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Exploring Signatures of Inner MITL Plasma Formation using Dedicated Experimental Platforms at the Z Pulsed Power Facility

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Large pulsed power accelerators, such as the Z Pulsed Power Facility at Sandia National Laboratories, routinely deliver large current pulses to a variety of high energy density physics experiments including compact x-ray sources, inertial confinement fusion targets, materials compression experiments, and more. The variety of experimental requirements for these studies typically span a large range in impedance and/or pulse shape, resulting in an assortment of coupling efficiencies between the pulsed power driver and physics load. State-of-the-art pulsed power physics models typically focus on the current losses observed in the multi-transmission line architecture of the vacuum post-hole convolute. However, recent investments in plasma modeling have begun to explore the regimes of plasma formation and subsequent current loss that could be generated in the radial inner MITL, where the highest electric and magnetic fields are observed. New plasma models may need to be developed to extrapolate and predict the performance of next generation pulsed power accelerator concepts being studied.

In order to provide validation data to inform these new plasma models, a series of dedicated experiments were performed at the Z Pulsed Power Facility focused on exploring inner MITL current loss. The experiments were designed to vary the anode-cathode transmission line gap, while keeping the combined inner MITL / load inductance constant, effectively constraining the observed convolute voltage. Some features of the inner MITL A-K geometry were designed to both (1) allow for unique diagnostic access, and (2) to accentuate/focus the plasma loss characteristics to this inner MITL region. Various diagnostics were utilized including electrical current measurements, surface velocimetry, optical emission spectroscopy, plasma interferometry, and more. This presentation will report on the design and initial findings of the experimental platform, comparisons to ongoing physics models in development, as well as context for historical trends.

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