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Excitation of plasma wakefields with tailored electron bunches¹ PATRIC MUGGLI, Max Planck Institute for Physics and USC, BRIAN ALLEN, YUN FANG, USC, VITALY YAKIMENKO, MIKHAIL FEDURIN, KARL KUSCHE, MARCUS BABZIEN, Brookhaven National Laboratory, CHRISTINA SWINSON, ROBERT MALONE, BNL — Exciting plasma wakefields with a train of electron bunches or with a specially tailored bunch rather than with a single, Gaussian, short bunch allows for larger wakefield amplitude, larger transformer ratio and possibly better energy transfer efficiency. Driving wakefields in high-density plasmas (e.g., $> 10 \times 16 \, cm^{-3}$) requires short, closely spaced ($< 300 \mu m$) bunches. By varying the plasma density over approximately four orders of magnitude, i.e., the frequency of the accelerator by approximately two orders of magnitude, we demonstrate that the resonant excitation can be achieved when the density is tuned such that the relativistic plasma wavelength is equal to the period between the drive bunches with approximately equal charge. Acceleration of a separate drive bunch with finite energy spread is also observed. As expected, maximum energy loss and gain are observed at that resonance. We also devise a method to tailor the charge along the bunch train to demonstrate transformer ratio enhancements. Initial experimental results of the interaction of this new bunch train, as well as of triangular current profile drive bunches will be presented.

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