

Main Ring Magnet System

Magnet design & measurements Installation, survey & alignment

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Superconducting magnet Design & measurements

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H. Yamaoka
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Power supply design, tuning Installation & Cabling

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T. Oki
T. Kawamoto
T. Sueno

Retired but still active, no time to rest

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K. Tsuchiya

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I. After the earth quake

– Tunnel Damage

- Visible mostly at the expansion joints
- Survey tunnel from inside and outside

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II. Current status

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– Field measurement

– R&Ds

- Rotation mechanism of the sextupole magnets
- Additional windings of the correction coils of the sextupole magnets

III. Activities for the fiscal year 2012

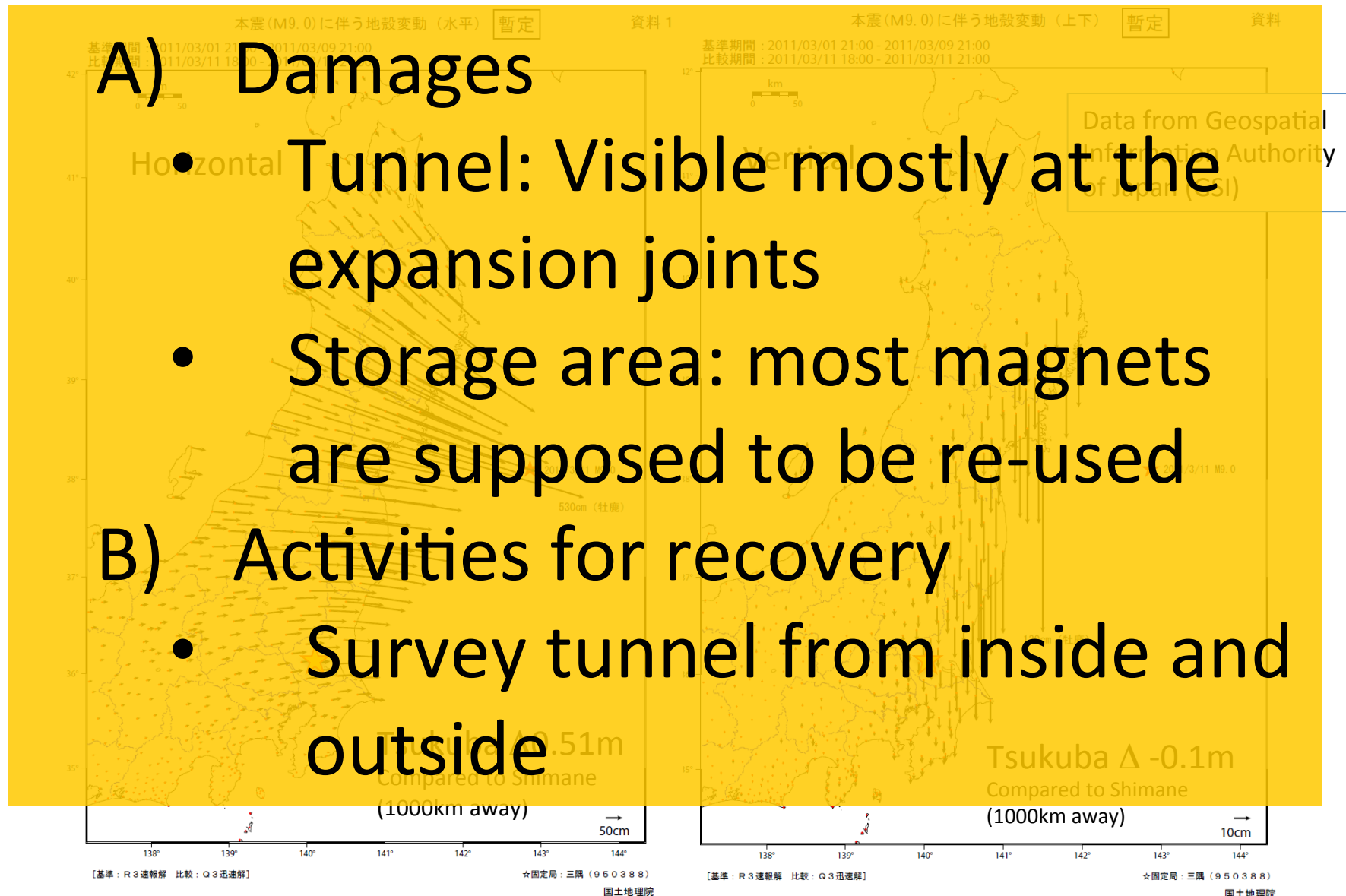
I. After the earthquake

A) Damages

- Horizontal Tunnel: Visible mostly at the expansion joints
- Storage area: most magnets are supposed to be re-used

B) Activities for recovery

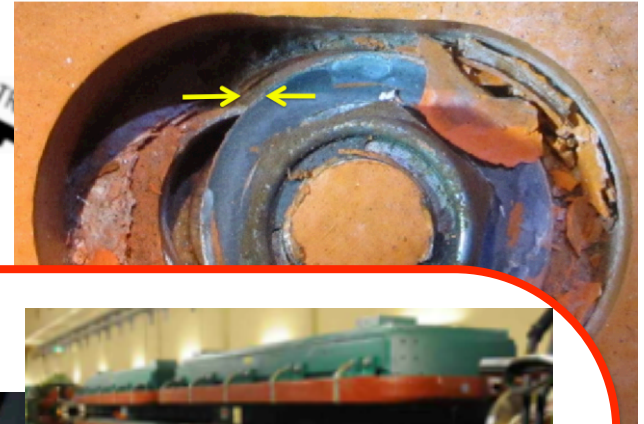
- Survey tunnel from inside and outside



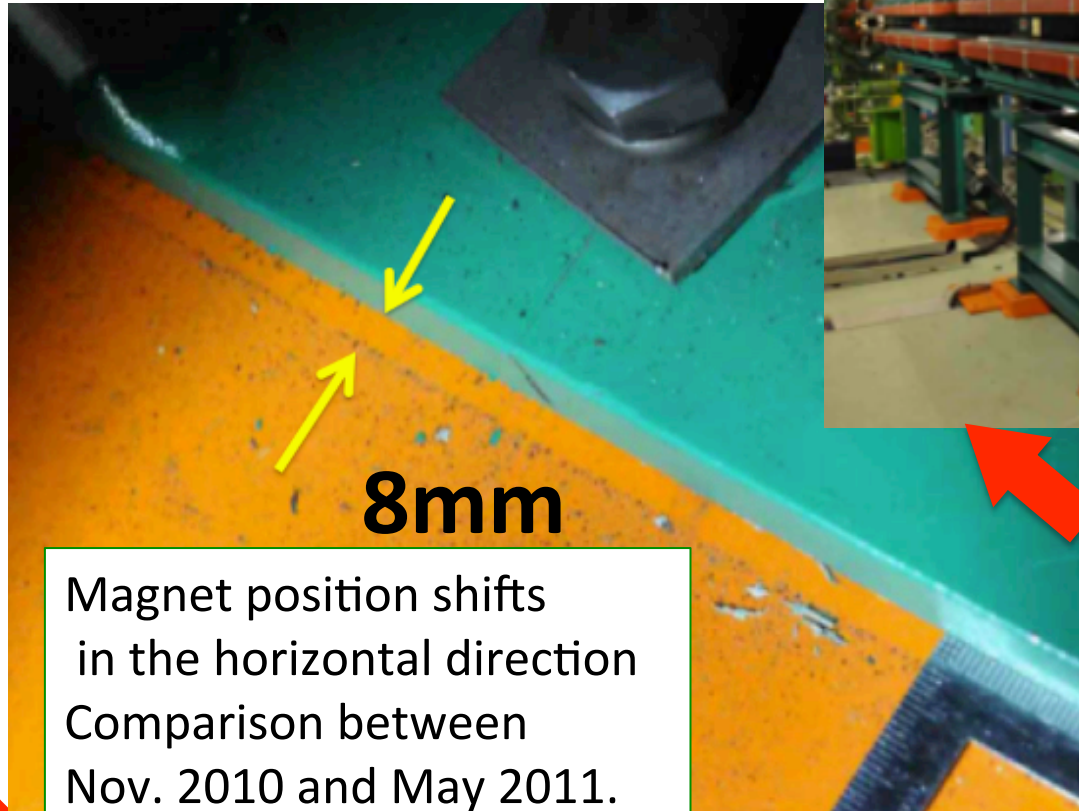
Tsukuba

OL111 B2E.85

2mm程ずれた跡有り



Few mm displacement



8mm

Magnet position shifts
in the horizontal direction
Comparison between
Nov. 2010 and May 2011.

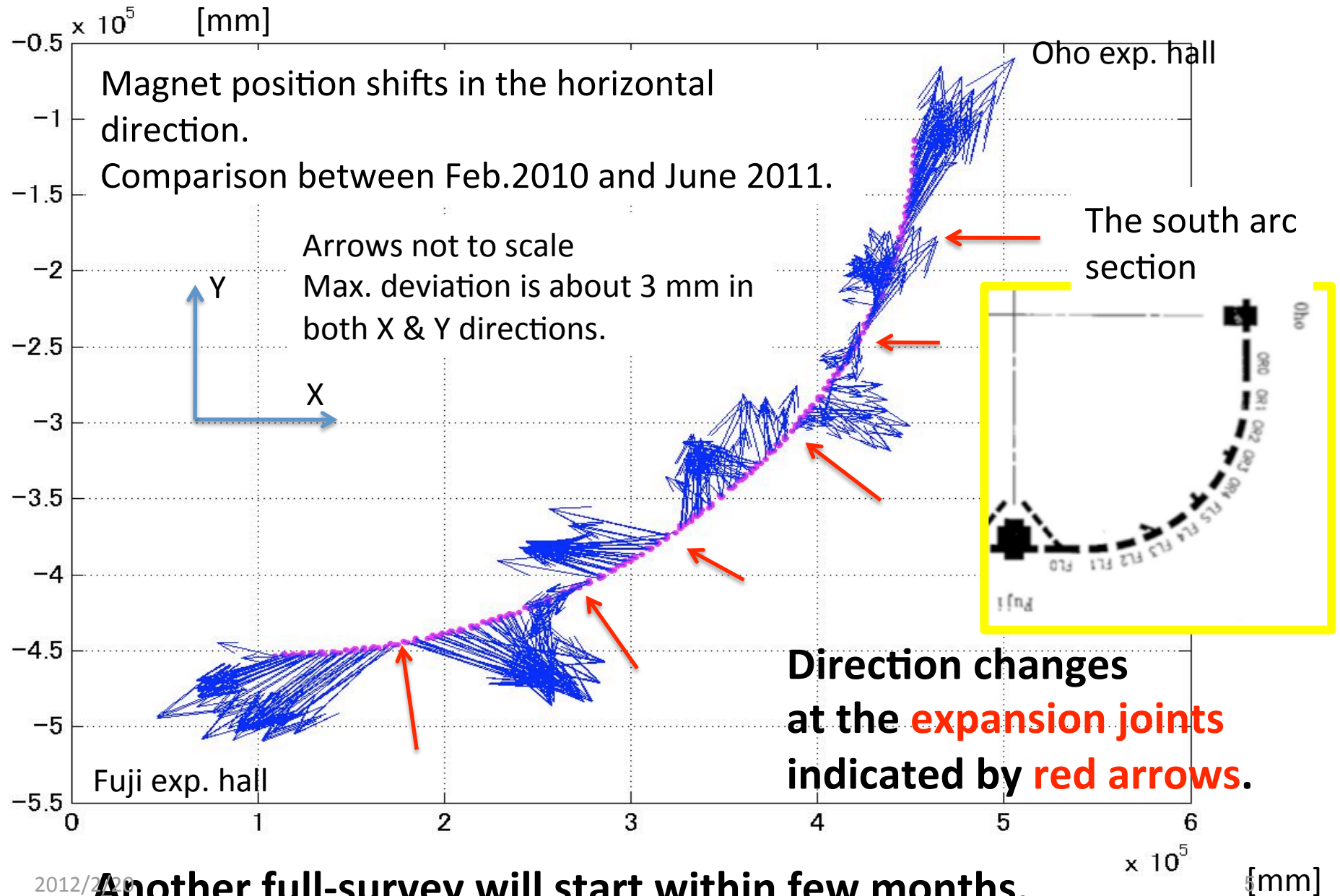
2012/2/20

phenomena

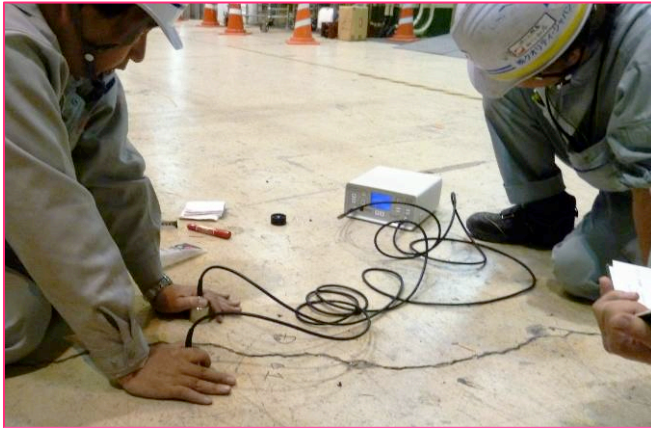
2011/03/22

Uneven floor

Survey tunnel from **inside** and outside (1)

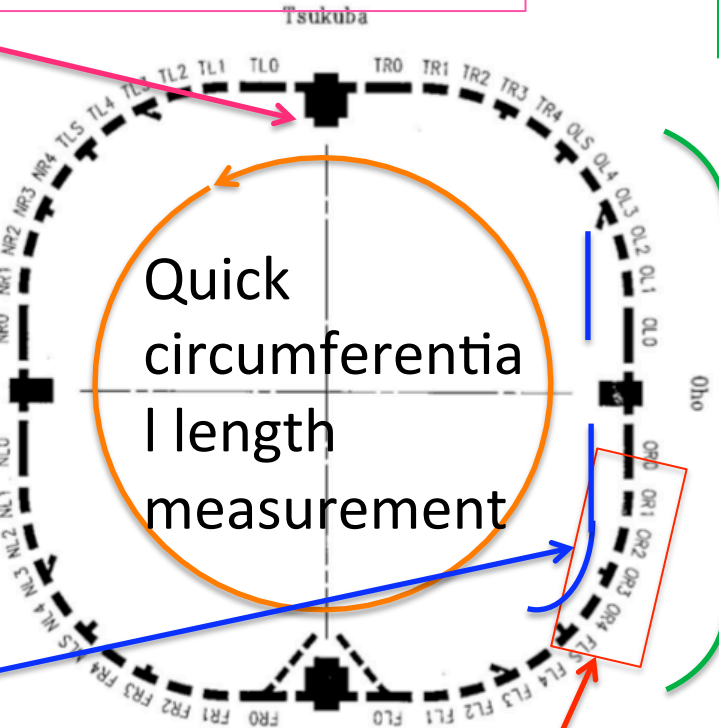


Survey tunnel from **inside** and outside (2)

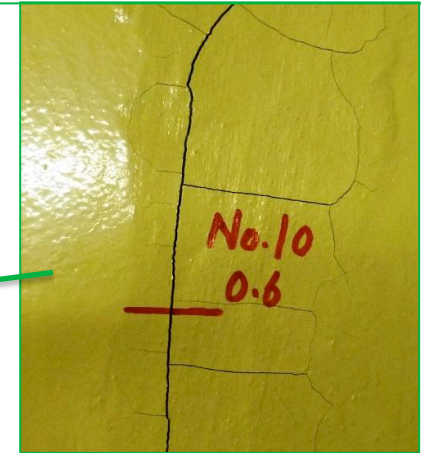


Measure cracks on the floor at BELLE

Depth: 30cm~80cm, >1.2m
Not yet fixed!!



Measure cracks depth on the wall.



Monitor GAP distance at expansion joints

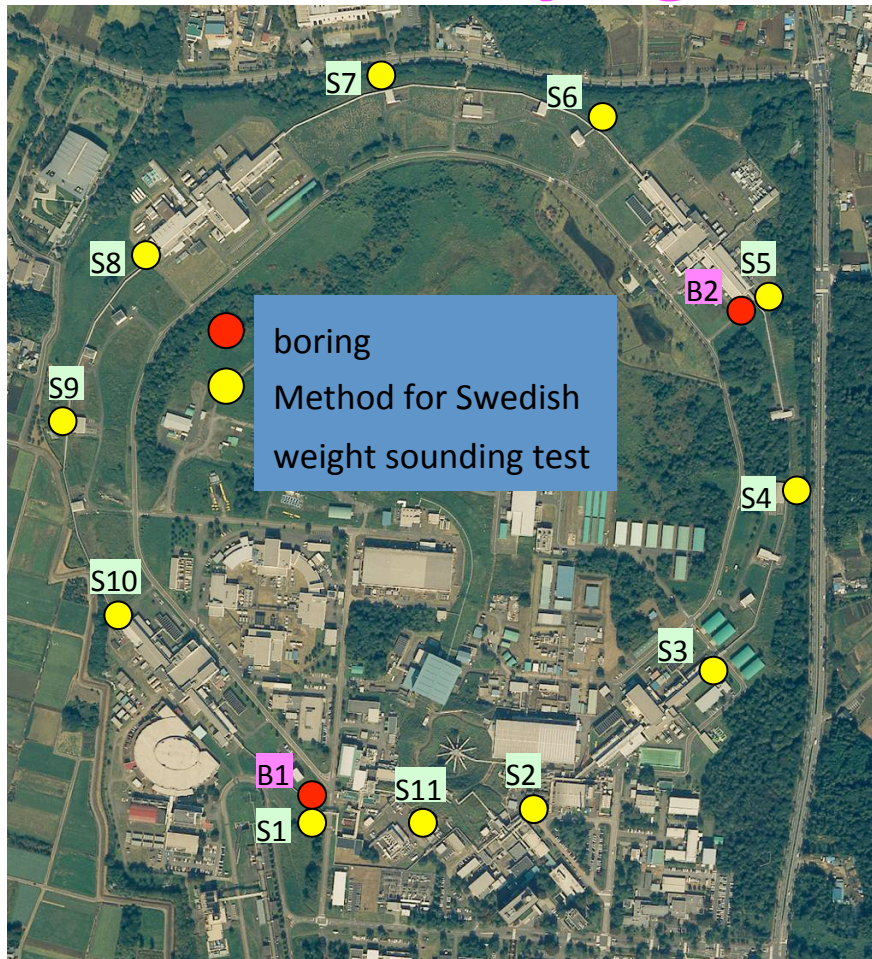


Measure Level by Hydrostatic water Level System (HLS)



Survey tunnel from inside and **outside** (3)

Soil surveying

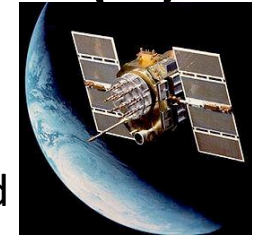


work in progress

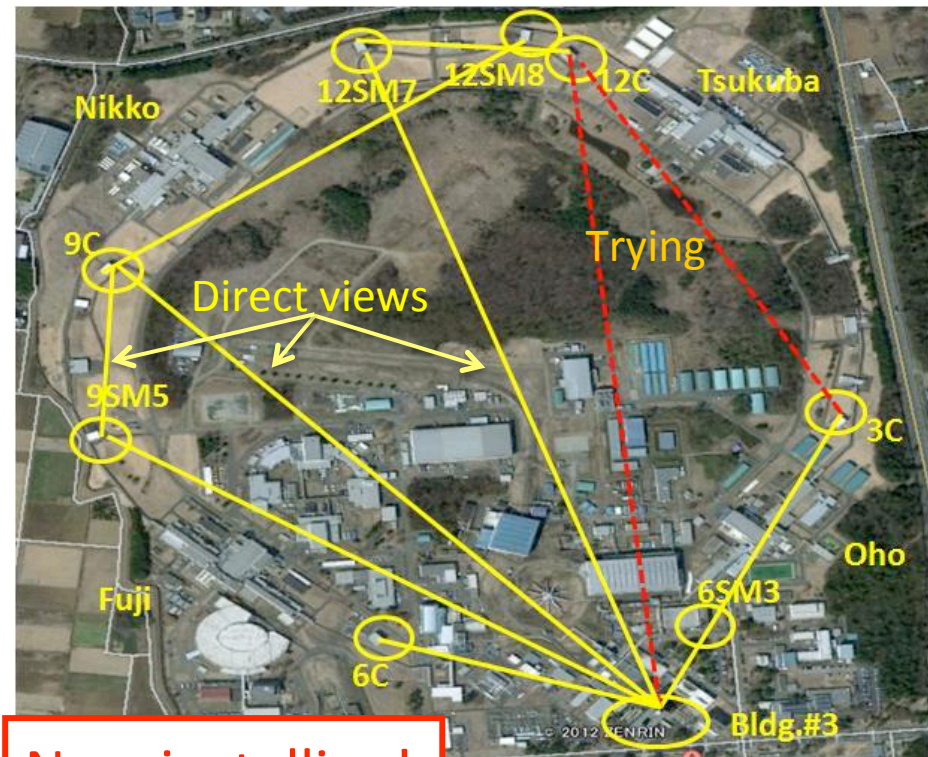
2012/2/20

Feb. 13- Mar. 30

Deformation meas. by **Global Positioning System**



- Five GPS antennas are mounted on the KEKB buildings, which can access to the tunnel
- One GPS antenna is mounted on bldg.#3
- GPS network is utilized for tunnel network!



Now installing!

Some magnets were damaged in the storage area

All of the KEKB Wigglers are needed at SuperKEKB

About 10 KEKB LER dipole magnets are needed at SuperKEKB



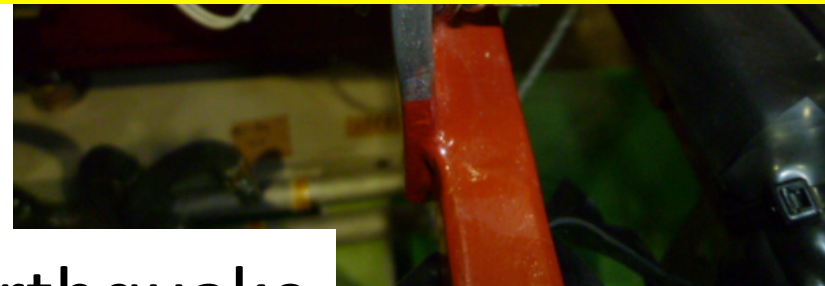
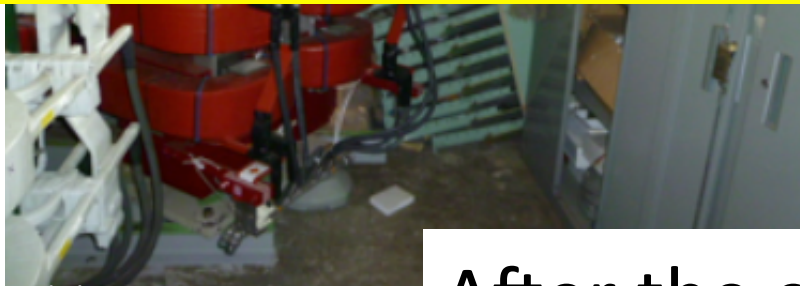
2012/2/20

Before the earthquake

Damaged in the storage area



- ✓ Wiggler Magnets:
 - All of the wiggler magnets were checked by field measurements and confirmed to be OK. → See next page
- ✓ Dipole Magnets:
 - Many of them are damaged and unusable.
 - There are probably 10~15 healthy magnets, though they need to be checked by field measurements this year.



After the earthquake

KEKB wiggler : re-measurement

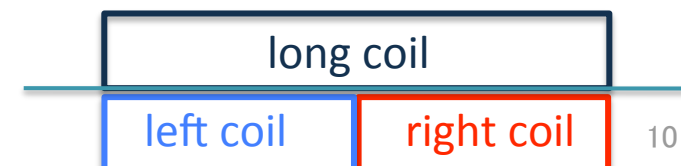
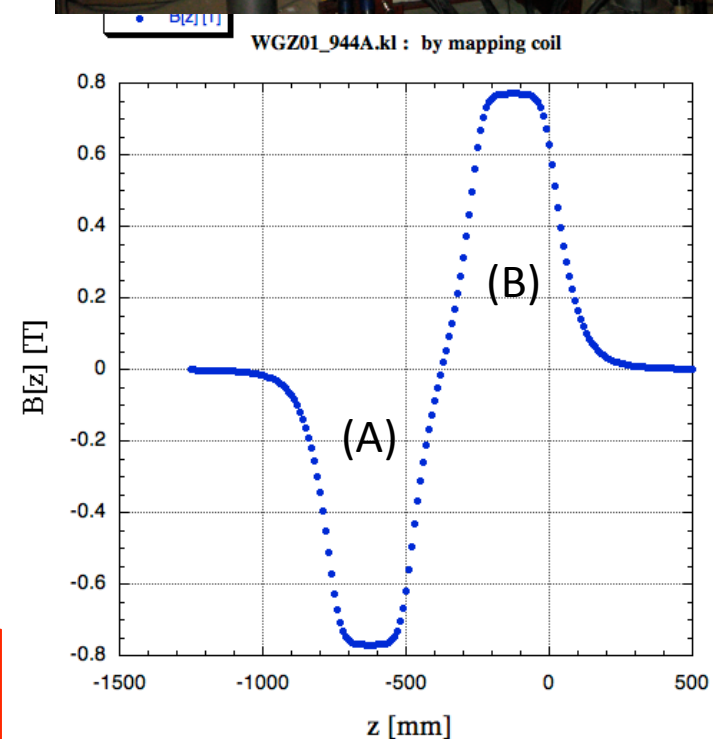
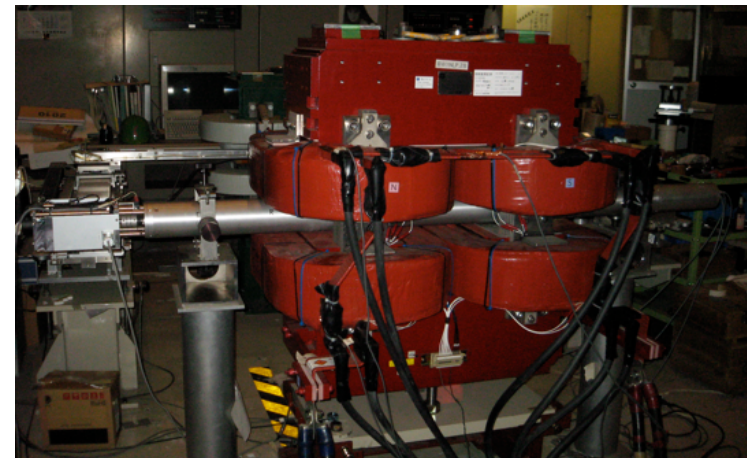
The KEB wigglers were re-measured.

Two reasons are ;

- The KEB wigglers will be re-used in SuperKEKB. The maximum currents will be **increased from 950 A (I_{\max_KEKB}) to 1400 A.**
- The KEB wigglers were taken out from the tunnel and were in storage. They **collided with each other due to the big earthquake (Mar. 11-th 2011).**

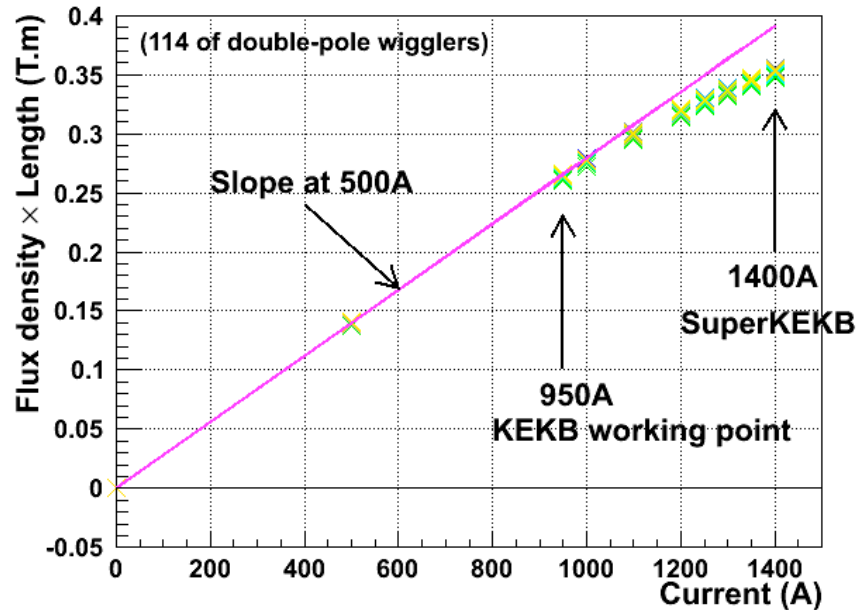
- *A rotating coil (long, right and left coils) was used for the measurement.*
- *These 3 probes of the rotating coil had been well calibrated during the last measurement.*

- Measure absolute values of area (A) and (B)
- Measure residual field : (A)+(B)

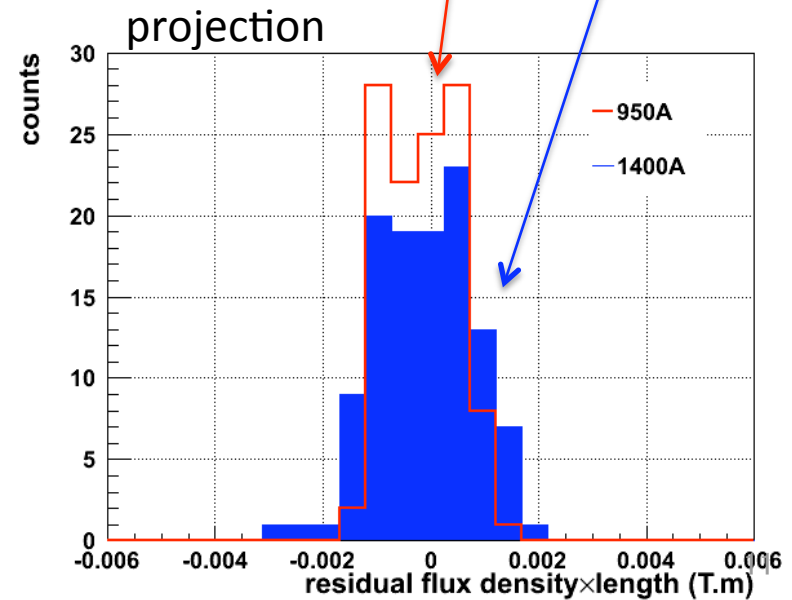
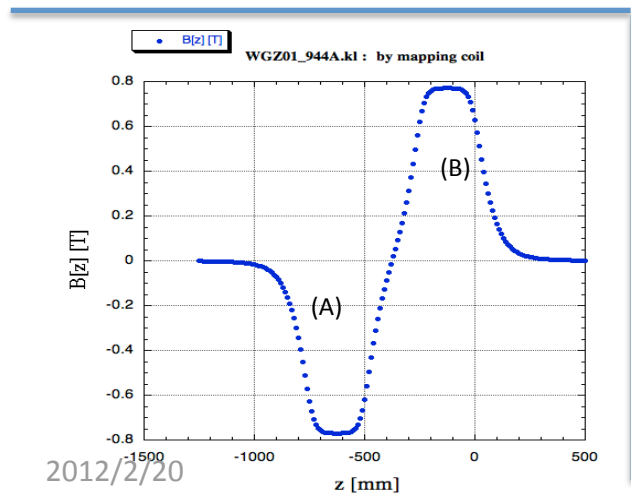
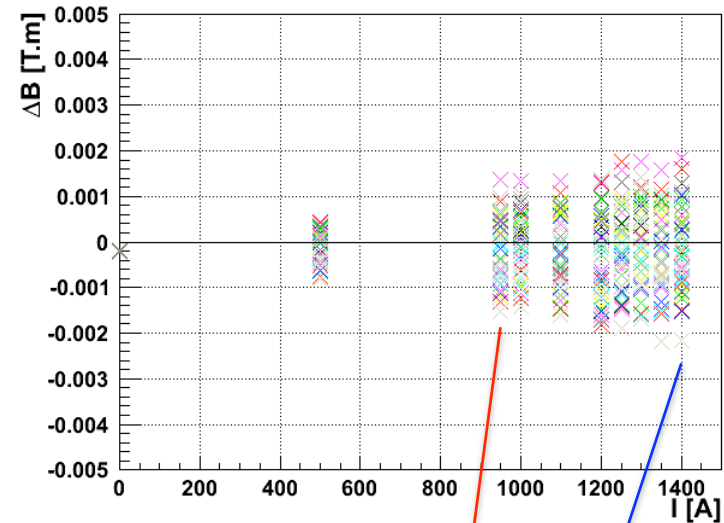


Results: All KEKB-wigglers are OK.

Excitation check: (A), (B)



Residual field check: (A)+(B)



2012/2/20

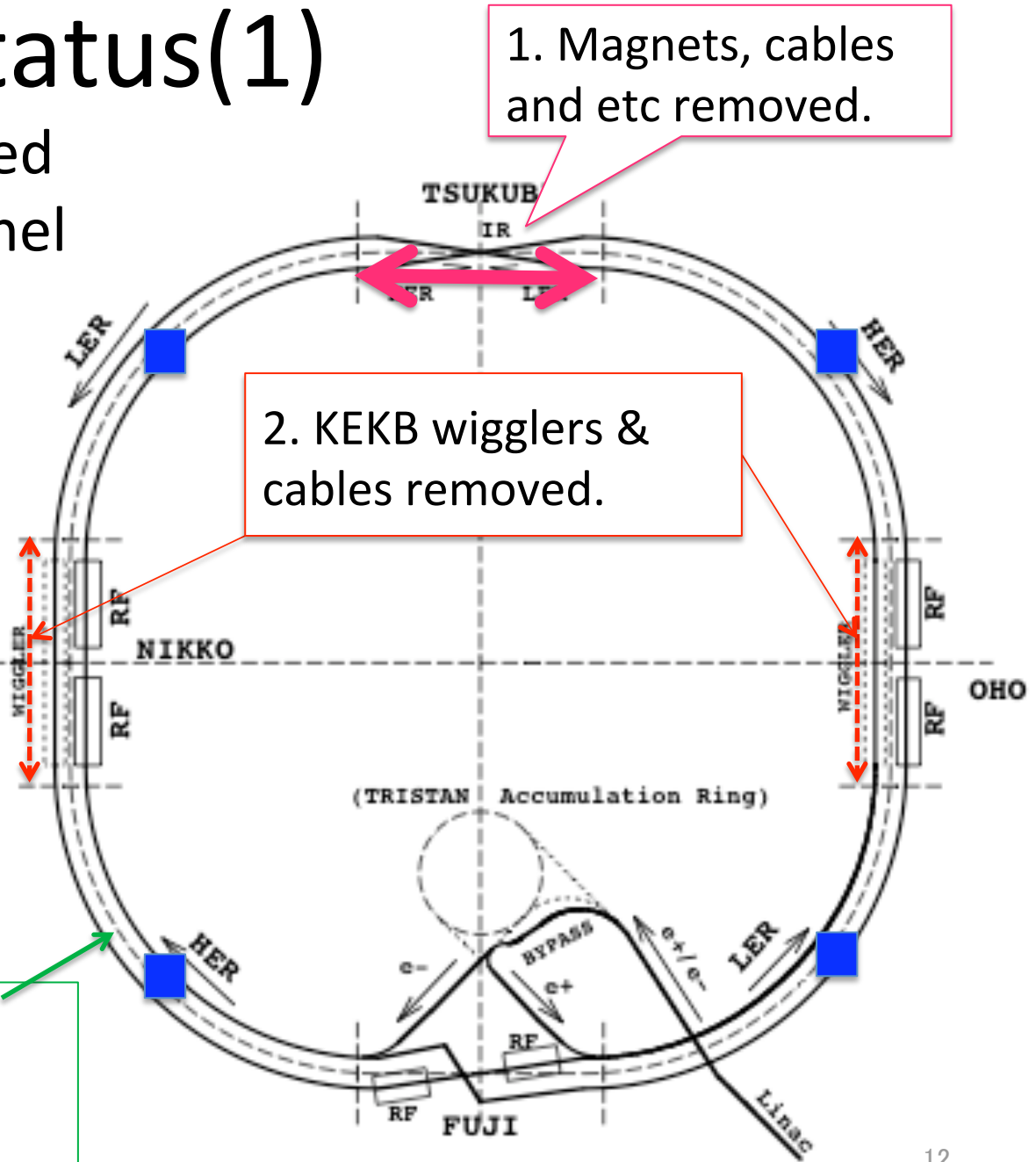
II. Current status(1)

Showing 4 completed items in the tunnel

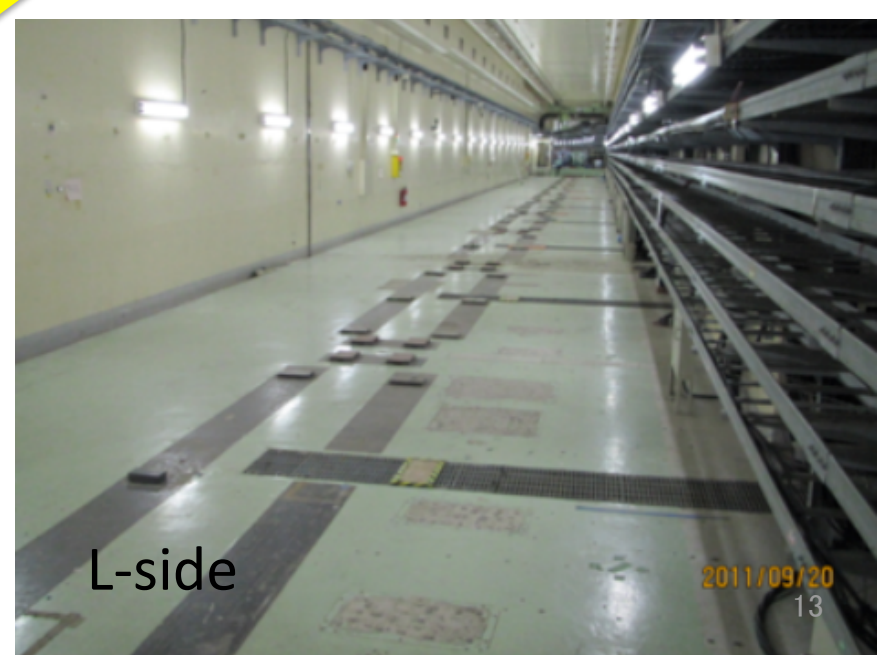
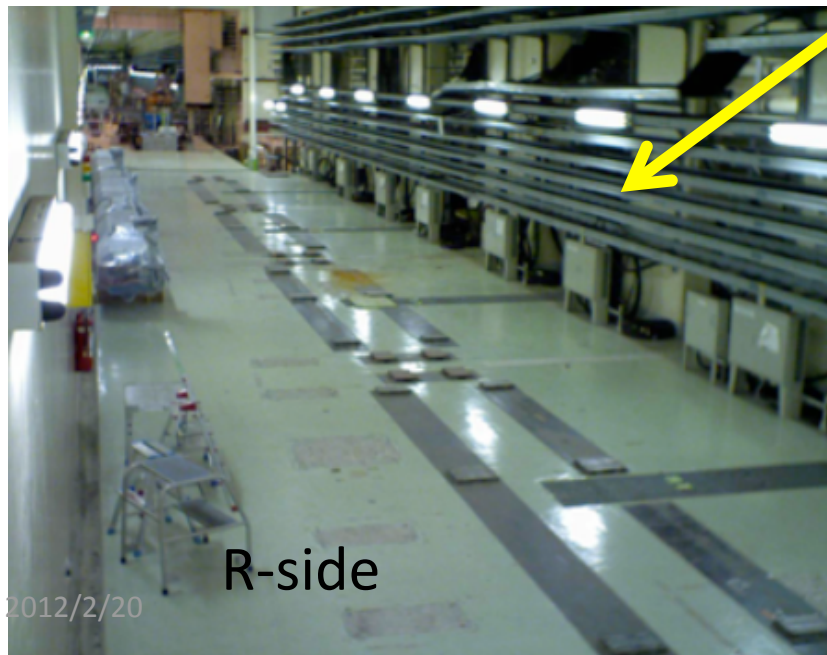
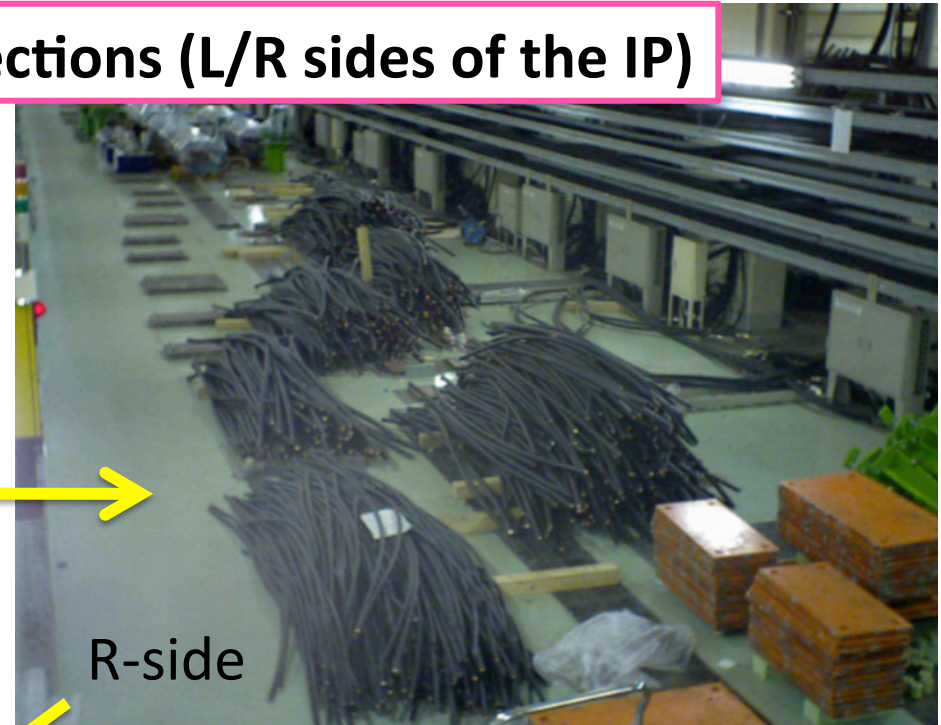
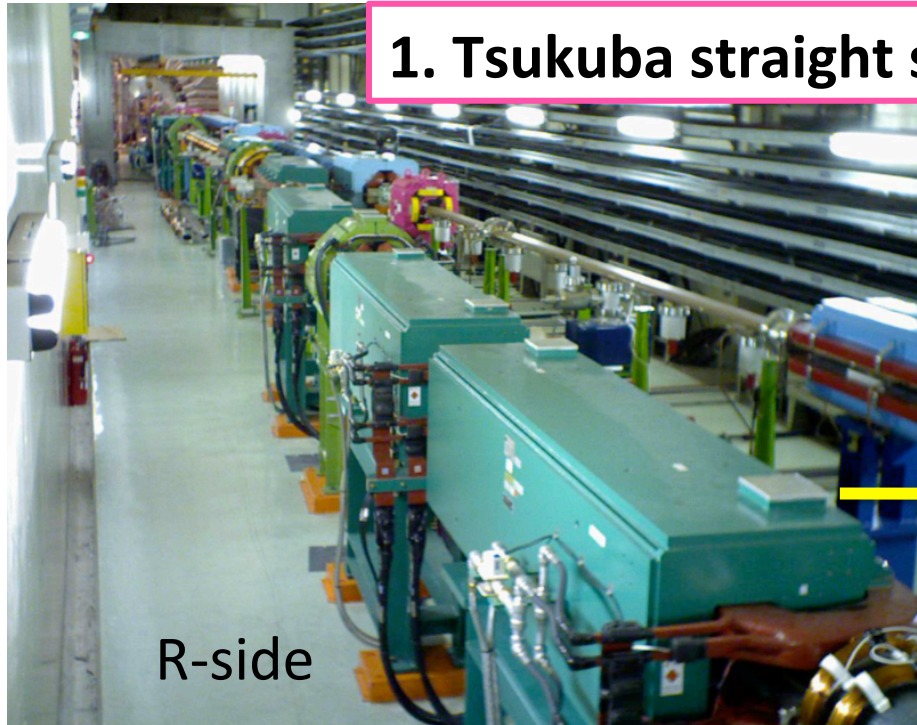
3. In all sections:

- A) KEKB LER dipoles and dipole correctors removed from the tunnel.
- B) SuperKEKB LER dipole positions surveyed and marked on the floor and base plates installed.

4. Installation of the 1st SuperKEKB magnet (LER dipole) in the tunnel.



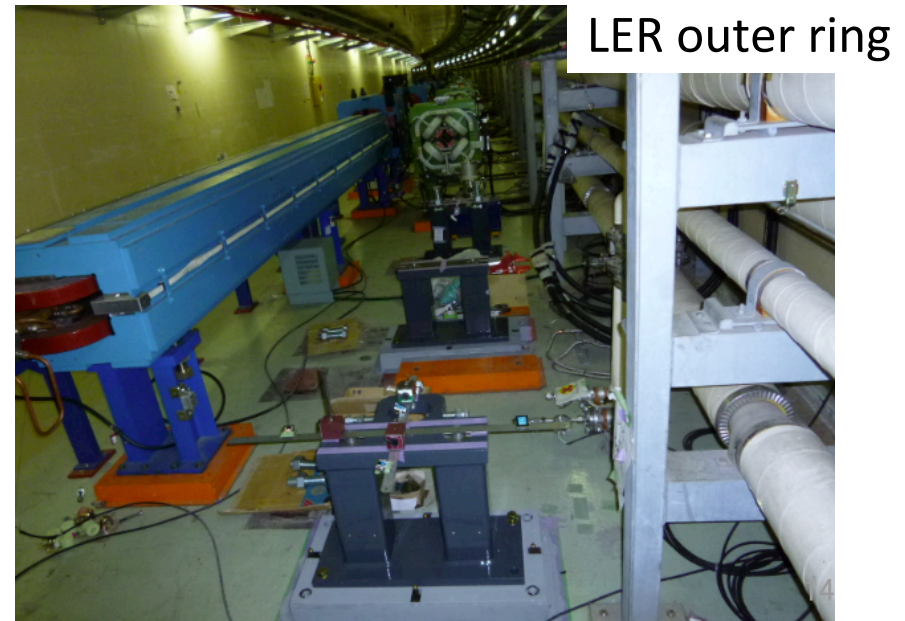
1. Tsukuba straight sections (L/R sides of the IP)



3. A) Survey for the new (longer) LER dipole magnets with laser tracker



3.B) Base plates (3/dople) installation in progress.



4. Installation of the 1st SuperKEKB magnet (LER dipole) in the tunnel.



Access road

String,
move
and set !



Go over the magnet!

2012/2/20



Over the HER dipole
Tight clearance (~6mm)



1st installation of the SuperKEKB magnet on Feb.7th 2012.

The main purpose of this installation was to debug the tools and methods for installing the 4 m dipole over the 6 m dipole.

We installed 2 dipole magnets. The rest of the LER dipoles are scheduled to be installed this year.

2012/2/20

II. Current status (2)

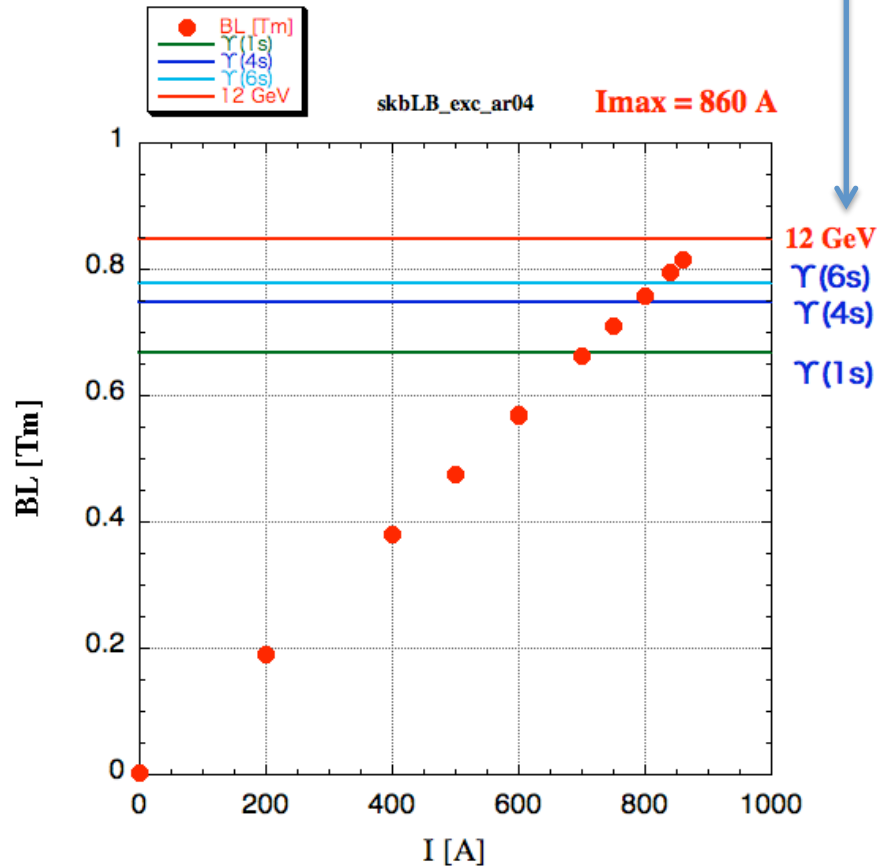
SuperKEKB_LER_B_{arc} : measurement status



- 111 / 142 dipoles have been delivered.
- 95 dipoles have been measured by a long flip coil system.
- 79 dipoles are in storage.

Excitation check

assuming the energy ratio $E_{LER}/E_{HER} = 4/7$



I [A]	B _{center} NMR [T]	Poisson	B _{NMR} / B _{μ=∞}
730	0.1660075		0.9953
760	0.1728672		0.9955
800	0.1819504		0.9954
840	0.1910295	0.19035	0.9953
860			

cf. : Due to constraints of LINAC, the injection and QCS system,

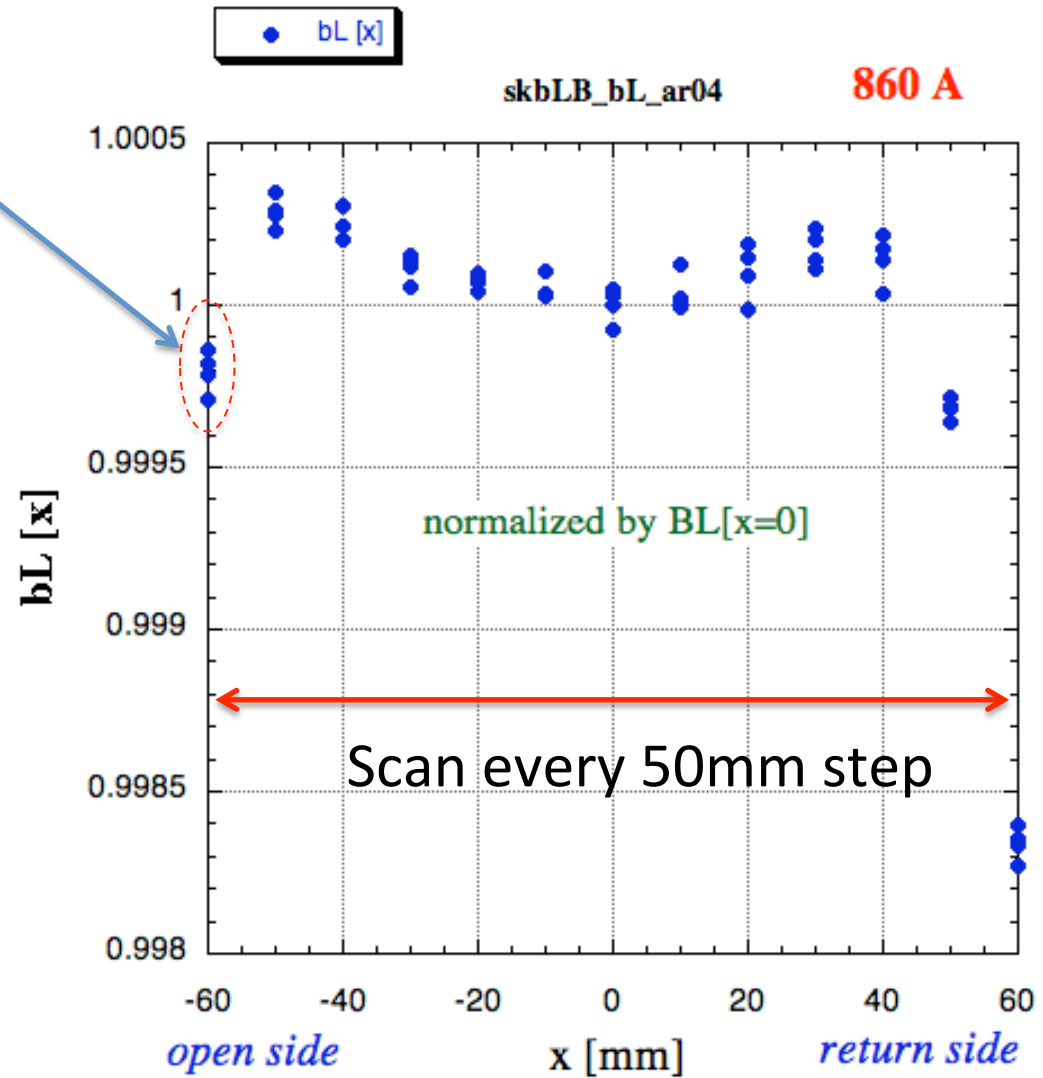
$$E_{LER_max} = 4.28571 \text{ GeV}, E_{HER_max} = 8.75875 \text{ GeV}$$

2012/2/20 $k = 0.0561$ & $E = 4.28571 \text{ GeV}$ \longrightarrow $BL = 0.802 \text{ Tm}$

bL[x] measured by long flip coil

measure 4 times at each point.
 Their variation (example) is ;

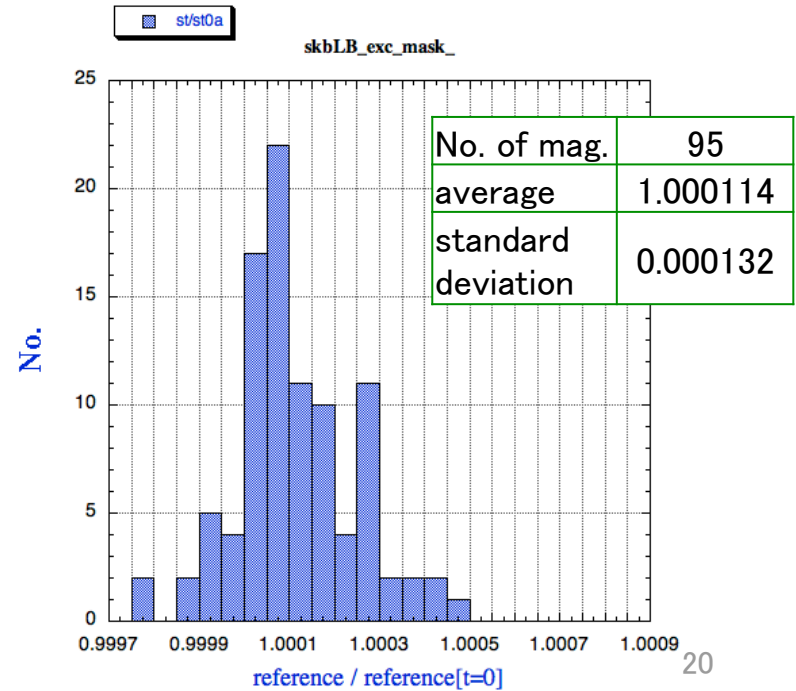
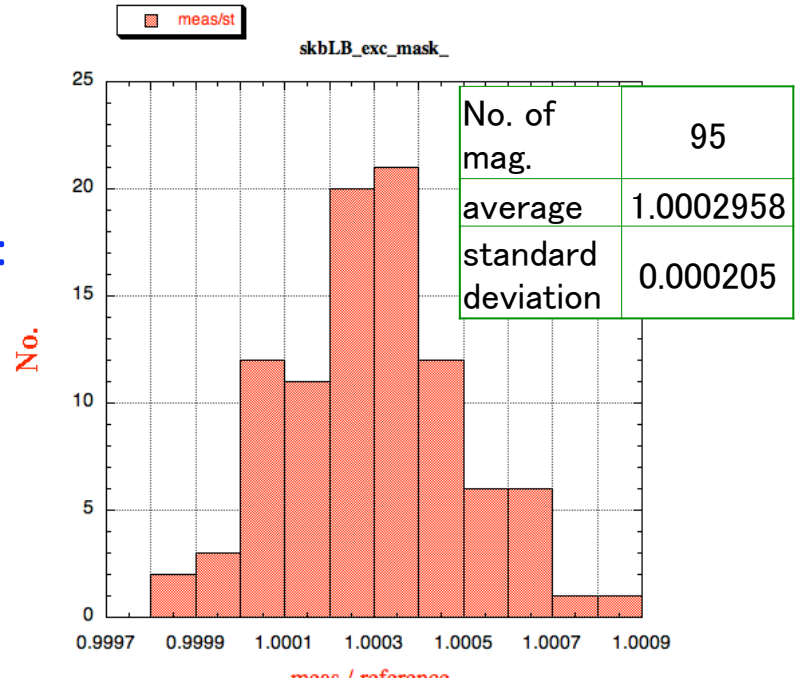
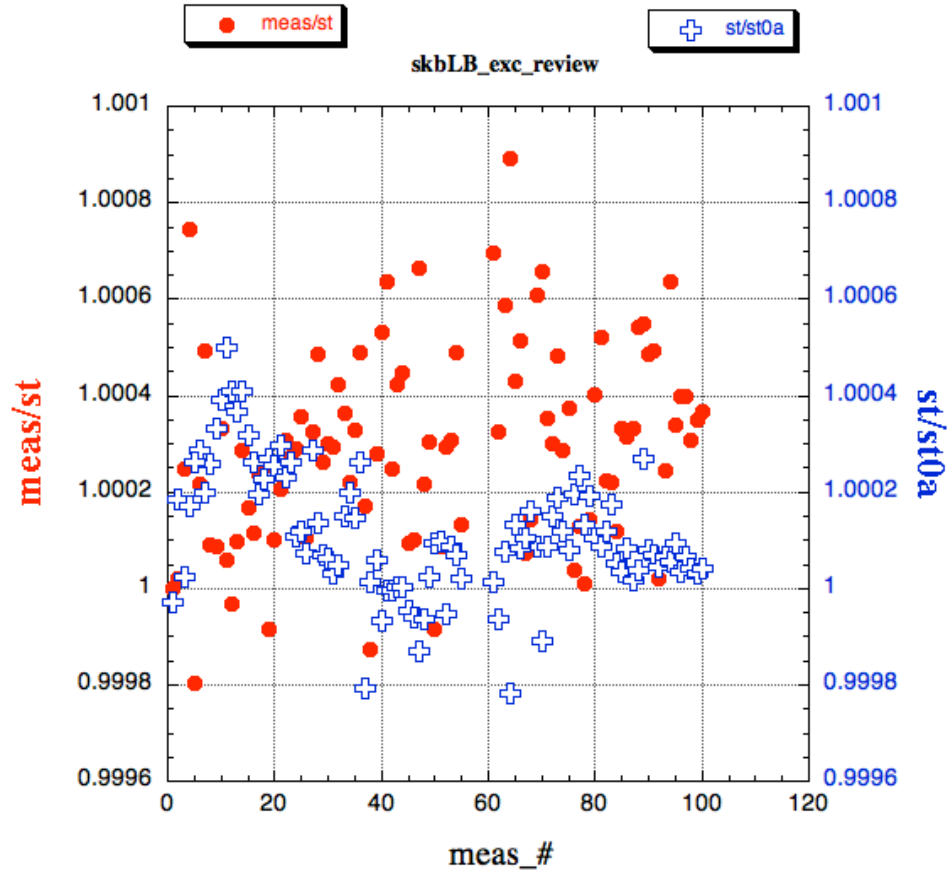
average	5024673.5
σ	285.697
σ /average	5.7e-05



Measure 0A, 500A, 700A, 800A as well.

each measured / reference (#1) @ 860A

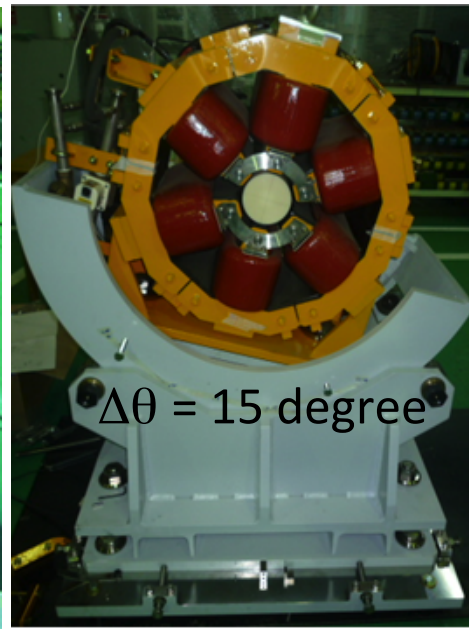
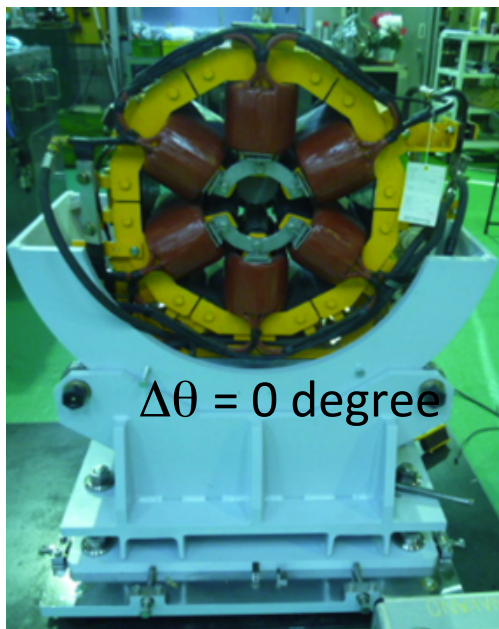
reference variation @ 860A :
 $st.[t] / st.[t_0]$



R&Ds

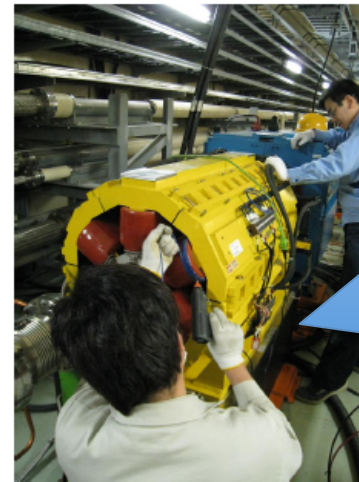
1. Rotation mechanism of the sextupole magnets

- Mechanical rotation :
 - 30< $\Delta\theta$ <30 degrees (over spec?)
- 24 sextupole magnets needed for LER (+ needed for HER?)

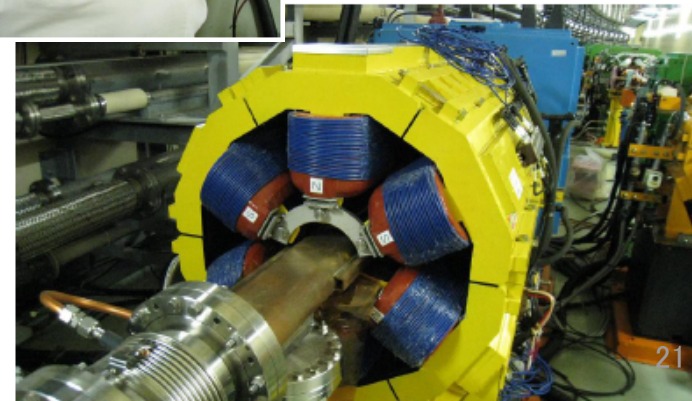


2012/2/20

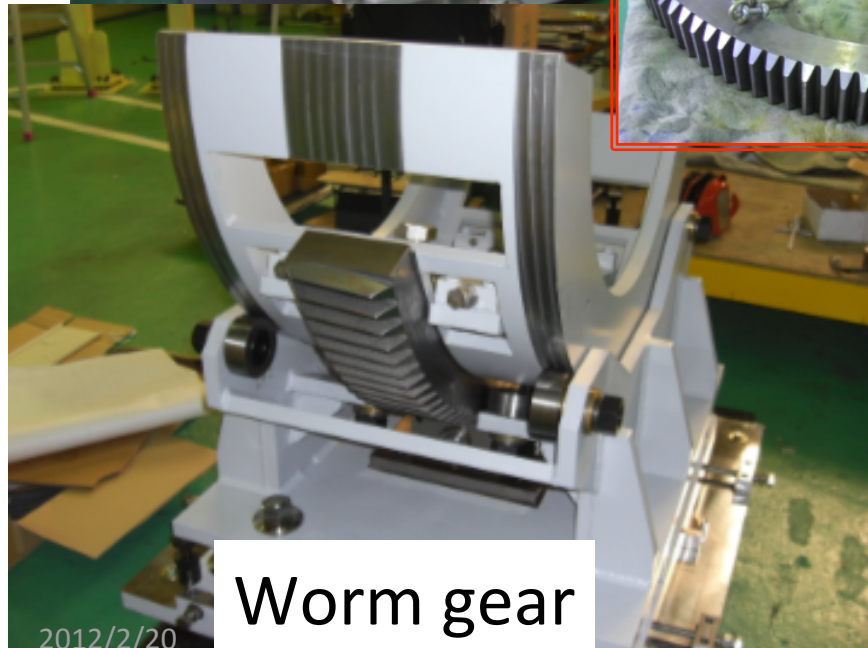
- ## 2. Additional windings of the correction coils of the **ALL** sextupole magnets (~100/ring)
- Needs to establish faster way to wind coils



Work is needed to be done **IN** the tunnel!
(photo from KEKB. 20 turns/pole with *a single* wire)



Rotation mechanism of the sextupole magnets

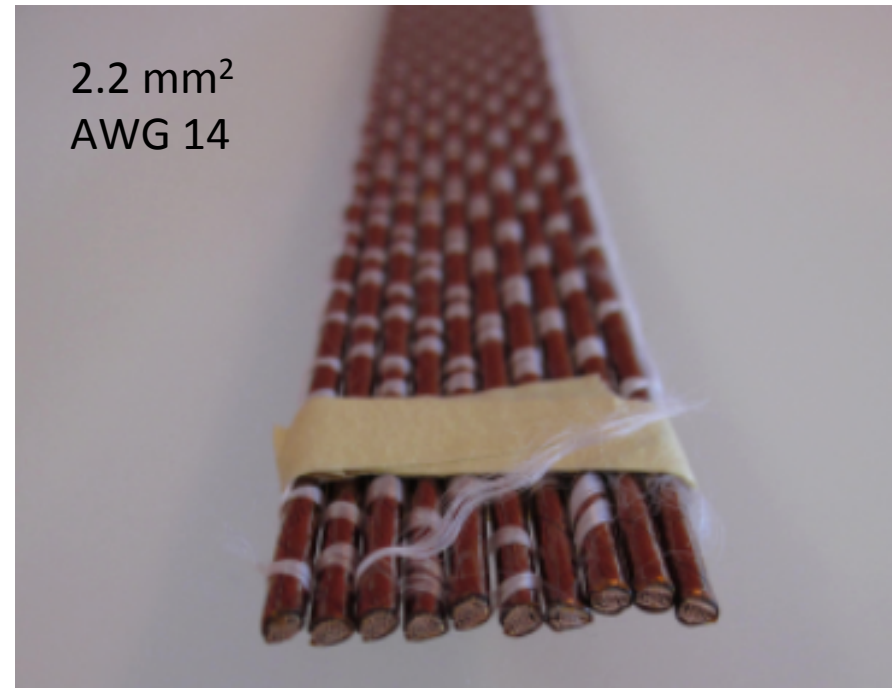
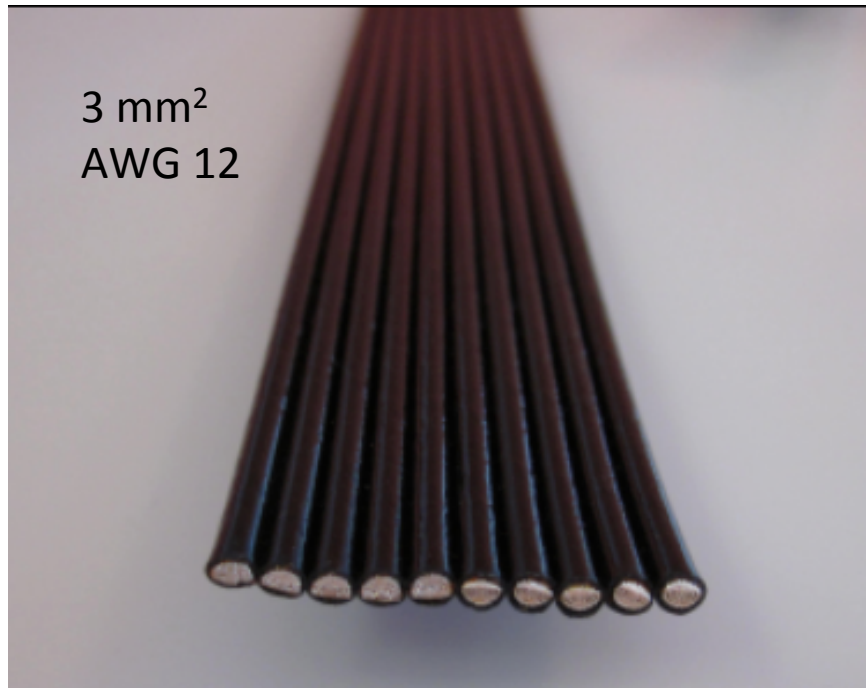


2012/2/20



KEKB Sextupole
(L=300 mm, ~700kg)
as a test load.

Additional windings of the correction coils



- ➔ We will try to wind an additional ~50 turns/pole efficiently on the poles of the magnets in the beam line.
- ➔ Use of flat cables is being investigated.
- ➔ Temperature rise for multi layer cases.

Activities for the fiscal year 2012

I. In the tunnel: many and many!

		4	5	6	7	8	9	10	11	12	1	2	3
LER/HER Survey	All arcs and straights	■	■	■	■								
Survey data analysis					■	■							
LER/HERQmag Alignment	6mag/day/team					■	■	■	■				
Remove magnets from Tsukuba arc	~70 magnets					■	■	■	■				
Marking Tsukuba Beam lines	Tsukuba/3C/12C								■	■	■		
Base plate installation	Tsukuba/3C/12C									■	■	■	■
LER wiggler position marking (280 mag)	Nikko/Oho				■	■	■	■	■	■			
Wiggler base plates installation	Nikko/Oho							■	■	■	■	■	■
Wiggler installation & alignment	Nikko/Oho									■	■	■	■
Chicane magnet	Nikko			■									
BS2* magnets	Nikko/Oho			■									
HERQmag replacement (7mag)	Oho									■	■	■	■
LER B supports alignment	arc sections	■	■										
LER B installation/alignment	arc sections				■	■	■	■					
LERStV installation/alignment	arc sections			■	■	■							
IR movable table design work										■	■	■	■

Installation of new pipes for Cooling water system by The utility group

preliminary, very

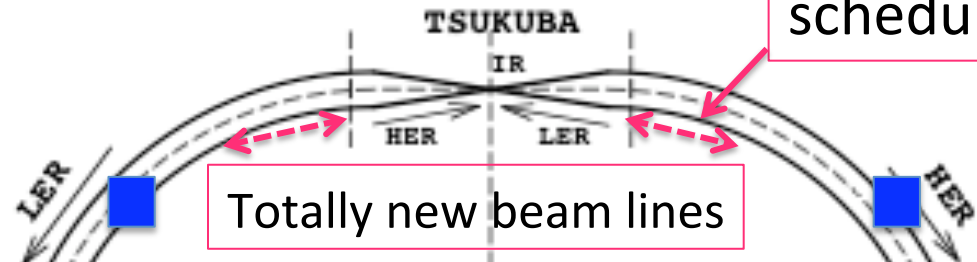
II. Field measurement

- LER new dipole : ongoing
- new wigglers : from spring 2012
- LER_Q ($L_{eff}=0.5837$) : from spring 2012
- HER_Qx : from spring 2012

III. GPS network

etc....

In the tunnel

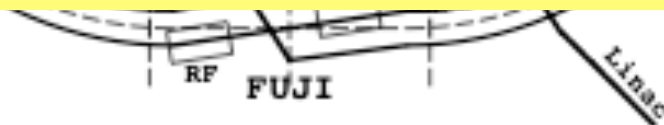


Both ends of IR
✓ Magnets, cables,,,
scheduled to be removed.

In all sections:
✓ LER dipoles (100),
HER quadrupoles (100)

Two important keys :

- Careful scheduling with a work of the vacuum/magnet cooling water system by the Plant and Facilities Department,
- Control tunnel temperature at SuperKEKB operating value for precision survey and alignment!



7 quadrupole magnets
replaced by shorter ones
this year.

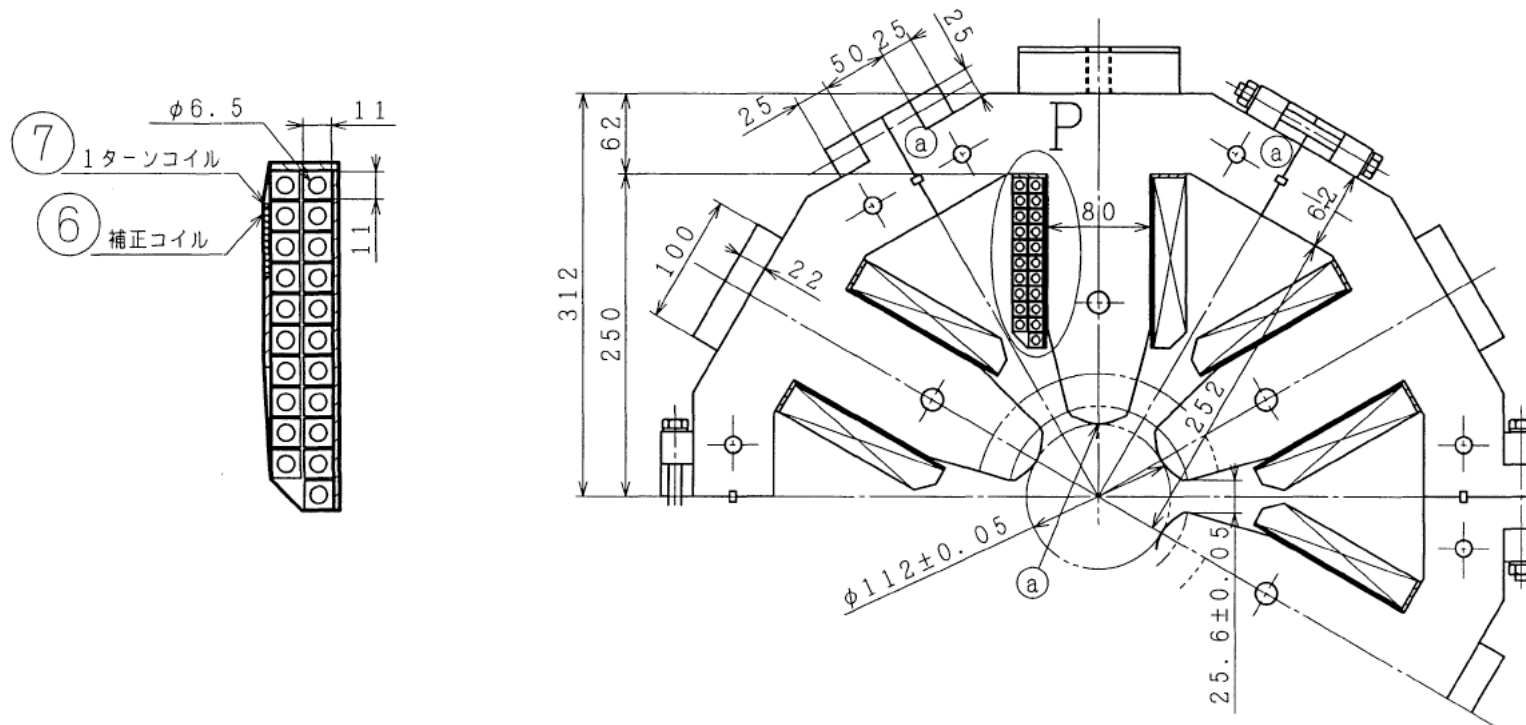
Thanks

New magnets (normal) production status

2012.2.15

LER magnet	number	specification	status
Dipole B_arc, B_lc	114 (+2) + 24 (+2)	fixed	<i>being delivered</i>
Wiggler : half / single pole	112 (+2) / 56 (+2)	fixed	<i>will be delivered in Mar. 2012</i>
Short dipole	2	<i>not yet</i>	2012
Q (Leff =0.5837)	20	≈ kb_Q.rf	<i>will be delivered in Mar. 2012</i>
QK (skew Q)	10	<i>not yet</i>	2012
SL + skew Sx (rotatable)	8 + 24	<i>not yet</i>	2012
Vertical Corrector	~ 220	fixed	<i>will be delivered</i>

HER magnet	number	specification	status
<i>Dipole (4 m) \subset LER dipole</i>	13	<i>= LER B_lc</i>	<i>being delivered</i>
BC* $L_{eff} = 0.3444$	8	<i>not yet</i>	2012
<i>additional kb wiggler</i>	+ 22	<i>fixed</i>	?
Q (0.56 m)	38 (+ 1)	\approx kb_Q.arc	<i>Contract process has started.</i>
Q (1.12 m)	2 (+ 1)		<i>Contract process has started.</i>
Qx	8 (+ 1)	\approx KB_QX	<i>delivered</i>
QK ($L_{eff} = 0.3444/0.3723$)	6 + 2	<i>not yet</i>	2012
SL + skew Sx (rotatable)	8 + 24	<i>not yet</i>	2012



10 turns (x 10 A) = 100 AT are wound with the main coil.

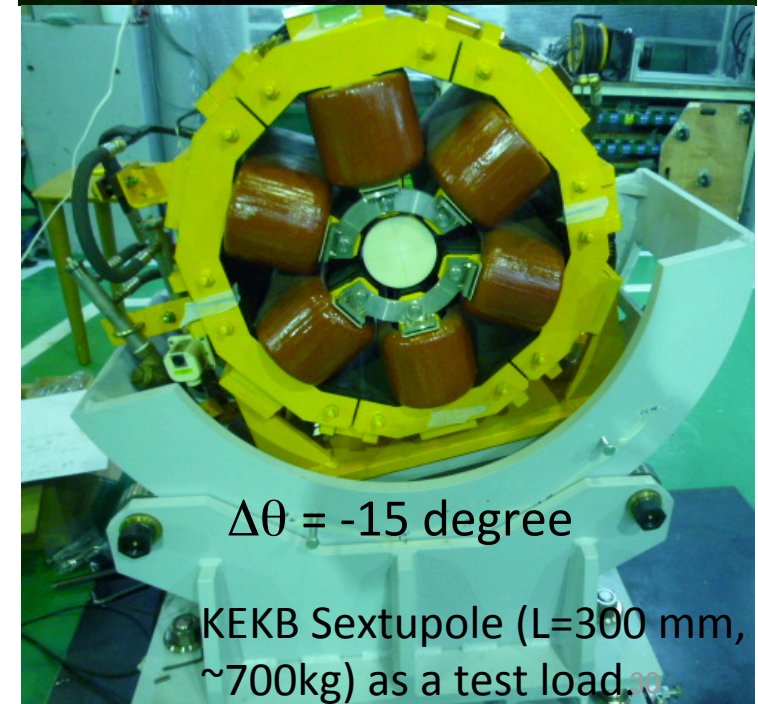
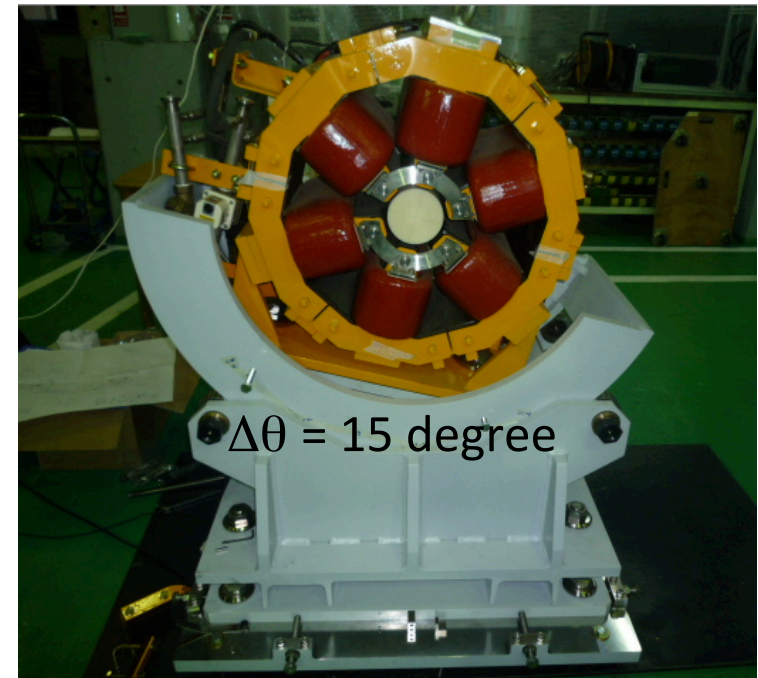
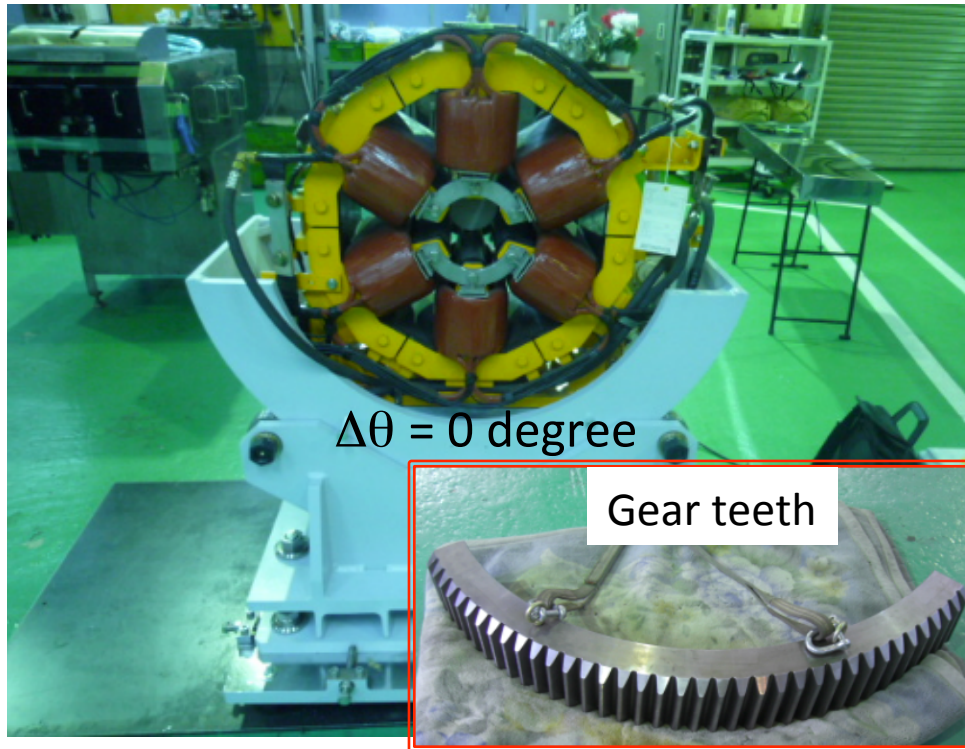
➔ These will be used to generate normal quadrupole field for beam-based alignment.

A request was made by the optics group to prepare additional windings to generate skew quadrupole field.

➔ Power supplies will be newly made for the additional coils.

➔ Specifications have not been fixed yet. We will try to wind an additional ~50 turns/pole efficiently on the poles of the magnets in the beam line.

➔ Use of flat cables is being investigated.



Rotation by stepping motor

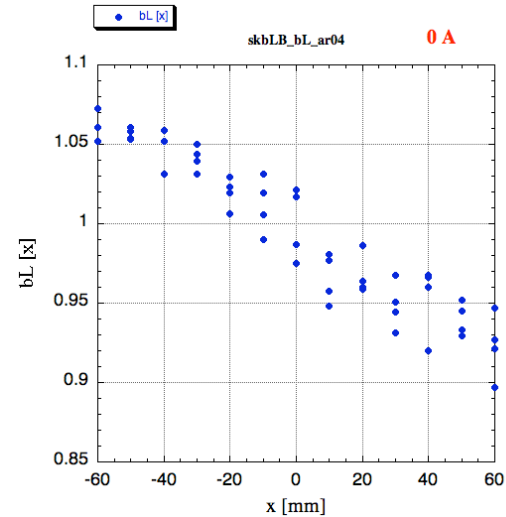
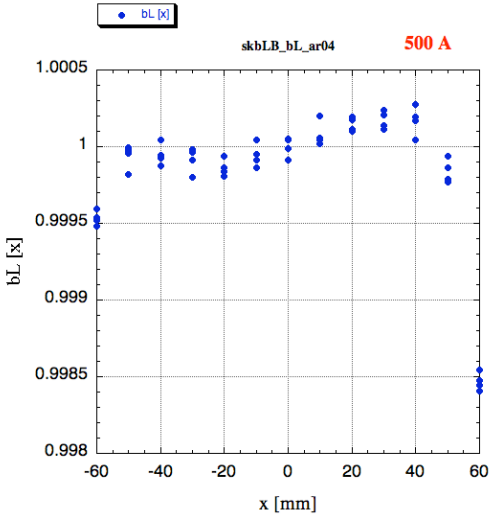
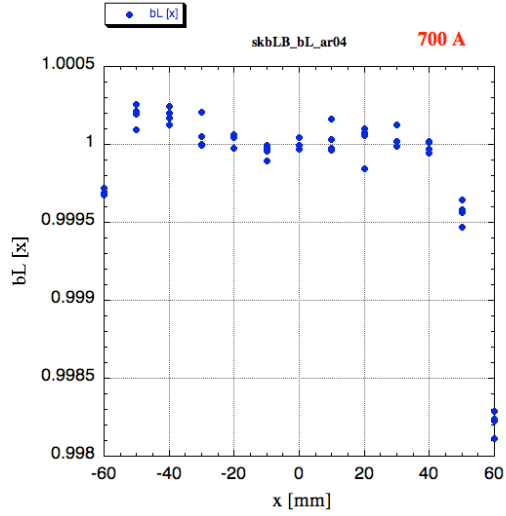
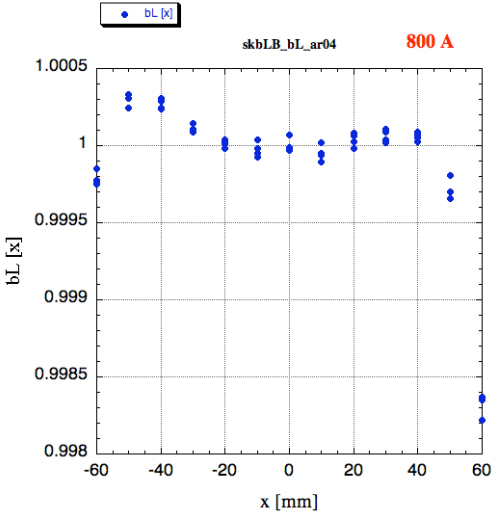
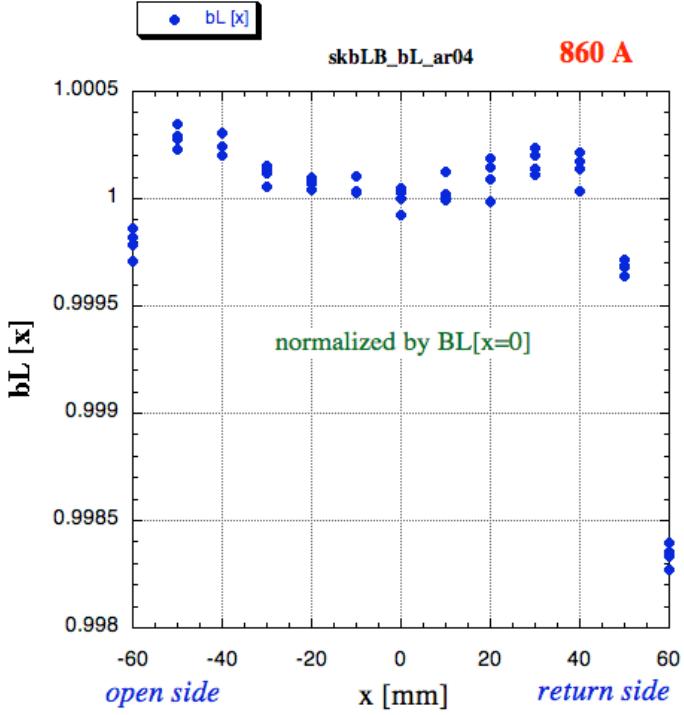
3 degrees/0.36 million pulses & 3 degree/gear tooth

- Takes ~4 minutes to rotate 15 degree
- Very smooth rotation up to ± 10 degree
- becomes heavier beyond ± 10 degree
- Rotation up to ± 30 degree achieved

Reproducibility, coupling to the horizontal/vertical motion, stability etc, need to be checked (and probably need to be improved).

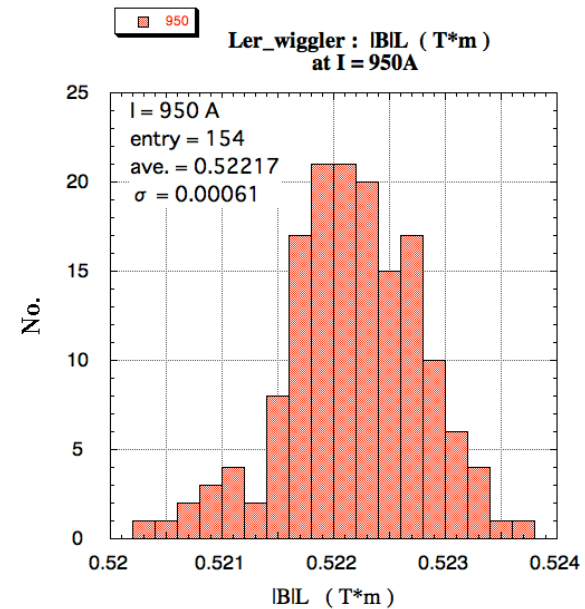
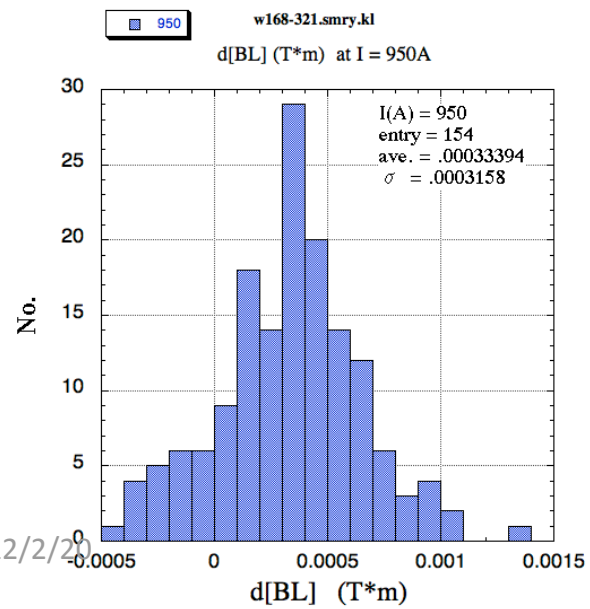
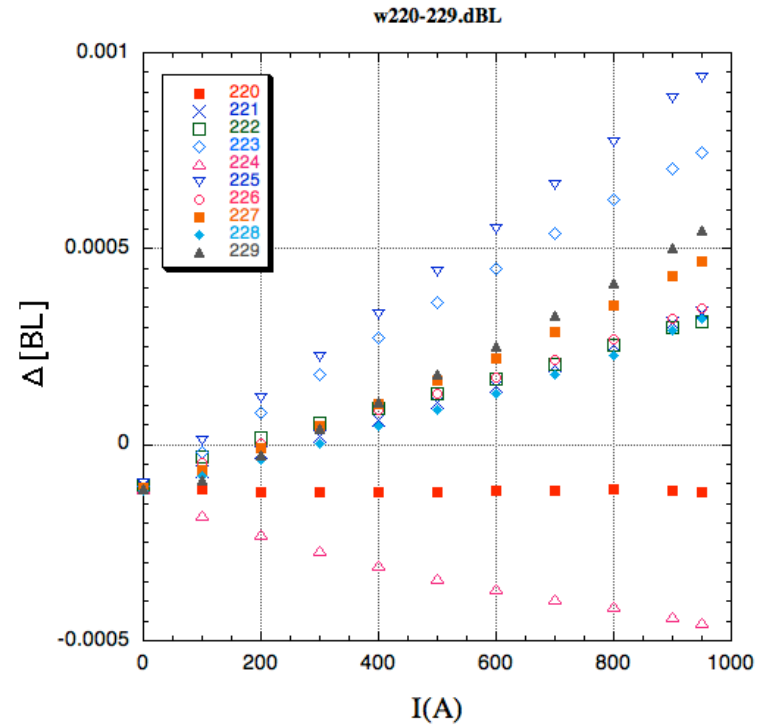
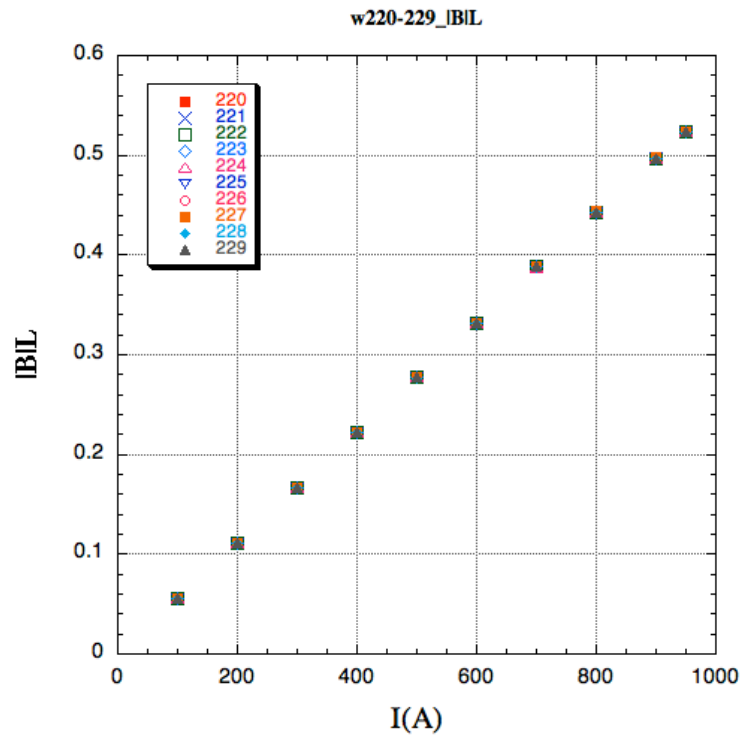
Handling of the power cables and cooling water pipes need to be examined.

bL[x] measured by long flip coil



measure 4 times at each point.
Their variation (example) is ;

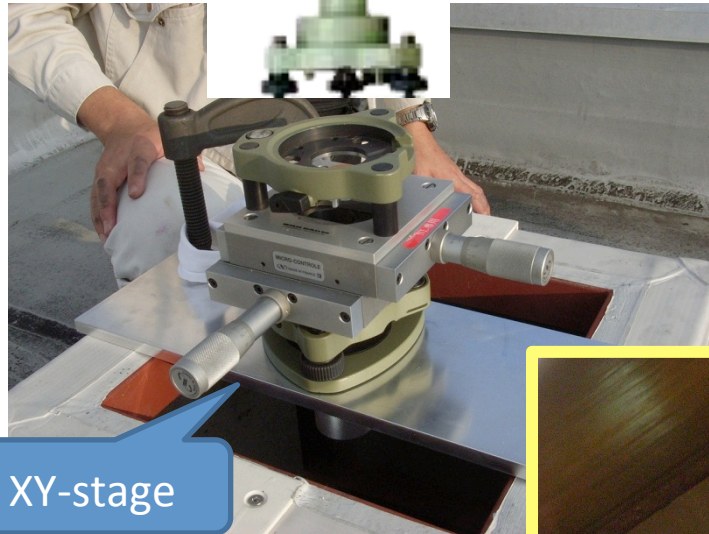
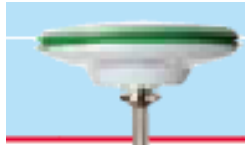
average	5024673.5
σ	285.697
σ / average	5.7e-05



2012/2/20

We made 8 pass-through holes on each top of building along KEKB ring

GPS
Antenna



XY-stage

Look up view from access
road to the tunnel@6C



Bldg.#3

6C



Look down view from
the scope



✓ Magnets, cables,,
scheduled to be removed.

✓ Magnets, cables and
etc removed.

Totally new beam lines

✓ KEKB wigglers &
cables removed.

✓ Two quads/tunnel
will be installed.

In all sections:
✓ KEKB LER dipoles and dipole correctors removed from the tunnel.
✓ SuperKEKB LER dipole positions surveyed and marked on the floor and base plates installed.
✓ LER dipoles (100), LER vertical dipole correctors (~220), LER wigglers (280) scheduled to be installed this year.

✓ 36 KEKB wigglers scheduled to be installed in HER next month.
✓ 7 quadrupole magnets replaced by shorter ones this year.

✓ done
2012/2/20
✓ to be done soon/this year

