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Compact, quality-preserving energy booster for intense laser-plasma ion sources

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Ion beams from laser-driven plasma sources can provide ultra-short (10s of fs for 10s of MeV), ultra-low slice emittance (10s of nm), and high-charge (100s of pC) properties. Demonstrated maximum energies for laser-ion sources are just short of those needed for pivotal applications, such as proton tumor therapy. Here, a robust and energy-scalable concept is presented that could boost the energy of an ultra-intense ion bunch through multiple stages to 100s of MeV/u and even towards the relativistic regime, using identical plasma booster stages based on magnetic vortex acceleration. Electromagnetic, full-3D particle-in-cell simulations are used to demonstrate the capability to capture, accelerate, and preserve the quality of a high-charge (200 pC), 20 nm emittance proton bunch, where both source and booster stages could be realized with capabilities of existing laser facilities.

Footnotes

Preprint:
Marco Garten, Stepan S. Bulanov, Sahel Hakimi, Lieselotte Obst-Huebl, Chad E. Mitchell, Carl Schroeder, Eric Esarey, Cameron G. R. Geddes, Jean-Luc Vay, and Axel Huebl. "A Laser-Plasma Ion Beam Booster Based on Hollow-Channel Magnetic Vortex Acceleration", submitted (2023) https://arxiv.org/abs/2308.04745

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