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Ion acceleration beyond 100MeV/amu in relativistic transparent laser-matter interactions

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The ultra-high contrast and relativistic intensities (>10^20 W/cm2) available at the LANL Trident laser for the first time allowed sub-micron solid matter laser interaction dominated by relativistic transparency of the target. This interaction efficiently couples laser momentum into all target ion species, making it a promising and competitive alternative to conventional accelerators on a much wider basis. However, little experimental research or simulations have up to now studied conversion efficiency or beam distributions, which is essential for advanced application, such as ion based fast ignition (IFI) or hadron cancer therapy. We here present experimental data addressing these aspects for both carbon C6+ ions and protons in comparison with the TNSA regime. Unique high resolution measurements of angularly resolved carbon C6+ and proton energy spectra for targets ranging from 30 nm to 25 micron - recorded with an ion wide angle spectrometer - are presented and used to derive thickness scaling estimates. While the measured conversion efficiency for C6+ reaches up to ~7%, peak energies of 1 GeV and 120 MeV have been measured for C6+ and protons, respectively.

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