

MEMORANDUM OF UNDERSTANDING (MOU)
IZEST and UNIVERSITY OF STRATHCLYDE collaboration
towards Exawatt science

This Memorandum Of Understanding (MOU) is made on the ...17 FEB 2012 (hereinafter referred to as the "Effective date), by and between:

- **ECOLE POLYTECHNIQUE**, a French public organisation, having its address at Route de Saclay, 91120 Palaiseau, France, (hereinafter referred to as "EP") represented by Mr. Xavier MICHEL acting as General Director of Ecole Polytechnique and duly authorised for the purposes hereof,
- The **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, a French government-funded technological Research organisation having its headquarters located at « Bâtiment Le Ponant D – 25 rue Leblanc 75015 Paris France» (hereinafter referred to as «CEA») represented by Mr Thierry MASSARD acting as Scientific Director of CEA-Military Applications and duly authorized for the purpose hereof,
- **UNIVERSITY OF STRATHCLYDE**, incorporated by Royal Charter, a charitable body registered in Scotland with registration number SCO15263 and having its Principal Office at 16 Richmond Street, Glasgow, G1 1XQ

Hereinafter jointly or individually referred to as the "Parties" or a "Party".

WHEREAS EP and CEA act in their own name and in the name of IZEST (hereinafter referred to as the "IZEST") directed by Pr. Gérard MOUROU

WHEREAS EP has been, since more than 40 years, a key player in the laser field with its LULI – *Laboratoire d'Utilisation des Lasers Intenses* – (suppression of fast electrons by frequency doubling, detailed analysis of plasma instabilities, particle acceleration), LOA – *Laboratoire d'Optique Appliquée* – (particle acceleration) and more recently its ILE – *Institut de la Lumière Extrême* – which introduced the Extreme Light in France and in Europe with the program ELI.

WHEREAS CEA has played, since the first demonstrations of the laser 50 years ago, a pioneering role in the laser-matter interaction field with the demonstration of the first neutron and the CPA concept on a large laser chain (P102).

WHEREAS IZEST is the first international centre dedicated to the exploration of fundamental physics coming from the laser-matter interaction in the regime beyond Exawatt. It will be based on a new amplifier concept (C3 for Cascaded Conversion Compression) adapted, in particular, to the LIL or PETAL.

WHEREAS IZEST has an international vocation. Therefore, even if it has been originally designed at the initiative of two laboratories (one from the Research Centre of EP and one from the CEA / CESTA), it will seek to partner with appropriate international laboratories such as the INRS -ALLS to form a consortium capable of going into international competition and to support the project beyond Exawatt science.

WHEREAS University of Strathclyde is a University dedicated to fundamental and applied research, graduate studies, to the training of researchers and to knowledge exchange.

WHEREAS IZEST and University of Strathclyde sharing strong interests in the laser-matter interaction in high intensity regime.

WHEREAS IZEST having considerable know-how in the field of high power ultrafast lasers, its conception and their applications,

WHEREAS IZEST and University of Strathclyde decide to join their effort to contribute to the definition of the "Roadmap of the next generation of high intensity lasers" and taking part to the identification of new paradigms based on the Extreme Light. Two of the objectives will be the study of the Backward Raman Scattering Laser Amplification and of the Plasma Optic. (hereinafter referred to as the "PROJECT"),

THE PARTIES AGREE AS FOLLOWS:

DEFINITIONS

In this MOU, and its annexes, the words used in capital letters, shall have the following meanings unless otherwise and clearly indicated by the context:

BACKGROUND means the information which is held by the Parties prior to the conclusion of this MOU or acquired in parallel with it, as well as copyrights or rights pertaining to such information following applications for, or the issue of patents and any other industrial property title.

CONFIDENTIAL INFORMATION means information identified as or relating to the work of the PROJECT which is disclosed by one Party to another in physical form and which is clearly designated, labelled and marked as confidential, including but not limited to know-how, unpublished Intellectual Property Rights, and any other business and technical information disclosing in carrying out the work of the PROJECT. Information disclosed orally during the work of the PROJECT shall also be considered as confidential if it was identified as confidential at the time of such disclosure and confirmed in writing within 30 days after disclosure.

KNOWLEDGE means the results, including information, whether or not they can be protected, arising from the Project governing by this MOU, as well as copyrights or rights pertaining to such results following applications for, or the issue of patents, designs, or similar forms of protection.

1 OBJECTIVE OF THE PRESENT MOU

This MOU defines:

- the overall scope of the PROJECT,
- the main terms of the cooperation between the Parties,
- the schedule of the exchanges to setup the collaboration,
- the conditions under which confidential information shall be treated.

2 OVERALL SCOPE OF THE PROJECT

By signing this MOU the Parties agree to setup within the next six (6) months French-UK collaboration (hereinafter referred to as the PROJECT) towards Exawatt science.

The main goal of the interaction between IZEST and University of Strathclyde will be to contribute to the definition of the "Roadmap of the next generation of high intensity lasers" and to ensure the scientific and technical coordination of the international community eager to discover new paradigms based on extreme high intensity lasers. New types of laser will be designed and demonstrated to achieve the desired objectives. Particular attention will be devoted to the Fundamental Physics of High Energy Particles and Strong Fields and to the development of lasers with very high intensity.

3 INTELLECTUAL PROPERTY

3.1 BACKGROUND

Each Party remains the sole owner of its BACKGROUND.

3.2 KNOWLEDGE

The rules of the property and the dissemination of the KNOWLEDGE shall be defined on a case by case basis in the specific future agreements between the Parties.

4 FINANCIAL PROVISIONS

This Memorandum is exclusive of any financial flows. Each Party shall bear its own costs and expenses for all necessary actions to be taken to fulfil this MOU, notably the travel expenses of its staff. Hosting expenses will be at the charge of the receiving Party.

SCHEDULE

The Parties will make their best efforts within the next six months to setup the cooperation. Especially milestones, contributions (in cash and in kind) and timetables will be discussed within this time before the collaboration starts.

5 CONFIDENTIAL INFORMATION AND COMMUNICATION

5.1 CONFIDENTIAL INFORMATION

5.1.1. A recipient of CONFIDENTIAL INFORMATION shall:

- not disclose CONFIDENTIAL INFORMATION to any third Party without the prior consent of the disclosing party,
- restrict dissemination of CONFIDENTIAL INFORMATION to only those employees and contractors who need to know for the purposes of carrying out the work in accordance with this MOU and which are subject to confidentiality obligations substantially identical to the one of this MOU,
- use the same degree of care as for its own information of like importance, but at least use reasonable care, in safeguarding against disclosure of CONFIDENTIAL INFORMATION,
- use CONFIDENTIAL INFORMATION solely for the purposes of carrying out this agreement.

5.1.2 However, the provisions of this article shall not apply to information for which the receiving party can prove in writing that:

- such information is or has become publicly known through no wrongful act on its part ;
or
- such information is available to the public and already known to the receiving party at the time of disclosure by the disclosing party ; or
- such information was rightfully received by the receiving party from a third party without breach of the present article or any confidentiality obligation; or
- such information was independently developed or discovered by the receiving party without use of a CONFIDENTIAL INFORMATION; or
- CONFIDENTIAL INFORMATION is required to be disclosed to comply with applicable laws or regulations, or with a court or administrative order, provided that the disclosing party receives reasonable prior written notice of such disclosure.

5.1.3. Nothing in this MOU shall affect the ownership of any CONFIDENTIAL INFORMATION or any intellectual property rights therein which each Party makes available to the other under this MOU, nor shall anything herein constitute a license, express or implied, from the disclosing party to the other party to use any of the said CONFIDENTIAL INFORMATION or any intellectual property rights therein for any purpose other than the purpose of this MOU.

5.2 COMMUNICATION

In accordance with the provisions relating to confidentiality of the present MOU, any project of communication or publication related to the PROJECT by a Party shall be submitted to the prior agreement of the other Parties no later than fifteen days before the submission of such project to the publishing organisation. The absence of answer from the other Parties within the fifteen days shall be construed as an implied approval of the communication or publication project.

6 EFFECTIVE DATE – DURATION

6.1 This MOU shall be effective from its signing by the latest Party who signs hereunder (hereinafter the “Effective date”) and shall expire after twelve months unless or until expressly superseded by a further agreement between the Parties.

The MoU shall be extended upon written agreement of the Parties and for a duration to be defined by the Parties.

It shall be rescinded by mutual consent by the Parties.

6.2 The provisions of articles 3 and 5 of this MOU shall remain in full force and effect for their own durations from the expiration or the earlier termination of this MOU.

6.3 Upon expiration or termination of this MOU, and at the first request from the disclosing party, the receiving party undertakes to return all tangible copies of CONFIDENTIAL INFORMATION received. In case it would not be possible, the receiving party shall provide a declaration of the destruction of such copies of CONFIDENTIAL INFORMATION, according to the written request of the disclosing party.

6.4 In every case, the receiving party shall not use any longer any CONFIDENTIAL INFORMATION from the normal or early term of this MOU.

6.5 One Party has the right to terminate this MOU by giving three months written notice prior to the end of the calendar year to the PROJECT.

No compensation of any kind shall be payable to the Party at or in consequence of its lawful termination by the Project.

7 GOVERNING LAW – DISPUTES

7.1. This MOU shall be governed by and construed in accordance with the laws of France.

7.2. Any dispute as may arise between the Parties hereto in connection with this MOU, which cannot be resolved amicably between the Parties, shall be submitted to the exclusive jurisdiction of the Courts of Paris, France.

8 **MISCELLANEOUS**

8.1. No failure to exercise or delay in the exercise of any right which the Parties may have, under this MOU or in connection with it, shall operate as a waiver thereof, nor shall any total or partial exercise of any such right prevent from any further or other exercise thereof or of any other such right.

8.2. In the event any one of the provisions of the MOU is held to be unenforceable under applicable law:

- such unenforceability shall not affect any other provision of the MOU; and
- the MOU shall be construed as if said unenforceable provision had not been contained herein; and
- the Parties shall discuss in good faith to replace the unenforceable provision with an enforceable provision, which has the effect nearest to that of the provision being replaced.

8.3. The Parties shall not amend this MOU except in writing.

8.4. Except as otherwise provided for in this MOU, none of the Parties shall assign or transfer any right acquired, granted, transferred or imparted to it hereunder to any third party, firm or corporation without the prior written consent of the other Party, which consent shall not be unreasonably withheld or delayed.

8.5. The Parties to this MOU shall remain independent contractors. Nothing contained in this MOU shall be construed or interpreted as a joint venture or agency relationship among the Parties.

IN WITNESS WHEREOF, the Parties have caused this MOU to be duly executed by their respective officers or representatives.

Made in three original copies,



For the **ECOLE POLYTECHNIQUE**
Name M. Xavier MICHEL
Position General Director
Date
Signature 14 FEV. 2012



Yves GNANOU
Le Directeur Général Adjoint
Chargé de la Recherche

Par intérim

For the **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**

Name M. Thierry MASSARD
Position Scientific Director of CEA - Military Applications
Date 17/2/2012
Signature



For the **UNIVERSITY OF STRATHCLYDE**

Name KENNETH MILLER
Position VICE PRINCIPAL
Date 17/2/12
Signature



Annex 1 – Technical description

Our work will work on unifying Ultrahigh Intensity Laser, Particle Physics and Plasma Physics. Strathclyde, and IZEST will work with Accelerator Physics Centres such as the John Adams Institute, KEK, and CERN. Our work will benefit from the exceptional contribution of the CEA-CESTA that will make available to us the world's largest available laser, i.e. PETAL coupled to the MegaJoule laser.

Our effort will be two-pronged. We *first* plan to demonstrate that state-of-the-art laser facilities could offer the possibility of producing electrons above 100 GeV, and ions to GeV level. It will be the prelude of laser-based high energy physics and the first step towards the TeV and beyond. The preparatory experiments will be done at the 100 TW level at Strathclyde and be extended on larger systems such as at GSI to finally be implemented on PETAL.

In parallel, encouraged by recent experiments showing that plasmas can be used as amplifying and focusing elements, such as those at Strathclyde (*), a novel laser technique called C3 for Cascaded Compression Conversion (***) will be tested. This novel approach will be developed in a staged manner, first at Strathclyde at the 100 TW level for a final implementation on PETAL where it could produce 100 PW, with the potential to go to the exawatt and beyond. These pulses will provide the strongest fields possible in the world and will be the gateway to extreme QED. Furthermore, combined with the 100 GeV electron beams to provide extremely high energy gammas and could bring laser physics from the eV level to the TeV and possibly PeV regime.

*) 10. G. Vieux, A. Lyachev, X. Yang, B. Ersfeld, J. P. Farmer, E. Brunetti, R. C. Issac, G. Raj, G. H. Welsh, S. M. Wiggins, and DA Jaroszynski, "Chirped pulse Raman amplification in plasma", New J. Phys. 13, 063042 (2011). and B Ersfeld & DA Jaroszynski, "Raman backscattering of a chirped pump in plasma", Phys. Rev. Lett. 95, 165002 (2005)

**) G.A. Mourou, N.J. Fisch, V.M. Malkin, Z. Toroker, E.A. Khazanov, A.M. Sergeev, T.. Tajima, B. Le Garrec, Exawatt-Zettawatt pulse generation and applications, Optics Communications 285 (2012) 720–724