Progress in ATF2 Extraction Line and Final Focus Tuning

Glen White, SLAC
(On behalf of all ATF2 community)

ATF2 Collaboration Meeting

Dec 14 2009

Developments , Oct - Dec 2009

- Control system updates.
- Tuning strategy.
- Online modeling improvements.
- EXT dispersion correction development.
- Tests of new dispersion monitoring tool.
- Working with fully calibrated cavity BPM system.
- FFS sextupole BBA.
- First routine use of post-IP C wirescanner.

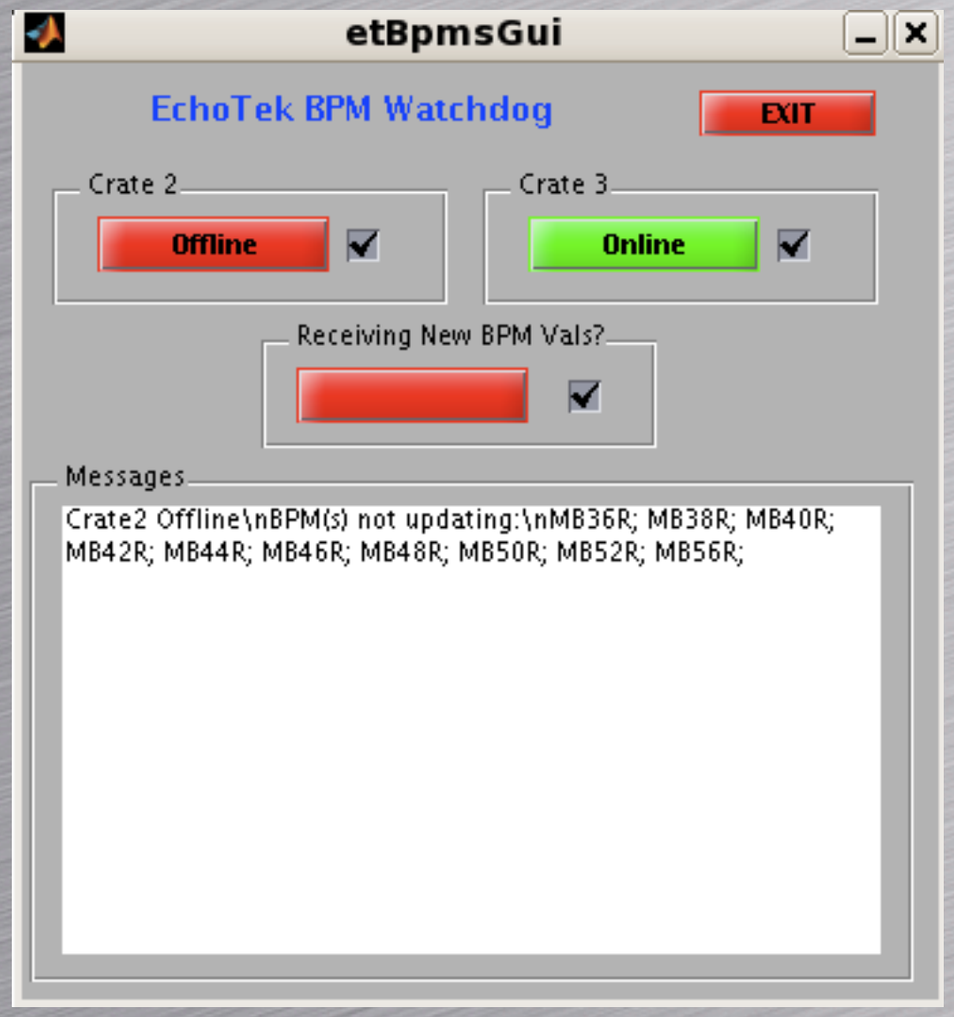
Tuning Strategy

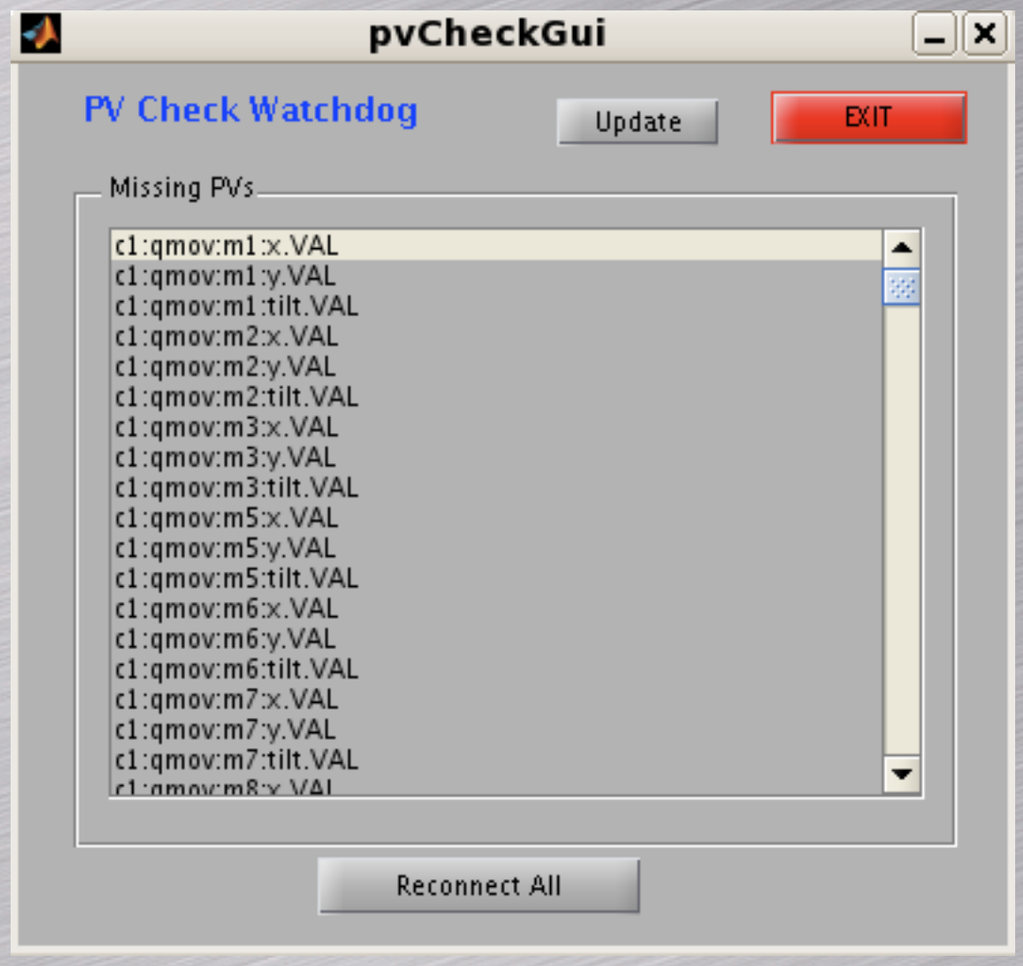
- Current tuning experience based on 8cm beta-x, 1cm beta-y (IP) optics configuration.
  - Target beamsize ~350 nm.
    - FFS sextupoles not needed.
- After initial tests tuning with IPBSM, look to quickly move to lower beta optics.
  - 1mm or 0.1 mm vertical? horizontal?
  - Depends on observed backgrounds in IPBSM, perform tests in January/February.

Watchdogs

- Software applications to monitor hardware and other reconstructed values of interest.

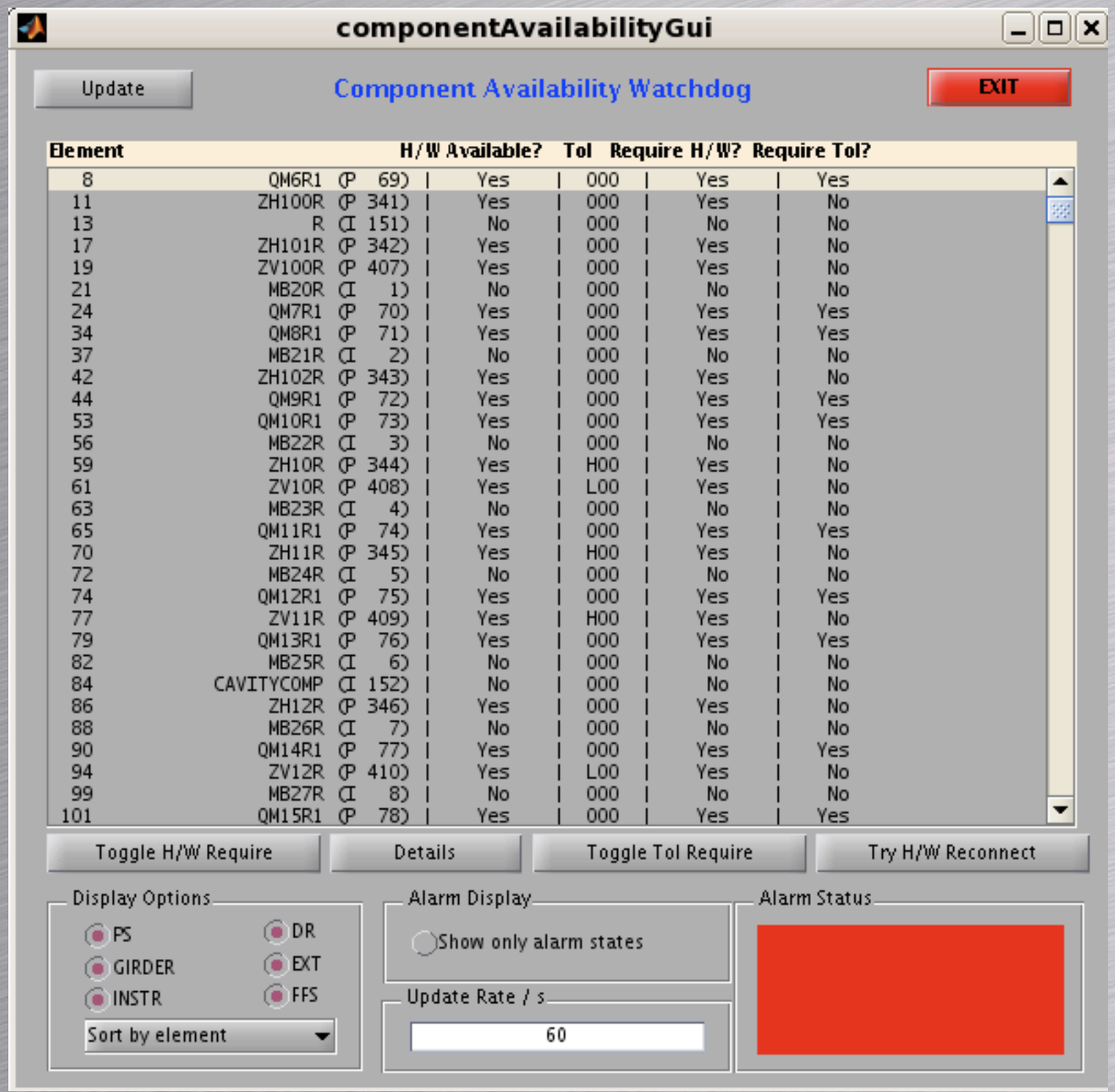
EPICS PV Watchdogs





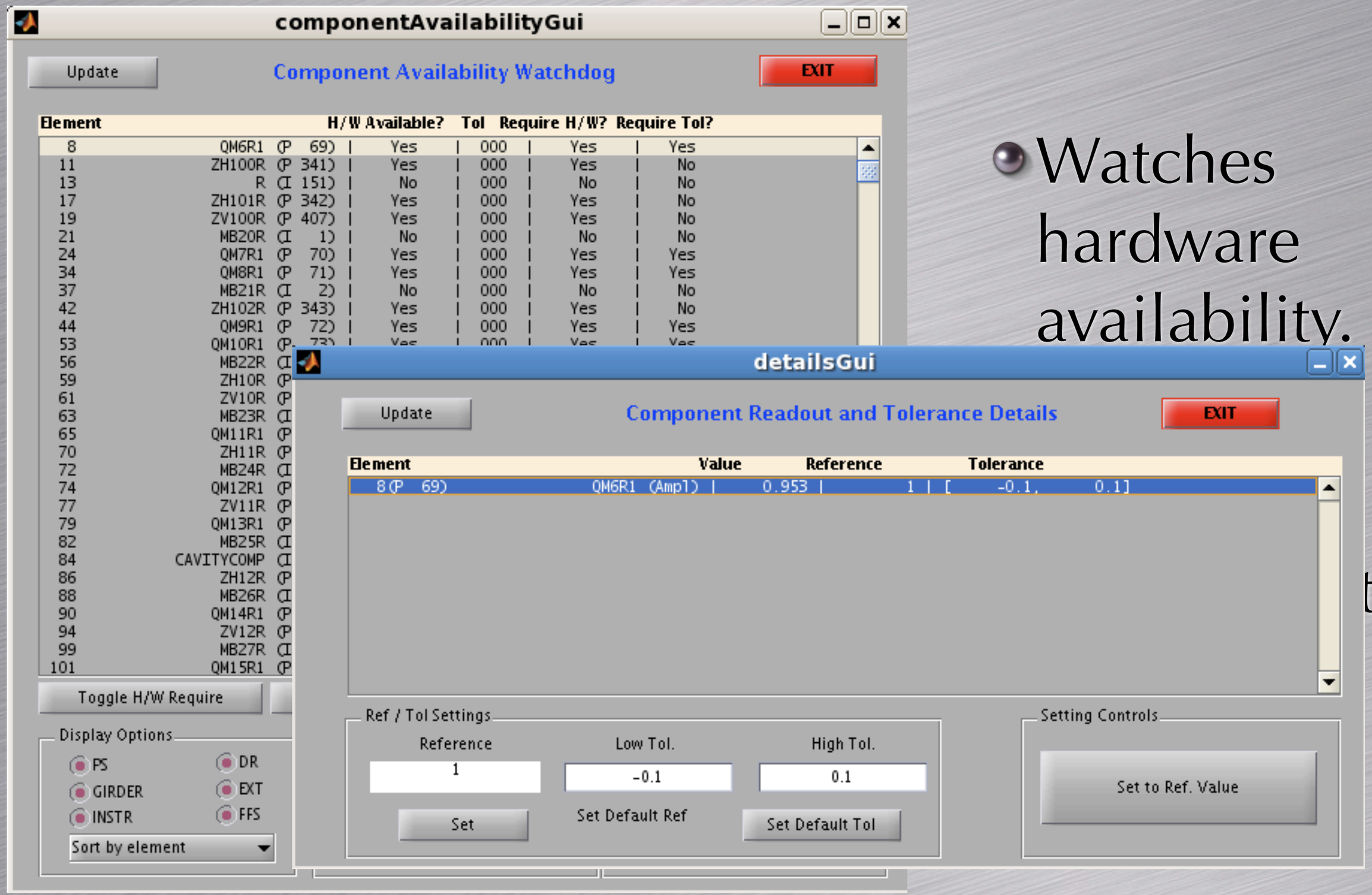
- Check required hardware channels available

Component Watchdog



- Watches hardware availability.
- Watches if component exceeds stated tolerance.

Component Watchdog



- Watches hardware availability.

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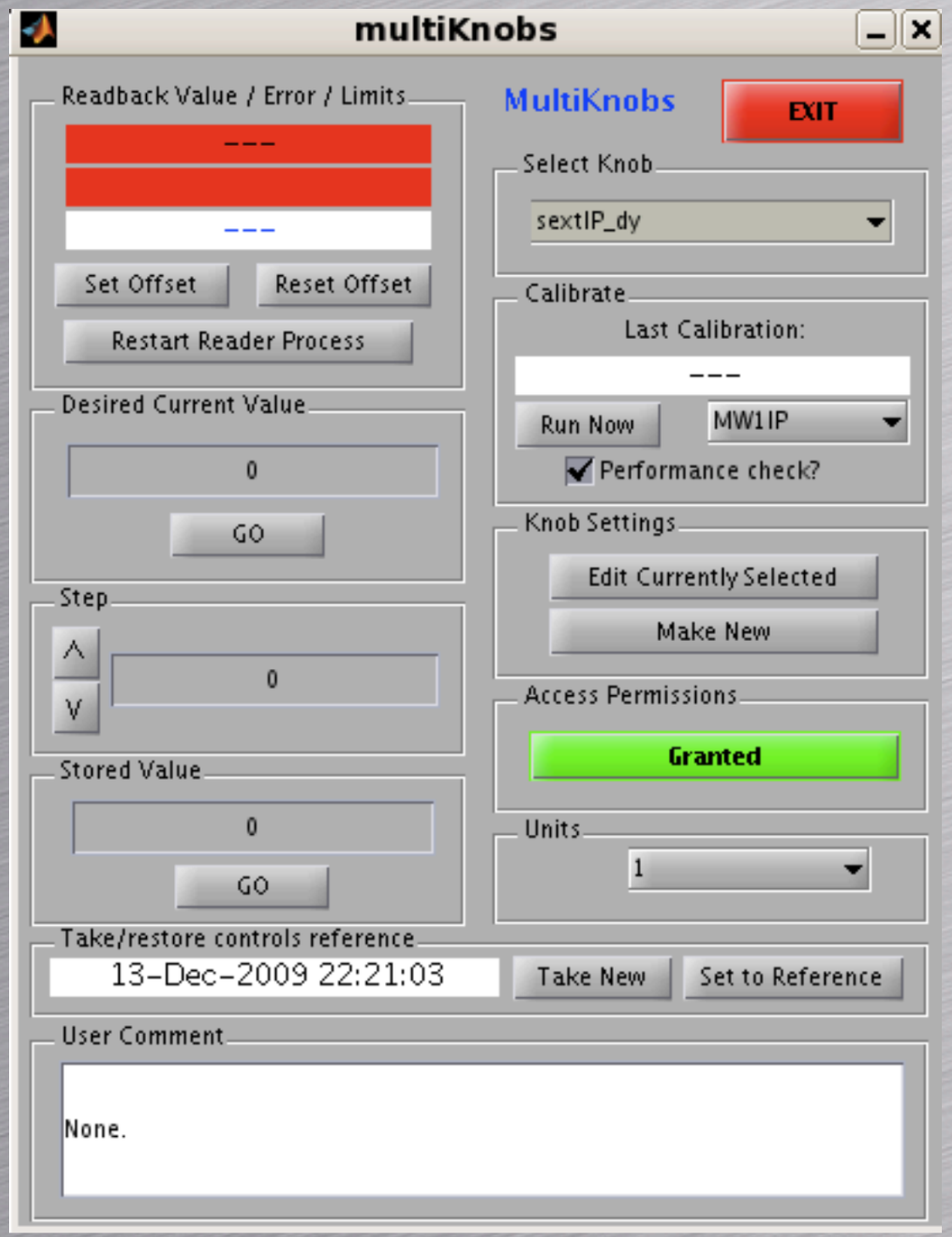
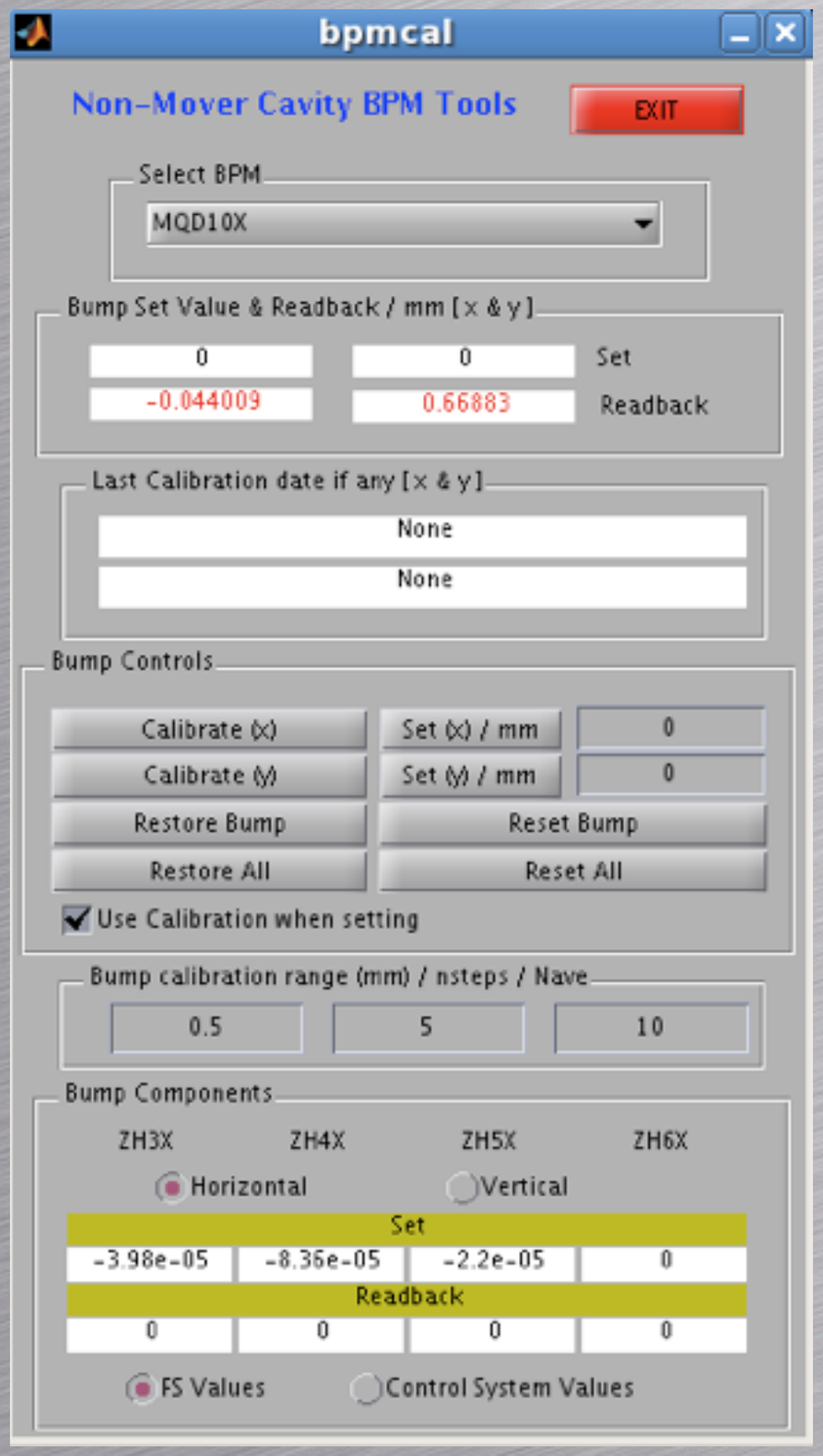
Multiknobs App



- Generic knob building and application tool.
- Apply to any PS or Mover device.
- Designed especially with sextupole multiknobs in mind.

Orbit Bump Tool



- Generate and monitor orbit bumps in EXT BPMs.
- Useful for calibration of non-mover based BPMs.
- Also provide EPICS interface, used by cavity bpm tools.

Improved Mover Interface

ATF2 Magnet Mover Main Display

Read Only Display | Help | EXIT

ALL MOVER FILE->SET+TRIM

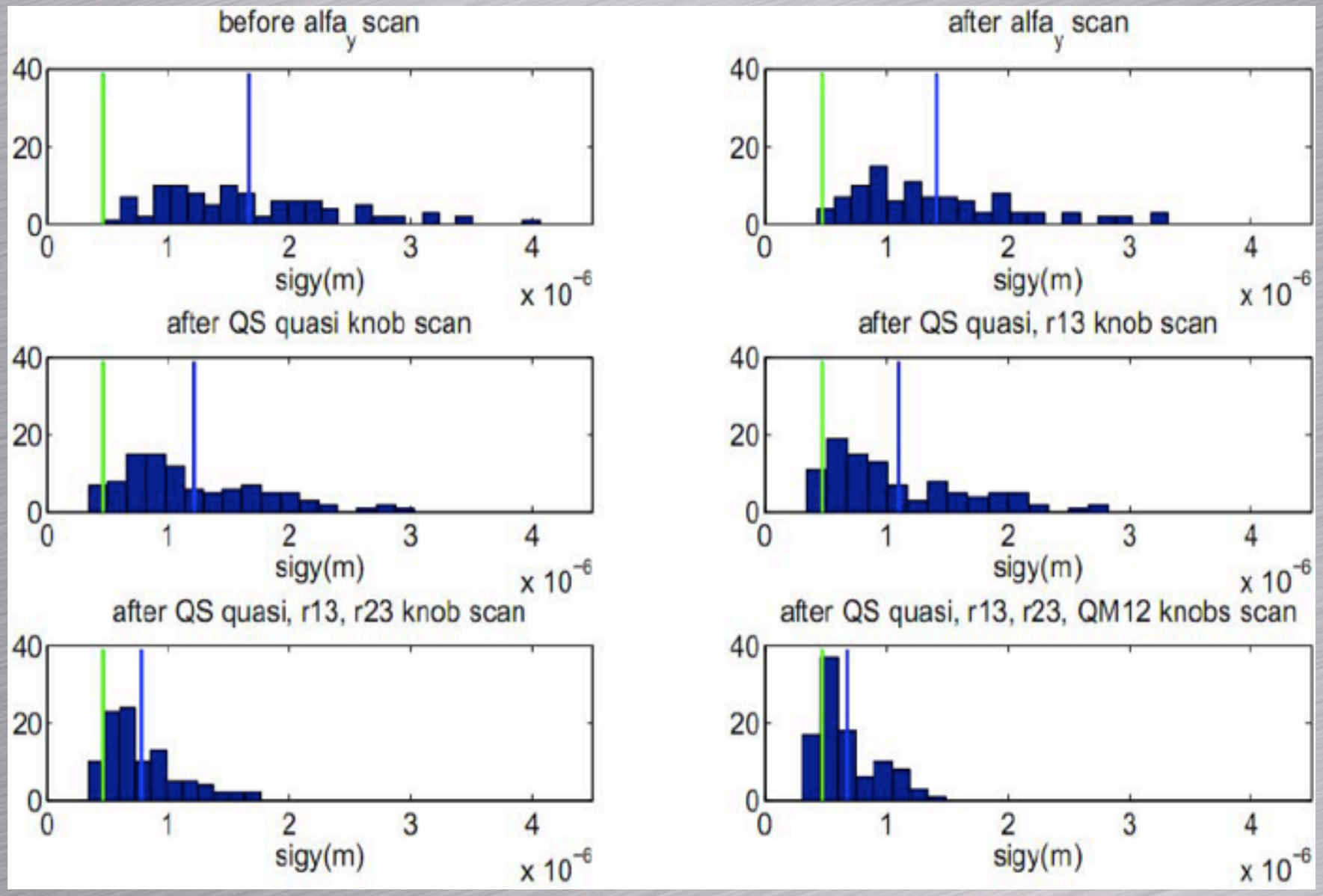
Magnet Display	X (um) FILE	X (um) SET	X (um) VALUE	Y (um) FILE	Y (um) SET	Y (um) VALUE	TILT (ur) FILE	TILT (ur) SET	TILT (ur) VALUE			
AQM16FF	0.0	0.0	1.0	0.0	0.0	0.4	0.0	0.0	2.9	trim	perturb	AQM16FF
AQM15FF	0.0	0.0	0.2	-200.0	-200.0	-199.7	0.0	0.0	-0.0	trim	perturb	AQM15FF
AQM14FF	-400.0	-400.0	-403.4	-800.0	-800.0	-800.6	0.0	0.0	-7.8	trim	perturb	AQM14FF
AFB2FF	0.0	0.0	1.2	0.0	0.0	1.1	0.0	0.0	10.8	trim	perturb	AFB2FF
AQM13FF	0.0	0.0	0.6	0.0	0.0	-0.5	20.0	20.0	18.2	trim	perturb	AQM13FF
AQM12FF	0.0	0.0	0.1	-200.0	-200.0	-200.4	0.0	0.0	0.1	trim	perturb	AQM12FF
AQM11FF	0.0	0.0	1.3	-200.0	-200.0	-199.6	0.0	0.0	3.7	trim	perturb	AQM11FF
AQD10BFF	0.0	0.0	1.0	0.0	0.0	0.4	0.0	0.0	2.9	trim	perturb	AQD10BFF
AQD10AFF	0.0	0.0	-2.0	-200.0	-200.0	-199.8	0.0	0.0	-4.1	trim	perturb	AQD10AFF
AQF9BFF	0.0	0.0	-2.4	0.0	0.0	0.4	0.0	0.0	-6.2	trim	perturb	AQF9BFF
ASF6FF	0.0	0.0	0.1	0.0	0.0	1.7	0.0	0.0	1.7	trim	perturb	ASF6FF
AQF9AFF	0.0	0.0	0.9	-200.0	-200.0	-199.3	0.0	0.0	4.1	trim	perturb	AQF9AFF
AQD8FF	0.0	0.0	-0.4	0.0	0.0	0.6	0.0	0.0	-2.3	trim	perturb	AQD8FF
AQF7FF	0.0	0.0	-4.2	0.0	0.0	0.5	0.0	0.0	-6.1	trim	perturb	AQF7FF
AQD6FF	0.0	0.0	1.1	0.0	0.0	1.2	20.0	20.0	24.4	trim	perturb	AQD6FF
AQF5BFF	0.0	0.0	2.7	0.0	0.0	1.3	0.0	0.0	6.3	trim	perturb	AQF5BFF
ASF5FF	0.0	0.0	-0.0	0.0	0.0	0.1	0.0	0.0	-0.8	trim	perturb	ASF5FF
AQF5AFF	0.0	0.0	-1.6	0.0	0.0	0.8	0.0	0.0	-4.0	trim	perturb	AQF5AFF
AQD4BFF	0.0	0.0	0.2	0.0	0.0	-0.1	0.0	0.0	2.5	trim	perturb	AQD4BFF
ASD4FF	0.0	0.0	-0.0	0.0	0.0	0.1	0.0	0.0	-0.8	trim	perturb	ASD4FF
AQD4AFF	400.0	400.0	398.6	0.0	0.0	-0.8	0.0	0.0	3.3	trim	perturb	AQD4AFF
AQF3FF	0.0	0.0	-0.0	100.0	100.0	99.8	0.0	0.0	-0.7	trim	perturb	AQF3FF
AQD2BFF	0.0	0.0	1.5	0.0	0.0	1.3	0.0	0.0	2.9	trim	perturb	AQD2BFF
AQD2AFF	0.0	0.0	-1.1	0.0	0.0	-1.0	0.0	0.0	-10.7	trim	perturb	AQD2AFF
ASF1FF	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.4	trim	perturb	ASF1FF
AQF1FF	0.0	0.0	0.2	0.0	0.0	0.5	0.0	0.0	-0.2	trim	perturb	AQF1FF
ASD0FF	0.0	0.0	0.5	0.0	0.0	-0.5	0.0	0.0	6.6	trim	perturb	ASD0FF
AQD0FF	50.0	50.0	49.7	0.0	0.0	-0.1	0.0	0.0	0.4	trim	perturb	AQD0FF

- Complete integration with ATF control system.
- File/Set/Value
- Save/restore functions.
- AFB2FF inclusion

8/1cm Beta Tuning Strategy

- Model consistency check.
- Establish EXT/FFS orbit and BBA.
  - In upstream EXT, use select Quads and screens to BBA.
  - Use cavity BPM system for alignment elsewhere.
  - Aim for complete beam-based offset calculation for BPM system and fast initial orbit restore.
- EXT dispersion correction
  - QS1X+QS2X sum knob (dispersion y + y′)
  - ZV5X / ZV6X / ZV7X dispersion bump (dispersion y′)
- EXT coupling correction
  - “fast method” - minimise vertical beam size on MW0X with QK1X and QK3X scans, MW3X with QK2X, QK4X.
- Measure Twiss and emittance with EXT wirescanners, extrapolate to IEX, check against DR measurements
- Establish IP or post-IP waist at wirescanner, QD0FF waist scan, dispersion measurement, twiss calculation, extrapolation to EXT measurement point and comparison.
- Beta-matching if required, or quick beta scan with QM12FF.
- IP beam size reduction: scan QK*X, dispersion knobs.

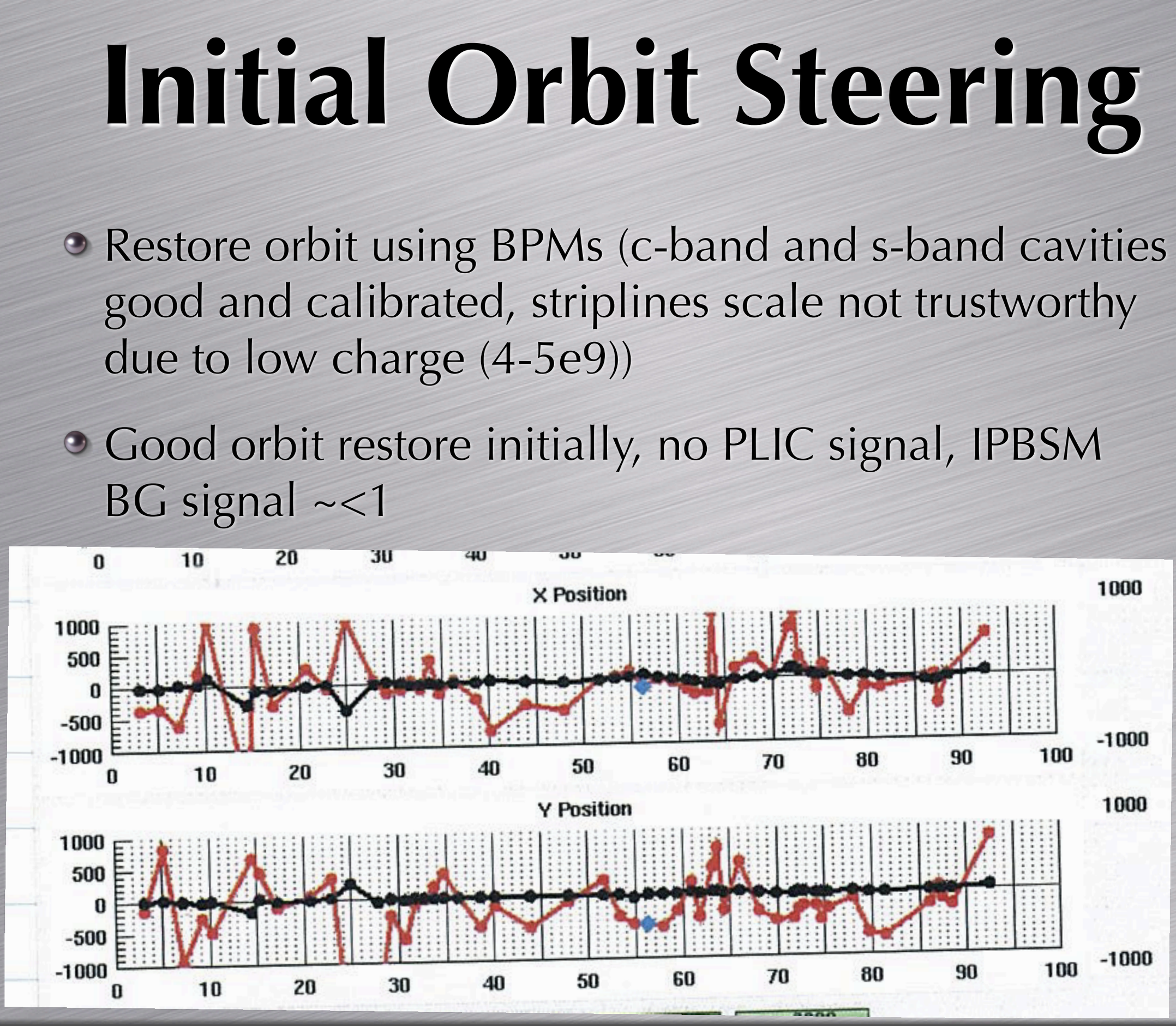
High-Beta Optics Tuning Simulation



- Simulation of tuning strategy for 8/1cm IP beta optics with large optics errors (1% magnet strength errors).

Initial Orbit Steering

- Restore orbit using BPMs (c-band and s-band cavities good and calibrated, striplines scale not trustworthy due to low charge (4-5e9))
- Good orbit restore initially, no PLIC signal, IPBSM BG signal ~<1



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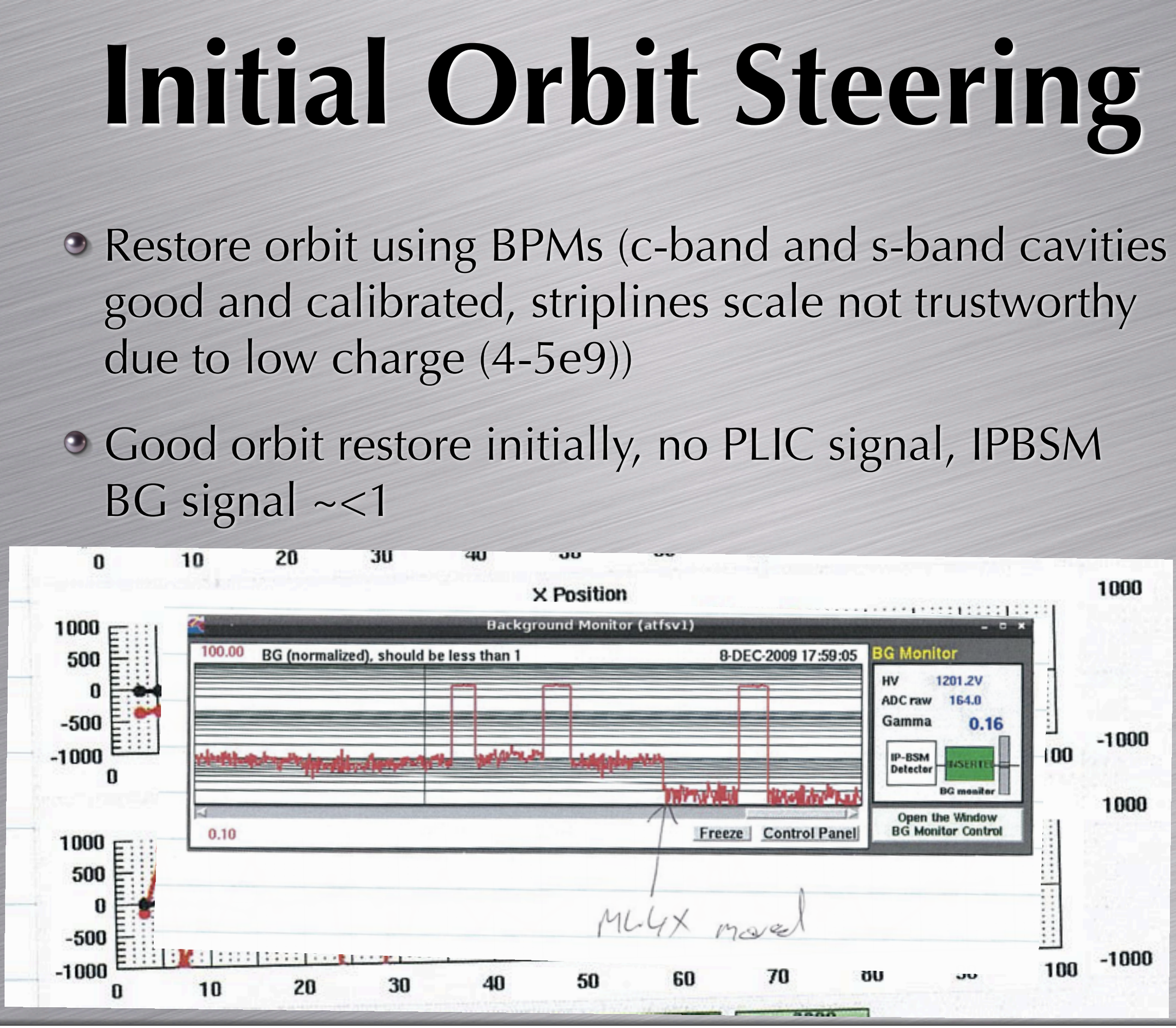
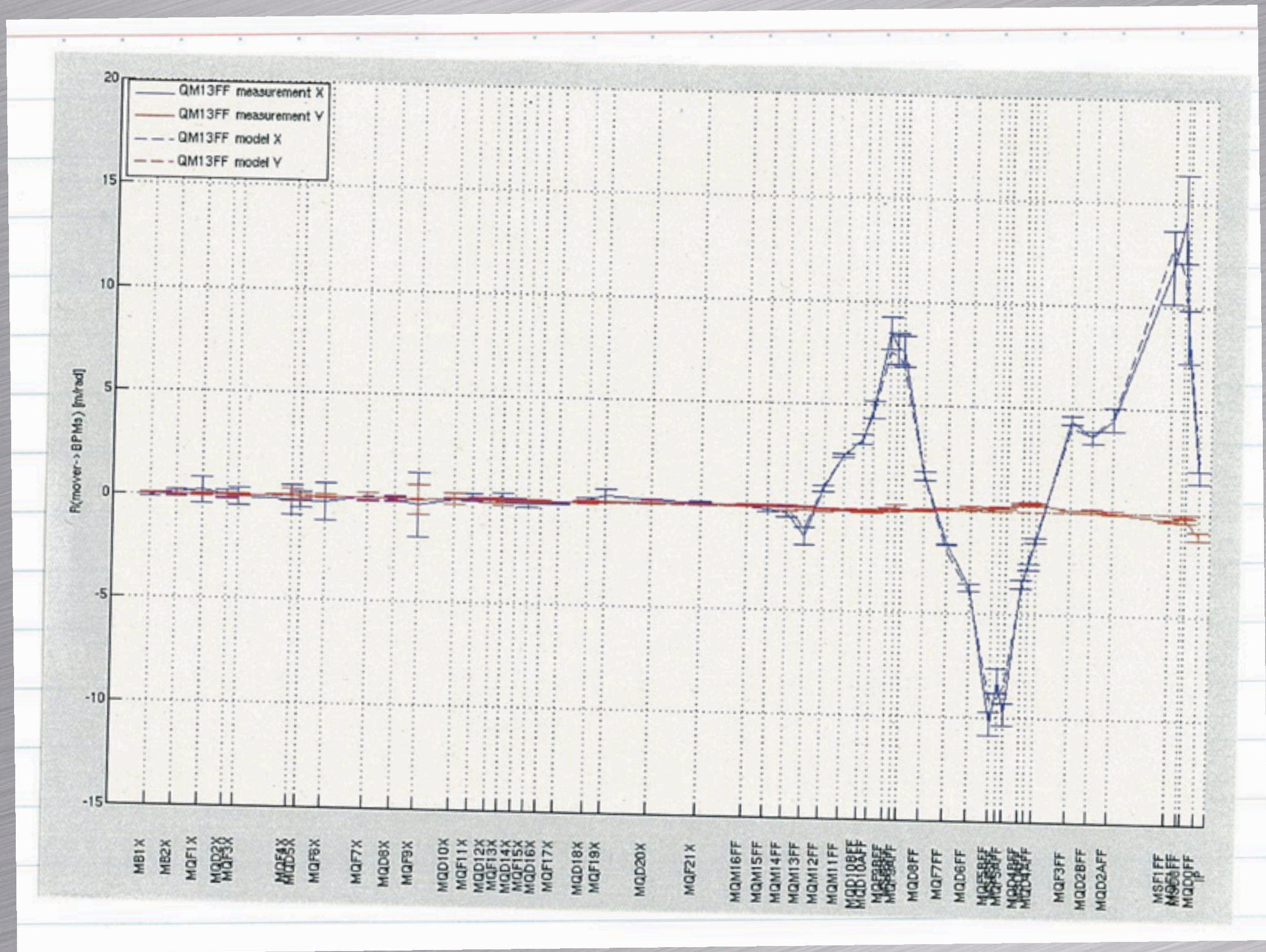


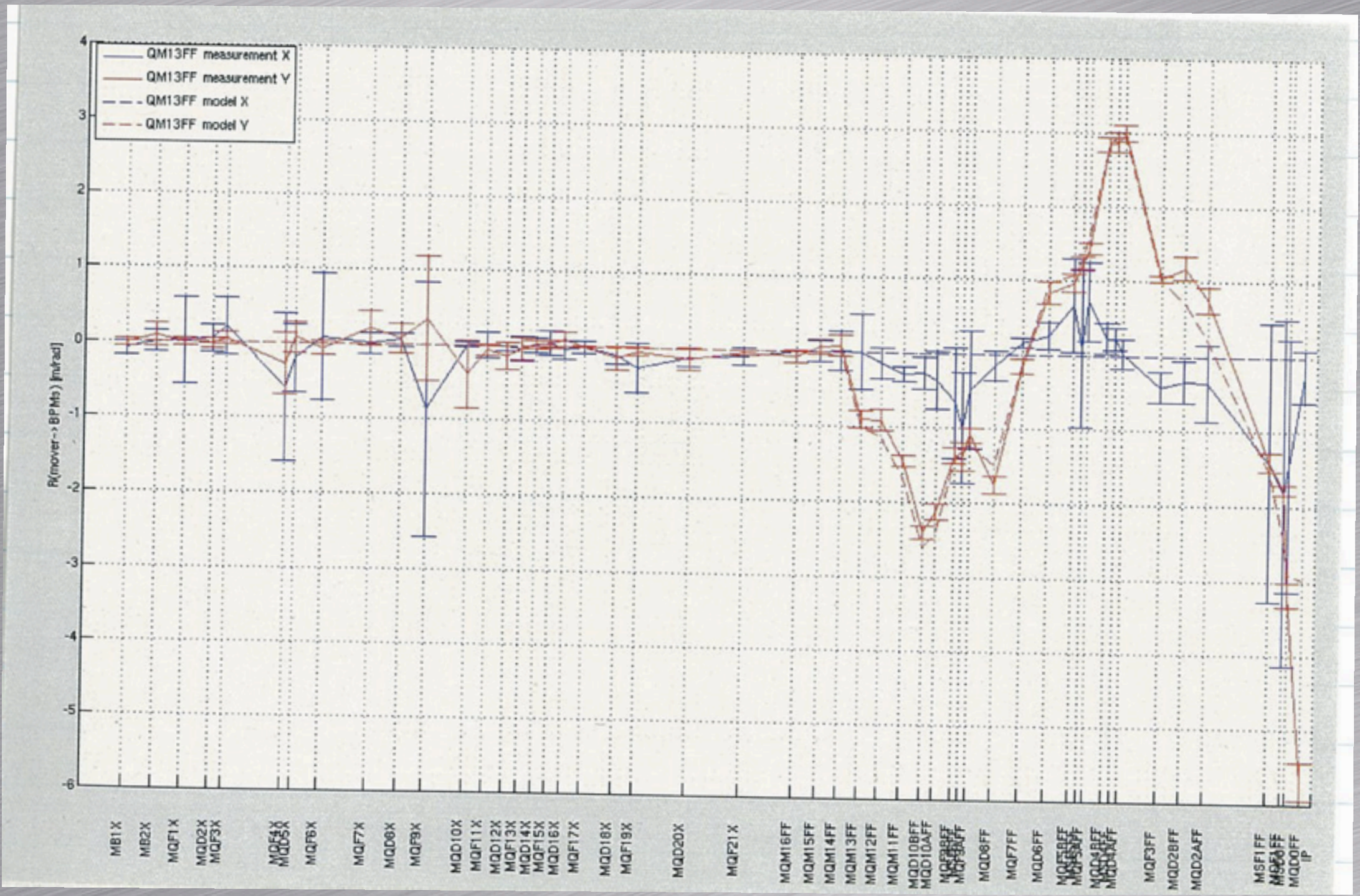
Online Model Check

- Horizontal and vertical transfer matrices using ZV1X / ZH1X correctors and QM13FF mover.
- FS started using DAC current readbacks instead of ADC for magnets, lead to much better modeling of magnet fields and good model agreement.
- Always perform this consistency check post-cavity BPM calibration.

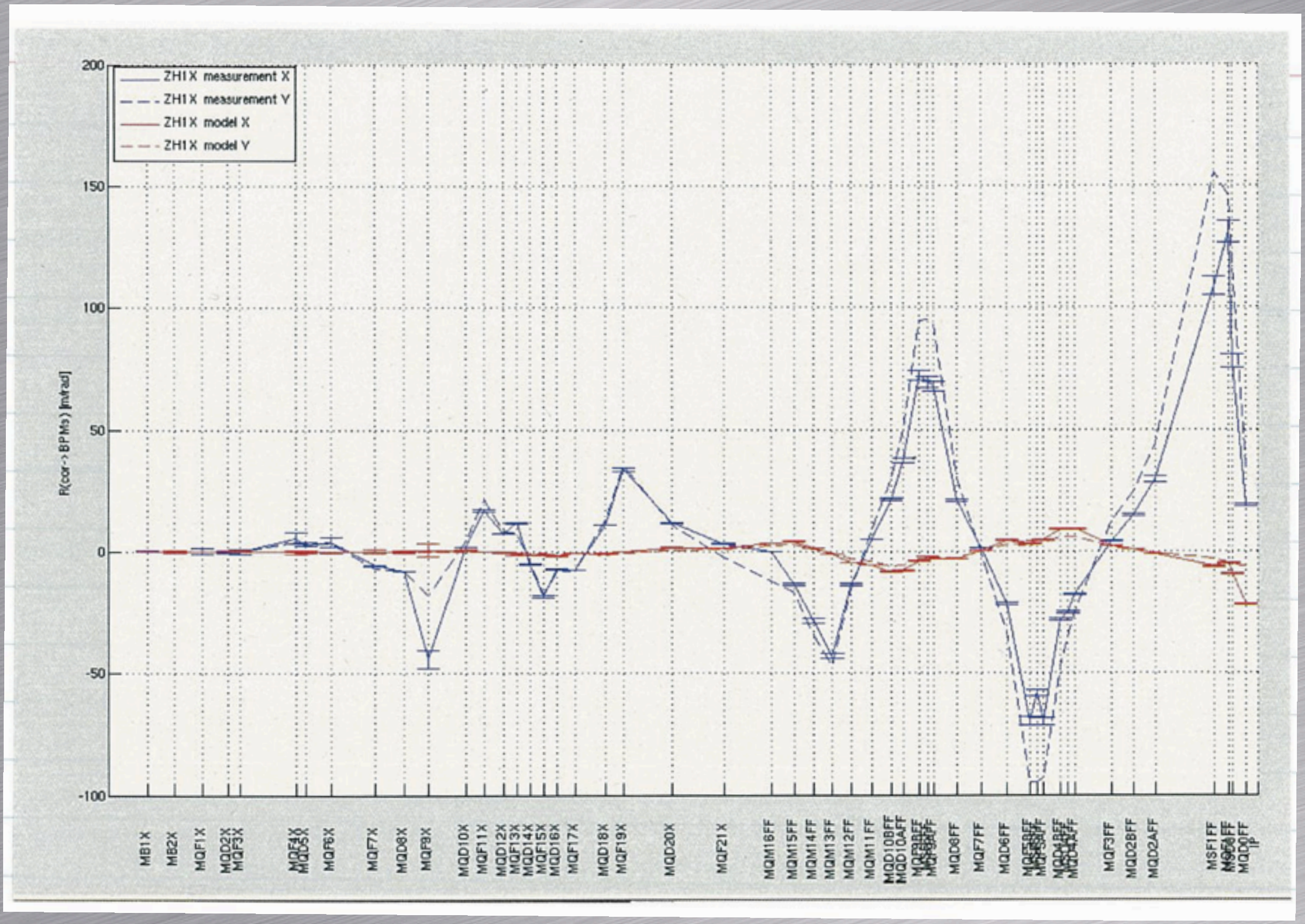
Online Model Check



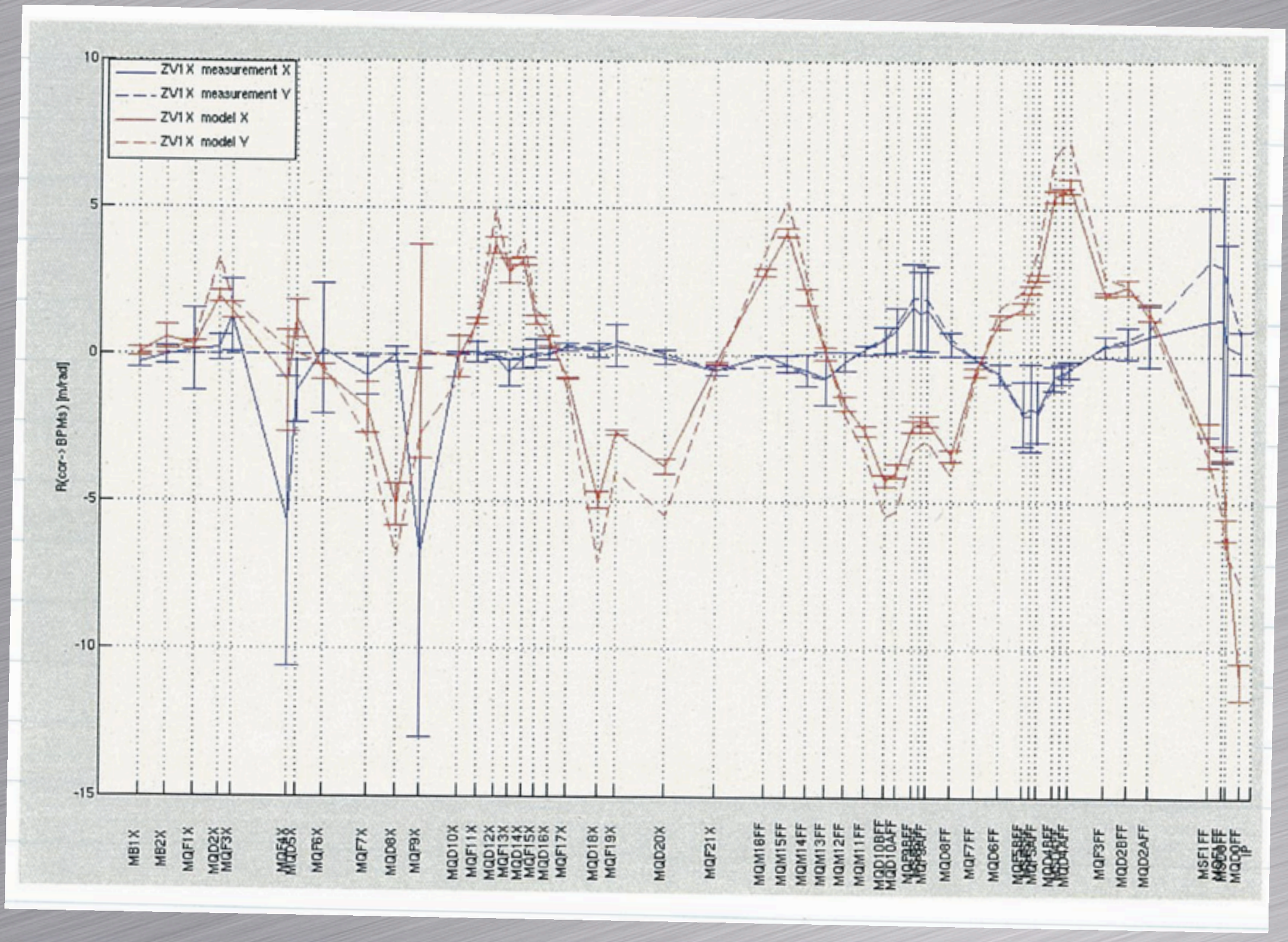
Online Model Check



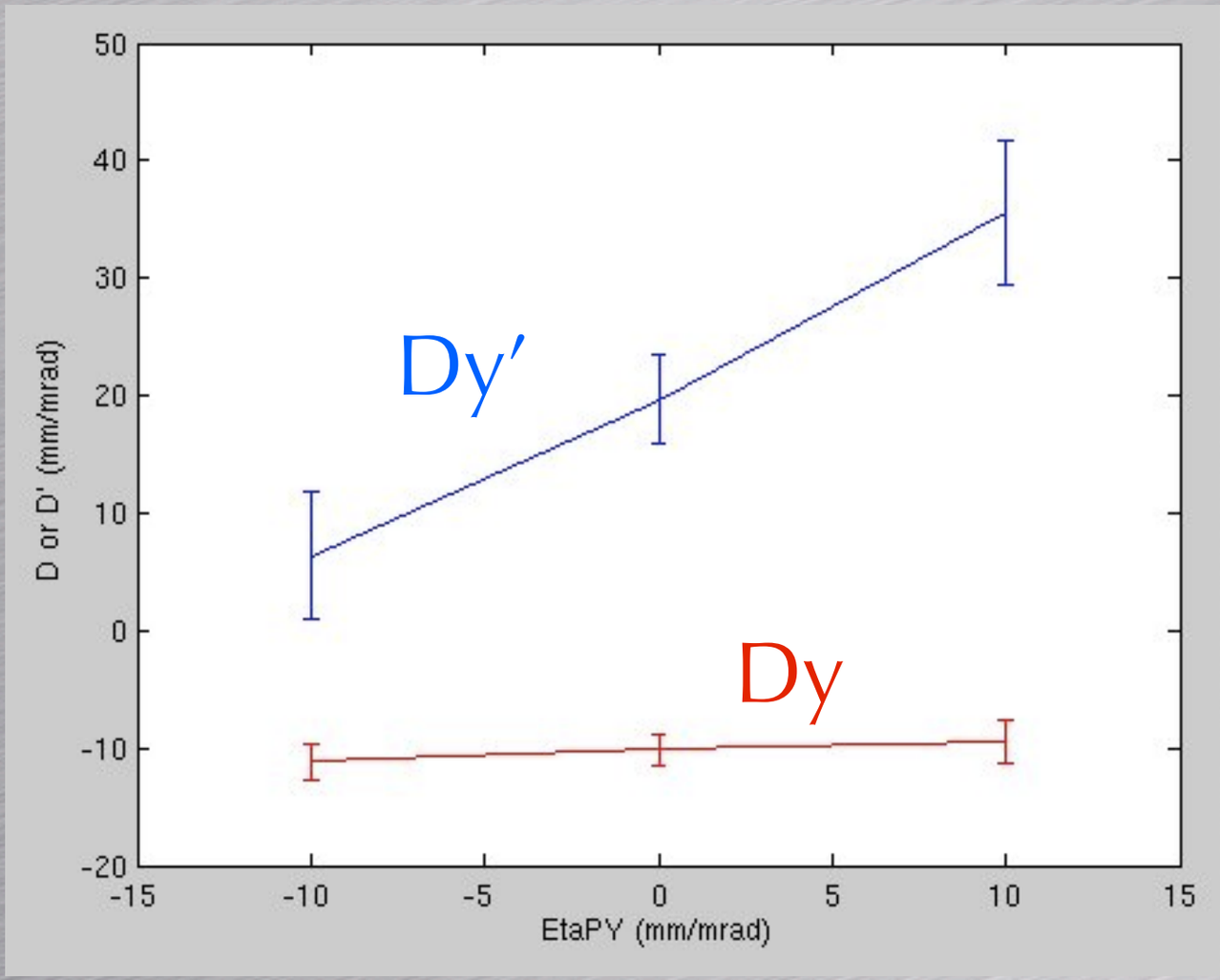
Online Model Check



Online Model Check

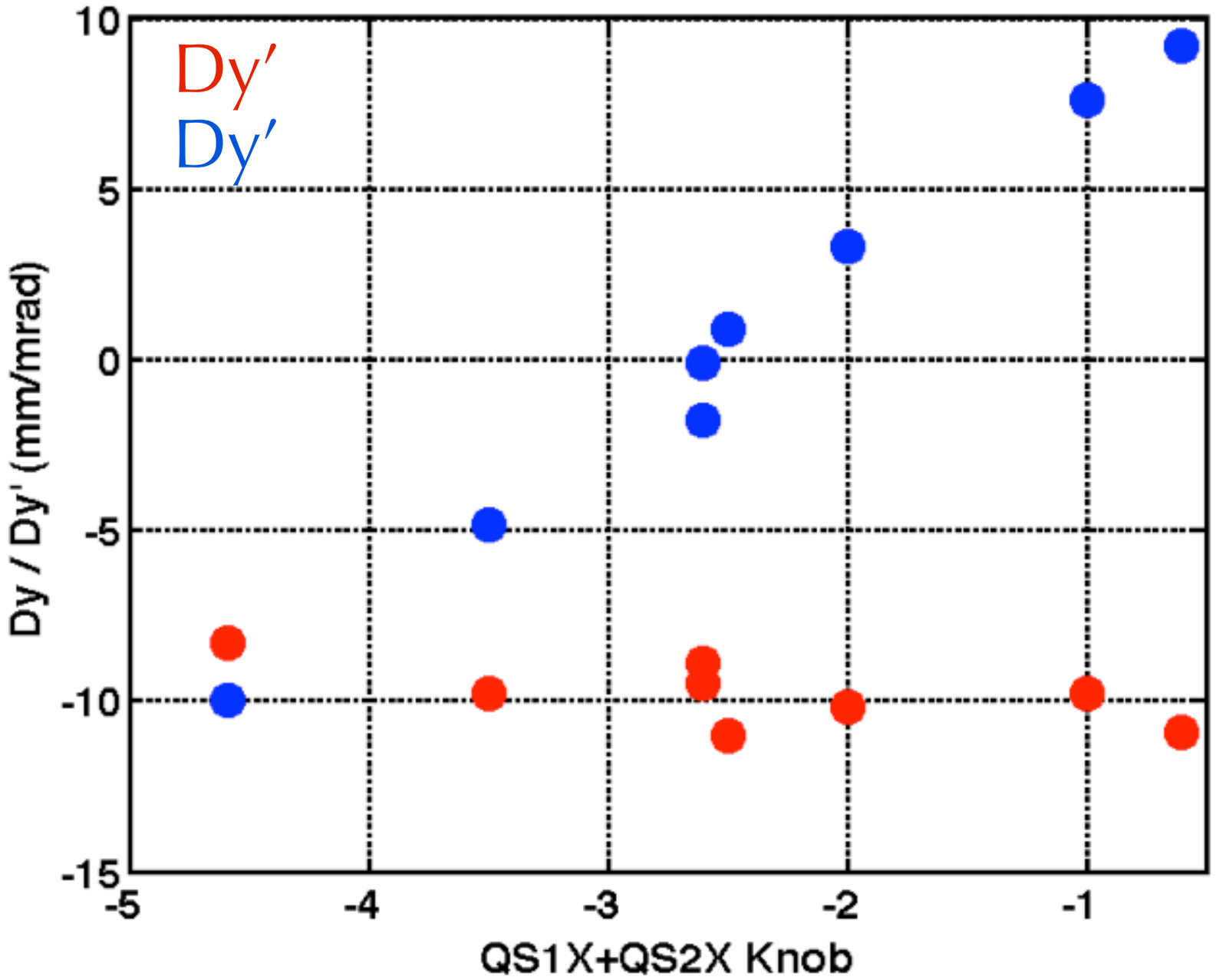


Dy′ Knob Check



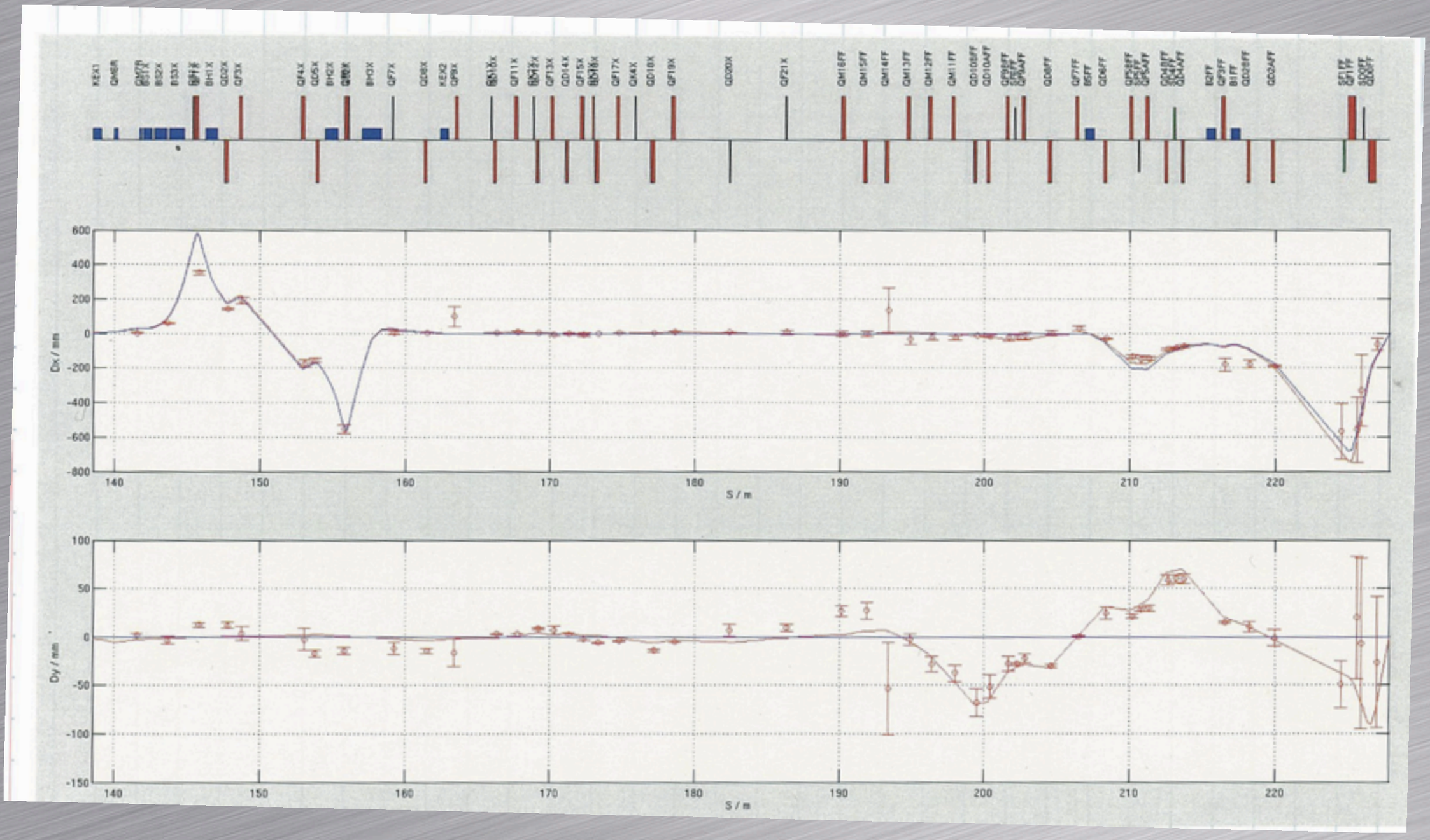
- Dy and Dy′ orthogonal knobs constructed using QS1X+QS2X+ZV5X+ZV6X+ZV7X
- Above plot shows scan of Dy′ knob.

Vertical Dispersion & Dispersion' Fit at MQD10X



- Sum knob only effect Dy' (red points)?!
- ZV5/6/7X bump mainly effect Dy, but also a little Dy'
- Behaviour changed when close to corrected in Dy and Dy'

Dispersion Measurements and Fits



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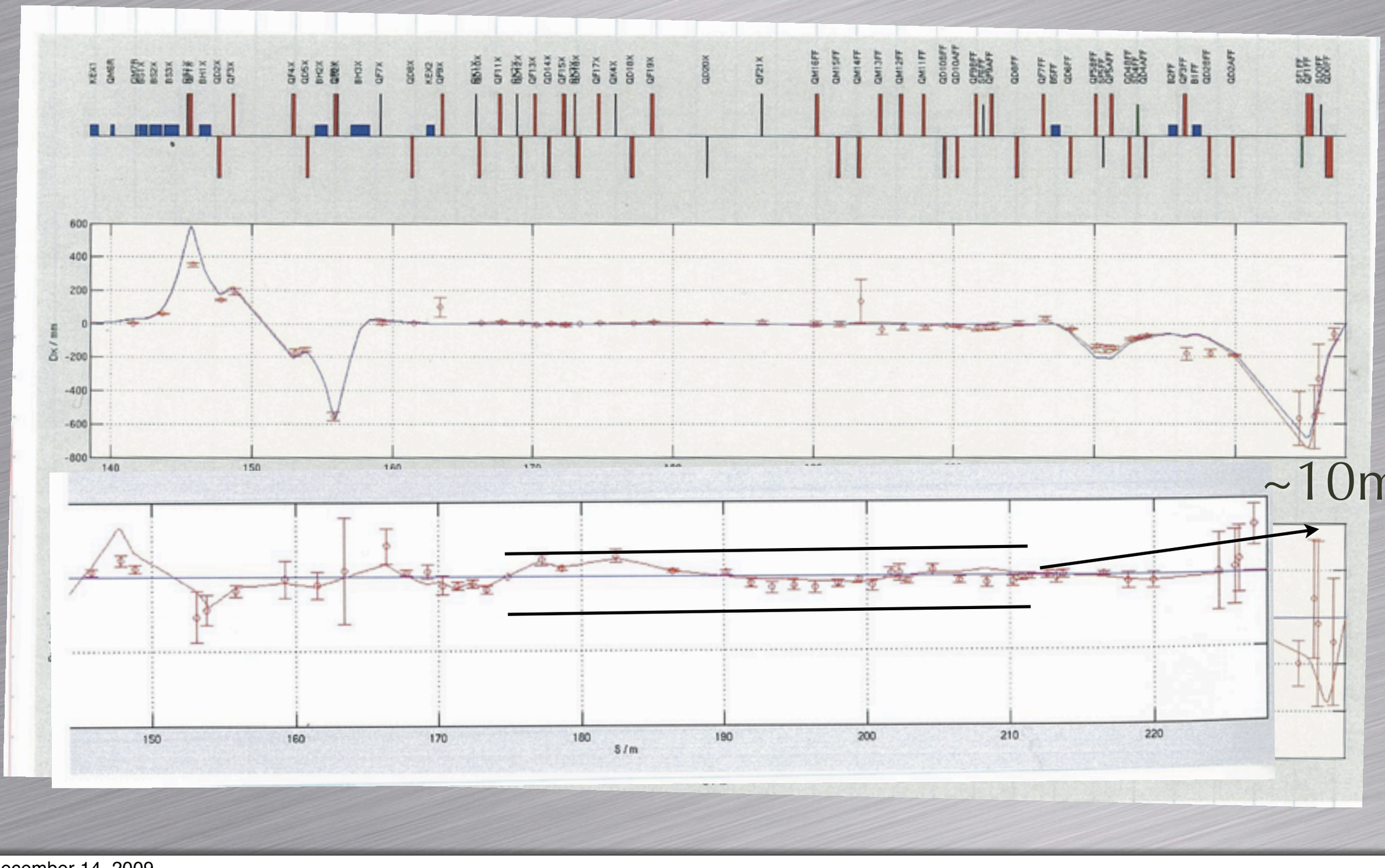
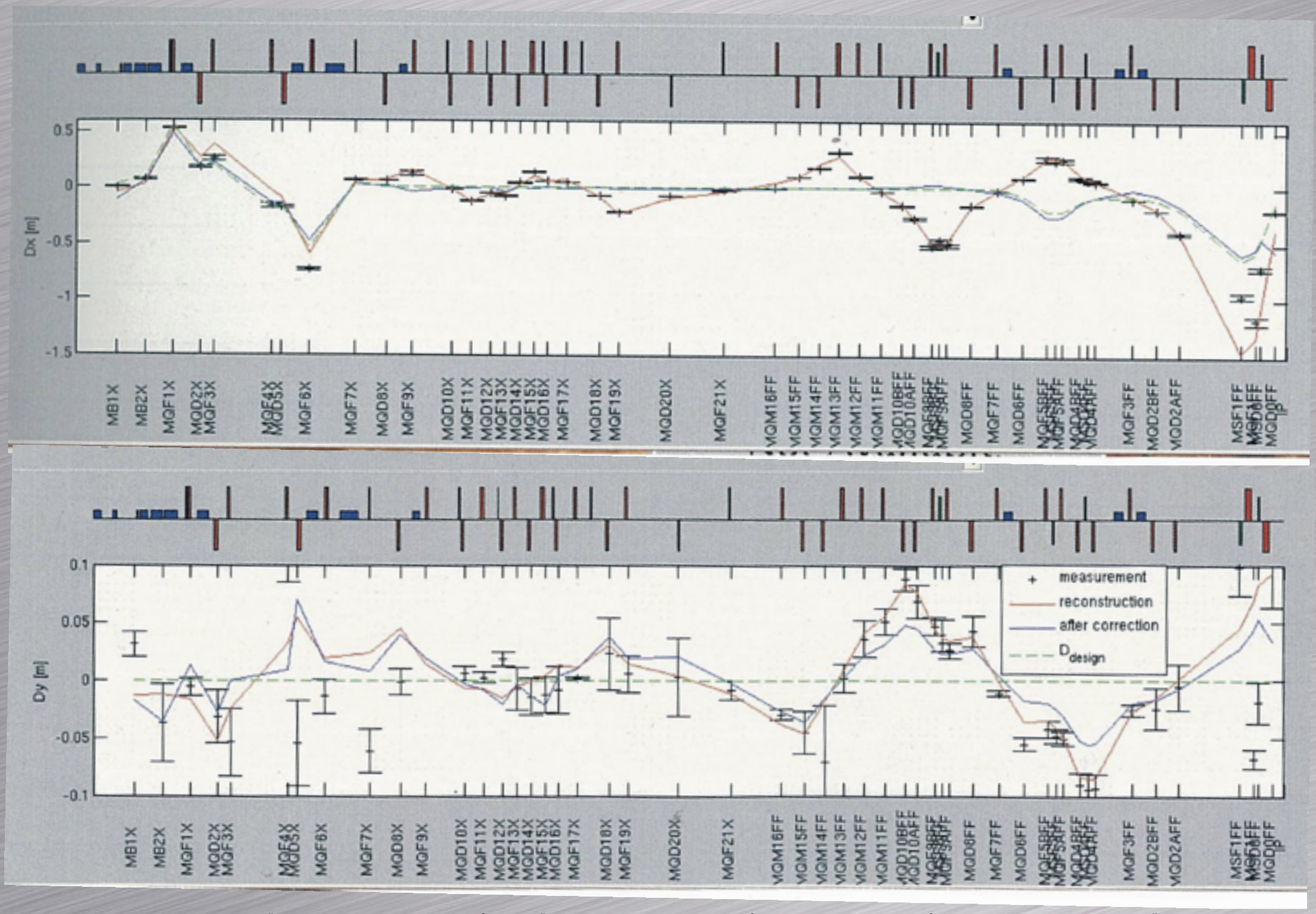


Online Dispersion Monitoring

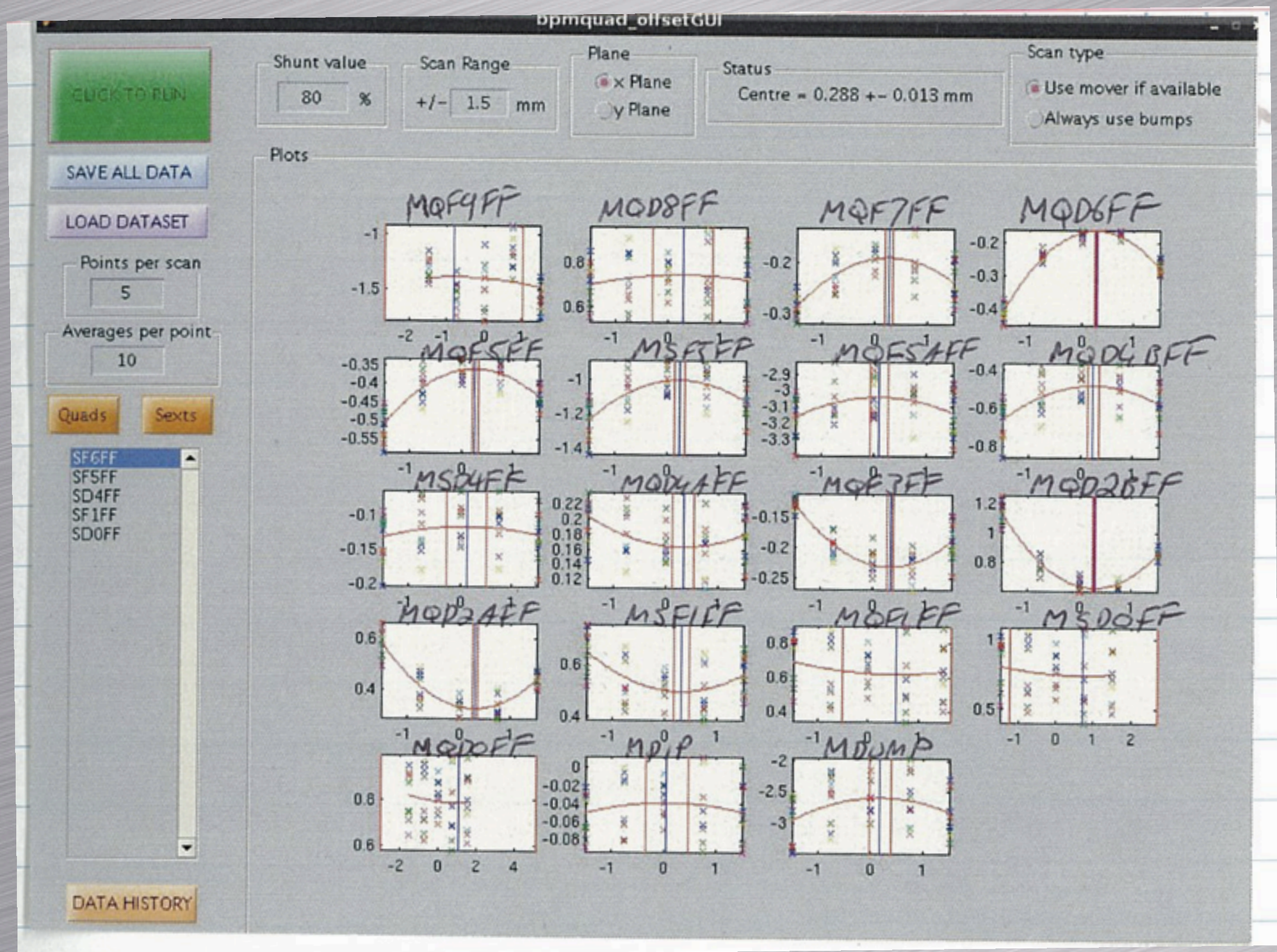


- Use SVD technique to fit dispersion function from BPM data.
- Monitor dispersion without the need for DR frequency ramp.

First attempt at FFS sextupole alignment

- Preparation for operation with FFS sextupoles turned on when going to lower IP beta functions next year.
- Set to max strength, move through beam and record parabolic downstream BPM responses
- SF6FF, SF5FF, SD4FF x & y ok, SF1FF x ok, SF1FF y and SD0FF x & y not possible
- Use IP wirescanner for SF1FF x and SD0FF x & y, but no time in last shift to try.

SF6FF Scan

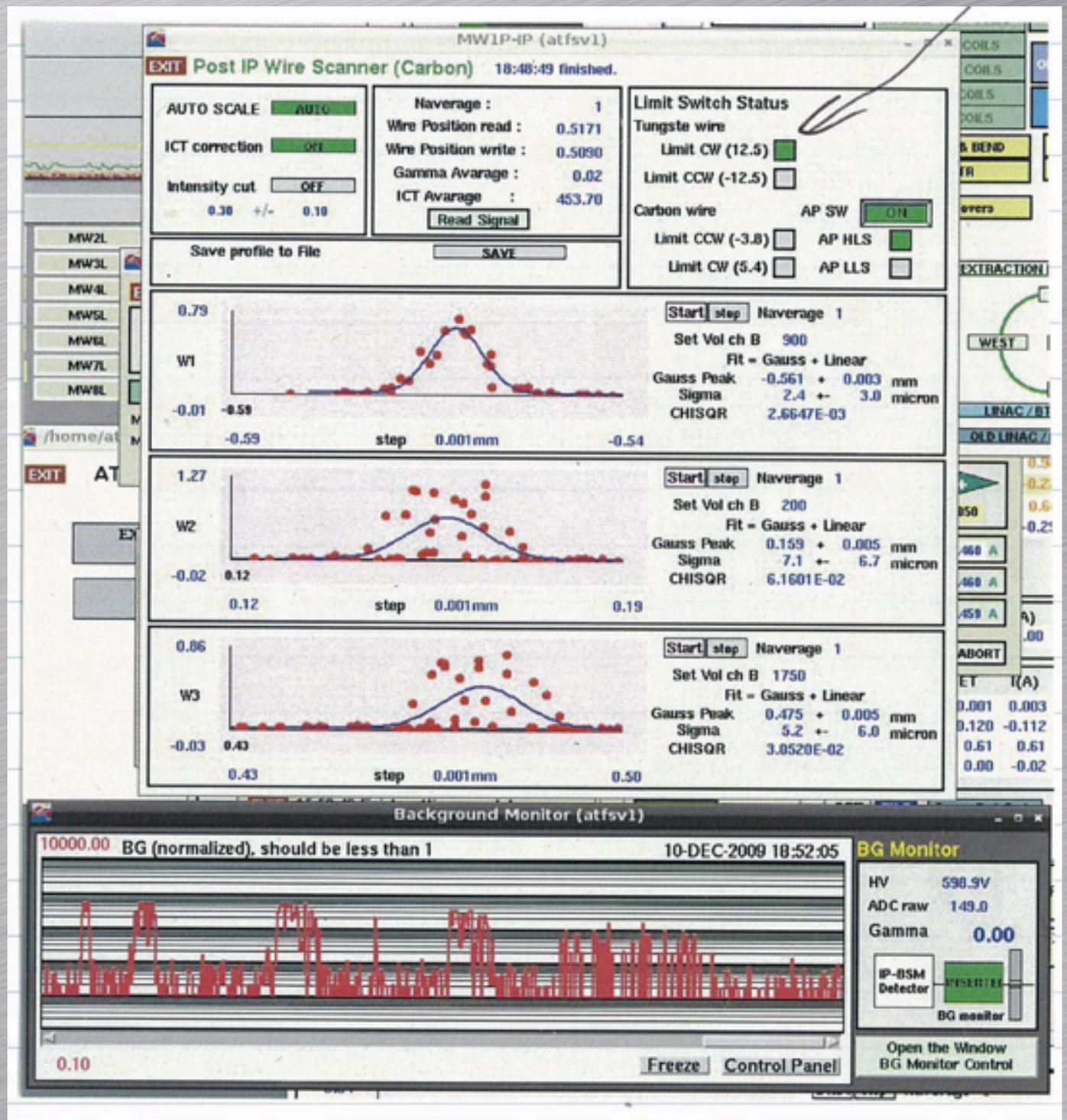

bpmquad_offsetGUI
CLICK TO RUN
SAVE ALL DATA
LOAD DATASET
Points per scan
5
Averages per point
10
Quads
Sexts
SF6FF
SF5FF
SD4FF
SF1FF
SD0FF
DATA HISTORY
Shunt value
80
%
Scan Range
+/-
1.5
mm
Plane
x Plane
y Plane
Status
Centre = 0.288 +- 0.013 mm
Scan type
Use mover if available
Always use bumps
Plots
MQF4FF
MQD8FF
MQF7FF
MQD6FF
MQF5FF
MSF3FF
MQE5AFF
MQD4BFF
MSD4FF
MQD4AFF
MQF3FF
MQD2BFF
MQD2AFF
MSF1FF
MQF1FF
MSDOFF
MQDOFF
MBPP
MBUMP

Measured Alignments

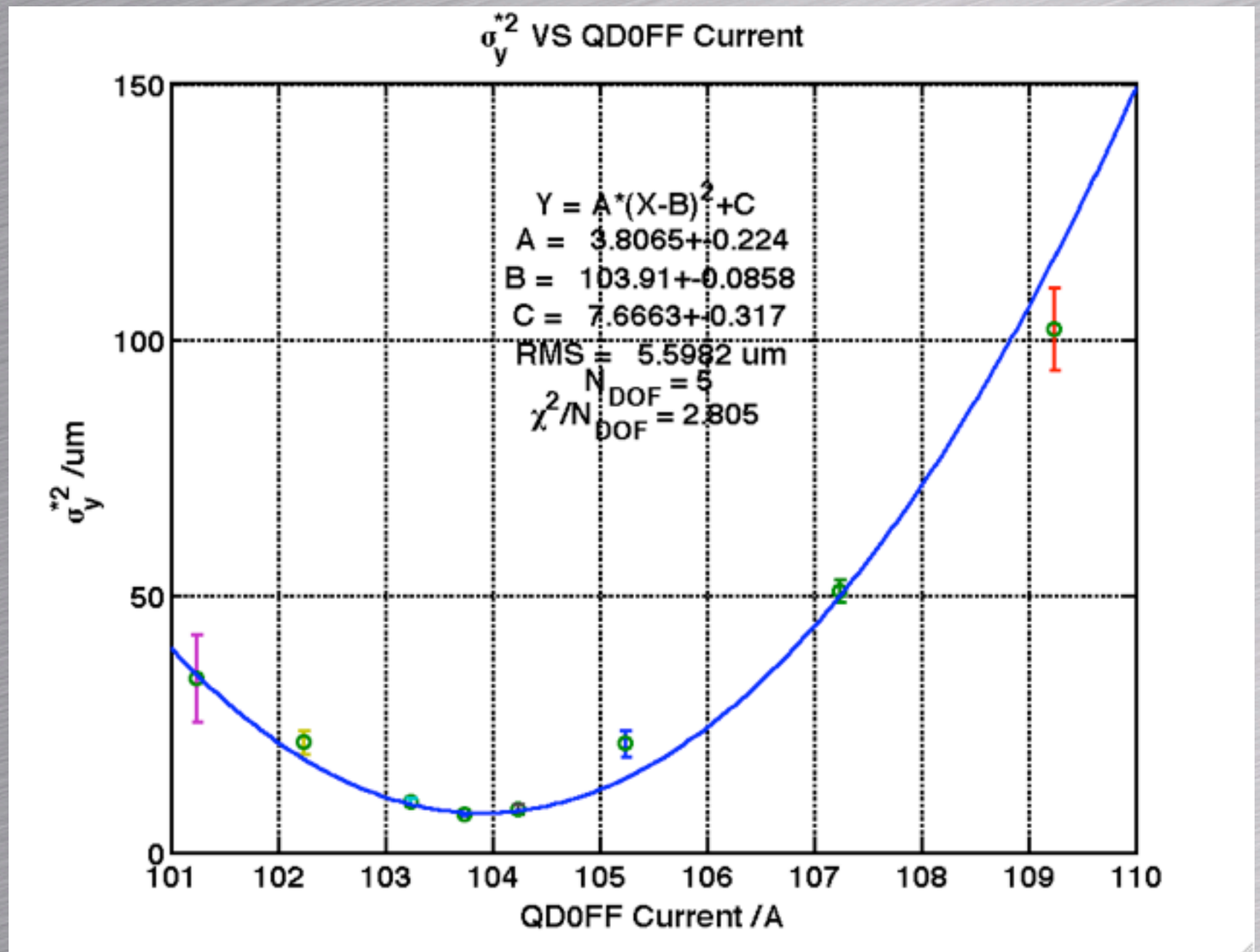
FFS Sextupole	Magnet -> Beam (mm)	Magnet -> BPM (mm)
SF6FF	0.29 +/- 0.01 (x) -0.106 +/- 0.02 (y)	1.75 +/- 0.16 (x) 0.604 +/- 0.034 (y)
SF5FF	-0.811 +/- 0.06 (x) 0.012 +/- 0.02 (y)	2.315 +/- 0.11 (x) 0.205 +/- 0.083 (y)
SD4FF	0.226 +/- 0.026 (x) 0.0729 +/- 0.034 (y)	0.395 +/- 0.038 (x) 0.375 +/- 0.029 (y)
SF1FF	0.537 +/- 0.159 (y)	0.42 +/- 0.16 (y)
SD0FF		

Found carbon wire scanner signal at MW1IP

- 3 wires found, optimal gain for IPBSM BK monitor 450-600 V
- 2 angle wires look very jittery, y wire ok 1um steps



IP Beam Scans with C Wirescaner



- After waist scan and QK1-4X skew quad scans for IP coupling minimisation, min beamsize = **1.48 +/- 0.61 um**
- Close to resolution limit of carbon wirescanner (1.25um)

Summary

- Most tools in place and tested for tuning
- Continue work to refine tools and speed up tuning process.
- Reached size limit of C wire, next step is to utilize IPBSM and start to explore <um tuning domain.