ATF2 IP Tuning Task Update

Glen White, on behalf of IP tuning task group
LAL/SLAC, September 17 2008

- Goals and methods
- Tuning simulation results
  - Improved sextupole multiknobs
  - RMS vs. beam core fitting
  - Pushed IP beta configurations
  - Results with Shintake monitor resolution data
- IP tuning task group meeting schedule

Tuning Goals and Methods

- Achieve ~35nm vertical spot size as measured by Shintake BSM
  - Have ignored horizontal in simulations so far, except that Sextupole knobs were orthogonalised to minimise extra x growth when reducing y.
- Construct multi-knobs to reduce from initial size ~<3um after initial alignment.
  - Sextupole x/y moves, final doublet dk, skew-quads (waist, dispersion, coupling)
  - Sextupole tilts / dk (higher-order IP terms)
- IP measurement speed v.slow w.r.t. ILC (~1 min), need to ensure efficient and orthogonal knobs.

Simulation Studies

- Define realistic starting conditions (100 seeds)
  - Standard installation errors + EXT BBA, disp corr, coupling corr, FFS BBA
- Study performance of IP tuning on 100 seeds (including dynamic errors).
- Check h/w limits not exceeded at any point.
- Study effect of dynamic errors on tuned machine.

Errors

Co-ordinate system used here is right-handed. Roll = rotation in x-y plane, pitch= rotation in y-z p

The reference ground motion model for ATF based on measured GM spectra on the DR floor is in t
(also available as a standalone Matlab routine- to be provided here shortly).

Error Parameter	Error magnitude
x/y/z Post-Survey	200 um
Roll Post-Survey	300 urad
BPM - Magnet field center alignment (initial install) (x & y)	30 um
BPM - Magnet alignment (post-BBA, if BBA not simulated) (x & y)	10 um
Relative Magnetic field strength (dB/B) (systematic)	1e-4
Relative Magnetic field strength (dB/B) (random)	1e-4
Magnet mover step-size (x & y / roll)	300 nm / 600 nrad
Magnet mover LVDT-based trim tolerance (x & y / roll)	1 um / 2 urad
C/S - band BPM nominal resolution (x & y)	100 nm
Stripline BPM nominal resolution (x & y)	10 um
IP BPM nominal resolution (x & y)	2 nm
IP Carbon wirescanner vertical beam size resolution	2 um
IP BSM (Shintake Monitor) vertical beam size resolution	use attached data
EXT magnet power-supply resolution	11-bit
FFS magnet power-suppy resolution	20-bit
Pulse - pulse random magnetic component jitter	10 nm
Pulse - pulse relative energy jitter (dE/E)	1e-4
Pulse - pulse ring extraction jitter (x, x', y, y')	0.1 sigma
Corrector magnet pulse-pulse relative field jitter	1e-4

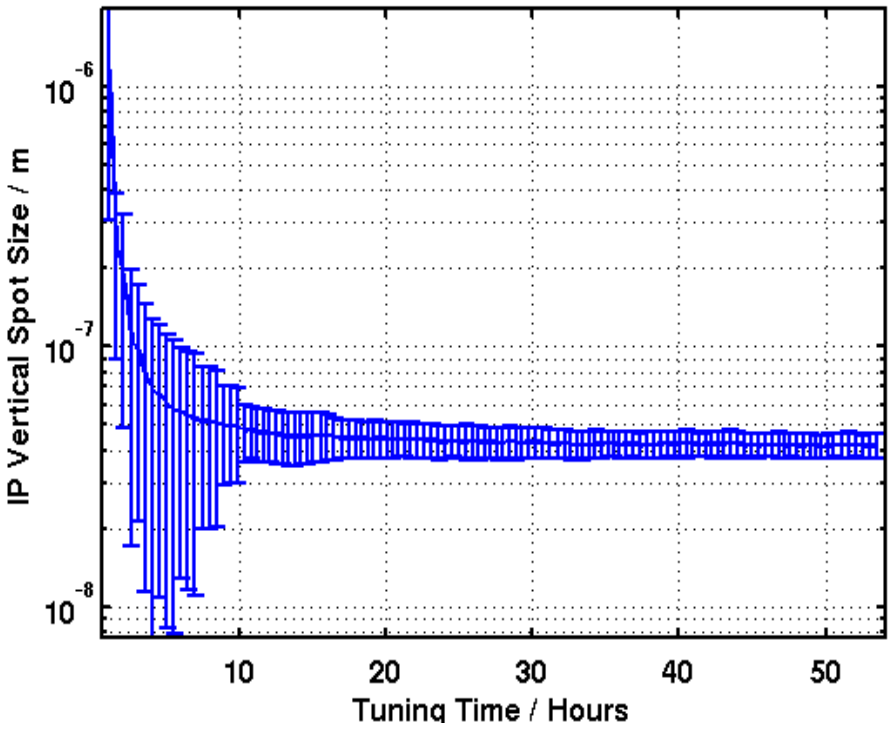
Done

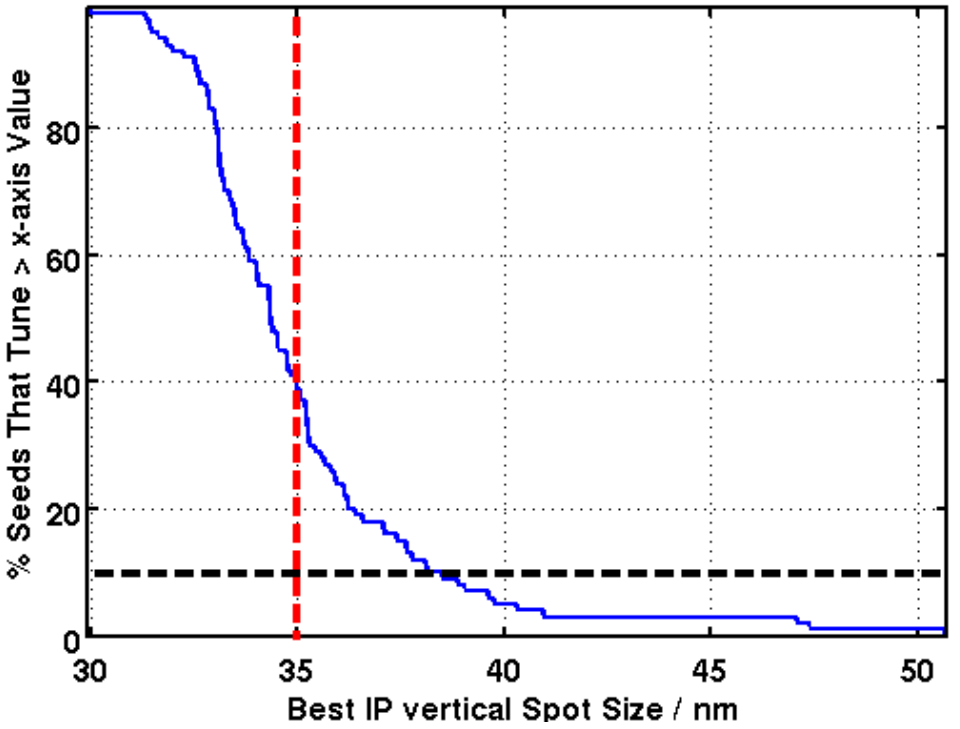
- Error list on wiki
- Also GM- ATF fitted Model
- Also include measured multipoles for final doublet, sextupoles and FFS bends.

Sextupole Mover System

- 5 Mover systems under FFS Sextupoles most important of all movers
- Need to move sextupoles during multi-knobs as quickly and accurately as possible.
- Need accurate move size vs. time vs. accuracy data to properly model (will be provided by JN)
- May need better motor drivers (faster) for these magnets (possible to salvage old nanobpm motor drivers maybe with help from DM)
- Use Sext BPMs as readback, not LVDTs (more accurate and faster).

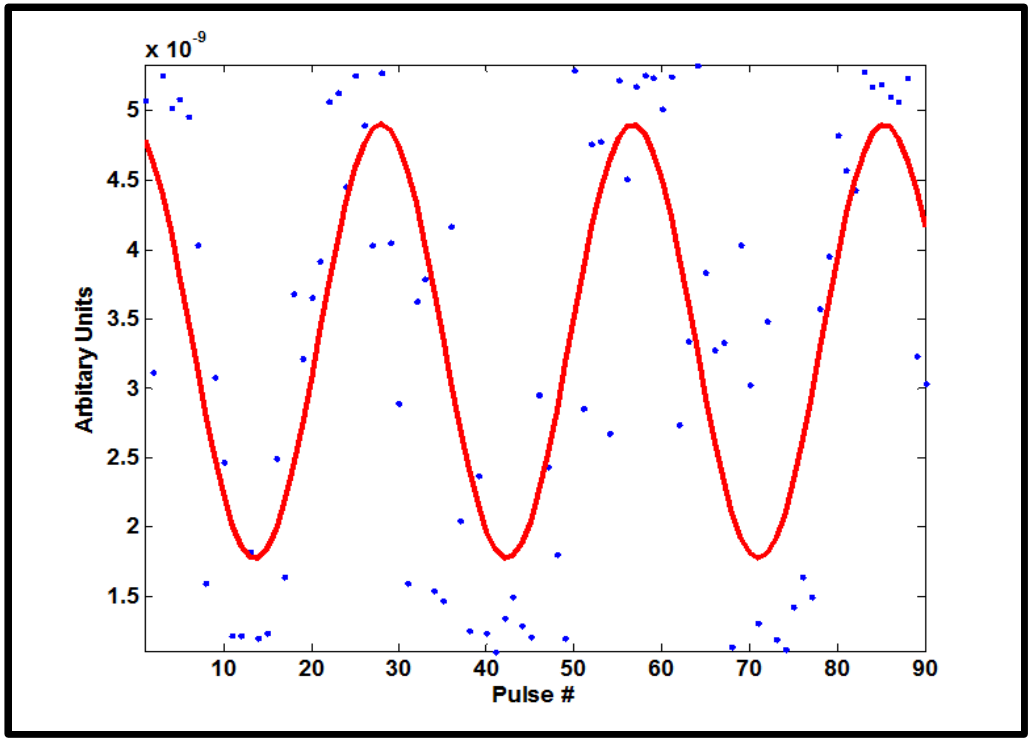
Improved Tuning Results with Better Sextupole Tuning Knobs

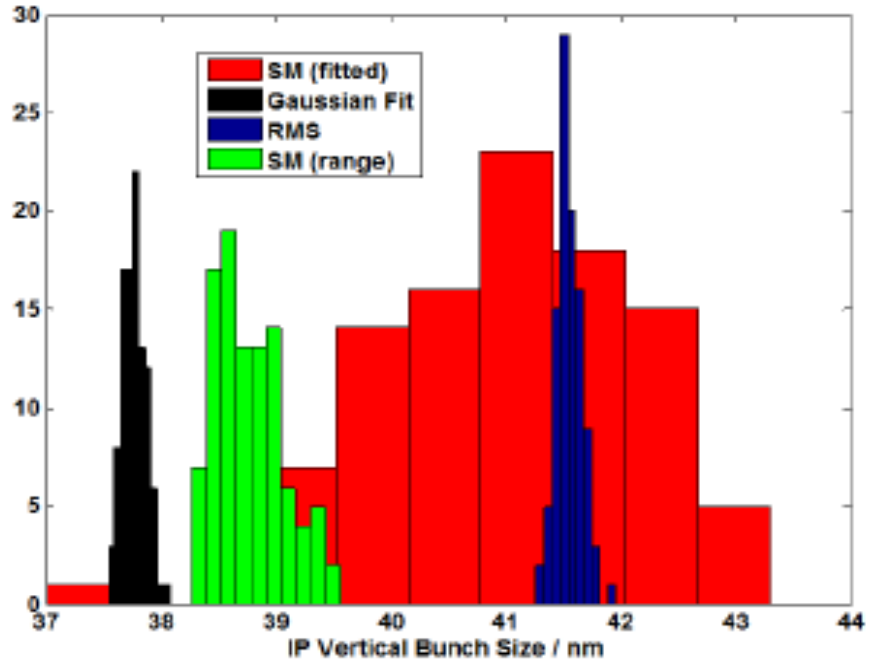




- 2nm IPBSM resolution throughout tuning
- No simulation of sext mover time
- No GM during tuning or BPM or IP measurement averaging

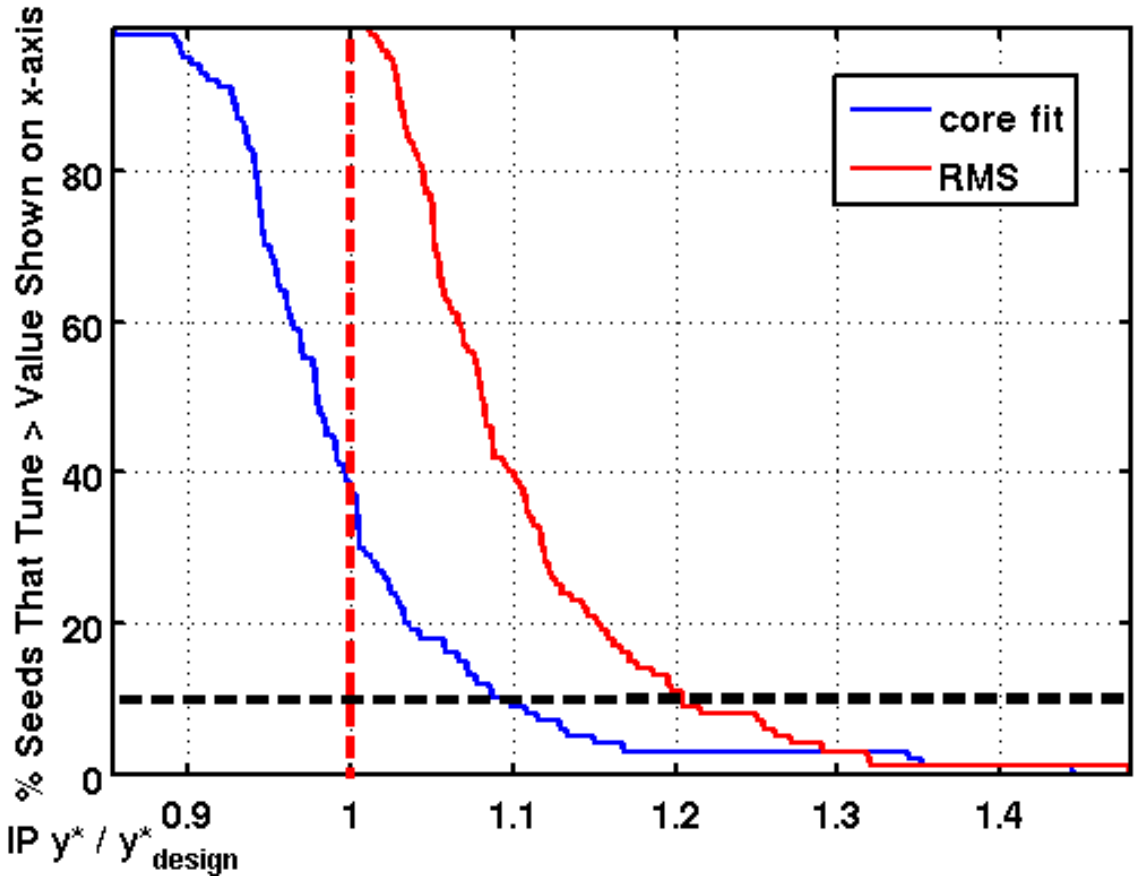
IP Measurement Process





- Can measure (in simulation) the beam size in different ways with different results (at 10% level).

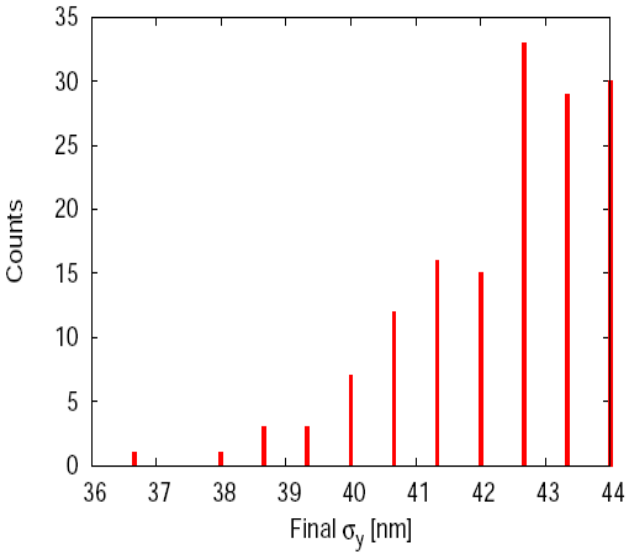
RMS vs. Core Fit Methods



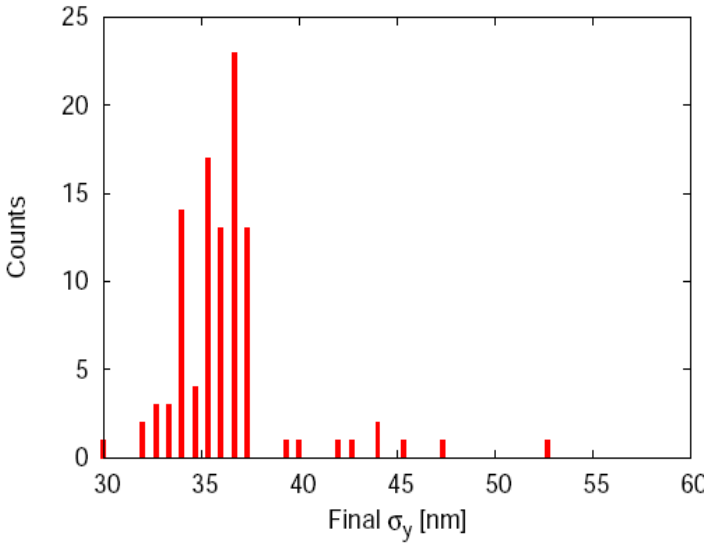
- Performance ~10% worse when using RMS fit method

Tuning Performance with 'Pushed' IP Vertical Beta

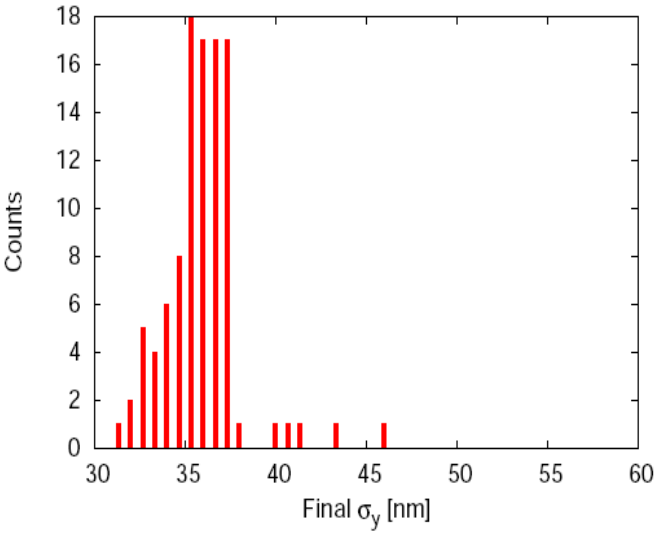
100 um



50um



25um

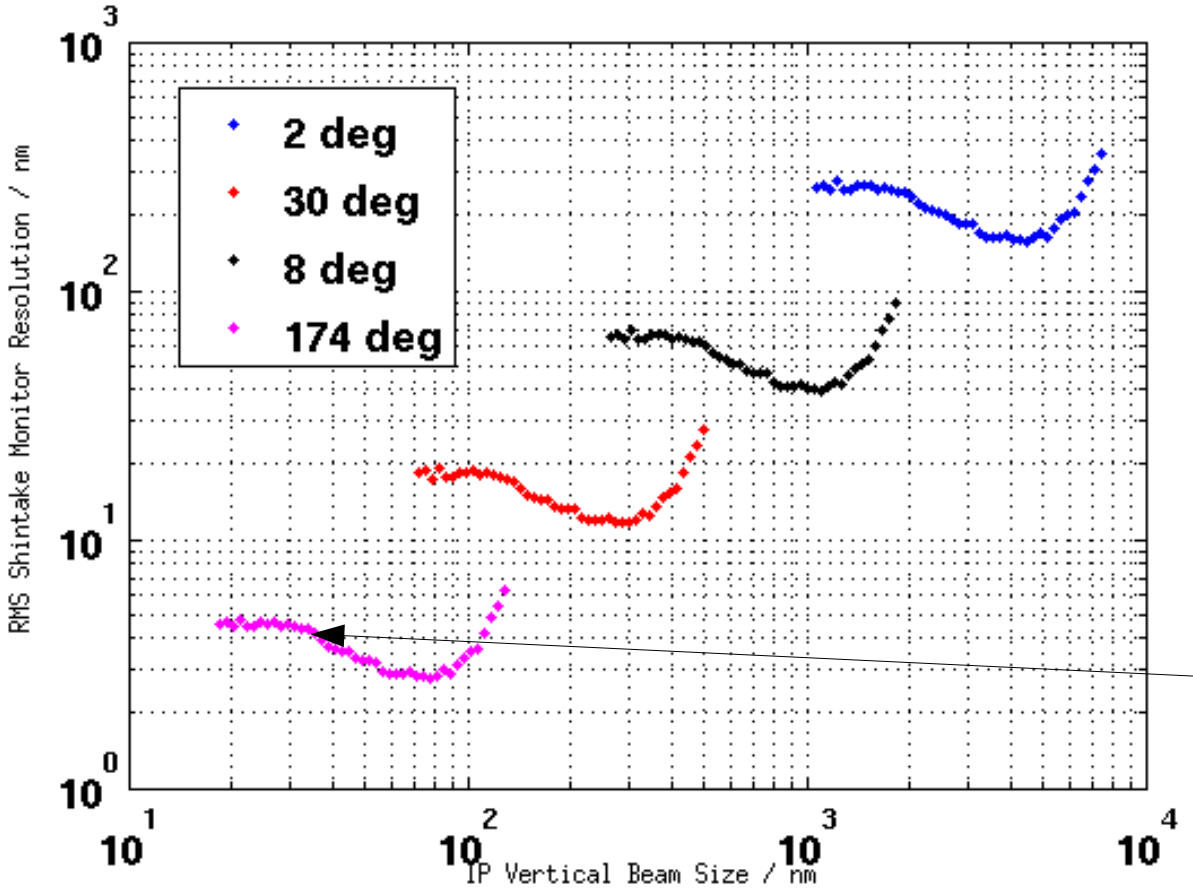


- Simulations from Rogelio
- RMS spot size method
- Shows inability to lower RMS spot size below ~35nm

IP Measurement Resolution

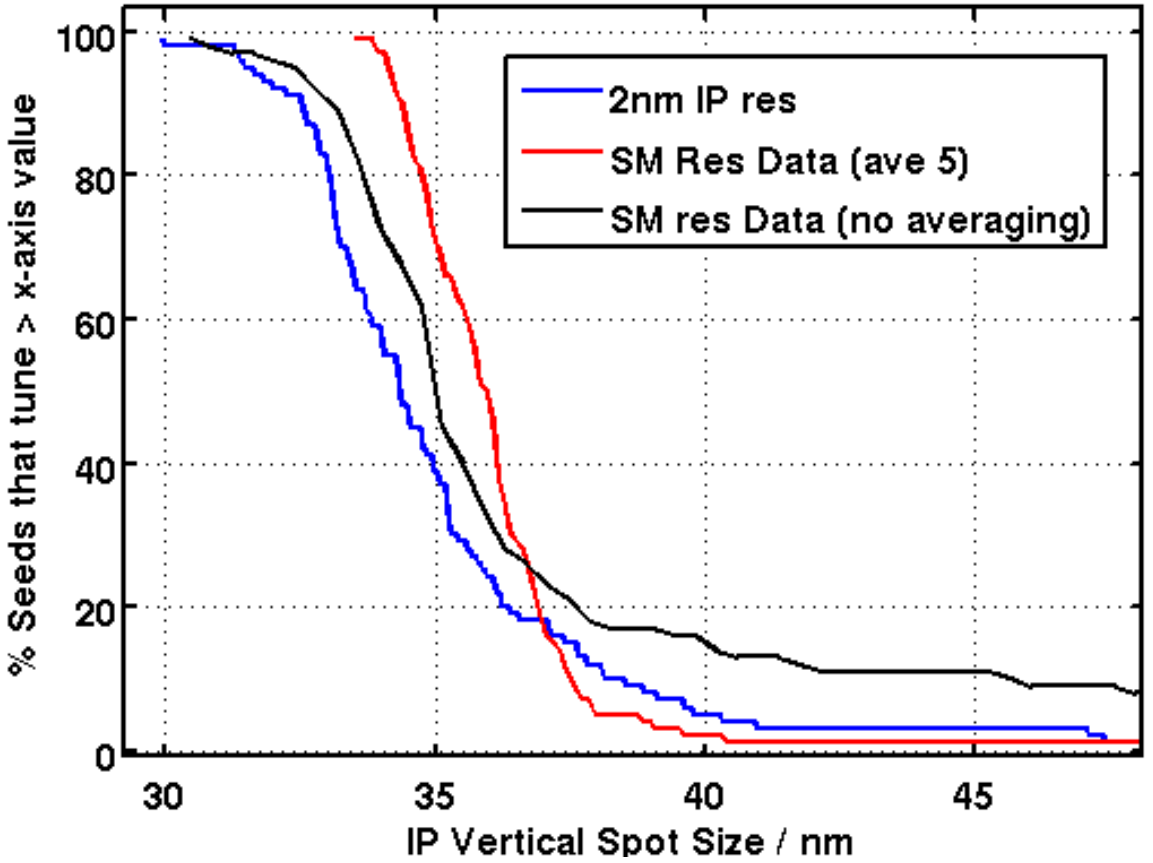
- Can now use calculated resolution data from Tokyo group for Shintake monitor vs. beam size
- Beneficial to integrate more than 1 IP measurement per tuning step (towards end of tuning when spot size is small) ?
  - IP beam size growth over integration time due to various drifts must be small compared to improvement in measurement resolution.

Shintake BSM Resolution Data



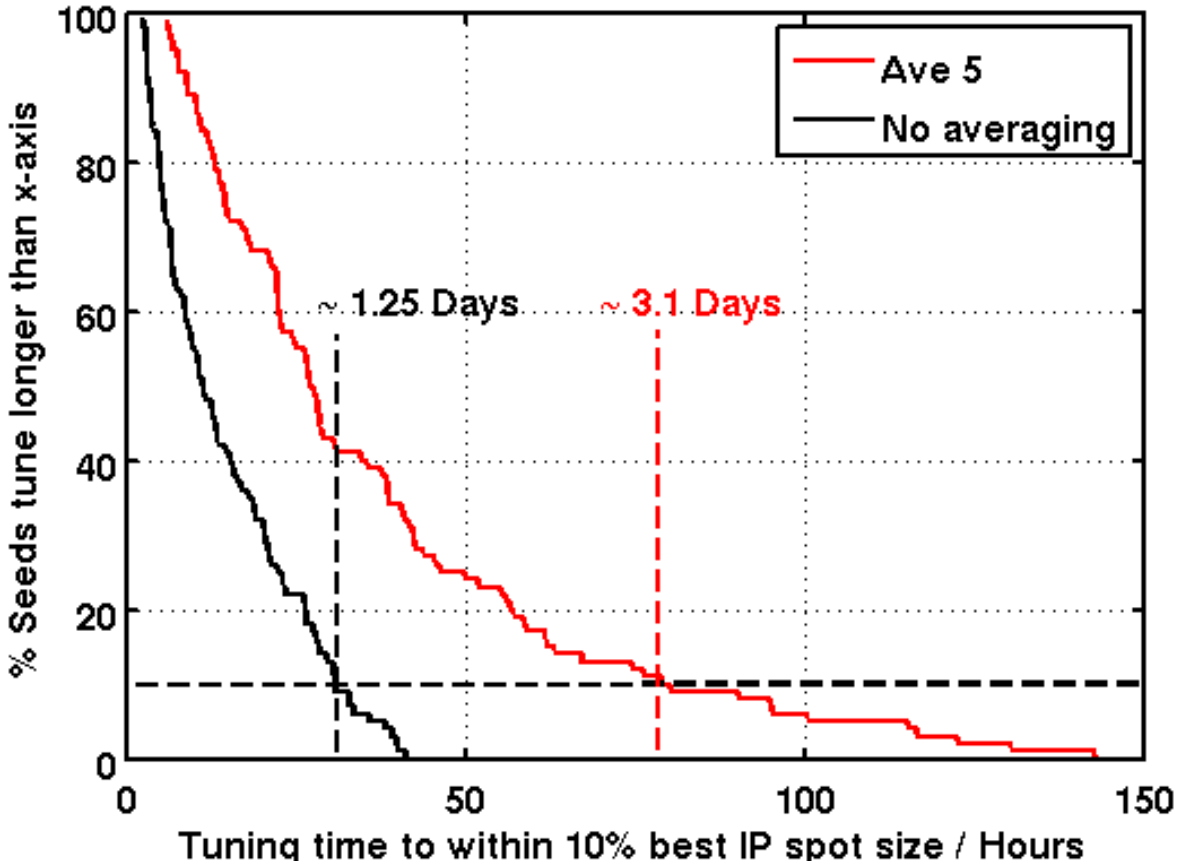
RMS resolution at
35nm goal spot size
~4nm

Results with IPBSM Resolution Data



- Tuning performance using IPBSM resolution data.

Tuning Time



- Tuning time with and without averaging of IP spot size measurements with IPBSM

Summary

- Results and timescale look promising.
- Tuning on RMS vs. beam core makes significant difference to results.
  - Maybe impossible to tune below ~35nm using RMS
- Things still to add to simulations
  - Sextupole mover realism
  - Known magnet multipole components
  - Dynamic effects during tuning
  - Check mover ranges
- Simulation results stored (100 seeds) for post-alignment and post-tuning cases on SLAC ATF2 ftp server (link from wiki). Formats supported: Lucretia & AML

Task Group Meeting Schedule

- Goal to present final tuning plan in Dec ATF2 meeting
  - Cross-checked results with multiple models
  - Details of tuning algorithms and planned implementation
- Internal update meetings ~ every 2 weeks by webex
  - All welcome to attend.
- First meeting Monday 22nd Sept. (08:00 UTC)
  - Meetings announced via atf2-commissioning mailing list