Plan for halo excitation MDs and update on simulations

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Outline

- Recap of need and principle
- Previous MD’s and different methodologies
- Simulation approaches
- New type of excitation with colored noise
- MD planning
Needs of an Active Halo Control for tail cleaning

- from collimator scraping tests we know that 5% of the beam is stored in its tails (>3.5 $\sigma$)
- scaling to HL-LHC this means 33.6MJ

Possible risks of sudden release are:
- crab cavity failures
- orbit jitters
- change of collimator position
- onset of collision
- etc.

The present collimation system is “passive” to beam losses

With an active halo control of the beams one could:
- regulate the diffusion speed over a certain time interval
- deplete the static halo population close to collimator jaws

The need of an Hollow Electron Lens was reviewed in Oct. 2016 by an external panel and is being considered as required to reach design performance of HL-LHC
Recap of halo depletion with LHC’s Transverse Damper - ADT

A sinusoidal voltage is applied to the ADT, the frequency $f_{\text{ADT}}$ corresponds to a fractional tune $Q_{x,\text{ADT}}$. Particles having a tune close to the excited tune experience higher kicks. The ADT frequency can be fixed or swept. The amplitude $A_{\text{ADT}}$ can be varied from 0 to 1, max $\sim 1.175$ murad at injection. A gated bunch by bunch excitation is possible.

thanks to D. Valuch and RF
Recap of previous MD’s in 2015 and 2016

- first tests in two MD blocks of 2015 explored the parameter space
- a three bunch scheme was used

- individual bunch intensity and emittance was monitored
- Tail measurement with wire scanners (BWS) was tested

- one bunch without excitation
- two bunches within excitation window
- the tails of one bunch were artificially populated

The bunch intensity showed good results for the blown up bunch and ~1% depletion after 5min

Wire scans couldn’t show that only tails were depleted
New methodology in MD1388 – Oct 2016

The test was split up in Tail and Core studies with **single bunches**

**Tail study:**
- populate tails
- apply excitation with fixed frequency or frequency sweep
- scrape the entire bunch for profile reconstruction

**Core study:**
- scrape with TCP down to 2.4sig, only remaining core, retract to 5.7sig
- apply excitation with fixed frequency or frequency sweep
- scrape the entire bunch for profile reconstruction

Reference scrapings for Core and Tail without ADT excitation were also taken. Additionally scraping while exciting.
Reproducibility:
the amplitude had to be increased by a factor 6 to reach the same amount of losses after 300s
Reconstructed profiles of the Tail and Core studies

- fixed frequency excitation shows a reduction in the tails
- frequency scans are less effective, but have a different amplitude

- ADT excitation seems to affect the core slightly by 0.8sigma for A=0.18

Scraping while excitation didn’t give significant difference, here not shown.
SixTrack simulations and detuning with amplitude

The amplitude detuning is way lower than obtained in measurements

Might be due to no non-linearities such as errors
SixTrack simulations

Simulating a flat halo from 3.38sig to 5.7sig with TCPs at 5.7sig
ADT excitation is switched ON after 1E3 turns~ 9s

Simulation of gaussian bunch shows much higher loss than in MD
Excitation with colored noise

suggested during HiLumi meeting, May 2016, T. Mastoridis

Instead of applying a fixed ADT frequency or sweep many tones cover a whole region of tune

![Graphs showing beam population density and particle density distribution.](image-url)
Generating excitation frequencies and amplitudes

Deriving from a detuning with amplitude measurement one would apply \( \sim x100 \) tones starting at 4sigma.

- As a first approach a linear shaped amplitude can be used.
- More accurate would be the inverse of the beam transfer function. How to measure and implement?

Normalization and scaling of \( A_{\text{max}} \) of final signal needs to be evaluated.
MD2485 planning (B1)

- 8 hours are allocated
- One run can be performed easily in 30min, meaning:
  Injection, blow-up, collimator movement, ADT excitation and Collimator scraping

Reference scraping
tail and core = 4x 15min 1h

Repetition of fixed frequency excitation cases with 3 bunch scheme + blow out 2bunches + scrape either nominal or populated bunch

Eventually increasing the amplitude while exciting and/or getting closer with the tune, while online monitoring indiv. Intensities and losses 2.5h

4h

Testing the colored shaped noise on single bunches

- Tail studies
- Core studies

- Applying at least two different maximum amplitudes
- Applying two different minimum sigma for the excitation area

D. Valuch: everything concerning the ADT, preparing the scripts and launching excitations
A. Gorzawski: Diamond detectors when using the 3 bunch scheme for indiv. losses