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Seeded Self Modulation of Transversely Asymmetric Long Proton bunches in Plasma

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The AWAKE experiment at CERN [1] recently demonstrated the world's first acceleration of electrons in a proton-driven plasma wakefield accelerator [2]. Such accelerators show great promise for a new generation of linear e-p colliders using GV/m accelerating fields. Effectively driving a wakefield in AWAKE requires 100-fold self-modulation of the 12 cm Super Proton Synchrotron (SPS) proton beam using a plasma-driven process which must be carefully controlled to saturation [3,4]. Previous works have modeled this process assuming cylindrical symmetry of the transverse space and momentum profiles of the proton bunch. In this work, 3D particle-in-cell simulations are used to investigate the self-modulation of non-round beams. Implications of such effects for effectively sustaining resonant wakefields are discussed.

[1] P. Muggli et al. (AWAKE Collaboration), Plasma Physics and Controlled Fusion, 60(1) 014046 (2017)

[2] M. Turner et al. (AWAKE Collaboration), Phys. Rev. Lett. 122, 054801 (2019)

[3] E. Adli et al. (AWAKE Collaboration), Phys. Rev. Lett. 122, 054802 (2019)

[4] E. Adli et al. (AWAKE Collaboration), Nature 561, 363–367 (2018)

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