High Throughput and High Precision Laser Micro Machining with Ultra Short Pulses

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Peter Brunner

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Peter Brunner hat in der angewandten Forschung und Entwicklung in namhaften Medizintechnik-Unternehmen in Fach- und Führungspositionen sowie als Mitglied von Geschäftsleitungen gewirkt. Sein beruflicher Weg führte ihn über Expertentätigkeiten auch zur KTI (Kommission für Technologie und Innovation) und über Jury- und Berater-tätigkeiten zur W.A. de Vigier Stiftung, zu venturekick, der Hightech-Jungunternehmer-förderung, und zum CSEM.

Welcome from BUAS

Dr. Gediminas Raciukaitis

Head of Deptartement of Laser Technologies, FTMC, Vilnius, Lithuania
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APPOLO coordinator, Head of Departement of Laser Technologies at Center for Physical Sciences and Technology, consultant on Laser Technologies EKSPLA UAB, co-founded ELAS UAB. He graduated from Vilnius University and got his PhD degree in field of laser spectroscopy. He is co-author of 130 peer-reviewd papers, 9 patents and plenty presentations at conferences.

Welcome from APPOLO, Moderation
Lasers are key enabling technology, and APPOLO project aims to boost their introduction into industry. Assessment of equipment for laser-based manufacturing is close related with development of novel laser processing approaches. 22 partners from 9 countries and new 14 partners jointing the consortium cover broad spectrum expertise and applications.

Dr. Christoph Harder

President Swissphotonics, Wollerau SZ
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Dr. Christoph S. Harder received the Electrical Engineering Diploma from the ETH in 1979 and the Master and PhD in Electrical Engineering in 1980 and 1983 from Caltech, Pasadena, USA. He is co-founder of the IBM Zurich Laser Diode Enterprise which pioneered the first 980nm high power pump laser for telecom optical amplifiers. He has been managing during the last few years the high power laser diode R&D effort in Zurich expanding, working closely with a multitude of customers, the product range into 14xx pumps as well as 808 and 9xx multimode pumps for industrial applications. He has published more than 100 papers and 20 patents and has held a variety of staff and management positions at ETH, Caltech, IBM, Uniphase, JDS Uniphase, Nortel and Bookham.

Moderation

Prof. Dr. Beat Neuenschwander

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Dr. Beat Neuenschwander studied physics at the University of Bern and realized 1996 his PhD at the Institute of Applied Physics. Since 2000 he is at the BUAS where he built up the laboratory for laser micro machining and laser surface Engineering. He lectures physics and applied laser technology, is member of the Swiss Commission for Technology and Innovation CTI and head of the optics section of the Swiss Society for Optics and Microscopy SSOM.

High Efficient and High Quality Surface Structuring of Metals
When metals are machined with ultra – short pulses they show an optimum fluence where the ablation process has its highest efficiency also going with good machining quality. Using higher fluences i.e. pulse energies leads, especially for steel, to a drop in the efficiency and surface quality. Thus for a given spot size high throughput and maintaining the machining quality can only be achieved by increasing the repetition rate at constant pulse energy.
But beside the pulse energy also the machining strategy has a big influence on the quality. Synchronization of laser and beam guiding device is a key for achieving high precision and a certain minimum pulse to pulse overlap is needed to get a good surface quality and to prevent from heat accumulation.
In the talk we will demonstrate how these *boundary conditions* influences the power scale – up process to obtain high throughput at still high machining quality.

Thorsten Kramer

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Since 2007: Chief Technology Officer CTO , Swiss Micro Laser GmbH, Stallikon
2007 –20012: Leiter Lasertechnik , ETA SA Manufacture Horlogère Suisse, Grenchen.
2004 –2007: Projektleiter , Robert Bosch GmbH, Ansbach
1999 –2003: Wissenschaftlicher Mitarbeiter, Fraunhofer-Institut für Lasertechnik ILT, Aachen.
1998: Diplom-Physiker RWTH Aachen

Shedding Light on Pulse Bursts
State-of-the-art ultrafast lasers are capable of generating so called pulse bursts, a sequence of single pulses emitted at the seed frequency. These pulse bursts can be used to adapt the ablation process to your needs with respect to ablation rate as well as surface structure and quality. The talk tells the difference between reality and fiction.

Dr. Ronald Holtz

CEO, Class 4 Laser Professionals AG , Lyss BE
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2014	Professor, University of Applied Sciences and Arts Northwestern Switzerland FHNW, Head of 3D-Laser Micromachining Group at the Institute of Product and Production Engineering (IPPE)
2011	CEO, CLASS 4 LASER PROFESSIONALS AG
1999 – 2012	Sales Manager Europe and Keyaccount Manager Medical Device Industry, ROFIN-LASAG AG
2000	Otto-von-Guericke-University Magdeburg, PHD thesis
1974 – 1982	polytechnic school *Juri Gagarin*, Naumburg

Industrial applications with ultra-fast lasers
More than 8 years are gone since the first official announcements of industrial like applications with ultra-fast lasers. The presentation is trying to give a subjective view about the status of industrial applications with ultra-fast lasers in typical fields of Swiss industry. Successful and less successful examples will be presented.

Dr. Marwan Abdou-Ahmed

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Dr. Marwan Abdou-Ahmed received his PhD degree in 2003 at the University of Saint-Etienne, and his Habilitation degree for the University Paris-Sud XI in 2012. He joined the IFSW in 2004 where he is responsible for the "laser development and laser optics" department since 2011. M. Abdou-Ahmed and his team are focusing on ultrafast and high-power thin-disk lasers and on beam shaping optics.

Laser for the Future, towards 1kW USP Power
The talk will mainly focus on the recent achievements on high-power (toward the kW-class) ultrafast thin-disk amplifiers achieved at the Institut für Strahlwerkzeuge of the University of Stuttgart. Furthermore, the amplification of the unconventional Laguerre-Gauss beams (donut-shaped intensity distribution), with radial or azimuthal polarization and developed within the project Ultrafast_Razipol (www.razipol.eu) will be presented during the talk.

Dr. Kurt Weingarten

General Manager, Lumentum Switzerland AG, Schlieren ZH
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Kurt received his PhD and Masters in Electrical Engineering at Stanford University, where he developed ultrafast electro-optical measurements on integrated circuits using ps lasers, and a BSEE at Georgia Tech in Atlanta. Kurt founded Time-Bandwidth Products in 1995 to develop simple, robust ultrafast mode-locked lasers for scientific and industrial applications. He founded the VC-funded telecom start-up GigaTera in 2000, which was later acquired by TBP in 2003. Now he is General Manager of Lumentum Switzerland AG.

Ultrafast Laser Solutions for microprocessing
We present picosecond and femtosecond laser systems optimized for high-speed synchronous scanner systems, based on our industrial PicoBlade product platform.

Dr. Claus Schnitzler

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Dr.-Ing. Claus Schnitzler studied physics at the RWTH Aachen university and has developed high average power InnoSlab lasers from 1999-2003. Since 2004 he has been working in the field of highpower diode laser chips and optical systems. He is co-founder and Managing Partner of AMPHOS GmbH.

High Power Ultra-Short Pulsed Lasers
Ultrafast Lasers with high average output power have become of huge interest for high volume industrial applications such as machining of glass, ceramics, composite materials and more. The parameter space required is extremely wide. Some applications require high pulse energy of multi-100µJ whereas other applications require high repetition rate in the multi-MHz regime. Therefore a system architecture with high flexibility and modularity is necessary to account for another important measure which is cost-of-ownership. Based on Yb:InnoSlab technology such unique systems can be realized.

Lars Penning

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Polygon Scanners: Capabilities, applications and system considerations
Since mid 2013 polygon scanners have become available on the commercial market. Polygon scanning technology offers very high scanning speeds, linear scanning speeds of 25 to 100 m/s are easily achieved.
The integrator should understand that this speed is achieved using a scanning architecture very different from well understood galvo scanning systems. In this lecture we will explain the system architecture of polygon scanner systems, what we offer as a key components, and what the integrator, system builder needs to do designing a performant laser processing system. Then we will discuss different scanning strategies. Using polygon scanners the laser process and scan strategy needs to be tailored for raster scanning operation, we will discuss some examples like surface treatment, drilling and 2.5 micro-machining. At last we will discuss integration considerations on the system level, what are the requirements of the laser, laser synchronisation and laser modulation/gating needs.

Dr. Christoph Wienken

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Since 2014:	Teamleader in Technical Sales at SCANLAB AG, Puchheim
2011 – 2014:	Technical Sales at SCANLAB AG, Puchheim
2011:	PhD in Physics: Biotechnological Applications of Microscale Thermophoresis
2008 – 2011:	Co-Founding of NanoTemper Technologies GmbH, München
University degree:	Diploma in Physics, Ludwig-Maximilians-Universität München

New Generation Galvo Scanning Technology
During the past decade galvo scanners with ultrashort pulsed lasers were established as a standard tool for high precision tasks proven for various industrial applications.
In our presentation we will give an overview on how currently existing galvo scanning technology works, its limitations and how our new SCANahead control can improve the obtainable result in laser processing with galvo scanners.

Dr. Grigory Lazarev

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Dr. Grigory Lazarev holds degree from Bauman Moscow Technological University. Since 2003 he worked for Amphora Labs, developing interference microscopy method with sub-nm sensitivity. In 2006 he joined SeeReal Technologies, working in R&D of the holographic 3D displays, where he authored number of patents in this field.
Since 2010 Dr. Lazarev is with Holoeye Photonics, where he deals with the development of LCOS-based spatial light modulators.

Spatial Light Modulators in Laser Microprocessing
LCOS technology has it´s background in projection applications such as RPTV, front projectors, pico projectors and NTE systems. Over the last decade this technology was commercialized for research applications, whereas last years we see growing volumes in industrial applications as telecommunications, medicine and metrology. Inherently high resolution, moderate cost and perfect scalability make LCOS SLM promising part of laser microprocessing systems.

Dr. Jens Holtkamp

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Dr. Jens Holtkamp received his diploma in mechanical engineering at RWTH Aachen University in 2004 and his PhD in 2009. From 2005 he worked at Fraunhofer ILT as scientific assistant. Since 2009 he was group manager for Micro and Nano structuring. In 2013 he was co-founder of Pulsar Photonics GmbH where is working as managing director.

Innovative beam forming concepts
Current developments in ultra-short pulse laser processing show the demand in new scanning- and beam shaping concepts to overcome quality reducing heat accumulation effects in the work piece and to enhance the economic efficiency of this technology. One approach is the application of beam splitting elements. Using a compact optical setup and a galvanometric scanning system these elements can be extended to a tooling system ready for industrial use.

Dr. Guido Hennig

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Dr. Guido Hennig, Laser Technology Manager at Daetwyler-Graphics, Switzerland, received his PHD in physics 1992 from University of Bonn investigating laser cooling and trapping of atoms. At Daetwyler he works on high power laser systems, beam delivery and modulation technologies and industrial laser engraving processes of gravure and embossing cylinders. 2002 he won the AKL-Innovation-Award, chaired 2010-2013 the LAMOM-Conference and chairs currently the Photonics-West-LASE-Symposium. He is author of several publications on Laser Engraving and Digital Printing.

Ultrafast Beam Modulation and delivery for printing and embossing applications
With R2R processes millions of reproductions (e.g. RFID-antennas or Fresnel-lenses) can be produced in a fast and economical way. Such printing and embossing cylinders require in many cases sub-µm or µm-structures. Ultra-short pulse lasers are appropriate tools to generate this structures. For an industrial large area treatment it is desired to perform the ablation process with a maximum of efficiency.

Dr. Thomas Bewer

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Dr. Thomas Bewer studied chemical engineering and worked in the process development of direct methanol fuel cells and glass forming. Since 2008 Thomas is employed by Trumpf Maschinen AG. Since 2011 he is heading the department *Advanced development*, which includes an application lab for Trumpf ultrashort pulsed lasers and the development of laser systems.

Laser equipment for microprocessing
Ultrashort-pulse-lasers offer broad opportunities for micro manufacturing. In order to meet different customer needs the components laser, optics and machine tool have to combine to a solution. In this talk a machine platform will be presented that allows a variety of optic configurations. Solutions based on this platform for fine cutting of transparent materials and metals will be presented.

Guilherme Mallmann

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2014: 2nd place in the *Innovation Award Laser Technology 2014* from the Arbeitskreis Lasertechnik AKL e.V. and European Laser Institute ELI.
Since 2013: Head of the group *Process and System Development* in the Department of Production Metrology at the Fraunhofer Institute for Production Technology
Since 2008: Research Associate in the Department of Production Metrology at the IPT
Master degree on Production Technology, RWTH Aachen
Bachelor degree on Electrical Engineering, Federal University of Santa Catarina, Brazil

Sensor based adaptive laser micromachining using ultrashort pulse lasers for zero-failure manufacturing
Within this presentation, the low coherence interferometry and the optical coherence interferometry are presented as alternative to the state of the art monitoring solutions for laser processes. Such distance measurement systems are able to be integrated coaxially to the optical path of a laser processing head, wherever scanning or fixed optic based, and enable a material and surface independent monitoring prior, during or after the process. This technology is especially robust against process emission and gases. Additionally it presents a constant measurement accuracy, which is independent of the working distance.
Applications cover the material independent characterization of the workpiece's real shape and position for a machine adjustment, automatic parameter setting, the set-up of an adaptive machining and the final workpiece inspection.

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