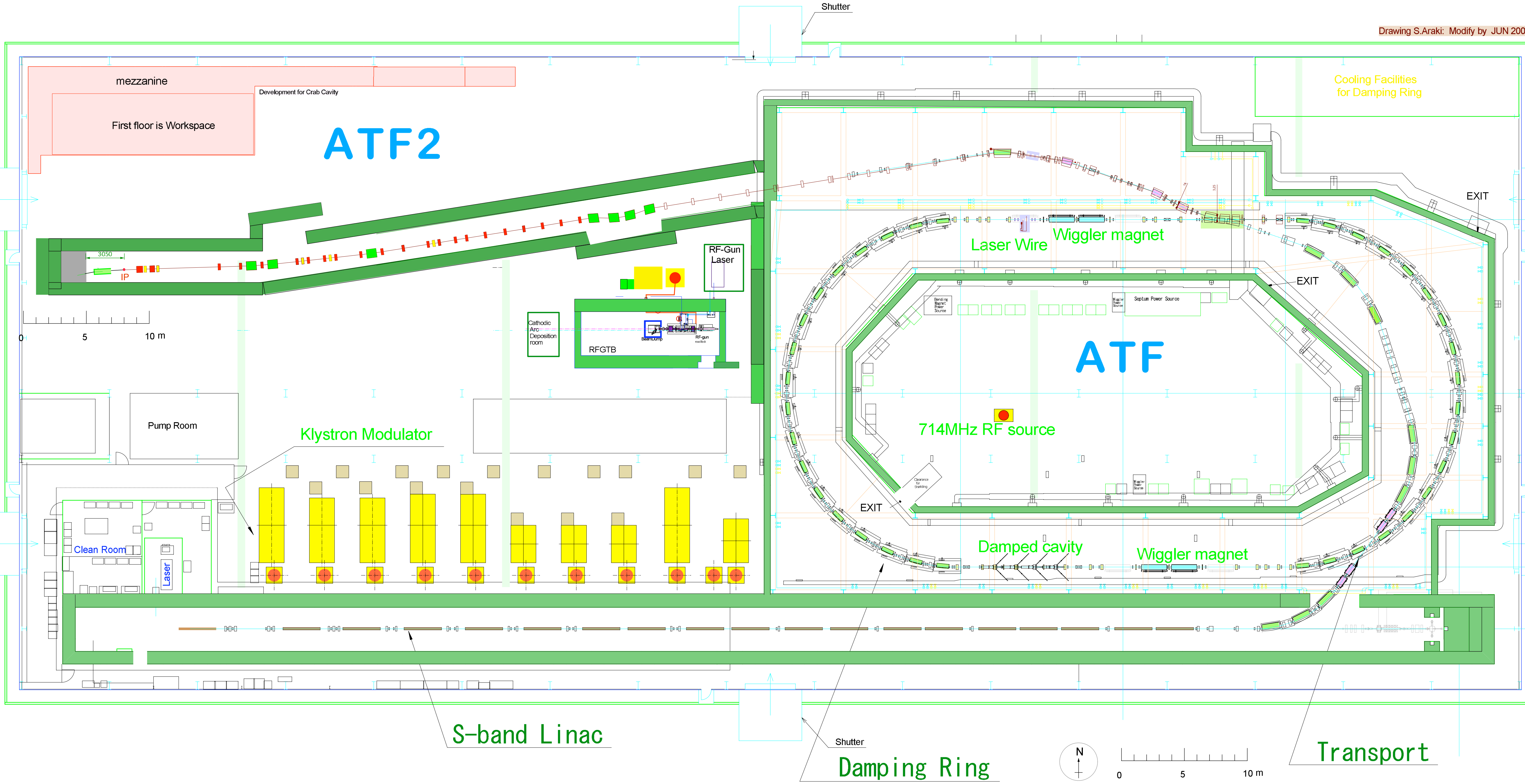
ATF2 Project at KEK

T. Tauchi, KEK

at Orsay

17 June, 2005


Drawing S.Araki: Modify by JUN 2005
Shutter
mezzanine
Development for Crab Cavity
First floor is Workspace
ATF2
Cooling Facilities
for Damping Ring
EXIT
3050
IP
Laser Wire
Wiggler magnet
RF-Gun
Laser
EXIT
0
5
10 m
Cathodic
Arc
Deposition
room
RFGTB
ATF
Pump Room
Klystron Modulator
714MHz RF source
EXIT
Clean Room
Laser
Damped cavity
Wiggler magnet
S-band Linac
Shutter
Damping Ring
N
0
5
10 m
Transport

Final Goal

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

Reduction of Risk at ILC

FACILITY construction, first result	ATF2/KEK 2005-07-08?	FFTB/SLAC 1991-93-94
Optics	Pantaleo's local choromaticity correction scheme; very short and longer L* (β^*_y=100μm, L_{tot}=36.6m)	Oide's conventional (separate) scheme; non-local and dedicated CCS at upstream; high symmetry; i.e. orthogonal tuning (β^*_y=100μm,, L_{tot}=185m)
Design beam size	34nm / 2.2μm, aspect=65 ($\gamma\epsilon_y$=3 x 10^{-8} m)	60nm / 1.92μm, aspect=32 ($\gamma\epsilon_y$=2 x 10^{-6} m)
Achieved	?	70nm (beam jitter remains !)

3.1: ATF2 proposed optics IP parameters in comparison with ILC.

params	ATF2	ILC
Beam Energy [GeV]	1.28	250
L* [m]	1	3.5 – 4.2
$\gamma\,\epsilon_x$ [m-rad]	3e-6	1e-5
$\gamma\,\epsilon_y$ [m-rad]	3e-8	4e-8
β^*_x [mm]	4.0	21
β^*_y [mm]	0.1	0.4
η' (DDX) [rad]	0.14	0.094
σ_E [%]	~0.1	~0.1
Chromaticity W_y	$\sim 10^4$	$\sim 10^4$

$\sim L^*/\beta^*_y$

Mode-I

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)

Mode-II

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 20nm.)

B2) Establishment of beam jitter controlling technique
at nano-meter level with ILC-like beam (2008 -?)

ATF2 Operation

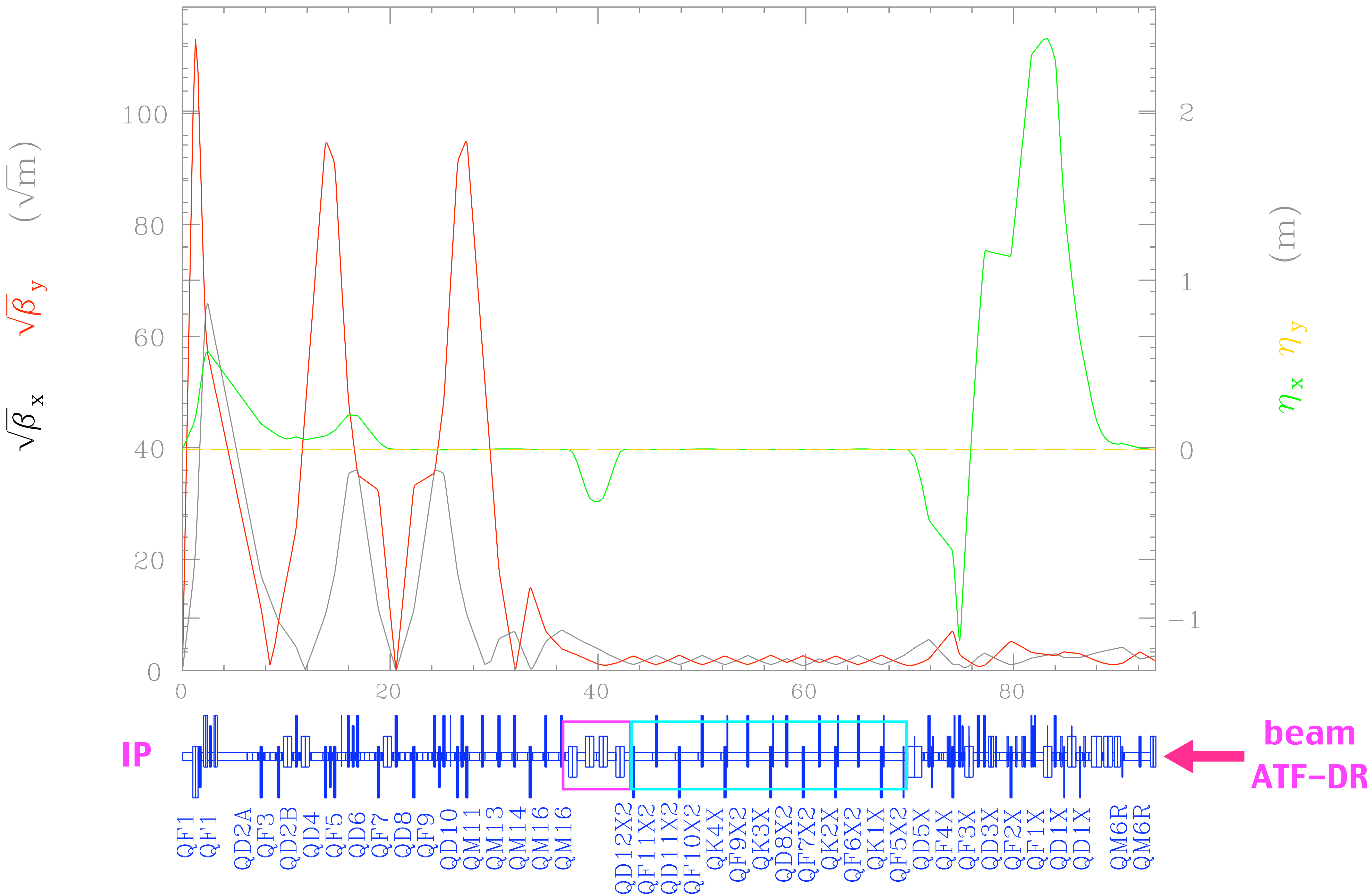
- The mode-I and -II can not go together for BSM and IP-BPM at the same FP.
- First, ATF2 will operate in the mode-I with the BSM.
- Next, ATF2 will operate in the mode-II with the IP-BPM.
- In long term, ATF2 will interchangeably operate the mode-I and -II.

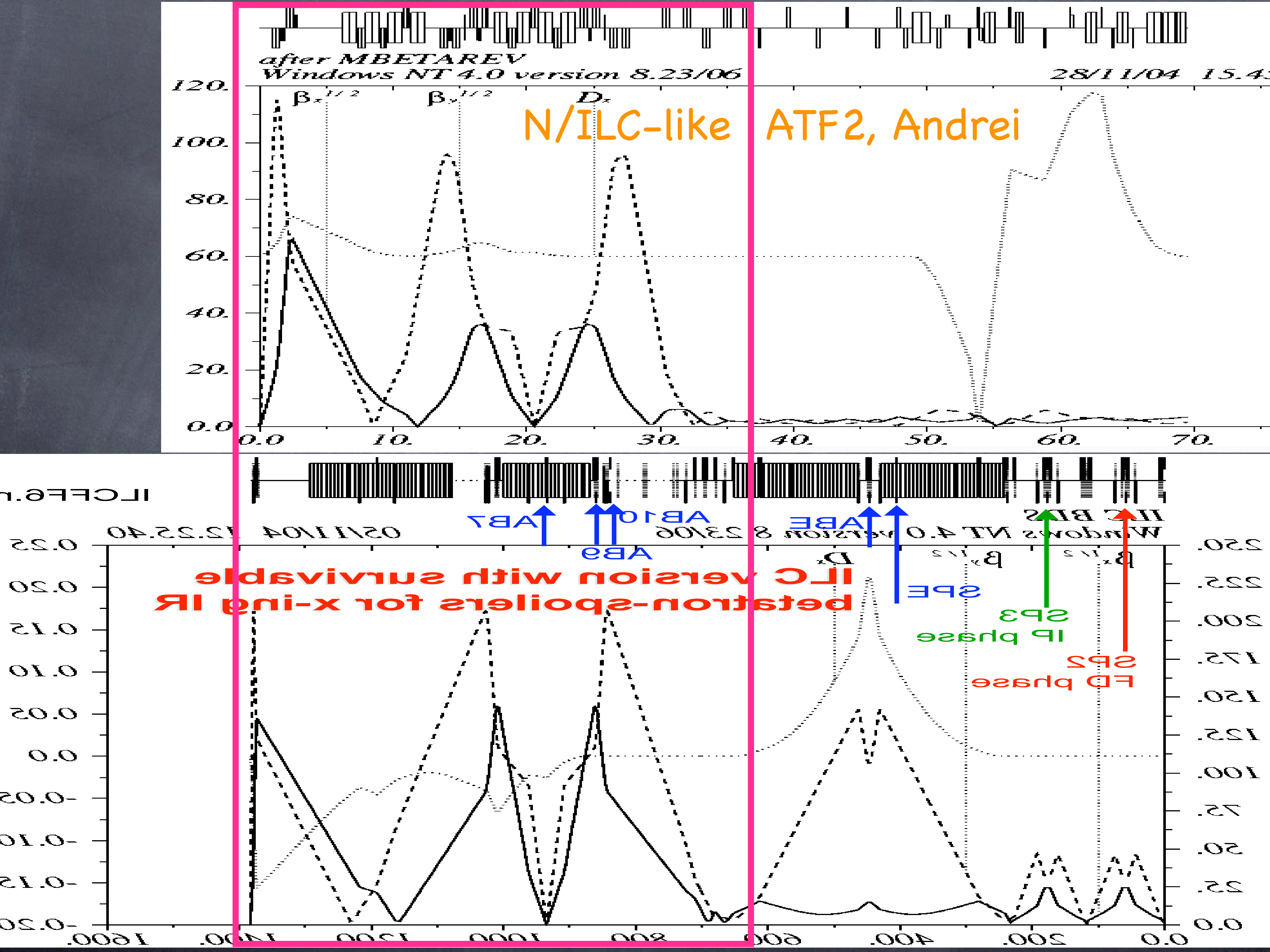
Requirements

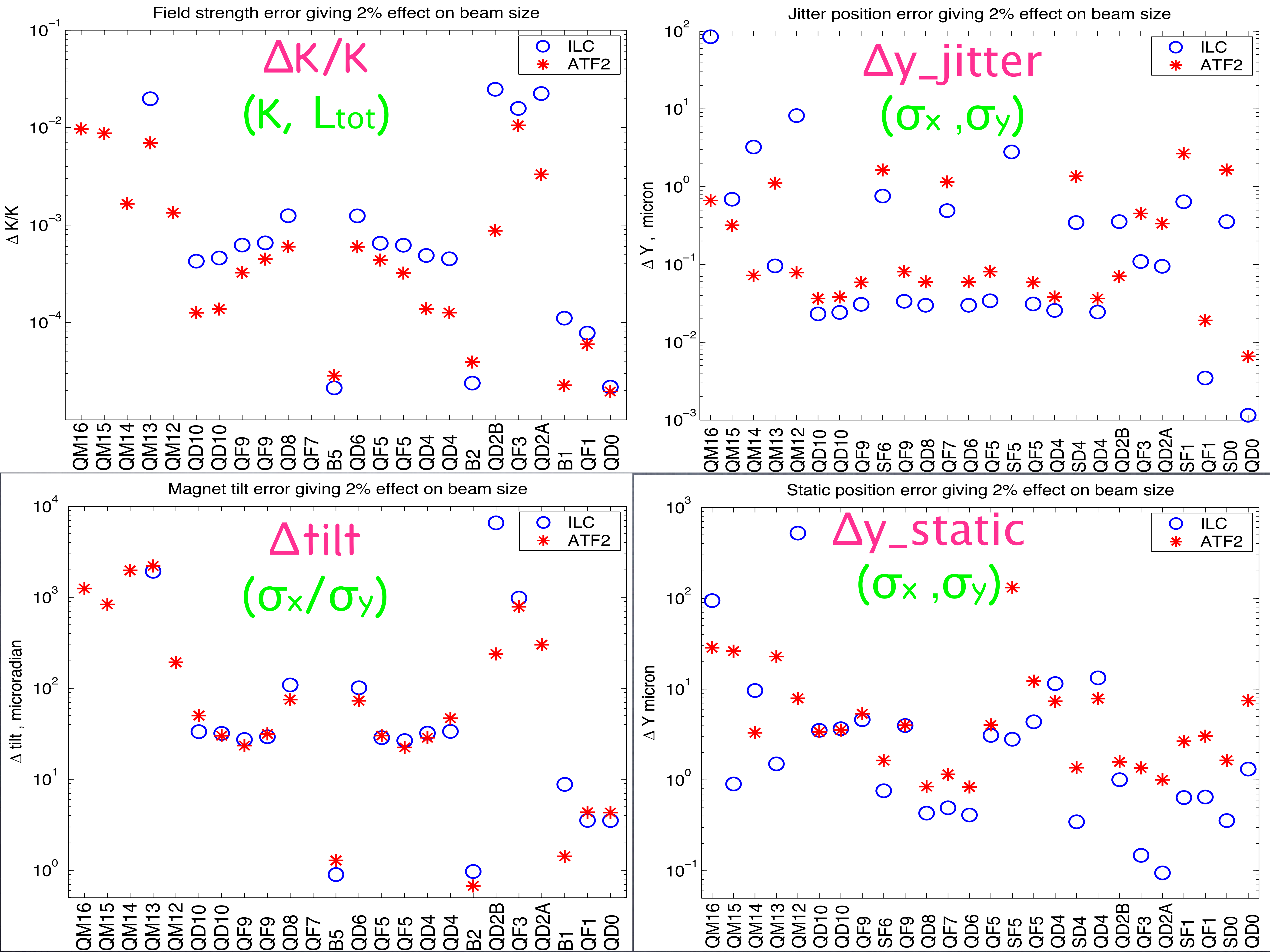
Mode	ATF-EXT	ATF2
I	Jitter < 30% of σ_y $\gamma\epsilon_y$=(4.5 → 3) x 10^{-8}m	BSM (laser in higher mode) BPMs with 100nm res. at Qs Power supplies of < 10^{-5} Active mover of Final Q
II	Jitter < 5% of σ_y (2nm jitter at FP)	BPM with < 2nm res. at FP Intra-bunch feedback for ILC style beam

Mode-I

Optics; FF, diagnostic, ATF-EXT




after MBETAREV
Windows NT 4.0 version 8.23/06
28/11/04
N/ILC-like
ATF2, Andrei
ILC version with survivable betatron-spoilers for x-ing IR
AB7
AB9
AB10
ABE
SPE
SP3 IP phase
SP2 FD phase



Field strength error giving 2% effect on beam size
ΔK/K
(K, Ltot)
Δ K/K
ILC
ATF2
QM16 QM15 QM14 QM13 QM12 QD10 QD10 QF9 QF9 QD8 QF7 B5 QD6 QF5 QF5 QD4 QD4 B2 QD2B QF3 QD2A B1 QF1 QD0
Jitter position error giving 2% effect on beam size
Δy_jitter
(σx ,σy)
Δ Y , micron
ILC
ATF2
QM16 QM15 QM14 QM13 QM12 QD10 QD10 QF9 SF6 QF9 QD8 QF7 QD6 QF5 SF5 QF5 QD4 SD4 QD4 QD2B QF3 QD2A SF1 QF1 SD0 QD0
Magnet tilt error giving 2% effect on beam size
Δtilt
(σx/σy)
Δ tilt , microradian
ILC
ATF2
QM16 QM15 QM14 QM13 QM12 QD10 QD10 QF9 QF9 QD8 QF7 B5 QD6 QF5 QF5 QD4 QD4 B2 QD2B QF3 QD2A B1 QF1 QD0
Static position error giving 2% effect on beam size
Δy_static
(σx ,σy)
Δ Y micron
ILC
ATF2
QM16 QM15 QM14 QM13 QM12 QD10 QD10 QF9 SF6 QF9 QD8 QF7 QD6 QF5 SF5 QF5 QD4 SD4 QD4 QD2B QF3 QD2A SF1 QF1 SD0 QD0

Q-BPM

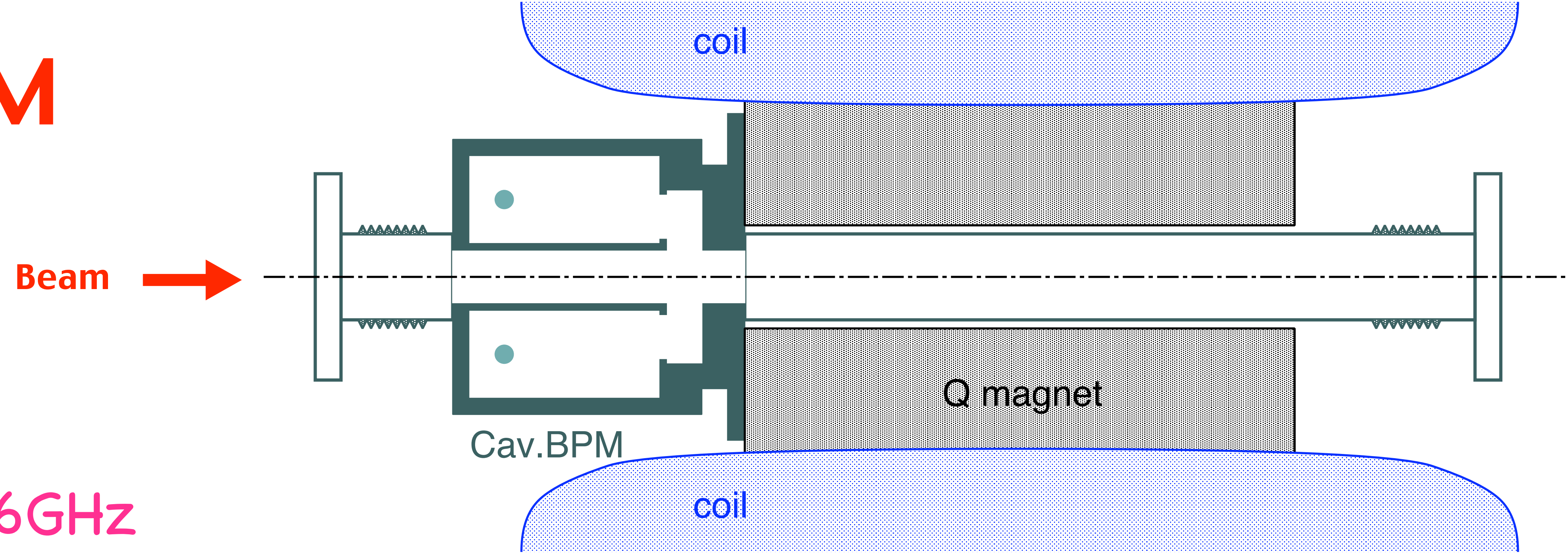
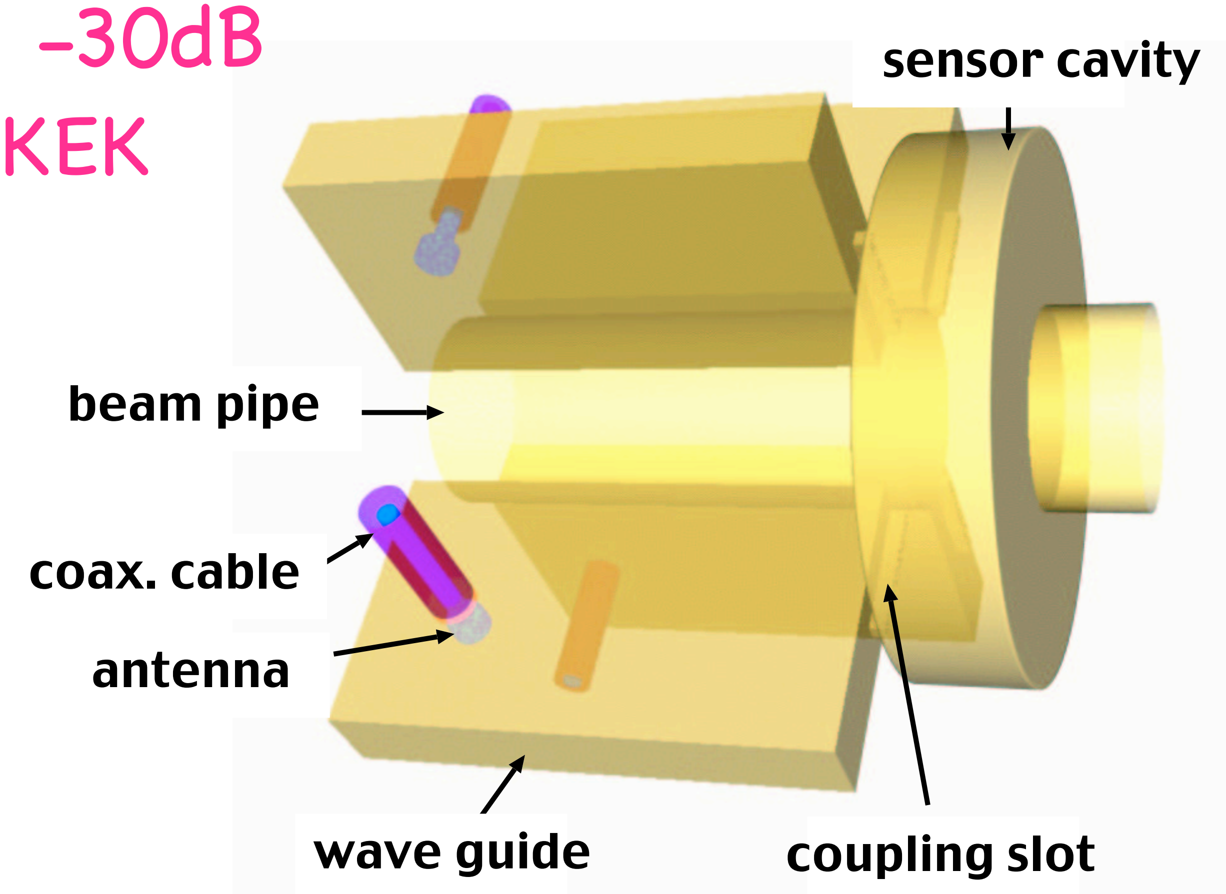


Figure 1: Cavity BPM attached on a quadrupole magnet.

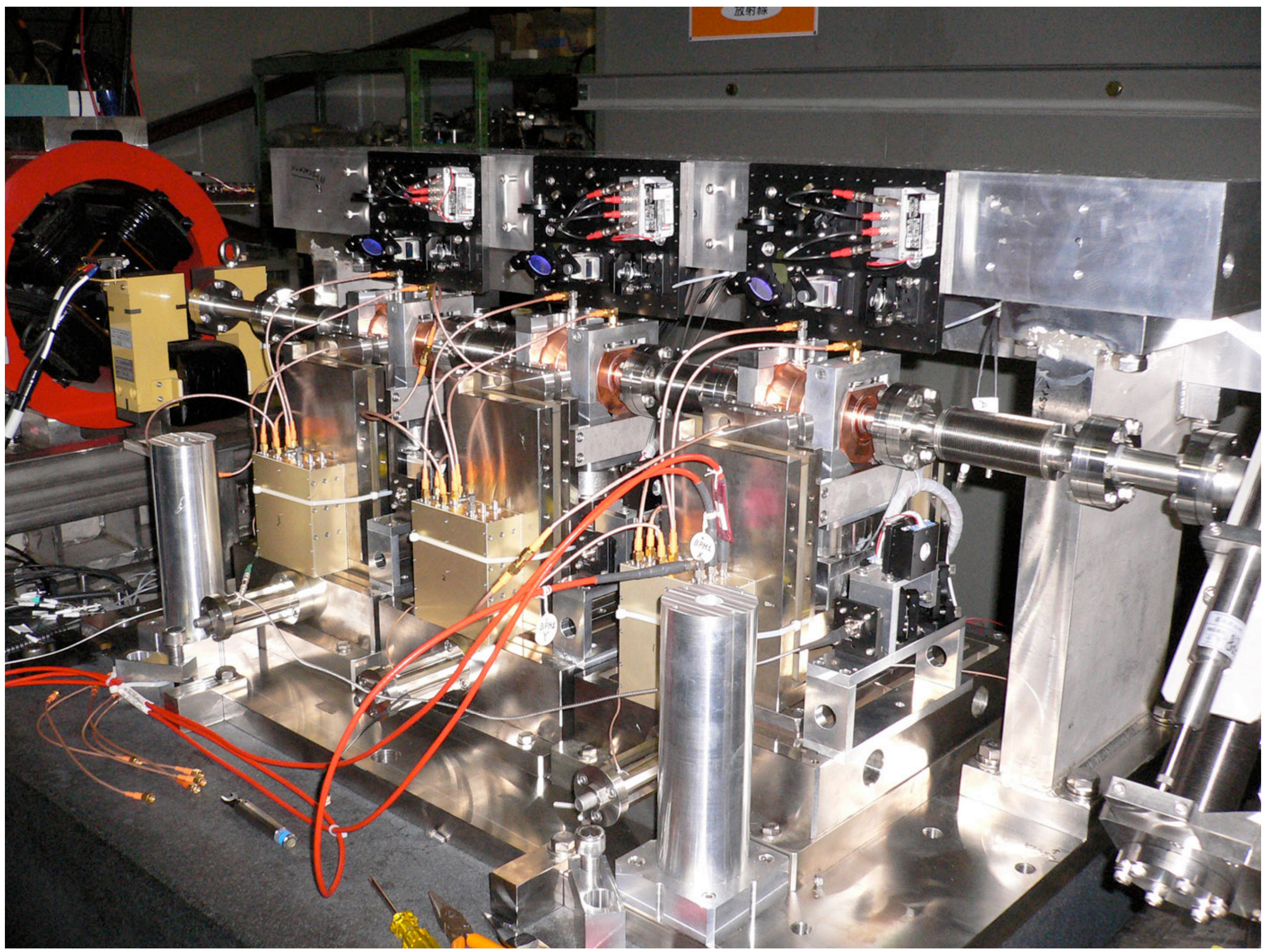
F_{TM110}=6.426GHz
20mm dia. beampipe
L = 12mm
Resolution = 100nm
x-y isolation < -30dB
based on the KEK cavity BPM.

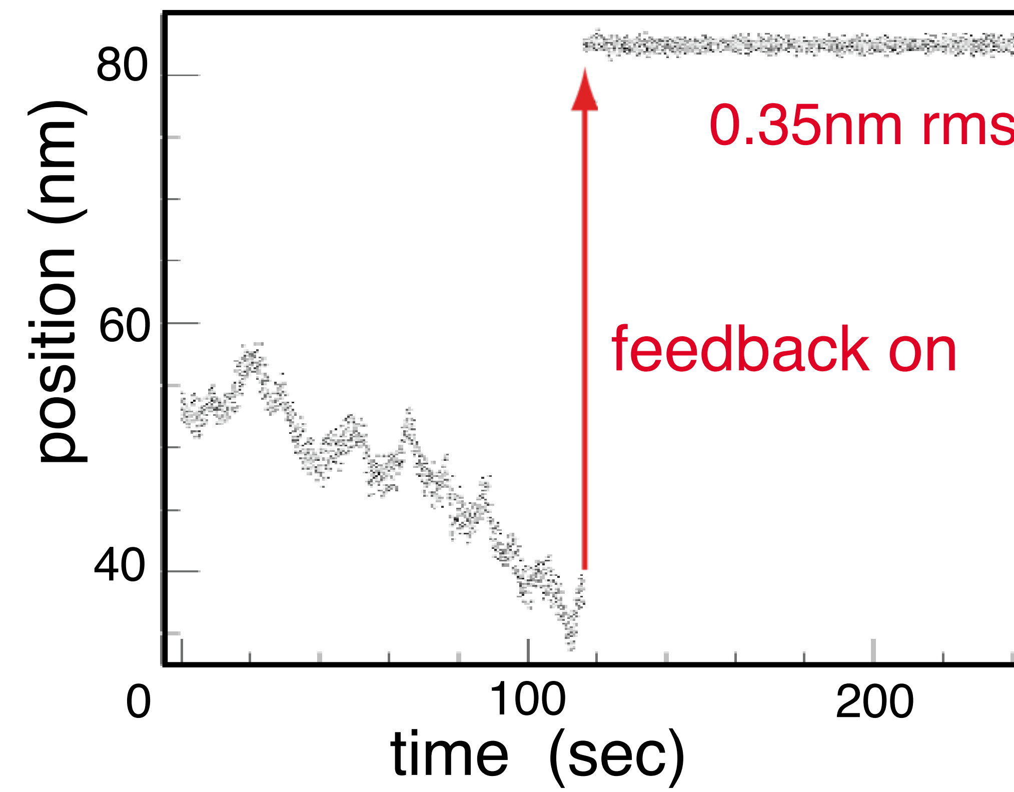


KEK 3-Cavity BPM system for nm resolution study

Goal < 2nm

KEK Design nm mover and nm position feedback, KEK design BPM and electronics





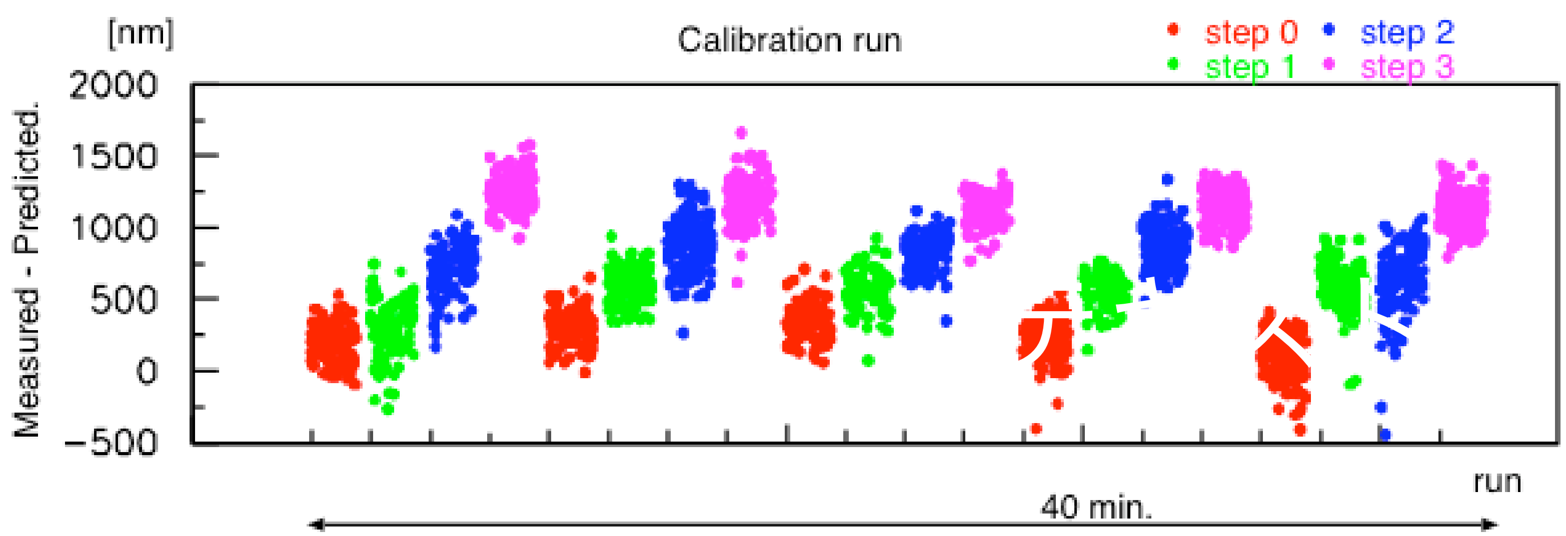
Performance of nm Mover

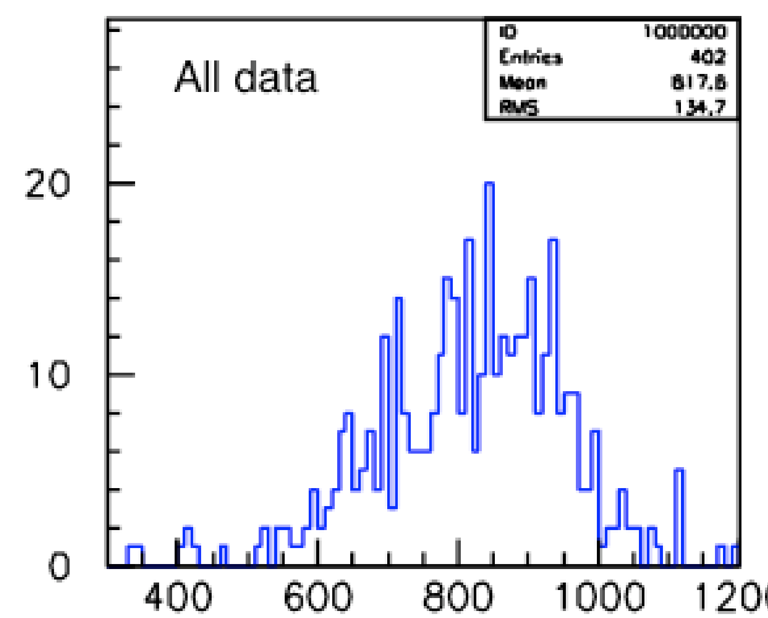
System is under beam test now

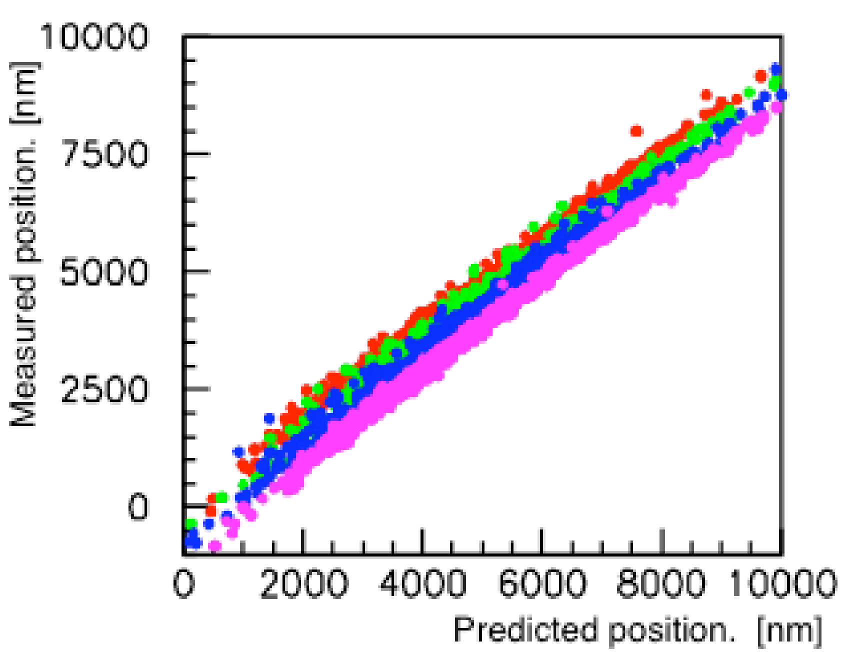
3 BPMs on nm mover, BPM Y positions are locked by laser interference position monitor and piezo actuator feedback.

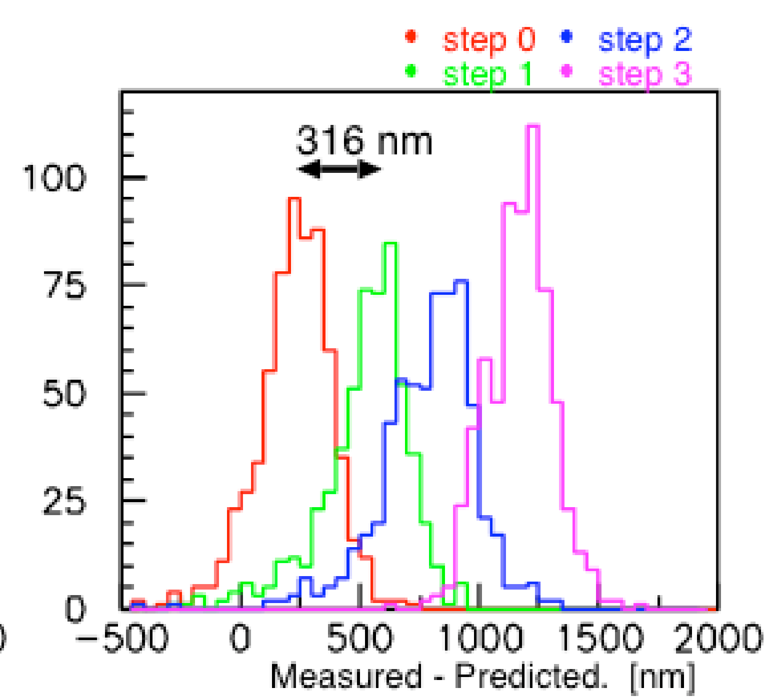
Resolution Result

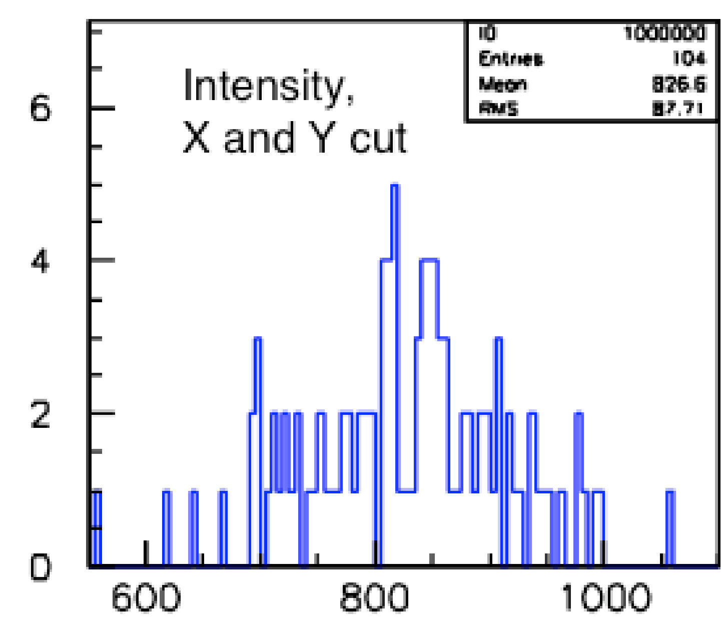
- estimated resolution: 72 nm (with cut) ,116 nm (all data)
- electronics noise limit: 25 nm (estimated by disconnecting the sensor cavity)





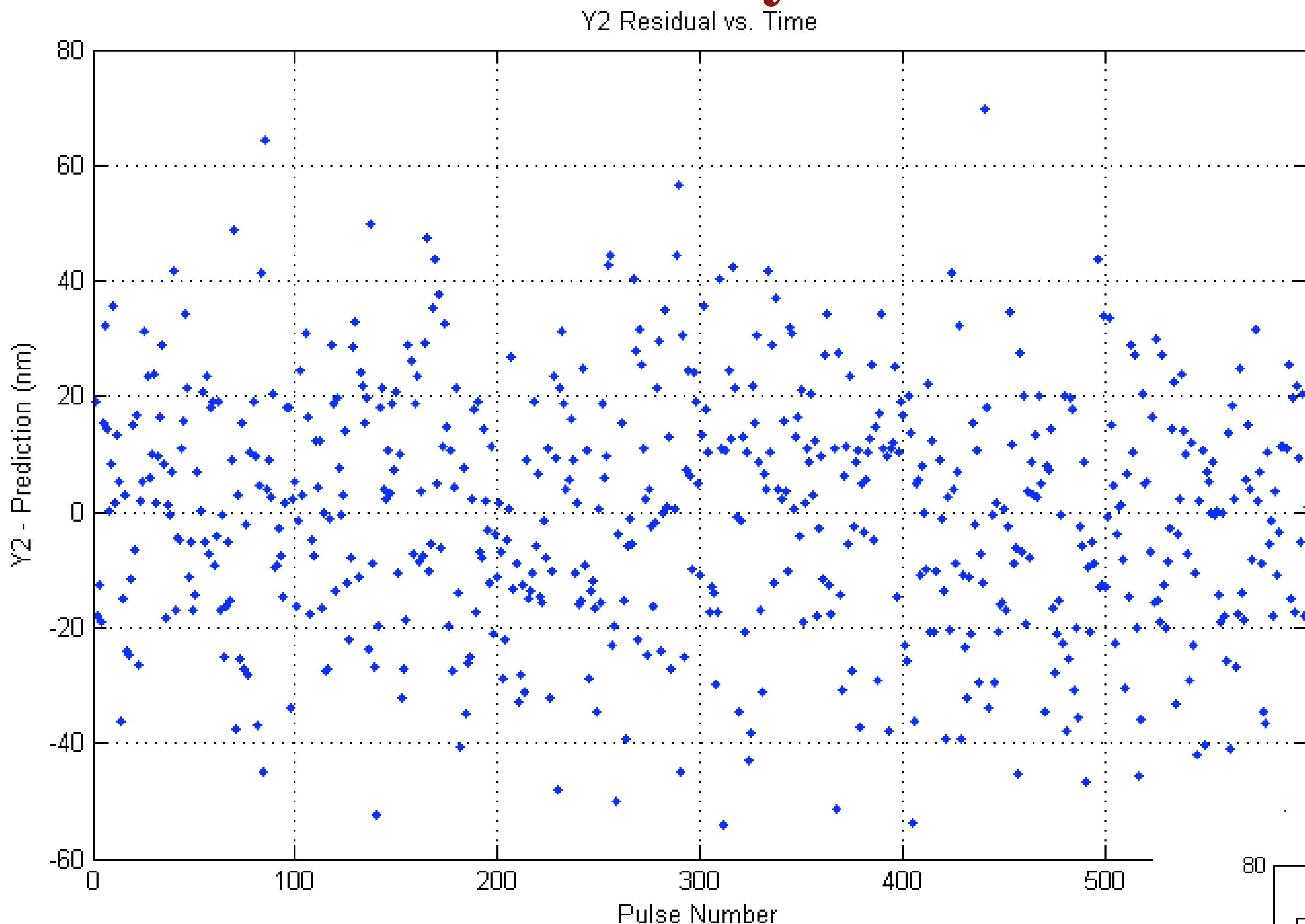


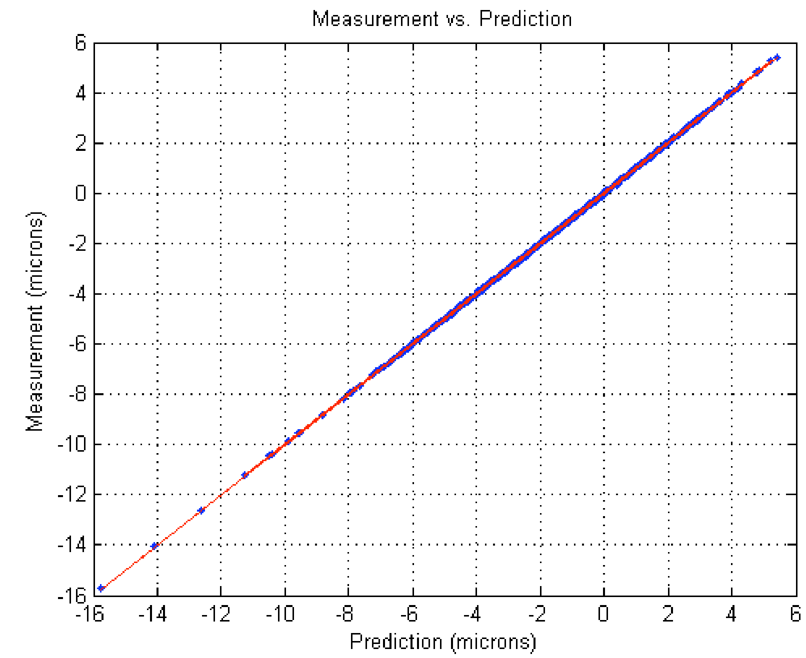


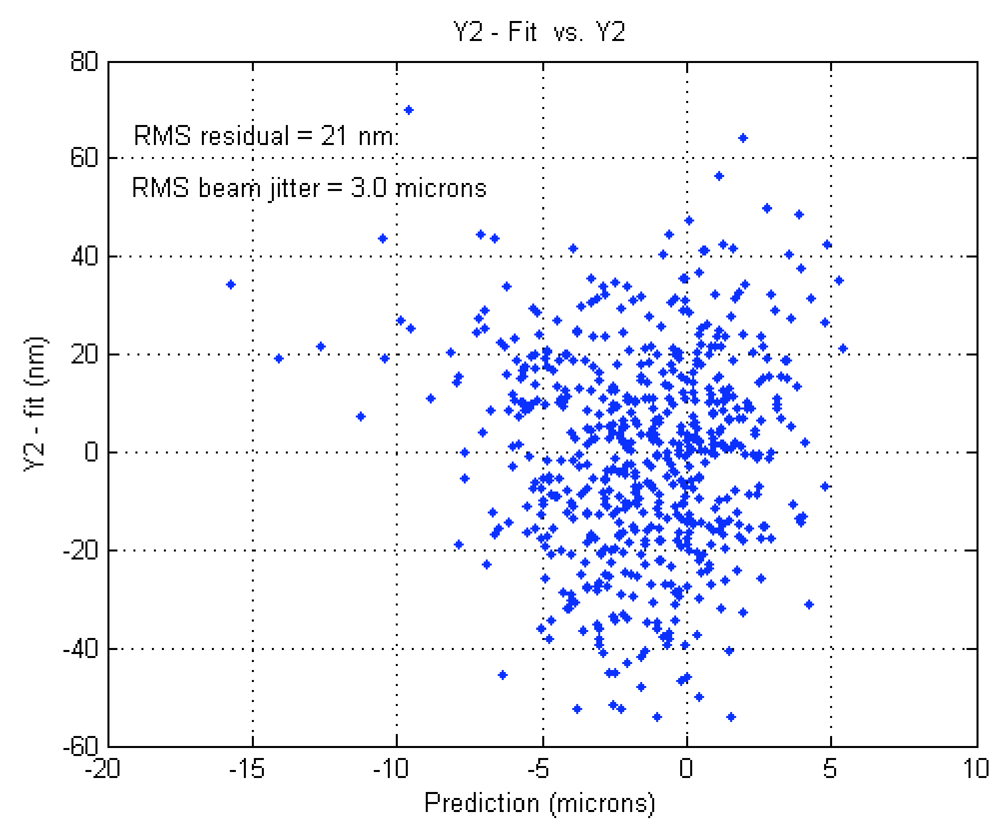


BINP cavity BPM

Preliminary Resolution





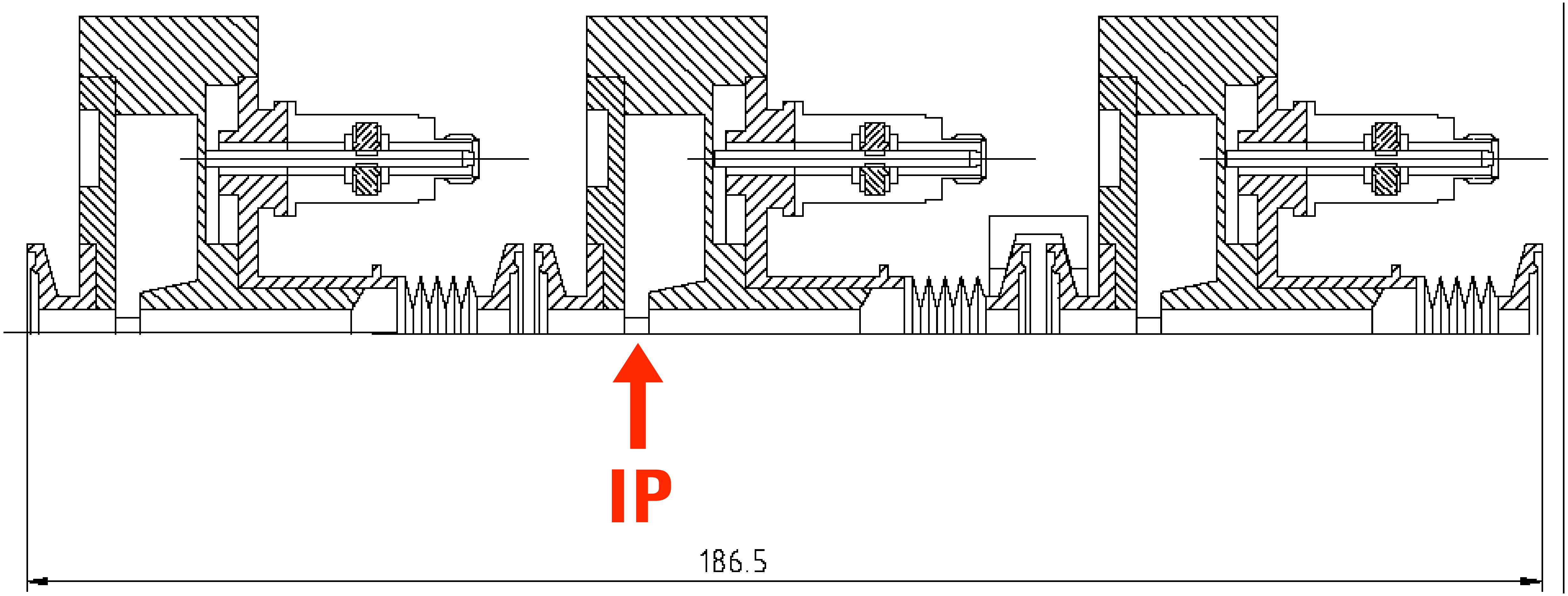


- $\sigma \sim 20$ nm
- Individual BPM resolution is better, this is measurement – prediction from 2 other BPMs
- Calibration scale is clearly off by ~20%

Mode-II

Novel IP-BPM R&D

V. Vogel



5mm diameter beam pipe

Asymmetric resonant cavity for flat beam

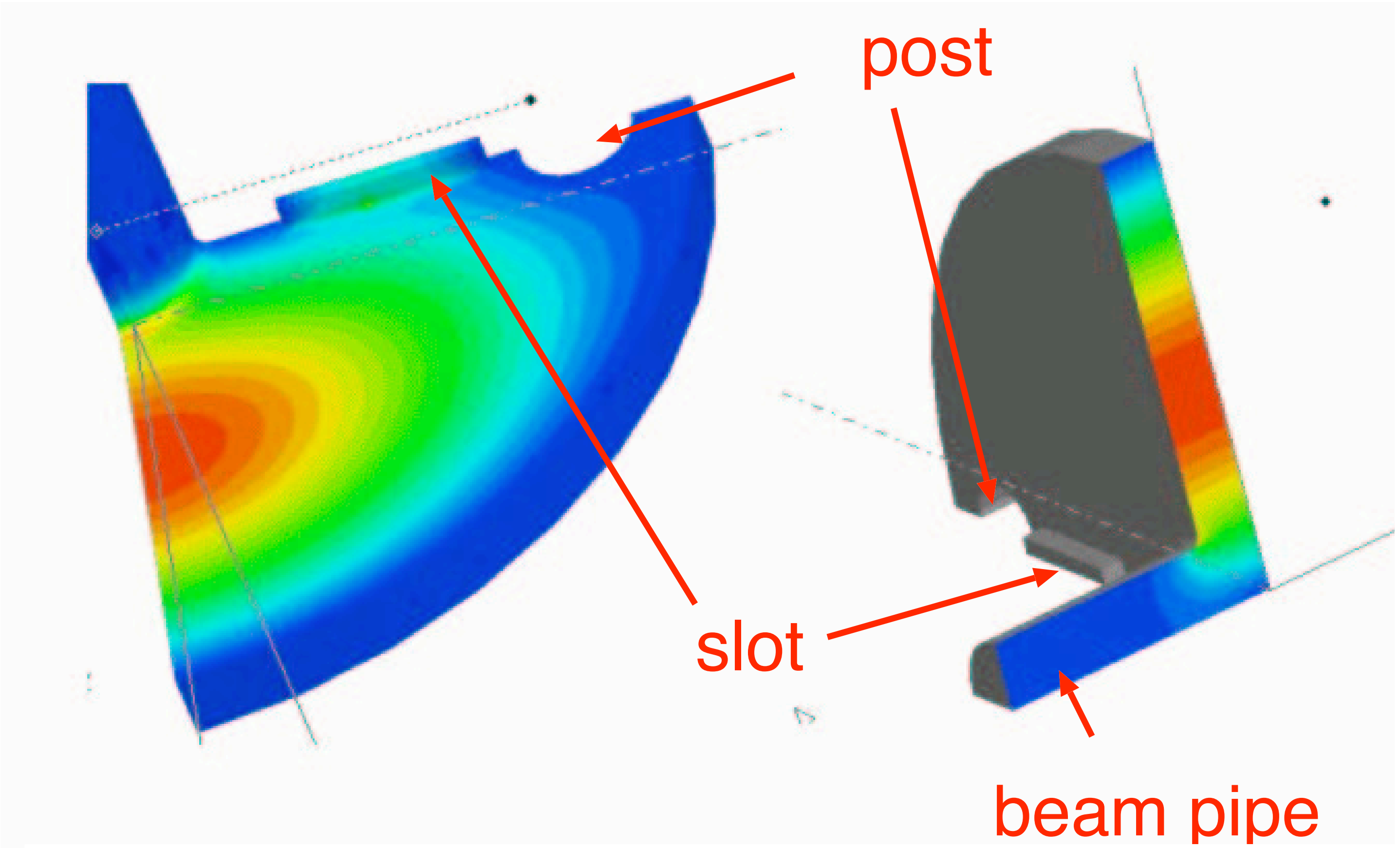
F_{TM110}=9GHz

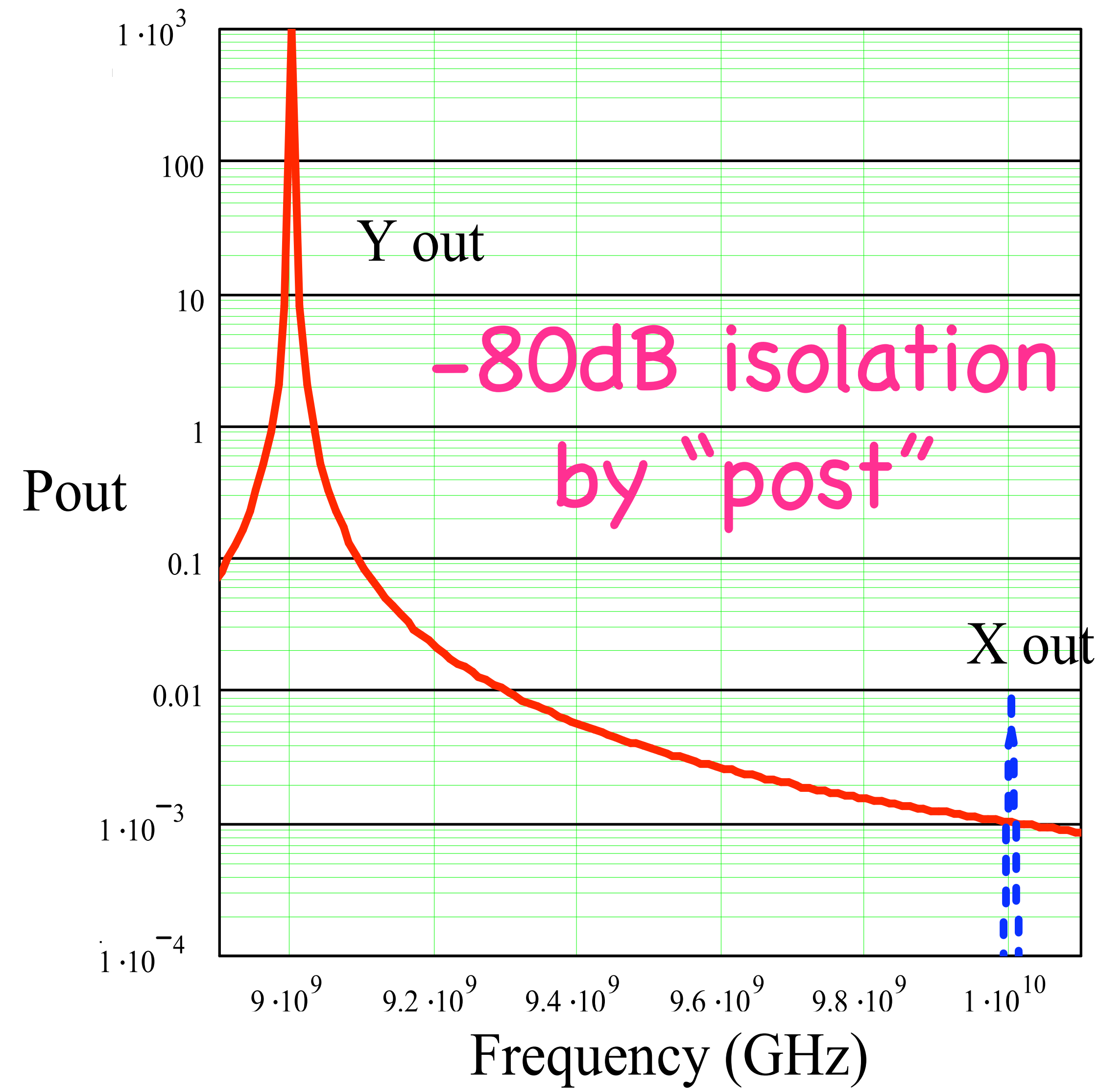
L_{eff}=7mm

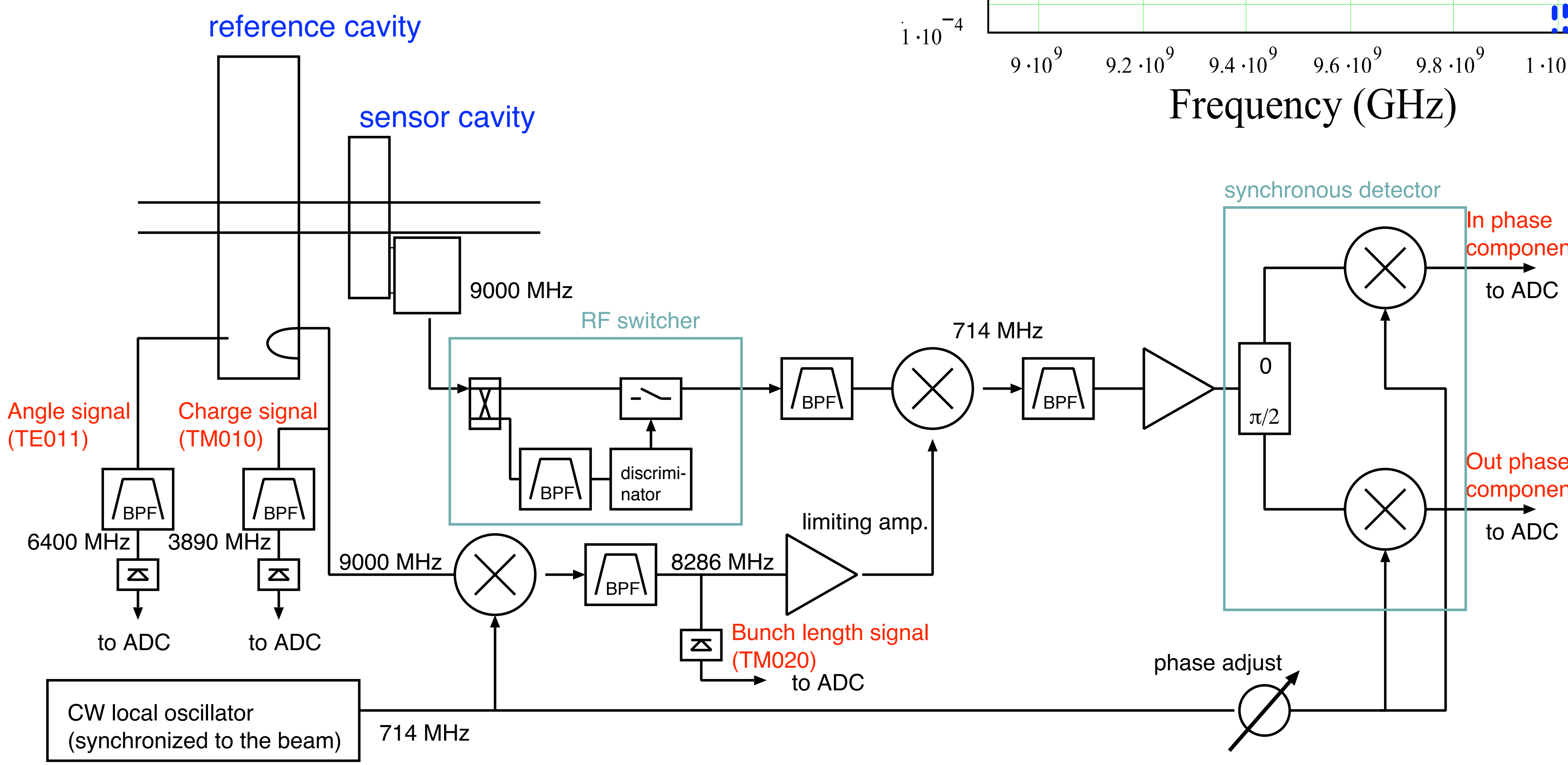
Resolution = 1-2nm

under the large beam divergence of 300μrad and the bunch length of 8mm

Angle sensitivity = 1nm/200μrad


post
slot
beam pipe


Y out
-80dB isolation
by "post"
X out
Pout
Frequency (GHz)
1 ·10^3
100
10
1
0.1
0.01
1 ·10^−3
1 ·10^−4
9 ·10^9
9.2 ·10^9
9.4 ·10^9
9.6 ·10^9
9.8 ·10^9
1 ·10^10

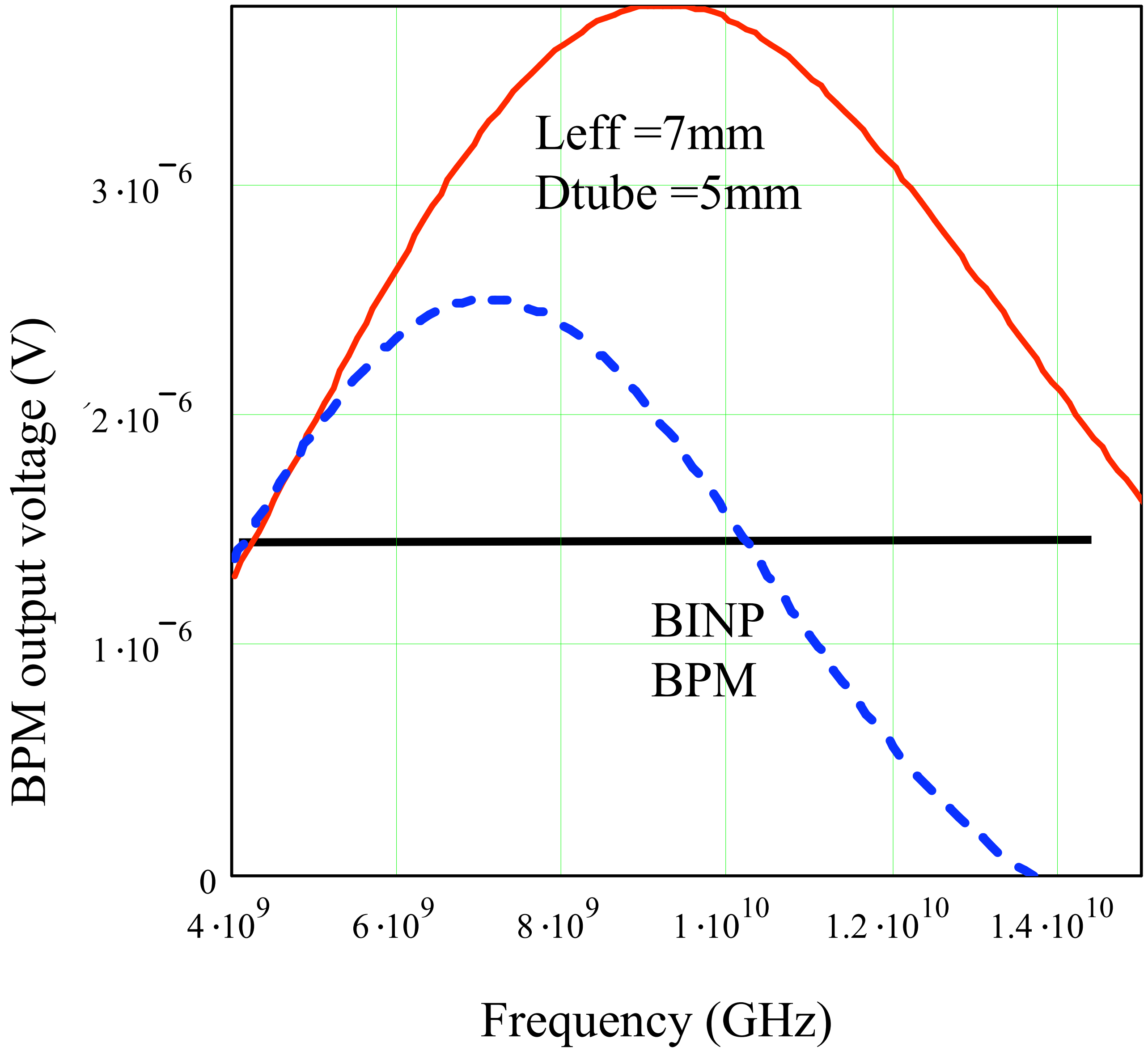

reference cavity
sensor cavity
9000 MHz
RF switcher
BPF
discrimi-
nator
714 MHz
synchronous detector
0
π/2
In phase
component
to ADC
Out phase
component
to ADC
Angle signal
(TE011)
Charge signal
(TM010)
6400 MHz
3890 MHz
to ADC
to ADC
9000 MHz
8286 MHz
limiting amp.
Bunch length signal
(TM020)
to ADC
phase adjust
CW local oscillator
(synchronized to the beam)
714 MHz

$Q=1*10^{10}$,
Zload=50 Ohm,
$\delta=1*10^{-9}$ m,

$\sigma_z = 8$ mm

Thermal noise
(dF=3 MHz, T = 300K)
1.57 μV

Qload=1500
$\beta = 2.0$



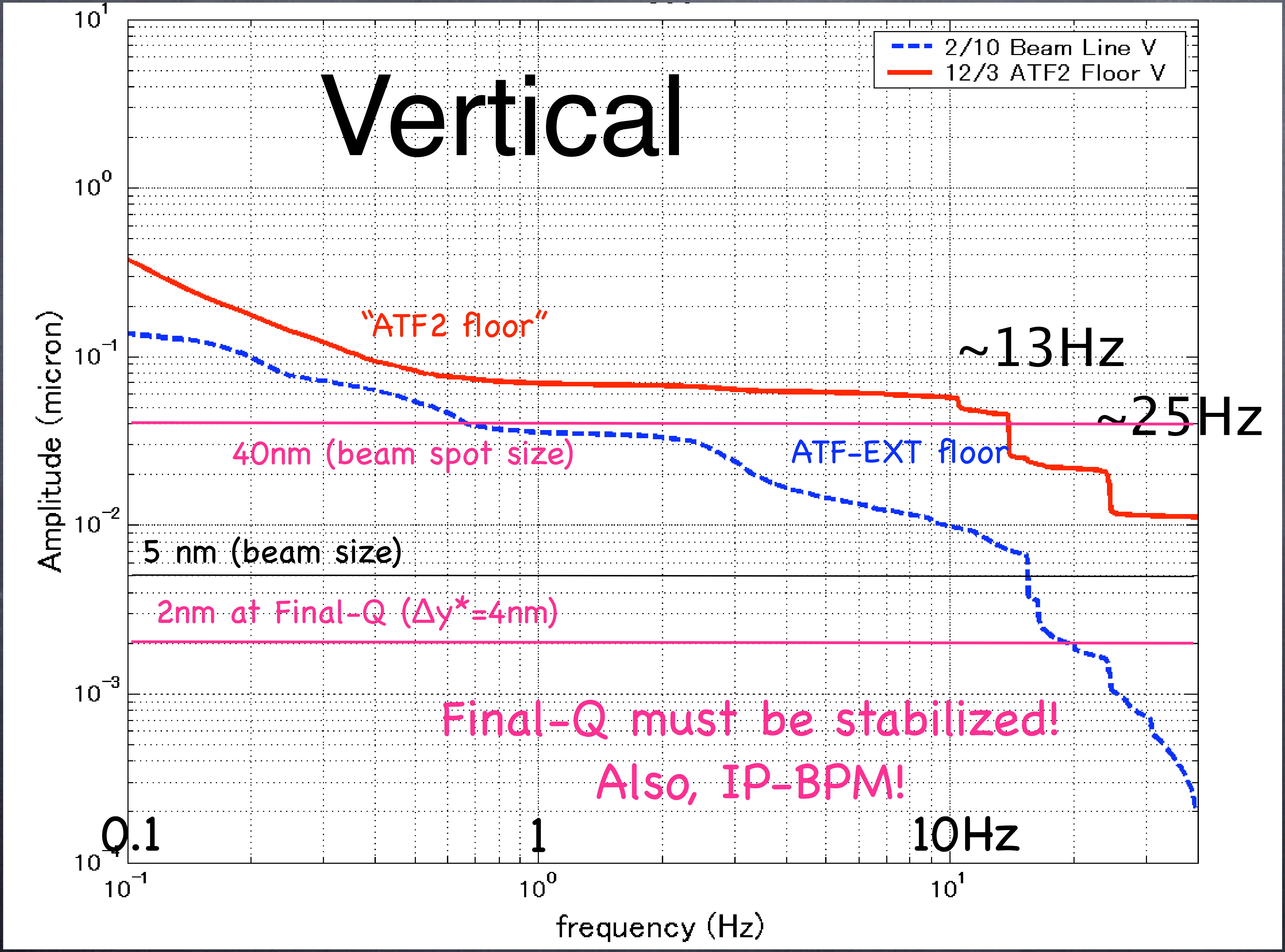
$$V = \pi * 10.8 * \delta * q * f^2 * (\tfrac{R}{Q})^{0.5} * T(\theta/2) * S(\omega,\sigma_z) * \left(\frac{\beta * Z_{load}}{(1+\beta) * 2 * Q_{load}} \right)^{0.5}$$

$$S(\omega,\sigma_z) = \frac{\sin(\omega*\sigma_z/2*c)}{\omega*\sigma_z/2*c}, \ldots.. S(\omega,\sigma_z) = \exp(\omega^2 * \sigma_z^2 / 2 * c^2)$$

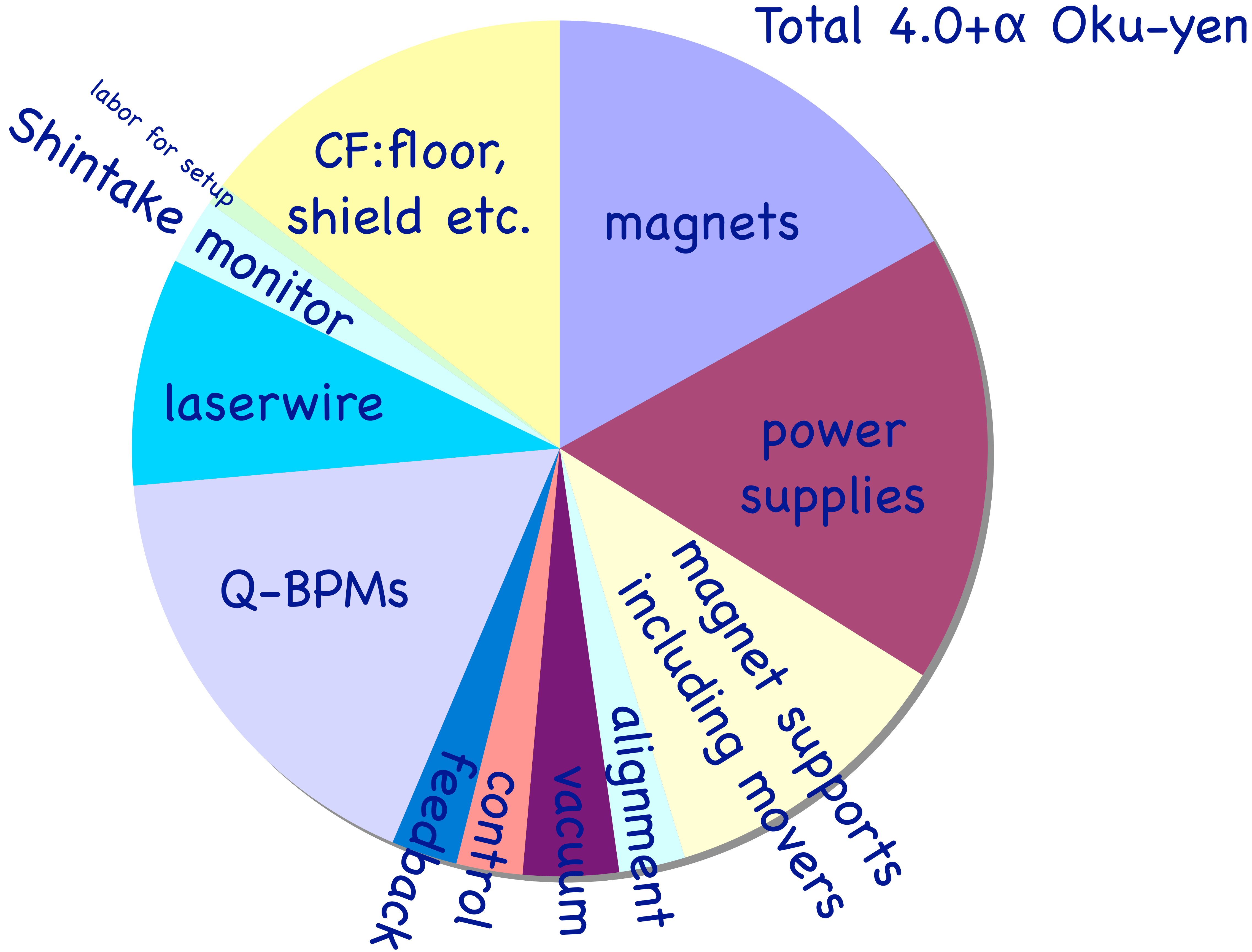
$$T(\theta) = \frac{\sin(\frac{\pi*Leff}{\lambda})}{\frac{\pi*Leff}{\lambda}}$$

Amplitude of GM

M.Masuzawa,
2nd mini-workshop on nano project at ATF,
11 Dec.2004



Cost Estimation



Optimal Design

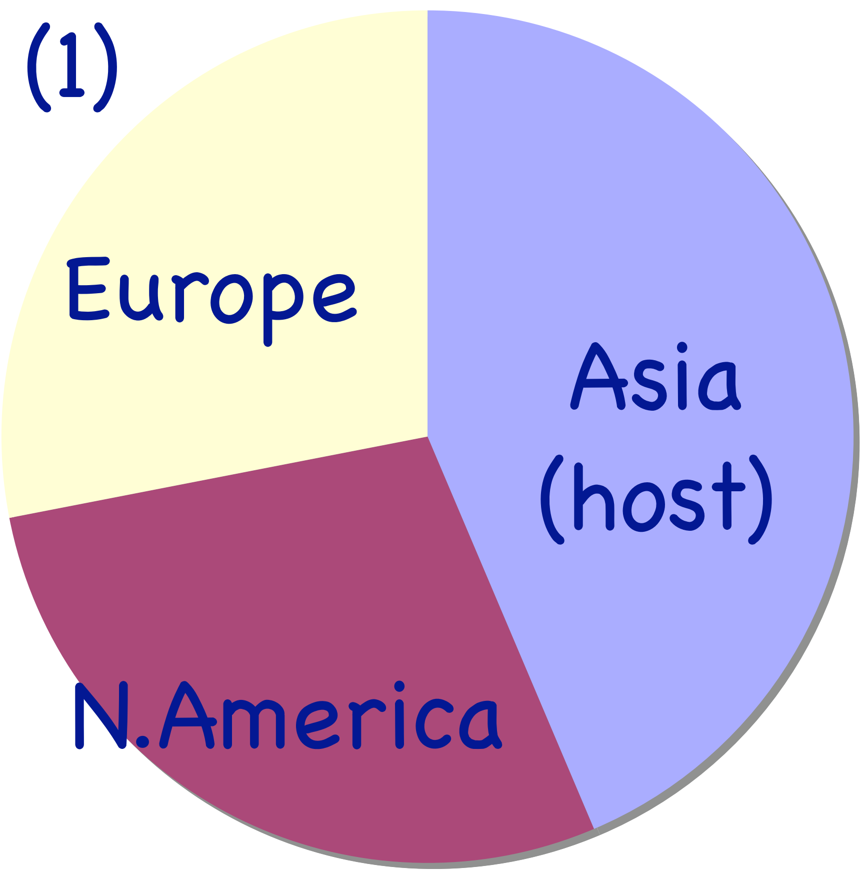
(1) mini-ILC model

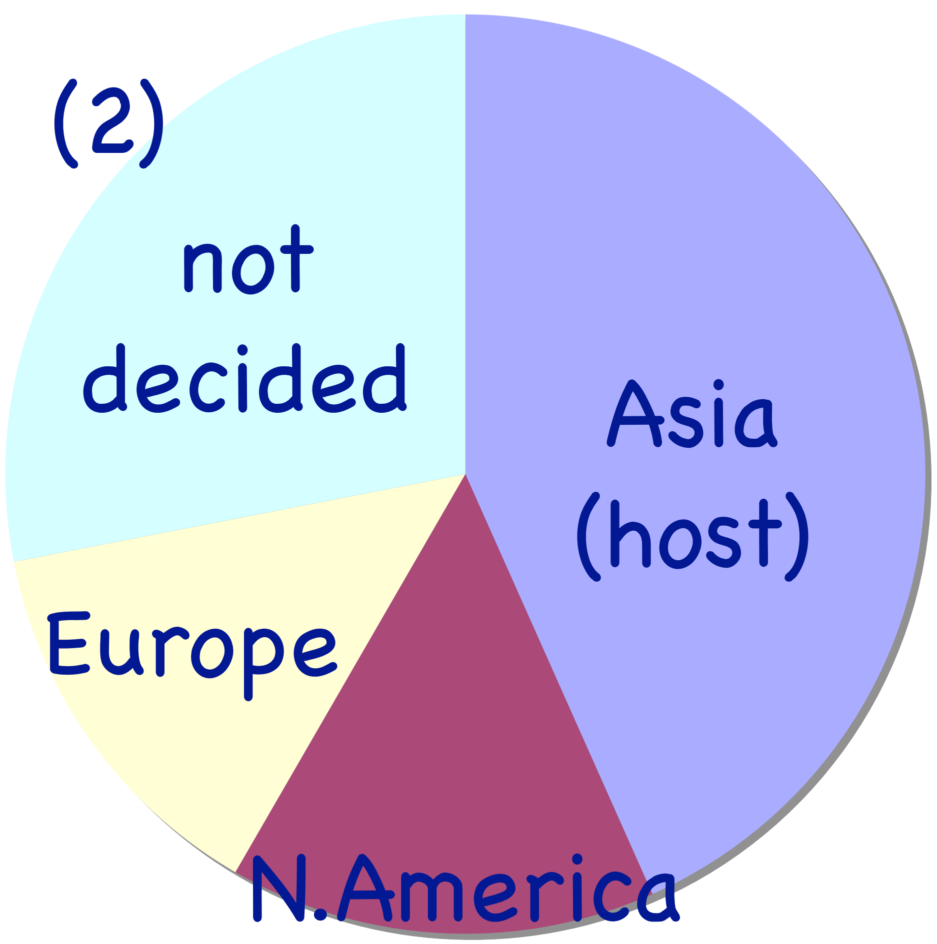
equal sharing on the components, while the host country prepares the conventional facility.

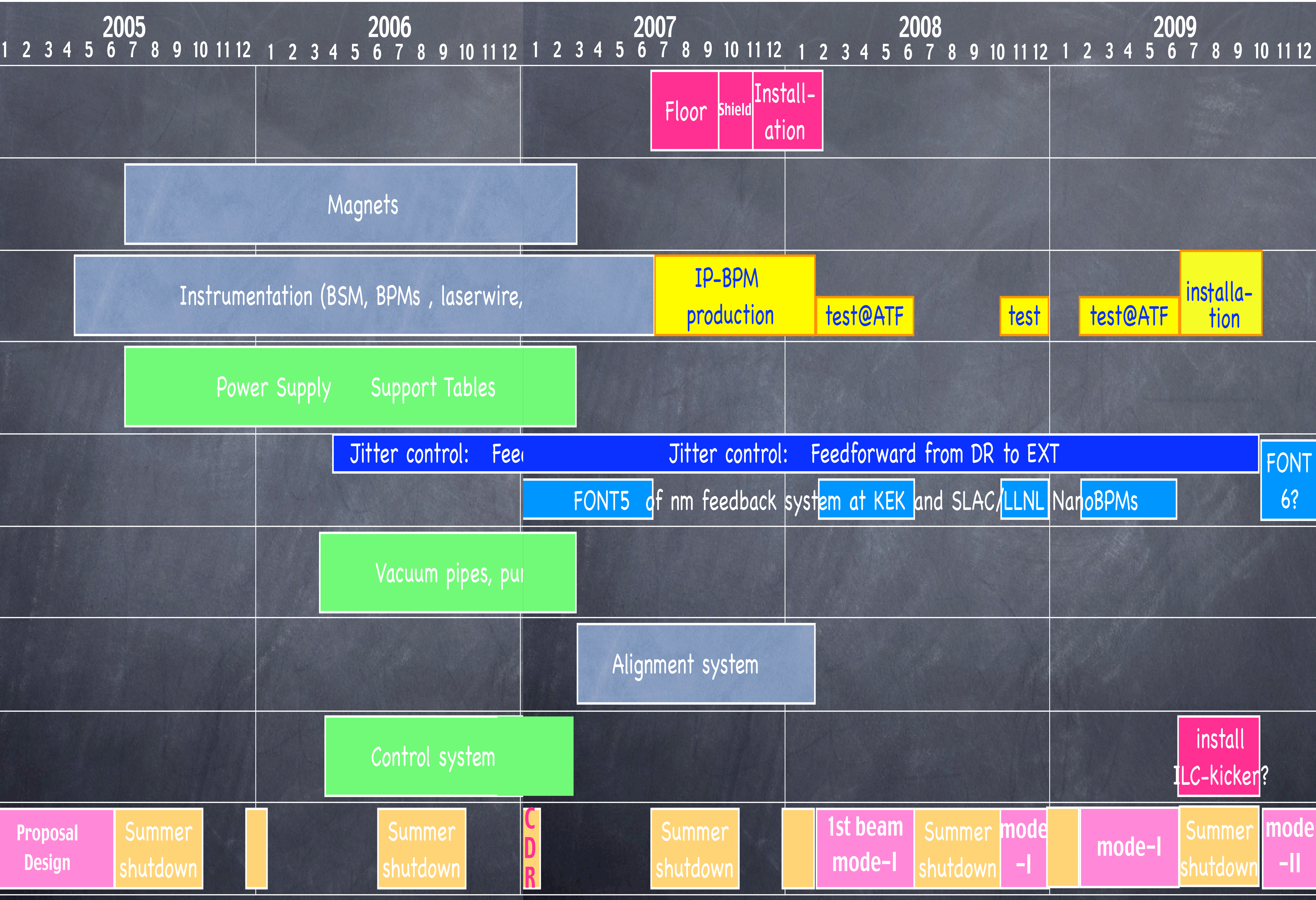
(2) tentative status

a la Japanese costing rule

"not decided" major components (1.14 Oku-yen)







2005
2006
2007
2008
2009
1 2 3 4 5 6 7 8 9 10 11 12
Floor
Shield
Install-ation
Magnets
Instrumentation (BSM, BPMs , laserwire,
IP-BPM production
test@ATF
test
test@ATF
installa-tion
Power Supply
Support Tables
Jitter control: Fee
Jitter control: Feedforward from DR to EXT
FONT 6?
FONT5
of nm feedback system at KEK and SLAC/LLNL NanoBPMs
Vacuum pipes, pu
Alignment system
Control system
install ILC-kicker?
Proposal Design
Summer shutdown
Summer shutdown
CDR
Summer shutdown
1st beam mode-I
Summer shutdown
mode-I
mode-I
Summer shutdown
mode-II

Toward "ATF2" Proposal

http://lcdev.kek.jp/ILC-AsiaWG/WG4notes/atf2/

February 3, 2005

Within the framework of the ILC-WG4

NEWS :

Feb. 12, 2005 Sample files are uploaded.

Feb. 03, 2005 This site is launced.

Dear WG4 participants,

At the recent ATF2 workshop, which was held at SLAC in January 5, (with about 50 people attaened and ~20 reports presented), it was recommended to continue development if the ATF2 proposal.

While further development of the ATF2 design (beam optics, critical beam instrumentation, etc.) will continue, we also need to document the proposal in a detailed and coherent way. A written proposal will help to communicate our intent to the international community and will help in determining the contribution from international partners.

As WG4 conveners, we (Tomoyuki, Andrei, Grahame) volunteered to be the core members of the editorial board for the ATF2 proposal. We have prepared a tentative table of contents and possible authors. The person whose name is listed first is a responsible person. The number of pages is a very rough number. Please check the list carefully and send any comments to the core members of the editorial board at ml-atf2eb@lcdev.kek.jp.

We propose to use LaTeX for typography. However, we can accept MS-Word and simple text file.

Tentative Schedule

Before LCWS05

Feb. 9th Fix authors
Feb. 25th 0th draft
Mar. 11th 1st draft

After LCWS05:
Near final text @ BDIR workshop, UK, 20-23 June