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High-power, kilojoule class laser channeling in millimeter scale underdense plasma[1]

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The interaction of high-energy, relativistic laser pulses with underdense plasma is of fundamental interest relevant to laser propagation phenomena, particle acceleration, x-ray generation and blast wave studies. In particular, the hole-boring fast-ignition scheme for inertial confinement fusion requires an ignition pulse to channel through millimeter scale underdense plasma to reach the dense fuel core. Experiments were performed using the OMEGA EP facility 9 ps short-pulse laser, with pulse energy ≈ 750 J (corresponding to 90 TW power and focused peak intensity of 5×10^{19} Wcm^{-2}) to investigate the interaction with a millimeter-scale, low-density plasma plume, generated by a long-pulse interaction with CH target. The second short-pulse beam generates a proton probe beam from a thin-foil target, which gives high-quality images of the electromagnetic fields generated in the interactions. The evolution and early time expansion of the channel is measured on a single shot using this method. At later times, the channel has evolved to show a strong instability. Plasmas up to near-critical density were also investigated by using low-density foam targets. Large-scale 2D particle-in-cell simulations using the OSIRIS code are performed to model the interactions and investigate the observed physical phenomenon. In collaboration with P. M. Nilson, A. G. R. Thomas, J. Cobble, R. S. Craxton, K. Flippo, A. Maksimchuk, W. Nazarov, P.A. Norreys, T. C. Sangster, R. H. H. Scott, C. Stoeckl, C. Zulick, and K. Krushelnick.

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