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Optimum and Controllable Multi-stage Proton Acceleration Manipulated by Double Beam Image Technique WENPENG WANG, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences — With the development of ultra-intense laser technology, laser intensity can increase up to the order of $\sim 10^{22}$ W/cm² in the laboratory. Ion beams in the MeV range and even the GeV range, driven by terawatt or petawatt lasers, exhibit ultra-short pulse duration, excellent emission, and ultra-high peak current. Thus, they can potentially be applied in fast ignition of inertial confinement fusion, medical therapy, proton imaging, and pre-accelerators for conventional acceleration devices. However, the generation of quasi-monoenergetic proton beams for realistic applications is still an experimental challenge. Here, the optimum and controllable two-stage proton acceleration is realized for the first time by a novel double beam image (DBI) technique in experiment. Two laser pulses are successfully tuned on two separated foils with both spatial collineation and time synchronizing, resulting in spectrum tailoring and an energy increase at the same time. Such a novel DBI technique can help us to realize the optimum two-stage acceleration in a feasible way, which opens the door for the exact manipulation of multi-stage acceleration to further improve the energy and spectra of particle beams.

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