

Design of a Plasma Discharge Circuit for Particle Wakefield Acceleration

Monday, 3 June 2013 19:30 (30 minutes)

Plasma wakefield acceleration is the most promising acceleration technique known nowadays, able to provide very high accelerating fields ($10\text{--}100\text{ GVm}^{-1}$), enabling acceleration of electrons to GeV energy in few centimetre. However, the quality of the electron bunches accelerated with this technique is still not comparable with that of conventional accelerators; Radiofrequency-based accelerators, in fact, are limited in accelerating field ($10\text{--}100\text{ MVm}^{-1}$) requiring therefore kilometric distances to reach the GeV energies, but can provide very bright electron bunches.

To combine high brightness electron bunches from conventional accelerators and high accelerating fields reachable with plasmas could be a good compromise allowing to further accelerate high brightness electron bunches coming from LINAC while preserving electron beam quality.

Following the idea of plasma wave resonant excitation driven by a train of short bunches, we have started to study the requirements in terms of plasma for SPARC_LAB. In particular, here we focus on the ionization process; we show a simplified model to study the evolution of plasma induced by discharge, very useful to design the discharge circuit able to fully ionize the gas and bring the plasma at the needed temperature and density.

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Session Classification: Wine and Poster Session

Track Classification: Wine and Poster Session