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ELIMAIA User Beamline: Dedicated Platform for Applications Using Laser-Driven Ion Beams

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Laser-driven ion sources are emerging as a compact and complementary alternative to conventional accelerators due to their unique features, including ultra-short bunch duration, ultrahigh dose rate, and low emittance. Over the past decade, research efforts have focused on optimizing key beam parameters (energy, flux, divergence, and shot-to-shot stability) to meet application demands.

The Extreme Light Infrastructure (ELI) ERIC is a pan-European research consortium dedicated to multidisciplinary applications of ultra-intense, ultra-short laser pulses. The ELI Beamlines Facility hosts various secondary particle and radiation sources, including an ion acceleration beamline, available to international users.

The ELIMAIA Beamline uses the L3-HAPLS laser system, achieving relativistic intensities up to $5 \cdot 10^{21}\ W/cm^2$. Commissioning experiments with solid foil targets have demonstrated proton fluxes above $10^{11}\ protons/shot/sr$ and cut-off energies exceeding $40\ MeV$. ELIMAIA supports research on ion acceleration mechanisms, high-repetition-rate targets, machine learning, nuclear reactions, and electromagnetic pulse studies.

The ELIMED Beamline, an end-station connected to ELIMAIA, provides controlled sample irradiation with a magnetic optics system for beam transport and energy selection. It is designed to deliver tailored ion beams for medical research (e.g. cancer therapy), radiobiology, radiation testing of electronics, material science, and cultural heritage studies, particularly in the ultra-high dose rate regime.

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