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Multi Spectral CTR Imaging and Interferometry of Laser Wakefield Accelerated Electron Bunches

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The low emittance of electron bunches from laser wakefield accelerators (LWFAs) makes them attractive for compact FELs and colliders. Single-shot, direct, non-intercepting diagnostics of this emittance outside the LWFA are, however, needed. Here we present single-shot coherent transition radiation (CTR) imaging and interferometry data from electron bunches ~2 mm after emerging from a 300 MeV LWFA. We combine near field (NF) and far field (FF) imaging of CTR from a foil just outside the accelerator. We also employ a multi-octave CTR spectrometer to diagnose the longitudinal structure of the beam. The NF system images the foil with high resolution at many narrow visible bandwidths. This measurement elucidates the transverse structure of micro-bunched portions of the beam. We find typical transverse radii of $2 \leq \sigma_{perp} \leq 3$ μm . The FF system collects CTR from a double Wartski interferometer to diagnose sub-bunch divergences as low as $\sigma_\theta \approx 0.5$ mrad. We have determined sub mm mrad emittance of a micro-bunched portion of the beam. Using multi-spectral NF images and CTR spectrum, we produce 3D reconstructions of the bunch. We will present data and analysis on bunch size, divergence and substructure revealed by the FF and NF imaging systems.

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