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Fast Reconnection in Highly-Extended Current Sheets on the NIF

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Magnetic reconnection is ubiquitous in astrophysical systems, acting to convert magnetic into kinetic energy. At sufficiently large system sizes with low dissipation, reconnection current sheets become unstable and form plasmoids, which have been linked to efficient particle acceleration. We present new results from an experimental platform to study turbulent reconnection that utilizes the uniquely large laser energies and system sizes of the National Ignition Facility. The experiments employ multiple overlapping laser beams to drive large-scale plasma plumes and embedded Biermann-battery magnetic fields, which reconnect as the plumes collide. The interaction is observed with multiple diagnostics, including proton radiography to detect magnetic field structures and gated x-ray imagers to infer plasma parameters and evolution. The experimental results are compared to radiation-hydrodynamic and particle-in-cell codes. We observe reconnection occurring in an extended, quasi-1D current sheet with large aspect ratio ~ 100. The 1-D geometry allows a rigorous and validated reconstruction of magnetic fields from the radiographic images, which show that the current sheet thins down to a half-width close to the electron gyro-scale, suggesting fast reconnection supported by the electron pressure tensor.