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High Flux X-ray Emission from a Large Radius Electron Bunch that was Injected after Significant Pulse Compression in a Laser Wakefield Accelerator

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A Laser Wakefield Accelerator producing two distinct electron populations: a 2 GeV component that was self-injected early in the interaction, and a sub-GeV component injected close to the laser depletion length, was shown to be an intense source of betatron x-rays. The x-rays were predominantly generated by the sub-GeV bunch.
Simultaneous measurements of the electron and x-ray spectra demonstrated that the larger oscillation radius of the sub-GeV beam was the main driver of the increased flux of emitted radiation, while the lower energy gain ensured moderate photon energies of 10-20 keV.
As many as 5×10^{10} x-ray photons with energies > 1 keV were recorded per laser shot, which has led to a significant improvement in the signal to noise ratio of betatron radiography images.
3D particle-in-cell simulations demonstrate that the first bunch was injected after the initially oversized laser spot underwent rapid self-focussing to the matched spot size. Continuous temporal compression and power amplification of the drive pulse in the wakefield increased the width and length of the wakefield bubble through increased a_0, leading to the injection of a second electron bunch with higher transverse momentum.

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