QUANTITATIVE ANALYSIS OF THE ABLATION OF X-PINCHES AT 80 kA

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The ablation phase of exploding multi-wire experiments driven by fast-rising currents in which both global and local magnetic fields are dynamically significant is poorly understood at present. In particular, a quasi-periodic modulation in the plasma flow accelerated from the wire cores following initiation appears at all current levels, and is not fully explained. The lack of a complete description of the physical process which drives this ablation structure leads to uncertainties in the scaling of the plasma parameters with drive current. Performance at very high current levels cannot be predicted with a high degree of confidence. Such scaling is particularly important for wire array z-pinches which show promise as a driver for high yield Inertial Confinement Fusion (ICF), as well as the generation of novel High Energy Density Physics (HEDP) states which may be achievable using exploding wire systems.

We present a quantitative investigation of the ablated plasma from a wire system in which magnetic field local to the wire is fixed and the global field varies, namely the x-pinch. Two-frame laser interferometry is used to examine 2 wire x-pinches formed from W, Al, Cu and Ni wires at 80 kA, along with gated XUV imaging and time integrated soft x-ray imaging. Two-dimensional areal electron density maps of the ablation structure are recovered as a function of both space and time with spatial resolution ~50 μm. Results show a change in the plasma characteristics from regions where the global field plays a significant role, to where the local field dominates, far from the cross-point, producing classical m=0 MHD instabilities. This is demonstrated through measurements of the periodicity of the plasma structure and the density contrast parallel to the wire as a function of distance from the cross-point. Data compare well to 3D MHD simulations using the Gorgon code which closely reproduce much of the experimental behavior observed.

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