About systematics in the track parameters reconstruction in RUN-I data.

V.V.Babintsev *
IHEP, Protvino, Russia.

2001

Abstract

Some indication on the systematics of the reconstructed tracks are observed for the real event data: pion-pair mass distributions depend on the Z-coordinate position of the reconstructed event vertex. The same result have been observed for the toy coordinate system when the simulated event vertex position is shifted to the wrong position.

1 Introduction.

In the PHENIX Note-35 [1] it was observed that the simulated and reconstructed muon distributions have a systematic errors of the momentum difference ($P_{sim} - P_{rec}$). At sufficiently high momentum these distributions have two bumps. At other momentum-values the width of the distributions depends on the momentum value of particles.

The presence of two bumps in the analyzed distributions can be connected with a wrong event vertex position determined in the reconstruction procedure.

With the aim to check connection between wrong vertex position definition and track parameters reconstructed values there were simulated muons

*e-mail: babintsev@mx.ihep.su

(plus and minus) at different energy values. They are detected in a toy registration system which includes 10 rows of two-layer systems (see Fig.1 with reconstructed tracks and the rows of cells). Each layer consists of the cells filled with liqued azote. Each cell has dimension 1*1 cm^2. (Let us consider tracks in a two-dimensional coordinate system). The rows are disposed parallel to the Z-axis (beam line). Between the rows there is only air medium. The first row of the cells is disposed at the distance of 100 cm (X-axis) from the event vertex. Magnetic field vector (1.2 Tl) is oriented along Y-axis (perpendicular to the plane of Fig.1).

Passage of the simulated muons through the toy system was realized with the help of GEANT3.21 code. There were taken into account only processes of multiple scattering and energy loss (the same case as in the cited Note). Energy loss of particles in the toy system are less than 5% for 0.4 Gev/c muons. It means that the momentum value of particles can be treated as fixed one.

With the aim to have deal with the plane picture there were analized only those tracks which have the deviation along Y-axis from X-Z plane not larger than 0.5 cm. Therefore we can use two-dimensional fit in the reconstruction procedure.

The output of the simulation are the coordinates of 'fired' cells which were used for track reconstruction and which were fitted by a circle. An example of a such fit one can see in Fig.1.

In the fitting procedure the coordinate errors were taken as a half size of the cell (for X and Z coordinates). The errors of the vertex position were taken as 0.25 cm. The vertex position is fixed by hands. Multiscattering errors in the toy system are much less than these values.

Track fitting procedure was realized using the ROOT Graph-method and using Minuit method with the functional

$$\chi^2 = \sum (\frac{X_i - x}{error})^2 + \sum (\frac{Z_i - z}{error})^2$$

$$x = X0 + R * Cos(\phi), \quad z = Z0 + R * Sin(\phi)$$

Total number of free parameters are 3. Both methods give the same results except of low energy tracks which are better connected with the given primary vertex in the Minuit method.

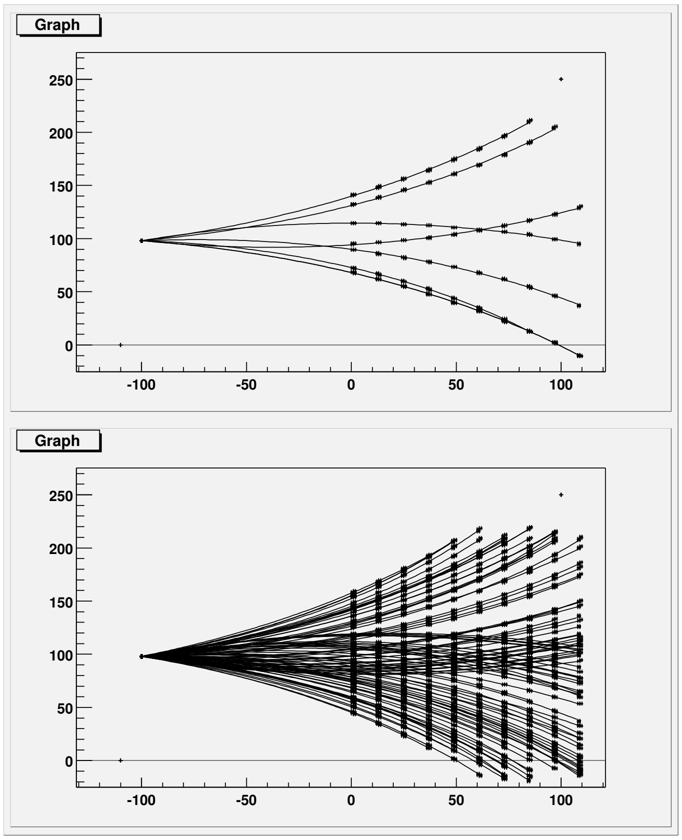

Figure 1: Reconstructed tracks (+-) in the toy detector system.

All muons were generated from one point from Z-axis and with a smooth angle distribution in the interval $70^0 - 110^0$. Let us define the real vertex position as a point O(Z=0).

The following two pictures (Fig.2 - for $\mu+$ and Fig.3 - for $\mu-$) present distributions

$$\Delta(\Theta) = \Theta_{sim} - \Theta_{rec}, \quad and \quad \Delta(P) = (P_{sim} - P_{rec})/P_{sim}$$

for 3 muon momentum values: 0.4, 1.2, 3.6 Gev/c. Solid line corresponds to the case of the 'wrong' reconstructed vertex position at O(Z=-0.5). Dotted lines correspond to the case of the symmetrical 'wrong' reconstructed vertex position at O(Z=+0.5).

One can see that the shift in the vertex position can cause the appearence of 2 bumps observed in the PHENIX Note-35 [1]. Momentum difference for plus and minus particles has different sign for the same wrong position of the event vertex. It explaines the results when for the whole HIJING events there have not been observed systematics.

2 The case of the real reconstructed tracks.

Let us see what we have for the real tracks from RUN-I. This analysis relies upon the standart micro-DST data. We used file NTRK12000.root which have about 16 run numbers in the range 12000-12400.

There were used tracks with $dch\_quality > 20$. To cut 'noisy' tracks we accept only those tracks which have momentum value greater than 300 MeV/c.

All results below have been checked for different environments

- all tracks
- tracks have been reconstructed using X1 and X2 wires in the drift chamber
- track parameters: mpx, mpy, mpz
- track parameters: mom, the0, phi0

For all mentioned cases we have the same results.

To compare these results with the toy simulation we analyze here those events which have z-vertex in the range:

- bbcz= (-15 ± 4) cm, point O1
- bbcz= (0 ± 4) cm, point O
- bbcz= $(+15 \pm 4)$ cm, point O2

We use only those tracks which are detected in the drift chamber in the range $/(zed - bbcz)/ < 25$ cm (to be certain that we have the same acceptance in all 3 analyzed z-points). Instead of this condition there has been tryed also the case of 'the0' cut where we obtained the same results.

In Fig.4 one can see the the0-dependence of the selected tracks on the z-coordinate of reconstructed event vertex in the case of positive particles and for centrality greater than 8. There is evident the0-dependence. The same results are obtained for the case of $centrality < 8$. Negatively charged particle show the same distributions.

The observed the0-dependence can be connected with the mensioned above systematic shiftment of the reconstructed event vertex position (the case when the value of the shiftment depends on z-coordinate). But it can be caused also with the un-considered inclination of detector systems to the beam-line, or it can be connected with detector efficiency dependence on z-coordinate and so on.

For example, one can see the depleted road across the presented graphs which can be connected with a low efficiency of one of the sub-systems or the presence of a 'dead' zone in the detector.

Therefore it is desirable to analyze the presence of the systematic in the real events at the same range of event vertex position. Taking into account the results of the simulated event distributions above one can analyze the pion pair mass distributions. As it was shown the opposite charged particles has different systematic-values when there is a wrong definition of the event vertex position. Therefore the mass distributions have to change its shapes when there are different event vertex shiftments.

In Fig.5 pion-pair distributions and their ratios are presented at different momentum interval. Mass distributions are constructed for events with vertex position in the range of Z=-15 and Z=+15 cm. Pions identification was defined in the standart classMicroTrack.C code using Dch-Tof system.

For comparison the same distributions are presented in Fig.6 for the simulated events in the toy system.

At the both pictures ratio of the pair-mass distributions taken at different Z event vertex positions (real events) and for different event vertex shiftment (simulated events) show the same main feature: the observed ratio is not constant and it changes its slope in the range of small mass values. (We do not consider here the details of the mass distributions).

We do not have any information of the efficiency dependence on Z-coordinate of event vertex for different sub-systems. Therefore one can consider this observation only as an indication of the systematic presence in the event vertex reconstruction.

3 Conclusions.

Using a simple toy-presentation of the detector it was shown that the track reconstruction systematics observed in the Note-35 [1] can be reproduced if one takes into account the offset of the reconstructed event vertex position along Z-axis from its real position. This shift-position changes its sign at the center point of the system (Z=0).

For the real reconstructed events from RUN-I it was shown that the pion-pair mass distributions depend on the Z vertex position (pions were selected using particle identification in the Dch-Tof system using standart code class-MicroTrack.C). According to the simulated mass distributions it is an indication of the systematic shiftment of the reconstructed event vertex position.

One can suppose that this effect connects with some un-considered inclinations of the beam line and the detector systems to the center line of the detector. It can be also result of the un-considered misaligment of the real field axis relative to the beam axis as it was mentioned in the Note-35 [1].

References

[1] J.M.Burward-Hoy, Note-35, (2001) "Momentum reconstruction systematics"

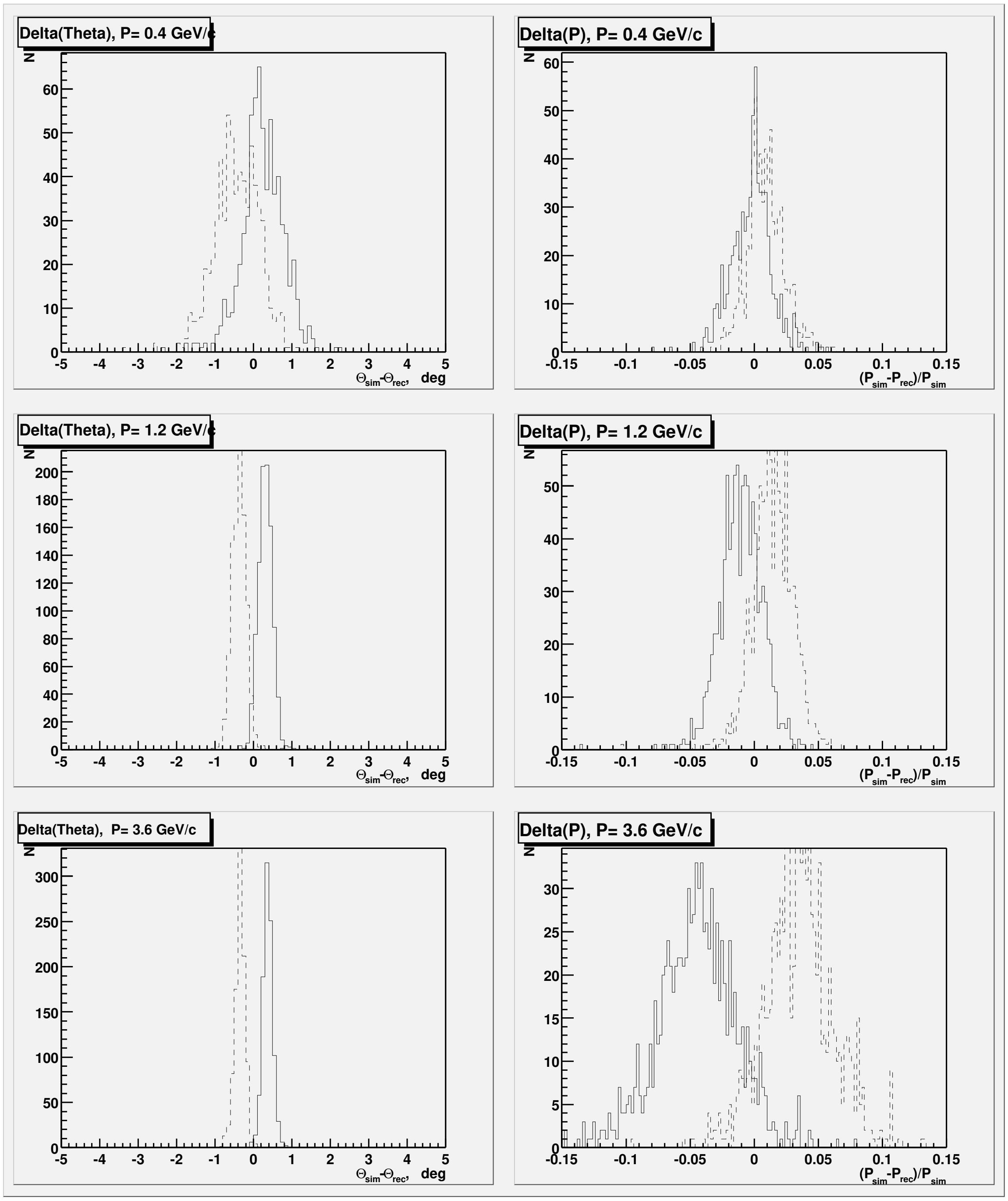

Figure 2: $\mu+$. Distributions of difference for simulated and reconstructed polar angle (left side) and for simulated and reconstructed momentum. Solid line - vertex shift is Z=-0.5 cm, dotted line - vertex shift is Z=+0.5 cm.

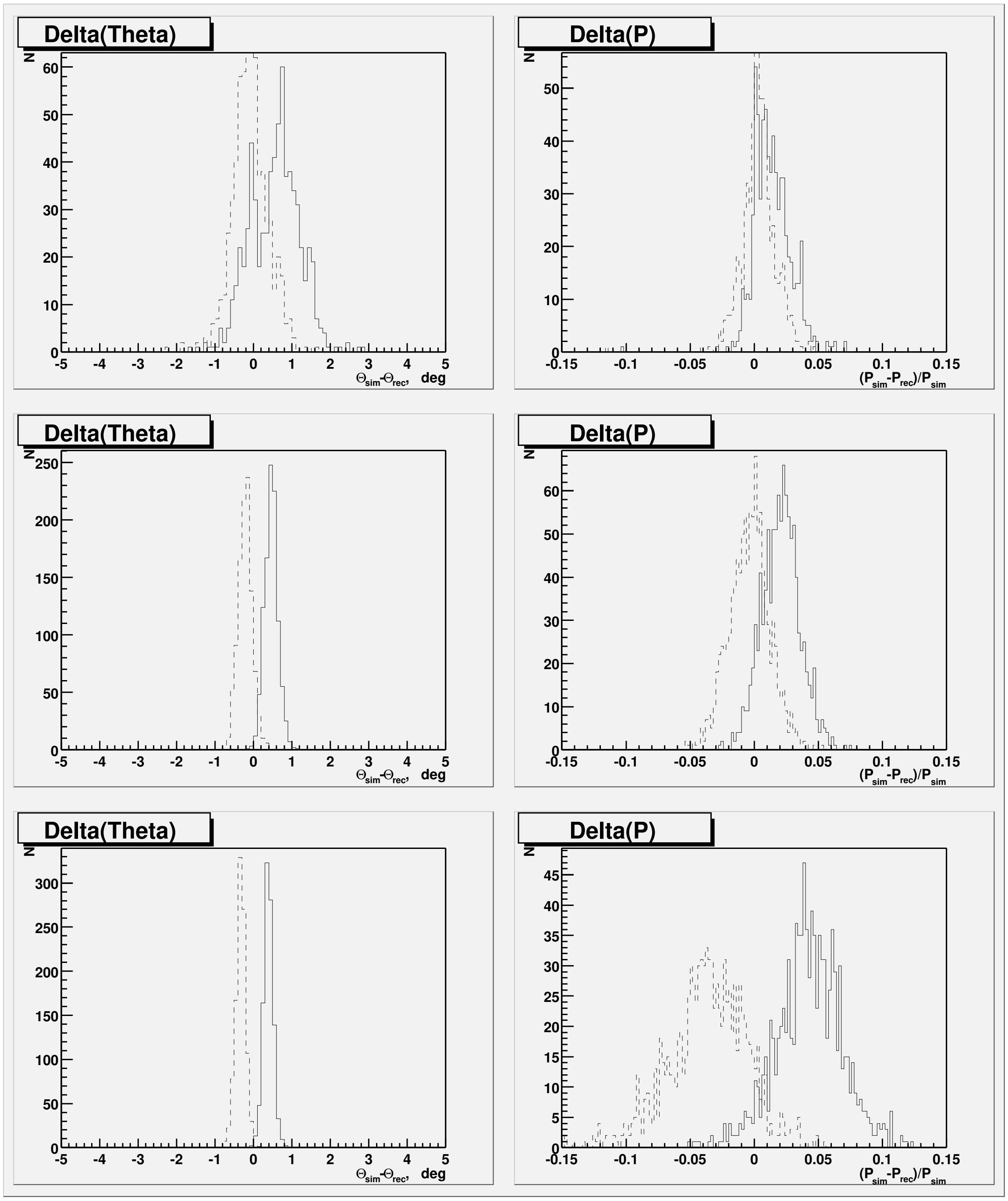

Figure 3: $\mu-$. Distributions of difference for simulated and reconstructed polar angle (left side) and for simulated and reconstructed momentum. Solid line - vertex shift is Z=-0.5 cm, dotted line - vertex shift is Z=+0.5 cm.

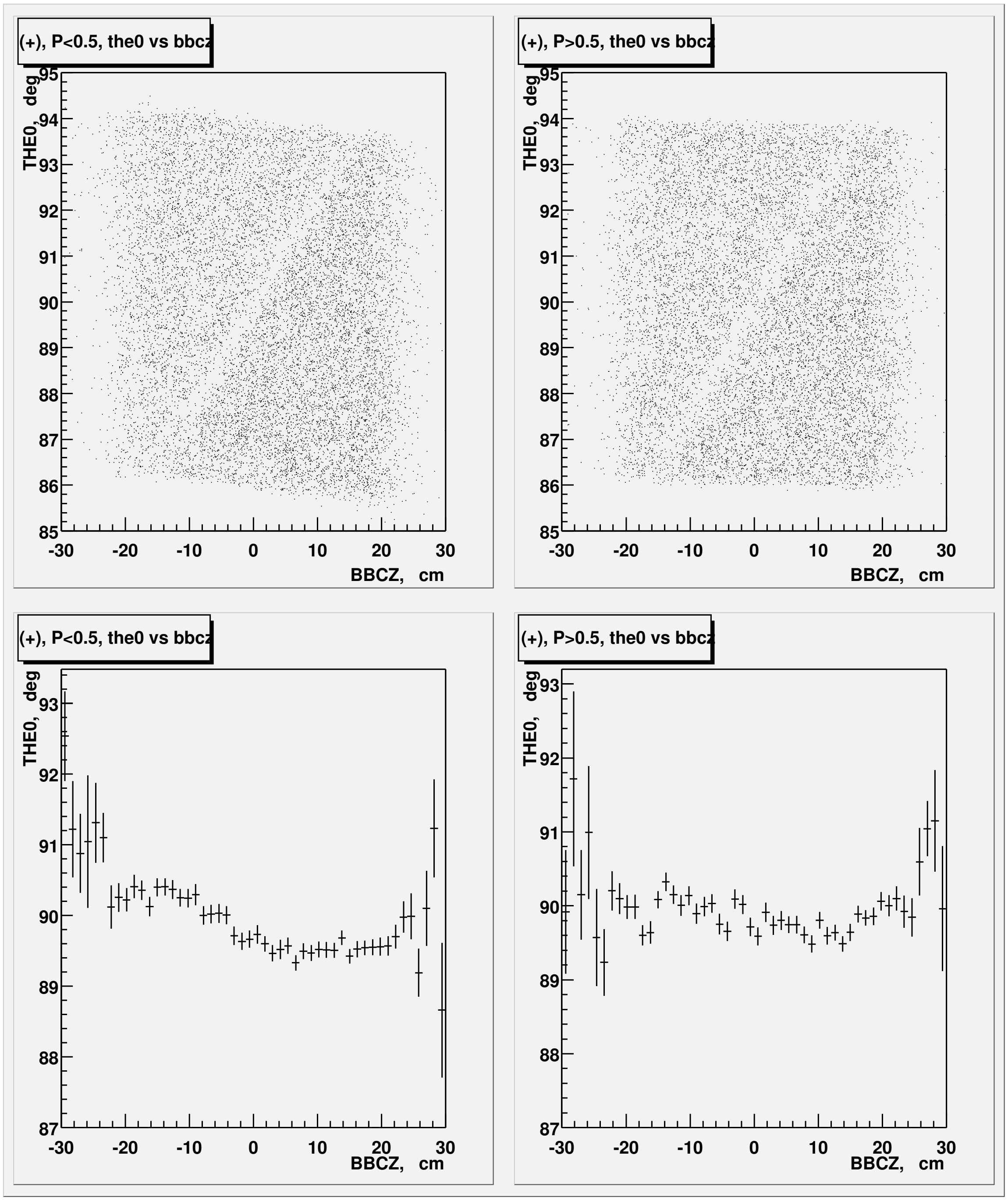

Figure 4: Real reconstructed tracks (+) for $P < 0.5$ GeV/c (left) and for $P > 0.5$ GeV/c (right). Centrality is greater than 8.

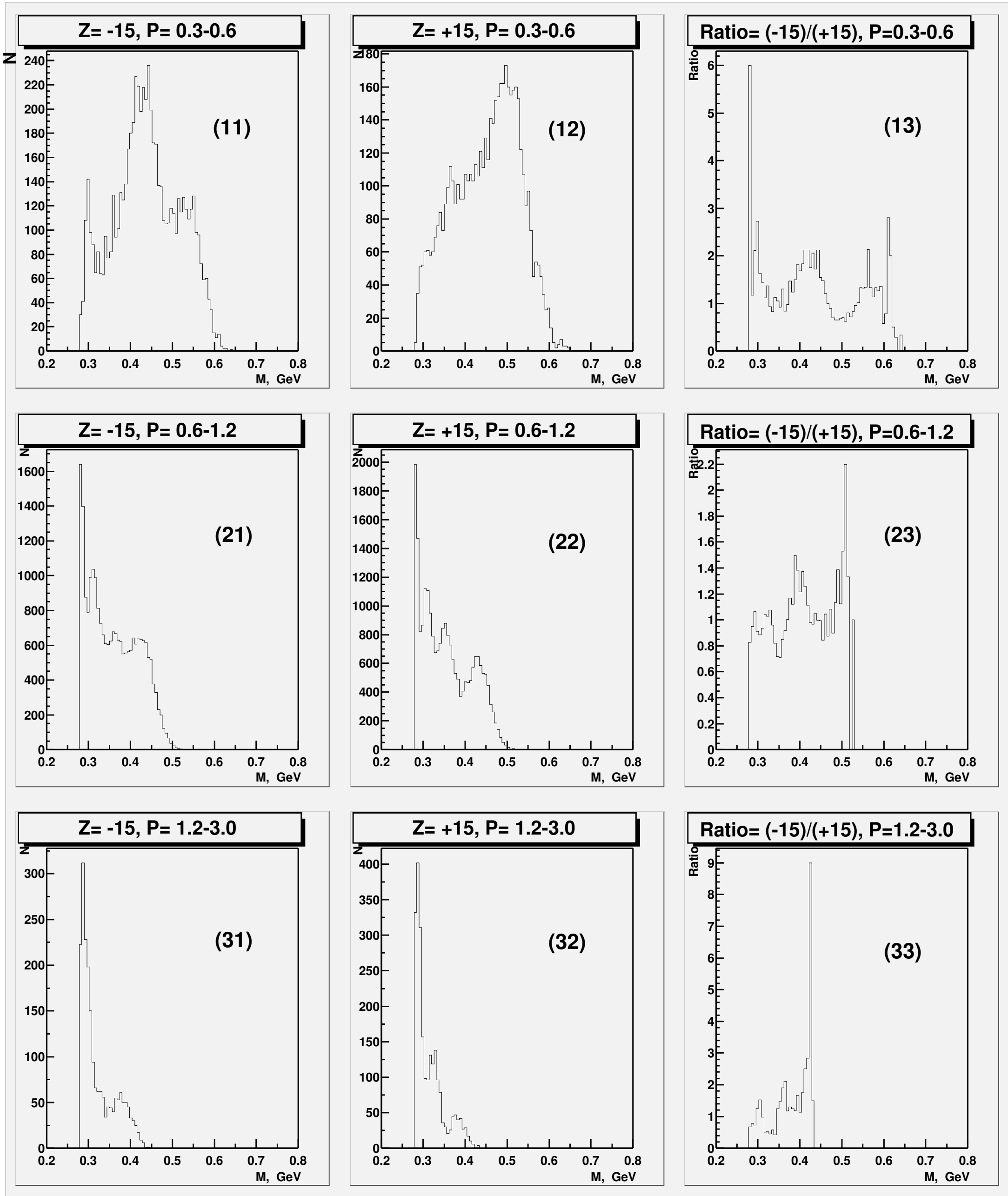

Figure 5: (PI+PI-)-mass distributions at different momentum values of particles: (11-13)- momentum interval is 0.3-0.6 GeV/c, (21-23)- 0.6-1.2 GeV/c, (31-33)- 1.2-3.0 GeV/c. Left column of histograms: event vertex position in the range $Z = -15 \pm 4\ cm$. The midle column: $Z = +15 \pm 4\ cm$. Right column: ratio of two histograms.

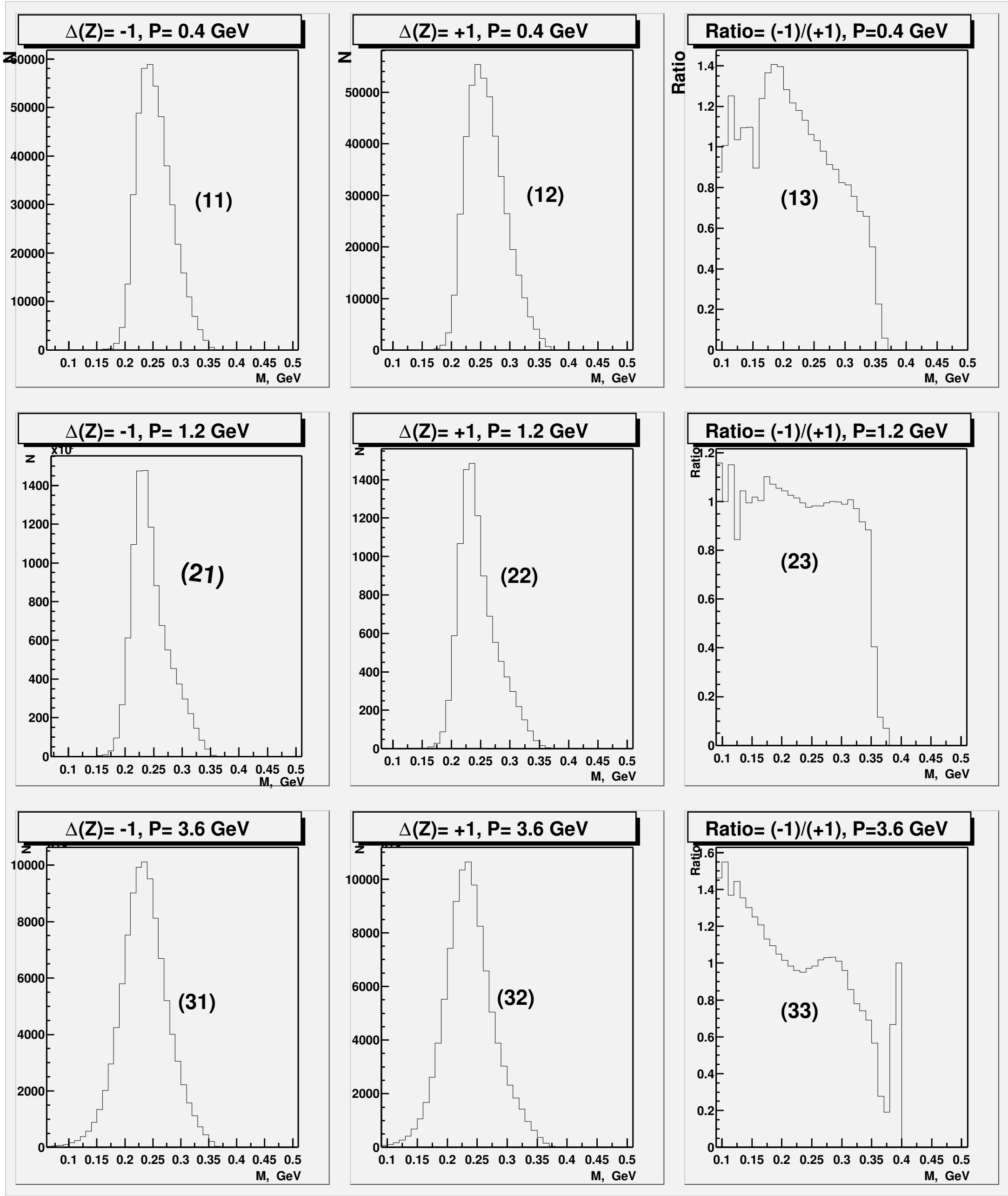

Figure 6: (mu+mu-)-mass distributions at different momentum values of particles: (11-13)- momentum P= 0.4 GeV/c, (21-23)- P= 1.2 GeV/c, (31-33)- P= 3.6 GeV/c. Left column of histograms: event vertex shiftment equals to $\Delta(Z) = -1.0$ cm. The midle column: $\Delta(Z) = +1.0$ cm. Right column: ratio of two histograms.