



Dynamic Tuning Studies for ATF2 FF

Glen White / SLAC

LET Meeting

Feb 26 2007

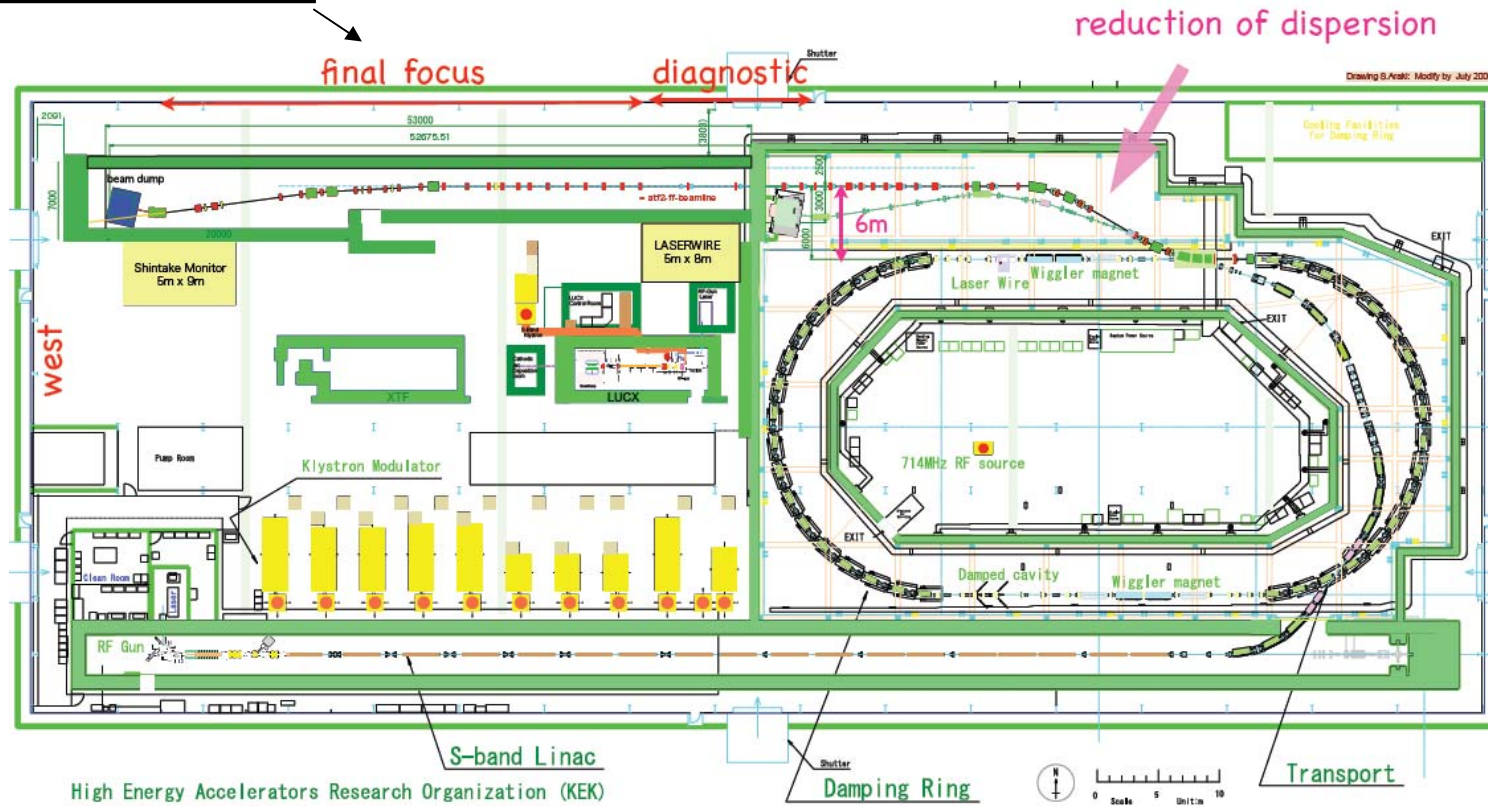
Overview

- Use static BBA and tuning procedure for ATF2 FF as described in Jan ATF2 meeting.
- Use Woodley-tuned v3.6 lattice (dispersion and coupling fixed in diagnostic section)-
 - Add FF errors.
 - Apply BPM alignment, BBA and sextupole tuning knobs for each of 100 seeds.
- Throughout tuning process, apply dynamic effects:
 - Ground Motion (Model 'A').
 - Random pulse-pulse component jitter.
 - Random pulse-pulse energy fluctuations.
- Use pulse-pulse feedback to maintain orbit.

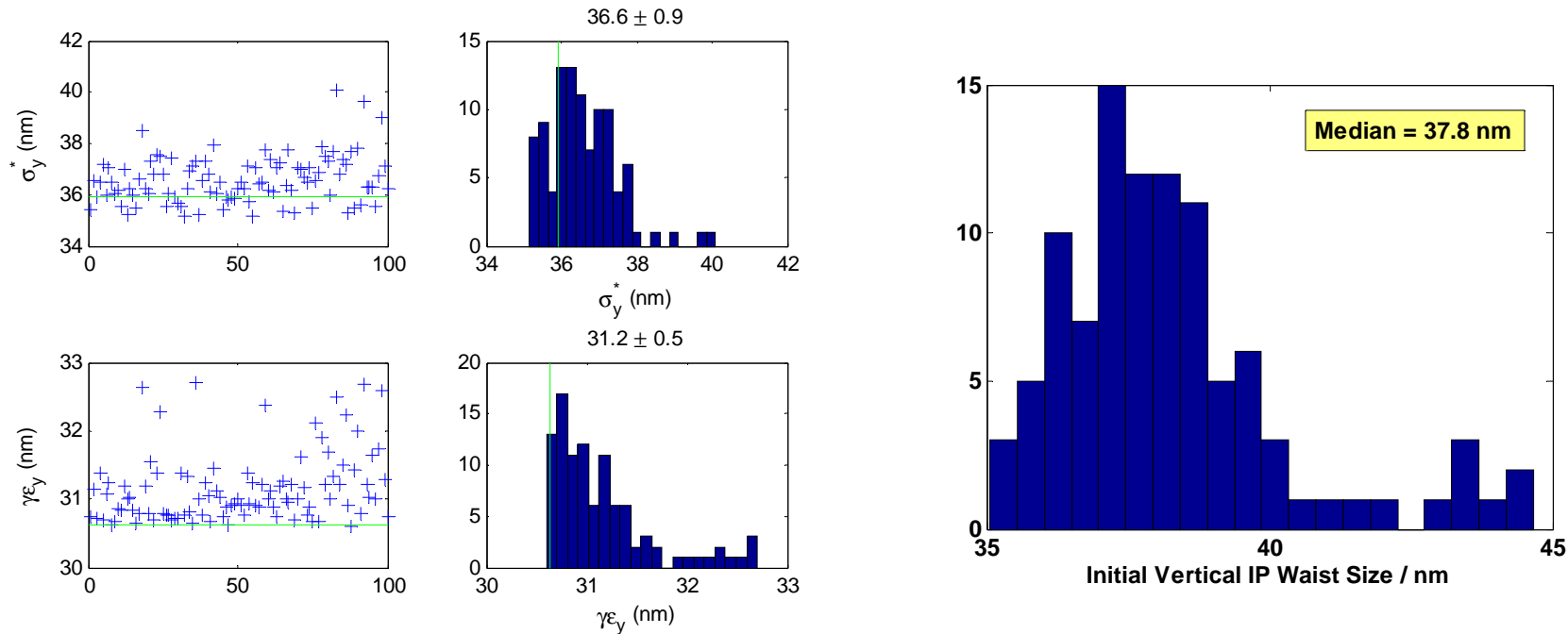
ATF2 Final Focus System

Tune FFS:
22 Quads, 5 Sexts.

Optics v3.5, 1 July 2006



Initial Beam Before Errors



- Initial set-up of MW ATF2 lattice with dispersion + coupling correction in diagnostic session gives IP sizes shown on left.
- Right plot after importing lattice into my simulation (using slice beam representation for simulation speed initially). Results relative to these starting conditions.

IP Beamsize Measurement

- ❑ Assume IP assembly of cavity BPM + shintake monitor for IP waist position + vertical size measurements.
- ❑ Shintake monitor measurement range 35nm – 350nm.
- ❑ Also assume presence of wirescanner for >1 micron waist sizes.
- ❑ Between 350nm and ~1um, proposal from Honda: use novel nano-pattern target film.
- ❑ So, assume a beamsize measurement all the way from initial few microns to target 35nm to tune on.

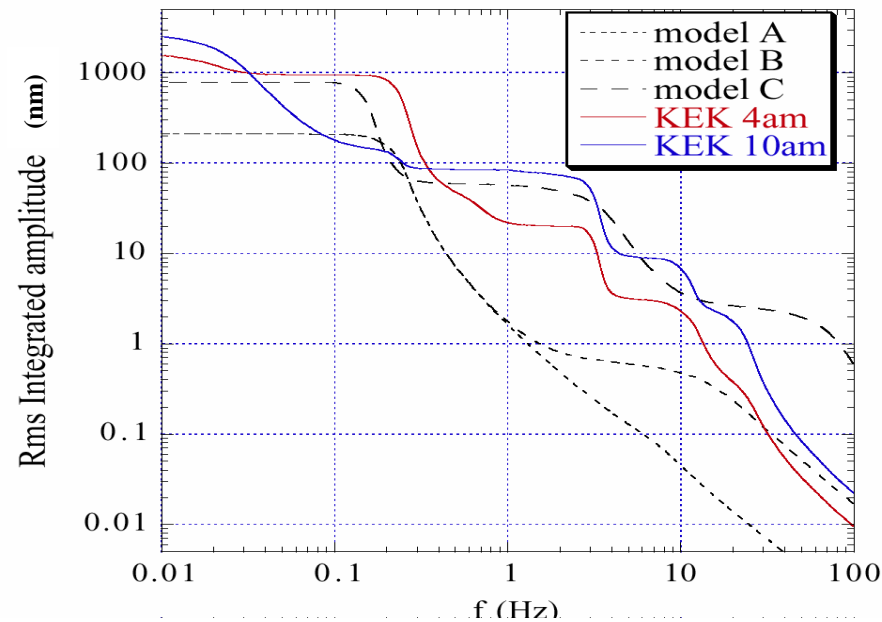
Static Error Parameters

- Assume movers on all FF quadrupoles and sextupoles.
- Cavity BPMs fixed to all FF Quads + Sexts.
- Also assume IP BPM with 5nm RMS resolution.

Quad, Sext x/y transverse alignment	200 um
Quad, Sext roll alignment	300 urad
Initial BPM-magnet field center alignment	30 um
dB/B for Quad, Sexts	1e-3 syst. + 1e-4 random
Mover resolution (x & y)	50 nm
BPM resolutions	100 nm
Power supply resolution	14 - bit
Shintake Monitor Resolution	2nm

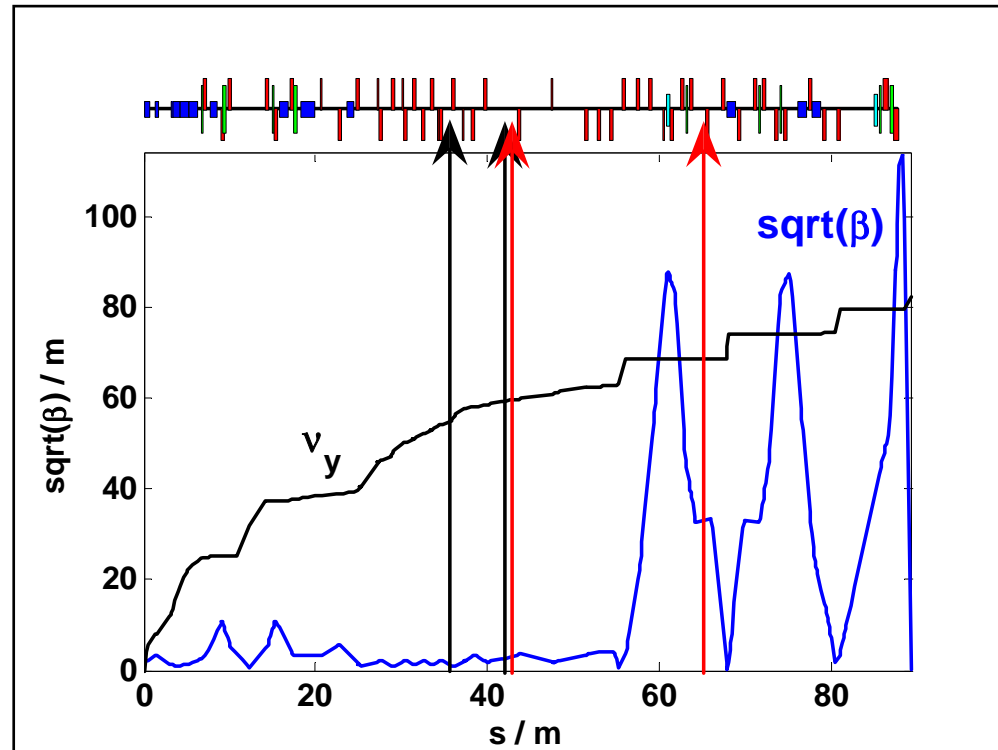
Dynamic Errors

- RMS pulse-pulse errors:
 - Component jitter: 25 nm.
 - Energy error: 5E-4.
 - Ring extraction jitter: 0.1 sigma (x,x',y,y').
- Ground motion, use model 'A'.



Pulse-Pulse Feedback Location

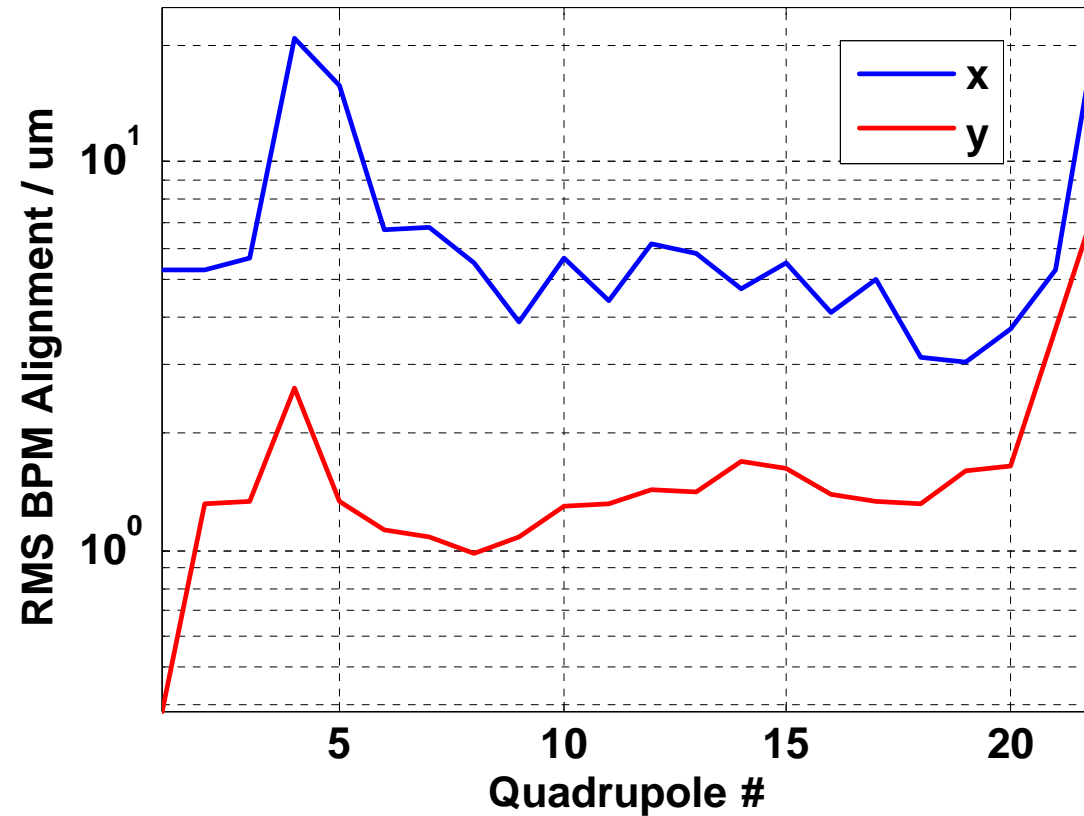
- 2 sets of kicker-bpm pairs for x and for y planes placed with ~ 90 degree phase separations.
- Vertical placement shown right kickers at $s=36.3, 42.5$ m; BPMs and $s=42.5, 66$ m.
- Horizontal similar.



New elements required (not in current deck)

- Bpm and vertical corrector in Wall
- Vertical corrector after QF17X.
- Horizontal corrector at $s = 58.3$ m.

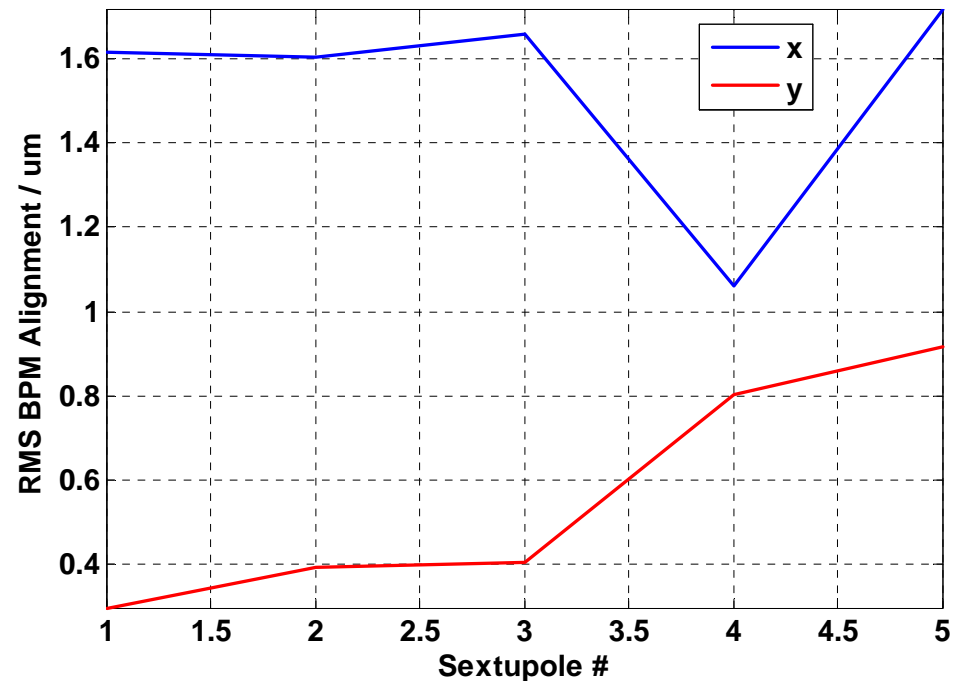
Quad BPM Alignment



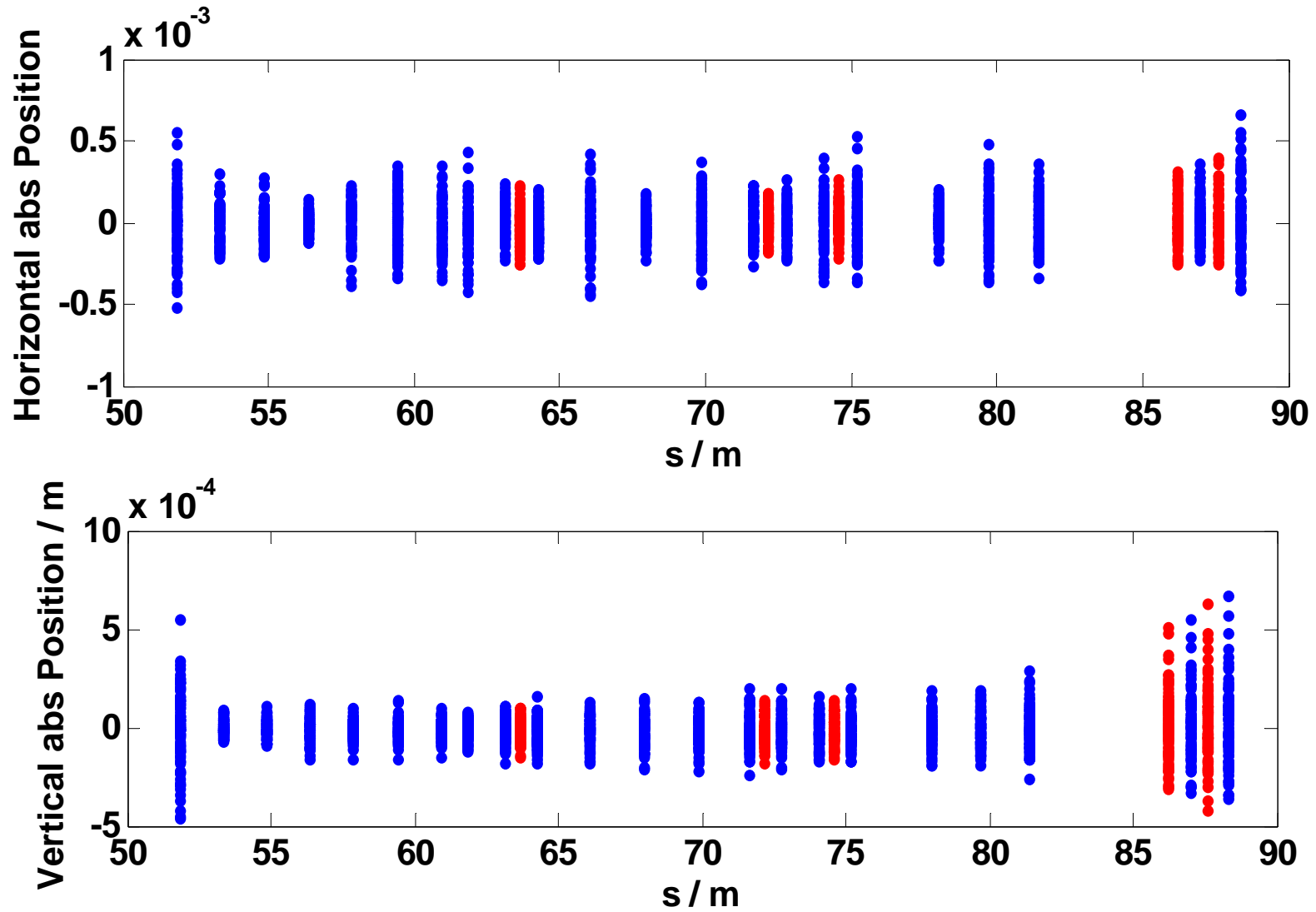
- RMS alignment of Quad field center – electrical center of Quad BPMs (100 seeds).

Sextupole BPM Alignment

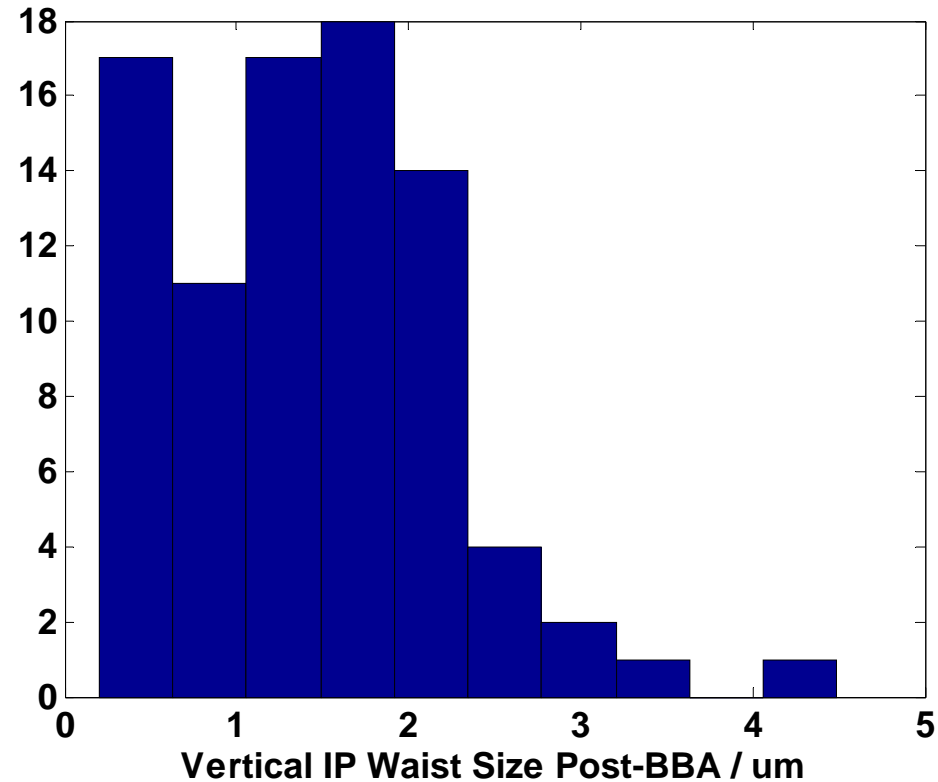
- Move Sextupole +/- 0.5mm through beam.
- Fit quadratic function to IP BPM response.
- Alignment from minimum of fit.
- RMS alignment results ->



Quad BBA



Beamsizes After BBA

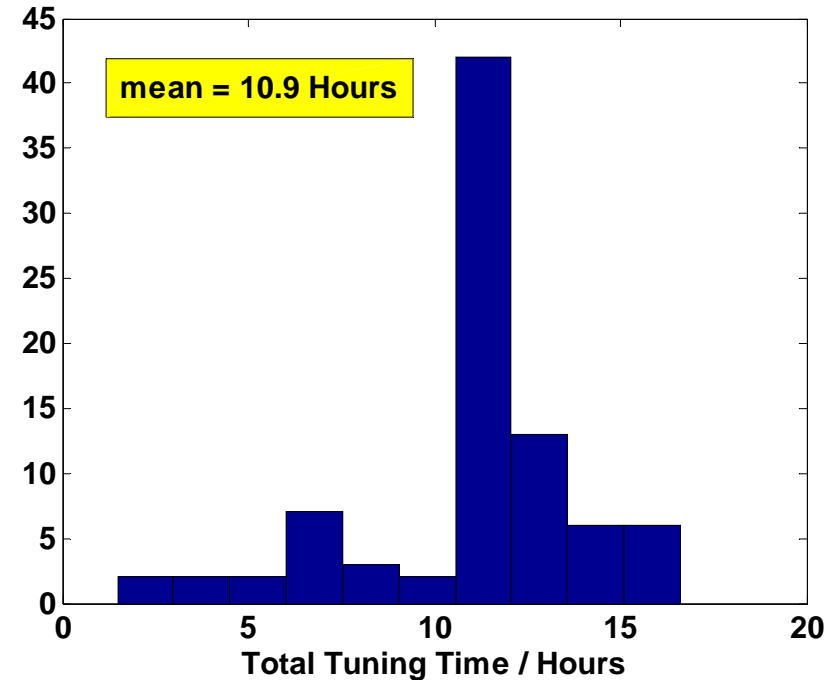
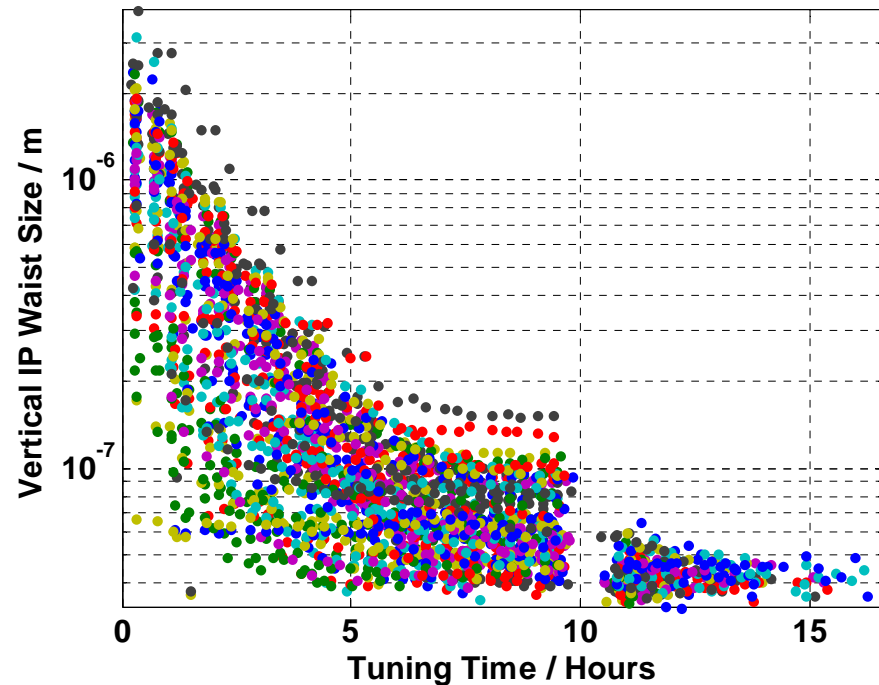


- IP waist size after BPM alignment and BBA.

Sextupole Multi-Knobs

- Use orthogonalised x- and y-moves of FFS sextupoles to correct vertical waist and dispersion + $\langle x'y \rangle$ coupling term.
- Higher-order IP aberration tuning performed by scanning sextupole tilts.
- In simulation, apply iteratively until beamsizes within 10% of initial pre-error value.

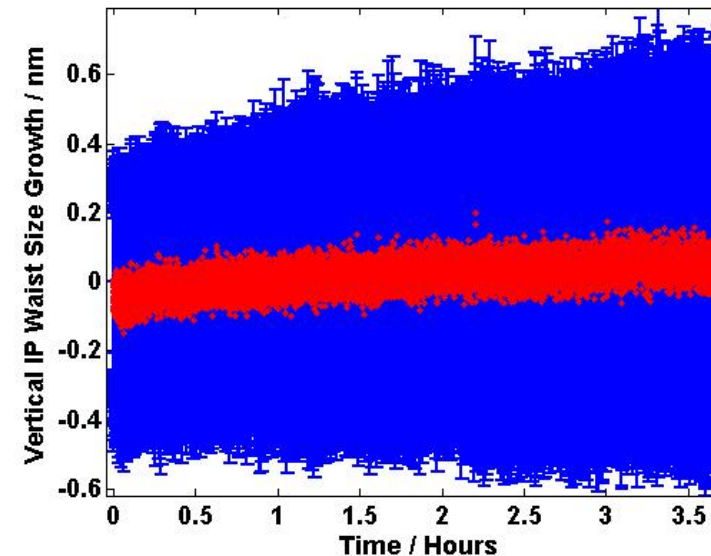
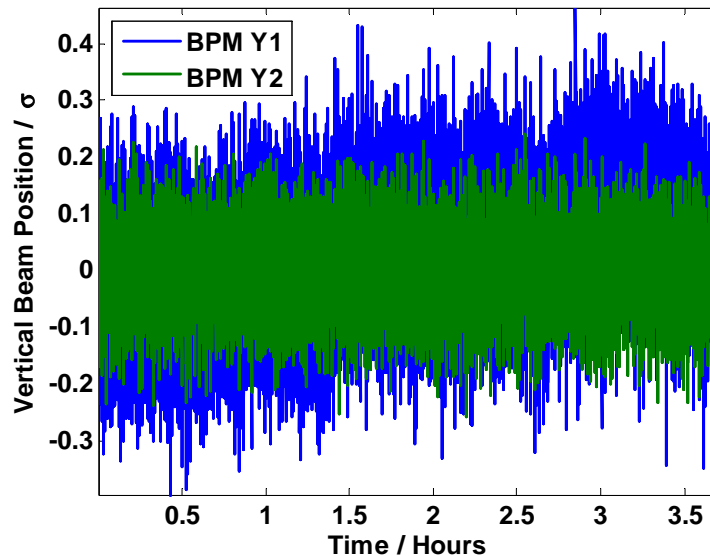
Multi-Knob Tuning Results



- Multi-knobs iteratively applied until IP beamsizes growth over initial conditions is $<10\%$ ($\sim <40\text{nm}$).

Feedback Performance

- After tuning, run simulation for 20,000 pulses and look at time evolution of spot size.
- Using simple gain feedback (gain of 0.1 used here- not optimised).
- In this case, rate of beamsize growth $\sim 0.6 \pm 0.5$ nm per day.



Summary and Other Work

- Alignment and tuning still works under dynamic conditions (such as modeled here).
- Repeat with GM B,C,K and in future use parameterization from ATF measurements.
- Check tuning performance without full cancellation of D' in EXT section (no EXT sextupoles).
- Explore phase-space of acceptable jitter tolerances.