WS101-14: Laser Wakefield Driven X-ray Sources in Canada: Future perspectives for non-destructive imaging and Global Food Security

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Very intense hard X-ray beams (1.5 µm X-ray source size, 5 µJ-50 µJ/shot in the 30 keV- 40 keV band, 50 mrad x 50 mrad divergence, critical energy for the X-ray spectrum of 30 keV) have been generated through ultra-relativistic self-guiding over long gas jet length (cm range). I will describe the experiments realized with our new laser facility (delivering up to 7J in 18 fs at 2.5 Hz on target) and I will discuss the empirical scaling laws we have obtained correlating the X-ray photon number to the laser and gas jet parameters. Our scaling indicates that a 40 keV X-ray beam with energy of 1 mJ range per shot can be produced with a driving laser with power in the 1 – 2 PW range. The X-ray source has been operated at the nominal 2.5 Hz repetition rate giving an average power in the 12 µW-125 µW range in the 30 keV-40 keV spectral band.

High throughput X-ray phase contrast imaging and 3D phase contrast tomography of various objects have been realized. We demonstrated that the phase contrast imaging was giving the possibility to see transparent very small objects (10 µm to 300 µm diameter range) embedded inside inhomogeneous and anisotropic thick (absorbing) environment. We will present the experimental demonstration and discuss the potential for non-destructive imaging. There is a need for a stand-alone system dedicated for plants and seeds screening available on production sites. I will present our funded program in Canada in developing high throughput X-ray phase contrast plant imaging and screening using LWFA-based X-ray sources (30 keV-80 keV). This effort is realized through an initiative led by the Global Institute for Food Security (GIFS) at the U of Saskatchewan that aims to establish the correlation between the phenotypic expression of a plant and its adaptation to biotic and abiotic environmental stress.