Contribution ID: **153** Type: **Poster Presentation**

Optimisation of compact radiation sources for NTR applications

Radiation sources have been shown to have many applications in nuclear threat reduction (NTR), including radiography (whether in ports or 'in the field') and nuclear scattering (either polarised or unpolarised gamma rays for identification of isotope specific content).

Laser wakefield acceleration (LWFA) is a mechanism by which electrons may be accelerated over much shorter distances than conventional accelerators - often by around three orders of magnitude. With the field of LWFA there are novel routes to generating x-ray sources including betatron (electrons synchrotron radiating in the accelerator) and inverse Compton scattering (ICS), but colliding the electron beam with a laser pulse after the acceleration phase. While both of these techniques have been used to generate radiation sources, thus far no optimisation has been conducted for applications in nuclear threat reduction.

Here we present a preliminary study on how the parameters of the wakefield accelerator might be tuned in order to optimise the technology for one or other of the radiation generation mechanisms. Particle-in-cell (PIC) simulation results are shown which indicate that novel laser focusing geometries could better condition the electron beams for ICS generation, and how moving to plasma density regimes far higher than is routine in LWFA may result in stronger betatron emission suitable for NTR applications.

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Session Classification: Lunch and Posters