Contribution ID: **115** Type: **not specified**

Beam-Based Alignment of the RF Gun using Phase-Scan

Wednesday 10 September 2025 11:10 (20 minutes)

Matching and ASTRA at PITZ This summer student project focuses on Beam-Based Alignment (BBA) procedures of the RF photogun at PITZ, addressing challenges that impact both the precision and overall performance of the high-brightness electron source. One of the issues encountered is that the beam is deflected by the Earth's magnetic field and a possible residual field, complicating the task of achieving accurate centering of the laser at the photocathode. To investigate this deviation in greater detail, the study utilizes the RF gun phase range where the beam experiences strong RF focusing while its energy varies significantly. This phase region is particularly sensitive to the laser's offset from the cathode center, which is assumed to coincide with the electric axis of the RF gun cavity. In addition, external and parasitic magnetic fields in the region of interest cannot be measured on-site with sufficient accuracy. To address these limitations, the basic measurement for laser BBA at PITZ —the detection of the beam centroid position on the scintillating (YAG) screen, located 0.803 m downstream of the cathode —was reproduced using ASTRA tracking simulations. This approach makes it possible to determine not only the laser offset on the cathode, but also to estimate the effective transverse magnetic field in the gun–drift section and to evaluate the screen coordinates of the laboratory axis. One practical result of these studies is the development and implementation of Helmholtz coils around the gun cavity to compensate for the influence of the Earth's (remnant) field.

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