

**SPIE.** LASER  
DAMAGE

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2014

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# LASER DAMAGE 2014.

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TECHNICAL  
PROGRAM

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XLVI ANNUAL SYMPOSIUM ON OPTICAL  
MATERIALS FOR HIGH-POWER LASERS

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National Institute of  
Standards and Technology  
Boulder, Colorado, USA  
Conference: 14-17 September 2014



2014

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# **SPIE.** LASER DAMAGE

**XLVI ANNUAL SYMPOSIUM ON OPTICAL MATERIALS FOR HIGH-POWER LASERS**

**Conference: 14–17 September 2014**

**National Institute of  
Standards and Technology  
Boulder, Colorado, USA**

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# Welcome

On behalf of SPIE and the Organizing Committee, we welcome you to the 46th Annual Symposium on Optical Materials for High Power Lasers. This meeting is the leading forum for the exchange of information on the physics/technology of materials for high-power/high-energy lasers. The series of conference proceedings has grown to be a comprehensive source of information on optics for lasers and includes topics on laser-induced damage mechanisms, materials and thin film preparation, durability, properties modeling, testing, and component fabrication.

The Symposium will include both oral and poster presentations with no parallel sessions. This year, a seminal tutorial focused on the growth and characterization of amorphous thin films for interference coatings will replace our Sunday afternoon Round Table Discussion.

Distinguished international researchers in the field of optics for high-power/high-energy lasers will present invited talks. Submissions are solicited for the four core technical sessions and the Mini-Symposium.

Welcome to Boulder. We hope you will have a great experience attending the sessions and enjoy your time networking with other experts in this field.



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## CONFERENCE CHAIRS

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**Gregory J. Exarhos**  
Pacific Northwest  
National Lab.  
(USA)



**Vitaly E. Gruzdev**  
Univ. of Mis-  
souri-Columbia  
(USA)



**Joseph A. Menapace**  
Lawrence Liver-  
more National  
Lab. (USA)



**Detlev Ristau**  
Laser Zentrum  
Hannover e.V.  
(Germany)



**MJ Soileau**  
Univ. of Central  
Florida (USA)

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## INTERNATIONAL PROGRAM COMMITTEE

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**Detlev Ristau** (Committee  
Chair), Laser Zentrum  
Hannover e.V. (Germany)

**James E. Andrew**, AWE plc  
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**Jonathan W. Arenberg**,  
Northrop Grumman Aerospace  
Systems (USA)

**Mireille Commandré**, Institut  
Fresnel (France)

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Livermore National Lab. (USA)

**Leonid B. Glebov**, CREOL, Univ.  
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**Takahisa Jitsuno**, Osaka Univ.  
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**Carmen S. Menoni**, Colorado  
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**Masataka Murahara**, Tokai Univ.  
(Japan)

**Jérôme Néauport**, Commissariat  
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**Semyon Papernov**, Univ. of  
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**Wolfgang Rudolph**, The Univ. of  
New Mexico (USA)

**Jianda Shao**, Shanghai Institute  
of Optics and Fine Mechanics  
(China)

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Jefferson National Accelerator  
Facility (USA)

**Christopher J. Stolz**, Lawrence  
Livermore National Lab. (USA)

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Arthur H. Guenther and  
Alexander J. Glass

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## ORGANIZER

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## NIST TECHNICAL SPONSOR

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Michael Kelley

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## CONFERENCE SITE

Monday – Wednesday  
NIST Building 1 (Radio Bldg.)  
325 Broadway  
Boulder, Colorado, USA  
[www.boulder.nist.gov](http://www.boulder.nist.gov)

## SUNDAY EVENTS HOTEL

**Boulder Marriott**  
2660 Canyon Blvd.  
Boulder, Colorado, USA  
Tel: 303 440 8877

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## HOTEL AND LODGING ACCOMMODATIONS

Hotel and Travel Information:  
[www.spie.org/ld](http://www.spie.org/ld)  
Visit [boulderlodging.com](http://boulderlodging.com)

## QUESTIONS?

SPIE, PO Box 10,  
Bellingham, WA98227-0010USA  
[www.spie.org/ld](http://www.spie.org/ld)  
[help@spie.org](mailto:help@spie.org)  
Tel: +1 360 676 3290  
Fax: +1 360 647 1445

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## SPECIAL EVENTS

# Sunday 14 September

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TUTORIAL ON

## Fundamentals of Growth and Characterization of Amorphous Thin Films for Interference Coatings

6:00 to 7:00 pm

Location: Boulder Marriott, Montrachet Room



Chaired by:

**Carmen S. Menoni**, Colorado State Univ. (USA)

**Wolfgang Rudolph**, Univ. of New Mexico (USA)

This tutorial will cover fundamentals of thin film growth of amorphous dielectrics used in the engineering of thin films coatings. Different deposition methodologies and the resulting characteristics of the films will be discussed. Routine and emerging thin film characterization techniques will be described with emphasis on film properties that affect film performance under intense laser illumination.



## Welcome and Social Mixer

7:00 to 8:30 pm

Location: Boulder Marriott, Montrachet Room

Join your colleagues for light refreshments and mingling.

Guest tickets are available onsite for purchase, \$20 USD.

**Registration Material Pick-up will available 5:30 to 8:30 pm.**

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# Monday 15 September

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## Open House and Reception

6:30 to 8:00 pm

Invitation and Driving Instructions included in Registration Packet.

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# Tuesday 16 September

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## Wine and Cheese Tasting Reception

6:30 to 8:00 pm

SPONSORED BY: **SPIE**, and  
**the Conference Co-chairs of Laser Damage XLVI**

## Reception at NCAR

1850 Table Mesa Dr., Boulder, CO

All attendees are invited to join us in an amazing location for an enjoyable evening of wine tasting, local brews, and a selection of cheese appetizers.

Guest tickets are available for purchase onsite, \$25 USD.

FOOD AND DRINK SPONSORED BY :



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## SPECIAL EVENTS

# Wednesday 17 September

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## NIST Facility Tours

12:10 to 12:55 pm

NIST has generously offered to provide 2 limited tours of the facility, including the **NIST-F1/NIST-F2 Atomic Clocks** and to **Josh Hadler's Laser Welding Lab**.



Space is limited. Sign up onsite by 2:00 pm on Tuesday to reserve your place. First come, first served for Laser Damage Attendees only. A sign-up sheet will be at the registration desk.

## Standardization Round-Table Discussion

12:30 to 1:30 pm · Location: NIST, Room 4020

OEOSC is hosting a (BYOL) brown bag lunch meeting to discuss standardization issues for laser damage specification and testing. There will be a brief presentation of the current state of affairs for ANSI and ISO standards in the areas of laser damage threshold specifications and associated metrology, followed by a discussion of what kinds of standards are needed by the optics community, and how best to address these needs. About 1 hr.

Pick up lunch in the cafe and bring it to the meeting. Gather in NIST lobby and a NIST Representative will take you all to the meeting room.



SPIE thanks the following sponsors for their generous support.

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<p><b>LDS COMPETITION TESTING SITE</b></p>	<p><b>WINE AND CHEESE TASTING RECEPTION- FOOD AND DRINK</b></p>
	
<p><b>REFRESHMENT BREAK SPONSOR</b></p>	<p><b>OPEN HOUSE AND RECEPTION HOST</b></p>
	

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## CONFERENCE 9237

Sunday–Wednesday 14–17 September 2014  
Proceedings of SPIE Vol. 9237

# Laser-Induced Damage in Optical Materials: 2014

*Conference Chairs:* **Gregory J. Exarhos**, Pacific Northwest National Lab. (USA); **Vitaly E. Gruzdev**, Univ. of Missouri-Columbia (USA); **Joseph A. Menapace**, Lawrence Livermore National Lab. (USA); **Detlev Ristau**, Laser Zentrum Hannover e.V. (Germany); **MJ Soileau**, Univ. of Central Florida Office of Research & Commercialization (USA)

*Program Committee:* **Detlev Ristau**, Laser Zentrum Hannover e.V. (Committee Chair) (Germany); **James E. Andrew**, AWE plc (United Kingdom); **Jonathan W. Arenberg**, Northrop Grumman Aerospace Systems (USA); **Mireille Commandré**, Institut Fresnel (France); **Stavros G. Demos**, Lawrence Livermore National Lab. (USA); **Leonid B. Glebov**, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); **Takahisa Jitsuho**, Osaka Univ. (Japan); **Klaus Mann**, Laser-Lab. Göttingen e.V. (Germany); **Carmen S. Menoni**, Colorado State Univ. (USA); **Masataka Murahara**, Tokai Univ. (Japan); **Jérôme Néauport**, Commissariat à l'Énergie Atomique (France); **Semyon Papernov**, Univ. of Rochester (USA); **Wolfgang Rudolph**, The Univ. of New Mexico (USA); **Jianda Shao**, Shanghai Institute of Optics and Fine Mechanics (China); **Michelle D. Shinn**, Thomas Jefferson National Accelerator Facility (USA); **Christopher J. Stolz**, Lawrence Livermore National Lab. (USA)

**LOCATION: NIST AUDITORIUM**

## **SUNDAY 14 SEPTEMBER**

### **SUNDAY EVENTS**

**Boulder Marriott,**  
2660 Canyon Blvd., Boulder, Colorado

### **REGISTRATION MATERIAL PICK-UP**

**Location: Montrachet Room (1st Floor) . . . 5:30 pm to 8:30 pm**

NIST Security Badges will be available for attendees  
with a passport or photo ID.

### **TUTORIAL**

**Location: Montrachet Room, 1st Floor . 6:00 pm to 7:00 pm**

#### **Fundamentals of Growth and Characterization of Amorphous Thin Films for Interference Coatings**

Chaired by: **Carmen S. Menoni**, Colorado State Univ. (USA) and  
**Wolfgang Rudolph**, Univ. of New Mexico (USA)

This tutorial will cover fundamentals of thin film growth of amorphous dielectrics used in the engineering of thin films coatings. Different deposition methodologies and the resulting characteristics of the films will be discussed. Routine and emerging thin film characterization techniques will be described with emphasis on film properties that affect film performance under intense laser illumination.

### **WELCOME AND SOCIAL MIXER**

**Location: Montrachet Room (1st Floor) . . . 7:00 pm to 8:30 pm**

Join your colleagues for light refreshments, appetizers, and mingling.

**Registration Material Pick-up continues until 8:30 pm.**

# CONFERENCE 9237

## MONDAY 15 SEPTEMBER

### CONFERENCE LOCATION

**NIST, Building 1** (Radio Bldg.),  
324 Broadway, Boulder, Colorado

### REGISTRATION MATERIAL PICK-UP

**Location: NIST Lobby Area . . . . . 7:30 am to 4:00 pm**

Attendees must check-in with NIST Security at entrance and have photo identification available. Please allow 15 minutes for extra time on Monday morning.

### POSTER PLACEMENT AT NIST

**Location: Rooms 1&2 . . . . . 7:50 am to 8:20 am**

### OPENING REMARKS, 2013 AWARD PRESENTATIONS, AND TRIBUTE

**Location: NIST Auditorium . . . . . 8:20 am to 8:50 am**

#### 2013 Award Winners

##### BEST ORAL PRESENTATION

**Application of time-resolved digital holographic microscopy to study femtosecond damage process in thin films [8885-45]**

**Nerijus Siauyls, Andrius Melninkaitis**, Vilnius Univ. (Lithuania);  
**Laurent Gallais-During**, Institut Fresnel (France)

##### BEST POSTER PRESENTATION

**Optical contamination control in the Advanced LIGO ultra-high vacuum system [8885-88]**

**Margot H. Phelps, Kaitlin E. Gushwa, Calum I. Torrie**, California Institute of Technology (USA)

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#### Tribute to Dr. Aleksander Manenkov

The Symposium honors the theoretical contributions of the late Dr. Aleksander Manenkov who provided fundamental insight into the dynamics of high-energy laser interactions with optical materials.

## LOCATION: NIST AUDITORIUM

### SESSION 1

**Location: NIST Auditorium . . . . . Mon 8:50 am to 10:10 am**

#### **Surfaces, Mirrors, and Contamination I**

Session Chairs: **Joseph A. Menapace**, Lawrence Livermore National Lab. (USA); **MJ Soileau**, Univ. of Central Florida Office of Research & Commercialization (USA)

8:50 am: **Contamination of optical components: protecting optics installed in advanced LIGO from particulate contamination** (*Keynote Presentation*), Calum I. Torrie, California Institute of Technology (USA) and Scottish Univ. Physics Alliance (United Kingdom) . . . . . [9237-1]

9:30 am: **Low-loss and high damage-threshold mirror development for gravitational-wave detectors**, Daisuke Tatsumi, Akitoshi Ueda, National Astronomical Observatory of Japan (Japan); Hitoki Yoneda, The Univ. of Electro-Communications (Japan); Kazunari Sato, Sigma Koki Co., Ltd. (Japan). . . . . [9237-2]

9:50 am: **Control of contamination of optical components in vacuum chambers**, Takahisa Jitsuno, Hidetoshi Murakami, Katsuhiro Mikami, Shinji Motokoshi, Tetsuji Kawasaki, Noriaki Miyanaga, Hiroshi Azechi, Osaka Univ. (Japan). . . . . [9237-3]

### **MONDAY POSTER OVERVIEW**

**Location: NIST Auditorium . . . . . 10:10 am to 10:40 am**

Poster authors are asked to give a 2-minute/2-viewgraph overview of their posters in the order that they appear in the Monday program.

### **POSTER VIEWING AND REFRESHMENT BREAK-MONDAY AM**

**Location: Rooms 1&2 . . . . . 10:40 am to 11:40 am**

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 am to 11:40 am and again from 4:00 pm to 4:50 pm.

### **Thin Films**

**Study on defect in ZnS/YbF3 infrared coating on silicon**, Yinhua Zhang, Wei Huang, Institute of Optics and Electronics (China) . . . . . [9237-50]

**Repair of a mirror coating on a large optic for high laser-damage applications using ion milling and over-coating methods**, Ella S. Field, John C. Bellum, Damon E. Kletecka, Sandia National Labs. (USA) [9237-51]

## CONFERENCE 9237

**The damage characteristics of laser coatings irradiated from crystal-film interface at oblique incident angles**, Xinbin Cheng, Zhi Song, Hongping Ma, Bin Ma, Zhanshan Wang, Tongji Univ. (China) . . . . [9237-52]

**Modification of multilayer mirror top-layer design for increased laser damage resistance**, Drew D. Schiltz, Dinesh Patel, Colorado State Univ. (USA); Luke A. Emmert, The Univ. of New Mexico (USA); Cory Baumgarten, Brendan A. Reagan, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA); Jorge J. Rocca, Carmen S. Menoni, Colorado State Univ. (USA). . . . . [9237-53]

**Post deposition annealing of ion-beam sputtered  $\text{Sc}_2\text{O}_3$ ,  $\text{Ta}_2\text{O}_5$ ,  $\text{Y}_2\text{O}_3$  and  $\text{SiO}_2$  films of varying thicknesses and its impact on laser resistance**, Dinesh Patel, Drew D. Schiltz, Jon A. Peaman, Leandro Acquaroli, Elzbieta Jankowska, Colorado State Univ. (USA); Luke A. Emmert, Wolfgang Rudolph, The Univ. of New Mexico (USA); Carmen S. Menoni, Colorado State Univ. (USA). . . . . [9237-54]

**Comprehensive studies of UV light intensification by nodular defects in  $\text{HfO}_2$ - $\text{SiO}_2$  multilayer mirrors**, Linas Smalakys, Gintare Bataviciute, Egidijus Pupka, Andrius Melninkaitis, Vilnius Univ. (Lithuania). . . . . [9237-55]

**Study of functional coatings on YAG crystal plate**, Yang Zhao, Hongfei Jiao, Xinbin Cheng, Tongji Univ. (China). . . . . [9237-56]

**Electron-beam deposited distributed polarization rotator for high-power laser applications**, James B. Oliver, Terry J. Kessler, Semyon Papernov, Christopher Smith, Brittany N. Taylor, Vern Gruschow, Jeffrey Hettrick, Brian Charles, Univ. of Rochester (USA) . . . . . [9237-57]

**Ring-like damage morphologies produced by continuous-wave laser irradiation**, Lucas N. Taylor, Joseph J. Talghader, Univ. of Minnesota, Twin Cities (USA) . . . . . [9237-58]

**Influence of polishing and coating techniques on laser-induced damage threshold of AR-coated ceramic Yb:YAG**, Mariastefania De Vido, Paul J. Phillips, Jodie M. Smith, Klaus G. Ertel, Paul D. Mason, Saumyabrata Banerjee, Oleg Cheklov, Thomas J. Butcher, Stephanie Tomlinson, Andrew Lintern, Justin Greenhalgh, Waseem Shaikh, Steve J. Hawkes, Cristina Hernandez-Gomez, John L. Collier, Rutherford Appleton Lab. (United Kingdom); Joachim Hein, Joerg Körner, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [9237-59]

POSTER SESSION

Location: Rooms 1&2 ..... Mon 10:40 am to 11:40 am

Fundamental Mechanisms

**Ultrafast UV laser-induced dynamics in fused silica**, Juan Du, Shanghai Institute of Optics and Fine Mechanics (China); Bing Xue, Takayoshi Kobayashi, The Univ. of Electro-Communications (Japan) and Japan Science and Technology Agency (Japan); Zehan Li, Yuanan Zhao, Yuxin Leng, Ruxin Li, Zhizhan Xu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9237-60]

**Defects induced laser damage and laser conditioning of DKDP crystals**, Yuanan Zhao, Guohang Hu, Shanghai Institute of Optics and Fine Mechanics (China); Yueliang Wang, Junxiu Chang, Shanghai Institute of Optics and Fine Mechanics (China) and Univ. of Chinese Academy of Sciences (China); Meiping Zhu, Shanghai Institute of Optics and Fine Mechanics (China); Xun Sun, Shandong Univ. (China); Yuangen Yao, Fujian Institute of Research on the Structure of Matter (China); Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9237-61]

**Bulk breakdown of transparent solids under irradiation with nanosecond laser pulses**, Zia U. Rehman, Yavor V. Grigorov, Khoa A. Tran, Karol A. Janulewicz, Gwangju Institute of Science and Technology (Korea, Republic of) ..... [9237-62]

**Dual-wavelength ultra-short pulse laser damage testing**, Mark Gyamfi, Lars O. Jensen, Peter Jürgens, Laser Zentrum Hannover e.V. (Germany); Mathias Mende, LASEROPTIK GmbH (Germany); Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) ..... [9237-63]

**Simulations of CO<sub>2</sub> laser interaction with silica and comparison to experiments**, Thomas Doualle, Laurent Gallais, Institut Fresnel (France); Philippe Cormont, David Hébert, Patrick Combis, Jean-Luc Rullier, Commissariat à l'Énergie Atomique (France) ..... [9237-64]

**Laser-induced periodic surface structure (LIPSS) formation in germanium above laser damage fluence by mid-IR femtosecond laser irradiation**, Drake Austin, Kyle Kafka, The Ohio State Univ. (USA); Jian Cheng, Harbin Institute of Technology (China); Simeon Trendafilov, Gennady B. Shvets, The Univ. of Texas at Austin (USA); Hui Li, Allen Yi, Cosmin Blaga, Enam Chowdhury, Louis F. DiMauro, The Ohio State Univ. (USA) ..... [9237-65]

**Multiple wavelengths initiation and growth of laser-induced damage in fused silica in the nanosecond regime**, Maxime Chambonneau, Margaux Chanal, Commissariat à l'Énergie Atomique (France); Guillaume Duchateau, Univ. Bordeaux 1 (France); Pierre Grua, Commissariat à l'Énergie Atomique (France); Jean-Yves Natoli, Institut Fresnel (France); Jean-Luc Rullier, Laurent Lamaignère, Commissariat à l'Énergie Atomique (France) [9237-66]

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## CONFERENCE 9237

**Dynamics of electron-plasma density induced by ultra-short laser pulses in wide-band-gap solids**, Vitaly E. Gruzdev, Univ. of Missouri-Columbia (USA) . . . . . [9237-67]

### SESSION 2

**Location: NIST Auditorium . . . . . Mon 11:40 am to 1:20 pm**

#### **Surfaces, Mirrors, and Contamination II**

Session Chairs: **Semyon Papernov**, Univ. of Rochester (USA);  
**Christopher J. Stolz**, Lawrence Livermore National Lab. (USA)

11:40 am: **The effects of plasma physics target shrapnel and debris plumes arising from early operations of the Orion laser**, James E. Andrew, AWE plc (United Kingdom) . . . . . [9237-4]

12:00 pm: **Photothermal microscopic studies of surface and subsurface defects on fused silica at 355nm**, Jian Chen, Jingtao Dong, Qi Zhang, Zhouling Wu, ZC Optoelectronic Technologies, Ltd. (China) . . . . . [9237-5]

12:20 pm: **Influence of organic contamination on laser-induced damage of antireflective coatings and PVD mirrors by nanosecond and femtosecond laser pulses**, Olivier Favrat, Isabelle Tovenca-Pecault, Jérôme Néauport, Martin Sozet, Laurent Lamaignère, Commissariat à l'Énergie Atomique (France) . . . . . [9237-6]

12:40 pm: **Mapping of total scattering as a tool for long-term investigations in the cleaning state of the functional coated samples**, Puja Kadkhoda, Stefan Günster, Lars O. Jensen, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) . . . . . [9237-7]

1:00 pm: **Surface modification and etching process optimization of fused silica during reaction CHF<sub>3</sub>-Ar plasma etching**, Sun Laixi, Jin Huang, Xin Ye, Hongjie Liu, Xiaoyan Zhou, Weidong Wu, China Academy of Engineering Physics (China) . . . . . [9237-8]

Lunch Break . . . . . Mon 1:20 pm to 2:40 pm



**SESSION 3**

**Location: NIST Auditorium . . . . . Mon 2:40 pm to 4:00 pm**

**Mini-Symposium:  
Applications Related to Laser Damage I**

Session Chairs: **Jonathan W. Arenberg**,  
Northrop Grumman Aerospace Systems (USA); **Stavros G. Demos**,  
Lawrence Livermore National Lab. (USA)

2:40 pm: **Laser initiated shocks: a successful commercial application in laser peening** (*Plenary*), Lloyd A. Hackel, Metal Improvement Co. (USA) . . . . . [9237-9]

3:10 pm: **Laser-particle interaction: damage and nanopatterning** (*Plenary*), Philippe Delaporte, Catalin Contantinescu, Aude Vatry, Aude Marchand, Olivier P. Utéza, David Grojo, Lasers, Plasmas et Procédés Photoniques (France) . . . . . [9237-10]

3:40 pm: **High-power fiber laser weapons operational conception**, Ramazan Ekici, Harpak (Turkey) . . . . . [9237-11]

**POSTER VIEWING AND  
REFRESHMENT BREAK-MONDAY PM**

**Location: Rooms 1&2 . . . . . 4:00 pm to 4:50 pm**

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 am to 11:40 am and again from 4:00 pm to 4:50 pm.

**SESSION 4**

**Location: NIST Auditorium . . . . . Mon 4:50 pm to 6:10 pm**

**Mini Symposium:  
Applications Related to Laser Damage II**

Session Chairs: **Stavros G. Demos**,  
Lawrence Livermore National Lab. (USA); **Jianda Shao**, Shanghai Institute of Optics and Fine Mechanics (China)

4:50 pm: **Laser-induced tissue damage and regeneration** (*Plenary*), Gregory B. Altshuler, Cynosure, Inc. (USA). . . . . [9237-12]

5:20 pm: **Laser micro-beam irradiation for cell lysis, molecular delivery, and screening** (*Plenary*), Vasana Venugopalan, Univ. of California, Irvine (USA) . . . . . [9237-13]

5:50 pm: **Attacking security of quantum key distribution by laser damage**, Vadim Makarov, Univ. of Waterloo (Canada) . . . . . [9237-14]

# CONFERENCE 9237

## CLOSING REMARKS

Location: NIST Auditorium ..... 6:10 pm to 6:20 pm

## Open House and Reception

MON 6:30 TO 8:00 PM

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Invitation and Driving Instructions included in Registration Packet.

## TUESDAY 16 SEPTEMBER

### REGISTRATION MATERIAL PICK-UP

Location: NIST, Bldg 1 (Radio Bldg) ..... 7:30 am to 4:00 pm

### POSTER PLACEMENT

Location: Rooms 1&2 ..... 7:50 am to 8:20 am

### SESSION 5

Location: NIST Auditorium ..... Tue 8:20 am to 9:50 am

#### Thin Films I

Session Chairs: **James E. Andrew**, AWE plc (United Kingdom);  
**Joseph A. Menapace**, Lawrence Livermore National Lab. (USA)

8:20 am: **Large-aperture plasma-ion-assisted coatings for femtosecond-pulsed laser systems** (*Keynote Presentation*), James B. Oliver, Jake Bromage, Christopher Smith, Daniel Sadowski, Univ. of Rochester (USA) ..... [9237-15]

## LOCATION: NIST AUDITORIUM

8:50 am: **Ultrafast optical breakdown of multilayer thin-films at kHz and MHz repetition rates: a direct comparison**, Ivan B. Angelov, Max-Planck-Institut für Quantenoptik (Germany); Michael K. Trubetskov, Max-Planck-Institut für Quantenoptik (Germany) and Moscow State Univ. (Russian Federation); Vladislav S. Yakovlev, Max-Planck-Institut für Quantenoptik (Germany) and Ludwig-Maximilians-Univ. München (Germany); Olga Razskazovskaya, Max-Planck-Institut für Quantenoptik (Germany); Martin Gorjan, Max-Planck-Institut für Quantenoptik (Germany) and Ludwig-Maximilians-Univ. München (Germany); Helena G. Barros, Ludwig-Maximilians-Univ. München (Germany); Ferenc Krausz, Max-Planck-Institut für Quantenoptik (Germany) and Ludwig-Maximilians-Univ. München (Germany); Vladimir Prevak, Ludwig-Maximilians-Univ. München (Germany) and UltraFast Innovations GmbH (Germany) . . . . . [9237-16]

9:10 am: **UV to IR laser damage of magnetron sputtering films submitted to multiple sub-picosecond pulses**, Dam-Be L. Douti, Laurent Gallais, Christophe Hecquet, Thomas Begou, Mireille Commandré, Institut Fresnel (France) . . . . . [9237-17]

9:30 am: **Thin films characterizations to design high-reflective coatings for ultrafast high-power laser systems**, Adrien Hervy, Sagem SA (France) and Aix-Marseille Univ. (France) and Ecole Polytechnique (France); Laurent Gallais, Aix-Marseille Univ. (France); Daniel Mouricaud, REOSC (France); Gilles Chériaux, Ecole Polytechnique (France); Olivier P. Utéza, Raphael G. C. R. Clady, Marc L. Sentis, Aix-Marseille Univ. (France); Antoine Freneaux, Ecole Polytechnique (France) . . . . . [9237-18]

## TUESDAY POSTER OVERVIEW

**Location: NIST Auditorium . . . . . 10:00 am to 10:40 am**

Poster authors are asked to give a 2-minute/2-viewgraph overview of their posters in the order that they appear in the Monday program.

## POSTER VIEWING AND REFRESHMENT BREAK-TUESDAY AM

**Location: Rooms 1&2 . . . . . 10:40 am to 11:40 am**

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 am to 11:40 am and again from 3:40 pm to 4:30 pm.

## Materials and Measurements

**Research on laser damage of final optics assembly on high-power laser facility**, Dongfeng Zhao, Shanghai Institute of Optics and Fine Mechanics (China) and Univ. of Chinese Academy of Sciences (China); Rong Wu II, Zunqi Lin, Jianqiang Zhu, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9237-68]

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- Development of an automated absorption measurement instrument (a “turn-key” system) for optical thin film coatings**, Jingtao Dong, Jian Chen, Zhouling Wu, ZC Optoelectronic Technologies, Ltd. (China) . . . . . [9237-70]
- Fabrication of long-period fiber gratings using focused 266nm laser irradiation without occurrence of the laser-induced damage**, Takuya Kiriya, Yuta Kuroki, Yoshiki Kasahara, Yuki Tamura, Masaharu Nisioka, Hidehumi Hata, Haruki Nakagawa, Tomosumi Kamimura, Hisami Nishi, Osaka Institute of Technology (Japan) . . . . . [9237-72]
- Investigation of binary coating material mixtures using grazing incidence XUV-reflectometry**, Istvan Balasa, Laser Zentrum Hannover e.V. (Germany); Xavier Neiers, Lab. de Chimie Physique (France); Mathias Mende, LASEROPTIK GmbH (Germany); Lars O. Jensen, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) . . . . . [9237-73]
- Toward separation of bulk and interface defects: damage probability analysis of thin film coatings**, Linas Smalakys, Gintare Batavičiute, Egidijus Pupka, Andrius Melninkaitis, Vilnius Univ. (Lithuania) . . . . [9237-74]
- Station for LIDT tests of optical components under cryogenic conditions**, Jindrich Oulehla, Josef Lazar, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic) . . . . . [9237-75]
- Detection of the laser-damage onset in optical coatings by the photothermal-deflection method**, Katsuhiro Mikami, Osaka Univ. (Japan) and Univ. of Rochester (USA); Semyon Papernov, Univ. of Rochester (USA); Shinji Motokoshi, Osaka Univ. (Japan); Stephen D. Jacobs, Univ. of Rochester (USA); Takahisa Jitsuno, Osaka Univ. (Japan) . . . . . [9237-76]
- The microstructural origins of features observed in oxide films by third-harmonic microscopy**, Luke A. Emmert, Cristina Rodriguez, The Univ. of New Mexico (USA); Dinesh Patel, Drew D. Schiltz, Elzbieta Jankowska, Carmen S. Menoni, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA) . . . . . [9237-77]
- An empirical investigation of the laser survivability curve: V**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA); Wolfgang Riede, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Jonathan H. Herringer, Arrow Thin Films, Inc. (USA) . . . . . [9237-78]
- Analysis of the laser damage characteristics of a production lot**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA); Detlev Ristau, Lars O. Jensen, Laser Zentrum Hannover e.V. (Germany) . . . . . [9237-79]

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- Study of laser-induced fatigue effects in synthetic fused silica in the UV**, Céline Gouldieff, Institut Fresnel (France) and Institut de Physique de Rennes (France); Frank R. Wagner, Jean-Yves Natoli, Institut Fresnel (France) . . . . . [9237-80]
- Controllable liquid spread speed in the groove using femtosecond laser**, Jiawen Li, Guoqiang Li, Yanlei Hu, Bing Xu, Jiaru Chu, Wenhao Huang, Univ. of Science and Technology of China (China) . . . . . [9237-81]
- Laser damage test-bench with ultrashort pulses down to 10 fs**, Olivier P. Utéza, Pierre Blandin, Raphael G. C. R. Clady, Nicolas Sanner, Marc L. Sentis, Lasers, Plasmas et Procédés Photoniques (France); Yu Li, Shen Yan Long, Northwest Institute of Nuclear Technology (China) . . . . . [9237-82]
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- Ultraviolet laser damage tests of scratches repaired by carbon dioxide laser on fused silica optics**, Philippe Cormont, Sandy Cavaro, Commissariat à l'Énergie Atomique (France); Thomas Doualle, Institut Fresnel (France); Gael Gaborit, Commissariat à l'Énergie Atomique (France); Laurent Gallais, Institut Fresnel (France); Laurent Lemaignère, Jean-Luc Rullier, Commissariat à l'Énergie Atomique (France) . . . . . [9237-85]
- A study of ps-laser-induced-damage-threshold in hybrid metal-dielectric mirrors**, Vaclav Skoda, CRYTUR spol s.r.o. (Czech Republic); Jan Vanda, Institute of Physics of the ASCR, v.v.i. (Czech Republic) . . . . . [9237-86]
- Coming clean: understanding and mitigating optical contamination in advanced LIGO**, Kaitlin E. Gushwa, California Institute of Technology (USA); Calum I. Torrie, California Institute of Technology (USA) and Scottish Univ. Physics Alliance (United Kingdom) . . . . . [9237-87]

## CONFERENCE 9237

**Laser-induced damage tests under multiple wavelength irradiation of ATLID TXA optics for ESA-Satellite Mission EarthCare**, Uwe Leinhos, MicroLiquids GmbH (Germany); Klaus Mann, Wilhelm Huettner, Julian Sudradjat, Laser-Lab. Göttingen e.V. (Germany); Georgios D. Tzeremes, European Space Agency (Netherlands) . . . . . [9237-88]

**Cleaning practices and facilities for the Nation Ignition Facility**, James A. Pryatel, Akima Infrastructure Services (USA); William H. Gourdin, Gerald S. Ruble, Susan C. Frieders, Lawrence Livermore National Lab. (USA) . . . . . [9237-89]

**Surface damage correction, and atomic level smoothing of optics by accelerated neural atom beam (ANAB) processing**, Michael Walsh, Kiet Chau, Sean Kirkpatrick, Richard Svrluga, Exogenesis Corp. (USA) . . . . . [9237-90]

### SESSION 6

**Location: NIST Auditorium . . . . . Tue 11:40 am to 1:00 pm**

#### Thin Films II

Session Chairs: **Jérôme Néauport**, Commissariat à l'Énergie Atomique (France); **Detlev Ristau**, Laser Zentrum Hannover e.V. (Germany)

11:40 am: **Research on thin films with high laser-induced damage threshold deposited by atomic layer deposition**, Yaowei Wei, Chengdu Fine Optical Engineering Research Ctr. (China) . . . . . [9237-19]

12:00 pm: **Nonlinear behavior and damage of dispersive multilayer optical coatings induced by two-photon absorption**, Olga Razskazovskaya, Tran Trung Luu, Michael K. Trubetskov, Eleftherios Goulielmakis, Max-Planck-Institut für Quantenoptik (Germany); Ferenc Krausz, Max-Planck-Institut für Quantenoptik (Germany) and Ludwig-Maximilians-Univ. München (Germany); Vladimir Pervak, Ludwig-Maximilians-Univ. München (Germany). . . . . [9237-20]

12:20 pm: **Design concepts for stable AR coatings on UV frequency conversion crystals**, Lars O. Jensen, Marius A. Mrohs, Stefan Günster, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany). . . . . [9237-21]

12:40 pm: **1064nm Fabry Perot Transmission Filter Laser Damage Competition**, Christopher J. Stolz, Lawrence Livermore National Lab. (USA); Mark Caputo, Andrew J. Griffin, Michael D. Thomas, Spica Technologies, Inc. (USA) . . . . . [9237-22]

Lunch Break . . . . . Tue 1:00 pm to 2:20 pm

**LOCATION: NIST AUDITORIUM**

**SESSION 7**

**Location: NIST Auditorium . . . . . Tue 2:20 pm to 3:40 pm**

**Thin Films III**

Session Chairs: **Vitaly E. Gruzdev**, Univ. of Missouri-Columbia (USA);  
**Takahisa Jitsuno**, Osaka Univ. (Japan)

2:20 pm: **Characterization of HfO<sub>2</sub>-SiO<sub>2</sub> rugate multilayers deposited by ion beam sputtering**, Roman Rauhut, Kristina Nehls, Lars Mechold, Laser Components GmbH (Germany). . . . . [9237-23]

2:40 pm: **Coupling effect of subsurface defect and coating layer on the laser-induced damage threshold of dielectric coating**, Meiping Zhu, Kui Yi, Hongji Qi, Hu Wang, Wei Sun, Zhenkun Yu, Yuanan Zhao, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [9237-24]

3:00 pm: **Interface absorption versus film absorption in HfO<sub>2</sub>/SiO<sub>2</sub> thin-film pairs in the near-ultraviolet and relation to pulsed-laser damage**, Semyon Papernov, Alexei A. Kozlov, James B. Oliver, Univ. of Rochester (USA) . . . . . [9237-25]

3:20 pm: **Defect-initiated dielectric breakdown by nanosecond laser pulses in optical thin films studied by a single-shot laser damage test**, Yejia Xu, Luke A. Emmert, The Univ. of New Mexico (USA); Dinesh Patel, Carmen S. Menoni, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA). . . . . [9237-26]

**POSTER VIEWING AND REFRESHMENT  
BREAK-TUESDAY PM**

**Location: Rooms 1&2 . . . . . 3:40 pm to 4:30 pm**

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 am to 11:40 am and again from 3:40 pm to 4:30 pm.

# CONFERENCE 9237

## SESSION 8

**Location: NIST Auditorium . . . . . Tue 4:30 pm to 5:50 pm**

### Fundamental Mechanisms I

Session Chairs: **Jonathan W. Arenberg**, Northrop Grumman Aerospace Systems (USA); **Carmen S. Menoni**, Colorado State Univ. (USA)

4:30 pm: **Silica laser damage mechanisms, precursors, and their mitigation** (*Keynote Presentation*), Jeffrey D. Bude, Lawrence Livermore National Lab. (USA) . . . . . [9237-27]

5:10 pm: **Microstructure variation of intrinsic defects and voids in fused silica after exposure to low-fluence laser pulse at 355nm**, Chunhong Li, Xin Ju, Univ. of Science and Technology Beijing (China) . . . . . [9237-28]

5:30 pm: **The effects of subsurface defects on laser damage performance for fused silica optics**, Hongjie Liu, Jin Huang, Fengrui Wang, Xinda Zhou, Xiaodong Jiang, China Academy of Engineering Physics (China) . . . . . [9237-29]

## CLOSING REMARKS

**Location: NIST Auditorium . . . . . 5:50 pm to 6:00 pm**

## Wine and Cheese Tasting Reception

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## WEDNESDAY 17 SEPTEMBER

### REGISTRATION MATERIAL PICK-UP

Location: NIST Bldg 1 (Radio Bldg) . . . . . 7:30 am to 4:00 pm

### SESSION 9

Location: NIST Auditorium . . . . . Wed 8:20 am to 9:40 am

#### Fundamental Mechanisms II

Session Chairs: **MJ Soileau**, Univ. of Central Florida Office of Research & Commercialization (USA); **Christopher J. Stolz**, Lawrence Livermore National Lab. (USA)

8:20 am: **Measurement of femtosecond laser damage thresholds at mid-IR wavelengths**, Drake Austin, Kyle Kafka, Cosmin Blaga, Louis F. Dimauro, Enam Chowdhury, The Ohio State Univ. (USA). . . . . [9237-30]

8:40 am: **Modeling the material properties at the onset of damage initiation in bulk potassium dihydrogen phosphate crystals**, Stavros G. Demos, Michael D. Feit, Lawrence Livermore National Lab. (USA); Guillaume Duchateau, Univ. Bordeaux 1 (France) . . . . . [9237-31]

9:00 am: **Using particle-in-cell simulations to model femtosecond pulse laser damage of metals and dielectrics**, Robert A. Mitchell III, Douglass W. Schumacher, Enam Chowdhury, The Ohio State Univ. (USA). . [9237-32]

9:20 am: **Optic damage modeling and analysis in the National Ignition Facility**, Zhi M. Liao, Brett A. Raymond, Jessie M. Gaylord, Robert N. Fallejo, Jeffrey D. Bude, Paul J. Wegner, Lawrence Livermore National Lab. (USA) . . . . . [9237-33]

Refreshment Break . . . . . Wed 9:40 am to 10:10 am

### SESSION 10

Location: NIST Auditorium . . . . . Wed 10:10 am to 12:10 pm

#### Materials and Measurements I

Session Chairs: **James E. Andrew**, AWE plc (United Kingdom); **Semyon Papernov**, Univ. of Rochester (USA)

10:10 am: **Experimental tools for nonlinear spectroscopy: absorption and refraction** (*Keynote Presentation*), Eric W. Van Stryland, Trenton R. Ensley, Matthew C. Reichert, David J. Hagan, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA). . . . . [9237-35]

## CONFERENCE 9237

- 10:50 am: **Thermal lensing of laser materials**, Mark J. Davis, Joseph S. Hayden, SCHOTT North America, Inc. (USA) . . . . . [9237-48]
- 11:10 am: **Femtosecond damage threshold at kHz and MHz pulse repetition rates**, Benedek J. Nagy, Lénárd Vámos, Daniel Oszetzky, Peter Rácz, Peter Dombi, Wigner Research Ctr. for Physics of the H.A.S. (Hungary) . . . . . [9237-37]
- 11:30 am: **Research on limiting of high-power laser radiation in nonlinear nanomaterials**, Alexandr Y. Gerasimenko, Mikhail S. Savelyev, National Research Univ. of Electronic Technology (Russian Federation) . . . . . [9237-38]
- 11:50 am: **Spectral and temperature-dependent infrared emissivity measurements of painted metals for improved temperature estimation during laser damage testing**, Sean M. Baumann, National Air and Space Intelligence Ctr. (USA); Michael A. Marciniak, Glen P. Perram, Air Force Institute of Technology (USA) . . . . . [9237-39]
- Lunch Break and NIST Tours . . . . . Wed 12:10 pm to 2:10 pm

### **NIST Facility Tours . . . . . Wed 12:10 pm to 12:55 pm**

**NIST** has generously offered to provide 2 limited tours of the facility, including the **NIST-F1/NIST-F2 Atomic Clocks** and to **Josh Hadler's Laser Welding Lab**. A sign-up sheet will be at the registration desk.

## SESSION 11

**Location: NIST Auditorium . . . . . Wed 2:10 pm to 3:50 pm**

### **Materials and Measurements II**

Session Chairs: **Carmen S. Menoni**, Colorado State Univ. (USA);  
**Jérôme Néauport**, Commissariat à l'Énergie Atomique (France)

- 2:10 pm: **Determination of multi-pulse damage thresholds from crater-size measurements**, Matthias Lenzner, Lenzner Research, LLC (USA); Zhanliang Sun, Wolfgang Rudolph, The Univ. of New Mexico (USA) . . . . . [9237-40]
- 2:30 pm: **Laser-induced damage morphology in fused silica at 1064nm in the nanosecond regime**, Maxime Chambonneau, Romain Diaz, Commissariat à l'Énergie Atomique (France); Guillaume Duchateau, Univ. Bordeaux 1 (France); Pierre Grua, Commissariat à l'Énergie Atomique (France); Jean-Yves Natoli, Institut Fresnel (France); Jean-Luc Rullier, Laurent Lemaignère, Commissariat à l'Énergie Atomique (France) [9237-41]

## LOCATION: NIST AUDITORIUM

2:50 pm: **Three-dimensional mapping of absorption defects at 355nm for potassium dihydrogen phosphate (KDP) used in high-power laser systems**, Jian Chen, Jingtao Dong, Qi Zhang, Zhouling Wu, ZC Optoelectronic Technologies, Ltd. (China) . . . . . [9237-42]

3:10 pm: **A maximum likelihood method for the measurement of laser damage threshold**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA); Micheal D. Thomas, Spica Technologies, Inc. (USA) . . . . . [9237-43]

3:30 pm: **Adaptive characterization of laser damage from sparse defects**, Sam Richman, Alexander R. Martin, Quentin Turchette, Trey Turner, Research Electro-Optics, Inc. (USA) . . . . . [9237-44]

Refreshment Break . . . . . Wed 3:50 pm to 4:20 pm

## SESSION 12

**Location: NIST Auditorium . . . . . Wed 4:20 pm to 5:40 pm**

### Materials and Measurements III

Session Chairs: **Detlev Ristau**, Laser Zentrum Hannover e.V. (Germany);  
**Vitaly E. Gruzdev**, Univ. of Missouri-Columbia (USA)

4:20 pm: **Harmonisation of two nanosecond laser-induced damage testing facilities at 1064nm in vacuum and ambient pressure**, Clemens Heese, Alessandra Ciapponi, European Space Research and Technology Ctr. (Netherlands); Jorge Piris, European Space Agency (Netherlands); Paul Allenspacher, Melanie Lammers, Wolfgang Riede, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Toncho Ivanov, European Space Research and Technology Ctr. (Netherlands) . . . . . [9237-45]

4:40 pm: **In-line quantitative phase imaging for damage detection and analysis**, Dam-Be L. Doui, Institut Fresnel (France); Sherazade Aknoun, Institut Fresnel (France) and Phasics S.A. (France); Laurent Gallais, Serge Monneret, Mireille Commandré, Institut Fresnel (France) . . . . . [9237-46]

5:00 pm: **Laser-induced damage threshold of a hybrid mirrors designed for broadband operation in HiLASE beam distribution system**, Jan Vanda, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Adrien Hery, Ecole Nationale Supérieure de Techniques Avancées (France) and Aix-Marseille Univ. (France) and REOSC (France); Vaclav Skoda, CRYTUR spol s.r.o. (Czech Republic) . . . . . [9237-36]

5:20 pm: **Mono-module disk laser**, Victor V. Apollonov, A. M. Prokhorov General Physics Institute (Russian Federation) . . . . . [9237-49]

## CLOSING REMARKS

**Location: NIST Auditorium . . . . . 5:40 pm to 5:50 pm**

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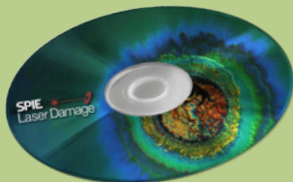
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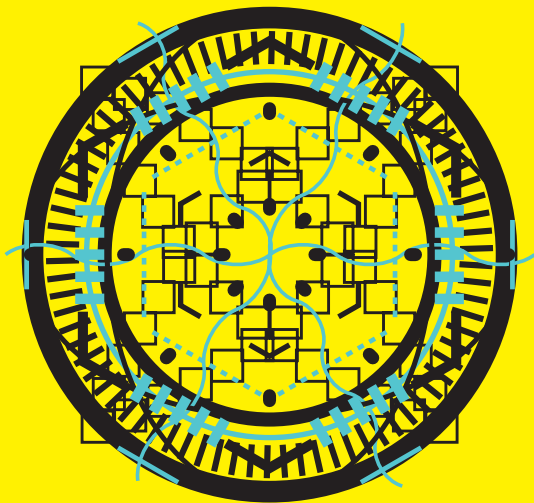
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