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3P73 - Visible Spectroscopy Techniques for Diagnosing Plasmas in High-Energy-Density Power-Flow Systems

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Pulsed power devices rely on the ability to deliver high voltages and currents to a variety of complex loads with minimal transmission losses. The Z Machine at Sandia National Laboratories can deliver up to 26MA within ˜100 nanoseconds to multiple physics targets. This type of current flow combined with MeV potentials across millimeter A-K vacuum gaps lead to a variety of extreme electrode heating conditions, which liberate both surface and entrained gases, forming plasmas that propagate into the vacuum gap and draw current from the load. Losses of up to 20% have been observed on Z for certain load configurations. An effort is underway to investigate plasma generation in the power flow regions of the Z Machine. Visible plasma spectroscopy is employed to spatially and temporally determine plasma formation and propagation, and to measure plasma parameters such as densities and temperatures. These are some of the first and most detailed measurements of their kind in such a hostile environment. In addition to plasma parameters, measurements of magnetic and electric fields by Zeeman splitting and Stark shifts, respectively, are also conducted [1]. Measurements are made using multifiber arrays input into streak and fast-gated spectrometers. Line shape analyses are performed using detailed, time-dependent, collisional-radiative (CR) and radiation transport modeling. Recent results and future plans will be discussed.

[1] S. Biswas, M.D. Johnston, et. al., "Shielding of the Azimuthal Magnetic Field by the Anode Plasma in a Relativistic Self-Magnetic-Pinch Diode,"Physics of Plasmas, 25, 113102 (2018).

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