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Axial Magnetic Field Compression in Laboratory Plasma Jets[1]

TOM BYVANK, WILLIAM POTTER, JOHN GREENLY, CHARLES SEYLER, BRUCE KUSSE, Cornell University — Compression of an axial magnetic field correlates with density hollowing and azimuthal rotation of a plasma jet generated by the COBRA pulsed power machine (1 MA peak current in 100 ns rise time) in a radial foil (thin disk of 15 μm Al or Ti) configuration. The plasma jet compresses an initially uniform ˜1 T axial magnetic field (Bz) as it collimates along the central z-axis. Experimental measurements use a Bdot magnetic probe placed in the center of the hollow plasma jet. Experimental results show compression of an applied 1.0+/-0.1 T Bz to 2.4+/-0.3 T with aluminum jets and to 2.2+/-0.2 T with titanium jets. Predictions made by the extended magnetohydrodynamics (XMHD) code, PERSEUS, show compression to a 3.4 T Bz at the probe location for aluminum plasmas. For titanium plasmas, implementing radiation into the code is in progress. Additionally using the XMHD simulation, we explore the effects of changing current directions and how the magnetic field being tied to the electrons in Hall MHD (rather than being frozen to the ions in ideal MHD) influences the magnetic field advection. We overview physical reasons for the discrepancy between the experimental and simulation magnetic field compression measurements, including: surface plasma on Bdot probes, 2D and 3D simulation effects, and differences between ablation of a solid foil compared to a foil initialized as a plasma.

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Tom Byvank
Cornell University

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