

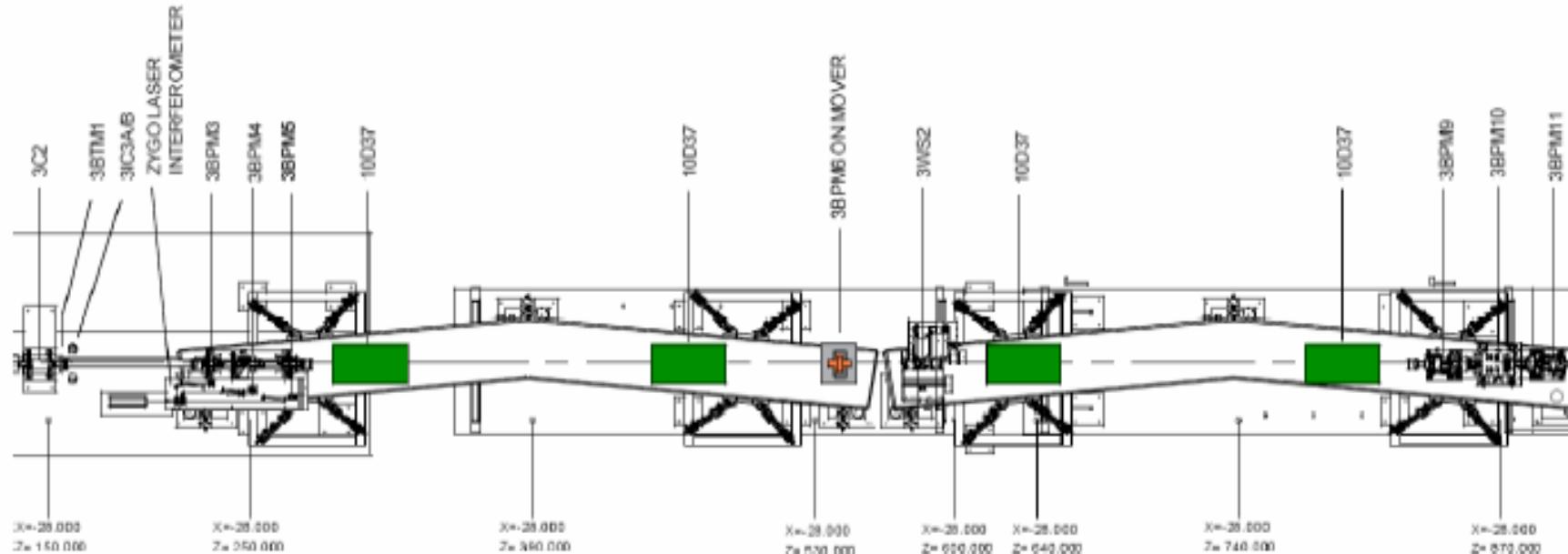


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at Stanford Linear Accelerator Center

*Magnets and Magnetic Measurements for Prototype Energy
Spectrometer T-474*



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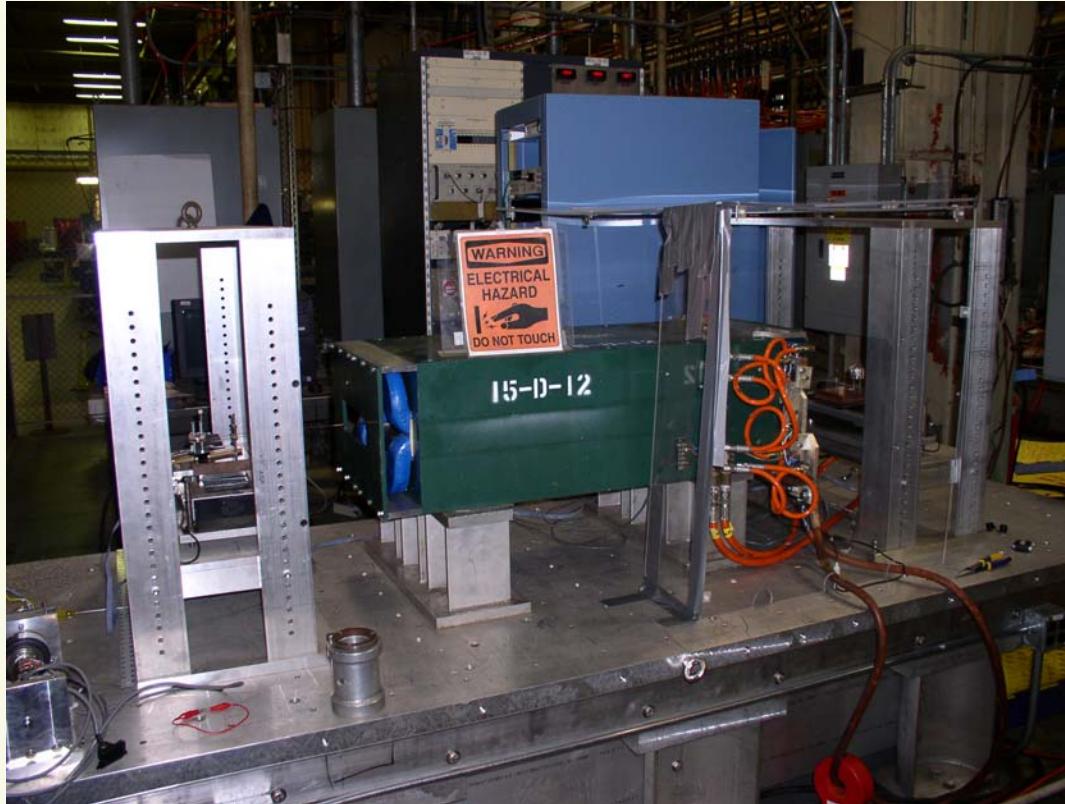


Plan view of the BPM based magnetic chicane
- four 10D37 bending magnet included.

5×10^{-5} – accuracy of the Bdl-integral requested



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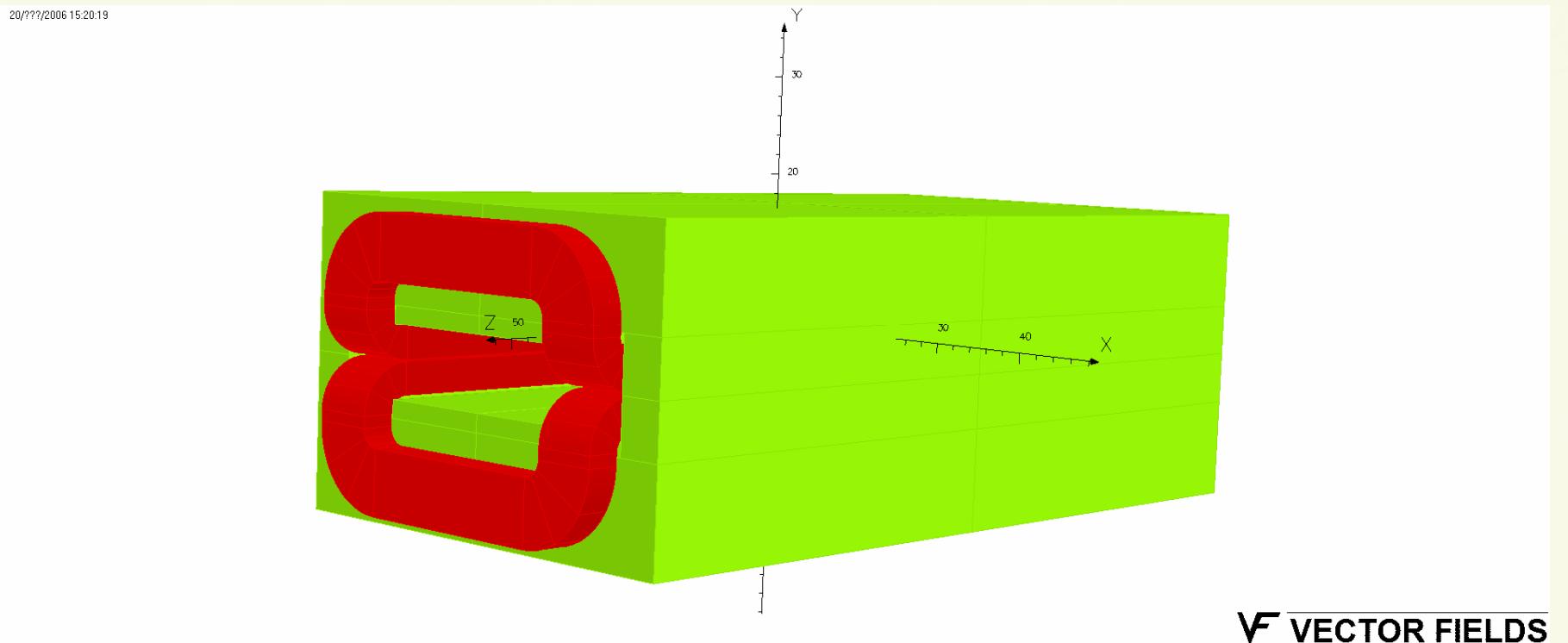
10D37 magnet in Test Laboratory

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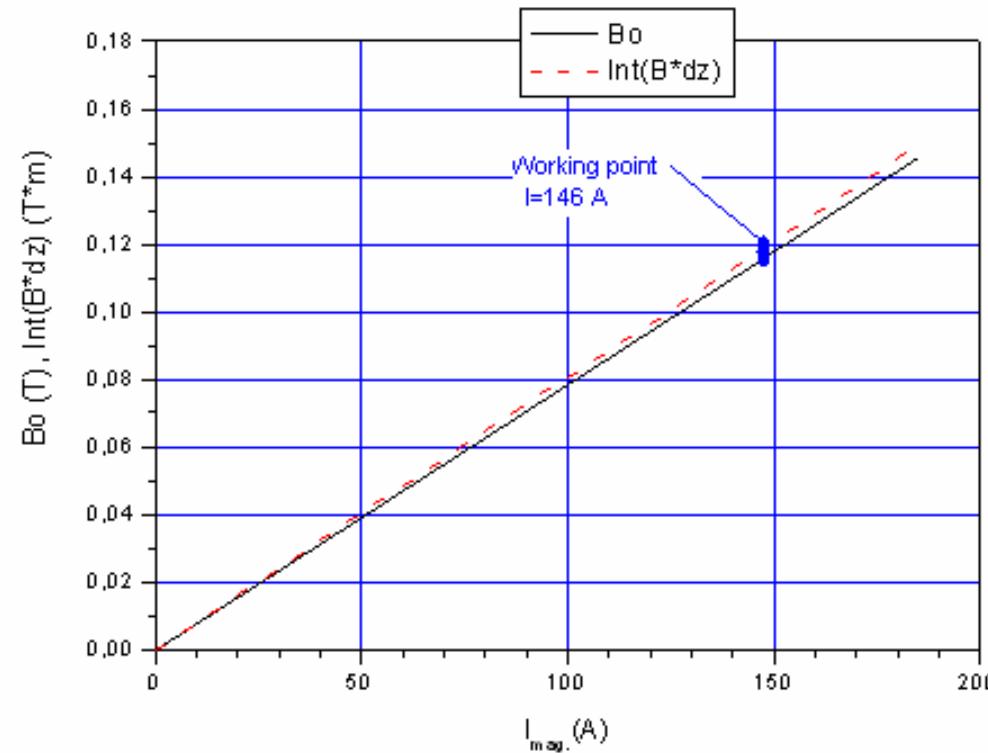
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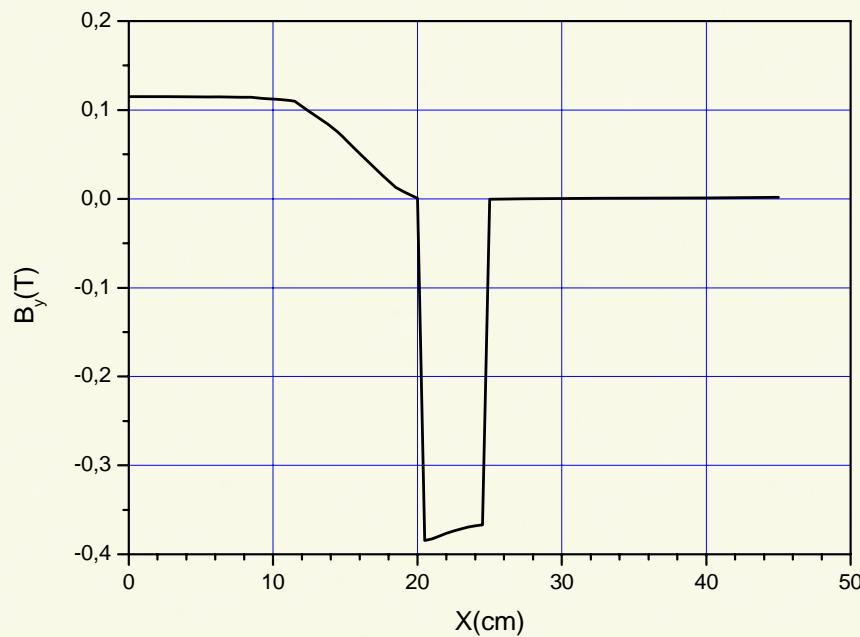
10D37 magnetic field simulations (N. Morozov,
JINR, Dubna)



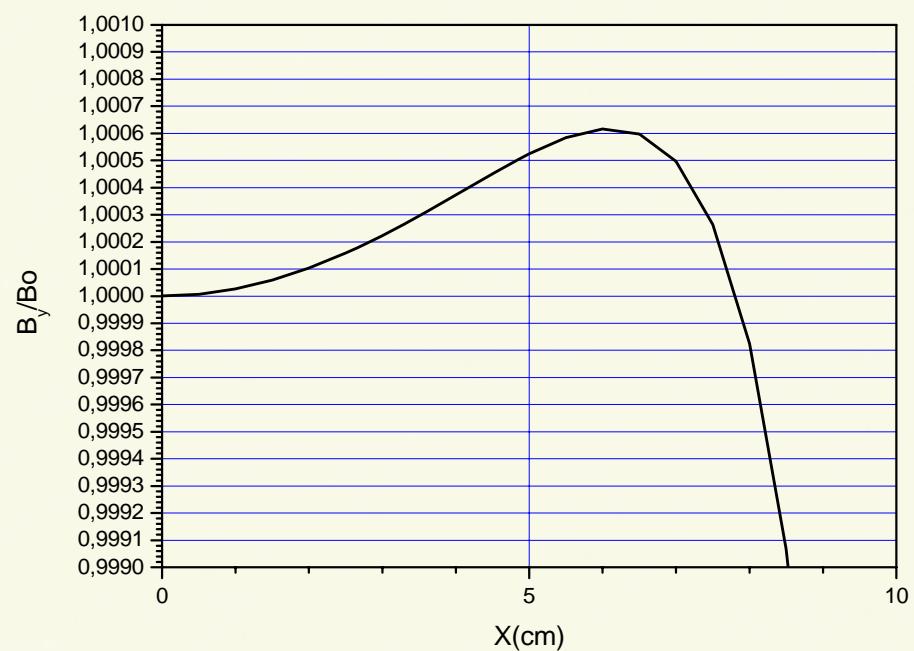
The magnetic field simulation for the 10D37 magnet was provided by the 3D TOSCA code. The magnet dimensions were taken from the SLAC drawings.

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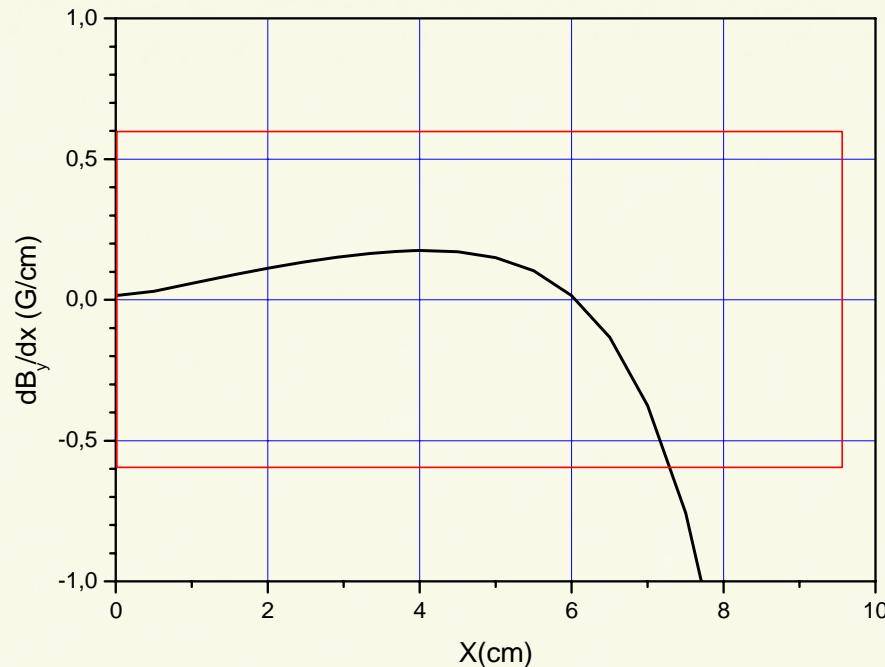




Magnetic field of the magnet in the middle transverse cross section



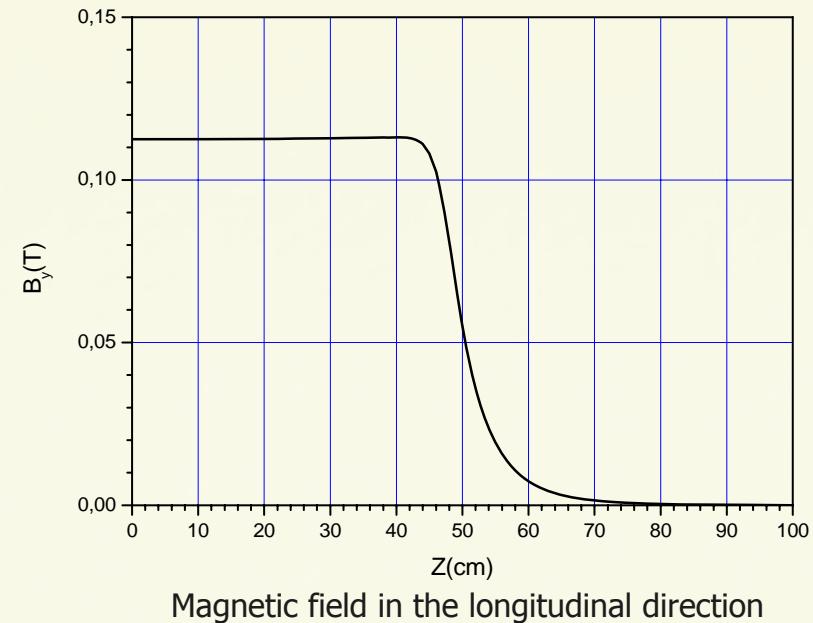
Normalized magnetic field in the middle cross-section of the magnet



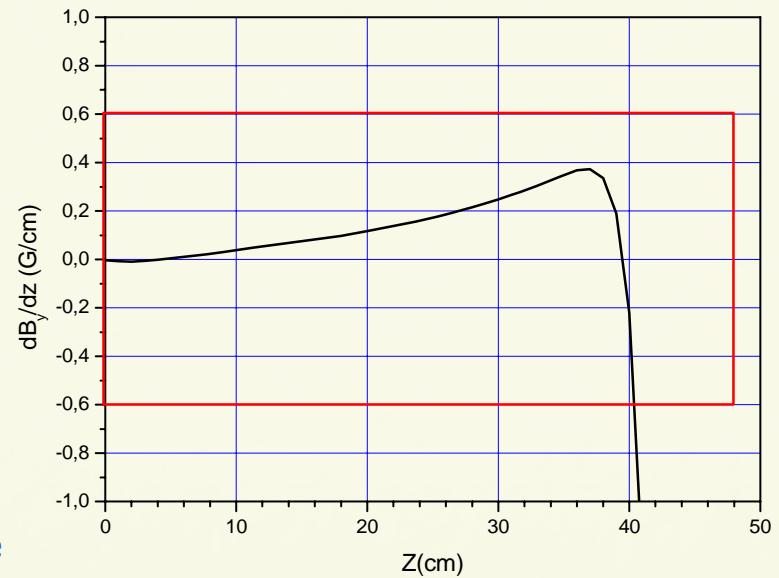
Magnetic field gradient in the middle cross-section of the magnet

-NMR probe can be used up to 7 cm from the magnet center in transverse direction

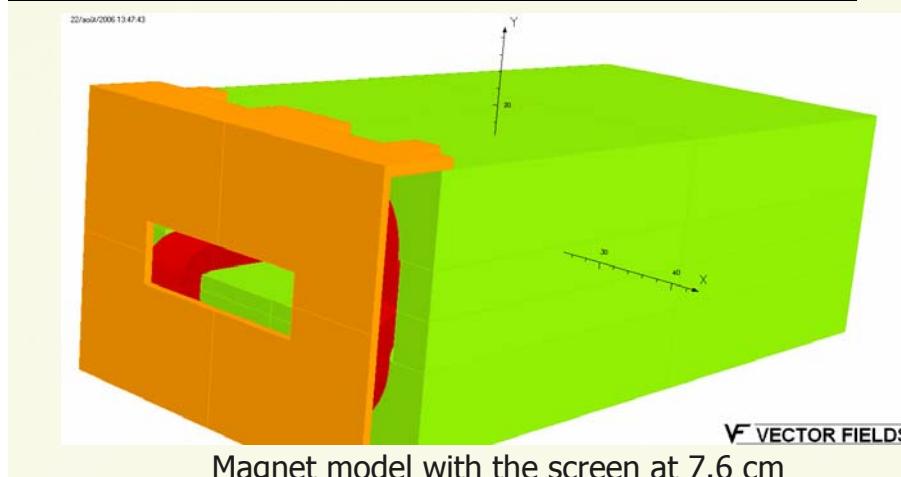
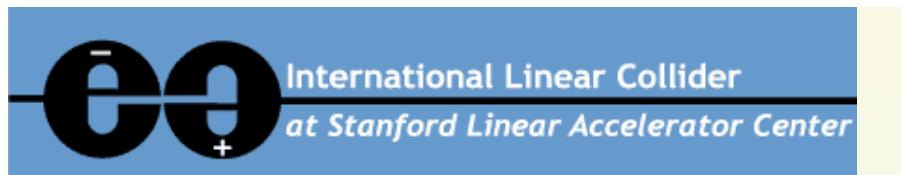
NMR probe can be used to the distance 40 cm from the magnet center. This region will cover the 78% of the total field integral.



Magnetic field in the longitudinal direction



Magnetic field gradient in longitudinal direction

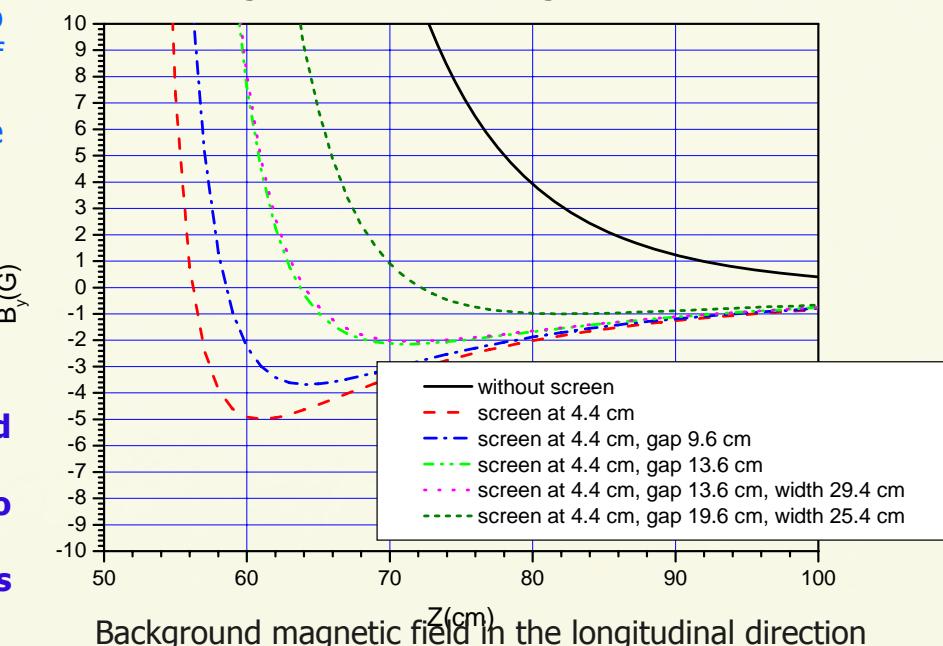
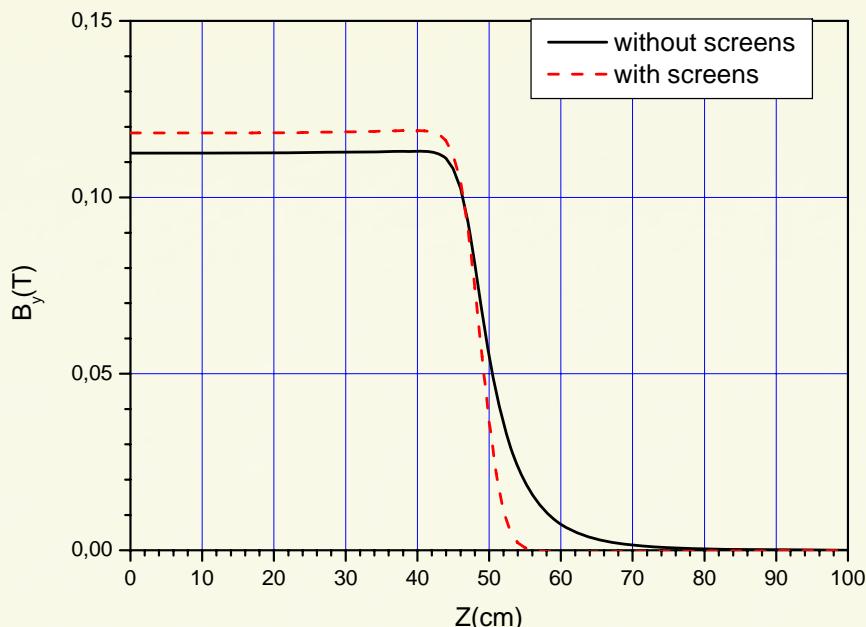


The required tolerance of the field integral measurement leads to finish measurement when the background field falls to the level of the earth field level ($\sim 0.3\text{-}0.5$ G).

Thus, main field should to be measured at the distance ever more then 100 cm.

Some simulation results

- magnetic field integral 10^{-4} uniformity region is ± 15 mm
- region for possible NMR probe use is $X \cdot Z = \pm 7 \cdot \pm 40$ cm
- relative contribution of the fringe field to the total field integral is 22%
- maximal level of the magnetic field in return yoke is no more 0.4 T
- temperature factor for the magnetic field integral is $6.1 \times 10^{-5} \times 1/C^\circ$





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Project: ILC

Magnet Type: Dipole

Magnet Name: 15-D-12

Serial Number: 108

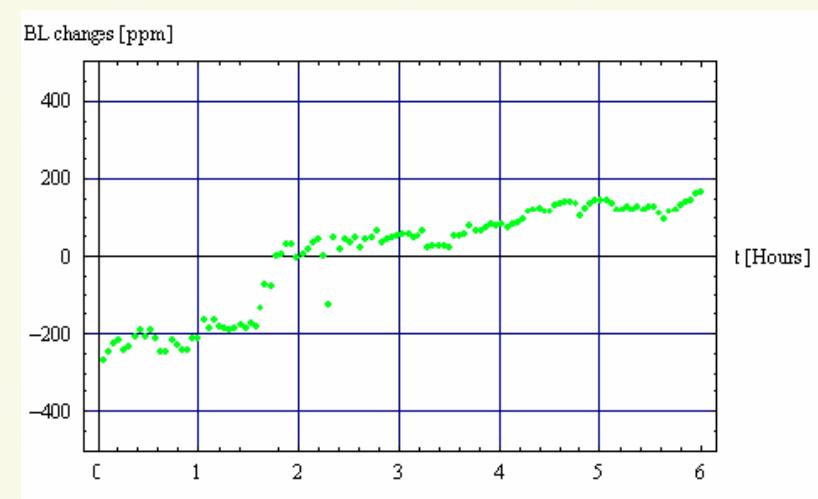
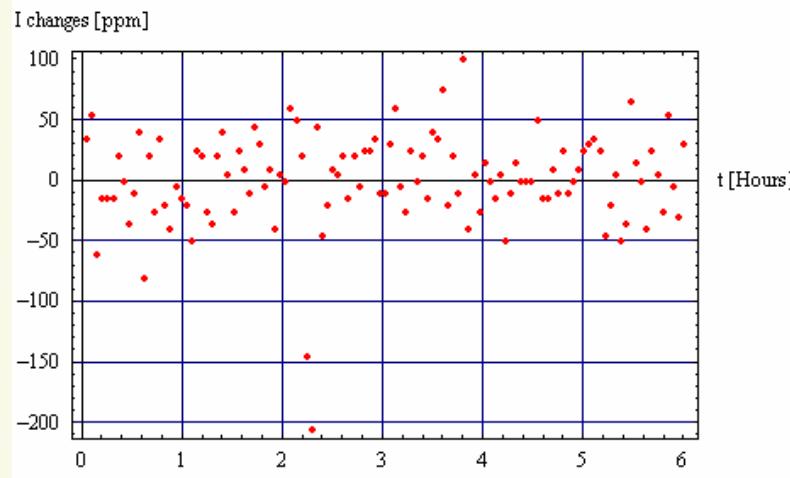
Date	Time	Run	Device	Oper	Comment
----->					
11-09-2006	15:43:29	2	10 wire	adf	5 Successive Standardizations from 0-200 amps to -200 and back to zero
11-10-2006	10:03:56	3	10 wire	adf	Retry Standardization with INIT_TURNON_CURRENT True and 20 amps
11-13-2006	11:03:46	4	10 wire	adf	4 Scans at 200 amps for determining coil constant
11-13-2006	11:46:45	5	10 wire	adf	Retest coil constant for repeatability
11-15-2006	14:41:58	6	72"	adf	Run to determine coil constant at 200 amps
11-15-2006	15:46:25	7	72"	adf	Verify Accuracy of coil constant
11-16-2006	10:06:06	8	72	adf	7 Hour Run at 200 amps
11-16-2006	10:15:01	8	Metrolab_G	adf	7 Hour Run at 200 amps
11-17-2006	10:21:35	9	Metrolab_G	adf	Stability Run for 2 hrs at 200 amps
11-17-2006	10:21:52	9	72	adf	Stability Run for 2 hrs at 200 amps
11-21-2006	13:14:25	10	Metrolab_G	adf	Retest Standardization with coil and NMR
11-21-2006	13:17:01	10	72"	adf	Retest Standardization with coil and NMR
11-22-2006	10:06:42	12	Metrolab_G	adf	Trip Test. Magnet Tripped off after running to 200 amps
11-22-2006	10:09:25	11	72"	adf	Trip Test. Magnet Tripped off after running to 200 amps
11-28-2006	09:46:43	13	Metrolab_G	adf	Rerun Standardization test after trip from 200 amps.
11-28-2006	10:24:05	13	72"	adf	Rerun Standardization w/ beam pipe after 200 amp trip.
11-29-2006	11:42:45	14	72"	adf	Int. Strength, -200 to 200 amps and back 25 amp steps
11-30-2006	13:19:42	15	Metrolab_G	adf	Stability run at -150 amps for 1 hour
11-30-2006	13:21:47	15	72	adf	Stability run at -150 amps for 1 hour
12-01-2006	09:38:08	16	72	adf	Stability run for 24 hours at 150 amps
12-01-2006	10:44:25	16	Metrolab_G	adf	Stability run for 24 hours at 150 amps

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Stability Tests

6 hours at 200 A run



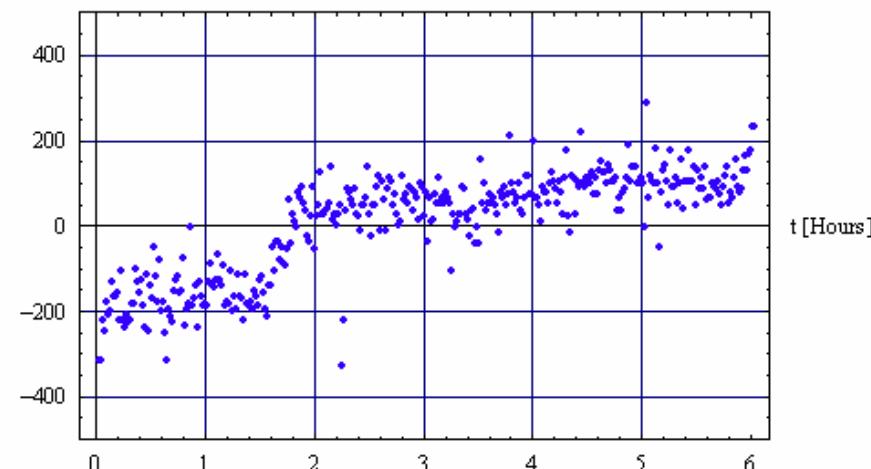
Power supply RMS stability (2σ): **80 ppm**

Magnetic field integral RMS stability (2σ): **270 ppm**



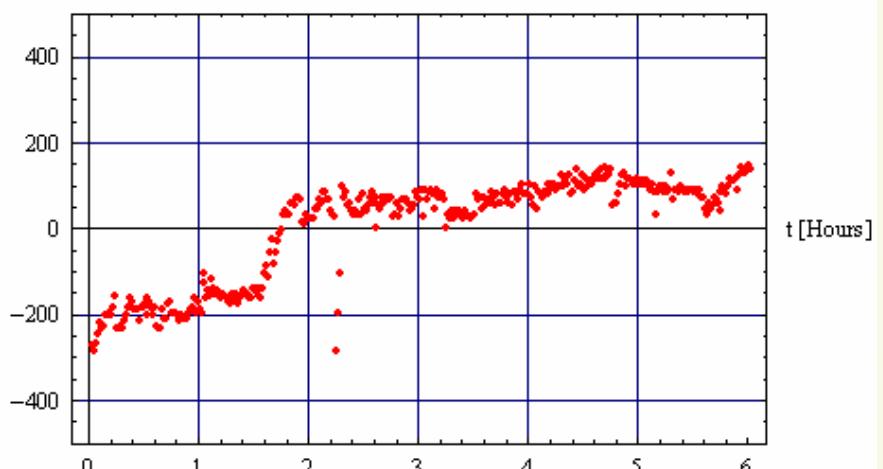
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B-nmr changes [ppm]



B-nmr RMS stability (2σ): **350 ppm**

B-hall changes [ppm]

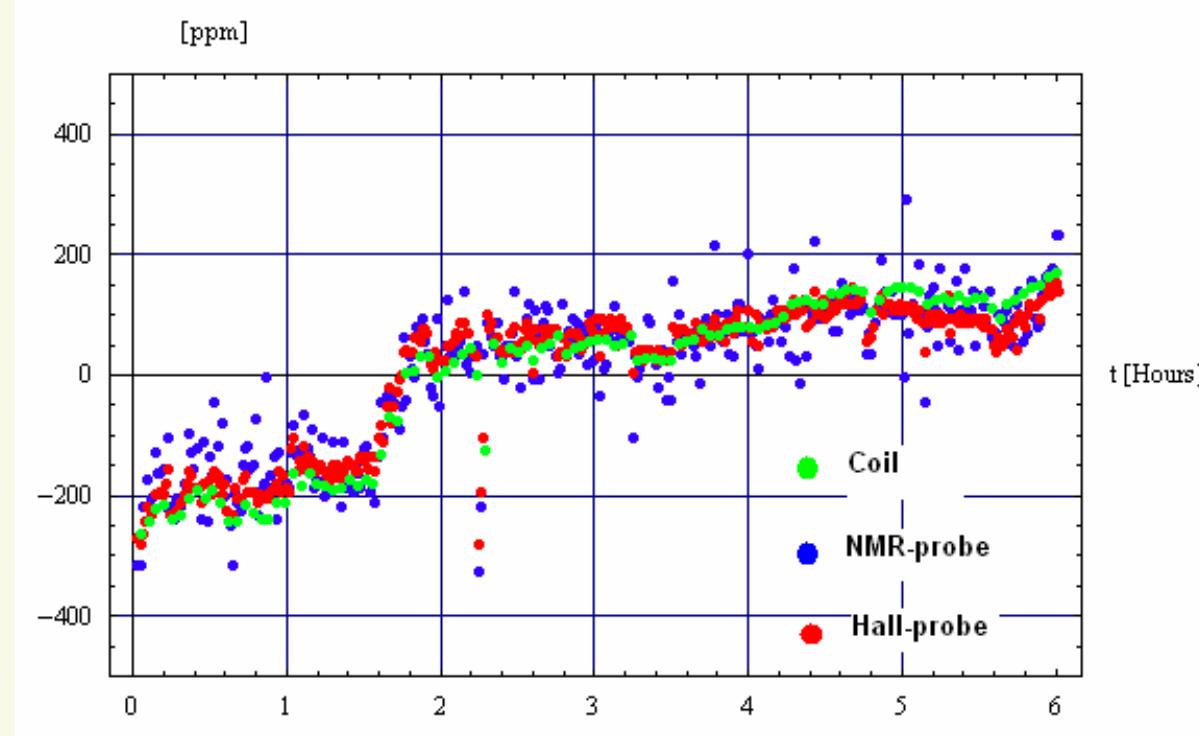


B-hall RMS stability (2σ): **350 ppm**

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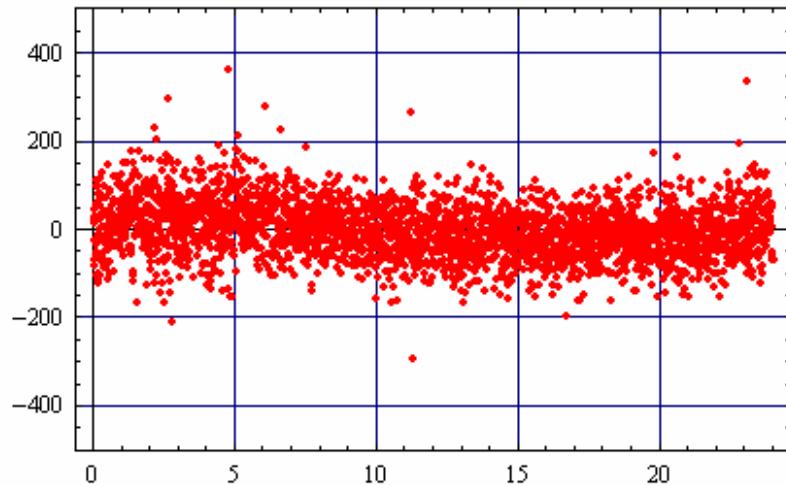
BdL-NMR &
BdL-Hall stability (2σ): ~ **100 ppm !**



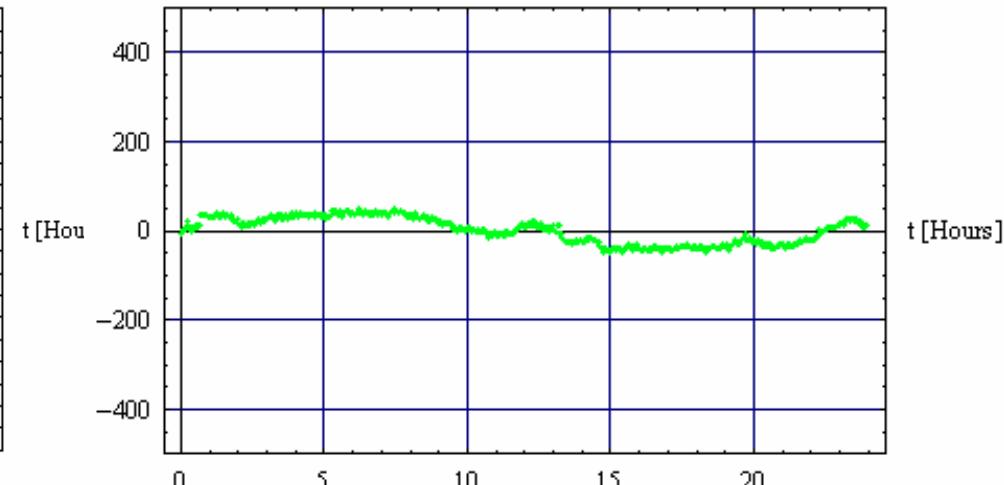
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24 hours at 150 A run

Imag changes [ppm]



BL changes [ppm]



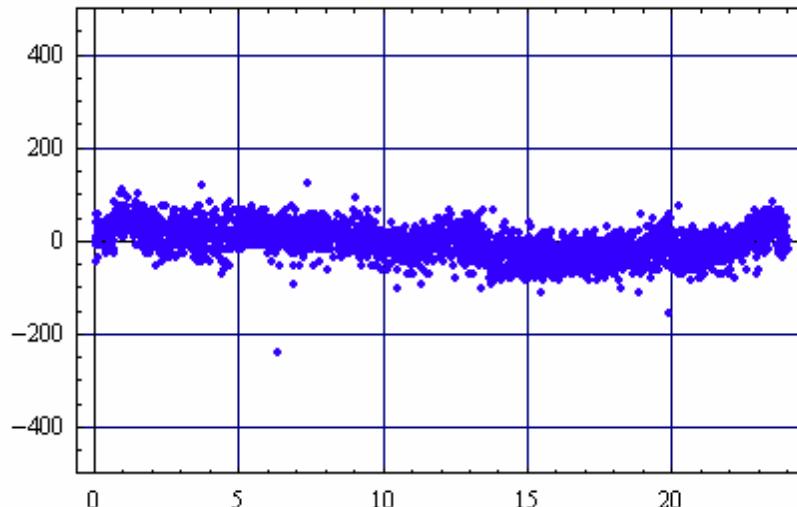
Power supply RMS stability (2σ): **130 ppm**

Magnetic field integral RMS stability (2σ): **60 ppm**

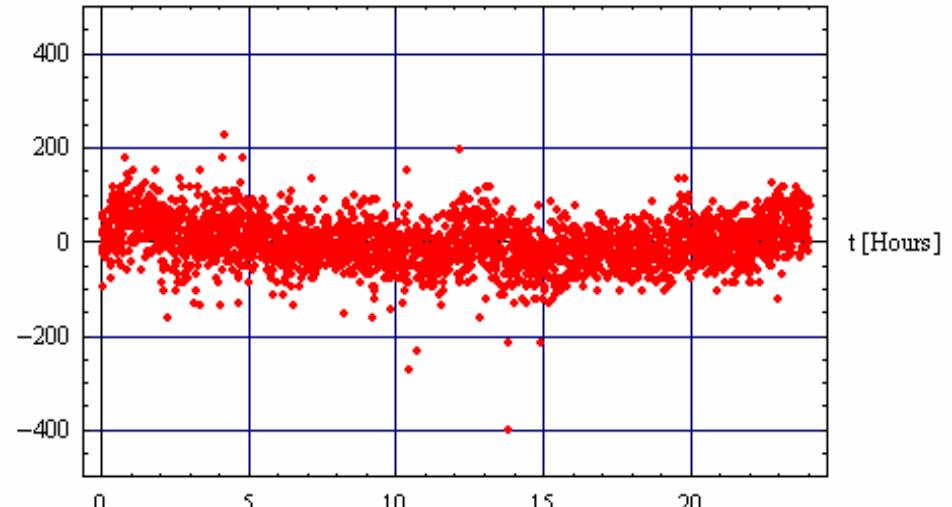


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B-nmr changes [ppm]



B-hall changes [ppm]



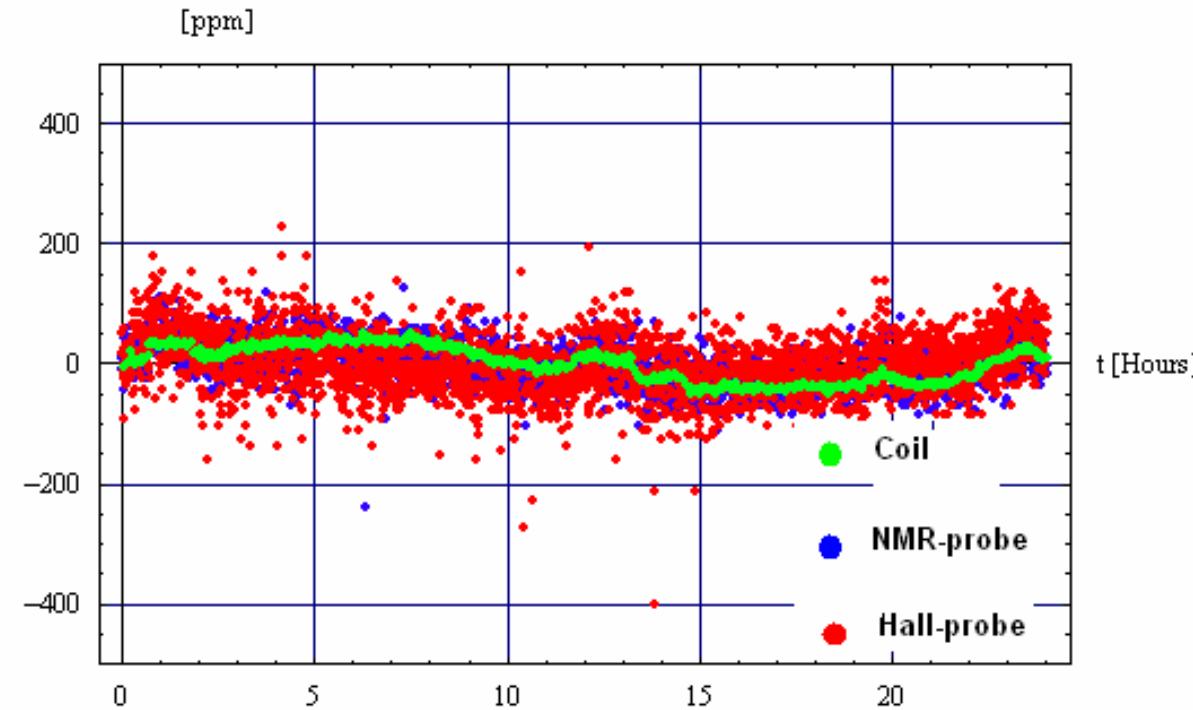
B-nmr RMS stability (2σ): **70 ppm**

B-hall RMS stability (2σ): **100 ppm**

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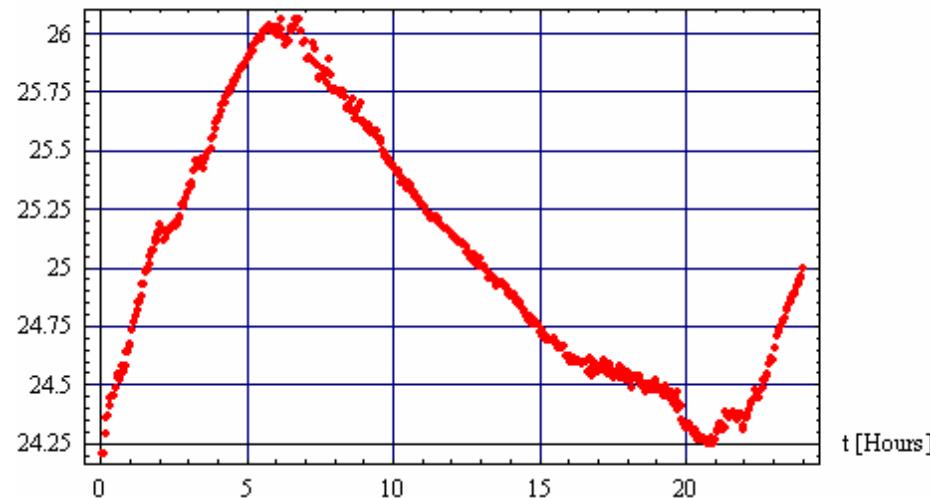


BdL-NMR &
BdL-Hall stability (2σ): ~ **100 ppm !**



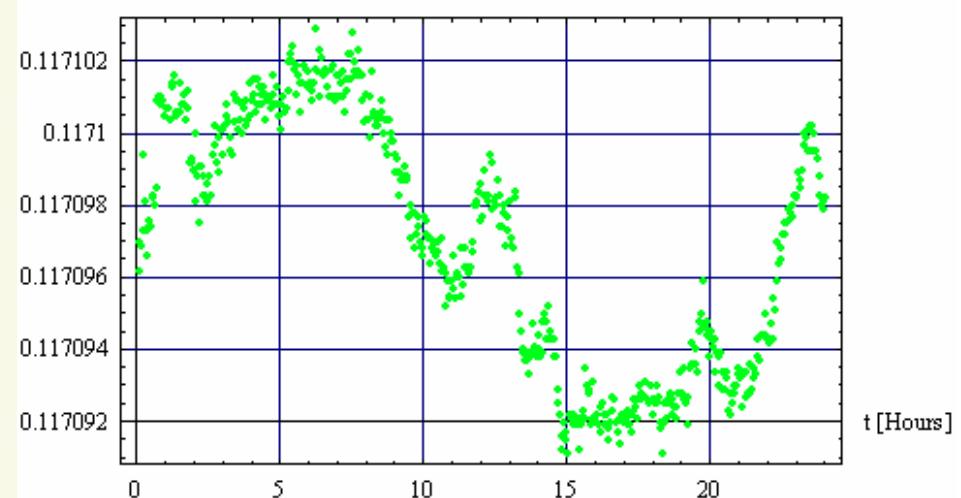
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T-pole [°C]



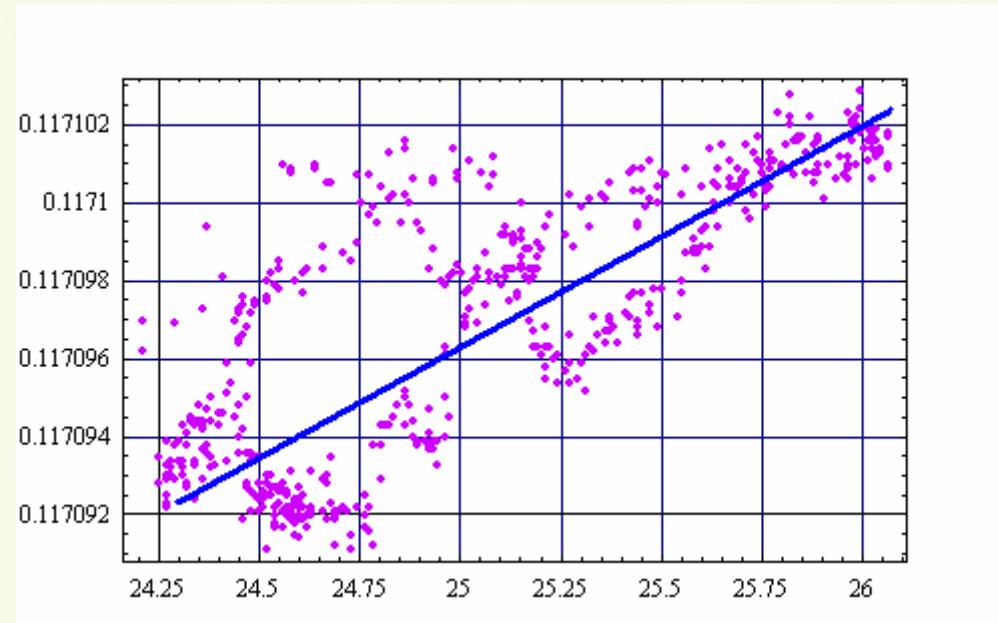
Temperture vs time

BL [T*m]



Field integral vs time

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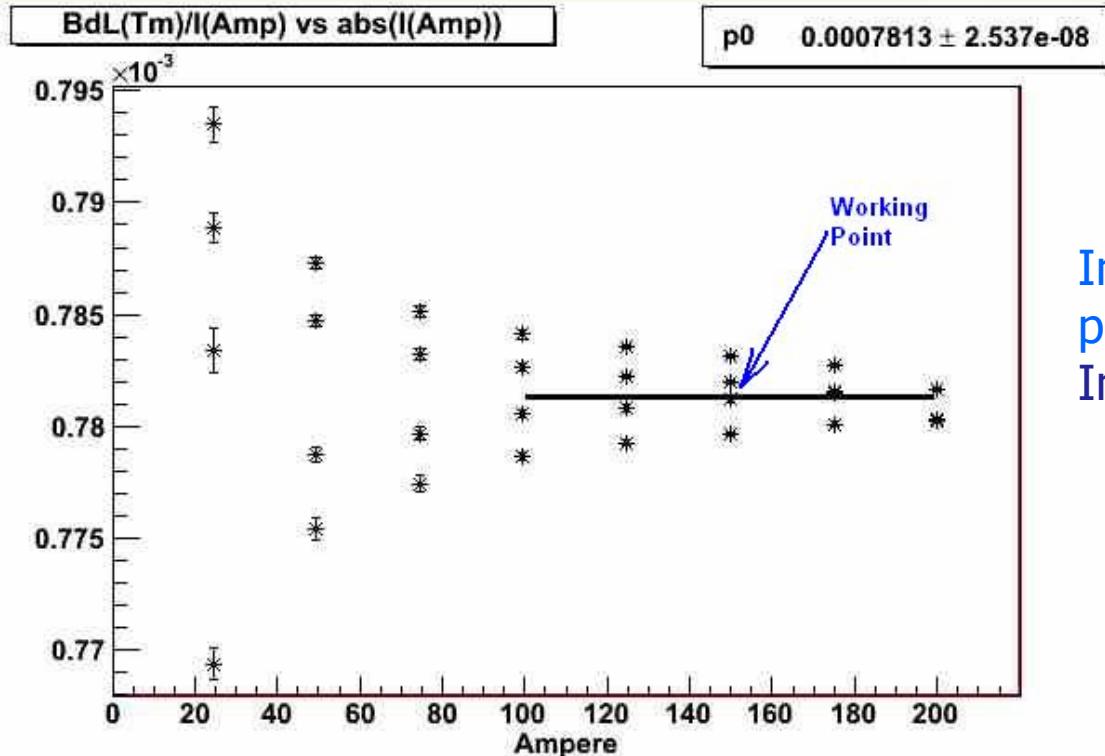
Dependence of the BdL integral versus temperature

The temperature factor for the magnetic field integral is

$5.7 \times 10^{-5} \text{ } 1/\text{C}^\circ$

-in a good agreement with estimated one from magnetic field simulations

$6.1 \times 10^{-5} \text{ } 1/\text{C}^\circ$



The dependence of the absolute value of the magnetic field integral divided by magnet current versus absolute value of the current

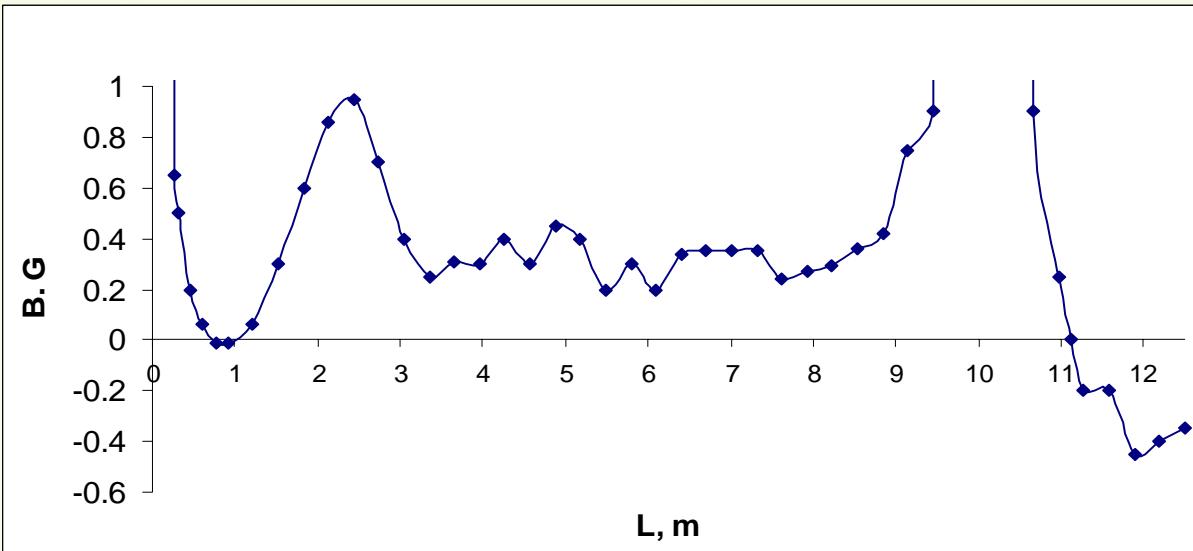


Today measurements results:

- Magnetic field integral RMS stability (2σ): **60 ppm** (near working point – 150 A)
 - (BdL-NMR) & (BdL-Hall) relative RMS stability (2σ): **~ 100 ppm** (both at 150 A and 200 A)
 - There is a considerable dependence of magnet **pole temperature** as well as **BdL** on the day time
 - The measured temperature factor for the magnetic field integral is **$5.7 \times 10^{-5} 1/C^\circ$** in a good agreement with estimated one from magnetic field simulations **$6.1 \times 10^{-5} 1/C^\circ$**
 - Mainly, magnetic field integral value ($\sim 0.117 T*m$ when $Imag \sim 150$ A) is in agreement with received one **$0.118 T*m$** from magnet simulations
- Analitical dependence of the magnetic field integral via magnet current obtained in the vicinity of the working point
 $Int(BdL) = 0.7813 \times 10^{-3} * Imag$

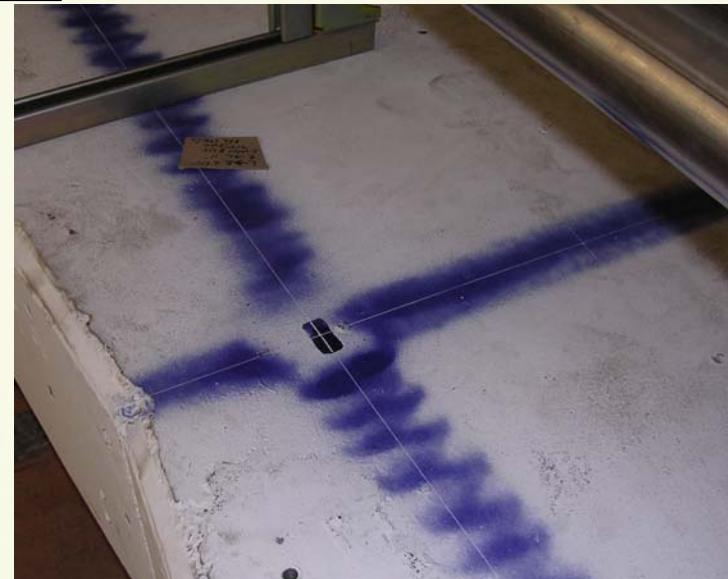


Residual field measurements



The residual magnetic field
on the full chicane length
(vertical component)

The anomaly behavior of the magnetic field on the distance near 10 meters is connected with the magnetic elements (impurity) in the girder.



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The place of the magnetic anomaly on the
concrete girder

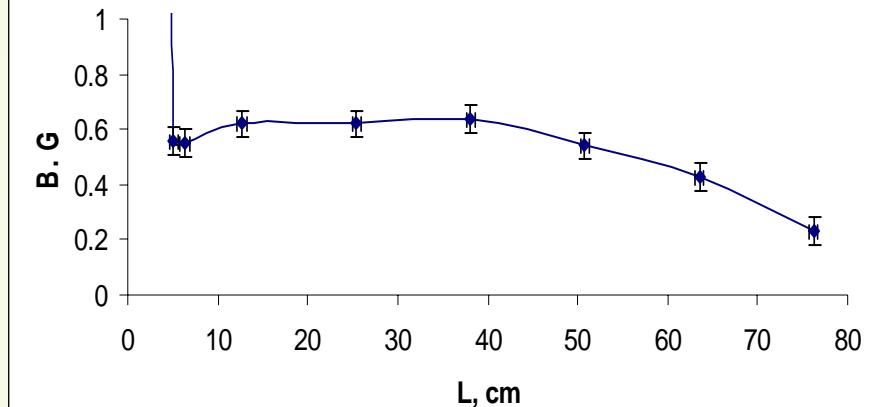


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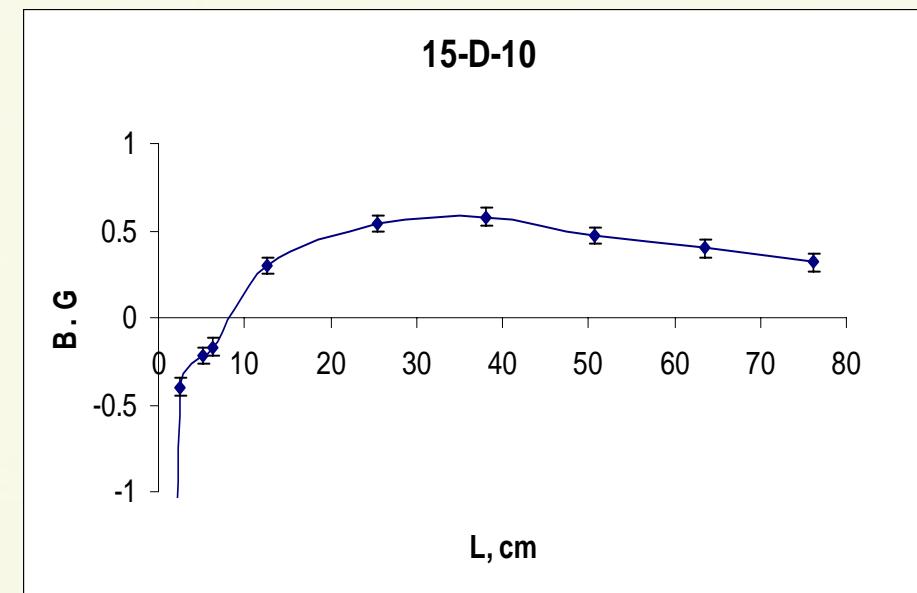


The distributions of the fringe residual magnetic field on the axis of the beam outside the magnets 10D37(#15-D-4 and #15-D-10) were measured

In the magnet **#15-D-4** the value of the magnetic field in the distance less than **3 cm** is more than **1 G**. In the magnet #15-D-10 this "critical" distance is less **1 cm**. The residual magnetic field on the similar magnet **#15-D12** on the measurement stand is about **0.5 G**. All these features can be connected with the different magnetic history of the magnets. This question needs the further clarification.



The residual fringe magnetic field from the magnet 10D37 #15-D-4



The residual fringe magnetic field from the magnet 10D37 #15-D-10