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Generating pre-bunched electron beams using modulated density downramp injection

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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 laser- and 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

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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)

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