20th Advanced Accelerator Concepts Workshop



Contribution ID: 87

Type: Contributed Oral

Generating pre-bunched electron beams using modulated density downramp injection

Monday, November 7, 2022 1:50 PM (20 minutes)

One of the two long-term applications of plasma-based accelerators is to develop the fifth-generation light source such as a compact free electron laser (FEL), which requires the generation of ultrahigh brightness electron bunches [1]. Recently, self-amplified spontaneous emission (SASE) by bunches from both laserand beam-driven plasma accelerators have been observed [2, 3]. If the drive electron bunch from a plasma accelerator is pre-bunched on the scale of the radiated wavelength, it is then possible to substantially enhance the longitudinal coherence of XFELs by superradiant amplified spontaneous emission. A possible way of generating pre-bunched electron beams is using modulated density downramp injection as recently proposed by Xu et al [4]. Here we show progress on a proof-of-concept experimental realization of this idea, with emphases on a practical method of generating a modulated density downramp by superimposing an ionization induced plasma grating [5] onto a shock front in a supersonic gas flow and the potential detection of bunched electrons using coherent transition radiation.

References

[1] Joshi, C. et al. "Perspectives on the generation of electron beams from plasma-based accelerators and their near and long term applications." Physics of Plasmas 27, no. 7 (2020): 070602.

[2] Wang, W. T. et al. "Free-electron lasing at 27 nanometres based on a laser wakefield accelerator." Nature 595, no. 7868 (2021): 516-520.

[3] Pompili, R. et al. "Free-electron lasing with compact beam-driven plasma wakefield accelerator." Nature 605, no. 7911 (2022): 659-662.

[4] Xu, X. L. et al. "Generation of ultrahigh-brightness pre-bunched beams from a plasma cathode for X-ray free-electron lasers." Nature communications 13, no. 1 (2022): 1-8.

[5] Zhang, C. et al. "Ionization induced plasma grating and its applications in strong-field ionization measurements." Plasma Physics and Controlled Fusion 63, no. 9 (2021): 095011.

Acknowledgments

This work was supported by the U.S. Department of Energy Grant No. DE-SC0010064 and the NSF Grant No. 1734315. The simulations were performed on the NERSC Cori cluster operated at LBNL

Primary authors: ZHANG, Chaojie (UCLA); Dr WU, Yipeng (UCLA); FARRELL, Audrey (UCLA); Dr NIE, Zan (UCLA); MARSH, Kenneth (UCLA); Dr XU, Xinlu; SU, Qianqian; Prof. MORI, Warren (UCLA); Prof. JOSHI, Chan (UCLA)

Presenter: ZHANG, Chaojie (UCLA)

Session Classification: WG1: Laser-Plasma Wakefield Acceleration

Track Classification: Working Group Parallel Sessions: WG1 Oral: Laser-Plasma Wakefield Acceleration