Electromagnetic characterization of nanostructured plasmonic photocathodes

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a PEMCAD seminar, BSc thesis or MSc thesis
Study field: Computational Engineering | Electrical Engineering
10. März 2025

Description

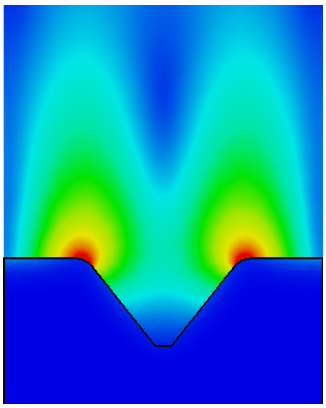
Contact
M.Sc. Margarita Bulgacheva

margarita.bulgacheva@
tu-darmstadt.de
Office: S2|17 217

This project focuses on the numerical characterization of sub-wavelength nanostructured photocathodes, which are a promising technology for improving photoemission quantum efficiency. By engineering the surface of the photocathode with a periodic array of nanogrooves, the structure can support a Surface-Plasmon-Polariton (SPP) mode. When coupled with an excitation laser pulse, this SPP mode enhances photon absorption, resulting in an increase in quantum efficiency (QE) and a reduction in the power requirements for the photocathode-laser system.

This research aims to contribute to the development of more efficient electron sources for future applications, particularly in the context of high-duty-cycle upgrades at facilities like the European XFEL (EuXFEL).

Task



- Numerical simulation of electromagnetic properties of surface-plasmon enhanced nanostructures
- Optimization of geometrical parameters of the nanostructure
- Comparing the results for different laser wavelengths
- Modeling possible fabrication imperfections and their effect on the cathode performance

References

- R.K. Li, et al. “Surface-plasmon resonance-enhanced multiphoton emission of high-brightness electron beams from a nanostructured copper cathode.” Physical review letters, vol. 110, 7, 2013.
- W. Barnes, A. Dereux, and T. Ebbesen, “Surface plasmon subwavelength optics", Nature, vol. 424, pp. 824–830, 2003.
- P. Musumeci, et al. "Multiphoton Photoemission from a Copper Cathode Illuminated by Ultrashort Laser Pulses in an RF Photoinjector", Phys. Rev. Lett., vol. 104, p. 084801, 2010.