ID contributo: **178** Tipo: **Oral contribution**

Evaluation of the transfer matrix of a plasma ramp with squared cosine shape via an approximate solution of Mathieu differential equation

lunedì 18 settembre 2023 16:45 (20 minuti)

The high longitudinal electric fields generated in plasma wakefields are very attractive for a new generation of high gradient plasma based accelerators. On the other hand, the strong transverse fields increase the demand for a proper matching device in order to avoid the spoiling of beam transverse quality. A solution can be provided by the use of a plasma ramp, a region at the plasma injection/extraction with smoothly increasing/decreasing plasma density. The transport of a beam inside a plasma ramp depends on the profile of the ramp itself. Establishing the transfer matrix for a plasma ramp represent an useful tool in order to evaluate the beam evolution inside plasma. In this paper a study of a cosine squared ramp is presented. An approximate solution of the transverse equation of motion is evaluated and exploited to provide a simple transfer matrix for the plasma ramp. The transfer matrix is then employed to demonstrate that this kind of ramp has the effect to minimize the emittance growth due to betatron dephasing. The behavior of a squared cosine plasma ramp will be compared with an experimentally measured plasma ramp profile in order to validate the applicability of the transfer matrix to real cases.

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Classifica Sessioni: WG1:Plasma-based accelerators and ancillary components

Classificazione della track: WG1: Plasma-based accelerators and ancillary components