

Interaction of high-intensity beam with structured solid surface plasma in relativistic regime

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Recent research into the interaction between high-intensity beams (e.g. laser or charged particle beams) and surface plasmas has revealed significant potential for generating extremely strong fields for particle acceleration and radiation production. This new approach has emerged by overcoming several challenges in beam-solid interactions. It therefore holds great promise for reforming the research direction of large-scale facilities pursuing the energy frontier and micro-scale facilities demanding great flexibility. At the same time, this research can provide new insights into the extremely complex nonlinear dynamics of surface plasmons in the strong fields, a new unexplored regime.

In this talk, I will present our recent theoretical work on the interaction between high-intensity lasers or beams and structured solid surfaces made of nanomaterials, such as well-aligned carbon nanotube (CNT) forests. It aims to achieve a TeV/m-level accelerating gradient for ultra-compact particle acceleration, as well as pushing the energy frontier [1,2,3]. Thanks to the excellent properties of relativistic surface plasmons (RSPs) on these structured nanomaterials, we can also expect to produce high-quality radiation [4]. A brief discussion of future research activities will be given, with potential facilities that could support our experimental demonstrations.

References:

- [1] Bifeng Lei et al. 2025 Plasma Phys. Control. Fusion 67 065036
- [2] Bifeng Lei et al. 2025 New J. Phys. 27 084301
- [3] Cristian Bonțoiu et al. eprint: arXiv:2502.00183v2, 11 Feb 2025. In the preview process of Sci. Rep.
- [4] Bifeng Lei et al. eprint: arXiv:2507.04561v1, 06 Jul 2025. In the preview process of PRL.

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