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4P58 - Understanding electrothermal instability growth by comparing z-pinches with engineered defects to 3D-MHD simulations

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The electrothermal instability (ETI) is driven by Joule heating and arises from the dependence of resistivity on temperature. When a metal is Joule heated through the boiling point, ETI may drive azimuthally correlated surface density variations or "strata"which provide the dominant seed for subsequent growth of the magneto Rayleigh-Taylor (MRT) instability. Simulations of z-pinch experiments are generally too coarsely resolved to adequately capture ETI physics, resulting in large discrepancies between experiment and simulation. Data on ETI can be difficult to interpret due to the complexity of inhomogeneities present in the metal (inclusions, surface defects, grain boundaries, etc.). To reduce such complexities, experiments will examine ETI growth from 99.999% pure aluminum 800-micron-diameter z-pinch rods driven to 800 kA in 100 ns. Rod surfaces are diamond turned to extreme smoothness, and then further machined to include carefully characterized "engineered"defects—designed lattices of micron-scale pits. Highly reproducible pit fabrication has been achieved using a 5-axis diamond turning lathe in slow tool servo mode. Engineered pits will divert current density and drive local overheating. Visible-light emissions from the rod surface will be captured with multi-frame high-resolution gated imagers. Laser shadowgraphy and interferometry may provide information on expansion dynamics at the pit location. Experiments will generate data to constrain 3D-MHD simulations, accelerating the development of an advanced computational model of instability growth during magnetically driven implosions.

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