Influence of near wavelength sized focal spots on laser driven ion acceleration

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A study of the influence of laser focal spot size on the acceleration of protons at intensities up to 5×10^{21} Wcm^{-2} is presented. Through the use of ellipsoidal, F/1 focusing plasma mirrors, focal spot sizes ($\sim 1.5\ \mu$m) on the order of the laser wavelength ($1.054\ \mu$m) are achieved [1, 2]. Results are compared with measurements made using the same laser, but instead employing a conventional planar plasma mirror, producing focal spots of approximately 4 μm full width at half maximum, from an F/3 off-axis parabola.

The effect of using wavelength scale focal spots on maximum proton energy is initially explored for micron thick targets, where the acceleration is dominated by target normal sheath acceleration. Furthermore, the spatial and spectral properties of the accelerated proton population are investigated, with a significant enhancement in the laser-to-proton energy conversion efficiency observed for tight focus. We also present measurements using ultra-thin foil targets, in a regime where the acceleration of high energy protons is driven by a hybrid mechanism involving significant radiation pressure and transparency effects [3]. In this case, we observe a reduction in the maximum achieveable proton energies for tight focus, with the proton energy exhibiting plateau-like behaviour as intensity is increased beyond $\sim 10^{21}$ Wcm^{-2}.

References

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