SYUL 2: Advanced Concepts for High Peak Power Ultrafast Lasers II

Time: Friday 14:00–15:30 Location: e415

Invited Talk SYUL 2.1 Fri 14:00 e415

Coherent Combination of Ultrafast Fiber Lasers — •Jens Limpert — Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Albert-Einstein-Str.15, 07745 Jena, Germany

Even the most advanced laser technologies have been pushed to their specific limitations in labs around the world. A significant increase in performance can not be expected in the coming years. New concepts have to be considered to address these issues and to enable new application fields. In that context, I will review the basics and achievements of coherent combination of amplified femtosecond pulses, a concept which has already out-performed single aperture femtosecond laser systems and which allows for a scaling to unprecedented performance levels. The spatially and temporally separated amplification of ultrashort laser pulses followed by coherent beam and pulse addition can bypass all performance restrictions of a single aperture laser system, therefore, enabling a quantum leap in performance of ultrafast lasers.

Invited Talk SYUL 2.2 Fri 14:30 e415

Cryogenic multipass amplifiers for high peak and average power ultrafast lasers — •Luis E. Zapata — Center for Free-Electron Laser Science, Deutsches Elektronen Synchrotron, Notkestrasse 85, 22607 Hamburg, Germany

Ultrafast laser sources are in demand for many scientific and industrial applications. For example, few-mJ pulses are useful for driving the OPCPAs in pump-probe experiments and, Joule class pulses are necessary for the generation of x-rays through inverse Compton scattering. Ultimately, high average power determines the usefulness of a given laser system by shortening the time necessary for the collection of data or, the throughput when a process yield is derived. The success of the laser system also markedly depends on its size, weight and reliability, which are strongly tied to its complexity. Liquid nitrogen cooled DPSSLs based on Yb3+ offer a clear advantage with regards to all the above points. Engineering leverage is gained by an intrinsic several-fold improvements in thermo-optic and thermo-mechanical properties as well as ~decade higher gain-coefficients, which enables simple, passively switched multipass geometries to be implemented. Our progress in scaling chirped-pulse amplifiers has produced 250-Watt at 100-kHz and 160-mJ at 250-Hz based on liquid nitrogen cooled Yb:YAG in rod and composite-disk geometries operating at high gain. Clear scaling towards 1-kW average power at 100 kHz in cryogenic rods and, one-Joule pulse energy in cryogenic composite disks has emerged. We propose an advanced monolithic array of gain-cells for scaling to multi-Joule energies and multi-kW average powers.

Invited Talk SYUL 2.3 Fri 15:00 e415

Multi-TW infrared laser using Frequency domain Optical Parametric Amplification — •Bruno E. Schmidt[1], Philippe Lassonde[2], Guilmot Ernotte[2], Mathieu Giguere[1], Nicolas Thire[2], Antoine Laramee[2], Heide Ibrahim[2], and Francois Legare[2] — [1]few-cycle Inc., (few-cycle.com), 2890 Rue de Beaurivage, Montréal, Qc, H1L 5W5, Canada — [2]Institut National de la Recherche Scientifique, Centre ÉMT, 1650 bd Lionel Boulet, Varennes, Qc, J3X1S2, Canada

The universal dilemma of gain narrowing occurring in fs amplifiers prevents ultra-high power lasers from delivering few-cycle pulses. This problem is overcome by a new amplification concept: Frequency domain Optical Parametric Amplification - FOPA. A proof of principle experiment was carried out at the Advanced Laser Light Source (ALLS) on the sub-two cycle IR beam line and yielded record breaking performance in the field of few-cycle IR lasers. 100μJ two-cycle pulses from a hollow core fibre compression setup were amplified to 1.43mJ without distorting spatial or temporal properties [1]. Pulse duration at the input of FOPA and after FOPA remains the same. Recently, we have started upgrading this system to be pumped by 250 mJ to reach 40 mJ two-cycle IR few-cycle pulses and latest results will be presented at the conference.

[1] B. E. Schmidt, N. Thiré, M. Boivin, A. Laramée, F. Poitras, G. Lebrun, T. Ozaki, H. Ibrahim, and F. Légaré, *Frequency domain optical parametric amplification.,* Nature Commun. 5, 3643 (2014).