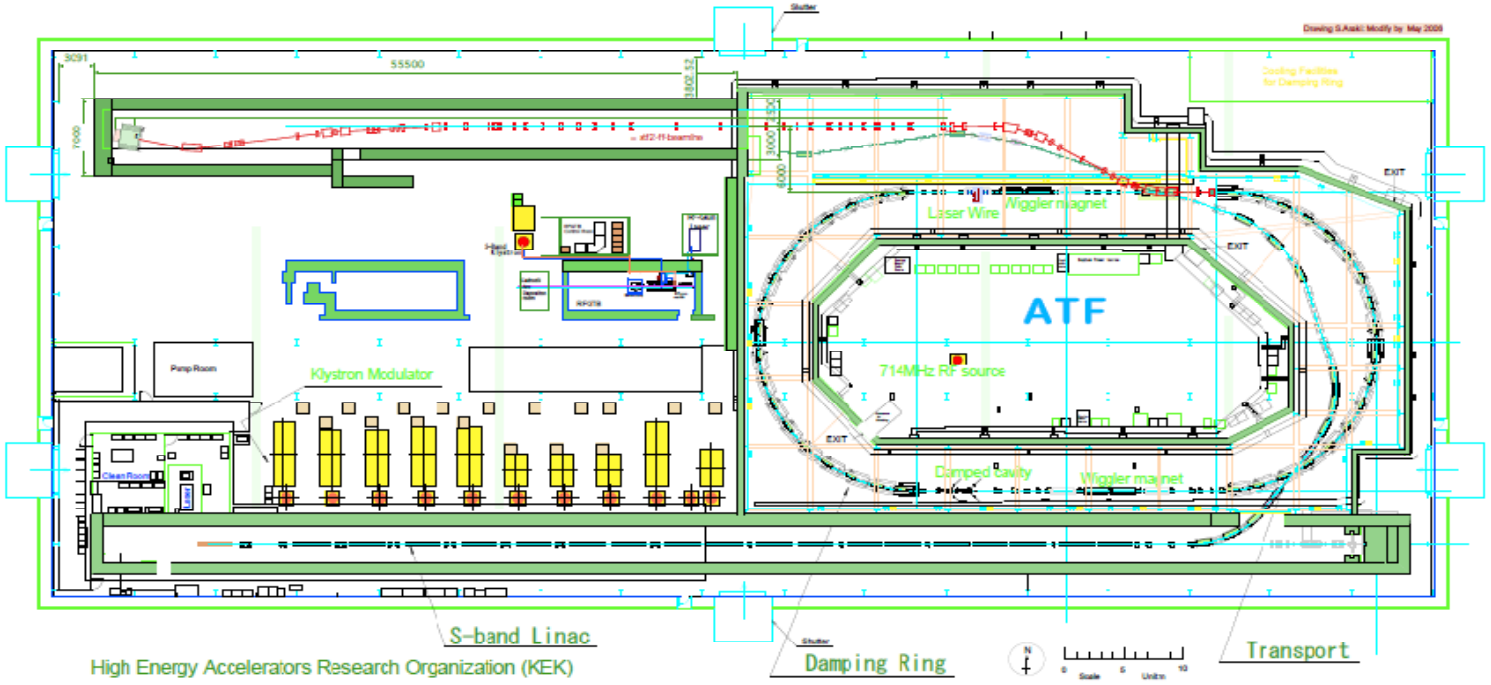
FD configuration, especially S-band BPMs

Toshiyuki Okugi (KEK)
3 / 17 / 2008
ATF2 meeting in KNU

Introduction - ATF2 Project



Beam energy

$E_{beam} = 1.3$ GeV

Emittances

$\varepsilon_x = 2 \times 10^{-9}$ m

$\varepsilon_y = 1 \times 10^{-11}$ m

Beta Function at IP

$\beta_x^* = 4$ mm

$\beta_y^* = 0.1$ mm

Beam Size at IP

$\sigma_x^* = 2.8$ μm

$\sigma_y^* = 34$ nm

-Prototype of ILC Final Focus Optics.

- Initial commissioning will be started from the end of 2008.

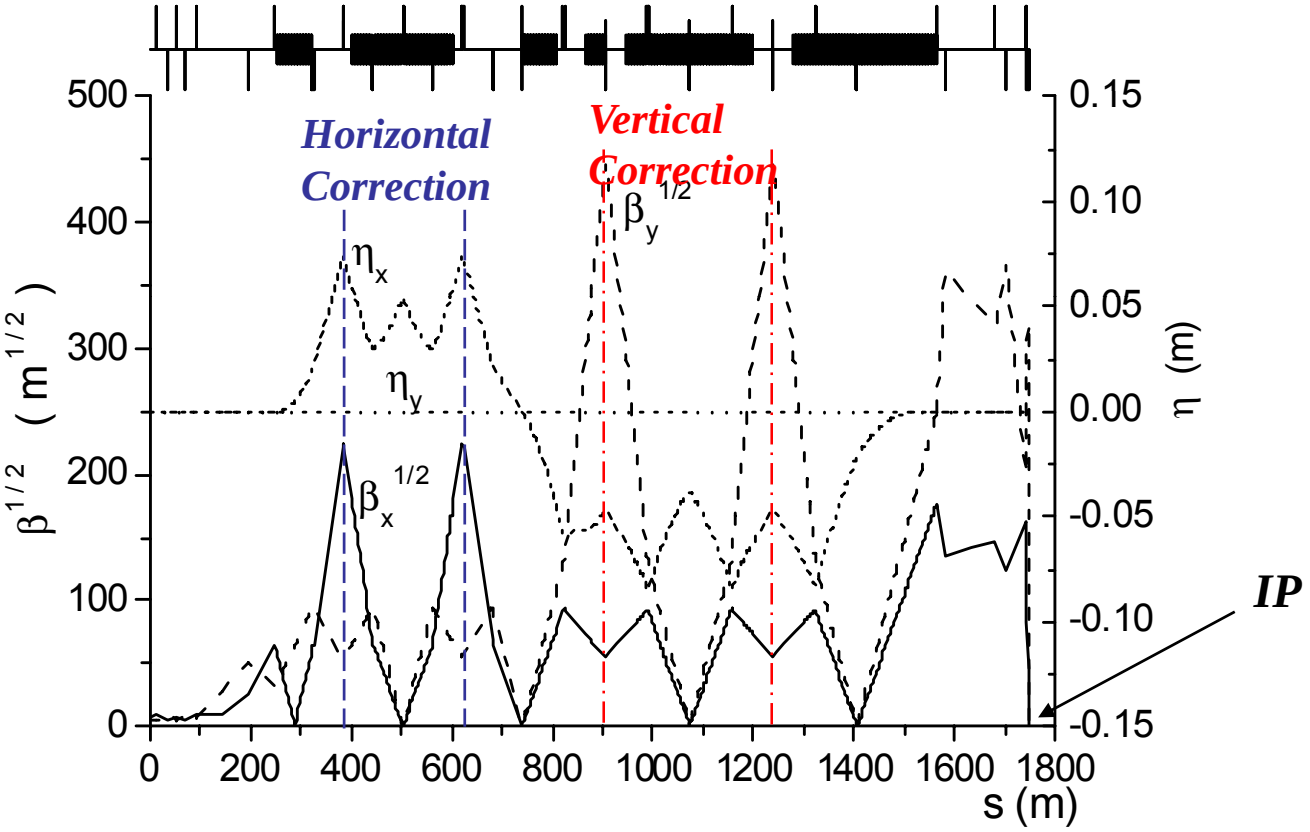
Design Parameters of ATF2

Parameters	ILC	FFTB	ATF-Ⅱ
E_{beam} [GeV]	250 / 500	46	1.3
N_{bunch}	2×10^{10}	5×10^{10}	1×10^{10}
$\gamma\varepsilon_x$ [radm]	1×10^{-5}	3×10^{-5}	2.5×10^{-6}
$\gamma\varepsilon_y$ [radm]	4×10^{-8}	2×10^{-6}	5.0×10^{-8}
β_x^* [mm]	21 / 30	3.0	4.0
β_y^* [mm]	0.4 / 0.3	0.1	0.1
L^* [m]	3.5 or 4.3	1.5	1.0
σ_x^* [μm]	0.66 / 0.55	1	2.8
σ_y^* [nm]	5.7 / 3.5	47	34

-FFTB with global chromaticity correction scheme,
was tested in 1993-1997 and achieved the smallest beam size of 55nm.

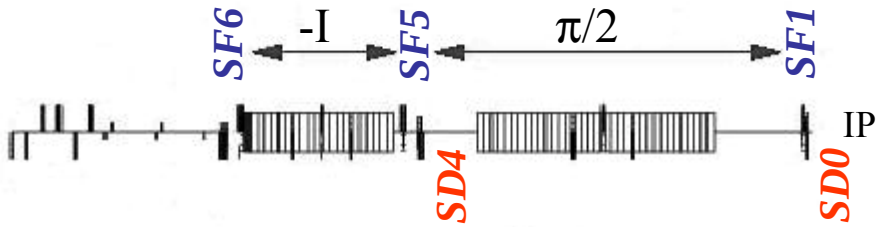
- ATF2, the ILC BDS test facility with local chromaticity correction method,
will be tested from the end of 2008

Beam Optics for Global Chromaticity Correction (Old Linear Collider Final Focus)



Chromaticity correction was done only by global correction section.

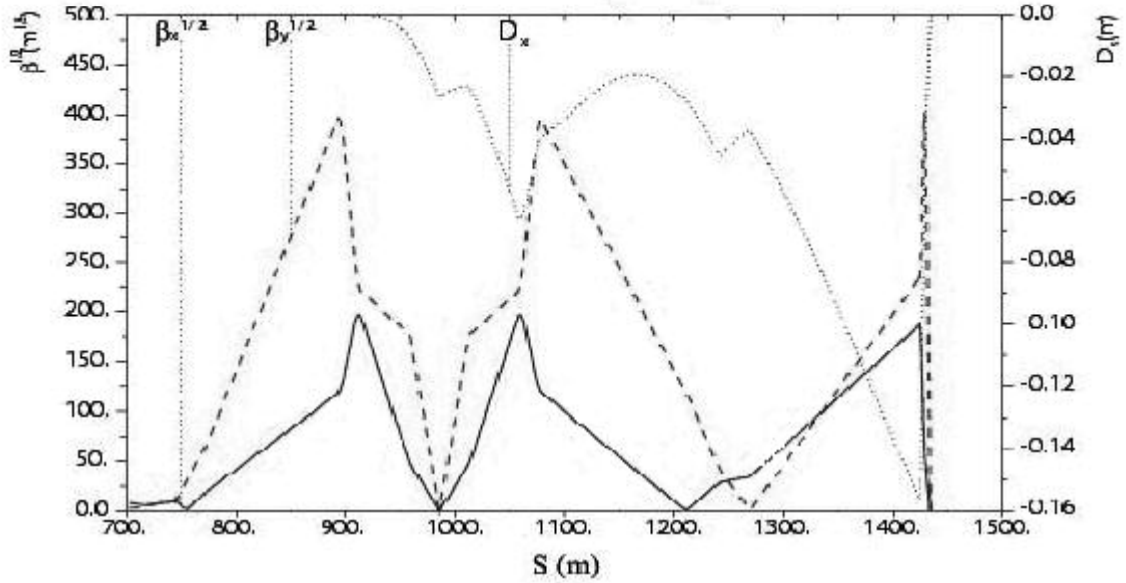
Beam Optics for Local Chromaticity Correction (Present ILC Final Focus)



Main Correction Items (coupled)

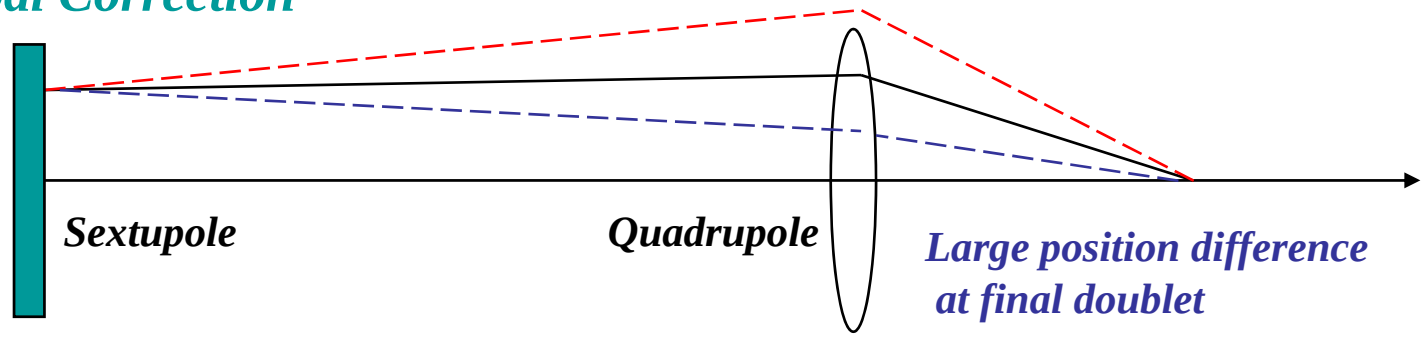
Horizontal Correction
2nd order Dispersion Correction

Vertical Correction

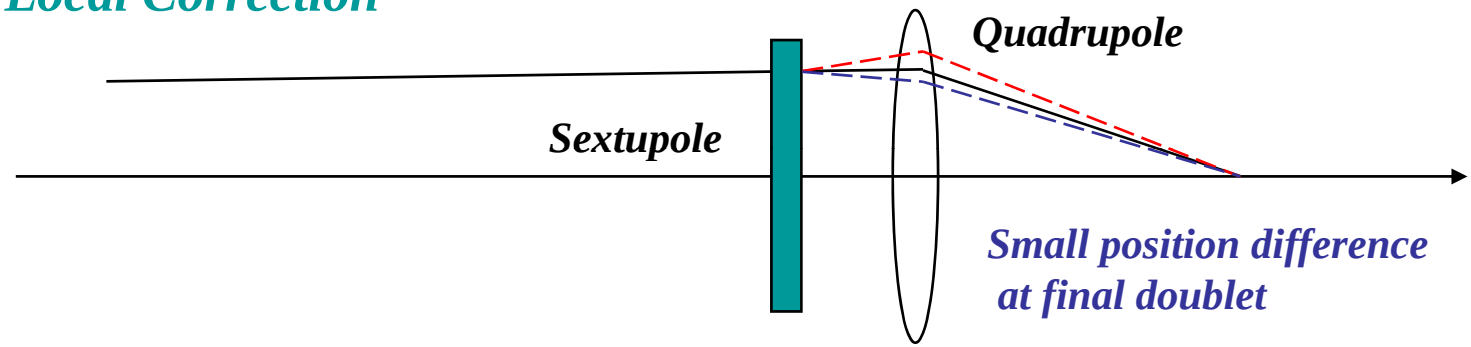


Sectupoles are located around the quadrupoles, which generate the large chromaticity.

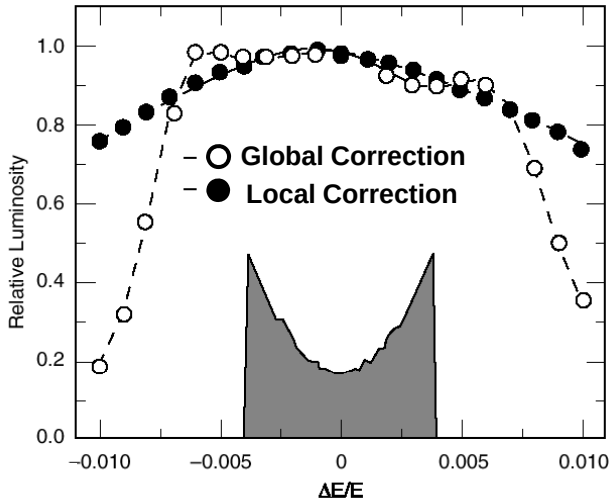
Global Correction



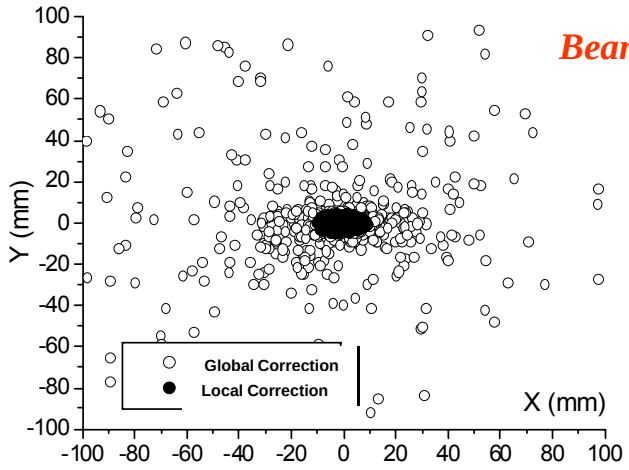
Local Correction



Bandwidth

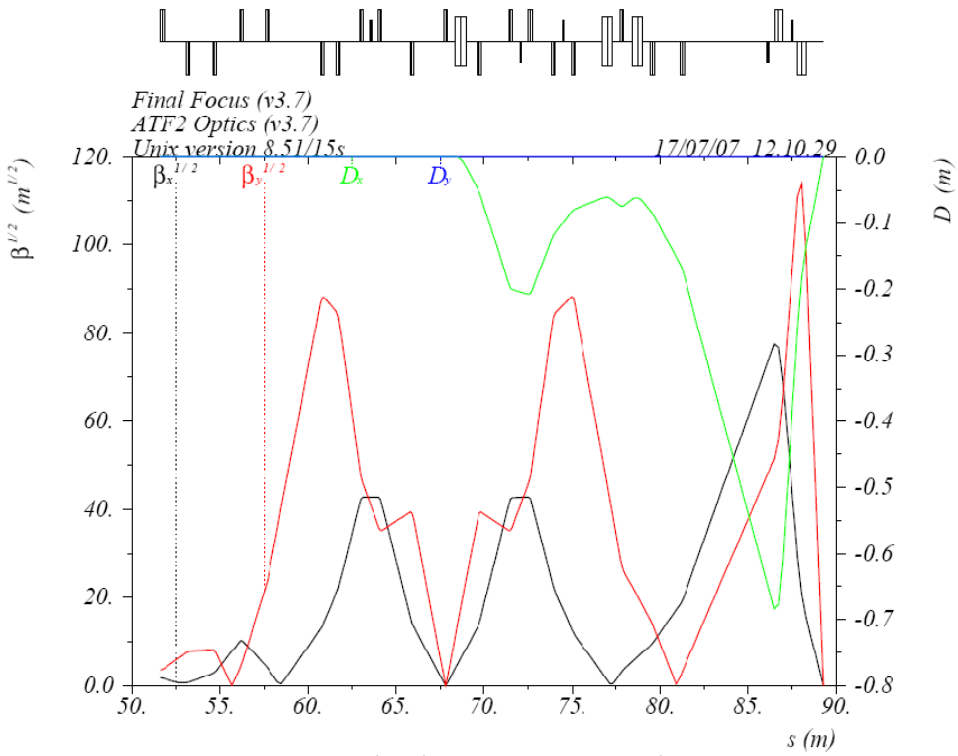


Beam Halo



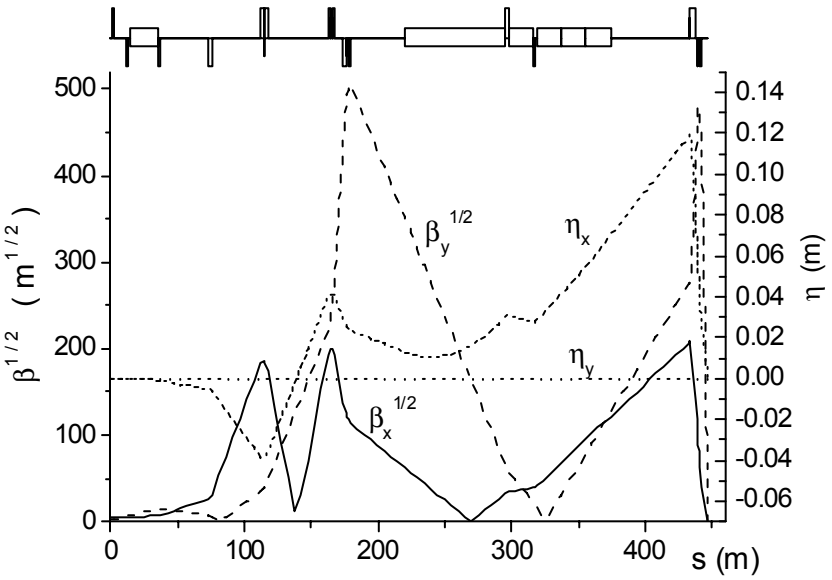
ATF2 Optics

-Prototype of ILC final focus beam line
(Local Chromaticity Correction)



ATF2 Final Focus Beam Line

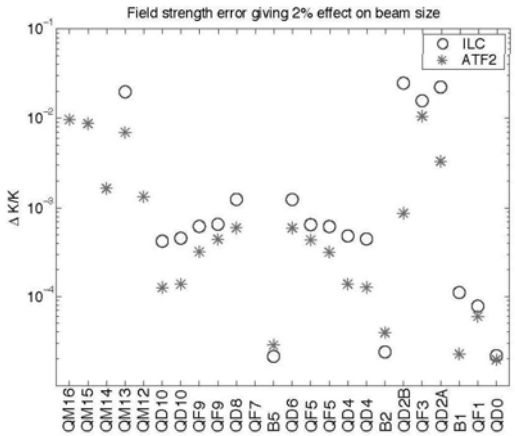
ILC Final Focus Beam Line



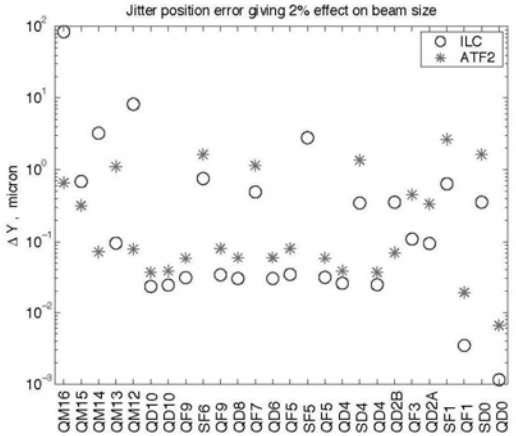
Alignment and Vibration Tolerance

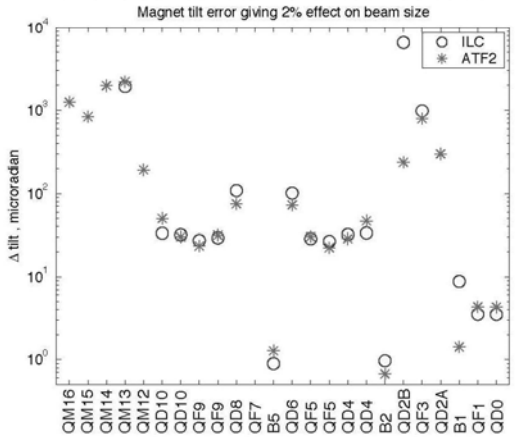
The tolerance of ATF2 quadrupoles are same order to that of ILC BDS.

Strength of Quadrupoles

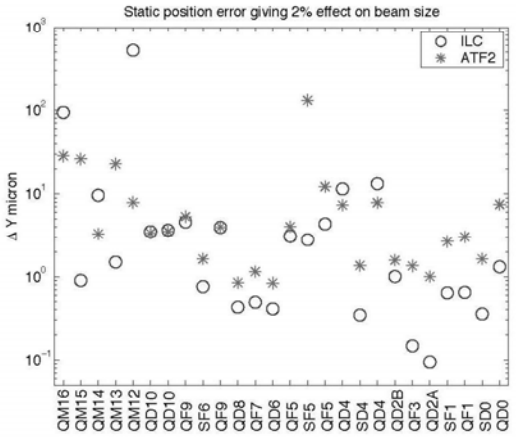


Vibration of Quadrupoles



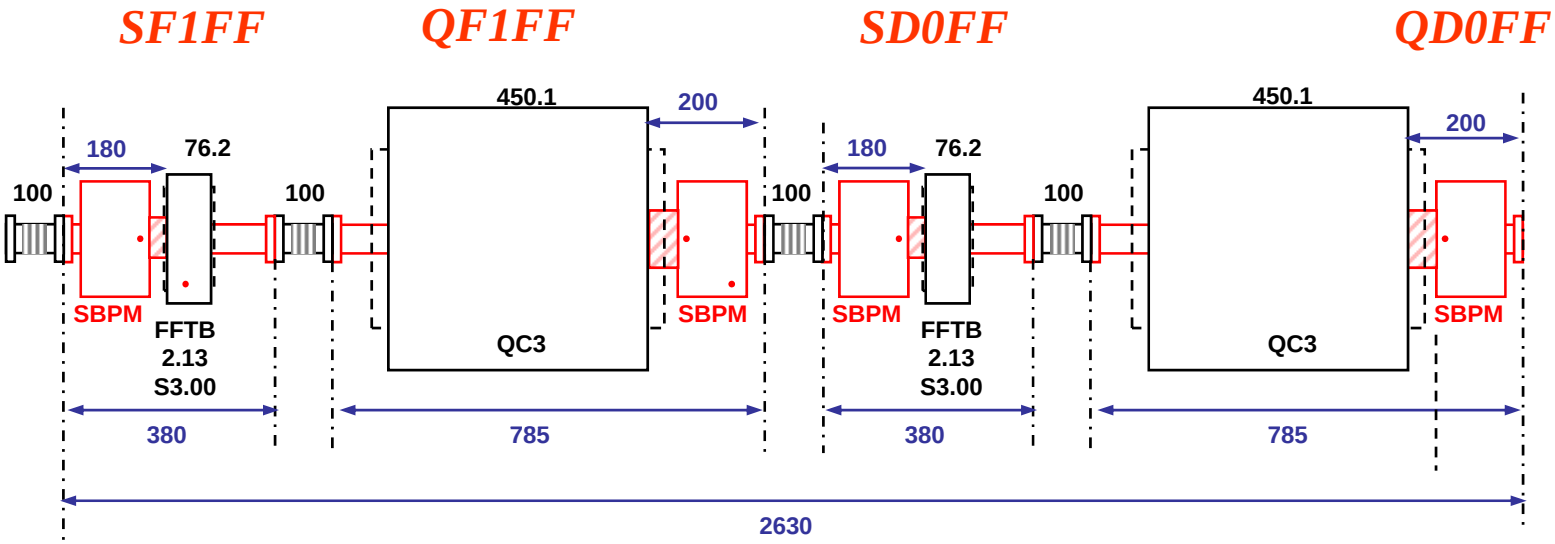


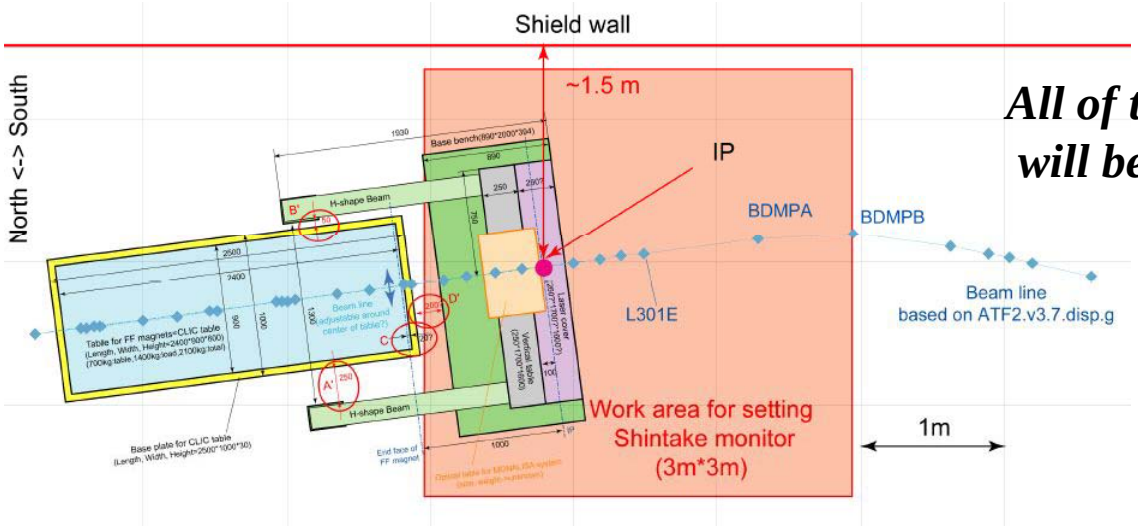
Rotation of Quadrupoles



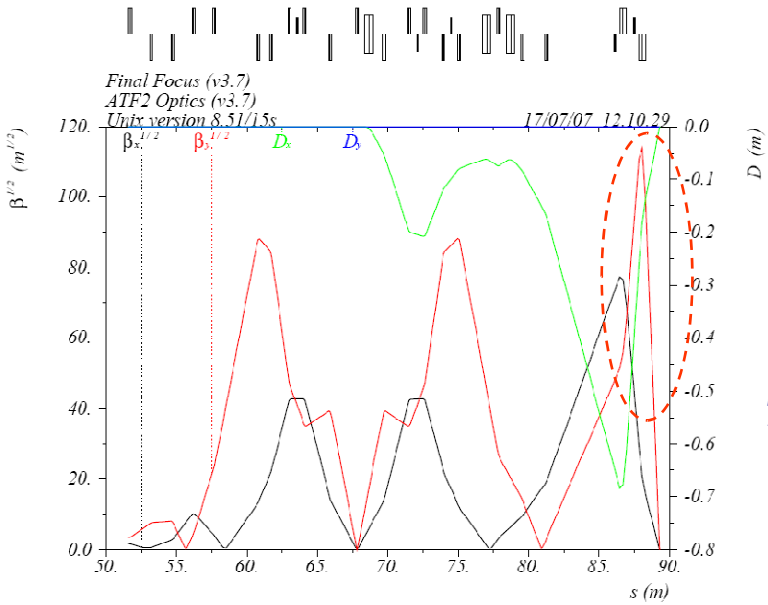
Position Alignment of Quadrupoles

Final Doublet Table Configuration





All of the Components will be mounted to one support table. (prepared by LAL)

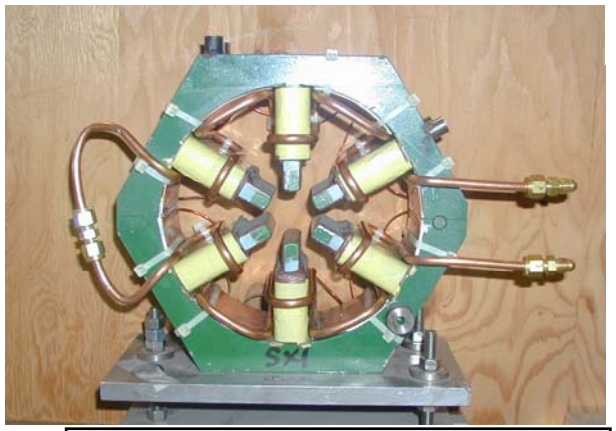


Sextupoles to use SD0 and SF1

Large Beam size around "Final Doublet"

$\sigma_x = 3.6\mu m$

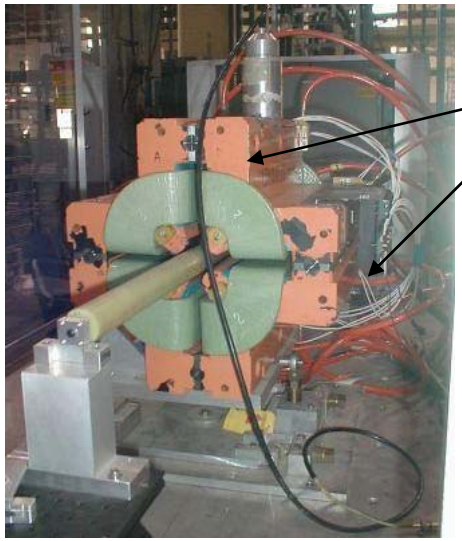
The large beam size make a background to "Shintake Monitor"



Bore diameter: 2.1259" = 54mm

Final Doublet Quadrupoles

Modified the SLAC QC3 magnet to make the large aperture



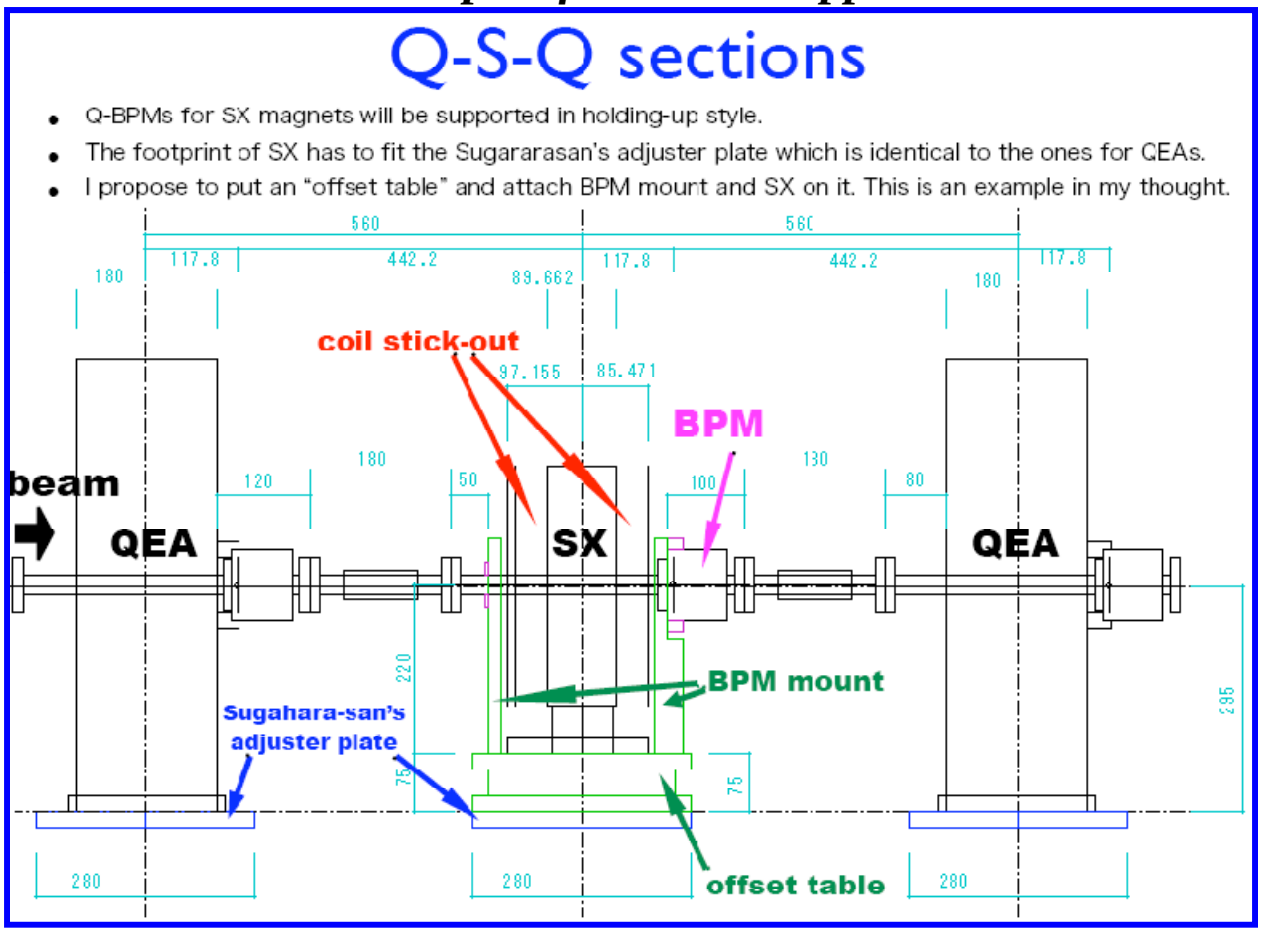
Shims to make a large aperture

Side-shim to reduce 12-pole

S-band BPM will be used around the Final Doublet and Sextupoles to make a large aperture.

We must make the S-band BPM support adopter for SF1 and SD0, because the weight of S-band BPMs are heavy.

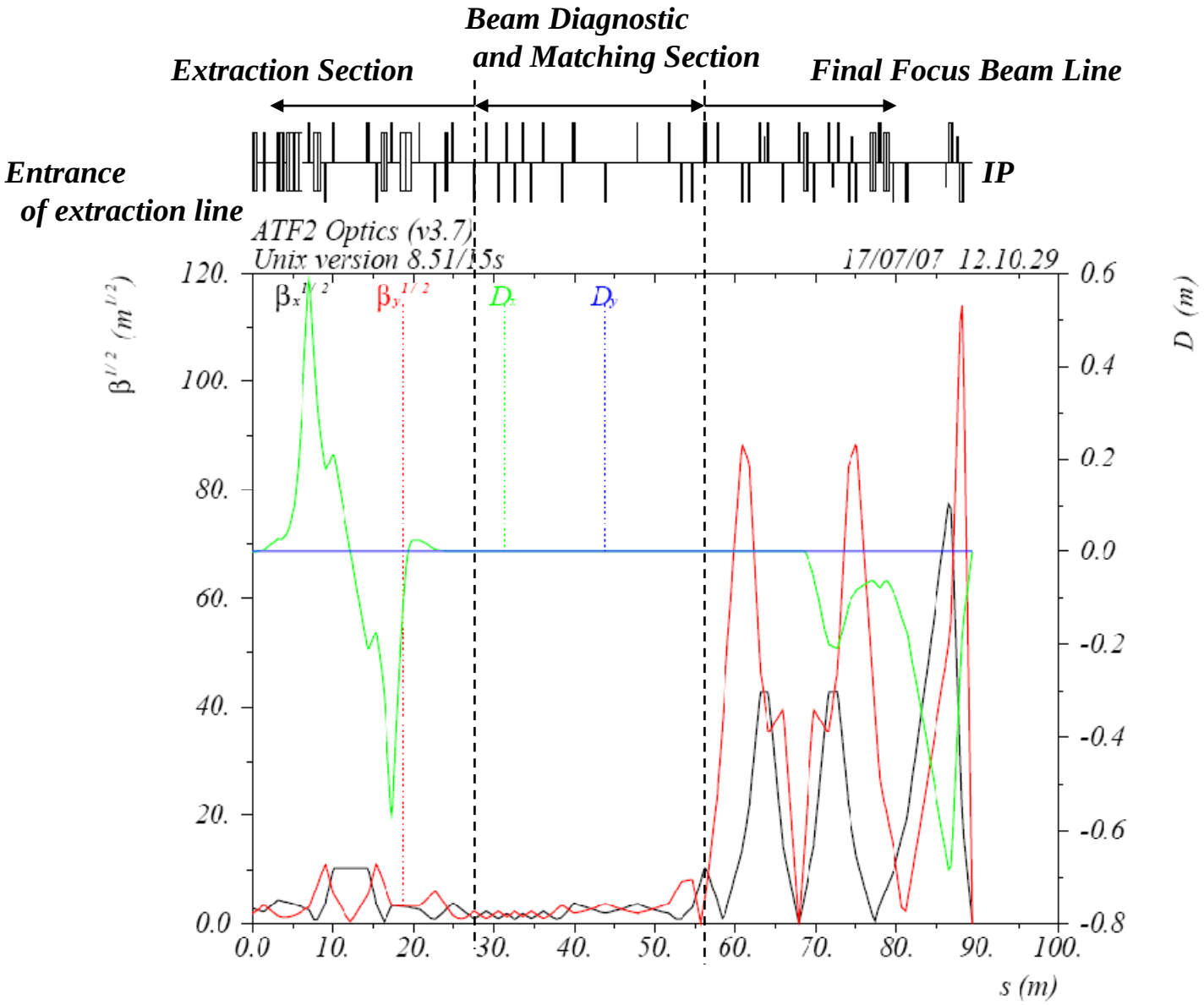
Example of the BPM support



This is not the supports for SF1 and SD0

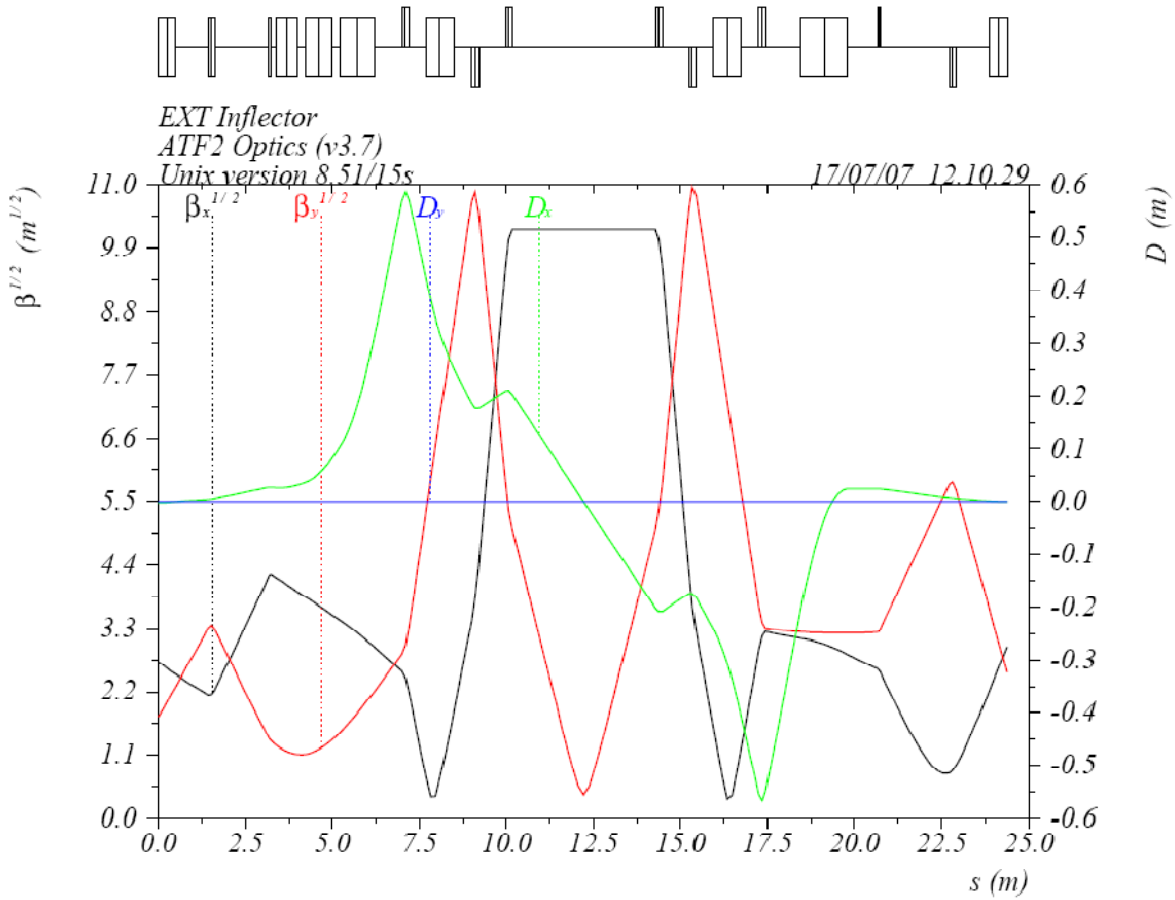
End of presentation

ATF2 Optics


Beam Diagnostic
and Matching Section
Extraction Section
Final Focus Beam Line
Entrance
of extraction line
IP
ATF2 Optics (v3.7)
Unix version 8.51/15s
17/07/07 12.10.29
$\beta_x^{1/2}$
$\beta_y^{1/2}$
D_x
D_y
$\beta^{1/2}$ ($m^{1/2}$)
D (m)
s (m)
120.
100.
80.
60.
40.
20.
0.0
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
0.0
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.

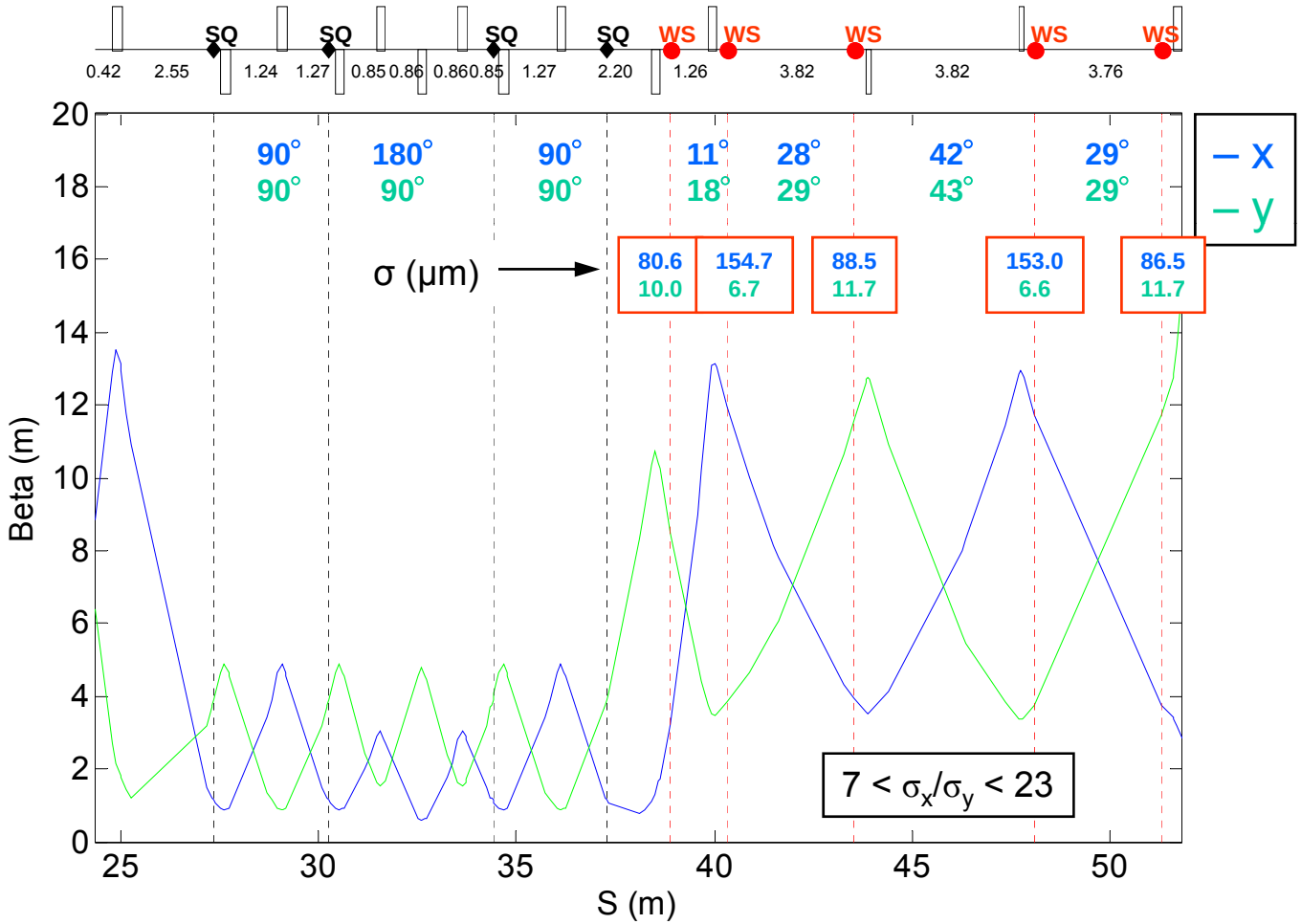
Extraction Section

- Renewal of present ATF extraction line to reduce the maximum dispersion
- Dispersion correction
- Extraction kicker jitter correction by double kicker system



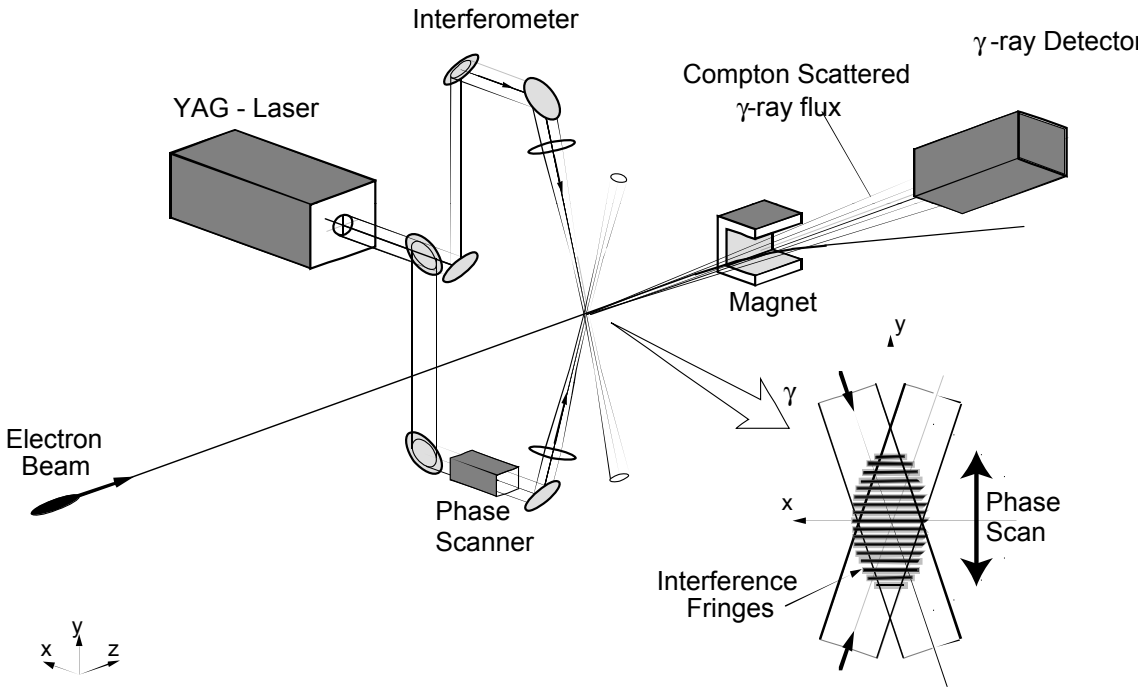
Beam Diagnostic and Matching Section

- *Emittance measurement with wire scanners*
- *Coupling correction with skew quadrupoles*
- *Matching to Final Focus beamline*



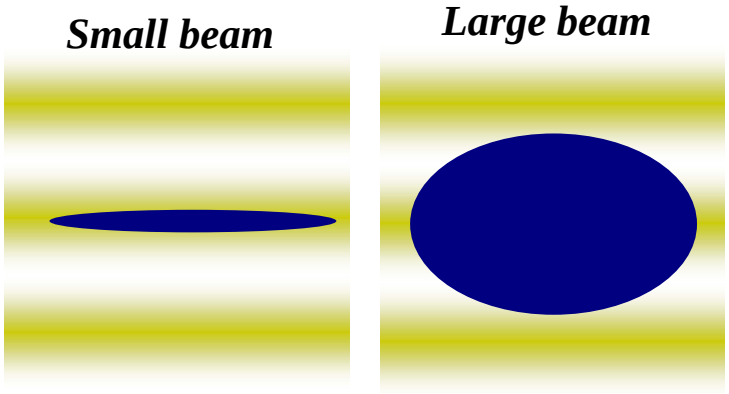
Beam size measurement in ATF2

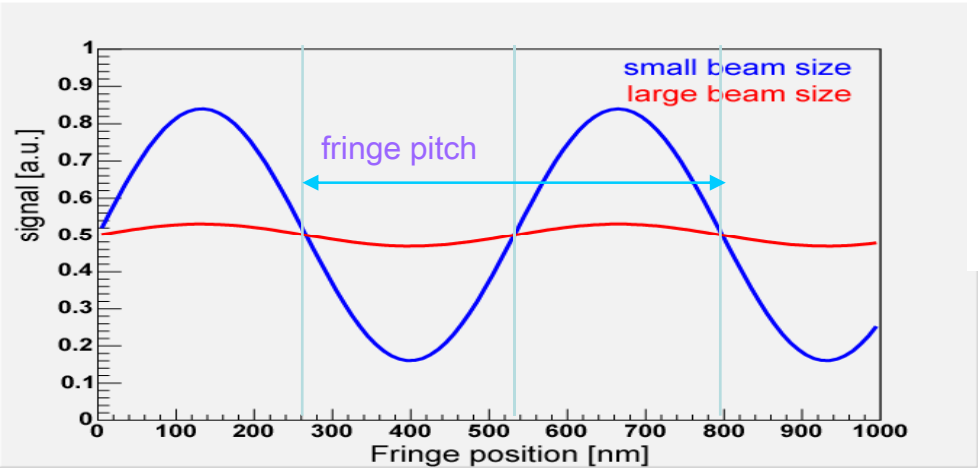
Small Beam Size was measured with Laser Interferometer (Shintake Monitor)



Since the breamstrulung

Beam Size Evaluation by Shintake Monitor





Emitted photon distribution

$$N_\gamma \propto \int_{-\infty}^{\infty} \exp[-\frac{(y-y_0)^2}{2\sigma_y^2}](1+\cos\theta\cos 2k_y y)dy$$
$$= N_0[1+\cos(2k_y y_0)\cos\theta]\exp[-2(k_y\sigma_y)^2]$$

$$N_\pm = N_0[1 \pm \cos\theta \exp[-2(k_y\sigma_y)^2]]$$

$$M \equiv \frac{N_+ - N_-}{N_+ + N_-}$$
$$= |\cos\theta|\exp[-2(k_y\sigma_y)^2]$$
$$= |\cos\theta|\exp[-2(\frac{\pi\sigma_y}{d})^2]$$

$$\sigma_y = \frac{d}{2\pi}\sqrt{2\ln\left(\frac{|\cos\theta|}{M}\right)}$$

Amount of interference

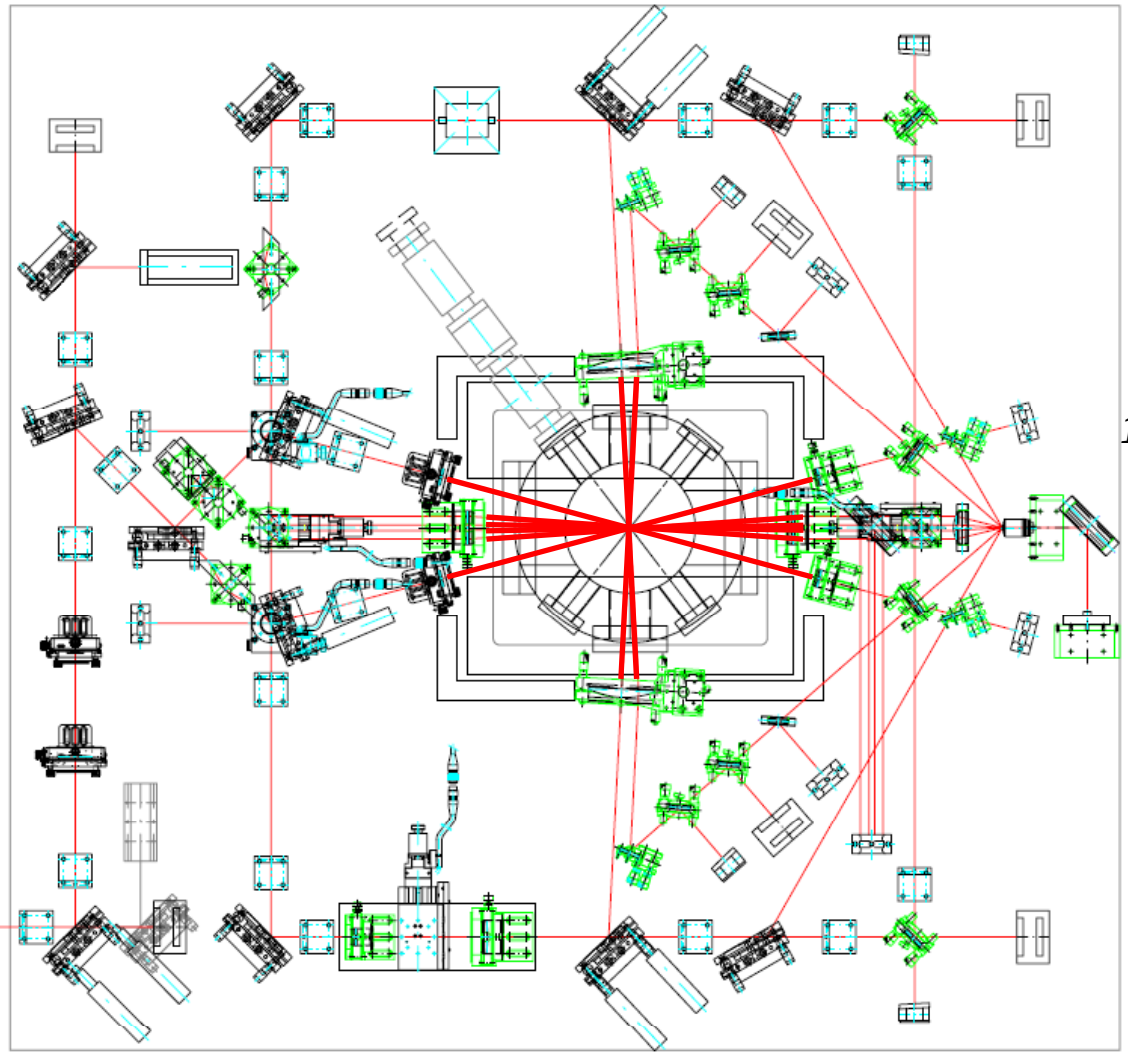
Layout of the Laser Table

2 degree mode

8 degree mode

30 degree mode

174 degree mode



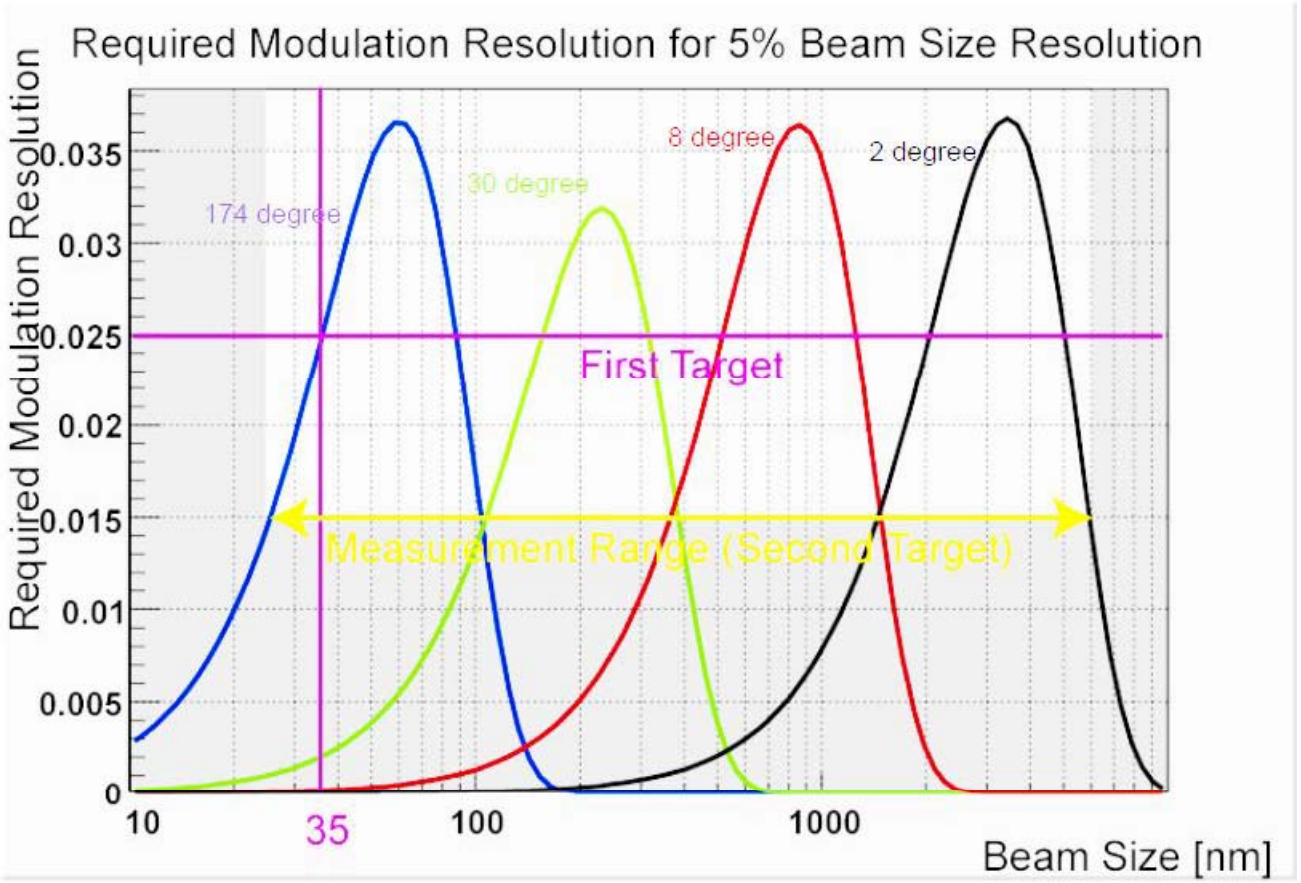
15μm pitch

3.8μm pitch

1.03μm pitch

266nm pitch

Measurable Range of Laser Interferometer



By changing 4 laser collision angle,
we can measure 25 – 6000 nm of beam size.