Abstract for an Invited Paper
for the DPP05 Meeting of
The American Physical Society

Measurement and modeling of the implosion of wire arrays with seeded instabilities[1]

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Wire array z-pinches are powerful and efficient sources of soft x-rays used for inertial confinement fusion studies, radiation physics and other work. Understanding the origin and evolution of three-dimensional (3D) magneto-Rayleigh-Taylor instabilities in the imploding plasma is important for optimizing x-ray power and yield. In the research presented, the impact of 3D structure on wire array z-pinch dynamics is studied by controlled seeding of wire perturbations. Al wires were etched at Sandia, creating 20% steps in radius with variable axial wavelength. With 9 mm periodicity, magnetic bubble formation at wire radius discontinuities is observed on the MAGPIE accelerator and in 3D magnetohydrodynamic (MHD) modeling due to non-uniformity in the current path and local **j** x **B** enhancement. Perturbations shorter than the 0.5 mm radial flare ablation mode dominate the evolution of the wire core and imprint the coronal plasma. The longer 0.5 mm natural mode is seen superimposed on these shorter scale length features, which offers insight into the physics of this mode and can constrain *ad hoc* perturbations used in 3D MHD codes. Variation of the x-ray pulse shape due to seeded perturbations will be discussed. Experiments employing localized spectroscopic dopants to track turbulent particle flow in wire arrays will also be presented as a tool for diagnosing 3D structure.

[1]Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the US DOEs National Nuclear Security Administration under contract DE-AC04-94AL85000.

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