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Core temperature and density profile measurements for inertial confinement fusion[1]

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An experimental investigation was performed to study the hot spot temperature and density spatial profiles of inertial confinement fusion implosion cores. The experiments at OMEGA employ deuterium-filled plastic shells which include a tracer amount of argon for spectroscopic diagnostics. At the collapse of the implosion argon K-shell line emission is recorded with three identical, gated (50ps) multi-monochromatic x-ray imagers (MMI) that view the core along three quasi-orthogonal lines of sight thus diagnosing the implosion core with an unprecedented level of detail. The MMI instruments use an array of pinholes and a flat multilayer mirror to provide unique multi-spectral core images distributed over a wide spectral range. Core images are obtained for several argon K-shell line transitions. In addition, a titanium doped tracer layer embedded in the plastic shell and located close to the core-shell boundary is used to image simultaneously in absorption the cold dense shell surrounding the core. The data analysis uses detailed atomic kinetics, Stark-broadened line shapes and radiation transport. Several analysis methods have been developed to analyze the data including quasi-analytic, and search and reconstruction based on a novel application of genetic algorithms to plasma spectroscopy. The analysis yields the time-history of the temperature and density profiles of the core, and the spatial extension of mixing. We also discuss time- and spatially-resolved argon line spectra recorded in implosions at Z with slit spectrometers and their application to core structure determination. These measurements and analysis are critical for understanding the plasma dynamics associated with the implosion process and benchmarking hydrodynamic models of high energy density plasmas.

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