Nondestructive Diagnostics of Proton Beam Halo and Transverse Bunch Position by Cerenkov Slow Wave Structures

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Abstract

An appearance of the halo around bunch of particles is very undesirable destructive phenomenon in high-intensity proton accelerators. We suggest using built-in short BWO section in form of the corrugated metallic waveguide, in order to control particle distribution in real time. In BWO low velocity proton bunch has synchronism with slow spatial harmonic of TM01 wave. Fields of slow harmonic sharply grow in direction from axis to walls and rf power, generated by flying bunch of the given charge, critically depends on transverse bunch size. Results of the simulation, carried out for 20 pC proton bunch of 10 ps duration, show that in 5 GHz BWO of 30 cm length the output rf pulse of several nanosecond duration is varied from mW-level (for 1 mm transverse bunch size) to several tens of mW (for bunch of 20 mm radius). This power level is high enough to control halo appearance in each single proton bunch. The producible rf power in a BWO is also dependent on bunch deflection from axis. This effect we plan to use in order to provide transverse bunch position monitoring by means of two additional rectangular cross-section BWOs which have corrugations on mutually perpendicular walls.

Halo diagnostics

Diagnostics of bunch position in BWO section

- Parameters of corrugation:
  - a: 72 mm
  - b: 14 mm
  - t: 15 mm
  - d: 10 mm

- Output signal power vs. bunch y-shift
- Output signal frequency vs. bunch y-shift
- Output signal spectrum (dyb = 10 mm)

Diagnostics of bunch position in BWO-TMT sections

- Parameters of corrugation:
  - a: 72 mm
  - b: 34 mm
  - t: 24 mm
  - d: 15 mm
  - ∆: 22 mm
  - ∆: 15 mm
  - ∆: 10 mm

- Output signal power vs. bunch y-coordinate
- Output signal frequency vs. bunch y-coordinate
- Output signal spectrum (Y=53mm - W_L)
- Output signal spectrum (Y=25mm - W_R)