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Energetic protons due to effective target heating from a near-critical plasma sphere using an ultra-short intense laser

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The prime challenge of laser-plasma based accelerators at the moment is to optimise the particle beams to obtain a steady mono-energetic and collimated bunch of energetic particles with the maximum possible efficiency. The present work is dedicated to optimising the laser and plasma parameters, and examining the ion acceleration processes that are present due to the laser plasma interactions. A 3D PIC simulation is performed using an ultra-short high intensity laser and a mass-limited near-critical plasma target. The focused laser energy due to the use of mass-limited target facilitates hot electron production. Effective electron heating and re-circulations helps in the formation of shocks which pushes the sheath accelerated protons further. Protons from a rectangular foil shaped target has been compared to those from a spherical target having the same dimensions. The target geometry has been observed to play a pivotal role in obtaining energetic protons. The curved front surface of the spherical target focuses the proton beam, whereas the curved rear surface hinders electrostatic sheath formation. Thus, the spherical target is favorable for the formation of quasi-monoenergetic beams of higher energetic protons due to a combined effect of various acceleration mechanisms, compared to a foil planar target.

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