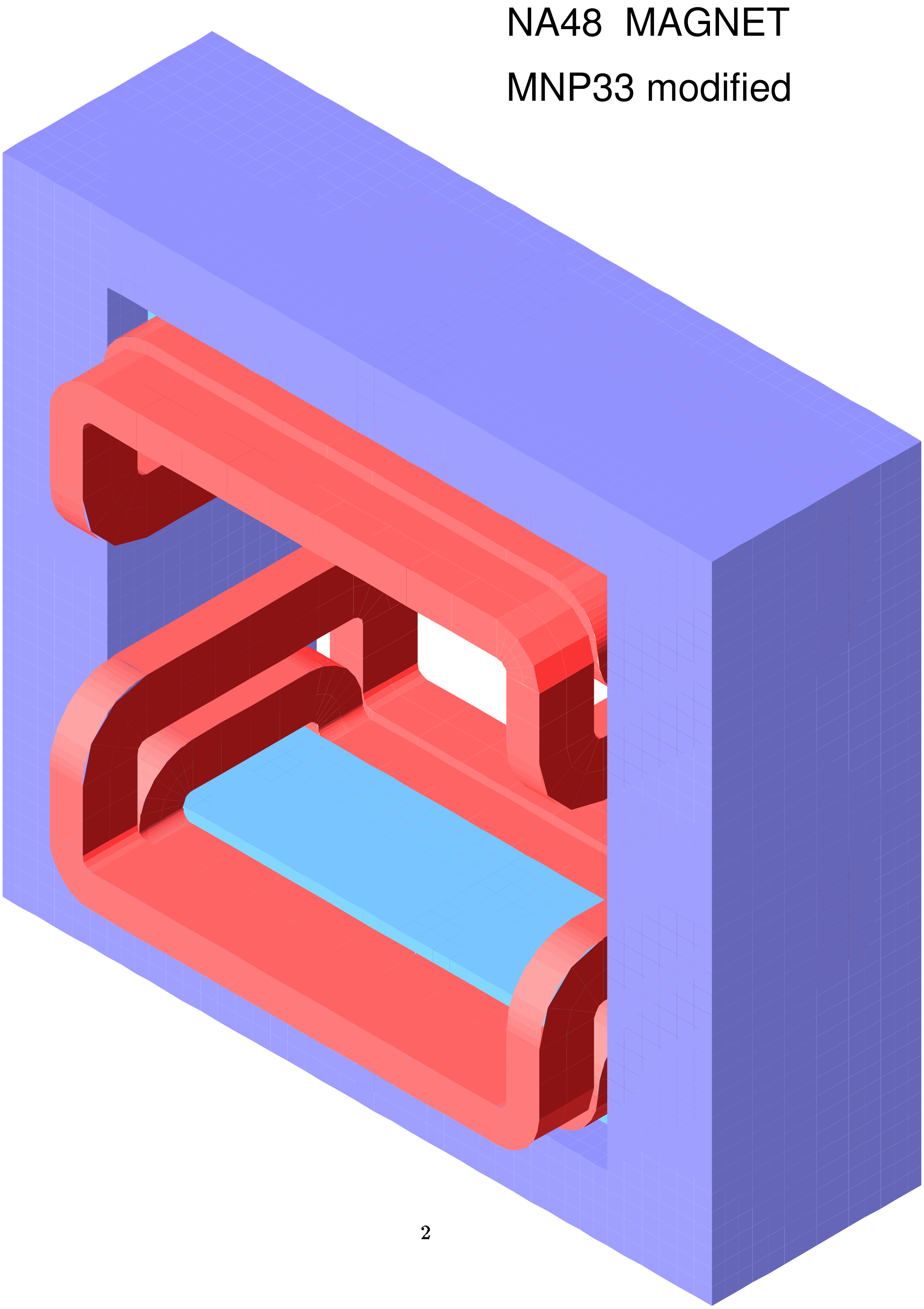
–


NA48 MAGNET
MNP33 modified

1 Introduction

The NA48 magnet is a modification of an old CERN magnet: MNP33.

The magnet had to fulfill the following requirements:

1. An apperture of at least 245x240 cm^2 to match the acceptance of the Kr-calorimeter.

2. A field integral between chambers 2 and 3 (+- 2.70m) at least: $\int_{-2.7m}^{+2.7m} B_y dz = 0.83\mathrm{T}\cdot\mathrm{m}$, corresponding to $P_T = 250 MeV/c$.

3. The uniformity of P_T in the active region must be better than 10% to allow an easy momentum calculation for the fast trigger.

4. A fringe field at the DC2 and DC3 chambers smaller than 200 Gaus. (This condition is required to avoid perturbations in the behaviour of the chambers and to insure a small deflection of particles between DC1-DC2 and DC3-DC4.)

These requirements have been met by modifying the existing magnet MNP33 of CERN, according to a (TOSCA) calculation of E. Griesmayer and G. Neuhofer (NA48 note 91-6).

The design of the MNP33 modification has been done by J.P.Grillet. Two blocks of iron and an additional coil have been ordered to increase the gap and obtain the required integrated field.

The magnet was installed in ECN3 during the summer 93 and the field map was measured in the fall of 93, with the help of the CERN group of W. Flegel

The data were analysed by J. Duclos in 94 and a final TOSCA calculation, taking into account the actual geometry, was made by F. Bergsma.

A brief description of the magnet and a comparison between the measured and calculated field can be found in Nucl. Instr. and Meth. (1995) , also NA48-NOTE 1995-11.

2 Measurement of the Magnetic Field Map

The apparatus for the field measurement includes:

1. An mechanical device, (used previously for the OMEGA magnet), with fully automatic motion in x, y, z direction, (P. Knobel)

2. A set of 12 Hall probes to measure simultaneously the 3 components Bx, By, Bz of 4 points in steps of 4 cm (in x direction), with automatic readout monitored by PC (G. Fremont, F. Bergsma)

3. Two Hall probes at fixed positions (top and bottom of the gap) were used as references. Absolute measurements were done using an NMR probe located at the centre of the magnet (x=0, y=0, z=0). Both positive and negative currents have been used after proper degaussing (R. Rey-Mermier)

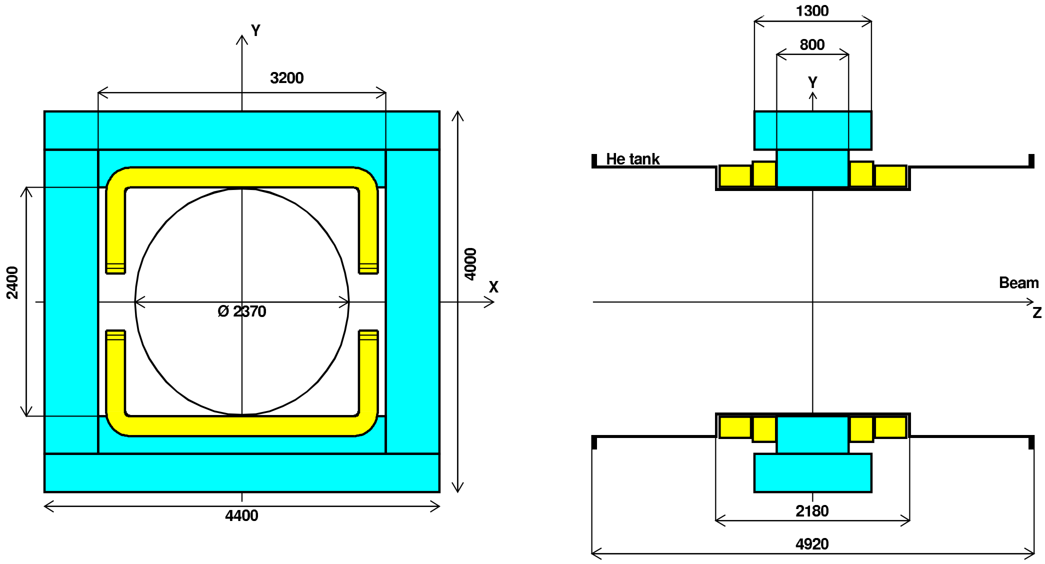
The precision required on the field integral is 10^{-3}. It is obtained by:

1. An absolute calibration of the Hall probes with 10^{-3} accuracy.

2. A temperature regulation insuring a stability of the Hall probes better than 10^{-3}.

3. A positionning of the Hall probes as respect to the magnet axis with a precision better than 1mm.

4. A precision of 1/10 mm on the relative position of the successive Hall probe positions in all the central part Z(- 2.75:2.75)m of the magnet.



Magnet caracteritics:

Total weight:	**105 tons**
Nominal current:	**1200 A**
Total nb. of A-turns:	**$0.98\ 10^6$**
By(0,0,0):	**0.3712 Tesla**
Integrated By(0,0,z):	**0.858 T.m**
Magnetic energy:	**430 KJoules**
Dissipated power:	**3.1 MW**

Figure 1: Magnet dimensions. The fiducial volume is defined by the Helium tank (internal diameter 2.37m)

3 Field maps

A complete map has has been measured for the nominal current of the "master" power supply: I=1200 A. In addition, partial maps should be measured also at lower currents: 1150 A and 500 A. The measurement is done inside the He-tank i.e. in the useful magnetic volume. In the longitudinal direction the mechanical system allows an automatic 'one shot' scan along 5.5m. The total volume has bee scanned using 3 mechanical settings: Z(- 2.75:2.75)m, Z(2.5:8)m, Z(-8:-2.5)m.

The field map of the NA48 magnet for the nominal current: 1200A is available as a NTUPLE:

MAP1200.NTUP on VM disk 402 and

/afs/cern.ch/user/j/jduclos/public/magnet/map1200.ntup

Each 'event' contents 10 words:

W(1)= X (cm) (-136:136) (+: Jura side)

W(2)= Y (cm) (-136:136) (+: top direction)

W(3)= Z (cm) (-640:640) (+: beam direction)

W(4)= FLAG: 1: measured value 2: extrapolated value

W(5)= BX(X,Y,Z) (Gauss) measured or extrapolated

W(6)= BY

W(7)= BZ

W(8)= BX(X,Y,Z) (Gauss) from TOSCA calculation

W(9)= BY

W(10)= BZ

The map is given only in the fiducial diameter $SQRT(X**2+Y**2) < 140$. To find the adress of the 'event' XYZ in the NTUPLE one has to refer to the file MAP1200.LINK as explained in the file MAP1200.README on DISK 402

4 saturation effects

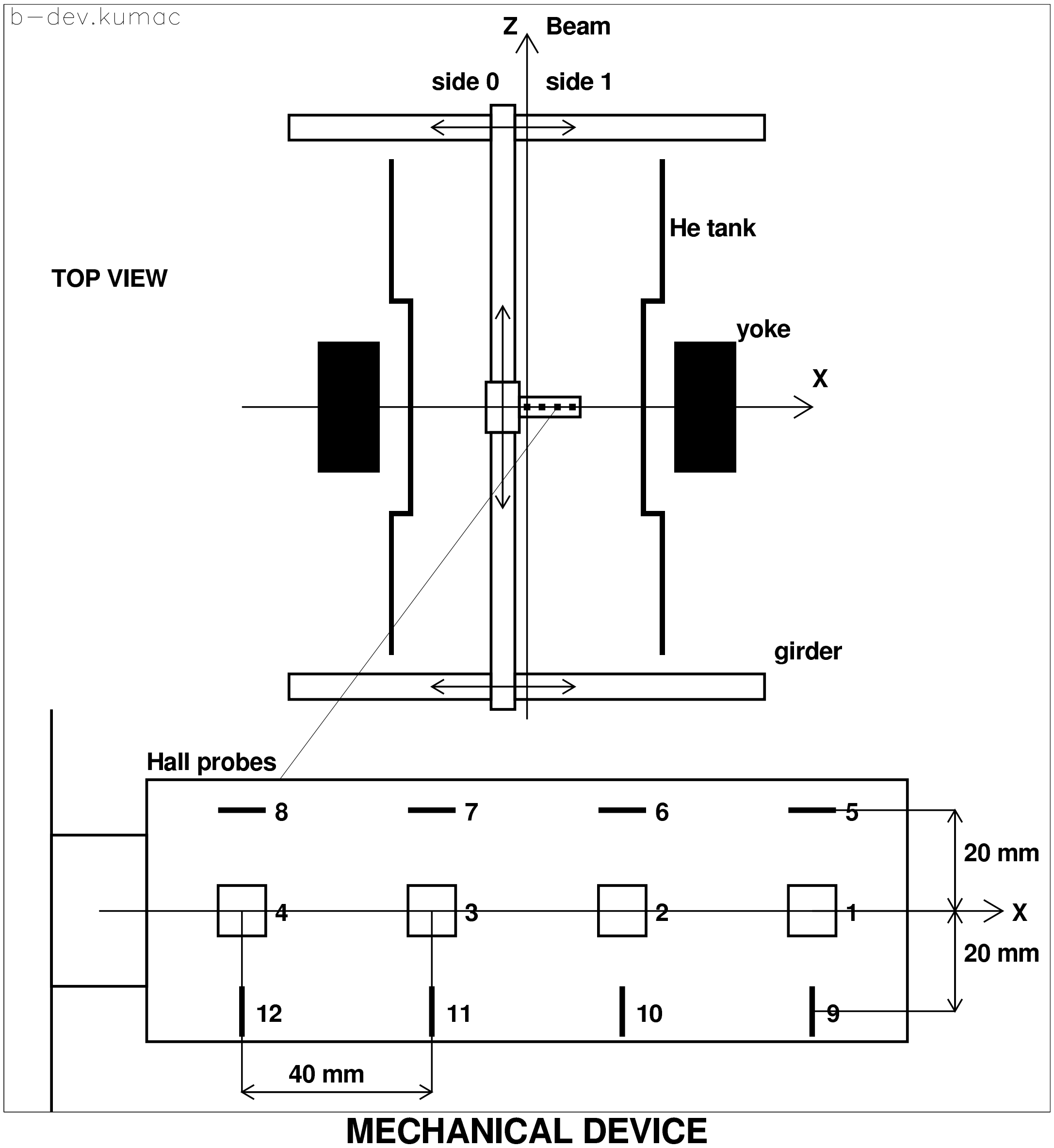


Figure 2: Mapping device

File: 310-1-1.dat

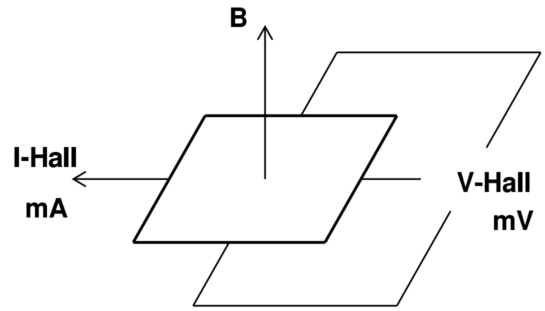
Sun Dec 05 23:31:13 1993

Current head 99.991
Current ref. 100.022
Temperat. head 39.47
Temperat. ref h 40.09
Temperat. ref b 39.61

Box No, side 310 0

x-pos 0 8
y-pos, Y-STEP -400 8

Probe	1	2	3	4
z-pos 0				
Main	-2.242	-1.902	-2.200	-2.167
Axial	-1.397	-1.413	-1.390	-1.384
Trans.	-0.063	-0.040	-0.016	-0.015
Refer.	-91.638	86.363		
z-pos 2640				
Main	-62.762	-53.056	-61.284	-60.229
Axial	0.260	0.664	0.736	0.836
Trans.	-0.165	-0.125	-0.049	0.142
Refer.	-91.639	86.362		



Mean values of references for normalisation

1200 A : 89 mV

1050 A : 78.1 mV

500 A : 37 mV

Treatment:

Normalise V-Hall to I-Hall = 100 mA (all probes)

Normalise V-Hall probes to a fixed (mean) value of references

Get B in Gauss using calibration curves

correct for component mixing

b-raw.kumac

RAW DATA

Figure 3: Raw data

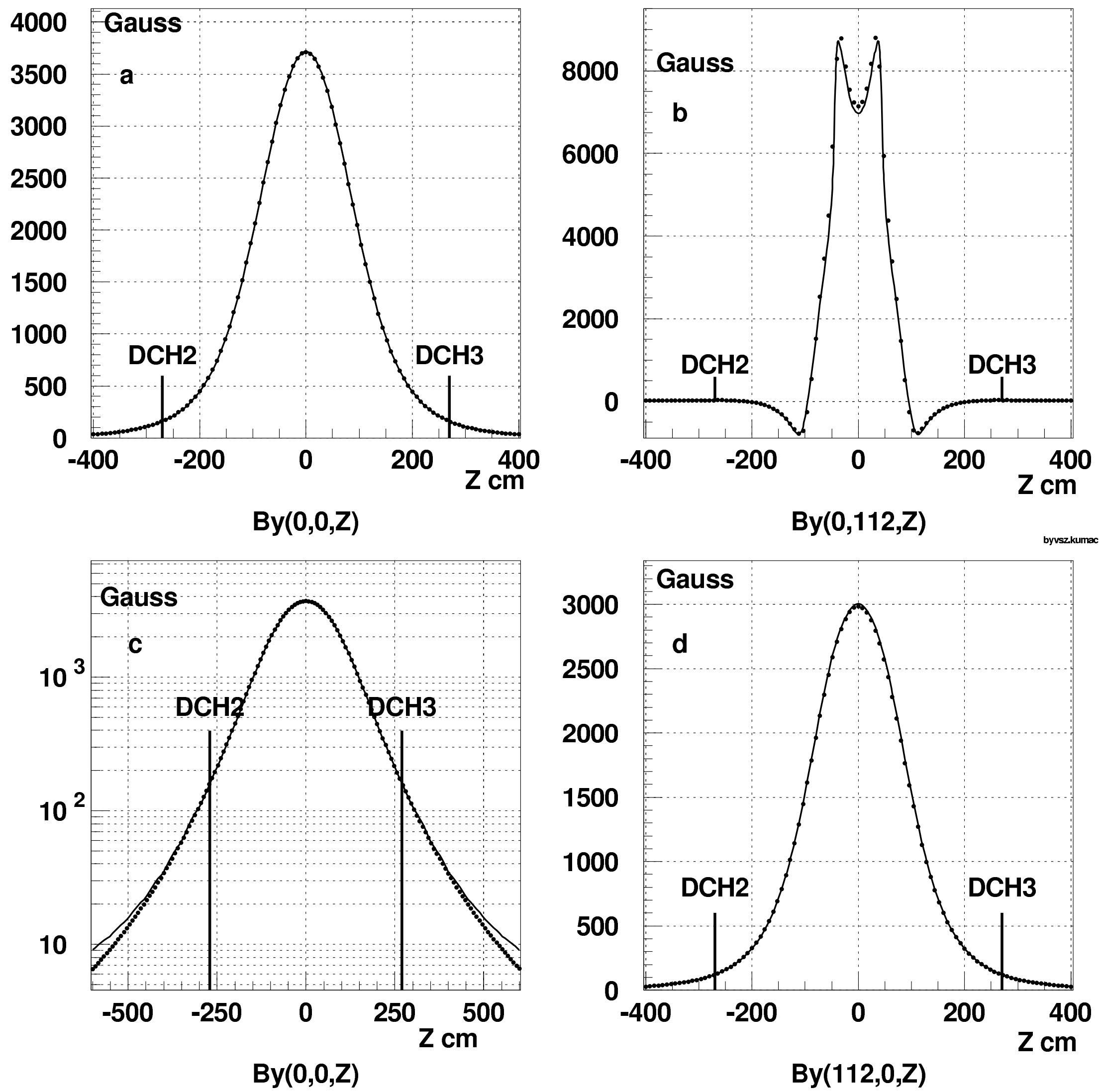


Figure 4: Plots of By vs Z, TOSCA calculations (lines) and measurement (points), without any normalization -a): x=0,y=0 -b): x=0,y=112cm -c): x=0,y=0, logaritmic coord. -d): x=112cm,y=0

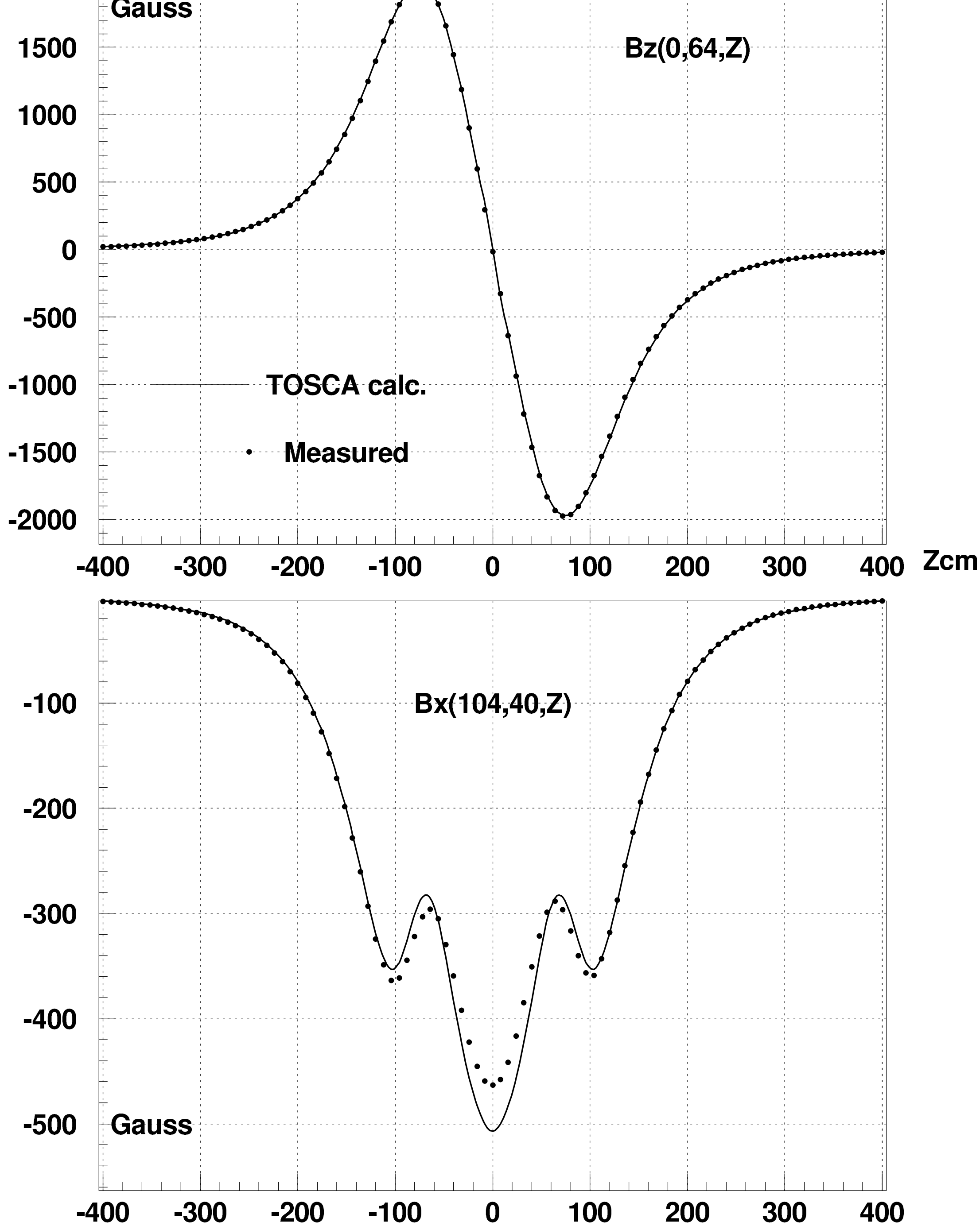


Figure 5: Plot of Bz vs z (x=0,y=64) and Bx vs z (x=104,y=40) TOSCA calculations (lines) and measurement (points)

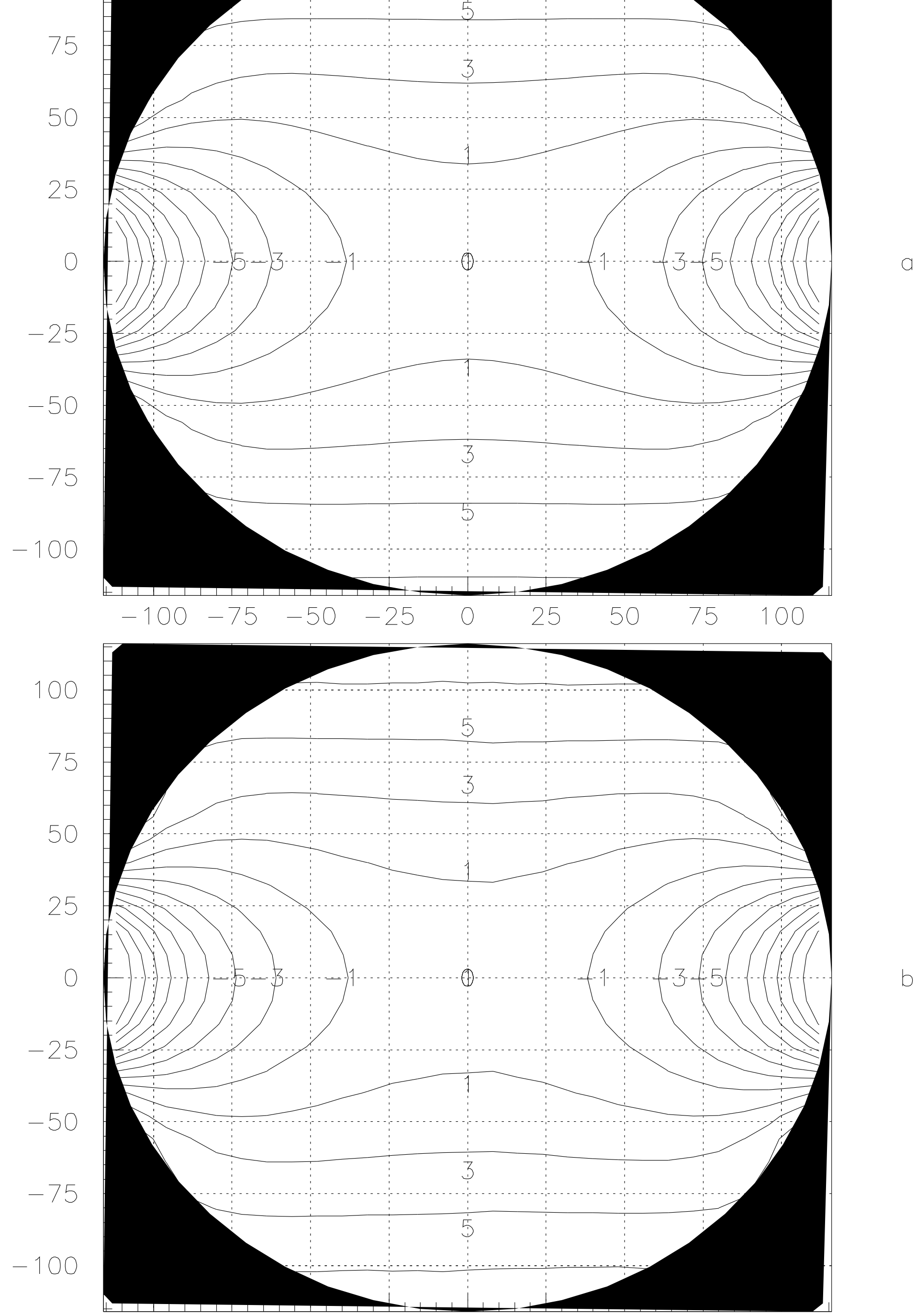


Figure 6: contours of Pt values in xy plan for calculated and measured field maps. The numbers indicate the percent deviation from the central value of Pt

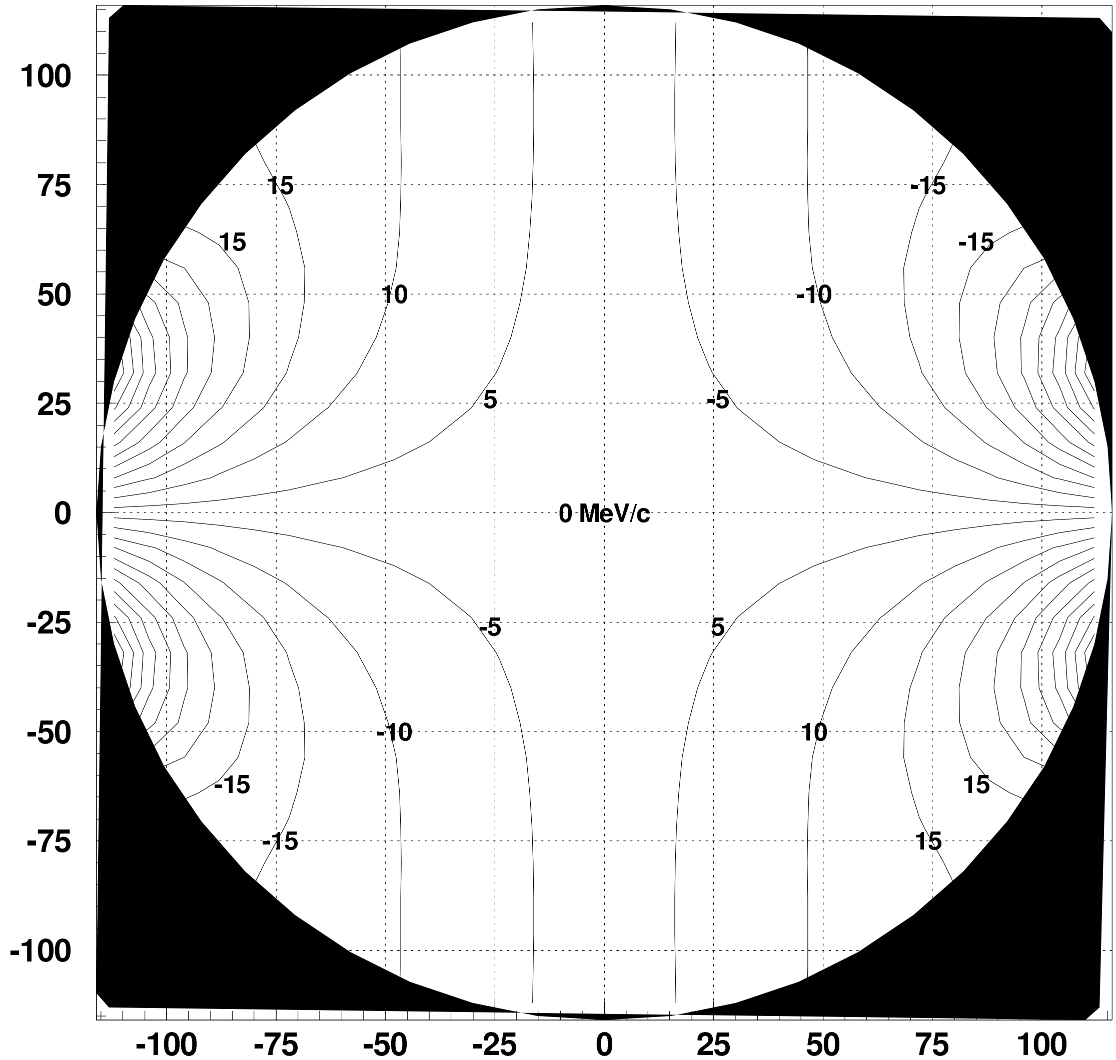


Figure 7: Contours of equal integrated field (-2.7m:2.7m) Bx, expressed as tranverse momenta (MeV/c), in the xy plan (cm), inside the He tank tube.

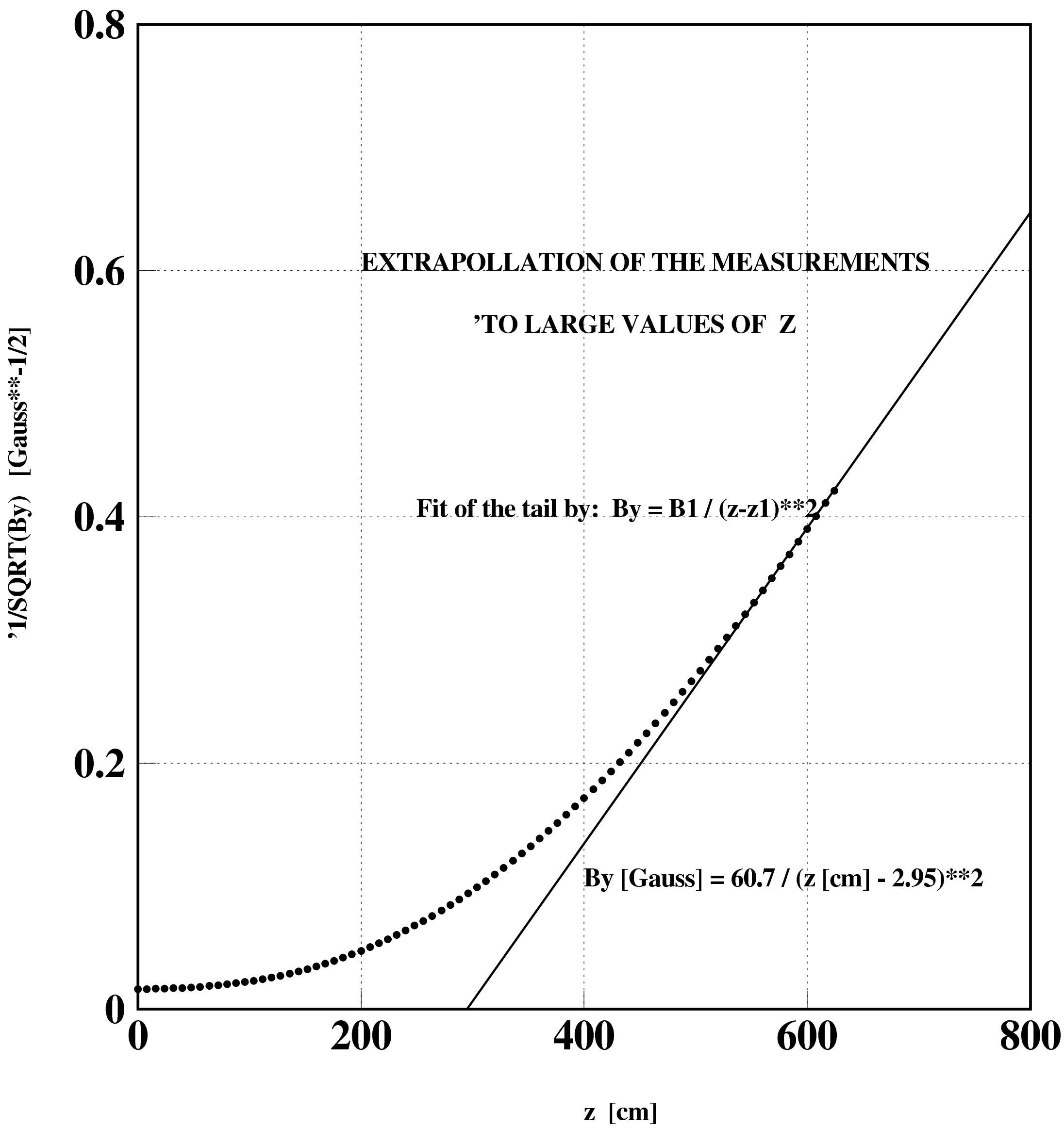


Figure 8: Extrapollation of measurements beyond —z— = 6.2 m by a fit in 1/d**2. the measured magnetic field behave indeed in 1/d**2 but with d =—z— -3m. taking into account the final size of the magnet, source of the field.

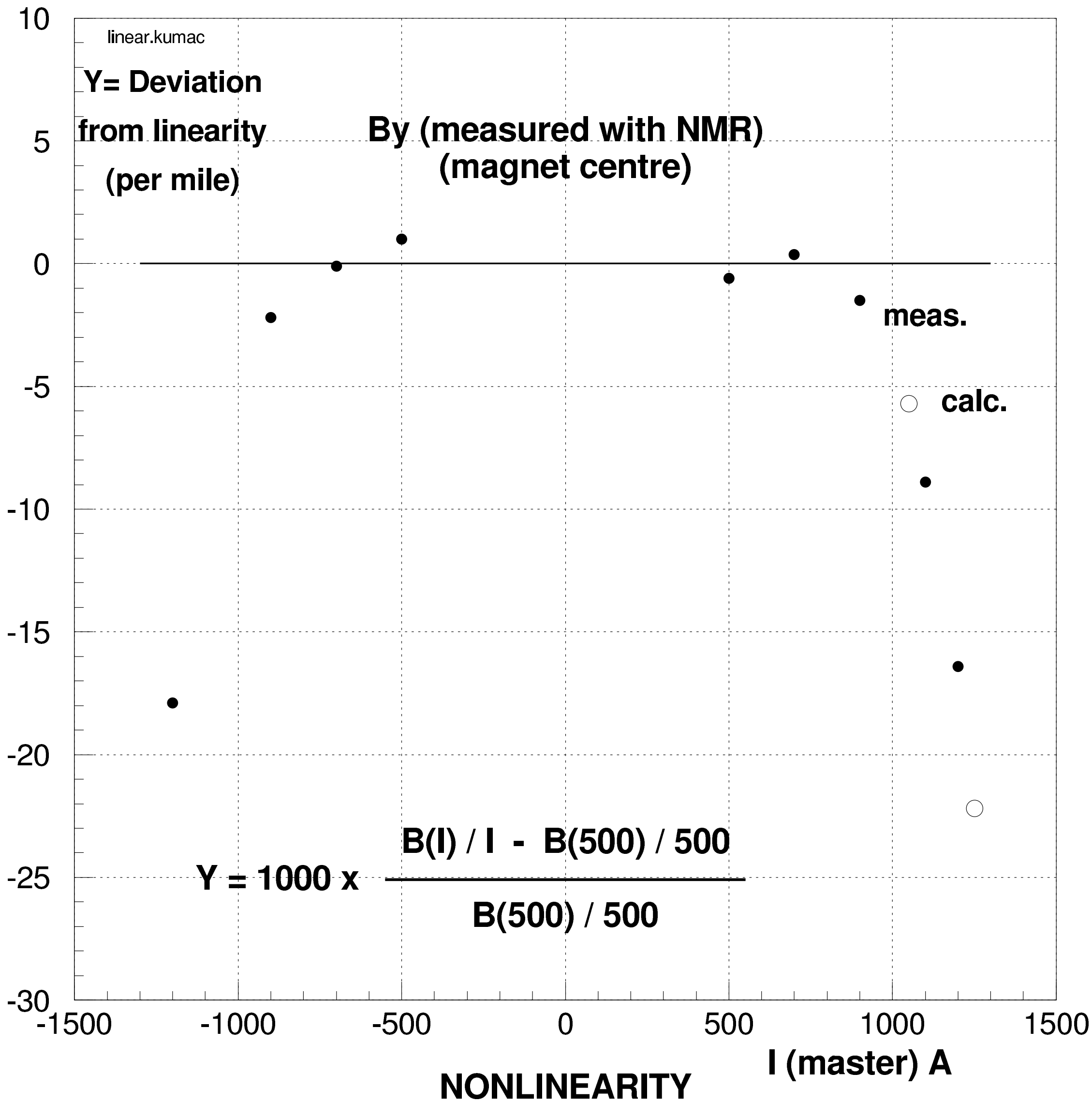
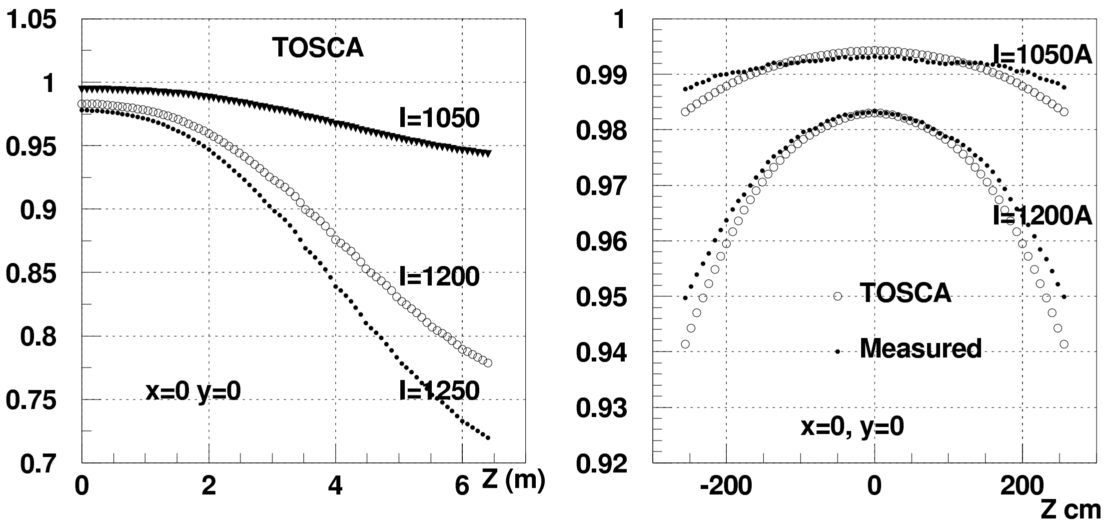


Figure 9: Saturation effect from NMR measurements



(500/I) * By(I) / By(500A)

The saturation effect is small about 2% for small z

Effect Larger than 20% beyond z = 3m but small effect on integr. field

'Quite similar effect in TOSCA and measurement, within 0.2% near the centre

A difference (TOSCA-meas.) larger than 0.5% only beyond Z = 2m

Suggests to use: B(I) = BT(I)*BM(1200)/BT(1200) (BT: TOSCA BM: meas.)

In other words: we use the saturation effect calculated by TOSCA

Figure 10: Saturation effect from TOSCA calculation. A clear effect appears in the field shape along Z

Current: I Amp.	reference (|Rf1|+|Rf|)/2	$B_y(000)$ NMR(Gauss)	$B_y(000)$ TOSCA(Gauss)
(-1200)	88.64	3704.3	
(-900)	66.76	2822.6	
(-700)	51.82	2200.0	
(-500)	36.95	1573.1	
500	(37.31)		1584.0
(500)	37.00	1570.6	
(700)	51.91	2201.0	
(900)	66.88	2824.6	
1050	(78.75		3307.3
(1100)	81.70	3426.5	
(1200)	88.86	3709.9	
1250	(92.74)		3872.0

Table 1: NMR measurements of $B_y(000)$ as a function of current. The reference is the average of Hall probes values (top and bottom of the gap). The precision on the current is not better than 1% (value in parenthesis). It is possible by interpollation to calculate the reference value (in parenthesis) corresponding to the TOSCA calculation to fit the value of By(000)