ATF2 IP Beam Tuning Status

Glen White (SLAC)

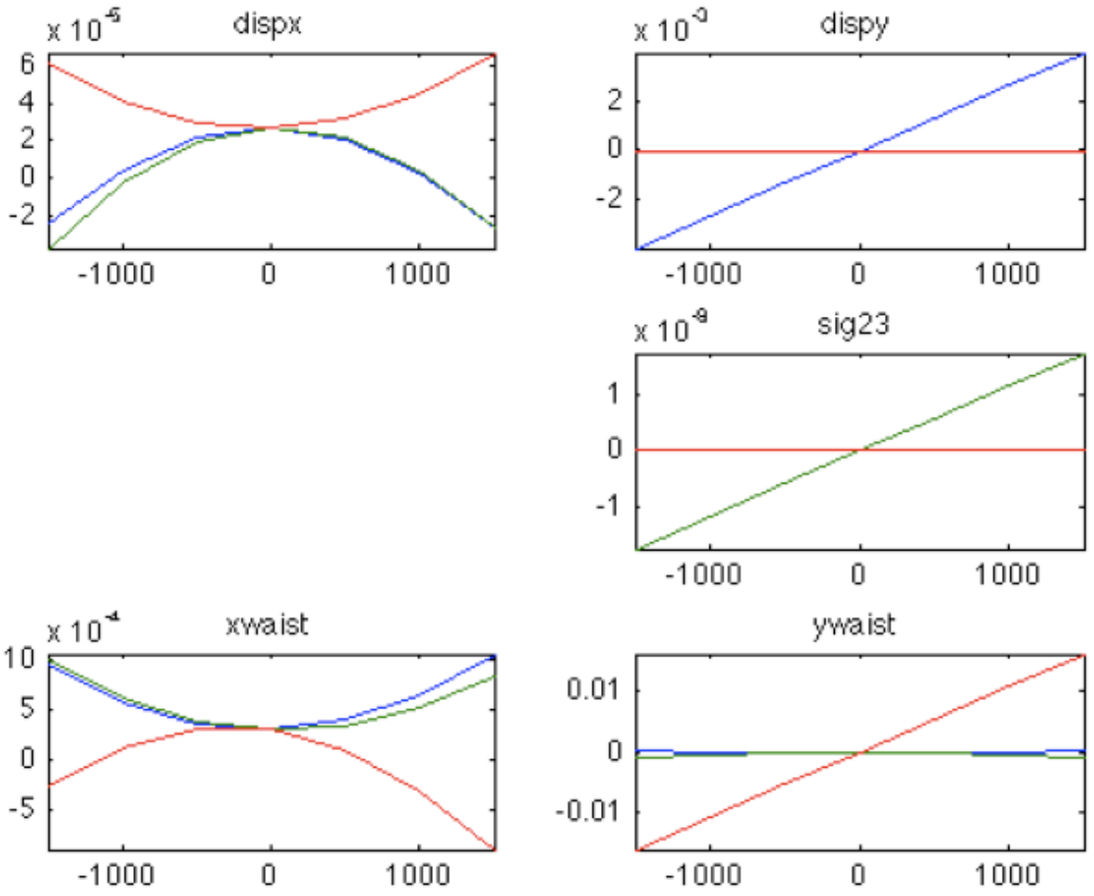
GDE/ALCPG Workshop

Sept. 2009

ATF2 Tuning Procedure

- **Orbit restore (8cm/1cm β_x/β_y), steering**
- **BBA**
- **EXT dispersion + coupling correction, ε measurement**
- **Optics matching**
- **IP y beamsize optimisation (use MW1IP W + C wire)**
  - QD0 scan.
  - QS1X/QS2X sum knob, ZV5/6/7X Dy′ bump and QK1-4X multiknob for dispersion/coupling
  - Get IP beam sigma matrix within capture range of sextupole multiknobs.
- **Iteratively apply multiknobs for lowest y beamsize.**

Sextupole Knob Orthogonality and Ranges



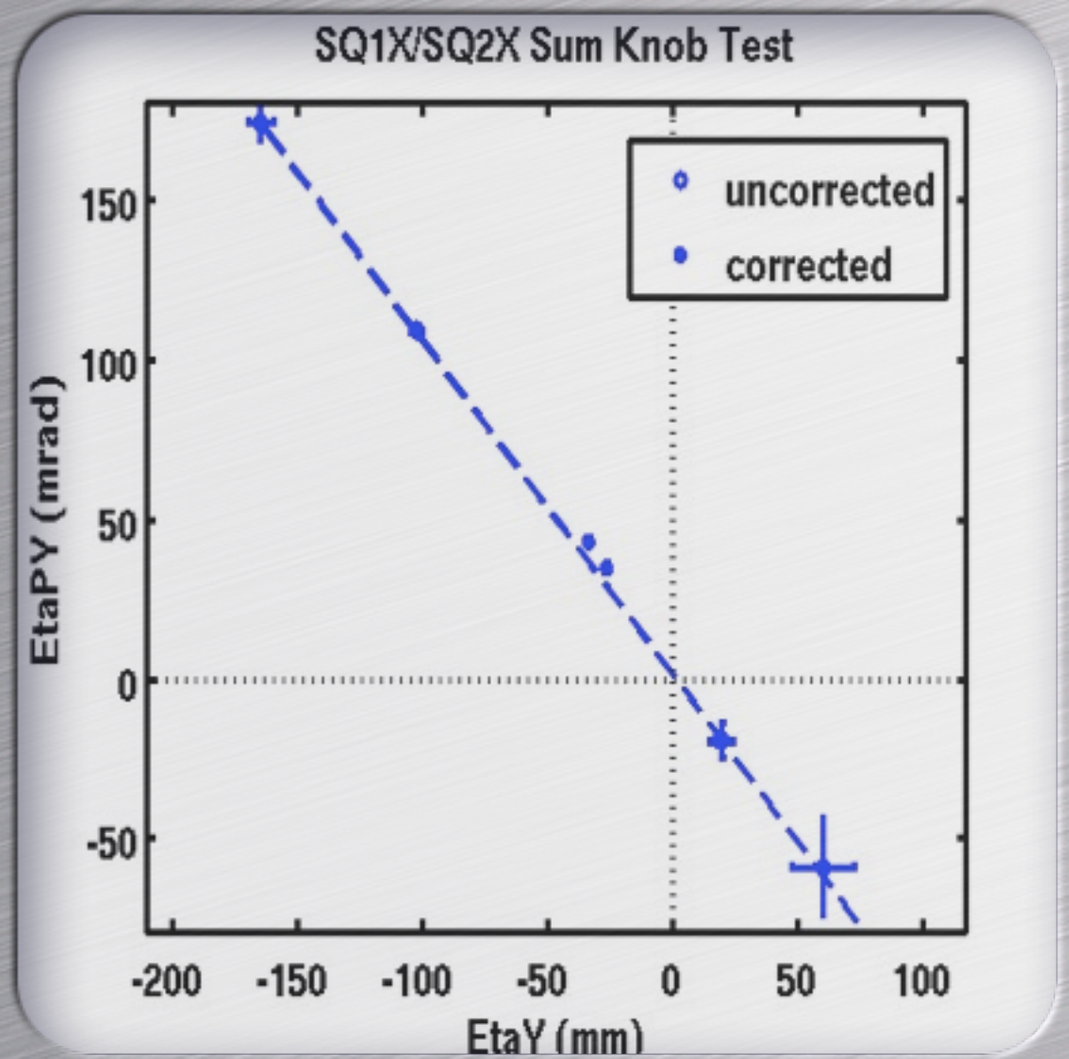
- Nominal optics
- Scan each knob over max range.
- Good orthogonality with perfect conditions
- Extend range by adding skew-quad in FFS?

Max range of Knobs:
- DispY = 4mm
- <x'y> = 2e-9
- Y Waist = 2cm

Non-orthogonality (max % effect by other knob)

Disp Y	<x'y>	Waist Y
0.06 %	0.004%	5.9%

Dispersion Correction

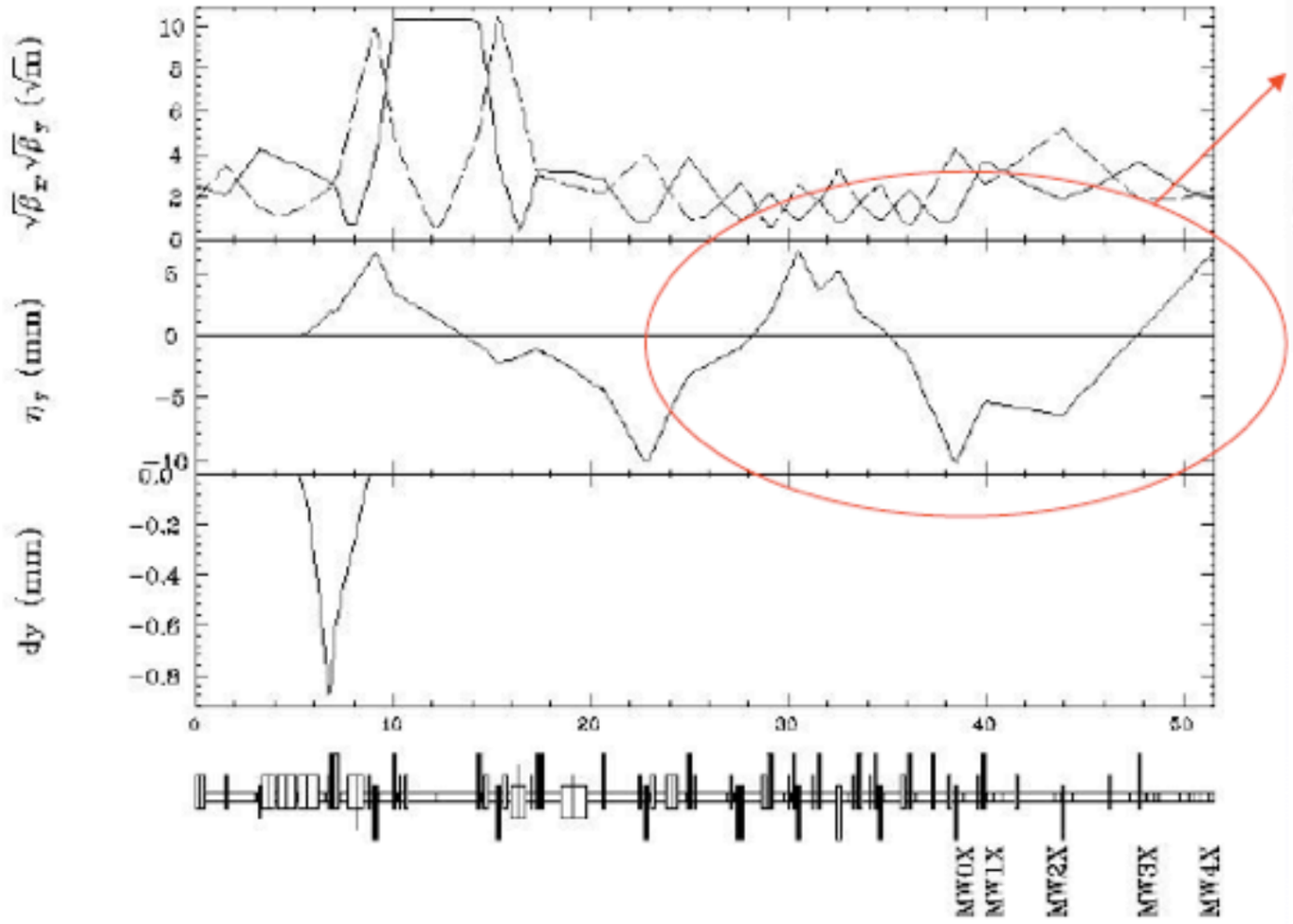


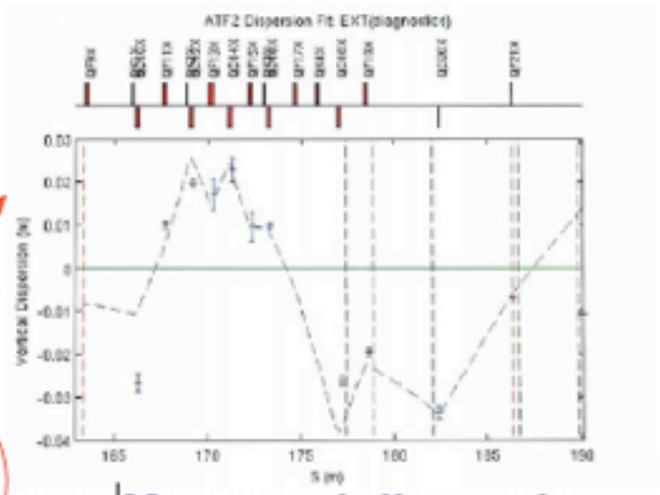
- EXT QS1X+QS2X sum knob designed to simultaneously correct etay + etay′
- Fine as long as dispersion errors originate in EXT
- Has been the case, this from April run.

Incoming Dispersion Source Seen

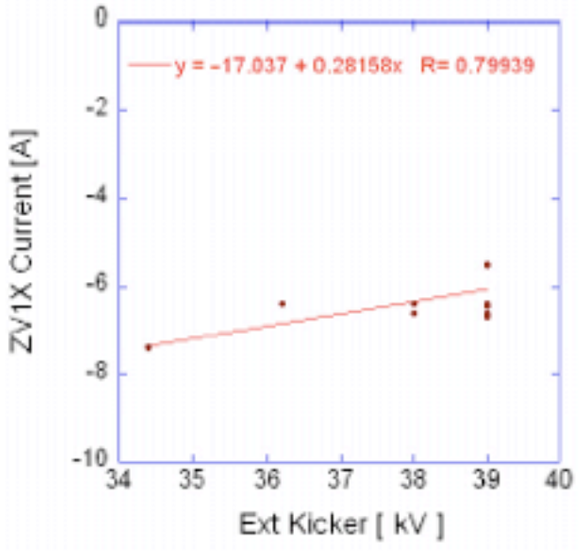
-ZV1X must be apply huge field to pass the beam.

-When we assumed the vertical kick at septum and ZV1X and ZV2X, we can simulate the residulal vertical dispersion.



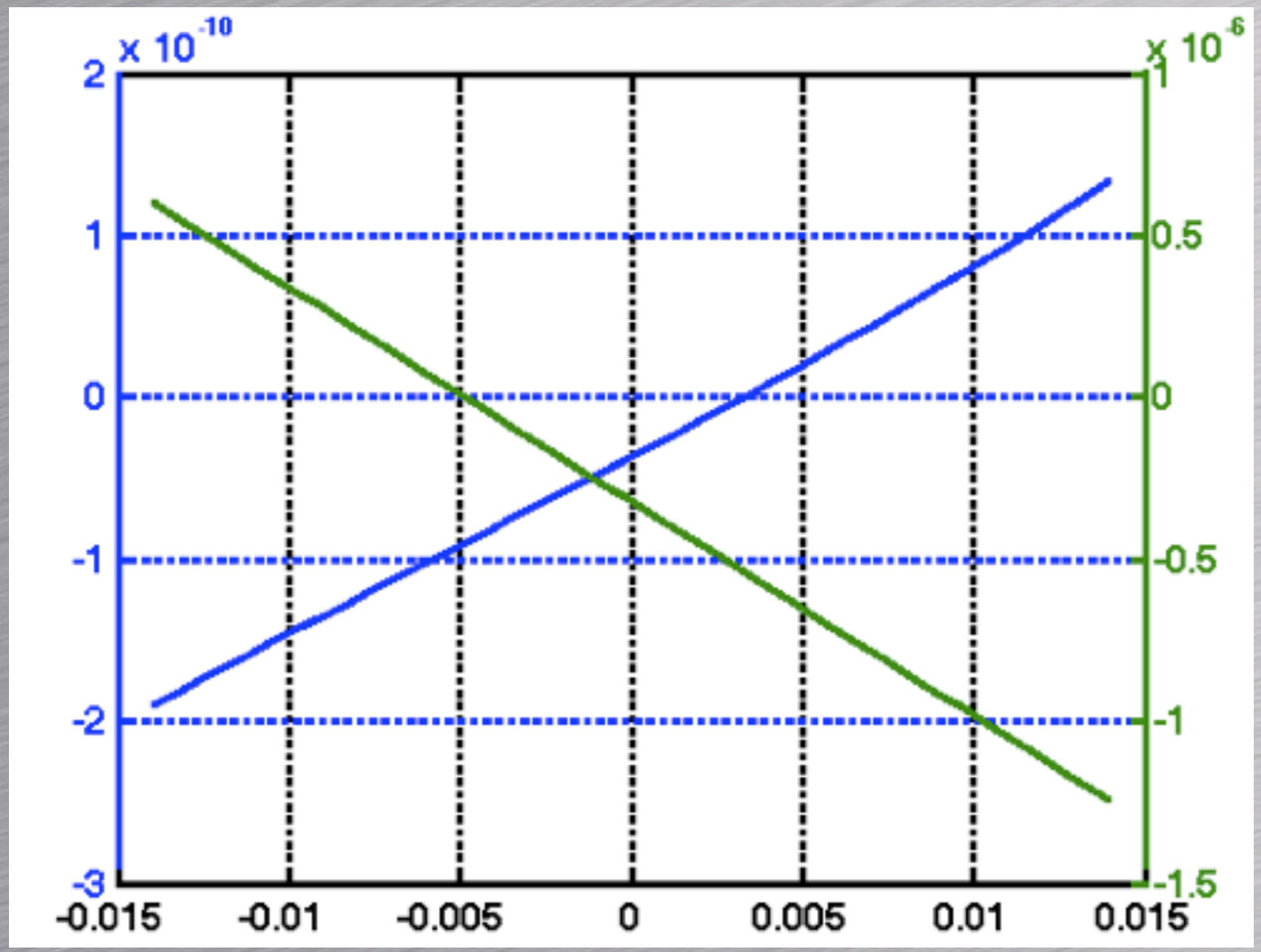


Measured dispersion



Vertical kick at septum was smaller for higher kicker voltage

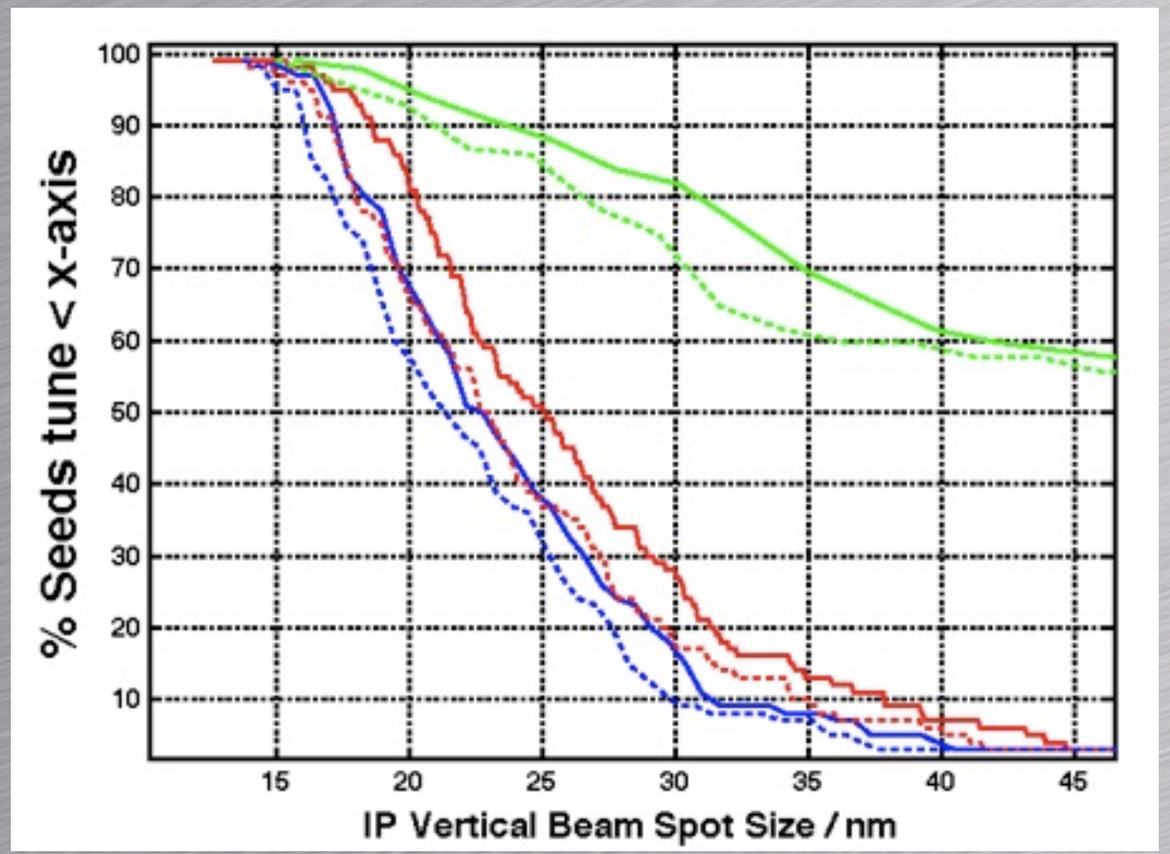
Effect of Incoming η_y

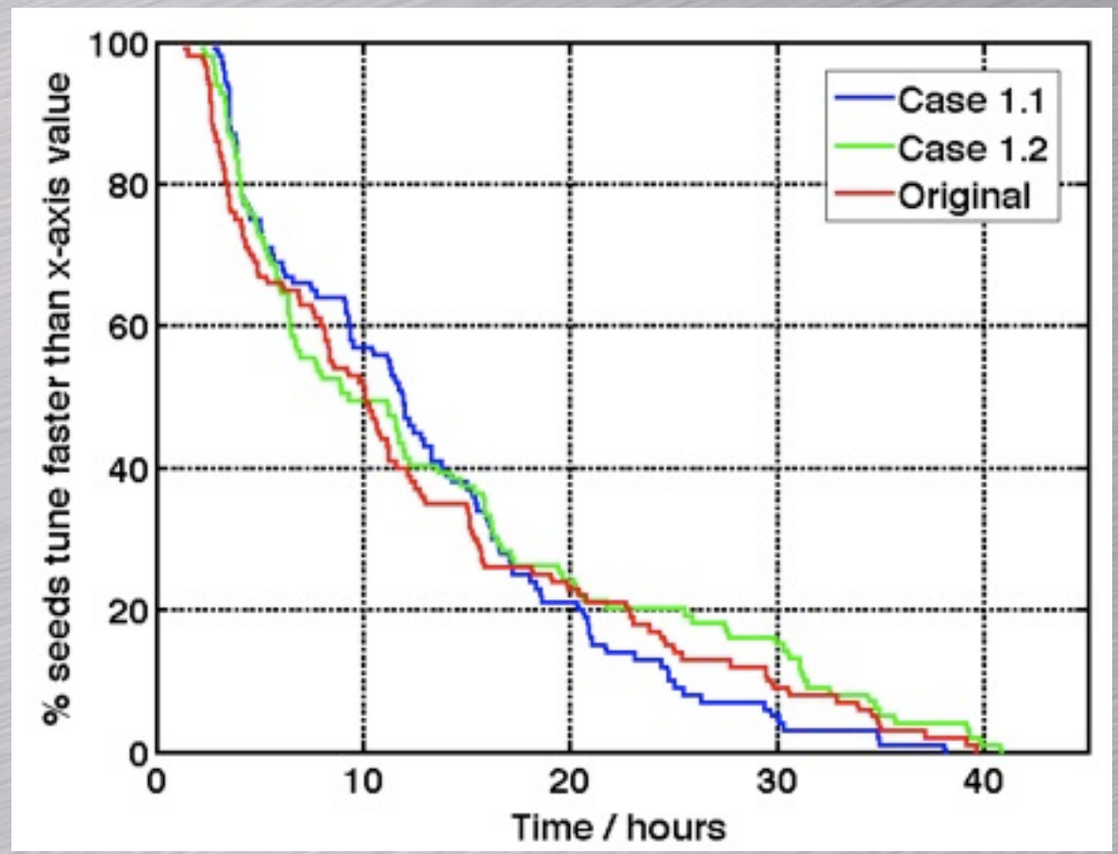


Simulated IP η / η′ response
to sum knob with 5mm η at IEX

- Incoming dispersion not at phase correctable by sum knob.
- Can run QS1X/QS2X independently but causes large coupling.
- Correct IP η at IP with sum knob with finite η′?
  - Study in simulation.

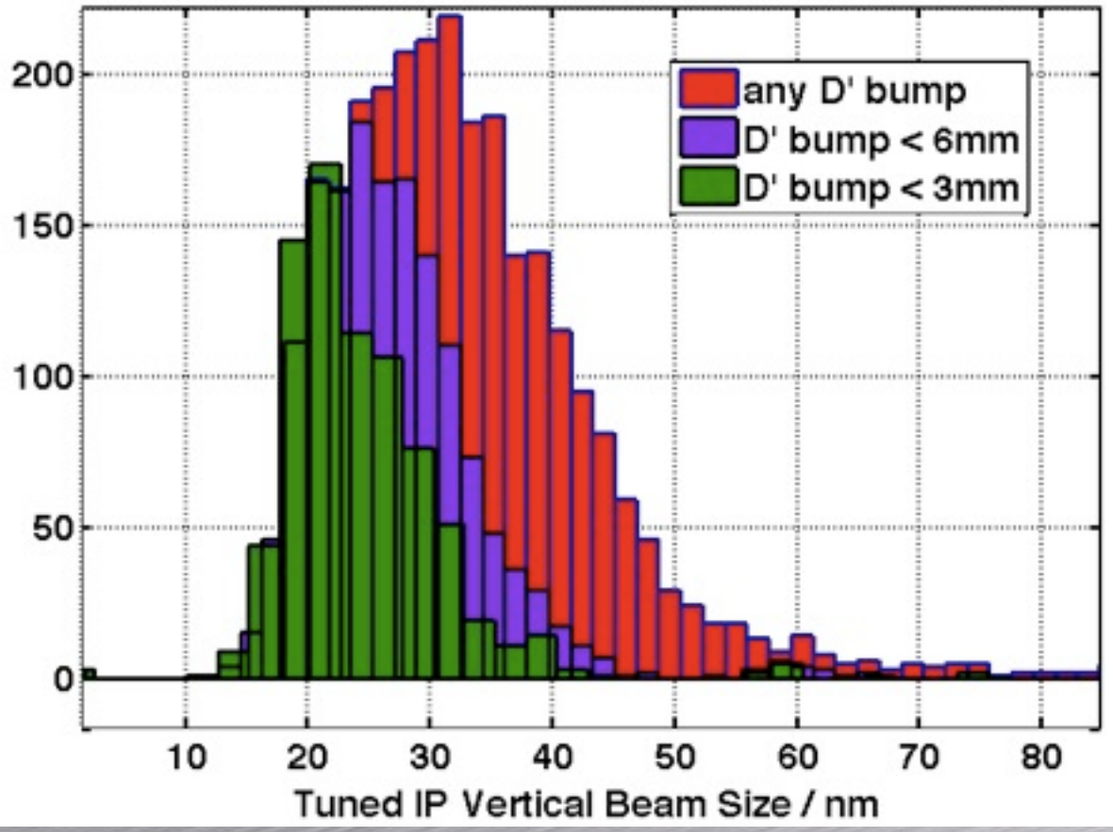
Simulated Tuning Performance

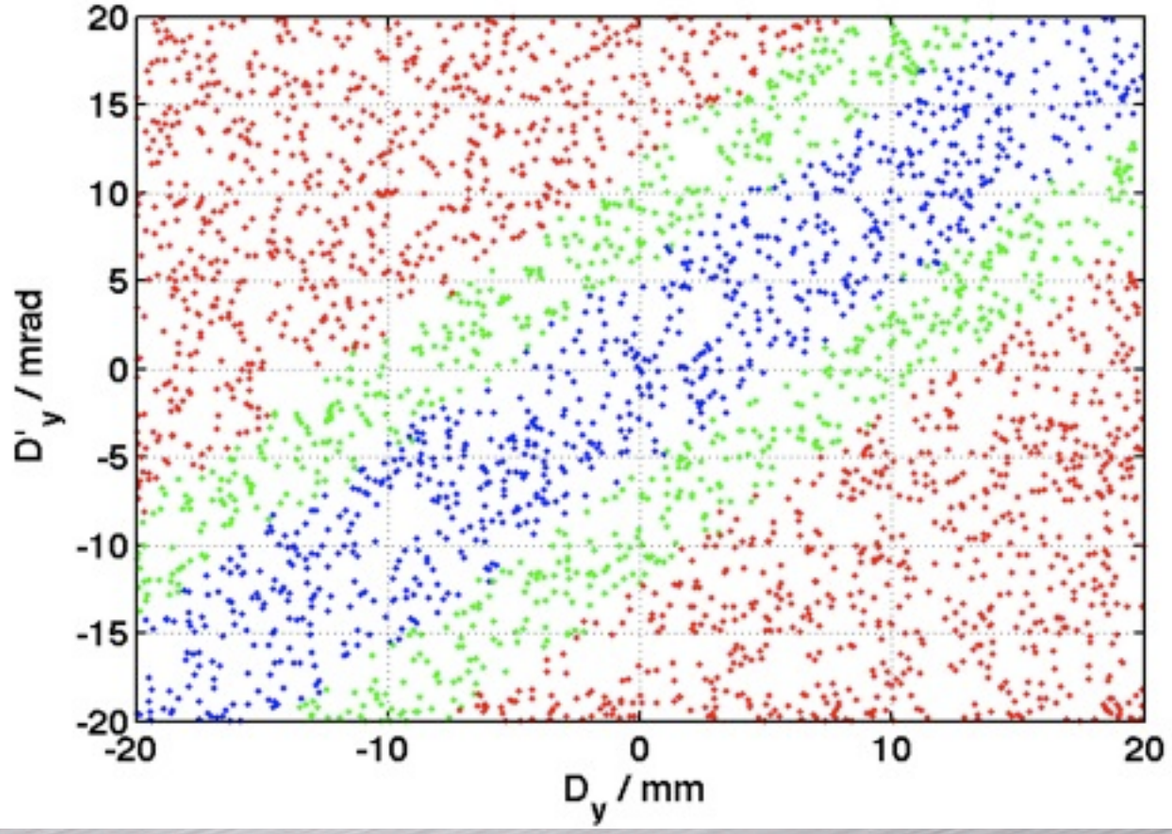




- Comparison of case 1.2 (green curves) with 1.1 (blue curves) and original simulations (just sum knob, no ip-minimisation, red curves). 1.1 = sum knob + dy′ closed-orbit bump. 1.2= sum knob only, minimising IP spot size.
- Solid curves are for RMS beam size, dashed for fitted gaussians.

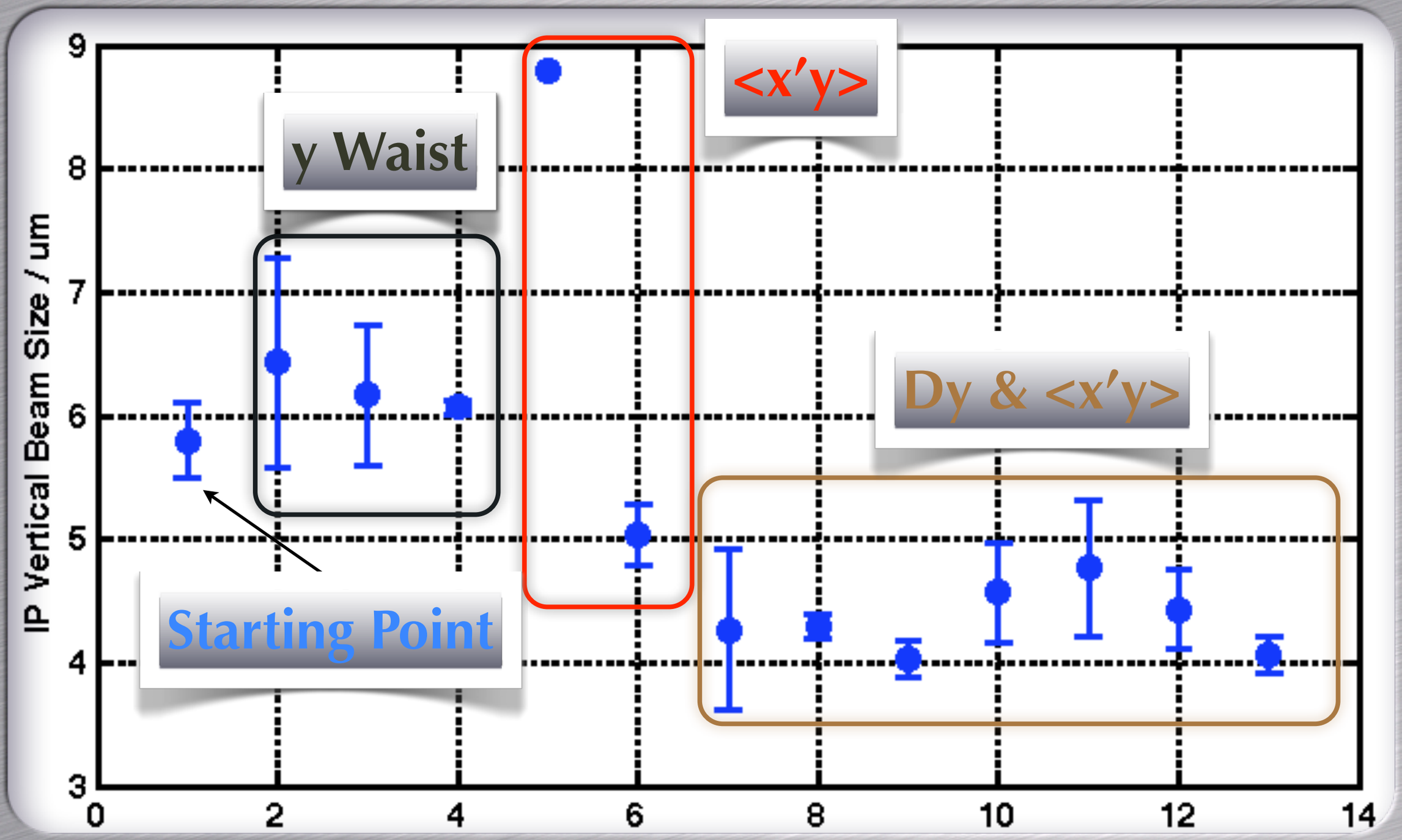
Tuning Performance with incoming dispersion from DR





- Tuning performed on 3000 seeds
- Performance varies with cuts on allowed incoming dispersion- these cuts are performed by restricting the data set by the allowed D′ bump size.

Application of Sextupole Multiknobs on shift



IP Vertical Beamsize Minimisation, best so far in shifts

(5 /20) by using FF multi-knobs (sextupole movers)

5.8μm (5.8 ,6.1 ,5.5) -> 4.1μm (3.9, 4.2, 4.1)

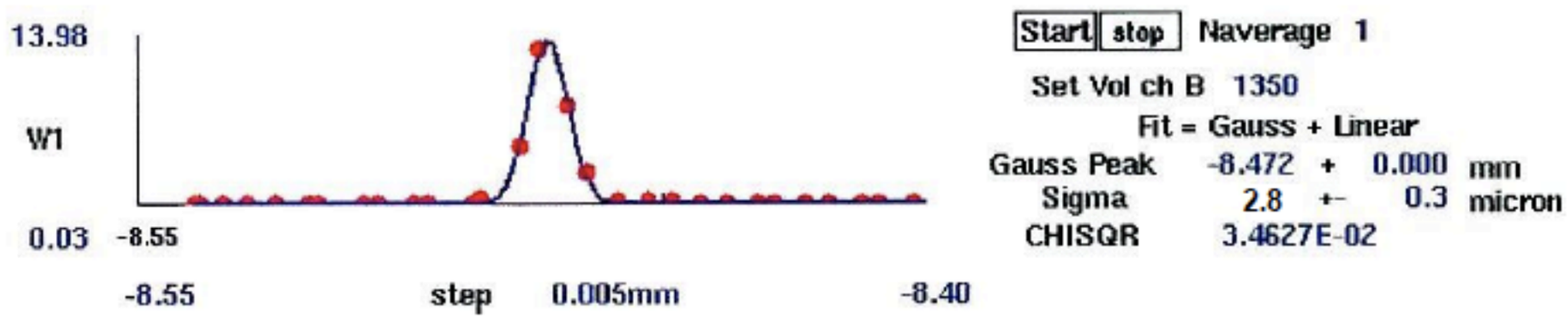
-Residual vertical dispersion was dominant for the vertical beam size

- Vertical dispersion was larger than correctable range for multi-knobs

(5 /26) - All sextupoles off
- QSs scan (vertical dispersion correction)
- QKs scan (coupling correction)
- QF6X scan (horizontal dispersion correction)

5.0μm (4,7 ,5.2, 5.2) -> 2.9μm (3.0, 2.8, 2.9)

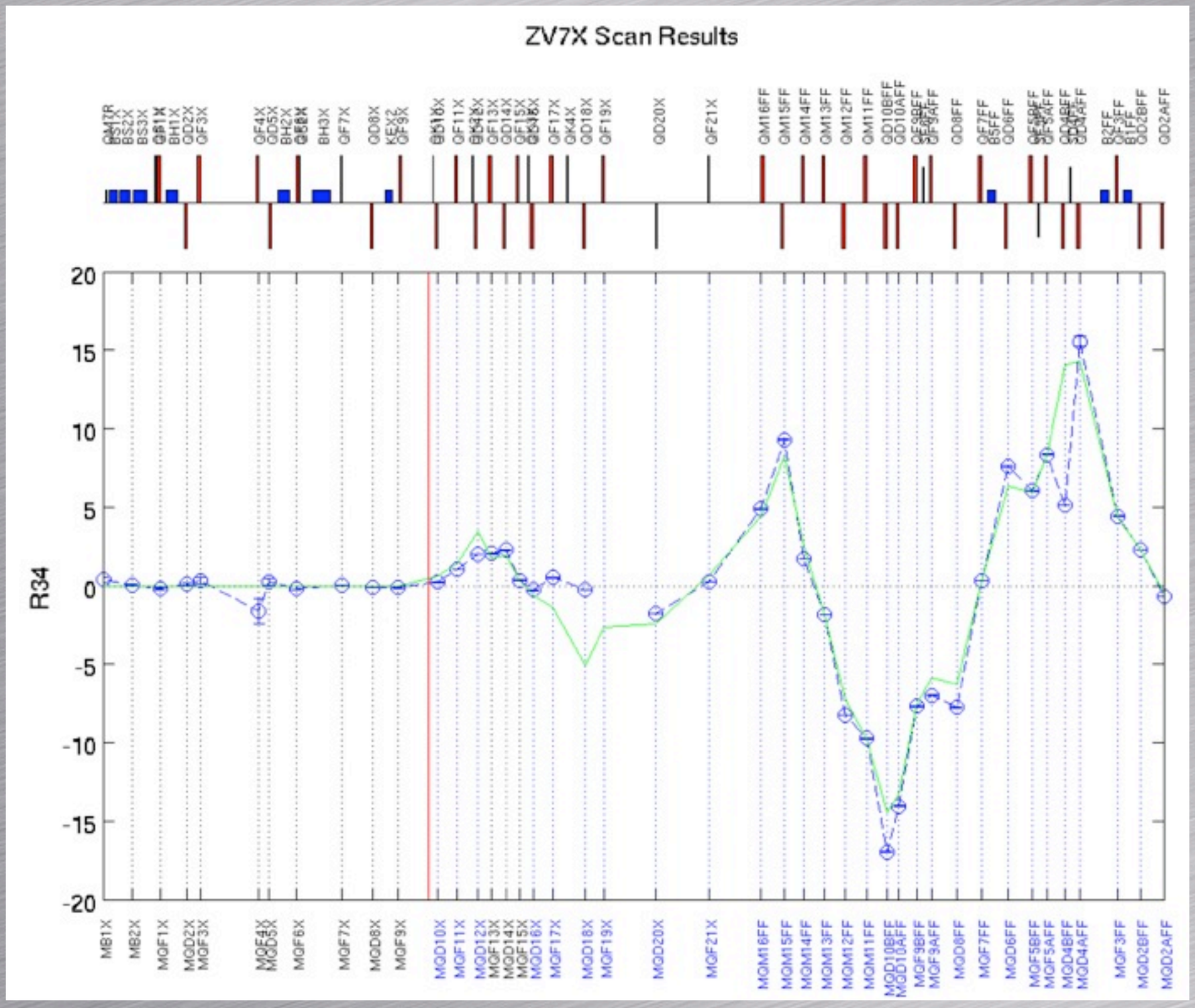
Almost limit of the beam size measurenet with 10μm diameter wire



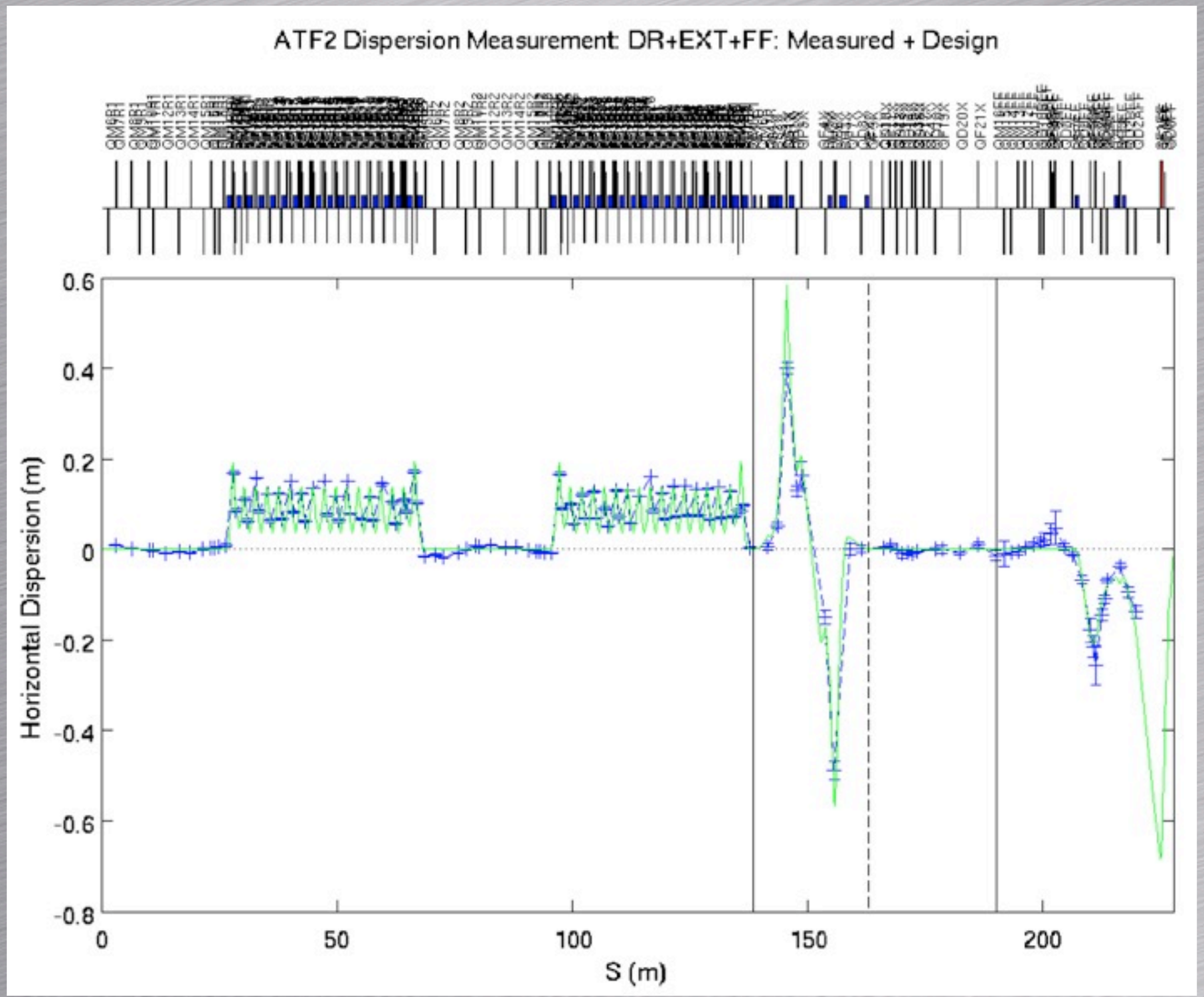
Model Improvements

- A lot of work to improve accuracy and reliability of online modelling within the Flight Simulator (Lucretia) and also VSYSTEM/SAD.
- Correct characterisation of systems in FS model.
- Use of FS-MAD interface for twiss generation into EXT and matching.

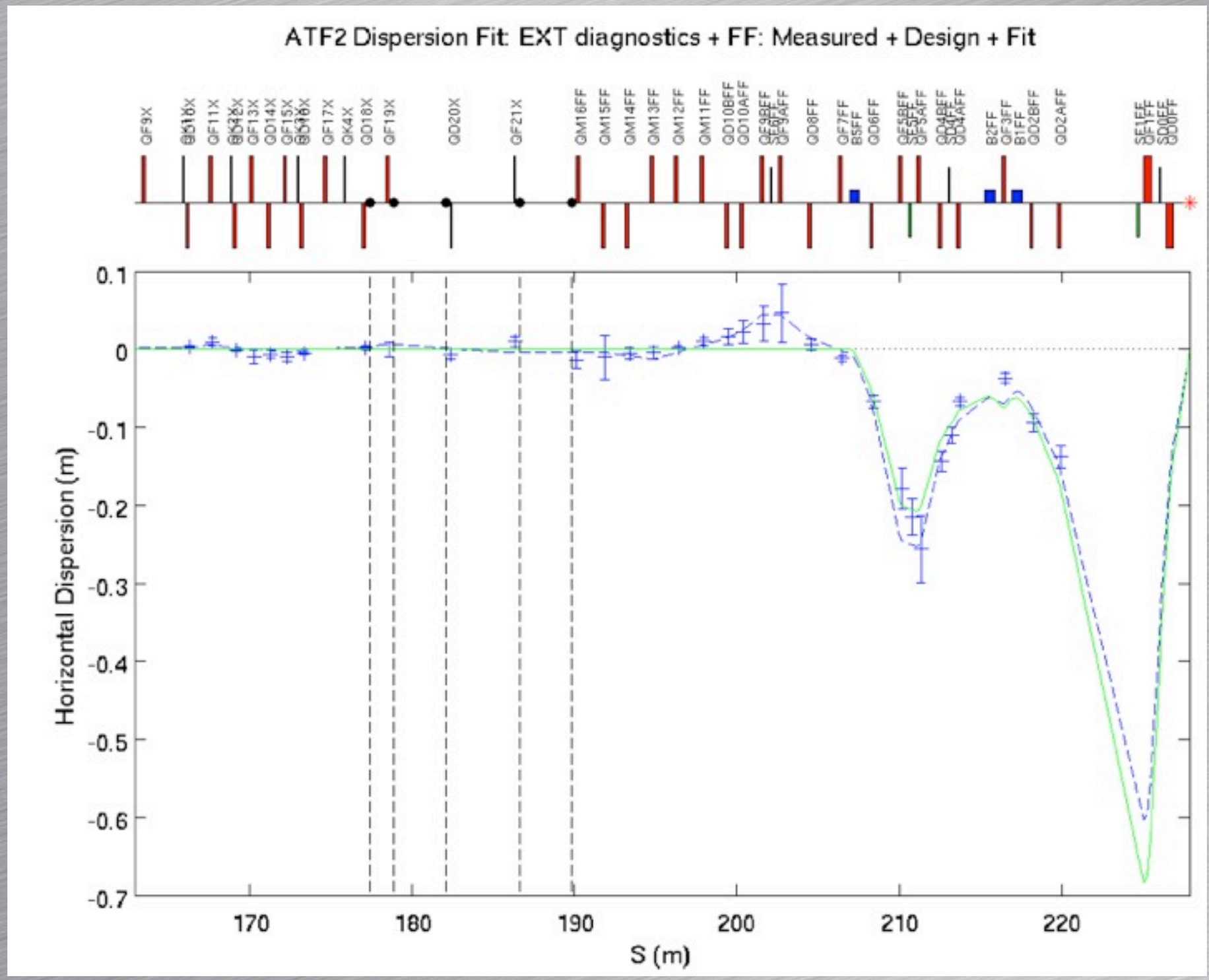
Response Matrix Tests - R34



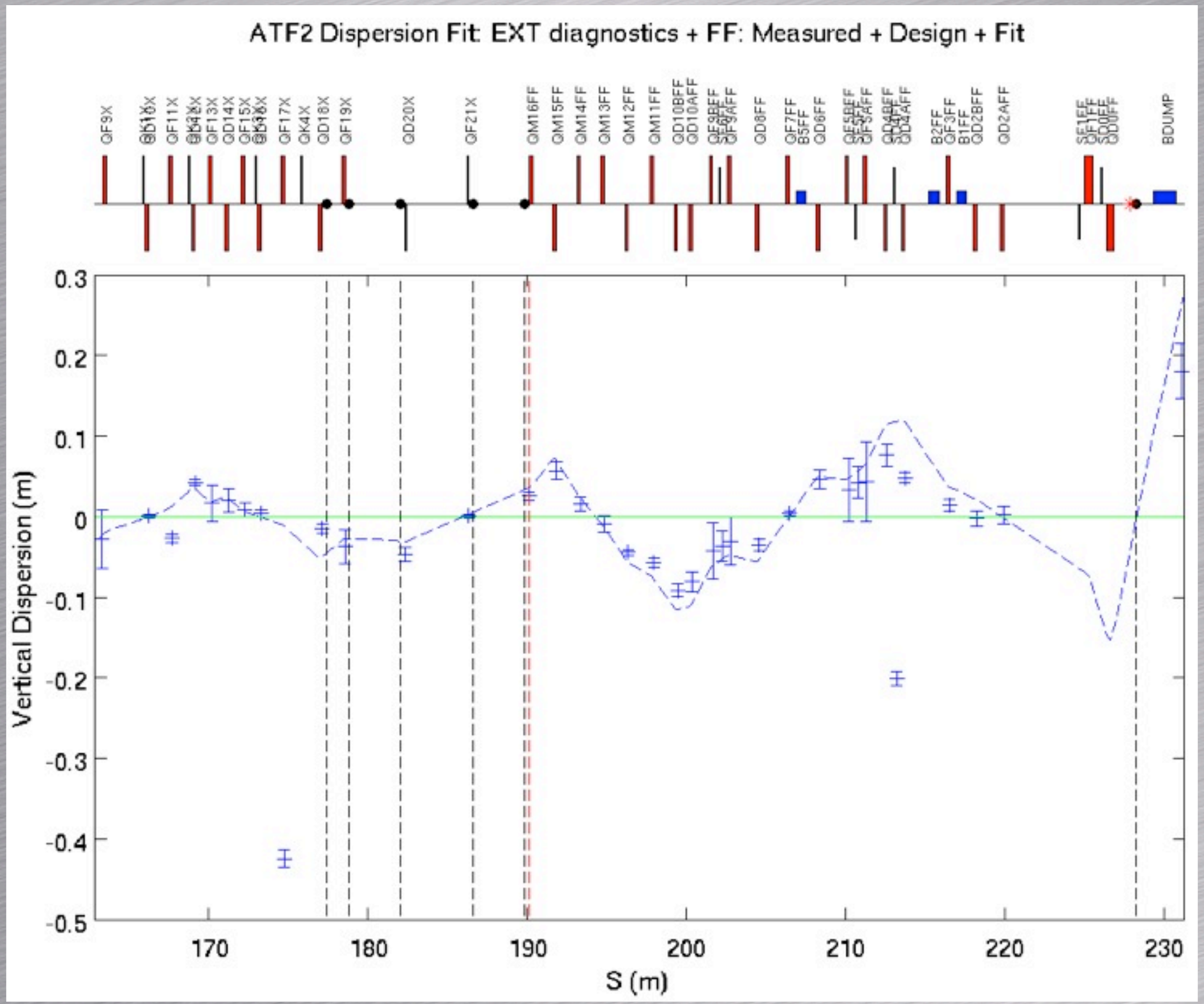
Dispersion Measurements and Modelling



EXT + FFS Dispersion

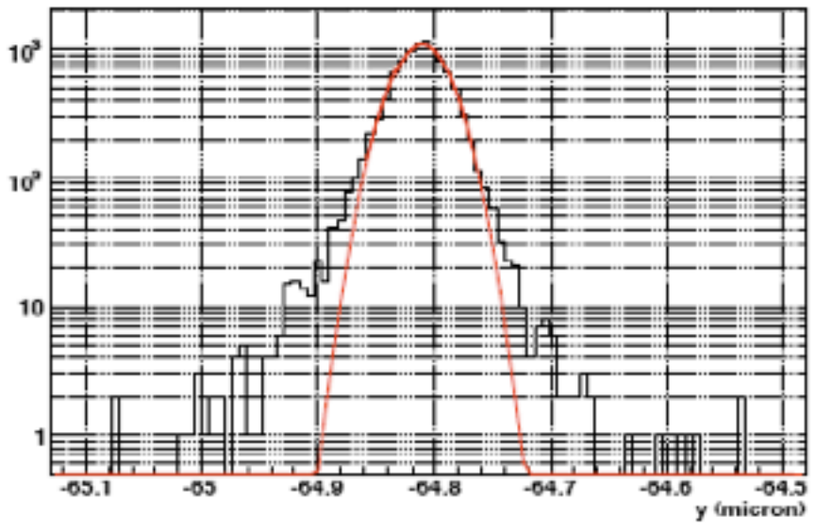


Vertical EXT+FFS Dispersion



SM IP Measurement

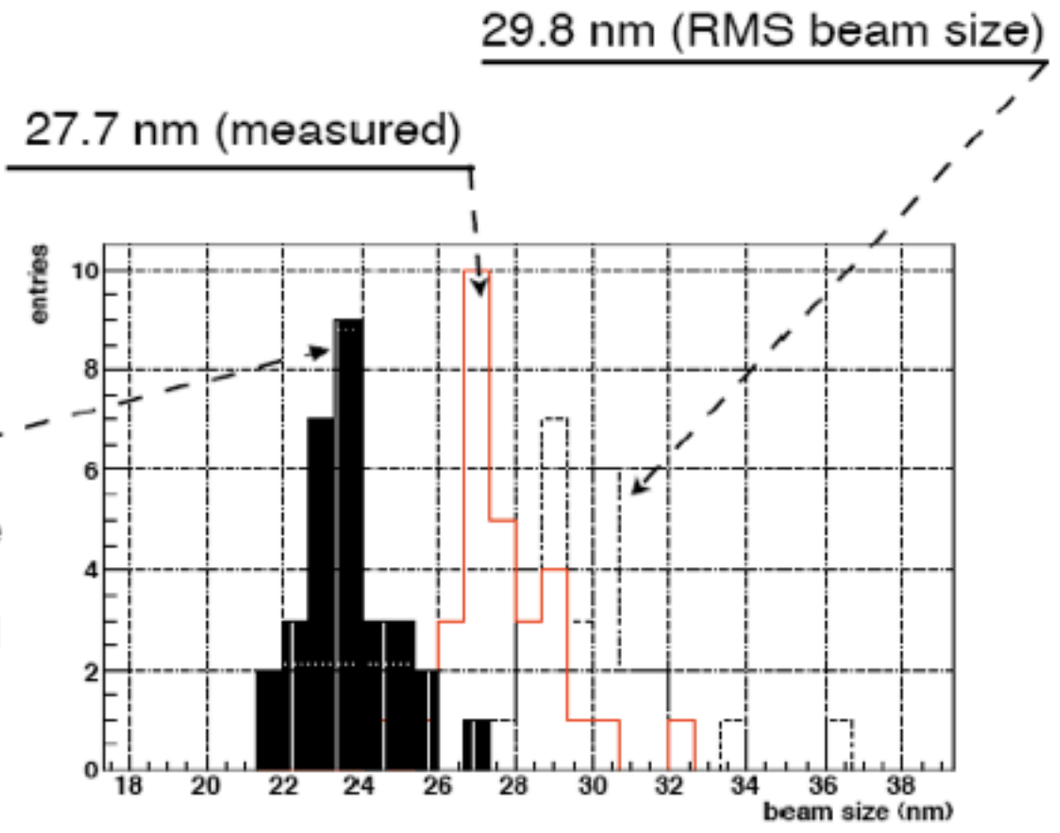
beam profile



23.7 nm (core beam size)

The larger deviation cause bigger difference

Measured size is between the core size and the RMS size



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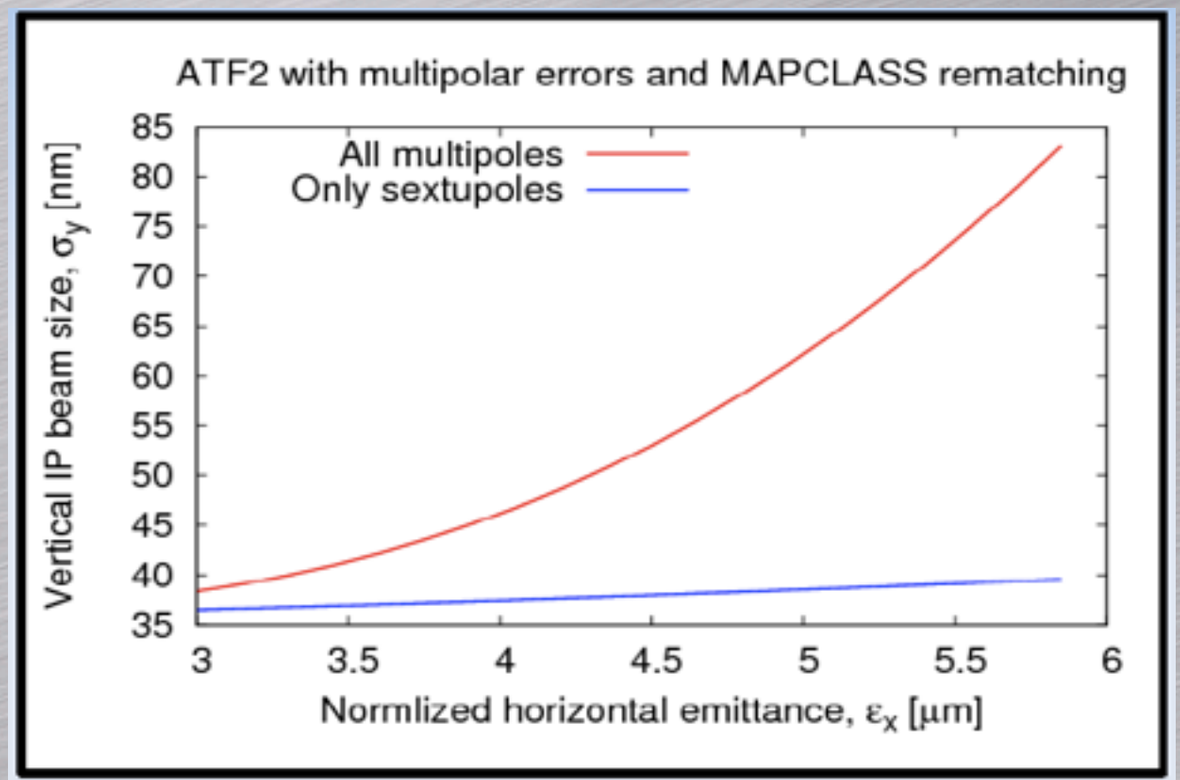
- IP beam size not gaussian, Shintake monitor measures somewhere between RMS and core in this case.

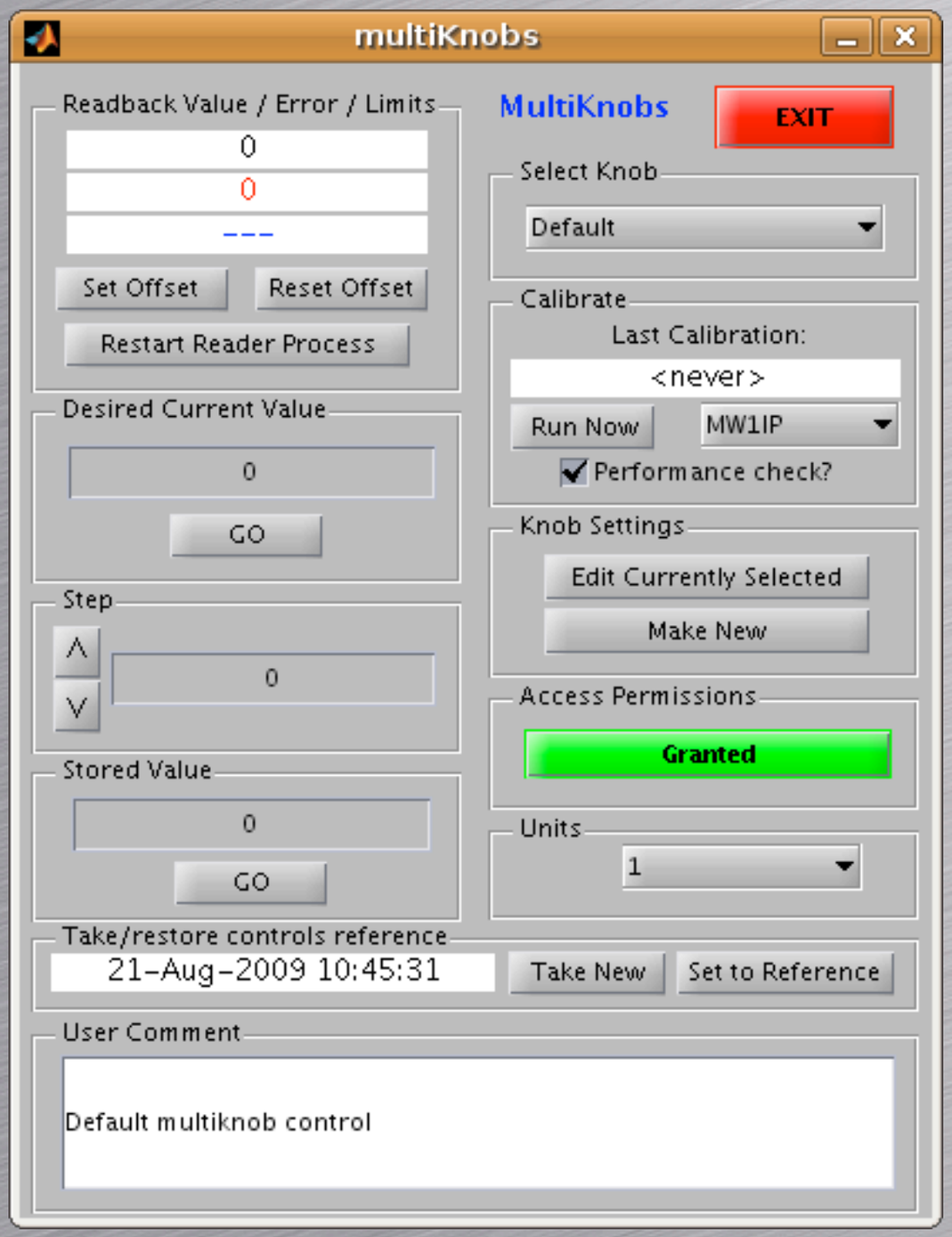
QF1 Multipoles

Magnet Name	Sextupole/ quad	Octupole/quad	10pole/quad	12pole/quad	20pole/quad
Tolerance (tightest)*	<0.03	<0.025	<~0.01	<0.05	<0.12
QD0 at 132.2 amps	0.0255	0.0052	0.007	0.036	0.0027
QF1 at 77.5 amps	0.0274	0.0058	0.0128	0.036	0.0027

- 12-pole component of QF1FF causes coupling at IP and vertical beamsize growth
- Mitigate either through increasing (doubling) IP horizontal Beta or building compensating 12-pole magnet



Flight-Simulator Tuning s/w improvements for Coming Runs



- New graphical interface for creating and applying multiknobs using any combination of FS variables.
- Implementation of closed-orbit Dy′ bump for EXT dispersion correction (using ZV5/6/7X).

Summary

- Understanding of IP tuning procedure gained through simulation.
- Have started to put tuning processes into practice in ATF2 runs Jan-June this year.
- Need to continue to work to build tuning tools and test in coming runs.
- Looking forward to challenges of small beamsize tuning with C IP wirescanner and IPBSM