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Modification of proton spectra using optical shaping of over-dense gas jets

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Over-dense gas targets are attractive for ion acceleration since they can provide debris free, high repetition sources of pure ion beams. The spatial profile of gas targets are typically not well suited for laser-plasma energy coupling, however, this can be improved by the addition of an optical prepulse which launches a blast-wave into the plasma. This technique has previously been shown to form short scale-length features in plasmas suitable for a 10.6 µm laser [Tresca PRL 115(9) 2015, Dover JPP 82(1) 2016].
We report on an experiment at the Vulcan Petawatt laser (lambda;$_L$=1.053 µm) where we used optical-shaping of an initially critically dense ($n = 1.7\,n_c$) gas jet. Without optical shaping, no forward-propagating protons were detected, however, a thermal spectrum was detected transverse to the laser propagation direction with a high energy bunch at 11 MeV. Only with optical shaping were forward going protons detected. These protons had a low energy of 1.7 MeV but were bunched with a 14% energy spread. However, damage to the nozzle tip during the laser-plasma interaction, limited shot-rate and reproducibility.

Working group

Laser-driven ion acceleration

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