MD 2186: New Method to Measure Margins between IP6 Absorbers and TCTs/Triplets

Yuancun Nie, Matthieu Valette, Christoph Wiesner, Daniel Wollmann

Introduction

- Goal:
    - Beam-based measurement of aperture margin between TCDQ (IR6) and TCTs in IP5 to validate protection in case of an asynch. dump (Beam 2).
    - Complementary approach to debunched ASD Tests?
- Method:
    - No beam in the Abort Gap
    - Simulate asynchronous MKD kick with a closed corrector bump between IR6 and IP5
    - For a given TCDQ position: move TCTPH (IP5) in until beam losses are observed to verify aperture

Procedure: Preparation and Ramp

- Inject **3 pilots** (~1e10 p+) in Buckets 1, 8911, 17851 for **Beam 2**

- Force SBF Equation to 'Beam Setup'

- Mask BIS interlocks acting on
  - TCDQ position/movement
  - TCTPH.IP5 position/movement (β^*, energy)

- Ramp to **6.5 TeV, collisions**, 30 cm, 160 µrad

Procedure: Test #1 (TCDQ at 7.3σ)

- 4-corrector bump of 2.2σ from IP6 to IP5
  - Steps of 0.5σ then 0.1σ
- Disable the Orbit Feedback before scraping the beam
- Blow up the horizontal emittance of the first pilot until losses are observed in IR6
- Open the IP5 TCTPH, TCDQ and TCSP position thresholds to parking
- **Move in the IP5 TCTPH** inside jaw in steps of 15 µm (0.05σ) until losses are observed (expected at 7.3σ)

Procedure: Test #1 (TCDQ at 7.3σ)

Calculated 2σ bump (Beam 2)
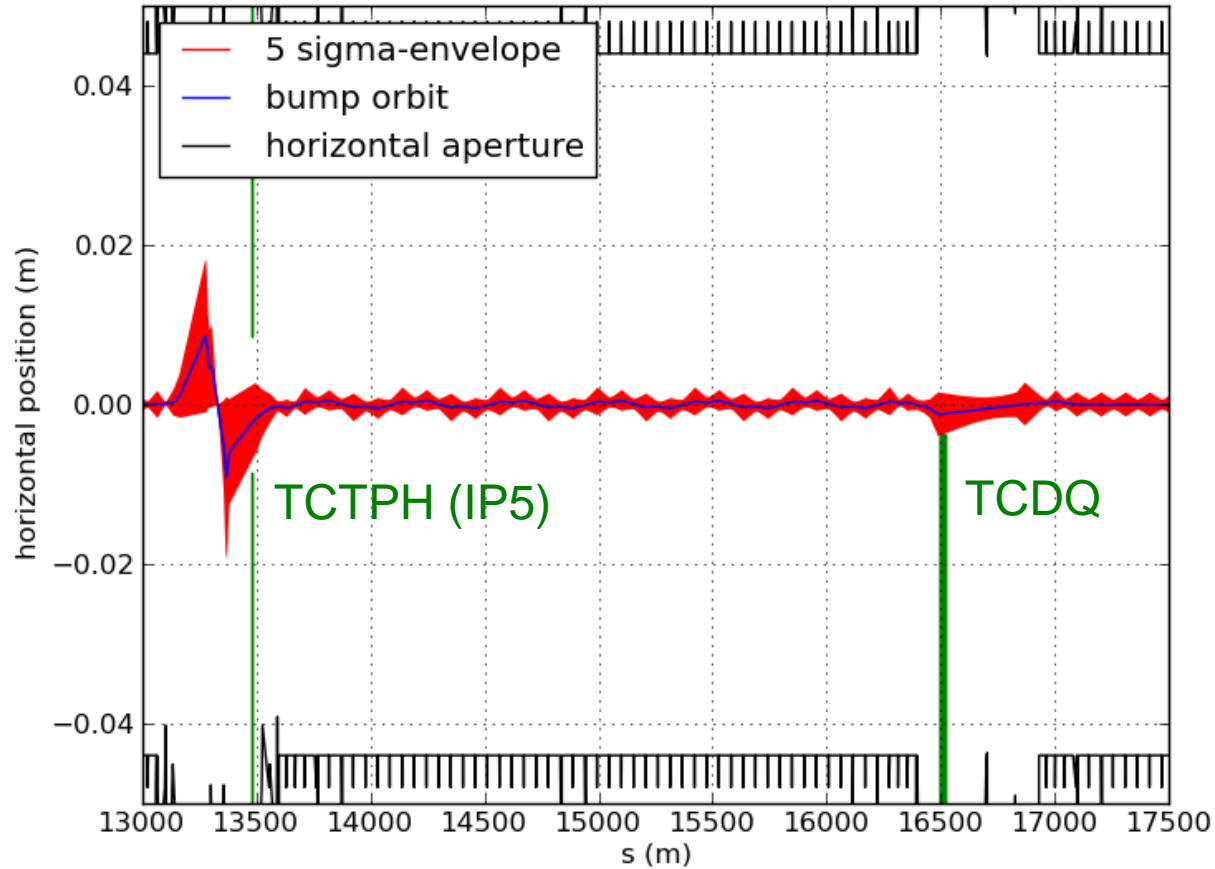
M. Valette

Procedure: Test #2 (TCDQ at 8.5σ)

- Retract the IP5 TCTPH to 9σ

- Retract TCDQ/TCSP to 8.5σ (top energy position of the TCTPH)

- Increase bump to 3.4σ (steps of 0.1σ)

- Blow up the second pilot until losses are observed in IR6

- **Move in the IP5 TCTPH** inside jaw in steps of 15 μm (0.05 σ) until losses are observed (expected at 8.5σ)

Procedure: Test #3 (Secondary losses in IP5) and Recovery

- Revert the bump to 2.3σ.
- Move the IP5 TCTPH (8.5σ) and the IR6 collimators (7.3σ) back to their nominal settings.
- Blow up the third pilot until secondary losses are observed in IP5

- Remove the bump and dump the beam.
- Unmask previously masked interlocks

Collimator settings during the MD

Phase	Collimator	Setting (σ)
Beginning (nominal settings)	IP5 TCT TCDQ/TCSP	8.5 7.3
Test #1	IP5 TCT TCDQ/TCSP	Move from 8.5 → 7.3 (until primary losses are observed) 7.3
Test #2 (Preparation)	IP5 TCT TCDQ/TCSP	9 8.5
Test #2	IP5 TCT TCDQ/TCSP	Move from 9 → 8.5 (until primary losses are observed) 8.5
Test #3	IP5 TCT TCDQ/TCSP	8.5 7.3

Note: In the case of an asynch. dump during the MD with unlucky timing (MKD rise time acting on one of the 3 pilots), the TCDQ might not (fully) protect the TCTPH in IP5. However, even in case of a direct hit, the intensity of 1e10 p+ is below the TCT damage level.

Thank you for your attention!

Summary of MD Parameters

Specie	Protons
Time required [h]	7 hours
Beams required [1, 2, 1&2]	2
Beam energy [GeV]	6.5 TeV
Optics (injection, squeezed, special)	Collisions ($\beta^* = 30$ cm, 160 µrad half crossing angle)
Bunch intensity [#p, #ions] and Number of bunches	3 pilots with 1e10 ppb in Buckets 1, 8911, 17851 (Beam 2)
Transverse emittance [m rad]	Not relevant
Bunch length [ns @ 4s]	Not relevant
Optics change [yes/no]	No
Orbit change [yes/no]	Closed 4 corrector-bump from IP6 to IP5
Collimation change [yes/no]	Retract IP6's TCDQ/TCSP and move the TCTs in IP5's TCTPH
RF system change [yes/no]	No
Feedback changes [yes/no]	No
What else will be changed?	ADT excitation of some pilots as for loss maps
Are parallel studies possible?	No
Other info/requests	No

Main MP-Relevant Parameters

- **3 pilots** (~1e10 p+), distributed in buckets 1, 8911, 17851

- Only **Beam 2**

- 6.5 TeV, **collision**, 30 cm, 160 μrad

- Orbit **bumps of 2.2σ and 3.4σ** in IR6-IP5

- **Changed collimator settings for TCDQ, TCSP, TCTPH in IP5**