ATF2 Topical Meeting, 5 July, 2013, KEK

Friday, July 5, 2013

10:30 - 12:30 New IP Chamber

Convener: Philip Bambade (Laboratoire de l''Accelerateur Lineaire (LAL) (IN2P3) (LAL))

10:30 **Final configuration with the 3D mechanical measurements** *30'*
Speaker: Mr. Sandry WALLON (LAL-CNRS)
Material: Slides

11:00 **Calibration of the Cedrat / PI piezo-mover systems and new results on the investigation of the stability** *30'*
Speaker: Oscar Roberto Blanco Garcia (Universite de Paris-Sud 11 (FR))
Material: Transparents

11:30 **Installation and alignment of the IP chamber** *30'*
Speaker: Nobuhiro Terunuma (KEK)
Material: Slides

12:00 **Discussion** *30'*
installation and alignment

12:30 - 14:30 Lunch

14:30 - 16:00 IPBPM and IP-feedback

Convener: Dr. Toshiaki Tauchi (KEK)

14:30 **KNU IPBPM and reference cavity** *30'*
Speaker: Mr. Siwon Jang (KNU)
Material: Slides

15:00 **Recent results of IP feedback studies** *30'*
Speaker: Prof. Philip Burrows (Oxford University)
Material: Slides

15:30 **IP position drift and feedback** *30'*
Speaker: Dr. Toshiyuki Okugi (KEK)
Material: Slides

16:00 - 16:20 coffee break

16:20 - 17:30 Discussion on the commissioning plan

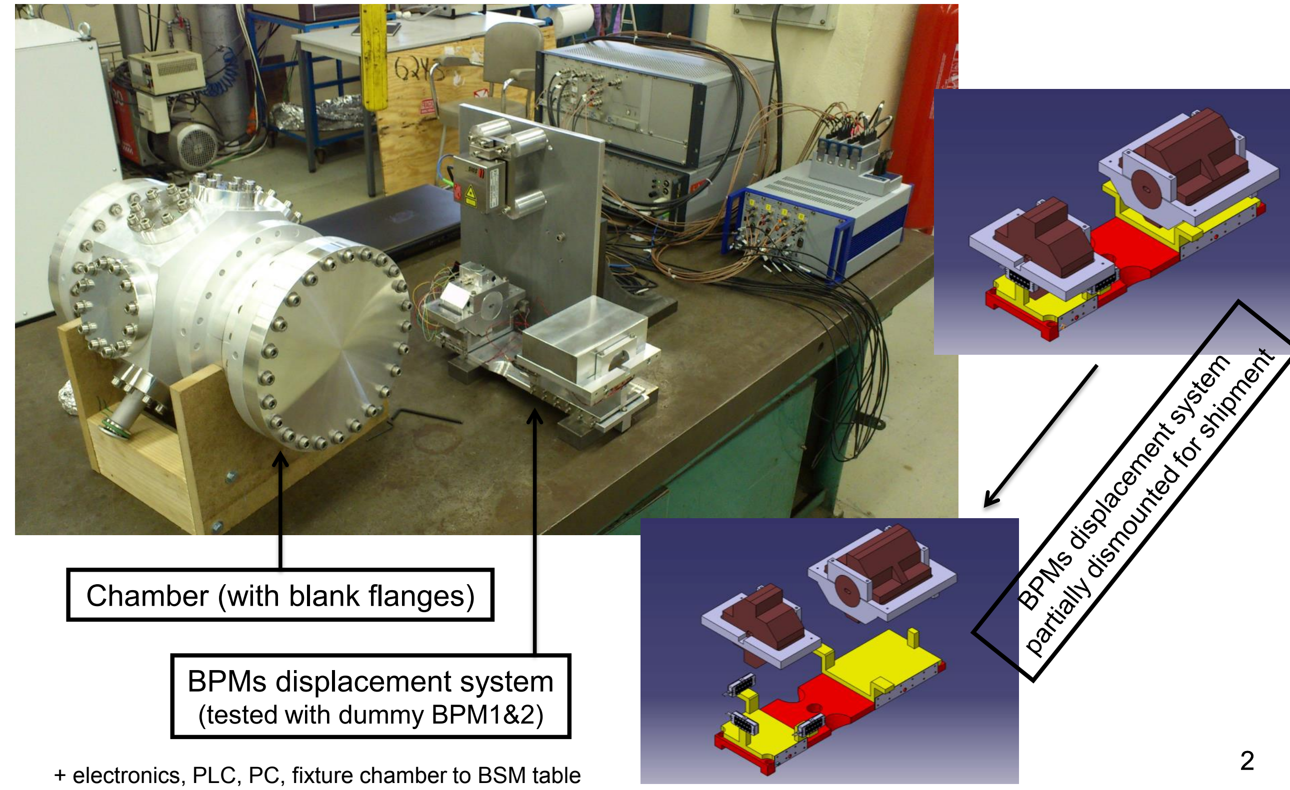
Planning and minimum requirements for the commissioning of the new IP setup, to enable operating the BSM to measure small spots.
- IPBPMs in the new IP chamber , calibration and electronics
- how to best match it to the continuing goal-1 effort

Convener: Philip Bambade (Laboratoire de l''Accelerateur Lineaire (LAL) (IN2P3) (LAL)) talk by Sandry WALLON

ATF2 - IP Chamber for IP-BPM

Final configuration with the 3D mechanical measurements and short status 1st to 12th July, 2013

Equipment shipped from LAL Orsay



+ electronics, PLC, PC, fixture chamber to BSM table

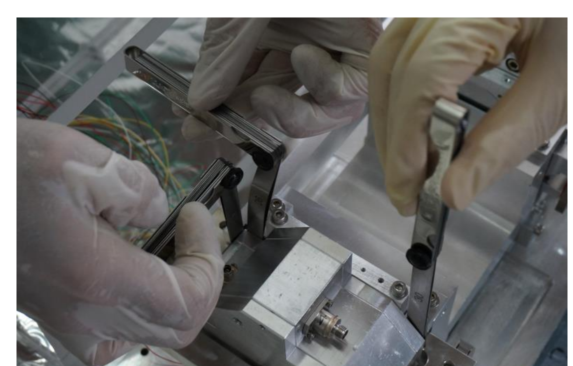
Assembling accuracy < 40um by shims with 20um thickness

Tests, checks, tunings at KEK

Checking BPM1&2 axis with respect of its cradle references
(can not be done at LAL Orsay due to BPM1&2 activation)

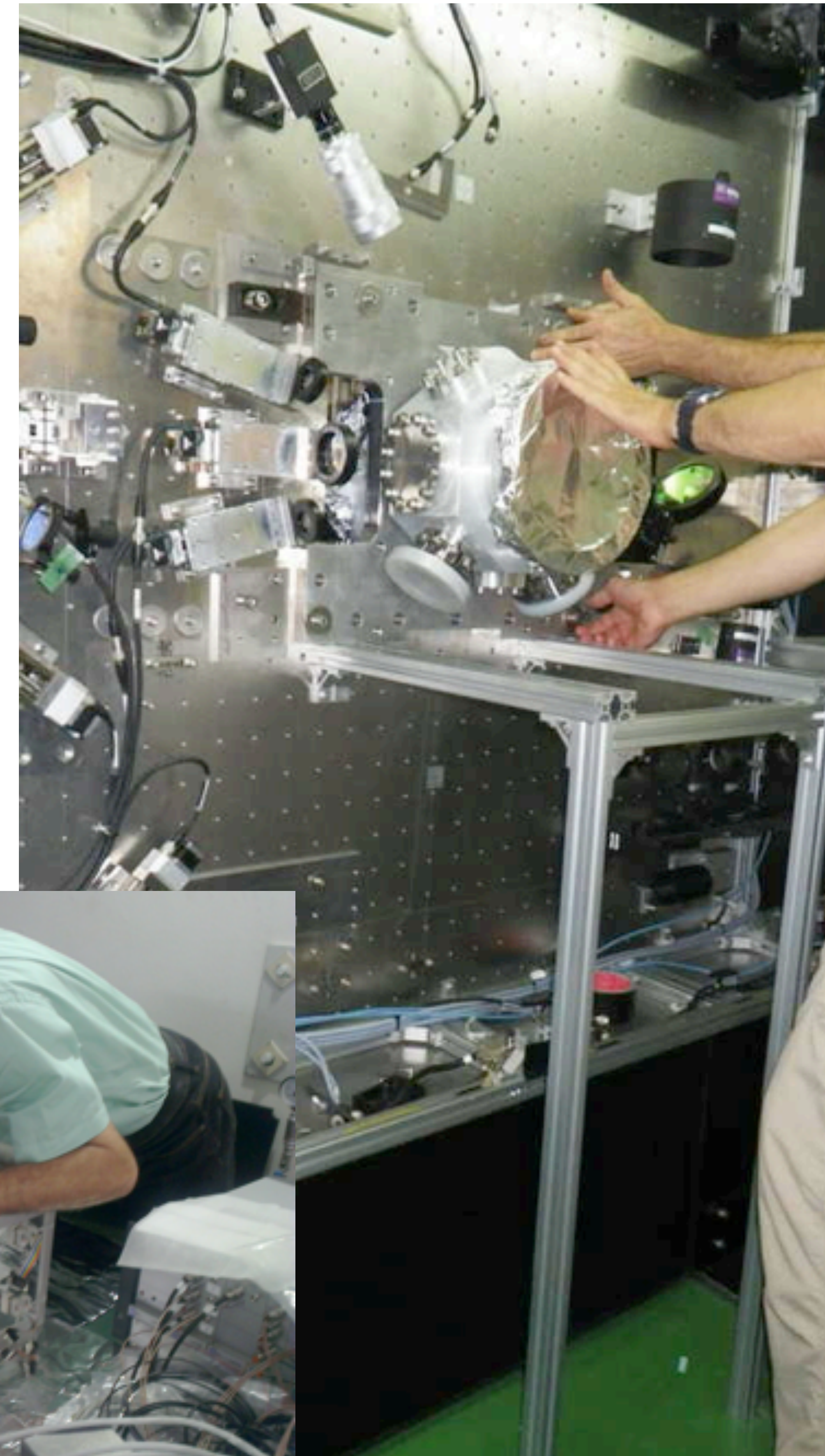
Tests, checks, tunings at KEK

Mounting BPMs
Adjustments w/ positioning tool
(distance to IP plane, lateral alignment, yaw)



New IP Chamber was just installed for vacuum test

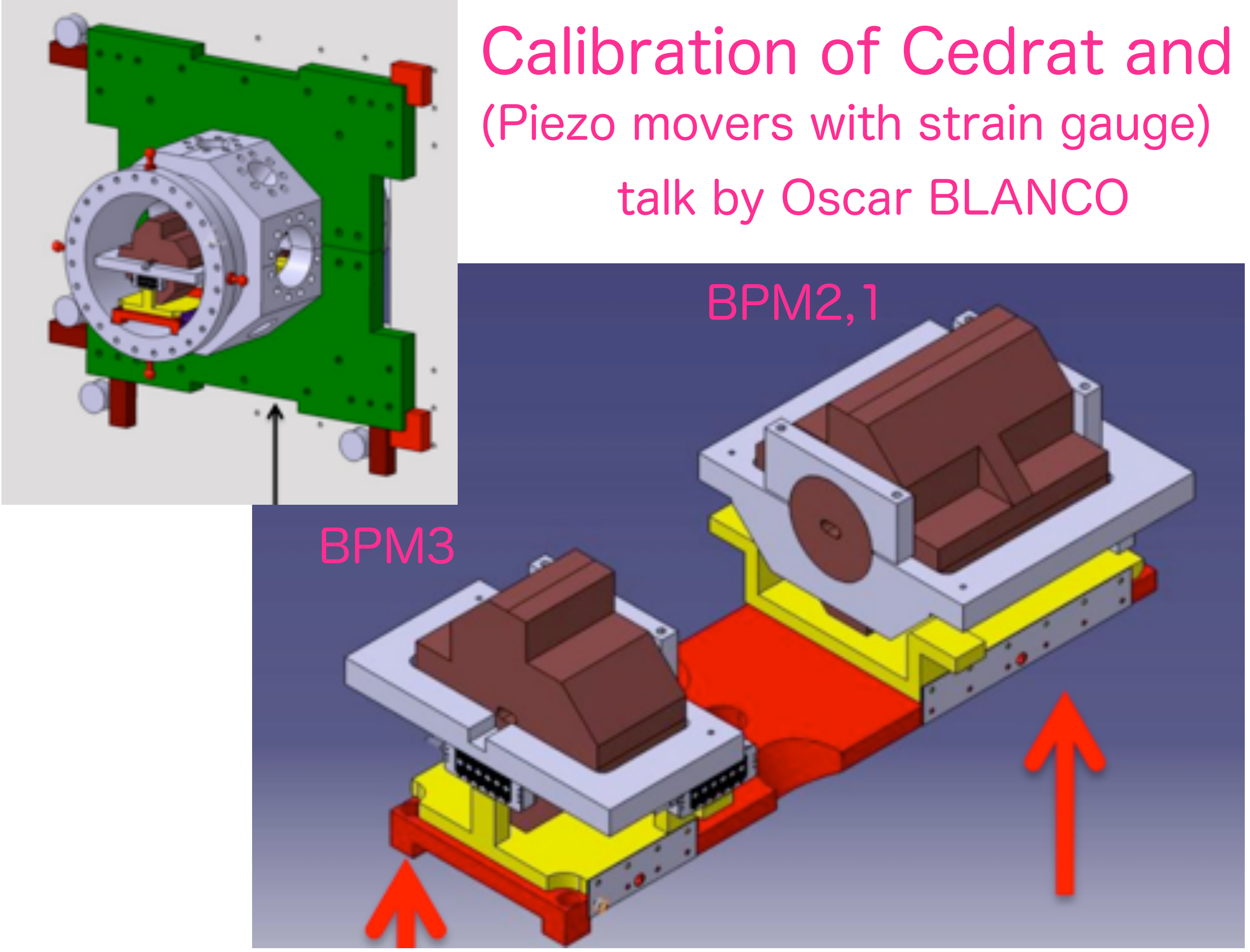
5th July, 2013



Calibration of Cedrat and PI movers

(Piezo movers with strain gauge)

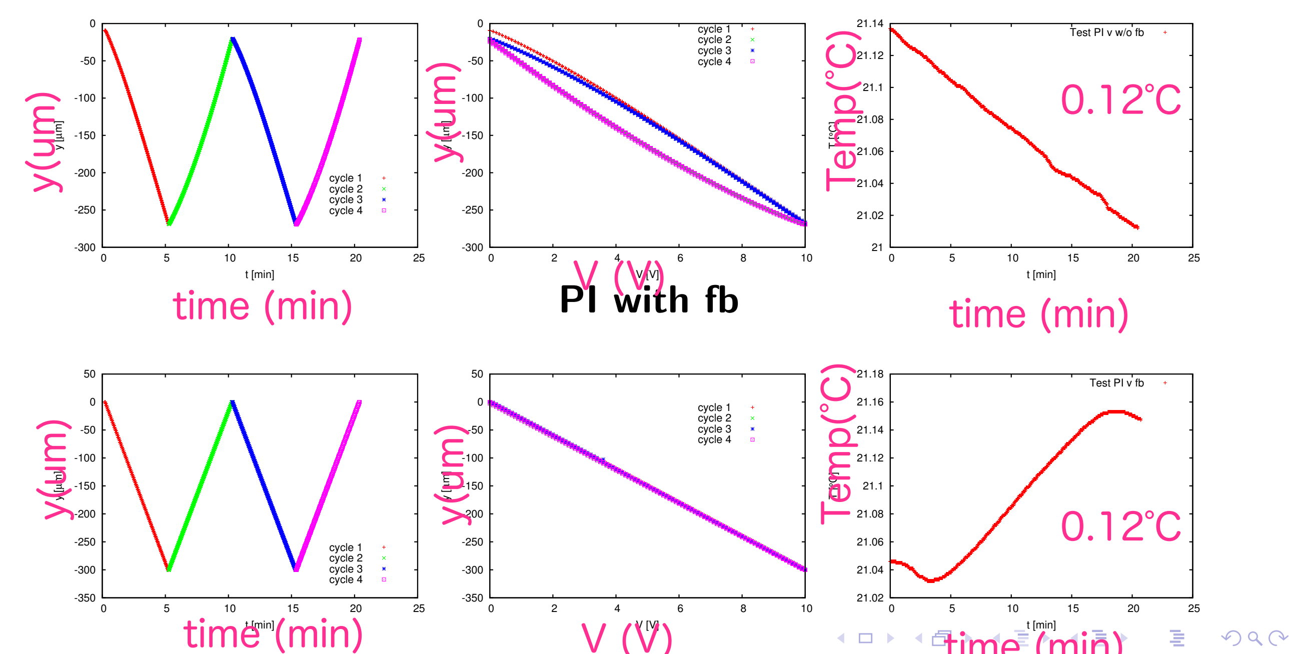
talk by Oscar BLANCO

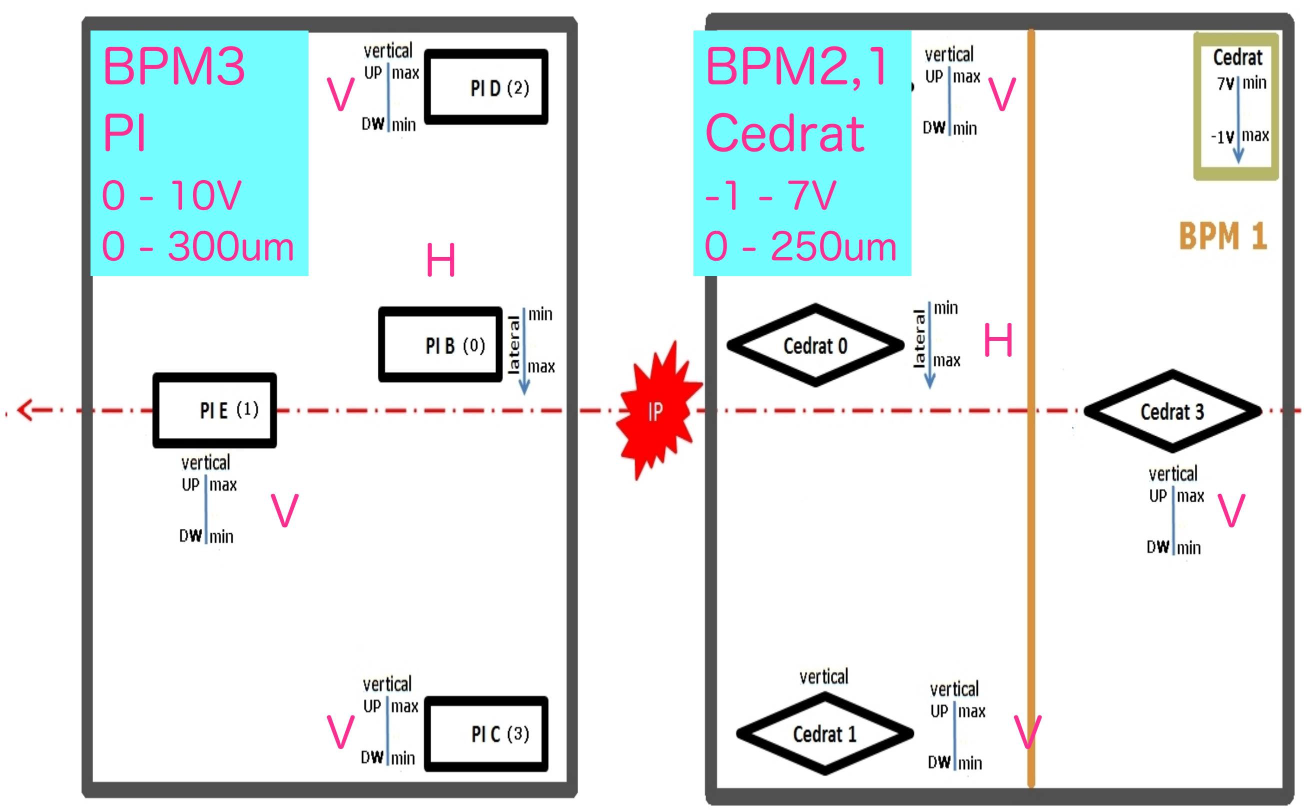


No Hysteresis with feedback

Four cycles,range (0∼10V, 0∼300μm)

analog feedback

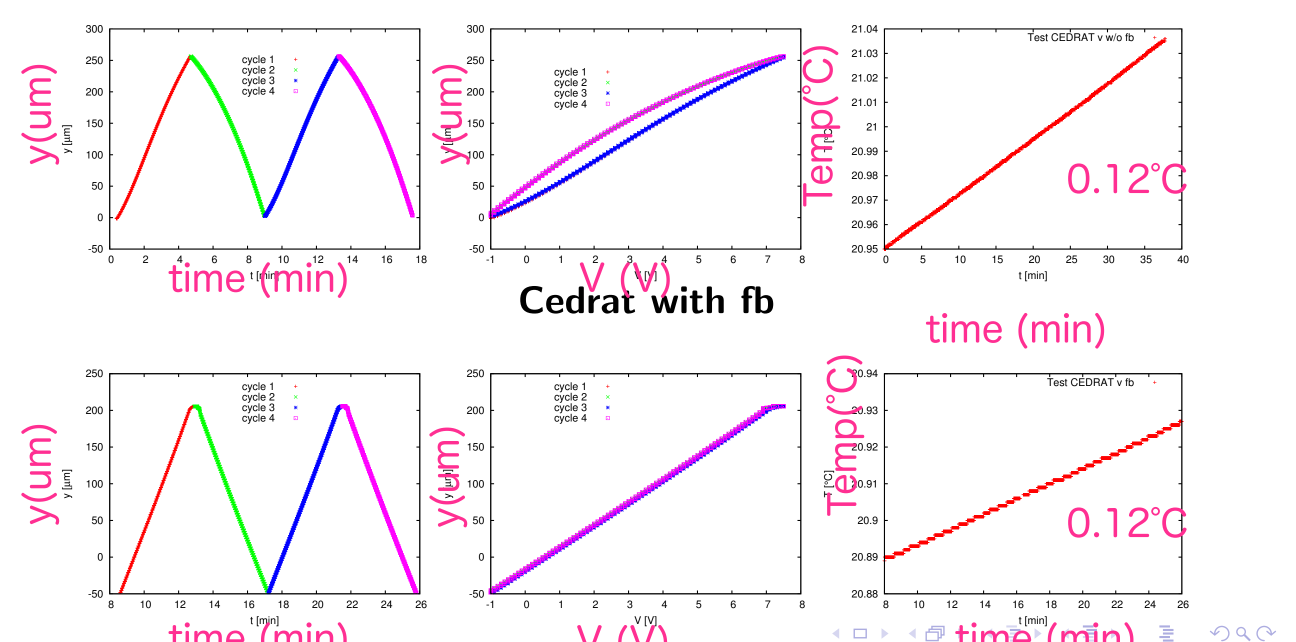




No Hysteresis with feedback

Four cycles, range (-1∼7V, 0∼250μm)

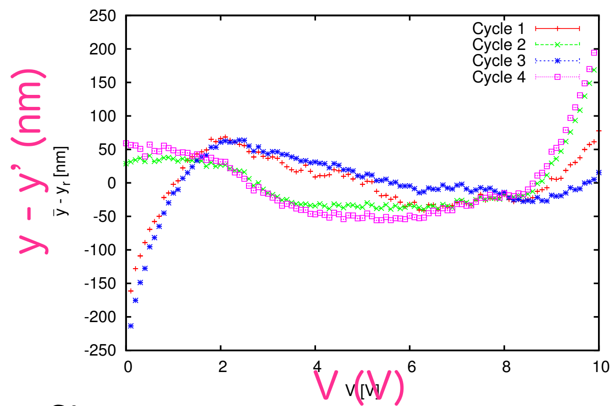
software feedback



2013年 7月 8日 月曜日

Linearity (with fb) PI

Cycle	Slope[nm/V]	Offset[nm]
1	-30011 ± 1	-191 ± 9
2	-29997 ± 1	-204 ± 9
3	-29982 ± 2	-502 ± 9
4	-30018 ± 2	84 ± 11

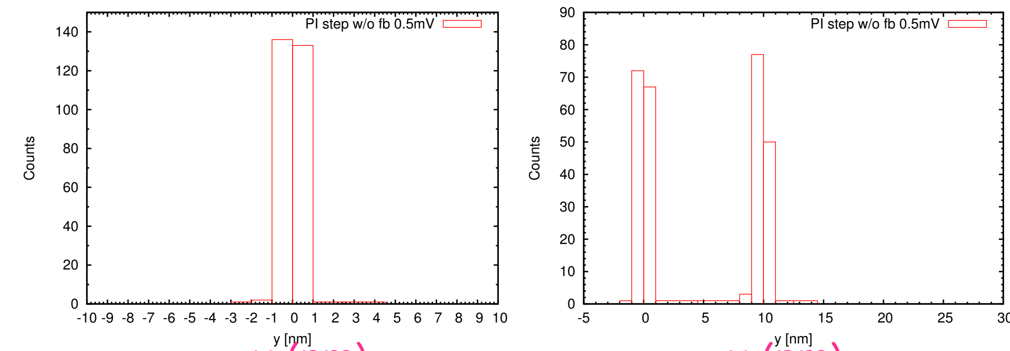


XY coupling
3um (1%)

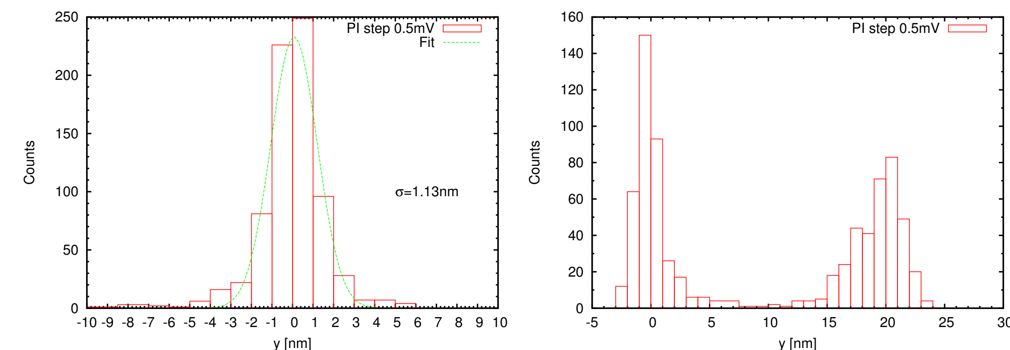
Slope mean $= 30002 \pm 7$

Frédéric Bogard showed ∼120nm/0.1°C from measuring setup (neglecting thermal inertia)

Position accuracy **PI without fb**



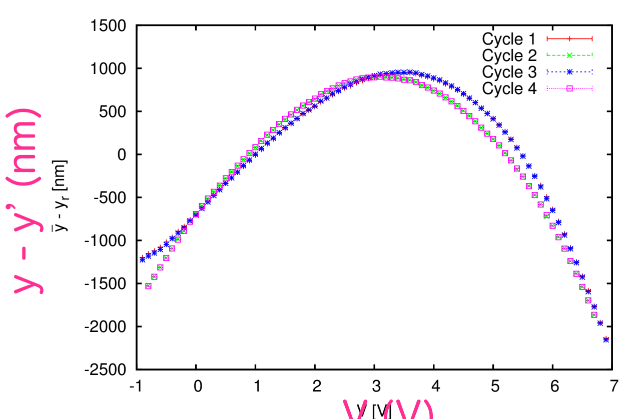
PI with fb
analog feedback



0.5mV→15nm

Linearity (with fb) Cedrat

Cycle	Slope[nm/V]	Offset[nm]
1	30988 ± 41	-18670 ± 154
2	31039 ± 42	-19092 ± 154
3	30993 ± 41	-18547 ± 156
4	31040 ± 42	-18935 ± 154

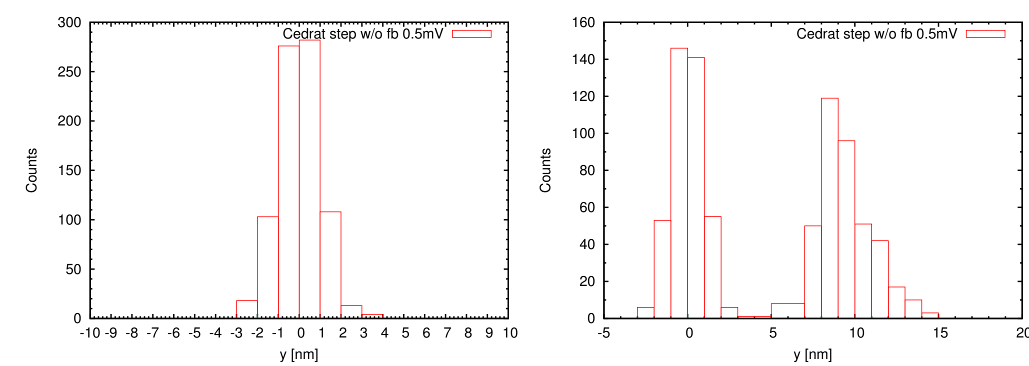


XY coupling
2.5um (1%)

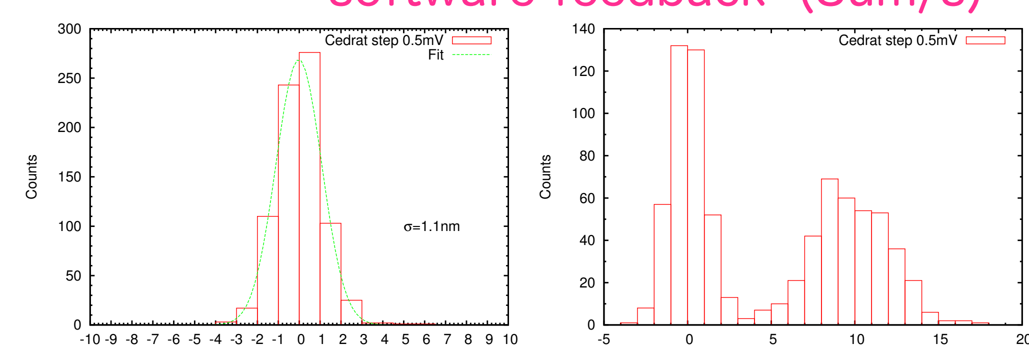
Slope mean $= 31015 \pm 12 (\pm 42)$

Temperature effect from setup not measured but expected to be similar

Position accuracy **Cedrat without fb**



Cedrat with fb
software feedback (3um/s)

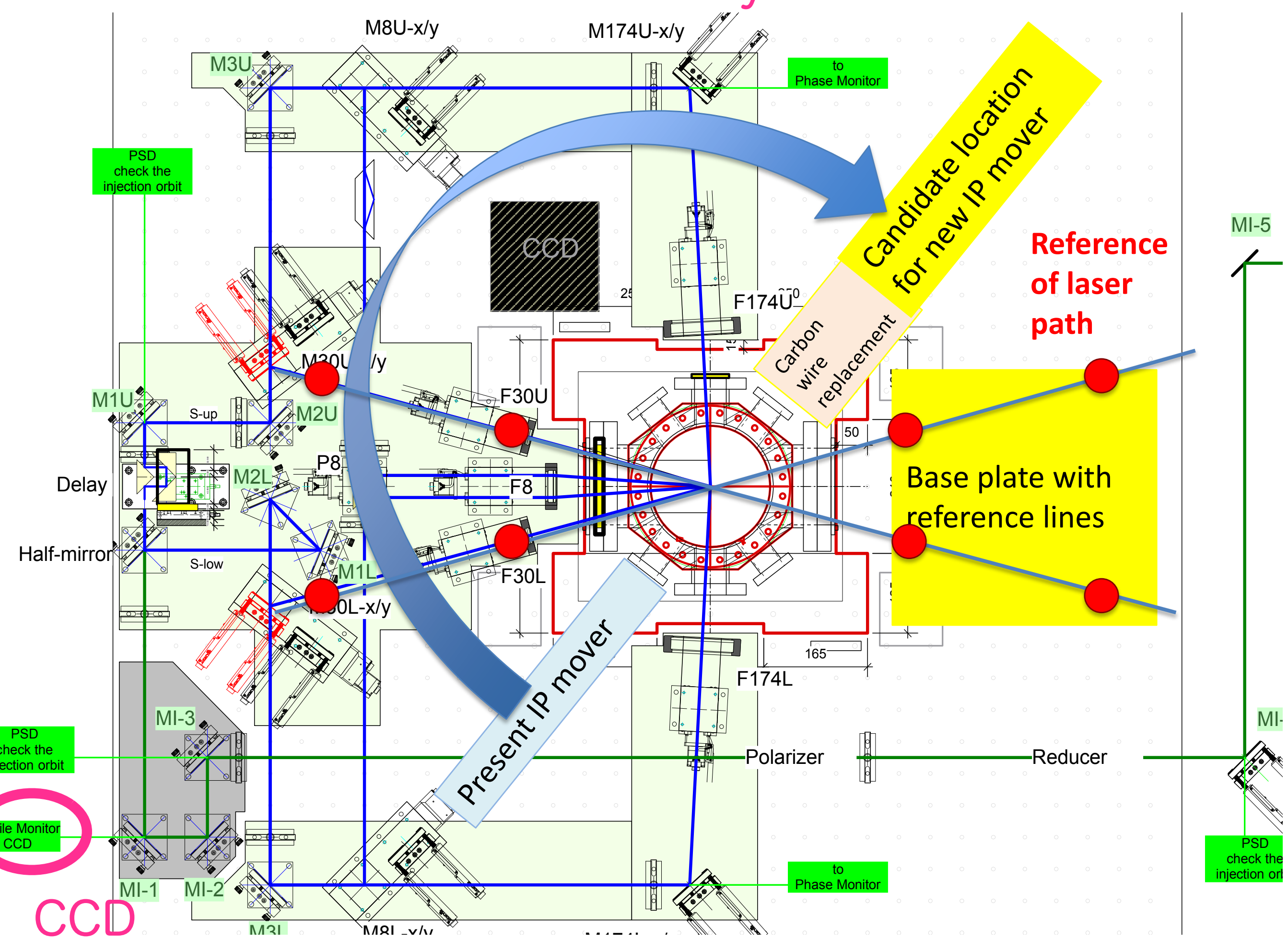


0.5mV→15.625nm

2013年 7月 8日 月曜日

Installation and Alignment

talk by Nobuhiro TERUNUMA



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Monitoring the IPBSM laser profile by CCD

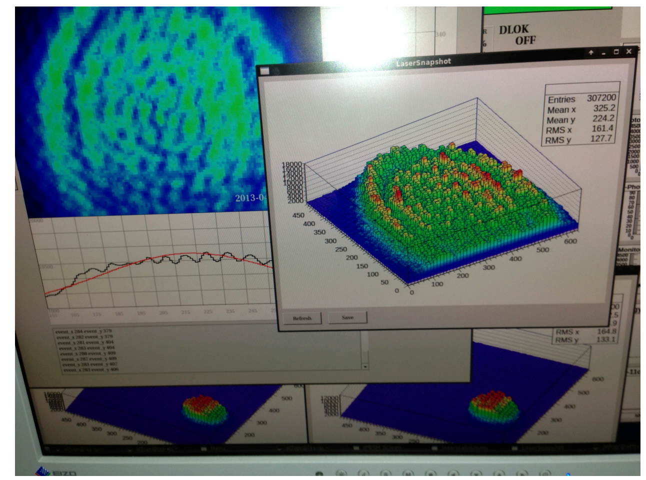


Image at the exit of laser unit

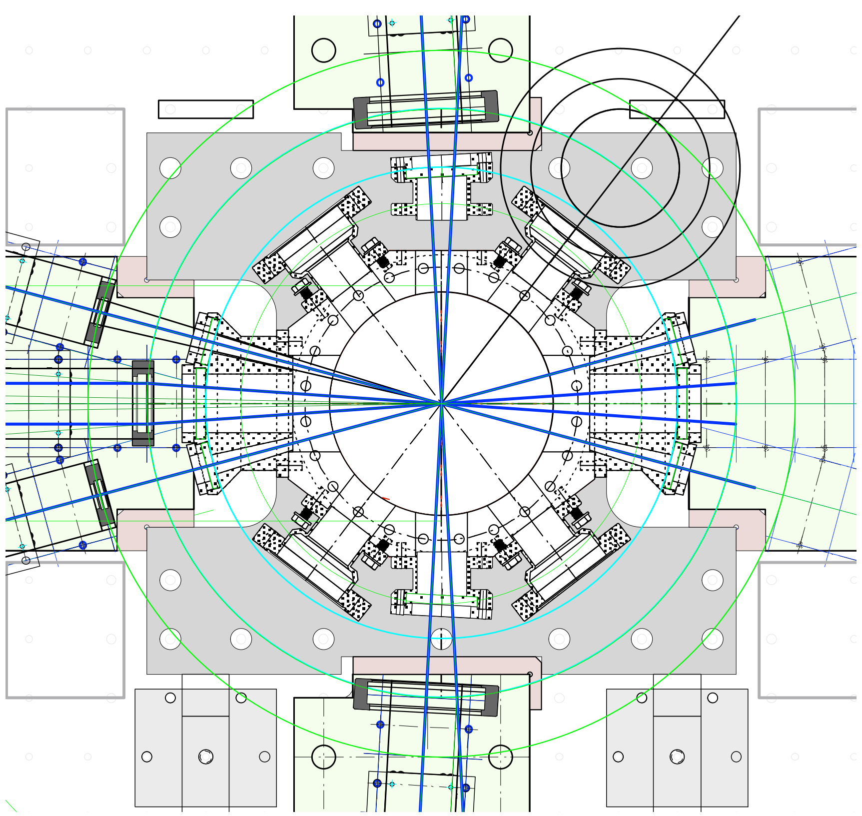
Individual monitoring of laser path

- There are two CCDs at present; at the exit of the laser unit and the vertical table.
- Add more CCDs to enable the Individual monitoring for upper and lower path but for 30 and 174.
- Sampling can be done about 1 Hz.

Interference fringe monitoring

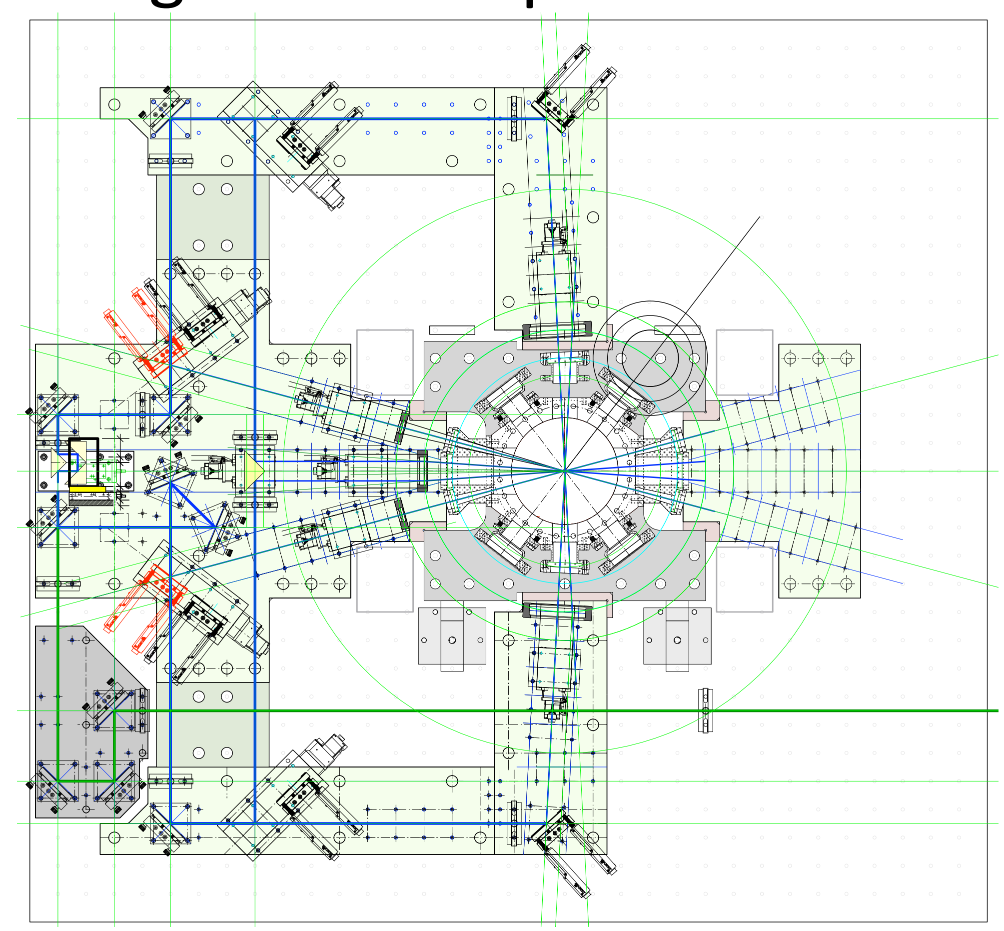
- It is possible but may not realistic because of the difficulty of the second interference control under that of IP.
- It is really difficult to make a path after IP especially for 174 mode.

4



normal incidence of laser on the viewport for 30 and 174 modes.

Binding reference plate for laser optics



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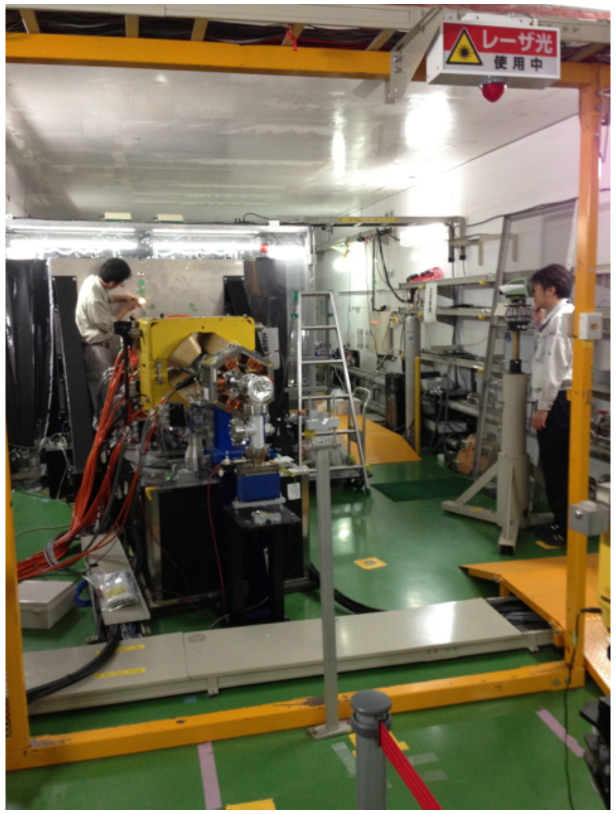
Reproduce the beam trajectory

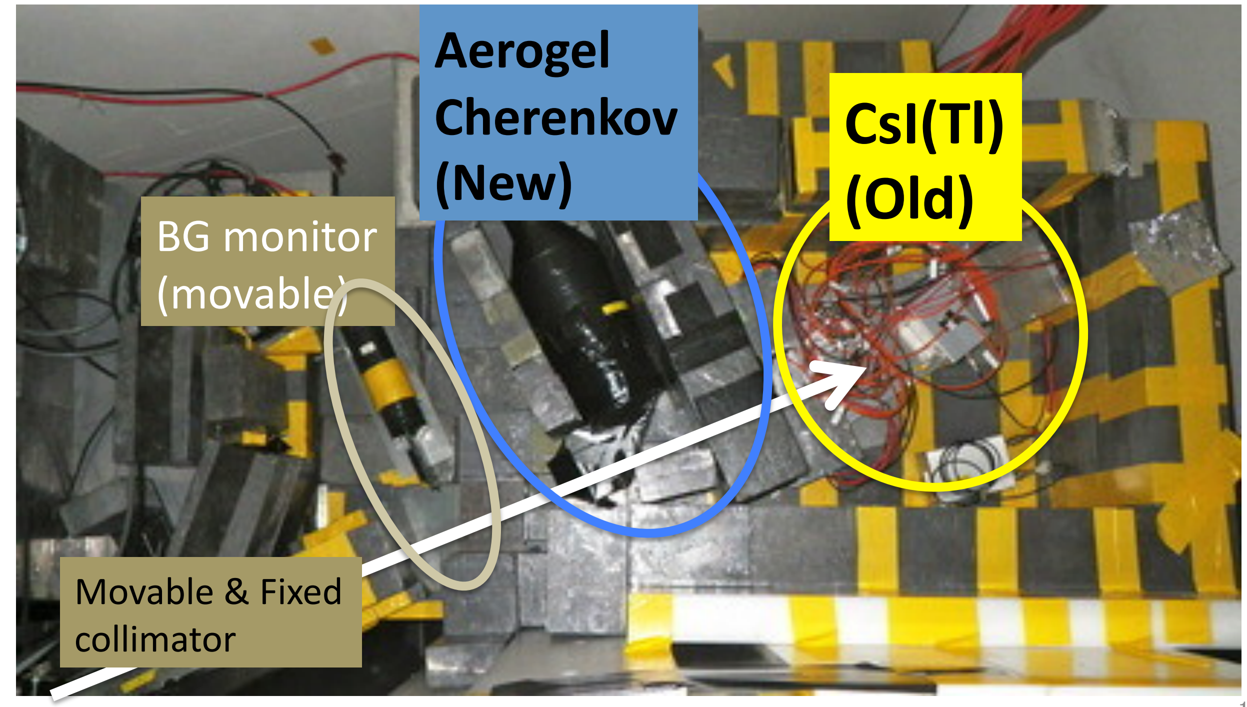


Define the beam trajectory by using the horizontal / Vertical reference of magnets. Magnet movers were set as same as that for the last beam runs.

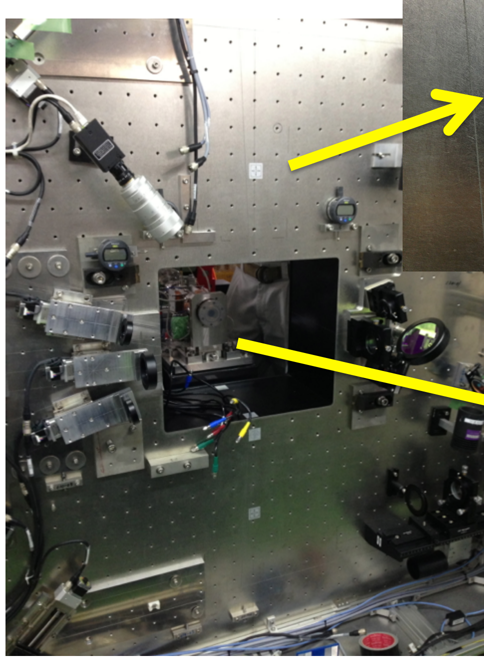
Alignment scope with laser is used to simulate the beam, optical straight toward the IPBSM detector.

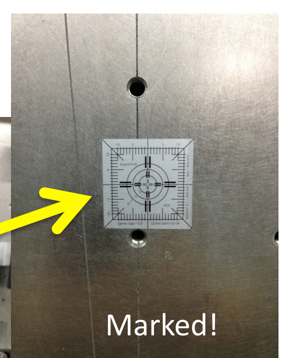
Gamma detectors since June 2013

Alignment of the collimators and the cherenkov head is essential for the better IPBSM measurement.



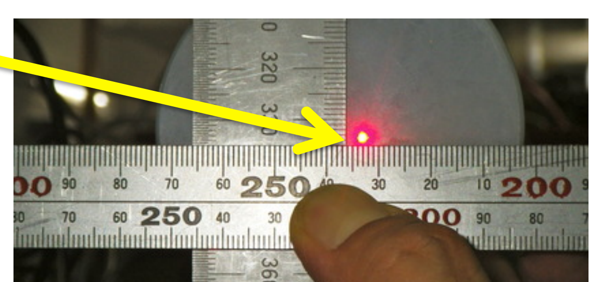
Copied beam trajectory – IPBSM table





Beam offset on the IPBSM table
- **3mm horizontally (south)**
- **2mm vertically (up)**

Same as measured in last year. The offset is also consistent with the chamber's position shift that evaluated by a beam in the past years.

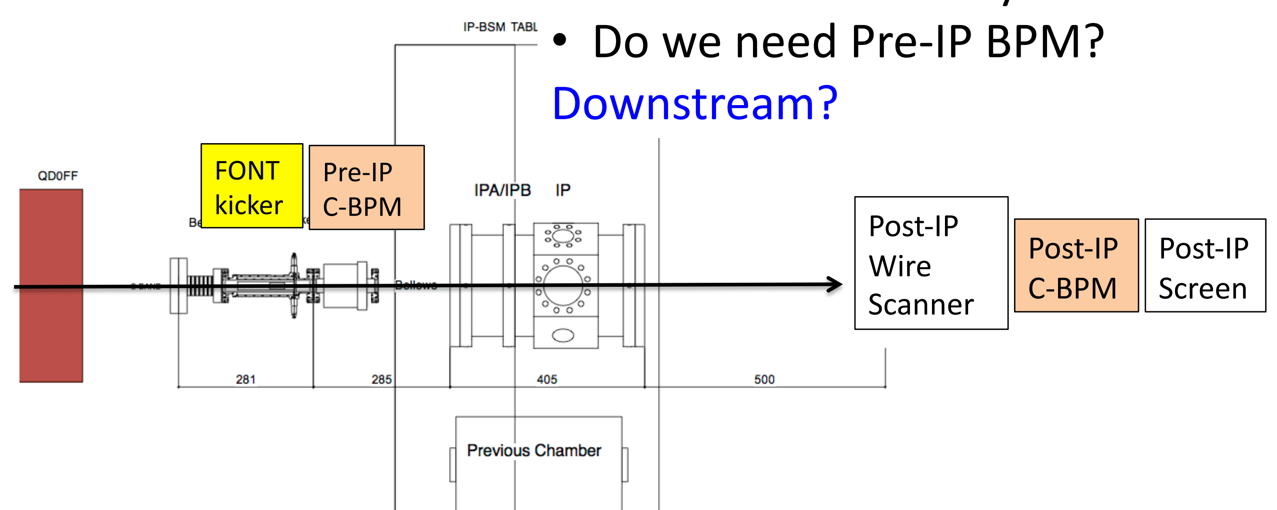


Offset from the reference of the IP table

Where is the IP reference cavity?

Upstream?
- Affect on the latency of feedback?
- Do we need Pre-IP BPM?

Downstream?



Discussion on the installation and alignment

Location of the reference cavities of IPBSMs

There are 2 possible locations at upstream and downstream of IP, whose distances from IP are almost same.

The reference cavities will be made as a block, and they have 16mm diameter aperture.

Both locations will be the same possible background sources for the same distance from IP.

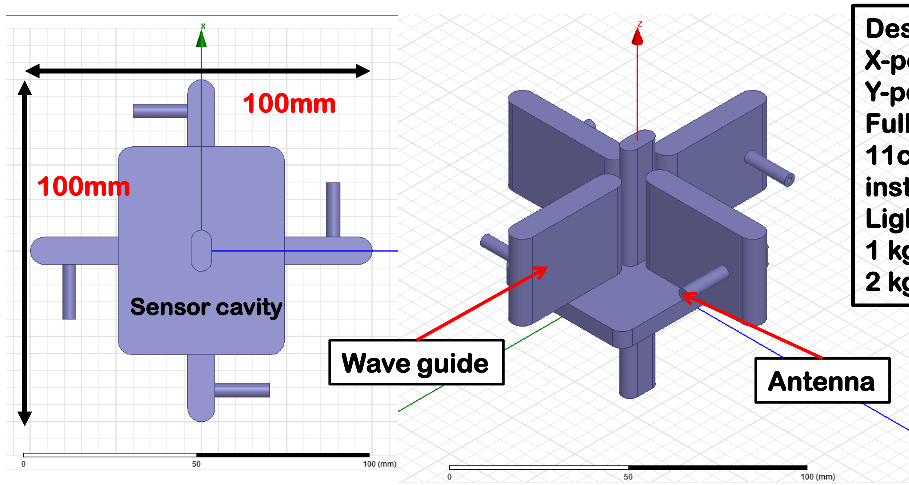
The downstream location is preferable for no wakefield issue and less interference with the pre-IP BPM.

New IPBPMs, electronics and reference cavities

talk by Siwon JANG

11cm Low-Q IP-BPM design

- 11cm Low-Q IP-BPM drawings of HFSS



Designed frequency
X-port: 5.712 GHz
Y-port: 6.426 GHz
Full size :
11cmx11cm (to install IP-Chamber)
Light weight:
1 kg (Single cavity)
2 kg (Double cavity)

KNU IP-BPM

Q_0 < design value
for poor quality of wall surface
but R/Q is close to the design value

	Port	f_0 (GHz)	β	Q_0	Q_{ext}	Q_L	τ (ns)	V_out (uV/2nm)
Designed	X-port	5.7127	5.684	4959.29	872.42	741.91	18.72	7.739
Designed	Y-port	6.4280	5.684	4670.43	821.61	698.70	17.23	7.448
Double_1	X-port	5.6968	0.656	362.34	552.14	218.77	6.112	9.740
Double_1	Y-port	6.4099	0.668	845.66	1266.7	507.11	12.59	6.010
Double_2	X-port	5.6975	0.817	483.38	591.45	265.99	7.430	9.410
Double_2	Y-port	6.4097	0.641	834.70	1302.5	508.70	12.63	5.927
Single_1	X-port	5.6991	0.855	502.05	587.04	270.61	7.557	9.444
Single_2	Y-port	6.4089	0.986	1238.0	1255.9	623.43	15.48	6.037

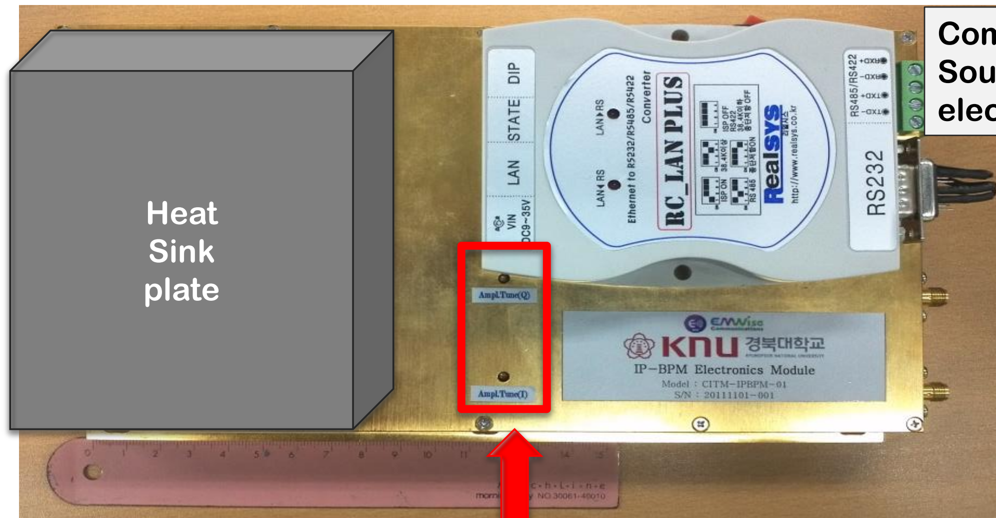
BPM 1,2
BPM 3

Average frequency: X-port 5.6978GHz
Y-port 6.4095GHz

The reference cavity frequency!

IP-BPM Electronics modification

A report of the basic performance will be set to the collaboration.



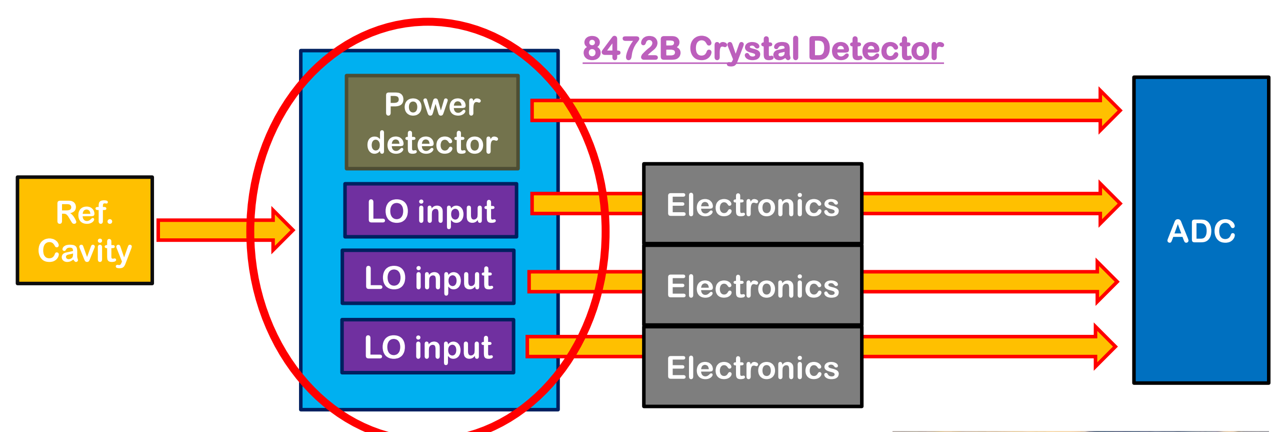
Combined power Source with main electronics power

Gain controller 54dB ~ 45dB

electronics location : compensation of cable length outside or inside the shields

Power divider for Ref. signals

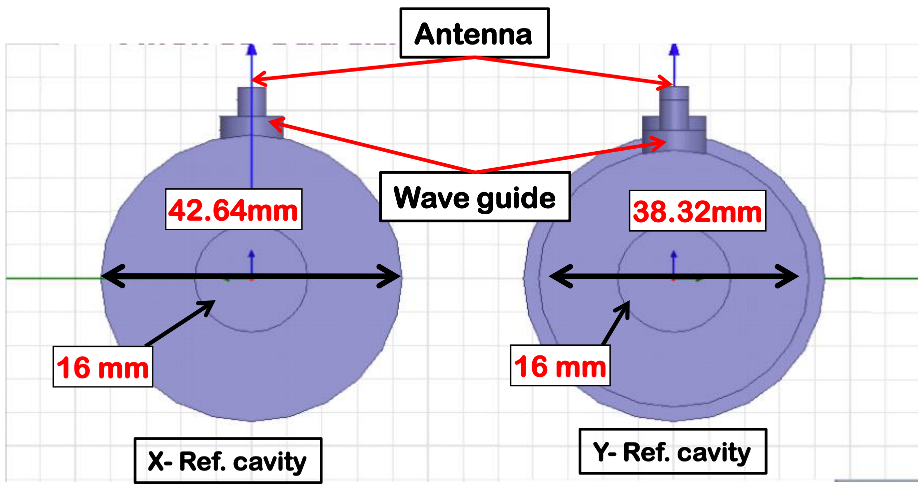
- The ref. cavity output is just one port, therefore the output signal should be split to connect LO signal port of each electronics and power detector.



8472B Crystal Detector

Reference cavity BPM design

- Reference cavity BPM drawings of HFSS



- Cavity size : 42.64mm,38.32mm
- Beam Pipe radius: 8 mm (circular pipe)
- Material of BPM: Steel Stainless

- HFSS simulation need more optimization.
- CST simulation also need to compare with HFSS results

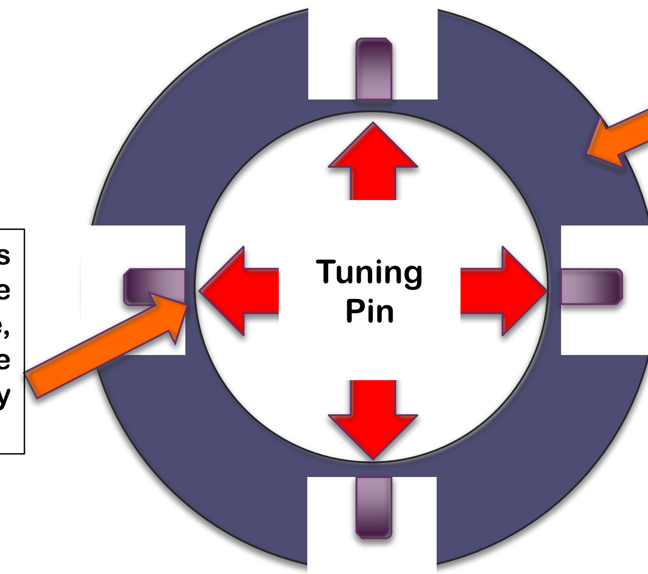
Reference cavity frequency tuning

consulting with Hayano-san (actually, such tuners were made by Takatomi (KEK).

- Way to tune the frequency of Reference cavity

Aim frequency:
X-port 5.6978GHz
Y-port 6.4095GHz

Stainless steel is hard to change the shape. Therefore, tuning pin will be welded on the very thin cavity surface.

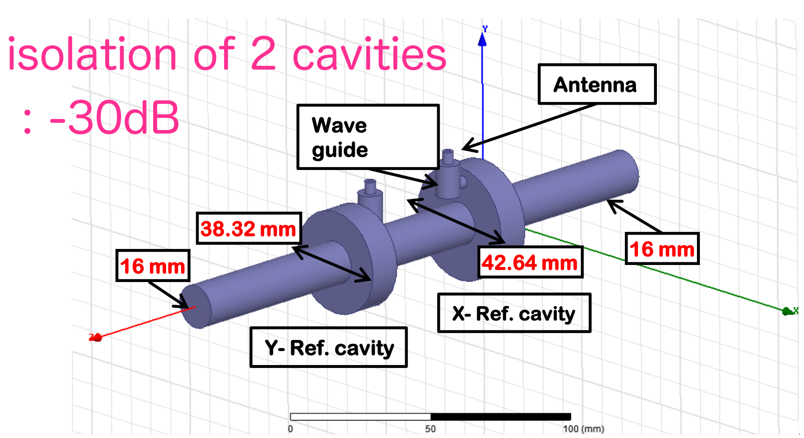


Cavity material: Stainless steel

Reference cavity BPM design

- Cavity shape for HFSS simulation

isolation of 2 cavities : -30dB



- Cavity size : 42.64mm,38.32mm
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- Material of BPM: Steel Stainless

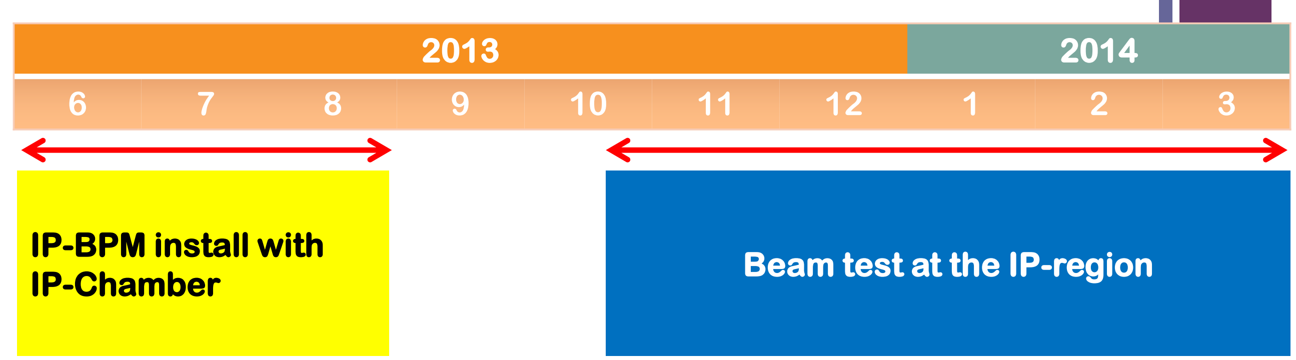
- HFSS simulation need more optimization.
- CST simulation also need to compare with HFSS results

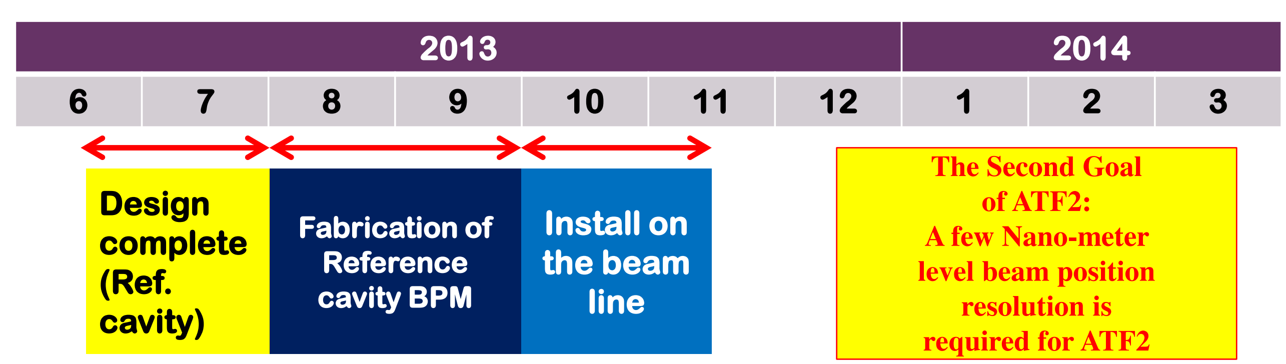
Port	f_0 (GHz)	β	Q_0	Q[illegible]	Q_L	τ (ns)
X-port	5.7034	0.0208	116[illegible]	[illegible].7	1140.68	31.83
Y-port	6.4100	0.0[illegible]	[illegible]3.61	36765.1	1165.46	28.94

Not decided values

Relative phase to the IPBPMs must be very stable, i.e. temperature control , shorter cables , SUS helps small temp. coefficient.

Low-Q IP-BPM Progress





low power test at KNU

IP FB Tests Status

talk by Philip BURROWS

Test programme

Preparations for beam stability in IP region with 2-bunch beam, bunch separation 270ns:

1. Readout of IPBPMs with 2-bunch beam

2. Upstream FONT FB: record beam in IPBPMs

3. Feed-forward from upstream FONT BPMs → IP kicker: record beam in IPBPMs

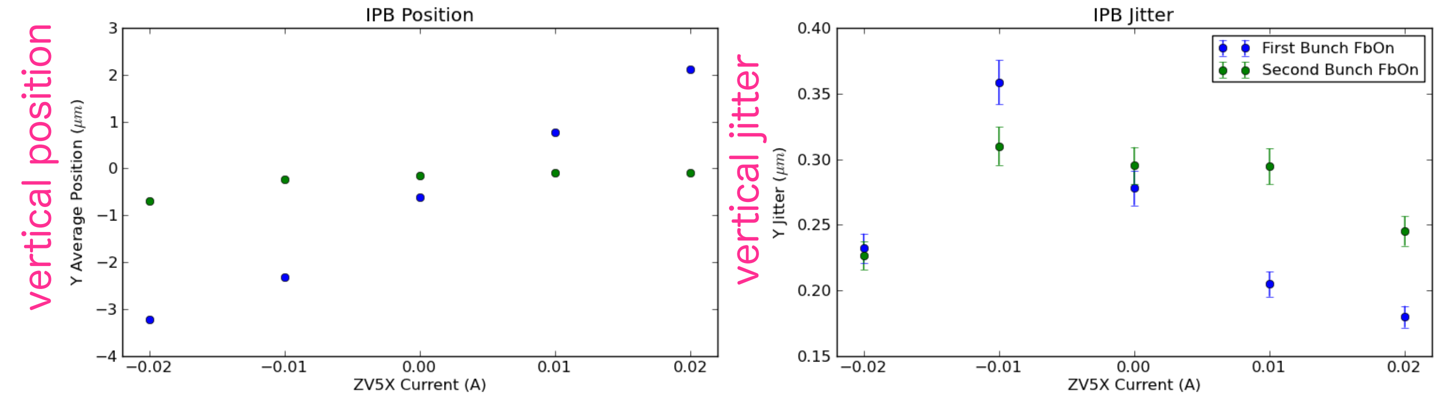
4. IP FB using IPBPM signal and IP kicker

present resolution < 120nm

Standard procedure is to correct beam in y at IPB

Upstream FB: position scan

- **FB gain nominal for correction in FONT region**
- **Scan ZV5X (upstream of FONT region)**
- **Monitor beam position and jitter at IPB**

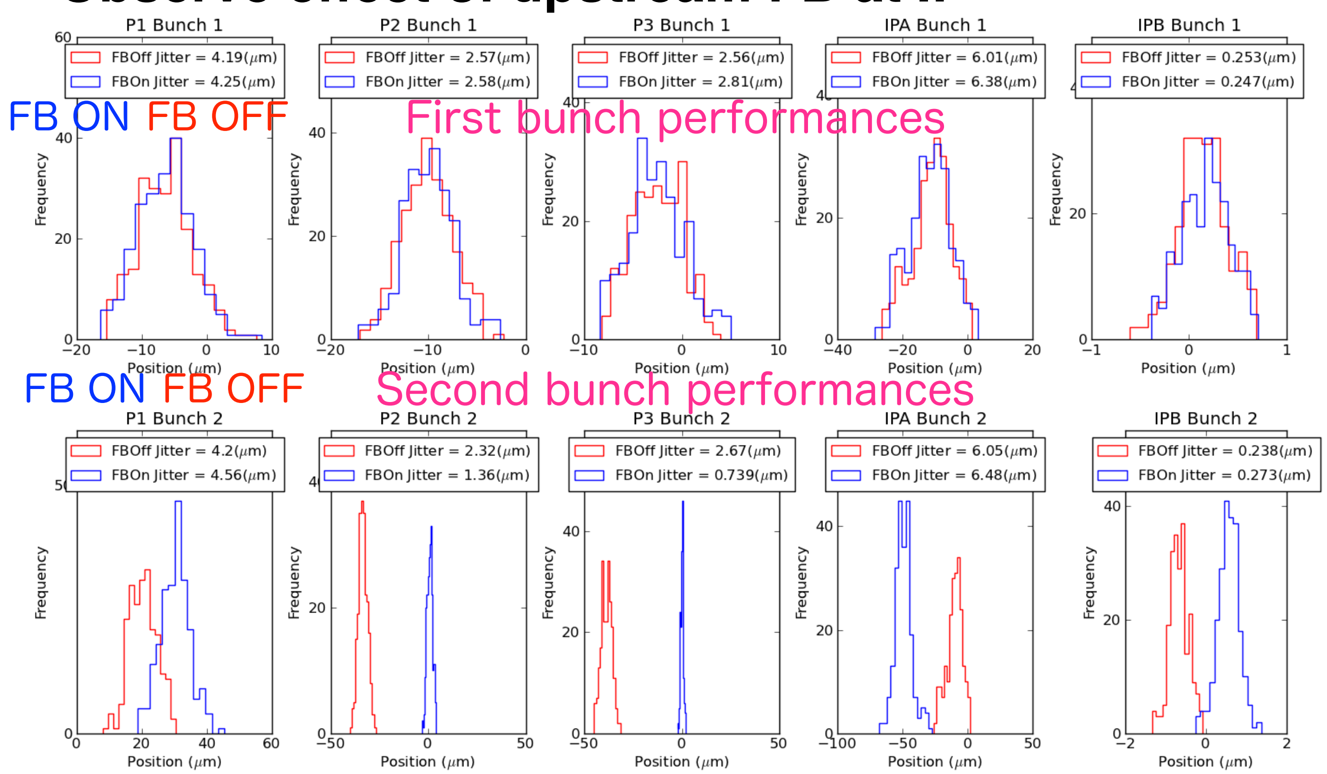


Upstream FB centres beam, but increases jitter

hard to understand this difference

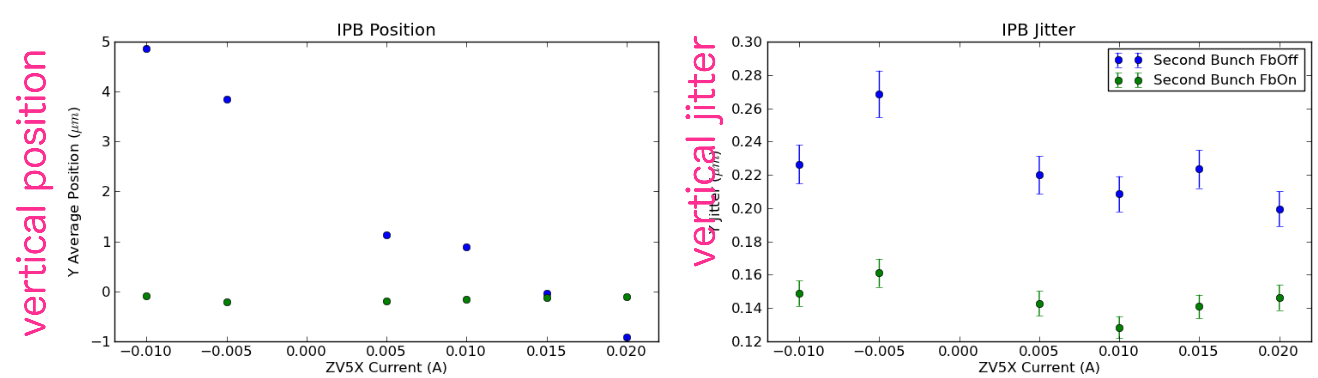
Upstream FB: example

Observe effect of upstream FB at IP



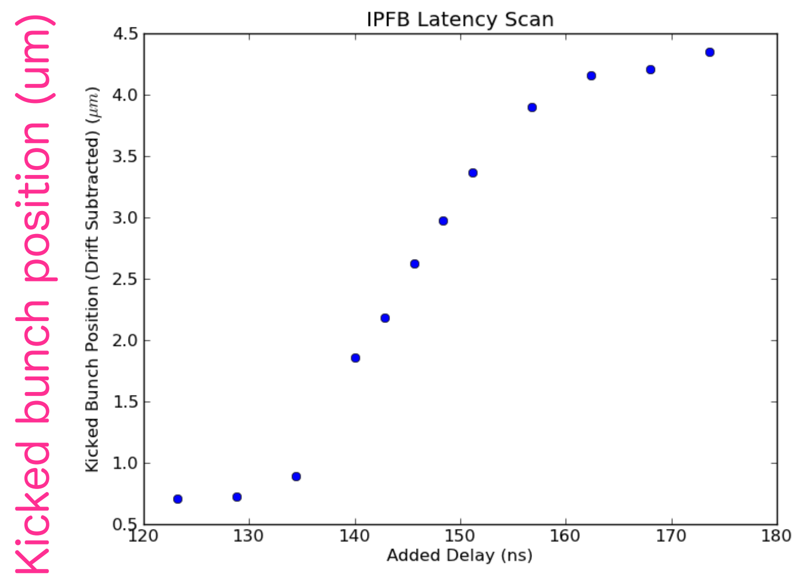
Feed-forward mode

- **FF gain optimised for best correction @ IP**
- **Scan ZV5X (upstream of FONT region)**
- **Monitor beam position and jitter at IPB**



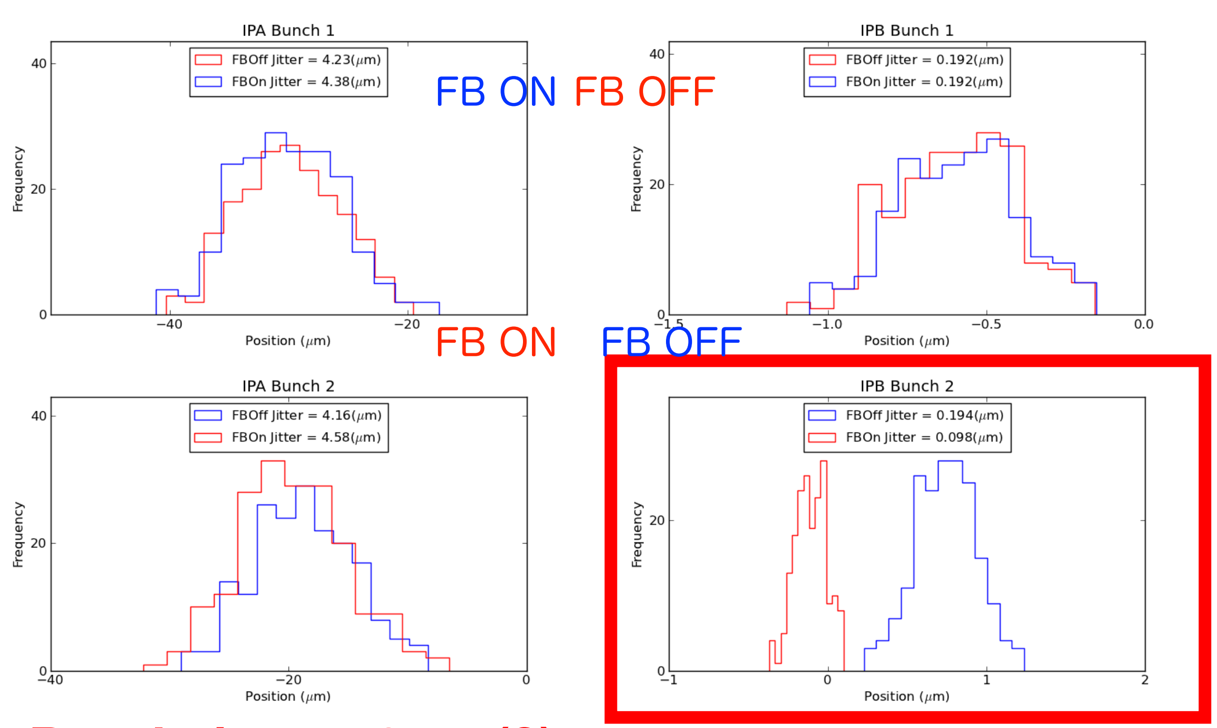
FF centres beam, and reduces jitter x 2

IP FB latency measurement



Latency ~ 160ns

Example of best IP FB



→ Resolution ~ 70nm (?)

Summary of June 2013 runs

Beam correction and jitter reduction observed at IP:

Upstream FB gives marginal jitter improvement, but only at low gain (< 0.5 * nominal).

Upstream FF gives clear factor 2 jitter reduction.

IPFB works well, reduces locally incoming jitter:

- **best performance is jitter reduced to 100nm**
- **probably limited by IPBPM resolution**

Data analysis preliminary, studies ongoing

Speculations

In order of performance:

1. Local IPFB works best to reduce jitter

2. Upstream FF correction applied locally at IP OK

3. Upstream FB works poorly, only at low gain

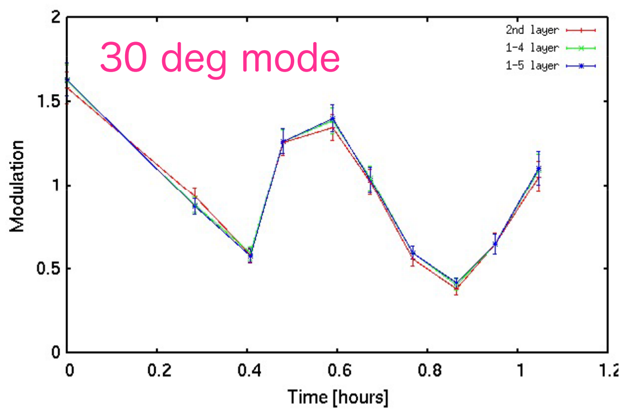
- **→ Not a surprise (to me at least)**
- **→ Jitter sources between FONT region and IP**
  - **eg. x jitter coupling into y?**
  - **more investigation needed**

IP position drift and slow feedback proposed

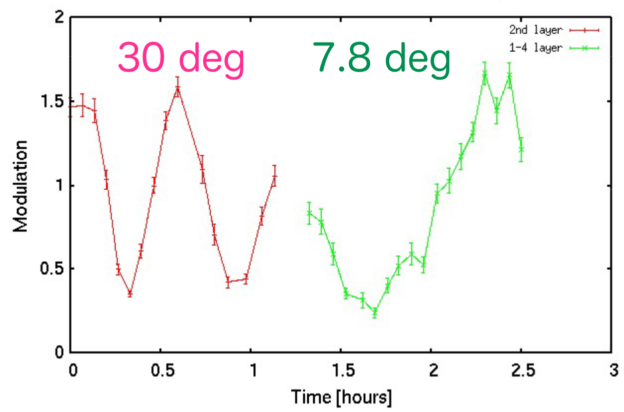
talk by Toshiyuki OKUGI

IPBSM signal drift evaluated by the fixed phase data taking

Data at 06/06



Data at 06/13



Definition of modulation

$$M = \frac{(Both\ path) - (Background)}{(Upper\ path) + (Lower\ path) - 2\times(Background)}$$

Motivation

We observed the evidence of the IP position drift by the IPBSM fixed phase data taking.

Fixed phase data taking of IP-BSM

We took the IPBSM signal by at the same laser phase.

We took 4 conditions of laser shutters of IPBSM laser,

1) *The shutters of both upper and lower paths are closed (Background).*
2) *The shutter of upper path is opened, but lower path is closed (Upper path signal).*
3) *The shutter of lower path is opened, but upper path is closed (Lower path signal).*
4) *) The shutters of both upper and lower paths are opened (Both path signal).*

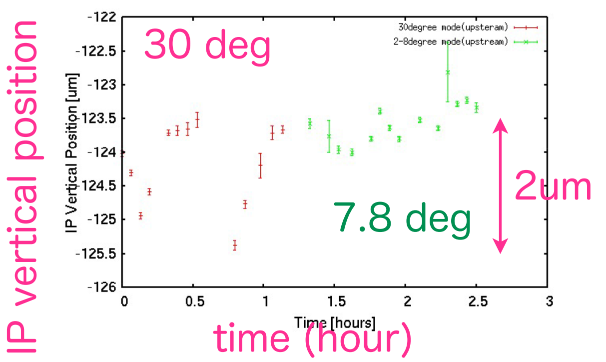
In order to decrease the signal drift in the data set, the data was taken as following sequence,

10 shots of (Background),
10 shots of (Upper path signal)
10 shots of (Lower path signal)
10 shots of (Both path signal)

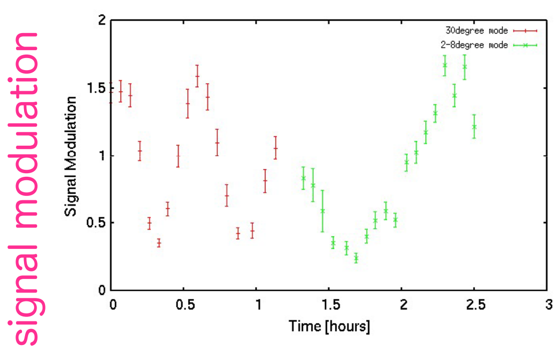
10 shots of (Background),
10 shots of (Upper path signal)
10 shots of (Lower path signal)
10 shots of (Both path signal)
...

Correlation of the IP beam position and IPBSM signal

IP beam position evaluated upstream BPMs

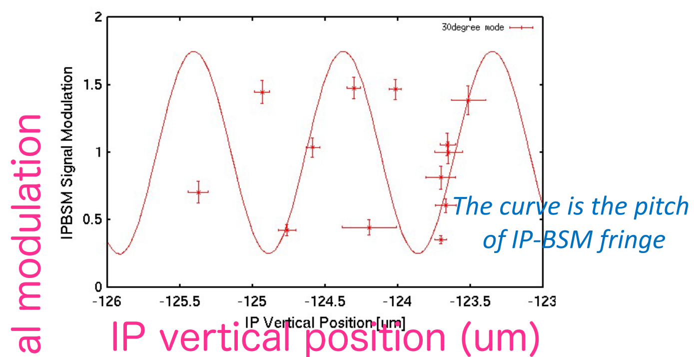


IPBSM modulation evaluated by phase fix data

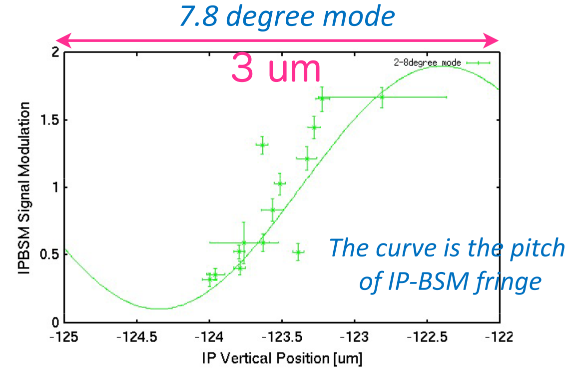


Correlation of IP beam position and IPBSM signal

30 degree mode

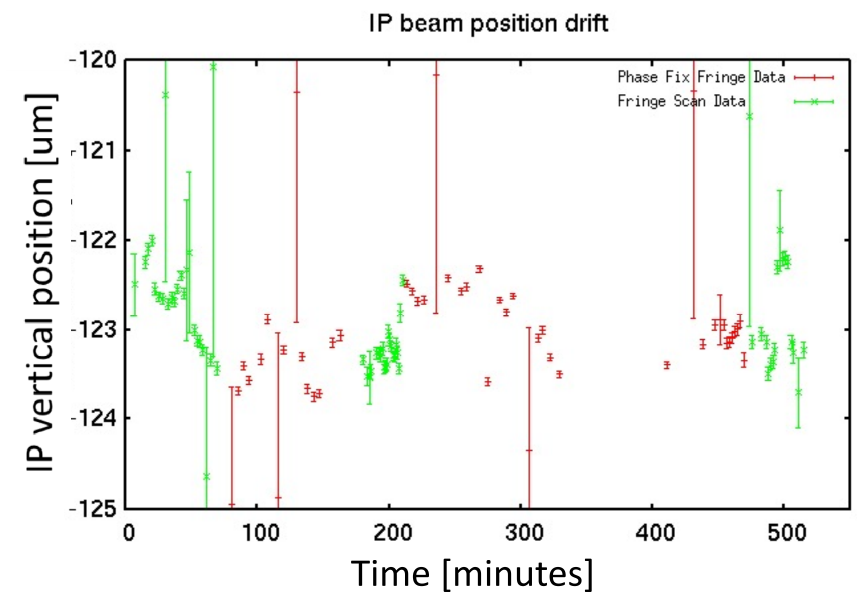


7.8 degree mode



Long time IP drift data (2013/06/13 swing)

We turned on both DR & ATF orbit feedback



We can observed 2 IP drift component

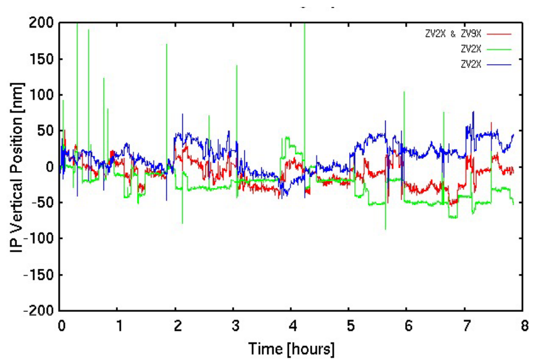
1) *the period was 4 hours (slow drift).*
2) *the period was 30-40minutes (sensitive to IP-BSM 30degree mode)*

2013年 7月 8日 月曜日

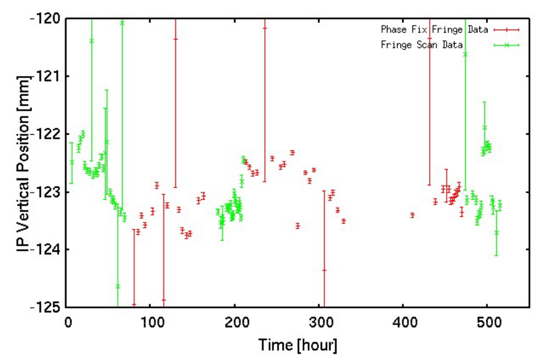
FB feedback Issues

The IP position and angle change by orbit FB was analyzed with the trend of the setting of FB steering.

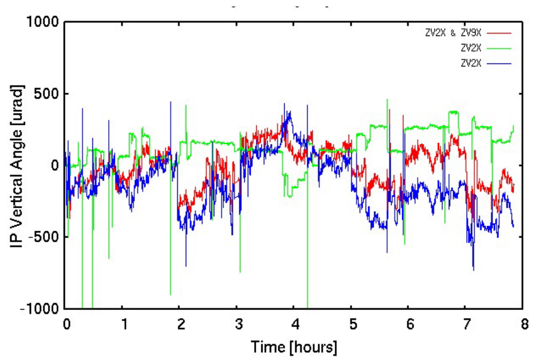
IP position change (2013/06/13 swing)



IP vertical position drift (2013/06/13 swing)



IP angle change (2013/06/13 swing)



IP position drift was about +/-1um (30 sigma).

Orbit FB changed the IP angle only by +/-500urad (1-2 sigma).

The IP position drift was too much.
It seems very difficult to correct the IP position drift by orbit FB at the entrance of ATF2 beam line.

But, it is not so difficult to correct the IP beam position with the steering just before IP by monitoring the IPBPM.

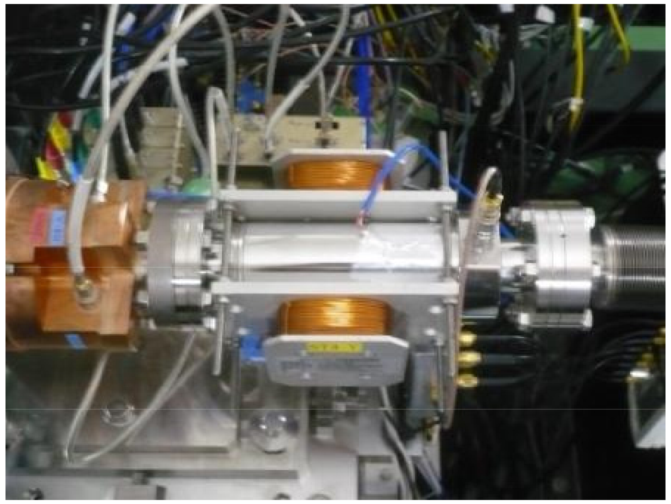
The IPBPM requires
- *no IQ phase change*
- *sub micron resolution (not required the nm resolution)*

for slow feedback

Requirement for the preparation of the IP-BPM database

	Coordinate	Database	Action
Reference cavity	Horizontal	Amplitude	Read
	Vertical	Amplitude	Read
3 Sensor Cavities	Horizontal	Attenuator	Read, Set
		Phase Shifter	Read, Set
		Position Calib. Factor	Read, Set
		I	Read
		Q	Read
		Position	Read
	Vertical	Attenuator	Read, Set
		Phase Shifter	Read, Set
		Position Calib. Factor	Read, Set
		I	Read
		Q	Read
		Position	Read

Air-core steering magnet for IP position feedback (slow drift FB)



The air-core steering magnet is borrowed from STF.

The steering magnet will be put around the FONT IP kicker. (OK?)

The rough evaluation of the performance to the IP position change

Sensitivity ; 1um/1A
Dynamic Range; +/-5um

Main motivation of air-core magnet is the fine adjustment of field strength, and the location is better to be close to IP as much as possible.

It is OK (P.Burrows).

Discussion on the commissioning plan

There are two priorities as;

1. Machine schedule in this fall

operation in 2 weeks/month for October to December

October : preparation of radiation safety inspection at ATF (DR, EXT and FF)

beam current of > 40mA, i.e. > 15bunches, 1×10^{10}/bunch

November : the ATF inspection for a few days

December : KEK radiation safety inspection in every 5 years, which will not have big impact to the ATF operation.

2. Commissioning the new IP chamber system

IPBPMs, piezo movers, reference cavities for the goal 1

i.e. the position resolution of IPBPMs is sub-micron level at least

Compatibility of IPBSM operation (IP beam size measurements)

3. Comments (C), Questions (Q)

C : IP position jitter/instability should be small enough for 37nm beam size tuning and measurements.

C : IPBPMs are useful with respect to the stability at IP.

C : Up to now, i.e. June 2013, from studies of FONT and Okugi-san etc., we were just ready to study with the IPBPMs. However, this situation was reset by replacement of IPBPMs. So, we will take a couple of months to understand performances with new IP chamber system.

Q : What is the limitation of position resolution of present IPBPMs, 100nm ?

A : We do not know. However, we have electronics noises in ADCs at 10's MHz which may limit it.

C : 100nm resolution is enough for the slow feedback (Okugi's proposal).

C : This 10's MHz may limit the new IPBPMs. So, Siwon should study it by communicating with FONT group. Also, he should check the noise with new KNU electronics in this occasion.

Q : There is a concern of the reference cavities, i.e. their readiness and the location.

A : As explained, the design will be completed in July. We will construct them in this August.

A : The location has no problem, i.e. it is just a matter to decide the upstream or downstream of IP. (The downstream is preferred at present.)

Q : Remote control of attenuators are essential for the IPBPMs in order to adjust the dynamic ranges. Do we have enough attenuators ?

A : 8 attenuators have been used for the IPBPM studies at the upstream test area. They should be available.

C : Please confirm the availability while S.Jang stays at ATF for next 2 weeks.

C : Step by step planning is needed in the commissioning schedule, e.g. beam conditions, ordering of procedures etc.

3. Comments (C), Questions (Q) continued

Q : Is there any long beam studies, such as continuous runs, in December ?

A : It may be difficult to decide now. However, we need such schedule by this September in order to prepare trip plans.

C : Environmental temperature is very stable in February and March as we could achieve the smallest beam size in this year. However, it may be difficult time for foreign collaborators.

A : No, we do not have any problem if it is scheduled well before, e.g. a couple of months earlier.

C : In Japan, we have no problem in operation, February. However, only two weeks are used to be schedule in March for JPS meeting and end of fiscal year.

C : We should have a series of meetings until next operation in this fall, i.e. October.

A : yes, they are very useful to know status of analysis, preparation works and to keep motivation for next beam studies.

C : We will plan meetings in every two weeks, at 3pm, Friday as the ATF operation meeting.