LPAW 2023
Laser and Plasma Accelerators Workshop 2023
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The E332 experiment at FACET-II: Towards solid density beams and intense gamma-ray beams

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The passage of an electron bunch through a conducting foil has a focusing effect from the Near-Field Coherent Transition Radiation (NF-CTR) generated on the surfaces. Passing through multiple foils may allow to self-focus bunches down to solid densities and generate collimated gamma-rays with micrometer source sizes and conversion efficiencies exceeding 10 % [1]. The possibility offered by this scheme to self-focus high-energy beams and generate extremely dense gamma-ray beams calls for an experimental demonstration.

We present the E332 experiment at the SLAC National Accelerator Laboratory where this mechanism can be studied with unprecedented electron beam parameters available with the FACET-II accelerator facility. Initial measurements were investigating the presence of NF-CTR focusing on single foils and the beam-induced heat damage, and are now followed by the first experimental tests of passing beams through multiple foils. We furthermore report on simulations of realistic electron beam and target configurations for FACET-II that give rise to focusing of electron bunches from 5 µm down to 1.5 µm (rms) and conversion efficiencies from electron beam to gamma rays in the few-percent range. The relative simplicity, unique properties, and high efficiency of this gamma-ray source open up new opportunities for both applied and fundamental research including laserless investigations of strong-field QED processes with a single electron beam.

Finally, we will present a theoretical and simulation study of beam-plasma collisions with a single foil, that shows the potential of the NF-CTR process to reach EM fields exceeding the Schwinger field strength in the electron rest frame, thus creating electron-positrons pairs that could be experimentally measured [2]. In this beam-plasma configuration, the interaction can be understood as the collision between the beam and the reflected self fields, which mimics in a much simpler and robust way the beam-beam collisions proposed by Yakimenko et al. [3] to probe nonperturbative QED.

References

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