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Particle physics applications of the AWAKE acceleration scheme

The AWAKE experiment had a very successful Run 1 (2016-8), demonstrating proton-driven plasma wakefield acceleration for the first time, through the observation of the modulation of a long proton bunch into micro-bunches and the acceleration of electrons up to 2 GeV in 10 m of plasma. The aims of AWAKE Run 2 (2021-4) are to have high-charge bunches of electrons accelerated to high energy, about 10 GeV, maintaining beam quality through the plasma and showing that the process is scalable. The AWAKE scheme is therefore a promising method to accelerate electrons to high energy over short distances and so develop a useable technology for particle physics experiments. Using proton bunches from the SPS, the acceleration of electron bunches up to about 50 GeV should be possible. Using the LHC proton bunches to drive wakefields could lead to multi-TeV electron bunches, e.g. with 3 TeV acceleration achieved in 4 km of plasma. This document outlines some of the applications of the AWAKE scheme to particle physics and shows that the AWAKE technology could lead to unique facilities and experiments that would otherwise not be possible. In particular, experiments are proposed to search for dark photons, measure strong field QED and investigate new physics in electron-proton collisions. The community is also invited to consider applications for electron beams up to the TeV scale.

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