Development and characterization of a high-resolution, monochromatic, laser-gated radiography system for HED hydrodynamics experiments on the NIF

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High-resolution X-ray radiography can be employed to experimentally validate radiation-hydrodynamic simulations of mixing plasmas under high-energy-density (HED) conditions. The requirements for imaging the fine flow dynamics during instability growth in these conditions, e.g., at the National Ignition Facility (NIF), are exceptionally demanding: 5 µm spatial resolution over a 1–2 mm field of view, with ~100 ps temporal resolution to minimize motion blur. In this talk, we will describe the development of both a toroidal crystal imager and a bright, short, laser-driven X-ray source which, when coupled together, meet these strict requirements.
The talk will cover the development of the laser-driven source, which includes testing several different approaches using both the NIF and ARC (Advanced Radiographic Capability) lasers and how the various sources performed when coupled to the crystal imager. Furthermore, the development and characterization of a toroidal crystal imager [1] and the challenges associated with using this to achieve the goal of 5µm spatial resolution will be discussed. By developing a new experimental platform, the spatial resolution, depth of field, temporal resolution, and fluence of the radiography system can be measured simultaneously on a single NIF shot, providing an efficient and comprehensive way to qualify future configurations. Together, these advances establish a powerful new radiography capability for HED experiments that will be broadly valuable to the user community at the NIF and other HED facilities.

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