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Durability Assessment of Discharge Capillaries Wall Materials in Plasma-based Particle Accelerators for the EuPRAXIA Project

As part of the ongoing advancements in plasma wake-field technology for particle acceleration within the EuPRAXIA@SPARC_LAB project, this study investigates the impact of high repetition rate plasma acceleration experiments on plasma sources. Utilizing an established experimental setup for plasma generation through gas-filled discharge capillaries, where plasma formation is achieved by ionizing hydrogen gas with high-voltage pulses, we assess the performance and longevity of capillaries made of plastic. This research builds upon previous work that optimized plasma density measurements and capillary configurations for efficient particle beam acceleration, focusing on the capillaries' ability to sustain future stable operations at high frequencies from 100Hz to 400Hz. Such a criterion is vital for the long-term feasibility of the EuPRAXIA project. The characterization of plasma sources, particularly through spectroscopic techniques based on Stark broadening, provides insights into the interplay between capillary materials and high-frequency plasma formation. This highlights the critical role of material durability in advancing plasma-based particle acceleration technology.

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