Update to FFS tuning Studies

with L*= 4 m

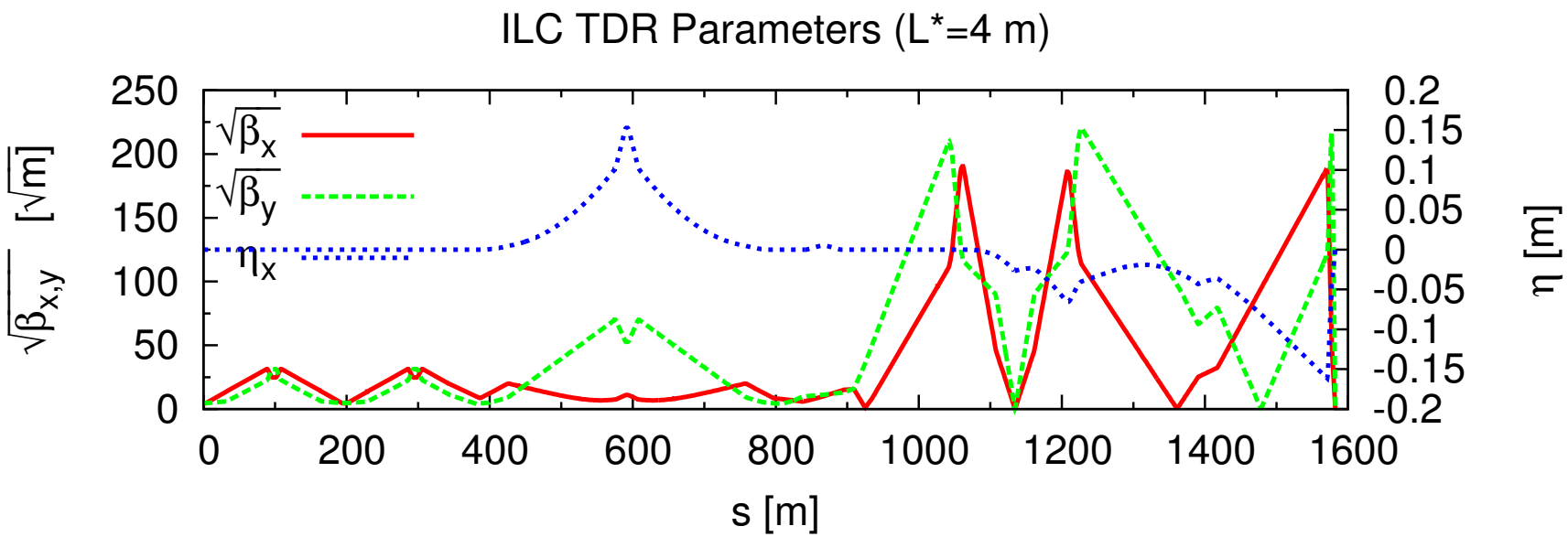
Edu Marin
emarinla@slac.stanford.edu
SLAC

March 30th, 2015
BDS Working Group Meeting

LATTICE

Lattice

Considered lattice in my study is the ILC-BDS with L* = 4 m[1]

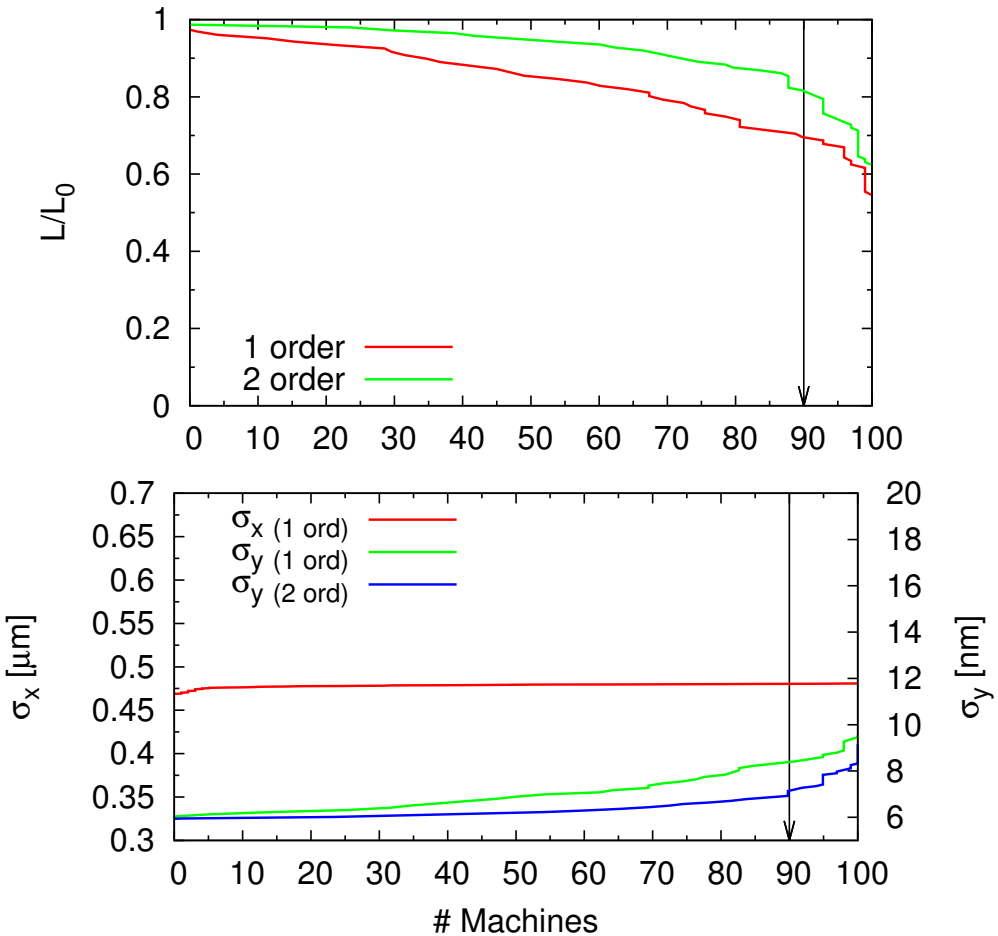


[1] Presented in LCWS 2014

TUNING STUDY

First & Second order Aberrations

Obtained confidence level when **artificially** removing 1st and 2nd order correlations evaluated from 100 particle distributions at the IP (after steering and BBA)



After 1st order

$< \sigma_x >= 478 \pm 2\text{nm}$

$< \sigma_y >= 7.1 \pm 0.9\text{nm}$

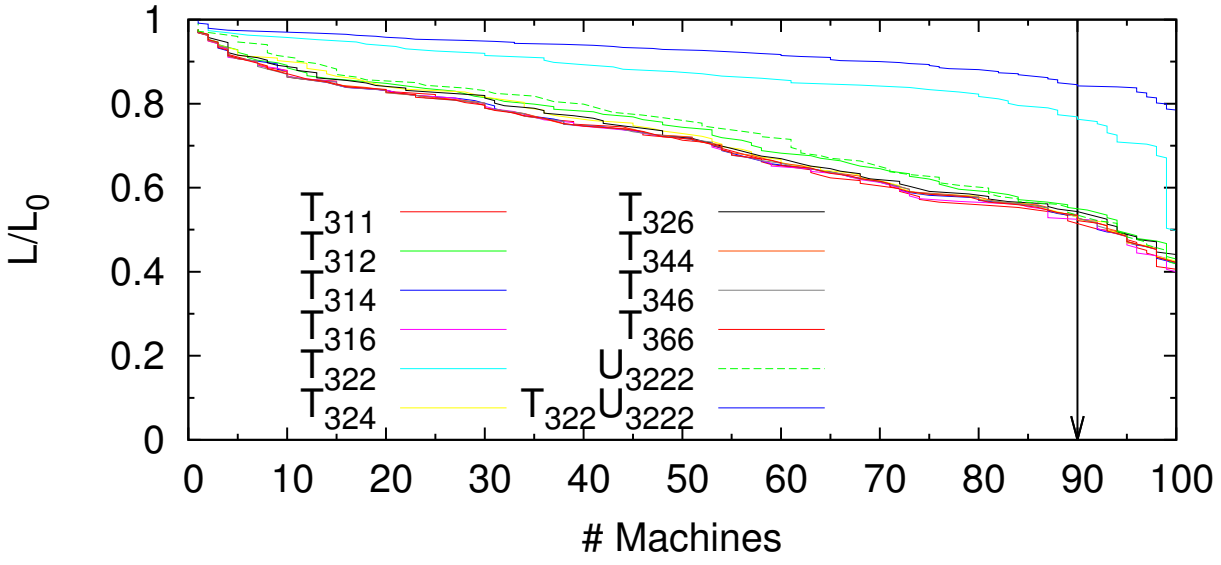
After 2nd order

$< \sigma_y >= 6.4 \pm 0.6\text{nm}$

Still 10% of machines with 20% Lumi loss

Second & Third order Correlations

Luminosity improvement due to 2nd & 3rd order correlations



Most important 2nd order correlation:

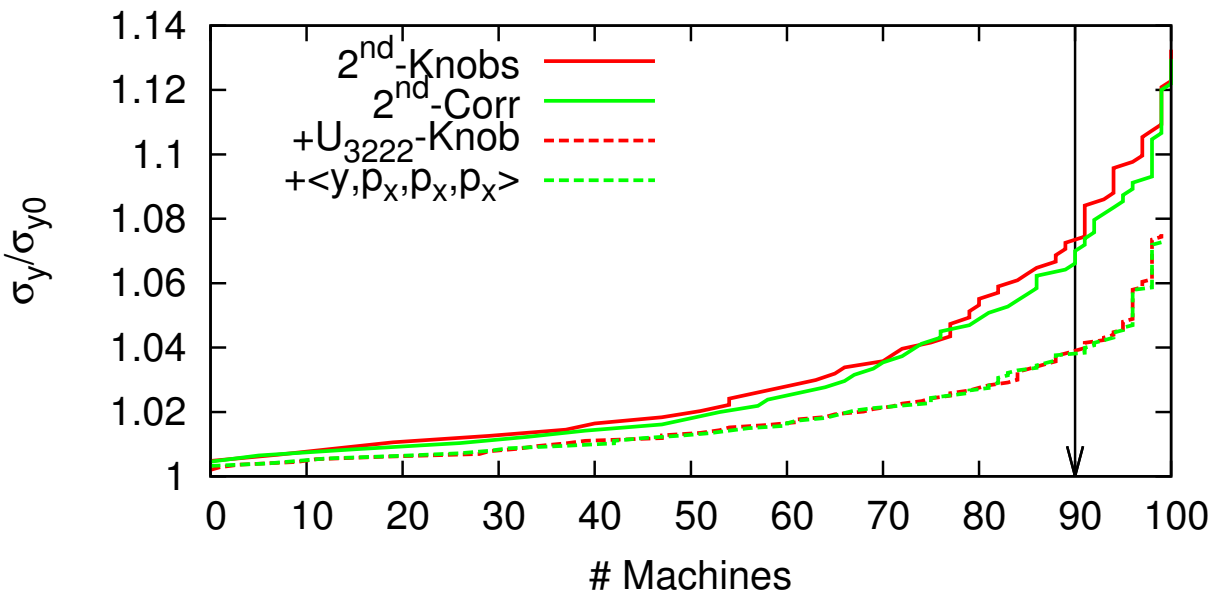
*T*322

3rd order correlation **U_{3222}** further reduces $\Delta\sigma_y$

KNOBS

High Order Knobs

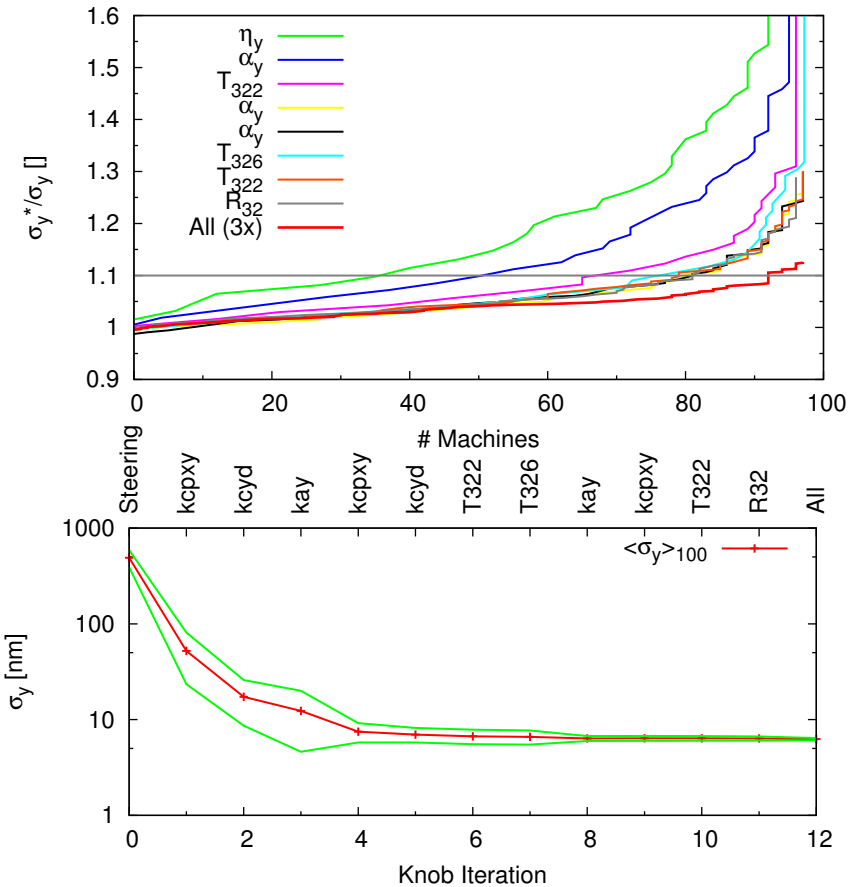
Knobs constructed by means of 4 skew sextupole strengths target 2nd order correlations $T_{312}, T_{324}, T_{322}$ and T_{326}
In addition to that, U_{3222} knob is obtained by means of strength variations of skew sextupole and octupole (OCM10) magnets



Comparable performance is obtained by the applying the knobs or artificially removing the calculated correlations

Integral Tuning Procedure

Tuning Procedure: **Steering + BBA + Knobs**



BACK-UP

Tuning Framework

Monte-Carlo study of 100 different machines

Error conditions:

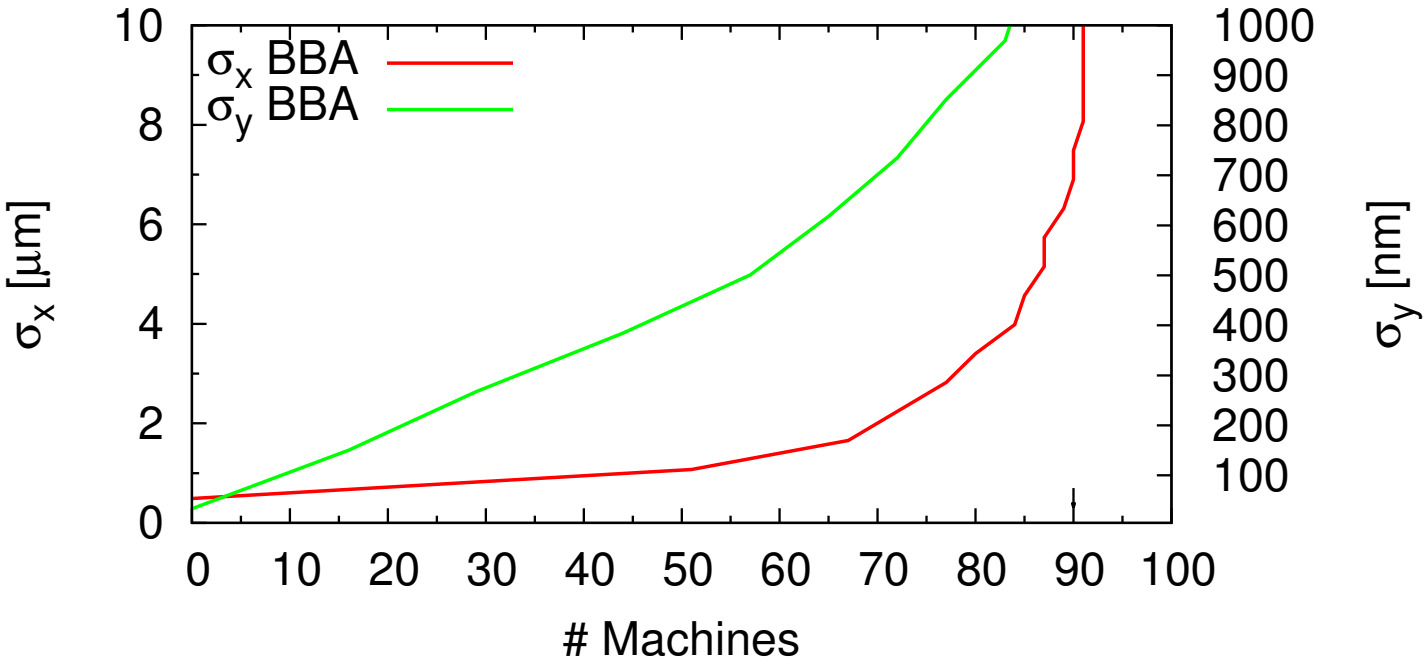
- Alignment (x/y) error: 100 μm
- Tilt error: 300 μrad
- Relative strength error: 10^{-4}
- BPM reading error: 1 μm
- BPM alignment error: 0.3 μm
- Mover error: 2 μm

Tuning Procedure:

- 1-to-1 Steering
- BBA of Sextupole & Octupole magnets
- Knobs scan

Spot Sizes before Knobs

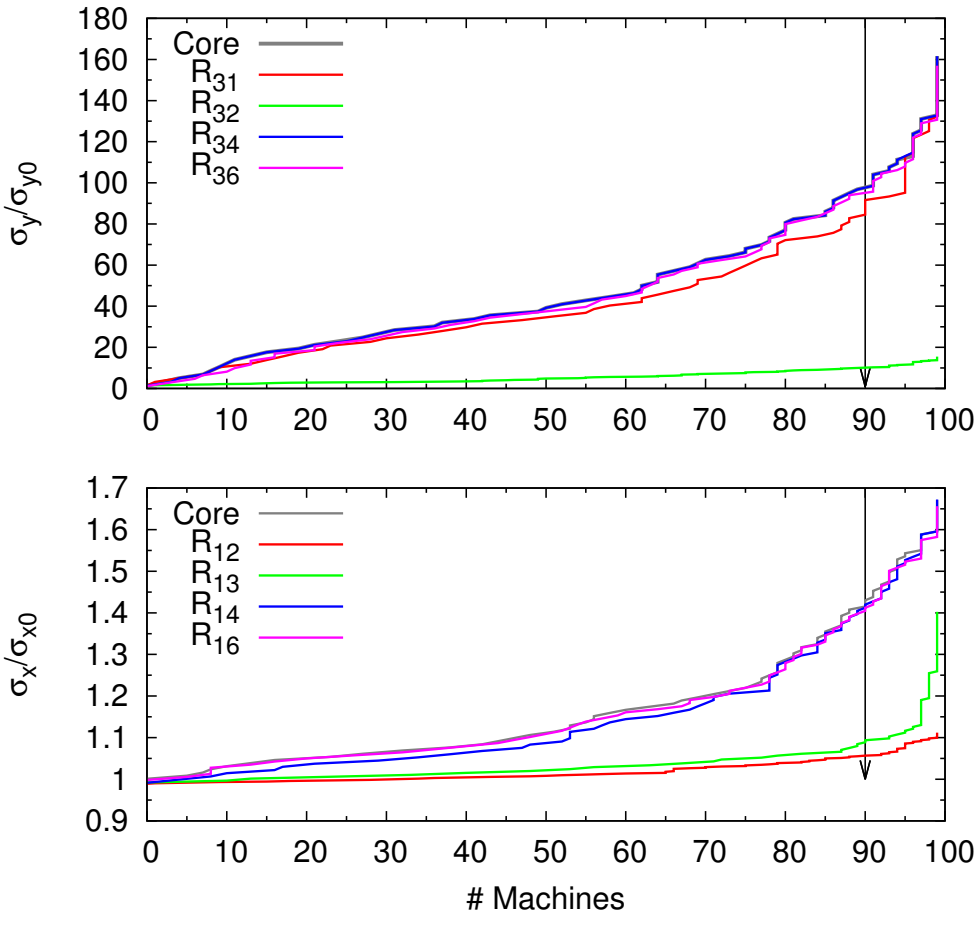
Obtained confidence level after BBA



$$< \sigma_x >= 587 \pm 104 \text{ nm}$$
$$< \sigma_y >= 377 \pm 265 \text{ nm}$$

ABERRATIONS STUDY

First order Correlations



Most important 1st order correlations:

in y

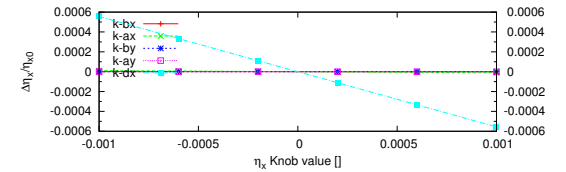
$< p_x, y >$

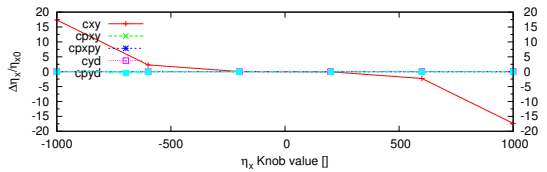
in x

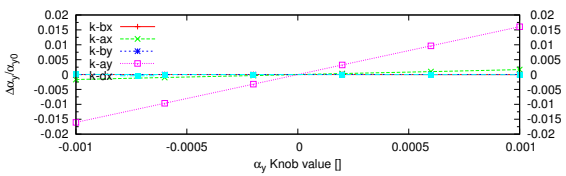
α_x and η_x

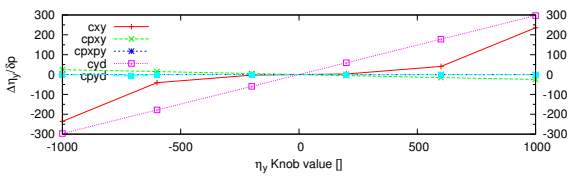
Linear Knobs

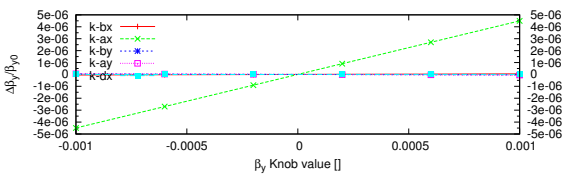
Linear Knobs constructed by means of transverse displacements of normal sextupole magnets to target α_x,α_y,η_x,η_y,$< p_x, y >$ and $< x, y >$

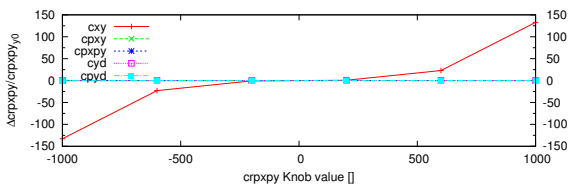


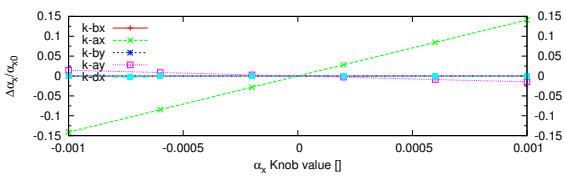


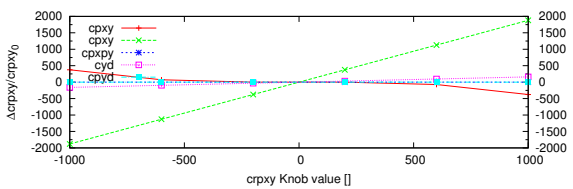


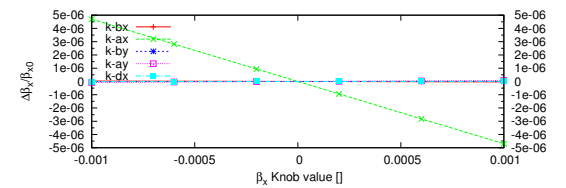


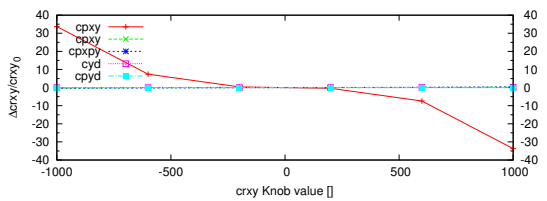




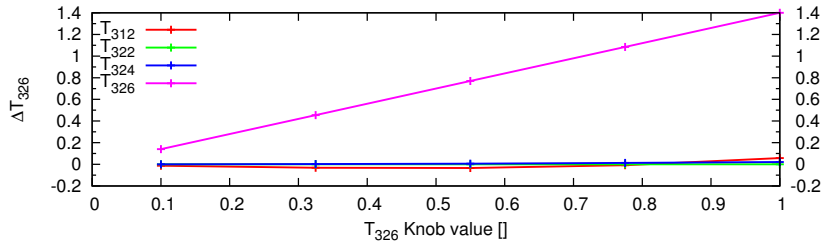


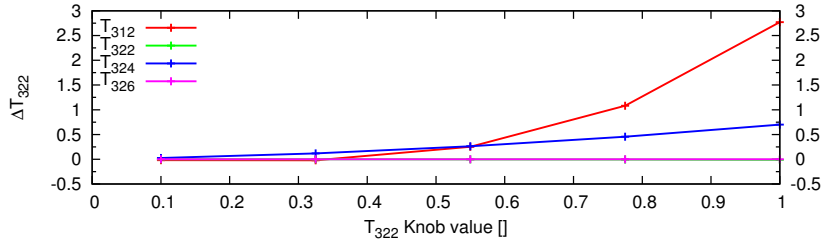


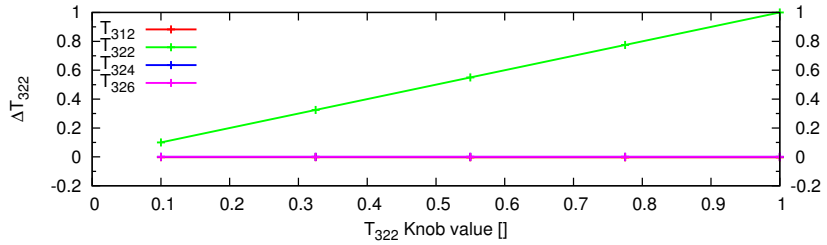


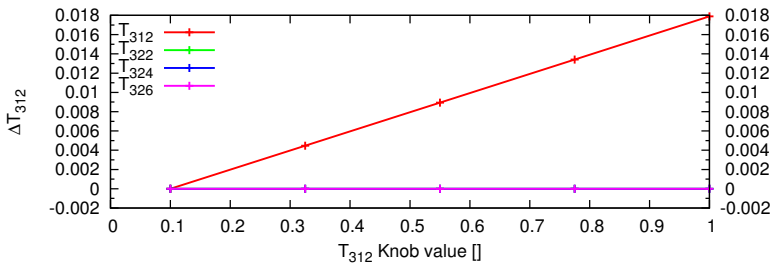


2nd Order Knobs









ALTERNATIVES UNDER CONSIDERATION

Knobs Range

Increasing η_x throughout the FFS reduces the strength of the sextupole magnets which relax the alignment tolerances for the quadrupoles magnets
In addition it increases the capability range of the tuning knobs which potentially could ease the tuning process