Collimation hierarchy limits and commissioning

R. Bruce, S. Redaelli

Acknowledgement: D. Wollmann

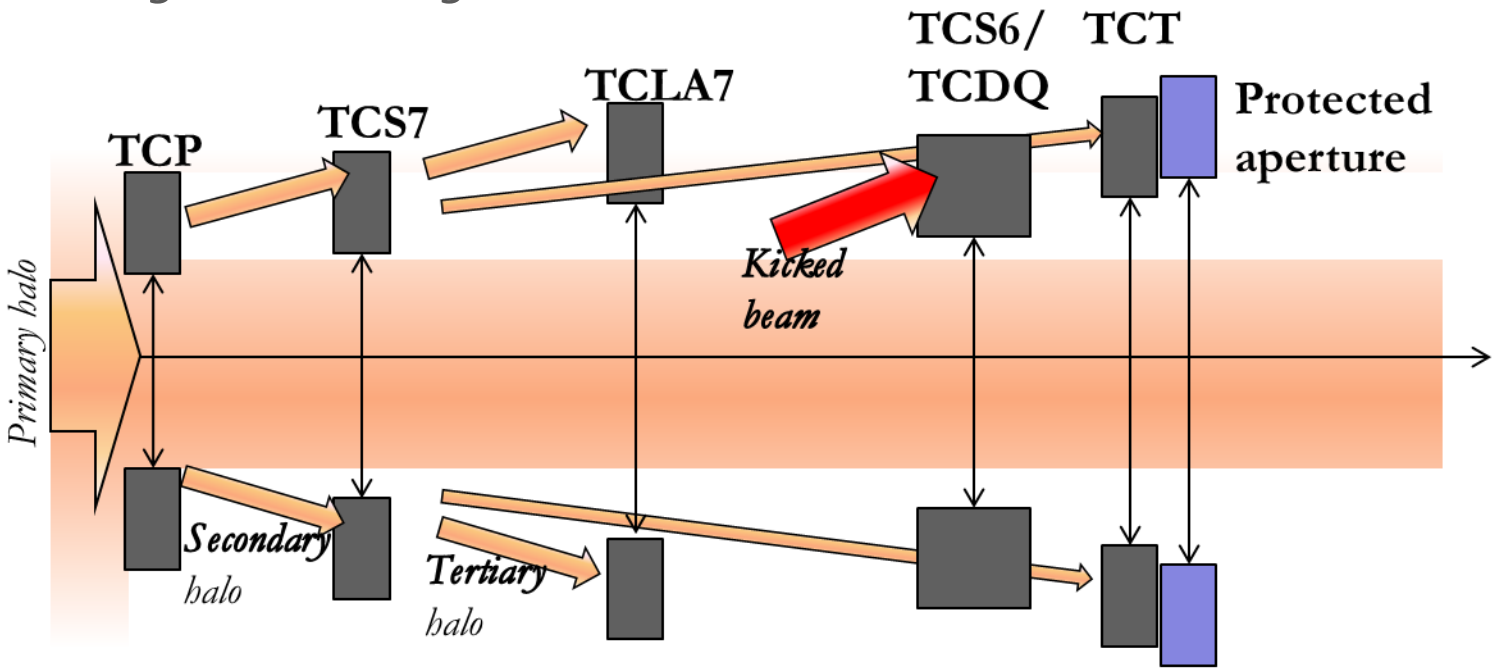
2017.03.20

Introduction

- Goal: review achievable collimator settings during the MDs and the tests that are anyway planned for the commissioning
- Outline
  - Review of operational collimator settings
  - Collimator settings on the strong beam
    - Assuming intensities above 3E11
  - Collimator settings on the weak beam
    - Assuming intensities below 3E11
  - Collimator commissioning
    - Initial tests planned for the hardware commissioning, to verify correct functioning of wire collimator and nearby collimators
    - Are there synergies with preparation tests for MD?

Collimation hierarchy

- Collimation system should protect sensitive machine elements from regular and irregular losses



Collimator settings for 2017 physics operation

- Assumed starting configuration: ATS optics with β*=40 cm
- Collimator settings calculated based on 2016 MDs and OP experience
- Settings given in collimation σ, using **3.5 µm emittance**

Collimator	2016	2017, 40cm ATS
TCP IR7	5.5	5.0
TCSG IR7	7.5	6.5
TCLA IR7	11.0	10.0
TCP IR3	15.0	15.0
TCSG IR3	18.0	18.0
TCLA IR3	20.0	20.0
TCSG IR6	8.3	7.3
TCDQ IR6	8.3	7.3
TCT IR1/5	9.0	9.0
Aperture 1/5	*9.9*	*9.9*
TCT IR2	37.0	37.0
TCT IR8	15.0	15.0

Settings in MD on BBLR wire compensation

- Assumptions for MDs at 6.5 TeV, 40 cm:
  - 1 strong beam (train), B1
  - 1 weak beam (intensity < 3E11), B2, affected both by long-range interactions from B1 and wire
- MP considerations: Above 3E11 protons, interlocks cannot be masked
  - For strong beam, collimator settings should be identical to the settings qualified for physics operation
  - Collimator settings in sigma not affected by change of crossing, but center must change
  - Even at a smaller crossing or larger β*, we cannot approach the beam further in units of σ in order to respect the collimation hierarchy
  - If we squeeze β* further during the year, a machine configuration with tighter will have to be qualified => potentially beneficial for the MDs

Procedure in previous BBLR MDs

- Beam-beam MDs in 2015-2016 to study long-range effects, e.g. CERN-ACC-NOTE-2016-0019
  - Gradually decreased crossing angle in steps
  - Shift in central orbit at TCTs
  - Strategy: moved TCTs using predefined sequence to always stay centered, keeping the gap in σ constant
  - Verified online with collimator BPMs that orbit was indeed centered
  - MP considerations: allowed, since
    - crossing and hence orbit excursion in triplet is decreased => margin to triplet aperture increased
    - TCT full gap stays constant, so TCT safety margin not affected
- A similar procedure should be possible for this year's MD if needed

Collimator settings for the weak beam

- Staying with total intensity below 3E11 protons => more freedom to mask interlocks and change settings
  - Need to use setup beam flag on one beam only
- Cleaning efficiency of IR7 collimation system not critical at very low intensity
- More "exotic" collimation schemes could be envisaged
- Still, staying long time in a given configuration, we should operate the horizontal TCTs 1 σ outside cut of TCSP in IR6 and the IR7 TCPs
  - Example configuration: TCPs and TCSP at 5 σ, TCTs at 6 σ (ε_n=3.5 µm)
  - Recommended to do betatron loss maps in such a configuration during commissioning => can obtain limits on allowed losses before BLMs dump, and check where we would dump

Collimator commissioning

- Tests proposed for the commissioning with beam to guarantee functionality as collimator also when wire is powered
  - Basic check of BPM response versus current and ramp rates with beam in the machine.
    - Compare BPM and BLM alignment for different currents
    - Monitor parasitically LVDTs, also at nearby collimators, and temperature and vacuum
  - Repeat detailed BPM calibrations for different current values.
  - Shift vertically the 5th axis and see the BPM response to centre the wire with the pickups.
  - Check alignment after 5th axis movement
  - Initial tests at injection, but try to repeat a sub-set at top energy
- Synergies with other planned preparation tests for the MD?

Conclusions

- Collimator settings on the strong beam
  - For intensities above 3E11, no interlocks can be masked. MP qualification needed
  - Use standard collimator settings qualified for physics operation
  - Consider same procedure as in previous MDs on BBLR to decreasing crossing angle at constant gap
- Collimator settings on the weak beam
  - For intensities below 3E11, interlocks can be masked
  - More freedom to change settings
  - No real inner limit on setting, as long as the TCSP is 1 σ further in. Example: TCTs at 6 σ (ε_n=3.5 µm)
  - Will scrape the beam if collimators are too close
- Collimator commissioning
  - Initial tests planned for the hardware commissioning, to verify correct functioning of wire collimator and nearby collimators
  - Are there synergies with preparation tests for MD?

Backup