Spécialité de Master « Optique, Matière, Paris »

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 01/10/2018

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Code d'identification :LiDYL Organisme :CEA

Site Internet / *web site*: http://iramis.cea.fr/LIDYL/
Adresse / *address:* CEA Saclay, 91191, Gif-Sur-Yvette, France
Lieu du stage / *internship place*: CEA Saclay

Internship title: Plasma mirrors on-chip : "towards extreme intensity light sources/compact particle accelerators"

Résumé / *summary*

With the advent of PetaWatt (PW) class lasers capable of achieving light intensities of 10^{22}W.cm^{-2} at which matter turns into a plasma, Ultra-High Intensity (UHI) physics now aims at solving two major challenges: can we produce high-charge compact particle accelerators with high-beam quality that will be essential to push forward the horizons of high energy science? Can we reach extreme light intensities approaching the Schwinger limit 10^{29}W.cm^{-2}, beyond which light self-focuses in vacuum and electron-positrons pairs are produced? Solving these major questions with the current generation of high-power lasers will require conceptual breakthroughs that I intend to develop with the help of a team of PhD students and MSc interns in the next five years.

In particular, I aim to show that so-called 'relativistic plasma mirrors', produced when a high-power laser hits a solid target, can provide simple and elegant paths to solve these two challenges. Upon reflection on a plasma mirror surface, lasers can produce high-charge relativistic electron bunches and bright short-wavelength attosecond harmonic beams. Could we use plasma mirrors to tightly focus harmonic beams and reach extreme light intensities, potentially approaching the Schwinger limit? Could we employ plasma mirrors as high-charge electron injectors in a PW laser capable of delivering accelerating gradients of 100TV.m-1, or in a laser wakefield accelerator, to build ultra-compact particle accelerators?

In this proposal, PhD/MSc candidates will answer these interrogations 'on-chip' using massively parallel simulations on the largest supercomputers in the world, to help devise/validate novel and readily-applicable solutions based on plasma mirrors. To this end, the successful candidates will make use of our recent transformative developments in 'first principles' Particle-In-Cell (PIC) simulations of UHI laser-plasma interactions that enabled the 3D modelling of plasma mirror sources with high-fidelity on current petascale and future exascale supercomputers

Candidates will have access to cutting-edge computing resources on US-based supercomputers (MIRA and THETA at Argonne Leadership Computing Facility) that are amongst the top 10 supercomputers worldwide. They will run large-scale PIC simulations with our 3D PIC code PICSAR (https://picsar.net) and visualize/interpret simulation results to help developing physical models of the laser/plasma mirror interaction.

This proposal implies strong collaboration (especially on the particle acceleration side) with Dr. J-L Vay's group at Lawrence Berkeley National Laboratory and possible student exchanges between the two groups during the internship/PhD.

Requirements: Ideal PhD candidates should have a solid background in Plasma physics and parallel computer programming. All candidates should be proficient in English.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Oui**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **Oui**

Lumière, Matière, Interactions	x	Lasers, Optique, Matière	x

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