Topic: **Design and Optical Characterization of Density-Tailored Gas Targets for Laser-Plasma Accelerators and Compact X-ray Sources**

Type of work: BSc. Thesis, Research Project, MSc. Thesis

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Abstract:

Laser-Plasma Accelerators (LPA) offer a compact and efficient approach to generating high-energy electron beams, with key applications in producing high-brightness X-ray sources for imaging fast dynamic processes. The performance of these systems critically depends on precise control of plasma density profiles. Implementing density-tailored gas targets with controlled up-ramps and down-ramps can significantly enhance electron injection and, consequently, increase the resulting X-ray flux.

Our group has developed a high-sensitivity interferometric station based on four-pass probing with relay-imaging for high-resolution tomography of gas jets. While effective for symmetric or thin jets, this technique faces limitations when applied to extended nozzles (>1 cm) in both symmetric and asymmetric configurations—commonly required for optimal LPA performance.

This project aims to develop a robust interferometric technique capable of accurately resolving complex and extended gas density profiles. The novel advanced gas targets will be implemented in LPA beamlines such as **ELI Gammatron** and ELBA, contributing to the development of next-generation compact accelerators and synchrotron X-ray sources. Additionally, selected targets will be employed in high-energy-density (HED) and laboratory astrophysics experiments at the **Plasma Physics Platform** at the ELI Beamlines facility. The student will have unique access to these world-class experimental infrastructures and the opportunity to collaborate with the teams operating the state-of-the-art laser systems and secondary radiation sources—gaining hands-on experience at the forefront of laser-plasma physics research.