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Overview of scalable plasma source R&D for the AWKE project at CERN

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Scalable plasma sources R&D for the AWAKE experiment at CERN focuses on two technologies as alternatives to the existing laser-ionised rubidium vapor plasma source: the Helicon Plasma Source (HPS) and the Discharge Plasma Source (DPS). The very stringent requirements of axial plasma electron density uniformity ($\delta n/n < 0.25\%$) and reproducibility are tackled thanks to a collaborative effort among several institutes addressing the source design and plasma characterization aspects. As a proof of principle of such alternative sources, a 10 m long DPS has been successfully tested for the self-modulation of a 400 GeV proton beam in the AWAKE experiment in May 2023. Since then, both sources have been operated and characterized in the different laboratories, implementing and comparing different plasma diagnostics.

This presentation will give an overview of the scalable plasma source R&D program within the AWAKE project timeline. Different characterization techniques used and corresponding results in terms of plasma electron density and temperature (spatially and/or temporally resolved) for the HPS and the DPS will be presented. Finally, we will discuss the next challenges for the sources design and diagnostics as well as the steps towards their length scalability.

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