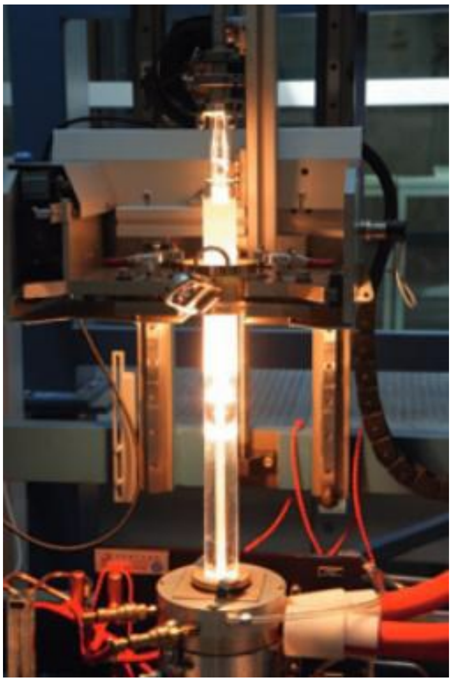
Ultrafast_RAZipol Newsletter December 2014



High-precision laser micro-machining has delivered a tremendous impact in daily life but its benefits and usefulness can easily be taken for granted. For example in the manufacture of smart phones, i-tablets, etc, high-precision laser micro-machining is essential to produce some of the key features we use in these devices. In the car industry it has been shown that diesel nozzles produced with ultrafast lasers lead to significantly reduced air pollution in comparison to nozzles produced with conventional fabrication techniques. Spinning nozzles used widely in the textile industry are also produced using ultrafast lasers.

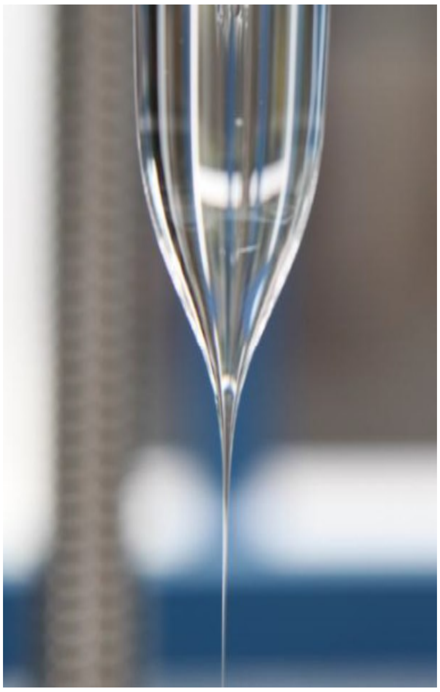
The main goal of the **Ultrafast_RAZipol** project is to demonstrate laser material processing at unprecedented levels of productivity (leading to drilling process times below 4s of high aspect ratio [40:1] holes compared to current times of 25s) and precision material processing (structure dimension <1 µm) using beams with novel radial and azimuthal polarization.

The challenge is not only to achieve high productivity at moderate levels of precision or highest quality at low speeds, but to reach both targets at the same time. Therefore an adequate ultrafast laser source with a very high average power and well-adapted beam parameters, including pulse duration, pulse energy, intensity profile, and polarization, is needed. Additionally, the laser beam has to be applied to the work-piece in a well-defined application-specific manner.

Finally, advanced processing strategies are required to obtain optimum results at high productivity. The ultrafast laser source planned for the Ultrafast_RAZipol project combines several quite unique features. Its modular 3-stage master oscillator power amplifier (MOPA) concept offers a high degree of flexibility to generate a broad range of pulse durations, pulse energies and repetition rates. The MOPA combines an ultrafast oscillator together with a Single Crystal Fibers as first amplification stage and thin-disk multipass amplifier as final amplification stage (Booster).

Although the potential range of material processing applications for this laser source is extremely broad, within the project, we will focus on two demonstration applications. The first application will be based on a fast scanner system which facilitates the production of complex structures like a "lab on a chip" on large wafers (8" diameter). The second application will be trepanning drilling of deep, high aspect holes with tight tolerances. Hence it is believed that Ultrafast_RAZipol will have a great impact on the environment since it targets cost-efficient solutions for a broad range of applications as well as fast and high-volume applications.

The first amplification result of beams with radial and azimuthal polarization have been achieved by the Ultrafast_RAZipol project, with up to 84 W of output power at a pulse duration of 780 fs. This source will be used to seed the multipass thin-disk amplifier and shall allow reaching power higher than 500 W at sub-1 ps pulses.



Photos show the in-house fiber drawing facilities at the IFSW for the production of the ring-shaped capillaries for the pumping of the thin-disk laser

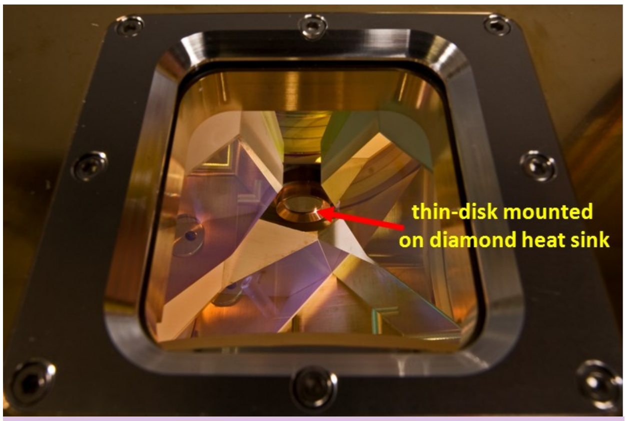
The Ultrafast_RAZipol project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619237

THE PARTNER'S ROLES & CONTRIBUTIONS

Universität Stuttgart

IFSW
UNIVERSITÄT STUTTGART
INSTITUT FÜR STRAHLWERKZEUGE
STUTTGART LASER TECHNOLOGIES

USTUTT is the Coordinator of the Project and is developing the radial/azimuthal polarization optics and their integration in the different laser architectures. Moreover USTUTT is developing the multi-pass thin-disk amplifier and its full analysis. The major contributions will include working in areas such as polarisation shaping, zero-phonon pumping scheme, ring pumping distribution scheme and efficient amplification of cylindrically polarised laser beams in thin-disk multipass amplifier.



The thin-disk multipass pumping module developed at the IFSW, part of the University of Stuttgart, allows 24-passes through the laser active medium (Thin-disk crystals) for an improved efficiency of the pump light absorption

JDSU

JDSU, (formerly known as Time-Bandwidth Products AG) is focusing on the laser development, as well as laser synchronisation and integration with scanners and other machine parts for the targeted material processing application.

cnrs

The Laboratoire Charles Fabry from CNRS and Institut d'Optique Graduate School is in charge of the development of the multipass pre-amplifier, based on single crystal fiber, to boost the pulse energy provided by the mode-locked oscillator developed by JDSU.

At the next Photonics West conference to be held at The Moscone Center, San Francisco, California (USA) from 7th to 15th February 2015, two conferences related to an overview of the single crystal fiber technology and the latest results obtained within the Ultrafast_RAZipol project will be presented and will reflect the collaboration between CNRS, FIB, USTUTT and JDSU.

The first presentation is scheduled on Sunday 8th February, 8:30 am during the Solid State Lasers XXIV: Technology and Devices conference (N° 9342) "Single crystal fiber for laser sources"
X. Delen, A. Aubourg, L. Deyra, F. Lesparre, I. Martial, J. Didierjean, F. Balembois, P. Georges

The second presentation is scheduled on Sunday 8th February, 9:00 am during the Solid State Lasers XXIV: Technology and Devices conference (N° 9342) "High power Yb:YAG single-crystal fiber amplifiers for femtosecond lasers"
F. Lesparre, I. Martial, J. Didierjean, J-T Gomez, W. Pallmann, B. Resan, A. LoEscher, J-P. Negel, T. Graf, M. Abdou Ahmed, F. Balembois, P. Georges

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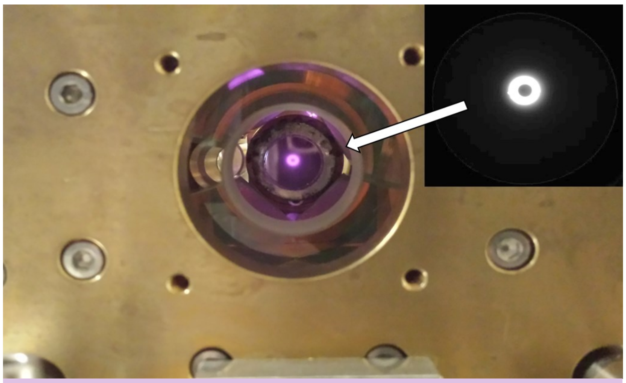
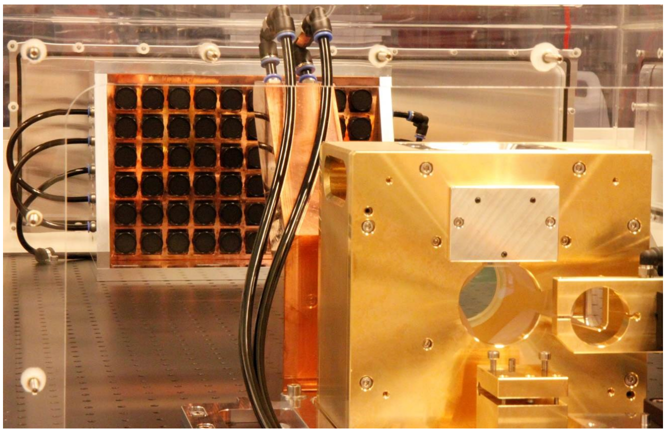
Developed and manufactured by FIBERCRYST, the TARANIS module is an innovative gain component for ultrafast lasers. A YAG crystal fiber (1 mm diameter and 40 mm length) doped with active ions is integrated in a very efficient cooling system.
Amplifiers based on this technology can handle hundred watts of average powers and tens of MW of peak powers while keeping very good M^2 and polarization state. In the Razipol project, the TARANIS technology will be used to amplify a 1 W femtosecond laser to 50-100 W power level, with a radial/azimuthal polarization state.

fibercryst

FIB is designing and producing innovative laser gain modules based on Yb doped crystal for high power amplification and is also designing and testing an integrated amplifier stage, as part of the complete laser system.



Above a photograph shows the ring-pumped thin-disk laser crystal. As can been seen no severe distortion of the ring shaped pumping (which may have been introduced by the multipass scheme of the pump light) could be observed especially for the hollow fiber homogenizer.



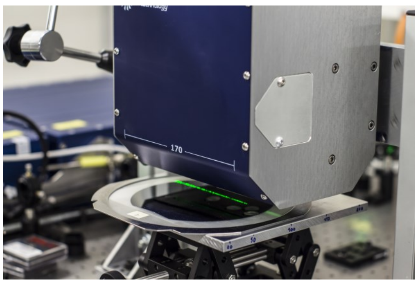
Array of 60 mirrors for the Thin-Disk multipass amplifier

To unlock the high power laser potential, a high precision large area polygon scanner system is matched with an unique ultra-high speed 10+ MHz Pulse on Demand modulator design

next scan technology

GFH GmbH

GFH is working on the integration and evaluation of new equipment into micromachining system and will be hosting the validation of the High Rep Rate (HRR) system for micro-machining and supporting the Low Rep Rate (LRR) system.



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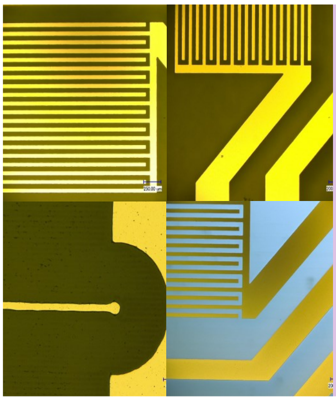
GSI SLV Mecklenburg-Vorpommern

SLV M-V is working on the application development for structuring thin metallic and dielectric layers for chip production using HRR laser system and will also produce a prototype test of HRR laser system for lab-on-a-chip (LOC's) on 6'' wafer.

C4L (Class 4 Lasers Professionals AG) is in charge of the machine set-up. They are also in charge of the laser and optics integration for the LRR system.

SLV M-V LAB-ON-A-CHIP DEVICES



The patterns on the lab-on-a-chip devices were structured on platinum-coated glass wafers with a Pt-thickness of about 100 nm. For these wafers SLV used their USP-Laser with a pulse duration of 6 ps and a wavelength of 343 nm. Due to the limitations of the scanning speed and accuracy, as well as the limited repetition rate and maximum average power, SLV were able to cut the Pt-layer by hatching with a speed of 1 m/s. This resulted in a good quality and a processing time of about 2 minutes for the whole wafer (≈16 cm²).

As part of the Ultrafast_RAZipol project, the higher repetition rates with high average powers and very fast polygon scanning systems will enable a significant higher process efficiency with much lower processing times up to a few seconds. Due to the much bigger scanning fields of the polygon scanning systems, it would also be possible to structure much bigger lab-on-a-chip wafers without "stitching" different scan fields, like SLV would have to do with their optics (SLV's maximum scan field size is about 54x54 mm²).

KITE is working closely with the Coordinator USTUTT to ensure that all the administrative, reporting and financial aspects of the project are managed in an effective and timely manner.

KITE INNOVATION EUROPE

For more information on the Ultrafast_RAZipol project please visit our website

www.razipol.eu

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