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An electron beam for physics experiments based on AWAKE technology

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The AWAKE experiment [1] will be taking data over the next two years to establish the method of proton-driven plasma wakefield acceleration. An R&D programme is being formulated for post-LS2 in which the AWAKE experiment demonstrates [2] that bunches of about 10^9 electrons with an energy of 10 GeV accelerated in about 10 m of plasma are achievable and that the energy gain is scalable with length. Given a clean electron beam of O(50 GeV) and of a much higher rate than from the SPS secondary beam, new and improved fixed-target or beam-dump experiments are possible. An example is the NA64 experiment [3] which is searching for hidden sector physics such as dark photons using the secondary SPS electron beam at an intensity of $\sim 10^6\ e^-/\mathrm{s}$. With the expectation of being able to increase this rate by at least a factor of 100 using the AWAKE beam, sensitivity to new physics is correspondingly extended. An electron beam of O(50 GeV) is also planned for the LHeC which under the AWAKE scheme could be achieved in a plasma cell of ~50 m in length, although with modest luminosities. This could open up the possibility of an LHeC-type project at relatively low cost and focusing on physics at low Bjorken-x such as saturation and QCD in general. An ultimate goal of the AWAKE technology is to use it to produce an electron beam of 3 TeV and collide with an LHC proton beam. This very high energy electron-proton collider [4] would probe a completely new regime in which QCD and the structure of matter is completely unknown. Again, this would be relatively low luminosity, but this is offset by the rapidly rising cross sections at low Bjorken x.

[1] AWAKE Coll., arXiv:1511.09032; arXiv:1512.05498

[2] E. Adli (AWAKE Coll.), IPAC2016 proceedings, p.2557-2560.

[3] https://na64.web.cern.ch

[4] A. Caldwell and M. Wing, arXiv:1606.00783

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