Title: **Relativistic laser-plasma interaction**
Acronym: O7
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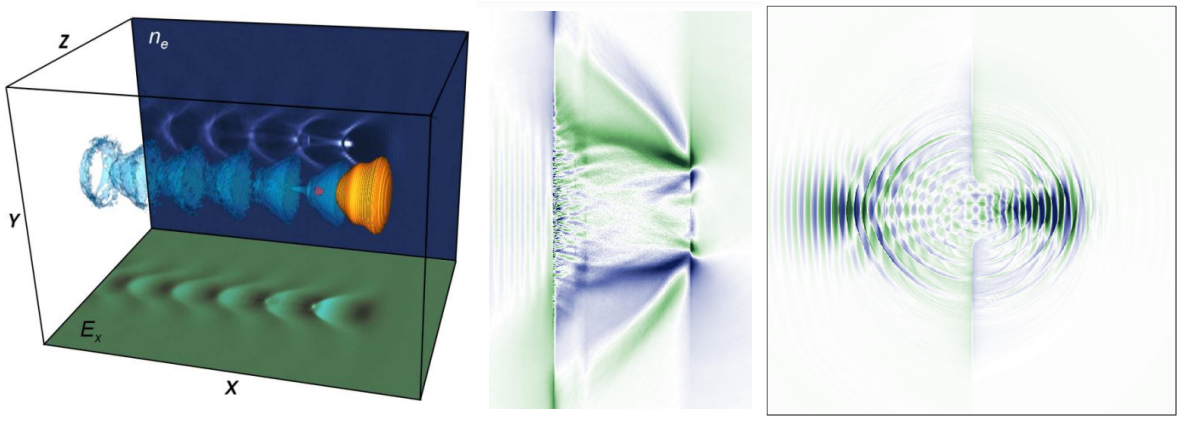
Prerequisites: First year of MSc in Physics or Engineering Schools.
Credits: 3 ECTS
Language: French/English
Keywords: Laser-generated plasmas. Laser-driven particle acceleration. Laser-plasma and beam-plasma instabilities.



The inception of ultrahigh-intensity lasers, delivering pulses of duration ranging from a few femtosecond to a few picoseconds and intensity exceeding $10^{18}\mathrm{Wcm}^{-2}$, unlocked the exploration of relativistic light-matter interactions, whereby the target electrons, accelerated to near-speed-of-light velocities, trigger a wealth of collective, radiative or nuclear processes. This research field has seen a boom in the past two decades due to the unprecedentedly extreme conditions that ultra-intense lasers can achieve, the unrivalled properties (brevity, energy density, etc.) of the generated particle and photon sources, and the growing number of applications of the latter in physics and beyond. The coming into operation of a new breed of multipetawatt laser facilities in Europe (e.g. Apollon in France) and Asia will further multiply the already many spin-offs of relativistic laser-plasma interactions. The purpose of this course is to provide the student with an in-depth review of the main concepts and phenomena underpinning this research field.

The following topics will be addressed:
- Electron dynamics in an intense laser wave in vacuum.
- Dispersion relation of an intense laser wave and self-induced relativistic transparency.
- Relativistic self-focusing of a laser wave.
- Relativistic laser-plasma instabilities.
- Laser-driven plasma wakefields and associated electron acceleration.
- Betatron radiation in plasma wakefields and inverse Compton scattering of laser light by wakefield-accelerated electrons.
- Electron heating in overcritical laser-plasma interactions.
- Relativistic plasma mirror and high-order harmonic generation.
- Transport of a high-current electron beam in a dense plasma: Alfvén's limit, generation of resistive fields, beam deceleration and plasma heating.
- Electron beam-plasma instabilities.
- Laser-driven ion acceleration.