Experimental in-line Phase-Contrast Imaging (PCI) of a shock wave

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X-ray radiography is extensively used in plasma physics [1]. It allows generating density maps of compressed laser-driven targets [2]. The choice of the photon energy used as probe is crucial in the design of X-ray absorption radiography. The photons should not too *"hard"*, in order they can partly be absorbed by the target, and at the same time not too *"soft"*, to achieve large enough flux on the detector. The case of targets with different material, for example ICF capsules, where low Z elements can be surrounded by high Z elements is particularly challenging [3]. A solution can be provided by Phase-Contrast Imaging (PCI) [4]. Here the main point is to reducing absorption below 10%, while maximizing the phase shift induced by the density gradient. As a result, one can overcome the above-mentioned problem and, at the same time, increase the contrast at the interface between un-shocked and shocked material.

An experiment has been performed at PHELIX (GSI, Darmstadt) laser facility in June 2017 to prove the feasibility of such a technique. A short laser pulse (with duration of 0.5 ps, energy of 30 J, and wavelength of 1.053 μm) irradiated a back-lighter target (a tungsten wire with diameter of 5 μm) producing photons with energy in the range 8-15 keV. A shock has generated in the target to be diagnosed using a second pulse with adjustable time duration, between 1 and 10 ns, energy of 30 J, wavelength of 1.053 μm. The target was a polypropylene cylinder with a diameter of 300 μm. Several images were obtained for different time delays (1-10ns) and time duration of the long pulse, demonstrating the suitability of PCI in a single-shot experiment with a *"full"* laser system. Note that this is the first demonstration of PCI with laser-driven back-lighter. PCI was indeed already employed to record images of shocked materials, but using FEL (Free Electron Laser) as back-lighter [5].

References

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