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Laboratory investigation of the interpenetration between two subcritical collisionless shocks

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Colliding collisionless shocks appear in a great variety of astrophysical phenomena and are thought to be possible sources of particle acceleration in the Universe. To investigate the detailed dynamics of this phenomenon, we have performed a dedicated laboratory experiment. We have generated two counter-streaming subcritical collisionless magnetized shocks by irradiating two teflon (CF_2) targets with 100 J, 1 ns laser beams on the LULI2000 laser facility. The interaction region between the plasma flows was prefilled with a low density background hydrogen plasma and initialized with an externally applied homogeneous magnetic field perpendicular to the shocks. We report here on measurements of the plasma density and temperature during the formation of the supercritical shocks, their transition to subcritical, and final interpenetration. We have also modeled the macroscopic evolution of the system via hydrodynamic simulations and the microphysics at play during the interaction via Particle-In-Cell simulations. The main goal was to understand what was the effect of the second shock on particle energization. We found that in the presence of two shocks the ambient ions reach energies around 1.5 times of the ones obtained with single shocks. Both the presence of the downstream zone of the second shock and of the downstream zone common for the two shocks play a role in the different energization: the characteristics of the perpendicular electric fields in the two areas allow, indeed, certain particles to keep being accelerated or to avoid being decelerated.