FIRST ATTEMPTS AT USING ACTIVE HALO CONTROL AT THE LHC *

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Abstract

The beam halo population is a non-negligible factor for the performance of the LHC collimation system and the machine protection. In particular this could become crucial for aiming at stored beam energies of 700 MJ in the High Luminosity (HL-LHC) project, in order to avoid beam dumps caused by orbit jitter and to ensure safety during a crab cavity failure. Therefore several techniques to safely deplete the halo, i.e. active halo control, are under development. In an first attempt a novel way for safe halo depletion was tested with particle narrow-band excitation employing the LHC Transverse Damper (ADT). At an energy of 450 GeV a bunch selective beam tail scraping without affecting the core distribution was attempted. This paper presents the first measurement results, as well as a simple simulation to model the underlying dynamics.

three bunch scheme

measurement of detuning with amplitude

blown-up bunch: for populated beam tails in tune region of interest to enhance measured parameters
witness bunch: nominal bunch for demonstrating the core is not affected during halo excitation
reference bunch: outside ADT excitation as probe for other sources of emittance Growth

initial bunch profiles

measurement of ADT excitation with fixed frequency \( Q_{\text{exc}} = 0.295 \) (~5.4\( \sigma \))

simulated tune footprint at injection energy for 6

simulation of ADT excitation with fixed frequency \( Q_{\text{exc}} = 0.295 \)

- symplectic Hénon map like model
- 10\(^3\) particles, 10\(^{-10}\) turns
- blown-up bunch with 2.3\( \sigma \) nominal

The very first attempt of using active halo control in the LHC by means of the transverse damper at injection energy showed first promising results. For the application of the ADT useful settings have been proposed which deliver similar results in a simplified 1D simulation tool. A detuning with amplitude measurement was successfully carried out. The presented measurements of excitations use an original experimental method referred to as three-bunch scheme that can be very useful also for other halo studies. In spite of some promising results, some tests were inconclusive. Before conclusions can be drawn on the feasibility of the method for operational halo control, the measurements would have to be repeated, to demonstrate a reliable reproducibility, and new tests have to be envisaged in more complex operational conditions with multiple bunches. Furthermore, more detailed simulations are planned.