

X-ray All-In-One – a novel diagnostic combination design to characterise the spectral and spatial emission from laser-solid interactions

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Laser-plasma interactions have long been a source for energetic particles and photons, recent efforts at the CLF have demonstrated their application to industrial scale imaging – using the high energy photon emission from laser solid interactions. Characterising these sources is key to bridge the gap between this emerging technology and the current performance of “conventional” CT and inspection machines. Inherently there is variation from shot-to-shot in high-intensity laser-plasma interactions, subtle variations in the laser pre-pulse, or wavefront, can result in significant changes in the emitted source. Increasing the stability and minimising variation in laser delivery is a key aspect of the future development that needs to be done. However, by characterising the emission on a single shot basis we can mitigate the changes by factoring it in during reconstruction.

Here, we present an on-line diagnostic capable of measuring the broad bremsstrahlung distribution from laser-solid interactions both spectrally and spatially. The design consists of several individual diagnostics paired to deliver more information over the minimum amount of solid-angle – allowing this diagnostic design to be “parasitic” to experiments rather than dominate the requirements.

Spatial measurements of the source are conducted via a penumbral foil made from a curved tungsten sheet, and imaged via a thick LYSO scintillator screen. This method can achieve <10um resolution up to 500 keV. The spectral emission is then determined by two scintillator rail spectrometers, that have been extended to the >10 MeV region using gamma-n activation in Al. Combined these diagnostics provide information suitable to reconstruct both the spatial and spectral emission of the x-ray source from high intensity laser-solid interactions.