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Laserlab-Europe Newsletter

The present document combines the second and third issue of the Laserlab Newsletter that were published since the start of the project. Instead of publishing only one issue per year electronically and in print as foreseen according to the grant agreement, Laserlab-Europe publishes the newsletter on a biannual basis. This highly appreciated newsletter has been started in FP6 with consecutive numbering, so that the issue numbers in this document are nos. 15 and 16.

Issue 15 of the Laserlab-Europe newsletter: June 2013 (M13);
Focus: Access success stories from different scientific fields, giving examples for potential users

Issue 16 of the Laserlab-Europe newsletter: December 2013 (M19);
Focus: Laserlab-Europe and industry relations

All issues of the newsletter “Laserlab Forum” may be found at:

http://www.laserlab-europe.eu/news-and-press

Issue 15 | June 2013

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

Access Success Stories

Cavity-enhanced down-conversion quantum light source for solid state quantum memories

In this Issue

Editorial


Tom Jeltes

Generosity, the readiness to give freely without expecting anything in return, is a virtue which is hopefully still common in private life, but can be considered exceptional in the competitive world of science. Generally, fellow scientists are not only seen as colleagues, but mainly as potential rivals in the continuing race for funding. Having to choose between publishing and perishing, it is tempting to keep your hard-won expertise to yourself.

Within LASERLAB-EUROPE, however, the spirit of friendly collaboration seems stronger than the natural tendency to competition. As former coordinator Wolfgang Sandner stresses in an interview in this edition of Laserlab Forum, the institutions that make up LASERLAB-EUROPE are generous enough to allow allocated funds for Transnational Access to be redistributed depending on the needs. This shows that the LASERLAB community is very much aware of the fact that collaboration is not only good for science as a whole, but that, ultimately, sharing insights and expertise is also beneficial for individual institutions and researchers.

The Transnational Access Programme can be regarded as an act of generosity in itself, as the host scientists involved are willing to share their facilities and devote time to assisting the guest researchers. It must be said, though, that in many cases the hosts become an integral part of the project, and often will co-author the resulting publications. It is in those projects that the full strength of the Access Programme becomes apparent, and the collaboration is clearly to the benefit of all involved. To give an idea of the variety of projects, in addition to the regular Access Highlight, this issue of Laserlab Forum features some very successful Access projects of the past decade. Enjoy and be inspired. **Tom Jeltes**

News

ERC Advanced Grant for development of novel materials

Prof. Costas Soukoulis (IESL-FORTH, Heraklion, Crete, Greece and Ames Lab & Iowa State University, Ames, Iowa, USA) has been awarded an Advanced Grant by the European Research Council (ERC) to promote the development of photonic crystals, metamaterials and plasmonics.

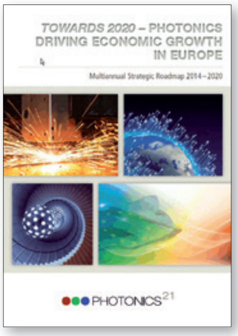
The novel materials will enable the realization of innovative electromagnetic properties unattainable in naturally existing materials. The implementation of the ERC Advanced Grant project requires novel ideas, advanced computational techniques, nanofabrication approaches and experimental testing. According to Soukoulis, the broad expertise of his team and their pioneering contributions to photonic crystals, metamaterials and plasmonics qualifies them for facing the challenges, and will ensure the maximum possible success of the project.

ICFO demonstrates novel quantum light source for solid state quantum memories

Researchers from LASERLAB-EUROPE partner ICFO, led by Prof. Hugues de Riedmatten, have demonstrated a novel quantum light source capable of connecting solid state quantum memories to the optical fibre networks. The source is ideally suited for long-distance quantum information networks.

The study has been published in Physical Review Letters and was selected as viewpoint in Physics. Quantum memories are important devices in quantum information science, in particular for the development of long-distance quantum communication using quantum repeaters. To overcome limitations of current solid state quantum memories, the authors used a novel type of quantum light source based on widely non-degenerate cavity-enhanced spontaneous down-conversion. The source creates ultra-narrowband photon pairs with one photon compatible with the solid state quantum memory and the other one at a telecommunication wavelength, thus allowing the connection between the quantum memory and the optical fibre network.

New Photonics Roadmap: Towards 2020 – Photonics Driving Economic Growth in Europe



The new photonics strategic roadmap 'Towards 2020 – Photonics Driving Economic Growth in Europe' was published in the frame of the Annual Meeting of the European Technology Platform Photonics21 on 30 April 2013. The rise of photonics in Europe from a niche activity to a Key Enabling Technology, and on to becoming one of the most important industries for the future, shows how photonics is on its path to making the 21st century that of the photon. The photonics roadmap outlines the photonics research and innovation priorities of the different application areas from 2014 to 2020.

www.photonics21.org

What is LASERLAB-EUROPE?

LASERLAB-EUROPE, the Integrated Initiative of European Laser Research Infrastructures, understands itself as the central place in Europe where new developments in laser research will take place in a flexible and co-ordinated fashion beyond the potential of a national scale. The Consortium currently brings together 30 leading organisations in laser-based inter-disciplinary research from 16 countries. Its main objectives are to maintain a sustainable inter-disciplinary network of European national laboratories; to strengthen the European leading role in laser research through Joint Research Activities; and to offer access to state-of-the-art laser research facilities to researchers from all fields of science and from any European laboratory in order to perform world-class research.

COST network on Inertial Confinement Fusion

© CEA

In April 2013, a new COST Action, 'Developing the Physics and the Scientific community for Inertial Confinement Fusion at the time of NIF ignition' was approved. Chair of the new network is Dimitri Batani from LASERLAB-EUROPE partner CELIA (Bordeaux, France).

In Inertial Confinement Fusion, energy is generated by nuclear fusion initiated by heating and compressing a fuel target, in most scenarios with the help of extremely powerful lasers. The new COST network is intended to build a community of scientists devoted to Inertial Confinement Fusion, in preparation of the opening to civilian research of the French Megajoule and Petal laser facilities in 2015, and the expected achievement of ignition at the US National Ignition Facility in the foreseeable future.

The idea is that the COST network will facilitate the preparation of the European high energy density physics community for the new physics associated with both the fusion process and the high-energy laser systems that are being developed like Megajoule/Petal, as well as at HiPER and ELI. Such physics includes the realisation of 'laboratory astrophysics', extreme states of matter, and advanced particle and radiation sources.

Specific goals of the COST Action include setting up common experiments, both in Europe and overseas; educating a new generation of scientists by organising summer schools; and studying important physical problems related to Inertial Confinement Fusion.

CLF wins contract for HiLASE

LASERLAB-EUROPE partner Central Laser Facility (CLF) in Oxfordshire, UK, has won a contract of almost 12 million euro to develop laser technology for the HiLASE project, which is being constructed near Prague (Czech Republic).

The scientists at the CLF's Centre for Advanced Laser Technology and Applications have developed a higher-energy diode pumped solid state laser system, which helped them to win the contract. According to CLF director John Collier, the fact that HiLASE has chosen CLF stems directly from CLF's breakthrough in combining high energy and high repetition rates in each laser pulse.

The goal of HiLASE is to develop new laser technology that will be more powerful, efficient, stable and easily maintained than those already in place across Europe.

International Award to FORTH for laser cleaning of Caryatids

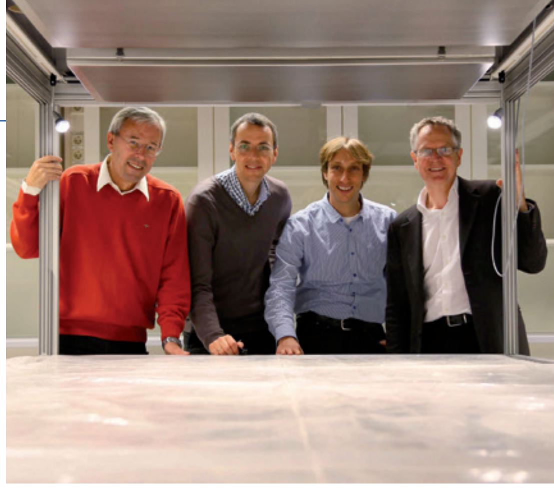
The Acropolis Museum and LASERLAB-EUROPE partner IESL-FORTH have been awarded the biennial Keck Award by the International Institute for Conservation of Historic and Artistic Works for their joint project regarding 'Laser rejuvenation of Caryatids opens to the public at the Acropolis Museum: A link between ancient and modern Greece'.

The award was given to the project partners for their contribution "towards the promotion of public understanding and appreciation of the accomplishments of the conservation profession". IESL-FORTH and the Acropolis Museum set up an advanced 'open-to-the-public' laser laboratory on the visitors' floor where the Caryatids are exhibited at the Acropolis Museum. This arrangement brings the visitors of the Museum in contact with conservational interventions that until now took place only inside 'restricted access' laboratory environments. Over 2 million visitors had the chance to follow the laser-assisted removal of accumulations of pollution from the Caryatids' surface.

© The Acropolis Museum, Athens, Greece

ERC Synergy Grant

In 2012, the European Research Council introduced the Synergy Grant, which is intended to enable researchers from different backgrounds and locations to combine their skills and resources in multidisciplinary projects with a maximum funding of 15 million euros for six years. In a very competitive selection process, only the top 11 projects out of 700 applications for 2012 were selected for funding.



Peter Zoller, Immanuel Bloch, Ehud Altman, Jean Dalibard (from left to right)

One of the lucky teams includes MPQ professor Immanuel Bloch, who, together with his distinguished colleagues Peter Zoller (University of Innsbruck), Ehud Altman (Weizmann Institute of Science, Israel) and Jean Dalibard (Collège de France), will use a Synergy Grant of 10 million euros to take the field of quantum technology to the next level.

The highly counterintuitive laws of quantum mechanics govern the microscopic world, as well as the collective behaviour of matter at low temperatures. The unique properties of such 'quantum matter' not only allow deeper understanding of the nature of quantum mechanics, but will also lead to revolutionary new quantum technologies. For example, much progress has already been made in the fields of superconductive materials, ultraprecise measurements, and basic quantum computers.

Using lasers and magnetic fields, Bloch and co-workers at MPQ are able to capture and cool atoms to temperatures a fraction of a degree above absolute zero. Trapped in magnetic fields or confined in arrays by optical lattices of standing waves of laser light, these atoms can be manipulated in a myriad of ways. This allows the researchers to use the arrays of ultracold atoms as a versatile model system for condensed matter physics, as quantum information processors, or for precision measurements.

Experimentalists Bloch and Dalibard, together with theorists Altman and Zoller, will now devise the construction of a novel joint experimental setup, which would allow them to reach a new level of understanding of the complex behaviour of quantum matter. The idea is to create new states of matter, including strongly correlated and so-called topological quantum phases, which will be connected to simulations of field theories. Another important aim of the project is to engineer quantum matter in such a way that new paradigms for information processing ('quantum computing') come within reach.

ERC Starting Grant

Since 2007, young scientists trying to build up their own research group can apply for a Starting Grant of up to 1.5 million euros. The previous issue of Laserlab Forum already featured four 2012 grantees. To their names can be added those of Alex Robinson and Caterina Vozzi.

Alex Robinson (CLF)

Magnetic guiding of electrons for fusion

In Inertial Confinement Fusion (ICF) experiments, nuclear fusion is generated by heating and compressing pinhead-sized fuel pellets, usually consisting of a mixture of deuterium and tritium. In the Fast Ignition variant of ICF, the heating is performed with a high-current beam of ultrafast electrons, generated by a petawatt laser pulse. A major difficulty lies in the fact that these electrons tend to spread out, which can be countered by application of strong magnetic fields to 'guide' the electrons to the target. With his ERC Starting Grant, Alex Robinson will carry out advanced computer simulations to see how 'structured guiding', relying on the automatic generation of magnetic fields due to the interaction of the fast electrons with resistivity gradients in the target, can be used to keep the electron beam collimated.

Caterina Vozzi (CUSBO)

Ultrafast dynamic imaging of complex molecules

Molecules can be stimulated to emit extreme ultraviolet (XUV) light, using intense femtosecond laser pulses. In this process, an electron is extracted by the laser light and subsequently brought back to the molecule to recombine, which gives rise to the emission of an XUV photon. It has been shown that this XUV light contains information on the electronic structure of the molecule, and allows imaging of the electronic orbits in the molecule. So far, only molecules consisting of two atoms have been investigated in this way. Recently, Caterina Vozzi has demonstrated a new approach for extending the imaging of molecular orbitals to triatomic molecules. With her ERC Starting Grant, she will try to develop time-resolved tomographic imaging of the evolving electronic structure in complex molecules undergoing electronic or vibrational excitation.

Interview Wolfgang Sandner

After almost a decade, Wolfgang Sandner, founding father and long-time coordinator of LASERLAB-EUROPE, handed the sceptre (or laser pointer) to his successor Claes-Göran Wahlström in October 2012. Instead of resting on his laurels, Sandner accepted a probably even bigger challenge as the designated Director General of the Extreme Light Infrastructure Delivery Consortium. We talk with him about past, present and future of LASERLAB and ELI.

How are you doing at the moment?
"Well, I am very busy actually, travelling a lot. We are currently establishing ELI as an International Association after Belgian Law, and as we speak we are waiting for the signature of the King of Belgium. In the meantime, we are preparing the first General Assembly Meeting, and talking with institutions from several countries which showed interest in joining the association. Italy is already represented, as well as the host countries of ELI – Czech Republic, Hungary, and Romania –, and we expect many other countries to follow."

Is there a big difference between leading ELI and LASERLAB-EUROPE?
"The main differences are that with ELI, we have to create everything from zero, and that the ELI research pillars have both a national and a strong pan-European dimension, due to their mission and funding model. That means, for instance, that sometimes I have to remind representatives from local governments of the pan-European nature of the project, and remind the scientists of the complementarity of future research opportunities for users. So it is as much a political task as it is a coordinating task. I find it particularly attractive to be able to help shape three major research infrastructures from the beginning. It is challenging but satisfying."

What makes ELI special?
"ELI is to become the first truly international laser facility, whereas other scientific communities, such as high energy physics and astronomy, have been operating international facilities for decades. It is also special that all ELI facilities will be based in new EU member states, as well as the fact that for each of the three pillars the host countries applied for structural funds from the EU, roughly 300 million euro each. Those funds are generally used for building bridges, roads, and railways. Once these pillars are fully constructed in 2017, a European Research Infrastructure Consortium (ERIC) will be established, which will be responsible for the operation of ELI. I like to compare this to a multi-national community having decided to build and operate a new airplane, contracting three different companies in three different countries to build the wings, engines, fuselage, etc. and, after assembly, leasing the airplane to a newly established airline, ELI-ERIC, for operation. The business model will only work if the passengers – the scientific user community – find it highly attractive to "fly with ELI", i.e., ELI must become one of the best user facilities of its kind."

How do you look back on your time with LASERLAB-EUROPE?
"The real success of LASERLAB-EUROPE is that we have been able to create one unified entity, synchronising and harmonising our research profiles on a European level. LASERLAB's predecessor, LASERNET, still consisted of two subnets, for high energy and analytical facilities, respectively. There was a memorable event, where we discussed whether they should stay separated or whether they should be combined. Eventually, we applied together for LASERLAB-EUROPE. The resulting community has turned into a family, with a spirit of collegiality and professional friendship, which I very much enjoy."

Could you give an example of spirit of unity within the consortium?
"I can give a simple example, concerning the most important activity of LASERLAB-EUROPE, namely Transnational Access. We decided that the money given by the EU to each facility could be redistributed depending on the actual user demands. This was not foreseen in the European regulation, and it means that our members voluntarily have to give up money which was allocated to them. This can only happen if there is an extraordinary collaborative spirit and a collective strive for scientific excellence in providing access to the user community."

How do you see the future of LASERLAB-EUROPE?
"Laser technology will be one of the key technologies of the 21st century, and it will be both of enormous scientific and of major socio-economic impact. This is also recognized by the EU. I am therefore very confident that LASERLAB-EUROPE will consolidate itself as a major driver for science and innovation in the European Research Area. I also think there is no way back. Even if the funding would stop, which I do not foresee, I think the benefits of being in a network are so convincing to all involved that LASERLAB will always survive in some form. I can tell you that I am extremely satisfied that Claes-Göran Wahlström is my successor. He will do an excellent job and I am looking forward to collaborating with him, in order to make sure that ELI and LASERLAB-EUROPE will provide complementary services for the laser community."

Access Success Stories

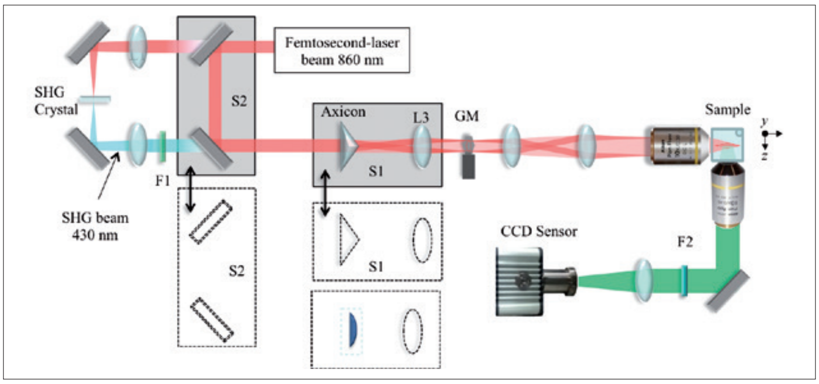
Ever since the beginning of LASERLAB-EUROPE, one of its most important features has been the Transnational Access Programme. Up to now, about 1,200 scientists from institutions outside LASERLAB-EUROPE had access to LASERLAB facilities to perform their experiments. Proposals for Transnational Access are reviewed by an external and independent Access Selection Panel on the basis of scientific merit. Access to LASERLAB facilities is free of charge; travel and accommodation expenses of visits with a typical duration of two to six weeks are covered by the Programme.

Each access project has its unique history and benefits. In many cases, the host researchers are not only involved in assisting their guests, but form an integral part of the research project. As a result, the host institutions benefit directly from the programme. Through the years, many long-term research collaborations have been formed as a result of Transnational Access. On the following pages, we highlight a few particularly successful access projects.

Tom Jeltes

Throwing light on multicellular tumour spheroids (ICFO)

© Pablo Loza-Alvarez



Schematic of the experimental multimodal light sheet setup running at ICFO used to image multicellular tumor spheroids (MCTS) grown by ITAV. The size of the MCTS is of 400micrometers in diameter.

In a very recent project, Corinne Lorenzo from the Institute of Advanced Technologies in Life Sciences (ITAV, Toulouse, France) visited Pablo Loza-Alvarez' lab at LASERLAB-EUROPE partner ICFO in order to try and image biological model systems used to study tumour cell proliferation. The results of Lorenzo's two visits in February and March of this year are so promising that two other research groups joined the collaboration and a benchmarking toolbox is currently being developed.

The Super-resolution Light Microscopy & Nanoscopy (SLN) Lab at the Institute of Photonic Sciences (ICFO, Barcelona) has a Selective Plane Illumination Microscope (SPIM), which has the potential to image at large penetration depths and in scattering tissue. Having met at several conferences on SPIM microscopy, Lorenzo and Loza-Alvarez had discussed the possibility of using ICFO's SPIM microscope to image Lorenzo's MultiCellular Tumour Spheroids (MCTS) with the aim of retrieving the entire three-dimensional information of these samples. Loza-Alvarez, on the other hand, was interested in the elaboration of a benchmarking protocol in order to determine under which illumination conditions an absorptive and scattering tissue is best imaged. Having heard of the LASERLAB-EUROPE Transnational Access Programme, Lorenzo decided to apply for access in December of 2012 and one month later she had received the final decision granting her two visits to the SLN lab.

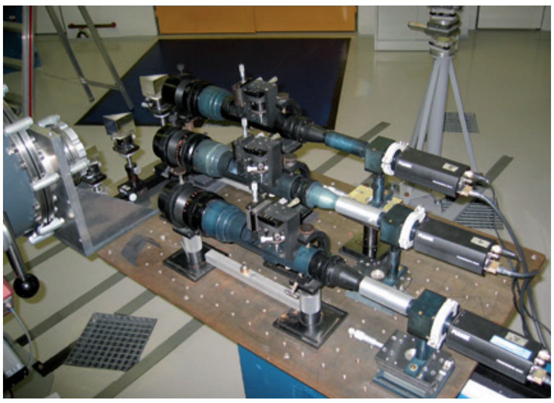
MCTS are 3D culture models with attractive advantages for investigation of cell proliferation in a multicellular context, as they display the organization of a tumour microdomain. However, due to their opacity and density, spheroids form highly challenging imaging samples for light microscopy and therefore represent, in terms of optical properties, a bona fide tissue paradigm.

The major issue addressed in the project was to find the optimal light sheet for 3D imaging of MCTS. To this aim, the 'Multi SPIM' microscope at ICFO was used and a variety of engineered fixed MCTS samples prepared by the IP3D group at the ITAV. The Multi SPIM is able to work in the linear and non-linear regime and under Gaussian or Bessel beam excitation schemes. SLN@ICFO is the only lab worldwide where such imaging techniques are available and allow a straight-forward comparison of the imaging capabilities of all different light sheet modalities.

Given the potential seen in this experiment, Lorenzo and Loza-Alvarez are now also working in collaboration with two associated groups: the Département Optique Théorique et Appliqué at Onera (Toulouse) and the Quantitative Image Analysis Unit at the Paris Pasteur Institute. All groups have complementary skills and expertise in cancer biology, cell imaging, image processing, biophotonics and optics.

Plasma interferometry diagnostic studies (PALS)

One of the longest-running and most productive access-related collaborations is situated at the Prague Asterix Laser System (PALS). Starting more than a decade ago, Tadeusz Pisarczyk from the Institute of Plasma Physics and Laser Microfusion (IPPLM, Warsaw, Poland) has used his multi-frame laser interferometry system to study plasmas in numerous experiments at PALS. For this purpose, he developed a modular optical system which allows quick assembly of the interferometer, depending on the experimental requirements. Several other researchers have since used the Polish system, benefiting from PALS facilities and Pisarczyk's expertise.



Registration system of the 3-frame interferometer at PALS

The idea of constructing multi-frame interferometric diagnostics has its origin in Pisarczyk's first LASERLAB Access project at PALS, some ten years ago. In this experiment he adapted an automated single-frame polaro-interferometer to study plasma parameters. The experience gained during the installation of this system and the results obtained turned out to be sufficiently useful and convincing to encourage extension of this method to a multi-frame approach. This led to the construction of an interferometric system with the capability to record three independent interferometric images with an adjustable time delay in the range of 1-3 nanoseconds. Each channel was equipped with a high-resolution, high dynamic range CCD camera. All cameras were connected to a computer, which allowed for easy control of the data acquisition process and maximally automated the work required to process the recorded data.

The successful implementation of a three-frame interferometer on PALS was expensive and included a great deal of complex technical work, and would not have been possible without strong support from the management of both PALS and IPPLM. The reason for this was that the components of this system had to be installed in the experimental chamber in such a way that they would not obstruct access to the chamber and could be used in parallel with other important diagnostic tools. For example, to this end a unique custom-designed lead-out of the diagnostic laser beams from the experimental chamber for different recording channels had to be constructed, using a system of prisms mounted on the window in the chamber door; when the door was opened, the prisms were removed, providing an unobstructed access to the chamber. Furthermore, the main subsystems of the interferometer (e.g., the delay line and the recording system) were designed as independent modules, with permanently mounted components, which allows for a quick assembly and disassembly of the interferometer, depending on the experimental requirements.

Over the time sufficient experience was gained with the multi-frame interferometer for it to become a routine diagnostic tool, which had the advantage that it could also be used for training of undergraduate and postgraduate students. Presently two students – one Czech and the other from Pisarczyk's Polish team – are working on PhD theses which rely on the multi-frame interferometry as a basic source of information on the parameters of the laser plasma.

Detecting explosives through non-transparent materials (LaserLaB Amsterdam)

An access project carried out at LaserLaB Amsterdam by forensic scientists shows that with the assistance of experts in laser diagnostics one can find solutions for pressing problems in society. Carmen García-Ruiz and María López-López of the University Institute of Research in Police Sciences (IUICP, Madrid) developed a way of detecting certain explosives using Raman spectroscopy during their visit to Amsterdam.

Non-invasive detection of concealed explosives is becoming a priority in terms of security, and has attracted particular attention in recent years due to the heightened threat of terrorism. Law enforcement teams throughout the world have to intensify research and development of efficient detection systems to be able to face the problem of hidden explosives at public places like airports, railway or coach stations.

In view of the growing need to apply research in experimental sciences to forensic science, the research group INQUIFOR was created as part of the University Institute of Research in Police Sciences (IUICP) of the University of Alcalá (Madrid, Spain) in 2010. Since then, INQUIFOR has focused on the development of new analytical tools to overcome analytical forensic challenges, especially those where explosive samples are involved

María López-López (left) and Carmen García-Ruiz

Time Resolved Raman spectroscopy (TTRS) is a promising tool which has been applied to identify various types of samples behind different non-transparent, diffusely-scattering materials. With the aim of detecting explosives using this technique, García-Ruiz, head of INQUIFOR, and her postdoc López-López contacted Freek Ariese from LaserLaB Amsterdam, one of the world experts in Raman technology. He provided them with detailed information on access opportunities and conditions through the LASERLAB-EUROPE Access Programme. The research proposal was submitted, reviewed, and the Spanish researchers obtained user access to LaserLaB Amsterdam to carry out the project in 2011.

The collaboration between the members of INQUIFOR and LaserLaB Amsterdam, experts in the analysis of explosives and in TRRS respectively, was considered a resounding success. With the technical support provided by the Amsterdam team, many experiments could be carried out in a short time span. The results obtained demonstrated that with TRRS the two main isomers of dinitrotoluene and other related explosive compounds can be detected non-invasively through different white plastic container walls several millimetres thick without having to manipulate the package.

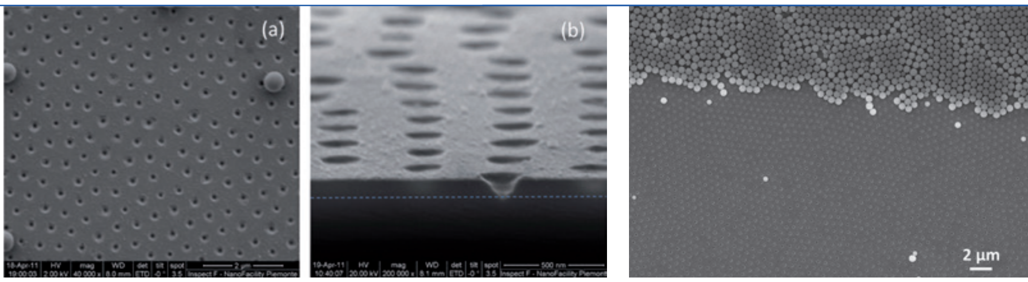
In conclusion, this study provided a new analytical tool for the non-invasive detection of explosives in the security and forensic fields. The work was published in Analytical Chemistry, and attracted substantial national and international media attention.

Periodic porous membranes produced by intense lasers (LP3)

Researchers from the Italian National Research Institute (INRIM, Torino, Italy) used the unique laser facilities at LASERLAB-EUROPE partner LP3 (Marseille, France) to create tiny holes in thin layers of silica. A chance encounter at a conference led to a new method to produce periodic porous membranes for nanofabrication.

In 2010, Luca Boarino and Natascia De Leo from INRIM participated in an international nanoscience conference (NANOSEA) held in Cassis, France. They presented a poster just next to another poster presented by researchers from LP3. The topic of the conference was 'self-assembled ordered nanomaterials' and the researchers realized during

Luca Boarino characterizing the laser-fabricated nanoporous materials at 'Nanofacility Piemonte'



Examples of a porous silica membrane produced by nanosphere-mediated laser ablation

this poster session that, combining their approaches, they could produce very efficiently periodic porous membranes – a key element for nanofabrication protocols.

The Italians were working on methods to fabricate devices on nano- and microscale from silica microspheres. They had a very large set of technological resources at their disposal, but no intense lasers. At the conference, they devised detailed methods to combine microsphere synthesis and near-field laser ablation to fabricate so-called mesoporous membranes (containing holes with a diameter of 2 to 50 nanometers). The scientists realized that the possibility to perform laser experiments with specially engineered micro- or nanospheres should provide a unique opportunity to study microsphere near-field laser ablation processes in detail.

After the conference, the INRIM researchers applied for Transnational Access, describing in their proposal the concept they discussed with the LP3 researchers. The proposal was accepted and after just two few-day visits at the LP3 laboratory, they were able to demonstrate that their concept holds.

In their experiments, they prepare silica nanospheres and assemble them into monolayers. Subsequently, a laser beam hits the monolayer deposited on top of the dense silica membranes. The laser interaction with the nanospheres creates extremely small and intense light spots, leading to a periodic nano-ablation of the membranes. Then, the approach fabricates beautifully ordered mesoporous membranes with the use of a single nanosecond laser pulse.

The LP3 laser facilities are unique, because the researchers can find all the equipment to prepare substrates (surface preparation), to irradiate the substrate (intense pulsed lasers) and to characterize directly the modified materials (optical, electron and atomic force microscopes) in one place. Thanks to all this equipment, the nanoscale experiments are not performed in the blind, which saves a lot of time. After the access experiments, further detailed characterization took place using the world-class nanoscale metrology facilities at INRIM and the results were published in *Nanotechnology*.

The Italian-French consortium will continue their research on this hybrid-photonic approach, which appears extremely promising because it is dry, clean and fast but also extremely flexible thanks to the use of laser ablation. The researchers plan to push their concept further with the help of another access project this year.

Access in numbers

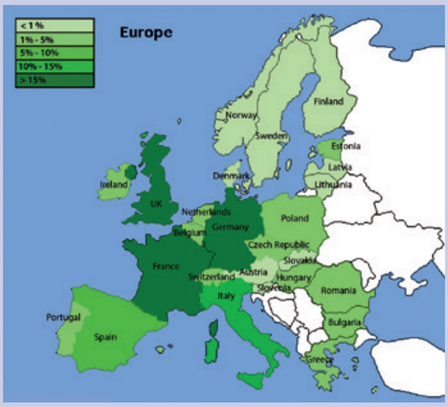


Figure 1: Geographical distribution of LASERLAB users

From 2004 to mid-2012, access to LASERLAB facilities has been granted to over 1000 scientists from institutions outside LASERLAB-EUROPE to perform 575 research projects. The LASERLAB-EUROPE users (see figure 1) come from all over Europe. Even though still almost 56% are from laboratories located in just 4 countries, namely France, Germany, Great Britain, and Italy, the LASERLAB policy towards integration of its new partners in South-Western and Eastern Europe shows an increase in the proportion of users based in these countries from 14% (2004-2008) to 16.5% (2009-2012).

More than half of the users (56%) are young researchers, i.e. PhD students or post-docs, showing that access has an important role for the training of the future European researcher community. Almost 28% of the young researchers are female, slightly more than the overall share of female users (23%), where the latter corresponds to the overall proportion in the relevant fields, mainly physics and chemistry.

The research carried out by LASERLAB users covers a broad range of scientific fields, with a clear increase of projects in life sciences (from 9% in the period 2004-2008 to 16% in 2009-2012) and a large number of projects directly linked to the new pan-European projects HiPER (mainly Fusion and Laboratory Astrophysics) and ELI (mainly Secondary Sources and Harmonics).

These collaborations have led to more than 600 publications in peer-reviewed journals, many of them in top scientific journals like Science, Nature, Nature Physics, Nature Materials and Physical Review Letters. The number is still bound to rise considerably in due course, given the delay between completion of a project, submission of a paper and actual publication. This scientific outcome is noteworthy, considering the large number of young researchers involved and the priority given to new users in the selection procedure.

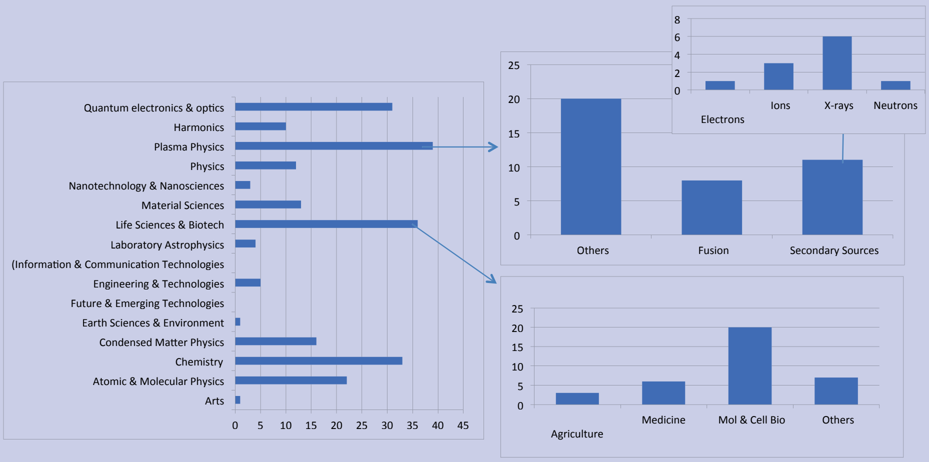


Figure 2: Scientific fields of user projects (2004-2012)

Networking Events

Venice International School on Lasers in Materials Science

Photo: courtesy of W. Kautek

Lecturers and attendees of SLIMS 2012

The Venice International School on Lasers in Materials Science (SLIMS) was held in Isola di San Servolo, Venice, Italy, from 8th to 15th of July, 2012. The School was organized in the framework of the activities of Venice International University (VIU) and continued the tradition of the first two editions of the School, which took place in the same location in 2008 and 2010. In 2012, SLIMS was recognized and supported as the 11th IUVSTA (International Union for Vacuum Science, Technique and Applications) School.

The main purpose of SLIMS was to provide PhD students and young research scientists, working in the field of laser-materials interactions with robust fundamental knowledge that is often lacking in their training, so that they may benefit from interaction with colleagues working in areas neighbouring their own research field. Although the School targeted the level of PhD students, advanced undergraduate and Master students as well as postdoctoral researchers joined in this edition. A total number of 35 students from 13 countries attended the School, with 25 students coming from EU countries.

The School comprised a set of lectures by 17 international experts in the field of laser-materials interaction. Students participated through posters and brief oral contributions. Structured discussions among lecturers and students took place in three specialized dedicated sessions. During the closing ceremony, prizes were awarded to the best student contributions.

The SLIMS 2012 programme included a number of lectures addressing the fundamentals of laser-materials interactions and laser-materials processing. The syllabus covered the mechanisms, relevant experimental and computational techniques, as well as current and emerging applications in nanoscience, biomedicine, photovoltaics, analysis and industry.

One of the distinctive features of the School was the opportunity for students to discuss their on-going projects or research plans with the lecturers. The students were strongly encouraged to present posters that were displayed over the School duration in the lecture hall. The posters were discussed during the extensive poster sessions and at coffee breaks. The students also gave brief oral presentations of their research in dedicated sessions and participated in the Best Student Presentation Award competition (dedicated to the memory of Professor Roger Kelly).

The School also included a presentation of LASERLAB-EUROPE by Marta Castillejo, one of the School Directors and Chair of the Board of User Representatives in LASERLAB-EUROPE, emphasizing the opportunities for access as well as the user training events. A round of questions and discussion about Laserlab took place after the presentation.

Marta Castillejo

Annual Meeting of NAUUL 2013

2nd Workshop on Operation of PW-class Lasers

The 2013 annual meeting of the Ultra-intense Ultrashort Lasers (NAUUL) Networking Activity took place the 13th and 14th of June 2013 at the Dornburg Castles, near Jena (Germany). It was co-organized by Gerhard Paulus (Helmholtz Institute, Jena), Philippe Martin (CEA, Saclay), and Ricardo Torres (CLPU, Salamanca). The meeting coincided with the 2nd Workshop on Operation of PW-class Lasers, the first of which took place last year in Paris.

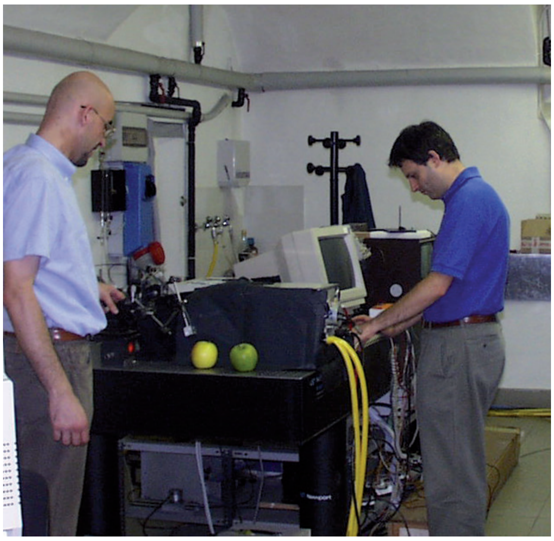
The workshop addressed the most pressing issues concerning the day-to-day operation of high-intensity lasers, and attracted some of the most recognised European experts on each topic. One of these problems is how to measure accurately the properties of laser pulses at such high powers. In particular, some novel methods for measuring ultra-high intensities were proposed, based on the momentum distribution of laser-produced ions (Gerhard Paulus), the laser-induced Zeeman effect (Evgeny Stambulchik), and non-linear Thomson scattering (Antonino Di Piazza). The enhancement of the pulse contrast and its measurement is another important issue, which becomes more critical as the intensities get higher. Also critical is the current impossibility to measure the pulse contrast in a single shot. Methods to reduce the pre/post-pulses and the experience with the Polaris laser in Jena (Malte Kaluza) and the Vulcan laser in the UK (Alexis Boyle) were presented.

Apart from the issues concerning the lasers themselves, the utilisation of these systems in the laboratory poses many technical difficulties. The protection of the electronic equipment against the electromagnetic pulse generated by the laser shot was addressed by Eyal Kroupp. The production of microtargets for laser-plasma interaction is becoming very challenging due to the ever more sophisticated target designs requested by the experimenters, and the need to deliver targets at the high repetition rates of current state-of-the-art high-intensity lasers. The most advanced techniques for target fabrication and characterization were presented by Chris Spindloe. The increasing repetition rate of forthcoming laser systems also poses a challenge to the detectors of the particles originated in the laser-target interaction. Josefine Metzkes showed her achievements in the development of online proton detectors based on scintillators.

Finally, representatives from two branches of the Extreme Light Infrastructure (ELI) – ELI-ALPS (Attosecond Light Pulse Source, Mikhail Kalashnikov) and ELI-NP (Nuclear Phyisics, Traian Dascalu) - presented an update of the progress on both projects, and the commercial companies Amplitude Technologies (Gilles Riboulet) and Thales Optronique (Denis Levaillant) provided the manufacturers' point of view into the problems of operating a PW-class laser. **Ricardo Torres**

Access Highlight: Non-destructive assessment of internal fruit quality by time-resolved reflectance spectroscopy

With near-infrared light, the internal state of food can be probed in a non-destructive way. Consequently, near-infrared spectroscopy (NIRS) can be used to enhance the quality of the food we eat. A relatively new laser-based technique, called time-resolved reflectance spectroscopy (TRS), has several advantages over the traditional NIRS techniques using lamps or LEDs. Since 2003, the Center for Ultrafast Science and Biomedical Optics (CUSBO) at Politecnico di Milano (Milan, Italy) has been offering Transnational Access to a unique TRS system for non-destructive measurements on food. Alessandro Torricelli from CUSBO explains.



The laboratory TRS system available at CUSBO

Food, like most biological materials, is opaque to near infra-red (NIR) radiation due to the complex interplay between light absorption and light scattering. Absorption and scattering are related to tissue composition (e.g., compounds with specific absorption bands, like water, sugars, chlorophylls, and carotenoids) and tissue structure (e.g., size and density of cells, intra- and extra-cellular environment), respectively. Absorption is relatively low in the NIR range. Therefore, light can penetrate deeply into biological tissue. Conversely, scattering is remarkably larger and this allows for NIR light radiation to diffuse in the sample volume and to be reemitted at tissue boundaries. Non-destructive monitoring of food quality by near infrared spectroscopy (NIRS) has rapidly evolved from the laboratory stage to industrial applications.

The common approach to NIRS is the continuous wave (CW) technique, where steady state light sources (e.g., lamps or LEDs with constant intensity in time) and photodetectors (e.g., photodiodes or CCD cameras) are used to measure light attenuation. The absorption characteristics of the sample are then derived by the Lambert-Beer Law. Indeed, light scattering can significantly affect light attenuation, resulting in a need for calibration for each new batch of samples. To tackle this effect, a modified version of the Lambert-Beer Law has been introduced, but results are far from optimal.

The portable TRS prototype available at CUSBO

In the last decade, the study of light propagation in diffusive media has been fostered by potential diagnostic and therapeutic applications in the biomedical field. Physical models for light diffusion based on an approximate solution of the Radiative Transfer Equation have been proposed, allowing for an accurate description of the contributions from light absorption and light scattering. These models consider light as a stream of photons instead of an electromagnetic wave and the physical framework is often referred to as photon migration. The absorption coefficient and the reduced scattering coefficient are introduced, assuming a given probability for photons to be absorbed or scattered per unit length. For photons traveling inside the medium, the energy balance is used to derive the photon density (i.e., the number of photons per unit volume and time) and the photon probability of being remitted at sample boundaries (i.e., diffuse reflectance).

In addition, advanced techniques have been proposed to improve the classical CW approach to NIRS, in particular time domain and space-resolved NIRS. The main feature of time-resolved reflectance spectroscopy (TRS) is its ability to retrieve information on photon path-length in a diffusive medium. Photon path-length is influenced by scattering and absorption events and it is generally much larger than the geometrical distance between source and detector, typically on the order of a few meters. TRS measures the distribution of photon time-of-flight (related to photon path length by the speed of light in the medium) at the picosecond or nanosecond time scale at a fixed source detector distance (e.g., 15 mm) by means of pulsed laser sources (with duration of tens of picoseconds) and fast detection techniques (e.g., time correlated single photon counting) (Torricelli et al., 2008).

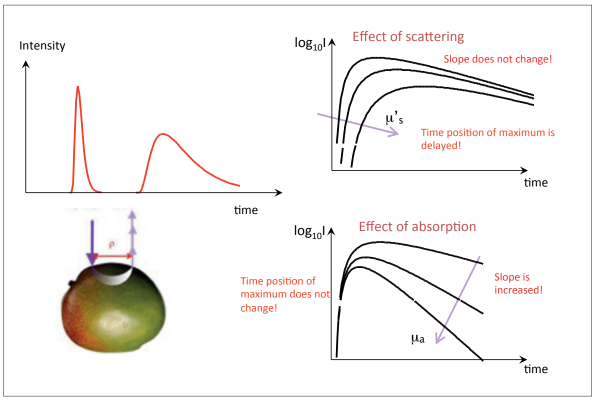
The use of TRS in combination with proper physical models for photon migration allows for complete optical characterisation, using simultaneous non-destructive measurements of the optical properties (absorption and scattering) of a diffusive medium. This can be of special interest for most fruits and vegetables, as well as for other foods (e.g. meat, fish, and cheese), because information derived by TRS refers to the internal properties of the medium, and is not so much affected by surface features as is the case for CW NIRS. Moreover, from the optical parameters information can be obtained on the physical properties, such as the density (or number) and size of particles or droplets (in case of emulsions). Those parameters are important for the processing of food (e.g., cheese, milk, juice, and puree) and subsequently for the quality of the derived food products.

TRS is totally non-invasive since the optical radiation in the 600-2000 nm spectral range (red and near infrared) is non-ionising. Moreover, very limited power (average power of a few mW) is typically employed in TRS systems. Therefore no chemical, mechanical or thermal damage can occur to the sample. TRS has the capacity to probe internal microstructural properties with minimal influence from the optical properties of the surface. Moreover, in case of anisotropic samples, suitable models are available to interpret diffuse reflectance data, e.g., fruits like melon with a thick skin can be modelled as layered media and the optical properties of upper and lower layers can be evaluated.

Within the framework of LASERLAB-EUROPE, CUSBO has been offering access to a unique TRS system for non-destructive measurements on food since 2003. The system is a broadband fully automated TRS spectrometer developed by PoliMi during the research project DIFFRUIT. PoliMi is also equipped with a portable TRS system, which can be used to perform measurements at harvest close to the orchards.

The first collaboration with experts in the food sector originated by a personal invitation to Prof. Bart Nicolai (MeBioS, KU Leuven, Belgium) and a TRS measurement campaign on pear was performed, also in comparison to CW NIRS (Nicolai et al., 2008). The following collaborations were initiated by the contacts provided by Dr. Paola Eccher Zerbini (CRA-IAA, Milan, Italy). CUSBO and CRA-IAA are closely located and actively collaborating in national and international projects. In many cases, users took advantage of the possibility to properly store fruit in controlled atmosphere rooms and to make classical destructive (e.g., firmness, brix, dry mass) and non-destructive (e.g., weight, skin colour) measurements at CRA-IAA facilities.

Dr. Eivind Vangdal (Planteforsk, Norway), for example, performed TRS measurements at CUSBO for maturity assessment and detection of defects in plums (Vangdal et al., 2010), whereas Dr. Pol Tijskens (HCP-WUR, Wageningen, The Netherlands) applied biological shift models to TRS data for maturity assessment in nectarines and mango (Tijskens et al., 2007). Susan Lurie (ARO, Israel) studied internal disorders in peaches and their detection by TRS (Lurie et al., 2012). On the other hand, Dr. Manuela Zude (ATB, Potsdam, Germany) gained access to the CUSBO TRS facility for the calibration of CW NIRS sensors by directly contacting LASERLAB-EUROPE (Zude et al., 2008).



Scheme of the method used for non-destructive measurements on food

For all access projects, the specific expertise from the various partners (e.g., postharvest, biological modelling) and from the group at the laser facility (e.g., light propagation in diffusive media, advanced technique for photon detection at the picosecond scale) contributed to the success of the experiments and to the opening of further collaborations. Several research projects in fact stem from LASERLAB-EUROPE collaborations: InsideFood (coordinated by Prof. Nicolai), 3D Mosaic (coordinated by Dr. Zude, ATB Potsdam) and TROPICO (coordinated by undersigned, with WUR Wageningen as partner).

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References

Lurie, S., et al., (2011) Chilling injury in stored nectarines and its detection by time-resolved reflectance spectroscopy, Postharvest Biol Technol 59:211–218

Nicolaï, B. M. et al., 2008. Time-resolved and continuous wave NIR reflectance spectroscopy to predict soluble solids content and firmness of pear, Postharvest Biol. Technol. 47, 68–74.

Tijskens, P. et al., 2007. Assessing harvest maturity in nectarines, Postharvest Biol Tec 45:204-213.

Torricelli, A. et al., 2008. Time-resolved reflectance spectroscopy for non-destructive assessment of food quality, Sens. & Instrumen. Food Qual., 2:82–89.

Vangdal, E. et al., 2010. TRS-measurements as a nondestructive method assessing stage of maturity and ripening in plum (Prunus domestica L.) Acta Horticulturae, 858, pp. 443-448.

Zude, M. et al., 2008. Approach for non-destructive pigment analysis in model liquids and carrots by means of time-of-flight and multi-wavelength remittance readings, Anal Chim Acta, 623:204–212 ISSN: 0003-2670.

ELI established as International Association

The Extreme Light Infrastructure (ELI), the world's first international user facility for laser research, has been established as an International Association during a notarial ceremony on April 11, 2013 in Brussels, Belgium.

The newly founded *ELI Delivery Consortium International Association* will be a non-profit organisation after Belgian law (AISBL). It will promote the sustainable development of ELI as a pan-European research infrastructure, support the coordinated implementation of the ELI research facilities, and preserve the consistency and complementarity of their scientific missions. It will also organise the establishment of an international consortium that will be in charge of the future operation of ELI, preferably in the form of a European Research Infrastructure Consortium (ERIC).

Founding members of the ELI-DC International Association are three international scientific institutions, the Romanian "Horia Hulubei" National Institute of Research and Development for Physics and Nuclear Engineering (IFIN-HH), the Hungarian ELI-Hu Research and Development Non-Profit Limited Liability Company, and the Italian Elettra-Sincrotrone Trieste S.C.p.A. The Institute of Physics of the Academy of Sciences of the Czech Republic will join the Association immediately after its establishment. Institutions from other countries such as Germany, the UK, France, and others are expected to follow.

L. Lehrner (ELI-ALPS), M. Douka (EC), N.-V. Zamfir (ELI-NP), R.-J. Smits (EC), W. Sandner (ELI-DC), V. Ružička (ELI Beamlines), C. Rizzuto (Elettra-Sincrotrone Trieste), F. Gliksohn (ELI-DC), H. Tuinder (EC) (from left to right)

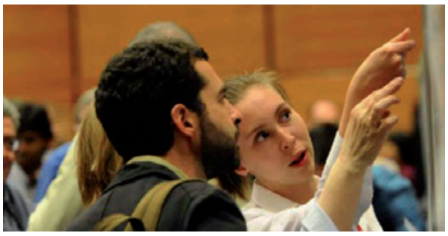
HiPER Preparatory Phase closes with a Laser Energy Workshop

A two day workshop on Laser Energy was held on 17th & 18th April in Prague to mark the end of the current 'Preparatory Phase' of the HiPER Project and the start of preparations for the next phase; 'Technology Development'.

HiPER is an ambitious ESFRI project which seeks to demonstrate the commercial viability of power production from laser-driven fusion. The workshop was held as part of the SPIE Laser and Optoelectronics Symposium and attracted over a hundred scientists, engineers and students.

Talks and posters covered every aspect of the Laser Energy challenge; laser technology, ignition physics, mass production of targets, fusion chamber concepts, advanced materials and the economic considerations of commercial power production.

The opening session included presentations from HiPER Project Director Chris Edwards and Ed Moses, Associate Director for the National Ignition Facility and Photon Science at the Lawrence Livermore National Laboratory in California. Dr Moses described progress towards ignition of Deuterium-Tritium fuel capsules at NIF and outlined plans for the LIFE project, which aims to harness fusion power within the next 15 years.



Delegates discuss details of plasma processes in fuel capsules at the HiPER poster session in Prague

The Laser Energy Workshop was followed on Friday 19th April by the Annual HiPER Participants' Forum. Chairing the closing session, Prof. John Collier, Director of STFC's Central Laser Facility, acknowledged the tremendous contribution made by the HiPER community and looked forward to the exciting advances in technology, physics and engineering which will underpin the future success of HiPER. He explained that a proposal for funding of project co-ordination and governance for the next two years was currently being considered by STFC.

Visit the HiPER website at www.hiper.org for more information and the latest HiPER Project news or send an e-mail to Chris Edwards (chris.edwards@stfc.ac.uk)

Forthcoming events

11 July 2013
JRA INREX Meeting | Paris, France

23 – 24 September 2013
Laserlab Workshop 'Characterisation of ultra-short high energy laser pulses'
Abingdon, UK

26 – 27 September 2013
Laserlab User Meeting | Marseille, France

23 – 24 October 2013
General Assembly Meeting | Lisbon, Portugal

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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Issue 16 | December 2013

Laserlab Forum

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

Laserlab and Industry

Impression of the novel photodetector envisioned by Frank Koppens and Gerasimos Konstantatos. Colloidal quantum dots (red) on a layer of graphene (honeycomb structure). © ICFO

In this Issue

Editorial

Tom Jeltes

Though much can be said against unrestricted involvement of industry with science – many scientists may even feel that their sacred scientific endeavour could be tainted by commercial thinking – it is also clear that much can be won by sensible collaboration between the people in the laboratory and those who know what kind of products society is willing to pay for.

In many cases, both worlds can benefit from close collaboration: commercial companies might turn a scientist's idea into a marketable product, or, the other way around, they may provide input for scientific research in the form of essential laboratory equipment.

To illustrate the importance of collaboration between science and industry, we dedicated several pages of this issue of Laserlab Forum to an 'Industry Focus', describing several ways in which business and academia can interact to the benefit of both.

To some extent, even researchers who operate in a purely academic environment have to think commercially, because they have to get funding to be able to buy equipment and hire junior researchers to pursue their scientific goals. Writing attractive funding proposals is a way of advertising yourself and your research. Evidently, this skill has become of paramount importance for the professional survival of scientists in the past decades and some do much better than others.

Still, I was surprised to see that all three ERC Advanced Grants awarded within the Laserlab-Europe community in 2013 go to researchers who also received this same grant at the first opportunity some five years ago. I would like to congratulate these outstanding researchers with their ability to convince 'the market' to buy their 'product'. More about their exciting new plans can be found in this sixteenth issue of Laserlab Forum.

Tom Jeltes

News

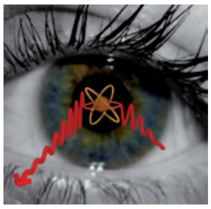
Herbert Walther Award for Massimo Inguscio

Massimo Inguscio, professor of Atomic Physics and Structure of Matter at Laserlab-Europe partner LENS (Florence, Italy) will receive the 2014 Herbert Walther Award for his 'groundbreaking experiments in modern atomic, molecular and optical physics, and for his scientific leadership world-wide'. Inguscio will get the award, which entails a plaque, a certificate, and 5000 euros, at the Spring Meeting of the Deutsche Physikalische Gesellschaft (DPG).

The Herbert Walther Award is a joint award by DPG and the Optical Society (OSA), and presented by each society in alternate years. Established in 2007, the Award recognizes distinguished contributions in quantum optics and atomic physics as well as leadership in the international scientific community. Inguscio will join the list of esteemed past recipients including Alain Aspect, Marlan O. Scully, Serge Haroche and David J. Wineland.

Inguscio is considered a leader in AMO physics thanks to his many cutting-edge experiments with ultra-cold atomic gases. Notably, he was among the first to research the possibilities of sympathetic cooling to cool atoms such as potassium.

Non-destructive detection of optical photons achieved at MPQ



© MPQ, Quantum Dynamics Division.

Scientists from the Quantum Dynamics Division of Prof. Gerhard Rempe at Laserlab-Europe partner MPQ (Garching, Germany) have for the first time realised a device with which an optical photon can be detected without destroying it. The new method, an important breakthrough for quantum information experiments, was reported in Science Express on 14 November 2013.

Up until now the only way to detect photons, quanta of light, was via absorption by a sensitive medium. In the process, the photon is destroyed. The MPQ device, though, allows researchers to 'see' the light particle while keeping it intact. They use a single rubidium atom locked inside an optical cavity. By preparing the atom in a so-called superposition of two states, a photon of the right energy, impinging on the cavity, will have an effect on the atom (it causes a phase-shift), without being absorbed by it.

So far, the chance of detecting a single photon is 74%; two out of every three photons survive the detection process, but according to the researchers, these values are not fundamentally limited. Repeated detection of photons allows construction of a deterministic quantum gate for photons, which would be an essential building block for optical quantum computers.

New laser-plasma research centre at Strathclyde

A new research centre devoted to the exploitation of laser-plasma based accelerators is being built at the campus of the University of Strathclyde, partner of Laserlab-Europe. The Scottish Centre for the Application of Plasma-based Accelerators (SCAPA), a facility of 10 million euros and 1200 m², is a project of the Scottish Universities Physics Alliance. SCAPA is scheduled to begin operation at the end of 2014 and will be led by Strathclyde's Professor Dino Jaroszynski.

The centre will house three shielded areas and seven laser-accelerator beam lines that will provide a range of very high energy particle beams (electrons, protons, ions) and very bright bursts of incoherent and coherent radiation (from terahertz to hard X-rays) for a wide range of applications. Two high power femtosecond laser systems will be used to produce the secondary sources of radiation. Relativistic electron beams with energies exceeding one GeV will be used as drivers of betatron, synchrotron and free-electron laser light sources. In addition, proton and ion beams with energies of 100's MeV will be produced using solid targets.

These radiation and particles beams will enable the study of a wide range of applications, including particle beam therapy, isotope generation, imaging, detector development, and damage of material in harsh environments such as fusion reactors and in space.

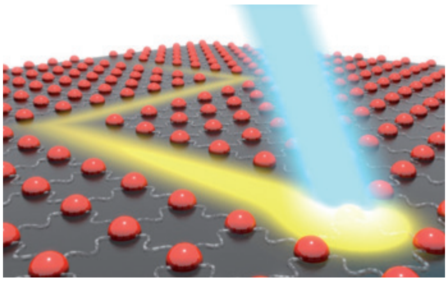
SCAPA will also host a Centre for Doctoral Training to train PhD students (new intake of ~12-14 per year) in advanced applications and the development of laser-based radiation sources. This should help with ultimately providing trained personnel for the ELI and other EU facilities. Furthermore, industrial partnership is expected to play a key role in SCAPA.

What is Laserlab-Europe?

Laserlab-Europe, the Integrated Initiative of European Laser Research Infrastructures, understands itself as the central place in Europe where new developments in laser research will take place in a flexible and co-ordinated fashion beyond the potential of a national scale. The Consortium currently brings together 30 leading organisations in laser-based inter-disciplinary research from 16 countries. Its main objectives are to maintain a sustainable inter-disciplinary network of European national laboratories; to strengthen the European leading role in laser research through Joint Research Activities; and to offer access to state-of-the-art laser research facilities to researchers from all fields of science and from any European laboratory in order to perform world-class research.

LaserLaB Amsterdam partner in nanolithography institute

Laserlab-Europe partner LaserLaB Amsterdam will participate in a new institute for fundamental and applied research on extreme ultraviolet lithography. The Advanced Research Centre for NanoLithography (ARCNL) will be located at the Science Park Amsterdam and is partially funded by ASML, the leading manufacturer of photolithography systems for the semiconductor industry. The ARCNL will host around one hundred researchers and has been given a budget of 100 million euros for a period of ten years.



The institute will focus on the physics of EUV light, infrared-laser physics, (surface-)physics of clusters and radicals and nanophotochemistry. LaserlaB Amsterdam's extensive experience in the field of EUV physics has contributed to the election of the Amsterdam consortium as a partner in the ARCNL; LaserLaB Amsterdam professors Wim Ubachs and Kjeld Eikema will contribute key expertise to the scientific problems associated with EUV lithography.

ERC Starting Grant Thibault Cantat

Recycling CO_2 might provide an alternative to fossil resources as a feedstock for organic chemicals. However, CO_2 is difficult to transform; only a handful of chemical processes recycling CO_2 have been industrialised so far. Thibault Cantat from SLIC (Saclay, France) will use the ERC Starting Grant he was awarded this year to design novel catalytic transformations in which CO_2 reacts with so-called functionalising reagents and reductants to produce a large spectrum of molecules.

Thibault Cantat (SLIC)

In 2012, Cantat and his team established a proof of concept of what they call the 'diagonal approach' by co-recycling CO_2 and PHMS (a chemical waste of the silicone industry), converting amines to formamides. The goal of Cantat's project is to synthesise amines, esters and amides, which are currently all obtained from fossil materials. Cantat also envisions that his project will increase the understanding of CO_2 activation and will provide invaluable insights into the basic modes of action of organocatalysts in reduction chemistry.

ERC Starting Grant Melike Lakadamyali

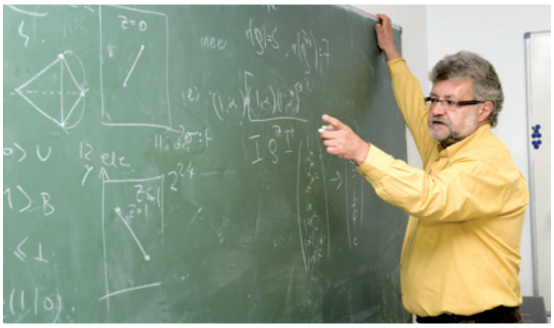
Melike Lakadamyali (ICFO)

Intracellular transport plays a key role in many processes inside cells and its breakdown can have catastrophic consequences. For example, transport failures are an early indicator and a likely cause of many neurodegenerative diseases. Understanding what goes wrong with intracellular transport during disease, requires knowledge of how so-called motor proteins work together to transport cargo, but those proteins are difficult to visualise due to their small size and complex environment.

Melike Lakadamyali from ICFO (Barcelona) received a Starting Grant from the ERC to try and overcome this visualisation problem by combining several advanced techniques (such as single particle tracking, quantitative single molecule counting, genetic manipulation, and fluorescence labelling) with 'nanoscopy' – a branch of fluorescence microscopy in which the diffraction limit is overcome. Lakadamyali believes that this multidisciplinary approach will for the first time provide a detailed picture of how motor proteins function inside living cells.

ERC Advanced Grants 2013

In the sixth round of the Advanced Grant competition of the European Research Council (ERC), three prominent scientists from LASERLAB-EUROPE partners have been awarded this prestigious grant of up to 3.5 million euro. For each of them it is their second Advanced Grant, after a first successful application in 2008.



Maciej Lewenstein (ICFO)

Maciej Lewenstein (ICFO)

Systems that interact with their environment play an important role in many areas of physics, chemistry, and biology. In recent years, considerable attention has been drawn to such 'open systems'. For example, recent advances in bio-photonics have allowed to observe Brownian motion of biologically functional particles in cells, and ultracold atoms have been proved to be eminently suited for building quantum simulators and basic quantum computers. In both systems, interaction with the environment plays a significant role. Many aspects of these open systems, however, are not well understood.

With his second ERC Advanced Grant, Maciej Lewenstein, Professor of quantum optics theory at ICFO (Barcelona), intends to develop a theory of classical Brownian motion of biological molecules on the surface of the cell membrane and in the cell, as well as a theory of quantum Brownian motion in an inhomogeneous environment. Furthermore, he aims at formulating new models of classical many-body open systems, and hopes to develop a theory of open-system quantum simulators. According to Lewenstein's expectations, investigating the connections between these seemingly disparate project goals will lead to a unified theory of open systems.

Victor Malka (LOA)

Victor Malka (LOA)

In free-electron lasers (FEL), coherent electromagnetic radiation is produced by a relativistic electron beam moving through a periodic magnetic field structure. This rather special type of laser can be used to generate a particularly broad spectrum of radiation, ranging from microwaves to X-rays. As such, free-electron lasers are part of the so-called *fourth generation* of light sources. With his new ERC Advanced Grant, Victor Malka intends to demonstrate the feasibility of a *fifth generation* light source: free-electron lasers injected with electron beams produced with laser-plasma accelerators.

In recent years, Malka's group at LOA, Palaiseau, has been able to produce very intense electric fields (in the order of hundreds of Gigavolts per metre) by controlling the collective motion of electrons in a plasma medium. Using different injection schemes, they have shown that local injection of electrons allows fine-tuning of the electron beam parameters. Combined with the fact that laser-plasma accelerators can nowadays deliver high-quality particle beams in ultra-short bunches (of a few femtoseconds) and high peak currents (of a few thousand amperes), laser-plasma accelerators seem a natural candidate to reduce the size and cost of future free-electron lasers.

The project, called *X-five,* aims at delivering bright X-ray beams at a repetition rate of 10 Hz, and will be especially of interest for applications which do not require very high average brightness. Malka foresees applications in, for example, medicine, radiation biology, chemistry and security.

Anne L'Huillier (LLC)

Anne L'Huillier (LLC)

As the field of attosecond science is entering the second decade of its existence, scientists are ready to move from merely mastering the generation and control of attosecond pulses to application in the emerging scientific field of 'ultrafast atomic physics', where one- or two-electron wave packets are created by absorption of attosecond pulse(s) and analysed or controlled by another short pulse.

With her second ERC Advanced Grant, Anne L'Huillier from Lund Laser Centre, will try to answer a number of basic questions: how long does it take for an electron to escape its potential, how long does it take for an atom to become an ion once the electron has left the atom, and where, how and when do the electrons leave the atom?

In order to answer the first of these questions, L'Huillier will measure photo-emission time delays for several atomic systems, using a tuneable attosecond pulse system. To study the ionisation process, XUV pump/probe experiments are required to find the transition between so-called non-sequential double ionisation (where photons are absorbed simultaneously and both electrons emitted at the same time) and sequential ionisation (where the electrons are emitted one at a time). Finally, L'Huillier wants to combine coincidence measurements with angular detection, allowing to characterise (two-particle) electronic wavepackets in both time and momentum.

Workshop on characterisation of ultra-short high-energy laser pulses

On 23-24 September 2013, a two-day workshop was held in Abingdon, UK, on the characterisation of ultra-short high-energy laser pulses. The workshop was hosted by the Central Laser Facility (CLF) on behalf of Laserlab-Europe and attended by over thirty participants from eleven institutions. It enabled the delegates to discuss the challenges surrounding the characterisation of laser pulses used in laser-matter interactions, which is fundamental to the understanding and interpretation of the resultant data.

The workshop was attended by delegates from established facilities and those that are developing their own systems. The sentiment throughout the presentations and discussions was one that enabled common problems to be aired and potential solutions identified. The format of the workshop was arranged so that the overall topic was divided into sessions, with a series of talks that were then used as discussion points for the rest of the session.

The first session concentrated on measuring the pulse durations of high energy Nd:Glass lasers, where the biggest problem is to ensure that there is a reliable pulse length measurement on a shot-to-shot basis. The discussion revolved around the issues of the B-integral (the nonlinear phase shift along the beam's optical axis, ed.) and its impact on the pulse shape and pulse length tuning and on pointing stability into the measuring devices. The methods used to attenuate the incident energy on the shot to reduce the B-integral for the diagnostics arms fell into two camps, with the relative merits of reflective and transmissive schemes being discussed. In addition, the technique of using a sub-aperture sample beam to measure the pulse length was explored.

The second session was targeted at Ti:Sapphire laser systems; since those have higher repetition rates than Nd:Glass lasers it was felt that the average pulse length measurement was appropriate for diagnosing the laser. With the shorter pulse lengths operated on these systems, the pulse-front tilt is an additional problem and the talks in the session led to discussions on the use of inverting interferometers for pulse-front tilt measurements and the availability and reliability of commercially available diagnostics. There was a later session dedicated to different techniques for measuring the pulse-front tilt, and this enabled a thorough discussion as to the limitations and advantages to the different schemes being developed by the speakers.

The third session discussed the difficulty associated with measuring the contrast of laser pulses. The talks from the session showed that whilst there are reliable schemes for determining the nanosecond contrast 'on the shot', the contrast within picoseconds of the arrival of the pulse still requires the use of a scanning device for stable measurement. It was also discussed that with the difficulty measuring the pulse duration on high-energy systems, measuring the contrast would be an even greater challenge.

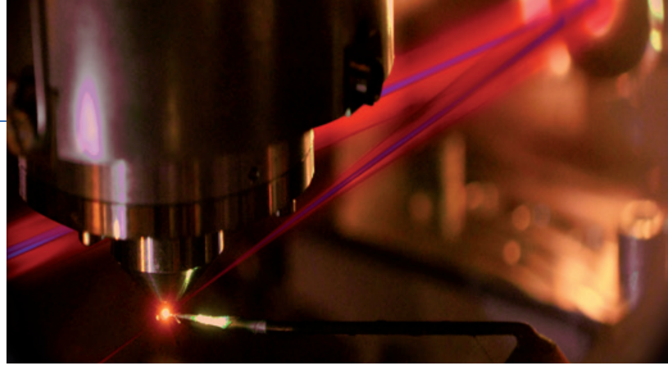
Measurement of the spatial beam quality on the shot was also an area that brought together a consensus that it was a difficult measurement to make; the best approach seemed to be an equivalent-plane measurement or one that recreated a spot from a wave-front measurement.

With the advent of multi-PW laser systems, the diagnostics challenges associated with these schemes led to an interesting discussion on the relative merits of using parabolas for beam expansion for very broad bandwidths and how to maintain their alignment. Techniques for measuring and characterising damage to the final gratings were also discussed.

The problems associated with higher repetition rate laser systems led to a discussion about automated processing of diagnostics and the potential problem with large amounts of laser diagnostic data and whether an average or sampling approach should be taken. Other highlights from this discussion included the use of reflective optical systems for polarisation control and the potential benefits of a dark-field imaging system for damage detection.

Ian Musgrave (CLF)

Science and industry: a two-way street



View inside a vacuum chamber at UFI.

Technological inventions, whether originating from the academic world or created in industry's research labs, are an essential ingredient for our modern economy. Close collaboration between science and industry increases the odds that such findings will eventually benefit society. In these collaborations, knowledge can flow in two directions.
On the one hand, to be able to answer a specific scientific question, scientists often create methods and machines that could also be used for applications outside their field. Generally, these scientific devices are difficult to use for others than those who built them. The step towards a user-friendly marketable product can either be made by creating a spin-off company with heavy involvement of the scientists themselves, or by contacting an established company with a relevant background.
On the other hand, scientific progress is greatly enhanced by dedicated companies supplying components and even fully functioning systems (e.g., frequency combs and other laser systems) to the scientific world. Close ties to relevant research groups, which can provide feedback about those products and can come up with new ideas and inventions, are essential for these high-tech companies.
In this 'Industry Focus', Laserlab Forum presents a short overview of some high-tech companies, both recent spin-offs and independent businesses, associated with several Laserlab-Europe partners. In addition, two new ERC Proof of Concept projects – from LaserLaB Amsterdam and ICFO – are presented, illustrating how the European Research Council stimulates development of scientific results into profitable products. **Tom Jeltes**

Ultrafast Innovations – MPQ

Ultrafast Innovations GmbH (UFI) was founded in 2009 as a spin-off from the Ludwig-Maximilians-Universität München (LMU) and the Max Planck Gesellschaft (MPG), Germany, which are also the stockholders of the company. The objective of UFI is to provide commercialized solutions developed at LMU and the Max Planck Institute for Quantum Optics (MPQ), especially by the groups of Ferenc Krausz and Ulf Kleineberg, to the growing ultra-short-pulse laser community.

UFI does this with success, as is shown by recent projects such as the installation of a beamline for attosecond streaking experiments for the King Saud University in Saudi Arabia, and the design and development of a new enhancement cavity for the Friedrich Schiller University in Jena, Germany. In general, UFI provides optical elements suited for ultra-short laser pulses, ranging from the infrared to extreme ultraviolet and x-rays.

"The idea is to use the technological and research expertise for industrial projects in a straight-forward way", says Hans Koop, UFI's current CEO. According to him, much of the success of the company should be credited to the vision and engagement of Ferenc Krausz who initiated the founding of UFI.

UFI, which has 10 employees, takes care of engineering, product development, and customer relations, whereas science remains the main task of the research groups of Ferenc Krausz and Ulf Kleineberg. Koop: "That means that UFI is basically working at the fount of new products and that UFI has access to passionate coworkers who made their profession their hobby. We really hope that UFI is beneficial for the people and all research institutions of the Garching research campus.
http://www.ultrafast-innovations.com/

Light4Tech – LENS

Light4Tech was founded as a joint venture between a group of academic researchers from the European Laboratory for Non-linear Spectroscopy (LENS) in Florence and several industrial partners in 2005. The company itself stands halfway between the worlds of research and industry, and it offers prototyping and technology transfer services mainly in the fields of photonics and (bio)physics. As such, it intends to fill the gap between basic research and industrial research. The company's know-how includes microscopy, biological imaging, machine vision, and image and data analysis. It employs five people.

Light4Tech is a versatile company: it not only works for high-tech companies that would like to develop a new product, but it is also hired to create products based on ideas from academic groups. It owns state-of-the-art labs, says Domenico Alfieri: "Our laboratories consist of two experimental rooms with a very accurate air control system. That's a prerequisite for advanced optical research. The labs are equipped with optical tables and related optical and electrical tools and chemicals." These labs are not only used by Light4Tech: the company also offers private and public researchers access to their labs.

"A typical approach with L4T starts with a joint technical discussion about the idea or product to be developed", says Alfieri. "This is then followed by a technical and economic feasibility study, which is performed by L4T."

Which ideas from the labs of LENS, the University of Florence, and other academic partners are eligible for the 'L4T treatment' is decided by a Scientific Committee together with an Industry Panel. Alfieri: "They evaluate the most promising research in terms of results and devices, looking at the potential market, to see which ideas can be patented or industrialised by L4T. Our motto is: we give legs to ideas."
http://www.light4tech.com/

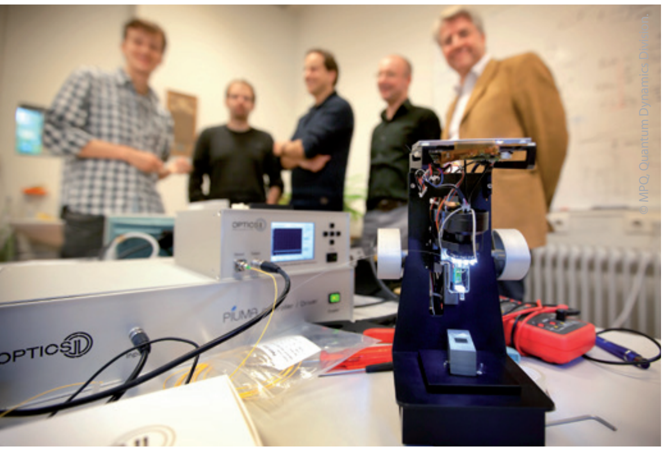
Optics11 – LaserLaB Amsterdam

In 2011, Davide Iannuzzi, University Research Chair Professor at LaserLaB Amsterdam, teamed up with serial entrepreneur Hans Brouwer to found Optics11. The company markets the 'fibre-top' technology Iannuzzi invented. This technology allows producing an atomic force microscope probe at the end of an optical fibre, which can be used at a distance in harsh and wet environments. The method uses a tiny cantilever at the tip of the probe, which reflects light back into the fibre.

The idea dates back to 2005. At the time, Iannuzzi tried to solve a technical problem related to one of his nanoscale experiments when he sketched the design of a new device based on an optical fibre. The Italian realized that using this design he could not only overcome the particular problem he was trying to solve, but that it had the potential to become a new platform for all kinds of miniaturised optomechanical sensors. After building a prototype for his laboratory, Ianuzzi decided he wanted to transform his idea into a mature technology.

Since then, among other grants, Iannuzzi collected a Starting Grant, a Proof-of-Concept and a Consolidator Grant from the ERC to develop his fibre-top technology, which is now being used in ten different countries.

"Academic entrepreneurship is a healthy exercise: it has been teaching me the difference between *doing* and *delivering*, while still widening my scientific horizon", Iannuzzi said about his commercial adventure on the recent occasion of his inaugural lecture as University Research Chair Professor. "Going outside the comfortable rooms of my own laboratory required a change of mindset. The focus had to shift from what we were doing for us to what we wanted to deliver to others. But the effort had its payback. Thanks to the spread of my technology, I am meeting scientists from the widest range of disciplines, which leads to many enlightening discussions."
http://www.optics11.com/

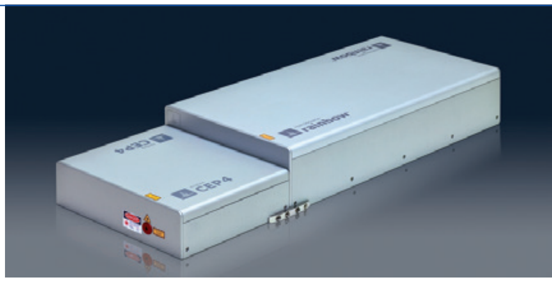


The 'fibre-top' atomic force microscope by Optics11.

Femtolasers – MBI

The group of Günter Steinmeyer from the Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy (MBI, Berlin) developed a method to stabilise the Carrier-Envelope Phase (CEP) of laser pulses. MBI had a patent filed, which was later transferred to Femtolasers Produktions GmbH in Vienna. Femtolasers now sells the CEP4™ method as an add-on to their FEMTOSOURCE™ rainbow™ series of ultrafast oscillators.

Since MBI's research is mostly directed at fundamental science, patents are more an exception than a rule. Nevertheless, the institute strongly supports patenting of relevant ideas and some of them are sold or licensed.



Femtolasers' rainbow oscillator with CEP4 module.

According to Steinmeyer, MBI was already an important customer of Femtolasers. "MBI has one of the biggest installations of Femtolasers' products in Europe. When we contacted them about the CEP stabilisation method, they immediately showed great interest. We then demonstrated the idea in the presence of several people from Femtolasers. The result was published in Nature Photonics in 2010, with an equal number of co-authors from MBI and Femtolasers."

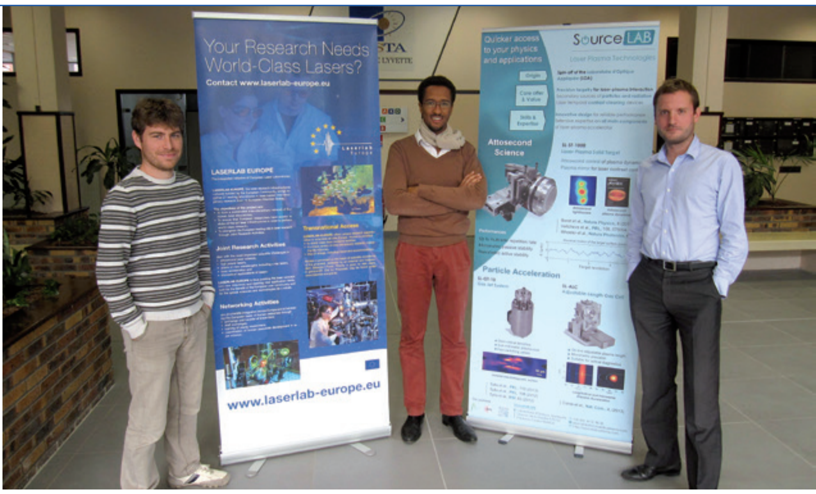
Next, Femtolasers took over and developed the lab demonstration into a product, while MBI agreed to support this process in any way possible. "There were a lot of technical questions and solutions, which we mostly discussed on the phone or via email; the payback has been a few more shared publications", says Steinmeyer. MBI wants to show that their ideas are not only of theoretical nature, but that they really enable superior stabilisation, he says. "We had to make it very clear that the feed-forward scheme is not just a cheap and inferior work-around for the proven feedback technology. And this can only be done by peer-reviewed publication in some of the top journals. In turn, this is the best advertisement that Femtolasers can get."
http://www.femtolasers.com/

SourceLAB – LOA

SourceLAB is a spin-off from the Laboratoire d'Optique Appliquée (LOA) in Palaiseau near Paris. It was founded in February 2011 by Antonin Borot and François Sylla based on their thesis works at LOA during the previous years. The company provides innovative targets and complete systems (laser, target, and detector) to generate and manipulate beams of particles and high-energy radiation.

CEO François Sylla recounts about the earliest stages of the conception of the company: "One year before the defense of my PhD thesis, I decided to start an entrepreneurial adventure in parallel to the scientific work I was carrying out. The company I intended to create, SourceLAB, should bring the technological fruits of four years of developments in the lab to the market, with the help of the technical expertise I acquired at LOA." Sylla therefore decided to spend the last year of his thesis work not only on the scientific side of the field of laser-plasma interaction, but to explore also the economic and societal side.

"Laser-plasma interaction in the so-called 'underdense regime', implemented by focusing an intense laser onto a gas jet, can be used to create relatively cheap and very compact accelerators delivering beams of very energetic electrons and ions", explains Sylla. "These beams have very interesting properties for scientific, industrial and medical applications." They could be used for such different applications as cancer radiotherapy, electron



The SourceLAB team presenting their company together with Laserlab-Europe. In the middle CEO François Sylla.

beam etching of integrated circuits, irradiation sterilisation of food, non-destructive testing of dense materials, and dating works of art.

Sylla's thesis work paved the way towards compact and energy-efficient laser-plasma accelerators, he says, allowing investigation within a wide range of plasma and laser parameters. In its first year, 2011, SourceLAB had two patents filed, and it was awarded an ERC Proof of Concept grant in the same year.

http://www.sourcelab-plasma.com/

Menlo Systems – MPQ

MenloSystems

Menlo Systems is a spin-off from the Max Planck Institute of Quantum Optics (MPQ) in Garching, Germany. It was founded by MPQ Director Theodor Hänsch and his co-workers Ronald Holzwarth and Michael Mei in 2001. Menlo's products are based on the frequency comb technology that brought Hänsch the 2005 Nobel Prize in Physics. The company currently employs more than seventy people.

A Nobel Prize being awarded for the technology you are trying to sell, does not hurt the business, says CEO Michael Mei. "But, actually, we managed to be profitable since early on, after collecting a small amount of private money and a grant from the German government for spin-offs. Also, some of our earliest customers pre-paid for the first units. But I am happy that we already started the business before the Nobel Committee decided to give the prize to Hänsch; the day the prize was announced our web statistics went out of the roof. And, more important, Ted Hänsch has been the best advisor you can think of from the very first day and he is exposed to many potential customers."

Another reason for Menlo's success lies, according to Mei, in the company's attitude. "We always try to make life as easy as possible for our customers. With every frequency comb and other products we also share some of our knowledge with the customers. Indeed, most of the time this is a two-way interchange; we get many things back from them as well."

It helps that he and Menlo's CTO Ronald Holzwarth are both scientists, Mei thinks. "In most places I have been you encounter incredibly smart people, and often it is such a pleasure to work with them that you forget how hard you actually work. If our employees feel the same, I think we do things right."

http://www.menlosystems.com/

Proof of Concept: bridging the gap to the market

The European Research Council actively stimulates its grantees to explore whether any ideas arising from projects funded by Advanced or Starting Grants might be developed into a profitable commercial product. For this purpose, the ERC established the Proof of Concept of up to 150,000 euros in 2011.

This year, Frank Koppens, together with Gerasimos Konstantatos, and Gijs Wuite, from Laserlab-Europe partners ICFO (Barcelona) and LLAMS (Amsterdam), respectively, received Proof of Concept grants to further develop products related to their Starting Grants.

Low-cost and extremely sensitive photodetector

Sensing and imaging in the short-wave infrared is used in such different areas as automotive vision systems for driver safety, food and pharmaceutical inspection, civil and military surveillance, night vision applications and environmental monitoring. The market is currently only limited by the high cost associated with the existing technology.

Frank Koppens' and Gerasimos Konstantatos' Proof of Concept project aims to develop a new type of cheap and extremely sensitive photodetector platform based on graphene and colloidal quantum dots. Graphene is a novel, Nobel Prize winning two-dimensional material with a wide palette of unique properties, including extremely high electronic conductivity. Colloidal quantum dots offer high absorption and bandgap tunability from ultraviolet to short-wavelength infrared. Combined, these two materials form a hybrid photosensitive system with high sensitivity and high gain, which can be integrated on thin, transparent, and flexible substrates – thereby strongly reducing its production costs.

Manipulation of single strands of DNA

The team of Gijs Wuite at LaserlaB Amsterdam has pioneered an experimental technique in which a single molecule of DNA can be manipulated and stretched while individual proteins interacting on it can be filmed in real-time under physiological conditions. For this purpose, a combination of microfluidics, optical tweezers (where micrometre-sized beads are captured and moved by laser beams) and fluorescence microscopy are combined in a single apparatus. The technique allows researchers to study the interaction of proteins with DNA in detail, which can help us increase our understanding of the genetic basis of diseases.

With the Proof of Concept grant, the team will establish a venture to market the apparatus and know-how. In this project, market research, intellectual property, possible establishment of a spin-off company and development of prototypes for launching customers will be investigated. Andrea Candelli, who recently obtained his PhD in this area of research, will take on the challenge to move the venture forward and render this technology commercially available to life scientists.

Networking Events

Laserlab users meet in Marseille

The Laserlab-Europe annual User Meeting of 2013 took place in Marseille, France on September 26 and 27. The meeting was organized by LP3 laboratory (Lasers Plasmas and Photonics Processing) and hosted by Aix-Marseille University at its beautiful administration site Palais du Pharo. The meeting was chaired by Marta Castillejo (CSIC, Spain) and Marc Sentis (LP3).

During these two very busy days, more than sixty people were present to listen to 27 scientific talks related to the main topic of the meeting: 'Using laser sources and secondary sources as diagnostic tools for science'. Of these presentations, 25 were given by Laserlab users coming from sixteen countries who had performed their research in 14 different Laserlab access facilities (CELIA, CUSBO, FORTH, HIJ-FSU, LASERIX, LaserLaB Amsterdam, LLC, LOA, LP3, LULI, PALS, SLIC, USZ and VULRC).

The various talks gave a stimulating overview of experiments in a broad range of research themes, reflecting the diversity of opportunities offered by the Laserlab access programme. Two very interesting and enlightening invited talks were given by John Tisch (Imperial College, UK) and Klaus Sokolowski-Tinten (University of Duisburg-Essen, Germany) on attosecond science and ultrafast X-ray sources to probe solids, respectively.

A lively round table discussion between users, facility operators and members of the Laserlab Access Board was organized by Laserlab User Representatives in order to collect feedback from users and to improve and enlarge access to the different facilities.

Besides these scientific exchanges, social events were organized around the wonderful old harbor of Marseille taking advantage of Marseille being the European Capital of Culture 2013. Thus, participants could visit the new museum MuCeM and share some typical Provençal cuisine. In addition, a visit of the LP3 laser facilities provided an opportunity for users to discover the new and unique ASUR Platform (10 TW, 25 fs, 100 Hz).

Marc Sentis

User meet in Marseille.

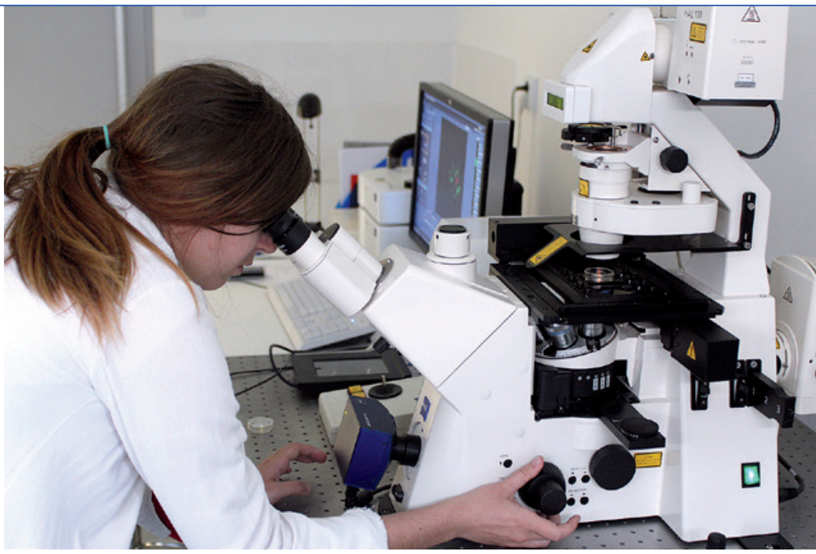


Photo: courtesy of W. Kautek

Practical training at the biophotonics workshop.

User Training Workshop on Biophotonics, Košice

In the last two weeks of June 2013, a User Training Workshop was held in Košice, Slovakia. The workshop, organized at the Pavol Jozef Sfarik University in Košice in collaboration with Laserlab-Europe partner ILC (Bratislava, Slovakia) and Université P. et M. Curie (UPMC, Paris), served to improve the theoretical and practical knowledge of doctoral students in advanced methods of biophotonics.

The two-week course provided students with a set of lectures on recent advances in biophotonics research, namely optical spectroscopy, imaging and time-resolved techniques. The lectures were coherently supplemented with practical demonstrations of the respective experimental techniques. Moreover, interdisciplinary teams, each of 3-4 students, were formed which had to select and develop their own individual projects, related to the focus of the school. The projects were publicly defended and evaluated during the last day of the school and prizes were awarded during the closing ceremony for the best student contributions.

The school of biophotonics was attended by eighteen PhD students and young researchers from five countries, and the lectures and practical trainings were imparted by fourteen internationally recognised experts in the field of biophotonics. Invited foreign speakers included Jürgen Popp (IPHT Jena), Marco Capitanio (LENS), Lorand Kelemen (BRC Szeged), Santiago Sanchez Cortes (IEM Madrid), Franck Sureau (UPMC Paris), and Wolfgang Becker (Becker-Hickl GmbH Berlin).

Information on Laserlab-Europe and the opportunities offered by the project was provided in the form of a 45 minute lecture given by Alzbeta Chorvatova from ILC, while opportunities for access to the Laserlab facilities and for user training events were advertised throughout the whole school. The students also benefited from dedicated lectures on safety and good laboratory practice as well as on ethical issues in biophotonics.

Finally, with the aim to evaluate feedback from the participants, a user training questionnaire was distributed and analysed. In summary, the school of biophotonics in Kosice was highly appreciated by all participants, students as well as lecturers. The student teams presented high-quality research that we believe can lead in future to new collaborative proposals for the Laserlab-Europe access programme.

Dusan Chorvat and Pavol Miskovsky

Access Highlight: Slicing Microlenses by Nonlinear Imaging Microscopy

A novel method for microlens characterization and 3D imaging has been investigated in collaboration between Laserlab-Europe partner IESL-FORTH (Institute of Electronic Structure and Lasers, Heraklion, Greece) and the Photonics Center of the Institute of Physics, University of Belgrade (Serbia), granted through the Transnational Access Programme of Laserlab. In this Access project, nonlinear imaging microscopy was used to 'slice' the lenses at different depths, and with the obtained data 3D images of the microlenses were reconstructed. In addition, important characteristics of microlenses – such as surface profile, diameter, volume, and in-depth changes – could be determined.

In our joint research project, we used microlenses manufactured in a novel material and with a well-examined technology developed in recent years at the Photonics Center of the Institute of Physics in Belgrade [1]. On the sunny island of Crete, not very far away from Belgrade, our colleagues at IESL-FORTH developed a prototype experimental setup for nonlinear microscopy [2]. The main property of this method is that it allows micro-objects to be sliced, in an optical manner, at very thin and closely separated layers. Subsequently, the object can be reconstructed in three dimensions using the obtained slices. The microlenses were taken to the laboratory for nonlinear microscopy in Crete in order to show that this advanced non-destructive technique is suitable for microlens characterization.

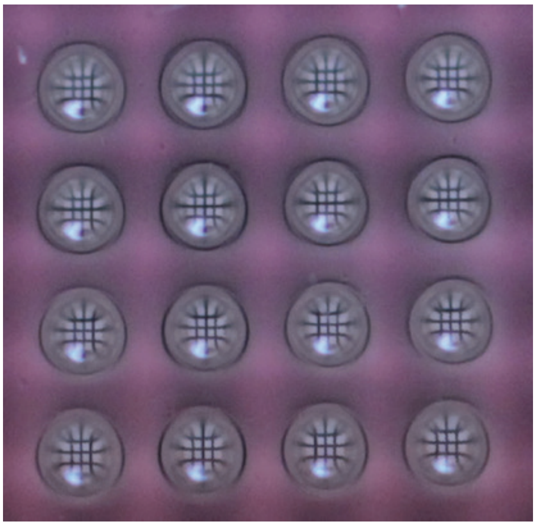


Figure 1: An image of a regular square grid observed through the microlens array. This figure was used for the cover page of J. Phys. D: Appl. Phys. 46, issue 19 (2013).

The collaboration of the two groups dates back to 2008, to a Laserlab User Meeting held in Herssonissos, Crete, where the undersigned went upon invitation by Prof. Costas Fotakis, then director of IESL, and nowadays director of FORTH. One year later, he spent four months in the laboratory for nonlinear microscopy as a Marie Curie fellow, working as an experienced researcher with George Filippidis and George Tserevelakis [3]. The materials and methods for microlens manufacturing were already well established in Belgrade by Branka Murić and Dejan Pantelić, but some novel diagnostic tool was needed in addition to standard ones like electron microscopy and profilometry. Nonlinear microscopy seemed a good candidate, and an application for Laserlab-funded access to IESL was submitted. The results were encouraging. We established another good method for microlens characterization and the number of applications where nonlinear microscopy can be utilized was significantly extended [4].

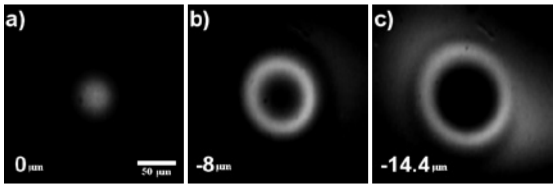


Figure 2: Three THG slice images of a microlens taken at different depths (denoted at the bottom left corner of each picture).

Today, microlenses are used in various high-tech applications and they are rapidly developing. For most applications it is very important to know the exact properties of the microlenses (surface profile, diameter) and to understand the (photo)chemical and physical changes in the material during microlens formation. The microlenses used in our joint research are made by direct laser writing in Tot'hema Eosin Sensitized Gelatin (TESG) layers. Tot'hema is a trade name of a drinkable solution used in medicine for treatment of anemia, while eosin is an organic dye also used in medicine. The resulting material is cheap, easy to use, and biocompatible. Because of the very strong absorption of eosin in the green region, a frequency-doubled CW Nd-YAG laser at 532nm was used for the writing of microlenses. Using precise mechanical stages, we were able to make very fine arrays of microlenses.

Nonlinear microscopy is a scanning technique which utilizes ultra-short laser pulses (1028 nm, 200fs in our case) to induce nonlinear effects, such as Second Harmonic Generation (SHG), Third Harmonic Generation (THG) and Two/Three Photon Excitation Fluorescence (TPEF/3PEF), in the focus of a laser beam inside the volume or at the surface of the micro-object. Whenever any of these nonlinear effects are present, they are detected – usually by photomultiplier – and the signal is recorded by a computer. Scanning the laser beam spot by spot, an image in the focal plane is obtained, which is simply called 'slice' in microscopic terminology. Moving the focal plane up or down through the sample, slices at arbitrary separation can be obtained and used for 3D reconstruction of the sample.

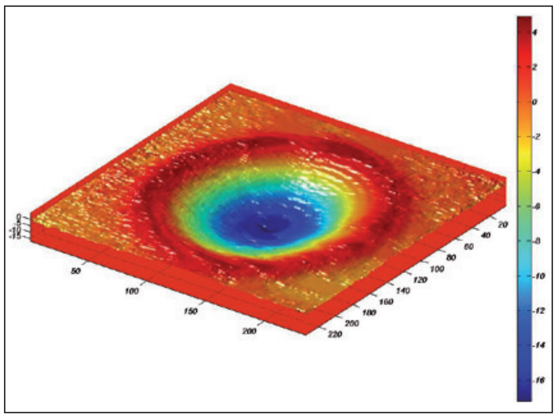


Figure 3: 3D-rendered reconstruction of a microlens obtained with THG microscopy. All dimensions are in micrometres.

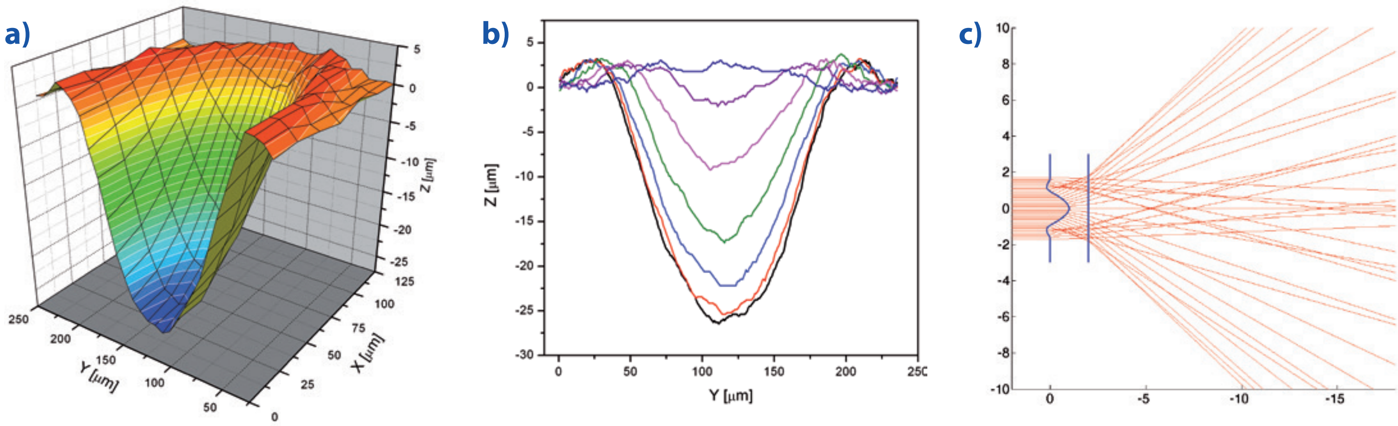


Figure 4: Cross-sectional view of the microlens from Figure 3. a) 3D and b) individual axial cross sections extracted from the 3D reconstruction. The distance between two adjacent cross sections is 25.5 µm. c) Ray tracing analysis performed with the obtained analytical shape (triple Gaussian) of the microlens profile. The distances are given in arbitrary units.

The nonlinear effects detected in this microscopic technique give us different, complementary information about the sample structure in the focal volume. The SHG is produced only in non-centrosymmetric structures and it is not of importance for our story since the material used for microlenses is isotropic. The THG process is highly efficient at the optical interfaces, where the abrupt change of refractive index exists. As a consequence, the signal at the photo detector is maximized whenever the focused laser beam is positioned at the interface of microlens material during the scanning process. Otherwise (if the focal point is inside or outside of the material), the THG process is very weak and there is no signal from the detector. Thus, scanning the laser beam and detecting the THG signal, one is able to reconstruct the 3D profile of the sample surface.

From the 3D model of a microlens it is possible to extract a lot of other quantitative data, such as axial and radial profiles, the volume of the microlens, ray tracing, etc. All of these data are important for microlens design and improvement. Apart from a single microlens, we also performed 3D imaging of a microlens array.

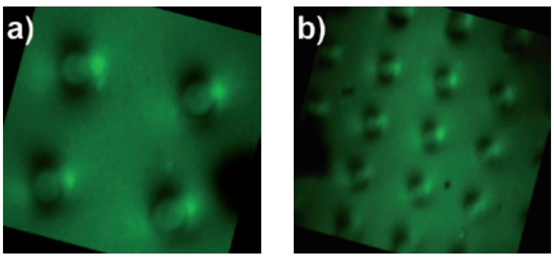


Figure 5: 3D reconstruction of a a) 2x2 and b) 4x4 microlens array, performed using the THG signal.

There is not a single ideal method for microlens characterization. All methods have both advantages and drawbacks and provide different and complementary information about the microlenses. However, only a few methods deal with changes of bulk material during the fabrication process of microlenses. Using nonlinear imaging microscopy, it is possible to obtain subsurface (volume) changes of a microlens by detecting TPEF signals arising mostly due to eosin. Mechanical and photochemical changes and vertical walls (which are not detectable by THG) are clearly visible in 3D models made after TPEF signal recording.

We performed 3D imaging of microlenses by the two modalities, THG and TPEF, of nonlinear microscopy using ultra short (femtosecond) laser pulses. Imaging the surface of microlenses by THG microscopy is a straightforward, rather simple, process that does not require any complicated algorithms for reconstruction of the surface shape from the signal. The proposed method allows 3D imaging of microlenses made from arbitrary materials, since THG is not sensitive to material variations. Whereas the THG signal allows the morphology to be determined, (photo)chemical changes, created during the process of microlenses manufacturing, give rise to TPEF signals. After imaging the microlenses by the two modalities of nonlinear microscopy, we used the data for obtaining other properties, such as the profile at arbitrary cross section, diameter, volume, focal length, astigmatism, etc.

Our results prove that nonlinear imaging microscopy is a powerful diagnostic tool for microlens characterization, since it enables in-depth investigation of the structural properties of the samples in a non-destructive manner. Moreover, the method and experimental set up used in this work are universal, versatile, and widely used, not only for microlens inspection but in a broad range of biophysical and material science problems.

To our knowledge, this is the first time that any researcher from Serbia has used the possibilities offered by Laserlab in order to improve and reinforce their research. The joint research project granted by Laserlab has enabled the symbiosis of the scientific experience and laser infrastructure from both institutions, which has led to high-quality results and publications.

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References

[1] B. Murić et al., *Opt. Materials* **30** 2008

[2] G. Filippidis et al., *J. Phys. D* **38** 2005

[3] G. Tserervelakis et al., *Micron* **41** 2010

[4] A. Krmpot et al., *J. Phys. D* **46** 2013

Much progress for HiPER

There have been extremely positive developments of importance to the European High Power laser Energy Research facility (HiPER) since the last issue of this newsletter.

Review of the ESFRI project portfolio

ESFRI has conducted a review of all projects on the Roadmap to ensure that progress to date and future plans are consistent with the ESFRI objectives. With over 100 refereed publications in the scientific literature arising from the Preparatory Phase of HiPER, technology development in many fields including lasers, materials studies and target fabrication, and the establishment of doctoral and post-doctoral training networks and a high profile COST action, HiPER is hoping for a very favourable outcome.

Launch of UK IFE Network

A network to assess UK capabilities in inertial fusion energy (IFE) has been established with funding from the Engineering and Physical Sciences Research Council. The network, led by Prof. Roland Smith of Imperial College, will conduct a number of meetings and workshops over the next two years to identify areas in which UK could contribute to any future major programme of research and technology development in IFE. John Collier and Chris Edwards are co-investigators of the network, which will ensure that HiPER takes full advantage of the initiative. Prof. Dimitri Batani, HiPER work package manager for fusion experiments, was among the speakers at the kick-off meeting held at the Royal Society in London on November 26th.

Scientific breakeven demonstration at NIF

'Scientific Breakeven' at the National Ignition Facility (NIF) was achieved at the end of September using a new design of target which gives improved hydrodynamic stability during the compression phase. Though HiPER is following 'direct drive', high gain routes to ignition, rather than the indirect drive approach of NIF, success at NIF will play an important role in securing funding for laser fusion in general and for HiPER in particular.

Visit the HiPER website at www.hiper.org for more information and the latest HiPER Project news or send an e-mail to Chris Edwards (chris.edwards@stfc.ac.uk)

Blueprints become reality!

In 2013, the Extreme Light Infrastructure (ELI) has set up huge construction sites for its buildings, procured some of the world's most advanced laser systems from international suppliers, and founded the ELI-DC International Association for coordination of the three sites and preparation of operation after 2017.

Construction activities with volumes of around 50M€ each were launched in both the Czech Republic and Romania at the end of spring. The visits of the European Commissioner for Research, Innovation and Science Máire Geoghegan-Quinn to the ELI Beamlines and ELI Nuclear Physics sites in October and November were the opportunity to celebrate these important milestones. In Hungary, ELI-ALPS is following the same track: it is currently completing the selection of its general contractor and will soon start pouring concrete.

On the technological front, two major contracts for the procurement of world-leading laser systems were passed: with Thalès Optronique for the supply of ELI-NP's high-power laser system (2 x 10 PW), and with Lawrence Livermore National Security (LLNS) for the supply of ELI Beamlines' L3 laser (10Hz, ultra-short-pulse, multi-PW diode-pumped laser). Procurement of major technological equipment will continue in the coming months at the three sites.

The local implementation teams have expanded substantially. A total of more than 275 people are currently involved in the three teams (200 in the Czech Republic, 50 in Romania, and 25 in Hungary). Among them should be mentioned in particular the newly appointed scientific directors of ELI-ALPS, Dimitris Charalambidis, and ELI-NP, Sydney Gales.

In April 2013 the *ELI Delivery Consortium International Association* (AISBL) was founded. It will support and coordinate the implementation of the present three ELI pillars, ensure ELI's character as unified pan-European infrastructure, and pave the way towards the future ELI-ERIC consortium, which will govern, operate and finance ELI after 2017. Wolfgang Sandner, Director General of the ELI-DC International Association and former Laserlab-Europe Coordinator, looks forward to welcoming representatives from many Laserlab-Europe countries also within this new organisation.

For more information, please contact Florian Gliksohn (florian-gliksohn@eli-laser.eu) or Wolfgang Sandner (wolfgang.sandner@eli-laser.eu).

Forthcoming events

Joint JRA Meeting
31 March – 1 April 2014, Warsaw, Poland

Laserlab Training School 'Laser Applications in Spectroscopy, Industry and Medicine'
7 – 11 April 2014, Riga, Latvia

Annual meeting NAUUL – 'Target interaction challenges and developments'
28 – 29 April 2014, Abingdon, UK

Laserlab Workshop 'Lasers for Life'
2 – 4 June 2014, London, UK

5th Target Fabrication Workshop
6 – 11 July 2014, St Andrews, Scotland

To find out more about conferences and events, visit the Laserlab online conference calendar.

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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