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Proton radiography of petawatt-driven channel formation in a plasma gradient MATTHEW HILL, NATHAN SIRCOMBE, MARTIN RAMSAY, COLIN BROWN, LAUREN HOBBS, PETER ALLAN, STEVEN JAMES, AWE, Aldermaston, RG7 4PR, UK, PETER NORREYS, NAREN RATAN, LUKE CEURVORST, Department of Physics, University of Oxford, OX1 3PU, UK —
Channel formation by ultra-intense laser pulses in underdense plasmas is a challenging simulation problem with direct relevance to many areas of current research. Recent experiments at the Orion laser facility have used high-energy proton radiography (>40 MeV) driven by a 1ω petawatt beam to directly probe the interaction of another petawatt beam with a well-characterized plasma density gradient. The interaction plasma was generated using a 3ω long-pulse beam and diagnosed using a 2ω optical probe, simultaneously imaged onto four gated optical imagers and two streak cameras. The unique capabilities of the Orion facility allowed a comparison of the channels generated by intense 1ω (1 μm, 100-500 J, 0.6 ps, 10^{21} W/cm^2, f/3 parabola) and 2ω (0.5 μm, 100 J, 0.6 ps, 10^{20} W/cm^2, f/6 parabola) pulses. Proton radiographs of these channels are presented along with PIC simulations performed using the EPOCH code, supported by K-α measurements of hot electron beam divergence and magnetic spectrometer data. Together these provide a solid foundation for improvements to hydrodynamic and PIC simulations, further developing the predictive capabilities required to optimize future experiments.

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