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The new results on the Lambda peak width for data samples at different years and comparison with MC results.

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1 Preface

In this work we continue the analysis of Lambda peaks for real and MC data([1]-[4]). In the last work ([1]) it was found that for the Lambda case the ratio of its sigmas($\sigma_{\Lambda exp}/\sigma_{\Lambda MC}$) depends on the Lambda momentum and on the data sample year. V.Yazkov suggested to compare the χ^2 distributions of drift chamber tracks for real and MC data.

The corresponding analysis was done for five data sets(MC and real): 1) year 2001, target=94μ;2)year 2001, target=98μ;3)year 2002, proton beam momentum - 20 GeV/c; 4)year 2002, proton beam momentum - 24 GeV/c and 5) year 2003.

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. Also this momentum range was divided into three sub-intervals(5.-6.4-7.1-8.6GeV/c). 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 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.

2 Results

For each track in each arm of our setup we have the values of χ^2 and the number of degrees of freedom ν. There is the standard function PROB(χ_0^2,ν_0) which gives the probability that a random variable having a χ^2-distribution with $\nu=\nu_0$ assumes a value which is larger than χ_0^2. On the Fig.1 and 2 this probability function is shown for year 2001(94μ target) and 2003 for MC and real data(here the events are summarized for all possible values of ν_0 - from 5 till 10). The peaks at zero correspond to very high values of χ^2. We see that for real data this peak is more higher than for MC data.

The probability functions $\text{PROB}(\chi_0^2, \nu_0)$ for real data and for MC one have a bit different shape, also the ratio(r) of these two functions has a bit different shape for different data samples($r_{2001\_94\mu}$, $r_{2001\_98\mu}$, r_{2002_20GeV}, r_{2002_24GeV}, r_{2003},). On Fig.3 the ratios($r_{2001\_98\mu}/r_{2001\_94\mu}$, $r_{2002\_20GeV}/r_{2001\_94\mu}$, $r_{2002\_24GeV}/r_{2001\_94\mu}$, $r_{2003}/r_{2001\_94\mu}$) of these functions are shown. We see that the shapes of ratio of r's are a bit different.

We obtained the r distributions for each sample and used them as a weight for MC events and after we found the values of Lambda peak width for MC data. The ratio of Lambda peak width of MC and real data for five data samples are shown on Fig.4. Taking into account the statistical errors we can conclude that this ratio does not depend on the sample type and its mean value is equal to 1.0525±0.0016. This ratio but for three momentum interval is shown on Fig.5. We can assume that this ration dos not depend on Lambda momentum also.

We found that for real data the shape of probability function depends on X- and Y-coordinates of tracks. On Fig.6-8 the two-dimensional distributions of X.vs.$\text{PROB}(\chi_0^2, \nu_0)$ and Y.vs.$\text{PROB}(\chi_0^2, \nu_0)$ for both arms are shown; these distributions are normalized on one-dimensional distributions of $\text{PROB}(\chi_0^2, \nu_0)$ and corresponding coordinate(X or Y) as in this case the correlation of X(Y) and PROB function are seen more clearly. We see that the values of X(Y) and PROB function are correlated. The plot of X.vs.PROB for right arm is not shown as it contains very small correlation. The same distributions for MC data don't exhibit any correlation - Fig.9-11. It is a question why the real data have such correlation. We obtained the value of r ratio for this three-dimensional case(PROB vs X vs Y) also: it equals to 1.0587±0.0019. This value is close to the previous one and as the one-dimensional case is more simple for operation then we used the first result.

The DIRAC Lambda trigger accepts the slab number 17 in the left arm there as the Lambda MC data shows more broad distribution of hitted slabs (Fig.12).
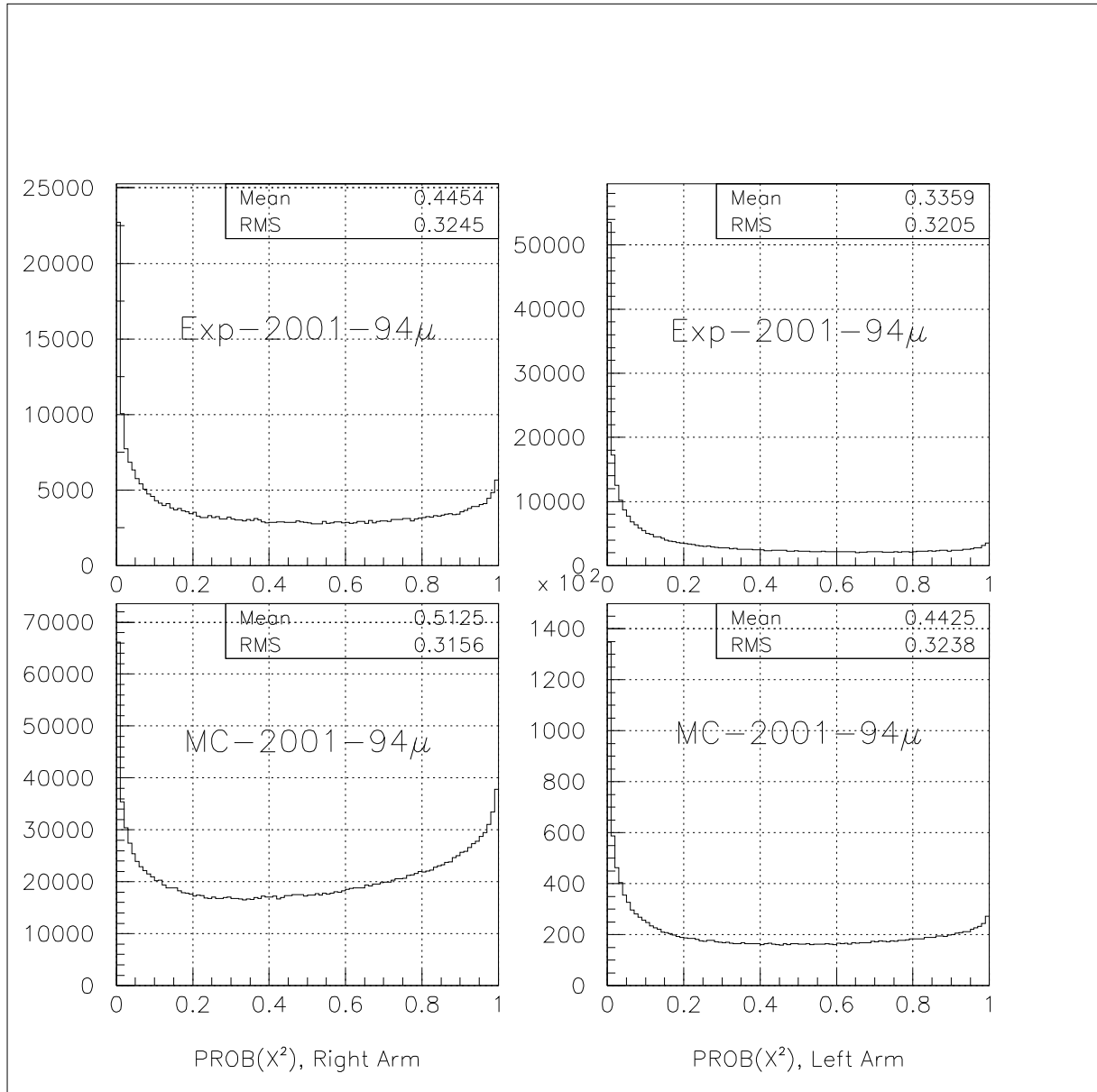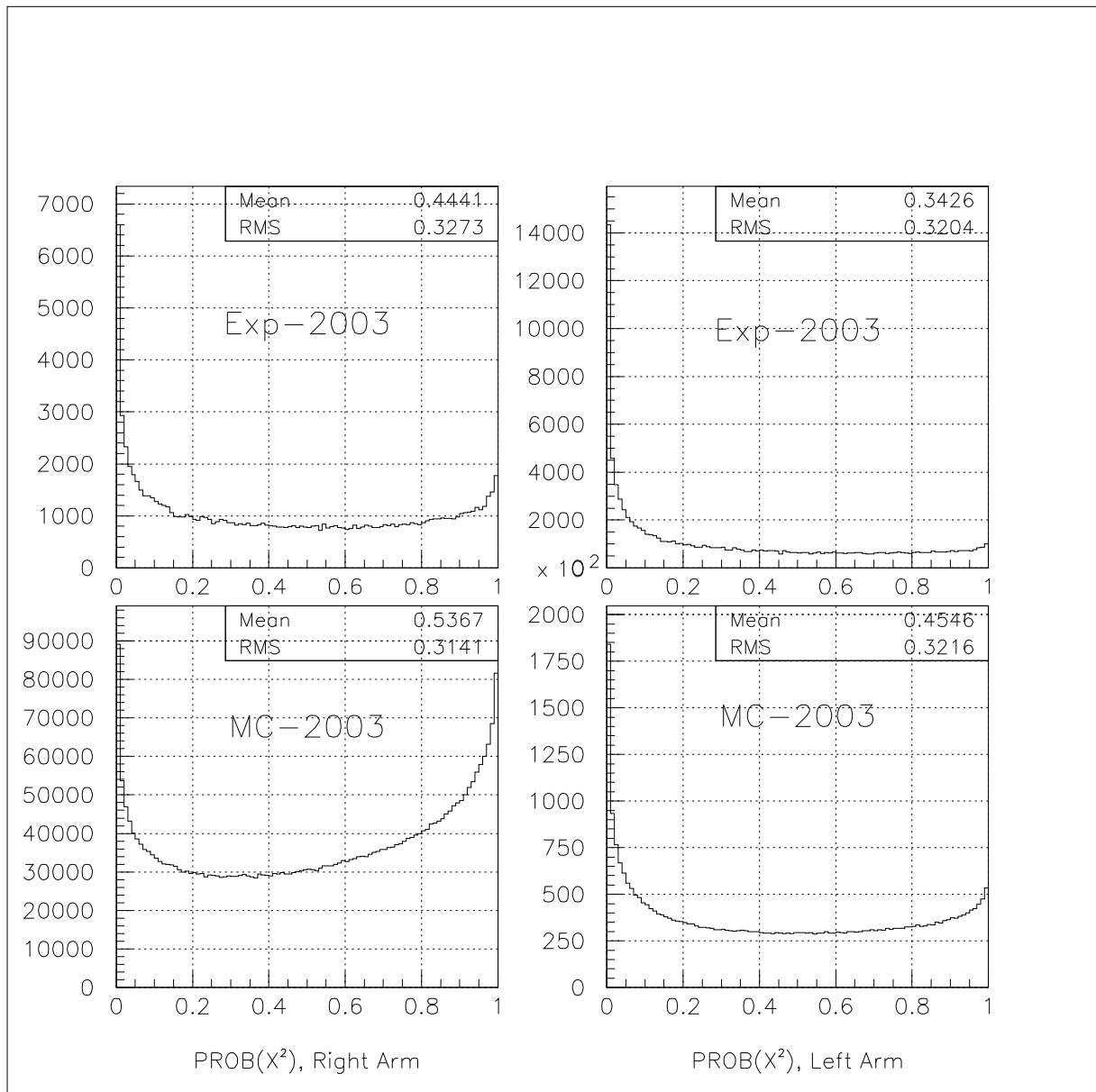
Figure 1: *The real and MC data. The probability function($PROB(\chi_0^2, \nu_0)$) for real(top) and MC(bottom) data. The data sample is year 2001 with 94μ target.*
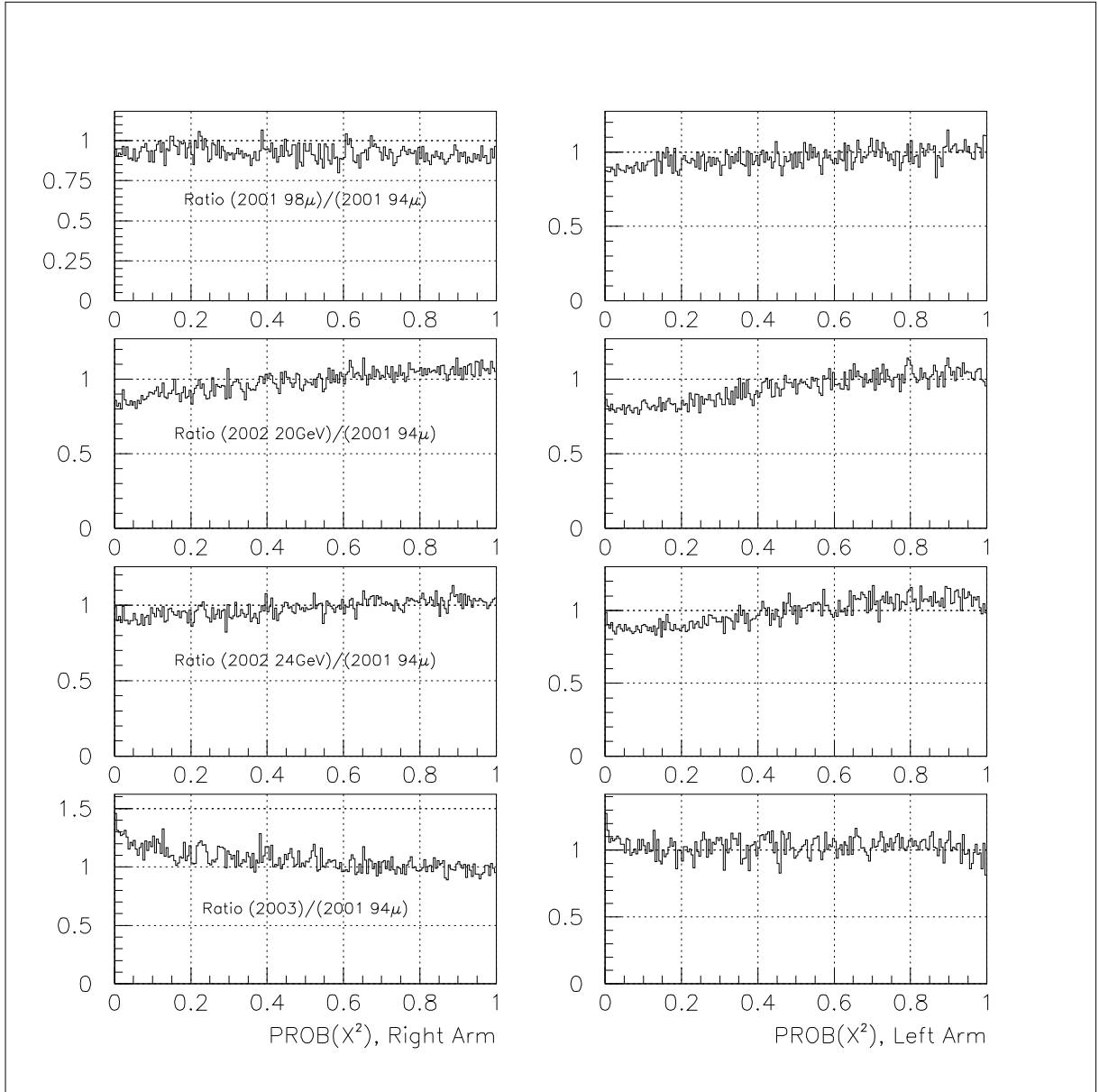
Figure 2: *The real and MC data. The probability function(PROB(χ^2_0,ν_0)) for real(top) and MC(bottom) data. The data sample is year 2003.*

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Figure 3: *The distributions of* $r_{2001\_98\mu}/r_{2001\_94\mu}$ *,* $r_{2002\_20GeV}/r_{2001\_94\mu}$ *,* $r_{2002\_24GeV}/r_{2001\_94\mu}$ *and* $r_{2003}/r_{2001\_94\mu}$, *where* r *is the ratio of probability functions:* $PROB(\chi_0^2, \nu_0)_{exp}/PROB(\chi_0^2, \nu_0)_{MC}$.
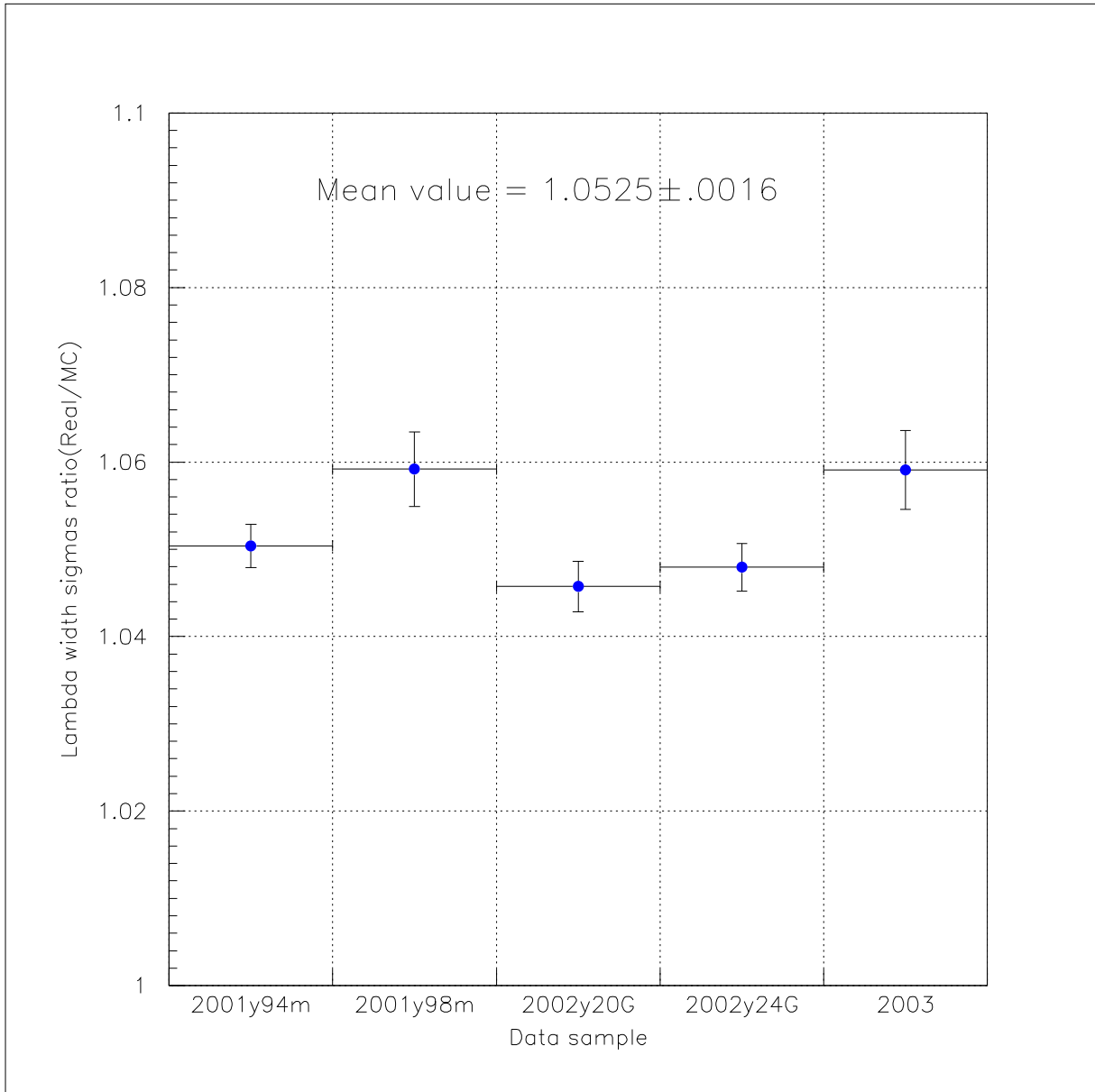
Figure 4: *The ratio of Lambda peak width of MC and real data for five data samples. The whole momentum interval is accepted.*
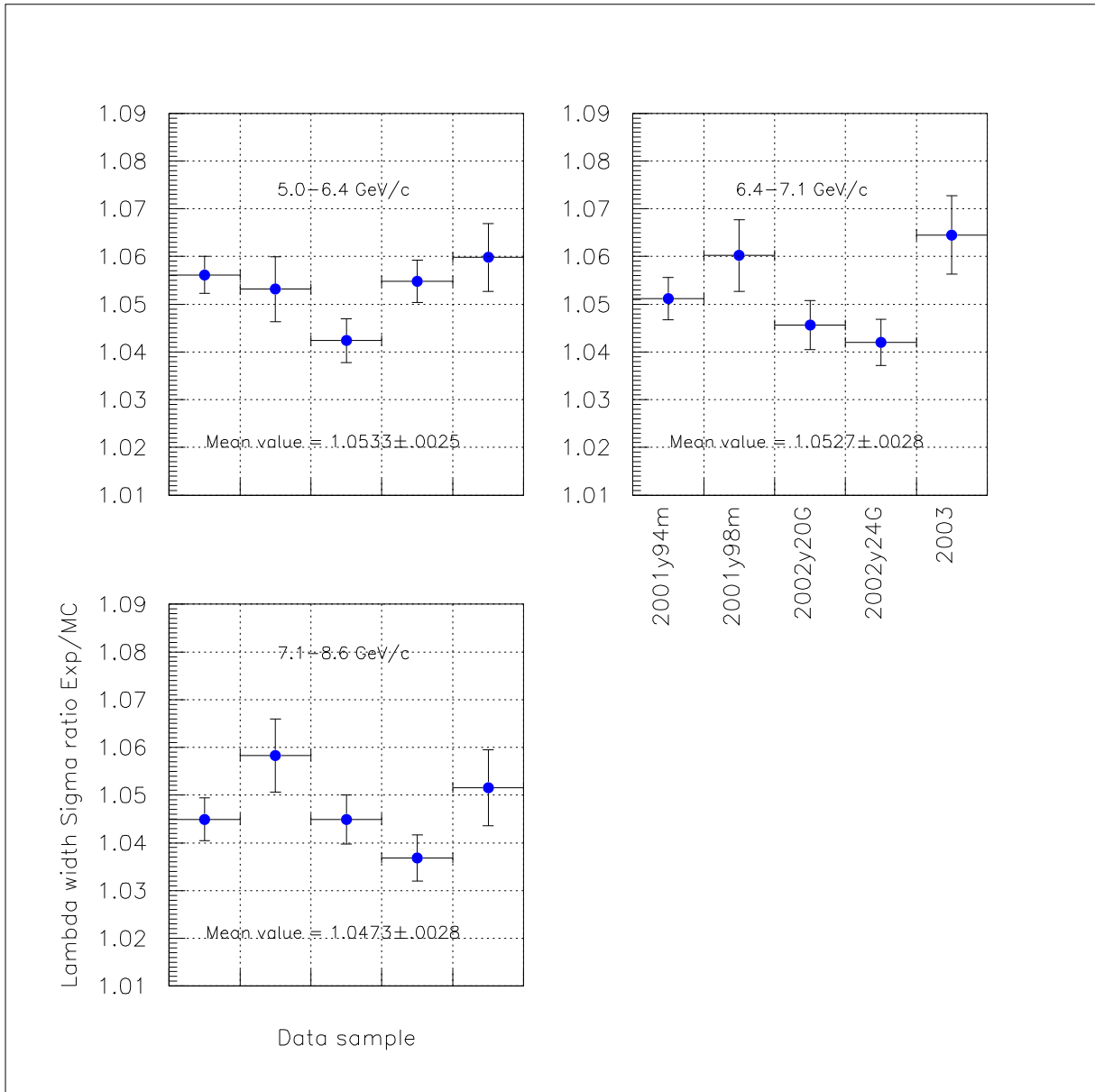
Figure 5: *The ratio of Lambda peak width of MC and real data for five data samples. The width of Lambda peak for five data samples. Blue marks - MC data, green ones - real data. On the top: left picture - Lambda momentum between 5 and 6.4 GeV/c, right one - from 6.4 to 7.1, on bottom - from 7.1 to 8.6.*
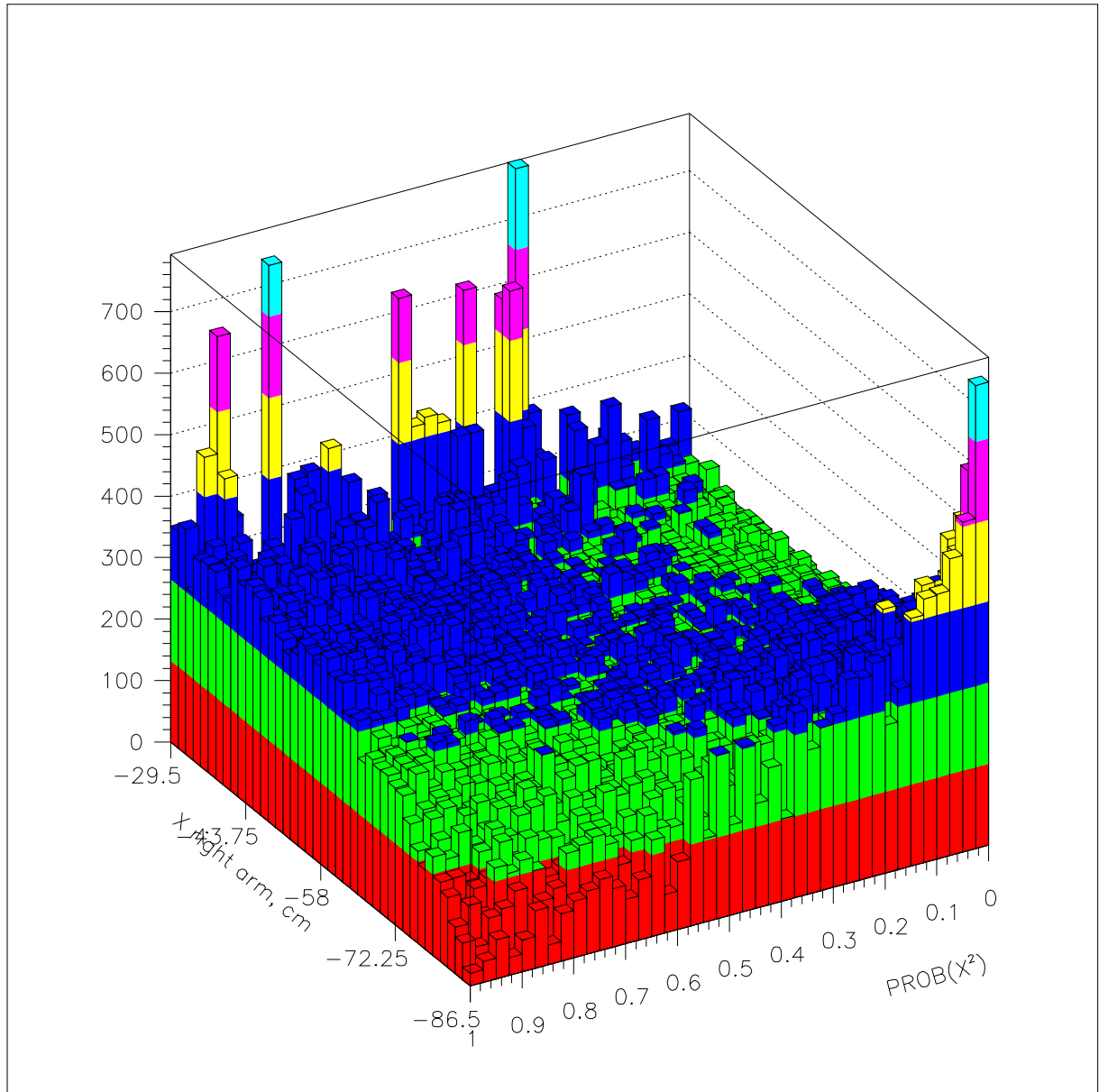
Figure 6: *The real data, year 2001 with 94μ target. The two-dimensional plot probability function(PROB(χ_0^2, ν_0)) vs X-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of X-coordinate; right arm.*

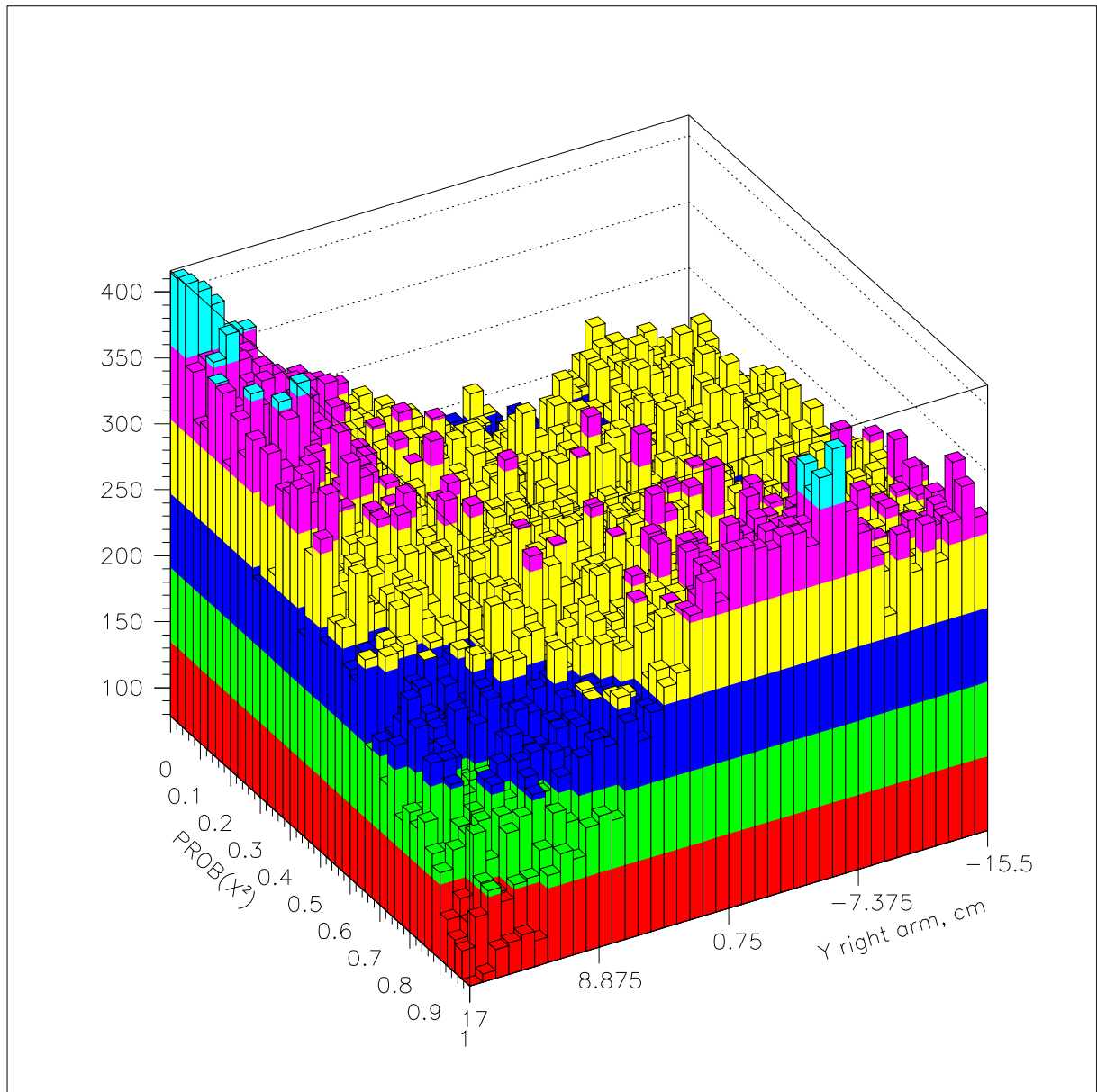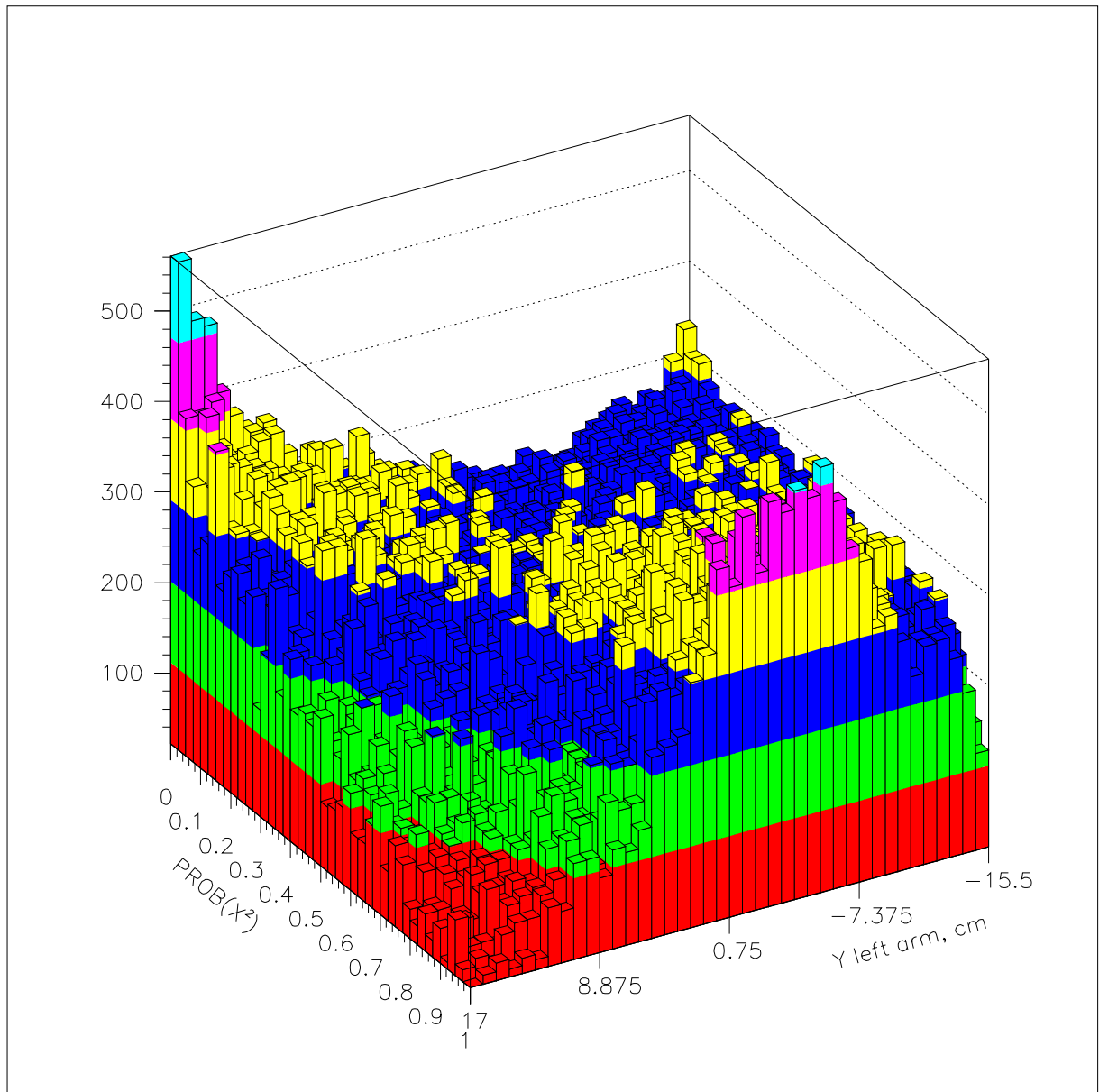Figure 7: *The real data, year 2001 with 94μ target. The two-dimensional plot probability function(PROB(χ_0^2, ν_0)) vs Y-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of Y-coordinate; right arm.*

Figure 8: *The real data, year 2001 with 94μ target. The two-dimensional plot probability function(PROB(χ_0^2, ν_0)) vs Y-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of Y-coordinate; left arm.*
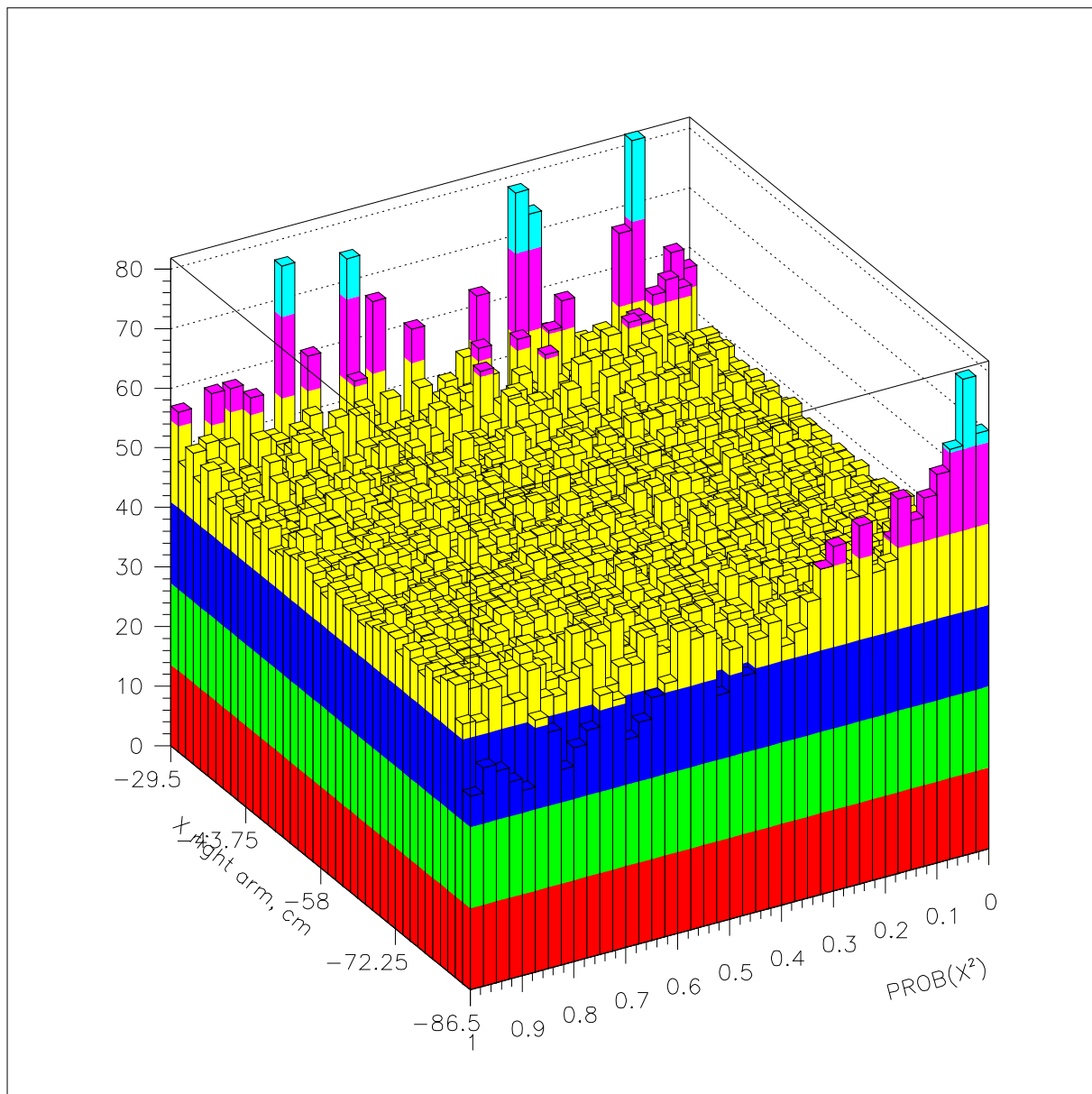
Figure 9: *The MC data, year 2001 with 94μ target. The two-dimensional plot probability function(PROB(χ_0^2, ν_0)) vs X-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of X-coordinate; right arm.*
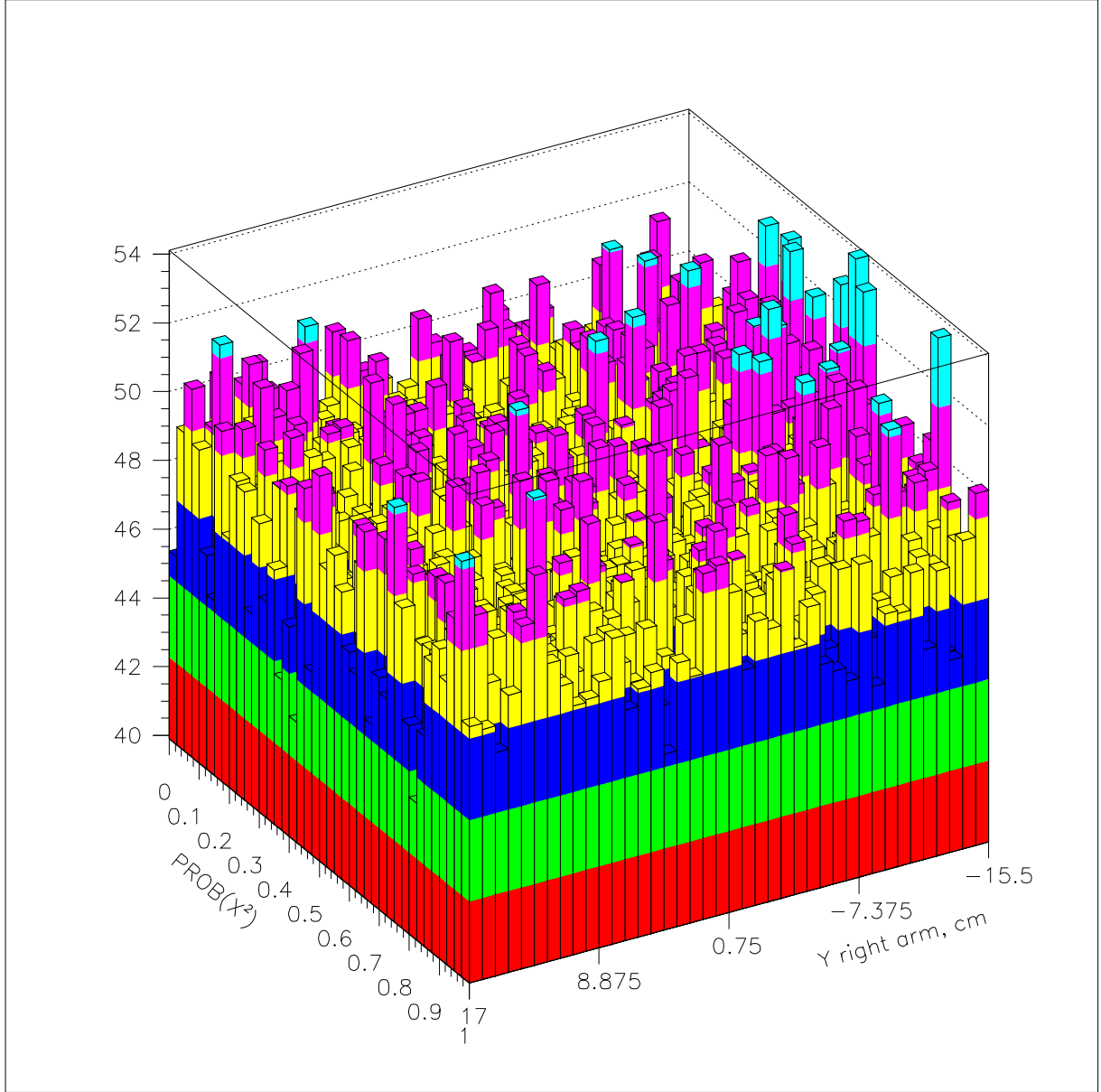
Figure 10: *The MC data, year 2001 with 94μ target. The two-dimensional plot probability function($PROB(\chi_0^2, \nu_0)$) vs Y-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of Y-coordinate; right arm.*
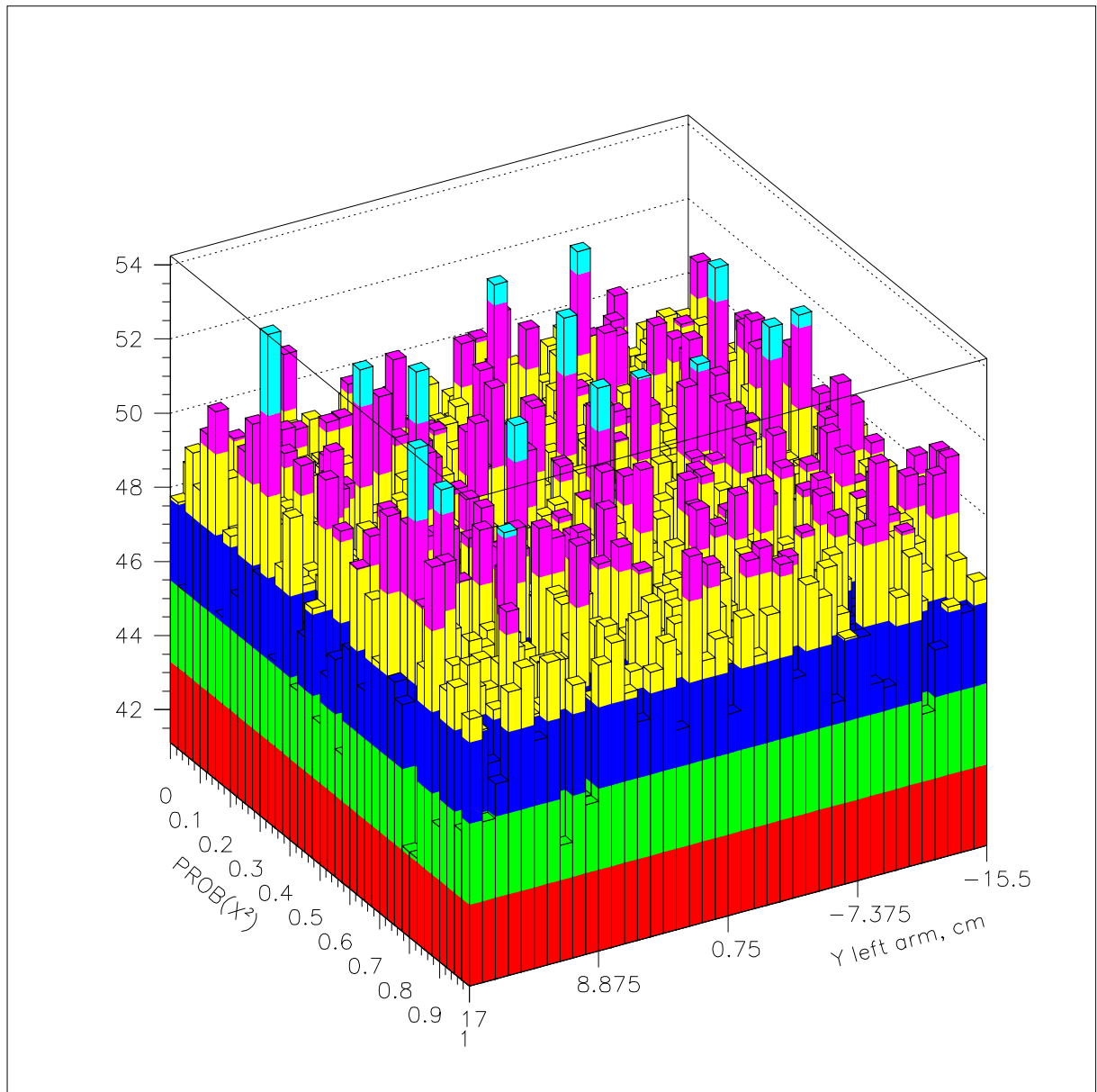
Figure 11: *The MC data, year 2001 with 94μ target. The two-dimensional plot probability function(PROB(χ^2_0,ν_0)) vs Y-coordinate of track at $z = z_{membrane}$, normalized by corresponding one-dimensional probability distribution and one-dimensional distribution of Y-coordinate; left arm.*
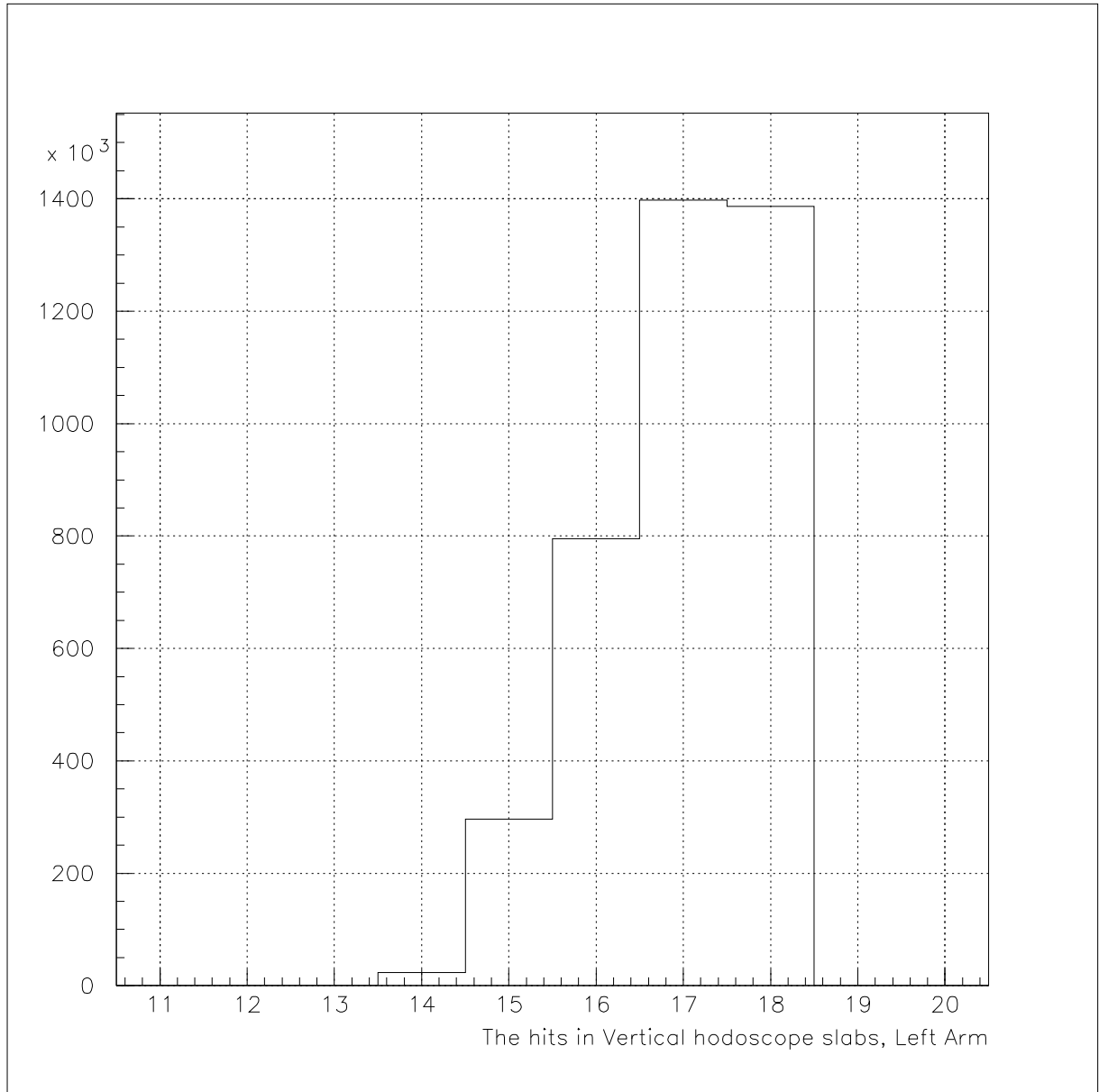
Figure 12: *The MC data. The distribution of right vertical hodoscope slabs which is hitted in the Lambda events.*

References

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

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

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

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