International Optical Design Conference (IODC)

June 13-17 2010, The Snow King Resort, Jackson Hole, Wyoming, United States

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The most important meeting in optical design for engineers, scientists and designers, IODC spans the breadth of optical design disciplines.

Take advantage of all IODC has to offer:

- Two meetings for the price of one- Collocated with the Optical Fabrication and Testing (OF&T) Topical Meeting
- Renowned plenary speakers
- More than 20 invited speakers discussing the latest breakthroughs in optical design
- Tabletop exhibits
- Design Problem presentations - Join the IODC community for a guaranteed highlight of the conference: the illumination and lens design contest presentations
- Poster session providing one-on-one discussion time with presenters
- Proceedings published by SPIE

Conference Program

View the conference program and plan your itinerary for the conference

- Browse speakers and the agenda of sessions
- Browse sessions by type or day
- Use Advanced Search to search by author, title, OCIS code and more
- Plan and print your personal itinerary before coming to the conference
- Download your personal itinerary to your mobile device
- Add your personal itinerary to your electronic calendar
- Email your itinerary to a colleague who might be interested in attending

Special Events

- 2 Plenary sessions
- Conference Reception
- Memorial Program, featuring tributes to a number of significant community members who have passed away recently
- Poster session
- Design Problem Presentations
- Best Student Paper Award Presentation
- Kidger Award Presentation
- Hilbert Grant Presentation

Co-Sponsoring Societies:

The organizers acknowledge the generous support from the following sponsors:

International Optical Design Conference (IODC)

June 13-17 2010, The Snow King Resort, Jackson Hole, Wyoming, United States

Program

The program for IODC will be held Monday, June 14 through Thursday, June 17, 2010. No events are scheduled for Sunday, June 13; however participants may register and pick up their materials on Sunday afternoon.

Online Conference Program

- Browse speakers and the agenda of sessions.
- Browse sessions by type or day.
- Use Advanced Search to search the program by author, title, OCIS code and more.
- Plan and print your personal itinerary before coming to the conference.
- Download your personal itinerary to your mobile device.
- Add your personal itinerary to your electronic calendar.
- Email your itinerary to a colleague who might be interested in attending.

You may search the program without creating an account; however, you will not be able to create or save a personal itinerary without first creating an account. We strongly recommend that you create a user account first.

About IODC

Optical design remains a rapidly developing field due to the increased performance demands, improved software and computing platforms for modeling, better algorithms, and new fabrication technologies for better performance. The International Optical Design Conference (IODC), which occurs every four years, provides the most important meeting in optical design for engineers, scientists and designers to stay abreast of the changes in this field. Attendees from around the world in a breadth of optical design disciplines will be able to interact in both informal and formal settings.

Topics of special interest for this IODC are illumination system fabrication, surface representation in lens design, desensitizing designs and reduction in cost, beam shaping, micro-optics, polarization, and computational imaging.

Topics Considered included the following:

1. **Lens Design**
   - Adaptive optics in optical systems
   - Astronomical optics
   - Asymmetric optics
   - Conformal optics
   - Diffractive and holographic optics
   - Gradient index optics
   - Lithographic optics
   - Liquid optics
   - Micro- and nano-optics
   - Optical design with freeform surfaces
   - Phase coded optics in digital imaging
   - Space-borne optics
   - Vision testing and enhancement optics
   - Zoom optics and multi-configuration optics
   - New lens designs
2. **Illumination Design**

- Theory for illumination/lighting design
- Radiometry and photometry
- Optical design with stray light as a consideration
- Optical design with color in illumination systems: tracing, color mixing, displaying, etc.
- Illumination optics (non-imaging concepts, freeform) design: mathematical representation, modeling, optimization, manufacture and metrology
- Applications in illumination, display, solar, and nonimaging optics
  - Lighting: architectural, roadway, etc.
  - Displays: backlit, projection, etc.
  - Solar: concentrators, flat panel, etc.
  - Nonimaging: lightpipes, freeform, etc.
  - Light shaping components (energy diffusers)
  - Source modeling: LEDs, HID, fluorescent, incandescent, etc.
  - Solid-state lighting design
  - Optical design specifications and requirements for human visual systems
  - Optical design specifications and requirements for non-visual effects of light
  - Rendering and visualization: simulation of environments to determine effectiveness of light for visual and non-visual systems. Software for rendering

3. **System Design**
   - Beam shaping optics
   - Beam splitting gratings
   - Computational imaging and digital processing
   - High-power laser system optics
   - Image performance criteria and aberration correction for digital photography
   - Instrument design
   - IR systems
   - Medical/bio-optics
   - Micro-electro-mechanical systems (MEMS)
   - Ophthalmic optics and instruments
   - Optical data storage systems
   - Photonic and optical interconnect systems
   - Special beams: vortex beams, Bessel Gauss beams, Ince Gauss beams, etc.
   - Telecommunications optics
   - X-ray systems

4. **Fabrication & Testing Design**
   - Desensitizing designs and reduction in cost
   - Fabrication and testing developments that expand the design horizon
   - Integration of design, manufacturing, and metrology
   - Materials (glass and other) and material characterization
   - Plastic and molded optics
   - Thin film coatings in optical designs
   - Testing and alignment of optical surfaces and systems
   - Tolerance generation and application
   - Zernike coefficients: advantages and deficiencies

5. **Software Design**

- Advances in optical design software
- Beam propagation
- Physical optics modeling and design methods
- Optimization developments in local and global methods
- Theory and mathematical methods applied to optical design including new optical surface descriptions
- Tolerancing of optical surfaces manufactured by subaperture processes
- Visualization and virtual-reality optical systems

6. **Polarization and Coherence in Optical Design**
   - Algorithms for polarization ray tracing
   - Simultaneous optimization of coating and optical designs
   - Ultra-low polarization optical designs, polarization aberration balancing
   - Optical design with anisotropic materials
   - Polarization aberrations, vector Zernike and other polynomials
   - Coherence analysis, estimating speckle statistics

7. **Other**
   - Education in optics, optical design and optical system modeling
   - History of optics and optical design
   - Mathematical theory and techniques
   - Standards
   - Other topics

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Special Events

Plenary Sessions

JMA • Joint IODC/OF&T Plenary Session

Monday, June 14, 2010, 8:00 a.m.–9:30 a.m.
Grand Room

8:10 a.m.–8:50 a.m.
JMA1, **Better Ways to Specify Aspheric Shapes Can Facilitate Design, Fabrication and Testing Alike, *Greg Forbes***; *QED Technologies, USA*

Modifying a widely used convention is rarely easy. With designers, fabricators, and metrologists gathered here, we have a rare opportunity to consider such a change in relation to optical aspheres. This evolving technology is currently burdened by the increasingly inadequate convention of expressing a rotationally symmetric asphere's sag as the sum of a conic component and an additive polynomial. When more than just a few terms appear in the polynomial, this becomes problematic and ultimately unworkable. Many of us are being burned by the fact that the associated coefficients are woefully unintuitive and inefficient. The norm is error-prone communications and a lack of easy options to appreciate the difficulty of manufacturing any particular asphere. Thankfully, the design and manufacture of increasingly complex aspheres is facilitated by a modified representation that is also ideal for exploiting cost-effective shapes. In particular, an orthogonalised representation gives a description that functions with fewer coefficients—typically using only one third the number of digits for current designs—and allows easy interpretations and sanity checks as well
as direct assessments of manufacturability. Examples are presented to motivate us to confront this sooner rather than later.

 8:50 a.m.–9:30 a.m.
JMA2, **Computational Imaging Technologies, *Kenneth Kubala***; *FiveFocal, USA*

Many computational imaging technologies introduced in the last several years use optical, mechanical, sensor and computational degrees of freedom to enable special system characteristics. The general computational imaging framework will be discussed along with the value of some specific approaches. Additionally, a simplified design approach that does not require tools beyond what the designer is currently accustomed to will be described.

IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger Award Presentation
Monday, June 14, 2010, 10:00 a.m.–12:30 p.m.
Grand Room

 10:00 a.m.–10:40 a.m.
IMA1, **The Evolution from III-V Opto-Electronics to Silicon Nanophotonics and Vertical Cavity Lasers to Photonic Crystal and Surface Plasmon Devices, *Axel Scherer***, *Uday Khankhoje, Tom Baehr-Jones, Se-Heon Kim; Caltech, USA*

Lithography and dry etching has evolved to replace accurate crystal growth that enabled the definition of high-Q optical cavities in the past with dry etching approaches to define ultra-small mode volumes. These "printed" optical cavities can now be used to define micro- and nano-lasers in which the three-dimensional geometry is used to control the laser performance, and that can be lithographically coupled together in-plane. Advanced microcavity lasers now include photonic crystal mirrors and surface plasmon contact geometries. By combining new methods of design, fabrication and testing, it has become possible to develop higher-level abstract device design approaches that enable SPICE-like modeling of optical circuits. However, the complexity of back-reflections and the wave-like behavior of light in microfabricated geometries limit the applicability of these approaches. Here, the evolution of integrated opto-electronics into photonic crystals and plasmonics is reviewed, with an emphasis on the specific cases of miniaturized lasers, plasmonic light emitters and silicon photonics.

Michael Kidger Memorial Scholarship Presentation

 Monday, June 14, 2010,11:55 p.m.–12:10 p.m.
Grand Room

The Michael Kidger Memorial Scholarship was established in 1998 to honor Michael John Kidger, a well-respected educator, design software developer and member of the optical science and engineering community. A full description can be found online at www.kidger.com.

The First Ten Years of the Kidger Scholarship
Tina Kidger will present a short review of the establishment and organization of the Scholarship and a brief update on the ten Kidger Scholarship awardees to date. She will then present the award to this year's Awardee, *Braulio Fonseca Carneiro de Albuquerque, Natl. Inst. for Space Research, São Paulo, Brazil.*

Robert S. Hilbert Memorial Student Travel Grant Presentation

Monday, June 14, 2010,12:10 p.m.–12:25 p.m.
Grand Room

The Robert S. Hilbert Memorial Student Travel Grant offers financial support to help defray the cost of student travel to the International Optical Design Conference (IODC), Frontiers in Optics (OSA's Annual Meeting) and other professional meetings. The grant was established in honor of Bob Hilbert (1941–2008), former Optical Research Associates (ORA®) President and CEO, who was a respected member of the optics community and enthusiastically embraced learning and optics education. The grant is sponsored by ORA, and administered by OSA Foundation.

OPTICAL RESEARCH ASSOCIATES

OSA FOUNDATION

Joint IODC/OF&T Poster Session

Monday, June 14, 6:00 p.m.–8:00 p.m.
Exhibit Hall, Pavilion

Poster presentations offer a great way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers. This year's joint poster session includes a number of outstanding presentations. There are nearly 30 IODC posters and nearly 15 OF&T posters scheduled for presentation.

Joint Conference Reception

Tuesday, June 15, 6:00 p.m.–7:30 p.m.
Atrium

Mingle with colleagues and friends from around the world during the conference reception. Light hors d'oeuvres will be served. Free to all technical conference attendees. Additional tickets can be purchased at Registration for US$65.

Memorial Program

Tuesday, June 15, 7:00 p.m.–8:00 p.m.
Grand Room

Attend the special memorial program to celebrate the lives of influential community members who have passed away. We will pay tribute to the following luminaries:

7:00 p.m.–7:10 p.m. Hans Buchdahl
7:10 p.m.–7:20 p.m. Juan Rayces
7:20 p.m.–7:30 p.m. Jim Palmer
7:30 p.m.–7:40 p.m. Bob Hopkins
7:40 p.m.–7:50 p.m. Bob Hilbert
7:50 p.m.–8:00 p.m. Warren J. Smith

Sponsored by:

OSA FOUNDATION

OSA The Optical Society
Fabrication, Design and Instrumentation Technical Division

Design and Illumination Problem Presentations

Wednesday, June 16, 7:30 p.m.–9:30 p.m.
Grand Room

Join the IODC community is for a guaranteed highlight of the conference: the illumination and lens design contest presentations. As usual, significant work has gone into developing and scoring the submissions, as well as all of the hard work put in by solution submitters. Additionally, the winner of the best student paper for the 2010 IODC will be announced at the conclusion of the design problem presentations.

Lens Design Problem
The "green" movement is all about conserving resources. When designing and manufacturing a lens, one way to minimize needed fabrication resources is to need only one testplate pair (positive and negative) plus an optical flat, and need only one type of optical glass. The Problem: Design a lens whose non-flat surfaces all share the same radius value, positive or negative, concave or convex.

Illumination Design Problem
The Problem: Transfer maximum monochromatic flux from a 1-mm-square Lambertian source in air to an equal-étendue nonimmersed target. The target surface is rectangular with a 16:9 aspect ratio. The surface area of the target must be at least 4

mm². The target is defined such that only rays incident on the target surface at angles of θmax or less, relative to the surface normal, are considered to be within the phase space of the target, where the value of θmax is determined by the equal-étendue requirement.

Best Student Paper Award Presentation

Sponsored by:

OSA FOUNDATION

OSA The Optical Society
Fabrication, Design and Instrumentation Technical Division

The IODC Best Student Paper Award has been established to encourage excellence in research and scientific presentation skills in the student optics community. Awards include a one-year OSA membership, a cash prize and a certificate.

Students participating in the competition are noted within the abstracts section of this program. Please support the next generation of optical engineers and scientists by attending the student presentations and the awards presentation.

Exhibits

Mezzanine-Grand/Lobby

Schedule plenty of time to visit with the many companies represented and see the latest products and technologies. For more information on the participating companies, see the Exhibit Guide.

Exhibit	Hours
Monday, June 14	9:30 a.m.–4:30 p.m.
Tuesday, June 15	10:00 a.m.–4:30 p.m.
Wednesday, June 16	10:00 a.m.–4:30 p.m.

International Optical Design Conference (IODC)

June 13-17 2010, The Snow King Resort, Jackson Hole, Wyoming, United States

International Optical Design Conference Meeting and Exhibit
Co-located with Optical Fabrication and Testing (OF&T)

Exhibit: June 14-16, 2010 at The Snow King Resort, Jackson Hole, Wyoming, USA

These co-located OSA Topical Meetings will feature one combined exhibit. This is the event where 300-500 industry experts and top scientists and developers will share their latest research and collaborate on new and future applications within this specialized field. The meetings will focus on the most advanced developments within these two specific topical areas of the optics and photonics industry. Exhibiting at this combined exhibit offers you an extremely targeted opportunity to display your company's products that fall within these co-located topical meeting areas.

Current Exhibitor List (as of May 25, 2010)

4D Technology
CDGM Glass
Engineering Synthesis Design
Jenoptik
Lacroix Optical
Optical Perspectives
Optical Research Associates
Optikos
Optimax
ORA
Photon Engineering
Photonics Media
Schott
Zeeko
Zemax
Zygo

Bonus: You will receive one free technical pass for every tabletop space or 10'x10' booth you purchase.

For More Information about Reserving Exhibit Space at OSA Meetings, please call +1 202.416.1474 or email exhibitsales@osa.org

Exhibitor Service Manual (includes set-up times, registration instructions, checklist of deadlines and shipping instructions)

For additional questions about exhibit logistics, please call +1 202-416-1972 or topicalexhibits@osa.org.

International Optical Design Conference
Optical Fabrication & Testing 2010
Topical Meetings and Tabletop Exhibits

June 13-17, 2010 ◆ Snow King Resort, Jackson Hole, WY

- International Optical Design Conference (IODC)
- Optical Fabrication and Testing (OF&T)

Welcome!

We are glad you will be joining us in Jackson Hole! This packet should include what you need to prepare for the meeting. If you have any questions or need more information, please contact Catherine Brosnan, Meetings Coordinator, at topicalexhibits@osa.org or +1 202.416.1995.

Exhibitor Service Manual

Please provide this information to anyone who will be attending the meeting and staffing your company's table.

All exhibit space will be assigned on-site based on the order of when a space contract was received.

Deadlines Summary

Date	Deadline
May 11, 2010	75-word description and company logo (.jpg preferred) due for exhibitor listings
May 11, 2010	Final day to request complimentary ID sign (Exhibitor Response Form)
May 11, 2010	Housing reservations due
May 17, 2010	Registration forms due (fax to +1 202.416.6100 or email topicalexhibits@osa.org)
June 4, 2010	Final day to order electrical power through OSA.
June 8, 2010	Final day to order internet through Snow King.
June 8, 2010	Snow King Resort begins accepting shipments from exhibitors; shipments received any earlier will incur storage charges

Exhibit Schedule

(For a complete schedule of the meeting, visit
http://www.osa.org/meetings/topicalmeetings/iodc/program/agenda/default.aspx

Sunday, June 13

Event	Time
Registration Open	3:00 p.m. – 6:00 p.m.
Set-up	3:00 p.m. – 6:00 p.m.

Monday, June 14

Event	Time
Set-up	7:00 a.m. – 9:00 a.m.
Registration Open	7:00 a.m. – 6:00 p.m.
Exhibit Hours	9:30 a.m. – 4:30 p.m.
Coffee Breaks	9:30 a.m. – 10:00 a.m. & 4:00 p.m. – 4:30 p.m.

Tuesday, June 15

Event	Time
Registration Open	7:30 a.m. – 6:00 p.m.
Exhibit Hours	10:00 a.m. – 4:30 p.m.
Coffee Break	10:00 a.m. – 10:30 a.m. & 4:00 p.m. – 4:30 p.m.

Wednesday, June 16

Event	Time
Registration Open	7:30 a.m. – 5:30 p.m.
Exhibit Hours	10:00 a.m. – 4:30 p.m.
Coffee Breaks	10:00 a.m. – 10:30 a.m. & 4:00 p.m. – 4:30 p.m.
Tear-down (Please be aware of the noise level as sessions do not end until 9:30 pm)	4:30 p.m. – 7:00 p.m.

Exhibitors may set their own hours each day. *We do not require that you remain at your table for the entire time since, in many cases, exhibit staff may want to attend sessions or keep in touch with the office.* ***However, tables should be staffed during Coffee Breaks.*** For more information contact Catherine Brosnan at topicalexhibits@osa.org or +1 202.416.1995.

Set-up Hours

Sunday, June 13	3:00 p.m. – 6:00 p.m.
Monday, June 14	7:00 a.m. – 9:00 a.m.

All exhibitors must be ready and have their displays set no later than 9:30 a.m. on Monday, June 14. Any exhibitor not ready will need to wait and finish their set up between 12:30 p.m. – 2:00 p.m. on that day.

Tear-down Hours

Wednesday, June 16	4:30 p.m. – 7:00 p.m.

Note: Session rooms are located near the exhibits. Please be aware of the noise level during tear-down as sessions will continue until 9:30 p.m.

Exhibit Details

The exhibit along with coffee breaks and poster sessions will be held in Mezzanine-Grand/Lobby of the Snow King Resort.

Exhibitors will be provided with a draped table and 2 chairs. A 7" x 44" (approx. 1.1m x 0.17m) company sign will be provided if ordered by the deadline. Your display must fit completely on the surface of the table for a total display space no larger than 6' x 2' x 8'. Decorations and signage may not be attached to or hung from any permanent structure. The total height all materials, including the table, must be no higher than 8 feet (approx. 2.5m).

Exhibitors will not receive the following items which must be ordered separately from the hotel:

- Electrical service
- Internet Service

Electrical Service - *Deadline: Friday, June 4, 2010*

Cost: $25.00 per day (6% tax)

NOTE: No electrical orders can be placed on-site. It must be ordered in advance. All electrical services must be ordered through OSA using the order form included in this packet. Exhibitors are highly encouraged to bring their own extension cords, power strips and surge protectors. These items are available through the hotel for an additional charge. Power converters are not available and international exhibitors should bring these items. Electrical circuits may be non-exclusive and may be shared with other exhibitors. Power drops for needs over 20 amps are $45.00 per day. Electrical will be charged tax (6%).

See Order Form for more information.

Internet Service - *Deadline: Tuesday, June 8, 2010*

Complimentary wireless service is available throughout the Snow King Resort. Wireless service is also available in the guest rooms in the official hotel block for no charge. Wired Internet service for the meeting room is available for a daily fee of $20 plus a one-time set-up fee of $70.

See Hotel's Order Form for more information.

Company ID Sign – *Deadline: Tuesday, May 11, 2010*

Any company wanting to receive a complimentary 7" x 44" ID sign must notify Management no later than Tuesday, May 11, 2010. Please use the notification form included in this packet, or send an email to topicalexhibits@osa.org.

Exhibitor Registration

Exhibitors may pick up their badges on-site at the registration desk during the following hours:

Date	Hours
Sunday, June 13	3:00 p.m. – 6:00 p.m.
Monday, June 14	7:00 a.m. – 6:00 p.m.
Tuesday, June 15	7:30 p.m. – 6:00 p.m.
Wednesday, June 16	7:30 p.m. – 5:30 p.m.
Thursday, June 17	7:30 a.m. – 10:00 a.m.

Exhibitor Badges – *Deadline: Monday, May 17, 2010*

Exhibitors – Do not use online registration. Fax the completed registration form to +1 202.416.6100 ATTN: Cathryn Wanders by Monday, May 17.

Each person attending the meeting must have a badge. Each exhibiting company will receive three complimentary badges:

1. Exhibitor Technical Badge – includes access to all technical sessions and receptions; one copy of technical digest on CD-ROM; one copy of conference program
2. Exhibitor Personnel Badge – access to the exhibit hall only
3. Exhibitor Personnel Badge – access to the exhibit hall only

If an additional registration is needed, that person must purchase a technical registration. The registration form is included with this packet.

Exhibitor Listing – *Deadline: Tuesday, May 11, 2010*

If you have not already done so, please email a 50-75 word description of your company (including complete contact information) plus company logo in JPG format (black/white or color) to Exhibit Management at *topicalexhibits@osa.org*. To have your description included in the Exhibitor Listings, it

must be received as soon as possible but no later than 5/11. This listing will be distributed to each registrant at the meeting. If you have any questions about the technical program, please email Erin Richardson at ericha@osa.org.

Security

The exhibit will be held in an open Mezzanine outside of the meeting rooms that will NOT be locked each night. It is strongly recommended that you take any valuable equipment (i.e. laptops, small components, other materials) with you or secure them each night. It is also recommended that you bring a drape or cloth to cover your table each night. Each exhibitor is required to have adequate insurance levels, and basic precautions should be taken. Reference your contract for required insurance levels.

Transportation

For more information about transportation to the hotel, including airline and rental car discounts and links to public transportation, go to http://www.osa.org/meetings/topicalmeetings/OFT/housingandtravel/transportation/default.aspx.

The closest airport is Jackson Hole Airport (JAC).

Airport Shuttle Information

Arriving Guests:

- Guests should contact the Snow King Resort the day prior to departure to arrange for a shuttle pick up: **+1 800.522.KING** (5464) or direct at **+1 307.733.5200**
- The shuttle will be waiting outside the airport's main entrance.
- The shuttle is complimentary; but, gratuities are greatly appreciated

Departing Guests:

- Departing guests can get back to the airport by contacting the front desk agent **one day prior** to their departure.
- The shuttle is complimentary; gratuities, however, are greatly appreciated.

Parking

Parking at the Snow King Resort is complimentary for guests and visitors.

LocalTransportation Information

A free Town Shuttle is available from the Snow King Resort to the town of Jackson. Please contact the concierge for a schedule and more information. START Bus provides service from Jackson to Teton Village.

Housing – *Deadline: Tuesday, May 11, 2010*

A block of sleeping rooms has been reserved for the convenience of meeting attendees and exhibitors at the Snow King Resort. The meeting's room rates are:

Single Room	USD $ 185
Double Room	USD $ 185
Extra Person Charge	USD $ 10

Attendees who book with in the meeting block will receive complimentary in-room wireless internet access.

Reservations may be made by calling the hotel toll-free at ++1 800.522.KING (5464) or direct at +1 307.733.5200 and requesting the Optical Society (OSA) group rate.

Reservations may also be made through Fax, Mail or Email. Please visit our Housing website at: http://www.osa.org/meetings/topicalmeetings/OFT/housingandtravel/hotelreservations/default.aspx.

The Snow King Resort must receive reservations **no later than 5/11/10**. After this date, the balance of the rooms will be released to the hotel.

Deposits and Cancellations:

1. One (1) night room and tax will be charged to your credit card upon making your reservation.
2. Reservations may be cancelled 72 hours prior to arrival to receive a full refund. Cancellations received within 72 hours of arrival will forfeit one (1) night's room and tax deposit.
3. Full payment in advance is not required.

Snow King Resort
400 E Snow King Ave
PO Box SKI
Jackson Hole, WY 83001
United States

Tel.: +1 307.733.5200
Fax: +1 307.733.4086

Shipping & Material Handling

Material Handling

The hotel will be available to help all exhibitors with their shipments. The hotel does have a freight elevator and can accept large boxes. The hotel generally does not accept pallets. If needed, please notify topicalexhibits@osa.org in advance and we will work with you to have your shipment delivered. Additional charges may be applied.

The hotel will begin accepting packages June 8th.

All packages must be shipped off property within 24 hours of completion of meeting.

There are no fees/charges for package handling of a reasonable nature.
• Each Exhibitor will be responsible for packing and labeling of all outgoing materials and filling out the Shipping Form.
• There are no fees/charges for package handling of a reasonable nature.

Shipping Address

IODC/OF&T 2010 Exhibits
c/o *Guest Name*
Company
Snow King Resort & Grand View Lodge
400 E. Snow King Ave.
Jackson Hole, WY 83001

Air Freight/Cargo

STS Air Cargo is available to assist those companies who need to ship exhibit materials to Jackson Hole. For more information, please contact:

Mike Carver
STS Air
PO Box 998
Millbrae, CA 94030
stsair@stsair.com
Phone: +1 800.692.6116
Fax: +1 650.692.6175

Customs

TWI Global will assist those companies which need to ship exhibit materials internationally. All materials shipped through TWI will be delivered to the hotel no later than Friday, June 11, 2010. For more information, please contact:

Alison Minichiello
TWI Group, Inc.
Tel: +1 718.995.0500
aminichiello@twiglobal.com
230-59 International Airport Center Blvd.
North Lobby, Suite #250
Jamaica, New York 11413

Promotional Opportunities

Take advantage of the opportunity to maximize your company's meeting presence through the unique sponsorships available at the IODC/OF&T meetings. Increase your company's visibility among qualified attendees while utilizing a cost-effective way to gain a competitive advantage. Don't miss your chance to reach hundreds of attendees!

To take advantage of a sponsorship opportunity, please call +1 202.416.1474 or email Regan Pickett at rpickett@osa.org.
For more information on exhibiting, please contact:

IODC/OF&T 2010
OSA Meetings and Exhibits Department
2010 Massachusetts Ave., NW
Washington, DC 20036
Tel: +1 202.416.1974 / Fax: +1 202.416.1408
Email: topicalexhibits@osa.org

The Snow King Resort

EXHIBITOR ELECTRICAL FORM

EXHIBITOR INFORMATION		PAYMENT INFORMATION	
CONFERENCE / GROUP / SHOW NAME: **The Optical Society (IODC/OF&T)**		* Client agrees to pay in full for loss or theft of any equipment provided by The Snow King Resort. * A 6% sales tax will be added to all charges.	
EXHIBITOR / VENDOR COMPANY:		**CHECK ONE:** [ ] VISA [ ] MASTERCARD [ ] AMERICAN EXPRESS	
ORDERED BY: ON SITE CONTACT(S):		CARD HOLDER'S NAME:	
ADDRESS:		CREDIT CARD NUMBER: EXP. DATE:	
CITY, STATE, ZIP:	PHONE:	INSTALLATION DATE:	DISMANTLE DATE:

ELECTRICAL NEEDS:

Standard Service: Extension Cord **$25.00/day**	**Maximum Service:** Power Drop (for needs over 20 amps) **$45.00/day**

~ Please fax or email completed form, **no later than June 4, 2010**, to:
Catherine Brosnan - +1 202.416.6100 OR cbrosn@osa.org

~ No services will be available at the meeting

Internet and Data Services
For Wyoming

CONTRACT
For High-Speed Internet Services

Customer Information

Customer Name:	
Billing Address:	
Billing City:	
Billing State:	
Billing Zip:	
Billing Contact:	
Billing Contact Phone #:	

Billing note: Customer will pay Snow King Resort at check out time. Snow King Resort handles all required payments to **Wyoming.com**.

Exhibit Room(s)

Room Name	Service Start Date	Service End Date	Other Info (OPTIONAL)

Pricing Schedule – Per Day Service Rates

Description And Cost Per Day Of Service	Total # Of Days	Total Cost
256kbps @ $20.00 per day	days	$0.00
<Select One>	days	$ .00
Total Internet Access Service Charges:	**$0.00**	

Pricing Schedule – One-Time Installation & Setup Charges

Company	One-Time Installation & Setup Charge
Wyoming.com	$50.00
Snow King Resort	$20.00
Total One-Time Charges:	$70.00

Grand Total Charges

Total Internet Access Service Charges	$ .00
Total One-Time Charges	$70.00
Grand Total Charges (Service & One-Time):	**$ .00**

Due to the nature of the Internet, services may be unavailable from time to time. Neither Wyoming.com nor Snow King Resort shall be liable for any interruption in service. Should all services be unavailable due to line outages or equipment failure, customer shall be entitled only to a partial or full credit for this outage. In no case will liability exceed the maximum amount outlined in this Contract Addendum.

Phone (307) 856-6400
FAX (307) 856-1499
937 W. Main Street
Riverton, WY 82501
sales@wyoming.com
www.wyoming.com

Internet and Data Services
For Wyoming

Project Scope Overview & Definition

I. **Wyoming.com** and Snow King Resort will provide the following services:

1. High-speed Internet service as selected and defined on page 1 of this contract.
2. A single 10/100 Ethernet hand-off to connect to Customer provided HUB, Switch or Computer/Laptop.
3. A single public (ARIN) static IP Address for WAN interface of Firewall or Router.

II. Service from **Wyoming.com** and Snow King Resort **does not include** the following:

1. Firewall – customer(s) must supply their own Firewall or Network Security.
2. Switch or HUB – customer(s) must supply their own (if necessary).
3. VPN capabilities – high-speed broadband service **will** support a VPN Tunnel if Customers Firewall will support VPN Tunnels.
4. Static public (ARIN) IP Addresses per workstation. Static public IP Address(es) are available as an optional service from **Wyoming.com** and Snow King Resort.
5. Computer or Laptop – customer(s) must supply their own Computer(s) and/or Laptop(s).

Special Notes or Instructions (Customer Specific Information)

.

Agreed to this **29** day of **May**, **2008** between the following parties:

AGREED TO BY (CUSTOMER):		**ACCEPTED BY (Snow King Resort / Wyoming.com)**	
Signature	**Date**	**Signature**	**Date**
Print (or type) Name & Title		**Print (or type) Name & Title**	

International Optical Design Conference (IODC) Topical Meeting and Tabletop Exhibits

Collocated with: Optical Fabrication and Testing

June 13-17, 2010 * Jackson Hole, Wyoming, USA

One registrant per form

SECTION A: BADGE INFORMATION – PLEASE PRINT CLEARLY

Do you want all OSA correspondence and subscriptions sent to the address listed below? ☐ Yes ☐ No

Last (Family) Name | First (Given) Name | Middle Initial

Professional Affiliation/Institution | Title

Mailing Address

City | State/Province | ZIP/Postal Code

Country | Email

Telephone with Country Code | Fax with Country Code

Emergency Contact (In case of emergency) | Phone with Country Code

SOCIETY MEMBERSHIP INFORMATION: ☐ The Optical Society (OSA) ID#_____ ☐ SPIE ID#_____

SECTION B: CONFERENCE REGISTRATION

I. Full Technical Registration – Includes admission to all IODC/OF&T technical sessions, exhibit, refreshments, the conference reception, and one copy of the IODC/OF&T 2010 Conference Program and Technical Digest on CD-ROM. IODC Proceedings are only included where indicated. Proceedings will not be sold at the meeting. **Students must provide valid student I.D. to receive the discounted registration.** Forms received without payment will not be processed. Forms received after the deadline of May 17, 2010 will be charged the higher fee.

	On or before May 17, 2010	**After May 17, 2010**
Printed and CD-ROM IODC Proceedings included:		
OSA/SPIE Member	☐ US$ 615	☐ US$ 720
Non-member	☐ US$ 780	☐ US$ 885
Printed IODC Proceedings ONLY included:		
OSA/SPIE Member	☐ US$ 610	☐ US$ 715
Non-member	☐ US$ 775	☐ US$ 880
CD-ROM IODC Proceedings ONLY included:		
OSA/SPIE Member	☐ US$ 590	☐ US$ 695
Non-member	☐ US$ 755	☐ US$ 860
Proceedings Sold Separately:		
Emeritus/ OSA/SPIE Student Member	☐ US$ 170	☐ US$ 260
Student Non-member	☐ US$ 230	☐ US$ 320

II. Exhibit Only Registration - Only includes admission to the exhibit hall for attendees. ☐ US$ 0 ☐ US$ 0

III. Exhibitor Technical Registration – One complimentary technical badge per Tabletop Space (subject to verification). EXT includes admission to all IODC/OF&T technical sessions, exhibit, refreshments, conference reception, and one copy of the 2010 Conference Program and Technical Digest on CD-ROM. IODC Proceedings NOT included.

Complimentary Technical Badge ☐ US$ 0 ☐ US$ 0

IV. Exhibit Personnel Only – Only includes admission to the exhibit hall for exhibitor staff. ☐ US$ 0 ☐ US$ 0

SECTION B PAYMENT $_____

SECTION C: CONFERENCE PUBLICATIONS

One copy of the IODC/OF&T 2010 Conference Program and Technical Digest on CD-ROM is included in the Full Technical and Exhibitor Technical Registration fee.

Additional copies are available for purchase. Extra IODC/OF&T 2010 Program and Technical Digest on CD-ROM _____ x US$ 75

IODC Proceedings: Proceedings may be included based on your selection above. Additional copies of proceedings will not be available for sale at the meeting.

IODC Printed and CD-ROM Proceedings _____ x US$ 75
IODC Printed Proceedings _____ x US$ 70
IODC CD-ROM Proceedings _____ x US$ 50

SECTION D PAYMENT $_____

SECTION E: ADDITIONAL PRODUCTS

Admission to the conference reception is included in the Full Technical and Exhibitor Technical Registration fee. Guest tickets may be purchased for $65 per person.

Extra IODC/OF&T Reception Tickets No. of Guests _____ x US$ 65 ☐ Paid Registrant – No Charge

OSA Foundation Donation ☐ US$25

SECTION E PAYMENT $_____

TOTAL PAYMENT $_____

SECTION F: PAYMENT INFORMATION

One registrant per form. This form can be copied for additional registrants. **PAYMENT MUST ACCOMPANY FORM TO COMPLETE PROCESSING.**
Your name and full address must be typed or printed clearly on your check or bank draft.

Method of Payment: (Make check payable to the **Optical Society of America** in US dollars on a US bank)

Check No. _____ Money Order No. _____ Bank Name _____ Date of Transfer_____

I authorize the Optical Society of America to charge my: ☐ VISA ☐ Master Card ☐ AMEX ☐ Diner's Club

Card Number_____ Exp. Date _____ Card Holder's Name_____

I authorize the Optical Society of America to charge the total payment indicated on this form to my credit card. If OSA receives the registration form after May 17, 2010, I authorize OSA to charge the on-site registration rate as stated in Section B. Payment amount subject to membership verification.

Signature_____

Refund Policy for pre-registration: A $75 service charge will be assessed for processing refunds. A letter requesting the refund should state the registrant's name and to whom the refund should be made payable. Requests for refunds must be received in writing no later than May 24, 2010 to be honored. Details should be mailed to OSA Meetings and Exhibits, 2010 Massachusetts Ave., NW, Washington, DC, 20036-1012 or faxed to 1.202.416.6140.

For Special Assistance while attending this meeting, call 1.202.416.1907.

Registration implies consent that any picture taken during OSA sponsored events can be used for meeting and promotional purposes without remuneration and that your name will be placed on an attendee list which is distributed to IODC/OF&T Exhibitors.

THREE WAYS TO REGISTER

Fax:
1.202.416.6140

Mail: OSA Finance Department
c/o IODC 2010 Registration
P.O Box 1976
Baltimore, MD 21298-8329

Express Mail: OSA Finance Dept.
c/o IODC 2010 Registration
2010 Massachusetts Ave., NW
Washington, DC 20036-1012

Optical Fabrication and Testing (OF&T) Topical Meeting and Tabletop Exhibits

Collocated with: International Optical Design Conference (IODC)

June 13-17, 2010 * Jackson Hole, Wyoming, USA

One registrant per form

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	On or before May 17, 2010	**After May 17, 2010**
OSA/SPIE Member	☐ US$ 540	☐ US$ 645
Non-member	☐ US$ 705	☐ US$ 810
Emeritus/ OSA/SPIE Student Member	☐ US$ 170	☐ US$ 260
Student Non-member	☐ US$ 230	☐ US$ 320

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Complimentary Technical Badge ☐ US$ 0 ☐ US$ 0

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SECTION B PAYMENT $_____

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Extra IODC/OF&T 2010 Program and Technical Digest on CD-ROM _____ x US$ 75

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IODC Printed and CD-ROM Proceedings _____ x US$ 75
IODC Printed Proceedings _____ x US$ 70
IODC CD-ROM Proceedings _____ x US$ 50

SECTION D PAYMENT $_____

SECTION E: ADDITIONAL PRODUCTS

Admission to the conference reception is included in the Full Technical and Exhibitor Technical Registration fee. Guest tickets may be purchased for $65 per person.

Extra IODC/OF&T Reception Tickets No. of Guests _____ x US$ 65 ☐ Paid Registrant – No Charge
OSA Foundation Donation ☐ US$25

SECTION E PAYMENT $_____

TOTAL PAYMENT $_____

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2010 Massachusetts Ave., NW
Washington, DC 20036-1012

International Optical Design Conference (IODC)

Optical Fabrication and Testing (OF&T)

June 13–17, 2010
The Snow King Resort
Jackson Hole, Wyoming, USA

Conference Program

IODC is Co-Sponsored by OSA and SPIE.
OF&T is Sponsored by OSA in Cooperation with SPIE.

The organizers acknowledge the generous support from the following sponsors:

UNIVERSITY OF CENTRAL FLORIDA
CREOL, THE COLLEGE OF OPTICS AND PHOTONICS

Fabrication, Design and Instrumentation Technical Division

International Optical Design Conference (IODC)

June 13–17, 2010
Jackson Hole, Wyoming, USA

Welcome to the 2010 International Optical Design Conference (IODC) taking place in beautiful Jackson Hole, Wyoming, USA. This quadrennial event brings together an international group of experts and practitioners of optical and illumination design, research and engineering. This year we have an abundance of outstanding plenary, invited and contributed talks in a wide variety of areas. We have speakers from many different parts of the world working in diverse industries, government labs and educational institutions. The program committee has once again done an excellent job of promoting the conference, providing input on speakers, soliciting contributed papers and reviewing submissions. Additionally, we are very pleased to be collocated with Optical Fabrication and Testing, which is a natural technical partner for our conference.

The 2010 IODC features three plenary speakers. Dr. Greg Forbes from QED Technologies will speak on "Better Ways to Specify Aspheric Shapes Can Facilitate Design, Fabrication and Testing Alike." Dr. Kenny Kubala from FiveFocal will then give a talk on "Computational Imaging Technologies." The third plenary talk will be given by Professor Axel Scherer from Caltech on "The Evolution from III-V Opto-Electronics to Silicon Nanophotonics and Vertical Cavity Lasers to Photonic Crystal and Surface Plasmon Devices."

Highlighted in this IODC are papers on surface representation in lens design, desensitizing and tolerancing optical systems, lighting and nonimaging system design, illumination system fabrication, beam shaping, polarization, and computational imaging. The illumination program has 5 full oral sessions and 10 invited talks, and the imaging program consists of 10 full oral sessions with 11 invited papers. Monday night will feature a strong joint poster session with OF&T. Tuesday night after the conference reception, the memorial program will feature tributes to the influential community members who have passed away since the last IODC. The results of the illumination and optical design problems will be presented on Wednesday night. We will also announce the winner of the best student paper award at the conclusion of the design problem session.

We have been honored to serve as chairs for the community. We appreciate and thank the many people who continue to make the IODC a special event that captures the state of our exciting field. Thank you to everyone for taking the time and effort to travel to Wyoming, especially those who have traveled long distances, to interact and share your work and expertise with the community.

Please enjoy your time in Jackson Hole and we look forward to seeing you at future IODC meetings.

Julie L. Bentley
Inst. of Optics, Univ. of Rochester, USA, **Co-Chair**

Anurag Gupta
Optical Res. Associates, USA, **Co-Chair**

Richard Neil Youngworth
Light Capture, Inc., USA, **Co-Chair**

Optical Fabrication and Testing (OF&T)

June 13–17, 2010
Jackson Hole, Wyoming, USA

Welcome to the 2010 Topical Meeting on Optical Fabrication and Testing (OF&T), which convenes for the first time at the Snow King Resort in Jackson Hole, Wyoming, USA. We chose this location and the week of June 14th–17th to co-locate with the International Optical Design Conference (IODC), since the two meetings share many common themes.

We co-chairs and program committee members of OF&T are very pleased with the high level of participation, from within the USA and internationally. All topics of interest to the precision optics community are amply represented with 26 invited talks, over 60 contributed papers and 14 poster presentations.

OF&T will kick off Monday morning with a plenary session, joint with IODC, featuring two speakers: Dr. Greg Forbes on " Better Ways to Specify Aspheric Shapes Can Facilitate Design, Fabrication and Testing Alike" and Dr. Kenny Kubala on "Computational Imaging Technologies." OF&T will then split off for a series of sessions that address advances in interferometry, the manufacture and testing of aspherics and freeform optics, molded-micro-diffractive- and integrated optics, and CNC grinding-polishing of optics from small to large. Focus sessions will cover topics such as mid-spatial frequency artifacts, PSD, and tolerancing-uncertainty-accuracy. Additional work, led by invited presentations, will explore new applications of optical materials, from chalcogenide glasses to SiC to spinel for armor. Laser/material interactions will be covered with invited presentations on laser microfabrication of devices in glass, and surface processing to increase laser system survivability. A highlight of the week will be a Wednesday evening talk by Dr. H. John Wood entitled, "Hubble Anthology."

We have a special interest in highlighting scientific and technical contributions by the next generation of professionals in our field of work, and 13 poster/oral presentations, authored by students, will be given during the week. Cash prizes for the best poster and oral presentations will be awarded by the program committee.

We appreciate that many of you have come long distances in this challenging economic climate, to be together with longstanding friends and colleagues. We encourage you to renew acquaintances, to mingle and meet other members of the OF&T community with like interests, and to make new contacts and friendships.

Thank you for coming and contributing to OF&T 2010. Enjoy your time in Jackson Hole.

Stephen Jacobs
Univ. of Rochester, USA,
Co-Chair

Jessica DeGroote Nelson
Optimax Systems Inc., USA, **Co-Chair**

Jannick Rolland
Inst. of Optics, Univ. of Rochester, USA, **Co-Chair**

Shai Shafrir
OptiPro Systems, Inc., USA, **Co-Chair**

Conference Highlights

Plenary Speakers

JMA • Joint IODC/OF&T Plenary Session
Monday, June 14, 2010, 8:00 a.m.–9:30 a.m.
Grand Room

8:10 a.m.–8:50 a.m.
JMA1, **Better Ways to Specify Aspheric Shapes Can Facilitate Design, Fabrication and Testing Alike,** ***Greg Forbes****; QED Technologies, USA*

Modifying a widely used convention is rarely easy. With designers, fabricators, and metrologists gathered here, we have a rare opportunity to consider such a change in relation to optical aspheres. This evolving technology is currently burdened by the increasingly inadequate convention of expressing a rotationally symmetric asphere's sag as the sum of a conic component and an additive polynomial. When more than just a few terms appear in the polynomial, this becomes problematic and ultimately unworkable. Many of us are being burned by the fact that the associated coefficients are woefully unintuitive and inefficient. The norm is error-prone communications and a lack of easy options to appreciate the difficulty of manufacturing any particular asphere. Thankfully, the design and manufacture of increasingly complex aspheres is facilitated by a modified representation that is also ideal for exploiting cost-effective shapes. In particular, an orthogonalised representation gives a description that functions with fewer coefficients—typically using only one third the number of digits for current designs—and allows easy interpretations and sanity checks as well as direct assessments of manufacturability. Examples are presented to motivate us to confront this sooner rather than later.

8:50 a.m.–9:30 a.m.
JMA2, **Computational Imaging Technologies,** ***Kenneth Kubala****; FiveFocal, USA*

Many computational imaging technologies introduced in the last several years use optical, mechanical, sensor and computational degrees of freedom to enable special system characteristics. The general computational imaging framework will be discussed along with the value of some specific approaches. Additionally, a simplified design approach that does not require tools beyond what the designer is currently accustomed to will be described.

IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger and Hilbert Award Presentations
Monday, June 14, 2010, 10:00 a.m.–12:30 p.m.
Grand Room

10:00 a.m.–10:40 a.m.
IMA1, **The Evolution from III-V Opto-Electronics to Silicon Nanophotonics and Vertical Cavity Lasers to Photonic Crystal and Surface Plasmon Devices,** ***Axel Scherer****, Uday Khankhoje, Tom Baehr-Jones, Se-Heon Kim; Caltech, USA*

Lithography and dry etching has evolved to replace accurate crystal growth that enabled the definition of high-Q optical cavities in the past with dry etching approaches to define ultra-small mode volumes. These "printed" optical cavities can now be used to define micro- and nano-lasers in which the three-dimensional geometry is used to control the laser performance, and that can be lithographically coupled together in-plane. Advanced microcavity lasers now include photonic crystal mirrors and surface plasmon

contact geometries. By combining new methods of design, fabrication and testing, it has become possible to develop higher-level abstract device design approaches that enable SPICE-like modeling of optical circuits. However, the complexity of back-reflections and the wave-like behavior of light in microfabricated geometries limit the applicability of these approaches. Here, the evolution of integrated opto-electronics into photonic crystals and plasmonics is reviewed, with an emphasis on the specific cases of miniaturized lasers, plasmonic light emitters and silicon photonics.

Michael Kidger Memorial Scholarship Presentation

Monday, June 14, 2010, 11:55 p.m.–12:10 p.m.
Grand Room

The Michael Kidger Memorial Scholarship was established in 1998 to honor Michael John Kidger, a well-respected educator, design software developer and member of the optical science and engineering community. A full description can be found online at www.kidger.com.

The First Ten Years of the Kidger Scholarship
Tina Kidger will present a short review of the establishment and organization of the Scholarship and a brief update on the ten Kidger Scholarship awardees to date. She will then present the award to this year's Awardee, *Braulio Fonseca Carneiro de Albuquerque, Natl. Inst. for Space Research, São Paulo, Brazil.*

Robert S. Hilbert Memorial Student Travel Grant Presentation

Monday, June 14, 2010, 12:10 p.m.–12:25 p.m.
Grand Room

The Robert S. Hilbert Memorial Student Travel Grant offers financial support to help defray the cost of student travel to the International Optical Design Conference (IODC), Frontiers in Optics (OSA's Annual Meeting) and other professional meetings. The grant was established in honor of Bob S. Hilbert (1941–2008), former Optical Research Associates (ORA®) President and CEO, who was a respected member of the optics community and enthusiastically embraced learning and optics education. The grant is sponsored by ORA, and administered by OSA Foundation.

Sponsored by:
OPTICAL RESEARCH ASSOCIATES

Administered by:
OSA FOUNDATION

Joint IODC/OF&T Poster Session

Monday, June 14, 6:00 p.m.–8:00 p.m.
Exhibit Hall, Pavilion

Poster presentations offer a great way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers. This year's joint poster session includes a number of outstanding presentations. There are nearly 30 IODC posters and nearly 15 OF&T posters scheduled for presentation.

Joint Conference Reception

Tuesday, June 15, 6:00 p.m.–7:30 p.m.
Atrium

Mingle with colleagues and friends from around the world during the conference reception. Light hors d'oeuvres will be served. Free to all technical conference attendees. Additional tickets can be purchased at Registration for US$ 65.

Memorial Program

Tuesday, June 15, 7:00 p.m.–8:00 p.m.
Grand Room

Attend the special memorial program to celebrate the lives of influential community members who have passed away. We will pay tribute to the following luminaries:

7:00 p.m.–7:10 p.m. Hans Buchdahl
7:10 p.m.–7:20 p.m. Juan Rayces
7:20 p.m.–7:30 p.m. Jim Palmer
7:30 p.m.–7:40 p.m. Bob Hopkins
7:40 p.m.–7:50 p.m. Bob Hilbert
7:50 p.m.–8:00 p.m. Warren J. Smith

OF&T Student Awards Ceremony and H. John Wood Presentation

Wednesday, June 16, 6:00 p.m.–7:30 p.m.
Teton Room

Attend this exciting session to hear about the winners of the OF&T Best Student Paper Award, followed by a talk on the Hubble by H. John Wood. Dessert and coffee will be served.

OF&T Best Student Paper Award Presentation
6:00 p.m., *Teton Room*

Sponsored by:
OSA FOUNDATION

Through the generous support of the OSA Foundation, the OF&T Best Student Paper Award has been established to encourage excellence in research and scientific presentation skills in the student optics community. Awards include a cash prize and a certificate. There will be first- and second-place winners for both oral and poster presentations.

Students participating in the competition are noted within the abstracts section of this program. Please support the next generation of optical engineers and scientists by attending the student presentations and the awards presentation.

Hubble Anthology, ***H. John Wood;*** *NASA Goddard Space Flight Ctr., USA*
6:30 p.m., *Teton Room*

Dr. H. John Wood is an astronomer and serves as an optical engineer for the Optics Branch at NASA's Goddard Space Flight Center. Since June 1990, he has been Optics Lead Engineer on the Hubble Space Telescope (HST) Project. He led the team that successfully determined the optical prescription of HST while on orbit. He then led NASA's effort to develop and test the corrective optics for HST. In addition to his work on Hubble, he served as Science Liaison in the Instrument Synthesis & Analysis Laboratory for new Earth Science and Space Science instrument engineering design at Goddard. He has recently been assigned as optics lead engineer for the ATLAS project, a lidar altimeter aboard ICESat-2, to measure the ice on both poles of the Earth.

A graduate of Swarthmore College, Dr. Wood earned the M.A. and Ph.D. in Astronomy from Indiana University. He has been at Goddard Space Flight Center for over 20 years. In addition to the Hubble Project, he has been Lead Optical Engineer on other Goddard projects: the Mars Observer Laser Altimeter and the Diffuse Infrared Background Experiment aboard the Cosmic Background Explorer (COBE). Earlier he served as assistant to the director at Cerro Tololo Inter-American Observatory (Chile) for two years. He held a Fulbright Research Fellowship for two years at the University Observatory in Vienna, Austria. He also served five years as a staff astronomer at the European Southern Observatory in Chile. His career began with six years on the astronomy faculty of the University of Virginia at Charlottesville.

Winner of the 1992 NASA exceptional service medal and the 1994 NASA exceptional achievement medal for his work on COBE and HST, he is the author of more than 50 research papers in astronomy and space optics. He recently received the 2009 NASA Medal for exceptional service in outreach on the HST project. He was also awarded the 2009 Robert H. Goddard award of Merit for exceptional achievement in his career at Goddard. He was invited by The Optical Society to edit special editions of *Applied Optics* and *Optics and Photonics News* on the HST first servicing mission.

Come hear Dr. Wood talk about Hubble Space Telescope (HST), orbiting high above the turbulence of the earth's atmosphere and providing breathtaking views of astronomical objects never before seen in such detail. Understanding the images makes them even more beautiful.

IODC Design and Illumination Problem Presentations and Student Awards Ceremony

Wednesday, June 16, 7:30 p.m.–9:30 p.m.
Grand Room

Join the IODC community for a guaranteed highlight of the conference: the illumination and lens design contest presentations. As usual, significant work has gone into developing and scoring the submissions, as well as all of the hard work put in by solution submitters. Additionally, the winners of the best student paper awards for the 2010 IODC will be announced at the conclusion of the design problem presentations.

Lens Design Problem
The "green" movement is all about conserving resources. When designing and manufacturing a lens, one way to minimize needed fabrication resources is to need only one testplate pair (positive and negative) plus an optical flat, and need only one type of optical glass. The Problem: Design a lens whose non-flat surfaces all share the same radius value, positive or negative, concave or convex.

Illumination Design Problem
The Problem: Transfer maximum monochromatic flux from a 1-mm-square Lambertian source in air to an equal-étendue nonimmersed target. The target surface is rectangular with a 16:9 aspect ratio. The surface area of the target must be at least 4 mm². The target is defined such that only rays incident on the target surface at angles of θmax or

less, relative to the surface normal, are considered to be within the phase space of the target, where the value of θmax is determined by the equal-étendue requirement.

IODC Best Student Paper Award Presentation

Sponsored by:

Fabrication, Design and Instrumentation Technical Division

The IODC Best Student Paper Award has been established to encourage excellence in research and scientific presentation skills in the student optics community. Awards include a one-year OSA membership, a cash prize and a certificate.

Students participating in the competition are noted within the abstracts section of this program. Please support the next generation of optical engineers and scientists by attending the student presentations and the awards presentation.

Exhibits

Mezzanine-Grand/Lobby

Schedule plenty of time to visit with the many companies represented and see the latest products and technologies. For more information on the participating companies, see the Exhibit Guide.

Exhibit Hours	
Monday, June 14	9:30 a.m.–4:30 p.m.
Tuesday, June 15	10:00 a.m.–4:30 p.m.
Wednesday, June 16	10:00 a.m.–4:30 p.m.

Invited Speakers

IODC Illumination Design Invited Speakers

Monday

2:00 p.m.–2:30 p.m.

IMB1, **A Practical and Predictive Two-Metric System for Characterizing the Color Rendering Properties of Light Sources for Architectural Applications**, ***Mark S. Rea***; *Lighting Res. Ctr., Rensselaer Polytechnic Inst., USA*

2:30 p.m.–3:00 p.m.

IMB2, **From Enthusiasm to Economy: Precision Optical Design as a Key to Making LED Luminaires Cost-Efficient in Street Lighting and Architectural Lighting**, ***Andreas Timinger***; *OEC AG, Germany*

3:00 p.m.–3:30 p.m.

IMB3, **Non-Visual Effects of Light: Implications for Design**, ***Mariana Figueiro***; *Lighting Res. Ctr., Rensselaer Polytechnic Inst., USA*

3:30 p.m.–4:00 p.m.

IMB4, **Primary Optics for LEDs—State of the Art of Optical Architectures**, ***Julius A. Muschaweck***[1], *Peter Brick*[1], *Stefan Grötsch*[1], *Simon Schwalenberg*[2]; [1]*OSRAM Opto Semiconductors, Germany*, [2]*OSRAM GmbH, Germany*

IODC Illumination Design Invited Speakers—Continued

Tuesday

2:00 p.m.–2:30 p.m.

ITuC1, **Evolution of Illumination Systems in Microlithography—A Retrospective**, ***Alois Herkommer***; *Carl Zeiss SMT AG, Germany*

4:45 p.m.–5:15 p.m.

ITuE2, **Fluorescence Modeling in Remote and Close LED Illumination Devices**, ***Teus Tukker***; *Philips Lighting, Netherlands*

Wednesday

10:45 a.m.–11:15 a.m.

IWB2, **Edge-Ray and Aplanatic Designs as Special Cases of Generalized Functional Designs**, ***John C. Bortz***, *Narkis Shatz; SAIC, USA*

11:45 a.m.–12:15 p.m.

IWB5, **Optical Design of Inhomogeneous Media to Perfectly Focus Scalar Wave Fields**, ***Pablo Benitez***, *Juan C. Miñano, Juan C. González; Univ. Politécnica de Madrid, Spain*

Thursday

8:15 a.m.–8:45 a.m.

IThA2, **Iterative Reflector Design Using a Cumulative Flux Compensation Approach**, ***William Cassarly***; *Optical Res. Associates, USA*

9:00 a.m.–9:30 a.m.

IThA4, **Perturbative Design of Illumination Systems**, ***R. John Koshel***[1,2]; [1]*Photon Engineering LLC, USA,* [2]*College of Optical Sciences, Univ. of Arizona, USA*

IODC Optical Design Invited Speakers

Monday

10:55 a.m.–11:25 a.m.

IMA3, **The Power of Negative Thinking**, ***David Shafer***; *David Shafer Optical Design, USA*

11:25 a.m.–12:10 p.m.

IMA4, **Sixth-Order Wavefront Deformations: The Coefficients and Insights into Wavefront Propagation in Optical Systems**, ***Jose Sasian***; *College of Optical Sciences, Univ. of Arizona, USA*

4:30 p.m.–5:00 p.m.

IMC1, **Application of Radial Basis Functions to Represent Optical Free-Form Surfaces**, ***Ozan Cakmakci***[1], *Ilhan Kaya*[2], *Gregory E. Fasshauer*[3], *Kevin P. Thompson*[1], *Jannick P. Rolland*[3]; [1]*Optical Res. Associates, USA,* [2]*Univ. of Central Florida, USA,* [3]*Inst. of Optics, Univ. of Rochester, USA*

5:30 p.m.–6:00 p.m.

IMC4, **Large Field-of-View and High Resolution Free-Form Head-Mounted Display**, ***Dewen Cheng***[1,2], *Yongtian Wang*[1], *Hong Hua*[2]; [1]*Dept. of Optoelectronic Engineering, Beijing Inst. of Technology, China,* [2]*3D Visualization and Imaging Systems Lab, College of Optical Sciences, Univ. of Arizona, USA*

IODC Optical Design Invited Speakers—Continued

Tuesday

8:30 a.m.–9:00 a.m.

ITuA3, **The 300-Year Quest for Binoculars**, ***John Greivenkamp***, *David Steed; College of Optical Sciences, Univ. of Arizona, USA*

11:00 a.m.–11:30 a.m.

ITuB3, **Light Field Photography, Microscopy and Illumination**, ***Marc Levoy***; *Stanford Univ., USA*

11:45 a.m.–12:15 p.m.

ITuB5, **Correcting Lateral Chromatic Aberrations by Image Processing**, ***Akihiko Utsugi***, *Kenichi Ishiga; Core Technology Ctr., Nikon Corp., Japan*

Wednesday

8:45 a.m.–9:15 a.m.

IWA4, **Challenges for Polarization Ray Tracing**, ***Russell A. Chipman***; *College of Optical Sciences, Univ. of Arizona, USA*

2:00 p.m.–2:30 p.m.

IWC1, **Unified Optical Modeling**, ***Frank Wyrowski***[1], *Michael Kuhn*[2]; [1]*Friedrich Schiller Univ. Jena, Germany,* [2]*LightTrans GmbH, Germany*

2:45 p.m.–3:15 p.m.

IWC3, **Mathematical Aspects of Laser Beam Shaping and Splitting**, ***Louis A. Romero***[1], *Fred M. Dickey*[2]; [1]*Sandia Natl. Labs, USA,* [2]*FMD Consulting, USA*

3:30 p.m.–4:00 p.m.

IWC5, **Microstructured Optics for Excimer-Based Systems: Applications for Imaging, Beam Shaping and Coherence Management**, ***Robert Brunner***[1,2], *Hans Jürgen Dobschal*[3], *Reinhard Steiner*[2], *Matthias Burkhardt*[2], *Matthias Cumme*[2], *Oliver Sandfuchs*[2], *Dennis Lehr*[2], *Michael Helgert*[2]; [1]*Univ. of Applied Sciences Jena, Germany,* [2]*Carl Zeiss Jena GmbH, Technology Div., Germany,* [3]*Carl Zeiss AG, Central Res., Germany*

OF&T Invited Speakers

Monday

10:00 a.m.–10:30 a.m.

OMA1, **Instantaneous Interferometry: Another View**, ***Daniel M. Sykora***, *Peter de Groot; Zygo Corp., USA*

11:15 a.m.–11:45 a.m.

OMA5, **Stitching Interferometry–The Long and Winding Road...** ***Michael Bray***; *MBO-Metrology, France*

2:00 p.m.–2:30 p.m.

OMB1, **Introduction to Surface Finish Metrology**, ***Theodore Vorburger***; *NIST, USA*

2:45 p.m.–3:15 p.m.

OMB3, **Clash of Cultures: Uncertainty vs. Accuracy**, ***Chris Evans***; *Zygo Corp., USA*

OF&T Invited Speakers— Continued

3:30 p.m.–4:00 p.m.

OMB5, **Pixel-Based Computations in Optical Metrology**, ***William P. Kuhn***; *Opt-E, USA*

4:30 p.m.–5:00 p.m.

OMC1, **Chalcogenide Glasses: Their Unique Functionalities for Present and Potential Applications in Photonics**, ***Miroslav Vlcek***[1], *Himanshu Jain*[2,3]; [1]*Faculty of Chemical Technology, Univ. of Pardubice, Czech Republic,* [2]*Ctr. for Optical Technologies, Lehigh Univ., USA,* [3]*Intl. Materials Inst. on New Functionality in Glass, Lehigh Univ., USA*

5:30 p.m.–6:00 p.m.

OMC4, **An Overview of the Maturation of SiC Optics Fab**, ***Joseph Robichaud***; *L-3 Communications, SSG-Tinsley, USA*

Tuesday

8:00 a.m.–8:30 a.m.

OTuA1, **International Standards for Optics in the Electronic Age**, ***Prudence M. J. H. Wormell***; *Imperial College, UK*

9:30 a.m.–10:00 a.m.

OTuA6, **The Forbes Polynomial: A More Predictable Surface for Fabricators**, ***Kevin Thompson***[1], *Florian Fournier*[2], *Jannick P. Rolland*[2], *G. W. Forbes*[3]; [1]*Optical Res. Associates, USA,* [2]*Inst. of Optics, Univ. of Rochester, USA,* [3]*QED Technologies, Inc., USA*

10:30 a.m.–11:00 a.m.

OTuB1, **Optical Testing of Mirrors for Giant Telescopes**, ***James Burge***; *Univ. of Arizona, USA*

12:15 p.m.–12:45 p.m.

OTuB7, **Optical Figure Measurement on Convex or Concave Meter-Class Aspheres with Nanometer-Class Accuracy**, ***Paul Glenn***; *Bauer Associates, Inc., USA*

2:00 p.m.–2:30 p.m.

OTuC1, **Ultrafast Laser Microfabrication of Photonic Devices inside Glass**, ***Kazuyoshi Itoh***, *Yasuyuki Ozeki*; *Osaka Univ., Japan*

3:30 p.m.–4:00 p.m.

OTuC6, **Novel Optical Materials and Devices by Direct Laser Writing**, ***Georg von Freymann***, *Stefan Linden, Martin Wegener, Klaus Bade, Volker Saile, Michael Thiel, Michael S. Rill, Manuel Decker, Justyna Gansel; Karlsruhe Inst. of Technology (KIT), Germany*

4:30 p.m.–5:00 p.m.

OTuD1, **Comparison of Linear Z-Axis and Rotational B-Axis Freeform Diamond Turning**, ***Gregg E. Davis***[1], *Jeffrey W. Roblee*[2], *Steven M. Omecinski*[1], *Alan Hedges*[1]; [1]*II-VI Inc., USA,* [2]*Ametek Precitech, USA*

5:30 p.m.–6:00 p.m.

OTuD4, **Precise Fast Molding of Optical Freeforms**, ***Jan Hamkens***; *Docter Optics GmbH, Germany*

OF&T Invited Speakers— Continued

Wednesday

8:00 a.m.–8:30 a.m.

OWA1, **Optical Fabrication and Post Processing Techniques for Improving Laser Damage Resistance of Fused Silica Optics**, ***Tayyab Suratwala***; *Lawrence Livermore Natl. Lab, USA*

9:30 a.m.–10:00 a.m.

OWA6, **Development of Transparent Ceramic Spinel ($MgAl_2O_4$) for Armor Applications**, ***Anthony Sutorik***; *US ARL, USA*

10:45 a.m.–11:15 a.m.

OWB2, **Corrosion Resistant Zirconia Coated Carbonyl Iron Particle-Based Magnetorheological Fluid**, ***Shai Shafrir***[1,2], *Henry J. Romanofsky*[3], *Michael Skarlinski*[2], *Mimi Wang*[4], *Chunlin Miao*[5], *Sivan Salzman*[5], *Taylor Chartier*[4], *Joni Mici*[2], *John C. Lambropoulos*[2], *Rui Shen*[4], *Hong Yang*[4], *Stephen D. Jacobs*[3]; [1]*OptiPro Systems, Inc., USA,* [2]*Dept. of Mechanical Engineering, Univ. of Rochester, USA,* [3]*Lab for Laser Energetics, Univ. of Rochester, USA,* [4]*Dept. of Chemical Engineering, Univ. of Rochester, USA,* [5]*Materials Science Program, Dept. of Mechanical Engineering, Univ. of Rochester, USA*

11:15 a.m.–11:45 a.m.

OWC1, **Glass Micro-Optics for Laser Beam Shaper and LED Collimation**, ***Steffen Reichel***, *Ralf Biertümpfel, Volker Wittmer; SCHOTT AG, Germany*

2:00 p.m.–2:30 p.m.

OWD1, **Unique and Unusual Applications of Ultraprecision ELID Grinding and Diamond Cutting**, ***Hitoshi Ohmori***; *RIKEN, Japan*

3:30 p.m.–4:00 p.m.

OWD6, **Advanced Molded Glass Lenses**, ***Jayson Nelson***, *Edward Patton*; *Rochester Precision Optics, USA*

4:30 p.m.–5:00 p.m.

OWE1, **Power Spectral Density: Is It Right?**, ***John P. Lehan***[1,2], *Ulf Griesmann*[3], *Jiyoung Chu*[3,4]; [1]*NASA Goddard Space Flight Ctr., USA,* [2]*Dept. of Physics, Univ. of Maryland, Baltimore County, USA,* [3]*NIST, USA,* [4]*Samsung Electronics Co., Republic of Korea*

6:30 p.m.–7:15 p.m.

OWF1, **Hubble Anthology**, ***H. John Wood***; *NASA Goddard Space Flight Ctr., USA*

Thursday

9:30 a.m.–10:00 a.m.

OThA5, **Fabrication of Aspheric Deposits by CW Laser Deposition**, ***Luis Rubio-Peña***, *José Andrés Ángel, Juan Valverde, Juan María González-Leal; Univ. of Cadiz, Spain*

10:30 a.m.–11:00 a.m.

OThB1, **Polishing Glass—From Basic Investigations to Industrial Applications**, ***D. Waechter***, *R. Zunke, U. Schneider, O. Dambon, F. Klocke; Fraunhofer IPT, Germany*

12:00 p.m.–12:30 p.m.

OThB6, **One Year of Finishing Meter-Class Optics with MRF® at L-3 IOS Brashear Optics**, ***François Piché***, Andrew R. Clarkson; *L-3 IOS Brashear Optics, USA*

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Thanks to all the Technical Program Committee members! Your time and efforts are appreciated!

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	IODC Grand Room	IODC Lodge Room, Pavilion	OF&T Teton Room
Sunday, June 13			
3:00 p.m.–6:00 p.m.	**Registration Open,** *Lobby*		
Monday, June 14			
7:00 a.m.–6:00 p.m.	**Registration Open,** *Lobby*		
8:00 a.m.–9:30 a.m.	**JMA • Joint IODC/OF&T Plenary Session**		
9:30 a.m.–10:00 a.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
9:30 a.m.–4:30 p.m.	**Exhibits Open,** *Mezzanine-Grand/Lobby*		
10:00 a.m.–12:30 p.m.	**IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger and Hilbert Award Presentations**		**OMA • Interferometry**
12:30 p.m.–2:00 p.m.	**Lunch** *(on your own)*		
2:00 p.m.–4:00 p.m.	**IMB • Illumination Engineering: Principles and Practice**		**OMB • Metrology**
4:00 p.m.–4:30 p.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
4:30 p.m.–6:00 p.m.	**IMC • Optical Surface Representation and Freeform Design**		**OMC • Optical Materials**
6:00 p.m.–8:00 p.m.	**JMB • Joint IODC/OF&T Poster Session,** *Exhibit Hall, Pavilion*		
Tuesday, June 15			
7:30 a.m.–6:00 p.m.	**Registration Open,** *Lobby*		
8:00 a.m.–10:00 a.m.	**ITuA • Optical Systems I: Telescopes, Binoculars and Reflective Systems**		**OTuA • Specification and Measurement**
10:00 a.m.–10:30 a.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
10:00 a.m.–4:30 p.m.	**Exhibits Open,** *Mezzanine-Grand/Lobby*		
10:30 a.m.–12:30 p.m.	**ITuB • Optical Design for Modern Digital Systems and Computational Imaging** (ends at 12:15 p.m.)		**OTuB • Large Optics** (ends at 12:45 p.m.)
12:30 p.m.–2:00 p.m.	**Lunch** *(on your own)*		
2:00 p.m.–4:00 p.m.	**ITuC • Design and Applications of Illumination Systems**	**ITuD • Design and Analysis Considerations for Optical System Fabrication and Testing**	**OTuC • Laser Writing in Materials**
4:00 p.m.–4:30 p.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby and Lodge Room, Pavilion*		
4:30 p.m.–6:00 p.m.	**ITuE • Modeling and Testing of Illuminations Systems and Components**	**ITuF •Manufacturing Considerations for Optical Design Producibility and Tolerance Desensitization**	**OTuD • Freefrom Optics**
6:00 p.m.–7:30 p.m.	**Joint Conference Reception,** *Atrium*		
7:00 p.m.–8:00 p.m.	**Memorial Program,** *Grand Room*		

	IODC Grand Room	OF&T Teton Room
Wednesday, June 16		
7:30 a.m.–5:30 p.m.	**Registration Open,** *Lobby*	
8:00 a.m.–10:00 a.m.	**IWA • Polarization in Optical Design** (ends at 9:45 a.m.)	**OWA • Materials Processing and Damage**
10:00 a.m.–10:30 a.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*	
10:00 a.m.–4:30 p.m.	**Exhibits Open,** *Mezzanine-Grand/Lobby*	
10:30 a.m.–12:30 p.m.	**IWB • Nonimaging Optical Design Techniques**	**OWB • Materials Processing and Damage— Continued** (10:30 a.m.–11:15 a.m.) ---------- **OWC • Micro-Integrated Optics** (11:15 a.m.–12:30 p.m.)
12:30 p.m.–2:00 p.m.	**Lunch** *(on your own)*	
2:00 p.m.–4:00 p.m.	**IWC • Beam Shaping and Propagation**	**OWD • Grinding/Cutting/Molding**
4:00 p.m.–4:30 p.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*	
4:30 p.m.–6:00 p.m.	**IWD • Optical Systems II: Zoom Lenses and Advanced Optical System Design** (ends at 6:15 p.m.)	**OWE • Mid-Spatials and PSD**
6:00 p.m.–7:15 p.m.		**OWF • Student Awards Ceremony and H. John Wood Presentation**
7:30 p.m.–9:30 p.m.	**IWE • Design and Illumination Problem Presentations and Student Awards Ceremony**	
Thursday, June 17		
7:30 a.m.–10:00 a.m.	**Registration Open,** *Lobby*	
8:00 a.m.–10:00 a.m.	**IThA • Design of Illumination Systems: Optimization and Tolerancing Approaches**	**OThA • Aspheres** (starts at 8:30 a.m.)
10:00 a.m.–10:30 a.m.	**Coffee Break,** *Mezzanine-Grand/Lobby*	
10:30 a.m.–12:30 p.m.	**IThB • What's in Your Optical Design and Analysis Toolkit?**	**OThB • Polishing**

Key to Shading	
No shading	**IODC Sessions**
	OF&T Sessions
	Joint Sessions

Sunday, June 13, 3:00 p.m.–6:00 p.m. Registration Open, *Lobby*

Monday, June 14, 7:00 a.m.–6:00 p.m. Registration Open, *Lobby*

JMA • Joint IODC/OF&T Plenary

Monday, June 14
8:00 a.m.–9:30 a.m.
Kevin Thompson; Optical Res. Associates, USA, Presider

Opening Remarks • 8:00 a.m.

JMA1 • 8:10 a.m. Plenary

Better Ways to Specify Aspheric Shapes Can Facilitate Design, Fabrication and Testing Alike, ***Greg Forbes****; QED Technologies, USA.*
Modifying a widely used convention is rarely easy. With designers, fabricators, and metrologists gathered here, we have a rare opportunity to consider such a change in relation to optical aspheres. This evolving technology is currently burdened by the increasingly inadequate convention of expressing a rotationally symmetric asphere's sag as the sum of a conic component and an additive polynomial. When more than just a few terms appear in the polynomial, this becomes problematic and ultimately unworkable. Many of us are being burned by the fact that the associated coefficients are woefully unintuitive and inefficient. The norm is error-prone communications and a lack of easy options to appreciate the difficulty of manufacturing any particular asphere. Thankfully, the design and manufacture of increasingly complex aspheres is facilitated by a modified representation that is also ideal for exploiting cost-effective shapes. In particular, an orthogonalised representation gives a description that functions with fewer coefficients _typically using only one third the number of digits for current designs_and allows easy interpretations and sanity checks as well as direct assessments of manufacturability. Examples are presented to motivate us to confront this sooner rather than later.
See the "Conference Highlights" section in the front of the book for more information on Greg Forbes, including a photo.

JMA2 • 8:50 a.m. Plenary

Computational Imaging Technologies, ***Kenneth Kubala****; FiveFocal, USA.*
Many computational imaging technologies introduced in the last several years use optical, mechanical, sensor and computational degrees of freedom to enable special system characteristics. The general computational imaging framework will be discussed along with the value of some specific approaches. Additionally, a simplified design approach that does not require tools beyond what the designer is currently accustomed to will be described.
See the "Conference Highlights" section in the front of the book for more information on Kenneth Kubala, including a photo.

9:30 a.m.–10:00 a.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby*

9:30 a.m.–4:30 p.m. Exhibits Open, *Mezzanine-Grand/Lobby*

IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger and Hilbert Award Presentations

Monday, June 14
10:00 a.m.–12:30 p.m.
Joseph Howard; NASA Goddard Space Flight Ctr., USA, Presider

IMA1 • 10:00 a.m. Plenary

The Evolution from III-V Opto-Electronics to Silicon Nanophotonics and Vertical Cavity Lasers to Photonic Crystal and Surface Plasmon Devices, *Axel Scherer, Uday Khankhoje, Tom Baehr-Jones, Se-Heon Kim; Caltech, USA.* Lithography and dry etching has evolved to replace accurate crystal growth that enabled the definition of high-Q optical cavities in the past with dry etching approaches to define ultra-small mode volumes. These "printed" optical cavities can now be used to define micro- and nano-lasers in which the three-dimensional geometry is used to control the laser performance, and that can be lithographically coupled together in-plane. Advanced microcavity lasers now include photonic crystal mirrors and surface plasmon contact geometries. By combining new methods of design, fabrication and testing, it has become possible to develop higher-level abstract device design approaches that enable SPICE-like modeling of optical circuits. However, the complexity of back-reflections and the wave-like behavior of light in microfabricated geometries limit the applicability of these approaches. Here, the evolution of integrated opto-electronics into photonic crystals and plasmonics is reviewed, with an emphasis on the specific cases of miniaturized lasers, plasmonic light emitters and silicon photonics.
See the "Conference Highlights" section in the front of the book for more information on Axel Scherer, including a photo.

IMA2 • 10:40 a.m.

Development of Subwavelength Structure Coating (SWC) and Its Application to Imaging Lenses, *Takeharu Okuno; Canon Inc., Japan.* We have developed a high performance anti-reflection coating with subwavelength structures. The principle and characteristics of the new anti-reflection coating as well as its application to imaging lenses are reported.

IMA3 • 10:55 a.m. Invited

The Power of Negative Thinking, *David Shafer; David Shafer Optical Design, USA.* In a highly corrected design the limiting aberrations are induced ones, not intrinsic. Their causes are explained, and some simple designs are shown which eliminate these aberrations. These designs have more negative lenses than usual.

OMA • Interferometry

Monday, June 14
10:00 a.m.–12:30 p.m.
James Burge; College of Optical Sciences, Univ. of Arizona, USA, Presider

OMA1 • 10:00 a.m. Invited

Instantaneous Interferometry: Another View, *Daniel M. Sykora, Peter de Groot; Zygo Corp., USA.* Single-camera frame instantaneous interferometry is an alternative optical test method where environmental noise prohibits conventional phase shifting methods. The flexibility and high performance of an optimized spatial carrier fringe method provides a compelling solution.

OMA2 • 10:30 a.m.

A Toolbox for Designing and Analyzing Phase-Shifting Interferometry Algorithms with Characteristic Polynomials, *Ulf Griesmann; Manufacturing Engineering Lab, NIST, USA.* Many recent advances in understanding of phase-shifting algorithms have yet to be incorporated into commercial phase-shifting interferometry software. A toolbox, for the open-source computer algebra system Maxima, simplifies analysis and design of arbitrary phase-shifting algorithms.

OMA3 • 10:45 a.m.

Diffraction Effects in Interferometry, *Ping Zhou, James Burge; College of Optical Sciences, Univ. of Arizona, USA.* Besides the geometrical errors, interferometry suffers errors due to diffraction, because the wavefront aberrations of the test and reference beams change as they propagate. This paper addresses errors due to diffraction effects in interferometry.

OMA4 • 11:00 a.m.

Step Height Measurement Using a Wavelength-Selective Multimode Laser Diode, *Takamasa Suzuki, Akihiro Nomura, Osami Sasaki; Niigata Univ., Japan.* A wavelength-selective interferometer based on the multimode oscillation of a laser diode is proposed and is used to conduct step height measurements. A selective spectrum allows us to generate a wide range of synthetic wavelengths.

IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger and Hilbert Award Presentations—Continued

IMA4 • 11:25 a.m. **Invited**

Sixth-Order Wavefront Deformations: The Coefficients and Insights into Wavefront Propagation in Optical Systems, ***Jose Sasian****; College of Optical Sciences, Univ. of Arizona, USA.* The oral presentation of this paper provides historical remarks on the development of aberration theory and discusses the topic of sixth-order wavefront aberrations. We present some insights on wavefront propagation and deformation in optical systems.

11:55 a.m.

Michael Kidger Memorial Scholarship Presentation

The Michael Kidger Memorial Scholarship was established in 1998 to honor Michael John Kidger, a well-respected educator, design software developer and member of the optical science and engineering community. A full description can be found online at www.kidger.com. Tina Kidger will present a short review of the establishment and organization of the Scholarship and a brief update on the ten Kidger Scholarship awardees to date. She will then present the award to this year's Awardee, *Braulio Fonseca Carneiro de Albuquerque, Natl. Inst. for Space Research, São Paulo, Brazil.*

12:10 p.m.

Robert S. Hilbert Memorial Student Travel Grant Presentation

The Robert S. Hilbert Memorial Student Travel Grant offers financial support to help defray the cost of student travel to the International Optical Design Conference (IODC), Frontiers in Optics (OSA's Annual Meeting) and other professional meetings. The grant was established in honor of Bob S. Hilbert (1941–2008), former Optical Research Associates (ORA®) President and CEO, who was a respected member of the optics community and enthusiastically embraced learning and optics education. The grant is sponsored by ORA, and administered by OSA Foundation.

OMA • Interferometry—Continued

OMA5 • 11:15 a.m. **Invited**

Stitching Interferometry—The Long and Winding Road... ***Michael Bray****; MBO-Metrology, France.* We will present the early history of the world's first *commercial* stitching interferometer, difficulties encountered and how we solved them, and interesting facts gathered along the road leading to our present involvement in stitching interferometry.

OMA6 • 11:45 a.m.

An Iterative Tilt-Immune Phase-Shifting Algorithm, ***Bo-Jhih Lin[1]****, Yi-Chun Chen[1], Chung-Min Lee[2,3], Chao-Wen Liang[1]; [1]Dept. of Optics and Photonics, Natl. Central Univ., Taiwan, [2]Dept. of Mathematics and Statistics, California State Univ. Long Beach, USA, [3]School of Science and Engineering, Reykjavik Univ., Iceland.* An iterative least-squares-based phase-shifting algorithm was developed to cope with random pistons and tilts from the phase shifter. The allowable tilt amount was 0.5 waves over the pupil. The achieved rms accuracy was 0.0024 radians.

OMA7 • 12:00 p.m. **Student Award Participant**

Interferometer Calibration Using the Random Ball Test, ***Wenrui Cai****, Dae Wook Kim, Ping Zhou, Robert E. Parks, James H. Burge; College of Optical Sciences, Univ. of Arizona, USA.* Two different approaches (systematically and randomly rotating the CaliBall™ to calibrate a Fizeau interferometer transmission sphere) are demonstrated with similar calibration results. Thus, the random approach is preferred as a quicker and easier measurement procedure.

OMA8 • 12:15 p.m.

Variable Null Optics for Subaperture Stitching of Aspheres, ***Paul E. Murphy****, Greg Forbes, Andrew Kulawiec; QED Technologies, USA.* Aspheres are often tested with null optics, but these are usually specific to the asphere prescription. We present a variable null system suitable for flexible asphere testing when employed with subaperture stitching.

12:30 p.m.–2:00 p.m. Lunch *(on your own)*

IMB • Illumination Engineering: Principles and Practice

Monday, June 14
2:00 p.m.–4:00 p.m.
R. John Koshel; Photon Engineering LLC and College of Optical Sciences, Univ. of Arizona, USA, Presider

IMB1 • 2:00 p.m. **Invited**

A Practical and Predictive Two-Metric System for Characterizing the Color Rendering Properties of Light Sources for Architectural Applications, ***Mark S. Rea****; Lighting Res. Ctr., Rensselaer Polytechnic Inst., USA.* Two convenient metrics, color rendering index (CRI), the industry standard, and gamut area index (GAI) can be used successfully together, but not separately, to characterize the color rendering properties of electric light sources.

IMB2 • 2:30 p.m. **Invited**

From Enthusiasm to Economy: Precision Optical Design as a Key to Making LED Luminaires Cost-Efficient in Street Lighting and Architectural Lighting, ***Andreas Timinger****; OEC AG, Germany.* Technical luminaries have to compete on an economic basis. Optics design plays a key role for the development of efficient products, providing unique light distributions and minimizing the total costs of ownership.

IMB3 • 3:00 p.m. **Invited**

Non-Visual Effects of Light: Implications for Design, ***Mariana Figueiro****; Lighting Res. Ctr., Rensselaer Polytechnic Inst., USA.* Light isn't just for vision anymore! Illumination design should consider the needs of the visual and non-visual systems. Discussed are the lighting characteristics impacting these two systems and the implications for designing light for architecture.

IMB4 • 3:30 p.m. **Invited**

Primary Optics for LEDs—State of the Art of Optical Architectures, ***Julius A. Muschaweck***[1]*, Peter Brick*[1]*, Stefan Grötsch*[1]*, Simon Schwalenberg*[2]*; [1]OSRAM Opto Semiconductors, Germany, [2]OSRAM GmbH, Germany.* Good primary optics for LEDs are crucial for applications working technically and economically. But what is "good"? For various optical architectures, we look at the complex interplay between optics, manufacturing, tolerancing, lifetime and cost.

OMB • Metrology

Monday, June 14
2:00 p.m.–4:00 p.m.
Shai Shafrir; OptiPro Systems, Inc., USA, Presider

OMB1 • 2:00 p.m. **Invited**

Introduction to Surface Finish Metrology, ***Theodore Vorburger****; NIST, USA.* A number of methods are available to measure surface finish; methods of stylus profiling and optical profiling are emphasized here. Documentary standards for measurement of surface texture and comparisons between methods are also discussed.

OMB2 • 2:30 p.m.

Predicting Image Degradation from Optical Surface Metrology Data, ***James E. Harvey***[1]*, Narak Choi*[1]*, Andrey Krywonos*[1]*, Gary Peterson*[2]*; [1]CREOL, College of Optics and Photonics, Univ. of Central Florida, USA, [2]Breault Res. Organization, USA.* A generalization of Peterson's surface scatter model results in an improved capability to predict image degradation from optical surface metrology data. A new surface scatter theory for moderately rough surfaces provides the necessary BSDF data.

OMB3 • 2:45 p.m. **Invited**

Clash of Cultures: Uncertainty vs. Accuracy, ***Chris Evans****; Zygo Corp., USA.* Accuracy of measurement is desirable but, by definition, cannot be quantified. ISO gives a formalism for evaluating uncertainty, combining information from many sources, and providing a guard-band for deciding if an optic meets specification.

OMB4 • 3:15 p.m. **Student Award Participant**

Fast Optical Profiler, ***Takeshi Nakazawa***[1]*, Jose Sasian*[1]*, Francy Abraham*[2]*; [1]College of Optical Sciences, Univ. of Arizona, USA, [2]Intel Corp., USA.* We present the optical design of a fast single shot profiler. A depth resolution of 0.6 micrometer RMS was achieved in an area of 1.2x0.9 mm with a 0.5 second data acquisition time.

OMB5 • 3:30 p.m. **Invited**

Pixel-Based Computations in Optical Metrology, ***William P. Kuhn****; Opt-E, USA.* Two examples of large, pixel based computations are described: calibration of an interferometer, and stitching of interferometry data. A simple calculation performed inefficiently is also presented to remind one to thoughtful in your approach.

4:00 p.m.–4:30 p.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby*

IMC • Optical Surface Representation and Freeform Design

Monday, June 14
4:30 p.m.–6:00 p.m.
Scott A. Lerner; Hewlett Packard, USA, Presider

IMC1 • 4:30 p.m. **Invited**

Application of Radial Basis Functions to Represent Optical Free-Form Surfaces, ***Ozan Cakmakci***[1]*, Ilhan Kaya*[2]*, Gregory E. Fasshauer*[3]*, Kevin P. Thompson*[1]*, Jannick P. Rolland*[3]*;* [1]*Optical Res. Associates, USA,* [2]*Univ. of Central Florida, USA,* [3]*Inst. of Optics, Univ. of Rochester, USA.* This paper presents the use of radial basis functions (RBF) for describing freeform optical surfaces. The RBF approximation framework along with preliminary optical design experiences will be summarized.

IMC2 • 5:00 p.m.

A Comparison of Anamorphic and Keystone-Distorted Surface Types for Aberration Correction, ***John R. Rogers****; Optical Res. Associates, USA.* Adding keystone distortion, in addition to anamorphism, to an off-axis asphere dramatically improves the ability of the surface to correct aberrations.

IMC3 • 5:15 p.m. **Student Award Participant**

A New Generation of Optical Systems with Theta-Polynomial Surfaces, ***Kyle H. Fuerschbach***[1]*, Kevin P. Thompson*[2]*, Jannick P. Rolland*[1]*;* [1]*Inst. of Optics, Univ. of Rochester, USA,* [2]*Optical Res. Associates, USA.* Recent advances have made it viable to fabricate optical surfaces that are not rotationally symmetric using a new generation of diamond-turning machines. These surfaces can greatly extend the field of view of optical systems.

IMC4 • 5:30 p.m. **Invited**

Large Field-of-View and High Resolution Free-Form Head-Mounted Display, ***Dewen Cheng***[1,2]*, Yongtian Wang*[1]*, Hong Hua*[2]*;* [1]*Dept. of Optoelectronic Engineering, Beijing Inst. of Technology, China,* [2]*3D Visualization and Imaging Systems Lab, College of Optical Sciences, Univ. of Arizona, USA.* An eyepiece based on a wedge-shaped free-form prism is successfully designed and developed. The tiling HMDs with wide angle and reasonable resolution using the prism eyepieces are proposed and discussed. One prototype result is presented.

OMC • Optical Materials

Monday, June 14
4:30 p.m.–6:00 p.m.
Tayyab Suratwala; Lawrence Livermore Natl. Lab, USA, Presider

OMC1 • 4:30 p.m. **Invited**

Chalcogenide Glasses: Their Unique Functionalities for Present and Potential Applications in Photonics, ***Miroslav Vlcek***[1]*, Himanshu Jain*[2,3]*;* [1]*Faculty of Chemical Technology, Univ. of Pardubice, Czech Republic,* [2]*Ctr. for Optical Technologies, Lehigh Univ., USA,* [3]*Intl. Materials Inst. on New Functionality in Glass, Lehigh Univ., USA.* Paper reviews unique properties and functionalities of chalcogenide glasses for photonic applications. We demonstrate their applications in extremely high-resolution lithography and for fabrication of diffractive elements. All-optical signal processing applications are discussed as well.

OMC2 • 5:00 p.m.

Distribution of the Coefficient of Thermal Expansion on CEARCERAM®-Z HS from Surface Deformation Measurement Approach, ***Kousuke Nakajima****, Nobuo Kawasaki, Tomokazu Morita; OHARA Inc., Japan.* The CTE distribution on CLEARCERAM®-Z HS was determined by surface deformation measurement approach. The result is compared with the one from a sampling procedure and the intuitive CTE distribution on the material is discussed.

OMC3 • 5:15 p.m. **Student Award Participant**

Thermal Shock During Cooling/Rinsing of Optical Glass, ***Han Liu****, Daniel Breyre, Robin Hargadon, Justin Long, John C. Lambropoulos; Univ. of Rochester, USA.* We measured thermal shock strength degradation of BK-7 glass versus surface finish, in water and silicone oil. There is little strength degradation prior to fracture. Retained strength depends on surface finish and cooling medium.

OMC4 • 5:30 p.m. **Invited**

An Overview of the Maturation of SiC Optics Fab, ***Joseph Robichaud****; L-3 Communications, SSG-Tinsley, USA.* L-3 SSG has been developing SiC optical systems for space-based applications for >20 years. Over this time significant advances have been made in SiC manufacturing. We provide data which illustrates the maturation of this technology.

JMB1
New Variance-Reducing Methods for the PSD Analysis of Large Optical Surfaces, *Erkin Sidick*; *JPL, USA.* We present two new methods for reducing variance in PSD data by replacing the zeros of a surface map by non-zero values obtained from a PSD fit or taken from inside of its circular area.

JMB2 Student Award Participant
Modifying the Rheological Properties of Zirconia Coated Carbonyl Iron Suspensions through Acid-Base Titration and the Addition of Di-Ammonium Citrate, *Michael D. Skarlinski*[1,2], *Stephen D. Jacobs*[2]; [1]*Dept. of Mechanical Engineering, Univ. of Rochester, USA,* [2]*Lab for Laser Energetics, Univ. of Rochester, USA.* The manipulation of surface chemistry through acid-base titration and the addition of DAC as a surfactant are shown to lower viscosity in several compositions of zirconia coated carbonyl iron suspensions, used in magnetorheological finishing.

JMB3
Overview of Optical Metrology Capabilities for the National Ignition Facility, *Michael J. Runkel*; *Lawrence Livermore Natl. Lab, USA.* Optics fabrication for the National Ignition Facility has required developing, fielding and maintaining over 30 large-aperture metrology systems with a broad range of measurement capabilities An overview of these systems' capabilities will be given.

JMB4
A Contactless Method for Characterization of Diffusers for Coherent Noise Reduction, *Shiguang Wang*; *Zygo Corp., USA.* Coherent noise reduction in interferometers often involves a rotating diffuser. This paper describes technical details about a contactless method for characterizing and optimizing diffusers based on measuring scattered light in spatial frequency domain.

JMB5 Student Award Participant
Demonstration of a Small Robust Carbon Fiber Mirror with Low Surface Error Suitable for Near-Infrared Astronomy, *Blake Coughenour*[1], *S. Mark Ammons*[2], *Michael Hart*[2], *Hop Bailey*[2], *Matt Rademacher*[2], *Robert Martin*[3], *Robert Romeo*[3]; [1]*College of Optical Sciences, Univ. of Arizona, USA,* [2]*Steward Observatory, Univ. of Arizona, USA,* [3]*Composite Mirror Applications, USA.* Carbon fiber reinforced polymer (CFRP) composite mirror created using new fabrication techniques is tested under actuation. Surface errors are found to be 82nm RMS of the relaxed surface, and 43nm RMS under best actuator correction.

JMB6
Grinding of Aluminum Mold Using a Rectangular Tool Controlled by an XYZ Machine, *Fermin Granados-Agustín, Elizabeth Percino-Zacarías, **Irce Leal Cabrera**; INAOE, Mexico.* In this paper, it is described the grinding process for an aluminum mold using and XYZ polishing machine to move the center of a rectangular tool. Experimental and calculated wear profiles are compared.

JMB7
Hartmann Null Screen with Drop Shape Spots for Measure the Spherical Aberration in a Plane-Convex Lens, *Maximino Avendaño-Alejo*, *Dulce González-Utrera, Rufino Díaz-Uribe; Univ. Nacional Autónoma de México, Mexico.* A new Hartmann null screens for a better alignment and centroid evaluation to test a plane-convex spherical lens is presented. The designs of these screens are based on the knowledge of the caustic by refraction.

JMB8
Testing a Small Aspheric Lens by Reflective Null CGH, *Dae-Chan Kim*[1], *Ho-Youl Lee*[1], *Hyun-Jun Jang*[2], *Ook-Hee Lee*[2], *Jong-Sub Song*[2], *Jong Ung Lee*[3], *Beom-Hoan O*[1], *Se-Geun Park*[1], *El-Hang Lee*[1], *Seung Gol Lee*[1]; [1]*Inha Univ., Republic of Korea,* [2]*Samsung Electro-Mechanics Automation Group, Korea, Republic of,* [3]*3Laser & Optical Information Engineering, Cheongju Univ., Republic of Korea.* A null CGH for compensating a small aspheric lens is designed to make the testing configuration simple and fabricated. Peak-to-valleys and rms heights of aspheric lenses are measured to be 0.270 and 0.040 waves, respectively.

JMB9
Parallel Point Diffraction Interferometer (PDI) and Shack-Hartmann Sensor (SHS) for Simultaneous Testing of an Optical System , *Perla C. Garcia-Flores*, *Jose R. Diaz-Uribe; UNAM-CCADET, Mexico.* An optical setup with a PDI and a SHS in parallel for simultaneously testing the same optical system is proposed. This allows a simple comparison of the results obtained with both methods.

JMB10 Student Award Participant
Quality Testing of Diamond-Abrasive, Metal-Bond Grinding Tool Materials, *Christopher D. Roll*, *Brian E. MacMillin, Paul Funkenbusch; Dept. of Mechanical Engineering, Univ. of Rochester, USA.* Metal-bond tool materials, with a variety of bonds and diamond compositions, have been characterized mechanically and examined microscopically. The results illustrate the potential use of such testing to track quality, consistency, and predictability related concerns.

JMB11 Student Award Participant
Effects of Bond Hardness and Diamond Concentration on the Erosion of Diamond Tool Materials, *Christopher D. Roll*, *Brian E. MacMillin, Paul Funkenbusch; Dept. of Mechanical Engineering, Univ. of Rochester, USA.* Erosion of the tool material during deterministic microgrinding is essential to produce self-sharpening. In this study the effect of bond hardness and diamond size on the erosion of bronze-bond, diamond-abrasive tool materials is reported.

JMB12
Controlled Edge Damage by Dynamic Impact, *Matthew L. Black*, *Don A. Clark, G. Scott Glaesemann; Corning Inc., USA.* Mechanical contact with glass substrates can induce visible and strength limiting damage. Glass edges are especially susceptible to such damage. Dynamic impact with a glass edge will likely produce classic sharp crack signatures.

JMB13
Complex Surface Measurement by Non-Contact Probes, *Scott DeFisher*, *Shai Shafrir; OptiPro Systems, USA.* UltraSurf is a five axis non-contact optical 3-D scanner for the measurement of complex optical surfaces. Interchangeable optical probes enable non-contact surface and thickness measurements of surfaces of ground or polished parts.

JMB14
Optical Testing of a Reflective Cone With a Null Screen., *Rufino Díaz-Uribe*[1], *Maximino Avendaño-Alejo*[1], *Perla C. Garcia-Flores*[1], *Luis M. Arredondo-Vega*[2], *Carlos Pérez-Santos*[2]; [1]*Univ. Nacional Autónoma de México, Mexico,* [2]*Ctr. de Investigaciones en Óptica, Mexico.* The design of a cylindrical null screen with its axis of symmetry parallel to the optical axis of the surface of the test cone is described. The optical setup and experimental results are presented.

JMB15
Chabot Observatory's Leah and Rachel: The Results of Modern Testing on 8 Inch (1883) and 20 Inch (1914) Refracting Telescopes, *Robert E. Schalck*; *Hardin Optical Co., USA.* We describe a unique opportunity to test two antique refracting telescopes using interferometers and the surprising results that they meet modern standards in terms of optical performance.

JMB16
Aspheres in a Double Gauss: Rehashing an Old Study, *Scott Sparrold*; *Edmund Optics, USA.* Aspheric placement in the Double Gauss form is re-evaluated. Several asphere placements are considered and their resulting aberration balances are studied. Conclusions about the utility and use of inflection aspheres are included.

JMB17
Simulation as a Tool for Teaching Spectrographs Optics to Undergraduate Physics Students, ***Guillermo E. Baldwin****, Rubén Sánchez, Miguel Asmad, Karem Tucto, Franco Gonzales; Pontificia Univ. Católica del Perú, Peru.* It is shown how undergraduate physics students were introduced to spectrographs optics through simulations. Evaluations of two equivalent theoretical spectrographs and a real commercial spectrograph are performed. A comparative work on spectrographs resolution is made.

JMB18
The Optics Toolkit at NASA's Goddard Space Flight Center, ***Joseph Howard****; NASA Goddard Space Flight Ctr., USA.* Analysis beyond the traditional design metrics such as spot size or wavefront variance is generally needed to address mission requirements for NASA. The Optics Toolkit is used with optical design software to complete these tasks.

JMB19
Optical Kit for Training Students in Lens Design, ***Irina L. Livshits****, Vladimir N. Vasilyev, Sergey K. Stafeev, Matvey A. Pashkovskiy; Engineering Ctr. OPTICA, Saint Petersburg State Univ. of Information Technologies, Mechanics and Optics, Russian Federation.* Educating optical designers is a very important part of the job at optical-related universities. Our optical design kit gives students practical skills and inspiration and allows them to have fun and enjoy becoming optical designers.

JMB20
The Design of a Binocular Visual System of Long Eye Relief Using a Freeform Profile, ***Xuemin Cheng***[1,2]*, Jianshe Ma*[1,2]*, Liangjun Chen*[1,2]*;* [1]*Graduate School at Shenzhen, Tsinghua Univ., China,* [2]*Dept. of Precision Instruments, Tsinghua Univ., China.* The design of a binocular visual system of long eye relief using a freeform profile is investigated in this paper. It provides a virtual enlarged image and is used for early diagnosis of eye problem.

JMB21 **Student Award Participant**
Sunlight and LED Hybrid Illumination in Indoor Lighting Design, *Wen-Shing Sun,* ***Chih-Hsuan Tsuei****; Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* We design a light integrating collector that can collect the sunlight and LED light to illuminate the indoor spaces uniformly, and then use in simulating the sunlight/LED hybrid illumination at daytime, LED lighting at nighttime.

JMB22
MLA Fiber Injection for a Square Core Fiber Optic Beam Delivery System: Design versus Prototype Results, ***Todd Lizotte***[1]*, Fred Dickey*[2]*;* [1]*Hitachi Via Mechanics Inc., USA,* [2]*FMD Consulting, USA.* We detail a square core fiber beam delivery design utilizing a unique micro lens array launch method, and resulting performance of a prototype created to verify the design and its stability.

JMB23
A Study of Thin Profile Solar Concentrators Using Wedge Prism with Diffractive Grating, *Tanant Waritanant*[1]*, Sakoolkan Boonruang*[2]*,* ***Te-yuan Chung***[1]*;* [1]*Dept. of Optics and Photonics, Natl. Central Univ., Taiwan,* [2]*Photonics Technology Lab, Natl. Electronics and Computer Technology Ctr. (NECTEC), Thailand.* Solar concentrators using wedge prism with diffractive grating or sawtooth profile mirror are proposed and studied. The concentrator length-to-thickness ratio can exceed 6 and the maximum concentration ratios exceed 3.5 for these designs.

JMB24
Miniaturized UV Fluorescence Collection Optics Integrated with Ion Trap Chips, ***Gregory R. Brady****, Shanalyn A. Kemme, A. Robert Ellis; Sandia Natl. Labs, USA.* For practical quantum computing, it will be necessary to detect the fluorescence from many trapped ions. We describe a design and integration approach using micro-optics to couple this fluorescence into an array of optical fibers.

JMB25
The First Order Optics of Novel Testing Equipment for Compact Camera Module, ***Jui-Wen Pan****; Inst. of Photonic System, Natl. Chiao Tung Univ., Taiwan.* We proposed a concept to improve the examining equipment for adjusting the back focal length of compact camera module (CCM). The volume of this equipment was reduced to 1% and examining speed was significantly improved.

JMB26
New Modeling and Algorithms Development on Local and Global System Optimization, *Quanxin Ding,* ***Hua Liu****; Luoyang Inst. of Electro-optical Equipment of AVIC, China.* To exert advantages of optimization methods for upgrade innovation, the relationship among Model Parameterization, Optimization Algorithm and Merit Function is defined. Some optimization strategies are discussed. Multiple typical results demonstrate validity and potential new challenges.

JMB27
Strategies on Catadioptric, Refractive with Diffractive Configurations, *Quanxin Ding,* ***Hua Liu****; Luoyang Inst. of Electro-optical Equipment of AVIC, China.* Strategies satisfies applied requirements on some criterion, such as MTF, RMS, PSF, utilized cost, test plate matching, fabrication feasibility and so on, achieves remarkable advantages in system efficiency. New concept and algorithm is developed.

JMB28
ABCD Matrix for Calculating Third-Order Aberrations Gradient Index Optical Elements , *Francisco Sorroche*[1]*,* ***José A. Díaz***[1]*, José Fernández-Dorado*[2]*, Josep Arasa*[3]*;* [1]*Univ. de Granada, Spain,* [2]*SnellOptics, Spain,* [3]*Univ. Politècnica de Cataluña, Spain.* This work presents the use of the ABCD matrix for obtaining the Seidel third-order aberration coefficients, i.e. contribution of GRIN to surface refraction and transfer, for each individual surface of GRIN optical elements.

JMB29 **Student Award Participant**
Three-Dimensional Polarization Ray Tracing and Diattenuation Calculation, ***Garam Yun****, Karlton Crabtree, Russell Chipman; College of Optical Sciences, Univ. of Arizona, USA.* A three-by-three polarization ray tracing matrix **P** for calculating polarization transformations associated with ray paths through optical systems is presented. Diattenuation of the optical system is calculated via singular value decomposition of the **P** matrix.

JMB30 **Student Award Participant**
Two Figures of Merit for Fast Estimating Tolerance Sensitivity in Lens Systems, ***Lirong Wang****, Jose M. Sasian; College of Optical Sciences, Univ. of Arizona, USA.* We propose two parameters *CS* and *AS* for fast estimating sensitivities to constant coma and linear astigmatism in misaligned lens system. We show that the figures correlate well with actual tolerancing of some lens systems.

JMB31
Mobile Phone Camera Lens Design with Reduced Flare, ***Xi Chen****; Aptina Imaging, USA.* Flare due to total internal reflection (TIR) from optical surfaces in a mobile phone camera is analyzed. An optimization method for lens design to reduce TIR flare is proposed and described.

JMB32
Development of Wide-Angle Three-Mirror System with Spiral Optical Axis, ***Takayuki Nakano****, Yoshihiro Matsumoto, Yasuhisa Tamagawa; Mistubishi Electric Corp., Japan.* A design method of wide-angle three-mirror system with spiral optical axis is proposed. An example system of F/2 and 30x24 degrees field-of-view is designed and fabricated for infrared imaging applications.

JMB33
Illustrating Method of Triplet Prisms for Minimizing the Chromatic Aberration, ***Wen-Shing Sun****; Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* We present an illustrating method for triplet prisms combination that can minimize the chromatic aberration. The apochromatic aberration equation, relation between relative partial dispersion and glass V-number can be quickly analyzed and found the combination.

JMB34
Wide Band Application of Holographic Lenses for Photovoltaic Power Generation, *Abhijit Ghosh,* ***Rajeev Ranjan****, Hira Lal Yadav; Natl. Inst. of Technology, Jamshedpur, India.* This paper reveals that low film thickness and high refractive index modulation are quite promising for achieving broad band operation and high diffraction efficiency over the entire useful solar spectrum for designing holographic concentrators.

JMB35 **Student Award Participant**
Design of Multichannel Optical Tomography System, ***J. B. Jeeva****[1], Megha Singh[1,2]; [1]VIT Univ., India, [2]SGNE Foundation, India.* A 32-channel optical tomography system designed provides 3-D projection data of an object. The system consists of laser diode source and photodiode detectors. From the 3-D data, tomographic slices of tissue equivalent phantom are obtained.

JMB36
Review of a High Resolution Catadioptric Optics Module, ***Nathalie Blanchard****, Nichola Desnoyers, Anne Martel, Mathieu Demers, Bruno Tremblay, Loïc Le Noc, Claude Chevalier, Alain Bergeron; INO, Canada.* A 1280x960 pixel high resolution catadioptric optics module with an effective f-number of F/1.05 and a total field of view of 22.6 degrees is presented.

JMB37
Anamorphic Eyepiece for Increased Field of View, ***Sean A. Moore****; US Army RDECOM CERDEC Night Vision and Electronic Sensors Directorate, USA.* An innovative design for an anamorphic eyepiece is described, which uses a microlens array with complicated surface features used with a modified microdisplay to provide a high resolution image with a panoramic field of view.

JMB38
Diffractive Null Lens for Parabolic Mirrors, ***Omar Garcia-Liévanos****[1], Sergio Vazquez-Montiel[2]; [1]IPN, Mexico, [2]INAOE, Mexico.* The phase coefficients control the diffracted ray, this travels through of the normal to the aspheric surface. The spherical and coma aberrations are corrected and the optimization process is not required.

JMB39
Surface Evaluation with Ronchi Test by Using Malacara Formula, Genetic Algorithms and Cubic Splines, *Alberto Cordero-Dávila[1],* ***Jorge González-García****[2]; [1]Posgrado en Física Aplicada, Benemerita Univ. Autónoma de Puebla BUAP, Mexico, [2]Univ. Tecnologica de la Mixteca UTM, Mexico.* In Ronchi test Malacara formula is used to evaluate surface errors, which are represented by cubic splines. The spline coefficients are estimated by means of genetic algorithms.

JMB40
Optical Design and Analysis of a Tunable Focus Liquid Lens with Meniscus Surfaces, ***Agustin Santiago-Alvarado****[1], Sergio Vázquez-Montiel[2], Fernando Iturbide-Jiménez[1]; [1]Univ. Tecnológica de la Mixteca, Mexico, [2]Inst. Nacional de Astrofísica, Óptica y Electrónica, Mexico.* In this work, we present the optical design of a tunable focus liquid lens composed with meniscus surfaces. The surfaces are elaborated of PDMS. Analysis of the opto-mechanical behavior of the lens is presented.

JMB41
Optical Design for the Submillimeter and Far InfraRed Experiment (SAFIRE), ***Bert Pasquale****[1], Dominic Benford[1], George Voellmer[1], S. Harvey Moseley[1], Peter Steigner[2]; [1]NASA Goddard Space Flight Ctr., USA, [2]Bastion Technologies, Inc., USA.* SAFIRE, the Submillimeter and Far InfraRed Experiment, was designed for interstellar physics in the airborne Observatory SOFIA. SAFIRE is a cryogenic Echelle Grating spectrograph for covering 120 to 470 microns, with R ranging from 2-12,000.

JMB42
Optical Design for the Composite InfraRed Spectrometer Lite (CIRS-Lite), ***Bert Pasquale****, John Brasunas, John Hagopian, Qian Gong; NASA Goddard Space Flight Ctr., USA.* Following up on Cassini/CIRS, we are building the next-generation Composite InfraRed Spectrometer for deep-space planetary exploration. CIRS-Lite combines Mid & Far-IR channels into a single instrument with 4x the spectral sensitivity.

JMB43
Design of a CGH Corrected Calibration Objective for the AO System at the Large Binocular Telescope, ***Christian Schwab****[1], Diethard Peter[2], Simon Aigner[3]; [1]Landesternwarte-ZAH, Univ. Heidelberg, Germany, [2]Max-Planck Inst. for Astronomy, Germany, [3]Dioptic GmbH, Germany.* We describe the optical design of a calibration unit for the off-axis laser guide stars at the Large Binocular Telescope's ARGOS facility. Artificial stars with the desired wavefront are created using a computer generated hologram.

Tuesday, June 15, 7:30 a.m.–6:00 p.m. Registration Open, *Lobby*

ITuA • Optical Systems I: Telescopes, Binoculars and Reflective Systems

Tuesday, June 15
8:00 a.m.–10:00 a.m.
Jannick P. Rolland; Inst. of Optics, Univ. of Rochester, USA, Presider

ITuA1 • 8:00 a.m.
Comparative Concepts for ATLAST Optical Designs, ***Bert A. Pasquale***[1]*, Philip Stahl*[2]*, Lee Feinberg*[1]*, Joseph Howard*[1]*, Qian Gong*[1]*, David Aronstein*[1]*; [1]NASA Goddard Space Flight Ctr., USA, [2]NASA Marshall Space Flight Ctr., USA.* The ATALST (Advanced Technology for Large Aperture Space Telescopes) effort has presented several design incarnations. Here we will compare the 9.2m segmented, the 8m monolithic on-axis and 8m x 6m off-axis concepts.

ITuA2 • 8:15 a.m.
Simultaneous Design of an Optical System and Null Tests of the Components: Examples and Results from the Large-Aperture Synoptic Survey Telescope, ***Lynn G. Seppala****; Lawrence Livermore Natl. Lab, USA.* Optical null tests for three lenses and two subsystems were incorporated into the optical design procedure for the Large-aperture Synoptic Survey Telescope. The "skip surfaces" feature in the OSLO optical design program was crucial.

ITuA3 • 8:30 a.m. **Invited**
The 300-Year Quest for Binoculars, ***John Greivenkamp****, David Steed; College of Optical Sciences, Univ. of Arizona, USA.* The modern form of the refracting telescope advanced rapidly following its invention in 1608, but almost 300-years elapsed before practical prismatic binoculars become available. The evolution of binoculars and the associated manufacturing issues are discussed.

ITuA4 • 9:00 a.m.
Withdrawn

OTuA • Specification and Measurement

Tuesday, June 15
8:00 a.m.–10:00 a.m.
Damon W. Diehl; ASE Optics, Inc., USA, Presider

OTuA1 • 8:00 a.m. **Invited**
International Standards for Optics in the Electronic Age, ***Prudence M. J. H. Wormell****; Imperial College, UK.* The Concept DataBase being developed by International Organization for Standardization originated in a project of the Technical Committee for Optics and Photonics. It pioneers universally accepted standards online, available to industries worldwide to benefit trade.

OTuA2 • 8:30 a.m.
The Truth about Scratch and Dig, ***David M. Aikens****; Savvy Optics Corp., USA.* Surface imperfection specifications (i.e. Scratch-Dig) are the most misunderstood, misinterpreted, and ambiguous of all optics component specifications. It is time to de-mystify this problematic specification once and for all.

OTuA3 • 8:45 a.m. **Student Award Participant**
Simultaneous Measurement of the Full-Field Aberration, *Chao-Wen Liang,* ***Pen-I Liao****; Natl. Central Univ., Taiwan.* A modified grating-slit test is shown to measure the full-field aberration at multi fields simultaneously by adding a slit-lens matching array. Experimental results shows sensitivity to observe changing off-axis aberration of a tilt lens.

OTuA4 • 9:00 a.m.
Characterization of an Alignment Procedure Using an Air Bearing and Off-the-Shelf Optics, ***Matt Dubin****, Laura E. Coyle, James H. Burge; College of Optical Sciences, Univ. of Arizona, USA.* We demonstrate that using a simple telescope mounted on a high quality bearing can yield comparable or lower uncertainty than an alignment telescope for the centering of elements in an optical system.

ITuA • Optical Systems I: Telescopes, Binoculars and Reflective Systems—Continued

ITuA5 • 9:15 a.m.
Anamorphic Imaging with Three Conic Mirrors, ***Joseph M. Howard***[1], *Bryan D. Stone*[2,3]; [1]*NASA Goddard Space Flight Ctr., USA,* [2]*Inst. of Optics, Univ. of Rochester, USA,* [3]*Optical Res. Associates, USA.* Design methods are described for unobstructed, plane-symmetric systems composed of three conic mirrors. Low order imaging constraints (without the requirement of nonanamorphism) are used to reduce the dimensionality of the configuration space. Examples are presented.

ITuA6 • 9:30 a.m. Student Award Participant
All-Spherical Catadioptric System for 0.8 m F/4.5 Astronomical Telescope: Can We Compete with the Ritchey-Chrétien Design? ***Mehdi Bahrami****, Alexander V. Goncharov, Christopher Dainty; Natl. Univ. of Ireland, Galway, Ireland.* Aspherical surfaces are difficult to manufacture; therefore we consider a possibility of using only spherical surfaces. Two optical designs for 800-mm F/4.5 seeing limited telescope are considered: Ritchey-Chrétien and a two-mirror Catadioptric system.

ITuA7 • 9:45 a.m.
A Family of 2 Mirror Unobscured Wide Field Telescope and Collimator Designs, ***Richard F. Horton****; ad hoc Optics LLC, USA.* A new family of 2 mirror unobscured telescopes of "Schiefspiegler" geometry, using aspheres, tilts and decenters, will serve as fast, high resolution, wide field telescopes/collimators. Examples will be described and compared to other designs.

OTuA • Specification and Measurement—Continued

OTuA5 • 9:15 a.m.
Roughness Measurement of Ultra Precision Surfaces using Light Scattering Techniques and Analysis, ***Tobias Herffurth****, Sven Schröder, Marcus Trost, Angela Duparré; Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* Light scattering techniques are used as powerful method for roughness measurements. Recent achievements in characterizing even large and curved surfaces are presented.

OTuA6 • 9:30 a.m. **Invited**
The Forbes Polynomial: A More Predictable Surface for Fabricators, ***Kevin P. Thompson***[1], *Florian Fournier*[2], *Jannick P. Rolland*[2], *G. W. Forbes*[3]; [1]*Optical Res. Associates, USA,* [2]*Inst. of Optics, Univ. of Rochester, USA,* [3]*QED Technologies, Inc., USA.* The Forbes polynomial is an important new surface type that allows coefficient tolerances to be meaningful and allows the difficulty of fabrication to be quantified. Implications and guidance to fabricators will be presented.

10:00 a.m.–10:30 a.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby*

10:00 a.m.–4:30 a.m. Exhibits Open, *Mezzanine-Grand/Lobby*

NOTES

ITuB • Optical Design for Modern Digital Systems and Computational Imaging

Tuesday, June 15
10:30 a.m.–12:15 p.m.
David M. Hasenauer; Optical Res. Associates, USA, Presider

ITuB1 • 10:30 a.m.
Thru Focus MTF Optimization in Lens Design, *Rob Bates; *FiveFocal LLC, USA.* A method of optimization using the thru-focus MTF is described. Operands based on the peak and distance from the evaluation plane to the peak are investigated for their insensitivity to local minima in DLS optimization.

ITuB2 • 10:45 a.m.
Fast Interpolation-Based Quality Evaluation for Digital-Optical System Optimization, *Michael D. Robinson, *Kathrin Berkner; Ricoh Innovations, USA.* We describe a computationally-efficient approach to approximate the end-to-end MSE merit function for evaluating and optimizing digital-optical imaging systems based on interpolation. We use commercial lens design software to verify the approach.

ITuB3 • 11:00 a.m. **Invited**
Light Field Photography, Microscopy and Illumination, *Marc Levoy; *Stanford Univ., USA.* Light fields represent radiance as a function of position and direction in space. I describe three systems for recording and generating light fields: a camera array, a handheld plenoptic camera, and a light field microscope.

ITuB4 • 11:30 a.m. **Student Award Participant**
Fidelity Comparison of Phase Masks for Hybrid Imaging, *Tom Vettenburg[1], *Andy Wood*[2], *Nicholas Bustin*[2], *Andrew R. Harvey*[1]; [1]*Heriot-Watt Univ., UK,* [2]*Qioptiq Ltd., UK.* Optical-digital hybrids are able to increase defocus tolerance; however, choosing the optimal pupil phase modulation is non-trivial. We show how hybrid imaging fidelity can be predicted and compare some of the most common phase-functions.

OTuB • Large Optics

Tuesday, June 15
10:30 a.m.–12:45 p.m.
Joseph Robichaud; L-3 Communication Systems, SSG Tinsley, Inc., USA, Presider

OTuB1 • 10:30 a.m. **Invited**
Optical Testing of Mirrors for Giant Telescopes, *James Burge; *Univ. of Arizona, USA.* Today's giant telescopes use mirrors that require new methods of optical testing. This paper summarizes developments at University of Arizona for measuring off-axis primary mirror segments, large convex aspheric secondary mirrors, and giant turning flats.

OTuB2 • 11:00 a.m.
Cryogenic Thermal Mask for Space-Cold Optical Testing for Space Optical Systems, *Dae Wook Kim, *James H. Burge; College of Optical Sciences, Univ. of Arizona, USA.* An optical testing configuration utilizing the Cryogenic Thermal Mask (CTM) provides thermal decoupling between a cryogenic optical system under test and a collimator operating at ambient temperature, while passing the test wavefront without significant degradation.

OTuB3 • 11:15 a.m.
SCOTS: A Quantitative Slope Measuring Method for Optical Shop Use, *Peng Su, *Robert E. Parks, Lirong Wang, Roger P. Angel, James H. Burge; Univ. of Arizona, USA.* SCOTS can rapidly measure highly aspherical shapes such as solar collectors, GMT primary. Implementation of SCOTS needs only a laptop computer. It illuminates surface with LCD screen and use reflected image to determine surface slopes.

OTuB4 • 11:30 a.m.
Edge-Control on Mirror Segments, *David Walker[1], *Anthony Beaucamp*[2], *Guoyu Yu*[3], *Hongyu Li*[4]; [1]*Univ. College London, Glyndwr Univ., Zeeko Ltd, UK,* [2]*Zeeko Res. Ltd, UK,* [3]*Glyndwr Univ., UK,* [4]*Univ. College London, UK.* We outline requirements for mirror segment edges for extremely large telescopes, and introduce the new CNC machine for process verification. We review a promising approach for edge-control using the *Precessions* process, and report progress.

ITuB • Optical Design for Modern Digital Systems and Computational Imaging—Continued

ITuB5 • 11:45 a.m. **Invited**

Correcting Lateral Chromatic Aberrations by Image Processing, ***Akihiko Utsugi****, Kenichi Ishiga; Core Technology Ctr., Nikon Corp., Japan.* We have developed an image processing algorithm that reduces lateral chromatic aberration. It analyzes a captured image to detect aberration without lens information, and reduces aberration by methods optimized for raw images and in-camera-processed images.

OTuB • Large Optics—Continued

OTuB5 • 11:45 a.m. **Student Award Participant**

Computation of Misalignment and Primary Mirror Figure Error Parameters of Classical Two-Mirror Telescopes, ***Tobias Schmid***[1]*, Kevin P. Thompson*[2,1]*, Jannick P. Rolland*[3,1]*;* [1]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA,* [2]*Optical Res. Associates, USA,* [3]*Inst. of Optics, Univ. of Rochester, USA.* It is demonstrated how secondary mirror misalignment parameters and primary mirror astigmatic figure error of two-mirror telescopes can be computed utilizing the nodal properties of coma and astigmatism, while taking into account pointing changes.

OTuB6 • 12:00 p.m.

Polishing Large Segments with Hydra, ***Erika Sohn****, Elfego Ruiz, Luis Salas, Esteban Luna, Manuel Núñez, Fernando Quiroz, Francisco Murillo, Joel Herrera, Jorge Valdéz; Inst. de Astronomia, Univ. Nacional Autónoma de México, Mexico.* We present improvements to the Hydra polishing system that open the possibility to polish high-precision free-form meter-class optics, and advances on a hollow borosilicate 84-cm mirror and the optical metrology necessary to measure this surface.

OTuB7 • 12:15 p.m. **Invited**

Optical Figure Measurement on Convex or Concave, Meter-Class Aspheres with Nanometer-Class Accuracy, ***Paul Glenn****; Bauer Associates, Inc., USA.* There is a need for enhanced metrology as the fabrication of large aspheres progresses. We present recent measurement results from our Four Point Stitching Profilometer, providing self-referenced measurement of large aspheres, concave or convex.

12:30 p.m.–2:00 p.m. Lunch *(on your own)*

NOTES

ITuC • Design and Applications of Illumination Systems

Tuesday, June 15
2:00 p.m.–4:00 p.m.
Paul Michaloski; Corning Tropel, USA, Presider

ITuC1 • 2:00 p.m. **Invited**
Evolution of Illumination Systems in Microlithography—A Retrospective , *Alois Herkommer; *Carl Zeiss SMT AG, Germany.* Illumination systems in microlithography have evolved from simple light mixing devices towards ultra-flexible contrast enhancement tools, enabling today's most advanced lithographic processes. A survey of the changing illumination requirements, design concepts and functionality is given.

ITuC2 • 2:30 p.m. Student Award Participant
Design of Illumination Devices for Delivery of Photodynamic Therapy in the Oral Cavity, *Cristina Canavesi[1], *Florian Fournier*[2,1], *Thomas H. Foster*[1,3], *Jannick P. Rolland*[1,2]; [1]*Univ. of Rochester, Inst. of Optics, USA,* [2]*CREOL, College of Optics and Photonics, USA,* [3]*Univ. of Rochester Medical Ctr., USA.* We present two designs for delivery of light in the oral cavity for photodynamic therapy under the requirements of average irradiance of 50 mW/cm^2 and spatial non-uniformities under 10% over an area of 25 mm^2.

ITuC3 • 2:45 p.m.
Overview of the Gamma Reaction History Diagnostic for the National Ignition Facility (NIF), *Robert M. Malone[1], *Brian C. Cox*[1], *Brent C. Frogget*[1], *Morris I. Kaufman*[1], *Aric Tibbitts*[1], *Thomas W. Tunnell*[1], *Scott C. Evans*[2], *Hans W. Herrmann*[2], *Yong H. Kim*[2], *Joseph M. Mack*[2], *Carl S. Young*[2], *Kevin D. McGillivray*[1], *Martin J. Palagi*[1], *Wolfgang Stoeffl*[3]; [1]*Natl. Security Technologies, LLC, USA,* [2]*Los Alamos Natl. Lab, USA,* [3]*Lawrence Livermore Natl. Lab, USA.* Off-axis parabolic mirrors relay Cherenkov light from a volume of pressurized gas. This nonimaging optical system has the high-speed detector placed at a stop position with the light delayed until after prompt gammas have passed.

ITuD • Design and Analysis Considerations for Optical System Fabrication and Testing

Tuesday, June 15
2:00 p.m.–4:00 p.m.
David Stephenson; Stillwater Optics, USA, Presider

ITuD1 • 2:00 p.m.
Considerations for Selecting a Retrosphere in Interferometric Optical Testing of Objectives, *J. Michael Rodgers; *Optical Res. Associates, USA.* A retrosphere is a convenient element to use in interferometric optical tests, but can cause ambiguities in the interferogram due to Fresnel diffraction. This paper evaluates these effects and presents an alternative retroreflector design concept.

ITuD2 • 2:15 p.m.
Tolerance Analysis of Glass Inhomogeneities, *Paolo Spanò; *INAF - Natl. Inst. for Astrophysics, Italy.* Glass inhomogeneities can be properly taken into account during design and manufacturing phases with ray-tracing routines. Based onto Zernike polynomials, a method is presented to compute tolerances. Results are compared with measurements on glass samples.

ITuD3 • 2:30 p.m.
Meaningful Surface Roughness and Quality Tolerances, *David M. Aikens; *Savvy Optics Corp., USA.* Meaningful surface quality and roughness tolerances can be derived based on physics and requirements rather than history and inertia. This paper describes how to develop such specifications for these annoying parameters.

ITuD4 • 2:45 p.m.
Point Spread Function Artifacts from Structured Mid-Spatial Frequency Errors, *John M. Tamkin, *Tom Milster; College of Optical Sciences, Univ. of Arizona, USA.* Structured mid-spatial frequency surface errors on aspheric optics can create ghost images and reduced contrast. This reduction in performance is shown to be non-linear with surface height using Fourier methods and plane wave spectrum analysis.

OTuC • Laser Writing in Materials

Tuesday, June 15
2:00 p.m.–4:00 p.m.
Brigid Mullany; Univ. of North Carolina at Charlotte, USA, Presider

OTuC1 • 2:00 p.m. **Invited**
Ultrafast Laser Microfabrication of Photonic Devices inside Glass, *Kazuyoshi Itoh, *Yasuyuki Ozeki; Osaka Univ., Japan.* We review the technique of microfabrication inside glass, focusing on the fabrication of photonic devices and the microwelding of glass. We also present temperature analysis of the processed region based on time-resolved Raman spectroscopy.

OTuC2 • 2:30 p.m. Student Award Participant
Laser Polishing of Fused Silica, *Annika Richmann[1], *Edgar Willenborg*[2], *Konrad Wissenbach*[2]; [1]*RWTH Aachen Univ., Chair TOS, Germany,* [2]*Fraunhofer Inst. for Laser Technology ILT, Germany.* Polishing results of polishing fused silica with CO_2-laser radiation with processing rates up to 1 cm^2/s are presented. The roughness of planar surfaces is reduced to Ra<6 nm. Polishing results on spherical lenses are likewise.

OTuC3 • 2:45 p.m. Student Award Participant
Self-Organized Formation of Nanoporous AAO by Prepatterned Nanoimprint Lithography, *Sheng-Hui Chen*[1], *Chun-Ko Chen[1], *Bo-Yu Huang*[1], *Shih-Liang Ku*[2], *Chao-Chun Huang*[2]; [1]*Dept. of Optics and Photonics, Natl. Central Univ., Taiwan,* [2]*Chung-Shan Inst. of Science and Technology, Taiwan.* Periodic nanopores have been fabricated on the aluminum foil using nanoimprint and anodization processes to obtain high order nanostructure. The results show that the growth position of the pores was limited by the pre-patterned design.

ITuC • Design and Applications of Illumination Systems—Continued

ITuC4 • 3:00 p.m.
Micro-Optics for High-Efficiency Optical Performance and Simplified Tracking for Concentrated Photovoltaics (CPV), ***William Sweatt****, Bradley H. Jared, Greg N. Nielson, Murat Okandan, Anton Filatov, Michael B. Sinclair, Jose L. Cruz-Campa, Anthony L. Lentine; Sandia Natl. Labs, USA.* Three-element micro-optical array, enabled by micro-photovoltaic cells, provides simple in-plane fine tracking (±10° FOV) and improves lens and anti-reflection coating optical efficiency. Prototype 49:1 concentration for 400nm < λ < 1600nm demonstrated.

ITuC5 • 3:15 p.m. Student Award Participant
Design, Assembly, and Testing of a Spectral Splitting Solar Concentrator Module, ***Eric Christensen****, Duncan Moore, Greg Schmidt, Blair Unger; Univ. of Rochester, Inst. of Optics, USA.* This paper describes the design, assembly, and testing of a concentrating photovoltaic module which uses spectral splitting to achieve high system power efficiency. An efficiency of 37.5% was measured on a prototype module.

ITuC6 • 3:30 p.m.
Injecting Light of High-Power LEDs into Thin Light Guides, ***Hugo J. Cornelissen****[1], Chenhung Ho[2], Haiyan Ma[2], Marcel P. C. M. Krijn[1], Hans A. van Sprang[1]; [1]Philips Res. Europe, Netherlands, [2]Delft Univ. of Technology, Optics Res. Group, Netherlands.* A new method using a thin-film dielectric multilayer filter is presented to couple light from a 1x1mm² LED into a 0.3mm thin light guide. Design and optical characterization of thin and compact collimators are discussed.

ITuC7 • 3:45 p.m.
LED Polarization Conversion and Angular Shaping Module for LCD Backlighting, ***Po-Chun Lin****[1], Cheng-Huan Chen[1], Han-Ping Yang[2], Hung-Yi Lin[2]; [1]Power Mechanical Engineering Dept., Natl. Tsing Hua Univ., Taiwan, [2]Mechanical and System Res. Labs, Industrial Technology Res. Inst., Taiwan.* A polarization conversion and angular shaping LED module has been proposed to improve the efficiency and uniformity for direct type LCD backlighting. The design includes simulation based on nanostructure, polarization and geometrical optics.

ITuD • Design and Analysis Considerations for Optical System Fabrication and Testing—Continued

ITuD5 • 3:00 p.m.
Use of the Abbe Sine Condition to Quantify Alignment Aberrations in Optical Imaging Systems, ***James H. Burge****, Chunyu Zhao, Matt B. Dubin; College of Optical Sciences, Univ. of Arizona, USA.* Violation of Abbe's sine condition is well known to cause coma in axisymmetric imaging systems. We define non-symmetric violations and show how they come from misaligned optical systems and how they cause image degradations.

ITuD6 • 3:15 p.m.
Controlling Surface Figure Errors of Optical Components, ***David J. Markason****; Raytheon Missile Systems, USA.* The random-phase screen transfer function is a useful tool to control the surface figure of optical components. Theory and proposed algorithms, tie in to lens design codes, and example specifications are reviewed.

ITuD7 • 3:30 p.m.
Thermal Considerations in the Design of a Long Focal Length, Low F-Number, Infrared Imager, ***Harvey M. Spencer****; DRS Sensor and Targeting Systems, USA.* Long focal length IR optics cause difficulties in achieving performance over varying temperatures due to the large Dn/Dt of IR materials. Modeling results are sensitive to the lens setup. Techniques for design optimization are presented.

ITuD8 • 3:45 p.m.
Tolerance Analysis and Experiment of Injection Double Lens in High Power Solid Laser Facility, ***Fang Wang****, Ping Li, Lanqin Liu, Lei Mo, Donghui Lin, Wengyi Wang, Jingqin Su, Qihua Zhu; Res. Ctr. of Laser Fusion, China Acad. of Engineering Physics, China.* The injection lens of the high power solid laser facility built soon was designed as double lens. The tolerance of the double lens was analyzed, and the optical performance of which was detected in experiment.

OTuC • Laser Writing in Materials—Continued

OTuC4 • 3:00 p.m.
Characterization of Photoresist and Study on Developed Resist Profile for the Fabrication of Gray-Scale Diffractive Optic Elements, *Jong Rak Park[1], Youngsik Kim[2], Melissa Zaverton[2], Justin Sierchio[2],* ***Tom D. Milster****[2]; [1]Dept. of Photonic Engineering, Chosun Univ., Republic of Korea , [2]College of Optical Sciences, The Univ. of Arizona, USA.* We have characterized photoresist used for fabrication of gray-scale diffractive optic elements using Dill's and Mack's parameters. Using the fast-marching method, simulations of resist profiles have been shown to match experimental results.

OTuC5 • 3:15 p.m. Student Award Participant
Maskless Lithography Tool for Fabrication and Inspection of Diffractive Optical Elements and Computer Generated Holograms, ***Melissa A. Zaverton****, Justin Sierchio, Young-Sik Kim, Delbert Hansen, Warren Bletcher, John Tamkin, Thomas Milster; Univ. of Arizona, College of Optical Sciences, USA.* A high-speed maskless lithography tool is described for fabricating diffractive optical elements and computer generated holograms. The system has the capability to write gray-scale features and is also used for inspection of the sample after fabrication.

OTuC6 • 3:30 p.m. Invited
Novel Optical Materials and Devices by Direct Laser Writing, ***Georg von Freymann****, Stefan Linden, Martin Wegener, Klaus Bade, Volker Saile, Michael Thiel, Michael S. Rill, Manuel Decker, Justyna Gansel; Karlsruhe Inst. of Technology (KIT), Germany.* We characterize chiral three-dimensional photonic nanostructures composed of both polymeric and metallic helices. Fabrication involves direct-laser writing and electrochemical deposition of gold. The structures' optical properties reveal new opportunities for realizing advanced polarizing optical devices.

4:00 p.m.–4:30 p.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby and Lodge Room, Pavilion*

ITuE • Modeling and Testing of Illuminations Systems and Components

Tuesday, June 15
4:30 p.m.–6:00 p.m.
Richard Pfisterer; Photon Engineering, LLC, USA, Presider

ITuE1 • 4:30 p.m. Student Award Participant
Modeling Transflective LCD Illumination Systems, ***Joshua J. Kim***[1]*, R. John Koshel*[1,2]*; [1]College of Optical Sciences, Univ. of Arizona, USA, [2]Photon Engineering LLC, USA.* Transflective LCD illumination models are simulated to assess image quality under influence of ambient light in terms of a user viewable image. Currently a contrast improvement of 168% is observed beyond a regular LC display.

ITuE2 • 4:45 p.m. Invited
Fluorescence Modeling in Remote and Close LED Illumination Devices, ***Teus Tukker****; Philips Lighting, Netherlands.* Light source modeling is an important part of the design of illumination systems. The irradiance and spectral details of the source are important for the design choices and the final performance of the luminair.

ITuE3 • 5:15 p.m. Student Award Participant
A Low-Cost, Flexible, High Dynamic Range Test for Free-Form Illumination Optics , ***Lirong Wang***[1]*, Peng Su*[1]*, Robert E. Parks*[1]*, Jose M. Sasian*[1]*, James H. Burge*[1,2]*; [1]College of Optical Sciences, Univ. of Arizona, USA, [2]Dept. of Astronomy/Steward Observatory, Univ. of Arizona, USA.* Software Configurable Optical Test System (SCOTS), a computerized "reverse Hartmann test," can rapidly quantitatively measure complex 3-D specular surfaces, for instance solar collectors, faceted automotive headlight or free-form surfaces without complex calibrations.

ITuF • Manufacturing Considerations for Optical Design Producibility and Tolerance Desensitization

Tuesday, June 15
4:30 p.m.–6:00 p.m.
Gary Wiese; Lockheed Martin Corp., USA, Presider

ITuF1 • 4:30 p.m.
The Adversarial Relationship between Optical Performance and Scratch-Dig, ***Cody B. Kreischer****; Kreischer Optics, Ltd., USA.* A key cost factor in making an optic is the surface quality (scratch-dig) specification. This paper deals with how an over-emphasis on surface quality can indirectly reduce the "as built" performance of optical systems.

ITuF2 • 4:45 p.m.
Lens Solutions Which Increase Manufacturing Yield, *Stan Szapiel,* ***Catherine Greenhalgh****; ELCAN Optical Technologies, Canada.* The classic method of design centering commonly used to increase the yield of electronic circuits is employed to improve manufacturability of complex lens designs.

ITuF3 • 5:00 p.m. Student Award Participant
The Effect of Selective Assembly on Tolerance Desensitization, ***Max C. Funck***[1]*, Peter Loosen*[1,2]*; [1]RWTH Aachen Univ., Germany, [2]Fraunhofer Inst. for Laser Technology, Germany.* Cost reduction and increased as-built performance can be achieved through both tolerance desensitization and use of compensators. We investigate how desensitization of selected parameters can further relax tolerances while using selective assembly as a compensator.

ITuF4 • 5:15 p.m
Withdrawn

OTuD • Freeform Optics

Tuesday, June 15
4:30 p.m.–6:00 p.m.
Jannick P. Rolland; Inst. of Optics, Univ. of Rochester, USA, Presider

OTuD1 • 4:30 p.m. Invited
Comparison of Linear Z-Axis and Rotational B-Axis Freeform Diamond Turning, ***Gregg E. Davis***[1]*, Jeffrey W. Roblee*[2]*, Steven M. Omecinski*[1]*, Alan Hedges*[1]*; [1]II-VI Inc., USA, [2]Ametek Precitech, USA.* In a cutting comparison between X-C-Z and X-C-B Slow Tool Servo techniques, the rotational B-axis achieved comparable figure results to the linear Z-axis, but finish suffered due to sub-divisional errors of the B-axis encoder.

OTuD2 • 5:00 p.m. Student Award Participant
The Assessment of a Stable Radial Basis Function Method to Describe Optical Free-Form Surfaces, ***Ilhan Kaya***[1]*, Ozan Cakmakci*[2]*, Kevin Thompson*[2]*, Jannick P. Rolland*[3]*; [1]CREOL, College of Optics & Photonics, Univ. of Central Florida, USA, [2]Optical Res. Associates, USA, [3]Inst. of Optics, Univ. of Rochester, USA.* This paper assesses a stable Radial Basis Function method to describe optical free-form surfaces. The main contribution is determination of number of basis required to achieve an accuracy demanded by non-imaging, precision, and lithography optics.

OTuD3 • 5:15 p.m.
Multi-Point Low-Coherence Optical Probe for Freeform Optical Metrology, ***Damon W. Diehl****, Christopher T. Cotton, Christopher J. Ditchman, Nathan E. Burdick, Howard S. Ammenheuser; ASE Optics, USA.* We have developed a four-beam non-contact optical probe that uses low-coherence interferometry to measure the position and orientation of the interior and exterior surfaces of a freeform optic by scanning the probe over the object.

ITuE • Modeling and Testing of Illuminations Systems and Components—Continued

ITuE4 • 5:30 p.m.
Backward Modelling of LED Primary Optics, ***Andre Domhardt****, Simon Wendel, Cornelius Neumann; Karlsruhe Inst. of Technology, Germany.* Secondary optic tailoring requires an appropriate, point source based, primary optic model, which can be calculated from spatial radiation patterns by applying backward tailoring. Furthermore, we demonstrate the resulting improvements on the design process.

ITuE5 • 5:45 p.m.
Withdrawn

ITuF • Manufacturing Considerations for Optical Design Producibility and Tolerance Desensitization—Continued

ITuF5 • 5:30 p.m.
Tolerance Assignment for Minimizing Manufacturing Cost, ***Michael Kehoe****; Resonon Inc., USA.* An automated procedure for tolerance assignment is described. Tolerances are assigned so as to minimize manufacturing cost, subject to a constraint on minimum acceptable lens performance. A simulation evaluates the cost-effectiveness of the program.

ITuF6 • 5:45 p.m.
Manufacturable Mobile Phone Optics: Higher Order Aspheres Are Not Always Better, ***James P. McGuire****; Optical Res. Associates, USA.* We review the design drivers for mobile camera phones, with particularly the aspheric order. The designer is often tempted to use high order aspheres, but better as-built performance can often be obtained at lower orders.

OTuD • Freeform Optics—Continued

OTuD4 • 5:30 p.m. Invited
Precise Fast Molding of Optical Freeforms, ***Jan Hamkens****; Docter Optics GmbH, Germany.* Explanation and market needs for high-efficiency molding of optical freeforms for illumination, solar, analytics and other industries - optical design, tool shop, high resolution measures, integrated tool optimization ◊ from prototyping to large scale production.

6:00 p.m.–7:30 p.m. Joint Conference Reception, *Atrium*

7:00 p.m.–8:00 p.m. Memorial Program, *Grand Room*

NOTES

Wednesday, June 16, 7:30 a.m.–5:30 p.m. Registration Open, *Lobby*

IWA • Polarization in Optical Design

Wednesday, June 16
8:00 a.m.–9:45 a.m.
Costin E. Curatu; Alcon Labs, USA, Presider

IWA1 • 8:00 a.m. Student Award Participant
Ray Tracing in Biaxial Materials, ***Wai Sze Tiffany Lam****, Stephen McClain, Gregory Smith, Russell Chipman; College of Optical Sciences, Univ. of Arizona, USA.* Algorithms for polarization ray tracing biaxial materials and calculating the directions of ray propagation and energy flow, the refractive indices, and the coupling coefficients for all four resultant reflected and transmitted rays are presented.

IWA2 • 8:15 a.m. Student Award Participant
Low Polarization Microscope Objectives, ***Brian J. Daugherty****, Russell Chipman; Univ. of Arizona, USA.* Microscope objectives used for biaxial ellipsometry require small levels of polarization aberrations. The approach outlined in this paper allows the design and fabrication of microscope objectives with twelve times less diattenuation than commercially available objectives.

IWA3 • 8:30 a.m.
Using Orientation Zernike Polynomials to Predict the Imaging Performance of Optical Systems with Birefringent and Partly Polarizing Components, ***Johannes Ruoff***[1]*, Michael Totzeck*[2]*; [1]Carl Zeiss SMT AG, Germany, [2]Carl Zeiss AG, Germany.* We use the concept of Orientation Zernike Polynomials, which have been shown to provide a complete and systematic description of vector imaging, to predict the polarization performance of high NA lithography lenses.

IWA4 • 8:45 a.m. Invited
Challenges for Polarization Ray Tracing, ***Russell A. Chipman****; College of Optical Sciences, Univ. of Arizona, USA.* New polarization methods allow the ray tracing simulation of polarization critical components, including multilayer biaxial films, anisotropic and gyrotropic crystals, electro-optical, magneto-optical, and stressoptical modulators, photonic crystals and meta-materials.

OWA • Materials Processing and Damage

Wednesday, June 16
8:00 a.m.–10:00 a.m.
Jessica DeGroote Nelson; Optimax Systems Inc., USA, Presider

OWA1 • 8:00 a.m. Invited
Optical Fabrication and Post Processing Techniques for Improving Laser Damage Resistance of Fused Silica Optics, ***Tayyab Suratwala****; Lawrence Livermore Natl. Lab, USA.* With improved optical fabrication and new post-treatments, the laser resistance of fused silica optical surfaces has increased dramatically in the past 12 years, enabling practical optic lifetimes during high laser fluence operation.

OWA2 • 8:30 a.m.
A Simple Method to Improve Etching Uniformity when Making Phase Type CGHs on a Thick Glass Substrate, ***Quandou Wang***[1]*, Lei Chen*[2]*, Ulf Griesmann*[1]*; [1]Manufacturing Engineering Lab, NIST, USA, [2]Ctr. for Nanoscale Science and Technology, NIST, USA.* A simple method to optimize the etching uniformity when making a CGH on a thick optical glass substrate is described, which uses a Teflon ring to enclose the substrate during reactive-ion etching (RIE).

OWA3 • 8:45 a.m.
Evaluating Subsurface Damage with Quantum Dots, *Wesley Williams,* ***Brigid Mullany****, Wesley Parker, Patrick Moyer; Univ. of North Carolina at Charlotte, USA.* Quantum dots were added to abrasive slurries used to finish glass samples. Confocal fluorescence microscopy detected quantum dots up to 7 μm beneath the surface, agreeing with depths of brittle fracture observed by etching.

OWA4 • 9:00 a.m.
A New Method of Damage Determination: 3-D Metrology, ***Jean-Philippe Champreux***[1]*, Olivier Cahuc*[1]*, Philippe Darnis*[2]*, Jean-Yves K'nevez*[1]*, Raynald Laheurte*[2]*, Nathalie Darbois*[3]*, Jérôme Néauport*[3]*; [1]Lab de Mécanique Physique, Univ. de Bordeaux, France, [2]Lab de Génie Mécanique et Matériaux de Bordeaux, Univ. de Bordeaux, France, [3]CEA CESTA, France.* This paper presents a new approach to measure damage created by the grinding operation. It presents the Abbott-Firestone curve and the depth distribution used to take information on the damage created under the surface.

IWA • Polarization in Optical Design—Continued

IWA5 • 9:15 a.m. Student Award Participant

Imprinting Aberrations in the Stokes Parameters of a Focal Spot, ***Amber M. Beckley****, Thomas G. Brown; Inst. of Optics, Univ. of Rochester, USA.* We explore polarization distribution in point spread functions and Stokes parameter signatures of pupil aberrations. With the aid of stress-engineered optical elements, we explore how pupil aberrations map onto Stokes parameters in the focal plane.

IWA6 • 9:30 a.m. Student Award Participant

Three-Dimensional Polarization Ray Tracing, Retardance, ***Garam Yun****, Russell Chipman; College of Optical Sciences, Univ. of Arizona, USA.* The retardance associated with a three-by-three polarization ray tracing matrix **P** is analyzed. A method to separate the geometrical transformation from the "physical" retardance is presented using a non-polarizing ray tracing matrix **Q**.

OWA • Materials Processing and Damage—Continued

OWA5 • 9:15 a.m.

Initiation of Laser Damage at Surface Imperfections on Fused Silica Optics, ***Philip E. Miller****, Tayyab I. Suratwala, Jeffrey D. Bude, Joseph A. Menapace, Nan Shen, Ted A. Laurence, William A. Steele, Michael D. Feit, Lana L. Wong; Lawrence Livermore Natl. Lab, USA.* Imperfections on optical surfaces contain fractured, densified and displaced material. After physical isolation, the laser damage susceptibility of specific defect structures has been determined. Fractures, rather than displaced or densified material limits laser damage performance.

OWA6 • 9:30 a.m. **Invited**

Development of Transparent Ceramic Spinel ($MgAl_2O_4$) for Armor Applications, ***Anthony Sutorik****; US ARL, USA.* This paper will describe the Army's efforts to develop polycrystalline transparent ceramic from magnesium aluminate spinel ($MgAl_2O_4$) for transparent armor applications, with particular emphasis on the development of cost effective ceramic powder synthesis and processing.

10:00 a.m.–10:30 a.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby*

10:00 a.m.–4:30 p.m. Exhibits Open, *Mezzanine-Grand/Lobby*

NOTES

IWB • Nonimaging Optical Design Techniques

Wednesday, June 16
10:30 a.m.–12:30 p.m.
G. Groot Gregory; Optical Res. Associates, USA, Presider

IWB1 • 10:30 a.m.
SWEPT CONICS: Single Mirror Transformers, *Paul K. Manhart*; *NASA Langley Res. Ctr., USA.* A class of optical surfaces called "Swept Conics" can be used to transform wavefronts from point sources to diffraction limited line or arc images, and vice versa.

IWB2 • 10:45 a.m. **Invited**
Edge-Ray and Aplanatic Designs as Special Cases of Generalized Functional Designs, *John C. Bortz*, *Narkis Shatz; SAIC, USA.* We show that both edge-ray and aplanatic concentrators are special cases of generalized functional designs. The formulas associated with the generalized functional method provide a convenient means of generating the shape profiles of such concentrators.

IWB3 • 11:15 a.m.
Novel Ideal Nonimaging Designs by Multichanneling the Phase-Space Flow, *Juan C. Miñano[1,2], Pablo Benitez[1,2], Julio Chaves[2], Jiayao Liu[1], Jose Infante[1]; [1]Univ. Politécnica de Madrid, Spain, [2]LPI, USA.* New ultra-thin SMS optical designs are presented. They are formed by discontinuous sections working in parallel (multichannel) to provide the desired optical function. Aplanatic (a particular case of SMS-design) multichannel very-thin designs are also shown.

IWB4 • 11:30 a.m. **Student Award Participant**
Freeform Reflector Design Using Integrable Maps, *Florian R. Fournier*[1], *William J. Cassarly[2], Jannick P. Rolland[1,3]; [1]CREOL, Univ. of Central Florida, USA, [2]Optical Res. Associates, USA, [3]Univ. of Rochester, USA.* We propose a design method for freeform reflectors based on source-target maps. The necessity to fulfill the integrability condition to obtain a smooth reflector surface is discussed and demonstrated with various reflector geometries.

OWB • Materials Processing and Damage—Continued

Wednesday, June 16
10:30 a.m.–11:15 a.m.
Jessica DeGroote Nelson; Optimax Systems Inc., USA, Presider

OWB1 • 10:30 a.m.
Laser Controlled Fracture Strength in Chemically Strengthened Glass, *Kyle Hoff*, *Xinghua Li, G. Scott Glaesemann; Corning Inc., USA.* Surface heating lasers with a quenching process can create controlled scribe lines with high edge strength. This work compares the edge strength of different chemically strengthened glasses with laser scribe and break edges.

OWB2 • 10:45 a.m. **Invited**
Corrosion Resistant Zirconia Coated Carbonyl Iron Particle-Based Magnetorheological Fluid, *Shai Shafrir*[1,2], *Henry J. Romanofsky[3], Michael Skarlinski[2], Mimi Wang[4], Chunlin Miao[5], Sivan Salzman[5], Taylor Chartier[4], Joni Mici[2], John C. Lambropoulos[2], Rui Shen[4], Hong Yang[4], Stephen D. Jacobs[3]; [1]OptiPro Systems, Inc., USA, [2]Dept. of Mechanical Engineering, Univ. of Rochester, USA, [3]Lab for Laser Energetics, Univ. of Rochester, USA, [4]Dept. of Chemical Engineering, Univ. of Rochester, USA, [5]Materials Science Program, Dept. of Mechanical Engineering, Univ. of Rochester, USA.* Zirconia coated carbonyl iron particle-based magnetorheological fluid was developed for magnetorheological finishing. Particles were coated via sol-gel synthesis. Spot polishing tests were performed over 3 weeks with no signs of fluid degradation or corrosion.

OWC • Micro-Integrated Optics

Wednesday, June 16
11:15 a.m.–12:30 p.m.
Matt Dubin; College of Optical Sciences, Univ. of Arizona, USA, Presider

OWC1 • 11:15 a.m. **Invited**
Glass Micro-Optics for Laser Beam Shaper and LED Collimation, *Steffen Reichel*, *Ralf Biertümpfel, Volker Wittmer; SCHOTT AG, Germany.* A design and measurements of glass diffractive optical beam shaper is shown generating a 'flat hat' light distribution. Furthermore the design of a LED collimation lens is presented including the manufacturing as lens array.

IWB • Nonimaging Optical Design Techniques—Continued

IWB5 • 11:45 a.m. **Invited**

Optical Design of Inhomogeneous Media to Perfectly Focus Scalar Wave Fields , ***Pablo Benitez****, Juan C. Miñano, Juan C. González; Univ. Politécnica de Madrid, Spain.* A method to design isotropic inhomogeneous refractive index distribution is presented, in which the scalar wave field solutions propagate exactly on eikonal functions, allowing perfect focusing from a point source onto a point absorber.

IWB6 • 12:15 p.m. **Student Award Participant**

Nobel Fast Catadioptric Objective with Wide Field of View, ***Jose M. Infante Herrero***[1,2]*, Fernando Muñoz*[3]*, Pablo Benitez*[2]*, Juan Carlos Miñano*[2]*, Wang Lin*[1]*, Juan Vilaplana*[3]*, Guillermo Biot*[1]*, Marta de la Fuente*[4]*;* [1]*Univ. Politécnica de Madrid, CEDINT, Spain,* [2]*Indra Sistemas SA, Spain,* [3]*LPI, USA,* [4]*INDRA SISTEMAS SA, Spain.* Using the Simultaneous Multiple Surface method in 2D (SMS2D), we present a fast catadioptric objective with a wide field of view (125ºx96º) designed for a microbolometer detector with 640x480 pixels and 25 microns pixel pitch.

OWC • Micro-Integrated Optics—Continued

OWC2 • 11:45 a.m.

Single Arm Interferometer System for Reflective Micro-Device Phase Measurement, ***Dale E. Ewbank****; Rochester Inst. of Technology, USA.* A Pohl fringe-producing system is used to measure phase for reflective electro-optical micro-devices at visible wavelengths. Relative phase versus voltage is extracted for devices utilizing polymer dispersed liquid crystal materials as the active layer.

OWC3 • 12:00 p.m.

Cost Optimized Fabrication of Micro-Optical Couplers, ***José Fernando Merchán Alba***[1]*, Karl-Heinz Brenner*[1]*, Rainer Börret*[2]*, Uwe Berger*[2]*;* [1]*Univ. Heidelberg, Germany,* [2]*Hochschule Aalen, Germany.* A cost effective fabrication method is applied to manufacture micro-optics. It allows the integration of micro-optical components. We used this technique to fabricate negative metal-masters of optical micro-couplers and replicated them in a monolithic substrate.

OWC4 • 12:15 p.m.

The Use of Elastic Averaging for Fabrication of Micro-Optics in a High Efficiency Photovoltaic System, ***Bradley Jared****, David Gill, William Sweatt, Gregory Nielson, Murat Okandan, Anton Filatov; Sandia Natl. Labs, USA.* Elastic averaging is introduced as a methodology for the fabrication and assembly of multi-element, micro-optic arrays. Its performance and use is evaluated in the demonstration of a high efficiency, photovoltaic tracking system.

12:30 p.m.–2:00 p.m. Lunch *(on your own)*

NOTES

IWC • Beam Shaping and Propagation

Wednesday, June 16
2:00 p.m.–4:00 p.m.
Daniel G. Smith; Nikon Res. Corp. of America, USA, Presider

IWC1 • 2:00 p.m. **Invited**

Unified Optical Modeling, ***Frank Wyrowski***[1], *Michael Kuhn*[2]; [1]*Friedrich Schiller Univ. Jena, Germany,* [2]*LightTrans GmbH, Germany.* Unified optical modeling aspires to place all significant modeling techniques into the same framework in order to enable a smooth combination of them in a modeling task. We call this theoretical modeling concept field tracing.

IWC2 • 2:30 p.m.

Gouy Phase Anomaly in Astigmatic Beams, ***Jannick P. Rolland***[1,2], *Tobias Schmid*[2], *John Tamkin Jr.*[1], *Kye-Sung Lee*[1], *Kevin P. Thompson*[3], *Emil Wolf*[1]; [1]*Univ. of Rochester, USA,* [2]*CREOL, Univ. of Central Florida, USA,* [3]*Optical Res. Associates, USA.* We simulate the newly predicted Gouy phase anomaly near astigmatic foci of Gaussian beams using a beam propagation algorithm integrated with lens design software and compare computational results with experimental data.

IWC3 • 2:45 p.m. **Invited**

Mathematical Aspects of Laser Beam Shaping and Splitting, ***Louis A. Romero***[1], *Fred M. Dickey*[2]; [1]*Sandia Natl. Labs, USA,* [2]*FMD Consulting, USA.* We will discuss general mathematical ideas arising in the problems of Laser beam shaping and splitting. We will be particularly concerned with questions concerning the scaling and symmetry of such systems.

IWC4 • 3:15 p.m. **Student Award Participant**

Airy Beams: Beyond Geometric Optics, ***Sophie Vo***[1], *Kyle Fuerschbach*[1], *Charlotte Pachot*[1], *Tobias Schmid*[2], *Kevin P. Thompson*[3], *Jannick P. Rolland*[1]; [1]*Inst. of Optics, Univ. of Rochester, USA,* [2]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA,* [3]*Optical Res. Associates, USA.* Airy beams are a new class of nondiffracting beam predicted in 1979 and observed in 2007. Beam propagation methods are shown to be an effective way to study the behavior of the beams in propagation.

OWD • Grinding/Cutting/Molding

Wednesday, June 16
2:00 p.m.–4:00 p.m.
Aric B. Shorey; Corning, Inc., USA, Presider

OWD1 • 2:00 p.m. **Invited**

Unique and Unusual Applications of Ultraprecision ELID Grinding and Diamond Cutting, ***Hitoshi Ohmori****; RIKEN, Japan.* Electrolytic in-process dressing (ELID) applications continue to expand. This talk describes the fabrication of large, double sided spherical Fresnel lenses for space telescope and solar light concentration optics by direct machining and replication molding.

OWD2 • 2:30 p.m.

Investigations on Grinding Tools for Silicon Carbide Based Advanced Materials, ***Christian Vogt****, Markus Schinhaerl, Florian Schneider, Peter Sperber, Rolf Rascher; Univ. of Applied Sciences Deggendorf, Germany.* The results of experiments with grinding tools for carbon fibre infiltrated Silicon Carbide (C/C-SiC) materials are presented. Trials with ELID-support show improved selfsharpening. Resin bond tools improved the surfaces smoothness whereas the form deviation increased.

OWD3 • 2:45 p.m.

Investigations on Magnetorheological Finishing of High-Quality Optical Surfaces with Varying Influence Function, *Markus Schinhaerl,* ***Christian Vogt****, Florian Schneider, Peter Sperber, Rolf Rascher; Univ. of Applied Sciences Deggendorf, Germany.* The paper reports on a testing series with a varying influence function (Spot) in magnetorheological finishing. Effects on the polishing quality and recent developments in the field of varying influence functions are presented and discussed.

OWD4 • 3:00 p.m.

Optimization of Deterministic Microgrinding (DMG) Conditions for Optical Glasses and Ceramics, ***Shai N. Shafrir***[1,2], *Christopher D. Roll*[2], *Paul D. Funkenbusch*[2]; [1]*OptiPro Systems, USA,* [2]*Dept. of Mechanical Engineering, Univ. of Rochester, USA.* Surface roughness under deterministic microgrinding conditions (fixed in-feed rate) with bond abrasive diamond ring tools is correlated to process conditions. Five different commercial sets of rough and medium tools were tested.

OWD5 • 3:15 p.m.

Optical Characterization of Molded Glass Optics, ***Allen Y. Yi***[1], *Fritz Klocke*[2], *Olaf Dambon*[2], *Fei Wang*[2], *Yang Chen*[1], *Wei Zhao*[1]; [1]*Ohio State Univ., USA,* [2]*Fraunhofer Inst. for Production Technology, Germany.* Ths paper delineates a detailed study of refractive index and its variation in compression molding of precision glass optical lenses.

IWC • Beam Shaping and Propagation—Continued

IWC5 • 3:30 p.m. **Invited**

Microstructured Optics for Excimer-Based Systems: Applications for Imaging, Beam Shaping and Coherence Management, ***Robert Brunner***[1,2]*, Hans Jürgen Dobschal*[3]*, Reinhard Steiner*[2]*, Matthias Burkhardt*[2]*, Matthias Cumme*[2]*, Oliver Sandfuchs*[2]*, Dennis Lehr*[2]*, Michael Helgert*[2]*;* [1]*Univ. of Applied Sciences Jena, Germany,* [2]*Carl Zeiss Jena GmbH, Technology Div., Germany,* [3]*Carl Zeiss AG, Central Res., Germany.* Imaging DOEs, randomly distributed microlenses and sub-λ-structures allow the improvement of the performance of Excimer-based imaging and illumination systems. The potentials and the challenges are discussed especially with the focus on the local profile.

OWD • Grinding/Cutting/Molding—Continued

OWD6 • 3:30 p.m. **Invited**

Advanced Molded Glass Lenses, ***Jayson Nelson****, Edward Patton; Rochester Precision Optics, USA.* In this presentation I will discuss recent development efforts to mold diffractive surfaces, lens arrays, and IR materials, and demonstrate how aspheres are being used in the design phase to improve overall system performance.

4:00 p.m.–4:30 p.m. Coffee Break/Exhibits, *Mezzanine-Grand/Lobby*

NOTES

IWD • Optical Systems II: Zoom Lenses and Advanced Optical System Design

Wednesday, June 16
4:30 p.m.–6:15 p.m.
Michael Gauvin; Lambda Res. Corp., USA, Presider

IWD1 • 4:30 p.m.
Optical Design Challenges of NFIRAOS, the First-Light Adaptive Optics System for TMT, *Jenny Atwood*, *Peter Byrnes, Glen Herriot; Natl. Res. Council Canada, Herzberg Inst. of Astrophysics, Canada.* NFIRAOS is a diffraction-limited, near-IR, multi-conjugate adaptive optics system. We present an overview of the optical design and design drivers, with particular attention given to the challenges of the laser guide star wavefront sensing optics.

IWD2 • 4:45 p.m.
Design and Construction of a Short-Wave Infrared 3.3X Continuous Zoom Lens, *Craig Olson*, *Tim Goodman, Chris Addiego, Steve Mifsud; L3 Communications, Sonoma Electro-Optics, USA.* We outline a design process for short-wave infrared (SWIR) continuous zoom lenses using a given design form that addresses the reduced material dispersion and corresponding aberration shifts in that band. Measurement data confirms the approach.

IWD3 • 5:00 p.m.
Toward the Global Optimum in Lithographic Lens Design, *Aurelian Dodoc*; *Carl Zeiss AG, Germany.* Significant advances have been made in recent years in the development of the lithography optics. This article describes the best performing lens types and design principles of the catadioptric concept of these lenses.

IWD4 • 5:15 p.m.
Performance of a Liquid Lens Enabled Optical Coherence Microscope with Gabor Fusion, *Jannick P. Rolland*[1,2], *Supraja Murali*[2,3], *Panomsak Meemon*[2], *Paul Glenn*[4], *Kevin P. Thompson*[5], *Kye-Sung Lee*[1]; [1]*Inst. of Optics, Univ. of Rochester, USA,* [2]*CREOL, Univ. of Central Florida, USA,* [3]*General Optics Asia, Ltd., India,* [4]*Bauer Associates, Inc., USA,* [5]*Optical Res. Associates, USA.* A custom microscope with an integrated Varioptic liquid lens has been fabricated and shown to provide subcellular resolution using Gabor image fusion. MTF testing and final fused images are shown.

IWD5 • 5:30 p.m.
Third Order Dispersion Effects Generated by Achromatic Doublets on sub-20 Femtosecond Optical Pulses, *Martha Rosete-Aguilar*, *Flor C. Estrada-Silva, Jesus Garduño-Mejía, Neil C. Bruce; Ctr. de Ciencias Aplicadas y Desarrollo Tecnologico, Univ. Nacional Autónoma de Mexico, Mexico.* We analyze the focusing of 20fs and 15fs ultrashort pulses using achromatic lenses by expanding the wave numbers of the pulse around the center frequency of the incident pulse up to the third order.

OWE • Mid-Spatials and PSD

Wednesday, June 16
4:30 p.m.–6:00 p.m.
David Aikens; Savvy Optics Corp., USA, Presider

OWE1 • 4:30 p.m. Invited
Power Spectral Density: Is It Right?, *John P. Lehan*[1,2], *Ulf Griesmann*[3], *Jiyoung Chu*[3,4]; [1]*NASA Goddard Space Flight Ctr., USA,* [2]*Dept. of Physics, Univ. of Maryland, Baltimore County, USA,* [3]*Natl. Inst. of Standards and Technology, USA,* [4]*Samsung Electronics Co., Korea, Republic of.* We concentrate on the instrumental issues surrounding power spectral density (PSD) determination employing Fizeau interferometers. We briefly discuss the properties of an ideal calibration method and some methods that have been used previously.

OWE2 • 5:00 p.m.
VIBE™ Finishing to Remove Mid-Spatial Frequency Ripple, *Jessica DeGroote Nelson*, *Brandon Light, Daniel Savage, Robert Wiederhold, Michael Mandina; Optimax Systems Inc., USA.* The VIBE process is a full-aperture, conformal polishing process incorporating high frequency and random motion designed to rapidly remove sub-surface damage in a VIBE pre-polish step and eliminate MSF errors in a VIBE finishing step.

OWE3 • 5:15 p.m.
Optical Surface Specification Using the Structure Function, *Robert E. Parks*; *College of Optical Sciences, Univ. of Arizona, USA.* The structure function is suggested as a means of specifying surface figure and roughness in order to avoid surface errors that have regions of high slope that produce unacceptable imaging performance.

OWE4 • 5:30 p.m.
Detection and Removal of Spatial Mid-Frequencies in Sub-Aperture Finishing, *Oliver Fähnle*, *Safer Mourad, Karin Hauser, Mark Meeder; FSIBA OPTIK AG, Switzerland.* A study is presented on the generation and removal of mid-frequencies in sub-aperture polishing applying Fluid Jet Polishing. To that aim, the footprint diameters are scaled and optimized by analyzing their impact on PSDs.

IWD • Optical Systems II: Zoom Lenses and Advanced Optical System Design—Continued

IWD6 • 5:45 p.m.
Dual Band Infrared Continuous Zoom Lenses, ***Jay N. Vizgaitis****; US Army RDECOM CERDEC NVESD, USA.* Three design solutions for dual band continuous zoom lenses for dual band MWIR/LWIR detectors. The designs maximize zoom range and performance while minimizing lens count. Dual f/number capability is utilized to increase the zoom range.

IWD7 • 6:00 p.m. Student Award Participant
Active Imaging Lens with Real-Time Variable Resolution and Constant Field of View, ***Jocelyn Parent****, Simon Thibault; Laval Univ., Pavilion of Optics and Photonics, Canada.* We present a smart lens with an active optic element to modify in real-time the distortion. This way, while keeping the total field of view constant, the resolution is increased in a zone of interest.

IWE • Design and Illumination Problem Presentations and Student Awards Ceremony

Wednesday, June 16
7:30 p.m.–9:30 p.m.

Join the IODC community for a guaranteed highlight of the conference: the illumination and lens design contest presentations. As usual, significant work has gone into developing and scoring the submissions, as well as all of the hard work put in by solution submitters. Additionally, the winners of the best student paper awards for the 2010 IODC will be announced at the conclusion of the design problem presentations.

See the "Conference Highlights" section in the front of the book for more information on the design problems and student presentation awards.

OWE • Mid-Spatials and PSD—Continued

OWE5 • 5:45 p.m.
2-D Spatial Frequency Considerations in Comparing 1D Power Spectral Density Measurements, ***Peter Z. Takacs****[1], Sam Barber[2], Eugene L. Church[1], Konstantine Kaznatcheev[1], Wayne R. McKinney[2], Valeriy Yashchuk[2]; [1]Brookhaven Natl. Lab, USA, [2]Lawrence Berkeley Natl. Lab, USA.* The frequency footprint of 1D and 2D profiling instruments needs to be carefully considered in comparing 1D surface roughness spectrum measurements made by different instruments. Contributions from orthogonal direction frequency components can not be neglected.

OWF • Student Awards Ceremony and H. John Wood Presentation

Wednesday, June 16
6:00 p.m.–7:15 p.m.
Jessica DeGroote Nelson; Optimax Systems Inc., USA, Presider
Stephen Jacobs; Univ. of Rochester, USA, Presider

6:00 p.m.
OF&T Student Award Presentations
Through the generous support of the OSA Foundation, the OF&T Best Student Paper Award has been established to encourage excellence in research and scientific presentation skills in the student optics community. Awards include a cash prize and a certificate. There will be first- and second-place winners for both oral and poster presentations.

OWF1 • 6:30 p.m. **Invited**
Hubble Anthology, ***H. John Wood****; NASA Goddard Space Flight Ctr., USA.* Orbiting high above the turbulence of the earth's atmosphere, the Hubble Space Telescope (HST) is providing breathtaking views of astronomical objects never before seen in such detail. Understanding the images makes them even more beautiful.
See the "Conference Highlights" section in the front of the book for more information on H. John Wood, including a photo and a bio.

Thursday, June 17, 7:30 a.m.–10:00 a.m. Registration Open, *Lobby*

IThA • Design of Illumination Systems: Optimization and Tolerancing Approaches

Thursday, June 17
8:00 a.m.–10:00 a.m.
Narkis Shatz; SAIC, USA, Presider

IThA1 • 8:00 a.m.
Optimization of Illumination Systems Using Moment of Illumination Data, *Kenneth E. Moore,* ***Mark G. Nicholson****; ZEMAX Development Corp., USA.* Moment of Illumination data is shown to be a useful optimization target in illumination systems, yielding smooth merit functions and good noise tolerance.

IThA2 • 8:15 a.m. Invited
Iterative Reflector Design Using a Cumulative Flux Compensation Approach, ***William Cassarly****; Optical Res. Associates, USA.* Some illumination design approaches use the (actual illuminance)/(desired illuminance); however, the ratio is undefined when the actual and desired illuminance distributions have different sizes. We show an encircled energy approach that avoids this limitation.

IThA3 • 8:45 a.m.
Monte Carlo Tolerancing Tool Using Non-Sequential Ray Tracing on a Compute Cluster, ***Christopher Reimer****; Elcan Optical Technologies, Canada.* Monte Carlo tolerancing and non-sequential ray tracing are both known to have a high computational cost. This paper describes an almost interactive tool that combines these techniques on a compute cluster.

IThA4 • 9:00 a.m. Invited
Perturbative Design of Illumination Systems, ***R. John Koshel****[1,2]; [1]Photon Engineering LLC, USA, [2]College of Optical Sciences, Univ. of Arizona, USA.* Using the principles behind perturbation theory allows designs based on realistic inputs to be iteratively designed, optimized and/or toleranced. A reflective system will be used to illustrate the technique.

OThA • Aspheres

Thursday, June 17
8:30 a.m.–10:00 a.m.
Jeffrey L. Ruckman; Lockheed Martin Missiles and Fire Control, USA, Presider

OThA1 • 8:30 a.m.
Superpolishing Aspherical Mirrors Using Active Optics, ***Emmanuel Hugot****[1], Marc Ferrari[1], Kacem El Hadi[1], Gerard Lemaitre[1], Pierre Montiel[1], Kjetil Dohlen[1], Pascal Puget[2], Jean Luc Beuzit[2]; [1]Lab d'Astrophysique de Marseille, France, [2]Lab d'Astrophysique de Grenoble, France.* Progress in active optics allowed superpolishing under stress of three toric mirrors for the VLT-SPHERE instrument, minimizing residual speckles in stellar images and improving the accuracy of exoplanet detection.

OThA2 • 8:45 a.m.
Optical Testing Techniques for Highly Aspheric Tertiary Mirrors, ***Steven P. Maffett****, Steven D. O'Donohue; ITT Geospatial Systems, USA.* ITT Geospatial Systems has completed a Highly Aspheric Tertiary (HAT) strip mirror. The off axis conic was successfully processed and this paper documents that separate refractive and holographic null tests are both acceptable methods.

OThA3 • 9:00 a.m.
Nulling Fizeau Interferometer for Aspheric Surface Measurements, *Piotr Szwaykowski,* ***Artur Olszak****; Engineering Synthesis Design, Inc., USA.* Sub-Nyquist interferometry offers a way to bypass fringe density limitations but has several restrictions. In this paper we discuss a new method of measurements which simplifies alignment and alleviates most phase unwrapping and retrace errors.

IThA • Design of Illumination Systems: Optimization and Tolerancing Approaches—Continued

IThA5 • 9:30 a.m.
Illumination Design and Optimization Strategies, ***Henning Rehn****;* *OSRAM Specialty Lighting, Germany.* We report our experiences on the optimization of illumination systems and discuss how to take advantage of multi CPU computers. As an example, the design of a LED airfield lamp is shown.

IThA6 • 9:45 a.m.
Fresnel Based Phase Optimised General Error Diffusion Algorithm for Optical Beam Shaping, ***Jamie L. Ramsey****[1,3], Victor P. Sivokon[1], Trevor J. Hall[2], Ivan Andonovic[3], Craig Michie[3]; [1]ELCAN Optical Technologies, Canada, [2]Univ. of Ottawa, Photonic Technology Lab, Canada, [3]Univ. of Strathclyde, Dept. of Electronic and Electrical Engineering, UK.* A method for performing optical beam shaping in the near-field region using diffractive optical elements generated by Fresnel based phased optimised general error diffusion algorithm.

OThA • Aspheres—Continued

OThA4 • 9:15 a.m.
Combined CGH with Aperture Divided into Angular Sectors for Null Corrector Certification, ***Ruslan K. Nasyrov****, Alexander G. Poleshchuk; Inst. of Automation and Electrometry, Russian Acad. of Science SB RAS, Russian Federation.* Encoding method of spherical and aspherical wavefronts into one computer-generated hologram is presented. Diffractive structures are alternately inscripted into angular sector sub-apertures. Aspherical wavefront errors are identified by those of the spherical wavefront.

OThA5 • 9:30 a.m. **Invited**
Fabrication of Aspheric Deposits by CW Laser Deposition, ***Luis Rubio-Peña****, José Andrés Ángel, Juan Valverde, Juan María González-Leal; Univ. of Cadiz, Spain.* A novel method for the fabrication of aspherics by a continuous-wave laser deposition technique is introduced and results for an IR-transmitting amorphous As-S alloy are reported.

10:00 a.m.–10:30 a.m. Coffee Break, *Mezzanine-Grand/Lobby*

NOTES

IThB • What's in Your Optical Design and Analysis Toolkit?

Thursday, June 17
10:30 a.m.–12:30 p.m.
Mark G. Nicholson; ZEMAX Development Corp., USA, Presider

IThB1 • 10:30 a.m.
Global Optimization with Traveling Aspherics—Aspheric Surface Number as Continuous Variable, ***Akira Yabe****; Consultant, Germany.* The author proposes a way to extend the aspheric surface number to a continuous variable. It is reported that the optimal aspheric surface numbers are achieved through the global optimization for practical lens design problems.

IThB2 • 10:45 a.m.
Recent Discoveries from Nodal Aberration Theory, ***Kevin P. Thompson***[1]*, Tobias Schmid*[2]*, Pai-Fong Kao*[3]*, Jannick P. Rolland*[2,3]*;* [1]*Optical Res. Associates, USA,* [2]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA,* [3]*Inst. of Optics, Univ. of Rochester, USA.* Nodal Aberration Theory (NAT) was discovered in 1977 and was last presented at this conference 25 years ago. This paper presents recent discoveries and why this theory is gaining in relevance for the future.

IThB3 • 11:00 a.m.
Automatic Determination of Optimal Aspheric Placement, ***Thomas G. Kuper****, John R. Rogers; Optical Res. Associates, USA.* We describe a tool that analyzes the characteristics of an existing lens, and then determines which surfaces should be made aspheric for optimal results. We apply this tool to several problems, and discuss the results.

IThB4 • 11:15 a.m.
Gaussian Quadrature Ray Selection on the Non-Circular Pupil, ***Brian J. Bauman***[1]*, Hong Xiao*[2]*;* [1]*Lawrence Livermore Natl. Lab, USA,* [2]*Univ. of California at Davis, USA.* Gaussian Quadrature methods of selecting rays in ray-tracing are derived for centrally-obscured and vignetted apertures, and are generalized for use in arbitrary wavelength bands. These design conditions perform as efficiently as the circular pupil case.

IThB5 • 11:30 a.m.
DOEs for Color Correction in Broad Band Optical Systems: Validity and Limits of Efficiency Approximations, ***Markus Seesselberg****, Bernd H. Kleemann; Carl Zeiss AG, Germany.* Based on design examples of optical systems with DOEs for color correction, limits of diffraction efficiency approximations are discussed. These formulae enable optical designers to estimate the amount of stray light from unwanted diffraction orders.

OThB • Polishing

Thursday, June 17
10:30 a.m.–12:30 p.m.
Stephen Jacobs; Univ. of Rochester, USA, Presider

OThB1 • 10:30 a.m. Invited
Polishing Glass—From Basic Investigations to Industrial Applications, ***D. Waechter****, R. Zunke, U. Schneider, O. Dambon, F. Klocke; Fraunhofer IPT, Germany.* The Fraunhofer IPT investigates the basic interactions in chemical-mechanical polishing of glass. The knowledge is put together in a monitoring system and the fundamental understanding is applied to current issues in full- and sub-aperture polishing.

OThB2 • 11:00 a.m.
Deterministic Computer-Controlled Polishing Process for High-Energy X-Ray Optics, ***Gufran S. Khan****, Mikhail Gubarev, Chet Speegle, Brian Ramsey; Marshall Space Flight Ctr., USA.* A deterministic computer-controlled polishing process for large X-ray mirror mandrels is presented. Using tool's influence function and material removal rate extracted from polishing experiments, design considerations of polishing laps and optimized operating parameters are discussed.

OThB3 • 11:15 a.m.
Magnetorheological Finishing of Tungsten Carbide Mold Materials, ***Christopher Hall***[1]*, Yuji Horie*[1]*, Paul Dumas*[1]*, Marc Tricard*[1]*,* ***Michael DeMarco***[1]*, Masanobu Tsuda*[2]*, Masato Kasugai*[2]*;* [1]*QED Technologies, USA,* [2]*Fuji Die, Japan.* Recent MRF polishing results of Tungsten Carbide (WC) mold materials will be presented. Excellent roughness values are reported, particularly on fine-grained TSJ02 WC, which led to sub-nanometer Ra values.

OThB4 • 11:30 a.m.
UFF Spotting Technique for Studying Polishing Process Conditions for Optical Glasses and Ceramics, ***Shai N. Shafrir***[1,2]*, Scott Bambrick*[1]*, Paul D. Funkenbusch*[2]*;* [1]*OptiPro System, USA,* [2]*Dept. of Mechanical Engineering, Univ. of Rochester, USA.* We report on the use of UltraForm Finishing spot taking technique to study the surface interactions and process parameters with a variety of polishing pads. The work extends from relatively soft glasses to hard ceramics.

IThB • What's in Your Optical Design and Analysis Toolkit?—Continued

IThB6 • 11:45 a.m.
Generalized Coddington Equations for Refractive/Diffractive Hybrid Surfaces, ***Chunyu Zhao****, James H. Burge; College of Optical Sciences, Univ. of Arizona, USA.* We derived the generalized Coddington Equations for diffractive/refractive hybrid surfaces by using the general Snell's law and differential ray tracing approach. The Equations are given in two forms: matrix formalism and explicit expressions.

IThB7 • 12:00 p.m.
Withdrawn

IThB8 • 12:15 p.m.
Objective with Supressed Single Reflexes, ***Jan Buchheister****, Christopher Weth; Carl Zeiss AG, Germany.* Using objectives in a reflected light condition can cause undesired reflexes at dielectric transitions. An optimization method to suppress single reflexes by reflecting them out will be shown as well as a design example.

OThB • Polishing—Continued

OThB5 • 11:45 a.m.
The Response of Pitch to Higher Frequency Vibrations, ***Brigid Mullany****, Jonathan Beaman; Univ. of North Carolina at Charlotte, USA.* Different grades of polishing pitch were subjected to vibrations with different frequencies (50Hz to 16kHz). Accelerometers monitored the extent to which vibrations pass through the pitch. Only vibrations over the pitch's resonance frequency are attenuated.

OThB6 • 12:00 p.m. **Invited**
One Year of Finishing Meter-Class Optics with MRF® at L-3 IOS Brashear Optics, ***François Piché****, Andrew R. Clarkson; L-3 IOS Brashear Optics, USA.* L-3 IOS Brashear Optics has been using the Q22-2000F, a 2.3-meter class MRF® platform, to figure a series of 0.75-1.8 meter class optics to completion. We describe accomplishments and performance, and demonstrate gains achieved.

NOTES

Key to Authors and Presiders

(Bold denotes Presider of Presenting Author)

International Optical Design Conference (IODC)/ Optical Fabrication and Testing (OF&T) Update Sheet

Agenda of Sessions Update:
In the program book, the rooms were omitted inadvertently from the top of the agenda of sessions for Monday and Tuesday. Please see the reverse of this page for a corrected agenda for Monday and Tuesday.

Withdrawals:
JMB3
JMB19
ITuD2

Key to Authors and Presiders Corrections:
On page 46, presentation IWC2 is attributed to John M. Tamkin, but should be attributed to John Tamkin, Jr.

On page 44, Chris Ghio is incorrectly listed as the presider for session OThA. On page 45, Kazuyoshi Itoh is incorrectly listed as the presider for session OThA. The presider for session OThA is Jeffrey L. Ruckman; Lockheed Martin Missiles and Fire Control, USA.

Presentation Updates: Please see the postdeadline papers book for times and locations of postdeadline paper presentations. Postdeadline papers will be presented throughout the week in various oral sessions as well as in the poster session.

The organizers acknowledge the generous support from the following sponsors:

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	IODC Grand Room	IODC Lodge Room, Pavilion	OF&T Teton Room
Sunday, June 13			
3:00 p.m.–6:00 p.m.	**Registration Open,** *Lobby*		
Monday, June 14			
7:00 a.m.–6:00 p.m.	**Registration Open,** *Lobby*		
8:00 a.m.–9:30 a.m.	**JMA • Joint IODC/OF&T Plenary Session**		
9:30 a.m.–10:00 a.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
9:30 a.m.–4:30 p.m.	**Exhibits Open,** *Mezzanine-Grand/Lobby*		
10:00 a.m.–12:30 p.m.	**IMA • Surface Plasmons Plenary, Emerging Technologies and Fundamental Optical Design, and Kidger and Hilbert Award Presentations**		**OMA • Interferometry**
12:30 p.m.–2:00 p.m.	**Lunch** *(on your own)*		
2:00 p.m.–4:00 p.m.	**IMB • Illumination Engineering: Principles and Practice**		**OMB • Metrology**
4:00 p.m.–4:30 p.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
4:30 p.m.–6:00 p.m.	**IMC • Optical Surface Representation and Freeform Design**		**OMC • Optical Materials**
6:00 p.m.–8:00 p.m.	**JMB • Joint IODC/OF&T Poster Session,** *Exhibit Hall, Pavilion*		
Tuesday, June 15			
7:30 a.m.–6:00 p.m.	**Registration Open,** *Lobby*		
8:00 a.m.–10:00 a.m.	**ITuA • Optical Systems I: Telescopes, Binoculars and Reflective Systems**		**OTuA • Specification and Measurement**
10:00 a.m.–10:30 a.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby*		
10:00 a.m.–4:30 p.m.	**Exhibits Open,** *Mezzanine-Grand/Lobby*		
10:30 a.m.–12:30 p.m.	**ITuB • Optical Design for Modern Digital Systems and Computational Imaging** (ends at 12:15 p.m.)		**OTuB • Large Optics** (ends at 12:45 p.m.)
12:30 p.m.–2:00 p.m.	**Lunch** *(on your own)*		
2:00 p.m.–4:00 p.m.	**ITuC • Design and Applications of Illumination Systems**	**ITuD • Design and Analysis Considerations for Optical System Fabrication and Testing**	**OTuC • Laser Writing in Materials**
4:00 p.m.–4:30 p.m.	**Coffee Break/Exhibits,** *Mezzanine-Grand/Lobby and Lodge Room, Pavilion*		
4:30 p.m.–6:00 p.m.	**ITuE • Modeling and Testing of Illuminations Systems and Components**	**ITuF •Manufacturing Considerations for Optical Design Producibility and Tolerance Desensitization**	**OTuD • Freefrom Optics**
6:00 p.m.–7:30 p.m.	**Joint Conference Reception,** *Atrium*		
7:00 p.m.–8:00 p.m.	**Memorial Program,** *Grand Room*		

IODC Postdeadline Presentations

• Monday, June 14, 2010 •

Exhibit Hall, Pavilion
6:00 p.m.–8:00 p.m.
JMB • Joint IODC/OF&T Poster Session

JMB44P
Design of Freeform Lenses for Illumination, ***Nikolai I. Petrov****, Georgy Tananaev, Emil Aslanov; LG Technology Ctr., Moscow, Russian Federation.* Reflective and refractive type of lenses for LED emitting into circle and square illumination areas are proposed. Lens surface profiles for extended sources are obtained from the solution of the first order differential equations.

JMB45P
Measurement and Characterization of Dimpled Planar Light Guide Prototypes, ***Michael Brown****, Duncan Moore, Greg Schmidt, Blair Unger; Inst. of Optics, Univ. of Rochester, USA.* A dimpled light guide solar concentrator has been manufactured, and measurements of this prototype have been successfully modeled to predict performance. A second generation prototype was manufactured with 70% optical efficiency at 60x geometric concentration.

JMB46P
Concentrated Photovoltaic Stepped Planar Light Guide, *Duncan Moore,* ***Greg R. Schmidt****, Blair Unger; Inst. of Optics, Univ. of Rochester, USA.* A stepped planar light guide concentrated photovoltaic system is presented. The guide design prevents trapped light from being rejected at other injection facets. Concentration in the guide is 112.5x.

• Tuesday, June 15, 2010 •

Grand Room
8:00 a.m.–10:00 a.m.
ITuA • Optical Systems I: Telescopes, Binoculars and Reflective Systems
Jannick P. Rolland; Inst. of Optics, Univ. of Rochester, USA, Presider

ITuA4P • 9:00 a.m.
Current Concept for the 4-m European Solar Telescope (EST) Optical Design, ***Jorge Sánchez-Capuchino***[1]*, Manuel Collados*[1]*, Dirk Soltau*[2]*, Roberto López*[1]*, José Luis Rasilla*[1]*, Bernard Gelly*[3]*;* [1]*Inst. de Astrofísica de Canarias (IAC), Spain,* [2]*Kiepenheuer-Inst. für Sonneohysik (KIS), Germany,* [3]*THEMIS, France*. EST is a pan-European project for a 4-meter class solar telescope conceptual design. Its concept integrates optical transfer stages assembling AO-MCAO with optical field de-rotation being time and wavelength invariant in terms of polarization.

Grand Room
4:30 p.m.–6:00 p.m.
ITuE • Modeling and Testing of Illuminations Systems and Components
Richard Pfisterer; Photon Engineering, LLC, USA, Presider

ITuE5P • 5:45 p.m.
Dimpled Planar Lightguide Solar Concentrators, ***Blair L. Unger****, Greg R. Schmidt, Duncan T. Moore; Inst. of Optics, Univ. of Rochester, USA.* Lightguide concentrators show tremendous promise for thin form-factor, lightweight, and inexpensive replacements for the current generation of refractive and reflective solar concentrators. We propose a new type of structure for reducing optical losses and dramatically increasing the practical upper limit on concentration within micro-structured lightguide concentrators.

IODC Postdeadline Presentations—*Continued*

• Tuesday, June 15, 2010 •

Lodge Room, Pavilion
4:30 p.m.–6:00 p.m.
ITuF • Manufacturing Considerations for Optical Design Producibility and Tolerance Desensitization
Gary Wiese; Lockheed Martin Corp., USA, Presider

ITuF4P • 5:15 p.m.
HHG Beam Wavefront Measurement by XUV PDI Sensor, *Pavel Homer, *Bedrich Rus, Jan Hřebíček, Michaela Kozlová, David Snopek; Inst. of Physics AS CR, v. v. i., Czech Republic.* We performed measurement of the XUV HHG (High Harmonics Generation) beam wavefront by the PDI (Point Diffraction Interferometer) sensor recently. We will discuss obtained results as well as design and setup of the PDI sensor.

• Wednesday, June 16, 2010 •

Grand Room
8:00 a.m.–10:00 a.m.
IWA • Polarization in Optical Design
Costin E. Curatu; Alcon Labs, USA, Presider

IWA7P • 9:45 a.m.
Stress Birefringence for Extended Depth of Focus Imaging, *Thomas G. Brown, *Amber M. Beckley; Inst. of Optics, Univ. of Rochester, USA.* A stressed element with sixfold symmetry can apodize a pupil with a superposition of positive and negative spherical aberrations. The point spread function for this system shows two marginal foci symmetrically separated from the paraxial focus, offering the possibility of using this type of element for extended depth of focus imaging.

• Thursday, June 17, 2010 •

Grand Room
10:30 a.m.–12:45 p.m.
IThB • What's in Your Optical Design and Analysis Toolkit?
Mark G. Nicholson; ZEMAX Development Corp., USA, Presider

IThB7P • 12:00 p.m.
Calculation of Third-Order Misalignment Aberrations with the Optical Plate Diagram, *Andrew Rakich; *Large Binocular Telescope Observatory, USA.* The Optical Plate diagram has been generalized to allow the calculation of third-order misalignment aberrations for axially-symmetrical optical systems. This method simplifies third-order analysis, yielding useful insight into asymmetric field aberrations in perturbed optical systems.

IThB9P • 12:30 p.m.
Optical Configuration for the VNS Spectrometer of the EarthCARE Multi-Spectral Imager Instrument, *Oana van der Togt[1], *Rob Vink*[1], *Isabel Escudero-Sanz*[2]; [1]*TNO, Netherlands,* [2]*European Space Agency ESTEC SRE-PAI, Netherlands.* We present the optical configuration of an imaging filter spectrometer, part of the European Space Agency Multi-Spectral Imager instrument, that will provide information on the clouds for a better understanding of Earth climate.

OF&T Postdeadline Presentations

• Monday, June 14, 2010 •

Exhibit Hall, Pavilion
6:00 p.m.–8:00 p.m.
JMB • Joint IODC/OF&T Poster Session

JMB47P
Application of the NANOMEFOS Non-Contact Measurement Machine in Asphere and Freeform Optics Production, *Rens Henselmans*, *Guido Gubbels, Casper van Drunen; TNO Science & Industry, Netherlands.* The NANOMEFOS machine is capable of fast, non-contact, universal measurement of aspheres and freeforms, up to Æ500 mm with an uncertainty below 30 nm (2σ). It is now being applied in optics production at TNO.

• Wednesday, June 16, 2010 •

Teton Room
6:00 p.m.–8:00 p.m.
OWF • Student Awards Ceremony and H. John Wood Presentation
Jessica DeGroote Nelson; Optimax Systems Inc., USA; and Stephen Jacobs; Univ. of Rochester, USA, Presiders

OWF2P • 7:30 p.m.
Fabrication and Test of Spherical Primary Optical Telescope (SPOT) Segments, *John Hagopian*, *Jason Budinoff, Bruce Dean, Joseph Howard, Carl Strojny; NASA Goddard Space Flight Ctr., USA.* Spherical primary telescopes are cost effective for large segmented apertures. The SPOT segments are cast in pyrex and shaped to allow radius of curvature control. This paper discusses design, fabrication and performance of SPOT segments.

OWF3P• 7:45 p.m.
Modeling of Deformed Segmented Mirrors in Grazing Incidence Telescopes, *Martina Atanassova*, *Timo Saha, William Zhang; NASA Goddard Space Flight Ctr., USA.* This work shows an approach for modeling "as-fabricated" and "as-mounted" segmented mirrors in grazing incidence telescopes. The model is used to balance the impact of fabrication/mount deformations with segment alignment in the final telescope.

Key to Authors and Presiders

(Bold denotes Presider of Presenting Author)