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Investigation on shot-to-shot stability of the plasma density for plasma-based accelerators at SPARC_LAB

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Compact accelerator machines are leading to produce accelerating gradients in the GV/m scale comparing the conventional one [1]. Mankind's daily life has been sinking into the pros of these state-of-the-art plasma-based machines. A medical linear accelerator (LINAC) is a flawless instance of these acceleration technologies that are used for external beam radiation therapy for patients with cancer through x-raying to the region of the tumor. Hence these devices are highly demanding nowadays a wide range of young plasma researchers passionate to deal with them. SPARC_LAB test-facility (INFN-LNF) research area is dedicated to the particle accelerator research infrastructure based on novel plasma acceleration concepts. Respecting this subject, to produce plasma channels, at SPARC lab test-facility that have lengths up to tens of centimetres, a gas-filled plasma tube is used, for which the gas ionization is produced through the applied pulse of a high-voltage to the electrodes at the capillary walls [2]. Within this context, the plasma formation process represents a crucial issue to oversee the plasma properties, which, successively, impact the electron beam dynamics. The shot-to-shot stability of the plasma density along the longitudinal dimension of the plasma-discharge capillary is one of the critical points in which roughly impacts the properties of the electron beam passing through the plasma source. Initializing from a neutral gas to produce plasma and through the limitation of the lifetime for few tens of microseconds proposes a barrier toward its uniformity, stability, and reproducibility. Consequently, this paper is dedicated to the study of the shot-to-shot stability of the plasma density longitudinally within the plasma-discharge capillary tube.

References

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