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Surface Current Density Distribution Measurements of an Electrically Exploded Foil via B-dot Probe Array Data Inversion, Revised

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Measurements are presented of the current per unit length as a function of time and transverse distance from the center of a water-tamped 80 µm thick Al foil as it explodes into warm dense matter by Ohmic heating. The foil width narrows smoothly to a central width of 15.2 cm, across which the measurements take place. Current is delivered from a 36 µF capacitor bank charged to 30 kV and discharged to a peak current of 342 kA in 2.0 µs. The distribution is calculated by the linear regularized inversion of signals from an array of B-dot probes distributed along the foil's central half-width. The probes are far enough away from the foil (1 cm) to be noninvasive and mechanically undisturbed during the time of interest. These results are compared to 3-D MHD ALEGRA simulations of the geometry externally coupled to a two-loop lumped circuit model representing the driver. Surface current density is strongly peaked at the foil edges for low-current calibration tests, where conductivity is essentially constant. It is broadly peaked in the center at the time of peak current for the high energy shot, though, due to the foil fusing first at the edges, which subsequently reduces current density there relative to the center by the time of peak current. There is broad agreement in this regard between the experiment and ALEGRA using thermal and electrical conductivity model SNL Sesame 29373. ALEGRA calculates that current peaks 0.5 µs earlier, though, and with a 50 kA higher current. This may be due to error in the conductivity tables or effects not well-modeled, such as an electro-thermal instability that results in higher total resistance, but with a distance scale too small for the present simulation to represent. This work is a revision of that presented at IPPC 2015.

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