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First Physics Results of AWAKE, a Plasma Wakefield Acceleration Experiment at CERN

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AWAKE is a plasma wakefield acceleration experiment using the 12cm-long, 400GeV proton bunch of the CERN SPS. In order to reach an acceleration gradient in the GeV/m range, the plasma electron density is $7 \times 10^{14} cm^{-3}$. The transverse self-modulation instability (SMI), strongly seeded by an laser ionization front, turns the long bunch into a train of micro-bunches at the plasma wavelength scale ($\sim$1mm) that resonantly drives the wakefields to large amplitude. Low energy electrons ($\sim$15MeV) can then be externally injected and accelerated to GeV energies.

The plasma source is a laser-ionized rubidium vapor source. The vapor density is measured with $< 0.5\%$ accuracy at both ends of the source.

The detection of the SMI is based on diagnostics aimed at measuring the proton bunch modulation: fluorescent screens for detection of the defocused protons at two locations, optical transition radiation (OTR) and streak camera for direct observation of the modulation, and coherent transition radiation (CTR) for modulation frequency measurements.

The first experiments focus of the study of the SMI. Experimental results obtained in late 2016 show signs of self-modulation on all diagnostics. Further SMI experiments will be conducted in 2017, together with the installation of the RF-gun and of the electron spectrometer. Injection and acceleration experiments will be conducted in 2018.

After a general introduction to AWAKE and to its physics, the experimental apparatus will be briefly described and the most recent experimental results will be presented. Mid- and long-term plans, including future experiments, the development of scalable plasma sources and possible applications to HEP will be discussed.

Experimental Collaboration

AWAKE Collaboration

Primary author: MUGGLI, Patric (Max Planck Institute for Physics)

Presenter: MUGGLI, Patric (Max Planck Institute for Physics)

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