# Permanent Quadrupole Study Plan

Kyoto Univ., KEK[A]
Y. Iwashita, H. Fujisawa, H.Tongu,
M. Masuzawa[A], T. Tauchi[A]

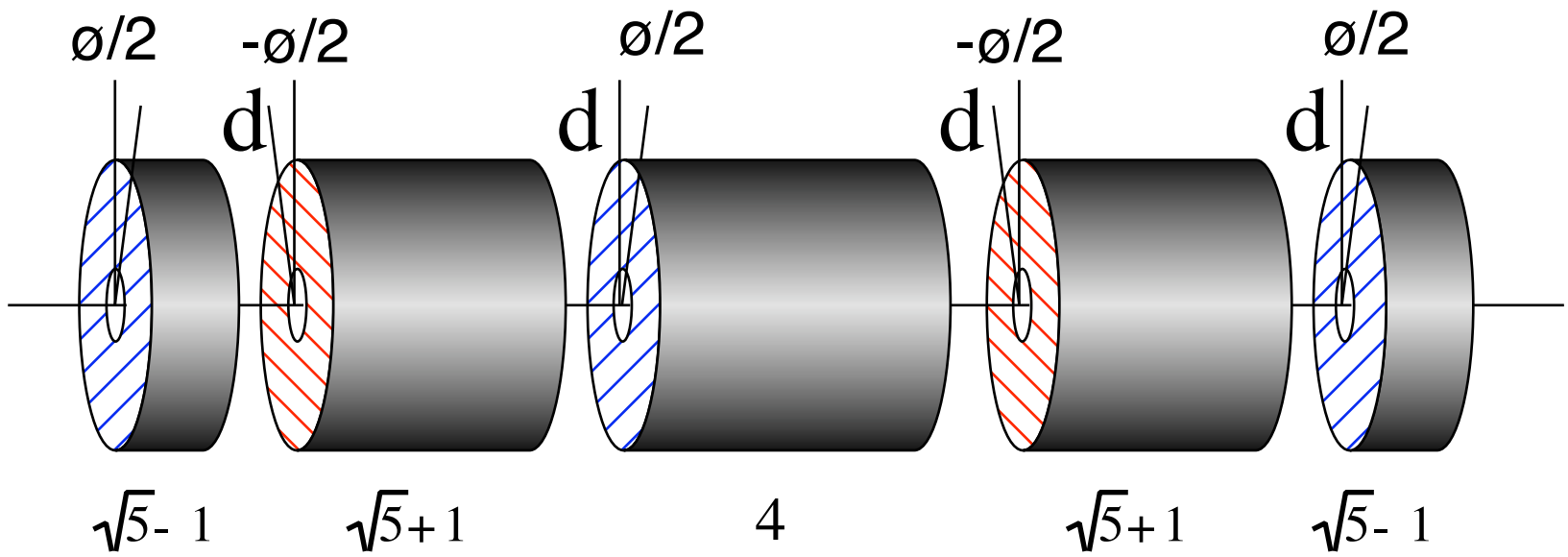
AccLab BmSci ICR KyotoUniversity

# Contents

- Gluckstern's Adjustable PMQ
  ( 5-Ring-Singlet )
- Preliminary Magnetic Field Measurements
- Initial Test Position at ATF2 Beam Line
- Summary

# Gluckstern's Adjustable PMQ – 5-Ring-Singlet –

# Gluckstern's skewless variable PMQ




$$M = R \bullet M2 \bullet R^{-2} \bullet M1 \bullet R^{2} \bullet M0 \bullet R^{-2} \bullet M1 \bullet R^{2} \bullet M2 \bullet R^{-1}$$

4x4 matrix: $M=\begin{pmatrix} Mxx & O^5 \\ O^5 & Myy \end{pmatrix}$ when d=0.

R.L. Gluckstern and R.F. Holsinger: Adjustable Strength REC Quadrupoles, IEEE Trans. Nucl. Sci., Vol. NS-30, NO. 4, August 1983, http://epaper.kek.jp/p83/PDF/PAC1983_3326.PDF

AccLab BmSci ICR KyotoUniversity

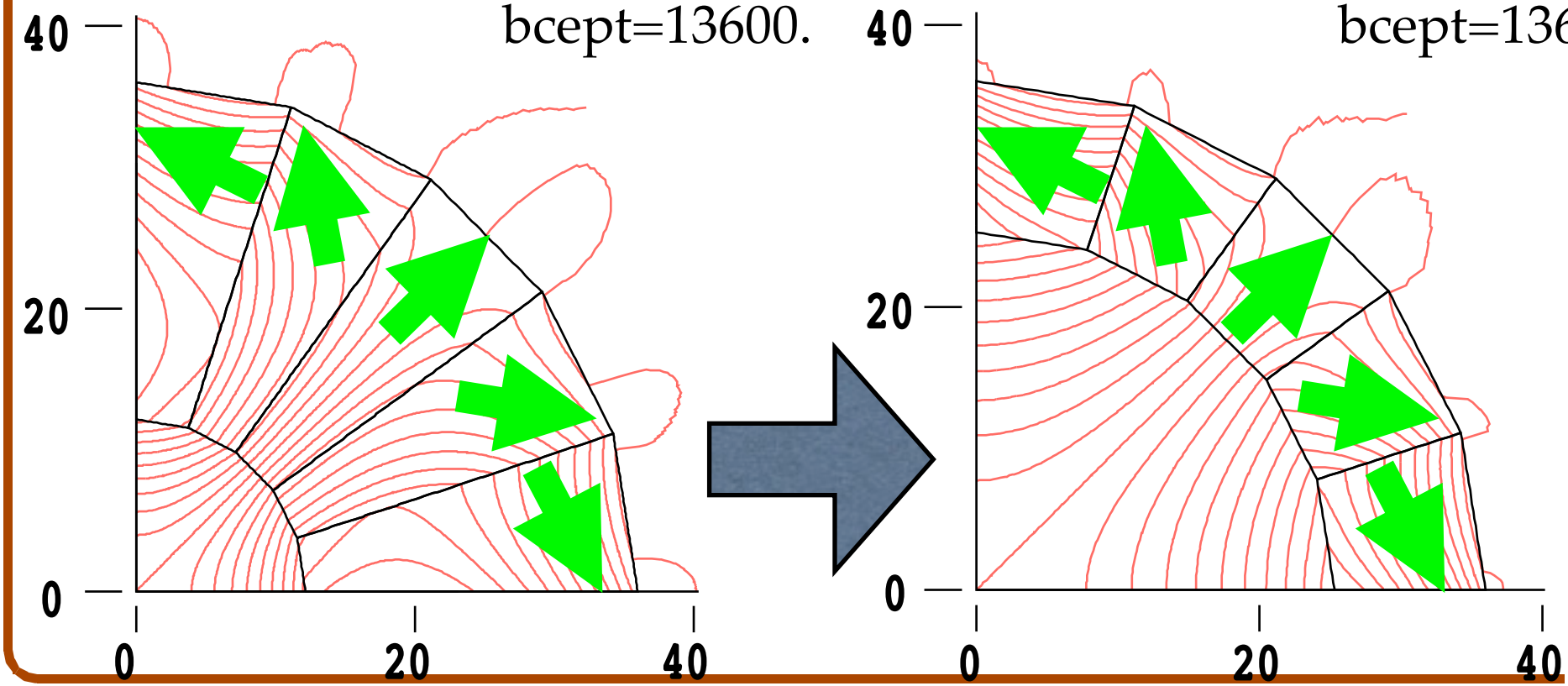
# Test at ATF2 – replace QD0

Req'd spec for QD0: L=45cm, ø50mm, G=13T/m

OD: ø72 (=2x(56-20))  GL=5.85 T

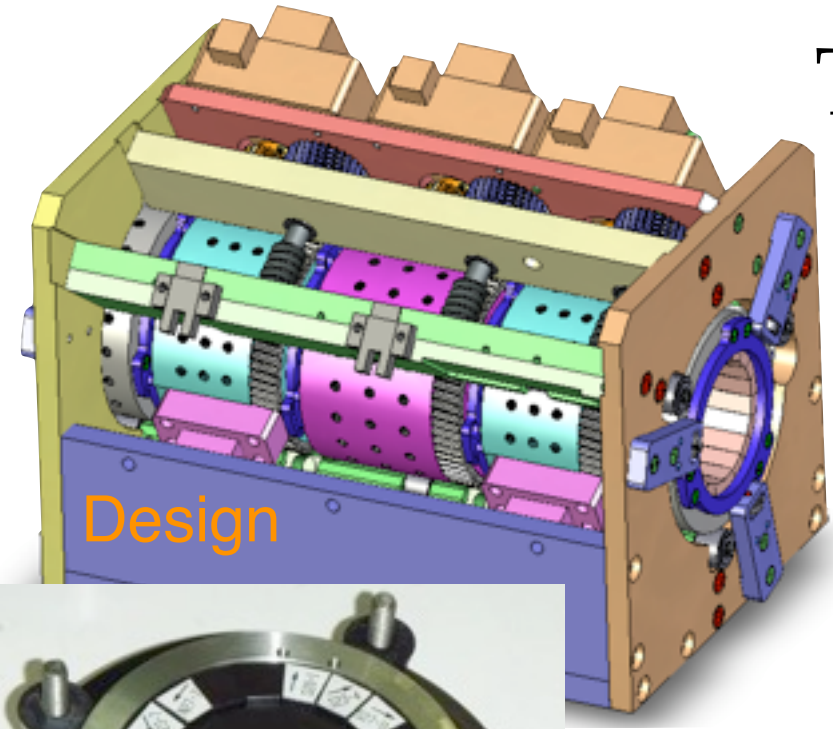
140T/m @ ø24  48H hcept=-12890, bcept=13600.

30T/m @ ø50  48H hcept=-12890, bcept=13600.



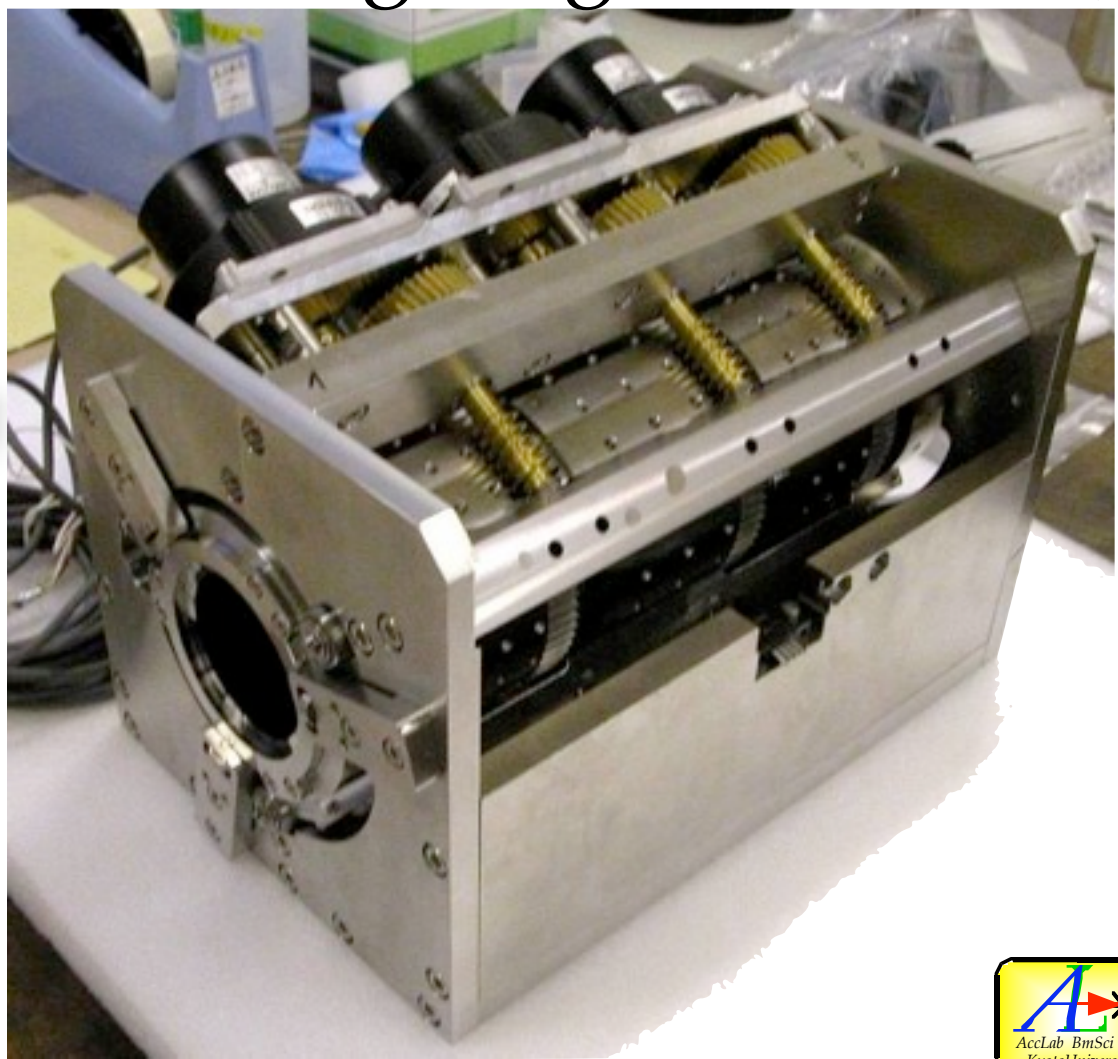
# Gluckstern's 5-ring PMQ Singlet(2):

## "Continuously Adjustable" PMQ fabricated




Disc(20mm)

## The 5-ring singlet PM-FFQ

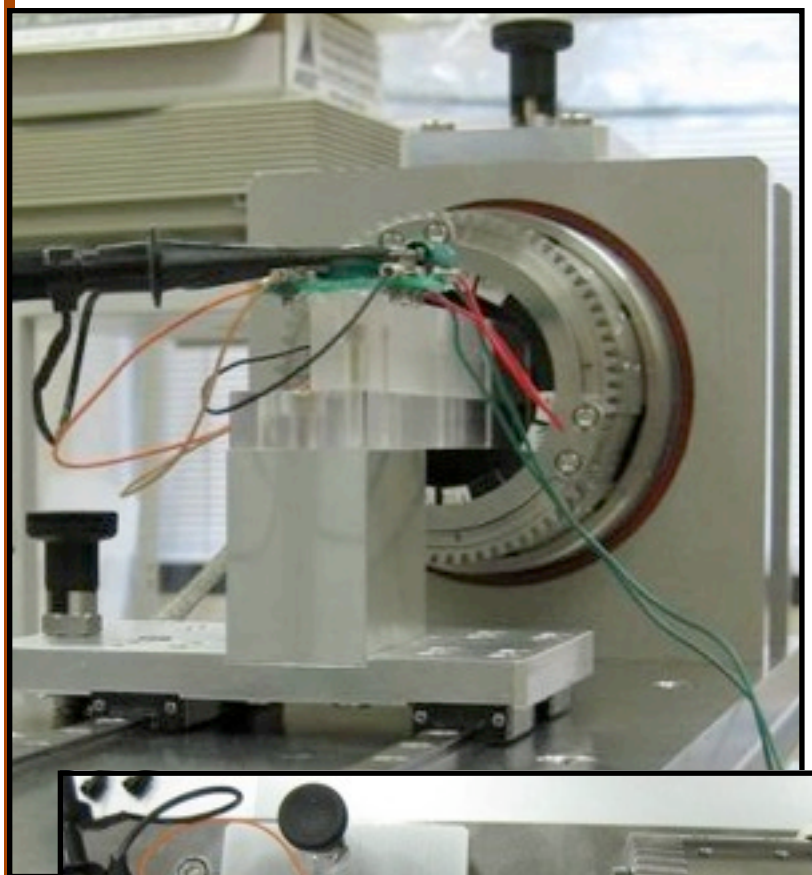


# Preliminary Magnetic Field Measurements

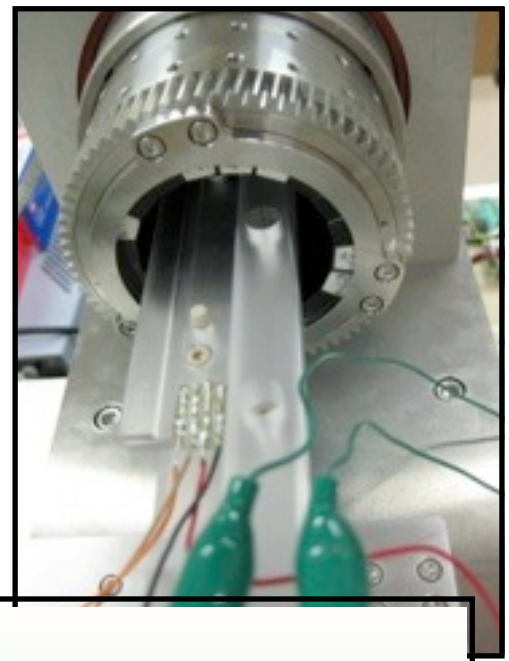
— based on the last year's —

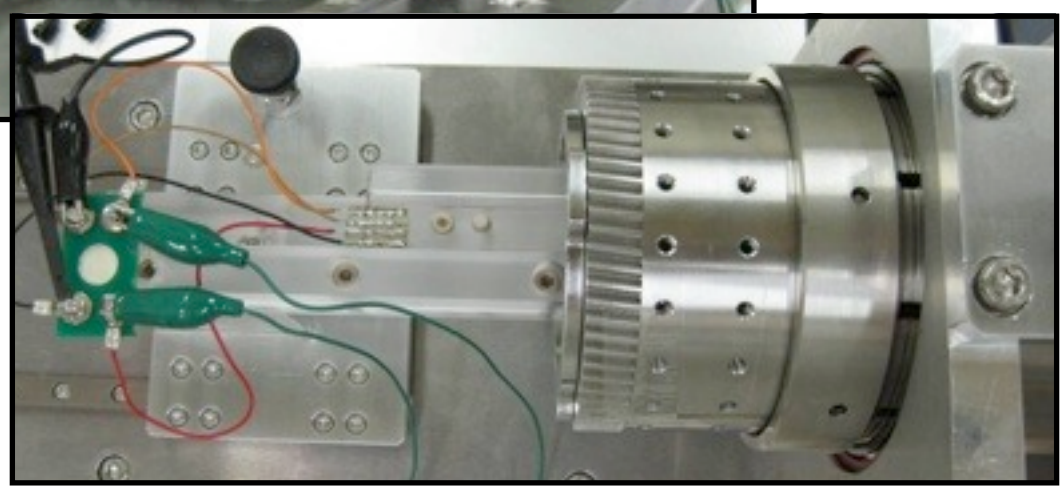
AccLab BmSci ICR KyotoUniversity

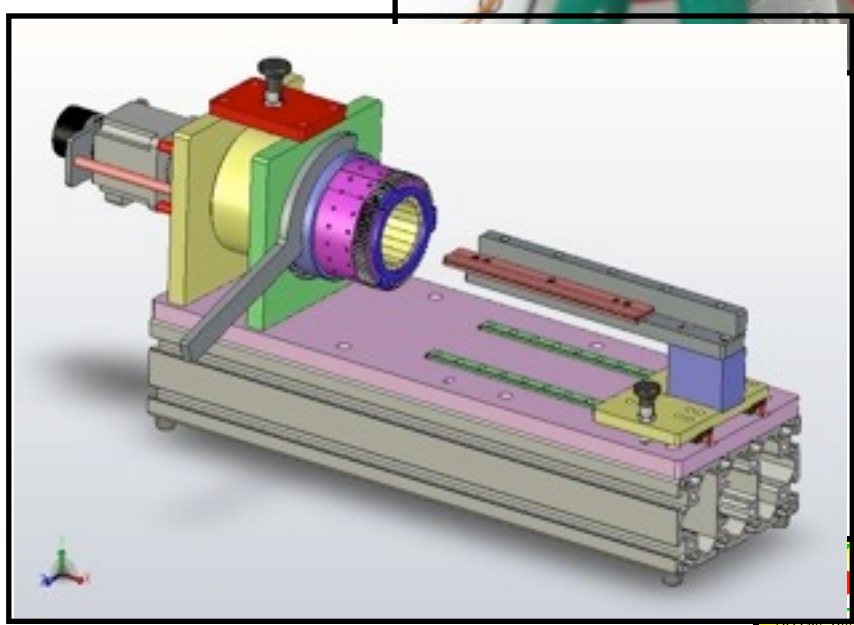
# Field Measurement:
## Rotating magnet instrument



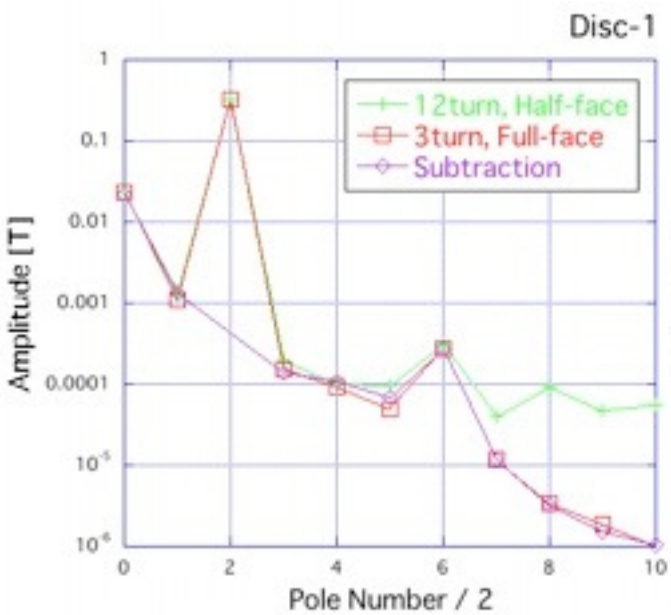
Magnets are rotated to find their magnetic center against the outer shell.

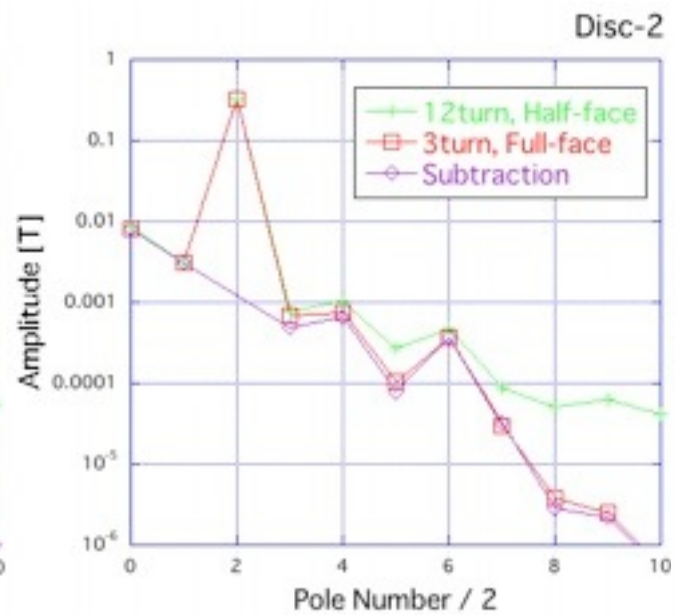


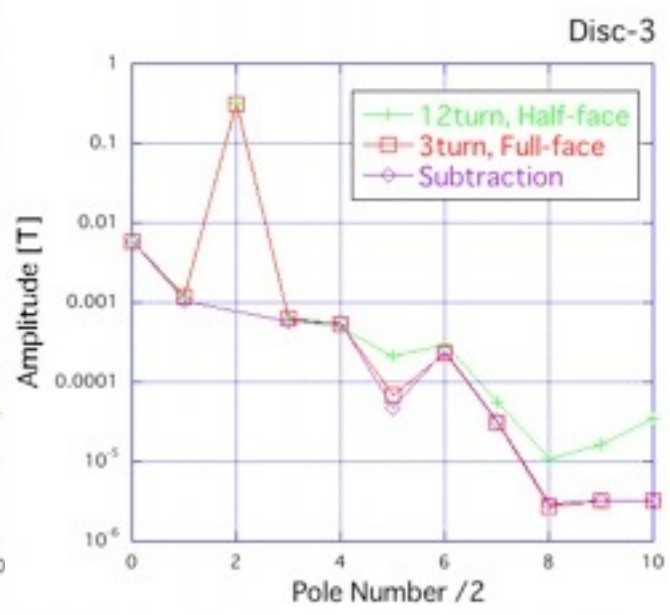


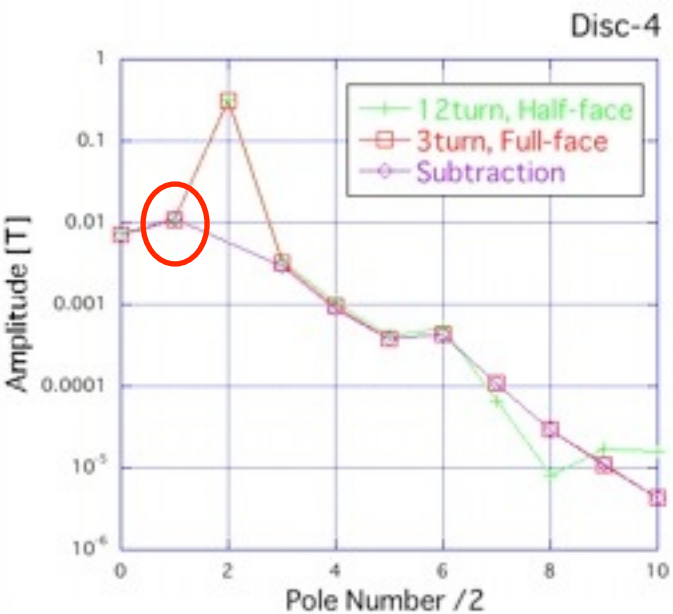


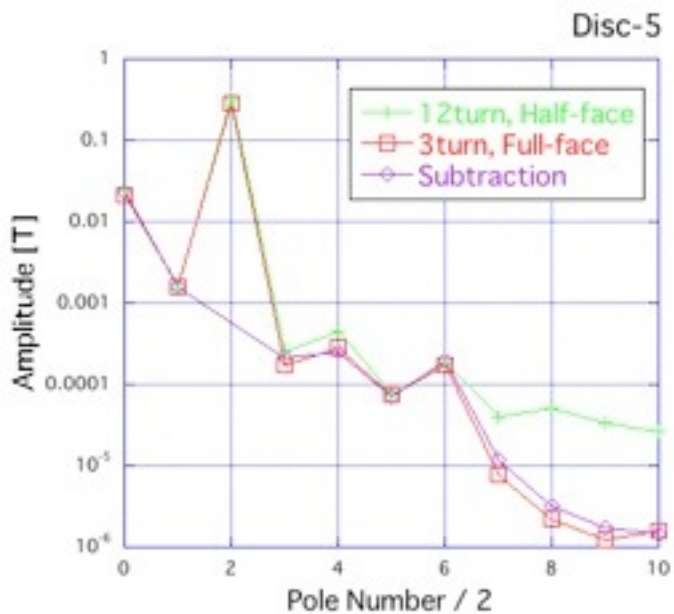
# Measurement on Each Magnet



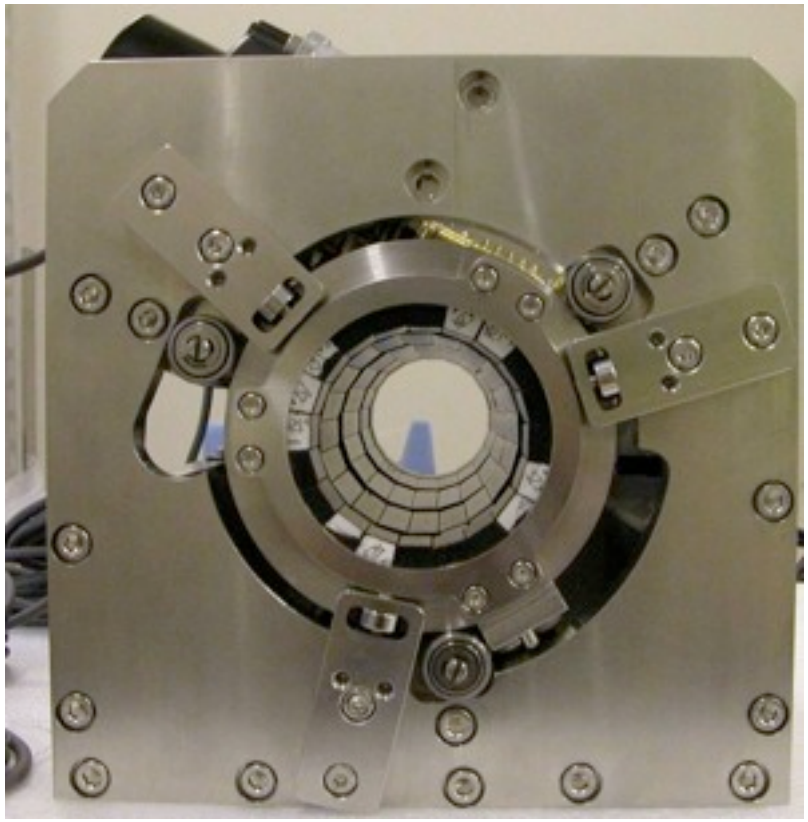



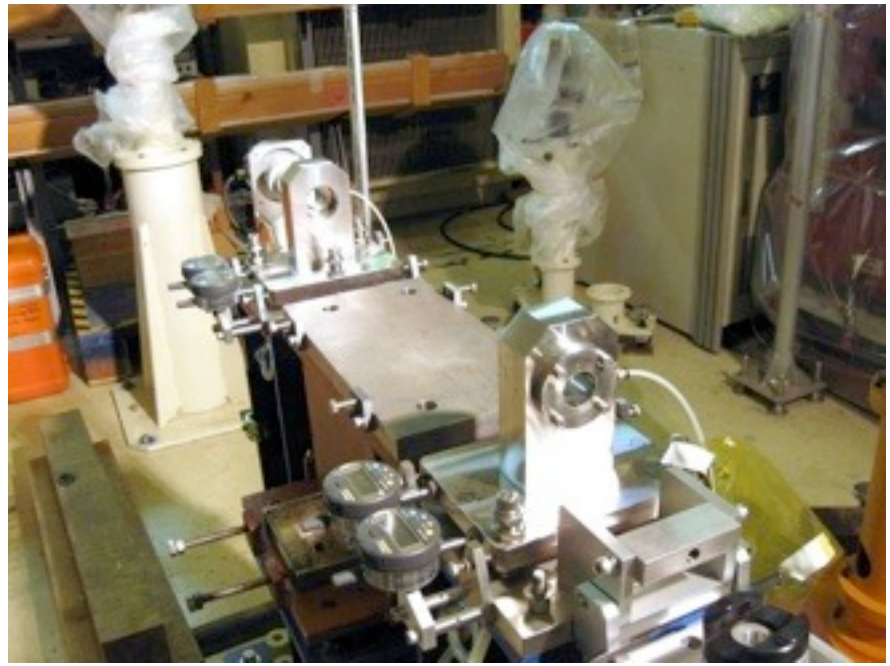



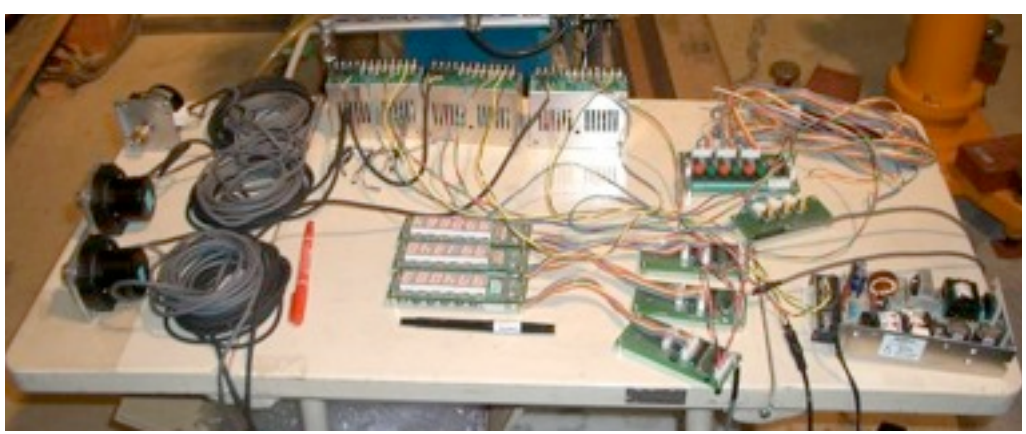

Normalized at r=1cm

AccLab BmSci ICR KyotoUniversity

# By Rotation Coil







# Reproducibility of Quadrupole

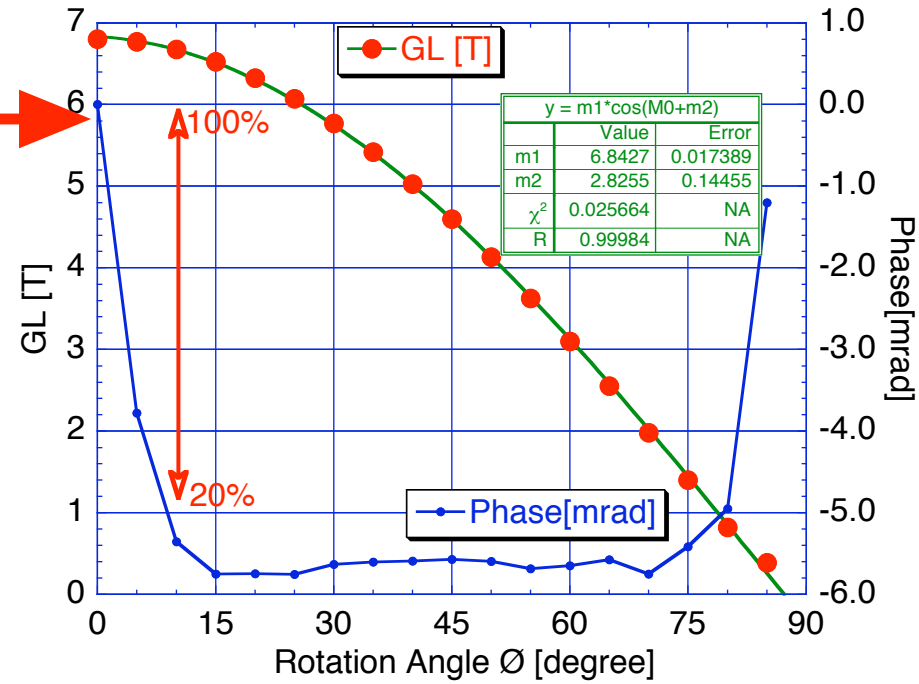
## GL for ATF2: 5.85T

Measured at r=11mm

Fitting by

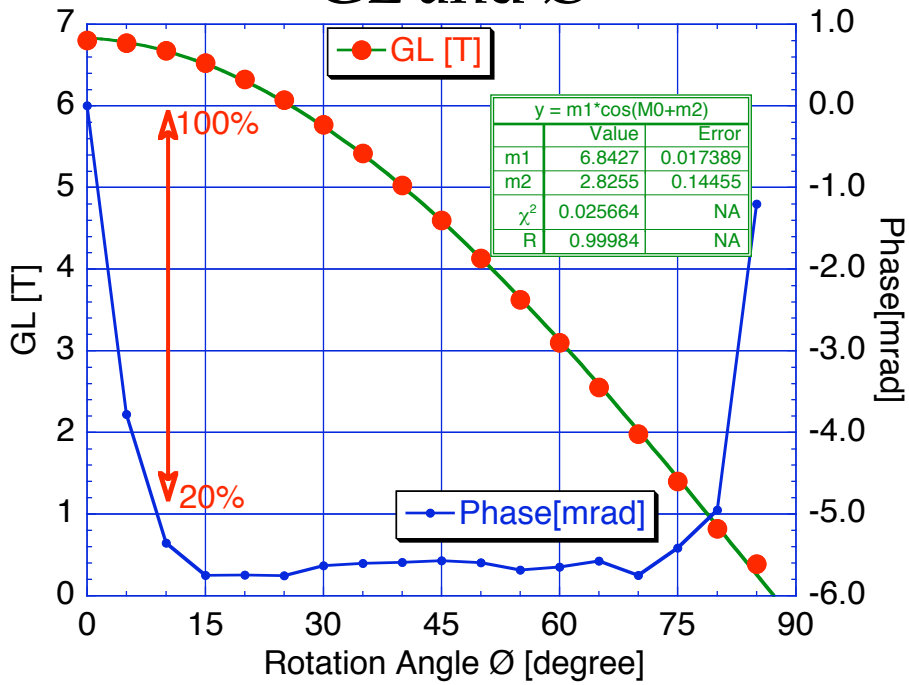
m1 x cos(ø+m2)

(0≤ø≤80°)

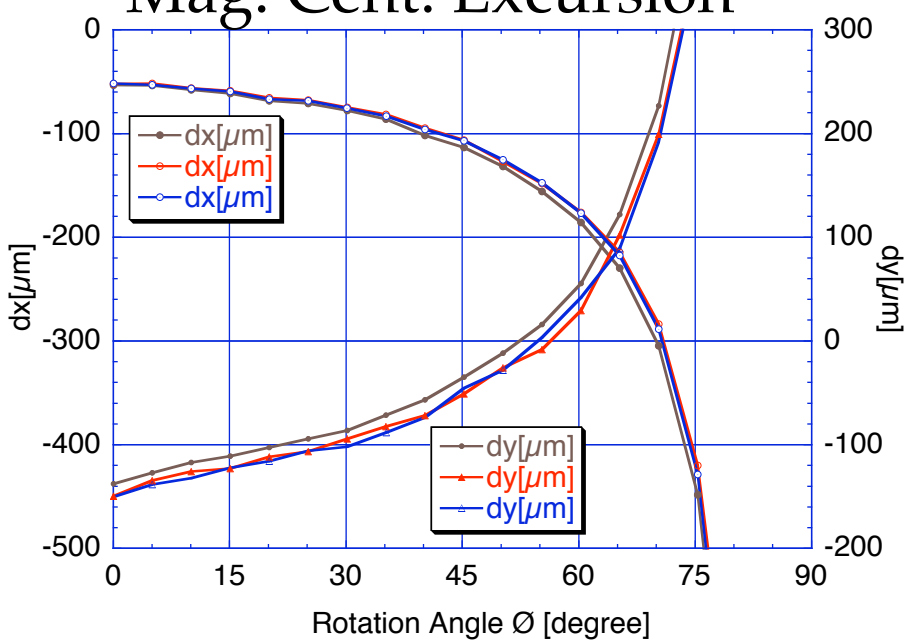



| No. | m1 [T] | Error [$10^{-3}$T] | m2 [mrad] | Error [mrad] |
|---|---|---|---|---|
| 1 | 6.851 | 6.9 | -48.0 | 1.06 |
| 2 | 6.846 | 7.2 | -45.1 | 1.11 |
| 3 | 6.847 | 7.1 | -48.8 | 1.08 |
| 5 | 6.858 | 8.7 | -51.4 | 1.33 |
| mean | 6.851 | 7.5 | -48.3 | 1.15 |

## GL and Ø




## Mag. Cent. Excursion



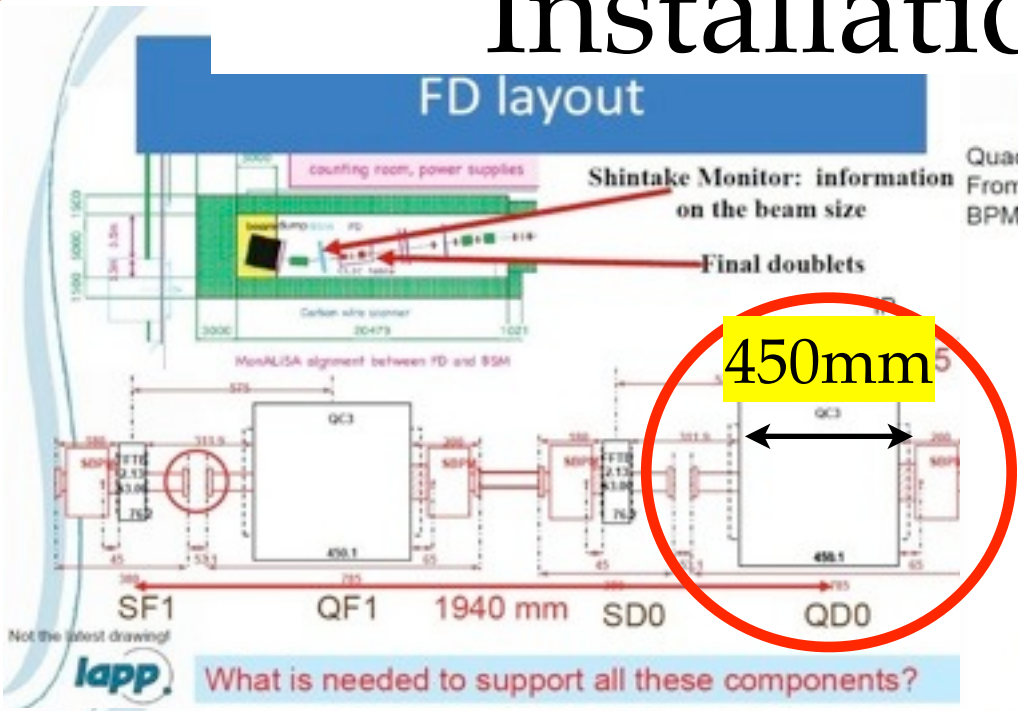

# Observations

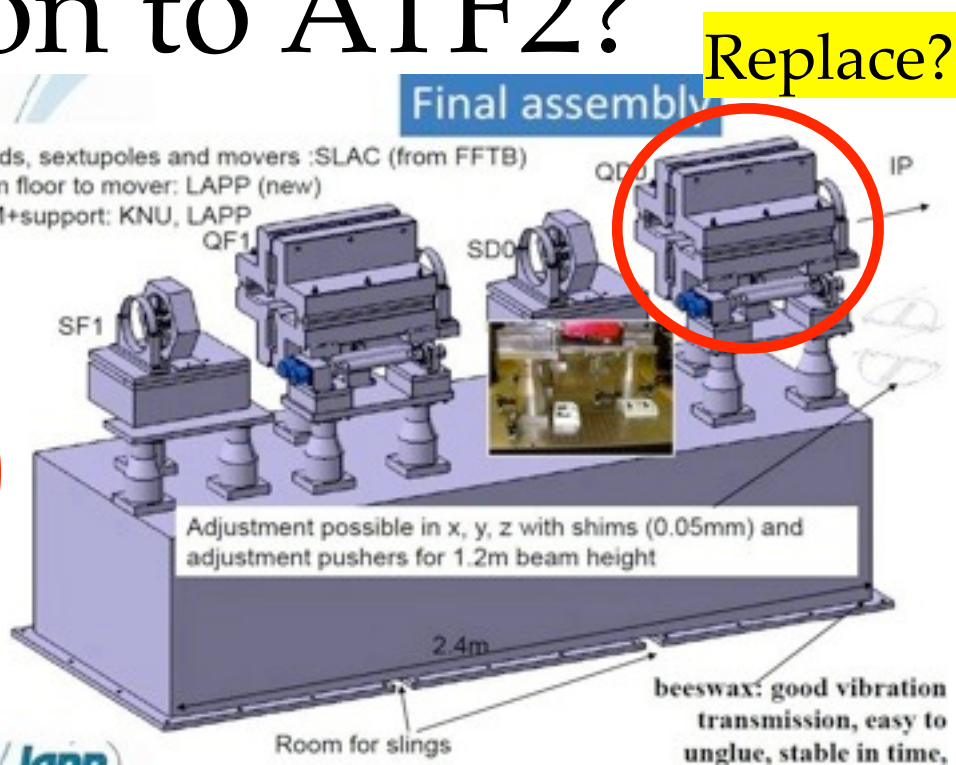
- GL (100~20%) can be covered.
- Angle adjustment needed.
- Good reproducibility.
- But the value is big
  – needs adjustment.
- Minor mechanical modification improved the friction.

AccLab BmSci ICR KyotoUniversity

# Initial Test Position at ATF2 Beam Line

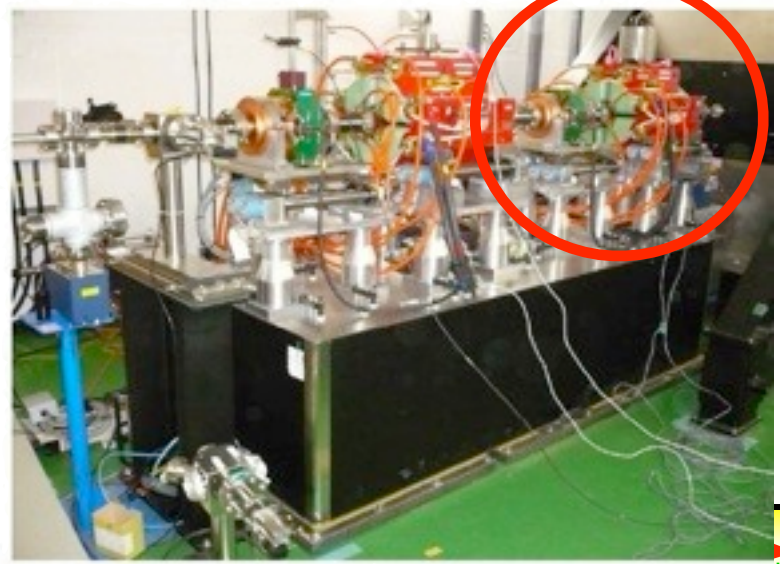
# Installation to ATF2?





new BPM Needed!



# Study Plan

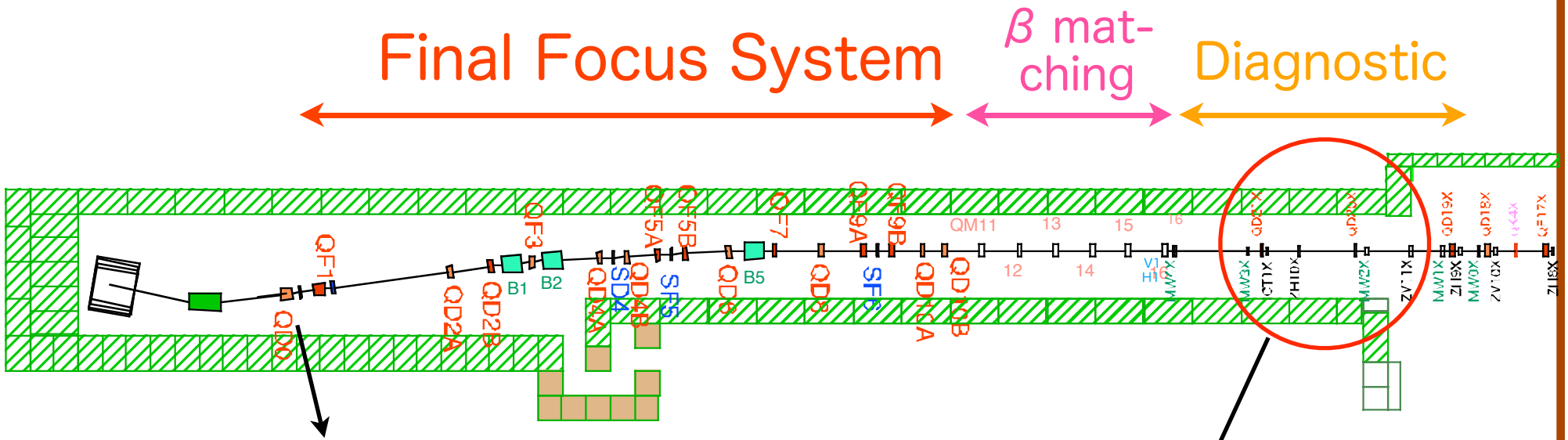
- Because the test at QD0 position interferes with the current activity, different position was sought.
- We need experiences in using this new device.
- Practical experience can be taken through operation at the upstream (no interfere with the original QD0)

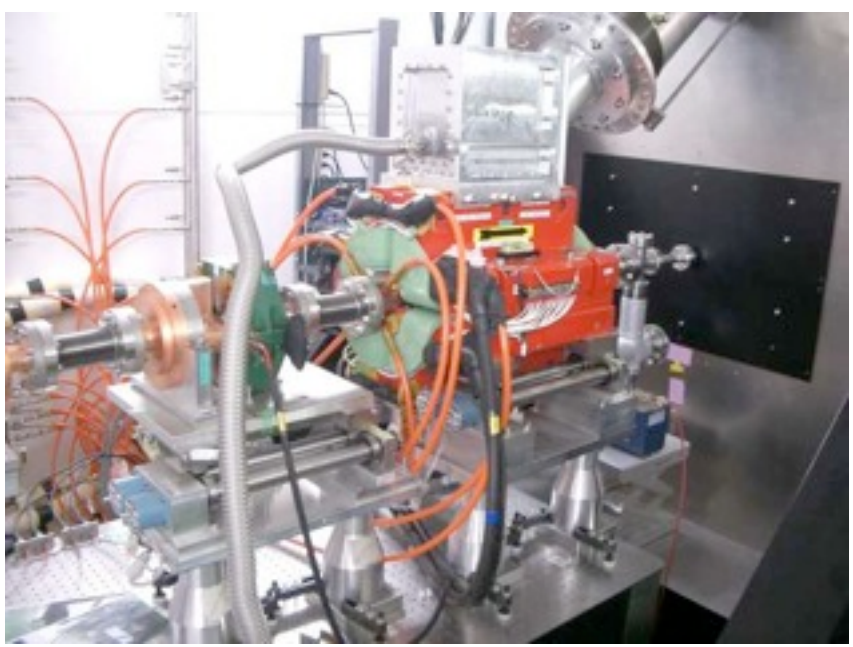
➡ Vacuum flange has to be fixed to the duct after the fabrication.

➡ Develop easy dismantle method.

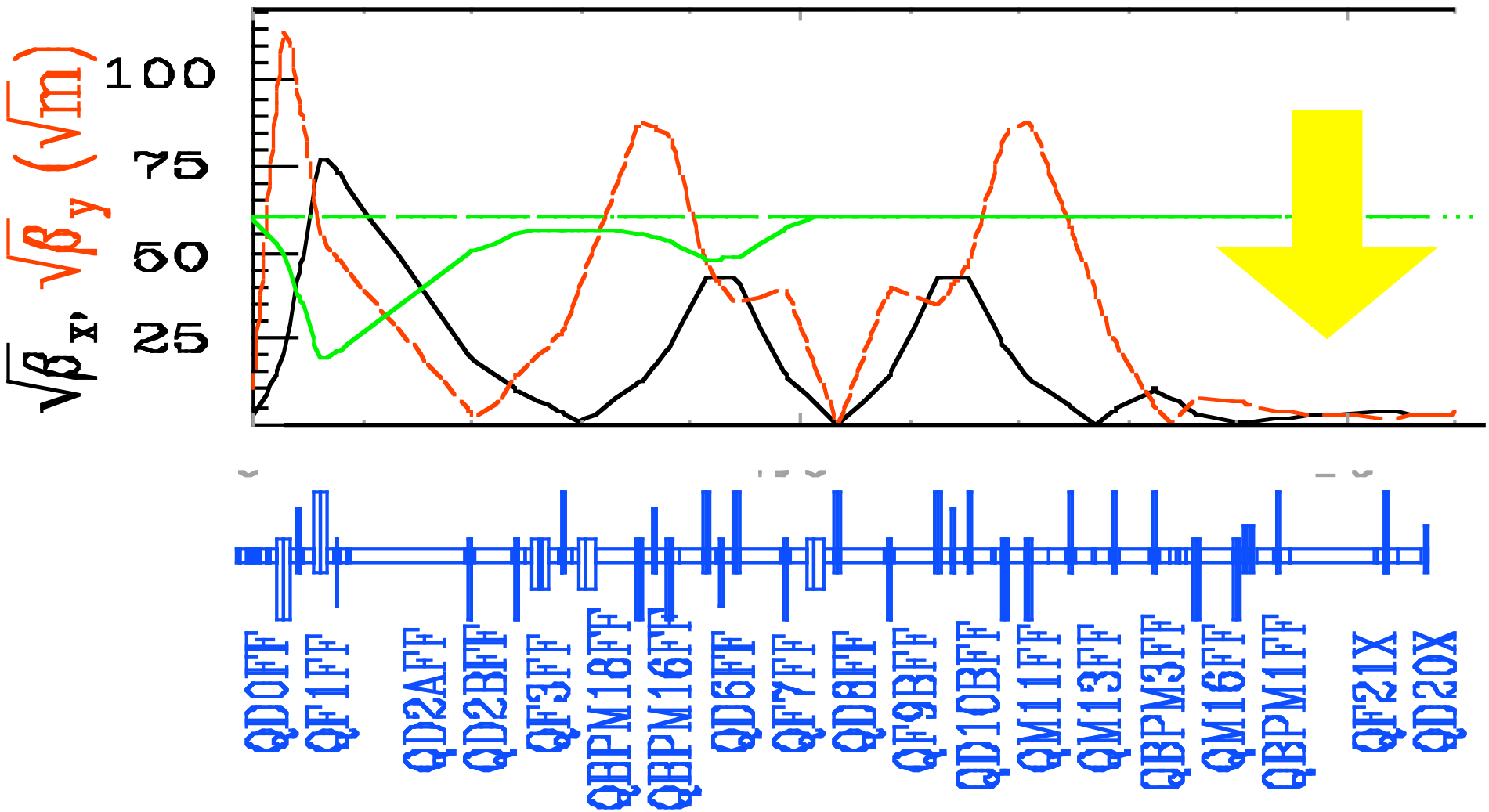
➡ Vibration evaluation (<50nm?), etc.

# Candidates for PMQ Location



# Optics


100
75
50
25
$\sqrt{\beta_x}, \sqrt{\beta_y}$ ($\sqrt{m}$)
QD0FF
QF1FF
QD2AFF
QD2BFF
QF3FF
QBPM18FF
QBPM16FF
QD6FF
QF7FF
QD8FF
QF9BFF
QD10BFF
QM11FF
QM13FF
QBPM3FF
QM16FF
QBPM1FF
QF21X
QD20X

# What can be Tested?

- Isn't just magnetic field measurement enough?
  No!— Only GL is measured by rotation coil.
  (If so, any beam test is waste of time. )
- What can be monitored?
  — Profile (size) by wire scanner
  — Position  by BPM
  — Size  by Shintake Monitor
- Evaluation: x-y coupling, high order, stability, reproducibility, etc.
- Practical experience: installation, stability...

# Summary

- Good reproducibility in magnetic center excursion and plane tilt, but they were big.

  ➡Readjusting the magnet pieces in the holder.

  ➡May use tree DOF's (three motors).

- Fix vacuum flange afterwards.

- Practical experience will be taken through operation at the upstream (no interfere with the original QD0)

# Appendix

# Demagnetization by Radiation

Energy deposit

| | GLD | SiD | SiD (by Takahashi) | neutron |
|---|---|---|---|---|
| BeamCAL | 17mW | 13mW | 29mW | |
| QD0 | 94mW | 97mW | 147mW | $10^5$ [n/cm$^2$s] |
| SD0 | 11mW | 11mW | 11mW | |
| QF1 | 16mW | 18mW | 15mW | |
| SF1 | 0.4mW | 0.3mW | 1mW | |

very preliminary results by T.Abe (university of Tokyo), in private communication

Demagnetization by 14MeV neutron

| Magnet | Demag. ratio [/1x10$^{13}$n/cm$^2$] | iHc [Oe] |
|---|---|---|
| 47H | 10.2% | |
| 44H | 1.8% | 16 |
| 39SH | 0.7% | 21 |
| 32EH | 0.3% | 30 |

T. Kawakubo, et al., The 14th Symposium on Accelerator Science and Technology, Tsukuba, Japan, November 2003, pp. 208-210, in Japanese, http://conference.kek.jp/sast03it/WebPDF/1P027.pdf

Continuous 1mo.(2.6x10$^6$s) operation may cause about 0.01[%] of (reversible?) demagnetization on NEOMAX 32EH. (1% for 10 years) ... needs more info.

AccLab BmSci ICR KyotoUniversity