Postdoc position in modeling and numerical computing of intense terahertz photonic sources

Project description

The project is funded by CEA-France.

Topic

When petawatt femtosecond laser pulses interact with a solid target at intensity larger than 10^{20} W/cm^2, the electrons accelerated by the laser ponderomotive force become relativistic and generate a broad spectrum of intense radiations, ranging from X/gamma photons down to Giga-/Tera-Hertz waves through various nonlinear conversion mechanisms driven by particle acceleration. Subsequent plasma expansion and ion acceleration are expected to produce intense bursts of electromagnetic waves as well [1].

The present post-doc position aims at exploring theoretically and numerically the conversion processes leading to giant electromagnetic pulses that belong to the terahertz frequency domain by means of analytical modeling and particle-in-cell simulations.

The possibility of designing high-power emitters operating in the terahertz frequency band is attracting more and more interest over the world for a broad range of applications, including coherent molecular spectroscopy, medical imaging for cancer detection, cosmology, homeland security and environmental monitoring. Reframed into the context of inertial fusion confinement (ICF), the generation of intense electromagnetic pulses with GHz-THz frequencies is harmful for any electronic device close to the plasma zone and for the diagnostics used on large-scale ICF facilities like the PETAL/LMJ laser in Aquitaine region [2]. It is thus necessary to understand their generation mechanisms and related efficiencies to find appropriate technological solutions. Besides, the processes responsible for this violent electromagnetic field emission may lead to the routine production of intense THz waves with field strength above 10 GV/m, which should open the route to new exciting developments in particle acceleration or for modifying some properties of condensed materials [3].

Your position

Your work will aim at studying the generation of giant THz/GHz electromagnetic pulses by petawatt laser pulses interacting with solid targets, encompassing wires and foils irradiated at different incident angles. You will build up models describing different laser-to-THz/GHz conversion mechanisms (coherent transition radiation, shielding surface currents, sheath radiation, antenna-type emissions). Particular attention will be given to the performance and angular distribution of the radiated THz power associated with each conversion mechanism. Although mainly oriented towards modeling activities and numerical simulations, you will also contribute to the interpretation of experiments carried out on the CELIA facility ECLIPSE IV [4] and evaluate the efficiency of various laser-to-THz conversion targets.

Familiar with the physics of relativistic plasmas and particle acceleration by ultrahigh intensity lasers, you will invest in the kinetic, particle-in-cell code CALDER adapted to describe radiation originating from different electron/ion populations and will contribute to refine target charging models available in the literature. This work will be done in cooperation with researchers at CEA-DIF and CELIA [3,5] who will guide you to map different THz emissions related to the various populations of accelerated particles according to their energy range, associated charge currents and characteristic time scales. Your novel interaction schemes will be simulated on the massively parallel supercomputers of CEA/TGCC, which hosts the most advanced European prototypes for Peta- and Exa-scale computing, before being confronted with experimental data.

Your profile
Our research is highly interdisciplinary and collaborative. We therefore strive to create an inclusive, supportive and enthusiastic work environment that values a team with diverse interests and personal backgrounds. For this position, the candidate must have:
- A university degree in plasma physics,
- Experience in scientific computing, with an ability to handle advanced simulation or programming codes (Python, Fortran, C++).

The position is available from October 2024 or earlier, depending on the availability of the selected candidate.

We offer you
- Close supervision of your work within a young research group,
- An interdisciplinary and collaborative work environment with a diverse range of tasks
- Training in theoretical physics and numerical simulation with access to the most efficient supercomputers in France and Europe,
- A competitive salary and working conditions following French university standards,
- An international environment, a wide range of cultural activities and an exceptional quality of life close to Bordeaux and the Arcachon Bay.

Application and contact
Please send your application to the email addresses below as a single pdf file containing the following items:
- A motivation letter that describes your suitability for the position (one A4 page)
- Your curriculum vitae (including a list of publications)
- Scanned transcripts of your B.Sc. and M.Sc. degrees including grades
- The names and contact details of at least two referees who can recommend you.

The position will be open until a suitable candidate is found.

Contact
Luc Bergé – luc.berge@cea.fr or luc.berge@u-bordeaux.fr – CEA-DIF, Arpajon, France & Centre Lasers Intenses et Applications, Univ. Bordeaux, CNRS, CEA, 33405 Talence, France.
Emmanuel D'Humières – emmanuel.dhumières@u-bordeaux.fr – Centre Lasers Intenses et Applications, Univ. Bordeaux, CNRS, CEA, 33405 Talence, France.

[1] J. Déchard et al., Phys. Plasmas **27**, 093105 (2020)
[2] A. Poyé et al., Phys. Rev. E **91**, 043106 (2015)
[3] P. Salén et al., Phys. Reports **836–837**, 1-74 (2019)
[4] M. Ehret et al., Phys. Plasmas **30**, 013105 (2023)
[5] E. Denoual et al., Phys. Rev. E **108**, 065211 (2023)

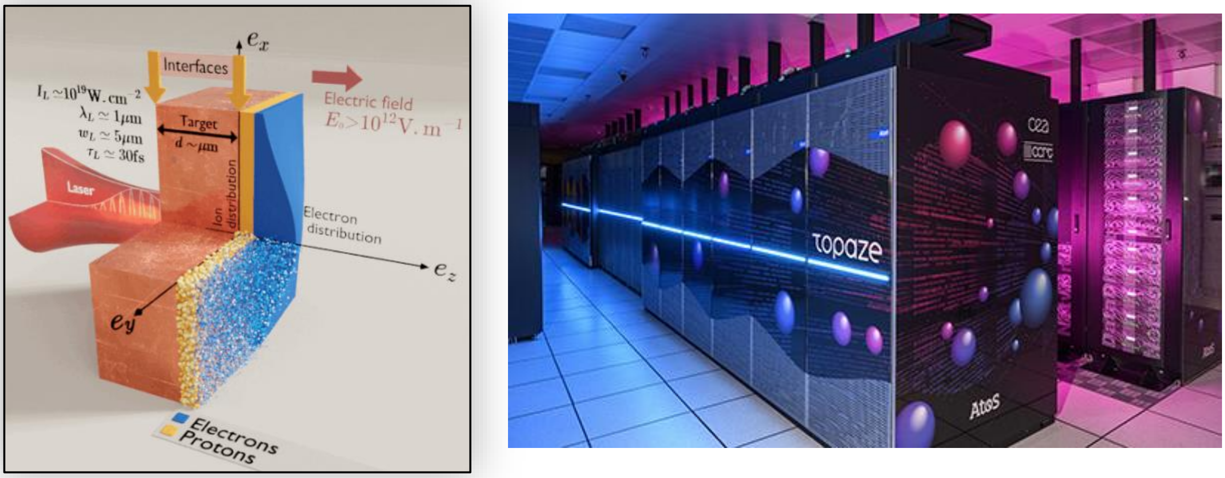

FIG 1. Left: Schematic representation of the acceleration of electrons then protons by TNSA (Target Normal Sheath-Acceleration) process in ultra-high intensity laser-solid interaction (credit: E. Denoual). Right: Supercomputer facilities at TGCC/CEA-DAM (credit: CEA/CADAM).