Contribution ID: **245** Contribution code: **TUP034** Type: **Poster Presentation**

Electromagnetic space-charge fields in a cylindrical cavity with a small aperture: analytical and numerical analysis

Tuesday 12 August 2025 16:00 (2 hours)

We present an analytical and numerical study of the electromagnetic space-charge fields generated by a relativistic charged particle beam propagating inside a cylindrical conducting cavity with a small aperture at one end. The system models a practical RF photoinjector geometry where the beam originates from a flat cathode and accelerates longitudinally through the cavity. By employing a Green's function method and the small-hole approximation, we derive closed-form expressions for the scalar and vector potentials and their associated electric and magnetic fields. The analytical solution accounts for both unperturbed cavity modes and perturbative effects due to radiation leakage through the aperture, modeled via a magnetic dipole moment. We further validate our results using a vectorized and parallelized numerical integration scheme in normalized coordinates. The resulting field profiles reveal the spatial structure and temporal evolution of the longitudinal and radial fields, showing excellent agreement with expected physical behavior. These results are crucial for understanding beam–field interactions in high-brightness electron sources and have implications for the design of high-gradient and high-power RF accelerators and vacuum electronic devices.

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Yes

Would you like to submit this poster in student poster session on Sunday (August 10th)

No

Footnotes

Funding Agency

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Yes

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