Requirements:
Higher order IR corrections
DA measurements

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Outline

IR corrections

- (Plans and resuls discussed by C. Zimmer, this workshop)
- Octupole (started), decapole, dodecapole
- Requirements for operations and instrumentation

DA measurements

- Motivation
- Recall results Run-3 Run-4 Run-5 (emittance blow-up method)
- DA (AC dipole method) – test Run-9
- Requirements for operations and instrumentation

IR corrections

Goal: measuring/correcting IR octupole, decapole, dodecapole
(scanning method for decapole and dodecapole correction)
→ Bumps 10-15mm

Requirements :

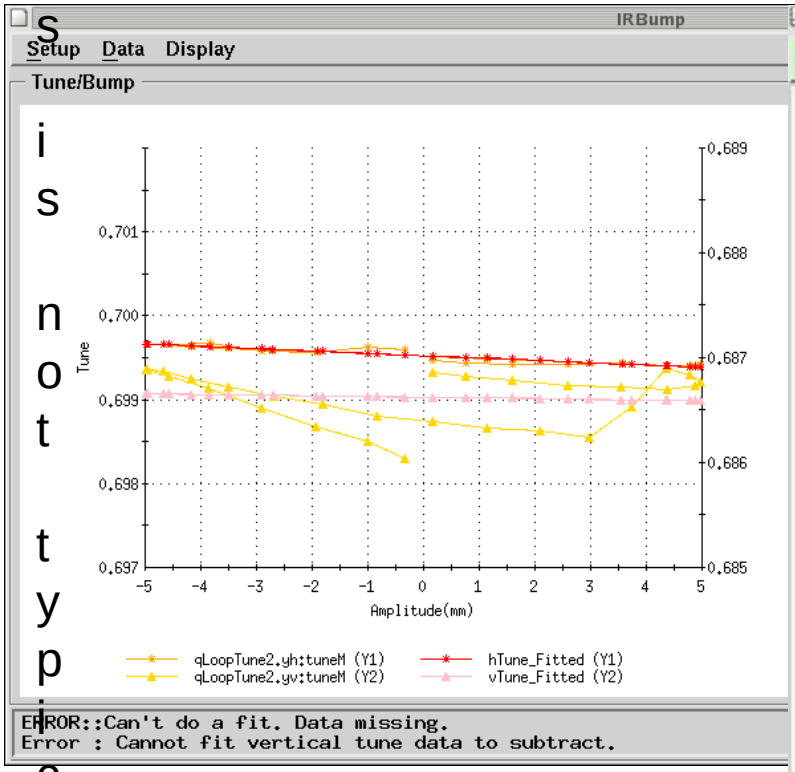
Closed orbit in triplets < 2mm → triplet and DX BPM's

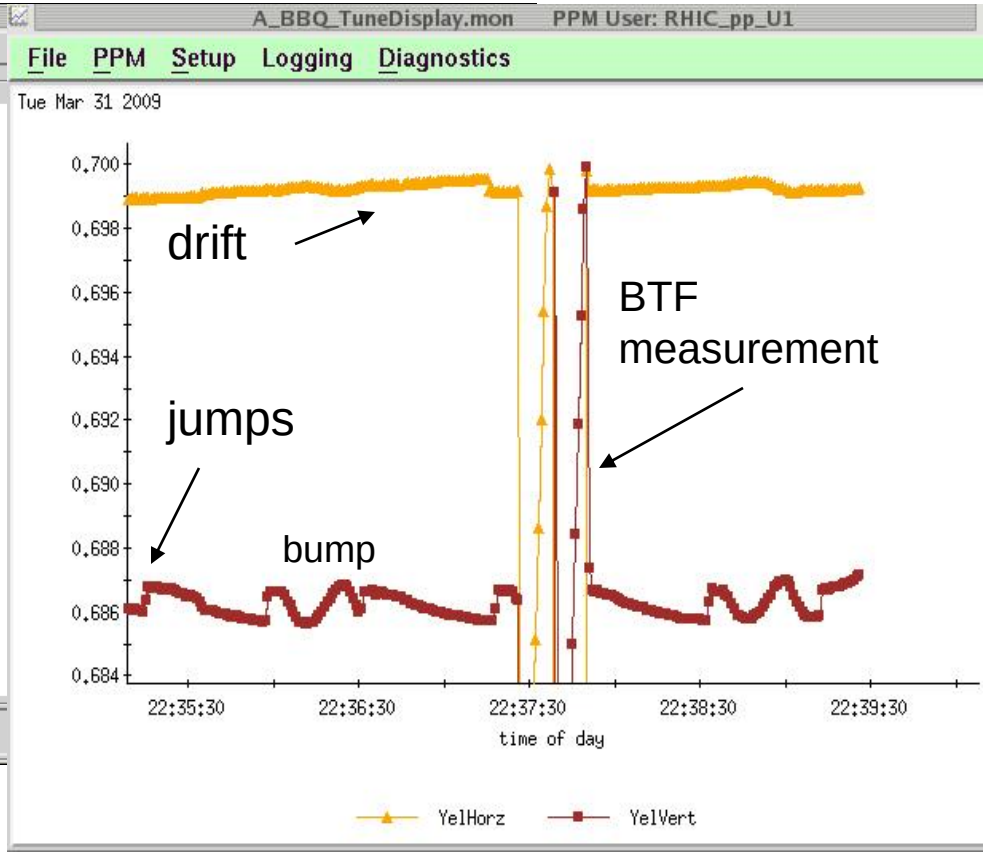
DQmin < 0.001 → BBQ based decoupling application operational

Resolution BBQ tune data ~ 10^{-5}
Stability BBQ over the duration of the measurement (~2-3 hours)
(stability= no drifts, no jumps)

Example of BBQ challenges

This is not typical





DA measurement: Motivation

Observations:

1. Extensive DA simulations and tracking during the design and construction phase of a project
2. Commissioning, operations → typically end of reduction of 1
3. DA measurements during experiments/MD time, rather time consuming

Motivation for continuation of DA measurements:

- Optics with low beta*
- New projects (ex: e-lens), new DA simulations, validation of models
- Validation of corrections techniques
- If DA measurement fast → operational figure of merit for machine configurations, complementing beam lifetime (for working points, resonance correction, beam-beam, IR correction, etc.)

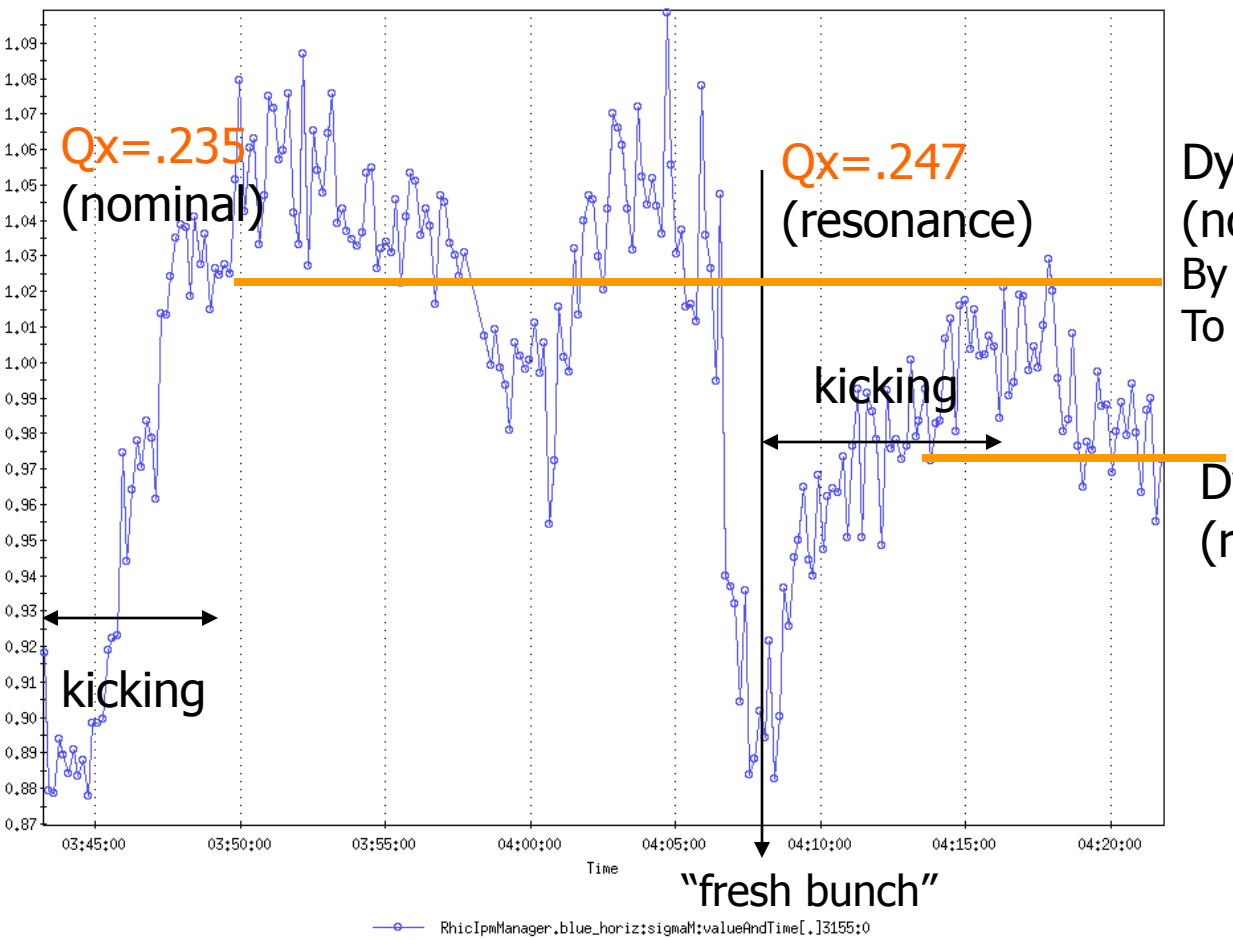
DA measurement – method (Run-3,4,5)

Method used:

- ramp 6 bunches (avoid possible emittance blow-up)
- use **scrapers** to confirm halo beam size (PIN diodes) and core beam size (DCCT and WCM, beam intensity)
- increase H emittance of bunches selectively via **tune meter kicks (1 Hz)**
- measure continuously emittance with **IPM** (and **Schottky)**
- emittance '**saturation**' defines **aperture**
- use scrapers to confirm beam size
- check **loss** pattern and use **orbit** to discriminate **physical from dynamic aperture** (physical typically at the abort, and triplets)
- repeat procedure for vertical emittance
- repeated procedure for horizontal **tune close to the 0.25 resonance**

DA measurement blue, β*=2m (Run-3)

Blue ring - **β*=2m** in IP6 and IP8

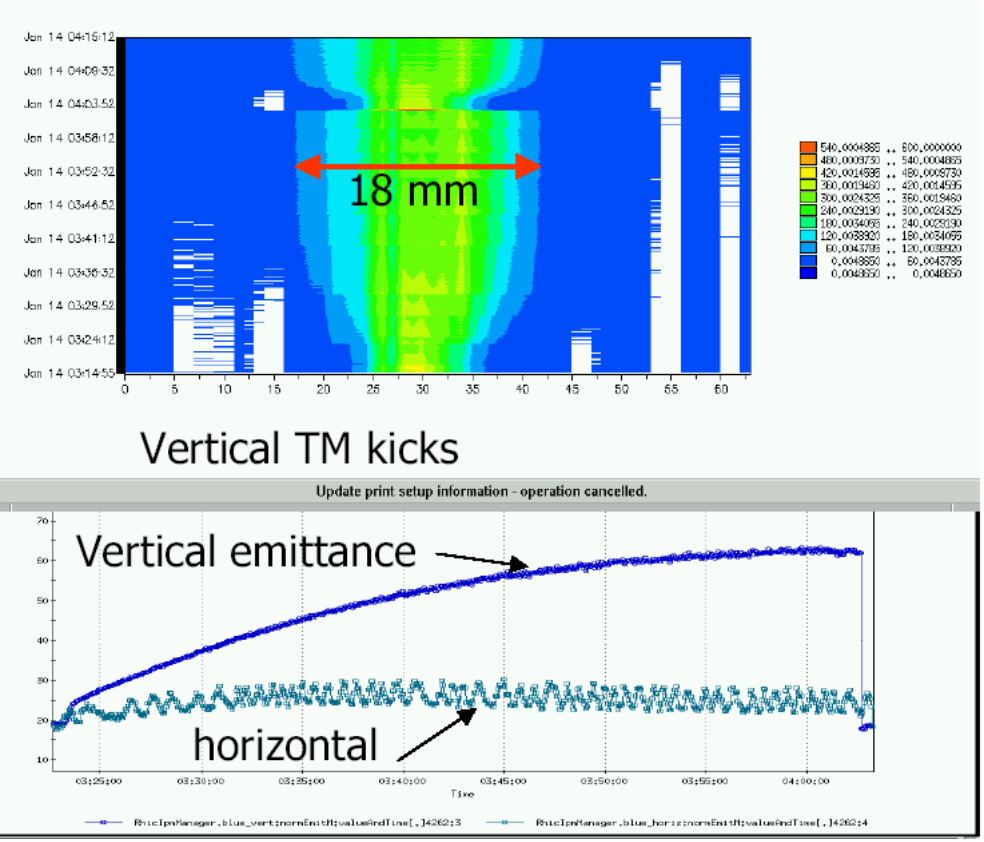


Dynamic aperture (nominal tune) ~**4.5 sigma**
By rescaling the emittance
To the initial one

Dynamic aperture (resonant tune) ~**3.6 sigma**

DA measurements (Run-4)

Fulvia, Nikolay, Steve T, Vadim
IPM measurements

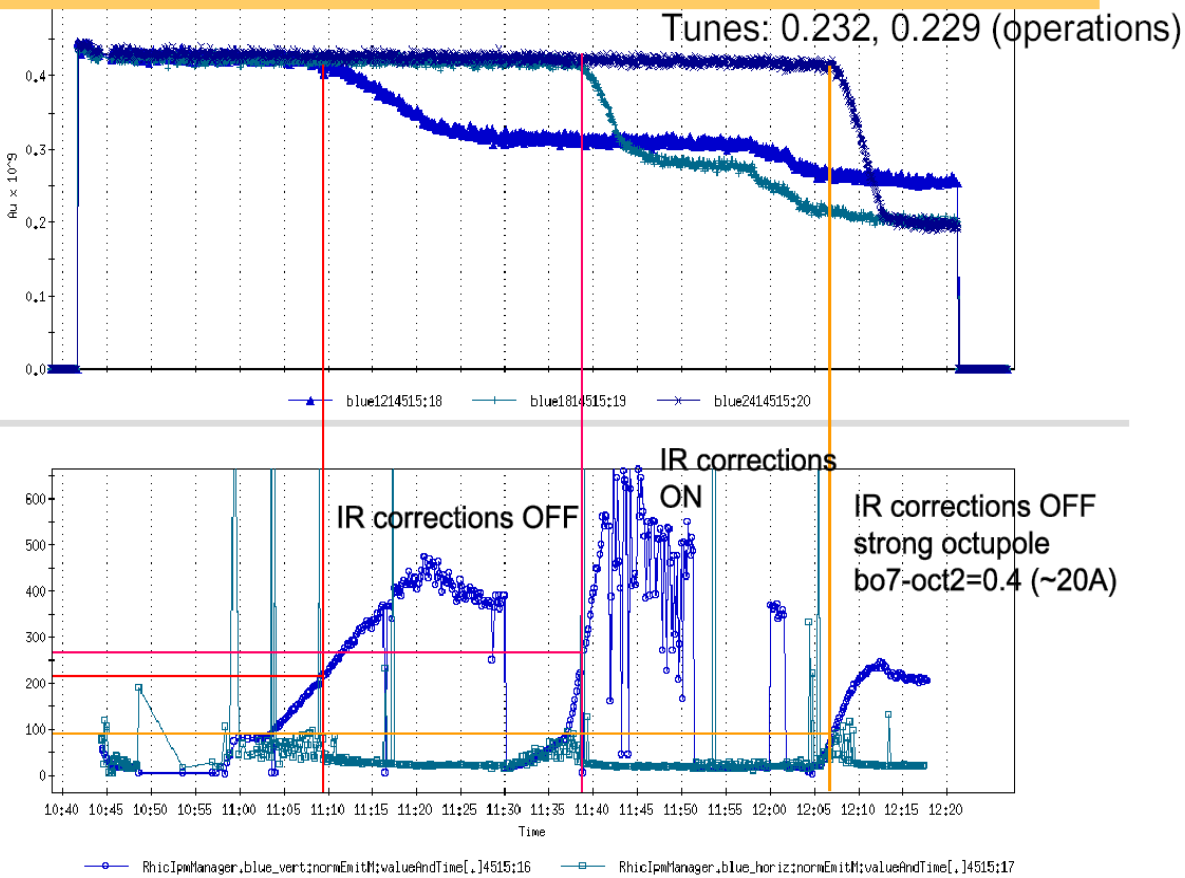


- Gradually increase beam size with tune-meter kicker to reach dynamic aperture limits
- Signature:
  - IPM emittance saturation
  - reaching limit of transverse distribution width
  - beam losses
- Beam loss location was at 6 and/or 8 o'clock triplets

DA measurement (Run-4)

Noting emittance when losses starts
Measurement uses different bunches each time

Dynamic aperture – blue (february 11)



- Measurement precision is limited to +-30π
- Measurements have been done with different IR corrector settings, with and without beam-beam and for different working points
- VER aperture > HOR
- Blue – Yellow consistent
- Dynamic aperture is tune dependent (no surprise)
- IR correction help (~30% hor - ~15% vert.)
- Best measured aperture (good working point, no beam-beam, IR correctors On) is about 11 σ (for 10π initial emittance)

AC dipole method

Excite beam with ac dipole, measure amplitude with M-turns BPM
correlate amplitude with onset of losses

Motivation:

- Potentially fast
- AC dipole at store can kick up to 8 sigma (tune meter kicker limited)

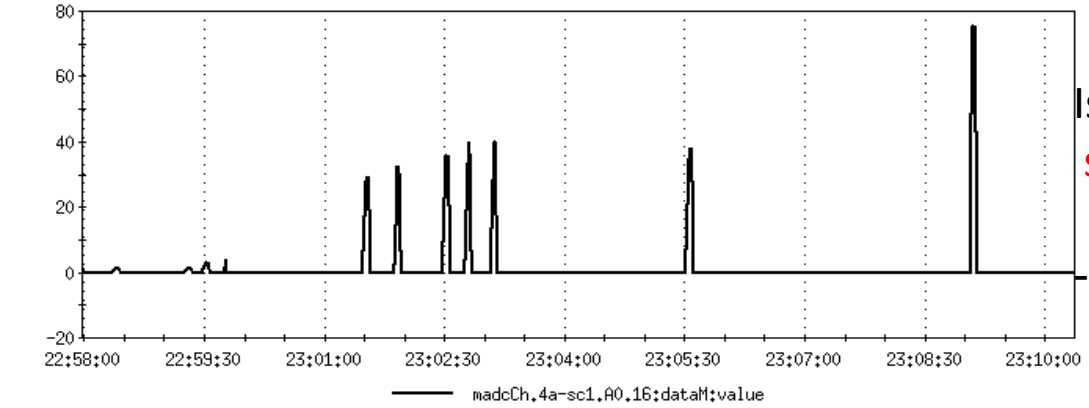
Caveat:

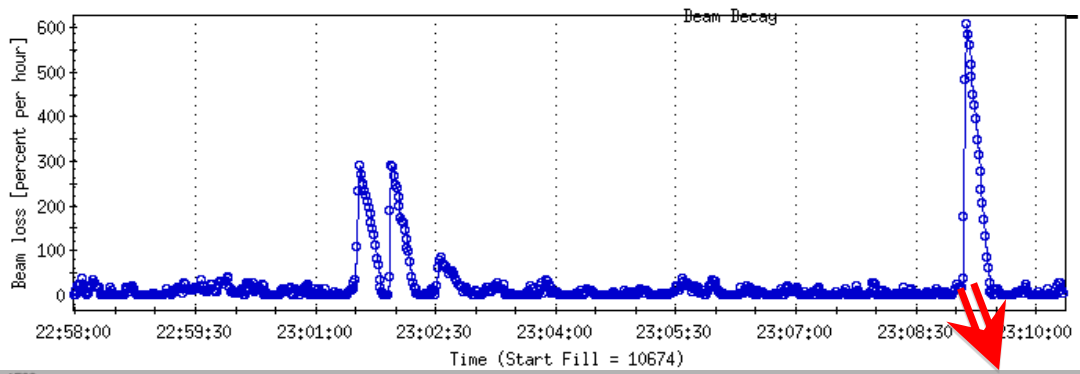
We are not measuring strictly DA of the bare machine

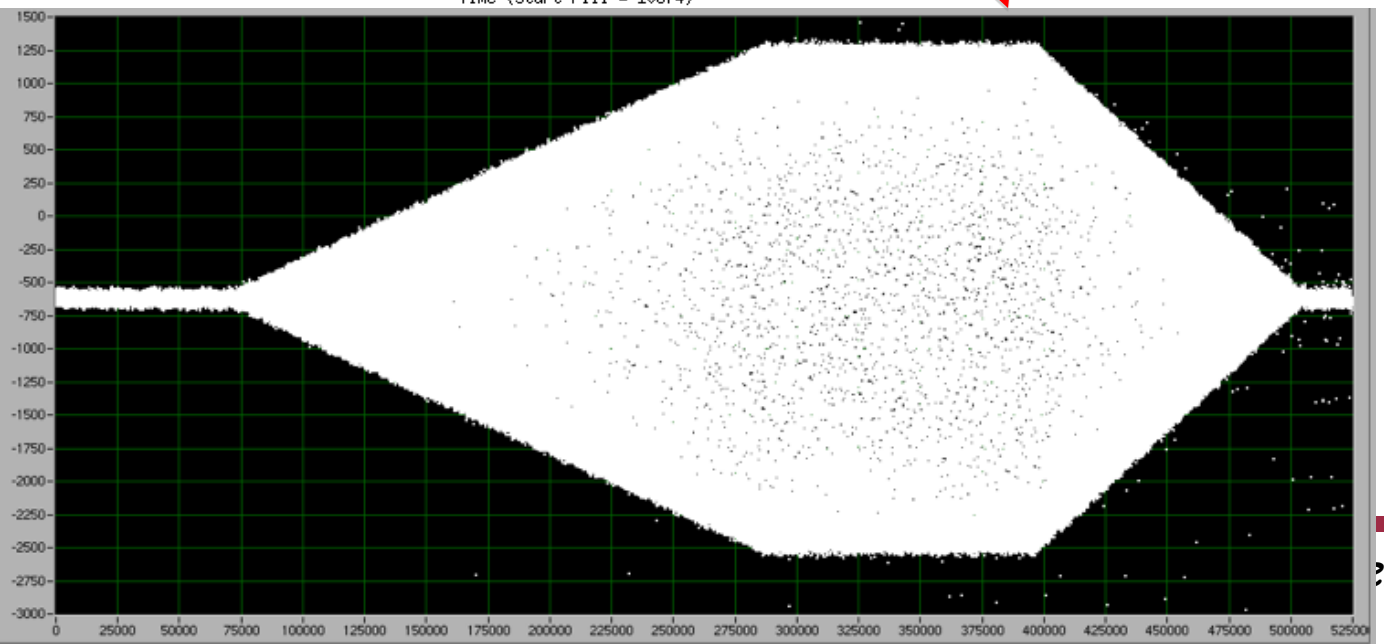
Test:

In Run-9 we spent 1-2 hours at injection to test the feasibility.

AC dipole excitation caused large decays, and we had to push the frequency very far away from the betatron tune to get sensible responses







Issues :

significant beam losses associated with ac dipole excitation.

- drove beam at more than 0.02 away from betatron tune. Trade off is the size of the excitation is limited, ~ 1mm
- need to investigate
  - non-linearity?
  - harmonics in the ac dipole current?
  - chromaticity too large?

DA measurement requirements

Emittance blow-up method

- Clean BBB IPM measurements
- Availability of Schottky emittance measurement if possible
- Automatic correlation of emittance measurement with increase of beam decay

AC dipole method

- Availability of M-turn BPM
- Need a **systematic study of AC dipole excitation** (preferably at store, where we need it)