MPD Cross-PWG meeting, January 31, 2023

Femtoscopy QA, request 31

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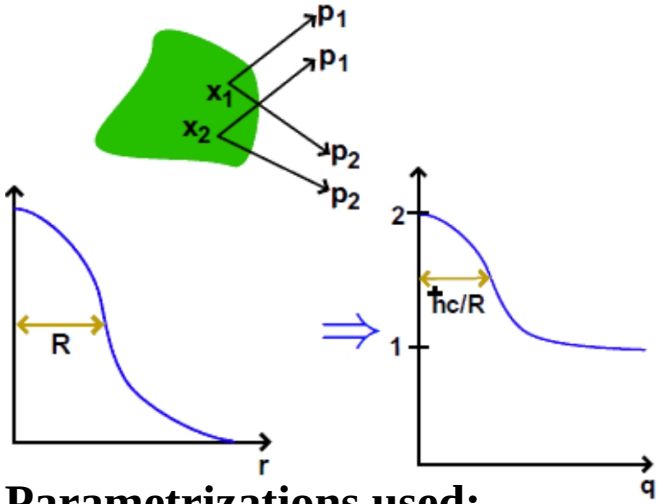
Femtoscopy



Parametrizations used:

1D CF: $C(q_{inv}) = 1 + \lambda e^{-R^2 q_{inv}^2}$

R – Gaussian radius in PRF,

λ – correlation strength parameter

Correlation femtoscopy :

Measurement of space-time characteristics **R, cτ** of particle production using particle correlations due to the effects of quantum statistics (QS) and final state interactions (FSI)

Two-particle correlation function:

theory: $C(q) = \frac{N_2(p_1, p_2)}{N_1(p_1) \cdot N_2(p_1)}, C(\infty) = 1$

experiment: $C(q) = \frac{S(q)}{B(q)}, q = p_1 - p_2$

$S(q)$ – distribution of pair momentum difference from same event

$B(q)$ – reference distribution built by mixing different events

Request 31

- Request 31: Femtoscopy-purpose, 50 M UrQMD BiBi@9.2 with freeze-out
- UrQMD + **Geant-3** based femtoscopy-purpose simulation with **freeze-out coordinates** project for minbias (b = 0-16 fm) Bi (83/209) +Bi (83/209) collisions at 9.2 GeV, detector configuration for femtoscopy only
- runMC.C
- runReco.C
- 100K events for QA
- Input root DST files at /eos/nica/mpd/users/gnigmat/mcDst/bibi_ecm_9.2 (53760 files) → file13 standard file (like file14) with additionally the freeze-out coordinates for all particles

Request 25 (for comparison)

- Request 25: General-purpose, 50M UrQMD BiBi@9.2
- UrQMD + **Geant-4** based general-purpose simulation project for minbias (b = 0-16 fm) Bi (83/209) +Bi (83/209) collisions at 9.2 GeV, full detector configuration.
- runMC.C
- runReco.C
- 100K events for QA

Femtoscopy QA test: correlation function

- **Reco**nstructed correlation function(CF) with mixing procedure:

  $CF_{reco} = [dN_{real}/dq_{inv} * W(r,p)] / [dN_{mixed}/dq_{inv}]$
- Correlation function with **pure QS** weight:

  $CF_{pure} = [dN_{real}/dq_{inv} * W(r,p)] / [dN_{real}/dq_{inv}]$, where W is QS weight

  $W=1+\cos(\Delta x \Delta p)$, where x distribution is Gaussian with width 5 fm
- The main test is to compare **reco** and **pure QS** CFs

  They should be very close
- Other QA tests are also important

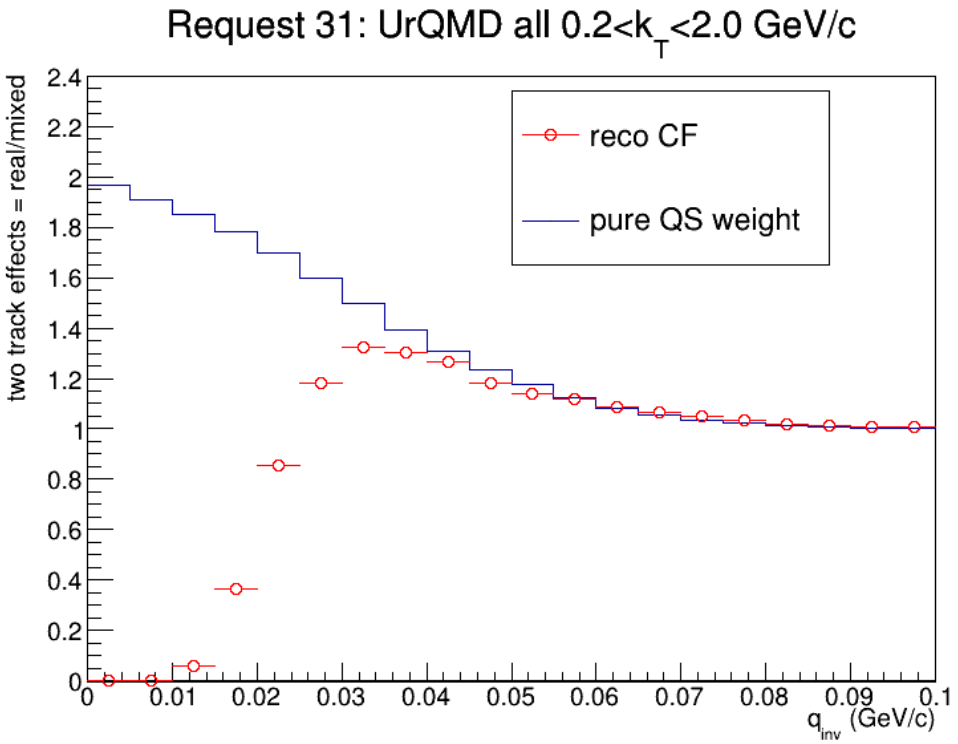
Pion selection for CF

- MC track PDG code is equal 211
- Primary tracks
- Nhits >= 20
- $0.2<p_T<2$ GeV/c
- $|\eta|<=1$
- The same selection conditions are for the whole study
- DST files are located in:

req31:/eos/nica/mpd/sim/data/qa/req31g4/dst/

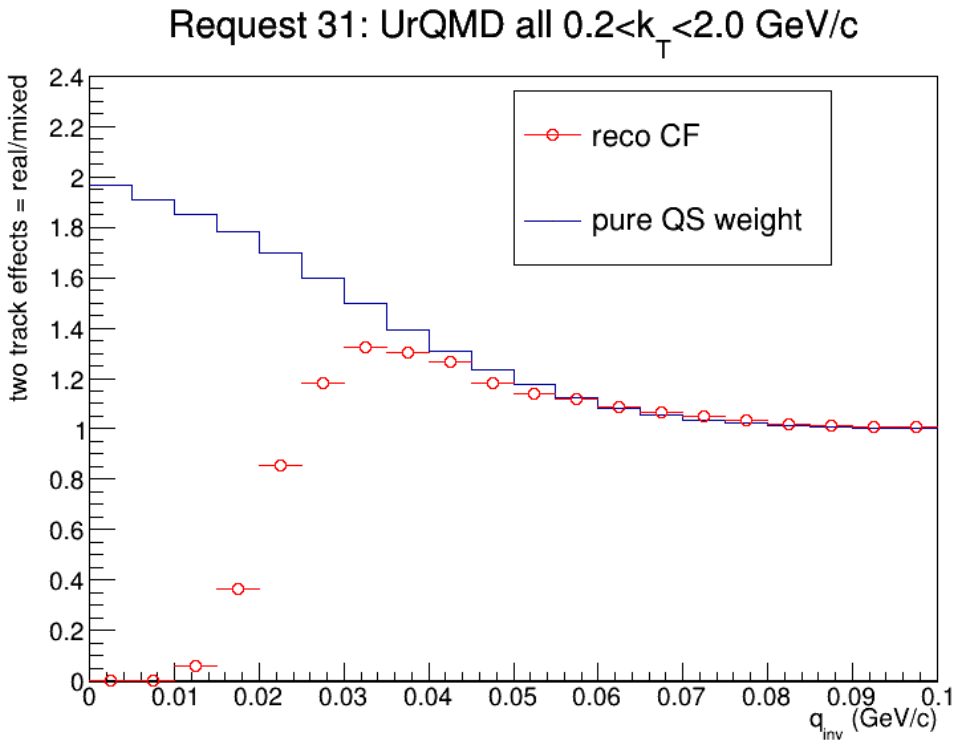
req25:/eos/nica/mpd/sim/data/exp/dst-BiBi-09.2GeV-mp07-22-500ev-req25/BiBi/09.2GeV-mb/urqmd/BiBi-09.2GeV-mp07-22-500ev-req25/

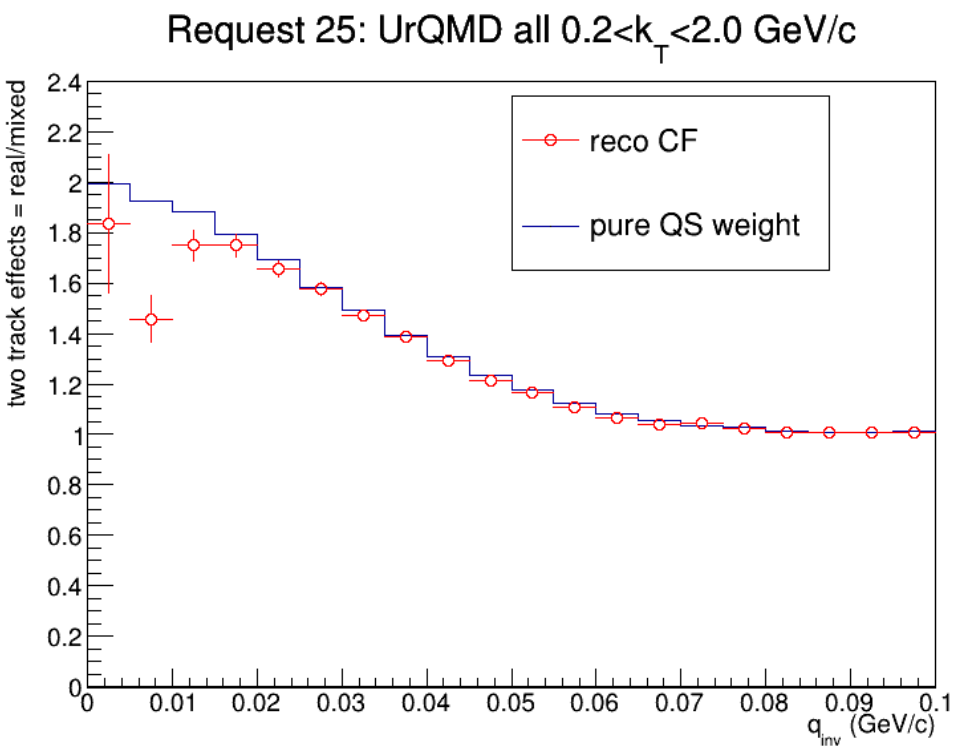
Reconstructed CF request 31



- Unexpected broad dip for request 31: significant two-track effects or something else?

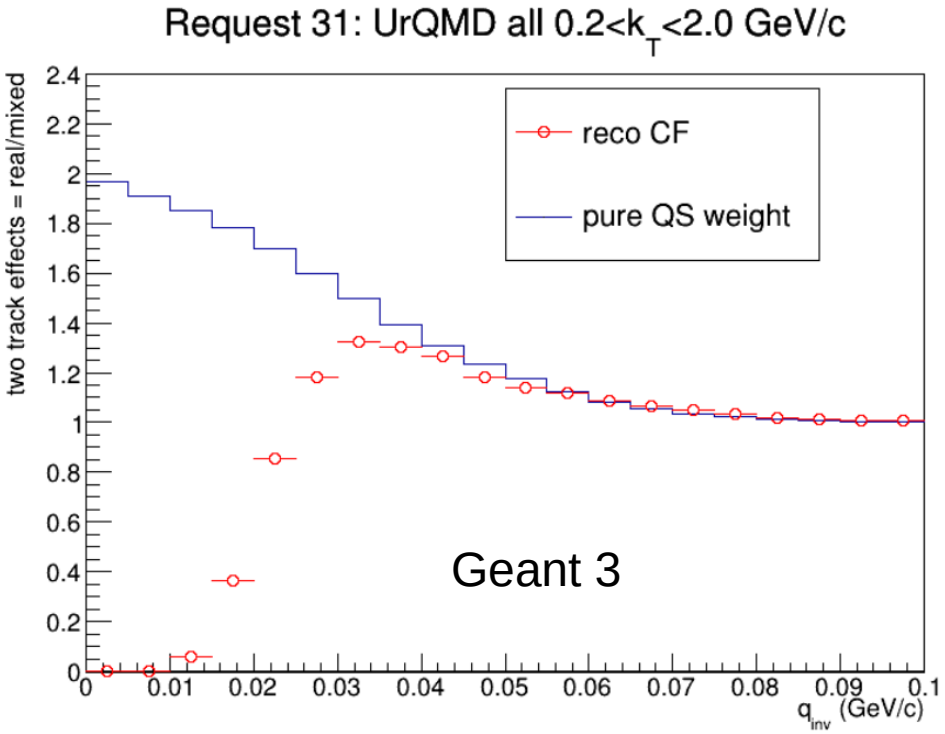
Reconstructed CF request 31 vs 25

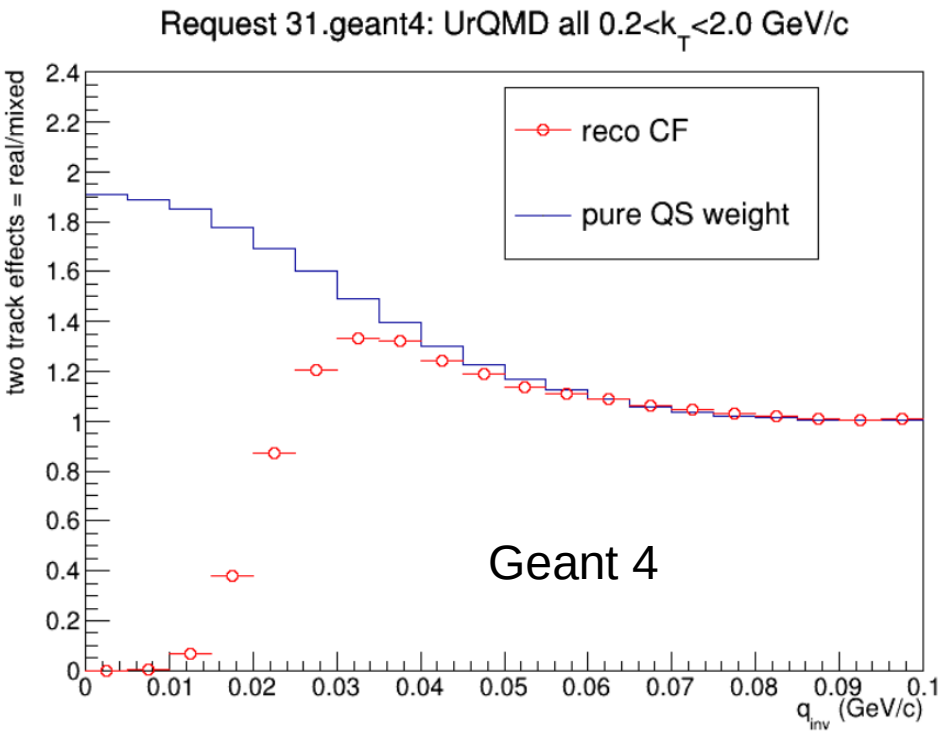




- No dip at small q for request 25
- The difference is version of GEANT?

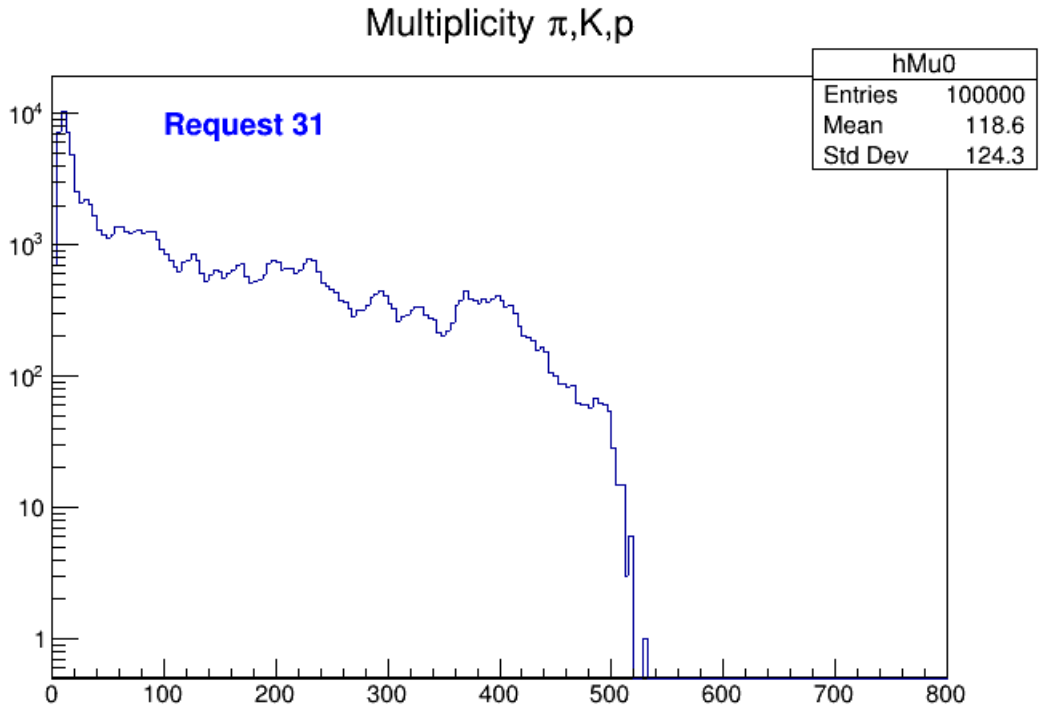
Reconstructed CF request 31: geant3 and geant4

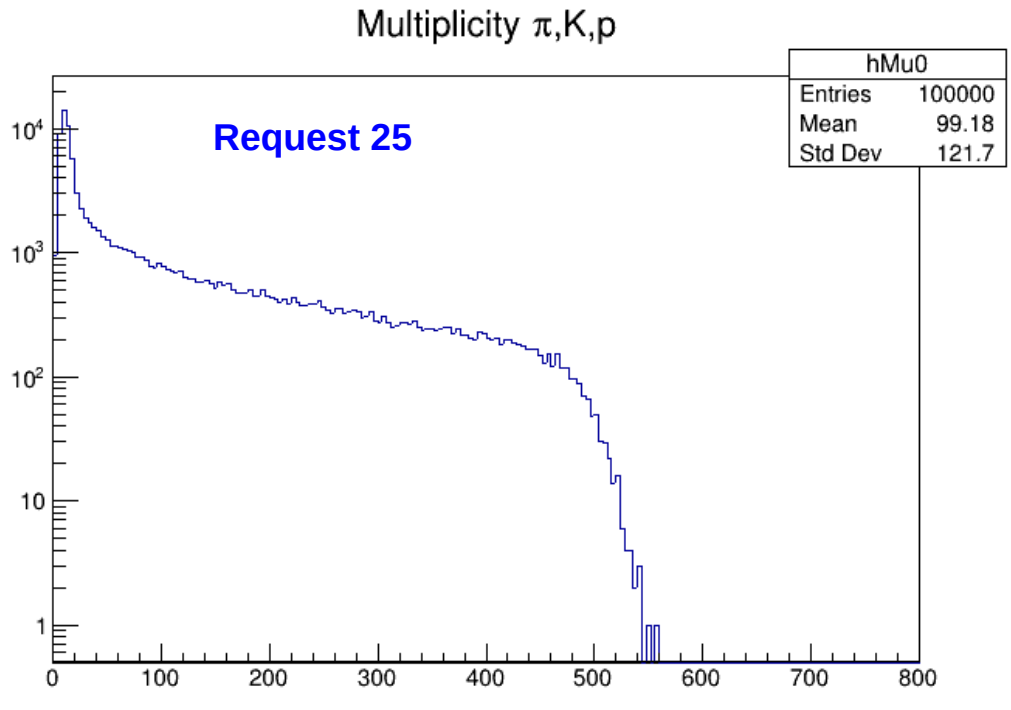




- There is no difference between Geant 3 and Geant 4
- Both CFs are very close to each other and the broad dip is for both...

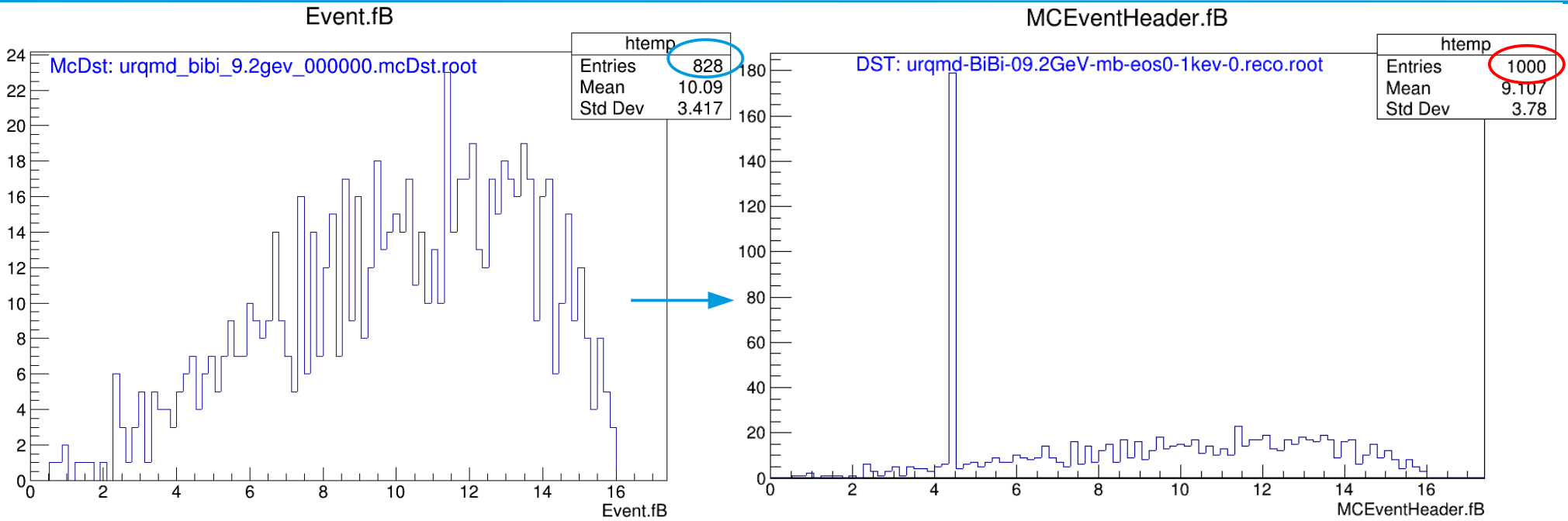
Multiplicity: π,K,p selected by PDG





- Multiplicity plot for request 31 is not a smooth function – deviations are outside statistical fluctuations

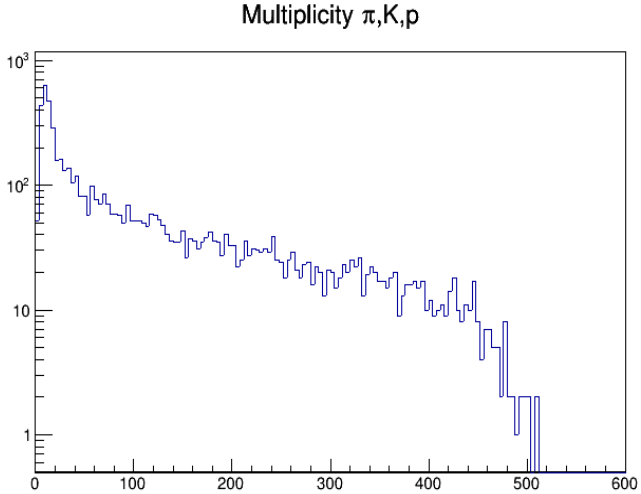
Impact parameter: one McDst file → one DST file



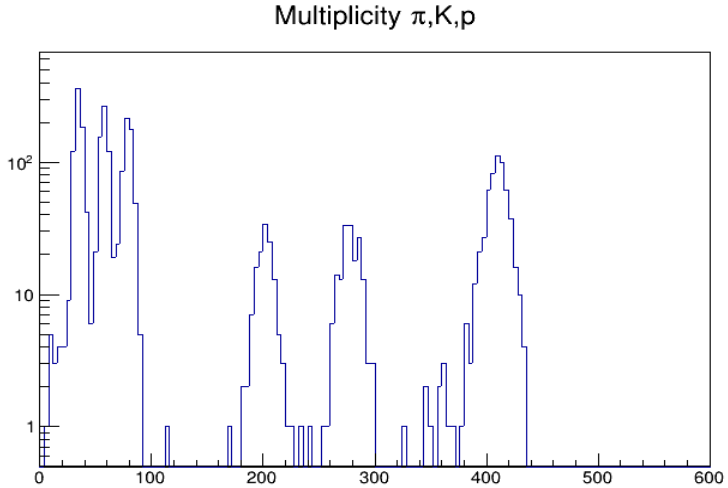
- Input file has 828 events
- b distribution looks like min. bias

- DST file has 1000 events
- Outlier with 172 events with the same impact
- Outliers are in the last 172 events of the file

Multiplicity: “good” and artificial events (10 files)



- “Good” events



- Artificial events at the end of file

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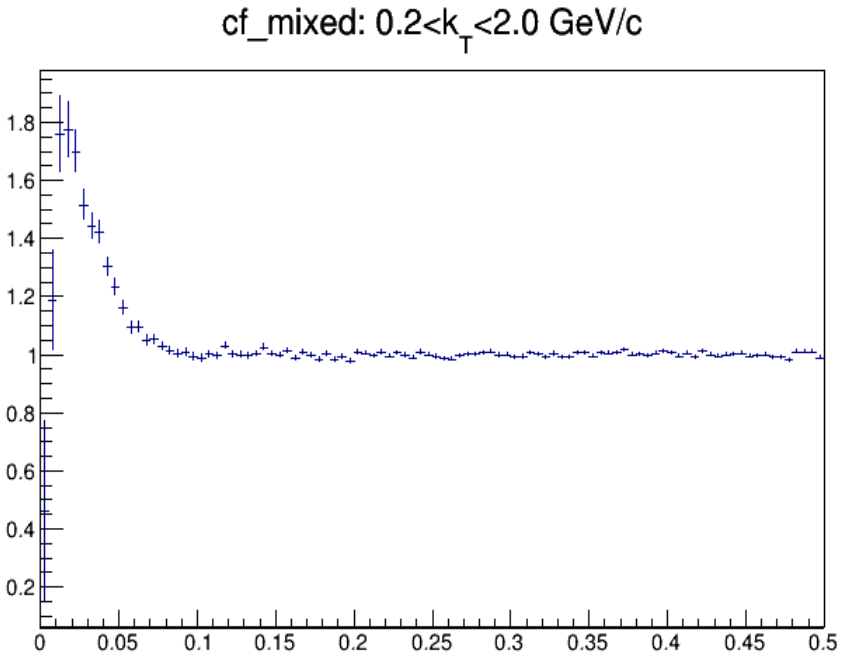
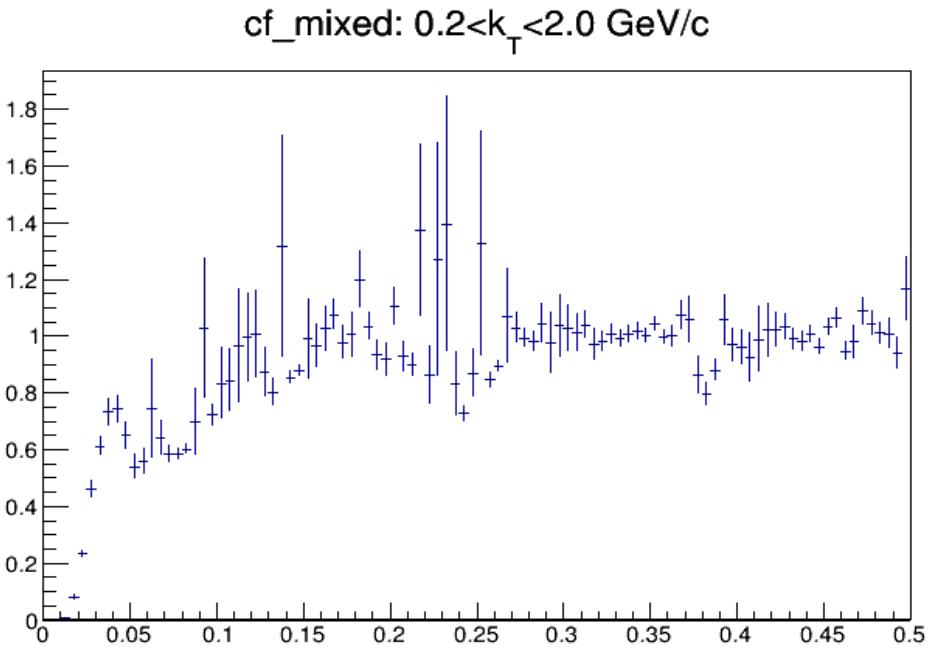
- For some reason, an incident occurred during the production of input files. The number of events is not equal 1000. We didn't know about it
- Reconstruction files contain artificial events with similar characteristics. Particles have close momenta, since the events are initially the same

Correlation function: “good” and artificial events

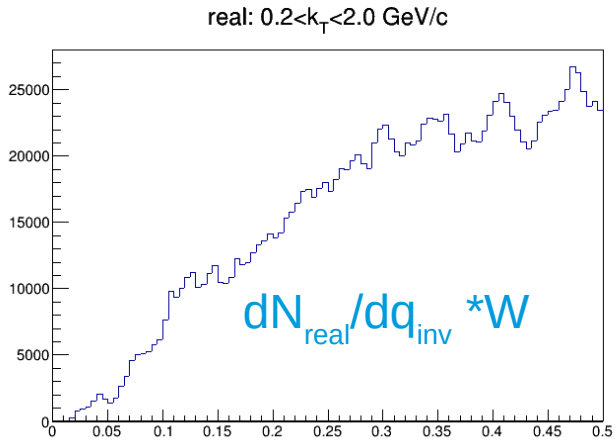


- “Good” events
- CF looks reasonable



- Artificial events with close multiplicity groups
- CF is completely destroyed

Correlation function: artificial and “good” events



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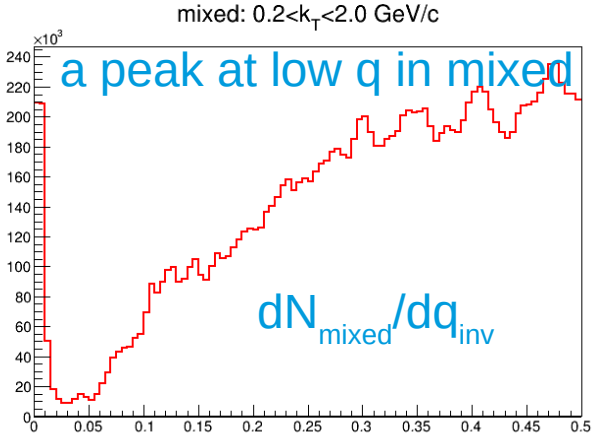

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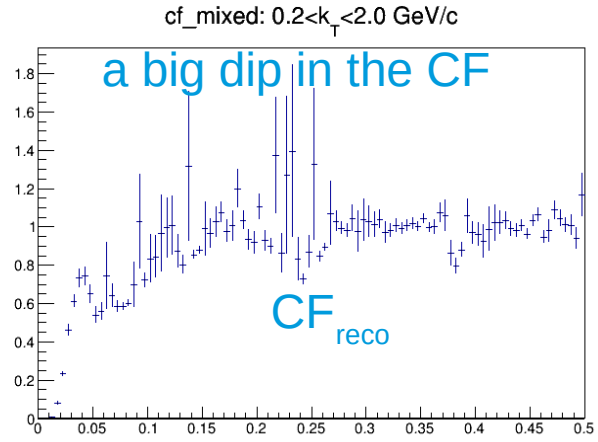
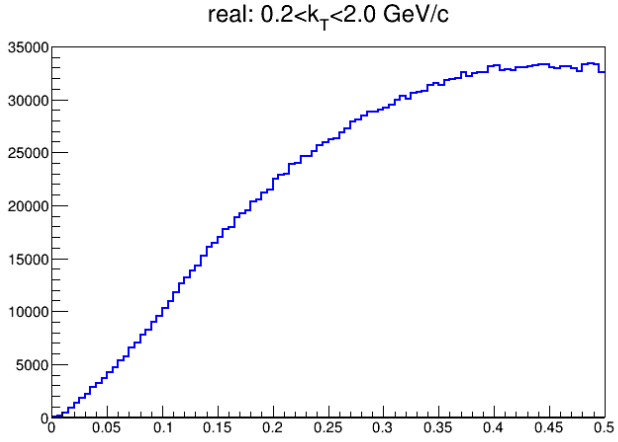
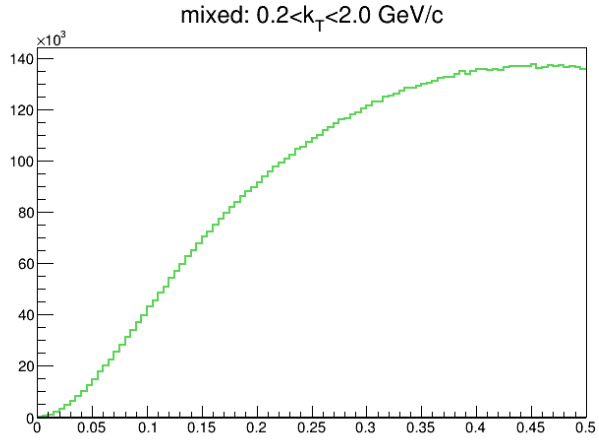
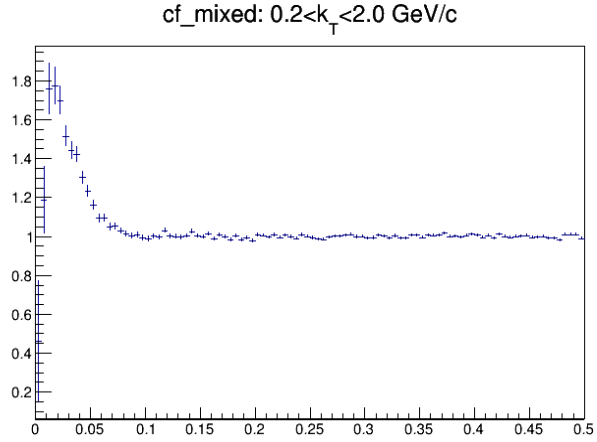
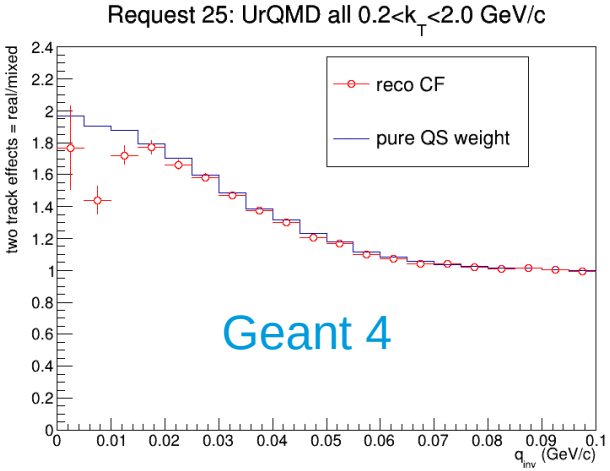


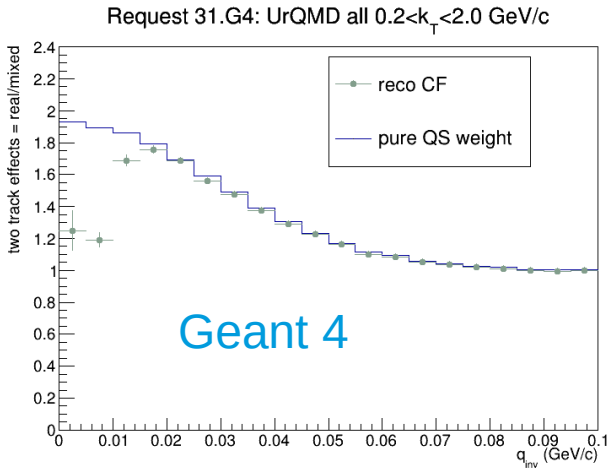


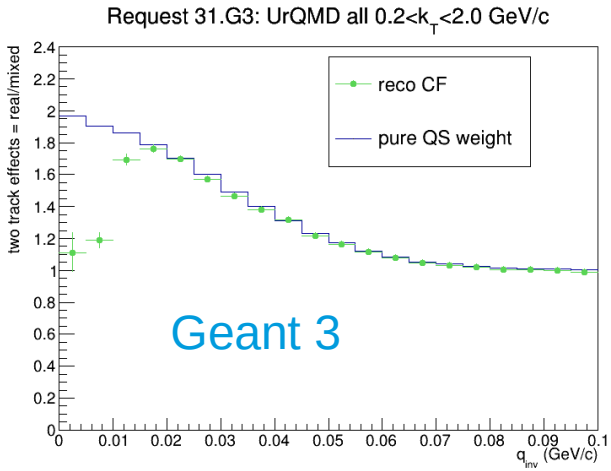




CF:request 25 and “good” events from request 31

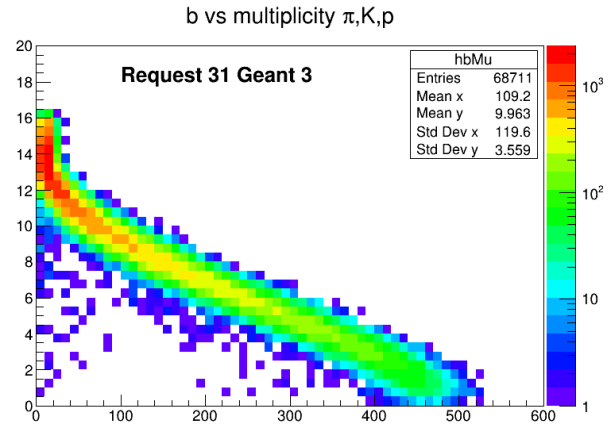


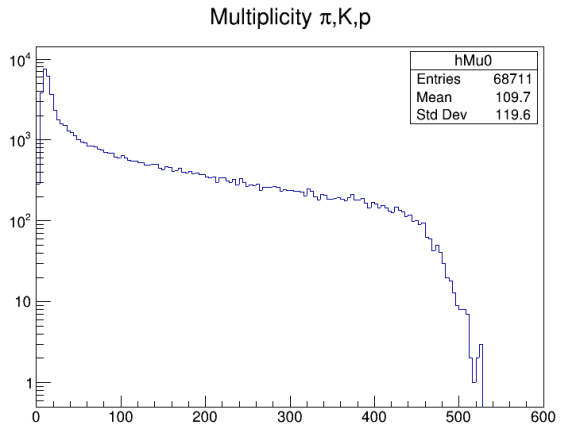


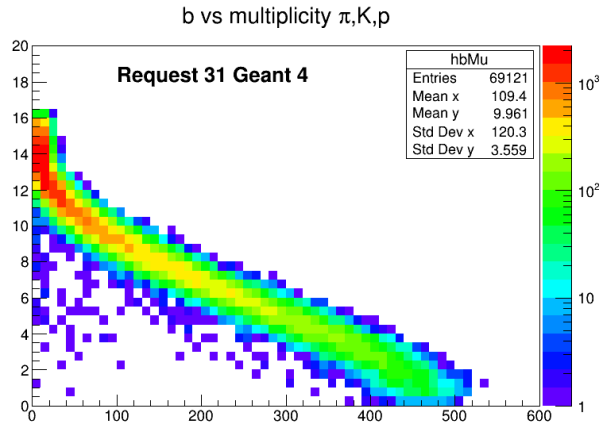


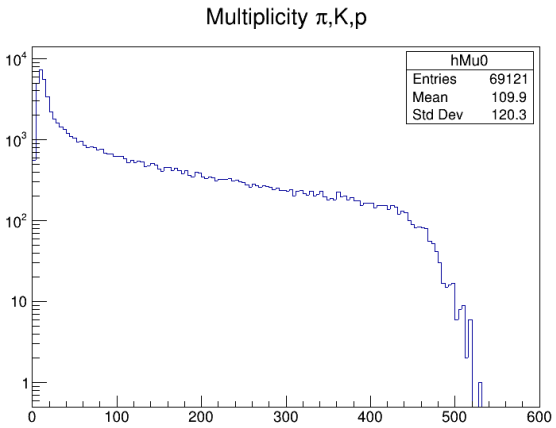
- There is no any cuts on two-track effects yet
- Regardless of it, the reconstructed CF looks pretty good
- There is a slight difference between the CFs from request 25 and 31 for some reason
- The problem with the big dip at low q in the CF for request 31 is gone
- CFs for both G3 and G4 look pretty similar

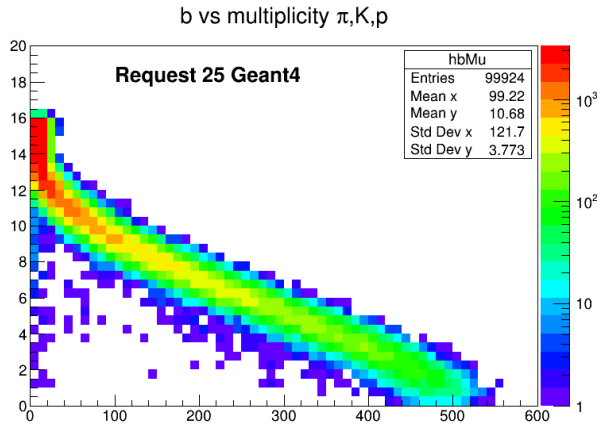
Comparison of multiplicity for 31 and 25 requests

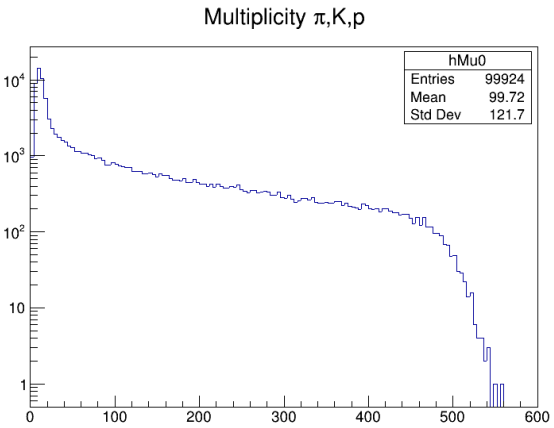




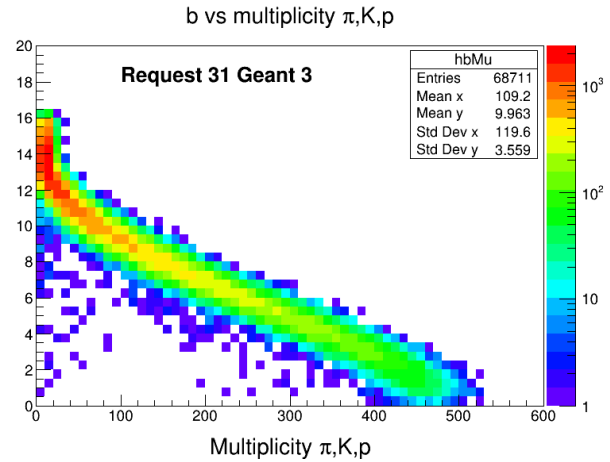


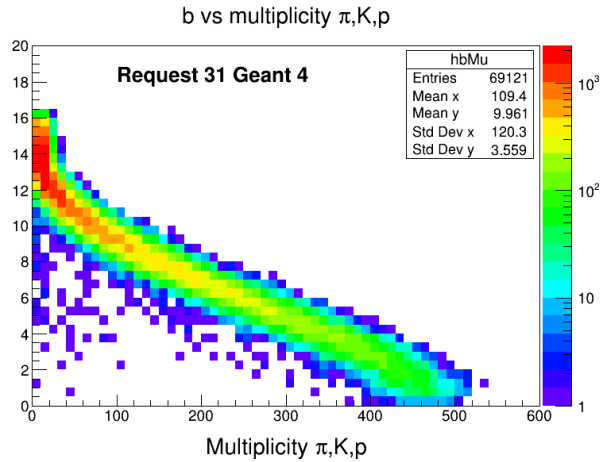


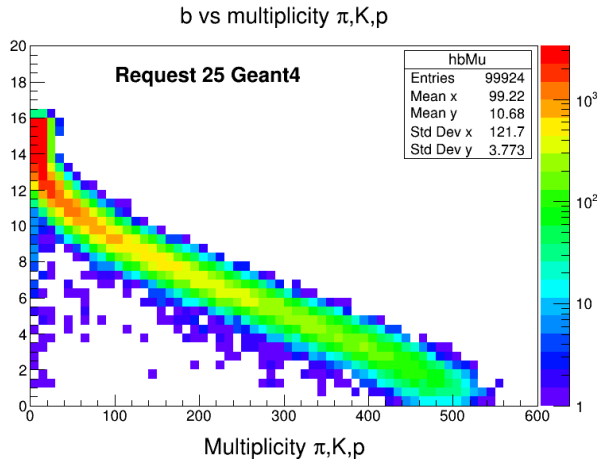


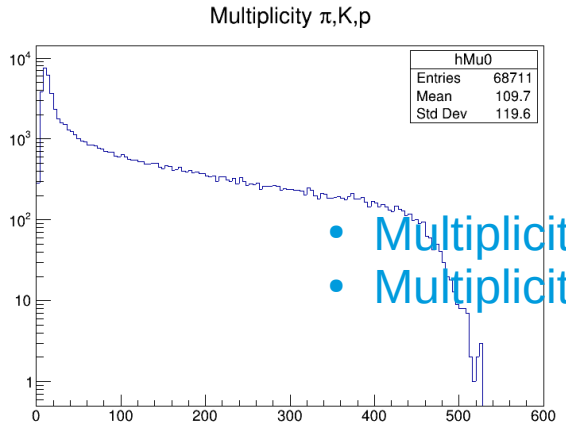


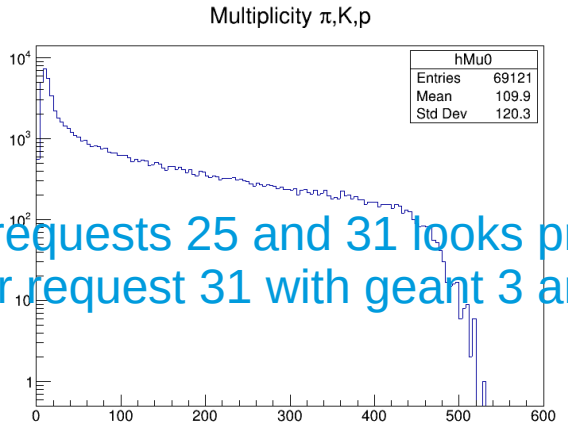
Multiplicity: π,K,p selected by PDG

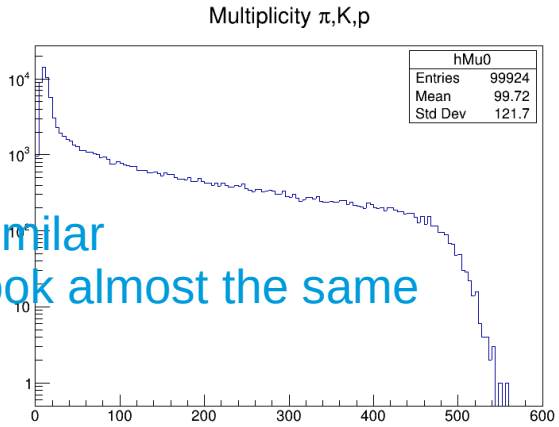












- Multiplicity for requests 25 and 31 looks pretty similar
- Multiplicities for request 31 with geant 3 and 4 look almost the same

Conclusions and outlooks

- There was a big problem with close track reconstruction for request 31;
- The reason: number of events are not exactly 1000 in the initial McDst input file;
- This circumstance led to artificial events that completely spoiled the correlation function;
- Solution:
  - Set nEvents in runMC.C to be equal to those in the file McDst;
  - generate files with the correct number of events to do new QA tests.

Thank you for your attention !