

*K. Egawa*

*2013.3.4*

# **Magnetic fabrication and field measurements**

# New magnets (resistive) production status

2013.Mar.

LER magnet	number	specification	status
Dipole B_arc, B_lc	114 (+2) + 24 (+2)	fixed	<i>installed in arc sections</i>
Wiggler : half / single pole	112 (+2) / 56 (+2)	fixed	<i>meas. &amp; installation almost completed</i>
near IR dipole	1.5 m : 1 2.23 m : 3	fixed	<i>contract in early May 2013</i>
near IR short dipole	2	fixed	<i>contract in early fiscal 2013</i>
Qw ( Leff =0.5837 )	20	≈ kb_LQw	<i>waiting measurement</i>
QK ( skew Q )	10	fixed	<i>contract in early fiscal 2013</i>
Sx_0.3m ( rotatable)	24	re-use Sx_0.3	<i>remodel in fiscal 2013</i>
Sx rotatable support	24	fixed	<i>contract in early May 2013</i>
Vertical Corrector	~ 220	fixed	installed
<i>additional vertical corrector</i>	*	<i>fixed</i>	<i>contract in fiscal 2013</i>

*New magnets (resistive) production status cont.*

2013.Mar.

<b>HER magnet</b>	<b>number</b>	<b>specification</b>	<b>status</b>
<i>Dipole (4 m) <math>\subset</math> LER dipole</i>	13	= LER B_lc	<i>waiting installation</i>
near IR dipole	2.23 m : 1 3.6 m : 1	fixed	contract in early May 2013
near IR short dipole	8	fixed	contract in early fiscal 2013
<i>additional kb wiggler</i>	+ 22	<i>fixed</i>	-
<b>near IR Q</b>	2	fixed	~ in early May 2013
<b>Q ( 0.56 m )</b>	38 (+ 1)	$\approx$ kb_HQ.arc	waiting delivery in this <b>Mar.</b>
<b>Q ( 1.12 m )</b>	2 (+ 1)	new	
<b>Qx</b>	8 (+ 1)	$\approx$ KB_HQx	waiting measurement
<b>Qsk</b>	6	fixed	contract in early fiscal 2013
<b>SL</b>	8 (+2)	fixed	contract in early May 2013
<b>Sx_abort</b>	2 (+1)		
<i>skew Sx</i>	24	<i>kekB_skew_Sx</i>	<i>re-use</i>

## Field measurement plan

KEKB wiggler : **completed** ( $I_{max}$  : 950 A  $\Rightarrow$  1400 A )

LER new dipole : **completed**

new wigglers : WS **completed**, WH **completed tomorrow**

LER\_Qw ( $L_{eff}=0.5837$ ) : **from March 2013**

HER\_Qx : **from Aug. or Sept. 2013**

HQ\_0.56m : **from May ~ July 2013**

HQ\_1.12m : **from Aug. or Sept. 2013**

kb\_L\_B.arc & B.Lc : **re-measure in Apr. 2013** ( $I_{max}$  will be reduced !)

### **measurement in FY2014**

$H_{SL} + H_{Sx\_abort}$  : 8 + (2) + 2 + (1)

$skew_{HSx}$  : 24

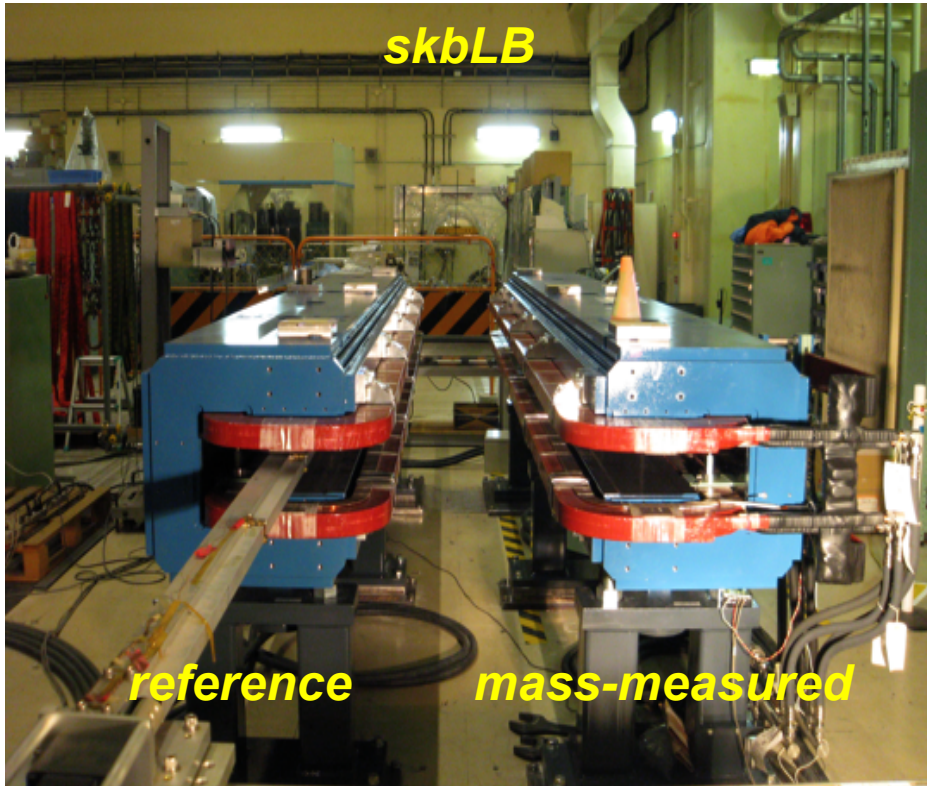
### **near IR**

**near IR dipole** : (1 + 3)<sub>LER</sub> + (1 + 1)<sub>HER</sub>

**short dipole** : 2<sub>LER</sub> + 8<sub>HER</sub>

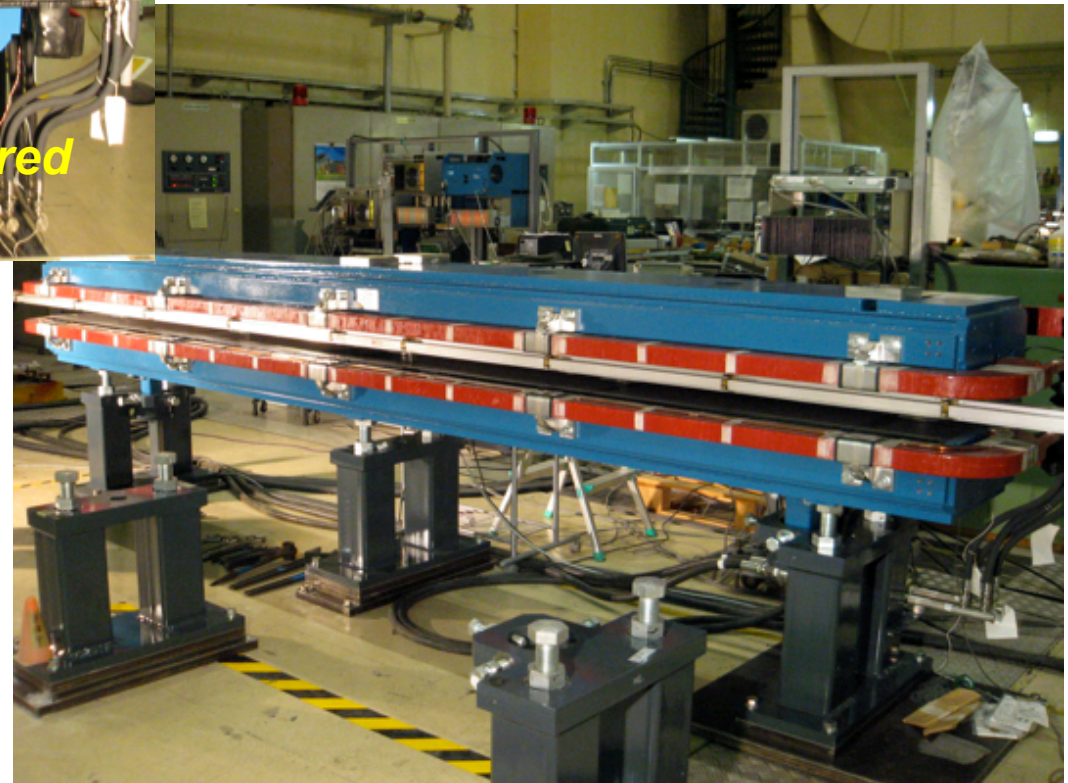
**near IR Q** : 2<sub>HER</sub>

**Qsk** : 10<sub>LER</sub> + 6<sub>HER</sub>



*New LER dipole  
field measurement*

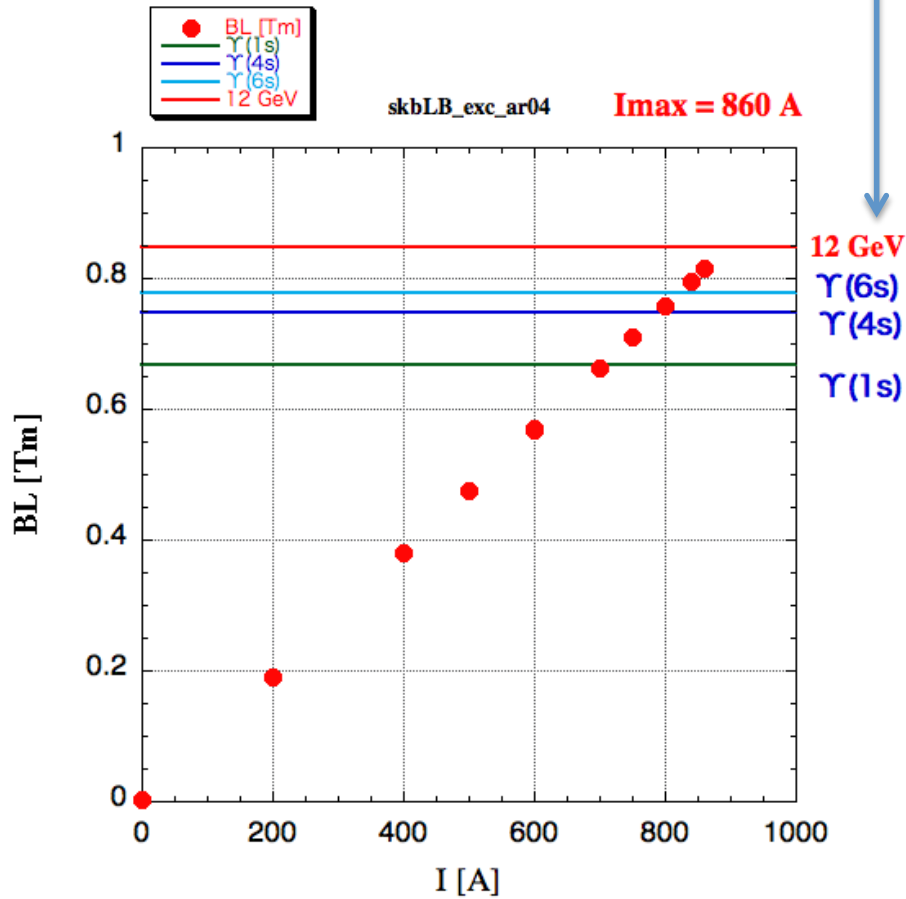
*6m-long flip coil system*



*After measuring each mass-measured  
magnet, the probe comes back to  
the reference magnet and measures  
it.*

# excitation

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



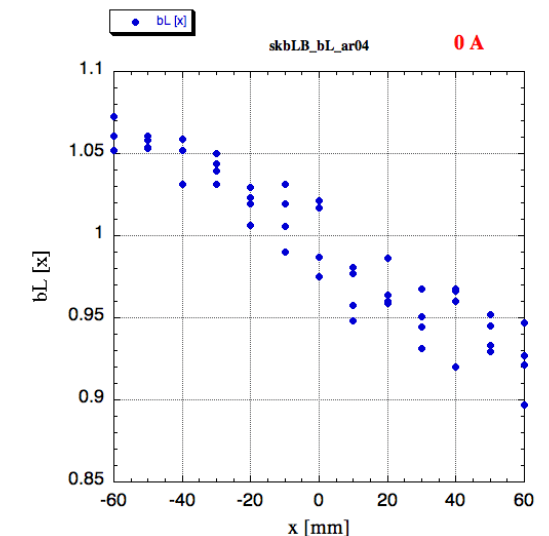
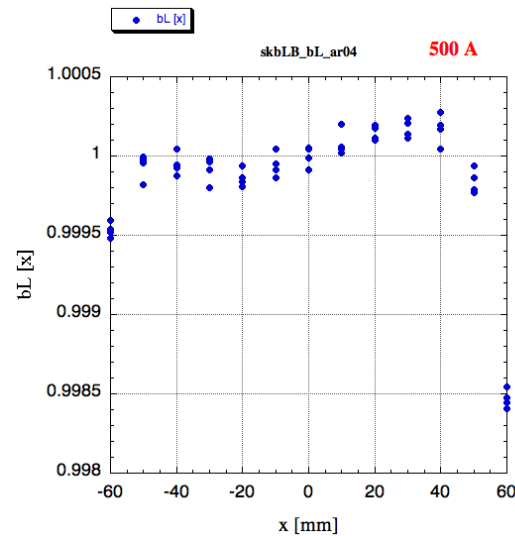
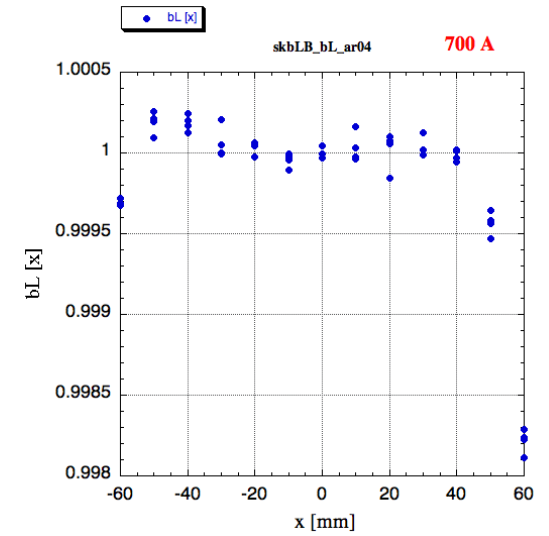
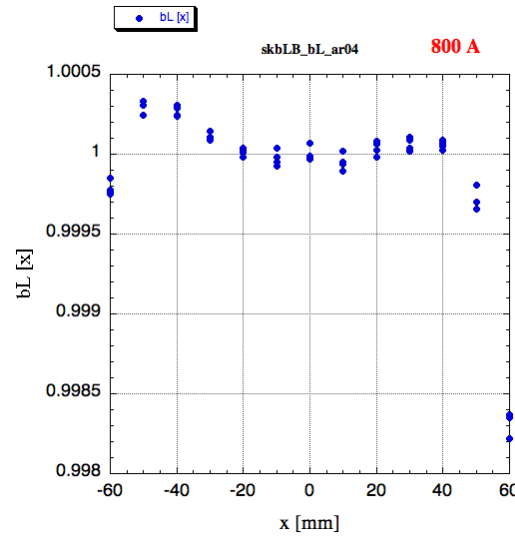
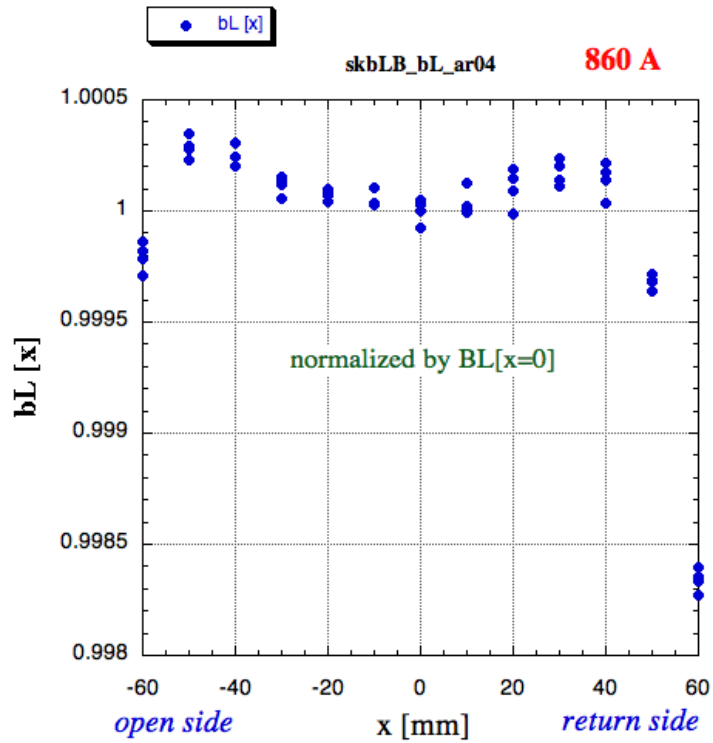
I [A]	$B_{center}$ NMR [T]	Poisson	$B_{NMR}/B_{\mu=\infty}$
730	0.1660075		0.9953
760	0.1728672		0.9955
800	0.1819504		0.9954
<b>840</b>	<b>0.1910295</b>	<b>0.19035</b>	<b>0.9953</b>
<b>860</b>			

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

$$E_{LER\_max} = 4.28571 \text{ GeV}, E_{HER\_max} = 8.75875 \text{ GeV}$$

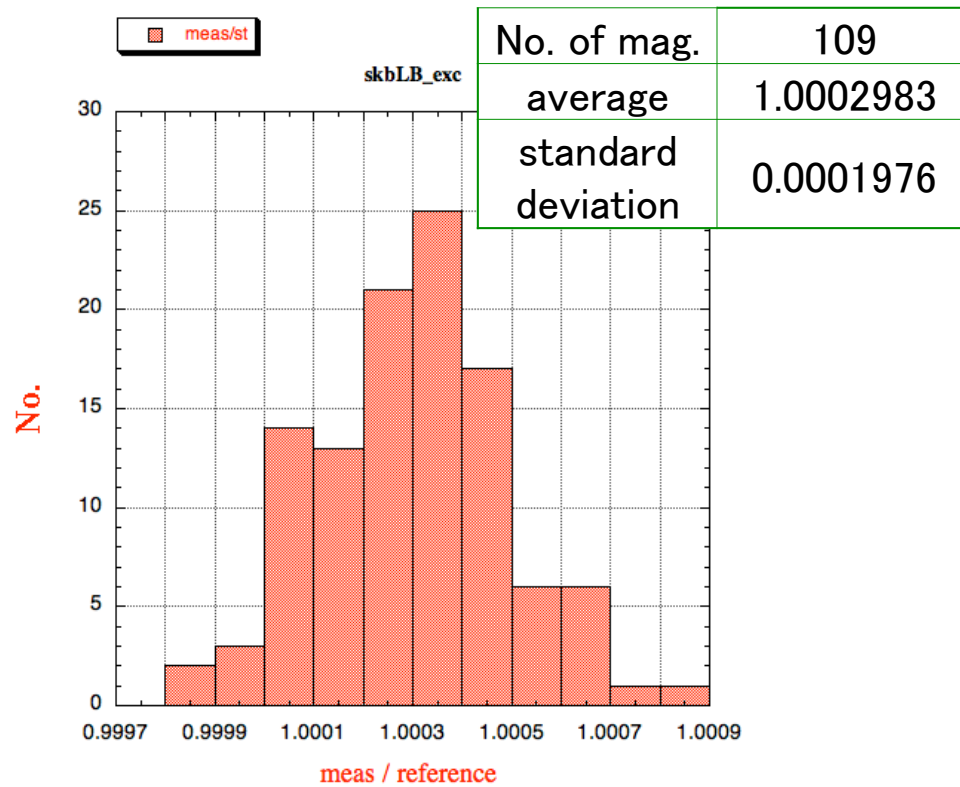
$$k = 0.0561 \ \& \ E = 4.28571 \text{ GeV} \ \longrightarrow \ BL = 0.802 \text{ Tm}$$

# bL[x] measured by long flip coil

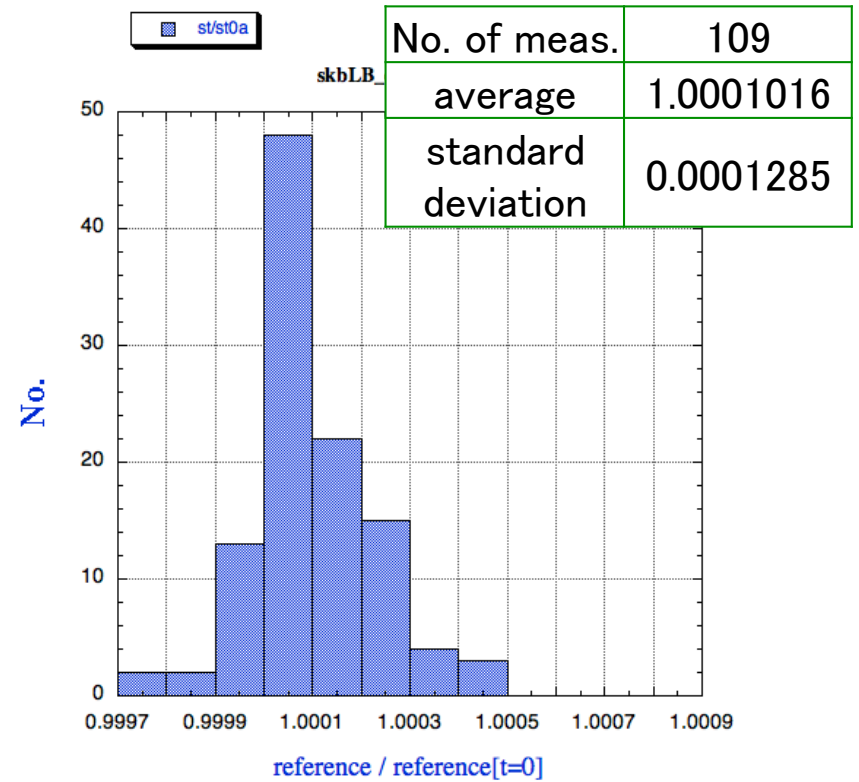


*measure 4 times at each point.  
Their variation (example) is ;*

average	5024673.5
$\sigma$	285.697
$\sigma$ / average	5.7e-05



normalized BL histogram of the 109 dipoles  
( $I_{max} = 860A$ )



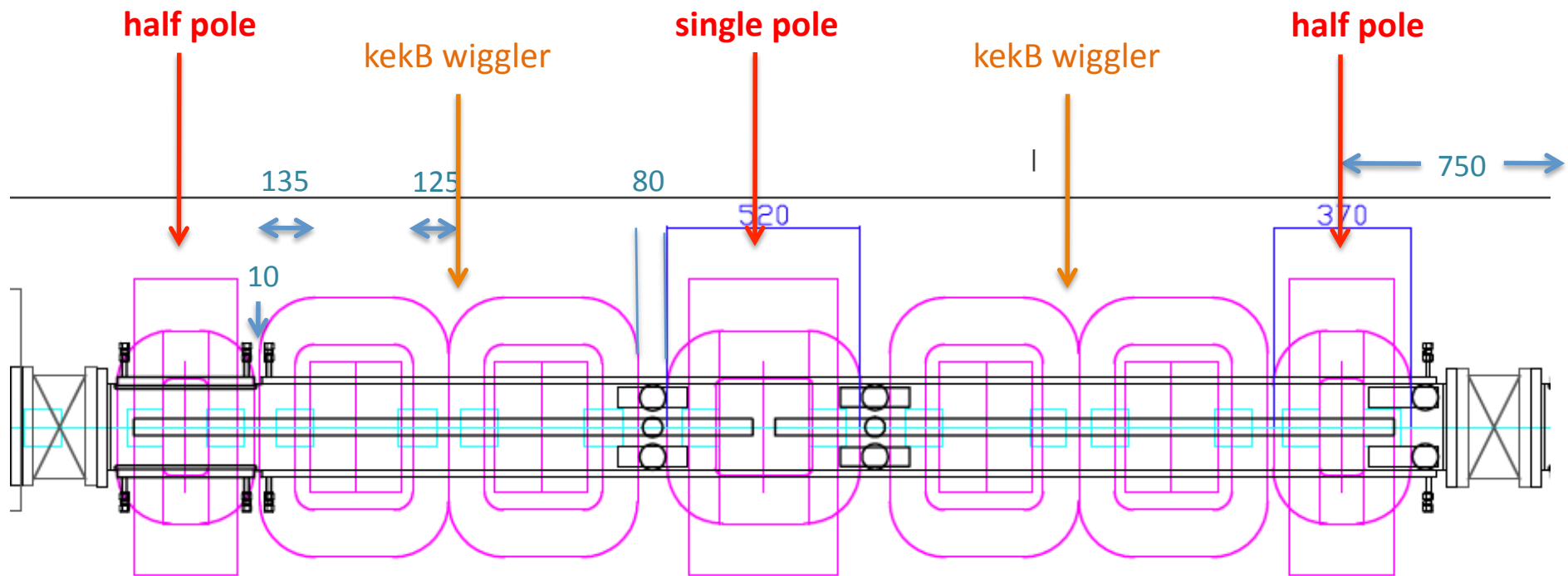
normalized BL histogram of  
the reference dipole

$k \approx 0.056 \Rightarrow$   
 $\delta k \approx 0.1107 \times 10^{-4}$

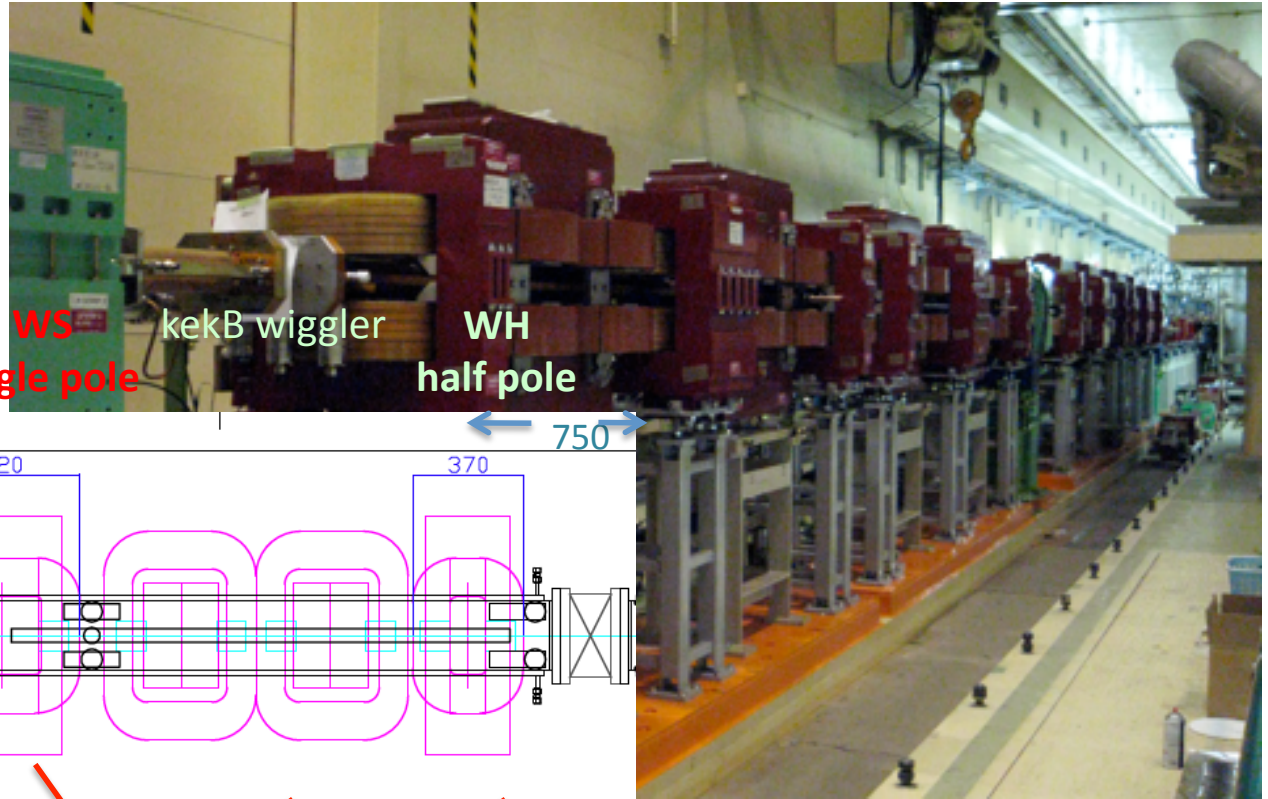


## SuperKEKB wiggler system

- To achieve the required small emittance, the wiggler sections need to be remodeled;  
**reduce** the **wiggle pitch**  $\Rightarrow 1/2$  and **increase** **peak field**  $0.77 \text{ T} \Rightarrow 0.98 \text{ T}$  (kekB wiggler for example ).
- **Two types of H-shape magnets** are produced and interleaved between the **existing kekB wigglers**.  
They are **single pole wiggler (WS)** and **half pole wiggler (WH)**

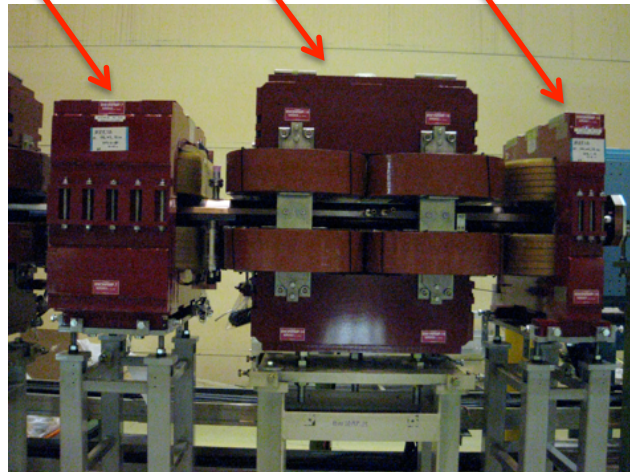
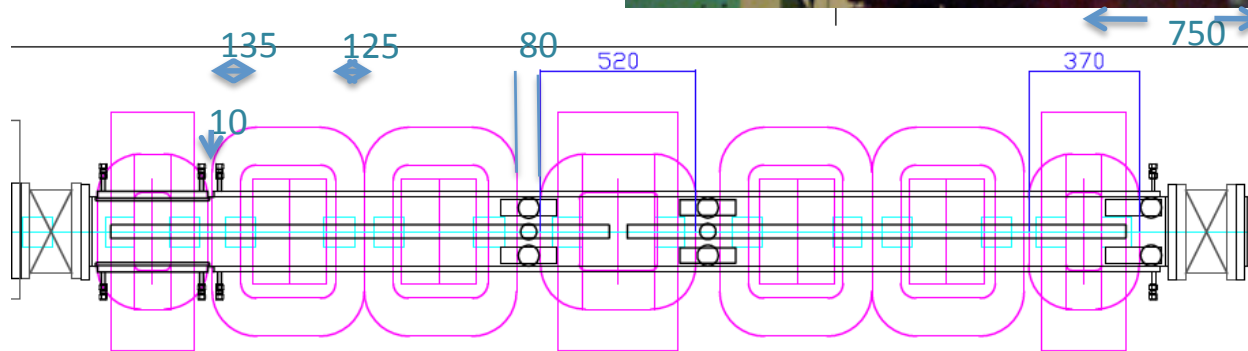


# View at Nikko

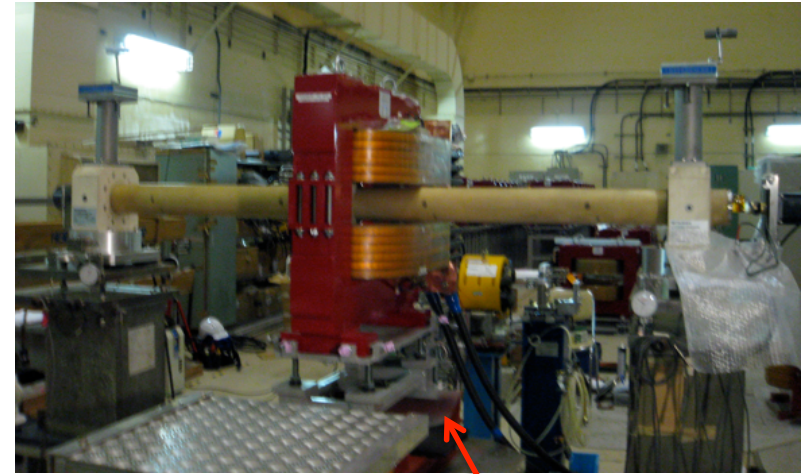


**WH**      kekB wiggler  
**half pole**      double pole

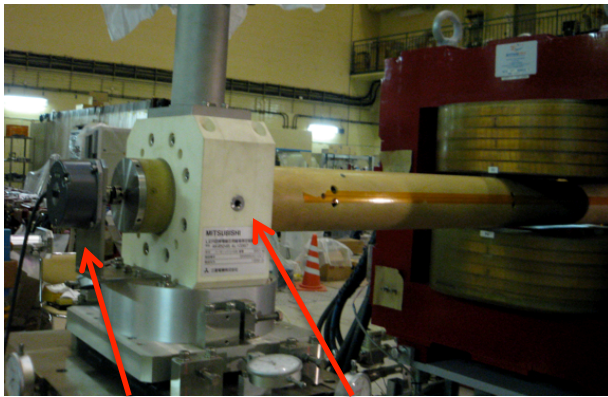
**WS**      kekB wiggler      **WH**  
**single pole**                      half pole



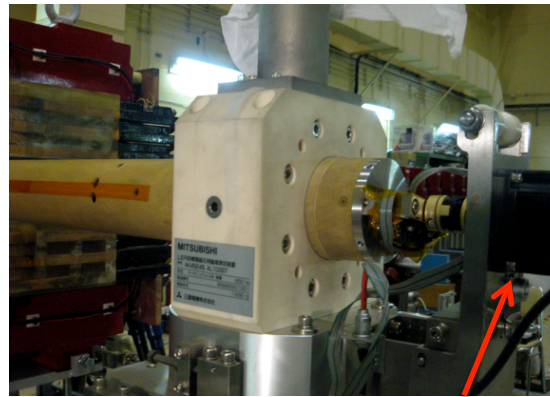
# LER harmonic coil system



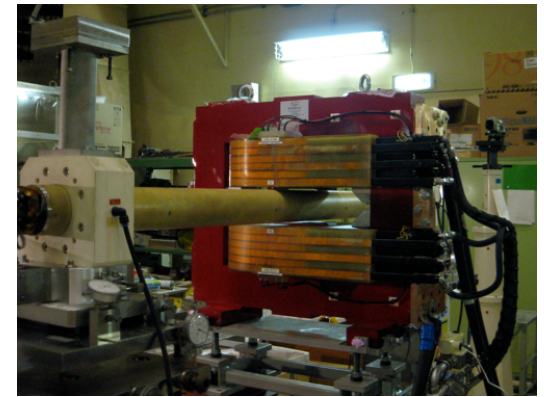
**5 axes mover**



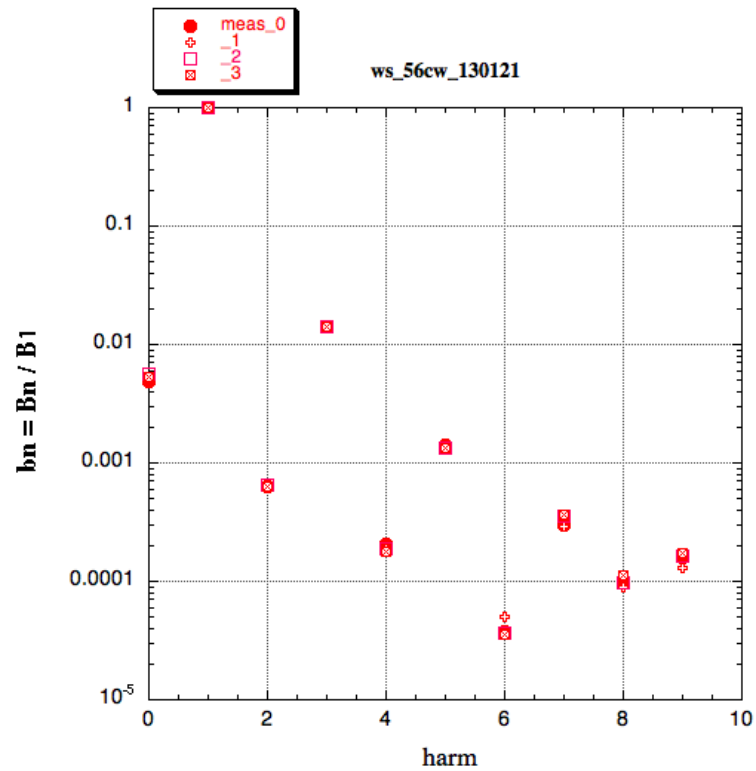
**encoder    air-bearing**



**motor**

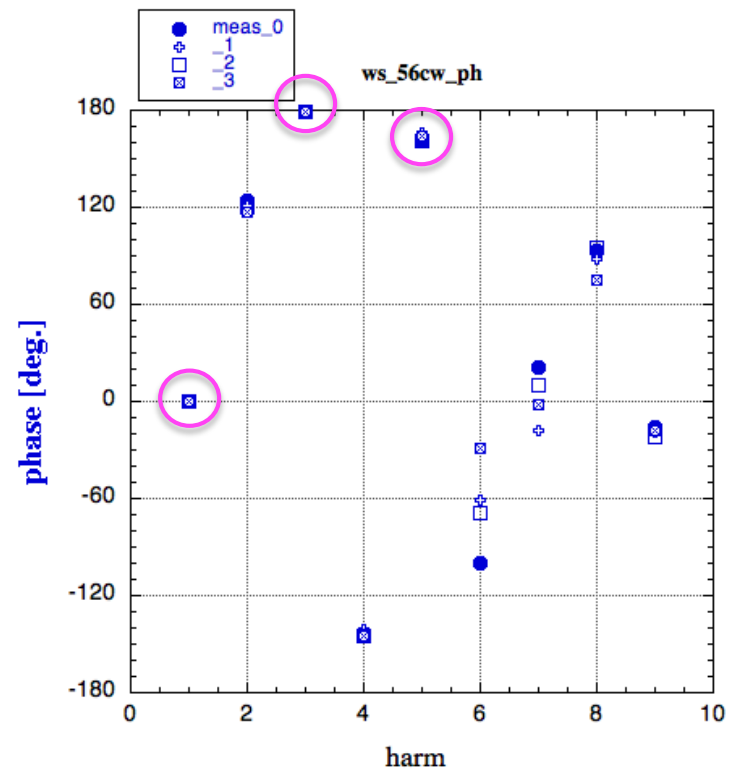


# Single Pole Wiggler (WS) : harmonic coil measurement

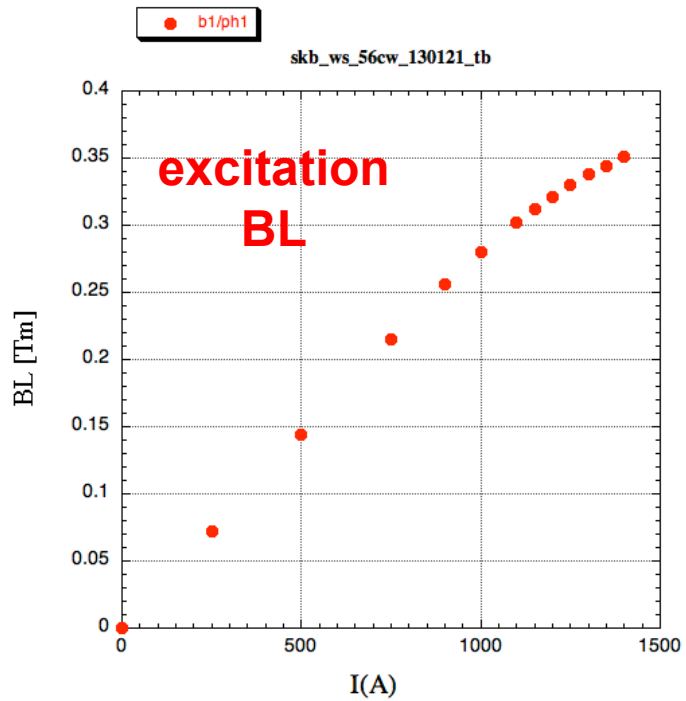


$$B_n L (r = a) / B_1 L (r = a)$$

$a =$  probe radius = **50.212** mm



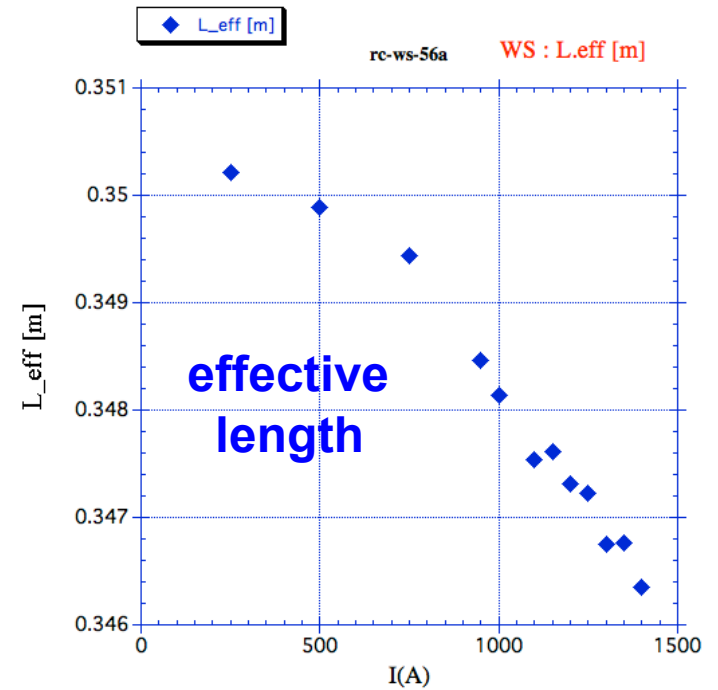
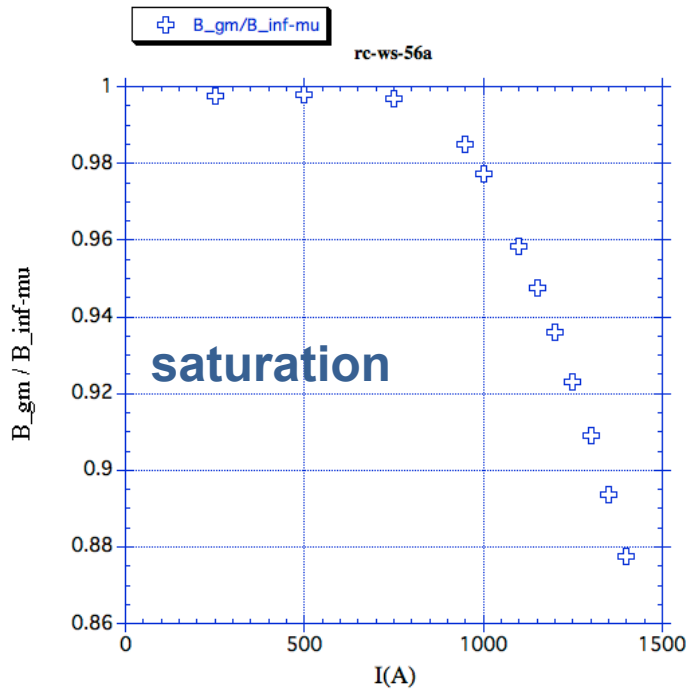
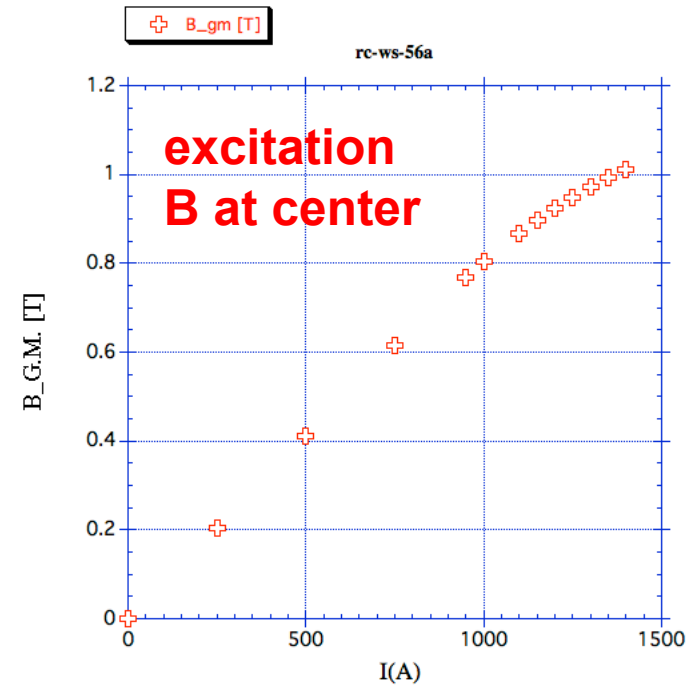
phase



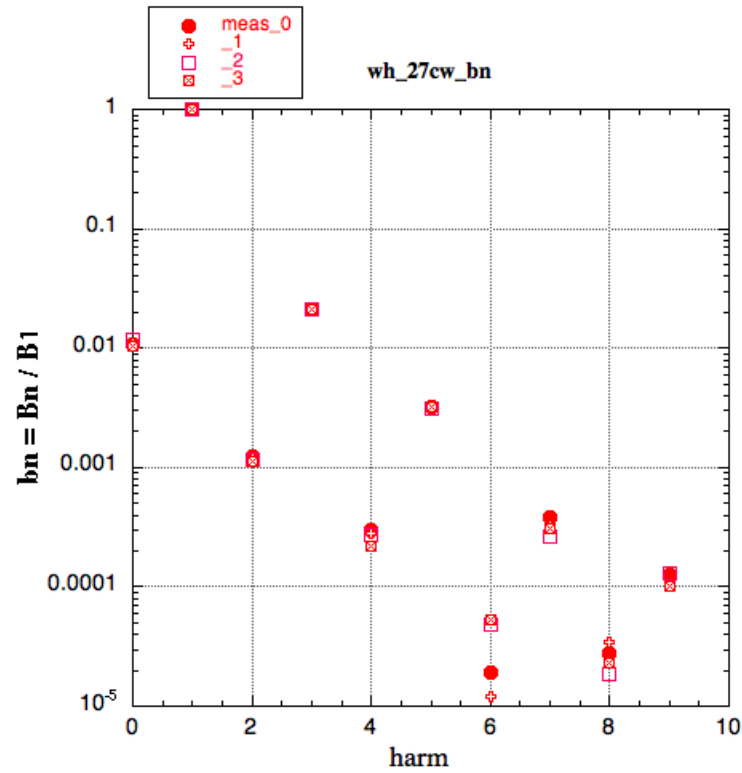
## WS

	Opera_3 D
BL [Tm]	0.3367
B_center [T]	0.9993

*Opera 3D cal.  
boundary condition  
[-300, +300] (mm)*

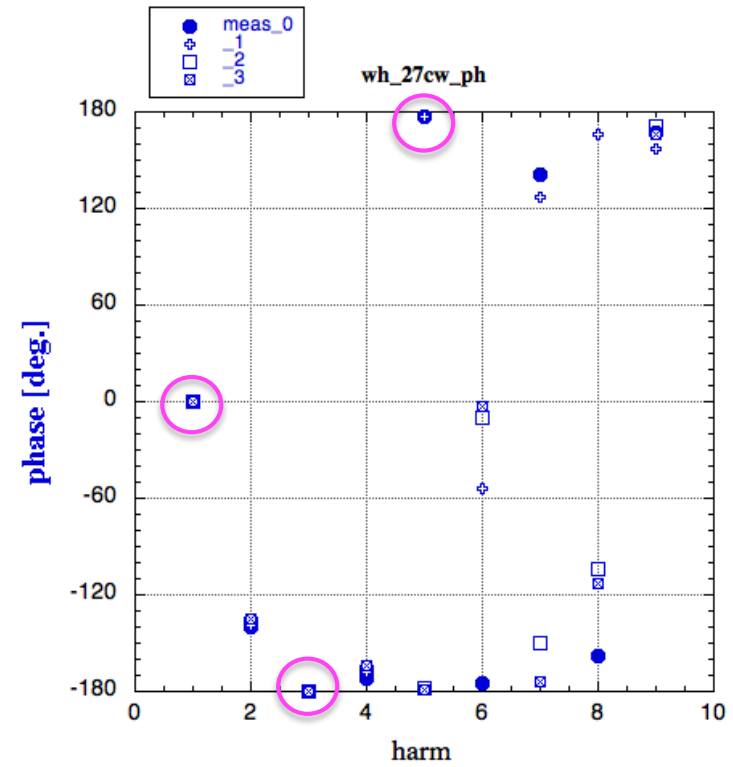


# Half Pole Wiggler (WH) : harmonic coil measurement

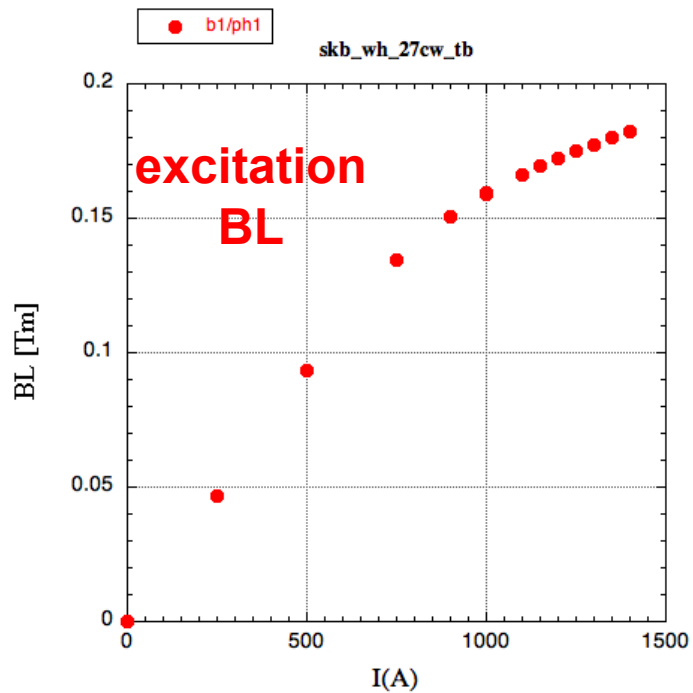


$$B_n L (r = a) / B_1 L (r = a)$$

a = probe radius = **50.212** mm



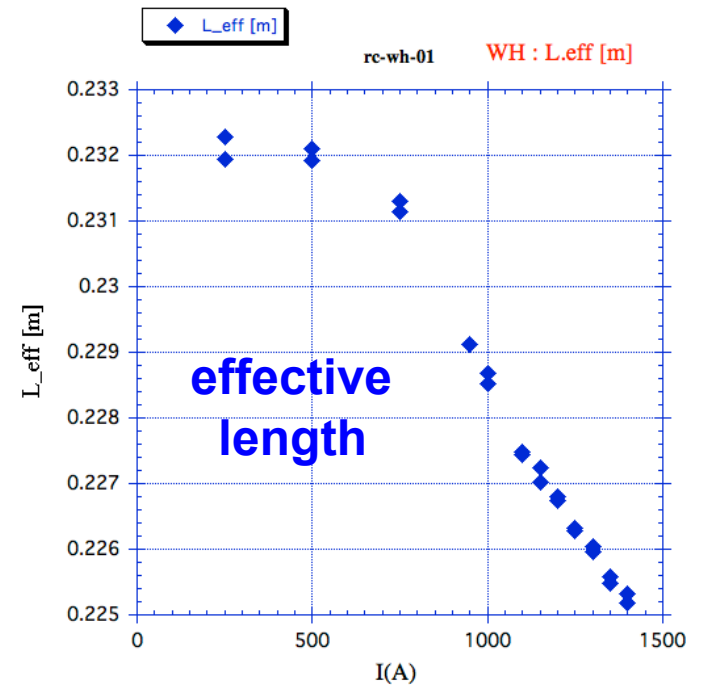
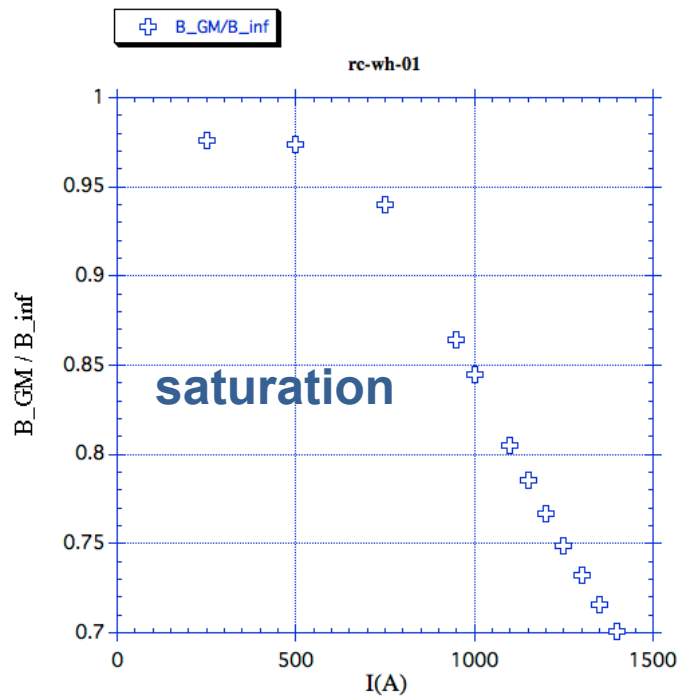
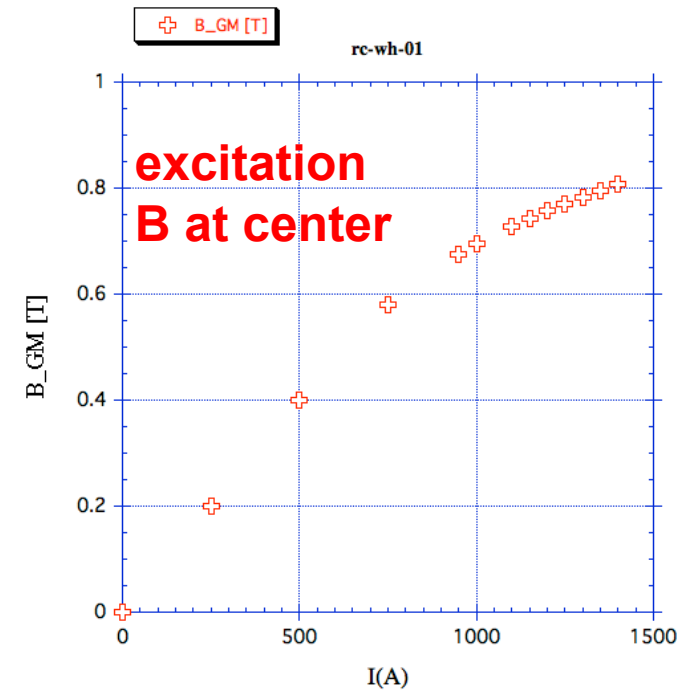
phase

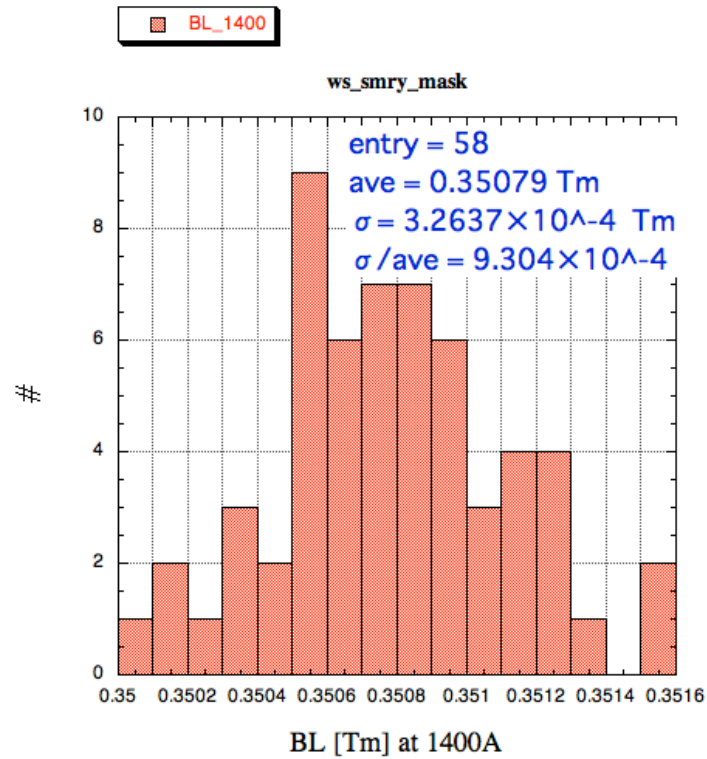


# WH

	Opera_3 D
BL [Tm]	0.1719
B_center [T]	0.7868

Opera 3D cal.  
boundary condition  
[-375, +195] (mm)

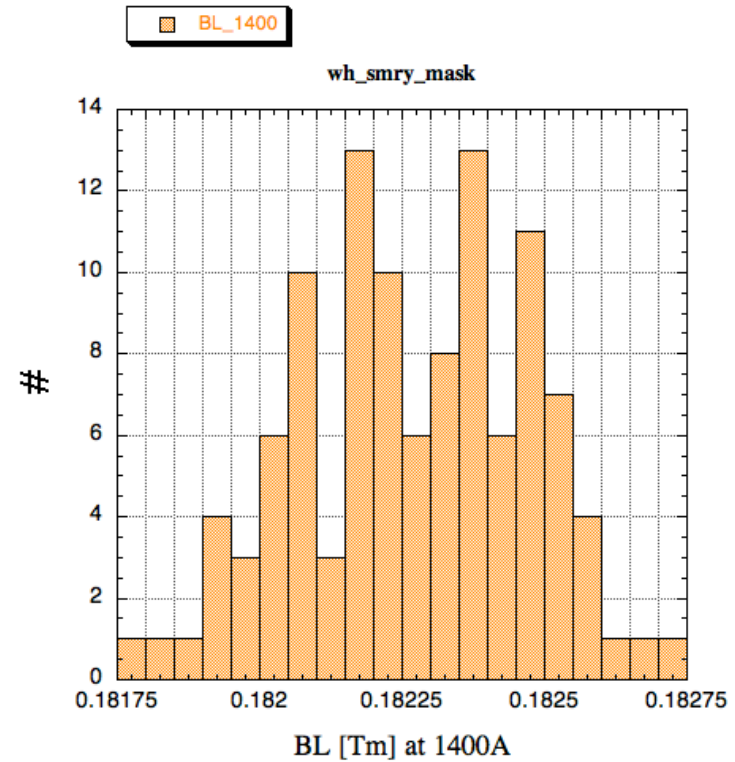




**WS BL histogram**

No. of mag.	58
average	0.35079 Tm
standard deviation	0.00032637 Tm
$\sigma / \text{average}$	$9.304 \times 10^{-4}$

$k \approx 0.0263 \Rightarrow$   
 $\delta k \approx 0.2448 \times 10^{-4}$



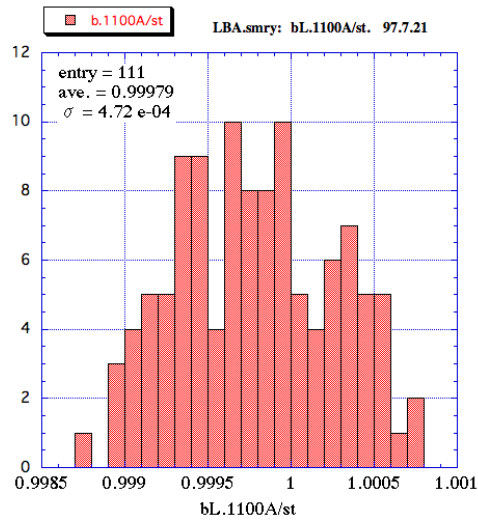
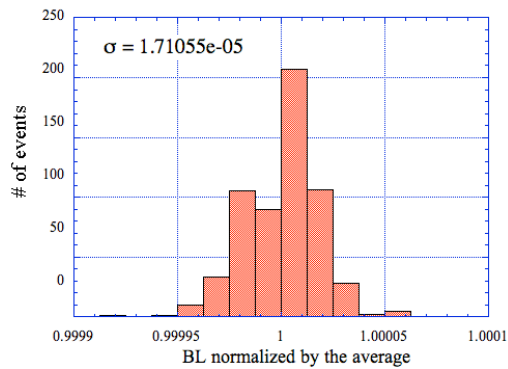
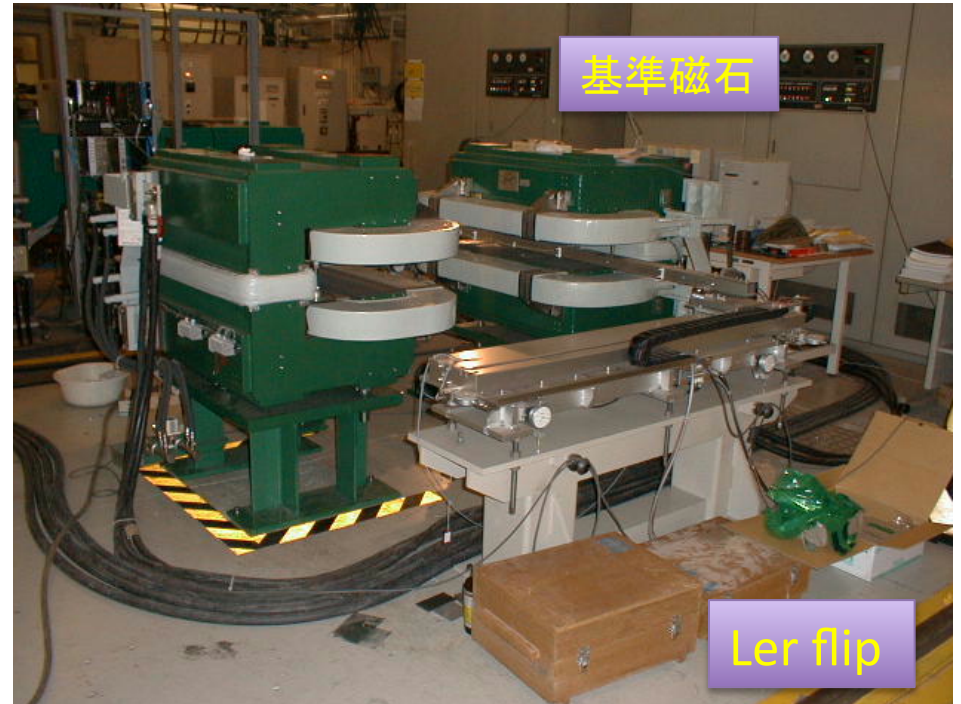
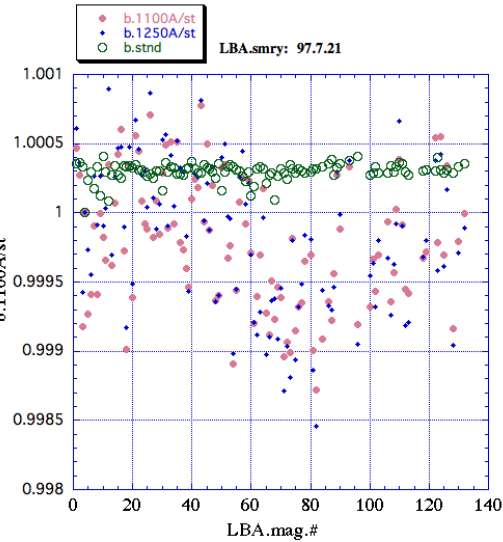
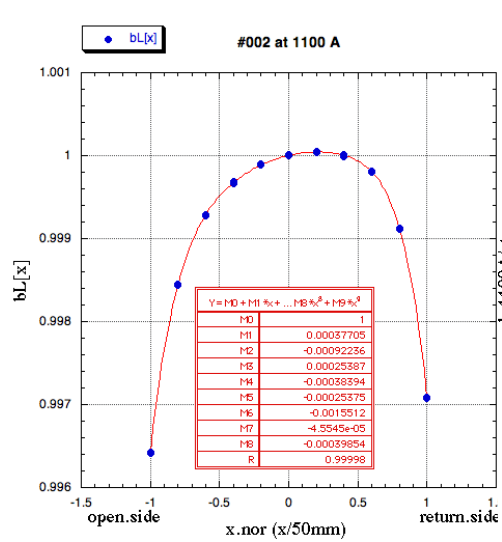
**WH BL histogram**

No. of mag.	110
average	0.182269 Tm
standard deviation	0.00019875 Tm
$\sigma / \text{average}$	$1.090 \times 10^{-3}$

$k \approx 0.01366 \Rightarrow$   
 $\delta k \approx 0.149 \times 10^{-4}$



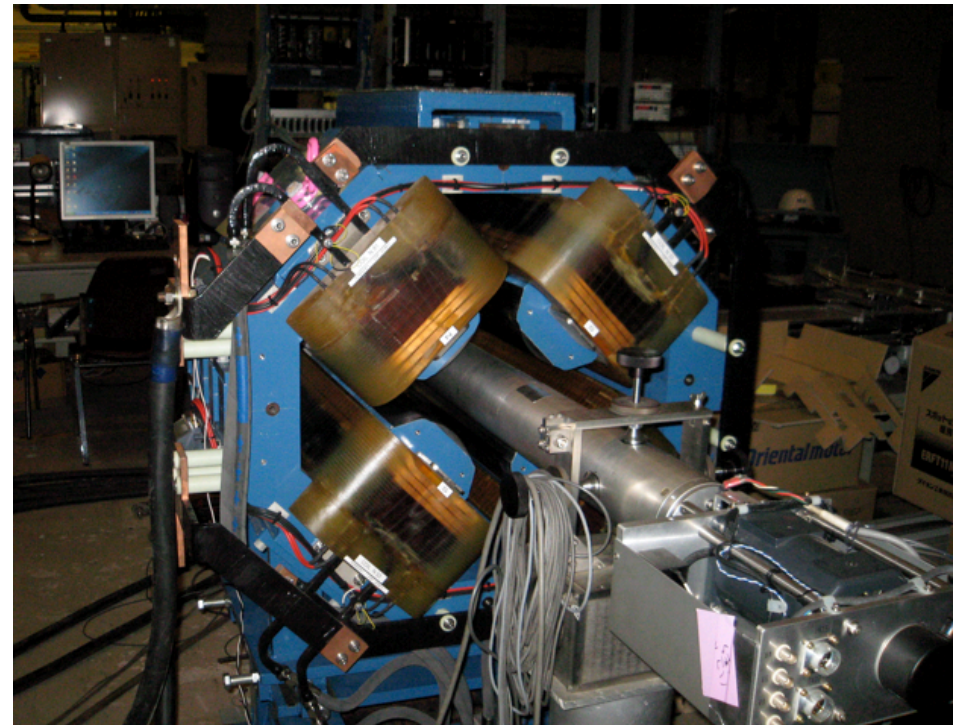
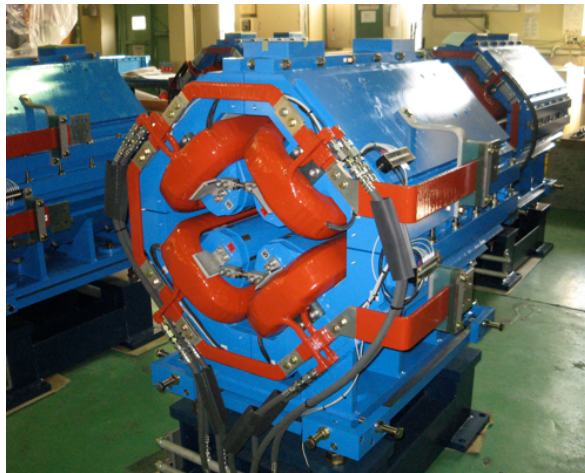
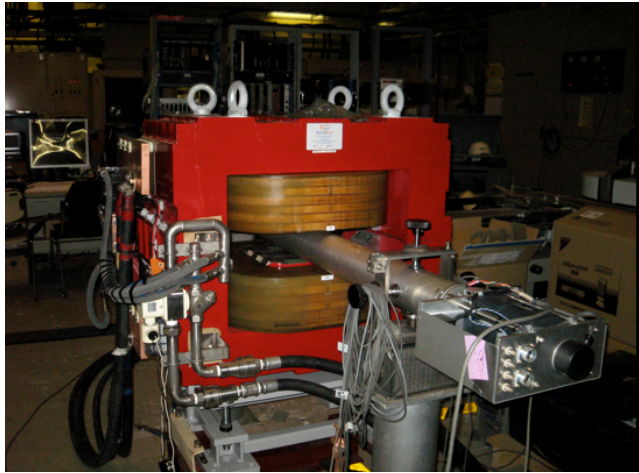
# kekB LER Dipole



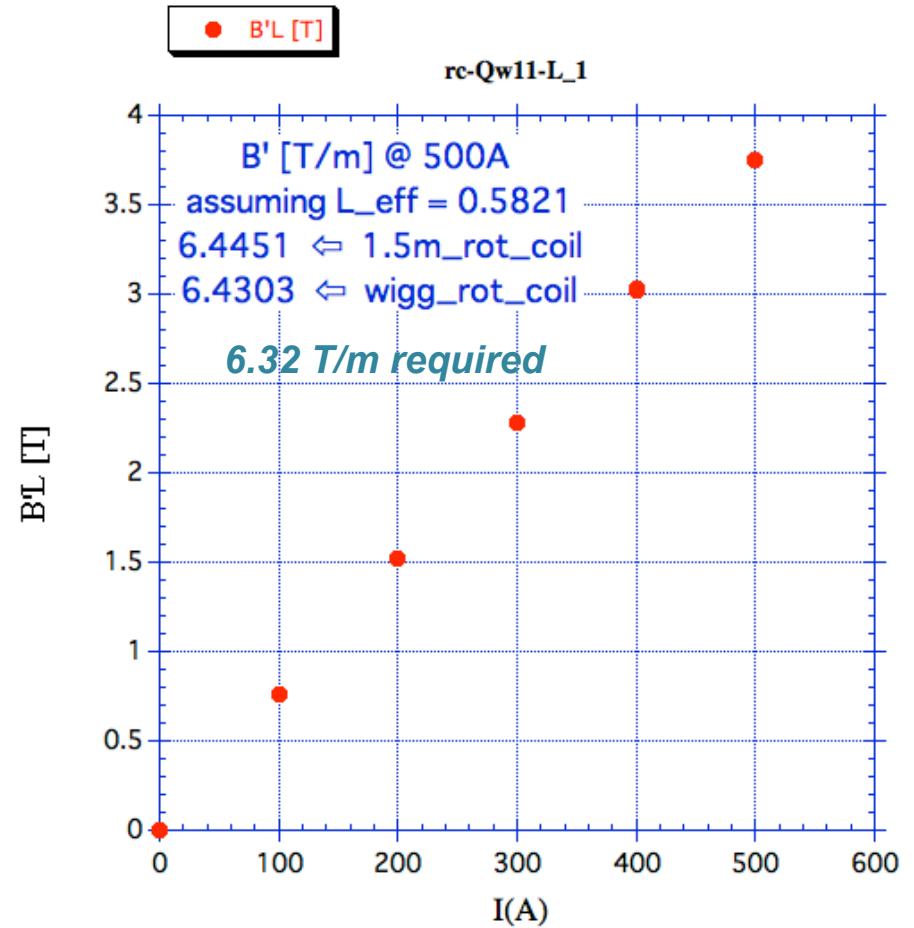
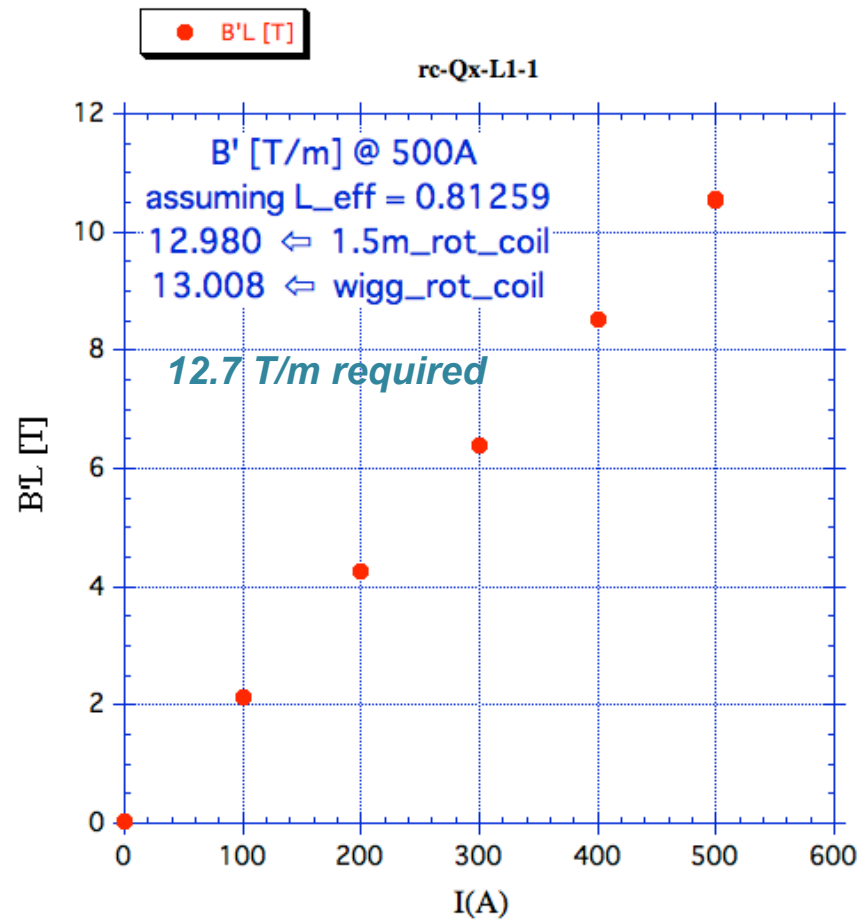
Normalized integrated field of the LER dipole magnet used as the reference.

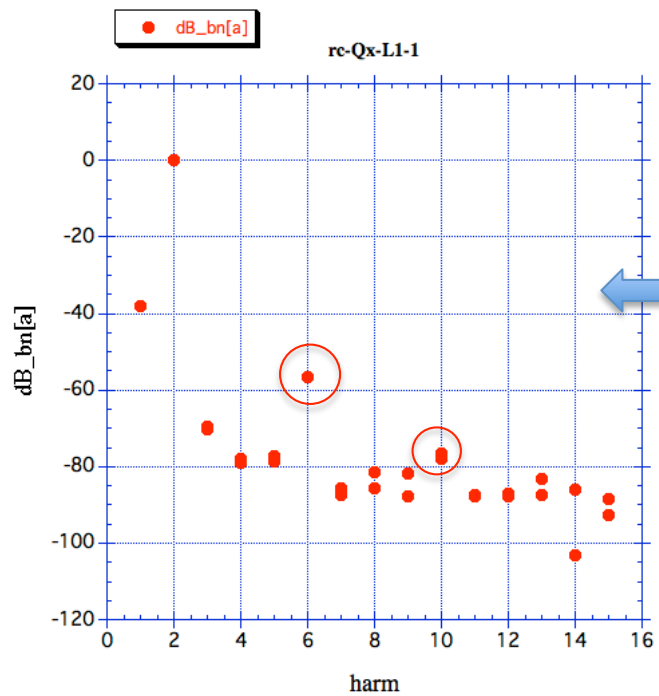
$k \approx 0.056 \Rightarrow$   
 $\delta k \approx 0.26432 \times 10^{-4}$

*New W wigglers, LQw, HQx :  
Quick measurements by Rotating Coil*

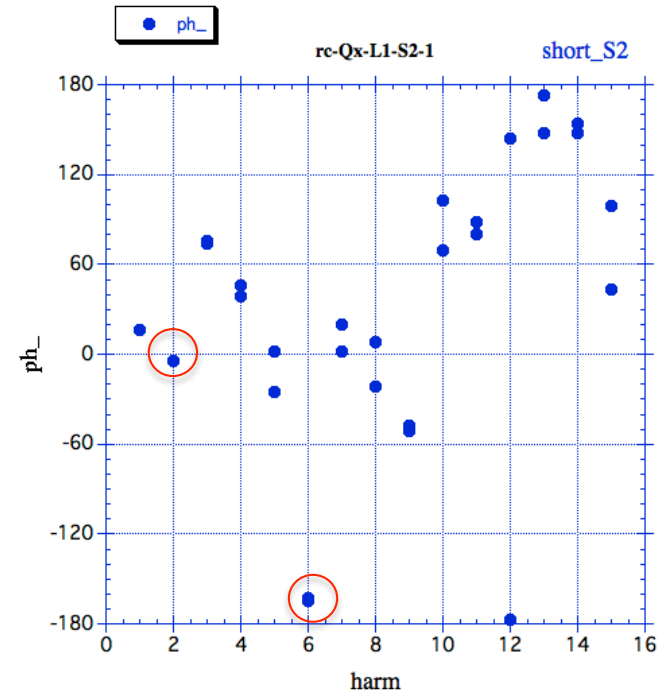
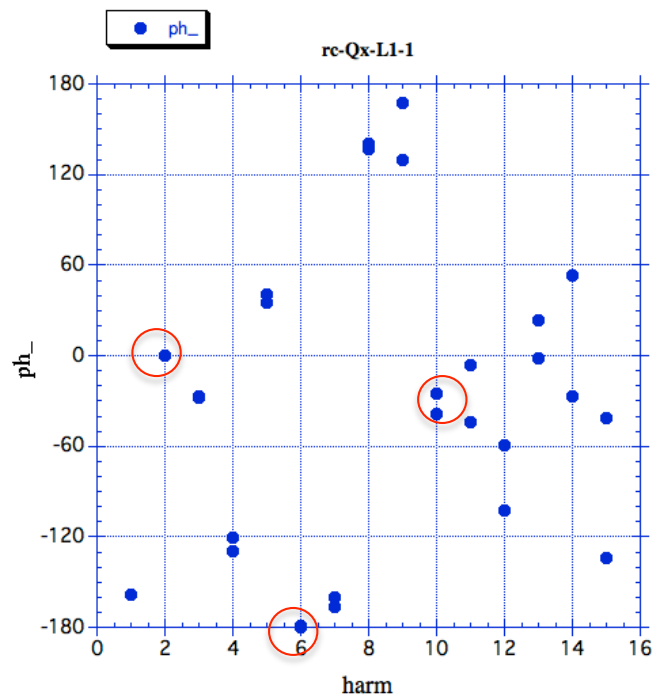
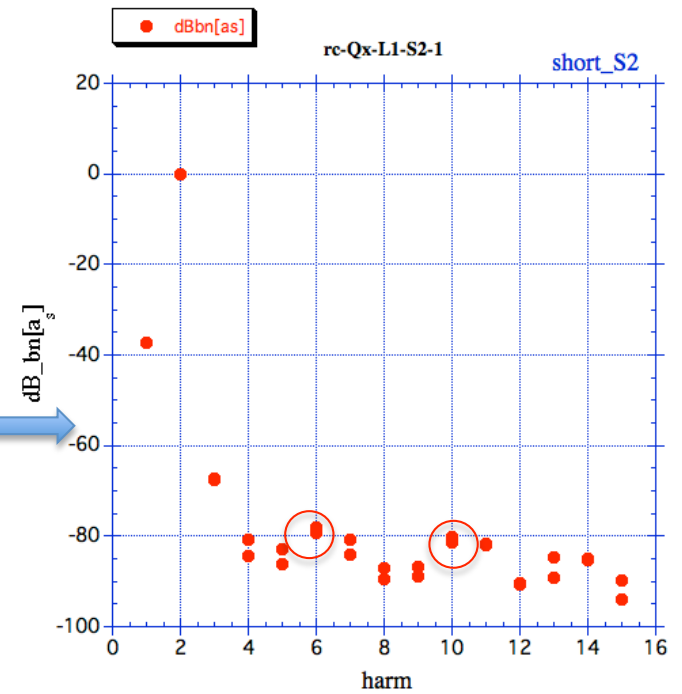


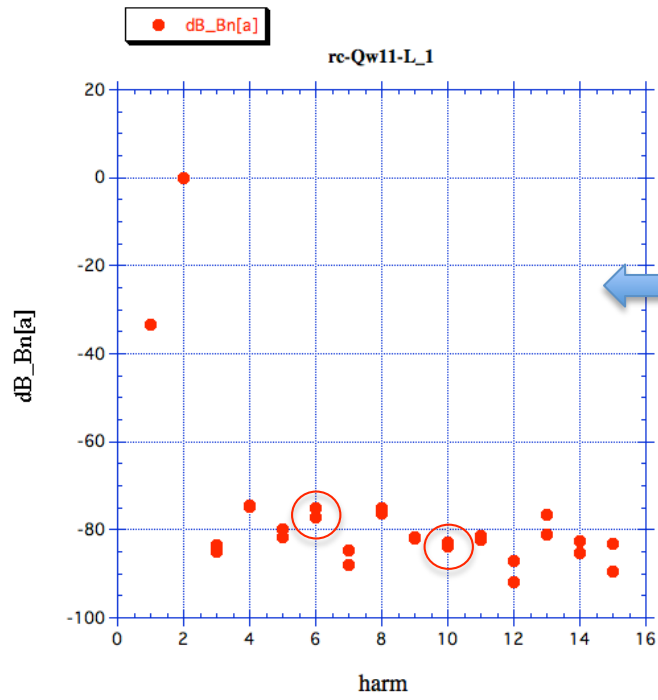
# HQx & LQw : wiggler & 1.5 m rotating coil measurements





	a [mm]
<del>wigg. rot</del>	<del>43.635</del>
1.5 m-rot-Long	42.08
1.5 m-rot-Short	37.225





	a [mm]
<del>wigg. rot</del>	<del>43.635</del>
1.5 m-rot-Long	42.08
1.5 m-rot-Short	37.225

