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Laser Channeling and Electron Filamentation in Near-Critical Density Plasma

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For commonly used NIR drive lasers, the time, length and density scales pertinent to high-plasma-density LPA are difficult to access experimentally. However, as users of PIC codes will know, in fully ionized collisionless plasmas, the same physics happens at different temporal and spatial scales as long as these scales are adjusted in accord with the reference laser frequency. Therefore, a Long Wave InfraRed (LWIR) drive makes it much more feasible to visualize the plasma evolution in the laser ion accelerator using fast optical probing. We present two case studies where such experimental approach allows direct comparison between PIC simulations and actual observations.

For the first case, we discuss electron beam filamentation in an overcritical density plasma. Using shadowgraphy, we observe how fast electrons originated upon an LWIR laser absorption on a sharp density gradient propagate into the upstream plasma. Changing the probe timing allowed us to observe the plasma dynamics during and after the drive pulse. 2D PIC simulations agree with the observed change in the filament size and density with the plasma density.

For the second case, we explored the channeling of a high power laser pulse in a critical density plasma. By stacking together multiple shots we can stitch together the channel formation process. Again, the speed of channel formation predicted by PC simulations agrees well with the experiment.

And because of the scaling invariance, our findings might be applicable to NIR drives as well.

Working group

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