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Techniques to seed the self-modulation instability of a long proton bunch in plasma

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The Advanced Wakefield Experiment (AWAKE) at CERN relies on the seeded Self-Modulation (SM) of a long relativistic proton bunch in plasma, to accelerate an externally injected MeV witness electron bunch to GeV energies.

During AWAKE Run 1 (2016-2018) and Run 2a (2021-2022), two seeding methods were investigated experimentally: relativistic ionization front seeding and electron bunch seeding.

In the first one, a short laser pulse co-propagates with the proton bunch and ionizes the rubidium vapor, generating the plasma.

In the second, a short electron bunch propagates in plasma and drives the seed wakefields.

Both seeding methods will be further employed during AWAKE Run 2b (2023-2024) to study their effect on the SM evolution in presence of a plasma density step.

In this contribution, we will show the main experimental results and discuss their impact for the future design of the experiment, in particular for Run 2c (starting in 2028), where the plasma will be split in two sections: one dedicated to SM of the proton bunch, and the other to the acceleration process.

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Footnotes

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Yes

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