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Energy Compression of a Laser-Plasma Accelerator

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Laser-Plasma accelerators (LPAs) promise a compact alternative to modern RF-technology, and support orders of magnitude higher electric fields. GeV-energy LPA electron beams from cm-scale sources have been demonstrated. The intrinsically short scale of the accelerating structure features femtosecond-long beams with kA peak current, but at the same time makes precise control of the beam properties a challenge. In particular, the central energy jitter and energy spread, both on the percent-level, have so far prevented LPAs to drive real-world applications.

Here, we present active energy compression of a laser-plasma accelerated electron beam.
At the LUX experiment at DESY, a dipole chicane stretches the beams in time and thereby imprints an energy-time correlation (a chirp), which is subsequently removed inside a RF cavity. Our setup reduces the fluctuation in central energy as well as the energy spread of the beams by more than an order of magnitude down to the permille-level.
The achieved performance-level –so far only attributed to modern RF based accelerators –opens the door for a variety of applications, such as compact plasma-based injectors for synchrotron storage rings.

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