SHOCK15-2015-000346

Abstract for an Invited Paper
for the SHOCK15 Meeting of
the American Physical Society

Coherent X-ray Imaging Techniques for Shock Physics[1]

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X-ray radiography has been used for several decades in dynamic experiments to measure material flow in extreme conditions via absorption of x-rays propagating through the materials. Image contrast in traditional radiography is determined by the absorption coefficients and areal densities of the materials at a given x-ray wavelength, and often limits these measurements to materials with sufficiently high atomic numbers and areal density, while low-Z materials and small areal density variations are completely transparent and not visible in the image. Coherent x-ray sources, such as those found at synchrotrons and x-ray free-electron lasers, provide new opportunities for imaging dynamic experiments due to their high spatial and spectral coherence, high brightness and short temporal duration ($<$ 100 ps). Phase-sensitive techniques, such as phase contrast imaging (PCI), rely on the overlap and interference of the x-rays due to spatial variations in their transmitted phase, and are enabled primarily by high spatial coherence of the x-ray source. Objects that are otherwise transparent to x-rays can be imaged with PCI, and small variations in areal density become visible that would be not observable with traditional radiography. In this talk an overview of PCI will be given, and current applications of this technique in high-energy density physics, shock physics and material dynamics will be presented. Other future uses of imaging using coherent x-ray sources in dynamic high-pressure experiments will be discussed.

[1]Work performed under the auspices of DOE by LANL under contract DE-AC52-06NA25396.