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Diagnostics of the electron temperature distribution of hot spot using a four-color quasi-monochromatic X-ray Kirkpatrick-Baez microscope

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In inertial confinement fusion (ICF), the formation of a high-quality hot spot is the key to achieving ignition, which needs to be realized by inertial compression with a considerable convergence ratio at limited laser energy. The high convergence ratio can contribute to the rapid growth of hydrodynamic instability and compression asymmetry, leading to a decrease in implosion performance. Effective diagnosis of the hot spot parameters such as electron temperature can help identify the origin of deviations between ICF implosion experiments and physical design.

We have established a diagnostic method for the spatial distribution of hotspot electron temperature based on diagnostic the hotspot X-ray bremsstrahlung spectroscopic features by developing a four-color quasi-monochromatic X-ray Kirkpatrick-Baez (KB) micro-imaging technique, which has been successfully applied to the implosion experiments conducted on the 100kJ laser facility in China. The four-color KB microscope using a single film reflector and multi-layer film reflector mixed group design, with four independent imaging channels (4.51keV, 6.4keV, 8.04keV, 9.67keV), the energy spectrum resolution of 10%, in the field of view of 200μm range of the spatial resolution is better than 5 μm. Based on this KB microscope, we have experimentally obtained four X-ray images of the hot spot with different energy points, and then carried out reconstruction work and successfully obtained the spatial distribution of the hot spot electron temperature. A mismatch between the strong region of the electron temperature distribution and the strong region of the hot spot X-ray emission was identified in some implosion experiments.

References:

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