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Laserlab Europe

Laserlab Forum

Newsletter of LASERLAB-EUROPE:
the integrated initiative of European laser infrastructures funded by the Seventh Framework Programme of the European Community

Laserlab Networking

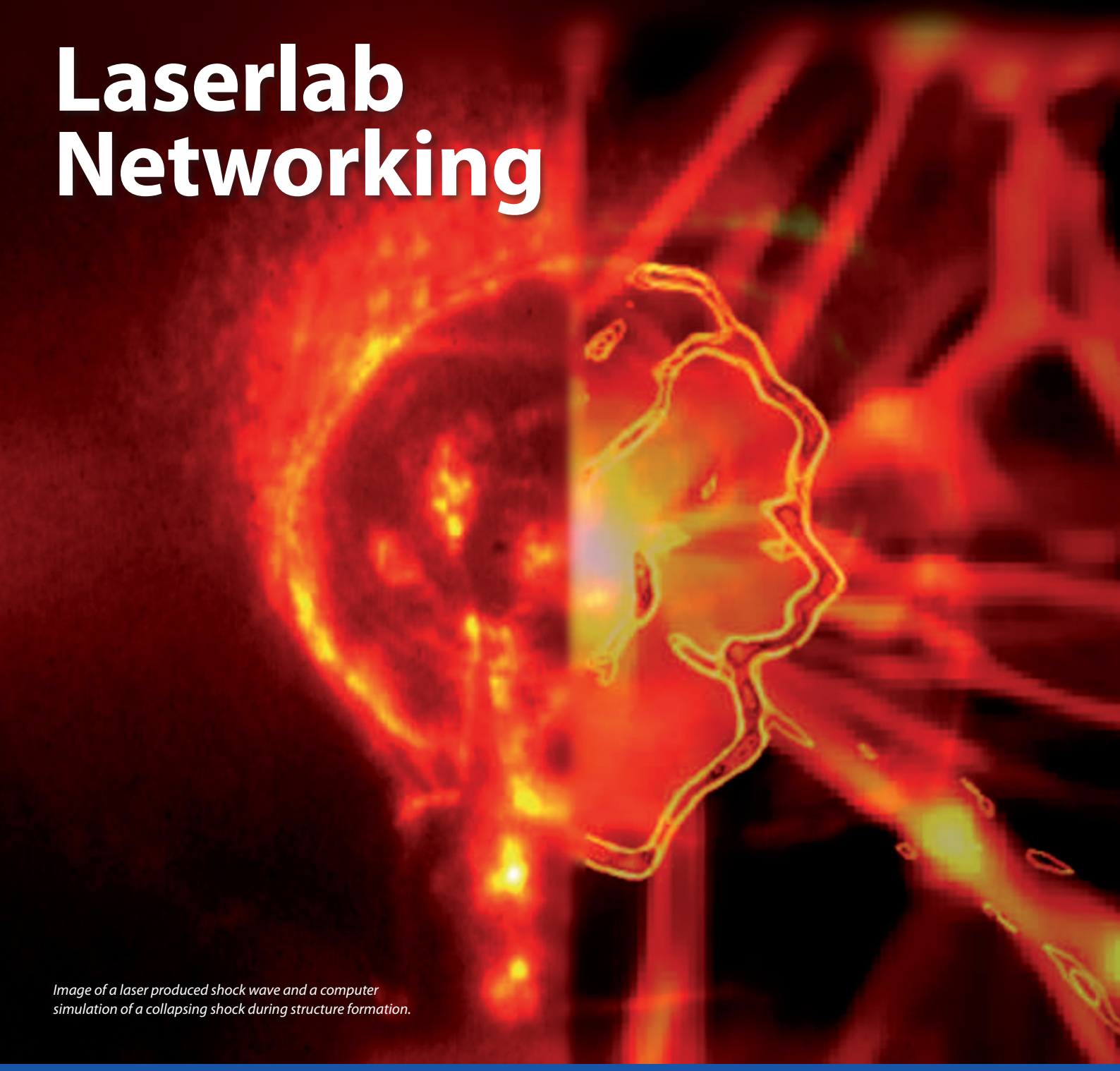


Image of a laser produced shock wave and a computer simulation of a collapsing shock during structure formation.

In this Issue

Editorial


Tom Jeltes

Lasers are everywhere, and it seems they can do anything. Many people will have heard of laser-assisted eye surgery, which has relieved millions of the need to wear eyeglasses or contact lenses. Fewer will know that brain surgeons also regularly use lasers. Thanks to scientists from the LASERLAB consortium, who developed a tailor-made laser at just the right wavelength, laser-based brain surgery will likely be more effective and safer in the near future.

For those who are not directly involved in laser science (and even for some who are), the fact that lasers can shed light on magnetic fields pervading distant galaxies will come as a surprise. As this issue's Access Highlight demonstrates, lasers can be used to create a situation in the lab that illuminates the origin of those cosmic fields billions of (light) years away. And in a different manner, laser science could be the key to our understanding of the fundamental constants of Nature (which might not be as constant as their name suggests). A comparison of traces of light from the distant Universe with accurate laser spectroscopy data could lead to a revolution in theoretical physics and cosmology alike…

Be their application as practical as in medicine, or as fundamentally scientific as in cosmology, the evolution of lasers depends on the scientists and engineers who build them. And the advancement of these laser experts is in turn greatly enhanced by sharing ideas. This issue of Laserlab Forum contains reports on many networking events, meetings and workshops organised in relation to LASERLAB-EUROPE. Because, as our new Coordinator Claes-Göran Wahlström puts it, building bridges and friendship between researchers is "good for science, good for LASERLAB-EUROPE and good for Europe."

Tom Jeltes

News

ERC Advanced Grant for photonic micro-robotics


Diederik Wiersma

Prof. Diederik Wiersma, currently director of LENS in Florence, has received an ERC Advanced Grant of 2.2 million euros. Wiersma intends to use the grant to create a whole new research area, photonic micro-robotics, by creating microscopic structures which can perform robotic tasks and are entirely powered and controlled by light.

For the project, the expertise available at LENS on complex photonic materials and direct laser writing will be combined and applied to create microstructured patterns in liquid crystal elastomers: rubber-like polymers with liquid crystalline properties. Direct laser writing will allow Wiersma and his team to realize structures with sub-micron resolution and nanometre scale accuracy. By using elastomers, it will be possible to create robotic elements that respond mechanically to optical triggers. These elements will be combined with static (photonic) structures, opening up a new strategy to make robots of various kinds.

The ultimate goal of the project is to create micro robots that can swim, walk, or crawl to their destinations and are able to perform specific tasks, controlled and driven by light. The

Visit of Portuguese high school physics teachers at the Rutherford Appleton Laboratory, UK

range of potential applications of this initially fundamental and curiosity-driven research is very broad. Micro robots would be able to penetrate into environments otherwise difficult to access and perform tasks such as sensing or sampling. As they can be made in large quantities, the micro robots could also be put into collective action in swarms – communicating either optically or mechanically with each other.

"The project is truly interdisciplinary", says Wiersma, "which makes it very challenging but also exciting. The photonic micro robotic structures will be created by bringing together concepts from physics and chemistry, while the inspiration for designs comes partly from biology and potential applications can be foreseen in medicine."

Laser for brain surgery

The EU project MIRSURG has led to the creation of a prototype compact all-solid-state laser system for minimally invasive neurosurgery. Research groups from LASERLAB partners ICFO (Barcelona) and MBI (Berlin) took part in the European project, which was coordinated by Valentin Petrov from MBI.

The new laser emits short pulses exactly at 6.45 microns. This mid-infrared wavelength had been identified as the most suitable for removing brain tumors, but it has not been applied widely because this particular frequency could only be created with large and expensive free-electron lasers.

The project partners managed to build a laser which combines the desired wavelength with a high single pulse energy of more than 5 mJ, short pulse duration of about 30 nanoseconds and good focusing capability. The repetition rate of 100-200 Hz ensures the targeted average power of over 1 Watt.

The greatly reduced collateral damage at wavelength of 6.45 microns is due to the combined absorption of water and resonant laser heating of non-aqueous components (proteins). The penetration depth of the newly developed laser is on the order of several microns. This is comparable to the cell size, and is therefore close to the optimum value, not achievable by any other state-of-the-art lasers.

The project partners of MIRSURG intend to further optimize the new table-top laser, assess its tissue ablation capabilities and, possibly within a follow-up project, demonstrate real solid-state laser surgery at 6.45 microns. "I hope that in the near future such a laser could become a practical surgical tool in every specialized operating room," said MIRSURG coordinator Petrov.

IST organizes Workshop on Lasers for high school teachers

Twelve Portuguese high school physics teachers had the opportunity of visiting the major facilities at the Rutherford Appleton Laboratory (RAL) last summer, as the highlight of the first Workshop on Lasers organized by LASERLAB-EUROPE partner Instituto Superior Técnico (IST) in Lisbon, Portugal.

A total of twenty four teachers were enrolled in this workshop, where they were given a thorough picture of modern laser technology and applications, from the basics to medical applications, telecommunications, and petawatt and attosecond science.

The workshop included both lectures by specialist researchers and visits to laboratories at IST. On this occasion, the twelve top participants were selected for a travel to RAL, were they visited several lasers in operation at the Central Laser Facility (CLF, partner of LASERLAB-EUROPE), as well as the Isis and Diamond facilities.

According to the workshop coordinator, Gonçalo Figueira, the trip was an unforgettable experience for the teachers involved. "We are certain that they will share their excitation with lasers with their pupils. This means that we are potentially reaching an audience of a few thousands of high school students, from all over the country."

COST network on X-ray metrology

In November 2012, a new COST network, 'Advanced X-ray spatial and temporal metrology', came into effect. LASERLAB-EUROPE is well represented in the network, which is chaired by Philippe Zeitoun (LOA, Palaiseau) and vice-chaired by Marta Fajardo (IST, Lisbon).

COST is a framework for European cooperation between scientists working on nationally-funded projects. The financial support averages 130.000 euros a year for a period of four years. In addition to LOA and IST, LASERLAB partners GSI Darmstadt, University of Jena, ULF-FORTH (Crete), University of Szeged and ICFO (Barcelona) are taking part in the new network.

X-rays are an excellent tool for probing matter, and they are applied in such different areas as security, medicine, food safety and cultural heritage. Recent developments in high-intensity free-electron lasers, plasma-based soft X-ray lasers and attosecond high harmonics have strongly changed the X-ray paradigm. The new COST network brings together hundreds of scientists aiming for progress in X-ray metrology. They will address such topics as damage on X-ray optics, high brightness and coherent X-ray sources and imaging diagnostics.

'New Frontiers in Cosmology' prize for drifting constants

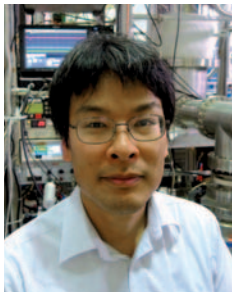
Wim Ubachs

For his search for the variation of fundamental constants in space and time, Prof. Wim Ubachs (LaserLaB Amsterdam) has received the 'New frontiers in Cosmology' prize. The prize consists of 250.000 US dollars to devote to research, and is made available by the Templeton Foundation.

Ubachs will use the awarded money to study the electron-to-proton mass ratio μ in extragalactic alcohol, a particularly sensitive probe of this fundamental constant of nature. Detailed measurements of light absorbed by methanol in galaxies at a distance of up to 7 billion light-years may reveal a change over time (or in space) of μ. Detection of a change in a fundamental 'constant' would alter our view on the Universe.

ERC Starting Grants 2012

The ERC Starting Grants were established in 2007 to give young scientists the possibility to build their own research groups. Grantees receive up to 1.5 million euros from the European Research Council to carry out the plans described in their proposals. Every year, a number of promising researchers from LASERLAB-EUROPE partners receive this prestigious grant. We introduce four of our 2012 grantees and their research projects.



Masaki Hori (MPQ)

Precision laser spectroscopy of antiprotonic and pionic atoms

With laser spectroscopy of antiprotonic atoms one can investigate the symmetry between matter and antimatter. According to the standard model, antimatter atoms should weigh exactly the same as their matter counterparts and oscillate with exactly the same frequency. Masaki Hori's ERC project aims at measuring the mass of the antiproton relative to the electron mass with a precision of 10-11, performing laser spectroscopy on helium atoms with one of the shell electrons replaced by an antiproton. The other part of Hori's project – laser spectroscopy of pionic helium atoms – represents an even bigger challenge. Here pions substitute one of the electrons in the helium atoms. This experiment will be the first one which attempts to study an atom which contains a so-called meson by laser spectroscopy.

Jérôme Faure (LOA)

Femtosecond laser-plasma based electron source

How do atoms move in a solid? How long does it take for a phase transition to occur or for a molecule to change its configuration? The direct observation of ultrafast phenomena that occur at the atomic scale in complex matter requires the use of short wavelength femtosecond x-ray or electron sources. Such sources have become available in the past decade and have permitted the first direct observations of atomic motion – however with a limited time resolution. Faure's ERC project aims at developing a femtosecond electron source using the interaction of a high repetition rate, few optical cycle laser with a plasma. In addition to studying relativistic laser-plasma interaction in the few cycle limit, the project should eventually provide a new electron source which will be used in diffraction experiments for probing the structural dynamics of condensed matter with a very high temporal resolution.

Giacomo Roati (LENS)

Quantum simulation of two-dimensional fermionic systems

Ultracold atoms are emerging as ideal quantum simulators of many-body phenomena. In particular, the combination of ultracold atoms and optical potentials has opened up a new way of studying condensed matter problems with higher controllability and unprecedented clarity. In his ERC project, Giacomo Roati aims to move further in this direction, using a new experimental set-up to investigate the physics of strongly correlated fermions in two dimensions. His focus will be on understanding the behaviour of high-temperature superconductors, which is a huge challenge to theorists because of the strong interactions between the electrons involved. Roati will take the experimental approach, exploiting the possibility to address single atoms, and to vary the temperature and interaction strength between fermionic atoms in optical lattices created by lasers.

Frank Koppens (ICFO)

Exploring Plasmons in Graphene

Graphene, a one-atom-thick layer of carbon, has attracted enormous attention in diverse areas of applied and fundamental physics. Among other things, graphene is a promising host material for light that is confined to nanoscale dimensions, more than 100 times below the diffraction limit. Due to its ultra-small thickness and extremely high purity, graphene can support strongly confined propagating light fields coupled to its charge carriers: surface plasmons. In his ERC project, Frank Koppens will experimentally investigate the new and virtually unexplored field of graphene surface plasmonics, and combine this with other properties of graphene to demonstrate the potential of carbon-based nano-optoelectronics. His aim is to explore the limits of light concentration, manipulation and detection at the nanoscale, to dramatically intensify nonlinear interactions between photons towards the quantum regime, and to reveal the subtle effects of cavity quantum electrodynamics on graphene-emitter systems.

LASERLAB-EUROPE has a new Coordinator

During the General Assembly Meeting in Munich, on October 25, Claes-Göran Wahlström (LLC, Sweden) took over from Wolfgang Sandner, who had led the consortium since the conception of its forerunner LASERNET in 2001. Laserlab Forum asked the new Coordinator about his background, views and plans for LASERLAB.

Wolfgang Sandner and Claes-Göran Wahlström

Claes-Göran Wahlström

Could you tell something about yourself and your history in laser science and LASERLAB-EUROPE?

"I obtained a PhD degree in atomic physics in 1986, focusing on fundamental properties of free atoms. A few years later, I spent a year at Imperial College, working with Prof. Henry Hutchinson in the field of atoms in intense laser fields. I took part in their first experiments on high-order harmonic generation in gases and I have stayed in the field of intense laser-matter interactions ever since.

From the start of the Lund high-power laser facility, in 1992, my work has been centred around activities there. Since 2006, the Lund Laser Centre, LLC, has been a European large-scale facility in a consecutive series of EC framework programmes, and since the very beginning an active partner in LASERLAB-EUROPE. I was the deputy director of LLC during most of this time, and as such also very active in LASERLAB-EUROPE, for example in the Access Board and in the Management Board. Since the retirement of the founder and original director of LLC, Prof. Sune Svanberg, I have been its director."

For how long will you be the Coordinator?

"There is no fixed term, but the present EC contract, LASERLAB III, is for another three years. My aim, of course, is to work for a prosperous future of LASERLAB beyond the end of this contract. That is one of my main tasks. There may exist several options for the future of LASERLAB. I want to explore these simultaneously and prepare in parallel the ground for more than one alternative. To make sure that LASERLAB is, at all times, as strong and successful as possible will be very important for any of these future options."

Could you say something about your predecessor?

"Wolfgang Sandner has been the best possible Coordinator since the very beginning of LASERLAB. His strategic views and political insight, in combination with his firm scientific background and research interest, has been of utmost value for the consortium. To take over after him is a great challenge, and honour. I will not try to simply copy his way of leading and guiding the consortium, because I would probably fail. Instead I will do my best to lead LASERLAB-EUROPE my own way and to use my own strengths and intuition as much as possible.

The day-to-day operation and management of LASERLAB-EUROPE has not dramatically changed because of the change of coordinator. A very important part of the management is handled by the LASERLAB administrative office in Berlin, headed by Daniela Stozno. This will continue, with frequent trips and calls between Lund and Berlin. I have known Daniela and her team since the beginning of this office, and I have great trust in them."

What role do you think the Coordinator of LASERLAB-EUROPE should play?

"It is a bit difficult to give a short answer to this question. I want to see a distributed leadership, with, for example, the different boards and sub-coordinators taking both initiatives and responsibilities. One task for the Coordinator is to stimulate coherence and synergies between the different actions. I believe strongly in bringing people together in joint activities; by working together to do good science, good friendship can develop and bridges between different research groups and laboratories be built. This is good for science, for LASERLAB and for Europe. The interaction between LASERLAB-EUROPE and the world outside Europe, including the developing countries, is something I also want to stimulate."

In what direction do you think laser science will develop in the next decade, also in relationship with LASERLAB-EUROPE?

"The emergence of the pan-European ESFRI projects ELI and HiPER makes the European landscape for laser science very fascinating, and opens up many new possibilities for synergy between the national infrastructures that make up LASERLAB-EUROPE, and these mission-oriented pan-European facilities. To fully explore the opportunities that this new landscape offers, it will be of utmost importance to build bridges between the different communities, by fostering close scientific and technical collaboration and exchange. In this context, I look forward to working with Wolfgang Sandner in his capacity as the new designated Director General of ELI.

Thematic Networks for Scientific and Technological Exchanges

Scientists are pushing the boundaries of what is scientifically possible and technologically feasible. This is especially true for two spectacular frontiers of laser science: high energy lasers systems and ultra-high intensity ultrashort pulse laser systems. Within LASERLAB-EUROPE, scientists, engineers and technicians from across Europe have been brought together in two dedicated thematic networks, called NAHEL and NAUUL, respectively.

The goal of the thematic networks is to pool distributed know-how and good practices, concerning both practical issues, such as laboratory management, data acquisition procedures, and safety issues, and scientific issues relevant for many LASERLAB-EUROPE participants. In the networks, the newly launched pan-European projects ELI (Extreme Light Infrastructure) and HiPER (High Power Energy Research facility) benefit from the assistance and advice from people involved in established infrastructures, whereas these latter infrastructures reap the fruits of new technologies developed in other LASERLAB-EUROPE infrastructures. For this purpose, annual network meetings are organised, as well as thematic workshops.

Networking Activity on High Energy Lasers (NAHEL)

High energy lasers exceeding a kilojoule in pulse energy exhibit very specific demands in terms of the optical components, technical procedures, and safety precautions. In addition, instrumentation, data taking requirements, and even theoretical approaches demand to a certain degree different approaches from those typical at the other facilities. This means a linkage between these laboratories is of particular use for the quality and scientific value of these installations.

NAHEL especially promotes the extended exchange of information among the network of participating institutions and reaches out to staff that are usually not involved in scientific communication like technical staff involved in the routine operation of these laser facilities. This last aspect makes NAHEL a unique opportunity in the community and triggers direct people-to-people information exchange outside the formal annual and thematic meetings on a scale that did not exist before. During the LASERLAB II period, the network has built a strong community identity based on about 50 people involved in scientific and technical activities across the participating laboratories. This was clearly visible during the annual meetings that will continue in LASERLAB III.

Construction works of the Centro de Láseres Pulsados in Salamanca (Spain). This building will host the 30J/30 fs (1 PW) laser system VEGA.

Among the most prominent deliverables of the network activities, the development of the GSI web-based data retrieval tool has been strongly influenced and shaped by discussions initiated during the network annual meetings. In parallel, the network has promoted exchange of information with other institutions, either to benefit from external know-how or to disseminate the conclusions of its work. Because of its weight the network was able to attract speakers that would otherwise not address smaller groups. This was done in the form of thematic meetings held by NAHEL as well as meetings where NAHEL participated. **Vincent Bagnoud**

Networking Activity on Ultra-High Intensity Ultrashort Pulse Lasers (NAUUL)

Ultrashort pulse petawatt technologies constitute one of the main frontiers in laser infrastructures. Very few ultrashort pulse petawatt lasers are operative across the world, a large fraction of which within LASERLAB-EUROPE. The main goal of NAUUL is to foster the exchange of knowledge accumulated over the last years with the development of ultraintense ultrashort pulse laser facilities in Europe, and stimulate the progress of similar initiatives in countries with less experience in the field.

During LASERLAB II, three annual meetings were held. The first one was dedicated to technological challenges in petawatt laser technology; the state of the art in gratings, mirrors, pulse contrast, pump lasers, radioprotection, crystals, coatings and cryotechnology was reviewed. The second NAUUL meeting was centred on laser facilities, and representatives from the most relevant European high-intensity lasers gave an overview of the current status of ultraintense laser technology in Europe and its future perspectives. The third meeting concentrated on the science that can be addressed with petawatt-class lasers, e.g. particle acceleration, nuclear photonics, exotic physics, etc., and brought together researchers from academic institutions involved in high-intensity laser science, representatives of laser companies, and scientists from the main European petawatt laser facilities.

The establishment of the thematic network NAUUL has coincided with the period ranging from conception to construction of several new ultraintense laser facilities, such as the Centre Interdisciplinaire de Lumière Extrême (CILEX) in France, the PetaWatt Field Synthesizer (PFS) at MPQ Garching, the POLARIS facility at the University of Jena, the ELBE radiation source at Helmholtz-Zentrum Dresden-Rossendorf, and the VEGA facility at Centro de Láseres Pulsados (CLPU) in Salamanca, as well as the three pillars of ELI in the Czech Republic, Hungary and Romania. The discussions carried out in the NAUUL meetings have no doubt helped to make the right decisions in their design. The extension of NAUUL in LASERLAB III will reinforce personal exchanges through small meetings or working sessions on specific topics related to the operation of the facilities, such as target area design, experimental planning, and target delivery.

Ricardo Torres

Networking events, workshops, summer schools

Scheme of the experimental and laser halls, and interlock system at the Ultra facility of the Central Laser Facility, UK.

Workshop 'Infrastructures for Lasers', Le Barp

In Le Barp, south of Bordeaux, the workshop 'Infrastructures for Lasers' took place on May 24-25, 2012. This extraordinary workshop, one of the Laserlab-Europe workshops on 'Scientific and Technological Exchanges', was organized by CELIA, with significant assistance by CEA/CESTA.

The aim of the workshop was to bring together experts in all practical and essential aspects of the infrastructures that surround a laser, from the initial steps of architectural design, civil engineering, up to the final steps of command/control over a laser system. In contrast to many other workshops, laser technology was not the topic; however, as was rapidly clear from the discussions, the surrounding elements are as crucial as the laser itself to make a successful facility. In the general context where several new laser facilities are to be constructed and commissioned in Europe, a workshop allowing for exchange of know-how between facilities, of which some have long been in operation, appeared as a potentially interesting step.

The workshop was organized in four sessions. The first one consisted of a visit of the LMJ (Laser Mégajoule) facility, under the expert guidance of Dr François Jéquier, from CEA/CESTA. This was a highly unusual visit, in the sense that the workshop participants actually did not see any of the laser halls; but they entered much more unusual places, especially on the lowest level, that includes all the air conditioning, cleanliness, and power stations. Management of air flows, in nuclearized or non-nuclearized environments, was explained.

The second session was a 'geographical' survey of the facility projects, whether brand new facilities or extensions of the existing ones, insisting on specific needs for infrastructure designs. Presentations were given on the P building at LOA, the Vulcan extension at RAL, the roadmap for the ELI facilities in Hungary and Romania, and the LULI ELFIE laser facility. Architect Rodrigo Diaz presented the CPLU building, design and construction.

The third and fourth sessions addressed successively several key topics, such as vibration control, cleanliness, radioprotection, professional training and command/control schemes.

In the concluding discussions, the importance of continued networking relations and direct exchanges between the participants was emphasized. The possibility to use the developments performed in one of the LASERLAB infrastructures, such as command/control programs, is certainly a benefit for all project leaders of new infrastructures. Pooling of past work and experience is at the core of the networking program of LASERLAB-EUROPE, and it was brilliantly illustrated in this last Scientific and Technological Exchanges Workshop of Laserlab-Europe II.

Philippe Balcou (CELIA)

Foresight Workshop on X-ray Imaging, Crete

In Aghia Pelagia, Crete, a targeted Foresight Workshop on 'Time-resolved X-ray Imaging' was jointly organized by ICFO and FORTH on 21-22 May 2012. The aim of this Gordon-style workshop was to establish the state of the art in time-resolved x-ray imaging with special emphasis on biological applications, and to identify the requirements to significantly advance applications, techniques and sources.

Some of the most important findings for the applications of x-ray imaging were operating parameters for high harmonic generation (HHG) based sources for bio imaging; namely, they should reach 1 keV to 10 keV at 10^{12} photons within 10 fs and 100 nm focus. Therefore, especially laser driver development and target engineering is required. Laser-driven electron beams for free-electron lasers (FEL) need further development before proving competitive.

HHG seeding for FELs might not be feasible in the mid-term due to flux requirements for HHG in most wavelength regions. The large bandwidths of HHG are furthermore an issue for image retrieval algorithms, since an assumption is narrow bandwidth illumination. A further challenge is the requirement on suitable imaging optics. Finally, a completely neglected challenge for making laser based x-ray imaging infrastructures interesting for the biomedical community, is the requirement for a supporting data management and retrieval infrastructure and support.

Jens Biegert (ICFO) & Stelios Tzortzakis (FORTH)

4th European Target Fabrication Workshop, Mainz

Following the success of the previous workshop in Oxford, UK in 2010, the 4th European Target Fabrication Workshop was held at the Erbacher Hof in Mainz, Germany from the 19th-23rd August 2012. In attendance were a total of 45 delegates from 18 institutions across the world, including representatives from Germany, France, Hungary, Spain, Italy, the USA and the UK.

The workshop consisted of six half-day sessions, covering general target fabrication, target characterisation and metrology, high repetition rate targetry, low-density materials, cryogenic targets, and ultra-thin targets. A hands-on target fabrication session also allowed delegates to try out various techniques in micro assembly. There was even time for a visit to the GSI ion beam facility, just outside Darmstadt, and the opportunity to view their Target Preparation Laboratory.

Once again, this has been a highly productive and successful meeting of the target fabrication community. The overall feel of the workshop was one of great positivity which grew over the four days as opportunities and collaborations arose. Microtarget requirements for high power lasers, now and in the future, acted as a catalyst to bring together many specialist branches of science and technology and it will be fascinating to see how much target fabrication, particularly in Europe, develops over the next few years.

This year's event was organised by the Technical University of Darmstadt and STFC. It was co-located with the International Nuclear Target Development Society (INTDS) conference to promote collaborations between the two communities and shared joint sessions on facility developments and metrology challenges.

During the summary session a number of challenges for the future were highlighted and a consensus was reached to hold the next workshop in St Andrews within 2-years' time.

Michelle King (STFC) & Gabriel Schaumann (TU Darmstadt)

LASERLAB users meet in Szeged, Hungary

Some 20 users of the LASERLAB-EUROPE facilities met with the User Representatives and Access Board (AB) members at the 2012 User Meeting. The title of the meeting was *"From quantum electronics towards medicine and particle physics"* and it was hosted by the Departments of Physics, University of Szeged, Hungary (USZ) in the Building of the Hungarian Academy of Sciences on 16-17 February 2012.

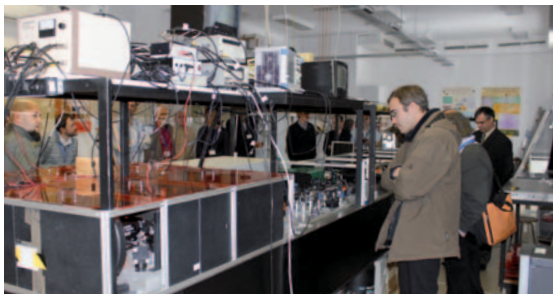
The scientific talks from users gave insight in a wide range of advanced studies and applications. The first session, titled 'Hot dense plasma diagnosis and emission characteristics', included an especially interesting presentation by Ingo Uschmann (Jena University, Germany) on the diagnostics of hot dense plasmas by advanced x-ray spectroscopy.

The second session was devoted to 'Advanced plasma applications'. The keynote lecturer, Valer Tosa (National Institute for R&D Isotopic and Molecular Technologies, Cluj-Napoca, Romania) gave a talk on gating of high-order harmonics emission by incommensurate two-color mid-IR laser pulses. In the third session, titled 'Particles and radiative sources', Jinchuan Ju (Université Paris-Sud 11, France) provided an overview of electron beam and x-ray radiation generated by laser wake field in dielectric capillary tubes.

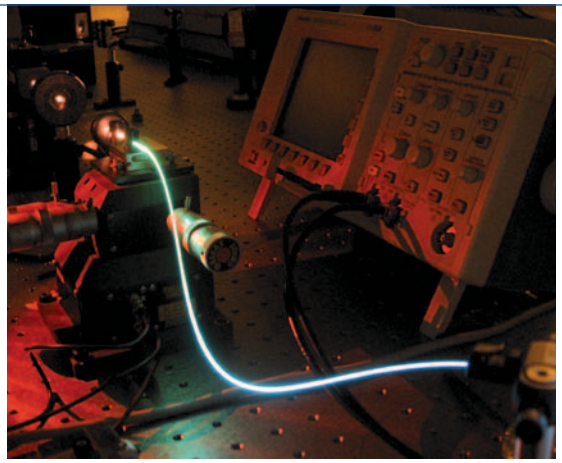
During the conference, Dusan Chorvat (International Laser Centre, Bratislava, Slovakia) presented the user training activities of LASERLAB-EUROPE, and Károly Osvay reported on the status of the "Extreme Light Infrastructure (ELI)" European project, especially focusing on Szeged, which is going to be the attosecond pillar of ELI, the ELI-ALPS. The traditional round-table meeting provided a discussion forum for users, user representatives and facility representatives, titled 'Towards LASERLAB III'.

A visit of the laser laboratories of the University of Szeged closed the two-day meeting. USZ hosts two high-power laser systems (HILL at 248 nm and TEWATI at 800 nm), which are the only high intensity laser systems in Hungary. At the time of the meeting the reconstruction of the main building of the Physics Institute – hosting both laboratories – was just completed so that the guests could see both laboratories in their final condition.

Sándor Szatmári (USZ)



Visitors in the TeWaTi (TeraWatt Titan-Sapphire Laser) laboratory of USZ



The bright line is the photonic crystal fibre where the supercontinuum is generated.

STELLA 2012 Summer School, Pavia

In the School for Training in Experiments with Lasers and Laser Applications (STELLA), participants – mainly PhD students – perform laboratory work in small groups. The STELLA Summer School took place for the fifth time in Pavia, Italy, in June 2012. Ondrej Novak reports from the participant's perspective.

Not only theoretical knowledge but also extensive experience is necessary when working in a laboratory; STELLA takes this into account. This year, the school was organized by Vittorio Degiorgio, Luca Tartara and their coworkers at the Faculty of Engineering of the University of Pavia.

The two-week meeting started with lectures, given by renowned scientists from European universities, who presented an overview of the state-of-the-art research in various fields of modern optics. We could choose two experimental courses – one for each week. The laboratory work, starting right from the second day, was supervised mainly by local assistants. During the two week laboratory work we gained experience with the optical laboratory equipment and methods and obtained a deep insight into the scientific issues of the selected topic.

To give an idea of the course contents I will describe the two courses I took part in, about supercontiuum generation and femtosecond diode-pumped lasers. In the first one we built an apparatus for coupling pulses of a Ti:sapphire laser to photonic crystal fibres. Precise coupling and its optimization required a fair amount of experimental patience and luck. The outcome was an astonishing, nicely shining fiber (see figure) and at its output a continuous spectrum over the whole visible and near infrared. A thorough characterization of the input and output pulses followed: the energy, pulse-width, spectral bandwidth, coherence were measured.

While we used a commercial femtosecond oscillator in the first week, we built a femtosecond oscillator from scratch in the second week. First, we set up a diode pumped Nd:glass laser in the CW regime. Step by step other elements were added to the initial arrangement, making it more complex. A semiconductor saturable absorber mirror (SESAM) was used to achieve mode-locking and a Gires-Tournois interferometer, a single prism and a set of two prisms were used to compensate the dispersion, respectively. Each laser regime was carefully optimized and output pulses properties determined.

Ondrej Novak (Institute of Physics, Prague, Czech Republic), participant of STELLA 2012

Summer School of Ultrafast Laser Science and Applications, Menorca

The University of Salamanca, in close collaboration with the Pulsed Laser Center (CLPU), organized the Summer School of Ultrafast Laser Science on the Balearic island of Menorca (Spain), from 10 to 15 June 2012.

This summer school for PhD students pursuing a research career in ultrafast optics was one of the activities scheduled by the Spanish network of ultraintense lasers (SAUUL), funded by the Ministry of Science and Innovation, which comprises eight laboratories specialized in intense femtosecond lasers. In this way, the Spanish laser network joins the efforts of the international community to train a new generation of laser scientists and technicians who can take full advantage of initiatives like LASERLAB-EUROPE, and meet the challenges posed by the ELI and HiPER projects.

The school was attended by 52 students from several European countries including Germany, United Kingdom, Lithuania, Poland, Austria, Switzerland, and Portugal. It included more than 25 lecture hours imparted by world-renowned researchers from different European institutions, and the topics were centred on the main areas of activity of the network.

Helder Crespo (University of Porto) and Emma Springate (Central Laser Facility, UK) gave a series of talks on ultrafast laser technology; John Tisch (Imperial College London) and Caterina Vozzi (Politecnico di Milano) lectured on attosecond science; Marcus Motzkus (University of Heidelberg) and Regina de Vivie-Riedle (Ludwig Maximilians University of Munich) talked about experimental and theoretical aspects of femtochemistry, whereas Javier Solis (Institute of Optics in Madrid) and Alfred Vogel (University of Luebeck) each offered a tutorial on short pulse laser applications to material processing and biomedicine. Furthermore, Juan M. Bueno (University of Murcia) gave a plenary talk about adaptive optics and multiphoton microscopy applied to ocular tissue imaging.

The schedule included a session on 'research opportunities', in which members of CLPU introduced LASERLAB-EUROPE III and the ELI project to the audience, with the intention of promoting the future community of users of the facilities. The school also gave the opportunity to students to present their own work in oral presentations or posters, receiving a total of 37 contributions of remarkable scientific quality.

Ricardo Torres (CPLU)

Access Highlight: Cosmic Magnetic Field Generation

The Universe is pervaded by magnetic fields. They are small in magnitude, but extend over huge distances, possibly generating the energy needed for galaxies to emit x-ray radiation. The origin of these cosmic magnetic fields is still unclear. Recently, an international collaboration of scientists compared theoretical simulations with experiments at LASERLAB-EUROPE partner LULI (Palaiseau, France), performed in the framework of the LASERLAB Transnational Access Programme. The collaboration provided the first experimental confirmation of the possible origin of cosmic magnetic fields, leading to a publication in Nature. Gianluca Gregori (Rutherford Appleton Laboratory and University of Oxford) explains.

We are well aware of magnetic fields in our environment and what they can do. The magnetic fields of the Earth and Sun protect us from the harmful effects of cosmic rays, allowing life to thrive on our planet. Further out, magnetic fields pervade the cosmos. To map out magnetic fields in the Universe, both synchrotron radio emission from cosmic rays and Faraday rotation measurements are used. These observations reveal large-scale magnetic fields exist in galaxies and clusters of galaxies, with strengths from a few nG to a few microG – a fraction of the Earth's magnetic field. In these galaxy clusters the temperatures can often be greater than 10^8 K, making them strong x-ray emitters. It is possible that the energy to heat the plasma comes from the magnetic field through some plasma instability. The magnetic field therefore plays a role in the structure of the universe.

Although we are very familiar with the observation of the magnetic fields in the universe and possible role in structure formation, we can only explain the magnetisation that we see through a magnetic dynamo mechanism, making it necessary to invoke a pre-existing seed field. The origin of this seed field is still a puzzle. Prior to galaxy formation, density inhomogeneities would drive violent motions in the universe, forming shock waves that generated turbulence and vorticity on all scales. In 1997, the Biermann battery effect was proposed to create the seed magnetic fields that would be amplified by the protogalactic dynamo. The Biermann battery effect would act to create the seed magnetic fields whenever the pressure and density gradients are not parallel.

Now, our international team of scientists have used a high-power laser at LASERLAB partner LULI to explode a rod of carbon surrounded by helium gas in a field free environment. The experiment was designed to recreate the conditions similar to those in the pregalactic epoch where shocks and turbulent motions form. However, before such a laboratory experiment qualifies as a possible astrophysical analogue, it must satisfy a number of conditions, allowing the magnetohydrodynamic (MHD) equation to be an accurate description of the plasma.

Consequently, it is necessary that the ratios of heat convection to conduction (the Peclet number), inertial forces to viscosity (the Reynolds number), and inertial forces to magnetic diffusivity (the magnetic Reynolds number) are all large compared to unity. Essentially, this means that viscosity, resistivity and thermal conduction can be neglected over a large range of spatial and temporal scales. Indeed, we found that these conditions are satisfied, and thus, due to the invariance of the MHD equations, it is subsequently possible to scale experiments to length and time scales relevant to space or astrophysical plasmas, even if this corresponds to changing their size through 22 orders of magnitude!

Looking at the experimental results, our team found that the explosion generated strong shock waves, around which strong electric currents and magnetic fields formed. When scaled, our measurements matched the pre-dynamo magnetic seeds predicted by theory prior to galaxy

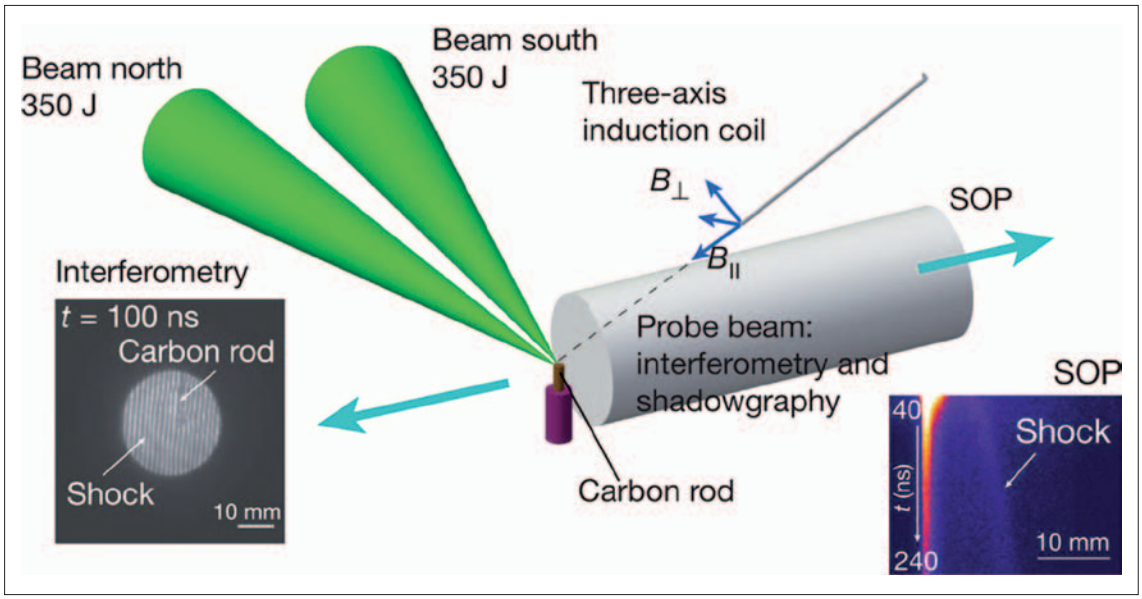


Figure 1: Schematic of the experimental setup showing the beams from the LULI laser and the location of the diagnostics. From G. Gregori et al., Nature 481, 480-483 (2012).

formation. This provides the first laboratory confirmation of numerical simulations performed more than two decades ago. Moreover, it establishes a platform where studies of the large-scale magnetization of the Universe could be performed in a laboratory, providing a complementary tool to numerical simulations and astrophysical observations. This point is well illustrated in Figure 2, where we show – side-to-side – the image of a laser produced shock wave next to a computer simulation of a collapsing shock during structure formation.

Our international team of scientists builds on a long-standing collaboration between the University of Oxford, LULI – Ecole Polytechnique, and ETH Zurich. The collaboration between Oxford and LULI started several years ago through LASERLAB experiments aimed at studying the equation of state of planetary interiors. A particular important collaboration is the one established between ETH and Oxford, where Oxford leads the experimental side and ETH provides the link to astrophysical simulations. Additional EU parties of the research teams include the University of York, and the Rutherford Appleton Laboratory. Finally, overseas collaborators include the University of Michigan, the University of California Los Angeles, the University of Osaka and the Lawrence Livermore National Laboratory (LLNL). LLNL hosts the largest laser system in the world: the National Ignition Facility – NIF. Compared to the LULI laser facility, at NIF the available energy in the laser is more than one thousand times larger. This would allow even more powerful shocks to be generated and possibly looking at more extreme environments in our Universe.

Gianluca Gregori

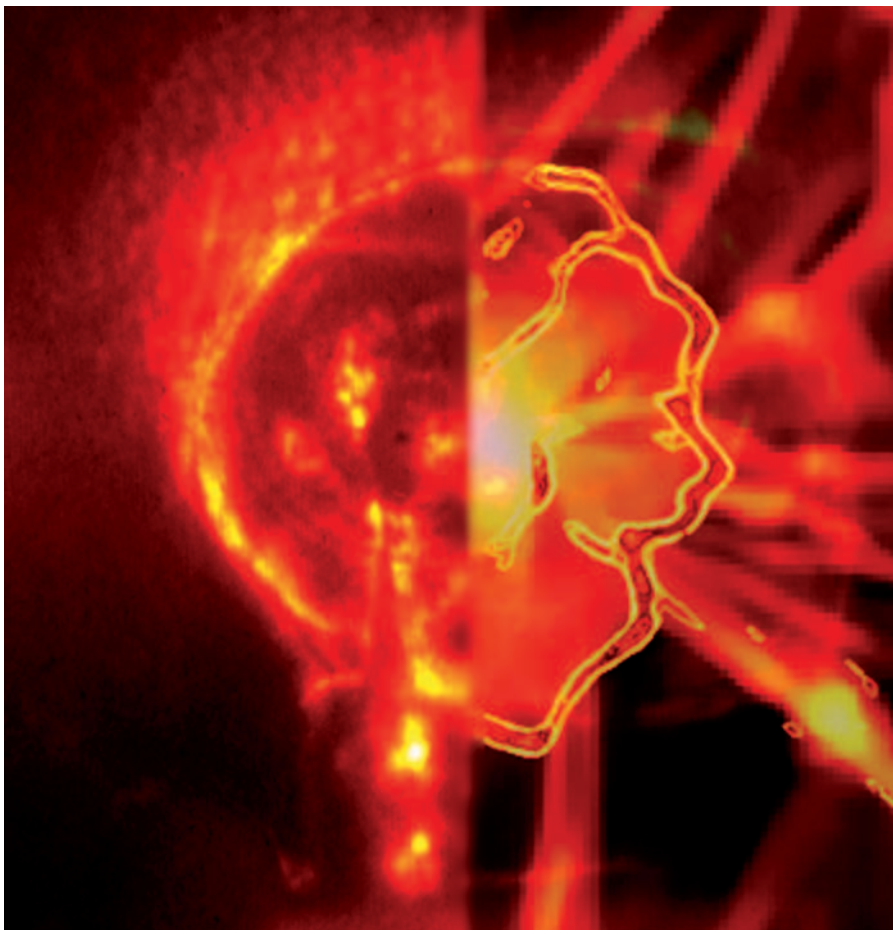


Figure 2: Left-hand side: An image of a laser-produced shock wave. Brighter colors correspond to regions of higher density or temperature. Right-hand side: A simulation of a collapsing shock wave arising during the pre-galactic phase. For the shock measurements credits to A. Ravasio (LULI), A. Pelka (LULI), J. Meinecke (Oxford) and C. Murphy (Oxford). For the numerical simulation credits to F. Miniati (ETH).

G. Gregori et al., Generation of scaled protogalactic seed magnetic fields in laser-produced shock waves, Nature 481, 480-483 (2012)

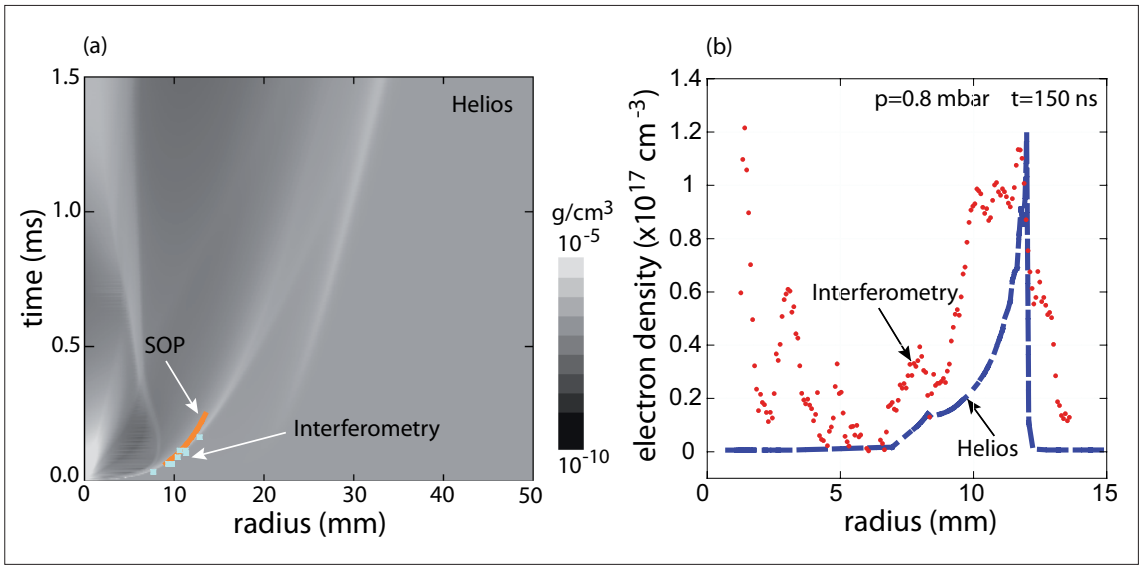
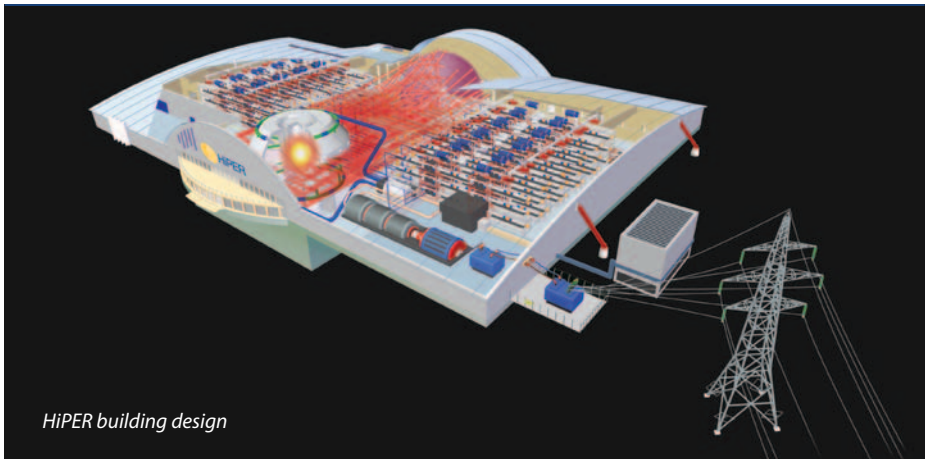


Figure 3: a) Simulations (done with a one-beam laser driver) and experimentally determined shock position using both interferometry and self-emission optical pyrometry. b) Calculated electron density at t =150 ns, versus electron density values extracted from interferometric measurements. From G. Gregori et al., Nature 481, 480-483 (2012).



HiPER building design

Laser Energy Workshop and HiPER Participants Forum

HiPER (the High Power Energy Research facility) and the US LIFE project have been invited to hold a Laser Energy Workshop within the SPIE Optics and Optoelectronics Symposium which will take place in Prague, 15 – 18 April 2013.

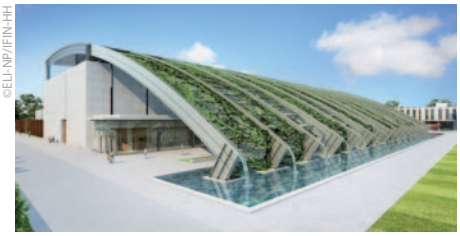
This workshop provides an excellent platform to publicise the technical progress that has been made during the HiPER Preparatory Phase and to discuss future plans. Representatives of existing and potential future funding bodies will be invited along with the HiPER Executive Board and members of the European Commission.

The Laser Energy Workshop will be followed by a HiPER Participants Forum where the plans for HiPER next phase will be discussed and a Fellow Forum where the young researchers of the project will have the opportunity to present their work.

This high-profile event is an important opportunity to celebrate the progress made during the HiPER Preparatory Phase and to assess current progress with the national funding campaigns for the physics and technology development phase.

Anne-Marie Clarke, HiPER

ELI Nuclear Physics Approved



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Architectural design of the ELI Nuclear Physics facility (Romania)

On 18 September 2012, the European Commission approved the funding of the ELI (Extreme Light Infrastructure) Nuclear Physics facility (ELI-NP). Hosted by Romania, ELI-NP is the second of the ELI 'pillars' to be approved by the European Commission – the Commission approved the funding of the ELI Beamlines facility in April 2011.

The ELI-NP facility will allow for the first time the investigation of a new frontier of physics: the 'laser – nucleus frontier'. A very broad range of science domains will thus open for highly advanced research, from new fields of fundamental physics, new nuclear physics and astrophysics, to applications in nuclear materials, nuclear materials management, material science and life sciences. The facility will rely on two cutting-edge technological systems, i.e., a very high intensity laser and a very intense gamma beam, that will be available either separately or for combined experiments.

Placed under the responsibility of the 'Horia Hulubei' National R&D Institute for Physics and Nuclear Engineering, the implementation of the ELI-NP facility will be carried out through two overlapping funding phases: the first phase – representing € 180 million co-funded by the European Regional Development Fund – will be completed by the end of 2015 and will allow research activities to start in 2016; the second funding phase, starting in 2014, will bring the facility to its maximum specifications by the end of 2016. Altogether, the implementation costs of the two phases will represent € 356.2 million.

ELI is the first ESFRI project to make use of this novel funding model, which will combine structural funds during implementation and national contributions to an ERIC consortium during operation. The approval of the funding of the third ELI 'pillar', the ELI-Attosecond facility (Hungary), is expected in the first quarter of 2013.

Florian Gliksohn,
Extreme-Light-Infrastructure (ELI)

Forthcoming events

April 2013
Networking Activity on Ultra-high intensity Ultrashort pulse Lasers (NAUUL) meeting

29-30 April 2013
JRA EUROLITE Meeting
Abingdon, UK

17-30 June 2013
User Training Workshop on Biophotonics
Kosice, Slovakia

How to apply for access

Interested researchers are invited to contact the LASERLAB-EUROPE website at www.laserlab-europe.eu/transnational-access, where they find all relevant information about the participating facilities and local contact points as well as details about the submission procedure. Applicants are encouraged to contact any of the facilities directly to obtain additional information and assistance in preparing a proposal.

Proposal submission is done fully electronically, using the LASERLAB-EUROPE Electronic Proposal Management System. Your proposal should contain a brief description of the scientific background and rationale of your project, of its objectives and of the added value of the expected results as well as the experimental set-up, methods and diagnostics that will be used.

Incoming proposals will be examined by the infrastructure you have indicated as host institution for formal compliance with the EU regulations, and then forwarded to the Users Selection Panel (USP) of LASERLAB-EUROPE. The USP sends the proposal to external referees, who will judge the scientific content of the project and report their judgement to the USP. The USP will then take a final decision. In case the proposal is accepted the host institution will instruct the applicant about further procedures.

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