The E332 Experiment at FACET-II: First Experimental Demonstration of Beam Self-Focusing in Electron Beam – Multifoil Collisions

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When an electron bunch passes through a conducting foil, its self-fields are reflected at the foil surface, also known as Near-Field Coherent Transition Radiation (NF-CTR) resulting in a focusing effect for the electron beam. Passing through multiple foils may allow to focus the electron beam 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.

For the first time we show experimental results of this very strong focusing effect on the electron beam passing through a "multi-foil" target. The unprecedented beam parameters available at the FACET-II accelerator facility allows for high statistics data taking and high precision measurements. We show the experimental results of the beam focusing effect when varying the number of foils, the beam waist position, looking at the beam size and divergence. We furthermore report on PIC simulations of realistic electron beam passing through the multifoil target and compare the result with the experimental data.

Eventually we present the first experimental results of this new focusing process using a laser-plasma accelerated electron beam at the APOLLON laser facility. With this very different beam parameters from such a laser-plasma accelerator, we have demonstrated beam focusing inside the multifoil, highlighting the broad potential of the multifoil concept that is applicable over a wide range of parameters and facilities. The relative simplicity and unique properties of this scheme opens up new opportunities for both applied and fundamental research including laserless investigations of strong-field QED processes with a single electron beam. It also constitutes an original and novel focusing device capable of extreme focusing for high-energy electron beams.

References

[1] A Sampath, X Davoine, S Corde *et al.*, Phys. Rev. Lett. **126**, 064801 (2021)