MD plans for e-cloud studies

L. Mether and K. Paraschou
for the e-cloud team

LHC Studies Working Group meeting
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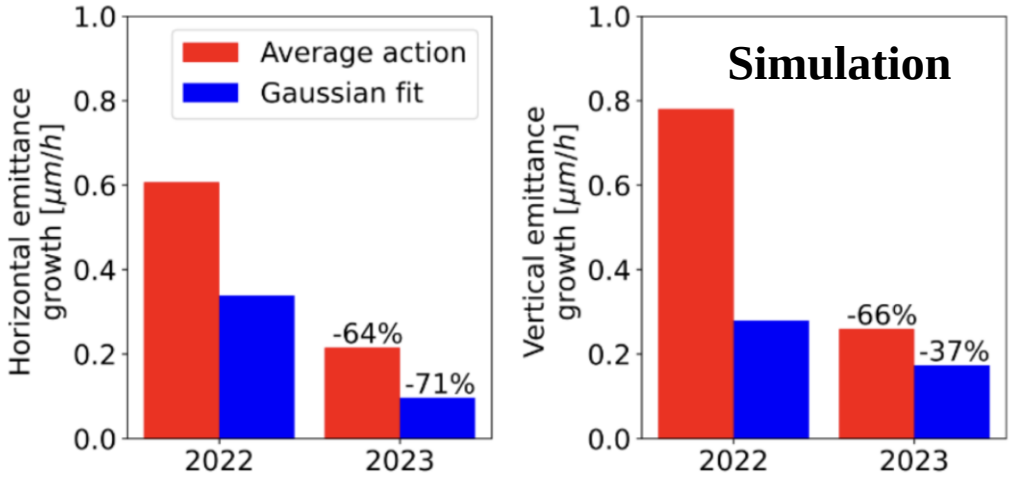
MD9554: Emittance growth from incoherent e-cloud effects at injection

Additional participation from collimation team: P. Hermes and M. Rakic (BE-ABP-NDC)

Motivation:

- The 2023 change in the injection optics (phase knob) affects the emittance growth as well as the halo formation caused by electron clouds **in simulations**



In simulations, 2023 phase knob reduces:

1. Emittance growth
2. Halo population

Goals:

- Study this effect with consecutive measurements
- Gives insight to the effectiveness of mitigating electron cloud effects with optics manipulations
- Learn about halo population from electron cloud effects
- Benchmark incoherent e-cloud simulations against measurements

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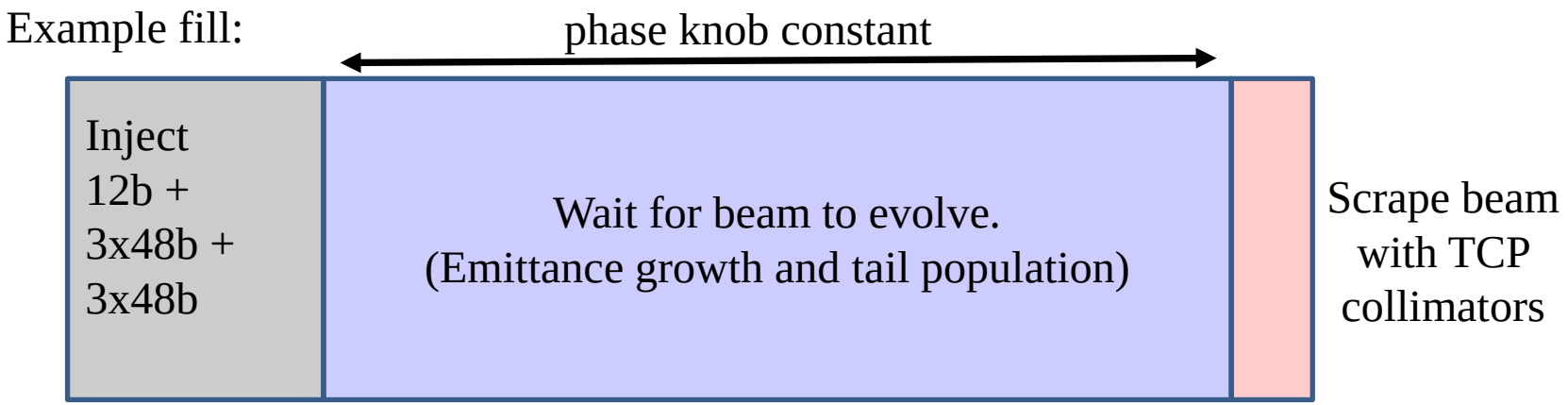


Setup:

- Use two trains of 3x48b with bunch intensity of **1.4e11 ppb**. (~300 bunches per beam)
- Inject and then trim phase knob **or** trim phase knob to 0/1 and inject
- Wait for emittance/halo to grow (order of tens of minutes)
- Scrape the beam in steps using the TCP collimators to estimate halo population
- Repeat

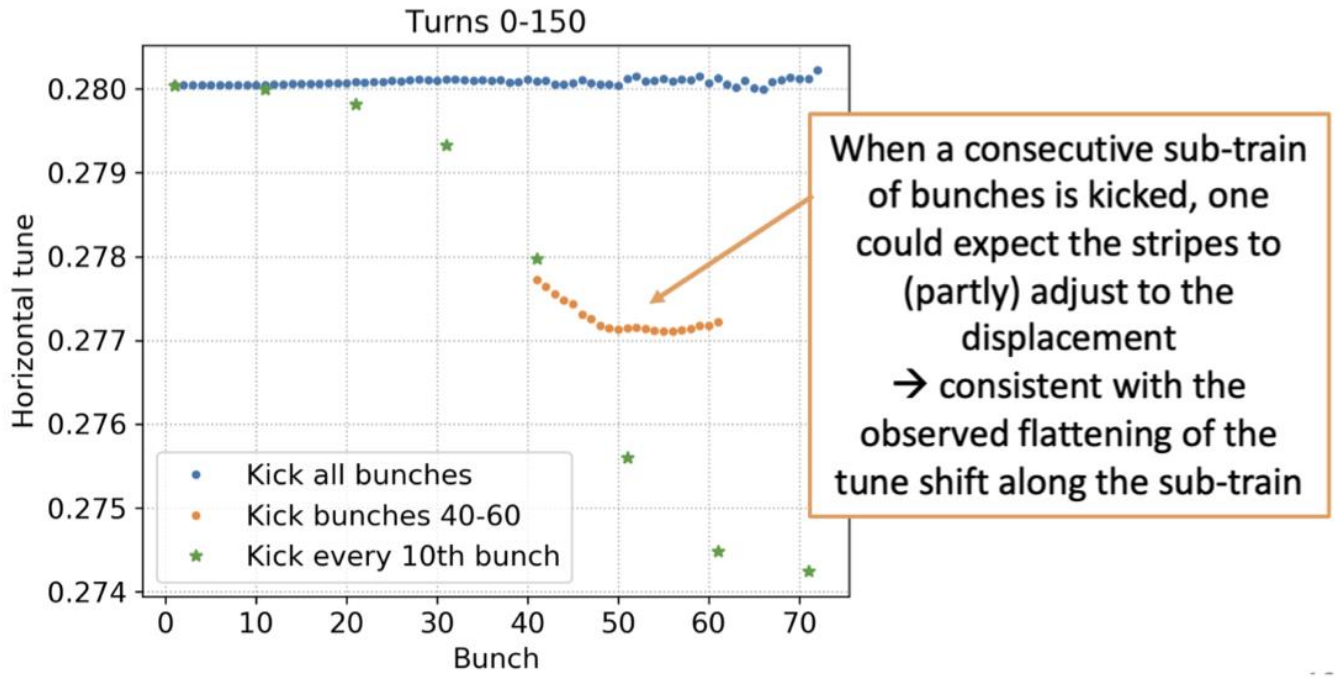
Time:

- 8 hours at **450 GeV**

MD6925: Electron cloud coupled-bunch tune shifts at injection

Motivation:

- Simulations show that the tune shift depends on how bunches are kicked (e-cloud and transverse impedance)
- Has been confirmed in SPS measurements
- Promising way of measuring electron cloud properties to improve models
- Tune shifts important for HL-LHC crab cavity impedance mitigation with comb-filter



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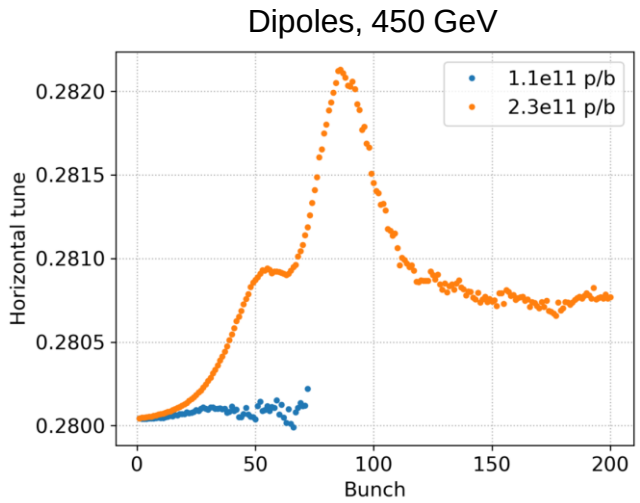
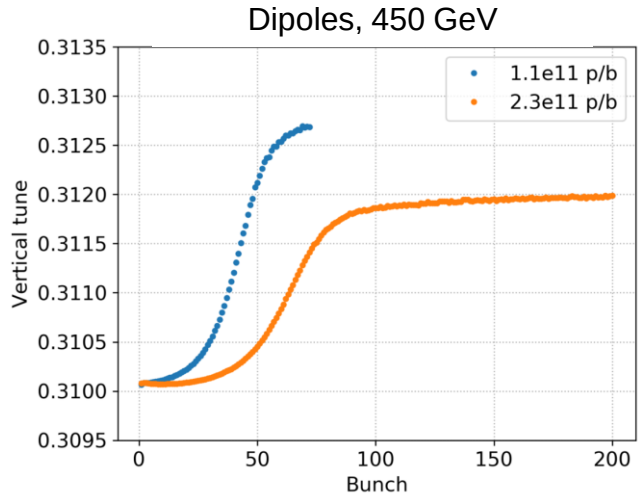
Setup:

- Inject 3-4 trains of at least 2x72 bunches (~600 bunches per beam)
- Use ADT to kick:
  - Single bunches, groups of bunches and full trains
  - Scan kick amplitude of ADT
- Repeat for different bunch intensities (in the range of **1.2-2.3e11 ppb**)
  - Larger signal (horizontal plane) expected for higher intensity
- Use of ADT in compliance with limits defined in:
  211th Machine Protection Panel Meeting (LHC) - https://indico.cern.ch/event/1058861/

Time:

- 8 hours at **450 GeV**





MD9552: Beam stability with trains at injection

Motivation:

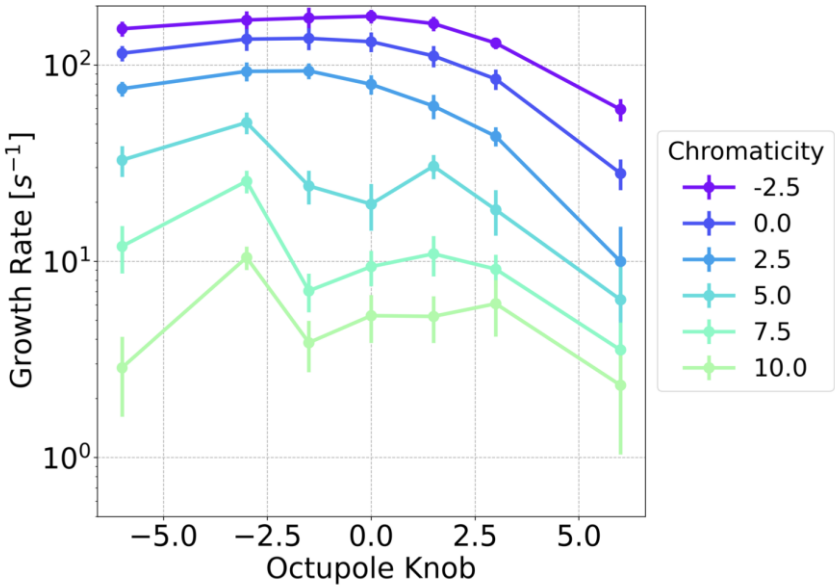
- Identify stability limits with operational beam at injection to minimize non-linearities
  - Expect improved stability since last assessment in 2022 (increased intensity, further scrubbing, filling pattern?)
  - Hints from simulations that short-term (10-turn) losses at injection are influenced by the strong octupole settings (more for Beam 1 than Beam 2)
- Test impact at injection of negative octupole polarity, foreseen for HL-LHC
  - Simulations indicate that negative octupole polarity can be more beneficial for e-cloud instabilities

Setup:

- Inject trains of operational beam (**1.6e11 ppb**):
- Evaluate stability thresholds by scanning for different settings of
  1. Chromaticity
  2. Octupole strengths
  3. ADT damping

Time:

- 8 hours at **450 GeV**



[L. Sabato, CERN-ACC-NOTE-2020-0050]

MD9551: Heat load with high bunch intensity at injection

Motivation:

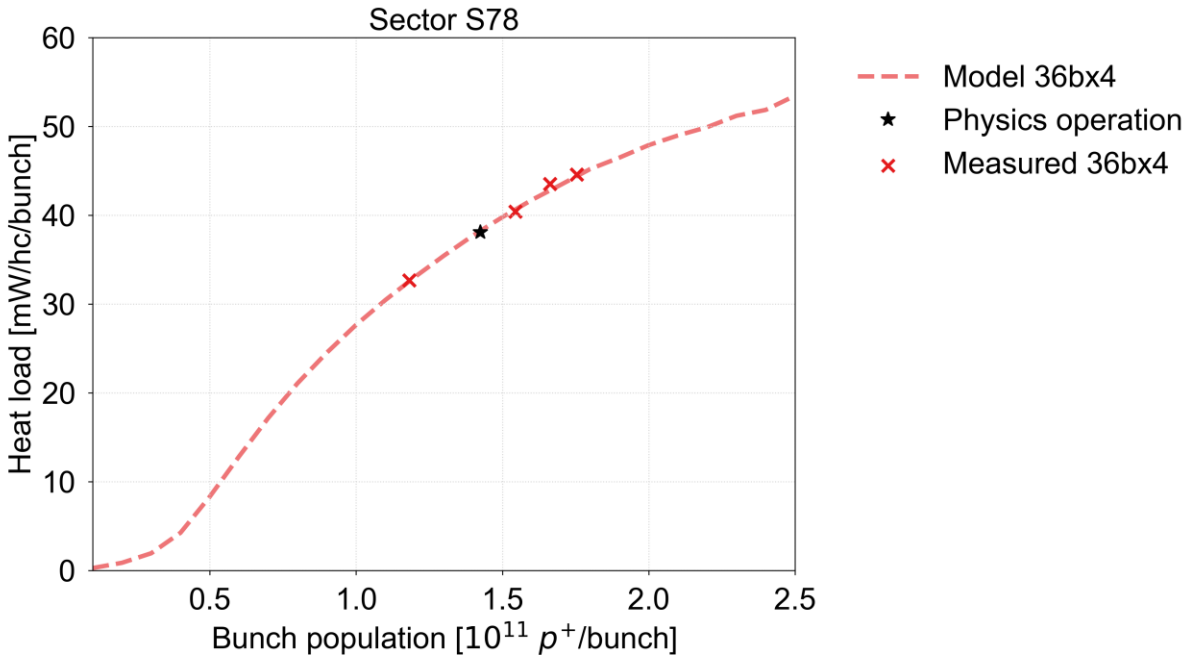
- Heat load currently measured only up to intensity ~1.8e11 p/b
  - Large uncertainty when extrapolating to 2.3e11 p/b, due to limitations in modelling of beam screen surfaces
- Improve estimates of cell-by-cell heat loads for the HL-LHC era
  - Direct measurements provide reliable data for selecting half-cells for BST and defining cryo margins in Run 4
- Important data for benchmarking and improving simulation models

Setup:

- Inject beam in trains of 2x72 or 3x48 bunches (144 bpi) (~950 bunches per beam) with up to **2.3e11 ppb**
- Store beam for ~30 minutes for a reliable heat load estimate
- Repeat for lower intensities (e.g., **1.8e11, 1.4e11 ppb**)

Time:

- 8h at **450 GeV**



MDsXXXX: Further heat load measurements

Motivation:

- Important input for improving modelling of cell-by-cell heat loads
  - To reconstruct the SEY on the element- or magnet level from the half-cell heat load, measurements in several different configurations are necessary

- MDXXXX: Heat load with different filling patterns (50 ns, 8b4e)
- MDXXXX: Heat load measurement at injection
- MDXXXX: Heat load with single beams

Setup:

- Operational beam conditions

- MD9550: Heat load with high intensity 8b4e beam at flat top → postponed

Summary

- MD9554: Emittance growth from incoherent electron cloud effects at injection
  - 1.4e11 ppb (~ 300 bunches per beam), 8h at 450 GeV

- MD6925: Electron cloud coupled-bunch tune shifts at injection
  - **1.2-2.3e11** ppb (~ 600 bunches per beam), 8h at 450 GeV

- MD9552: Beam stability with trains at injection
  - 1.6e11 ppb (< 2500 bunches per beam), 8h at 450 GeV

- MD9551: Heat load with high bunch intensity at injection
  - **1.4-2.3e11** ppb (~ 950 bunches per beam), 8h at 450 GeV

- MDsXXXX: Further heat load measurements
  - 1.6e11 ppb