Simulations in the analysis of experimental data measured by BM@N drift chambers

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BM@N - **B**aryonic **M**atter at **N**uclotron

The experiment is aimed at the study of hot compressed nuclear matter produced in collisions of heavy nuclei with emphasis put on strange matter production.

- Fixed target experiment;
- JINR Nuclotron is capable to accelerate heavy-ion beams with energies from 1 to 6 GeV per nucleon;
- Various nuclei up to Au are to be used as target or projectile nuclei – p, d, C, Ar, Cu, Xe, Au, etc.

BM@N experimental layout:
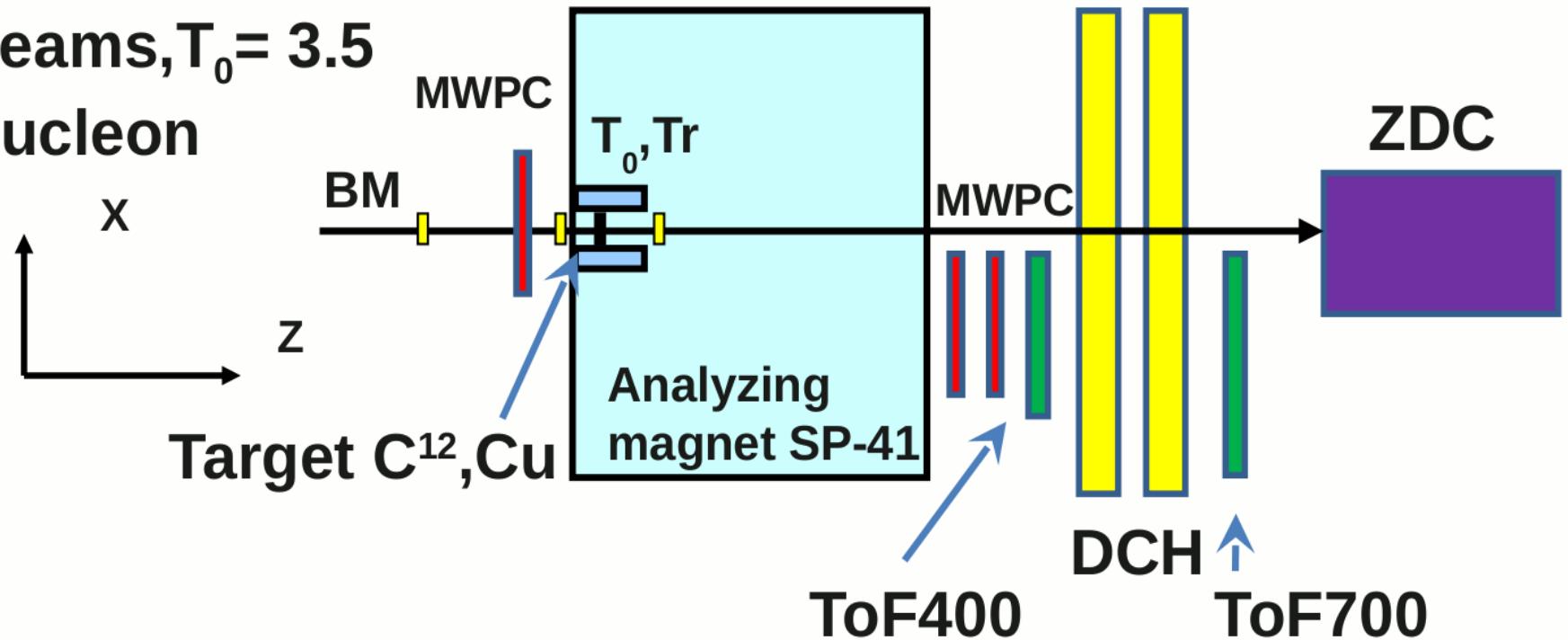
Drift chambers (DCH) main characteristics:
- tracking detector;
- two identical chambers, placed outside the magnetic field;
- octagonal shape with edge length 120 cm, fiducial area about 4.5 m^2;
- each chamber consists of 4 segments filled with working gas (70/30% mixture of Ar and CO_2);
- there are two planes consisting of 256 wires placed in each segment.

DCH measured variable: electron drift time to anodes

Data processing chain:

electron drift time ➔ distance of closest approach (calibration) ➔
➔ detector hits: x,y,z (calculations) ➔ particle track (fitting, track finding)

Correction procedures:

1.) Corrections of radius-time calibration curve ➔ autocalibration;
2.) Corrections for the uncertainties of detector positions (and inclination angles) ➔ alignment (local: DCH2 aligned to DCH1 and global: DCH1 aligned according to beam).

It is reasonable to tune up the presented analysis technique on pure beam data, i.e. without target.
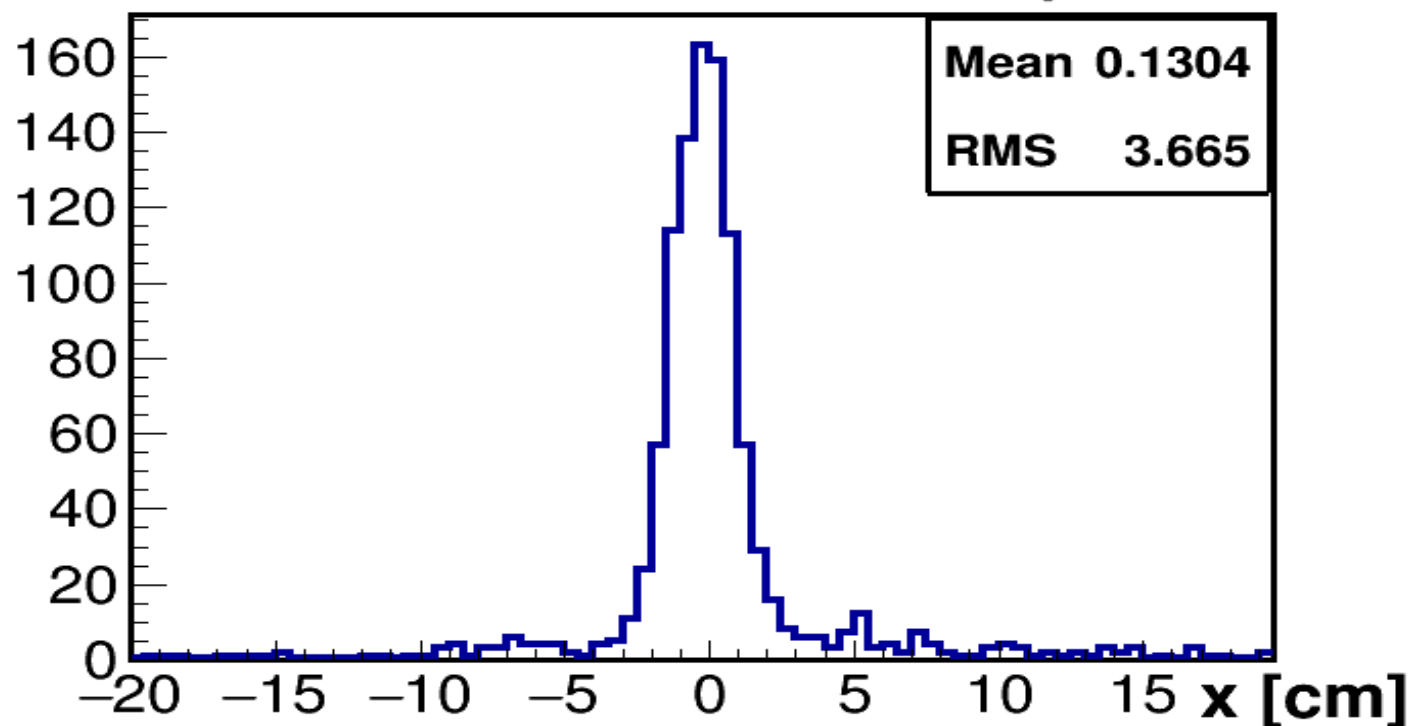
Check1: Using GEANT, the reconstructed experimental tracks are traced backward to the point where their deflection begins. If everything is O.K. then: coordinates $x,y \rightarrow 0$ and momentum components $p_x, p_y \rightarrow 0$, $p_z \rightarrow p_{beam}$.
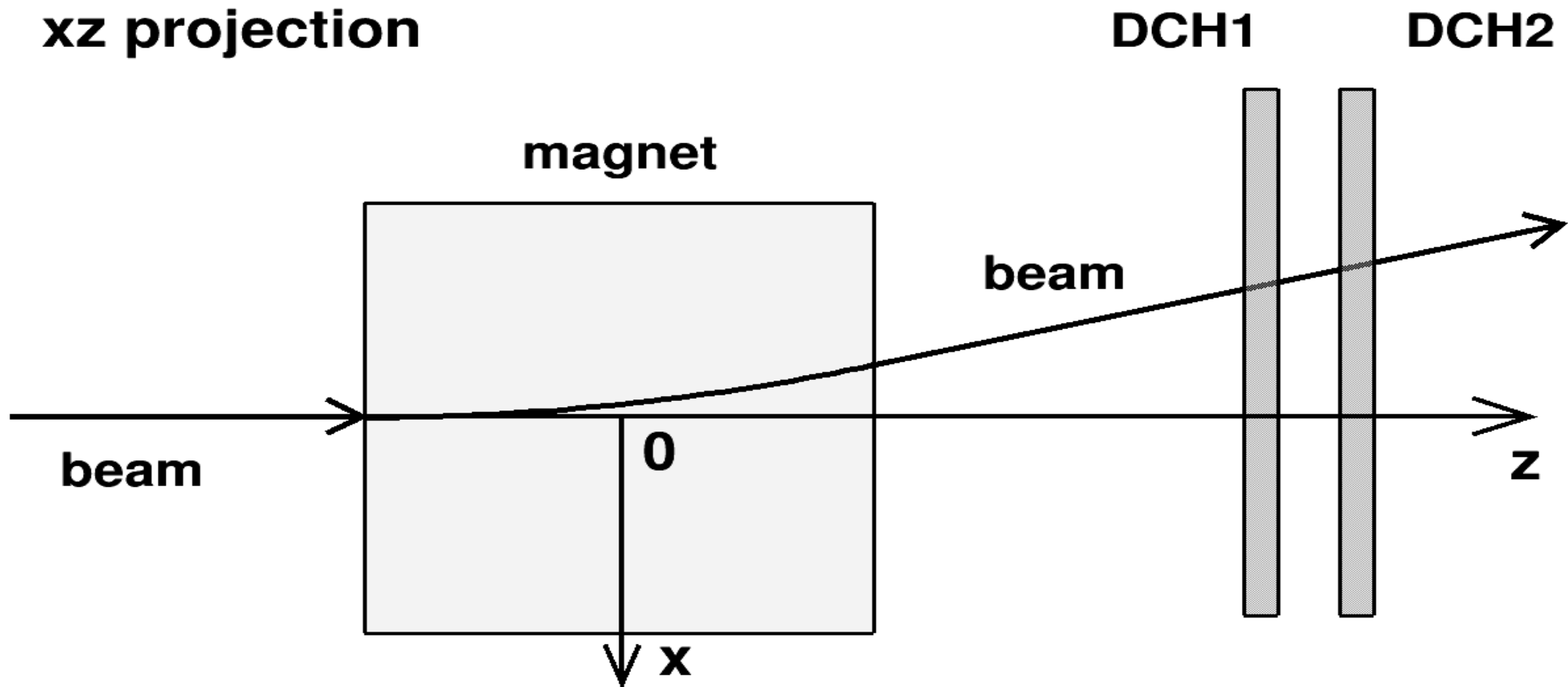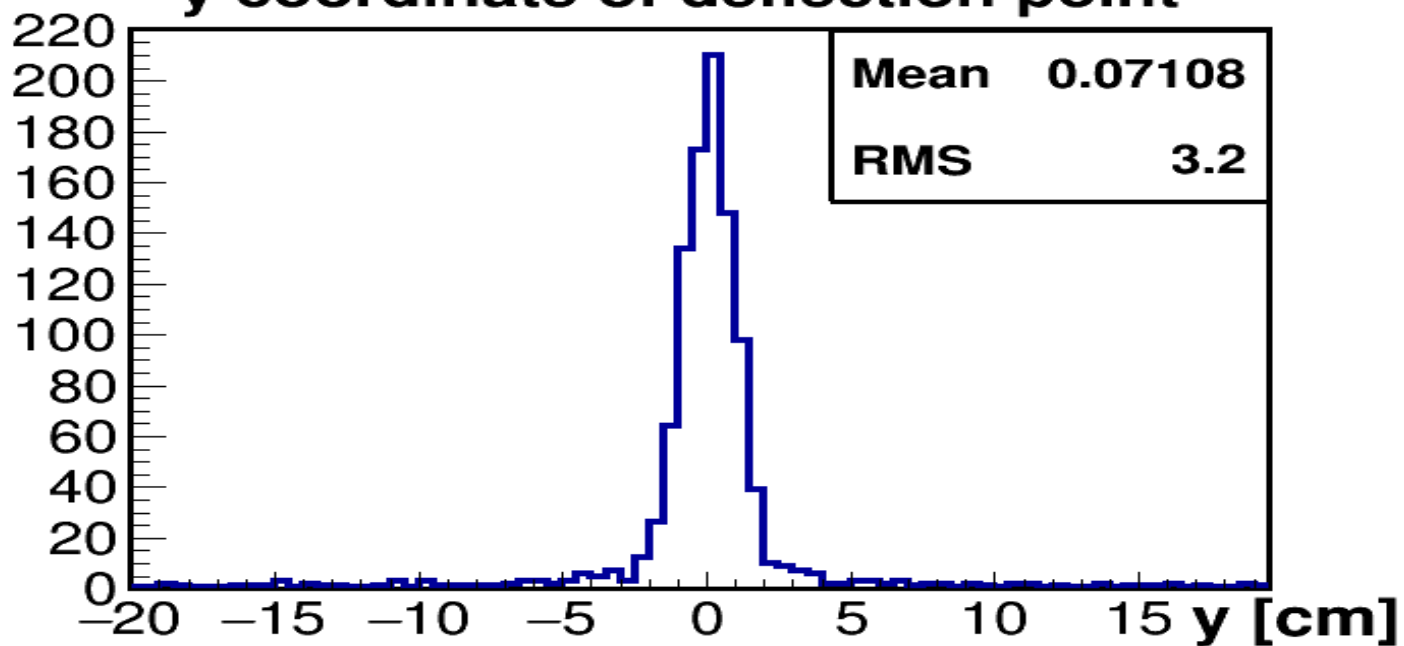
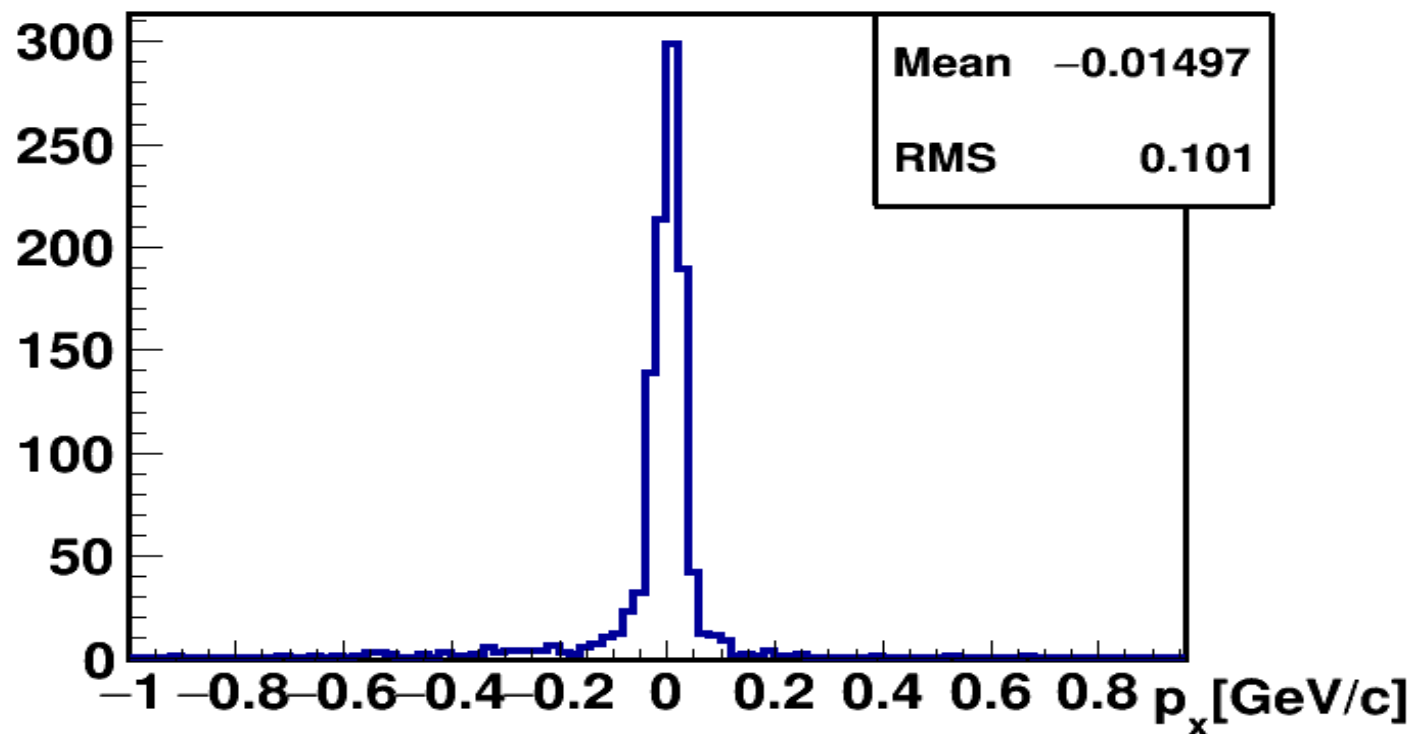Example for typical run from deuteron beam data,
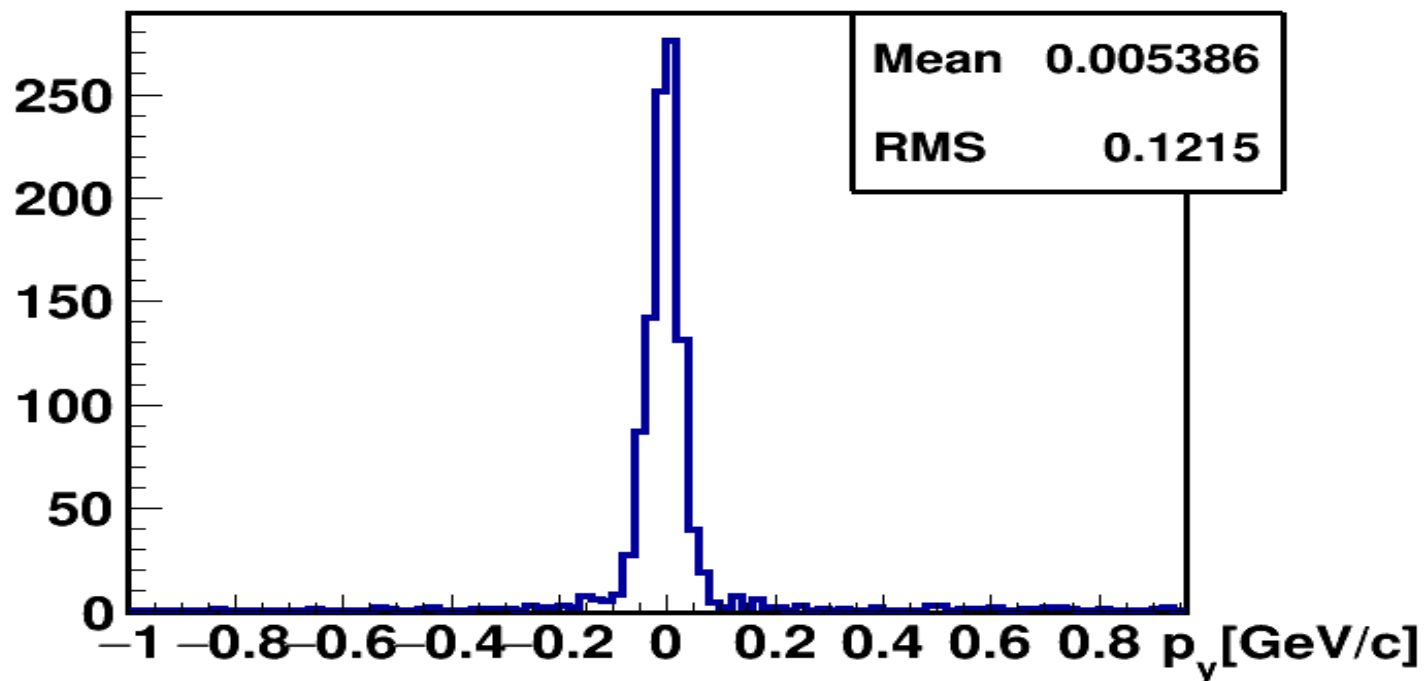p_{beam} = 8.68 GeV/c

x component of beam momentum at deflection point

| Mean | −0.01497 |
| RMS | 0.101 |

y component of beam momentum at deflection point

| Mean | 0.005386 |
| RMS | 0.1215 |

z component of beam momentum at deflection point

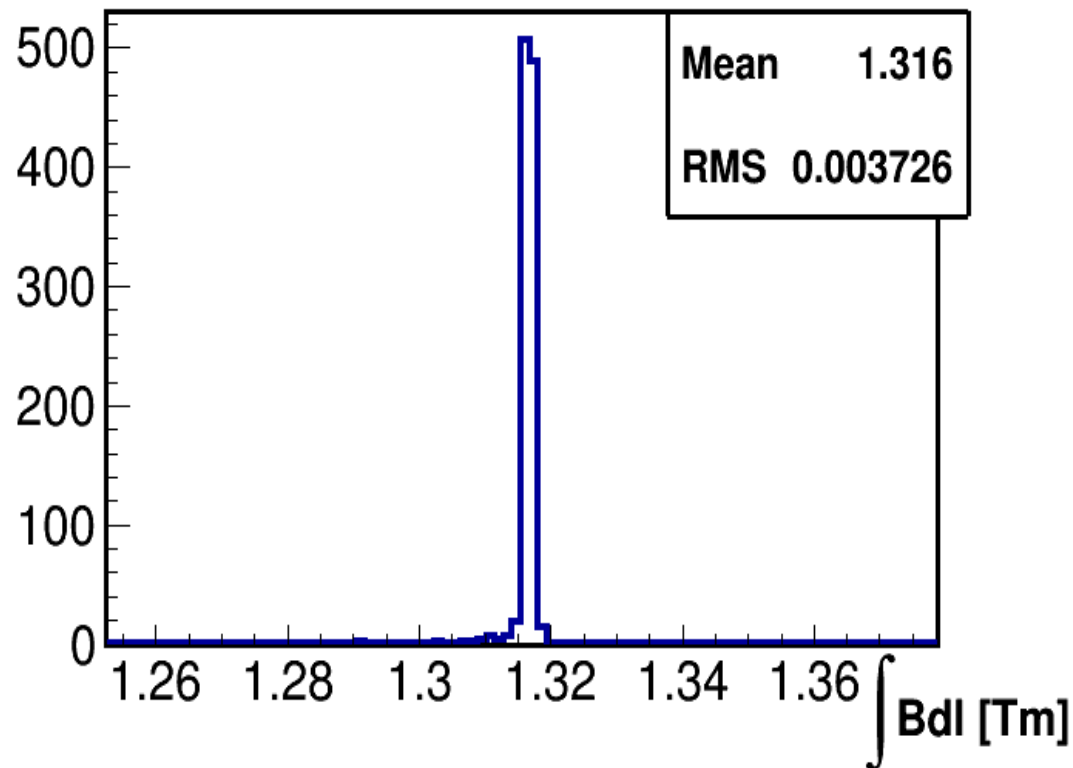Mean   8.673

RMS   0.01069

p_z[GeV/c]
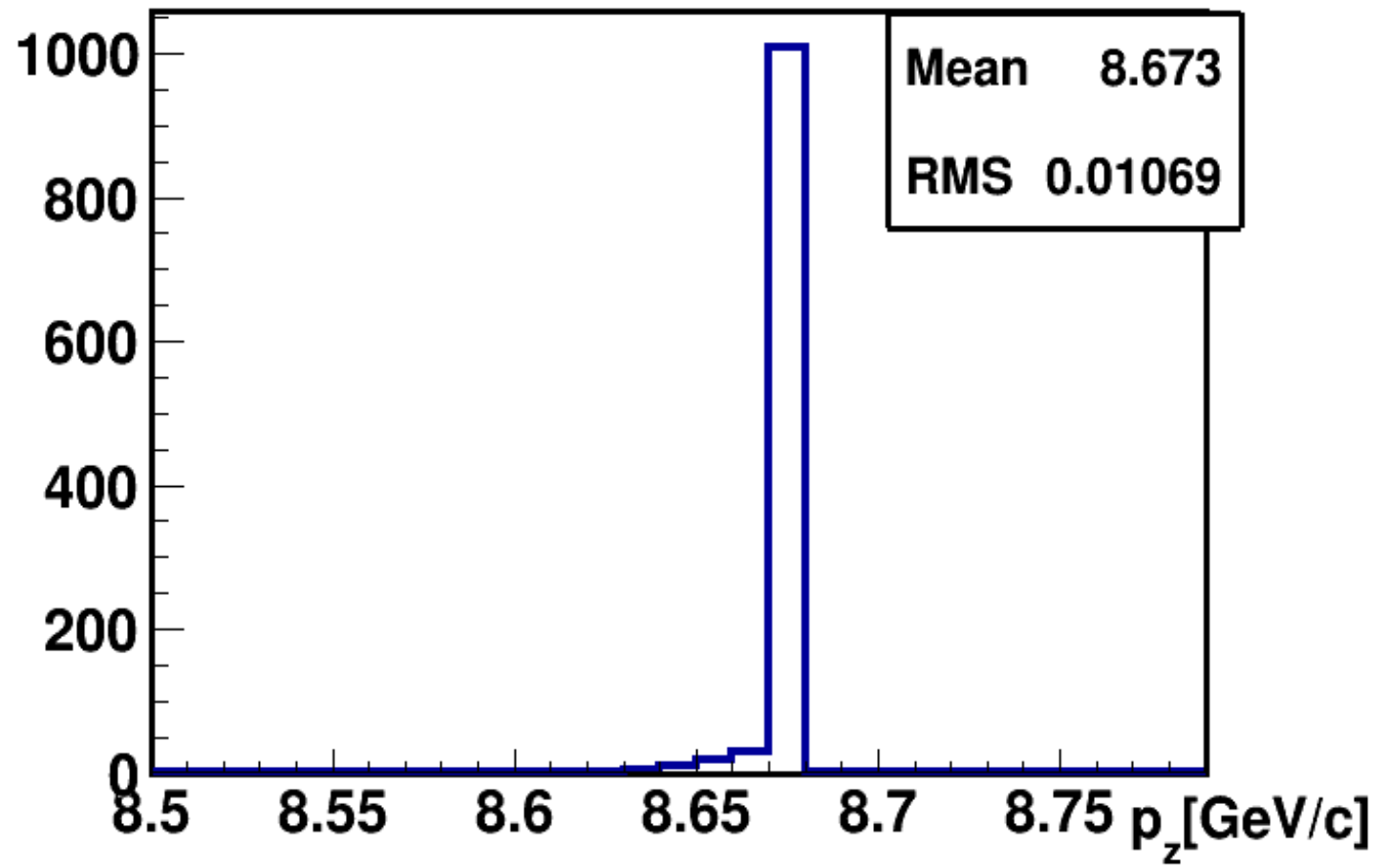
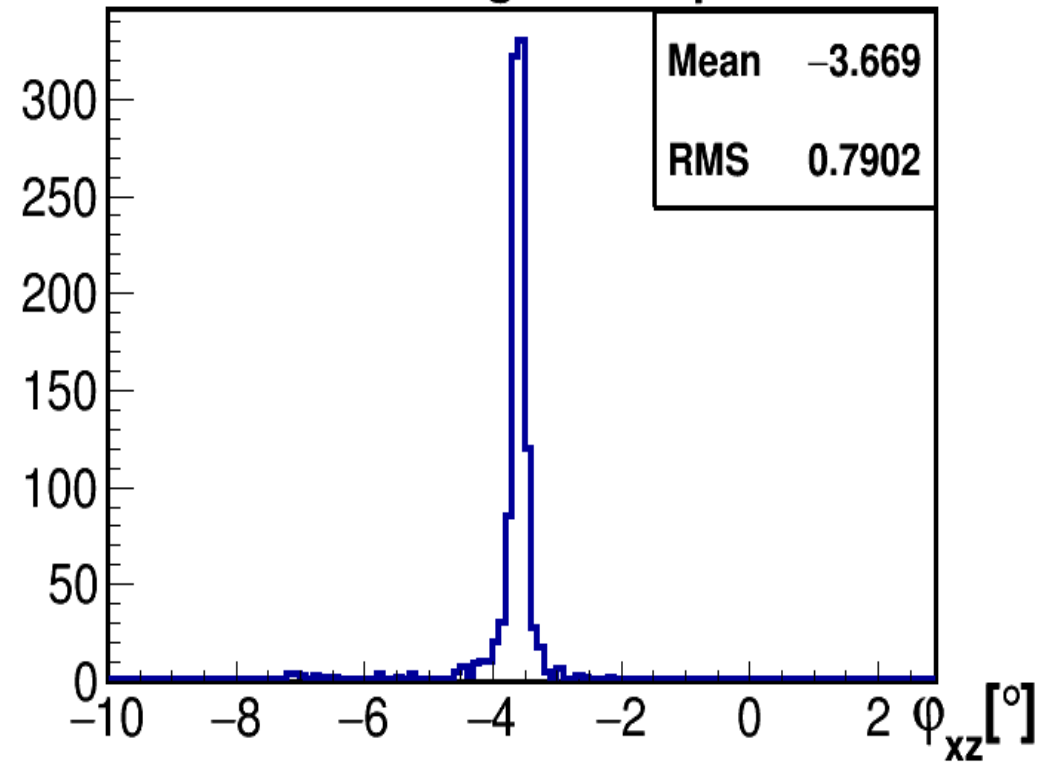# Check2:   momentum reconstruction of deuteron beam

Deflection of beam by magnetic field in *xz* plane is described by angle φ_{xz} which depends on magnetic field integral and beam momentum **p**:

$$\varphi_{xz}(rad) = q\frac{\int Bdl}{p} \quad \Rightarrow \quad p = q\frac{\int Bdl}{\varphi_{xz}}$$

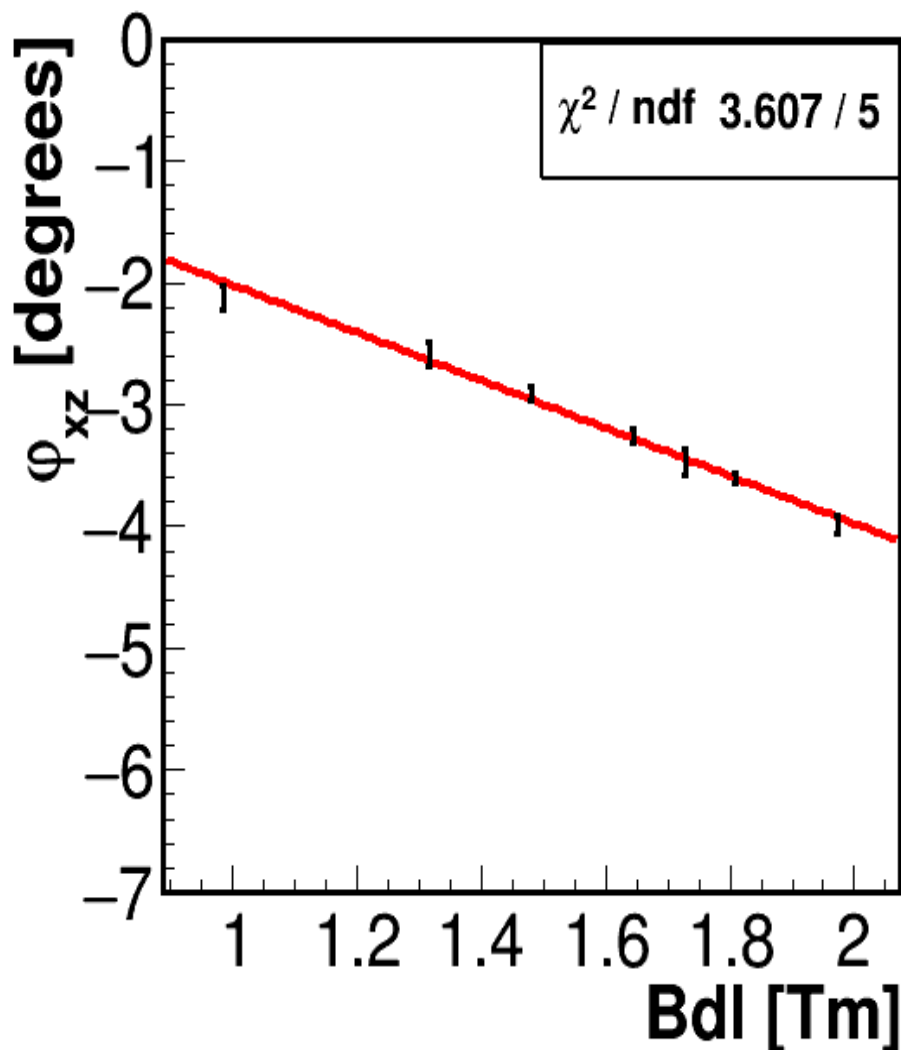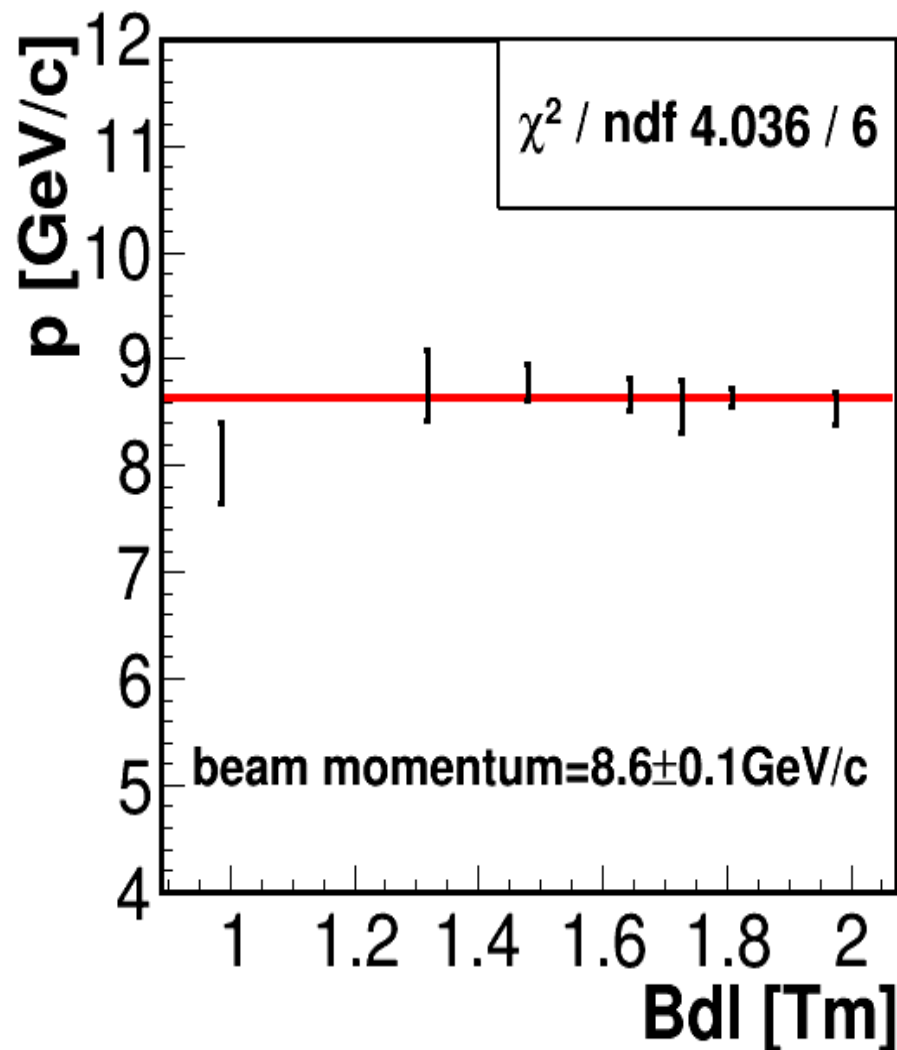**integral of By component of mag. field**

Mean	1.316
RMS	0.003726

$\int Bdl$ [Tm]

deflection angle in xz plane

Mean	−3.669
RMS	0.7902

φ_{xz}[°]

DCH xz beam angle vs magnetic field integral

χ^2 / ndf 3.607 / 5

φ_{xz} [degrees] vs Bdl [Tm]

deuteron momentum vs magnetic field integral

χ^2 / ndf 4.036 / 6

beam momentum=8.6±0.1GeV/c

p [GeV/c] vs Bdl [Tm]

Nominal deuteron momentum value: **8.68 GeV/c**, i.e. the reconstructed and nominal momenta seem consistent.

Summary:

1) Complex track reconstruction algorithm for the BM@N drift chambers was proposed, programmed and tested.
2) GEANT simulations were included in the testing procedures.
3) The basic checks were based on the reconstruction of the initial deuteron beam kinematic and geometric characteristics – momentum components and *x,y* coordinates.
4) The reconstructed values seem consistent with the expected ones.