

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

DIRAC Note 2008-05  
March 25, 2008

# **On the polynomial calculations which are used in ARIANE instead of magnetic map**

O.Gorchakov

GENEVA  
2008

# 1 Preface

The aim of this work was to recalculate the polynomials which are used in ARIANE in the cases when it needs to bind the particle coordinates before the magnet and after the magnet. The recalculation is needed due to some changes of DIRAC-II setup acceptance. In principle there is a common method for it -a propagation of particle through the field using the existing magnetic map but this method consumes a lot of CPU time and it was decided to use in ARIANE the polynomials which allow to find the coordinates, directions and momentum of the particle via the polynomials which depend on particle coordinates and space directions behind the magnet.

The following polynomials(tables) were obtained:

1. To calculate the  $p_x, p_y, p_z$  momentum components of the particle which it has when it is created in the target. This polynomial depends on  $x, y, \tan(\theta_x)$ , and  $\tan(\theta_y)$  at the level of vacuum membrane.
2. To calculate  $\tan(\theta_y)$  as function of  $x, y$  and  $\tan(\theta_x)$ .
3. To calculate  $T_i(T_i = x, y, \tan(\theta_x), \text{ and } \tan(\theta_y))$  at the level  $z=-500\text{cm}$ (it's about fiber detector)) as function of momentum,  $x, y, \tan(\theta_x)$ , and  $\tan(\theta_y)$  at the level of vacuum membrane.
4. To calculate the covariant matrix  $R_{T_i T_j}$  as function of particle momentum.
5. The 5-dimensional table which determines the allowed 5-dimensional regions of momentum,  $x, y, \tan(\theta_x)$ , and  $\tan(\theta_y)$  at the level of vacuum membrane.

# 2 Results

To obtain all of these polynomials we needed to simulate some(huge) number of particle tracks. This was done by GEANT-DIRAC version where the DIRAC-II changes were taken into account. There were simulated two samples of tracks: they start from target and they start from the plane at  $z=-500\text{cm}$  with the momentum between 0.9 and 11 GeV/c. The tracks were accepted if they passed through the vacuum membrane, at least four drift chambers, horizontal and vertical hodoscopes. For the first sample also it was needed to pass through the fiber detector.

## 2.1 The $p_x, p_y, p_z$ and $\tan(\theta_y)$ approximation.

To approximate the each of three projections of particle momentum the length of polynomial was chosen to be of 101 ,the fitting was done separately for  $p < 5\text{GeV}/c$  and  $p > 5\text{GeV}/c$ . For case of  $\tan(\theta_y)$  the polynomial length was 35. The results of fitting are shown on Fig. 1-4. On Fig.1 the values of  $\delta p_x$ ,  $\delta p_z$ ,  $\delta p_z$  and  $\delta \tan(\theta_y)$ (the negative particles) are shown, where the  $\delta$  means the difference between the Monte-Carlo values and values calculated by fitting polynomial. On Fig.2 the values of  $\sigma$  of these four parameters(  $\delta p_x$ ,  $\delta p_z$ ,  $\delta p_z$  and  $\delta \tan(\theta_y)$ ) are shown in the dependence of particle momentum. On Fig.3 ,4 the results for positive particle case are shown. The corresponding momentum distributions are shown on Fig.9(top distributions).

## 2.2 The $x, y, \tan(\theta_x)$ , and $\tan(\theta_y)$ at the level $z=-500\text{cm}$ approximation.

To approximate the each of these values the length of polynomial was chosen to be of 475, the momentum interval was divided into 10 subintervals and the fitting was carried for each of them separately. The results of fitting are shown on Fig. 5-8. On Fig.5 the values of  $\delta x$ ,  $\delta y$ ,  $\delta \tan(\theta_x)$ , and  $\delta \tan(\theta_y)$ (the negative particles) are shown. On Fig.6 the values of  $\sigma$  of these four parameters(  $\delta x$ ,  $\delta y$ ,  $\delta \tan(\theta_x)$ , and  $\delta \tan(\theta_y)$ ) are shown in the dependence of particle momentum. On Fig.7 ,8 the results for positive particle case are shown. The corresponding momentum distributions are shown on Fig.9(bottom distributions).

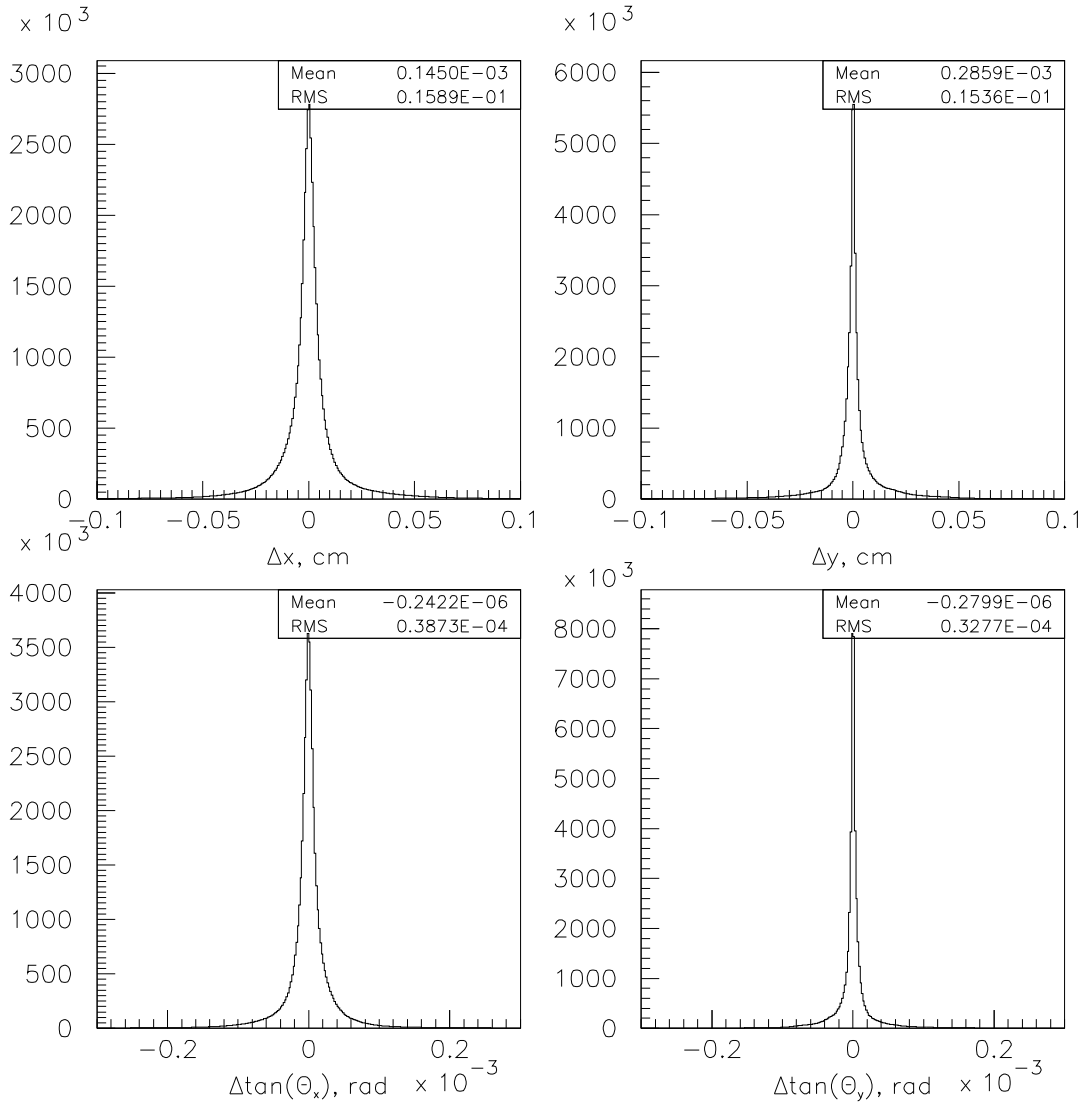


Figure 1: *The distributions of  $\delta p_x$ ,  $\delta p_z$ ,  $\delta p_z$  and  $\delta \tan(\theta_y)$  (the negative particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.*

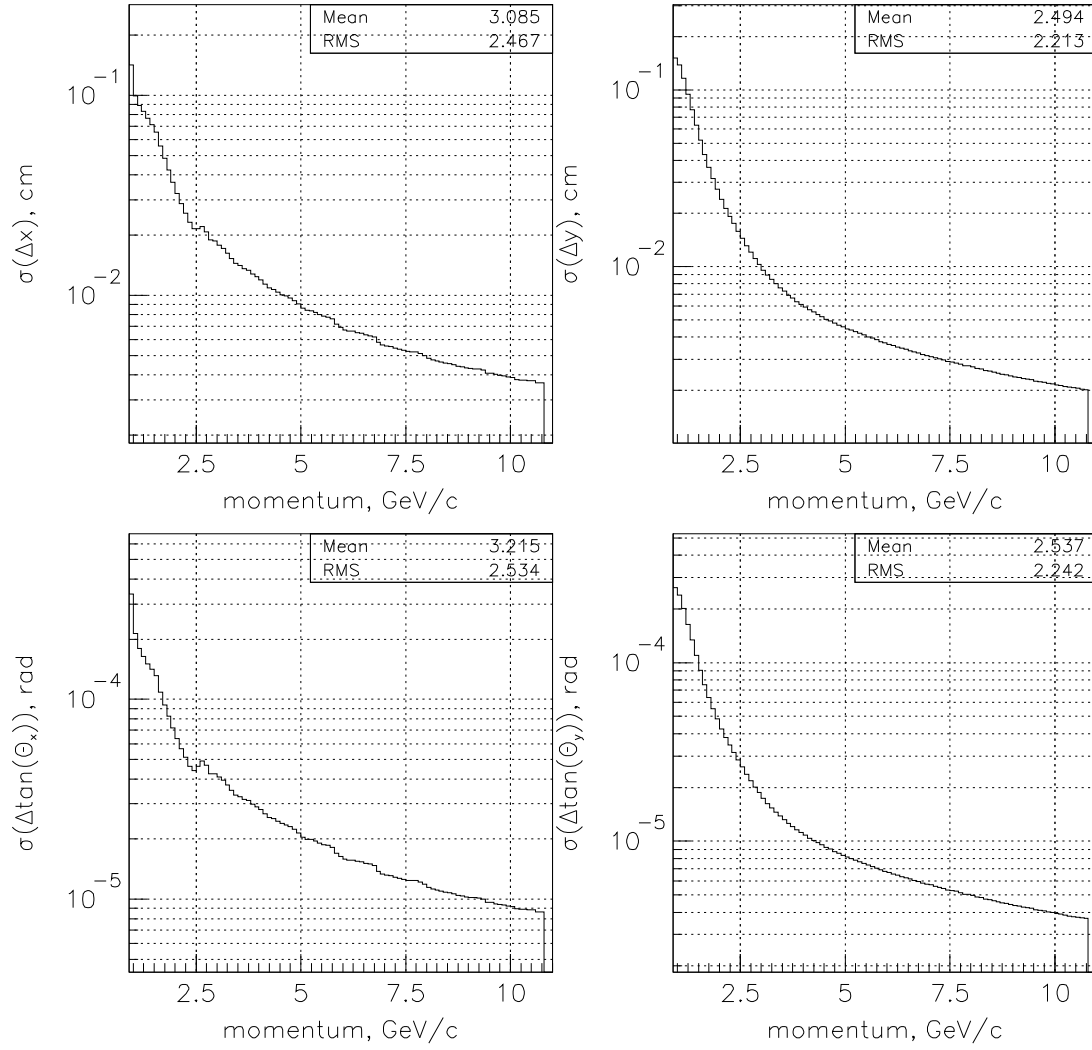


Figure 2: The distributions of  $\sigma(\delta p_x)$ ,  $\sigma(\delta p_z)$ ,  $\sigma(\delta p_z)$  and  $\sigma(\delta \tan(\theta_y))$  (the negative particles) in the dependence of particle momentum.

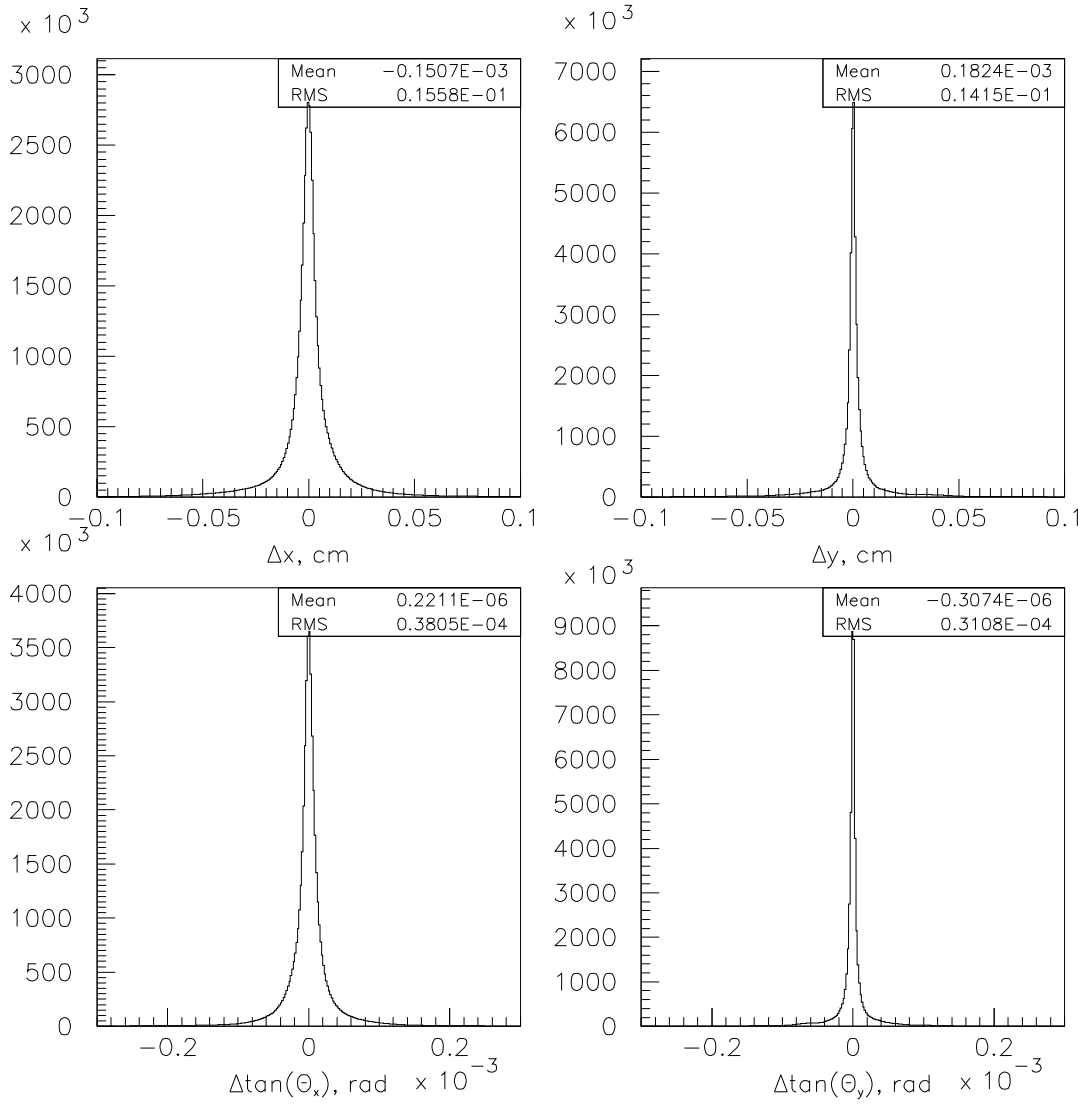


Figure 3: The distributions of  $\delta p_x$ ,  $\delta p_z$ ,  $\delta p_z$  and  $\delta \tan(\theta_y)$  (the positive particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.

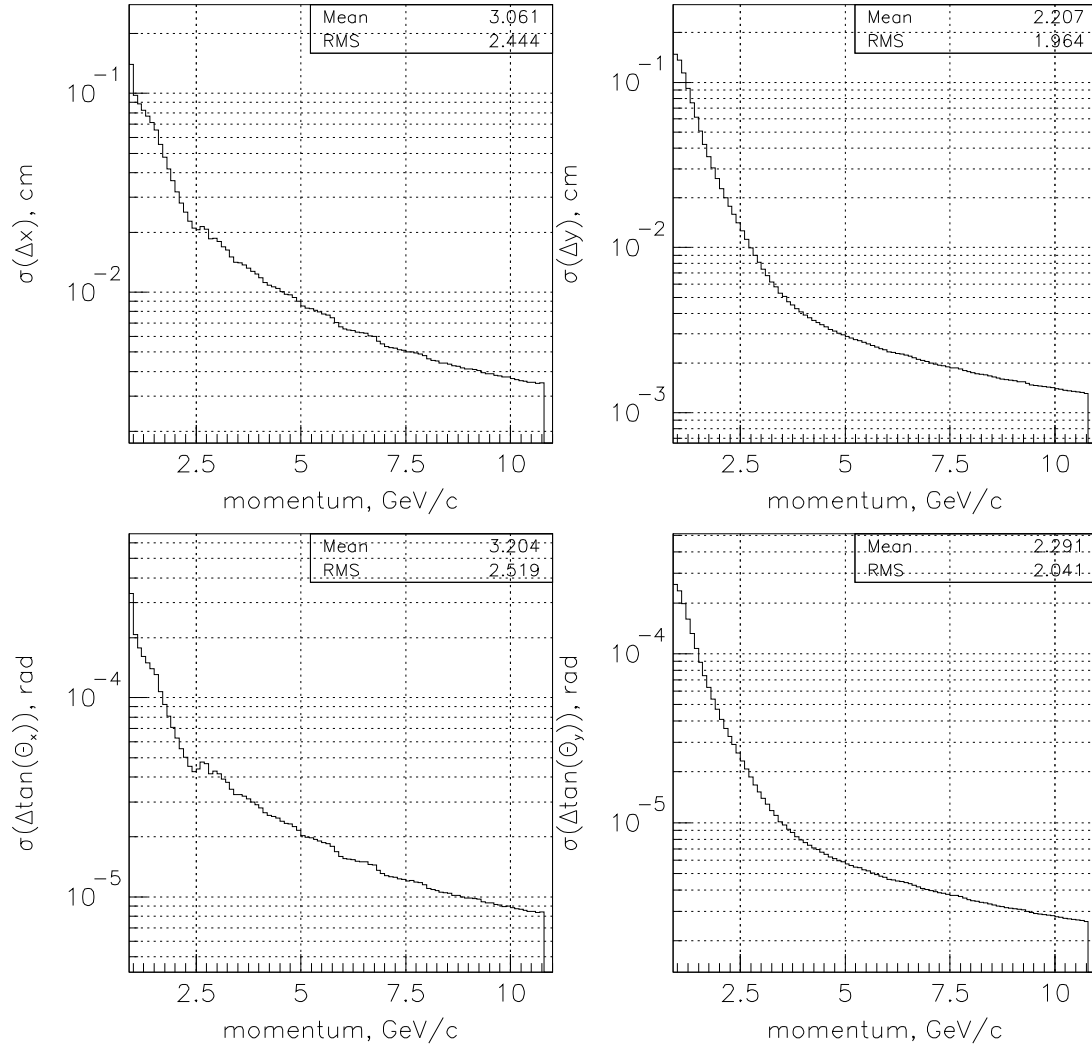


Figure 4: The distributions of  $\sigma(\delta p_x)$ ,  $\sigma(\delta p_z)$ ,  $\sigma(\delta p_z)$  and  $\sigma(\delta \tan(\theta_y))$  (the positive particles) in the dependence of particle momentum.

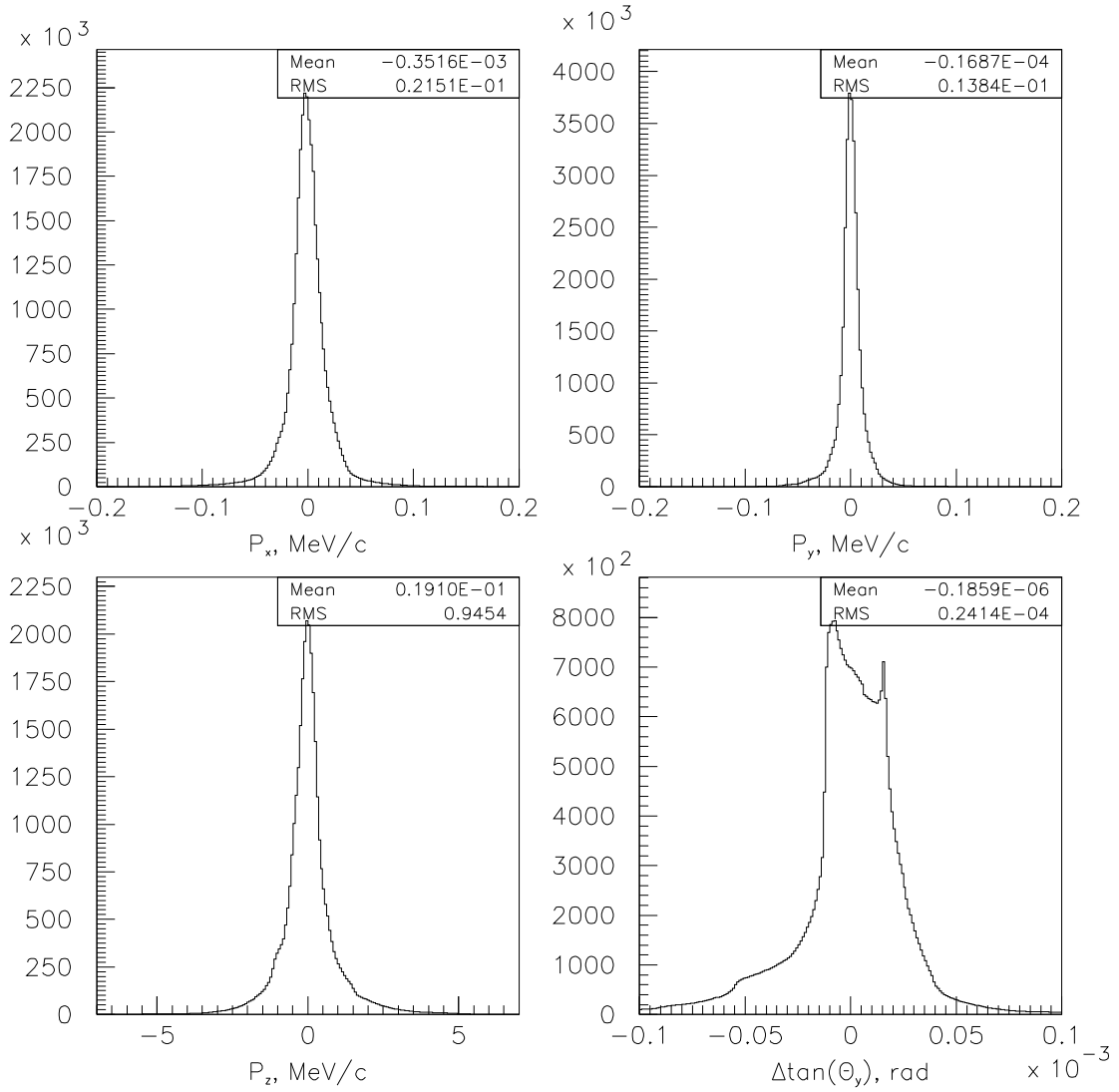


Figure 5: The distributions of  $\delta x$ ,  $\delta y$ ,  $\delta \tan(\theta_x)$ , and  $\delta \tan(\theta_y)$  (the negative particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.



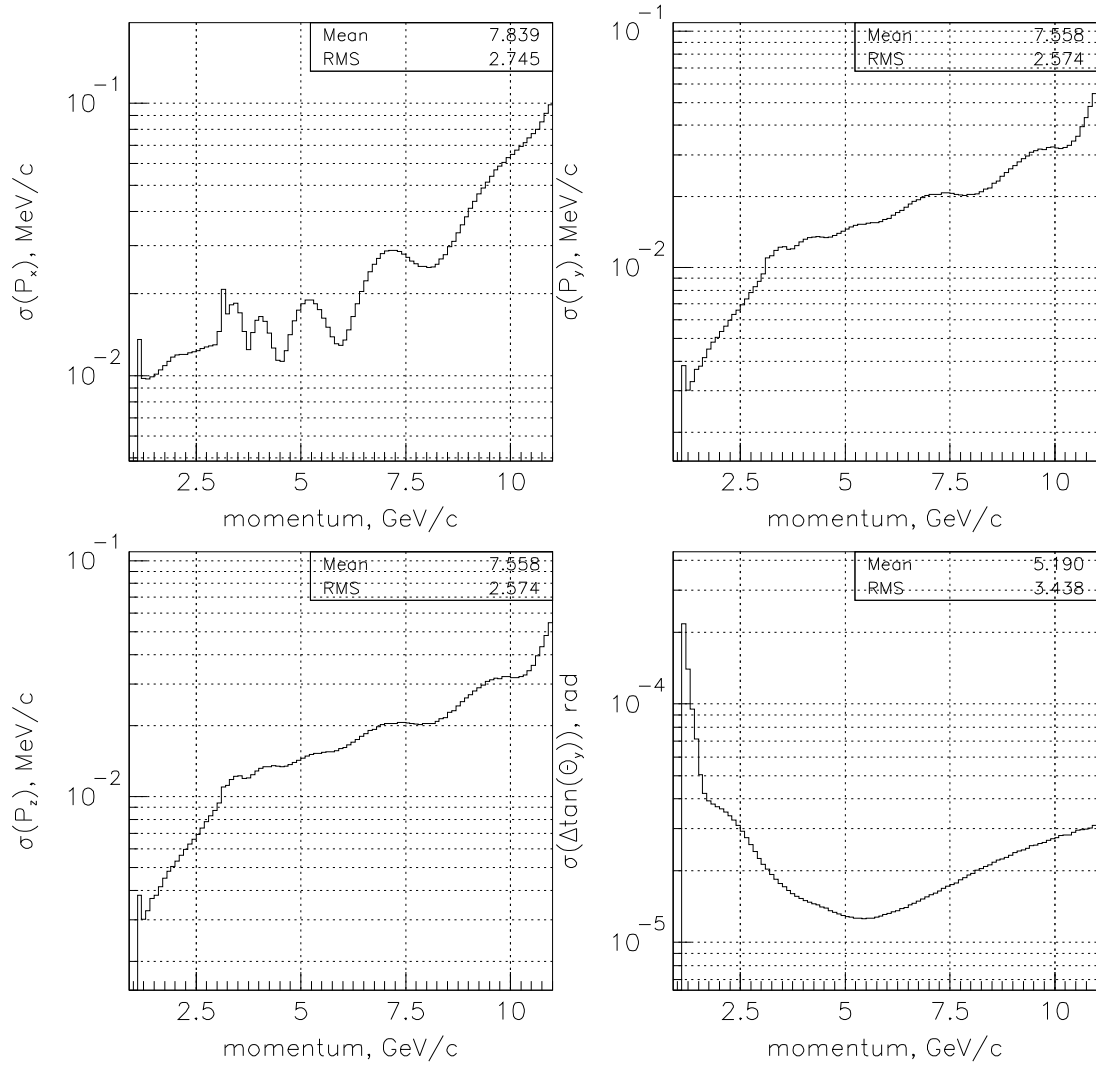


Figure 6: The distributions of  $\sigma(\delta x)$ ,  $\sigma(\delta y)$ ,  $\sigma(\delta \tan(\theta_x))$  and  $\sigma(\delta \tan(\theta_y))$  (the positive particles) in the dependence of particle momentum.

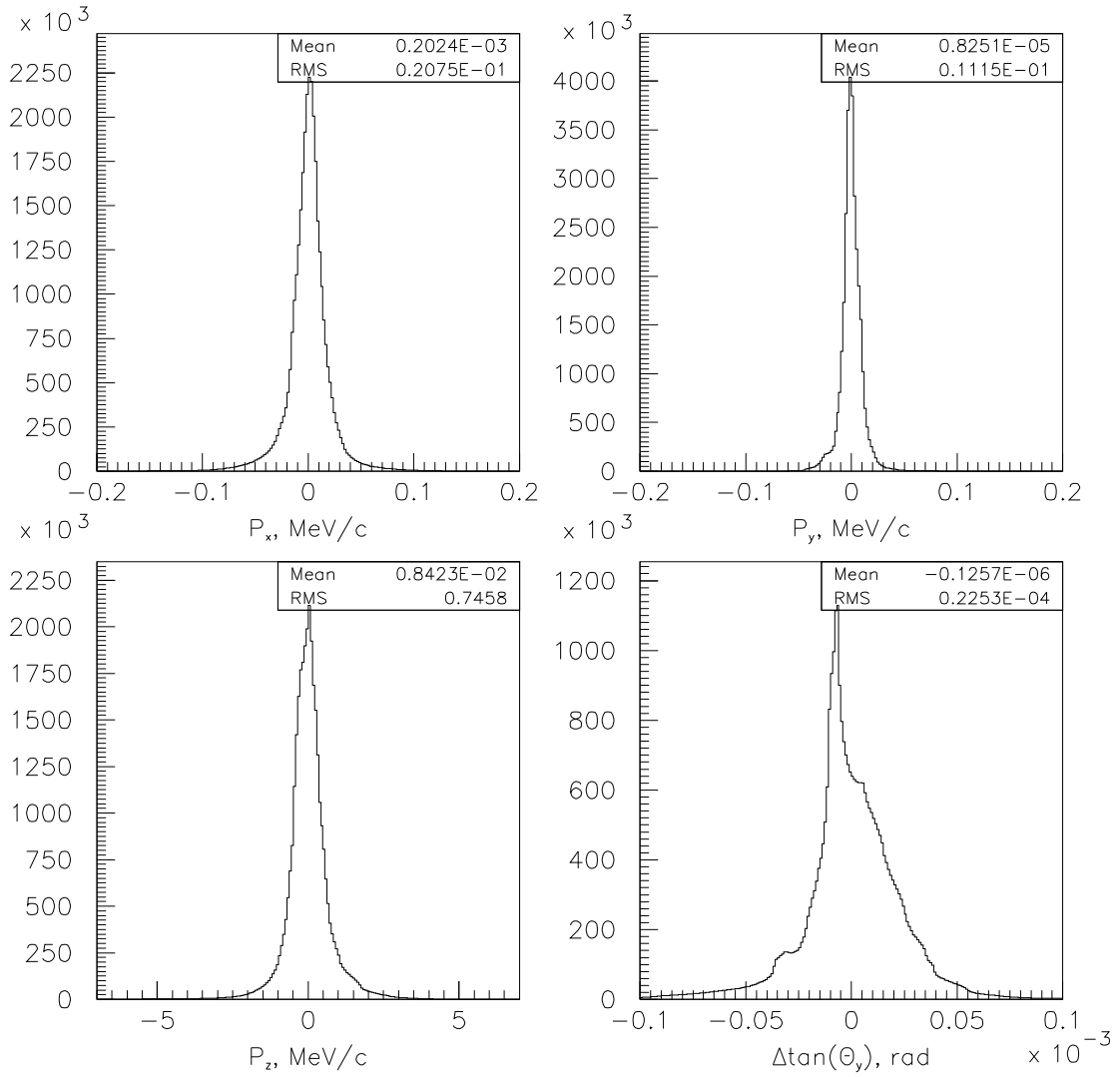


Figure 7: The distributions of  $\delta x$ ,  $\delta y$ ,  $\delta \tan(\theta_x)$ , and  $\delta \tan(\theta_y)$  (the positive particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.

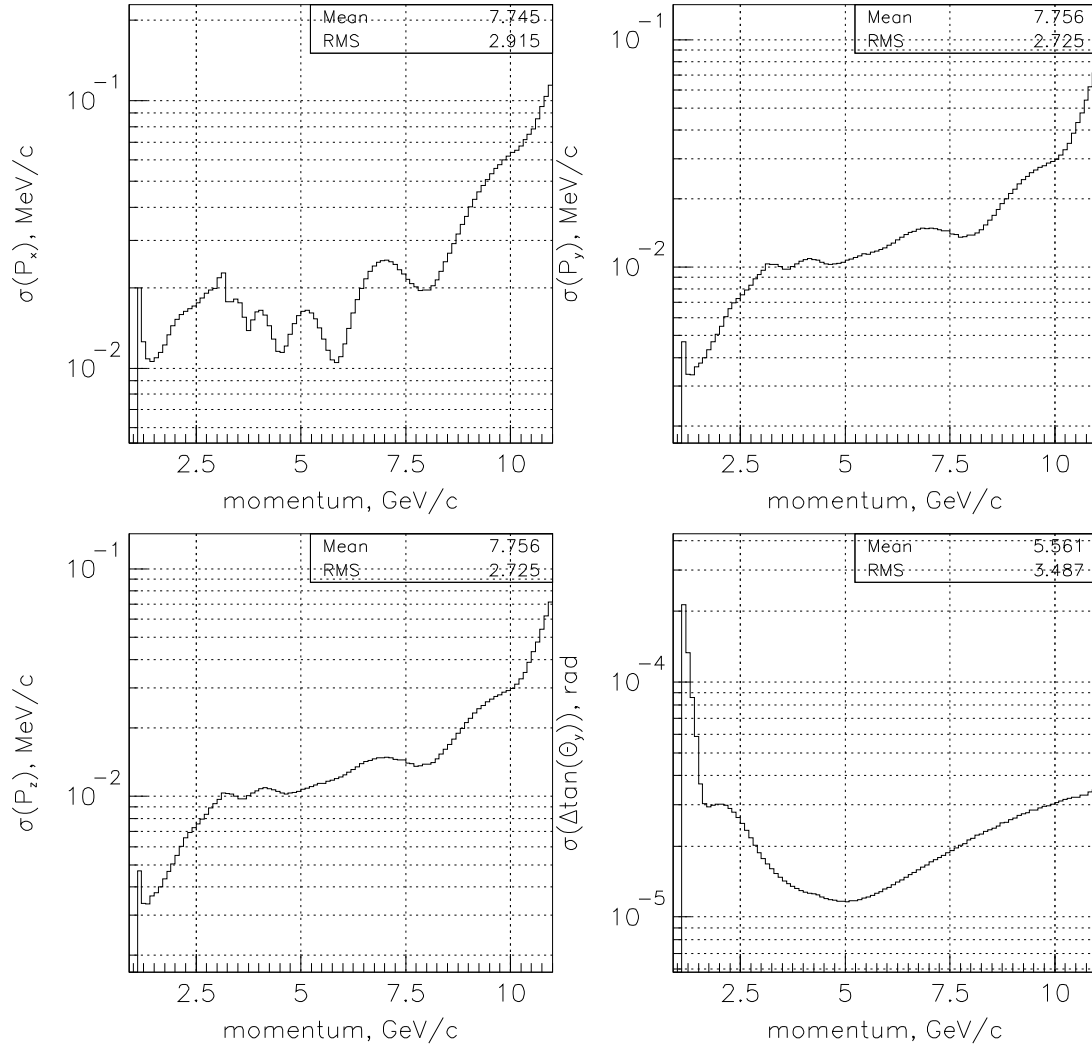


Figure 8: The distributions of  $\sigma(\delta x)$ ,  $\sigma(\delta y)$ ,  $\sigma(\delta \tan(\theta_x))$  and  $\sigma(\delta \tan(\theta_y))$  (the positive particles) in the dependence of particle momentum.

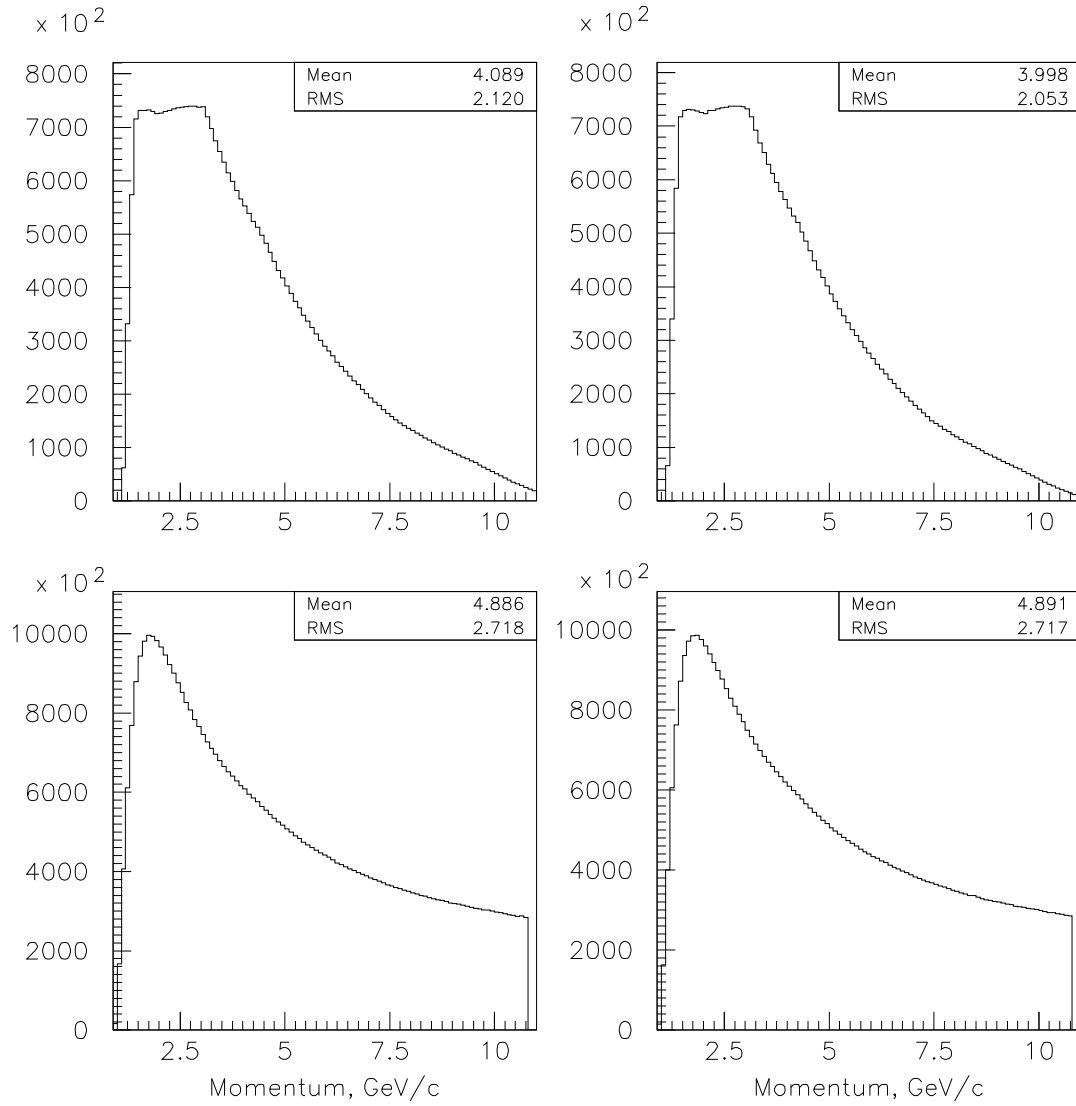


Figure 9: *The momentum distributions for the case of tracks from the target (the top distributions, left one - negative particles, right one - positive particles) and for the case of tracks starting at  $z=-500\text{cm}$  (the bottom distributions, left one - negative particles, right one - positive particles).*