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## Local plasma density measurements of a Discharge Plasma Source for AWAKE using Thomson Scattering

The development of scalable plasma sources is essential for future plasma wakefield acceleration (PWFA) applications. In this work, we present a pulsed-DC Discharge Plasma Source (DPS) developed for the AWAKE experiment at CERN, which requires a highly uniform electron density of  $7 \times 10^{14}$  cm<sup>-3</sup> maintained over tens to hundreds of meters. This DPS has already demonstrated to be compatible with AWAKE for the self-modulation of the proton bunch in different gases [1,2].

To assess the applicability of the DPS for electron acceleration, requiring an axial uniformity of better than 0.25%, we evaluate its uniformity by performing localised Thomson scattering [3] measurements on a 3-meter prototype. Time-resolved, axial and radial scans revealed a density uniformity within  $\pm 6\%$  along the 3-meter length, excluding the cathode region. This spread approaches our diagnostic precision, highlighting the need for more precise diagnostics to assess whether the plasma axial uniformity meets AWAKE's stringent requirements. These initial results demonstrate the DPS's potential for achieving the required uniformity and emphasise the importance of high-precision, local diagnostics for characterising plasma sources in next-generation PWFA experiments.

- [1] C. Amoedo (The AWAKE Collaboration), in preparation (2025).
- [2] Turner et al., PRL 134, 155001 (2025).
- [3] Stollberg et al., PPCF 66, 024002 (2024)

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