



MD12723: HL-LHC optics rMPP

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MD goals

Following successful deployment, correction, and validation of new ramp and squeeze in MD2, we propose:

- 1) ATS squeeze up to factor 6.6 (1.2 km beta in arc, but $\beta^* = 1\text{m}/37.5\text{ cm}$ in IP1/5). Pushed optics for the arcs, never tested in the machine.
 - a) Optics measurements and corrections.
 - b) Aperture measurements in the arcs.
 - c) On- / off-momentum loss maps with degraded off-momentum beta-beating.
 - d) *Investigate feasibility of a beta increase in IR4 during the squeeze at flat top.*

- 1) Test new K-smoothing algorithm for ramp & squeeze (M. Hostettler).
 - a) It will improve any future optics transitions during ramp, as unnecessary acceleration/deceleration of the current will be removed.

- 1) Improve optics correction during the ramp, if time allows.

This test will indicate the extent of optics manipulations that could be used in the HL-LHC optics to enhance performance or mitigate unexpected issues.

MP comments

MD12723 HL optics cycle

- If completely new optics, one should first take up some pilots only. This is to be clarified for the first ramp. Define number of pilots and total intensity. Second ramp pilots only as well.

The first ramp and following squeeze will use only one pilot per beam as it is possible that beta-beating will exceed 20% during the squeeze. The second ramp could use up to 3 pilots $\sim 3 \times 10^{10}$ protons if beta-beating is well corrected.

- Some words on tools to be used for optics measurements (AC-dipole etc.)

This is a standard OMC procedure where the only active devices used are AC dipole and K-modulation. Main measurements are BPM and BBQ tune data. As a novelty we will try using the DOROS BPMs. On- and off-momentum AC dipole measurements are performed for a complete set of corrections.

To check tune stability, at least ~ 20 AC dipole shots (~ 25 min) are necessary under static conditions. One of the critical aspects to be learned. To be re-done in 2025 with the dipole PC upgrade.

Off-momentum AC data part of usual correction (as k-mod), now also critical for D_x, D_y

- Third ramp with loss maps, can take two nominals and pilots to stay below 3×10^{11} total. However, aperture checks with nominals is risky.

Loss map will use a standard procedure. The nominal bunch will be used to correct the orbit and align the collimators, then it will be extracted with the ADT and only the pilots will be used to do loss maps.

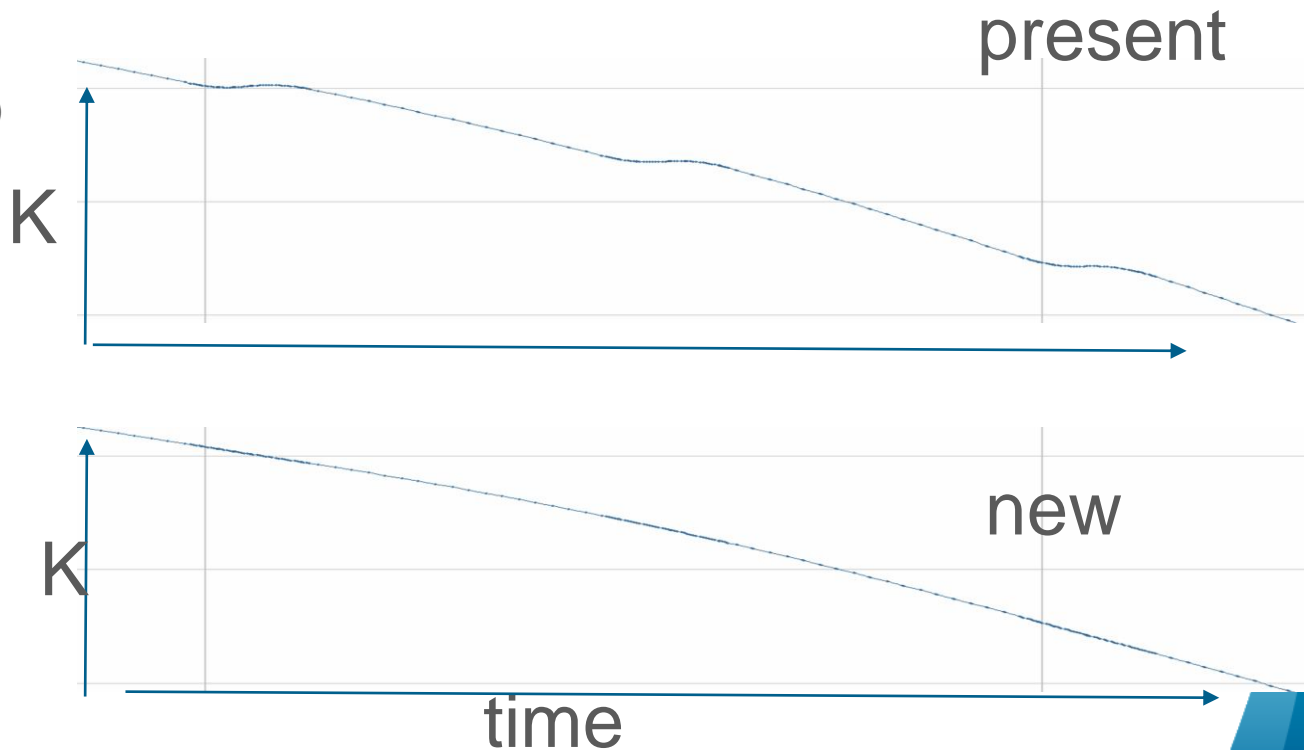
Back-up

Ramp and squeeze

Discrete normalized fields (K) are smoothed by LSA before being converted in currents (I)
Present smoothing algorithm impose $K'(t)=0$ at matched points which introduces unnecessary $I''(t)$ steps.

New algorithm, removes the steps.

Needed to fit HL-LHC optics ramp and squeeze.



Squeeze at FT

ATS squeeze up to factor 6.6 (but $\beta^*=1\text{m} / 37.5\text{ cm}$) challenging for optics correction and aperture in the arcs.

- 1) Optics measurements and corrections:
 - a) K-modulation (using DOROS) and on- / off-momentum AC dipole for complete set of corrections
 - b) Check tune stability, at least ~ 20 AC dipole shots ($\sim 25\text{min}$) necessary under static conditions. One of the critical aspects to be learned. To be re-done in 2025 with the dipole PC upgrade.
 - c) Off-momentum AC data part of usual correction (as k-mod), now also critical for D_x, D_y
- 1) Aperture measurements at FT in the arcs, on- / off-momentum
- 2) Loss maps at FT on- / off- momentum
- 3) Investigate feasibility of a beta increase in LLS4 during the squeeze For this MD only B2 V in a few intermediate segments of squeeze.

