Joint DESY and University of Hamburg Accelerator Physics Seminar

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(16:00 in Room 459/30b)

Study of Self–Modulation of an Electron Beam in Plasma

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Abstract

The acceleration of electron beams in plasma wakefields driven by charged particle beams is among the most promising candidates for future TeV-scale compact electron accelerators. Currently available high energy proton beams that could serve as driver beams in a plasma wakefield accelerator (PWFA) are much longer than what is required for efficient excitation of high-amplitude wakefields and thus for generating the desired high acceleration gradients. The self-modulation instability (SMI) is a phenomenon which enables the transformation of a long charged particle beam into a train of equidistant short bunches when passing through a plasma. Such bunch trains can resonantly drive wakefields in plasma and generate multi-GV/m acceleration gradients. The proof-of-principle experiment AWAKE was started at CERN to demonstrate acceleration of electrons in plasma wakefields driven by self-modulated proton beams.

Since the underlying physics of the SMI is the same for any charged particle beam, the use of electron beams for studying the SMI is an appealing option, as the electron beams are easier to handle. The Photo Injector Test facility at DESY in Zeuthen (PITZ) offers a unique possibility to study and experimentally demonstrate the self-modulation of long electron beams in plasma: it is capable of generating long electron beams, and it possesses a variety of diagnostic devices for the electron beam characterization. For the SMI studies, measurements of the longitudinal phase space are of main importance, as they reflect characteristic features of the SMI.

The SMI was observed by using long electron beams passing through a plasma. Preparations for the self-modulation experiment, including the development of a plasma source, are described. Results of the first longitudinal phase space measurements of the SMI at PITZ and supporting beam dynamics simulations are presented.

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