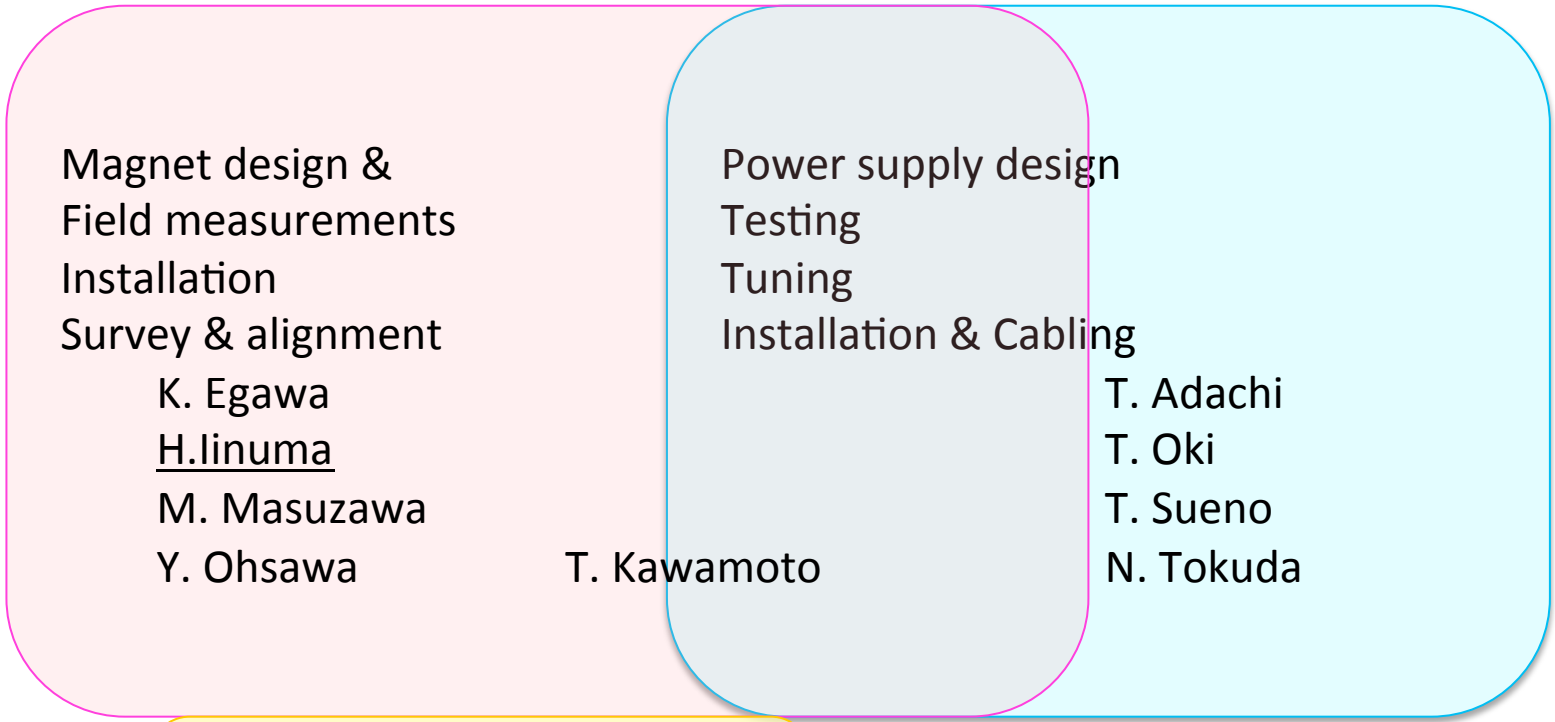
Main Ring Magnet system

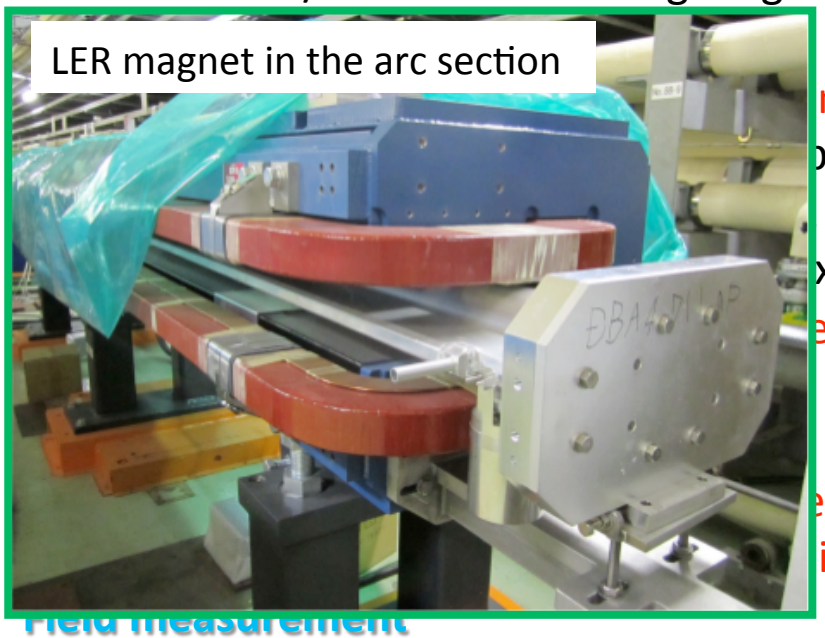


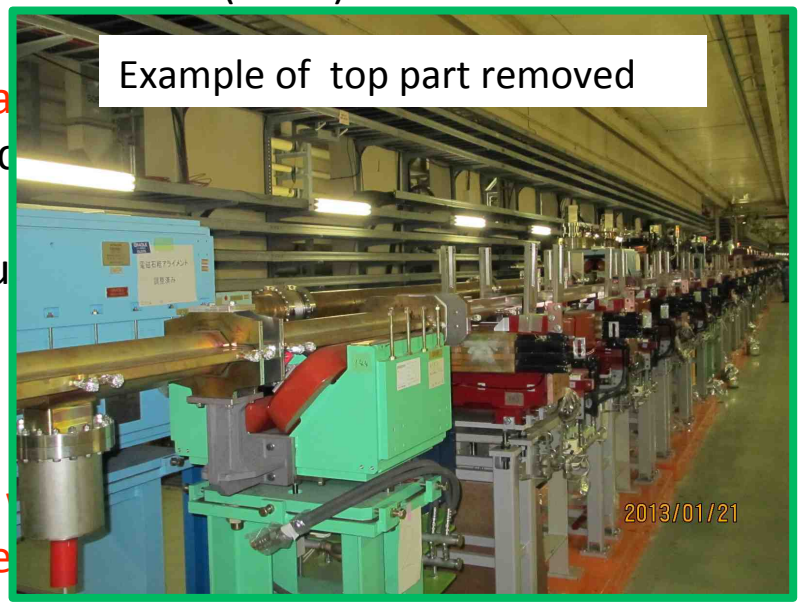
Retired but still active
R. Sugahara
K. Tsuchiya

Eleven people including senior members

Since last review

1. **In the tunnel**
   - Magnet installation to the Tsukuba section.
     - ~60 dipoles, ~100 quadrupoles almost **done**.
       - Sextupole magnets and steering magnets in FY2014.
   - Top part of the LER magnets in the arc sections removed for vacuum chamber installation (and put the magnets back together again).
     ~500 magnets, **done**.
   - LER horizontal steering magnet installation (~200) in the arc section almost **done**.
   - HER vertical/horizontal steering magnet installation (~400) in the arc section almost

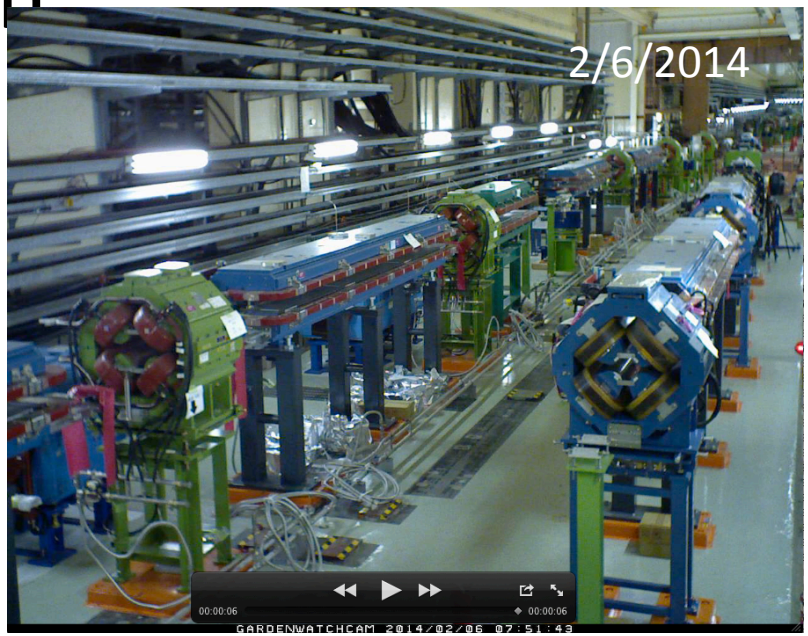


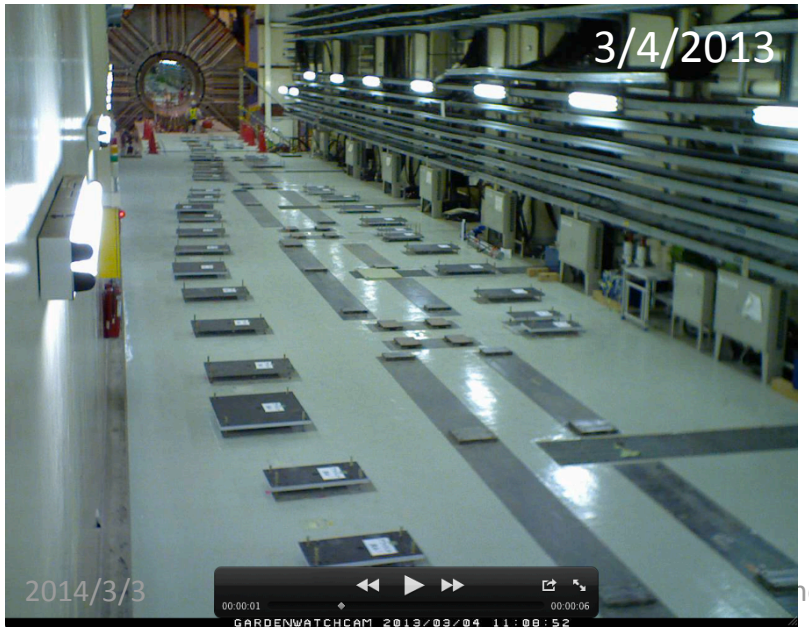


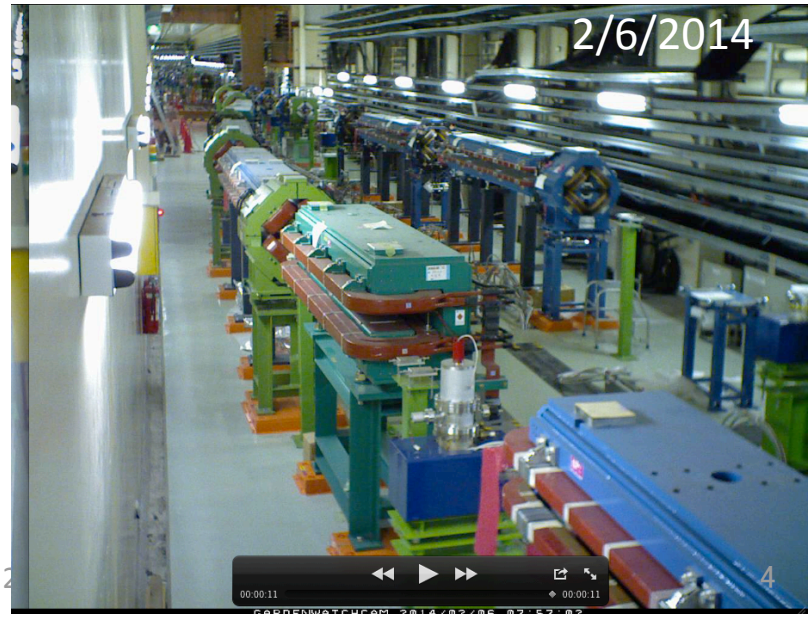
2. ma
   blac
   xtu
   es.
   ets
   ifie
3. **Field measurement**
4. **Manufacture and overhaul of Power supplies**
5. **And more.**

1.In the tunnel

Magnet installation in the Tsukuba section







Magnet installation & alignment at the Tsukuba section **almost done**

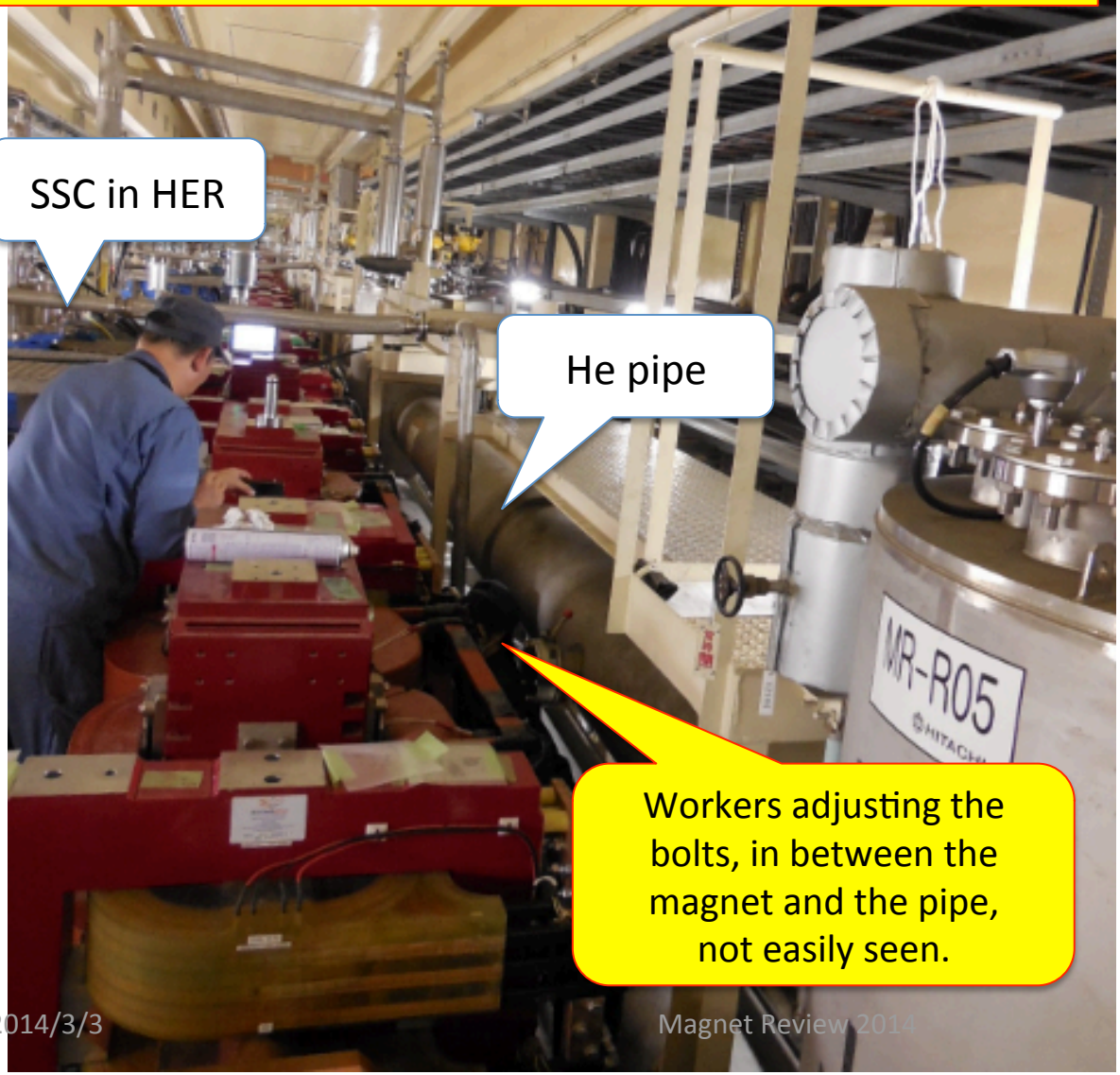
- ~60 dipoles, ~100 quadrupoles **almost done**.
- Very tough work…
  - Work pace: 40minutes/Long Dipole → 60m / week
  - Two teams worked from the IP in clock and anti-clockwise directions.

- Horizontal position is confirmed by Laser Tracker(LT)
- Slope is confirmed by digital level
- Height is confirmed by N3 with level marker on the wall, and LT.

Sextupole magnets and steering magnets are going to be installed in FY2014.

Alignment work is ongoing

Nikko wiggler alignment in a very tight space



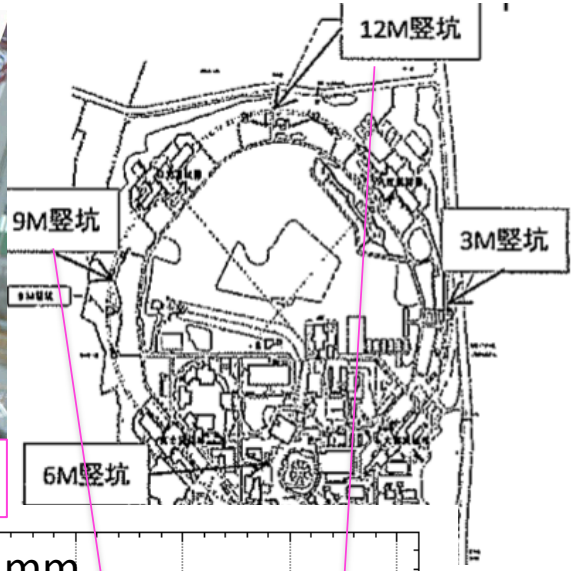
Alignment accuracy depends on temperature!!
…However, tunnel temperature is 16 degree at places, ~10 degree lower than during the operation, which affects the alignment.

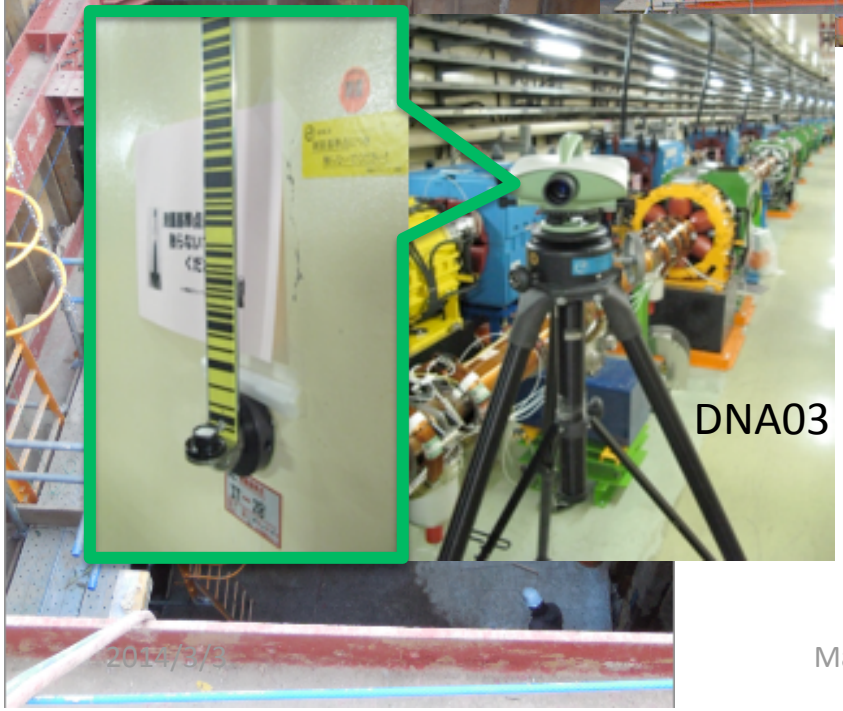
Linear coefficient of expansion 10^{-5} (1/°C)
Iron,concrete

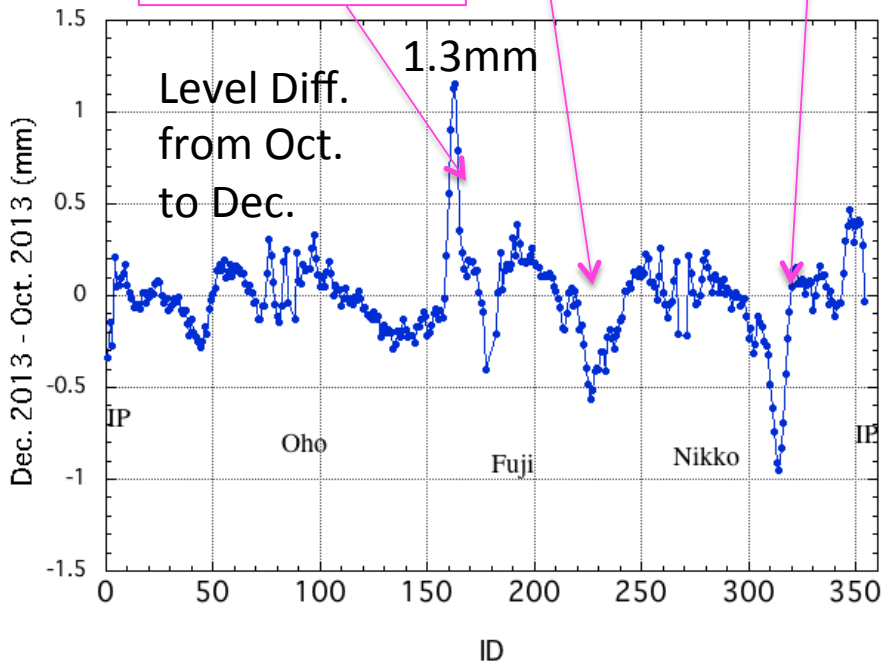
Ohsawa

Alignment work is ongoing, but…

Difficult to coexist with the heavy duty construction work above ground.
Effects of construction of the new utility buildings and new tunnel are clearly seen.



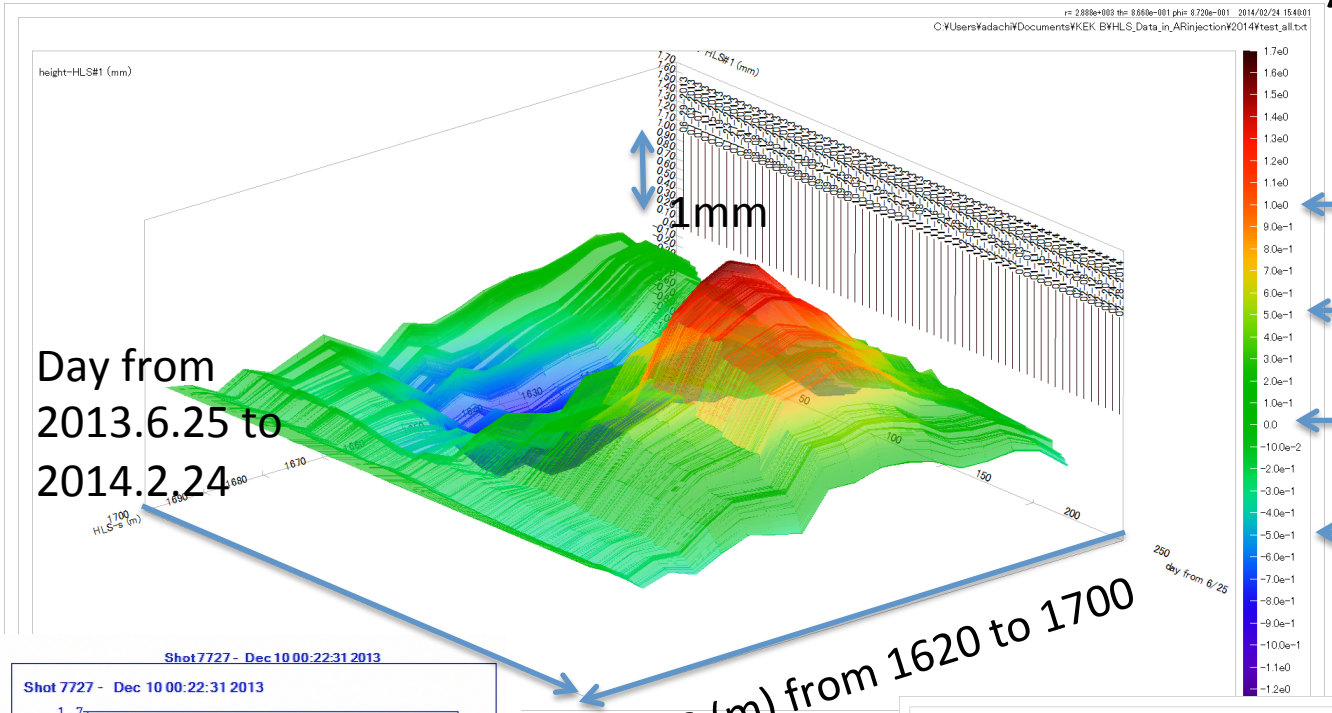


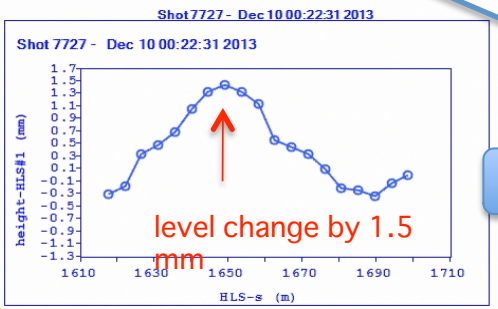


Consistent measurement by HLS

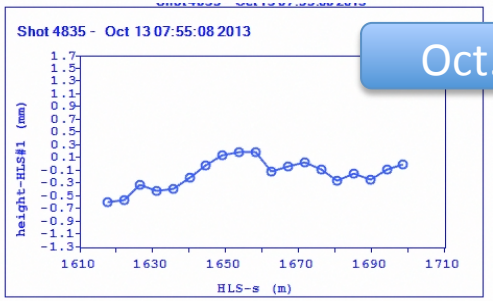
Kawamoto
Adachi

Hydrostatic Leveling System



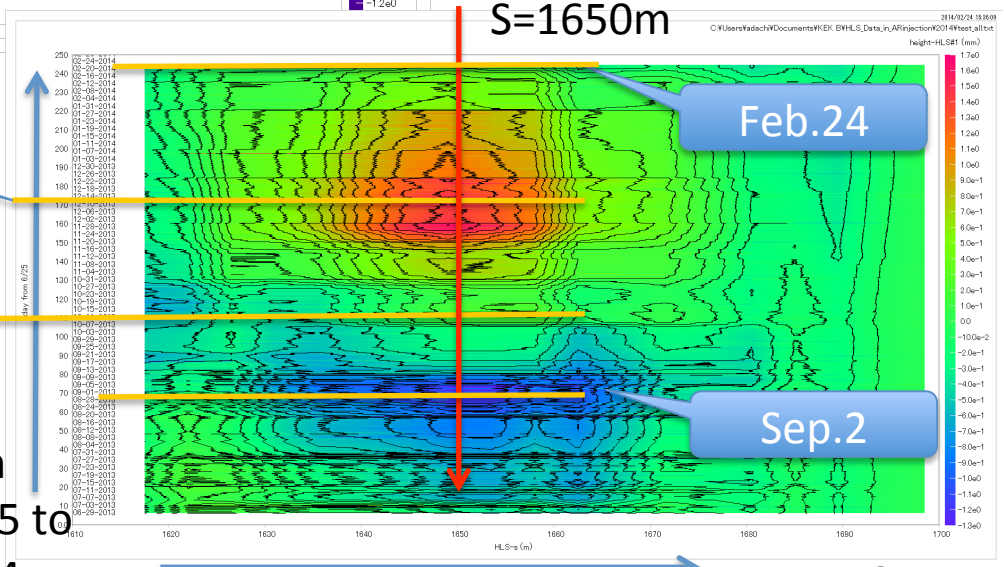


Dec.10



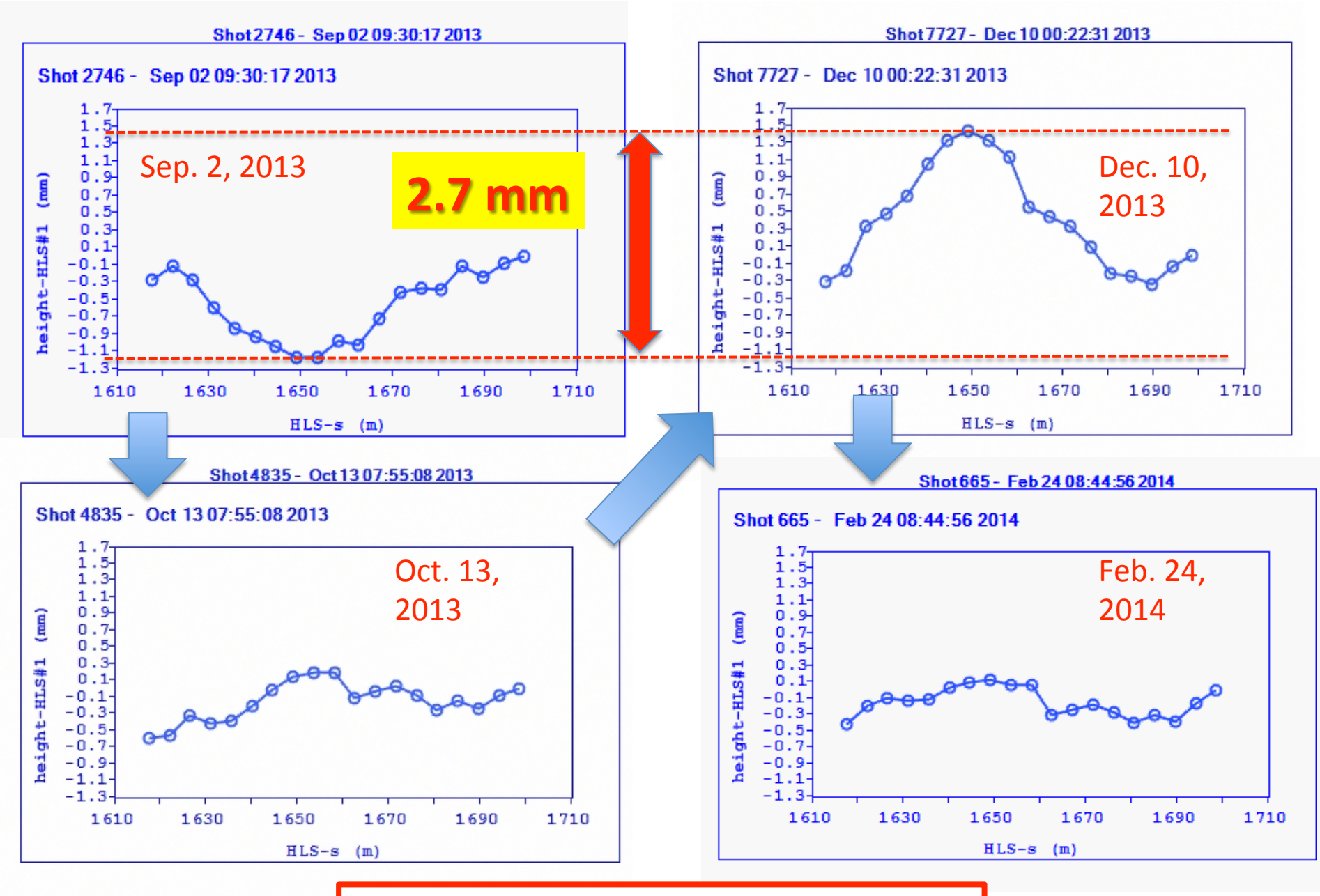
Oct.13

S=1650m



Day from
2013.6.25 to
2014.2.24

S (m) from 1620 to 1700

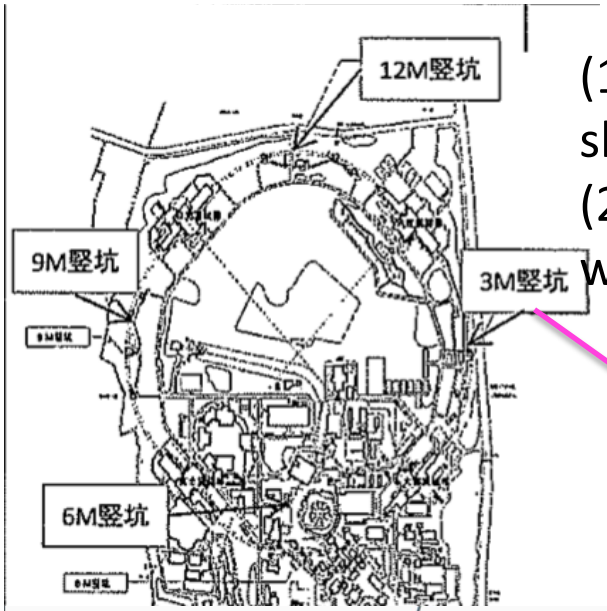


We really worry how difficult a situation we will encounter with the final, fine alignment.

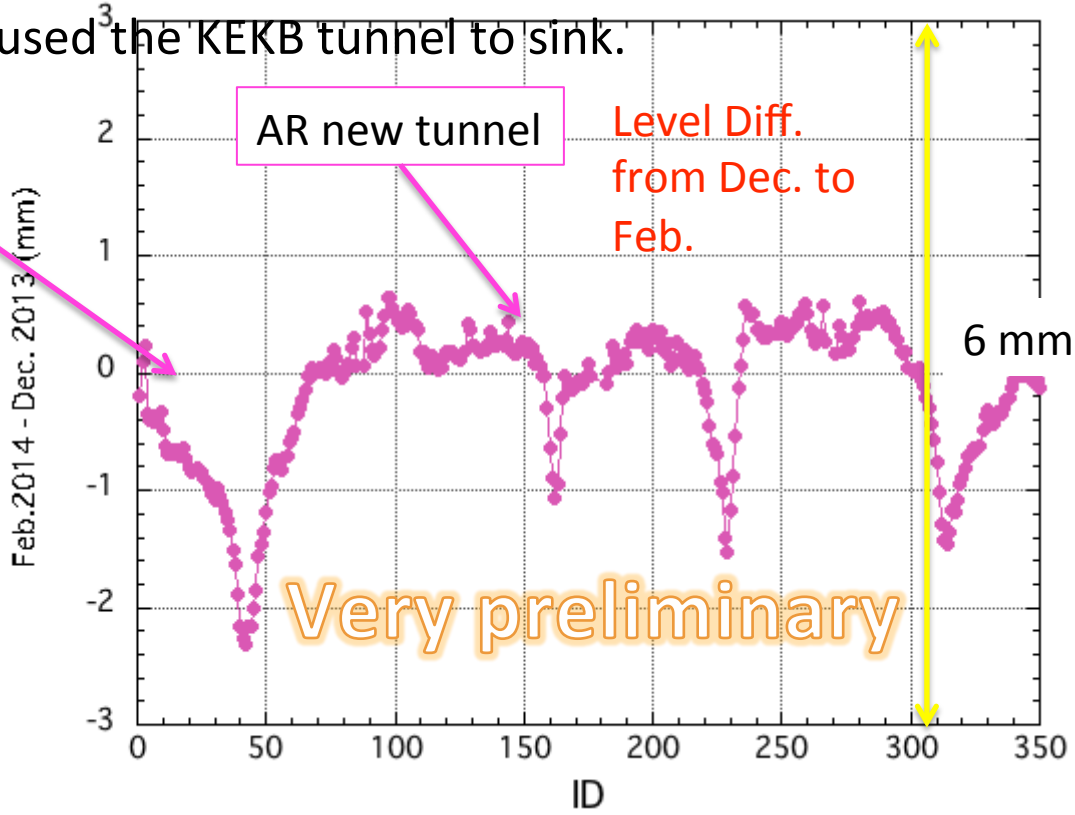
Ohsawa

Alignment work is ongoing, but…

Difficult to coexist with the heavy duty construction work above ground.
Effects of construction of the new utility buildings and new tunnel are clearly seen.



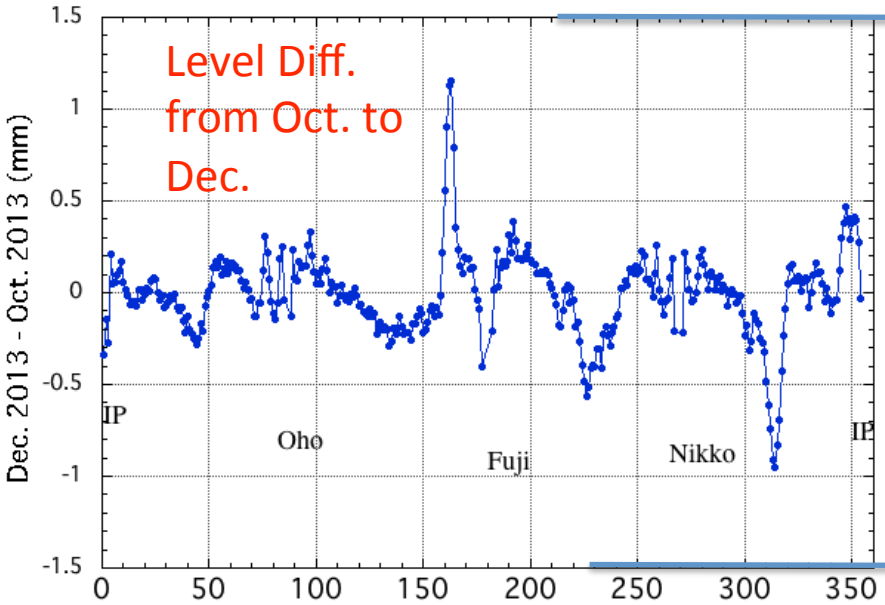
(1)Effects of new utility building “3M” have started to show.
(2)Concrete blocks have been placed in the new AR tunnel, which caused the KEKB tunnel to sink.

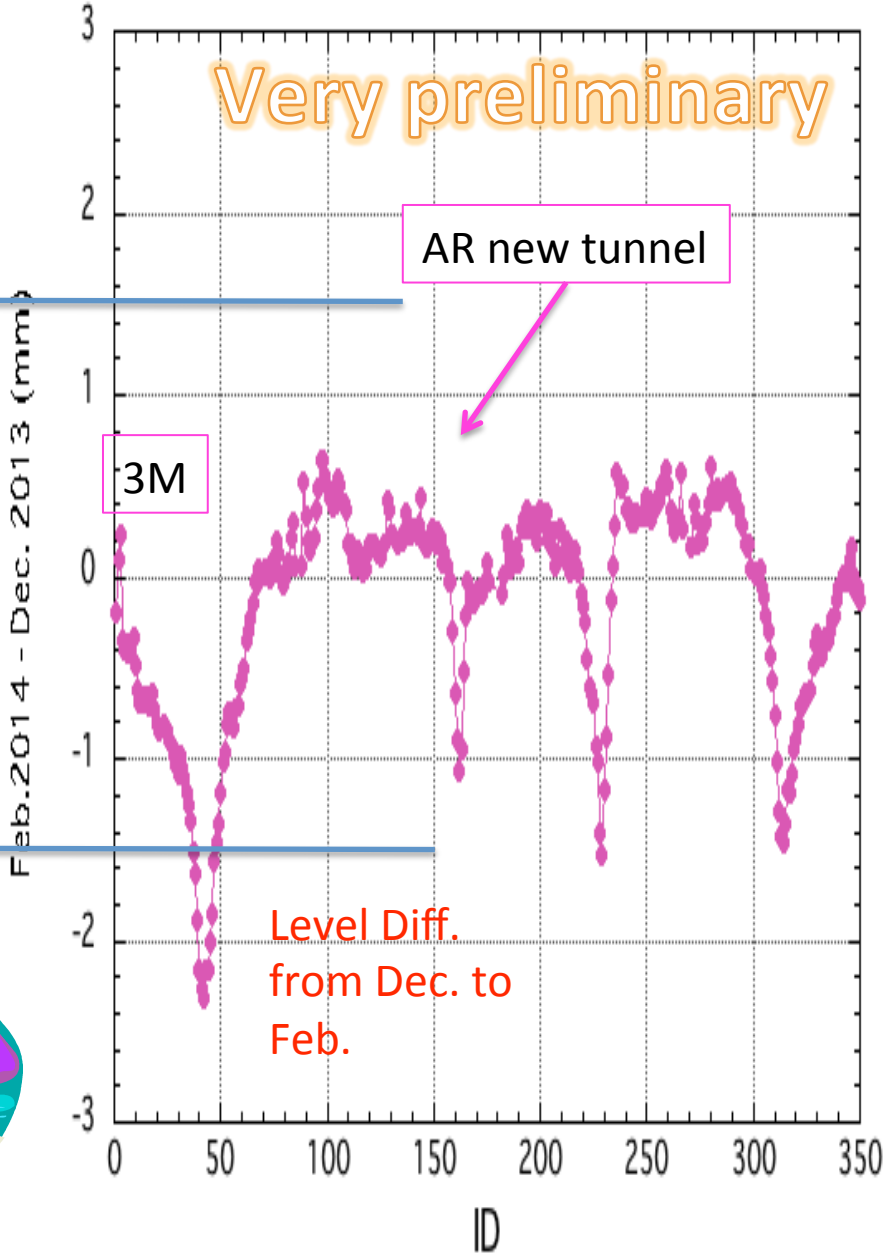


Tunnel level change between Dec. 2013 and Feb. 2014 NEW!!! (very preliminary)

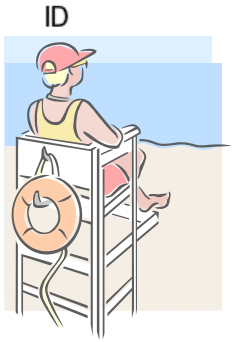
Magr

I have this plot several hours ago.
And I do not know what to say now.





Keep watching!!



Cooling water pipes, power cables

Part of the cooling water pipe lines being installed.
(not connected to the individual magnets yet)

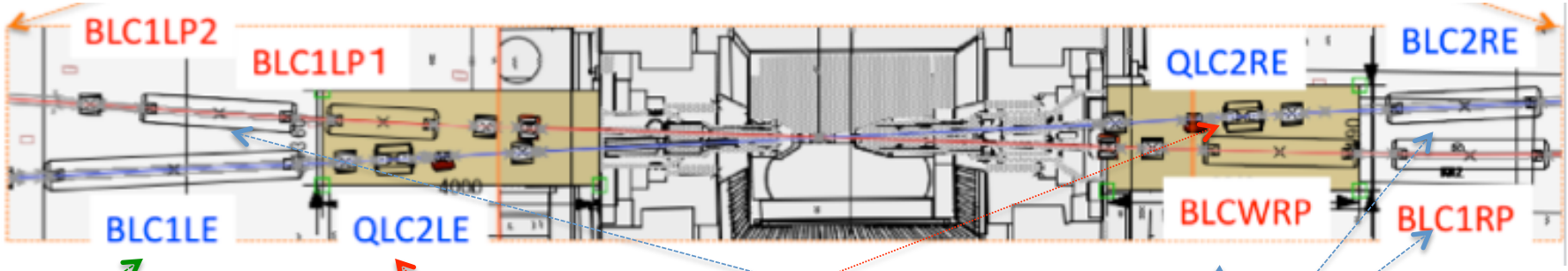
Power cables *between* wiggler magnets have been connected in the Oho and Nikko straight sections. Wiggler polarity has been checked.

Power cable work for the Tsukuba straight section magnets

2. More fabrication

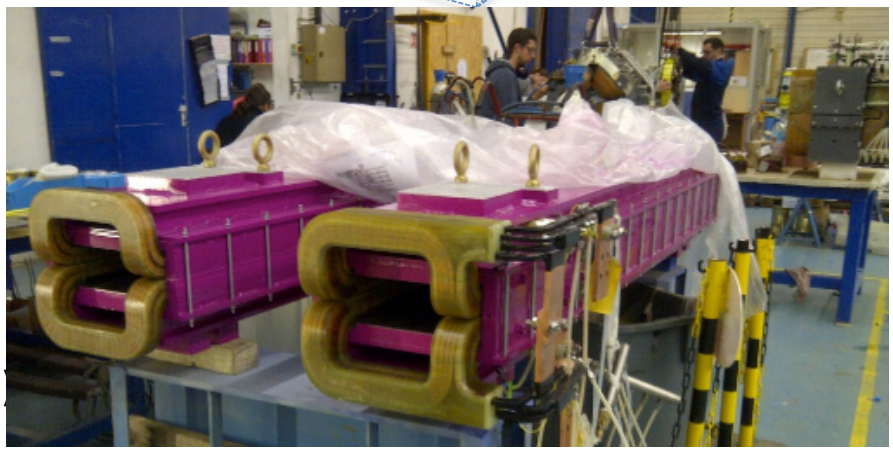
- Skew quads, IR magnets are ongoing: 60 magnets in total.
- Tilting support for 24 sextupole magnets were fabricated.
- 24 KEKB sextupole magnets were modified to fit in the tilting support.

Near IR Magnet production status (BL* and QLC2*)



~3.6 m long dipole
Yoke was sent to machining company.
Coils have been molded and electrical tests are ongoing.

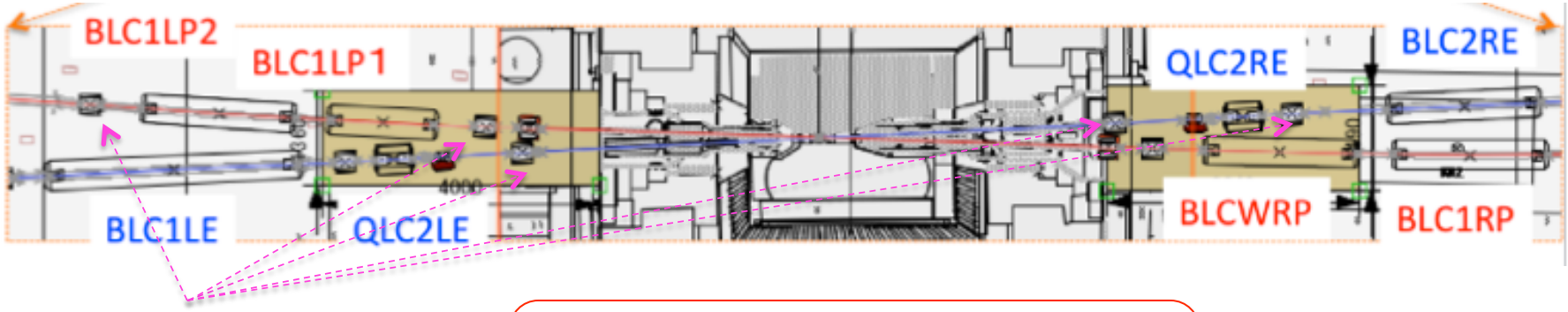
Two quadrupoles (QLC2LE/QLC2RE)
Coils are ready for assembly, which will take place 1st week of March.

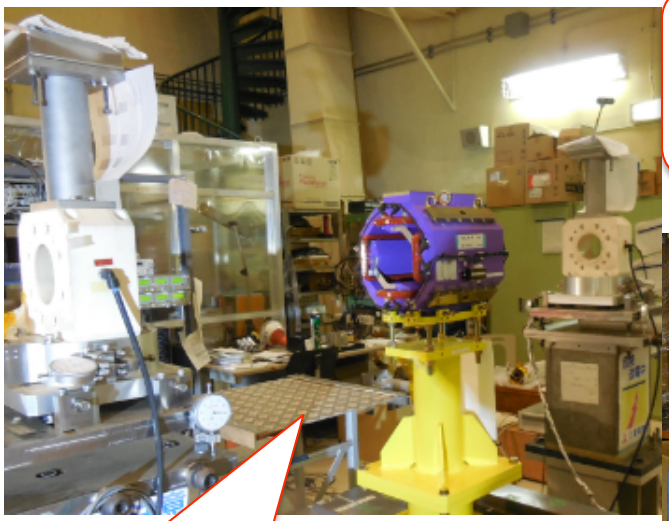


~2.2m Dipoles
All coils have been wound.
2 magnets (out of 4) have been assembled.

6 dipole magnets and 2 quadrupole magnets will be transported by air in March.

Near IR Magnet production status (QK* and BC* and etc.)



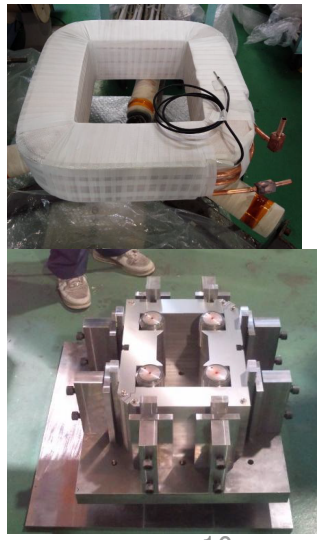


All 16 (+1spare) **Skew Quads** (QK*)
arrived at KEK and the magnetic measurements completed.

Small dipole magnets near the IP, BC1LP and BC1RP arrived at KEK and waiting for the field measurements.

Other small dipole magnets (BC*E) and etc. are being fabricated and scheduled to be shipped to KEK in the end of March.

ZV* ×25



BCE* ×8

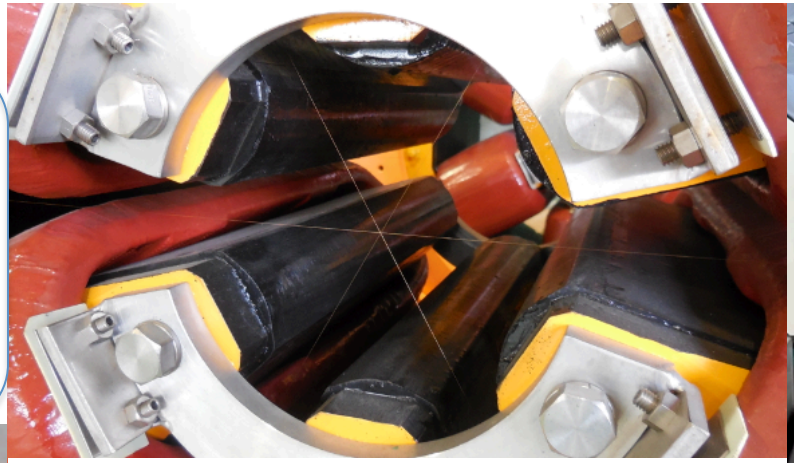
Tilting table for sextupole magnets production and magnet modification are almost completed

16 tables (of 24) arrived at KEK.

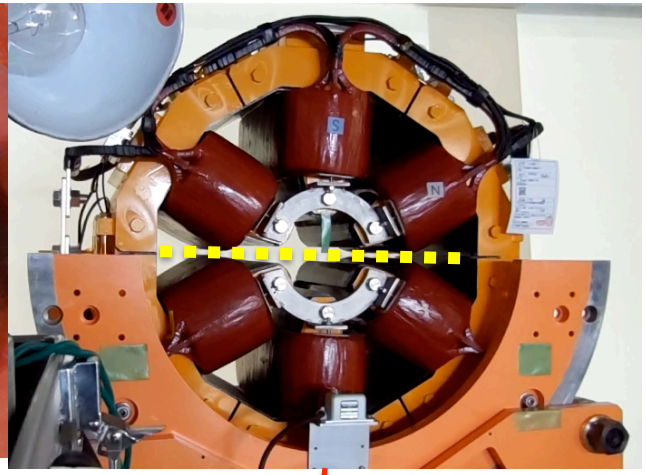
24 KEKB sextupole magnets have been modified to fit to the tilting table.

Alignment of the tilt axis to the magnet center ongoing

Using an optical scope to monitor the magnet center (crossed wires) as the magnet is tilted +/- 30 degree.



0.1mm ϕ wire spanned to indicate the magnet center.



From “normal” sextupole to “skew” sextupole

R. Sugahara
Officially retired, but...

Special movie

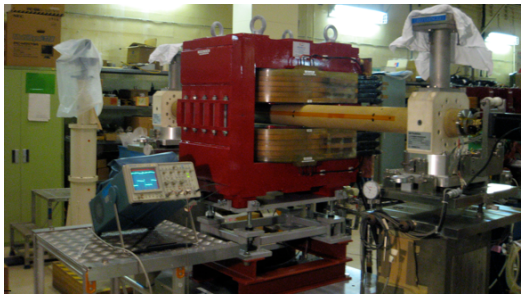
3.Field measurement

Status of magnet fabrication and field measurements

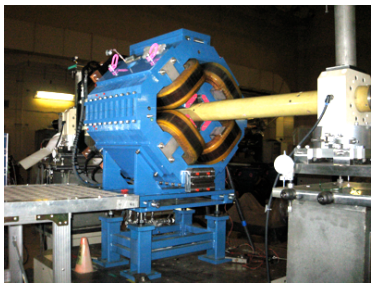
More than two thousand magnets are now installed and aligned properly.
We fabricate more than 500 new magnets and measure magnetic field.

New magnets (not all)

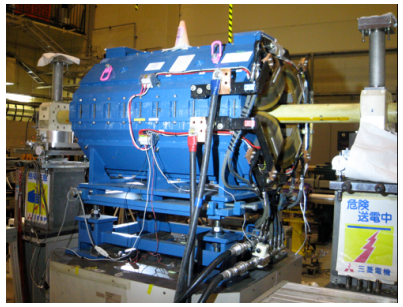
Magnet type	Number (new/reuse)	
	LER (e^+)	HER (e^-)
dipole	171 (125/46)	146 (23/123)
quadruple	455 (27/428)	379 (61/318)
sextuple	108 (0/108)	110 (10/100)
wiggler	280 (168/112)	60 (22/38)
H, V Corrector	416(185,231)	435(17,418)
total	1330 (405/925)	1130 (133/997)



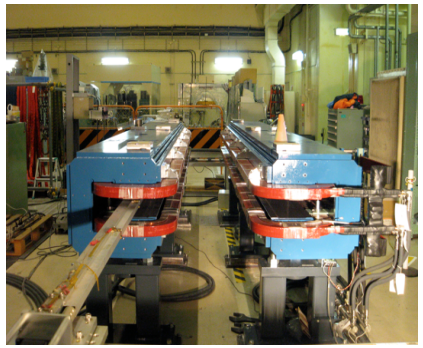
Single pole wiggler×114



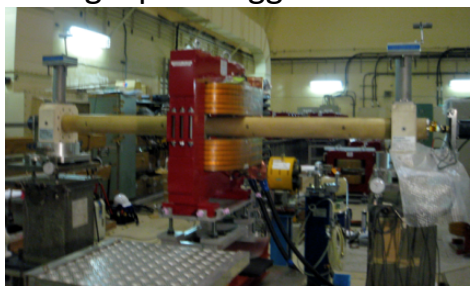
HER Qs×38



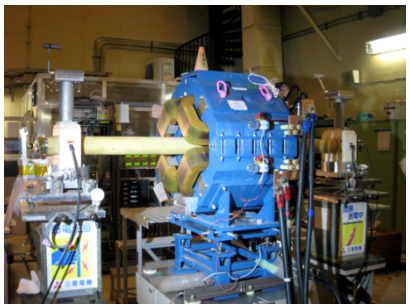
HER Q(1.12m)×3



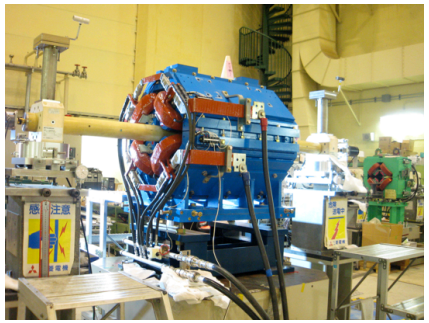
LER dipole (4m)×142



Half pole wiggler ×58



LER Qw×20



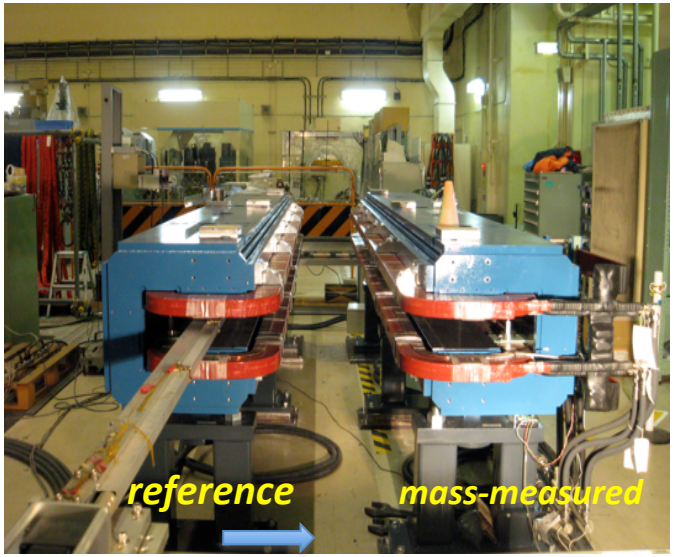
HER Qx×9

Skew Quads (QK*) ×16

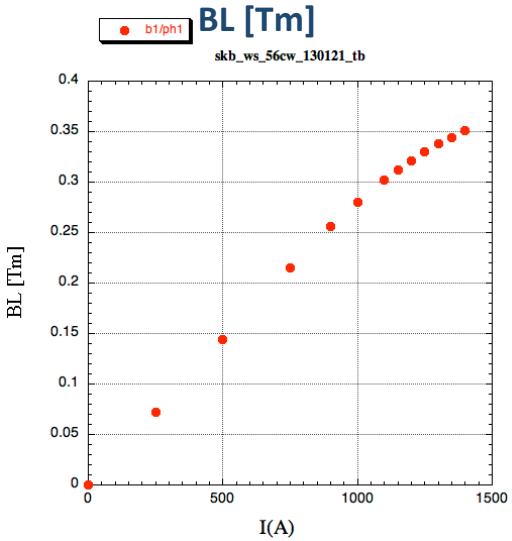
Brief look from field measurement

the Long-harmonic system

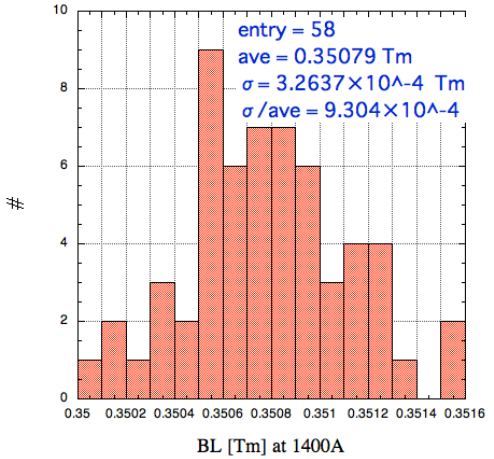
6m-long flip coil system



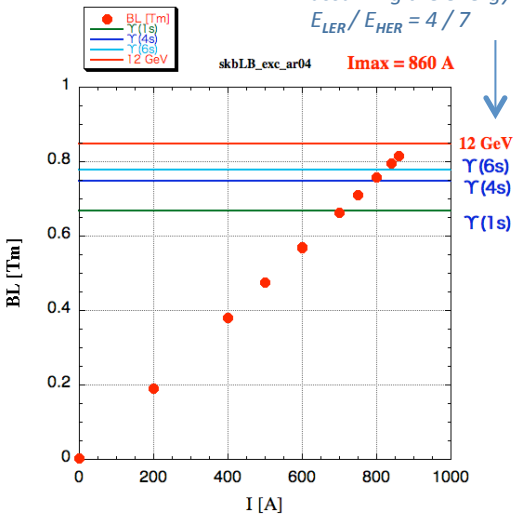
BL [Tm]



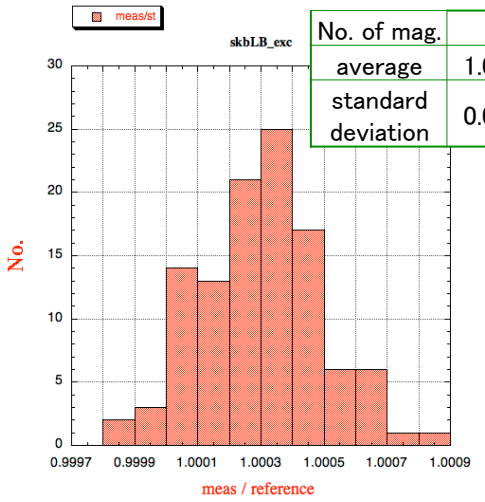
BL histogram



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



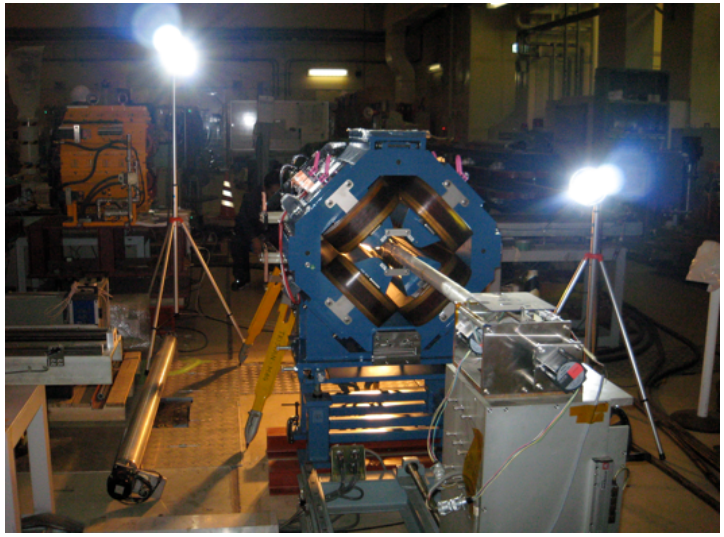
BL@center

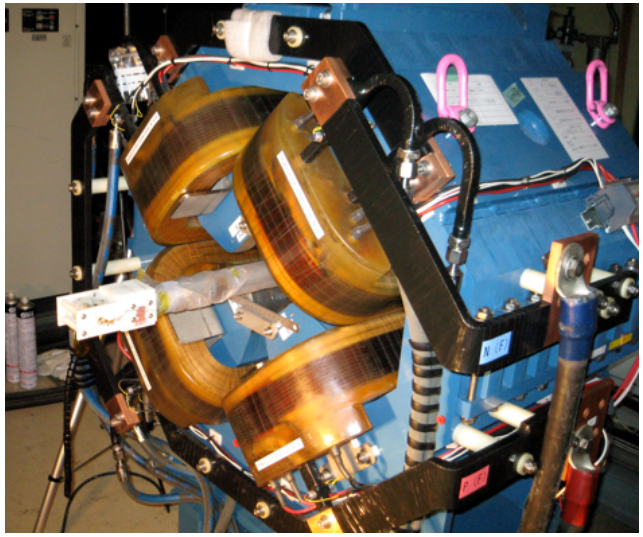


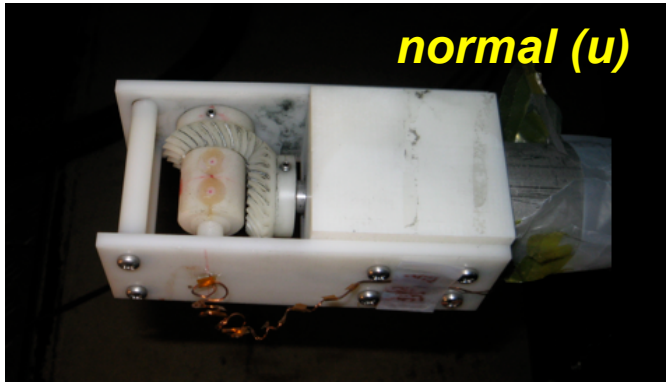
No. of mag.	109
average	1.0002983
standard deviation	0.0001976

Good quality

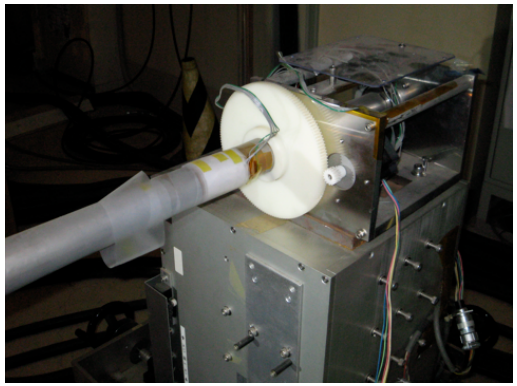
mapping (new HER_Qs)

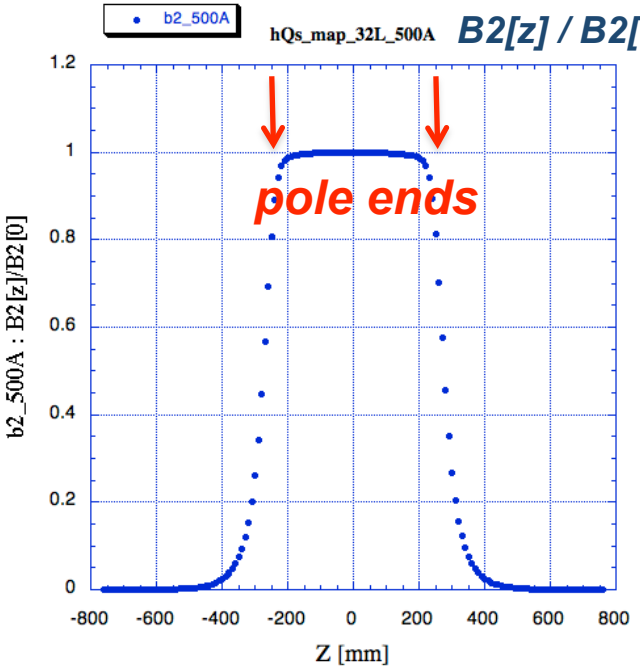


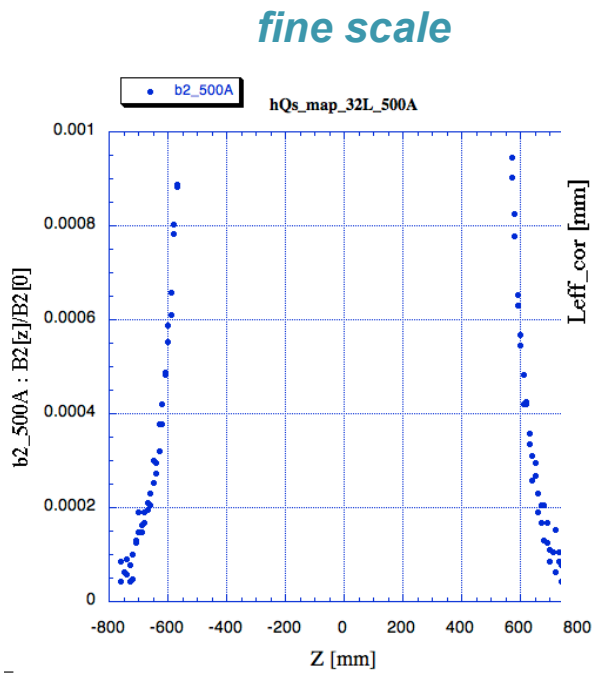


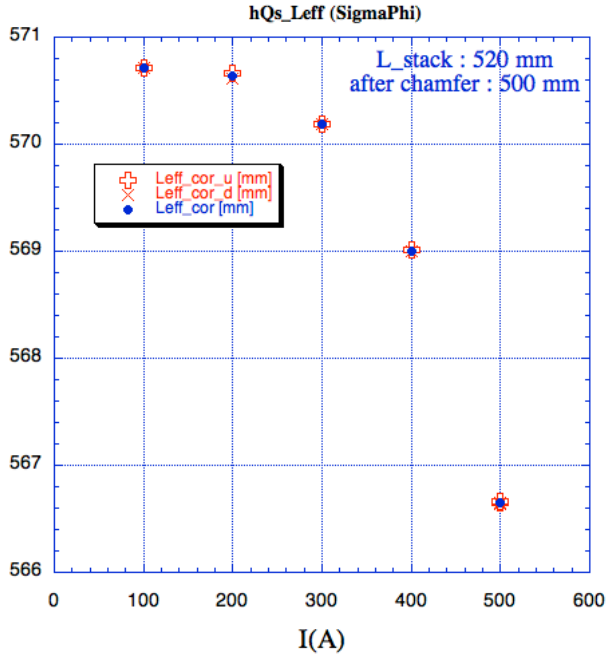


twin coil probe





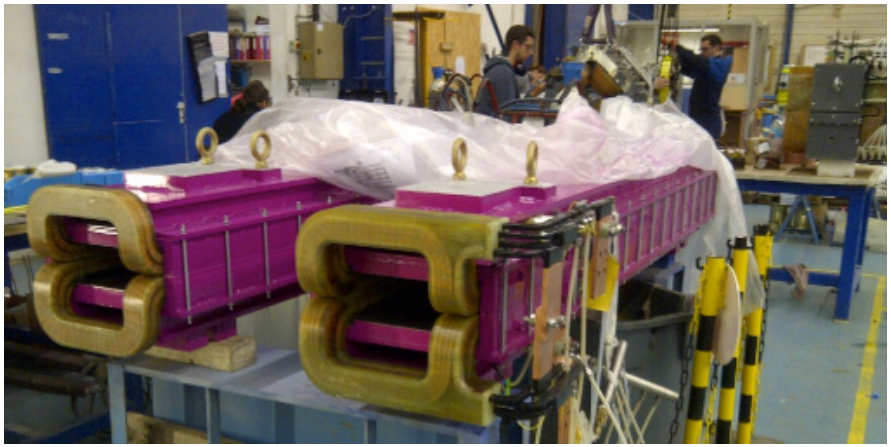


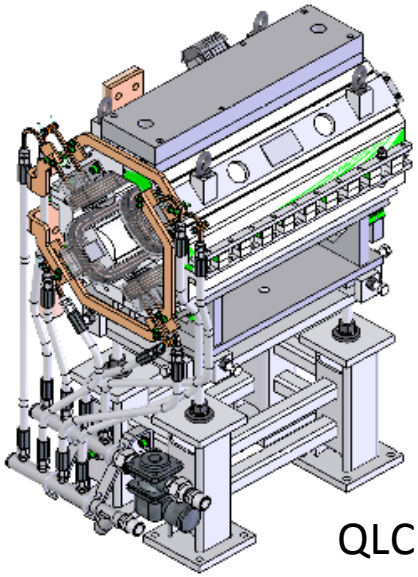


I (A)	L_eff_cor_u [mm]	L_eff_cor_d [mm]	L_eff_cor [mm]	*estimation from harm-coil [mm]*
500	566.65411	566.64801	566.65106	
100	570.71851	570.70844	570.71344	*570.72576*
200	570.66632	570.61694	570.64166	*570.61746*
300	570.18652	570.18695	570.18677	*570.12534*
400	569.0094	569.00031	569.00488	*569.04067*
500	566.66705	566.64032	566.65369	*566.91602*
			Good quality	

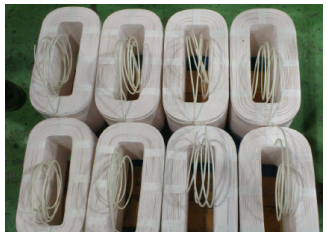
Other new magnets to be measured. …

BLC*×6

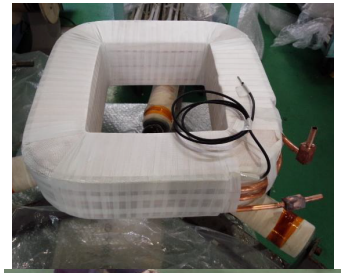




QLC*×2



ZV* ×25



BCE* ×8

BCP*×2

4. Magnet Power Supply System

T. Adachi
T. Oki
T. Sueno
N. Tokuda

Power supplies of SuperKEKB magnets

- ~ 2300 power supplies operated in KEKB. Most of them are re-used in SuperKEKB. ~620 power supplies are overhauled.
- ~ 700 power supplies are manufactured for SuperKEKB as below

output power or current	FY 2011	FY 2012	FY 2013	FY 2014	typical loads
0.95 MW	2	–	–	–	LER/HER Main Bends
0.4 - 1 MW	8	1	–	–	LER/HER Wigglers
2.4 - 50 kW	–	–	102	–	Local Bends, Quads, Sexts
0.5 - 0.8 kW	–	29	100	~100	Steering magnets, Correction coils
1.5 - 3 kW	–	–	–	~240	Solenoids against electron-cloud
800 - 2000 A	–	–	2	6	Supercond. Quads
200 - 500 A	–	–	–	4	Supercond. Solenoids
± 60 A	–	–	4	~40	Supercond. Correction coils
440, 630 kW	–	2	–	–	DR Main Bends
5 - 60 kW	23	–	26	–	DR Bends, Quads, Sexts

Installation of new mega-watt class power supplies

Mega-watt class power supplies are installed with their power receiving equipment.

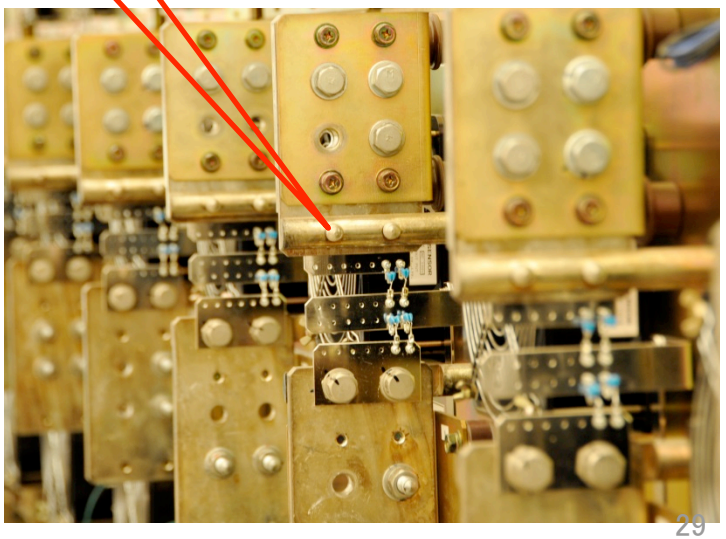
Magnets being used as a test load for a running test.

Overhaul of medium class power supplies (< 100 kW)

Most of the medium class power supplies are being re-used in SuperKEKB. 339 power supplies has been overhauled.

Replacement of chemical capacitors, AC-DC converters, circuit breakers and IGBTs are performed. Ceramic capacitors are added at the output terminal to reduce switching noise.

Running test with dummy load is done at both factory and KEK.



Overhaul of small class power supplies (< 0.8 kW)

Only 129 of new small class power supplies were/will be manufactured, while 1,885 small class power supplies are re-used in SuperKEKB

Some of the re-used power supplies were overhauled. The number of overhauled power supplies was only 265, limited by budget.

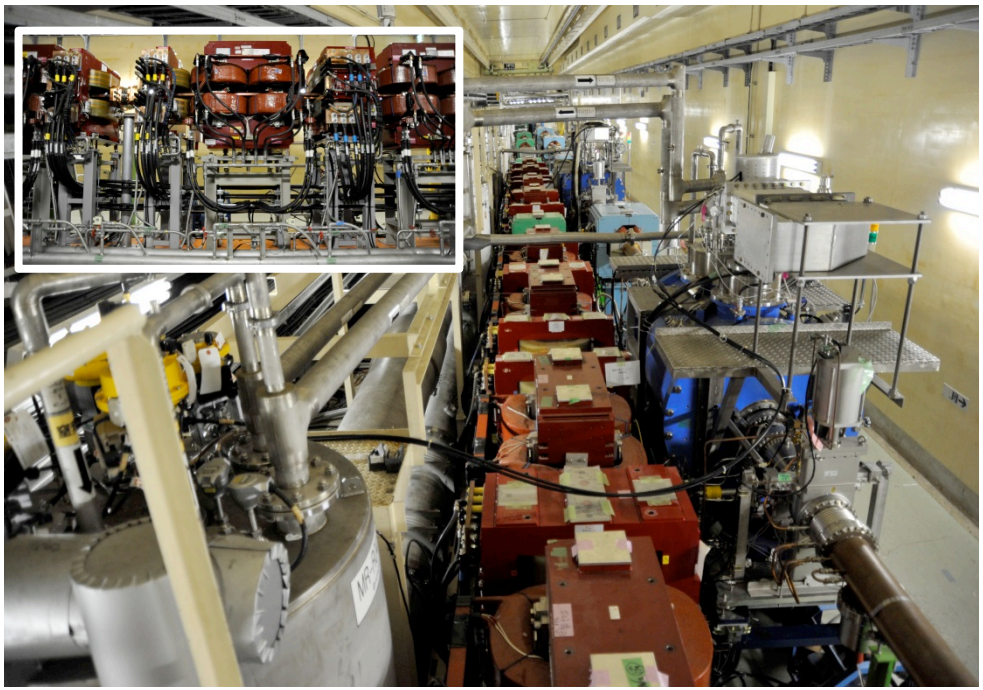
Running test with dummy load, however, has been performed for all of re-used supplies. Fault was found in 3% of power supplies.

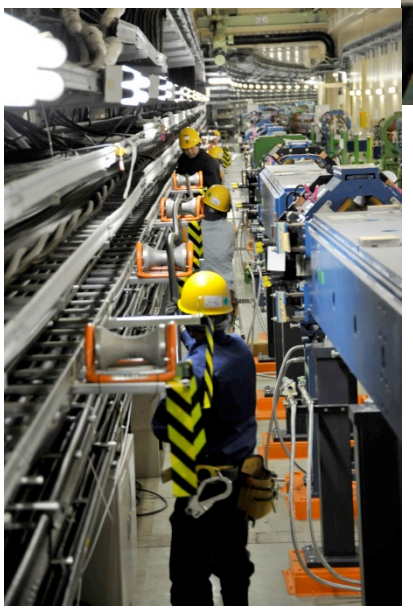
Circuit breakers replacement

279 of circuit breakers (420 V/210 V/100 V) at 8 power supply buildings have been replaced.

Cabling

Stored cables are carried …





…and installed from PS building to KEKB tunnel.

Cabling for Nikko wigglers was heavy work: complicated, but little working space.

Schedule of magnets and power supplies

In the Tunnel

- Sextupole magnets and steering magnets installation in Tsukuba and abort sections.
- Installation of near-IR magnets
- Cooling water pipes, power cables installation and adjustment
- Survey and FINAL alignment of the magnets in the tunnel

Field measurement and operation

- More field measurement for new 66+α magnets in FY2013~Early FY2014
- Prepare database of excitation parameters .

-- Address each magnet based on lattice

-- Grouping power supply “family”

Power Supply

- Manufacture 350+40 new power supplies
- Cabling

AC input : Feb. – March 2014

DC output : Sep. 2013 – May 2014

Interlock : Nov. 2013 – July 2014

Current monitor : May - July 2014

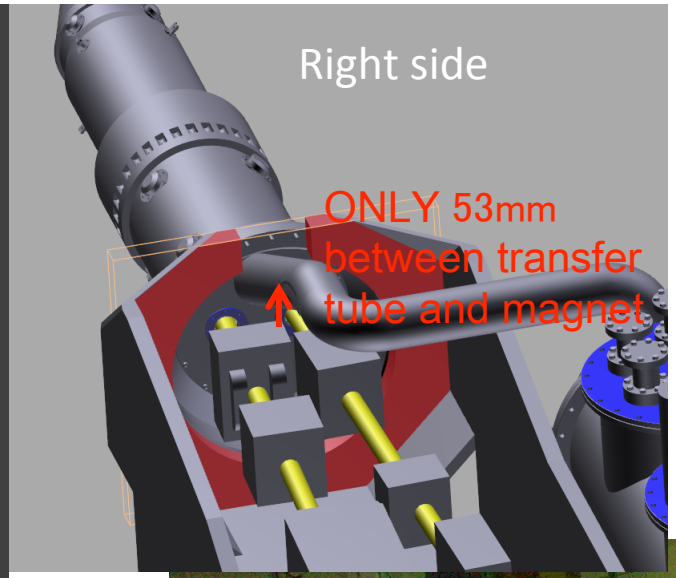
Network : May - July 2014

- Start-up and tuning

- Test operation : January 2014.

- Full-scale start-up and tuning : September 2014.

5. And more.



IR mockup

Installation may be tricky…
We made a mockup to study:

- ✓ How to install magnets, pipes such a busy area?
- ✓ How to connect cooling water, power supplies and other life lines for facility