ADVANCES IN COMPACT WIRE-ARRAY Z-PINCH X-RAY SOURCES AND Z-PINCH DIAGNOSTICS

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The Z facility at Sandia National Laboratories is a 100-ns, 20-MA pulsed power driver for plasma radiation sources. Experiments with tungsten wire-array z pinches on the Z facility can produce >200 TW and 1.8 MJ of soft x rays in the 100-10,000 eV range. The best performance from tungsten wire arrays on the Z facility was originally obtained with 40-mm diameter arrays [1,2]. As part of a concentrated multi-year campaign studying both single and nested (concentric) wire arrays, we have experimentally demonstrated comparable results using 20-mm diameter arrays, a feat that was not obviously achievable even a few years ago. The use of compact x-ray sources is critical to designs for double-ended, z-pinch driven hohlraum inertial confinement fusion (ICF) concept. Concurrent with our compact x-ray source research, we have also actively pursued the development of advanced diagnostics for studying z pinches, such as monochromatic x-ray backlighting/imaging [3] and grazing-incidence cameras [4]. Monochromatic x-ray backlighting has played a critical role in confirming models for wire ablation physics [5,6] and also in verifying the role of rapid current transfer and ablation of the inner wire array in a nested array implosion [7]. These observations helped us develop methods for controlling the radiation pulse shapes attainable from nested wire-array implosions, allowing us to experimentally demonstrate radiation pulse shapes equivalent to those required for fusion capsule implosions [8]. Recent experiments studying single-array implosions have demonstrated high coupling efficiency between the pulsed power and the x-ray pulses from short-implosion-time arrays that appears to be the result of contributions from non-kinetic sources of energy, a result consistent with array-on-rod tests [9]. These diagnostics and experiments have provided us with a wealth of new data on z-pinch dynamics that is being used to constrain models for wire-array z pinches.

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