Simulation of the α, dispersion, coupling and β multiknobs in large β optics

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Introduction

- Simulation to scan the minimum vertical beam size using the coupling and dispersion corrections with skew quadrupoles, the α waist scan knobs with final doublet and the β_y knob with QM12.
  - at the Post-IP wire scanner (change QD0,QF1 from 130.34A, 70.84A to 105.24A, 66.87A)
  - nominal β_x =8cm, β_y =1cm optics
  - tracking in MAD with energy spread 0.0008
  - 1mrad rotation errors and 1% strength errors to all quads
  - dispersion correction: using skew quads QS1X and QS2X
  - coupling correction: using skew quads QK1X to QK4X
  - waist correction: using QD0FF and QF1FF
  - β_y correction: using QM12FF

Orthogonal waist scan simulations in large β optics (β_x =8cm, β_y =1cm)

- QD0 and QF1 strengths were found fitting with the MAD program to get at the Post IP wire scanner:
  - α_x= 1.0, α_y=0.0, $\delta_{QD0\ /QD0}$= -8.99e-4, $\delta_{QF1\ /QF1}$= -5.37e-3
  - α_x= 0.0, α_y=1.0, $\delta_{QD0/QD0}$ = -7.72e-3, $\delta_{QF1/QF1}$ = -1.36e-3
- 1mrad rotation errors and 1% strength errors (which is about 10 times the actual) to all quads in ATF2 line to get obvious effect.
- with errors added to final doublet and without to compare correction effect.
- waist scans in several steps.

Dispersion correction with quasi sum knobs of QS1X/QS2X

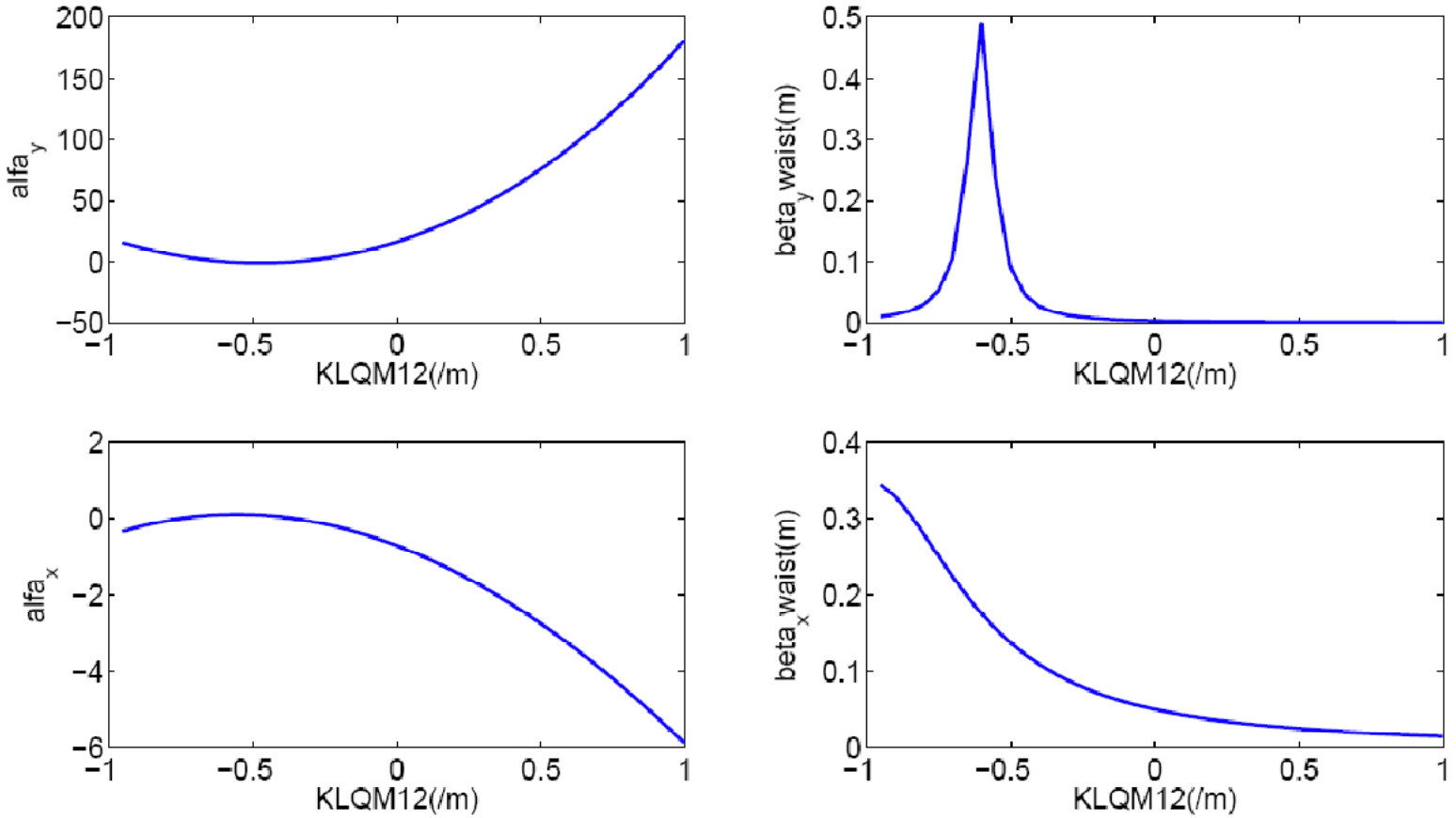
- Dispersion correction was done after waist scan since it will introduce a little coupling which described in Benoit's presentation (http://ilcagenda.linearcollider.org/getFile.py/access?contribId=71&sessionId=10&resId=0&materialId=slides&confId=3511), and then correct with the skew quads coupling knobs.
- After check to compare the minimum vertical beam size corrected with quasi knob(KLQS2X=0.7KLQS1X) and sum knob(KLQS1X=KLQS2X), there is almost no difference of the minimum vertical beam size.

Coupling correction with QK1~4X

Knob (normalised)	QK1X	QK2X	QK3X	QK4X
<xy>	1	-0.4667	-0.55	-0.8722
<xy'>	-0.8722	-0.55	0.4667	-1
<x'y>	0.55	0.8722	1	-0.4667
<x'y'>	-0.4667	1	-0.8722	-0.55

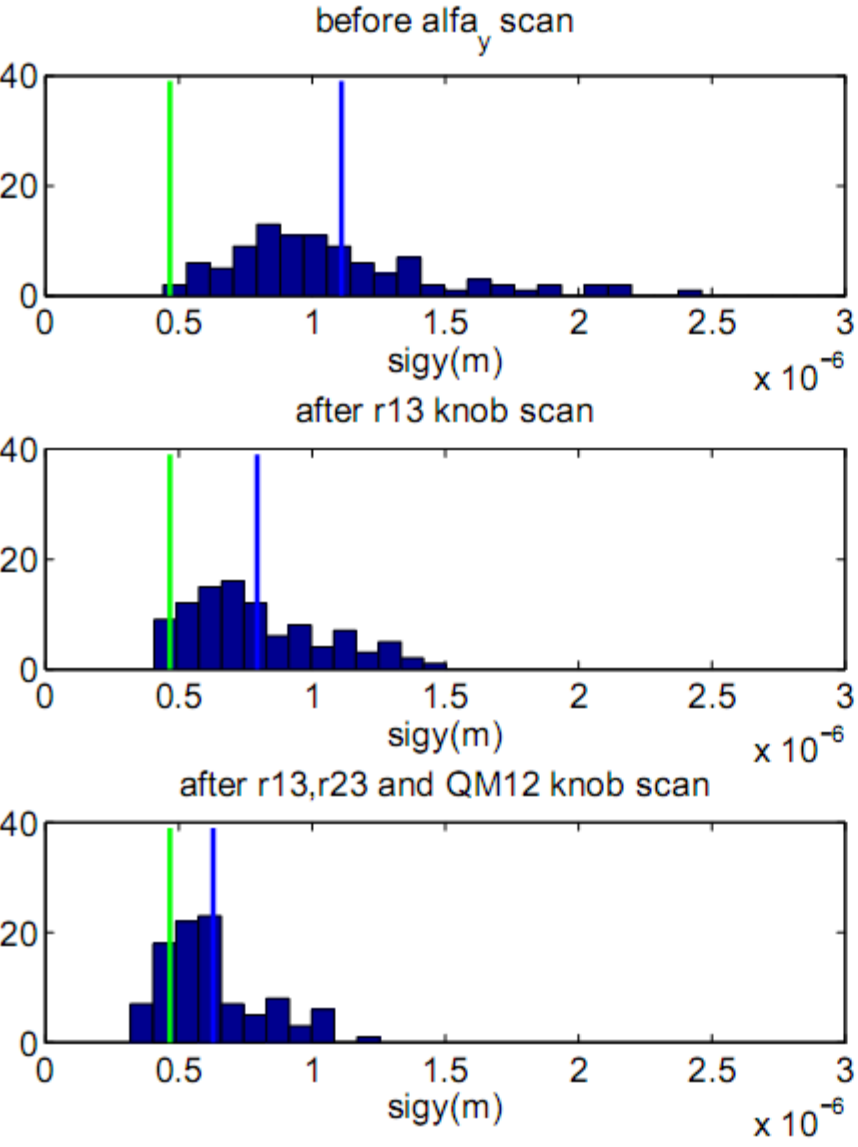
- choose first <xy> knob and then <x'y> knob to correct coupling to minimize the vertical beam size at Post IP wire scanner. the <x'y> is dominant especially in the nominal optics($\beta_y^*=0.0001\mathrm{m}$).
- scan in several steps in the strength limit of QK1X~4X, QK1,4X=20A, QK2,3X=5A

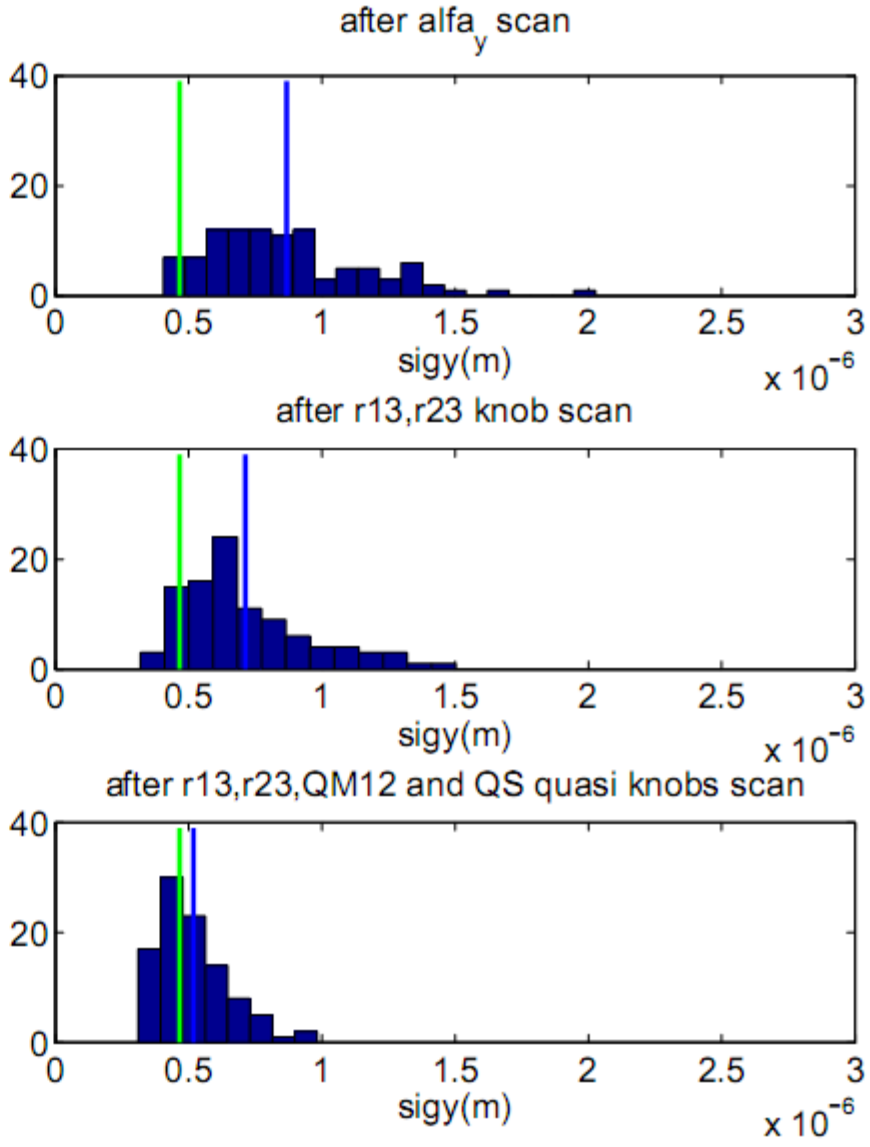
QM12FF scan β_y at Post-IP wire



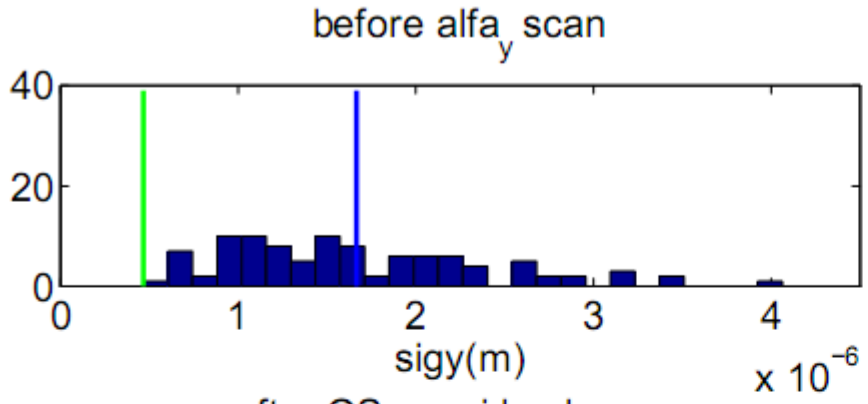
when introduce 1% strength errors, the matching quads may change the beta function at Post IP wire scanner. That's why to use matching quad to correct α_x, β_x, α_y and β_y. Choose QM12FF which will be to correct β_y with no changing too much α_y.

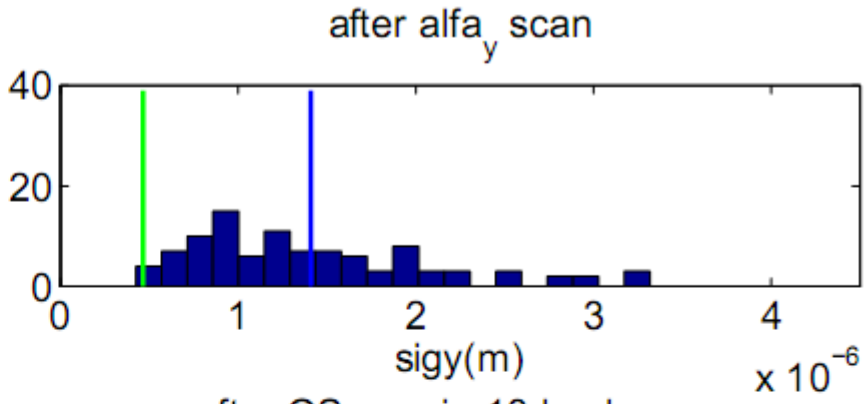
After multiknobs correction to find minimum vertical beam size without QD0&QF1 errors with energy spread 0.0008

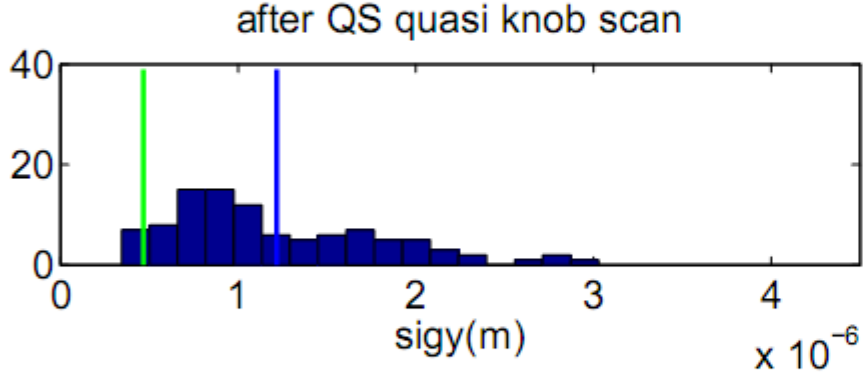


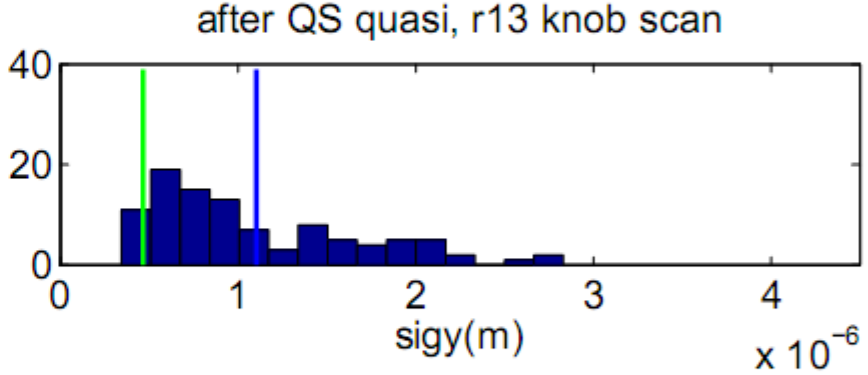


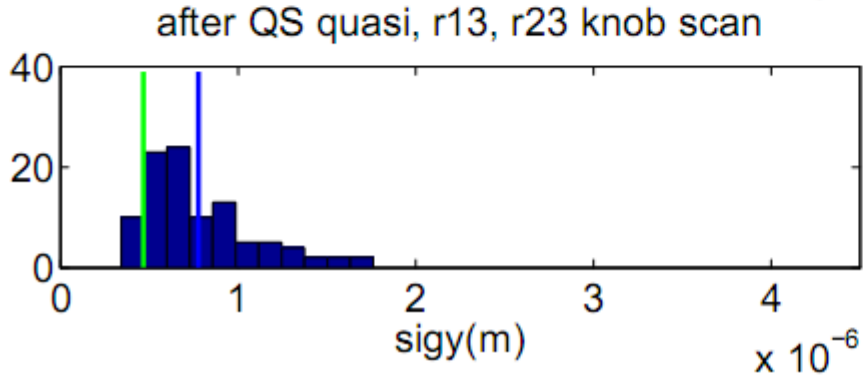
After multiknobs correction to find minimum vertical beam size with QD0&QF1 errors and energy spread 0.0008

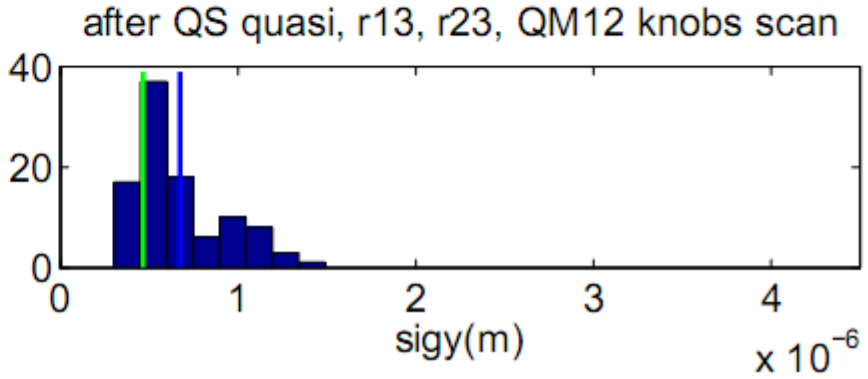




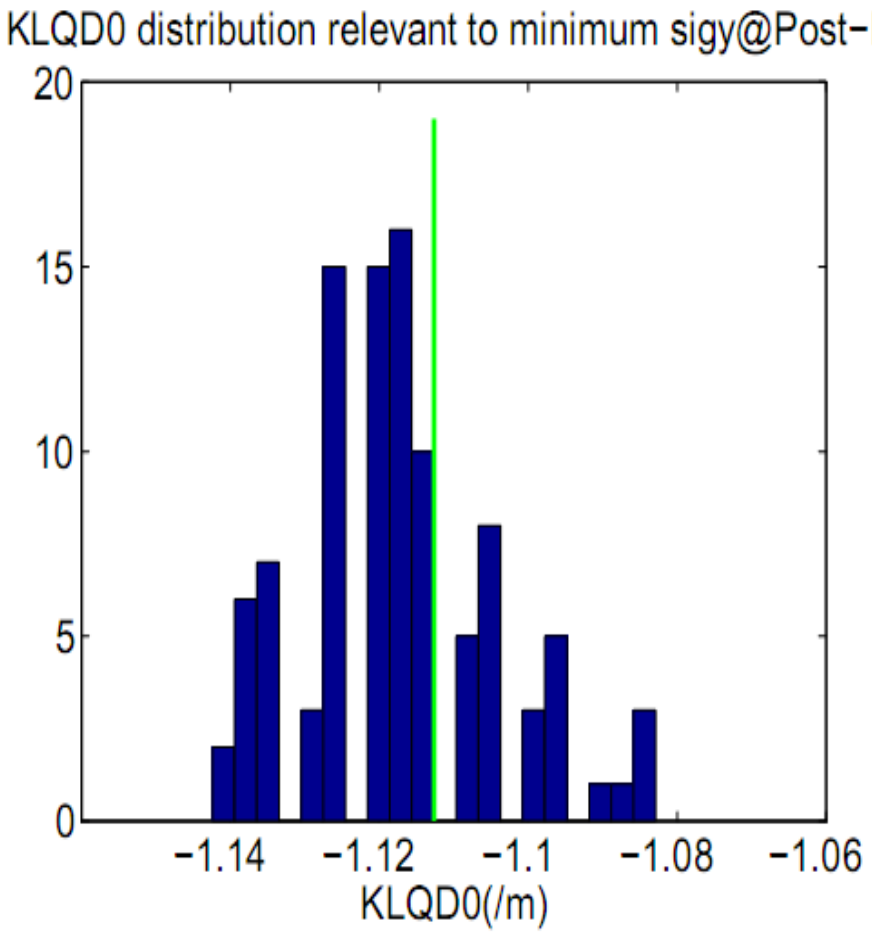


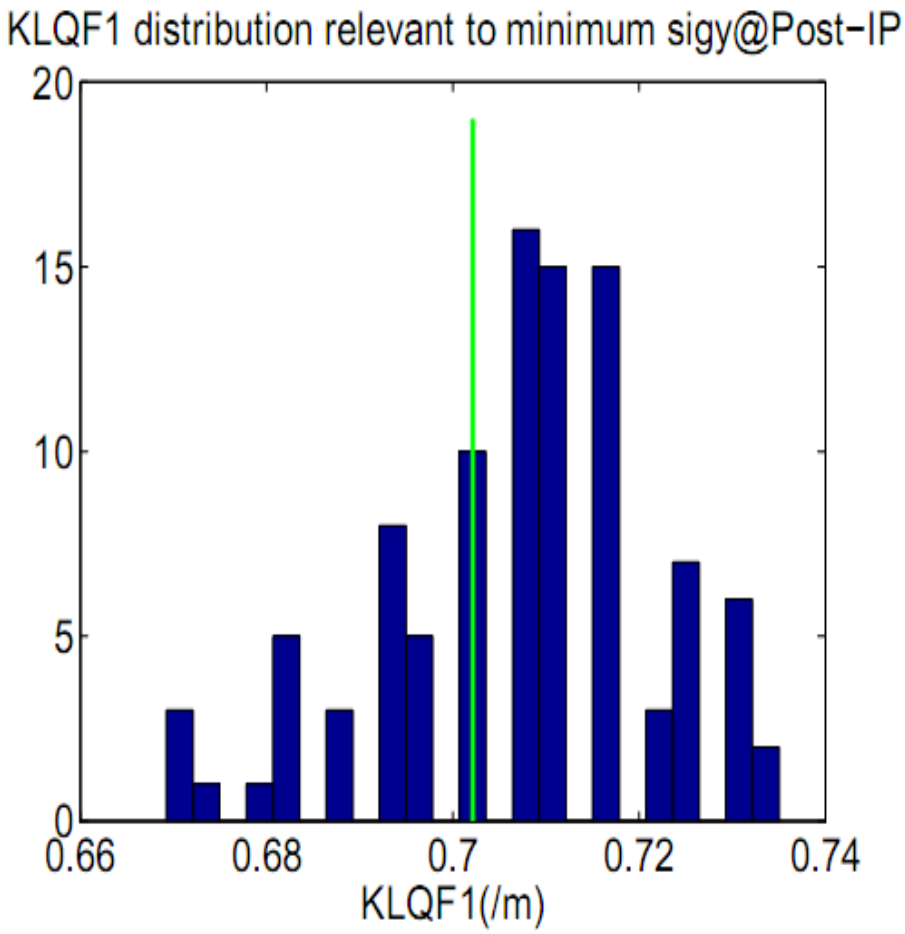






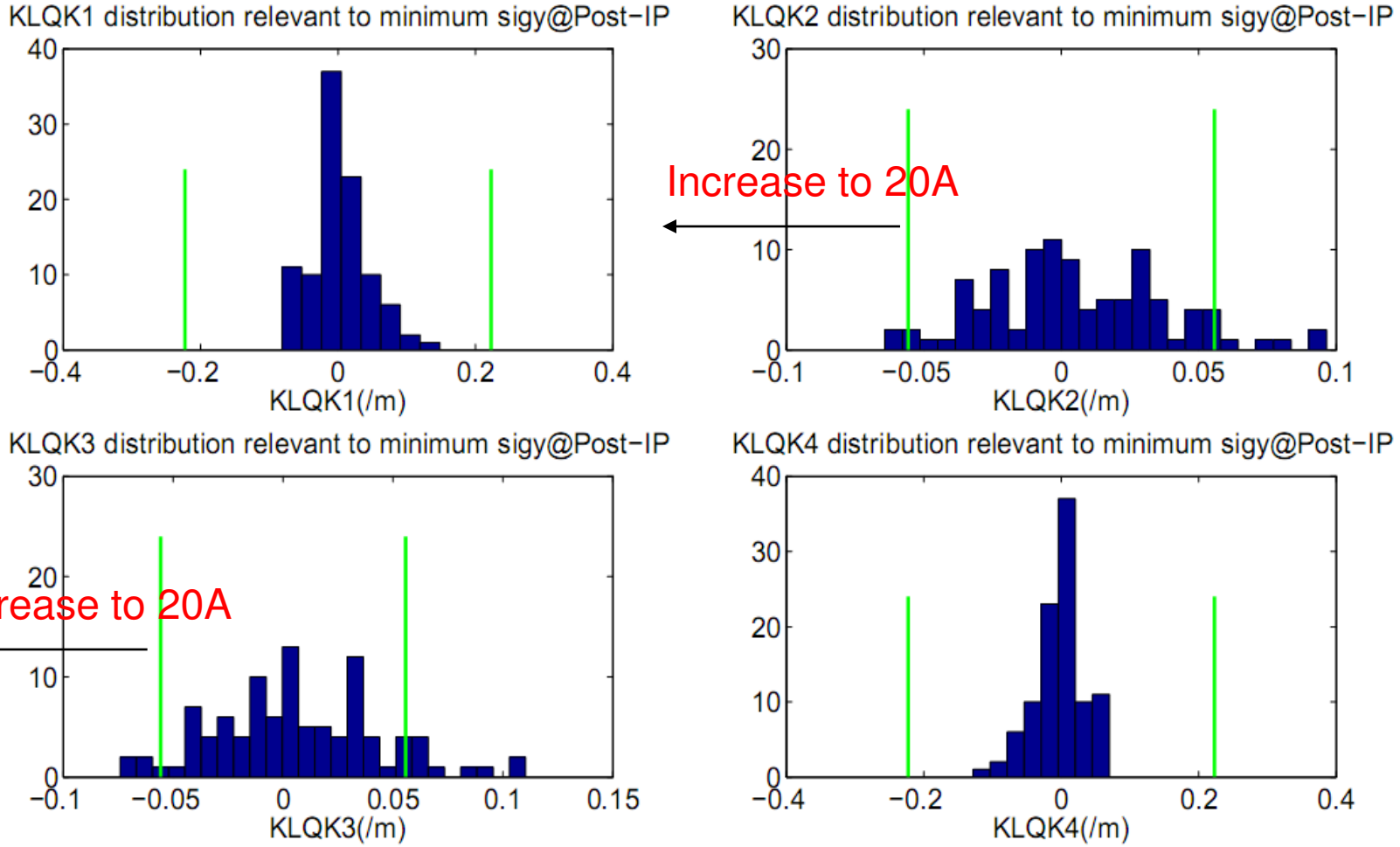
KLQD0&KLQF1 distribution relevant to minimum sigy at PIP





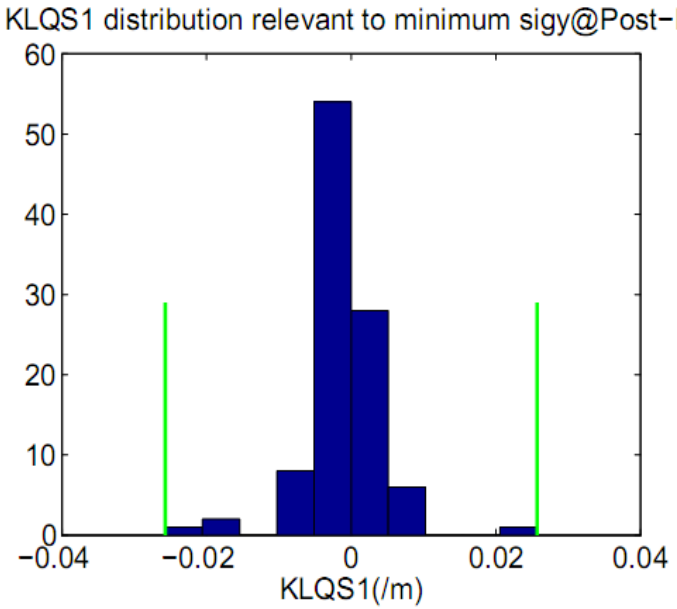
• waist scan in several steps. The green line is the nominal setting at PIP waist.

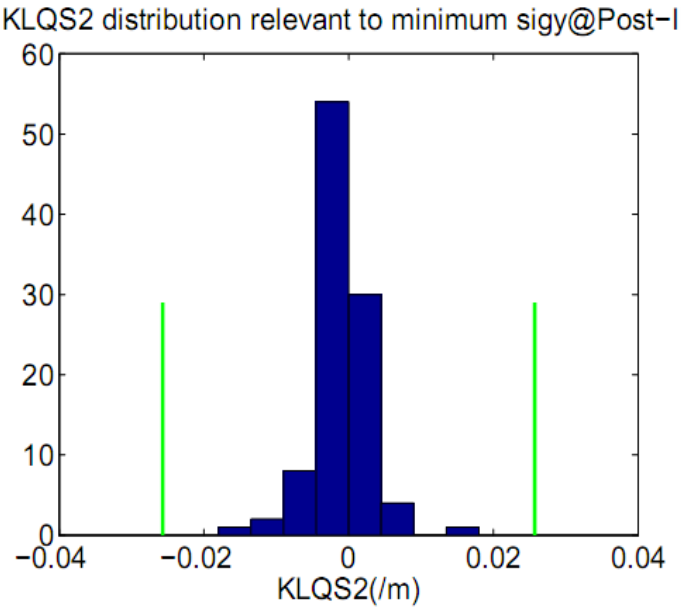
KLQ1~4X distribution relevant to minimum sigy at PIP

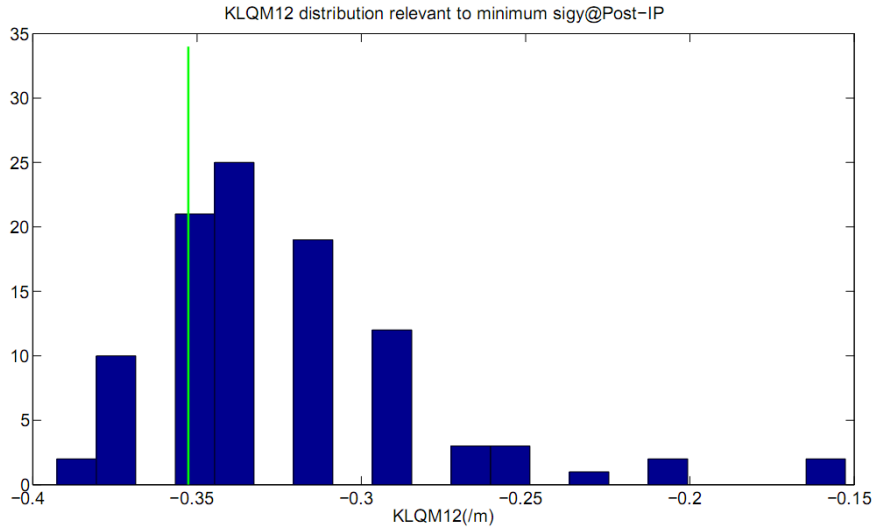


- The green line are the strength limit of the skew quads.

KLQS1/2X&KLQM12 distribution relevant to minimum sigy at PIP







Conclusion and prospect

- After correction with all the multiknobs in the large β optics when introducing 1mrad rotation errors and 1% strength errors to all quads, the beam size go down to 6.7e-7m, while the linear beam size is 4.66e-7m.
- In commissioning, these multiknobs could be realised by setting these knobs and scanning several times. We should prepare this in the software.