ICUIL News

N° 3

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Chief Editor: Christine Labaune

The International Committee on Ultra-High Intensity Lasers

Greetings from the Chair

Professor Toshiki Tajima

Professor Toshiki Tajima
chairman of ICUIL

I am thrilled to report to you this year that the high intensity laser (HIL) laboratories are rapidly ever expanding with increasing membership around the world with many reaching the threshold intensity of 10^{19}W/cm^2. Numerous facilities have entered our ICUIL Worldlab Map from Asia, America, and Europe. Not only this, many labs are increasing their peak intensity by a large factor beyond this threshold. APRI of Korea is surpassed the PW mark while SIOM of China is now looking at the 10PW regime. Lawrence Berkeley Laboratory just received a new PW laser for laser wakefield acceleration. The University of Munich (LMU) ATLAS laser has recently entered a new building (for CALA) to accommodate a jump into 3PW power. And much much more... In order to fully recalibrate this rapidly expanding HIL community, we need to collect up-to-date data of its vibrant state-of-HIL at the upcoming ICUIL Conference 2012 at Constanza, Romania (Sept. 17-21, 2012, see in this newsletter), as we traditionally update our status at this biennial event.

This year marks the beginning of the Delivery Consortium of Extreme Light Infrastructure (ELI), the largest ultrahigh intensity project of the world (www.extreme-light-infrastructure.eu/). 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. Even though ELI has three base camps (in Prague, Szeged, and Bucharest), the fundamental ultrahigh intensity science concept of ELI unites the three tightly and we are pleased that ICUIL is poised to help insure this integration. 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. It is encouraging that our Japanese colleagues at JAEA are spear-heading such a project in assisting the process of putting the molten core into isolation. ICUIL encourages and supports this endeavor.

We have witnessed ever closer convergence 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 describes 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

2012 ICUIL Conference - *September 16-21, 2012,* Mamaia, Romania

(http://icuil2012.inflpr.ro/Index.html)

This biennial meeting emphasizes on the generation, amplification, compression, and measurement of high-intensity pulses as well as applications. The scope of ICUIL 2012 includes, but is not limited to:

- Ultrahigh-intensity-laser design and performance
- Novel Technologies for Ultra-Intense Lasers
- Laser Acceleration
- Applications with extreme light
- Short-wavelength sources
- Attosecond science
- Plasma optics

This conference will also feature a special workshop on high-damage threshold laser components and a student poster competition.

Abstract submission deadline: June 30, 2012
Early registration: May 4, 2012
Hotel reservation deadline: June 22, 2012

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 collider, ion beam sources,

Photo: Mr. Takuya Shimomura of Kansai Photon Science Institute ,JAEA. This photo was chosen for the Excellent Prize at the Fifth Exhibition of the 'Panel for Beauty in Science and Technology' in Japan .

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, the 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.

Since 2011 a new noteworthy movement has been launched to harness world's largest energy lasers for the purpose of highest intensities. At NIF the systematic and coordinated experimental campaign toward laser fusion ignition is under way and perhaps in the next few years may mark an important milestone toward this goal. Meanwhile, we suggested (Tajima and Mourou, 2002) that if we wish to go far beyond PW into EW and ZW, we have to employ kJ and MJ lasers. This is now ongoing with the LMJ lasers such as PETAL under the organization of IZEST (International Center for Zetta- and Exawatt Science and Technology) to apply these lasers to ultrahigh intensities for fundamental science exploration. Shown is a snapshot of us at the first IZEST launching workshop in Nov. 2011.

How do we see the future of ultrahigh intensity lasers and ICUIL? There are many forward-looking cross currents in our community. We see ultrafast optics ranging from fs to now as and perhaps to zs. Discussed above, we also see large energy lasers join the high intensity frontier. I do not have a crystal ball to foretell the future. Instead, let me refer to the Pulse Duration-Intensity Conjecture Gerard Mourou and I stumbled into back in 2011: In order to make ever shorter radiation pulses, we must increase the intensity of the driving laser. This Conjecture promotes a confluence of ultrafast optics, large energy lasers, and ultrahigh intensity science. It was originally seen in all solid-state lasers, but we begin to see its reach even in free electron lasers. We also sense that the extension of the Conjecture may hold even for beams of charged particles, thus making the scientific confluence of lasers and accelerators even closer.
With this let me salute all of you with the award-winning picture by Kansai Photon Science Institute's T. Shimomura, in the scientific photography contest in Japan last year, which also graces our ICUIL homepage.

XXXII ECLIM – *September 10-14, 2012, Warsaw, Poland*

(http://eclim2012.wat.edu.pl/)

The ECLIM 2012 is dedicated to bring together scientists involved in fundamental and applied research in the field of high intensity laser interactions with matter, with emphasis on

- laser fusion
- laser-produced plasmas
- particle generation and acceleration
- laser-driven X-ray and EUV sources

The conference will provide an excellent opportunity for researchers, students, scientists and technologists to share a common place for fruitful discussions, present new results within the conference topics. A special session with aim to promote high-intensity laser interactions and laser fusion studies will be organized.

Abstract submission deadline: May 30, 2012
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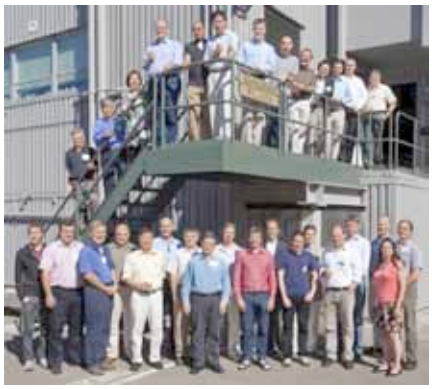
ICUIL-ICFA Joint Task Force: White Paper

Particle accelerators and lasers have made fundamental contributions to science and society, and are poised to continue making great strides in the 21st century. Lasers are essential to modern high performance accelerator facilities that support fundamental science and applications, and to the development of advanced accelerators. The demand for high average laser power even in near-future accelerator applications is already outpacing the state of the art in lasers. A class of more-futuristic accelerators for particle physics, driven entirely by lasers, would require average laser power far exceeding today's state of the art.

In September 2009 the ICFA-ICUIL Joint Task Force (JTF) chaired by Wim Leemans was launched to explore lasers for future accelerators through a collaboration of the ICFA and ICUIL communities. In April 2010 a first and inaugurating JTF Workshop was held at Darmstadt, followed with a second one in Berkeley in September of 2011. About 40 experts were invited from both the accelerator and the laser communities.



Group picture of the 2011 joint ICFA-ICUIL workshop on High Average Power Lasers for Future Accelerators, held at Lawrence Berkeley National Laboratory on September 20-22, 2011.

The collaboration between the two communities has resulted in the creation of a substantial White Paper, entitled "High power laser technology for accelerators", as part of this ICFA Beam Dynamics Newsletter (http://www-bd.fnal.gov/icfabd/Newsletter56.pdf), edited by W. Leemans, W. Chou (chair, ICFA Beam Dynamics Panel) and M. Uesaka (chair, ICFA Advanced and Novel Accelerator Panel)

Four general areas in future accelerator science and technology were considered that will either be driven by lasers or have a need for laser technology beyond today's state of the art : colliders for high-energy physics based on lasers; laser stripping for H- sources; light sources (such as X-ray free electron lasers), and medical ion therapy accelerators.

Requirements for laser performance in each of the four areas were established and a first look at laser technologies that could meet these requirements was reported. Further details can be found in the whitepaper.

ICAN, International Coherent Amplification Network, kick-off: a New European Community Program

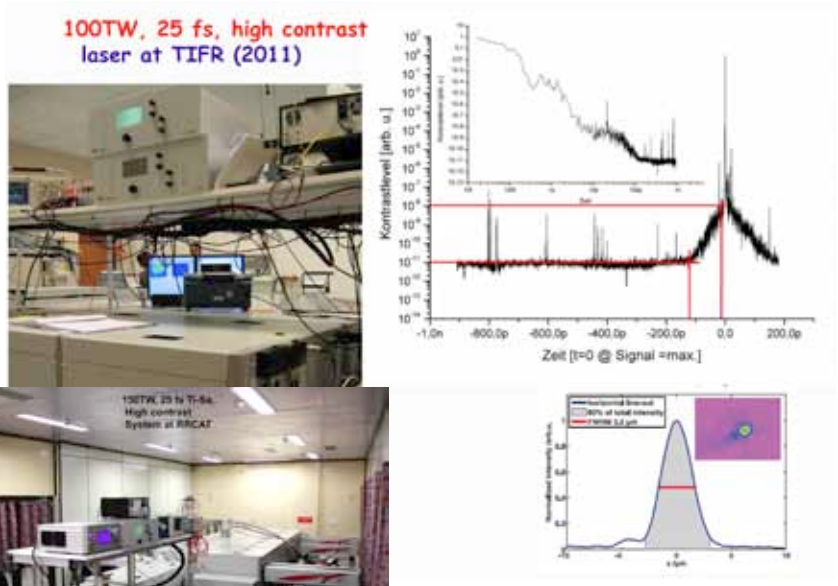
The ICAN project that was presented in ICUIL News n°2 was kicked off on 21-22 February 2012 at CERN. Solving the the sempiternal peak-average power and efficiency laser problem and opening the possibility to provide simultaneously high peak and high average powers will be of a considerable importance since it enlarges immediately the number of laser applications with an immediate pay off for science and society. It will open the laser to numerous new applications that are unreachable today.

The plan is to study for 18 months all aspects of this approach in order to evaluate if it is economically viable. The beneficiary-consortium is formed by the EP, ORC, FhG, and CERN backed up by a team of world experts coming from different areas of science and technology, like femtosecond fiber optics, instrumental optics, astronomy, manufacturing, and business. Although our primary target application will be particle acceleration for high-energy physics, we are conscious that our approach could be extended to the environment to treat nuclear waste, material science for radiographing parts, in medicine for imaging and treating cancer, but also for isotope production, THz archeology to visualize hidden frescos, paintings or texts. For energy this technology could be extended to thermonuclear fusion and fission drivers.

During the 18 months, 10worshops and conferences will be scheduled to address all ICAN' aspects. At the end of this conceptual study we will propose the full design of a demonstrator module capable to deliver, pulses, >10J energy, 100fs duration at >1kH repetition rate with >20% efficiency. With its 10kW of average power it would represent a landmark in utraintense laser technology and the gateway of numerous laser applications.

Ultra intense laser-driven research in India

India has taken significant strides in ultraintense laser science with the installation of a 100 TW, 25 fs Ti-sapphire laser at the Tata Institute of Fundamental Research (TIFR), Mumbai in 2011 and a similar, 150 TW laser at the Raja Ramanna Centre for Advanced Technology (RRCAT), Indore in 2012. The Bhabha Atomic Research Centre, Mumbai is also in the process of setting up an ultrahigh intensity laser lab. These institutions, well known for their research on basic laser-plasma interaction physics, physics of laser fusion, x-ray emission and its applications and particle acceleration, are gearing up to enter the petawatt regime in the next few years. TIFR plans to set up a high intensity laser center at its new campus in Hyderabad. While TIFR focuses on basic research, RRCAT and BARC are also involved in laser building and development. All these centres are integrating themselves into the global high intensity laser network and seek to become hubs for joint experiments with international researchers. For more discussions, please contact grk@tifr.res.in and panaik@rrcat.ernet.in or visit www.tifr.res.in/~uphill and www.rrcat.ernet.in/technology/laser/lpd/index.html



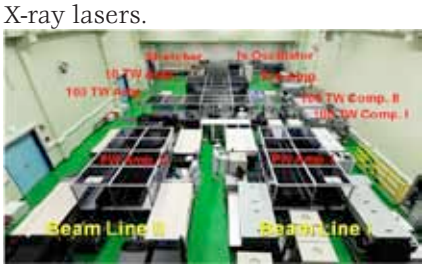
Korean Petawatt Laser System, "PULSER",

starts international users' service

The construction of the Korean femtosecond petawatt laser facility has been completed and the facility is now moving to the user service phase. In 2003, through the Ultrashort Quantum Beam Facility (UQBF) project (Project leader: Prof. Jongmin Lee), Korea started to construct a femtosecond PW laser facility for research on high field science. In 2010, the research team had demonstrated a Ti:sapphire-based CPA PW laser system for the first time in the world.

The research team has named the PW laser system as PULSER, which is an acronym of Petawatt Ultrashort Laser System for Extreme Science Research. Now in 2012, the PULSER has two PW beam lines and each beam line can deliver PW laser pulses at a repetition rate of 0.1 Hz : Beam Line I produces 1.1 PW (30-fs, 33-J) laser pulses1) and Beam Line II does 1.5 PW (30-fs, 44.5-J) laser pulses2).

The PULSER system is extended from a 100 TW laser system, which is now called LiFSA (Light Source for Femto/atto-Sciences and Applications). During the PW laser construction, the research team has performed many outstanding laser-plasma experiments with the LiFSA system, such as the generation of energetic particles (electron and proton) and the demonstration of grazing incidence pumping (GRIP) X-ray lasers.



Cylindrical and rectangular PW interaction chambers have been installed and tested on site. Using PW laser pulses, several landmark experiments such as multi-GeV electron beam generation and monoenergetic proton beam generation through radiation pressure acceleration (RPA) mechanism are being carried out for the research on high field science. Many other experiments in high field physics, including relativisitic high harmonic generation (RHOH) and generation of energetic photon (hard X-ray and gamma ray), are scheduled with the PULSER system.

The PW laser facility will be run as an international user facility and it is about to start up the users' service. International potential users can submit a research proposal at a certain period of time, which will be noticed later. For more detailed information on the laser system and how to get access, please contact at leejm@gist.ac.kr (Jongmin Lee).

References

1) J. H. Sung, S. K. Lee, T. J. Yu, T. M. Jeong, and J. Lee, "0.1 Hz, 1.0 PW Ti:sapphire laser," Opt. Lett. 35, 3021(2010).
2) T. J. Yu, S. K. Lee, J. H. Sung, J. W. Yoon, T. M. Jeong, and J. Lee, "Generation of high-contrast, 30 fs, 1.5 PW laser pulses from chirped-pulse amplification Ti:sapphire laser," Opt. Express 20, 10807(2012)

2011 LEI conference

Szeged (Hungary), September 2011

The LEI conference provides the scientific communities involved in various sub-fields of ELI with an opportunity of meeting and discussing the most important scientific achivements, theoretical predictions and site construction matters towards the implementation of the research infrastructures at the ELI sites of as well as the planning of the 200PW facility.

The 2011 LEI conference was held in Szeged (Hungary) in September 2011. The main topics covered short pulse and high intensity lasers, high harmonics and attosecond pulse generation and applications, laser based X-ray generation and applications, photonuclear physics, laser generated particle beams and applications and extreme field sciences.

7th IFSA Conference

Bordeaux (France), 12-16 September 2011

The Seventh Conference on Inertial Fusion Sciences and Applications was held at the Palais des Congrès in Bordeaux-Lac, France. The goal of IFSA 2011 is to bring together scientists in the fields of inertial fusion sciences, high energy density physics, and related applications.

In recent years, significant advances have been made in high energy density science, with dramatic achievements in laser, Z-pinch and particle beam technologies, and in research on central hot spot ignition and alternative fusion schemes (fast ignition, shock ignition, impact ignition,), equations of state and radiative properties of warm dense matter, or particle acceleration. Ignition and subsequent high gain target experiments have become realistic near-term goals with the construction of two large-scale national projects, the National Ignition Facility in the U.S.A., and the Laser MégaJoule in France. First National Ignition Campaigns have for instance provided hohlraum target and laser drive conditions suitable for compressing ICF capsules while reduced yields from THD cryogenic targets allowed fielding a suite of x-ray and neutron diagnostics to study thermonuclear fuel assembly. Fast ignition studies and the development of high-intensity lasers have opened the new field of relativistic laser-plasma interaction. The extreme states thus achieved will advance contributions to science and industrial applications such as material processing, novel accelerators, ultra-brigth ultra-short X-ray sources...

Ultrafast Optics 2011

Monterey, California, 26-30 September

The 8th biennial international Ultrafast Optics (http://ultrafastoptics2011.org/) conference was held in Monterey. The Ultrafast Optics meeting series specifically emphasizes the technology required to generate, measure and amplify ultrashort duration pulses. Approximately 150 technical attendees and nearly 2 dozen companies participated in the meeting. Included in the program were invited overviews of leading ultra-high intensity laser projects and facilities in France, England, South Korea, Japan, Russia, China and the United States. Keynote presentations reviewed ultrafast nonlinear optics, ultrafast solid state laser technology and imaging with high-order harmonic sources. Contributed and invited papers covered several topics of importance to intense laser operations and experiments including novel techniques for pulse cleaning and measurement. Representatives from Switzerland and China announced that their countries would host the 2013 and 2015 meetings respectively.

2011 Annual ICUIL General Assembly Meeting

Toshiki Tajima, Chris Barty , Wolfgang Sandner, Terry Kessler, Tsuneyuki Ozaki, Gerard Mourou, Hiroshi Azechi, John Collier, Thomas Kuehl, Ravi Kumar, Christine Labaune, Wim Leemans, Bedrich Rus, Heinrich Schwoerer, Alexander Sergeev, Zheng Ming Sheng, Ken-ichi Ueda

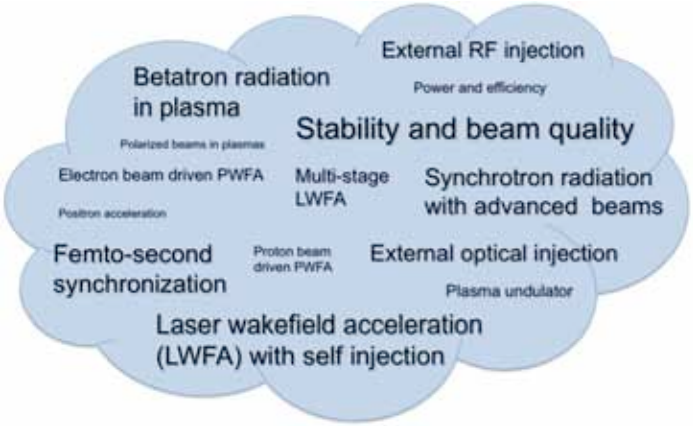
The annual ICUIL General Assembly meeting was held on the last day of the 2011 LEI Conference in Szeged, Hungary. Eleven ICUIL members participated in a productive three-hour meeting, exceeding quorum and completing an extensive agenda. Dino Jaroszynski summarized his presentation at IUPAP's annual 2011 GA meeting, which had included elements of ELI, IZEST, EuroNNAC and XCELS. He reported that genuine interest and enthusiasm was received by IUPAP members. ICUIL members unanimously voted to work with IUPAP in supporting the UNESCO initiative to request a United Nations proclamation of an International Year of Light in 2015. Chris Barty, standing in for Wim Leemans, summarized the progress of a 3 day workshop for the Joint Task Force (ICUIL/ICFA) at LBNL, highlighting publication of a white paper in the December issue of the ICFA beam dynamics newsletter. Progress on the 2012 Biennial Conference was presented by Daniel Ursescu, standing in for Dan Dumitras. The 5th ICUIL Conference will be held September 16-21, 2012 in Mamaia, Romania. This biennial meeting will focus on the generation, amplification, compression, and measurement of high-intensity pulses as well as applications. Gerard Mourou and Wolfgang Sandner reviewed the key technological bottlenecks including high damage threshold coatings and gratings, large aperture polarization switches, large aperture Ti:Sa crystals, and most critically, human resources. The ICUIL Chairman, Toshi Tajima concluded the meeting by initiating the process of member rotation that will occur at the annual ICUIL General Assembly meeting in 2012.

EuroNNAc 2012 Meeting

The European Network for Novel Accelerators (EuroNNAc) aims at sponsoring and developing ultra-compact accelerators based on novel acceleration technologies (http://www.cern.ch/euronnac-web). Novel high-gradient acceleration topics include for example laser-driven plasma wakefield acceleration but is not restricted to this. For example, the use of electron and proton beam drivers are included, as well as dielectric structures. The EuroNNAc network presently consists of 52 institutes in Europe, Asia and the US. From May 2 to 5 a meeting of the member's board was held at CERN. The agenda and the presentations are available on the INDICO web site: http://indico.cern.ch/conferenceDisplay.py?confId=187383

The coherent description of various test areas and the fostering of enhanced collaboration and technical exchange is one of the main objectives for EuroNNAc. The meeting therefore had a focus on discussing the ongoing research and facilities. The goal was to get a view on a possible distributed test facility formed out of the various individual activities.

As a first step the 14 most important technical goals were discussed and summarized. Fa-cilities in Europe were matched to these goals. Even though the collection of data is not yet complete, the results already allow a graphical visualization of research topics, as shown in the figure. The figure illustrates the areas of research where most focus is put and the areas that are not so well covered, for example several topics important for High Energy physics applications. The font size reflects the number of stars the activity received within the agreed EuroNNAc classification scheme.



IZEST, International Zettawatt-Exawatt Science and Technology Laser-based High-Field Fundamental Physics

IZEST aspires to play an important role in laser-Based High-Field Fundamental Physics. It intends to initiate a joint strategy, form coordination groups, and provide recommendations for the Exawatt facilities in the planning stage.

Fundamental High Energy Physics has been mainly driven by the high-energy fermionic colliding beam paradigm. Today the possibility to amplify laser to extreme energy and peak power offers, in addition to possibly more compact and cheaper ways to help HEP, a suit of complementary new alternatives underpinned by single shot, large field laser pulse, that together we could call Laser-based High Field Fundamental Physics.

The main mission of the International center on Zetta-Exawatt Science and Technology (IZEST) is to muster the scientific community behind this new concept. As an example, we project to use the laser field to probe the nonlinearity of vacuum due to nonlinearities and light-mass weak coupling fields such as Heisenberg-Euler QED, dark matter and dark energy. We envision that seeking the non-collider paradigm without large luminosity substantially shortens our time-line; we further accelerate the latter by adopting the existing large energy laser LIL. The accelerated research on the non-collider paradigm in TeV and beyond could, however stimulate innovation in collider thinking such as lower luminosity paths, novel radiation cooling, and gamma-gamma colliders. The advancement of intense short-pulsed laser energy by 2-3 orders of magnitude empowers us a tremendous potential of unprecedented discoveries. These include: TeV physics, physics beyond TeV, new light-mass weak-coupling field discovery potential, nonlinear QED and QCD fields, radiation physics in the vicinity of the Schwinger field, and zeptosecond dynamical spectroscopy of vacuum. In addition, we want to take advantage of the ultrashort particle or radiation pulses produced in the femto, atto, and zeptosecond timescale to perform a new type of particle/radiation precision metrology that would help to remove the uncertainty around the neutrino speed. Finally, the TeV particles that can be produced on demand could offer a new tool to TeV Astrophysics.

Today, a number of exawatt class facilities in Europe and in the world are already in the planning stage, like the ELI-Fourth Pillar and the Russian Mega Science Laser. IZEST should serve as a common platform opened to the international scientific community with a passion for this emerging opportuny and the desire to participate. IZEST headquarter will be located at the Ecole Polytechnique. The experimental program will be performed at the beginning on the most powerful European laser, the LIL and Petawatt laser at the CEA-CESTA in Bordeaux and on the Russian Exawatt once completed. It is expected that a large part of the work will also be carried out in the IZEST-associated laboratories around the world.

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