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The momentum distribution of $p\pi^-$ pairs in the target with aerogel counters and without.

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1 Preface

In our previous work([1]) we determined the momentum distributions for Coulomb and nonCoulomb $K^+\pi^-$ and π^+K^- pairs which are created in pNi interactions in the DIRAC setup target. In this work we made the same for $p\pi^-$ pairs. These pairs are the background events for $K^+\pi^-$ pairs and the knowing of momentum distribution of $p\pi^-$ pairs is needed for preparing of these pairs Monte-Carlo generators which will be used in data analysis.

For this purpose we used the experimental data ntuples where the $K^+\pi^-$ pairs with admixture of $p\pi^-$ pairs were mainly accumulated for all the data of year 2008.

At the stage of analysis of ntuple events the two sets of cuts were used. The first one is the standard set for $K^+\pi^-$ selection:

1. The cut on the total momentum of $(K^+/p)\pi^-$ pairs($5.0 \div 11$Gev/c).
2. The cuts on the values of pair c.m.s. relative moment: Q_x, Q_y and Q_L(6, 4 and 20 MeV/c, respectively).
3. The cuts on the ionization hodoscope hit amplitudes.
4. Only two hits must be in ScFi hodoscope.
5. The cuts on the track time in both arms to remove the most part of accidental events.
6. The cuts on amplitude and time in Nitrogen Cherenkov counters to reject the electrons and positrons.
7. The cuts on amplitude and time in heavy gas Cherenkov counters to eliminate pions.
8. The cuts on amplitude in aerogel Cherenkov counter to suppress protons.

The second set of cuts is like the previous one but without cuts on aerogel Cherenkov counter. The results obtained by these two sets can show us how well the digitization of aerogel counter is made in DIRAC simulation software.

In our analysis we used the track time distributions to separate the kaons and protons. In this way we can determine the numbers of kaons and protons in the same arm. The procedure of fitting of two overlapping gaussians is the same as in our previous work([1]). In this analysis when we calculate the values of pair relative momentum and the particle time of flight we suggest that the heavy mass particle is kaon.

For each of total momentum intervals of pairs the number of events in proton time peaks was calculated and in such a way we could obtain the shape of $p\pi^-$ pairs momentum distributions.

Applying the value of $p\pi^-$ acceptance, which was found by Monte-Carlo simulation, we reconstructed these pairs momentum distribution shape in pNi-collisions.

2 Results: $p\pi^-$ pairs analysis

The Fig.1-4 belong to the full set of cuts(including the cuts on aerogel counter). For each of pair momentum interval the Δt distribution was fitted by the sum of two gaussians and polynomial(Fig.1-3). The results of these fits(the number of events in the peak, its width and position) are shown on Fig.4. The like results for the second set of cuts(there is no cut on aerogel counter) are shown on Fig.5-8. We see that the shapes of proton momentum distributions are very different for these two sets of cuts.

On Fig.9 the ratios of detected protons and kaons with taking into account the aerogel counters information and without, the ratio of detected protons with taking into account the aerogel counters information and without and the same for kaons are shown. We see that the proton/kaon ratio is reduced in 9 times when we apply the aerogel counter cuts but these cuts decrease the number of kaons on 1/3.

The acceptances, obtained by Monte-Carlo, for these two sets are shown on Fig.10 and their shape are quite different; also there is strange bump at 7 GeV/c and it is due to the digitization procedure of aerogel counter response in DIRAC software.

Using these two acceptances we found the $p\pi^-$ pair momentum distributions in the target(Fig.11). The second one(without aerogel counter cuts) was fitted by $a * exp(b * p)$ function, where p is pair momentum. The value of the slope was obtained to be equal -0.307 ± 0.007. The shape of first distribution is very complicated and it means that the aerogel digitization is a bit wrong.

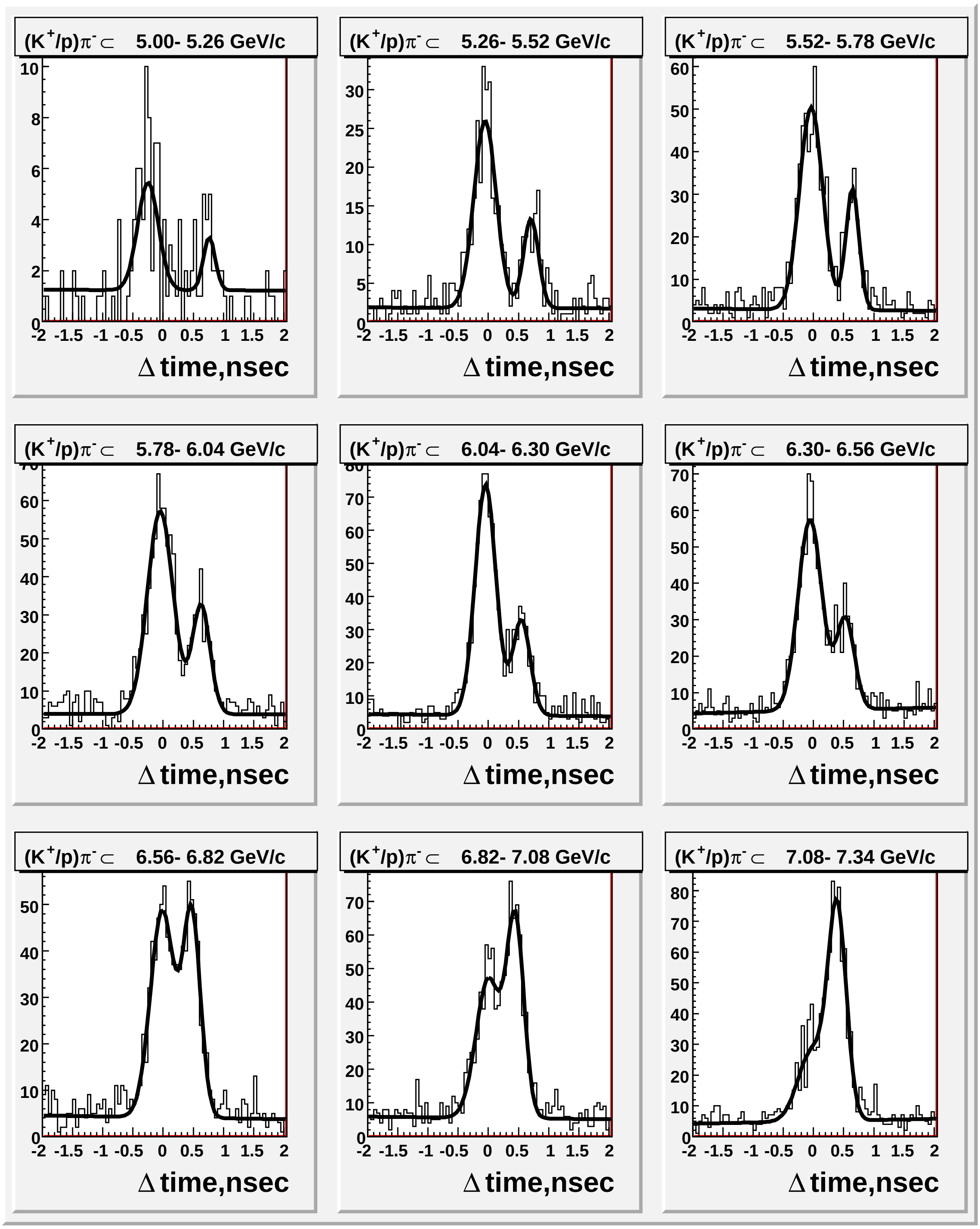

Figure 1: *The events after all the cuts are applied to select the $(K^+/p)\pi^-$ pairs. The Δtime distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. The full set of cuts is applied.*

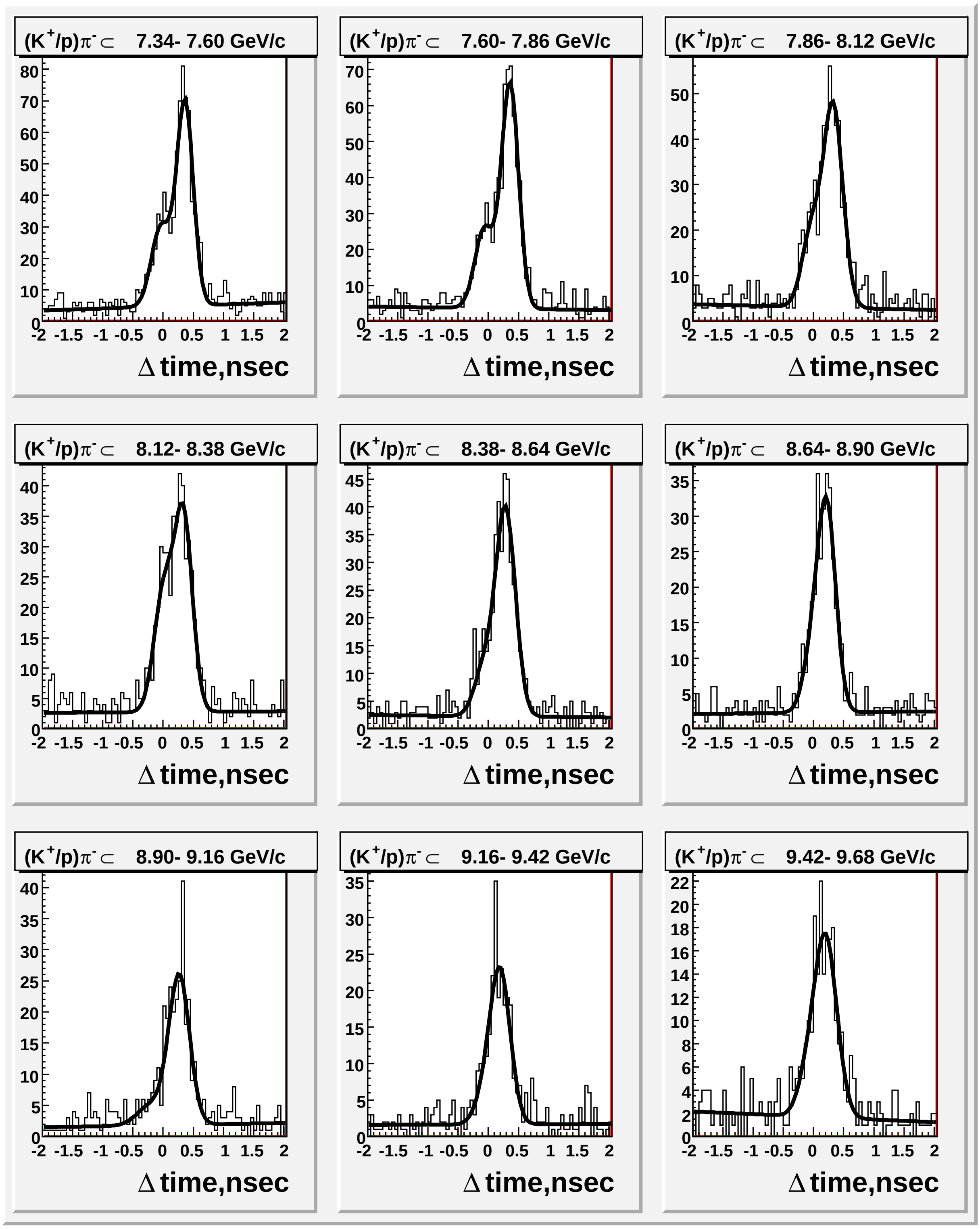

Figure 2: *The events after all the cuts are applied to select the* $(K^+/p)\pi^-$ *pairs. The* Δ*time distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. The full set of cuts is applied.*

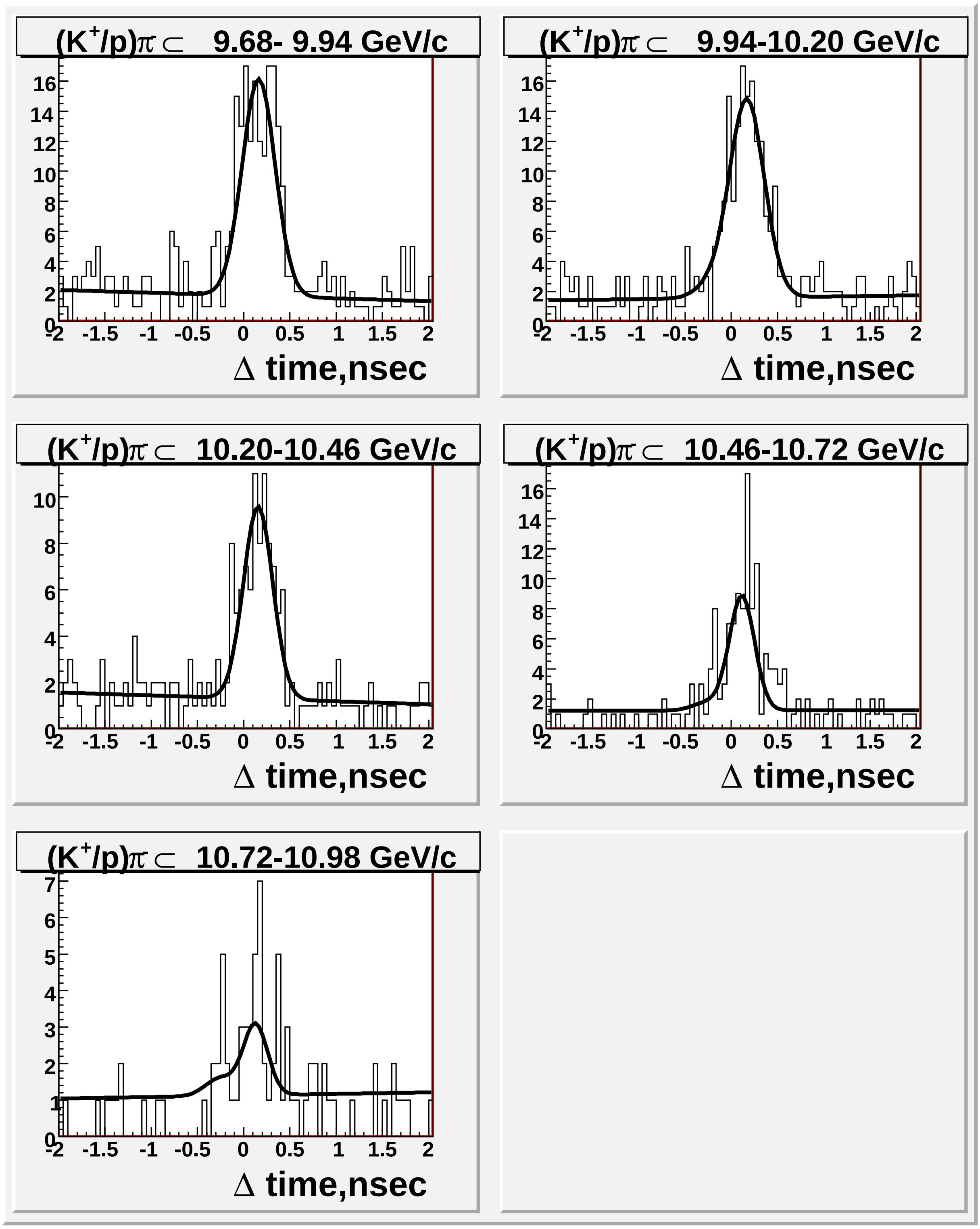

Figure 3: *The events after all the cuts are applied to select the $(K^+/p)\pi^-$ pairs. The Δtime distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. The full set of cuts is applied.*

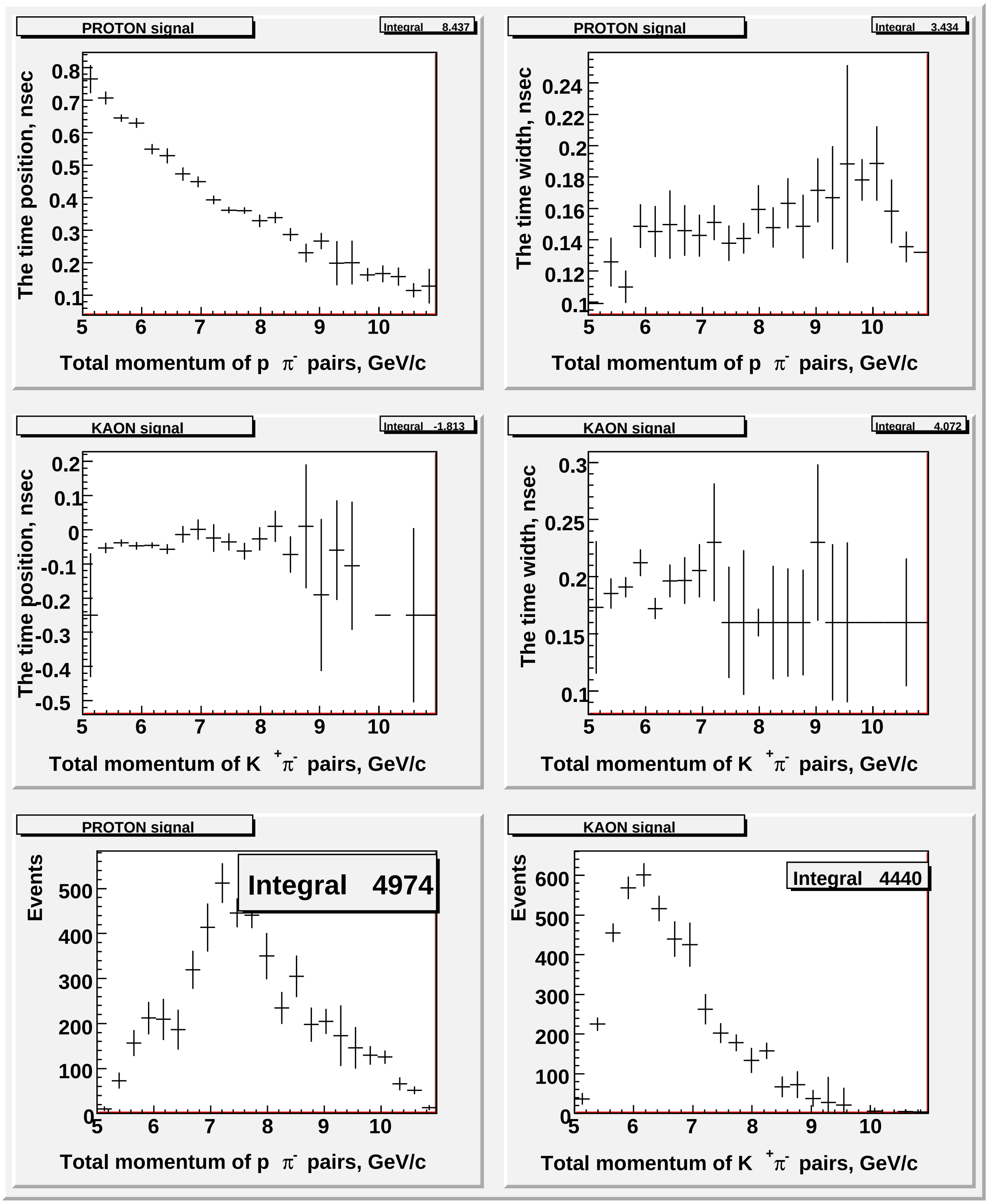

Figure 4: *The values of position and width of proton(top)and K^+ ones(middle) relative time peaks on dependence of pair total momentum. The detected number of proton and kaons as function of their total momentum(bottom). The full set of cuts is applied.*

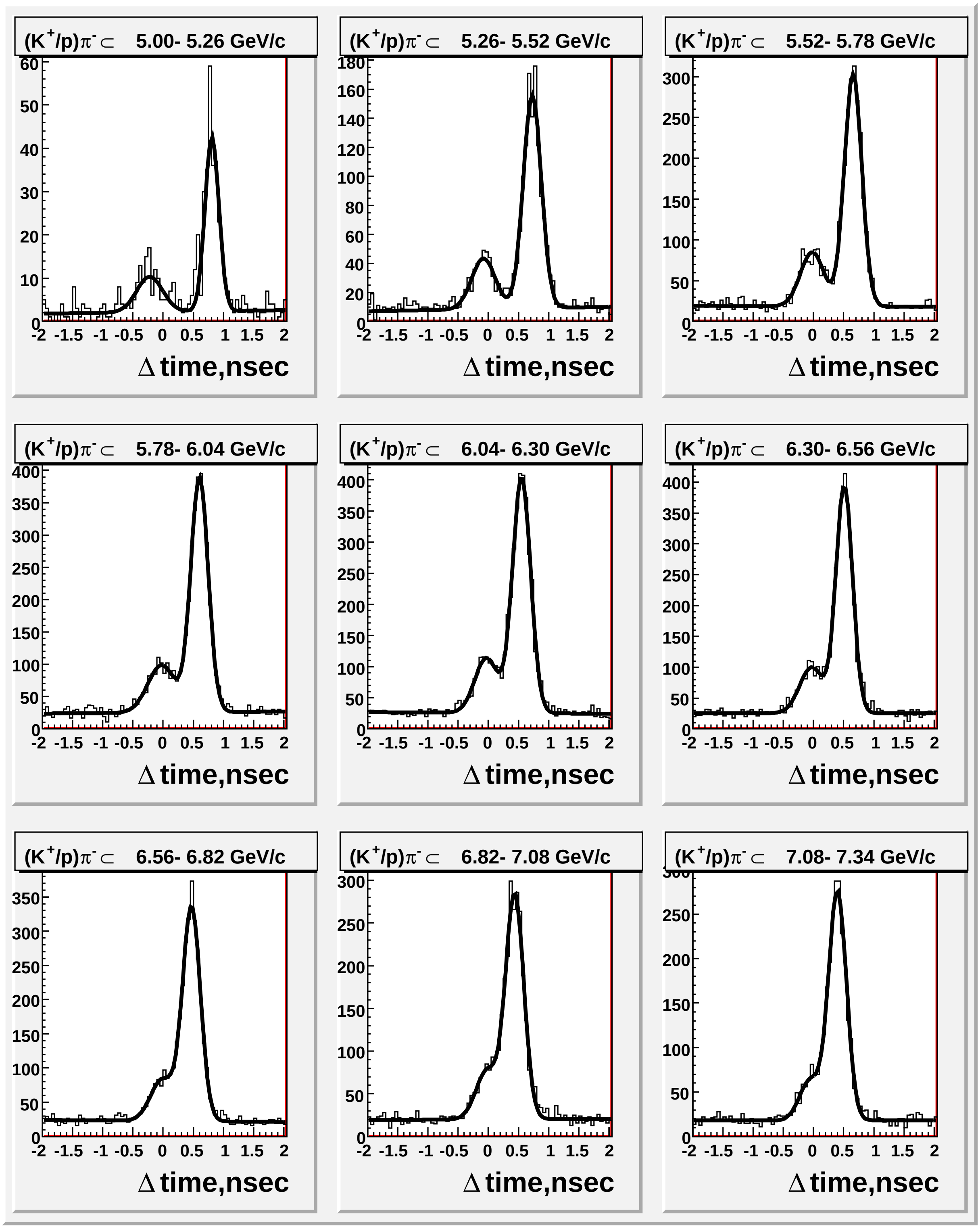

Figure 5: *The events after all the cuts are applied to select the $(K^+/p)\pi^-$ pairs. The Δtime distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. There is no aerogel counter cuts.*

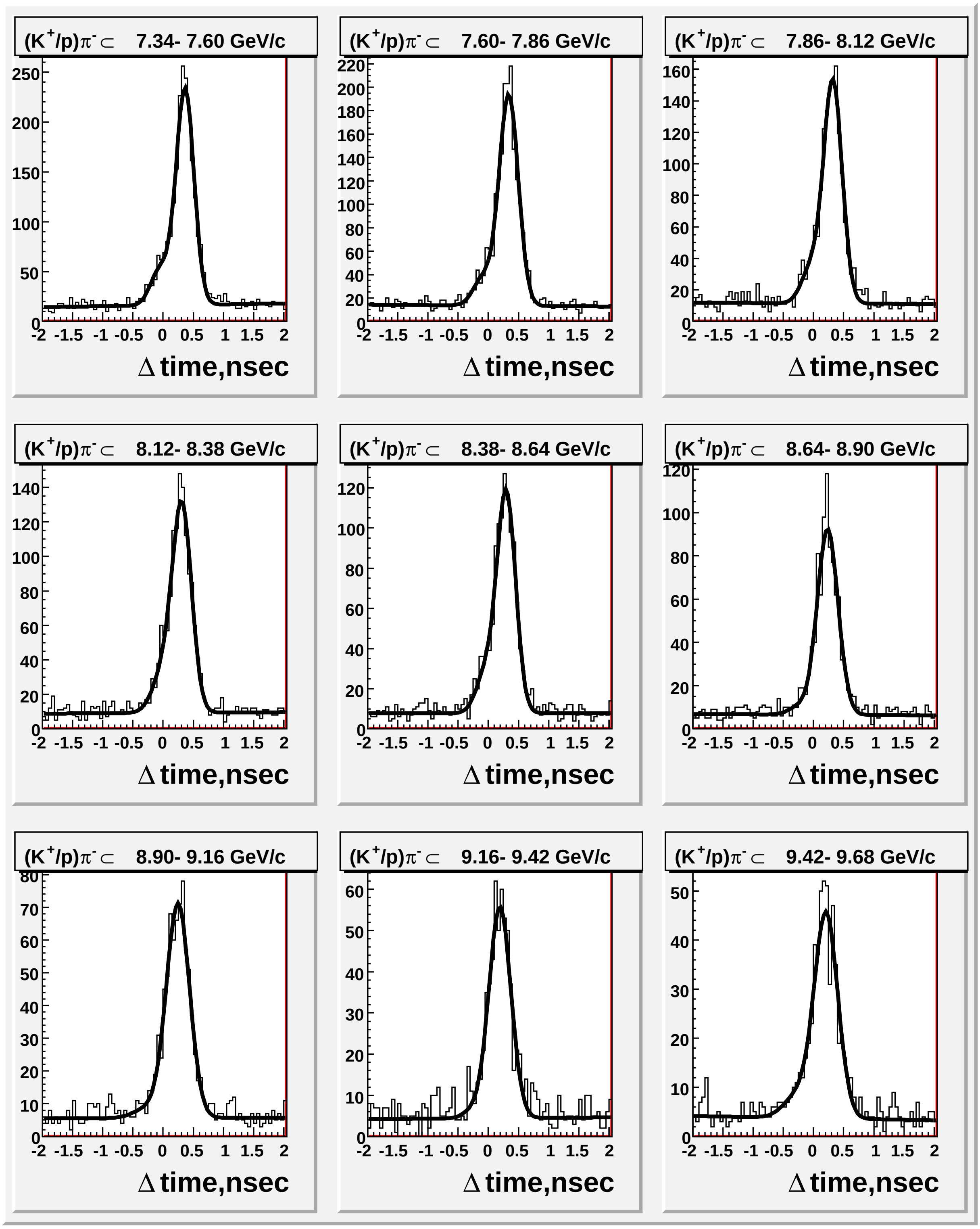

Figure 6: *The events after all the cuts are applied to select the* $(K^+/p)\pi^-$ *pairs. The* Δ*time distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. There is no aerogel counter cuts.*

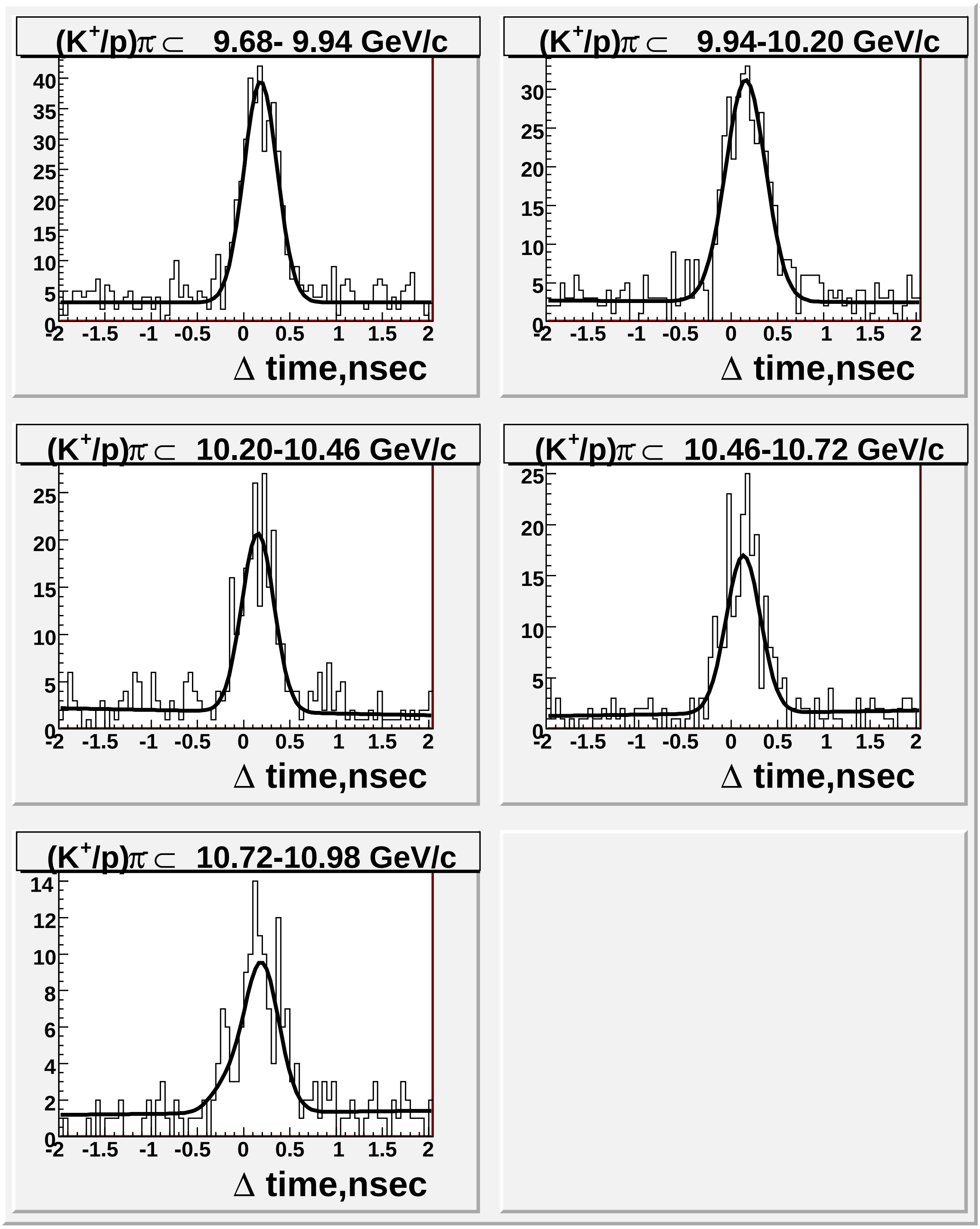

Figure 7: *The events after all the cuts are applied to select the* $(K^+/p)\pi^-$ *pairs. The* Δ*time distributions for different values of the pair momentum are fitted by sum of two gaussians and polynomial of first degree. The right peaks are from protons and the left ones - from kaons. There is no aerogel counter cuts.*

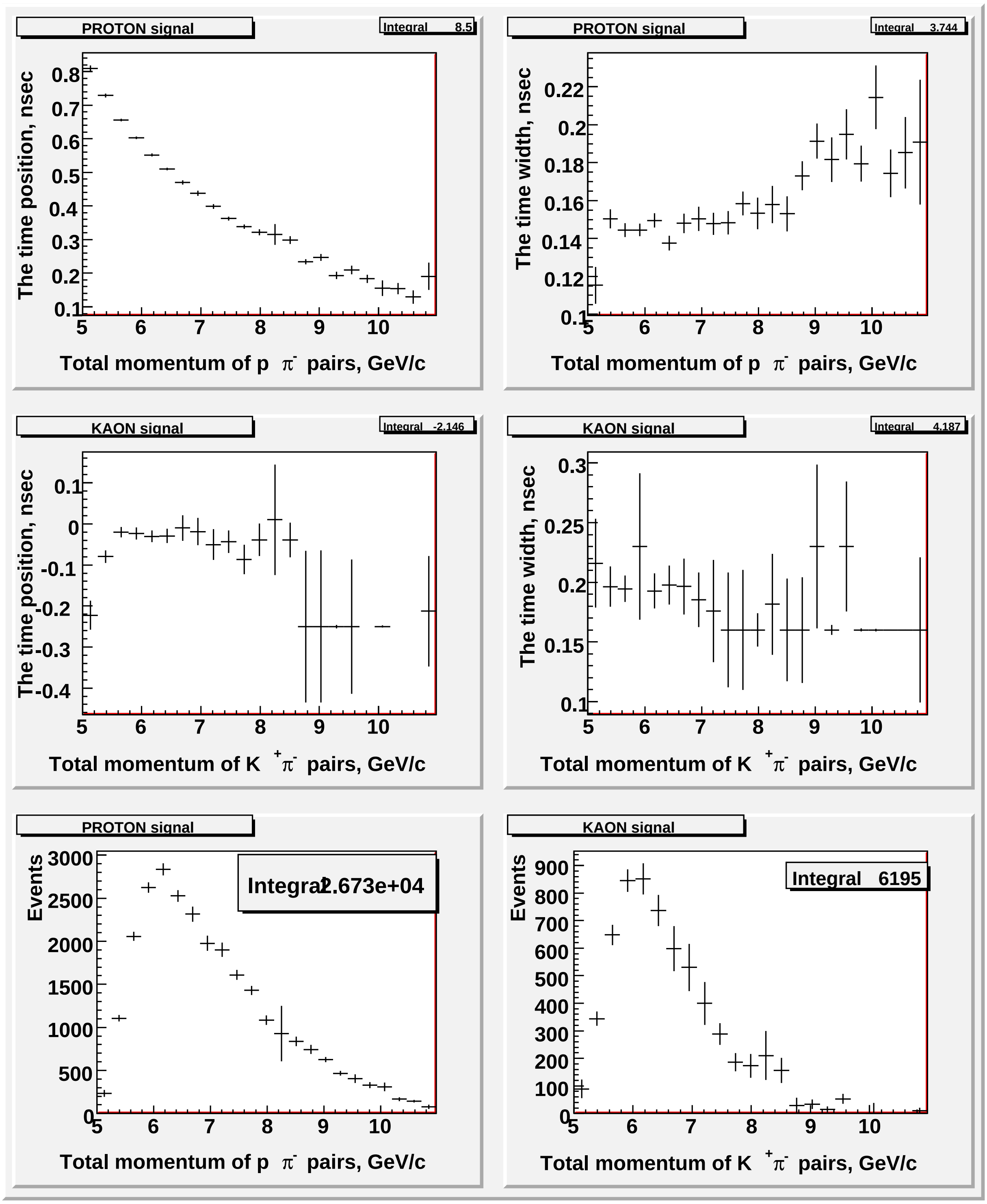

Figure 8: *The values of position and width of proton(top)and K^+ ones(middle) relative time peaks on dependence of pair total momentum. The detected number of proton and kaons as function of their total momentum(bottom). There is no aerogel counter cuts.*

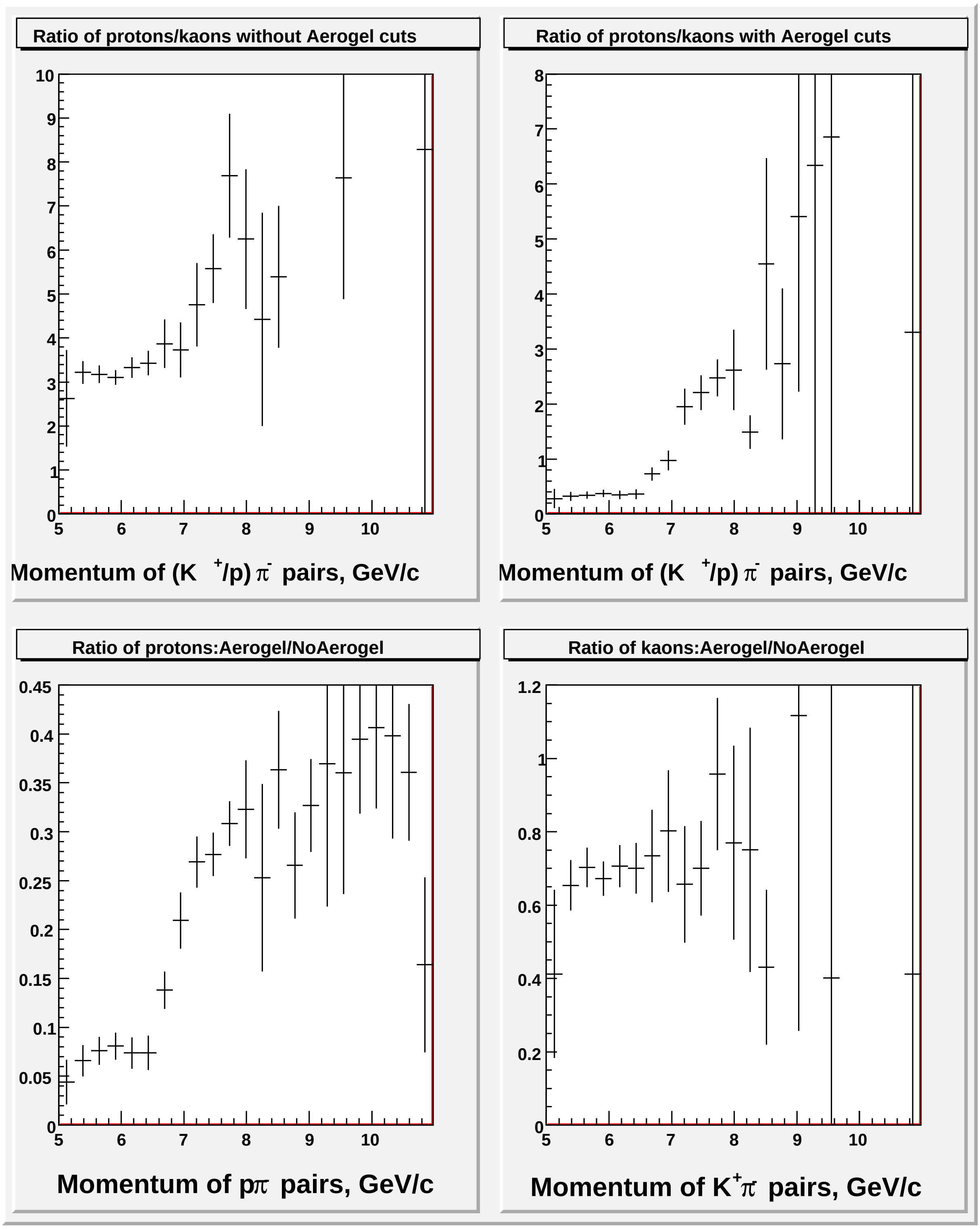

Figure 9: *The ratio of detected protons and kaons without taking into account the aerogel counters information(left on top). The ratio of detected protons and kaons with taking into account the aerogel counters information(right on top). The ratio of detected protons with taking into account the aerogel counters information and without(left on bottom). The ratio of detected kaons with taking into account the aerogel counters information and without(left on bottom).*

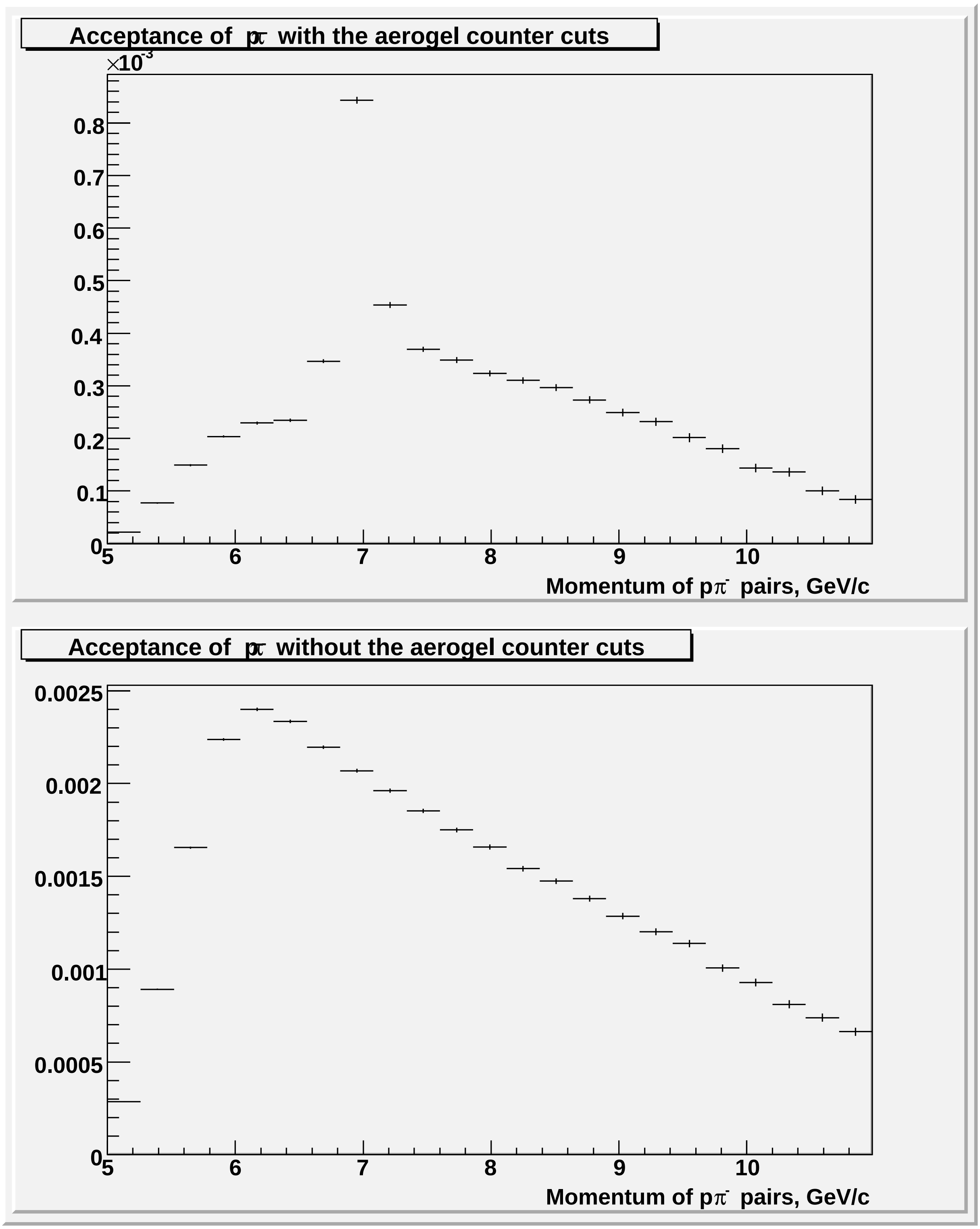

Figure 10: *The $p\pi^-$ pairs acceptance, obtained by Monte-Carlo. For the full set of cuts(top) and with absence of aerogel counter cuts(bottom).*

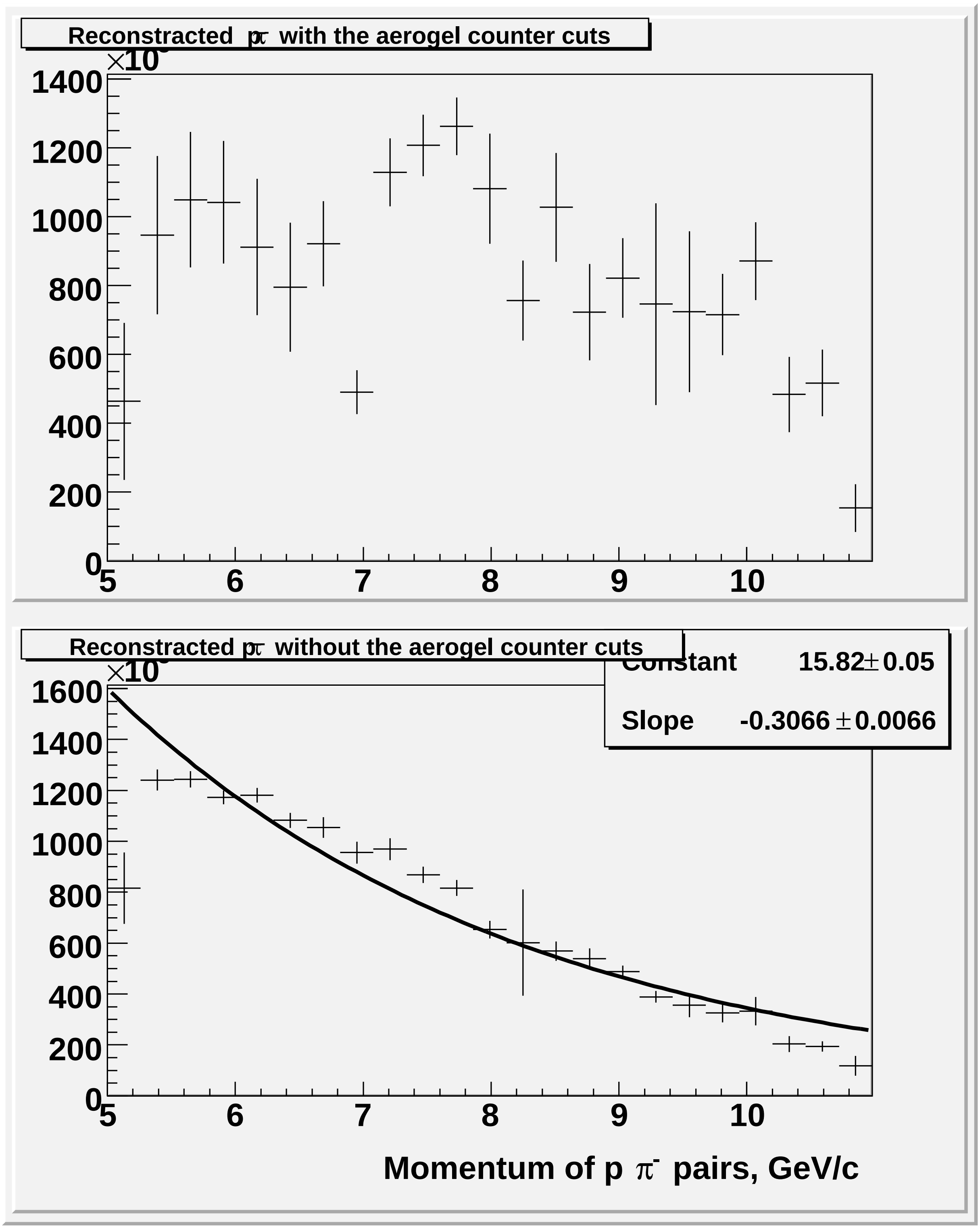

Figure 11: *The reconstructed $p\pi^-$ pair momentum distribution in the target, for full set of cuts(top) and with absence of aerogel counter cuts(bottom). The down distribution is fitted by $a * exp(b * p)$ function, where p is pair momentum.*

References

[1] The momentum distribution of $K^+\pi^-$ and π^+K^- pairs (Coulomb and nonCoulomb) , O.Gorchakov [JINR], DIRAC Note 2010-01.