Status of π/μ analysis for the pion form factor

Peter A. Lukin,
Budker Institute of Nuclear Physics,
Novosibirsk, Russia

Graziano Venanzoni,
LNF, INFN,
Frascati, Italy

Outline

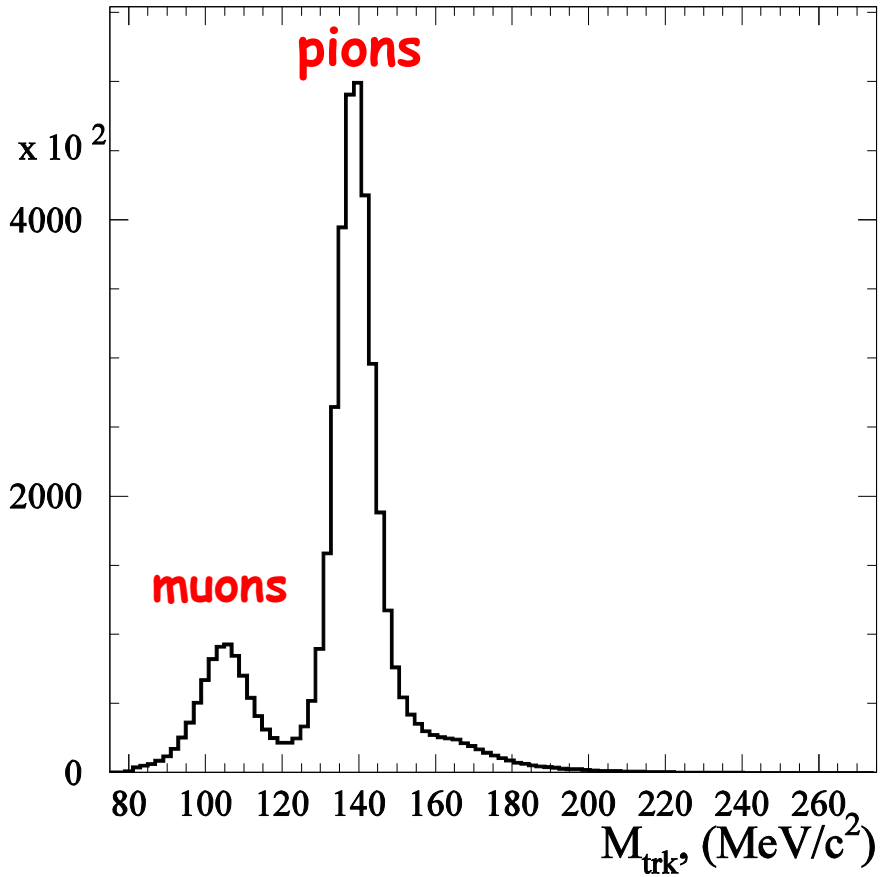
- Introduction
- Data and MC samples in the analysis
- Problems, we faced right after the analysis has begun
- Works, done in trying to solve the problems
  - → Study of Point-of-Closest-Approach (PCA) parameters
  - → Study of the muon polar angle in analysis of collinears events at LA analysis at 1 GeV
- Another approach
- Results
- Conclusion
- Plans

Introduction

Goal of the analysis: To measure pion form factor using $N_{\pi\pi}/N_{\mu\mu} \Rightarrow$ Good possibilty to decrease systematic error, because many factors cancel in ratio

In the analysis we use 2-body ISR events and we do not detect radiative photon (Small Angle analysis)

To have everything under control we study separtely muons and pions



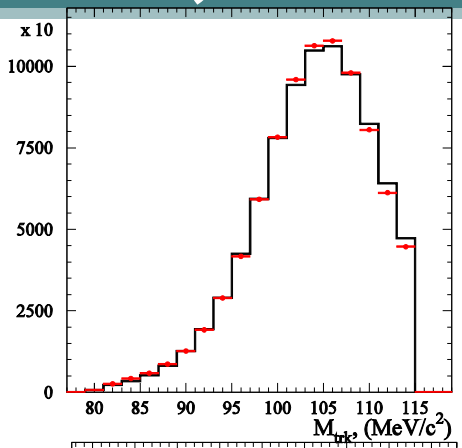
Track mass distribution

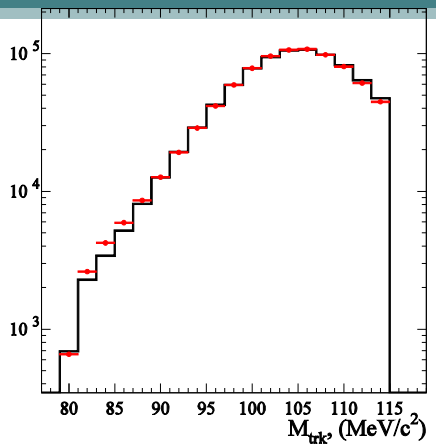
Data and MC samples

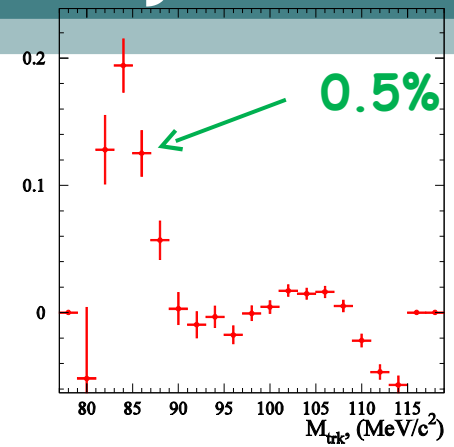
- ✓Experimental Data Runs 23542 – 27079, Luminosity Integral is 241.38 pb^{-1}
- ✓ $\pi\pi\gamma$ MC Simulation Runs 23587 - 27079, Phokhara Generator, Luminosity Integral is 240.19 pb^{-1}(× 6)
- ✓ $\mu\mu\gamma$ MC Simulation Runs 23546 - 27079, Phokhara Generator, Luminosity Integral is 240.64 pb^{-1}(× 6)
- ✓ $ee\gamma$ MC Simulation Runs 23546 - 27079, Babayaga Generator, Luminosity Integral is 236.57 pb^{-1}(× 2)

Problems, discovered after analysis has started

M_{trk}

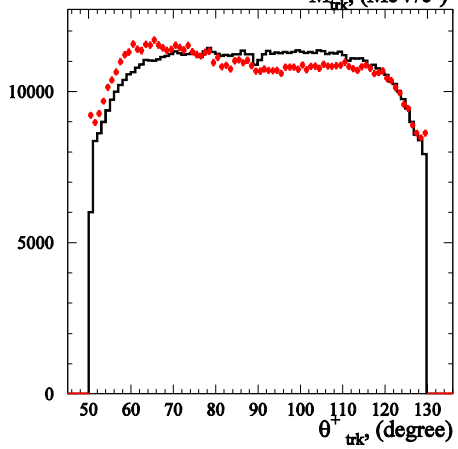


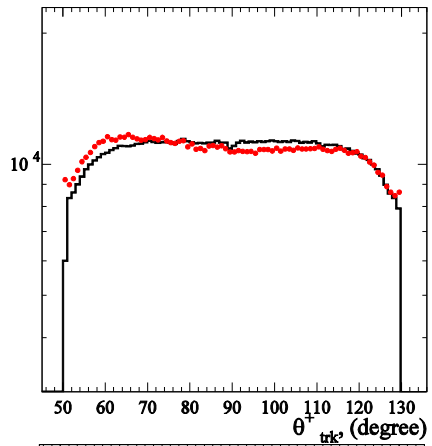


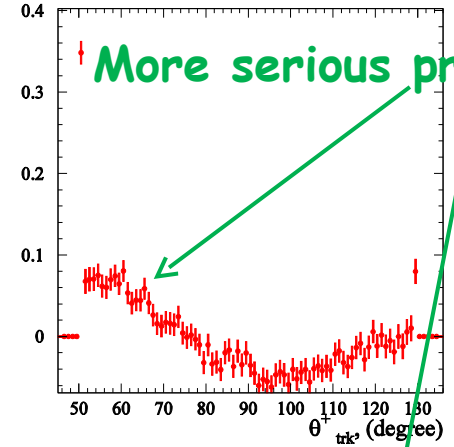


0.5% effect

θ^+_{trk}

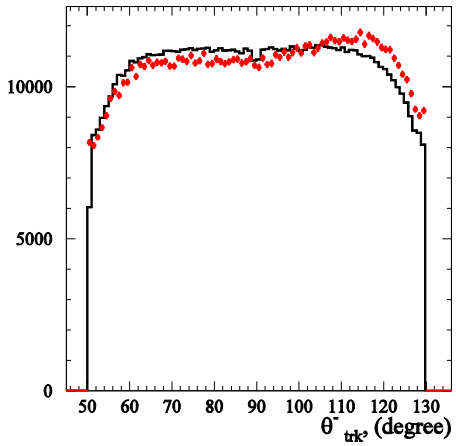


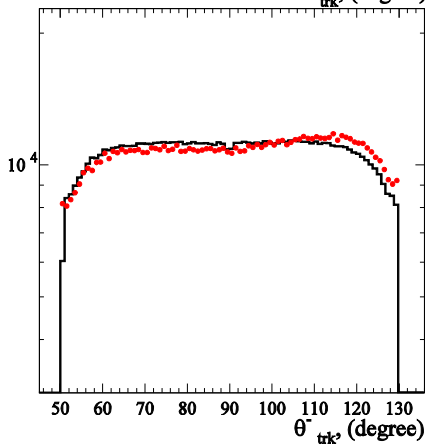


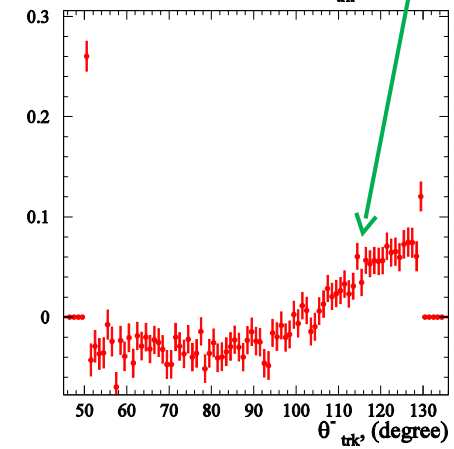


More serious problem

θ^-_{trk}



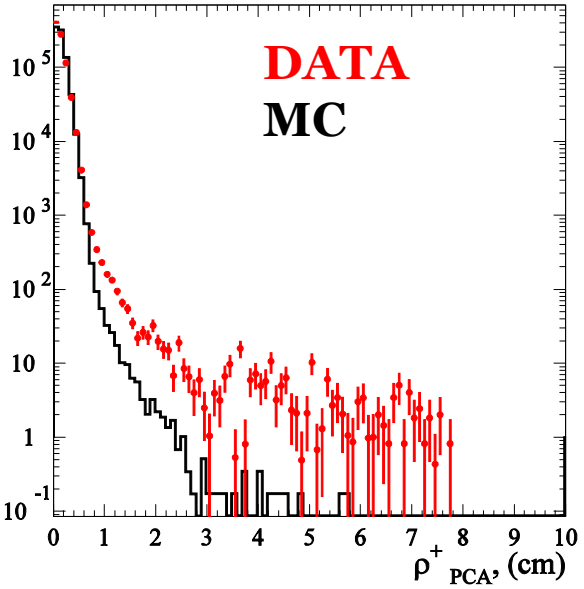


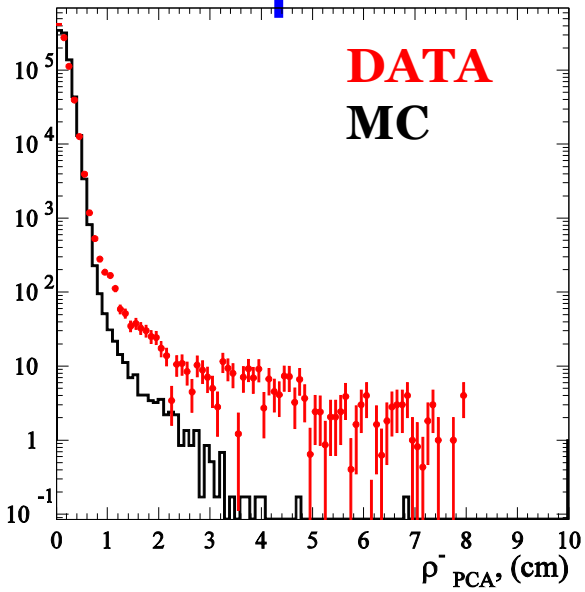


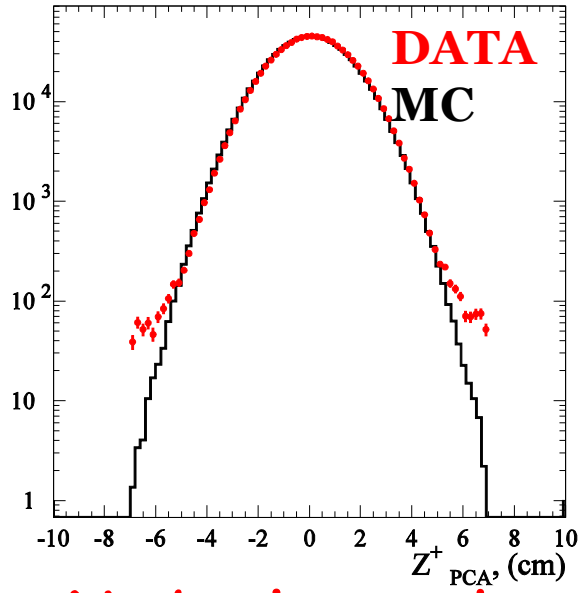
Background ?

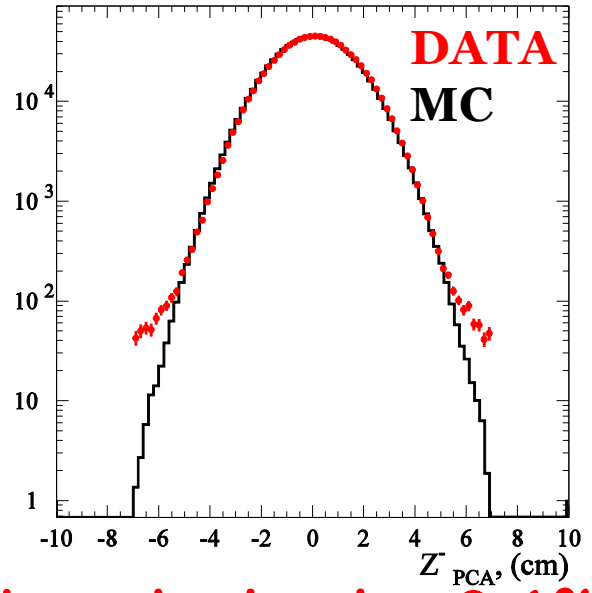
Works, done to solve the problems

(Point-of-Closest-Approach parameters)





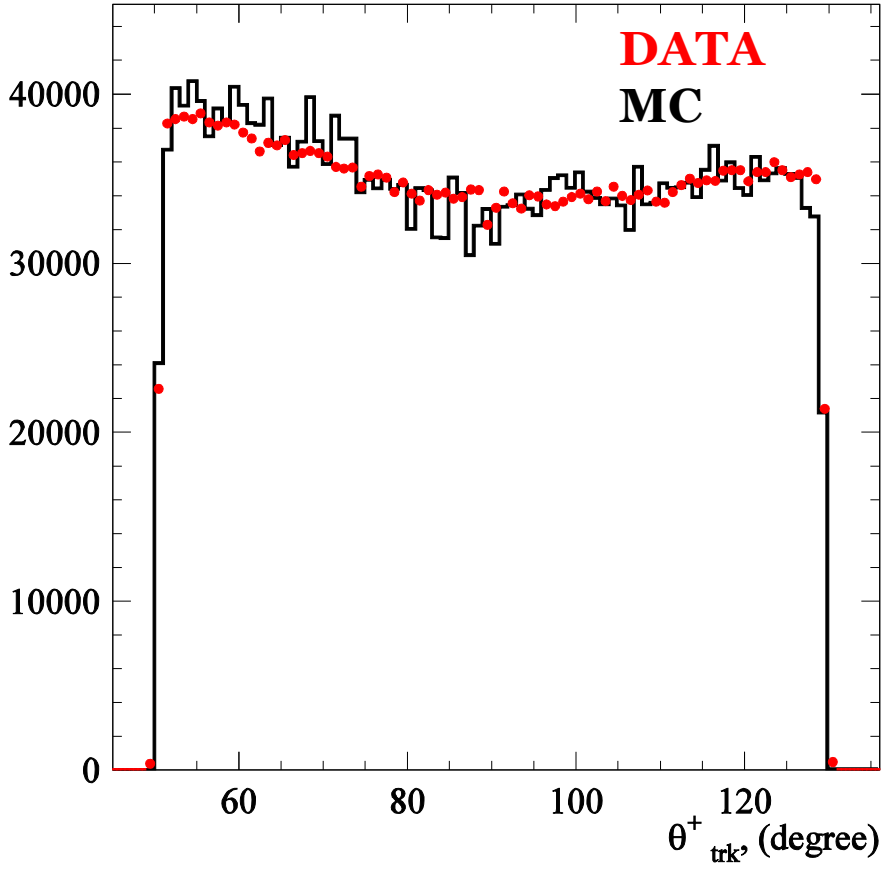


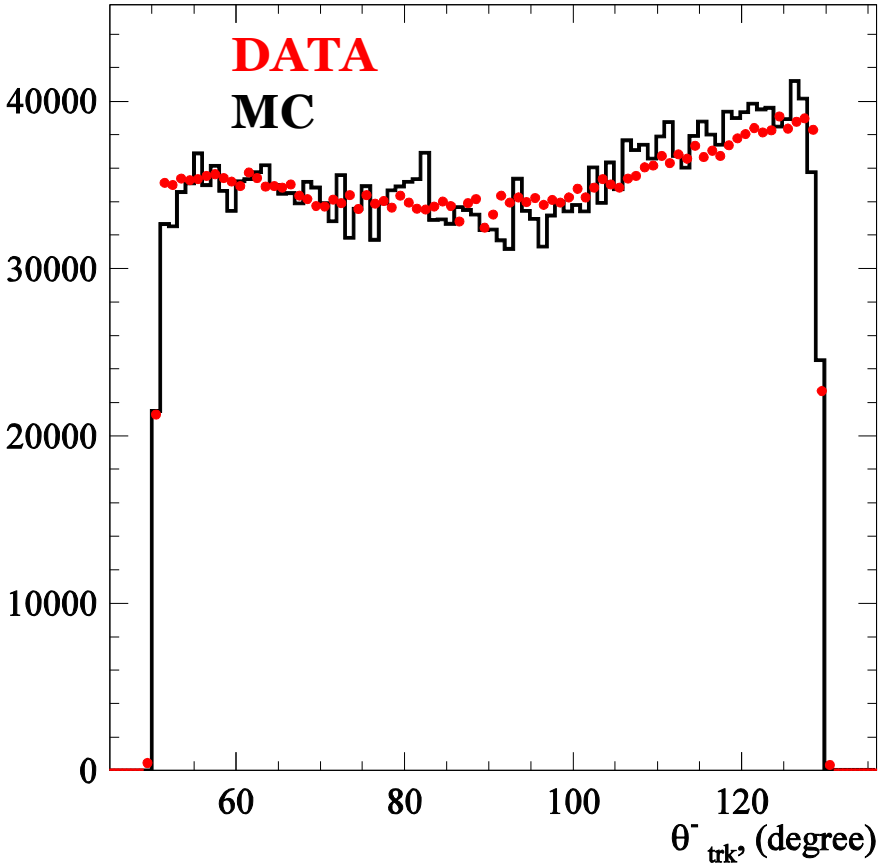


No background was found at the level < 0.1%

Works, done to solve the problems

(Polar angles of collinear muons at 1 GeV LA analysis)

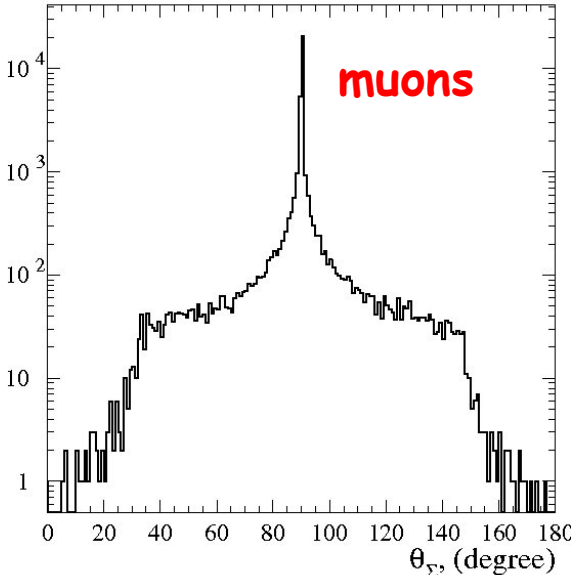


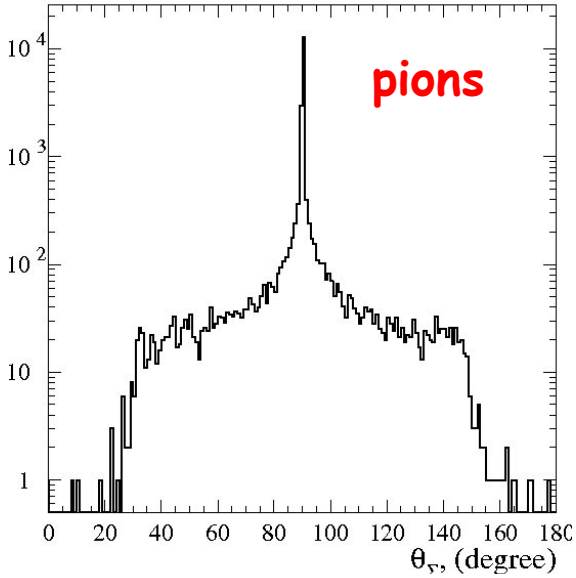


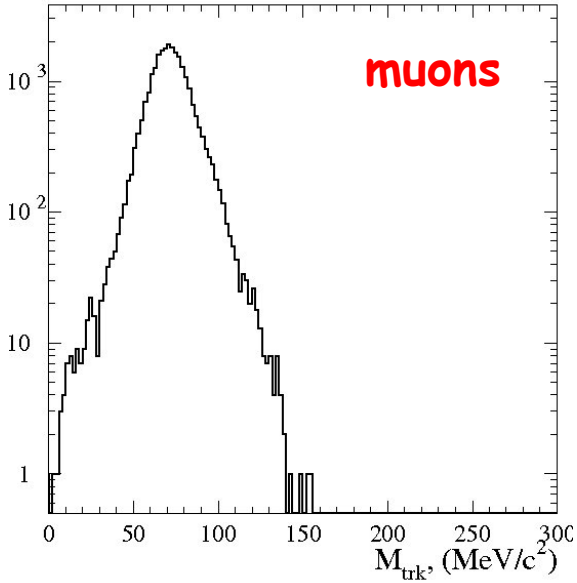
- Could contribute to our sample due to imperfections of reconstruction and poor angular resolution ?
- In MC sample NO asymmetry effects observed !!! (see next slide)

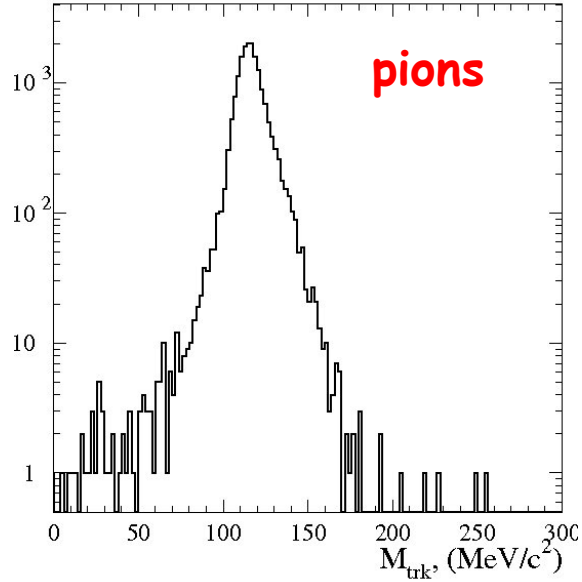
Works, done to solve the problems

(Contributions of collinear events at 1 GeV to SA sample)





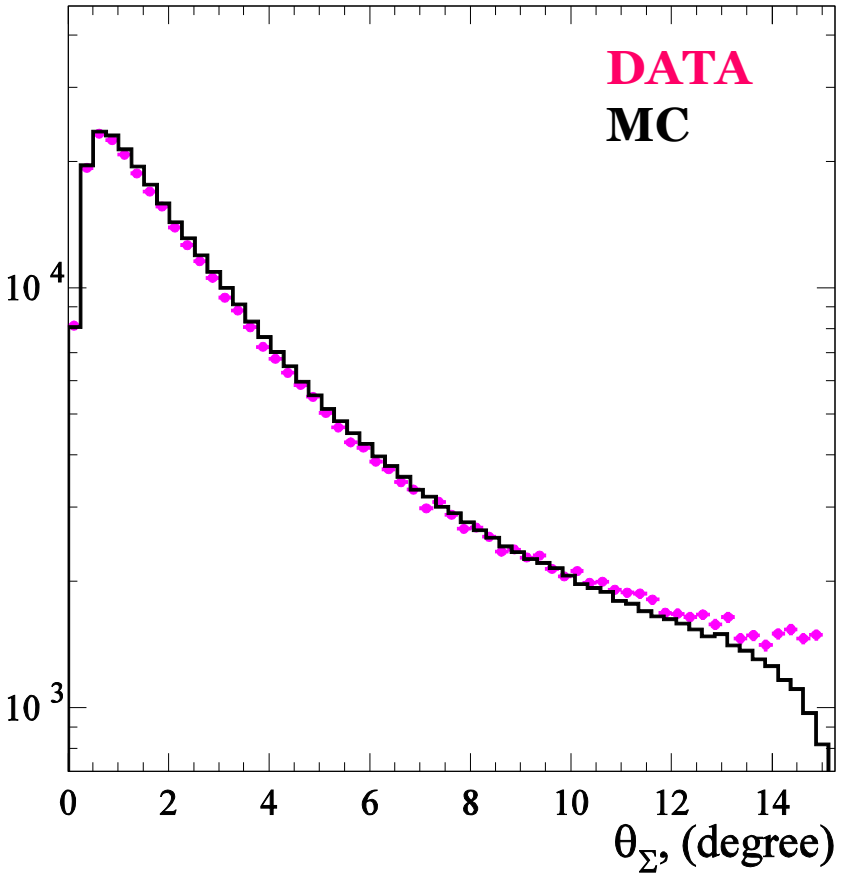


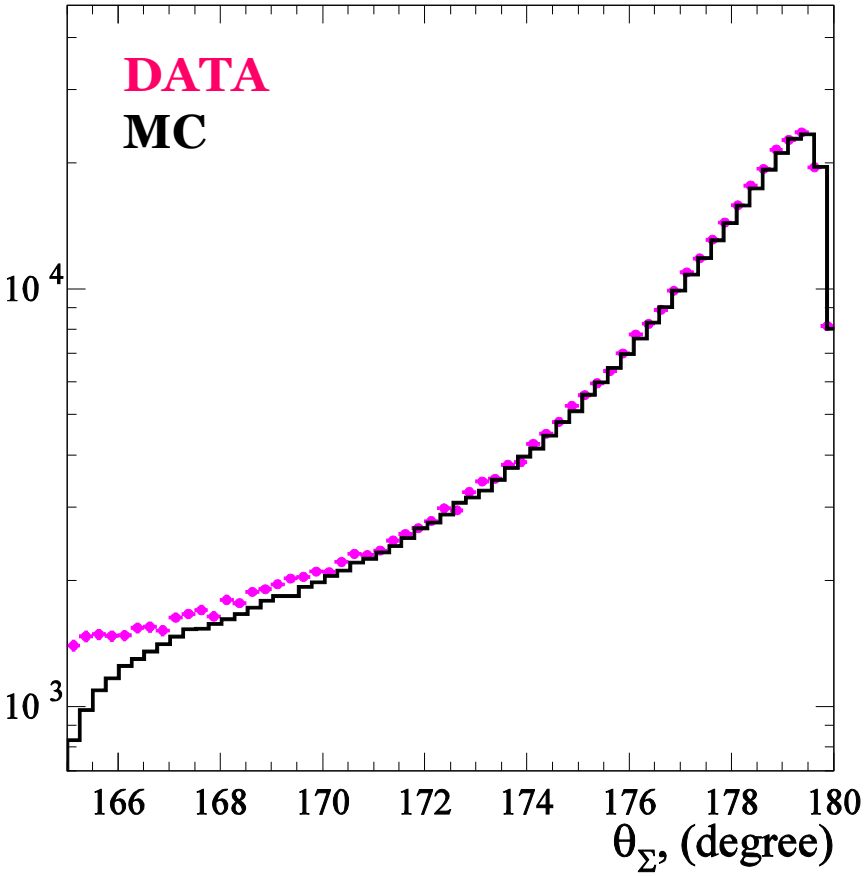


Collinears suppressed by θ_{Σ} cut. But if angular resolution will be worse ?

Works, done to solve the problems

(θ_Σ distribution for muons)





There are some discripances in 12-15 and 165-168 degrees ranges
Background ? Resolution ?
For crosschecks we will change cut to θ_Σ < 10 and θ_Σ > 170

New approach

Idea

To see how broad Q^2 range "suffers from" problems discovered ?

Method

→ $0.35 < Q^2 < 0.95\ GeV^2$ divided in 31 bins ($\Delta Q^2 = 0.02\ GeV^2$)

→ At each Q2 bin:

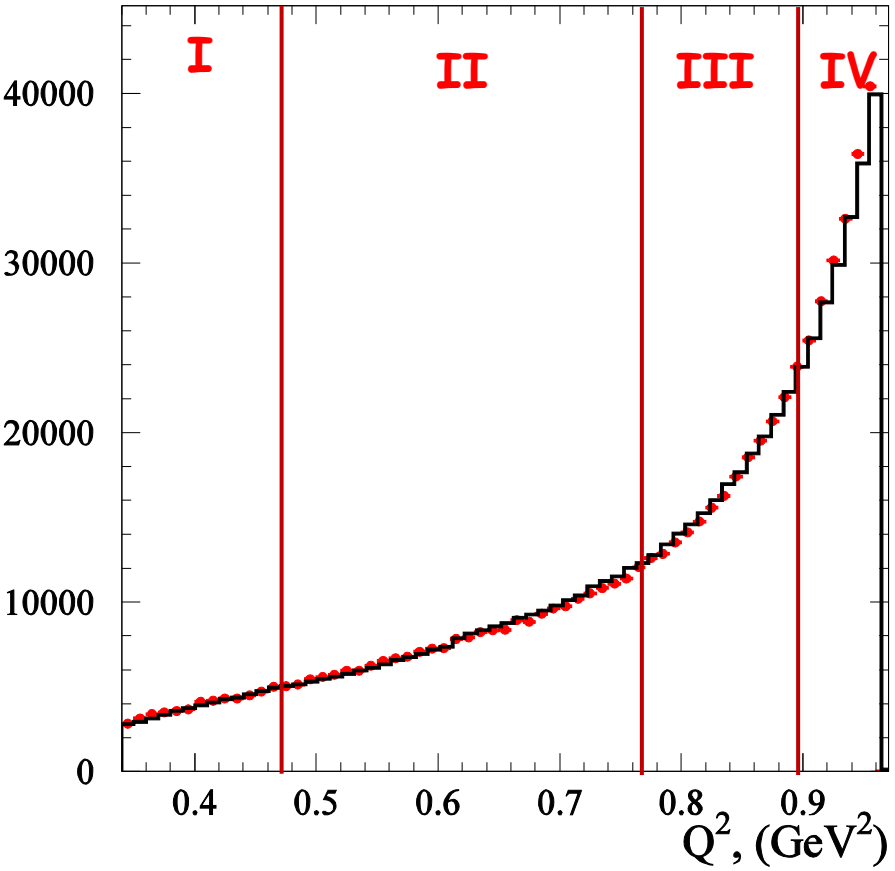
- $ee\gamma$ = DATA(NOR), $W_{ee\gamma} = W^{XOR}_{DATA}(M_{trk})$
- $W_{\mu\mu\gamma} = W_{MC}(M_{trk})$, $W_{\pi\pi\gamma} = W_{MC}(M_{trk})$
- $W_{\mu\mu\gamma}$, $W_{\pi\pi\gamma}$, $W_{ee\gamma}$ are applied then to subtract background and normalize MC for DATA/MC comparision muon polar angle distribution

→ Comparision was performed for

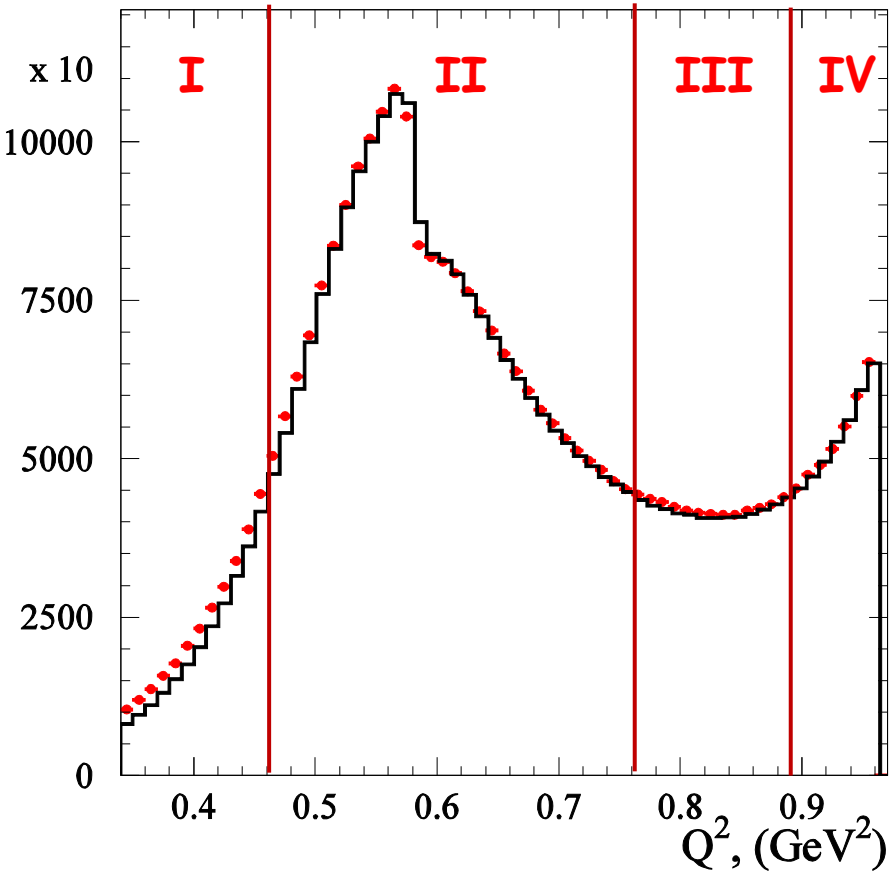
- muons ($M_{trk} < 115$ MeV/c)
- pions ($M_{trk} > 130$ MeV/c)

Results

π/μ polar angle distributions will be presented in 4 Q^2 bins (points are DATA, histograms are MC):

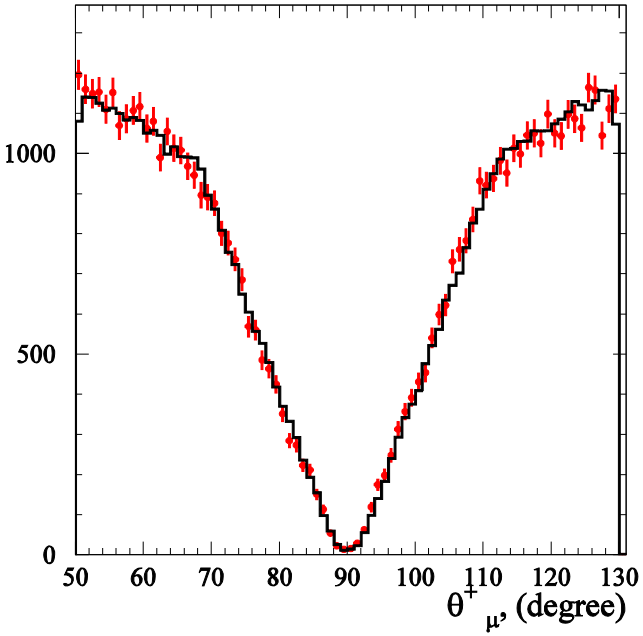


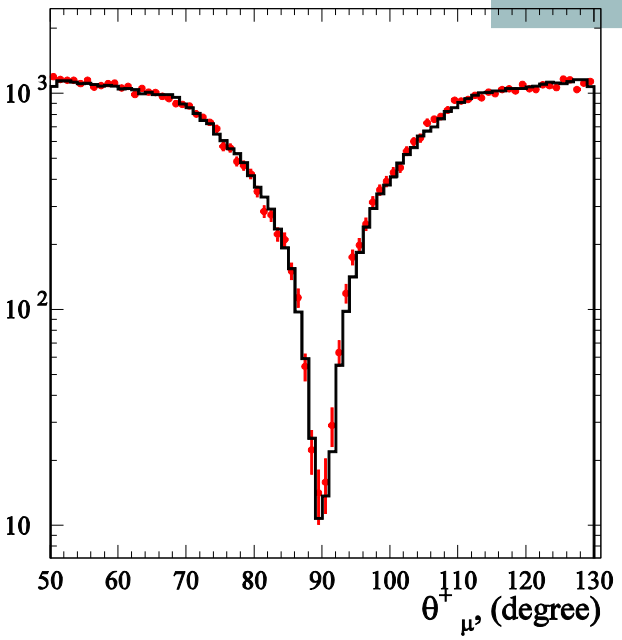
Q^2 muons

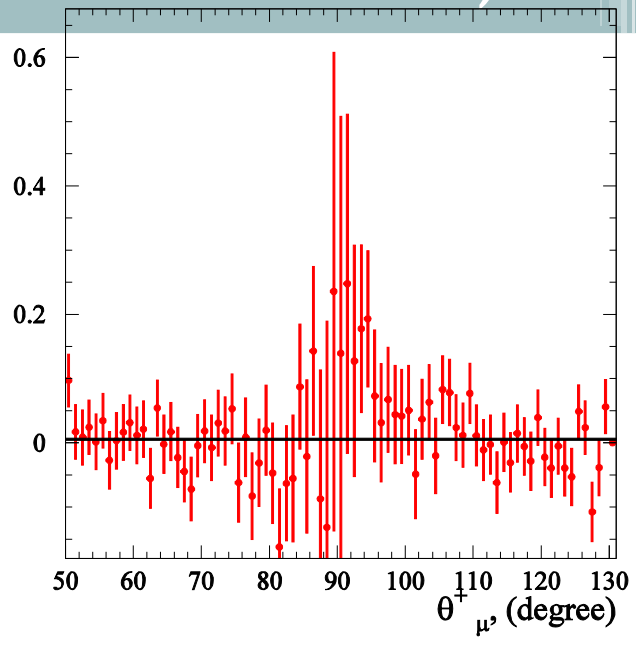


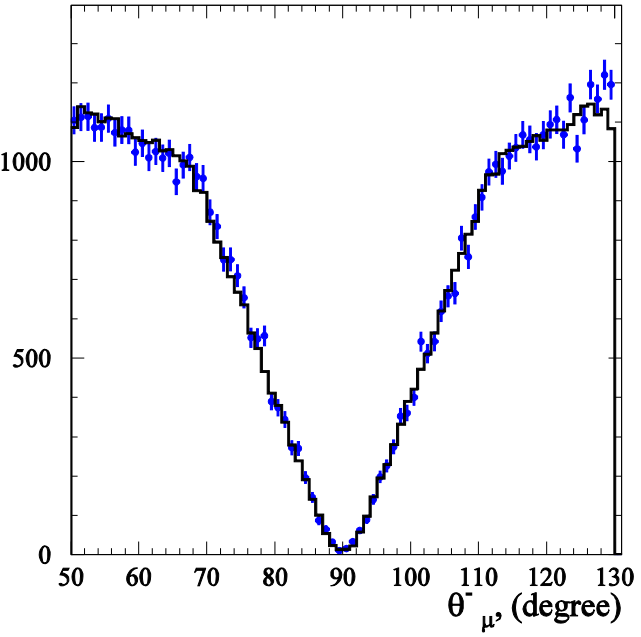
Q^2 pions

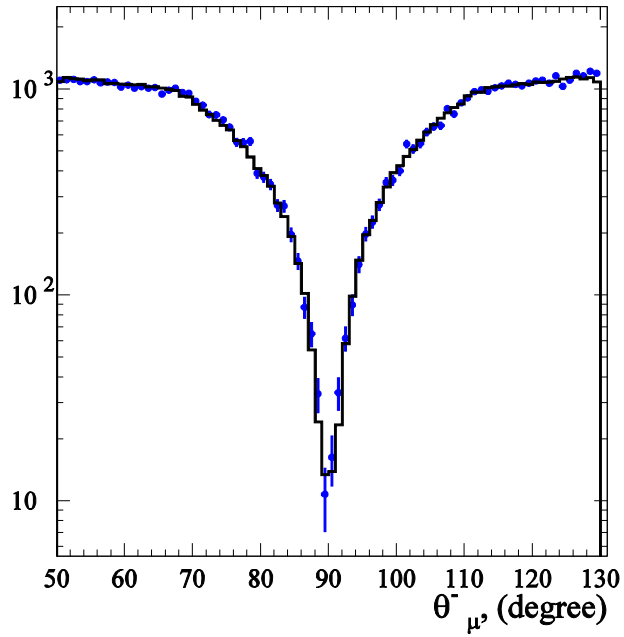
Results muons ($0.35 < Q^2 < 0.47$ GeV^2)

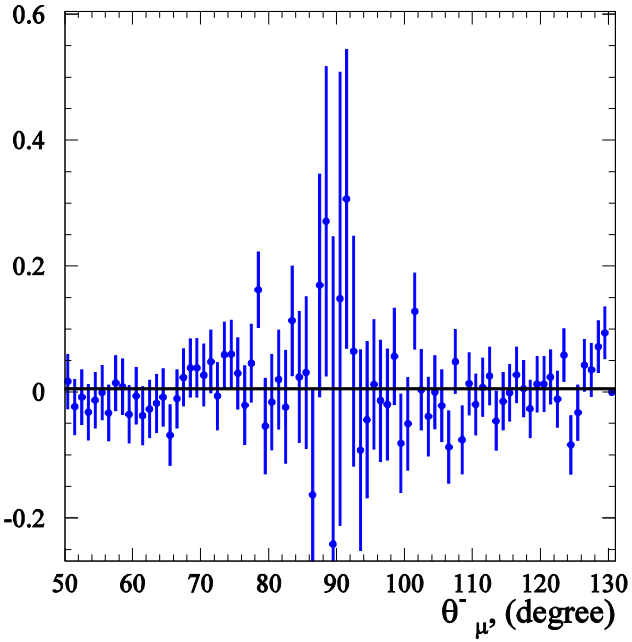




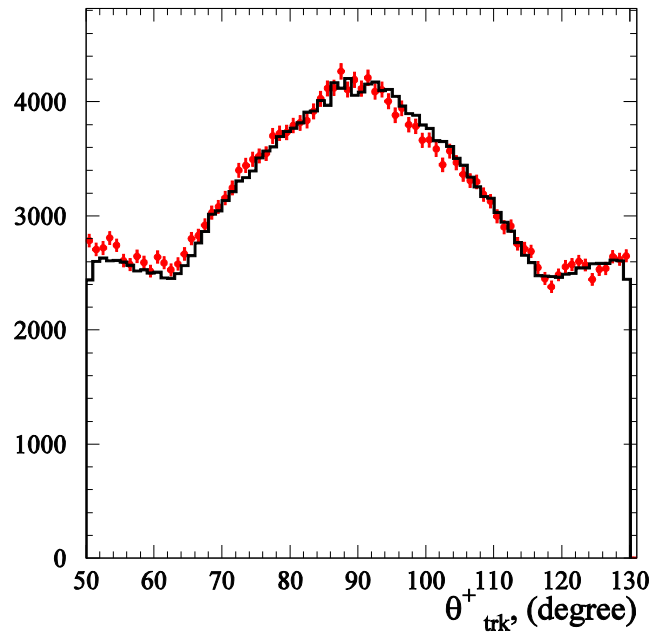


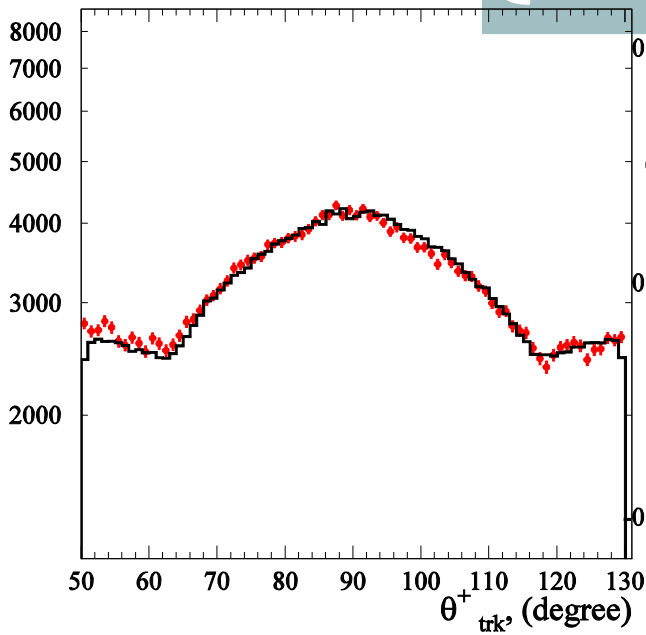


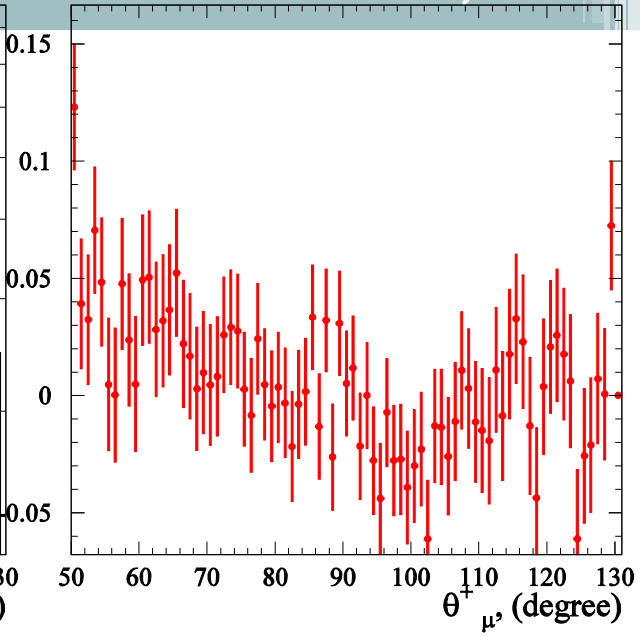


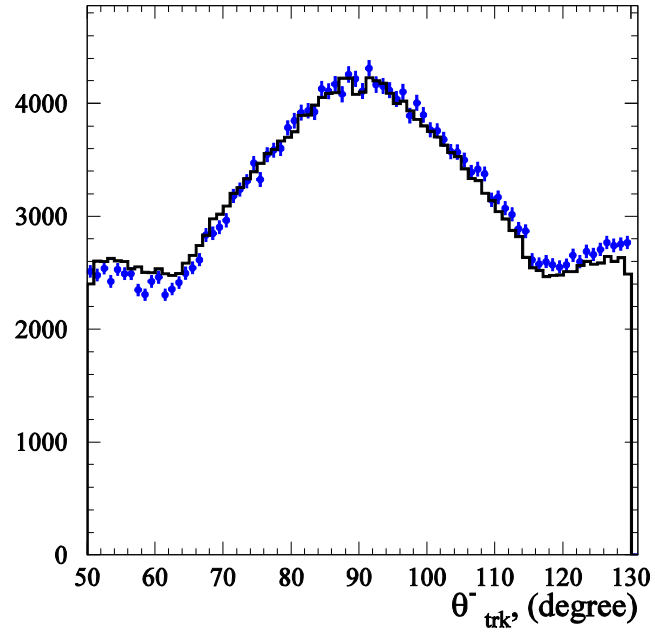


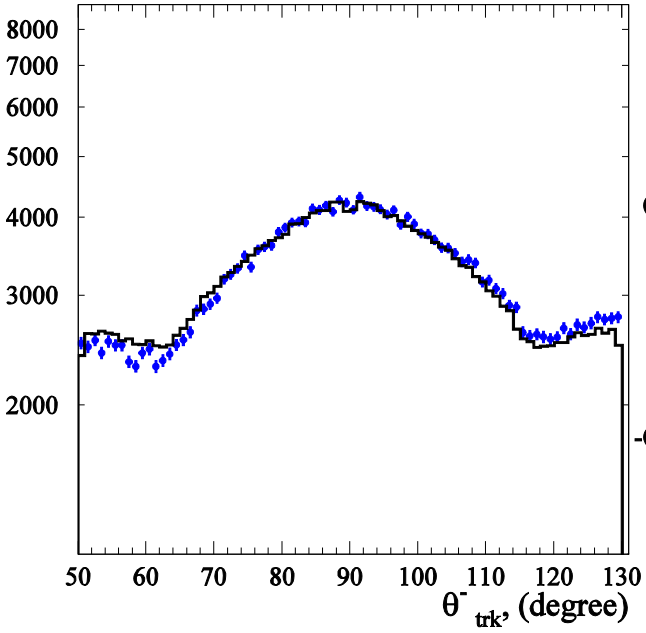
Results muons ($0.49 < Q^2 < 0.77\ GeV^2$)

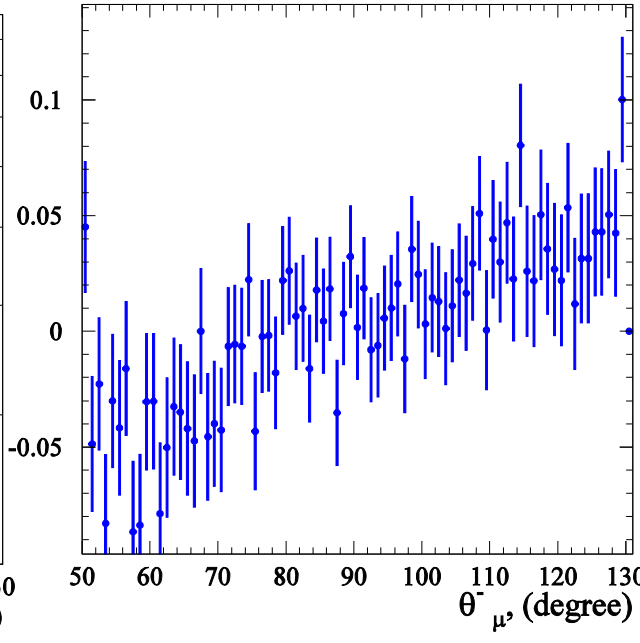




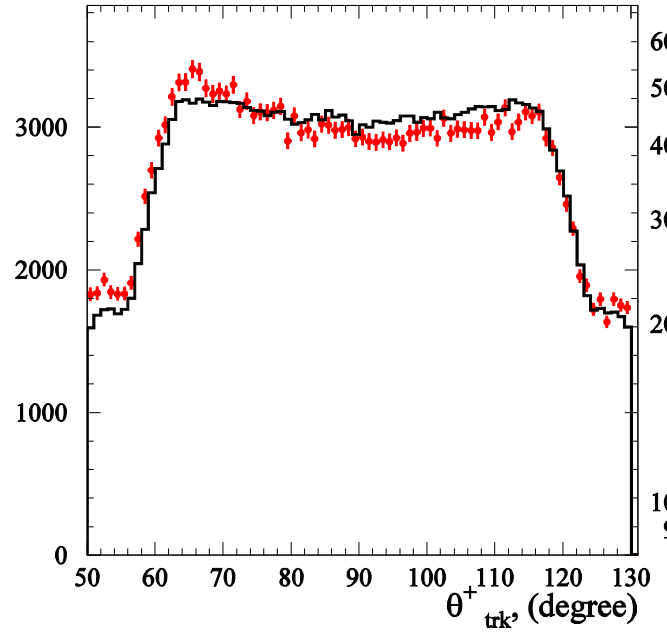


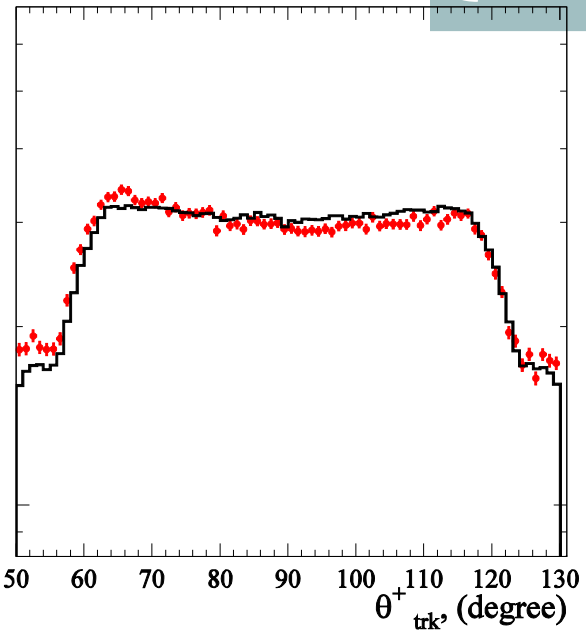


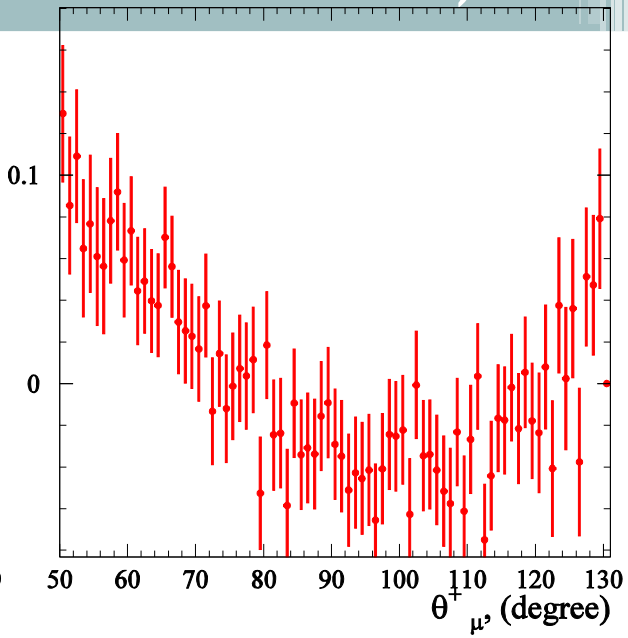


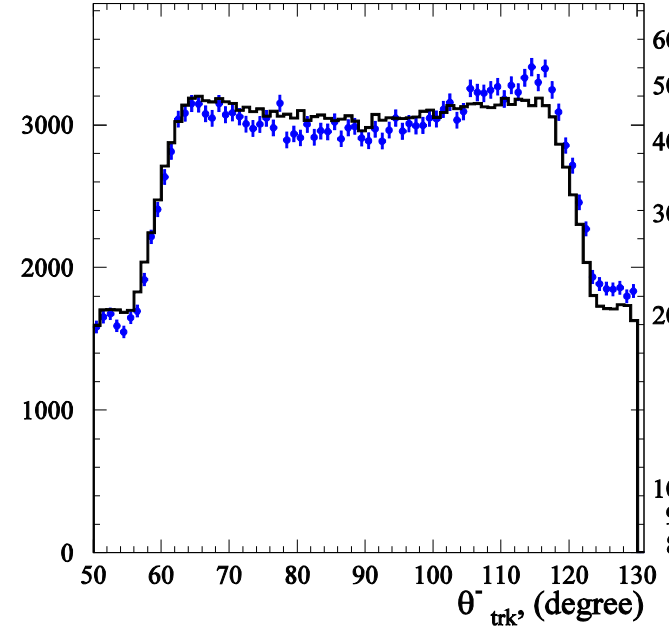


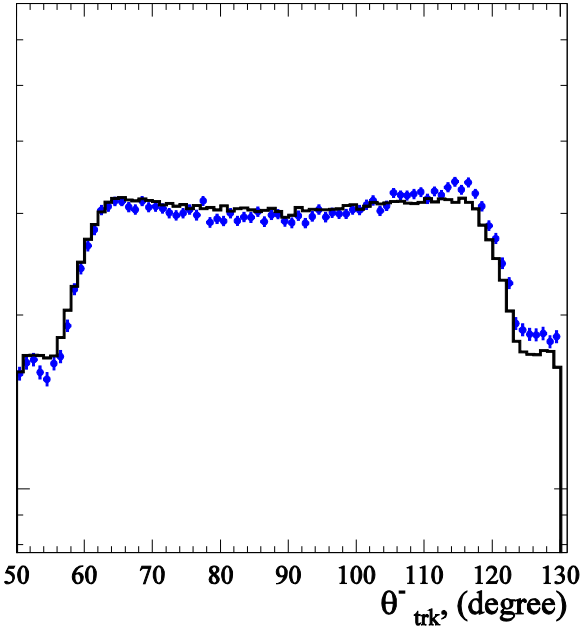
Results muons ($0.77 < Q^2 < 0.89$ GeV^2)

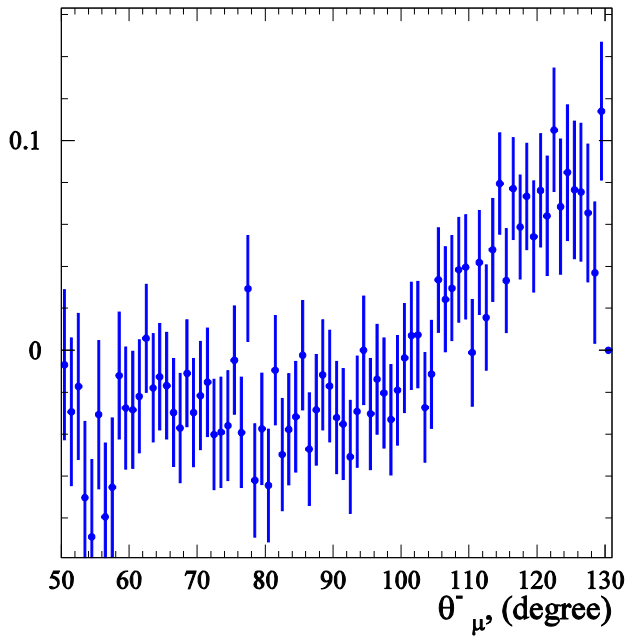




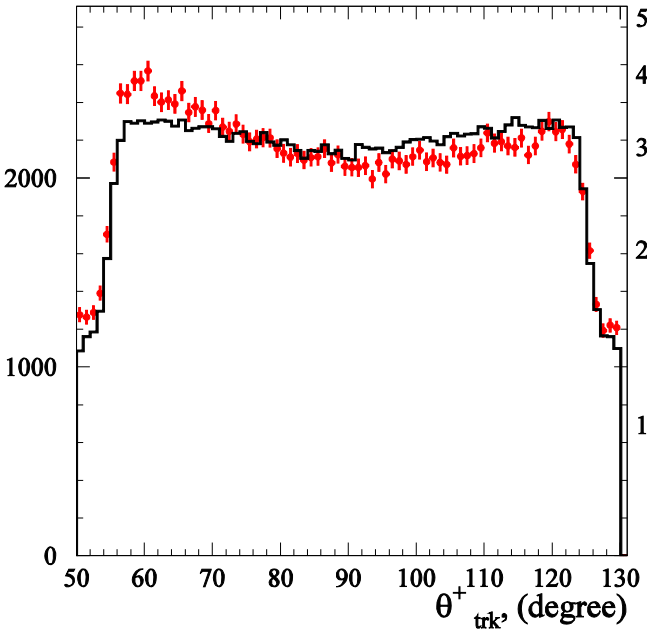


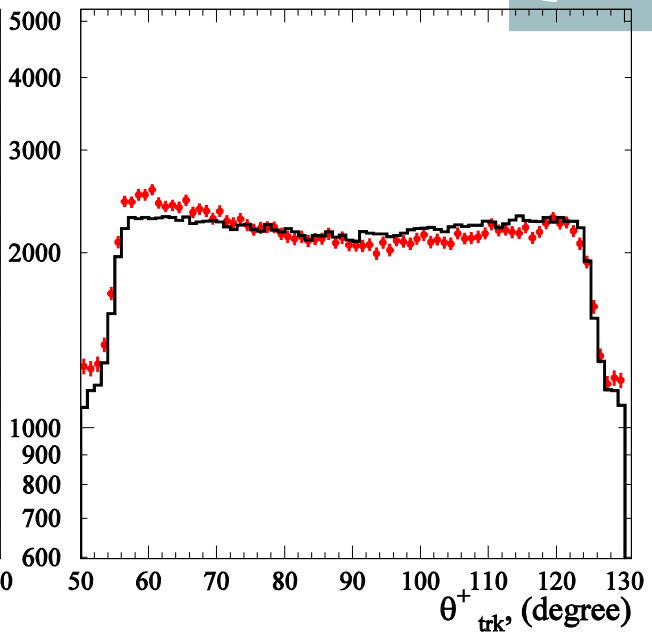


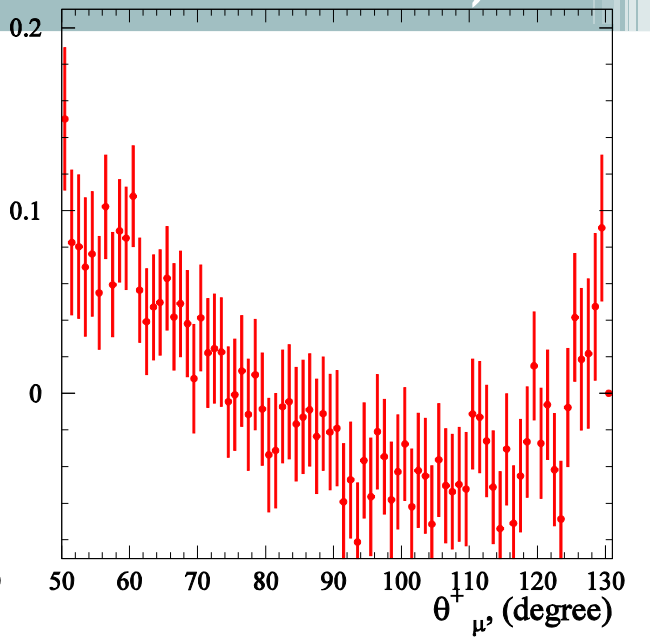


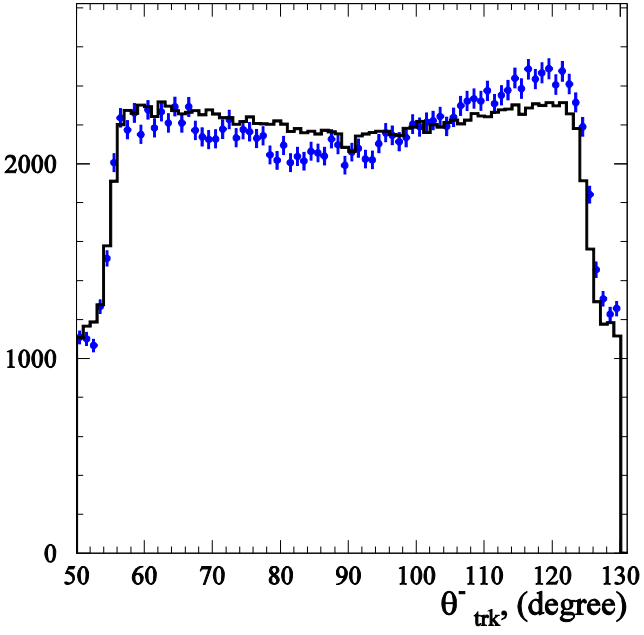


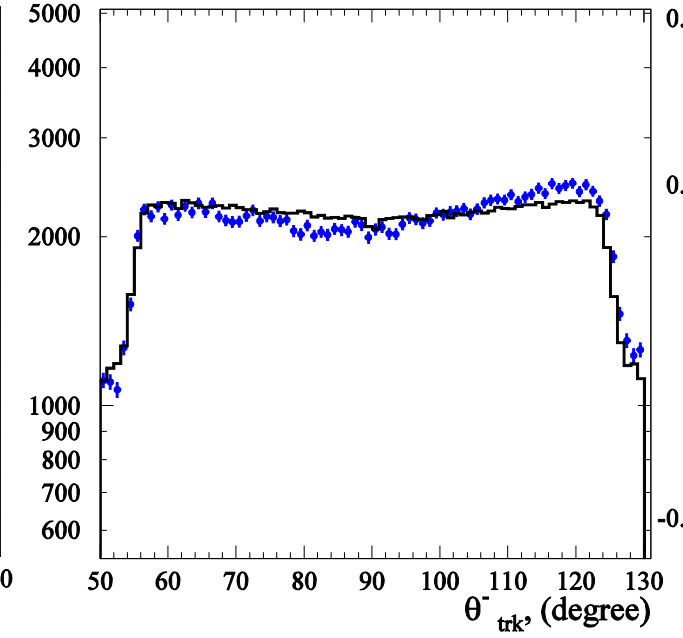
Results muons ($0.91 < Q^2 < 0.95\ GeV^2$)

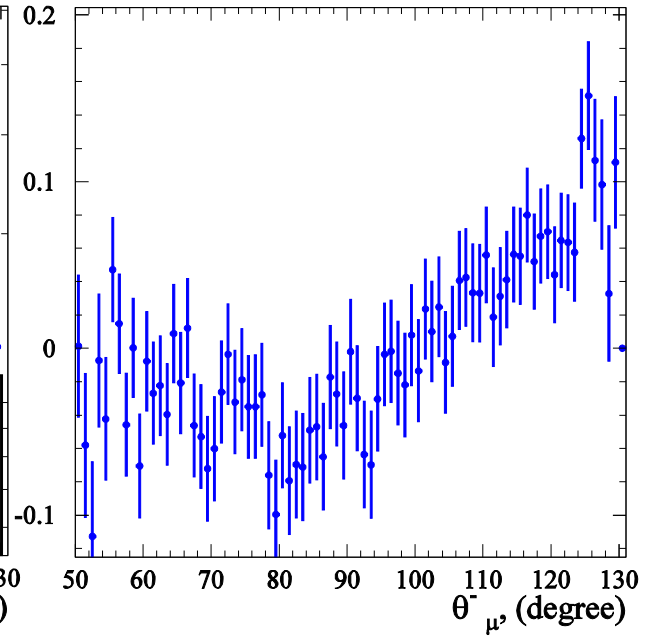




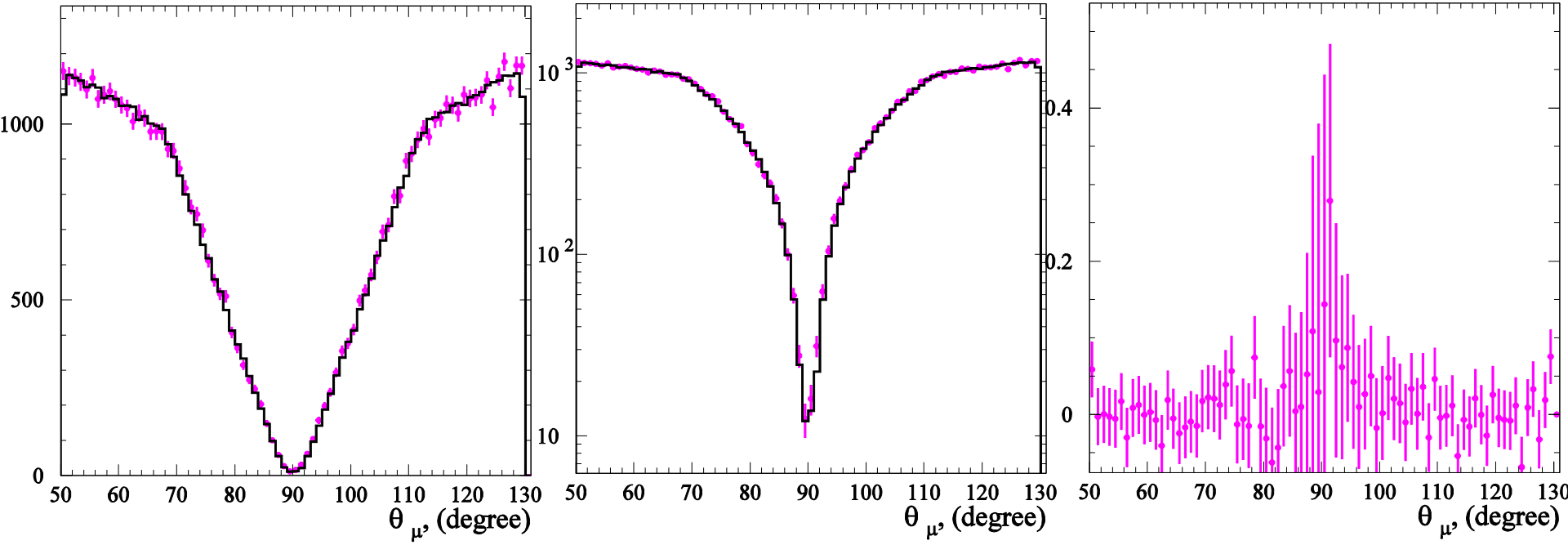






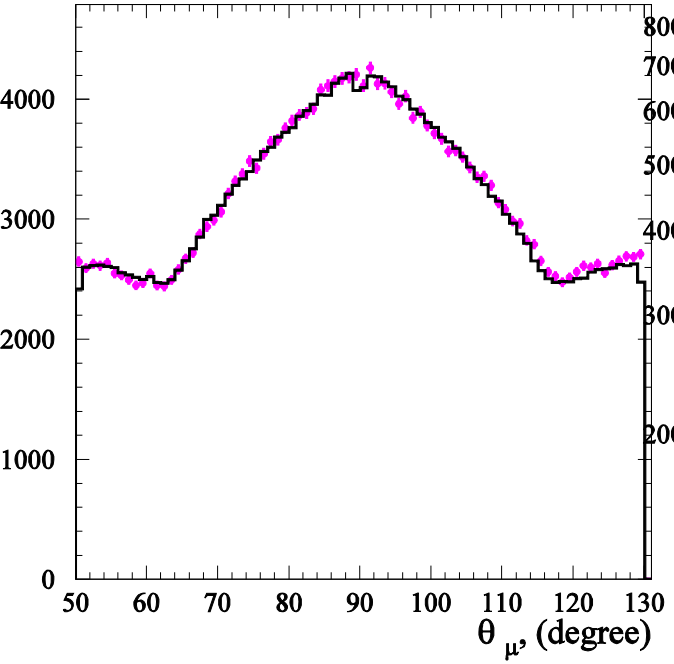


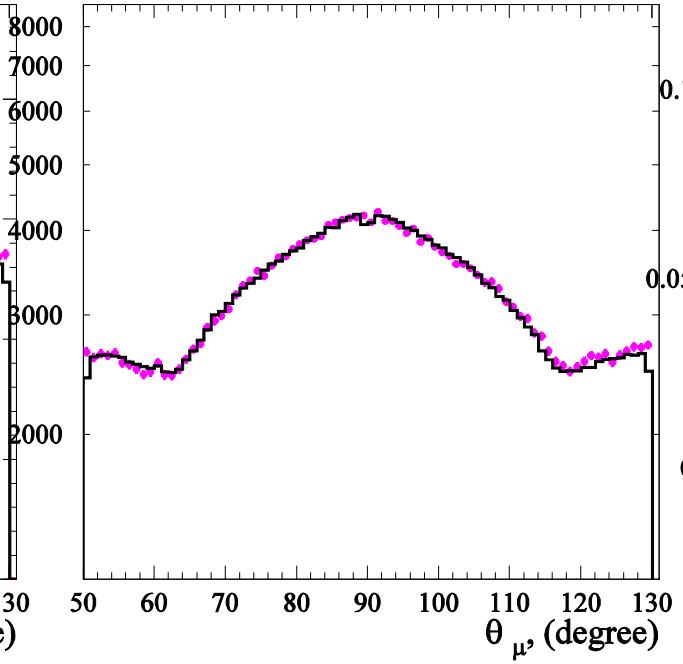
Results muons, integrated over charge ($0.35 < Q^2 < 0.47$ GeV^2)

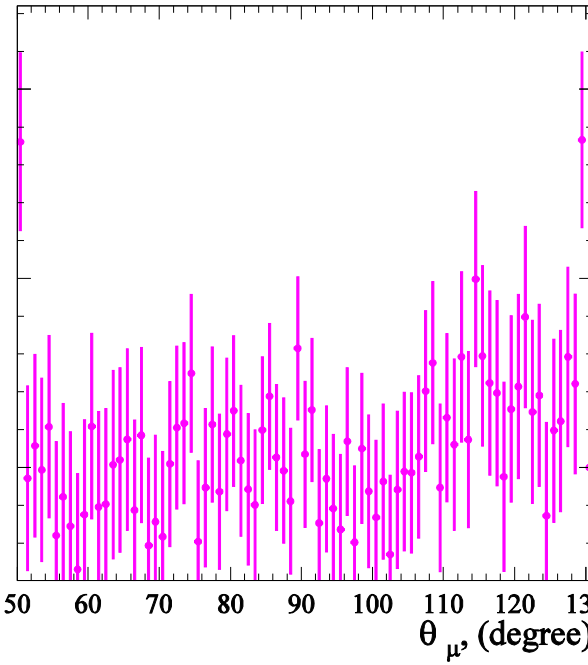


Agreement is good enough because everything is OK in different muon charges

Results muons, integrated over charge ($0.49 < Q^2 < 0.77\ GeV^2$)

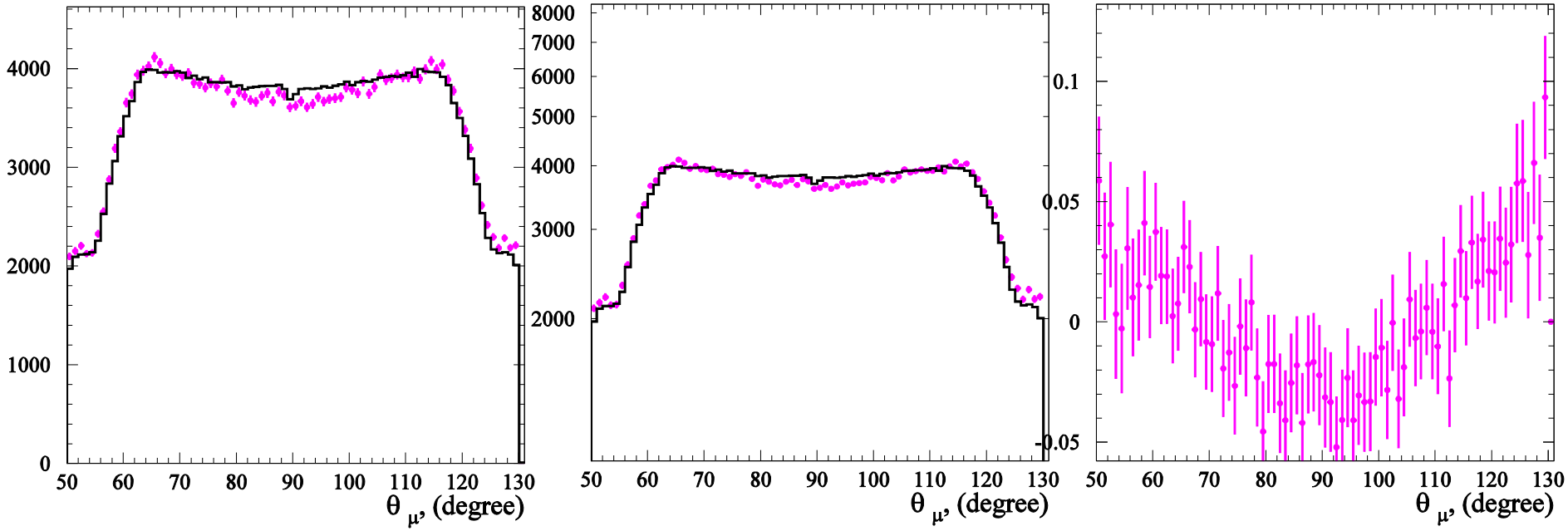






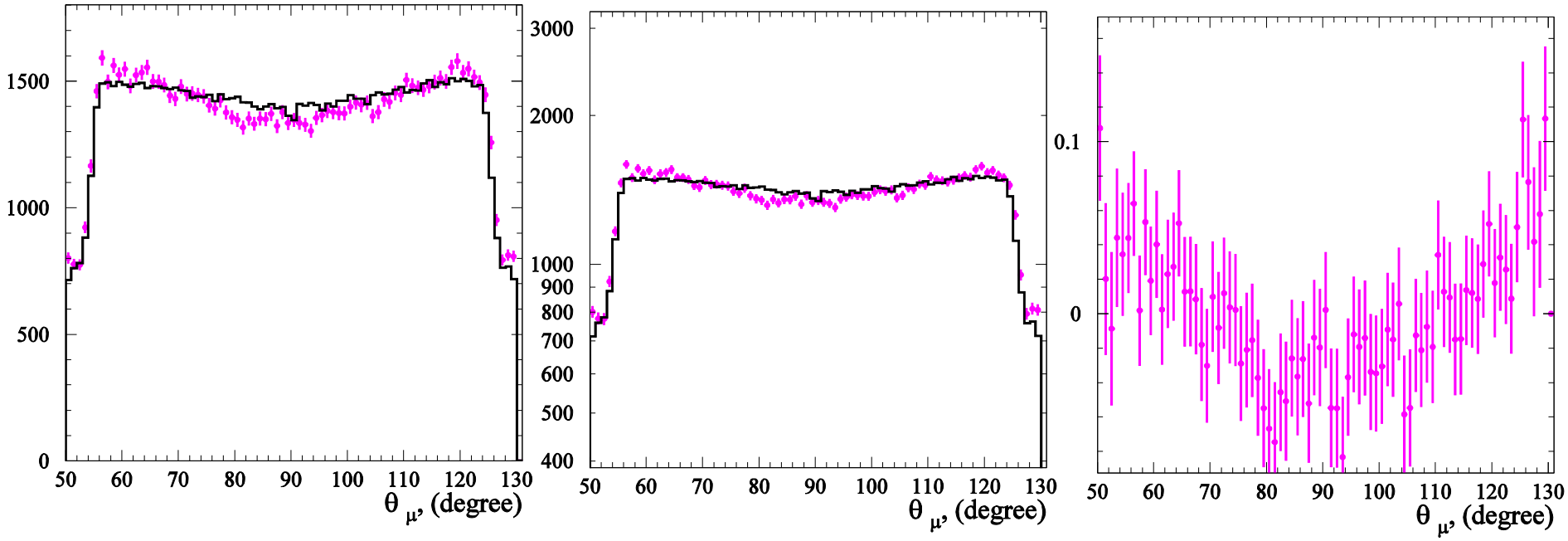
Agreement is not bad in this bin too due to the same reason, as in bin above

Results muons, integrated over charge ($0.77 < Q^2 < 0.89\ GeV^2$)



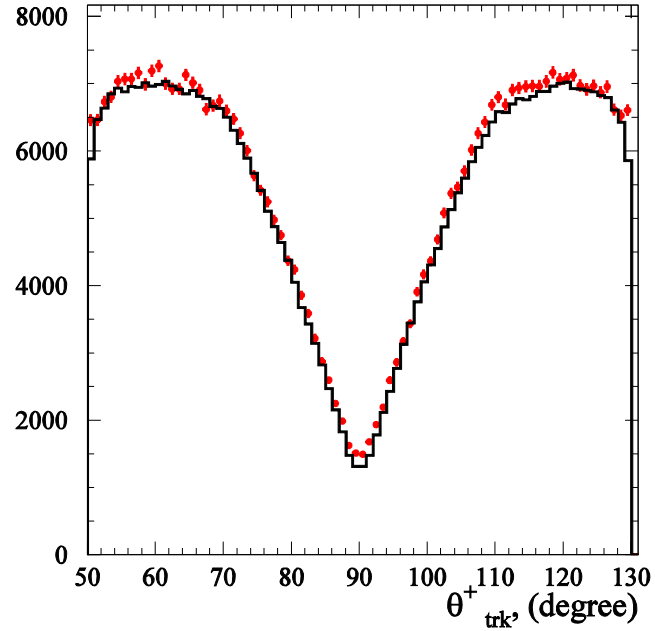
Discripance is smaller, but still present

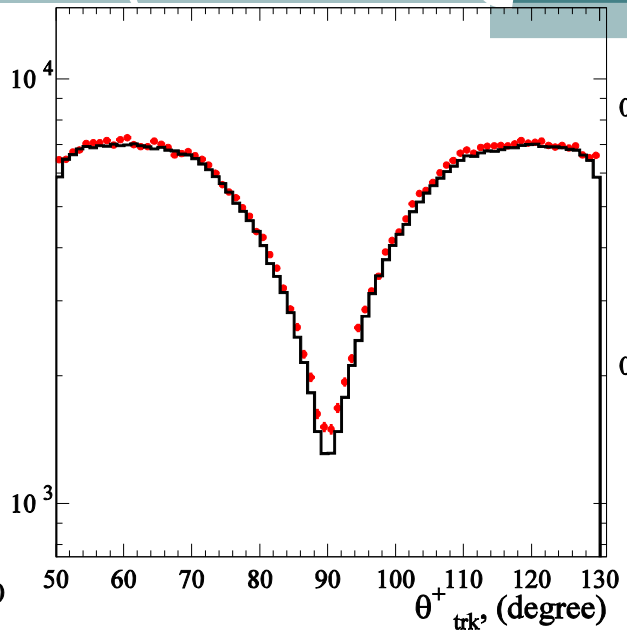
Results muons, integrated over charge ($0.91 < Q^2 < 0.95$ GeV^2)

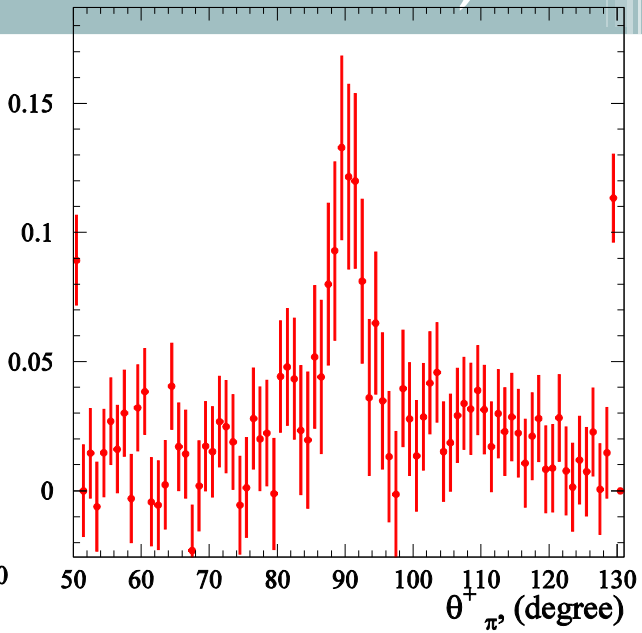


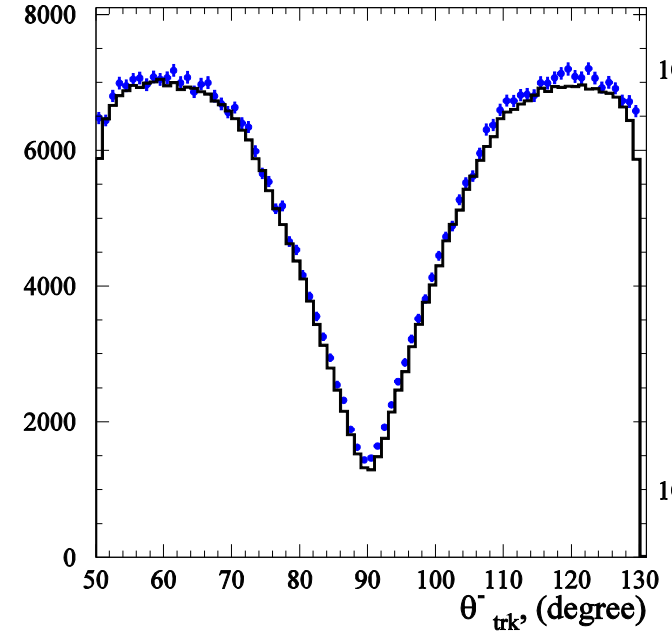
Discripance is smaller, but still present

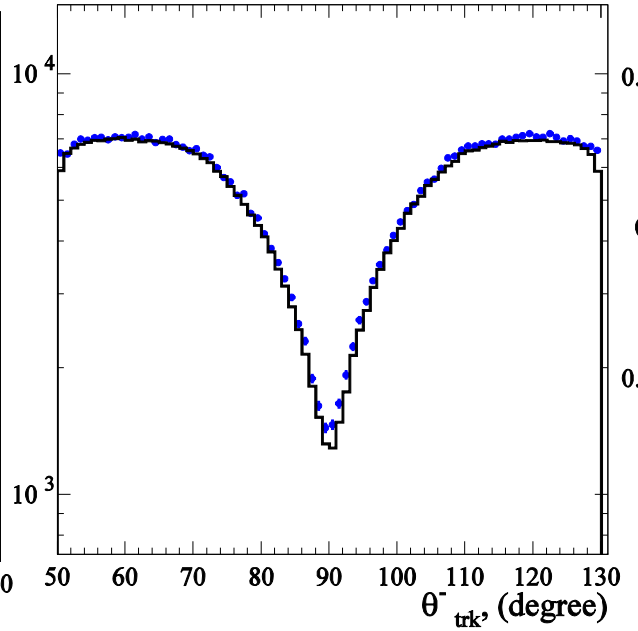
Results pions ($0.35 < Q^2 < 0.47$ GeV^2)

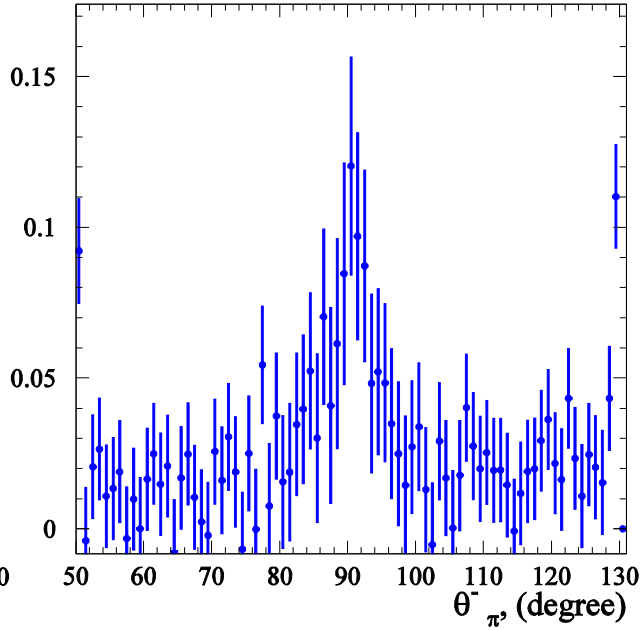




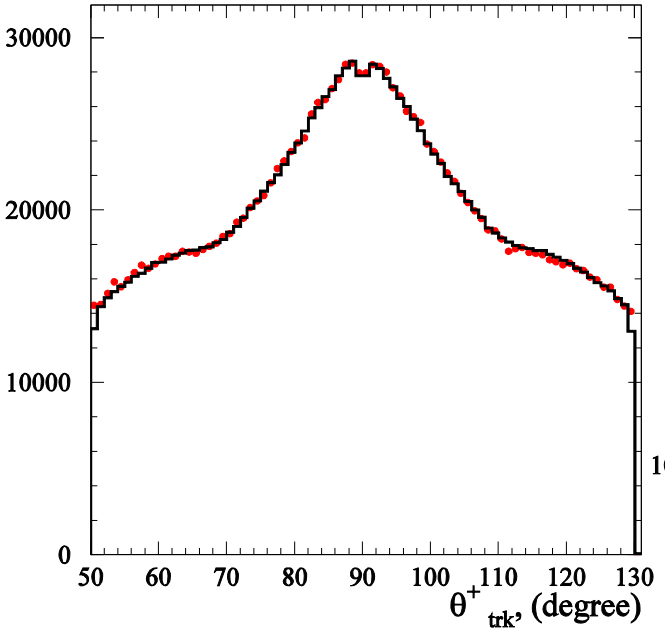


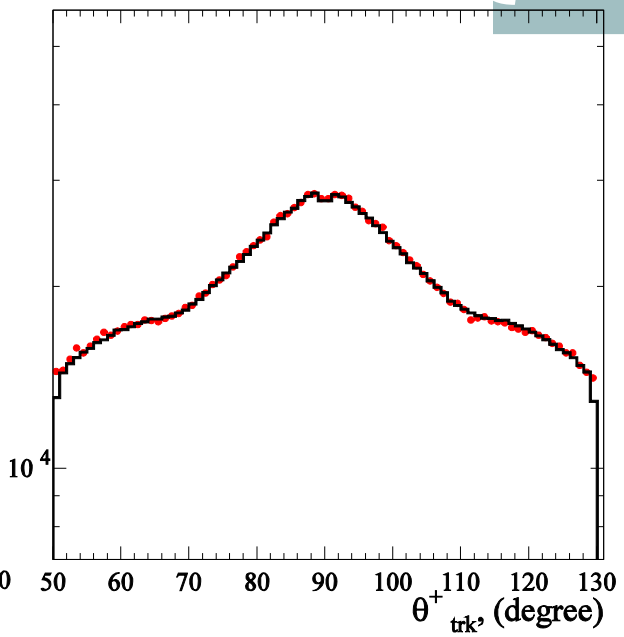


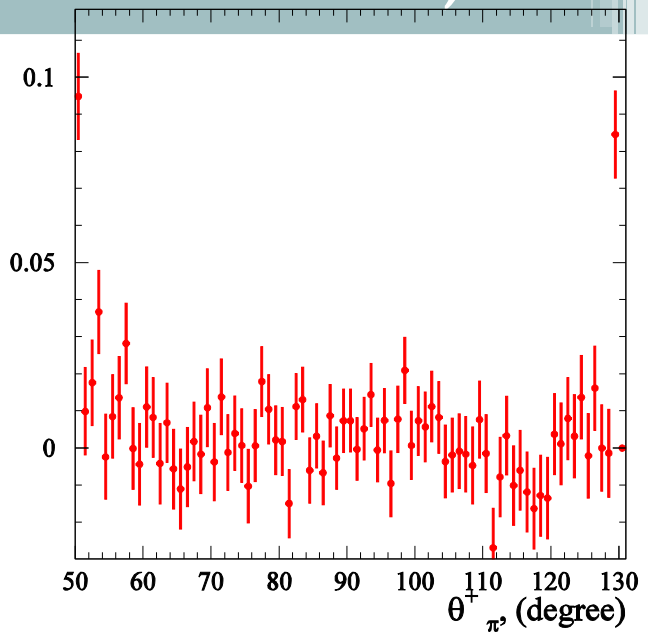


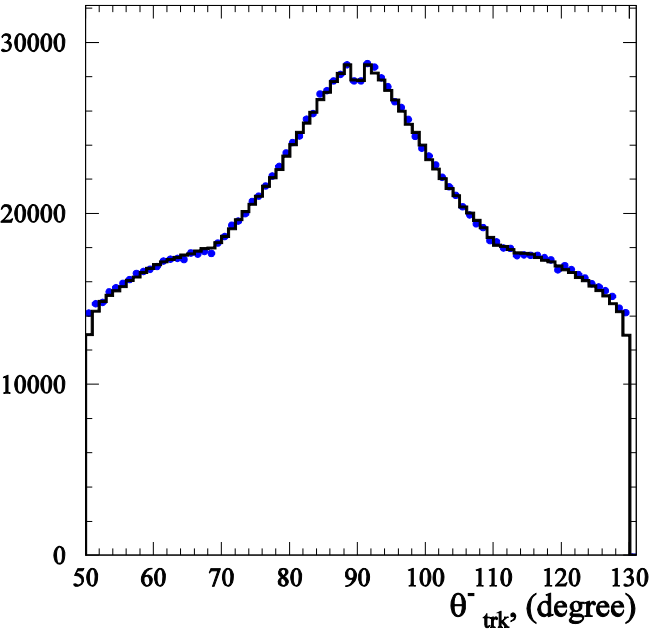


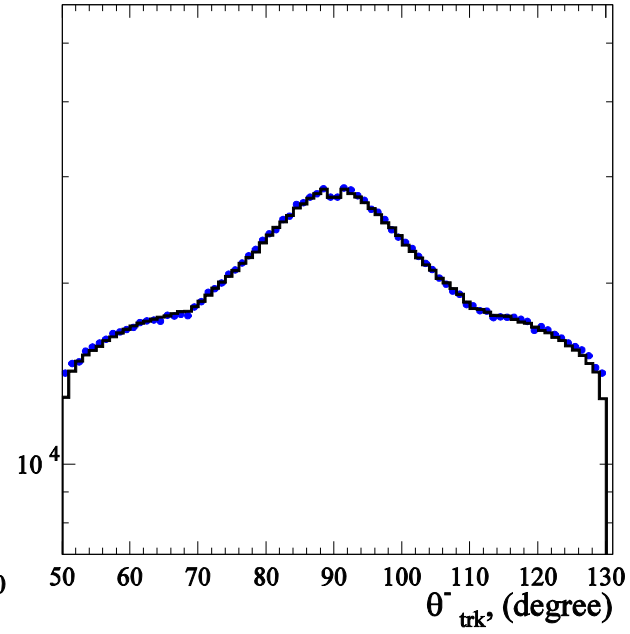
Results pions ($0.49 < Q^2 < 0.77$ GeV^2)

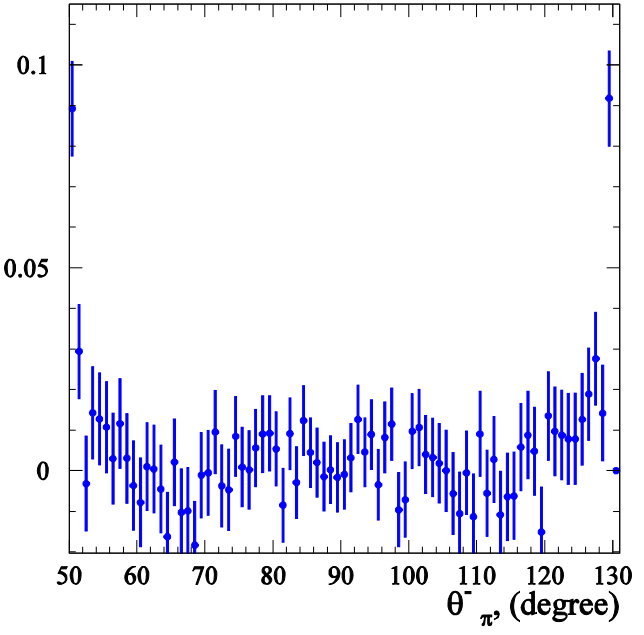




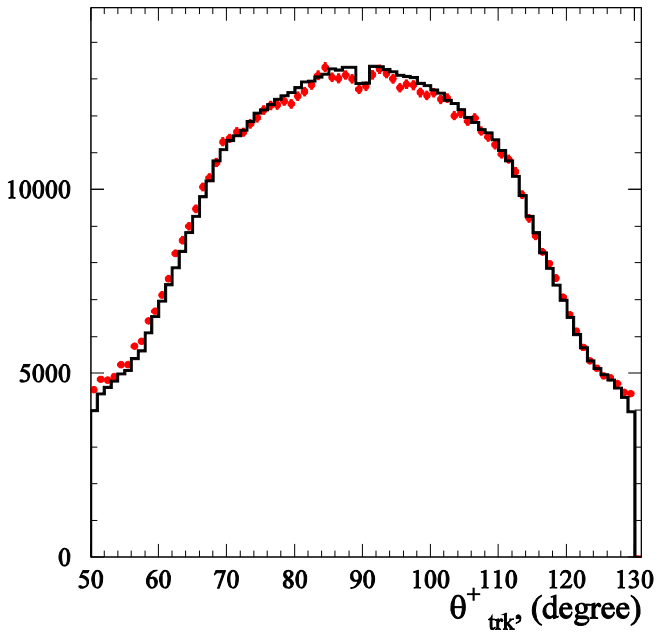


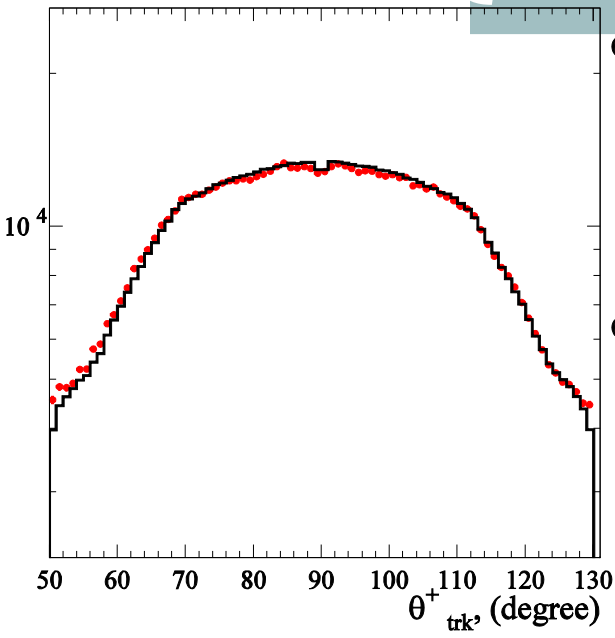


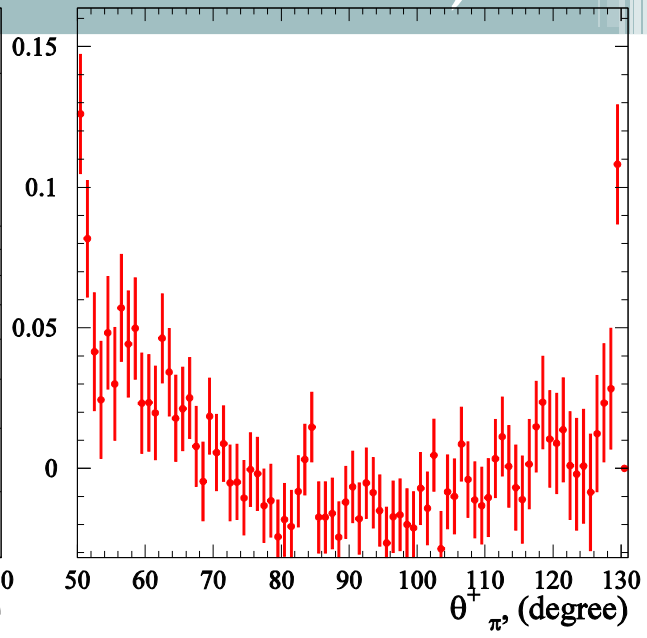


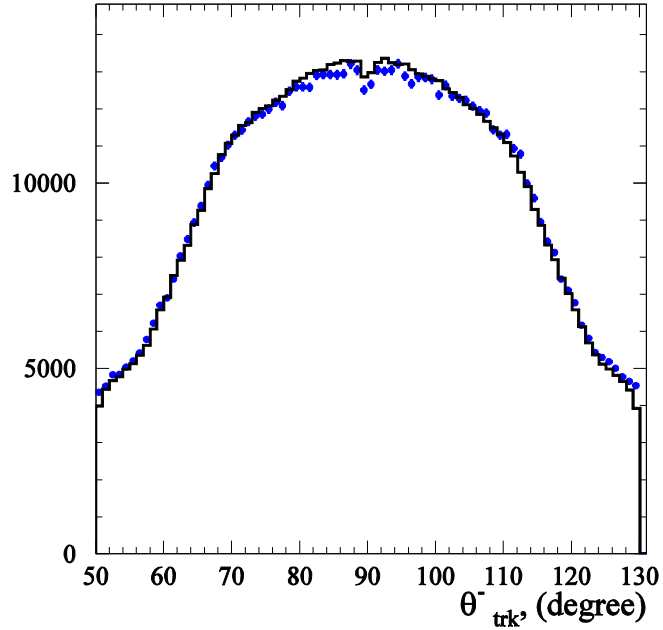


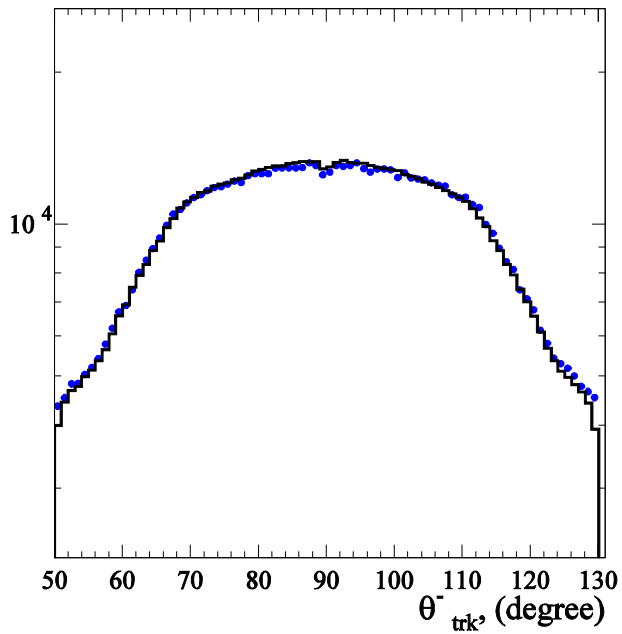
Results pions ($0.79 < Q^2 < 0.89$ GeV^2)

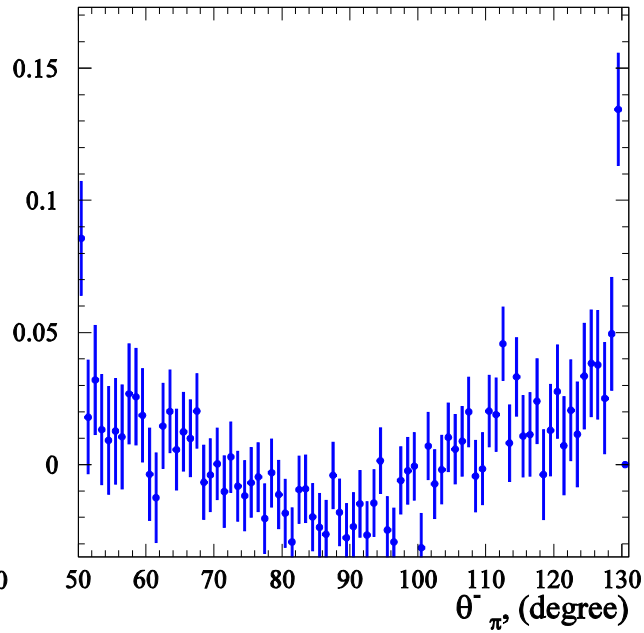




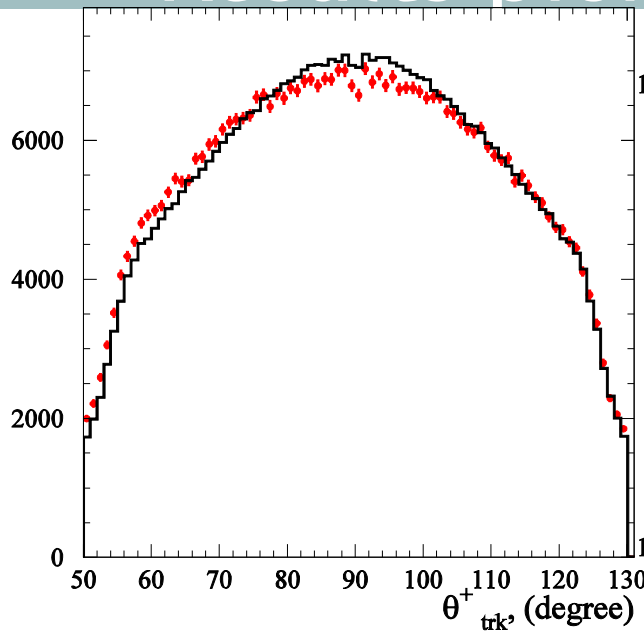


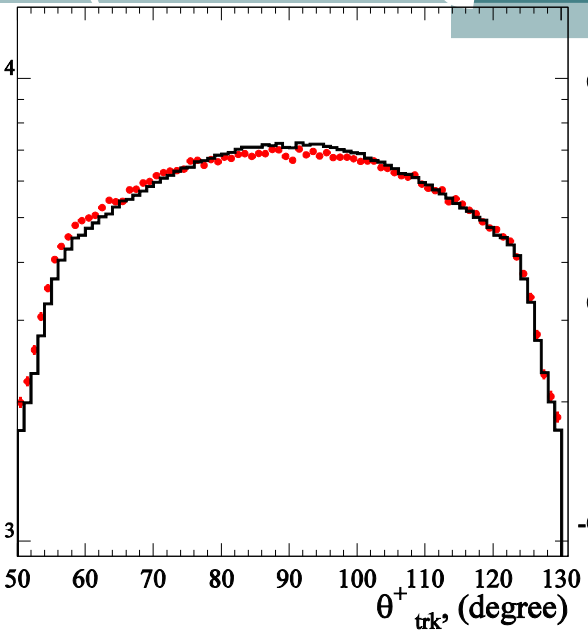


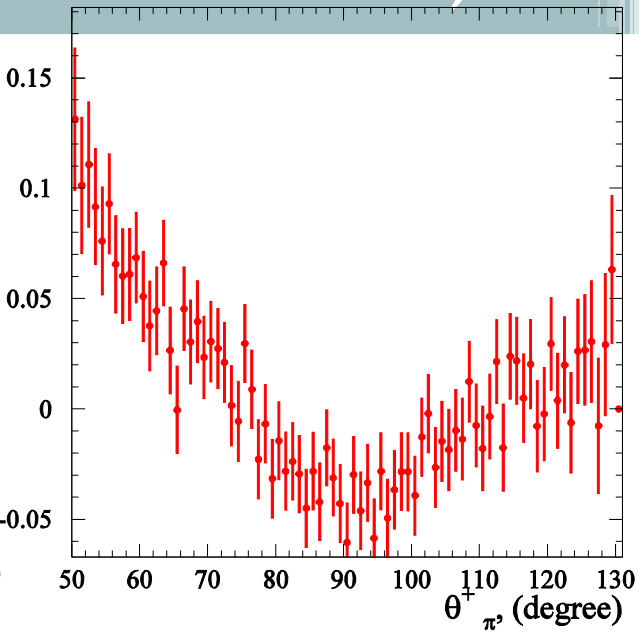


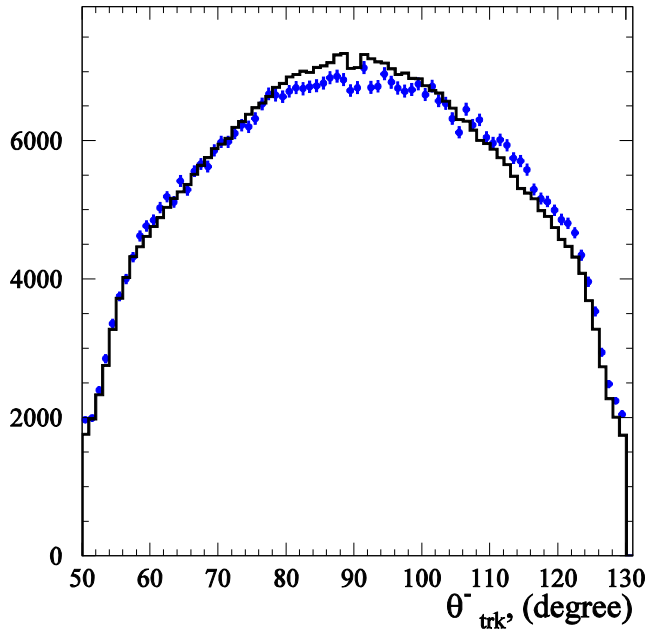


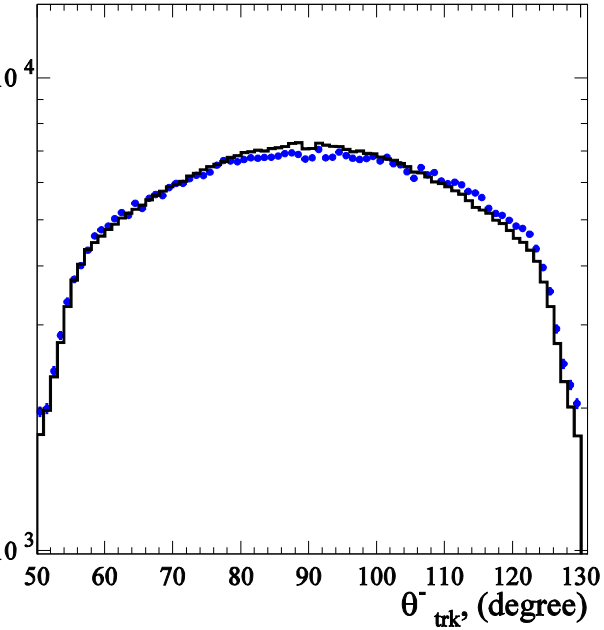
Results pions ($0.91 < Q^2 < 0.95$ GeV^2)

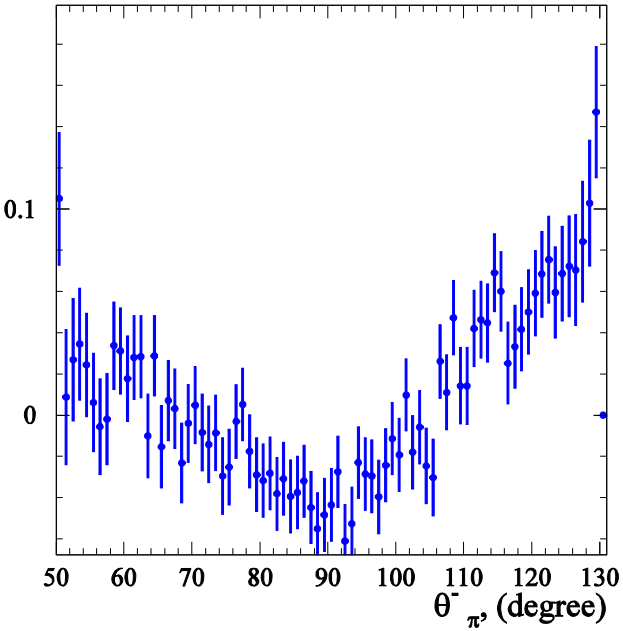




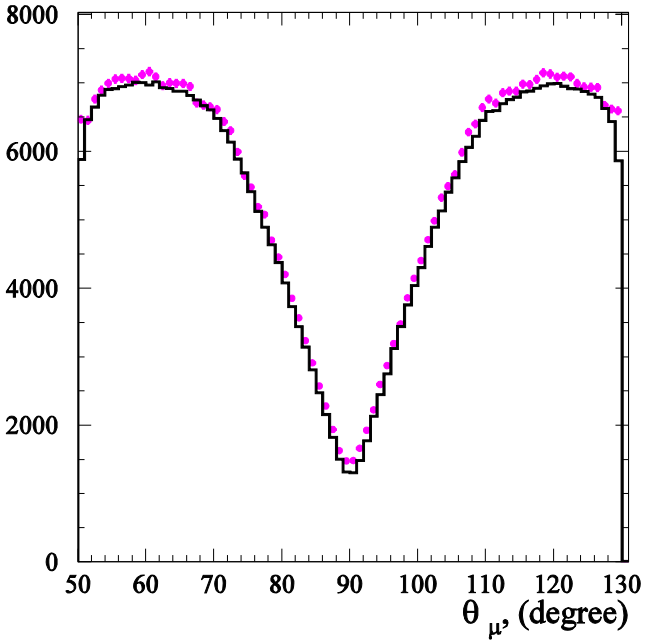


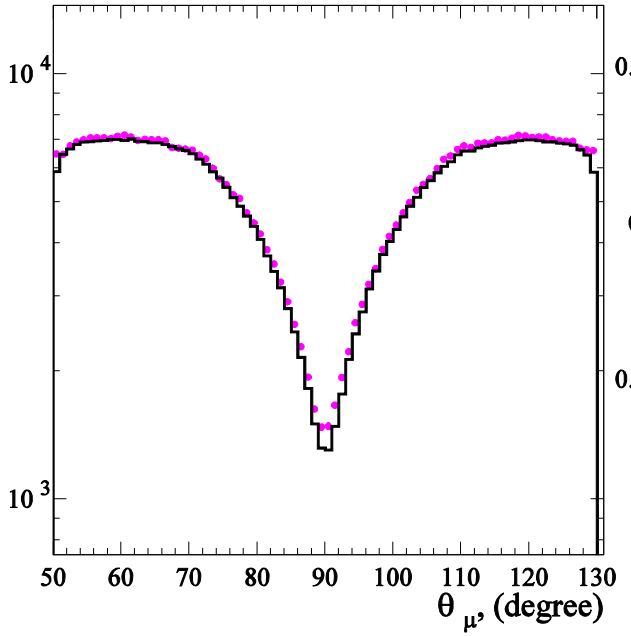


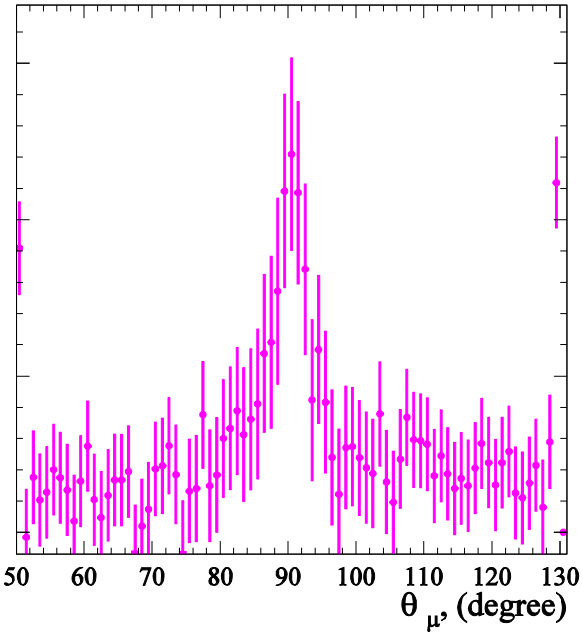




Results pions, integrated over charge ($0.35 < Q^2 < 0.47$ GeV^2)

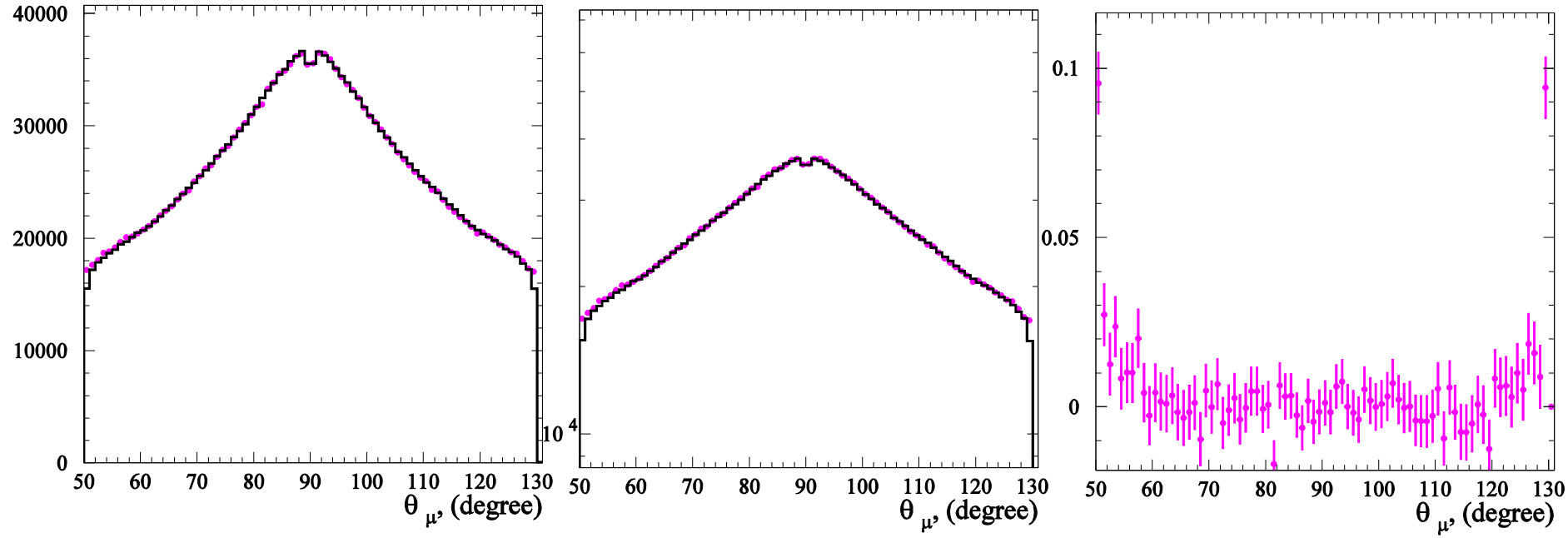






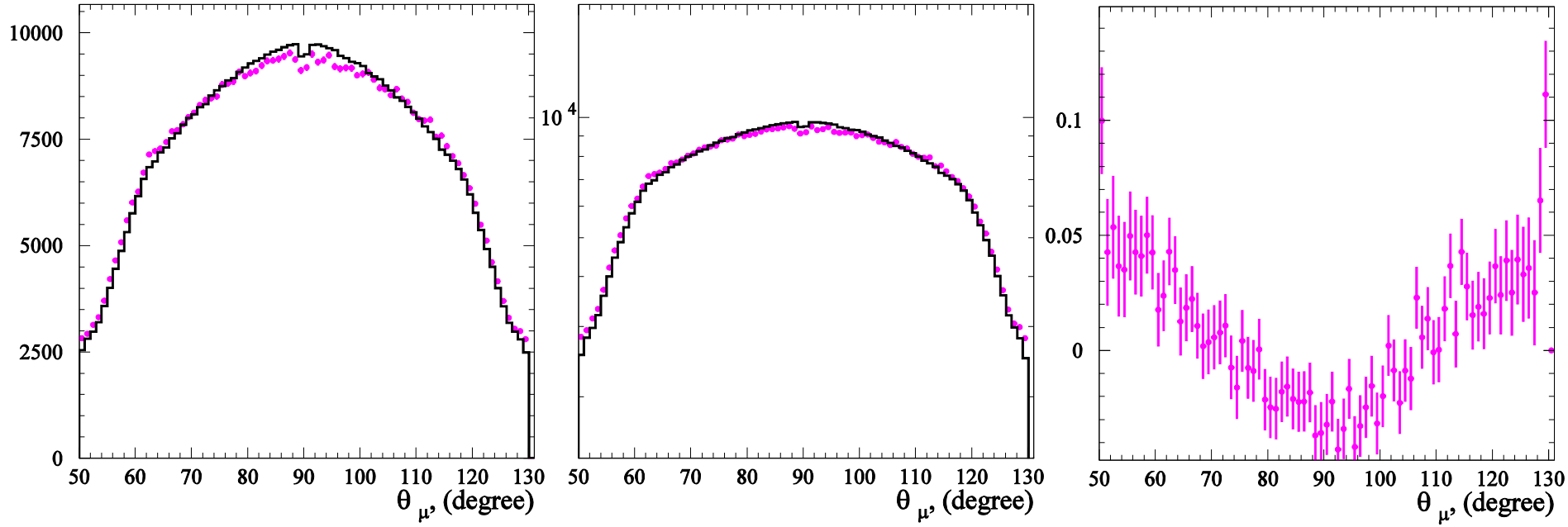
Agreement is good

Results pions, integrated over charge ($0.49 < Q^2 < 0.77\ GeV^2$)



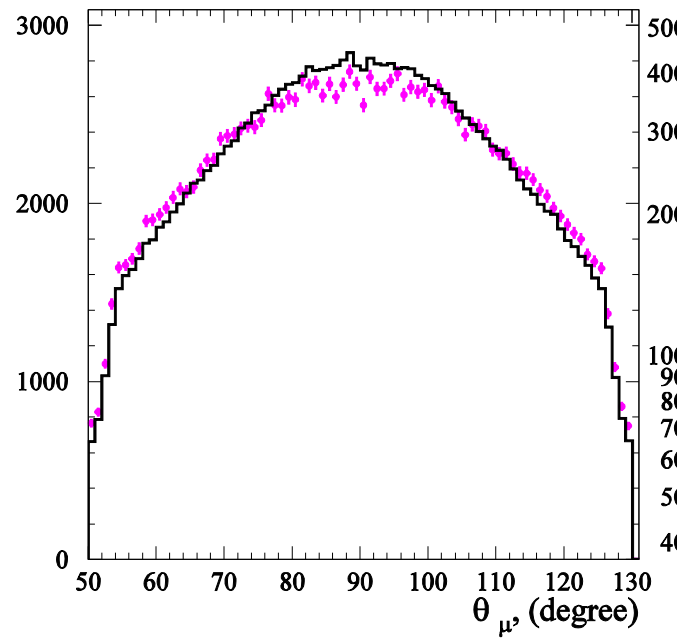
Agreement is still good

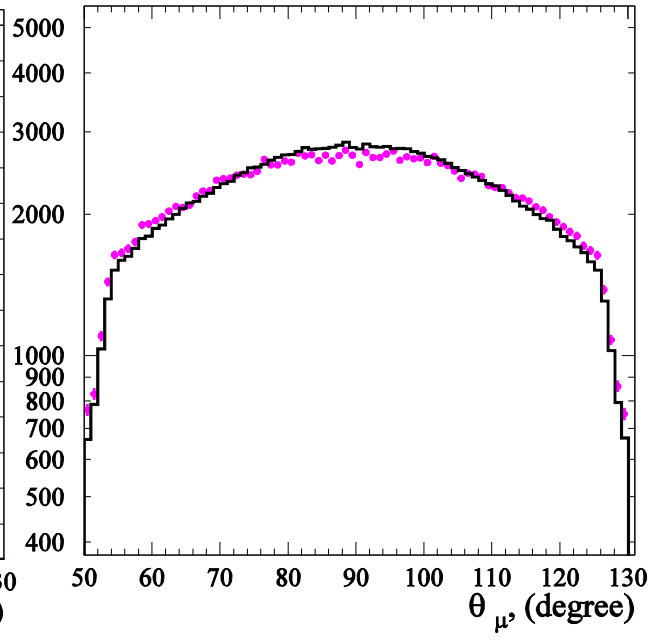
Results pions, integrated over charge ($0.79 < Q^2 < 0.89$ GeV^2)

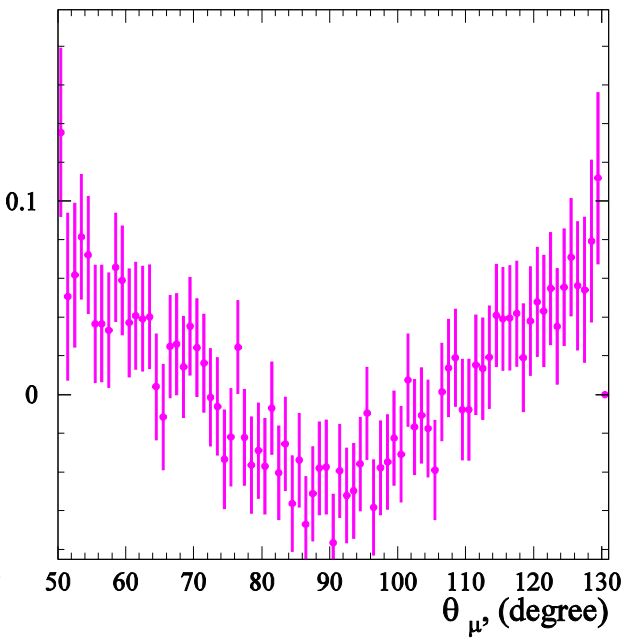


Some discripance, but still reasonable

Results pions, integrated over charge ($0.91 < Q^2 < 0.95$ GeV^2)







The same discripance of the same level like in the corresponding bin for muons

Conclusion

→ In 0.35 < Q^2 < 0.77 GeV^2 range everything is clear (hope crossing fingers)

→ In 0.77 < Q^2 < 0.89 GeV^2 pions and muons require some resolution adjustment (see plans) and …

→ In 0.91 < Q^2 < 0.95 GeV^2 resolution adjustment should be stronger

See the next slide:

Plans (Nearest, by the end of October)

→ $\theta(P_z)$ resolution tuning
→ Investigate tighter θ_Σ cut $\theta_\Sigma < 10$ or $\theta_\Sigma > 170$
→ Use Last Hit information
→ Kinematic fit

After that go on with analysis (efficiencies etc. …)