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The new results on the Lambda peak width and $\triangle X$ coordinates at the target for 2002 year and comparison with MC results.

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1 Preface

In this work we continue to tune the alignment of the setup using the analysis of lambda peaks for real and MC data, the analysis of ΔX coordinates distributions at the target and the analysis of Coulomb correlated pion pairs like it was done in ([1]-[5]).

The main aim of this job was to find the optimal values of the magnetic field position along Z-axis(Z_{membr}) and the correction for the each arm angle α_x in the horizontal plane(for both arms this angle(its initial value is 19^o) was increased or decreased simultaneously.

The corresponding analysis was done for data of year 2002, proton beam momentum - 20 GeV/c.

2 Results

2.1 ΔX distributions for $\pi^+\pi^-$ pairs.

On the Fig.1-4 these results are shown. For both tracks of $\pi^+\pi^-$ pairs the distributions of the values of X-coordinates at the level of the target were obtained. It was done for set of two-dimensional parameters - Z_{membr} versus α_x. For each of these distributions the fitting by gaussian was done and the parameters, mean value and σ, were plotted(Fig.1-3). Also the values of ΔX were plotted(Fig.4). We see that the mean value of X-coordinate depends both on the values of Z_{membr} and α_x and for the arms this dependence has the opposite signs. The σ of X-coordinates varies little. The main sense is connected with the behavior of ΔX distribution(Fig.4). On this plot the region we are interested is the points with $\Delta X = 0$ and it means that is the line which is drawn in the red on this picture. The parameters of this line: $Z_{membr} = 143.332 + 595.571 * \alpha_x$. To find the optimal values of Z_{membr} and α_x the analysis of Lambda peaks should be applied.

2.2 Λ peak analysis

There were selected the proton-pion pairs with total momentum from 5.0 to 8.6 GeV/c. As the momentum distribution for MC and real data pairs are a bit different then the MC events were weighted to get the same momentum distribution as for real data. As the real data and MC have a bit different distributions of the χ^2 in the drift chambers then the corresponding correction was also applied. The real data distributions were fitted by the function which is the sum of Gaussian and polynomial of the second degree. The last one describes the background.

The used fitting procedure was the standard one - MINUIT. In the principle it is the problem for all the fitting procedures to obtain the most correct values of errors of parameters. As in our case the real data distributions have some background whereas the MC ones don't have it(it means that MC distributions have the tails which fall up to zero) and , in principle, this fact could influence on the result for fitting of MC distributions then the MC distributions were slightly modified to make the fitting conditions equal for both types of data: the proportional constant "background" was added to each MC distribution(the ration of peak/background must be the same for MC and real data). The MC data distributions were fitted therefore by the function which is the sum of Gaussian and polynomial of the second degree.

We can use the distribution of mean value of Lambda peak for different values of Z_{membr} and α_x (Fig.5) to determine these two parameters optimal values. This can be done if we demand that the mean value of Lambda peak must be equal to the table value(the green line). The intersection point gives the optimal values of both parameters:$Z_{membr} = 143.285cm$ and $\alpha_x = -0.00008rad$. The both lines are drawn also on the 2-dimensional plot where the distribution of the Lambda peak width are shown(Fig.6). The bin where these two line intersect contains the value of $0.000439 \pm 0.000004GeV/c^2$.

The same two plots but for MC data are shown on Fig.7 and 8. Using the last distribution we can test the consistency of GEANT-DIRAC and ARIANE softwares: Z_{membr} must be 143.95 cm and α_x equals to zero. We fitted the second distribution by 2-dimensional polynomial of third degree , found the minimum of this polynomial and obtained that Z_{membr}=143.93 cm and α_x=-0.000004 rad. Within the errors they coincide with proper values.

So now we can finally compare the two Lambda widths, for MC and real data(Fig.9 and 10), they are 414.5 ± 2.4(MC) and $437.9 \pm 4.0KeV/C^2$(real data), correspondingly. Their ration is equal to 1.056$\pm$0.011. You can see that the Lambda peak shape is different for real data and MC. We can compare the RMS only for Lambda events which belong to 2σ or 3σ intervals($\sigma = 414.5KeV/C^2$). The results for the RMS ratio differ from the previous one: 1.036 at 3σ and 1.019 at 2σ. Which values should be selected? It determines our systematical error which goes from Lambda peak comparison.

2.3 Coulomb peak analysis.

Also we analyzed the parameters(position and width) of coulomb peaks for different values of total momentum. The distributions of the coulomb peak mean value are shown on Fig.11-14 and the width ones are on Fig.15-18. The statistics is not to big hence we see a significant fluctuations. For the optimal values of Z_{membr} and α_x the mean value of Q_L equals to 0.0387559,-0.064175,-0.300251,-0.0969145 correspondingly and for the width(gaussian σ):1.0692,1.20919,1.11575,1.19571.

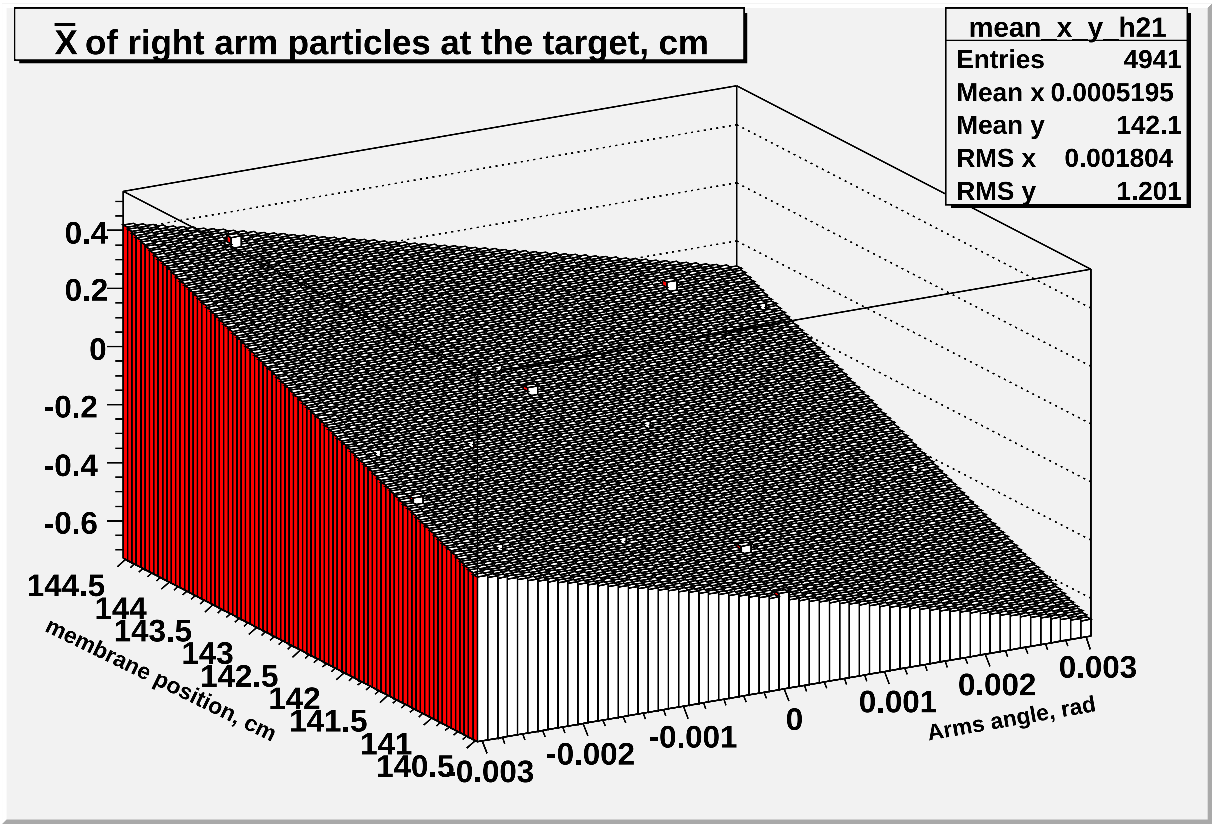

Figure 1: *The distribution of mean value of X-coordinate at the level of target of right arm tracks.*

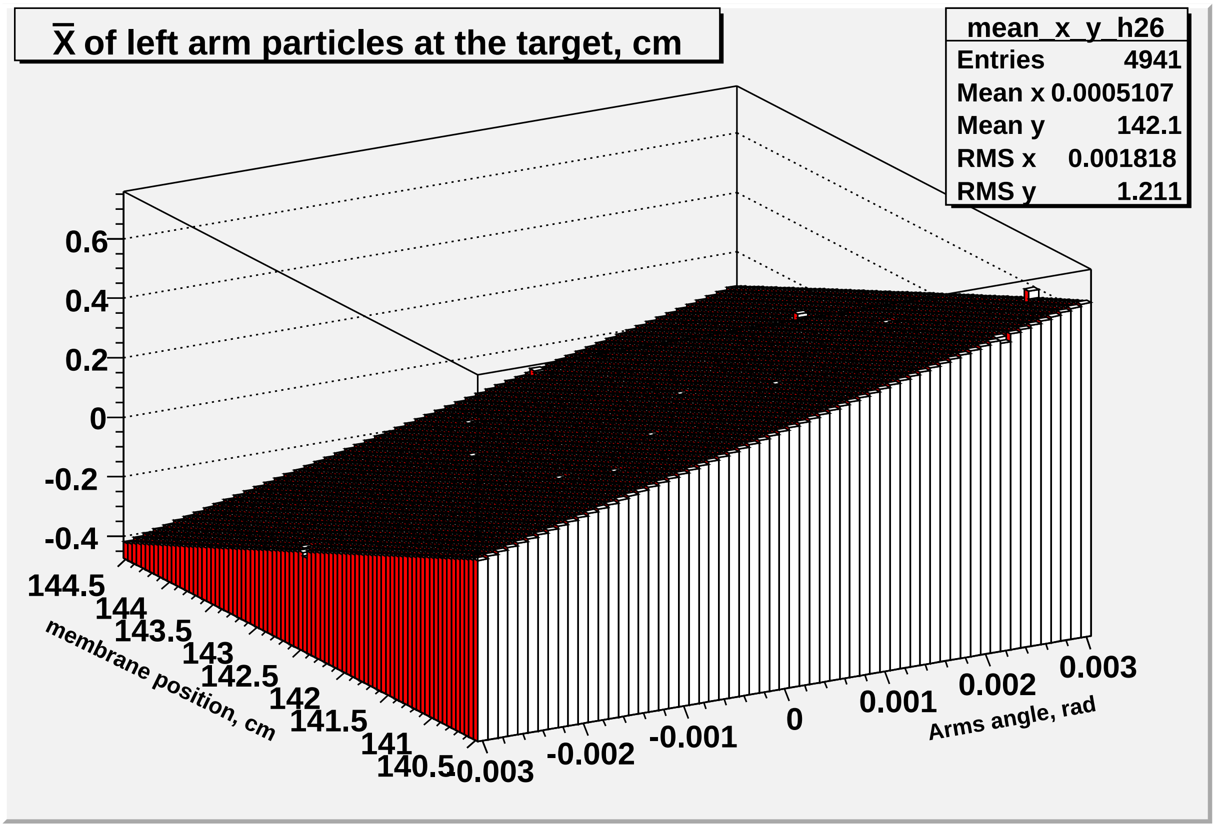

Figure 2: *The distribution of mean value of X-coordinate at the level of target of left arm tracks.*

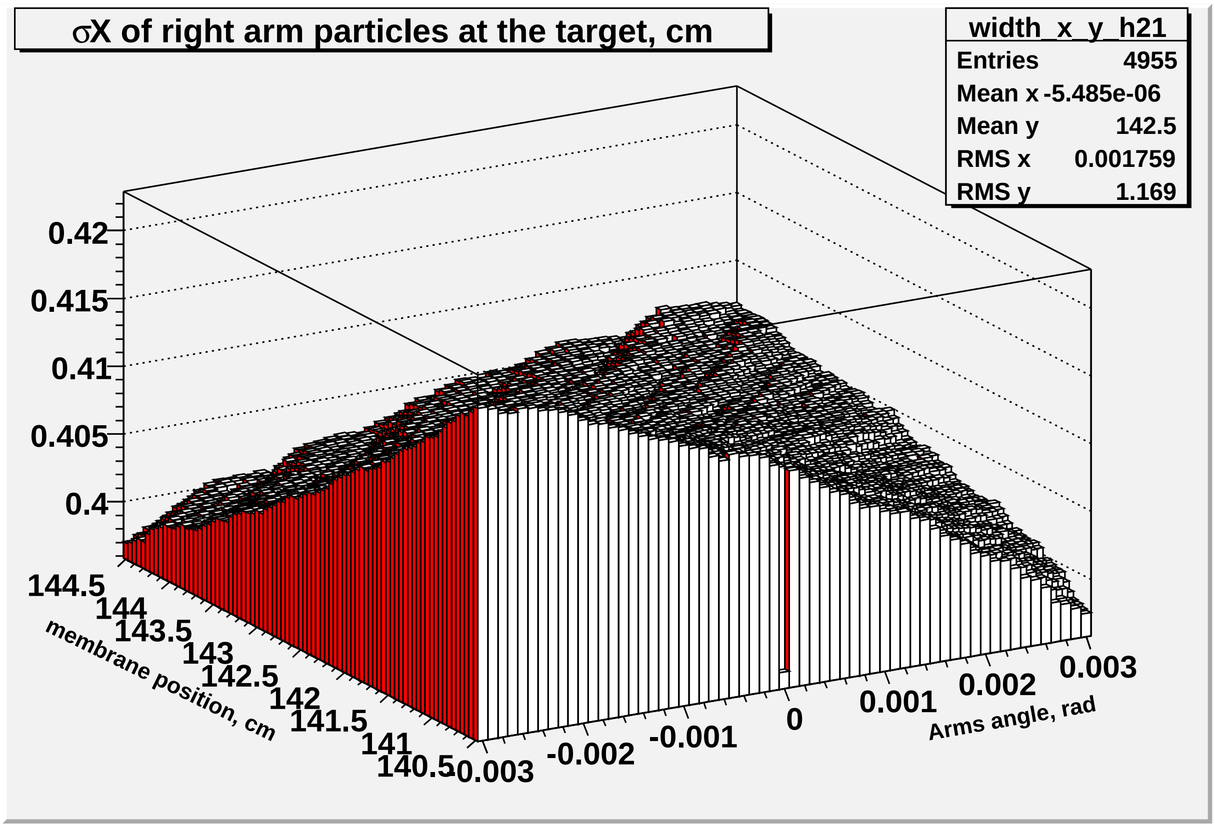

Figure 3: *The distribution of width value of X-coordinate at the level of target of right arm tracks.*

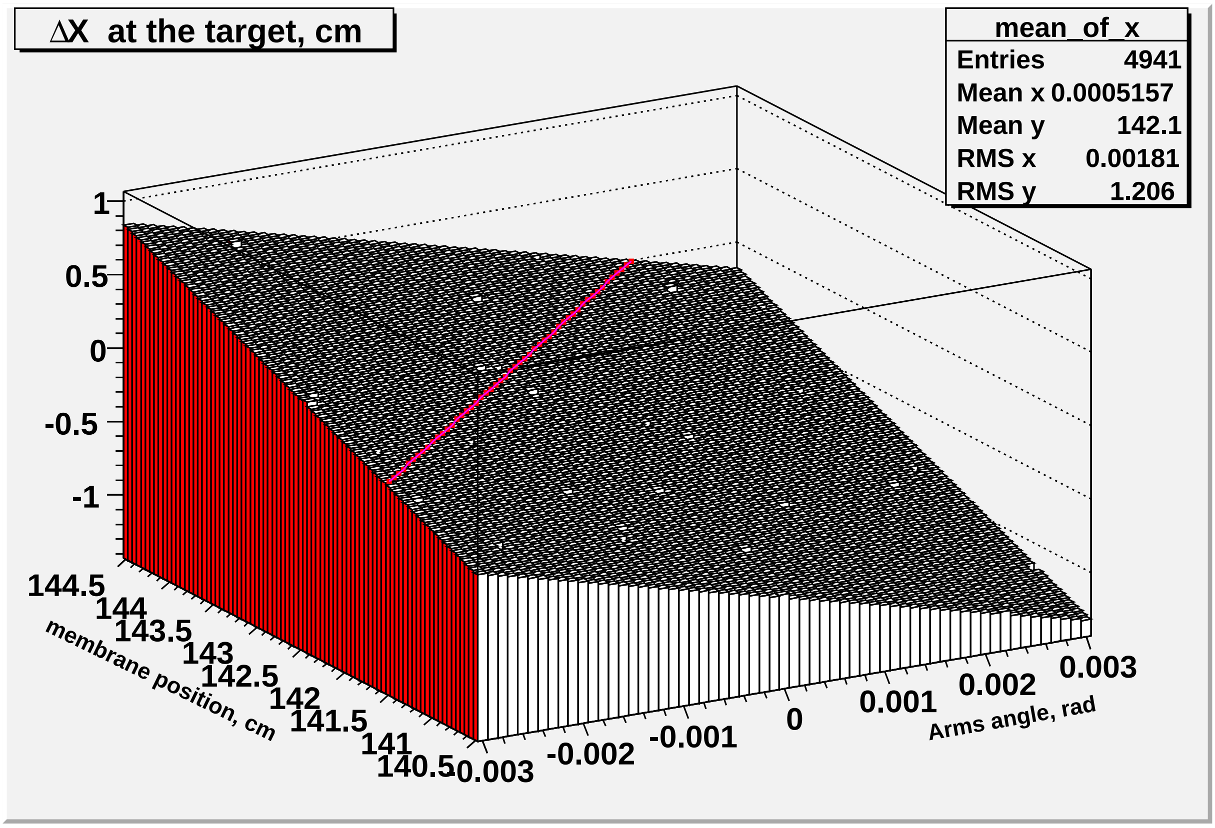

Figure 4: *The distribution of ΔX-coordinate at the level of target.*

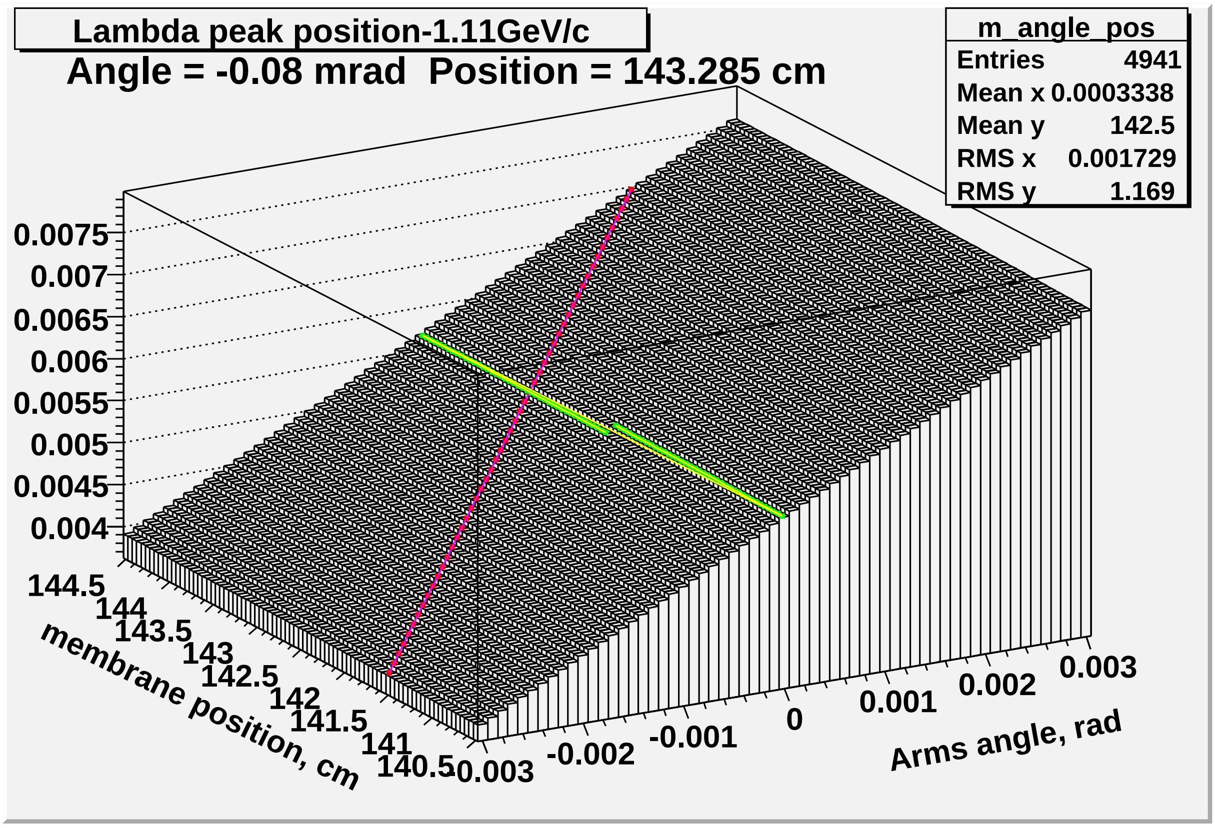

Figure 5: *The distribution of the Lambda peak position for real data.*

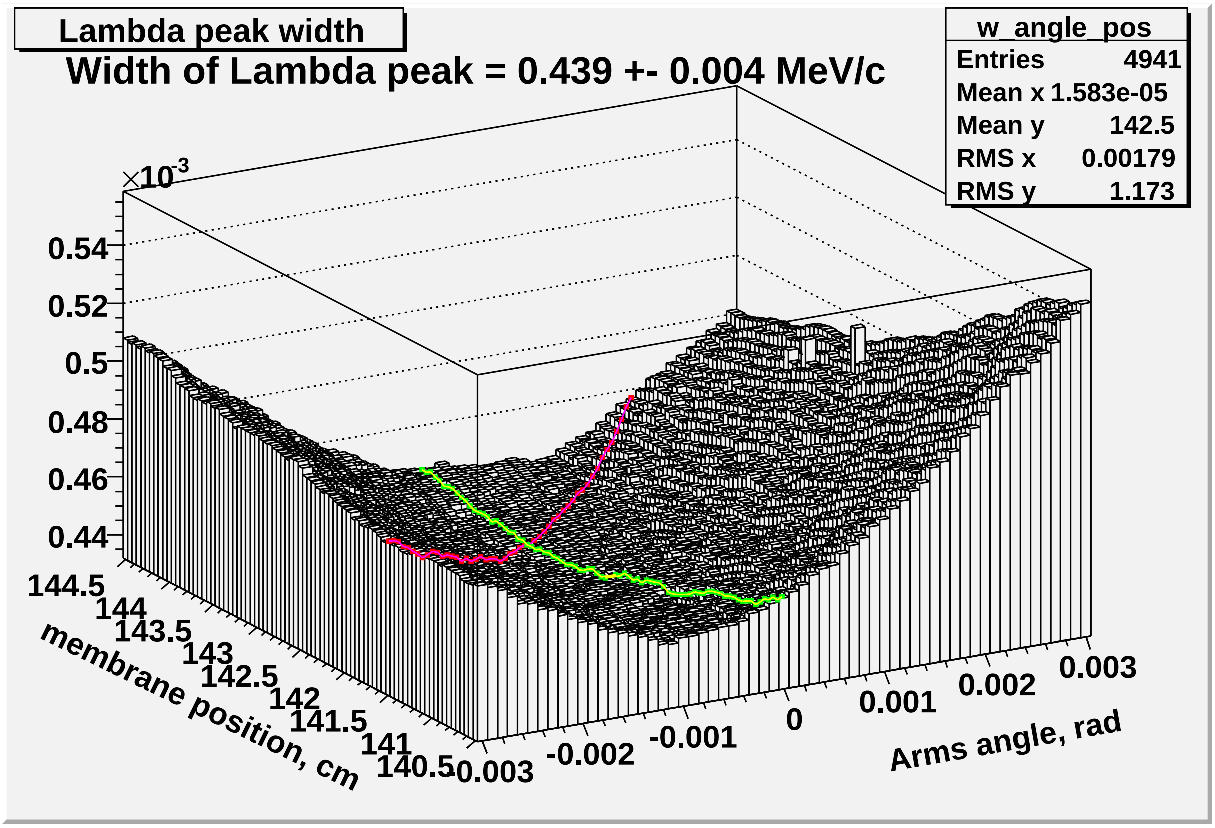

Figure 6: *The distribution of the Lambda peak width for real data.*

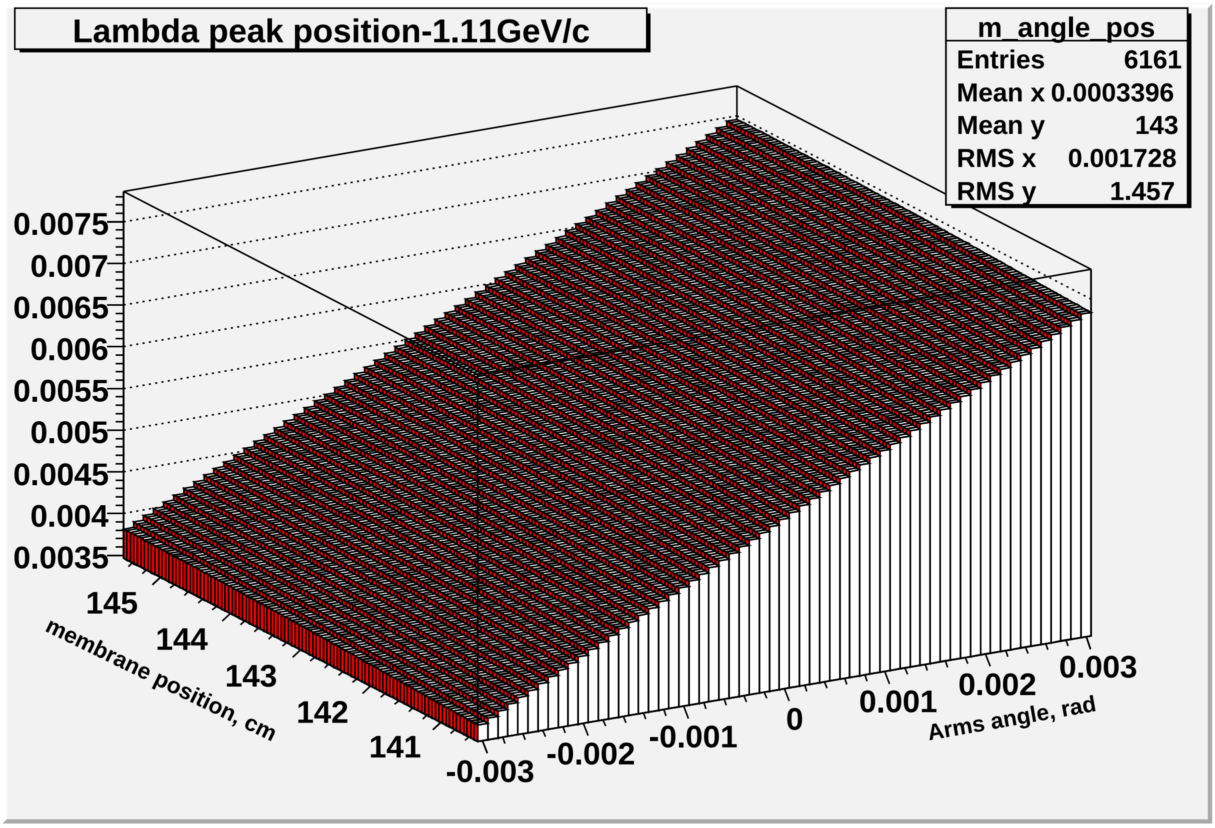

Figure 7: *The distribution of the Lambda peak position for MC data.*

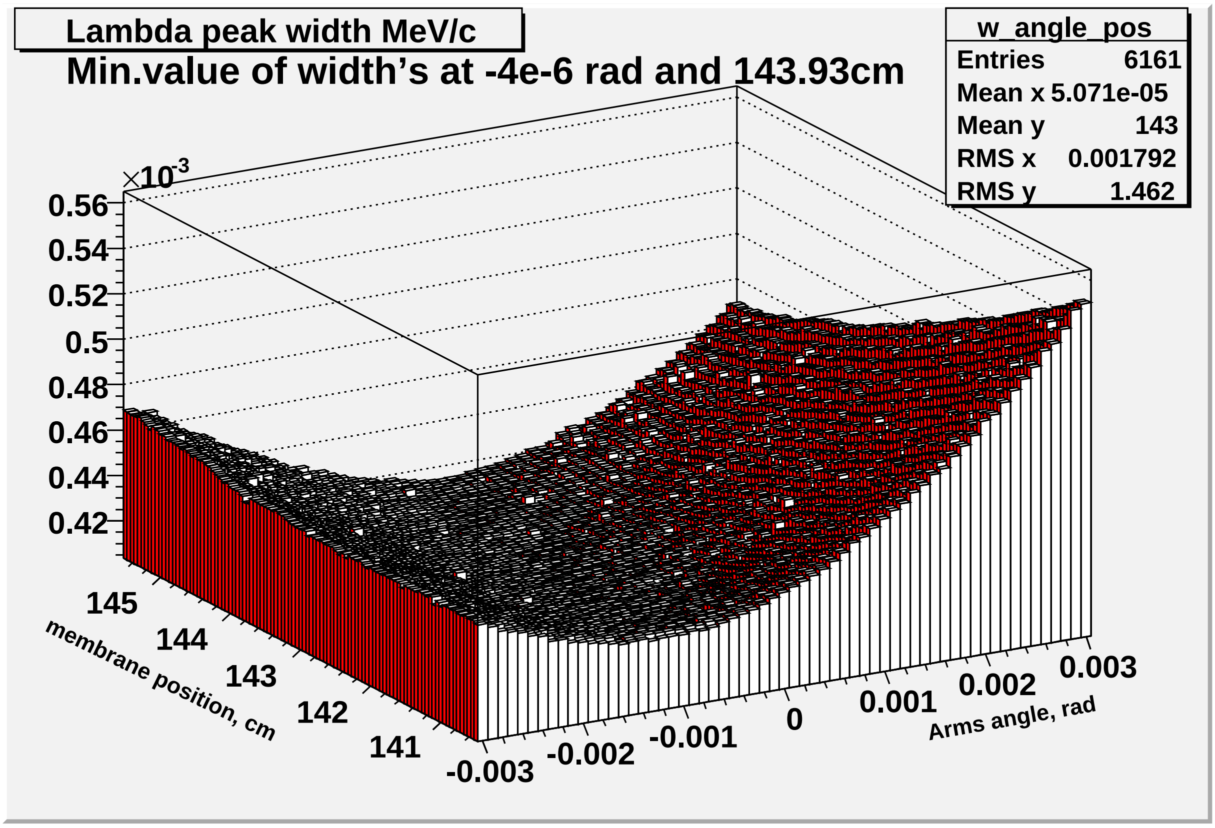

Figure 8: *The distribution of the Lambda peak width for MC data.*

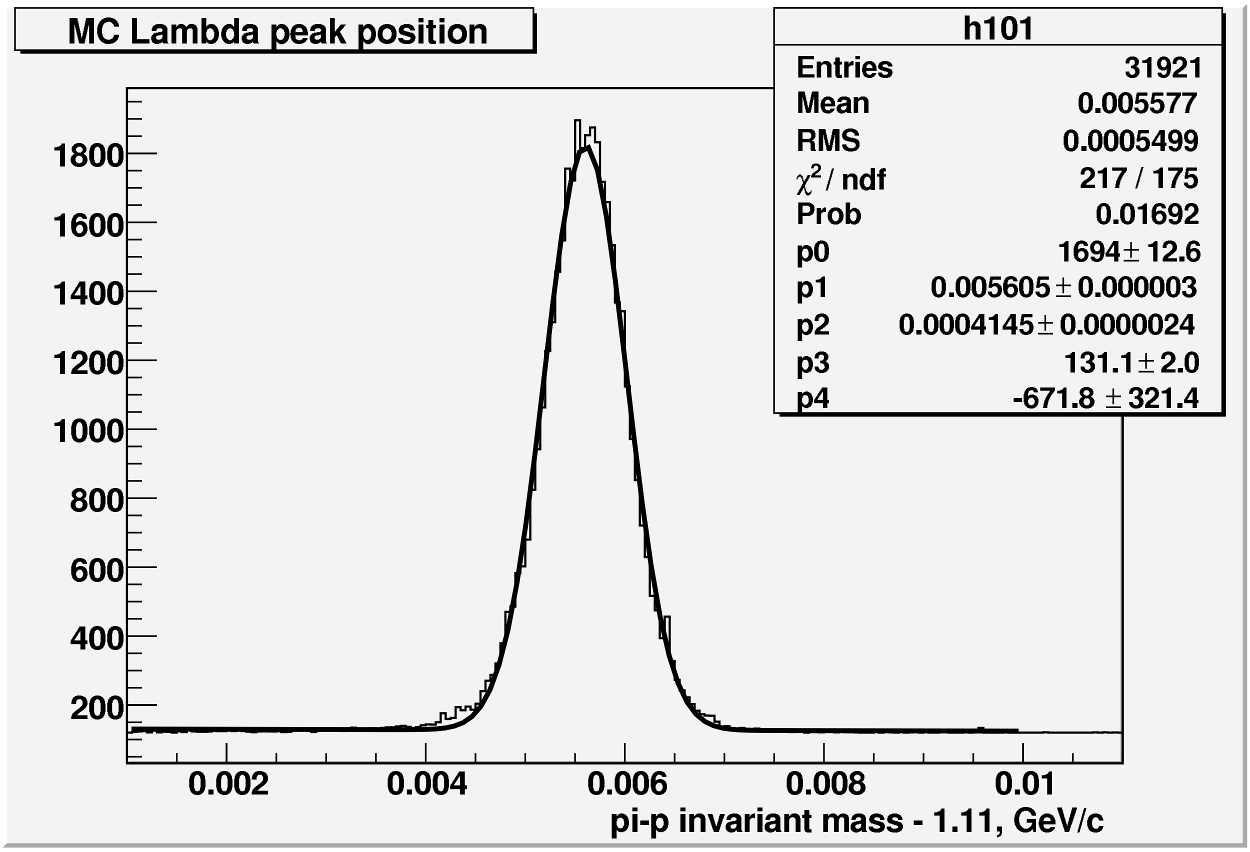

Figure 9: *The distribution of the Lambda peak position for MC data.*

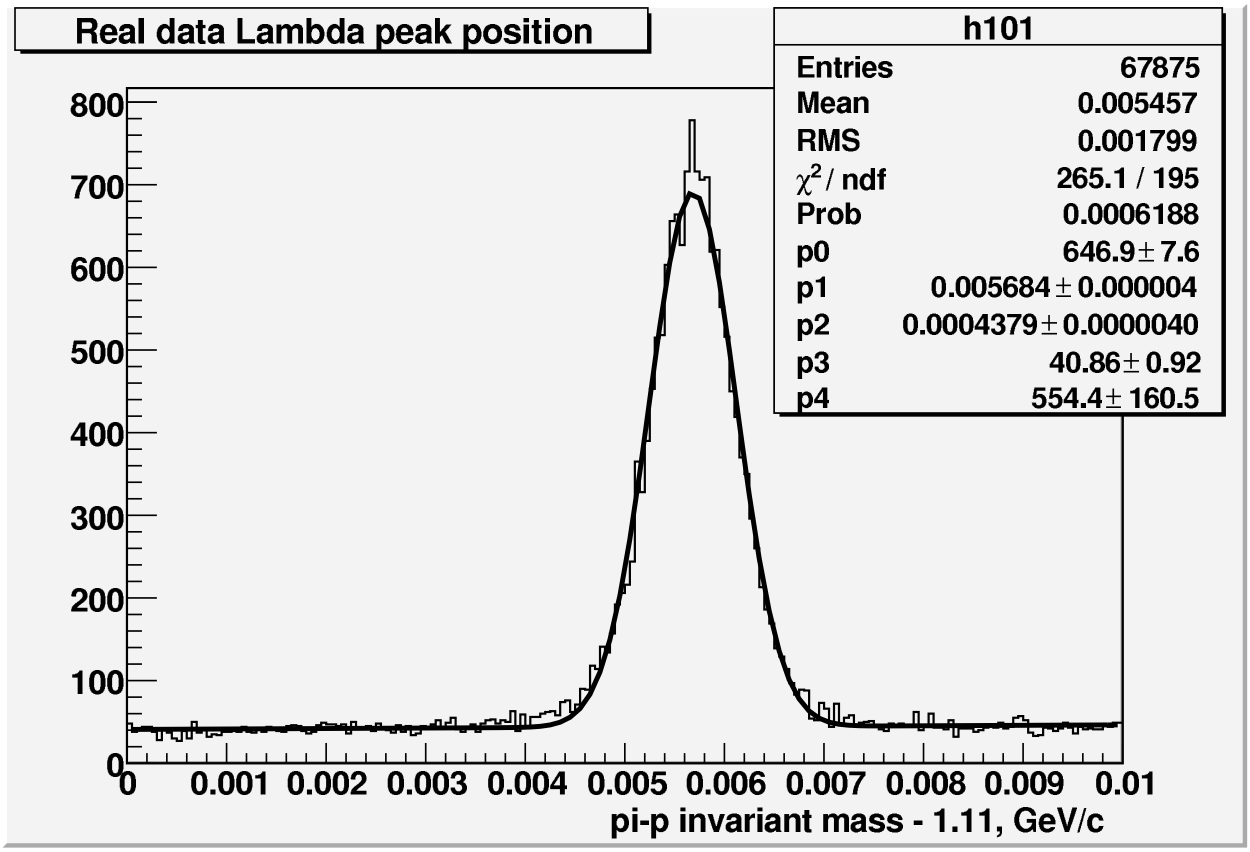

Figure 10: *The Lambda peak for real data.*

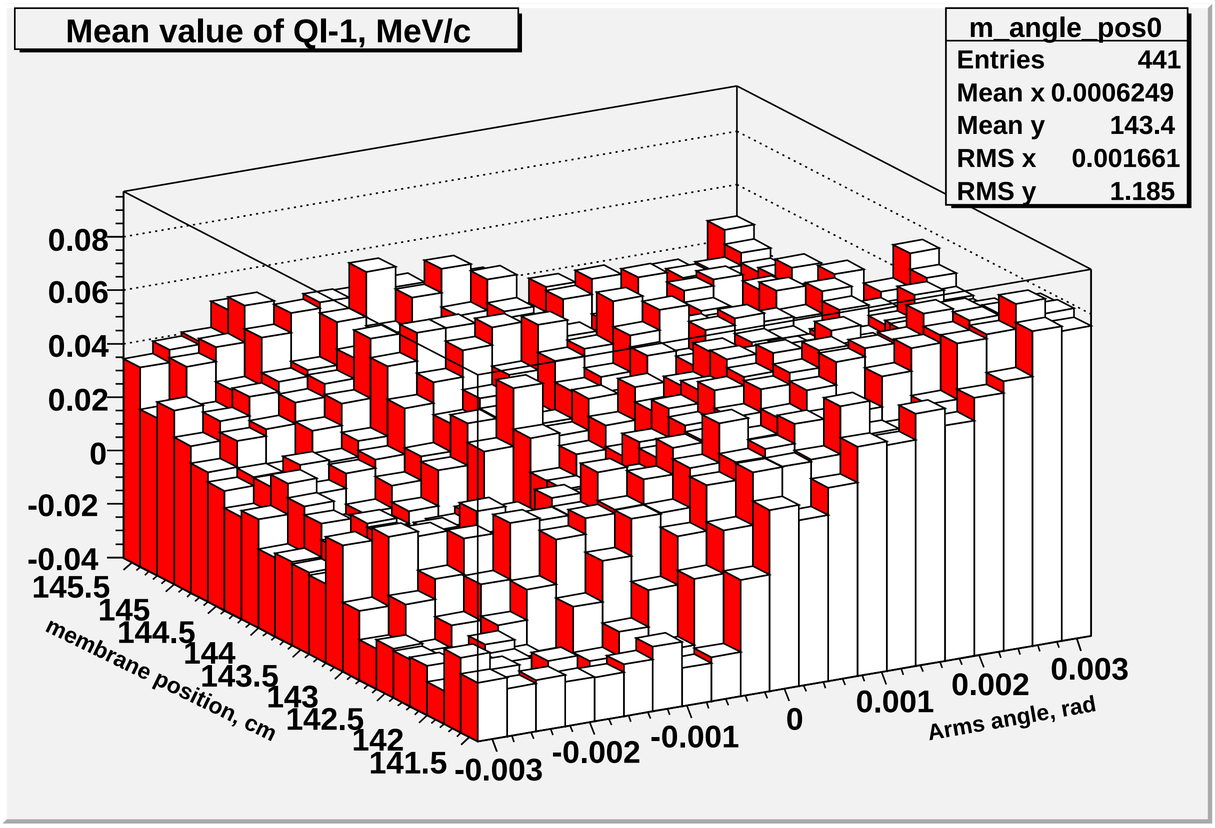

Figure 11: *The distribution of the Coulomb peak position for real data. Pair total momentum is between 3 and 4 GeV/c.*

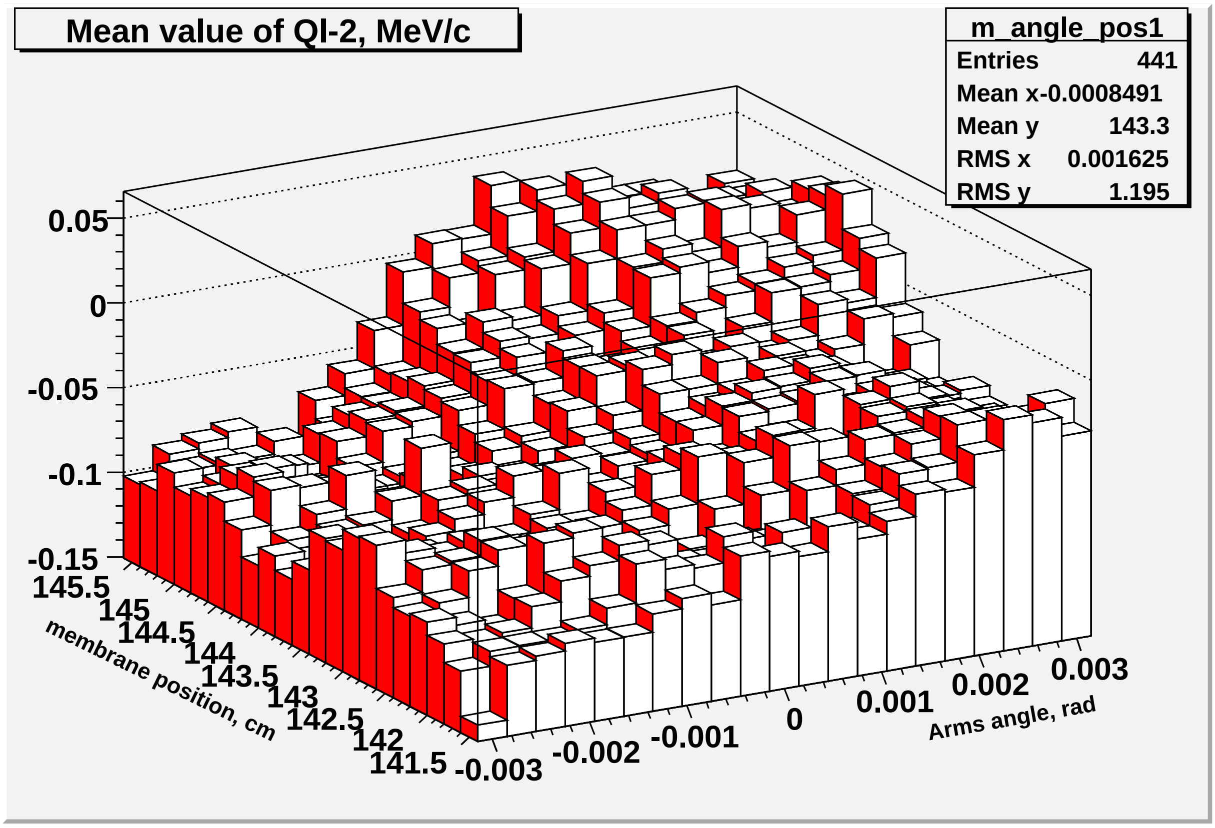

Figure 12: *The distribution of the Coulomb peak position for real data. Pair total momentum is between 4 and 5 GeV/c.*

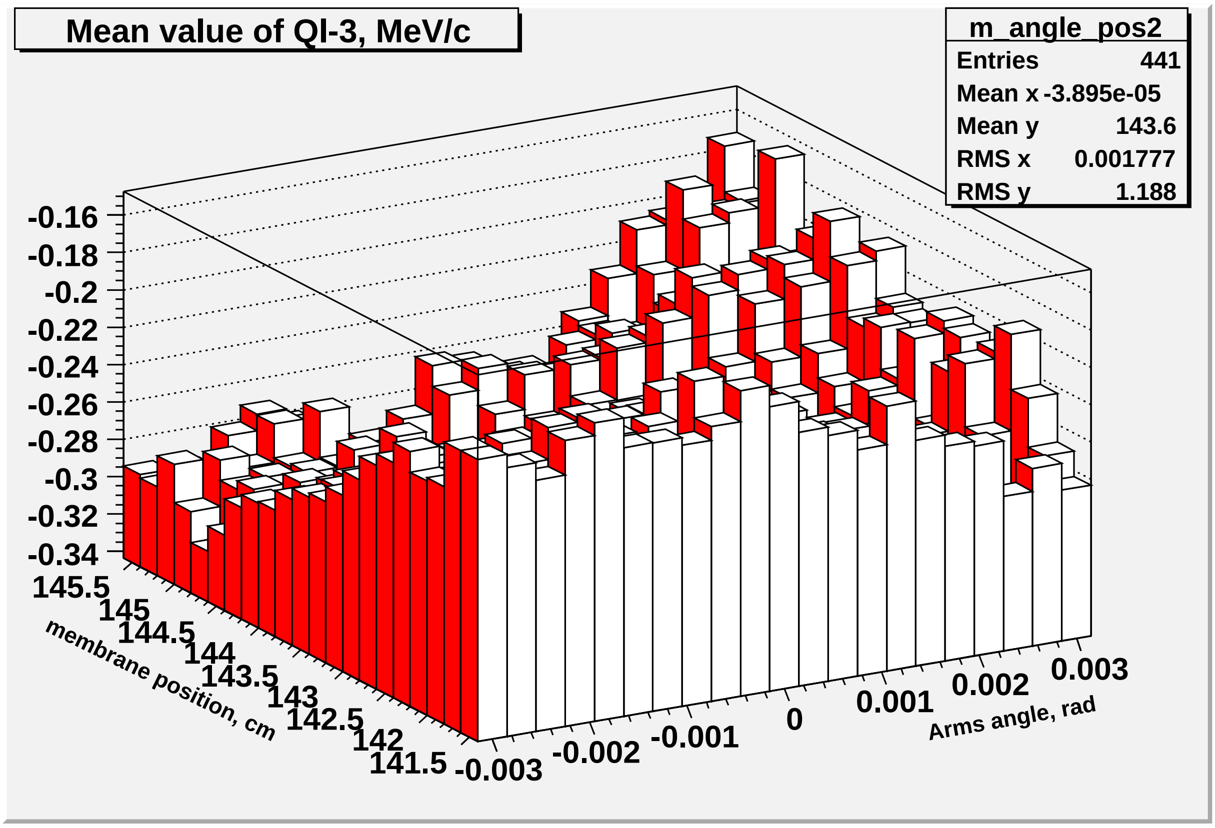

Figure 13: *The distribution of the Coulomb peak position for real data. Pair total momentum is between 5 and 6 GeV/c.*

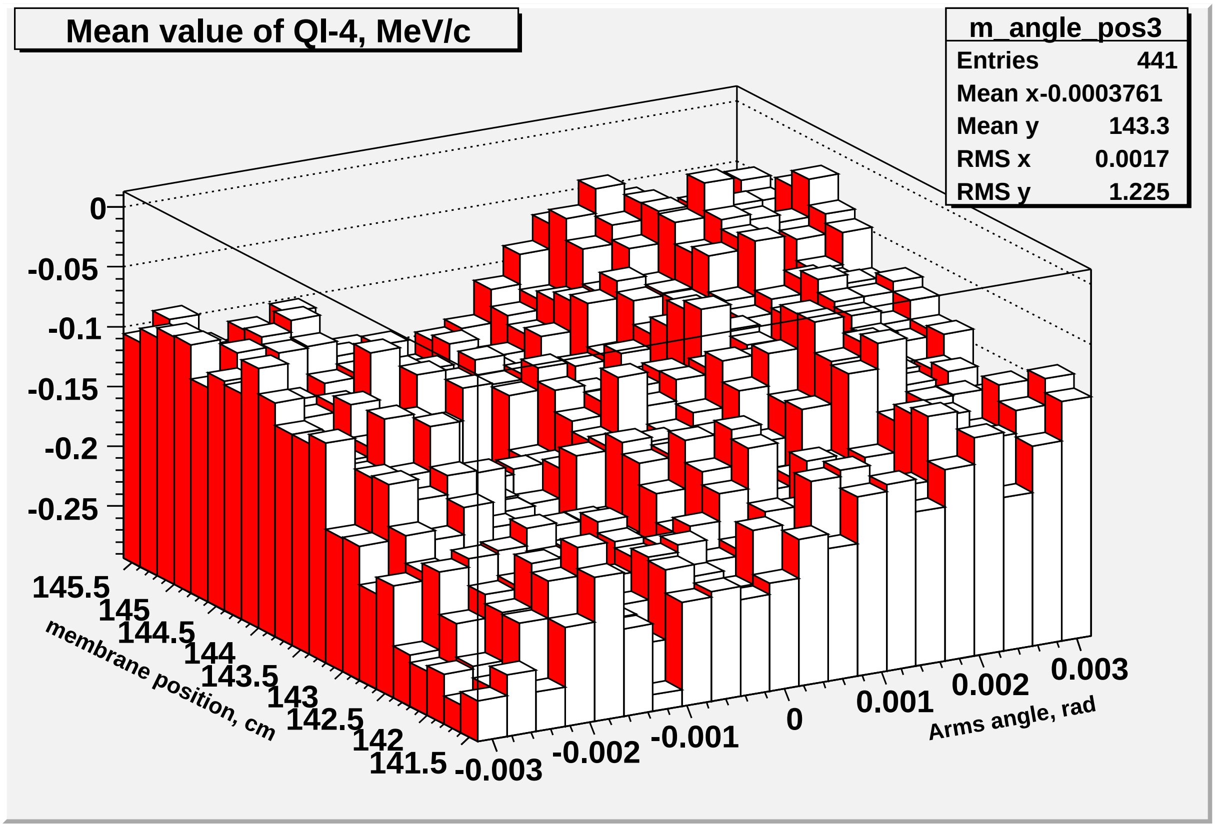

Figure 14: *The distribution of the Coulomb peak position for real data. Pair total momentum is between 6 and 7 GeV/c.*

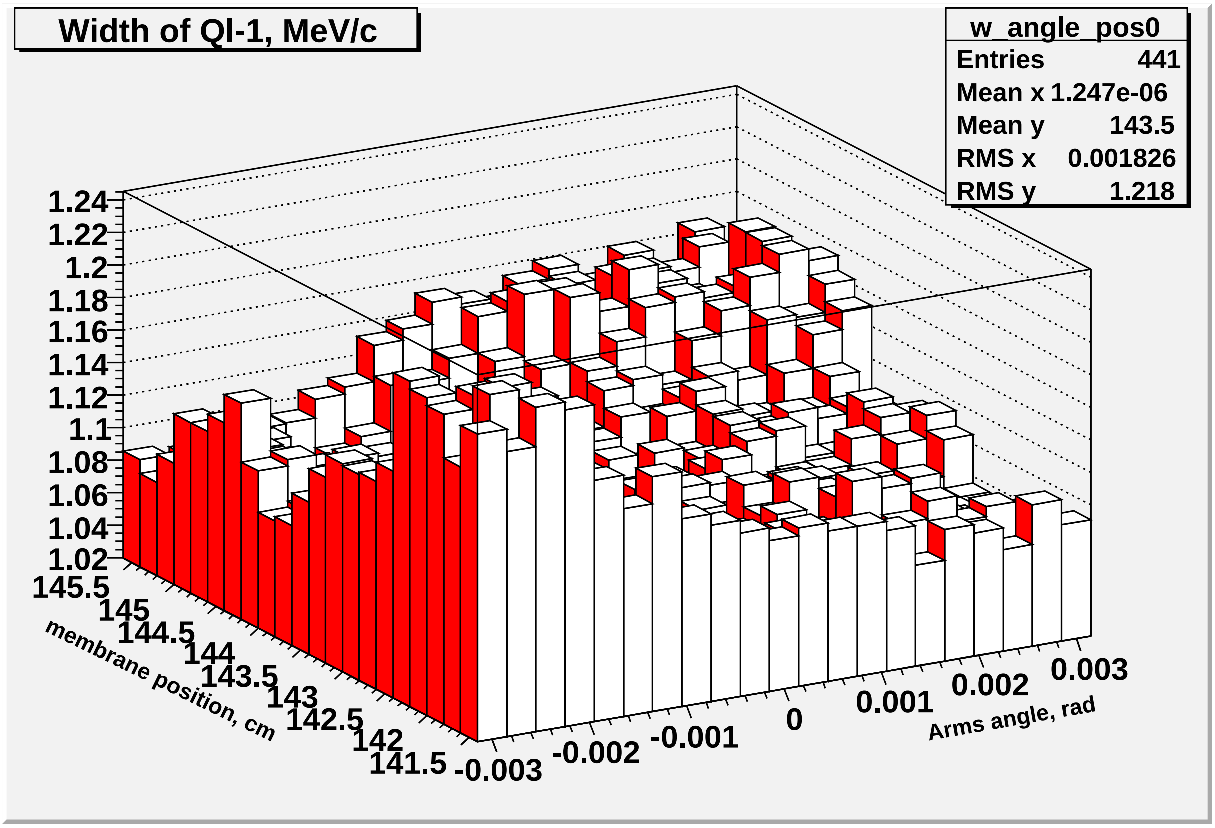

Figure 15: *The distribution of the Coulomb peak width for real data. Pair total momentum is between 3 and 4 GeV/c.*

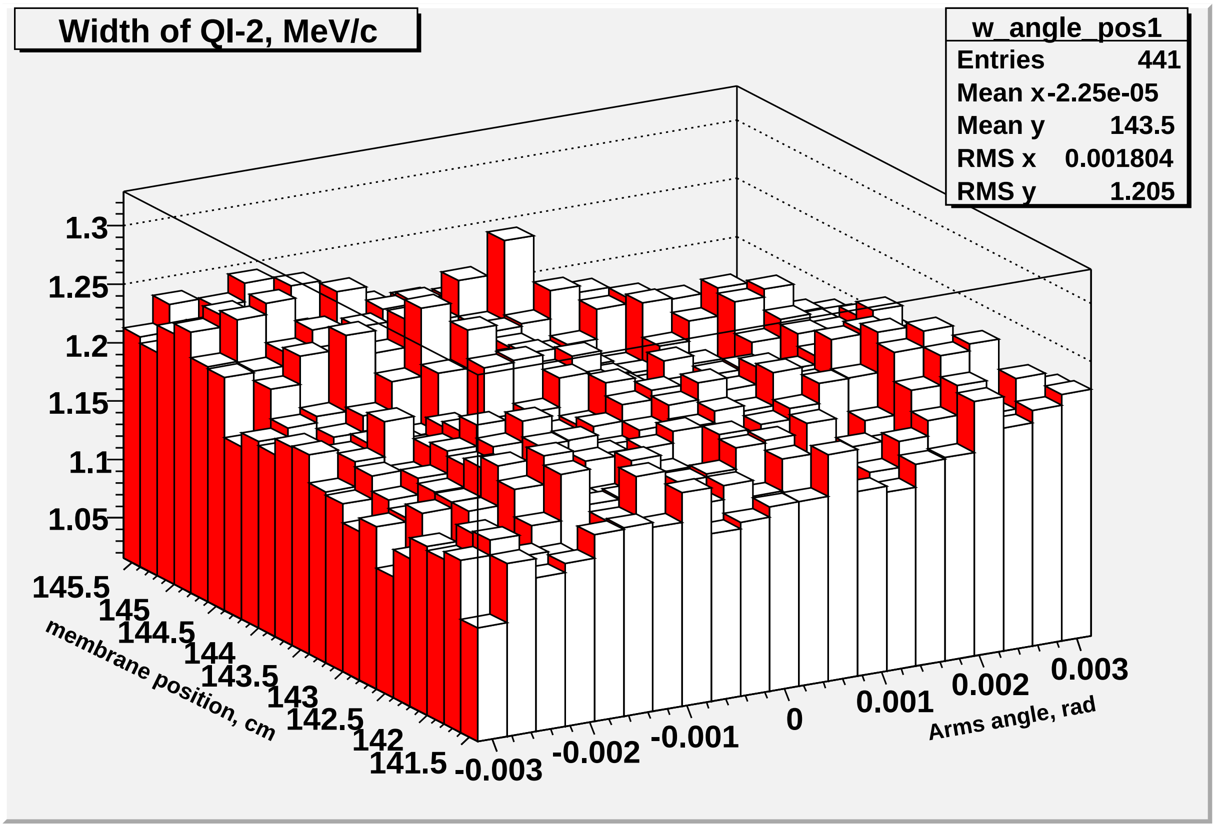

Figure 16: *The distribution of the Coulomb peak width for real data. Pair total momentum is between 4 and 5 GeV/c.*

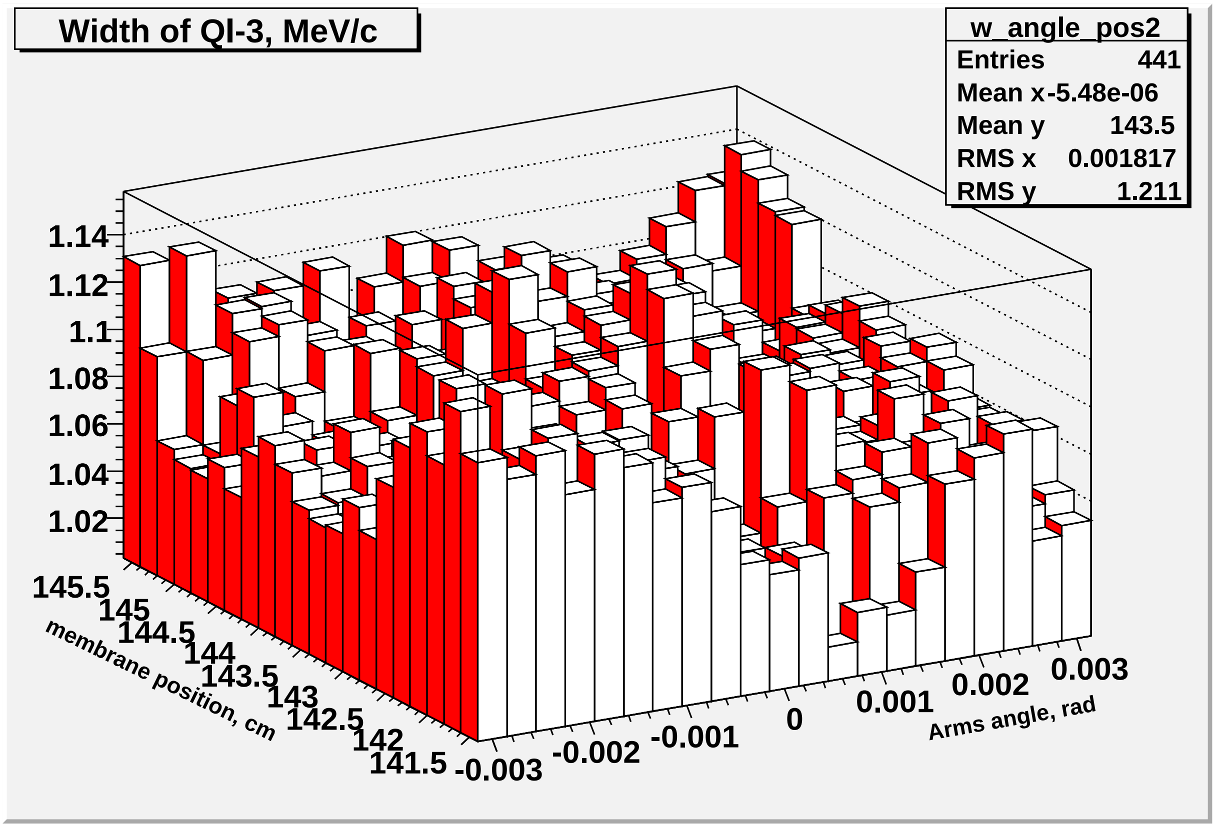

Figure 17: *The distribution of the Coulomb peak width for real data. Pair total momentum is between 5 and 6 GeV/c.*

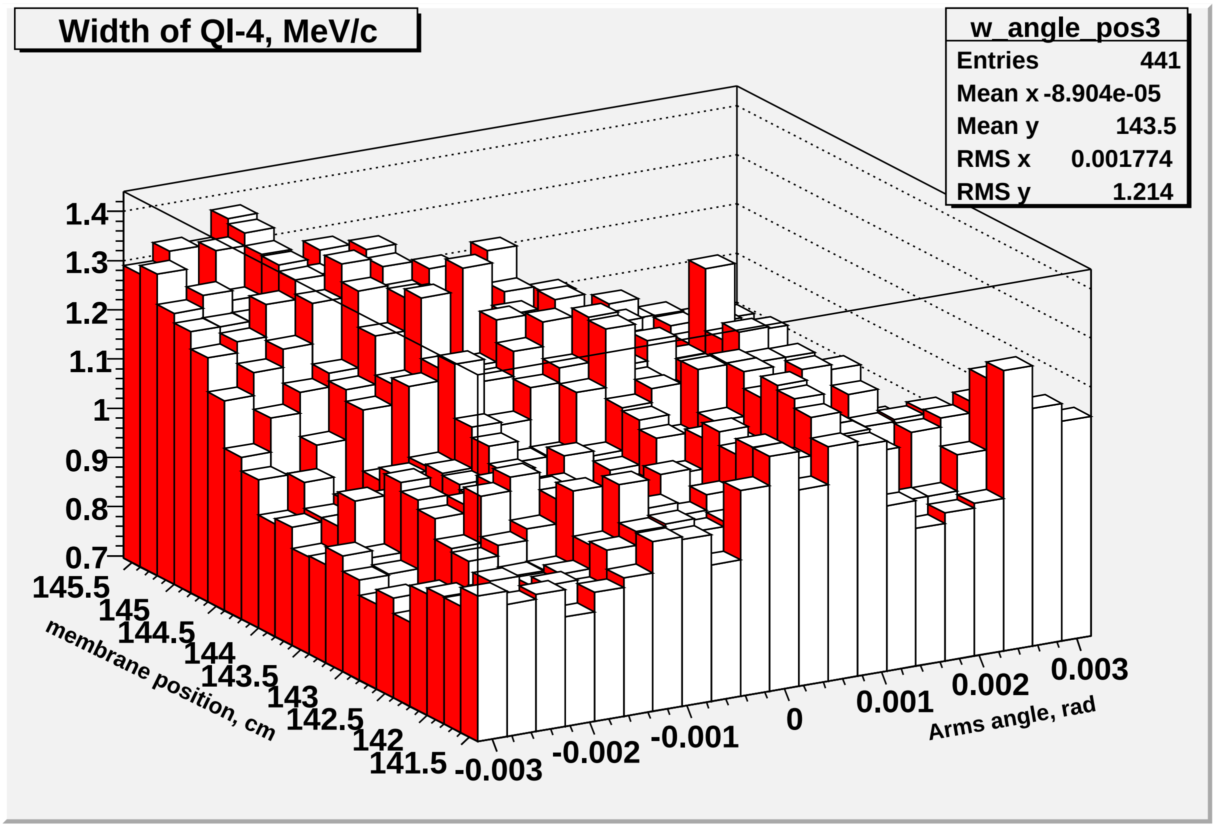

Figure 18: *The distribution of the Coulomb peak width for real data. Pair total momentum is between 6 and 7 GeV/c.*

References

[1] O.Gorchakov [JINR], DIRAC Note 2009-02.

[2] O.Gorchakov [JINR], DIRAC Note 2008-11.

[3] O.Gorchakov [JINR], DIRAC Note 2007-17.

[4] O.Gorchakov [JINR], DIRAC Note 2007-12.

[5] O.Gorchakov [JINR], DIRAC Note 2005-21.