Multi-Petawatt Lasers and Ultra-High Energy Electrons as Tools for Fundamental Physics Research at ELI-Beamlines

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The recent development of high-power ultrashort petawatt and multi-petawatt laser systems pushed the boundaries of laser wakefield acceleration (LWFA) of ultra-short (fs) electrons to 10 GeV, thanks to its extremely high accelerating gradients ($>$ 100 MeV/mm) and consequently opened the way for innovative studies of fundamental physics problems. These last can be identified in electron-laser collisions and pair generation for studying nonlinear Breit-Wheeler process, quantum vacuum, as well as in the generation of ultra-relativistic muon beams. In the talk I will present the two high-power unique lasers available at ELI-Beamlines: L3-HAPLS (30 J, 30 fs, 10 Hz, 1 PW) and L4-Aton (1.5 kJ, 150 fs, 100s shots/day, 10 PW) together with the recently commissioned ELBA beamline.

ELBA is a unique platform for state-of-the-art LWFA, where the L3 laser pulses are split in two by a 50:50 wavefront splitting mirror: the central part of the beam is focused by a 10-meter focal length off-axis parabola into a gas jet to generate multi tens of GeV electron energy beams while the outer part of the beam can be focused on the electron beam by a f/1.5 off-axis parabola with a hole. Future plans and studies to accommodate experiments with the 10 PW laser and to generate muon beams to tens of GeV energy range will be introduced.