Comparison among the distinct configurations of inlets in a gas-filled plasma-discharge tube for compact accelerator machines: Typical, tapered, and enlarged inlets

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Ultramodern particle accelerators bottomed on the plasma acceleration technology can achieve high energies up to GV/m by overcoming the barriers of conventional accelerator devices through compacting the machine using plasma technology. The plasma is generated by a considerable electric field effective for ionizing the injected gas. These novel compact machines are required to accelerate charged particle beams through electron (LWFA) [1] density modulations inside plasma either by an intense laser pulse or by an energetic particle beam (PWFA) [2]. The experiments scheduled at the SPARC_LAB test facility have been targeting to demonstrate the acceleration of high brightness electron beam through the above-mentioned schemes. The accelerated beam quality hangs on the plasma properties, particularly on the local density, whose clarified as the number of free plasma electrons involved in a cubic centimetre. The plasma waves amplitude, the spatial dimensions, the accelerating gradient, depending on the background plasma electron density. The different longitudinal plasma electron density results in a variation of the accelerating structures, hence the longitudinal plasma electron density must be tracked to fully control the accelerated beam quality. Gas-filled plasma-discharge capillaries up to centimetre-scale length have been trustworthy devices to be located in the compact accelerators to rule the evolution of the plasma [3, 4]. Thus, a wide range of plasma sources with distinct numbers and shape of inlets for injecting the gas into the plasma channel has been investigated to target the plasma evolution on the plasma density for overcoming the limitations and adapt the plasma properties to the accelerating beam. The analyses' results have been achieved by changing the length, shape, and number of gas inlets.

References

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