ATF2 Status

T. Tauchi

ILC PAC, KEK, 13 -14 December 2012

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6. Summary

ATF2 : Goal - I (- 2012)

A. Achievement of 37nm beam size

A1) Demonstration of a new compact final focus system;
proposed by P.Raimondi and A.Seryi in 2000,

A2) Maintenance of the small beam size
(several hours at the FFTB/SLAC)

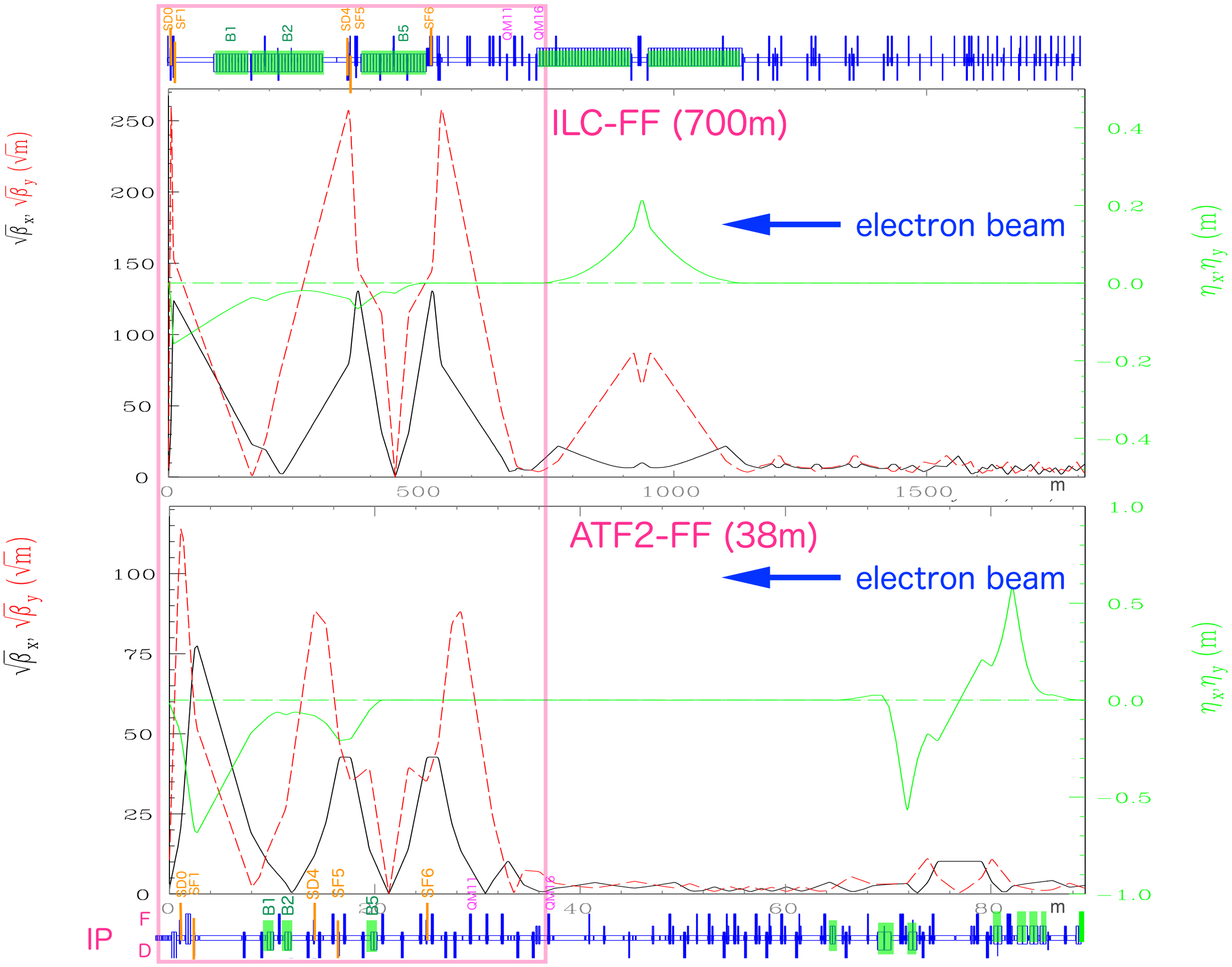
Goal - II (2013 -)

B. Control of the beam position

B1) Demonstration of beam orbit stabilization with
nano-meter precision at IP.
(The beam jitter at FFTB/SLAC was about 40nm.)

B2) Establishment of beam jitter controlling technique
at nano-meter level with ILC-like beam

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	5×10^{-6}	1×10^{-5}	6.6×10^{-7}	$2.5/3.3\times10^{-5}$
ε_x	nm	2	1.0 (DR)	0.1 (DR)	3.2/2.4
$\gamma\varepsilon_y$	m-rad	3×10^{-8}	4×10^{-8}	2×10^{-8}	$1.0/1.2\times10^{-7}$
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	$\sim10^4$	$\sim10^4$	$\sim5\times10^4$	$1.7/3.2\times10^3$
σ^*_x	μm	2.8	0.655	0.039	10.2/7.8
σ^*_y	nm	37	5.7	0.7	59/59

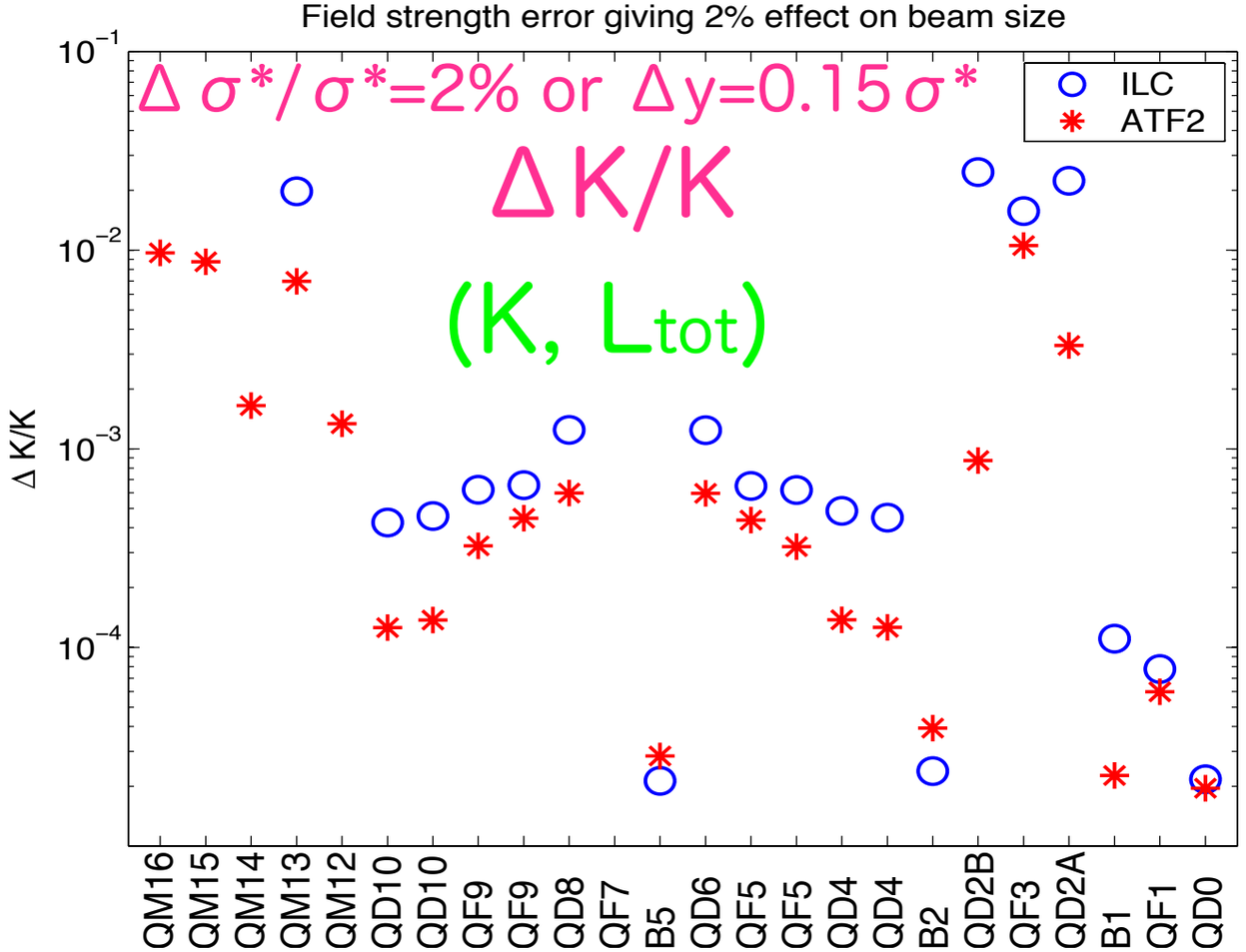


2012年 12月 14日 金曜日

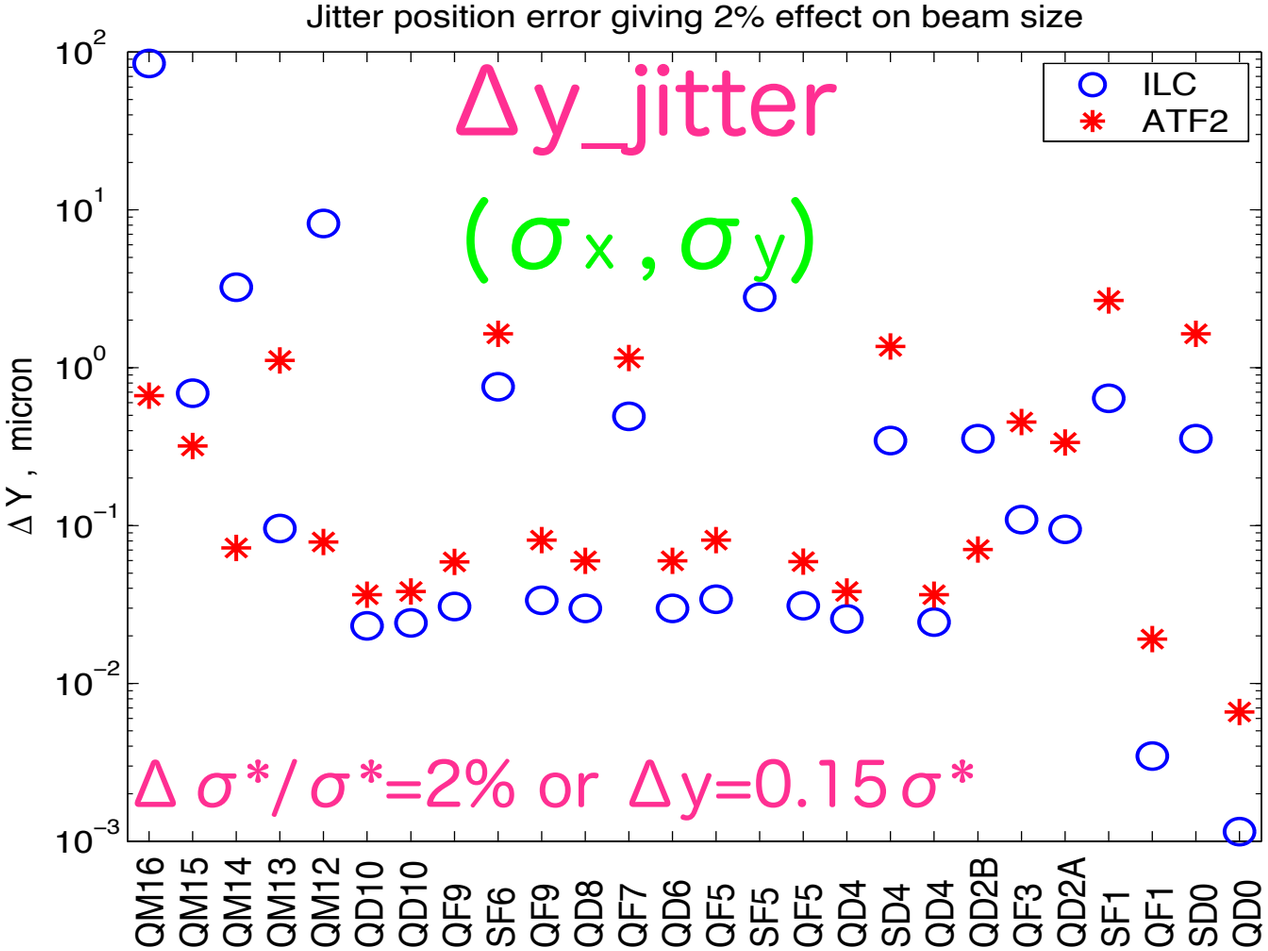
ATF2 Features

- The same number of magnets as the ILC-FF.
- The tuning knob, methods are the same,too.
- Beam instrumentation has been developed with the ILC specifications; BPMs, BSMs, movers, magnet support, laserwires, HA power supplies, FONT-feedback system etc. .
- International participation in the commissioning and operation

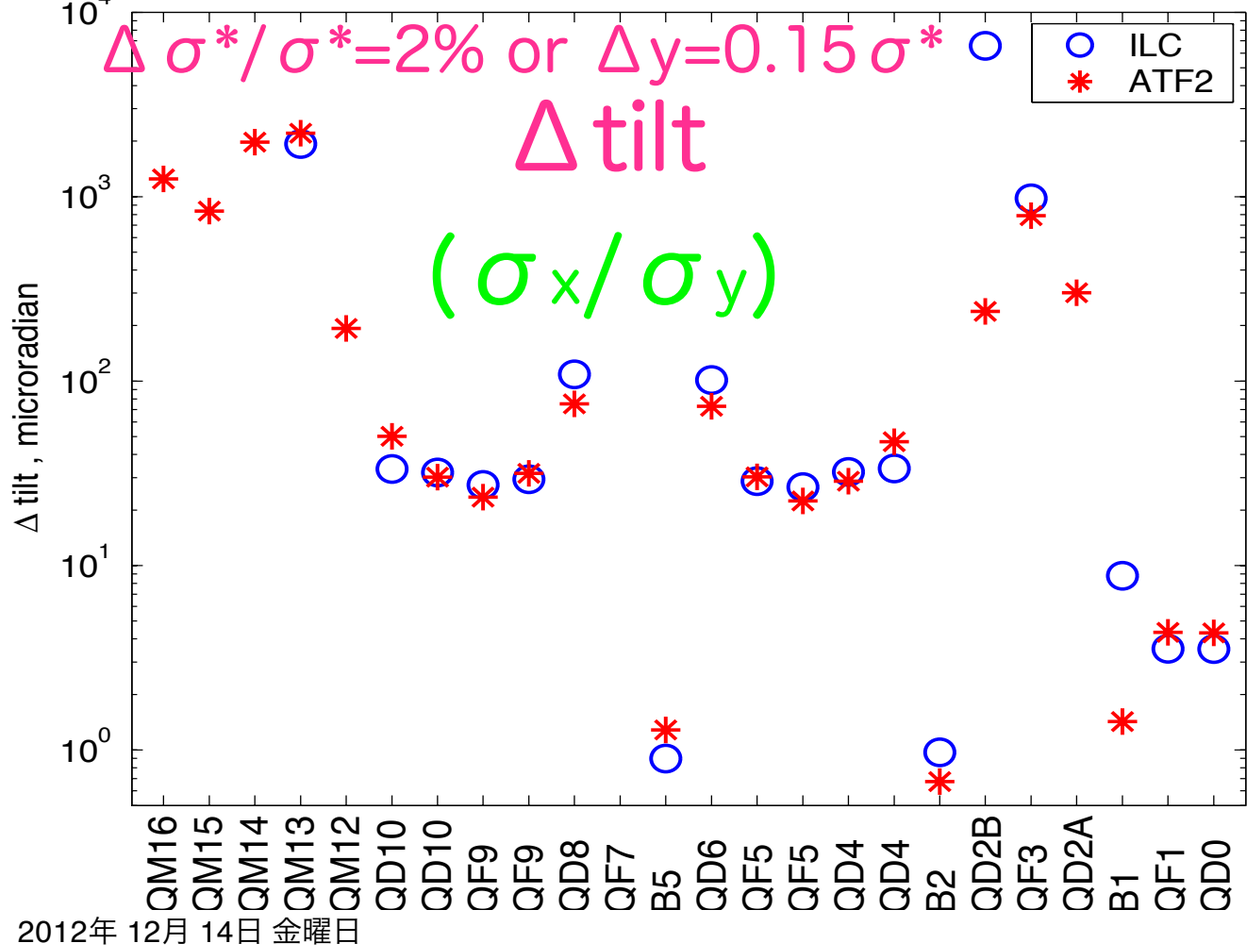
Field strength error giving 2% effect on beam size



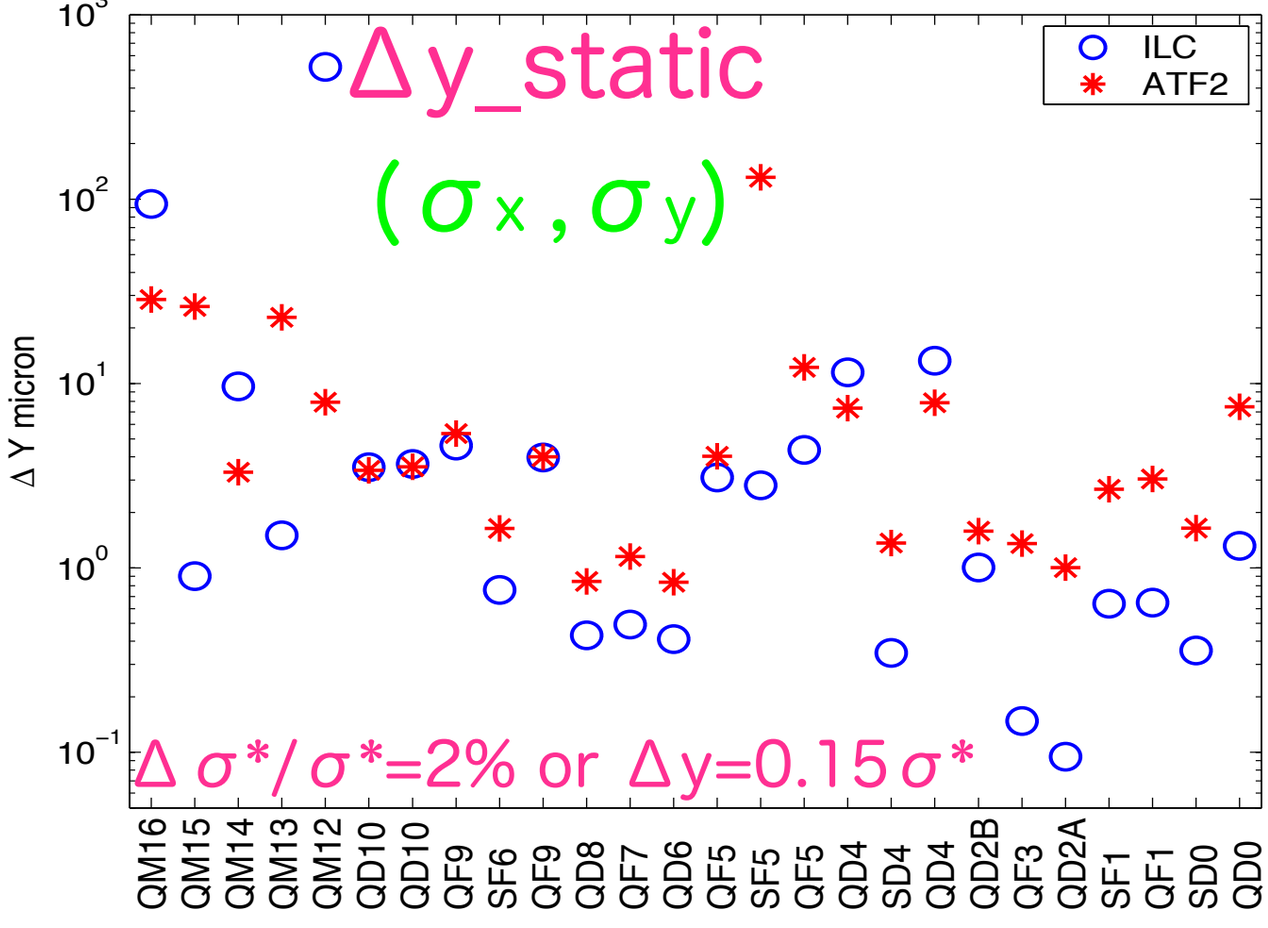
Jitter position error giving 2% effect on beam size



Magnet tilt error giving 2% effect on beam size



Static position error giving 2% effect on beam size

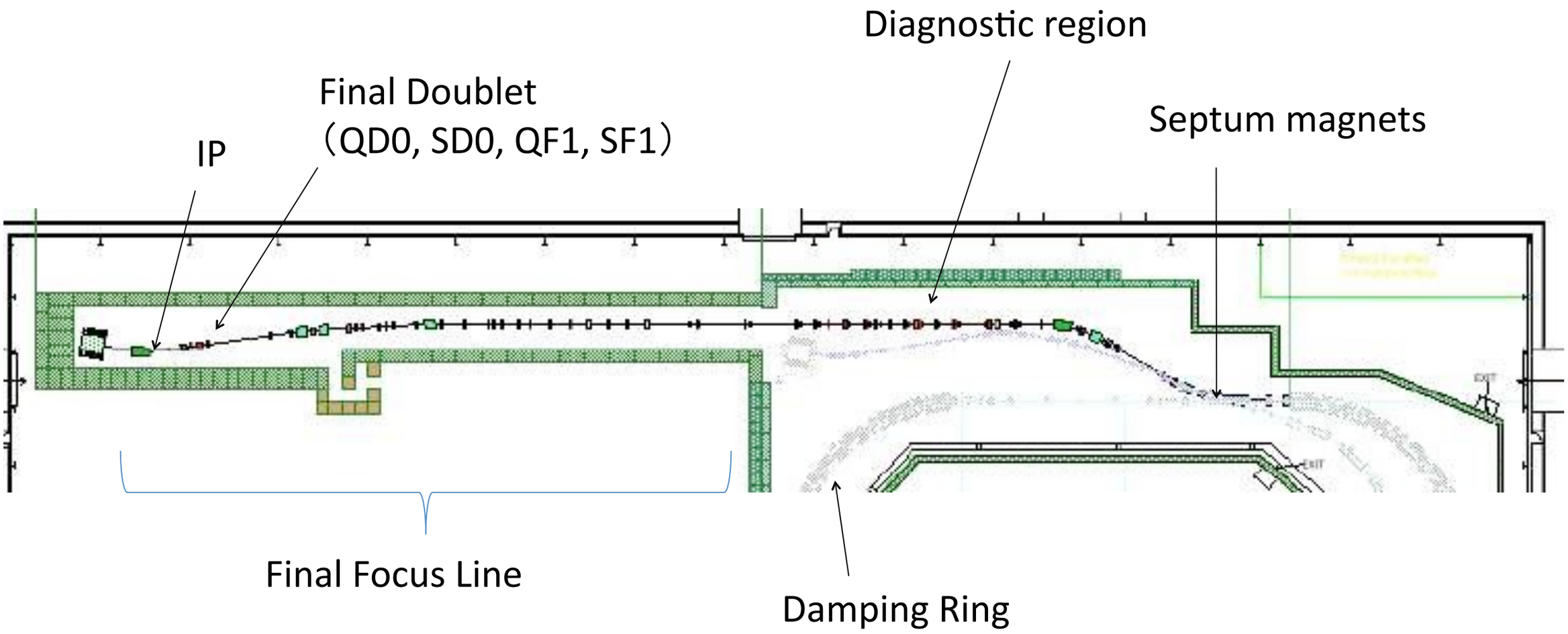


2012年 12月 14日 金曜日

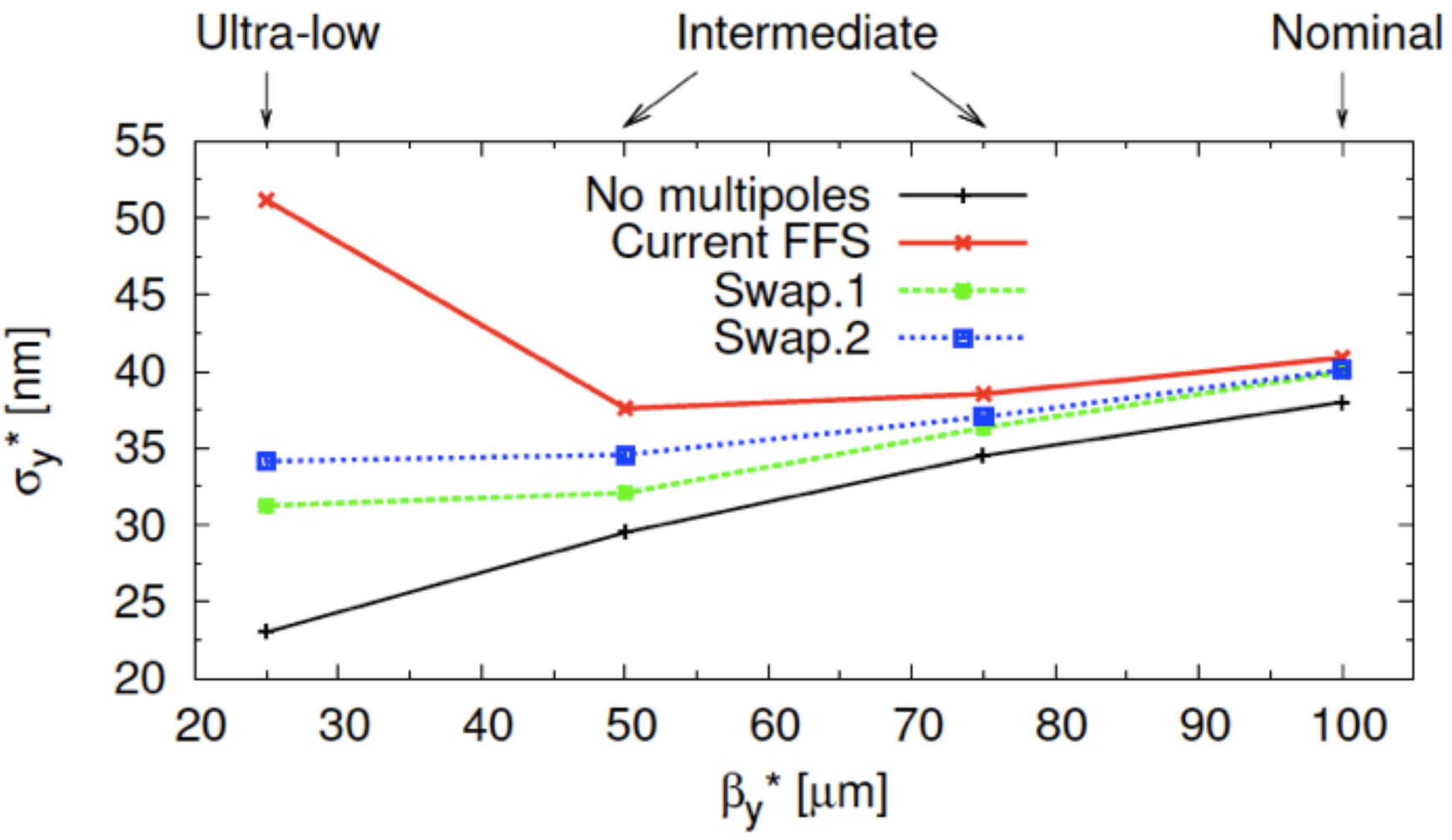
Parameters at ATF2

3.11 Earthquake

IP Parameter	nominal	May 2010	Feb 2011	Dec 2011	Feb 2012
Beam energy	1.3GeV	1.3GeV	1.3GeV	1.3GeV	1.3GeV
Emittance in x	2 nm	1.7nm	1.8-1.7nm	2nm	1.8nm
Emittance in y	12 pm	<10pm	27-28pm	~50 pm wakefield@mOTR	15.6 pm
Beta function in x	4 mm	4cm	10mm	1cm	4cm
Beta function in y	0.1mm	1mm	0.1mm	0.5mm	0.3mm
beam size in x	2.8 μm	~10 μm	-	9.2μm/2	11.2μm
beam size in y	35 nm	300 nm 8deg.mode	1.8um@PIP C-wire	850nm 5deg.mode	165nm 30deg.mode


Diagnostic region
Final Doublet
（QD0, SD0, QF1, SF1）
IP
Septum magnets
Final Focus Line
Damping Ring

Effect of Magnet Swap on Tracked Beam size for optimized lattice (v4.5 BX2.5BY1 lattice, emit_x=2nm)

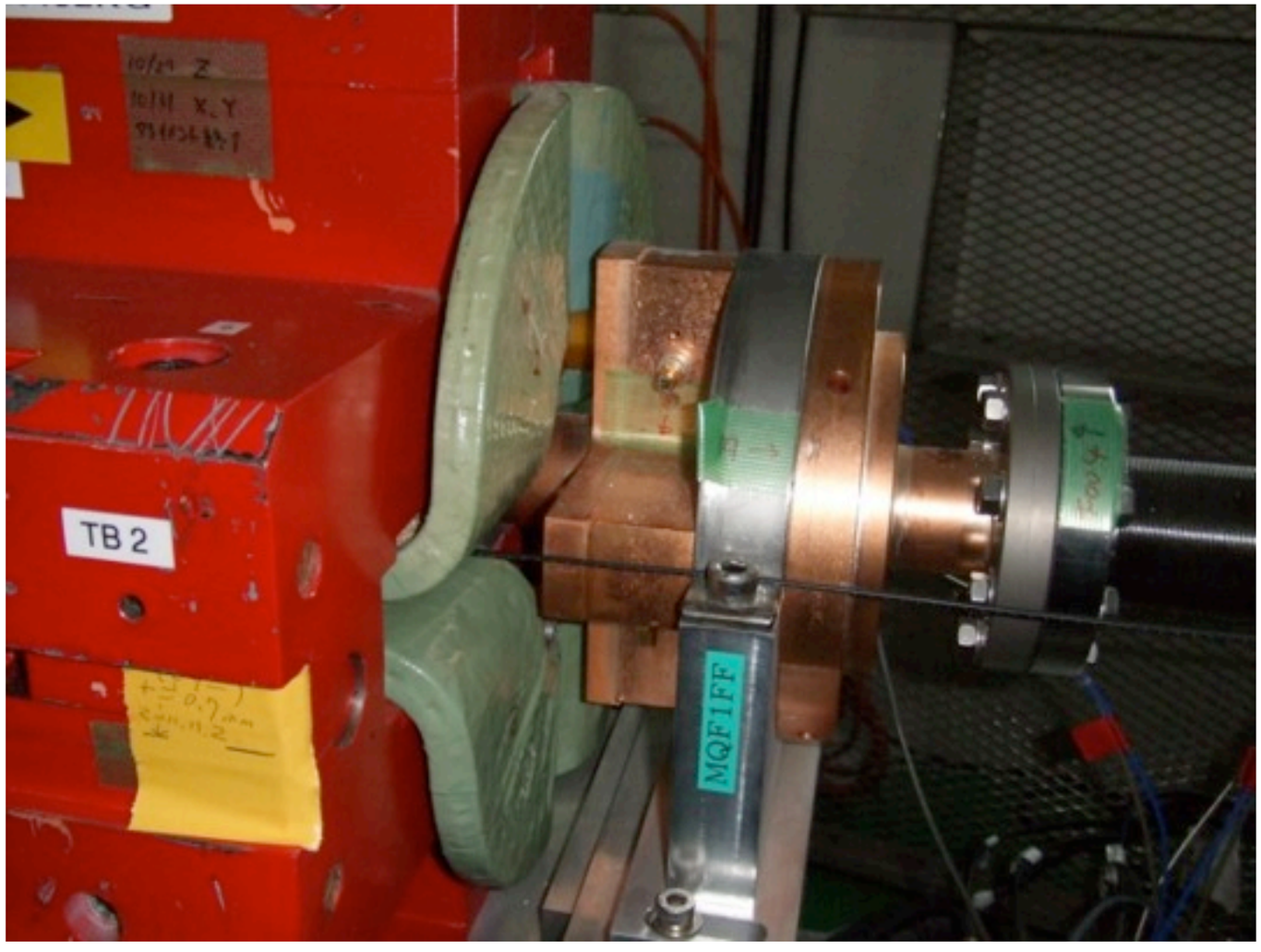


- Very little effect for this configuration.
- Need to check for larger emit_x (3-4nm)

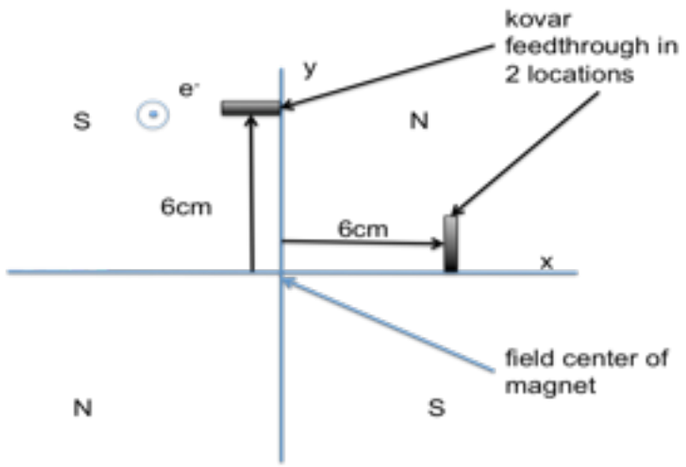
G.White、ATF2 meeting July 6

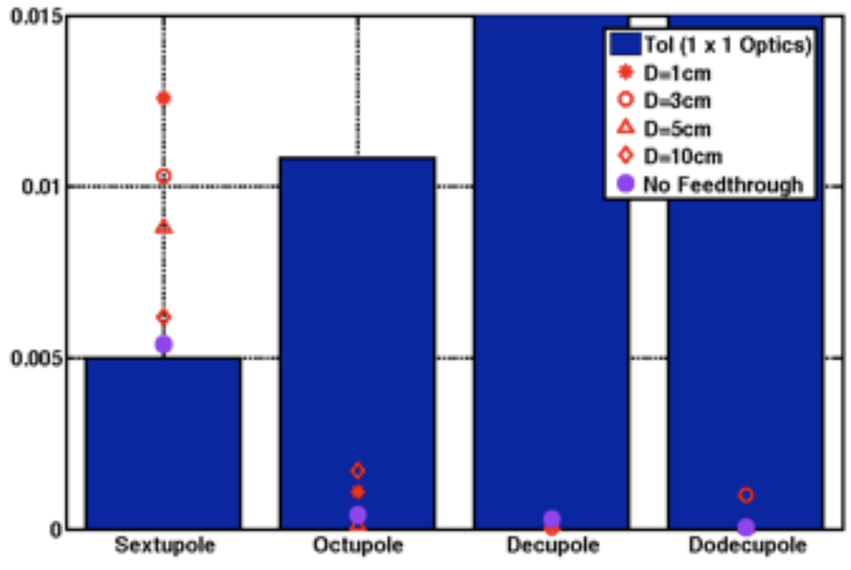
S-band BPM feed-through

- feed-through of Cavity BPM has Kovar, i.e. magnetic , at Final doublet; the s-band BPMs have been removed.



Feed through of S-band BPM(Kovar)

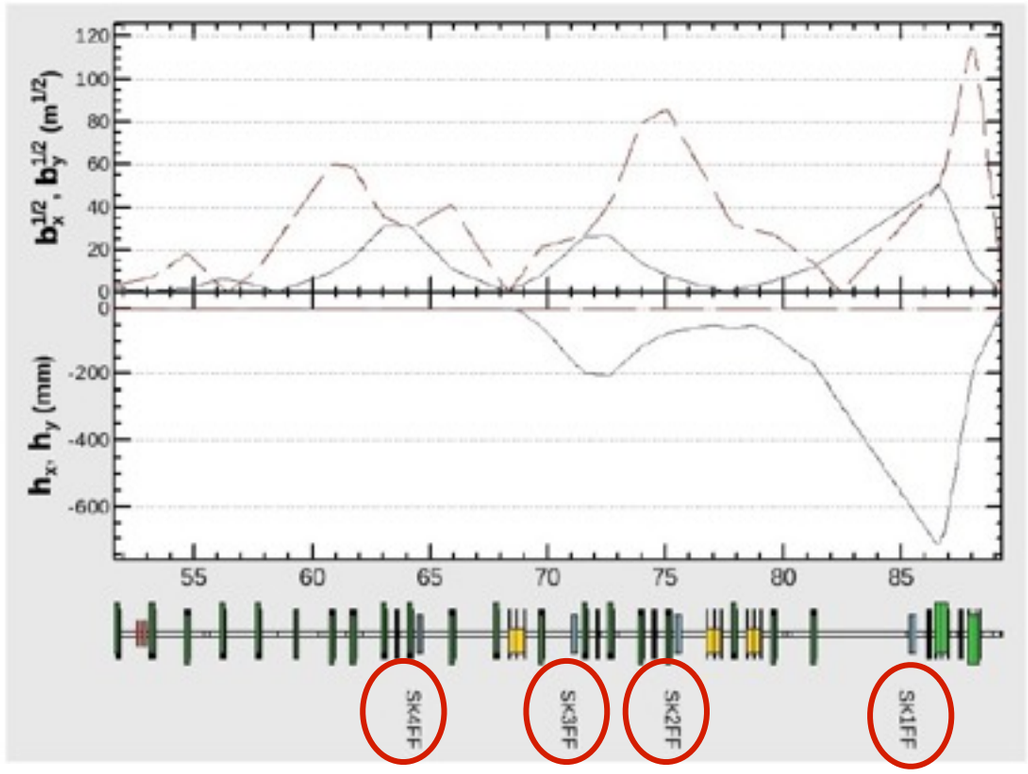


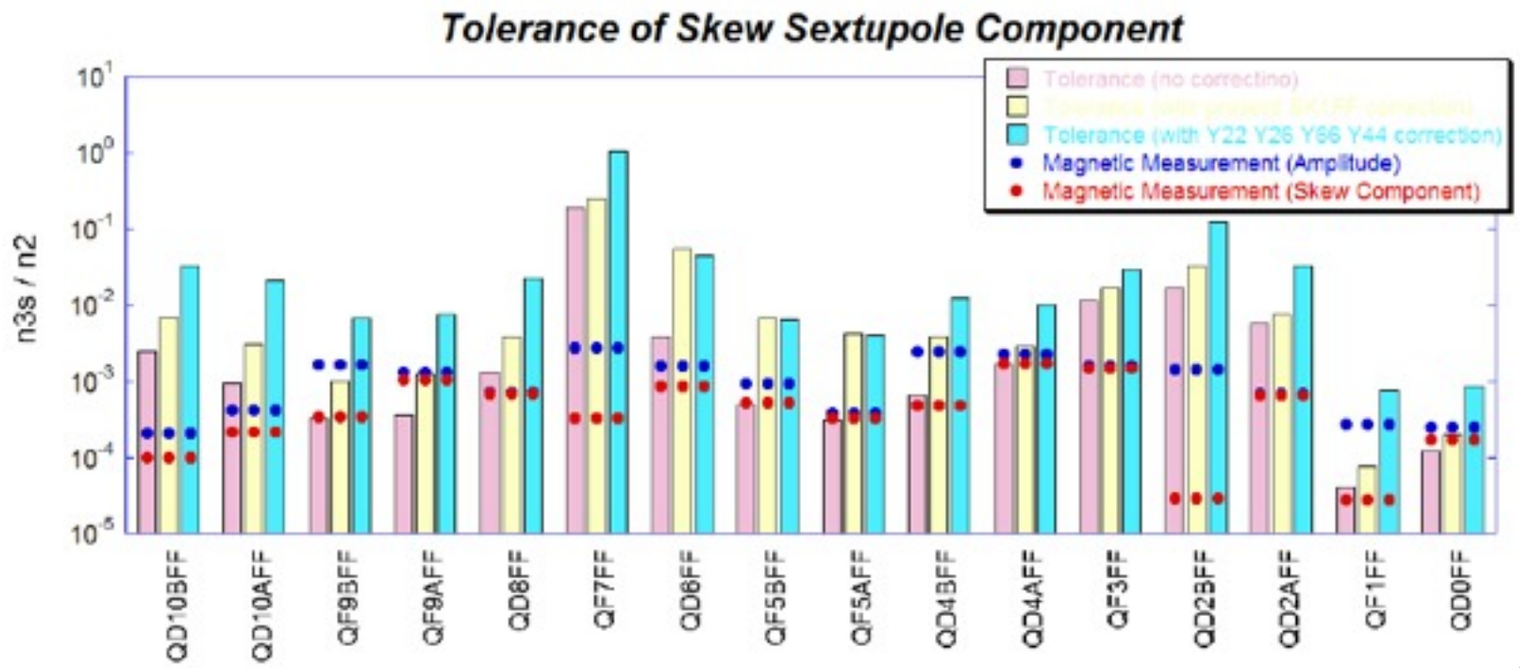


Skew multipole components measured with kovar feedthrough in position A at varying distances from magnet coil face.

Addition of Skew 6 magnets

From 1 to 4 magnets
to correct skew sextupole
components at quadrupole magnets





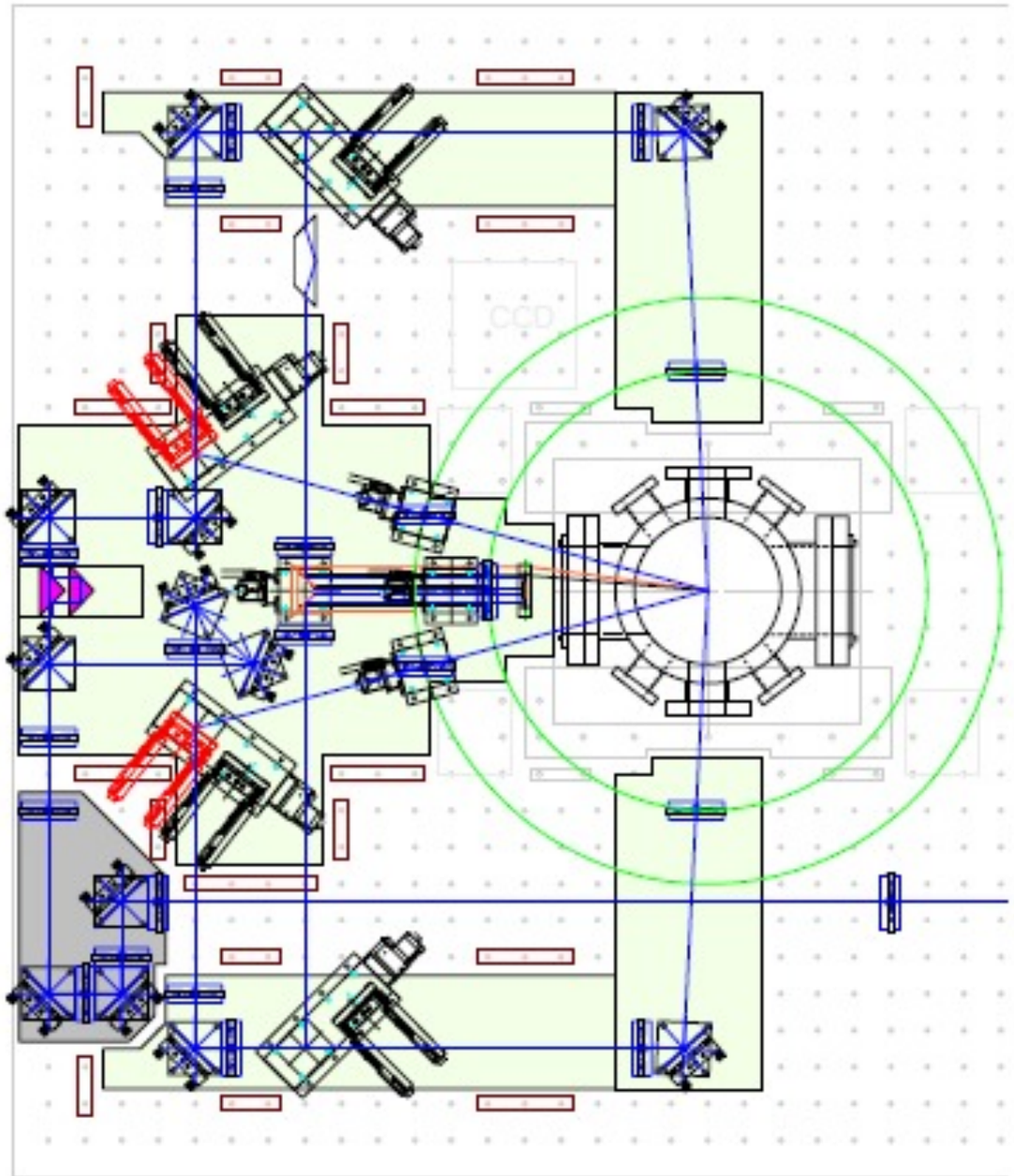
Red ; No correction
Yellow ; with SK1FF correction
Blue; with 4 SKs correction
(10A maximum)

By using 4 SKs correction, tolerances for QF9BFF, QF9AFF, QD4BFF, QD4AFF, QF1FF, QD0FF increase.

T.Okugi、ATF2 meeting July 13

New IP-BSM System from 2012 Autumn Operation

by N.Terunuma



All optical component should be aligned with respect to the reference line of base plate
(old system don't have the reference line for the optical component).

Laser collision angle will be controlled by linear stage (old system used the rotator).

- *The laser paths for lower angle mode can be kept in higher angle mode measurement.*

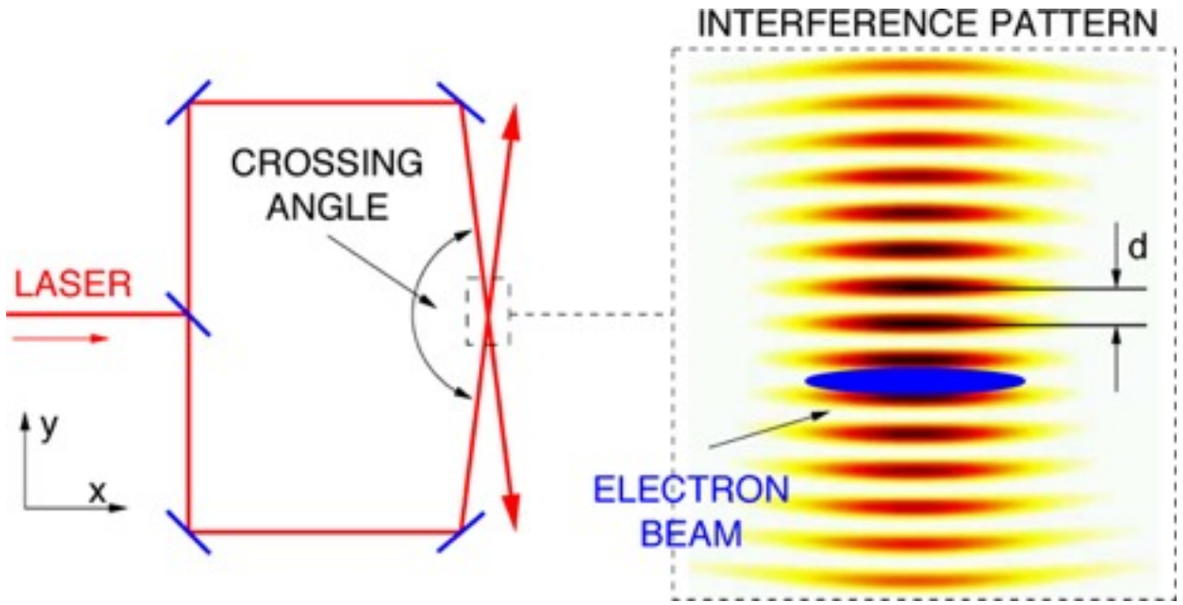
Path length for upper path and lower path are designed to the same length

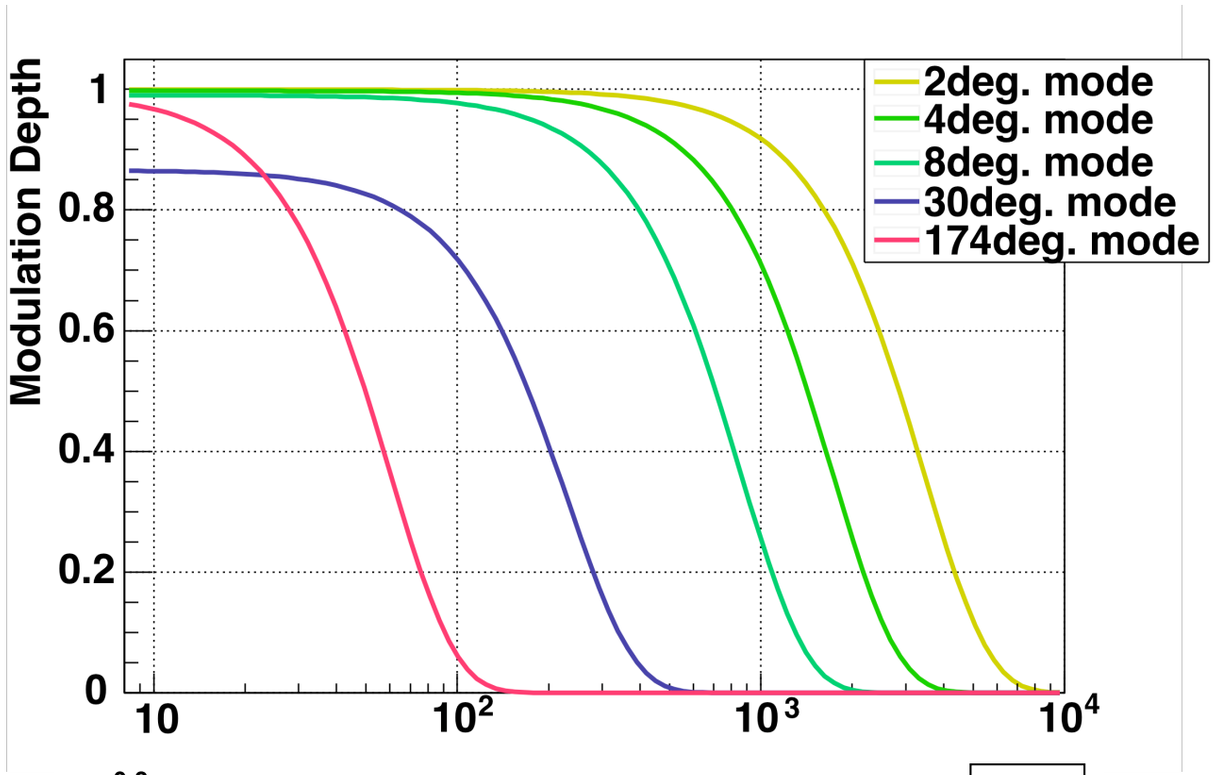
All focal lenses will be on the linear stage.
(old system was used the reducer to change the focal length)

-The focal points for upper path and lower path can be set to same .position.

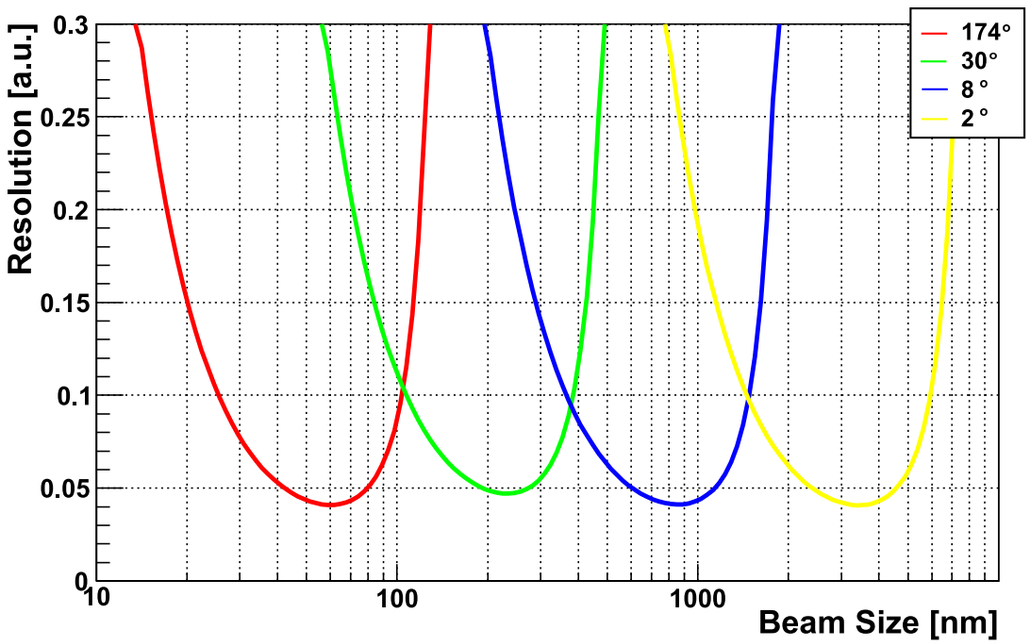
Dove prism for 30degree mode will be removed.

IPBSM : Beam size measurement as a function of crossing angle

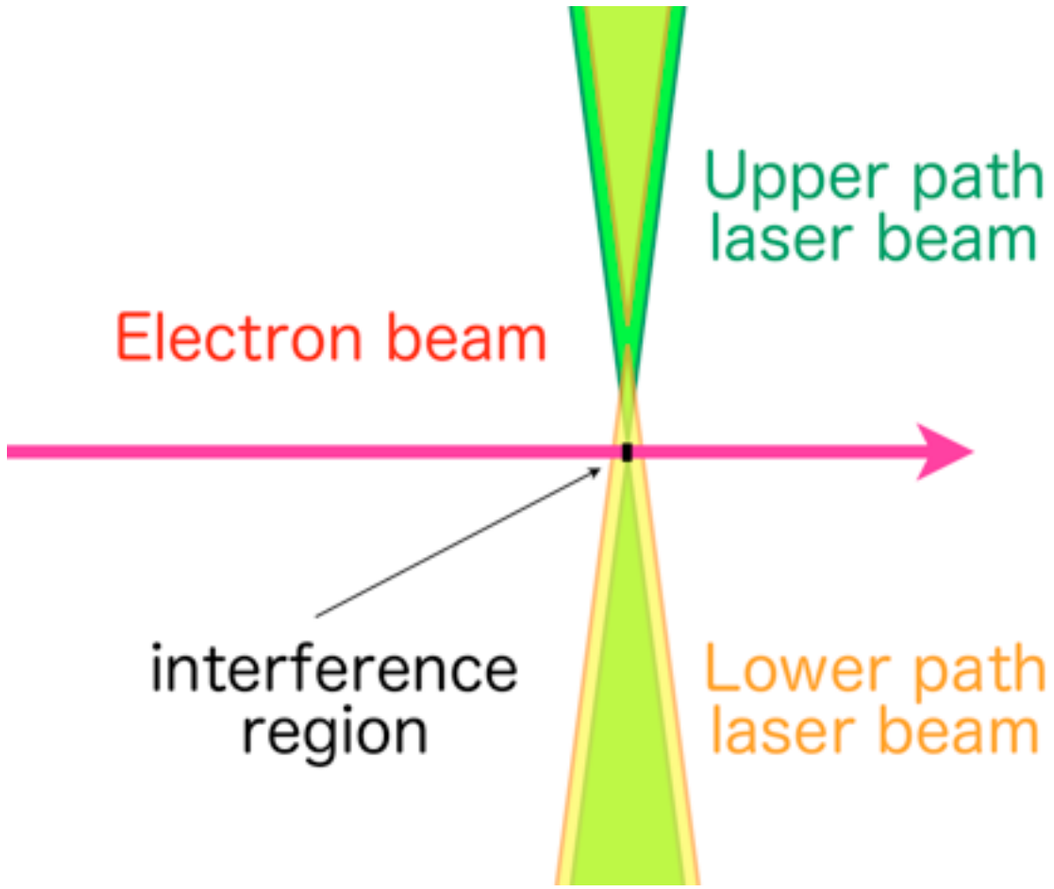




	174°	30°	8°	2°
Fringe pitch	266 nm	1.03μm	3.81μm	15.2μm
Minimum	**25 nm**	100 nm	360 nm	-
Maximum	**100 nm**	360 nm	-	6 μm



Degradation of Modulation



N_0 = average energy in the interference region

N_1 = energy in non-overlapping region

$$N_\gamma(\phi_L) = N_0(1 + \tilde{M}\cos(\phi_L - \phi_0)) + N_1 = (N_0 + N_1)(1 + \frac{N_0}{N_0 + N_1}\tilde{M}\cos(\phi_L - \phi_0))$$

Therefore, modulation is just degraded by $\dfrac{N_0}{N_0 + N_1}$

Repetition rate 1.5 Hz → 3 Hz

- Speedup the beam tuning
- Adaptation of monitor systems, e.g. BPMs in the DR

BPMs@DR at 3Hz
FONT (IP-feedback)
Cavity Compton
IPBSM
6.6kV power system failed

RF(modulator)-2 failed 11/9
IPBSM 30deg.
new QF1FF
ref. cavities removed
10x1 Optics

Air-conditioning in the DR does not work since the begging in October, which causes variation of the DR circumference; e.g. a few kHz/day

earthquake M7.3 12/7
realignment in the DR
wakefield studies
large vertical emittance

ATF2 beam tuning shift plan in last 2 weeks, 2012

	1:00 – 9:00	9:00 – 17:00	17:00 – 25:00
12/10 Mo	---	---	*Kubo*
12/11 Tu	Kuroda + A	White + B	*Okugi* + C
12/12 Wd	Woodley + D	*Tauch*i + E	Kuroda + A
12/13 Th	Kubo + B	*Okugi* + C	Tauchi + D
12/14 Fr	White + E	Terunuma + A	Woodley + B
12/15 Sa	Kuroda + C	Terunuma + D	White + E
12/16 Su	Kubo + A	Tauchi + B	Woodley + C
12/17Mo	Okugi + D	White + E	*Terunuma* + A
12/18 Tu	*Kuroda* + B	Tauchi+ C	Okugi + D
12/19 Wd	Woodley + E	*Kubo* + A	White+ B
12/20 Th	*Okugi* + C	Kuroda + D	Kubo + E
12/21 Fr	White+ A	*Tauchi* + B	

Name: Study/Tuning leader (*Italic: shift leader (for safety)*)

A-D: Study/Tuning sub-leaders

The assignments are not strict and you may move and/or join flexibly to any shifts.

A: J. Nelson, E. Marin, L. Corner

B: Y. Renier, H. Garcia Morales

C: S. Boogerd, J. Snuverink,m

D: Y-I Kim, N. Blaskovic, Davis

E: J. Pfingstner, Akagi, Tanaka

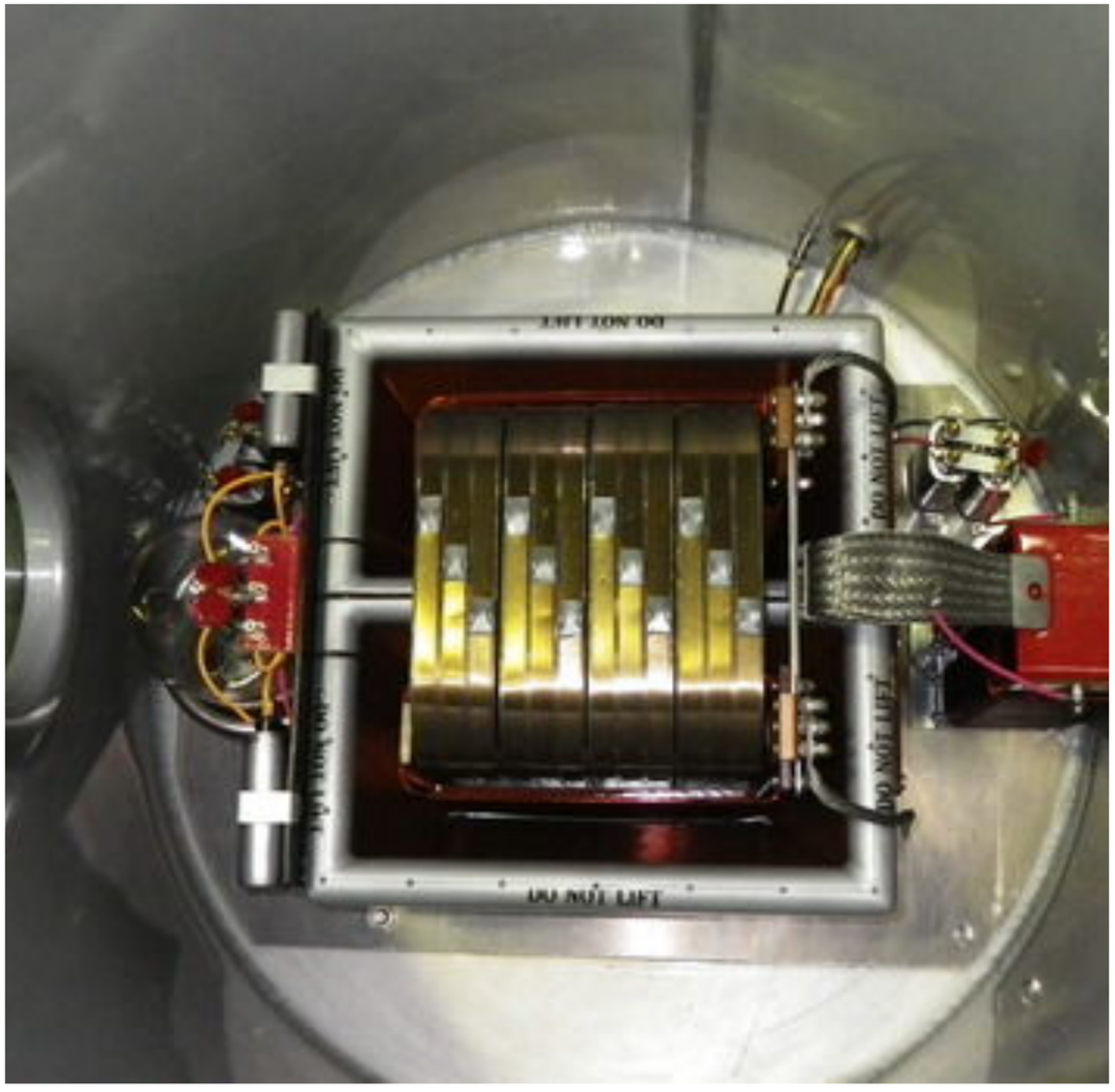
5 operation teams by young/senior researchers

Failure of LINAC RF#2

- The LINAC RF#2 had a serious trouble in evening of last Friday, 11/9 2012.
- Survey had been done from Nov. 12th to 15th. We had to de-assemble the Klystron section to check the inside of the HV tank.
- It was found the HV pulse transformer, DC-HV cables and sockets, Thyratron trigger box and Grid resister were damaged.
- The trouble seems to be started by the unexpected shots of the Thyratron with much higher repetition but without the trigger.

Devices for Recovery

HV pulse transformer is swapped by that for SLAC 5045 klystron

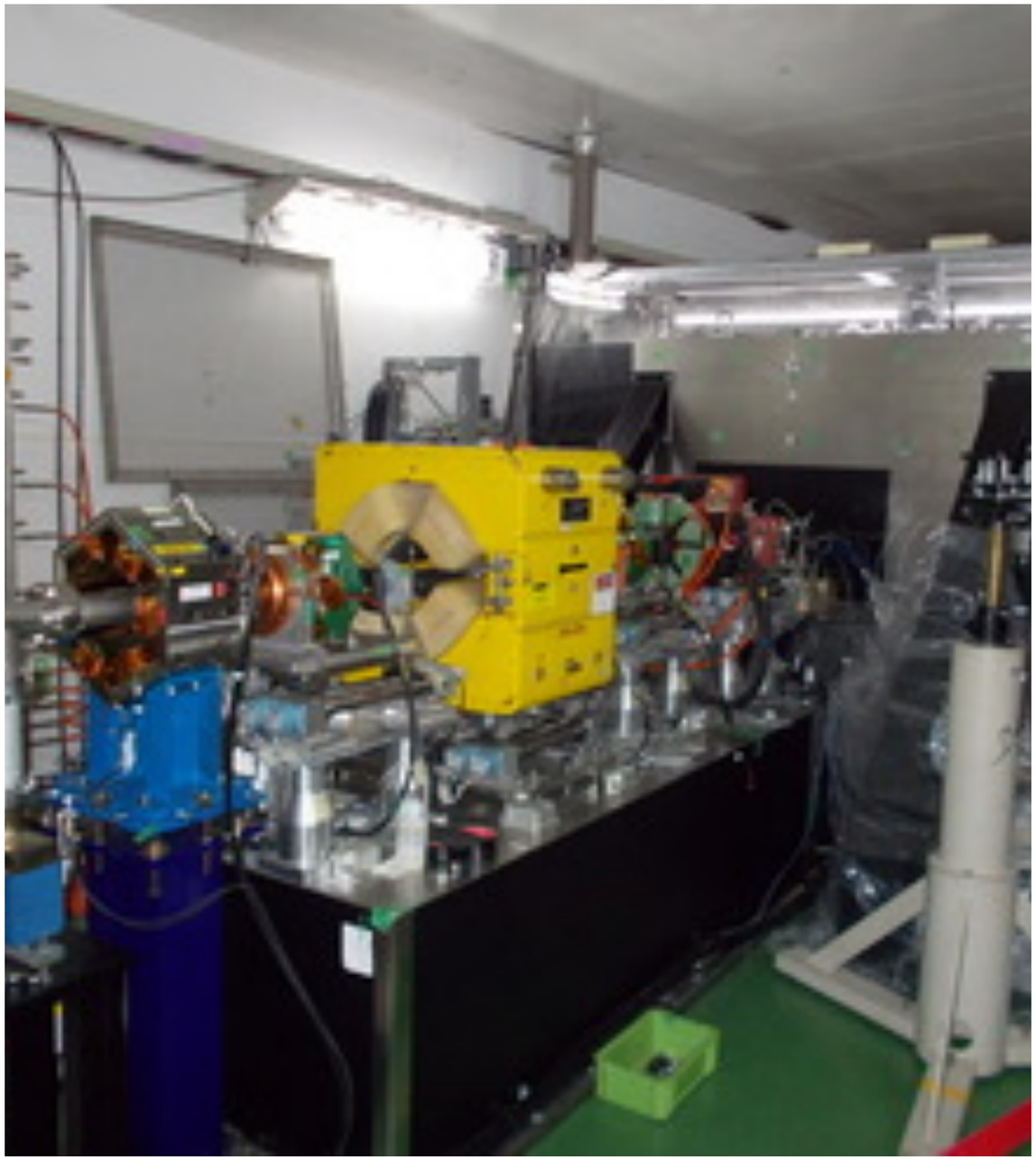


Spare klystrons, Toshiba 3712, 80 MW.

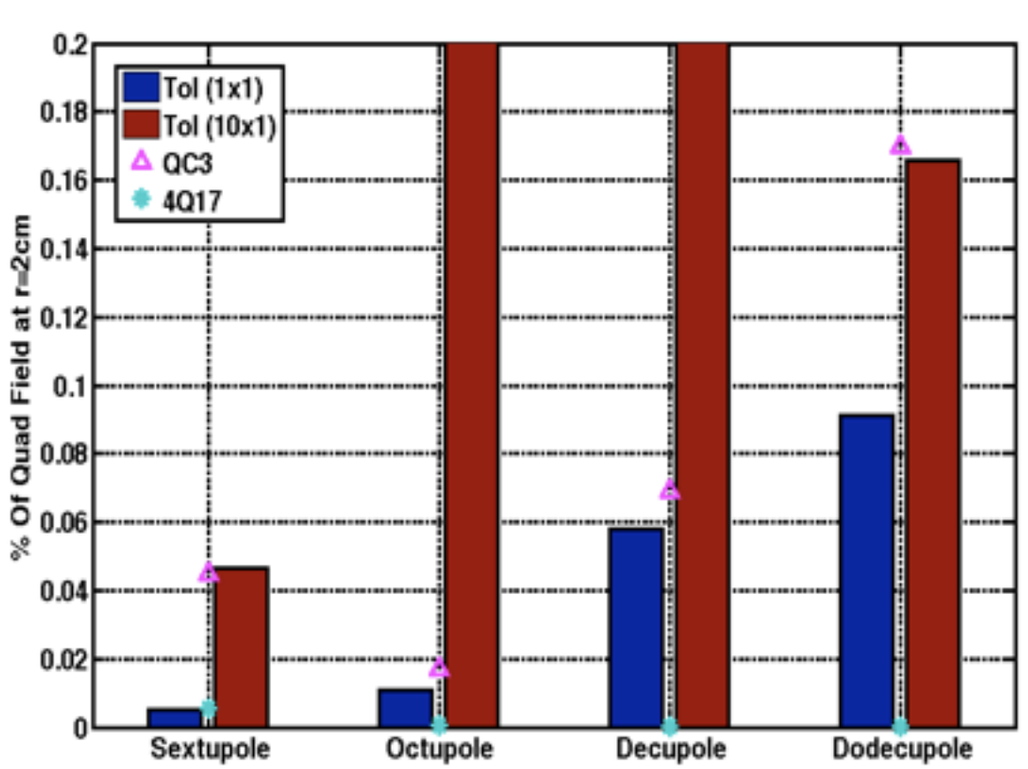
Use bland new klystron. We have more but repaired and low powered.

New QF1FF was installed

2012 11/19-22



- New magnet was put on the mover.
- Mover keeps its middle position more than a day.
- Cabling was almost done.
- Fine alignment is in progress.
- Vacuum chambers will be connected today.



Reference Cavities

2012 11/19-22

- Three C-band reference cavities (not used at present) were removed from the beamline.
- That for S-band was also relocated 3 meter upstream. We need relocate the pickup cable.

4 OTR measurements and reconstruction of IP parameters

2012.12.11 20:10

Horizontal projected emittance parameters at first OTR

energy	= 1.2690	GeV	
emit	= 1.6021 +-	0.0787 nm	
emitn	= 3978.5209 +-	195.4115 nm	
emit*bmag	= 1.9924 +-	0.0339 nm	
bmag	= 1.2437 +-	0.0412	(1.0000)
bmag_cos	= 0.1695 +-	0.0000	(0.0000)
bmag_sin	= -0.5698 +-	0.0000	(0.0000)
beta	= 9.1707 +-	0.3830 m	(6.3052)
alpha	= -7.2455 +-	0.3377	(-4.4943)
chisq/N	= 3.2873		

Horizontal projected emittance parameters at IP

sig	= 40.3602 +-	0.2032 um	(7.9947)
sigp	= 293.8991 +-	1.4073 ur	(200.4496)
beta	= 1017.7782 +-	56.7444 mm	(39.8952)
alpha	= -7.3399 +-	0.4061	(-0.0238)

Horizontal projected emittance parameters at waist

L	= -0.1361 +-	0.0004 m	
beta	= 18.5476 +-	0.9924 mm	
sig	= 5.4511 +-	0.2787 um	

β^*_x=18.5±1.0mm

Vertical projected emittance parameters at first OTR

energy	= 1.2690	GeV	
emit	= 40.6210 +-	0.5315 pm	
emitn	= 100.8760 +-	1.3200 nm	
emit*bmag	= 42.5895 +-	0.5652 pm	
bmag	= 1.0485 +-	0.0045	(1.0000)
bmag_cos	= 0.2594 +-	0.0000	(0.0000)
bmag_sin	= 0.1517 +-	0.0000	(0.0000)
beta	= 8.1739 +-	0.1095 m	(6.1903)
alpha	= 3.5609 +-	0.0511	(2.5763)
chisq/N	= 87.1894		

Vertical projected emittance parameters at IP

sig	= 1.1553 +-	0.0162 um	(0.0639)
sigp	= 630.5855 +-	0.3151 ur	(635.3753)
beta	= 32.8570 +-	0.5697 mm	(0.1006)
alpha	= 17.9063 +-	0.3092	(0.0019)

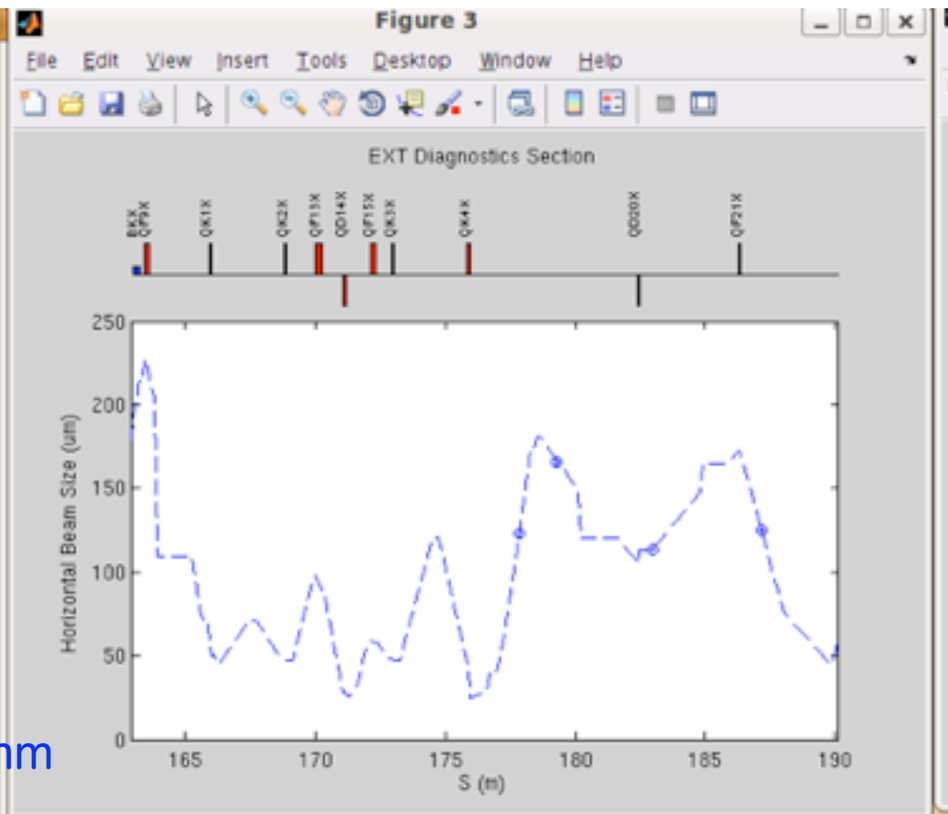
Vertical projected emittance parameters at waist

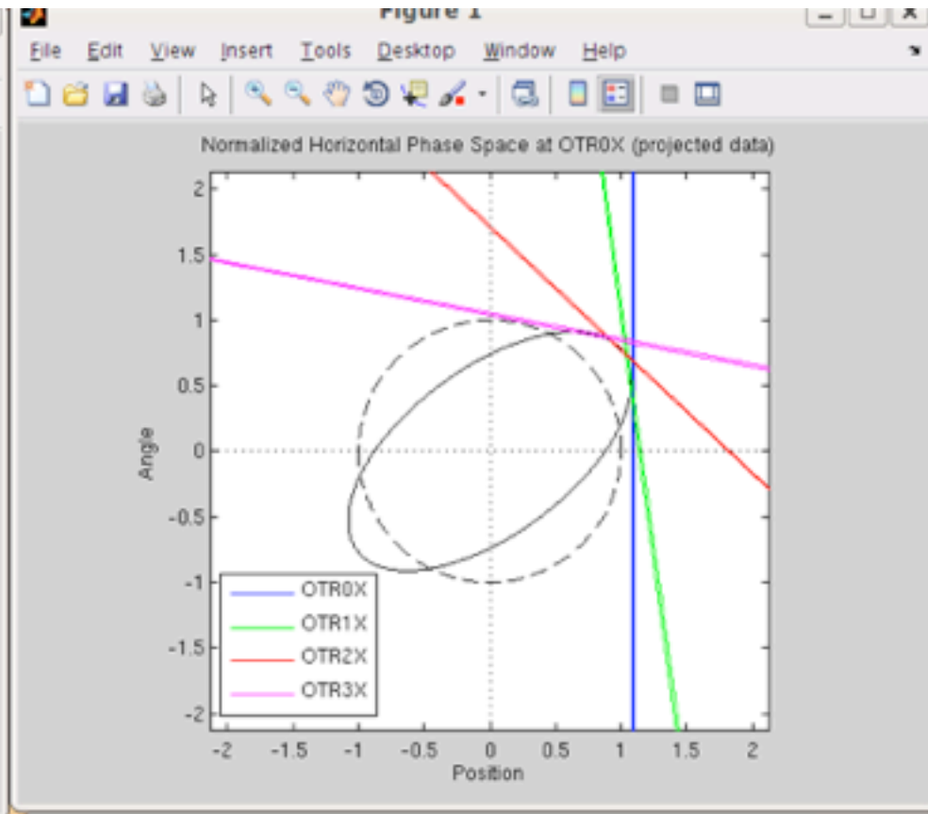
L	= 0.0018 +-	0.0000 m	
beta	= 0.1022 +-	0.0017 mm	
sig	= 0.0644 +-	0.0004 um	

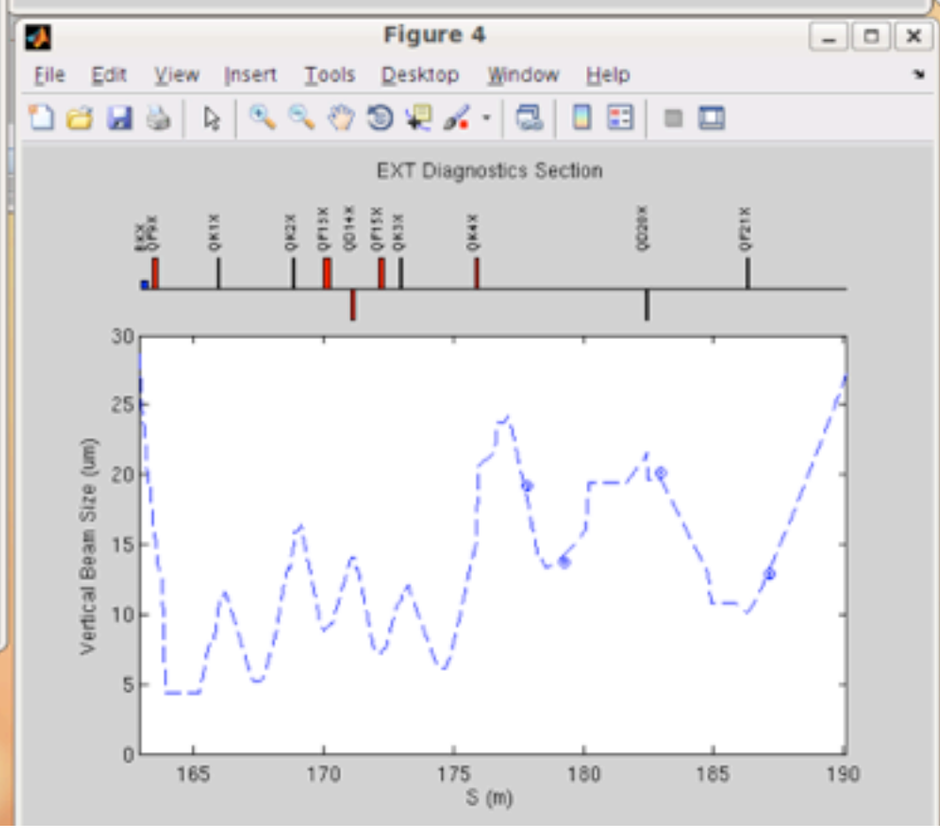
β^*_y=0.10±0.002mm

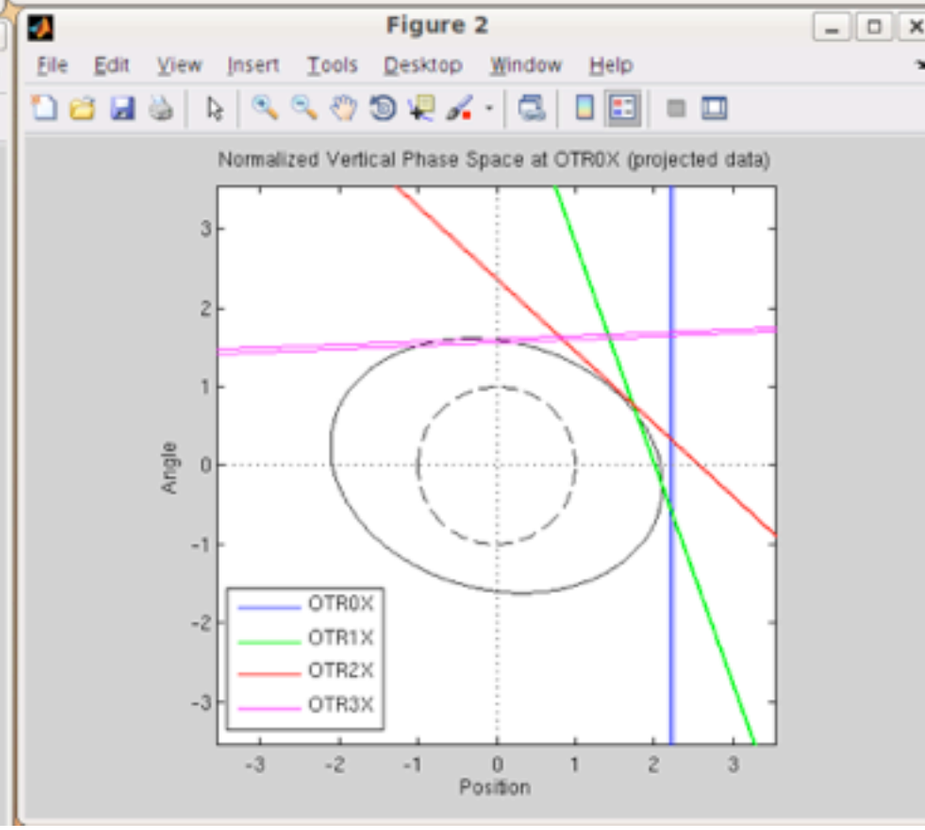
OK

456)









4 OTR measurements and reconstruction of IP parameters

2012.12.12 6:41

β^*_x=30.3±0.5mm

β^*_y=0.085±0.002mm

β^*=0.1±0.002mm

Estimation of IP Beta function by 5umΦ IP carbon wire scans

20:45 correct horizontal dispersion at final focus by scanning QF1FF strength and damping ring frequency (+- 2kHz)

new magnet setting 122.674 A (min. beam size)

- eta_x = 5.38 mm
- 5 micron contribution to beam size

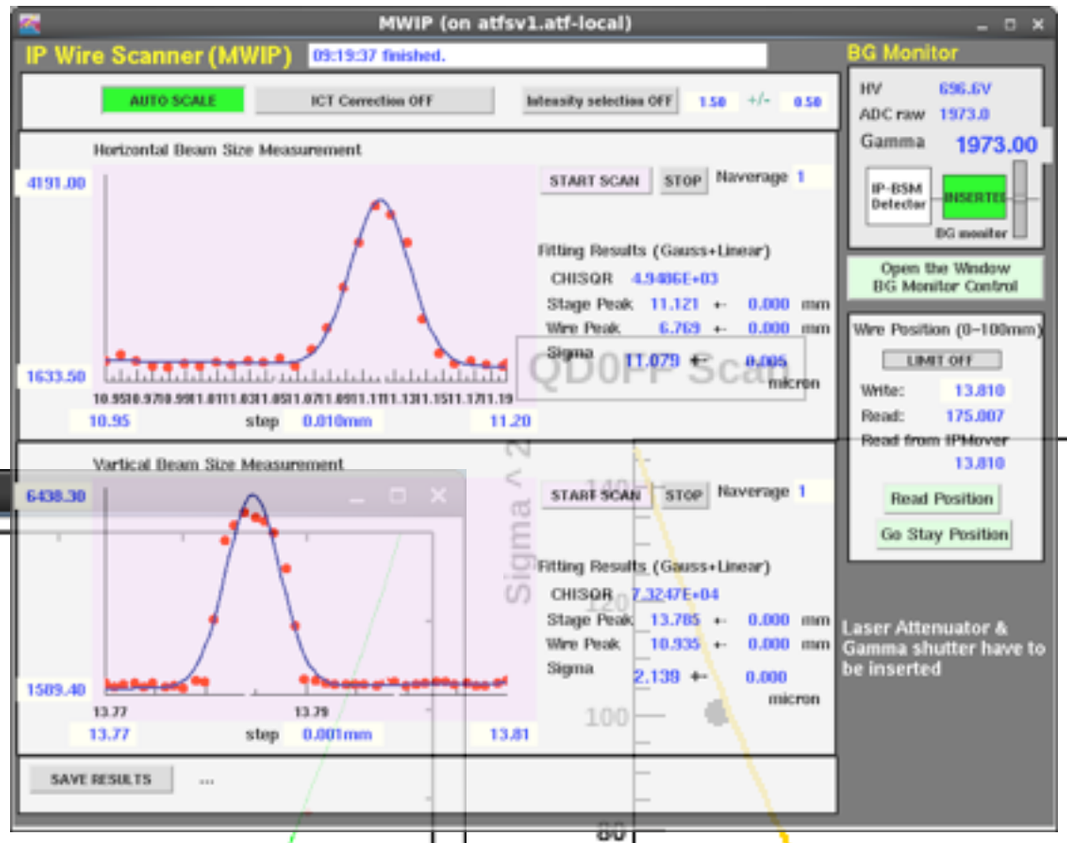
horizontal beam size: 13.575 um

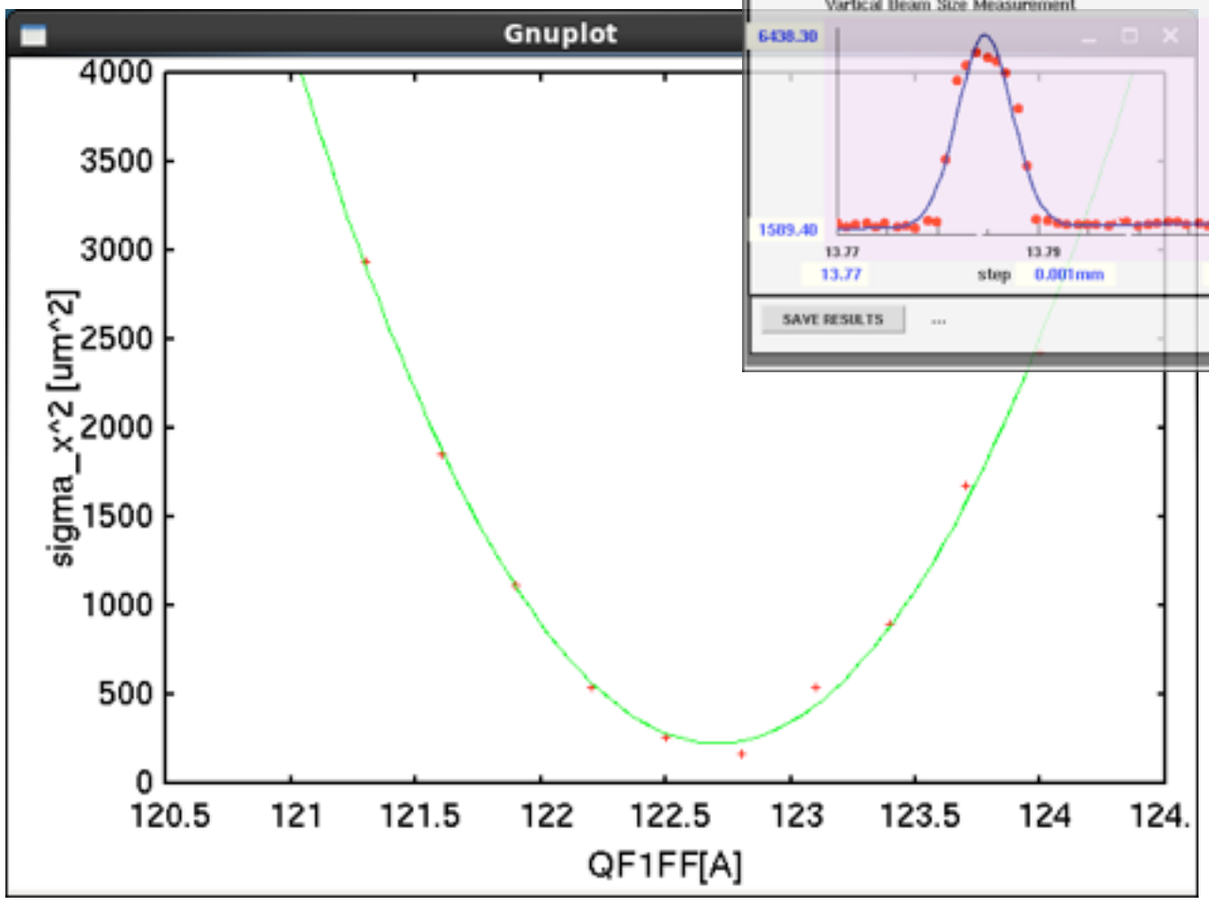
estimated beta*_x 0.057 m

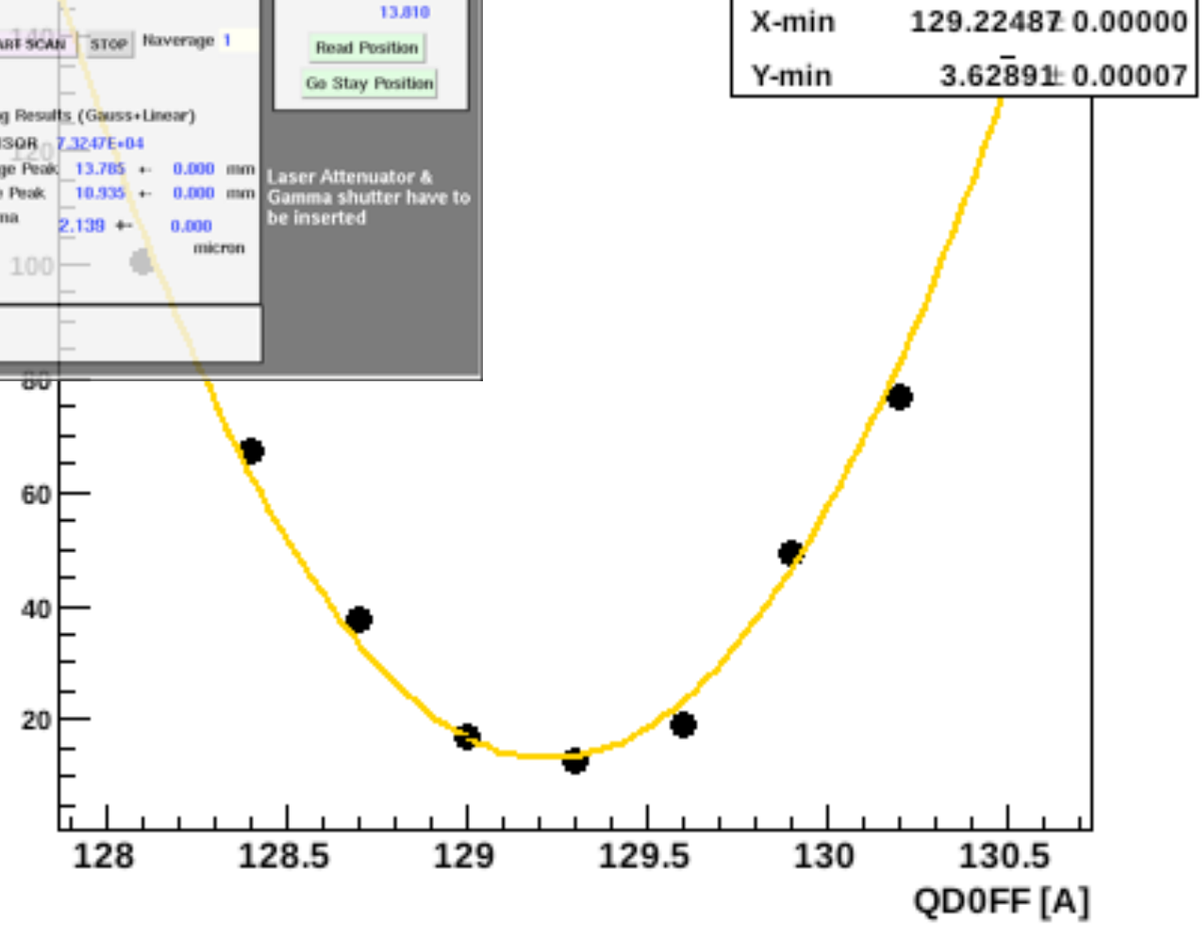
estimated hor. emittance 4 nm

2012 12/21 21:52 move to vertical knob scans, QD0FF scan

- change to 129.225A
- beam size 3.8 um
- If we assumed to emit_y=40pm (OTR measurement), beta_y*=0.093mm.
- QD0FF_carbon_121211_221347.png:



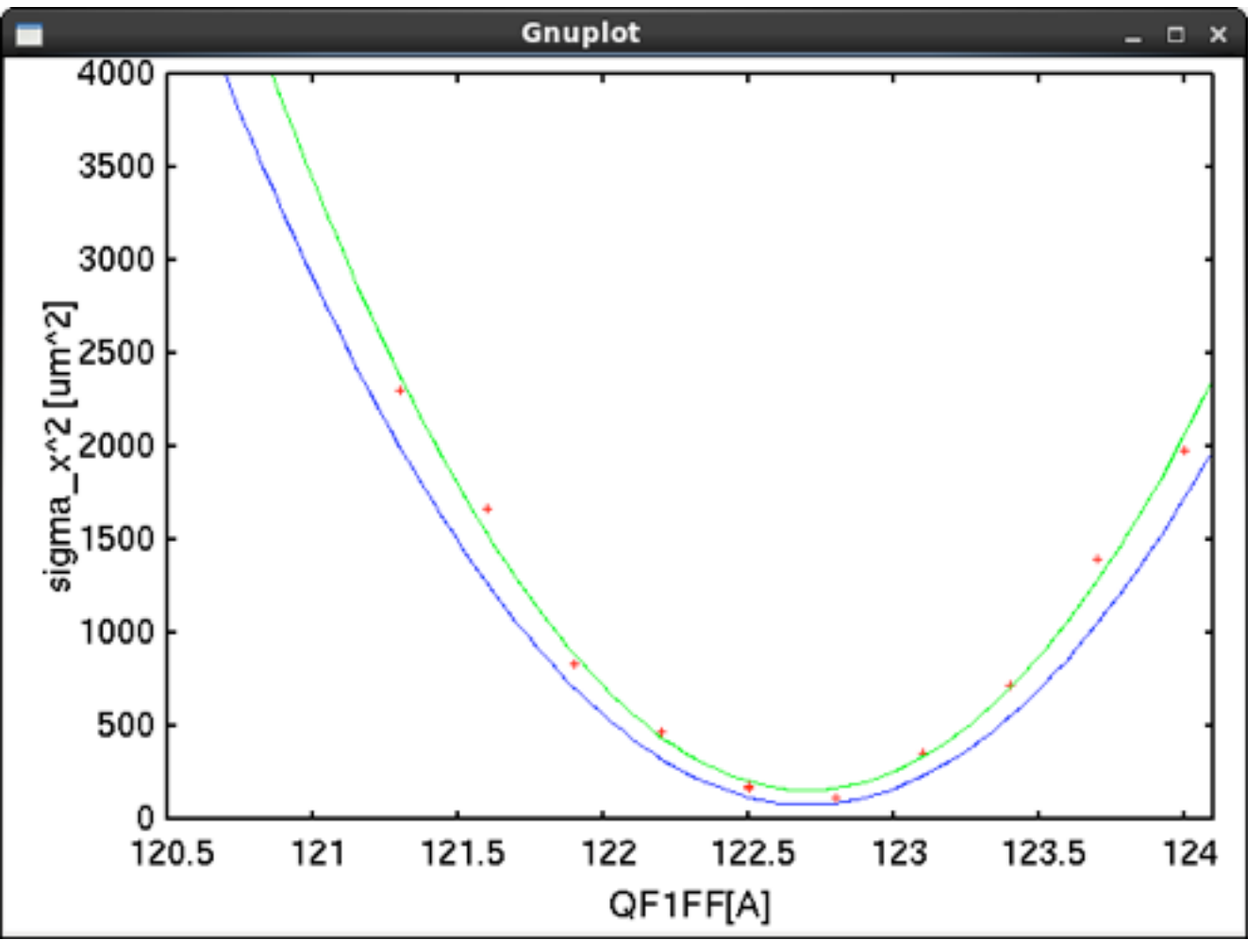




2012 12.13 Day shift

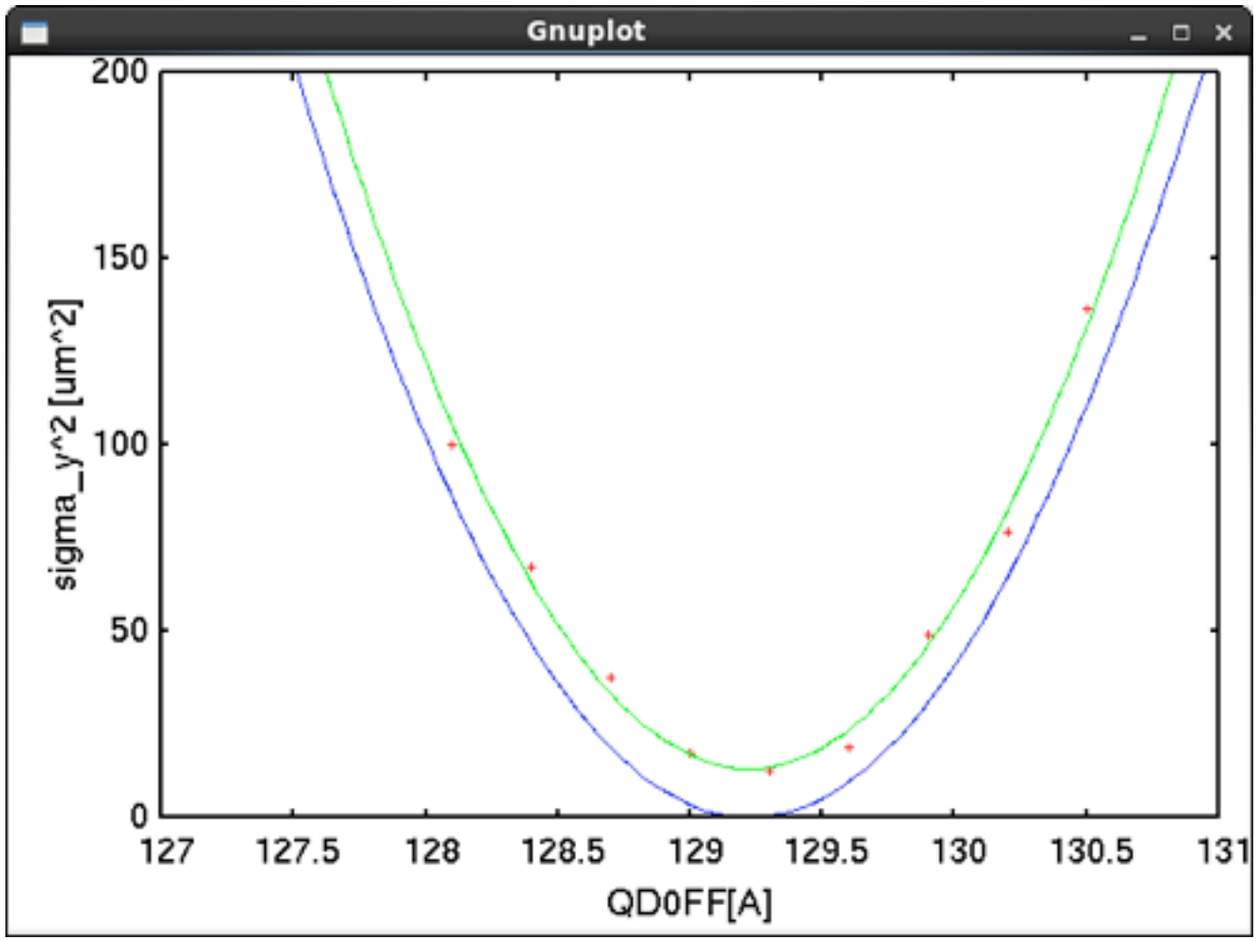
QF1FF current scan

red cross; measurement
green line; fit to the measured data
blue line; SAD model (emittx=2nm)

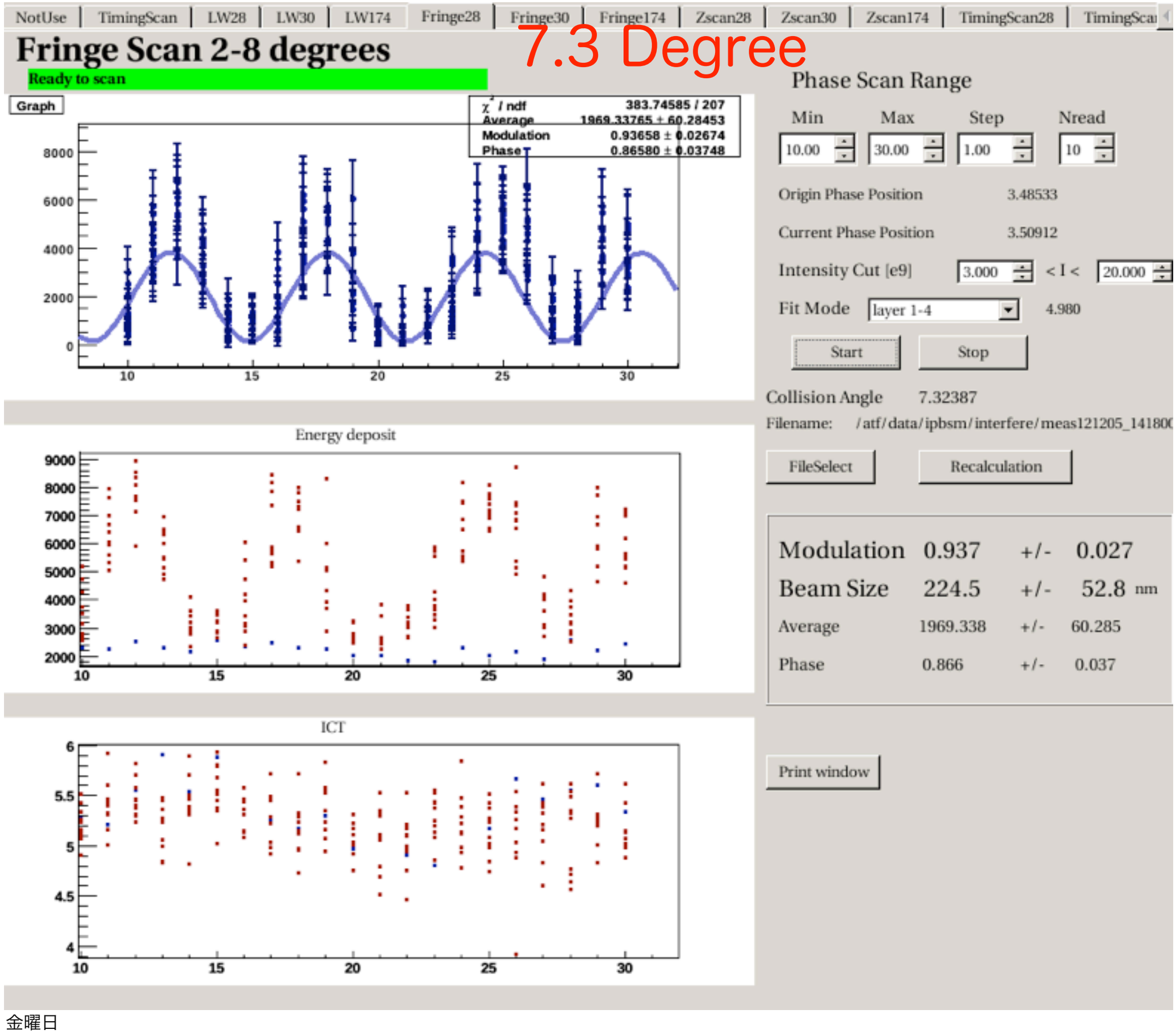


QD0FF current scan

red cross; measurement
green line; fit to the measured data
blue line; SAD model (emitty=40pm)

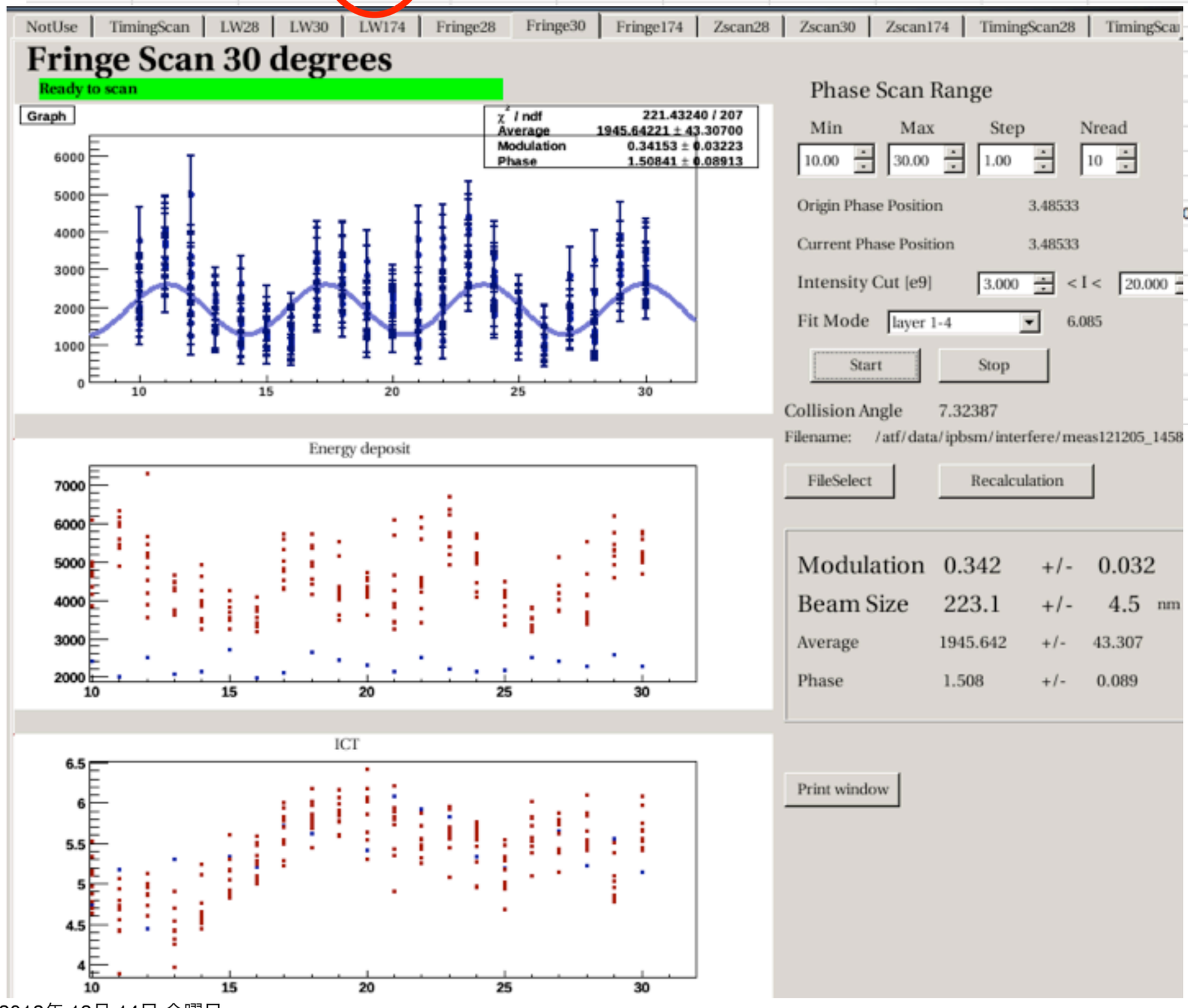


IP vertical beam size measurement by IPBSM 2012 12.5 14:22



IP vertical beam size measurement by IPBSM 2012 12.5 15:00

5 continuous measurements			M30LY: 11.719		2012/12/5 30 deg		10x1 beta							
data	M	M_error	beamsize	beamsize_err	avg	avg_err	phase	phase_err	Nav	Noflines	1/err^2M	1/err^2size	size/err^2M	size/err^2size
145649	0.208	0.053	276	6	2178	85	2.964	0.268	3	80	355.998576	0.027777778	74.04770381	7.666666667
145810	0.342	0.032	223.1	4.5	1946	43	1.508	0.089	10	220	976.5625	0.049382716	333.984375	11.01728395
150556	0.248	0.033	258.6	3.9	2322	53	1.2	0.13	10	220	918.2736455	0.06574622	227.7318641	17.00197239
150749	0.251	0.033	257.6	3.9	2242	52	0.651	0.129	10	220	918.2736455	0.06574622	230.486685	16.93622617
150942	0.184	0.025	288	2.6	2073	37	−1.764	0.134	10	220	1600	0.147928994	294.4	42.6035503

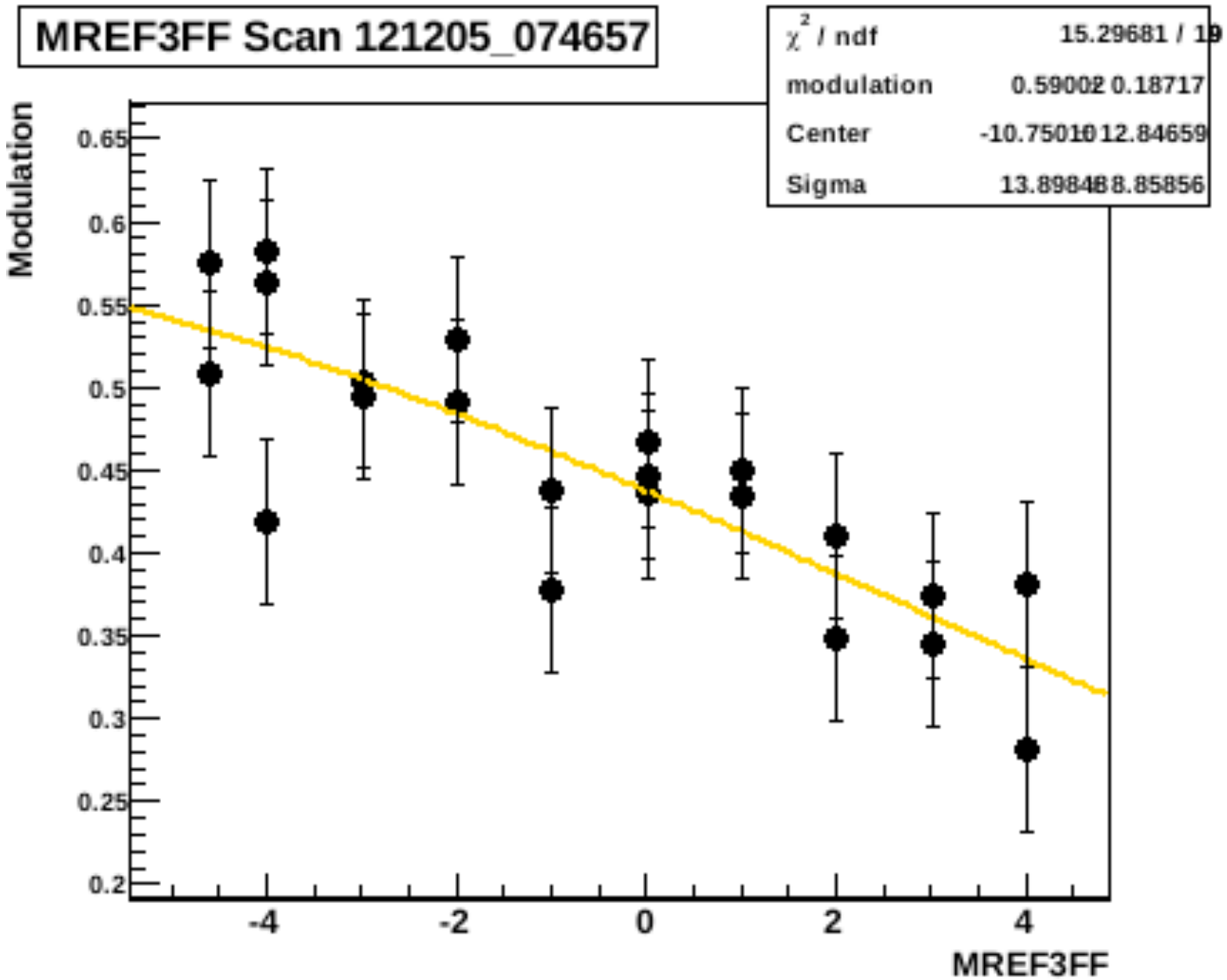


5 measurements

30 Degree

Very consistent with one at 7.3 degrees

Installation of a c-band reference cavity (MREF3FF) for wakefield study at large Beta(y), 12/5 Owl shift



Earthquake in Japan

JMA (Japan Meteorological Agency)				http://www.jma.go.jp/jma/kishou/know/shindo/explane.html	
Scale(m)	gal JMA lower end	Acc(cm/s^2) 0.45x10$^{m/2}$	People	Indoor Situations	Outdoor Situations
0			Imperceptible to people.		
1	0.8	1.4	Felt by only some people in the building.		
2	2.5	4.5	Felt by most people in the building. Some people awake.	Hanging objects such as lamps swing slightly.	
3	8	14	Felt by most people in the building. Some people are frightened.	Dishes in a cupboard rattle occasionally.	Electric wires swing slightly.
2012.12.7 (M7.3)@Tsukuba 4	25	45	Many people are frightened. Some people try to escape from danger. Most sleeping people awake.	Hanging objects swing considerably and dishes in a cupboard rattle. Unstable ornaments fall occasionally.	Electric wires swing considerably. People walking on a street and some people driving automobiles notice the tremor.
5- Lower	80	142	Most people try to escape from a danger. Some people find it difficult to move.	Hanging objects swing violently. Most Unstable ornaments fall. Occasionally, dishes in a cupboard and books on a bookshelf fall and furniture moves.	People notice electric-light poles swing. occasionally, windowpanes are broken and fall, un-reinforced concrete-block walls collapse, and roads suffer damage.
5- Upper		253	Many people are considerably frightened and find it difficult to move.	Most dishes in a cupboard and most books on a bookshelf fall. Occasionally, a TV set on a rack falls, heavy furniture such as a chest of drawers falls, sliding doors slip out of their groove and the deformation of a door frame makes it impossible to open the door.	In many cases , un-reinforced concrete-block walls collapse and tombstones overturn. Many automobiles stop because it becomes difficult to drive. Occasionally, poorly-installed vending machines fall.
2011.3.11 (M9.0)@Tsukuba 6- Lower	250	450	Difficult to keep standing.	A lot of heavy and unfixed furniture moves and falls. It is impossible to open the door in many cases.	In some buildings, wall tiles and windowpanes are damaged and fall.
6- Upper		800	Impossible to keep standing and to move without crawling.	Most heavy and unfixed furniture moves and falls. Occasionally, sliding doors are thrown from their groove.	In many buildings, wall tiles and windowpanes are damaged and fall. Most un-reinforced concrete-block walls collapse.
7	400	1423	Thrown by the shaking and impossible to move at will.	Most furniture moves to a large extent and some jumps up.	In most buildings, wall tiles and windowpanes are damaged and fall. In some cases, reinforced concrete-block walls collapse.

Work for wakefield sources, 2012 12.12 20:00 - 12.13 3:00

The work had been started at 20:00 and whole ATF2 beamline was opened. The evacuation was started at 1:30AM and leakage check was done at 3:00AM. After that, it took 5 hours to reach the vacuum pressure for beam operation

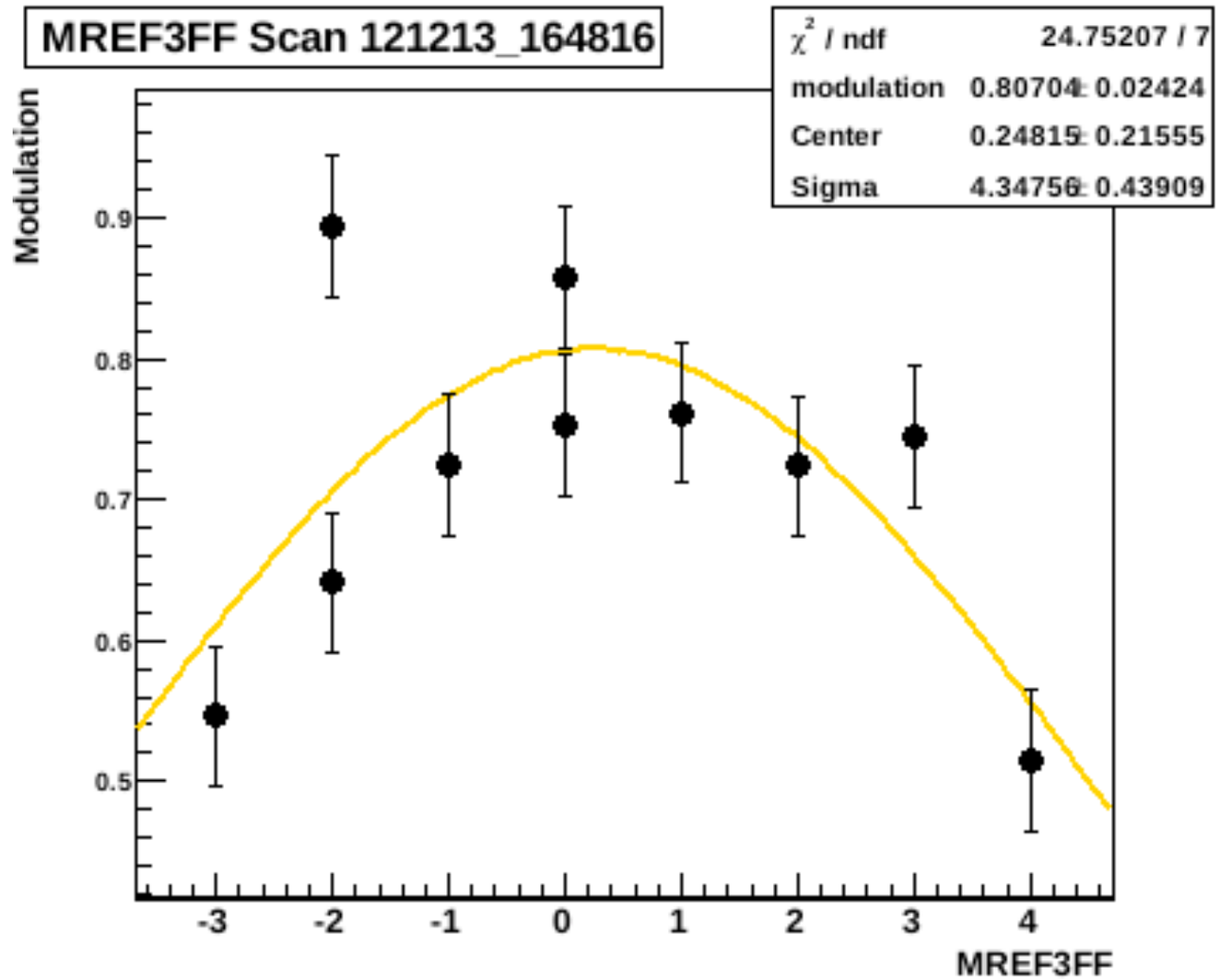
(1) T-tube for pumping port was exchanged Cross-tube to have a vertical symmetry.
(2) MS1X screen monitor was removed.
(3) MFB1FF, stripline BPM for slow feedback was removed.
(4) A gate valve was relocated to the low betay position.
(5) Test Cavity BPM for CLIC (near LW) was removed.
(6) Parallel chamber system for IP-BPM test stand was removed.
(7) MW0X and MW4X, wire scanners, were removed because we could not move to the beam-stay-clear position.
(8) MW2X and MW3X were checked and put their wire holder into beam-stay-clear (twice wider aperture) position.
(9) A few bellows (wider diameter) were replaced to the standard one which has similar aperture of the neighbor chambers.

In addition above, we looked inside of the beamline.

(1) The mOTR had no interfere objects. It keeps the aperture of bellows mounted on both side of the OTR. Bellows is bigger than the standard beam pipe (diameter 24mm).
(2) No structure such as bent electrode or fallen electrode was found. I just saw the circular straight aperture.

2012 12.13 16:10 MREF3FF scan

- no clear dependence after -1mm, 0mm, 1mm (all modulation close to 0.9)
- FF magnet power tripped, beam off
- modulation seems a bit reduced afterwards (only those points taken into account)
- set to 0.0 mm (low background: ~1500), very high background at negative values
- MREF3FF_fringe_121213_164816.png:



Multi-knobs by (skew) sextupoles

Linear Knobs

Ax, Ex, Ay, Ey, C2

	Ax			Ex			Ay		
	x	y	tilt	x	y	tilt	x	y	tilt
SF6FF	142.0	0.0	0.0	250.0	0.0	0.0	348.0	0.0	0.0
SF5FF	-127.0	0.0	0.0	-301.0	0.0	0.0	300.0	0.0	0.0
SD4FF	9.0	0.0	-1.0	-298.0	0.0	0.0	-679.0	0.0	0.0
SF1FF	-65.0	0.0	0.0	714.0	0.0	0.0	-334.0	0.0	0.0
SD0FF	-94.0	0.0	0.0	890.0	0.0	0.0	-808.0	0.0	0.0

	Ey			Coup1			Coup2		
	x	y	tilt	x	y	tilt	x	y	tilt
SF6FF	0.0	-51.0	0.0	0.0	0.0	0.0	0.0	24.0	0.0
SF5FF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SD4FF	0.0	-290.0	0.0	0.0	0.0	0.0	0.0	124.0	0.0
SF1FF	0.0	-96.0	0.0	0.0	100.0	0.0	0.0	-1.0	0.0
SD0FF	0.0	350.0	0.0	0.0	-100.0	0.0	0.0	99.0	0.0

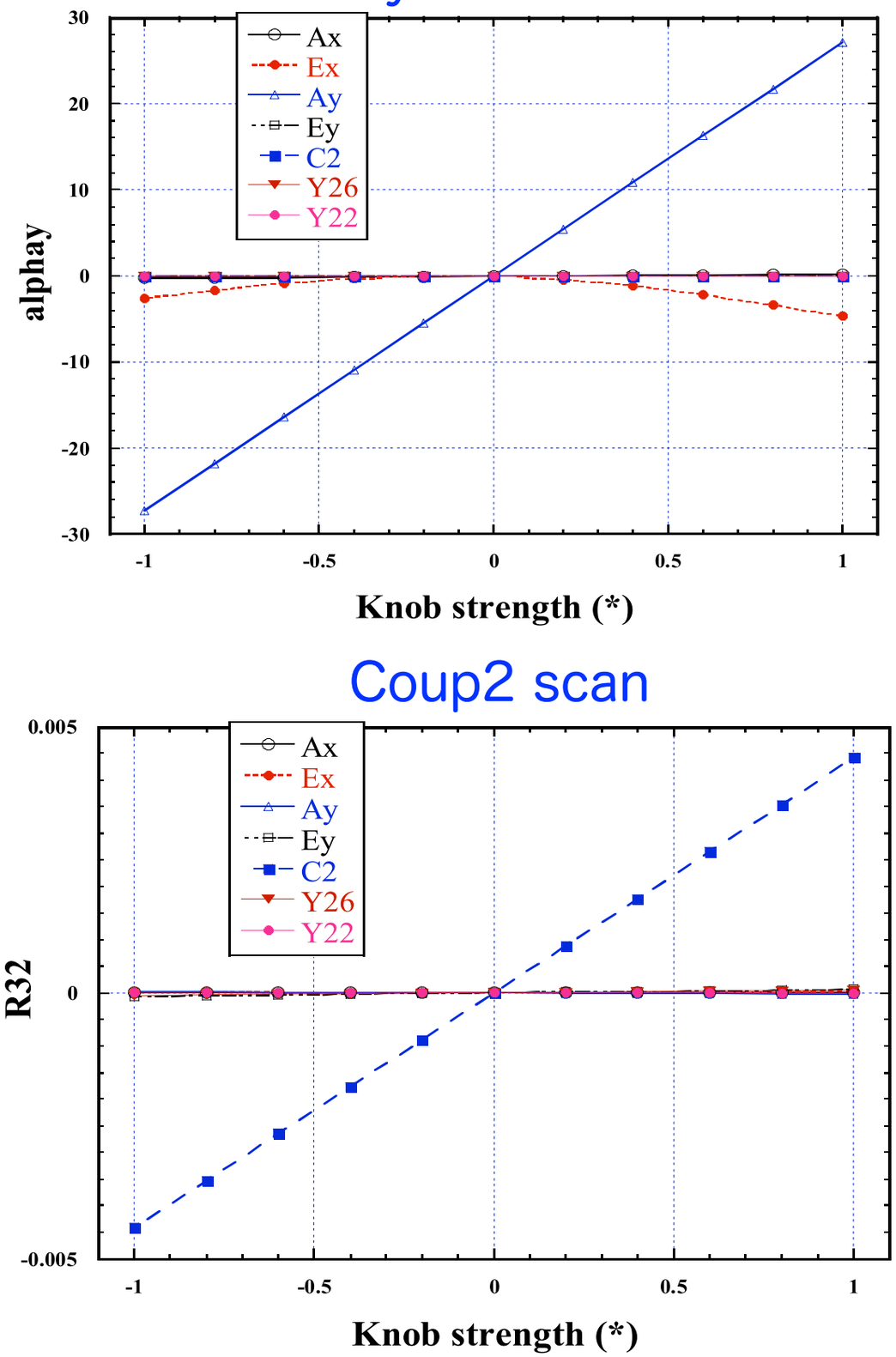
Non-linear knobs

Y26, Y22

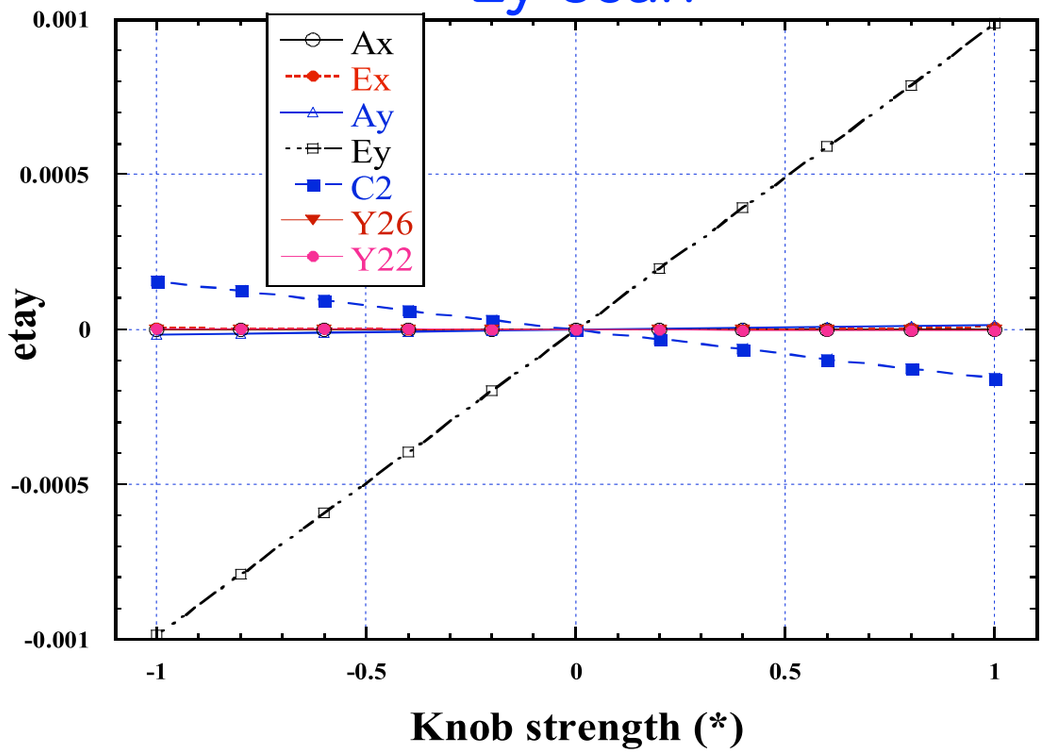
	Y24	Y46	Y22	Y26
SF6FF	0.002	0.008	0.000	0.000
SF5FF	-0.008	-0.032	0.000	0.000
SD4FF	-0.097	-0.390	0.000	0.000
SF1FF	0.004	-0.022	0.000	0.000
SD0FF	0.016	-0.103	0.000	0.000
SK1FF	0.000	0.000	-0.002	-0.352
SK2FF	0.000	0.000	0.068	0.083
SK3FF	0.000	0.000	0.000	0.000
SK4FF	0.000	0.000	0.716	1.420

Response of beam parameters at IP to each knob (1)

Ay scan

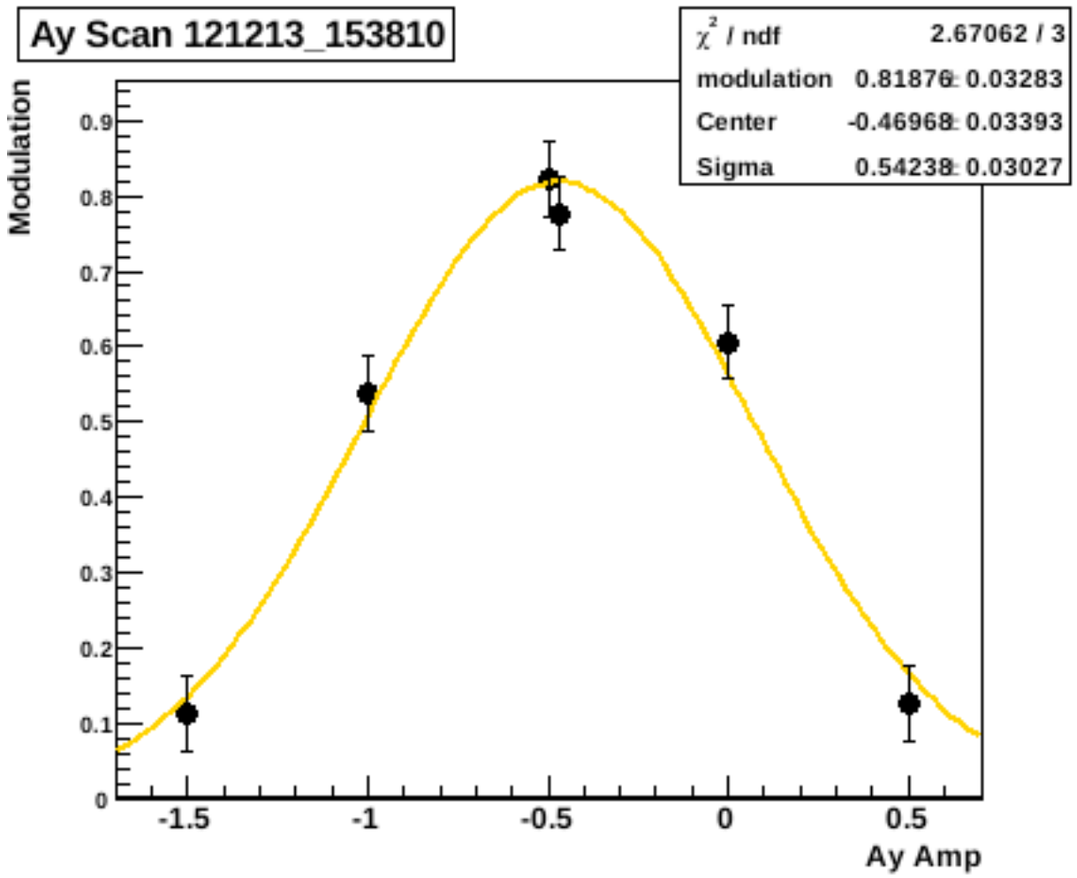


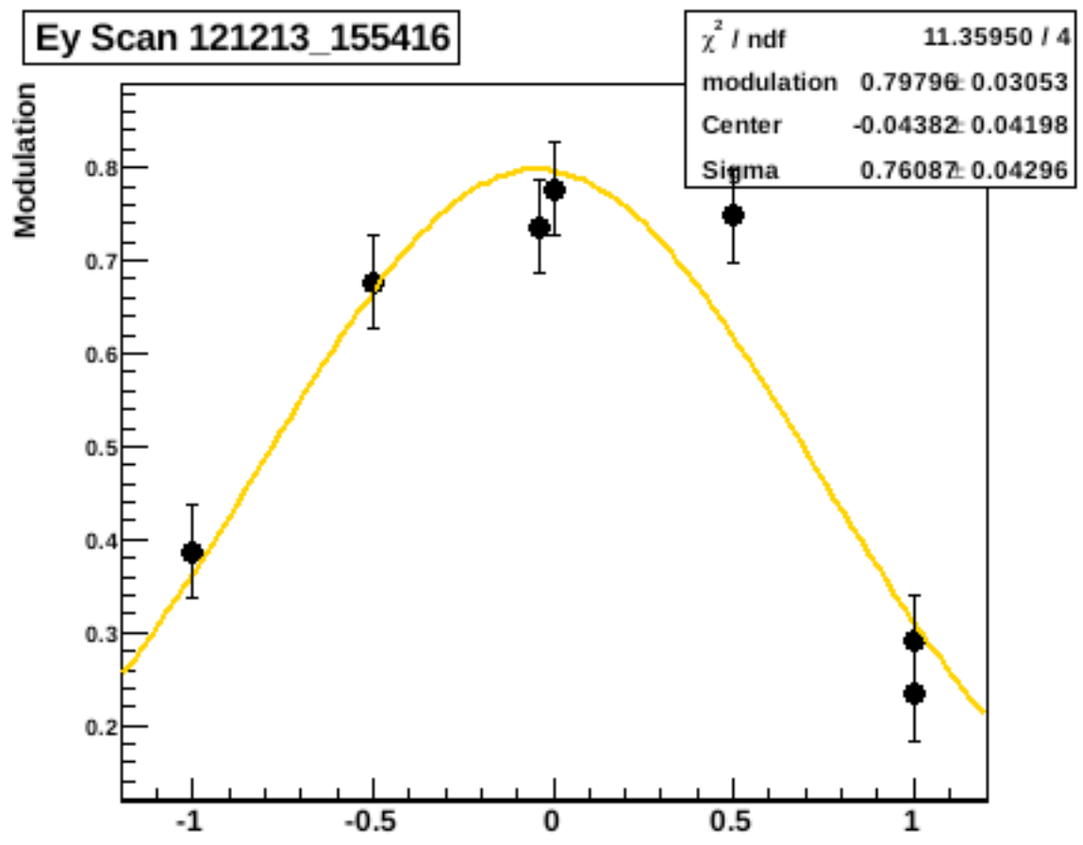
Ey scan

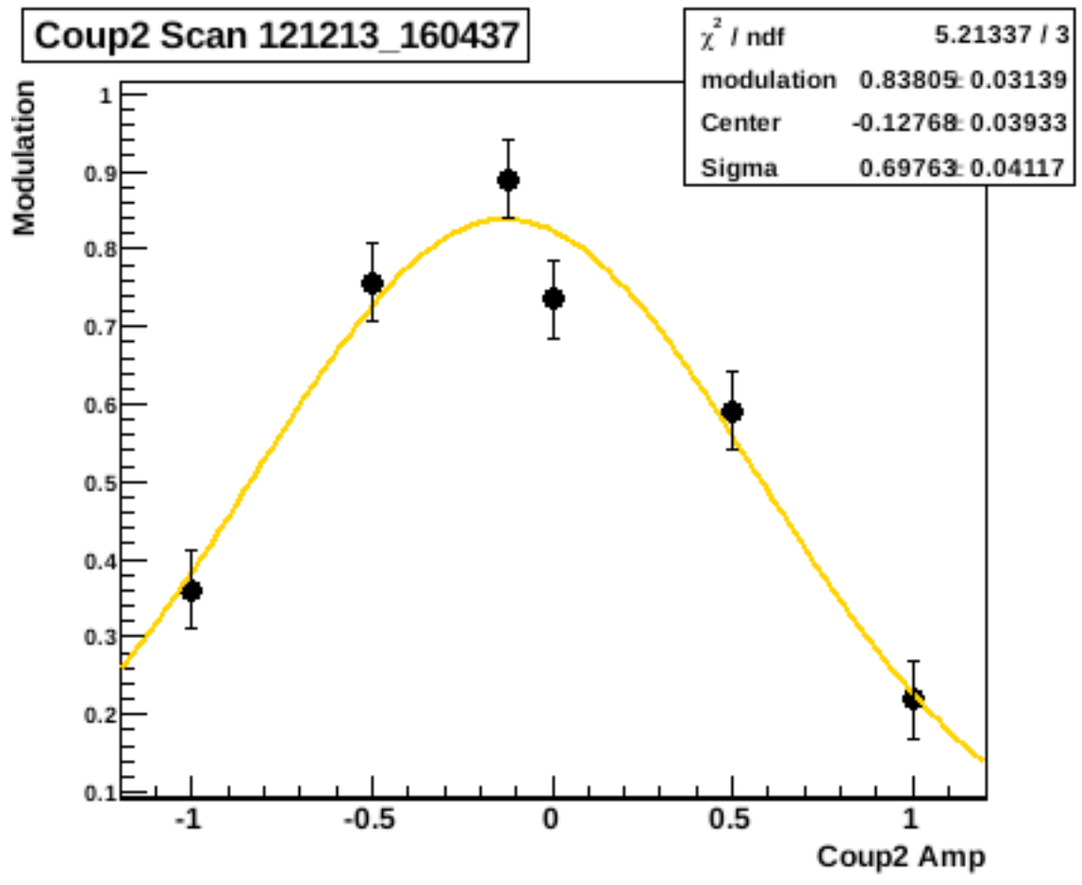


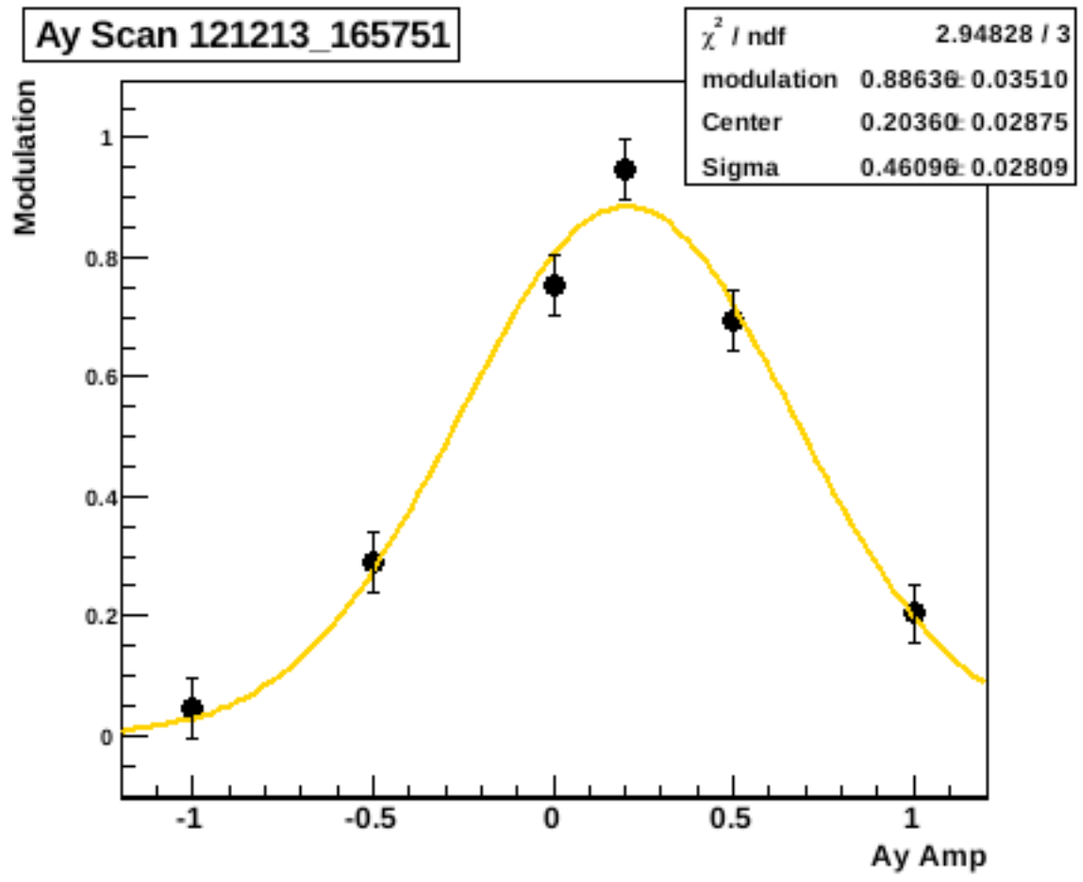
Coup2 scan

6.87 degree mode, 2012 12.13

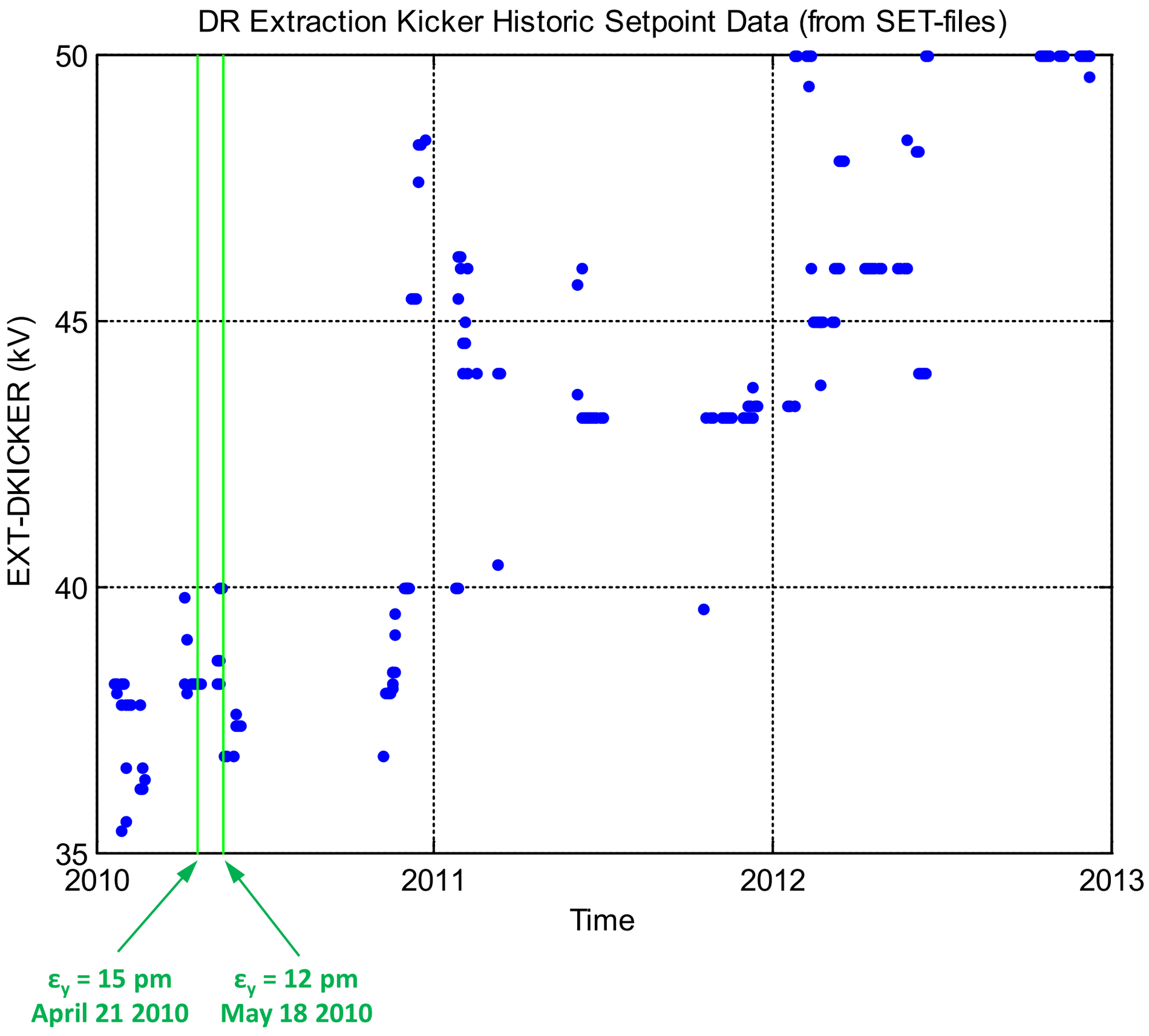




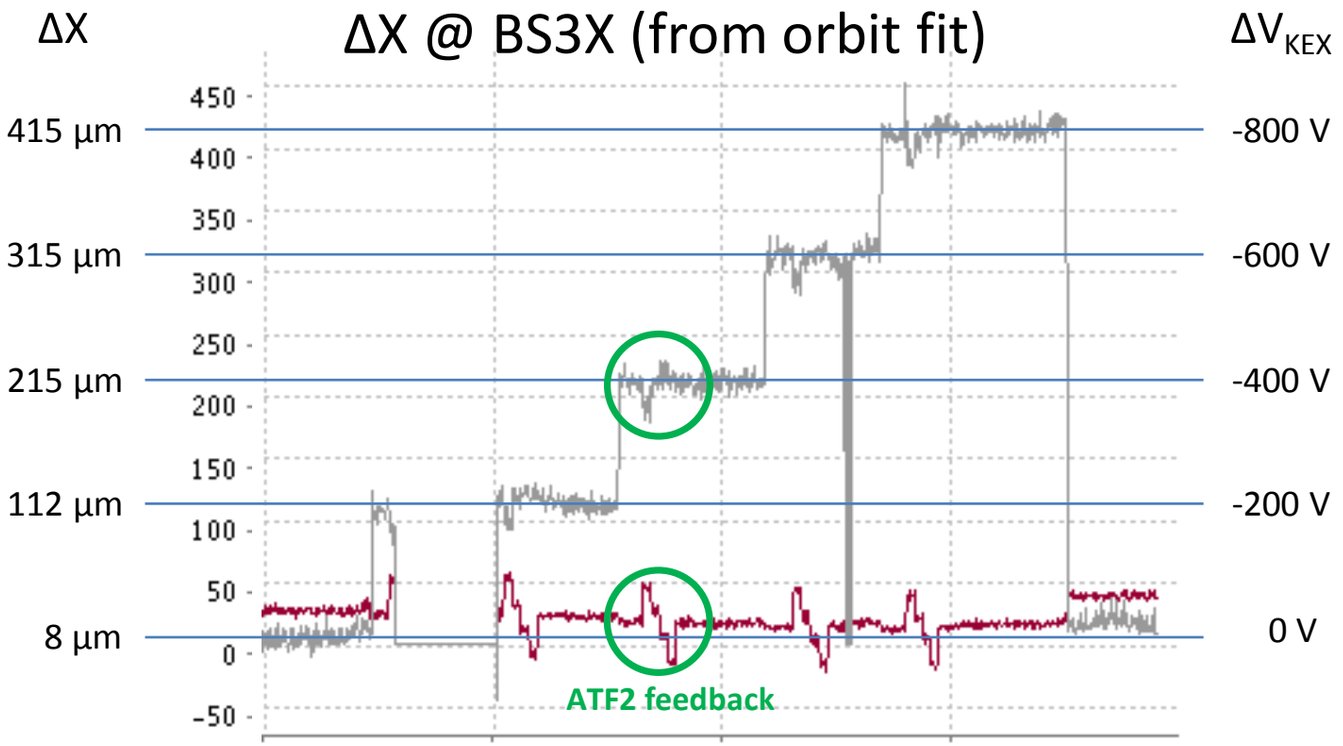




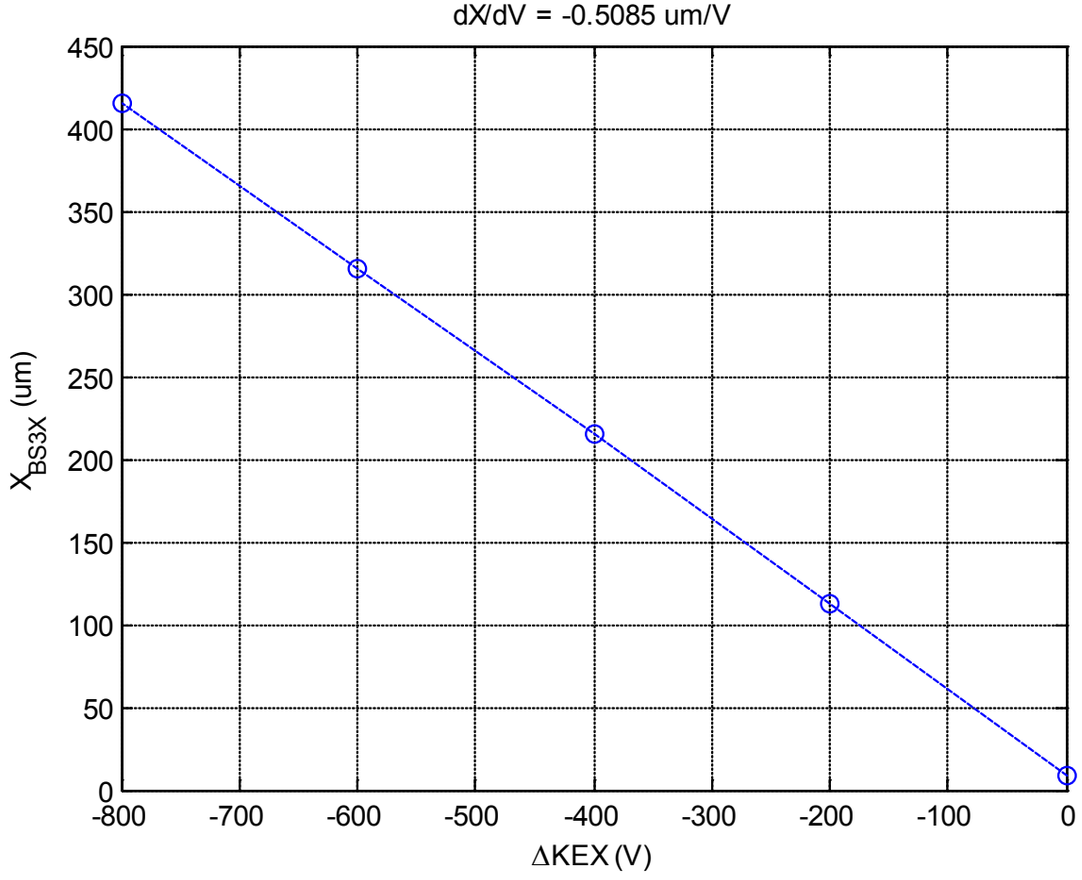
Issue of large vertical emittance at EXT



large vertical emittance due to BS3X skew Q?



Horizontal orbit position at BS3X center estimated by back-propagation from EXT BPM measurements (QF1X-QF4X)
… courtesy of Yves Renier



$$\Delta x = R_{12}\Delta\theta\ ,\ \Delta\theta = c\Delta V\ ,\ c = \frac{1}{R_{12}}\left(\frac{\Delta x}{\Delta V}\right)$$

R12 = 4.7329 μm/μrad
dX/dV = -0.5085 μm/V
dθ/dV = -0.1074 μrad/V
θ_0 = -5 mrad ⇨ V_0 = 46.5 kV
(SLAC NDR KEX: 0.1158 μrad/V)

measurement: 2012/12/07 Owl Shift
BS3X Skew Quadrupole Field Dependence on EXT Kicker Strength by Mark Woodley

Summary

1. IPBSM upgrade was done and commissioned at <30 degree mode.
2. ATF was quickly recovered troubles and earthquake.
3. New QF1FF was installed.
4. Candidate sources of wakefield were removed as much as possible.
5. Measured optics is well consistent with the model (design).
6. R&Ds are progressing towards the goal 2.
7. Present IP beam has M=0.34 at 30 degree mode of IPBSM.
8. Issue to be solved is the large vertical emittance at EXT.
9. We are eager to achieve the beam size of less than 70nm in this run, i.e. by end of 2012.