Newsletter
September 2013
Issue 6

# LA³NET Brochure released !

**I am delighted to announce the official release of the LA³NET brochure.** On 28 pages this glossy publication summarizes the work done by our Fellows, presents their individual backgrounds, gives details about the project's broad research and training programme and also presents all partner institutions. It was realized in close collaboration between all project partners and I believe it will be an excellent way to showcase our Fellows and their research. The brochure will be distributed at relevant conferences and workshops, but can also be obtained from us – *simply send us a short email*.

**LA³NET goes international.** The consortium has presented first research results at the Free Electron Laser (FEL) conference in New York City, USA and the International Beam Instrumentation Conference in Oxford, UK. At the latter, we had a dedicated stand where we presented our Fellows' research results, announced upcoming events and distributed – for the first time – our brochure to the wider community. We had interesting discussions at both events and several additional institutions are now considering joining the LA³NET initiative.

The second **LA³NET prize** was awarded to Volker Sonnenschein, a final year PhD student at the University of Jyväskylä, Finland, working within the IGISOL-LASER group. In the course of his PhD studies he has made a number of outstanding contributions in the continual development of solid state laser technology which is currently in use at a number of Radioactive Beam Facilities (RIB) worldwide including JYFL, ISOLDE (CERN), GANIL (France), TRIUMF (Canada), Oak Ridge (USA) and in the future at RIKEN (Japan). *Congratulations – well deserved !*

Finally, there are only a few days left until registration for our **laser and optics design workshop** at the Fraunhofer Institute for Laser Technology in Aachen, Germany closes. During the three days, we will cover general optics design, provide an overview of different laser sources and discuss methods to characterize beams in detail. Participants will be able to choose from a range of topical areas that go deeper in more specific aspects including tuneable lasers, design of transfer lines, noise sources and their elimination and non-linear optics effects. *I hope to see you there !*


Prof. Carsten P. Welsch, Coordinator

## Special Interest Articles

- Fellow Activity
- Partner News
- Upcoming LA³NET Events

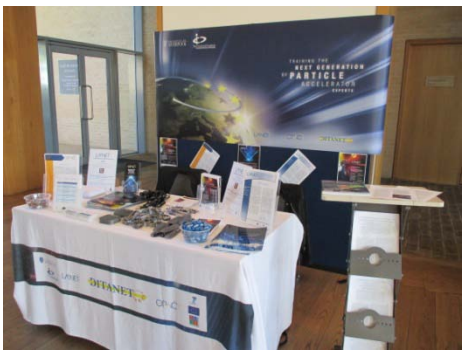
## Individual Highlights

- LA³NET Prize Winner 2013
- LA³NET at IBIC13

## Major LA³NET presence at IBIC 2013 16th - 19th September 2013

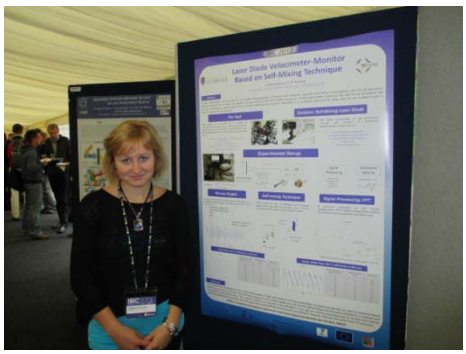
IBIC 2013
International Beam Instrumentation Conference

**To complement LA³NET research posters presented at the International Beam Instrumentation Conference (IBIC13) in Oxford in the UK, Rob Ashworth and Helen Williams promoted the project with an industry stand.**



The LA³NET brochure was officially launched, research results from the LA³NET network were disseminated and future network events were advertised along with the LA³NET Researcher Prize which has a growing reputation. In addition, the project as a whole was publicised in order to attract new adjunct partners to join and to nurture new relations with organisations from industry and academia.

Prof. Carsten Welsch presented a poster summarising the initial LA³NET research results in beam diagnostics. This included the work of Andrii Borysenko at KIT on electron bunch shape detection described previously and the research of Mateusz Tyrk at the University of Dundee on an electro-optic bunch temporal profile monitor (see below under 'Fellow activity'). Alexandra Alexandrova from the University of Liverpool also contributed a poster entitled 'Laser Diode Velocimeter-Monitor Based on Self-Mixing Technique'.



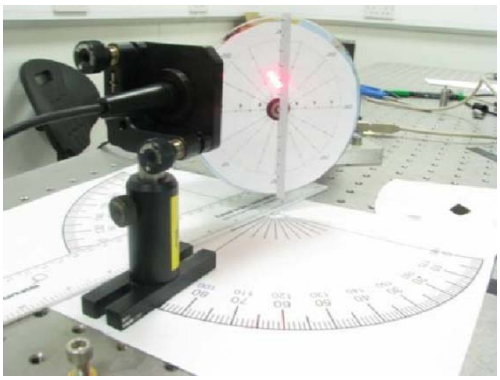

## Laser Velocimeter

**Gas jets have been successfully exploited for beam instrumentation purposes and are, amongst others, a promising way for online monitoring of the 2-dimensional transverse beam profile** [1]. For such a monitor, it would be highly desirable to have a compact sensor able to record the jet velocity and density profile in order to understand its dynamics in detail. It should be possible to integrate such a monitor in a simple way in an existing set-up to provide accurate information about the velocity and density of the gas jet. The sensor would ideally consist of comparably cheap components.

A promising option is a velocimeter based on laser self-mixing (SM) which is currently being developed by A. Alexandrova in the QUASAR Group based at the Cockcroft Institute/University of Liverpool, UK.

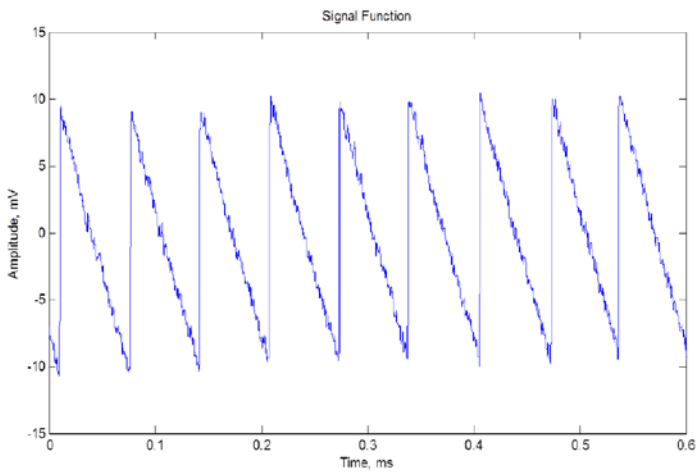
*[1] M. Putignano et al., "A fast, low perturbation ionization beam profile monitor based on a gas-jet curtain for the ultra low energy storage ring", Hyperfine Interactions 194.1-3 (2009) 189.*

SM is used to characterize some properties of a moving object by using both laser light and the cavity where the laser originates from. It is based on the following principle: laser light is scattered or reflected from a moving target and returned into the laser cavity. The laser plays the rule of a coherent heterodyne receiver and at the same time the amplifier of the signal. The initial radiation interacts with the scattered or reflected radiation and produces a signal in both the power and frequency spectrum of the laser. It is a system without a complex optical system, based on an in-expensive and compact diode laser which can be easily installed and used to provide central information about the target. This includes target velocity, distances of movement, property of the surface (for solid target), density and property of scattered molecules (for liquids and/or gases). SM can be used with any kind of laser as long as the properties of the laser are correctly taken into account in the equations for the electric field and carrier density. In the case of a supersonic gas jet, a laser diode (LD) is going to be used. Such system can be compact, easily integrated into an existing set-up and is very cheap, thereby fulfilling all central requirements on such detector.



Rotating disc target arrangement, image courtesy of A. Alexandrova

In first experiments the main goal was to investigate ways to receive the right type of signal and how to improve its quality and amplitude. It was found that in order to receive a proper signal many different variables need to be optimized, such as distance to the target, noise in the diode, noise in the amplifier and collimation. In the regime of weak feedback a neat phase transition and a linear decay following it should be achieved. As a result of the optimization, the measured SM signal became very close to the theoretically expected one, see figure below.




Example signal received from self-mixing with a mirror as target. Image courtesy A. Alexandrova

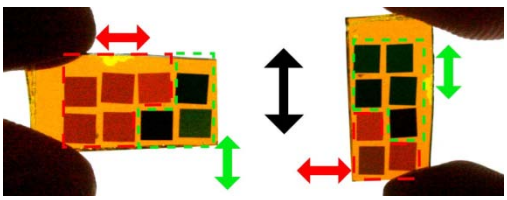
# Fellow Activity

## Publication and Presentation from Mateusz Tyrk

**Mateusz Tyrk from the University of Dundee has been reaping the rewards from his research publishing an article with other colleagues on 'Picosecond pulsed laser induced optical dichroism in glass with embedded metallic nanoparticles'** [2]. The article describes how picosecond (~10 ps) pulsed laser irradiation at 532 nm led to the efficient and scalable fabrication of dichroic areas in glass with spherical silver nanoparticles of ~30 – 40 nm in diameter embedded in a surface layer of thickness ~20 µm. The observed dichroism is due to the uniform and permanent shape transformation of the nanoparticles - from spherical to spheroidal shapes - throughout the irradiated areas and along the laser polarization direction, paving the way for new metamaterials that are going to be used in future electron bunch profile monitors and affordable manufacture of polarization-selective diffractive optical elements. The shape modification threshold and the dichroism as a result of Surface Plasmon Resonance band separation were identified.

The process was then studied as a function of the laser polarization, repetition rate and the number of pulses fired per spot. Previously, and in order to achieve an optimum dichroism via fs pulsed laser irradiation of the nanocomposites in ambient temperature, a laser repetition rate of 10 kHz was suggested. This hindered the operation where high processing speeds are required. The experimentally applied values presented in his paper can be tailored depending on the requirements. This might eventually lead to an industrially affordable fabrication of new optical elements such as wavelength- and polarization-selective diffraction gratings based on glasses containing metallic nanoparticles.

Mateusz has also presented his findings in a talk on the reshaping of silver nanoparticles in glass at CLEO/Europe - IOEC 2013 (Conference on Lasers and Electro-Optics - International Quantum Electronics Conference) held in Munich in May.



Images of the 5 × 5 mm squares irradiated at laser fluence of 88 mJ/cm2 at 200 kHz. Number of pulses per spot in the irradiation areas on the left hand side are (from left to right): 500, 300, 100, 200 (top row) and 400, 200, 100, 100 (bottom row). The right hand side image shows the same as the one on the left but flipped 90° clockwise. The black arrow represents the polarization of the light penetrating the samples from the back of the image (perpendicular to the paper). The red arrow represents the polarization direction of the laser beam for irradiation of the areas grouped within the red dash-lines. The green arrow represents the polarization direction of the laser beam for irradiation of the areas grouped within the green dash-lines. The dichroic effect is easily observable, with higher extinction for the nanoparticles elongated along the polarization direction of the penetrating light.

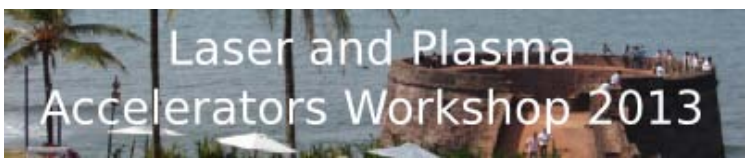
*[2] M. Tyrk et al., "Picosecond pulsed laser induced optical dichroism in glass with embedded metallic nanoparticles', Optics Express, Vol. 21, Issue 19, pp. 21823-21828 (2013).*

## Partners RHUL host secondment for Thomas Hofmann

**In July LA$^3$NET Fellow Thomas Hofmann spent two weeks away from CERN at Royal Holloway University of London (RHUL) working on laser optics design.** RHUL and CERN are engaged in various collaborations including Thomas's project on the development of a laser emittance meter. RHUL is strongly involved in the laser scanner subsystem of his project comprising a laserhead, delivery optics to beam pipe and focussing and scanning optics. The work at RHUL centred on optimisation of the laser optics to couple the laser beam into a transport fibre. Furthermore, measurements were taken of the beam parameters (M-square) of the beam when focussed into the beampipe.

## Jurjen Couperus at LPAW 2013

Jurjen Couperus from HZDR presented a poster on 'Characterisation of gas-jet targets for laser-plasma acceleration' at the Laser and Plasma Accelerator Workshop (LPAW) in Goa, India earlier in September.




## Fellow Representative Election

**The annual election of a representative for the Fellows to act as mouthpiece on the project steering committee is underway.**

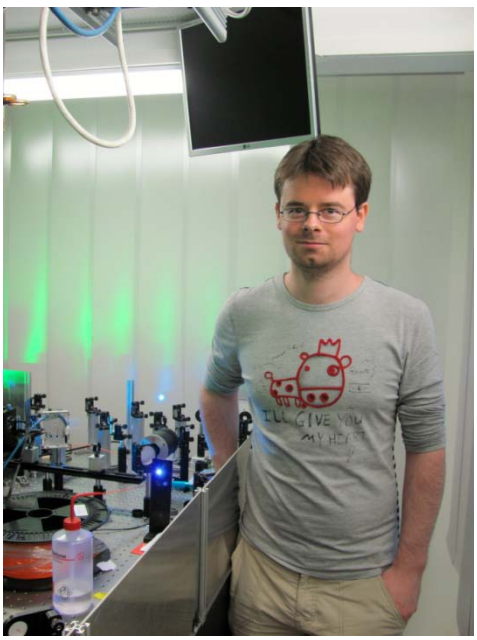
Andrii Borysenko did an excellent job in the first year including the delivery of a fine speech at the mid-term review which must have contributed to the glowing report we received from the EC.
Now he is re-standing with Luca Stockhausen and Jurjen Couperus contesting the position to bring in new blood. At the moment it is neck and neck in the voting.

Andrii Borysenko

## LA³NET Researcher Prize 2013

**The 2013 LA³NET Researcher Prize attracted a number of quality applicants from across the globe**. The winner of the €1,000 prize for the researcher judged to have made an important contribution to the field of laser application at accelerator facilities was **Volker Sonnenschein.**

Volker is currently a final year PhD student at the University of Jyväskylä, Finland, working within the IGISOL group. Responsibilities cover the operation and maintenance of the Ti:sapphire laser system used for the selective and efficient production of radioactive ion beams (RIB) and future high-resolution spectroscopy of exotic nuclei, investigation of new laser ionization schemes, programming of data acquisition and laser control systems, development of new laser technologies, laser spectroscopy and data analysis as well as communication with other groups and participation in collaborative efforts.



His work is based on intra-cavity second harmonic generation (IC-SHG) and the development and application of narrowband Ti:sapphire and injection-locked Ti:sapphire lasers. During his PhD he has made a number of outstanding contributions in the continual development of solid state laser technology which is currently in use at a number of Radioactive Beam Facilities (RIB) worldwide including JYFL, ISOLDE (CERN), GANIL (France), TRIUMF (Canada), Oak Ridge (USA) and in the future at RIKEN (Japan). He has also supported technology transfer activities travelling to share his experience with other groups, among them GANIL, Mainz, RIKEN and Leuven.

One of the most important goals in the field of RIB production is the need for high efficiency and high selectivity and Volker has worked on recent developments to perform laser spectroscopy in the ion source as well as in supersonic atomic jets. His development of a pulsed injection locked Ti:sapphire laser will advance the ability to extract fundamental nuclear structure properties of the most exotic elements available via the sensitive measurement of parts-per-million perturbations on the atomic level structure. This will be the challenge for many facilities in the future. Additionally he has dramatically improved the performance of second, third and fourth harmonic generation through techniques of intracavity frequency doubling. This will allow the range of elements available via resonant laser ionization to be expanded.

**The competition is open to all researchers both from within or outside of the network who are in the first five years of their research careers (after achieving the qualification that would enable them to register for a PhD). The deadline for the 2014 prize is 30th June 2014.**

Further Information:
www.liv.ac.uk/la3net/la3net_prize/

## Partner News

### CLPU Spread the Word at Iberoamerican Event

**During the summer, CLPU were funded through Laserlab Europe III to have a stand in the Expo space of the VIII Iberoamerican Conference on Optics and XI Latin-American meeting on Optics, Lasers and Applications (RIAO OPTILAS 2013) held at the University of Porto, Portugal.**


This event is the major scientific meeting in Optics and Photonics for Latin America recognizing the importance of the Iberoamerican contribution to the development of Optics and Photonics at a global level. It is a forum for discussion and the sharing of ideas and experiences in all fields of optics and for establishing cooperation among Iberoamerican institutions and researchers from all over the World. In addition, ETOP2013, the conference on Education and Training on Optics and Photonics, was run in conjunction with RIAO/OPTILAS2013.

The combined event comprising RIAO/OPTILAS2013, ETOP2013 and the Optics and Photonics exhibition ran from the 22nd to 26th July attracting around 200 participants. It was the ideal platform to promote the activities of CLPU including participation in LA$^3$NET. Publicity material was eagerly received and supplies of the LA$^3$NET brochure were exhausted.

### LA$^3$NET Network Swells to 32 Partners

**The University of Strathclyde Glasgow in the UK has joined LA$^3$NET as an adjunct partner.** The University has the third largest number of students of the Scottish universities and was awarded UK University of the Year 2012/13 by the Times Higher Education. Strathclyde is also to be the base for the Centre for Applied Photonics in collaboration with the Fraunhofer Gesellschaft, Europe's largest organisation for contract research.

The Strathclyde Intense Laser Interaction Studies (SILIS) group within the University conducts both experimental and theoretical research into high-power laser-plasma interactions. The group hosts the ALPHA-X facility, a 10 Hz, 40 TW, 30 fs Ti:Sa laser system, which is used for studies of electron acceleration, X-ray production, and their applications, and the TOPS facility , a 1 kHz, 3 mJ, 30 fs, Ti:sapphire laser. A new £8m, 1200 m$^2$ facility (SCAPA) is currently being developed, funded by the University and the Scottish Universities Physics Alliance (SUPA), which will host a 5 Hz, 200 TW, 30 fs, Ti:sapphire laser. Group members are also frequent users of high power laser facilities at the UK's Central Laser Facility, within the Laserlab-Europe consortium and further afield.

The SILIS group is internationally recognised as a leading group in the development and application of high power laser-driven particle accelerators, including both electron acceleration driven by plasma waves and ion acceleration driven by strong electric fields in dense plasma. The group also has active programmes of research on the development of plasma-based amplification schemes and in short-pulse radiation sources, including betatron radiation and strong field-based gamma ray sources. Other internationally recognised research programmes include the generation and transport of high current beams of relativistic electrons in dense plasma (relevant to inertial fusion) and laser-driven nuclear physics.

## Developments on Recruitment in the Network

**Following the suggestion from the Project Officer at the mid-term review to look at alternative ways to ensure all the technical project commitments were achieved the surplus funding from certain delays in recruitment was earmarked to cover the recruitment of a new Fellow.** The Project Officer from the European Commission confirmed that we can go ahead and redistribute this to fund an alternative project in line with the original technical annex of the Grant Agreement.

In the brief time available a number of suggestions for an additional Fellow were received from different partners and following a review by independent steering committee members it was decided that the proposal from GANIL was most aligned to the project objectives. Consequently, **an additional two year project will be funded at GANIL for a Fellow to be recruited on a 'Study of resonant laser ionization in the REGLIS low energy branch of the S3 spectrometer at SPIRAL2-GANIL.'**

## New LA³NET Project at GANIL

**The REGLIS (Rare Elements in-Gas Laser Ion Source and Spectroscopy) device will be installed at the Equipex project S3 (Super Separator Spectrometer), currently under construction as part of the SPIRAL2 facility at the GANIL (Grand Accélérateur National d'Ions Lourds) laboratory in Caen, France**. REGLIS will be a source for the production of new and pure radioactive ion beams at low energy as well as a spectroscopic tool to measure nuclear hyperfine interactions. It consists of a gas cell in which the heavy ion beam coming from the S3 spectrometer will be stopped and neutralized, coupled to a laser system that assures a selective re-ionization of the atoms of interest. Owing to the unique combination of such device with radioactive heavy ion beams from S3, a new area of unknown isotopes at unusual isospin will become accessible. This device has been very recently selected by the French National Agency for the funding of the gas cell set up and will benefit from the international expertise of the group from KU Leuven, who obtained an ERC grant for their contribution to the project. REGLIS will provide the Equipex project S3 with a unique tool and will become a world leading facility in laser spectroscopy.

The purpose of the early stage position is to study the possibility to integrate an existing all solid state Titanium:Sapphire laser system in the REGLIS set up and to improve and develop the laser system in order to fulfil the requirements for the spectroscopic studies at REGLIS. The solid state laser system used is developed in collaboration with the University of Mainz (Germany), the TRIUMF laboratory (Canada) and the ISOLDE group in the CERN facility.

**The trainee will design, build and test a tracking system for the scan of frequency doubled light by synchronizing a remote controlled grating laser with a motorized SHG crystal. The feasibility of using difference frequency generation to extend the range of the existing Titanium:Sapphire cavities will also be investigate**. This is very challenging but would considerably increase the possibilities of such a set-up. The trainee will also work off-line to develop and evaluate ionization schemes for elements requested at the low energy branch of S3.

This project takes place within a large international collaboration (KU Leuven, Mainz University, TRIUMF laboratory, ISOLDE at CERN) and the trainee will have the opportunity to contribute to scientific experiments in these laboratories and also to benefit from the expertise of the partners in LA³NET.

## ESR15 recruited for STFC project

The post hosted by STFC in the UK for the project on **Ultrafast lasers for accelerator timing** has now been filled. The post is based at STFC Daresbury National Laboratory and the project will be carried out in collaboration with the University of Manchester Photon Science Institute in the UK. The final hurdle now is the approval of visa for the successful candidate currently at CERN, Rui Pan.

**Welcome to the network !**

## Future LA$^3$NET EVENTS

**The LA$^3$NET events calendar is filling up with the 2$^{nd}$ Topical Workshop on Laser Technology and Optics Design arranged for the 4$^{th}$ to 6$^{th}$ November 2013 at the Fraunhofer ILT in Aachen, Germany and the 3$^{rd}$ Topical Workshop on Acceleration Techniques to be held at HZDR in Dresden, Germany between the 28$^{th}$ and 30$^{th}$ April 2014.**

In addition, the 3$^{rd}$ School on Advanced Laser Applications has been set for 22$^{nd}$ to 26$^{th}$ September 2014 with local organisers CLPU using Salamanca University as the venue.

The final LA$^3$NET International conference is yet to be arranged but a final symposium on Accelerators for Science and Society has been fixed. This will be run in conjunction with the oPAC project as a joint outreach event to be held in Liverpool, UK on the 26$^{th}$ June 2015.

**ENLIST NOW FOR WORKSHOP ON LASER TECHNOLOGY AND OPTICS DESIGN BEFORE REGISTRATION CLOSES.**

*Conference venue for 3rd LA$^3$NET School on Advanced Laser Applications at Accelerators: Hospedería Fonseca, Salamanca, Spain*

## Last Chance to Register for the LA³NET Topical Workshop on Laser Technology and Optics Design

**The registration deadline for the 2nd Topical Workshop is imminent. The workshop will address the key aspects of optics design relevant for particle accelerators.** It will cover general optics design, provide an overview of different laser sources and discuss methods to characterize beams in details. Participants will be able to choose from a range of topical areas that go deeper in more specific aspects including tuneable lasers, design of transfer lines, noise sources and their elimination and non-linear optics effects.

The workshop will be held at the Fraunhofer ILT in Aachen, Germany from the 4th to 6th November 2013 and is open for external delegates. The workshop will be free of charge but participants will need to contribute €350 towards the cost of accommodation and the meals provided. For further details and to register see

liv.ac.uk/la3net/.../2nd_topical_workshop/

## 3rd LA³NET Topical Workshop on Acceleration Techniques

**The Acceleration Techniques workshop will be held at HZDR in Dresden, Germany from the 28th to 30th April 2014.** The workshop will involve talks from key players in the field as invited speakers from organisations including CLPU, HZDR and the University of Liverpool as well as organisations from outside of the network including support from the EUCARD2 sub-programme European Network on Novel Accelerators (EuroNNAc). There will be contributions from the Fellows and other participants. There will also be a discussion forum on the state of the art and future funding requirements in this field.

## Joke Box

**I asked the boss if I could leave an hour early the other day.**

**He said, "Only if you make up the time."**

**I said, "OK, it's 45 past 30."**

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## LA³NET Events

| | |
|---|---|
| Nov 4th-6th 2013 | Laser Technology & Optics Design Topical Workshop, ILT, Germany |
| April 28th–30th 2014 | Topical Workshop on Novel Acceleration Schemes, HZDR, Germany |
| Sept 22nd-26th 2014 | School on Advanced Laser Applications at Accelerators, CLPU, Spain |

## Other Events

| | |
|---|---|
| Spring 2014 | Libera Workshop, Instrumentation Technologies, Solkan, Slovenia |
| May 8th–9th 2014 | oPAC Workshop: Beam Diagnostics, Cividec, Vienna, Austria |
| June 15th- 20th 2014 | IPAC14, Dresden, Germany |
| July 7th-11th 2014 | oPAC Accelerator School, Royal Holloway University of London, UK |
| Sept 1st–5th 2014 | Linac14, Geneva, Switzerland |

## NOTICE BOARD

Good luck to the LA³NET Fellows in their preparations for the delivery of a workshop of their choosing to be discussed at Aachen. Also, now would be a good time to deliver individual outreach activities to schools and to produce a podcast to help disseminate ideas about the science behind your project to the general public.

DEADLINE FOR THE NEXT NEWSLETTER 30th November 2013

## About LA³NET

The exploitation of Lasers for Applications at Accelerator facilities for ion beam generation, acceleration and diagnostics is the goal of this new Network within the FP7 Marie Curie Initial Training Network (ITN) scheme. In this frame, research centres, universities and industry partners from across Europe will develop beyond-state-of-the-art techniques and technologies through a joint inter-sectorial training program for early stage researchers within a unique European partnership.

LA³NET is funded by the European Commission under
Grant Agreement Number 289191