Laboratoire de physique subatomique et des technologies associées
Unité Mixte de Recherche 6457
IMT Atlantique – CNRS / Nucléaire & Particules – Nantes Université

Internship proposal Master 2 (2026-2027)

Title : Towards the analysis of γ spectra emitted by high Z converters as a diagnostic for laser-plasma accelerated electron sources

Context:

Laser Plasma acceleration (LPA) enables the generation of a versatile source of particles and radiation (electrons, ions and γ) over a broad energy range. Among other applications, it triggers a strong interest towards the production of radioisotopes, specifically those relevant for medical application purposes. Most production means for these nuclides (nuclear reactors and cyclotrons) are indeed fully exploited for the generation of isotopes massively used to diagnose and treat patients. This leads to a production of promising radioisotopes, that require in depth studies, which is marginal on these facilities. Some installations have dedicated research programs to investigate the production of innovative isotopes (Arronax, Cyrcé, …) but these facilities are too few to cover the currently growing demand. Developing a complementary and versatile accelerator, able to produce moderate quantities of isotopes is perfectly relevant in this context. LPA could represent this new opportunity. It does not only meet the requirement in terms of versatility of the source but it could also offer a more compact alternative, the accelerating medium representing a volume of a few cm_3 thanks to accelerating fields 3 orders of magnitude higher than in conventional facilities. This latter point could lead to a much lighter dismantling procedure for this type of installation both in terms of costs and complexity when compared to conventional accelerators. Nevertheless, the properties of the LPA particle beams are very different from their conventional counterparts: the average current is typically much lower, which is why the production of small quantities of isotopes is considered here, and the energy dispersion is significantly higher. This can lead to the production of undesired isotopes during the irradiation preventing the use of the samples in a medical context. Precisely characterizing the energy distribution of the particle beam is then of primary importance. When considering electron beams to produce radionuclides, a high-Z converter is required to obtain a gamma source able to trigger nuclear reactions. During previous experiments involving electron sources, two distinct converters material were used: tantalum and tungsten. Tracing back information on the electrons' energy from γ spectrometry measurements of these converters seems to be a promising route that we would like to investigate. This internship will take place in the context of a European research project (EIC-Pathfinder Open, EUROPA: lasEr-driven Universal Radio-isOtope Production Accelerator, https://europa-project.eu/) that started in April 2026 and that will last for 4 years.

Aim of the internship:

We propose the student to integrate the PRISMA (Physics of Radiation Interaction with Matter and Applications) team to contribute to the existing effort on the study of the potential of LPA for the production of radioisotopes in the medical context. He/she will work on:

- Conducting a literature review on the subject to familiarize with the proposed methodology.
- The identification of the isotopes generated within the converter during the irradiation and the estimation of the associated activity based on the analysis of the recorded γ spectra.
- Using the Monte Carlo code PHITS to compare the predicted isotopes with the experimental data and retrieve information on the spectral features of the incoming electron beam.

Duration and salary: 6 months, paid internship

Supervisor:

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Location:

Subatech laboratory (laboratoire de physique SUBAtomique et des TECHnologies associées, Nantes Université, IMT Atlantique, CNRS), Nantes

PhD thesis: Possible