

# State-of-the-Art Electron Beams for Compact Tools of Ultrafast Science

*Thursday 8 May 2025 15:15 (1 hour)*

In this talk, I will present a recent review of the state-of-the-art in electron beams for single-shot megaelectronvolt ultrafast electron diffraction and compact light sources [1]. The primary focus will be on sub-100 femtosecond electron bunches in the 2–30 MeV energy range. I will show that our latest simulation and experimental results enable significantly improved bunch parameters for these applications.

Furthermore, we will discuss:

- the regime of optimal blowout beam generation [2];
- strong bunch compression within half of an RF wavelength [3];
- phase-space degradation and aberrations arising from cathode image charge, nonlinear space-charge fields, and nonlinearities in RF and static focusing magnetic fields [4].

Finally, I will demonstrate control and reduction of slice emittance through the ponderomotive laser force, supported by direct 3D simulations [5].

References:

- [1] Salén, P., Opanasenko, A., Perosa, G., & Goryashko, V. (2025). State-of-the-art electron beams for compact tools of ultrafast science. *Ultramicroscopy*, 268, 114080.
- [2] Shamuilov, G., Opanasenko, A., Pepitone, K., Tibai, Z., & Goryashko, V. (2022). Emittance self-compensation in blow-out mode. *New Journal of Physics*, 24(12), 123008.
- [3] Opanasenko, A., Perosa, G., Ribbing, J., & Goryashko, V. (2023). Half-wavelength velocity bunching: non-adiabatic temporal focusing of charged particle beams. *New Journal of Physics*, 25(12), 123049.
- [4] Goryashko, V., Opanasenko, A., & Togawa, K. (2025). Self-aberration in high-brightness uniformly charged particle beams. *Results in Physics*, 68, 108096.
- [5] Ribbing, J., Perosa, G., & Goryashko, V. (2025). Relativistic ponderomotive force in the regime of extreme focusing. *Optics Letters*, 50(6), 2093–2096.

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