Development of a Table-top X-ray Laser for 24/7 Advanced Spectroscopy (EMPULSE)

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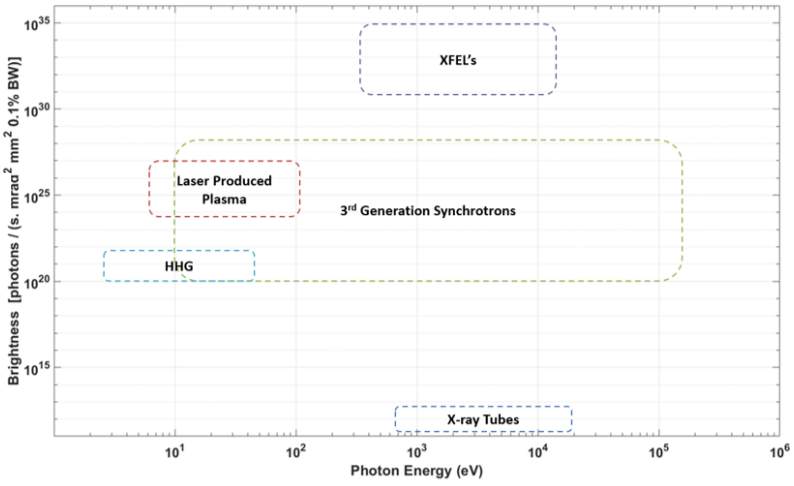
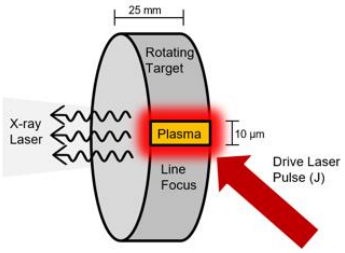
X-ray spectroscopy is important for chemical and material research. Common sources for X-rays are synchrotrons, albeit its many advantages, they suffer from a limited access model. Therefore, even with a few trade-offs; table-top X-ray sources provide an attractive alternative. The brightness comparison between laboratory sources and synchrotrons is shown in Figure 1a [1]. For this poster, we present the design, development and diagnostics for such a table-top X-ray source based on laser produced plasmas for round the clock advanced spectroscopy. The building blocks of the laser are identified, the results from the front-end are shown, and potential applications are discussed. The backbone of the system is a femtosecond fibre oscillator pulse with a duration of 120 fs, repetition rate of 80 MHz and an energy of 6 nJ. In order to get a high peak power high energy pulse to create a plasma, we utilize the technique of chirped pulse amplification (CPA). The system front-end consists of a self-developed pulse picker, a 4-pass single grating stretcher and a self-developed regenerative amplifier. There are four powerful flash lamp pumped amplifiers to increase the energy and a grating pair compressor to shorten duration after which the pulse is delivered onto the solid target to create a plasma for X-ray lasing, as shown in figure 1b:

1a





1b

The output of the regen is up to 0.2 mJ at 2Hz. A compressed 15 J laser is to be extracted after the after he rod chain amplification for generating enough population inversion in the plasma for the emission of X-rays, which can then be characterized and used for different X-ray Spectroscopy experiments such as Near and Extended Edge X-ray Absorption spectroscopy[2].

[1] Boutet, S. and Yabashi, M., 2020. X-Ray Free Electron Lasers And Their Applications.

[2] Wachulak, P., Fok, T., Bartnik, A., Janulewicz, K.A., Fiedorowicz, H., 2019. EXAFS of titanium LIII edge using a compact laboratory system based on a laser-plasma soft X-ray source. Appl. Phys. B 126