Slow and Fast Orbit Feedbacks

V.Ptitsyn, D. Bruno, R. Hulsart, W. MacKay, A. Marusic,
W. Meng, K. Mernick, R. Michnoff, M. Minty,
C. Montag, T. Roser, T. Satogata, C. Schultheiss,
P. Thieberger, D. Trbojevic. J. Tuozzolo

RHIC Retreat 2009

Closed Orbit Stability

- Slow variations (24h):
  - Reproducibility of the ramp orbit (especially important for polarized protons)
  - Orbit stability at the store

Last run issue: Better orbit stability needed in important locations (collision points, collimators).

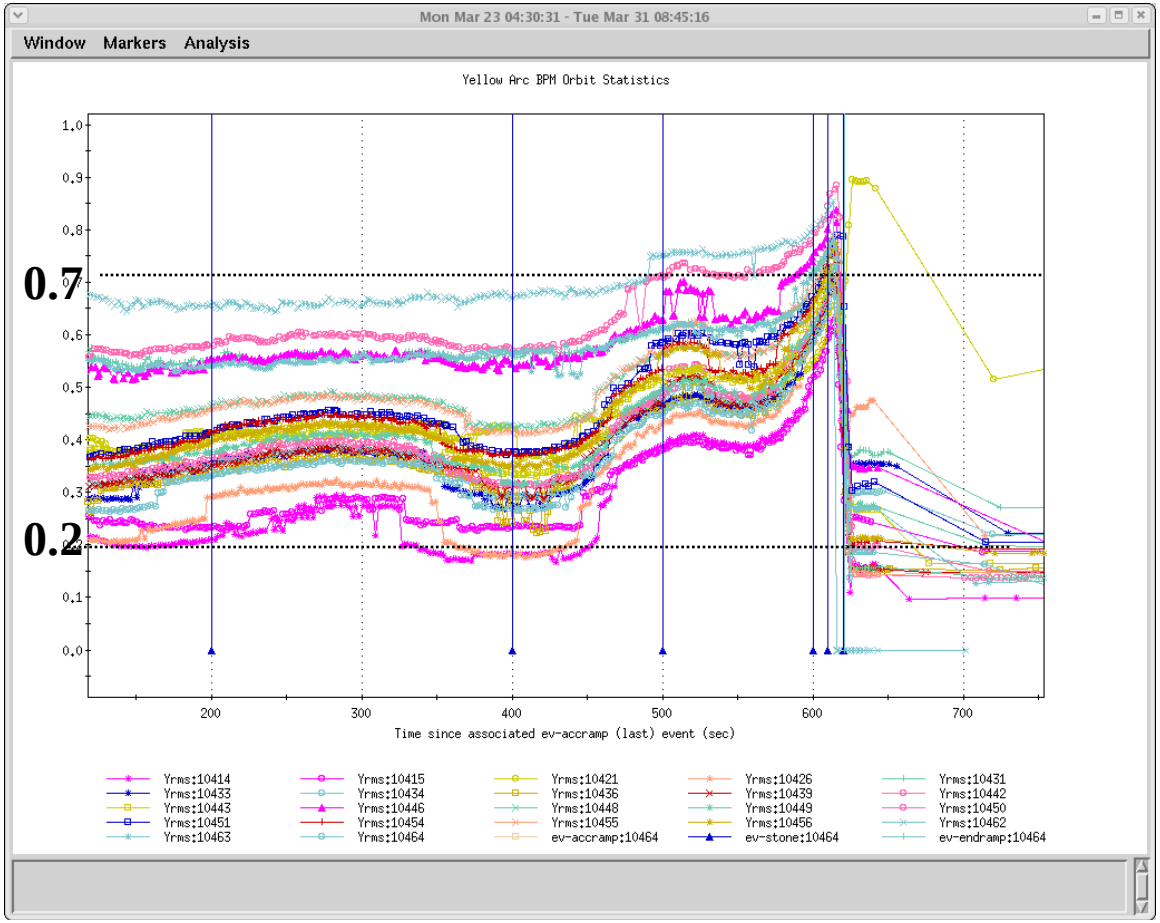
- Fast variations (10 Hz)

Mainly factor at the store. Needed orbit stability at the collision points and at the triplets.

- The operation at near integer working point will require taking care about both fast and slow orbit variations.

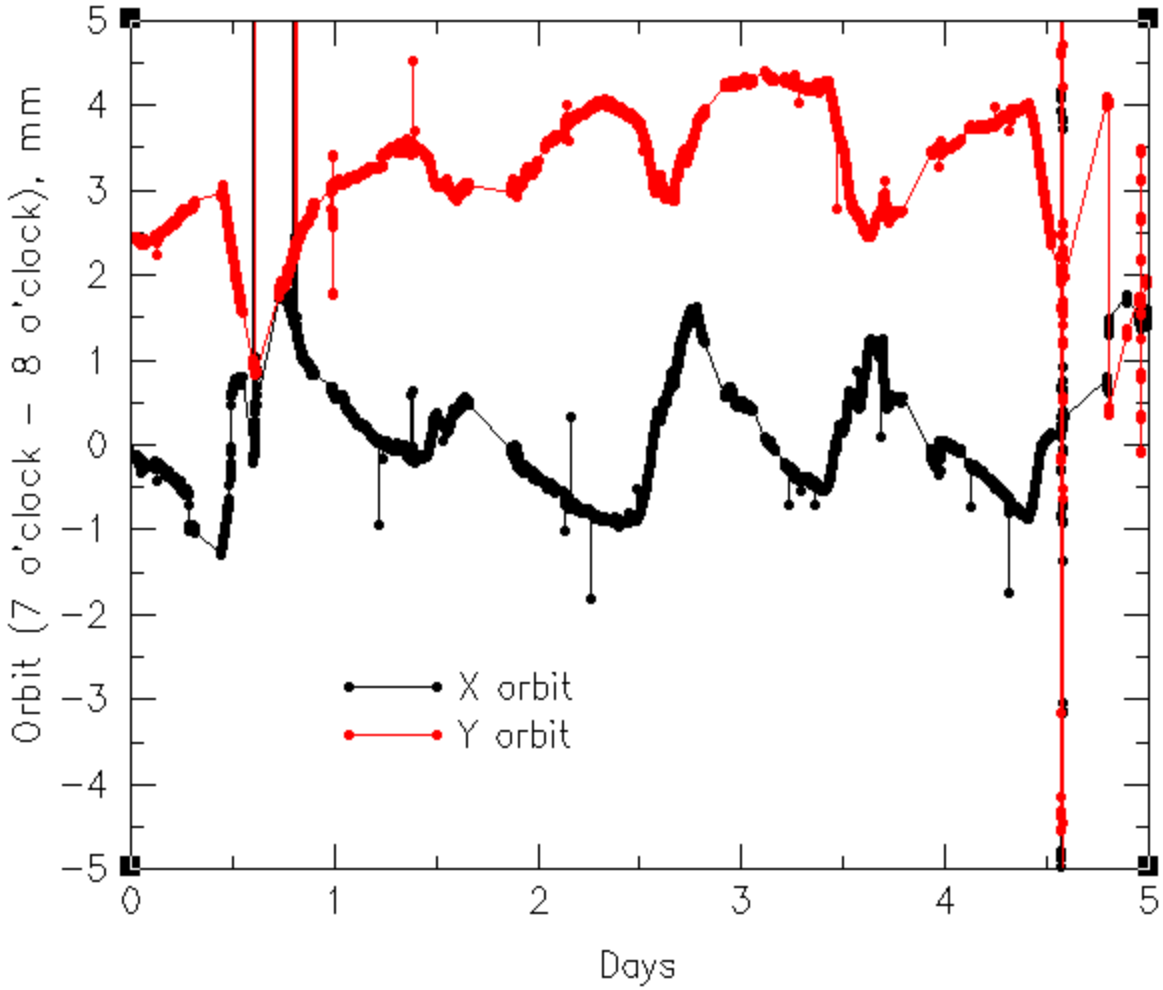
Slow orbit variation examples from Run-9

Yellow vertical rms orbit taken during a week of the RHIC operation.
Data are from rotator ramp. No orbit corrections done during that time.



IR8 orbit variation during pp2pp run

No orbit correction done during the stores.



Correction of slow variations

- Presently used solutions:
  - 0.5h store orbit correction
  - Correction on the ramp in certain time-intervals

- Possible schemes for future upgrade of the ramp correction:
  - Proper propagation of the correction done at the injection trough the whole ramp.
  - Feedback using IR4 corrector and two (or three) BPMs from arcs
  - Feedback using 6 (12) correctors at IRs and number of BPMs

    Issues: Lattice and golden orbit dependences on the time on the ramp
  - Feedback using all correctors and BPMs. Hard to implement within the existing stepstone system.

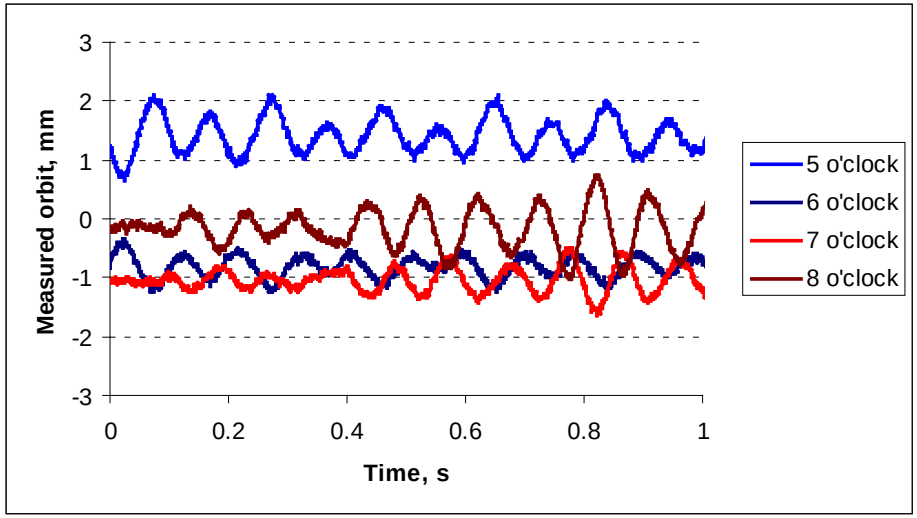
- Additional measures to provide the orbit stability in specific locations at the store.

  Three-bump application in collimator locations on top of global orbit correction already tested in last run (T.Satogata)

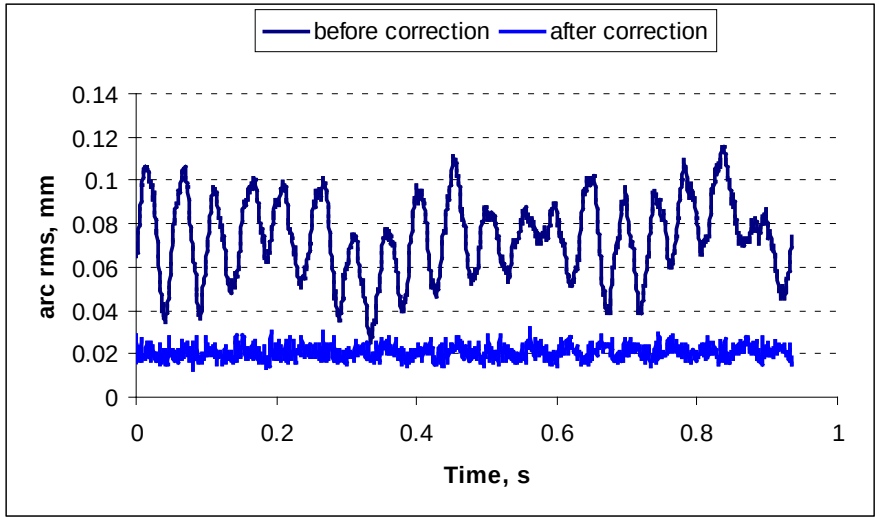
Fast orbit variation (10Hz problem)

250 GeV Run-9 data

IR6 and 8



Arc rms



-known source: triplet vibrations

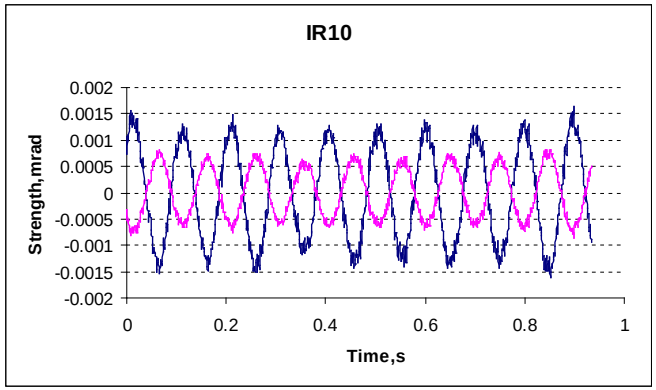
-successful demonstration of dynamical damping at 6 o'clock triplet, using mechanical position detectors and actuators (P.Thieberger, et al)

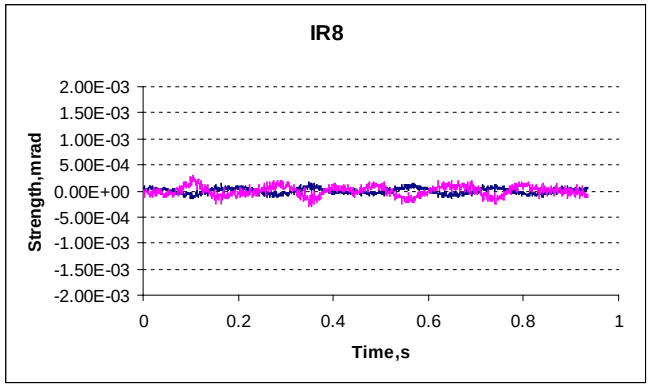
-local feedback, tried in previous runs, stabilizes the relative beam position at the collision points, but orbit oscillations in triplets can be still large

-global feedback is under development which would allow to minimize the orbit oscillations in triplets and whole rings.

Simulations of correction schemes

- Correctors near the IR triplets
  -12 correctors (one near each triplet)
  - 4 correctors (IR6 and IR8 only)
- BPMs in triplets (4, 12 or 24). Some of arcs BPMs?

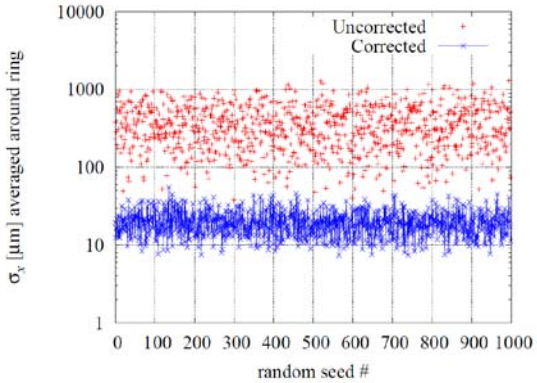


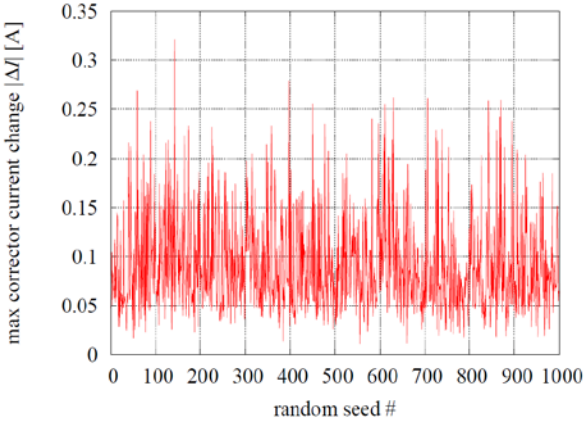


Simulations with logged 10Hz orbit data (Vadim)

Plots show the required corrector strength to compensate for 10 Hz variation. Maximum strength ~ 1.5murad. Largest corrector strength is in IR4, IR10, IR6

Simulations with random quad misalignments (Waldo)





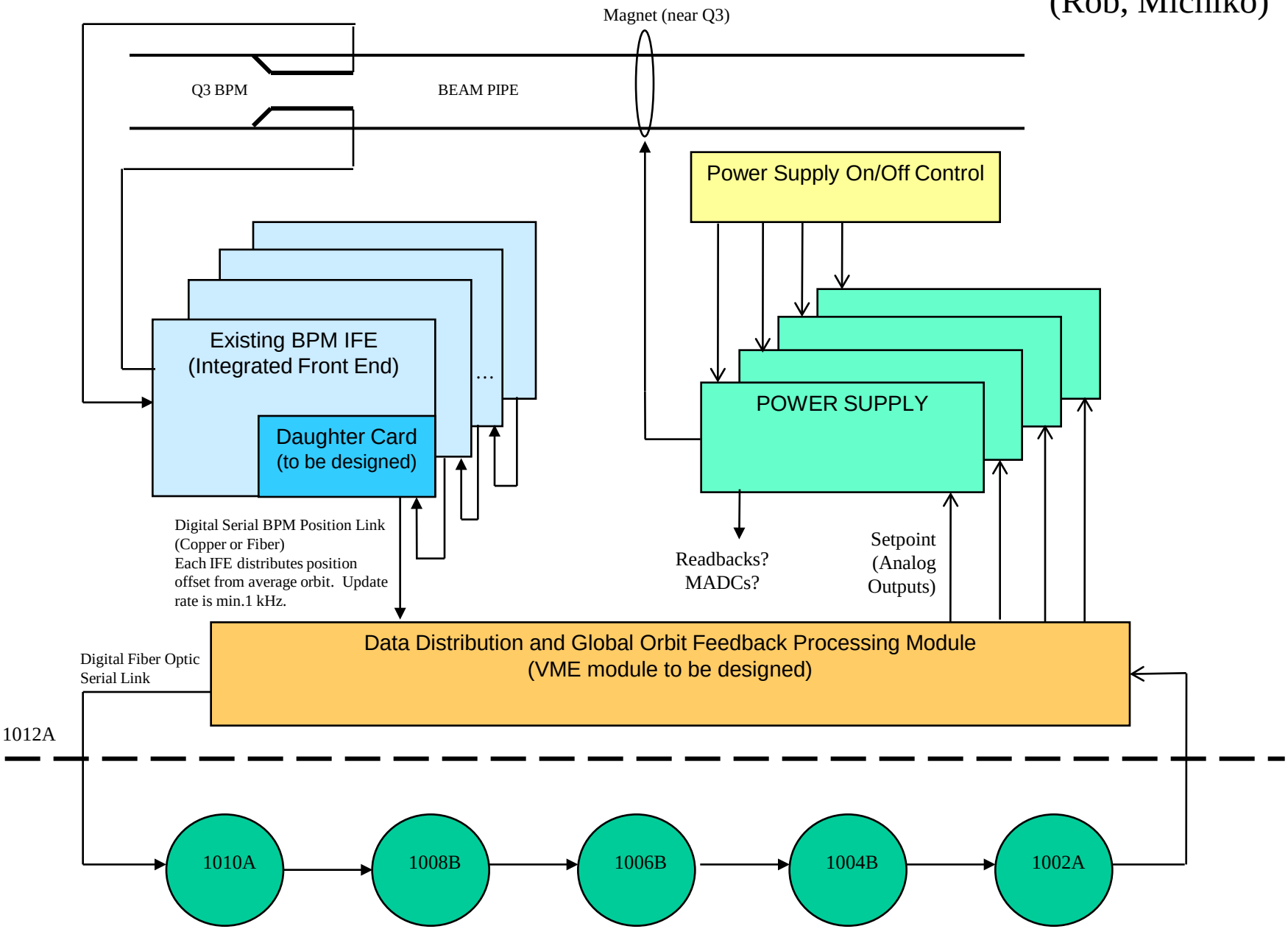
Fast feedback parameters

- Goal frequency range: 1-20 (60Hz)
- Delay time (BPM acquisition, data transfer, correction calculation, magnet field risetime) : < 1ms
- System architecture. Processing scheme: distributed.
- BPMs:

  No need to install dedicated new BPMs!

  With upgrade of the electronic boards, existing (selected) BPMs would provide clean (filtered) data input for the feedback system.
- Magnet design is under development.

  Air-cored or laminated steel core design (developed by W.Meng).
  Magnet strength; field quality.
- Interaction with slow orbit correction.
- Goal: to have a system with at least 4 (preferably, with more) correctors for system tests for next run.

Proposed RHIC Global Orbit Feedback System Block Diagram

(Rob, Michiko)