EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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The correction of the magnetic field and angular misalignment of DIRAC setup.

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1 Simulation and results

Our goal was to improve the magnetic field description and to correct the horizontal angular misalignment of arms.

We obtained the value of β, assuming the following correction for magnetic field: $H_{final} = H_{initial} * (1 + \beta * x)$, where x is x-coordinate. This functional dependence was suggested by V.Yazkov([1]). Also we found the corrections ($\delta\alpha_1$ and $\delta\alpha_2$) for angular positions of the setup arms in horizontal plane(Z-coordinate is along the setup axis, X-coordinate is in horizontal plane. Fig. 1).

The Coulomb pairs(also there is the contribution of the atomic pairs) were used to determine the value of $\delta\alpha_1 + \delta\alpha_2$(-0.3mrad) and $\beta(0.75 \cdot 10^{-4} cm^{-1})$(Fig. 2-9. $P_{\pi^+\pi^-}$ - total momentum of $\pi^+\pi^-$-pairs. All the used events satisfied the cut $Q_t \leq 4MeV/c$). The Q_L-distributions were used for it. The position of Q_L-peak of Coulomb pairs must be close to zero and isn't depended on the pair total momentum. Also the position of Q_L-peak of Coulomb pairs depends on the sum of $\alpha_1 + \alpha_2$ only. We minimized the χ^2-functional which is the sum of $(Q_{L_0}/\sigma_{Q_{L_0}})^2$ over all the total momentum intervals, we used $A_0 \cdot exp((Q_L - Q_{L_0})^2/2/\sigma^2_{Q_{L_0}})$ function for the fit. The background was fitted by polynomial.

The Λ-events (Fig. 10-16. $P_{\pi p}$ - total momentum of πproton-pairs.) were used to determine $\delta\alpha_1$ and $\delta\alpha_2$ at fixed value of $\delta\alpha_1 + \delta\alpha_2$=-0.3mrad, which was obtained from Coulomb pairs set. We found that the value of $\delta\alpha_1$ =0.09 mrad(Fig. 9). We minimized the χ^2-functional which is the sum of $((M_0 - M_\Lambda table)/\sigma_{M_0})^2$ over all the total momentum intervals , we used $A_0 \cdot exp((M_{p\pi} - M_0)^2/2/\sigma^2_{M_0})$ function for the fit. The background was fitted by polynomial. For both samples of data the information from DC and SFD was used.

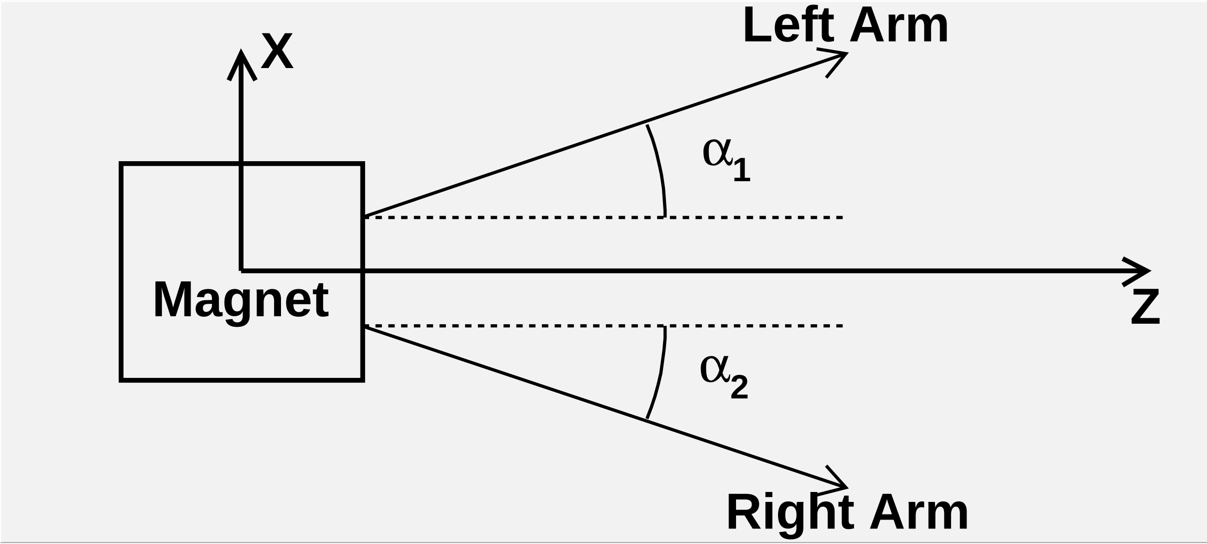

Figure 1: *DIRAC setup coordinate system.*

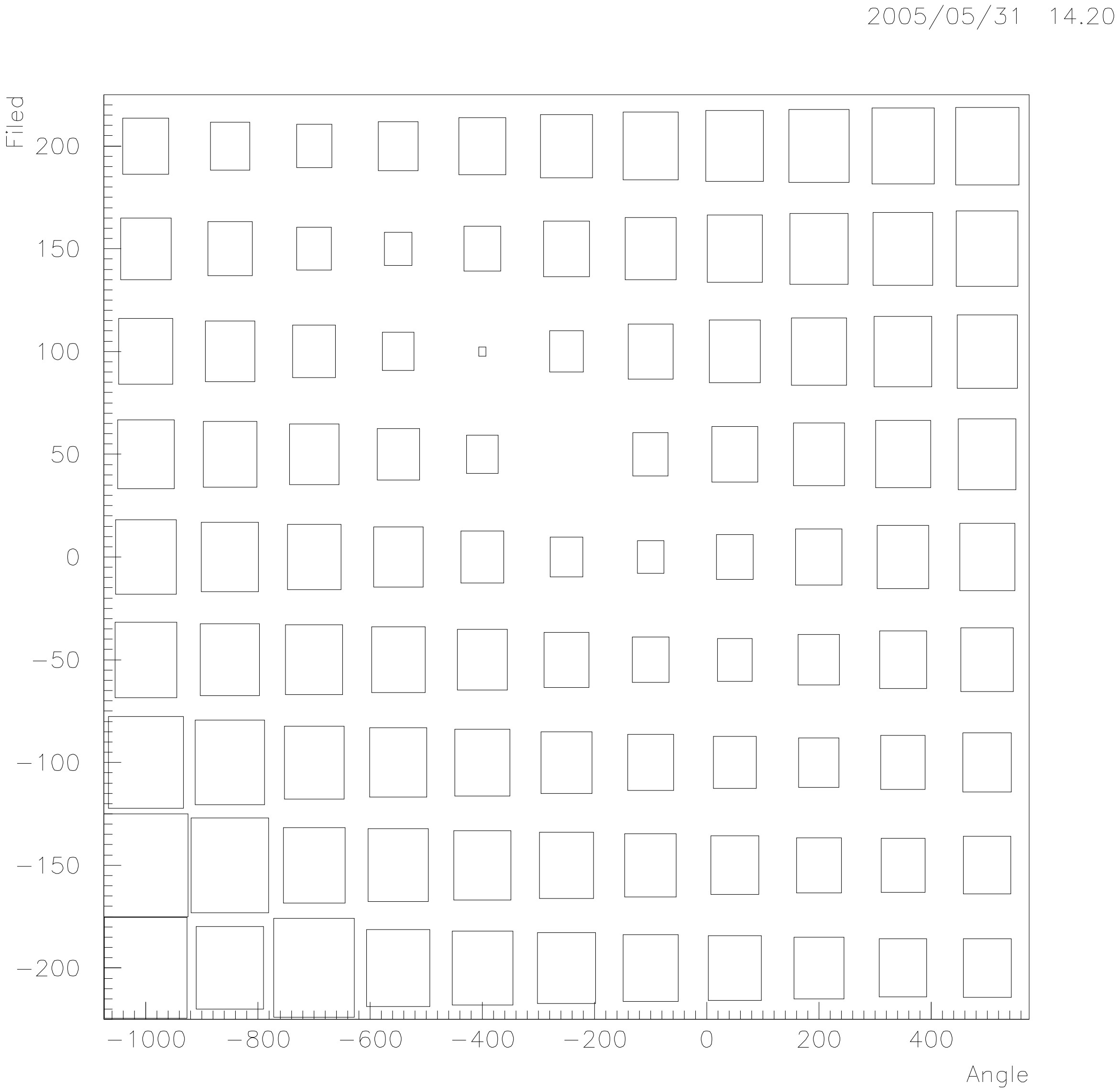

Figure 2: *The distribution of* χ^2 *as function of* $(\delta\alpha_1 + \delta\alpha_2)\cdot 10^6$*(rad) and* $\beta \cdot 10^6 (cm^{-1})$ *for Coulomb pairs*

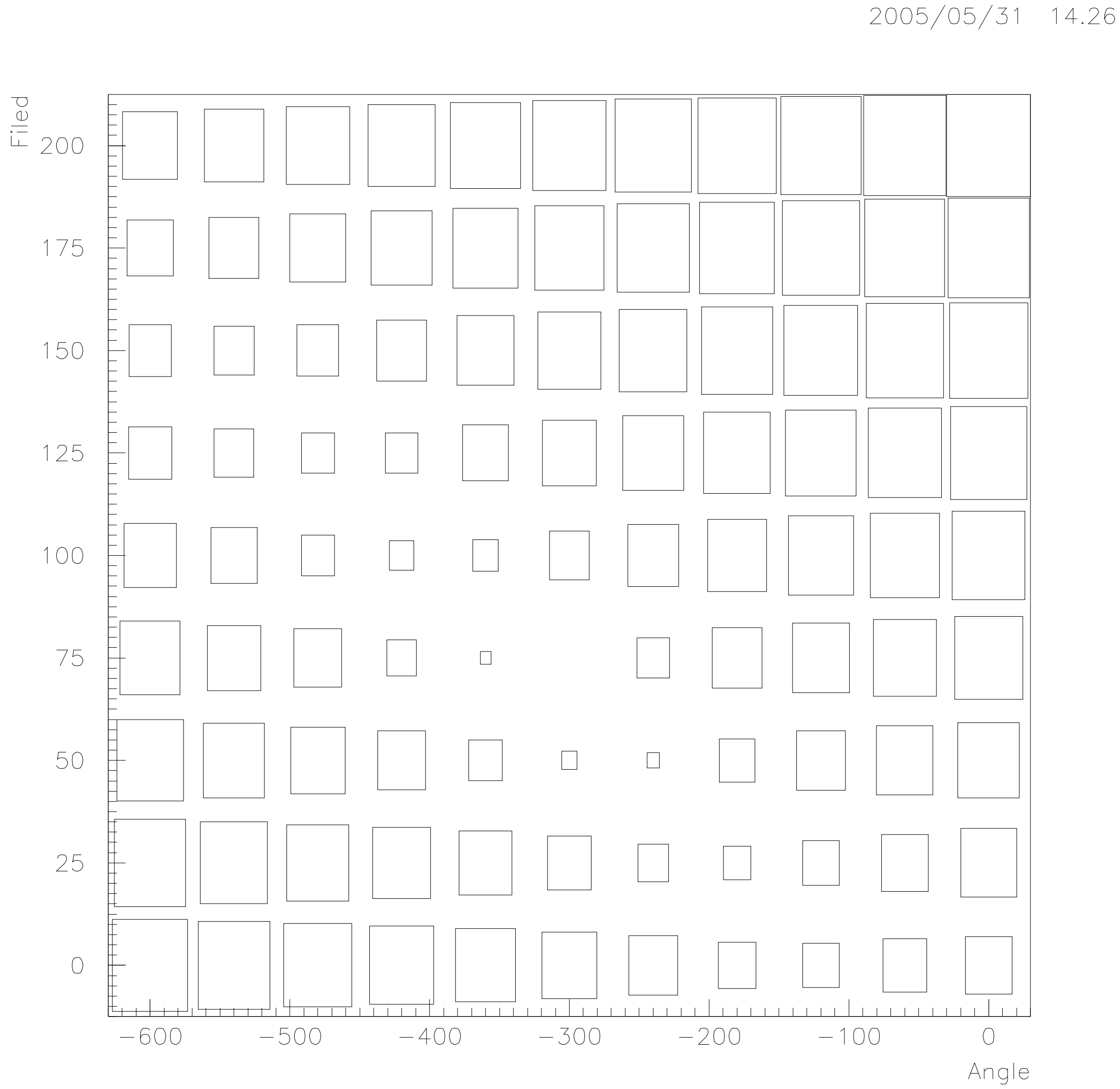

Figure 3: *The distribution of* χ^2 *as function of* $(\delta\alpha_1 + \delta\alpha_2)\cdot 10^6$*(rad) and* $\beta \cdot 10^6 (cm^{-1})$ *for Coulomb pairs*

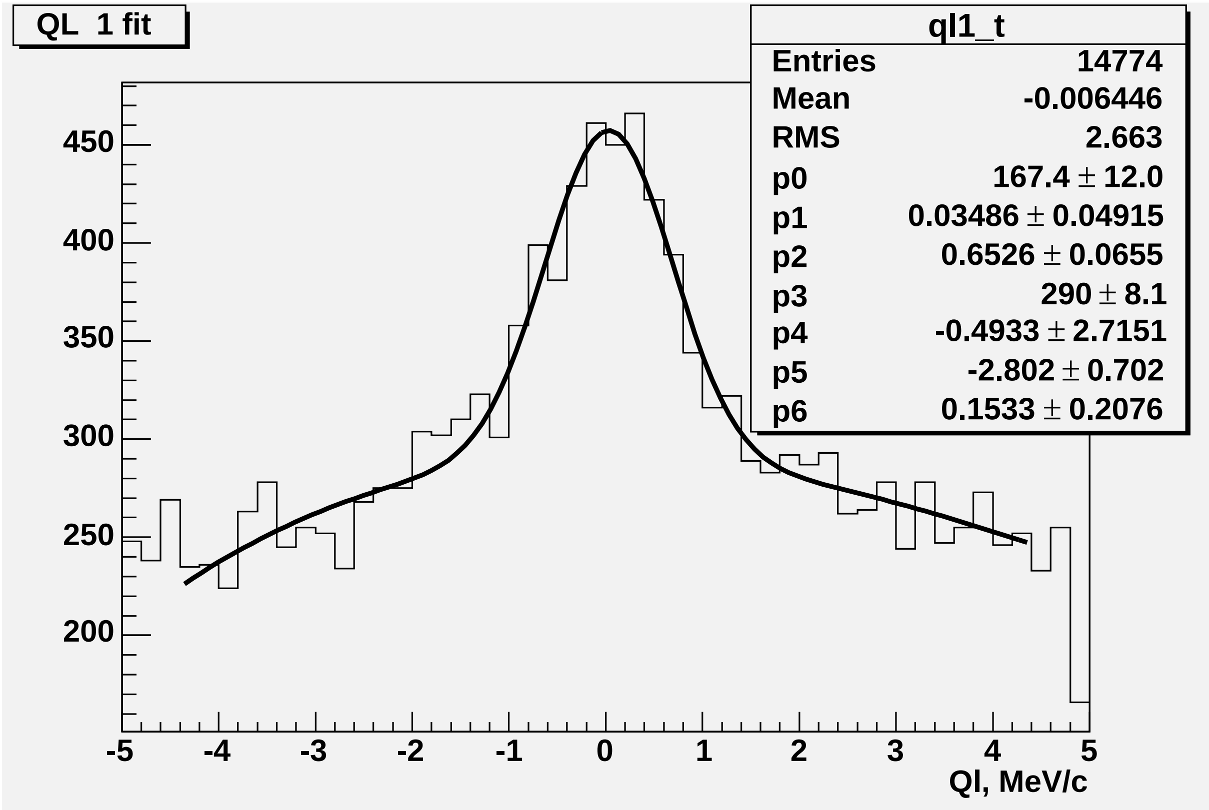

Figure 4: *The fitted Q_L distribution for Coulomb pairs with $2.9 < P_{\pi^+\pi^-} < 3.6$ GeV/c*

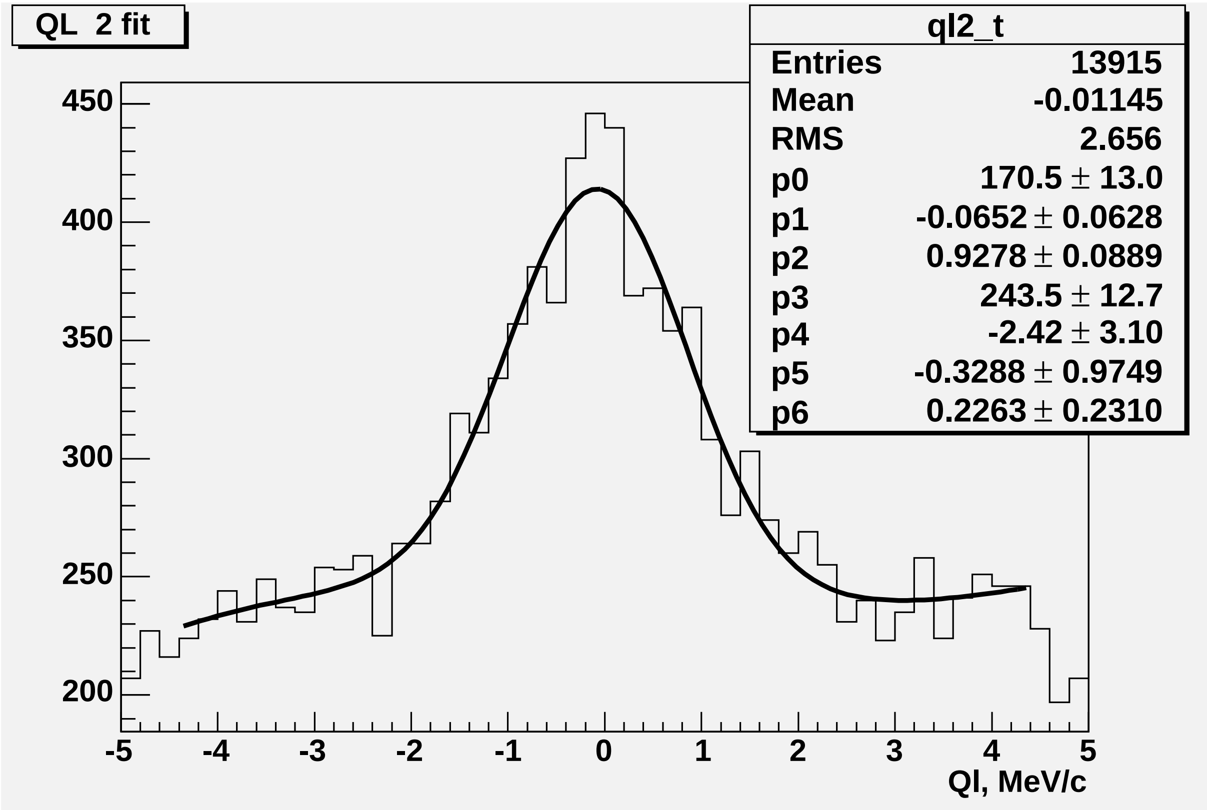

Figure 5: *The fitted* Q_L *distribution for Coulomb pairs with* $3.6 < P_{\pi^+\pi^-} < 4.3$ *GeV/c*

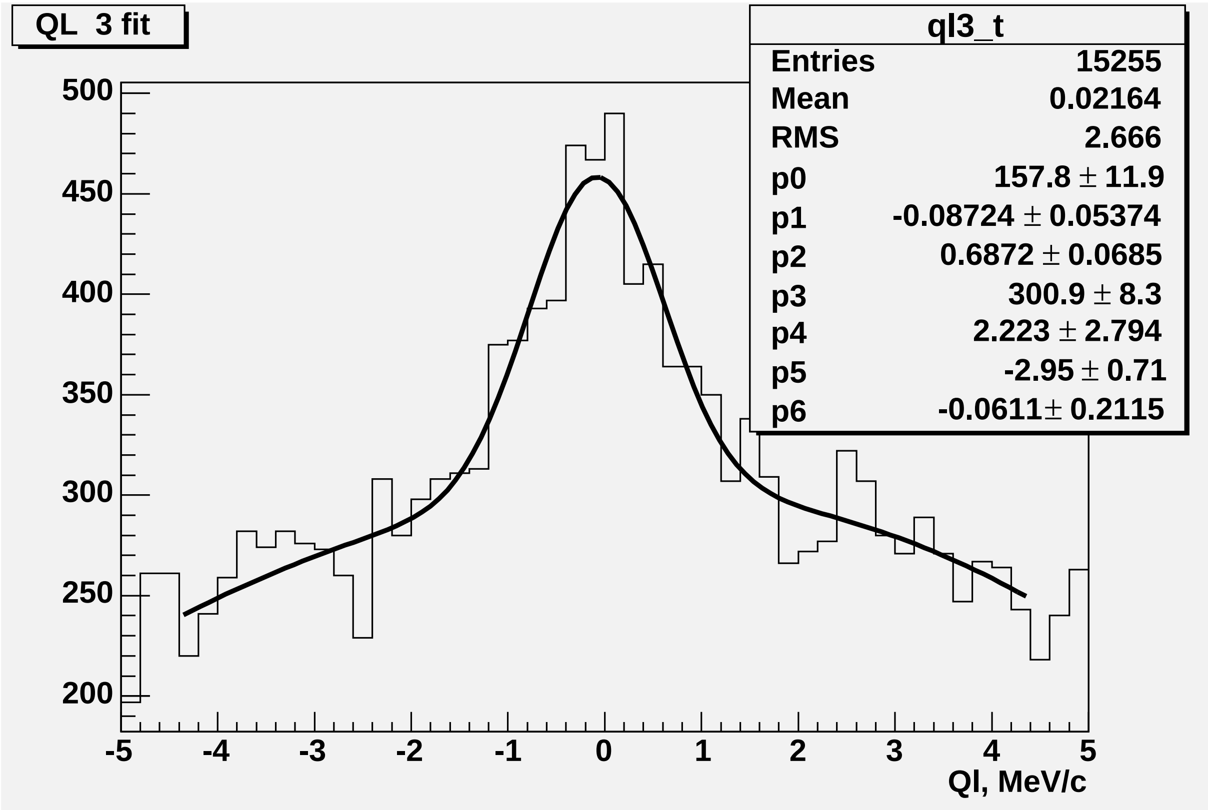

Figure 6: *The fitted* Q_L *distribution for Coulomb pairs with* $4.3 < P_{\pi^+\pi^-} < 5.3$ *GeV/c*

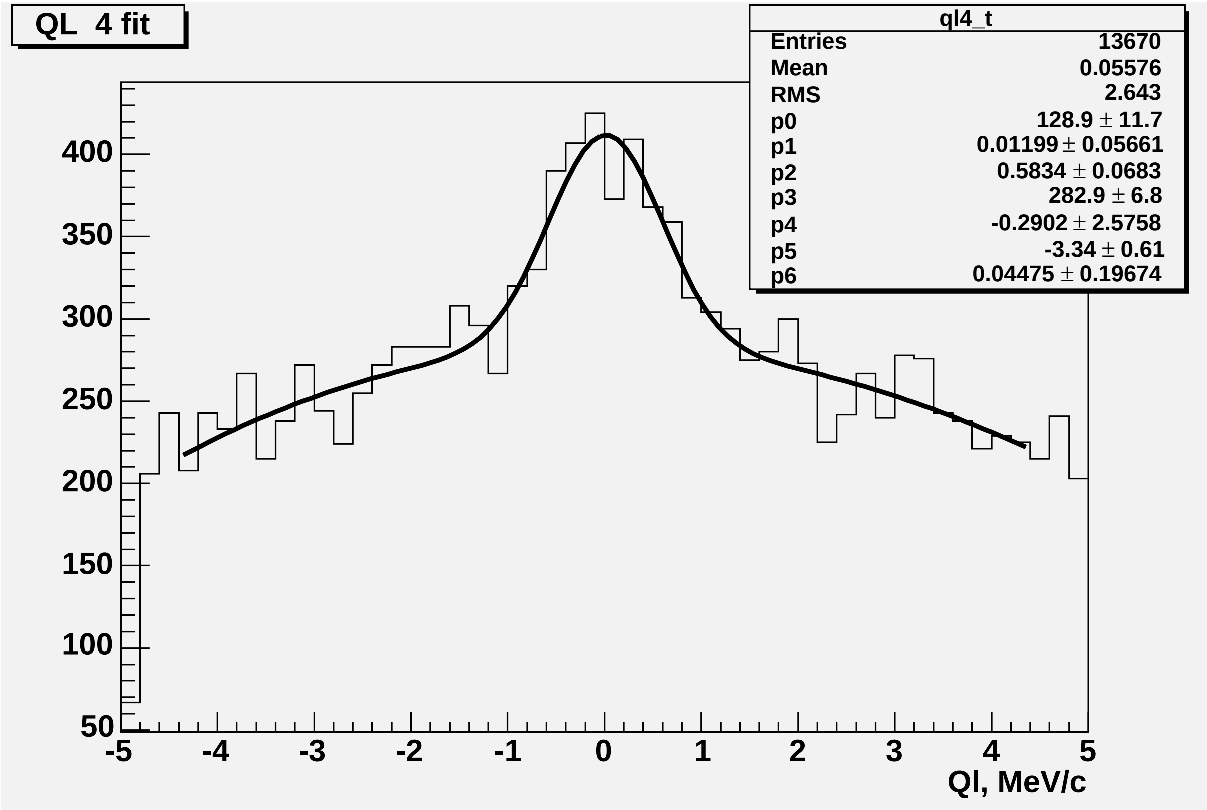

Figure 7: *The fitted* Q_L *distribution for Coulomb pairs with* $5.3 < P_{\pi^+\pi^-} < 8.0$ *GeV/c*

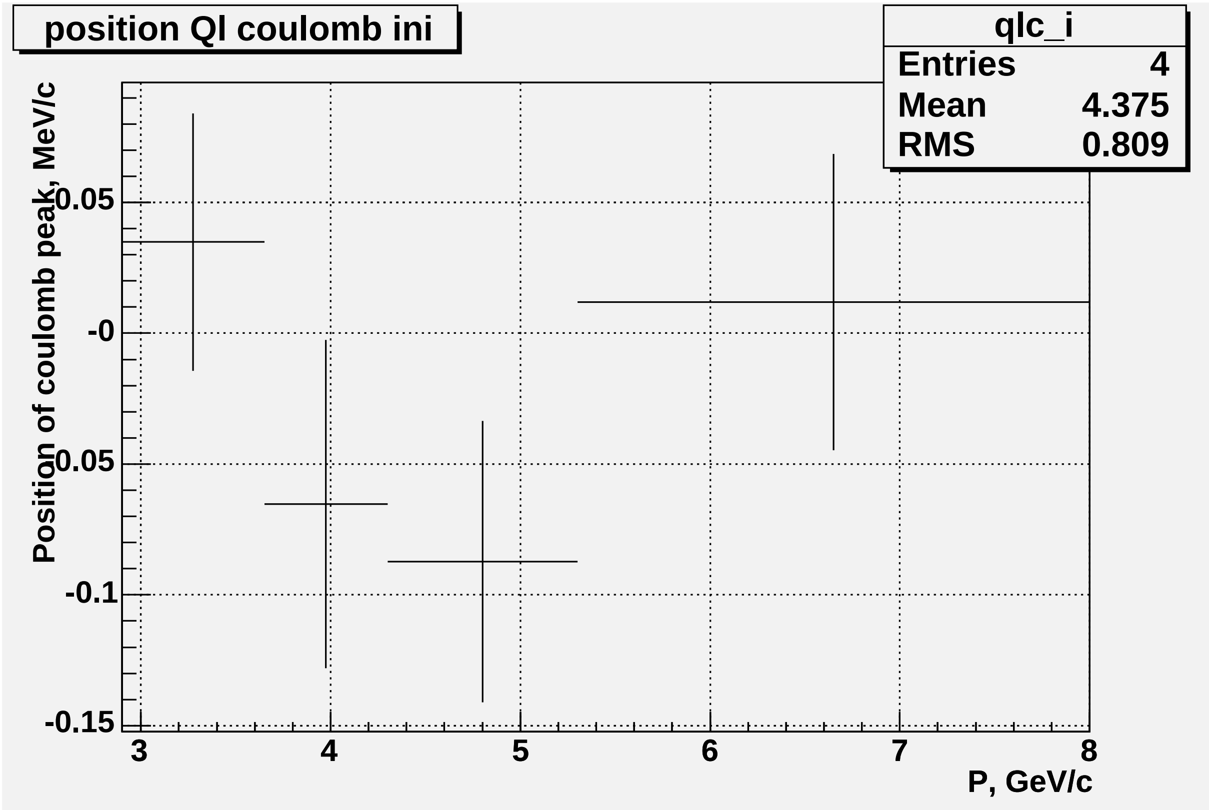

Figure 8: *The dependence of Coulomb peak position on pair momentum*($P_{\pi^+\pi^-}$) *at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *and* $\delta\alpha_1 + \delta\alpha_2$*=-0.3mrad. The mean value of* Q_L *for the all the events equals* $-0.033 \pm 0.055 MeV/c$.

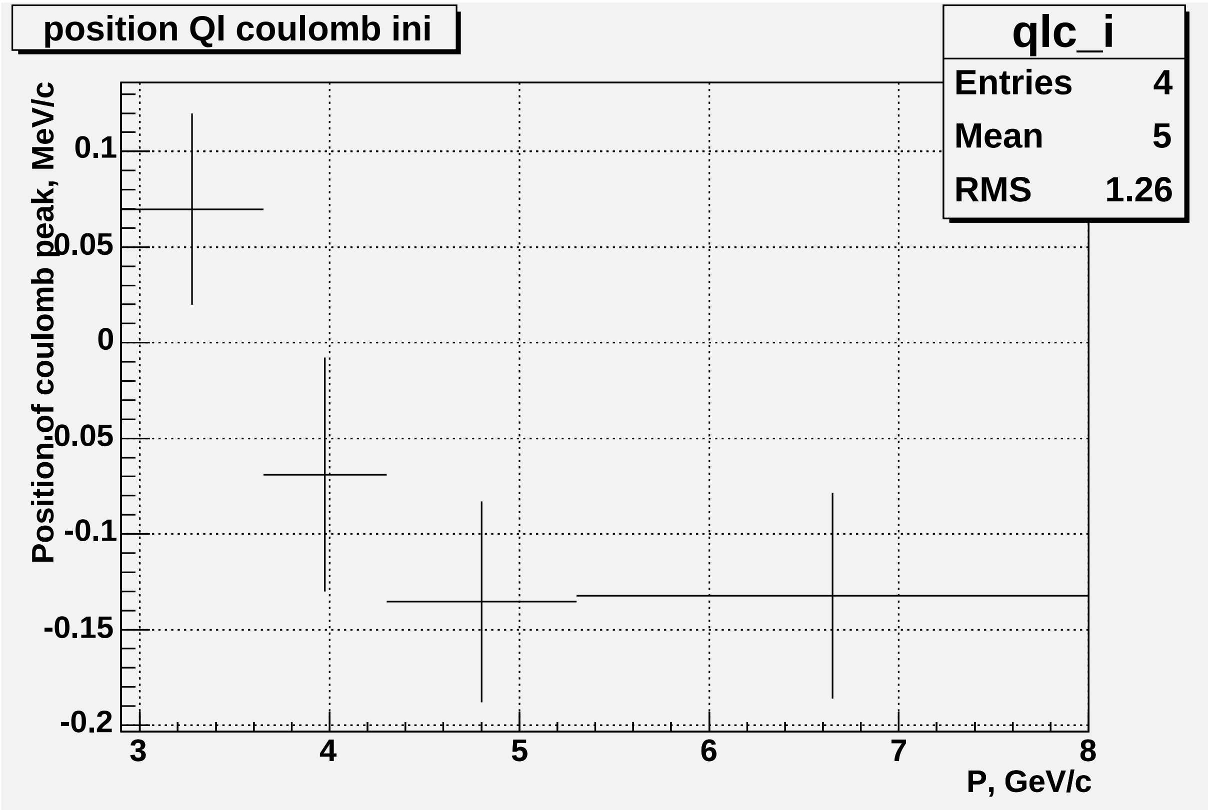

Figure 9: *The dependence of Coulomb peak position on pair momentum*($P_{\pi^+\pi^-}$) *at* $\beta = 0.$ *and* $\delta\alpha_1 + \delta\alpha_2 = 0$. *The mean value of* Q_L *for the all the events equals* $-0.066 \pm 0.061 MeV/c$.

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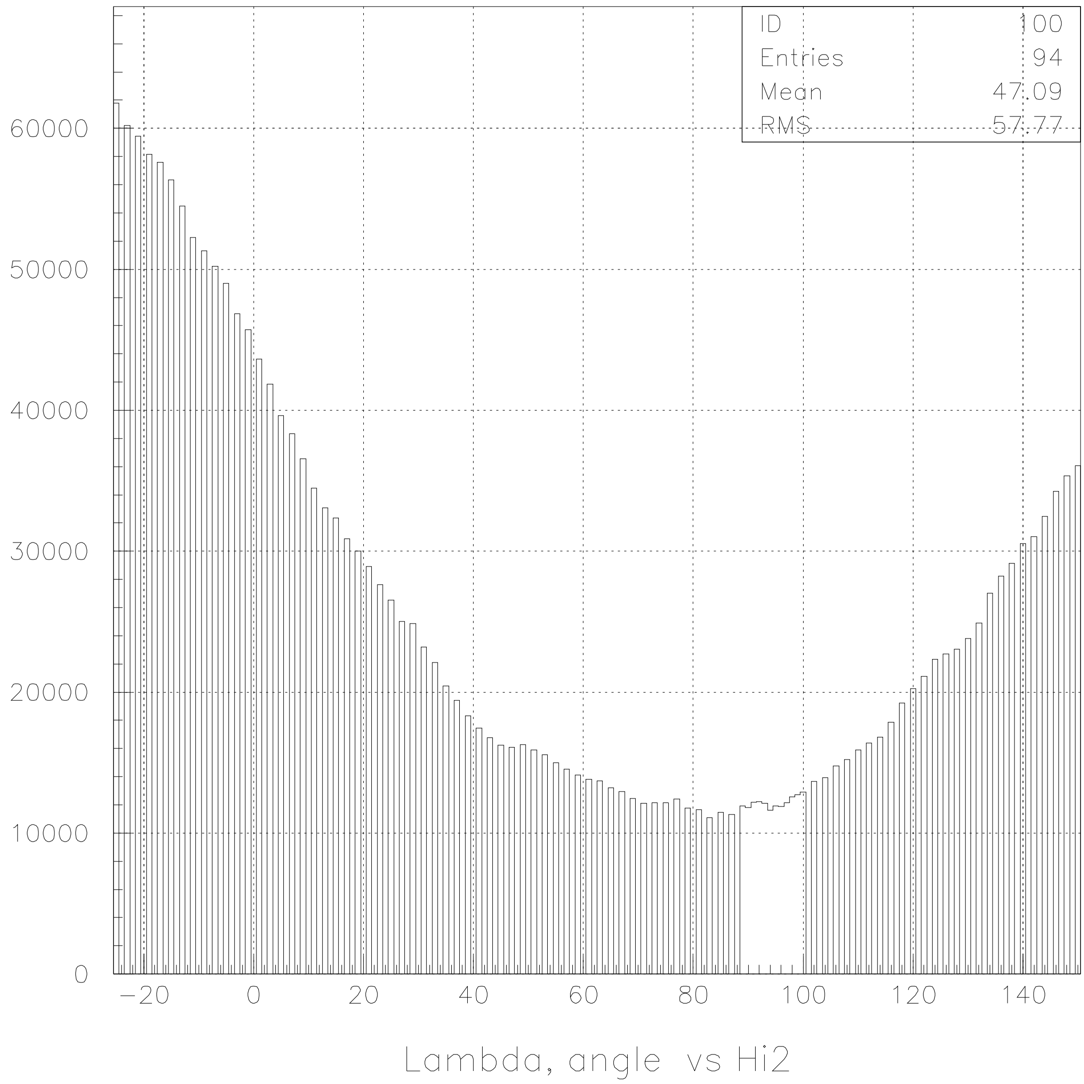

Figure 10: *The Λ-events sample. The dependence of* χ^2 *on* $\delta\alpha_1 \cdot 10^6$*(rad) at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *and* $\delta\alpha_1 + \delta\alpha_2$*=-0.3mrad*

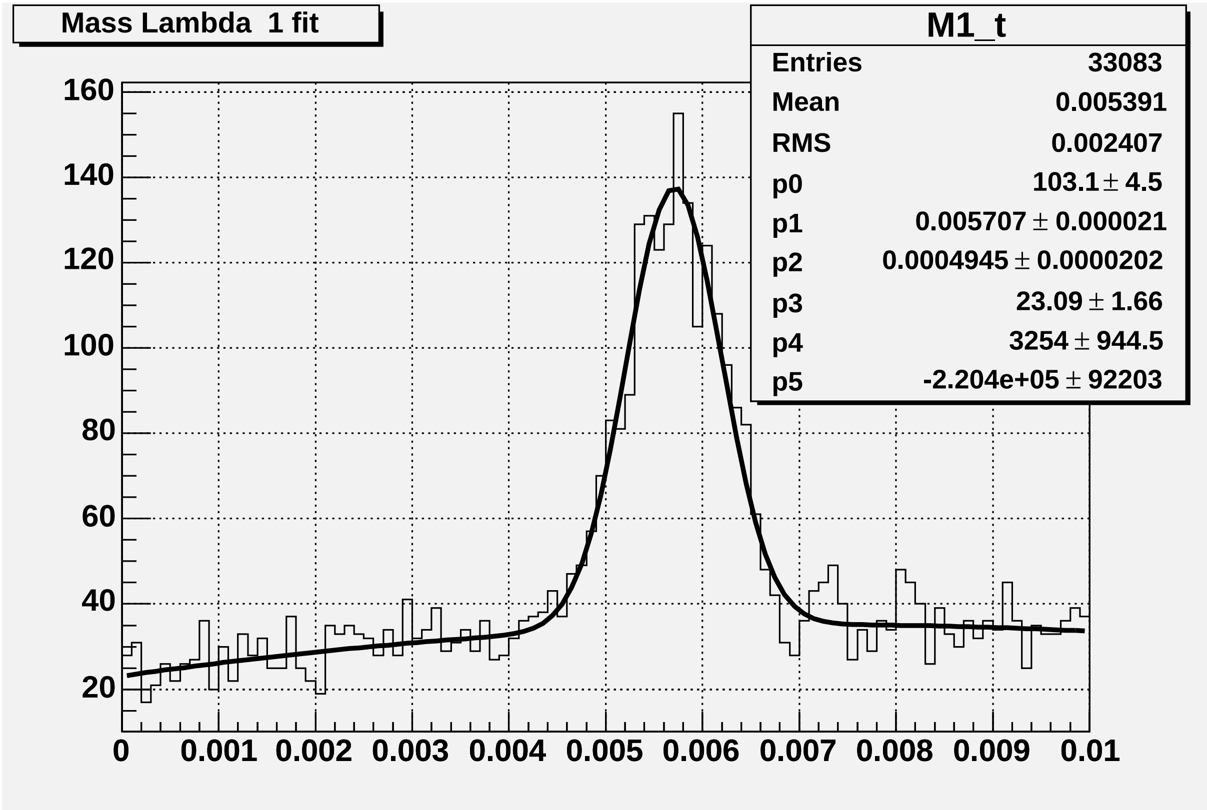

Figure 11: *The invariant mass distribution of* πp *system at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *,* $\delta\alpha_1$*=0.09mrad,* $\delta\alpha_2$*=-0.39mrad and* $5.6 < P_{\pi p} < 7.1$ *GeV/c. The value of* $1.11 GeV/c^2$ *was subtracted. The The PDG value of* Λ*-mass is equal to* $M_\Lambda - 1.11 = 0.005683 \pm 0.000006 GeV/c^2$.

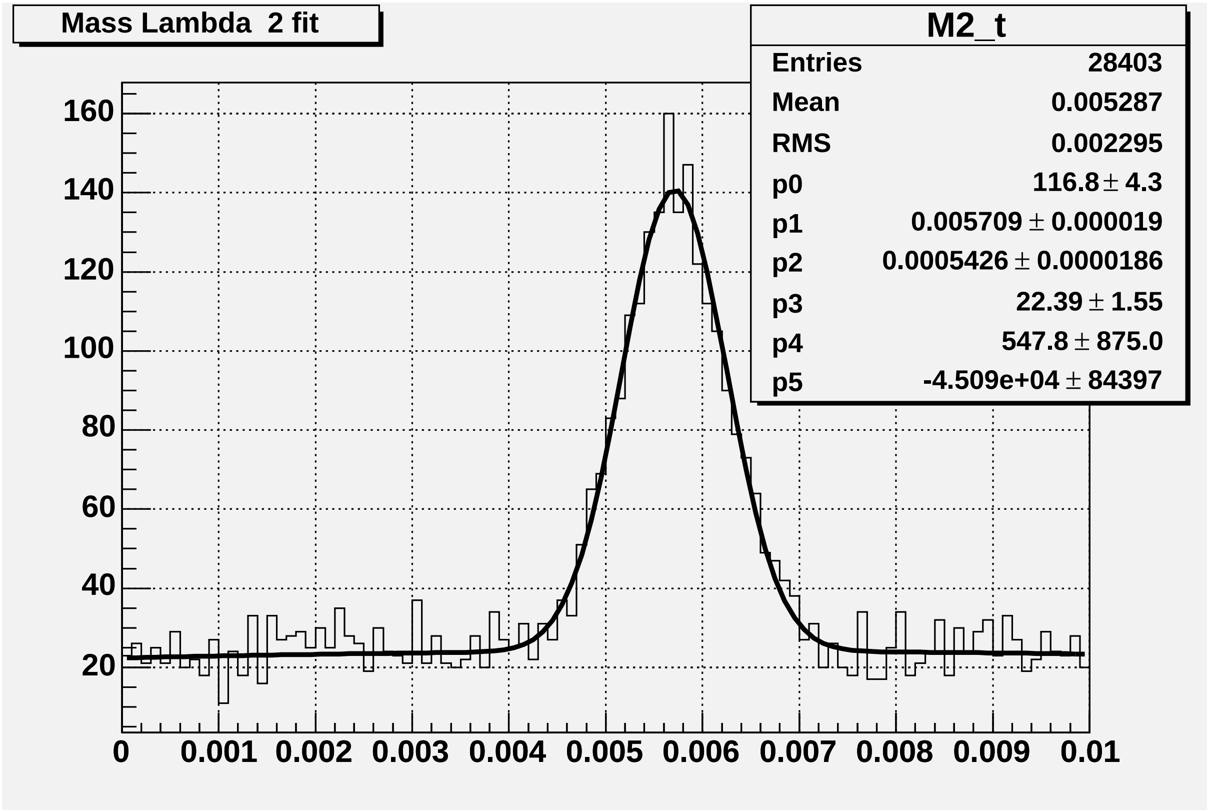

Figure 12: *The invariant mass distribution of* πp *system at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *,* $\delta\alpha_1$*=0.09mrad,* $\delta\alpha_2$*=-0.39mrad and* $7.1 < P_{\pi p} < 7.6$ *GeV/c. The value of* $1.11 GeV/c^2$ *was subtracted. The The PDG value of* Λ*-mass is equal to* $M_\Lambda - 1.11 = 0.005683 \pm 0.000006 GeV/c^2$*.*

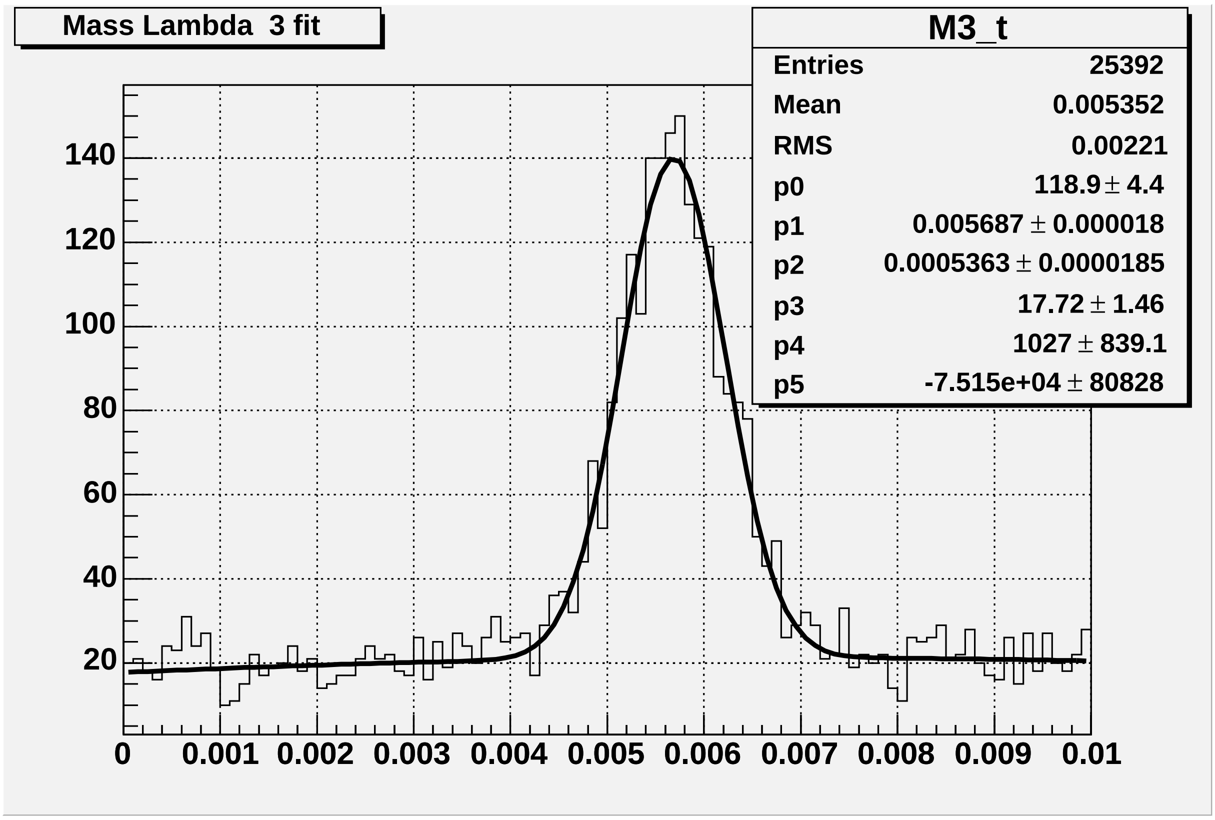

Figure 13: *The invariant mass distribution of* πp *system at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$, $\delta\alpha_1$*=0.09mrad,* $\delta\alpha_2$*=-0.39mrad and* $7.6 < P_{\pi p} < 8.1$ *GeV/c. The value of* $1.11 GeV/c^2$ *was subtracted. The The PDG value of* Λ*-mass is equal to* $M_\Lambda - 1.11 = 0.005683 \pm 0.000006 GeV/c^2$.

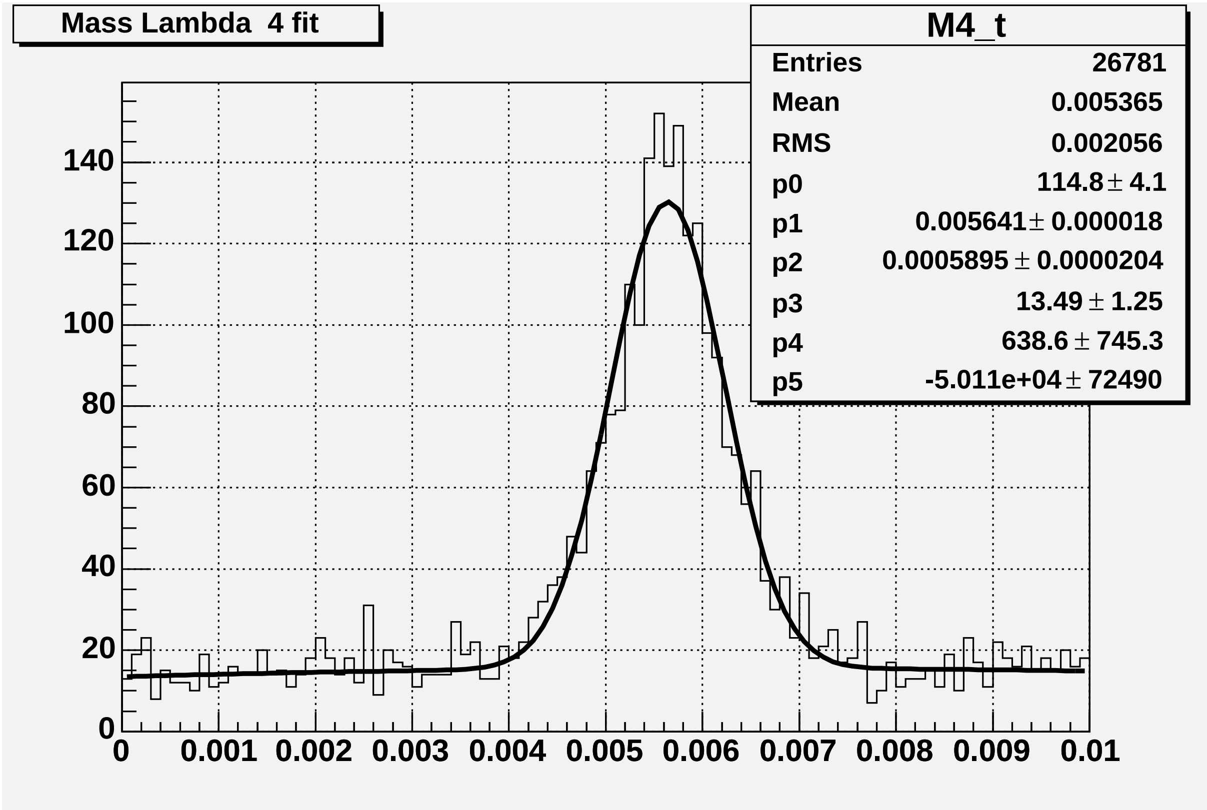

Figure 14: *The invariant mass distribution of* πp *system at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$, $\delta\alpha_1$*=0.09mrad,* $\delta\alpha_2$*=-0.39mrad and* $8.1 < P_{\pi p} < 8.5$ *GeV/c. The value of* $1.11 GeV/c^2$ *was subtracted. The The PDG value of* Λ*-mass is equal to* $M_\Lambda - 1.11 = 0.005683 \pm 0.000006 GeV/c^2$.

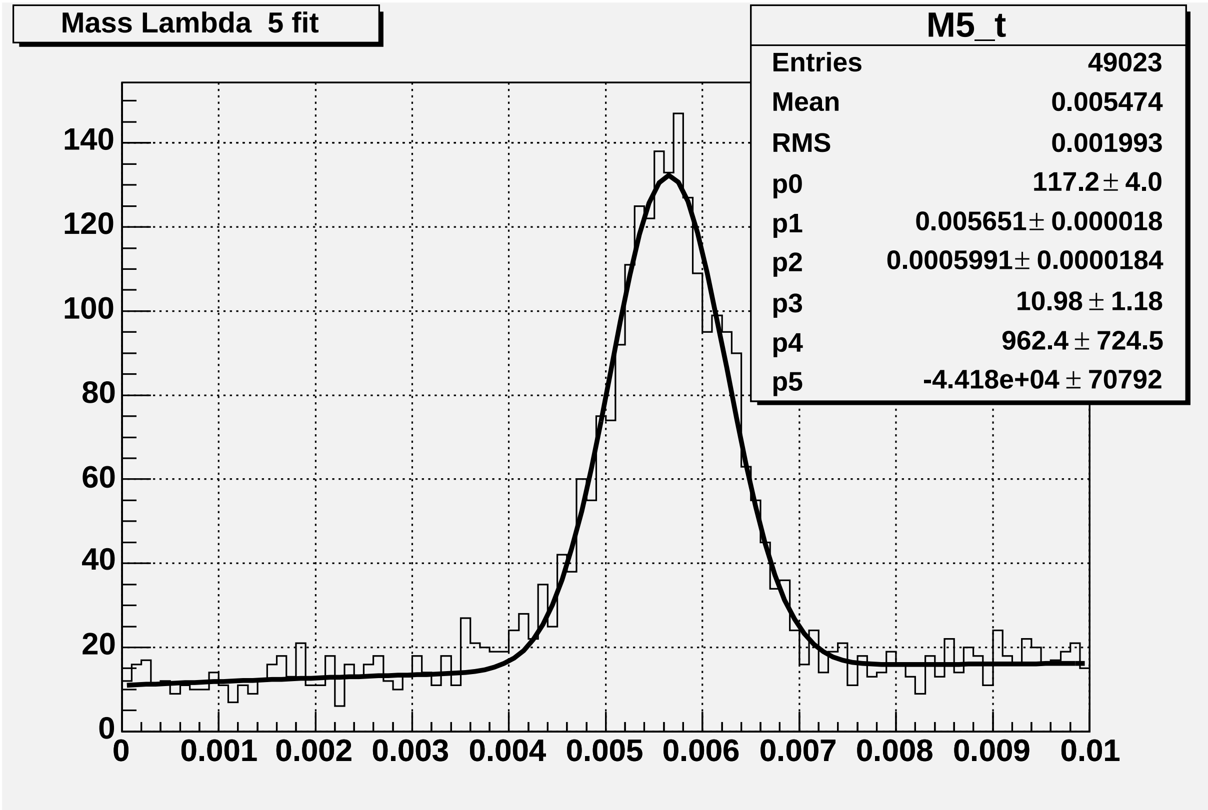

Figure 15: *The invariant mass distribution of* πp *system at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *,* $\delta\alpha_1$*=0.09mrad,* $\delta\alpha_2$*=-0.39mrad and* $8.5 < P_{\pi p} < 9.7$ *GeV/c. The value of* $1.11 GeV/c^2$ *was subtracted. The The PDG value of* Λ*-mass is equal to* $M_\Lambda - 1.11 = 0.005683 \pm 0.000006 GeV/c^2$*.*

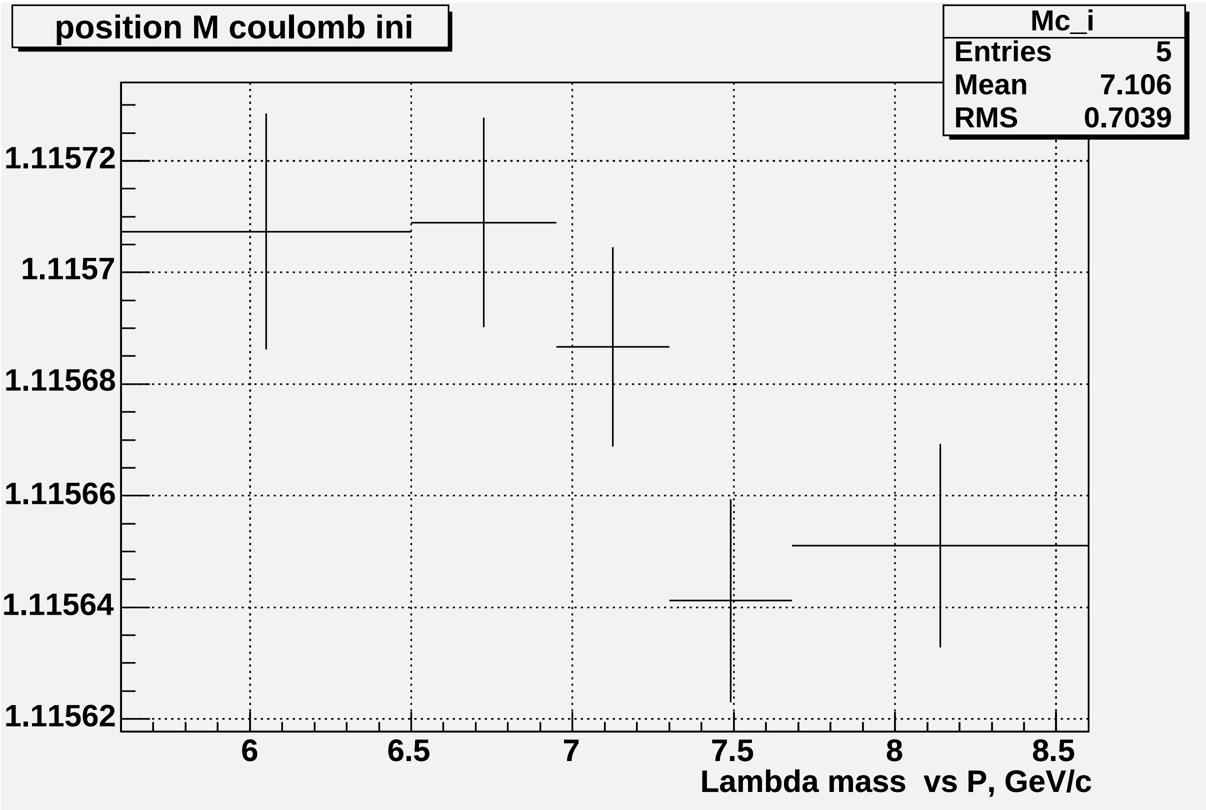

Figure 16: *The dependence of* Λ*-peak position on its momentum at* $\beta = 0.75 \cdot 10^{-4}(cm^{-1})$ *,* $\delta\alpha_1$*=0.09mrad and* $\delta\alpha_2$*=-0.39mrad. The mean value of* Λ*-mass for the all the events equals* $1.115678 \pm 0.000021 GeV/c^2$*. The The PDG value of* Λ*-mass is equal to* $M_\Lambda = 1.115683 \pm 0.000006 GeV/c^2$*.*

References

[1] V.V.Yazkov. Correction of possible inaccuracy of magnetic field map. DIRAC Note 2005-14.