Brief Summary of ATF2 Status

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ATF2 Final Goal

Ensure collisions between nanometer beams; i.e. luminosity for ILC experiment

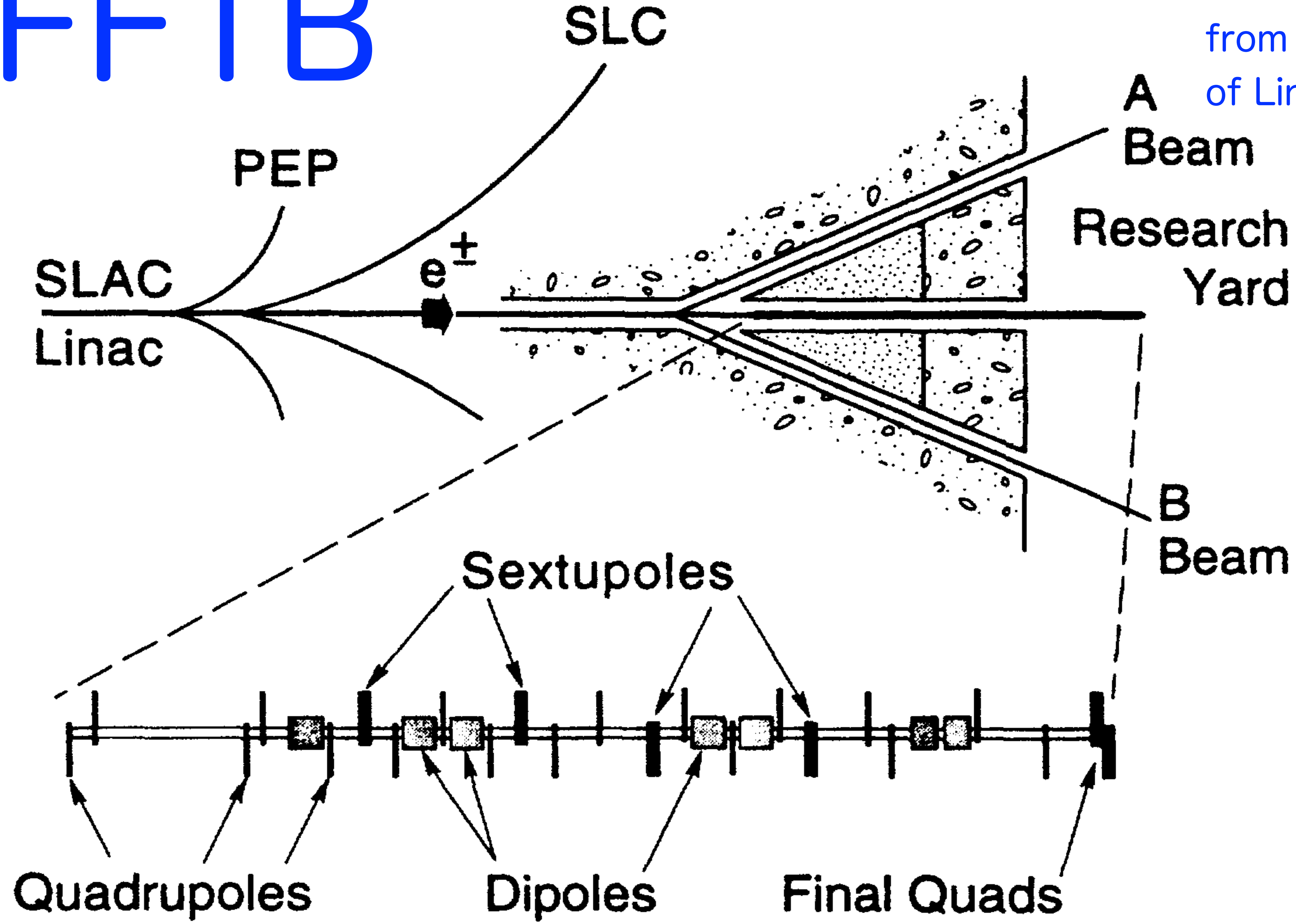
Reduction of Risk at ILC

Optics and bean tuning
Stabilization

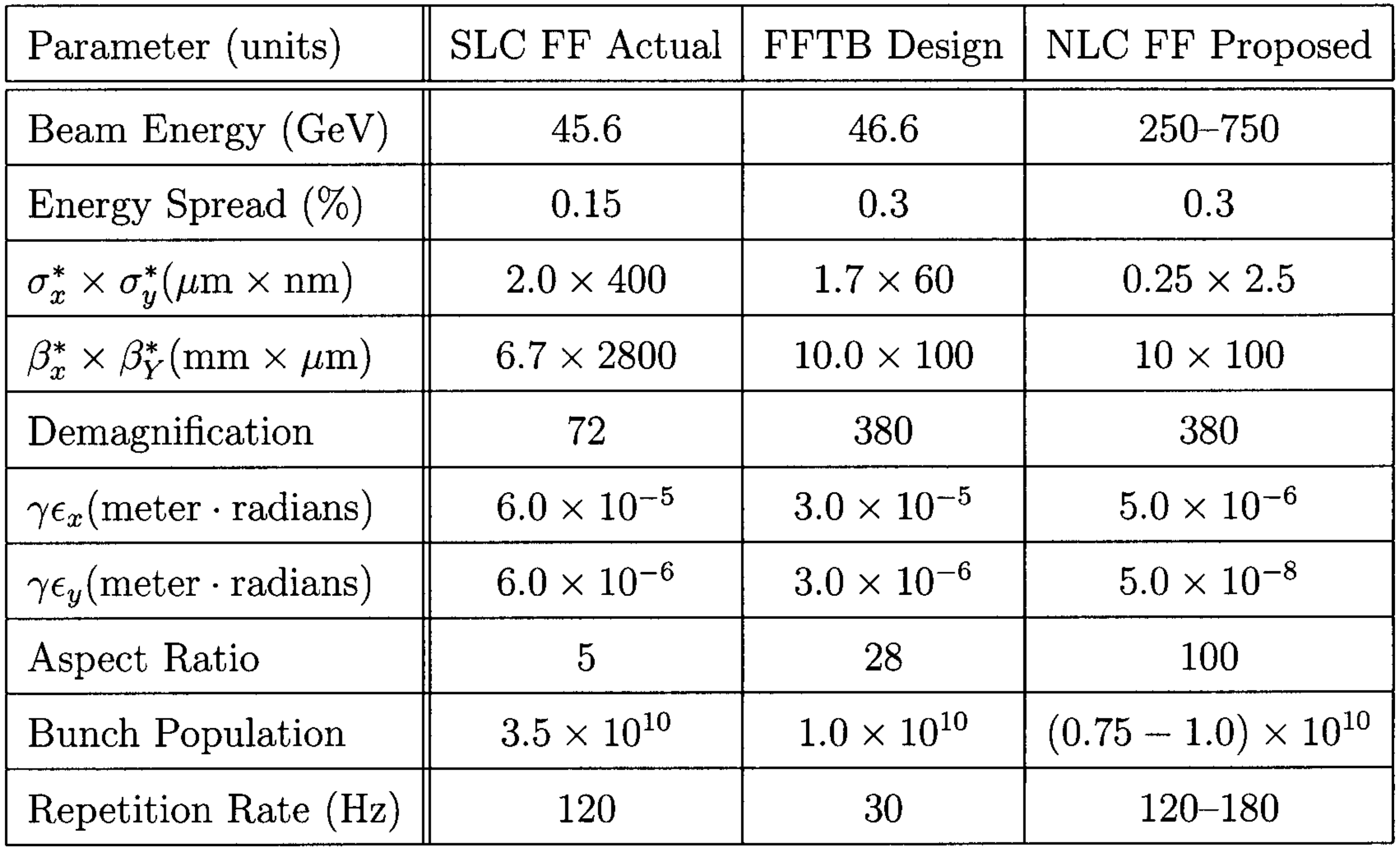
FACILITY construction, first result	ATF2/KEK; 1.3GeV 2005-08-13?	FFTB/SLAC; 47GeV 1991-93-94
Optics	Local chromaticity correction scheme; very short and longer L* (β^*_y=100μm, L_{FF}=30m)	Non-local and dedicated CCS at upstream; high symmetry in x, y ; i.e. orthogonal tuning (β^*_y=100μm, L_{FF}=185m)
Design beam size	2.8μm / 37nm, aspect=76 ($\gamma\varepsilon_y$=3 x 10^{-8} m)	1.92μm /52nm, aspect=37 ($\gamma\varepsilon_y$=2 x 10^{-6} m)
Achieved	?	70nm (FD jitter remains !)

FFTB

200m from end of Linac



Final Focus Test Beam



Parameter (units)	SLC FF Actual	FFTB Design	NLC FF Proposed
Beam Energy (GeV)	45.6	46.6	250–750
Energy Spread (%)	0.15	0.3	0.3
$\sigma_x^* \times \sigma_y^* (\mu\text{m} \times \text{nm})$	2.0×400	1.7×60	0.25×2.5
$\beta_x^* \times \beta_Y^* (\text{mm} \times \mu\text{m})$	6.7×2800	10.0×100	10×100
Demagnification	72	380	380
$\gamma\epsilon_x (\text{meter} \cdot \text{radians})$	6.0×10^{-5}	3.0×10^{-5}	5.0×10^{-6}
$\gamma\epsilon_y (\text{meter} \cdot \text{radians})$	6.0×10^{-6}	3.0×10^{-6}	5.0×10^{-8}
Aspect Ratio	5	28	100
Bunch Population	3.5×10^{10}	1.0×10^{10}	$(0.75 - 1.0) \times 10^{10}$
Repetition Rate (Hz)	120	30	120–180
L* (m)		0.4@IPBSM	1.5-2.5

: Chromaticity ~L*/β^*_y

Table 2.1: Comparison of IP beam parameters for SLC Final Focus, FFTB, and NLC Final Focus.

Beam Switch Yard

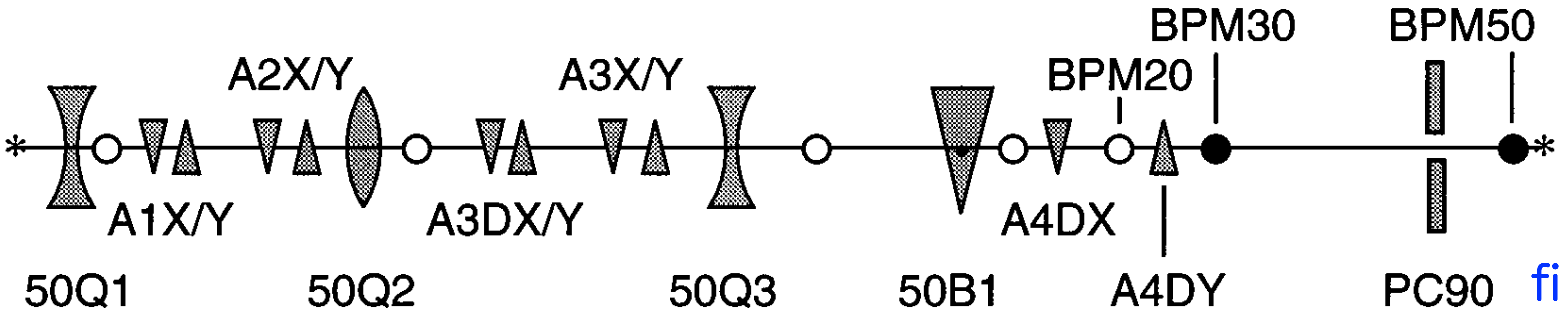


Figure 2.2: Schematic layout of the Beam Switch Yard. Normal quadrupoles are shown as lenses, bend magnets as large wedges, steering magnets as upright (xcor) or inverted (ycor) small wedges. Pre-existing BPMs are shown as open circles, FFTB BPMs as closed ones.

Beta Matching

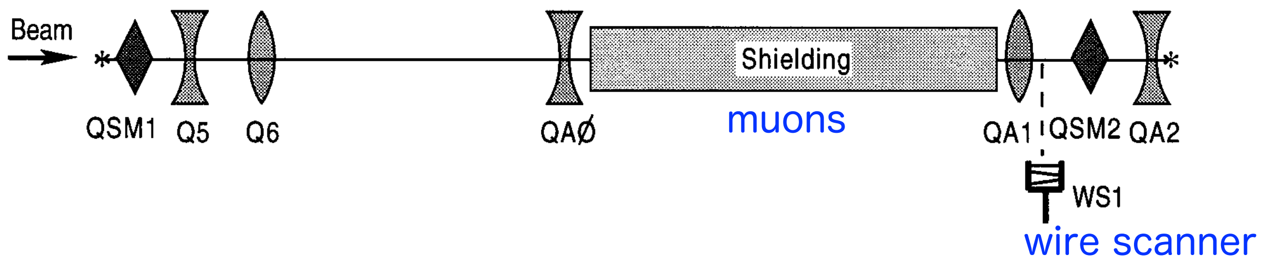


Figure 2.3: Schematic layout of the Beta Match region. Notation is as before, with the addition of diamonds to represent skew quadrupoles. Also shown are the locations of the beam reconstruction wire scanner, WS1, and the 16 meter muon shielding wall which permits access to FFTB during SLC running. ; $\beta^*_{x/y}$ from 1m/1m to designed values

CCSX

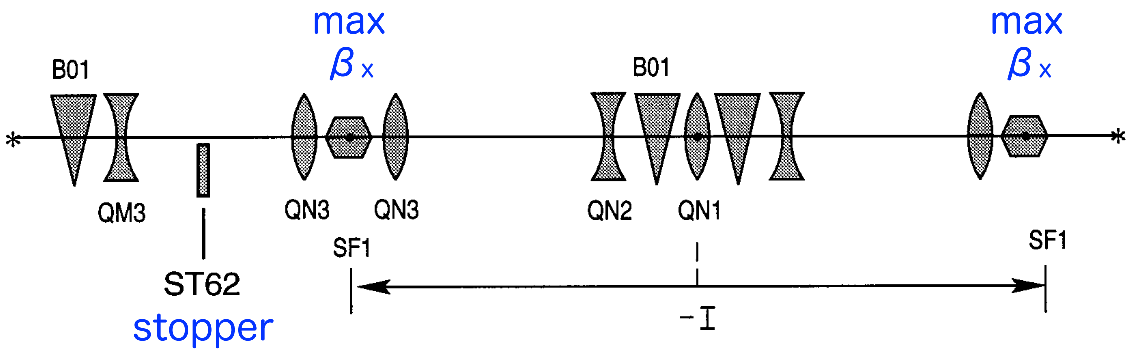


Figure 2.4: Schematic layout of the CCSX region. Chromatic Correction sextupoles are indicated by hexagons. Also shown is the movable stopper, ST62, which is inserted for incoming beam reconstruction.

Beta exchanger

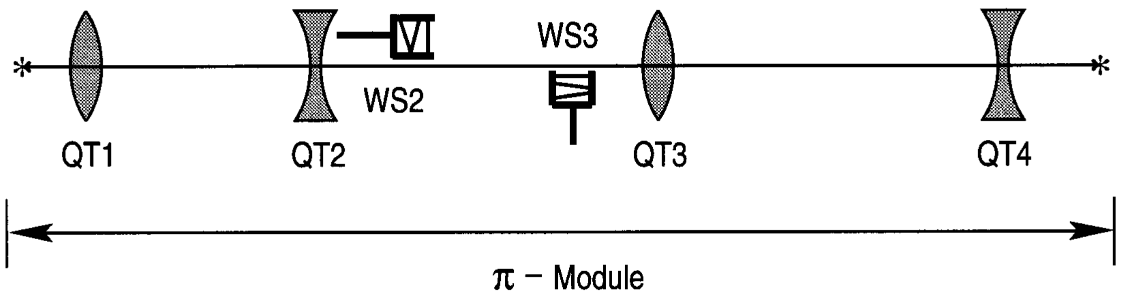


Figure 2.5: Schematic layout of Beta Exchanger region. Because of strength limitations, the "QT2" magnet is in fact a pair of quadrupoles set at the same strength with a separation of only a few centimeters. The optics contains a horizontal waist at the WS2 location and a vertical waist at the WS3 location.

Changes $\beta_x \gg \beta_y$ at SF1 to $\beta_y \gg \beta_x$ at SD1, i.e. the horizontal and vertical magnifications are 0.395 and 6.15, respectively.

CCSY

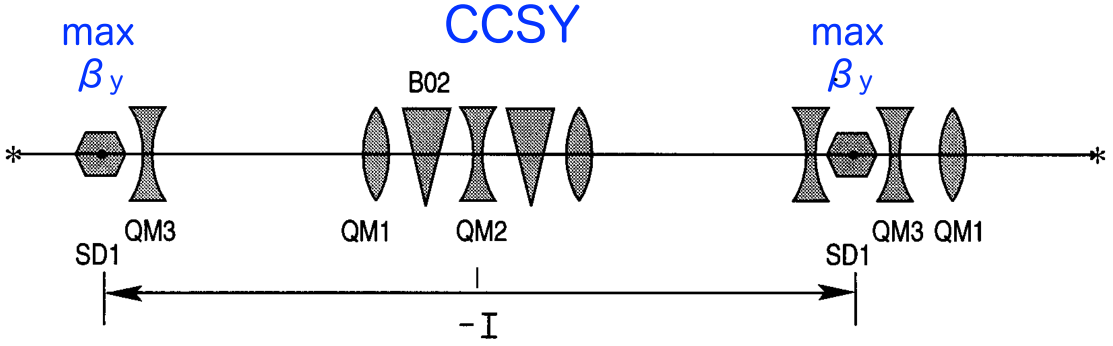


Figure 2.6: Schematic layout of CCSY region. The CCSY is optically identical to the CCSX, with the exception that the dipole and quadrupole polarities are reversed from one to the other.

Final transformer

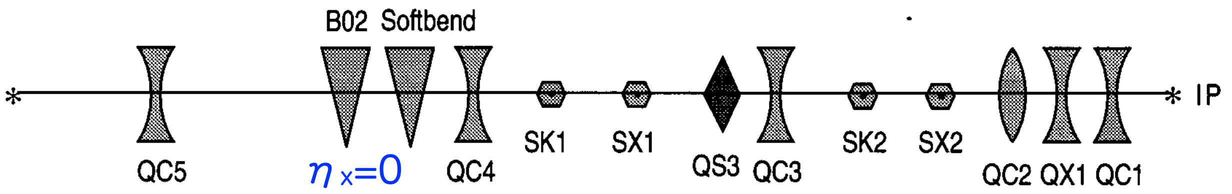


Figure 2.7: Final Transformer between the CCSY and the Focal Point. Small hexagons are sextupoles for correction of residual geometric sextupole aberrations in the line.

Focal point; L*=0.4m at IPBSM

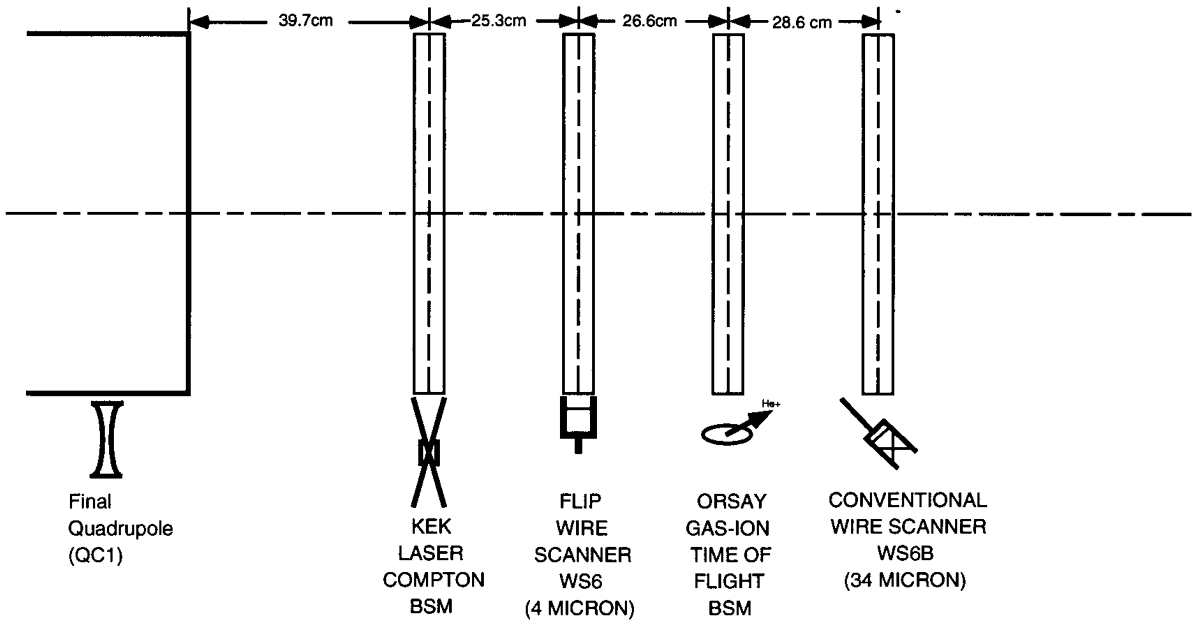


Figure 2.8: Arrangement of diagnostic devices at the FFTB Focal Point.

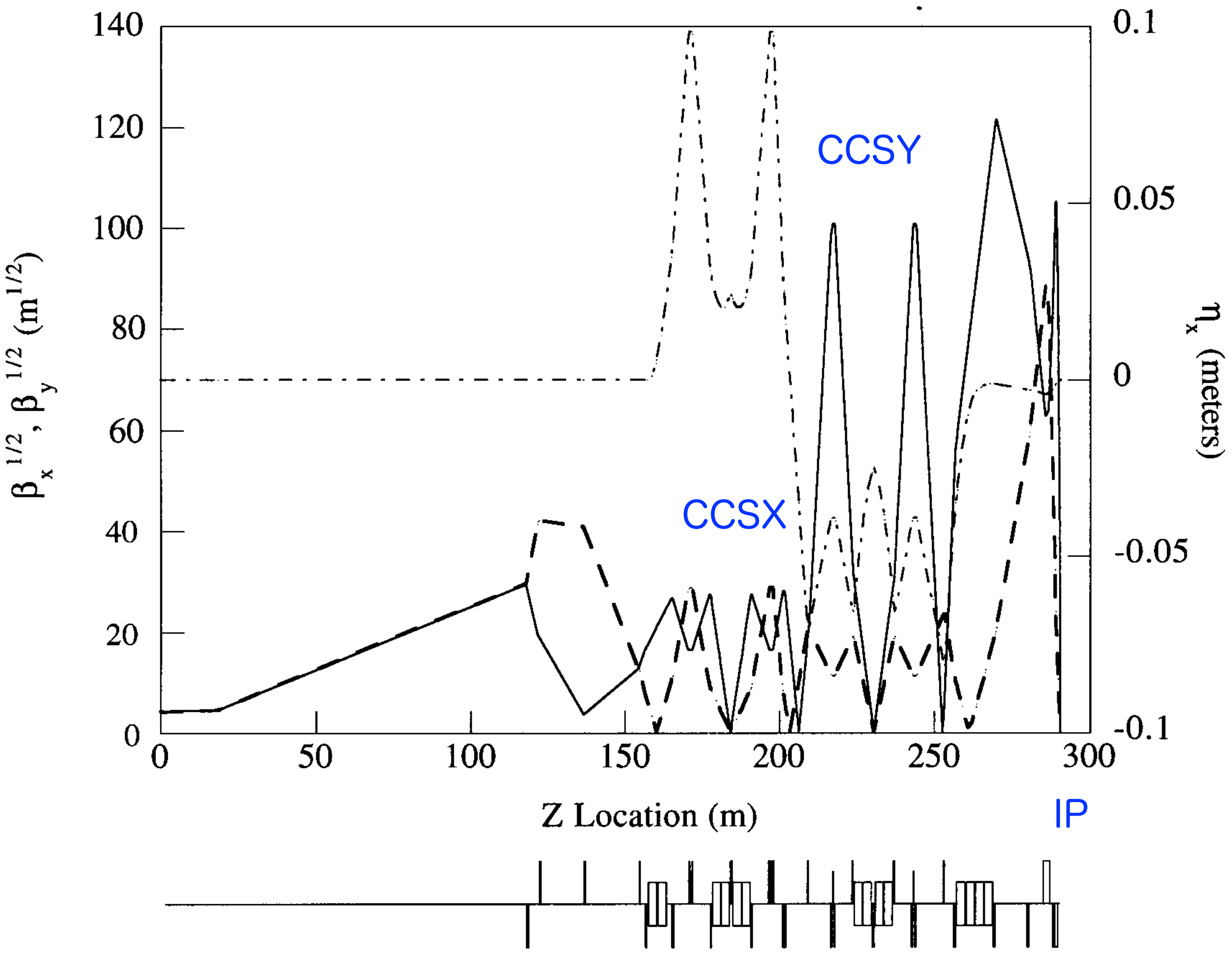


Figure 2.10: FFTB beam optical functions. Shown are $\beta_x^{1/2}$ (dashes), $\beta_y^{1/2}$ (solid), and η_x (dot-dash). The vertical dispersion function, η_y, has a design value of zero everywhere.

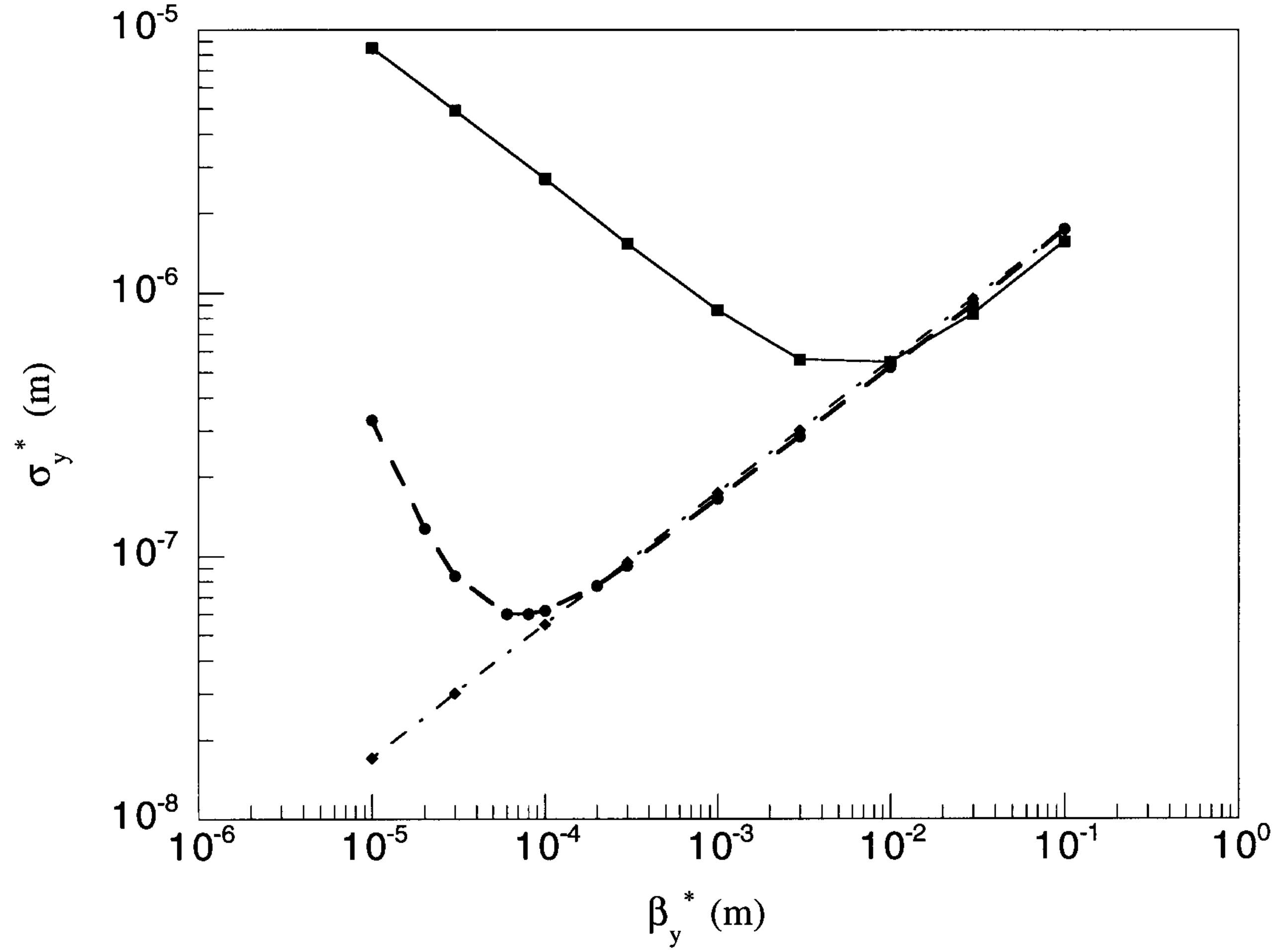
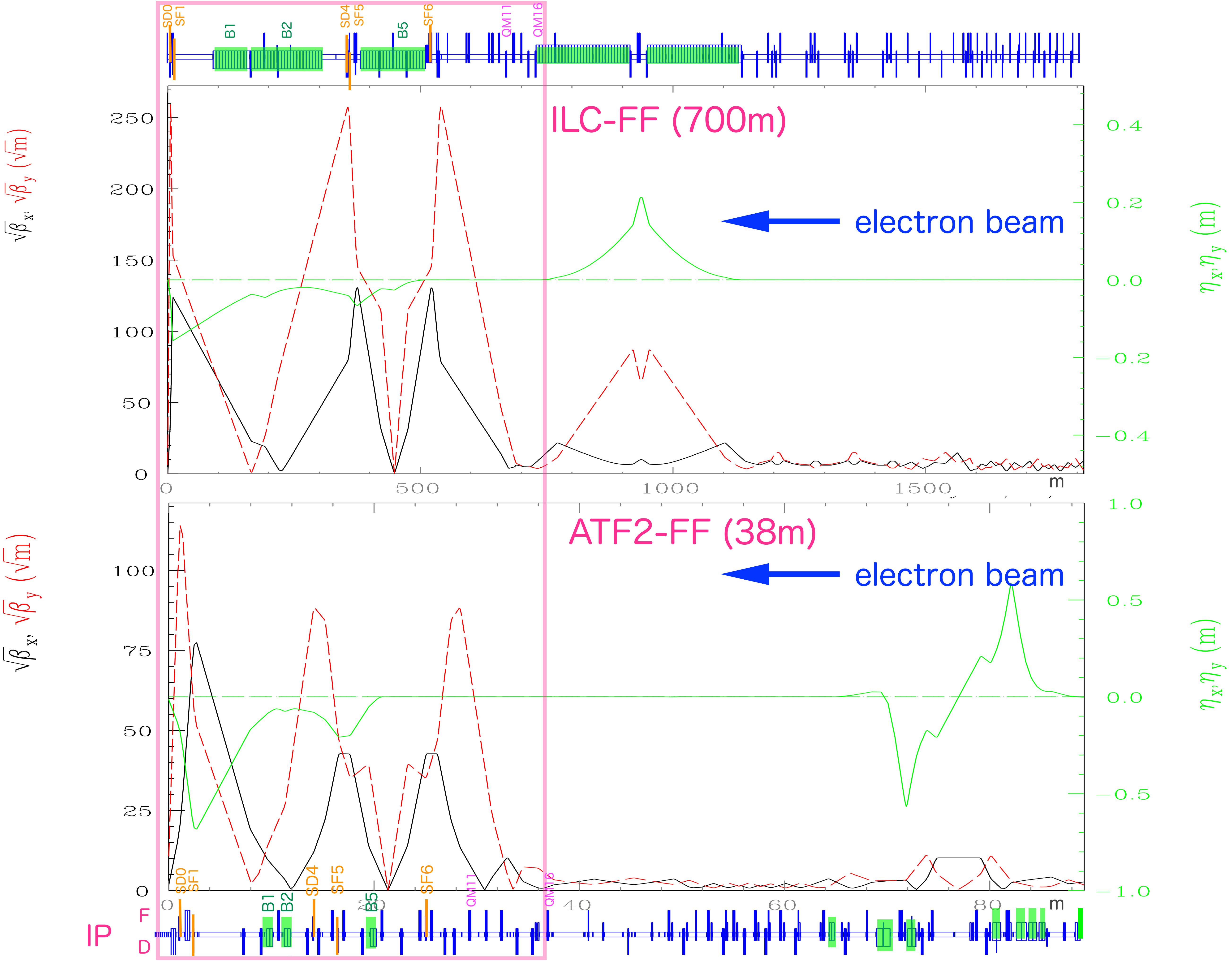


Figure 2.11: Chromatically-corrected (dashes) and -uncorrected (solid) beam sizes in the FFTB as a function of β_y^*. The linear monochromatic size is shown (dot-dash) for comparison.

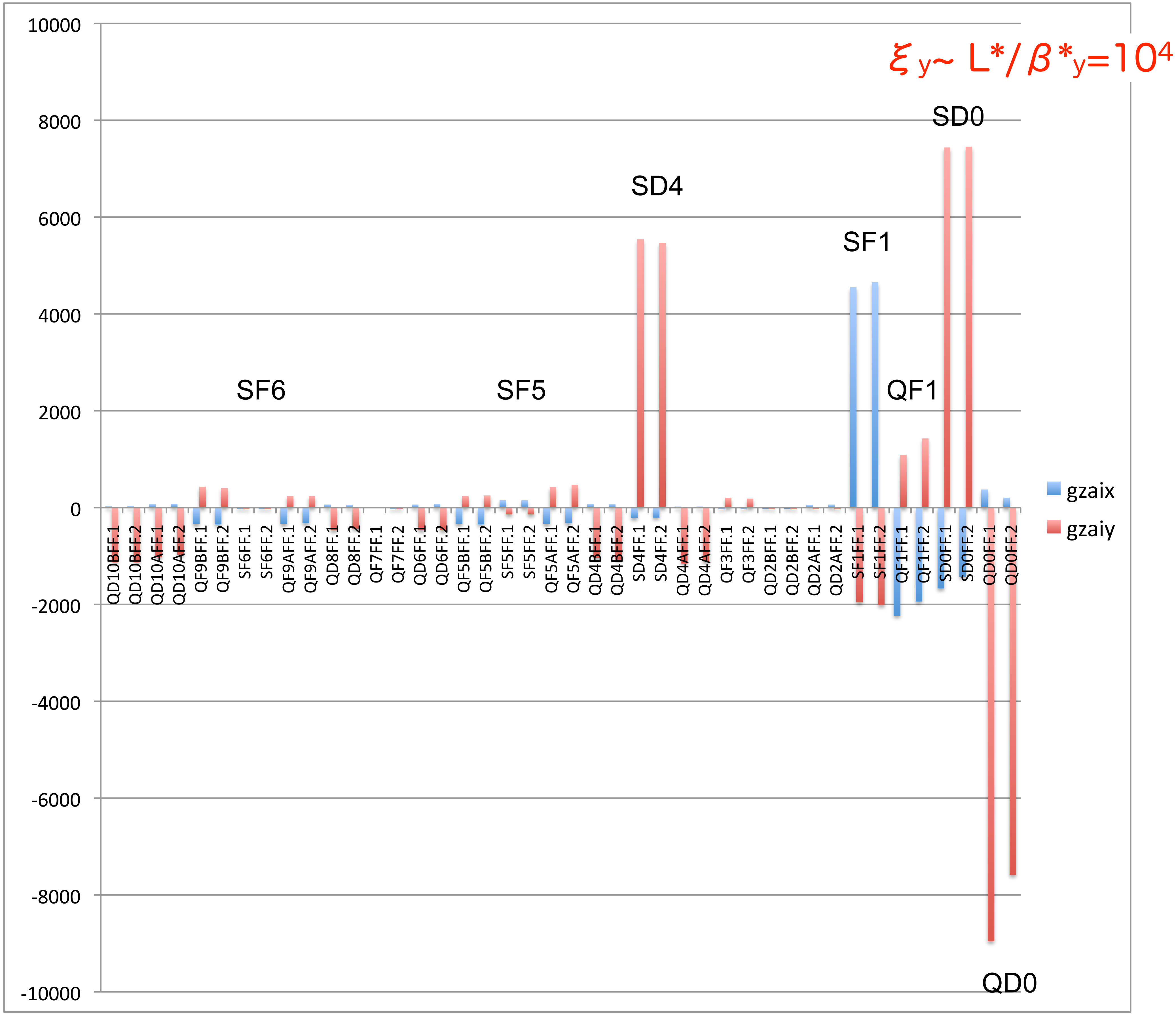
E_b=46.6GeV, δE_b=0.3%, L^*=0.4m

ε_y=32pm, β^*_y=100μm, σ_0=57nm

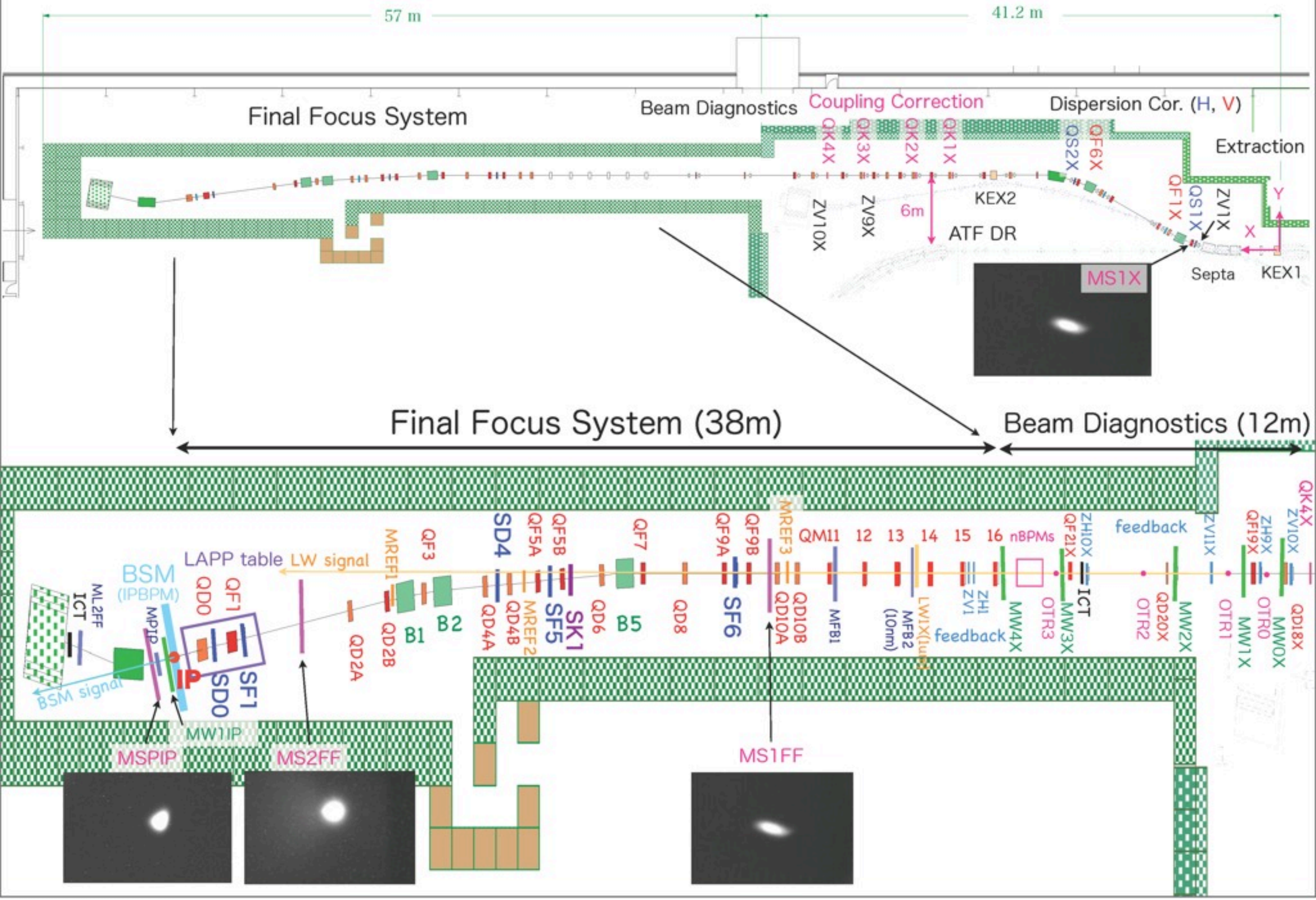
Parameters	unit	ATF2	ILC	CLIC	S-KEKB (LER/HER)
Beam Energy	GeV	1.3	250	1500	4/7
L*	m	1	3.5-4.5	3.5	0.47/1.3
$\gamma\varepsilon_x$	m-rad	5x10^{-6}	1x10^{-5}	6.6x10^{-7}	2.5/3.3x10^{-5}
ε_x	nm	2	1.0 (DR)	0.1 (DR)	3.2/2.4
$\gamma\varepsilon_y$	m-rad	3x10^{-8}	4x10^{-8}	2x10^{-8}	1.0/1.2x10^{-7}
ε_y	pm	12	2(DR)	1(DR)	13/8.4
β^*_x	mm	4	21	6.9	32/25
β^*_y	mm	0.1	0.4	0.07	0.27/0.41
η'	rad	0.14	0.0094	0.00144	
σ_E	%	~0.1	~0.1	~0.3	0.08/0.06
Chromaticity	L*/β^*_y	~10^{4}	~10^{4}	~5x10^{4}	1.7/3.2x10^{3}
σ^*_x	μm	2.8	0.655	0.039	10.2/7.8
σ^*_y	nm	37	5.7	0.7	59/59


SD0
SF1
B1
B2
SD4
SF5
B5
SF6
QM11
QM16
ILC-FF (700m)
electron beam
$\sqrt{\beta_x}, \sqrt{\beta_y}$ ($\sqrt{m}$)
η_x, η_y (m)
0
50
100
150
200
250
0.4
0.2
0.0
−0.2
−0.4
0
500
1000
1500
m
ATF2-FF (38m)
electron beam
$\sqrt{\beta_x}, \sqrt{\beta_y}$ ($\sqrt{m}$)
η_x, η_y (m)
0
25
50
75
100
1.0
0.5
0.0
−0.5
−1.0
0
20
40
60
80
m
SD0
SF1
B1
B2
SD4
SF5
B5
SF6
QM11
QM16
IP
F
D

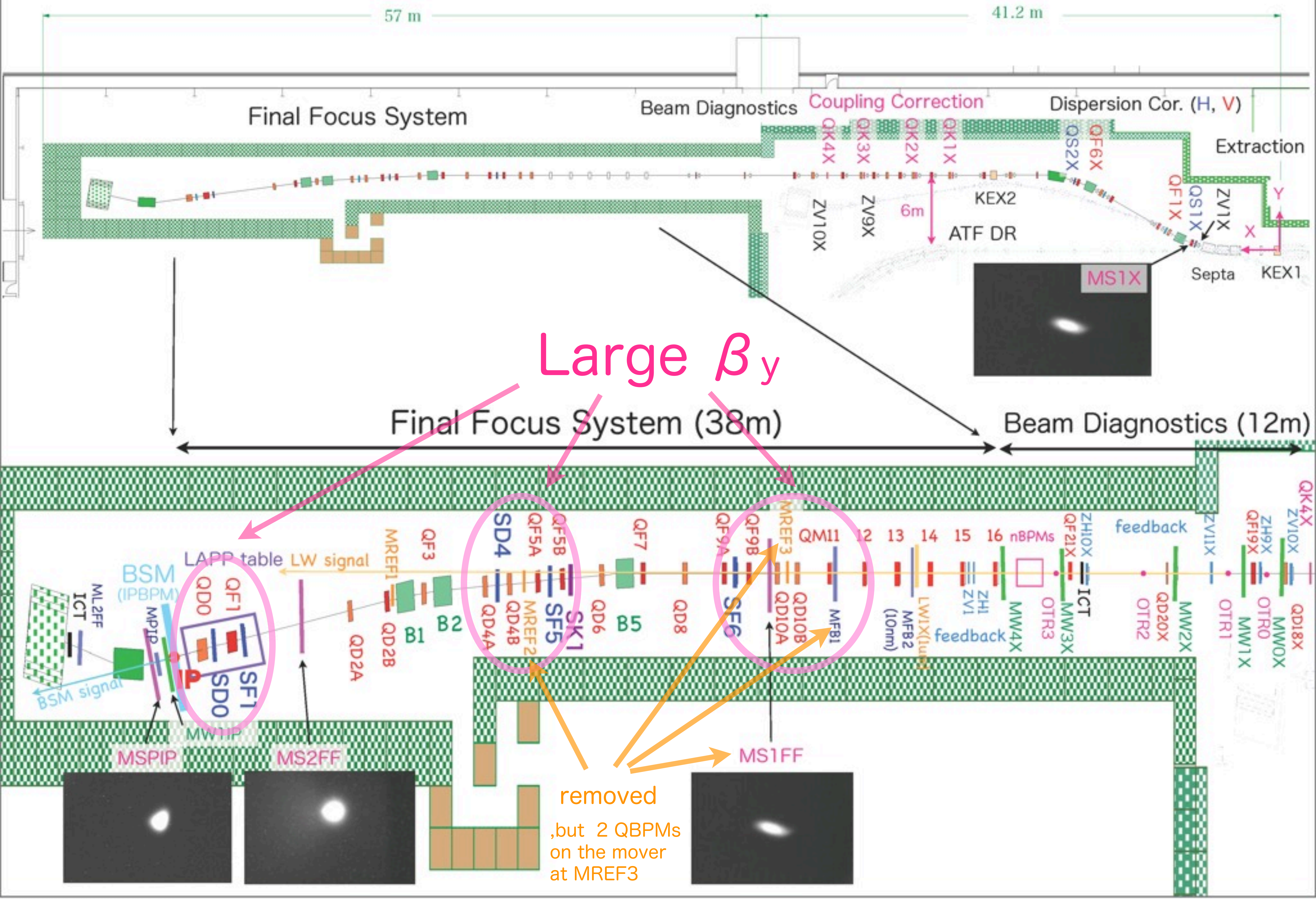
Chromaticity at the FF magnets at the nominal ATF2 optics



$\xi_y \sim L^*/\beta^*_y = 10^4$



2013年 1月 23日 水曜日



Large β_y

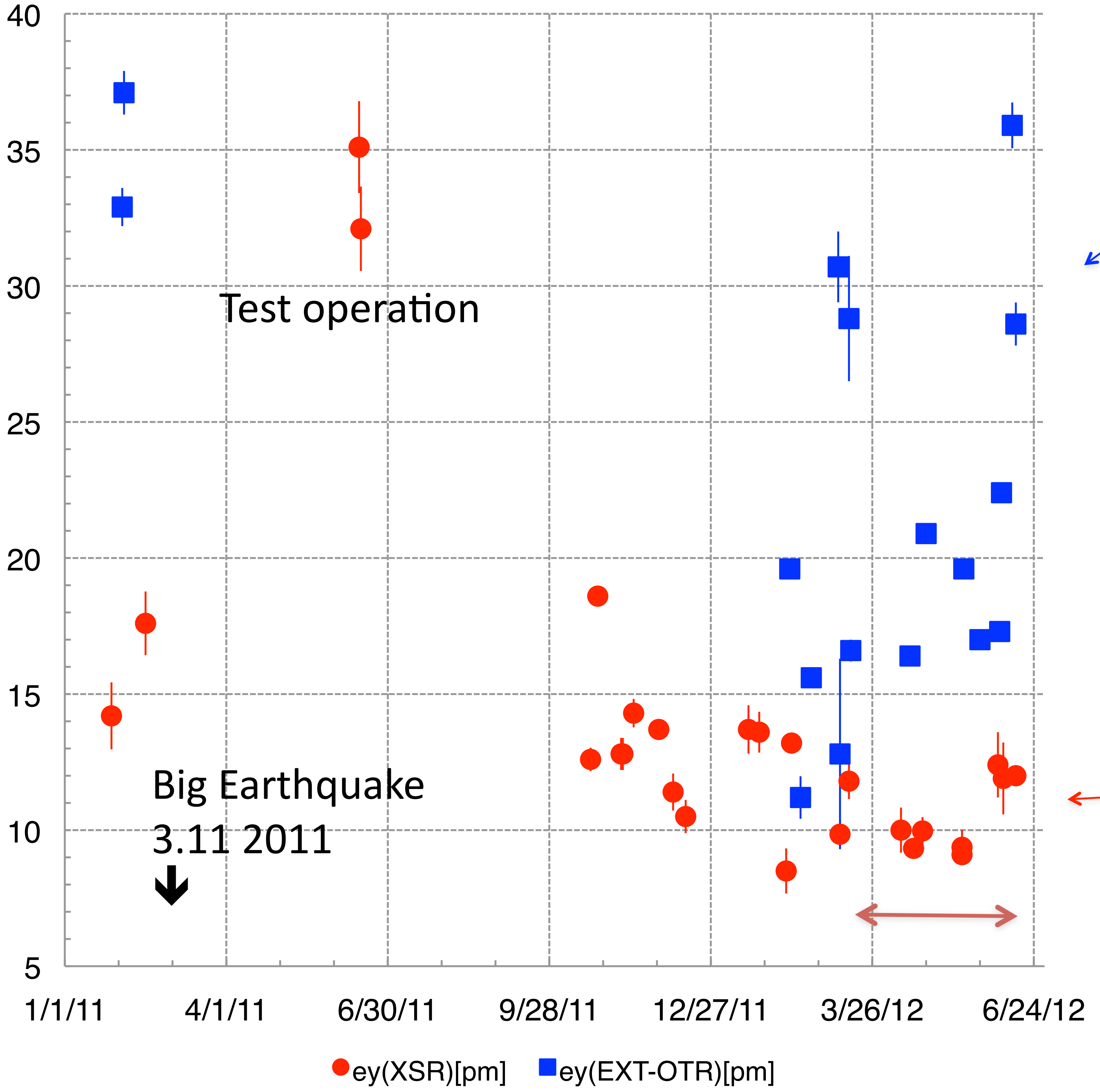
removed
,but 2 QBPMs
on the mover
at MREF3

Parameters at ATF2

IP Parameter	nominal	May 2010	Feb 2012	Jun 2012	Dec 2012
Beam energy	1.3GeV	1.3GeV	1.3GeV	1.3GeV	1.3GeV
Emittance in x	2 nm	1.7nm	1.8nm	1.3nm	1.4nm* 1.9nm**
Emittance in y	12 pm	<10pm	15.6 pm	31 pm	20 pm* 30pm**
Beta function in x	4 mm	4cm	4cm	4cm	4cm
Beta function in y	0.1mm	1mm	0.3mm	0.1mm	0.1mm
beam size in x by IP carbon wires	2.8 μm	~10 μm	11.2μm	11.2μm	11.4μm
beam size in y by IPBSM	37 nm	300 nm 8deg.mode	165nm 30deg.mode	220nm 30deg.mode	73nm* 174deg.mode

* 1x10^9/bunch/bunch, ** 5x10^9/bunch

Vertical emittance at DR and EXT



Emittance growth at the EXT

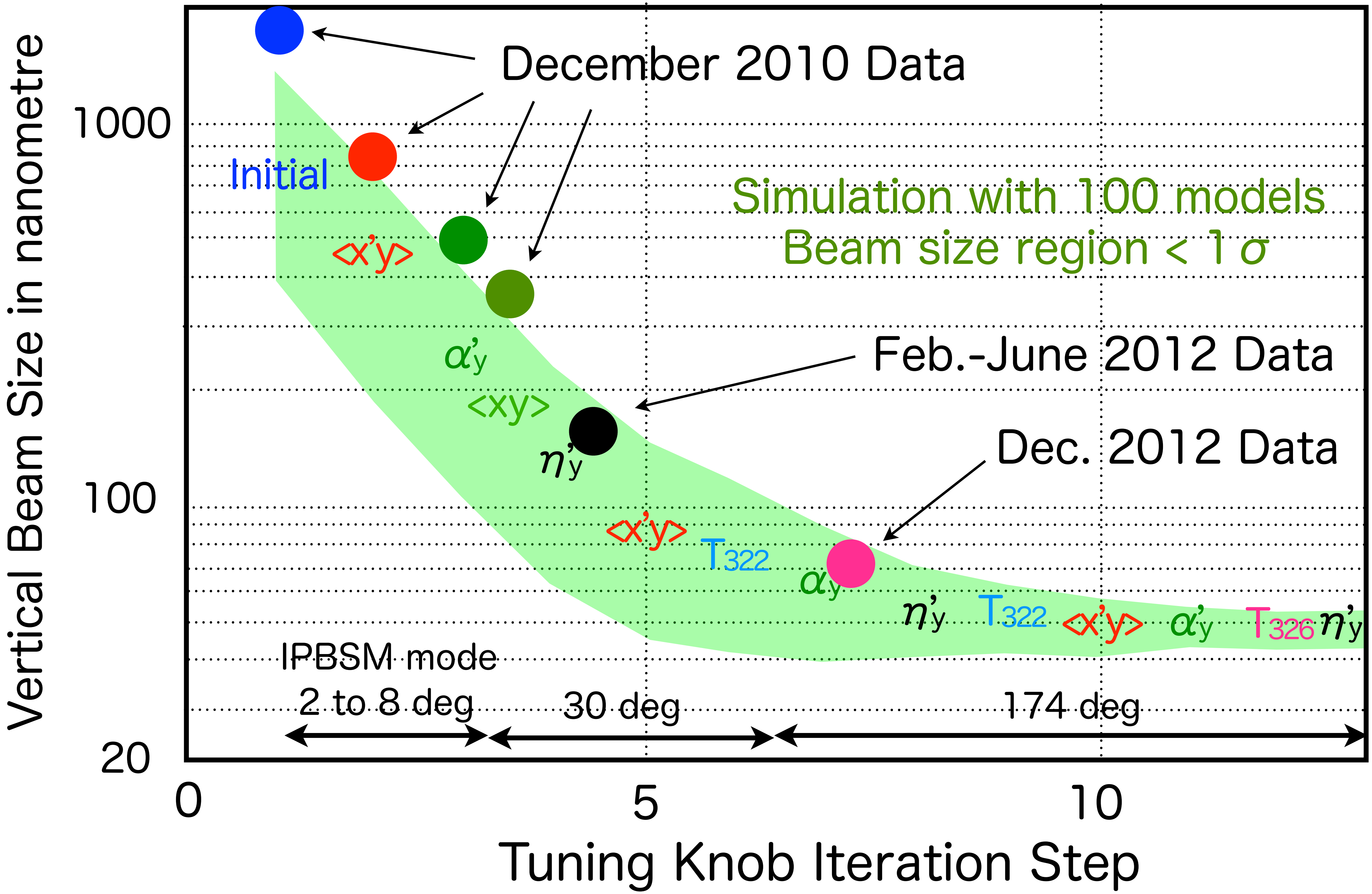
Emittance in DR is around 10-12 pm

On-going R&D

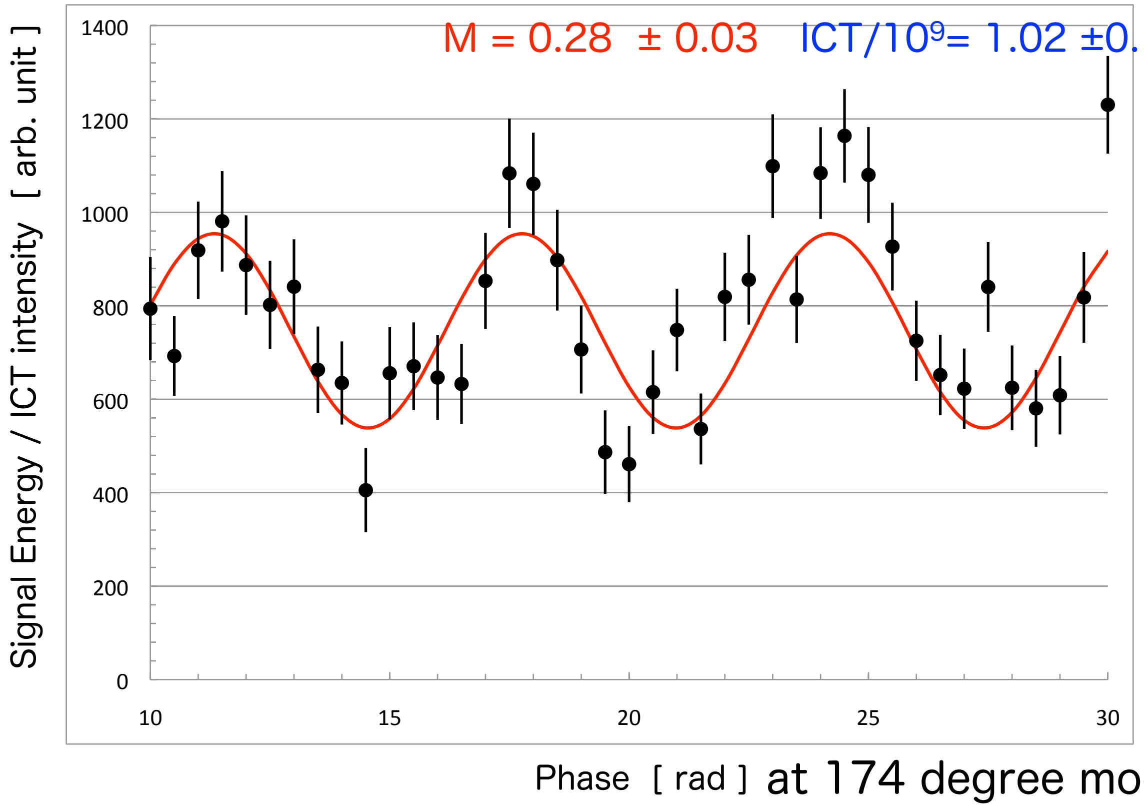
→ Laser wire measurement

→New BPM calibration concept (K. Kubo, A. Wolski)

2009	2010	2011	2012
Major works in summer: installation and removal of fast-kicker system	FD alignment, installation of IP-wire, IPBPMs and M-OTRs, new stripline BPM electronics, new EXT kicker control BS3X rolled ~4mr (Mar.)	installation of 1 skew sextupole and removal of 2nd kicker(Jan.) alignment of DR and EXT	Upgrade of IPBSM, installation of 3 skew sextupoles and removal of s-band BPMs of QD0,QF1 and 2 reference cavities@large β replacement of QF1 alignment of DR (Dec.)
Major accidents:		2/16 fire@modulator#0 3.11 earthquake M9.0	no air-conditioning@DR modulator#2 trouble (Nov) 12.7 earthquake M7.3
Optics: $\beta^*_x/_y$=8cm/1mm till Mar. $\beta^*_x/_y$=4cm/1mm	$\beta^*_x/_y$=4cm/1mm till Oct. $\beta^*_x/_y$=4cm/0.1mm	$\beta^*_x/_y$=4cm/0.1mm	$\beta^*_x/_y$=4cm/0.1mm $\beta^*_x/_y$=4cm/0.3mm in Feb.
IP beam tuning : commission of IPBSM-LW mode till Oct. Commission of IPBSM fringe-scan modes	310±30nm@8deg. in May 280±90nm@6deg. in Dec.	commissioning of IPBSM-LW at 30deg. (Jan-Feb.)	166±7nm@30deg. in Feb. (220nm@30deg. in June) 73±5nm@174deg. in Dec.
Remarks and issues: commissioning of BPM system (res.0.2-0.4um) for orbit measurement (BBA, dispersion....)	commissioning of M-OTR system for emittance measurement	wakefield at the M-OTR recovery of the earthquake	3Hz operation since Oct. Wakefield at the large vertical beta function region Emittance growth at EXT


December 2010 Data
Initial
<x'y>
α'y
<xy>
η'y
Simulation with 100 models
Beam size region < 1 σ
Feb.-June 2012 Data
Dec. 2012 Data
<x'y>
T322
αy
η'y
T322
<x'y>
α'y
T326
η'y
IPBSM mode
2 to 8 deg
30 deg
174 deg
1000
100
20
0
5
10
Vertical Beam Size in nanometre
Tuning Knob Iteration Step

Preliminary ATF2@KEK meas121221_183019



M = 0.28 ± 0.03 ICT/10^9= 1.02 ±0.11(rms)

at 174 degree mode

266nm/pitch

FFTB@SLAC

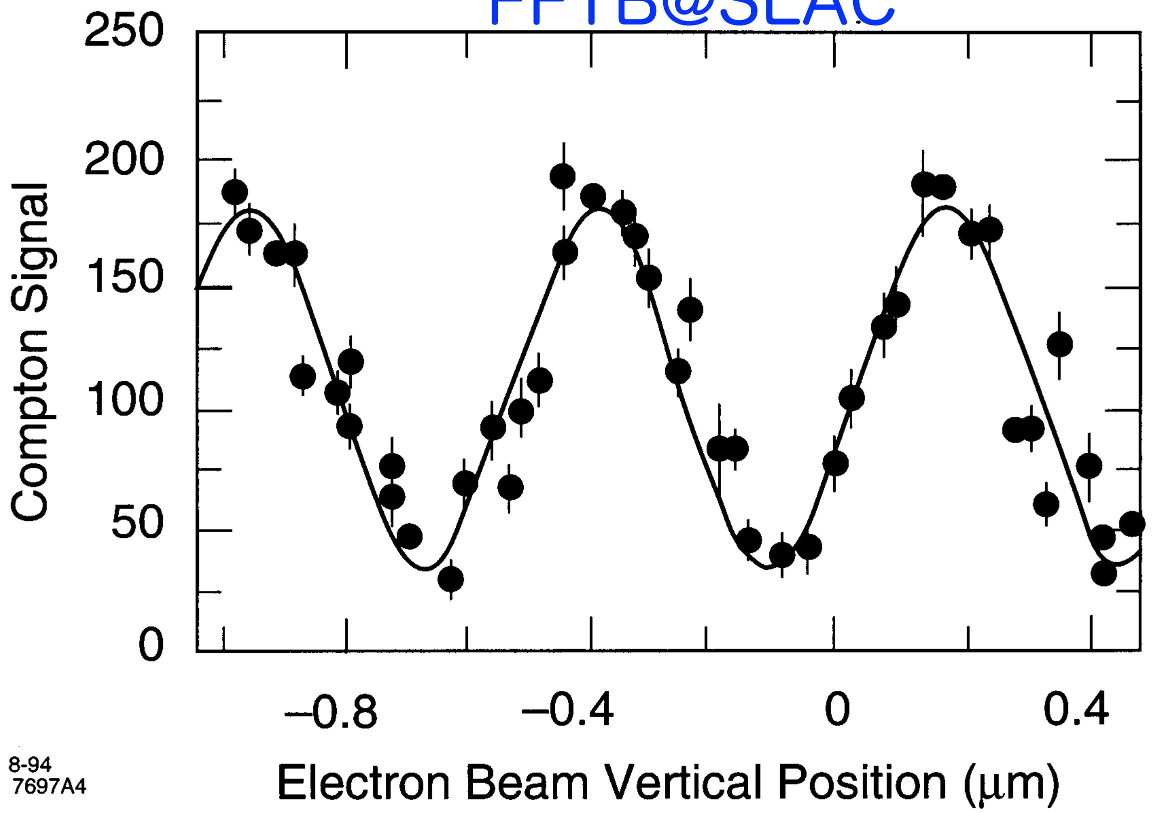
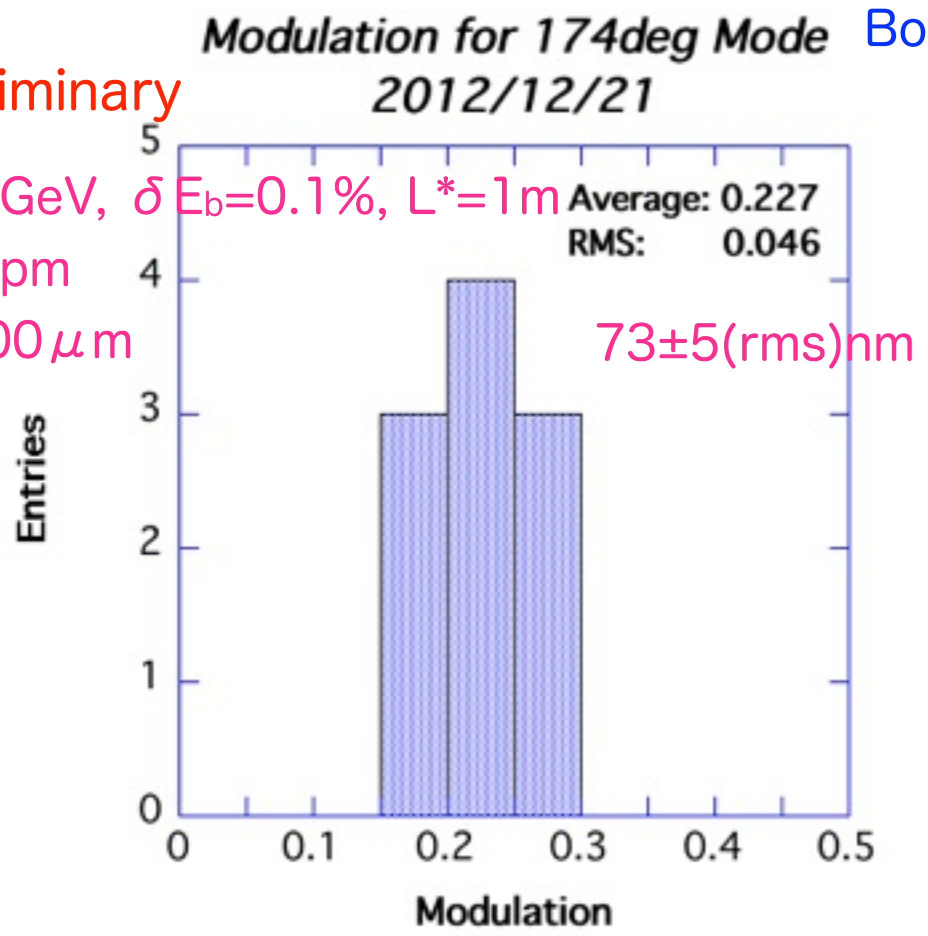


Figure 5.6: Laser-Compton beam size measurement performed in May of 1994. The measured size is 77±7 nanometers.

Both assumes no modulation reduction

Preliminary



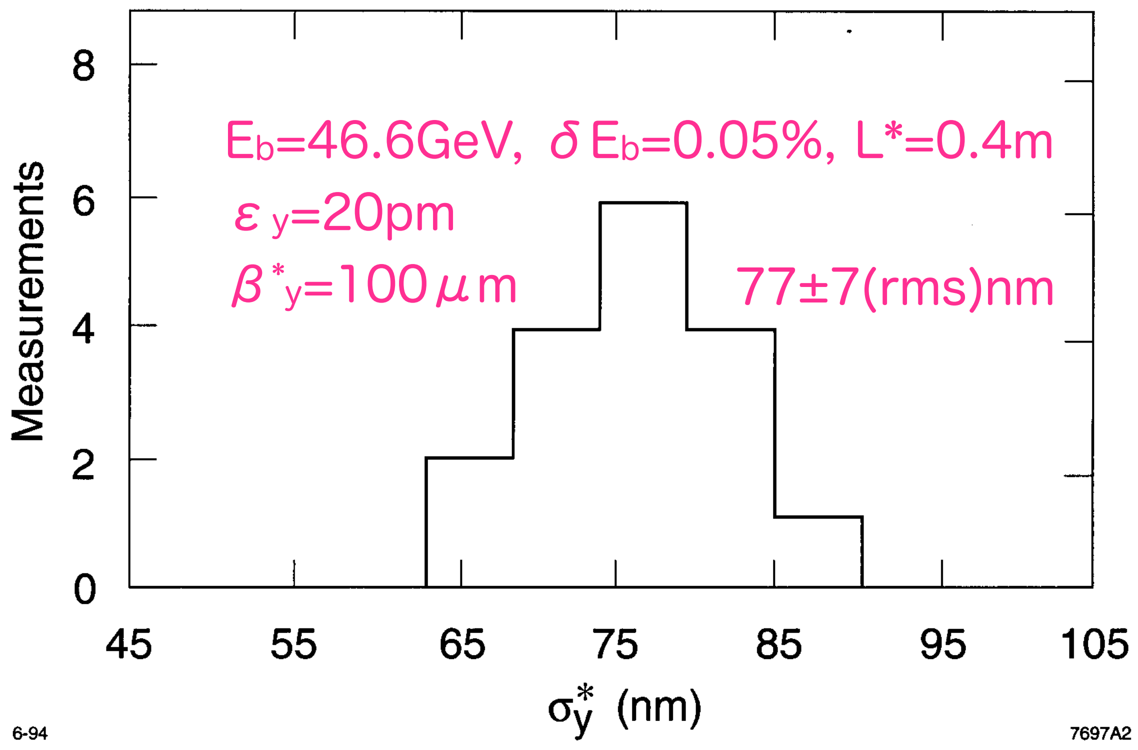
E_b=1.3GeV, δE_b=0.1%, L*=1m

ε_y=20pm

β^*_y=100μm

73±5(rms)nm

rms of laser size = 17/12um



E_b=46.6GeV, δE_b=0.05%, L*=0.4m

ε_y=20pm

β^*_y=100μm

77±7(rms)nm

Figure 5.7: Histogram of measurements made during the last 3 hours of the May, 1994 FFTB run. Average size measured was 77 nm, with an RMS of 7 nm.

rms of laser size = 50um -> M reduction of 10%

Summary

1. IPBSM upgrade was done and commissioned at all degree modes.
2. ATF was quickly recovered troubles and earthquake.
3. New QF1FF was installed.
4. R&Ds are progressing towards the goal 2.
5. Present IP beam has M=0.23±0.05 at 174 degree mode of IPBSM, it corresponds to the vertical beam size of 73±5nm.
6. The beam size might be limited by the wakefield at large beta function region.
7. Another issue is the large vertical emittance at EXT.
8. We would like to mitigate these issues to achieve 37nm in 2013.