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**The new magnetic field polynomials for
ARIANE**

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1 Preface

The aim of this work was to recalculate for DIRAC-II setup acceptance case 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. Practically the same calculations were made in [1] but lately it was found that some misprint was made when the magnetic field codes were included into GEANT-DIRAC([2]) and therefore the recalculations are needed. That misprint led to wrong value of X-coordinate in upstream part of magnetic volume and therefore the value of magnetic field was calculated in a bit wrong space point. As the main component of field(H_y) has a small gradient(in X-direction) and the angles(to Z axis) of tracks are very small then the influence of this misprint is not very big but it is better to get correct values of needed polynomial.

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 $T_i(T_i = x, y, \tan(\theta_x)$, 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 δp_x , δp_z , δp_z and $\delta \tan(\theta_y)$ (the negative particles) are shown, where the δ means the difference between the Monte-Carlo values and values calculated by fitting polynomial. On Fig.2 the values of σ of these four parameters(δp_x , δp_z , δp_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 δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ (the negative particles) are shown. On Fig.6 the values of σ of these four parameters(δx , δy , $\delta \tan(\theta_x)$, 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).

The distributions of mean values of δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ which are the difference between the Monte-Carlo values and values calculated by previous, a bit wrong, fitting polynomial, are shown on Fig.10 and 11. We see that for the left and right arms the effects have different signs; for δx and $\delta \tan(\theta_x)$ for case of pair the total effect is systematical and about of value which is due to the multiple-scattering processes in our setup.

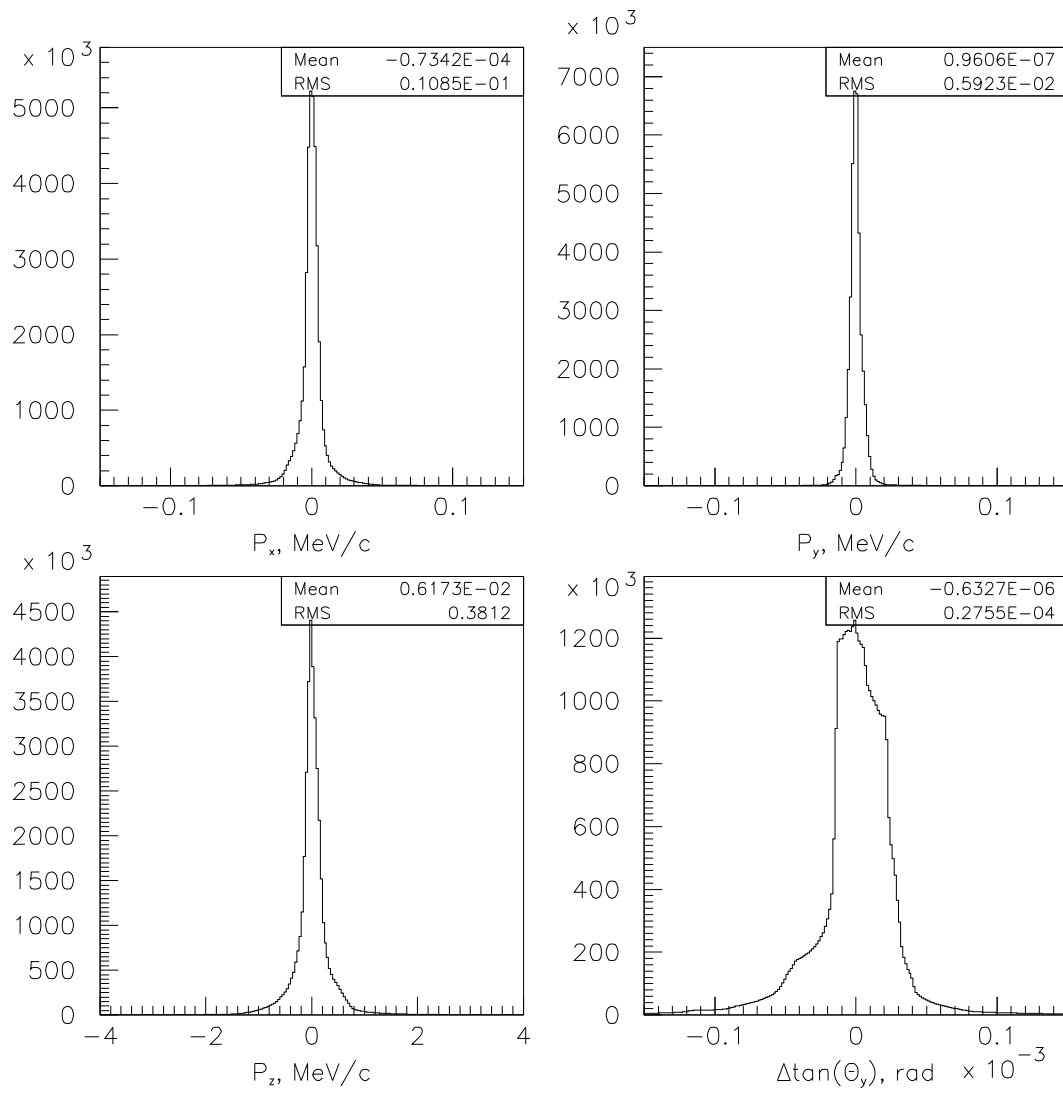


Figure 1: *The distributions of δp_x , δp_z , δp_z and $\delta \tan(\theta_y)$ (the negative particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.*

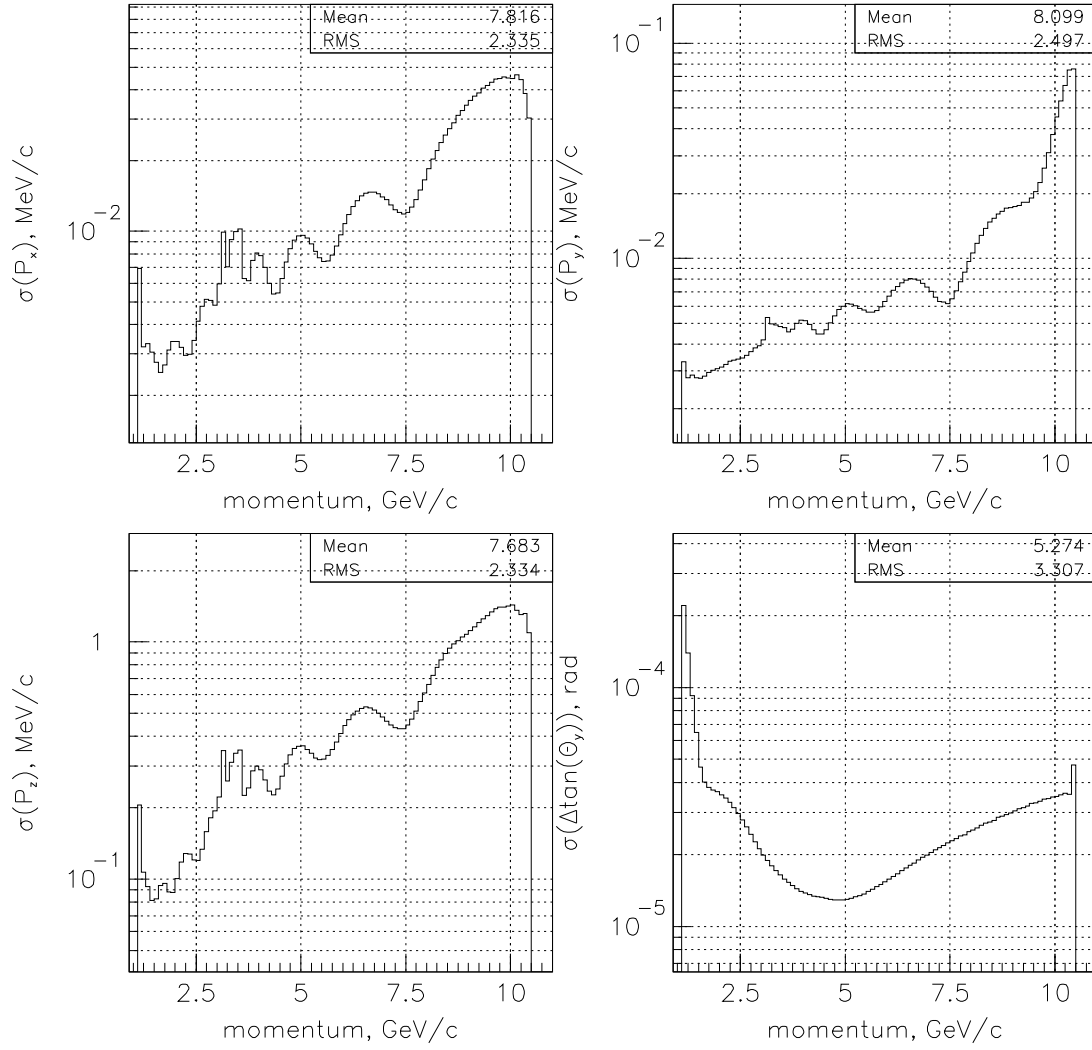


Figure 2: The distributions of $\sigma(\delta p_x)$, $\sigma(\delta p_z)$, $\sigma(\delta p_z)$ and $\sigma(\delta \tan(\theta_y))$ (the negative particles) in the dependence of particle momentum.

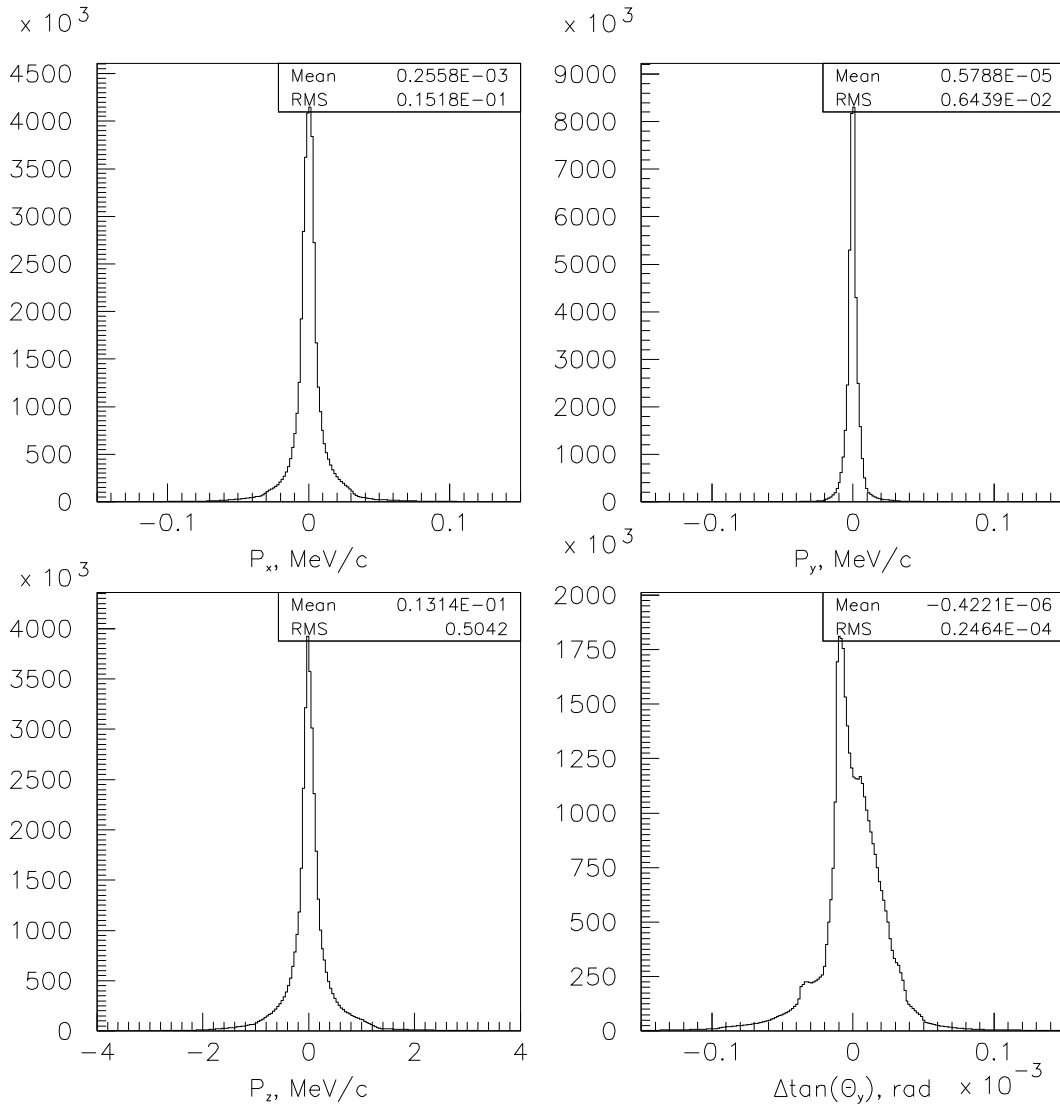


Figure 3: The distributions of δp_x , δp_z , δp_z and $\delta \tan(\theta_y)$ (the positive particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.

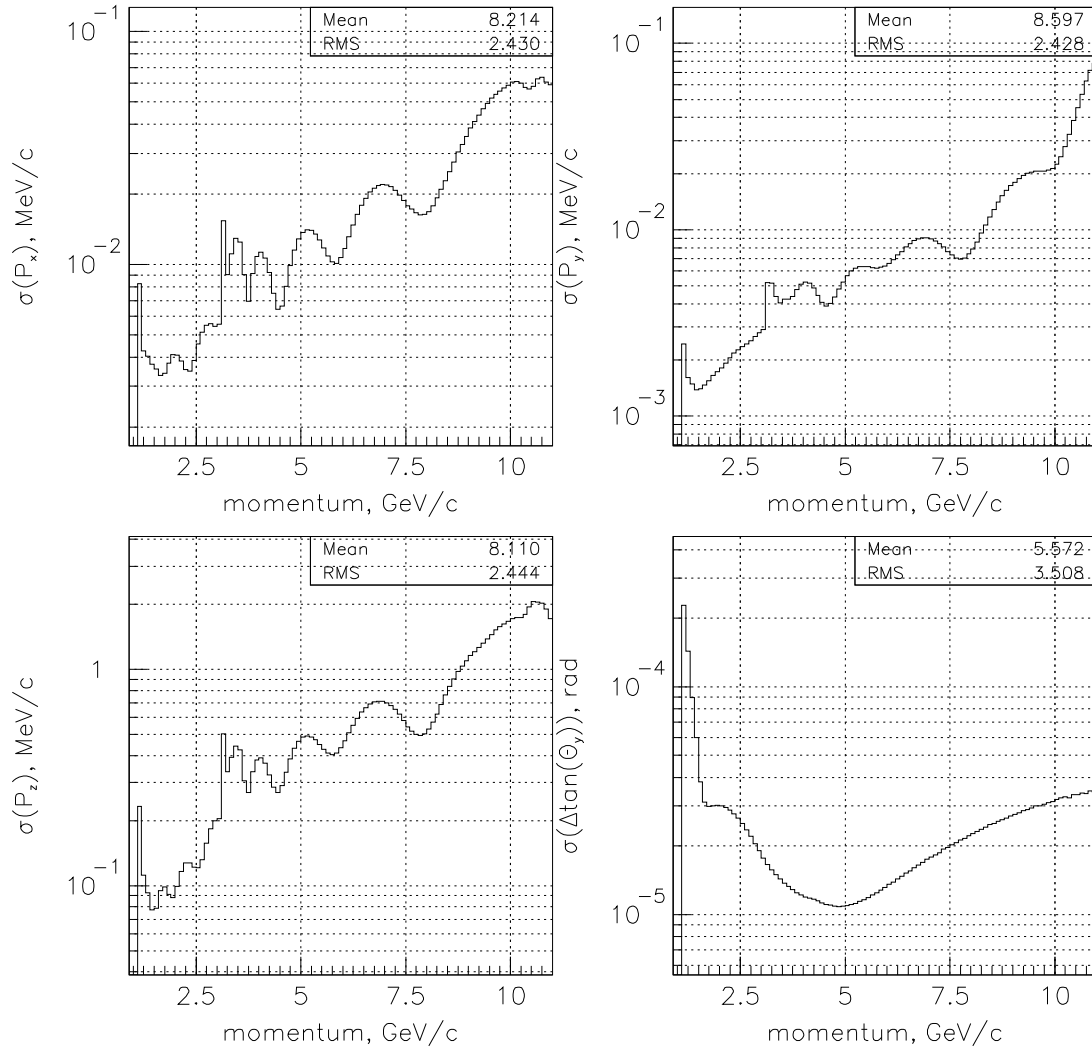


Figure 4: The distributions of $\sigma(\delta p_x)$, $\sigma(\delta p_y)$, $\sigma(\delta p_z)$ and $\sigma(\delta \tan(\theta_y))$ (the positive particles) in the dependence of particle momentum.

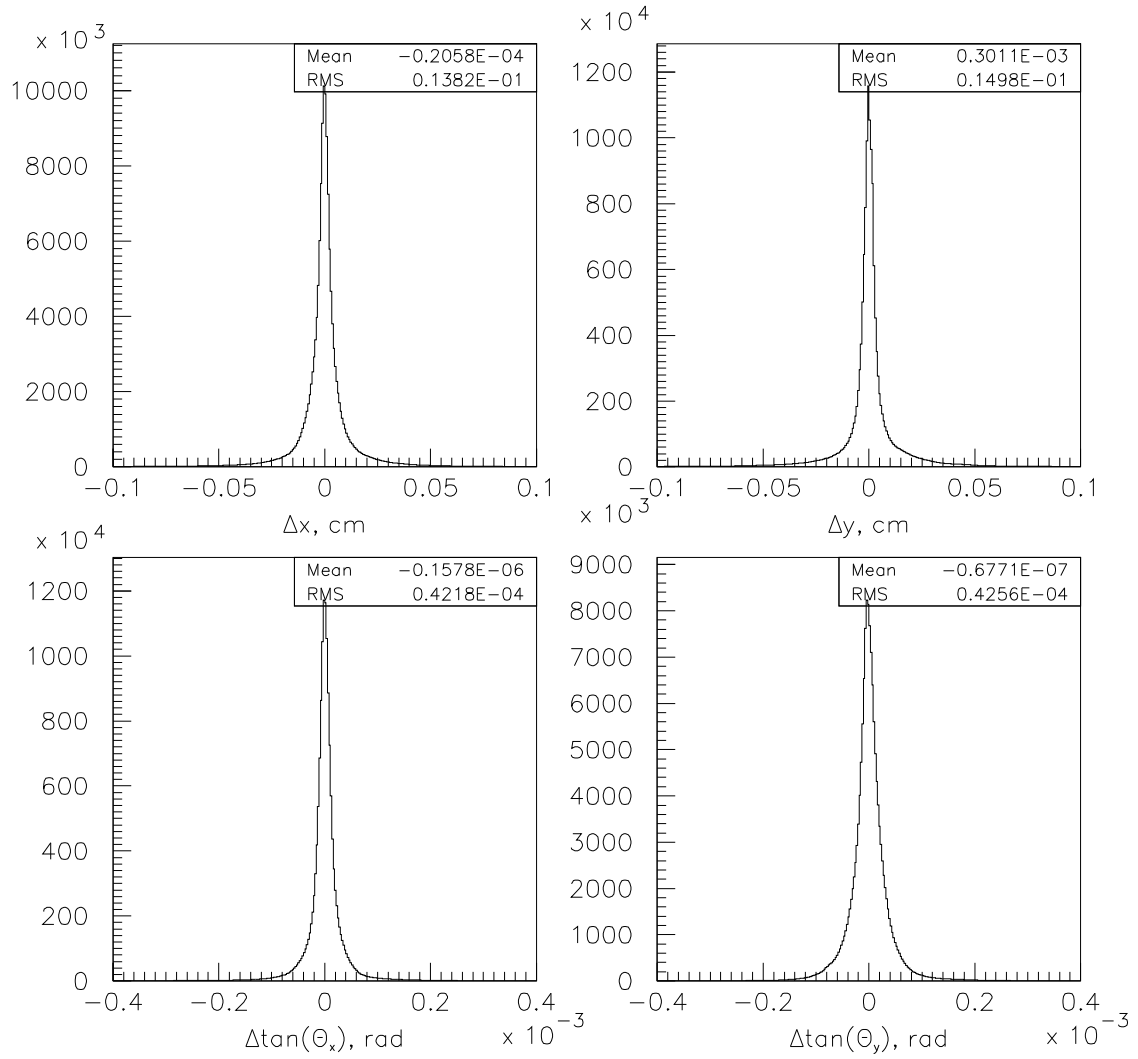


Figure 5: *The distributions of δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ (the negative particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.*

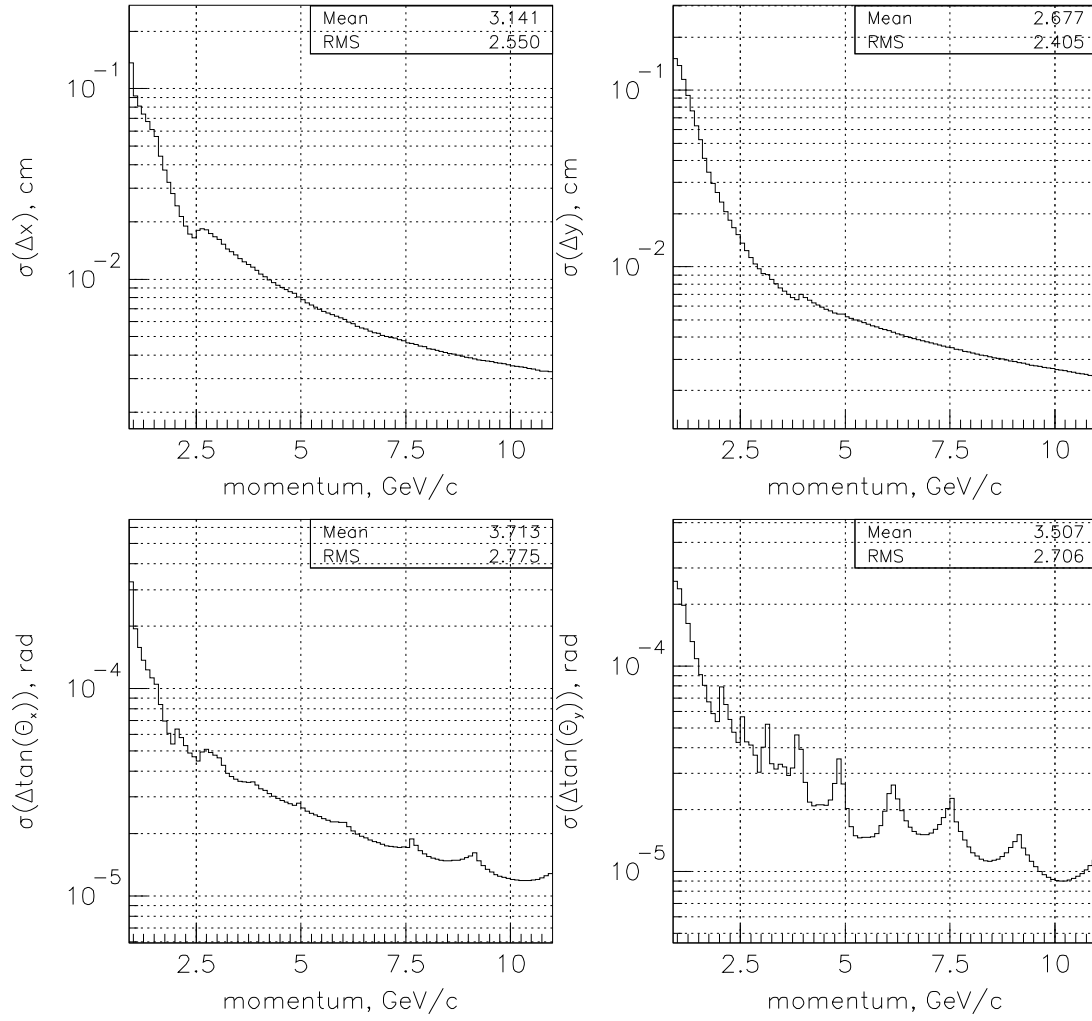


Figure 6: *The distributions of $\sigma(\delta x)$, $\sigma(\delta y)$, $\sigma(\delta \tan(\theta_x))$ and $\sigma(\delta \tan(\theta_y))$ (the positive particles) in the dependence of particle momentum.*

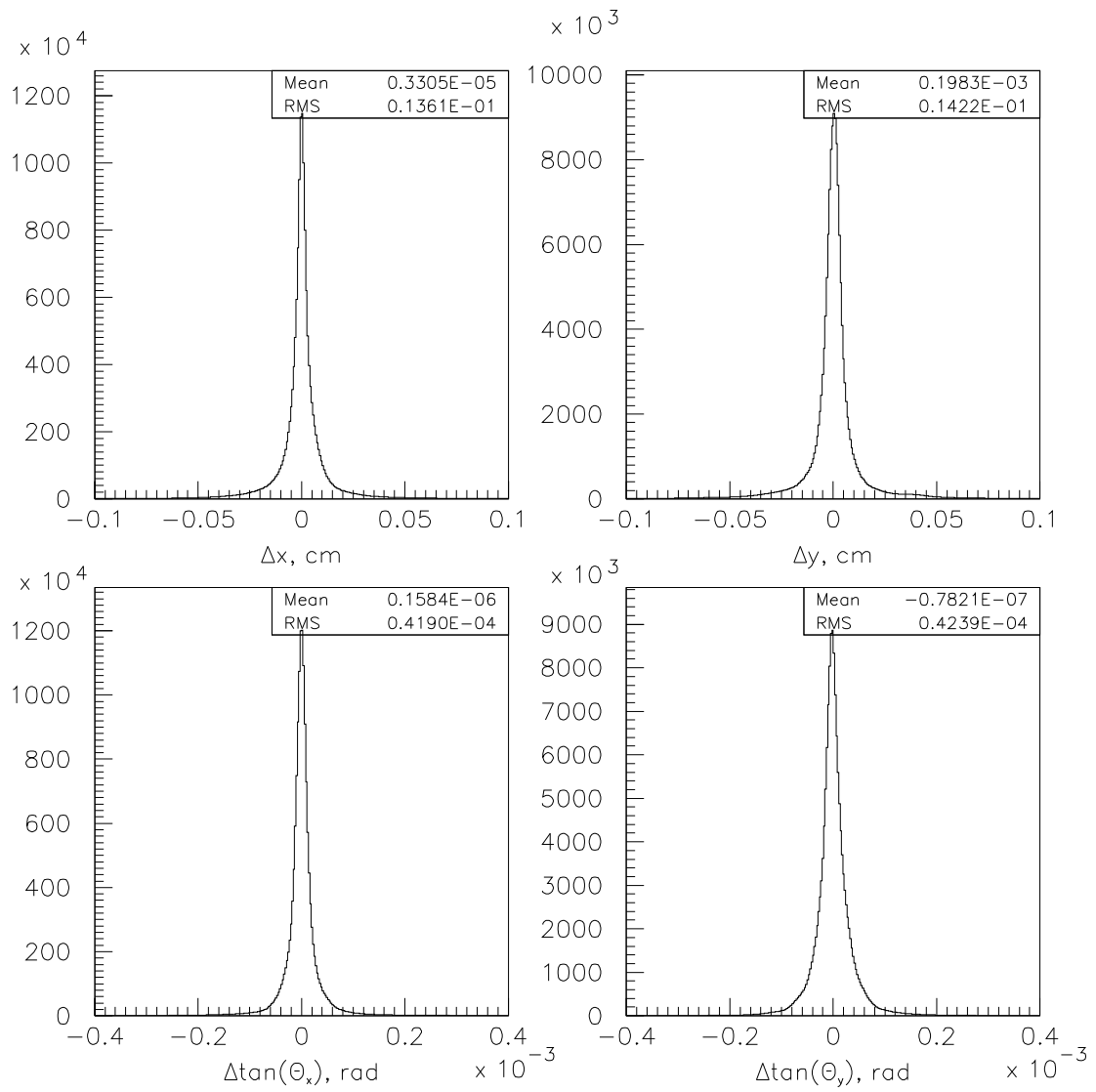


Figure 7: The distributions of δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ (the positive particles), which are the difference between the Monte-Carlo values and values calculated by fitting polynomial.

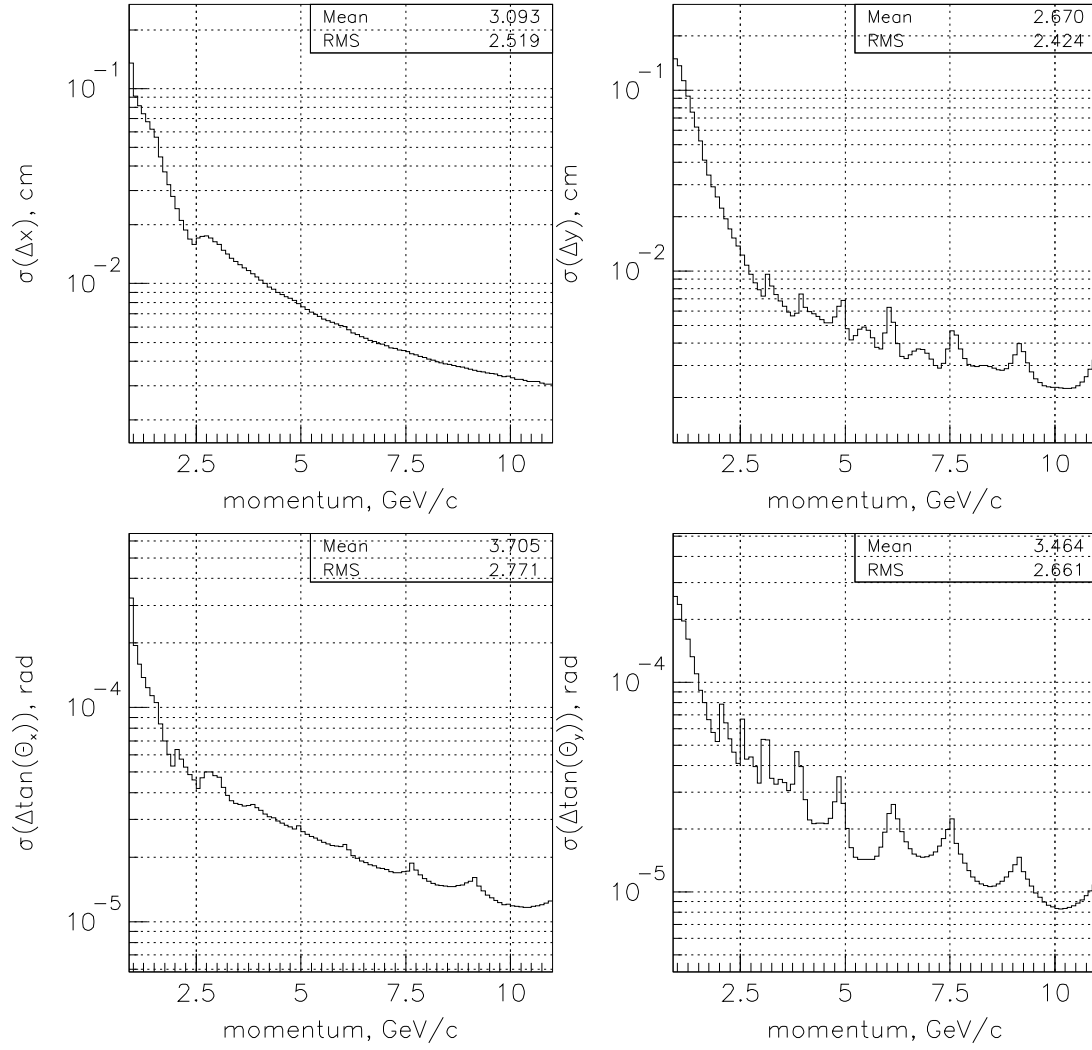


Figure 8: *The distributions of $\sigma(\delta x)$, $\sigma(\delta y)$, $\sigma(\delta \tan(\theta_x))$ and $\sigma(\delta \tan(\theta_y))$ (the positive particles) in the dependence of particle momentum.*

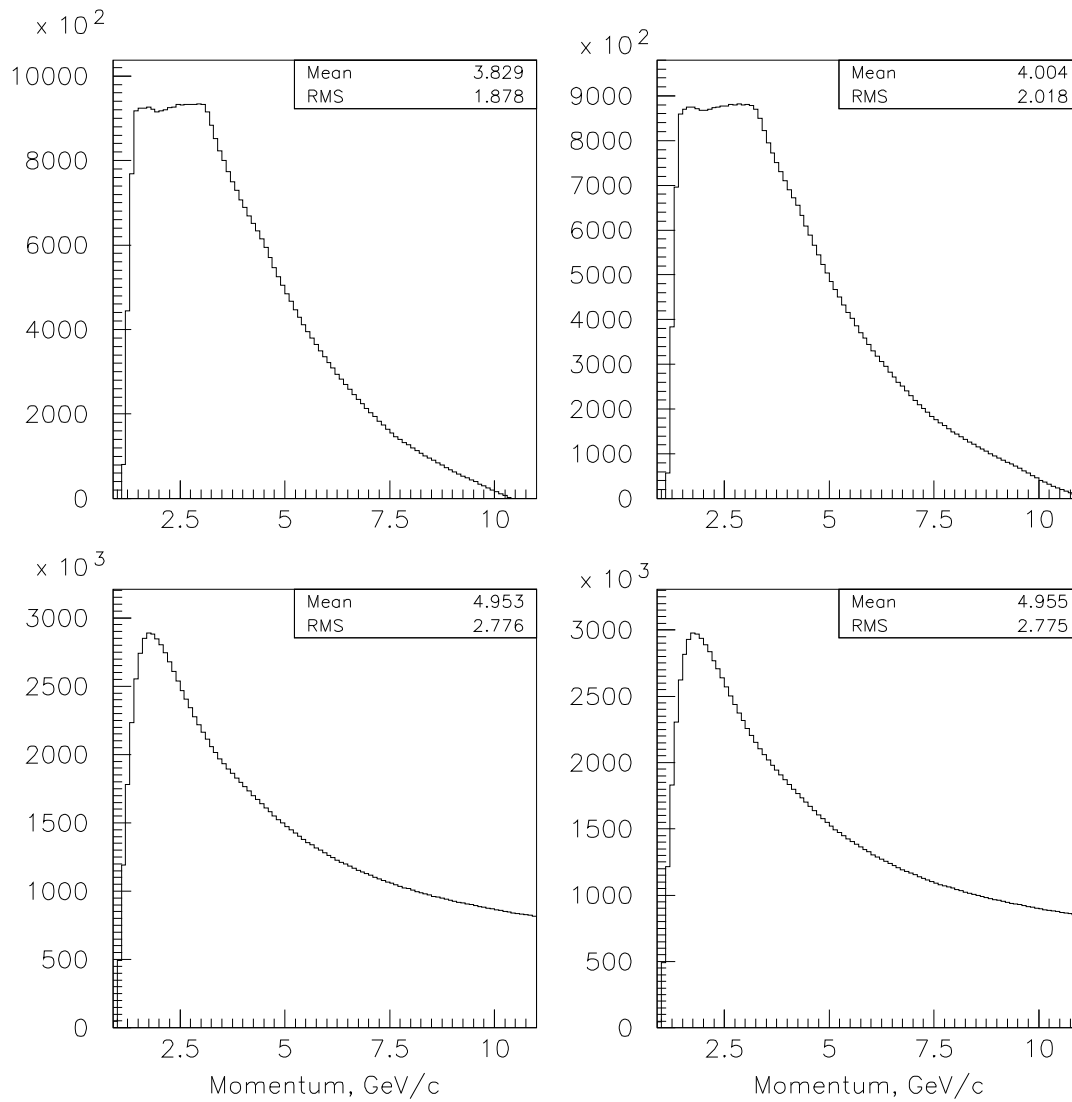


Figure 9: *The momentum distributions for the case of tracks from the target(the top distributions, left one - negative particles, right one - positive particles) and for the case of tracks starting at $z=-500\text{cm}$ (the bottom distributions, left one - negative particles, right one - positive particles).*

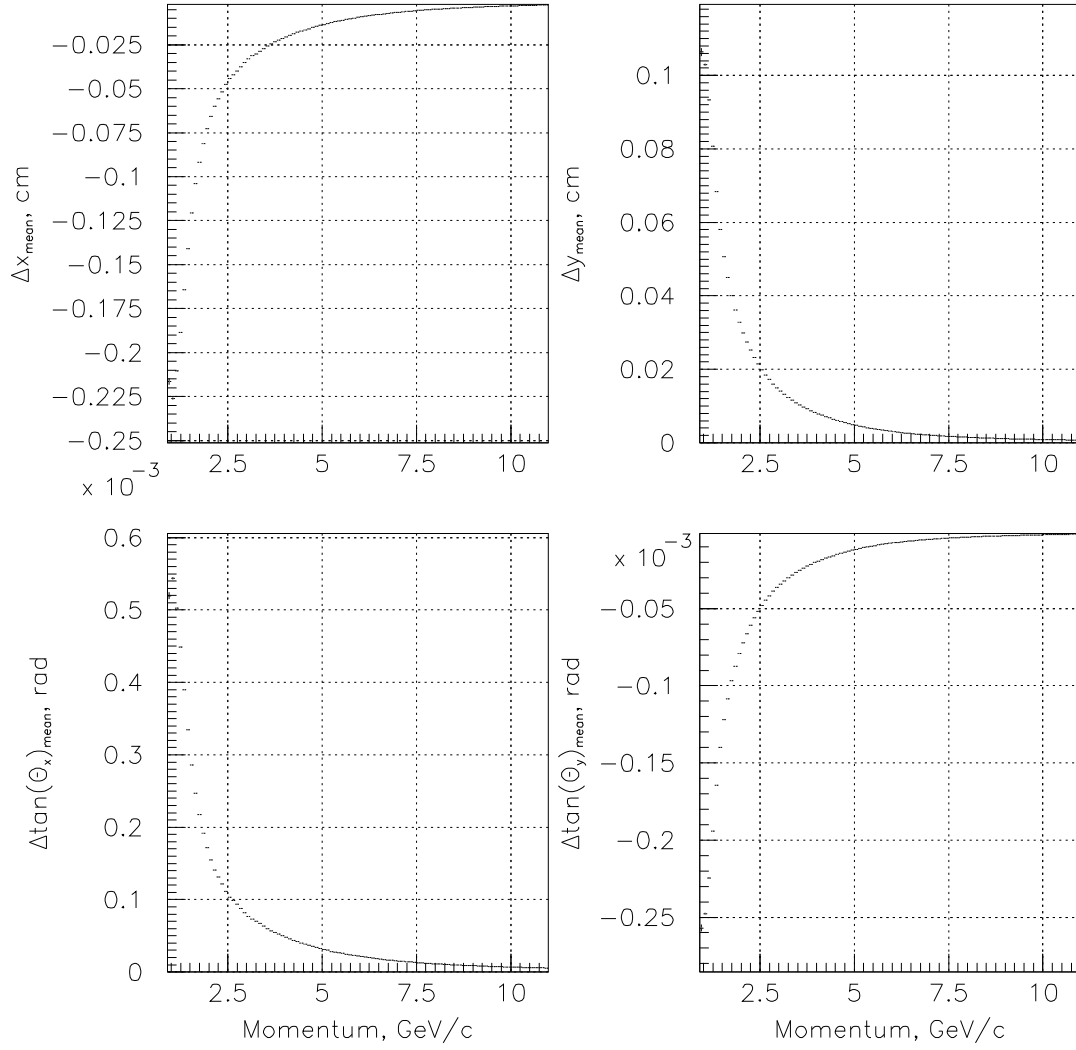


Figure 10: *The distributions of mean values of δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ (the negative particles), which are the difference between the Monte-Carlo values and values calculated by previous, a bit wrong, fitting polynomial.*

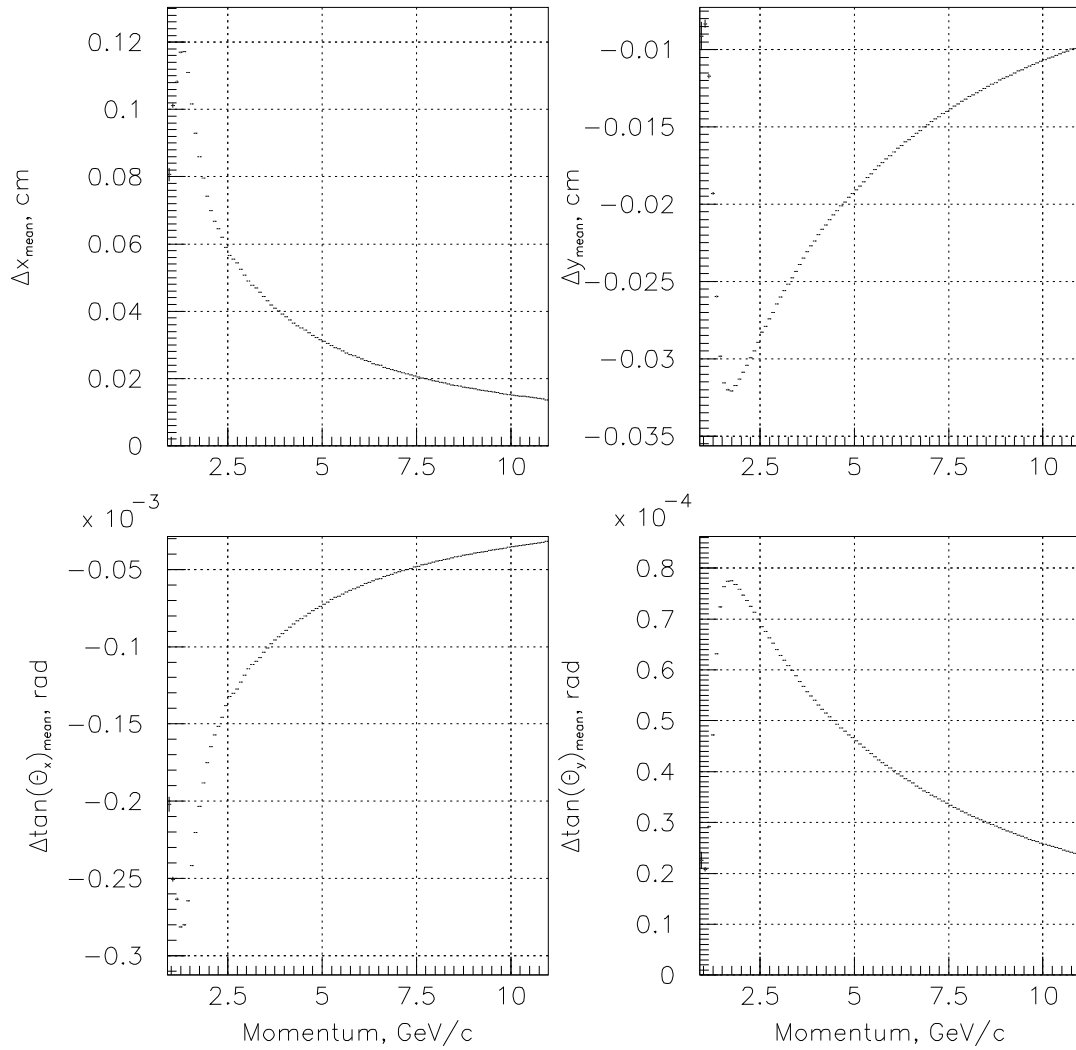


Figure 11: *The distributions of mean values of δx , δy , $\delta \tan(\theta_x)$, and $\delta \tan(\theta_y)$ (the positive particles), which are the difference between the Monte-Carlo values and values calculated by previous, a bit wrong, fitting polynomial.*

References

- [1] O.Gorchakov [JINR], DIRAC Note 2008-05.
- [2] P.Zrelov (JINR) and V.Yazkov (NPI), DIRAC Note 1998-08.