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Polarized Beams from Laser-Plasma Accelerators

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The generation of polarized particle beams still relies on conventional particle accelerators, which are typically very large in scale and budget. Concepts based on laser-driven wake-field acceleration have strongly been promoted during the last decades. Despite many advances in the understanding of fundamental physical phenomena, one largely unexplored issue is how the particle spins are influenced by the huge magnetic fields of the plasmas and, thus, how highly polarized beams can be produced. The realization of laser-plasma based accelerators for polarized beams is now being pursued as a joint effort of groups from Forschungszentrum Jülich (Germany), University of Crete (Greece), and SIOM Shanghai (China) within the ATHENA consortium. As a first step, we have theoretically investigated and identified the mechanisms that influence the beam polarization in laser-plasma accelerators. We then carried out a set of Particle-in-cell simulations on the acceleration of electrons and proton beams from gaseous and foil targets. We could show that intense polarized beams may be produced if pre-polarized targets of high density are employed. Such polarized sources for electrons, protons, deuterons and 3He ions are now being built in Jülich. Proof-of-principle measurements at the (multi-)PW laser facilities PHELIX (GSI Darmstadt) and SULF (Shanghai) are in preparation.

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