

Study on the effect of impact ionization by the proton bunch on plasma density

The Advanced Wakefield Experiment (AWAKE) at CERN is a proof-of-principle of plasma wakefield acceleration. The proton bunch travels through a 10m plasma cell containing Rubidium plasma, created through ionization by a laser pulse. While the bunch propagates through the plasma, we expect the bunch to experience self-modulation instability (SMI), resulting in the creation of micro-bunches. The goal of the first phase of AWAKE is to confirm this prediction.

Since the SMI highly depends on the plasma density, the density must be very well defined. We believe the additional electron density, arising from impact collisions between protons and rubidium atoms, to be negligible to the plasma electron density. The focus of this work is to investigate and confirm this hypothesis.

Theoretical calculations, combined with Monte Carlo simulations, were carried out to characterize the collisions taking place during the experiment.

In the collisions between the protons and the rubidium, we account both for direct ionization, caused by the protons, as well as the secondary ionization, arising from secondary electrons. Therefore we can determine the electron density generated from the impact collisions and assess the impact on the SMI.

A brief explanation on the AWAKE experiment will be given, along with more details about the simulations and the results.