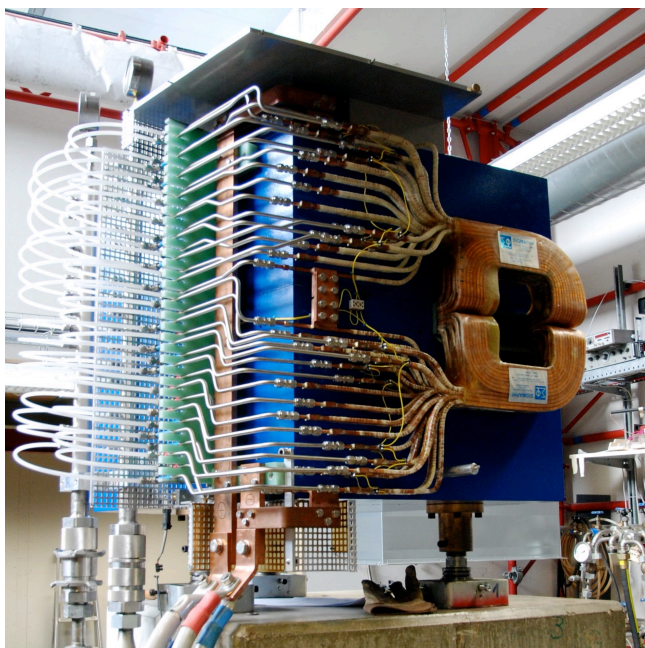

AHB Dipole (High Intensity Proton Beam)



AHB dipole (reserve magnet)

gap = 70 mm
bending angle = 29.8°

$I_{\text{MAX}} = 1025 \text{ A}$
(PS limit 150 V)

MEASUREMENT DATE:

17.Nov. – 1.Dec.2010

MEASUREMENT ARM:

brass cylinder interface $\varnothing 40 \text{ mm}$

aluminum pipe $\varnothing 28 \text{ mm}$, 1 m

carbon pipe $\varnothing 12.1 \text{ mm}$, 1.5 m

MEASURING SPEED:

4.5 mm/sec (X-axis)

25 mm/sec (Z-axis)

INTEGRATION TIME:

20 msec

DVM-1 (1 V RANGE):

Hall probe sbv397 (150 mA)

DVM-2 (10 V RANGE):

150 V / 1300 A (ext PS), $\sim 16 \text{ A/s}$

AIR CONDITIONING:

ON ($T_{\text{SET}} = 24^\circ$)

OPERATORS:

Roland Deckardt

Vjeran Vranković (report)

DATA DIRECTORY:

afs: sys/alpha_dux51/swdir/
magnet/meas/ahb

Alignment and positioning

The magnet was measured from both ends and for that it had to be rotated and positioned four times.

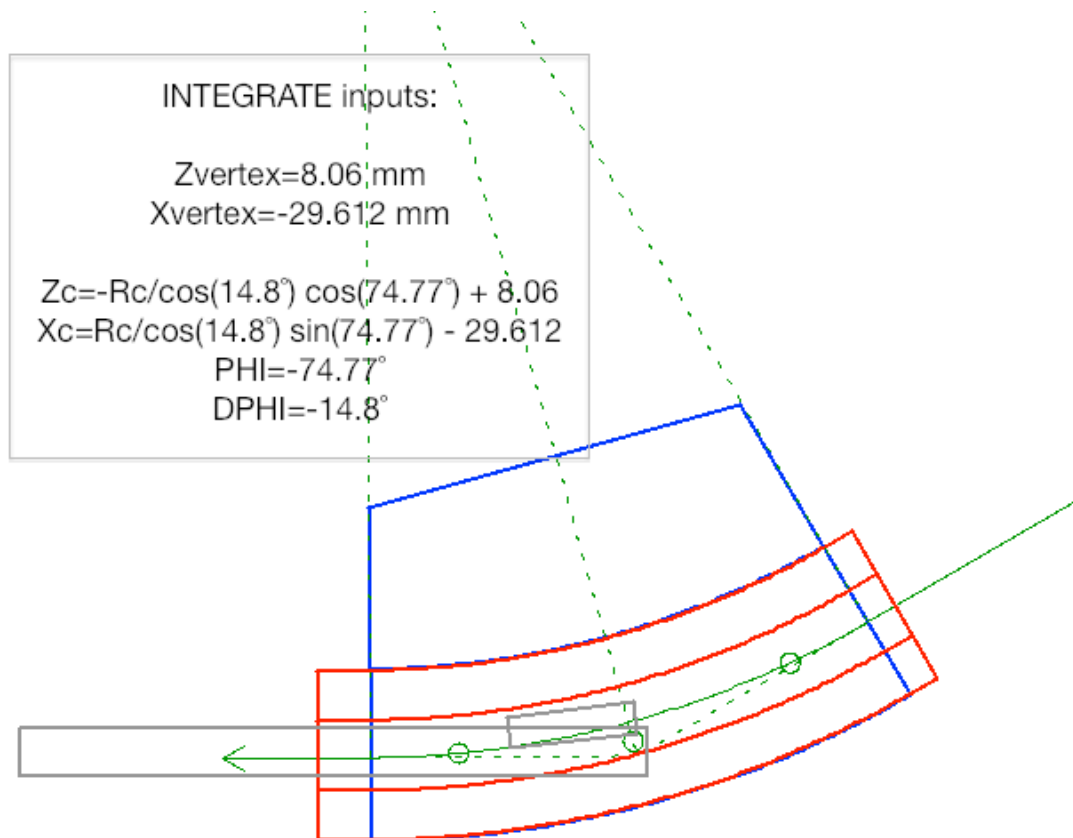
The aligning of the magnet was done magnetically by finding positions of the three reference holes in the pole. The middle reference point is chosen to be the center of the coordinate system.

The probe was leveled with a spirit level built into the measuring arm. The probe axis angle was adjusted in the magnet to be perpendicular to the vertical field component.

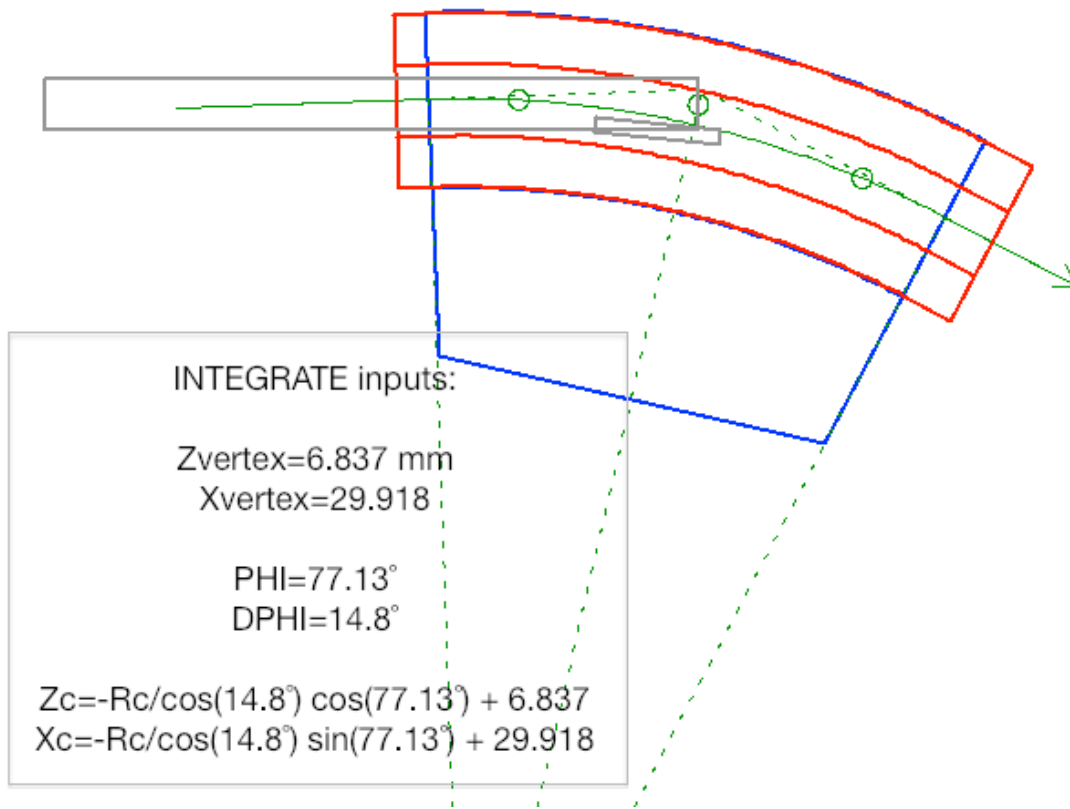
Filename	Current	Rotation angle	Magnet side
ahbf01	1000 A	164.77°	beam exit
ahbe02	excitation curve		
ahbf03	800 A		
ahbf04	500 A		
ahbf05	1000 A	171.63°	
ahbf06	800 A		
ahbf07	500 A		
ahbe08	excitation curve	12.87°	beam entrance
ahbf09	1000 A		
ahbf10	800 A		
ahbf11	500 A		
ahbf12	1000 A	6.94°	
ahbf13	800 A		
ahbf14	500 A		

Field analysis (INTEGRATE+TRACK)

The field maps were measured at three currents $I = 500$ A, 800 A and 1000 A.



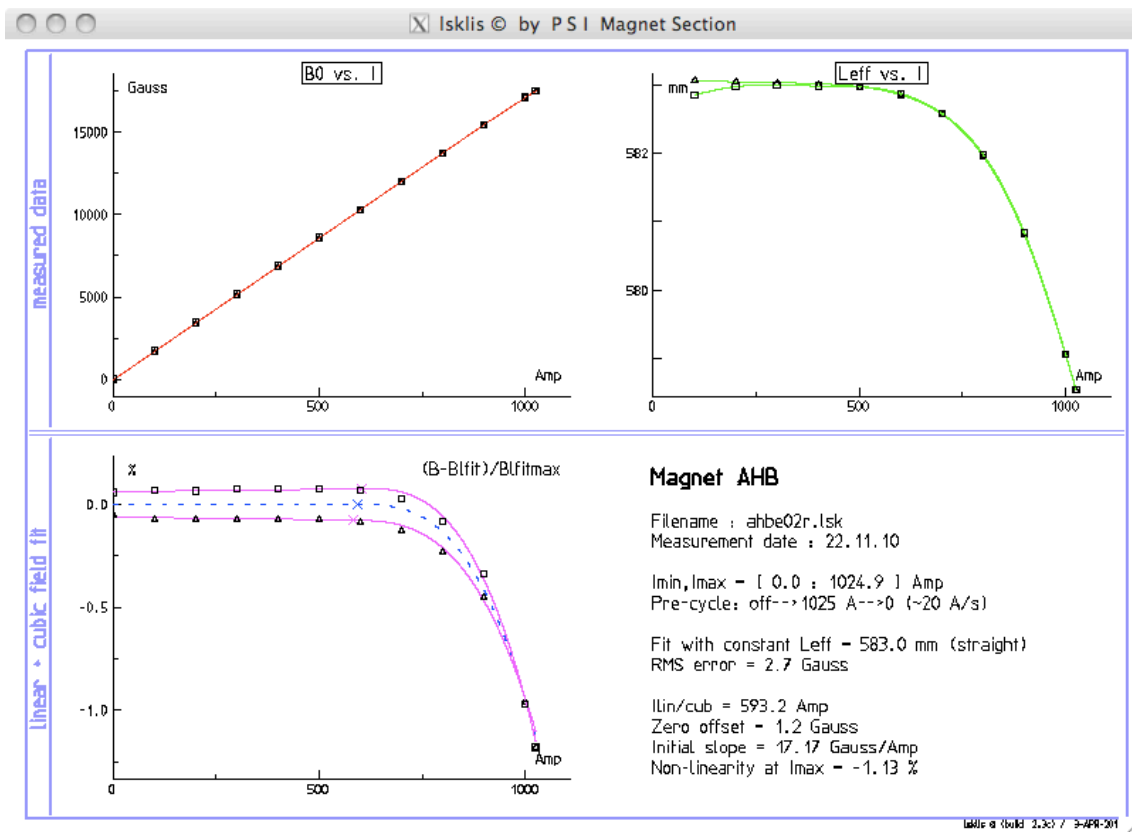
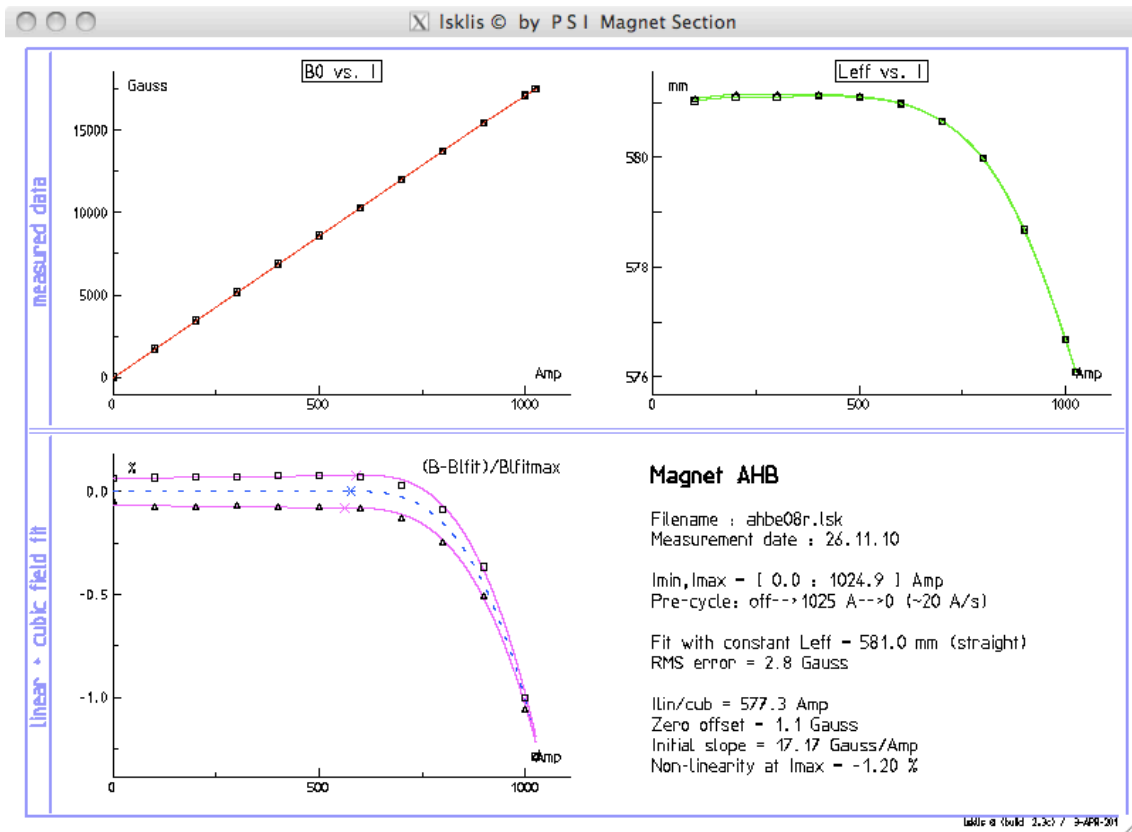
Current [A]	Bending radius [mm]	Leff/Lz LSKLIS	Edge angle [deg]	$p_{\text{INTEGRATE}}$ [MeV/c]	p_{TRACK} [MeV/c]
500	2235.7	0.99078	0.17	576.21	575.96
800	2231.9	0.99080	0.18	919.53	919.13
1000	2220.9	0.99087	0.29	1139.46	1138.93



Current [A]	Bending radius [mm]	Leff/Lz LSKLIS	Edge angle [deg]	p _{INTEGRATE} [MeV/c]	p _{TRACK} [MeV/c]
500	2227.4	0.99030	-0.16	574.13	573.91
800	2223.3	0.99032	-0.09	916.20	915.84
1000	2211.1	0.99040	-0.02	1134.78	1134.28

The maximum current from the external power supply used for the measurements was restricted by the limit of 150 V to 1025 A. This is lower than the operational current of the magnet and therefore it was needed to extrapolate the measured values.

Excitation curves



Magnet AHB

File : ahbe08r.lsk
 Date : 26.11.10

Pre-cycle : off-->1025 A-->0 (~20 A/s)

#Curr: 23 (nPaths=2)
 Z-dir: from -1300.00 mm, steps of 2.00 mm
 X-dir: at 0.00 mm

linear_<Ilin> and cubic_<Ilin:Imax> approximation of Bc:
 $B_{lin} = b_0 + b_1 * I_{rel}$; $I_{rel} = I / I_{max}$
 $B_{cub} = B_{lin} + b_2 * I_{rel}^2 + b_3 * I_{rel}^3$; $I_{rel} = (I - I_{lin}) / (I_{max} - I_{lin})$

	Ilin_A	Imax_A	b0_G	b1_G	b2_G	b3_G	RMS_G
	=====	=====	=====	=====	=====	=====	=====
/	562.4	1024.9	-10.3	17597.3	2.4	-200.3	2.4
\	590.6	1024.9	12.6	17606.0	-14.5	-210.1	3.3
-	577.3	1024.9	1.1	17601.8	-6.5	-204.7	2.8

/ = increasing current branch
 \ = decreasing current branch
 - = average

constLeff (straight) = 581.0 mm
 constLeff = 575.4 mm
 constBendingRadius = 2227.5 mm
 halfBendingAngle = 14.8 deg
 Leff / Lz = 0.99034
 particle E0 = 938.272 MeV

I_Amp	Bdz_Gmm	p_MeV/c	E_MeV	Bc_G	err_G
=====	=====	=====	=====	=====	=====
0.00*	-4075.8	-0.468	0.000	-7.0	3.3
100.12/	992207.4	113.956	6.895	1707.8	-0.9
200.10/	1989540.9	228.501	27.423	3424.3	-1.0
300.07/	2987563.5	343.125	60.772	5142.1	0.4
400.06/	3984907.5	457.672	105.671	6858.7	0.2
500.03/	4982155.0	572.207	160.716	8575.1	0.2
600.02/	5979023.0	686.698	224.444	10290.9	-0.8
700.00/	6971711.5	800.710	295.215	11999.5	-3.8
799.97/	7957530.0	913.932	371.547	13696.3	-2.0
899.95/	8928607.0	1025.462	451.665	15367.7	2.8
999.91/	9869748.0	1133.553	533.223	16987.5	-2.8
1024.92*	10095486.0	1159.479	553.286	17376.1	-15.5 (average of 2 fits)
999.91\	9875148.0	1134.173	533.700	16996.8	-3.5
899.94\	8942816.0	1027.094	452.870	15392.1	3.6
799.96\	7973494.0	915.766	372.827	13723.7	-3.7
699.99\	6988014.5	802.582	296.431	12027.6	-5.2
600.01\	5994728.5	688.502	225.510	10317.9	-1.6
500.02\	4997924.5	574.018	161.660	8602.3	0.3
400.05\	4000103.5	459.417	106.438	6884.9	0.2
300.06\	3001961.0	344.779	61.341	5166.9	-0.2
200.09\	2004345.4	230.202	27.827	3449.8	0.1
100.11\	1006498.9	115.598	7.094	1732.4	0.1
0.00*	7174.9	0.824	0.000	12.3	-0.3

$p = Bdz / \text{halfBendingAngle} * Leff / Lz * c * e^{-13} * \text{factor}$
 $\text{factor} = p(\text{TRACK}) / p(\text{LSKLIS}) = 0.99924$
 $E = \sqrt{E_0^2 + p^2} - E_0$
 $Bc = Bdz / \text{constLeff}$
 $\text{err} = Bc - B_{fit}$

Magnet AHB

File : ahbe02r.lsk

Date : 22.11.10

Pre-cycle : off-->1025 A-->0 (~20 A/s)

#Curr: 23 (nPaths=2)

Z-dir: from -1250.00 mm, steps of 5.00 mm

X-dir: at 0.01 mm

linear_<Ilin> and cubic_<Ilin:Imax> approximation of Bc:

Blin = b0 + b1 * Irel ; Irel = I / Imax

Bcub = Blin + b2 * Irel^2 + b3 * Irel^3 ; Irel = (I - Ilin) / (Imax - Ilin)

	Ilin_A	Imax_A	b0_G	b1_G	b2_G	b3_G	RMS_G
	=====	=====	=====	=====	=====	=====	=====
/	582.1	1024.9	-9.8	17594.3	-13.4	-165.0	2.7
\	602.3	1024.9	12.2	17603.2	-24.0	-194.0	2.8
-	593.2	1024.9	1.2	17598.7	-18.7	-179.5	2.7

/ = increasing current branch

\ = decreasing current branch

- = average

constLeff (straight) = 583.0 mm

constLeff = 577.6 mm

constBendingRadius = 2236.3 mm

halfBendingAngle = 14.8 deg

Leff / Lz = 0.99082

particle E0 = 938.272 MeV

I_Amp	Bdz_Gmm	p_MeV/c	E_MeV	Bc_G	err_G
=====	=====	=====	=====	=====	=====
0.00*	-4208.2	-0.483	0.000	-7.2	2.6
100.11/	995722.2	114.402	6.949	1707.9	-0.7
200.10/	1996363.4	229.368	27.629	3424.3	-0.8
300.10/	2997505.8	344.393	61.208	5141.5	-0.2
400.10/	3998790.2	459.433	106.445	6859.0	0.7
500.05/	4998857.5	574.334	161.825	8574.4	0.3
600.03/	5998286.5	689.162	225.901	10288.7	-1.6
700.00/	6995266.5	803.708	297.163	11998.7	-3.6
799.98/	7984898.5	917.410	373.976	13696.2	-3.5
899.95/	8963318.0	1029.824	454.886	15374.5	3.6
999.92/	9911664.0	1138.782	537.255	17001.1	-3.2
1024.94*	10139501.0	1164.959	557.550	17391.9	-9.8 (average of 2 fits)
999.91\	9910587.0	1138.658	537.159	16999.3	-3.4
899.94\	8974889.0	1031.153	455.870	15394.3	5.5
799.96\	8000095.5	919.156	375.197	13722.3	-3.9
699.98\	7010461.0	805.454	298.300	12024.8	-5.7
600.01\	6013768.5	690.941	226.955	10315.2	-2.0
500.03\	5013982.0	576.072	162.734	8600.3	0.2
400.09\	4013563.5	461.131	107.193	6884.3	0.7
300.10\	3012278.0	346.090	61.794	5166.9	0.5
200.10\	2010369.9	230.978	28.012	3448.3	-0.6
100.11\	1009588.2	115.995	7.143	1731.7	0.1
0.00*	6697.2	0.769	0.000	11.5	-0.7

p = BdZ / halfBendingAngle * Leff / Lz * c * e-13 * factor

factor = p(TRACK) / p(LSKLIS) = 0.99912

E = sqrt(E0^2 + p^2) - E0

Bc = BdZ / constLeff

err = Bc - Bfit