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Development of Uniform Electron-Beam Sources for Materials Study*

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We are pursuing the development of 0.5-4 MV, 40-120 J/cm2 electron beams to benchmark and validate models of dynamic material response. Large-area sources at low impedance can be achieved using multiple parallel ring diodes, whose multiple current returns keep the local self-magnetic field below the threshold for pinching, thus alleviating the need for an external magnetic field. We report here on development of single and double ring-diode sources on the Gamble II generator at NRL. The Gamble II parameters (~1 MV, ~800 kA, 50-ns FWHM) provide an excellent test-bed for ring-diode-source development. In parallel, we are developing a source on the EROS generator at AWE. EROS, with its lower current (~100 kA), longer pulse (~120-ns FWHM) and higher voltage (2-4 MV) is very useful in stretching the parameter space for model benchmarking. The lower current should allow a simple, large-area diode that avoids pinching by operating below the energy-deposition threshold for anode plasma formation. In both cases, the beam passes through the anode foil and then through low-pressure gas to the target. The beam profile at the target is affected both by scattering in the foil and by self-field effects during transport. Both sources are modeled using an integrated chain comprising a circuit model, particle-in-cell modeling of the diode, Monte-Carlo scattering in the anode foil, and transport through low-pressure gas to the target. The latter employs a new gas-chemistry model developed at NRL[1]. The resulting electron beams are diagnosed using calorimetry and thermal imaging of the target plane, with a common diagnostic arrangement used on both generators. Interferometry and spectroscopy have also been applied to the transport region in Gamble II experiments to validate the gas-chemistry model. This talk will describe both modeling and experimental results.

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[1] Angus, et al., PhysPlas. 23, 053510.

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