MEASUREMENTS OF X-RAY AND NUCLEAR SHOCK-BANG TIMES IN ICF PLASMAS AT OMEGA AND THE NIF

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Recent measurements of nuclear and x-ray shock-bang times in ICF implosions at OMEGA and the NIF provide additional constraints on implosion modeling and may elucidate the underlying physics of e-i equilibration in the shock phase. As the ions are predominantly heated by the converging and rebounding shock that initiates the shock burn, the ion temperature is initially much higher than the electron temperature; this temperature difference relaxes at the electron-ion equilibration time scale [1]. The timing of the nuclear and x-ray bang times is expected to be different because of different temperature dependence, and this difference is in turn related to plasma conditions and degree of e-i equilibration at shock-bang.

At the National Ignition Facility (NIF), the particle-time-of-flight (pTOF) routinely measures the nuclear shock-bang time using D^{3}He-protons produced in near-vacuum hohlraum implosions. On N150224, x-ray shock-bang self-emission has been observed for the first time in streak x-ray radiography in a near-vacuum hohlraum implosion [2], along with measured nuclear shock-bang time from pTOF. These measurements provide a new approach for probing physics governing the interaction between electrons and ions during the shock phase prior to deceleration. A new instrument, the magnetic particle-time-of-flight (magPTOF), is a more robust and versatile version of pTOF. It recently underwent its first qualification shot (N150326), and will measure the nuclear shock-bang time [3] for a wider range of D^{3}He gas-filled hohlraum implosions, including those with much higher x-ray background.

At OMEGA, nuclear shock-bang time and burn history are routinely measured in implosions using existing streak camera diagnostics. X-ray self-emission during shock-bang was previously observed using x-ray framing camera [4], and experimental efforts are underway to improve on this measurement. The potential also exists to measure both x-ray and nuclear shock-bang times with a single diagnostic with high relative accuracy. This presentation explores the possibility of these measurements, the precision with which they can be made, and the diagnostics necessary, at OMEGA and the NIF.

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