Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides (BGPP)

17 June - 20 June 2012, Cheyenne Mountain Resort, Colorado Springs, Colorado, United States

BGPP - Bragg Gratings, Photosensitivity, and Poling (BGPP) Topical Meeting gives you the opportunity to discover the impact on telecommunications and sensing and witness first-hand the latest advances and breakthroughs in the field of fiber gratings.

BGPP continues to be a popular meeting for covering the state-of-the-art advances in fiber gratings in a relaxed and nonpressured atmosphere. The program is tailored for informal exchanges, forming new partnerships, and reconnecting with colleagues. Attendees come from around the world to participate in this exchange of knowledge.

Papers will be considered in the following topic categories:

Fundamentals of Photosensitivity and Poling

- Improvements in the understanding of photosensitivity in fibers, waveguides, and bulk materials
- Femtosecond laser induced photosensitivity in dielectrics
- Fundamental understanding of femtosecond laser-matter interaction
- Photosensitivity of nano-materials and precipitates
- New glass compositions and processing methods for enhanced photosensitivity
- Gratings in new materials systems (polymers, crystals, chalcogenide glasses, etc)
- Modeling of the kinetics of UV and femtosecond IR-induced index changes occurring during grating writing
- Basic studies of point defects responsible for photosensitivity
- Role of Hydrogen in UV and femtosecond IR -induced index change mechanism
- Role of stress and structural change in UV and femtosecond IR -induced index change mechanisms
- Thermal stability of UV and femtosecond IR -induced index changes in glasses
- Effects of high optical power levels on grating properties
- Ultra high temperature and chemical composition gratings
- Gratings in fibers without UV photosensitivity
- Physics and chemistry of poling
- Advances in thermal and UV-assisted poling of fibers and waveguides

Grating Properties and Fabrication Techniques

- Advances in grating fabrication techniques, including direct write, holographic lithography and phase mask methods
- Advances in femtosecond laser grating fabrication
- Reel to reel grating fabrication and other mass production techniques
- Properties of gratings in non-telecom and non-silica fibers
- Grating measurement, characterization, and profile reconstruction techniques
- Grating synthesis and design (inverse scattering)
- Modeling of optical properties of new gratings and devices
- Wavelength and phase tuning of Bragg gratings
- Radiation-mode and cladding mode coupling of fiber gratings
- Gratings in new geometries
- Grating defects and noise (PMD, PDL, phase ripple, out of band reflections, MPI, etc)
- UV and IR laser induced birefringence
- Post processing techniques for grating performance correction
- Direct writing, patterning or phase trimming of integrated optical devices with UV or femtosecond lasers
- Volume Bragg gratings

Applications of Gratings and Poled Glass

- Applications of arbitrary complex grating filters
- Optical signal processing using fiber gratings
- Multichannel tunable dispersion compensators and other telecom related grating filters
- Devices based on femtosecond laser-grating fabrication
- Devices based on poled glass
- Nonlinear fiber grating applications, including enhanced continuum generation and Bragg solitons
- Fiber grating sensors and sensor systems
- Gratings for ultra high temperature, pressure and radioactive environments
- Mode conversion gratings and devices based on higher order mode propagation
- Applications of gratings in photonic crystal fibers
- Grating devices for OCDMA
- Fiber lasers incorporating gratings, including DFB, DBR, high power and multiwavelength lasers.
- Comparison of fiber gratings with other optical filter technologies
- Grating based spectrum and polarization measurement
- Applications of long period gratings in systems, including gain flattening, mode conversion, and sensing
- Medical and bio-photonic applications
- Gratings in microwave photonics
- Complex filters in astrophotonics
- Slow light in fiber gratings

FBG Sensor Symposium

Because of their small size, passive nature, immunity to electromagnetic interference, and capability to directly measure physical parameters such as temperature and strain, fiber Bragg grating sensors have developed beyond a laboratory curiosity and are becoming a mainstream sensing technology. This symposium gathers world leading experts in the field of FBG sensing technology and applications allowing attendees to receive the most up to date results on fiber Bragg grating sensor research and applications from other premier labs from around the world.

General Chairs

Morten Ibsen, *University of Southampton, UK*
Paul Westbrook, *OFS Laboratories, USA*

Program Chairs

Stephen Mihailov, *Communications Research Center, Canada*
Lin Zhang, *Aston University, UK*

This event is part of the Advanced Photonics Congress, allowing attendees to access to all meetings within the Congress for the price of one and to collaborate on topics of mutual interest.

Advanced Photonics: OSA Optics & Photonics Congress

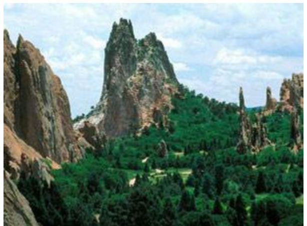
- Access Networks and In-house Communications (ANIC)
- Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)
- Integrated Photonics Research, Silicon, and Nano-Photonics (IPR)
- Nonlinear Photonics (NP)
- Specialty Optical Fibers (SOF)
- Signal Processing in Photonic Communications (SPPCom)

Sponsor:

OSA

Advanced Photonics Congress

17 June - 21 June 2012, Cheyenne Mountain Resort, Colorado Springs, Colorado, USA



Seven Collocated Meetings Covering All Aspects of Advanced Photonics

- Access Networks and In-house Communications (ANIC)
- Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)
- Integrated Photonics Research, Silicon, and Nano-Photonics (IPR)
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- Signal Processing in Photonic Communications (SPPCom)

OIDA Workshop

Photonic Integration for Advanced Modulation Format Transmission at 100Gb/s and Beyond - Status of the Industry and Challenges Ahead Workshop
Thursday, 21 June
08:30 - 17:00
Complimentary to all Advanced Photonics Registrants!

Special Items for Purchase:

OIDA Luncheon and Session
21 June 2012, 13:45 - 14:15
USD $35

Advanced Photonics Congress attendees are invited to join the OIDA Workshop on Photonic Integration for Advanced Modulation Format Transmission at 100Gb/s and Beyond-Status of the Industry and Challenges Ahead for a luncheon and a session presented by David Welch.

Exhibitors

Interested in being an Exhibitor at the Advanced Photonics Congress?

Exhibit space at this Congress is very limited, so be sure to sign up for your tabletop exhibit space today! This Congress provides you an audience of 400 scientists. Call Regan Pickett at 202-416-1474 or e-mail exhibitsales@osa.org for more information.

Corporate Sponsor:

Sponsor:

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides (BGPP)

17 June - 20 June 2012, Cheyenne Mountain Resort, Colorado Springs, Colorado, United States

Program

Please note: The Joint BGPP & SOF Plenary Session (JM1B) will begin at 8:00 AM on Monday, 18 June in the White River Room.

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A number of distinguished invited speakers have been invited to present at the meeting.

Plenary

JM1B
Monday, 18 June
8:00 - 10:00
White River


Philip Russell, *Max Planck Institute for the Science of Light*

Nanoscale Glass Blowing
Abstract: The past 15 years has seen the emergence of glass fibers with intricate transverse microstructures, often with nanoscale features. Their ability to guide and manipulate light in unexpected ways has led to many novel applications.


Eric Udd, *Columbia Gorge Research, USA*

Fire and Ice: 25 Years or Applying Fiber Optic Sensor Technology
Abstract: Over the past 25 years fiber grating sensor technology has been applied in extreme environments where conventional sensor technology has limited or in some cases non-existent measurement capabilities enabling widespread application potential.

Special Events

The congress has a variety of special events throughout the meeting including the OIDA Workshop, Congress Reception and special presentations. For more detailed information, view our Special Events page

BGPP Networking Reception

This welcoming network reception is open to all BGPP attendees and will be held on Sunday, 17 June from 18:00 - 19:30.

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides (BGPP)

17 June - 20 June 2012, Cheyenne Mountain Resort, Colorado Springs, Colorado, United States

BGPP Invited Speakers

Plenary

[Philip Russell]
Max Planck Institute for the Science of Light

Nanoscale Glass Blowing

Abstract: The past 15 years has seen the emergence of glass fibers with intricate transverse microstructures, often with nanoscale features. Their ability to guide and manipulate light in unexpected ways has led to many novel applications.

[Eric Udd]
Columbia Gorge Research, USA

Fire and Ice: 25 Years or Applying Fiber Optic Sensor Technology

Abstract: Since 1987 I have been heavily involved in identification of application that matched up well with fiber gratings sensors. Because initial costs were and in some cases continue to be high this often involved environmental measurements that were difficult and in some cases had not been performed using conventional sensor approaches. Much of my work has been in aerospace and has ranged from cryogenic measurements associated with liquid oxygen tanks to rocket nozzles...somewhat more hostile environments than "fire and ice". Along the way I diversified into applying fiber gratings sensor technology to civil structures, oil and gas, medical, utility and other areas. This paper provides a short summary of some of these ventures which I hope will be as interesting to readers as it has been to me.

BGPP 1: Fundamentals of Photosensitivity and Poling

Femtosecond direct writing of linear and nonlinear optical properties in photosensitive glass, Lionel Canioni, *LOMA, Univ. Bordeaux, 33405 Talence Cedex, France*

Optical Anisotropy of Self-assembled Nanostructure in Glass, Yasuhiko Shimotsuma, *Kyoto Univ., Japan*

BGPP 2: Grating Properties and Fabrication Techniques

Waveguide Bragg Gratings for the Realization of High-Quality Monolithic Cavities, Edward H. Bernhardi, *Universiteit Twente, Netherlands*

Monolithic Fiber Lasers for the Mid-infrared, Real Vallee, *Université Laval, Canada*

BGPP 3: Applications of Gratings and Poled Glass

Advances and Prospects of Frequency Doublers Based on Periodically Poled Silica Fibres, Costantino Corbari, *University of Southampton, UK*

Plasmons and nanoparticle coatings on optical fibers: playing with Tilted Fiber Bragg Gratings, Jacques Albert, *Carleton University, Canada*

BGPP FBG Sensor Symposium

Measuring Detonation, Deflagration and Burn Velocities with Fiber-optic Bragg Grating Sensors, Jerry Benterou, *Lawrence Livermore National, USA*

Miniaturized Photonic Sensors with Fiber Lasers, Geoffrey Cranch, *US Naval Research Laboratory, USA*

Regenerated Gratings for Optical Sensing in Harsh Environments, John Canning, *University of Sydney, Australia*

Polymer Optical Fibre Bragg Gratings, David Webb, *Aston University, UK*

Advanced Optical FBG Sensor Systems and Examples of their Application in Energy Facility Monitoring, Reinhardt Willsch, *Institute of Photonic Technology, Germany*

High Temperature Fiber Sensors for Energy Applications, Kevin Chen, *University of Pittsburgh, USA*

Title to be Announced, Ye Fang, *Corning Inc., USA*

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides (BGPP)

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Special Events

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8:00 - 10:00
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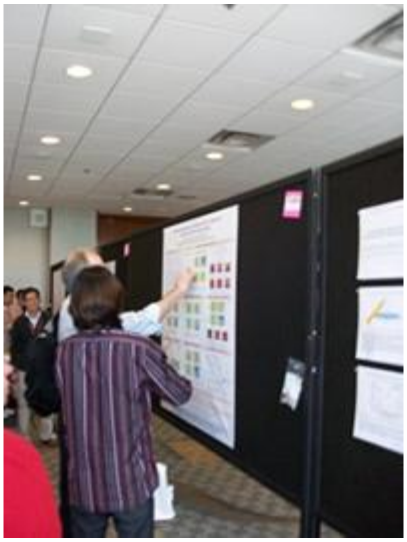
Poster Sessions



JM5A - Joint Poster Session I
Monday, 18 June
18:00 - 19:30
Centennial Room and Terrace

JTu5A - Joint Poster Session II
Tuesday, 19 June
18:00 - 19:30
Centennial Room and Terrace

The Joint Poster sessions are an integral part of the technical program and offer a unique networking opportunity, where presenters can discuss their results one-to-one with interested parties. During both poster sessions light refreshments will be offered plus an opportunity to meet with exhibitors.

NP and BGPP Postdeadline Papers Session - JW4D

Wednesday, 20 June,
16:00 - 17:36
Colorado I

The joint postdeadline paper session will give participants the opportunity to hear new and significant material in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timeliness were accepted. Post-deadline Books will be available at OSA Registration Desk.

Conference Receptions

Poster Reception & Exhibits

Monday, 18 June
18:00 - 19:30

Centennial Room and Terrace

This Poster Reception is an opportunity to review the poster presentations and grab light refreshments and snacks.Â Don’t miss this opportunity to network with your colleagues and walk through the Exhibit floor.

Congress Reception & Exhibits

Tuesday, 19 June
18:00 - 19:30
Centennial Room and Terrace

This Reception brings together all of the meetings within the congress IPR, NP BGPP, SOF, SPPCom, and ANIC for a fun evening of networking with light appetizers and drinks. This event features another Joint Poster Session and is a great anoth er great opportunity to learn about the latest products and innovations. Complimentary to full Technical attendees!

BGPP Welcome Reception *(Invitation Only)*

Sponsored by **Fianium**
Sunday, 17 June
18:00 - 19:30
Grand River Terrace

BGPP attendees are invited to kick-off the conference with this networking event. Join your colleagues for an intimate reception with drinks and light appetizers.

New! Networking Cookout

Wednesday, 20 June
18:30 - 20:30
The Courtyard
*Ticketed event - This event is **not** included in the Congress registration fees.*

Join us at this great event! Come meet with leaders of the optics and photonics community in a great informal and fun setting . Enjoy the sunset as you grab dinner, drinks and lively conversation! For $20 USD for full technical registrants, $10 USD for students.

Optoelectronics Industry Development Association (OIDA) Workshop

Photonic Integration for Advanced Modulation Format Transmission at 100Gb/s and Beyond - Status of the Industry and Challenges Ahead Workshop
Thursday, 21 June

08:30 - 18:00
Complimentary to all Advanced Photonics Registrants!

Program Topic: Ever growing internet traffic calls for more bandwidth at higher interface density and the telecom industry responded by migrating from a simple OOK to advanced modulation format transmission. Commercial systems e.g., coherent DP-QPSK modulation systems operating at 100Gb/s per wavelength have been deployed while many new developments are underway. They target different applications and vary by technology platform but all have one feature in common: **optical components based on photonic integration.**

It is becoming increasingly evident that the photonic integration, in some shape or form is the key to further advancement of such systems. The objective of this workshop is to provide a snapshot of the photonic integration techniques and platforms used for advanced modulation format transmission today and discuss challenges going forward. This workshop is sponsored by OIDA member company Infinera, Inc.

OIDA Luncheon Workshop Program

Photonic Integration
Thursday, 21 June
12:30 - 14:00

Tickets to lunch can be purchased for $35 USD when you register.

All Advanced Photonics Congress registrants are invited to join the OIDA Photonic Integration Workshop featuring guest speaker David Welch, Co-Founder and Executive Vice President of Infinera Corporation.

ADVANCED PHOTONICS CONGRESS 2012

- Access Networks and In-house Communications (ANIC)
- Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)
- Integrated Photonics Research, Silicon, and Nano-Photonics (IPR)
- Nonlinear Photonics (NP)
- Specialty Optical Fibers & Applications (SOF)
- Signal Processing in Photonic Communications (SPPCom)

17-21 June 2012 ✦ Cheyenne Mountain Resort, 3225 Broadmoor Valley Road, Colorado Springs, CO, 80906 USA

We're glad you'll be joining us in Colorado Springs this summer! This packet should include what you need to prepare for the meeting. If you have any questions or need more information, please contact Meetings & Exhibits Coordinator Sam Nystrom 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.

Exhibit space will be assigned on-site based on the order of receipt of space contracts.

IMPORTANT DEADLINES	
17 May 2012	Housing reservations deadline.
21 May 2012	Registration forms due (fax to +1 202.416.6100 or email topicalexhibits@osa.org).
21 May 2012	50-75 word description due for exhibitor listings. Exhibitor Listing Form included at end of this kit.
21 May 2012	Exhibitor Response Form due; form included at end of this kit.
4 June 2012	Final day to order electrical power, internet, or other services from hotel. **On-site orders will be charged a 25% additional fee and service may be delayed. Exhibit Order Form included at end of this kit.**
14 June 2012	The Cheyenne Mountain Resort begins accepting shipments from exhibitors; shipments received earlier may be declined.

EXHIBIT SCHEDULE

Click **HERE** for a complete schedule of the meeting.

17 June 2012	15.00-18.00	Registration Open
18 June 2012	7.00-18.00	Registration Open
18 June 2012	7.00-10.00	Exhibit Set-Up
18 June 2012	10.00-10.30 15.30-16.00	Exhibit Hours / Coffee Break
18 June 2012	18.00-19.30	Joint Poster Session / Exhibitor Reception
19 June 2012	7.30-18.00	Registration Open
19 June 2012	10.00-10.30 15.30-16.00	Exhibit Hours / Coffee Break
19 June 2012	18.00-19.30	Joint Poster Session/Exhibits/Conference Reception
20 June 2012	7.30-11.00	Exhibit Tear-Down

Exhibitors may set their own hours each day. *We do not require that you remain at your display for the entire time, however,* ***displays should be staffed during scheduled Coffee Breaks, Poster Sessions, and Receptions.*** *Attendee traffic patterns vary daily. Most attendees will leave the technical sessions for the coffee breaks that are located in the exhibit area but will then return to the sessions. Exhibit traffic is limited during other times to the poster sessions and receptions that are located in the exhibit area.*

EXHIBIT DETAILS

The exhibit, poster sessions, conference reception, and stand alone coffee breaks will be held in the Centennial Room of the Cheyenne Mountain Resort.

Exhibitors (tabletops and booths) will be provided with one 6' x 30" (1.8288m x .762m) draped or skirted table, two chairs, and one wastebasket.

Tabletop: Your display must fit completely on the surface of the table for a total display space no larger than 6'w x 2'd x 8'h (approx. 1.829m x .61m x 2.438m). 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. 2.438m).

Booth: Your display must fit completely within a 10' x 10' (3.048m x 3.048m) area which will be marked. Decorations and signage may not be attached to or hung from any permanent structure. In the front half of the booth (from aisle), the total height of all materials must not exceed 4 feet (1.219m). In the back half, the total height must be no higher than 8 feet (2.438m).

Please see the Exhibit Order Form at end of this kit for more information and pricing on electrical, internet, and audiovisual services. Contact Andre D'Amour, Assistant Director, Conference Services, at +1.719.538.4009 or adamour@benchmarkmanagement.com for further details. Exhibitors can order the following items directly from the hotel:

ELECTRICAL SERVICE - **Deadline: Monday, 4 June 2012**

Cost: US $25.00 for a dedicated 20 Amp 110V outlet with power strip.
This is an estimate of an order placed by 4 June. Orders placed later than this date may be charged a higher rate.

NOTE: It is highly recommended that power be ordered in advance. On-site orders will be charged a 25% additional fee and service may be delayed. Exhibitors can bring their own converters, extension cords, power strips and surge protectors, but these items may also be available through the hotel for a charge. International exhibitors should bring power converters with them, as they may not available. Electrical circuits may be non-exclusive and may be shared with other exhibitors.

INTERNET SERVICE - **Deadline: Monday, 4 June 2012**

Wireless internet is complimentary in all public spaces and guest rooms. It is not available in the meeting rooms, including the Centennial Room, where the exhibits will take place.

Wired Internet service is available upon request. Cost: US $100.00 for wired high speed internet access.

Note that the exhibit hours are flexible, and there will be time during the day to leave the exhibit area to utilize the wireless service in a guest room or public space.

AUDIOVISUAL SERVICE - **Deadline: Monday, 4 June 2012**

Computers, telecommunications, and projections equipment are all available for rental from the Cheyenne Mountain Resort. Please keep in mind that exhibits displays must stay within the 10' x 10' (3.048m x 3.048m) booth dimensions and 6'w x 2'd x 8'h (approx. 1.829m x .61m x 2.438m) tabletop dimensions.

EXHIBITOR REGISTRATION

Exhibitors may pick up their badges at the meeting's registration desk during the following hours.

17 June 2012	13.00–18.00
18 June 2012	7.00–18.00
19 June 2012	7.30-17.00

EXHIBITOR BADGES – DEADLINE: MONDAY, 21 MAY 2012

Exhibitors – Do not use online registration. Fax the completed REGISTRATION FORM to +1.202.416.6100 ATTN: Cathryn Wanders by Monday, 21 May 2012.

Each person attending the meeting must have a badge. Each exhibiting company will receive three complimentary badges. Please complete the provided registration form (one per person).

(1) Exhibitor Technical Badge – includes access to all technical sessions and conference reception; one copy of technical digest on CD-ROM; one copy of conference program
(2) Exhibitor Personnel Badges – 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. Please note, **by signing up to exhibit, you are NOT automatically registered for the conference**. A form must be submitted.

EXHIBITOR LISTING – Deadline: Monday, 21 May 2012

If you have not already done so, please email a 50-75 word description of your company (including complete contact information) to Sam Nystrom at topicalexhibits@osa.org. To have your description included in the Exhibitor Listings, it must be received no later than 21 May 2012. This listing will be distributed to each registrant at the meeting. The Exhibitor Listing Form is included at the end of this kit.

SECURITY

The hotel has security on the property; however security will not be specifically designated to monitor the meeting rooms. 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 exhibit space contract for required insurance levels.

Please do not store valuables under your table or leave objects such as phones, cameras, etc. on your table unless the booth is staffed.

TRANSPORTATION

For more information about transportation to the hotel, including airline and rental car discounts and links to public transportation, please visit our Travel Information Website.

AREA AIRPORTS

Colorado Springs is served by the Colorado Springs Airport (COS). It is approximately 20 minutes from the Cheyenne Mountain Resort. COS is served by 10 commercial airlines and affiliates, offering 120 daily flights. Another option is the Denver International Airport (DEN), located approximately an hour from the Cheyenne Mountain Resort. DEN is served by 15 commercial airlines and their affiliates.

Airline Discount
For your convenience, OSA management has arranged discounted air travel with American Airlines. You may visit the American Airlines website at www.aa.com to search for available flights and use the authorization code **8762EJ** to receive your discount. You may also call the American Airlines Meeting Services Desk directly at +1.800.433.1790 for assistance with reservations and ticket purchases.

SHUTTLE SERVICES

A shuttle service provide by the resort is available from COS for approximately US $30 per person roundtrip or US $18 per person one-way. Call +1.719.538.4000 to set up a pickup and have your flight dates, times, and numbers ready.

Super Shuttle
SuperShuttle is the nation's leading shared-ride airport shuttle, providing door-to-door ground transportation and provides service to and from 28 major airports in 23 cities. **Service is available at Denver International Airport (DEN), but not at Colorado Springs Airport (COS).** Super Shuttle is pleased to offer a discount to participants attending the Advanced Photonics Congress. Please refer to code **CQAFL**. Discounted reservations may be made on the Super Shuttle website or by phone at +1.800.BLUE VAN (258.3826).

TAXIS

A one-way taxi from COS to the Cheyenne Mountain Resort is approximately US $25.

Yellow Cab: +1.719.634.5000
Spring Cab: +1.719.444.8989

RENTAL CARS

A selection of rental cars is available from Colorado Springs Airport and Denver International Airport.

Rental Discount
Avis Rent-a-Car is pleased to offer low rates with unlimited mileage to participants attending OSA Optics and Photonics Congresses. For reservations call +1.800.331.1600 or consult the worldwide telephone directory and refer to Avis Worldwide Discount **#D004076**. Reservations may also be made on the Avis website.

DRIVING DIRECTIONS TO CHEYENNE MOUNTAIN RESORT

FROM COLORADO SPRINGS AIRPORT (COS)

1. Go west on Mark Proby Pkwy approximately 3 miles to Academy Blvd.
2. Turn left on Academy and stay in the left-hand lane.
3. Follow Academy approximately 4 miles to Highway 115.
4. Exit north at Highway 115.
5. Proceed approximately one mile to Cheyenne Mountain Blvd.
6. Turn left on Cheyenne Mountain Blvd. and go one block to Broadmoor Valley Rd.
7. Turn left and go three blocks to Cheyenne Mountain Resort.

FROM DENVER INTERNATIONAL AIRPORT (DEN) VIA I-25

1. Head south.
2. Take the ramp onto Peña Blvd.
3. Take Exit 285 to merge onto I-225 S towards Colorado Springs/Aurora.
4. Take 1A on the left to merge onto I-25 S towards Colorado Springs.
5. Exit 138 - Circle Drive.
6. Turn West (toward the mountains).
7. Two miles to Highway 115 South - Canon City.
8. Continue under the overpass and LEFT turn onto ramp.
9. First traffic light, Cheyenne Mountain Boulevard, turn RIGHT.
10. Take the first LEFT, Broadmoor Valley Road - (Resort's sign on the corner).
11. One half mile to Cheyenne Mountain Resort - Main Entrance on the LEFT.

PARKING AT RESORT

Complimentary self-parking and valet-parking is available in a secure outdoor lot at the resort.

HOUSING

A block of sleeping rooms has been reserved for the convenience of Advanced Photonics meeting attendees at the Cheyenne Mountain Resort. **In order to secure the group rate, you must reserve your room by Thursday, 17 May 2012.**

The daily meeting rates are:

Single/Double Room	**US $169.00**
Extra Person Charge	**US $10.00**
Resort Fee	**US $8.00**

Rates will be honored 3 days prior and post conference dates. State and local taxes are 9.4%. Check-in time is 13.00 and check-out time is 15.00. If you book within the block, the following services are complimentary to make your stay more enjoyable:

- Fitness classes
- Outdoor tennis
- Boating and fishing (seasonal)
- Bell and Room Attendant gratuities
- 800 and Local call access
- Newspaper and in-room coffee and tea
- Fitness Center and Aquatics access and parking

Some of the amenities available at the Cheyenne Mountain Resort include delicious Hotel Dining, an 18-hole Golf Course, various Recreational Activities, and nearby Area Attractions.

Book your Hotel Reservation:

- ONLINE
- Call: +1.719.538.4000 and request 2012 OSA Advanced Photonics Congress Rate

SHIPPING & MATERIAL HANDLING

MATERIAL HANDLING / DELIVERY & STORAGE

Delivery, load-in and load-out must occur at the hotel loading dock. There are no exceptions. Exhibitor vehicles may park in the driveway to the loading dock for the amount of time required to perform their task. If this time is expected to exceed 30 minutes, the exhibitor must obtain special written authorization. In addition, exhibitors must supply their own equipment to transport supplies into the Hotel. During move-in, any damage incurred to the walls, carpet, doors, door frames and elevators will be billed. Should the exhibitor leave without cleaning up properly, they will be responsible for any additional labor charges to restore the room to its prior condition. A pre- and post-conference walk-through inspection of the space to be used may also be required.

If needed, please notify topicalexhibits@osa.org in advance and we will work with you to have your shipment delivered.

SHIPPING INSTRUCTIONS

Due to limited space, the Cheyenne Mountain Resort cannot accept packages more than 2 weeks prior to the start of the meeting. Incoming shipments will not be assessed an incoming shipping fee. Please label your incoming boxes as follows:

Cheyenne Mountain Resort
Advanced Photonics Optical
Attn: Vendor Name
3225 Broadmoor Valley Road
Colorado Springs, CO 80906

RETURN SHIPMENTS

All packages must be shipped off property within 24 hours of completion of meeting. All exhibitors are responsible for packing and labeling their own materials (boxes, crates, display cases). The Cheyenne Mountain Resort will not be liable for any items left in the room after the conference. All outgoing materials (boxes, crates, display cases) must be properly labeled with a shipping label and form, provided by the hotel. Outgoing boxes are $7.50 a piece.

After completing the above, the hotel will transport all boxes and display cases to the Shipping/Receiving area at the end of the conference. Please retain a copy of your shipping form for tracking purposes.

FREIGHT FORWARDING SHIPMENTS / CUSTOMS BROKERS

Vendors using freight forwarding companies or customs brokers are responsible for making their own pick-up and ship-out arrangements. Please inform Andre D'Amour, Assistant Director, Conference Services, at +1.719.538.4009 or adamour@benchmarkmanagement.com of any freight forwarding shipments that you may have in the event that you are not present when the pick-up is made. Please make sure that all necessary documents are included with your shipment.

AIR FREIGHT / CARGO – DOMESTIC SHIPMENTS

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TWI Group, Inc.
230-59 International Airport Center Blvd.
North Lobby, Suite #250
Jamaica, New York 11413
Tel: +1.718.995.0500
aminichiello@twiglobal.com

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Take advantage of the opportunity to maximize your company's meeting presence through the unique sponsorships available at Advanced Photonics 2012. 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.

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Topical Meeting Exhibit 2012
Buyers' Guide Submission Instructions

- **Fax: +1 202.558.3995, Attn: Sam Nystrom – topicalexhibits@osa.org**
- Please provide the following information for inclusion in the Buyers' Guide, which will be provided to all attendees. One listing per company is provided. Should a company miss this deadline, you will not be listed in the Guide.
- **SUBMIT BY 21 MAY 2012**
- *Provide all information as it is to be published. Please write **legibly** in dark ink and fax to +1 202.558.3995 or email to topicalexhibits@osa.org.*
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- **50-75 word description** *(any descriptions over 75 words may be edited):*

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OSA®
The Optical Society

DUE: Monday, 21 May 2012

Exhibitor Response Form

Advanced Photonics Congress 2012

- *Access Networks and In-house Communications (ANIC)*
- *Bradd Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)*
- *Integrated Photonics Research, Silicon, and Nano-Photonics (IPR)*
- *Nonlinear Photonics (NP)*
- *Specialty Optical Fibers & Applications (SOF)*
- *Signal Processing in Photonic Communications (SPPCom)*

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Company: ____

Contact: ____

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B) We ordered electricity through the hotel:

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C) We ordered audiovisual through the hotel:

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Direct In-Dial Phone		75			
Wired High Speed Internet Access		100			
Wi-Fi access per computer*		75			
*requires IT assistance to set up					
Other:					
Computer		**Cost per Day**	**# of Days**	**Quantity**	**TOTAL**
PC Laptop w/ Windows XP Pro		150			
20" LCD Panel		100			
24" LCD Panel		200			
Other:					
Projection A/V		**Cost per Day**	**# of Days**	**Quantity**	**TOTAL**
Flipchart		45			
Easel		10			
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13" CRT Preview Monitor		45			
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50" Plasma Screen w/ Floor Stand		550			
Other:					
Electrical		**Cost per Day**	**# of Days**	**Quantity**	**TOTAL**
5 Amp 110V w/ power strip		15			
Dedicated 20 Amp 110V w/ power strip		25			
Additional Power Strips		5			
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Access Networks and In-house Communications (ANIC)
Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)
Integrated Photonics Research, Silicon, and Nano-Photonics (IPR)
Nonlinear Photonics (NP)
Specialty Optical Fibers & Applications (SOF)
Signal Processing in Photonic Communications (SPPCom)

17–21 June, 2012
Colorado Springs, CO, USA

Welcome to the 2012 Advanced Photonics Congress! We hope you enjoy all that Colorado Springs offers, and take full advantage of the scientific sessions before you. The Congress has co-located six stimulating veteran topical meetings (listed above) to allow attendees exposure to a wide variety of topics.

This year's Congress will offer 8 plenary speakers, ample opportunities for networking, and multiple events to motivate discussions on the latest research and exhibits featuring companies which will help enhance your organization. There will be two joint poster sessions, the first will have served refreshments on Monday, 18 June from 18:00–19:30. The second poster session with the conference reception will be on Tuesday, 19 June from 18:00–19:30. A special feature of this year's Congress is the OIDA Workshop, "Photonic Integration for Advanced Modulation Format Transmission at 100Gb/s and Beyond - Status of the Industry and Challenges Ahead" with an optional Luncheon program with guest speaker David Welch, Co-Founder and Executive Vice President of Infinera Corporation on Thursday, 21 June. We hope that bringing together leaders and experts among the different communities to share information and discuss topics across the disciplines of optical science and engineering will provide you with a rich experience in Colorado Springs.

The Access Networks and In-house Communications (ANIC) topical meeting is designed to present many of the latest advances in the development of FTTx technologies ranging from significant advancements in device development to the development of sophisticated algorithms to transmit data, control and monitor the network, and efficiently distribute the signals. This year's meeting will have a plenary speaker, 7 invited speakers, 10 oral presentations and 4 poster presentations.

The Bragg Gratings, Photosensitivity, and Poling (BGPP) topical meeting gives you the opportunity to discover the impact on telecommunications and sensing and witness first-hand the latest advances and breakthroughs in the field of fiber gratings. BGPP continues to be a popular meeting for covering the state-of-the-art advances in fiber gratings in a relaxed and non-pressured atmosphere. The program is tailored for informal exchanges, forming new partnerships, and reconnecting with colleagues. This year's meeting will feature a plenary speaker, 13 invited speakers, 51 oral presentations and 11 poster presentations.

The Integrated Photonics Research, Silicon, and Nano-Photonics (IPR) is a long standing meeting with a great tradition of excellence in innovative science, advanced engineering and cutting edge technology that covers all aspects of research in a burgeoning area of integrated photonics. This year's meeting will include traditional areas such as photonic integrated circuit design, technology and applications; physics and technology of on-chip active and passive photonic devices; planar waveguide technology, lightwave circuits and systems-on-the chip; theory, modeling and numerical simulation of waveguide and integrated photonic devices and circuits; integrated diffractive optics and micro-photonics. Also, IPR 2012 will continue to cover hot topics in nano-photonics, including generation, detection, transport and utilization of optical fields on the "nanoscale." A new feature of IPR 2012 is an emerging area of research that relates to various aspects of slow light, including basic physics, implementation and potential use in integrated photonics. This year's meeting will include 2 plenary speakers, 28 invited speakers, 70 oral presentations and 8 poster presentations.

The Nonlinear Photonics (NP) topical meeting is a venue for researchers interested in nonlinear optical processes in structures, devices and systems. The meeting covers all aspects of nonlinear photonics and is devoted to both temporal and spatial nonlinear effects. It covers computational as well as experimental aspects and discusses nonlinear material aspects as well as nonlinear systems. The meeting will also feature 2 plenary speakers, 8 invited speakers, 68 oral presentations and 76 poster presentations.

The Speciality Optical Fibers and Applications (SOF) meeting will discuss synthesis, processing, characterization, modeling, physical properties and applications of specialty and novel optical fibers with high technological impact potential. The purpose of this conference is to bring together global leaders from academia, industry, and the public/government sector to survey the present state of the art and project future trends in specialty optical fiber materials, designs, and applications. Particular attention will be paid to high energy fiber lasers, novel optical amplifiers and lasers, infrared and nonlinear fibers, micro-structured and photonic crystal fibers, active and passive polymer optical fibers, fiber-based sensors, crystalline and ceramic optical fibers, and fibers for biomedical and bioscience uses. We have scheduled a plenary speaker, 20 invited speakers, 3 tutorial speakers, 38 oral presentations, and 11 poster presentations.

The Signal Processing in Photonic Communications (SPPCom) meeting will discuss photonic transmission technology required in communication networks of all kind, from access to long haul and submarine, focusing on advanced signal processing techniques to overcome signal impairments, and to achieve increased system capacities and spectral efficiencies. The topical meeting with feature 16 invited speakers, 26 oral presentations, and 1 poster presentation.

We all are very pleased to have you join us and we look forward to a great meeting!

ANIC
Pandelis Kourtessis, *London Herts Univ., UK*
Thomas Pfeiffer, *Alcatel-Lucent, Germany*
Antonio Teixeira, *Universidade de Aveiro, Portugal*

BGPP
Morten Ibsen, *Univ. of Southampton, UK*
Paul Westbrook, *OFS Laboratories, USA*

IPR
Dan-Xia Xu, *National Research Council Canada*
Anatoly Zayats, *King's College London, UK*

NP
Wieslaw Krolikowski, *Australian Natl. Univ., Australia*
Frank Wise, *Cornell Univ., USA*

SOF
Ishwar Aggarwal, *Univ. of North Carolina at Charlotte, USA*
John Ballato, *Clemson Univ.,USA*

SPPCom
Fred Buchali, *Alcatel-Lucent, Bell-Labs, Germany*
Robert Killey, *Univ. College of London, UK*
David Plant, *McGill Univ., Canada*

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Congress Highlights

BGPP Welcome Reception (Invitation Only)

Sponsored by Fianium
Sunday, 17 June, 18:00–19:30
Grand River Terrace

BGPP attendees are invited to kick-off the conference with this networking event. Join your colleagues for an intimate reception with drinks and light appetizers.

Joint Poster Sessions

JM5A – Monday, 18 June, 18:00–19:30
JTu5A –Tuesday, 19 June, 18:00–19:30
Centennial Room and Terrace

The Joint Poster Sessions are an integral part of the technical program and offer a unique networking opportunity, where presenters can discuss their results one-to-one with interested parties. During both poster sessions, refreshments will be offered plus attendees have an opportunity to meet with exhibitors.

Conference Receptions

Poster Reception & Exhibits

Monday, 18 June, 18:00–19:30
Centennial Room and Terrace

This Poster Reception is an opportunity to review the poster presentations and grab light refreshments and snacks. Don't miss this opportunity to network with your colleagues and walk through the Exhibit floor.

Congress Reception & Exhibits

Tuesday, 19 June, 18:00–19:30
Centennial Room and Terrace

This Reception brings together all of the meetings within the congress IPR, NP BGPP, SOF, SPPCom, and ANIC for a fun evening of networking with light appetizers and drinks. This event features another Joint Poster Session and is a great chance to learn about the latest products and innovations. Complimentary to full Technical attendees!

Optoelectronics Industry Development Association (OIDA) Workshop

Photonic Integration for Advanced Modulation Format Transmission at 100Gb/s and Beyond – Status of the Industry and Challenges Ahead Workshop

Thursday, 21 June, 08:30–18:00
White River

Complimentary to all Advanced Photonics Congress Registrants!

Program Topic: Ever growing internet traffic calls for more bandwidth at higher interface density and the telecom industry responded by migrating from a simple OOK to advanced modulation format transmission. Commercial systems e.g., coherent DP-QPSK modulation systems operating at 100Gb/s per wavelength have been deployed while many new developments are underway. They target different applications and vary by technology platform but all have one feature in common: **optical components based on photonic integration.**

It is becoming increasingly evident that the photonic integration, in some shape or form is the key to further advancement of such systems. The objective of this workshop is to provide a snapshot of the photonic integration techniques and platforms used for advanced modulation format transmission today and discuss challenges going forward. This workshop is sponsored by OIDA member company Infinera, Inc.

OIDA Luncheon Workshop Program
Photonic Integration
Thursday, 21 June, 12:30–14:00
Colorado II & III

Tickets to lunch can be purchased for $35 USD when you register.

All Advanced Photonics Congress registrants are invited to join the OIDA Photonic Integration Workshop featuring guest speaker David Welch, Co-Founder and Executive Vice President of Infinera Corporation.

Plenary and Keynote Speakers

Fire and Ice: 25 Years of Fiber Grating Sensor Technology

Monday, 18 June
JM1B.1 • 08:30, *White River*

Eric Udd, *Columbia Gorge Research, USA*

President of Columbia Gorge Research has been deeply involved with fiber optic sensors since 1977 and helped pioneer early work on fiber optic gyros, fiber optic smart structures for health monitoring, high temperature and high speed fiber optic sensors systems, multi-axis strain sensors and fiber optic pressure sensors. He worked for McDonnell Douglas from 1977 to 1993, where he managed over 25 DoD, NASA and internally funded fiber optic sensor programs. Mr. Udd has held a series of positions moving from Engineer/Scientist, to Manager-Fiber Optics, and in 1989 was appointed as one of 40 McDonnell Douglas Fellows. In 1993, he started Blue Road Research and directed the growth of the company through its acquisition by Standard MEMS in January 2000. In January 2006, Mr. Udd left Blue Road Research to found Columbia Gorge Research. Columbia Gorge Research is strongly focused on the objective of moving fiber optic sensor technology to the field quickly and efficiently supporting both end users and developers of the fiber optic sensor technology by forming synergistic relationships with other companies and organizations. Mr. Udd has 45 issued US Patents and several more pending on fiber optic technology, has written and or presented over 150 papers and has chaired approximately 30 international conferences on fiber optic sensor technology. He has edited the books *Fiber Optic Sensors: An Introduction for Engineers and Scientists*, Wiley, 1991 (2nd edition 2011) and *Fiber Optic Smart Structures*, Wiley, 1995. Mr. Udd is a Fellow of SPIE and OSA and a member of IEEE and the LEOS. Mr. Udd has been awarded the Richardson Medal for 2009 by the Optical Society of America for his work on fiber optic sensors and the field of fiber optic smart structures.

Negative Refraction and Light Bending with Plasmonic Nanoantennas
Monday 18 June
JM1A.1 • 08:30, *Colorado I*

Vlad Shalaev, *Purdue Univ., USA*

Vladimir (Vlad) M. Shalaev, Scientific Director for Nanophotonics in Birck Nanotechnology Center and Distinguished Professor of Electrical and Computer Engineering at Purdue University, specializes in nanophotonics, plasmonics, and optical metamaterials. Vlad Shalaev received several awards for his research in the field of nanophotonics and metamaterials, including the Max Born Award of the Optical Society of America for his pioneering contributions to the field of optical metamaterials and the Willis E. Lamb Award for Laser Science and Quantum Optics. He is a Fellow of the IEEE, APS, SPIE, and OSA. Prof. Shalaev authored three books, twenty one book chapters and over 300 research publications.

Nanoscale Glass Blowing
Monday, 18 June
JM1B.2 • 09:15, *White River*

Philip Russell, *Max Planck Institute for the Science of Light, Germany*

Philip Russell is a Director at the Max-Planck Institute for the Science of Light in Erlangen, Germany and holds the Krupp Chair in Experimental Physics at the University of Erlangen-Nuremberg. He obtained his doctorate in 1979 at the University of Oxford. His research interests currently focus on scientific applications of photonic crystal fibers and related structures. He is a Fellow of the Royal Society and the Optical Society of America (OSA) and has won several international awards for his research including the 2005 Körber Prize for European Science, the 2005 Thomas Young Prize of the Institute for Physics (UK) and the 2000 OSA Joseph Fraunhofer Award/Robert M. Burley Prize - for the invention of photonic crystal fiber.

The Roles of Optics in Information Processing
Monday, 18 June
JM1A.2 • 09:15, *Colorado I*

David A.B. Miller, *Stanford Univ., USA*

David A. B. Miller received his Ph.D. from Heriot-Watt University in Physics in 1979. He was with Bell Laboratories from 1981 to 1996, as a department head from 1987. He is currently the W. M. Keck Professor of Electrical Engineering, and a Co-Director of the Stanford Photonics Research Center at Stanford University. He has been active in professional societies and was President of the IEEE Lasers and Electro-Optics Society in 1995. His research interests include physics and devices in nanophotonics, nanometallics, and quantum-well optoelectronics, and fundamentals and applications of optics in information sensing, switching, and processing. He has published more than 240 scientific papers and the text "Quantum Mechanics for Scientists and Engineers", holds 69 patents, has received numerous awards, is a Fellow of OSA, IEEE, APS, and the Royal Societies of Edinburgh and London, holds two honorary degrees, and is a Member of the National Academy of Sciences and the National Academy of Engineering.

Technology Platforms for Photonic Integrated Circuits
Tuesday, 19 June
JTu1B.1 • 08:30, *Colorado I*

Michael Wale, *Oclaro*, *UK*

Michael Wale is Director Active Product Research at Oclaro, based at Caswell, UK, in which role he is responsible for strategic programs in photonic integration technologies and their applications. Mike received his BA, MA and D. Phil. degrees in physics from the University of Oxford, UK. He has been active in photonics research, development and manufacturing since the early 1980s, with particular emphasis on photonic integrated circuit technology. Alongside his role at Oclaro, Mike is a part-time Professor at Eindhoven University of Technology in The Netherlands and an Honorary Professor at Nottingham University in the UK. Prof. Wale is a member of the Executive Board of the European Technology Platform, Photonics21, and chairman of its Working Group on Design and Manufacturing of Optical Components and Systems.

Complex Nonlinear Opto-Fluidics
Tuesday, 19 June
JTu1B.2 • 09:15, *Colorado I*

Mordechai (Moti) Segev, *Technion – Israel Institute of Technology, Israel*

Mordechai (Moti) Segev is a Distinguished Professor of Physics, at the Technion, Israel. He received his B.Sc. and D.Sc. from the Technion in 1985 and 1990, respectively. After spending three years at Caltech as a post-doc, he joined Princeton in 1994 as an Assistant Professor, becoming an Associate Professor in 1997, and a Professor in 1999. In the summer of 1998, he went back to Israel, eventually resigning from Princeton in 2000. Moti Segev's research interests are mainly in Nonlinear Optics, Solitons, Sub-Wavelength Imaging, Lasers and Quantum Electronics, although he finds much entertainment in more demanding fields such as basketball and hiking. He has more than 280 publications in refereed journals, many book chapters, and has given more than 100 Plenary, Keynote and Invited presentations at conferences. Among his most significant contributions are the discoveries of photorefractive solitons, of incoherent (white light) solitons and of accelerating wavepackets of Maxwell's equations, first observation of 2D lattice solitons, first experimental demonstration of Anderson localization in a disordered periodic system, and the invention of sparsity-based subwavelength imaging technique. Moti Segev is a Fellow of the OSA and of the APS. He has won numerous awards, among them the 2007 Quantum Electronics Prize of the EPS, the 2009 Max Born

Award of the OSA, and the 2008 Landau Prize (Israel). In 2011, he was elected to the Israel Academy of Sciences and Humanities. However, above all his personal achievements, Moti Segev takes pride in the success of the graduate students and post-doctoral fellows that have worked with him over the years. Among those are currently 16 university professors in the United States, Germany, Taiwan, Croatia, Italy, India and Israel.

Future Optical Access Networks
Wednesday, 20 June
JW1A.1 • 08:30, *Platte*

Yun Chung, *Korea Advanced Inst. of Science and Technology, Republic of Korea*

Y. C. Chung is a professor of electrical engineering at the Korea Advanced Institute of Science and Technology (KAIST), which he joined in 1994. From 1987 to 1994, he was with the Lightwave Systems Research Department at AT&T Bell Laboratories. From 1985 to 1987, he was with Los Alamos National Laboratory under AWU-DOE Graduate Fellowship Program. His current activities include high-capacity WDM transmission systems, all-optical WDM networks, optical performance monitoring techniques, WDM passive optical networks, and fiber-optic networks for wireless communications, etc. He has published over 500 journal and conference papers in these areas and holds over 80 patents. Prof. Chung is a Fellow of IEEE and OSA, and a Member of Korean Academy of Science and Technology.

Quo Vadis, Spatial Multiplexing?
Wednesday, 20 June
JW1A.2 • 09:15, *Platte*

Henning Buelow, *Universitaet Erlangen, Germany*

Henning Buelow is Distinguished Member of Technical Staff in the Department of Optical Technologies at Bell Labs Alcatel-Lucent in Stuttgart, Germany. He received his Dipl.-Ing. degree in electrical engineering from the University of Dortmund, Germany, and a Ph.D. from the University of Berlin for work on integrated optical switching matrices. He joined Bell Labs (former Alcatel-Lucent Research-and-Innovation) in Stuttgart, Germany, in 1990. Since then he worked on optical amplifiers, on polarization mode dispersion, and on dynamic distortion mitigation in high bit-rate transmission systems by electronic and optical signal processing. His current research interests are mode multiplexed systems and coded modulation for coherent systems. Between 2008 and 2011 he has been Guest-Professor with the University of Erlangen, Germany.

Tutorial Speakers

Nonlinear Fibers for Parametric Signal Generation Amplification and Processing
Monday, 20 June
SM4E.4 • 17:15, *Rio Grande/Gunnison*

Stojan Radic, *Univ. of California San Diego, USA*

Stojan Radic joined the UCSD faculty in November 2003. He received his Ph.D. in optics from The Institute of Optics (Rochester) in 1995. Radic gained a worldwide reputation while working in industry, first at Corning in the Photonics Technology division, and later at Bell Laboratories in Lightwave Systems Research (1998-03). Immediately prior to coming to the Jacobs School, Radic held a chaired position at Duke University. Radic has published 40 articles in refereed journals, and serves on committees for Optical Fiber Communication (OFC), Conference on Lasers and Electro-Optics (CLEO) and Optical Amplifiers and their Applications (OAA) conferences.

Recent Developments in Fiber Lasers, Mode Stability Issues in LMA Fibers
Tuesday, 19 June
STu4F.5 • 17:15, *Rio Grande/Gunnison*

Jens Limpert and **César Jauregui Misas**, *Friedrich-Schiller-Universität Jena*

Prof. Jens Limpert was born in Jena, Germany, in 1975. He received his M.S in 1999 and Ph.D. in Physics from the Friedrich Schiller University of Jena in 2003. His research interests include high power fiber lasers in the pulsed and continuous-wave regime, in the near-infrared and visible spectral range. After a one-year postdoc position at the University of Bordeaux, France, where he extended his research interests to high intensity lasers and nonlinear optics, he returned to Jena and is currently leading the Laser Development Group (including fiber- and waveguide lasers) at the Institute of Applied Physics. He is author or co-author of more than 150 peer-reviewed journal papers in the field of laser physics. His research activities have been awarded with the WLT-Award in 2006 and with an ERC Starting Grant in 2009. Jens Limpert is member of the German Physical Society and the Optical Society of America.

Dr. César Jauregui Misas was born in Santander, Spain, in 1975. He received both his Telecommunication Technical Engineering degree and his Telecommunication Engineering degree at the University of Cantabria. In 2003, he got his Ph.D. degree at that same University. In 2005 he began a two-year post-doc stay at the Optoelectronics Research centre, where he investigated the phenomenon of slow-light in optical fibers. Since 2007 he is working at the Institute of Applied Physics in Jena. His primary research concerns are high-power fiber lasers, non-linear effects in optical fibers and Fiber Optic sensors. César Jáuregui has co-authored more than 120 papers presented in conferences and scientific journals. He has been awarded with several academic prizes. Among them, in 2004, he was awarded with a prize for the best Thesis at the University of Cantabria.

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Program Chairs

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John Canning, *Univ. of Sydney, Australia*
Monica Ferraris, *Politecnico di Torino, Italy*
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Applications of Gratings and Poled Glass
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Kin Chiang, *City Univ. of Hong Kong, Hong Kong*
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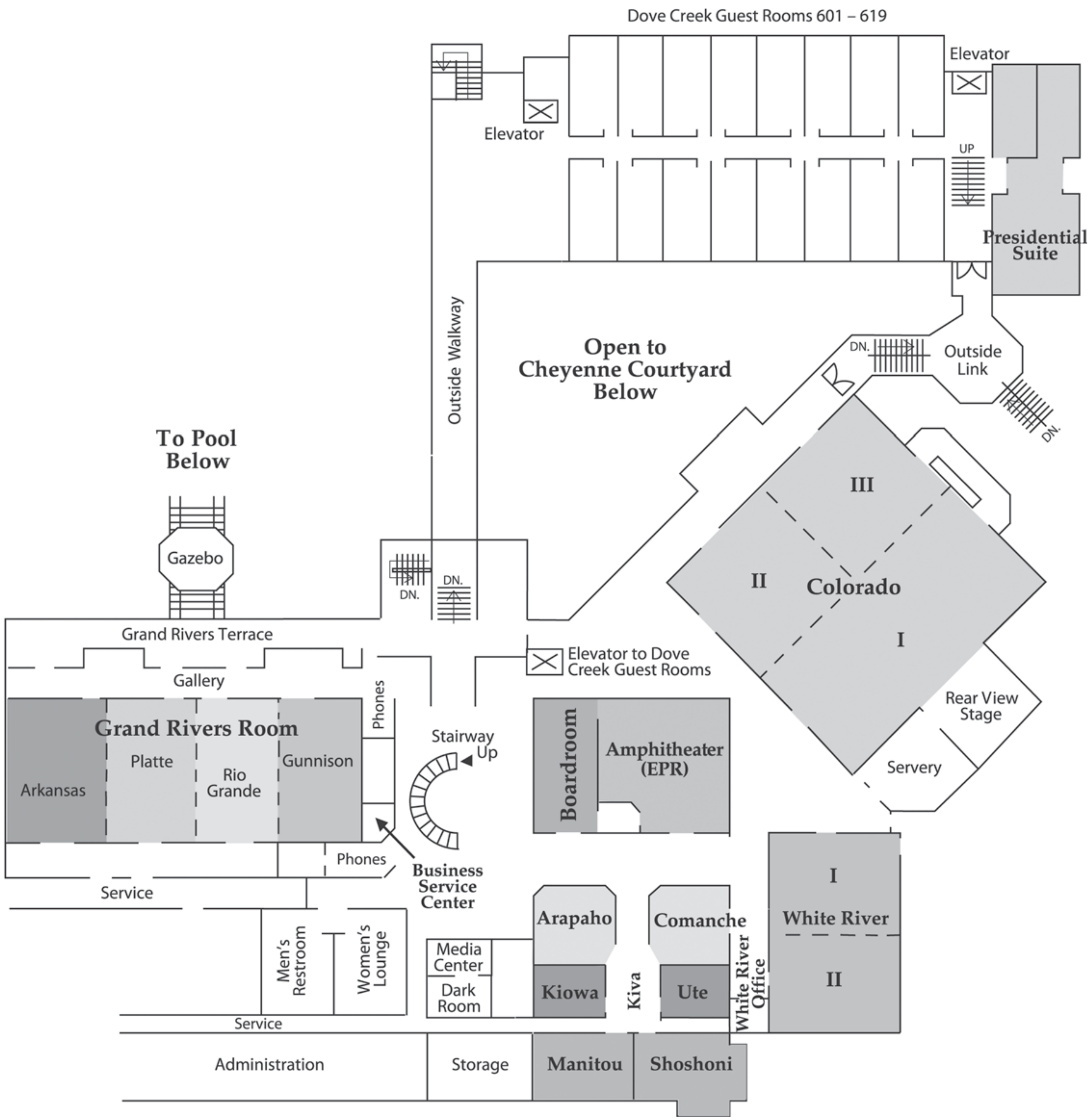
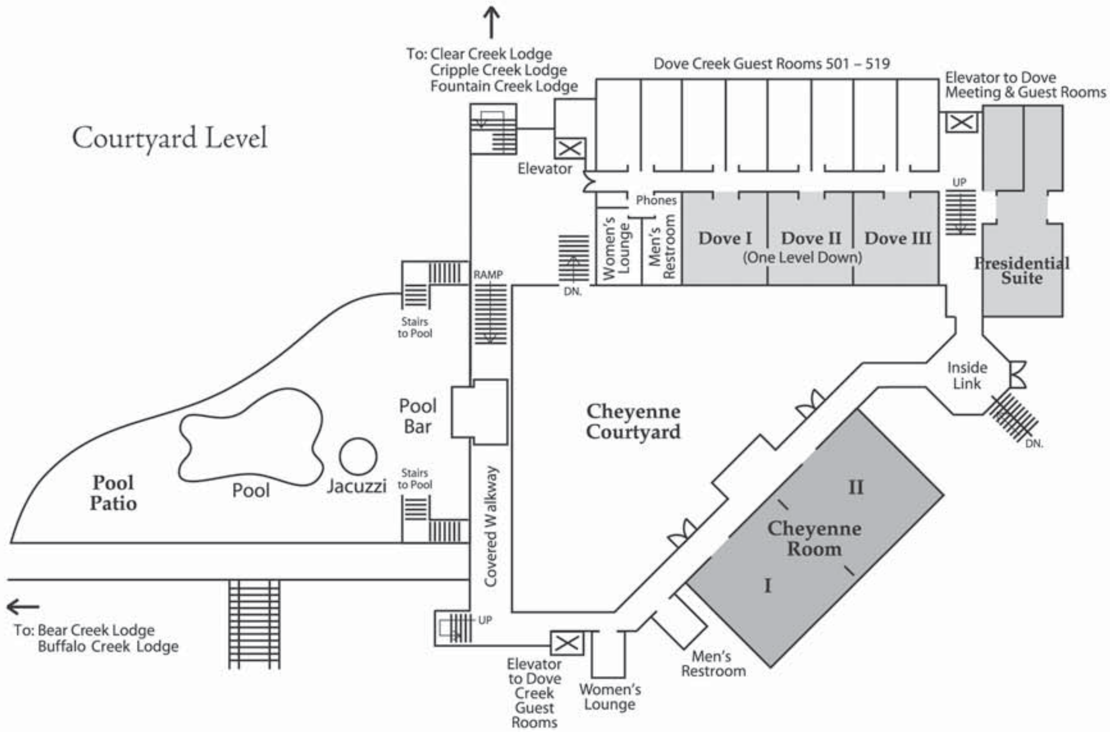
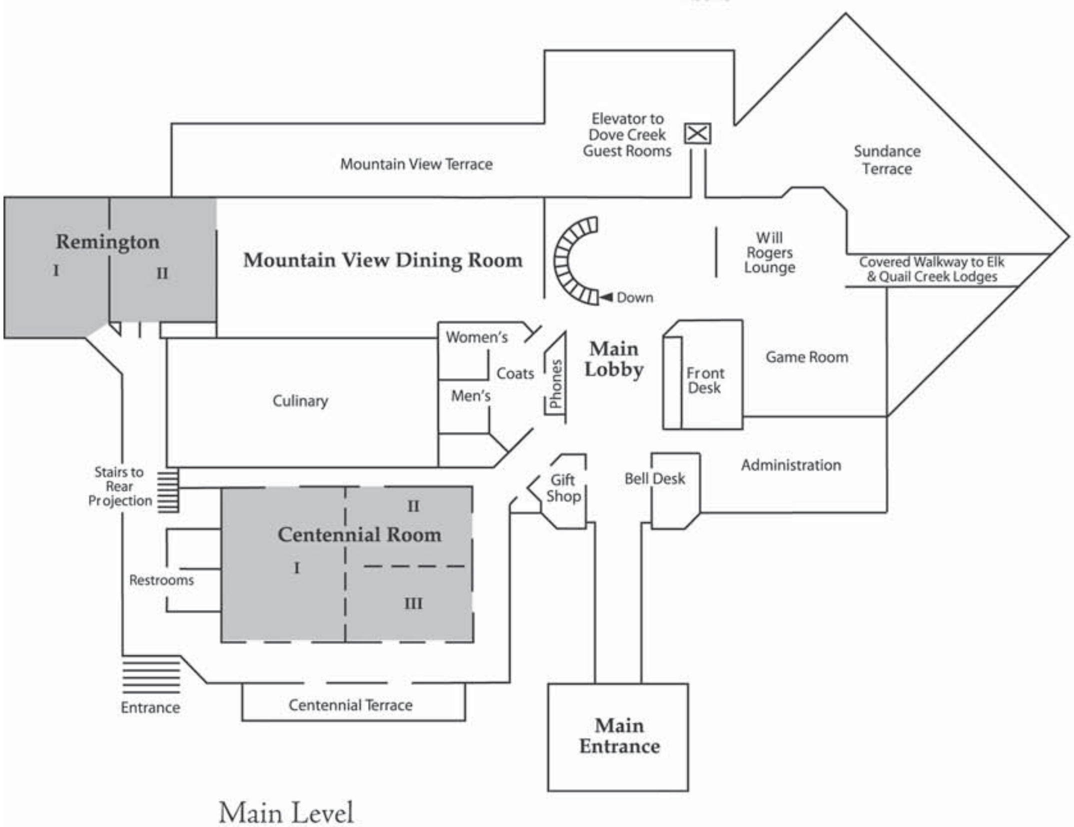
CHEYENNE MOUNTAIN RESORT
colorado springs

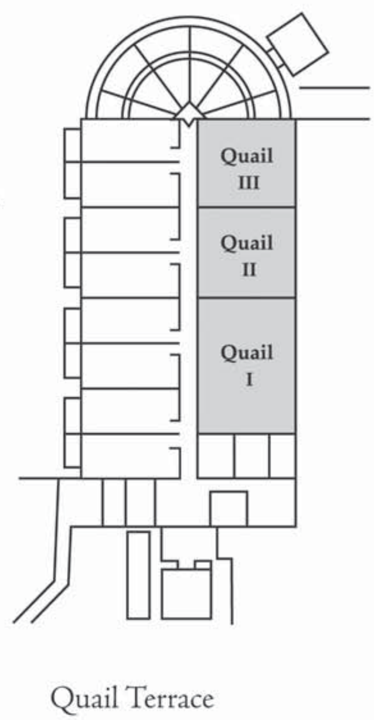
Conference Level



Main Level, Courtyard Level, and Quail Terrace Maps



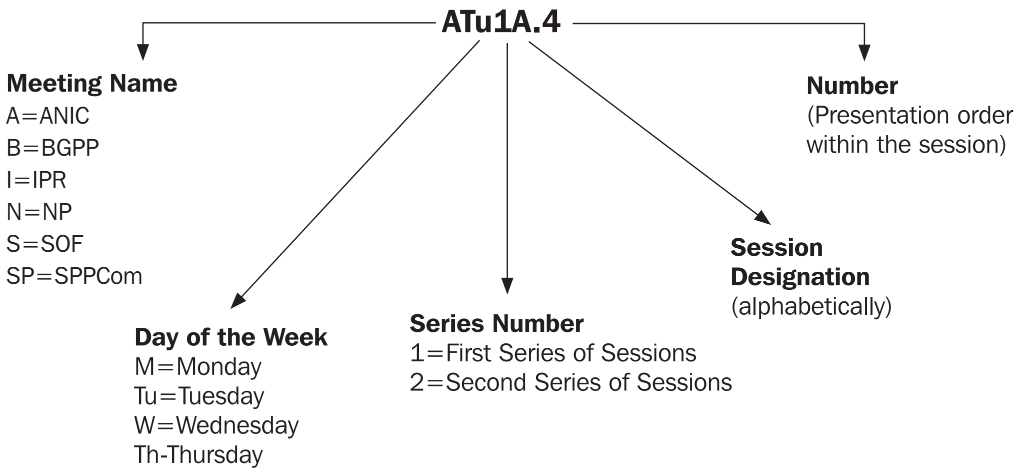




Captured Session Content

We are delighted to announce that your 2012 Advanced Photonics technical registration includes a valuable new enhancement! A portion of the sessions at this year's congress are being digitally captured for on-demand viewing. All captured content from listed sessions will be live for viewing within twenty-four hours of being recorded. Just look for the symbol ▶ in the Agenda of Sessions and abstracts to easily identify the presentations being captured. Content will be available for 60 days following the Congress.

Explanation of Session Codes



The first letter of the code designates the meeting (For instance, A=Access Networks and In-house Communications, B=Bragg Gratings, Photosensitivity and Poling in Glass Waveguides, I=Integrated Photonics Research, Silicon and Nano-Photonics, N=Nonlinear Photonics, S=Specialty Optical Fibers & Applications, SP=Signal Processing in Photonic Communications, J=Joint). The second element denotes the day of the week (Monday=M, Tuesday=Tu, Wednesday=W). The third element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded AW1A.4 indicates that this paper is part of the Access Networks and In-house Communications meeting (A) and is being presented on Wednesday (W) in the first series of sessions (1), and is the first parallel session (A) in that series and the fourth paper (4) presented in that session.

Invited papers are noted with **Invited**

Turorials are noted with **Tutorial**

Plenaries are noted with **Plenary**

Captured Content Sessions are noted with ▶

Exhibit Hours

18 June 2012	10:00–10:30 15:30–16:00	Exhibit Hours / Coffee Break	*Centennial Room*
	18:00–19:30	Joint Poster Session / Exhibits / Reception	*Centennial Room & Terrace*
19 June 2012	10:00–10:30 15:30–16:00	Exhibit Hours / Coffee Break	*Centennial Room*
	18:00–19:30	Joint Poster Session / Exhibits / Conference Reception	*Centennial Room & Terrace*

Agenda of Sessions — Sunday, 17 June

15.00–18.00	**Registration, Lower Lobby,** *Conference Level*
18:00–19:30	**BGPP Welcome Reception (Invite Only),** *Grand Riverview Terrace*

— Monday, 18 June

	Colorado II	Colorado III	Colorado I	White River	Rio Grande/Gunnison
	IPR	IPR	NP	BGPP	SOF
07:00–18:00	**Registration,** *Lower Lobby, Conference Level*				
07:50–08:00				**Opening Comments**	
08:00–10:00				**JM1B • Joint BGPP and SOF Plenary Session - Eric Udd and Philip Russell,** *White River*	
08:20–08:30	**Opening Comments**				
08:30–10:00	**JM1A • Joint IPR & NP Plenary Session I - Vladimir Shalaev and David Miller,** *Colorado I* ▶				
10:00–10:30	**Coffee Break and Exhibits,** *Centennial Room*				
10:30–12:30	**IM2A • Highly Integrated Optical III-V Circuits**	**IM2B • Theory, Modeling & Simulations I: Numerical Methods**	**NM2C • Soliton and Localization Effects in Nonlinear Dynamics** ▶	**BM2D • Grating Properties and Fabrication: Femtosecond Inscription** (ends at 12:15)	**SM2E • Joint SOF, BGPP & NP Session I**
12:30–13:30	**Lunch Break,** *On Your Own*				
13:30–15:30	**IM3A • Lasers and Integration**	**IM3B • Theory, Modeling & Simulations II: Plasmonics and Nano-optics**	**NM3C • Advances in Nonlinear Signal Processing and Applications** ▶	**BM3D • Grating Properties and Fabrication: Novel Fibers and Grating Design**	**SM3E • PBG & PCF Fibers**
15:30–16:00	**Coffee Break and Exhibits,** *Centennial Room*				
16:00–18:00	**IM4A • Electro-Optic Modulators and Switches** ▶	**IM4B • Theory, Modeling & Simulations III: Active Photonics**	**NM4C • Nonlinearities in Lasers and Dissipative Systems**	**BM4D • Fundamentals of Photosensitivity and Poling: Photo-induced Processes and Gratings**	**SM4E • Joint SOF & NP Session**
18:00–19:30	**JM5A • Joint Poster Session & Reception/ Exhibit,** *Centennial Room & Terrace*				

Key to Conference Abbreviations

ANIC	Access Networks and In-house Communications
BGPP	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides
IPR	Integrated Photonics Research, Silicon and Nano Photonics
NP	Nonlinear Photonics
SPPcom	Signal Processing in Photonics Communications
SOF	Specialty Optical Fibers

Agenda of Sessions — Tuesday, 19 June

	Platte	Colorado II	Colorado III	Colorado I	White River	Rio Grande/ Gunnison
	SPPCom	IPR	IPR	NP	BGPP	SOF
07:30–18:00	**Registration,** *Lower Lobby, Conference Level*					
08:20–08:30	**Opening Comments**					
08:30–10:00	**SpTu1A • OFDM I**	**JTu1B • Joint IPR & NP Plenary Session II – Michael Wale and Moti Segev,** *Colorado I*			**BTu1C • Grating Properties and Fabrication: Long Period Gratings**	**STu1D • Fiber & Fabrication**
10:00–10:30	**Coffee Break and Exhibits,** *Centennial Room*					
10:30–12:30	**SpTu2A • OFDM II**	**ITu2B • Waveguides, Polarizers and Dispersion**	**ITu2C • Slow Light in Photonic Crystals**	**NTu2D • Nonlinear systems and Nonlinear Dynamics**	**BTu2E • Applications of Gratings and Poled Glass: FBG Sensors and Interrogation Systems**	**STu2F • Fiber Based Devices**
12:30–13:30	**Lunch Break,** *On Your Own*					
13:30–15:30	**SpTu3A • DSP Algorithm I**	**ITu3B • Microphotonic Filters**	**ITu3C • Tunable Delay**	**NTu3D • Nonlinearities in Novel Propagation Environments**	**BTu3E • Sensor Symposium I**	**STu3F • Mid IR**
15:30–16:00	**Coffee Break and Exhibits,** *Centennial Room*					
16:00–18:00	**SpTu4A • Subsystems**	**ITu4B • Integration of Silicon Photonics with Other Technologies**	**ITu4C • Metamaterials, Sensors and Optical Properties of Nanoparticles**	**NTu4D • Spatial Effects and Periodic Structures**	**BTu4E • Sensor Symposium II** (ends at 17:15)	**STu4F • Fiber Lasers I**
18:00–19:30	**JTu5A • Joint Poster Session & Reception/ Exhibit,** *Centennial Room & Terrace*					

Key to Conference Abbreviations

ANIC	Access Networks and In-house Communications
BGPP	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides
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Agenda of Sessions — Wednesday, 20 June

	Arkansas	Platte	Colorado II	Colorado I	White River	Rio Grande/ Gunnison
	ANIC	SPPCom	IPR	NP	BGPP	SOF
07:30–18:00	**Registration,** *Lower Lobby, Conference Level*					
08:20–08:30	**Opening Comments**					
08:30–10:00	**JW1A • Joint SppCom & ANIC Plenary Session - Yun Chung and Henning Buelow,** *Platte*		**IW1B • Plasmonics and Applications**	**NW1C • Novel Nonlinear Effects**	**BW1D • Fundamentals of Photosensitivity and Poling: Direct Laser Writing and Thermal Poling**	**SW1E • Fiber Based Sensors**
10:00–10:30	**Coffee Break and Exhibits,** *Colorado Gallery and Grand Rivers Gallery*					
10:30–12:30	**AW2A • PON Technology Trends**	**SpW2B • Coherent System Implementation**	**IW2C • Nanophotonics for Energy Conversion and Applications**	**NW2D • Theory of Novel Nonlinear Processes**	**BW2E • Applications of Gratings and Poled Glass: Novel Bragg Gratings Filters** (ends at 12:15)	**SW2F • Fiber Lasers II**
12:30–13:30	**Lunch Break,** *On Your Own*					
13:30–15:30	**AW3A • Indoor Networks**	**SpW3B • High Capacity System**	**IW3C • Photonic Crystals**	**NW3D • Rogue Waves and Novel Propagation Effects**	**BW3E • Applications of Gratings and Poled Glass: Applications of Gratings and Poled Glass: Lasers Grating Structures and Reflectors**	**SW3F • Applications of Fiber Lasers/ Devices**
15:30–16:00	**Coffee Break and Exhibits,** *Colorado Gallery and Grand Rivers Gallery*					
16:00–18:00	**AW4A • OFDM- and WDM-PON Technologies**	**SPPCom Postdeadline Paper Session and Rump Session**	**IW4C • Bionanophotonics and Si Nanophotonics**	**NP Postdeadline Paper Session**	**BW4E • Applications of Gratings and Poled Glass: FBG Applications to Optical Signal Processing** (ends at 17:15) **BGPP Postdeadline Paper Session** (17:15–18:00)	**SW4F • Lasers, Components and Fiber Characterization**
18:30–21:30	**Networking Dinner (Tentative),** *Cheyenne Courtyard/Backup: Centennial Room*					

Key to Conference Abbreviations

ANIC	Access Networks and In-house Communications
BGPP	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides
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Agenda of Sessions — Thursday, 21 June

	Colorado I	Platte	White River
	NP	SPPCom	OIDA Workshop
07:30–12:30	**Registration,** *Lower Lobby, Conference Level*		
08:30–10:00	**NTh1A • Novel Nonlinear Materials** ▶	**SpTh1B • DSP Algorithm II**	**Integration for Advanced Modulation Format Transmission at 100Gb/S and Beyond – Status of the Industry and Challenges Ahead Workshop**
10:00–10:30	**Coffee Break,** *Colorado Gallery and Grand Rivers Gallery*		
10:30–12:30	**NTh2A • Nonlinear Effects in Optical Waveguides** ▶	**SpTh2B • Monitoring** (10:30–12:00)	**Continued from Above**
12:30–14:00			**OIDA Lunch – Ticketed,** *Colorado II & III*
14:00–18:00			**OIDA Workshop (continued)**

Key to Conference Abbreviations

ANIC	Access Networks and In-house Communications
BGPP	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides
IPR	Integrated Photonics Research, Silicon and Nano Photonics
NP	Nonlinear Photonics
SPPcom	Signal Processing in Photonics Communications
SOF	Specialty Optical Fibers

Colorado I

Joint Integrated Photonics Research, Silicon and Nano Photonics/ Nonlinear Photonics

White River

Joint Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides/ Specialty Optical Fibers

07:00–18:00 Registration, *Lower Lobby, Conference Level*

Colorado I

08:20–08:30
Opening Comments

08:30–10:00
JM1A • Joint IPR & NP Plenary Session I
Frank Wise; Cornell Univ., USA; Anatoly Zayats; Univ. of London King's College, UK, Presider

JM1A.1 • 08:30 Plenary

Negative Refraction and Light Bending with Plasmonic Nanoantennas, Vladimir M. Shalaev[1]; [1]*Purdue Univ., USA.* We review the exciting field of optical metamaterials and outline the recent progress in developing tunable and active MMs, semiconductor-based and loss-free negative-index MMs. We also discuss a new approach for broadband light bending.

JM1A.2 • 09:15 Plenary

The Roles of Optics in Information Processing, David A. B. Miller[1]; [1]*Stanford Univ., USA.* Optics has many potential roles it could play in information processing. History, prospects and technology for interconnects and other applications are summarized, including key requirements for potentially viable technological approaches.

White River

08:20–08:30
Opening Comments

08:30–10:00
JM1B • Joint BGPP and SOF Plenary Session
John Ballato; Clemson Univ., USA; Morten Ibsen; Univ. of Southampton, UK, Presider

JM1B.1• 08:30 Plenary

Fire and Ice: 25 Years of fiber grating sensor technology, Eric Udd[1]; [1]*Columbia Gorge Research, LLC, USA.* Over the past 25 years fiber grating sensor technology has been applied in extreme environments where conventional sensor technology has limited or in some cases non-existent measurement capabilities enabling widespread application potential.

JM1B.2 • 09:15 Plenary

Nanoscale Glass Blowing, Philip Russell[1]; [1]*Max Planck Institute for the Science of Light, Germany.* The past 15 years has seen the emergence of glass fibers with intricate transverse microstructures, often with nanoscale features. Their ability to guide and manipulate light in unexpected ways has led to many novel applications.

10:00–10:30 Coffee Break, *Centennial Room*

NOTES

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
IM2A • Highly Integrated Optical III-V Circuits
Milan Mashanovitch; Univ. of California Santa Barbara, USA, Presider

IM2A.1 • 10:30 Invited
Generic InP-based integration technology, today and tomorrow, Meint K. Smit[1]; *[1]Electrical Engineering, Technische Universiteit Eindhoven, Netherlands.* Generic Photonic Integration Processes will cause a revolution in micro and nanophotonics. Generic InP-based technology provides a broad photonic functionality, both active and passive. It also has a good potential for future integration with electronics.

IM2A.2 • 11:00
Modified Uni-Traveling Carrier Photodiodes Heterogeneously Integrated on Silicon-on-Insulator (SOI), Andreas Beling[1], Yang Fu[1], Zhi Li[1], Huapu Pan[1], Qiugui Zhou[1], Allen Cross[1], Molly Piels[2], Jon Peters[2], John E. Bowers[2], Joe C. Campbell[1]; *[1]ECE Department, Univ. of Virginia, USA; [2]ECE Department, Univ. of California Santa Barbara, USA.* We propose and demonstrate a novel InP-based evanescently-coupled modified uni-traveling carrier photodiode (MUTC PD) on SOI waveguide. A 100-μm long waveguide MUTC PD reaches a third-order local intercept point (IP3) of 20 dBm at 7 GHz and 10 mA.

IM2A.3 • 11:15 Invited
Selective-area-growth technology for flexible active building blocks, Helene Debregeas[1], Jean Decobert[1], Nadine Lagay[1], Ronan Guillamet[1], David Carrara[1], Olivier Patard[1], Christophe Kazmierski[1], Romain Brenot[1]; *[1]III-V Lab, France.* Selective area growth enables to locally tune the epitaxial material thickness and composition on a single InP substrate. This paper presents this technology and its application to photonic integrated circuits, illustrated by two realisations.

IM2A.4 • 11:45 Invited
Large-scale Monolithic Integration Enabling Terabit Transmitters and Coherent Super-channel Architecture, Masaki Kato[1], Damien Lambert[1], Vikrant Lal[1], Matthias Kuntz[1], John Summers[1], Peter Evans[1], Scott Corzine[1], Matthe Fisher[1], Roman Malendevich[1], Jefferey Rahn[1], Amod Damle[1], Andrew Dentai[1], Ranjani Muthiah[1], Randal Salvatore[1], Adam James[1], Pavel Studenkov[1], Eva Strzelecka[1], Thomas Vallaitis[1], Forrest Sedgwick[1], Omer Khayam[1], Radhakrishnan Nagarajan[1], Jie Tang[1], Jiaming Zhang[1], Huan-Shang Tsai[1], Tim Butrie[1], Mark Missey[1], David Krause[1], John McNicol[1], Kuang-Tsan Wu[1], Han Sun[1], Mike Reffle[1], Fred Kish[1], David Welch[1]; *[1]Infinera Corporation, USA.* In this talk, we review InP-based, 10 wavelength, polarization-multiplexed quadrature phase-shift keying (PM-QPSK) transmitter and receiver photonic integrated circuits (PICs) that enable terabit coherent super-channel architecture.

Colorado III

Integrated Photonics Research, Silicon and Nano Photonics

10:30–12:30
IM2B • Theory, Modeling & Simulations I: Numerical Methods
Kurt Busch; Humboldt Universitat zu Berlin, Germany, Presider

IM2B.1 • 10:30 Invited
Future Requirements of Modeling Software for Integrated Optical Communication Systems, Michael Hochberg[1], Thierry J. Pinguet[2,3], Tom Baehr-Jones[1]; *[1]Electrical and Computer Engineering, Univ. of Delaware, USA; [2]Electrical Engineering, Univ. of Washington, USA; [3]Luxtera, Inc., USA.* As silicon photonics processes mature, the infrastructure needed to support large scale design needs to follow suit. We discuss here future requirements for modeling of integrated optical communication systems.

IM2B.2 • 11:00 Invited
Simulation and Optimization of Photonic Integrated Circuits, Jackson Klein[1], James Pond[1]; *[1]Lumerical Solutions, Inc, Canada.* We will demonstrate the simulation of photonic integrated circuits, initially using analytical models for each element of the circuit. The results of physical electromagnetic and electrical solvers will then be incorporated to simulate realistic photonic integrated circuits.

IM2B.3 • 11:30
CAPHE: Time-domain and Frequency-domain Modeling of Nonlinear Optical Components, Martin Fiers[1,2], Thomas Van Vaerenbergh[1,2], Joni Dambre[3], Peter Bienstman[1,2]; *[1]Department of Information Technology, Ghent Univ., Belgium; [2]Center for Nano- and Biophotonics, Ghent Univ., Belgium; [3]Department of Electronics and Information Systems, Ghent Univ., Belgium.* We present CAPHE, a tool for modeling optical circuits in time and frequency domain. Some applications are optical filter design, variational studies and dynamical modeling of strongly nonlinear components (microrings, microdisks, SOAs).

IM2B.4 • 11:45
Topology optimization of nano-photonic systems, Yuriy Elesin[1], Fengwen Wang[1], Jacob Andkjær[1], Jakob S. Jensen[1], Ole Sigmund[1]; *[1]Technical Univ. of Denmark, Denmark.* We describe recent developments within nano-photonic systems design based on topology optimization. Applications include linear and non-linear optical waveguides, slow-light waveguides, as well as all-dielectric cloaks that minimize scattering or back-scattering from hard obstacles.

Colorado I

Nonlinear Photonics

10:30–12:30
NM2C • Soliton and Localization Effects in Nonlinear Dynamics
F. Oemer Ilday; Bilkent Universitesi, Turkey, Presider

NM2C.1 • 10:30 Invited
Tiny Waves we Should Never Ignore, Shalva Amiranashvili[1], Carsten Bree[1], Fedor Mitschke[2], Ayhan Demircan[3]; *[1]Weierstrass Institute for Applied Analysis and Stochastics, Germany; [2]Univ. of Rostock, Germany; [3]no Affiliation, Germany.* Tiny dispersive waves are naturally generated by non-resonant wave interactions and Cherenkov radiation of solitons. We have found that these waves may in turn feed the solitons and spontaneously switch them to a large-amplitude state.

NM2C.2 • 11:00
Do solitons arise from modulational instability?, Christoph Mahnke[1], Fedor Mitschke[1]; *[1]Institut fuer Physik, Universitaet Rostock, Germany.* The notion that a train of solitons arises from cw by modulational instability is rejected by using discrete scattering transform, adopted to infinite domain. Inclusion of the Raman effect, however, can induce soliton formation.

NM2C.3 • 11:15
Modulation Instability in Xenon-Filled Hollow-Core Photonic Crystal Fiber Francesco Tani[1], John C. Travers[1], Ka Fai Mak[1], Wonkeun Chang[1], Philip Russell[1,2]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Department of Physics, Univ. of Erlangen-Nuremberg, Germany.* Abstract: We experimentally access the modulation instability regime in xenon-filled kagomé PCF. Soliton orders ~100 are obtained with few-μJ, 490 fs pulses at 800 nm. Numerical simulations confirm pulse breakup into ultrashort solitons.

NM2C.4 • 11:30
Stimulated Modulation Instability in Silicon for Energy Efficient Supercontinuum Generation, Peter DeVore[1,2], Daniel R. Solli[1,3], Claus Ropers[1,3], Prakash Koonath[1], Bahram Jalali[1,2]; *[1]Department of Electrical Engineering, Univ. of California, Los Angeles, USA; [2]California NanoSystems Institute, Univ. of California, Los Angeles, USA; [3]Courant Research Center Nano-Spectroscopy and X-Ray Imaging, Univ. of Göttingen, Germany.* Nonlinear losses limit supercontinuum efficiency in silicon. This fundamental limitation can be relaxed and higher energy efficiency and a more stable output can be obtained by stimulating modulation instability with an off-resonant weak seed.

NM2C.5 • 11:45
Spontaneous Generation of Spectral Incoherent Solitons through Supercontinuum Generation Bertrand Kibler[1], Claire Michel[1], Alexandre Kudlinski[2], Benoit Barviau[1,2], Guy Millot[1], Antonio Picozzi[1]; *[1]Laboratoire Interdisciplinaire Carnot de Bourgogne, France; [2]Laboratoire PhLAM, France.* We study experimentally the highly nonlinear regime of supercontinuum generation in photonic crystal fibers. We report a transition from continuous to discrete spectral incoherent solitons in the low-frequency edge of the supercontinuum spectrum.

White River

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:15
BM2D • Grating Properties and Fabrication: Femtosecond Inscription
Manfred Rothhardt; IPHT, Germany, Presider

BM2D.1 • 10:30 Invited
Monolithic Fiber Lasers for the Mid-Infrared, Real Vallee[1]; *[1]Centre d'optique photonique et laser, Universite Laval, Canada.* The recent development of rare-earth doped as well as Raman gain fluoride all-fiber laser operating beyond 2.2 µm is reviewed.

BM2D.2 • 11:00
Fiber Bragg grating operating in the visible range written with 400 nm femtosecond pulses and a phase-mask, Julien Carrier[1], Martin Bernier[1], Real Vallee[1]; *[1]Université Laval (COPL), Canada.* A Bragg grating with reflectivity of 99.9% at 542.2 nm was written in silica fiber using 400 nm femtosecond pulses and a phase-mask. This is the first step towards the development of all-fiber visible lasers.

BM2D.3 • 11:15
Discrete non-planar reflections of a fs laser pulse written volume Bragg grating (VBG), Daniel Richter[1], Christian Voigtländer[1], Jens U. Thomas[1], Andreas Tünnermann[1], Stefan Nolte[1]; *[1]Friedrich-Schiller-Univ. Jena, Abbe Center of Photonics, Institute of Applied Physics, Germany.* We present a VBG inscribed in fused silica by three beam interference of fs pulses. The generated twodimensional grating structure exhibits a discrete diffraction pattern which can be described based on the Ewald sphere.

BM2D.4 • 11:30
Orientation dependence of higher order mode reflections in femtosecond pulse written fiber Bragg gratings, Jens U. Thomas[1], Markus Mundus[1], Ch
ristian Voigtländer[1], Ria G. Becker[1], Andreas Tünnermann[1,2], Stefan Nolte[1,2]; *[1]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität, Germany; [2]Fraunhofer Institute for Applied Optics and Precision Engineering, Germany.* Ultrashort pulse lasers allow for the inscription of fiber Bragg gratings largely independent of the fiber geometry. Here, we investigate how the orientation of a reflected higher order mode depends on the FBG's cross-section.

BM2D.5 • 11:45
Reflection Characteristics of Type II FBG Made With Femtosecond Radiation, Dan Grobnic[1], Stephen J. Mihailov[1], Robert B. Walker[1], Christopher W. Smelser[1]; *[1]Communications Research Centre, Canada.* We have designed an experiment to show that in spite of the broadband loss along the grating, type II gratings manifest low loss in a reflective configuration

Rio Grande/Gunnison

Specialty Optical Fibers

10:30–12:30
SM2E • Joint SOF, BGPP & NP Session I
John Ballato; Clemson Univ., USA, Presider

SM2E.1 • 10:30 Invited
Ultrafast Laser Processing of Glass: From New Phenomena to Applications, Peter G. Kazansky[1], M. Beresna[1], M. Gecevicius[1]; *[1]Univ. of Southampton, UK.* Ultrafast laser processing of glass reveals new phenomena. Reviewed, are recent demonstrations of 5D optical memory, vortex polarization converters employing self-assembled nanostructuring, ultrafast laser calligraphy and polarization writing control using pulses with tilted front.

SM2E.2 • 11:00 Invited
High Power Passive Components for kW Lasers, Bertrand Gauvreau[1], Mathieu Faucher[1], Nigel Holehouse[1]; *[1]ITF Laboratories Inc., Canada.* Accelerating deployment of industrial kilowatt fiber lasers caused a rapidly increasing demand for high performance passive components. We present a leading manufacturer point of view on the trends and future limitations of the technology.

SM2E.3 • 11:30
AgBr-TlI, AgBr-KRS-5 photonic crystals and fibers based on them for Middle and Far infrared, Andrey I. Chazov[1], Alexandr S. Korsakov[1], Dmitry S. Vrublevsky[1], Viktor S. Korsakov[1], Vladislav V. Zhukov[1], Liya V. Zhukova[1], Nadezhda Terlyga[1]; *[1]Ural Federal Univ. named after the first President of Russia B.N.Eltsin, Russian Federation.* Crystals of new composition for manufacturing of photonic fibers for middle and far infrared range are described. Doping of AgCl-AgBr solid solutions with TlI resulted in higher photostability and wider transmission range of grown crystals and extruded fibers.

SM2E.4 • 11:45
Direct UV Written Waveguide's Dispersion in Flexible Silica Flat Fibre Chip, Desmond M. Chow[1], Din Chai Tee[1], Seyed Reza Sandoghchi[1], Faisal Rafiq Mahamd Adikan[1]; *[1]Electrical Engineering, Univ. of Malaya, Malaysia.* Dispersion of Direct UV Written channel waveguides in novel flexible silica Flat Fibre chip was numerically simulated via Finite Element Method. Result shows nearly zero chromatic dispersion at communication band with application in Integrated Optics.

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

Colorado III

Integrated Photonics Research, Silicon and Nano Photonics

Colorado I

Nonlinear Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

IM2A • Highly Integrated Optical III-V Circuits—Continued

IM2A.5 • 12:15
Cryogenic Operation of Silicon Photonic Modulators, Jeremy Wright[1], Doug C. Trotter[1], William Zortman[1], Anthony L. Lentine[1], Eric Shaner[1], Michael R. Watts[2], Akin Akturk[3], Marty Peckerar[3]; [1]*Sandia National Laboratories, USA;* [2]*Massachusetts Institute of Technology, USA;* [3]*Univ. of Maryland, USA.* For the first time simulation and operation of a silicon photonic modulator is demonstrated at cryogenic temperatures. The device operated at 5Gbps and 10Gbps at a temperature of 115K opening application areas in harsh environments.

IM2B • Theory, Modeling & Simulations I: Numerical Methods—Continued

IM2B.5 • 12:00
Perfectly Matched Layers Conforming to Triangular Lattices for Numerical Simulations of Photonic Crystal Devices, Shichang She[1], Ya Yan Lu[1]; [1]*City Univ. of Hong Kong, Hong Kong.* For simulating photonic crystal devices with a triangular lattice structure, it is advantageous to use hexagon unit cells and truncate the domain along the edges of these unit cells. A perfectly matched layer (PML) technique that conforms to triangular lattices is developed in this paper.

IM2B.6 • 12:15
Three-dimensional periodic LOD-FDTD method with a fundamental scheme, Yuu Wakabayashi[1], Junji Yamauchi[1], Hisamatsu Nakano[1]; [1]*Hosei Univ., Japan.* We develop a three-dimensional implicit FDTD method based on the locally one-dimensional scheme to analyze periodic structures. Computational time is reduced to 29% of that for the explicit FDTD method with acceptable results being maintained.

NM2C • Soliton and Localization Effects in Nonlinear Dynamics—Continued

NM2C.6 • 12:00
Partition of the instantaneous and delayed nonlinear responses in optical fibers, Olivier Vanvincq[1], Abdelkrim Bendahmane[1], arnaud mussot[1], Alexandre Kudlinski[1]; [1]*Universite de Lille 1, France.* We provide a semi-analytical model for partitioning the nonlinear response of silica glass into electronic and nuclear contributions to describe the propagation of ultrashort solitons with a duration comparable to the Raman response time scale.

NM2C.7 • 12:15
Highly Localized Plasma Formation in Air Using Space-time Focusing of mJ Ultrafast Pulses, Michael Greco[1], Charles G. Durfee[1]; [1]*Colorado School of Mines, USA.* Space-time focusing of spatially-chirped Ti:Sapphire laser pulses is used to generate a plasma in air axially localized to 28x less than the confocal parameter, suppressing filamentation on the way to the focus.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
IM3A • Lasers and Integration
Joris Van Campenhout; InterUniv. Microelectronics Center, Belgium, Presider

IM3A.1 • 13:30 Invited
Recent Advances in Germanium Based Devices, Kazumi Wada[1]; [1]*Materials Engineering, Univ. of Tokyo, Japan.* The present paper has reviewed recent advances in Ge growth and devices in Si microphotonics. We have shown a high quality Ge growth without a post-growth annealing. Strain-engineered Ge will be an important material platform for not only photodetectors but modulators and light emitters.

IM3A.2 • 14:00 Invited
Low Power Computer Interconnect with 1060nm VCSEL, Jean Benoit Héroux[1], Shigeru Nakagawa[1]; [1]*IBM Research - Tokyo, Japan.* Results on an optical link using a high efficiency 1060 nm VCSEL are presented. Clear eye patterns are obtained at 25 Gbps. A Tx module with a 1.7 pJ/bit energy consumption at 10 Gbps is demonstrated.

13:30–15:30
IM3B • Theory, Modeling & Simulations II: Plasmonics and Nano-optics
Jackson Klein; Lumerical Solutions, Inc., Canada, Presider

IM3B.1 • 13:30 Invited
Discontinuous Galerkin Methods in Nanophotonic, Kurt Busch[1,2]; [1]*Institut für Physik, AG Theoretische Optik & Photonik, Humboldt Universitat zu Berlin, Germany;* [2]*Max-Born-Institut, Germany.* Nanophotonic devices typically feature complex geometries and materials with nonlinear optical properties. This poses serious challenges to computational approaches. The Discontinuous Galerkin Time-Domain method provides a rather flexible approach to accurate computations of such systems.

IM3B.2 • 14:00 Invited
Non-asymptotic Effective Medium Theory, Igor Tsukerman[1]; [1]*Electrical & Computer Eng, The Univ. of Akron, USA.* In the proposed non-asymptotic homogenization theory the coarse-grained fields are defined to satisfy Maxwell's equations and boundary conditions exactly. The end result is an extended material tensor with 36 local and additional nonlocal parameters.

13:30–15:30
NM3C • Advances in Nonlinear Signal Processing and Applications
John Dudley; Universite de Franche-Comte, France, Presider

NM3C.1 • 13:30 Invited
Advances in Optical Signal Processing Based on Phase Sensitive Parametric Mixing, David J. Richardson[1], Joseph Kakande[1], Radan Slavík[1], Francesca Parmigiani[1], Periklis Petropoulos[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We review our recent work in the area of optical processing of phase encoded signals, focusing in particular on optical phase quantization - a key functionality for regeneration and test and measurement applications.

NM3C.2 • 14:00
High resolution time-to-space conversion of sub-picosecond pulses at 1.55µm by non-degenerate SFG in PPLN crystal, Dror Shayovitz[1], Christine Silberhorn[2], Dan M. Marom[1], Harald Herrmann[2], Wolfgang Sohler[2], Raimund Ricken[2]; [1]*Applied Physics, Hebrew Univ. of Jerusalem, Israel;* [2]*Applied Physics, Univ. of Paderborn, Germany.* We demonstrate time-to-space conversion of ultrashort optical pulses using sum-frequency generation in PPLN. An order of magnitude increase in conversion efficiency over our previous work was achieved, whilst maintaining a resolution factor of 90.

NM3C.3 • 14:15
All-optical nonlinear simultaneous polarization and intensity regeneration of a 40-Gb/s telecommunication signal, Philippe Morin[1], Julien Fatome[1], Christophe Finot[1], Stéphane Pitois[1], Guy Millot[1]; [1]*ICB, Universite de Bourgogne, France.* We experimentally report the simultaneous all-optical regeneration of the polarization state and the intensity profile of a 40 Gb/s Return-to-Zero telecommunication signal by means of Kerr effect occurring in a single segment of fiber.

BM2D • Grating Properties and Fabrication: Femtosecond Inscription—Continued

BM2D.6 • 12:00

Femtosecond Laser-induced, Electro-optically Tunable Waveguide Bragg Gratings in Lithium Niobate, Sebastian Kroesen[1,2], Wolfgang Horn[1,2], Cornelia Denz[1,2]; [1]*Westfälische Wilhelms-Universität, Institute for Applied Physics, Germany;* [2]*Westfälische Wilhelms-Universität, Center for Nonlinear Science (CeNoS), Germany.* We demonstrate the fabrication of electro-optically tunable, type-II Bragg gratings in lithium niobate. The waveguide is structured periodically to achieve narrowband reflections in the c-band. An electric field is used to achieve electro-optic tuning of the reflection maximum by $\Delta\lambda = 625$ pm.

SM2E • Joint SOF, BGPP & NP Session I—Continued

SM2E.5 • 12:00

Spectral Broadening of mid-IR Femtosecond Pulses in Highly Germanium Doped Fiber, Nikolai Tolstik[1], Dmitry S. Klimentov[1], Vladislav Dvoyrin[1], Irina Sorokina[1], Evgeni Sorokin[2], Vladimir Kalashnikov[2]; [1]*Department of physics, NTNU, Norway;* [2]*Institut für Photonik, TU Wien, Austria.* We demonstrate spectral broadening of femtosecond mid-IR pulses in a single-mode highly germanium-doped fiber.

SM2E.6 • 12:15

Study of the linewidth dependence of the double peaked Brillouin spectrum on temperature and strain in an aluminosilicate fiber, Francesca H. Mountfort[1], Mohammad Belal[1], Jayanta K. Sahu[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* The spontaneous Brillouin spectrum of an aluminosilicate fiber shows two distinct peaks. Respective linewidths exhibit strain coefficients of -0.0204±0.0043MHz/με and 0.02374±0.0053MHz/με and temperature coefficients of -0.66±0.2447MHz/°C and 0.50±0.1459MHz/°C.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
BM3D • Grating Properties and Fabrication: Novel Fibers and Grating Design

Paul Westbrook; OFS Laboratories, USA, Presider

BM3D.1 • 13:30 Invited

Waveguide Bragg Gratings for the Realization of High-Quality Monolithic Cavities, Edward H. Bernhardi[1], Henk van Wolferen[2], Kerstin Wörhoff[1], René de Ridder[1], Markus Pollnau[1]; [1]*Integrated Optical MicroSystems Group, Univ. of Twente, Netherlands;* [2]*Transducers Science and Technology Group, Univ. of Twente, Netherlands.* The fabrication and characterization of waveguide Bragg gratings integrated with aluminum oxide channel waveguides are reported. Passive and lasing Bragg-grating-based cavities with Q-factors exceeding 1.5 × 106 and 1.1 × 1011, respectively, are demonstrated.

BM3D.2 • 14:00

Relief Bragg grating reflectors inscribed into solid core photonic crystal fibres, Maria Konstantaki[1], Paul Childs[1], Michele Sozzi[1], Stavros Pissadakis[1]; [1]*FORTH-IESL, Greece.* Relief Bragg gratings are inscribed inside the capillaries of solid core photonic crystal fibres using 248nm laser radiation and toluene vapors. These gratings exhibit reflection extinction ratios greater than 20dB, while surviving up to 1200oC.

BM3D.3 • 14:15

Direct-write depressed cladding waveguide Bragg-gratings in ZBLAN glass, Simon Gross[1], David G. Lancaster[2], Heike Ebendorff-Heidepriem[2], Tanya M. Monro[2], Alexander Fuerbach[1], Michael J. Withford[1]; [1]*Macquarie Univ., Australia;* [2]*Univ. of Adelaide, Australia.* Strong waveguide Bragg-gratings (10 dB reflectivity) were fabricated by the direct-write technique in ZBLAN glass. Based on a depressed cladding, an array of 169 periodic and in phase modifications was placed inside the core.

13:30–15:30
SM3E • PBG & PCF Fibers

Stojan Radic; Univ. of California San Diego, USA, Presider

SM3E.1 • 13:30 Invited

Large-core Single-mode Solid Photonic Bandgap Fibers, Liang Dong[1], Kunimasa Saitoh[2], Fanting Kong[1], Paul Foy[1], Thomas Hawkins[1], Devon Mcclane[1]; [1]*Clemson Univ., USA;* [2]*Hokkaido Univ., Japan.* Mode-area scaling of single-mode fibers is critical to power scaling of fiber lasers. Significantly different guidance principle of solid photonic bandgap fibers provides new design opportunities. Recent progress in this area will be reported.

SM3E.2 • 14:00

Low Loss (34 dB/km) Silica Hollow Core Fiber for the 3 μm Spectral Region, Fei Yu[1], William J. Wadsworth[1], Jonathan C. Knight[1]; [1]*Physics, Univ. of Bath, UK.* We describe the characteristics of a silica hollow-core fiber for transmission around 3 μm wavelength, with minimum attenuation of 34 dB/km. The design is based on the use of a negative curvature core wall.

SM3E.3 • 14:15

Photonic bandgap confinement in an all-solid tellurite glass photonic crystal fiber, Joris Lousteau[1], Gerardo Scarpignato[1], George Athanasiou[2], Nadia G. Boetti[1], Emanuele Mura[1], Massimo Olivero[3], Trevor Benson[2], Daniel Milanese[1]; [1]*DISAT, Politecnico di Torino, Italy;* [2]*GGIEMR, Univ. of Nottingham, UK;* [3]*DELEN, Politecnico di Torino, Italy.* The manufacturing process and the fiber characterization procedures of an all-solid tellurite glass photonic bandgap fiber are described and discussed. Results of experimental loss measurements are compared with modeling predictions to discuss the fiber quality

Colorado II — Integrated Photonics Research, Silicon and Nano Photonics

Colorado III — Integrated Photonics Research, Silicon and Nano Photonics

Colorado I — Nonlinear Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

IM3A • Lasers and Integration—Continued

IM3A.3 • 14:30
Silicon-Organic Hybrid (SOH) Lasers at Telecommunication Wavelengths, Matthias Lauermann[1], Dietmar Korn[1], Patrick Appel[1], Luca Alloatti[1], Wolfgang Freude[1], Juerg Leuthold[1], Christian Koos[1]; *[1]Institute of Photonics and Quantum Electronics (IPQ) and Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology, Germany.* We demonstrate for the first time lasing in silicon-organic hybrid (SOH) strip waveguides. Optical gain is provided by a dye-doped polymer cladding enabling room-temperature lasing at telecommunication wavelengths.

IM3A.4 • 14:45
Electrically Pumped Germanium-on-Silicon Laser, Rodolfo E. Camacho-Aguilera[1], Yan Cai[1], Neil Patel[1], Jonathan T. Bessette[1], Marco Romagnoli[2], Lionel C. Kimerling[1], Jurgen Michel[1]; *[1]Massachusetts Institute of Technology, USA; [2]APIC Corporation, USA.* Germanium lasing from Ge-on-Si pnn heterojunction diode structures is demonstrated. Selective growth of highly phosphorus doped Ge in oxide trenches shows a design for CMOS compatible laser integration.

IM3A.5 • 15:00
High n-type doped germanium for electrically pumped Ge laser, Yan Cai[1], Rodolfo E. Camacho-Aguilera[1], Jonathan T. Bessette[1], Lionel C. Kimerling[1], Jurgen Michel[1]; *[1]Massachusetts Institute of Technology, USA.* We demonstrate an active phosphorous concentration of 4x1019 cm-3 in Ge by delta doping. Dopant enhanced diffusion is observed and modeled. Photoluminescence (PL) and electroluminescence (EL) confirm the high doping level with stronger emission.

IM3A.6 • 15:15
Deep submicron etched-slot coupled semiconductor lasers fabricated by standard UV-lithography, Tingting Yu[1], lei Wang[1], Li Zou[1], Jianjun He[1]; *[1]Zhejiang Univ., China.* A single mode deep submicron etched-slot coupled laser is fabricated using standard UV-lithography. A threshold current of 22mA and SMSR near 40dB is achieved and the slope efficiency is 0.178W/A.

IM3B • Theory, Modeling & Simulations II: Plasmonics and Nano-optics—Continued

IM3B.3 • 14:30
Optimal On/Off Scheme for All-Optical Switching, Philip T. Kristensen[1], Mikkel Heuck[1], Jesper Mork[1]; *[1]DTU Fotonik, Technical Univ. of Denmark, Denmark.* We present a two-pulsed on/off scheme based on coherent control for fast switching of the optical energy in a micro cavity and use calculus of variations to optimize the switching in terms of energy.

IM3B.4 • 14:45
Control of dispersion in photonic crystal waveguides using group symmetry theory, Pierre Colman[1,2], Sylvain Combrié[1], Gaëlle Lehoucq[1], Alfredo De Rossi[1]; *[1]Thales Research and Technology, France; [2]Danmarks Tekniske Universitet, Denmark.* We demonstrate dispersion tailoring by coupling modes in a photonic crystal waveguide. Different dispersion features are generated and controlled by a single geometrical parameter. This concept is demonstrated experimentally with very good agreement with theory.

IM3B.5 • 15:00
Scattering of Evanescent Wave by Nanowires, David A. Shapiro[1], Leonid L. Frumin[1], Oleg V. Belai[1], Serge V. Perminov[2]; *[1]Institute of Automation and Electrometry, Russian Federation; [2]A.V. Rzhanov Institute of Semiconductor Physics, Russian Federation.* The scattering of evanescent wave, one of the main processes of nanophotonics, is studied in 2D geometry using boundary integral equations and special two-domain Green function. The problem is studied for a single, a pair, and a series of nanowires.

IM3B.6 • 15:15
Polarization converters using optical nano-waveguides, Junji Yamauchi[1], Takashi Hashimoto[1], Yuu Wakabayashi[1], Hisamatsu Nakano[1]; *[1]Hosei Univ., Japan.* Polarization converters using optical nano-waveguides are proposed and investigated numerically. An extinction ratio of more than 15 dB is obtained over a wavelength range of 1.3 µm to 1.7 µm for an embedded air-core waveguide.

NM3C • Advances in Nonlinear Signal Processing and Applications—Continued

NM3C.4 • 14:30
Observation of Low-Contrast All-Optical Switching in Silicon Nitride Microdisks Based on the Zeno Effect, Scott Hendrickson[1], Chad Weiler[1], Ryan M. Camacho[2], Peter Rakich[2], Ian Young[2], Mike Shaw[2], Todd Pittman[3], Jim Franson[3], Bryan C. Jacobs[1]; *[1]Johns Hopkins Univ. Applied Physics Lab, USA; [2]Sandia National Laboratories, USA; [3]Univ. of Maryland, Baltimore County, USA.* Low-contrast all-optical Zeno switching has been demonstrated in a Silicon Nitride microdisk resonator surrounded by hot Rubidium vapor. The device is based on the suppression of the cavity field buildup due to non-degenerate two-photon absorption.

NM3C.5 • 14:45
Low-Power All-Optical Switching Using EIT and the Zeno Effect, David Clader[1], Scott M. Hendrickson[1], Ryan M. Camacho[2], Bryan C. Jacobs[1]; *[1]The Johns Hopkins Univ. Applied Physics Laboratory, USA; [2]Sandia National Laboratories, USA.* We present theoretical results for an all-optical switch based on electromagnetically induced transparency and the Zeno effect in a microdisk resonator. We predict 20 dB of switching contrast with only 100 nW of control-beam power.

NM3C.6 • 15:00
Dual-channel, single-photon upconversion detector at 1300 nm, Paulina S. Kuo[1,2], Jason S. Pelc[3], Oliver Slattery[2], Lijun Ma[2], Martin M. Fejer[3], Xiao Tang[2]; *[1]Joint Quantum Institute, NIST-Univ. of Maryland, USA; [2]Information Technology Laboratory, National Inst of Standards & Technology, USA; [3]E. L. Ginzton Laboratory, Stanford Univ., USA.* We show a dual-channel, upconversion detector at 1.3-µm-wavelength based on phase-modulated periodically poled LiNbO3, and use it for wavelength- to time-division multiplexing to achieve high data rates, useful for quantum key distribution.

NM3C.7 • 15:15
Silicon-Chip Femtosecond Source, Kasturi Saha[1], Yoshitomo Okawachi[1], Bonggu Shim[1], Jacob S. Levy[2], Mark A. Foster[1], Michal Lipson[2,3], Alexander L. Gaeta[1,3]; *[1]School of Applied & Engineering Physics, Cornell Univ., USA; [2]School of Electrical and Computer Engineering, Cornell Univ., USA; [3]Kavli Institute at Cornell for Nanoscale Science, Cornell Univ., USA.* We demonstrate an on-chip, high-repetition-rate femtosecond pulse source using a high-Q silicon-nitride-based parametric frequency comb. Sub-200-fs pulses at a 99-GHz repetition rate are generated.

15:30–16:00 Coffee Break, *Centennial Room*

16:00–18:00
IM4A • Electro-Optic Modulators and Switches

Michael Watts; Massachusetts Institute of Technology, USA, Presider

IM4A.1 • 16:00 Invited
High-Speed Silicon Photonic Transceivers, Mehdi Asghari[1], Dazeng Feng[1], Jonathan Luff[1]; *[1]Kotura, Inc., USA.* This talk will review the key components needed for high speed, low power, Silicon Photonics transceivers. Particular attention will be paid to the use of WDM to enhance aggregate bandwidth density and power consumption tradeoffs within the overall solution.

16:00–18:00
IM4B • Theory, Modeling & Simulations III: Active photonics

Michael Hochberg; Univ. of Washington, USA, Presider

IM4B.1 • 16:00 Invited
Nanowire Arrays for Photovoltaics and Lighting: Electronic and Optical Properties, Bernd Witzigmann[2], Marcus Deppner[2], Shuqing Yu[2], Jan Kupec[1], Friedhard Roemer[2]; *[1]ETH Zurich, Switzerland; [2]Univ. of Kassel, Germany.* Semiconductor nanowire arrays possess both subwavelength electromagnetic as well as quantum electronic features. In this paper, the properties of nanowire arrays are discussed for their use as light emitting diodes and photovoltaic devices.

16:00–18:00
NM4C • Nonlinearities in Lasers and Dissipative Systems

Philippe Grelu; Universite de Bourgogne, France, Presider

NM4C.1 • 16:00 Invited
Nonlinear Engineering: from the Soliton-Similariton Laser to Nonlinear Laser Lithography, F. Oemer O. Ilday[1]; *[1]Bilkent Universitesi, Turkey.* We demonstrate a novel nanolithography method, tightly governed by positive and negative feedback, resulting in extremely uniform nanostructures. The underlying mechnanism is inspired by and bears much similarity to mode-locked lasers.

White River

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides

Rio Grande/Gunnison

Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

BM3D • Grating Properties and Fabrication: Novel Fibers and Grating Design—Continued

BM3D.4 • 14:30
Integrated Holographic Polymer-Dispersed Liquid Crystal Bragg Reflector into Photonic Crystal Fibre, Gianluigi Zito[1], Stavros Pissadakis[1]; *[1]Foundation for Research and Technology-Hellas (FORTH), Institute of Electronic Structure and Laser (IESL), P.O. Box 1385, 71 110, Greece.* The fabrication of a Bragg phase grating by photo-induced modulation of a liquid crystal/polymer composite material integrated into a photonic crystal fibre is demonstrated.

BM3D.5 • 14:45
Dynamic Frequency Tuning in a Fiber Grating Cavity, Zhangwei Yu[1,2], Irina V. Kabakova[3], Pierre-Yves Fonjallaz[2], Oleksandr Tarasenko[2], Walter Margulis[1,2], Martijn de C. Sterke[3]; *[1]Applied Physics, Royal Institute of Technology, Sweden; [2]Acreo AB, Sweden; [3]CUDOS and IPOS, Univ. of Sydney, Australia.* Dynamic frequency tuning of trapped light in a phase-shifted fiber grating cavity is demonstrated by high-voltage electrical pulses. Y-polarization light is found to be sensitive to refractive index changes caused by a transverse pressure-wave.

BM3D.6 • 15:00
Physical Insight into Dispersionless FBG Designs, Michalis N. Zervas[1,2], Michael K. Durkin[2]; *[1]Univ. of Southampton, UK; [2]SPI Lasers, UK.* We provide physical insight into the role different sections play in inverse-scattering-designed dispersionless FBGs. Using this knowledge we design and fabricate strong (>30dB) bidirectional dispersionless filters.

BM3D.7 • 15:15
Characterization of Integrated Bragg Grating Profiles, Alexandre D. Simard[1], Yves Painchaud[2], Sophie LaRochelle[1]; *[1]Universite Laval, Canada; [2]TeraXion, Canada.* Spectral responses of gratings in SOI are extracted using time windowing to eliminate parasitic reflections. Filtering high spatial frequencies of the phase profile, obtained by layer peeling, allows examination of the wafer thickness uniformity.

SM3E • PBG & PCF Fibers—Continued

SM3E.4 • 14:30 Invited
Hybrid photonic crystal fiber components and amplifiers, Thomas T. Alkeskjold[1], Marko Laurila[2], Kristian R. Hansen[2], Mette Jørgensen[2], Sidsel Petersen[2], Jesper Lægsgaard[2], Christina Olausson[1], Jes Broeng[1]; *[1]NKT Photonics, Denmark; [2]DTU Fotonik, Department of Photonics Engineering, Denmark.* We present recent development of hybrid photonic crystal fiber amplifiers and components providing enhanced spectral and modal filtering.

SM3E.5 • 15:00
Pixelated Bragg fibers, Assaad Baz[1], Geraud Bouwmans[1], Laurent Bigot[1], Yves Quiquempois[1]; *[1]Physics of Lasers, Atoms and Molecules Laboratory, Univ. of Lille, France.* We report on a new Bragg Fiber design for which the high index rings are replaced by discontinuous rings made of circular high index rods. Advantages of this new kind of fibers are presented

SM3E.6 • 15:15
All-Glass AgPO3/Silica Photonic Band-Gap Fibre, Gianluigi Zito[1], Ioannis Konidakis[1], Stavros Pissadakis[1]; *[1]IESL, FORTH, Greece.* Photonic band-gap guidance is demonstrated in an all-solid microstructured optical fibre consisting of a silver-metaphosphate cladding structure embedded in silica. Tuning of that all-solid fibre transmission spectrum was achieved by UV laser irradiation.

15:30–16:00 Coffee Break, *Centennial Room*

16:00–18:00
BM4D • Fundamentals of Photosensitivity and Poling: Photo-induced Processes and Gratings
John Canning; Univ. of Sydney, Australia, Presider

BM4D.1 • 16:00 Invited
Femtosecond direct laser writing of linear and nonlinear optical properties in photosensitive glass, Lionel Canioni[1], Gautier Papon[1], Arnaud Royon[1], Nicolas Marquestaut[1], Yannick Petit[1,3], Kevin Bourhis[3], Marc Dussauze[2], Thierry Cardinal[3]; *[1]LOMA, Univ. Bordeaux, France; [2]ISM, Univ. Bordeaux, France; [3]IC-MCB, CNRS, France.* Glasses specifically tailored with photosensitive agents such as silver are efficient material for direct laser writing localized linear and non linear optical properties. The relation between the photo-induced structures and the modifications of the linear and optical properties are discussed.

16:00–18:00
SM4E • Joint SOF & NP Session
Liang Dong; Clemson Univ., USA, Presider

SM4E.1 • 16:00 Invited
Nonlinear Frequency Generation in Poled Fibers: From Sum-Frequency to Polarization-Entangled Photon Pairs, Li Qian[1], Eric Y. Zhu[1], Zhiyuan Tang[1]; *[1]Electrical and Computer Engineering, Univ. of Toronto, Canada.* We review progress in periodically-poled silica fibers (PPSFs). Using a birefringent PPSF, we enable spectrally-separate QPM and demonstrate polarization-dependent sum-frequency generation and direct polarization-entangled photon pair generation.

Colorado II	Colorado III	Colorado I
Integrated Photonics Research, Silicon and Nano Photonics	Integrated Photonics Research, Silicon and Nano Photonics	Nonlinear Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

IM4A • Electro-Optic Modulators and Switches—Continued

IM4A.2 • 16:30 Invited

Photonic Integration in State-of-the-Art Silicon Electronics Processes, Jason Orcutt[1]; *[1]Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* Photonic integration within state-of-the-art CMOS and DRAM processes leverages the existing electronic manufacturing infrastructure to minimize cost. Suitable design techniques combined with in-foundry optimization or post-processing have enabled integration within several advanced technologies.

IM4A.3 • 17:00

Low Power SiGe Electroabsorption Modulators for Optical Interconnects, Edward Fei[1], Elizabeth Edwards[1], Yijie Huo[1], Xiaochi Chen[1], Stephanie Claussen[1], Xi Liu[1], Yiwen Rong[1,2], Theodore Kamins[1], David Miller[1], James Harris[1]; *[1]Electrical Engineering, Stanford Univ., USA; [2]Phillips Lumileds, USA.* We demonstrate low voltage quantum-confined Stark effect electroabsorption in a Ge/SiGe quantum well diode with a new thin intrinsic layer design, showing the potential for absorptive modulators with low photocurrent dissipation power.

IM4A.4 • 17:15

Integrated Electro-optical Switching with Phase-Modified Liquid Crystal Blends, Florenta Costache[1], Martin Blasl[1], Kirstin Bornhorst[1], Andreas Rieck[1], Haldor Hartwig[1]; *[1]Fraunhofer Institute for Photonic Microsystems, Germany.* Liquid crystal-oil-blends with modified nematic-isotropic transition temperatures were developed for electro-optical waveguides. Microsecond, low loss switching is demonstrated on devices designed to include such waveguides. These devices are operable at room temperature.

IM4A.5 • 17:30

Ultra-Wide Bandwidth Design for Very-Low Voltage Substrate-Removed Electro-optic Intensity Modulators, Selim Dogru[1], Nadir Dagli[1]; *[1]Department of Electrical and Computer Engineering, Univ. of California, Santa Barbara, USA.* Ultra-wide bandwidth, very-low drive voltage modulator design is presented. Design combines buried electrodes made of doped semiconductors and dielectrics with very large dielectric constant dispersion. 0.4 V Vπ device with bandwidth exceeding 100 GHz is possible.

IM4A.6 • 17:45

Thin Film Electro-Optic Devices for 50 GHz Applications, Jianheng Li[1], Zhifu Liu[1], Bruce W. Wessels[1]; *[1]Department of Materials Science and Engineering and Materials Research Center, Northwestern Univ., USA.* We have demonstrated mm scale, thin film electro-optic modulator utilizing a photonic crystal structure. By decreasing device length the EO response was greater than 50 GHz. The microwave response of the modulator was measured and simulated.

IM4B • Theory, Modeling & Simulations III: Active photonics—Continued

IM4B.2 • 16:30

Suppressing Mode Competition in Terahertz Quantum Cascade Lasers, Huda M. Tanvir[1], B.M.Azizur Rahman[1], Kenneth Grattan[1]; *[1]School of Engineering and Mathematical Sciences, City Univ. London, UK.* Terahertz QCLs based on metal-metal waveguides are often susceptible to lase with higher order modes. This paper aims to introduce a waveguide structure that is able to suppress the generation of higher order modes.

IM4B.3 • 16:45

Quasi-Phase-Matching for Broadband Discrete Mid-IR FWM in Width-Modulated Si Photonicwire Waveguides, Jeffrey B. Driscoll[1], Richard R. Grote[1], Jerry I. Dadap[1], Nicolae C. Panoiu[2], Richard M. Osgood[1]; *[1]Department of Electrical Engineering, Columbia Univ., USA; [2]Electronic and Electrical Engineering, Univ. College London, UK.* We investigate quasi-phase-matching via silicon waveguide width-modulation as an effective means to achieve four-wave-mixing between the telecommunications bands and mid-IR.

IM4B.4 • 17:00

Intersubband optical properties of GaAs/InGaAs nanopore superlattices, Yinying Xiao-Li[1], John O'Brien[1]; *[1]Electrical Engineering, Univ. of Southern California, USA.* GaAs/InGaAs nanopore superlattices are analyzed. Subband gaps are observed from 1-20 meV. Optical absorption due to intersubband transitions is studied and strong absorption peaks covering terahertz and far-infrared ranges are observed at various temperatures.

IM4B.5 • 17:15

Multiple versus Single Quantum Well Transistor Laser Performances, Iman Taghavi[1,2], Hassan Kaatuzian[1], Jean Pierre Leburton[2,3]; *[1]Photonics Research Laboratory, Electrical engineering, Amirkabir Univ. of Technology, Islamic Republic of Iran; [2]Beckman Institute for advanced science and technology, Univ. of Illinois at Urbana-Champaign, USA; [3]Electrical engineering, Univ. of Illinois at Urbana-Champaign, USA.* We present a transport-based model that can be used to investigate the optoelectronic operations of transistor lasers with multiple quantum well. Significant enhancement in device performances is anticipated when the MQW structure is properly designed.

IM4B.6 • 17:30

Buried metal grating for vertical fiber-waveguide coupling with high directionality, Pin-Tso Lin[1], Che-Yao Wu[1], Po-Tsung Lee[1]; *[1]photonics, National Chiao Tung Univ., Taiwan.* We numerically propose a buried metal grating coupler which can forbid diffractions toward substrate by itself. When the grating is higher than 600 nm, it can reach 90% coupling directionality without using substrate mirror.

IM4B.7 • 17:45

Time-Domain Analysis of High-Order Laterally-Coupled DFB Lasers, akram akrout[1], Kais Dridi[1], Trevor Hall[1]; *[1]Photonic technology laboratory, Ottawa Univ., Canada.* A time-domain traveling wave algorithm is extended to investigate high-order laterally-coupled distributed feedback semiconductor laser. The effect of longitudinal spatial hole-burning is mitigated by means of fine tuning of the grating duty cycle.

NM4C • Nonlinearities in Lasers and Dissipative Systems—Continued

NM4C.2 • 16:30

Environmentally stable, passively modelocked, all-normal dispersion fibre similariton laser, Neil Broderick[1], Claude Aguergaray[1], Jocelyn S. Chen[2], Vladimir Kruglov[1]; *[1]Physics, Univ. of Auckland, New Zealand; [2]Southern Photonics Ltd., New Zealand.* We report on a new similariton fibre laser system based on a nonlinear amplifying loop mirror. The laser is robust and produces linearly chirped pulses that can be recompressed to 350fs.

NM4C.3 • 16:45

Effect of Slow Gain Dynamics in Mode-Locked Fiber Lasers: Chirped Soliton Molecules, Alexandr Zaviyalov[1], Philippe Grelu[2], Falk Lederer[1]; *[1]Institute of Condensed Matter Theory and Solid State Optics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany; [2]Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR 6303 CNRS, Université de Bourgogne, France.* We theoretically and experimentally demonstrate the pivotal role of the gain dynamics in the formation of chirped soliton molecules in mode-locked lasers. Such molecules are characterized by an increasing separation from leading to trailing pulses.

NM4C.4 • 17:00

Ultrabroadband Mode-Locked Laser Based on Self-Similar Amplification, Andy Chong[1,2], Hui Liu[3], Bai Nie[4], Brandon G. Bale[5], Stefan Wabnitz[6], Marcos Dantus[4], William Renninger[3], Frank W. Wise[3]; *[1]Electro-Optic program, Univ. of Dayton, USA; [2]Department of Physics, Univ. of Dayton, USA; [3]Department of Applied Physics, Cornell Univ., USA; [4]Department of Chemistry, Michigan State Univ., USA; [5]Photonic Research Group, Aston Univ., UK; [6]Department of Information Engineering, Universit a di Brescia, Italy.* We demonstrate an ultrabroadband mode-locked spectrum beyond the gain bandwidth from a fiber laser based on self-similar amplification. 21-fs pulses (the shortest from a fiber laser) are generated after phase correction.

NM4C.5 • 17:15

Dissipative rogue waves out of fiber lasers, Nail N. Akhmediev[1], Philippe Grelu[3], Jose-Maria Soto-Crespo[2]; *[1]Optical Sciences Group, Australian National Univ., Australia; [2]Instituto de Optica, CSIC, Spain; [3]Laboratoire Interdisciplinaire Carnot de Bourgogne, Universite de Bourgogne, France.* We study rogue waves in dissipative systems such as unidirectional fiber laser. We have found that the probability of producing extreme pulses in this setup is higher than in any other system considered so far

NM4C.6 • 17:30

1.8 GHz Harmonically Mode-Locked Fiber Laser Employing Raman-Like Optoacoustic Interactions in PCF, Myeongsoo Kang[1], Philip Russell[1]; *[1]MPI for the Science of Light, Germany.* By making use of 1.8 GHz acoustic resonances in a 1.8 µm photonic crystal fiber core we generate a high-repetition-rate optical pulse train at the 317th harmonic of an Er-doped fiber ring laser.

NM4C.7 • 17:45

Crescent Waves in Optical Cavities, YuanYao Lin[1], JIsha P. Chandroth[1], Tsin-Dong Lee[1], Ray-Kuang Lee[1]; *[1]National Tsing Hua Univ., Taiwan.* We theoretically and experimentally generate stationary crescent surface solitons pinged to the boundary of a micro-structured vertical cavity surface emission laser by triggering the intrinsic cavity mode as a background potential.

18:00–19:30 Joint Poster Sessions & Reception/ Exhibit, *Centennial Room & Terrace*

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

BM4D • Fundamentals of Photosensitivity and Poling: Photo-induced Processes and Gratings—Continued

BM4D.2 • 16:30
Three Bragg Grating Types in Hydrogen-Loaded Heavily Germanium - Doped Fibers, Oleg Medvedkov[1], Sergei Vasiliev[1], Pavel Gnusin[1], Evgeny Dianov[1]; *[1]FORC RAS, Russian Federation.* Competition of two photosensitivity mechanisms in H2-loaded Ge-doped fibers (75 mol.% GeO2) results in complicated dynamics of FBG writing with successive formation of three grating types. The induced refractive index annealing is also nonmonotonic.

BM4D.3 • 16:45
Temperature-Resolved Spectroscopy of UV-Induced Absorption in H_2 - Loaded Germanosilicate Fiber, Pavel Gnusin[1], Sergei Vasiliev[1], Oleg Medvedkov[1], Evgeny Dianov[1]; *[1]FORC RAS, Russian Federation.* Annealing of UV-induced absorption near 1.4-μm in H2 - loaded germanosilicate fibers is investigated by means of temperature-resolved spectroscopy. As a result, the contribution of H-containing groups to the induced refractive index is estimated.

BM4D.4 • 17:00
Stress changes induced by cw-244-nm Ar+ irradiation in H2-loaded SMF-28e optical fibers, Georgios Violakis[1], Nandita Aggarwal[1], Hans G. Limberger[1]; *[1]STI, EPFL, Switzerland.* Fiber Bragg Gratings were fabricated in H2-loaded SMF-28e fibers using a cw-244-nm Ar+ laser with varying total fluence. Stress measurements revealed initial expansion followed by compaction.

BM4D.5 • 17:15
Design of silver activated phosphate and borophosphate based glasses for multi-scale structured optical materials, Thierry Cardinal[1], Evelyne Fargin[1], Kevin Bourhis[1], Yannick Petit[1,2], Arnaud Royon[2], Gauthier Papon[2], Marc Dussauze[3], Lionel Canioni[2], Vincent Rodriguez[3], David Grojo[4], Olivier Uteza[4], Philippe Delaporte[4], Laurent Binet[5], Daniel Caurant[5]; *[1]ICMCB, France; [2]LOMA, France; [3]ISM, France; [4]LP3, France; [5]LCMC, France.* Silver activated exotic phosphate and borophosphate glass composition allows fabricating, after thermal poling and/or laser structuring, multi-scale structured optical materials. The spatial distribution and the identification of the silver species is are of important for optical property tailoring.

BM4D.6 • 17:30
Thermal decay of UV Ar+ and ArF excimer laser fabricated Bragg gratings in SMF-28e and Bi-Al-doped optical fiber, Georgios Violakis[1], Pouneh Saffari[1], Hans G. Limberger[1], Valery M. Mashinsky[2], Evgeny Dianov[2]; *[1]Ecole Polytechnique Federale de Lausanne, Switzerland; [2]FORC, Russian Federation.* Fiber Bragg Gratings fabricated in pristine Bi-Al-SiO2 and SMF-28e fibers using pulsed ArF-excimer and cw-244-nm Ar+ laser were annealed. Gaussian decomposition of the master curves revealed energy distributions depending on fiber and laser used.

BM4D.7 • 17:45
Mid-Infrared Bragg grating in chalcogenide fiber, Martin Bernier[1], Mohammed El-Amraoui[1], Younes Messaddeq[1], Real Vallee[1]; *[1]COPL, Université Laval, Canada.* We report the writing of high reflectivity fiber Bragg gratings operating in the Mid-Infrared at 3.44 microns in a low-loss single-mode As2S3 chalcogenide fiber using 800 nm femtosecond pulses and a phase-mask.

SM4E • Joint SOF & NP Session—Continued

SM4E.2 • 16:30
Highly nonlinear photonic crystal fiber with an unprecedented high figure of merit at 1 μm, Alexandre Kudlinski[1], Damien Labat[1], Gilles Mélin[2], Arnaud Mussot[1]; *[1]PhLAM, Univ. Lille 1, France; [2]PRYSMIAN Group, France.* We report a highly-nonlinear germanium doped photonic crystal fiber with Kerr and Raman nonlinear coefficients of 69.3 W-1.km-1 and 94 W-1.km-1 respectively, with losses of 17.5 dB/km at 1 μm, which leads to a record figure of merit at 1 μm.

SM4E.3 • 16:45 Invited
Nonlinear properties of silicon optical fibers, Anna C. Peacock[1], Priyanth Mehta[1], Todd D. Day[2], Justin Sparks[2], Pier J. Sazio[1], John V. Badding[2], Noel Healy[1]; *[1]Optoelectronic Research Centre, Univ. of Southampton, UK; [2]Department of Chemistry, Pennsylvania State Univ., USA.* The nonlinear transmission properties of hydrogenated amorphous silicon core fibers are characterized for short pulse propagation. The influence of the material quality and core size will be discussed in relation to device performance.

SM4E.4 • 17:15 Tutorial
Tutorial: Nonlinear Fibers for Parametric Signal Generation, Amplification and Processing, Stojan Radic[1]; *[1]Univ. of California San Diego, USA.* Abstract not provided.

18:00–19:30 Joint Poster Sessions & Reception/ Exhibit, *Centennial Room & Terrace*

Joint

18:00–19:30
JM5A • Joint Poster Session I

JM5A.1
Low confinement loss of the tellurite hybrid-guiding photonic bandgap fiber, Tonglei Cheng[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Institute, Japan.* We present a numerical investigation on the low confinement loss properties of a tellurite hybrid-guiding photonic bandgap fiber with a solid core surrounding byhigh-index rods and air-holes.

JM5A.2
Coherent Multiple Pulses Generation in a Passively Mode-locked Fiber Laser Cavity with Normal Dispersion, Weiqing Gao[1], Meisong Liao[1], Hiroyasu Kawashima[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Institute, Japan.* The coherent multiple pulses with the number from 2 to 5 are observed in a 1.55 µm normal dispersion cavity. The spectra are highly modulated and the largest pulse separation of 31.9 ps is observed.

JM5A.3
Tungstate-tellurite glass fibers for spectral region up to 3 µm, Vitaly Dorofeev[1], Alexander Moiseev[1], Igor Kraev[1], Sergey Motorin[1], Mikhail Churbanov[1], Alexey F. Kosolapov[2], Evgeny Dianov[2]; [1]*Institute of Chemistry of High-Purity Substances of RAS, Russian Federation;* [2]*Fiber Optics Research Center RAS, Russian Federation.* Optical fibers were produced from high-purity TeO2-WO3-La2O3-(Bi2O3) glasses. Total loss was less than 0.5 dB/m at 1.2-2.8 µm and about 2 dB/m at maximum of OH-groups absorption at 3 µm with further sharp increase.

JM5A.4
Raman Response and SSFS in Phospho -Tellurite Fiber, Yasutake Ohishi[1], Shohei Miyoshi[1], Xin Yan[1], Takenobu Suzuki[1]; [1]*Toyota Technological Institute, Japan.* Phospho-tellurite fiber has high controllability of Raman gain properties. With this feature, wavelength shift and delayed propagation of optical pulse induced by SSFS can be effectively controlled.

JM5A.5
Demonstration of Large Mode Photonic Crystal Fibers in DWDM application, Pedro S. Meledina[2,1], Edward A. Whittaker[1]; [1]*Physics Dept, Stevens Institute of Technology, USA;* [2]*AT&T Labs, USA.* We report on the application of PCF-LMA-25 fiber in a ULH DWDM network, showing no transmission impairments at different Sonet rates or at a combined 0.5 Terabits with 43 wavelengths after 720 km

JM5A.6
Phosphate Double-Cladding Optical Fibre for High-Power Laser Applications, Emanuele Mura[1], Joris Lousteau[1], Nadia G. Boetti[1], Gerardo Scarpignato[1], Davide Negro[1], Silvio Abrate[2], Daniel Milanese[1]; [1]*DISAT - Department of Applied Science and Technology, Politecnico di Torino, Italy;* [2]*PhotonLab, Istituto Superiore Mario Boella, Italy.* Phosphate glasses were developed in order to fabricate a passive double-cladding optical fibre for high-power amplifier and lasers applications. The fibre preform was fabricated by rotational casting technique. The use of this technique is reported for the first time using phosphate glasses.

JM5A.7
RIN transfer in random distributed feedback fiber lasers, Javier Nuño del Campo[1], Mercedes Alcon-Camas[1,2], Juan D. Ania-Castanon[1]; [1]*Instituto de Óptica "Daza de Valdés", CSIC, Spain;* [2]*Dpto. Tecnología Fotónica, ETSI Telecomunicación, UPM, Spain.* A numerical analysis of the RIN transfer from the Raman pumps to the signal in random distributed feedback fiber lasers is presented. Results show RIN transfer levels comparable to those in distributed Raman amplification.

JM5A.8
Experimental Investigation of Fiber Optical Parametric Amplifier Pulse Generators, Armand A. Vedadi[1], Camille-Sophie Bres[1]; [1]*EPFL, Switzerland.* In light of recent theoretical results, the possibility to generate optical Sinc pulses rather than wider Gaussian pulses using fiber optical parametric amplification is experimentally investigated. The impact of pump phase modulation is also discussed.

JM5A.9
Terahertz Field Detection Boost by Nonlinear Collapse of Normally Dispersed Optical Pulses, Marco Peccianti[2,1], Matteo Clerici[2], Mostafa Shalaby[2], Lucia Caspani[2], Antonio Lotti[3], Arnaud Couairon[4], David Cooke[5], Tsuneyuki Ozaki[2], Daniele Faccio[6], Roberto Morandotti[2]; [1]*Institute for Complex Systems, National Research Council, Italy;* [2]*Énergie Matériaux Télécommunications, institut national de la recherche scientifique, Canada;* [3]*Dipartimento di Scienza e Alta Tecnologia, Università dell'Insubria, Italy;* [4]*Centre de Physique Theorique,, CNRS, France;* [5]*Dept. of Physics, McGill Univ., Canada;* [6]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK.* We demonstrated the Terahertz field signal enhancement in the Air Biased Coherent Detection scheme in the transition from below to above the critical power for self-focusing of positively chirped optical probe pulses.

JM5A.10
Dual mode mode-locked laser based on an integrated nonlinear microring resonator, Marco Peccianti[1,2], Alessia Pasquazi[1], Brent Little[3], Sai T. Chu[3], David J. Moss[4], Roberto Morandotti[1]; [1]*INRS-Energie Mat & Tele Site Varennes, Canada;* [2]*Institute for Complex Systems - CNR, Italy;* [3]*Infinera Ltd, USA;* [4]*CUDOS, School of Physics, Univ. of Sydney, Australia.* We demonstrate a mode locked laser based on an integrated high-Q microring resonator that exhibits stable operation of two slightly shifted spectral optical comb replicas, generating a highly monochromatic radiofrequency modulation.

JM5A.11
All-Optical Phase Regeneration in a Highly Nonlinear Lead-Silicate Fiber, Mohamed A. Ettabib[1], Francesca Parmigiani[1], Xian Feng[1], Liam Jones[1], Joseph Kakande[1], Radan Slavík[1], Francesco Poletti[1], Giorgio M. Ponzo[1], Jindan Shi[1], Marco N. Petrovich[1], Periklis Petropoulos[1], Wei H. Loh[1], David J. Richardson[1]; [1]*Univ. of Southampton, UK.* We demonstrate phase regeneration of a 40-Gb/s DPSK signal in a 1.7m-long lead-silicate fiber using a black-box phase-sensitive amplifier. Results show an improvement in the EVM values of the signal after regeneration for various noise levels.

JM5A.12
Coherent Superposition of 800 and 400-nm Spectral Components in Supercontinuum Pulse Generated in Ar-Gas-Filled Hollow Core Fiber, Fumihiko Kannari[1], Kenta Yoshikiyo[1], Shohei Kondo[1], Yu Oishi[1]; [1]*Keio Univ., Japan.* 800 and 400 nm broadband components in a supercontinuum pulse generated by phase modulation based on copropagation of fundamental and second-harmonic femtosecond pulses in an Ar-gas-filled hollow core fiber were separately compressed and coherently superposed.

JM5A.13
Nonlinear Dynamics of Micro-Resonator Based Optical Parametric Oscillators, Andrey B. Matsko[1], Anatoliy Savchenkov[1], Lute Maleki[1]; [1]*OEwaves Inc, USA.* We study the dynamics of hyper-parametric oscillation in high-Q calcium fluoride and magnesium fluoride optical ring micro-resonators. Hard and soft excitation of oscillation, mode locking regimes, and super-mode competition are investigated.

JM5A.14
Stimulated Emission Pumping Enabling Sub-Diffraction-Limited Spatial Resolution in CARS Microscopy, Carsten Cleff[1], Petra Gross[1], Carsten Fallnich[1], Herman L. Offerhaus[2], Jennifer L. Herek[2], Kai Kruse[3], Willem Beeker[3], Chris J. Lee[3], Klaus J. Boller[3]; [1]*Westfälische Wilhelms-Universität Münster, Germany;* [2]*Optical Sciences Group, MESA+ Research Institute for Nanotechnology, Univ. of Twente, Netherlands;* [3]*Laser Physics & Nonlinear Optics Group, MESA+ Research Institute for Nanotechnology, Univ. of Twente, Netherlands.* Suppression of CARS signal generation is demonstrated by equalization of the ground and Raman states via a control state in a theoretical investigation. Using donut-shaped control light fields for population transfer results in sub-diffraction-limited spatial resolution CARS microscopy.

JM5A.15
Demonstration of polarization pulling in a fiber-optical parametric amplifier, Birgit Stiller[1], Philippe Morin[2], Duc minh Nguyen[1], Julien Fatome[2], Herve Maillotte[1], Stéphane Pitois[2], Thibaut Sylvestre[1]; [1]*Optics/ FEMTO-ST institute, Univ. of franche-comte, France;* [2]*institut carnot de bourgogne, universite de bourgogne, France.* We report the experimental demonstration of all-optical polarization pulling of an initially polarization-scrambled signal using a fiber-optical parametric amplifier. Nonlinear polarization pulling has been achieved for both the signal and idler with 25 dB gain.

JM5A.16
Optical Characterization of Nonlinear THz Emitters, Silvia Mariani[1], Filippo Ghiglieno[1], Alessio ANDRONICO[1], Ivan Favero[1], Sara Ducci[1], Yanko Todorov[1], Carlo Sirtori[1], Martin Kamp[2], Mathieu Munsch[3], Julien Claudon[3], Jean-Michel Gerard[3], Giuseppe Leo[1]; [1]*Physics, Univ. Paris Diderot - Paris 7, France;* [2]*Physics, Wuerzburg Univ., Germany;* [3]*CEA, France.* We report on the optical characterization of AlGaAs nonlinear THz emitters based on triply resonant microcylindrical cavities. Reflectivity spectra measured from 2D arrays of pillars showing the excitation of THz whispering gallery modes are presented.

JM5A.17
Engineering of apodized chirped gratings based on desired second-order nonlinearity function, Ameneh Bostani[1], Amirhossein Tehranchi[1], Raman Kashyap[1]; [1]*Ecole Polytechnique de Montreal, Canada.* A novel design for apodized aperiodically poled lithium niobate is proposed to generate smooth ultra-wide second-harmonic intensity response. To exactly realize a desired effective second-order nonlinearity function, poled regions should be located in specific places

JM5A.18
Twofold enhancement of the gain bandwidth in two pumps fiber optical parametric chirped pulse amplifiers, Arnaud Mussot[1], Alexandre Kudlinski[1], Emmanuel Hugonnot[2]; [1]*phlam, France;* [2]*CEA, France.* We demonstrate with realistic numerical simulations that the gain bandwidth of two pumps fiber optical parametric chirped amplifiers can be twice as large as the one of a single pump configuration.

JM5A.19
All-Optical broadband phase noise emulation, Liam Jones[1], Francesca Parmigiani[1], Joseph Kakande[1], Periklis Petropoulos[1], David J. Richardson[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We demonstrate and characterize a technique to emulate broadband phase noise. This is achieved by exploiting cross-phase modulation induced spectral broadening, in a highly nonlinear fiber, of a signal from an intense incoherent light source.

JM5A.20
All-Optical Time-Stretch Digitizer for Capturing Ultrafast Optical Time Series and Rogue Events, Ali Fard[1], Brandon Buckley[1], Sanja Zlatanovic[2], Camille-Sophie Bres[3], Stojan Radic[2], Bahram Jalali[1]; [1]*Univ. of California Los Angeles, USA;* [2]*Univ. of California San Diego, USA;* [3]*Ecole Polytechnique Fédérale de Lausanne, Switzerland.* We propose an all-optical time-stretch oscilloscope, combining four-wave mixing and time-stretch technique for real-time capture of ultrafast optical time-series, beyond the bandwidths achievable by electronics. As a proof-of-concept, we demonstrate capture of 40-Gbits/s optical data.

JM5A.21
Measurement of phase noise in four-wave mixing and its effect on wavelength conversion, Aravind Anthur[1], Rubeena Shihab[1], Deepa Venkitesh[1]; [1]*IIT-Madras, India.* Increase in phase noise due to Four-Wave Mixing (FWM) is analyzed and experimentally verified using delayed self-heterodyne and heterodyne scheme. The possible scheme is suggested to minimize the phase noise on FWM based wavelength conversion of phase modulated data.

JM5A • Joint Poster Session I—Continued

JM5A.22

Quantum Optics with Strongly Localized Polaritons in Polaritonic Crystals, Alexander P. Alodjants[1], Eugene S. Sedov[1], Sergei M. Arakelian[1], YuanYao Lin[2], Ray-Kuang Lee[2]; *[1]Physics and Applied Mathematics, Vladimir State Univ. named after A.G. and N.G. Stoletov's, Russian Federation; [2]Institute of Photonics Technologies, National Tsing-Hua Univ., Taiwan.* We propose a new type of spatially periodic structure representing polaritons in 2D lattice. We examine ground state properties, dissipative dynamics of the system in the presence of two- and three body polariton scattering effects.

JM5A.23

High Power Dual-wavelength Self-similar Parabolic Pulse Yb3+ Doped Fiber Laser, Weici Liu[1], Stefan Skupin[1,2], Edward Arévalo[1]; *[1]Institute of Condensed Matter Theory and Optics, Friedrich Schiller Univ., Germany; [2]Max-Planck-Institute for the Physics of Complex Systems, Max-Planck-Institute, Germany.* A simple and switchable high power dual-wavelength self-similar parabolic pulse Yb3+-doped fiber laser scheme is proposed, which is based on normal dispersion single-mode fiber, Yb3+ doped gain fiber and multimode fiber Bragg grating.

JM5A.24

Airy Beam-induced Optical Routing, Cornelia Denz[1], Patrick Rose[1], Falko Diebel[1], Martin Boguslawski[1]; *[1]Institute of Applied Physics, Univ. of Muenster, Germany.* We present a new all-optical routing scheme based on the Airy beam family. The demonstrated router has 16 individually addressable output channels and can be used as optically induced splitter with configurable outputs as well.

JM5A.25

Spectral width and pulse duration tuning in Yb+ mode-locked fiber laser with birefringent Lyot filter, Yuri Fedotov[1], Sergey M. Kobtsev[1], Aleksey Rozhin[2], Sergei K. Turitsyn[2], Chengbo Mou[2]; *[1]Department of Laser Physics and Innovation Technologies, Novosibirsk State Univ., Russian Federation; [2]Photonic Research Group, Aston Univ., UK.* A method of pulse duration and spectral width control in all-fiber Ytterbium mode-locked laser with SWCNT is presented. It is shown that PM-fiber can also serve as a spectrally selective filter.

JM5A.26

Detuning in Mode Coupled Waveguides, Scott Shepard[1], Joshua Copeland[2]; *[1]Louisiana Tech Univ., USA; [2]CenturyLink, USA.* The different propagation speeds in glass and silicon waveguides detunes their coupling. We demonstrate conditions under which maximal power transfer can still be achieved.

JM5A.27

Bidirectional Pumping for Entangled Photons, Abhishek Anchal[1], Pradeep Kumar Krishnamurthy[2]; *[1]Laser Technology Program, Center for Laser Technology, Indian Institute of Technology, Kanpur, India; [2]Department of Electrical Engineering and Laser Technology Program, Center for Laser Technology, Indian Institute of Technology, Kanpur, India.* We study a bidirectional FWM scheme for entangled photon generation. Simulation shows 26% increase in signal power and a 33% decrease in pump power compared to unidirectional FWM.

JM5A.28

Key regimes of single-pulse generation of fiber lasers mode-locked due to non-linear polarization evolution, Sergey Smirnov[1], Sergey M. Kobtsev[1], Sergey V. Kukarin[1], Alexey V. Ivanenko[1]; *[1]Department of Laser Physics and Innovation Technologies, Novosibirsk State Univ., Russian Federation.* Three key regimes of single-pulse generation of all-normal-dispersion lasers mode-locked due to non-linear polarization evolution are considered. The regimes differ from each other in short-term pulse stability, in shape of spectra and auto-correlation functions

JM5A.29

Čerenkov-type second-harmonic generation in a periodically poled ferroelectric crystal, Ksawery K. Kalinowski[1], Yan Sheng[1], Wieslaw Z. Krolikowski[1]; *[1]Australian National Univ., Australia.* We study both theoretically and experimentally the Čerenkov second-harmonic generation in a periodically poled LiNbO3 crystal. In particular we demonstrate strong sensitivity of the Čerenkov signal to the wavelength and position of the fundamental beam.

JM5A.30

Cherenkov-type second- and third-harmonic generation in random quadratic media, Mousa Ayoub[1], Philip Roedig[1], Jörg Imbrock[1], Cornelia Denz[1]; *[1]Institute of Applied Physics, Germany.* In this contribution, we analyze numerically and experimentally Cherenkov-type second-and third-harmonics in two dimensional random Chi^{(2)} photonic crystals and the effect of the shape and size of individual ferroelectric domains on the spatial intensity distribution.

JM5A.31

Dynamic Weber Soliton, Cornelia Denz[1], Falko Diebel[1], Patrick Rose[1], Martin Boguslawski[1]; *[1]Institute of Applied Physics, Univ. of Muenster, Germany.* We report on the first experimental observation of an oscillating spatial soliton in parabolic Weber photonic lattices imprinted in photorefractive nonlinear media. The existence and propagation of the soliton is shown numerically and experimentally.

JM5A.32

Complex Soliton Dynamics in Lattices with Longitudinal Modulation, Panagiotis Papagiannis[1], Yannis Kominis[1,2], Kyriakos Hizanidis[1], Sotiris Droulias[1]; *[1]School of Electrical and Computer Engineering, National Technical Univ. of Athens, Greece; [2]Dept. of Mathematics, Univ. of Patras, Greece.* Soliton dynamics in longitudinally modulated optical lattices depend on both their initial power and momentum. New features are revealed such as enhanced beam mobility, dynamical switching and routing, extended and quasiperiodic trapping.

JM5A.33

Withdrawn

JM5A.34

Disorder mapping in VCSELs using frequency-selective feedback, Yoann Noblet[1], Thorsten Ackemann[1], Neal Radwell[1,2], Roland Jager[3]; *[1]Physics, Univ. of Strathclyde, UK; [2]Physics and Astronomy, Glasgow Univ., UK; [3]ULM Photonics GmbH, Germany.* We report on a simple method with a high spectral and spatial resolution for mapping variations in the cavity resonance of a plano-planar broad-area laser based on frequency-selective feedback.

JM5A.35

Optical Induction of Multiperiodic Photonic Ratchets, Cornelia Denz[1], Martin Boguslawski[1], Andreas Kelberer[1], Patrick Rose[1]; *[1]Institute of Applied Physics, Univ. of Muenster, Germany.* We present a highly flexible multiplexing method to optically induce multiperiodic photonic lattices. We demonstrate its versatility by the induction of a photonic ratchet. The corresponding refractive index landscape is analyzed implementing digital holography techniques.

JM5A.36

Thermal nonlinearities in gold nanostructures, Oliver Kahl[1], Dmitry A. Fishman[1], Scott Webster[1], Fabian Niesler[2,3], Martin Wegener[2,3], David J. Hagan[1], Eric W. Van Stryland[1]; *[1]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; [2]Institut für Angewandte Physik, Karlsruhe Institute of Technology (KIT), Germany; [3]Institut für Nanotechnologie, Karlsruhe Institute of Technology (KIT), Germany.* The plasmon resonance is found to broaden and red-shift under strong femtosecond/picosecond irradiation. Using a standard two-temperature model we find a correlation mapping the electron gas and lattice temperatures to the Drude damping coefficient.

JM5A.37

Fast Effective Nonlinear-Optical Response in Anisotropic Glasses of Co-alkanoates, Svitlana Bugaychuk[1], Anatoliy Tolochko[1], Gerturda Klimusheva[1], Yuriy Garbovskiy[1,3], Daria Melnik[1], Inna Tokmenko[2], Tatiana Mirnaya[2]; *[1]Institute of Physics NAS Ukraine, Ukraine; [2]Institute of General and Inorganic Chemistry NAS Ukraine, Ukraine; [3]Univ. of Colorado at Colorado Springs, USA.* Anisotropic glasses of Co-alkanoates have layered structure. Fast nonlinear response due to changes of electronic polarizability in coordination complexes is investigated. Thermal nonlinear response in metal alkanoates matrices is negligiblel small.

JM5A.38

Rogue Wave Description: Rational Solitons and Wave Turbulence Theory, Bertrand Kibler[1], Kamal Hammani[1], Claire Michel[2], Christophe Finot[1], Antonio Picozzi[1]; *[1]Laboratoire Interdisciplinaire Carnot de Bourgogne, France; [2]Laboratoire de Physique de la Matière Condensée, France.* We show that rogue waves can emerge from optical turbulence and that their coherent deterministic description provided by the rational solutions is compatible with the statistical description provided by the wave turbulence theory.

JM5A.39

Four-wave mixing instabilities in telecom fibers, Julien Fatome[1], Christophe Finot[1], Guy Millot[1], Andrea Armaroli[2], Stefano Trillo[2]; *[1]ICB, Universite de Bourgogne, France; [2]Dipartimento di Ingegneria, Universit di Ferrara, Italy.* Instabilities in fiber four-wave mixing are investigated, revealing the formation of colliding dispersive shock waves in the normal GVD regime and collective modulation instabilities in the anomalous GVD regime.

JM5A.40

Optical rogue waves in Raman fiber lasers, Stephane Randoux[1], Pierre Suret[1]; *[1]Universite de Lille 1, France.* We present an experimental measurement of probability density functions for the power of the intracavity Stokes field in a Raman fiber laser. Rare extreme events associated to a nongaussian statistics are observed.

JM5A.41

Synchronization of Limit Cycles in Nonlinear Passive Fiber Ring Resonators by Cross-Phase Modulation, Michael Kues[1], Petra Gross[1], Carsten Fallnich[1]; *[1]Institute of Applied Physics, Germany.* The synchronization of limit cycle states occurring in nonlinear fiber ring resonators by a weak coupling via seeding in different polarizations is shown by numerical simulations, leading to an optical control of the frequency comb.

JM5A.42

Analysis of the Multi-Pulsing Instability in Mode-Locked Lasers Using Dynamical Dimension Reduction, Eli Shlizerman[1], J. Nathan Kutz[1]; *[1]Applied Mathematics, Univ. of Washington, USA.* We introduce a dimension reduction method for determining the stability of mode-locked pulses and the onset of the multi-pulsing instability. Applying it to the master mode-locking model, operating regimes and high-energy pulses are demonstrated.

JM5A.43

Intermittent Self-Pulsing in a Fiber Raman Laser, Atalla El-Taher[1], Sergey Sergeyev[1], Elena G. Turitsyna[1], Sergei K. Turitsyn[1], Paul Harper[1]; *[1]Aston Univ., UK.* We report on an experimental study of intermittent self-pulsing caused by the coupling of the first and second Stokes cascades in a fiber Raman laser.

JM5A.44

Formation and propagation of shock waves in nonlocal media, Neda Ghofraniha[1], Luigi Amato Santamaria[2], Viola Folli[2], Claudio Conti[3,2]; *[1]IPCF, CNR, Italy; [2]ISC, CNR, Italy; [3]Physics Department, La Sapienza Univ., Italy.* We report on the observation of shock waves in nonlocal thermal nonlinear media, investigating the way nonlinearity and nonlocality affect the point of shock formation and its dynamic through the samples.

JM5A • Joint Poster Session I—Continued

JM5A.45

Suppression of the frequency drifts in polarization modulational instability spectra by means of a photon reservoir, Patrice T. Dinda[1], Zambo Abou'ou[1], Claude M. Ngabireng[1]; [1]*Universite de Bourgogne, France.* By appropriately combining the effects of second- and fourth-order dispersion, and by carefully choosing the pump power, we create a photon reservoir which suppresses the drifts of sidebands in the spectra of polarization modulational instability

JM5A.46

Withdrawn

JM5A.47

Nonlinear switching in a purely plasmonic directional coupler, Ulf Peschel[1], Daniel Ploss[1], Jing Wen[1], Arian Kriesch[1]; [1]*Institute of Optics, Information and Photonics: Nonlinear Optics and Nanophotonics, Univ. of Erlangen-Nuremberg, Cluster of Excellence Engineering of Advanced Materials and Erlangen Graduate School in Advanced Optical Technologies, Germany.* Plasmonic components allow for subwavelength integration while simultaneously generating extraordinary field enhancement thus amplifying nonlinear effects. Here we present first experimental results indicating nonlinear switching in a plasmonic directional coupler of a few micrometers length.

JM5A.48

Influence of Nonlinear Pulse Propagation on Squeezed Vacuum Pulse Generation in a Photonic Crystal Fiber, Fumihiko Kannari[1], Shota Sawai[1]; [1]*Keio Univ., Japan.* During femtosecond laser pulse propagation through a photonic crystal fiber, copropagation of Stokes and anti-Stokes pulses influences quantum correlation in the broadened spectrum. A -4.0dB squeezed vacuum pulse is obtained with a fiber polarization interferometer.

JM5A.49

Cavity Polariton Breathers, Oleg Egorov[1], Falk Lederer[1]; [1]*Institute of Condensed Matter Theory and Solid State Optics, Friedrich-Schiller-Universität Jena, Germany.* We predict the existence of breathing solitons in semiconductor microcavities. Parametric mixing of polaritons from the upper and lower branch of the dispersion relation gives rise to their formation requiring a nonzero excitonic dispersion.

JM5A.50

Power and spectral optimization of random distributed feedback fiber lasers, Dmitriy V. Churkin[1,3], Ilya Vatnik[3], Sergey Babin[2,3]; [1]*Aston Univ., UK;* [2]*Novosibirsk State Univ., Russian Federation;* [3]*Institute of Automation and Electrometry SB RAS, Russian Federation.* We present the optimization of power and spectral performances of the random DFB fiber laser using the balance equation set. The numerical results are in good in agreement with experiments.

JM5A.51

Withdrawn

JM5A.52

Quantum-classical correspondence in multimensional nonlinear systems: Anderson localization and "superdiffusive" solitons, Andrea Fratalocchi[1], Danilo Brambila[1]; [1]*KAUST Univ., Saudi Arabia.* We have theoretically studied Anderson localization in a 2D+1 nonlinear kicked rotor model. The system shows a very rich dynamical behavior, where the Anderson localization is suppressed and soliton wave-particles undergo a superdiffusive motion.

JM5A.53

Gain-controlled Soliton Routing in Dissipative Optical Lattices, Yannis Kominis[1,2], Sotiris Droulias[1], Panagiotis Papagiannis[1], Kyriakos Hizanidis[1]; [1]*School of Electrical and Computer Engineering, National Technical Univ. of Athens, Greece;* [2]*Dept. of Mathematics, Univ. of Patras, Greece.* We investigate dynamical soliton trapping in optical lattices under the presence of gain and loss mechanisms. It is shown that depending on soliton initial power and velocity dynamical gain-controlled routing can take place.

JM5A.54

Nonlinear refractive and absorptive response of a thin nonlocal media, Marcelo D. Iturbe-Castillo[1], Emma V. Ramirez Garcia[2], Maximino L. Arroyo Carrasco[2], Marcela M. Mendez Otero[2], Edmundo Reynoso Lara[2], Sabino Chavez Cerda[1]; [1]*Inst Nat Astrofisica Optica Electronica, Mexico;* [2]*Benemerita Universidad Autonoma de Puebla, Mexico.* A model to describe both nonlinear refractive and absorptive response of a thin nonlocal media is proposed. The model is used to obtain the far field intensity of the close or open aperture z-scan technique

JM5A.55

Asymmetric collision of two bright spatial solitons in a Kerr media, Marcelo D. Iturbe-Castillo[1], Daysi Ramirez Martinez[2], Marcela M. Mendez Otero[2], Maximino L. Arroyo Carrasco[2]; [1]*Inst Nat Astrofisica Optica Electronica, Mexico;* [2]*Benemerita Universidad Autonoma de Puebla, Mexico.* We study numerically the asymmetric collision of spatial solitons and their waveguide properties. We demonstrated that the amount of energy confined by each waveguide is function of the initial angle and separation between the solitons

JM5A.56

Hydrogen pressure sensor based on a tapered-FBG written by DUV femtosecond laser technique, Susana Silva[1,2], L. Coelho[1,2], F. X. Malcata[3,4], Martin Becker[5], Manfred W. Rothhardt[5], Hartmut Bartelt[5], O. Frazão[1]; [1]*INESC Porto, Portugal;* [2]*Departamento de Física e Astronomia da Faculdade de Ciências, Universidade do Porto, Portugal;* [3]*ISMAI - Instituto Superior da Maia, Portugal;* [4]*Instituto de Tecnologia Química e Biológica, Portugal;* [5]*Institute of Photonic Technology, Germany.* An optical fiber sensor based on a tapered-FBG coated with 150 nm-thick Pd film is proposed for hydrogen pressure detection. The FBG was written in a 50 m-diameter tapered fiber by DUV femtosecond laser technology.

JM5A.57

Direct writing of Bragg grating structures in waveguide bundles, Markus Thiel[1]; [1]*Fiber Optical Sensor Systems, Fraunhofer HHI, Germany.* Femtosecond laser processing of waveguide bundles with Bragg structures in bulk glass offers the possibility of stronger Bragg reflection signals, due to the higher refractive index contrast. First results of this new design are presented and will be discussed.

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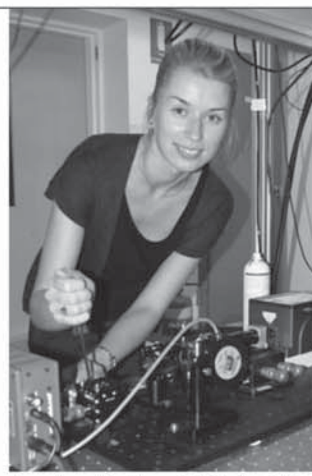

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Platte

Signal Processing in Photonics Communications

Colorado II

Joint Integrated Photonics Research, Silicon and Nano Photonics/ Nonlinear Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

07:30–18:00 Registration, *Lower Lobby, Conference Level*

08:30–10:00
SpTu1A • OFDM I
Xiang Zhou; AT&T Corp., USA, Presider

SpTu1A.1 • 08:30 Invited
Real-time Coherent Optical OFDM Receiver for Intradyne Detection in High Data Rate Transmission, Noriaki Kaneda[1], Timo Pfau[1], Stephen Corteselli[1], Qi Yang[2], Andreas Leven[3], Young-Kai Chen[1]; [1]*Bell labs, USA;* [2]*State Key Laboratory of Optical Communication Technologies and Networks, China;* [3]*Bell Laboratories, Alcatel-Lucent, Germany.* We review an implementation of real-time coherent optical OFDM receiver in FPGAs. 28.6-Gb/s data per optical wavelength is demonstrated in intradyne detection. QPSK modulated sub-carriers are detected using 9.83-GS/s ADCs and DSP implemented on FPGAs.

SpTu1A.2 • 09:00
Multi-Band OFDM versus Single-Carrier DP-QPSK for 100 Gbps Long-Haul WDM Transmission, Julie Karaki[1], erwan pincemin[1], Didier Grot[1], Thierry Guillossou[1], Yves Jaouën[2], Raphaël Le Bidan[3]; [1]*France Telecom Orange Labs, France;* [2]*Telecom ParisTech, France;* [3]*Telecom Bretagne, France.* We experimentally compare the performance of coherent DP-MB-OFDM and DP-QPSK for 100 Gbps long-haul WDM transport. We show that, after transmission over 1000 km of DCF-free G.652 fiber line, DP-MB-OFDM and DP-QPSK have nearly the same performance at 100 Gbps.

SpTu1A.3 • 09:15
Nonlinear transmission performance of reduced guard interval OFDM and quasi-Nyquist WDM, Sean Kilmurray[1], Tobias Fehenberger[1], Polina Bayvel[1], Robert Killey[1]; [1]*Univ. College London, UK.* The nonlinear transmission performance of reduced guard interval OFDM and quasi-Nyquist-WDM (PDM-QPSK, PDM-QAM-8 and PDM-QAM-16) with high information spectral densities is compared over ULAF and SMF, both by simulations and analytically.

SpTu1A.4 • 09:30 Invited
Real-time OFDM and Nyquist transmitters, Juerg Leuthold[1]; [1]*Karlsruher Institut für Technologie, Germany.* We compare OFDM and Nyquist WDM multi-carrier transmission. Single-laser 26 Tbit/s OFDM and 32.5 Tbit/s Nyquist WDM transmission is reported. Experimentally we demonstrate a spectral efficiency of 18 bit/s/Hz.

08:30–10:00
JTu1B • Joint IPR & NP Plenary Session II
Wieslaw Krolikowski; Australian National Univ., Australia; Dan-Xia Xu; National Research Council, Canada, Presider

JTu1B.1 • 08:30 Plenary
Technology Platforms for Photonic Integrated Circuits, Michael J. Wale[1]; [1]*Oclaro Technology Ltd, UK.* Generic technology platforms offer attractive design and manufacturing routes of photonic integrated circuits. This paper reviews current position, with particular reference to European platforms based on InP, silicon and dielectric materials.

JTu1B.2 • 09:15 Plenary
Complex Nonlinear Opto-Fluidics, Mordechai Segev[1]; [1]*Technion Israel Institute of Technology, Israel.* Our work on symbiotic dynamics of light and nano-particles in liquids will be reviewed. Light-force varies the local particle density, modifies the fluid properties, inducing flow patterns, causing synergetic nonlinear-dynamics of light, nano-particles and fluid.

10:00–10:30 Coffee Break, *Centennial Room*

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides

Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

07:30–18:00 Registration, *Lower Lobby, Conference Level*

White River

08:30–10:00
BTu1C • Grating Properties and Fabrication: Long Period Gratings
Hans Limberger; Ecole Polytechnique Federale de Lausanne, Switzerland, Presider

BTu1C.1 • 08:30
Wavelength-Selective Mode-Switching in a Reflective Long Period Grating Mach-Zehnder Interferometer, John Canning[1], Martin Kristensen[2,1], Kevin Cook[1]; *[1]Univ. of Sydney, Australia; [2]Engineering, Aarhus Univ., Denmark.* We demonstrate that two consecutive long-period-gratings separated by 100mm interfere with high visibility allowing us to switch easily between the core and the cladding mode with a small wavelength shift of 3.2nm, corresponding to a signal switching contrast better than 14dB.

BTu1C.2 • 08:45
Polarization-dependent refractometer based on a surface long-period grating inscribed in a D-shaped photonic crystal fiber, Hyun-Joo Kim[1], Oh-Jang Kwon[1], Young-Geun Han[1]; *[1]Hanyang Univ., Republic of Korea.* Transmission characteristics of a surface long-period grating (SLPG) inscribed in a D-shaped photonic crystal fiber (PCF) are investigated, which exhibits strong dependence on TE and TM polarization modes.

BTu1C.3 • 09:00
Hybrid Sagnac interferometer based on a D-shaped polarization-marinating fiber incorporating a fiber Bragg grating and a long-period fiber grating, Oh-Jang Kwon[1], Cheolju Kang[1], Young-Geun Han[1]; *[1]Hanyang Univ., Republic of Korea.* A hybrid Sagnac interferometer with a locally D-shaped polarization maintaining fiber (PMF) incorporating a fiber Bragg grating (FBG) and a long-period fiber grating (LPFG), is invesitigated for simultaneous measurement of ambient index and temperature.

BTu1C.4 • 09:15
Long-period fiber grating inscribed in a tapered fiber, Min-Seok Yoon[1], Hyun-Joo Kim[1], Young-Geun Han[1]; *[1]Hanyang Univ., Republic of Korea.* A long-period fiber grating (LPFG) written in a tapered fiber was proposed and experimentally demonstrated. Strain sensitivity of the proposed LPFG based on a tapered fiber was improved to be -2.99 nm/mε.

BTu1C.5 • 09:30
Phase Reconstruction from Transmission for Long-Period Fiber Gratings, Bing Zou[1], Kin S. Chiang[1]; *[1]Department of Electronic Engineering, City Univ. of Hong Kong, Hong Kong.* We demonstrate a method to reconstruct the phase spectrum of a long-period fiber grating (LPFG) from its transmission spectrum. We apply the method to different kinds of LPFGs and verify it both numerically and experimentally.

BTu1C.6 • 09:45
Post-fabrication wavelength trimming of fiber Bragg gratings by using a 213-nm 8-ps pulsed laser, Yuval P. Shapira[1], Vladimir Smulakovski[1], Boris Spektor[1], Moshe Horowitz[1]; *[1]Technion - Israel Institute of Technology, Israel.* We demonstrate post-fabrication wavelength trimming of FBGs in two fiber types by using a 213-nm pulsed laser and show that it has significant advantages compared to trimming by using Argon-Ion laser.

Rio Grande/Gunnison

08:30–10:00
STu1D • Fiber & Fabrication
Shibin Jiang; AdValue Photonics, Inc., USA, Presider

STu1D.1 • 08:30
Laser Annealing of Amorphous Silicon Core Optical Fibers, Noel Healy[1], Sakellaris Mailis[1], Todd D. Day[2], Pier J. Sazio[1], John V. Badding[2], Anna C. Peacock[1]; *[1]Optoelectronics Research Centre, UK; [2]Penn State Univ., USA.* Laser annealing of an optical fiber with an amorphous silicon core is demonstrated. The annealing process produces a fiber that has a highly crystalline core, whilst reducing the optical transmission losses by ~3 orders of magnitude.

STu1D.2 • 08:45
Annealing of Semiconductor Core Optical Fibers, Nishant Gupta[1], Colin McMillen[3], Rajendra Singh[1,2], Ramakrishna Podila[4], Apparao Rao[4], Thomas Hawkins[5], Paul Foy[5], Stephanie Morris[5], Kelvin Poole[1], Lin Zhu[1], John Ballato[5], Robert Rice[6]; *[1]Holcombe Department of Electrical and Computer Engineering, Clemson Univ., USA; [2]Center for Silicon Nanoelectronics, Clemson Univ., USA; [3]Department of Chemistry, Clemson Univ., USA; [4]Department of Physics and Astronomy, Clemson Univ., USA; [5]The Center for Optical Materials Science and Engineering Technologies (COMSET) and the School of Materials Science and Engineering, Clemson Univ., USA; [6]Dreamcatchers Consulting, USA.* Ex-situ rapid photothermal annealing is shown, through X-ray diffraction, Raman spectroscopy and Schottky diodes, to enhance the structural homogeneity of silicon optical fibers by increasing local crystallinity, thus advancing their optoelectronic performance.

STu1D.3 • 09:00
Fabrication of Polymeric Micro-Photonic Structures on the Tip of Optical Fibers, Stephen M. Kuebler[1,2], Henry E. Williams[1], Daniel J. Freppon[1], Raymond C. Rumpf[3]; *[1]Chemistry Department, Univ. of Central Florida, USA; [2]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; [3]EM Lab, W. M. Keck Center for 3D Innovation, Univ. of Texas at El Paso, USA.* A method is described for fabricating truly three-dimensional micro-photonic structures directly onto the end face of an optical fiber.

STu1D.4 • 09:15
Fabrication of Microstructured Fibers Using an Effect of Pressure Self-Regulation in Sealed Holes, Sergey Semjonov[1], Alexander N. Denisov[1], Evgeny Dianov[1]; *[1]Fiber Optics Research Center, Russian Federation.* Theoretical aspects of drawing the holey preform with sealed holes at the top end are discussed. Experimental results on drawing in such a regime are presented.

STu1D.5 • 09:30
One-step Multi-material Preform Extrusion for Robust Chalcogenide Glass Optical Fibers, Guangming Tao[1], Soroush Shabahang[1], Ayman F. Abouraddy[1]; *[1]Univ. of Central Florida, CREOL, USA.* We demonstrate a novel process of one-step extrusion of multi-material fiber preforms containing chalcogenide glasses and polymers. The polymer lends mechanical robustness to the drawn chalcogenide infrared fibers and tapers.

STu1D.6 • 09:45
Molten Core Fabrication of Crystalline Oxide Core Optical Fiber, John Ballato[1], Colin McMillen[2], Thomas Hawkins[1], Paul Foy[1], Lin Zhu[3], Robert Rice[4], Oscar Stafsudd[5]; *[1]The Center for Optical Materials Science and Engineering Technologies (COMSET) and the School of Materials Science and Engineering, Clemson Univ., USA; [2]Department of Chemistry, Clemson Univ., USA; [3]Holcombe Department of Electrical and Computer Engineering, Clemson Univ., USA; [4]Dreamcatchers Consulting, USA; [5]Department of Electrical and Computer Engineering, Univ. of California- Los Angeles, USA.* A reactive molten core process was employed to make optical fibers with cores in the bismuth germanate family, containing a biphasic crystalline mixture of acentric Bi2GeO5 and cubic bismuth oxide (δ-Bi2O3/BiO2-x).

10:00–10:30 Coffee Break, *Centennial Room*

Tuesday, 19 June

Platte

Signal Processing in Photonics Communications

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
SpTu2A • OFDM II
Noriaki Kaneda; Bell Labs, USA, Presider

SpTu2A.1 • 10:30 Invited
DSP-enabled OFDM superchannel transmission, Sethumadhavan Chandrasekhar[1], Xiang Liu[1]; *[1]Alcatel-Lucent Bell Labs, USA.* Digital signal processing has enabled the generation and detection of orthogonal-frequency-division-multiplexing based superchannels that advantageously leverage parallelism to achieve high data-rate, high spectral-efficiency, and potentially low cost-per-bit.

SpTu2A.2 • 11:00
Raised-Cosine OFDM for Enhanced Out-of-Band Suppression at Low Subcarrier Counts, Rene M. Schmogrow[1], Benedikt Baeuerle[1], David Hillerkuss[1], Bernd Nebendahl[3], Christian Koos[1,2], Wolfgang Freude[1,2], Juerg Leuthold[1,2]; *[1]Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology, Germany; [2]Institute for Microstructure Technology, Karlsruhe Institute of Technology, Germany; [3]Agilent Technologies, Germany.* Raised-cosine instead of rectangular windowing of OFDM symbols provides a steeper spectral roll-off. After dispersion-compensated transmission, inverse windowing at the receiver maintains orthogonality. Therefore, multiple OFDM bands even with few subcarriers can be efficiently multiplexed.

SpTu2A.3 • 11:15
Spectral Shaping on DFT-OFDM for Higher Transmission Reach, Susmita Adhikari[1], Maxim Kuschnerov[2], Sander L. Jansen[2], Adriana Lobato[3], Oscar Gaete[4], Beril Inan[4], Werner Rosenkranz[1]; *[1]Christian Albrechts Univ., Germany; [2]Nokia Siemens Networks, Germany; [3]Federal Armed Forces Univ., Germany; [4]Technical Univ. of Munich, Germany.* We investigate spectral shaping on DFT-OFDM and show that transmission reach can be significantly improved by 31% and 7% when compared to OFDM and DFT-OFDM for dispersion managed standard single mode fiber links.

SpTu2A.4 • 11:30 Invited
High Performance, Low Overhead CO-OFDM for Next Generation Fiber Transmission Systems, Qunbi Zhuge[1], Mohammad E. Mousa-Pasandi[1], Mohamed Morsy-Osman[1], Xian Xu[1], Mathieu Chagnon[1], Ziad Elsahn[1], David Plant[1]; *[1]McGill Univ., Canada.* We present novel channel equalization and phase estimation approaches to reduce overhead in reduced-guard-interval (RGI) CO-OFDM systems. We also discuss the tolerance of RGI CO-OFDM to laser phase noise and fiber nonlinearity.

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

10:30–12:30
ITu2B • Waveguides, Polarizers, and Dispersion
Jason Orcutt; Massachusetts Institute of Technology, USA, Presider

ITu2B.1 • 10:30 Invited
Silicon-Photonics Devices for Low-Power, High-Bandwidth Optical I/O, Joris Van Campenhout[1], Marianna Pantouvaki[1], Peter Verheyen[1], Hui Yu[2], Peter De Heyn[2], Guy Lepage[1], Wim Bogaerts[2], Philippe Absil[1]; *[1]InterUniv. Microelectronics Center, Belgium; [2]Photonics Research Group, Dept. of Information Technology, Ghent Univ. - imec, Center of Nano- and Biophotonics (NB Photonics), Belgium.* Electro-optic transceivers integrated in silicon-photonics interposers are attractive for realizing low-power high-bandwidth Optical I/O for future advanced logic and memory. We review recent results obtained at imec on low-voltage silicon ring modulators and Ge photodetectors.

ITu2B.2 • 11:00
High Extinction, Broadband, and Low Loss Planar Waveguide Polarizers, Jared F. Bauters[1], Martijn Heck[1], Daoxin Dai[1], Demis D. John[1], Jonathon Barton[1], Daniel Blumenthal[1], John E. Bowers[1]; *[1]UCSB - ECE, USA.* A technique for making high extinction and broadband polarizers in a low loss planar waveguide platform is presented and characterized. Extinction greater than 78 dB is obtained with low loss for the desired polarization.

ITu2B.3 • 11:15
Engineering Spectral Variation of FSR by Tailoring Dispersion for Octave-Spanning Comb Generation Based on Micro-Resonators, Lin Zhang[1], Vivek Singh[1], Pao-Tai Lin[1], Anuradha Agarwal[1], Lionel C. Kimerling[1], Jurgen Michel[1]; *[1]Microphotonics Center and Department of Materials Science and Engineering, Massachusetts Institute of Technology, USA.* The free spectral range of integrated resonators is engineered over an octave-spanning frequency range with greatly improved uniformity, which is enabled by dispersion tailoring using a nano-scale slot structure, for on-chip frequency comb generation.

ITu2B.4 • 11:30
Waveguide arrays in diffusive photopolymers, Eric Moore[1], Adam Urness[1], Robert Mcleod[1]; *[1]Electrical, Computer, and Energy Engineering, Univ. of Colorado, USA.* We describe two methods, liquid deposition photolithography and holographic lithography, for fabricating two-dimensional arrays of optical waveguides with high channel counts. Both methods rely on refractive index patterning via monomer diffusion in photosensitive polymers.

Colorado III

Integrated Photonics Research, Silicon and Nano Photonics

10:30–12:30
ITu2C • Slow Light in Photonic Crystals
Thomas Krauss; Univ. of St Andrews, UK, Presider

ITu2C.1 • 10:30 Invited
Ultrafast nonlinearities and dispersion in slow-light photonic crystal lattices, Chee Wei Wong[1], J. F. McMillan[1], T. Gu[1], M. Marko[1], X. Li[1], P. Hsieh[1], S. Kocaman[1]; *[1]Columbia Univ., USA.* We describe the ab initio control of photons in highly-dispersive slow-light photonic crystals and superlattices. Ultrafast nonlinearities such as chip-scale four-wave mixing, regenerative oscillations, self-phase modulation, and phase-resolved soliton dynamics and compression will be highlighted.

ITu2C.2 • 11:00
Narrowband Optical Parametric Gain in Slow Light Photonic Crystal Waveguides, Sourabh Roy[1], Marco Santagiustina[1], Gadi Eisenstein[2], Amnon Willinger[2], Sylvain Combrié[3], Alfredo De Rossi[3]; *[1]Department of Information Engineering, Universita degli Studi di Padova, Italy; [2]Electrical Engineering Department, Technion, Israel; [3]Thales Research and Technology, France.* A complete and rigorous model of parametric gain in photonic crystal waveguides, including dispersive losses, has been derived. The predicted narrowband amplification might enable tuneable slow light device applications.

ITu2C.3 • 11:15
Efficient Parametric Gain at 1.55 um in a GaInP Photonic Crystal Waveguide, Isabelle Cestier[1], Gadi Eisenstein[1], Sylvain Combrié[2], Alfredo De Rossi[2]; *[1]Technion Israel Institute of Technology, Israel; [2]Thales Research and Technology, France.* We demonstrate efficient optical parametric amplification in 1.5mm long GaInP photonic crystal waveguides operating at 1.55 µm. Owing to low linear and nonlinear losses we achieved a 10.6 dB gain using 31ps, 800mW pump pulses.

ITu2C.4 • 11:30
Distributed Feedback Effects in Active Semiconductor Photonic CrystalWaveguides, Yaohui Chen[1], Jesper Mork[1]; *[1]DTU Fotonik, Technical Univ. of Denmark, Denmark.* We present a rigorous coupled-wave analysis of slow-light effects in active photonic crystal waveguides. The presence of active material leads to coherent distributed feedback effects that significantly alter the magnitude and phase of output fields.

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
NTu2D • Nonlinear Systems and Nonlinear Dynamics
Dmitry Skryabin; Univ. of Bath, UK, Presider

NTu2D.1 • 10:30
Pulse shaping assisted investigation of interacting dispersion-managed solitons, Alexander Hause[1], Philipp Rohrmann[1], Fedor Mitschke[1]; *[1]Institut für Physik Universität Rostock, Germany.* Fiber-optic dispersion-managed solitons can form stable molecules. Systematically mapping out parameter space using a flexible pulse shaper, we investigate the binding mechanism and confirm predictions. Phenomena off equilibrium are also described and explained.

NTu2D.2 • 10:45
Soliton Eigenvalue Evolution in Plasma-Influenced Nonlinear Gas-Fiber Optics, John C. Travers[1], Wonkeun Chang[1], Philipp Hoelzer[1], Philip Russell[1,2]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Department of Physics, Univ. of Erlangen-Nuremberg, Germany.* We study the influence of ionization on soliton evolution and the self-frequency blue-shift in a gas-filled photonic crystal fiber by numerically solving the direct scattering problem of a suitably perturbed nonlinear Schrödinger equation.

NTu2D.3 • 11:00
Adler synchronization of spatial laser solitons pinned by defects, Yoann Noblet[1], Pavel Paulau[2], Craig McIntyre[1], William Firth[1], Pere Colet[3], Gian-Luca Oppo[1], Thorsten Ackemann[1]; *[1]Physics, Univ. of Strathclyde, UK; [2]Institut fur Theoretische Physik, Technischen Universität, Germany; [3]IFISC, Universitat Illes Balears, Spain.* Spatial disorder due to growth fluctuations in broad-area semiconductor lasers induces pinning and frequency shifts of spatial laser solitons. We demonstrate frequency and phase-locking between two spatial solitons in VCSELs with frequency-selective feedback.

NTu2D.4 • 11:15
Vector Solitons with Slowly Precessing States of Polarization, Chengbo Mou[1], Sergey Sergeyev[1], Aleksey Rozhin[1], Sergei K. Turitsyn[1]; *[1]Photonics Research Group,Aston Uni, UK.* We observed new types of polarization rotating vector solitons in a carbon nanotube mode locked fiber laser with anomalous dispersion cavity.

NTu2D.5 • 11:30
Characterization of Temporal Cavity Solitons by Frequency Resolved Optical Gating (FROG), Jae K. Jang[1], Stuart G. Murdoch[1], Stephane Coen[1]; *[1]Physics, The Univ. of Auckland, New Zealand.* Temporal cavity solitons, i.e., persistent pulses of a continuously-pumped nonlinear fiber ring cavity, are held stable for several minutes, allowing for the first time their characterization in both amplitude and phase, using FROG.

10:30–12:30
BTu2E • Applications of Gratings and Poled Glass: FBG Sensors and Interrogation systems
Jose Azana; INRS-Energie Materiaux et Telecom, Canada, Presider

BTu2E.1 • 10:30 Invited
Plasmons and nanoparticle coatings on optical fibers: playing with Tilted Fiber Bragg Gratings, Jacques Albert[1], Christophe Caucheteur[2], Li-Yang Shao[3], Anatoli Ianoul[1], Sean Barry[1]; *[1]Carleton Univ., Canada; [2]Université de Mons, Belgium; [3]China Jiliang Univ., China.* Strong, narrowband, and polarized cladding mode resonances from tilted fiber Bragg gratings are used to probe uniform and granular nanoscale metal coatings. The effects of Plasmon field localization on the grating transmission are described.

BTu2E.2 • 11:00
A shear-displacement sensor based on a ferrofluidic defected microstructured optical fibre Bragg grating, Alessandro Candiani[2,1], Maria Konstantaki[1], Walter Margulis[3], Stavros Pissadakis[1]; *[1]IESL, FORTH, Greece; [2]Department of Fiber Photonics, ACREO, Sweden; [3]Department of Information Engineering, Univ. of Parma, Italy.* A shear sensor based on a ferrofluid infiltrated microstructured optical fiber Bragg grating is presented. Shear displacements between 250μm and 4.5mm are measured, corresponding to spectral changes in the reflected spectra greater than 5dB.

BTu2E.3 • 11:15
Femtometer-Resolution Wavelength Interrogation of a Phase-Shifted Fiber Bragg Grating Sensor Using an Optoelectronic Oscillator, Ming Li[1], Wangzhe Li[2], Jianping Yao[2], Jose Azana[1]; *[1]INRS-Energie Materiaux et Telecom, Canada; [2]Univ. of Ottawa, Canada.* A novel technique to achieve femtometer-resolution wavelength interrogation of a PSFBG sensor is proposed and demonstrated using an optoelectronic oscillator. Wavelength interrogation of a PSFBG strain sensor with a resolution of 360fm is experimentally demonstrated

BTu2E.4 • 11:30
Use of an FBG Sensor for In-situ Temperature Measurements of Gas Dielectric Barrier Discharges, Meenu Ahlawat[1], Bachir Saoudi[1], Elton Soares de Lima Filho[1], Michel Wertheimer[1], Raman Kashyap[1,2]; *[1]Department of Engineering Physics, Ecole Polytechnique de Montreal, Canada; [2]Department of Electrical Engineering, Ecole Polytechnique de Montreal, Canada.* We report the use of a fibre Bragg grating (FBG), which is immune to electromagnetic-fields and/or high-voltages encountered in plasma environments, to measure the temperature in various noble gases, Nitrogen and air dielectric barrier discharge.

10:30–12:30
STu2F • Fiber Based Devices
Li Qian; Univ. of Toronto, Canada, Presider

STu2F.1 • 10:30 Invited
Optical Microfibers and Nanofibers, Limin Tong[1]; *[1]Zhejiang Univ., China.* Optical micro-nanofibers exhibit interesting properties including tight optical confinement, high fractional evanescent waves, steep field gradient and abnormal dispersion, which open opportunities for developing microscale fiber-optic components, devices ranging from resonators, lasers to sensors.

STu2F.2 • 11:00 Invited
High Power All-Fiber Isolator for 1 Micron Fiber Lasers, Shibin Jiang[1]; *[1]AdValue Photonics, Inc., USA.* We successfully developed an all-fiber isolator by using our proprietary Faraday rotator fiber. The throughput power of all-fiber isolator is several times higher than that of current free-space fiber pigtailed isolator.

STu2F.3 • 11:30
A Novel Dual-Core Photonic Crystal Fiber Coupler With A Metal Wire, Shuyan Zhang[1], Xia Yu[1], Ying Zhang[1]; *[1]Precision Measurements Group, Singapore Institute of Manufacturing Technology, Singapore.* We report a novel fiber coupler design with plasmonics effect. The coupling length is reduced by 40 times in the near infrared region. The air hole diameter and the pitch size will affect coupler performance.

Platte	Colorado II	Colorado III
Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

SpTu2A • OFDM II—Continued

SpTu2A.5 • 12:00
Improving PDL Tolerance of Long-Haul PDM-OFDM Systems Using Polarization-Time Coding, Elie Awwad[1], Yves Jaouën[1], Ghaya Rekaya-Ben Othman[1]; [1]*Institut Télécom / Télécom ParisTech, France.* We show that Polarization-Time codes can mitigate PDL impairments in long-haul OFDM systems. Coding gains are maintained in weakly non-linear regime and no extra penalty is added when non-linear effects become severe.

SpTu2A.6 • 12:15
Beyond 1Tb/s Superchannel Optical Transmission based on Polarization Multiplexed Coded-OFDM over 2300 km of SSMF, Ding Zou[1], Ivan B. Djordjevic[1]; [1]*Electrical and Computer Engineering, Univ. of Arizona, USA.* The novel OFDM channel estimation method is used to compensate for chromatic dispersion and polarization-mode dispersion separately. Together with low-density parity-check coded multi-band OFDM, we can achieve beyond 1Tb/s serial transmission over 2300km of SSMF without any countable error.

ITu2B • Waveguides, Polarizers, and Dispersion—Continued

ITu2B.5 • 11:45
Asymmetric Codirectional Coupler between Regular Nanowaveguide and Slot-waveguide for Polarization Conversion, Benjamin Wohlfeil[1], Lars Zimmermann[2], Klaus Petermann[1]; [1]*Institut für Hochfrequenztechnik, Technische Universität Berlin, Germany;* [2]*IHP GmbH, Germany.* A polarization converter based on an asymmetric codirectional coupler made of SOI nanowaveguides is proposed. Strong coupling between the fundamental TM mode of a nanowaveguide and the fundamental TE mode of a slot-waveguide is achieved.

ITu2B.6 • 12:00
An Integratable Electrically Tunable Dispersion Trimming, Kambiz Jamshidi[1], Stefan Meister[2], Bulent Franke[2], Aws AlSaadi[2], Sebastian Kupijai[2], Thomas Schneider[1]; [1]*Inst. of High Frequency Technology, HfTL, Germany;* [2]*TU Berlin, Institut für Optik und Atomare Physik, Germany.* An electrically tunable dispersion trimming method is proposed which can be integrated in a CMOS compatible process. Feasibility of the method is studied by simulations to produce or compensate variable dispersions up to 65 ps/nm.

ITu2B.7 • 12:15
Withdrawn

ITu2C • Slow Light in Photonic Crystals—Continued

ITu2C.5 • 11:45
How Much Can Slow Light Increase the Efficiency in Thin-Film Planar Solar Cell Devices?, Olivier G. Deparis[1], Ounsi El Daif[2]; [1]*Facultes Univ Notre-Dame de la Paix, Belgium;* [2]*IMEC, Belgium.* Slow-light induced enhancement of solar light absorption is predicted in Bragg resonators built from layers of active (photovoltaic) and passive (transparent conductive oxide) materials. Applications to photo-current enhancement in realistic thin-film solar cells are discussed.

ITu2C.6 • 12:00 Invited
Resonance fluorescence in a photonic crystal waveguide: Mollow triplet sampling of the slow-light modes, Stephen Hughes[1]; [1]*Queen's Univ. at Kingston, Canada.* We introduce a formalism to study resonance fluorescence of a driven quantum dot in a photonic crystal waveguide. Unusual Mollow triplets emerge due to simultaneous sampling of different parts of the slow-light band structure.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
SpTu3A • DSP Algorithm I
Moshe Nazarathy; Technion Israel Institute of Technology, Israel, Presider

SpTu3A.1 • 13:30 Invited
Hardware Efficient Carrier Recovery Algorithms for Single-Carrier QAM systems, Xiang Zhou[1]; [1]*AT&T Corp, USA.* This paper presents an overview on recent advancement of carrier synchronization techniques for optical systems using single-carrier quadrature-amplitude-modulation (QAM), with a special emphasis on a class of newly proposed multi-stage carrier phase recovery algorithms

13:30–15:30
ITu3B • Microphotonic Filters
Jean Benoit Heroux; IBM Japan, Japan, Presider

ITu3B.1 • 13:30 Invited
Refractive Index Engineering with Subwavelength Gratings in Silicon Waveguides, Pavel Cheben[1]; [1]*National Research Council Canada, Canada.* Subwavelength structures in silicon waveguides are presented, including practical components such as fiber-chip grating couplers, waveguide crossings, a polarization converter, a waveguide multiplexer and a Terahertz optical switch.

13:30–15:30
ITu3C • Tunable Delay
Thomas Krauss; Univ. of St Andrews, UK, Presider

ITu3C.1 • 13:30 Invited
Application of Time-Space Duality to Temporal Cloaking, Alexander L. Gaeta[1], Moti Fridman[1], Alessandro Farsi[1], Yoshitomo Okawachi[1]; [1]*Cornell Univ., USA.* We utilize time-lens technology based on parametric four-wave mixing to create a short temporal gap in a light beam that can allow for one dimensional cloaking of an event.

NTu2D • Nonlinear Systems and Nonlinear Dynamics—Continued

NTu2D.6 • 11:45
Spatio-temporal collapse of ultrashort pulses in multimode optical fibers, Graham D. Hesketh[1]; [1]*Optoelectronics Research Centre, UK.* Investigating MW peak-power ultra-short pulse propagation in multimode fibers using a multimode Schrödinger equation reveals nonlinear and dispersive effects can cause dramatic compression in space-time even for launch peak powers below the self-focusing power, Pcrit.

NTu2D.7 • 12:00
All-fiber transform-limited spectral compression by self-phase modulation of amplitude-shaped pulses, Julien Fatome[1], Bertrand Kibler[1], Esben R. Andresen[2], Hervé Rigneault[2], Christophe Finot[1]; [1]*Laboratoire Interdisciplinaire CARNOT de Bourgogne, France;* [2]*Institut Fresnel, France.* We demonstrate efficient spectral compression of picosecond pulses in an all-fiber configuration at telecommunication wavelengths. Thanks to parabolic pulse shaping, a spectral compression by a factor 12 is achieved with an enhanced Strehl ratio.

NTu2D.8 • 12:15
Beam steering using spatial OPA in Kerr media: a space-time analogy of parametric slow-light, Gil Fanjoux[1], Thibaut Sylvestre[1]; [1]*Universite de Franche-Comte, France.* In a way similar to an optical pulse that can be optically delayed via slow light propagation, we theoretically demonstrate that beam steering can be readily achieved using optical parametric amplification in Kerr-type nonlinear media.

BTu2E • Applications of Gratings and Poled Glass: FBG Sensors and Interrogation systems—Continued

BTu2E.5 • 11:45
Transverse load tilted fiber Bragg grating sensor with variable sensitivity, Tingting Sun[1,2], Yang Zhang[1], Jacques Albert[1]; [1]*Department of Electronics, Carleton Univ., Canada;* [2]*School of Physics and Optoelectronics Engineering, Nanjing Univ. of Information Science & Technology, China.* A transverse load sensor for small forces (<7N) is demonstrated with a tilted fiber Bragg grating compressed between soft materials. The sensitivity of the device is optimized for different force ranges by changing the material.

BTu2E.6 • 12:00
Simultaneous Sensing of Temperature and Strain by Combined FBG and Mode-Interference Sensors, Alexander Siekiera[1,2], Rainer Engelbrecht[1,2], Lars Buethe[1], Bernhard Schmauss[1,2]; [1]*Lehrstuhl für Hochfrequenztechnik, Universität Erlangen, Germany;* [2]*Erlangen Graduate School in Advanced Optical Technologies, Universität Erlangen, Germany.* We examine the combination of a FBG and mode-interference sensor for simultaneous temperature and strain sensing. Results for temperature and strain sensitivities are presented and the sensor performance in a simultaneous measurement experiment is evaluated.

BTu2E.7 • 12:15
Real-time 3D shape sensing and reconstruction scheme based upon fibre optic Bragg gratings, Ranjeet S. Bhamber[1], Thomas Allsop[2], G. Lloyd[3], David Webb[2], Juan D. Ania-Castanon[1]; [1]*Instituto De Optica "Daza De Valdes", Spain;* [2]*Photonics Research Group, Dept of Electronic Engineering, Aston Univ., UK;* [3]*Moog Insensys Ltd, UK.* An array of FBG curvature sensors are wavelength-interrogated and the recovered data combined with a three-dimensional algorithm to reconstruct in real time the enveloped object with a 1% to 9% volumetric error.

STu2F • Fiber Based Devices—Continued

STu2F.4 • 11:45
Polymer Optical Fibers for Luminescent Solar Concentration, Esmaeil-Hooman Banaei[1], Ayman F. Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA.* We present the design and numerical optimization of an all-polymer fiber as a luminescent solar concentrator. Large-area, lightweight, and flexible fabrics constructed of such fibers are a low-cost solar-energy harvesting alternative useful for mobile applications.

STu2F.5 • 12:00
Design and Analysis of Heterogeneous Trench-Assisted Multi-core Fiber under Bending Condition, Jiajing Tu[1], Kunimasa Saitoh[1], Masanori Koshiba[1], Katsuhiro Takenaga[2], Shoichiro Matsuo[2]; [1]*Division of Media and Network Technologies, Hokkaido Univ., Japan;* [2]*Optics and Electronics Laboratory, Fujikura Ltd, Japan.* Heterogeneous trench-assisted multi-core fiber (Hetero-TA-MCF) is proposed to achieve larger effective area. The crosstalk value at 1550-nm of Hetero-TA-MCF can be lower than -"50" dB after 100-km propagation.

STu2F.6 • 12:15
Multimaterial Fibers for Generating Structured Nanoparticles, Joshua J. Kaufman[1], Guangming Tao[1], Soroush Shabahang[1], Esmaeil-Hooman Banaei[1], Ayman F. Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA.* We present a pathway to the fabrication of structured spherical nanoparticles that leverages the scalability of fiber fabrication technology and an in-fiber Playteau-Rayleigh capillary instability. Thermal treatment of multi-material fibers post-drawing produces spherical nanoparticles.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
NTu3D • Nonlinearities in Novel Propagation Environments
Anna Peacock; Univ. of Southampton, UK, Presider

NTu3D.1 • 13:30 Invited
Photonic microcells, Fetah Benabid[1]; [1]*Univ. of Bath, UK.* We review the recent progress on hollow-core photonic crystal fibers and its integrated form of photonic microcells in both their design and fabrication and in their applications for coherent optics, Raman comb generation laser metrology, and discharge based lasers.

13:30–15:30
BTu3E • Sensor Symposium I
Sophie LaRochelle; Universite Laval, Canada, Presider

BTu3E.1 • 13:30 Invited
Measuring Detonation, Deflagration and Burn Velocities with Fiber-optic Bragg Grating Sensors, Jerry Benterou[1], Eric Udd[2]; [1]*Detonation Science, Lawrence Livermore National Laboratory, USA;* [2]*Applied Science, Columbia Gorge Research, USA.* Embedded fiber-optic Bragg grating sensors allow the measurement of the progress of high-speed reactions inside energetic materials. These sensors show promise as tools to measure the performance of solid rocket motor propellants and high explosives.

13:30–15:30
STu3F • Mid IR
Ishwar Aggarwal; Univ of North Carolina at Charlotte, USA, Presider

STu3F.1 • 13:30
Guided mode resonance filter as wavelength selecting element in Er:ZBLAN fiber laser, Eric G. Johnson[1], Yuan Li[1], Ryan Woodward[1], Menelaos Poutous[1], Indumathi Raghu[1], Ramesh Shori[2]; [1]*Clemson Univ., USA;* [2]*Naval Air warfare Center, USA.* A Guided Mode Resonance filter is fabricated and integrated into a Er:ZBLAN fiber laser as a selective feedback element, with a tunable laser range between 2.7-2.9 µm.

STu3F.2 • 13:45
High-purity tungstate-tellurite glasses for Mid-IR, Vitaly Dorofeev[1], Alexander Moiseev[1], Igor Kraev[1], Sergey Motorin[1], Alexey F. Kosolapov[2]; [1]*Institute of Chemistry of High-Purity Substances RAS, Russian Federation;* [2]*Fiber Optics Research Center RAS, Russian Federation.* Monolithic preforms of high-purity TeO2-WO3-La2O3-(Bi2O3) glasses were produced. Absorption of hydroxyl groups was down to n×0.001 cm-1 at ~3 µm in both core and cladding. Optical fibers with loss less than 0.5 dB/m at region of 1.2-2.8 µm were made from them.

Platte	Colorado II	Colorado III
Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Tuesday, 19 June

SpTu3A • DSP Algorithm I—Continued

SpTu3A.2 • 14:00
Joint ICI Cancellation based on Adaptive Cross-Channel Linear Equalizer for Coherent Optical Superchannel Systems, Cheng Liu[1], Jie Pan[1], Thomas F. Detwiler[1,2], Andrew J. Stark[1], Yu-Ting Hsueh[1], Gee-Kung Chang[1], Stephen E. Ralph[1]; *[1]Georgia Institute of Technology, USA; [2]Adtran Inc., USA.* We demonstrate a novel joint adaptive ICI cancellation algorithm based on "super receiver" architecture for superchannel coherent systems. Improved performance over conventional coherent receivers is achieved for both BTB and after 960km SSMF transmission.

SpTu3A.3 • 14:15
Inter-Channel Crosstalk Cancellation by MAP Detection for Nyquist-WDM Superchannel, Jie Pan[1], Cheng Liu[1], Thomas F. Detwiler[1], Andrew J. Stark[1], Yu-Ting Hsueh[1], Stephen E. Ralph[1]; *[1]Electrical and Computer Engineering, Georgia Institute of Technology, USA.* A novel maximum a posteriori (MAP) inter-channel interference (ICI) cancellation algorithm for the Nyquist-WDM system is proposed and demonstrated with improved system performance.

SpTu3A.4 • 14:30 Invited
Efficient Training-Based Channel Estimation for Coherent Optical Communication Systems, Fabio Pittalà[1,2], Amine Mezghani[3], Fabian N. Hauske[1], Yabin Ye[1], Idelfonso T. Monroy[2], Josef A. Nossek[3]; *[1]European Research Center, Huawei Technologies Co Ltd, Germany; [2]Fotonik, Technical Univ. of Denmark, Denmark; [3]Institute for Circuit Theory and Signal Processing, Technische Universität München, Germany.* A low-complexity technique for frequency domain channel estimation based on constant amplitude zero-autocorrelation (CAZAC) sequences is theoretically investigated.

SpTu3A.5 • 15:00
Outage Probability derivations for PDL-disturbed Coherent Optical Communication, Pierre Delesques[1,2], Philippe Ciblat[2], Gwillerm Froc[1], Yves Jaouën[2], Cédric Ware[2]; *[1]System, Network & Services, Mistubishi Electrics R&D Centre Europe, France; [2]Communications & Electronics, Institut Télécom/Télécom ParisTech, France.* We derive in closed-form the outage probability for different statistical models of PDL and evaluate their accuracy. From the resulting expressions, we quantify its impact on optical transmissions as an SNR penalty.

ITu3B • Microphotonic Filters—Continued

ITu3B.2 • 14:00
Design and Fabrication of Mid-IR Guided Mode Resonance Filters, Eric G. Johnson[1], Ryan Woodward[1], Menelaos Poutous[1], Aaron Pung[1], Yuan Li[1], Indumathi Raghu[1]; *[1]Clemson Univ., USA.* This paper summarizes design and fabrication results for Mid-IR Guided Mode Resonance filters based on Hexagonal and Rectangular arrays for use at 2.8 um. The devices are fabricated in Quartz substrates with Hafnium Dioxide.

ITu3B.3 • 14:15
Apodized comb filters on SOI using sidewalled sampled gratings, Venkatakrishnan Veerasubramanian[1], Guillaume Beaudin[2], Alexandre Giguere[2], Boris Le Drogoff[3], Vincent Aimez[2], Andrew G. Kirk[1]; *[1]McGill Univ., Canada; [2]Univ. of Sherbrooke, Canada; [3]INRS, Canada.* We propose comb filters using sidewalled sampled gratings, where the etch depths in the fingers and spaces have been apodized in a complementary fashion. We numerically demonstrate filters with 40 dB SMSR, 92 GHz bandwidth, 200 GHz channel spacing, and 120 dB/decade roll-off.

ITu3B.4 • 14:30
Differentiation between changes in liquid refractive index and surface adsorbed molecular thickness using SOI wire waveguide ring resonator biosensor arrays, Yuki Atsumi[1,2], Dan-Xia Xu[1], Andre Delage[1], Jens Schmid[1], Martin Vachon[1], Pavel Cheben[1], Siegfried Janz[1], Nobuhiko Nishiyama[2], Shigehisa Arai[2,3]; *[1]Institute for Microstructural Sciences, National Research Council Canada, Canada; [2]Dept. of Electrical and Electronic Engineering, Tokyo Institute of Technology, Japan; [3]Quantum Nanoelectronics Research Center, Tokyo Institute of Technology, Japan.* For silicon wire based ring resonator biosensors, we investigate the retrieval of changes in the cladding-liquid refractive index and adsorbed molecular-film thickness by monitoring the resonance-shifts of sensors operating in the TE and TM polarizations.

ITu3B.5 • 14:45
Low cross-talk silica arrayed-waveguide grating for visible light spectroscopy, Junya Odori[1], Takemasa Yoshida[1], Keisuke Sorimoto[1], Hisao Iitsuka[2], Hitoshi Kawashima[2], Tsuda Hiroyuki[1]; *[1]Science and Technology, Keio Univ., Japan; [2]National Institute of Advanced Industrial Science and Technology, Japan.* Silica arrayed-waveguide grating with a channel spacing of 2 nm for visible light was fabricated. The loss and the cross-talk at around the center wavelength of 671.2 nm were 5.39 dB and -30.1 dB, respectively.

ITu3B.6 • 15:00
Widely and continuously tunable narrow-band photonic filters with MEMS integration, Guanquan Liang[1]; *[1]Electrical and Computer Engineering, National Univ. of Singapore, Singapore.* A planar silicon photonic structure is designed for narrow-band filtering (~ 2 nm) in a wide photonic band gap (~210 nm) with broad tunable resonant range (~100 nm) around the optical communication wavelength 1550 nm.

ITu3C • Tunable Delay—Continued

ITu3C.2 • 14:00 Invited
On-chip Slow and Fast Light Using Stimulated Brillouin Scattering, Ravi Pant[1], Adam Byrnes[1], Christopher G. Poulton[2], Enbang Li[1], Duk-Yong Choi[3], Steve J. Madden[3], Barry Luther-Davies[3], Benjamin J. Eggleton[1]; *[1]CUDOS School of Physics, Univ. of Sydney, Australia; [2]CUDOS, School of Mathematical Sciences, Univ. of Technology Sydney, Australia; [3]CUDOS, Laser Physics Centre, Australian National Univ., Australia.* We report the first demonstration of on-chip SBS slow and fast light using stimulated Brillouin scattering. Slow (~2307 km/s), fast and negative (~-6818 km/s) group velocities were observed in a 7cm long chalcogenide waveguide.

ITu3C.3 • 14:30
Highly Tunable Delay Line with Linear Phase Modulation and Optical Filtering, Arash Mokhtari[1], Kambiz Jamshidi[1], Stefan Preussler[1], Avinoam Zadok[2], Thomas Schneider[1]; *[1]Institut für Hochfrequenztechnik, Hochschule für Telekommunikation Leipzig, Germany; [2]Faculty of Engineering, Bar-Ilan Univ., Israel.* Tunable delay and advancement of 10 GHz pulses by over 300 ps and minimal distortion is demonstrated experimentally. The method is based on frequency-to-time mapping, subsequent modulation by a simple sine wave and judicious filtering.

ITu3C.4 • 14:45
Phase Characteristics of EIT-Like Spectral Responses in Coupled Ring-Resonators, Xiaoyan Zhou[1], Lin Zhang[2], Hao Zhang[1], Wei Pang[1]; *[1]State Key Laboratory of Precision Measuring Technology and Instruments, Tianjin Univ., China; [2]Microphotonics Center and Department of Materials Science and Engineering, Massachusetts Institute of Technology, USA.* We show different phase responses in the coupled ring-resonators that exhibit an EIT-like amplitude response, corresponding to three operating regimes. This deepens our understanding of the double-resonator devices in terms of delay and nonlinear performance.

ITu3C.5 • 15:00 Invited
Physics and applications of slow and fast light in semiconductor optical waveguides, Jesper Mork[1], Yaohui Chen[1], Sara Ek[1], Minhao Pu[1], Kresten Yvind[1]; *[1]Danmarks Tekniske Universitet, Denmark.* We review the physics of slow and fast light based on coherent population oscillations in active semiconductor waveguides. Exploiting these effects, microwave phase shifters realizing 360 degree phase shift and operating at tens of GHz have been realized.

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NTu3D • Nonlinearities in Novel Propagation Environments—Continued

NTu3D.2 • 14:00
Theory of photoionization-induced nonlinear phenomena in gas-filled photonic crystal fibers, Mohammed F. Saleh[1], Wonkeun Chang[1], Philipp Hoelzer[1], John C. Travers[1], Nicolas Joly[1,2], Philip Russell[1,2], Fabio Biancalana[1]; [1]*Max-Planck-Inst Physik des Lichts, Germany;* [2]*Physics, Univ. of Erlangen-Nuremberg, Germany.* Based on a recently developed model that is able to describe pulse propagation in gas-filled hollow-core PCFs, we show that the photoionization process can lead to soliton self-frequency blue-shift, self-phase modulation, and modulation instability.

NTu3D.3 • 14:15
Cross-Phase Modulation in a Hydrogenated Amorphous Silicon Optical Fiber, Priyanth Mehta[1], Noel Healy[1], Todd D. Day[2], Pier J. Sazio[1], John V. Badding[2], Anna C. Peacock[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [2]*Department of Chemistry and Materials Research Institute, Pennsylvania State Univ., USA.* We experimentally demonstrate cross-phase modulation (XPM) in a hydrogenated amorphous silicon-silica optical fiber. Additional numerical analysis shows that shifts in the probe wavelength are induced by the pump indicating potential for Kerr based switching applications.

NTu3D.4 • 14:30
Nonlinear control of the trajectory and spectrum of Airy beams, Yi Hu[1,2], Zhe Sun[2], Domenico Bongiovanni[1], Daohong Song[2], Zhuoyi Ye[2], Cibo Lou[2], Jingjun Xu[2], Zhigang Chen[2,3], Roberto Morandotti[1]; [1]*INRS-EMT, UNIV. OF QUEBEC, Canada;* [2]*TEDA Applied physics school, Nankai Univ., China;* [3]*Department of Physics & Astronomy, San Francisco State Univ., USA.* We demonstrate the nonlinear control of self-accelerating Airy beams. We show that under both self-focusing/defocusing nonlinearities, the ballistic trajectory of an Airy beam persists while its spatial spectrum reshapes, leading to distance-dependent negative/positive spectral defects

NTu3D.5 • 14:45
Nonlinearity-induced suppression of Landau-Zener tunneling, Alois Regensburger[1,2], Christoph Bersch[1,2], Georgy Onishchukov[2], Ulf Peschel[1]; [1]*Institute of Optics, Information and Photonics, Univ. of Erlangen/Nuremberg, Germany;* [2]*Max Planck Institute for the Science of Light, Germany.* We experimentally demonstrate discrete temporal diffraction, Bloch oscillations and Landau-Zener tunneling in a fiber network. For increasing power levels Landau-Zener tunneling is suppressed thus leading to nonlinear localization at a few lattice sites.

NTu3D.6 • 15:00
Kovacs and inverse Kovacs effect in the optical scale-free regime, Eugenio Del Re[1,2], Jacopo Parravicini[1,2], Aharon Agranat[3], Claudio Conti[1,4]; [1]*Physics, Univ. of Roma La Sapienza, Italy;* [2]*CNR-IPCF, Univ. of Rome Sapienza, Italy;* [3]*Applied Physics, Hebrew Univ. of Jerusalem, Israel;* [4]*CNR-ISC, Univ. of Rome Sapienza, Italy.* We demonstrate a Kovacs and inverse Kovacs effect in the optical response of out-of-equilibrium ferroelectrics by activating scale-free optical propagation and diffraction cancellation through small-amplitude temperature humps.

BTu3E • Sensor Symposium I—Continued

BTu3E.2 • 14:00 Invited
Miniaturized Photonic Sensors with Fiber Lasers, Geoffrey A. Cranch[1], Gary A. Miller[1], Clay Kirkendall[1]; [1]*US Naval Research Laboratory, USA.* This manuscript and accompanying talk will describe a range of miniature photonic sensors that have been developed based on fiber laser strain sensor technology. These include hydrophones, inertial and magnetic field sensors.

BTu3E.3 • 14:30 Invited
Regenerated Gratings for Optical Sensing in Harsh Environments, John Canning[1]; [1]*Univ. of Sydney, Australia.* Regeneration and its application to developing high temperature resistant gratings and applications is reviewed.

BTu3E.4 • 15:00 Invited
Polymer optical fibre Bragg gratings, David J. Webb[1]; [1]*Aston Institute of Photonic Technologies, Aston Univ., UK.* This paper provides a review of the current state of research and development into polymer fibre Bragg gratings, along with a description of some current challenges.

STu3F • Mid IR—Continued

STu3F.3 • 14:00
Modeling and experimental research of nano- and microstructurized IR fibers (2-40 um) based on defective crystals, Andrey I. Chazov[1], Alexandr S. Korsakov[1], Dmitry S. Vrublevsky[1], Viktor S. Korsakov[1], Vladislav V. Zhukov[1], Liya V. Zhukova[1], Sergey Kortov; [1]*Ural Federal Univ. named after the first President of Russia B.N.Eltsin, Russian Federation.* Microstructurized infrared fibers made of silver halide solid solutions doped with TlI are discussed. A few types of fibers have been designed using dedicated software. The waveguides manufactured showed wider transmission range up to 2-40 µm, low optical losses of 0.1 dB/m and improved flexibility.

STu3F.4 • 14:15
Reactive In-Situ Processing of Silicon Optical Fiber, Stephanie Morris[1], Thomas Hawkins[1], Paul Foy[1], Colin McMillen[2], Jiahua Fan[3], Lin Zhu[3], Roger Stolen[1], John Ballato[1], Robert Rice[4]; [1]*The Center for Optical Materials Science and Engineering Technologies (COMSET) and the School of Materials Science and Engineering, Clemson Univ., USA;* [2]*Department of Chemistry, Clemson Univ., USA;* [3]*Department of Electrical and Computer Engineering, Clemson Univ., USA;* [4]*Dreamcatchers Consulting, USA.* Silicon carbide (SiC) is added to the silicon (Si) core of crystalline core optical fibers to provide an in-situ reactive getter of oxygen to achieve oxygen-free fibers in order to minimize scattering and propagation loss.

STu3F.5 • 14:30 Invited
Progress in Fluoride Glass Fibers, Mohammed Saad[1]; [1]*Irphotonics, Canada.* Recently, tremendous progress has been made in fluoride glass fiber technology. Fiber transmission has been extended up to 5.5 um by using indium fluoride glass fibers. Current Fiber loss is around 45 dB/km and more than 100 kpsi mechanical strength.

STu3F.6 • 15:00
Mid-IR coherent supercontinuum generation in all-solid step-index soft glass fibers, Alexander M. Heidt[1], Francesco Poletti[1], Jonathan Price[1], David J. Richardson[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We numerically demonstrate that normal dispersion femtosecond pumping of tailored soft glass step-index fibers can generate highly coherent mid-IR supercontinuum light with two octaves bandwidth, suitable for recompression to few-cycle pulse durations.

Platte	Colorado II	Colorado III
Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

SpTu3A • DSP Algorithm I—Continued

SpTu3A.6 • 15:15
On the Performance of a Soft Decision FEC Scheme Operating in Highly Non-Linear Regime, Paolo Leoni[1], Vincent Sleiffer[2], Stefano Calabrò[3], Maxim Kuschnerov[3], Sander L. Jansen[3], Bernhard Spinnler[3], Berthold Lankl[1]; *[1]Institut für Informationstechnik, Universität der Bundeswehr München, Germany; [2]COBRA institute, Eindhoven Univ. of Technology, Netherlands; [3]Nokia Siemens Networks GmbH & Co. KG, Germany.* We investigated the performance of a hybrid FEC scheme against nonlinearities, implementing a 100 Gbps-PDM-DQPSK system, with equally modulated neighboring channels. Experimental results show that the code input-output BER relationship remains unaffected.

ITu3B • Microphotonic Filters—Continued

ITu3B.7 • 15:15
Polarization-Independent Guided-Mode Resonance Filter with Crossed Integration of Waveguide Cavity Resonators, Kenji Kintaka[1], Tatsuya Majima[2], Koji Hatanaka[2], Junichi Inoue[2], Shogo Ura[2]; *[1]Natl Inst of Adv Industrial Sci & Tech, Japan; [2]Kyoto Institute of Technology, Japan.* A cavity-resonator-integrated guided-mode resonance filter (CRIGF) can provide high-efficiency narrowband reflection with a small aperture. Polarization-independent reflection was experimentally demonstrated by crossed integration of two CRIGFs with 10 μm aperture for the first time.

ITu3C • Tunable Delay—Continued

15:30–16:00 Coffee Break, *Centennial Room*

16:00–18:00
SpTu4A • Subsystems
Kim Roberts; Ciena Corporation, Canada, Presider

SpTu4A.1 • 16:00 Invited
Dynamic optical arbitrary waveform generation and measurement for telecommunications, Nicolas K. Fontaine[1], David J. Geisler[2], Ryan P. Scott[2], S.J. Ben Yoo[2]; *[1]Alcatel-Lucent Bell Labs, USA; [2]Dept. of Electrical and Computer Engineering, Univ. of California, Davis, USA.* Spectral slice optical arbitrary waveform generation and measurement techniques synthesize and characterize wideband waveforms in many spectral slices. We show 160-GHz bandwidth measurements using 4 slices and 60-GHz bandwidth waveform generation in 6 slices.

SpTu4A.2 • 16:30
Spurious-Free Dynamic Range of a High-Speed Photonic Time-Stretch A/D-Converter System, Caroline Gee[1], George Sefler[1], Peter DeVore[1], George Valley[1]; *[1]The Aerospace Corporation, USA.* We measure spurious-free dynamic range (SFDR) for a 10GHz photonic time-stretch A/D-Converter (TS-ADC) system. Second-order spurs limit the SFDR to 92dB-Hz^(1/2) near 5GHz. Simulations that include modulator arm bias mismatch and equalization agree with experiments.

SpTu4A.3 • 16:45
Single-shot and real-time self-referenced phase characterization of GHz-rate QPSK signals, Hamed Pishvai Bazargani[1], Jose Azana[1], Claire Callender[2], Antonio Malacarne[1], Jean-Baptiste Quélène[1], Patrick Dumais[2]; *[1]INRS, Canada; [2]Communications Research Center (CRC, Canada.* Phase Reconstruction using Optical Ultrafast Differentiation (PROUD) is implemented in an integrated-waveguide format, demonstrating self-referenced phase characterization of GHz-rate Quadratic Phase-Shift Keying (QPSK) signals in a single-shot and in real-time.

16:00–18:00
ITu4B • Integration of Silicon Photonics with Other Technologies
Christopher Doerr; Alcatel-Lucent, USA, Presider

ITu4B.1 • 16:00 Invited
Hybrid Si/III-V Devices for Optical Interconnects, John E. Bowers[1], Martijn J. Heck[1], Yongbo Tang[1], Siddharth Jain[1]; *[1]Univ. of California Santa Barbara, USA.* A hybrid silicon integrated broadband (60 nm) DFB array and high-speed modulator (50 Gbps) are presented, showing the potential of this technology for future transmitters in optical interconnects.

ITu4B.2 • 16:30 Invited
Silicon-silica monolithic photonic integration for telecommunications applications, Tai Tsuchizawa[1], Hidetaka Nishi[1], Rai Kou[1], Hiroshi Fukuda[1], Hiroyuki Shinojima[1], Yasuhiko Ishikawa[2], Kazumi Wada[2], Koji Yamada[1]; *[1]NTT Corporation, Japan; [2]Univ. of Tokyo, Japan.* Applying silicon photonics to telecommunications, which requires low loss and polarization independence, we have developed a photonic platform monolithically integrating dynamic devices made with Si wire waveguides and passive devices made with high-delta silica waveguides.

16:00–18:00
ITu4C • Metamaterials, Sensors, and Optical Properties of Nanoparticles
Anatoly Zayats; Univ of London King's College London, UK, Presider

ITu4C.1 • 16:00 Invited
The Road Ahead for Metamaterials: Improved material Building Blocks, Alexandra Boltasseva[1,2]; *[1]Purdue Univ., USA; [2]Technical Univ. of Denmark, Denmark.* New plasmonic materials such as transparent conducting oxides and transition-metal nitrides could replace conventional silver and gold in optical metamaterials and offer many advantages including low loss, compatibility with standard semiconductor nanofabrication processes, and tunability.

ITu4C.2 • 16:30
200ps compact tunable true-time delay line for microwave photonic applications, Sylvain Combrié[1], Pierre Colman[1,2], Gaëlle Lehoucq[1], Alfredo De Rossi[1]; *[1]Thales Research and Technology, France; [2]Danmarks Tekniske Universitet, Denmark.* Using the large group indices (vg < c/50) available in Photonic Crystal waveguides, a 200ps tunable true-time delay line is demonstrated over a 20GHz bandwidth. The total footprint of the device is about 1.5mm x 15μm.

ITu4C.3 • 16:45
Sensitive Detection of Organic Compounds by Positional Localization on Asymmetric Split Ring Resonator Arrays, Richard M. De La Rue[1,2]; *[1]Universiti Malaya, Malaysia; [2]School of Engineering, Univ. of Glasgow, UK.* Asymmetric Split-Ring Resonators (A-SRRs) exhibit steep reflection resonances and trapped-modes. By localizing polymethyl-methacrylate (PMMA) films at specific positions on A-SRR nanoantenna arrays, it is possible to obtain sensitive detection and enhancement of molecular resonance features.

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NTu3D • Nonlinearities in Novel Propagation Environments—Continued

NTu3D.7 • 15:15
Sub-Wavelength Nonlinear Accelerating Beams, Ido Kaminer[1], Mordechai Segev[1]; *[1]Technion Israel Institute of Technology, Israel.* We show that optical nonlinearities allow sub-wavelength beams to propagate in circular trajectories without being attenuated in spite of their partially evanescent spectrum. Such beams are exact solutions to Maxwell's equations with Kerr or saturable nonlinearity

BTu3E • Sensor Symposium I—Continued

STu3F • Mid IR—Continued

STu3F.7 • 15:15
Ultra low loss fluoride glass fibers for supercontinuum generation and fiber lasers, Gwenael Maze[1], Marcel Poulain[1]; *[1]Le Verre Fluore, France.* Low optical losses at pump and emission wavelengths are required for supercontinuum generation and high power fiber lasers. Metal fluoride of high purity are needed for that purpose.

15:30–16:00 Coffee Break, *Centennial Room*

16:00–18:00
NTu4D • Spatial Effects and Periodic Structures
Karsten Rottwitt, Danmarks Tekniske Universitet, Denmark, Presider

NTu4D.1 • 16:00 Invited
Parametric Cavity Polariton Solitons, Falk Lederer[1], Oleg A. Egorov[1]; *[1]Univ. of Jena, Germany.* We review stable resting 1D bright cavity polariton solitons in semiconductor microcavities. These solitons exist due to phase-matched parametric mixing in cases where the product of dispersion and nonlinearity has the 'wrong' sign.

NTu4D.2 • 16:30
Observation of spontaneous parametric down-conversion in quadratic nonlinear waveguide arrays, Alexander S. Solntsev[1], Frank Setzpfandt[2], Falk Eilenberger[2], Che W. Wu[1], Dragomir Neshev[1], Andrey A. Sukhorukov[1], Thomas Pertsch[2], Yuri S. Kivshar[1]; *[1]Nonlinear Physics Centre, Australian National Univ., Australia; [2]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universitat Jena, Germany.* We characterize experimentally the process of bi-photons generation through spontaneous parametric down-conversion in LiNbO3 waveguide arrays. We demonstrate the formation of unique spatial-spectral distribution of photons and its dependence on phasematching conditions.

NTu4D.3 • 16:45
Observation of Discrete Solitons and Truncated Bloch-Wave Solitons in Time, Christoph Bersch[1,2], Georgy Onishchukov[1], Ulf Peschel[2]; *[1]Max-Planck Institute for the Science of Light, Germany; [2]Institute of Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany.* We experimentally observe the formation of discrete temporal solitons, truncated Bloch-wave solitons and arbitrary soliton clusters in time-periodic potentials. In the recirculating fiber-loop setup, the complete nonlinear evolution is monitored with an all-optical oscilloscope.

16:00–17:30
BTu4E • Sensor Symposium II
Morten Ibsen; Univ. of Southampton, UK, Presider

BTu4E.1 • 16:00 Invited
Advanced Optical FBG Sensor Systems and Examples of Their Application in Energy Facility Monitoring, Reinhardt Willsch[1], Wolfgang Ecke[1], Manfred W. Rothhardt[1], Hartmut Bartelt[1]; *[1]Institute of Photonic Technology (IPHT), Germany.* Design and realization of fiber Bragg grating sensor systems are described for implementation of structural health monitoring in energy plants. Application examples in conventional, renewable, and nuclear energies demonstrate their potential in advanced energetics.

BTu4E.2 • 16:30 Invited
Fiber Bragg Gratings in Air-Hole Microstructured Fibers for High-Temperature Pressure Sensing, Rongzhang Chen[1], Tong Chen[1], Qingqing Wang[1], Charles Jewart[1], Botao Zhang[1], Kevin Cook[2], John Canning[2], Dan Grobnic[3], Stephen J. Mihailov[3], Kevin P. Chen[1]; *[1]Electrical and Computer Engineering, Univ. of Pittsburgh, USA; [2]Interdisciplinary Photonics Labortories, School of Chemistry, Univ. of Sydney, Australia; [3]Communication Research Center Canada, Canada.* We report two types of high temperature fiber Bragg gratings fabricated in air-hole microstructured fibers using femtosecond laser direct writing and thermal regeneration. The gratings are tested for pressure sensing at temperature up to 800°C

16:00–18:00
STu4F • Fiber Lasers I
Scott Christensen; Lockheed Martin Coherent Technologies, USA, Presider

STu4F.1 • 16:00 Invited
Progress on Tm-doped Fiber Lasers, Lawrence Shah[1], Andrew Sims[1], Pankaj Kadwani[1], Joshua D. Bradford[1], Christina C. Willis[1], Martin Richardson[1]; *[1]Univ. of Central Florida, CREOL, USA.* We will present recent efforts in the Laser Plasma Laboratory to develop 100 W polarized, narrow linewidth, quasi diffraction-limited CW Tm:fiber "light engines" for spectral beam combining and propagation experiments at 2030-2050 nm.

STu4F.2 • 16:30
High-energy and high-peak-power nanosecond pulse generation based on an all-fiber MOPA scheme, Wang Jianjun[1]; *[1]Research Center of Laser Fusion, CAEP, China.* A high energy and high peak power nanosecond pulsed source based on all fiber configuration is presented. 36mJ/10ns and 3.6MW/10ns output was obtained.

STu4F.3 • 16:45
Theoretical and Experimental Results Comparing the Modal Instability Threshold in Photonic Crystal Fibers with and without Gain Tailoring, Clint Zeringue[1], Craig Robin[2], Iyad Dajani[2]; *[1]ZMod-Dynamic LLC, USA; [2]High Power Solid State Lasers Branch, Air Force Research Laboratory, USA.* Approximately 1kW of continuous-wave output power is obtained, with (M2) of <1.3 in fiber with preferential gain for the (LP01) mode. Experimental results are compared to a recently developed model based on coupled-mode theory.

Platte	Colorado II	Colorado III
Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Tuesday, 19 June

SpTu4A • Subsystems—Continued

SpTu4A.4 • 17:00 Invited

500Gb/s PIC Based Coherent Optical Modem, Jefferey Rahn[1], Saurabh Kumar[1], Matthew Mitchell[1], Roman Malendevich[1], Han Sun[2], Kuang-Tsan Wu[2], Pierre Mertz[1], Kevin Croussore[1], Gilad Goldfarb[1], Hong Wang[1], Masaki Kato[1], Vikrant Lal[1], Peter Evans[1], Damien Lambert[1], Huan-Shang Tsai[1], Parmijit Samra[1], Brian Taylor[1], Alan Nilsson[1], Atul Mathur[1], Xiangjun Zhao[1], Song Yu[1], Steve Grubb[1], Radhakrishnan Nagarajan[1], Fred Kish[1], David Welch[1]; [1]*Infinera Corporation, USA;* [2]*Infinera Canada, Canada.* We present a 500 Gb/s, PM-QPSK Photonic Integrated Circuit (PIC) based MODEM, software configurable into 250 Gb/s TCM mode, as a flexible optical network building block, operating over a 6000 km link with flex ROADMs.

SpTu4A.5 • 17:30

Impact of DSP on the design of InP-based transceivers for highly-compact cost-effective 100Gbit/s PM-QPSK, Donald S. Govan[1], Wladek Forysiak[1], Chris F. Clarke[1]; [1]*Oclaro Technology Ltd, UK.* We consider the design of InP-based modulators and receivers for applications in highly compact modular 100G PM-QPSK transceivers. Numerical simulations demonstrate that coherent detection followed by DSP enables reduction in electrical bandwidth requirements.

SpTu4A.6 • 17:45

Analysis of Parallel Optical Sampling Rate and ADC Requirements in Digital Coherent Receivers, Abel Lorences Riesgo[1], Michael Galili[1], Christophe Peucheret[1]; [1]*Photonics Engineering, Technical Univ. of Denmark, Denmark.* We comprehensively assess analog-to-digital converter requirements in coherent digital receiver schemes with parallel optical sampling. We determine the electronic requirements in accordance with the properties of the free running local oscillator.

ITu4B • Integration of Silicon Photonics with Other Technologies—Continued

ITu4B.3 • 17:00

Long Period Gratings based on silica PLCs for optical signal processing applications, Jia Jiang[1], Patrick Dumais[1], Christopher J. Ledderhof[1], Claire Callender[1]; [1]*Communications Research Centre Canada, Canada.* Planar waveguide long period gratings have been implemented by creating a permanent refractive index modulation on the lower cladding of a waveguide. Design and fabrication of silica and polymer LPG devices for applications in high-speed optical signal processing are presented.

ITu4B.4 • 17:15

Single Mode 3D Diffusive Photopolymer Optics for Optical Integrated Circuits, Chunfang Ye[1], Keith Kamysiak[1], Amy Sullivan[2], Robert Mcleod[1]; [1]*Univ. of Colorado at Boulder, USA;* [2]*Agnes Scott College, USA.* We demonstrate single mode three-dimensional optics fabricated via direct-write lithography in diffusive photopolymers, including uniform waveguides, symmetrical waveguide tapers, 900 sharp waveguide bends and waveguides through thin hybrid subcomponents.

ITu4B.5 • 17:30 Invited

High Density Hybridly Integrated Light Source with a Laser Diode Array on a Silicon Optical Waveguide Platform, Takanori Shimizu[1,2], Nobuaki Hatori[1,2], Makoto Okano[1,3], Masashige Ishizaka[1,2], Yutaka Urino[1,2], Tsuyoshi Yamamoto[1,2], Mashiko Mori[1,3], Takahiro Nakamura[1,2], Yasuhiko Arakawa[1,4]; [1]*PECST, Japan;* [2]*PETRA, Japan;* [3]*AIST, Japan;* [4]*The Univ. of Tokyo, Japan.* A novel high-density hybridly integrated light source with a laser diode array on a silicon optical waveguide platform was developed. This light source is a practical candidate for use with photonic integrated circuits for interchip optical interconnection.

ITu4C • Metamaterials, Sensors, and Optical Properties of Nanoparticles—Continued

ITu4C.4 • 17:00

Optical Properties of Nanoscale Suspensions, Anna Kudryavtseva[1], Nickolay V. Tcherniega[1]; [1]*P.N. Lebedev Physical Institute, Russian Federation.* Stimulated Low-Frequency Raman Scattering with high conversion efficiency was registered in colloid suspension of diamond nanoparticles. Luminescence in blue range and directed X-ray radiation induced by laser pulses was observed in ZnS aqueous suspensions.

ITu4C.5 • 17:15

Laser Direct Microfabrication Using Light-Induced Nanoparticle Incandescence, Mathieu Hautefeuille[1], Victor Velazquez[1], Juan Hernández-Cordero[2], Reinher Pimentel[2], Lucia Cabriales[1], Enrique López-Moreno[1], Marcela Grether[1]; [1]*Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Mexico;* [2]*Instituto de Investigación en Materiales, Universidad Nacional Autonoma de Mexico, Mexico.* We report the application of nanoparticle incandescence induced by low-power, near infrared focused laser beams to microfabrication. Microstructures have been successfully etched and sintered in polymeric matrices in which microclusters of different nanomaterials were incorporated.

ITu4C.6 • 17:30

Laser Triggered Displacement of Embedded Carbon Microparticles in PDMS, Francisco Sánchez-Arévalo[1], Juan Hernández-Cordero[1], Reinher Pimentel-Domínguez[1]; [1]*Reología y mecánica de Materiales, Instituto de Investigaciones en Materiales, UNAM, Mexico.* We present experimental evidence of laser-triggered displacement of carbon microparticles embedded in PDMS. Changes in the PDMS surface due to thermal effects owing to optical absorption of the microparticles are evaluated using dynamic speckle analysis.

ITu4C.7 • 17:45

Nanoparticle self-assembly a new approach to fabricating optical interconnects, single photon sources and more, John Canning[1], Masood Naqshbandi[1], Brant Gibson[2], Melissa Nash[1], Hari Jeyaseelan[1], Maxwell Crossley[1]; [1]*Univ. of Sydney, Australia;* [2]*Physics, Univ. of Melbourne, Australia.* A novel approach to fabricating optical waveguides and self-assembled structures at room temperature opens the way for integrating complex materials onto existing platforms. We demonstrate the fabrication of 7cm optical microwires, and integrate nanodiamonds in these waveguides.

18:00–19:30 Joint Poster Sessions & Reception/ Exhibit, *Centennial Room & Terrace*

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NTu4D • Spatial Effects and Periodic Structures—Continued

NTu4D.4 • 17:00
Enhanced Čerenkov second-harmonic emission in nonlinear photonic structures, Ksawery K. Kalinowski[1], Philip Roedig[2], Yan Sheng[1], Mousa Ayoub[2], Jörg Imbrock[2], Cornelia Denz[2], Wieslaw Z. Krolikowski[1]; [1]*Laser Physics Centre, Research School of Physics and Engineering, Australian National Univ., Australia;* [2]*Institute of Applied Physics and Center for Nonlinear Science, Westfälische Wilhelms-Universität, Germany.* We demonstrated significant (over 2×102) enhancement of the Čerenkov second-harmonic generation in periodically poled nonlinear crystal. We show that this effect is caused by the simultaneous fulfillment of the Čerenkov and Raman-Nath emission conditions.

NTu4D.5 • 17:15
Nonlinear propagation below cut-off in line-defect waveguides, Stefania Malaguti[1], Gaetano Bellanca[1], Sylvain Combrié[2], Alfredo De Rossi[2], Stefano Trillo[1]; [1]*Universita degli Studi di Ferrara, Italy;* [2]*Thales Research and Technology, France.* We describe nonlinear propagation in a line-defect photonic crystal waveguide below transmission cut-off in terms of novel temporal gap-soliton solutions. All-optical control of the group-velocity over mm-length scales is envisaged.

NTu4D.6 • 17:30
Modulational Instability in Nonlinear PT-symmetric Photonic Lattices, Yaakov Lumer[1], Mikael C. Rechtsman[1], Mordechai Segev[1]; [1]*Physics, Technion, Israel.* We study nonlinear PT-symmetric lattices, and find a variety of new phenomena, among them nonlinearly-induced transition to stable PT-symmetry, instability suppression at high nonlinearities and modulation instability in unexpected regimes.

NTu4D.7 • 17:45
Observation of all-optical Berezinskii-Krosterlitz-Thouless crossover in a photonic lattice, Guohai Situ[1], Jason W. Fleischer[1]; [1]*Princeton Univ., USA.* We experimentally observe an all-optical Berezinskii-Kosterlitz-Thouless transition, in which vortices spontaneously appear due to nonlinear interactions. We show that the number of vortices and their correlations agree with predictions from mean-field theory.

BTu4E • Sensor Symposium II—Continued

BTu4E.3 • 17:00 Invited
Resonant Waveguide Grating Biosensors for Cell Biology and Drug Discovery, Ye Fang[1]; [1]*Corning Incorporated, USA.* Label-free optical biosensors have been long used for biomolecular interaction analysis. Here I review recent advances of resonant waveguide grating biosensor systems for whole cell sensing, and their applications in cell biology and drug discovery.

STu4F • Fiber Lasers I —Continued

STu4F.4 • 17:00
Short-wavelength fiber Raman laser pulse-pumped by multi-mode laser diode at 806 nm, Tianfu Yao[1], Johan Nilsson[1]; [1]*Univ. of Southampton, UK.* We demonstrate a fiber Raman laser emitting at 835 nm when pumped by bursts of 50 - 100 ns pulses from a multi-mode laser diode at 806 nm. The slope efficiency reaches 38%.

STu4F.5 • 17:15 Tutorial
Recent Developments in Fiber Lasers, Mode Stability Issues in LMA Fibers, Jens Limpert[1], Cesar Jauregui[1]; [1]*Friedrich-Schiller-Universität Jena, Germany.* The very high average powers currently extracted from Large Mode Area Fibers show that thermally-related effects will play a very prominent role in the future development of fiber laser systems.

18:00–19:30 Joint Poster Sessions & Reception/ Exhibit, *Centennial Room & Terrace*

Joint

18:00–19:30
JTu5A • Joint Poster Session II

JTu5A.1
General Memory Polynomial for Transmission Impairments Mitigation in Coherent Communication Systems, Nelson Costa[1,2], Daniel Fonseca[1,3], Adolfo Cartaxo[1], Tiago F. Alves[1]; [1]*Instituto de Telecomunicações, Portugal;* [2]*Nokia Siemens Networks Portugal, S.A., Portugal;* [3]*Nokia Siemens Networks LLC US, USA.* A general memory polynomial (GMP) for transmission impairments mitigation in optical coherent detection systems is proposed. An error vector magnitude improvement of 9 dB, resulting mainly from the regenerator characteristic of the GMP, is shown.

JTu5A.2
A Novel Restoration Algorithm for Business and Residential FTTx Broadband Access Networks, Navid Ghazisaidi[1]; [1]*Ericsson Inc., USA.* A novel restoration algorithm for FTTx broadband access networks based on the concept of utility optimization is introduced to maximize both business and residential end-users happiness by scoring different scenarios.

JTu5A.3
Extended WDM-PON Employing High Polarization Dependence R-SOAs and EDFA/Raman Amplification, Ulysses Duarte[1], Joao Rosolem[1], Murilo Romero[2]; [1]*Converged Networks, Research and Development Center in Telecommunications (CPqD), Brazil;* [2]*Electrical Engineering, Univ. of Sao Paulo (USP), Brazil.* An extended WDM-PON employing high polarization dependence R-SOAs and EDFA/Raman amplification at the CO is proposed in this work. We experimentally demonstrated error free operation over 70 km using directly modulated R-SOAs at 1.25 Gb/s.

JTu5A.4
Simplified Numerical Simulation of Bursty Packet Traffic Amplification by Erbium-Doped Fiber Amplifier, Telmo Pelicano[1,2], João Pinto[1,2], Paulo S. Andre[1,2]; [1]*Instituto de Telecomunicacoes, Portugal;* [2]*Physics Department, Aveiro Univ., Portugal.* We propose a simplified numerical model to study burst induced signal distortion in EDFAs. The obtained experimental and simulated results for the signal amplitude decay rate are comparable, with a simulation time of 4.7 µs/bit.

JTu5A.5
Experimental Demonstration of an Indoor Localization System with Single Channel Imaging Receiver, KE WANG[1,2], Ampalavanapillai Nirmalathas[1,2], Christina Lim[2], Efstratios Skafidas[1,2]; [1]*National ICT Australia - Victoria Research Laboratory, Australia;* [2]*Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia.* In this paper we experimentally demonstrate an optical wireless based indoor localization system with single channel imaging receiver. Compared with the system with non-imaging receiver, the localization accuracy can be improved from ~13.08cm to ~5.1cm.

JTu5A.6
Thermal radiation from patterned Pt microstructures, Gabriel Vasile[1,2], Mustafa Arikan[1], Snorri Ingvarsson[1]; [1]*Science Institute, Univ. of Iceland, Iceland;* [2]*National Institute of Research and Development for Cryogenics and Isotopic Technologies, Romania.* We investigate the thermal radiation in the infrared regime of micro-fabricated Platinum (Pt) heaters, i.e. resistively heated wires, with Gold (Au) nanoparticles deposited on the surface and photonic crystals (holes, pillars and gratings).

JTu5A.7
A reinterpretation of the metamaterial perfect absorber, Yong Zeng[1]; [1]*Los Alamos National Laboratory, USA.* We analytically prove that the appearance of two almost out-of-phase currents inside a metamaterial is necessary for a perfect absorber. We further show that evanescent waves consume the electromagnetic energy significantly.

JTu5A.8
All-Optical Delta Sigma Modulator Employing Semiconductor Ring Lasers, Azeemuddin Syed[1,2], Mohammad R. Sayeh[2]; [1]*Center for VLSI and Embedded Systems Technology, International Institute of Info Tech, India;* [2]*Electrical and Computer Engineering, Southern Illinois Univ. Carbondale, USA.* A semiconductor ring laser is designed so as to work as an inverted integrator coupling three of such integrators an all-optical Delta Sigma Modulator is designed. The phenomenon of injection locking and switching is used.

JTu5A.9
Design of Doubly Coupled Resonator Optical Waveguides, Shuntaro Makino[1], Yuki Kawaguchi[1], Kunimasa Saitoh[1], Masanori Koshiba[1]; [1]*Graduate School of Information Science and Technology, Hokkaido Univ., Japan.* We propose doubly-coupled resonator optical waveguides (D-CROWs). D-CROWs are composed of cascaded ring resonators based on 1-D photonic crystals. We show that D-CROWs realize small group velocity compared with conventional 1-D photonic crystals based CROWs.

JTu5A.10
Bending devices based on Long-Range Surface Plasmon Polariton Waveguides embedded in Fluorinated Polymer, Jia Jiang[1], Sarkis Jacob[1], Claire Callender[1]; [1]*Communications Research Centre Canada, Canada.* This work presents low-loss bending waveguides based on long-range surface plasmon polaritons (LRSPP) excited by end-fire coupling. The waveguides were fabricated by embedding thin film stripes of gold in a low optical absorption perfluorocyclobutane (PFCB) polymer.

JTu5A.11
Spoof plasmon polaritons formed by 1D strip grating, ELAMINE Hatem[1,2], Guizal Brahim[3], Oueslati Meherzi[1], Gharbi Tijani[2]; [1]*Raman Spectroscopy, Tunisia;* [2]*Femto-ST, UMR CNRS No. 6174, Route de Gray, France;* [3]*Charles Coulomb Laboratory, UMR 5221 CNRS-UM2 (L2C), France.* We demonstrate using the parametric formulation of combined boundary condition method (CBCM) with the adaptive spatial resolution (ASR) that 1D metallic strip grating infinitely thin and perfectly conducting create spoof plasmon polaritons.

JTu5A.12
Nano-selective area growth of InGaAs/InP using CBr4 in- situ etching, Nadezda Kuznetsova[1], Elizaveta Semenova[1], Shima Kadkhodazadeh[2], Martin Schubert[3], Kresten Yvind[1]; [1]*Photonics Engineering, DTU, Denmark;* [2]*Center for Electron Nanoscopy, DTU, Denmark;* [3]*Modern Optics and Photonics, The Univ. of Konstanz, Germany.* We are investigating the conditions for nano-patterned selective area epitaxial growth using e-beam lithography on HSQ resist and in-situ etching in the MOVPE reactor.

JTu5A.13
Modeling of a nano-metallic surface plasmonic lens for wider optical window operation, Ghanshyam Singh[1], Abhishek Goyal[1], Vijay Janyani[1]; [1]*Malaviya National Institute of Tech., India.* A simplified implementation of the Nano-metallic lens with equidistant slits but bearing different widths is evaluated. The design tolerance and variation in the focal point position in accordance to alteration in the properties of the lens are explored in brief.

JTu5A.14
Design and Development of a New Polymer Microstructured Fiber for Application in FTTH Networks, Katrin Welikow[1], Pawel Gdula[1,2], Pawel Szczepanski[1,2], Ryszard Buczynski[3,4], Ryszard Piramidowicz[1]; [1]*Institute of Microelectronics and Optoelectronics, Warsaw Univ. of Technology, Poland;* [2]*National Institute of Telecommunication, Poland;* [3]*Institute of Electronic Materials Technology, Poland;* [4]*Faculty of Physics, Univ. of Warsaw, Poland.* This paper is focused on designing and modeling of a new type of microstructured plastic optical fiber for application in Fiber-To-The-Home systems, with improved modal dispersion and bending losses.

JTu5A.15
Optical Dispersion Measurements in Chalcogenide Glass Fibers and Tapers, Soroush Shabahang[1], Guangming Tao[1], Ayman F. Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA.* Dispersion of chalcogenide (ChG) bulk samples, multiple-ChG fibers and tapers is measured. We demonstrate normal and anomalous waveguide dispersion in the tapers and support the results with finite-element simulations.

JTu5A.16
Cladding Glass Development for Semiconductor Core Optical Fibers, Stephanie Morris[1], Thomas Hawkins[1], Paul Foy[1], John Ballato[1], Steve Martin[2], Robert Rice[3]; [1]*The Center for Optical Materials Science and Engineering Technologies (COMSET) and the School of Materials Science and Engineering, Clemson Univ., USA;* [2]*Department of Materials Science & Engineering, Iowa State Univ. of Science and Technology, USA;* [3]*Dreamcatchers Consulting, USA.* Cladding glass compositions have been developed to minimize thermal expansion mismatch in the glass clad crystalline core fibers. These tailored compositions have also shown to reduce oxygen content in the fibers.

JTu5A.17
Engineerable waveguide arrays in a 7-core fiber via tapering, Darren D. Hudson[1], Thomas Büttner[1], Eric Mägi[1], Alvaro Casas Bedoya[1], Thierry Taunay[2], Benjamin J. Eggleton[1]; [1]*School of Physics, Univ. of Sydney, Australia;* [2]*OFS Laboratories, USA.* We present a method to create coupled waveguide arrays via tapering 7-core germanosilicate fiber. Using an ultrashort pulse laser system the device is shown to exhibit nonlinear waveguide array physics, including nonlinear optical pulse chopping.

JTu5A.18
Quantum Frequency Conversion by Four-wave Mixing Using Bragg Scattering, Lasse Mejling[1], Karsten K. Rottwitt[1], Colin J. McKinstrie[2], Michael G. Raymer[3]; [1]*Department of photonics engineering, Technical Univ. of Denmark, Denmark;* [2]*Bell Laboratories, Alcatel-Lucent, USA;* [3]*Department of physics, Univ. of Oregon, USA.* Two theoretical models for frequency conversion (FC) using nondegenerate four-wave mixing are compared, and their range of validity are discussed. Quantum-state-preserving FC allows for arbitrary reshaping of states for an appropriate pump selection.

JTu5A.19
Fiber Raman Depolarizer, Sergey Sergeyev[1]; [1]*Aston Univ., UK.* We report on a theoretical study of activated de-correlation of signal and pump states of polarization based on an advanced vector model of a fiber Raman amplifier accounting for random birefringence and periodic fiber spinning.

JTu5A.20
Thin Plasmonic Grating for All-Optical Switching Mark Bloemer[1], Giuseppe D'Aguanno[2], Nadia Mattiucci[2]; [1]*AMRDEC, USA;* [2]*AEgis Tech., USA.* We utilize narrow Fano-like resonances in gratings composed of metal films that support long range surface plasmons to provide all-optical switching with low input powers. Switching is illustrated for a grating embedded in chalcogenide glass.

JTu5A.21
Saturable Absorption of Cr:YAG Crystal in Visible Region for Passively Q-switched Pr:YLF Laser, Fumihiko Kannari[1], Ryo Abe[1], Junichiro Kojou[1]; [1]*Keio Univ., Japan.* We experimentally prove that a Cr:YAG crystal exhibits saturable absorption in 639, 607, and 521 nm. We demonstrate passively Q-switched Pr:YLF lasers at these visible wavelengths using a Cr:YAG crystal for the first time.

JTu5A.22
Higher-Order Moment Characterisation of Rogue Wave Statistics in Supercontinuum Generation, Simon Toft Sørensen[1], Ole Bang[1], Benjamin Wetzel[2], John M. Dudley[2]; [1]*DTU Fotonik, Department of Photoincs Engineering, Technical Univ. of Denmark, Denmark;* [2]*Institut FEMTO-ST, Université de Franche-Comté, France.* The noise characteristics of supercontinuum generation are characterized using higher-order statistical moments. Measures of skew and kurtosis, and the coefficient of variation allow quantitative identification of spectral regions dominated by rogue wave like behaviour.

JTu5A • Joint Poster Session II—Continued

JTu5A.23
THIRD-HARMONIC GENERATION IN OPTICAL MICROFIBERS, Aurélien Coillet[1,2], Philippe Grelu[1]; *[1]ICB UMR 6303 Université de Bourgogne, France; [2]FEMTO-ST UMR 6174 Université de Franche-Comté, France.* We explain the relatively easy, wideband, THG conversion that we observe experimentally in silica glass microfibers by the tapering geometry. As a challenging perspective, we compare THG effective efficiencies in silica and tellurite glasses.

JTu5A.24
Nonlinear Surface Plasmon Polaritons, Miriam Deutsch[1]; *[1]Univ. of Oregon, USA.* We present analytical analyses of the nonlinear interaction of SPP fields at a silver-vacuum interface, in the presence of a third order optical susceptibility in the metal. Both sum- and difference-frequency generation interactions are addressed.

JTu5A.25
Coherent Superposition of ω and 2ω Spectral Components in Supercontinuum Pulse Generated in Ar-Gas-Filled Hollow Core Fiber, Kenta Yoshikiyo[1], Shohei Kondo[1], Yu Oishi[1], Fumihiko Kannari[1]; *[1]Electronics and Electrical Engineering, Keio Univ., Japan.* 800 and 400 nm broadband components generated by phase modulation based on nonlinear copropagation of fundamental and second-harmonic femtosecond pulses in an Ar-gas-filled hollow core fiber were separately compressed and coherently superposed to generate broadband shaped laser pulses.

JTu5A.26
Multiple transmission filters for enhanced energy in mode-locked fiber lasers, J. N. Kutz[1], Feng Li[2], Alex P. K. A. Wai[2], Edwin Ding[3]; *[1]Univ. of Washington, USA; [2]Electronic and Information Engineering, The Hong Kong Polytechnic Univ., China; [3]Mathematics and Physics, Azusa Pacific, USA.* We demonstrate that incorporating multiple sets of waveplates and polarizers in a ring cavity laser allows for the suppression of multi-pulsing and a significant enhancement (an order of magnitude) of the mode-locked pulse energy.

JTu5A.27
Interaction of dark vector polariton solitons, Albrecht Werner[1,2], Oleg A. Egorov[1,2], Falk Lederer[1,2]; *[1]Institute of Condensed Matter Theory and Solid State Optics, Friedrich Schiller Univ., Germany; [2]Abbe Center of Photonics, Friedrich Schiller Univ., Germany.* We study the interaction dynamics and stability properties of dark vector polariton solitons in a semiconductor microcavity.We observe both the spontaneous symmetry breaking of polarization and the fusion of two vector solitons.

JTu5A.28
PM Raman fiber laser at 1679 nm, Ask S. Svane[1], Karsten K. Rottwitt[1]; *[1]DTU Fotonik, Technical Univ. of Denmark, Denmark.* We demonstrate a PM Raman fiber laser emitting light at 1679 nm. The laser has an slope efficiency of 67 % and an output power of more than 275 mW with a 27 pm linewidth.

JTu5A.29
Multi-solitons in a Dispersion Managed Fiber Laser using a Carbon Nanotube-Coated Taper Fiber, Amos Martinez[1], Mika Omura[2], Masato Takiguchi[3], Bo Xu[1], Takahiro Kuga[3], Takaaki Ishigure[2], Shinji Yamashita[1]; *[1]Electronic Engineering, The Univ. of Tokyo, Japan; [2]Faculty of Science and Technology, Keio Univ., Japan; [3]Institute of Physics, The Univ. of Tokyo, Japan.* Stable, phase-locked, sub 300fs soliton pairs and triplets are generated in a dispersion-managed mode-locked fiber laser using a taper fiber coated with a carbon nanotube (CNT)-polymer as a saturable absorber.

JTu5A.30
Formation of dissipative soliton during self-diffraction of waves, Svitlana Bugaychuk[1], Robert Conte[2,3]; *[1]Institute of Physics NAS Ukraine, Ukraine; [2]LRC MESO École normale supérieure de Cachan (CMLA), France; [3]Service de physique de l'état condensé (CNRS URA 2464), France.* We derive complex Ginzburg-Landau equations (CGLEs) for wave self-diffraction at four-wave mixing in nonlinear cavity. Either bright or dark dissipative solitons of the intensity spatial pattern are formed inside a cavity that is described by CGLEs.

JTu5A.31
Bifurcation to chaotic polarization mode hopping in vertical-cavity surface-emitting lasers, Martin Virte[1,2], Marc Sciamanna[1], Krassimir Panajotov[2,3]; *[1]OPTEL Research Group, Supelec, Laboratoire Matériaux Optiques, Photoniques et Systèmes (LMOPS) EA-4423, France; [2]Department of Applied Physics and Photonics (IR-TONA), Vrije Universiteit Brussels, Belgium; [3]Institute of Solid State Physics, Bulgaria.* We make an in-depth analysis of a bifurcation scenario that leads to chaotic hopping between two elliptically polarized modes in VCSELs. Our work brings new light on recent experiments using quantum dot VCSELs.

JTu5A.32
Rectangular Similariton solutions to the Nonlinear Schrodinger Equation, Neil Broderick[1], Claude Aguergaray[1], Vladimir Kruglov[1]; *[1]Physics, Univ. of Auckland, New Zealand.* In this paper we extend the class of self-similar solutions to the Nonlinear Schrodinger Equation to Rectangular pulses, show how they could be generated experimentally and discuss practical applications.

JTu5A.33
Withdrawn

JTu5A.34
Effect of the modulation parameters on the evolution of a spectrally phase modulated pulse in a tapered fiber for supercontinuum generation, Pedro L. Bertarini[1], Emiliano R. Martins[2], Sérgio C. Zilio[3], Ben-Hur V. Borges[1]; *[1]Escola de Engenharia de São Carlos, Universidade de São Paulo, Brazil; [2]School of Physics and Astronomy, Univ. of St Andrews, UK; [3]Instituto de Física de São Carlos, Universidade de São Paulo, Brazil.* In this paper we demonstrate how the supercontinuum (SC) generated by a spectrally phase modulated femtosecond pulse in a tapered fiber is influenced by the modulation parameters.

JTu5A.35
Threshold and Above Threshold Analysis of Two-Dimensional Square Lattice Index and Gain Coupled Photonic Crystal Laser with Transverse Magnetic Polarization, Marcin Koba[1,2], Pawel Szczepanski[2,3]; *[1]Univ. of Warsaw, Poland; [2]Warsaw Univ. of Technology, Poland; [3]National Institute of Telecommunications, Poland.* In this work, a threshold and an above threshold analyses based on the coupled mode theory for square lattice photonic crystal band edge laser with gain and index modulation are presented.

JTu5A.36
Photon and phonon coupling by electrostrictive forces in photonic crystal fiber, Jean Charles Beugnot[1], Vincent Laude[1]; *[1]Institut FEMTO-ST, France.* We demonstrate that the acoustic phonons involved in stimulated Brillouin scattering (both forward and backward) in optical fibers can be completely described by using electrostrictive forces. Numerical calculations for photonic crystal fiber illustrate the model.

JTu5A.37
Tunable Wavelength Broadcasting in a PPLN with Multiple QPM Peaks, Meenu Ahlawat[1], Amirhossein Tehranchi[2], Krishnamoorthy Pandiyan[3], Myoungsik Cha[4], Raman Kashyap[1,2]; *[1]Department of Engineering Physics, Ecole Polytechnique de Montreal, Canada; [2]Department of Electrical Engineering, Ecole Polytechnique de Montreal, Canada; [3]School of Electrical and Electronic Engineering, SASTRA Univ., India; [4]Department of Physics, Pusan National Univ., Democratic People's Republic of Korea.* Tunable multiple-idler broadcasting of a signal to selective WDM channels is demonstrated utilizing temperature-assisted tuning of QPM pump wavelengths based on cascaded nonlinear mixing in bulk PPLN with an aperiodic domain in the center.

JTu5A.38
Pulse delaying using Raman-assisted parametric amplification in polarization-maintaining fibers, Nour NASSER[1], Gil FANJOUX[1], Eric Lantz[1], Thibaut Sylvestre[1]; *[1]department of Optics, FEMTO-ST, France.* We study both analytically and numerically pulse delaying and advancement through Raman-assisted optical parametric amplification in polarization-maintaining fibers and show that the Raman gain enhances the optical delay up to 35%.

JTu5A.39
Existence regime of stable fiber-optic three-soliton molecules, Philipp Rohrmann[1], Alexander Hause[1], Fedor Mitschke[1]; *[1]Universitat Rostock, Germany.* We investigate conditions for existence of stable compounds of three solitons in dispersion-managed fiber. With such compounds one might transmit 2 bits per timeslot in a solitonic system.

JTu5A.40
High-repetition-rate ultrashort pulse generation in nonlinear fibers with exponentially decreasing dispersion, Qian Li[1], K. Nakkeeran[2], Ping Kong A. Wai[1]; *[1]The Hong Kong Polytechnic Univ., Hong Kong; [2]Univ. of Aberdeen, UK.* A simple method for the generation of ultrashort pulse train with high-repetition-rate is proposed and demonstrated numerically.

JTu5A.41
Nonlinear propagation of incoherent waves in single-mode fibers: from wave turbulence theory to experiments, Stephane Randoux[1], Pierre Suret[1], Antonio Picozzi[2]; *[1]Universite de Lille 1, France; [2]Institut Carnot de Bourgogne, France.* We revisit the traditional treatment of the wave turbulence theory and we study theoretically, numerically and experimentally the nonlinear propagation of partially incoherent optical waves in single mode optical fibers.

JTu5A.42
Self-induced transparency quadratic solitons in noncentrosymmetric media doped with quantum dots, Sergey A. Ponomarenko[1]; *[1]Dalhousie Univ., Canada.* We discover and numerically explore self-induced transparency quadratic solitons (SIT-QS) in semiconductor waveguides doped with quantum dots. We discuss a hybrid nature of the SIT-QS and the material parameter range for their experimental realization.

JTu5A.43
Extreme value statistics in quasi-CW Raman fiber lasers, Dmitriy V. Churkin[1,3], Oleg Gorbunov[2,3], Sergey Smirnov[2,3]; *[1]Aston Univ., UK; [2]Novosibirsk State Univ., Russian Federation; [3]Institute of Automation and Electrometry SB RAS, Russian Federation.* It is found that rare extreme events are generated in a Raman fiber laser. The mechanism of the extreme events generation is a turbulent-like four-wave mixing of numerous longitudinal generation modes.

JTu5A.44
Withdrawn

JTu5A.45
Dissipative Optical Solitons In Dense Media Of Doped Waveguides, Alexey Prokhorov[1], Mikhail Y. Gubin[1], Andrey Y. Leksin[1], Maxim G. Gladush[2], Alexander P. Alodjants[1], Sergei M. Arakelian[1]; *[1]Department of Physics and Applied Mathematics, Stoletov's Vladimir State Univ., Russian Federation; [2]Department of Molecular Spectroscopy, Institute for Spectroscopy RAS, Russian Federation.* We consider the problem of formation of optical solitons for -scheme of Raman-type atom-field interaction in dense medium doped by silica waveguide taking into account dissipative and nonlinear (local) field effects in general.

JTu5A • Joint Poster Session II—Continued

JTu5A.46
Withdrawn

JTu5A.47
Q-Switched Fiber Laser Based on Dynamic Spectral Overlapping of a Fiber Bragg Grating and a Tunable Fiber Fabry-Perot Filter, Rodolfo Martinez[1], MONGA J. kaboko[1], Mikhail G. Shlyagin[2], Johan Meyer[1]; [1]*Electrical & Electronic Engineering Science, Univ. of Johannesburg, South Africa;* [2]*Optics, CICESE, Mexico.* An active Q-switched Erbium-doped fiber ring laser is presented. The Q-switching principle is based on dynamic spectral overlapping of two filters, namely a Fiber Bragg Grating based filter and a tunable Fabry - Perot filter.

JTu5A.48
Superposed Bragg grating made with femtosecond radiation for multiparameter sensing, Dan Grobnic[1], Stephen J. Mihailov[1], Robert B. Walker[1], Christopher W. Smelser[1]; [1]*Communications Research Centre, Canada.* We report the result of superposing IR ultrafast type II gratings made with different order phase masks in unloaded SMF-28 fiber. The process and the resulting spectra are described.

JTu5A.49
Highly Strain-Sensitive Long-Period Grating in Hi-Bi Fiber with a Reference Fiber Bragg Grating, Toru Mizunami[1], Toshihiro Mori[1], Tsubasa Fujiyoshi[1]; [1]*Electrical Engineering and Electronics, Kyushu Institute of Technology, Japan.* A fiber Bragg grating was fabricated in PANDA fiber with a long-period grating strain sensor for determination of polarization. A strain sensitivity of 3.6 pm/με was obtained. Strain/temperature discrimination was also discussed.

JTu5A.50
Fiber Bragg Grating Inscription With Ultraviolet Radiation and Two Beam Interference in Microstructured Optical Fiber, Martin Becker[1], Thomas Geernaert[2], Tigran Bagdasaryan[2], Kay Schuster[1], Pawel Mergo[3], Manfred W. Rothhardt[1], Hartmut Bartelt[1], Francis Berghmans[2], Hugo Thienpont[2]; [1]*Institute of Photonic Technology, Germany;* [2]*Brussels Photonics Team B-PHOT, Vrije Universiteit Brussel, Belgium;* [3]*Maria Curie-Sklodowska Univ., Poland.* Fiber Bragg grating (FBG) inscription in microstructured optical fibers (MOF) is accompanied (by) low intensity and contrast ratio of the interference. Nanosecond and femtosecond ultraviolet exposure reveal the feasibility of gratings pure silica MOFs.

JTu5A.51
Chemical sensor using Mach-Zehnder interferometer based on a pair of largely tilted fiber gratings, Xianfeng Chen[1,2], Kaiming Zhou[1], Adebayo Adedotun[1], Lin Zhang[1]; [1]*Aston Univ., UK;* [2]*School of Electronic Engineering, Bangor Univ., UK.* We propose an in-fiber Mach-Zehnder interferometer formed by a pair of largely tilted fiber gratings. The interference spectral characteristics have been investigated. The experimental results using this device as a chemical sensor have a sensitivity as high as 719nm/RIU.

JTu5A.52
Synthesis of Arbitrary Group Delay Responses with All-Pass Optical Cavities Structures, Miguel A. Preciado[1], Xuewen Shu[1], Kate Sugden[1], Miguel A. Muriel[2]; [1]*Photonics Research Group, Aston Univ., UK;* [2]*Photonics Technology, Universidad Politecnica de Madrid, UK.* We propose a systematic method for the synthesis of arbitrary group delay responses by using all-pass structures of coupled optical cavities. Optimum structure parameters design, in terms of filter order and accuracy, are obtained.

JTu5A.53
Fiber Bragg grating Fabry-Perot structures under loading and their applications in switchable multi-wavelength lasers, Xuewen Shu[1]; [1]*Aston Univ., UK.* Characteristics of fiber Bragg grating based Fabry-Perot (FBG-FP) structures under transversal loading are investigated. A novel switchable multi-wavelength fiber laser employing loaded FBG-FP is also demonstrated.

JTu5A.54
Fiber-optic end probe with two-dimensional metallic slit arrays for sensing in the infrared region, Kyuho Kim[1], Sookyoung Roh[1], Dawoon Choi[1], Byoungho Lee[1]; [1]*School of Electrical Engineering, Seoul National Univ., Republic of Korea.* We demonstrate a fiber-optic SPR based sensor with metallic nanostructures on the fiber end facet. Two-dimensional metallic slit arrays are designed to induce the plasmonic reflection in the infrared region. The proposed sensor shows a high sensitivity of 1000 nm/RIU.

JTu5A.55
Output Radiating Arrayed Waveguide Grating: Characterization of Phase Errors and UV Trimming, David Sinefeld[1], Noam Goldshtein[1], Roy Zektzer[1], Nahum Gorbatov[2], Moshe Tur[2], Dan M. Marom[1]; [1]*Applied Physics, Hebrew Univ. of Jerusalem, Israel;* [2]*Faculty of Engineering, Tel Aviv Univ., Israel.* We developed a phase error measurement technique for AWG that radiate to free-space, based on pair-wise far-field interference of adjacent waveguide pairs. We also performed initial phase trimming experiments on individual waveguides with a UVlaser.

JTu5A.56
Frequency dependence of the Brillouin spectrum of an aluminosilicate optical fiber on temperature and strain, Francesca H. Mountfort[1], Mohammad Belal[1], Jayanta K. Sahu[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* The spontaneous Brillouin spectrum of an aluminosilicate fiber shows two distinct peaks. Strain and temperature coefficients of 0.0392±0.0027MHz/με, 1.5±0.2MHz/°C for Peak 1 and 0.031±0.0025MHz/με, 1.1±0.1MHz/°C for Peak 2 is obtained for exploitation in temperature-strain distinction.

JTu5A.57
Generation and application of tunable supercontinuum, Zhao Lei[1]; [1]*Chinese Academy of Engineering Physics, China.* Supercontinuum with tunable wavelength range from the blue end of the visible to the near-infrared is obtained. Fluorescence microscopy by a commercial confocal microscope is achieved using the tunable supercontinuum as illumination light.

JTu5A.58
Similaritons in fiber Bragg gratings written in fiber amplifiers, Yuval P. Shapira[1], Moshe Horowitz[1]; [1]*Electrical Engineering, Technion - Israel Institute of Technology, Israel.* We show, by using numerical simulations, that self-similar pulses can be obtained at the output of a fiber Bragg grating written in a fiber amplifier.

NOTES

Platte	Colorado II
Joint Signal Processing in Photonics Communications/ Access Networks and In-house Communications	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

07:30–18:00 Registration, *Lower Lobby, Conference Level*

08:30–10:00
JW1A • Joint SPPCom and ANIC Plenary Session
Chao Lu; Hong Kong Polytechnic Univ., Hong Kong, and Ed Harstead, Alcatel-Lucent, USA, Presiders

JW1A.1 • 08:30 Plenary

Future optical access networks, Yun Chung[1]; *[1]Korea Advanced Inst of Science & Tech, Republic of Korea.* This paper discusses the most competitive technical solutions for future optical access networks capable of providing >10-Gb/s service to each subscriber.

JW1A.2 • 09:15 Plenary

Quo vadis, spatial multiplexing? Henning Buelow[1]; *[1]Alcatel-Lucent, Bell Labs, Germany.* Application areas and motivation of high bit-rate transport over fiber bundle, multi-core fiber, and multimode fiber are revisited. With a focus on mode multiplexing, recent research is reviewed and direction of future research is discussed.

08:30–10:00
IW1B • Plasmonics and Applications
Alexandra Boltasseva; Purdue Univ., USA, Presider

IW1B.1 • 08:30 Invited

Molding light propagation with phase discontinuities, Zeno Gaburro[2,1], N. Yu[1], M. A. Kats[1], F. Aieta[1,4], P. Genevet[1,3]; *[1]Harvard Univ., USA; [2]Dipartimento di Fisica, Univ. of Trento, Italy; [3]Institute for Quantum Studies and Department of Physics, Texas A&M Univ., USA; [4]Dipartimento di Fisica e Ingegneria dei Materiali e del Territorio, Università Politecnica delle Marche, Italy.* Conventional optical components rely on gradual phase shifts accumulated during light propagation to shape light beams. New degrees of freedom are attained by introducing abrupt phase changes over the scale of the wavelength.

IW1B.2 • 09:00

Design of Ultra-Small Mode-Evolution Type Polarization Rotator Based on Surface Plasmon Polariton, Masa-aki Komatsu[1], Kunimasa Saitoh[1], Masanori Koshiba[1]; *[1]Graduate School of Information Science and Technology, Hokkaido Univ., Japan.* We propose an ultra-small polarization rotator based on a surface plasmon polariton phenomenon. Numerical simulations show that a 5-μm-long polarization rotator with extinction ratio better than -15 dB on the entire C-band is achievable.

IW1B.3 • 09:15

Experimental Investigation of CMOS-Compatible Metal-Insulator-Silicon-Insulator-Metal Waveguides, Min-Suk Kwon[1], Jin-Soo Shin[2], Sang-Yung Shin[2]; *[1]Electrical and Computer Engineering, Ulsan National Institute of Science and Technology, Republic of Korea; [2]Electrical Engineering, Korea Advanced Institute of Science and Technology, Republic of Korea.* Metal-insulator-silicon-insulator-metal waveguides are experimentally investigated. Their fabrication process is explained, and their measured characteristics are discussed. Their measured propagation loss is 0.262 (0.219) dB/μm when the width of silicon is ~156 (~183) nm.

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

07:30–18:00 Registration, *Lower Lobby, Conference Level*

08:30–10:00
NW1C • Novel Nonlinear Effects
Neil Broderick; Univ. of Auckland, Australia, Presider

NW1C.1 • 08:30
Sagnac Interferometer for Background Reduction in Stimulated Raman Scattering Loss Spectroscopy, Sven Dobner[1], Michael Kues[1], Carsten Cleff[1], Carsten Fallnich[1], Petra Gross[1]; *[1]Institute for Applied Physics, Westfälische Wilhelms-Universität, Germany.* We use a Sagnac interferometer for an unprecedented background reduction of 17dB in stimulated Raman scattering (SRS) loss spectroscopy employing a 1MHz ytterbium fiber laser/amplifier system.

NW1C.2 • 08:45
Enhancement of a nanocavity lifetime through slow light propagation, Patricio Grinberg[1], Kamel Bencheikh[1], Maia Brunstein[1], Alejandro M. Yacomotti[1], Yannick Dumeige[2], Juan A. Levenson[1], Philippe Hamel[1]; *[1]Laboratoire de Photonique et de Nanostructures, Centre National Recherche Scientifique, France; [2]FOTON, Université Européenne de Bretagne - CNRS, France.* We show that the lifetime of a semiconductor photonic crystal nanocavity is enhanced thanks to two cooperative effects: slow light propagation base on coherent population oscillations effect and cavity nonlinear refractive index dispersion.

NW1C.3 • 09:00
Self-locked OPO in CMOS-compatible microring resonators, Alessia Pasquazi[1], Marco Peccianti[1,2], Lucia Caspani[1], Luca Razzari[1,3], Marcello Ferrera[1,4], David Duchesne[1,5], Matteo Clerici[1], Brent Little[6], Sai T. Chu[6,7], David J. Moss[8], Roberto Morandotti[1]; *[1]INRS-Energie Mat & Tele Site Varennes, Canada; [2]Institute for Complex Systems - CNR, Italy; [3]Italian Institute of Technology (IIT), Italy; [4]Univ. of St Andrews, UK; [5]Massachusetts Institute of Technology, USA; [6]Infinera Ltd, USA; [7]Department of Physics and Materials Science, Hong Kong; [8]CUDOS, School of Physics, Univ. of Sydney, Australia.* We report a novel geometry for OPOs in a CMOS-compatible microring resonator. It exploits non-critical lasing of the pump inherently positioned within the resonances of the microcavity, thus counteracting the effect of thermal fluctuations.

NW1C.4 • 09:15
A novel extraction algorithm for spectral phase interferometry, Alessia Pasquazi[1], Marco Peccianti[1,2], Jose Azana[1], David J. Moss[3], Roberto Morandotti[1]; *[1]INRS-Energie Mat & Tele Site Varennes, Canada; [2]Institute for Complex Systems - CNR, Italy; [3]CUDOS, School of Physics, Univ. of Sydney, Australia.* We demonstrate an innovative extraction algorithm for X-SPIDER that significantly extends the measurement time window of the method without requiring device design modifications.

08:30–10:00
BW1D • Fundamentals of Photosensitivity and Poling: Direct Laser Writing and Thermal Poling
Lionel Canioni; CPMOH-Universite Bordeaux 1, France, Presider

BW1D.1 • 08:30 Invited
Optical anisotropy of self-assembled nanostructure in glass, Yasuhiko Shimotsuma[1], Miki Nakabayasi[1], Kiyotaka Miura[1], Kazuyuki Hirao[1], Peter G. Kazansky[2]; *[1]Department of Material Chemistry, Kyoto Univ., Japan; [2]Optoelectronics Research Centre, Univ. of Southampton, UK.* Femtosecond laser direct writing of form birefringence originated from self-organized nanostructure in glass is reviewed. Its application to rewritable five-dimensional optical data storage is also demonstrated.

BW1D.2 • 09:00
Direct Laser-Writing in a silver-zinc doped phosphate glass: Spatial discrimination of aggregates - Formation mechanism, Yannick Petit[1,2], Arnaud Royon[1], Nicolas Marquestaut[1], Gautier Papon[1], Kevin Bourhis[2], Marc Dussauze[3], Oriane Mollet[4], Aurélien Drezet[4], Serge Huant[4], Vincent Rodriguez[3], Thierry Cardinal[2], Lionel Canioni[1]; *[1]ICMCB, Univ. Bordeaux / CNRS, France; [2]LOMA, Univ. Bordeaux / CNRS, France; [3]ISM, Univ. Bordeaux / CNRS, France; [4]Néel Institute, Univ. Joseph Fourier / CNRS, France.* We report on spatially and spectrally-resolved linear optical properties induced by Direct Laser Writing in a prepared silver-doped phosphate glass, opening interesting possibilities for elementary photonics bricks. The formation mechanism of optical structures is proposed.

BW1D.3 • 09:15
Thermally poled oxide glasses: correlation between polarization mechanisms and non linear optical properties, Vincent Rodriguez[1], Marc Dussauze[1], Tatiana Crémoux[1], Frédéric Adamietz[1], Evelyne Fargin[2], Thierry Cardinal[2]; *[1]ISM-Chemistry, Université Bordeaux 1, France; [2]ICMCB-CNRS, Université Bordeaux 1, France.* We have investigated structural rearrangements induced by poling on oxide glasses. Combined Raman/SHG micro-imaging technique has highlighted strong correlations between NLO properties and poling mechanisms.

08:30–10:00
SW1E • Fiber based Sensors
Michalis Zervas; Univ. of Southampton, UK, Presider

SW1E.1 • 08:30 Invited
Novel Super-Lattice Polarization-Maintaining Photonic Crystal Fibre for Pressure Sensing, Hwa Yaw Tam[1], Ming-Leung Vincent Tse[1], Lok-Hin Cho[2], Chao Lu[2]; *[1]Electrical Engineering, Hong Kong Polytechnic Univ., Hong Kong; [2]Electronics and Information Engineering, Hong Kong Polytechnic Univ., Hong Kong.* A novel super-lattice polarization-maintaining photonic crystal fiber designed for the realization of highly sensitive fiber-optic pressure sensor using the Sagnac loop interferometer method was fabricated. The fiber has a birefringence of 8.5x10-4

SW1E.2 • 09:00
Acrylate coated optical fibers for up to 200°C application temperatures, Valery Kozlov[1], Kevin Bennett[1]; *[1]Corning Incorporated, USA.* Optical fibers with specialty acrylate coatings (single and dual coat designs) were tested at temperatures up to 200°C in normal atmosphere to define fiber properties stability and maximum operating temperatures.

SW1E.3 • 09:15
A magnetic field sensor based on a ferrofluid infiltrated PMMA-microstructured optical fibre, Alessandro Candiani[3,1], Alexander Argyros[2], Richard Lwin[2], Sergio Leon-Saval[2], Stefano Selleri[3], Stavros Pissadakis[1]; *[1]IESL, FORTH, Greece; [2]Institute of Photonics and Optical Science, The Univ. of Sydney, Australia; [3]Department of Information Engineering, Univ. of Parma, Italy.* A magnetic field sensor based on a ferrofluid infiltrated PMMA-microstructured optical fibre is presented. The infiltrated fibre sensor is operating in transmission mode while measuring magnetic fields up to 1250Gauss.

Platte	Colorado II
Joint Signal Processing in Photonics Communications/ Access Networks and In-house Communications	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

JW1A • Joint SPPCom and ANIC Plenary Session—Continued

IW1B • Plasmonics and Applications—Continued

IW1B.4 • 09:30
Enhancement of thermal dissipation by encapsulation with MgF2 or SiO2 of Hybrid III-V/SOI nanolasers, Rama Raj[1], Alexandre Bazin[1], Fabrice Raineri[1]; [1]*LPN-CNRS, France.* We report on the improvement of the thermal dissipation of hybrid III-V/SOI nanolasers by encapsulating the structures with MgF2 or SiO2. Careful design was necessary to obtain theoretical quality factor above 106 . CW operation was then obtained.

IW1B.5 • 09:45
Angular Study of the Random Laser Emission, Crescencio Garcia-Segundo[1], Francisco Tenopala-Carmona[1], Natanael B. Cuando-Espitia[2], Juan Hernández-Cordero[2]; [1]*Instrumentación y Medición, Centro de Cciencias Aplicadas y Desarrollo Tecnológico, Universidad Naciuonal Autónoma de México, Mexico;* [2]*Reología, Instituto de Investigación en Materiales. Universidad Nacional Autónoma de Mexico, Mexico.* We present experimental results of a random laser in a cylindrical cell. With this configuration we manage to exhibit that the laser's lasing modes, the lasing threshold and the peak wavelength exhibit angular dependence.

10:00–10:30 Coffee Break, *Colorado Gallery and Grand Rivers Gallery*

NOTES

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NW1C • Novel Nonlinear Effects—Continued

NW1C.5 • 09:30
Longitudinal power distribution in a random DFB fiber laser, Dmitriy V. Churkin[1,2], Atalla El-Taher[1], Ilya Vatnik[2], Juan D. Ania-Castanon[3], Paul Harper[1], Eugeny Podivilov[2], Sergey Babin[2,4], Sergei K. Turitsyn[1]; [1]*Aston Univ., UK;* [2]*Institute of Automation and Electrometry SB RAS, Russian Federation;* [3]*Instituto de Optica "Daza de Valdés, Spain;* [4]*Novosibirsk State Univ., Russian Federation.* We have measured the longitudinal power distribution inside a random distributed feedback fiber laser. Both analytic solution and results of direct numerical modeling are in excellent agreement with experimental observations.

NW1C.6 • 09:45
Demonstration of Kerr Nonlinearity in Silicon Microcylindrical Resonators, Natasha Vukovic[1], Noel Healy[1], Priyanth Mehta[1], Anna C. Peacock[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We investigate the Kerr nonlinearity in a-Si:H based microcylindrical resonators. The large resonant wavelength shift observed for pulsed excitation is used to demonstrate ultrafast all-optical switching.

BW1D • Fundamentals of Photosensitivity and Poling: Direct Laser Writing and Thermal Poling—Continued

BW1D.4 • 09:30
Picosecond Laser Pulse Induced Phase Transformation in Sapphire, Jiyeon Choi[1], Thierry Cardinal[2], Dongsik Shin[1], Yongkwon Cho[1], Jeong Suh[1]; [1]*Dept. of Laser and electron beam application, Korea institute of machinery and materials, Republic of Korea;* [2]*ICMCB, Université Bordeaux, France.* Picosecond laser-induced structural change in z-cut sapphire wafer were investigated through Raman spectroscopy and transmission electron microscopy. The broadening at 417 cm-1 and the presence of a new Raman peak near 420 cm-1 were observed.

BW1D.5 • 09:45
Zeosil formation by femtosecond laser irradiation, John Canning[1], Matthieu Lancry[2], Kevin Cook[1], Betrand Poumellec[2]; [1]*Univ. of Sydney, Australia;* [2]*LPCES, Universite de Paris Sud, France.* We report the fabrication of zeosil by exploiting rapid local heating and quenching, under very high induced pressures, when silica is irradiated by femtosecond near IR laser.

SW1E • Fiber based Sensors—Continued

SW1E.4 • 09:30 Invited
Light That Spins Inside Fibers, Siddharth Ramachandran[1], Poul Kristensen[2]; [1]*ECE Department, Boston Univ., USA;* [2]*OFS-Fitel, Denmark.* Polarisation- and phase-vortices are emerging as light-beams of immense interest in several scientific and technological applications. We review recently developed techniques for generating them, as well as manipulating their nonlinear optical properties, with optical fibers.

10:00–10:30 Coffee Break, *Colorado Gallery and Grand Rivers Gallery*

NOTES

Arkansas

Access Networks and In-house Communications

Platte

Signal Processing in Photonics Communications

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
AW2A • PON Technology Trends

Ampalavanapilla Nimalathias, Univ. of Melbourne, Australia, Presider

AW2A.1 • 10:30 Invited

Options for TDM PON beyond 10G, Doutje van Veen[1], Dusan Suvakovic[1], Hungkei Chow[1], Vincent Houtsma[1], Ed Harstead[3], Peter J. Winzer[2], Peter Vetter[1]; *[1]Bell Labs, Alcatel-Lucent, USA; [2]Bell Labs, Alcatel-Lucent, USA; [3]Alcatel-Lucent, USA.* This paper proposes an architecture to increase the downstream transmission of TDM PON from 10-Gbps to 40-Gbps. Challenges like chromatic dispersion tolerance, optical power budget, cost, and coexistence with legacy PONs are discussed.

AW2A.2 • 11:00

Auto-Tuning PID controller based on Genetic Algorithms for the Bandwidth Allocation in LR-PONs, Tamara Jimenez[1], Noemí Merayo[1], Ramón J. Durán[1], Patricia Fernández[1], Ignacio de Miguel[1], Juan Carlos Aguado[1], Rubén M. Lorenzo[1], Evaristo J. Abril[1]; *[1]Dpt. of Signal Theory, Communications and Telematic Engineering, Univ. of Valladolid, Spain.* A new bandwidth allocation algorithm for LR-EPONs based on a PID controller tuned with Genetic Algorithms is proposed to efficiently fulfill the subscribers' bandwidth requirements.

AW2A.3 • 11:15

OSNR Monitoring Technique Using Bragg Gratings Imprinted in High Birefringent Fibers, Ana Sousa[1,2], Paulo S. Andre[1,2]; *[1]Instituto de Telecomunicacoes, Portugal; [2]Physics, Aveiro Univ., Portugal.* We propose a technique to monitor the optical signal to noise ratio, based on the use of high birefringent fibre Bragg gratings. This technique is effective with signals with OSNR up to 20 dB.

AW2A.4 • 11:30 Invited

Diverging applications for PON technologies, and future technology trends, Ed Harstead[1]; *[1]Alcatel-Lucent, USA.* Until recently, the history of PON has been about FTTH: evolving to higher speeds while reducing costs to satisfy the requirements for residential access. That has begun to change. In this manuscript, the divergence of the PON application space and what it means for PON technology evolution will be surveyed.

10:30–12:30
SpW2B • Coherent System Implementation

Alan Lau; Hong Kong Polytechnic Univ., Hong Kong, Presider

SpW2B.1 • 10:30 Invited

Digital sub-banding - a signal processing architecture radically improving OFDM coherent optical receivers, Moshe Nazarathy[1], Alex Tolmachev[1]; *[1]Technion Israel Institute of Technology, Israel.* We review a digital sub-banding ASIC/FPGA DSP architecture for optical OFDM receivers achieving record low complexity and high performance by digitally demultiplexing the received signal into multiple frequency-domain sub-bands to be processed in parallel.

SpW2B.2 • 11:00

A Novel Phase Modulation Detection Technique For Coherent Self-Heterodyne Optical Receiver, Tam Huynh[1], Lim Nguyen[2], Liam P. Barry[1]; *[1]Rince Institute, School of Electronic Engineering, Dublin City Univ., Ireland; [2]Department of Computer and Electronics Engineering, Univ. of Nebraska-Lincoln, USA.* We propose a novel self-heterodyne coherent receiver structure based on phase modulation detection that potentially simplifies the front-end of a coherent optical receiver. The scheme has been demonstrated via simulations and experimentally for 10 Gb/s DQPSK.

SpW2B.3 • 11:15

Joint Equalization and Polarization-Time Coding Detection to Mitigate PMD and PDL Impairments Souha Ben Rayana[1,2], Ghaya Rekaya-Ben Othman[1], Yves Jaouën[1], Hichem Besbes[2]; *[1]COMELEC, Telecom ParisTech, France; [2]COSIM, Sup'Com, Tunisia.* We propose new criteria to joint linear time-domain equalization and ML detection supporting polarization-time codes and avoiding noise enhancement induced by PDL effect. An almost full-mitigation of PMD and PDL impairments is demonstrated.

SpW2B.4 • 11:30 Invited

Recent advances in signal processing for real-time implementation - 40Gb/s, 100Gb/s and beyond, Maxim Kuschnerov[1], O. Agazzi[2], V. Veljanovski[1], J. Slovak[1], M. Herrmann[1], C. Hofer[1], U. Bauer[1], T. Rieger[1], S. Camatel[1], P. Voois[2], N. Swenson[2], M. Bohn[1]; *[1]Nokia Siemens Networks, Germany; [2]ClariPhy Communications Inc., USA.* The progress of signal processing is presented for coherent optic product applications. Requirements are discussed for present and future products. Common pitfalls in system testing are described.

10:30–12:30
IW2C • Nanophotonics for Energy Conversion and Applications

Zeno Gaburro; Harvard Univ., USA, Presider

IW2C.1 • 10:30 Invited

Template-Stripped Plasmonic Films For Photovoltaics, David Norris[1]; *[1]ETH Zurich, Switzerland.* Template stripping is a simple and versatile process for creating smooth patterned films from various materials. We demonstrate improved plasmonic performance for template-stripped metals and discuss the use of such films for photovoltaic applications.

IW2C.2 • 11:00

Efficiency Improvement in Ultrathin Plasmonic Organic Bulk Heterojunction Solar Cells, Shiva Shahin[1], Palash Gangopadhyay[1], Robert A. Norwood[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA.* Au NP plasmonic effect enhances light absorption and thus the efficiency of organic BHJ solar cells. Using an optimized 20% surface coverage of Au NPs followed by only 50nm of P3HT: PCBM increases the efficiency by 30%.

IW2C.3 • 11:15

Temporal and Spatial Imaging of Energy Flow at the Nanoscale via Molecular Plasmonics, Gary Wiederrecht[1], Jasmina Hranisavljevic[1]; *[1]Center for Nanoscale Materials, Argonne National Laboratory, USA.* Efforts to spatially and temporally resolve photoinduced energy and charge transfer in hybrid plasmonic nanostructures are discussed. The ability to use these nanostructures to characterize photoinduced energy and charge transfer processes important for solar energy conversion is described.

IW2C.4 • 11:30

Highly Sensitive SOI Optical Sensors with Porous Si, Zhixuan Xia[2], Murtaza Askari[2], Stanley C. Davis[1], Kenneth H. Sandhage[1], Ali Adibi[2]; *[1]Georgia Institute of Technology, USA; [2]School of Electrical and Computer Engineering, Georgia Institute of Technology, USA.* We demonstrate microring resonators using a thin layer of porous silicon (pore size ~30 nm) as the cladding. With a loaded Q factor of 25,000, this new type of resonators is promising for bio/chemical sensing.

IW2C.5 • 11:45

Wide Stiffness Range Cavity Optomechanical Sensors for Atomic Force Microscopy, Yuxiang Liu[1,2], Houxun Miao[1,2], Vladimir Aksyuk[1], Kartik Srinivasan[1]; *[1]Center for Nanoscale Science & Technology, National Institute of Standards & Techno, USA; [2]Institute for Research in Electronics and Applied Physics, Univ. of Maryland, USA.* We present chip-based sensors that integrate nanomechanical cantilevers with near-field optical readout for atomic force microscopy. Cantilever stiffness is varied over four orders of magnitude while maintaining fm/Hz^(1/2) displacement sensitivity, indicating potential in wide-ranging applications.

Colorado I

Nonlinear Photonics

White River

Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides

Rio Grande/Gunnison

Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
NW2D • Theory of Novel Nonlinear Processes
Nail Akhmediev, Australian National Univ., Australia, Presider

NW2D.1 • 10:30 Invited
Polariton Solitons, Dmitry V. Skryabin[1]; *[1]Univ. of Bath, UK.* Abstract not available

NW2D.2 • 11:00
Classical Optical Simulation of Bi-Photon Generation in Quadratic Waveguide Arrays, Markus Gräfe[1], Alexander S. Solntsev[2], Robert Keil[1], Andreas Tünnermann[1], Stefan Nolte[1], Alexander Szameit[1], Andrey A. Sukhorukov[2], Yuri S. Kivshar[2]; *[1]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universitat Jena, Germany; [2]Australian National Univ., Australia.* We suggest and demonstrate experimentally that evolution of classical light can simulate bi-photon generation through spontaneous parametric downconversion and correlated quantum walks in waveguide arrays, including violation of Bell's inequality.

NW2D.3 • 11:15
Incoherent soliton turbulence, Bertrand Kibler[1], Claire Michel[2], Josselin Garnier[3], Antonio Picozzi[1]; *[1]Laboratoire Interdisciplinaire Carnot de Bourgogne, France; [2]Laboratoire de Physique de la Matière Condensée, France; [3]Ecole Normale Supérieure, France.* We report a phenomenon of incoherent soliton turbulence in nonlocal nonlinear media: It is thermodynamically advantageous for the system to generate an incoherent soliton in order to reach the most disordered equilibrium state (maximum entropy).

NW2D.4 • 11:30
Multi-shocks generation and collapsing instabilities induced by competing nonlinearities, Andrea Fratalocchi[1], Stefano Trillo[3], Matteo Crosta[1,2]; *[1]Physical Science and Engineering, KAUST Univ., Saudi Arabia; [2]Physics, Sapienza Univ., Italy; [3]Electrical Engineering, Ferrara Univ., Italy.* We investigate dispersive shock dynamics in materials with competing cubic-quintic nonlinearities. Whitham theory of modulation, hydrodynamic analysis and numerics demonstrate a rich physical scenario, ranging from multi-shock generation to collapse.

NW2D.5 • 11:45
Dispersive shock waves in quadratic media, Matteo Conforti[1], Fabio Baronio[1], Stefano Trillo[2]; *[1]Dipartimento di Ingegneria dell'Informazione, Università di Brescia, Italy; [2]Dipartimento di Ingegneria, Università di Ferrara, Italy.* We investigate dispersive shock wave formation driven by a pulse undergoing phase-mismatched second-harmonic generation in a quadratic medium.

10:30–12:15
BW2E • Applications of Gratings and Poled Glass: Novel Bragg Grating Filters
Stavros Pissadakis; FORTH-IESL Greece, Presider

BW2E.1 • 10:30
Silver Nanowire Coated Tilted Fibre Bragg Gratings, Alexander Bialiayeu[1], Jacques Albert[1], Anatoli Ianoul[2], Adam Bottomley[2], Daniel Prezgot[2]; *[1]Department of Electronics, Carleton Univ., Canada; [2]Department of Chemistry, Carleton Univ., Canada.* A 3.5-fold increase in sensitivity of Tilted Fibre Bragg grating based refractometers is reported. The sensor was coated with silver nanowires which resulted in strong polarization dependence of the grating resonances.

BW2E.2 • 10:45
All-fibre Lyot filters based on 45° tilted gratings UV-inscribed in PM fibre, Zhijun Yan[1], Kaiming Zhou[1], Adebayo Adedotun[1], Lin Zhang[1]; *[1]Photonics Research Group, Aston Univ., UK.* we report all-fibre Lyot filters formed by concatenating fibre gratings with structure tilted at 45° UV-inscribed in PM fibre. Such polarisation filters exhibit distinct transmission property for potential application in fibre lasers and sensors.

BW2E.3 • 11:00
Bragg grating notch filters in silicon-on-insulator waveguides, Yves Painchaud[1], Michel Poulin[1], Christine Latrasse[1], Nicolas Ayotte[1], Marie-Josée Picard[1], Michel Morin[1]; *[1]TeraXion Inc, Canada.* Bragg gratings containing a central π phase shift or used in a Fabry-Perot configuration are found to provide ultra-narrow spectral features. Transmission notches having a full width at half maximum as small as 530 MHz (4.3 pm) are reported.

BW2E.4 • 11:15
Continuously Tunable Chirped Microwave Pulse Generation Using an Optically Pumped Tilted Fiber Bragg Grating, Jianping Yao[1], Hiva Shahoei[1]; *[1]Univ. of Ottawa, Canada.* Photonic generation of a continuously tunable chirped microwave waveform using a tilted-fiber-Bragg-grating written in an erbium/ytterbium co-doped fiber is proposed. A chirped waveform with a tunable chirp rate from 1.8 to 7 GHz/ns is generated.

BW2E.5 • 11:30
Phase Manipulation of RF Signals Using a Fiber Bragg Grating with Step Group Delay Profile, Manik Attygalle[1], Dmitrii Stepanov[1]; *[1]Defence Science &Technology Organisation, Australia.* We propose a novel technique to achieve fixed or time varying phase shifts in radio-frequency (RF) signals using a single fiber Bragg grating (FBG) with a step group delay profile.

BW2E.6 • 11:45
Apodized Point-by-Point Fiber Bragg Gratings In An All-Optical, Actively Q-switched All-Fibre Laser, Robert J. Williams[1], Nemanja Jovanovic[1,2], Graham Marshall[1], M. J. Steel[1], Michael J. Withford[1]; *[1]Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), MQ Photonics Research Centre, Department of Physics and Astronomy, Macquarie Univ., Australia; [2]Macquarie Univ. Research Centre in Astronomy, Astrophysics & Astrophotonics, Department of Physics and Astronomy, Macquarie Univ., Australia.* We report an all-optical, actively Q-switched, all-fibre laser utilizing an ultrafast laser-inscribed, wavelength-tunable, apodized fibre Bragg grating. The tailored spectrum of the apodized point-by-point gratings enables an order of magnitude improvement in pulse duration.

10:30–12:30
SW2F • Fiber Lasers II
Bryce Samson; Nufern USA, Presider

SW2F.1 • 10:30 Invited
Harvesting the Full Absorption in Cladding-Pumped Fibers, Michalis N. Zervas[1,2]; *[1]Optoelectronics research Centre, Univ. of Southampton, UK; [2]SPI Lasers, UK.* We investigate the wavelength and length dependence of the pump absorption along cladding-pumped single as well as coupled multimode fibers showing strong deparures from Beer's law.

SW2F.2 • 11:00
High power, linearly polarized, continuously tunable ytterbium-doped rod-type photonic crystal fiber laser, Romain ROYON[1], Jerome Lhermite[1], Laurent Sarger[2], Eric Cormier[1]; *[1]CELIA, CNRS, France; [2]LOMA, CNRS, France.* An ytterbium-doped fiber laser continuously tunable from 976nm to1120nm and delivering up to 30W of average power linearly-polarized is demonstrated. Moreover the bandwidth of our system can be tuned from 100pm to more than 1nm.

SW2F.3 • 11:15
1 mJ Pulse Energies in Tm-doped Photonic Crystal Fiber, Pankaj Kadwani[1], Andrew Sims[1], Lasse Leick[2], Jes Broeng[2], Lawrence Shah[1], Martin Richardson[1]; *[1]Univ. of Central Florida, CREOL, USA; [2]NKT Photonics A/S, Denmark.* Thulium doped PCF have been inspected in cw and pulsed configurations at 2 microns. Greater than 400 µJ, 49 ns pulses in Q-switched oscillator configuration and 1.05 mJ pulses in amplifier configuration have been demonstrated.

SW2F.4 • 11:30 Invited
High Efficiency 1908nm Tm-doped Fiber Laser Oscillator, Daniel J. Creeden[1], Benjamin R. Johnson[1], Scott D. Setzler[1]; *[1]BAE Systems, USA.* We report a monolithic, high power, high efficiency oscillator in Tm-doped fiber operating in the 1908nm region. With this approach, we have generated >100W of power with over 47% optical efficiency and 20% electrical efficiency.

Arkansas

Access Networks and In-house Communications

Platte

Signal Processing in Photonics Communications

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

AW2A • PON Technology Trends—Continued

AW2A.5 • 12:00 Invited

Optical and Wireless Convergence, Milos Milosavljevic[1], Wansu Lim[1], Pandelis Kourtessis[1], John Senior[1]; [1]*Univ. of Hertfordshire, UK.* This paper presents the requirements and possible solutions for wireless convergence in next generation PONs. System level simulation of LTE was performed to evaluate two different approaches for connecting eNBs to ONUs.

SpW2B • Coherent System Implementation—Continued

SpW2B.5 • 12:00 Invited

1 Tb/s Coherent Transceiver, Kim Roberts[1]; [1]*Ciena Corporation, Canada.* Abstract: CMOS DACs, spectral shaping of subcarriers, frequency selective optical switching, and polarization multiplexed (PM) 16-QAM allows 1 Tb/s to be transmitted within 200 GHz of optical spectrum alongside commercial 100 Gb/s WDM signals.

IW2C • Nanophotonics for Energy Conversion and Applications—Continued

IW2C.6 • 12:00

Dispersion engineering of modified annular photonic crystals and their use in polarization independent optical devices, Mirbek Turduev[1]; [1]*Electrical and Electronics Engineering, TOBB Economics and Technology Univ., Turkey.* A novel type of PC named MAPC is studied for bandgap engineering and polarization-independent device applications. By introducing asymmetry to the unit-cell of PC, conventional EFCs for the second-band is transformed into tilted rectangular shapes.

IW2C.7 • 12:15

Raman Enhancement from Arrays of Etched Silicon Nanowires, Jaspreet Walia[1], Mohammadreza Khorasaninjead[1], Simarjeet S. Saini[1]; [1]*ECE and Waterloo Institute of Nanotechnology, Univ. of Waterloo, Canada.* Etched silicon nanowires (SiNWs) display a Raman scattering enhancement per unit volume (REV) of 70 and 7 over bulk silicon and SOI wafers. The enhancement is understood in terms of optical confinement in the SiNWs.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
AW3A • Indoor Networks

Rene Schmogrow; Karlsruhe Inst. of Technology, Germany, Presider

AW3A.1 • 13:30 Invited

Wireless Networks Indoor Application, Green Broadband Wireless Networks, Ampalavanapilla Nirmalathas[1]; [1]*Univ. of Melbourne, Australia.* Abstract not available

AW3A.2 • 14:00 Invited

Accurate Localization Technique for Smart Fiber-Wireless In-House Networks, Eduward Tangdiongga[1], Solomon Abraha[1], Antonino Crivellaro[2], Chigo Okonkwo[1], Roberto Gaudino[2], Ton Koonen[1]; [1]*COBRA Research Institute, Eindhoven Univ. of Technology, Netherlands;* [2]*Dipartimento di Elettronica, Politecnico di Torino, Italy.* The use of a RoF scheme for localization purposes of mobile stations for in-house networks is presented. Using impulse radio UWB over SMF and time-of-arrival localization method, mobile stations can be localized within centimeters accuracy.

13:30–15:30
SpW3B • High Capacity System

Juerg Leuthold; Karsruhe Institut fur Technologie, Germany, Presider

SpW3B.1 • 13:30 Invited

Spectrally Efficient Transmission: a Comparison between Nyquist-WDM and CO-OFDM Approaches, Gabriella Bosco[1]; [1]*Politecnico di Torino, Italy.* We compare Nyquist-WDM and CO-OFDM techniques for the generation of superchannels based on PM-16QAM modulation. We analyze by simulation the robustness to optical filtering and to crosstalk induced by adjacent superchannels.

SpW3B.2 • 14:00

Reduction of crosstalk-induced OSNR penalties in high bit rate optical spatially multiplexed systems, Matthias Westhäuser[1], Simon Akhtari[1], Martin Finkenbusch[1], Peter Krummrich[1]; [1]*TU-Dortmund (LS-HFT), Germany.* We investigate and compare the performance of various optimization techniques for reduction of crosstalk-induced OSNR penalties in spatially multiplexed systems by optical MIMO equalization. Residual penalties were greatly reduced using RLS and matrix inversion optimizers.

SpW3B.3 • 14:15

Mitigation of combined PMD- and crosstalk-induced signal distortions in spatially-multiplexed multi-core fiber networks, Matthias Westhäuser[1], Martin Finkenbusch[1], Simon Akhtari[1], Peter Krummrich[1]; [1]*TU-Dortmund (LS-HFT), Germany.* We investigate the performance of optical equalization of combined PMD- and crosstalk-induced distortions in 112 Gbit/s multi core fiber systems. The residual mean OSNR penalties are reduced to < 0.1 dB.

13:30–15:30
IW3C • Photonic Crystals

David Norris; ETH Zurich, Switzerland, Presider

IW3C.1 • 13:30 Invited

Electrically driven photonic crystal nanocavity devices, Gary Shambat[1], Bryan Ellis[1], Jan Petykiewicz[1], Arka Majumdar[1], Marie Mayer[2], Tomas Sarmiento[1], James Harris[1], Eugene Haller[2], Jelena Vuckovic[1]; [1]*Stanford Univ., USA;* [2]*Materials Science, UC Berkeley, USA.* We demonstrate electrically driven photonic crystal cavity lasers and LEDs with record low control energies. Our lateral injection platform opens the door to new opportunities in active control of photonic crystal devices.

IW3C.2 • 14:00 Invited

Integrable ultralow-power nanophotonic devices on InP photonic crystals, Kengo Nozaki[1], Akihiko Shinya[1], Shinji Matsuo[2], Tomonari Sato[2], Yasumasa Suzaki[2], Toru Segawa[2], Ryo Takahashi[2], Masaya Notomi[1]; [1]*NTT Basic Research Laboratories, Japan;* [2]*NTT Photonics Laboratories, Japan.* Photonic crystal nanocavities are expected to greatly reduce the size and energy consumption of various optical devices. We have demonstrated this feature in all-optical switches and random access memories for on-chip nanophotonic integration.

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NW2D • Theory of Novel Nonlinear Processes—Continued

NW2D.6 • 12:00
Analytic theory of fiber-optic Raman polarizers, Victor V. Kozlov[1,2], Javier Nuno[3], Juan D. Ania-Castanon[3], Stefan Wabnitz[1]; *[1]Department of Information Engineering, Universita degli Studi di Brescia, Italy; [2]Department of Physics, St. Petersburg State Univ., Russian Federation; [3]Instituto de Optica, Consejo Superior de Investigaciones Cientficas, Spain.* The Raman polarizer is a Raman amplifier which not only amplifies but also repolarizes light. We propose a relatively simple and analytically tractable model, the ideal Raman polarizer, for describing the operation of this device.

NW2D.7 • 12:15
Radiative decay of bright solitons in nonlocal nonlinear media with random noise, Fabian Maucher[1,3], Wieslaw Z. Krolikowski[3], Stefan Skupin[1,2]; *[1]Max Planck Institute for the Physics of Complex Systems, Germany; [2]Institute of Condensed Matter Theory and Optics, Friedrich Schiller Univ., Germany; [3]Laser Physics Centre, RSPhysSE, Australian National Univ., Australia.* We show that radiative decay of bright solitons decreases dramatically with the nonlocality-induced finite correlation length of the random noise. We give an analytical expression for the soliton life-time in the weakly nonlocal regime.

BW2E • Applications of Gratings and Poled Glass: Novel Bragg Grating Filters—Continued

BW2E.7 • 12:00
Optical Spectrum Analyzer using a 45° tilted fiber grating, Kaiming Zhou[1], Xianfeng Cheng[1], Zhijun Yan[1], Adebayo Adedotun[1], Lin Zhang[1]; *[1]Electronic engineering department, Aston Univ., UK.* We report an optical spectrum analyzer utilizing direct side-tapping by a 45○ tilted fiber grating. The angular dispersion is analyzed and 45○ is found to give highest dispersion. High resolution up to 0.13nm was obtained.

SW2F • Fiber Lasers II—Continued

SW2F.5 • 12:00 Invited
Short-Pulse Fiber Lasers using CNT and Graphene, Shinji Yamashita[1]; *[1]Univ. of Tokyo, Japan.* We review our works on the short-pulse fiber lasers passively mode-locked by carbon nanotubes (CNT) and graphene. We have demonstrated operations at various wavelength regions, high output powers, and high repetition rates.

12:30–13:30 Lunch Break, *On Your Own*

13:30–15:30
NW3D • Rogue Waves and Novel Propagation Effects
Falk Lederer; Friedrich-Schiller-Univ. Jena, Germany, Presider

NW3D.1 • 13:30 Invited
Light with no spatial scale: diffraction cancellation, anti-diffraction, scale-free instability and subwavelength beam propagation in dipolar glasses, E DelRe[1,2], Aharon Agranat[3], Claudio Conti[1,4]; *[1]Physics, Univ. of Roma La Sapienza, Italy; [2]IPCF-CNR, Univ. of Roma La Sapienza, Italy; [3]Applied Physics, Hebrew Univ. of Jerusalem, Israel; [4]ISC-CNR, Univ. of Roma La Sapienza, Italy.* We discuss the experiments and theory of scale-free optical propagation and diffraction cancellation in nanodisordered ferroelectrics, where light beams manifest a variety of effects that are incompatible with known linear and nonlinear phenomenology, such as subwavelength beam propagation.

NW3D.2 • 14:00
Do optical event horizons really exist? The physics of nonlinear reflection at a soliton boundary, Goëry Genty[1], Miro Erkintalo[1,2], John M. Dudley[3]; *[1]Tampere Univ. of Technology, Finland; [2]Univ. of Auckland, New Zealand; [3]Université de Franche-Comté, France.* We discuss the physics of optical event horizons and clarify how the observed horizon dynamics can be interpreted in the framework of wave mixing processes between a soliton and an incident linear dispersive wave.

NW3D.3 • 14:15
Longitudinal and periodic modulation of the dispersion of an optical fiber : a new degree of freedom in nonlinear optics, arnaud mussot[1], Maxime Droques[1], Alexandre Kudlinski[1], Geraud Bouwmans[1], Gilbert Martinelli[1]; *[1]Phlam/ircica, Univ. of Lille, France.* We investigate experimentally the MI process in a dispersion oscillating fiber. An important number of unstable frequencies over 10 THz are generated that then lead to a new degree of freedom for tailoring nonlinear effects.

13:30–15:30
BW3E • Applications of Gratings and Poled Glass: Lasers Grating Structures and Reflectors
Yves Painchaud; TeraXion Inc., Canada, Presider

BW3E.1 • 13:30 Invited
Advances and Prospects of Frequency Doublers Based On Periodically Poled Silica Fibres, Costantino Corbari[1], Albert Canagasabey[1], Morten Ibsen[1], Alexey V. Gladyshev[2], Peter G. Kazansky[1]; *[1]Optoelectronics Research Centre, Univ. of Southampton, UK; [2]Fiber Optics Research Center, Russian Academy of Sciences, Russian Federation.* Record high efficient frequency doublers in periodically poled silica fibres are demonstrated for light generation at 532 nm and 775 nm. The onset of nonlinear conductivity is shown to limit the maximum $\chi(2)$ in glass.

BW3E.2 • 14:00
Laser Cavity Made with Ultrafast IR Type II Gratings In Heavily Doped Er-Yb fiber, Dan Grobnic[1], Stephen J. Mihailov[1], Robert B. Walker[1], Christopher W. Smelser[1]; *[1]Communications Research Centre, Canada.* We are reporting for the first time a laser cavity built in heavily doped Er-Yb fiber with type II Bragg gratings mirrors made with IR femtosecond radiation using the phase mask method.

BW3E.3 • 14:15
Highly Efficient Distributed Feedback Brillouin Fiber Laser, Kazi S. Abedin[1], Paul Westbrook[1], Tristan Kremp[1], Benyuan Zhu[1], Jeffrey W. Nicholson[1], Jerome Porque[1], Xiaoping Liu[1]; *[1]OFS Laboratories, USA.* An efficient single frequency distributed feedback (DFB) Brillouin fiber laser producing 22mW of Stokes output, using 81mW of pump from a semiconductor DFB laser, is shown. The laser operated for a pump frequency detuning >1GHz.

13:30–15:30
SW3F • Applications of Fiber Lasers/Devices
Dan Creedon; Massachusetts Inst of Tech Lincoln Lab, USA, Presider

SW3F.1 • 13:30 Invited
Military Interest in Fibers, Iyad Dajani[1], Craig Robin[1], Angel Flores[1]; *[1], USA.* There is great interest in optical fibers for military applications. We focus on fiber laser research for directed energy platforms. Power scaling of fiber amplifiers and beam combining are the cornerstones of developing these platforms

SW3F.2 • 14:00 Invited
Progress on Mid IR Chalcogenide Fiber and Devices, Francois Chenard[1]; *[1]IRflex Corporation, USA.* Ongoing efforts on high-purity chalcogenide glasses and fiber draw processes enable the production of commercial-grade mid-infrared fibers for 2-10 micron transmission. Our fiber supports the development of cutting-edge devices for mid-infrared applications.

Arkansas	Platte	Colorado II
Access Networks and In-house Communications	Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

AW3A • Indoor Networks—Continued

AW3A.3 • 14:30
Impact of Polarization State on High-Speed Indoor Optical Wireless Communication System, KE WANG[1,2], Ampalavanapillai Nirmalathas[1,2], Christina Lim[2], Efstratios Skafidas[1,2]; *[1]National ICT Australia - Victoria Research Laboratory, Australia; [2]Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia.* In this paper we experimentally investigate the impact of polarization state on our recently proposed indoor gigabit optical wireless communication system. Our findings indicate that ~0.7 dB variation in the receiver sensitivity will be introduced.

AW3A.4 • 14:45 Invited
Relevant Wavelengths for Free Space Optics in Future Broadband Networks, Erich Leitgeb[1], Markus Löschnigg[1], Thomas Plank[1]; *[1]Technische Universität Graz, Austria.* In modern access networks the optical domain is playing the dominant role, because only in optics the high carrier frequency allows a huge bandwidth with high available date rates. We show Optical Wireless solutions for future networks.

AW3A.5 • 15:15
Different modulation formats for Gigabit-over-POF, Stefano Straullu[1], Silvio Abrate[1], Antonino Nespola[1], Paolo Savio[1], Roberto Gaudino[2]; *[1]ISMB, Italy; [2]Politecnico di Torino, Italy.* Comparison of the performances of 2-PAM and duobinary modulation formats for the transmission of Gigabit Ethernet signal over SI-POF. We demonstrated that duobinary provides the best performances, without any significant increase in implementation complexity.

SpW3B • High Capacity System—Continued

SpW3B.4 • 14:30 Invited
MIMO Processing for Space-Division Multiplexed Transmission, Sebastian Randel[1], Roland Ryf[1], Christian Schmidt[1], Miguel A. Mestre[1], Peter J. Winzer[1], R. J. Essiambre[1]; *[1]Bell Laboratories, Alcatel-Lucent, USA.* We review recent progress in space-division multiplexed transmission over fibers that support multiple coupled modes. We show that mode coupling can almost completely be undone by multiple-input multiple-output digital signal processing, even after long distance transmission.

SpW3B.5 • 15:00
Symbol spaced adaptive MIMO equalization for ultra high bit rate coherent optical communication, Albert (Alik) Gorshtein[1,2], Dan Sadot[1,2]; *[1]Ben Gurion Univ. of the Negev, Israel; [2]MultiPhy Networks Ltd., Israel.* An improved adaptive MIMO equalizer is proposed for 1Sample/Symbol coherent systems ISI introduced by the AAF is kept and eventually recovered by MLSE. 1dB improvement is achieved compared to conventional MIMO.

SpW3B.6 • 15:15
Non-linearity Compensation Limits in Optical Systems with Coherent Receivers, Gabriella Bosco[1], Andrea Carena[1], Pierluigi Poggiolini[1], Vittorio Curri[1], Fabrizio Forghieri[2]; *[1]Politecnico di Torino, Italy; [2]Cisco Systems, Italy.* We use an analytical model for fiber propagation in uncompensated optical systems to analyze the bandwidth of nonlinear noise in WDM transmission in order to assess the limits of non-linearity compensation in coherent receivers.

IW3C • Photonic Crystals—Continued

IW3C.3 • 14:30
All Optical Ultrafast Gates with surface grown QWs in Photonic Crystals heterogenously Integrated on SOI, Rama Raj[1], Fabrice Raineri[1], Alexandre Bazin[1]; *[1], France.* : Ultrafast AOG activated with low energies is demonstrated in InGaAs surface QW Photonic crystals on SOI . Recovery time of such gates is 12ps and are activated with pulses with energies as low as 40fJ

IW3C.4 • 14:45
InGaAsP photonic crystal nanocavities with a Fano line shape resonant at 1.55 µm, Yi Yu[1], Sara Ek[1], Mikkel Heuck[1], Kresten Yvind[1], Jesper Mork[1]; *[1]Department of Photonics Engineering, Technical Univ. of Denmark, Denmark.* We fabricated and characterized InGaAsP photonic crystal nanocavities. By carefully tailoring the structural parameters, both an efficient coupling and a suitable Q-factor can be achieved. Depending on the design of the coupling region, sharp Fano lines may be observed.

IW3C.5 • 15:00
Demonstration of Optically Controlled re-Routing in a Photonic Crystal Three-Port Switch, Sylvain Combrié[1], Mikkel Heuck[2], Stephane Xavier[1], Gaëlle Lehoucq[1], Stefania Malaguti[3], Gaetano Bellanca[3], Stefano Trillo[3], Philip T. Kristensen[2], Jesper Mork[2], Alfredo De Rossi[1]; *[1]Thales Research and Technology, France; [2]Department of Photonics Engineering, Danmarks Tekniske Universitet, Denmark; [3]Department of Engineering, Univ. of Ferrara, Italy.* We present an experimental demonstration of optically controlled re-routing of a signal in a photonic crystal cavity-waveguide structure with 3 ports. This represents a key functionality of integrated all-optical signal processing circuits.

IW3C.6 • 15:15
Ultra-Compact Silicon Waveguide Photodetectors Utilizing Critically-Coupled Photonic Crystal Cavities at 1.55 µm, Richard R. Grote[1], Jeffrey B. Driscoll[1], Nicolae C. Panoiu[2], Richard M. Osgood[1]; *[1]Electrical Engineering, Columbia Univ., USA; [2]Department of Electronic & Electrical Engineering, Univ. College London, UK.* We present a waveguide photodetector design for weak absorbers, such as ion-implanted silicon and polysilicon, utilizing a critically-coupled 1D photonic crystal cavity. Device lengths of < 15 µm can be achieved if scattering loss is managed.

15:30–16:00 Coffee Break, *Colorado Gallery and Grand Rivers Gallery*

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NW3D • Rogue Waves and Novel Propagation Effects—Continued

NW3D.4 • 14:30
Modulational Instability and Solitons in Nonlocal Media with Competing Nonlinearities, Wieslaw Z. Krolikowski[3], Bo Esbensen[1], Alex Wlotzka[2], Ole Bang[1], Morten Bache[1]; [1]*Technical Univ. of Denmark, Denmark;* [2]*Univ. of Karlsruhe, Germany;* [3]*Australian National Univ., Australia.* We investigate propagation and spatial localization of light in nonlocal media with competing nonlinearities. We show that the competing focusing and defocusing nonlinearities enable coexistence of dark or bright spatial solitons in the same medium by varying the intensity of the beam.

NW3D.5 • 14:45
Kuznetsov-Ma Soliton Dynamics in Nonlinear Fiber Optics, Bertrand Kibler[1], Julien Fatome[1], Christophe Finot[1], Guy Millot[1], Goëry Genty[2], Nail N. Akhmediev[3], Benjamin Wetzel[4], Frederic Dias[5], John M. Dudley[4]; [1]*Laboratoire Interdisciplinaire Carnot de Bourgogne, France;* [2]*Tampere Univ. of Technology, Finland;* [3]*The Australian National Univ., Australia;* [4]*Institut FEMTO-ST, France;* [5]*Univ. College Dublin, Ireland.* The Kuznetzov-Ma (KM) soliton is a solution of the nonlinear Schrödinger equation derived in 1977 but never observed experimentally. Here we report experiments showing KM soliton dynamics in nonlinear breather evolution in optical fiber.

NW3D.6 • 15:00
Rogue wave clusters with atom-like structures, David J. Kedziora[1], Adrian Ankiewicz[1], Nail N. Akhmediev[1]; [1]*Australian National Univ., Australia.* We study the hierarchy of rational solutions of the nonlinear Schroedinger equation that are higher-order rogue waves in this model. This analysis reveals the existence of clusters, analogous to atoms with their shells of electrons.

NW3D.7 • 15:15
Dissipative rogue wave generation from a mode-locked fiber laser experiment, caroline Lecaplain[1], Philippe Grelu[1], Jose-Maria Soto-Crespo[2], Nail N. Akhmediev[3]; [1]*ICB UMR 6303, Universite de Bourgogne, France;* [2]*Instituto de Optica, CSIC, Spain;* [3]*The Australian National Univ., Australia.* Rare events of extremely high optical intensity are experimentally recorded at the output of a mode-locked fiber laser operating in a chaotic multiple-pulse regime. These fluctuations result from ceaseless nonlinear interactions between pulses.

BW3E • Applications of Gratings and Poled Glass: Lasers Grating Structures and Reflectors—Continued

BW3E.4 • 14:30
A seven core fiber DFB, Paul Westbrook[1], Kazi S. Abedin[1], Thierry Taunay[1], Michael Fishteyn[1], Tristan Kremp[1], Jerome Porque[1]; [1]*OFS Laboratories, USA.* We demonstrate fiber DFB lasers in a seven core Er doped fiber. DFB grating cavities were fabricated in all cores at once via a single UV exposure. Lasing was observed in all seven cores.

BW3E.5 • 14:45
Simulation of two-photon absorption in Raman DFB lasers, Tristan Kremp[1], Kazi S. Abedin[1], Paul Westbrook[1]; [1]*OFS Laboratories, USA.* We present an efficient split-step solver for the nonlinear coupled mode equations with two-photon absorption to investigate the feasibility of Raman DFB lasers in highly nonlinear materials such as chalcogenide glasses.

BW3E.6 • 15:00
Raman DFB Fiber Laser with Truly Unidirectional Output, Jindan Shi[1], Shaif-ul Alam[1], Morten Ibsen[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We report a single-frequency, kilohertz-linewidth (<2.5kHz), 30cm-long Raman distributed-feedback fiber laser with unidirectional output. The threshold power, slope efficiency and maximum output power are observed to be ~980mW, 7.7% and 296mW respectively.

BW3E.7 • 15:15
Ultra-Wide Range Wavelength Conversion Using FWM in a Raman DFB Fiber Laser, Jindan Shi[1], Shaif-ul Alam[1], Morten Ibsen[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We demonstrate for the first time to our knowledge, four-wave-mixing (FWM) in a 30cm-long center π phase-shifted Raman distributed-feedback (DFB) fiber laser. The FWM-to-signal conversion efficiency is -24dB and the wavelength conversion range is 94.1nm.

SW3F • Applications of Fiber Lasers/Devices—Continued

SW3F.3 • 14:30 Invited
Narrow Linewidth Fiber Amplfiers, Scott Christensen[1]; [1]*Lockheed Martin Coherent Technologies, USA.* Abstract not available.

SW3F.4 • 15:00 Invited
Thulium-Doped Fiber Amplifier Development for NASA's ASCENDS Mission, Mark W. Phillips[1]; [1]*Lockheed Martin Coherent Technologies, USA.* This paper describes the power-scaling capability and radiation resistance of a 2 micron Tm:glass single mode fiber amplifier that scales single frequency output power from 30mW to >8W while maintaining absolute frequency uncertainty of <1MHz.

15:30–16:00 Coffee Break, *Colorado Gallery and Grand Rivers Gallery*

Arkansas

Access Networks and In-house Communications

Platte

Signal Processing in Photonics Communications

Colorado II

Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:00–18:00
AW4A • OFDM- and WDM-PON Technologies
Milos Milosavjevic; Univ. of Hertfordshire, UK, Presider

AW4A.1 • 16:00 Invited

Uplink Solutions for Future Access Networks, Rene M. Schmogrow[1], Philipp C. Schindler[1], David Hillerkuss[1], Christian Koos[1,2], Wolfgang Freude[1,2], Juerg Leuthold[1,2]; *[1]Institute of Photonics and Quantumelectronics, Karlsruhe Institute of Technology, Germany; [2]Institute for Microstructure Technology, Karlsruhe Institute of Technology, Germany.* We demonstrate an uplink with an optical carrier (seed) sent to the optical network unit over 75 km of SSMF. Two ONUs transmit either 10 Gbit/s OFDM or sinc-shaped Nyquist pulses.

AW4A.2 • 16:30

Linearity Improvement of Directly Modulated PONs by Digital Pre-Distortion of Coexisting OFDM-based Signals, Tiago F. Alves[1], José Morgado[1], Adolfo Cartaxo[1]; *[1]IST/Instituto de Telecomunicações, Portugal.* Digital pre-distortion of five OFDM-based wired-wireless signals for compensation of directly-modulated PONs nonlinearity is demonstrated experimentally. This technique leads to EVM-compliant levels in all signals and to EVM improvements that reach 5.7dB in UWB signals.

AW4A.3 • 16:45

Remote Heterodyne Reception of OFDM-QPSK as Downlink-Solution for Future Access Networks, Philipp Schindler[1], Rene M. Schmogrow[1], David Hillerkuss[1], Moshe Nazarathy[2], Shalva Ben-Ezra[3], Christian Koos[1], Wolfgang Freude[1], Juerg Leuthold[1]; *[1]Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology, Germany; [2]Israel Institute of Technology, Israel; [3]Finisar, Israel.* We demonstrate transmission of 46.5 Gbit/s OFDM-QPSK signals over a distance of 100 km within an optical bandwidth of 25 GHz, and heterodyne detection of the OFDM subcarriers with a remotely supplied local optical oscillator.

AW4A.4 • 17:00

An OFDM-PON with non-preselected ONUs: dimensioning and experimental results, Iván Cano[1], María C. Santos[1], Xavier Escayola[1], Victor Polo[1], Josep Prat[1]; *[1]Universitat Politecnica de Catalunya, Spain.* An OFDM-PON with a simple centralized wavelength control of low-cost non-preselected independent ONU sources is presented, dimensioned, and tested experimentally. The rejection-ratio is reduced to less than 1% increasing the cost-effectiveness of the access network.

16:00–18:00
SPPCom Postdeadline Paper Session and Rump Session

16:00–18:00
IW4C • Bionanophotonics and Si Nanophotonics
Gary Wiederrecht; Argonne National Laboratory, USA, Presider

IW4C.1 • 16:00 Invited

Subwavelength Photonics for Biosensing, Brian T. Cunningham[1]; *[1]Univ of Illinois at Urbana-Champaign, USA.* Nanostructured surfaces are applied towards point-of-care diagnostic biosensing. Photonic crystal enhanced fluorescence is used for detection of cancer biomarkers in serum. Metal nanodomes integrated with biomedical tubing to monitor intravenously delivered drugs and urinary metabolites.

IW4C.2 • 16:30

λ-size Silicon Modulator, Volker J. Sorger[1], Noberto D. Lanzillotti-Kimura[1], Ren-Min Ma[1], Xiang Zhang[1,2]; *[1]Univ. of California, Berkeley, USA; [2]Materials Sciences Division, Lawrence Berkeley National Laboratory, USA.* We report an experimental demonstration of a 3λ-size, silicon waveguide-integrated electro-optic modulator with a record high extinction ratio exceeding 1dB/μm, extremely low insertion loss (-1dB) in the ON-state, and an ultra-broadband (>0.5μm) bandwidth based on free-carrier switching in ITO.

IW4C.3 • 16:45

Ultralow-Power 160-Gb/s All-Optical Demultiplexing in Hydrogenated Amorphous Silicon Waveguides, Ke-Yao Wang[1], Keith G. Petrillo[1], Mark A. Foster[1], Amy C. Foster[1]; *[1]Electrical and Computer Engineering, Johns Hopkins Univ., USA.* We demonstrate demultiplexing of 160-Gb/s OTDM data signals to 10 Gb/s using four-wave mixing in hydrogenated amorphous silicon nanowaveguides. We observe error-free (BER < 10-9) operation with record-low switching powers for an integrated device.

IW4C.4 • 17:00

Polarization Insensitive Wavelength Conversion Based on Four-Wave Mixing in a Silicon Nanowire, Minhao Pu[1], Hao Hu[1], Christophe Peucheret[1], Hua Ji[1], Michael Galili[1], Leif K. Oxenløwe[1], Palle Jeppesen[1], Jørn M. Hvam[1], Kresten Yvind[1]; *[1]DTU Fotonik, Photonics Engineering, Danmarks Tekniske Universitet, Denmark.* We experimentally demonstrate, for the first time, polarization-insensitive wavelength conversion of a 10 Gb/s NRZ-OOK data signal based on four-wave mixing in a silicon nanowire with bit-error rate measurements.

Wednesday, 20 June

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:00–18:00
NP Postdeadline Paper Session

16:00–17:15
BW4E • Applications of Gratings and Poled Glass: FBG Applications to Optical Signal Processing
Sophie LaRochelle; Universite Laval, Canada, Presider

BW4E.1 • 16:00
100 nm Wide Fiber Bragg Grating Dispersion Compensator Around Zero Dispersion Wavelength, Francois Trepanier[1], Michel Morin[1], Guillaume Brochu[1], Yves Painchaud[1], Desmond C. Adler[2], Wolfgang Wieser[3], Robert Huber[3]; *[1]TeraXion Inc, Canada; [2]St. Jude Medical, USA; [3]Ludwig Maximilians Univ., Germany.* Nonlinearly chirped fiber Bragg gratings compensate 600 ps of chromatic dispersion from 4 km of SMF-28 fiber around the zero dispersion wavelength with less than 10 ps of residual delay over a 100 nm bandwidth.

BW4E.2 • 16:15
Tunable Fractional Order Temporal Differentiator Using an Optically Pumped Tilted Fiber Bragg Grating, Jianping Yao[1], Hiva Shahoei[1]; *[1]Univ. of Ottawa, Canada.* An optically tunable photonic fractional temporal differentiator using a tilted-fiber-Bragg-grating written in an erbium/ytterbium co-doped fiber is proposed. The temporal differentiation of a Gaussian pulse with a bandwidth of 28 GHz at different orders is demonstrated.

BW4E.3 • 16:30
Design of picosecond flat-top optical pulse generator using a linearly-chirped fiber Bragg grating in Transmission, María R. Fernández-Ruiz[1,2], Alejandro Carballar[2], Jose Azana[1]; *[1]Énergie, Matériaux et Télécommunications, Institut National de la Recherche Scientifique, Canada; [2]Departamento de Ingeniería Electrónica, E.T.S. de Ingenieros, Spain.* A picosecond rectangular pulse-shaper based on a linearly-chirped fiber Bragg grating in transmission is presented. The design exploits the space-to-frequency mapping and the degree of freedom in the reflection spectral phase specifications.

BW4E.4 • 16:45
Long period fiber grating designs for real-time ultra-fast Hilbert transformations, Reza Ashrafi[1], Jose Azana[1]; *[1]INRS-EMT (Institut National de la Recherche Scientifique - Energie, Matériaux et Télécommunications), Canada.* A novel all-optical design for implementing THz-bandwidth Hilbert transformers based on a uniform-period long-period grating (LPG) with a properly designed grating apodization profile is proposed and numerically demonstrated.

BW4E.5 • 17:00
Ultrafast optical pulse shaping by exploiting the first-order Born approximation in long period gratings, Reza Ashrafi[1], Jose Azana[1]; *[1]INRS-EMT (Institut National de la Recherche Scientifique - Energie, Matériaux et Télécommunications), Canada.* A novel general approach for THz-bandwidth optical filter synthesis, particularly interesting for ultrafast optical pulse shaping, based on the first-order Born approximation in long period gratings is proposed and numerically validated.

16:00–18:00
SW4F • Lasers, Components and Fiber Characterization
Iyad Dajani; US Air Force Research Laboratory, USA, Presider

SW4F.1 • 16:00 Invited
Making lower energy photons from fiber lasers, Stuart D. Jackson[1]; *[1]Institute of Photonics and Optical Scien, Australia.* I will briefly review progress in the development of high power longer wavelength fibre lasers with a special emphasis on fibre design for efficient performance.

SW4F.2 • 16:30
Flattened fundamental mode in optical Fibers, arnaud mussot[1], Constance Valentin[1], Yves Quiquempois[1], Geraud Bouwmans[1], Laurent Bigot[1], Marc Douay[1], Laure Lago[2], Pierre Calvet[2], Emmanuel Hugonnot[2]; *[1]phlam, France; [2]CEA, France.* We present the design and the fabrication of a microstructured fiber that delivers a flat-top intensity profile. Characterization of this fiber shows that it is suitable for applications such as high-power amplification or micro-machining.

SW4F.3 • 16:45
Phase-locking a fiber laser array by phase contrast filtering and nonlinearity, François Jeux[1,3], Agnes Desfarges-Berthelemot[1], Vincent Kermene[1], Julien Guillot[1,2], Alain J. Barthelemy[1]; *[1]XLIM Research Institute, CNRS / Université de Limoges, France; [2]CILAS, France; [3]ASTRIUM, France.* A new compound cavity is proposed to passively phase-lock an array of fiber lasers. Simulations show that the scheme enhances combining efficiency. Preliminary experiments with four lasers will be reported demonstrating the expected operation.

SW4F.4 • 17:00
Field-flattened high-order modes, Mike Messerly[1]; *[1]Lawrence Livermore National Laboratory, USA.* We present a method for designing circularly-symmetric waveguides that support a field-flattened higher order mode and show that adding these flattened, concentric rings does not alter the effective index or flattened nature of the mode.

Arkansas	Platte	Colorado II
Access Networks and In-house Communications	Signal Processing in Photonics Communications	Integrated Photonics Research, Silicon and Nano Photonics

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

AW4A • OFDM- and WDM-PON Technologies—Continued

AW4A.5 • 17:15
Wired-Wireless OFDM Signals Coexistence in LR-PONs Using Two Centralized Compensation Stages, Tiago F. Alves[1], Maria Morant[2], Adolfo Cartaxo[1], Roberto Llorente[2]; *[1]IST/Instituto de Telecomunicações, Portugal; [2]Nanophotonics Technology Centre, Universidad Politécnica de Valencia, Spain.* Transmission in coexistence of five OFDM signals along LR-PONs employing two centralized compensation stages is demonstrated experimentally. All OFDM signals are EVM-compliant with EVM fluctuations below 1dB for OLT-ONU distances between 75km and 125km.

AW4A.6 • 17:30
Exploiting Faraday rotation in Reflective PON architectures, Stefano Straullu[1], Giuseppe Rizzelli[2], Valter Ferrero[2], Roberto Gaudino[2], Silvio Abrate[1], Fabrizio Forghieri[3]; *[1]ISMB, Italy; [2]Politecnico di Torino, Italy; [3]Cisco Photonics, Italy.* We experimentally investigate on reflective PON architectures that includes Faraday rotation at the ONU, showing an increased resilience to back-scattering induced impairments.

AW4A.7 • 17:45
Uncooled operation of directly-modulated and polarization insensitive self-seeded Fabry-Peròt laser diodes, Marco Presi[1], Andrea Chiuchiarelli[1], Raffaele Corsini[1], Pallab Choudhury[1], Ernesto Ciaramella[1]; *[1]Institute of Communication, Information and Perception Technologies, Scuola Superiore Sant'Anna, Italy.* We report an experimental characterization of uncooled operation (0-60°C) of directly-modulated self-seeded Fabry-Peròt laser diodes. Error-free 1.25Gb/s operations across the C-band have been obtained with sensitivities compatible with power budget of short reach WDM-PON.

BGPP Postdeadline Paper Session

IW4C • Bionanophotonics and Si Nanophotonics—Continued

IW4C.5 • 17:15
Trimming of Athermal Silicon Resonators, Vivek Raghunathan[1], Stefano Grillanda[2], Vivek Singh[1], Antonio Canciamilla[2], Francesco Morichetti[2], Anuradha Agarwal[1], Jurgen Michel[1], Andrea Melloni[2], Lionel C. Kimerling[1]; *[1]Materials Science and Engineering, Massachusetts Institute of Technology, USA; [2]Electronics and Information, Politecnico di Milano, Italy.* Thin photosensitive layer of As2S3 sandwiched in between a-Si core and negative thermo-optic polymer over-cladding enables trimming of athermal rings. Exposure to visible light can shift their resonances by 195GHz at trimming rates around 1GHz/min.

IW4C.6 • 17:30
Demodulation of 40 Gb/s DPSK Signals Using a Silicon Microring Resonator with Electro-Optic Wavelength Tuning, Gordon K. P. Lei[1,2], Ke Xu[1,2], Stanley M. G. Lo[1,2], Chester Shu[1,2], Hon K. Tsang[1,2]; *[1]Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong; [2]Center for Advanced Research in Photonics, The Chinese Univ. of Hong Kong, Hong Kong.* We demonstrate demodulation of 40 Gb/s DPSK signals using a silicon microring resonator with electro-optic wavelength tuning. Error-free operations have been achieved with a 3.5-dB receiver sensitivity variation over the full tuning range.

IW4C.7 • 17:45
Ultra-Compact High-Speed Electro-Optic Switch Utilizing Hybrid Metal-Silicon Waveguides, Eric Dudley[1], Wounjhang Park[1]; *[1], USA.* This paper presents a design for an ultra-compact electro-optic switch based on hybrid waveguide technology. At 1V drive voltage, switching at speeds up to 30Gbits/sec can be achieved in a device that is 30 µm long.

18:30–21:30 Networking Dinner (tentative), *Cheyenne Courtyard*

Colorado I	White River	Rio Grande/Gunnison
Nonlinear Photonics	Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides	Specialty Optical Fibers

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

NP Postdeadline Papers—Continued

BGPP Postdeadline Papers

SW4F • Lasers, Components and Fiber Characterization—Continued

SW4F.5 • 17:15
Low-Loss Coupling Between Single-Mode Optical Fibers with Very Different Mode-Field Diameters, Arash Mafi[1], Peter Hofmann[2,3], Clemence Jollivet Salvin[2], N. Peyghambarian[3], Axel Schulzgen[2]; [1]*Electrical Engineering, Univ. of Wisconsin Milwaukee, USA;* [2]*The College of Optics and Photonics, Univ. of Central Florida, USA;* [3]*College of Optical Sciences, Univ. of Arizona, USA.* We show that short segments of graded-index optical fiber can provide broadband, very low-loss coupling between single-mode optical fibers with very different mode-field diameters.

SW4F.6 • 17:30
Residual Dispersion Compensation with a Spiral PCF, Yousaf O. Azabi[1], Arti Agrawal[1], B.M.Azizur Rahman[1], Kenneth Grattan[1]; [1]*School of Engineering and Mathematical Sciences, City Univ. London, UK.* We propose a novel Archimedean spiral PCF design for residual dispersion compensation. The proposed fiber can be fabricated using sheet rolling techniques, and shows D ~ -149ps/nm/km in the range (1.3-1.7µm).

SW4F.7 • 17:45
Geometric Control of Crystallography in Semiconductor Core Optical Fiber, Stephanie Morris[1], Colin McMillen[1], Thomas Hawkins[1], Paul Foy[1], Roger Stolen[1], John Ballato[1], Robert Rice[2]; [1]*The Center for Optical Materials Science and Engineering Technologies (COMSET) and the School of Materials Science and Engineering, Clemson Univ., USA;* [2]*Dreamcatchers Consulting, USA.* Crystalline semiconductor core optical fibers have become a topic of recent interest. This work focuses on the role that the core geometry can play on the crystallinity and crystallography of crystalline semiconductor core optical fibers.

18:30–21:30 Networking Dinner, *Cheyenne Courtyard*

Colorado I

Nonlinear Photonics

Platte

Signal Processing in Photonics Communications

07:30–12:30 Registration, *Lower Lobby, Conference Level*

08:30–10:00
NTh1A • Novel Nonlinear Materials
Thibaut Sylvestre; Universite de Franche-Comte, France, Presider

NTh1A.1 • 08:30 Invited
Four Wave Mixing in Silicon-Organic Waveguides, Manfred Eich[1]; *[1]Technische Universität Hamburg-Harburg, Germany.* In order to achieve high conversion efficiencies in micro photonic waveguides we functionalize silicon waveguides with novel third order nonlinear polymers. Such structures are envisaged for high efficient entangled photon sources and parametric amplifiers.

NTh1A.2 • 09:00
Materials for Loss-Based Switching in Silicon-Organic Hybrid Devices, Joel M. Hales[1], Hyeongeu Kim[1], Anthony DeSimone[1], Henry Wen[2], Taige Hou[2,3], Alex Jen[4], Seth Marder[1], Michal Lipson[3], Alexander L. Gaeta[2], Joseph W. Perry[1]; *[1]School of Chemistry and Biochemistry, Georgia Institute of Technology, USA; [2]School of Engineering and Applied Physics, Cornell Univ., USA; [3]School of Electrical and Computer Engineering, Cornell Univ., USA; [4]Department of Materials Science and Engineering, Univ. of Washington, USA.* We determine the critical parameters to produce highly efficient all-optical switching via nonlinear-loss-based decoupling in silicon microring resonators with organic material claddings. Switching energies as low as 100 fJ are possible.

NTh1A.3 • 09:15
Surface Optical Nonlinearity in GaP Nanopillar Waveguides, Marcin Swillo[1], Reza Sanatinia[2], Srinivasan Anand[2]; *[1]Royal Institute of Technology (KTH), Sweden; [2]Royal Institute of Technology (KTH), Sweden.* Second harmonic generation in GaP nanopillars is investigated by polarization measurements and light confinement analysis. Effective thickness of the nonlinear surface region is ~ 10nm and the corresponding nonlinear coefficient 20 times larger than in bulk.

NTh1A.4 • 09:30
Dual-Arm Z-scan for measuring nonlinearities of solutes in solution, Manuel R. Ferdinandus[1], Matthew Reichert[1], Trenton R. Ensley[1], Dmitry A. Fishman[1], Scott Webster[1], David J. Hagan[1], Eric W. Van Stryland[1]; *[1]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA.* Performing identical and simultaneous Z-scans on two samples (solvent and solvent plus solute), the effects of solvent n2 can be essentially eliminated, thus overcoming a longstanding problem in organic dye nonlinear characterization.

NTh1A.5 • 09:45
Towards mode-locked fiber laser using topological insulators, François Bernard[1]; *[1]OPERA-photonique, Université Libre de Bruxelles, Belgium.* Topological insulators have lately been extensively studied. Their optical properties though have not been well described yet. We recently highlighted that a topological insulator exhibits saturable absorber-like behavior when placed in a 1550 nm laser beam.

08:30–10:00
SpTh1B • DSP Algorithm II
Fabio Pittalà; Huawei Technologies Co. Ltd., Germany, Presider

SpTh1B.1 • 08:30 Invited
Decision-aided carrier phase estimation for coherent optical communication systems, Changyuan Yu[1,2], Pooi-Yuen Kam[1], Shaoliang Zhang[1,3], Jian Chen[4]; *[1]National Univ. of Singapore, Singapore; [2]A*STAR Institute for Infocomm Research, Singapore; [3]NEC Laboratories America, USA; [4]Nanjing Univ. of Posts and Telecommunications, China.* We review the performance of decision-aided maximum likelihood (DA ML) phase estimation and its adaptive counterpart in different modulation formats.

SpTh1B.2 • 09:00
Coherent Optical Single-carrier Frequency-division-multiplexing System with Overlap Frequency Domain Equalization, Chunxu Zhao[1], Zhang Su[1], Liu Di[1], Juhao Li[1], Fan Zhang[1], Zhangyuan Chen[1]; *[1]Peking Univ., China.* Overlap FDE based on MMSE criterion is proposed and applied on the CO-SCFDM system without CP for the first time. Simulation results show it has similar characteristics as the conventional CO-SCFDM system.

SpTh1B.3 • 09:15
Fiber Nonlinearities Compensation by Polar Gaussian MLSD, Domenico Marsella[1], Marco Secondini[1], Enrico Forestieri[1], Roberto Magri[2]; *[1]Scuola Superiore Sant'Anna, Italy; [2]Ericsson, Italy.* A novel maximum likelihood sequence detection (MLSD) strategy to combat fiber non-linearities is presented and compared to known compensation techniques such as backpropagation.

SpTh1B.4 • 09:30 Invited
Frequency-Domain Signal Processing for Chromatic Dispersion Equalization and Carrier Frequency Offset Estimation in Optical Coherent Receivers, Tadao Nakagawa[1]; *[1]NTT Network Innovation Laboratories, Japan.* Frequency-domain equalization (FDE) and spectrum-based optical carrier frequency offset estimation (FOE) are presented. These signal processing operations are both carried out in frequency domain and suitable for coherent optical communications.

10:00–10:30 Coffee Break, *Colorado Gallery and Grand Rivers Gallery*

Colorado I

Nonlinear Photonics

10:30–12:30
NTh2A • Nonlinear Effects in Optical Waveguides
John Harvey, Univ. of Auckland, New Zealand, Presider

NTh2A.1 • 10:30
Four-Wave Mixing Fiber Source for Coherent Raman Scattering Microscopy, Simon Lefrancois[1], Dan Fu[2], Gary R. Holtom[2], Lingjie Kong[1], William J. Wadsworth[3], Patrick Schneider[4], Robert Herda[4], Armin Zach[4], Sunney X. Xie[2], Frank W. Wise[1]; *[1]Applied Physics, Cornell Univ., USA; [2]Chemistry and Chemical Biology, Harvard Univ., USA; [3]Physics, Univ. of Bath, UK; [4]TOPTICA Photonics AG, Germany.* We present a two-color picosecond fiber laser system based on four-wave mixing in photonic crystal fiber. Seeding the process overcomes pulse walk-off and noise. 1 µm pulses are converted to 800 nm for CARS microscopy.

NTh2A.2 • 10:45
Integrated liquid-core optical fiber for nonlinear liquid photonics, Khanh Kieu[1], Yegeniy Merzlyak[1], Lukas Schneebeli[1], Joel M. Hales[2], Joseph W. Perry[2], Robert A. Norwood[1], N. Peyghambarian[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]Georgia Technology Institute, USA.* We have developed a technique that allows splicing of liquid core optical fiber (LCOF) to standard single-mode optical fiber with low loss (<1dB). As an example, we performed inverse Raman spectroscopy in a CCl4 filled LCOF that is spliced to SMF28 on both sides

NTh2A.3 • 11:00
Supercontinuum generation with picosecond ultraviolet pulses in a solid-core photonic crystal fiber, Thibaut Sylvestre[1]; *[1]Universite de Franche-Comte, France.* Black light supercontinuum generation is demonstrated as a result of picosecond pumping a solid-core photonic crystal fiber at 355~nm through the combined effects of intermodal four-wave mixing and cascaded Raman scattering.

NTh2A.4 • 11:15
Counting photon numbers of Bragg-Scattering FWM frequency conversion at telecom wavelengths, Katarzyna Krupa[1], Alessandro Tonello[1], Victor V. Kozlov[2,3], Vincent Couderc[1], Philippe Di Bin[1], Stefan Wabnitz[3]; *[1]Université de Limoges, XLIM, UMR CNRS 7252, France; [2]Department of Physics, St.-Petersburg State Univ., Russian Federation; [3]Dipartimento di Ingegneria dell'Informazione, Università di Brescia, Italy.* We experimentally study Bragg-Scattering Four-Wave Mixing in nonlinear fiber at telecom wavelengths with photon counters. We discuss frequency conversion of attenuated laser under different pump polarizations. Performances are limited by Raman noise.

NTh2A.5 • 11:30
Experimental demonstration of all-fiber continuous wave optical parametric amplifier operating at 1 µm, arnaud mussot[1], Alexandre Kudlinski[1], Laure Lago[2], Damien Bigourd[2], Thibaut Sylvestre[3], Min Lee[3], Emmanuel Hugonnot[2]; *[1]phlam, France; [2]CEA, France; [3]femto-st, France.* We report the first experimental demonstration of an all-fiber optical parametric amplifier around 1 µm with a broad bandwidth of 16 nm and a high amplification gain of 25 dB

NTh2A.6 • 11:45
Octave-spanning Infrared Supercontinuum Generation in Robust Chalcogenide Nano-tapers, Soroush Shabahang[1], Guangming Tao[1], Mohammad U. Piracha[1], Dat Nguyen[1], Peter Delfyett[1], Ayman F. Abouraddy[1]; *[1]Univ. of Central Florida, CREOL, USA.* We fabricate robust step-index chalcogenide nano-tapers. Using picosecond pulses at 1.55 µm, we generate octave-spanning low-power-threshold near-infrared and mid-infrared supercontinuum (0.85-2.35 µm).

NTh2A.7 • 12:00
Generation of Photon Pairs in Cubic Nonlinear Waveguide Arrays, Alexander S. Solntsev[1], Andrey A. Sukhorukov[1], Dragomir Neshev[1], Yuri S. Kivshar[1]; *[1]Australian National Univ., Australia.* We analyze the quantum statistics of photon pair generation through spontaneous four-wave mixing in nonlinear waveguide arrays and predict pump power-controlled transition between bunching and anti-bunching correlations due to self-focusing of the pump beam.

NTh2A.8 • 12:15
All-optical fiber-based devices for ultrafast amplitude jitter magnification, Charles-Henri Hage[1], Bertrand Kibler[1], Julien Fatome[1], Christophe Finot[1]; *[1]Laboratoire Interdisciplinaire CARNOT de Bourgogne, France.* We propose two fiber-based architectures that enable the all-optical magnification of ultrafast amplitude fluctuations of picosecond or femtosecond pulse trains. An increase of the fluctuations by more than one order of magnitude is experimentally achieved.

Platte

Signal Processing in Photonics Communications

10:30–12:00
SpTh2B • Monitoring
Chao Lu; Hong Kong Polytechnic Univ., Hong Kong, Presider

SpTh2B.1 • 10:30 Invited
Performance monitoring through signal processing in current and future optical communication systems, Alan P. Lau[1], Fabian N. Hauske[2], Trevor B. Anderson[3,4], Chao Lu[5]; *[1]Hong Kong Polytechnic Univ., Hong Kong; [2]Huawei Technologies Duesseldorf GmbH, European Research Center, Germany; [3]National ICT Australia, Victorian Research Laboratory, Univ. of Melbourne, Australia; [4]Monitoring Division, Univ. of Melbourne, Australia; [5]Dept. of Electronic and Information Engineering, The Photonics Research Center, The Hong Kong Polytechnic Univ., Hong Kong.* We review the current status of Optical Performance Monitoring(OPM) in deployed optical networks and discuss on emerging OPM trends and challenges brought about by the migration towards coherent communications with digital coherent receivers.

SpTh2B.2 • 11:00
PDL-aware In-band OSNR Monitoring based on the Spectral Properties of Concatenated CAZAC Sequences, Fabio Pittalà[1,2], Fabian N. Hauske[1], Yabin Ye[1], Neil G. Guerrero[1], Idelfonso T. Monroy[2], Josef A. Nossek[3]; *[1]European Research Center, Huawei Technologies Co Ltd, Germany; [2]Fotonik, Technical Univ. of Denmark, Denmark; [3]Institute for Circuit Theory and Signal Processing, Technische Universität München, Germany.* A novel method for accurate in-band OSNR monitoring based on analysis of the power spectral density of concatenated received CAZAC training sequences is demonstrated over a wide range of combined linear distortions.

SpTh2B.3 • 11:15
Accurate Blind Chromatic Dispersion Estimation in Long-haul 112Gbit/s PM-QPSK WDM Coherent Systems, Vitor Ribeiro[1], Stenio Ranzini[1], Júlio Oliveira[1], Vitor Nascimento[1], Eduardo Magalhães[1]; *[1]Photonics, CPqD, Brazil.* Chromatic dispersion can vary due to optical network reconfigurations and hence blind estimators are desired. We propose an improved CD estimation method evaluated experimentally exhibiting good estimation accuracy and robustness to optical filtering and noise

SpTh2B.4 • 11:30
Natural Expression of the Best-Match Search Godard Clock-Tone Algorithm for Blind Chromatic Dispersion Estimation in Digital Coherent Receivers, Christian Malouin[1], Philip Thomas[1], Bo Zhang[1], Jason O'Neil[1], Ted Schmidt[1]; *[1]Juniper Networks Inc., USA.* We reveal the natural expression of the "best-match search" Godard clock-tone algorithm for blind chromatic dispersion estimation. The complexity is reduced by more than 2 orders of magnitude compare to the conventional method

SpTh2B.5 • 11:45
PDL Monitoring based on the Eigenvalues Spread of a Data-Aided Zero-Forcing Frequency Domain Equalizer, Fabio Pittalà[1,2], Fabian N. Hauske[1], Yabin Ye[1], Neil G. Guerrero[1], Idelfonso T. Monroy[2], Josef A. Nossek[3]; *[1]European Research Center, Huawei Technologies Co Ltd, Germany; [2]Fotonik, Technical Univ. of Denmark, Denmark; [3]Institute for Circuit Theory and Signal Processing, Technische Universität München, Germany.* Precise and robust PDL monitoring is demonstrated over a wide range of combined channel impairments. The PDL value is extracted from the zero forcing filter matrix estimated by using short CAZAC training sequences.

Key to Authors and Presiders

Advanced Photonics: OSA Optics and Photonics Congress
Update Sheet 2012

Online Access to Technical Digest

In addition to the Technical Digest CD, full Technical Attendees now have an alternate way to access the digest papers at the meeting. Access the papers through Optics InfoBase: http://www.opticsinfobase.org/browseconferences.cfm?congress=12Photonics. You will use the same login email address and password provided during the meeting registration process. Access is currently limited to Advanced Photonics Full Technical Attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Session Changes

The BGPP session JM1B will begin on Monday, 18 June at 08:00 in White River. The session will be preceded by opening comments beginning at 07:50.

Presentations NW1C.4 and NW1C.5 are reversed in the program. NW1C.4, **Longitudinal Power Distribution in a Random DFB Fiber Laser**, will be presented by Dmitriy Churkin from 09:15-09:30 on Wednesday, 20 June. NW1C.5, **A Novel Extraction Algorithm for Spectral Phase Interferometry,** presented by Alessia Pasquazi will be from 09:30 - 09:45.

The NP and BGPP Postdeadline sessions have merged and will now be held on Wednesday, 20 June from 16:00 – 17:36 in Colorado I as session JW4D. Postdeadline books will be available at the registration desk.

SPPCom will not be having a Postdeadline Session. Instead, they will host a workshop in Platte from 16:00-18:00. Details of the workshop appear below in the New Events section.

An additional poster presentation has been added during Monday's Joint Poster session:
JM5A.58
Optically-induced, Bandwidth-tunable, Chirped Volume Bragg Gratings, Sebastian Kroesen[1,2], Wolfgang Horn[1,2], Cornelia Denz[1,2]; [1]*Westfälische Wilhelms-Universität, Institut für Angewandte Physik, Germany;* [2]*Westfälische Wilhelms-Universität, Center for Nonlinear Science (CeNoS), Germany.* We demonstrate reconfigurable chirped volume Bragg gratings centered at λ=1542 nm in photorefractive lithium niobate. The reflection bandwidth and chirp rate can be controlled by an adaptive lens system. The dispersion characteristics are obtained by the modulation phase shift method.

Presenter Changes

Sebastian Jakobs will be presenting the invited talk NTh1A.1, entitled **Four Wave Mixing in Silicon-Organic Hybrid Waveguides**.

Alex Clark will be presenting the postdeadline paper NW4D.6 entitled **Ultra-low Raman Noise Correlated Photon-Pair Generation in a Dispersion Engineered As2S3 Waveguide**.

New Events

Networking Cookout
Wednesday, 20 June
18:30 – 20:30, *The Courtyard*
Ticketed event – This event is not included in the Congress registration fees. Join us at this great event! Come meet with leaders of the optics and photonics community in a great informal and fun setting. Enjoy the sunset as you grab dinner, drinks and lively conversation! For $20 USD for full technical registrants, $10 USD for students.

SPPCom Workshop: Trends in Linear and Non-linear Digital Signal Processing for Communication Over all Degrees of Freedom of Light
Wednesday, 20 June
16:00-18:00, *Platte*
This workshop will consist of one hour of invited talks, followed by an open-forum discussion. Attendees are invited to converse with the speakers, make comments or ask questions. Speakers will include the following individuals:

- **Trends in High Spectral Efficiency Transmission,** Gabriella Bosco, *Politecnico di Torino, Italy*
- **Trends in High-speed Digital Signal Processing for Optical Communications,** Maxim Kuschnerov, *Univ. of Melbourne, Australia*
- **What Does the Future Hold for All-optical OFDM?,** Jeurg Leuthold, *Karlsruhe Institute of Technology, Germany*
- **Trends in Photonic Integrated Circuits for Coherent Optical Communications,** Jeff Rahn, *Infinera Corp., USA*
- **Trends in High-speed Optical Transport,** Kim Roberts, *Ciena Corporation, Canada*

Other speakers and topics will also be presented during the Workshop.

Withdrawn

Title: Widely and Continuously Tunable Narrow-band Photonic Filters with MEMS Integration
Contact: Guanquan Liang
Abstract ID: ITu3B.6

Title: Observation of all-optical Berezinskii-Krosterlitz-Thouless crossover in a photonic lattice
Contact: Guohai Situ
Abstract ID: NTu4D.7

Title: High Power Passive Components for kW Lasers
Contact: Bertrand Gauvreau
Abstract ID: SM2E.2

Presider Changes

Igor Tsukerman will now be presiding over session **IM4B: Theory, Modeling & Simulations III**, on Monday, 18 June.

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JW4D: Joint NP and BGPP Postdeadline Session

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Wednesday, 20 June, *Colorado I*

16:00 – 17:36

Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP)

Nonlinear Photonics (NP)

16:00 – 17:36
JW4D • Joint NP and BGPP Postdeadline Session
John Dudley, Universite de Franche-Comte, France

JW4D.1 • 16:00
Optimization of Tapered Photonic Crystal Fibers for Blue-Enhanced Supercontinuum Generation, Uffe Møller[1], Simon Sørensen[1], Casper Larsen[1], Christian Jakobsen[2], Jeppe Johansen[2], Peter M. Moselund[2], Carsten L. Thomsen[2], Ole Bang[1, 2]; [1]*DTU Fotonik - Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark;* [2]*NKT Photonics A/S, Birkerød, Denmark.* Tapering of photonic crystal fibers is an effective way of shifting the dispersive wavelength edge of a supercontinuum spectrum down in the deep-blue. We discuss the optimum taper profile for blue-enhanced supercontinuum generation.

JW4D.2 • 16:12
Low-Power All-Optical Switching through Frozen Light at Degenerate Band Edges, Nadav Gutman[1], Andrey A. Sukhorukov[2], Falk Eilenberger[3], C. Martijn de Sterke[1]; [1]*School of Physics, the Univ. of Sydney, Australia;* [2]*Research School of Physics and Engineering, Australian National Univ., Australia;* [3]*Institute of Applied Physics, Universität Jena, Germany.* We predict that nonlinear waveguides designed to support frozen light at degenerate band edges enable tunable bistable response and orders-of-magnitude lower all-optical switching threshold compared to conventional slow-light at regular band-edges.

JW4D.3 • 16:24
Demonstration of chalcogenide optical parametric oscillator, Raja Ahmad[1], Chams Baker[1], Martin Rochette[1]; *McGill Univ., Canada.* The first chalcogenide glass based optical parametric oscillator (OPO) is demonstrated. The OPO –pumped in C band– resonates simultaneously in the L and S bands, with a threshold peak power of 21.6 dBm and >19 % conversion efficiency.

JW4D.4 • 16:36
Spectral broadening of femtosecond pulses in polycrystalline anatase titanium dioxide waveguides, C.C. Evans[1], K. Shtyrkova[1], J.D.B Bradley[1, 2], E. Ippen[2], E. Mazur[1]; [1]*School of Engineering and Applied Sciences, Harvard Univ., USA; Research Laboratory of Electronics, Massachusetts Inst. of Technology, USA.* We observe the first nonlinear spectral broadening of femtosecond pulses in single-mode anatase TiO2 waveguides at 793 and 1565 nm. The broad applicability and low two-photon absorption of TiO2 makes it a promising material for integrated photonics.

JW4D.5 • 16:48
Photonic chip based tunable and dynamically reconfigurable microwave photonic filter using stimulated Brillouin scattering, Ravi Pant[1], Adam Byrnes[1], Enbang Li[1], Duk-Yong Choi[2], Christopher G. Poulton[3], Shanhui Fan[4], Steve Madden[2], Barry Luther-Davies[2], Benjamin J. Eggleton[1]; [1]*CUDOS School of Physics, Univ. of Sydney, Australia;* [2]*CUDOS Laser Physics Centre, Australian National Univ., Australia;* [3]*CUDOS School of Mathematical Sciences, Univ. of Technology Sydney, Australia;* [4]*Department of Electrical Engineering, Stanford Univ., USA.* We report the first demonstration of on-chip tunable narrowband microwave photonic filter with shape reconfiguration. Stimulated Brillouin scattering is exploited in a chalcogenide chip to demonstrate a microwave filter with 3dB bandwidth ~23MHz over 2-12GHz.

JW4D.6 • 17:00
Ultra-low Raman Noise Correlated Photon-Pair Generation in a Dispersion Engineered As_2S_3 Waveguide, M.J. Collins[1], A.S. Clark[1], J. He[1], D.Y. Choi[2], R.J. Williams[3], A.C Judge[1], M.J. Steel[3], B. Luther-Davies[2], C. Xiong[1], B.J. Eggleton[1]; [1]*School of Physics, Univ. of Sydney, Australia;* [2]*Research School of Physics and Engineering, Australian National Univ., Australia; Department of Physics and Astronomy, Macquarie Univ., Australia.* We demonstrate ultra-low Raman noise generation of correlated photon-pairs in a dispersion-engineered 10mm As_2S_3 waveguide at room temperature. We show a coincidence-to-accidental ratio (CAR) of 16.8, a 250 times increase compared with previously published results.

JW4D.7 • 17:12
Tunable Picosecond Tm Fiber Laser, Youngjae Kim, Bryan Burgoyne[1], Cedric Aboutarabi[1], Guido Pena[1], Alain Villeneuve[1]; *Genia Photonics Inc., Canada.* We demonstrate a tunable picoseconds Tm fiber laser with tuning range about 90 nm centered at 1950 nm and pulse width of 130 ps. Repetition rate is 10 MHz. Time average power is 1 W.

JW4D.8 • 17:24
Second-Harmonic Vortex Generation with a Poled Glass, Costantino Corbari[1], Alexey V. Gladyshev[2], Mindaugas Gecevicius[1], Martynas Beresna[1], Peter G. Kazansky[1]; [1]Optoelectronics Research Centre, University of Southampton, UK; [2]Fiber Optics Research Center, Russian Academy of Sciences, Russian Federation. A Simple method for nonlinear vortex generation is presented. Spin-to-Orbital transfer with total angular momentum conservation between photons at the fundamental and at the second-harmonic frequency is demonstrated.

Optimization of Tapered Photonic Crystal Fibers for Blue-Enhanced Supercontinuum Generation

Uffe Møller,[1,*] Simon T. Sørensen,[1] Casper Larsen,[1] Christian Jakobsen[2], Jeppe Johansen[2], Peter M. Moselund[2], Carsten L. Thomsen[2], and Ole Bang[1,2]

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Abstract: Tapering of photonic crystal fibers is an effective way of shifting the dispersive wavelength edge of a supercontinuum spectrum down in the deep-blue. We discuss the optimum taper profile for blue-enhanced supercontinuum generation.

OCIS codes: (060.4370) Nonlinear Optics, fibers; (320.6629) Supercontinuum generation.

1. Introduction

Supercontinuum (SC) sources generating light in the visible part of the electromagnetic spectrum have proven to be valuable tools in various biological applications [1]. For these applications it is beneficial that as much light as possible is available in the visible part of the spectrum. In the recent years, much research has been devoted to tailoring the photonic crystal fibers (PCFs) for optimizing the desired SC spectrum. Tapering of fibers have shown to be an effective way to blueshift the short wavelength edge of the SC by means of changing the fiber dispersion and increasing the nonlinearity [2, 3]. In this work, we present an asymmetrical PCF taper fabricated directly on the draw-tower. The fiber is tapered back to its initial diameter to facilitate better handling and coupling efficiency, and to allow for an investigation of the asymmetry. We demonstrate high power SC generation with extended bandwidth and, by introducing the concept of a group-acceleration mismatch [4,5], we give a clear interpretation of the results and provide a recipe for optimizing the taper shape for maximum bandwidth and available power in the blue edge of the spectrum.

An SC spectrum largely consists of a solitonic red edge linked to a dispersive wave (DW) blue edge through a complex trapping mechanism. As the solitons are redshifting they cause the DWs to blueshift through group-velocity (GV) matching [6]. The position of the blue edge for a given fiber can hence be estimated from numerically calculated GV curves if the position of the solitonic edge is known. Figure 1(a) illustrates the blue edge wavelength as a function of hole-to-pitch ratio and pitch assuming group velocity matching to a loss edge of 2300 nm or 50 nm below the 2nd ZDW. The GV profile of the fiber, and hence the link between the spectral edges, can be altered by tapering [2, 4].

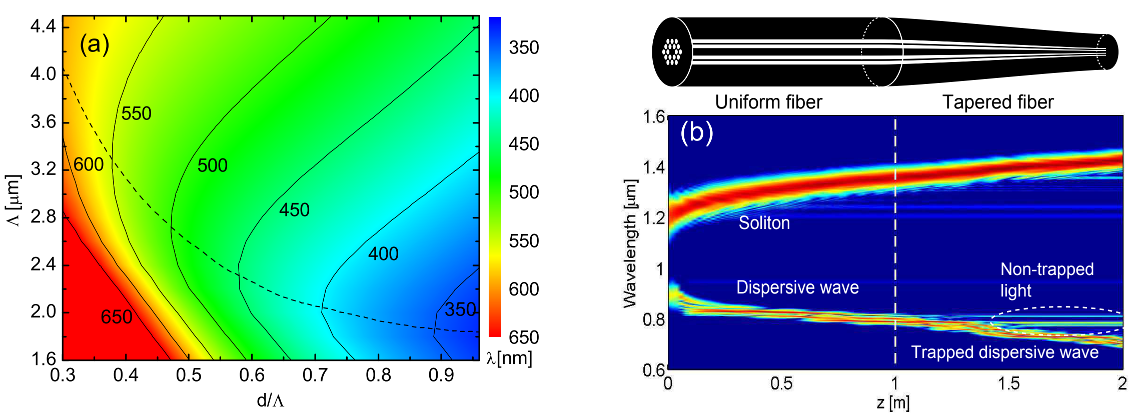

Fig. 1: (a) Blue edge wavelength λ as a function of hole-to-pitch ratio d/Λ and pitch Λ assuming group velocity matching to a loss edge of 2300 nm or 50 nm below the 2nd ZDW. The dashed line indicates the optimum Λ for a given d/Λ. (b) Spectral evolution of a 20 fs fundamental soliton and trapped wave through a fiber taper with an initial 1 m uniform fiber.

In a uniform fiber a soliton can trap and blueshift a DW as long as it keeps redshifting and decelerating. However, when a soliton and trapped DW enter a taper, the soliton undergoes a relatively larger change in GV (deceleration), which diminishes the trapping potential and causes light to escape. The trapping process and leakage is illustrated in Fig. 1(b) with a careful numerical simulation of the propagation of a soliton and seeded DW through a tapered fiber; the DW clearly starts shedding light in the tapered part of the fiber. We have recently demonstrated that the taper induced relative change in GV, or Group-Acceleration Mismatch (GAM), is responsible for the amount of blueshifted light; more light is blueshifted when the GAM is minimised by making the down-tapering more gradual. This can be understood as an enhancement of the interaction between the soliton and DW due to a minimization of the walk-off.

2. Experiments

By fabricating an asymmetric taper where the fiber is tapered back to its original diameter, the concept of GAM can be verified experimentally. The PCF taper was fabricated directly on the draw tower, which offers unprecedented control of the fiber parameters and excellent reproducibility. Figure 2(a) shows the spectra obtained when pumping the fiber with a high-power 1064 nm ps laser and compares the spectra obtained when pumping from the short and long down-tapering side of the taper with that of a uniform fiber of a similar length. The taper had 3 m uniform fiber before and after the tapered section, and the dispersion of the uniform fiber and the taper waist is shown in Fig. 2(b). Tapering yields a clear extension of the spectral bandwidth, and, as expected due to the lower GAM, pumping from the long down-tapering side significantly enhances the available power in the extended bandwidth as illustrated in Fig. 2(c).

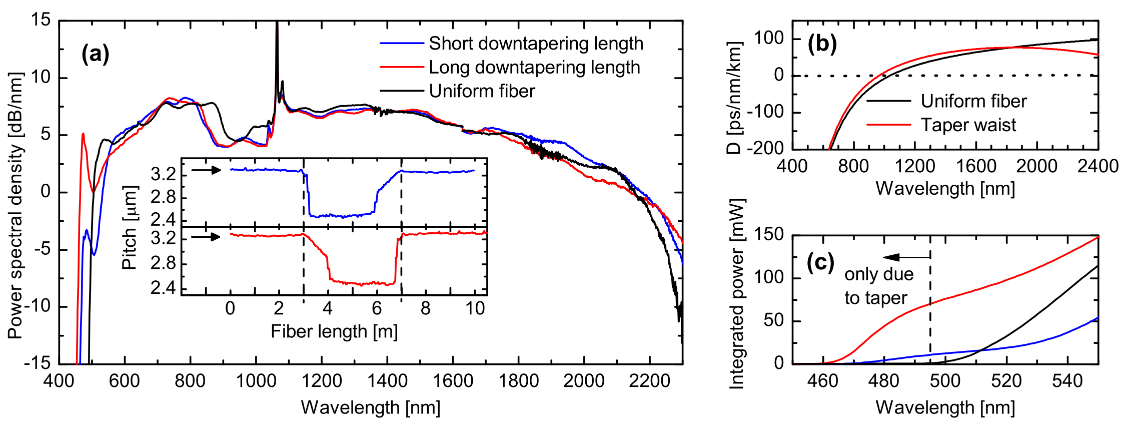

Fig. 2: (a) Experimental output spectra when pumping the asymmetric taper from the short (blue line) and long (red line) downtapering ends. The spectrum of a 10 m uniform fiber (black line) is shown for comparison. The inset shows the tapering profile and the arrows indicate the pump direction. (b) Calculated dispersion of the uniform fiber (black line) and the taper waist (red line). (c) Integrated power in the blue edge for the fibers shown in (a). The vertical line indicate the blue edge of the uniform fiber (495 nm), all power shifted below this wavelength is generated in the taper.

3. Conclusion

In conclusion, we have numerically and experimentally verified the importance of the concept of group-acceleration matching (GAM) to find the optimal taper shape. It was demonstrated that the taper degree determines the blue edge and the taper shape has a strong impact on the power in the blue edge. A longer down-tapered section yields a higher power in the blue edge of the spectrum due to a correspondingly lower GAM.

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Low-Power All-Optical Switching through Frozen Light at Degenerate Band Edges

Nadav Gutman[1,*], Andrey A. Sukhorukov[2], Falk Eilenberger[3], and C. Martijn de Sterke[1]
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Abstract: We predict that nonlinear waveguides designed to support frozen light at *degenerate band edges* enable tunable bistable response and orders-of-magnitude lower all-optical switching threshold compared to conventional slow-light at regular band-edges.

OCIS codes: (190.3270) Kerr effect; (190.1450) Bistability; (230.7370) Waveguides.

1. Introduction

Nonlinear phenomena such as bistability, self-pulsation, solitons and slow light enhancement [1-4] have been demonstrated in periodic waveguides where they can be associated with the presence of a photonic band edge. A *regular* photonic *band edge* (RBE) has the form: $\Delta\omega \propto \Delta k^2$ (Fig. 1(a) red), where ω and k are the frequency and the wavenumber respectively. However, to observe these phenomena, high intensities are needed, for example more than of 10 kW in an optical fiber. The purpose of this submission is to report the prediction that power requirement can be reduced by an order of magnitude in quartic *degenerate band edges* (DBEs), of the form $\Delta\omega \propto \Delta k^4$ (Fig. 1(a) blue). We also show that the nonlinear response near DBEs qualitatively differs from that near RBEs, which is a consequence of the high intensity present in modes with zero group velocity ("*frozen light*").

2. Background

The first theoretical investigation of DBEs in *photonic crystals* (PCs) referred to a 1D magnetic PC [5]. We later showed that DBEs can be created in a variety of waveguides such as fiber gratings [6,7] periodic nanowires [8] and photonic crystal waveguides [9]. We use coupled mode theory to describe mode propagation near a DBE, leading to a formulation of the modes in terms of defective matrices which can be written in Jordan normal form. We use perturbation theory of such matrices [10] to show that the dispersion near a quartic DBE follows the 4th root of the frequency detuning from the band edge: $\Delta k_j \propto \sqrt[4]{\Delta\omega}\, e^{i(\pi/4)j}$ $(j = 0,..,3)$. Thus, Δk_j can be complex corresponding to evanescent waves. The key feature of DBEs is the degeneracy of evanescent and propagating modes at the band edge. This degeneracy plays a key role at the interfaces of structures with a DBE, since satisfying the boundary conditions requires the field to be a superposition of these degenerate modes. Though each has large amplitude, at the interface the amplitude of the superposition is small. This effect becomes more extreme close to the band edge. The degeneracy leads to *frozen light*: the field inside the waveguide initially grows as $|E|^2 \propto z^2$ (Figs. 1(b)-(c), blue), though the group velocity is zero [5]. The longer the waveguide the more the field grows before it eventually decays. In contrast, near RBEs the field intensity decreases exponentially (Figs. 1(b)-(c), red), independent of the waveguide length.

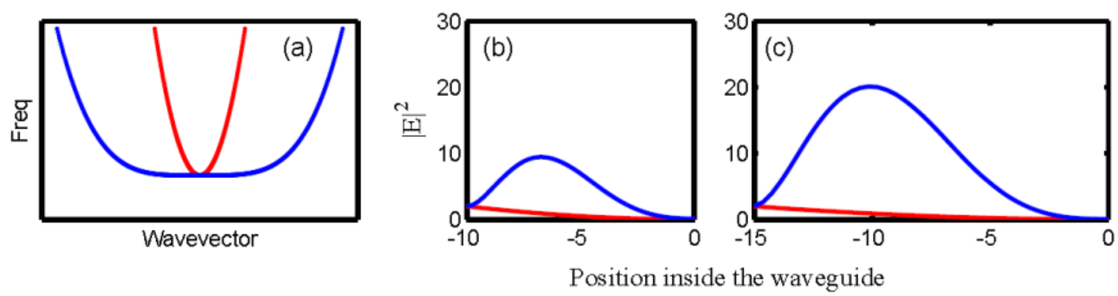

Fig. 1: (a) The dispersion of a RBE (k^2, red) and quartic DBE (k^4, blue) band edge. (b) and (c) field intensity inside a waveguides with different lengths. RBE (red) and quartic DBE (blue). at the band edges frequency

3. Solutions near nonlinear degenerate band edges

The solutions for the fields in the presence of a Kerr nonlinearity were found by backward integrating the coupled mode equations: $\overline{E}(z) = \int_0^{-L} M_{NL}(\overline{E})dz$, where L is the length of the waveguide and M_{NL} is the set of the coupled equations. Figure 2(a) compares the cw transmission versus input power for an RBE and a DBE. The curves indicate stable solutions, while unstable solutions are marked by plus (+) symbols. There are two key differences in the behavior of DBEs and RBEs. First, for RBEs (Fig. 2(a), red) there can be bistability (the curve folds backward), while in DBEs the bistability can always be avoided (Fig. 2(a), blue) by adjusting the input state. Secondly, the switching from low to high transmission occur at an input power which is more than an order of magnitude lower for the DBE than for the RBE. For example, in a silica fiber grating with a mode area of $30\,\mu m^2$, the required input peak power for switching in a DBE is 850 W, while for an RBE it is around 10 kW. To demonstrate these features, we performed full time-dependent simulations. Figures 2(b) and (c) show the transmission of a triangular input pulse for DBE and RBE waveguides respectively. As there is no instability in the DBE waveguide, the transmission strictly follows the input power according to the blue curve in Fig. 2(a). For the RBE waveguide, the transmission jumps from stable to stable band, without reaching unite transmission. At higher input powers the fields evolve from being stable (Fig. 2(d)) to self-pulsation (Fig. 2 (e)) through modulation instability. Again, in the DBE this occurs at much lower powers.

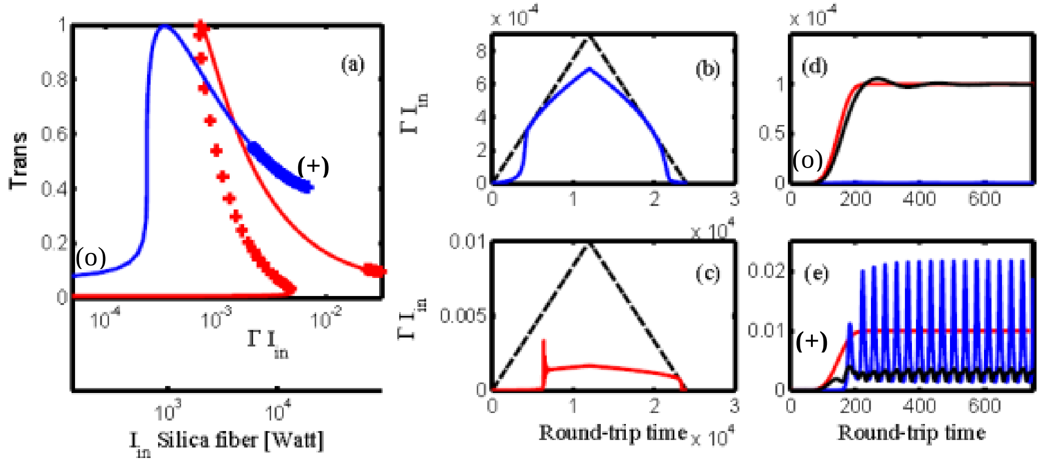

Fig. 2 :(a) Transmission versus input power for RBE (red) and DBE (blue). Unstable solutions are marked as plus signs. Output power versus time for a triangular input power. (d) stable and (e) instable self pulsation true modulation instability.

3. Conclusion

This is, to the best of our knowledge, the first analysis of nonlinear effects in waveguides with DBEs. We show how DBEs and frozen light affect stability and self pulsation. Since the frozen light modes and the associated energy grow with the length of the structure, this accordingly enhances the nonlinear phenomena. While the power levels quoted refer to fiber grating geometries, similar improvements in power levels occur in other geometries with DBEs.

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Demonstration of chalcogenide optical parametric oscillator

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Abstract: The first chalcogenide glass based optical parametric oscillator (OPO) is demonstrated. The OPO –pumped in the C-band– resonates simultaneously in the L-and S-bands, with a threshold peak pump power of 21.6 dBm and >19 % power conversion slope.

OCIS codes: (060.2320) Fiber optics, amplifiers and oscillators; (190.4970) Nonlinear optics, parametric oscillators and amplifiers; (190.4410) Nonlinear optics, parametric processes.

Optical parametric oscillators (OPOs) are attractive owing to their tunability over an exceptionally broad frequency range with respect to laser sources made from conventional gain media. OPOs have been realized in different nonlinear materials, based on both the second and third order susceptibilities $\chi^{(2,3)}$. The $\chi^{(2)}$ based OPOs [1] are however bulky, susceptible to misalignment, and can exclusively operate at wavelengths longer than that of the pump laser. On the other hand, $\chi^{(3)}$ based OPOs from silica fibers require high pump powers and long interaction lengths and are thus impractical [2]. The $\chi^{(3)}$ OPOs based on integrated devices or microresonators [3-8] are incompatible with the existing fiber technology despite being attractive in terms of compactness. Furthermore, the microresonator based OPOs suffer from longer response times, from hundreds of picoseconds to hundreds of nanoseconds, and are thus restricted to low bandwidth applications while the silicon based OPOs are restricted to beyond 2 µm wavelengths owing to large two-photon absorption and free-carrier generation in the telecommunications bands [3]. The OPOs based on microstructured fibers [9] are attractive for their fiber compatibility and their controlled dispersion profile but such OPOs have only been realized using silica glass that itself is a weak nonlinear medium.

Among $\chi^{(3)}$ optical materials, arsenic triselenide (As_2Se_3) chalcogenide glass boasts one of the highest nonlinear refractive index coefficient n_2= 2.3 × 10^{-13} cm^2/W [10], that is up to 1000 × that of silica, 20 × that of Bi_2O_3, 4 × that of As_2S_3, and 3 × that of Si [10-12]. In terms of chromatic dispersion, As_2Se_3 exhibits a large normal dispersion in the 1550 nm wavelength band, where the abundant existing lasers could be utilized for OPO pumping. The large dispersion prevents efficient parametric gain close to the pump wavelength, thereby rendering it difficult to realize OPOs from As_2Se_3 in bulk or in an optical fiber format. This limitation may however be overcome by shaping the As_2Se_3 waveguide into a microwire [13] for which the anomalous waveguide dispersion overcomes the normal material dispersion. In addition to enabling zero total dispersion at the pump wavelength, such a microwire exhibits a large waveguide nonlinear coefficient γ [14] ($= n_2\omega_P/cA_{eff}$, ω_P being the pump angular frequency, c being the speed of light and A_{eff} being the effective mode area in the microwire) and thus lowers the power threshold for nonlinear applications including the OPO operation.

Here, we present an OPO based on the use of an As_2Se_3 microwire coated with a poly-methyl meth-acrylate (PMMA) cladding. The PMMA cladding, in addition to providing physical strength to the ~1um chalcogenide wire [15], serves to optimize phase-matching conditions towards efficient and broadband parametric gain [13]. The OPO oscillates simultaneously at two wavelengths that are the Stokes and anti-Stokes wavelength shifts of +53 nm and -50 nm from the pump laser wavelength, respectively. The large nonlinearity, reduced chromatic dispersion from the PMMA cladding and the long effective length of As_2Se_3 hybrid microwires allows the OPO to oscillate at a low threshold peak pump power of 21.6 dBm and with a total power conversion efficiency >19%.

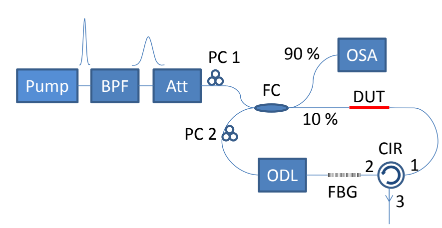

Fig. 1. Experimental setup for the OPO operation. BPF: band-pass filter; Att: optical attenuator; PC: fiber polarization controller; FC: fiber coupler; OSA: optical spectrum analyzer; DUT: device-under test; CIR: optical circulator; FBG: silica fiber bragg grating; ODL: optial (tunable) delay line.

The hybrid As_2Se_3-PMMA microwire is prepared from a chalcogenide fiber provided by Coractive High-Tech and following a procedure detailed in Ref. [13, 14]. The microwire has an As_2Se_3 core diameter of 1.01 µm, As_2Se_3-PMMA composite diameter of ~15 µm and is 10 cm long, with a total insertion loss of 5.0 dB when coupled to conventional silica fiber. Fig. 1 shows the experimental setup for the OPO operation. The pump laser is a 20 MHz mode-locked laser that emits pulses of full-width at half maximum (FWHM) duration of ~450 fs and spectrally centered at λ =1551 nm. The pump is filtered with a ~0.25 nm bandpass filter (BPF) centered at 1552 nm to lengthen the pulses to FWHM duration ~ 22ps. The resulting pump pulses are delivered to the microwire via the 10 % output port of a 90/10 fiber coupler (FC). This results in the optical parametric amplification on both sides of the pump wavelength in an almost symmetric manner, determined precisely by the dispersion profile of the microwire. In order to realize OPO, the generated parametric signal is fed-back to the microwire via the 90% input port of the FC, thus completing the laser cavity. The residual pump pulse is filtered out from the fed-back signal using a fiber Bragg grating resonant at the pump wavelength combined with an optical fiber circulator (CIR). This avoids any unfavourable interference of the incoming pump pulse with the preceding residual one. A fiber-coupled (tunable) optical delay line (ODL) is

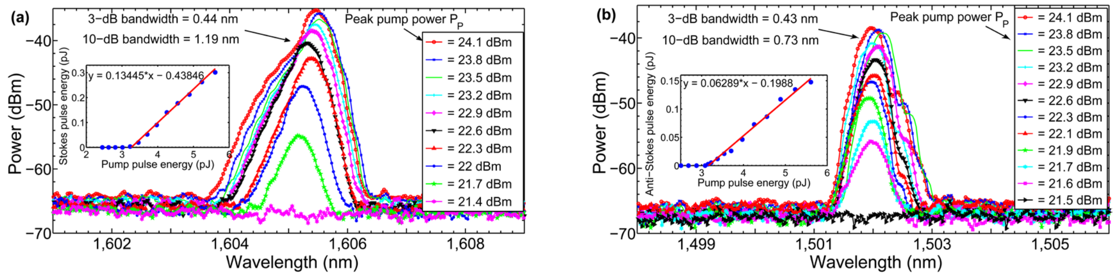

Fig. 3. Output spectra of the (a) Stokes and (b) anti-Stokes OPO signals for the increasing values of input peak pump power. (Inset) The pulse energy in the Stokes and the anti-Stokes output signals are plotted against the input pump pulse energies and are included as inset in (a) and (b) respectively.

introduced for a precise control of the cavity length so that the amplified Stokes and anti-Stokes signals that resonate in the loop cavity are synchronized with the incoming pump pulse. The dispersive walk-off between the pump and amplified signals is ignored since the walk-off length of ~ 2.2 m [16] resulting from the wavelength separation between the pump and the Stokes/anti-Stokes signals is considerably longer than the length of the parametric gain medium i.e., the 10 cm long microwire. Finally, fiber polarization controllers (PC) are inserted in the pump path and cavity path to align the polarization states of the incoming pump with the two oscillating signals. The operation of the OPO is observed on an optical spectrum analyzer (OSA) connected to the 90 % output port of the fiber coupler.

Increasing the pump power from zero, when the total single-pass parametric gain exceeds the round-trip cavity loss of 8 dB, the OPO oscillates simultaneously at the Stokes and anti-Stokes wavelengths of 1605 nm and 1502 nm respectively, thus converting a C-band pump laser to L-band (Stokes) and S-band (anti-Stokes) outputs. Figs. 2 (a) and (b) show the spectra of the output Stokes and anti-Stokes OPO signals with increasing pump power. The spectral FWHMs of the OPO outputs are ~ 0.44 nm, while the 10-dB bandwidths are 1.19 nm and 0.73 nm for the Stokes and the anti-Stokes signals, respectively. The Stokes signal carries 3.3 dB more energy than the anti-Stokes one. This is explained from the additional Raman gain at the Stokes wavelength that coincides with the ~53 nm Raman shift of bulk As_2Se_3 [13]. Both the Stokes and the anti-Stokes signals have a threshold peak pump power of ~21.6 dBm, corresponding to a pump pulse energy of 3.15 pJ. The power conversion slope of the Stokes output (Fig.2.a inset) exceeds 13 %, with the Stokes output pulse carrying > 0.3 pJ energy for the pump pulse energy of 5.6 J. The power conversion slope of the anti-Stokes signal is >6 % corresponding to a pulse energy ~ 0.15 pJ, thus providing a combined Stokes and anti-Stokes power conversion efficiency of > 19 %. This conversion efficiency is large considering the small foot-print and the low-power operation of this OPO.

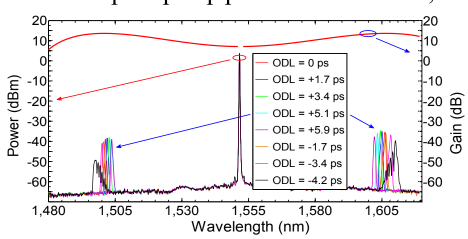

Fig. 2. Output of the OPO as observed on an OSA for various delay values on the oscillating Stokes and anti-Stokes signals. The calculated parametric gain spectrum under the experimental conditions is also included.

Fig. 3 shows the output spectra of the OPO as recorded on the OSA. The spectra show the simultaneous oscillation of the doubly-resonant OPO at the Stokes and anti-Stokes wavelengths. After setting up the OPO, we study the effect of adding a relative delay on the oscillating Stokes and anti-Stokes signals, thus compromising their precise synchronization with the pump pulse. The OPO operates over a wide temporal detuning of approximately ± 5 ps beyond which there is no output signal. This detuning allows the Stokes and anti-Stokes wavelengths tuning by up to 8 nm. This wavelength tuning results from the synchronization, with the incoming pump pulse, of different frequencies in the parametric gain spectrum which have different propagation constants. In order to compare the experimental results with theory, the single-pass parametric gain in a microwire with a diameter of 1.01 µm is calculated for 24.1 dBm peak pump power. The calculated parametric gain profile is included in Fig. 3, showing that the predicted gain is maximum (parametric gain = 13.7 dB, Raman gain = 2.8 dB [16]) at wavelengths where the experimental OPO oscillates.

In summary, we have demonstrated the first OPO in chalcogenide glass. The OPO oscillates simultaneously at Stokes and anti-Stokes wavelengths in the L- and the S- telecommunications frequency bands respectively, with the pump lying in the C-band. The OPO has a high conversion efficiency of >19 % and a threshold peak pump power of 21.6 dBm.

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Spectral broadening of femtosecond pulses in polycrystalline anatase titanium dioxide waveguides

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Abstract: We observe the first nonlinear spectral broadening of femtosecond pulses in single-mode anatase TiO_2 waveguides at 793 and 1565 nm. The broad applicability and low two-photon absorption of TiO_2 makes it a promising material for integrated photonics.
OCIS codes: 190.4390 Nonlinear optics, integrated optics; 190.4400 Nonlinear optics, materials; 320.6629 Supercontinuum generation;

1. Introduction

Titanium dioxide (TiO_2) is an emerging material for on-chip nonlinear microphotonic devices, which balances a strong optical nonlinearity with a high refractive index, and wide wavelength transparency. TiO_2 is most comparable to silicon nitride, displaying visible transparency and minimal two-photon absorption for wavelengths near 800 nm [1]. However, TiO_2 has a Kerr nonlinearity that is three-times stronger than silicon nitride (8×10^{-19} m^2/W), it possesses a higher refractive index (2.4 versus 2.0), and it can be deposited at low temperatures (< 400 °C), allowing for back-end integration with silicon microphotonic devices. To explore the scope of future nonlinear applications in TiO_2, we report the first observations of spectral broadening in polycrystalline anatase TiO_2 waveguides at both 793 and 1565 nm.

2. Experimental details

We structure two sets of waveguides in 250-nm thin films of polycrystalline anatase TiO_2, deposited on oxidized silicon substrates using reactive sputtering of titanium metal in an oxygen/argon environment. We define S-shaped, strip-waveguides using electron beam lithography, then form waveguides by reactive ion etching with a chromium mask [2]. We clad the resulting waveguides with a transparent fluoropolymer and cleave the chip to prepare end-facets. The waveguides are 200 and 900 nm wide and are 6 and 9 mm long for measurement at 793 and 1550 nm, respectively.

We launch femtosecond pulses using objective coupling into the waveguides and record the output spectra as a function of pulse energy using a spectrometer and an optical spectrum analyzer (793 nm and 1565 nm, respectively). We use 100 fs pulses from a Ti:Sapphire oscillator centered at 793 nm and 190 fs pulses from an optical parametric oscillator tuned to 1565 nm. We control the power and polarization using a half wave-plate followed by a polarizer.

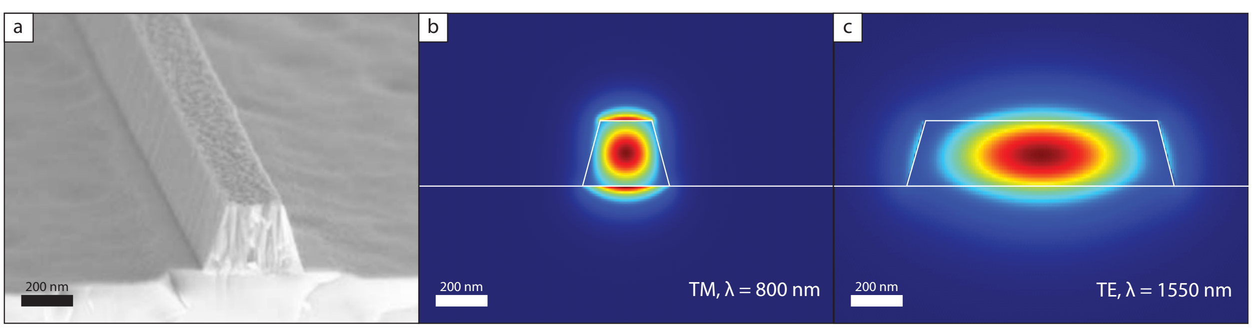

Fig. 1 Scanning electron micrograph of a 200-nm wide polycrystalline anatase TiO_2 waveguide (a) and mode profiles for the 200-nm-wide (b) and 900-nm-wide (c) waveguides for measurements at 793 and 1565 nm, respectively.

3. Results

Figure 1 shows a cross section of a polycrystalline anatase waveguide without top-cladding and the mode-profiles corresponding to our measurements at 792 and 1565 nm. Figure 2 shows the spectra obtained after pulse propagation in a 200-nm and a 900-nm waveguide (793 nm and 1564 nm, respectively). We observe broadening by a factor of 3.2 around 793 nm and 3.8 around 1550 nm for 46 and 231 pJ pulses as measured at the –15 dB point, respectively. In addition, we observe a shift of the peak wavelength during 793-nm measurements and additional peaks forming during 1565-nm measurements.

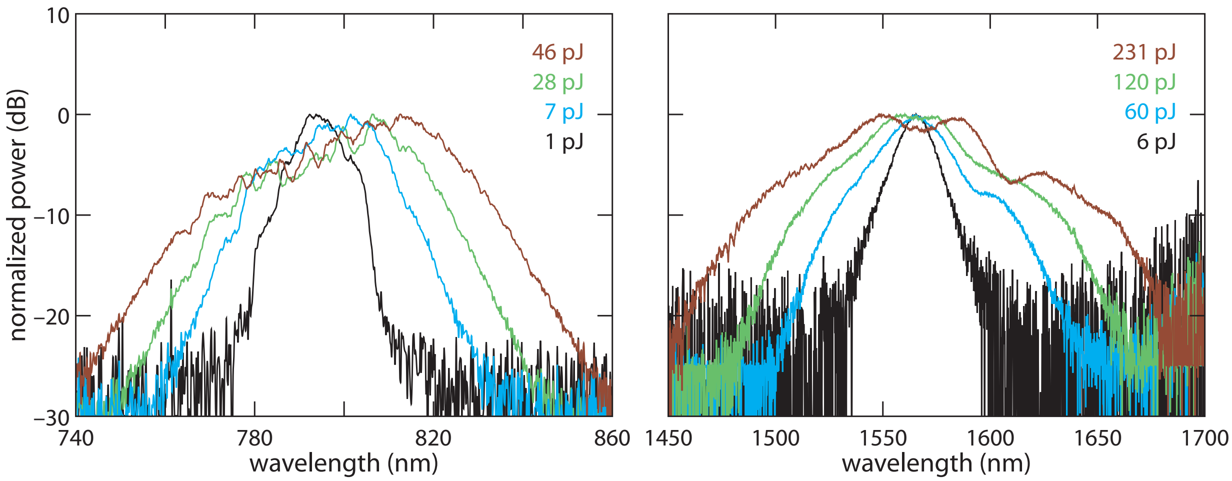

Fig. 2 Spectral broadening of femtosecond pulses in anatase waveguides centered at 795 nm (left) and 1565 nm (right).

4. Discussion

We report the first observation of spectral broadening in polycrystalline anatase TiO_2 waveguides at two wavelengths which span the octave from the interconnect band around 793 nm to the U-band. The spectra around 793 nm display more pronounced broadening at lower pulse energies. This may be attributed to different effective areas, resulting in large changes to the effective nonlinearity [3]. Estimated effective nonlinearities are 39.4 and 7.6 $W^{-1}m^{-1}$ for the 800-nm and 1550-nm waveguides, respectively. Thus, the Kerr coefficient at these wavelengths is likely very similar. The shift in the peak of the spectrum at 793 nm, as well as the asymmetrical structure in the measurements at 1565 nm are consistent with intra-pulse Raman scattering by the strong 141 cm^{-1} anatase Raman peak.

The devices we establish here represent the first nonlinear application of integrated TiO_2 photonics. All measurements were extremely stable with time and repeatable, indicating the robustness of the material. As with silicon photonics, waveguide dispersion is extremely tunable in TiO_2, which will enable further applications such as supercontinuum sources [4], comb generation[5] and wavelength conversion. In addition, the low two-photon absorption may lead the way to ultrafast, non-resonant all-optical switching applications. Based on these first nonlinear results in TiO_2 waveguides, we show that TiO_2 is a promising material for future integrated nonlinear photonics applications.

4. Summary

We demonstrate spectral broadening in anatase TiO_2 waveguides near 800 and 1550 nm. Using pulse energies of tens to hundreds of pJ, we observe broadening factors greater than 3. We conclude that TiO_2 has considerable potential for further on-chip nonlinear optical applications.

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Photonic chip based tunable and dynamically reconfigurable microwave photonic filter using stimulated Brillouin scattering

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Abstract: We report the first demonstration of on-chip tunable narrowband microwave photonic filter with shape reconfiguration. Stimulated Brillouin scattering is exploited in a chalcogenide chip to demonstrate a microwave filter with 3dB bandwidth ~23MHz over 2-12GHz.
OCIS codes (190.2640) Stimulated scattering, modulation, etc.; (190.4390) Nonlinear optics, integrated optics; (060.5625) Radio frequency photonics

Microwave filters form a critical part of microwave signal processing and find applications in Radar communications, radio over fiber (RoF), and mobile communications. These filters are usually implemented in electrical domain where they suffer from electromagnetic interference (EMI), limited tunability and limited reconfigurability of both filter shape and bandwidth [1]. Microwave Photonic (MWP) filters, on the other hand, provide wide tunability, natural immunity to EMI, and potential for both bandwidth and shape reconfigurability [1]. Over the past decade a number of MWP filter designs such as tap delay line based filters and single pass-band filters have been demonstrated in optical fiber and on-chip ring resonators using a number of techniques [1-3].

Here, we report the first demonstration of an on-chip, dynamically reconfigurable, tunable, narrowband microwave photonic filter with large Q. We exploit the large stimulated Brillouin scattering (SBS) cross-section (g_B ~ 0.74 x 10^{-9} m/W) and small effective mode area (~2.3 μm^2) [4] of a chalcogenide (As_2S_3) rib waveguide to achieve large gain in a 6.5 cm long waveguide at moderate pump power. For on-chip MWP filters, our device provides a narrow 3dB bandwidth f_{3dB} ~23 ± 2MHz with stable amplitude ~20 ± 2 dB over a wide frequency range (2-12 GHz) resulting in a Q ~ 600, which is ~40 times the Q previously reported for on-chip MWP filters [3]. The shape factor (S) of the MWP filter, which is defined as the ratio of -20dB to -3dB bandwidth, is tuned from 3.5 to 2 by tailoring the pump profile.

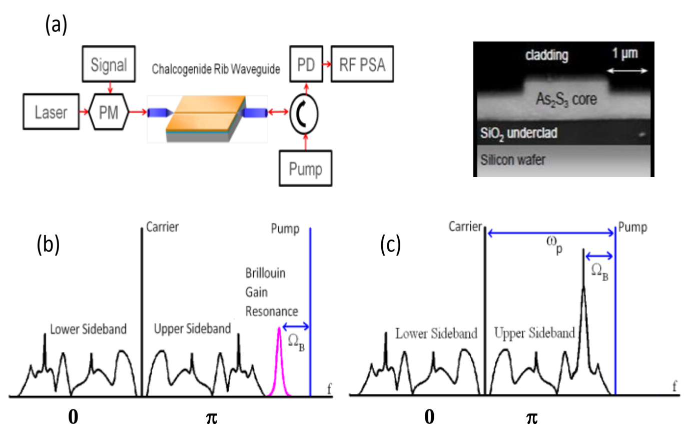

Figure 1(a) Schematic of the photonic chip based microwave photonic filter exploiting stimulated Brillouin scattering (b) phase modulated microwave signal when the Brillouin gain resonance is detuned from the upper side band, (c) phase modulated signal when the Brillouin gain resonance is tuned to the upper side band resulting in filtered RF signal

Figure 1(a) shows the schematic of a MWP filter exploiting SBS in a chalcogenide (As_2S_3) photonic chip. The RF signal is used to phase modulate (PM) an optical carrier, which results in equal amplitude upper and lower side bands with a π phase shift [5] as shown in Fig. 1(b). The PM signal is counter-propagated with a CW pump. When the pump is off or detuned from the PM signal (Fig. 1(b)), no signal is observed on the radio frequency spectrum analyzer (RFSA) because the beat signal between the carrier and upper sideband undergoes complete destructive interference with the beat signal generated by the carrier and lower side band, due to the π phase shift between the sidebands [5]. In order to filter a desired part of the RF spectrum, the spectral location of the Brillouin gain resonance is tuned to overlap with the signal in one of the PM sidebands (e.g. upper sideband in Fig. 1(c)). The amplified signal in the upper sideband results in the beat signal with the carrier being amplified relative to its π phase shifted counterpart in the lower sideband and therefore the destructive interference between the two out of phase beat signals is incomplete. This results in a filtered signal appearing on the RFSA centered at the RF frequency.

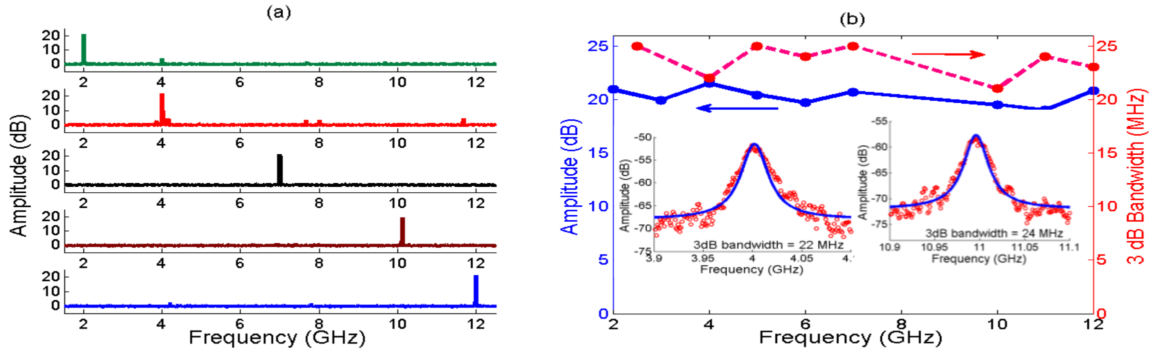

Figure 2(a) Tuning of the filter centre frequency over the range of 2-12 GHz and (b) bandwidth and amplitude stability of the filter response. Inset: Filter profiles taken at centre frequencies of 4 and 11 GHz.

Figure 2(a) shows the tuning response of the on-chip MWP filter demonstrating a wide tuning range (2-12 GHz), which was obtained by tuning the optical carrier frequency such that the RF carrier frequency is downshifted from the pump by the Brillouin shift. A constant SBS gain of ~ 20dB was used to obtain the tuning response. The amplitude and bandwidth fluctuations in the filter response over the tuning range are shown in Fig. 2(b) demonstrating good amplitude (20 ± 2 dB) and bandwidth (f_{3dB} ~23 ± 2 MHz) stability. The inset in Fig. 2(b) shows the MWP filter profiles centered at RF carrier frequencies of 4 GHz and 11 GHz.

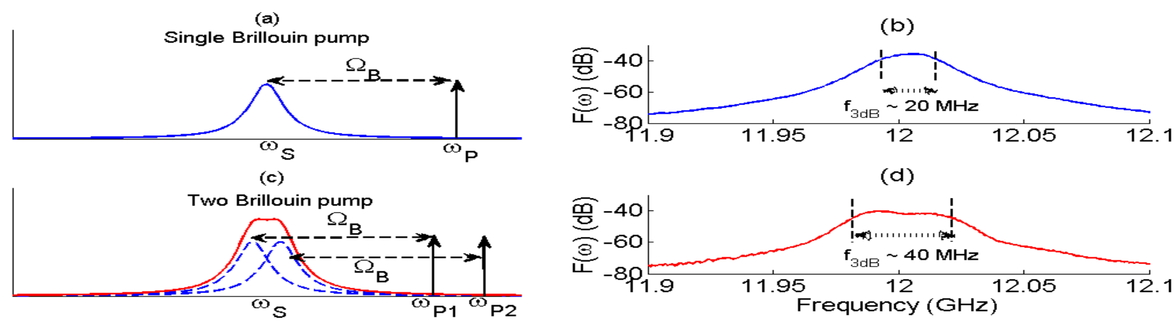

Figure 3 Theoretical filter response for (a) single and (c) two pumps demonstrating filter profile reshaping (flat top) with improved 3dB bandwidth. Measured filter profiles for (b) single pump f_{3dB} ~ 20 MHz and (d) dual pump f_{3dB} ~ 40 MHz with shape factor improved from S=3.5 (single pump) to S=2 (dual pump). The reshaping results in flat top filter profile.

To reconfigure the filter 3dB bandwidth [2] and shape factor S we tailor the pump profile. Figures 3(a) and 3(c) show that when we tailor pump spectrum from single-pump to dual-pump configuration the overall filter profile (solid Fig. 3(c)), which results from two individual gain profiles (dashed Fig. 3(c)), has a flat top shape and larger f_{3B}. Figures 3(b) and 3(d) show the measured MWP filter profiles for single CW pump and two CW pumps (separated by 18 MHz), respectively. Using two pumps, a flat top filter profile is achieved with f_{3dB} improved from ~20 MHz to ~40 MHz, which improved S from ~3.5 for single pump to ~2 for dual pump.

In conclusion, we have presented the first demonstration of a photonic chip based tunable, high Q, narrowband MWP filter with shape reconfiguration. A MWP filter with a stable 3dB bandwidth (~23 ± 2 MHz) and amplitude response (~20 ± 2 dB) over the tuning range of 2-12 GHz is demonstrated. Filter response was reconfigured by tailoring the pump profile which results in shape factor enhancement from 3.5 to 2.

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Ultra-low Raman Noise Correlated Photon-Pair Generation in a Dispersion Engineered As_2S_3 Waveguide

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Abstract: We demonstrate ultra-low Raman noise generation of correlated photon-pairs in a dispersion-engineered 10mm As_2S_3 waveguide at room temperature. We show a coincidence-to-accidental ratio (CAR) of 16.8, a 250 times increase compared with previously published results.

OCIS codes: (130.4310) Nonlinear; (190.5650) Raman effect; (270.0270) Quantum Optics

The generation of correlated photon pairs at telecommunication wavelengths is attractive for quantum communication, with the most commonly used integrated platforms being periodically poled lithium niobate (PPLN) [1] and silicon waveguides [2].These both have inherent drawbacks in that PPLN requires bulky temperature control to achieve phase matching and silicon suffers from two-photon absorption and the formation of free carriers. As_2S_3 chalcogenide glass has been used in photonics for decades, successfully applied to ultra-fast signal processing, sensing and recently quantum optics in the form of correlated photon pair generation in As_2S_3 planar waveguides by spontaneous-four-wave-mixing (SFWM) [3]. Chalcogenide has a high nonlinearity, low two-photon absorption and no free carriers in addition to photosensitive properties that can be exploited for on-chip filtering, making As_2S_3 an attractive integration platform [4]. However, a limit in the performance of As_2S_3 photon pair sources has been observed due to spontaneous Raman scattering (SpRS) [3].

In this paper we present a dramatic improvement to the correlated photon-pair statistics achieved in a chalcogenide device, with a coincidence-to-accidentals ratio (CAR) of 16.8, more than two orders of magnitude improvement over our previously published result [3] and at a level useful for quantum communication applications. This result is enabled by careful dispersion-engineering of the phase mismatch for SFWM in the device allowing the photon channels to be placed in the low spontaneous Raman window at 7.4THz detuning, where the SpRS intensity has been measured to be 100 times lower than the intensity close to the pump.

Device characteristics: Our device, illustrated in Fig. 1(a), is a rib waveguide 2 μm in width and 350 nm high above a 500 nm As_2S_3 layer, deposited on a silica-on-silicon substrate and overclad with a polymer layer. The propagation loss is 0.3 $dB.cm^{-1}$ with 5 dB per facet coupling loss. The nonlinear coefficient γ was measured to be 10 $W^{-1}m^{-1}$ and the dispersion calculated at the pump wavelength of 1545.36 nm is -209 $ps.nm^{-1}km^{-1}$ and 25.5 $ps.nm^{-1}km^{-1}$ for the TE and TM mode respectively. In our previous work, the waveguide dispersion and length restricted us to TE operation limiting the SFWM bandwidth to be only ±1.4THz about the pump where the SpRS efficiency is high, adding detrimental uncorrelated noise in the source [3]. The key here is the tailoring of the dispersion of the waveguide and the use of a shortened device, enabling TM mode operation, and SFWM over a broad bandwidth of up to 9 THz, as shown in Fig. 1(b). The normalized pair and Raman photon generation rate is shown in Fig. 1(b). The dispersion engineering allows the signal and idler channels to be shifted to the low SpRS window at 7.4 THz [5,6], shown as the shaded region in Fig. 1(b), where the SpRS is significantly reduced.

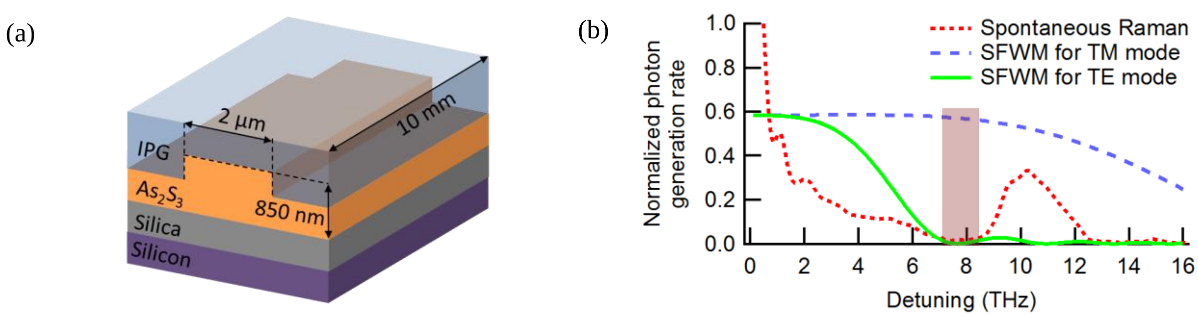

Fig. 1(a) Cross section of the As_2S_3 waveguide. IPG: Inorganic polymer glass (b) Calculation of the normalized photon generation versus detuning from the pump. The short dashed line shows the spontaneous Raman photon rate, with a characteristic minimum at 7.4THz (shaded). The long dashed line is the SFWM correlated pair photon generation rate in the TM mode, and the solid line is the pair generation rate for the TE mode. Only the TM mode provides sufficient bandwidth for pair generation in the low Raman window.

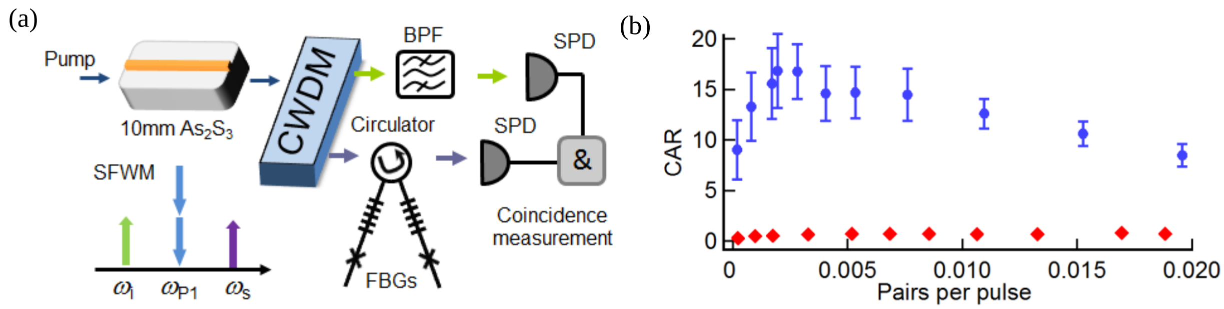

Fig. 2(a) Correlated photon pair generation via SFWM in the waveguide. Signal and idler photons are spectrally separated and filtered before reaching a pair of single photon detectors. CWDM: coarse wavelength division multiplexer, BPF: Band-pass filter, SPD: single photon detector, FBG: fiber Bragg grating, SFWM: spontaneous-four-wave-mixing. (b) The measurements of CAR: For small pump detuning (red diamonds) and detuned to the low Raman window (blue circles). Poissonian errors bars are used.

Experiment: Figure 2(a) shows our experimental setup. A mode-locked tunable Pritel fiber laser centered at 1545 nm produces 10 ps pulses at a repetition rate of 50 MHz with peak power ranging between 0.1 and 1 Watt. This passes through an isolator, followed by two cascaded 1550/980nm wavelength division multiplexer modules to block any residual cavity pump photons. An attenuator and polarization controller condition the pulses before reaching a band pass filter centered at 1545 nm, positioned directly before the chip to block any photons generated by SpRS in the silica fibers. The pump pulses are then coupled to the waveguide using a lensed fiber, with 5 dB insertion loss per facet. A coarse wavelength division multiplexer separates the generated signal and idler photons into two single mode fibers providing 50 dB of pump suppression. A four-port circulator with two narrow-band apodized point-by-point fiber Bragg gratings are used to filter the signal photons at 1489 nm while a bandpass filter is used for the idler photons at 1595 nm, providing an additional 50 dB of out-of-band noise suppression. Signal and idler photons are detected by InGaAs single photon detectors (IDQ210) with a 1 ns window synchronized with the pump laser. At 10% detection efficiency, a dead time of 10 µs and a 50 MHz triggering rate, the detector dark count rate was ~ 40 s^{-1}. We define the CAR as the ratio of correlated events to the system noise. A higher CAR is desired, indicating a better signal to noise ratio. A coincidence event occurs when two photons generated in the same pump pulse are detected simultaneously. Photons that arrive at the detectors synchronized with the pump clock but separated by one period are accidentals and include detector dark counts, pump leakage, multiple-pair generation and SpRS noise photons.

Results: Using the setup in Fig. 2(a) we measure the CAR as a function of input power. Our signal and idler channels are positioned in the low Raman window at ~7.4 THz detuning either side of the pump enabling us to achieve a CAR of 16.8 (shown in Fig. 2(b) as circles). The coincidence rate significantly exceeds the accidental rate, as SFWM is dominant at this detuning. The CAR was limited due to loss introduced by the gratings and poor detection efficiency at the longer wavelength. Shifting our photon channels to a relatively near detuning of 1.9 THz we measure a maximum CAR of 0.7, shown in Fig. 2(b) as diamonds. Here the accidental rate is comparable with the true coincidence rate, as uncorrelated SpRS noise is dominant. It should be noted that this is still an order of magnitude improvement from the previous CAR of 0.07, measured in a CW experiment at similar detuning [3], bought about through the increased peak power of the pulses and the ability to gate the detectors synchronized with the arrival of generated photons. The addition 25 times improvement is due to the dispersion engineering enabling access to the low Raman window. The detector parameters, system losses and filter bandwidths remain unchanged for the different detuning regimes so we can attribute the improvement in CAR to the reduction of SpRS

In conclusion, ultra-low Raman noise correlated photon pairs were generated at the low Raman window in a 10 mm dispersion engineered planar waveguide. A CAR of 16.8 was measured at room temperature using a pulsed pump, a 250 times improvement to the original, near detuned and CW pumped, As_2S_3 waveguide experiment. This work shows the potential for As_2S_3 waveguides to be used as a platform for quantum photonics and communication.

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Tunable Picosecond Tm Fiber Laser

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Abstract: We demonstrate a fully programmable, rapidly tunable picoseconds Tm fiber laser. We achieved tuning range about 90 nm centered at 1950 nm and pulse width of 130 ps. Repetition rate is 10 MHz and time average power is 1 W over the whole wavelength range.

OCIS codes: (140.3510) Lasers, fiber (140.4050); Mode-locked laser; (300.6340) Spectroscopy, infrared; (230.7405) Wavelength conversion devices

1. Introduction

Recently, Thulium (Tm)-doped fiber lasers have generated a lot of interest because of their eye-safe 2 μm wavelength, broad gain bandwidth (1.8 μm-2.1 μm) and high power. Because of those characteristics, numerous applications are feasible with Tm fiber lasers [1,2]; remote sensing, mid-IR spectroscopy with DFG, LIDAR and pump for optical parametric oscillator (OPO) to name a few.

Regarding Tm fiber laser developments, CW tunable laser [1], picoseconds fiber laser [2], femtoseconds tunable fiber laser [3] were demonstrated. So far, however, there has been little progress reporting picoseconds tunable lasers using Tm fiber to the best of our knowledge. Picosecond tunable lasers around 2 μm are relevant for the research and development of special optical fibers for supercontinuum generation and offer all the advantages to optimally pump various OPOs. It is also worth noting that various nonlinear mid-IR spectroscopic techniques are also feasible by using pulsed tunable Tm fiber lasers.

In this paper, we present a tunable picoseconds Tm fiber laser. We obtained more than 90 nm tuning range (limited by the CFBG) centered at 1950 nm, 130 ps pulses at 10 MHz, and 1 W time average power.

2. Experiments and Results

Schematic of tunable picoseconds Tm fiber laser is described in Fig. 1. We used dispersion-tuned active mode-locking to accomplish smooth wavelength tuning capability. Detailed information about dispersion-tuned mode-locking is available from references [4,5]. We used a chirped fiber Bragg grating (CFBG) as a dispersive element, which has dispersion of -12 ps/nm and reflectivity of 70 % at 1950 nm. FWHM of the CFBG is 100 nm and the center wavelength is 1950 nm. The modulation bandwidth of the electro-optic intensity modulator (EOM) is 10 GHz and the electrical pulse width is 130 ps. Shorter pulse could be obtained by using a higher bandwidth EOM and our 20 psec pulsers. For Tm fiber amplifiers, we used three commercially available Tm amplifier modules. We used two low saturation output power amplifiers (50 mW) as a gain for an oscillator and a preamplifier, respectively. The saturation output power of the booster amplifier is 1 W. All optical devices use polarization maintaining (PM) fiber.

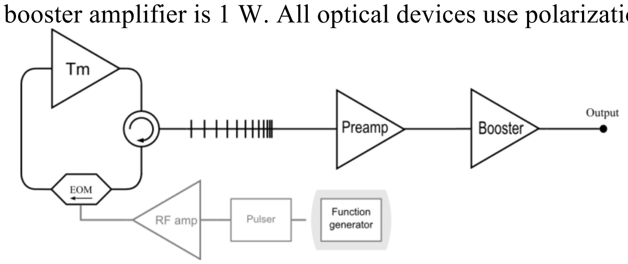
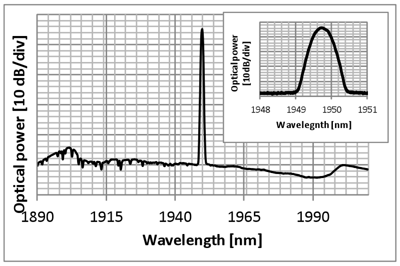
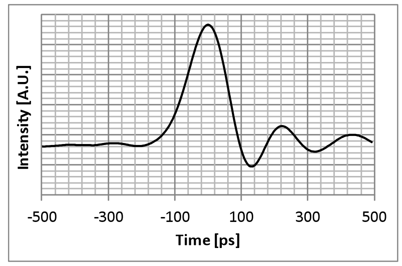


Fig. 1 Schematic of picosecond tunable Tm fiber laser

Fig. 2 shows a typical optical spectrum and pulse shape of the laser signal from the dispersive cavity. FWMH of the laser spectrum is 0.35 nm and the central wavelength is 1949.75 nm as shown in Fig. 2-a. The repetition rate is 10.904 MHz, but can be increase by reducing the cavity length or by using harmoninc modelocking. The optical spectrum was well fitted with a Gaussian spectrum. The optical signal to noise ratio is 43 dB. The slight increase of ASE around 1900 nm and 2000 nm indicates the location of CFBG edges. Inset of Fig. 2-a shows a magnified laser spectrum. For pulse shape measurements, we used an extended InGaAs PIN detector with 7 GHz bandwidth and a sampling oscilloscope with 65 GHz bandwidth. Pulse width measured from Fig. 2-b is 135 ps but we believe that the real pulse width may be less since the measurement is limited by the bandwidth of the detector.



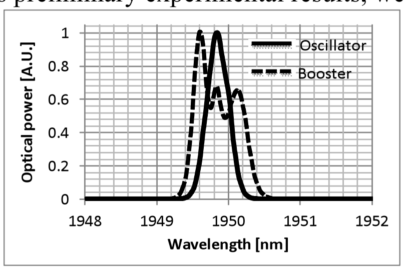
(a)



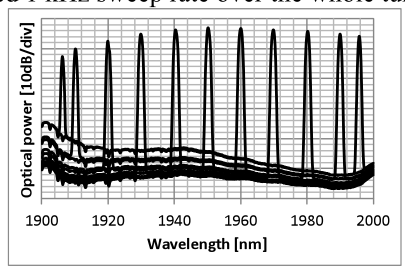
(b)

Fig. 2 Pulse spectrum (a) and pulse shaped measurement (b) at 1949.75 nm

As for the time average power, we obtained tens of microwatts out of the oscillator. After the preamplifier, we reached ~ 10 mW output power. We obtained ~ 1 W time average power after the booster and peak power was calculated to be 0.68 kW. Fig. 3-(a) shows the comparison of optical spectra of the oscillator and booster. Spectral broadening due to self-phase modulation (SPM) is evident and FWHM becomes 0.74 nm. Finally, the optical spectra of our tunable ps Tm laser are found in Fig. 3-(b). It covers the wavelength from 1906.3 nm to 1995.7 nm (~ 90 nm tuning range). As preliminary experimental results, we also achieved 1 kHz sweep rate over the whole tuning range.



(a)



(b)

Fig. 3 Optical spectrum of the oscillator and spectrum broadening after booster (a) and optical spectra of tunable ps Tm fiber laser (b).

3. Discussion and Conclusion

In this paper, we presented a tunable ps Tm fiber laser. We achieved 135 ps pulse width and 1 W time average power. Tuning range was ~ 90 nm centered at 1950 nm.

It is important to mention that pulse width shorter than 135 ps (as short as 25 ps) could be readily achievable from the oscillator by using an EOM with a larger bandwidth as was demonstrated at other wavelengths [6]. Another way is to deploy a pulse compression scheme after the booster since SPM is dominant in Fig.3-(a). We believe that a pulse width of a few ps is feasible by using either approach or combining both methods, which is currently being pursued.

Output power is also easily scalable with higher output power amplifiers. Wavelength scalability is a feature we currently are investigating. Fig.3-(b) shows clearly that the amount of gain is sufficient beyond 1995.7 nm, which means that we could easily reach more than 90 nm by replacing the 100 nm CFBG with a larger bandwidth CFBG, or using multiple CFBGs. Our laser design is flexible enough to accommodate multiple gain mediums with different center wavelengths in order to generate even broader bandwidth.

The wavelength sweep capability is a very interesting feature for any spectroscopic analysis. As wavelength is exclusively determined by repetition rate in dispersion-tuned mode-locking, we can accomplish smooth and customized sweep through the function generator. We accomplished a 1 kHz sweep rate for this paper but further investigation on the maximum sweep rate is needed. Fully programmable wavelength on demand and slower or faster sweep are also possible. It is notable that we can adjust the phase of more than two electric signals from the function generator with the minimum step size, 16 bits. Using this feature, our tunable ps Tm fiber laser can be synchronized with our master oscillator power amplifier (MOPA). With a clock recovery circuit, it is also technically possible to let our tunable ps Tm laser synchronize with any type of laser.

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Second-Harmonic Vortex Generation with a Poled Glass

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Abstract: A Simple method for nonlinear vortex generation is presented. Spin-to-Orbital transfer with total angular momentum conservation between photons at the fundamental and at the second-harmonic frequency is demonstrated.
OCIS codes: (260.0260) Physical optics; (190.2620) Harmonic generation and mixing ; (160.6030) Silica;

1. Introduction

Optical vortex beams are characterized by a wave-front dislocation where the electric-field is not defined and the phase spirals around the singularity in the electromagnetic field. The special properties of such beams associated with their orbital angular momentum allow for useful applications such as the exchange of angular momentum between light and matter and optical tweezers [1]. Spin-to-orbital conversion promises new avenues for quantum computation [2]. However, the decomposition of the light total angular momentum into a spin part (SAM) and orbital part (OAM) is still very much debated especially in the non-paraxial approximation [3]. Spin-to-orbital transfer in nonlinear parametric vortex generation provides an interesting test for the conservation law of the total momentum between photons at the fundamental and harmonic waves.

In sharp contrast to the complexities associated with vortex generation by linear methods we present in this work a simple nonlinear method for vortex generation. We show that the interaction between a Gaussian circularly polarized IR beam with a silica glass plate containing an embedded DC-field (poled glass) results in the material being modified in 3-dimensions by the beam itself. The process is modeled in the framework of electric-field induced second-harmonic (EFISH). Generation of circularly polarized second-harmonic (SH) vortex of topological charge 1 is predicted and experimentally confirmed by revealing the single-branched phase spiral through interference. The total angular momentum is conserved through the process and spin-to-orbital transfer from the photons at the fundamental wave to the SH photons is observed.

2. Experimental methods and Results

The process known under the name of “glass poling” allows freezing a DC-field in the bulk of glass. A 22 x 22 x 1 mm^3 fused silica glass plate (Vitrosil) is brought to 280 ^oC while simultaneously applying 4 kV across it via a pair of silicon electrodes for 25 minutes. Under the action of the external field, impurity ions (Na^+) drift away from the anode leaving behind a negatively charged uniform region constituted by $Si\text{-}O^-$ non-bridging oxygen hole centers. As a result an electric field develops between this region and the anode. The charges are then immobilized in their new sites by cooling the glass to room temperature thus freezing the uniform field (E_{dc}). Since the region depleted of charge carriers extends for approximately 4 μm and 4 kV were applied E_{dc} is in the range of 10^9 V/m. This value is sufficient to give rise to second order nonlinear effects. In fact the $\chi^{(2)}$ estimated via $\chi^{(2)} = 3\,\chi^{(3)}\,E_{dc} \sim 0.6$ pm/V. (See for example $\chi^{(2)}_{LBO} = 2.2$ pm/V).

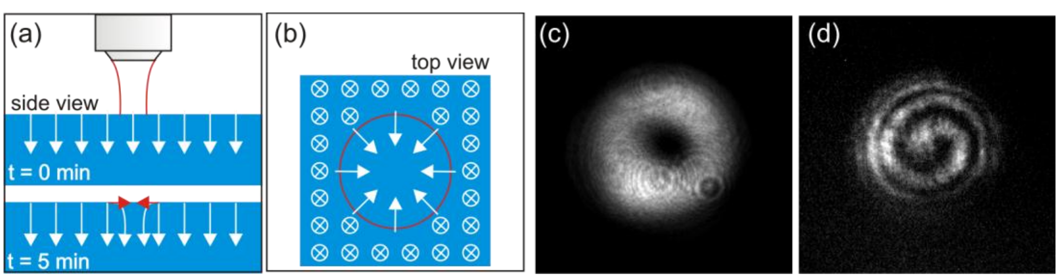

Figure 1 (a) schematic of the experimental layout with an IR Gaussian beam focused on the surface of a poled glass plate with an embedded uniform DC-field (E_{dc}). Multi-photon absorption causes erasure and redistribution of E_{dc} with the appearance of field components parallel to the surface. (b) Top view of the modified glass plate with radially distributed field lines. After 5 minutes of exposure the singularity in E_{dc} is fully established and (c) a well-defined circularly polarized SH vortex is generated. (d) The single-branch spiral obtained via interference indicates that the vortex has topological charge 1.

Light itself is exploited to manipulate the 3-dimensional spatial distribution of E_{dc} . The circularly polarized laser beam of a Nd:YVO_4 laser delivering 8 ps pulses at the wavelength of 1064 nm at 200 kHz is focused via a ×10 objective (NA = 0.25) on the surface of the glass specimen. The peak intensity is 4×10^{12} W/cm^2. At such intensities the electrons stored in the Si-O$^-$ defects are ionized by multi-photon absorption and travel along the electrostatic field to eventually locally screened it. In response to the removal of charges the electrostatic field redistributes itself giving rise to components of the field parallel to the glass surface and directed radially towards the centre of the beam (Fig.1b).

The components of E_{dc} parallel to the surface are responsible for SHG. The formation of the singularity in the SH wave-front can be intuitively understood considering that SH light beams produced through the coupling with DC fields of opposite directions are π-out of phase. Therefore in the centre of the singularity the SH electric-field must go to zero. Incident circular polarization gives origin to a so-called “doughnut” beam (Fig. 1c). The SH beam preserves the circular polarization of the fundamental beam as tested by analyzing the SH beam with a linear polarizer and observing that its characteristic intensity distribution is not modified. The beam is in fact an optical vortex. We proved it by de-focusing the pump beam so that the SH vortex is made to interfere with the SH generated by the coupling of the non-paraxial converging IR photons with the E_{dc} components perpendicular to the glass surface. A single-branch spiral is produced indicating that a vortex of charge 1 is formed (Fig. 1d). The results match well with numerical predictions based on the formalism of EFISH (Fig. 2).

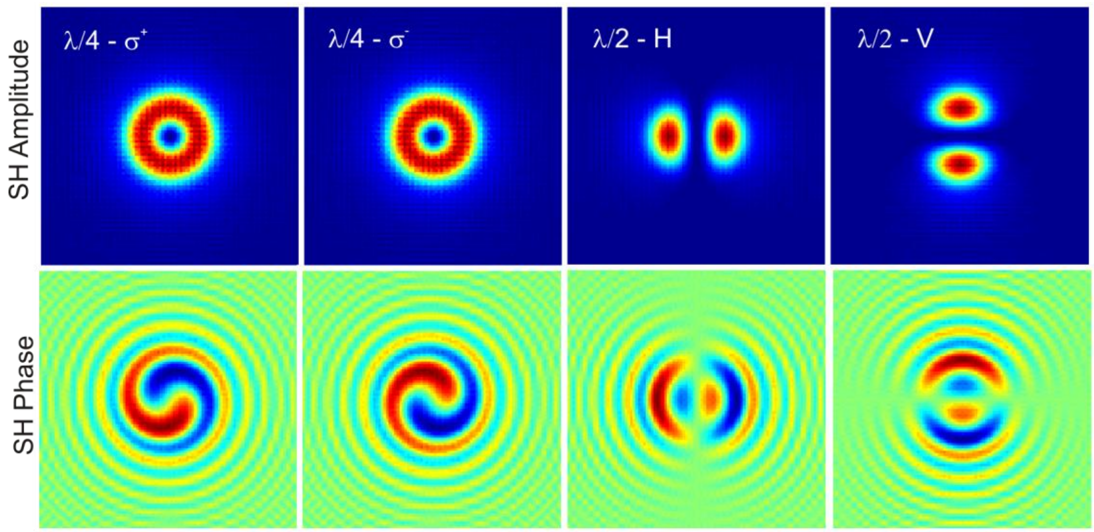

Figure 2 Nonlinear vortex generation is modeled via the formalism of EFISH and solving the coupled mode equations for the complex amplitude of the SH field as it travels through the nonlinear medium assumed of 4 μm thickness. The fundamental is taken as a plane wave with Gaussian intensity distribution. Amplitude and phase are retrieved for both circular and linear polarization of the fundamental beam

This experiment suggests that spin-to-orbital conversion in second-order nonlinear processes requires total conservation of momentum. In the parametric process of SH generation two photons at frequency ω combine to create one photon at frequency 2ω. Energy conservation is expressed by $2\hbar\omega = \hbar\omega + \hbar\omega$. Total angular momentum conservation is expressed as $(1 + 1)[SAM_{2\omega} + OAM_{2\omega}] = (1 + 0)\,[SAM_{\omega} + OAM_{\omega}] + (1 + 0)\,[SAM_{\omega} + OAM_{\omega}]$.

In conclusion a simple all-optical method for the nonlinear generation of optical vorteces is demonstrated and applied to the study of spin-to-orbital transfer in second-harmonic generation where the pump beam does not carry OAM. The creation of 2D arrays of topological singularities in E_{dc} is foreseen by the same method.

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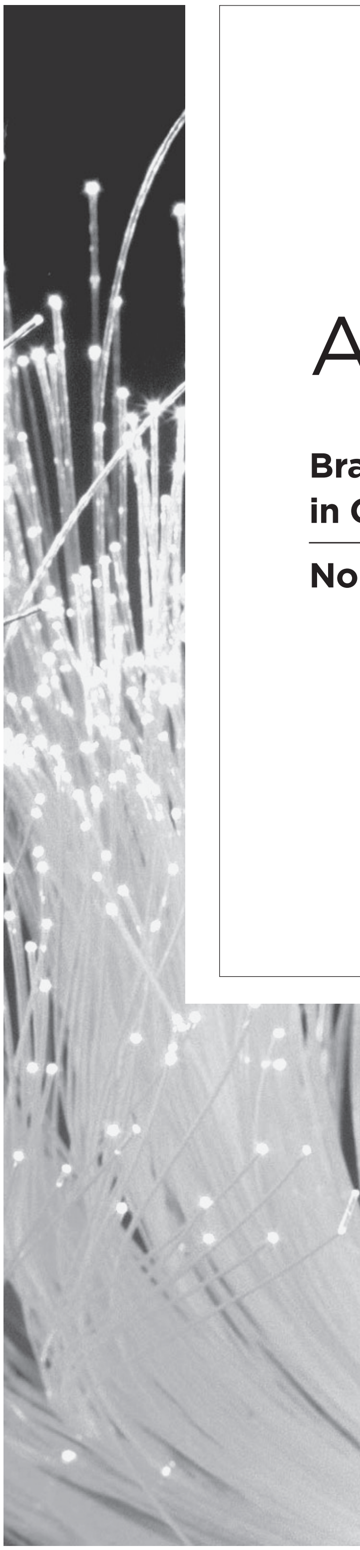

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