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Study of external electron beam injection into proton driven plasma wakefields for AWAKE Run2

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During its first experimental run (2016-2018), AWAKE [1] reached two important milestones: the demonstration of the seeded self-modulation of the 400 GeV/c proton bunch delivered by the CERN Super Proton Synchrotron [2,3], and the acceleration of externally injected electrons from 19 MeV to 2 GeV [4]. The goal of the second run (starting in 2021) is to accelerate an electron bunch with a narrow final energy spread (%-level) and preserving its incoming emittance. To do so, we will exploit beam loading of the wakefields, full blow out of the plasma electrons by the accelerated bunch and beam matching to the plasma ion column [5]. Thus, at the injection point the electron bunch density has to be much higher than the plasma electron density and the beam beta function parameters matched to the plasma focusing. For AWAKE Run2 it is planned to use two separated plasma sections: one dedicated to the self-modulation of the proton bunch and one for the electron acceleration. We therefore investigate the injection properties and geometry of the electron bunch into the second section, including foils and suitable diagnostics for beam transverse size and vector measurements, given the spatial constraints of the vapor source.

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