ICUIL News

N° 5

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Chief Editor: Christine Labaune

ICUIL

The International Committee on Ultra-High Intensity Lasers

Greetings

T. Tajima, Chair of ICUIL

Norman Rostoker Chair Professor – University of California at Irvine

Toshi Tajima at the 4th IZEST Conference at the French Embassy in Tokyo in November 2013 (KEK: host)

Year 2013 started with a bang to us the high intensity laser community as well. The Extreme Light Infrastructure (ELI)-Delivery Consortium (DC) International Association has been founded on April 11, 2013 and as Director General and CEO appointed as of July, 2013 was Professor Wolfgang Sandner, our former Co-Chair of ICUIL. As among the early birds of European ESFRI roadmap projects, ELI has started at 850M Euro budget and as of 2018 it is expected to be operational. ELI-Beamlines, ELI-Nuclear Physics, and ELI-ALPS (attosecond science pillar) have now already started construction and well into their way. Also in a serious launching stage is the XCELS (Extreme Center for Exawatt Laser Science) at the level of subexawatt (200PW). They have launched an impressive workshop "Laser Ascent to Subatomic and Applications" in Moscow as a step toward this realization in Russia. This aspires to be the fourth and final pillar of ELI, ELI-High Field Science. Meanwhile, Professor Peter Higgs joined the second IZEST (International Center for Zetta- Exawatt Science Technology) Conference at Strathclyde as Featured Speaker to strengthen the tie between the high energy physics community and the high intensity laser community in November 2012. Just about a year later (December, 2013) he and Professor Francois Englert have been awarded last year's Nobel Prize for Physics for their pioneering contributions on 'Higgs' bosons. Also last year Dr. Weiren Chou and Professor Mayda Velasco along with Dr. Nikolay Solyak, Professor Gerard Mourou and myself suggested a Higgs factory using the CAN (Coherent Amplification Network) laser in the Tevatron tunnel. These are just a few that signify the bang of 2013.

There has been a new initiative at SLAC (Stanford Linear Accelerator Center) to hold a first meeting "High Power Laser Workshop" on Oct. 1-2, 2013. This workshop will be repeated this year again. The workshop took place in parallel to (or in conjunction with) SSRL/LCLS Annual Users Meetings and Workshop (a synchrotron and X-ray Free Electron Laser community meeting), another sign that the high intensity laser community and accelerator community have come closer to work together. In a similar line with this, in Europe the European Network for Novel Accelerators (EuroNNAc) organized its first European Advanced Accelerator Conference (EAAC) 2013. This year in turn in US the 2014 Advanced Accelerator Conference will be hosted, counting 16th this time from the very first AAC in Malibu, CA, in 1985. ICUIL would like to salute AAC's historic, pioneering, and heroic efforts in these three decades in pushing the envelope of high field science from the advanced accelerator research perspective.

One of the major recommendations of the collaborative endeavors between ICUIL and ICFA (International Committee for Future Accelerators) in the Joint Task Force Report (in ICFA Newsletter, 2011, eds. W. Leemans, W. Chou, and M. Uesaka) stated that we need a new development of laser technology that has higher repetition rate and higher efficiency. International Coherent Amplification Network (ICAN) has produced a credible breakthrough on this and is on its way to start a development consortium this year. Representing ICUIL, on this development I (along with Professor Kuehl) reported to the ICFA General Assembly this February.

I am continuously impressed with our Asian colleagues' progress. If I am not mistaken, the current highest intensity laser is at GIST (Gwangju Institute of Science and Technology, Korea) at 1.5PW. Fast in its footsteps are Chinese initiatives such as at SIOM, IOP, Peking University, Shanghai Jiaotong University in China, with which I have had an in-person in-depth impression last September when I was invited as Einstein Professor in these institutions. Osaka University in Japan is also pursuing an exawatt initiative. The picture (see attached) was taken at the 4th IZEST Conference (hosted by KEK last November) when I was giving a talk on the report of IZEST world science activities, in which Asian colleagues play important roles.

And lastly but perhaps most importantly, India is stepping up its aspiration and camaraderie to volunteer to host the 2014 ICUIL Conference. As you see in this Newsletter written by Professor Ravi Kumar, he is hosting the ICUIL at Goa and also is mounting the Indian showcasing of the high intensity laser efforts and their liaison with wider scientific and industrial communities of India. The ICUIL community is very grateful for their effort and in turn is most interested in promoting our continued ascent of our science and technology extended to India and at the same time to broaden our reach into many other corners of the world. This year we shall mark an important step in making our inroad into the Indian subcontinent.

Greeting from the Director General of CERN

Rolf-Dieter Heuer

High-energy physics studies the fundamental particles and forces that make up and govern our universe. Large facilities like the LHC at CERN are needed to observe these tiny particles and determine their properties with higher and higher resolution. Accordingly, the last decades have shown a clear trend: every new accelerator at the energy frontier, being more power full than its predecessor, could provide a significant step forward in resolution and beam energy. The energy of the particle beams however dictates the technology, which in turn determines the size of machine and tunnel. As you know, a team of worldwide experts is already studying a next possible machine at CERN that could have a tunnel of up to 100 kilometres.

But that doesn't mean that we aren't looking around for other, better technologies that could make acceleration of particles more efficient, e.g. using plasma wake acceleration. In particular with CERN's AWAKE project we even contribute to the basic research in this field. The update of the European Strategy for Particle Physics recommends design studies for accelerator projects in a global context for high-energy-frontier machines coupled to "vigorous" accelerator R&D. That is because high gradients and high energies will remain a core challenge of particle physics, and tackling them with ingenious technologies like high-intensity and high-coherence lasers that could shorten accelerators dramatically would be a revolution in the field. Laser technology has changed our daily lives in many ways, and I am curious to see whether your studies at the forefront of technology will lead to applications that we cannot imagine right now.

Of course every R&D project has its hurdles, and the quality of the accelerated beam in terms of energy spread, intensity and some other areas remains a challenge. We know, however, that challenges can be tackled by a global network of experts, and that a laser that provides extremely coherent light also needs a coherent community. In the world of research, be it for laser, accelerators or detectors, it is very important that we bundle and coordinate our studies in a worldwide effort. It is encouraging to see so much coherence in your field – so let there be light!

Seventy-first meeting of ICFA (International Committee for Future Accelerators)

On February 20-21 2014, the regular board meeting of ICFA took place at DESY in Hamburg. ICUIL was represented by Toshiki Tajima with a SKYPE presentation, and by Thomas Kuehl, who participated in this meeting. ICFA is leading a concerted international effort to coordinate and support these world-wide activities, aiming to define the future of high-energy physics in the next twenty-to-thirty years. The agenda included reports and discussion on a number of future accelerator projects. Ideas for large scale facilities were presented which will be proposed to be installed in Japan, Europe, China and Korea. In his short Skype presentation, which was attended by all representatives, ICUIL chairman Toshiki Tajima explained the latest progress in laser technology towards an improvement of average power, as needed for a wide application of laser drivers for high energy accelerators.

The connection between the ICFA and ICUIL communities was further documented in the report of Brigitte Cros, Univ. Paris-Sud, chair of the ICFA Panel on Advanced and Novel Accelerators. Although the main line of discussions was centered on the extension of classical accelerator schemes, the importance of novel laser acceleration approaches is well recognized. It was emphasized that a next dedicated meeting on laser acceleration would be a timely step to encourage a close interplay between international developments towards novel acceleration schemes.

XCELS, the Exawatt Center for Extreme Light Studies

XCELS is a prospective project for international collaboration that was presented in ICUIL News n°4. XCELS aimed at establishing an international center for the study of extreme light fields is the only Russian mega-science project in the field of laser physics.

In the frame of the first Memoranda of collaboration in the area of extreme light between CEA, Ecole Polytechnique and IAP, and between CEA, Ecole Polytechnique and Russian National Nuclear University (MEPHI), the parties have agreed to cooperate in the following mutually beneficial areas:

- Promoting creation of XCELS, the Exawatt Center for Extreme Light Studies, a new mega-science class research infrastructure in Russia with the international vocation that is based on construction at IAP RAS of a 200 PW laser with the OPCPA (Optical Parametric Chirped Pulse Amplification) architecture.
- Promoting development of IZEST, the International Center for Zetawatt and Exawatt Science and Technology, a joint research and development project of EP and CEA that is dedicated to unite efforts of scientists and research organizations worldwide in exploration of new routes in mastering the beyond-Exawatt power level.
- Supporting collaboration between French and Russian research laboratories in the area of extreme light science, application, and technologies; promoting partnership of appropriate laboratories to form consortia capable of performing complementary research and going into international competition.

On May 16, a delegation of the Directorate-General for Research and Innovation of the European Commission met with leaders of the mega-science projects at the RF Ministry of Education and Science. The delegation was headed by Mrs. Ana Arana Antelo, the head of Unit for Research Infrastructures, and included several European experts, well-known scientists Robert Aymar, Susana Gota Goldmann, Jean Moulin, Steve Myers, Horst Stoeker. By this meeting the EC started evaluation of prospective cooperation between ESFRI and the Russian mega-science program and inclusion of some Russian projects to the European research infrastructure roadmap. The EC appointed certain experts for each project, Susana Gota Goldman (CEA) and Wolfgang Sandner (ELI) being responsible for XCELS evaluation.

A particular interest of the EC to the XCELS project is explained by its complementarity to the European research infrastructure ELI that is one of the major projects of the ESFRI roadmap ELI – Extreme Light Infrastructure – aims at creating in Europe new scientific centers based on superhigh-power laser complexes the radiation of which may be used for a wide scope of basic and applied research.
The ELI project is intended for construction of 4 research centers dedicated to different trends:
1) creation of sources of charged particles and hard electromagnetic radiation with unique characteristics;
2) attosecond physics;
3) nuclear optics; and
4) producing laser fields of extreme intensity for studying new states of matter and vacuum.

First three centers based on lasers with a peak power of about 10 petawatt will be located in Czech Republic, Hungary, and Romania. Construction of the fourth ELI center that is intended to be equipped with the world's most powerful subexawatt laser complex is currently pending in the EC countries for financial and technological reasons. The Russian project XCELS has characteristics comparable or even superior to those planned by European colleagues for the fourth ELI center. That is why evaluation of a possibility to combine the efforts of the EC and Russia for constructing a unified pan-European infrastructure ELI+XCELS functioning on the basis of coordinated activity of 4 centers. The European experts believe that this cooperation opens up a unique opportunity for EC countries to implement in full the ELI project and for Russia to become an equitable partner of the All-European scientific community. A legal form of Russian participation in the ELI+XCELS alliance may be associated membership in the European research infrastructural consortium (ERIC) – a new type of legal entity specially developed by EC for construction and functioning of research infrastructures comprising several centers in different countries.

On June 19, the second evaluation meeting took place at the EC headquarters in Brussels. Both appointed experts, Susana Gota Goldmann and Wolfgang Sandner, supported the ELI+XCELS alliance. Following this meeting, on behalf of EC they visited Nizhny Novgorod in July and were acquainted with the state-of-the art in developing of the XCELS project.

High Power Laser Science and Technology in China

Ruxin Li

Celebrating its 50th anniversary, the Shanghai Institute of Optics and Fine Mechanics has pioneered important advances in high power lasers, high-field laser physics and solid-state lasers.

Ruxin Li

Founded in May 1964, the Shanghai Institute of Optics and Fine Mechanics (SIOM) has been widely recognized as the most important research center of laser science and technology in China. SIOM has become a comprehensive research institute with primary research fields that include high power laser technologies, high-field laser physics, information optics, quantum optics, solid-state laser technologies and their applications, and materials for laser and optoelectronics. Here, in commemoration of our 50th anniversary, I would like to highlight some of our recent progress.

SIOM has been engaged in the research and development of high power laser technology and engineering for decades, and developed in recent years the first Chinese multikilojoule laser facility, Shenguang (SG for short and means "magic light" in Mandarin) –II facility. The SG-II laser facility includes nine laser beams [see Fig.1(a) and (b)], that has been stably operated for more than10 years and will be upgraded to be a 20 kJ-class laser facility in the near future. This facility has become an international user facility for high energy density physics research.[1]

SIOM developed the first Chinese petawatt (PW) femtosecond laser facility in 2007 based on the chirped pulse amplification (CPA) scheme. This laser system was recently upgraded to 2 PW based on a 100-mm dia. Ti:sapphire amplifier [see Fig.2].[2] Now, a 10 PW level femtosecond laser system combining the Ti:sapphire-based CPA chain and an OPCPA booster amplifier is being built. A hybrid Ti:sapphire-CPA and LBO-OPCPA laser system as prototype,[3] has been developed to produce 0.61 PW/33.8 fs pulse output near 800nm.

SIOM has successfully developed large aperture (up to 400 mm) Nd-doped laser glass slabs, which are the key active material of high-power laser-fusion drivers. Moreover, optical coatings for high-power laser applications can be customized for wavelength ranges from deep ultraviolet to infrared. The laser-induced damage thresholds for mirrors and polarizers are higher than 60 J/cm^2 and 30 J/cm^2 (1064 nm, 10 ns) respectively.

Driven by the PW laser facility, a two-stage laser wake field accelerator (LWFA) with near-GeV quasi-monoenergetic electron beams (QMEBs) was demonstrated in 2010.[4] The collimated QMEBs with peak energy of ~0.8 GeV are achieved with an acceleration gradient of 187 GV/m. More recently, by optimizing the seeding phase of electrons into the second stage, electron beams beyond 0.5 GeV with 3% RMS energy spread were produced over a short acceleration distance of 2 mm.[5]

SIOM has been developing space-borne solid-state lasers and lidar systems since 2001. The first space-qualified solid-state laser developed in SIOM was the transmitter of the laser altimeter on China's lunar explorer Chang'E-1, which was launched in 2007 and operated for about 16 months in orbit. On the Chang'E-3 launched last December, an ytterbium (Yb)-doped pulsed fiber laser system was developed as the transmitter of the scanning image lidar. To our knowledge, it was the first space-qualified fiber laser source operating in deep space.

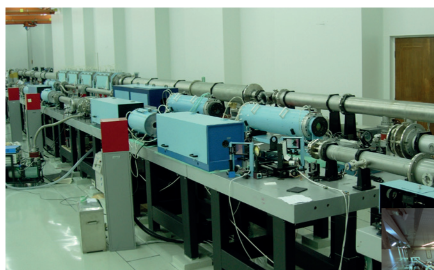


Fig. 1. (a)The SG-II laser facility with eight beams was completed in 2000, with a beam aperture of 240 mm and total output energy of 6 KJ at 1053nm/1ns and 3 KJ at 351 nm/1 ns, respectively.
(b)The ninth beam of SG-II facility, which was built in 2005 as a probe and high-pressure shock-wave driver; its output reaches 5.2 KJ per pulse with a beam aperture of 350 mm.

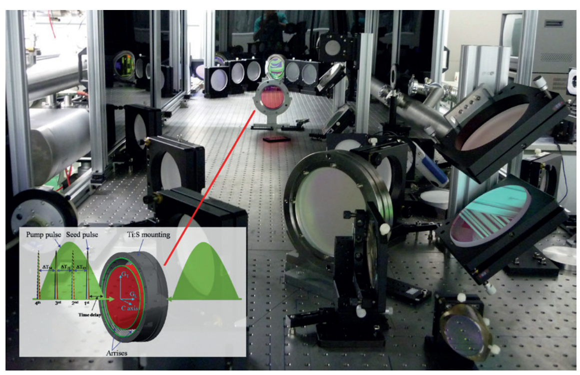
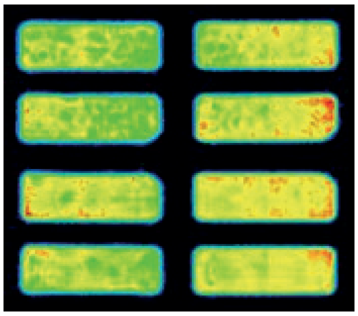


Fig. 2. The 100 mm diameter Ti:sapphire multi-pass amplifier for the 2 PW femtosecond laser facility, in which both active and passive schemes for suppressing transverse parasitic lasing was successfully implemented.

1. J. Zhong, *et al.*, Nature Phys. 6, 984 (2010)
2. Y. X. Chu, *et al.*, Opt. Express 21, 29231 (2013)
3. J.-Y. Lee, *et al.*, Opt. Lett. 38, 4837 (2013)
4. J. S. Liu, et al., Phys. Rev. Lett. 107, 035001 (2011)
5. W. T. Wang, et al., Appl. Phys. Lett. 103, 243501(2013)

Ruxin Li is director, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences; e-mail: ruxinli@mail.shcnc.ac.cn; http://english.siom.cas.cn.

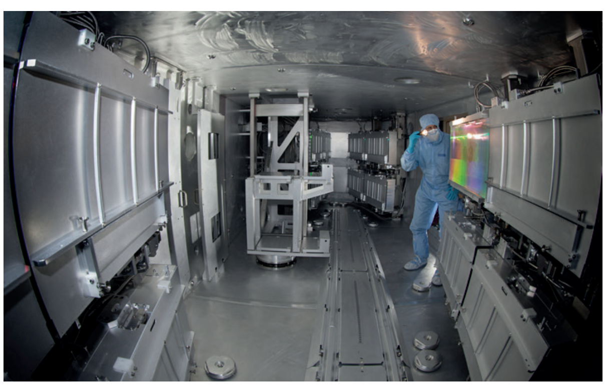
NIF's High Energy Petawatt Laser Is on the Fast Track to Completion



Output beamlet profiles measured at RMDE, totaling 10.41 kJ in eight 365x160 mm2 beamlets, from shot N140218-004-999.

The National Ignition Facility's Advanced Radiographic Capability (ARC), a petawatt (1015-watt) laser system, is rapidly moving along the path to completion and commissioning. Over the past year, the ARC utilities, including electrical cabling, vacuum and ventilation systems, platforms, and cleanrooms, have been installed. On Sept. 12, the ARC team completed a major milestone by propagating first light into ARC Compressor Vessel 1, and the first ARC main laser system shot to the Roving Mirror Diagnostic Enclosure (RMDE) calorimeters (at the exit of the NIF laser bay) was fired in November. A recent series of laser shots to the RMDE calorimeters operationally tested a subset of the ARC systems, including the ARC Injection Laser System (ILS), Integrated Computer Control System (ICCS) automated shot software and Laser Performance Operations Module (LPOM) shot setup and analysis software. An ARC shot on Feb. 18 fired 10.41 kJ in 4 beams (8 beamlets or split beams), as recorded by the RMDE calorimeters in the image at right.

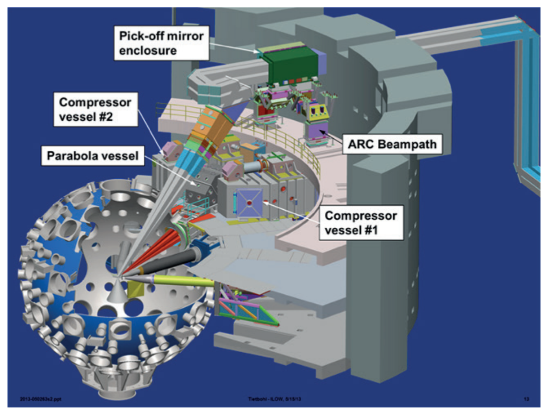
TheARC ILS consists of the ARC master oscillator, dual regenerative amplifiers for the A and B beamlets, the split-beam injection system, and modifications to the NIF preamplifier module to switch between NIF to ARC operation using ICCS controls. The laser shots were performed in parallel with the installation and alignment of the compressor and Parabola Vessel line replaceable units (LRUs) in the Target Bay and the ARC short-pulse diagnostics LRUs in the Target Bay and switchyard. Grating alignment in the compressor vessels is now complete.



Engineer JB McLeod inspects one of the first four high-efficiency diffraction gratings installed in the ARC compressor vessels. ARC's one-meter-wide multilayer dielectric gratings were specially developed at LLNL to withstand the record levels of energy generated by NIF's lasers.

When complete, ARC will be the world's most energetic short-pulse laser, capable of creating picosecond-duration laser pulses to produce energetic x rays in the range of 50-100 keV for backlighting NIF experiments. ARC is designed to deliver kilojoule laser pulses with adjustable pulse durations from 1 to 50 picoseconds and a peak focused intensity above 1017 W/cm2. ARC uses up to four NIF beamlines, propagating two short-pulse beams per NIF aperture in a split-beam configuration. Staggering the arrival of the eight ARC beamlets onto backlighter targets will produce an x-ray "movie" to diagnose the fuel compression phase leading up to ignition of a cryogenic deuterium-tritium target with tens-of-picoseconds resolution. "ARC is important to help us understand what's happening in the compressed core of NIF targets," said John Edwards, NIF program director for inertial confinement fusion.

ARC will also enable new experiments in frontier science and high-energy-density stewardship science.



After amplification in the NIF laser, the ARC beams are compressed in the Target Bay and focused to backlighters near Target Chamber center. The ARC quad of beamlines can provide up to eight backlighters for ignition evaluation.

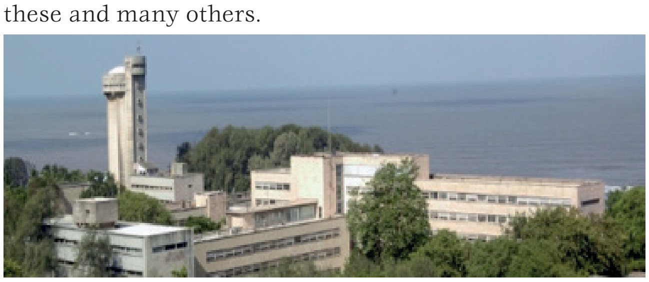
Technicians monitor the successful insertion of transport mirrors in the 11-foot-high ARC Parabola Vessel. The Parabola Vessel will focus ARC's quadrillion-watt beams on backlighter targets near Target Chamber center to produce an x-ray "movie" to diagnose NIF target implosions.

Get ready for ICUIL 2014 in Goa, India (October 12-17)!

The ICUIL 2014 website

Come October and high intensity laser enthusiasts across the world will make a beeline for Goa, the lovely beach city on the west coast of India, for the ICUIL2014 conference. Preparations are in full swing – website (www.icuil2014.org) launched many months ago, registration opened and abstract submissions slated to close on May 23, 2014. The Conference Co-Chairs Chris Barty and G. Ravindra Kumar and the Technical Programme Committee Co-Chairs Catherine Le Blanc, Chang Hee Nam and Jake Bromage along with the Local Organizing Committee are trying their best to put together an exciting programme. Hit the website and see what is unfolding!

ICUIL is expected to showcase the latest on multilateral projects like the ELI, XCELS and IZEST as well as the efforts in individual institutions across the world. The laser community is truly going global in its aspirations and collaboration seems to lead the way to scale newer peaks. The horizon has now moved to the multi-petawatt scale and exciting breakthroughs in the application arena have brought in GeV electron acceleration and novel EM radiation sources. ICUIL 2014 will see intense discussions on these and many others.

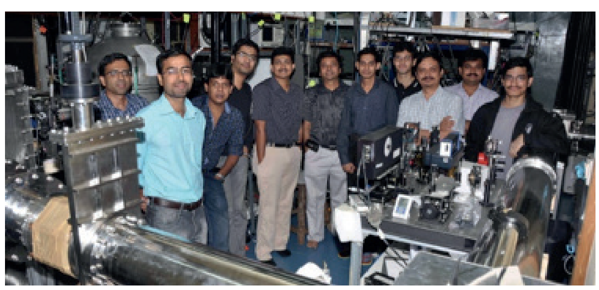


Aerial view of the TIFR campus with its picturesque location beside the Arabian Sea

The Tata Institute of Fundamental Research (TIFR), Mumbai (see pic) has been the hub of preparations for ICUIL2014. Located on the west coast of India (and literally next to the sea!), the Institute has, over the past 68 years focused on fundamental questions in the physical and biological sciences, computer science and mathematics. It has paid particular attention to basic questions in particle physics and astronomy and probes these using its own facilities as well as in international collaborations. It has conducted pioneering experiments on proton decay in the 1970s and 1980s, has radio telescopes in different parts of the country (one of the world's largest radio telescopes, the Giant Meter wave Radio Telescope is about 200 kms from Mumbai) and is currently setting up the India-based Neutrino Observatory (INO), an international effort, in the southern part of India. TIFR has led Indian contributions to collaborative efforts at CERN, Fermi lab and KEK. Since the 1990s, the Institute has been interested in high power laser driven research in basic physics. It currently hosts 100TW and 20 TW, femtosecond Ti-sapphire lasers. Like TIFR, another centre of the Department of Atomic Energy (DAE), the Raja Ramanna Centre for Advanced Technology in another city, Indore, has a 150 TW, femtosecond Ti-Sapphire laser. With these lasers and a multiplicity of set ups and diagnostics, these two Indian centres have made many advances in high intensity laser–plasma interaction studies and laser driven particle acceleration (see the collage below for some recent work).

Currently both centres have approved and funded plans for the installation of petawatt laser facilities by 2016. They seek to expand their activities many fold and are seeking new talent and collaborations with international groups. India aspires to become a centre where multinational groups can get together and perform experiments and simulations. Lastly, she seeks to participate as a significant partner in the development of international laser facilities.

On a broader scale, India is majorly expanding its effort in basic sciences with government funding slated to double in the next few years. Several new institutes dedicated to basic research have started functioning in the last decade. Since the opening of the economy in 1991, the country has benefited from a high trajectory of growth and basic sciences have been a major beneficiary of this progress. The DAE funds the biggest of these projects including the INO while the Department of Science and Technology administers large funding in the university sector in the physical sciences. The DAE has also facilitated India's participation at a significant level in ITER and is currently encouraging its foray into the LIGO project. The scene certainly looks very promising for high intensity laser science and related disciplines.



Some members of the TIFR group

ICUIL2014 Goa just precedes 2015, declared by the UN as the 'International Year of Light'. May it boost the global as well as Indian efforts in the years to come!

Breaking Points for ELI

It was celebrated as a a "breaking point" on the cover pages of newspapers in Szeged, Hungary, on February 6: Prime Minister Victor Orban, together with ELI-ALPS Managing Director Lorant Lehrner and with the ELI-DC Director General, Wolfgang Sandner, laid the cornerstone for the building of the ELI Attosecond Light Pulse Source (ELI-ALPS).

The presence of the Prime Minister indicates the support that ELI-ALPS enjoys from the Hungarian Government. While still waiting for the arrival of Structural Funds from the European Union the Hungarian Government had already pre-financed building planning and construction preparation such that a contract with an international consortium of constructors had already been concluded early in the year. Similarly, ELI-ALPS' international industrial and scientific partners, including many from the ICUIL community, have already concluded contracts to help developing the Technical Design Report and supplying scientific equipment.

Recently, however, the waiting was finally over and ELI-ALPS – and, hence, ELI as a whole - has taken another huge step on its way towards implementation. The European Commission, more precisely, the Directorate General on Regional Policy (DG Regio), during the first week of May has officially released the first and major part of the over 200 Mio Euro EC contribution towards the construction of ELI-ALPS. Therewith, construction of the ELI facilities in the Czech Republic, Hungary and Romania is now fully secured at a total level of 850 Mio Euro, with roughly 85% percent coming from the European Union and 15% from the host countries. ELI is a pioneer among the research infrastructures contained in the European ESFRI Roadmap in using EU structural funds for construction.

Similar progress as in Hungary occurs at the other pillars. The building construction at ELI-Beamlines in Prague and at ELI Nuclear Physics (ELI-NP) in Magurele, Romania, is making impressive progress, as can be monitored in real time on their web sites www.eli-beams.eu/about/building/ and www.eli-np.ro/civil-construction/construction_photos.php respectively. ELI-NP recently celebrated the conclusion of a multi-ten-million-Euro contract for delivery of a world-wide unique gamma beam source. A contract over delivery of two 10-petawatt lasers had already been concluded earlier, similar to a contract over a 10-Hertz, diode-pumped petawatt laser to be built by Livermore for ELI-Beamlines in Prague. The Romanian lasers will be built by a French company, while the gamma beam source will be developed by a European consortium of companies and institutions under the leadership of the Italian nuclear physics institute INFN – demonstrating the international character of ELI and its close cooperaton with industry and academia during implementation.

The pan-European character of the ELI project has recently been further strengthened by the British Science and Technology Facilities Council STFC with its CEO John Womersley (also ESFRI Chair) having officially joined the ELI-DC International Association. STFC and RAL's Central Laser Facility will jointly represent UK in the Association. It now contains members from the three host countries CZ, HU, and RO, as well as from Italy, Germany, and the United Kingdom. Wolfgang Sandner, Director General of the ELI-DC International Association AISBL, is already negotiating with other countries to join, and is inviting the international ICUIL community to maintain its strong support for this world-wide unique laser project.

Further information of the ELI project can be found on www.eli-laser.eu.

The Hungarian Prime Minister Victor Orban (right) and Wolfgang Sandner, General Director of the ELI-DC International Association (left), laying the Foundation Stone for the ELI-ALPS facility in Steged, Hungary, on February 6, 2014 together with Lorant Lehrner, Managing Director of ELI-ALPS (hidden behind Orban). In the back József Pálinkás, President of the Hungarian Academy of Sciences (left), and Zsuzsa Németh, Minister of National Development (center).

The entrance of the ELI-ALPS building in Szeged, Hungary, as it will present itself to the users and visitors after 2018 when ELI is expected to commence operation as the world's first international laser user facility in Hungary, Czech Republic and Romania (Copyright: ELI-HU Nonprofit Kft.)

Contacts Editor: Christine Labaune, christine.labaune@polytechnique.fr
Toshiki Tajima, toshiki.tajima@physik.uni-muenchen.de