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Generation and focusing of short pulse high intensity laser accelerated protons[1]

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Much progress has recently been reported in generating MeV energy protons from intense laser-matter interactions, having potential applications in areas such as radiography, oncology, and ion-proton beam fast ignition. Experiments were conducted on the sub-ps LANL Trident laser, where we systematically investigated proton focusing and conversion efficiency from curved surface targets in both open and closed cone-shaped target geometries. We clearly show that the focusing is strongly affected by the electric fields in the beam, bending the trajectories near the axis. We also find that in the cone geometry, a sheath electric field effectively "channels" the proton beam through the cone tip, substantially improving the beam focusing properties. The far-field energy and angular distribution of the proton beam were measured using a mesh that images the beam onto a RCF detector. For the cone-shaped targets using a 300 μm-radius curved surface foil, a 60 μm diameter proton spot was determined. Proton generation and focusing were modeled using 2-D hybrid PIC simulations, which compared well with RCF data. The proton conversion efficiency varied strongly with the target geometry. Simulations indicate this is due to that charge flow on the structure and the coupling to the hot electrons and electric fields in the plasma.

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