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Simulation of coupled space charge and wakefield effects for a prototype TW-gun at SwissFEL

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In the injector section of electron linacs, both internal space charge forces and wakefield effects influence the beam dynamics. So far, existing simulation approaches can not account for both effects simultaneously. To fill this gap, we have developed a computational method to account for both effects self-consistently*. It couples a space charge solver in the rest frame of the bunch with a wakefield solver by means of a scattered field formulation. The novelty of this approach is that it enables us to simulate the creation of wakefields throughout the emission and acceleration process.

In our contribution, we present extensive studies of the coupled wakefield and space charge effects in a traveling wave electron gun under development at the Paul Scherrer Institute. Wakefields created by the multi-cell design and the transition to the beam pipe are accounted for. Hence, the respective influences of these causes for geometric wakefields on particle dynamics are compared, providing detailed insights into the coupling of wakefields on bunches at low energies. Specifically, uncorrelated energy spread and emittance are investigated which are of key interest for FEL operation.

Footnotes

- J. Christ and E. Gjonaj, "Scattered field formulation for wakefield and space charge calculations", presented at the IPAC'23, Venice, Italy, May 2023, paper WEPA088, unpublished.

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