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Transition from Instability to Seeded Self-Modulation of a Proton Bunch in Plasma FABIAN BATSCH, PATRIC MUGGLI, Max Planck Inst for Phys, AWAKE COLLABORATION — A proton bunch propagating in plasma, with its length much longer than the plasma wavelength, undergoes a self-modulation (SM) process that turns it into a train of micro-bunches with modulation at the plasma frequency[1]. For a plasma wakefield accelerator with external electron injection, excellent control of the phase of the SM is a key pre-requisite. In the AWAKE experiment, a 10 m-long plasma is formed by a relativistic laser ionization front (RIF), co-propagating with the proton bunch at a variable position within or ahead of the bunch. We study time-resolved images of the self-modulated bunch for plasma densities around $10^{14}\,\mathrm{cm}^{-3}$. Depending on the position of the RIF, the SM may evolve from noise as an instability or may be triggered by the RIF, and be called seeded SM. While in the first case the phase is expected to be random, the second promises phase reproducibility. We determine the timing/phasing of the SM and its reproducibility for different relative positions of the RIF within the bunch. Detailed experimental results will be presented.

[1]AWAKE Collaboration, Phys. Rev. Lett. 122, 054802 (2019)

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