



Contribution ID: 223

Type: talk

## Physics plans for AWAKE Run 2

*Thursday, 19 September 2019 18:40 (20 minutes)*

During its Run 1, AWAKE has very successfully demonstrated the self-modulation of long SPS proton bunches in plasma, as well as the acceleration of externally injected, 19MeV electrons up to 2GeV. The goal of Run 2 is to accelerate an externally injected electron bunch, i.e. charge  $>100\text{pC}$  to GeV energy with a narrow final energy spread and preservation of its incoming emittance. To achieve this goal, two plasmas will be used, the first one for self-modulation of the proton bunch and the second one for acceleration of the electron bunch. The plan is to include a plasma density step in the first source since numerical simulation results indicate that this allows for the wakefields to be maintained at near their peak value after their growth saturation. The parameters of the 165MeV electron bunch will be set to allow for plasma electrons blow-out within the wakefields driven by the proton bunch, matching to the pure ion column focusing, and loading of the wakefields. New plasma and beam diagnostics are also investigated. At the same time, plasma sources allowing for generating very long plasmas (10s to 100s of meter) are also actively developed. Physics plans and challenges will be presented.

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**Session Classification:** WG1 - Hybrid staging and future PWFA experiments

**Track Classification:** WG1 - Electron beams from plasmas