Congress report

LASER World of PHOTONICS – DGLM Application Panel: Laser-advanced new methods for diagnostics and therapeutics

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As part of the LASER World of PHOTONICS Congress and Exhibition, which was held from 22 to 25 June 2015 at the International Congress Centre Munich, the *Deutsche Gesellschaft für Lasermedizin* (DGLM) e.V. organized an application panel on the topic "Laser-advanced new methods for diagnostics and therapeutics".

Medical laser applications represent a constantly growing part of the photonic market, more recently driven by diagnostics than therapy. Compact lasers have become available with a high degree of effectiveness and reliability at comparably low cost and new wavelengths are being added daily which are opening up new future perspectives. To transform a laser into a successful medical device requires intense and careful cooperation between industry and research coupled with commitment and a feeling for the right moment. Evaluation of medical and social benefits, the power of competing techniques, rules and regulations, financing and reimbursement issues all play their role in the development and placement of a medically approved device or procedure. Furthermore all medical procedures require continuous reevaluation with respect to competing techniques and their usefulness and clinical outcome. Consequently, the lectures focused on how cooperation can ensure the success of biophotonic innovations from bench to bedside with the help of clinicians, researchers, engineers and innovators from industry. Medical, scientific and industrial representatives provided information about their specific tasks and their efforts to launch a specific device or procedure.

Conference Chairs
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Abstracts

Photoacoustics: Basic principles, clinical potential, and a European effort to clinical system development

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Photoacoustic imaging is a novel medical imaging modality based on ultrasound (US) that is generated by absorption of light pulses. The last decade has seen a huge rise in activities of basic research and system development. Photoacoustics is regarded as a future medical imaging modality with high potential, but breakthroughs are required both on the system side and in the identification of "killer applications". Physicians will only accept a new modality and integrate it into their care practice if the method is offered in a practical way, and if it brings a definite medical benefit at an acceptable cost. This talk will address the principle of US generation with light. Furthermore, it will address the way in which this principle can be used for imaging biological tissues. Potential medical applications will be presented with some preliminary results. Finally, the European consortium FULLPHASE will be introduced, whose aim is to develop a clinically applicable, compact photoacoustic scanner with a handheld probe. This consortium is composed of manufacturers of lasers (Osram, Quantel Lasers) and medical equipment (ESAOTE), academic research groups, and clinical partners in disease areas such as rheumatology and cardiovascular disease.

Latest developments in pulsed diode laser technology, and its integration in a medical ultrasound scanner

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Photoacoustics is a novel medical imaging technique with a high potential for early detection of different diseases such as skin cancer or rheumatology. It is a hybrid modality with pulsed laser light for excitation of the tissue, and ultrasound (US) as a response. One of the hurdles for its introduction into the clinic, or even in clinical pilot studies and larger trials, is the bulkiness and price of existing photoacoustic systems. This presentation describes how recent developments in diode laser technology have led to a compact US scanner with built-in photoacoustic functionality which is a key factor for the introduction of photoacoustic technology in the clinic. The industrial partners in the European consortium FULLPHASE have developed a diode laser system and driver that deliver pulse energies which until now were only achievable with Nd:YAG lasers. The efficiency and compactness allows integration in a handheld probe. The talk will highlight the laser technology and its radical integration with a medical US scanner, leading to a first prototype for clinical pilot studies.

Translation of the research on photoacoustic imaging into a portable photoacoustic/ ultrasound scanner

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While fusion of photoacoustic technology with traditional ultrasound (US) imaging is a conceptually logical step, it requires: 1) bringing together partners with specific expertise over complementary backgrounds, 2) research platforms to perform clinical studies and 3) clinical evidence. This talk will describe: a) the process needed to create a well-balanced consortium and 2) to develop a research prototype of a hybrid photoacoustic/US scanner to perform small clinical studies in the European project FULLPHASE. This process is unique in that for the first time an established manufacturer of existing medical imaging devices is introducing photonics for point-of-care imaging in a widely accepted imaging modality. Aspects to be highlighted are the conditions under which such a process will be successful, the various steps in terms of increasing the technological readiness level of the system, and the process of gathering clinical evidence.

A new approach in laser machining of optical fibers to manufacture diffusors for medical therapy

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Utilizing an ultra-short laser material processing technique at a wavelength of 1025 nm and a pulse width of about 400 fs, micro-scattering centers are introduced in the core region of 400 or 600 µm optical quartz fibers. This technique enables the fabrication of special fibers, so-called "scattered light diffusors", which emit light laterally, near the distal fiber end, over a diffusor length of typically 10–30 mm. These laser light diffusors are required for certain medical therapies, e.g. laser-induced interstitial thermotherapy (LITT), photodynamic therapy (PDT), varicose vein and endovenous laser therapy (EVLT). The optical lateral output enforced by a given pattern of a pre-defined length can be easily set above 80%. The out-coupling light intensity distribution can be adjusted for the desired therapy, e.g. to give a radial homogenous profile over a certain diffusor length. The laser-machined fibers also allow the in-coupling of light along the processed zone which is an interesting property for sensor and industrial applications.

The talk will present and discuss the strategies developed at LMTB's Laser Application Lab in collaboration with medical and industrial partners to optimize the process of machining the scattered light diffusors. The discussion will be supported by specific examples.

Optical fiber solutions for laser ablation of soft tissue and imILT

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Clinical Laserthermia Systems AB (CLS) has developed a treatment protocol – immunostimulating interstitial laser thermotherapy (imILT^{CLS}) aimed at substantially improving today's treatment regimen for metastatic cancer disease. It is intended for controlled local tumor ablation with a follow-on release of tumor specific antigens aimed at systemic immune activation against the remaining cancer. The tumor ablation is based on a proprietary and patented technique based on LITT in order to optimize an immunologic effect. CLS's current technology has its foundations in laser fiber technology. This has its limitations with achievable lesion sizes due to the maximum power that can be used without carbonizing tissue. CLS does not have the resources and expertise needed for in-house fiber development and production and has actively searched for industry partners to collaborate with CLS on the design and development of a fiber delivery system tailored to imILT^{CLS} specifications. In collaboration with Laser- und Medizin-Technologie GmbH, Berlin (LMTB), CLS has initiated the technical development of an application specific laser fiber to allow the treatment of a wider range of tumors with a single treatment. One promising technical solution for increasing achievable lesion sizes, therefore magnifying the immunological benefits of the treatment, is to use a diffuser solution that can withstand the high power levels that are required during an imILT procedure.

The product is the result of a synergy between the know-how on the medical application gained by CLS through clinical experts at study clinics, and the production technology input provided by LMTB. During the regulatory work needed to achieve an approved medical device, CLS has developed both *ex vivo* and *in vivo* models relevant to test safety and performance of new fiber solutions, which has given further input to the design.

Clinical requirements on optical fibers for endovenous energy application

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During the last decade, endovenous laser treatment (ELT) has developed rapidly. Laser treatment of insufficient veins is a promising minimally invasive modality with a high occlusion rate. Initially this laser light application used bare-fiber techniques in combination with light of wavelengths in the range of 800–1000 nm. However, protocols using radial emitting ELT fibers in combination with infrared laser light have shown clinical advantages over the bare-fiber technique and near-infrared irradiation. With regard to the clinical application and the clinical outcome, in terms of occlusion rate and side effects, requirements are presented for new light application systems as well as the potential impact on the clinical application.