Annual Report to IUPAP
September 2014

www.ICUIL.org

ICUIL Board

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Toshiki Tajima

Co-Chairs
Chris Barty
Alexander Sergeev

Secretary
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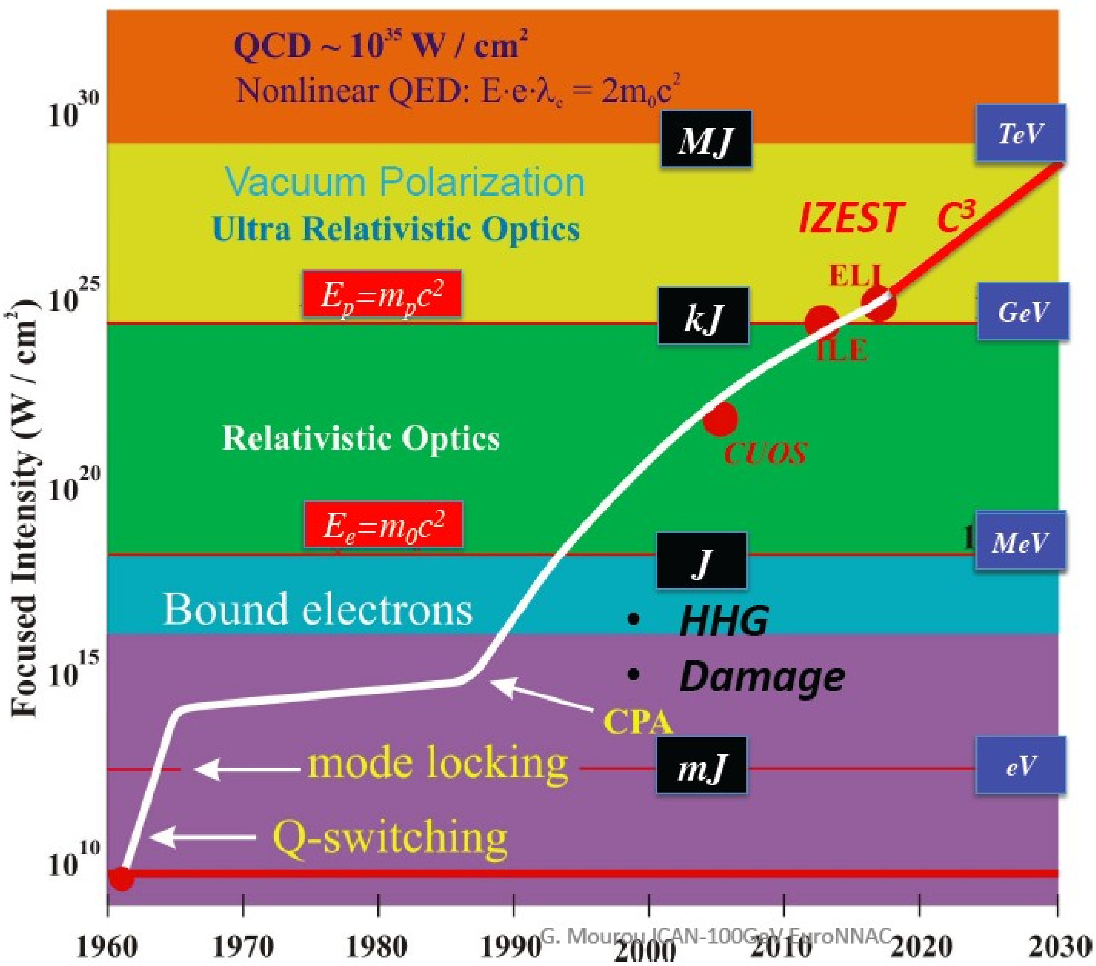
ICUIL Activity Overview

ICUIL continues to be engaged with the advancement of the international field of ultra-high intensity lasers. 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. As summarized in this report, ICUIL continues to be active in promoting collaborations required to establish high-intensity laser infrastructures for the benefit of the international physics community. Thanks to the ICUIL leadership, the laser intensity continues to exponentiate over the years. See below what we call the Mourou Chart (after the first Chair of ICUIL, Professor Gerard Mourou). This activity overview highlights progress and events for 2014.



A European ESFRI roadmap project, the Extreme Light Infrastructure (ELI) consists of ELI-Beamlines, ELI-Nuclear Physics, and ELI-ALPS (attosecond science pillar) which are on their way towards initial operation in 2018. Professor Wolfgang Sandner, our former Co-Chair of ICUIL, continued in his role as Director General and CEO of the ELI Delivery Consortium. The Extreme Center for Exawatt Laser Science (XCELS), aspiring to be the fourth pillar - ELI-High Field Science, has the goal of achieving 200 petawatts for frontier experiments.

The high intensity laser community and accelerator community engaged in synergistic activities over the last year. ICUIL representatives reported to the ICFA (International Committee for Future Accelerators) General Assembly in February. In response to recommendations in the Joint Task Force Report that lasers having higher repetition rate and higher efficiency are required, the International Coherent Amplification Network (ICAN) started a development consortium and the European Network for Novel Accelerators (EuroNNAc) is holding an Advanced Accelerator Conference in the US this year. Also, the Stanford Linear Accelerator Center (SLAC) will host a high power laser workshop in 2014.

Laser facilities around the world continue to advance rapidly. 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, and Jiaotong University in China. University in Japan is also pursuing an exawatt initiative. Lawrence Livermore National Laboratory (LLNL) is near completion of their Advanced Radiographic Capability (ARC) petawatt level laser. India is hosting the 2014 ICUIL Conference at Goa where they will showcase their high intensity laser efforts and liaisons with the wider scientific and industrial communities of India.

ICUIL Biennial Conferences

ICUIL has a decade-long history of promoting unity and coherence in the field by convening conferences dedicated to ultra-high intensity lasers and their applications. The 6th biennial ICUIL conference will be held **September 12-17 in Goa, India** and will be hosted by the **Tata Institute of Fundamental Research**, with R. Kumar serving as the conference chairman. It will be located in the city of Goa, on the west coast of India, about 600 km south of Mumbai. 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 Tata Institute of Fundamental Research (TIFR), Mumbai has been the hub of preparations for ICUIL2014. TIFR has led Indian contributions to collaborative efforts at CERN, Fermi lab and KEK. It currently hosts 100TW and 20 TW, femtosecond Ti-sapphire lasers. Another center of the Department of Atomic Energy (DAE), the Raja Ramanna Centre for Advanced Technology has a 150 TW, femtosecond Ti-Sapphire laser. With these lasers and a multiplicity of set ups and diagnostics, these two Indian centers have made many advances in high intensity laser–plasma interaction studies and laser driven particle acceleration Currently both centers have approved and funded plans for the installation of petawatt laser facilities by 2016.

2014 Annual General Assembly (GA) Meeting

It is anticipated that a quorum will be reached at the annual GA meeting held in Goa, India in October. The agenda for the meeting will consist of member rotation, the 2014 ICUIL Conference, website development, the world map, fund raising, and laser infrastructure initiatives and collaborations with ICFA, ELI, XCELS, and IZEST. Bi-monthly teleconferences continue to be effective in maintaining progress in each of these activities.

ICUIL Member Rotation

Several of the current ICUIL members will have completed two terms of service by 2016 and will be required to step down according to the bylaws of the ICUIL charter. A gradual member rotation will begin in 2014 to maintain continuity and ensure that ICUIL continues to advance while maintaining balance both geographically and between the various high field science working groups of IUPAP.

ICUIL Newsletter

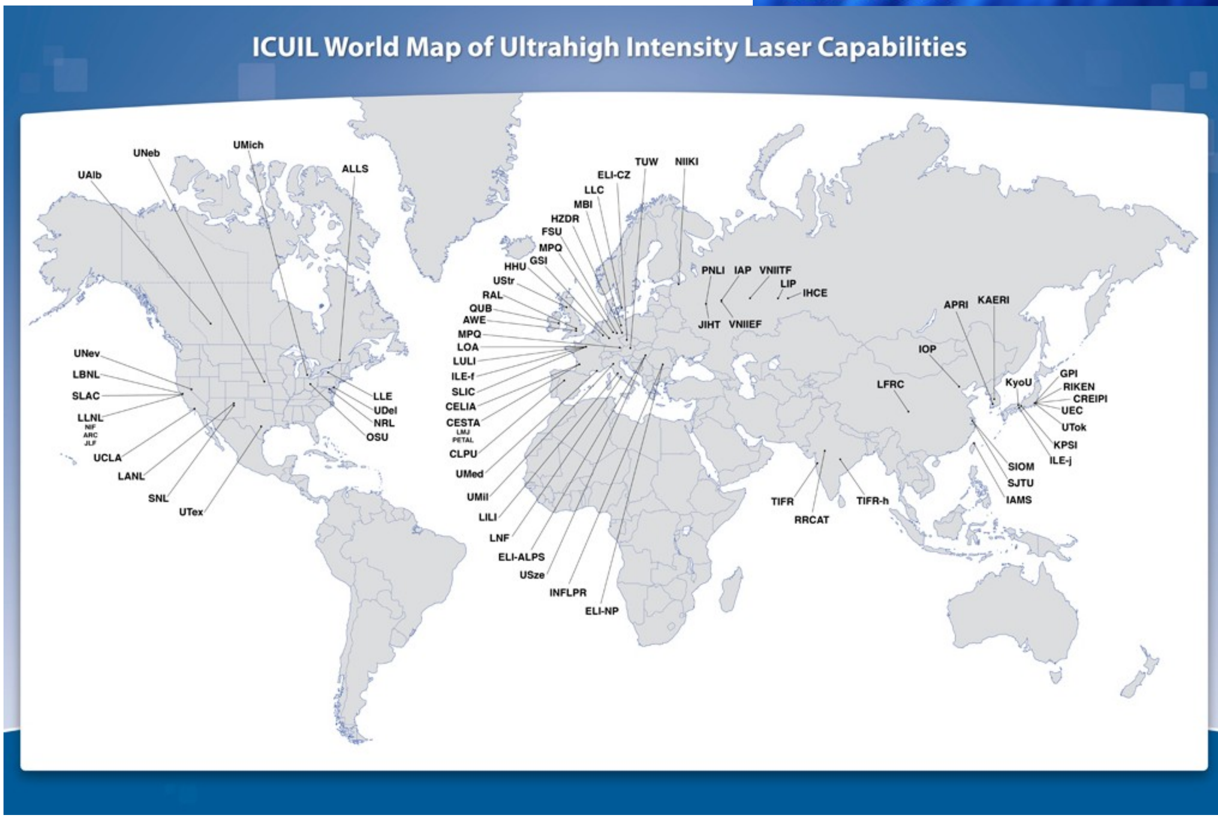
ICUIL continues to achieve its goal of publishing a newsletter annually. The fifth ICUIL Newsletter (Volume 5) was sent out to the high intensity laser community in June 2014 and is also available at the ICUIL website. The chief editor, C. Labaune, managed the illustration and publication resources to distribute an eight-page newsletter to hundreds of readers, highlighting the major laser construction and laser science projects within the HIL community, major conferences, and related workshops.

Fund Raising

ICUIL has continued its corporate support program to afford maintenance of the ICUIL website, publish an annual newsletter, and support biennial conferences. The remaining funds are being targeted towards support of new outreach activities including student competitions held at the biennial conferences.

ICUIL Website

One of the features of the ICUIL website is an interactive world map that highlights the high intensity laser facilities around the world as shown below. Surveys of the worldwide laser community are conducted by ICUIL in an effort to provide an accurate accounting of all existing and planned ultrahigh intensity laser facilities that are capable of reaching intensities above 10E19 W/cm2.



2014 ICUIL Membership

Toshiki Tajima	Chairman	International
Chris Barty	Co-Chairman	United States
Alexander Sergeev	Co-Chairman	Russia
Terry Kessler	Secretary	United States
Tsuneyuki Ozaki	Treasurer	Canada
Gerard Mourou		France
Hiroshi Azechi		Japan
John Collier		United Kingdom
Dino Jaroszynski		United Kingdom
Thomas Kuehl		Germany
Ravi Kumar		India
Christine Labaune		France
Wim Leemans		United States
Ruxin Li		China
Chang Hee Nam		Korea
Bedrich Rus		Czech Republic
Wolfgang Sandner		Germany
Heinrich Schwoerer		South Africa
Ken-ichi Ueda		Japan

Associate Members (without vote)

Ryosuke Kodama	Japan
Sandro de Silvestri	Italy
Nilson Dias Vieira Jr.	Brazil
Claes-Goran Wahlstrom	Sweden

ICUIL Related Science and Technology Highlights

I. ICFA/ICUIL Joint Task Force (JTF)

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 the machine and its tunnel. A team of worldwide experts is already exploring the next possible machine at CERN that could have a tunnel of up to 100 kilometers. The field requires alternative technologies that could make acceleration of particles more efficient, e.g. using plasma wake acceleration. In particular with CERN's AWAKE project, ICUIL is contributing 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 research and design. 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 of accelerators or detectors. In February, 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. 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.

II. Extreme Light Infrastructure (ELI)

In February, Prime Minister Victor Orban, together with ELI- Attosecond Light Pulse Source (ALPS) Managing Director Lorant Lehrner and with the ELI DC Director General, Wolfgang Sandner, laid the cornerstone for the building. 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. 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, during the first week of May officially released the first and major part of the over 200 million 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. ELI-NP recently celebrated the conclusion of a multiten-million-Euro contract for delivery of a world-wide unique gamma beam source. A contract over delivery of two 10petawatt lasers had already been concluded earlier, similar to a contract over a 10-Hertz, diode pumped petawatt laser to be built by Lawrence Livermore National Laboratory for ELIBeamlines 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 cooperation 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.

III. Exawatt Center for Extreme Light Studies (XCELS)

XCELS is a prospective project for international collaboration and is aimed at establishing an international center for the study of extreme light fields in Russia. The XCELS is now at the prototyping stage. It includes creation of two modules with the power of 15 PW at IAP RAS by the end of 2016 and is based on the laser architecture proved during construction of "PEARL" and "PEARL-10" facilities. Further work on creation of a subexawatt laser will be performed at the implementation stage. It includes construction of a new building and engineering infrastructure in the suburb of Nizhny Novgorod city, assembling of the 0.2EW 12-channel laser system, several high-average-power laser facilities for innovative applications, an electron source with particle energies of 100 MeV, experimental laboratories, computer and communication centers, and supporting services. To accommodate XCELS, ground area of about 5 hectares, rather far from highways and industrial plants will be used. The total area of the laboratory, administrative and ancillary facilities will be about 25 000 m^2, about 15 000 m^2 of which must have different degrees of radiation protection. The operational stage will start in 2020, and during two subsequent years all research laboratories around the XCELS source will come to the continuous operation mode. They include laboratories for experiments on the physics of strong fields, high-energy physics, laboratory astrophysics and cosmology, nuclear optics, neutron physics, laboratories for studying the properties of vacuum, attosecond and zeptosecond physics, and fundamental metrology. XCELS will also comprise a powerful center for data processing and computer modeling of the interactions of extreme light fields.

In 2014 XCELS became a part of the CREMLIN project under The Horizon 2020 call that unites efforts of 19 large European labs including DESY, CERN, ESRF, JINR, Kurchatov Institute, and others. This will foster scientific cooperation between the Russian Federation and the European Union in the development and scientific exploitation of large scale research infrastructures. It has been triggered by the recent so-called megascience projects initiative launched by and in the Russian Federation which is now very actively seeking European integration. The proposed megascience facilities have an enormous potential for the international scientific communities and represent a unique opportunity for the EU to engage in a strong collaborative framework with the Russian Federation. The CREMLIN proposal is a first step to identify, build and enhance scientific cooperation and strong enduring networks between European research infrastructures and the corresponding megascience facilities to maximize scientific returns. The proposal follows the specific recommendations of an EC Expert Group by devising concrete coordination and support measures for each megascience facility and by developing common best practice and policies on internationalization. The Extreme Light Infrastructure Delivery Consortium (ELI-DC) and the IAP RAS will jointly lead the work package devoted to the XCELS project. On the European side, the French CEA, Laser Interactions and Dynamics Laboratory (LIDyL) is another partner in this work package. ELI-DC, CEA and the IAP will organize workshops on the development and technological challenges of next generation high power lasers, and carry out expert meeting, round table discussions and workshops devoted to internationalization and governance issues of high power laser infrastructures.

IV. Shanghai Institute of Optics and Fine Mechanics (SIOM)

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. 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. 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 than 10 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. SIOM developed the first Chinese petawatt, 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. 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 has been developed to produce 0.61 PW/33.8 fs pulse output near 800nm. SIOM has successfully developed large aperture 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/cm2 and 30 J/cm2 (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. The collimated QMEBs with peak energy of ~0.8 GeV are achieved with an acceleration gradient of 187 GV/m.

V. National Ignition Facility's Advanced Radiographic Capability (ARC)

The Advanced Radiographic Capability (ARC) at LLNL, a petawatt 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. One year ago, 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) 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 shot setup and analysis software. The ARC 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. 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 10E17 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. ARC will also enable new experiments in frontier science and high-energy-density stewardship science.

VI. International Center for Zetta-Exawatt Science and Technology (IZEST)

IZEST, headquartered at the Ecole Polytechnique, will unify a number of exawatt class facilities such as the ELI-Fourth Pillar, the Russian XCELS, as well as possible Japanese and Chinese exawatt lasers. Almost 30 laboratories in 13 countries have signed a collaboration agreement with IZEST. The second IZEST meeting was held November, 2012 at Strathclyde University, Scotland. The main objective of the conference was to explore the potential of very high fields available from the next generation of high power lasers and also the potential of combing them with high-energy particle beams from laser-plasma accelerators, for fundamental studies of the structure of matter. The third IZEST meeting was held at the Lawrence-Livermore National Laboratory in July 2013 to discuss the development of novel exawatt and zettawatt laser technologies and the development of frontier, ultrahigh intensity science and applications. The last meeting of 2013 was held in in Asia in November at the French embassy in Tokyo. The meeting was followed, November 20 by the IZEST Participant Council at the University of Tokyo hosted by Professor K. Yamanouchi and his staff. Participation of the most prominent Asian laboratories in particle physics, and ultra intense lasers in Japan, Korea, Taiwan, and India, in addition to those of the European Union, Russia and the USA occurred. An important contingent from industry was also in attendance. A large part of the meeting was devoted to the revolutionary laser architecture ICAN (International Coherent Amplification Network) that has the ability to generate laser pulses at ultra-high Intensity, high average power and high efficiency. The main applications discussed included Particle Colliders, a Higgs factory, High-energy Astrophysics, Nuclear Transmutation, Proton Therapy, Proton Diagnosis, Nuclear Pharmacology, the identification of spent nuclear fuel in general and exposed fuel (i.e. Fukushima), as well as Homeland Security. In January 2014, IZEST had the privilege to present to the Ecole Polytechnique Levée de Fonds Bureau headed by Claude Bebear, Olivier Mitterand and the President Jacques Biot. In a symposium called Passion Lumière Extrême, highly distinguished researchers like Michel Spiro (CEA), Gilles Cohen Tannoudji (CEA), Etienne Parizot (APC-Université Diderot), Roy Aleksan (CEA), Olivier Napoly (CEA) and other top scientists from the University, demonstrated the wide range of applications in the extreme light regime for fields like High Energy Physics, Nuclear Physics, Astrophysics and Cosmology. Currently there is a strong emphasis within the accelerator community on utilizing the strong fields supported within plasma for extending current and future acceleration facilities beyond the limitations of RF technologies. The emphasis is now placed on laser-driven technologies and the progress being made by labs working around the globe on the challenge of accelerating electrons to 100s of GeV.