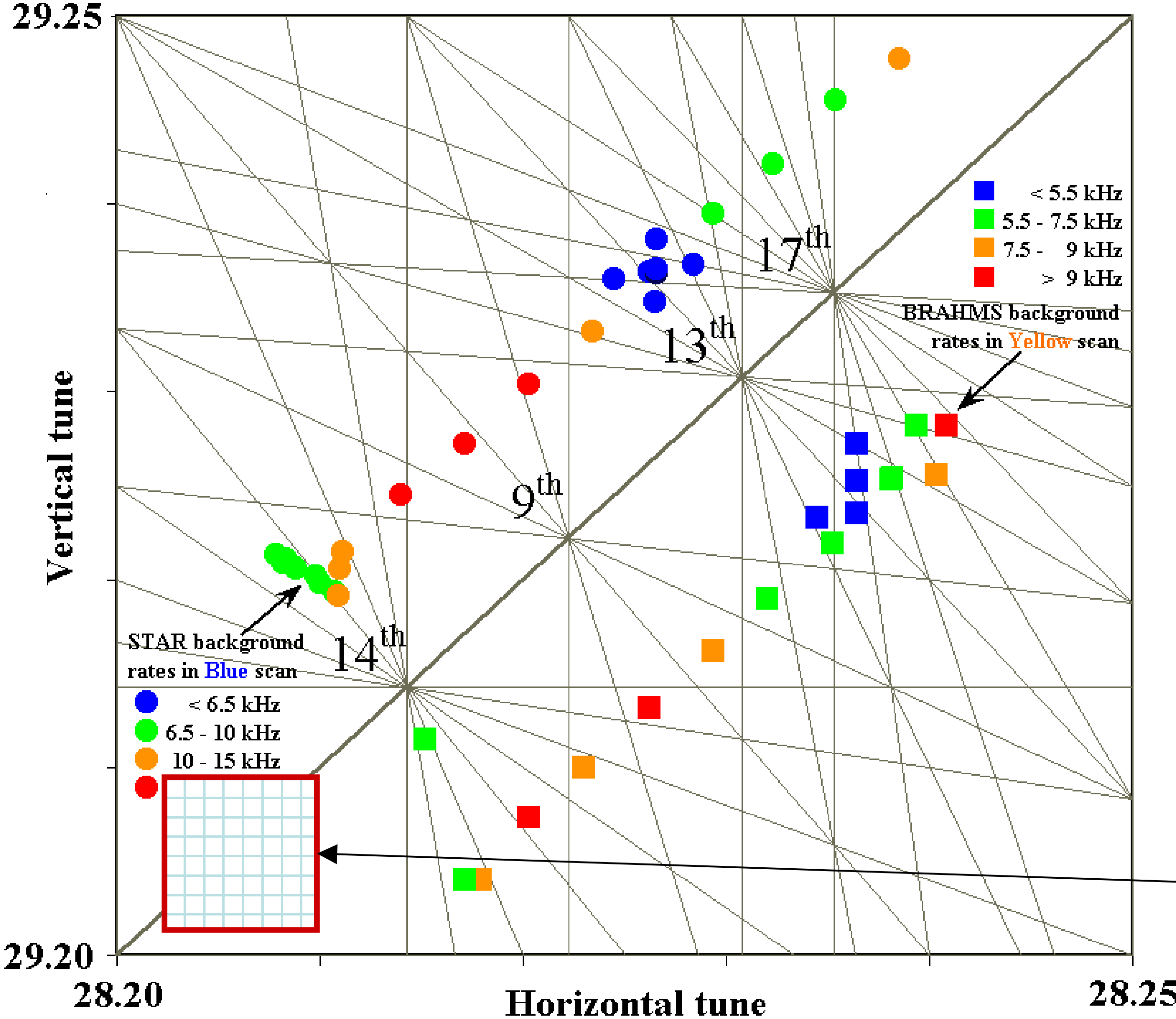
Flattop and Nonlinear studies

V.Ptitsyn

Conclusion. List of possible studies.

- Tracking studies
- Nonlinear chromatism
- Dynamic aperture measurement
- Resonance measurements and correction
- Nonlinear tune spread/detuning measurement
- Tune scans, working point studies
- Action-angle jump technique
- Tune dependence on closed orbit
- AC dipole experiments

Working point scan



from W.Fischer

Still the question:
The working point in 2001 versus working point in 2002 (especially for protons)

Wolfram's tune box in 2001

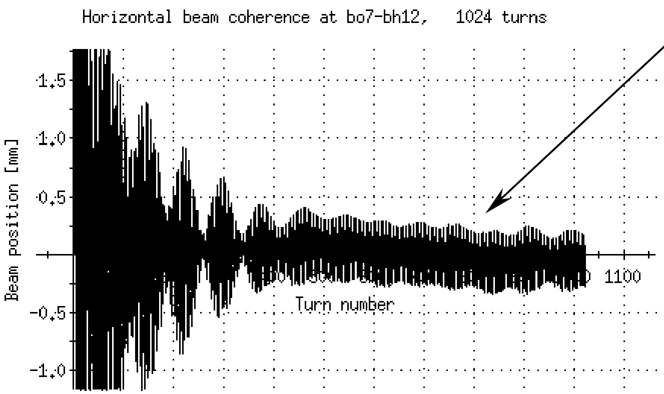
Deuteron-gold collisions, ξ / IP $\approx$ 0.001, 4 head-on collisions

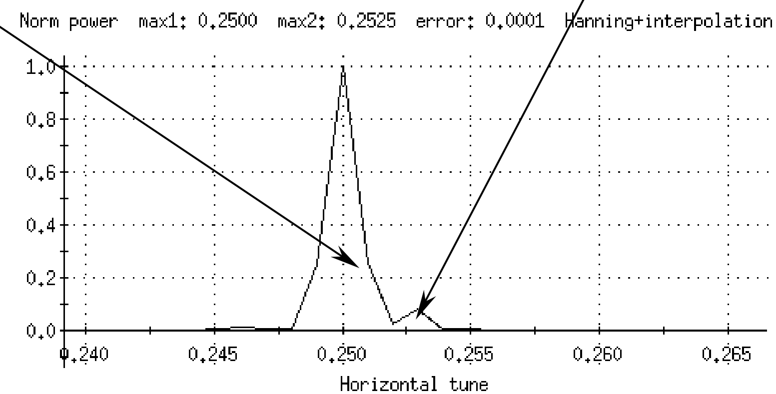
Resonance studies (run 2001)

- Beam trapped into resonance islands (0.2 and 0.25) was observed during the operation and studied during the studies
- Octupole or decapole corrections was used to eliminate resonance signal

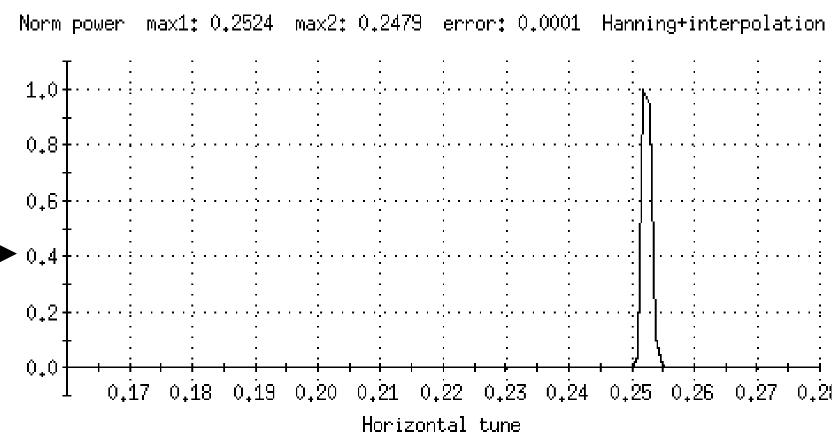
Beam trapped into island

Betatron tune signal





After correction by IR octupoles

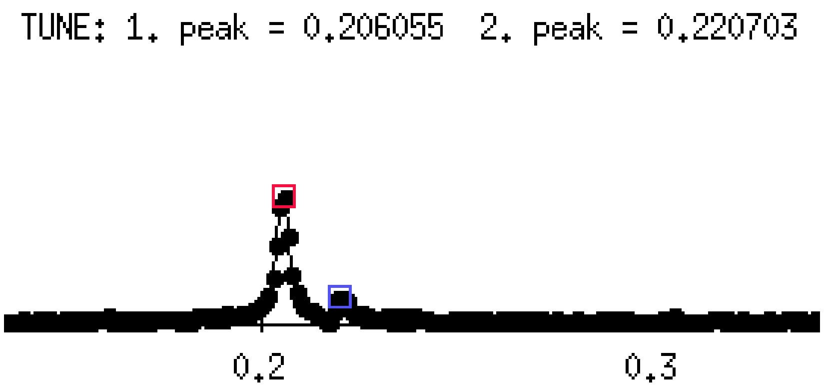


Resonance Studies (Run 2002)

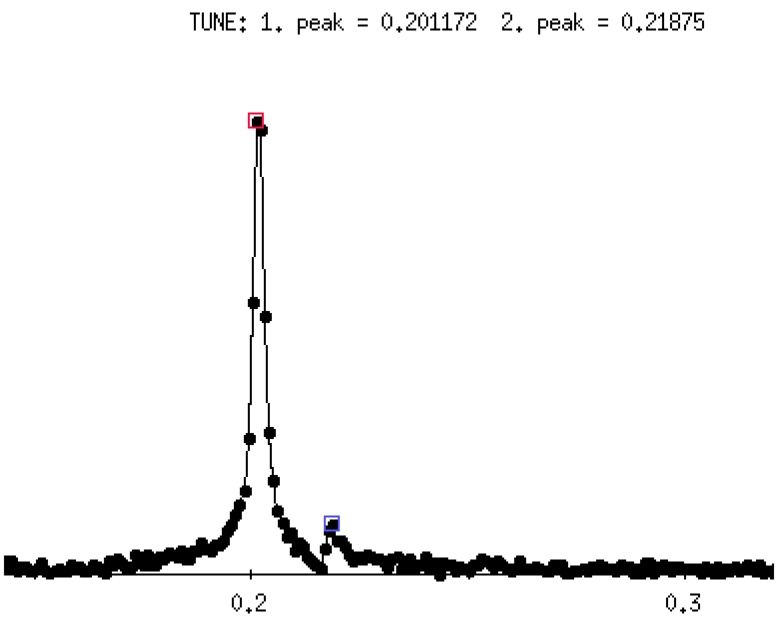
- Participated: P.Cameron, A.Drees, A.Fedotov, F.Pilat,V.Ptitsyn

- The main goal is to develop efficient way of the resonance correction when it would be needed for RHIC operation.
- After Run 2001 two possible area for resonance correction: transition (large tune spread because of the octupoles) and storage (working point was close to 0.2)
- At Run 2002 these areas were not big issues already (or temporarily?)

- The resonance correction (0.2 resonance) based just on beam loss/beam lifetime data was not very efficient (time consuming).



Before correction



After correction

Resonance observation

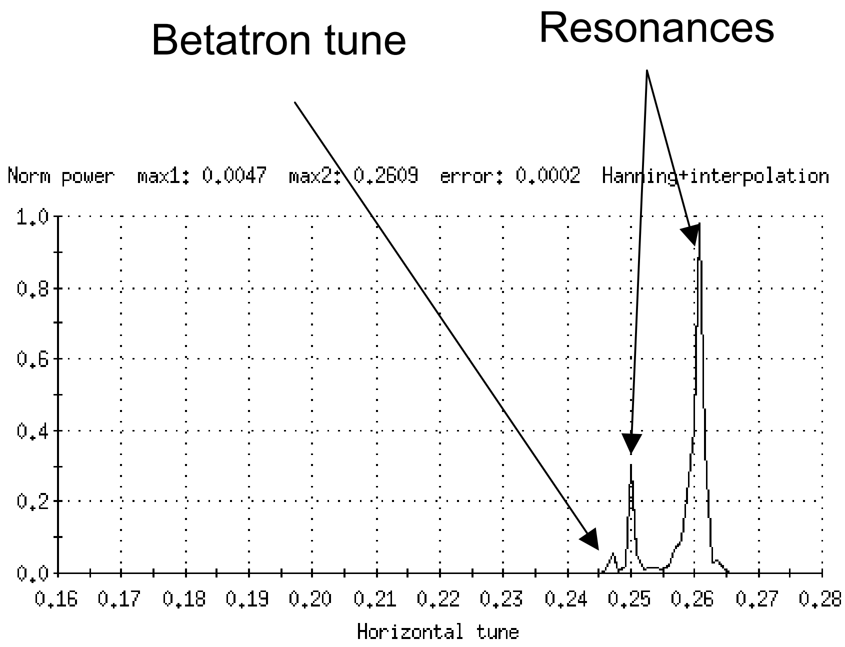
- Setup to create/enhance the resonance island:
- Tune to 0.245/246
- Chromaticity to 0
- Octupole induced tune spread (arc octupoles)

- Balance resonance detuning and tune spread to get clearly resonance picture

- RhicInjection (TBT data), TuneMeter, Beam Transfer function and Schottky monitor have been used to observe the resonance signal

Observation at the injection

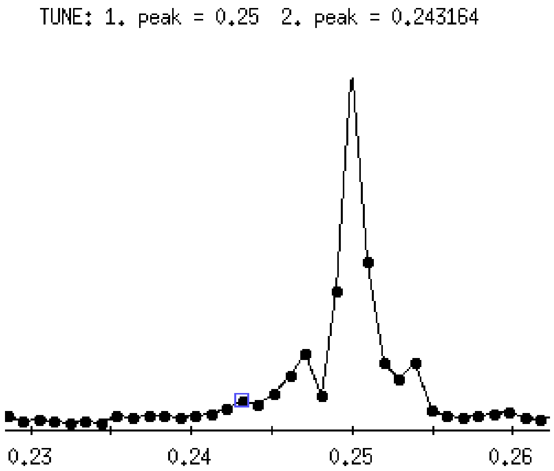
- Injection orbit error again used to drive beam to large amplitudes
- For larger octupole induced tune spreads and/or larger injection errors the two resonance peaks have been observed

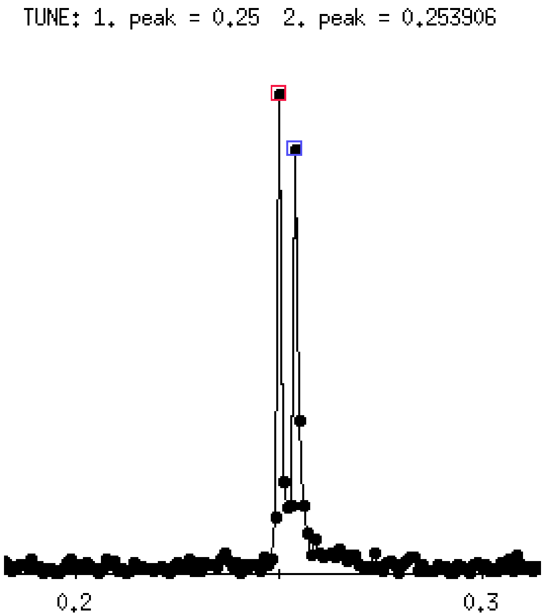


The position of the second peak depends on the main tune

Observation at the store

- After careful resonance setup, the tunemeter kicker managed to put beam into resonances!

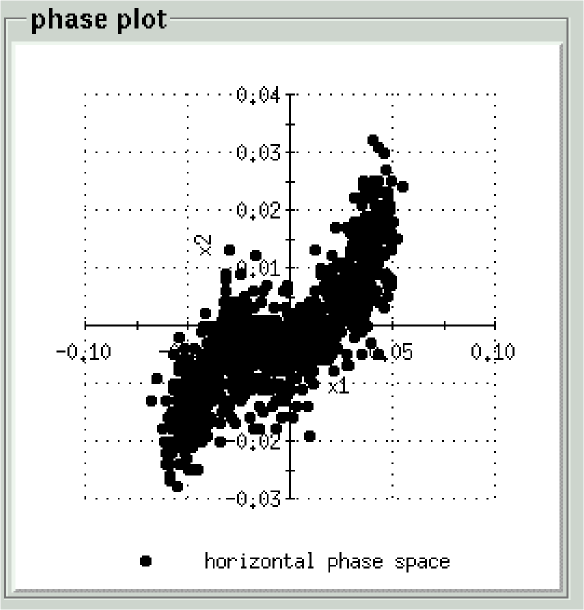


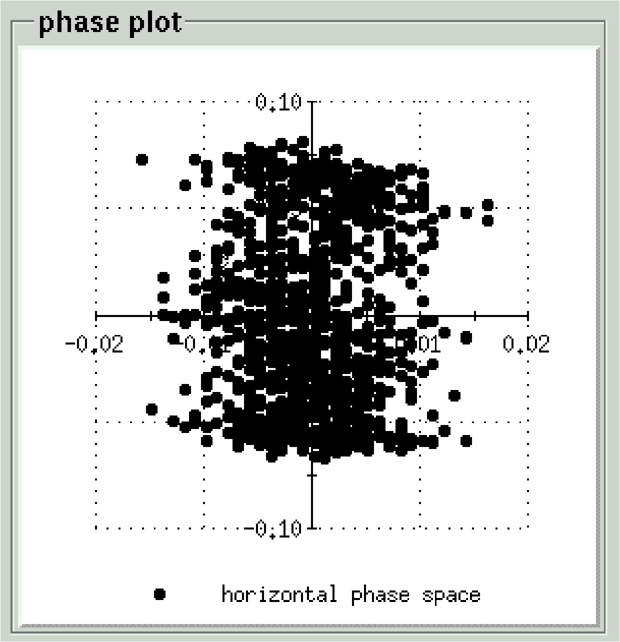


But the beam has not survived in the islands for a long, the next measurements (within few seconds) does not show the resonance signal already.

- Unfortunately there was no time available to try the correction at the store
- With AC dipole coming up as the powerful tool, it would be good to try to see the phase space distortion (driving term technique) close to 0.25 resonance.

Need to do more detailed analysis with existing data, especially with TBT data.





(Dynamic) aperture measurements

Goal: collect data to compare with (up-to-date) model

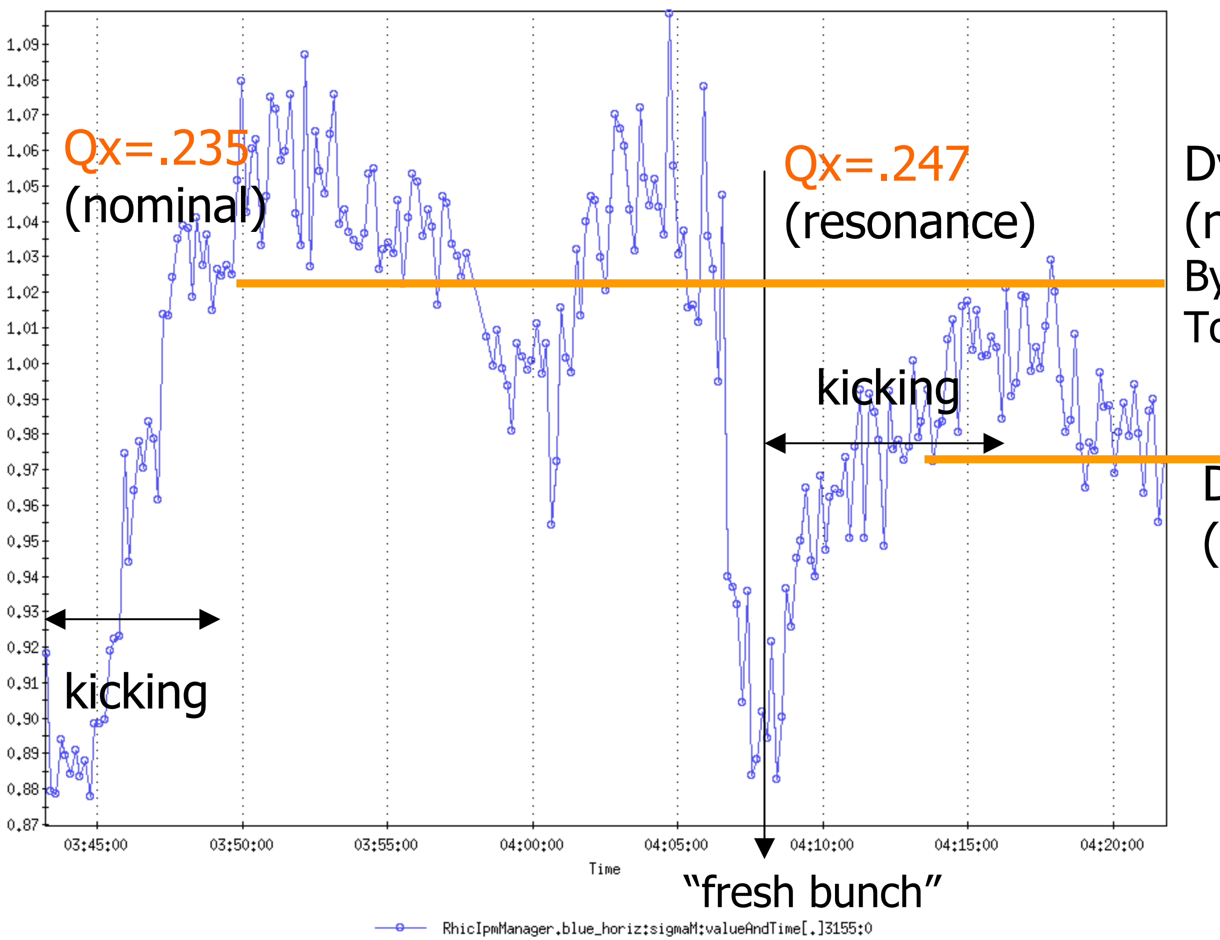
Method used:

- ramp **6 bunches** (avoid possible emittance blow-up), **nominal tunes**
- 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**
- repeat procedure for horizontal **tune close to the 0.25 resonance**

Team: F.Pilat, R.Fliller, V.Ptitsyn, S.Tepikian, K.Vetter

Dynamic aperture, blue, β*=2m

Blue ring - β***=2m** in IP6 and IP8

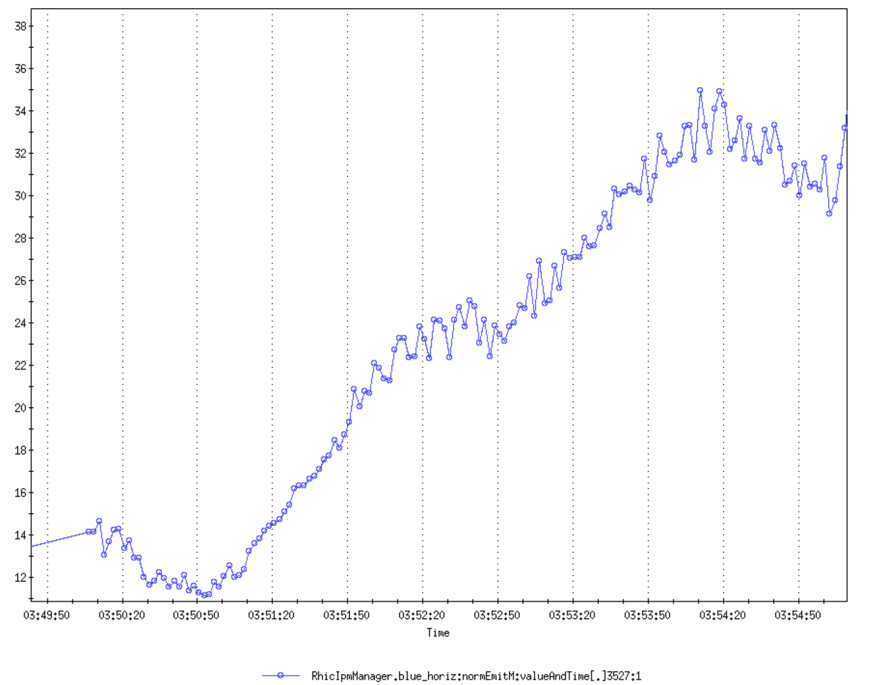


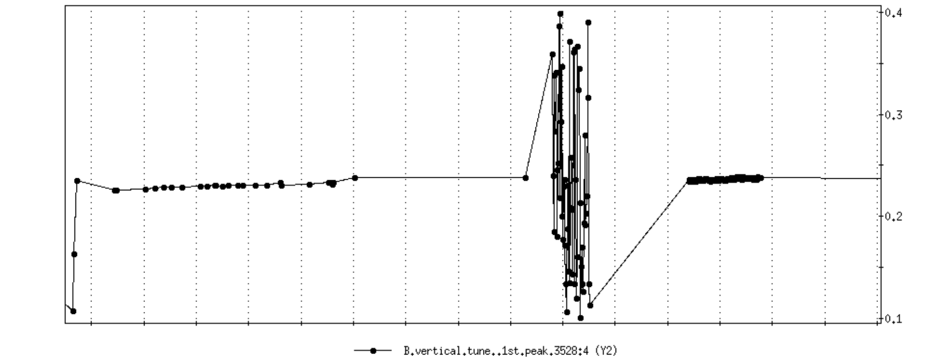
Dynamic aperture (nominal tune) ~**4.5 sigma**
By rescaling the emittance
To the initial one

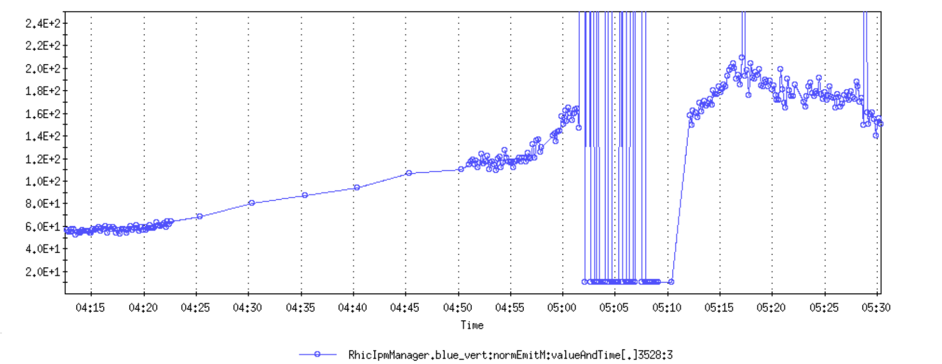
Dynamic aperture (resonant tune) ~**3.6 sigma**

data to compare with simulation

Dynamic aperture, blue, β*=1m







horizontal

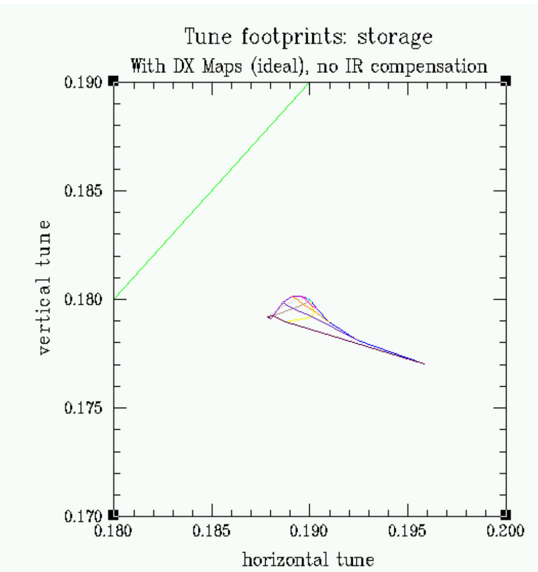
vertical

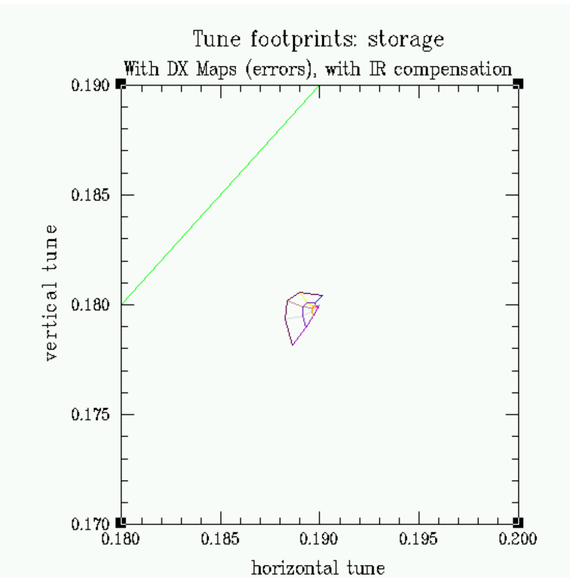
Data on aperture at β*=1m need more analysis work…..
(beam ex april 23 2-5am)

Further DA studies

- Improved IPM should provide more precise data.
- DA reduction by beam-beam effects.
- The method is most valuable if it can provide the absolute value of the aperture. The relative aperture comparison (say between different working points) may be obtained with more precision from background and lifetime data.
- Thus more careful evaluation how to get the absolute value of DA from the IPM and Schottky data is required.

Nonlinear detuning/tune spread at flattop





Tune footprints from tracking

Design lattice

- Studies should evaluate the possible techniques:
  - Schottky signal
  - Beam transfer function
  - AC dipole: oscillation amplitude versus dipole field curve
  - TBT signal information

Tracking studies

- Last workshop pointed out the lack of tracking studies for the machine lattice used in the operation. (The studies on the design stage were done for β* configuration: (10,10,1,1,10,10) .

- Considerable progress last summer on the off-line model improvements/developments: postpocessing tools and measured magnet error inclusion. Led by Nikolay, Fulvia, Ray and others.

- First tracking results with realistic machine model at store (IR errors) started to come up