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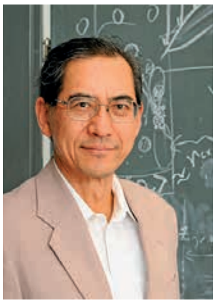
ICUIL
The International Committee on Ultra-High Intensity Lasers

Greetings from the Chair

Professor T. Tajima



The thrill I reported on the rapid progress in ultrahigh intensity lasers in this column last year is still reverberating in my mind and around the world. We are witnessing still further progress in the high intensity laser (HIL) laboratories that are rapidly ever expanding with increasing membership around the world with many reaching the threshold intensity of 1019W/cm2. For example, in Korea the new organization Institute for Basic Science opened the Center for Relativistic Laser Science directed by Chang-Hee Nam, while in China SIOM is aiming at 10PW laser. India is taking its initiative to host the next ICUIL Conference in India (see in this Newsletter). The Extreme Light Infrastructure (ELI) is among the largest ultrahigh intensity project of the world and it entered the Delivery Consortium (www.extreme-light-infrastructure.eu/). It has as of April 11 (shown in the picture) founded the International Association as the crux of the ELI-DC and our Wolfgang Sandner is serving as Director General of ELI-DC. Congratulations!! Some of the pillars have begun their projects now. This project is an inspiration to the world and ICUIL in the sense that it boldly goes into the uncharted waters beyond 10PW and the science of the highest intensity frontier such as in accelerator beams, attosecond science, and nuclear photonics, all driven by ultrahigh intensity lasers. It goes without saying that ELI is the first large-scale infrastructure pan-European scientific project that has its infrastructure all located in East Europe since the fall of the Iron Curtain. The world is expectant of its extraordinary historic unification spirit that could soothe the rifts of centuries. For example, ELI-Nuclear Pillar (Bucharest) will lead the utilization of laser-driven high-energy gamma beams for investigating nuclear physics and engineering. It so happens that such an approach is extremely helpful to assist the disastrous nuclear calamity of Fukushima. Such an energy-specific directed gamma beam can detect specific isotopes of the molten core of Fukushima reactors through the nuclear resonant fluorescence without ever touching the radioactive material.

The high intensity community is looking even beyond what ELI can deliver. In order to reach EW and ZW, it is now necessary to increase the energy of the laser. This is what IZEST (International Center for Zetta- Exawatt Science and Technology) aims at. This is because the compression of the pulse length is seeing the bottom of the 'lake', i.e. the single laser period of 3fs. In order to reach this goal, two strategies have appeared. One is to utilize (or to be suggested to use) the existing large energy (kJ-MJ) lasers, LMJ in Bordeaux (or NIF in Livermore). The other is to launch a new construction of large energy lasers to address this challenge among others applications, as seen in XCELS of Russia. IZEST, for example, is in the phase of making up its Science Case book defining several major targets.

Our fruitful close collaborative relationship and work between the communities of ICUIL and ICFA (International Committee for Future Accelerators) initiated in late 2008 between the Chairs of ICUIL and ICFA. Over the last year this has culminated into the formation of a document that described the recommended future course of actions of ICUIL and ICFA communities to address the challenges that the laser acceleration project will face. This document has been complied by the Joint task Force (JTF) of ICUIL-ICFA, collecting the works through its two workshops, and was published in the ICFA Newsletter #56 (2011). It pointed out that the laser driven acceleration approach is paving a way to help a variety of high-energy accelerator physics issues such as the future high-energy

2014 ICUIL Conference *- October 12-17, 2014, Goa, India*

The venue will be Hotel Cidade de Goa, located on a pristine, beautiful beach in the city of Goa, on the west coast of India, about 600 kms south of Bombay. Goa is very well connected by air to Bombay and Delhi. From Goa, attendees can visit the Tata Institute of Fundamental Research (TIFR, www.tifr.res.in/~uphill), the Bhabha Atomic Research Centre (BARC)] and the Raja Ramanna Centre for Advanced Technology (RRCAT, www.rrcat.ernet.in/technology/laser/lpd/index.html).

TIFR has an operational 100TW laser system focusing on basic intense laser science and applications (a recent break through is the acceleration of neutral atoms to MeV energies!) while RRCAT has a 150 TW system with laser particle acceleration as a major goal, apart from basic physics. BARC will soon have a 200 TW laser system. Apart from these, TIFR and RRCAT have already funded proposals to set up petawatt scale laser facilities in the next 2, 3 years.

collider, ion beam sources, electron beam source for FEL, and compact ion beam cancer therapy application. It concluded that the scientific case for the laser based accelerator physics is compelling and proven, and yet the community needs to come to grip with the technological requirements. One of the most urgent and glaring needs for development, it states, is to realize the efficient high-average power laser technology.

In order to meet these recommendations and challenges, a project called ICAN (International Coherent Amplification Network) between the laser and accelerator communities was launched last year and is now funded by the European Community (EC). This network has identified the fiber laser as the primary candidate for achieving highly efficient, high-average power lasers in the future. Meanwhile, EC has launched a new initiative centered at CERN by forming EuroNNAc (European Network for Novel Accelerators) encompassing a few dozen accelerator and laser institutions worldwide. It had its first inaugurating workshop last year and recently held its second workshop in May 2012.

I do not have a crystal ball to see how the ultrahigh intensity laser community will thrive this year. I am confident, however, that this community is with full of energy, full of ingenuity, and full of vigor, which I trust will turn in another stellar year.

XCELS as a prospective project for international collaboration

XCELS, the Exawatt Center for Extreme Light Studies, is one of the six mega-science projects to be implemented in the territory of Russia that was chosen by the RF Government on a competitive basis in 2011. This initiative is analogous to the European Program ESFRI. One of the basic requirements is participation in constructing and exploiting research complexes of foreign partners. The participation is understood in a wide sense, including execution of research programs, equipment of laboratories, operating costs, technology exchange, design and projection works, and so on. The XCELS project is the only Russian mega-science project in the field of laser physics. That is why it is in the center of attention of the Russian laser and optical community. It is also attracting keen interest of a number of foreign laboratories, agencies, and companies. Two recent events are of particular importance in this connection. A unique scientific Workshop «The Laser Ascent to Subatomic Physics and Applications» took place at the French Embassy in Moscow on April 26. 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) were signed during this workshop.

A particular interest of the European Commission 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. 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 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).

8th IFSA – Inertial Fusion Science and Applications - Conference -

Septemb 8-13, 2013, Nara, Japan

The Eighth International Conference on Inertial Fusion Sciences and Applications (IFSA 2013) will be held at the Nara Prefectural New Public Hall, Nara, Japan, September 8 – 13, 2013. The goal of IFSA 2013 is to bring together scientists in the fields of inertial fusion sciences, high energy density physics, and related applications. Submitted papers will be peer reviewed, and the proceedings of the conference will be published.

Key deadlines : April 15, 2013, Deadline of abstract submission
July 12, 2013, Notification of program structure
July 31, 2013, Deadline for ILE and APR technical tours
September 9-October 25, 2013, Proceeding submission and review process

http://www.ifsa13.org/index.html

2012 Prize of the Russian Government in science and technology

The research of the scientists from the Russian Academy of Sciences and the Rosatom State Corporation has obtained the recognition of merit. It was awarded the Prize of the Russian Government in the field of science and technology in 2012 for the work "Petawatt Laser Complexes Based on Optical Parametric Amplification".

A pioneer approach to creating sources of petawatt pulsed laser radiation using, instead of laser, parametric amplification of coherent optical radiation of femtosecond duration in large-aperture nonlinear optical crystals was proposed and brought into life. The researchers of the Institute of Applied Physics RAS (IAP RAS) in Nizhny Novgorod in collaboration with the Russian Federal Nuclear Center (RFNC) in Sarov constructed two petawatt laser facilities "PEARL" and "FEMTA" of original architecture based on multicascade parametric amplification of frequency modulated pulses under the conditions of ultrabroadband synchronism in DKDP crystals (deuterated potassium dihydrogen phosphate). The peak power of 0.56 PW (24 J, 43 fs) with high spatial quality of radiation that can be focused up to the intensity of 1022 W/cm2 was obtained at "PEARL". The power level at the "FEMTA" facility surpassed 1 PW (70 J, less than 70 fs). The two facilities were created on the Russian technology base, including the key technologies of high-rate growth of large-aperture water soluble nonlinear optical crystals and of constructing pump lasers for parametric amplification power cascades. It was demonstrated experimentally that the constructed laser complexes allow creating and studying extreme states of matter, accelerate charged particles up to ultrarelativistic energies at a rate of several orders those of the best traditional accelerators, thus opening up opportunities for new promising applications in accelerator technique, power engineering, biomedicine, diagnostics, and technical tasks.

The achieved results have been recognized worldwide and are currently employed for constructing still more powerful, multipetawatt laser facilities, including «PEARL-10» at IAP RAS and "VULCAN-10 PW" (United Kingdom). Four researchers from RFNC: Sergey Garanin, Boris Zimalin, Nikolai Rukavishnikov, and Stanislav Sukharev, and six representatives of IAP RAS: Evgeny Katin, Vladimir Lozhkarev, Anatoly Potemkin, Alexander Sergeev, Efim Khazanov, and Andrey Shaykin are the Prize Winners.

2013 Einstein Professorship: Toshiki Tajima

Prof. Toshiki Tajima was awarded as the Einstein Professorship for 2013 by Chinese Academy of Sciences (CAS). The Einstein Professorship Program is a key initiative of the CAS. Einstein Professorships are awarded each year to 20 distinguished international scientists actively working at the frontiers of science and technology, for conducting lecture-tours to China. Recipients of these prestigious Einstein Professorships should be recognized as international leaders in their particular fields, as measured by awards and prizes, invited lectures, national or international committee membership and/or leadership, and history of publications. The host institute of Prof. Tajima is Shanghai Institute of Optics and Fine Mechanics, CAS.

High Average Power High Efficiency Demonstrator ICAN-B

For 18 months the consortium ICAN sponsored by the European Commission has studied the possibility for a laser to produce simultaneously:

1) **High peak power in the PW regime,**
2) **Average power in the MW range**
3) **Efficiency at the 30% level**
4) **The first digital laser with heuristic capability**. Each fiber laser can be independently controlled in phase and amplitude at kHz rate offering the possibility to modify at the same rate the laser wave front, and amplitude distribution across the beam in a digital way. Using genetic algorithm this laser offer unique heuristic capabilities. This feature is of paramount importance in the context of laser plasma interaction where the simulation provides an idealistic outcome that does not fit with the reality. The heuristic capability will look and find an optimized output.

This study provides a good basis for the construction of the demonstrator ICAN-B that would be apposite to relativistic electron and proton science with the generation of gamma ray, neutron, and muon or neutrino sources. Higgs factory is an example of important scientific application.

ICAN-B demonstrator could have paramount societal applications in the domain of nuclear pharmacology, transmutation of nuclear waste, in energy with subcritical reactor or in medicine with proton therapy.

An ICAN conference with the participation of 13 countries is organized at CERN the June 27-28 to go over the final conclusions of the ICAN work-study and to discuss the strategy that could make possible the construction and applications of the novel ICAN-B demonstrator, in the domain of High-energy Physics and Nuclear Physics.

Center for Relativistic Laser Science (CoReLS) Launched in Korea

In the past few decades Korea has focused on industrial development and now has become competitive in the fields such as electronics, heavy industry, and construction. In basic science, however, it has been relatively weak. Since basic science not only extends the boundary of human understanding but also forms the foundation for technological excellence, in 2012, the Korean government established the Institute for Basic Science (IBS) to promote the research in basic science. When fully installed, IBS will comprise 50 research centers, each of which focuses on a selected research topic in basic science. One of the earliest research centers is the Center for Relativistic Laser Science (CoReLS), which explores the superintense laser-matter interaction.

CoReLS's research is focused to the understanding of physics under extreme conditions induced by superintense laser field and the utilization of obtained knowledge for overcoming current technological barriers. More specifically, relativistic interactions between superintense laser field and plasma are explored. The goal is pursued cooperatively by the five research groups of CoReLS: laser group, low-density laser-plasma group, high-density laser-plasma group, atto science group, and laser-plasma theory group. The groups are now being built, and each group will have around 10 members including the group leader, research fellows, students, and technical staffs. CoReLS is directed by Prof. Chang Hee Nam who has pioneered the development of advanced femtosecond laser technology and atto science in Korea.

Figure 1. Opening ceremony of CoReLS: uncovering the IBS center plate

A remarkable strength of CoReLS is the two petawatt beamlines: 1.0 PW and 1.5 PW at 30 fs, the latter being the most powerful femtosecond laser as of 2012. These beamlines were developed by the ultrashort quantum beam racility (UQBF) project – a research project led by Prof. Jongmin Lee. The researchers of the UQBF project, who constructed the petawatt beamlines and produced noticeable novel results in electron acceleration, relativistic high harmonic generation, and proton acceleration [3], joined CoReLS to make a continuous progress. Moreover enthusiastic researchers are joining from all over the world. With the cutting-edge laser system and devoted researchers, CoReLS will make a profound contribution in understanding the physics of superintense laser-matter interactions.

Researcher positions are available at CoReLS. An inquiry about job opening can be made to Ms. Minji Kim (mjk614@ibs.re.kr). Come to the Far East to explore the extreme science!

Figure 2. Petawatt interaction chambers at CoReLS

Route to Exa-Zettawatt Laser: Damage-less Optics

Since its inception, the laser has seen a constant increase in peak power and focused intensity. This opens many new possibilities for fundamental science (e.g. subatomic physics, TeV astrophysic) and applications (e.g. medicine with imaging, therapy, nuclear waste recycling). Fast progress on the increase of laser power has traditionally relied on solid state optics using techniques such as CPA (Chirped Pulse Amplification), which are however limited by a very low damage threshold of the order of 0.1 J/cm2, mostly due to the diffraction gratings. Hence for m2 surface area diffraction gratings, the maximum admissible short pulse energy is of the order of few kiloJoules.

The goal of the IZEST program is to find a way to produce exa-zettawatt pulses by compressing the large energy -10kJ to MJ- in few ns pulses produced by large scale fusion laser, LMJ, NIF into the femtosecond regime. For this program we need to beat the current damage limitation. Our preferred solution is to use a plasma as "compression grating" and reflective mirror as conceptually described in a technique called C3. Pulse compression is obtained using the Raman or Brillouin Backward Scattering in plasma when a pump pulse and a counter signal one meet in a plasma. The moving plasma grating formed by the interference produces an energy transfer from the pump to the signal. Also, an efficient focusing mirror action has been demonstrated over a large area produced at high intensity in the femtosecond regime. We dub these optics damage-less because it is impossible to damage a plasma.

Switching to plasma makes possible to work at a fluence in the 5 10^3 J/cm2 regime, a mere gain of 10^4 over conventional optics. Therefore a cm^2 plasma grating can replace a m^2 size grating. In addition, once extremely high fluence laser beams produced, we cannot use conventional optics any more and plasma mirrors are the only possibilities. This possibility to use plasmas for multi-kiloJoule beams amplification, compression and focusing to wavelength-scale, will allow in a foreseeable future to create light intensities approaching the Schwinger limit of $\sim 10^{29}$ W/cm^2 to breakdown and explore vacuum structure. Proof-of-principle experiments as well as multi-dimensional kinetic simulations show the feasibility of such an approach. The future of high field optics1 will be based to a large extent on such damage-less optics.

2013 ICUIL

The ICUIL continues to be actively concerned with the growth and vitality of the whole international field of ultra-high intensity laser science, technology and education. Our goals are to provide a venue for discussions, among representatives of high-intensity laser facilities and members of user communities, on international collaborative activities such as the development of the next generation of ultra-high intensity lasers, exploration of new areas of fundamental and applied research, and formation of a global research network for access to advanced facilities by users.

2012 ICUIL Conference

The 5th biennial ICUIL Conference was held from September 16 to September 21 in Mamaia, Rumania. This conference was hosted by the National Institute for Laser, Plasma and Radiation Physics, Bucharest, with D. Dumitras serving as the General Chairman. More than 170 attendees from around the world participated in an excellent program including 80 talks and 35 posters. Three of the invited talks given by ICUIL members focused on high intensity laser facilities around the word; W. Sandner - European Facilities, C. Barty - American Facilities, and H. Azechi - Asian Facilities. Following the success of the 2004 (Lake Tahoe, USA), 2006 (Cassis, France), 2008 (Tongli, China), 2010 (Watkins Glen, USA) conferences, the 2012 conference was another excellent opportunity for ICUIL to promote unity and coherence in the field of ultrahigh intensity lasers and their applications.

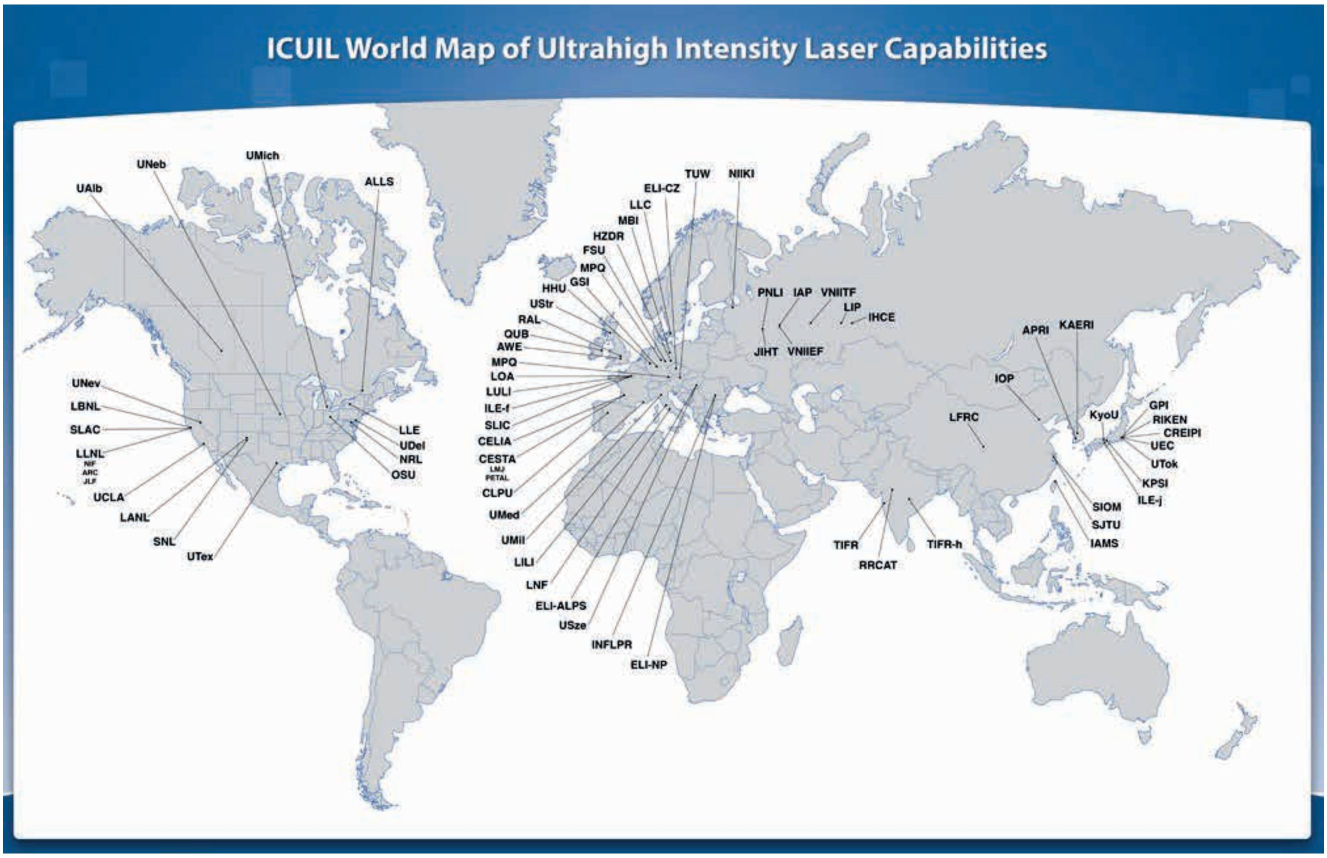
More than170 participants gathered at the 2012 ICUIL Conference in Mamaia, Romania.

A competitive poster session was held at the 2012 ICUIL Conference. Many young scientists from around the world presented their work during the regularly scheduled poster sessions. Four members of the ICUIL Board served as judges of the posters and presentations. First prize was awarded to C. Brabetz of Germany, second prize to L. Ionel of Romania, and third prize to K. Izuno of Japan.

2012 - Annual Meeting of the ICUIL Committee

Young scientists (3rd, 4th, 5th), poster judges from ICUIL Board, and conference chairman (2nd)

The annual GA meeting was held on the last day of the 2012 ICUIL Conference in Rumania. The agenda consisted of member rotation, the 2012 and 2014 ICUIL Conferences, website development, the world map, fund raising, and laser infrastructure initiatives and collaborations such as ELI and IZEST. One of the features of the ICUIL website is an interactive world map which highlights the high intensity laser facilities around the world as shown below. A survey of the worldwide laser community has been conducted by ICUIL in an effort provide an accurate accounting of all existing and planned ultrahigh intensity laser capabilities. This survey has included input from more than 100 individuals representing every leading laser institution and facility and has gathered more than 300 pages of related materials. From these interactions and materials, a map of all existing and planned facilities that are capable of producing intensities above 10E19 W/cm2 (the present ICUIL definition of “ultrahigh” intensity”) has been created. The data base generated in the creation of the ICUIL world map reveals that ICUIL related activities are growing worldwide at an incredible pace. In 2009 the sum of the peak power from all existing “ICUIL” related facilities was ~12 PW. By 2015 the survey data suggests this number will be almost 130 PW. Simple estimates based on the scale of facilities currently being constructed and planned further suggests that more than 1500 new scientists and staff may be required to complete these projects and that the total worldwide ultrahigh intensity laser enterprise over this period will exceed $4.5B. It is the intent of ICUIL to maintain an up to date map via periodic survey mailings to the community and via input obtained from the community at the biennial ICUIL conferences.



2012 World Map of High-Intensity Laser Facilities

International endeavor to establish Laser-Based High Energy Physics and Applications Conference

Strathclyde University – UK - November 13-15, 2012

The second IZEST meeting on the ascent on laser-Based High Energy Physics was held at the Strathclyde University where we had the privilege to hear Peter HIGGS as a distinguished speaker. During the first two days, many renown speakers have covered the different aspects of laser-based Fundamental physics in disciplines like Prompt acceleration, Physics Beyond the Standard Model, Vacuum Structure, Dark Matter Search, TeV Astrophysics. The last day was devoted to the applications of IZEST's ultrahigh intensity lasers, in nuclear medicine, proton therapy, nuclear waste control, detection and transmutation.

IZEST 2012: Laser Ascent to High Energy Physics

ELI Delivery Consortium

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 ceremony and the subsequent reception were attended by Robert-Jan Smits, Director-General of DG Research and Innovation, and by Ana Arana Antelo, Head of Unit "Research Infrastructures", together with representatives from the European Commission and various ELI partner countries.
ELI is part of the ESFRI Roadmap for international research infrastructures of high priority for Europe. Based on strong international collaborations it is being constructed in three pillars in the Czech Republic, Hungary, and Romania, utilizing EU Structural Funds.
When fully implemented in 2017 ELI will contain some of the world's most powerful lasers and make them available for the international scientific community. With its ultra-intense and ultra-short pulses of light it will create new states of matter in dense plasmas, probe the structure of vacuum or produce secondary radiation of high-energy photons or particles. These, in turn, will be used to understand fundamental dynamic processes in such different species as nuclei, molecules, or biological cells.
ELI's technologies and capabilities will bring Europe at the forefront of this scientific field and stimulate the socio economic development in the host countries and in the EU in general.
The newly founded ELI Delivery Consortium International Association will be a non-profit organization 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.

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