DIAGNOSING PULSED POWER-PRODUCED PLASMAS WITH X-RAY THOMSON SCATTERING AT THE NEVADA TERAWATT FACILITY*

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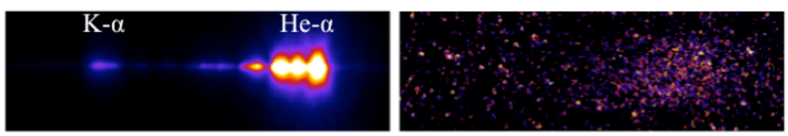
X-ray Thomson scattering (XRTS) is an extremely valuable technique for diagnosing high-energy-density (HED) systems in the laboratory. X-rays can probe transient plasmas with small length scales and high densities, revealing information about that density, the temperature and the ionization state. This technique has become common at high-intensity laser facilities where multiple beams can create the plasma system of interest as well as probing x-rays sources. Pulsed power facilities, on the other hand, require an additional capability or a difficult load configuration in order to create a separate x-ray source while driving the HED experiment. At present, the Nevada Terawatt Facility (NTF) is one of few facilities in the world that have a high-intensity laser (Leopard) coupled to a pulsed power driver (ZEBRA). We present first time results from the initial implementation of XRTS on NTF to study current-driven plasmas.

Using the Leopard laser with ~30-40 J and 0.8 ns pulse width ($I_L \sim 1.1 \times 10^{15}$ W/cm^2), we generated a 4.75 keV He-α x-ray source from a 2 µm Ti foil. This was placed ~5 mm from a single graphite foil load, roughly 400 µm thick and 3 mm wide. The ZEBRA driver was run to peak current of ~0.6 MA with a 200 ns rise time. Filtered diodes measured the x-ray yield suggesting laser conversion efficiency was roughly 0.18%. Bandwidth measurements using a HAPG crystal in the Von-Hamos configuration was found to be $\Delta E/E \approx 0.2\%$ for He-α emission, better than the required ~1% for these non-collective XRTS experiments. We achieved scattered signal-to-noise ratios of ~3 and will present scattering spectra from two times into the current (70 ns, 220 ns) along with discussion of the current analysis.



(*Left*) Ti x-ray source spectrum. (*Right*) Scattered signal from 70 ns into current.

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