20th Slovak-Czech-Polish Optical Conference on Wave and Quantum Aspects of Contemporary Optics

Jarmila Müllerová
Dagmar Senderáková
Libor Ladányi
Ľubomír Scholtz
Editors

5–9 September 2016
Jasná, Slovakia

Organized by
Institute of Aurel Stodola, Faculty of Electrical Engineering, University of Žilina (Slovakia)
Department of Physics, Faculty of Electrical Engineering, University of Žilina (Slovakia)
International Laser Centre, Bratislava (Slovakia)
Slovak Electrotechnic Society (Slovakia)

Sponsored by
Slovak Research and Development Agency (Slovakia)
Czech and Slovak Society for Photonics (Czech Republic)
Kvant, s.r.o. (Slovakia)
OptiXs, s.r.o. (Czech Republic)

Published by
SPIE
Contents

ix Authors
xiii Conference Committees
xvii Introduction

INVFITED TALKS

10142 02 Coherent sources for mid-infrared laser spectroscopy (Invited Paper) [10142-55]
10142 03 Analysis of linear and nonlinear effects in optical fiber (Invited Paper) [10142-32]
10142 04 Femtosecond diode-pumped mode-locked neodymium lasers (Invited Paper) [10142-28]
10142 05 Tissue viability monitoring: a multi-sensor wearable platform approach (Invited Paper) [10142-1]
10142 06 Propagation of the vortex beam through the simple sample in the optical vortex microscope (Invited Paper) [10142-20]
10142 07 Spectroscopy of materials for terahertz photonics (Invited Paper) [10142-80]
10142 08 Siloxane-based photonic structures and their application in optic and optoelectronic devices (Invited Paper) [10142-66]
10142 09 Adaptive automatic data analysis in full-field fringe-pattern-based optical metrology (Invited Paper) [10142-49]

HOT TOPICS

10142 0A Directed evolution of enzymes using microfluidic chips [10142-65]
10142 0B Raman spectroscopy to monitor the effects of temperature regime and medium composition on micro-organism growth [10142-52]
10142 0C Scaffolds fabricated by 3D two-photon photopolymerization for live cell studies [10142-25]
10142 0D Semi-automated sorting using holographic optical tweezers remotely controlled by eye/hand tracking camera [10142-29]
### LASERS AND OPTICAL TRAPPING

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0E</td>
<td>Analysis of frequency noise properties of 729nm extended cavity diode laser with unbalanced Mach-Zehnder interferometer [10142-75]</td>
</tr>
<tr>
<td>10142 0F</td>
<td>Temperature-induced tuning of emission spectra of liquid-crystal optical microcavities [10142-22]</td>
</tr>
</tbody>
</table>

### LASERS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0G</td>
<td>High-power thulium-doped fiber laser in an all-fiber configuration [10142-56]</td>
</tr>
<tr>
<td>10142 0H</td>
<td>Analysis of pumping schemes for high brightness diode-side-pumped lasers [10142-13]</td>
</tr>
<tr>
<td>10142 0I</td>
<td>Towards laser-based open-path detection of hydrogen sulfide [10142-27]</td>
</tr>
</tbody>
</table>

### QUANTUM OPTICS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0J</td>
<td>Two-photon photopolymerization with multiple laser beams [10142-45]</td>
</tr>
<tr>
<td>10142 0K</td>
<td>Mean-field and quantum-fluctuation dynamics in the driven dispersive Jaynes-Cummings model [10142-6]</td>
</tr>
<tr>
<td>10142 0L</td>
<td>Theoretical analysis of motion of a microparticle in an optically created cubic potential [10142-54]</td>
</tr>
</tbody>
</table>

### FIBER OPTICS, NLO

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0M</td>
<td>Simultaneous transfer of optical frequency and time over 306 km long-haul optical fibre link [10142-77]</td>
</tr>
</tbody>
</table>

### MEASUREMENTS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0N</td>
<td>Vortex self-imaging experiments on aberration insensitive localization of micro-objects [10142-63]</td>
</tr>
<tr>
<td>10142 0O</td>
<td>Automatic system for gauge block calibration optimized to meet legal length metrology requirements [10142-51]</td>
</tr>
<tr>
<td>10142 0P</td>
<td>Polymeric slot waveguide for photonics sensing [10142-31]</td>
</tr>
<tr>
<td>10142 0Q</td>
<td>Optical binding of particle pairs in retro-reflected beam geometry [10142-50]</td>
</tr>
<tr>
<td>10142 0R</td>
<td>Changes in optical properties of biological tissue: experiment and Monte Carlo simulation [10142-41]</td>
</tr>
<tr>
<td>Session</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>10142 0S</td>
<td>Preparation and measurement of FBG-based length, temperature, and vibration sensors [10142-76]</td>
</tr>
<tr>
<td>10142 0T</td>
<td>Length measurement in absolute scale via low-dispersion optical cavity [10142-73]</td>
</tr>
<tr>
<td>10142 0U</td>
<td>Multiscale experimental characterization of solar cell defects [10142-9]</td>
</tr>
<tr>
<td>10142 0V</td>
<td>Towards optical detection of the Bloch-Siegert effect in atomic vapors [10142-79]</td>
</tr>
<tr>
<td>10142 0W</td>
<td>Surface flatness measurement of quasi-parallel plates employing three-beam interference with strong reference beam [10142-44]</td>
</tr>
</tbody>
</table>

**INTERFERENCE-DIFFRACTION**

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 0X</td>
<td>Coplanar three-beam interference and phase edge dislocations [10142-16]</td>
</tr>
<tr>
<td>10142 0Y</td>
<td>Fast white-light interferometry with Hilbert transform evaluation [10142-17]</td>
</tr>
<tr>
<td>10142 0Z</td>
<td>Digital algorithms for parallel pipelined single-detector homodyne fringe counting in laser interferometry [10142-10]</td>
</tr>
<tr>
<td>10142 10</td>
<td>2D photonic crystal and its angular reflective azimuthal spectrum [10142-53]</td>
</tr>
<tr>
<td>10142 11</td>
<td>Surface plasmon resonance system with magneto-optic garnet [10142-39]</td>
</tr>
</tbody>
</table>

**PHOTONICS AND PLASMONICS**

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 12</td>
<td>Spectral phase-shift detection of surface plasmon resonance [10142-18]</td>
</tr>
<tr>
<td>10142 13</td>
<td>Waveguide silicon nitride grating coupler [10142-33]</td>
</tr>
<tr>
<td>10142 14</td>
<td>Photonics approach to traffic signs [10142-37]</td>
</tr>
<tr>
<td>10142 15</td>
<td>Preparation of ring resonator based on PDMS using laser lithography [10142-64]</td>
</tr>
<tr>
<td>10142 16</td>
<td>Spontaneous parametric down-conversion in one-dimensional photonic structures with boundaries [10142-14]</td>
</tr>
</tbody>
</table>

**POSTER SESSION**

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10142 17</td>
<td>Automatic device for measuring biomechanical properties of cadaveric lumbar vertebrae of the human spine [10142-21]</td>
</tr>
<tr>
<td>10142 18</td>
<td>Influence of load by high power on the optical coupler [10142-2]</td>
</tr>
<tr>
<td>10142 19</td>
<td>Axial asymmetry in holographic and incoherent correlation imaging [10142-61]</td>
</tr>
<tr>
<td>10142 1A</td>
<td>Fixing methods for the use of optical fibers in interferometric arrangements [10142-4]</td>
</tr>
</tbody>
</table>
Reflectance measurements of GaP-ZnO core-shell NWs [10142-60]

Microfluidic structures for LOC devices designed by laser lithography [10142-68]

Delivery of 1.9μm laser radiation using air-core Bragg fibers [10142-46]

Optimization of passively mode-locked Nd:GdVO₄ laser with the selectable pulse duration 15-70 ps [10142-47]

Fabrication of 2D and 3D photonic structures using laser lithography [10142-72]

PDMS-based waveguides with surface relief Bragg grating [10142-62]

Simulation of the shape from focus method using polychromatic point spread function [10142-42]

Hollow-core photonic-crystal-fiber-based optical frequency references [10142-78]

Iodine absorption cells quality evaluation methods [10142-67]

Miniature fiber temperature sensor based on Fabry-Perot interferometer [10142-38]

Two proposals of quantum chaos indicators related to the mean number of photons: pulsed Kerr-like oscillator case [10142-69]

Fibre optic portable rail vehicle detector [10142-5]

Effect of pulse chirp parameter on the soliton high-speed transmission systems [10142-81]

Simulation of turbulences and fog effects on the free space optical link inside of experimental box [10142-8]

Optical properties of GaAs-based LED with Fresnel structure in the surface [10142-74]

Noise reduction in an optical emission spectrometer with rotating diffraction grating [10142-35]

New approach for identifying the zero-order fringe in variable wavelength interferometry [10142-36]

Polysiloxane optical fibres and fibre structures [10142-26]

Detailed analysis of routing protocols with different network limitations [10142-3]

Spectral interferometric fiber optic temperature sensor with enhanced sensitivity [10142-23]

Designing of MO-SPR bio-chip with photonic crystal [10142-40]

Design of an all-fiber erbium-doped laser system for simulating power load in backbone networks [10142-48]
10142 1X Laser treatment of alumina-based ceramics using second harmonics of Q-switched Nd:YLF laser [10142-19]

10142 1Y Self-referenced interferometer for form measurement of hollow cylinders [10142-30]

10142 1Z Analysis of spectral response of optical switching devices based on chalcogenide bistable fiber Bragg gratings [10142-70]

10142 20 Study of nonlinear magneto-optic effects in BBO [10142-57]

10142 21 PDMS-based photonic and quasi-photonic crystal for LED application [10142-71]

10142 22 Holographic lens formed in a self-developing photopolymer film [10142-34]

10142 23 Experimental FSO network availability estimation using interactive fog condition monitoring [10142-58]

10142 24 Measurement of the optical fiber numeric aperture exposed to thermal and radiation aging [10142-7]

10142 25 Optimization of Stokes polarimeter based on a twisted nematic liquid crystal [10142-43]

10142 26 Intracavity interferometry using synchronously pumped OPO [10142-59]
Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Aas, Mehdi, 0F
Abuhelala, Mohamed, 1T
Acef, Ouaili, 1J
Baránek, M., 0N
Baravets, Yauhen, 02, 0G
Bartoněk, Luděk, 17
Bednářek, Lukáš, 18, 1W, 24
Běhal, Jaromír, 19
Berezina, Sofia, 1G
Bernatová, Silvie, 08, 0O
Bouchal, Petr, 0N, 19
Bouchal, Zdeněk, 0N, 19
Breierová, E., 0B
Brüstlová, Jitka, 0U
Brzobohatý, Oto, 0Q
Buchta, Zdeněk, 0O, 0S, 1Y
Buis, Arjan, 05
Cada, M., 07
Čech, Miroslav, 04
Černoch, Antonín, 20
Chmelickova, Hana, 1X
Chochol, J., 07
Chovan, J., 0P
Chvátal, Lukáš, 0Q
Čip, Ondřej, 0E, 0M, 0O, 0S, 0T, 0Z, 1I, 1J
Ciprian, D., 12
Čížek, Martin, 0E, 0M, 0O, 0Z
Cubík, Jakub, 1A, 1M
Cunderlikova, Štěpánka, 0O
Čýžewski, Adam, 14
Dado, Milan, 13
Dalek, Lukasz, 1Q
Daminová, Jana, 0Q
Dasskiwicz, Marek, 14, 1Q, 1R
Davidson, Alan, 05, 1A, 1M
Dolnák, Ivan, 13
Držík, Milan, 10
Du-Burck, Frédéric, 1J
Dulačková, M., 12
Duešová, Jan, 1B, 1P, 21
Dvořáček, František, 0O
Dvořáčková, Štěpánka, 0O
Fajkus, Marcel, 1A
Figurová, Mária, 08, 1C
Filip, Radim, 0E, 0L
Fordey, Tomáš, 19
Frank, Milan, 1D, 1E
Galas, Jacek, 14, 1Q, 1R
Gašo, Peter, 08, 15, 1C, 1F, 1P
Gawlik, Wojciech, 0V
Ginossar, E., 0K
Glesk, Ivan, 05, 1T
Goraus, Matej, 08, 1G, 21
Gromela, Lubomír, 0R, 0U
 Hájek, Lukáš, 18, 1Q, 1W, 24
Halaďa, Lubomíra, 07, 1I
Hamarová, I., 1H
Hamrle, Jaroslav, 20
Haroniková, A., 0B
Hejduš, Stanislav, 1M
Helen, Radek, 0S
Hiklova, Helena, 1X
Hliubina, P., 12, 1U
Holda, Miroslava, 0Z, 1I, 1J, 1Y
Horžátko, Pavol, 02, 0G
Horváth, P., 1H
Hrabina, Jan, 0E, 0M, 0T, 1I, 1J
Hucl, Václav, 0E, 0M, 0O, 0Z
Hyll, Martin, 21
Jabczynski, Jan K., 0H
Jákl, Petr, 0J, 0L
Janák, Vladislav, 17
Jandura, Daniel, 08, 15, 1F, 1G, 1P
Javůrek, D., 16
Jaworski, Piotr, 0I
Jelinek, Michal, 04, 1D, 1E
Jelinek, Michal, 05
Ježek, Jan, 0A, 0B, 0F, 0J
Jiang, Dapeng, 04
Jonaš, Alexandre, 0F
Jurečka, Stanislav, 03
Káčik, Daniel, 1K, 22
Kadulova, M., 1U
Kalaga, J. K., 1L
Karča, Jan, 0A, 0D
Kášik, Ivan, 1D
Kaskow, Mateusz, 0H
Kaspár, Pavel, 0R
Kepak, Stanislav, 1A, 1M, 1O
Keprt, Jiří, 17
Keša, Peter, 0D
Kiraz, Alper, 0F
Kolejak, P., 07
Konečný, Pavel, 0D
Konečný, Pavel, 0O
Kopczyński, Krzysztof, 0H
Koralewski, Leszek, 14
Koudelka, Petr, 1O
Wikliński, Piotr, 14, 1Q
Woźniak, Władysław A., 25
Xu, Jun, 04
Zavadilová, Alena, 26
Zavodny, Petr, 1M, 24
Zbořil, Ondřej, 1A, 1W
Zemánek, Pavel, 0A, 0B, 0D, 0F, 0J, 0L, 0Q
Zendzian, Waldemar, 0H
Zucco, Massimo, 1J
Conference Committees

Conference Chairs

Jarmila Müllerová, University of Žilina (Slovakia)

Honorary Chairs

Anton Štrba, Comenius University in Bratislava (Slovakia)
Dagmar Senderáková, Comenius University in Bratislava (Slovakia)

International Scientific Committee Chairs

Dušan Pudiš, University of Žilina (Slovakia)
František Uherek, International Laser Centre (Slovakia)

International Scientific Committee

Jiří Čtyroký, Institute of Photonics and Electronics (Czech Republic)
Milan Dado, University of Žilina (Slovakia)
Milan Držík, International Laser Centre (Slovakia)
Miloslav Dušek, Palacký University Olomouc (Czech Republic)
Wojciech Gawlik, Jagiellonian University in Kraków (Poland)
Ivan Glesk, University of Strathclyde (United Kingdom)
Ondřej Haderka, Joint Laboratory of Optics, Palacký University Olomouc (Czech Republic)
Petr Hlubina, VŠB – Technical University of Ostrava (Czech Republic)
Miroslav Hrabovský, Palacký University Olomouc (Czech Republic)
Pavel Cheben, National Research Council (Canada)
Jan Jabczyński, Military University of Technology in Warsaw (Poland)
Zbygniew Jaroszewicz, Maksymilian Pluta Institute of Applied Optics (Poland)
Stanislav Jurečka, University of Žilina (Slovakia)
Henryk Kasprzak, Wrocław University of Technology (Poland)
Jaroslav Kováč, Slovak University of Technology in Bratislava (Slovakia)
Andrzej Kowalczyk, Nicolaus Copernicus University in Toruń (Poland)
Václav Kubeček, Czech Technical University in Prague (Czech Republic)
Wiesław Leoński, University of Zielona Góra (Poland)
Marian Marcińak, International Institute of Telecommunications (Poland)
Alžbeta Marček-Chorvátová, International Laser Centre (Slovakia)
Jan Masajada, Wrocław University of Technology (Poland)
Adam Miranowicz, Adam Mickiewicz University in Poznań (Poland)
Petr Malý, Charles University in Prague (Czech Republic)  
Ivan Martinček, University of Žilina (Slovakia)  
Jarmila Müllerová, University of Žilina (Slovakia)  
Krzysztof Patorski, Warsaw University of Technology (Poland)  
Jan Peřina, Jr, Institute of Physics (Czech Republic)  
Pavel Peterka, Institute of Photonics and Electronics (Czech Republic)  
Jaromír Pištora, VŠB – Technical University of Ostrava (Czech Republic)  
Kamil Postava, VŠB – Technical University of Ostrava (Czech Republic)  
Ivan Richter, Czech Technical University in Prague (Czech Republic)  
Dagmar Senderáková, Comenius University in Bratislava (Slovakia)  
Tomasz Szoplik, Warsaw University (Poland)  
Pavel Tománek, Brno University of Technology (Czech Republic)  
Ján Turán, Technical University of Košice (Slovakia)  
Wacław Urbanczyk, Wroclaw University of Technology (Poland)  
Tomasz R. Woliński, Warsaw University of Technology (Poland)  
Pavel Zemánek, Institute of Scientific Instruments (Czech Republic)  

Organizing Committee  
Daniela Brunová, Chair, University of Žilina (Slovakia)  
Libor Ladányi, University of Žilina (Slovakia)  
Mária Pálušová, University of Žilina (Slovakia)  
Lubomír Scholtz, University of Žilina (Slovakia)  
Ivana Lettrichová, University of Žilina (Slovakia)  
Ľuboš Šušlík, University of Žilina (Slovakia)  
Milan Kňava, University of Žilina (Slovakia)  

Session Chairs  
1 Invited Talks 1  
Dušan Pudiš, University of Žilina (Slovakia)  

2 Invited Talks 2  
Waclaw Urbanczyk, Wroclaw University of Technology (Poland)  

3 Hot Topics  
Ivan Glesk, University of Strathclyde (United Kingdom)  

4 Lasers and Optical Trapping  
Pavel Honzátko, Institute of Photonics and Electronics (Czech Republic)  

5 Lasers  
Václav Kubeček, Czech Technical University in Prague (Czech Republic)
6 Quantum Optics
Karol Bartkiewicz, Adam Mickiewicz University in Poznań (Poland)

7 Invited Talks 3
Jan Peřina Jr., Institute of Physics (Czech Republic)

8 Invited Talks 4
Frantisek Uherek, International Laser Centre (Slovakia)

9 Invited Talks 5
Tomasz Stefaniuk, King’s College London (United Kingdom)

10 Invited Talks 6
Jozef Novák, Slovak Academy of Sciences (Slovakia)

11 Fiber Optics, NLO
Stanislav Jurečka, University of Žilina (Slovakia)

12 Measurements 1
Pavel Peterka, Institute of Photonics and Electronics (Czech Republic)

13 Measurements 2
Petr Hlubina, VŠB – Technical University of Ostrava (Czech Republic)

14 Interference – Diffraction
Agnieszka Popiołek-Masajada, Wroclaw University of Technology (Poland)

15 Invited Talks 7
Kamil Postava, VŠB – Technical University of Ostrava (Czech Republic)

16 Photonics and Plasmonics
Maciej Wojtkowski, Nicolaus Copernicus University in Toruń (Poland)
Introduction

The 20th Slovak-Czech-Polish Optical Conference on Wave and Quantum Aspects of Contemporary Optics (20th SCPOC) was held on 5–9 September, 2016 in the Wellness Grand Hotel, Jasná, located in the Demänovská Dolina Valley, one of the most beautiful valleys in the Low Tatras National Park, Slovakia.

The conference was a continuation of a series of regular meetings of Czech, Slovak and Polish optical communities started in Rusava (the Czech Republic), in 1972. In early 1990s, the meetings have grown to international conferences under the name, "Wave and Quantum Aspects of Contemporary Optics."

For over 40 years, the biennial conference organized in turn in Czechoslovakia and Poland and from 1996 in Slovakia, the Czech Republic and Poland, has become a place to exchange knowledge on the latest optical research, to meet friends and co-workers.

One of the most important aims of scientific conferences is to encourage and promote international collaboration and co-operation. Therefore it was great pleasure for the 20th Slovak-Czech-Polish Optical Conference to host almost 130 participants from 7 countries. The scientific programme comprised 18 invited talks, 52 contributed talks, and 48 poster presentations.

The contributions covered generally all aspects of optics, e.g. quantum and nonlinear optics, quantum information and cryptography, ultrafast optical phenomena, wave optics, interferometry and holography, optical technologies for optical communications and networks, waveguide and optoelectronics devices, laser physics, technology, photonic crystals, photonic nanostructures and integrated optics, biophotonics, design and manufacture of optical components and optical devices, optical materials, their fabrication and characterization, optical data storage and data processing, teaching and training in optics, optical imaging, sensing and metrology, etc.

This volume contains peer-reviewed submitted contributions based on presentations given at the conference, including invited lectures in the current fields of optics.

The International Scientific Committee has rated the scientific level of 20th SCPOC high. In particular, the presence of many young participants was greatly appreciated as the guaranty of the living future of common optical conferences. The 21st Czech-Polish-Slovak Optical Conference on Wave and Quantum Aspects of Contemporary Optics will be held in the Czech Republic in 2018.
Concluding, we would like to express our thanks to the members of the International Scientific Board and to the session chairs. We also would like to express our gratitude to the organizing organizations and sponsors and to the local organizing committee for their attitude and diligent work behind the scenes, resulting in great conference facilities.

The conference is still characterised by a special pleasant atmosphere created by the participants themselves above all. The gratitude belongs to each of them for their individual scientific and human contributions to exchanging ideas and experience, and keeping a warm spirit of friendship.

Jarmila Müllerová