1 kHz Laser-Driven High-Energy Ultra-Relativistic Electron Beams

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The extremely high electric fields sustainable by plasma make the Laser Wakefield Acceleration (LWFA) the most compact technique to generate very highly relativistic electron beams in the MeV-to-GeV regime. However, the limited repetition rate and low efficiency of this technology has, to date, prevented people from unleashing its full potential as a unique source for basic research, biomedical applications and high flux sources of secondary radiations as hard X-rays.

In recent years a new direction emerged showing the possibility to accelerate electron beams at 1 kHz repetition rate. In this talk I will show the generation of unprecedented, collimated (2 mrad divergence), and quasi-monoenergetic (25% energy spread) electron beams with at a record energy up to 50 MeV at 1 kHz repetition rate. Said innovative results have been achieved in the new Laser Wakefield ALFA platform open for user experiments developed at ELI-Beamlines. The driver for the accelerator is the in-house developed L1-Allegra 1 kHz multi-cycle (15 fs FWHM) laser system. The acceleration was driven by 1.7 TW pulses but, thanks to its modular OPCPA (Optical Parametric Chirped Pulse Amplification) design, the system is scalable to above 5 TW.

The electron beams reported in this work are a step forward towards the development of in-demand high brilliance X-ray sources for medical imaging and high dose rate machines for radiotherapy based on high energy electrons.