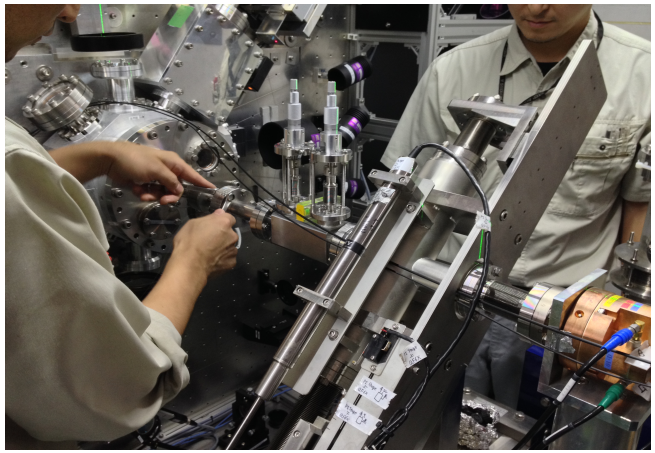
IPBPM beam commissioning and resolution study

Siwon Jang, Yumi Lee
KNU
Oscar Blanco
LAL/CERN

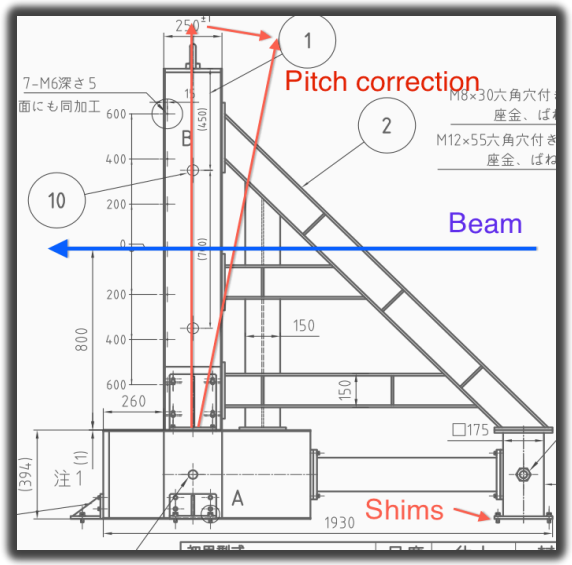
Contents

- The installation of IP-BPMs
- Simple resolution study by using 3 YI signals
- Further resolution study with I & Q signals
- Non-linearity of calibration slope problems for IPBPM-B and C

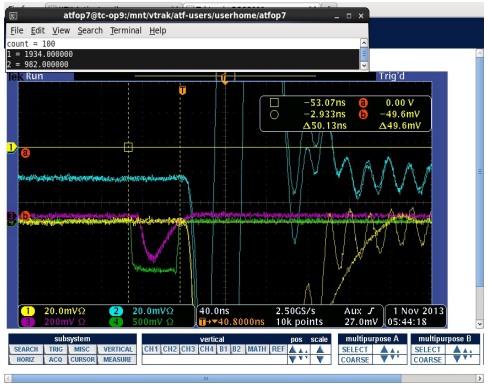
Installation of IP-BPM



Ref. BPM install

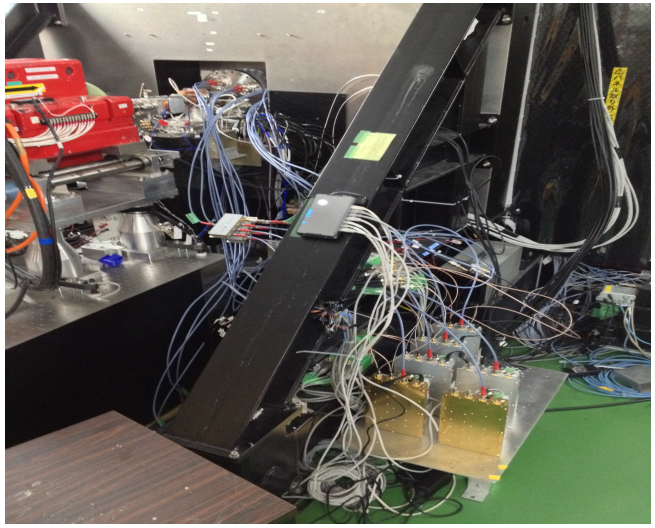


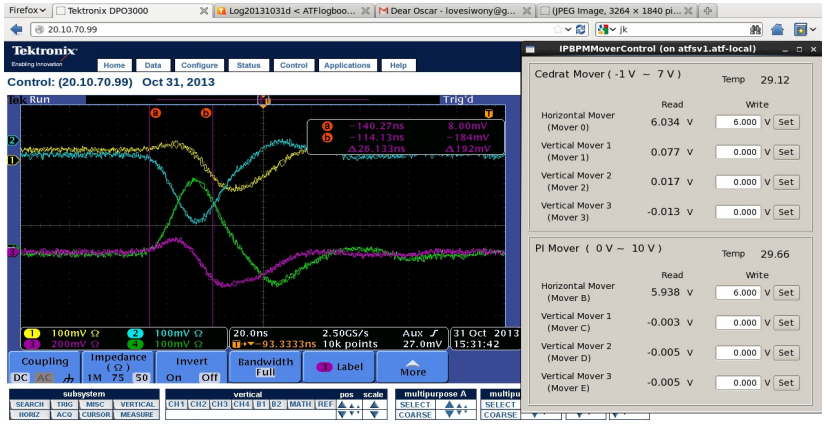
IP-chamber re-align
by using IP-BPMs



ADC system
check
(C009-H)

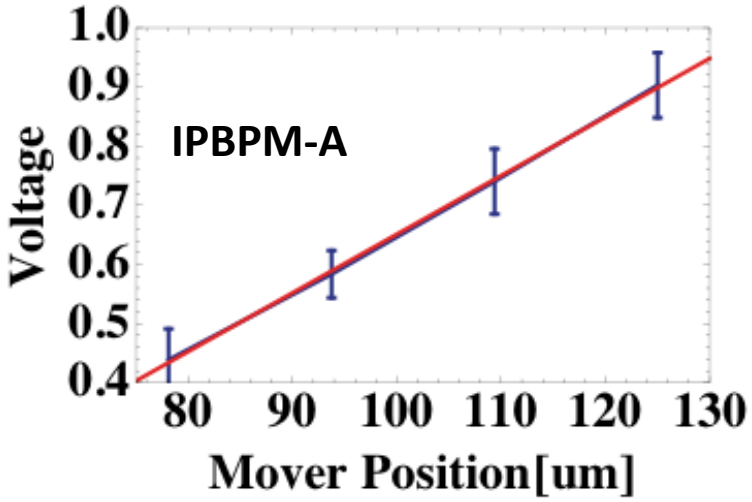
Electronics w/ cable connection

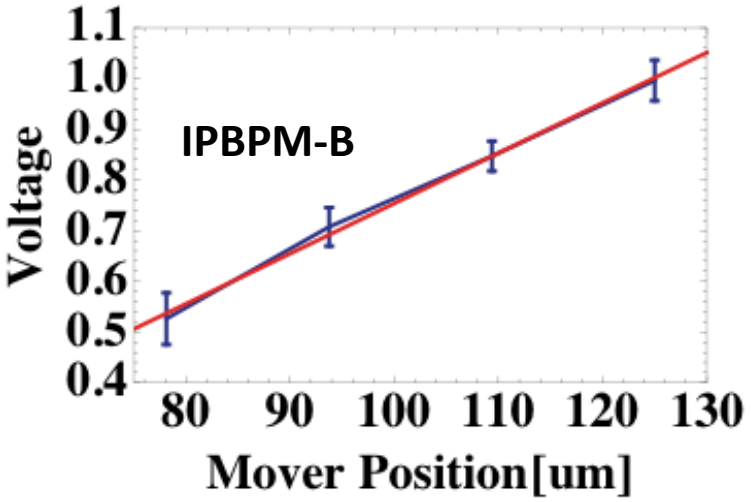


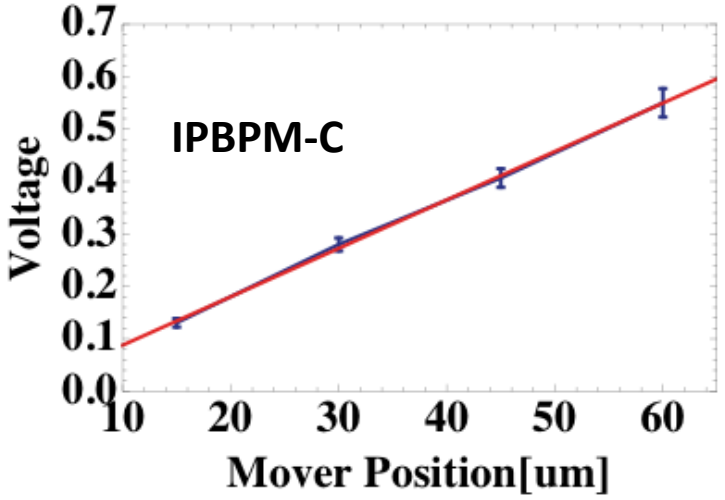


IP-mover
control
program
with
I-Q tuning

Simple resolution test by using Low-Q IP-BPM

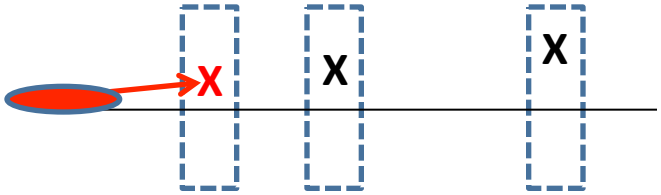




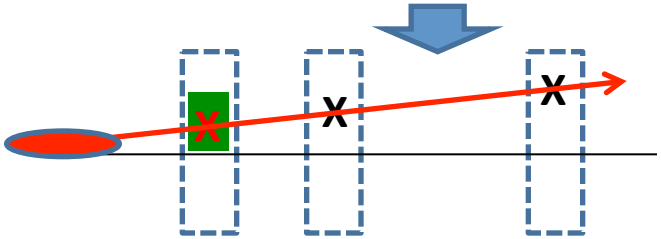


	IP-BPM A [uV/nm]	IP-BPM B [uV/nm]	IP-BPM C [uV/nm]
30dB att.	9.9113	9.9105	9.2349
0dB att.	313.42	313.39	292.03

Position resolution of Low-Q IP-BPM-A

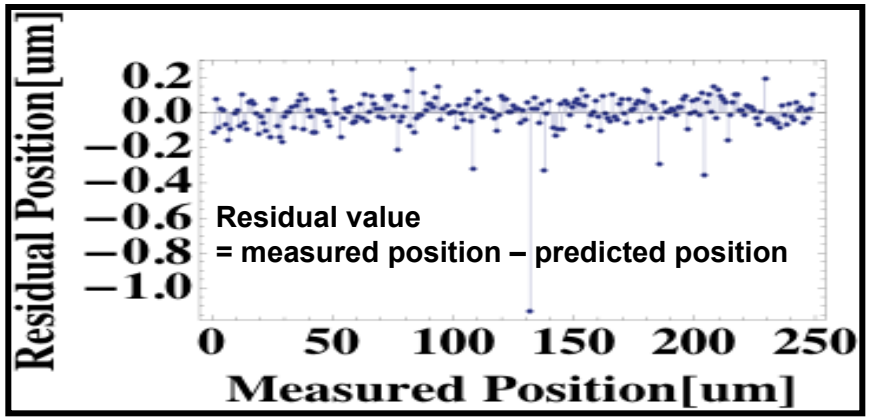


Beam position prediction♪

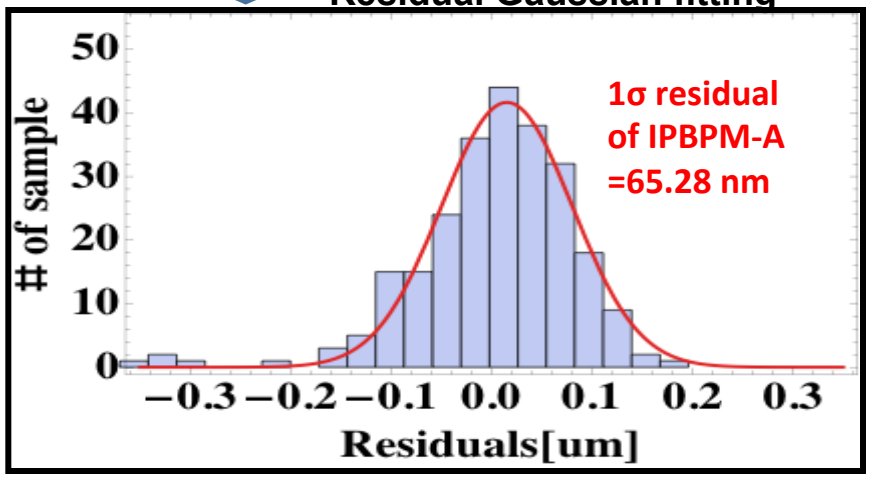


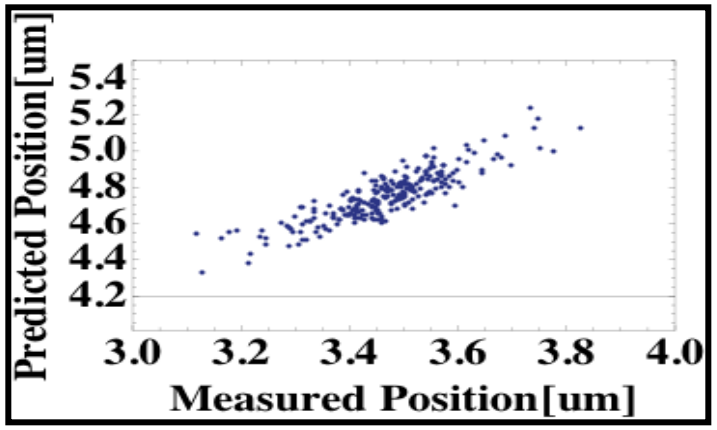
Beam position measurement

Convert to residual



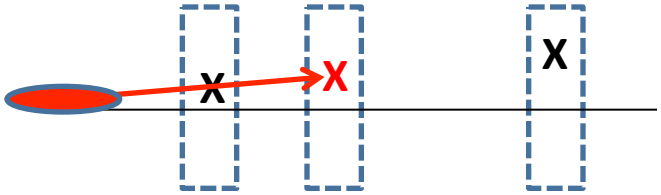
Residual Gaussian fitting



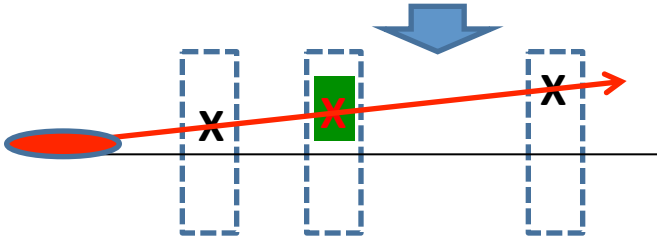


$$\text{Resolution} = G.factor \times \frac{\text{Residual}}{\text{Calibration factor}} = 34.60 \text{ nm}$$

Position resolution of Low-Q IP-BPM-B

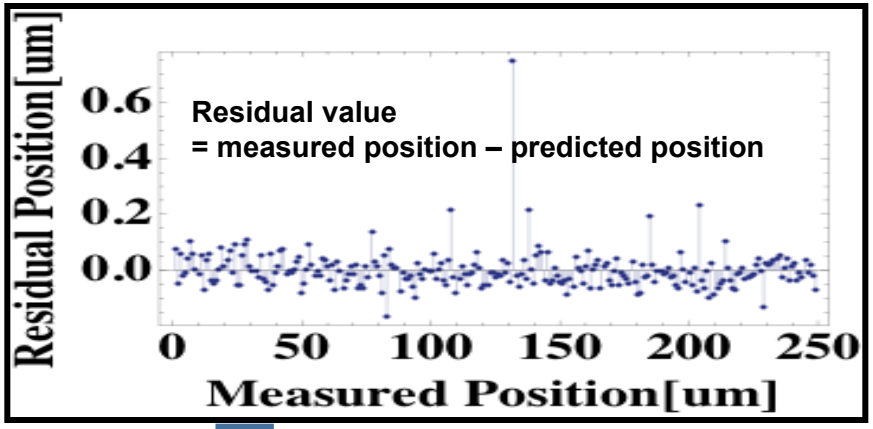


Beam position prediction♪

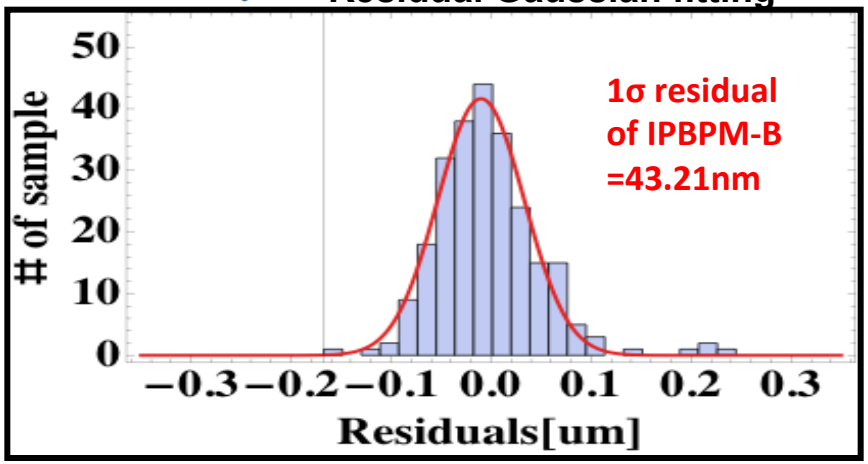


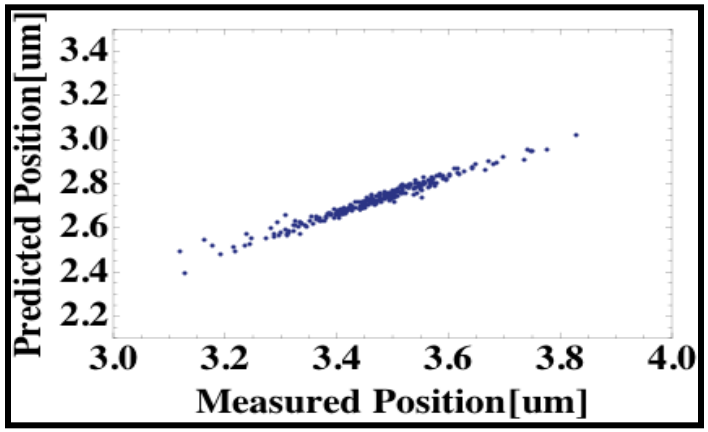
Beam position measurement

Convert to residual



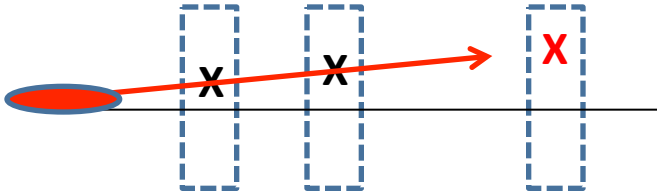
Residual Gaussian fitting



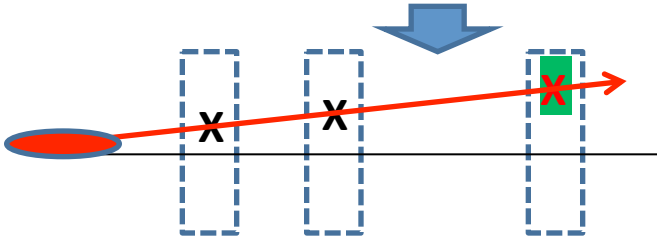


$$\text{Resolution} = G.factor \times \frac{\text{Residual}}{\text{Calibration factor}} = 34.57\ \text{nm}$$

Position resolution of Low-Q IP-BPM-C

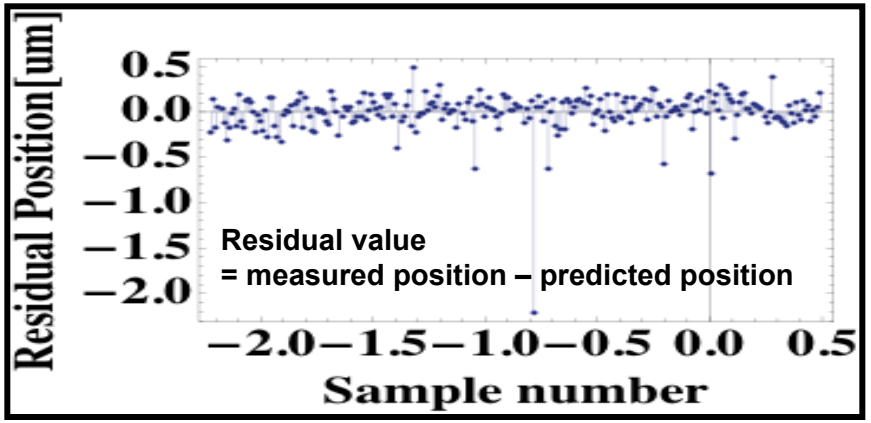


Beam position prediction♪

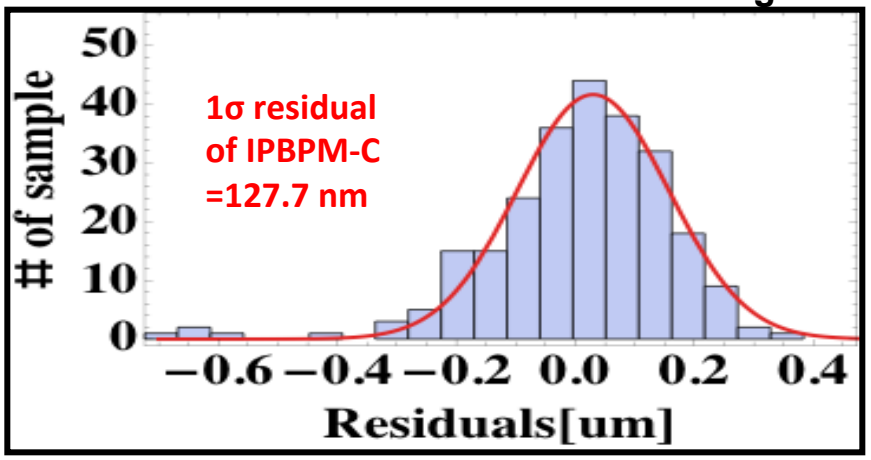


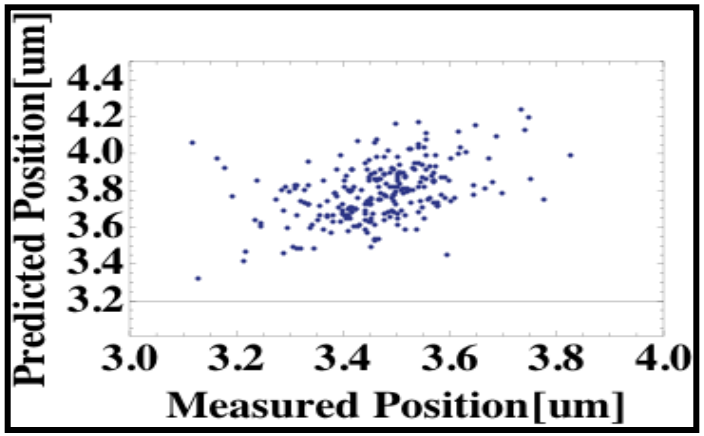
Beam position measurement

Convert to residual



Residual Gaussian fitting



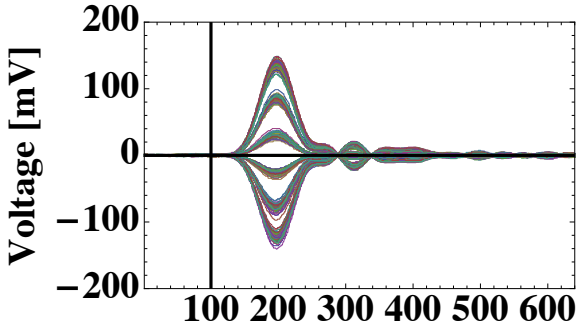


$$\text{Resolution} = G.factor \times \frac{\text{Residual}}{\text{Calibration factor}} = 34.47\ \text{nm}$$

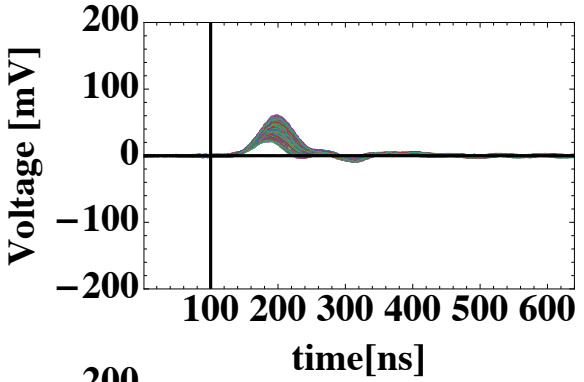
The resolution study with I and Q signals of y-port

- **2013/12/19 swing shift data**
- **The optics condition: 10 x 1000**
- **The used analysis method are Geometric method and SVD method.**
- **For the calibration run and resolution run, the one fixed point was used to calculate calibration factor and resolution of IP-BPMs**
- **The calibration run performed under the 20dB, 30dB, 40dB case.**
- **The resolution run take a 1000 signals data set.**

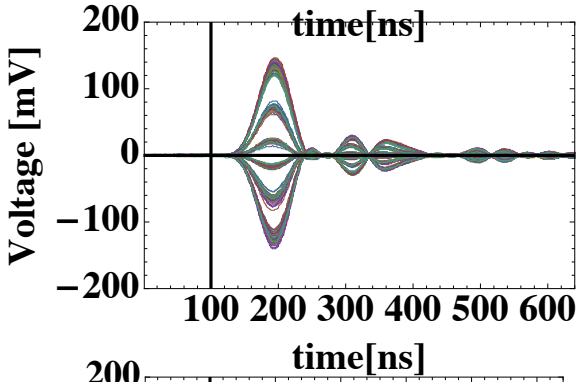
30dB calibration case



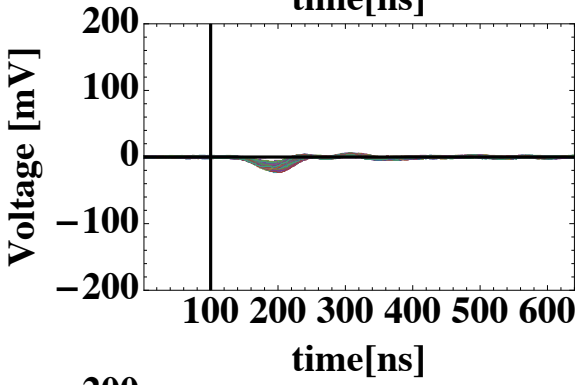
IPAYI signal



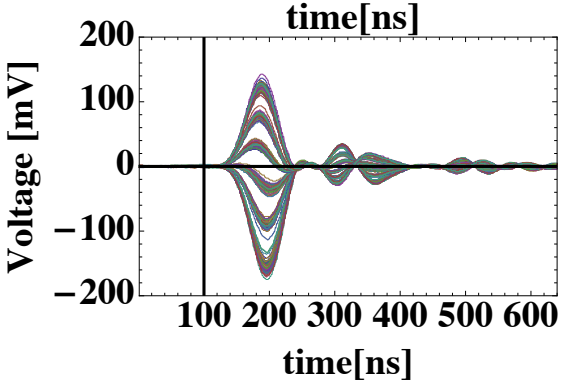
IPAYQ signal



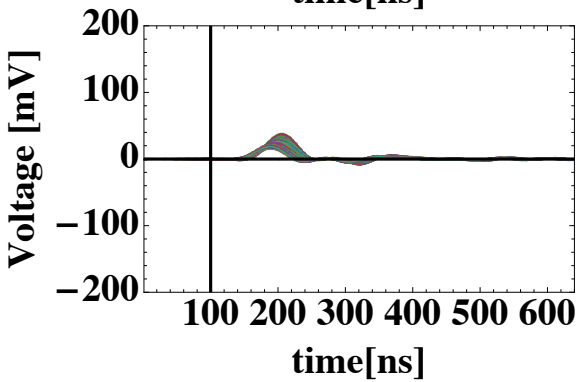
IPBYI signal



IPBYQ signal

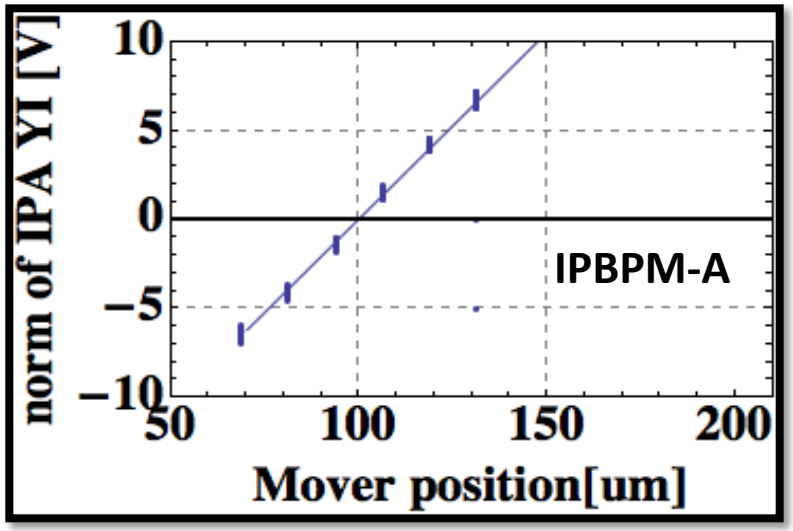


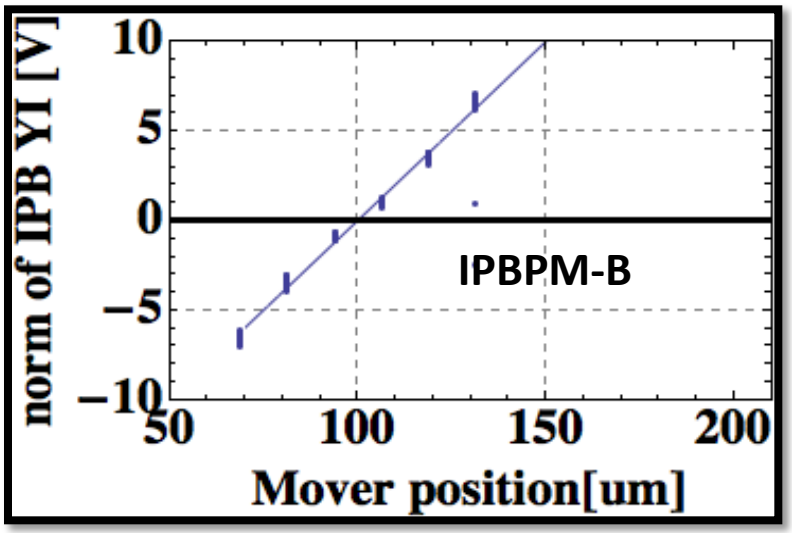
IPCYI signal

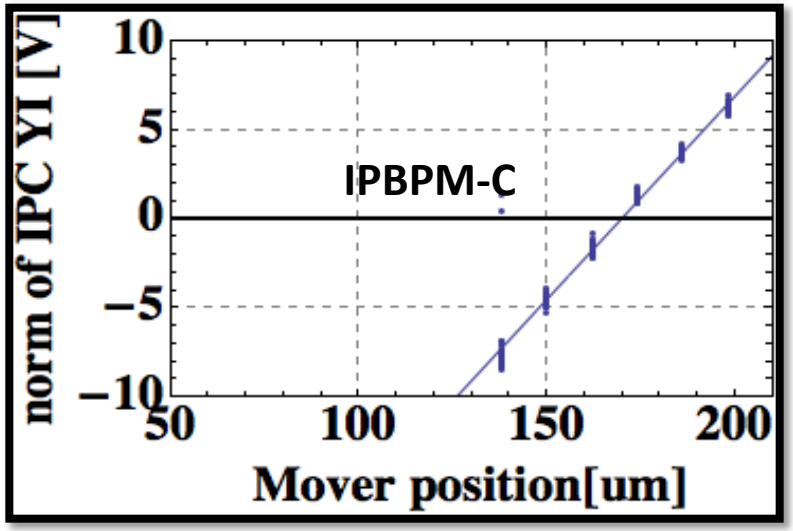


IPCYQ signal

The calibration run by using Low-Q IP-BPM

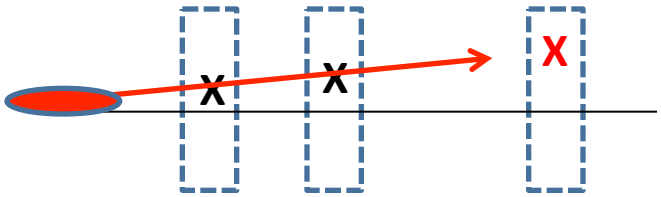




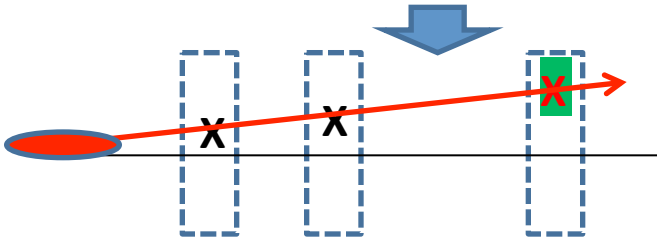


	IP-BPM A	IP-BPM B	IP-BPM C
30dB att.	209.776 [mV/um]	199.849 [mV/um]	227.802 [mV/um]
0dB att.	6.633 [V/um]	6.319 [V/um]	7.203 [V/um]

Simple resolution test by using Low-Q IP-BPM

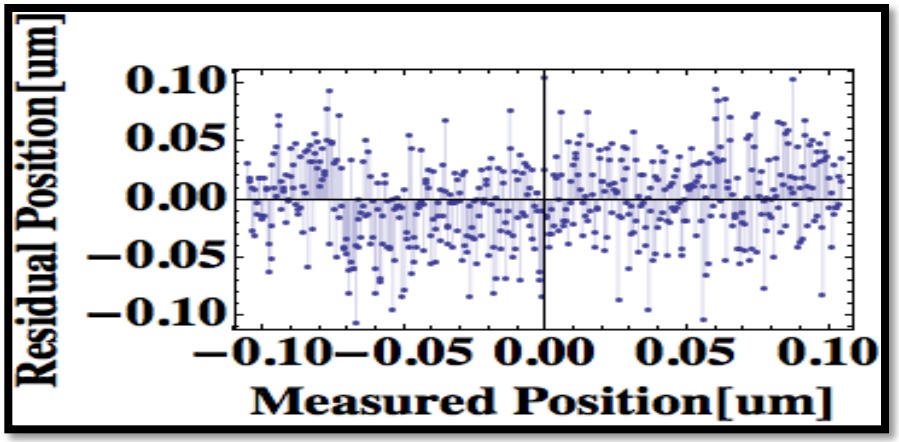


Beam position prediction♪

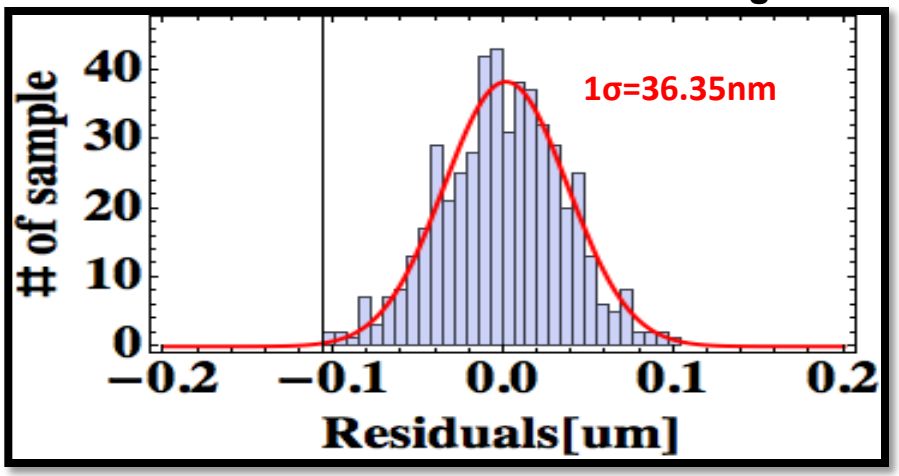


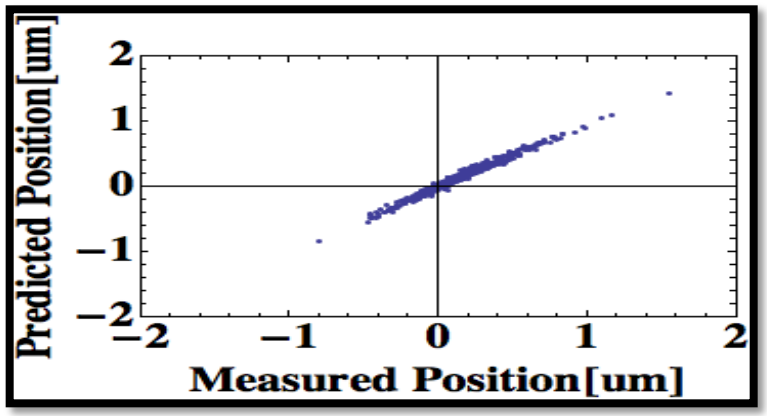
Beam position measurement

Convert to residual



Residual Gaussian fitting





$$\text{Resolution} = \frac{\text{Residual}}{\text{Calibration factor}} = 36.35\ \text{nm}$$

Current status

- **The main problem is that the SVD or Geometrical method results value shows different resolution. We assumed the reason that wrong analysis (most possible reason), new oscilloscope data array is too big. Maybe, I mistake some thing during calculation. Anyway i will solve this problem as soon as possible.**

	IP-BPM A	IP-BPM B	IP-BPM C
SVD 1 sigma	36.3539 nm (0.63x10^10 particles)	36.4339 nm (0.63x10^10 particles)	36.22 nm (0.63x10^10 particles)
with Geometrical factor	19.8387 nm (0.545711)	29.1045 nm (0.79883)	9.16801 nm (0.25312)
Normalized beam current (10^10 particles)	12.4984 nm	18.3358 nm	5.77585 nm

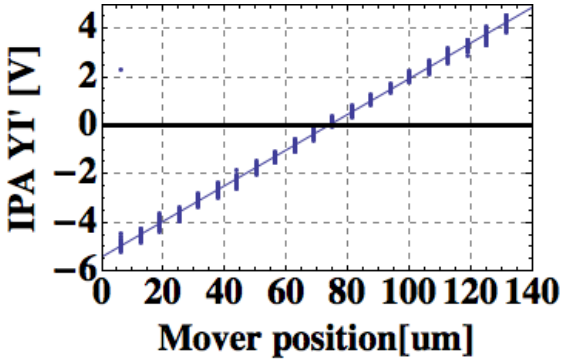
Non-linearity problem

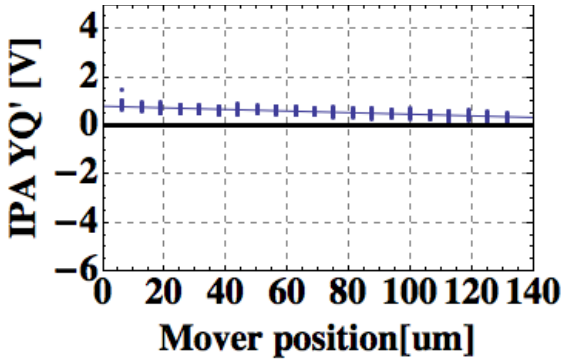
- 1. IPBPM-B shows non-linear calibration slope with wide dynamic range.

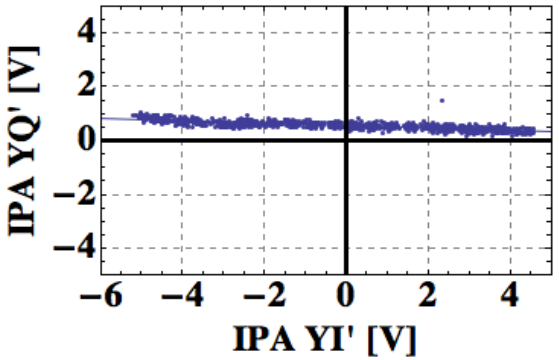
- 2. IPBPM-C shows non-linear behavior for peak point of YI signal due to different vertical mover positions.

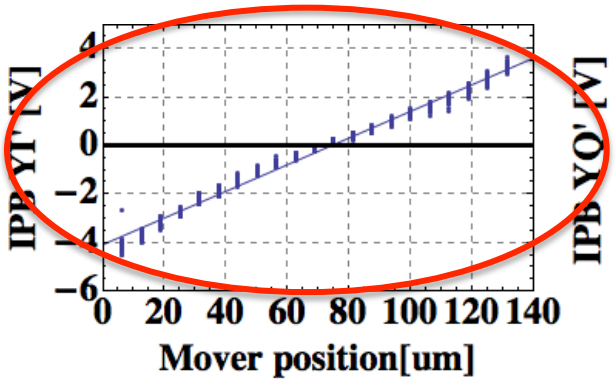
IPBPM misalignment status

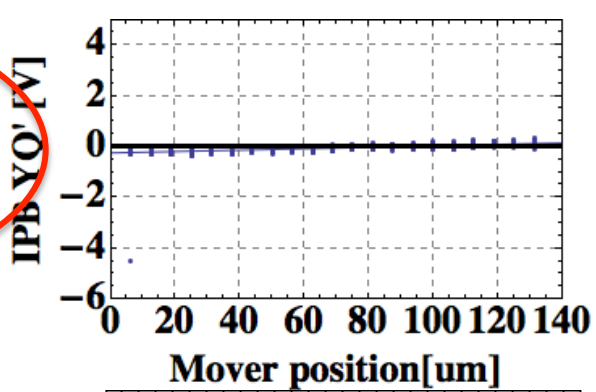
20131213 swing shift data for 40dB att. case

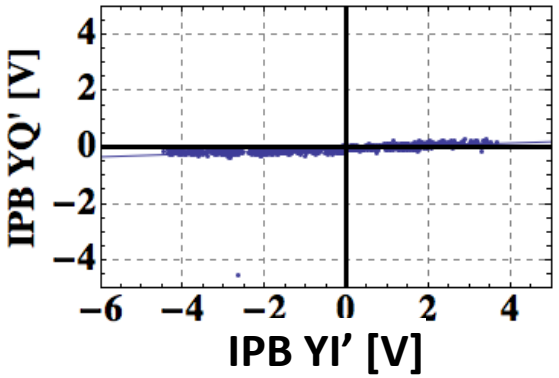


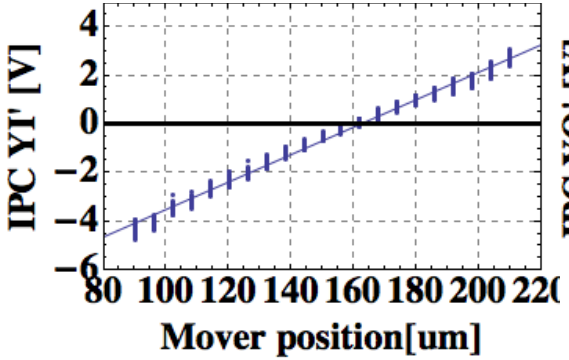


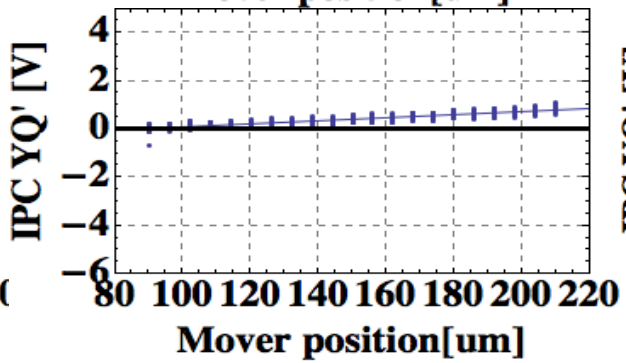


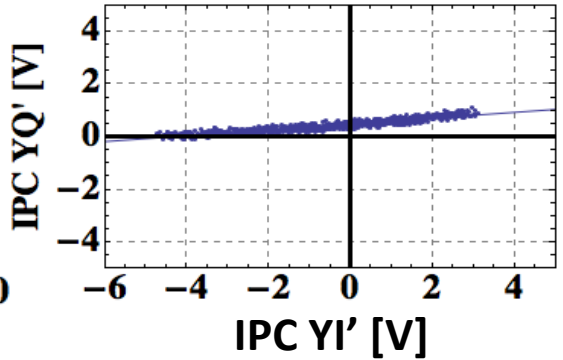












The report for 2014/01/31 day shift

- **2014/01/31 day shift**
- **Main purpose of beam shift:**
  - The study for non-linearity of IP-BPM signals due to different I-Q rotation phase was performed in Jan. 31 day beam shift.
- **The optics condition: 10 x 1000**
- **Summary of beam test:**
  - **We can make more linear behavior of IP-BPM signals due to more precise IQ-tuning.**
  - **Near the center range(±20um) for 30dB att. case, the signals of three IP-BPMs behavior shows linear.**
  - **For the wide range with 30dB att. case, the calibration slope still shows nonlinearity.**

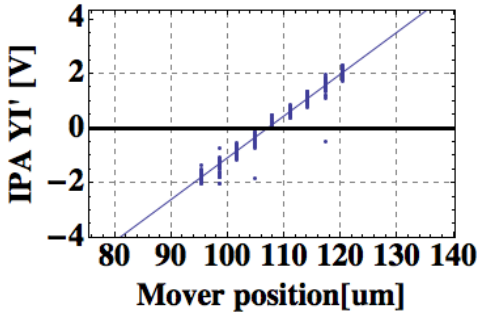
IP-BPM non-linearity problem

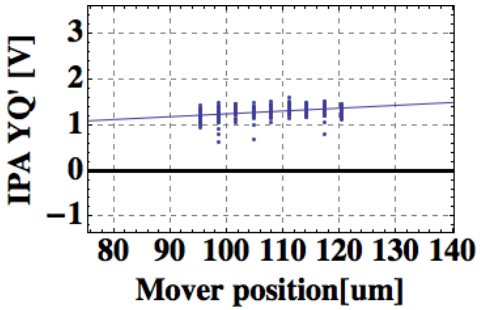
- During the 2014/01/31 day shift, to solve non-linearity problem, we performed non-linearity of IP-BPMs due to IQ-tuning.

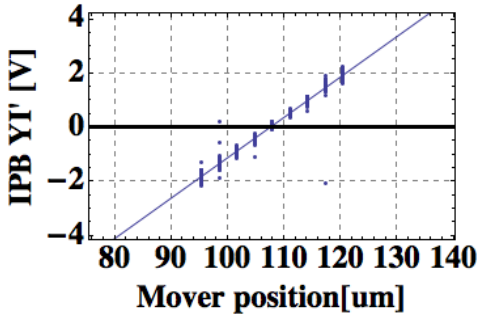
- If, we well tuned IQ-rotation phase we can achieved linear calibration factor with near the beam center range (±20um) and 30dB att case.

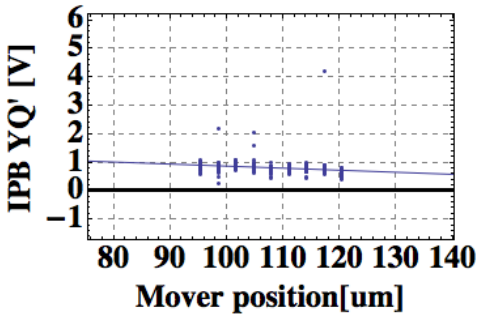
IP-BPM non-linearity problem

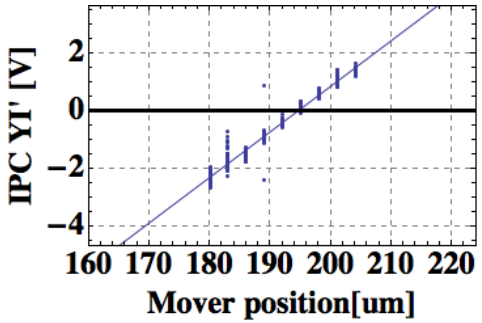
2014/01/31 day shift data 30dB att. case

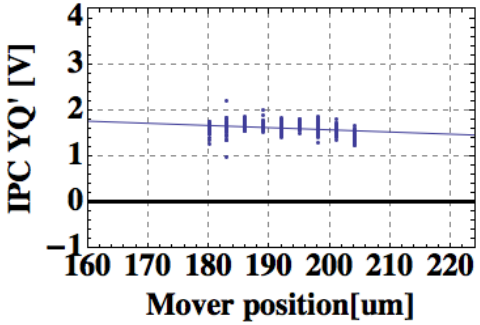




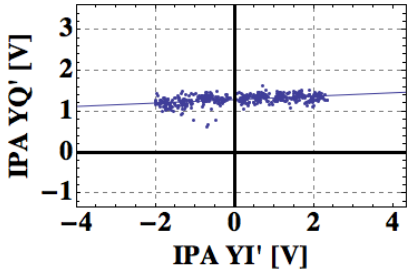


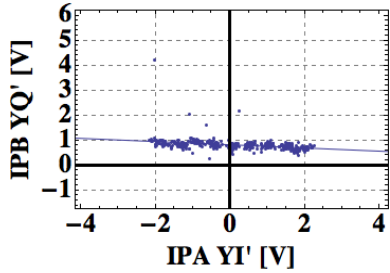


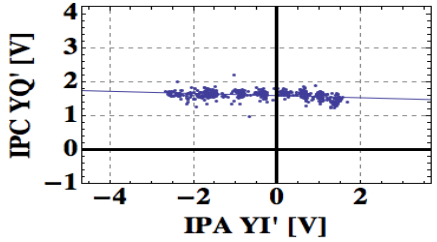




This calibration data sets are for 30dB att. case. Three IPBPMs calibration slopes shows good linearity due to fine IQ-tuning.

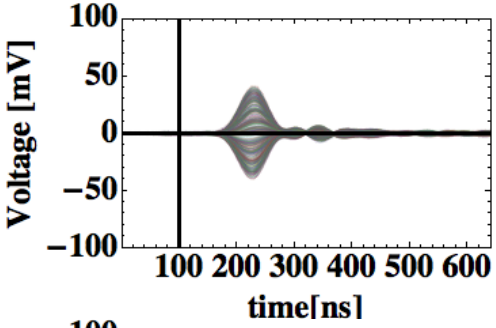




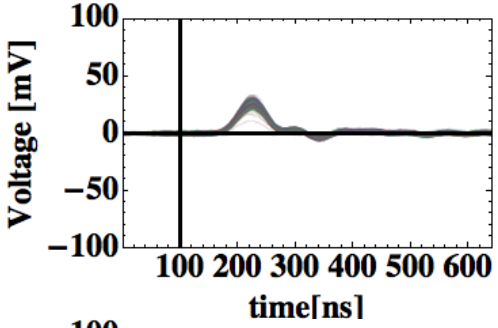


IP-BPM non-linearity problem

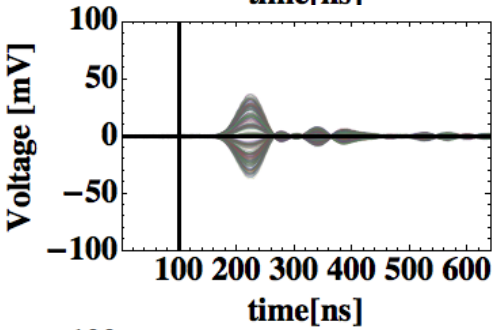
2014/01/31 day shift data 30dB att. case



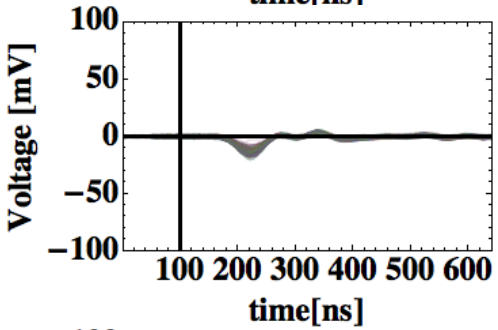
IPBPM-A YI



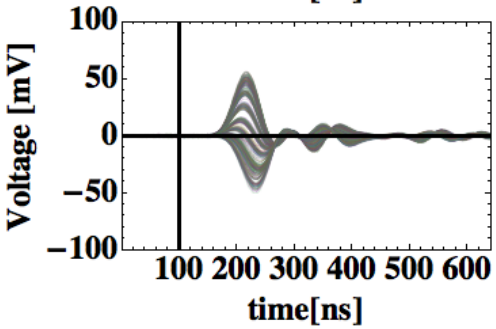
IPBPM-A YQ



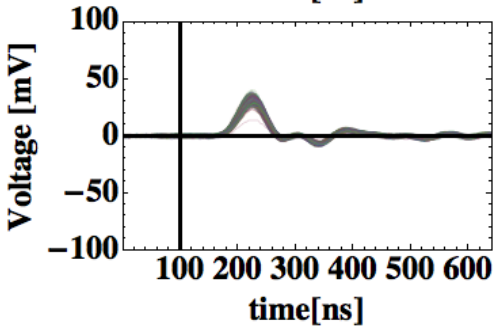
IPBPM-B YI



IPBPM-B YQ



IPBPM-C YI



IPBPM-C YQ

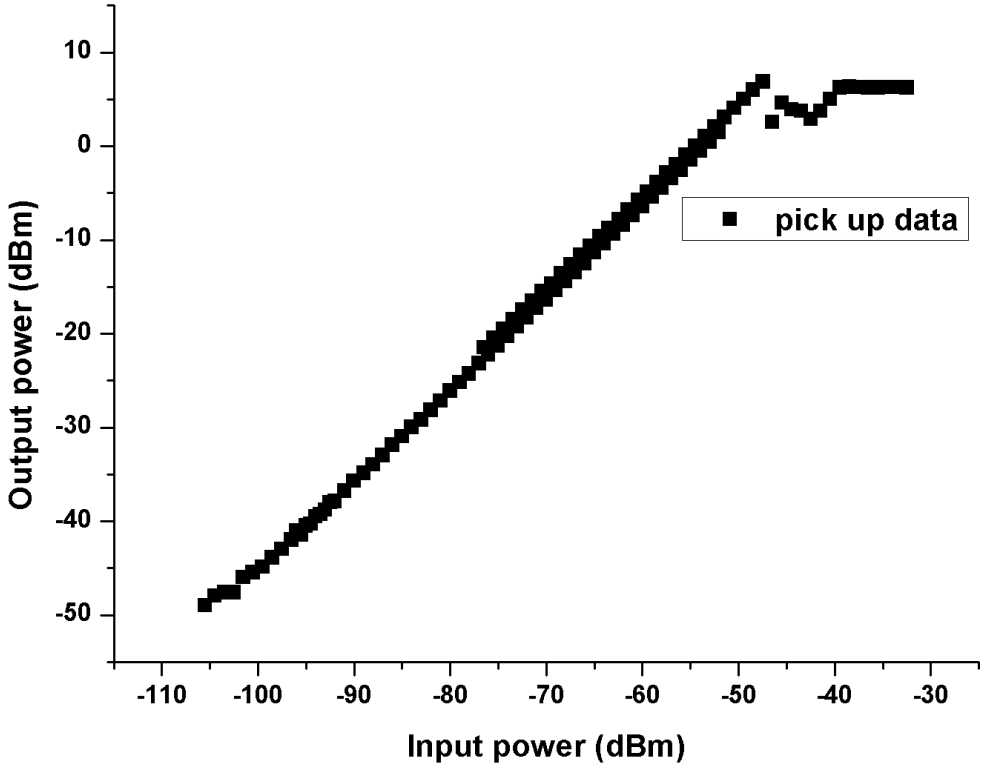
The IPBPM-C peak point of YI signal shows non-linear behavior due to different vertical mover position. This non-linearity effects to calibration study.

Electronics linearity check

Current electronics conversion gain was set to near the 54dB. The linear range was from -46dBm to near the -100dBm.

The limit thermal noise of electronics was enough to detect 2nm beam position. However, if we want a more wide dynamic range with 0dB att. case then we should reduce conversion gain than now.

So, yesterday and today we will change the conversion gain of three electronics from 54dB to 45dB.



Summary and plan

- **We achieved 30nm beam position resolution by using three YI signals. To achieve more small resolution, we should study more detailed.**
- **We had a problem about non-linearity effect for IPBPM-B and C. The non-linearity of IPBPM-B can be solve due to more precise IQ rotation tuning but IPBPM-C peak point non-linearity behavior problem should check more detailed.**
- **To get the more wide dynamic range in the 0dB att. case, we will change the total conversion gain from 54dB to 45dB.**
- **After the non-linearity problem study, we will performed angle misalignment study between IPBPM A and B.**
- **If we can not solve misalignments problem then we will re product three IP-BPMs during summer shut-down period to achieve 2nm beam position resolution.**