMAGE THRESHOLD APODIZING OPTICS

- color center soft apertures to prevent Fresnel diffraction and self-focusing spikes in high-power laser systems
- multilayer dielectric graded reflectivity mirrors for enhancing beam-quality and brightness of high-power industrial lasers

John Marciante | Associate Professor

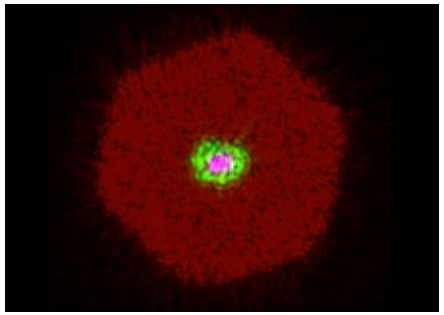
Department: The Institute of Optics
Focus: Laser physics, Waveguide physics, Nonlinear optics, Ultrafast optics
Email: john.marciante@rochester.edu

RESEARCH TOPICS:

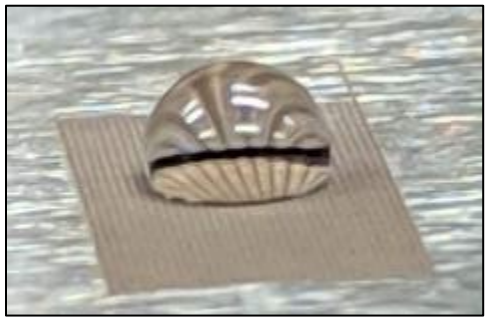


Spatiotemporal laser dynamics
- Thermal mode instability
- Nonlinear optical instabilities
- Beam filamentation
- Coupled-mode dynamics

High-power lasers
- Multi-kW CW fiber lasers
- kW-class femtosecond fiber lasers
- High-power broad-area diode lasers
- Wavelength stabilized pump lasers



Novel active optical fibers
- Tm/Ho doped coaxial fibers
- Cladded linear index graded fibers
- Semi-guiding high-aspect-ratio fibers
- Tb-doped fibers for visible lasing



Laser system design
- Coherent beam combination
- Laser surface modification
- Nonlinearity suppression
- Laser cinema display

Susana Marcos| Nicholas George Professor of Optics; Professor of Ophthalmology

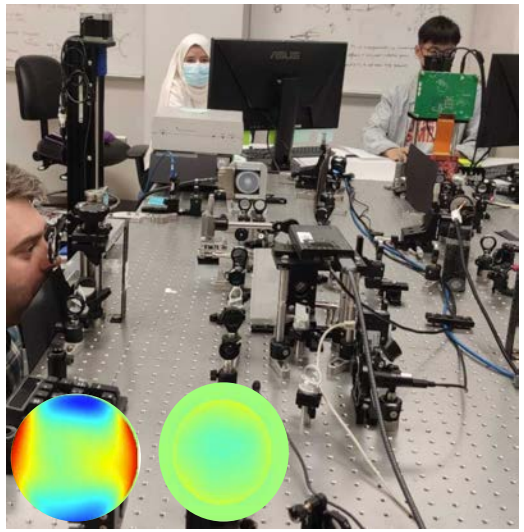
David R Williams Director, Center for Visual Science

Department: Center for Visual Science**,** Institute of Optics, Flaum Eye Institute (Ophthalmology)

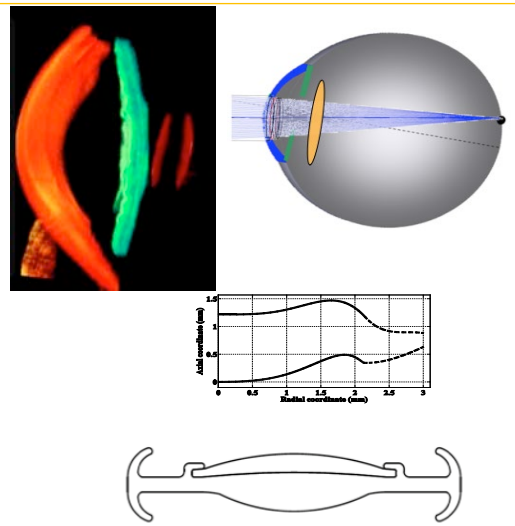
Focus: Visual Optics; Ocular Imaging; Eye's optical corrections; Visual psychophysics

Email: smarcos2@ur.Rochester.edu

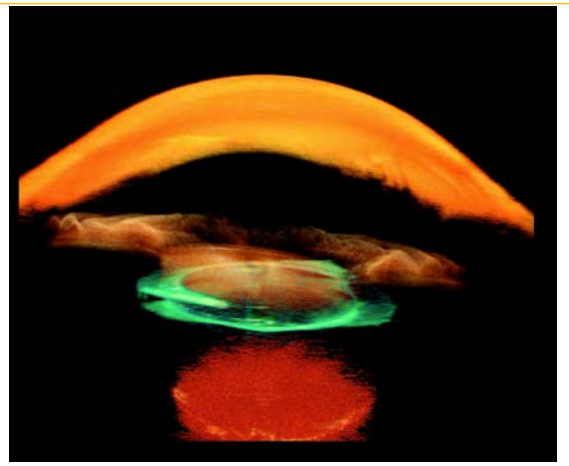
RESEARCH TOPICS:



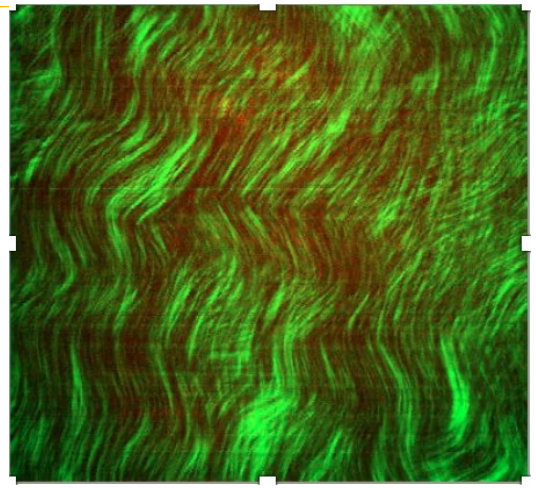
Visual Simulations under Adaptive Optics corrections



Optical Design and Custom Selection of Ophthalmic Corrections



3D quantitative Anterior Eye Segment Optical Coherence Tomography



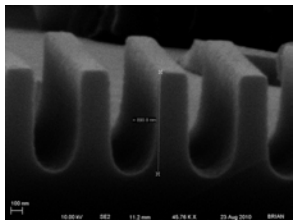
Two Photon/Second Harmonic Generation Microscopy of Ocular Tissue

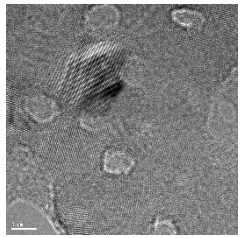
Brian McIntyre| Instructor & Mgr URnano

Department: Physics
Focus: Nanofabrication and Metrology, Electron Microscopy
Courses: OPT 307 – Practical Electron Microscopy
Email: brian.mcintyre@rochester.edu

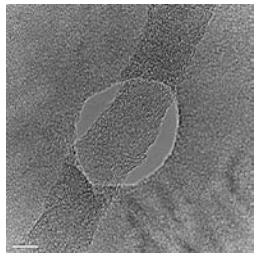
UNIVERSITY OF ROCHESTER URnano INTEGRATED NANOSYSTEMS CENTER

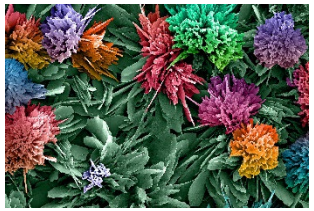
RESEARCH TOPICS:

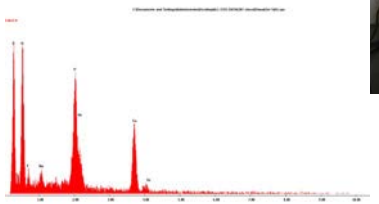


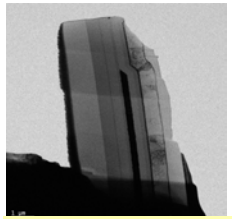


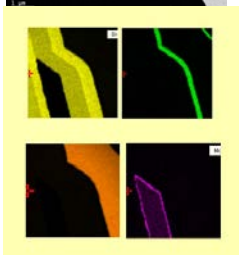
High Resolution Imaging in SEM, TEM and STEM Modes, AFM, EDS

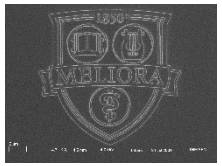




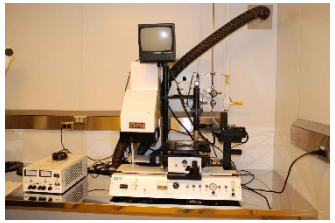




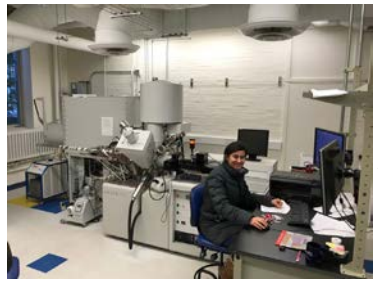




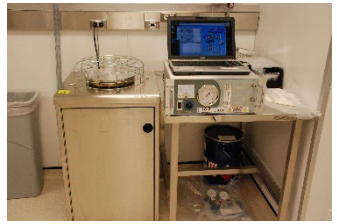
Electron Beam Lithography



Electron Mirror Fabrication and Characterization



XPS



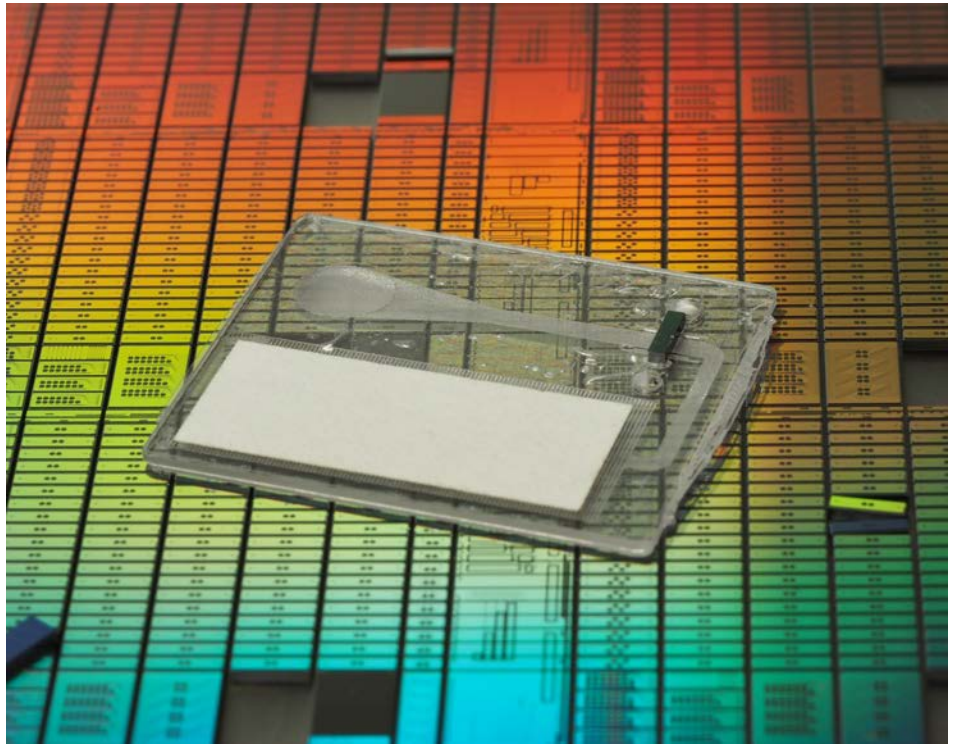
Optical Lithography, Deposition and Etch

Ben Miller| Dean's Professor of Dermatology; Professor of Optics

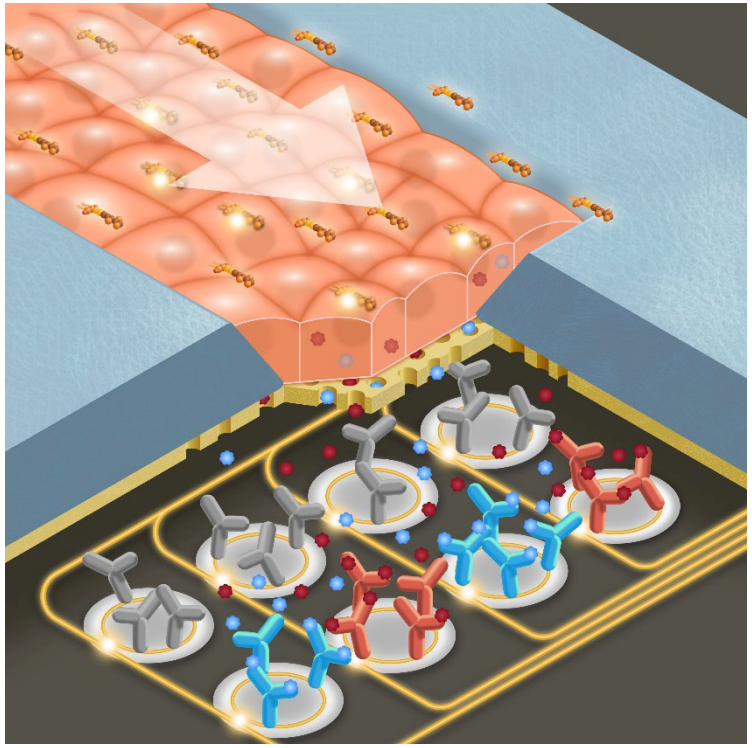
Department: Dermatology; Institute of Optics; Biomedical Engineering; Biochemistry and Biophysics
Focus: Integrated photonics; chemical and biological sensing; global health
Email: benjamin_miller@urmc.rochester.edu

RESEARCH TOPICS:

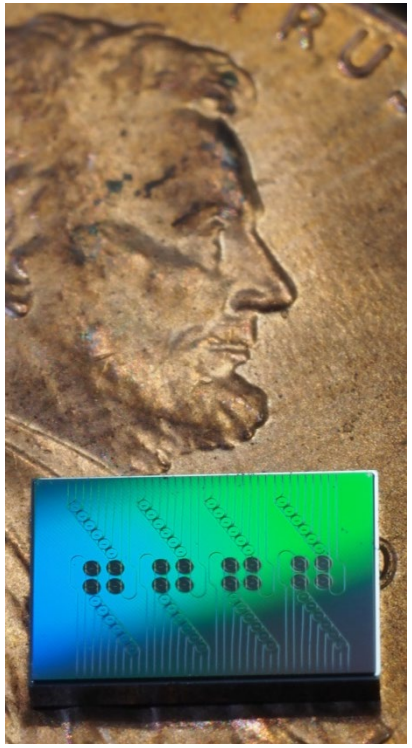
Disposable photonic diagnostics



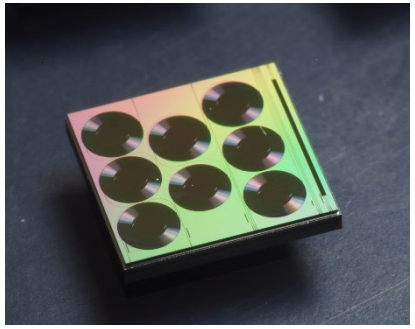
Sensor/Tissue Chip integration



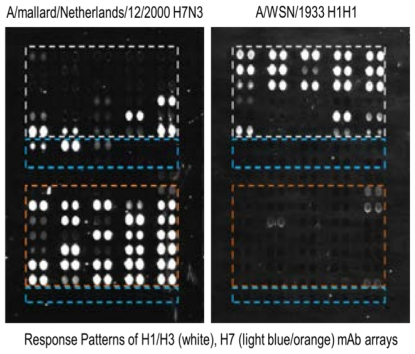
On-chip spectrometers



On-chip Raman



Interferometry



Response Patterns of H1/H3 (white), H7 (light blue/orange) mAb arrays

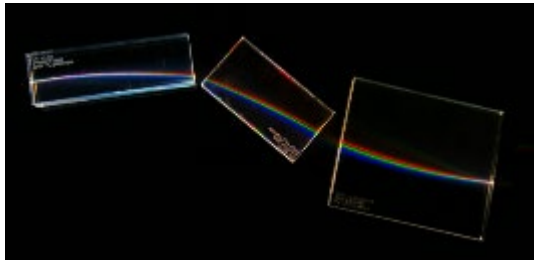
Duncan T. Moore| Professor

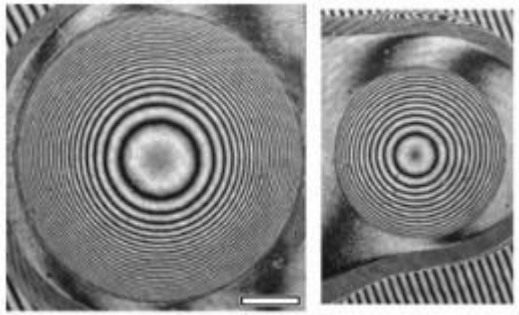
Department: Institute of Optics / Simon School of Business
Focus: Gradient-index Optics, Nonimaging Optics, Lens Design, Technical Entrepreneurship
Courses: TEM411 – Technical Entrepreneurship
Email: duncan.moore@Rochester.edu

RESEARCH TOPICS:

Gradient-index (GRIN) Optics

have an index of refraction that varies as a function of position. Research in our group focuses on glass and plastic GRIN lenses to be used in optical systems. These elements are useful to a lens designer since they provide additional degrees of freedom, and thus can improve system performance. Research topics currently pursued include fabricating GRIN materials, metrology of GRIN materials, designing and tolerancing the optical systems, 3D printed GRIN materials(free form GRINS), and using GRIN for color correction and athermalization.



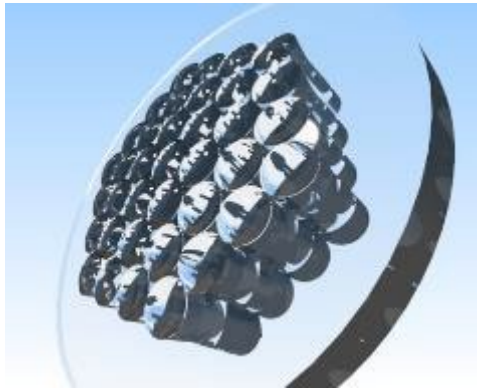


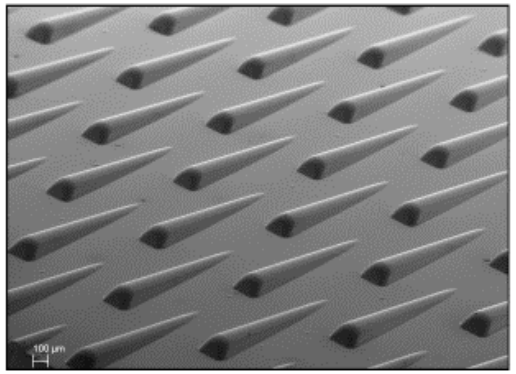
Nonimaging Optics

is the study of the transfer of radiation between a source and target. Unlike traditional optics, systems are not constrained to the point-to-point transfer of light, instead focusing on the total flux transfer. Our research focuses on both solar concentrator and illumination design:

Solar Concentrators—Devices that attempt to transfer the maximum possible flux to the smallest possible target.

Illumination—Designs that work to meet prescribed design conditions, such as irradiance uniformity, intensity uniformity, and high efficiency.

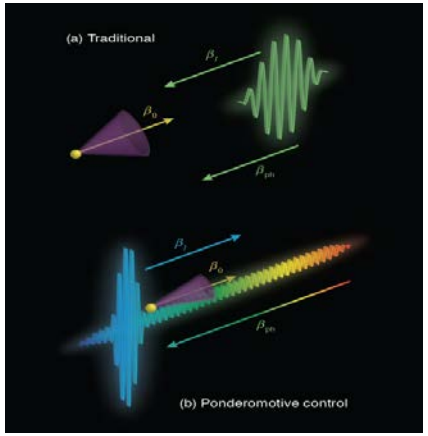




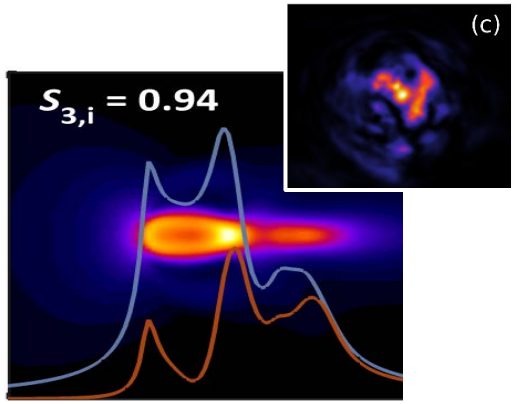
John Palastro| Associate Professor

Department: Laboratory for Laser Energetics, Institute of Optics, Mechanical Engineering
Focus: Short and long pulse laser-matter interactions, plasma-based accelerators and radiation sources
Email: jpal@lle.rochester.edu

RESEARCH TOPICS:

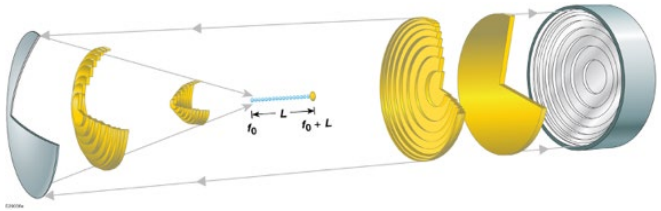


Plasma accelerators and radiation sources
- Laser wakefield acceleration
- Direct laser acceleration
- Laser-plasma betatrons
- Nonlinear Thomson scattering
- THz generation
- Photon acceleration

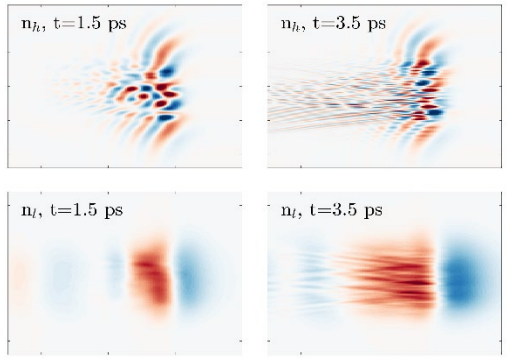


Nonlinear laser pulse propagation
- Self-focusing and filamentation
- Supercontinuum generation
- Propagation through turbulence
- Nonlinear birefringence

Spatiotemporal pulse shaping
- Far-field shaping and control
- Arbitrary velocity intensity peaks
- Extend range of high intensity



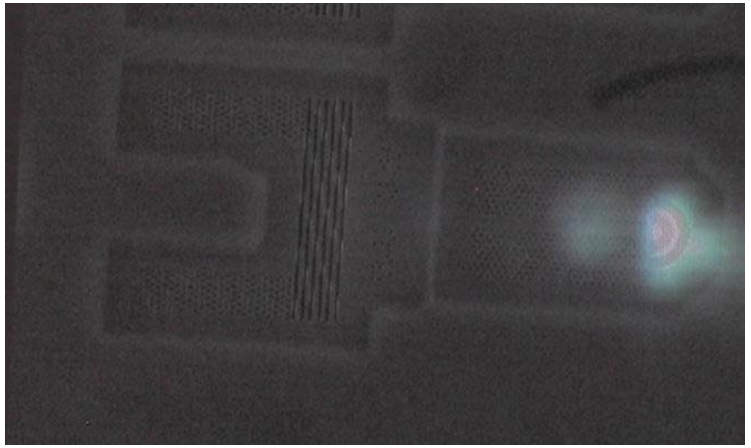
Inertial confinement fusion
- Parametric instabilities
- Wave-particle interactions
- Nonlinear laser absorption
- Instability mitigation



Pablo A. Postigo | Professor

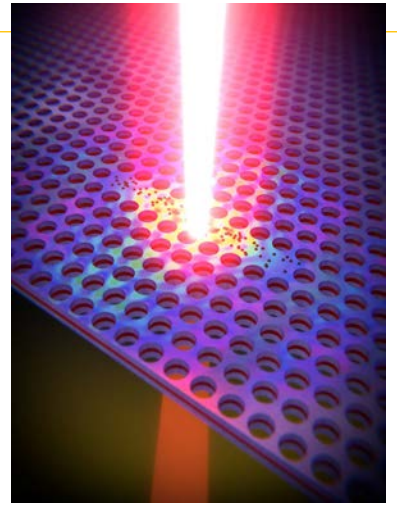
Department: The Institute of Optics
Focus: On-Chip Quantum Photonics, Thresholdless Lasers, Optomechanics for Quantum Sensing, Biophotonics
Email: ppostigo@ur.rochester.edu

RESEARCH TOPICS:



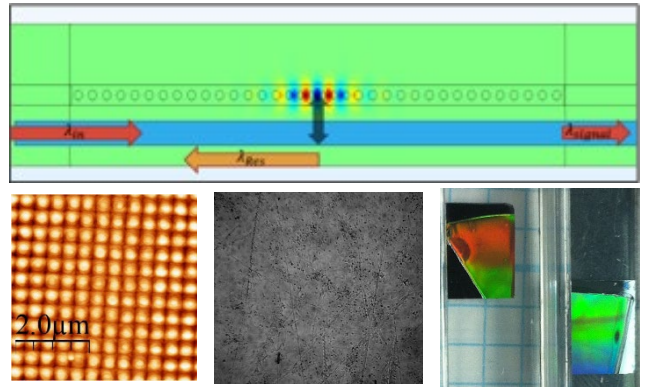
Deterministic On-Chip Quantum Photonics

Development of on-demand, on-chip, integrated and scalable sources of indistinguishable single photons



Thresholdless Micro Lasers

- Design and fabrication of thresholdless vertical-emitting micro-lasers in the visible and NIR.



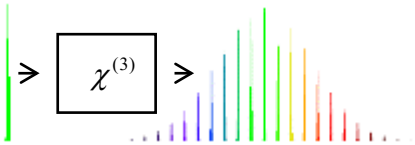
Nano-optomechanics, Nano-coatings and Bio-Nanophotonics

- Nano-optomechanics for Quantum Sensing
- Anti-reflective nanostructured coatings
- Light nano-transport in living cells

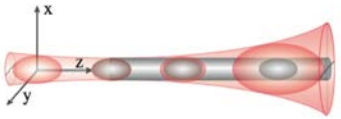
Will Renninger| Assistant Professor

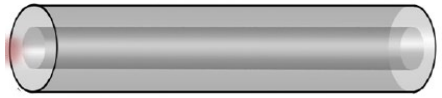
Department: The Institute of Optics
Focus: Experimental nonlinear optics, ultrafast optics, fiber optics, quantum optomechanics
Courses: OPT411/PHY 401 & OPT287/MTH287 – Math Methods | OPT492 – Research Techniques and Topics in Nonlinear Fiber Optics
Email: william.renninger@rochester.edu

RESEARCH TOPICS:



Deep-brain imaging



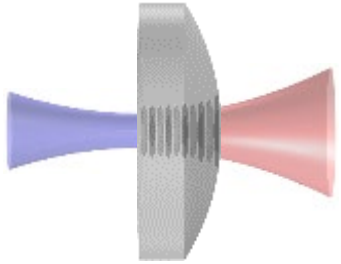


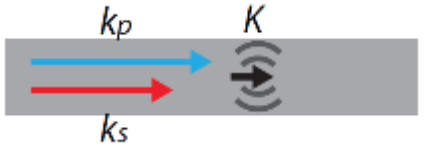
ultrafast optics and applications

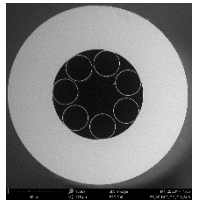
- femtosecond pulse generation
- Kerr fiber resonators
- solitons, self-similarity, chaos
- microresonators
- parametric processes
- multi-photon/deep-brain imaging

frontiers in nonlinear optics

- multi-mode phenomena
- optical bullet formation
- phase matching in 3d
- optical angular momentum







quantum optomechanics

- strong coupling
- information transfer
- quantum-level displacement sensing
- phonon material science
- tailored energy/momentum conservation
- phonon lasers

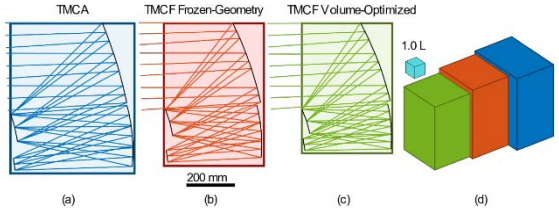
optomechanical waveguides

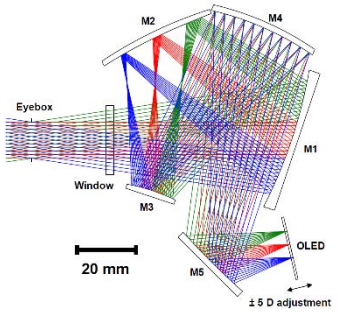
- distributed sensing
- reducing quantum noise
- rf processing
- room temperature optomechanics
- entropy-wave coupling with light

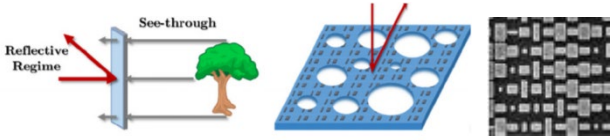
Jannick Rolland | Brian J. Thompson Professor of Optical Engineering | Director of the NSF I/UCRC Center for Freeform Optics

Department: The Institute of Optics | The Center for Visual Science | Biomedical Engineering
Focus: freeform optics, biomedical imaging
Courses: OPT440 Freeform Optics | OPT442 Instrumental Optics | OPT410 Introduction to AR/VR | OPT438 Selected Topics on AR/VR | OPT503 Practicum in AR/VR
Email: rolland@optics.rochester.edu

RESEARCH TOPICS:





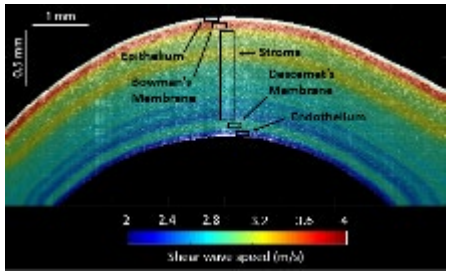


Freeform Optics Foundation

- aberrations theory
- freeform mathematical descriptions
- optical design with freeform elements – unobscured, all-reflective
- refractive freeform elements
- freeform components metrology
- assembly and testing
- bridging design to manufacture

Augmented Reality Optics

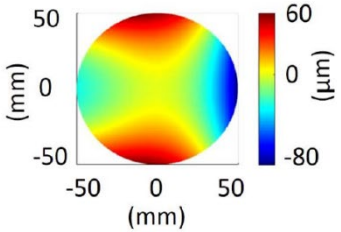
- nanophotonic elements to enable novel imaging systems
- freeform optics
- metaform and metasurfaces
- waveguides
- eyetracking



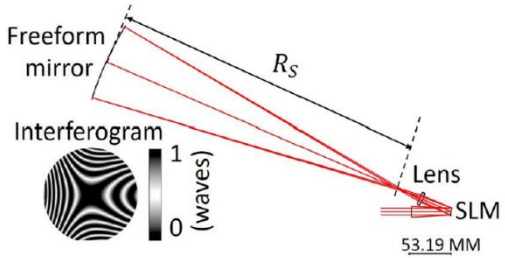
Biomedical Imaging

- high-definition optical coherence tomography
- fluorescence microscopy
- hybrid microscopy
- optical coherence elastography (OCE)
- cornea, brain, skin, tear film

Co-founder of LighTopTech Corp.



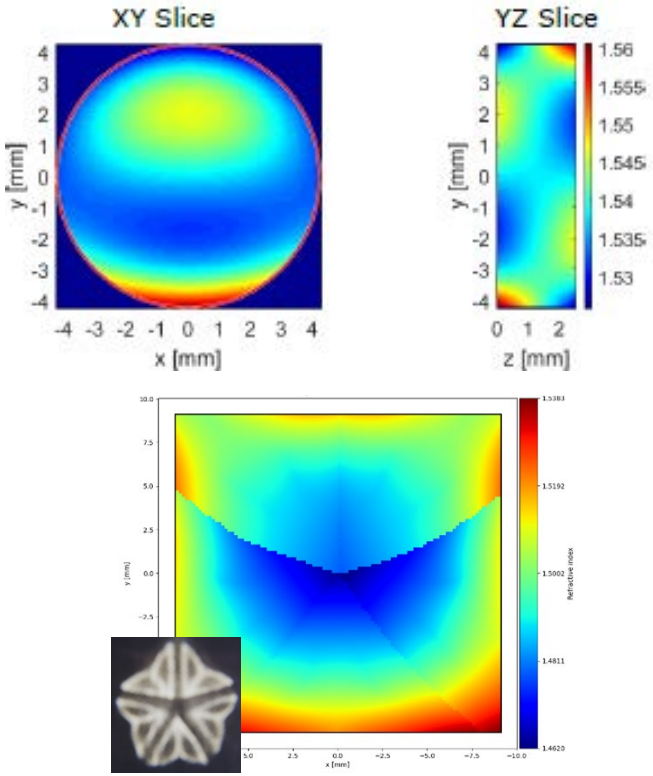
Advanced Optical Metrology (freeform)



Greg R. Schmidt| Research Professor

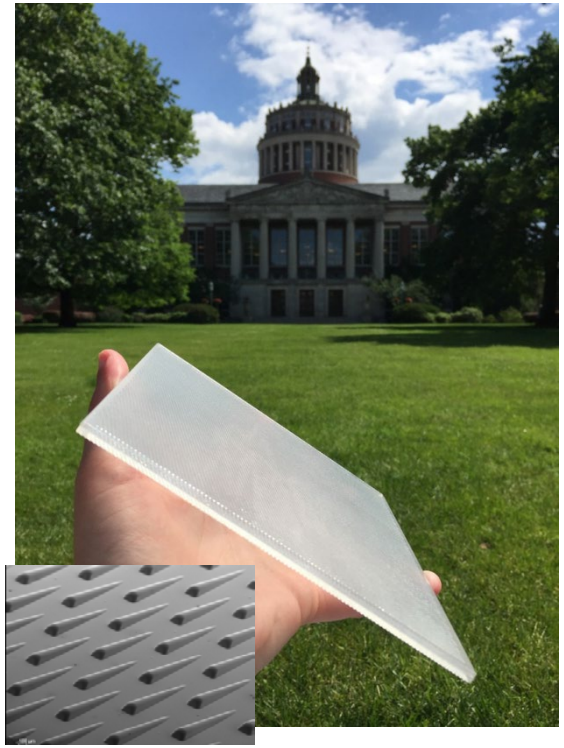
Department: The Institute of Optics
Focus: Design and Metrology of Freeform Gradient-index materials, and Non-imaging Optics
Email: greg.schmidt@rochester.edu

RESEARCH TOPICS:



Gradient-index (GRIN) Materials

- Freeform and 3D printed GRIN materials
- GRIN Metrology
- Thermal Metrology
- Polymer, Glass, Ceramic, Chalcogenide GRINS
- Nano-particle GRIN polymers



Optical System Design

- 3D printed optics
- AR/VR system design
- Freeform GRIN optics
- GRIN material Athermalization
- GRIN Tunable Chromatic Properties
- Micro Optics **Solar Concentrators**
- Illumination and nonimaging Optics

Nick Vamivakas | Professor

Department: The Institute of Optics
Focus: Condensed matter physics, Nanophotonics, Optical physics, Quantum optics
Courses: OPT223 – Quantum Theory | OPT225 – Optoelectronics | OPT256/456 – Advanced Lab
OPT261 – Physical Optics | OPT532 – Quantum Optics
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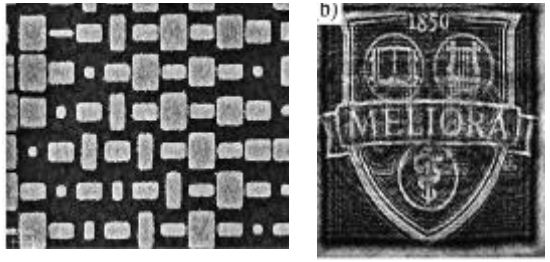
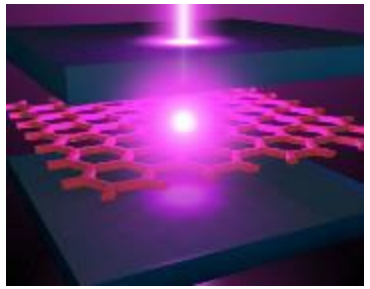
RESEARCH TOPICS:



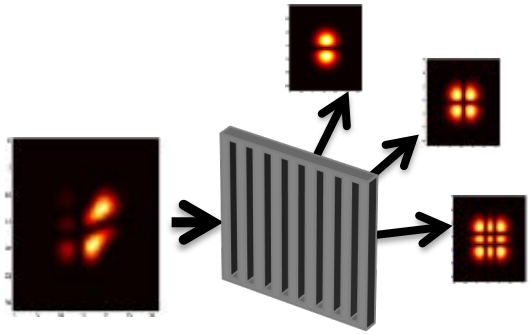
nanophotonics

- nanophotonic light sources and detectors
- flat optics (ex. hologram see right)
- nanophotonic elements to enable novel imaging systems



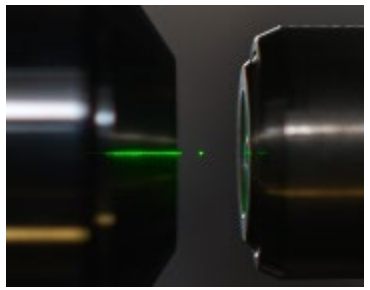
quantum optics

- quantum communication
- integrated quantum photonics
- quantum enhanced sensing
- novel materials
- structured light-matter interaction



optical physics

- new directions in optical coherence
- diffraction unlimited imaging
- universal modal analysis



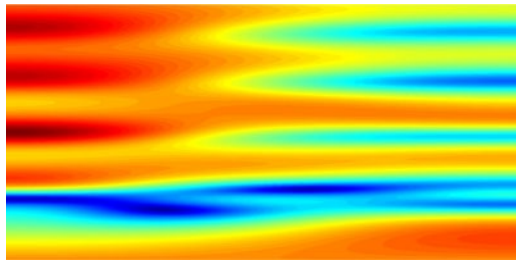
levitated nano-optomechanics

- precision sensing
- exploring quantum foundations
- levitated nanoparticle (see right)

Taco Visser| Professor

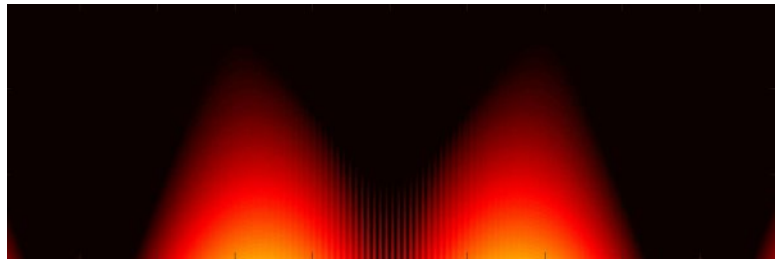
Department: The Institute of Optics
Focus: **Coherence Theory, Surface Plasmons and Physical Optics**
Courses: Optics 412 Quantum Optics | Optics 479 Singular Optics | Optics 535 Coherence Theory

RESEARCH TOPICS:



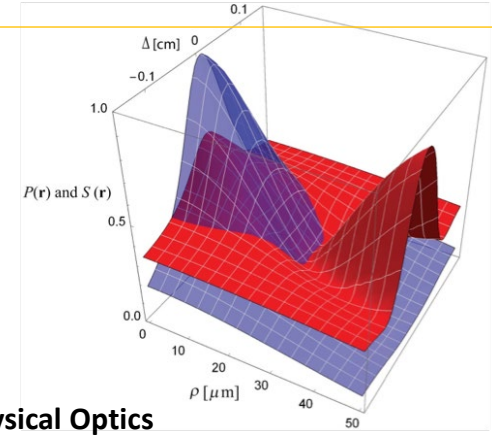
Coherence Theory

How does the scattering and propagation of light change its coherences properties? How can we use these changes to our advantage?



Surface Plasmons

Surface Plasmons are surface waves that propagate along the interface of a metal and a dielectric. We study how they affect the transmission of light through sub-wavelength apertures.



Physical Optics

Optical elements, like lenses and filters, but also the atmosphere, change the polarization state of light beams that pass through them. A better understanding of the underlying processes helps us to design information-carrying beams that are more robust against all sorts of perturbations.

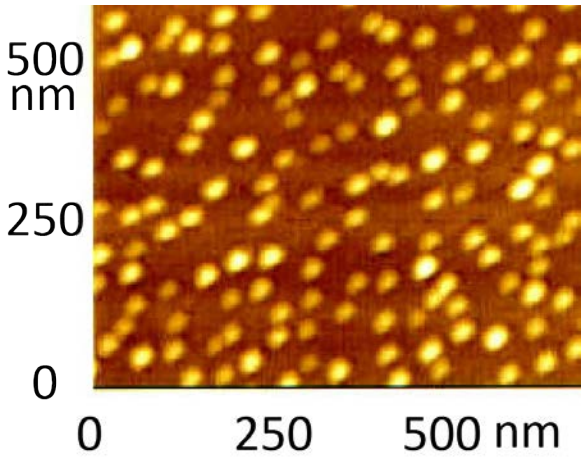
Gary Wicks

Professor, The Institute of Optics
Professor, Materials Science

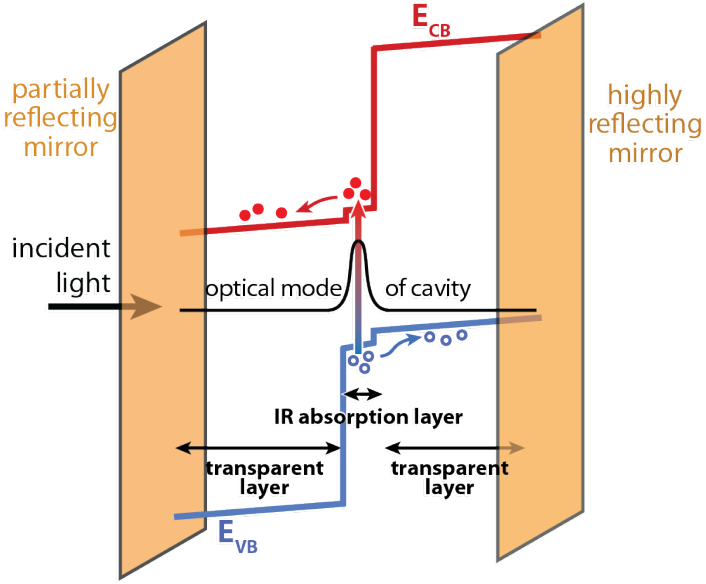
Research areas

- Optical Physics of Semiconductors
- Advanced Photonic Semiconductor Nanostructures and Devices
  - Infrared Detectors & Emitters, Single Photon Detectors & Emitters
- Molecular Beam Epitaxial Growth of III-V Semiconductors

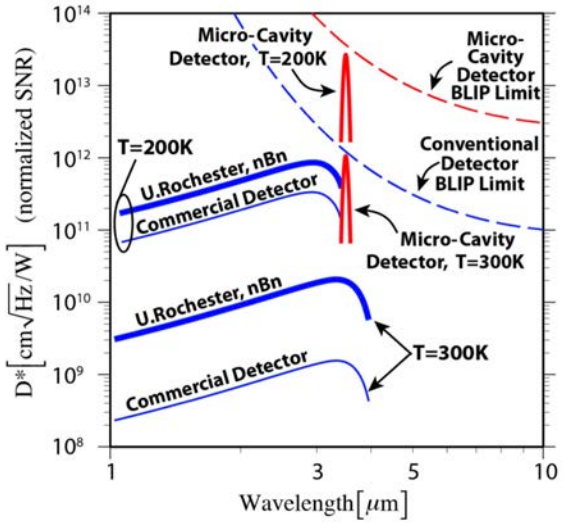
InAs Quantum Dots
– lasers and single photon emitters



Micro-Cavity Enhanced Infrared Detectors
– ultra-high performance for mid-IR laser detection



Advanced Infrared Detectors and Avalanche Photodiodes



David R. Williams | William G. Allyn Professor of Medical Optics

Departmental affiliations: The Institute of Optics, the Center for Visual Science, the Flaum Eye Institute, Brain & Cognitive Sciences, and Biomedical Engineering
Focus: Vision Science
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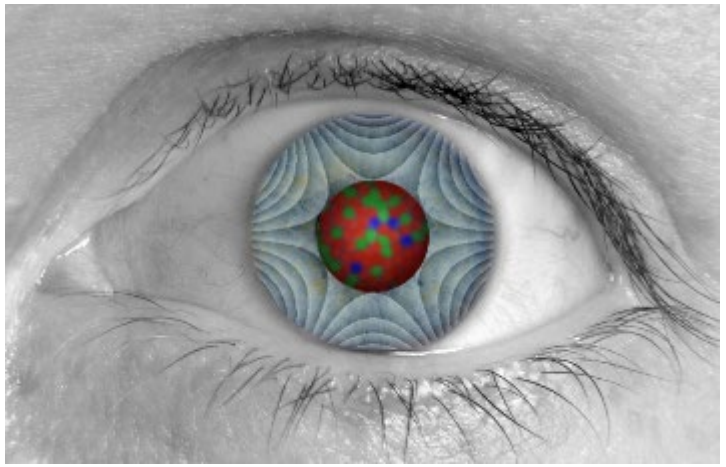
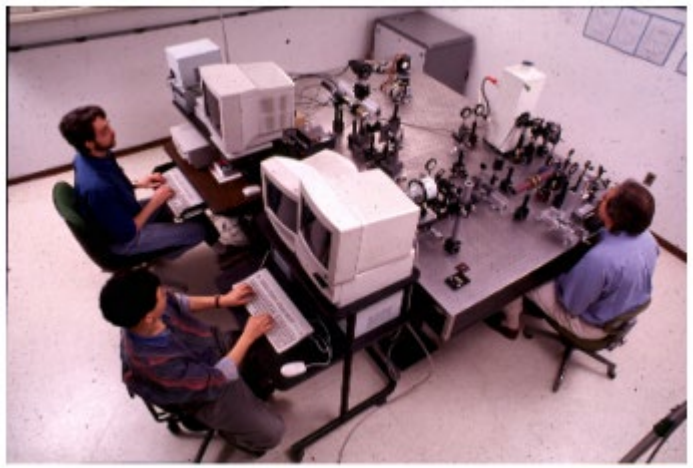
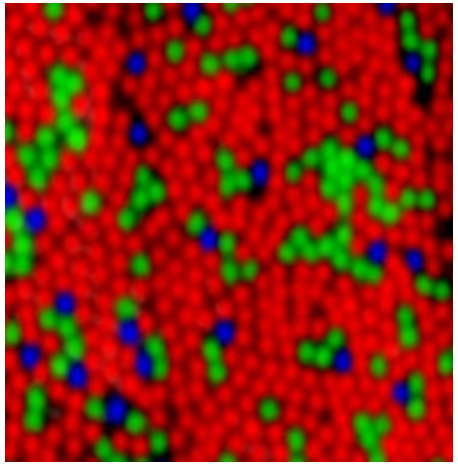
RESEARCH TOPICS:

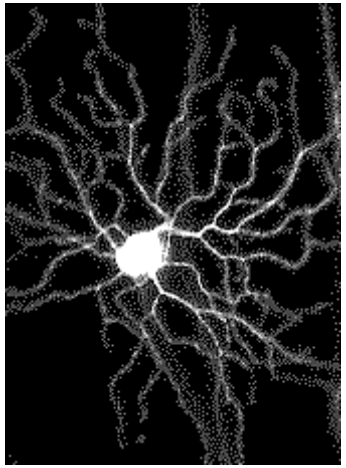


The limits of human vision
in space, time, and wavelength



High resolution retinal imaging
with adaptive optics





Deciphering the retina's code for
communicating with the brain

Jim Zavislan | Professor

Department: The Institute of Optics
Focus: Medical Optics, Optical Metrology, Optical System Design
Courses: OPT 201–Geometrical Optics Lab|OPT202–Physical Optics Lab |OPT 204–Sources and Detectors Lab|OPT225–Sources&Detectors | OPT241–Geometrical Optics | OPT242–Aberrations&Testing | OPT261–Physical Optics|OPT256/456 – Optics Laboratory | OPT 443–Fundamentals of Modern Optical Systems | TEM 441/OPT 482 – System Integration And Product Development
EAS 141–Basic Mechanical Fabrication
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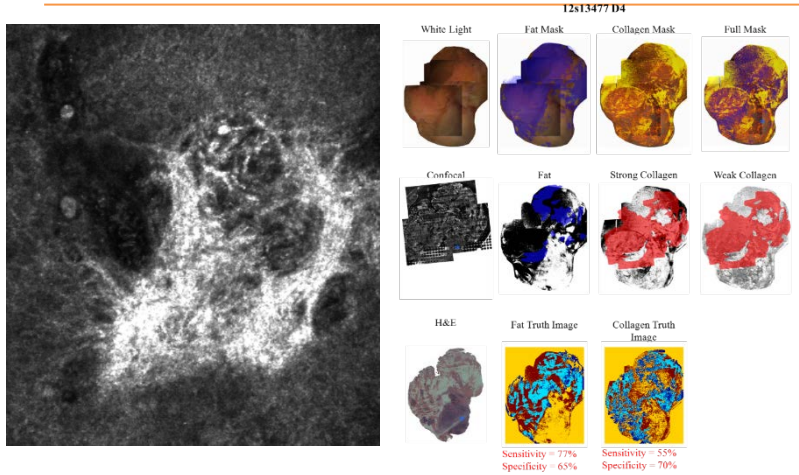
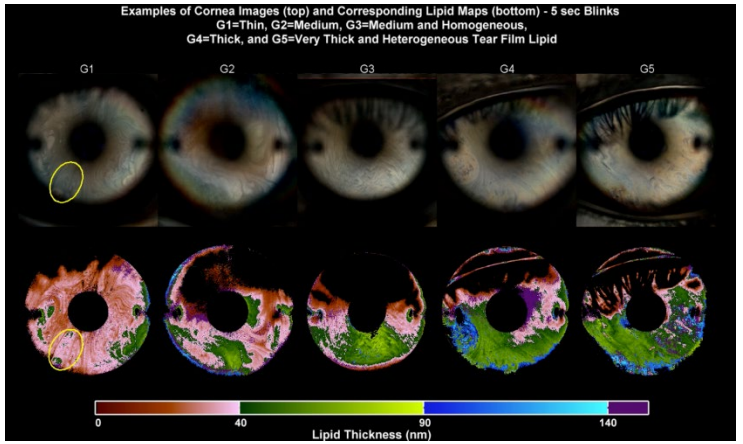
RESEARCH TOPICS:



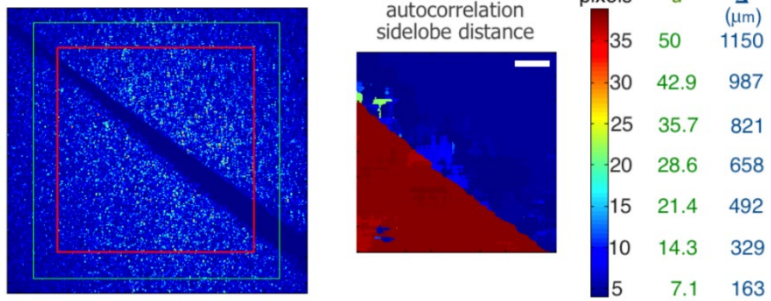
IMAGING IN THICK TISSUES

- optical biopsy using reflectance confocal microscopy
- label-free immune cell identification
- nano-particle tracking in tissue
- resolution standards for in-vivo imaging microscopes
- optimizing image fidelity in thick tissue imaging
- rapid assessment of surgical margins



MULTIMODAL ASSESSMENT OF THE OCULAR SURFACE

- non-invasive dynamic mapping of the aqueous and lipid layers
- non-invasive and objective characterization of dry eye physiology and response to environment
- objective assessment monitoring of dry eye treatments



METROLOGY BASED ON STRUTURED SPATIAL COHERENCE

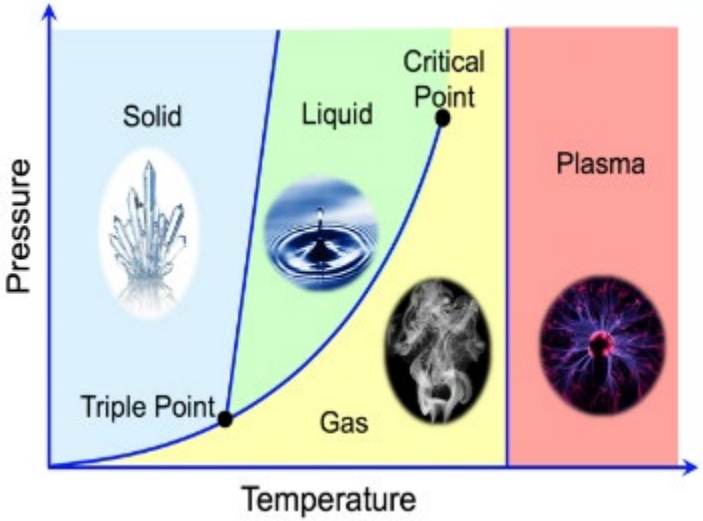
- single image extraction of three dimensional topologies from structured spatial coherence and higher- order irradiance statistics

Xi-Cheng Zhang | M. Parker Givens Professor of Optics

Department: The Institute of Optics
Focus: Ultrafast Photonics; Nonlinear Optics; Laser Physics; TeraHertz Waves
Courses: OPT202 – Instrumentation Lab | OPT492 – Ultrafast Lasers
OPT492 THz Science and Applications | OPT465 – Lasers
Email: xi-cheng.zhang@rochester.edu

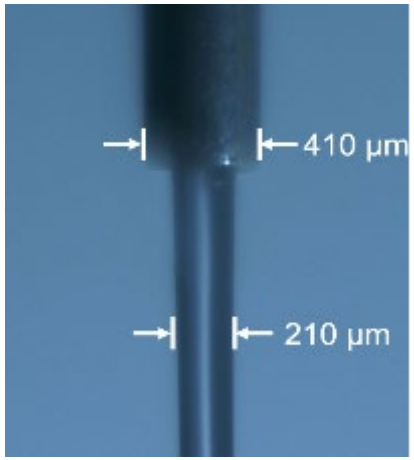
Research Topics:

THz Wave Photonics



THz Air Photonics

THz Liquid Photonic



Applications
- Nondestructive testing
- THz-matter interaction
- Far-infrared spectroscopy
- Time-resolved measurement

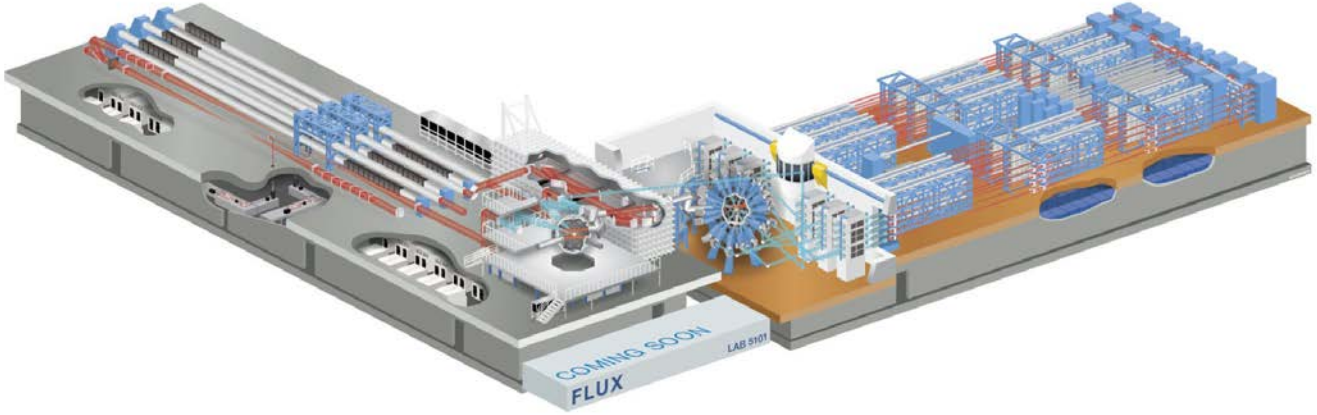
Three of four states of universal matter, solid, gas, and plasma, have been used to generate THz waves. The use of liquids, especially water, as THz sources is a real challenge. A flowing waterline produced by a syringe needle is used to generate intense THz wave under femtosecond laser excitation. Extreme THz science is one of our current research topics.

http://www.hajim.rochester.edu/optics/sites/zhang/index.html

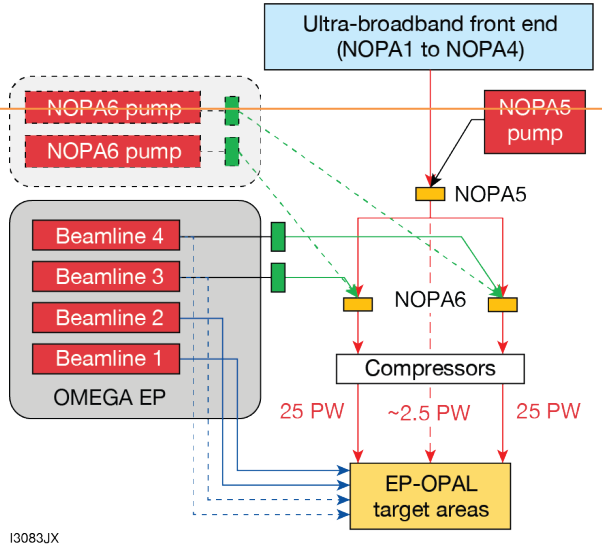
Jon Zuegel | Distinguished Scientist & Professor

Department: Laboratory for Laser Energetics & The Institute of Optics
Focus: **Laser and Materials Science and Technology**
Courses: none

RESEARCH TOPICS:



Fusion Laser Science and Technology



Ultraintense Laser Science and Technology

The Laser and Materials Technology Division develops laser and nonlinear optical science and technology, laser and optical materials, laser systems, and laser diagnostics for both fusion and ultraintense/high-field physics research.

Photo credits: Eugene Kowaluk, LLE