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A review of space charge models for high brightness electron injectors

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Achieving lower beam emittance through effective space charge compensation is critical for enhancing beam brightness and luminosity in accelerator physics. Traditional solenoid-based methods are limited to linear compensation and often introduce chromatic aberrations. Our study aims to develop novel techniques that compensate for both linear and non-linear space charge forces. As a first step, we reviewed and scrutinised existing space charge models. We employ Particle-In-Cell (PIC) simulations, Fast Fourier Transform (FFT) methods, and the OPAL framework to model electric fields and implement compensation schemes. Preliminary results demonstrate that our models align well with overall trends when compared to OPAL, an open-source tracking code. This research holds promise for applications in particle colliders, X-ray free electron lasers (FELs), and medical treatments, potentially improving beam quality in these advanced technologies.

Footnotes

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