ATF2:Summary of Tolerance

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1. Summary of ATF2 proposal vol.1
2. Tolerance for Q Power Supply
3. Tolerance of SX component of Q
   with Correction
4. Tolerance of Q Misalignment
   with Linear Knob Correction

(Studies 2,3 and 4 are preliminary should be sophisticated.)

2nd ATF2project meeting 30MAY2006

1. Summary of ATF2 proposal vol.1

Tolerable field ratio at r=10mm for 2% beam size growth

Qname	B1/B1	B2/B1	B3/B1	B4/B1	B5/B1	B6/B1	B7/B1	B8/B1	B9/B1
QM16	9.65E-03	2.65E-01	3.74E+00	6.94E+01	9.12E+02	1.37E+04	1.76E+05	2.27E+06	2.94E+07
QM15	7.57E-03	3.54E-01	2.26E+00	1.79E+02	8.85E+02	6.95E+04	3.10E+05	1.88E+07	9.62E+07
QM14	-7.82E-04	-1.48E-01	-8.62E+00	-2.26E+03	-8.97E+04	-1.01E+07	-2.48E+08	-4.26E+10	-1.40E+12
QM13	3.15E-03	1.66E-01	1.55E+00	4.82E+01	4.95E+02	1.08E+04	1.22E+05	2.24E+06	2.69E+07
QM12	8.04E-04	1.46E-02	2.05E-01	5.80E+00	7.48E+01	1.72E+03	2.48E+04	4.96E+05	7.38E+06
QD10	-7.08E-05	-1.56E-03	-5.64E-03	-2.63E-01	-1.25E+00	-2.77E+01	-1.39E+02	-2.77E+03	-2.38E+04
QD10A	-7.76E-05	-1.05E-03	-2.07E-03	-5.92E-02	-8.81E-02	-2.00E+00	-3.24E+00	-6.10E+01	-1.11E+02
QF9	2.14E-04	1.40E-03	1.48E-03	1.78E-02	1.35E-02	1.69E-01	1.14E-01	1.21E+00	8.93E-01
QF9A	2.37E-04	2.30E-03	2.64E-03	2.81E-02	2.30E-02	2.87E-01	1.92E-01	2.09E+00	1.46E+00
QD8	-3.07E-04	-6.79E-03	-2.31E-02	-9.09E-01	-2.55E+00	-8.09E+01	-2.66E+02	-6.41E+03	-2.58E+04
QF7	1.14E-02	3.82E-01	1.10E+01	2.70E+02	6.14E+03	1.36E+05	2.94E+06	6.25E+07	1.31E+09
QD6	-3.72E-04	-3.31E-03	-2.52E-02	-2.63E-01	-1.68E+00	-1.34E+01	-8.73E+01	-6.17E+02	-4.07E+03
QF5	2.39E-04	1.06E-03	2.67E-03	9.12E-03	1.95E-02	5.60E-02	1.22E-01	3.12E-01	7.06E-01
QF5A	2.16E-04	5.85E-04	1.50E-03	5.36E-03	1.15E-02	3.46E-02	7.65E-02	2.03E-01	4.64E-01
QD4	-7.82E-05	-4.32E-04	-2.21E-03	-1.82E-02	-8.12E-02	-5.29E-01	-2.45E+00	-1.45E+01	-7.03E+01
QD4A	-7.11E-05	-7.28E-04	-6.54E-03	-1.47E-01	-1.27E+00	-1.71E+01	-1.34E+02	-2.54E+03	-1.90E+04
QD2B	5.67E-04	1.33E-02	7.75E-02	3.74E+00	6.07E+00	1.52E+02	3.92E+02	5.42E+03	2.33E+04
QF3	-3.75E-03	-6.17E-02	-3.97E-01	-1.01E+01	-2.51E+01	-7.21E+02	-1.35E+03	-3.87E+04	-6.86E+04
QD2A	-1.17E-03	-4.05E-02	-6.08E-02	-9.92E-01	-1.54E+00	-3.04E+01	-3.44E+01	-2.87E+02	-7.12E+02
QF1	2.71E-05	1.86E-04	1.01E-04	6.62E-04	2.46E-04	1.06E-03	5.69E-04	2.94E-03	1.19E-03
QD0	-1.12E-05	-9.77E-05	-1.58E-04	-2.34E-03	-3.08E-03	-5.15E-02	-4.73E-02	-5.13E-01	-5.98E-01

[J.Jones]

Summary of ATF2 proposal vol.1(cont.)

Vibration tolerance for 2% beam size growth

magnet	dy[um]	tilt[urad]
"QM16"	3.77E+01	7.82E+02
"QM15"	1.65E+01	5.20E+02
"QM14"	2.23E+00	1.20E+03
"QM13"	2.03E+01	1.39E+03
"QM12"	5.00E+00	1.21E+02
"QD10"	2.13E+00	3.16E+01
"QD10"	2.22E+00	1.89E+01
"QF9"	3.36E+00	1.48E+01
"SF6"	1.03E+00	
"QF9"	2.52E+00	1.99E+01
"QD8"	5.30E-01	4.72E+01
"QF7"	7.23E-01	3.84E+04
"B5"		6.85091
"QD6"	5.26E-01	4.59E+01
"QF5"	2.54E+00	1.90E+01

magnet	dy[um]	tilt[urad]
"SF5"	8.25E+01	
"QF5"	7.69E+00	1.41E+01
"QD4"	4.62E+00	1.80E+01
"SD4"	8.58E-01	
"QD4"	4.93E+00	2.94E+01
"B2"		28.9975
"QD2B"	9.95E-01	1.50E+02
"QF3"	8.51E-01	4.94E+02
"QD2A"	6.30E-01	1.89E+02
"B1"		7.18013
"SF1"	1.68E+00	
"QF1"	1.91E+00	2.72E+00
"SD0"	1.03E+00	
"QD0"	4.70E+00	2.71E+00

[A.Seryi]

2. Tolerance for Q Power Supply

Qs are classified into 5 groups(cf. Kumada case1)

QD0, QF1, QD4&10, QM, others

In this simulation, for each Q, K1 error is

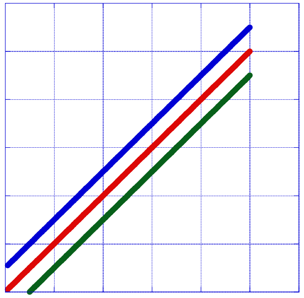
$dK1/K1 = \sigma \; maxK1/K1$

Here maxK1 is maximum Abs[K1] of the group and

σ =10ppm(QD0)

30ppm(QF1, QD4&10)

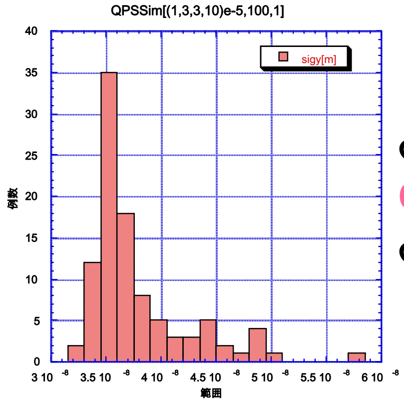
σ_x(QM, others)



Sim. Cond.

ε_x=2e-9,$\gamma\varepsilon_y$=3e-8, δ=8e-4

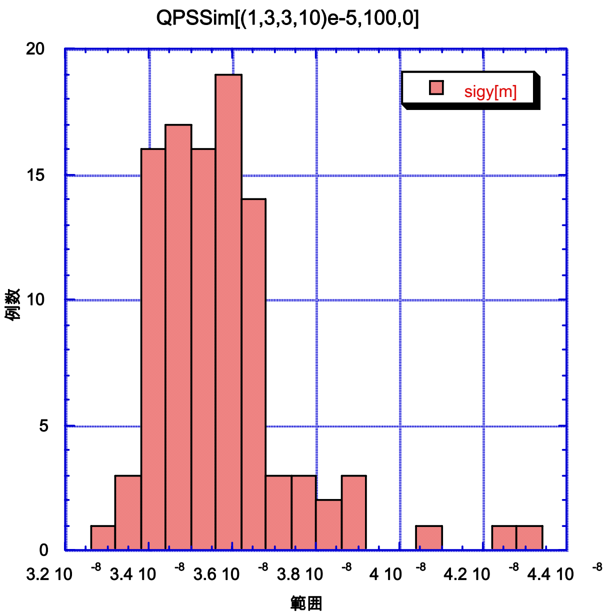
→ideal σ_y=34.8nm



σ_x =100ppm

Gaussian error dist

σ_y(95%CL)=48nm



← σ_x =100ppm

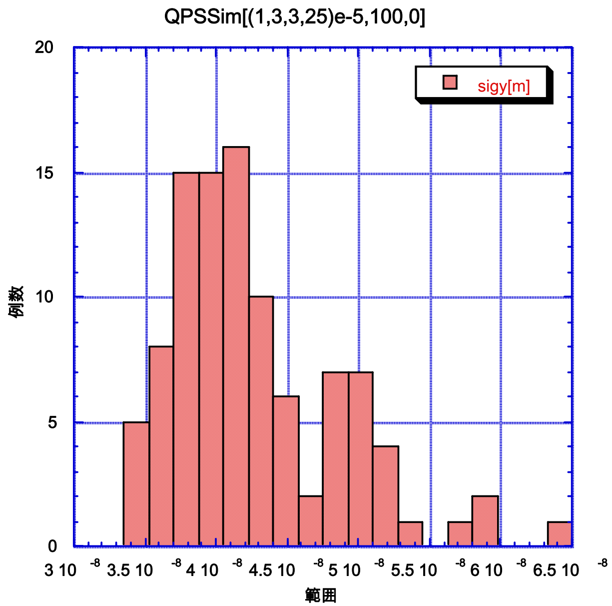
Uniform error dist.

σ_y(95%CL)=38.5nm

σ_x =250ppm

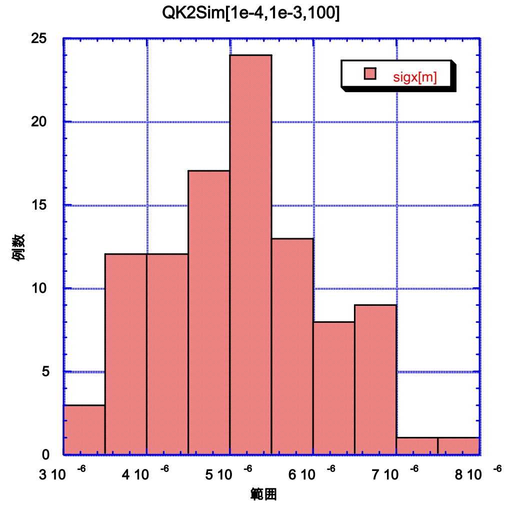
Uniform error dist. →

σ_y(95%CL)=52nm

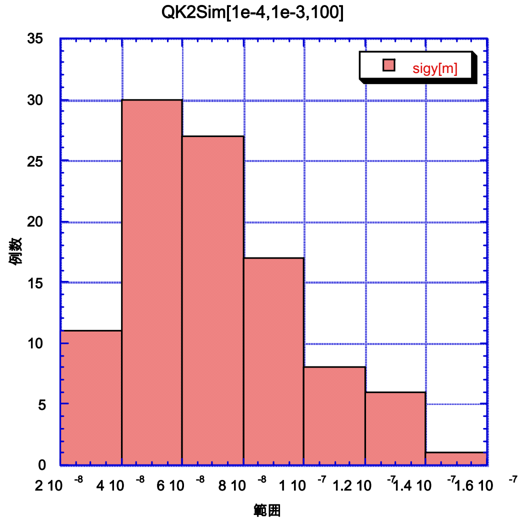


3. Tolerance of SX component of Q with Correction

sigx

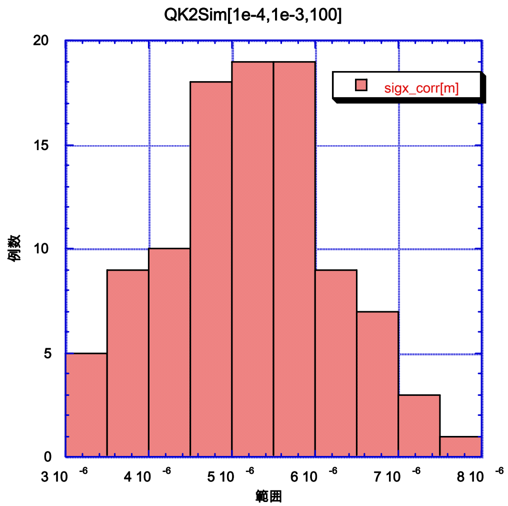


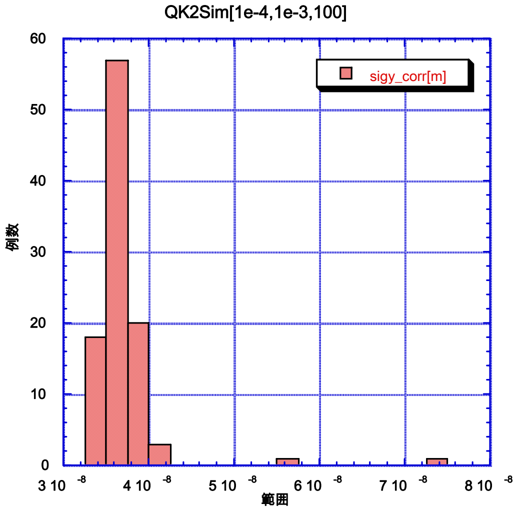
sigy



Gaussian error
σdB2/B1@r=10mm
=1e-4 for FD
=1e-3 for 20cm Q

After Correction





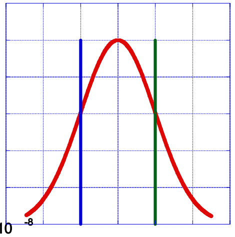
Correction
Knob: SX
Trial and error looking at σy
step: dK2=1e-2

Perfect BSM resolution is assumed

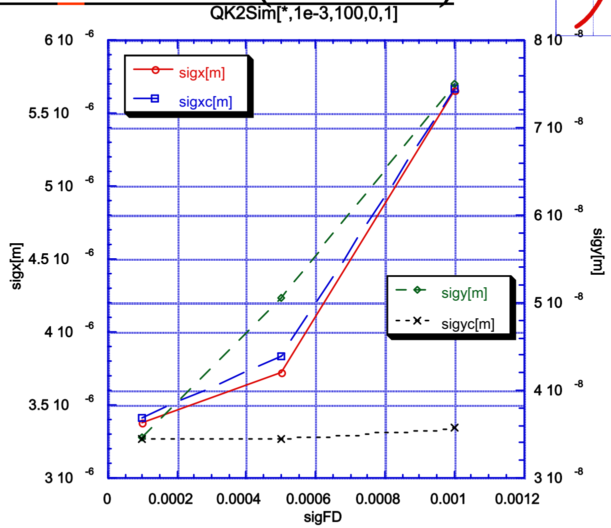
Tolerance of SX component of Q with Correction(cont.)

δ=1e-3(for 20cm Q)

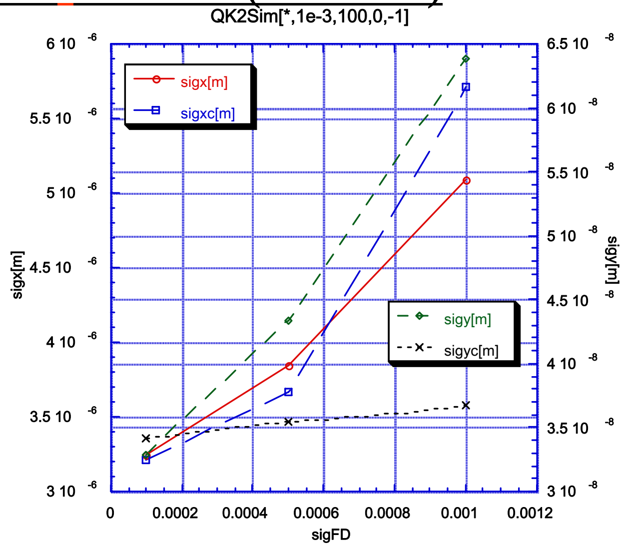
variable(for FD)



dK2=+2 K1 δ/r (r=10mm)

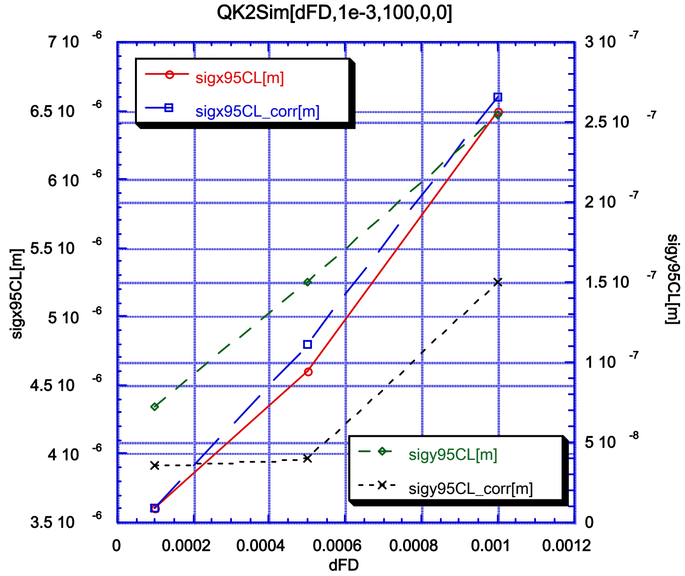


dK2=-2 K1 δ/r (r=10mm)

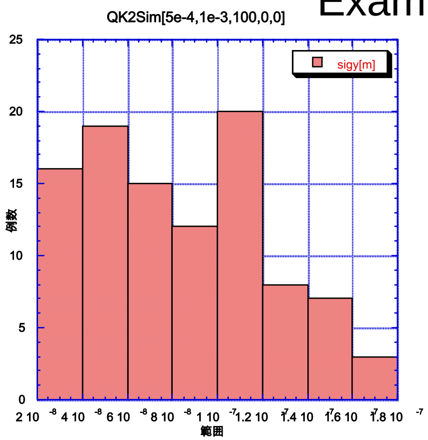


dK2=2 sgn K1 δ/r

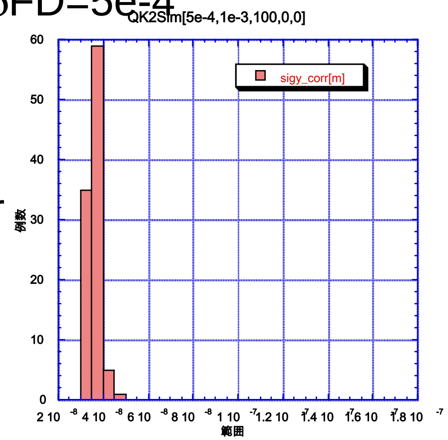
(r=10mm, sgn=±1: random for each Q)



Example:δFD=5e-4



Corr →



It seems OK for δFD=5e-4.

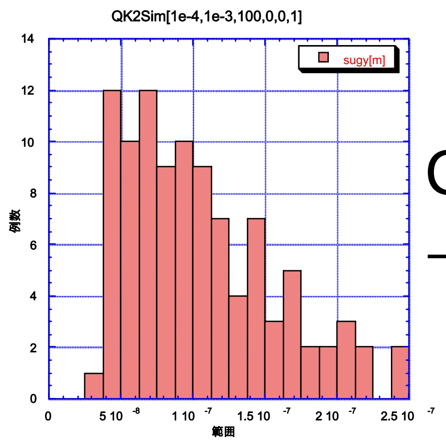
Tolerance of SX component of Q with Correction(cont.2)

dK2=2 sgn K1 δ/r Sin[θ], dSK2=2 sgn K1 δ/r Cos[θ]

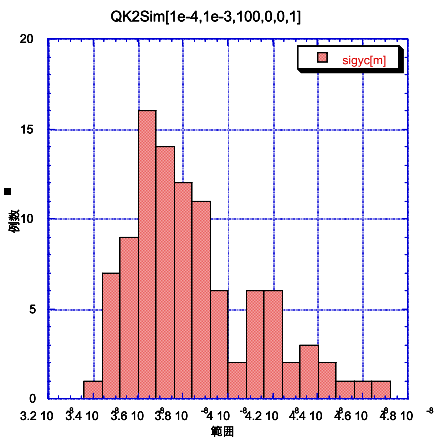
(r=10mm, sgn=±1: random for each Q,0<θ<2π:uniformly random)

Correction: roll(1mrad step) of SX+K2(1% step) of SX

δFD=1e-4

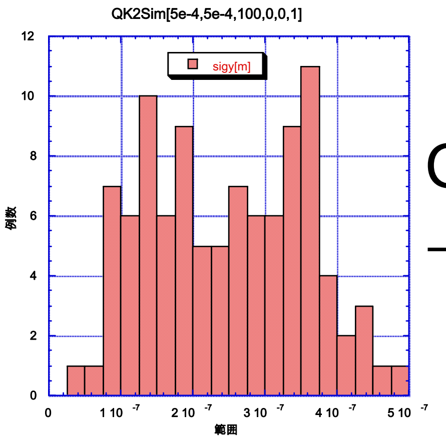


Cor.
→

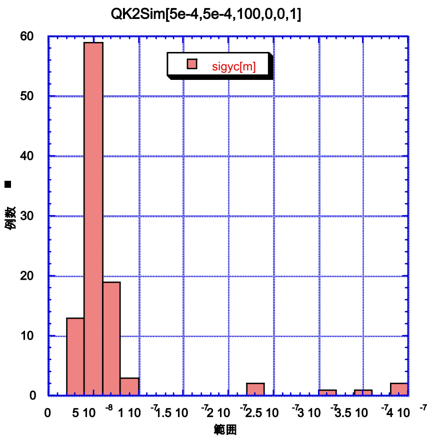


After cor.,
σy(95%CL)=44nm
Iteration of correction x2
→ σy(95%CL)=47nm
Iteration of cor. is not effective

δFD=5e-4, δ20cmQ=5e-4



Cor.
→



After cor.,
σy(95%CL)=225nm
SK2 of FD affects significantly to σy. Tolerance of SK2 should be much less than 1e-4.

4. Tolerance of Q Misalignment with Linear Knob Correction

<u>Knob</u>

Mover of SX

DX→WaistX, WaistY, PEX

DY→PEY, Coupling(R1,R2)

Each knobs are orthogonalized by linear combination

<u>Correction</u>

Order: R2,R1,WY,PEY

Correction step:

WaistY:1mm(σy>1μm) 100μm(σy>100nm) 20μm(σy<100nm)

R1:1e-2 (σy>1μm) 1e-3(σy>100nm) 1e-4(σy<100nm)

R2:1e-3 (σy>1μm) 1e-4(σy>100nm) 2e-5(σy<100nm)

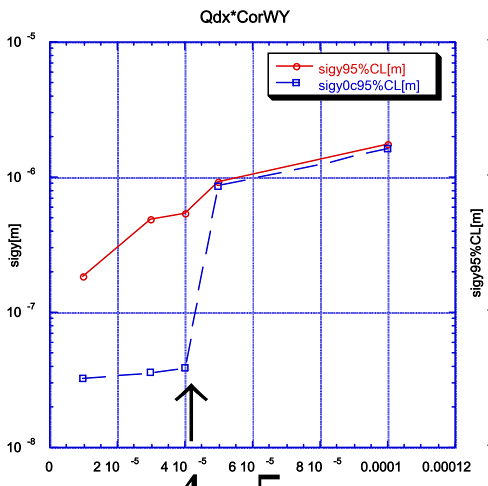
PEY: 10μm

because of the resolution of the σy calculation by tracking(NP=1000)

<u>Performance for Single Type of Error of Q</u>

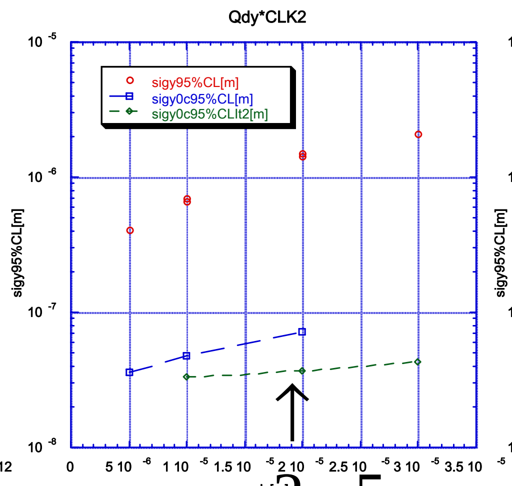
Gaussian error is assumed. Iterative correction was done for errors DY and Roll.

dX



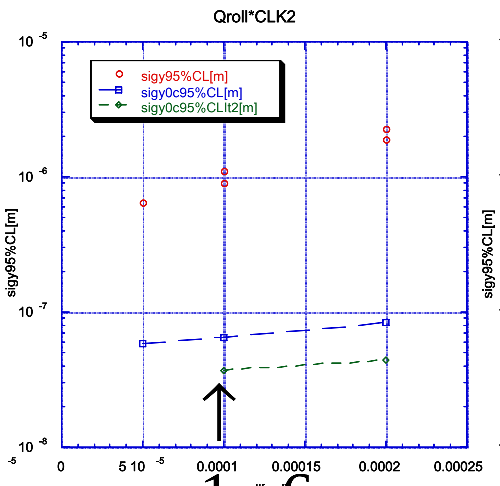
4e-5

dY



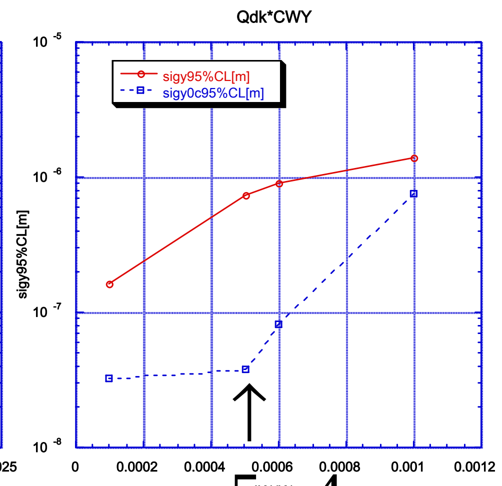
2e-5

dθ



1e-6

dK1



5e-4

95% CL values are plotted.

Tolerance of Q Misalignment with Linear Knob Correction(cont.)

All types of errors

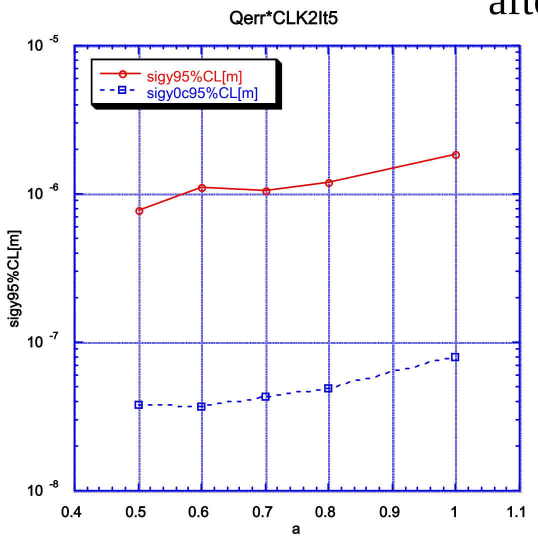
(dK1/K1, dx, dy, roll)=a×(5e-4, 40μm, 20μm,100μrad)

Correction

\# of iteration ≤ 5

Iteration stops if σy≤ 35nm

For a<0.7, σy<40nm after correction



Mover Spec. Requirement

Minimum step

	min. coeff. knob	min.step
WY:2e-5	SF1_DX=-0.0121574 wy	2.4e-7
PEY:1e-5	SD4_DY= -0.186651 py	1.9e-6
R1:1e-4	SD0_DY= -0.220771 r1	2.2e-5
R2:2e-5	SD0_DY= -0.127017 r1	2.5e-6

Dynamic range

For a=0.6	max. coeff. knob	max.step
maxWY:1.98e-3	SD4_DX= 0.0721866 wy	1.4e-4
maxPEY:3e-4	SD0_DY= 0.429982 py	1.3e-4
maxR1:1.3e-3	SF6_DY= 0.526463 r1	6.5e-4
maxR2:3.8e-3	SF6_DY= 0.387005 r1	1.5e-3

Summary & Discussion

- Tolerances for multipole component of Q & vibration are reviewed(proposal vol.1).
- Some results of study for tolerance with correction are reported. But these are not completed and to be done more;

1. Higher order parameters should be included in the knobs. Then SX strength will be used as a part, so the correction for the SX component of Q should be done again.
2. Optics for the study should be updated.
3. Tolerance for FD is defined separately with the other Q(?)