ATF2 Tuning Summary Nov & Dec 2010

Glen White, SLAC

11th ATF2 Project Meeting, SLAC

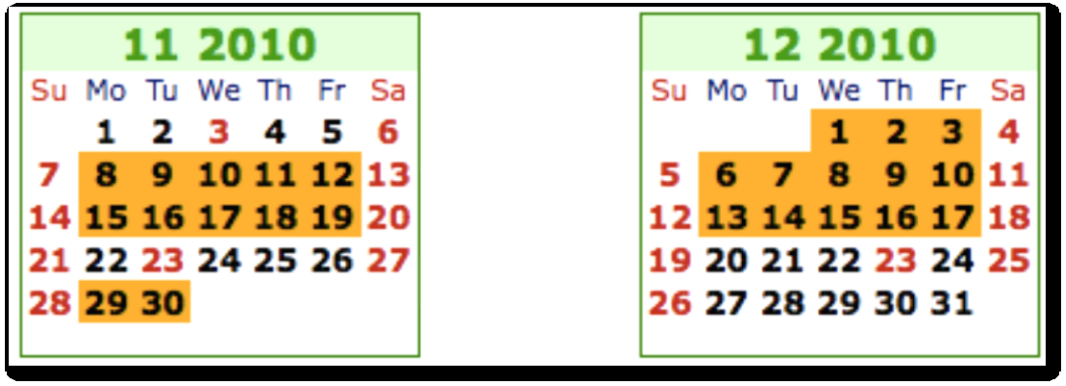
Jan 13 2011

New Optics

- To deal with multipoles, Edu performed non-linear rematching using “MAPCLASS”
  - **D. Wang cross-checked with SAD**
- Solution looked for with only 1 Sext rotated.
- Separate study done with SAD. Good agreement with MADX.
- During these runs, no sextupole tilt applied.
- Skew sextupoles sourced at KEK, will be installed for next running period.
- Questions raised about accuracy of multipole measurements from IHEP, it is critical these are good for this rematching to work.

Sext	Tilt[mrad] σ_y [nm] (MADX MADX)
No tilt	97.4
SD0FF	1.6 70.5
SF1FF	-2.15 68.9
SD4FF	-4.2 60.8
SF5FF	11.0 49.8
SF6FF	4.74 59.6

ATF2 Tuning Shifts Winter 2010



11 2010

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

12 2010

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

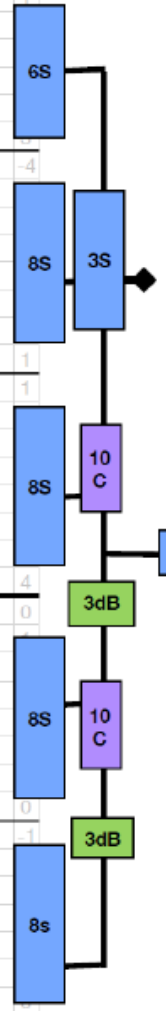
- 5 Weeks of shifts available for ATF2 tuning since spring/summer run
- ~6 shifts per week weeks 1-4 + 1 week dedicated run week 5.

Week 1

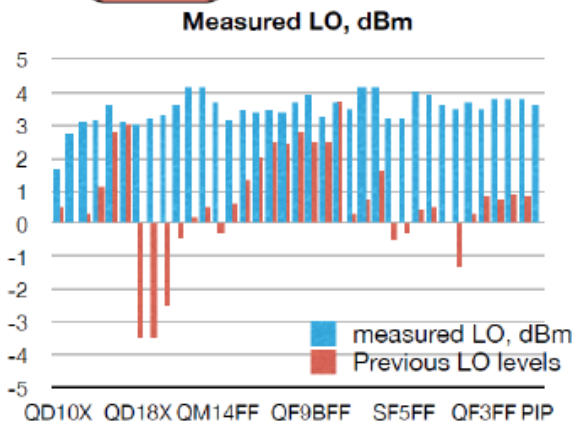
- Cavity BPM RF distribution improvements and calibration
- IPBPM setup
  - 3 new c-band cav bpms – MPREIP, IPBPMA, IPBPMB
  - Using SLAC electronics + standard RHUL readout scheme
- 1cm/0.1mm $\beta_{x/y}$ ATF2 optics loaded with multipole-correction tuned optics
  - Orbit establishment/steering etc for low IPBSM backgrounds.
  - Backgrounds look good for IPBSM operation.
- Online model and lattice checkout
- OTR software development and installation of new Aluminium & Aluminised Kapton targets.

C-Band BPM LO Distribution Improved

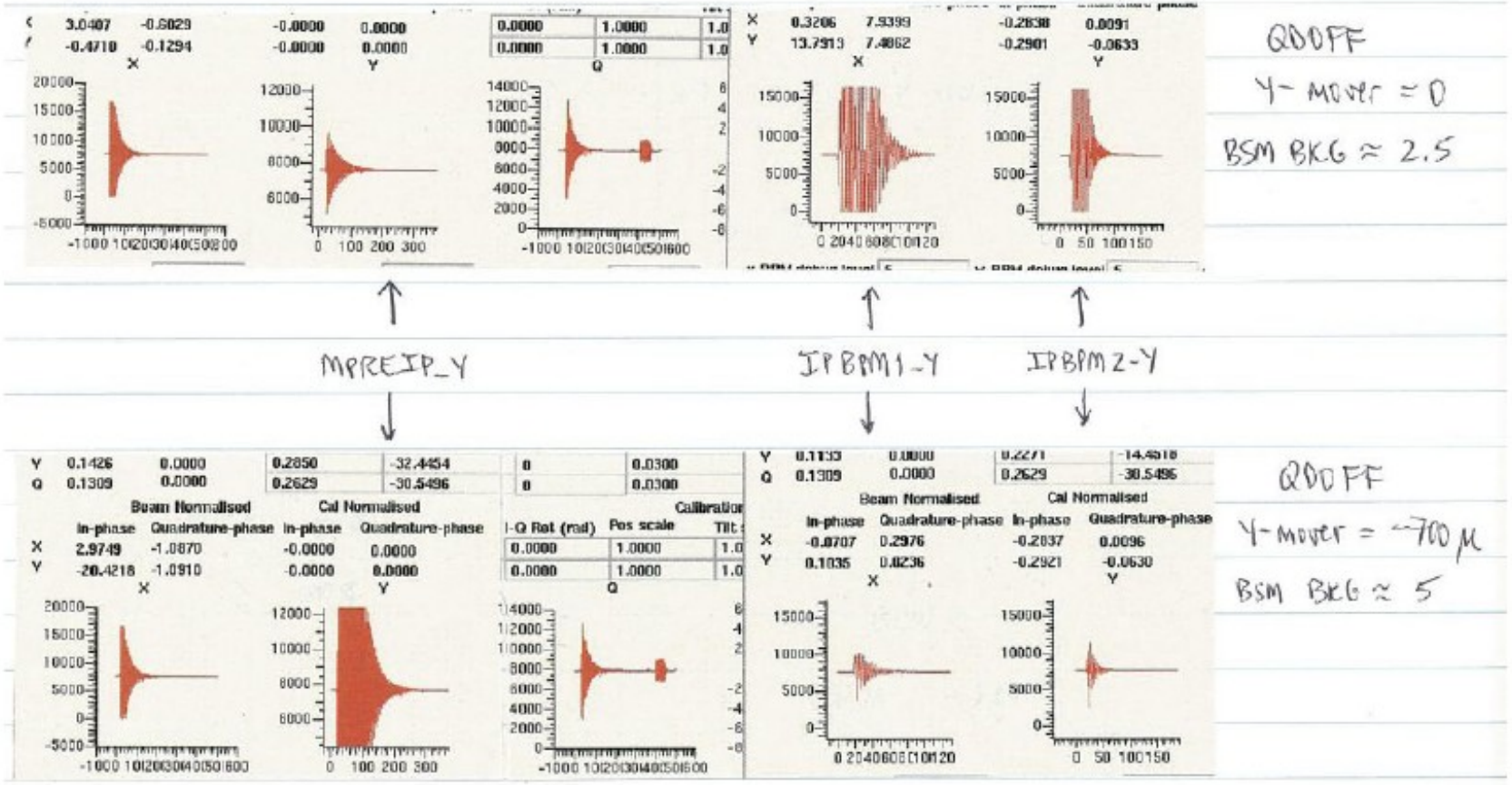
	est losses from hardware*	added atten at box	measured LO, dBm
QD10X	17.85	0	1.65
QF11X	17.85	0	2.71
QD12X	17.85	0	3.08
QD16X	17.85	1	3.12
QF17X	17.85	2	3.62
REF1X	17.85	3	3.07
QD18X	19.15	2	3.02
QF19X	19.15	2	3.21
QD20X	19.15	3	3.33
QD21x	19.15	5	3.62
QM16FF	19.15	6	4.15
QM15FF	19.15	6	4.17
QM14FF	19.15	6	3.67
QM13FF	19.15	6	3.16
QM12FF	24	4	3.42
QM11FF	24	5	3.37
QD10BFF	24	5	3.44
REF3FF	24	5	3.37
QD10AFF	24	5	3.66
QF9BFF	24	5	3.9
SF6FF	24	6	3.24
QF9AFF	24	6	3.69
QD8FF	27	0	3.48
QF7FF	27	0	4.12
QD6FF	27	1	4.13
QF5BFF	27	0	3.18
SF5FF	27	0	3.2
QF5AFF	27	0	4.01
REF2FF	27	0	3.9
QD4BFF	27	0	3.59
SD4FF	19.75	2	3.5
QD4AFF	19.75	1	3.67
QF3FF	19.75	4	3.52
REF1FF	19.75	4	3.79
QD2BFF	19.75	4	3.81
QD2AFF	19.75	4	3.8
PIP	19.75	0	3.62

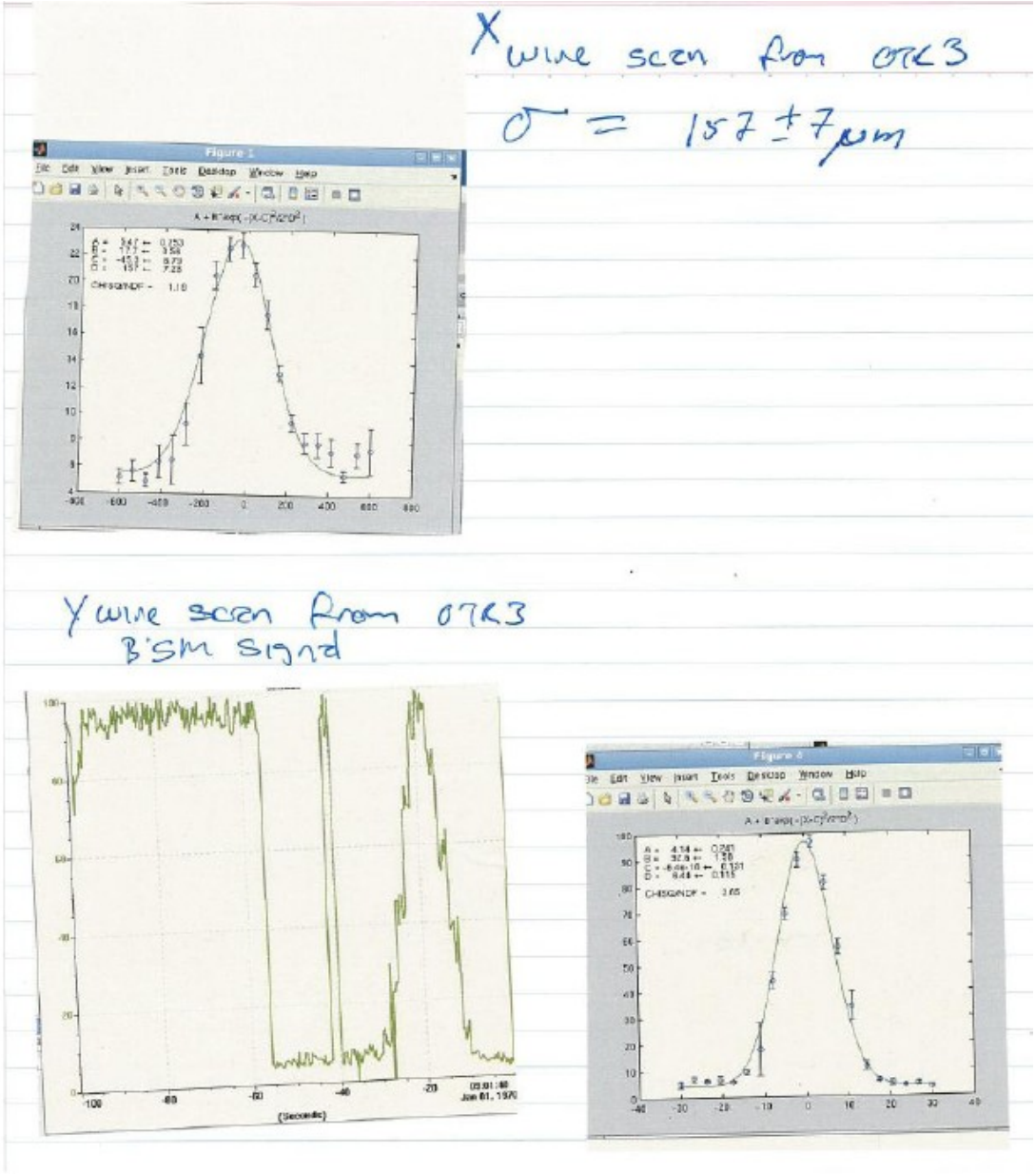


hardware*	call it	IL + split
10dB coupler	10C	10.25
8-way pulsar	8S	10.5
6 way splitter	6S	9.2
3-way pulsar	3S	5.4
2-way pulsar	2S	3.25
3 dB atten	3A	3
*not including cable losses		



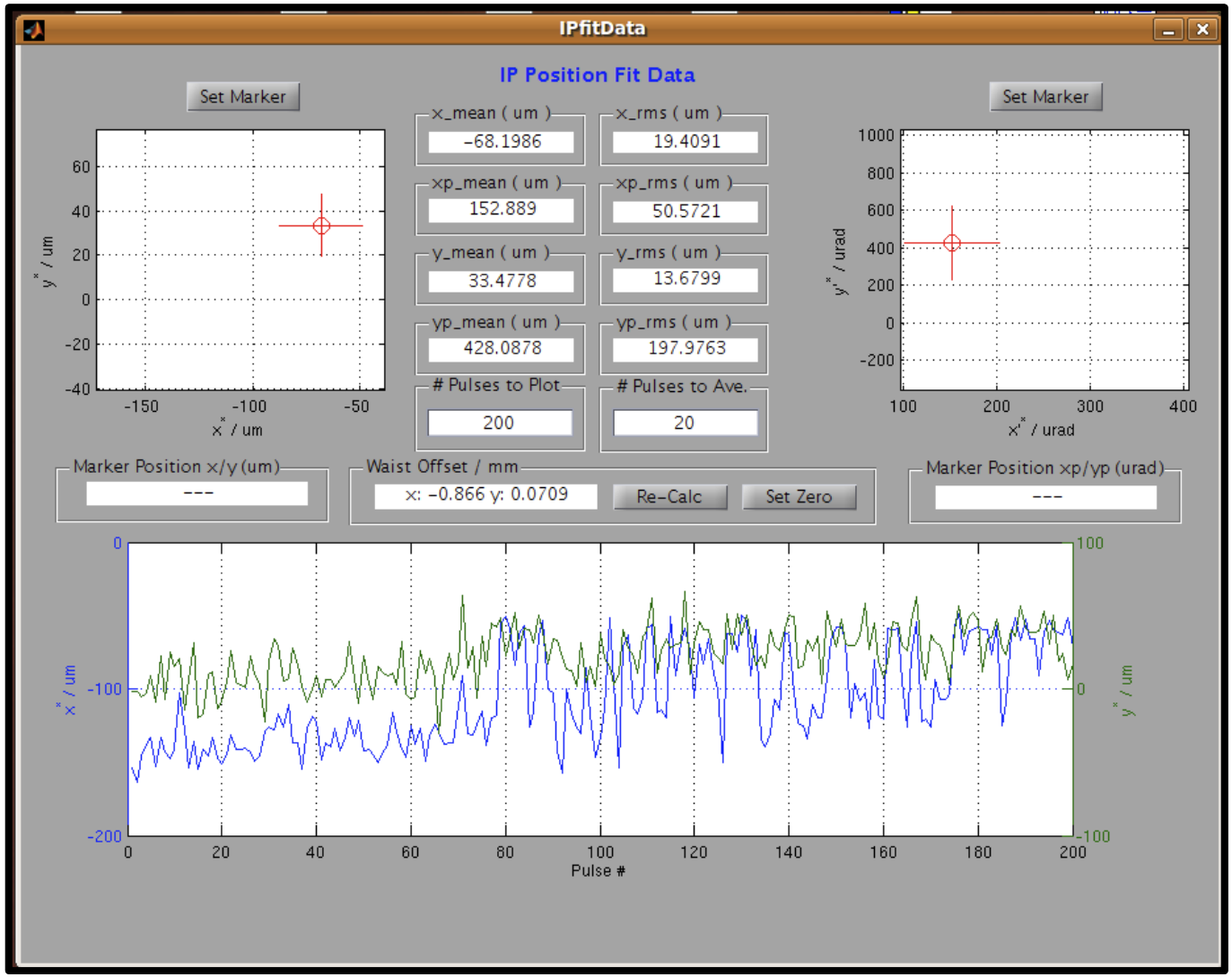
Steering Through IPBPM System





OTR Wire-scans

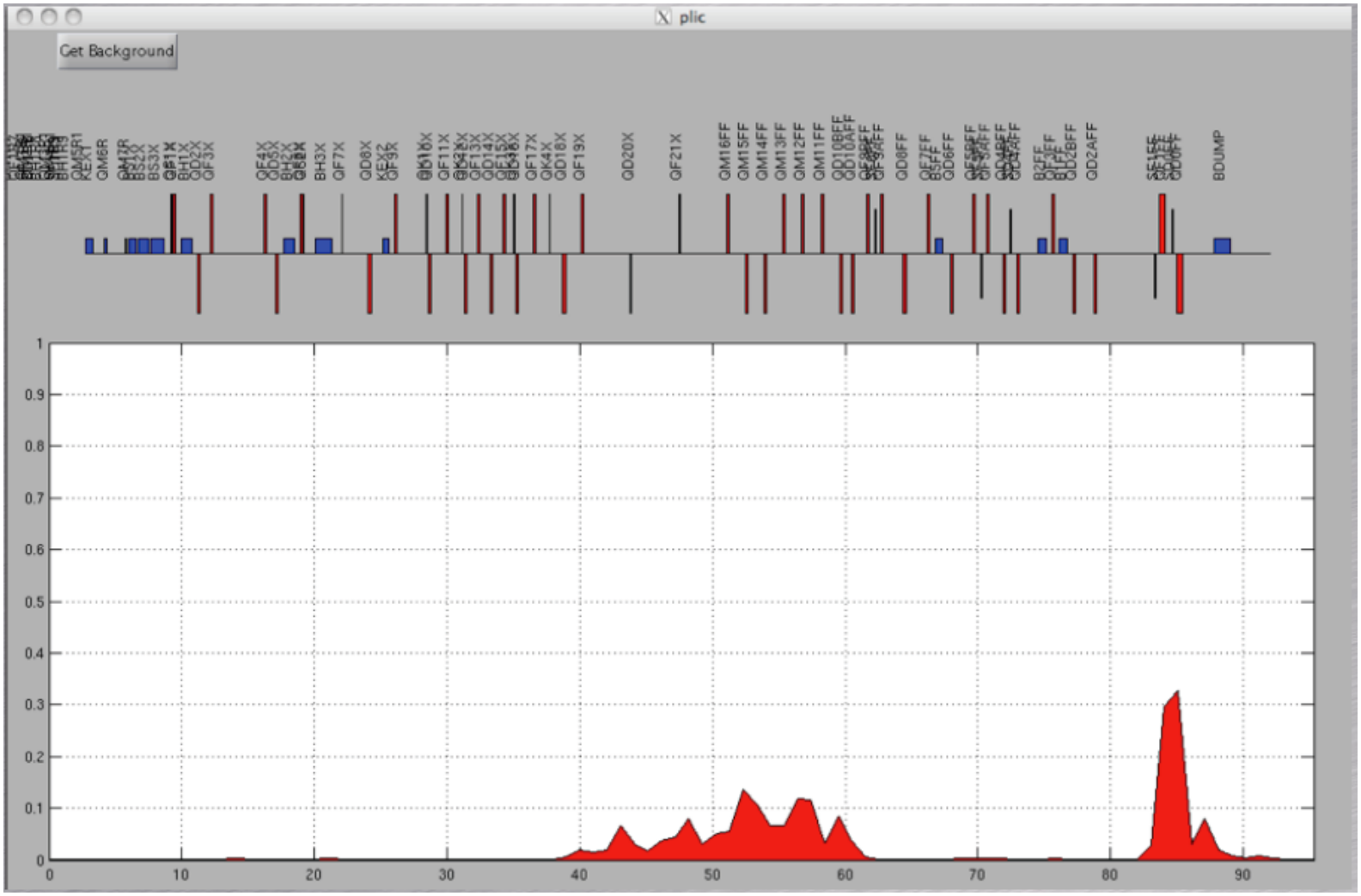
IP Position Reconstruction for Maintaining Orbit at IPBSM



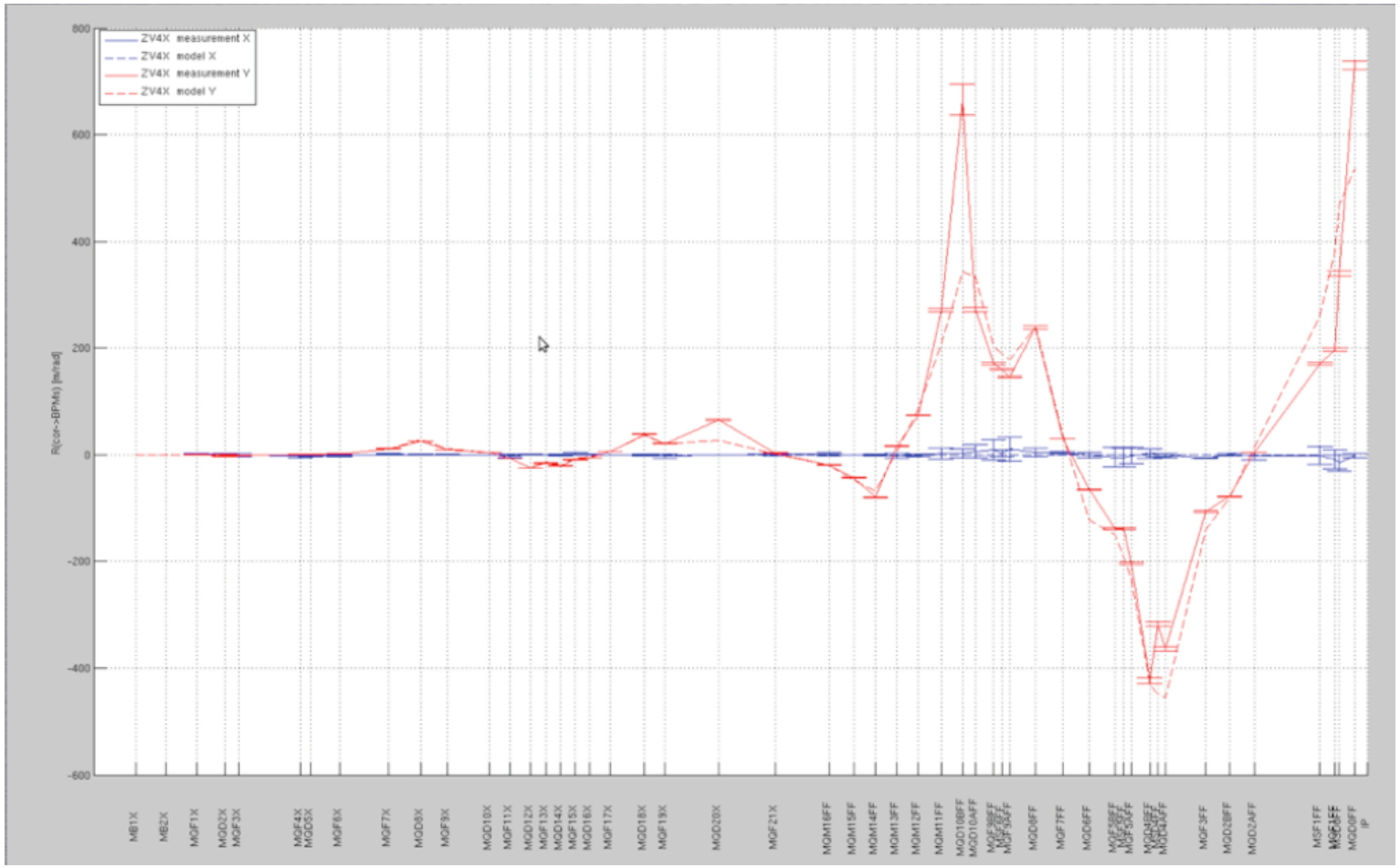
Week 2

- MPREIP / IPBPM calibration using FFS movers
- C-band BPM system looks stable from previous week, S-band BPM calibration and operation now looks good, except when operate DR frequency ramp
- Digitisation of PLIC signal
- EXT dispersion correction successful, discovered BBA in QF1X-QF6X essential to proper functioning of correction system.

Digital PLIC Display

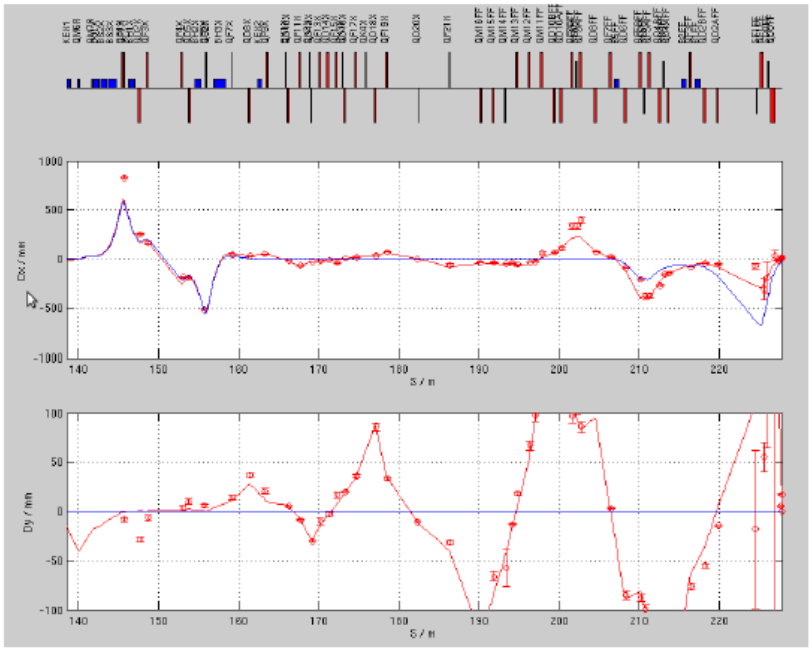


BPM-Model Response



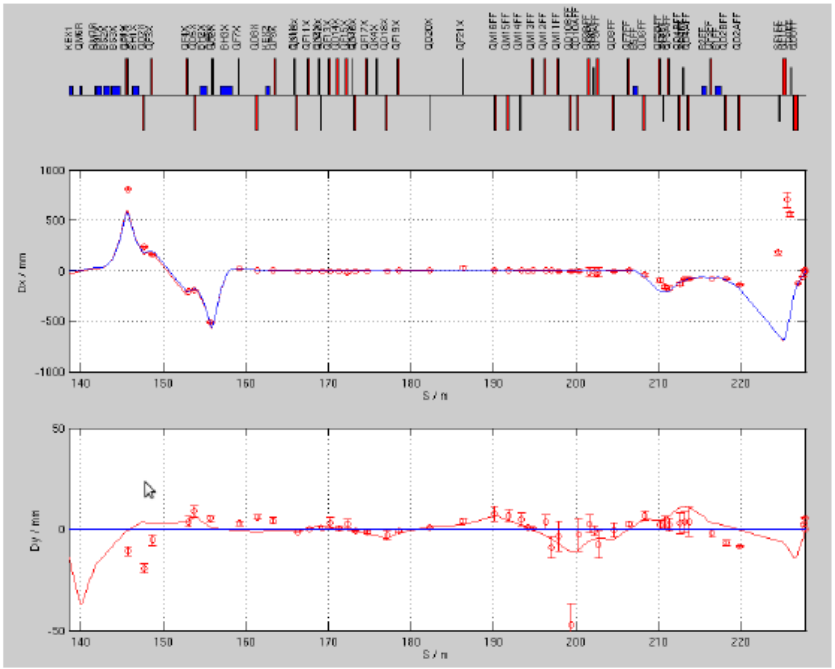
Dispersion Correction

Before Correction



Fitted dispersion values for BEAMLINE element 1923 (IP):
eta x = 6.84 +- 0.134 mm
eta x' = 64.5 +- 2.02 mrad
eta y = 0.405 +- 0.00726 mm
eta y' = -236 +- 3.78 mrad

After Correction



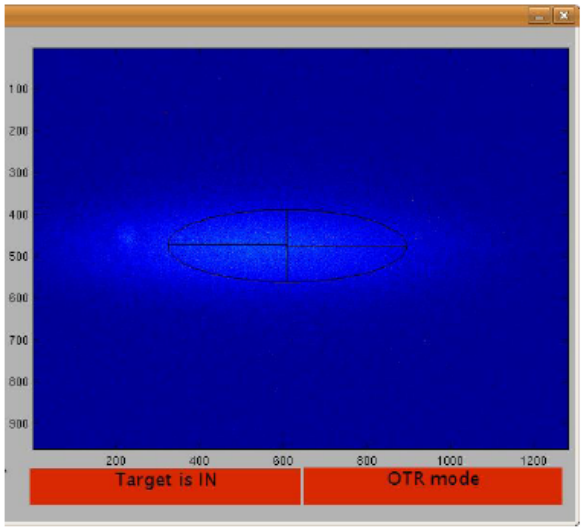
Fitted dispersion values for BEAMLINE element 1923 (IP):
eta x = 0.487 +- 0.152 mm
eta x' = 140 +- 2.31 mrad
eta y = -0.0163 +- 0.00544 mm
eta y' = 12.6 +- 1.93 mrad

Week 3

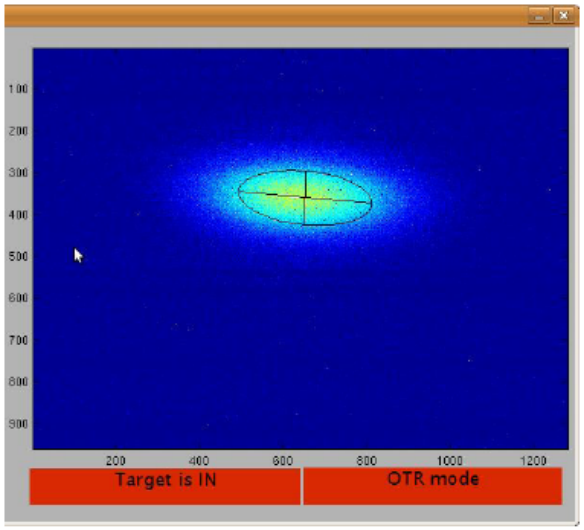
- IPBPM mechanical alignment
- Vertical emittance measurement and correction
  - 2nm * 40 pm emittance measured in EXT
- IP Carbon wire used
  - ~15um * 2-3um measured
- OTR measurements
  - Only 3 OTRs available- OTR1X removed due to vacuum leak (fixed and re-installed Fri).
  - Vertical axes calibrated.
- Failed to get any signal with IPBSM
  - Suspect bad signal:bkg, request relaxed IP beta configuration again for better signal
- BBA
  - Quads BBA using mixture of screens and BPM system
  - Sextupoles much harder due to large x jitter

OTR y Scale Calibration

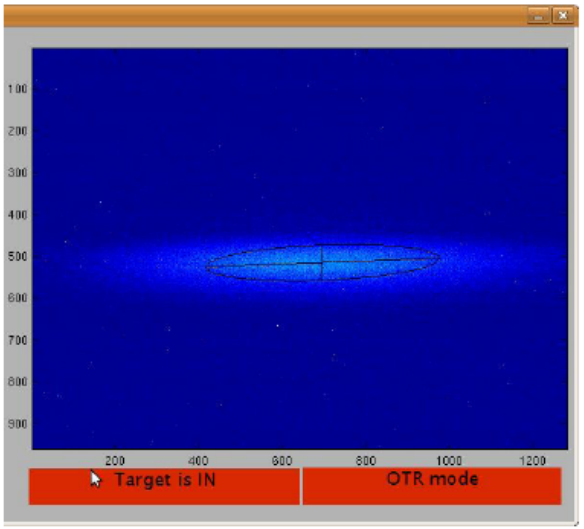
OTR0X

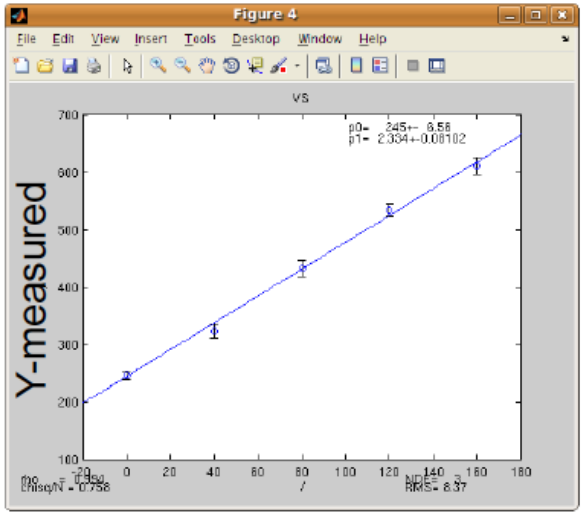


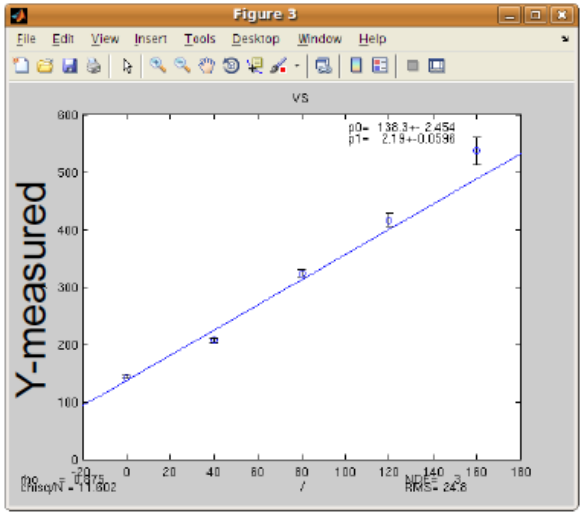
OTR2X

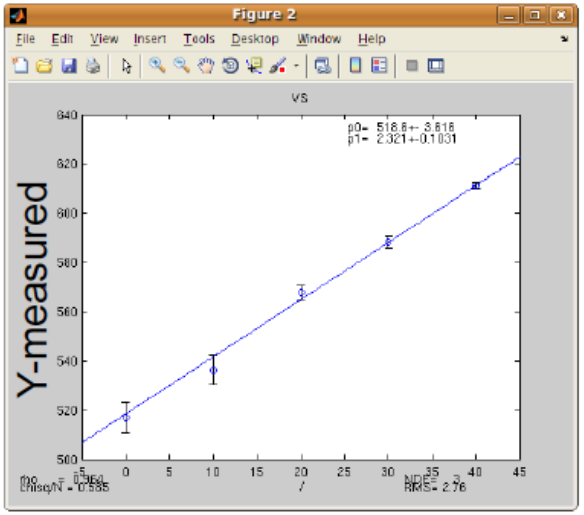


OTR3X



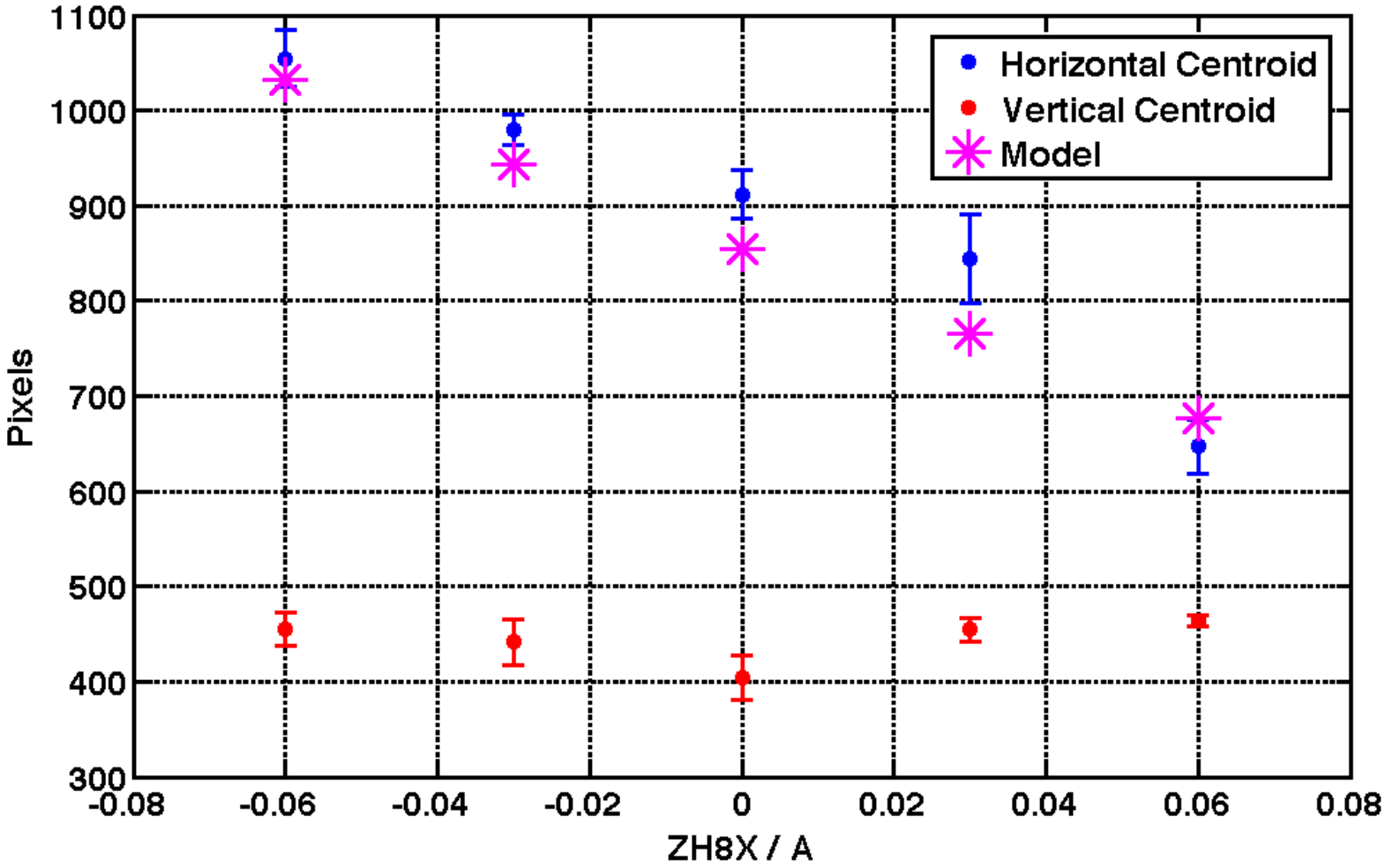




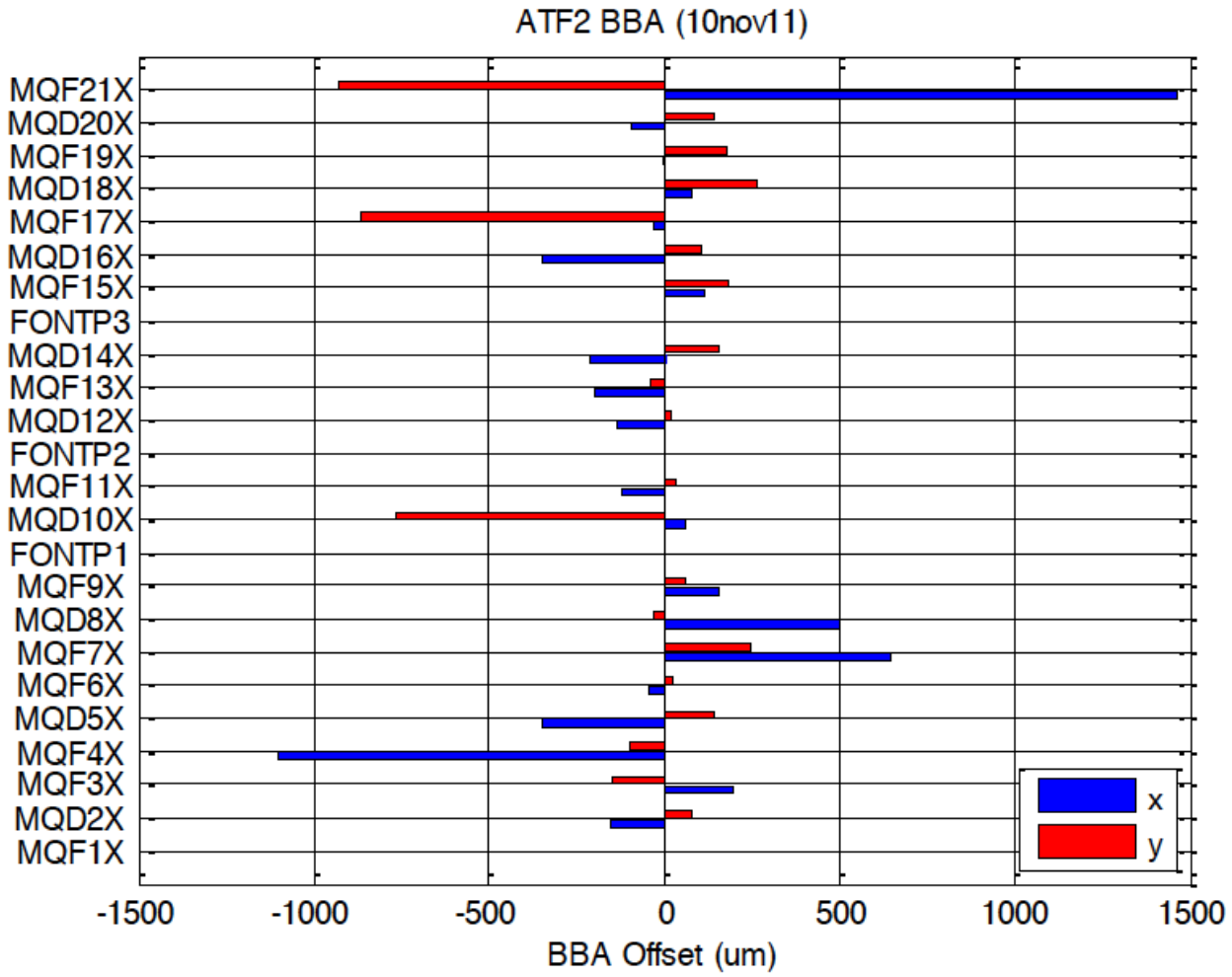


OTR Y-mover Position (μm)

Test Calibration and Roll Alignment of OTR0X



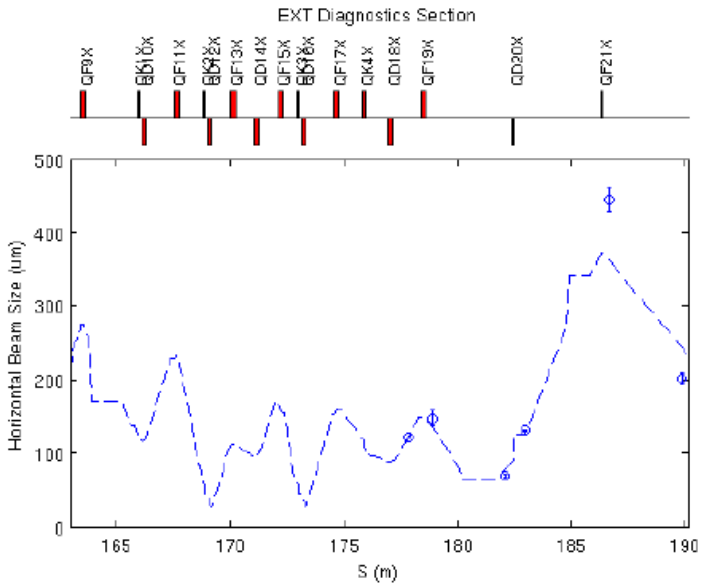
BBA of EXT/FFS Magnets -> BPM Readout Centres

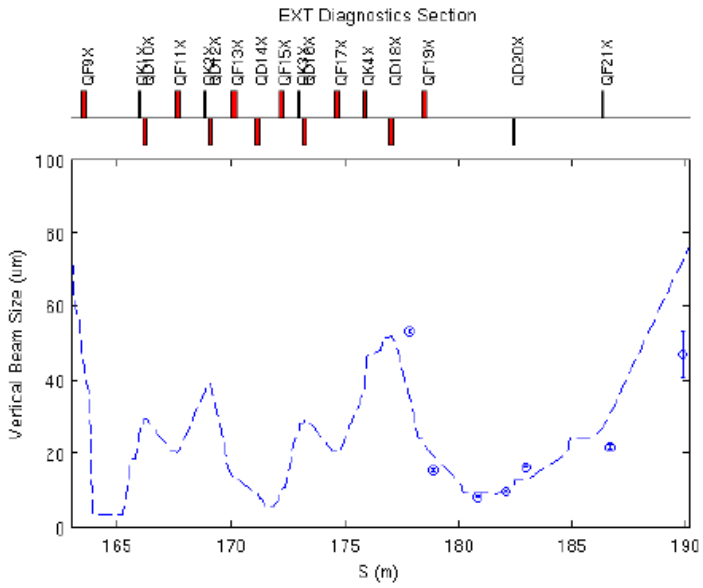


Week 4

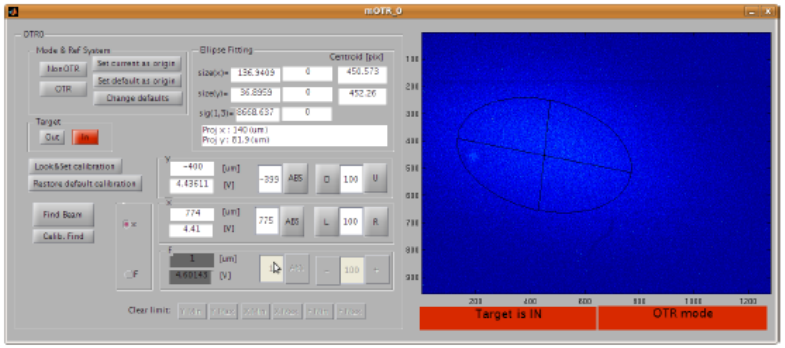
- Joint ATF2, laserwire study
  - Laserwire EXT optics with ~1um beam waist at laserwire location matched into 1cm * 1mm IP beta optics (relaxed vertical focusing for better IPBSM backgrounds)
- Emittance measurements with wirescanners + laserwire + OTRs (3 OTRs, OTR1X signal not found).
- IPBSM signal found
- Coupling correction with OTRs
  - Minimum vertical emittance ~30pm (~12pm measured in the DR).

EXT Beamsize Measurements (OTRs, laserwire and wirescanners)

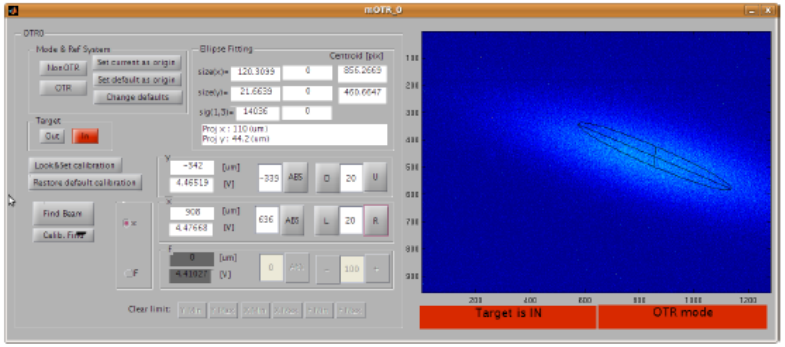




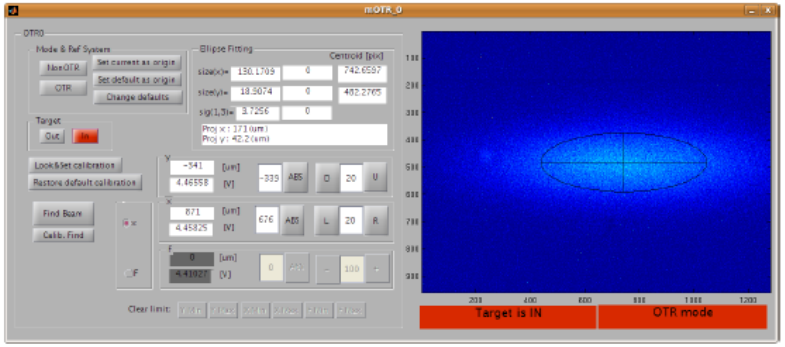
Coupling Correction With OTRs



OTR0X before corrections



OTR0X after dispersion correction



OTR0X after coupling correction

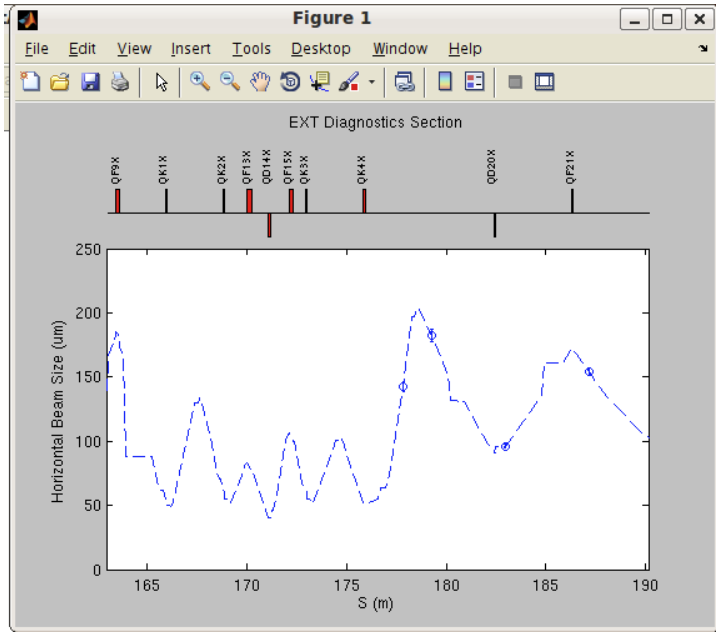
Week 5

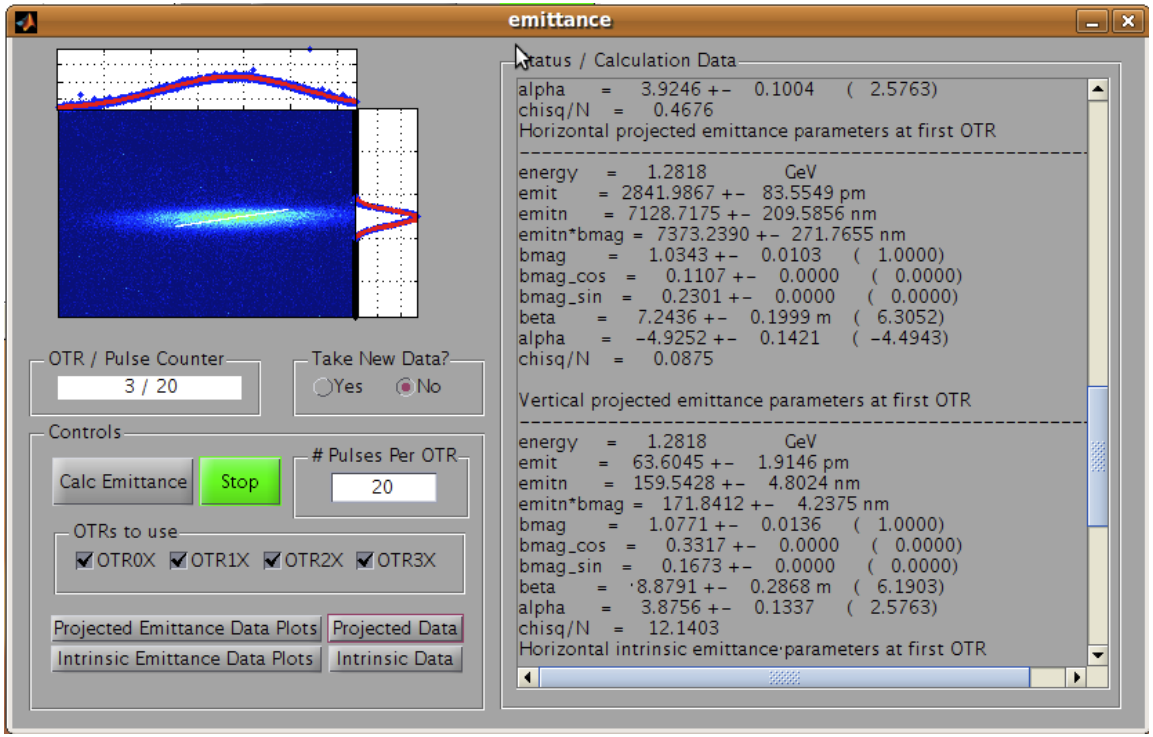
- Continuous ATF2 tuning study week
  - Back to 0.1mm beta_y optics
- Full emittance vs. QK1-4X scan with OTRs
  - Actually scan normalised emittance * BMAGY
- All 4 OTRs now operational and automated emittance calculation software working
  - Emit_x/y ~1.7nm/34pm (14pm in DR)
  - Multiple measurements show good stability for measurement system and plausible error estimates
- BBA for SF6/SF5/SD4, not possible for SF1/SD0 (12A limit compared with 50A for others)
- Steering correction in EXT & FFS now works well with fully calibrated BPM system
- Problems seen with 2 movers for matching quads, x/y movement seems to be largely coupled.
  - Check out next visit.
- IP C wire cut whilst scanning ~<2um
- IPBSM vertical inteference mode found
- From waist scans, appear well beta-matched at IP
- Using usual set of IP multiknobs, beam brought to 368nm using 2 & 6 degree modes of IPBSM operation.
- Failed to get IPBSM working in 30 degree mode to further reduce beam size

Cont. Tuning Week Summary

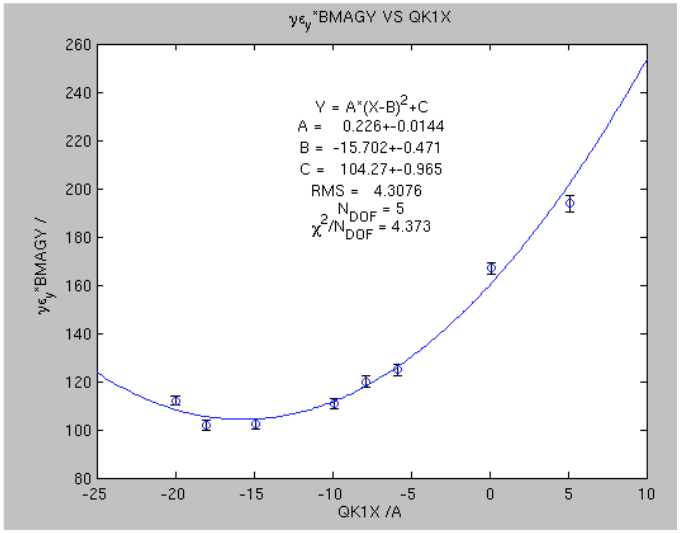
Monday	•DR setup + tune (ε_y = 14pm) •mOTR setup, tuning (ε_y<34 pm EXT, 27pm MW) •EXT Emit meas + cor •EXT Disp meas + cor
Tuesday	•IP C wire measurements •Sext BBA •BPM checks + diagnostics •IP σ_y < 2um
Wednesday	•IPBSM 2 degree mode •Start σ_y = **1.8 um** •<x'y> scan, σ_y = **1.3um** •IPBSM 6 degree mode •σ_y = **1.0 um** •<x'y> scan, σ_y = **804 +/- 133 nm** •Waist_y scan, σ_y = **720 +/- 53 nm**
Thursday	•IPBSM tune, σ_y = **612 +/- 103 nm** •+ 4 hours, σ_y = 482,394,594,498 = **492 +/- 82 nm** •<xy> scan σ_y = 327,401,375 = **368 +/- 38 nm**

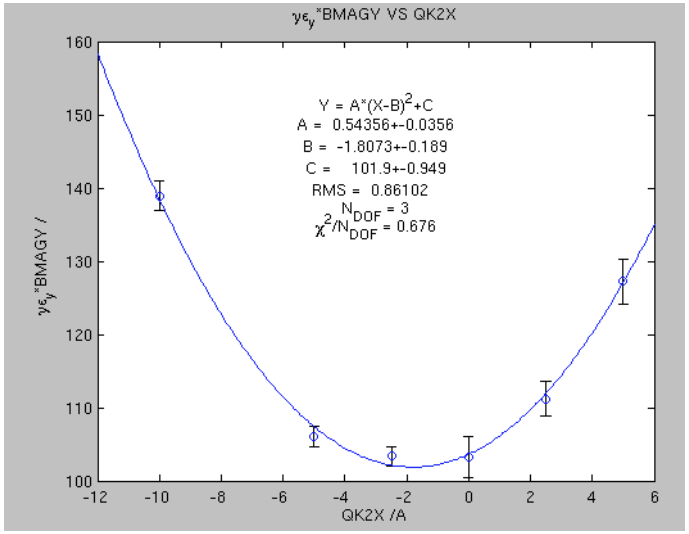
Auto Emittance Measurement Controls

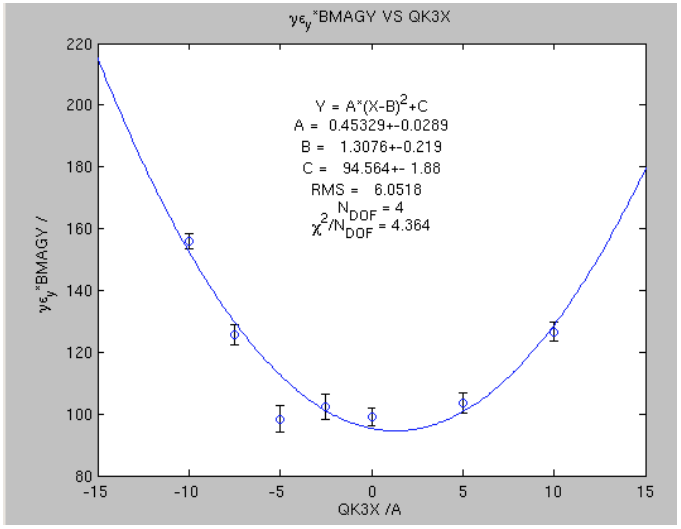


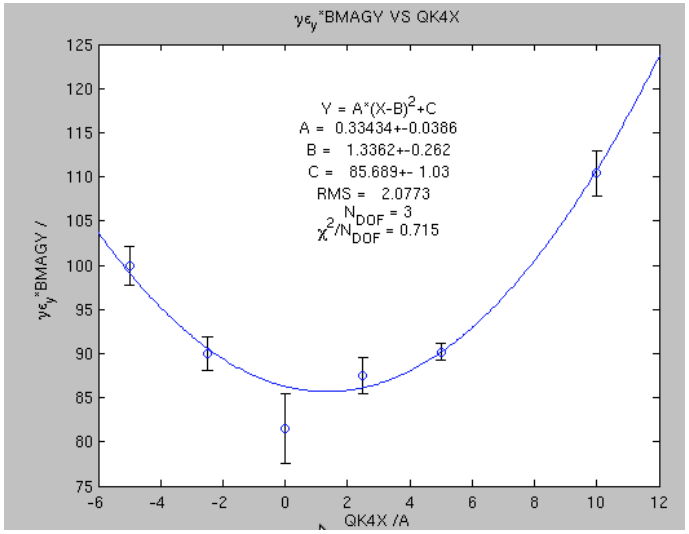


OTR Coupling Correction

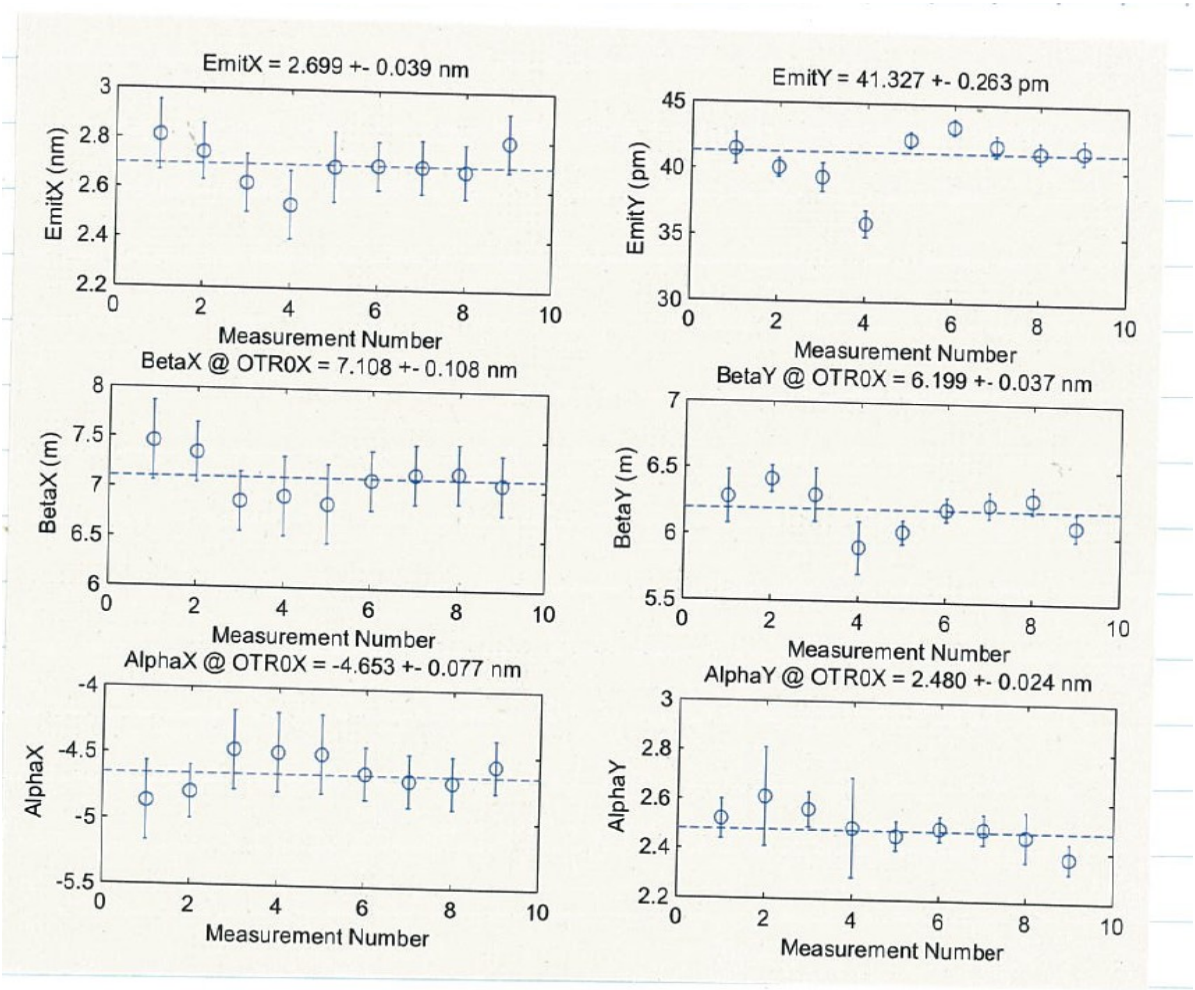




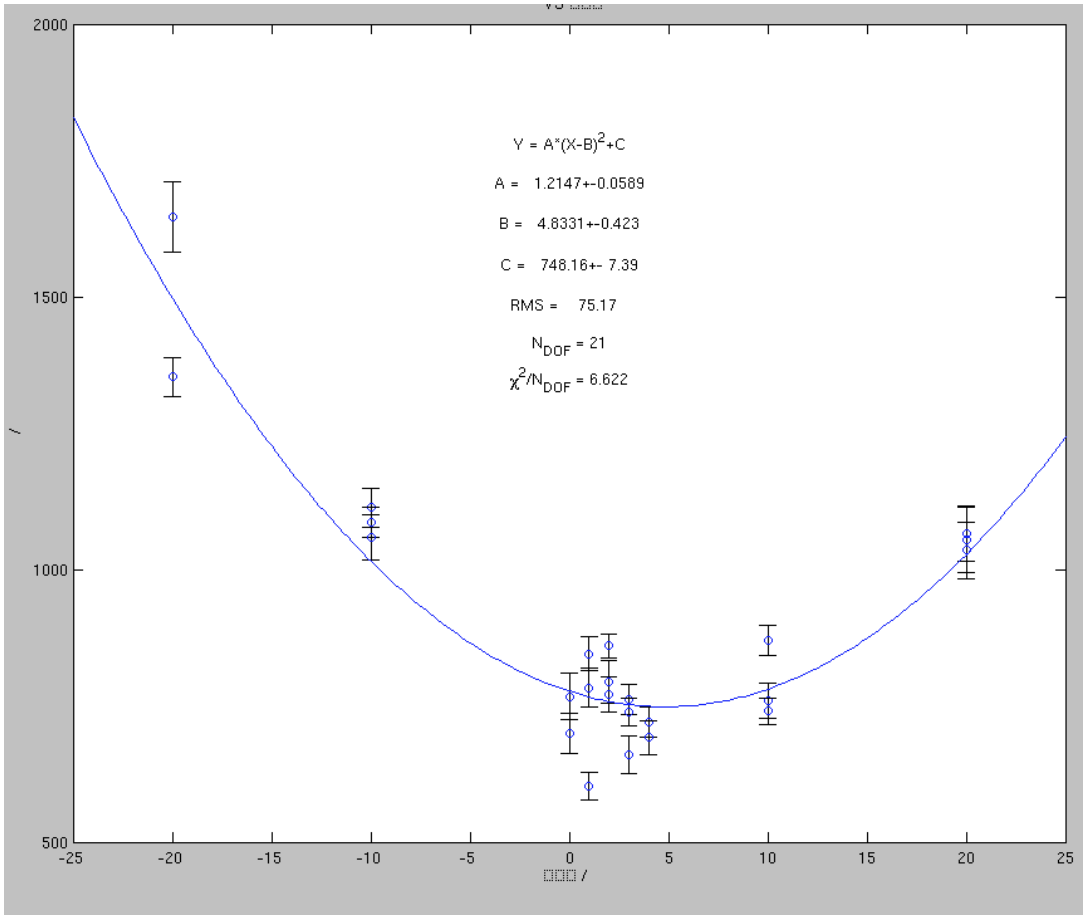


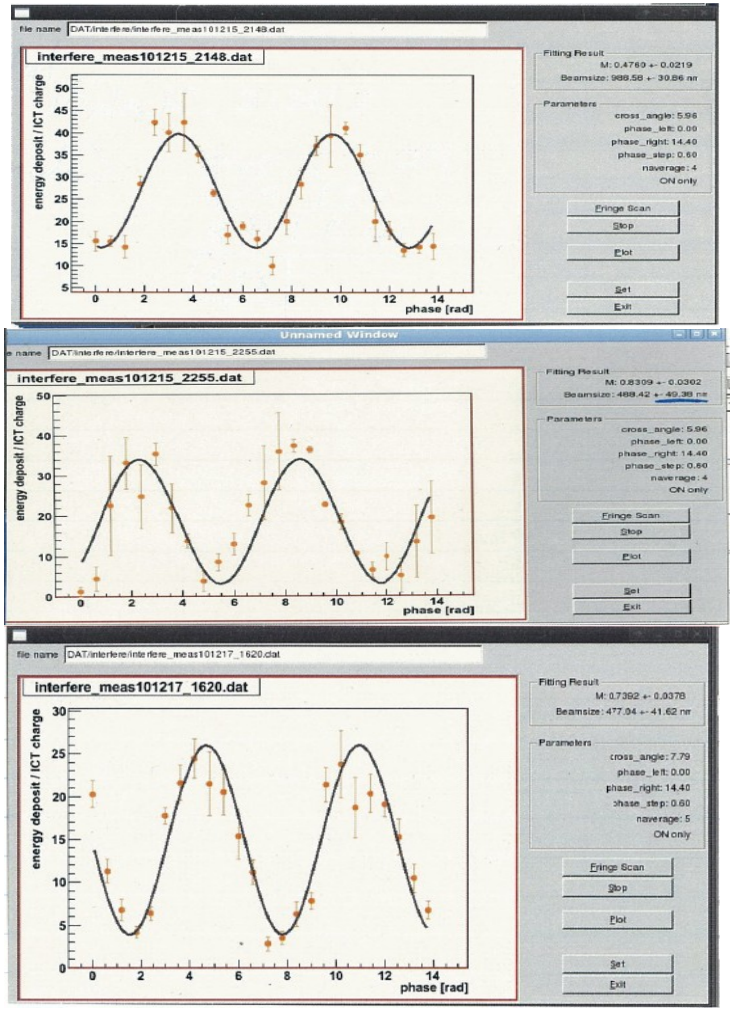


OTR Measurement Stability

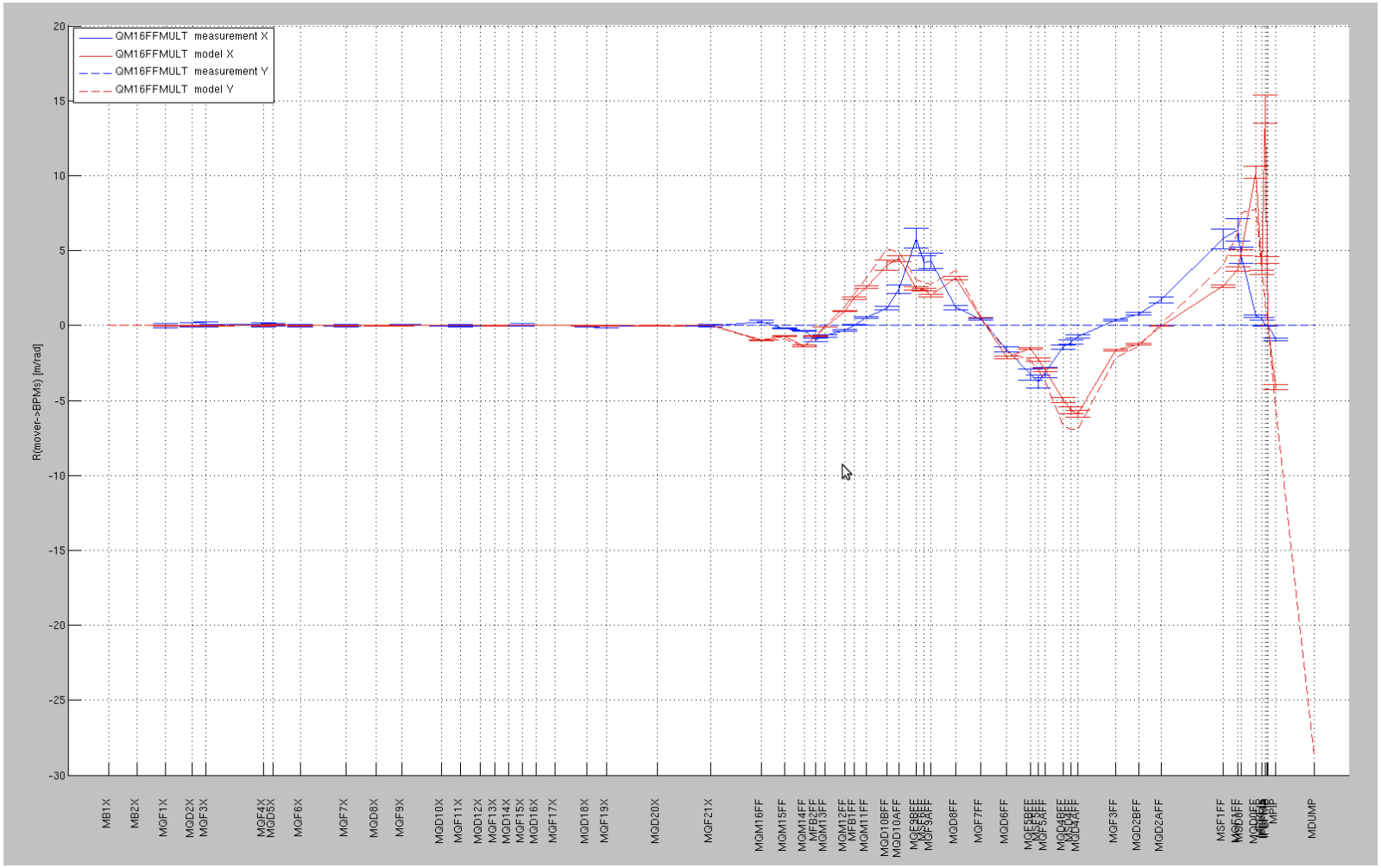


IPBSM Scans (alpha_y)

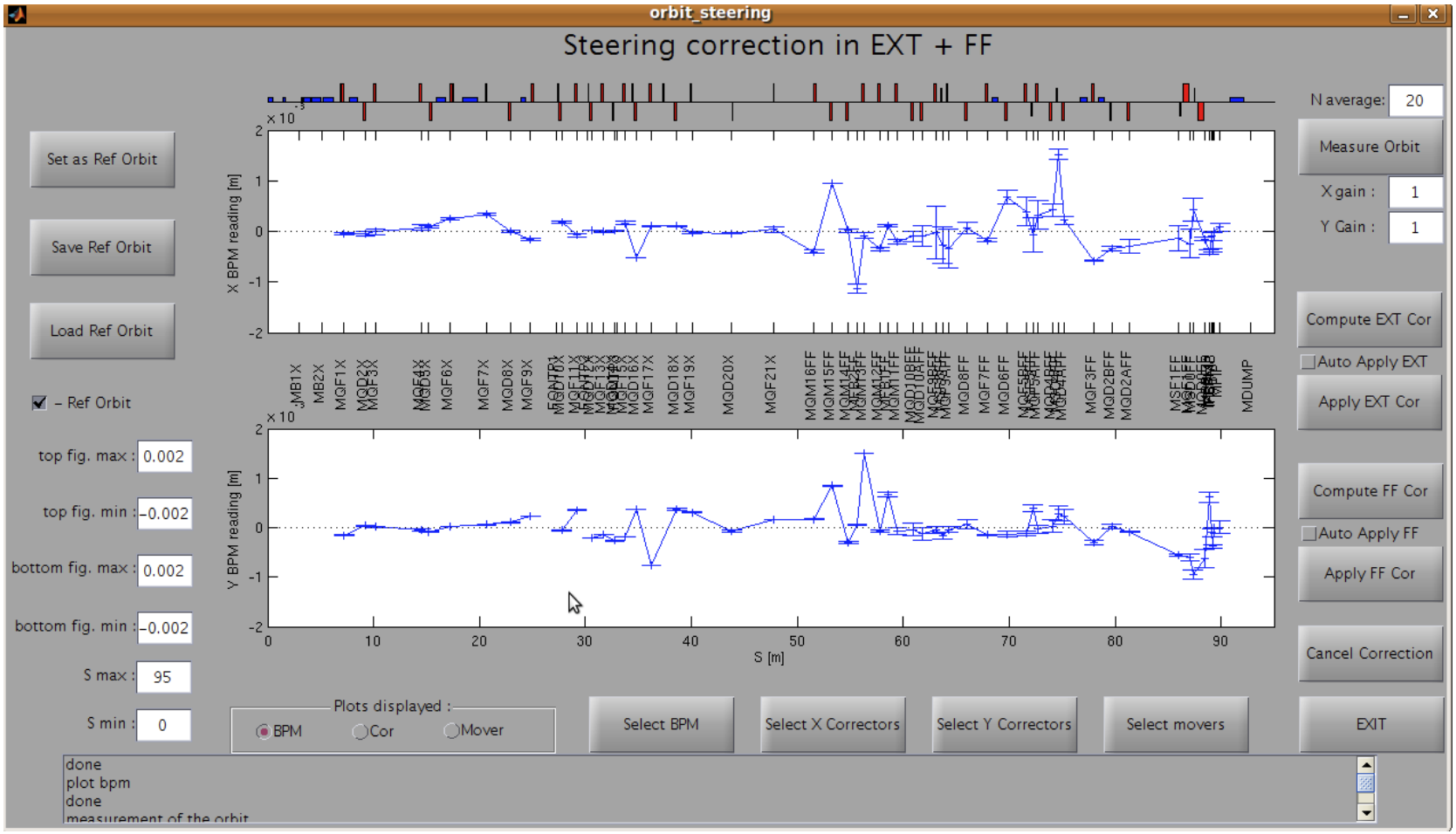




Coupled Motion Seen With AQM16FF



Steering


orbit_steering
Steering correction in EXT + FF
N average: 20
Measure Orbit
X gain : 1
Y Gain : 1
Set as Ref Orbit
Save Ref Orbit
Load Ref Orbit
Compute EXT Cor
Auto Apply EXT
Apply EXT Cor
Compute FF Cor
Auto Apply FF
Apply FF Cor
Cancel Correction
EXIT
– Ref Orbit
top fig. max : 0.002
top fig. min : -0.002
bottom fig. max : 0.002
bottom fig. min : -0.002
S max : 95
S min : 0
Plots displayed :
BPM
Cor
Mover
Select BPM
Select X Correctors
Select Y Correctors
Select movers
X BPM reading [m]
Y BPM reading [m]
S [m]
done
plot bpm
done
measurement of the orbit