eli beamlines

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February 2017

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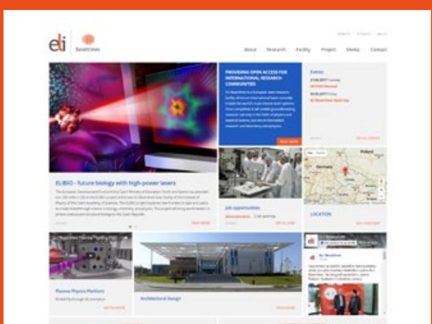

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EDITORIAL

Dear readers,
last year brought us several great results in the development of technologies for the ELI Beamlines. In the development of laser technology, a special attention should be taken the two diode-pumped systems, which were developed in collaboration with LLNL and STFC. Verification tests of both systems ranked them to the very top in its category worldwide.
Recently, we have succeeded in cooperation with ARDOP to install the first secondary source - high harmonics beamline, whose operational testing will begin in coming weeks.

Although the last year was very intense in the completion of development activities the new year 2017 bring indeed a grant challenge in installation and commissioning of most of our instrumentation.
At the same time, we out goal is to be prepare for the first experiment that could be conducted by external users.

It's great to see how increasing materialization of our activities also increases the user community ELI Beamlines. Through dedicated user workshops we are receiving unique feed back and recommendation for finalization of the experimental set-up and operational regimes.
We are proud launched two new project this year ELIBIO and HIFI that will be lead by two internationally recognized scientists Janos Hajdu and Sergey Bulanov.

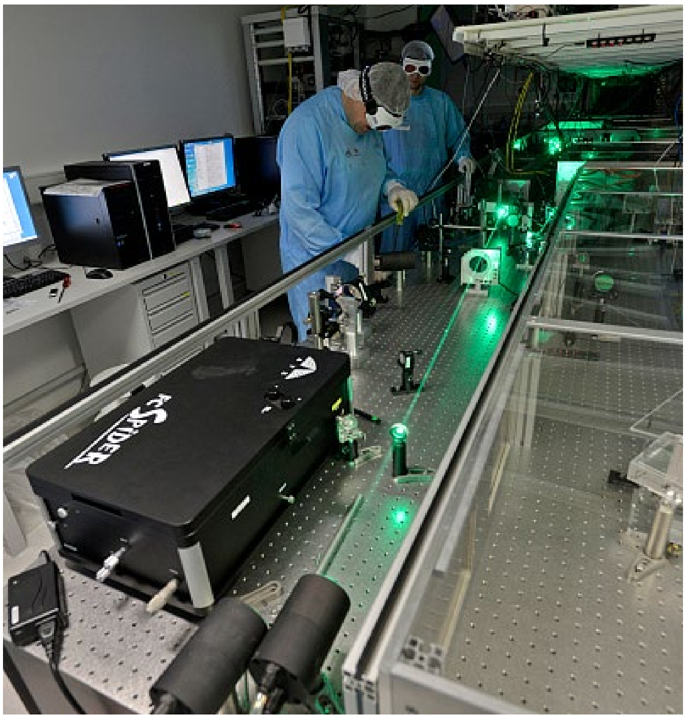
ELI Beamlines has reached the level of well recognized research centre. As such we are working on improving ways how to convey what we are offering to the users. One principle element of this strategy is our new website that brings more user-friendly and interactive information about our instrumentation and research programs that we implement.

Please enjoy the first ELI Beamlines Newsletter, I wish you courage, faith and efforts to conquer everything you desire in the new year 2017.

Roman Hvězda
Project Manager

CONTENTS

RA1: Laser systems
Laser system 1



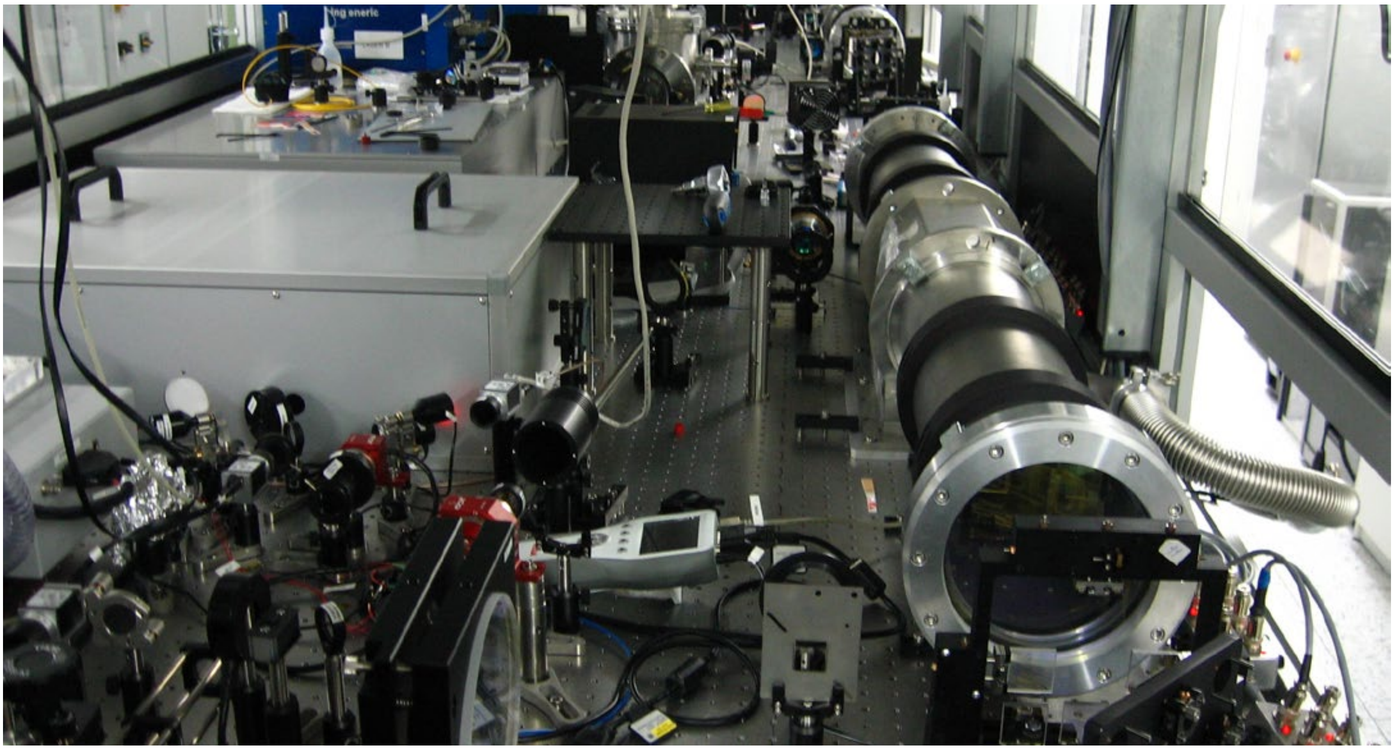
Pavel Bakule is aligning the beam-dump next to the fourth stage of the OPCPA.

The L1 laser is an advanced system designed to generate up to 100 mJ broadband pulses with a duration of 15 fs at pulse repetition rate of 1 kHz, currently under development by a team led by Pavel Bakule. Due to the advanced technology of optical parametric chirped-pulse amplifiers (OPCPA) pumped by picosecond thin-disk lasers, the output beam will be capable of delivering high-flux optical radiation with a very high beam contrast, allowing for efficient secondary source generation, such as X-rays, high harmonics, etc.
The L1 front-end has successfully reached the final parameters of the laser front-end at the beginning of 2016 with a pulse energy higher than 11 mJ and compressible to 12 fs [1]. Since then, the system is ready to be shipped from IoP laboratory at Na Slovance to the new ELI building in Dolní Břežany.
The development in 2016 has focused on increasing reliability and robustness of the system, implementation of diagnostics, and improvement of the existing lasers. One example is a fiber-based seed distribution system for the pump lasers. Tyler Green et al. has developed a multi-functional seeder system for laser amplifiers that replaces several large and complicated optical systems (such as diffraction grating-based pulse stretchers, pulse pickers, and long delay lines) with an all-fiber, hands-free solution [2]. This concept makes the system more compact, robust, and easy to operate.
Furthermore, R. Boge and J. Horáček have successfully implemented an active cavity stabilization for a thin disk regenerative amplifier. Simply said, the pump lasers are now capable of aligning themselves to fully operational state within few seconds. Afterwards, the maximum performance is automatically maintained by applying corrections for environmental fluctuations, such as thermal effect, air flux, etc. This significantly shortens the warm-up time of the lasers and thereby increases the operational time dedicated for users. Because the L1 pump lasers consistently use a thin-disk technology [3], it is now straightforward to implement the same stabilization system in all of them, making the pump lasers almost turn-key systems.
Although the laser hall is not yet available for the final installation of the main L1 beamline, a lot of effort is already spent on preparation of the vacuum part of the beamline, to safe some time once the new halls are commissioned. Piece by piece, the unique mechanical mounts are produced in cooperation with the technical team, led by Pavel Korouš. Manual adjustment to the optics is highly undesirable in vacuum, as it requires opening and closing of the vacuum chamber and thus stopping all the lasers. Therefore, many optical elements are equipped with stepper motors, allowing for the remote control. However, for some safety systems, such as safety shutter, higher speed and reliability is required. For instance, when sudden laser damage is detected on a grating, the laser beam must be safely blocked in a fraction of a second. Therefore, a pneumatic laser shutter has been developed to meet the requirements for the machine protection. Another example of an impressive mechanical engineering is a mount for a chirped mirror compressor, designed to hold tens of chirped mirrors while keeping a small footprint, which is necessary for fitting the compressor within a limited space of the vacuum chamber.
In conclusion, the progress of L1 in 2016 lies in a successful attainment of the final parameters of L1 frontend and in detailed implementation of many subsystems in several L1 test-labs. In 2017 we are looking forward to put all pieces, now being developed separately, together in the new laser hall in Dolní Břežany. ■

References:

[1] František Batysta, Roman Antipenkov, Jakub Novák, Jonathan T. Green, et al., "Broadband OPCPA system with 11 mJ output at 1 kHz, compressible to 12 fs," Opt. Express 24, 17843-17848 (2016)
[2] Martin Horáček, Lukáš Indra , Jonathan Tyler Green, et al., "Multi-channel, fiber-based seed pulse distribution system for femtosecond-level synchronized chirped pulse amplifiers" Review of Scientific Instruments, Manuscript ID: A162424 (in print, 2017)
[3] Jakub Novák, et al., "Thin disk amplifi er-based 40 mJ, 1 kHz, picosecond laser at 515 nm," Opt. Express 24, 5728-5733 (2016)

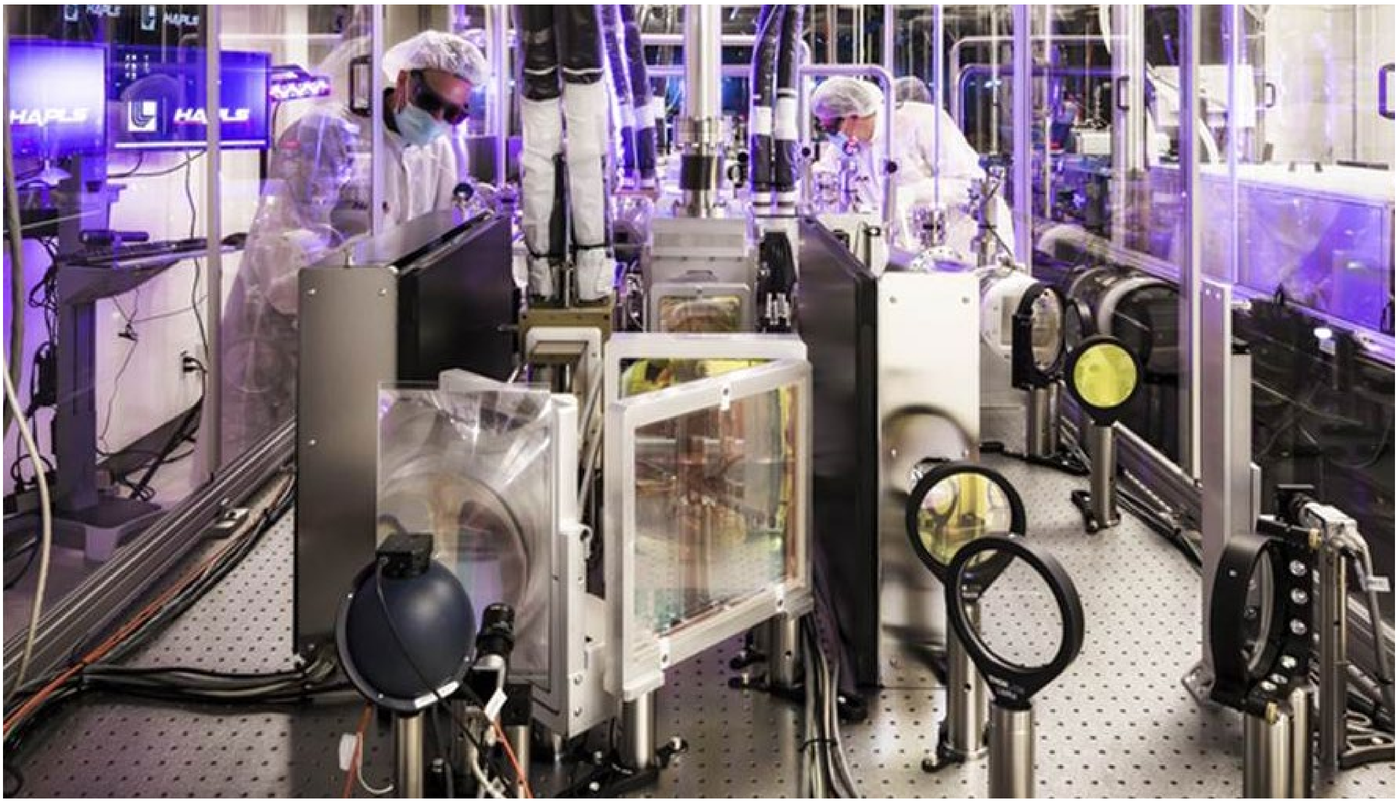
Laser system 2



In 2016, the diode pumped cryogenically cooled Yb:YAG multislab laser system designed for operation at 10J/10Hz has undergone several changes mainly in terms of its auxiliary systems. The major upgrade was done at a cryogenic cooling system (CS) of the 10J laser head, which is a key part for efficient high energy Yb:YAG crystal based laser operation. The laser crystals are required to be cooled at cryogenic temperatures due to the material's excellent thermo-optic and spectroscopic properties at these temperatures. Generally speaking, the lower temperature is, the more energy can be stored and extracted from the Yb:YAG crystals. The worldwide and commonly used CSs for high-energy class diode-pumped solid-state lasers employ a liquid nitrogen (LN2) bath as a heat exchanger. The major disadvantage of such a solution is a need to establish a cumbersome LN2 plant, and, moreover, personal safety issues have to be addressed (thread of LN2 leakage). ELI-Beamlines project came with an innovative approach. The cryogenic laser operation is based on Brayton's cooling cycle utilizing compression and subsequent expansion of the working medium (helium gas). The waste heat is dissipated into the water instead of LN2, which yields benefits in the device compactness (no need of LN2 plant), no needs of safety issues to be implemented and finally in the cheaper operation. This cooling system Brayton (CSB) has been developed, tested and implemented at ELI-Beamlines premises in cooperation with the Czech company ATEKO Inc. This year, two additional heat-exchangers were added into the Cold-box resulting in an increase of the cooling power of about 25%, which is very favourable for cryogenically cooled Yb:YAG based laser systems, as mentioned above. Currently, we are able to cool down the Yb:YAG multislabs below 130 K (which is well below the specified temperature 150 K) and to keep the temperature stability within +/- 0.1 K at the set temperature level, regardless if the pump diodes are running (it represents approx. 300W of additional heat load to be removed from the crystal) or not.

Furthermore, a significant progress has been done in the field of ultrashort pulse generation from the L2 broadband front-end. The ultrashort pulses are generated in two independent hearts – femtosecond oscillators. The first oscillator seeds the OPCPA amplifier, while the second one seeds the pump laser. Similarly as with a car, the engine works well only if all the cylinders operate synchronously. Therefore, both oscillators have to be synchronized with a great precision to operate at the same frequency. In 2016, this two oscillators were successfully synchronized by means of high-frequency electronic lock with a precision better than 100 fs (1 fs = 0.000000000000001 s). The performance of this synchronization was successfully tested by operating the first stage of OPCPA, amplifying the broadband pulses approximately by a factor of 1000. ■

Laser system 3



High-Repetition-Rate Advanced Petawatt Laser System of ELI Beamlines, photo by Lawrence Livermore National Laboratory.

HAPLS (High-Repetition-Rate Advanced Petawatt Laser System) is under development at Lawrence Livermore National Laboratory (LLNL) as the L3 laser for ELI Beamlines. This petawatt laser aims for 30 J pulse energy with <30 fs pulse duration at unprecedented 10 Hz repetition rate. It is based on gaseous helium cooled Nd:glass multi-slab amplifier pumped by diodes with highest peak power commercially available in the world (800kW peak power per diode array). Pump pulses are then converted into second harmonic pumping a helium cooled multi-pass Ti:sapphire amplifier.

This year more than 10 scientists from ELI Beamlines helped with the development of all important parts of HAPLS directly in Livermore. The Nd:glass pump laser reached pulse energy of 80 J at 3.3 Hz repetition rate. A lot of attention was paid to a stable long term operation as required by the use in a user facility. Also a single shot and burst operation was successfully tested. Pulses were then converted into second harmonic pumping the main multi-pass Ti:sapphire amplifier (beta) seeded by preamplified broadband pulses.

The broadband front-end and the first Ti:sapphire amplifier (alpha) have proven a capability of routine reliable operation and the main work was focused on the commissioning of the beta amplifier. Using pulses from the pump laser, the beta amplifier reached the pulse energy of 14 J at 3.3 Hz in an hour-long run.

Amplified broadband pulses were diagnosed in the power amplifier diagnostics package (PAD) delivered and commissioned by ELI staff. With PAD, pulse compressibility, shape, and duration are measured and show that current laser performance is well within the specified values.

Also with the help of ELI employees, a lot of progress has been achieved on the laser control system. It converges to the point where the whole laser system can be operated completely remotely from a control room. It takes control over all utility systems (chillers, helium, air, power supplies), diagnostics (tens of cameras, energy monitors, etc.), timing, motors, shutters, and safety protocols.

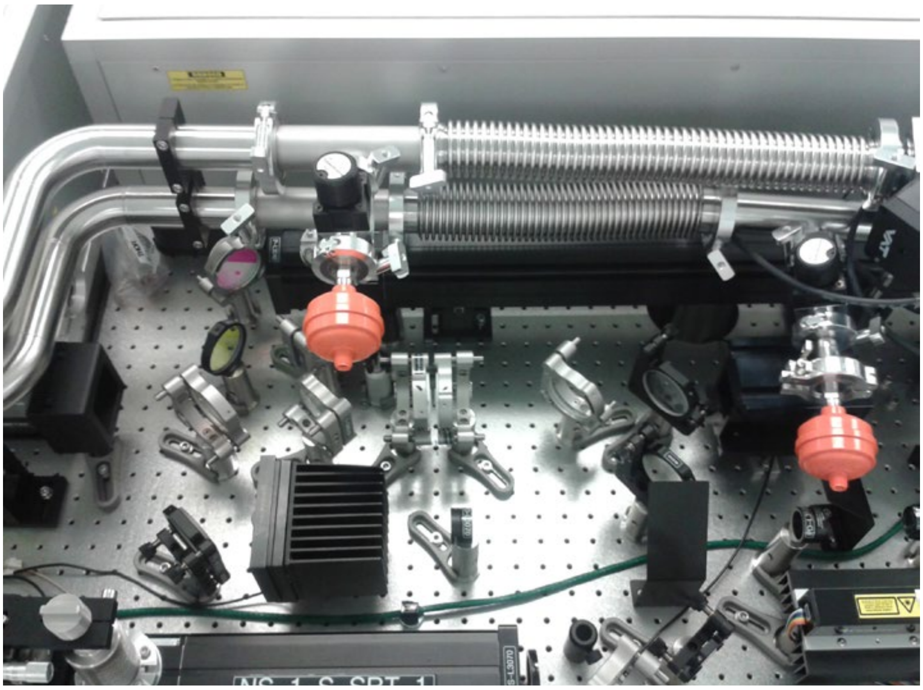
All above mentioned achievements led to the fulfillment of an important milestone D6, which is the last one before the transport to Dolní Břežany. As soon as the technical state of the dedicated laser hall allows, the laser will be deployed here and upgraded to its final specifications. ■

Laser system 4

The cabling between capacitors and the flashlamps in the test lab.

2016 has been an eventful year for the L4 project where progress has been made on many fronts. To ensure high temporal contrast at the experimental target, the laser front end is developed using a combination of OPCPA amplification and a sophisticated pulse cleaner. This year the picosecond OPCPA pre-amplification stage was completed along with the temporal pulse cleaner and, since September, National Energetics and ELI Beamlines staff have made significant progress in bringing the main nanosecond OPCPA stages online in Austin. Key activities on the ns OPCPA development included testing the pump lasers (delivered this year by Ekspla), constructing image relays, setting/calibrating diagnostics, and amplifying pulses. In addition to populating the optical table, extensive testing has been performed on the new high energy glass amplifier modules. To ensure long term reliability, gain and temperature stability have been measured over 100,000 shots and other crucial parameters, such as the quality of coolant flow, have been analyzed. In preparation for the main glass amplifier installation, over 3 km of high voltage cable in total has been routed from the capacitor banks to the test lab by National Energetics and Ekspla.

Some of the most intensive work this year has taken place outside of the lab. To verify the suitability of the optical designs, several laser induced damage threshold studies have been carried out for various critical optical components both at ELI and in the US. ELI Beamlines, in cooperation with National Energetics, has completed the design of the 10PW compressor assembly which will be the largest infrastructure of the facility. In addition to finalizing the optical and mechanical details of the 10 PW compressor, ELI Beamlines and NE have been working together on the details of integration of the L4 laser as a whole into the ELI building. As the only laser at ELI to extend across all three levels of the laser building, close collaboration and careful attention to detail is essential to ensure a successful L4 installation. ■



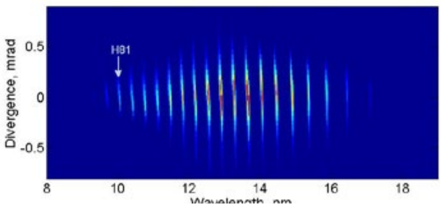
One of the OPCPA stages

RA2: X-ray Sources Driven by Ultrashort Laser Pulses

The year 2016 brought significant progress in research and development of all types of X-ray sources considered for user operation at ELI Beamlines.

High-flux beams of coherent XUV radiation

A series of experiments with increasing laser power was performed at PALS laboratory in order to explore the scaling of optimal conditions for high-order harmonic generation (HHG) in gases with one compact generating medium. The experimental results together with underlining theory enables extrapolation to the driving parameters when using ELI lasers (particularly L1 laser system) giving a trustable estimate of expected source parameters. The vacuum system of the HHG beamline was installed and successfully tested at HiLASE center in Dolní Břežany. Full operation of this beamline driven by commercial 1kHz laser is supposed to start next March.

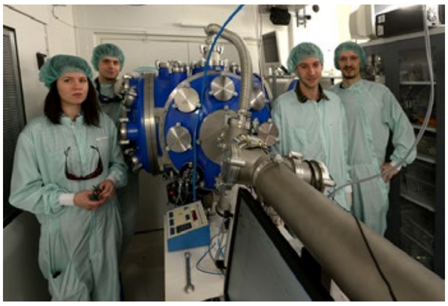


Typical HHG spectrum with loose focusing geometry in hellium.

Incoherent X-ray source from laser plasma

The plasma X-ray source was manufactured and factory tests were successfully performed at the supplier's. It is now ready to be shipped to the Czech Republic where the final acceptance tests will be performed.

HHG beamline at HiLASE.

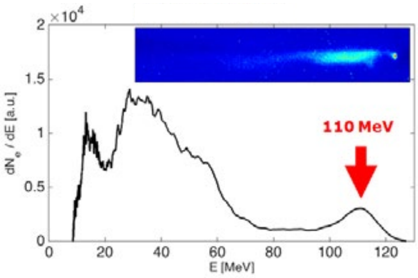


HHG team at PALS.

Incoherent X-ray source from laser-driven relativistic electron beams

Laser betatron

During the last experiment in the PALS Centre, collimated electron beams with energy of 110 MeV were generated using 10 TW Ti:sapphire laser system. Such highly relativistic electron beam can be used to generate ultra-short flashes of X-rays when transversally oscillating in the accelerating plasma structure (betatron oscillations), when another laser pulse scatters on them (Compton source), or when they pass through a periodical system of static magnetic fields (undulator radiation).

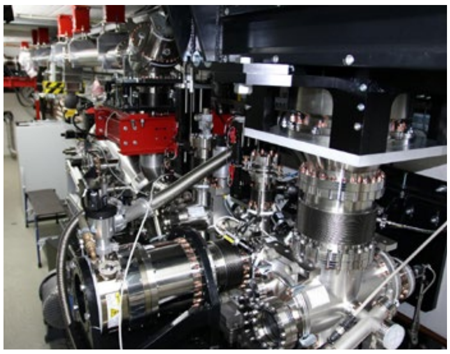


Electron spectrum (He+Ar)

The X-ray source size is as small as few microns making this type of radiation perfect tool for e.g. high resolution dynamical studies.

Laser driven undulator X-ray source (LUX)

The year 2016 was very fruitful for the Laser driven undulator X-ray source beamline developed in collaboration of University of Hamburg (group of prof. F. Grüner) and ELI Beamlines (group of G. Korn) and currently commissioned at DESY laboratory, Hamburg. During the year most of the installations of the initial beamline hardware setup were performed and the beamline successfully produced its first energetic electron beams in an experiment driven by a dedicated 200 TW laser system. During a fi rst test run, LUX was able to accelerate electrons to about 400 mega-electronvolts, using a plasma cell that is just a few millimetres long (see part of the experimental setup on the photo below). Classical radio frequency driven accelerators require several tens of meter length to reach the same energy.
By the end of the year the LUX beamline setup was finalized with a short magnetic slalom course, a so-called undulator, in which the fast electrons from the plasma accelerator will produce x-rays. The x-ray experiments are expected in the first half of 2017. ■



LUX beamline in Desy, Hamburg, Credit: Lukas Pribyl, ELI Beamlines.

RA3: Particle Acceleration by Lasers

In 2016 the Ion Acceleration team of ELI Beamlines has focused on three main activities: scientific, Engineering, International Cooperation.

ELISE installation at PALS in Prague.

ELISE functional test at SBT-CEA in Grenoble.

A close look at the solid hydrogen ribbon flow from the ELISE nozzle.

In fact the team is in charge of implementing the ELIMAIA (ELI Multidisciplinary Applications of laser-Ion Acceleration) user beamline, which will be the first experimental area fully dedicated to the generation and use of laser driven ion beams for experiments on applied science in different disciplines (Physics, Biology, Medicine, Chemistry, Material Science, etc.). For this reason a substantial part of the work was dedicated to engineering activities, such as design of vacuum chambers, realization and testing of target tower and ion diagnostics. Nevertheless, the team has carried out outstanding research, both experimental and theoretical, in the field of ion acceleration. Among a number of papers produced, the recent activity on the use of a cryogenic thin solid hydrogen ribbon for proton acceleration at PALS laser facility was published in the prestigious journal PRX (D. Margarone et al., Phys. Rev. X 6 (2016) 041030). This result is strategic for a future use of ELIMAIA at high repetition rate for users who need high integrated dose on their samples. In fact, besides providing a refreshable target which can potentially operate at 3-5 Hz, it enables the production of a pure beam of protons which is requested both by the users and by the beamline operators. Furthermore it causes no deposition, and the source operation is easy and reproducible. 30% conversion efficiency from laser energy to overall proton beam energy has been predicted with the future use of L3-PW laser.
Furthermore, a patent application was submitted to EPO and the corresponding paper on prompt gamma ray diagnostics and enhanced hadron-therapy using neutron-free nuclear reactions, was published (L. Giuffrida et al., AIP Advances 6 (2016) 105204).
At the same time the existing international cooperation was enhanced through grant applications with Queen's University (UK) and INFN-LNS (Italy); launching the idea of a European network aimed at establishing a distributed targetry lab for future users (Building a Target Network for Advanced Laser Light Sources) together with HZDR (Germany); a joint experiment on ion acceleration in the Lund (Sweden) laser center; participation and coordination of the EUCALL-WP6 (HIREP) on high repetition rate target delivery; and last but not least, organization of the 3rd ELIMED workshop (Catania, Italy) aimed at gathering the user community for ELIMAIA with a special focus on laser-based radiation biology, dosimetry and hadrontherapy. ■

RA4: Applications in Molecular Bio-Medical and Material science

2016 saw the realization of the first RP4 femtosecond molecular dynamics experiments byELI Beamlines (in the E3 lab in HiLase). The first experiment performed (Oct 2016), was a transient absorption study of a carotenoid-phthalocyanine dyad molecular complex that mimics photosynthesis. In this experiment RP4 researchers could follow the energy transfer following the initial excitation by a 400 nm photon (fig. 1) with femtosecond (fs) precision.

Following the successful commissioning experiments this lab is now engaged in experiments with international collaborators.

One experiment on charge-transfer dynamics in Cu-containing bio-inorganic model complexes has been performed with users from CFEL/Hamburg University and one experiment aiming at the development of ultrafast pump-probe ellipsometry is presently underway in collaboration with guests from

Borislav Angelov, Shirly Espinoza, Christopher Brooks, Martin Precek, Jakob Andreasson, Olena Kulyk, Eva Klimesova, Miroslav Kloz, Mateusz Rebarz

Leipzig university. Following the extension of the experimental capabilities into the IR range, experiments on proton dynamics in Solid Oxide Fuel Cell materials are planned in collaboration with Chalmers University of Technology in Sweden. In 2016 RP4 researchers also headed a FLASH beamtime on sample explosion dynamics (one color VUV/VUV pump/probe) in single particle Coherent Diffractive Imaging experiments and participation in ESRF beamtimes, including use of the ELI Beamlines Eiger X 1M detector. Further activities include participation in characterization of the Uppsala aerosol sample delivery system (Uppsala, Sweden), ellipsometry experiments in Hamburg and IoP (Slovanka), time resolved optical spectroscopy at the Free University of Amsterdam and participation in the development of water window dosimetry methods at the Polish Military Academy.

During 2016 RP4 has been busy with instrument development and the preparation of strategic tenders. The tender documentation for all the main items of the optical spectroscopy program has been prepared and launched. The MAC chamber for molecular experiments in the gas phase and coherent imaging has been built and will be delivered in early December. In-house design and development work for the electron and ion spectrometers for this station is underway. We have developed the conceptual design for a von Hamos spectrometer for X-ray absorption and emission spectroscopy together with Polish and Swedish researchers. The end of the year will see the launching of the tender for the X-ray diffraction station and the signing of the collaboration contract for the VUV monochromator and refocusing optics for the HHG source. These are the last of the planned large RP4 tenders and will be complemented during 2017 by a number of smaller tenders. 2016 has also seen a very notable effort from RP4 to revise the design of the E1 beam transport system to support the L1 and the complementary Astrella laser. Finally we have equipped the preliminary bio and chemistry sample preparation labs.

During 2016 RP4 has organized a highly appreciated workshop on time resolved and VUV ellipsometry (Oct. 2016). This workshop was co-hosted with CEITEC in Brno and brought together national and international experts and resulted in the establishment of collaborations for early experiments. Two independent meetings on time resolved protein crystallography with THz and optical pulse shaping techniques to initiate sample dynamics (June and July) has also been organized. RP4 continues to be involved in the EUCALL-WP7 on pulse characterization and control together with a number of other European Research Institutes. International collaborations have been formalized through three MoUs (Polish Academy of Science, Jan Kochanowski University in Kielce, Poland, Leipzig University). Two articles published in peer reviewed scientific journals and one manuscript is presently under review.

An important event happened in early November when we were informed that our application for funding for an "Excellent Research Team" was successful. The application was prepared in a collaboration between ELI Beamlines, BIOCEV and Professor Janos Hajdu at Uppsala University. This will allow us to equip part of the ELI Beamlines bio-lab complex, invest in further infrastructure and greatly enhance our research capabilities in bio-molecular dynamics, using both the ELI Beamline light sources as well as other new X-ray sources like the European XFEL. In addition to this major funding we have also secured funding to initiate a research collaboration between Visegrad countries on time resolved X-ray spectroscopy at ELI Beamlines. ■

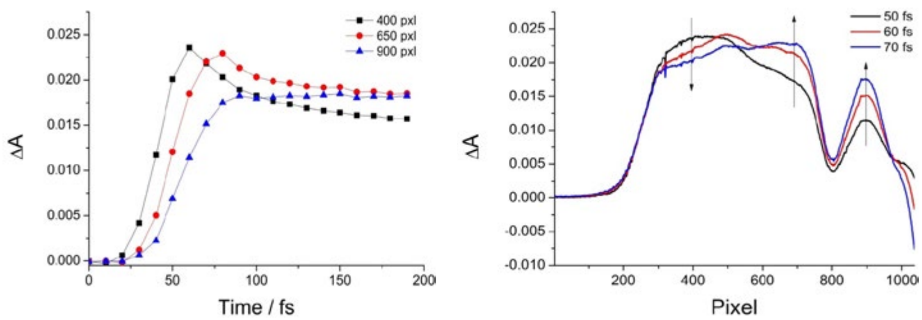


Fig 1. (left) Absorption difference showing the energy transfer from the carotenoid S2 state to the phthalocyanine (PS). The dynamics happens of the fs time scale. (right) The ultrafast time evolution of the ultrafast transients followed up to a delay of 200 fs.

RA5/6: Plasma and High Energy Density Physics, Exotic Physics and Theory

The groups R5 and R6 have been very active this year as far as experimental campaigns and publications are concerned.

Experiments were performed on a large variety of topics. An important research topic remains plasma amplification, which is demonstrated in the publication of two articles in Physical Review Letters, one experimental [PRL 116, 075001 (2016)] and one theoretical [PRL 117, 235003 (2016)]. This year's research concentrated on optimization and control of the amplification process. Investigations were carried out concerning suprathermal electrons in the context of shock ignition on the PALS facility. On the same facility, experiments were performed for magnetic field generation using capacitor coils and downramp LWFA for betatron optimization. Experiments were also performed on foreign installations such as OMEGA (preheat, warm dense matter), and TRIDENT (neutron acceleration and K-alpha emission from nano-structured targets).

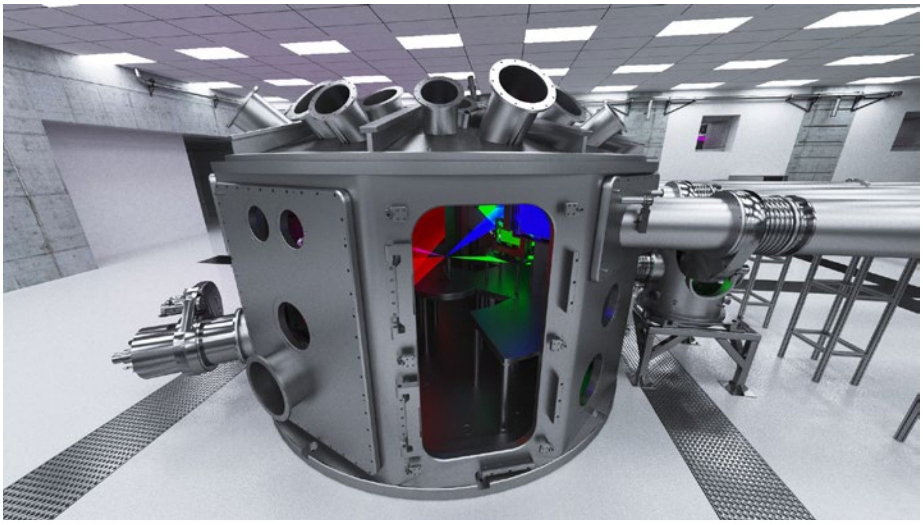
On the engineering side the group is eagerly awaiting the delivery of their big experimental vacuum chamber P3, which is at present under construction and expected to be installed in the experimental hall E3 in March 2017. Smaller engineering activities took place in the construction of the pulsed power device and the betatron and the gamma-ray spectrometer for diagnostic purposes. The latter two have been successfully tested on installations such as PALS, the Lund Laser Centre and the HZDR in Dresden.

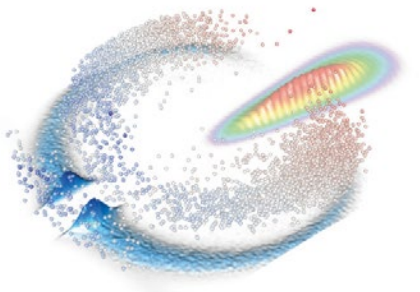
The R56 group has been very prolific this year as far as publication activities are concerned. In total the members of R56 authored or co-authored about 30 articles in refereed journals, among which two PRLs and one Rep. Prog. Phys.

On the numerical tool development side a new one-dimensional code for radiation-hydrodynamics has become available which describes all transport in the non-local framework and which will be important for pre-pulse physics studies.

Last but not least we are excited that we received a mega grant (HIFI) in the framework of the Excellent Research Team (ERT). The purpose of the ERT grant is to attract a key foreign researcher of international reputation, Prof. Sergey Bulanov, to build up a team of excellent researchers in the field of ultra-intense laser-matter interaction which will prepare the first flagship experiments to be performed with the 10 PW laser. As far as the investments are concerned the grant has a dual purpose. On the one side the computing infrastructure (ECLIPSE) will be considerably upgraded to allow multi-dimensional simulations in the high-field regime. On the other side the technological infrastructure will be extended to allow for synchronized multi-beam experiments which are required for high-field investigations. Theory/simulation and experiment/technology will evolve together to prepare physics investigations in a completely new regime.

We are looking forward to 2017 when installation work will finally start in the experimental halls. ■





Two pictures representative for the activities of R5, 6.

Top: a cartoon of the P3 chamber with a volume of about 50 cubic meters.

Left: a simulation result investigating the collision of a high-intensity laser pulse with aplasma.

Sometimes in the future I want to have my own research group

Shirley Josefina Espinoza Herrera was born at Christmas in 1982 in Planeta Rica, Columbia. She studied at the Faculty of Sciences, National University of Columbia and came for her PhD studies to the Charles university in Prague.

How did you get to know about ELI Beamlines and what did you find attractive about it?
I did my PhD studies in Physics at Matfyz here in Prague, then, in order to get international experience I moved to the US and Italy to conduct additional postdoc research. I have siblings living here in Prague, and I liked the Czech scientific environment. So, I always kept an eye open for professional possibilities in the Czech Republic. I got to know about ELI Beamlines through some Czech colleagues that visited me during my work at the IOM, CRN in Trieste, Italy. And I found the idea of this research institute very attractive, because it is based on new research in unknown fields. There are only a few similar experiments running in the world. For me, as a young researcher, this is a great opportunity to be part of something completely new. The possibility of developing scientific research, in a permanent position in my field, while surrounded by family and friends was very attractive to me.

How long are you working here and what is your job?
I have been working here at ELI for more than a year and half. Until now, I have been involved in basic research into sensors, spectroscopy and ellipsometry techniques. That is also my main job here at ELI: I am involved in the development of ellipsometric and spectroscopic instrumentation. We use high intensity, pulsed lasers, to implement a technique called time-resolved ellipsometry, and later we will use VUV ellipsometry, i.e. soft X-ray beams from non-linear processes to make experiments at relatively high energies. By these techniques we can tune the excitation energy and gain new information about the physical phenomena occurring in different materials such as metals, insulators and semiconductors, in the femtosecond time scale.

What do you like the most about your job?
What I like the most about my job is the opportunity for travelling around the world. Early this year I spent some time at Monash University, in Australia, working on methods for early detection of Malaria infection and have participated in several conferences, such as the ICORS conference in Brazil where I presented my work on materials for Surface Enhanced Raman Spectroscopy, a technique that is being studied for the detection of metastatic cancer cells. Other conferences where I participated this year were DPG in Regensburg and ICSE in Berlin, presenting the development of our ellipsometry technique. Thanks to these last conferences we got what could be called ELI's first users. Researchers from Uni. Hamburg and Uni. Leipzig came to perform measurements on Copper complexes and ZnO respectively. We could test our setup and the results were promising, on the ZnO samples we got time resolution never seen before.

Do you like living in the Czech Republic? Can you compare a life style here and in your homeland?
Yes, I like the calmness and security of living in Prague and the opportunity of travelling to different countries with different cultures in just few hours. Sometimes I have travelled through different European countries just for a long weekend. In Colombia, surrounded by Latin-American Spanish speaking countries, the culture seems rather homogenous. You could take a half day flight and still find yourself speaking Spanish, listening to the same kind of music and having the same political discussions. The lifestyle here in CZ is more cosmopolitan, back in Colombia life is more family and tradition oriented. I like being part of both cultures.

What do you like and really dislike in the Czech Republic?
What I like the most is the culture, the humor of the Czech people, and what I don't like is the cold winter. After a lot of years living here, I have still problems with the gray days. I like the snow on the mountains during skiing holidays, but I am definitely happier with a sunny and hot day like the ones of my hometown, Planeta Rica, Colombia.

How do you see your career in 20 years? Do you have any milestones you want to reach?
Yes, I have a lot of milestones. In 20 years, I see myself as a well-established scientist, having my own research group, with whom I will be doing awesome science and, if possible, the place will still be ELI Beamlines. ■

Moving Towards Mid-IR Picosecond Lasers with High Average Power

In November of this year, we started a new research project at the HiLASE Centre with South Korean partners to develop a 2.1 micrometer (μm) laser using a Holmium doped Yttrium-Aluminum-Garnet (Ho:YAG) crystal, targeting average powers up to 100 W, with a picosecond pulse duration and a high repetition rate of 100 kHz (scalable to 800 kHz).
But why it is so important? Where is the link with our beamline PERLA C, where we have already achieved a stable 5.4 mJ pulse energy? Is it just another attempt to achieve next world primacy or there is something more? The answer is in the wavelength.
The HiLASE "work horse" laser medium is the Ytterbium doped Yttrium-Aluminum-Garnet (Yb:YAG) crystal, with an emission around 1 μm. In terms of eye safety, NIR wavelengths around 1.0 μm should always be considered seriously because the retina is not sensitive to this NIR spectrum and the iris does not reduce incident light intensity, and thus the light is directly focused by the lens onto the retina. Even a brightness of 10 μW per square cm of 1 μm radiation could cause irreversible chemical changes in the retina.
For wavelengths longer than 1.4 μm, this radiation is attenuated by the water in the vitreous part of the eye. Lasers based on Ho:YAG crystals offer high efficiencies and high output powers, while reducing the risk of damage to the retina, as its 2 μm radiation is highly absorbed in water compared to 1 μm radiation. Various applications, specifically those with a medical focus like dermatology, cardiology, gastroencology, gynecology, urology and nefrology, have a great need for laser sources operating from 2.1 to 2.2 μm. Practical medical experiments shows that for most applications, better results were achieved by a laser in the near 2 μm wavelength because they only penetrated up to 0.5 mm, compared to 1 μm lasers, which penetrated up to 10 mm. Experiments with lithotripsy and stomatology indicate high future needs for 2.1 μm laser sources with a high pulse energy, up to the mJ level.

In order to see the significance of this difference, the average human cell is about 30 μm wide and a typical fiber coupled laser for surgery has a multimode stepindex optical fiber with a core size of 200 – 400 μm and a beam divergence of 440 – 880 mrad (respectively). By simple calculation the minimal interaction zone is 25,000 cells for a 1 μm laser compared to 67 cells for a 2.1 μm laser.
Another advantage of the project is that the laser pulses will have a picosecond duration in comparison to the historical nanosecond duration; 1000 times shorter in duration. As shown in figure 1, using picosecond lasers for surgery dramatically reduces the amount of pain for the patient during the procedure.
Ho:YAG picosecond lasers also have a great opportunity to adapt into industry. Participating on the project will also be: Czech and Slovak company, Korean research institution and Korean private companies specialized in laser development, crystal growing and medical field with public support of Czech Technology Agency and Korean Institute of Advance Technology under DELTA program. ■

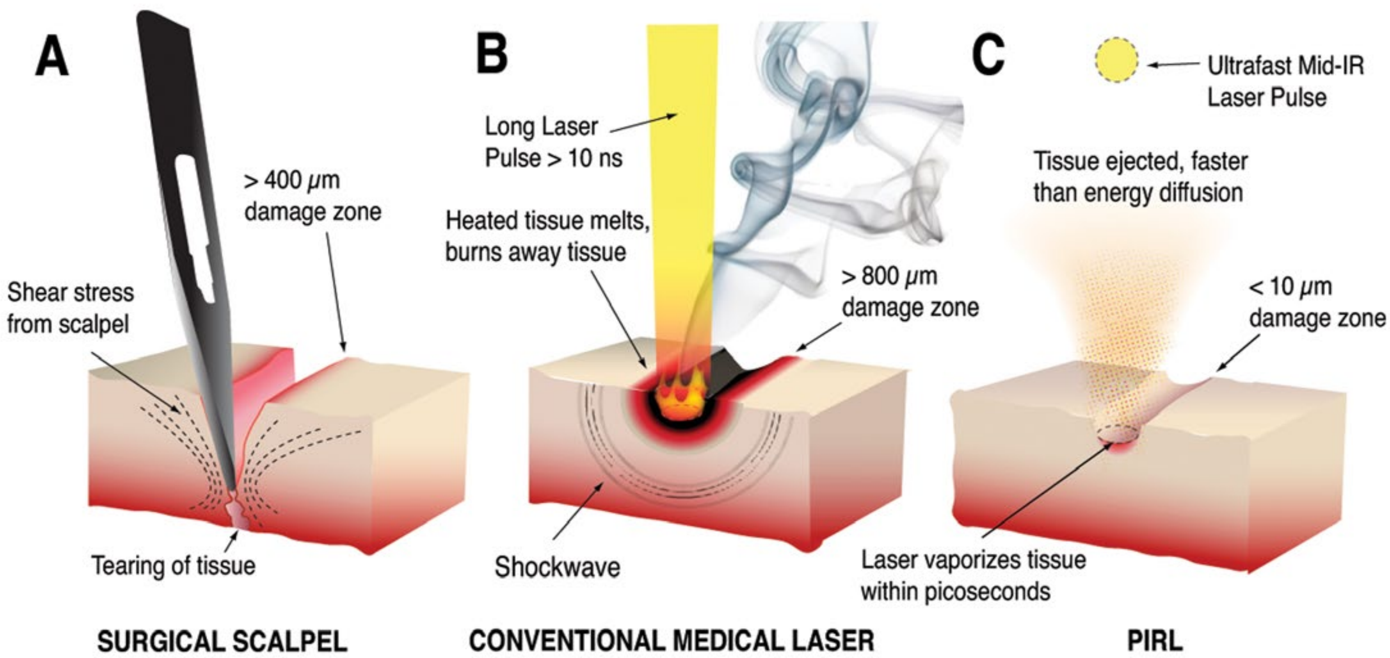


Fig.1 Nanoseconds vs picoseconds lasers by Amini-Nik, Saeid, et al. "Ultrafast mid-IR laser scalpel: protein signals of the fundamental limits to minimally invasive surgery." PLoS One 5.9 (2010): e13053.

Funding confirmed for major Czech-British partnership for 'next generation' laser centre

Scientists from the Czech Institute of Physics and STFC's Central Laser Facility will work together on a new "Centre of Excellence" for the industrial exploitation of new laser technology. The 45 Million Euro venture is co-funded by the European Commission and the Czech Ministry of Education, Youth and Sports (MEYS) and will be one of the first projects to be funded under the "Widespread Teaming" programme within Horizon 2020.

The H2020 programme will bring 10 Million Euro to the project, with the remainder from MEYS upon fulfilling the conditions of the Czech Operational Programme for Research, Development and Education. The project will further laser development based on the needs of high-tech industry and support the transfer of STFC know-how in effective cooperation with companies.
The new Centre of Excellence will be based at the HiLASE facility at Dolní Břežany, close to Prague. HiLASE incorporates advanced solid state laser systems that are ideally suited to high-tech industrial applications, opening up new processing techniques for surface hardening, semiconductor processing and micro/nano-machining, for example. Brian Bowsher, STFC Chief Executive, said: "I am delighted that this project has been selected for funding by the European Commission. STFC recently delivered a £10 million contract to HiLASE and the funding for this new centre of excellence will allow us to ensure the research at the facility is fully exploited for industry. We also look forward to collaborating on the centre of excellence as an opportunity to build our ongoing partnership with our Czech colleagues."

Out of the 169 European projects, only 10 have successfully passed the evaluation in the second phase of the Call. The HiLASE CoE is the only Czech project which will be funded. Katerina Valachova, Czech Minister of Education, Youth and Sports (MEYS) said "I am very pleased that arising from our previous investment of funds from the Operational Programme Research and Development for Innovation we have created an infrastructure that is able to obtain European funding that will significantly contribute to the growth of international competitiveness of the Czech Republic".
The HiLASE facility is located within the Science and Technology Advanced Region (STAR). Jan Ridky, Director of the IoP, highlighted the importance of a common strategy for the development of the STAR region. "From the very beginning, the management of the Institute of Physics and both laser centres is actively involved at the heart of regional matters. The Teaming initiative itself puts the emphasis on the active approach to clustering which has been shown on the European level as an effective tool to boost the convergence of scientific and research institutions and industry. In the longer term, we are committed to supporting education and awareness within the STAR territory."
Jiri Drahos, President of the Czech Academy of Sciences (CAS) appreciated that the HiLASE centre is already following the new moto of the Czech Academy of Sciences - Top Research in the public interest. "The success of this proposal clearly shows that the CAS is able to develop basic curiosity driven research as well as the high quality applied research in accordance with the needs of contemporary society, where the research results are shared with industry." ■

First Annual HiLASE workshop

The First Annual HiLASE workshop was held on October 10-12, 2016 at Chateau Stirin, Central Bohemia, Czech Republic. The workshop highlighted the most recent achievements of HiLASE Centre in the development of kW-class picosecond-nanosecond diode pumped solid state laser systems and associated technologies, results of our laser-material experiments and applications. Moreover, the scientific and technological opportunities for laser experiments at high average power were introduced. The event also served as a forum to discuss joint results and technological bottlenecks as well as to prepare new projects and take part in networking. The HiLASE Centre aims to continue in building strategic partnerships with research organizations and corporations active in high power photonics or employing advanced laser technologies in their research, applications and product development activities. ■

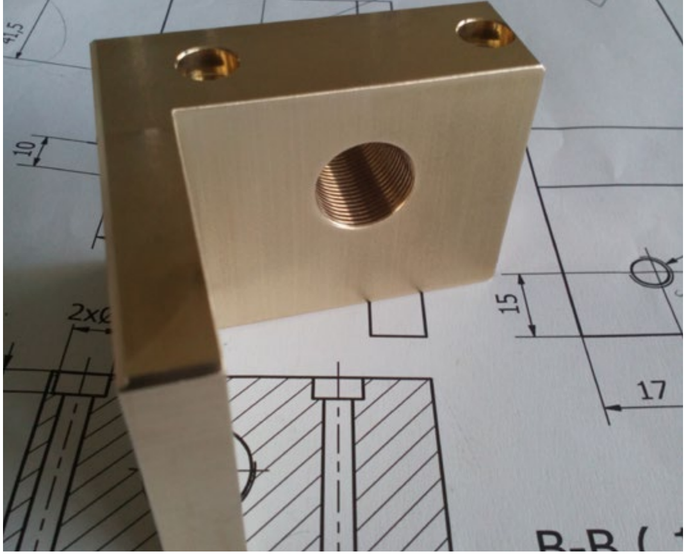
Technology mission lead by CzechInvest to Korea

In September 2016, Tomas Mocek, Head of the HiLASE Centre and Michael Pisarik, Business Development Manager, participated in a technology mission to South Korea. The mission was undertaken in connection with the action plan signed by Czech Prime Minister, Bohuslav Sobotka and South Korean President, Park Geun-Hye in February 2015. The two-year pact between the countries is a guarantee of cooperation in the areas of science and research. While in South Korea, the HiLASE representatives together with other Czech researchers, institutions and companies presented progressive technologies and the research potential of the Czech Republic. The offered possibilities included development of high-performance laser systems, optomechanical components for laser systems and modifications of optical materials. ■

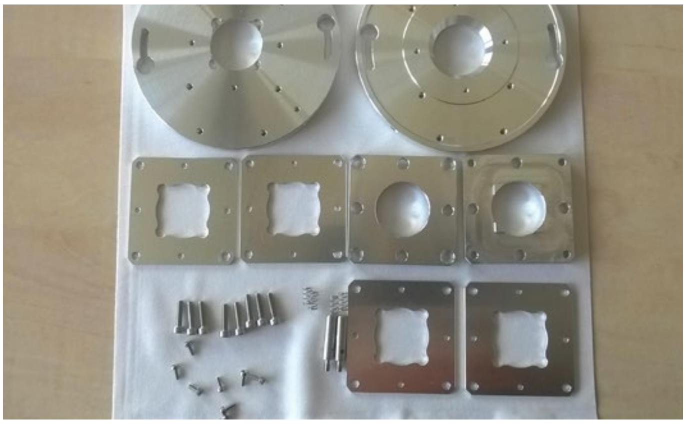
GALERY

Technical Workshops at ELI Beamlines

In the last issue of the newsletter, we showed off the new technical workshops, which were put into operation at ELI Beamlines in early 2016. Now, here are some images of components that were manufactured in the workshops for the construction of our laser systems.



Block (experimental program).



Alternative SHG crystal insert (L1 laser system).

Mount rack holder (L1 laser system).

Pneumatic Iris Prototype - parts (L1 laser system).

Beam dump (L1 laser system).

ECU mirror mount prototype (experimental program).

Beam dump - parts (L1 laser system).

Week of Science and Technology

From 1st to 13th of November 2016, the 16th year of the Week of Science and Technology ASCR was held. It is the largest science festival in the Czech Republic, more than 80 offices of the Academy of Sciences and partner organizations were opened for public. Teams of laser centers ELI Beamlines and HiLASE were involved in both within the interactive exhibits of the Institute of Physics at the building of the Academy of Sciences in Prague, as well as within the framework of the Open Days at their workplaces in Dolni Brezany.
The exhibition of the Institute of Physics ASCR showed nearly 700 attendees that physics is not boring and that we can explore it with our own eyes, hands and own heads in many fascinating ways. ■

German-Czech Innovation Day

The 21st of November, the laser centre ELI Beamlines hosted a German-Czech Innovation Day, which was organized by the Central Bohemian cluster STAR. The aim of this bilateral workshop was to learn about good experience of cooperation in the field of scientific research infrastructure from the German partners and opportunities of technology transfer from R&D institutions. The seminar was attended by 60 guests from the Czech Republic and Germany. ■

Visit of the Vice Minister of China

On December 1st, 2016 the Vice Minister of Science and Technology of China Mr. Yin Hejun and his delegation visited the ELI Beamlines centre in Dolni Brezany.
They were welcomed by Jan Ridky, the director of the Institute of Physics of the CAS, and by Roman Hvezda, the project manager of ELI Beamlines. After discussions they visited the ELI-Beamlines laser halls and then the HiLASE centre. ■

Day of National Infrastructures

On November 3rd, 2016, a Day of National Infrastructures was held in ELI Beamlines in Dolni Brezany. It was the first time that the representatives of all the research infrastructures in the Czech Republic met together. The conference was organized under the auspices of the Ministry of Education, Youth and Sports and the Council for major infrastructures for research, experimental development and innovation, and was attended by more than 130 representatives of the academic and industrial spheres. ■

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