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Design of the PST: A Diagnostic for 1-D Imaging of Fast Z-pinch Power Emissions

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Fast Z-pinch technology developed on the Z machine at Sandia National Laboratories can produce up to 280 TW of thermal x-ray power for applications in inertial confinement fusion (ICF) and weapons physics experiments. During implosion, these Z-pinches develop Rayleigh-Taylor (R-T) instabilities which are very difficult to diagnose and which functionally diminish the overall pinch quality. The Power-Space-Time (PST) instrument is a newly configured diagnostic for measuring the pinch power as a function of both space and time in a Z-pinch. Placing the diagnostic at 90 degrees from the Z-pinch axis, the PST provides a new capability in collecting experimental data on R-T characteristics for making meaningful comparisons to magneto-hydrodynamic computer models. This paper is a summary of the PST diagnostic design. By slit-imaging the Z-pinch x-ray emissions onto a linear scintillator/fiber-optic array coupled to a streak camera system, the PST can achieve ~100 μm spatial resolution and ~1ns time resolution. Calculations indicate that a 20 μm thick scintillating detection element filtered by 1000 Å of Al is theoretically linear in response to Plankian x-ray distributions corresponding to plasma temperatures from 40 eV to 150 eV. By calibrating this detection element to x-ray energies up to 5000 eV, the PST can provide pinch power as a function of height and time in a Z-pinch for temperatures ranging from ~40 eV to ~400 eV. With these system parameters, the PST can provide data for an experimental determination of the R-T mode number, amplitude, and growth rate during the late-time pinch implosion.

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