
CERN

MD2193 – Impedance Measurements of TCSPM Collimator

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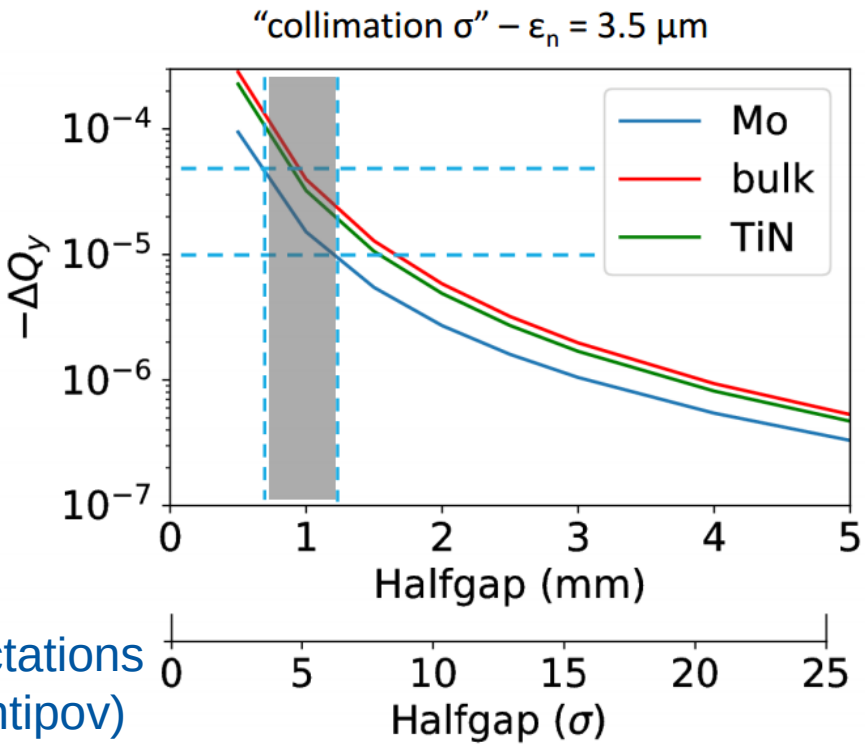
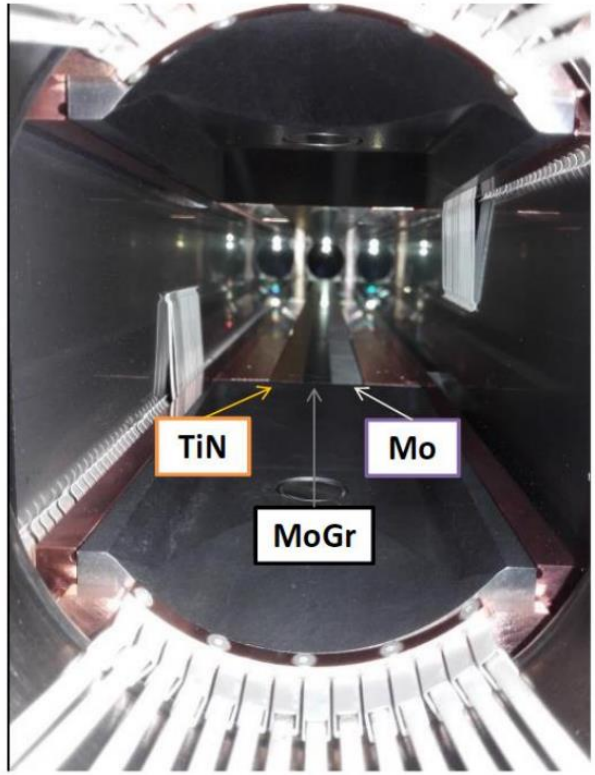
Introduction

- Aim: estimate impedance of the installed TCSPM.D4R7 collimator measuring the tune-shift induced by a change in collimator gap;
- Try to measure immediately Mo coating!
- Low impedance collimator → very pushed sensitivity: 10^{-5}!!

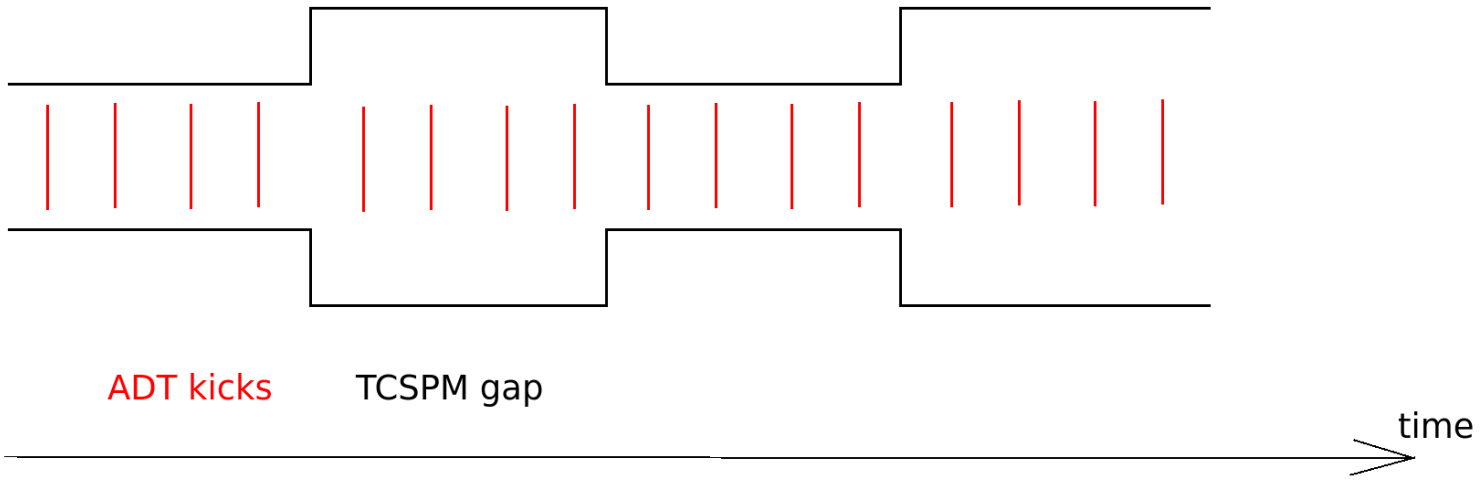


Expectations (S.Antipov)



Method

- For a given gap:
  - Use the ADT to kick the beam in AC-Dipole build-up mode (30μm);
  - From damped oscillations, reconstruct the tune of the collective motion of the bunch;
  - Kick the beam 3-4 times, to decrease error bar;
- Open collimator to 20σ:
  - Kick the beam again, to get tune with open collimator and hence tune shift;
- Repeat several times, to decrease error bar;



Caveats

- To get reasonable results (stable readouts, acceptable noise, …):
  - TCSPM gaps should be as small as possible e.g. around 5σ (TCSG presently operated at 6.5σ);
  - All other strong sources of impedance possibly out → move out TCSGs and TCLAs (e.g. 20σ);
- TCPs should always be kept as primary bottleneck, to avoid scraping the beam on the coating while kicking;
- We should spare beam tails as much as possible, not to get bunches unstable → octupoles to 470A, to be on the safe side;
- TCSG.D4R7 (closest to TCSPM.D4R7) should be measured either, for reference and for assessing actual benefit;
- Important to have collimator properly aligned → BPMs are essential for speeding-up / better alignment (including angle);
- Measurements performed at FT → no tune change / squeeze / adjust;
- 2 nominal bunches requested, staying within SBF:
  - Regular normalized emittances (2.x μm rad);
  - Different intensities for a bit of sensitivity on measurements (e.g. 1.2 10^{11} and 0.8-1 10^{11});

Parameters Table (from MPP MD Procedure)

Number of MD's	1
Time required per MD [h]	8
Beams required [1, 2, 1&2]	2
Beam energy [GeV]	6.5 TeV
Optics (injection, squeezed, special)	Injection optics
Bunch intensity [#p, #ions]	Nominal bunch (1.2E11)
Number of bunches	2 bunches of different intensities
Transv. emittance [m rad]	Not relevant, but not too large – e.g. below 2.5um
Bunch length [ns @ 4s]	Not relevant
Optics change [yes/no]	No
Orbit change [yes/no]	No
Collimation change [yes/no]	Yes: the TCSPM.D4R7.B2 will be move repeatedly in and out to perform the measurements; the same will be done with the TCSG.D4R7.B2 (installed immediately upstream). For cleaner signals, all other TCSGs and TCLAs will be moved out. TCP collimators could be further closed, to measure smaller gaps of the TCSPM.
RF system change [yes/no]	No
Feedback changes [yes/no]	No
What else will be changed?	Once at FT, octupole current should be increased to 470A, to guarantee bunch stability when reducing the collimator gaps.
Are parallel studies possible?	No
Other info/requests	Relaxed setup beam flag

Detailed Steps (from MPP MD Procedure)

1. Preparation: inject the necessary 1-2 nominal bunches + few pilots. Verify intensity and emittance.
2. Preparation: play with TCSPM.D4R7.B2 fifth axis, to verify the possibility to expose the desired coating stripe to the circulating beam and accurately set the measurement position.
3. Preparation: ADT set up, to be verified at flat top. It is essential to find a sizable kick amplitude while avoiding scraping tails.
4. Preparation: standard ramp. No deployment of tune change, squeeze or collision beam processes.
5. Mask MASKABLE BLMs and Collimator interlocks.
6. Increase octupole current to 470A.
7. Verify validity of ADT set up and fine tune it.
8. Open all IR7 TCSG and TCLA collimators, e.g. to 20σ and 25σ.
9. Move IR7 TCP collimators to measurement position, i.e. 4σ, from the operational one, i.e. 5σ.
10. Measure TCSG.D4R7.B2 impedance:
    a. Set its opening 1.5σ wider than the one of TCPs (to respect hierarchy), i.e. 5.5σ;
    b. Perform tune-shift measurements, with the collimator opening changed back and forth between 5.5σ and 20σ;
11. Measure TCSPM.D4R7.B2 impedance:
    a. Align the collimator to the beam, with the help of BPMs, including tilt angle;
    b. Use the fifth axis capability of the collimator to move the stripe of coating material to the beam height;
    c. Thanks to the alignment, the collimator can be moved back and forth between 5σ and 20σ.

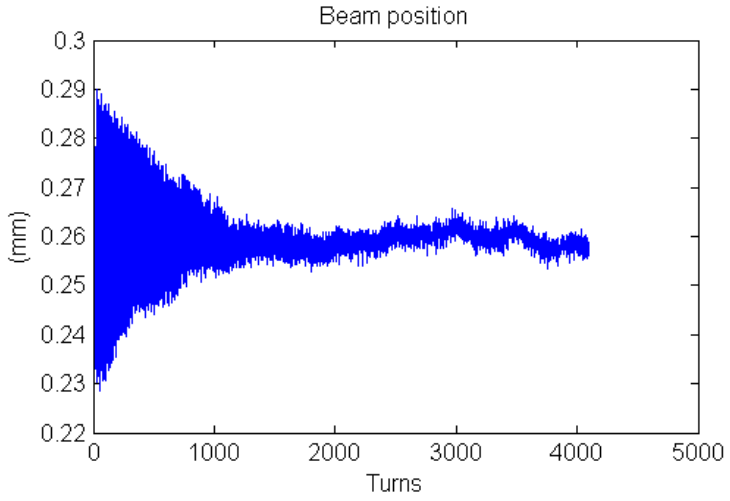
    Measurements will be carried out for all the three stripes, giving priority to the Mo one.

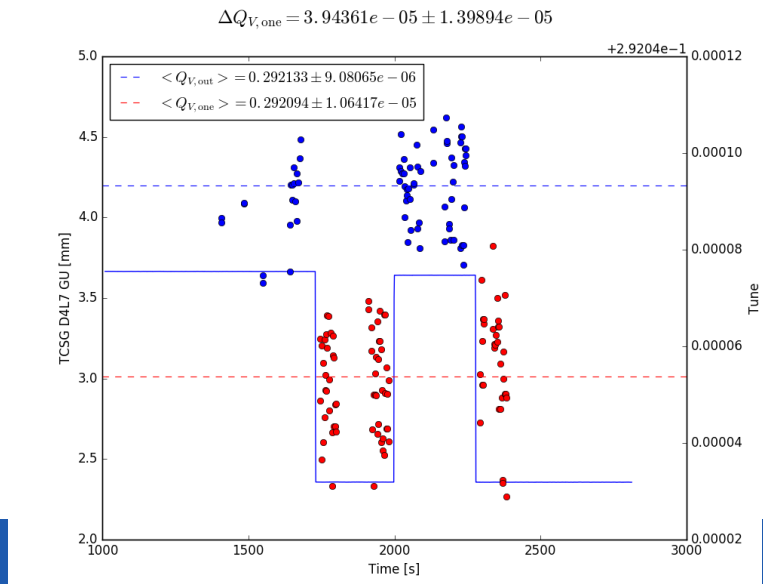
If time permits, a measurement of the instability threshold with octupole current can be carried out at the end.

Reserve Slides

Details on ADT

- Tests performed last year with both single bunches (MKQA as exciter) and full beam (ADT as exciter).
- Excitation amplitude considerations should be split into two groups based on **if you can change machine parameters.**
- For the case (MD1477) where the MKQA was used. For low chromaticity (a few units), low octupoles (150A-200A) and reduced ADT gain, **an excitation amplitude of 30um at flat top was sufficient.**
- This excitation gives ~1000 turns of usable data which was able to give a tune measurement with a **standard deviation of ~1e-5**.





D. Valuch *et al*, Update on Single Collimator Impedance Measurements using ADT Data, ColUSM #75, 19th August 2016
L.R.Carver, 2017-04-24