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High energy K-α radiography using high-energy, high-intensity, short-pulse lasers[1]

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Many laser facilities utilizes x-ray backlighters to radiographically diagnose various stages of hydrodynamics experiments. These backlighters have x-ray energies $<\sim 9$ keV generated by thermal plasmas from long-pulse lasers. However, many future high energy density experiments on new facilities such as Omega-EP and NIF will perform experiments that will require backlighters in the 15-100 keV range and better than ~ 10 μm spatial resolution. High-energy K-α x-ray sources can be created through the interaction of high-energy electrons, generated by high-intensity short-pulse lasers, with target material. Not only K-α sources are more efficient way to generate high-energy photons but also advantageous in creating quasi-monochromatic backlighters by K-edge filters to provide required contrast. We have performed several experiments using the JanUSP, Vulcan 100 TW and Petawatt lasers to understand the K-α source characteristics and to implement a workable radiography. Our measurements show that the K-α size from a simple foil target is larger than 60 μm thus less than optimally efficient as a point source for high-resolution imaging. We also measured the total K-α yield is invariant to the target thickness verifying that refluxing plays a major role in photon yields and that smaller radiating volumes emit brighter K-α radiation [1]. Thus, 1-D radiography with the required brightness and spatial resolution can be obtained using small-edge-on foils. Subsequently, we employed this technique to perform an EOS experiment in a 400 μm thick Al sample. We tested many small volume sources in different geometrical shapes such as cone/wire and embedded wires to understand photon yields from these 2-D point sources. We will compare our measurements with hybrid-PIC LSP simulations. In addition, we are developing imaging detectors and diagnostics tools that are workable in the 15-100keV range. This paper will present the results.

[1] H. S. Park et al., Rev. Sci. Instrum. 75, 4048 (2004)

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