

Multi-knobs for Ver5 Optics

Toshiyuki OKUGI, KEK

2012 / 10 / 5

ATF2 weekly meeting

Linear knob

Linear knobs are calculated by changing the positions of FF sexts.

ΔX for FFsext -> change the α_X , α_Y , η_X , η_X'

- ΔX for SF6FF, SF5FF, SD4FF, SF1FF, SD0FF are orthogonal to make AX, AY, EX, EPX knobs .*
- One other free parameter is adjusted to make a large dynamic range of knobs.*

ΔY for FFsext -> change the η_Y , η_Y' , $\langle x'y \rangle$

- ΔY for SF6FF, SD4FF, SF1FF, SD0FF are orthogonal to make EY, EPY, Coup2 knobs .*
- Since the strength of SF5FF is small, SF5FF is not use for the correction.*
- One other free parameter is adjusted to make a large dynamic range of knobs.*

Parameters for Linear Knobs

AX,AY – Beam waists are moved by 1cm.

EX,EY – Dispersions are changed by 1mm.

EPX, EPY – Angular dispersions are changed by 1mrad.

Coup2 – $\Delta\langle x'y \rangle / \sqrt{\epsilon_x \epsilon_y} = 1$

		AX	AY	EX	EPX	EY	EPY	Coup2
SF6FF	X	+142um	+348um	+250um	- 268um			
	Y					- 51um	+148um	+24um
SF5FF	X	- 127um	+300um	- 301um	+295um			
	Y					0	0	0
SD4FF	X	+9um	- 679um	- 298um	+542um			
	Y					- 290um	- 61um	+124um
SF1FF	X	- 65um	- 334um	+714um	-1108um			
	Y					- 96um	+329um	- 1um
SD0FF	X	- 94um	- 808um	+890um	-1666um			
	Y					+350um	+119um	+99um

The dynamic range of EX knob is about 50% to that of Glen's 2.5x1 optics.

The dynamic range of AY knob is about 75% to that of Glen's 2.5x1 optics.

Since the strength of SF5FF is small, the contribution of other sexts are large.

Normal Sextupole Field Correction Knobs

Sextupole field correction knobs by changing the strength of FF sexts.

Sextupole field

$$B_y = \frac{B^{(2)}}{2} (x^2 - y^2)$$

$$B_x = B^{(2)} x y$$

$$\Delta X_{IP} = \frac{R_{12} K_2}{2} (\underset{X_{22}}{\Delta x^2} + 2 \underset{X_{26}}{\eta \Delta x} \frac{\Delta p}{p} + \underset{X_{66}}{\eta^2 \frac{\Delta p^2}{p^2}} - \underset{X_{44}}{\Delta y^2})$$

ignore (effect is small)

$$\Delta Y_{IP} = R_{12} K_2 (\underset{Y_{24}}{\Delta x \Delta y} + \underset{Y_{46}}{\eta \Delta y} \frac{\Delta p}{p})$$

ΔK_2 for SF6FF, SF5FF, SD4FF, SF1FF, SD0FF are orthogonal to make X22, X26, X66, Y24, Y46 knobs

Parameters for Normal Sextupole Knobs

	SF6FF	SF5FF	SD4FF	SF1FF	SD0FF
Y24	+0.002A	- 0.008A	- 0.097A	+0.004A	+0.016A
Y46	+0.008A	- 0.032A	- 0.390A	- 0.022A	- 0.103A

Modified currents are listed on the table.

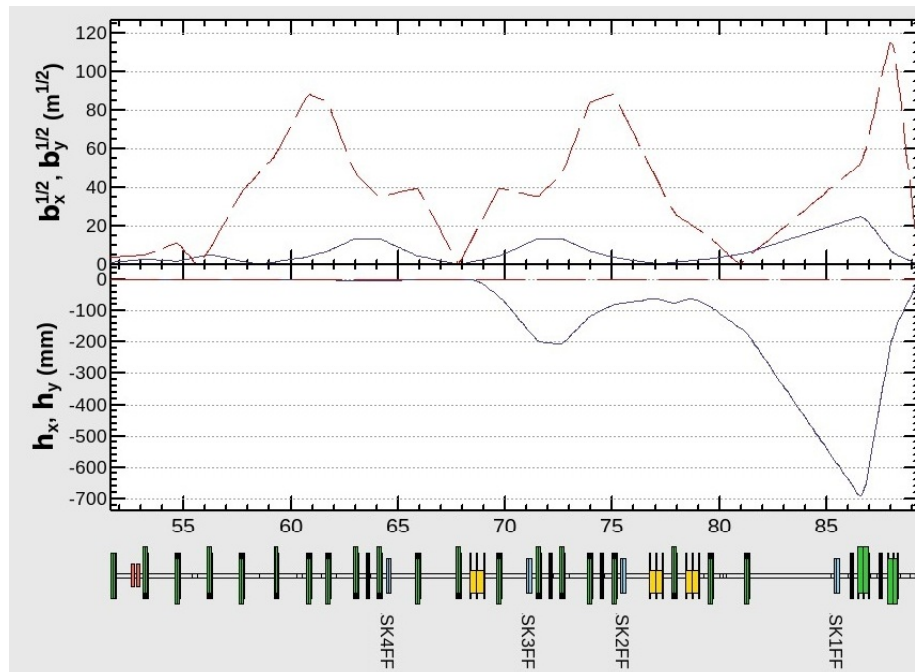
Skew Sextupole Field Correction Knobs

Skew sextupole field

$$B_x = \frac{B_s^{(2)}}{2} (x^2 - y^2)$$

$$\Delta y_{IP} = \frac{R_{34} K_{2S}}{2} \left(\underbrace{\Delta x^2}_{Y_{22}} + 2 \underbrace{\eta \Delta x \frac{\Delta p}{p}}_{Y_{26}} + \underbrace{\eta^2 \frac{\Delta p^2}{p^2}}_{Y_{66}} - \Delta y^2 \right) \underbrace{}_{Y_{44}}$$

We will put 4 skew sextupole correctors



SK1FF ; sensitive to Y22, Y26, Y66

SK2FF ; sensitive to Y44

SK3FF ; sensitive to Y22, Y26, Y66

SK4FF ; sensitive to Y22

**Y22, Y26, Y66, Y44 knobs
are calculated by the combination
of SK1FF, SK2FF, SK3FF, SK4FF.**

Parameters for Skew Sextupoles

With All SKs

	Y22	Y26	Y66	Y44
SK1FF	+0.0006A	- 0.1200A	+0.4581A	+0.0365A
SK2FF	+0.0674A	+0.0229A	- 0.1180A	+4.4102A
SK3FF	- 0.0210A	- 1.7221A	- 3.4060A	- 1.4333A
SK4FF	+0.6831A	- 1.2748A	- 5.3300A	- 0.9083A

*No SK1FF
(No Y66 knob)*

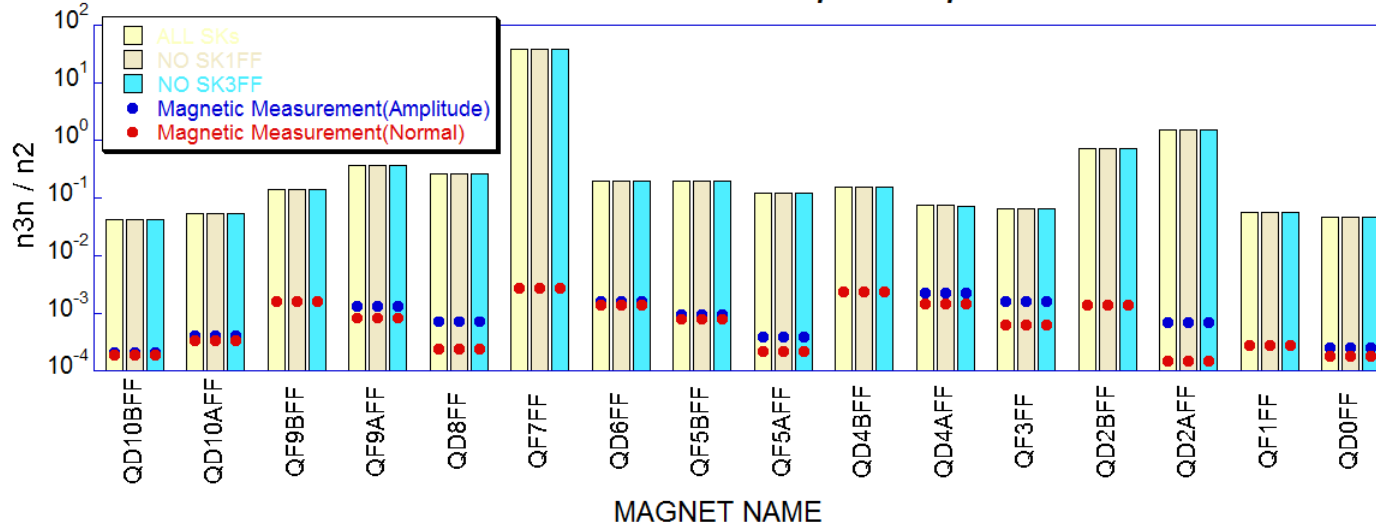
	Y22	Y26	Y66	Y44
SK1FF	+0.0000A	+0.0000A	N/A	+0.0000A
SK2FF	+0.0676A	- 0.0080A	N/A	+4.4974A
SK3FF	- 0.0163A	- 2.6141A	N/A	- 1.1824A
SK4FF	+0.6904A	- 2.6706A	N/A	- 0.4922A

*No SK3FF
(No Y66 knob)*

	Y22	Y26	Y66	Y44
SK1FF	- 0.0022A	- 0.3516A	N/A	- 0.1590A
SK2FF	+0.0682A	+0.0826A	N/A	+4.5384A
SK3FF	+0.0000A	+0.0000A	N/A	+0.0000A
SK4FF	+0.7159A	+1.4202A	N/A	+1.3581A

Tolerances for Sextupole Field Errors

Tolerances of Normal Sextupole Component

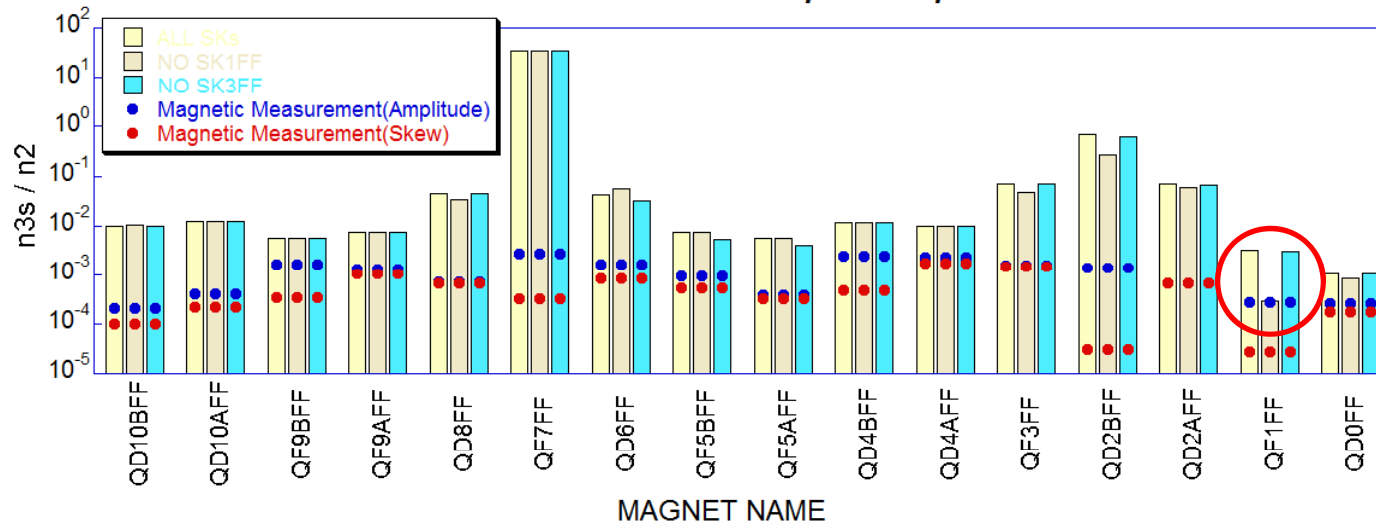


We only have 3 PSs for SK magnets.

Yellow ALL SKs
Red NO SK1FF
Blue NO SK3FF

Definition of tolerance
 $\Delta\sigma = 0.05 \sigma$

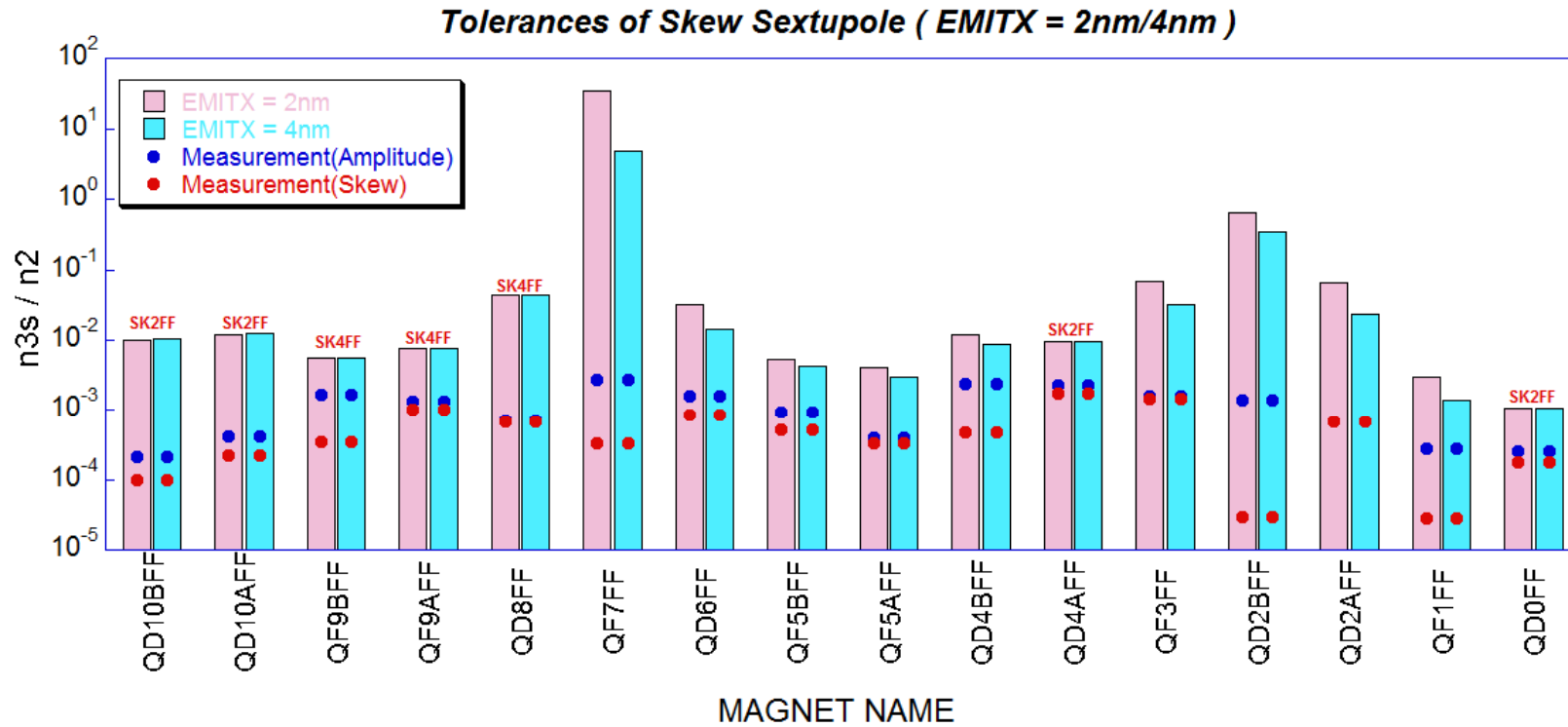
Tolerances of Skew Sextupole Component



emitx = 2nm
emity = 12pm
 $\Delta p/p = 0.08\%$

Small tolerance of skew 6pole for "NO SK1FF" -> "No SK3FF" at the 2012 October run.

Horizontal Emittance Dependence



Enough tolerable for 4nm horizontal emittance beam.

Summary

I presented the parameters of linear and sextupole knobs for Ver5 optics.

For Linear Knobs

The dynamic range of EX knob is about 50% to that of Glen's 2.5x1 optics.

The dynamic Range of AY knob is about 75% to that of Glen's 2.5x1 optics.

For Sextupole Knobs

We will start the 2012 October operation with 3 SK magnets.

*Since tolerance of skew 6pole for "NO SK3FF" is comparable to that for "ALL SKs",
I recommend not to be wired to "SK3FF" at the 2012 October run.*

*The correction with SK1FF, SK2FF and SK4FF is enough tolerable
for 4nm horizontal emittance beam.*