ATF2 LATTICES

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PLAN OF THE TALK

1. The ATF2 Nominal and Ultra-Low β^* Lattice.
2. Multipoles
3. Possible Solutions
   - Alternative lattices
4. Squeeze sequence
5. Feasibility of the ATF2 Bx2.5By1.0 Lattice.
   - Knobs for the ATF2 Bx2.5By1.0 lattice.
   - Tuning results.
6. Swapping the magnets
7. Conclusions and Future Plans.

1. ATF2 IDEAL LATTICES

ATF2 Nominal Lattice

$\sigma_x = 3.2\ \mu m$
$\sigma_y = 37.0$ nm (rms)
$\sigma_y = 35.0$ nm (core)
$\beta_x = 3.9$ mm
$\beta_y = 0.1$ mm

ATF2 Ultra-low β* Lattice

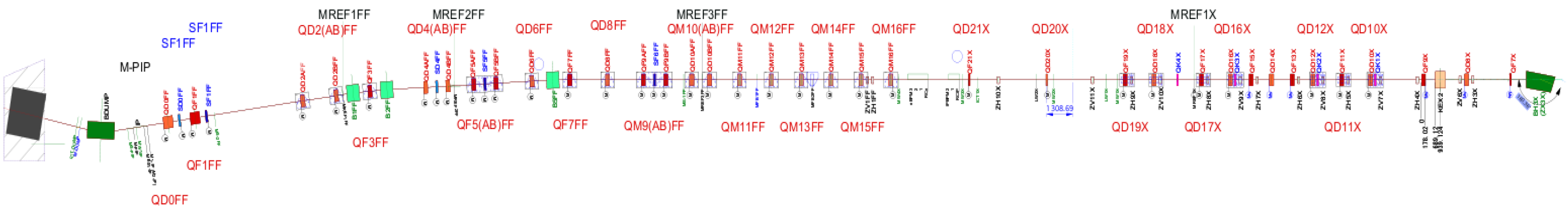
$\sigma_x = 3.8\ \mu m$
$\sigma_y = 22.9$ nm (rms)
$\sigma_y = 18.9$ nm (core)
$\beta_x = 4.2$ mm
$\beta_y = 0.025$ mm

Project	L* [m]	β_y^* [μm]	ξ_y
ATF2 Nominal	1.0	100	~19000
ILC Desgin	3.5	400	~15000
ATF2 Ultra-low	1	25	~76000
CLIC 3 TeV	3.5	90	~63000

2.1. MULTIPOLES IN THE ATF2- EXT FFS

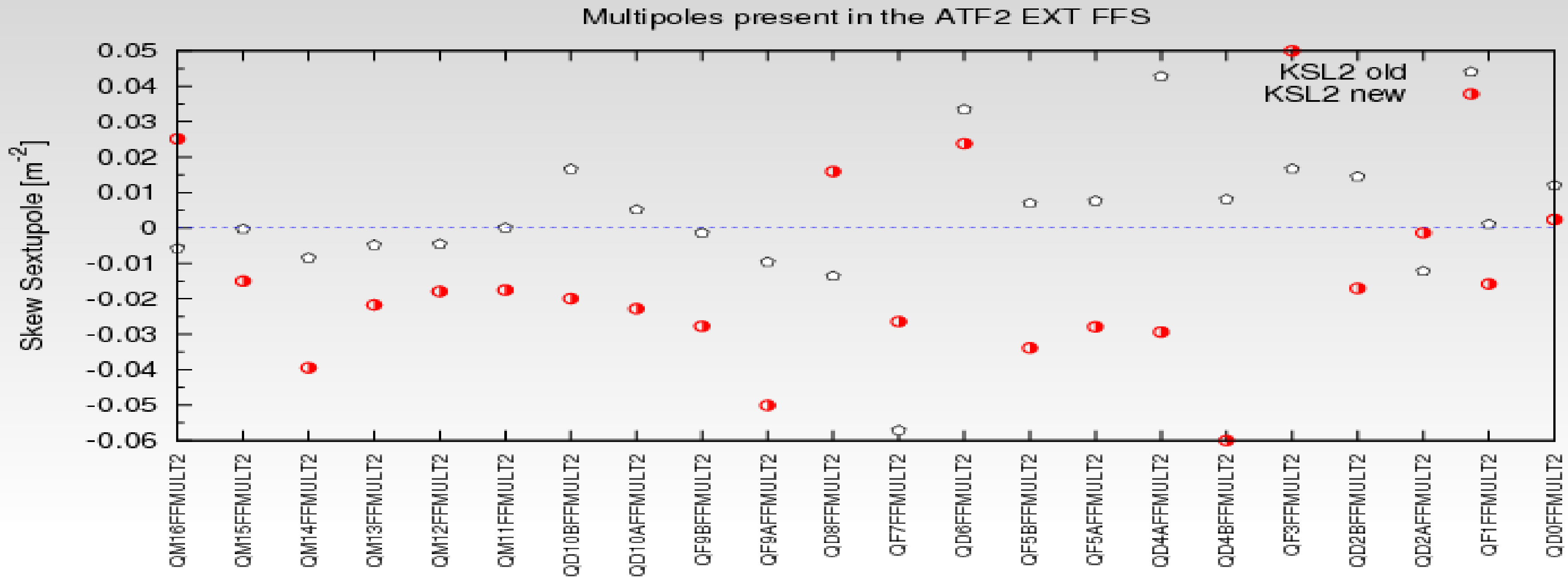
Multipoles included:

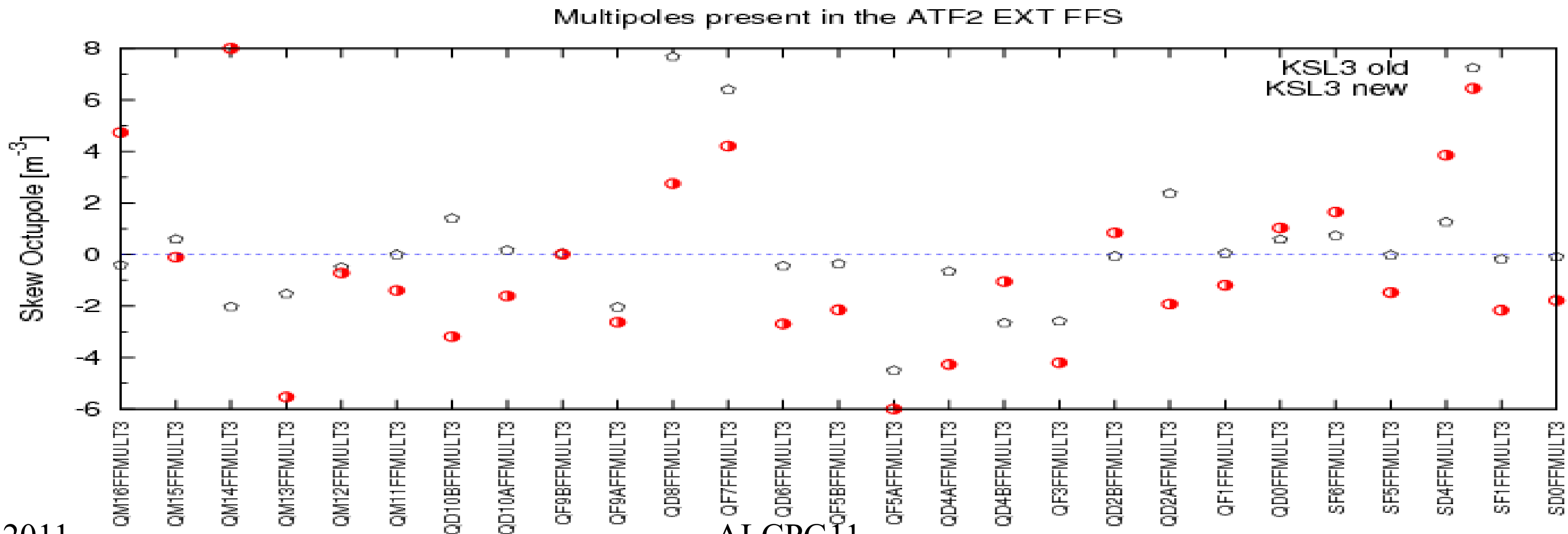
- Final doublet: Multipoles up to 18 pole
- Sextupoles: Multipoles up to 18 pole
- FFS Quadrupoles: Multipoles up to 8 pole
- EXT Quadrupoles: Multipoles up to 8 pole



2.2. MULTIPOLES IN THE ATF2- EXT FFS

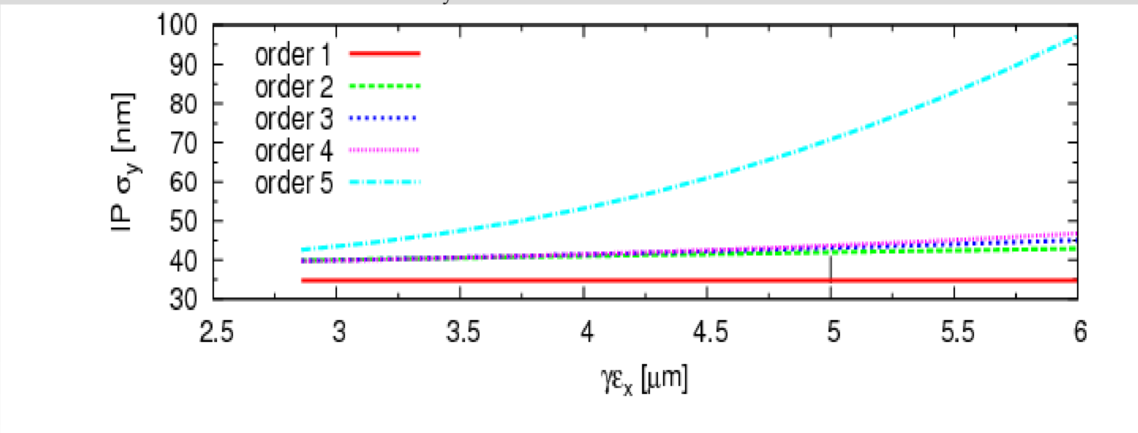
Comparision between last multipoles and the previous one:





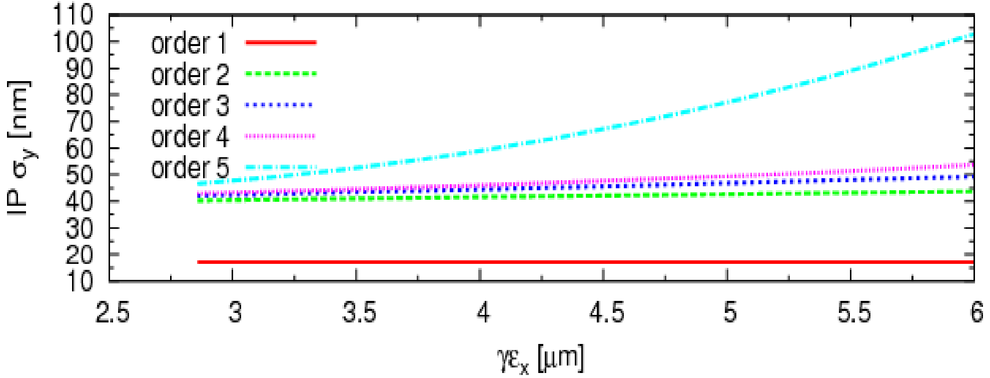
2.2. MULTIPOLES EFFECT

ATF2 β_y=100µm β_x=4mm With Multipoles



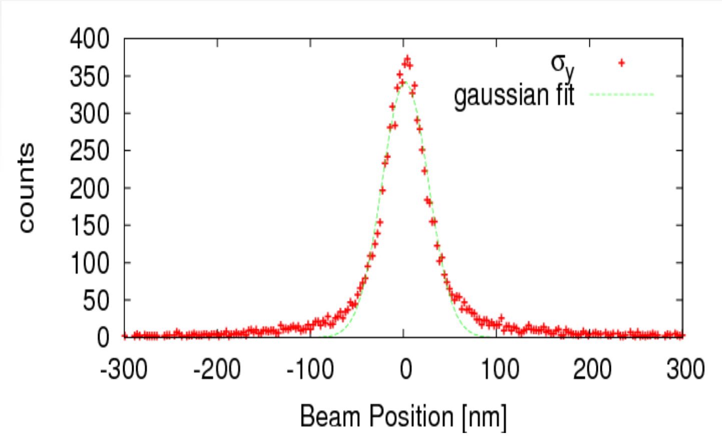
The skew sextupole component is corrected thanks to the skew sextupole inserted in the line last January

ATF2 β_y=25µm β_x=4mm With Multipoles



ATF2 Nominal Lattice

σ_x= 4.3 µm
σ_y= 72 nm (rms)
σ_y= 49 nm (Shintake)
σ_y= 41 nm (core)



ATF2 Ultra-low β* Lattice

σ_x= 5.5 µm
σ_y= 79 nm (rms)
σ_y= 52 nm (shintake)
σ_y= 30 nm (core)

3. POSSIBLE SOLUTIONS

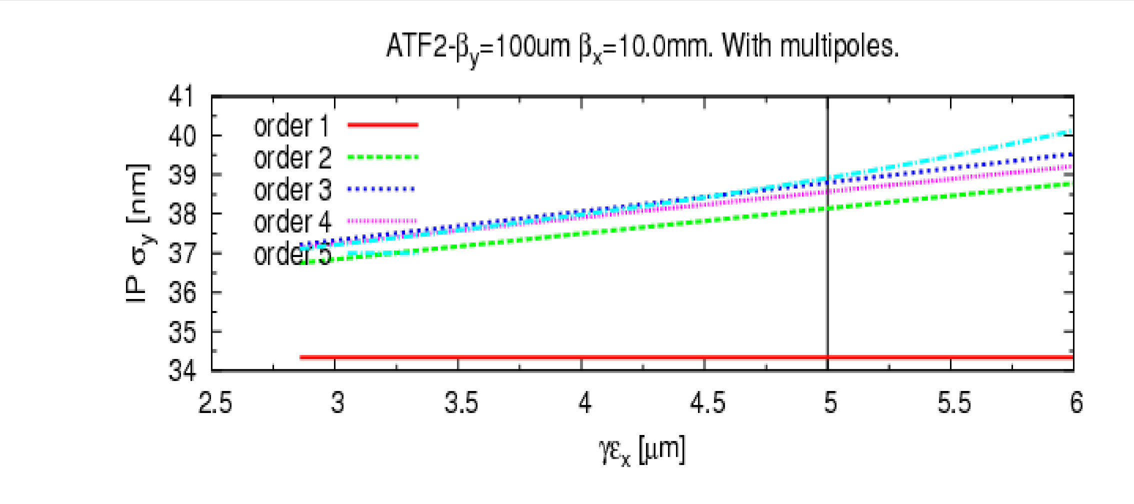
The possible cures in order to accommodate the existing multipoles could be:

- Decrease β_x at QF1FF
- Run the machine at lower horizontal emittance
- Replace the Normal conducting QF1 by a Super conducting magnet (*)
- Swap the magnets

(*) not covered in this talk. For further details refer to the following presentation:

Impact on the beam size using a SC QF1 on the ATF2 Ultra-low β* lattice , during the ATF2 SC meeting in October 2009.

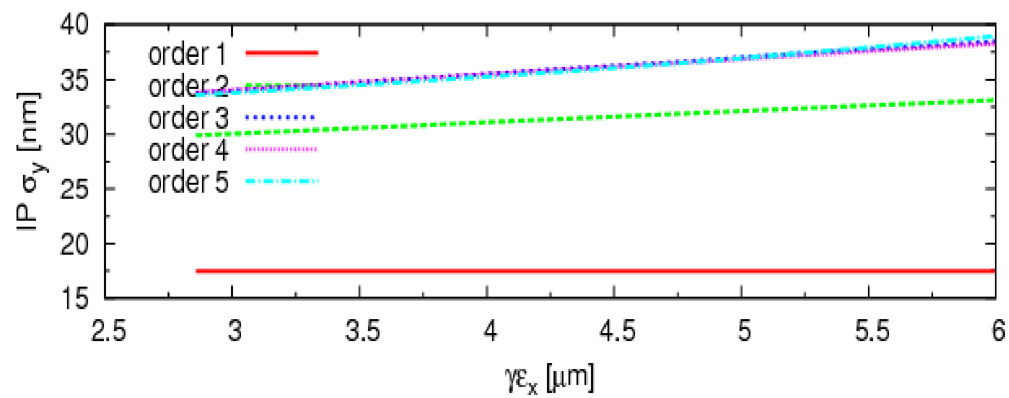
3.1 ALTERNATIVE LATTICES: DECREASE β_x at QF1



ATF2 *Nominal* Lattice

$\sigma_x = 4.9\ \mu m$
$\sigma_y = 38.5$ nm
$\beta_x = 10$ mm
$\beta_y = 100\ \mu m$

ATF2 β_y=25μm β_x=10mm With Multipoles



ATF2 *Ultra-low* Lattice

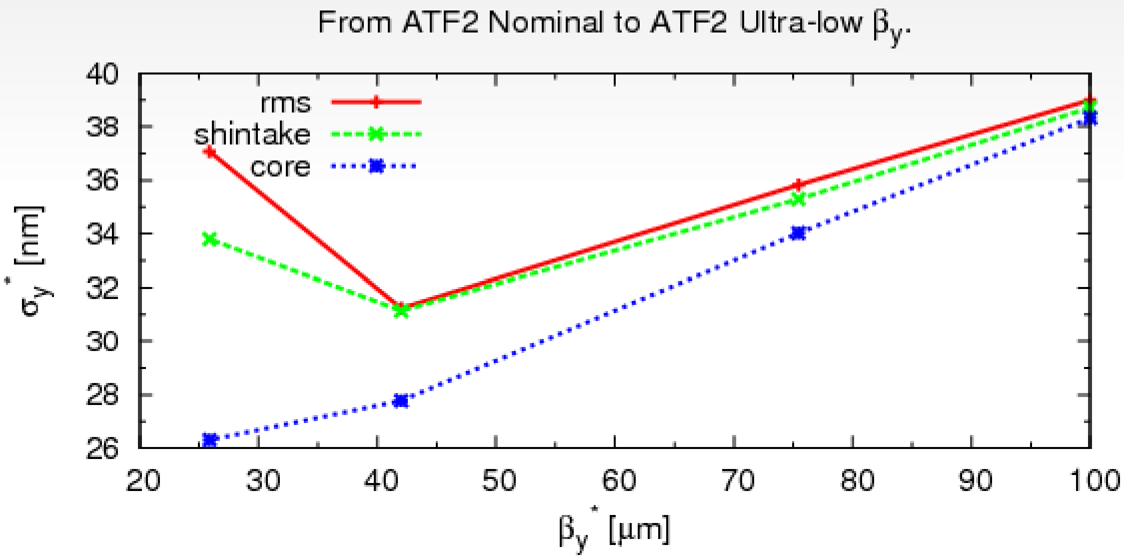
$\sigma_x = 4.8\ \mu m$
$\sigma_y = 37.0$ nm
$\beta_x = 10$ mm
$\beta_y = 25\ \mu m$

All these lattices are available at: http://clicr.web.cern.ch/CLICr/ATF2/New_Multipoles2

4. SQUEEZE SEQUENCE

To reach a successful tuning for the Ultra low lattice is recommended to follow a squeeze sequence.

In this sense, 2 Intermediate lattices (β_y= 42 µm & β_y= 75 µm) have been worked out.



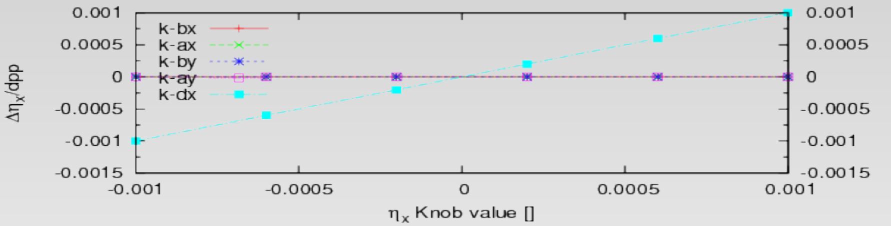
The Shintake monitor observed a minimum beam size at β_y =42 µm.

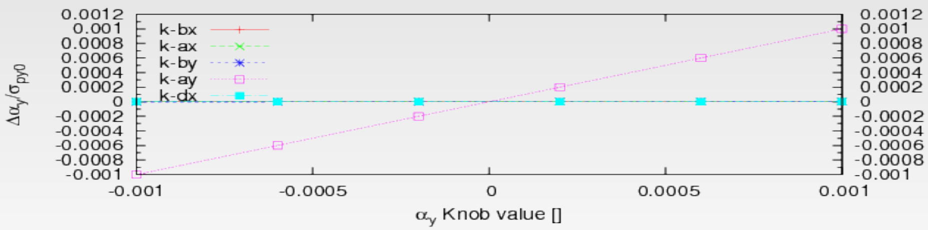
The new chromaticity is about ~ 47.000 < 63.000 (CLIC)

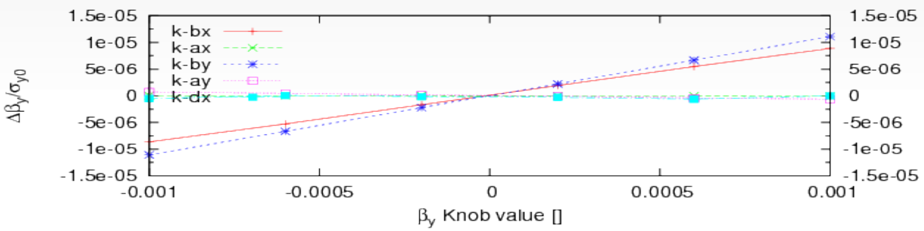
Chromatic effects can not be corrected for the ATF2 β_y = 25µm lattice

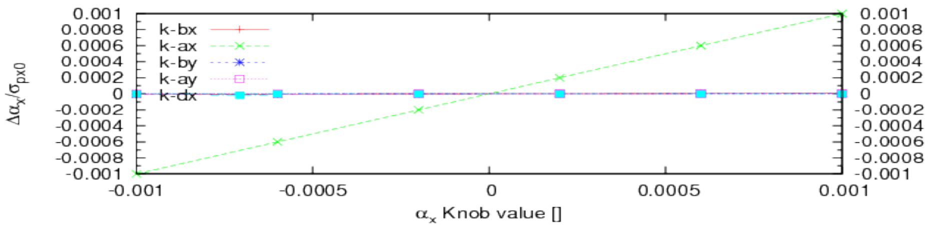
5.1 ATF2 Bx25By1 KNOBS

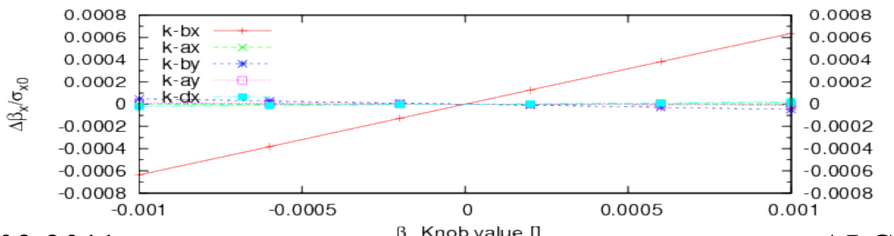
Horizontal displacements sextupoles Vertical displacements

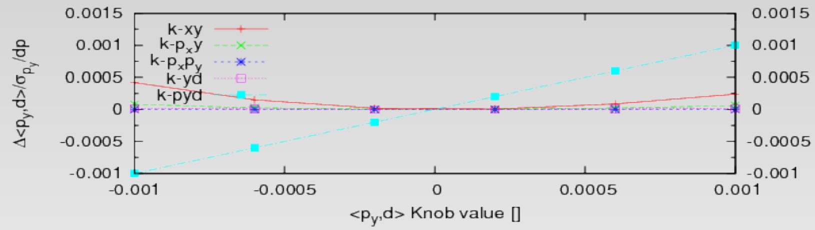


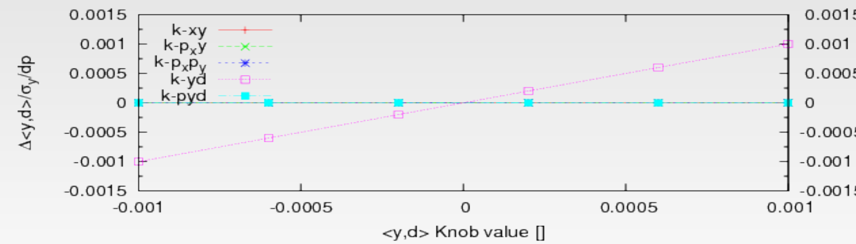


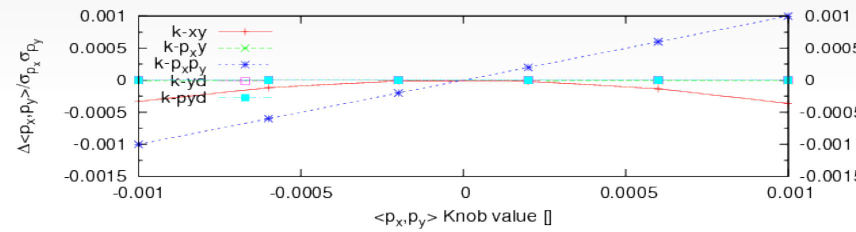


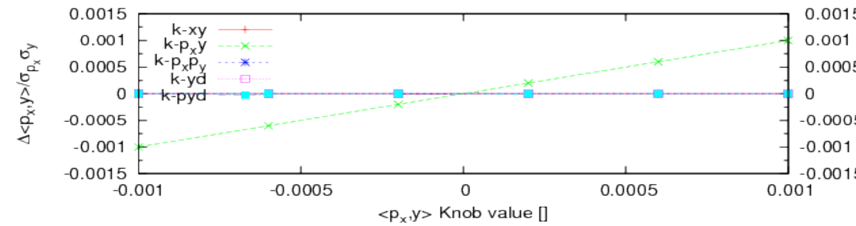


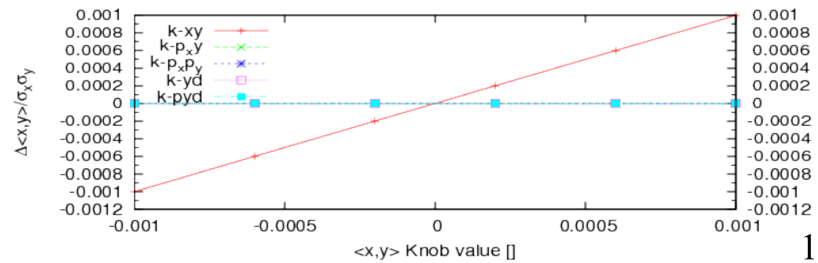






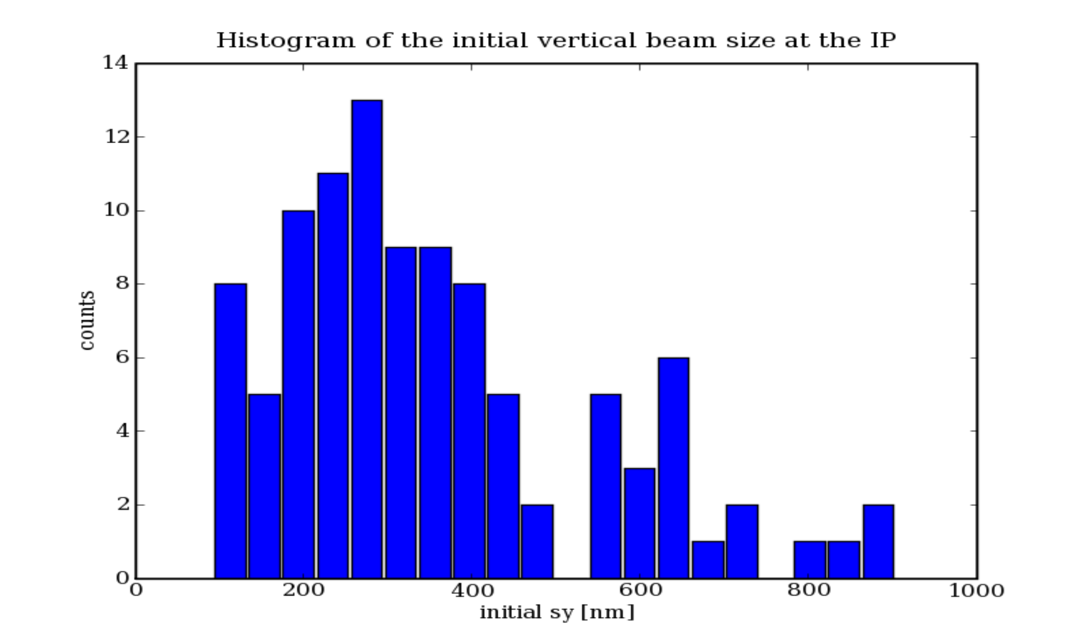






5.2. TUNING CONDITIONS

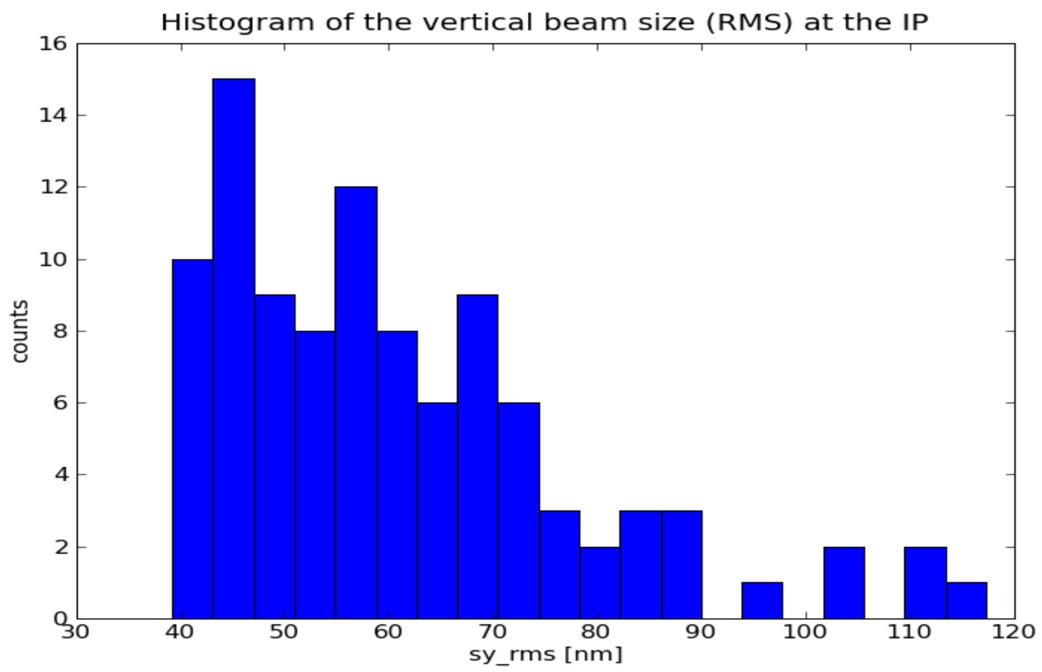
- Statistical Study of 100 seeds.
- Quads & Sext. misalignent: 30 µm
- Quads & Sext tilt: 300 µmrad
- Strength error: 10^{-4}
- Tuning via MAD-X & MAPCLASS using Simplex algorithm

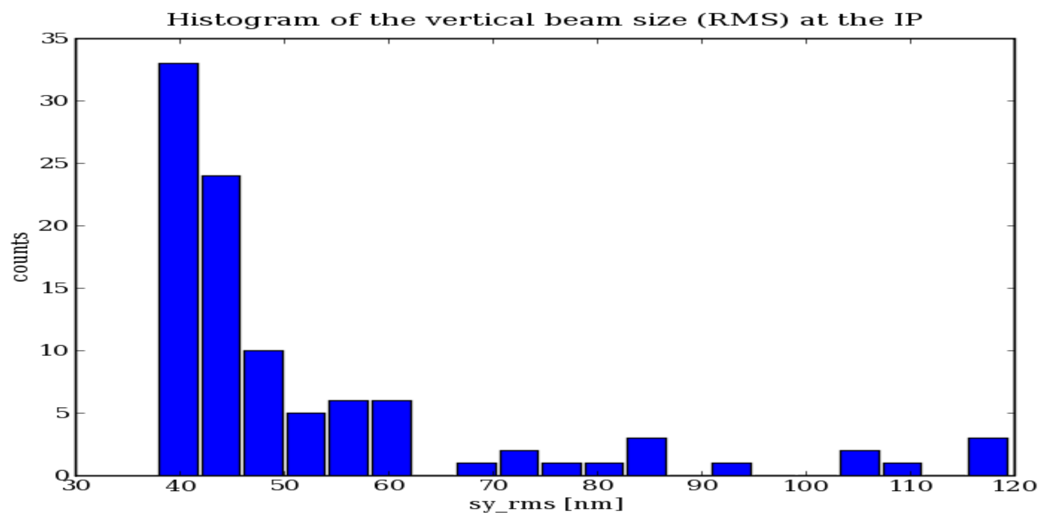


Constraint:

<u>minimize σ_y evaluated as the BSM does</u>

5.3. TUNING RESULTS





After scanning the obtained set of knobs 3 times...

53 % seeds < **60 nm** (rms)

(new multipoles)

75 % seeds < **60 nm** (rms)

(old multipoles)

Next steps:

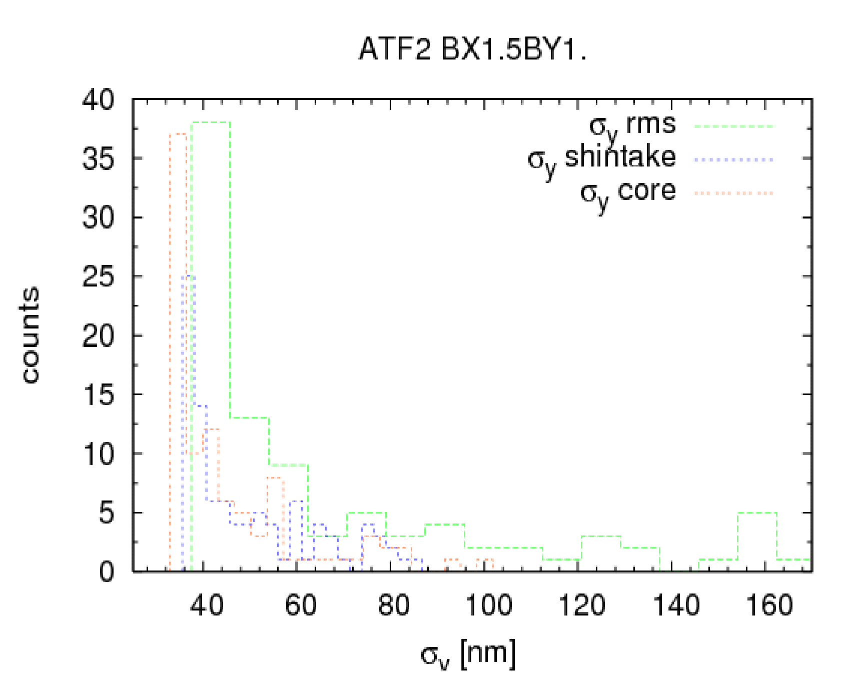
- Try to improve the algorithm
- To include ground motion

5.4. SWAPPING THE MAGNETS

Optimizing the magnets locations according to their field quality.

ATF2 Swap BX1.5BY1.0

$\sigma_x = 4.0\ \mu m$
$\sigma_y = 42.0$ nm (rms)
$\beta_x = 6.2$ mm
$\beta_y = 100.0\ \mu m$



Tuning results

62 % $\sigma_y < 48$ nm (rms)
70 % $\sigma_y < 47$ nm (Shintake)
85 % $\sigma_y < 48$ nm (core)

This lattice was obtained with the previous multipoles version.

A new swapping option could be work out according to the new multipoles.

6. CONCLUSIONS & FUTURE PLANS

- The last multipoles evaluation release (v4.4) have been introduced into the model.
- New designs for both Nominal and Ultra-low lattices have been obtained. Still work ongoing for improvements in terms of β_x^*.
- A first statistical tuning study shows that 53% of the seeds reach a final σ_y <60 nm.

To be done...

- To decrease β_x^* in order to obtain a more suitable ratio σ_y/σ_x and get closer to ILC and CLIC designs.
- To implement the squeeze tuning technique for the ATF2 Intermediate lattice.
- Hopefully the tuning algorithm will improve.
- Consider a new lattice in terms of better magnet distribution
- To include the ground motion into the tuning simulations.