



Contribution ID: 341

Type: Talk

[331] First Observation of the Seeded Proton Bunch Self-Modulation in Plasma

Wednesday 28 August 2019 14:00 (30 minutes)

The Advanced Wakefield Experiment (AWAKE) recently demonstrated that a 400 GeV/c proton bunch can drive high amplitude plasma wakefields. To effectively excite wakefields, the drive bunch length should be on the order of the plasma electron wavelength (typically $< 3\text{mm}$). However, available proton bunches at CERN have an rms length of 6-12 cm. To be still able to excite high-amplitude wakefields, the experiment uses the plasma to modulate the bunch density, a process called the Seeded Self-Modulation. Transverse seed wakefields driven by the bunch in plasma act back on the bunch itself and periodically focus and defocus it, creating a microbunch train. This microbunch train can then resonantly excite a high amplitude plasma wakefield.

Using the two-screen diagnostic in AWAKE, we measured the transverse proton bunch distribution downstream the plasma exit and proved that: 1) a 400 GeV/c proton bunch self-modulates in plasma; 2) the driven wakefield amplitudes grows from their initial seed level along the bunch and along the plasma. In this contribution, we discuss the physics behind the seeded self-modulation process and show the experimental results.

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Session Classification: Nuclear, Particle- & Astrophysics