PCMAG field map

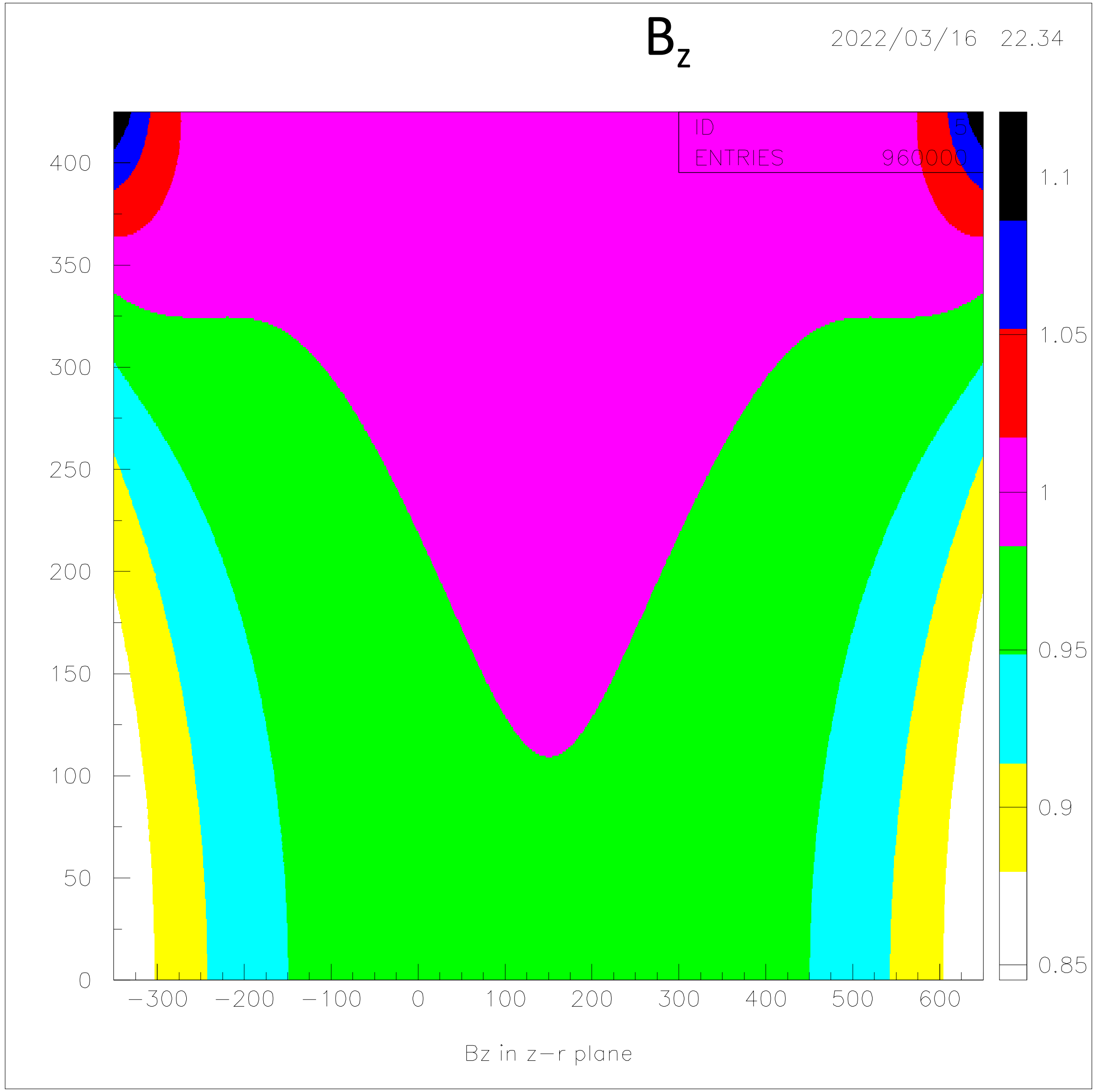
And some effects on curved tracks

File PCMagFieldMap.dat (from Tadeas Bilka (Belle2) 16/12/2021)

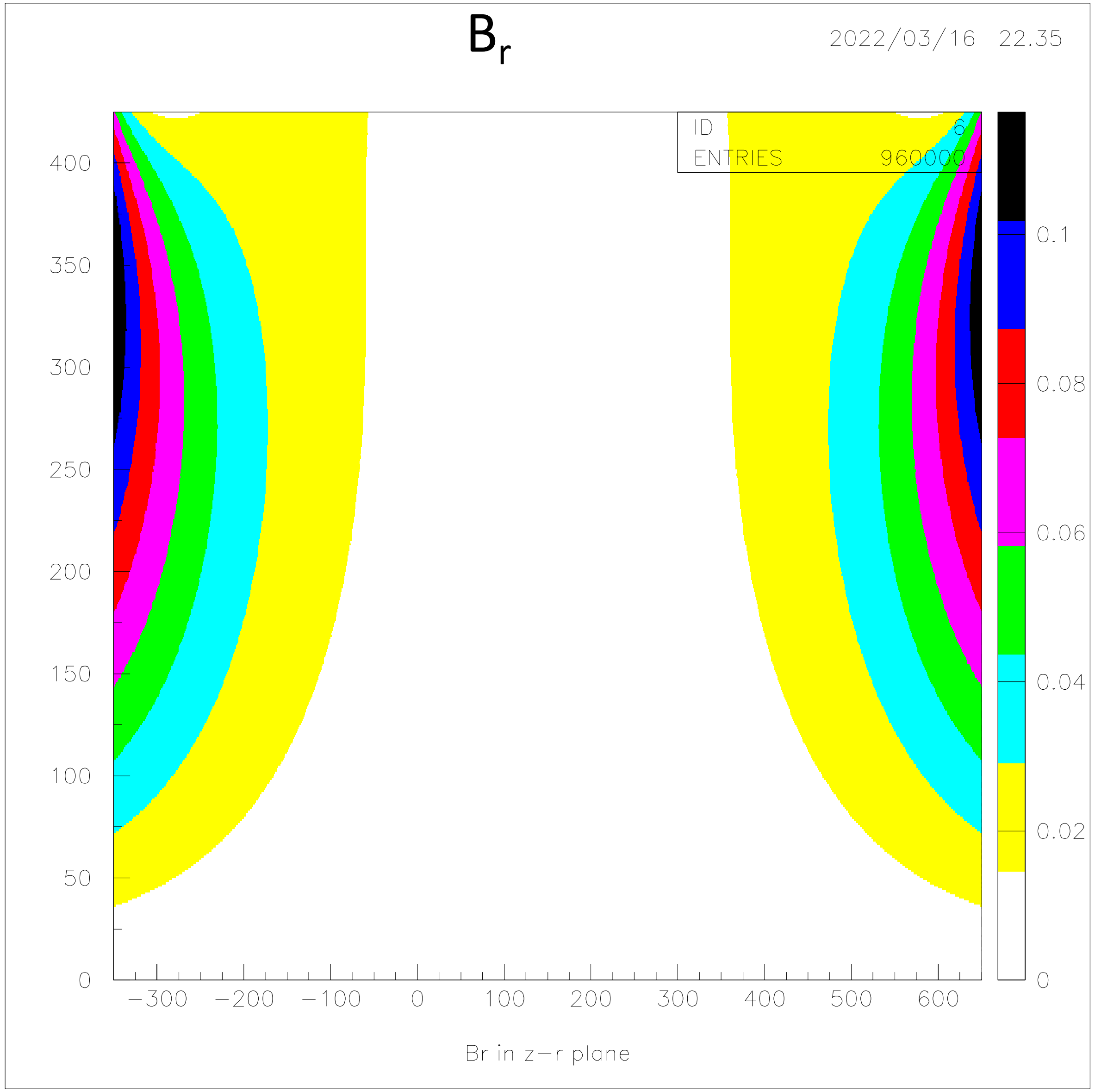
(28.784171 Mb)

- Solenoidal field (cylindrical symmetry)
- Simple textfile, 960000 data point lines: r, z, B_r , B_z (r, z in mm; B_r , B_z in Tesla)
- 1600 points along z from -799.5 to +799.5 in steps of 1 mm
- 600 groups with r from 0.5 to 599.5 in steps of 1 mm
- r=0 magnet axis
- z=0 does NOT correspond to maximum in B_z ; B_{max} approx. at z = +150.5

- Magnet (inner) length = 1000 mm
- Magnet (inner) diameter = 850 mm (max. radius 425 mm in plots)
- LP active drift length = 570 mm

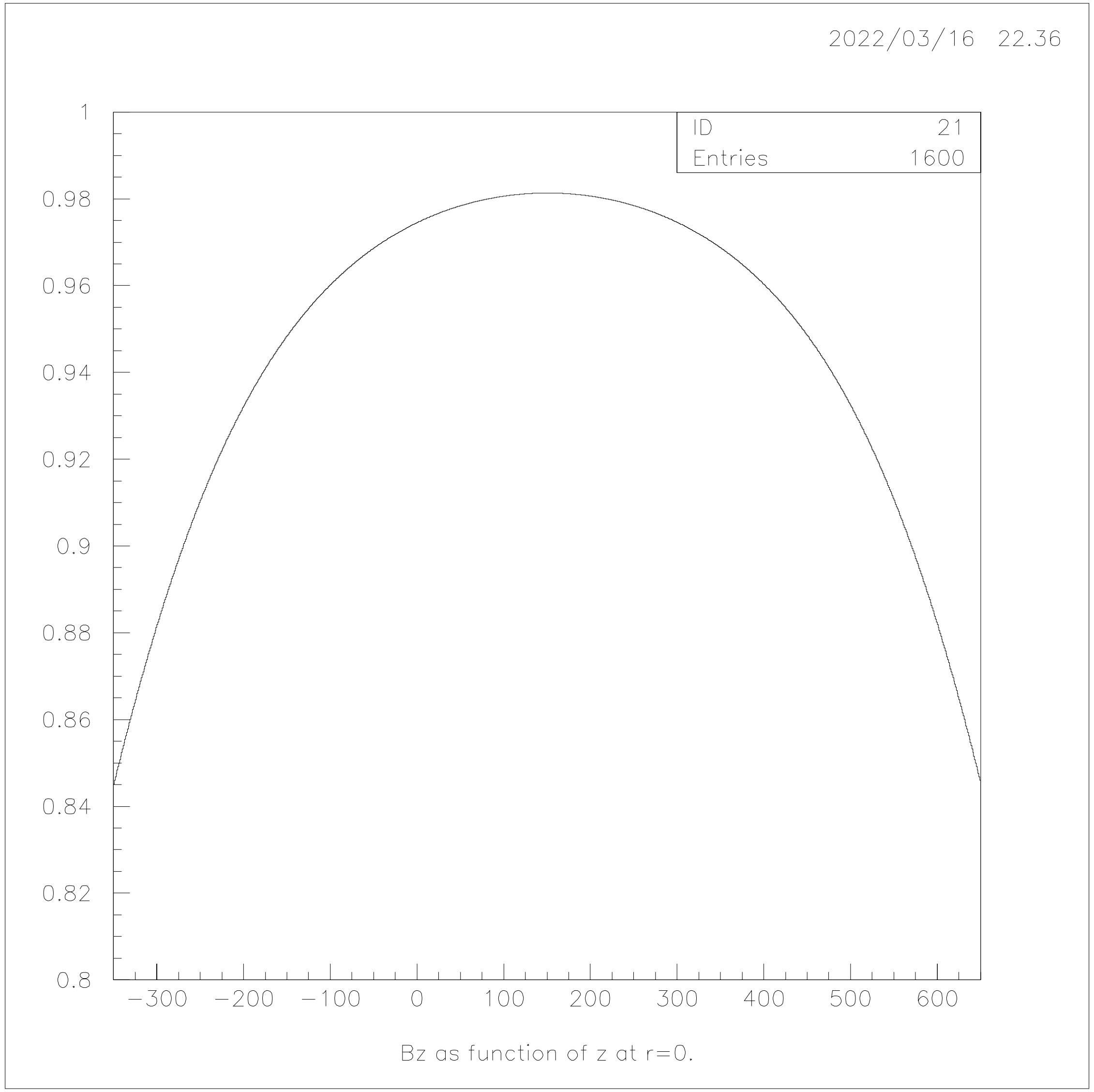


B_z
2022/03/16 22.34
ID
ENTRIES 960000
400
350
300
250
200
150
100
50
0
−300 −200 −100 0 100 200 300 400 500 600
1.1
1.05
1
0.95
0.9
0.85
Bz in z−r plane



B_r
2022/03/16 22.35
ID 6
ENTRIES 960000
400
350
300
250
200
150
100
50
0
−300 −200 −100 0 100 200 300 400 500 600
0.1
0.08
0.06
0.04
0.02
0
Br in z−r plane

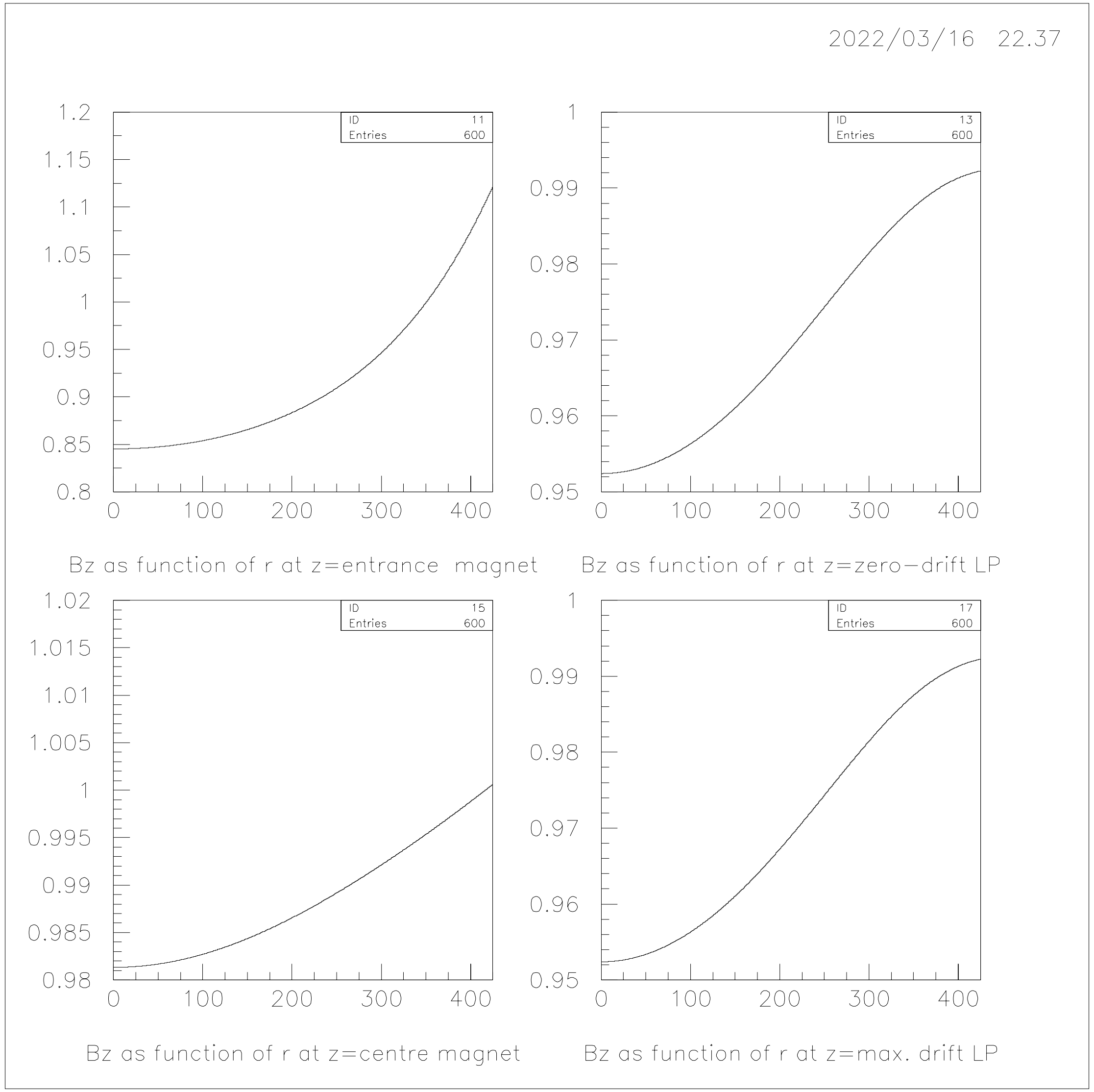
B_z [T] as function of z at r=0 (magnet axis)



B_z [T] as function of r at 4 z-positions along magnet axis

Entrance magnet

Centre Magnet (TPC centred)

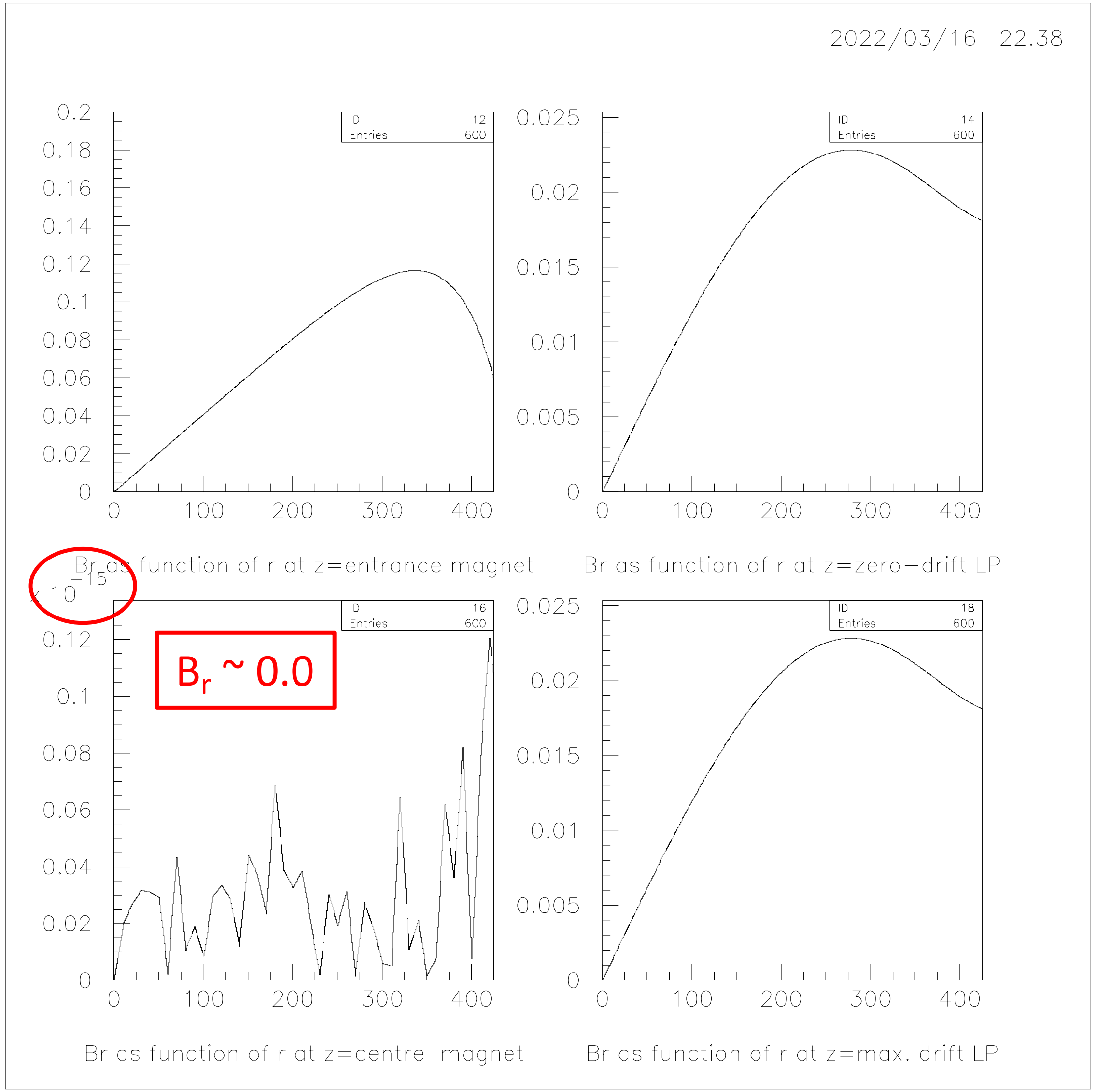


Zero drift In LP

These two are same B-field (symmetry)

Max. drift In LP

B_r [T] as function of r at 4 z-positions along magnet axis



Entrance magnet

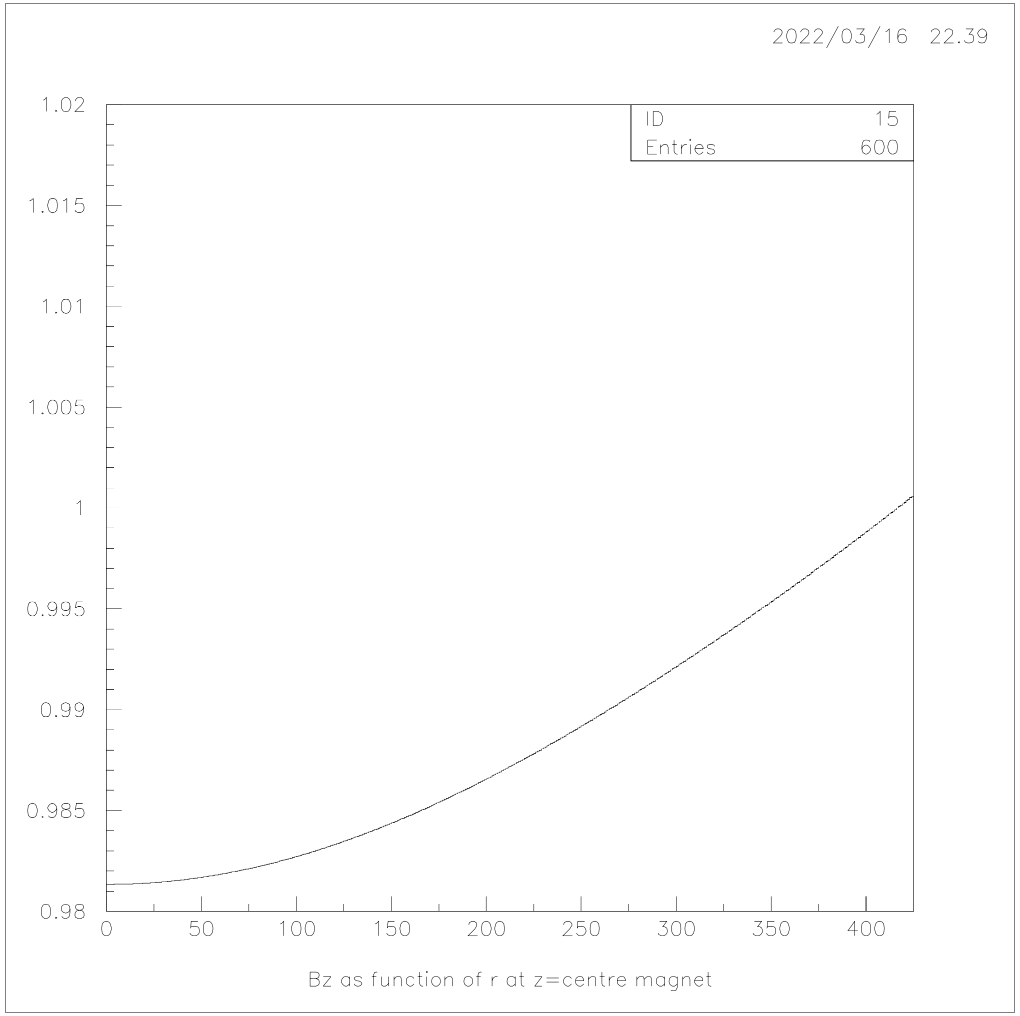
Zero drift In LP

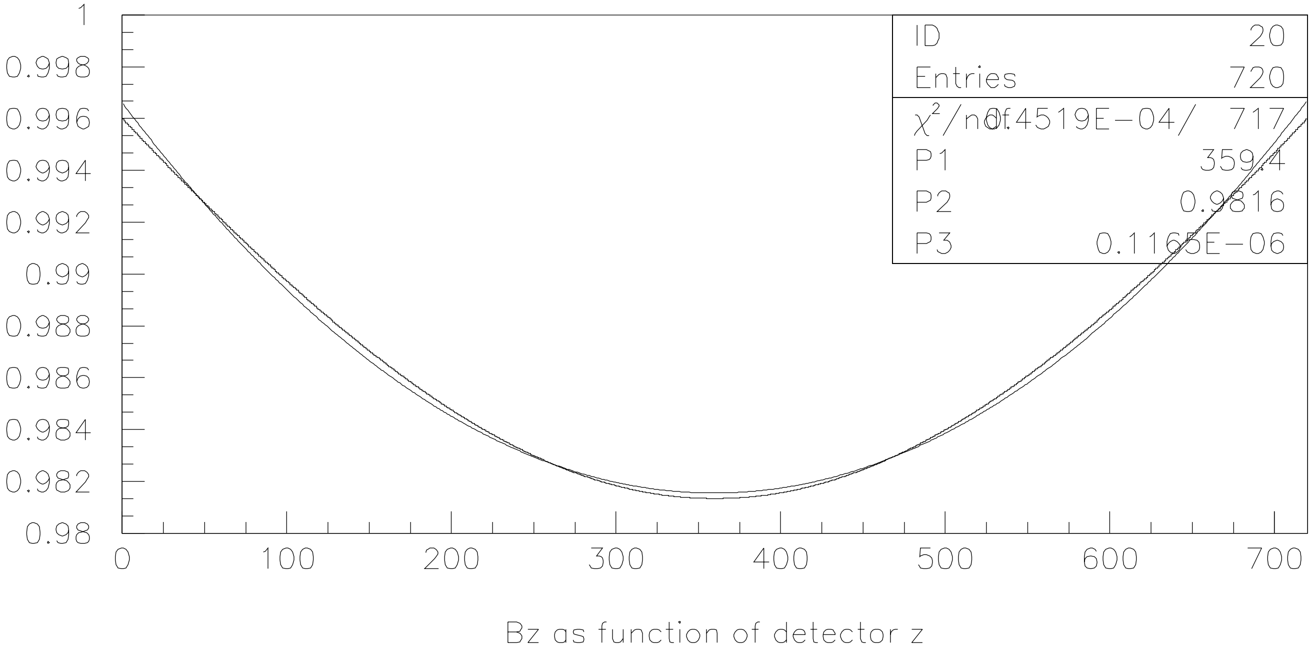
These two are same B-field (symmetry)

Centre Magnet (TPC centred)

Max. drift In LP

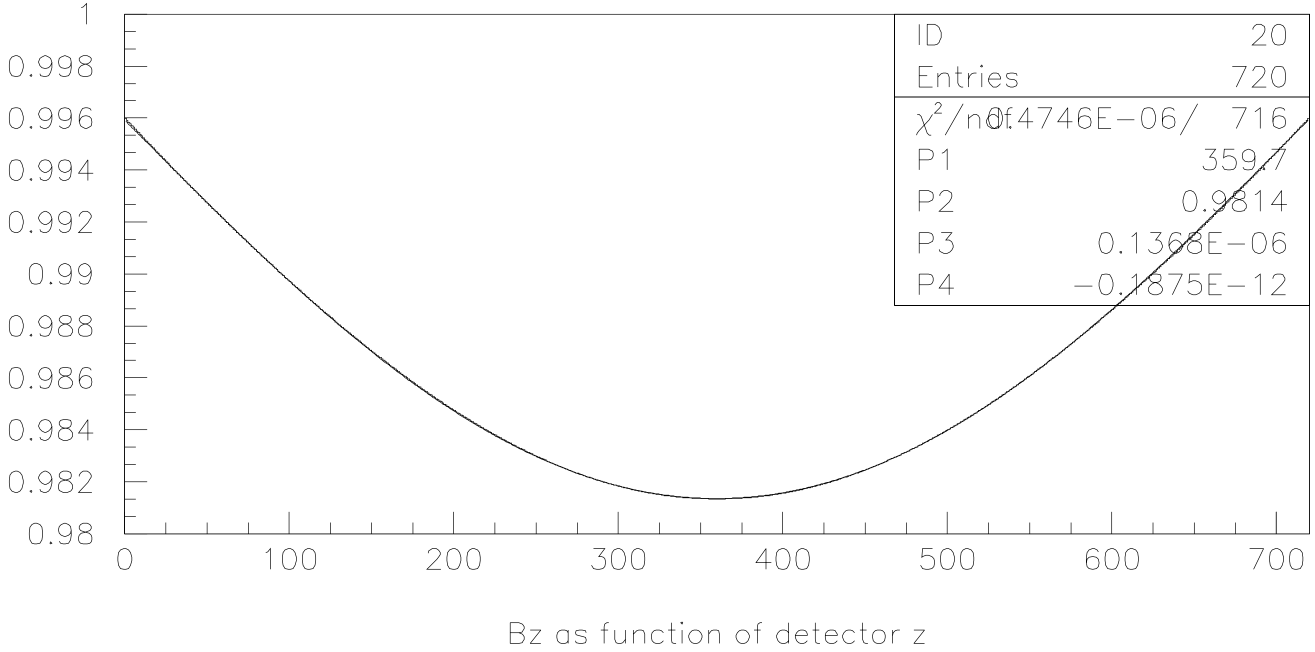
Bz as function of r at z=centre-of-magnet; Br at this z is 0 T





(symmetric) Quadratic fit to B-field

z is now along(!) the beam 'inside' LP;
At 'centre' of the magnet



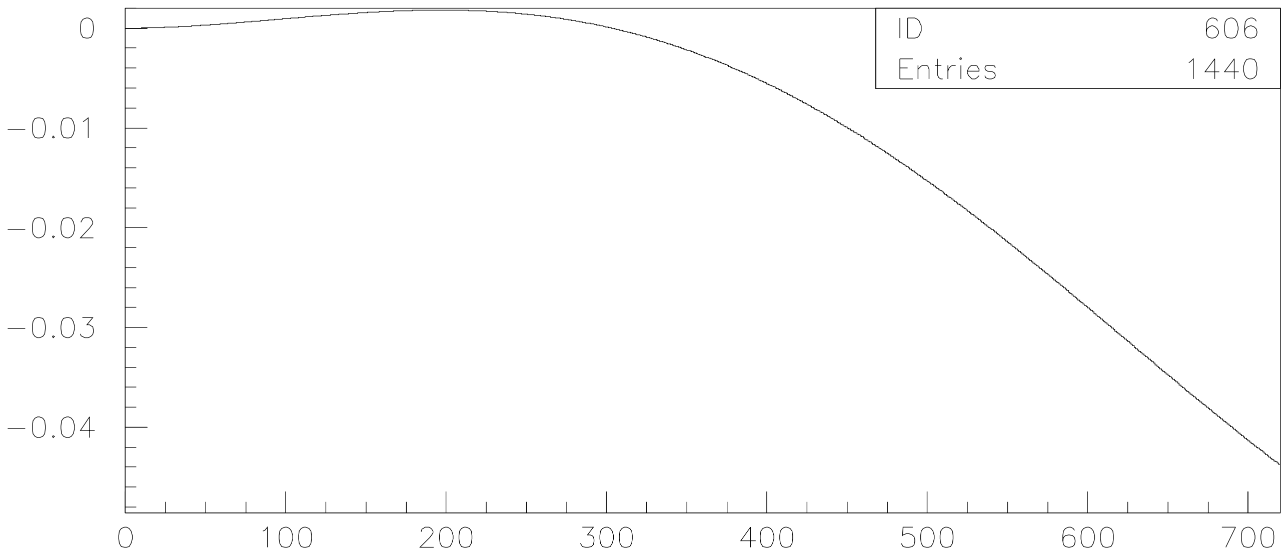
(symmetric) Quartic fit to B-field
So only z^2 and z^4 terms

```
 Detector name/positions:
 Entr      0.00
 Mim0    156.50
 Mim1    182.00
 Mim2    207.50
 TpxE    280.00
 TpxC    360.00
 TpxB    440.00
 Mim3    512.50
 Mim4    538.00
 Mim5    563.50

Entr
     B=1.000T  z=   0.00 beam posit. =     -0.000    -0.000    -0.000    -0.000    -0.000    -0.000
     B=0.990T  z=   0.00 beam posit. =     -0.000    -0.000    -0.000    -0.000    -0.000    -0.000
     B=0.980T  z=   0.00 beam posit. =     -0.000    -0.000    -0.000    -0.000    -0.000    -0.000
     Buse_map  z=   0.00 beam posit. =      0.000     0.000     0.000     0.000     0.000     0.000

Mim0
     B=1.000T  z= 156.50 beam posit. =     -3.676    -1.837    -1.225    -0.919    -0.735    -0.612
     B=0.990T  z= 156.50 beam posit. =     -3.640    -1.819    -1.213    -0.909    -0.728    -0.606
     B=0.980T  z= 156.50 beam posit. =     -3.603    -1.801    -1.200    -0.900    -0.720    -0.600
     Buse_map  z= 156.50 beam posit. =     -3.649    -1.824    -1.216    -0.912    -0.729    -0.608

Mim1
     B=1.000T  z= 182.00 beam posit. =     -5.000    -2.499    -1.666    -1.249    -0.999    -0.833
     B=0.990T  z= 182.00 beam posit. =     -4.950    -2.474    -1.649    -1.237    -0.989    -0.824
     B=0.980T  z= 182.00 beam posit. =     -4.900    -2.449    -1.632    -1.224    -0.979    -0.816
     Buse_map  z= 182.00 beam posit. =     -4.961    -2.479    -1.653    -1.239    -0.991    -0.826

Mim2
     B=1.000T  z= 207.50 beam posit. =     -6.465    -3.230    -2.153    -1.615    -1.292    -1.077
     B=0.990T  z= 207.50 beam posit. =     -6.401    -3.198    -2.132    -1.599    -1.279    -1.066
     B=0.980T  z= 207.50 beam posit. =     -6.336    -3.166    -2.110    -1.583    -1.266    -1.055
     Buse_map  z= 207.50 beam posit. =     -6.411    -3.203    -2.135    -1.601    -1.281    -1.068

TpxE
     B=1.000T  z= 280.00 beam posit. =    -11.824    -5.904    -3.935    -2.951    -2.361    -1.967
     B=0.990T  z= 280.00 beam posit. =    -11.705    -5.845    -3.896    -2.922    -2.337    -1.948
     B=0.980T  z= 280.00 beam posit. =    -11.587    -5.786    -3.856    -2.892    -2.314    -1.928
     Buse_map  z= 280.00 beam posit. =    -11.710    -5.847    -3.897    -2.923    -2.338    -1.948

TpxC
     B=1.000T  z= 360.00 beam posit. =    -19.552    -9.755    -6.500    -4.875    -3.899    -3.249
     B=0.990T  z= 360.00 beam posit. =    -19.356    -9.657    -6.435    -4.826    -3.860    -3.217
     B=0.980T  z= 360.00 beam posit. =    -19.159    -9.559    -6.370    -4.777    -3.821    -3.184
     Buse_map  z= 360.00 beam posit. =    -19.339    -9.649    -6.430    -4.822    -3.857    -3.214

TpxB
     B=1.000T  z= 440.00 beam posit. =    -29.236   -14.570    -9.707    -7.279    -5.822    -4.852
     B=0.990T  z= 440.00 beam posit. =    -28.941   -14.424    -9.610    -7.206    -5.764    -4.803
     B=0.980T  z= 440.00 beam posit. =    -28.646   -14.278    -9.513    -7.133    -5.706    -4.755
     Buse_map  z= 440.00 beam posit. =    -28.885   -14.396    -9.592    -7.192    -5.753    -4.794

Mim3
     B=1.000T  z= 512.50 beam posit. =    -39.636   -19.729   -13.142    -9.854    -7.882    -6.568
     B=0.990T  z= 512.50 beam posit. =    -39.235   -19.531   -13.010    -9.755    -7.803    -6.502
     B=0.980T  z= 512.50 beam posit. =    -38.834   -19.333   -12.879    -9.656    -7.724    -6.436
     Buse_map  z= 512.50 beam posit. =    -39.131   -19.481   -12.977    -9.730    -7.783    -6.485

Mim4
     B=1.000T  z= 538.00 beam posit. =    -43.787   -21.785   -14.510   -10.879    -8.702    -7.251
     B=0.990T  z= 538.00 beam posit. =    -43.343   -21.567   -14.365   -10.770    -8.615    -7.179
     B=0.980T  z= 538.00 beam posit. =    -42.900   -21.348   -14.220   -10.661    -8.528    -7.106
     Buse_map  z= 538.00 beam posit. =    -43.220   -21.506   -14.325   -10.740    -8.591    -7.159

Mim5
     B=1.000T  z= 563.50 beam posit. =    -47.977   -23.858   -15.890   -11.913    -9.529    -7.940
     B=0.990T  z= 563.50 beam posit. =    -47.490   -23.619   -15.731   -11.794    -9.434    -7.861
     B=0.980T  z= 563.50 beam posit. =    -47.004   -23.380   -15.572   -11.675    -9.338    -7.781
     Buse_map  z= 563.50 beam posit. =    -47.347   -23.549   -15.684   -11.759    -9.406    -7.838
```

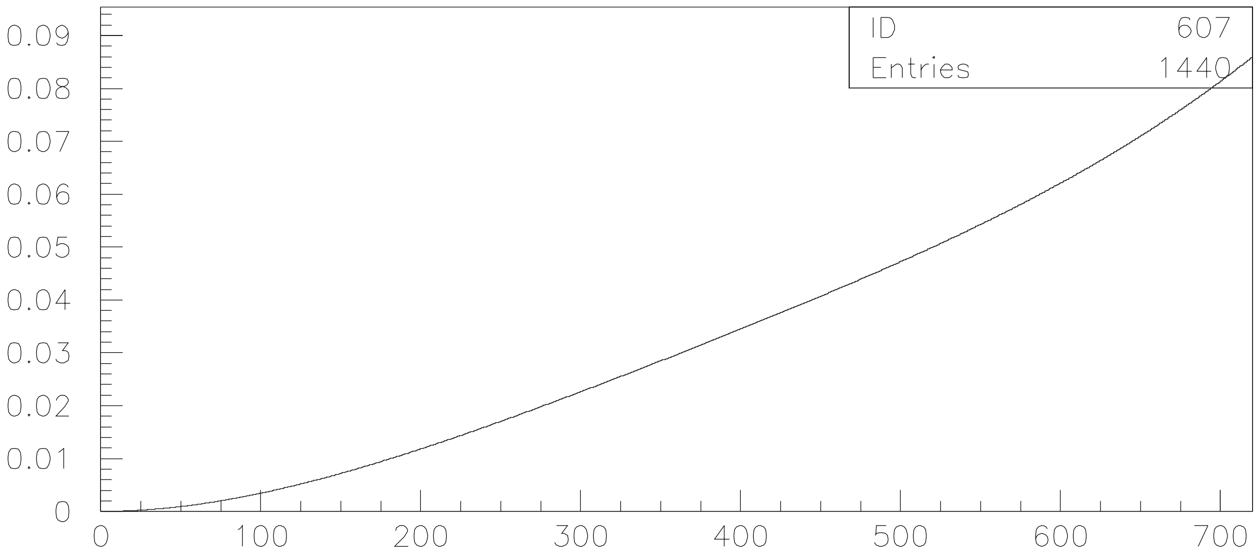
Beam deflections at the various detectors:

1. B=1.000 T
2. B=0.990 T
3. B=0.980 T
4. Use B-map info

At 6 beam momenta = 1, 2, 3, 4, 5, 6 GeV



Difference track position for B=0.990 T and B-map at p=6 GeV



Difference track position for B=0.980 T and B-map at p=6 GeV

But don't forget that beam momentum has long tail towards lower momentum down to even 1 GeV

From Martin Ljunggren's Master thesis (Lund, 2011)

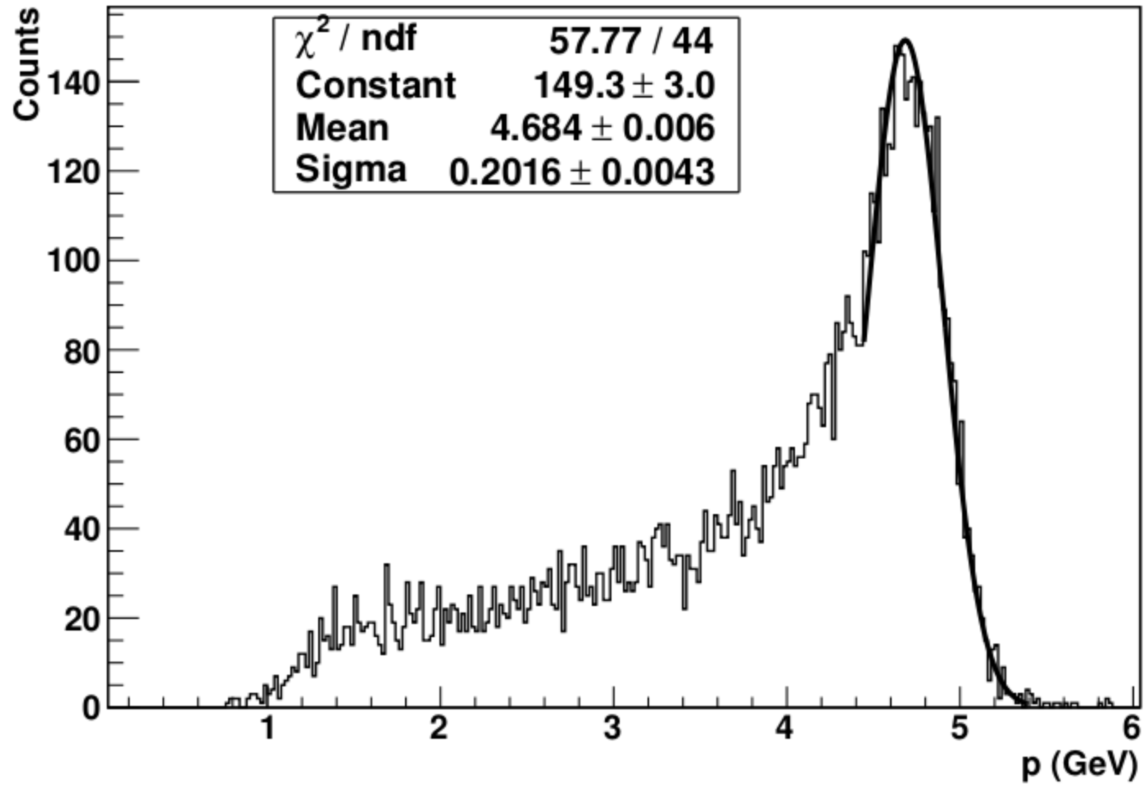
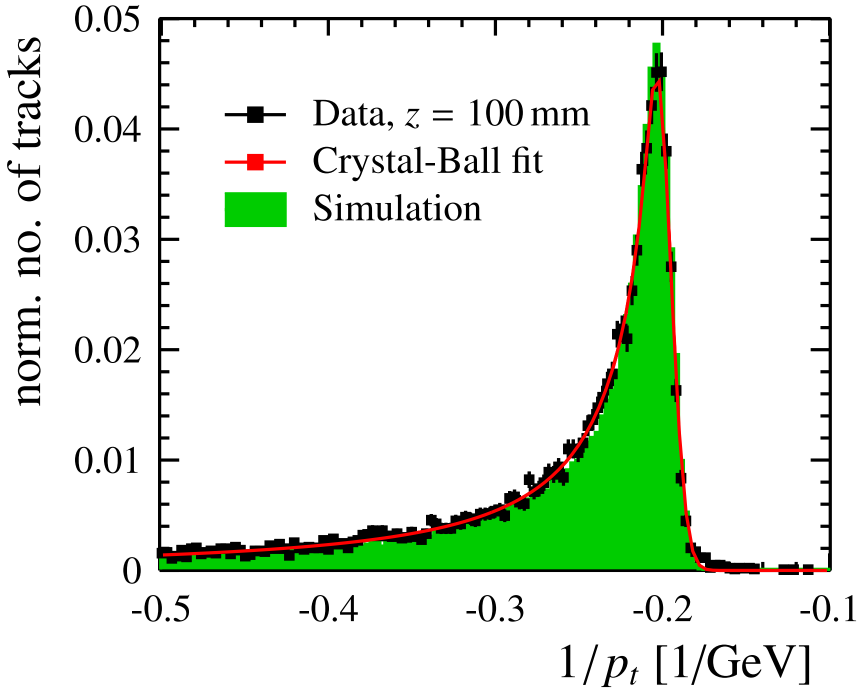
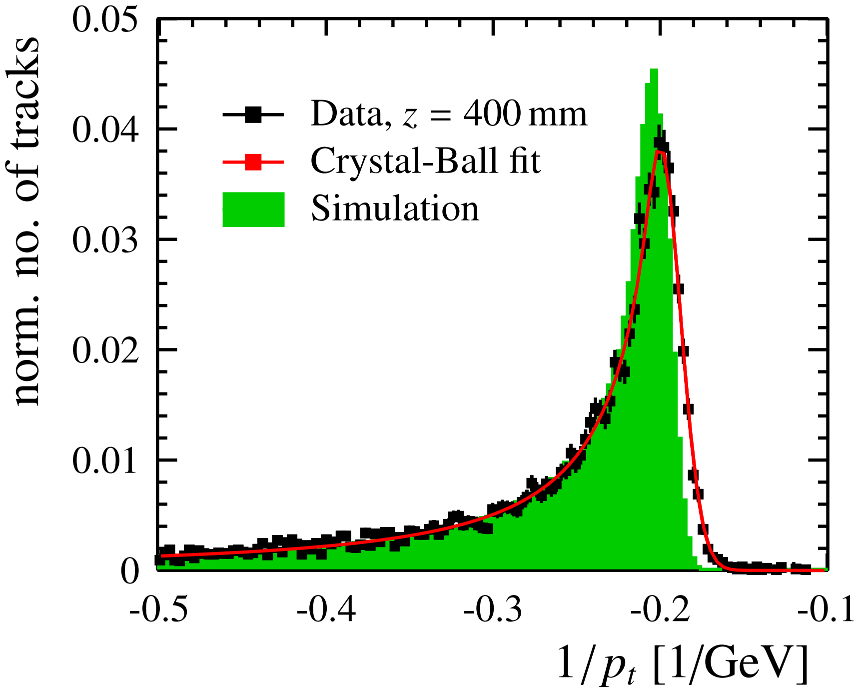


Figure 7.35: Momentum distribution from a run with a magnetic field of 1T and a drift distance of 150mm.

From Felix Mueller's PhD thesis (Hamburg/DESY, 2016)



(a) z = 100 mm



(b) z = 400 mm

Figure 6.38: Comparison of the particle momentum distribution derived from data (black) and simulation (green) for two different drift distances. The Crystal-Ball function is fitted to the data to determine the momentum resolution from the Gaussian part of the function.

Few concluding remarks (some (all?) of them well known):

- PCMAG B field is NOT uniform (we know)
- When using EUDET/AIDA beam telescope (precision ~ 5 µm) one has (probably) to take B-field map into account. But it is good to have 5 µm track reference precision in our GridPix beam test.
- This may also become important when using Lycoris (sitting in area of large B_r)

- LP tracks over full radial acceptance (r = +/- 360 mm) are NOT a circle (becomes significant at lower momenta, which are present in the beam at e.g. 5 GeV).

Have to make momentum cut in resolution studies (also to limit track angle

effects at large radius)