MD#4
Impedance localization measurements

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Motivation

Method

MD plans

Motivation

General considerations:

- Beam passing through the accelerator **excites wakefields** that can act back on the beam itself giving rise to beam induced heating and beam instabilities.
- The beam coupling impedance is the parameter used to quantify this detrimental effect.
- **Identifying impedance sources** would allow us to detect and cure high impedance devices.

For LHC:

- The **impedance model** calculated until now can explain **only part** of the observed tune shift. (for instance, the transverse impedance of the **TDI** is known to be larger than expected).
- **Unexpected impedance sources** could explain the discrepancy between model and measurements allowing new predictions for intensity threshold.

What we want to do:

- Apply our method to localize main transverse impedance to prove our method.
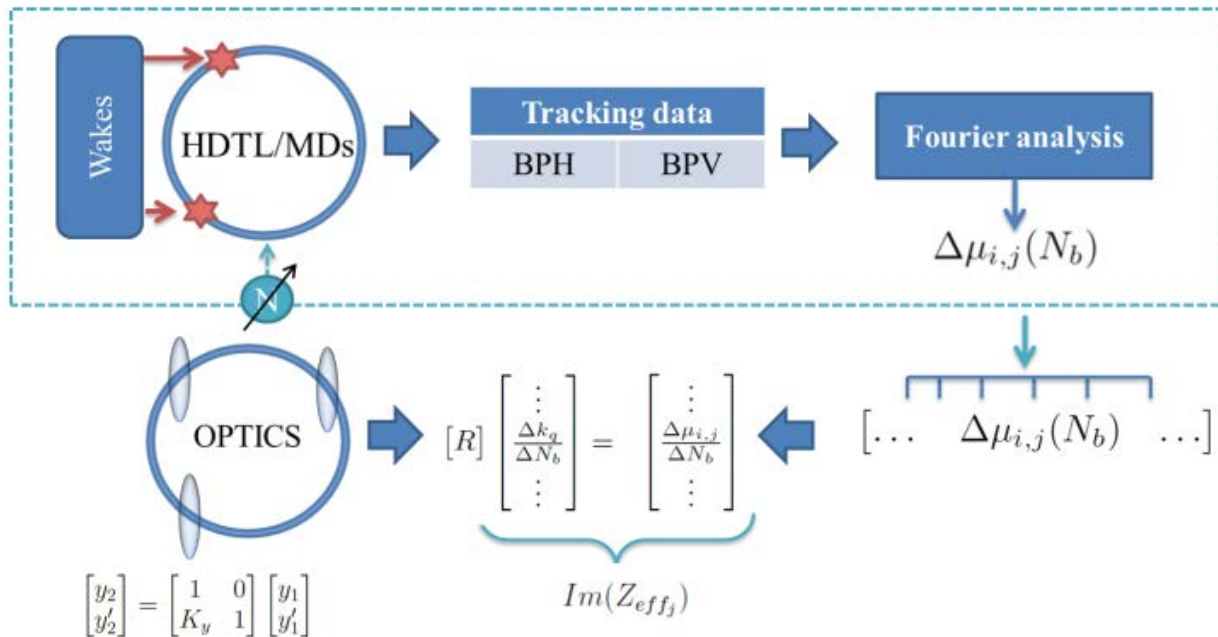
Method

Observable:
- Local impedance sources provokes **phase advance beating** along the machine.
- Beating strength **changes with intensity**.

Measurement:
- Measure the phase advance beating from **Multiturn BPM** data acquisitions.
- **Reconstruct** measurements beating with LHC optic model $\rightarrow$ **local impedance sources**.

[1] "Localizing impedance sources from betatron-phase beating in the CERN SPS", G. Arduini, C. Carli , F. Zimmermann EPAC'04.
[2] "Transverse Impedance Localization Using dependent Optics" R.Calaga et al., PAC'09.

MD plan A

beam

8 bunches with different intensities in **both rings @ Injection:**

5e9 … 1e10 … 5e10 … 1e11 equally spaced.

Transverse emittance: **nominal (not critical)**
Longitudinal emittance: **nominal (not critical)**

COMMENTS

- **SPS USER:** Transverse scraping , ramp on LHC2 with LHCINDIV.
  PS USER: LHCINDIV
  PSB USER: LHCINDIV_high_int_SPS_PSB

planning

Operation:

- **AC dipole kick** (should allow better measurement resolution)
- Tune shift = **~2.1e-3** → **Need to retune** the AC dipole for high intensity bunches.
- Gating on single bunch → measure bunch tune → set AC dipole → BPM acquisition.

Time estimation:

Injection: 2' x 8b (B1+B2) = ~**30'**
+ Gating and tuning AC dipole: 1' x 8b = 10**'**
+ Multiturn Single bunch → 1' x V/H meas. x 8b (B1+B2)= **15'**
+ Move TDI = **5'**
+ Repeat procedure = **55'**

Total: 2h00'

- The MD should be placed after ramp down to save time.

- Transverse damper: OFF,
  Octupoles: OFF,
  Abort Gap cleaning: OFF
  Chromaticity H,V small (~2).

- Parallel measurements could be done with ADT (ICE colleagues)

MD plan B

beam

8 bunches with different intensities in **both rings @ Injection:**

5e9 … 1e10 … 5e10 … 1e11 equally spaced.

Transverse emittance: **nominal (not critical)**
Longitudinal emittance: **nominal (not critical)**

COMMENTS

- **SPS USER:** Transverse scraping , ramp on LHC2 with LHCINDIV.
  PS USER:LHCINDIV
  PSB USER:LHCINDIV_high_int_SPS_PSB

planning

Operation:

- **Kicker** (lower measurement resolution)
- **8 bunches** with Intensity **from 5e9 to 1.5e11 @ injection**.
- Tune shift = **~2.1e-3**.
- Gating on single bunch→ Kick → BPM acquisition.

Time estimation:

Injection: 2' x 8b (B1+B2) = **32'**
+ Multiturn Single → 1' x V/H meas. x 8b (B1+B2)= **15'**
+ Move TDI = **5'**
+ Repeat procedure = **55'**

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Total: 2h00'

- The MD should be placed after ramp down to save time.

- Transverse damper: OFF,
  Octupoles: OFF,
  Abort Gap cleaning: OFF
  Chromaticity H,V small (~2).

- Parallel measurements could be done with ADT (ICE colleagues)

Impedance localization measurements on MD#4

MD plans (in case of issues)

In case of issues, we can reduce to 4 bunches increasing acquired measurements:

Modified plan A:

Time estimation:
Injection: 2' x 4b (B1+B2) = **15'**
+ Gating and tuning AC dipole: 1' x 4b = **4'**
+ Multiturn Single bunch acquisition → 1' x **2** V/H measurements x 4b (B1+B2)= **30'**
+ Move TDI → **5'**
+ Repeat procedure → **55'**
Total = 2h00'

Modified plan B:

Time estimation:
Injection: 2' x 4b (B1+B2) = **15'**
+ Multiturn Single bunch acquisition → 1' x **2** V/H measurements x 8b (B1+B2)= **30'**
+ Move TDI → **5'**
+ Repeat procedure → **55'**
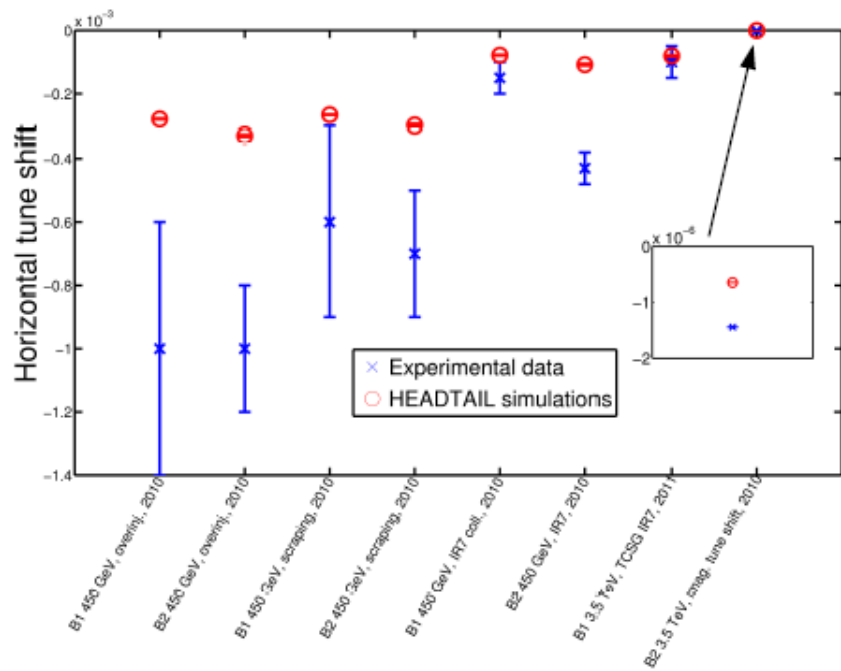**Total = 2h00'**

Many thanks!

Figure 1: Horizontal tune shifts measured and simulated, in various cases.
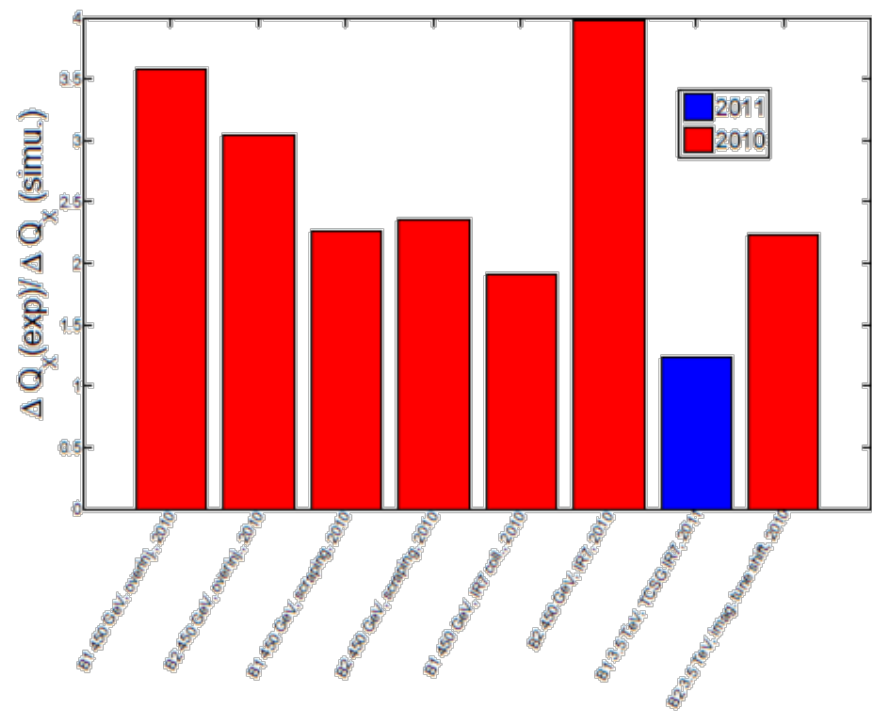

Figure 5: Discrepancy factor between the horizontal tune shifts measured and simulated, in various cases.
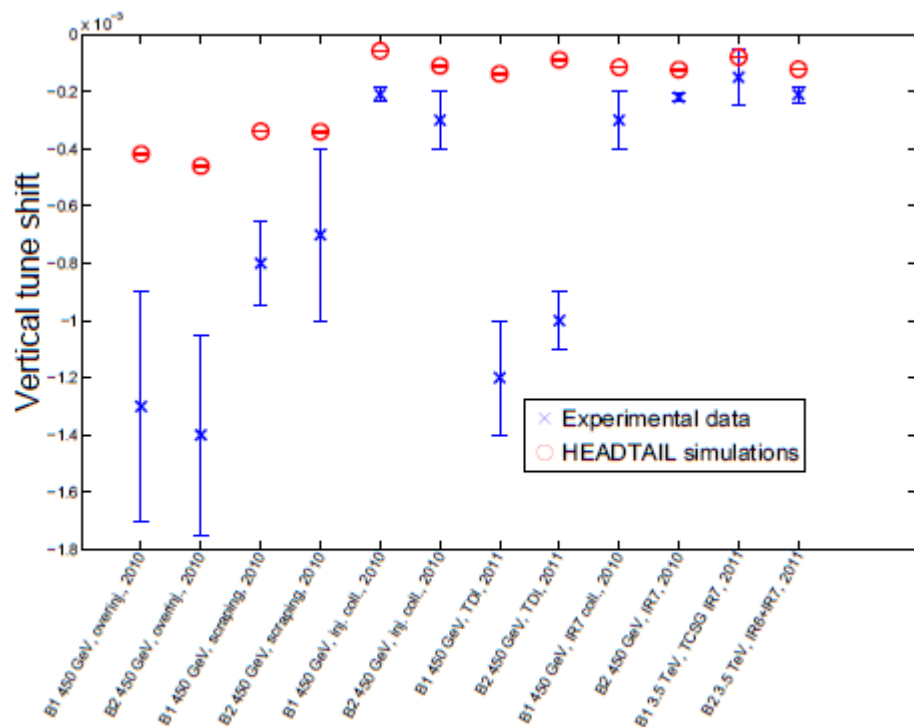
Figure 2: Vertical tune shifts measured and simulated, in various cases.
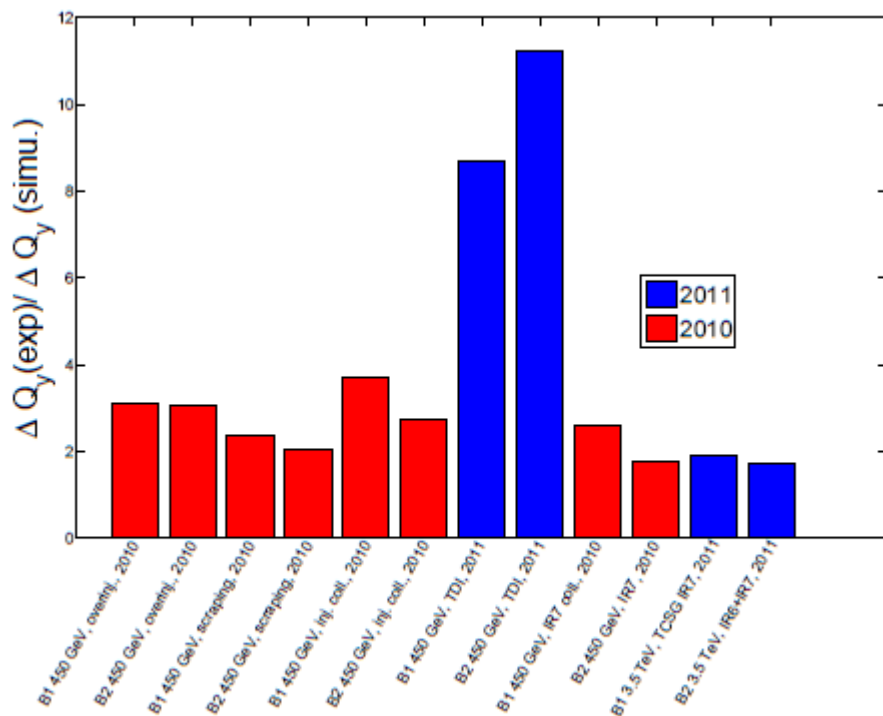

Figure 6: Discrepancy factor between the vertical tune shifts measured and simulated, in various cases.