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Investigation of Exploding Wire Plasmas Using High Resolution Point Projection X-ray Absorption Spectroscopy[1]

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We have determined the properties of plasma around and between two exploding wires using high-resolution x-ray absorption spectroscopy. Plasma densities and temperatures ranging from $10^{20}cm^{-3}$ and a few eV to $10^{17}cm^{-3}$ and $30eV$ have been measured in experiments at Cornell University with two $25\mu m$ aluminum (Al) wires spaced $1mm$ apart driven by $\sim 100kA$ peak current pulses with $50-100ns$ rise time [1]. The wire plasma was backlit by the $1.4-1.6keV$ continuum radiation produced by a Mo wire X-pinch. The spectrometer employed two spherically bent quartz crystals to record the absorption and backlighter spectra simultaneously. The transition between the dense Al wire core and the coronal plasma is seen as a transition from cold K-edge absorption to Mg-, Na- and finally Ne-like absorption at the boundary. In the plasma that accumulates between the wires, ionization states up to Be-Like Al have been seen. The spectrometer geometry and $\sim 2\mu m$ X-pinch source size provide $0.3eV$ spectral resolution and $20\mu m$ spatial resolution[2], enabling us to see $1 \rightarrow 2$ satellite transitions as separate lines as well as O-, F- and N-like $1 \rightarrow 3$ transitions that have not been seen before. A step wedge was used to calibrate the transmission, enabling density to be measured within 50% and temperature to be measured within 25%. A genetic algorithm was developed to fit synthetic spectra calculated using the collisional-radiative code SCRAM[3] to the experimental spectra. In order to obtain agreement it was necessary to assume 3 plasma regions with variable thicknesses, thereby allowing the inferred plasma conditions to vary along the absorption path. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin company, for the National Nuclear Security Administration under DE-AC04-94AL85000

[1] P. F. Knapp, Ph.D. thesis, Cornell University, 2011
[2] Knapp *et al.*, Rev. Sci. Instrum., 82, 063501 (2011)
[3] Hansen *et al.*, High Energy Density Physics, 3(1-2):109 - 114 (2007)

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