Reconstruction of Twiss parameters

Sha BAI (IHEP)

FJPPL – FKPPL ATF2 workshop
LAL, 19~20 March, 2012

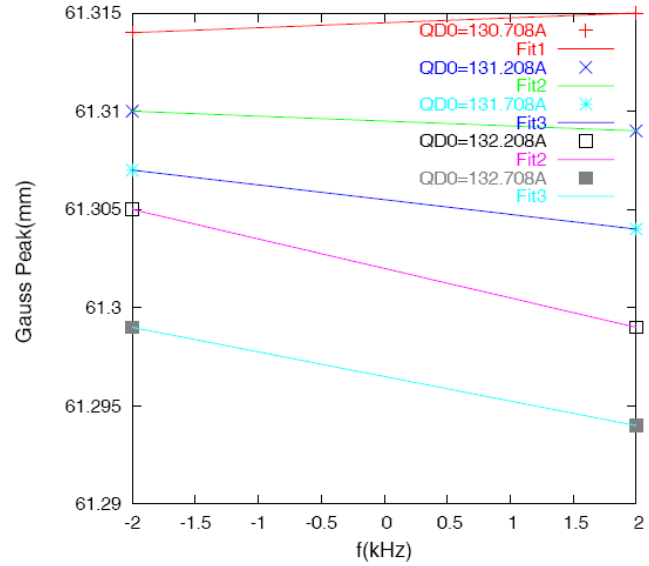
Outline

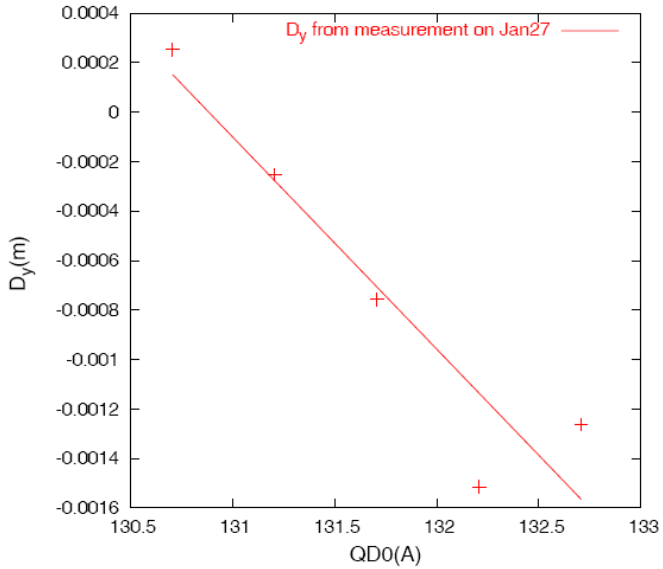
- IP wire scanner dispersion and vertical beam size measurement on Jan27
- Vertical projected emittance parameters at first OTR
- Twiss parameters analysis from σ_y scan with QD0FF
- Consistency of OTR and IP Twiss parameter measurements
- Systematic effect
- Conclusion

IP wire scanner measurement

QD0FF(A)	RAMP	Peak(mm)	σ_y(um)
130.708	+2kHz	61.315	9.265
	-2kHz	61.314	
131.208	+2kHz	61.309	5.842
	-2kHz	61.310	
131.708	+2kHz	61.304	2.5
	-2kHz	61.307	
132.208	+2kHz	61.299	5.416
	-2kHz	61.305	
132.708	+2kHz	61.294	10.680
	-2kHz	61.299	

D_y measurement





QD0[A]	D_y[m]
130.708	0.00025
131.208	-0.00025
131.708(waist)	-0.00076
132.208	-0.0015
132.708	-0.0013

Vertical projected emittance parameters at first OTR

energy = 1.2818 GeV

emit = 26.8171 ± 0.8137 pm

emitn = 67.2668 ± 2.0410 nm

emitn*bmag = 81.2983 ± 3.2832 nm

Bmag = 1.2086 ± 0.0294 (1.0000)

Bmag_cos = -0.0936 ± 0.0000 (0.0000)

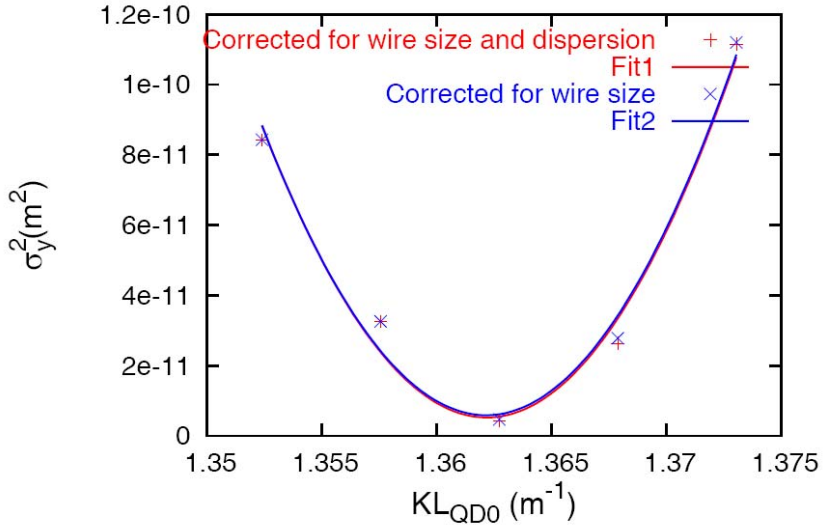
Bmag_sin = 0.5537 ± 0.0000 (0.0000)

beta = 6.9850 ± 0.3050 m (6.3764)

alpha = 3.6578 ± 0.1675 (2.7281)

Chisq/N = 4.5809

σ_y scan with QD0



Fit with $Y=A(X-B)^2+C$

A = (8.68 ± 0.89) e-07
B = 1.36218 ± 0.00032
C = (5.24 ± 0.63) e-12
COVac= -0.770

Calculate Twiss Parameter :

- *Method 1:*

$$\beta_y = \frac{\varepsilon_y a^2}{A} = 0.000071 \pm 0.000007 \ (\mathrm{m})$$

$$\alpha_y = \frac{A(B-Q)}{\varepsilon_{EXT} a} = 11.60 \pm 8.04$$

$\varepsilon_{y(EXT)}$ = 26.8pm
by OTR measurement

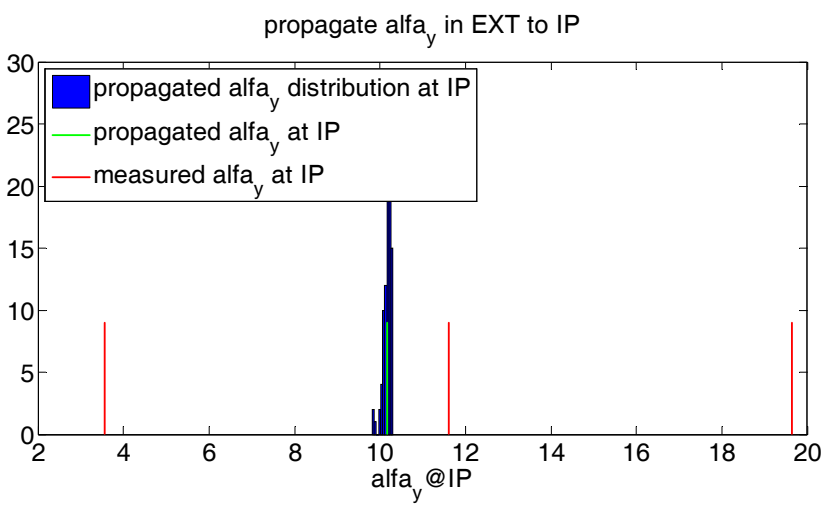
- *Method 2* is not applicable, since BX2.5BY1 optics is loaded and minimum σ_y can not be resolved.

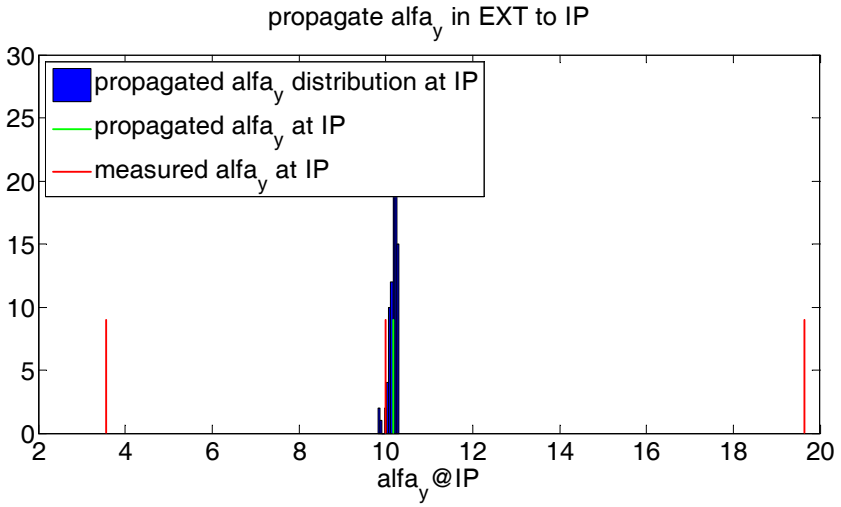
Consistency of OTR and IP Twiss parameter measurements

- Refit the QM quads based on the OTR measured central Twiss values
- Vertical waist measured value with quite large error, subtract 0.2 sigma of the measurement error

Propagation of Vertical Twiss (measured on Jan27) to IP

$\sim \alpha_y$



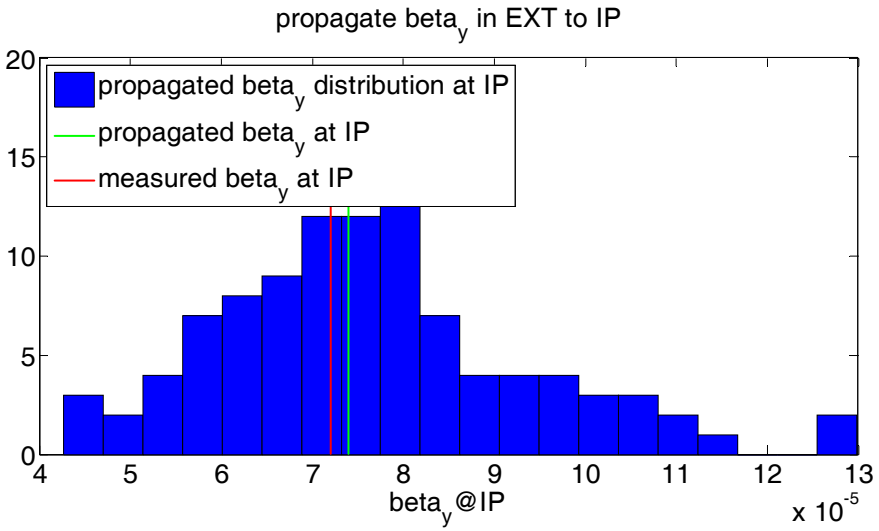


Average $\alpha_{y\_propagated} = 10.17 \approx \alpha_{y\_measured} - 0.2\sigma = 10.0$ error < 2%

- The twiss parameters which measured at first OTR were propagated to the IP.
- The propagated α_y are compared with the measured ones, after subtracting 0.2σ, good consistency was got.

Propagation of Vertical Twiss (measured on Jan27) to IP

$\sim \beta_y$



Average $\beta_{y\_propagated} = 0.000074$

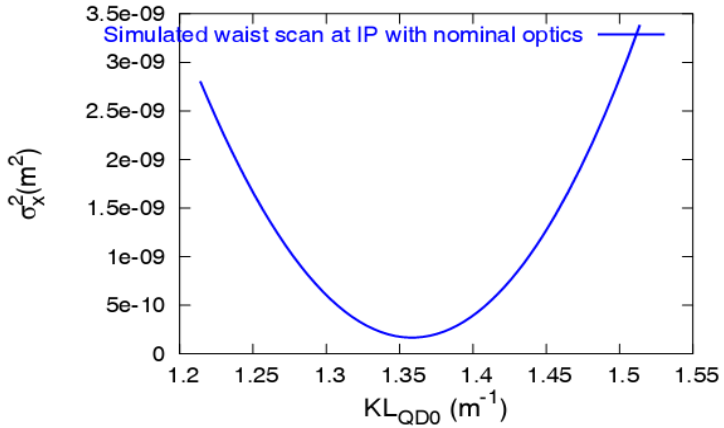
$\approx$

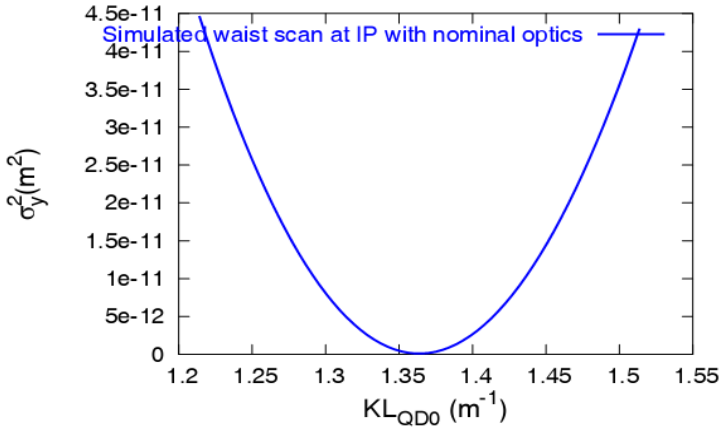
$\beta_{y\_measured} = 0.000072$

error < 3%

- The twiss parameters which measured at first OTR were propagated to the IP.
- The propagated β_y are compared with the measured ones, and good consistency was got.

Systematic Effect





Method 1:

$\beta_x=\varepsilon_x*a^2/A=2e\text{-}9*2.43^2/1.29932e\text{-}7=0.0909\pm0.0002$

$\beta_y=\varepsilon_y*a^2/A=1.18e\text{-}11*1.27^2/1.88722e\text{-}9=0.01008\pm0.00034$

Method 2:

$\varepsilon_x=\sqrt{AC}/a=\sqrt{1.29932e\text{-}7*1.65111e\text{-}10}/2.43=(1.906\pm0.015)e\text{-}9$

$\beta_x=a\sqrt{C}/A=2.43*\sqrt{1.65111e\text{-}10}/1.29932e\text{-}7=0.0866\pm0.0008$

- the simulation check shows that the systematic is well controlled in methods 1 and 2 for β and emittance estimation at the IP, once β is small enough. and prove that the measured twiss analysis methods give reliable results with small enough systematic effect.

Conclusion

- Good consistency of OTR and IP Twiss parameter measurements, considering large error for the measured vertical waist.
- Systematic effect of twiss analysis methods is quite small.