Open charm as a function of spherocity in pp @ 13 TeV with PYTHIA8

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Outline

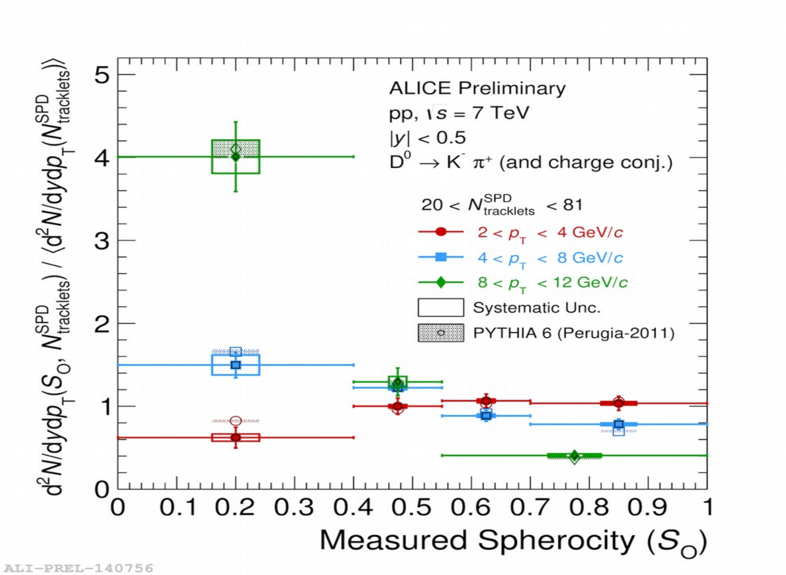
- Motivation
- Data sets
- Analysis Details
- PYTHIA8 analysis
- Summary

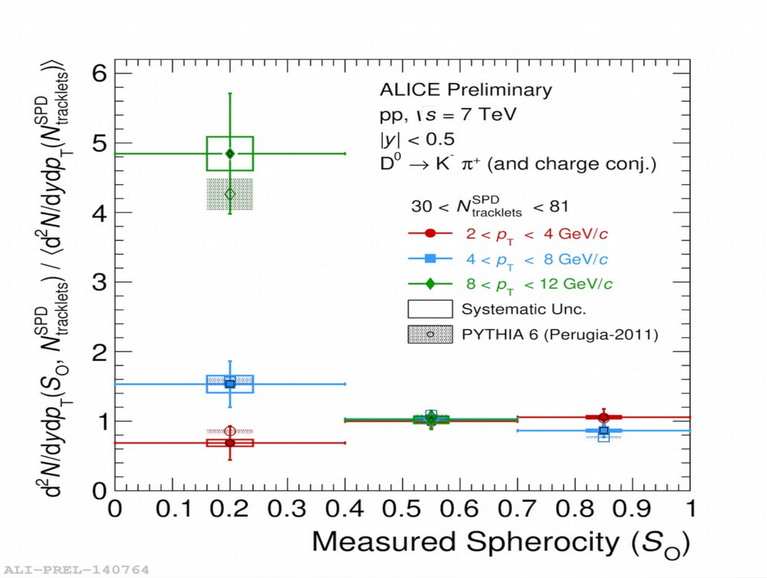
Motivation

- Recent studies in small colliding systems in high multiplicity domains have shown some collective behaviours similar to the heavy-ion collisions where these effects can be understood through the formation of QGP.
- Proper discrimination of soft and hard sectors of QCD will help to understand these effects. Event shape observables, e.g., transverse spherocity, are useful tools to disentangle these two domains.
- Event multiplicity and transverse spherocity can give insight about the property of an event based on the number of multi-parton interactions and also on the gluonic contribution in jets.

Motivation

- Heavy quarks have small rate of thermal production in the quark gluon plasma (QGP).
- Experience the entire evolution of the medium.
- Investigate the interplay between hard and soft components in the full pp collision.
- Test **Multiple-Partonic Interaction:** Several hard interactions in one pp collision.
- Test of QCD calculations.
- Studying the fragmentation processes (baryons vs. mesons).

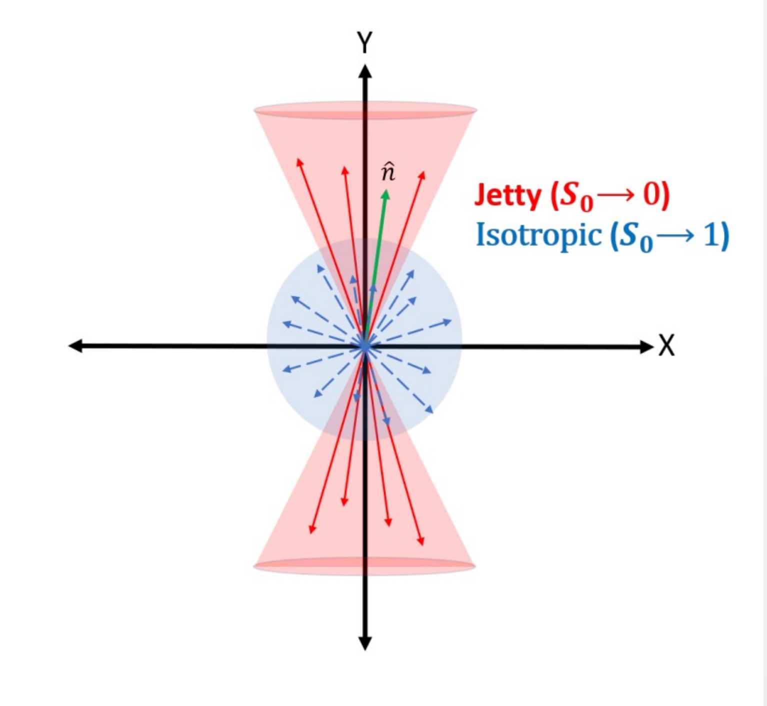




Spherocity

- In hadron collisions, **event shape observables** measure the deviation of an energy flow of events from a jetty-like to isotropic structure.
- Defined in terms of geometrical distribution of the pT 's of the charged hadrons in the final state.
- The most widely used method to calculate the event shape is using the momenta of all particles in an event.
- The

$$S_O = \frac{\pi^2}{4} \min_{\vec{n}=(n_x,n_y,0)} \left(\frac{\sum_i |\vec{p}_{\mathrm{T_i}} \times \hat{n}|}{\sum_i p_{\mathrm{T_i}}} \right)^2,$$



- The value of transverse spherocity run from 0 to 1.
- $S_0 =$ 0 "pencil like" limit (hard events)

  1 "isotropic" limit (soft events)

Data Set

- Analysed **pp** data for $\sqrt{S}$ **=13 TeV.**
- We have analysed the following data sets:

LHC2016 (d,e,g,h,j,k,l,o,p) .

LHC2017 (c,e,f,i,j,k,l,m,o,r).
LHC2018 (b,d,e,f,g,h,i,k,l,m,n,o,p).

- **Event selection**:

Trigger:- **kINT7(minimum bias)**: at least one hit in the SPD or VZERO
Events within interaction vertex $|V_z| < 10$**cm**

- **Multiplicity bins: [20-81],[20-30],[30-81]**
- **PT bins: [1-2],[2-4],[4-6],[6-8],[8-12],[12-24]**
- **Spherocity Intervals: [0-0.4], [0.4-0.55],[0.55-0.7], [0.7-1]**

SPD tracklets Corrections

- Number of tracklets observed in SPD depends on the Z-vertex as well as on the time.

- To remove the dependency on Z-vertex as well as on time corrections have been applied.Correction procedure uses Poissonian extraction for the correction factor

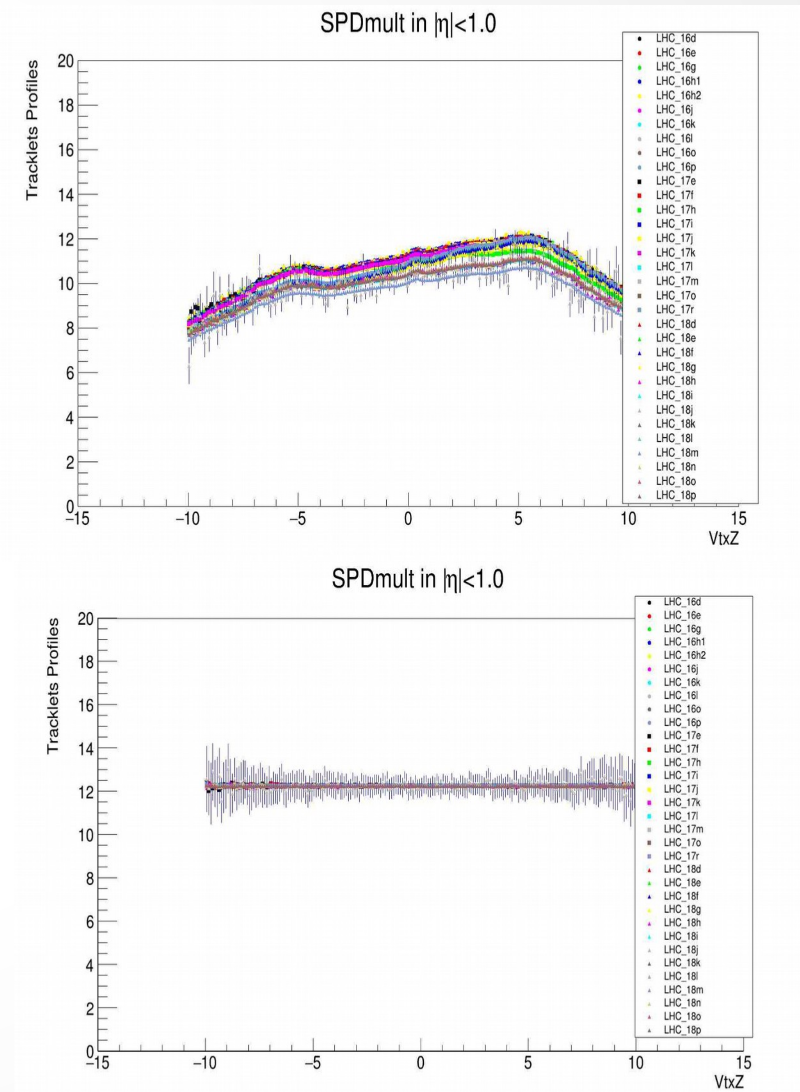
$$N_{corr}(z) = (N_{raw} * \langle N_{ref} \rangle) / \langle N_{period}(z) \rangle$$

- N_{raw} measured number of tracklets, to be corrected event by event.

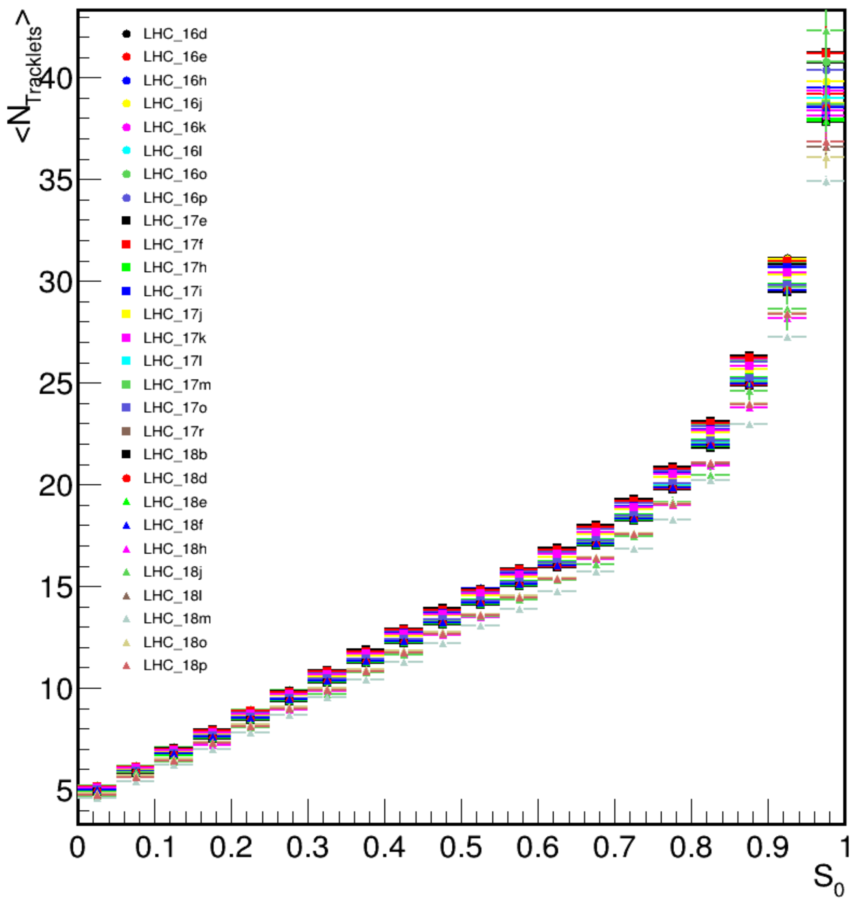
- $\langle N_{ref} \rangle$ mean number of tracklets in the reference z-vertex bin **12.25.**

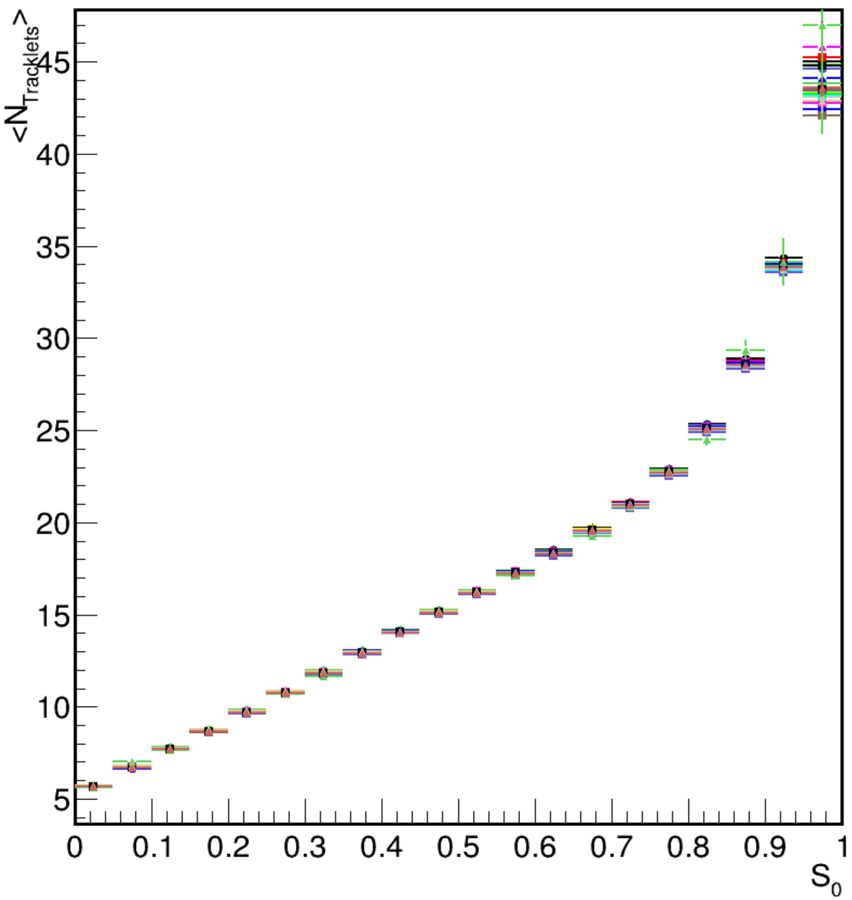
- $\langle N_{period}(z) \rangle$ mean number of tracklets for event with vertex at given value of z for the period under consideration

- Poissonian statistics is used to get an integer value for $\mathbf{N_{corr}(z)}$



Tracklet vs Spherocity distribution (2016)





Selection Cuts

- **esdTrackCuts->SetRequireTPCRefit(kTRUE);**
- **esdTrackCuts->SetRequireITSRefit(kTRUE);**
- **esdTrackCuts->SetMinNCrossedRowsTPC(70);**
- **esdTrackCuts->SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kAny);**
- **esdTrackCuts->SetPtRange(0.3,1.e10);**
- **esdTrackCuts->SetEtaRange(-0.8,0.8);**
- **esdTrackCuts→SetMinRatioCrossedRowsOverFindableClustersTPC(0.8);**

To achieve a better reconstruction of the event shape variable (spherocity), the two sets of track cuts namely, Hybrid track cuts and TPConly track cuts + TPCrefit were tried, which are listed below:

- **TPConly Track Cuts+TPCrefit: FILTER BIT 1: Standard cuts on primary tracks**

  GetStandardTPCOnlyTrackCuts()+TPCrefit

- **Hybrid Track Cuts:**

FILTER BIT 256:

AliESDtrackCuts::GetStandardITSTPCTrackCuts2011(kFALSE)

SetMaxDCAToVertexXY(2.4)

SetMaxDCAToVertexZ(3.2)

SetDCAToVertex2D(kTRUE)

SetMaxChi2TPCConstrainedGlobal(36)

SetMaxFractionSharedTPCClusters(0.4)

esdfilter→SetHybridFilterMaskGlobalConstrainedGlobal(1<<8)

FILTER BIT 512:

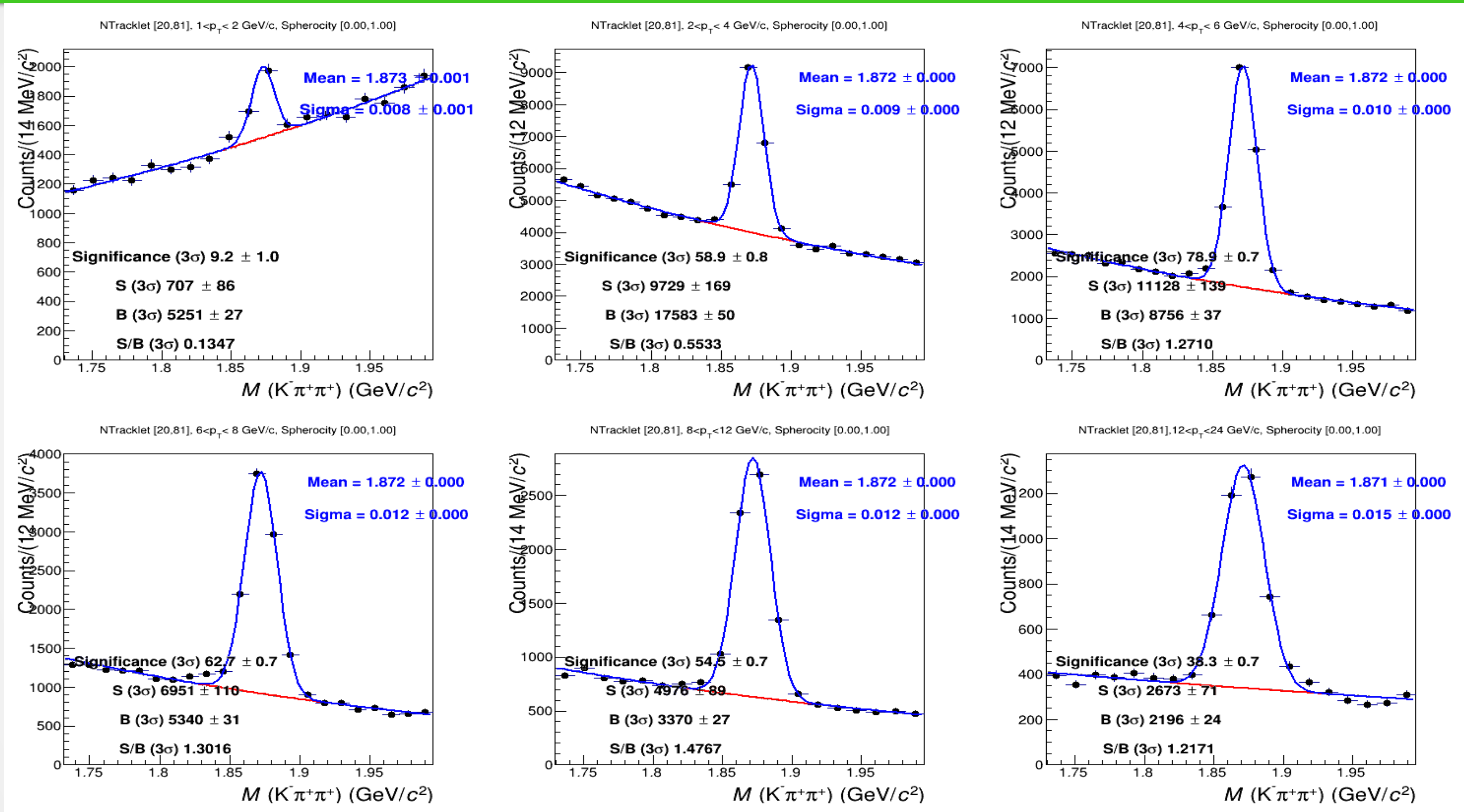
SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kOff)

SetRequireITSRefit(kTRUE)

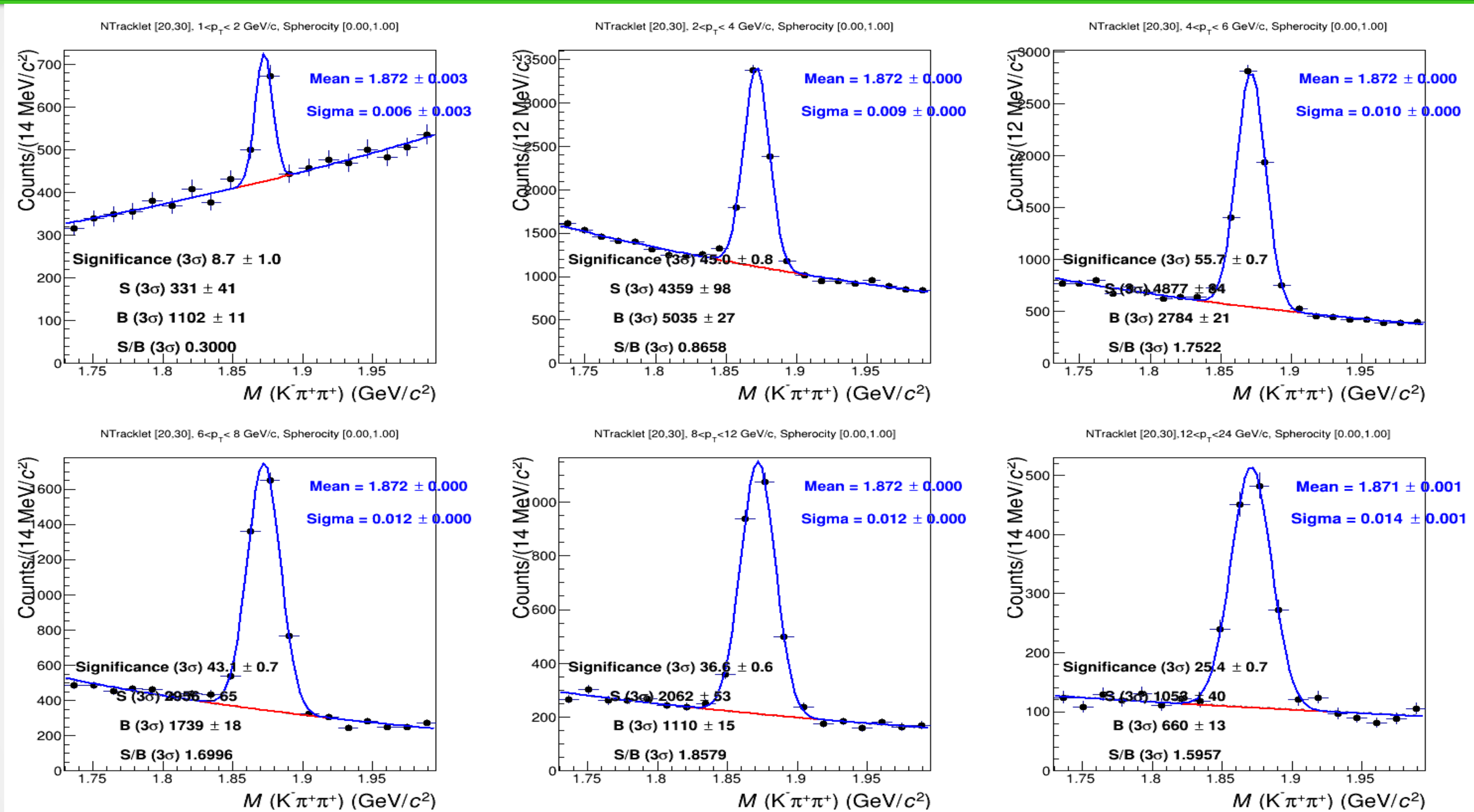
esdfilter→SetGlobalConstrainedFilterMask(1<<9);

esdfilter→SetWriteHybridGlobalConstrainedOnly(kTRUE)

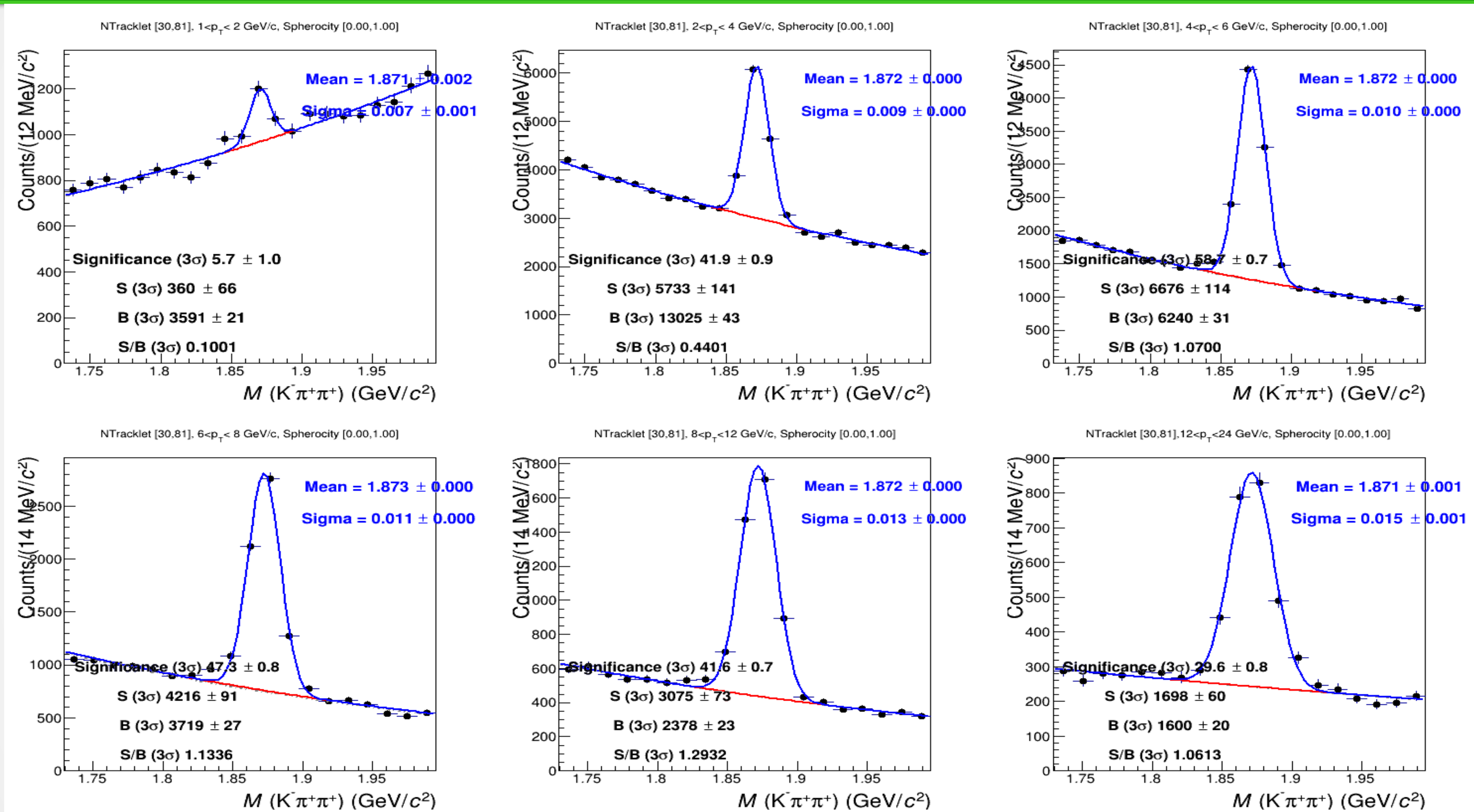
Mass Spectra: [mult:20-81 & Sph:0-1]



Mass Spectra: [mult:20-30 & Sph:0-1]



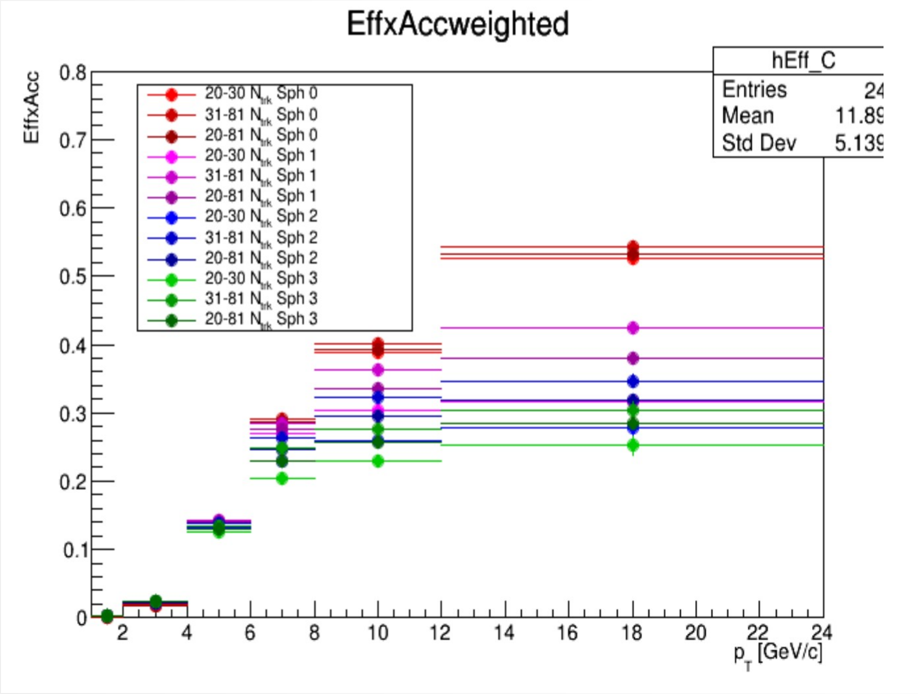
Mass Spectra: [mult:30-81 & Sph:0-1]

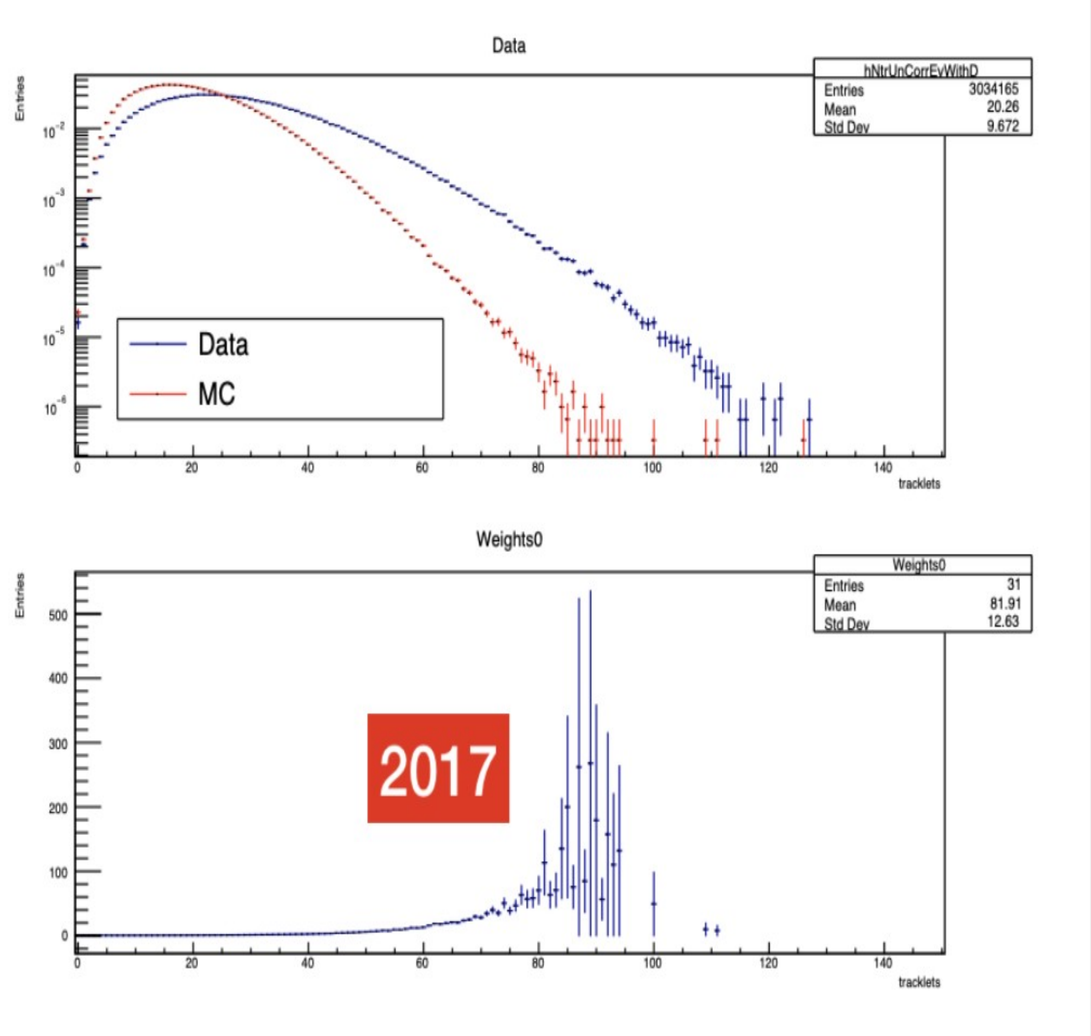


Weighted Efficiency * Acceptance

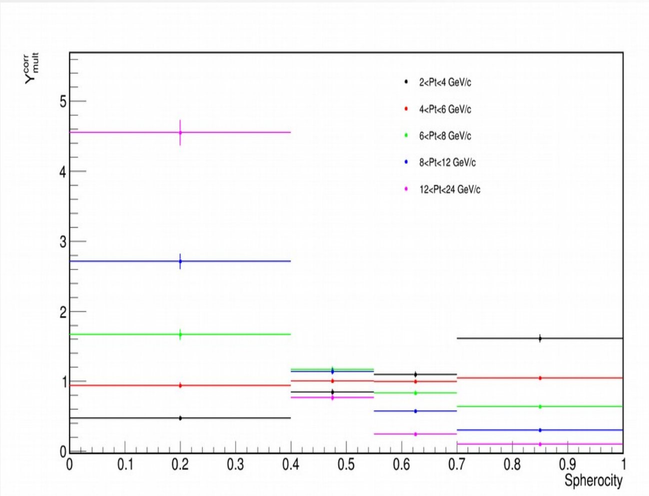
- Product of efficiency and acceptance was computed and multiplicity weighted Weights obtained with PYTHIA8

- Weights are needed to be applied due to the difference between multitiplicity distribution in data and MC

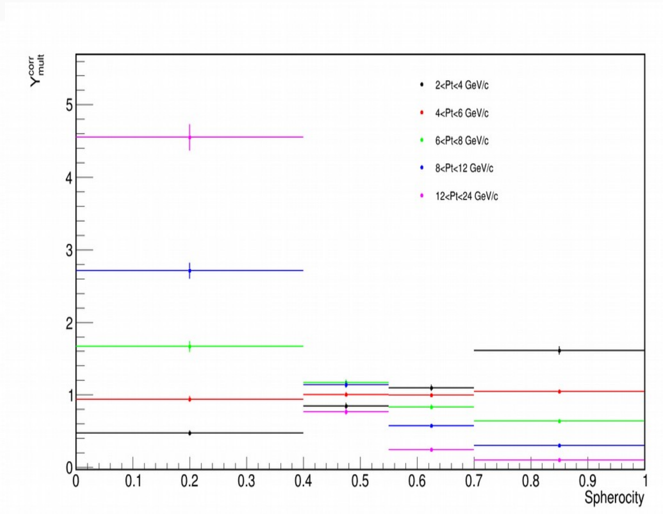




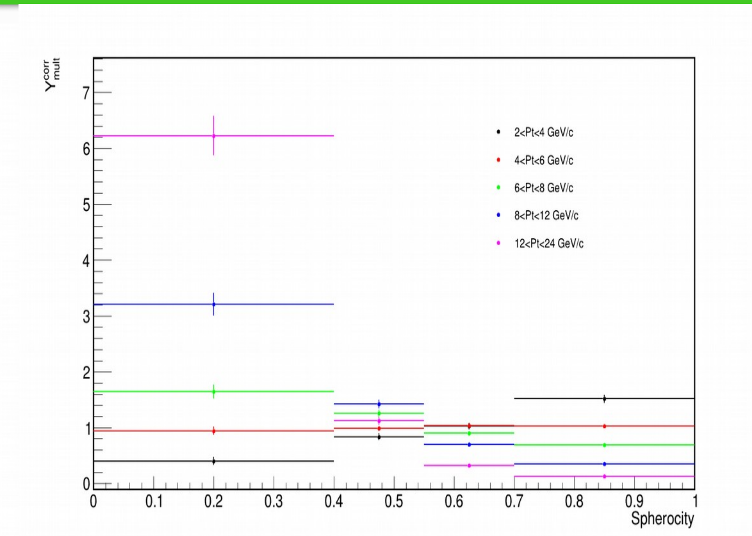
D* self normalised yield vs spherocity



Mult: 20-81



Mult: 20-30

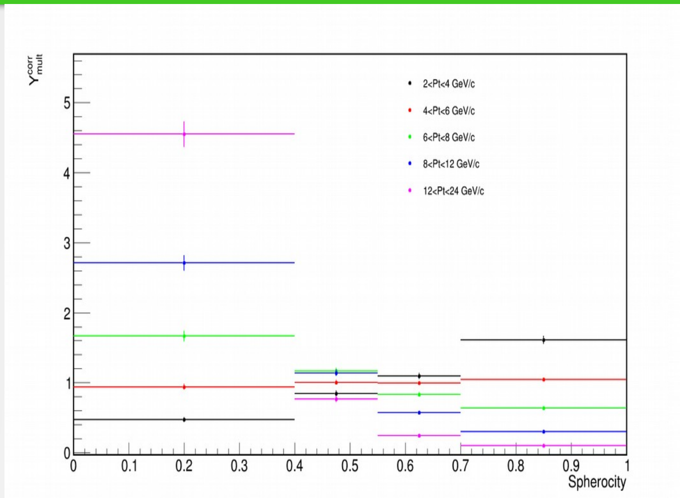


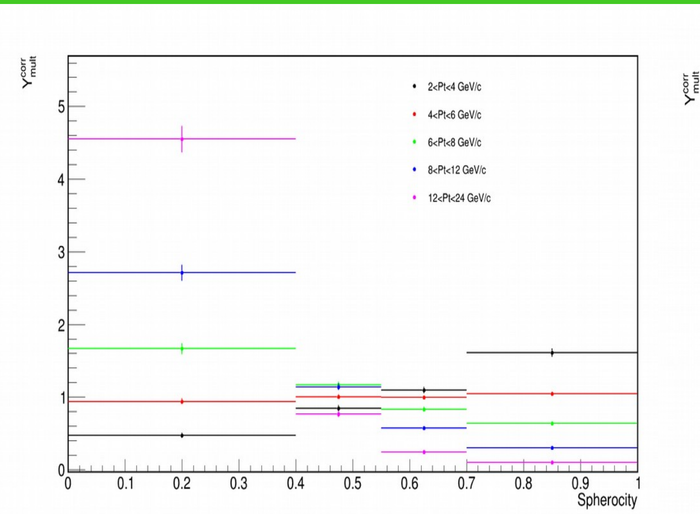
Mult: 31-81

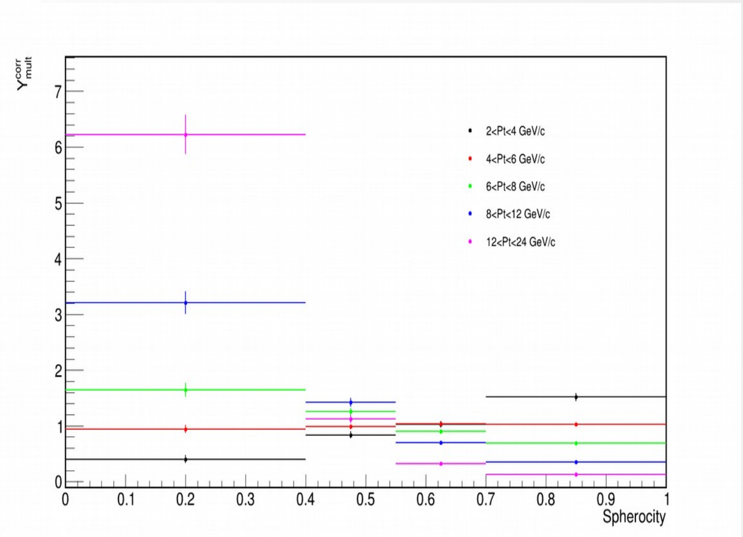
$$Y_{corr}^{mult,sphero} = \left(\frac{1}{N_{events}^{i,j}} \frac{N_{rawD+}^{i,j}}{\varepsilon_{promptD+}^{i,j}} \right) \Big/ \left(\frac{1}{\langle N_{events}^{j} \rangle} \frac{\langle N_{rawD+}^{j} \rangle}{\varepsilon_{promptD+}^{j}} \right)$$

Plots contain only statistical uncertainties

Comparison with D^0 @ 7 TeV results



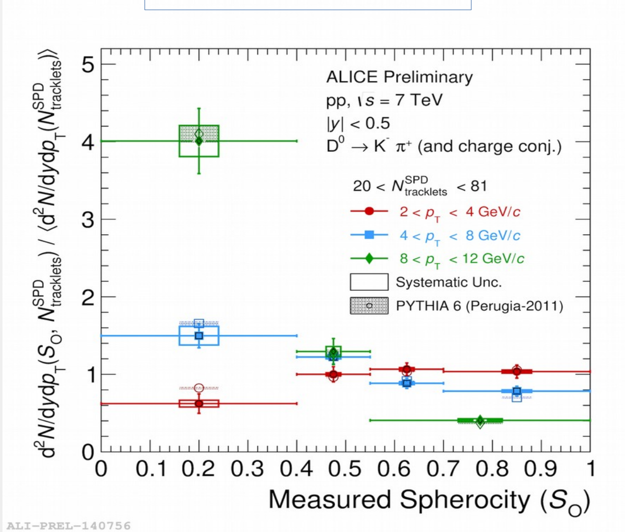


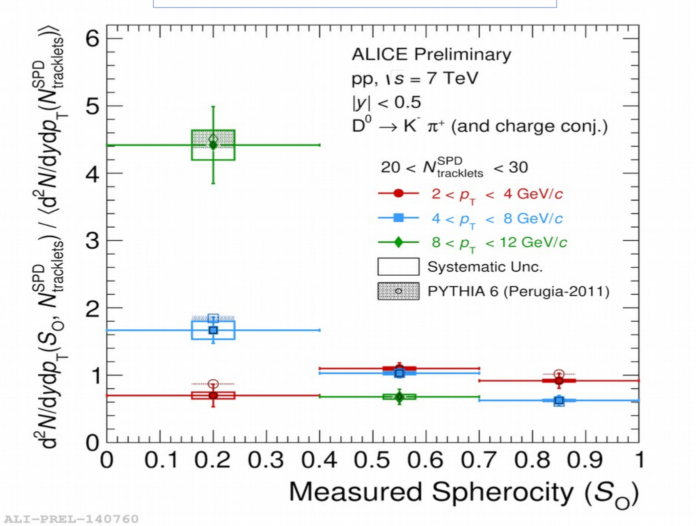


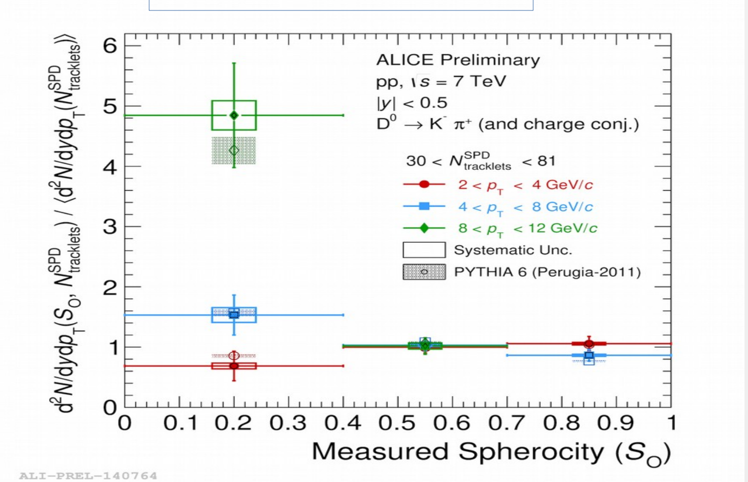
Mult: 20-81

Mult: 20-30

Mult: 31-81





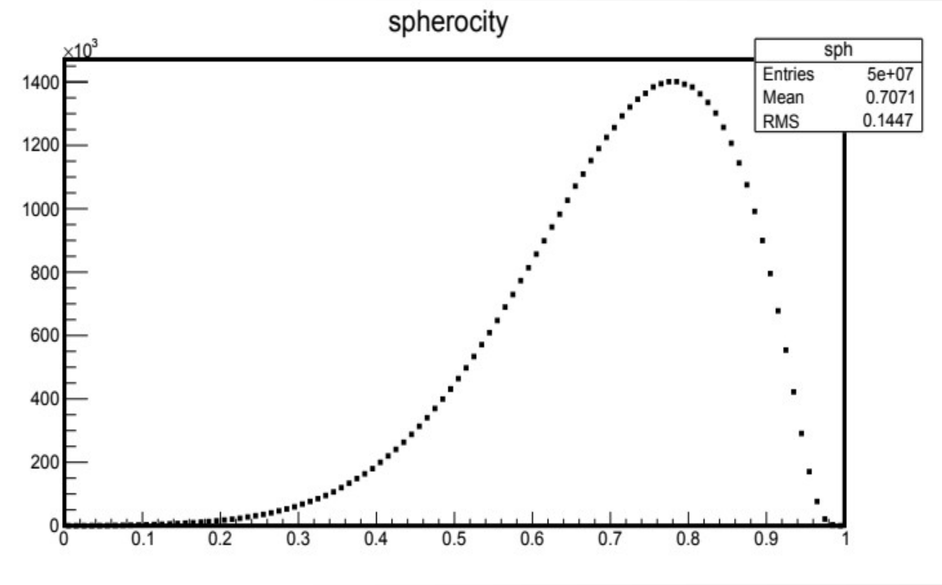


No preliminaries are available at 13 TeV . Results obtained for D^0 at 7 TeV in pp collisions

PYTHIA8

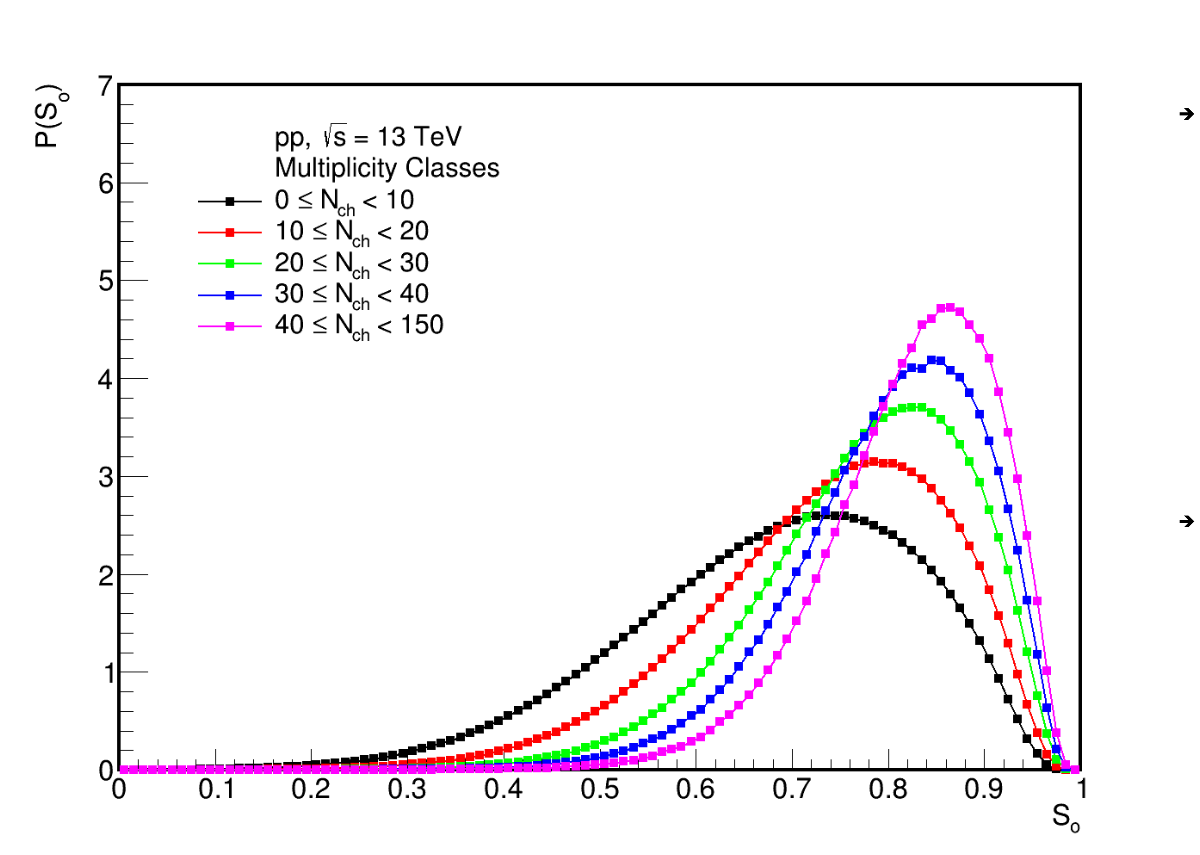
- **Data generation:** PYTHIA 8.302
  50M pp collisions @ $\sqrt{s}$ = 13 TeV

- **Configuration Used**:
  HardQCD:hardccbar = on
  HardQCD:hardbbbar = on
  Tune:pp = 14
  ColourReconnection:mode = on



- Track selection: $p_T^{track} > 0.15$ GeV/c, $|\eta^{track}| < 0.8$

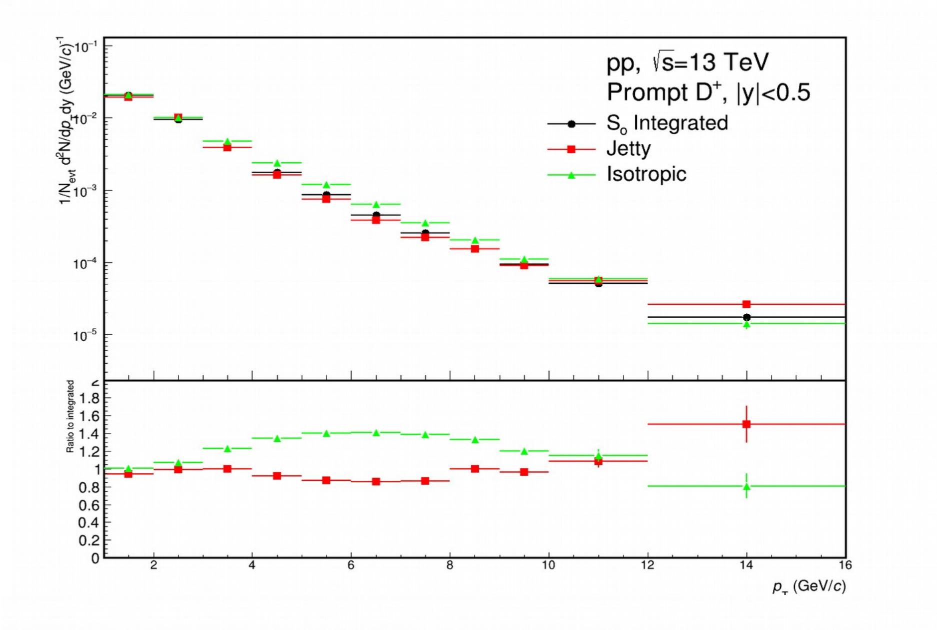
Spherocity vs multiplicity

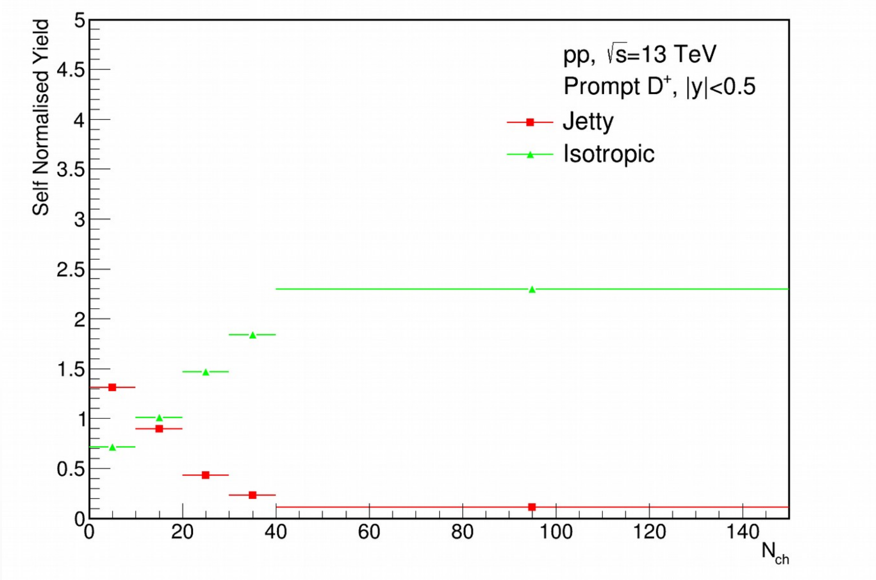


- The peak of the transverse spherocity distribution shifts towards isotropic events with charged-particle multiplicity, which shows that higher contribution of softer events is from high-multiplicity pp collisions. So when the final state multiplicity in an event is higher, the probability of the event becoming isotropic is also higher.
- Therefore, the study of particle production as a function of event shape classes has great importance to understand the particle production mechanism.

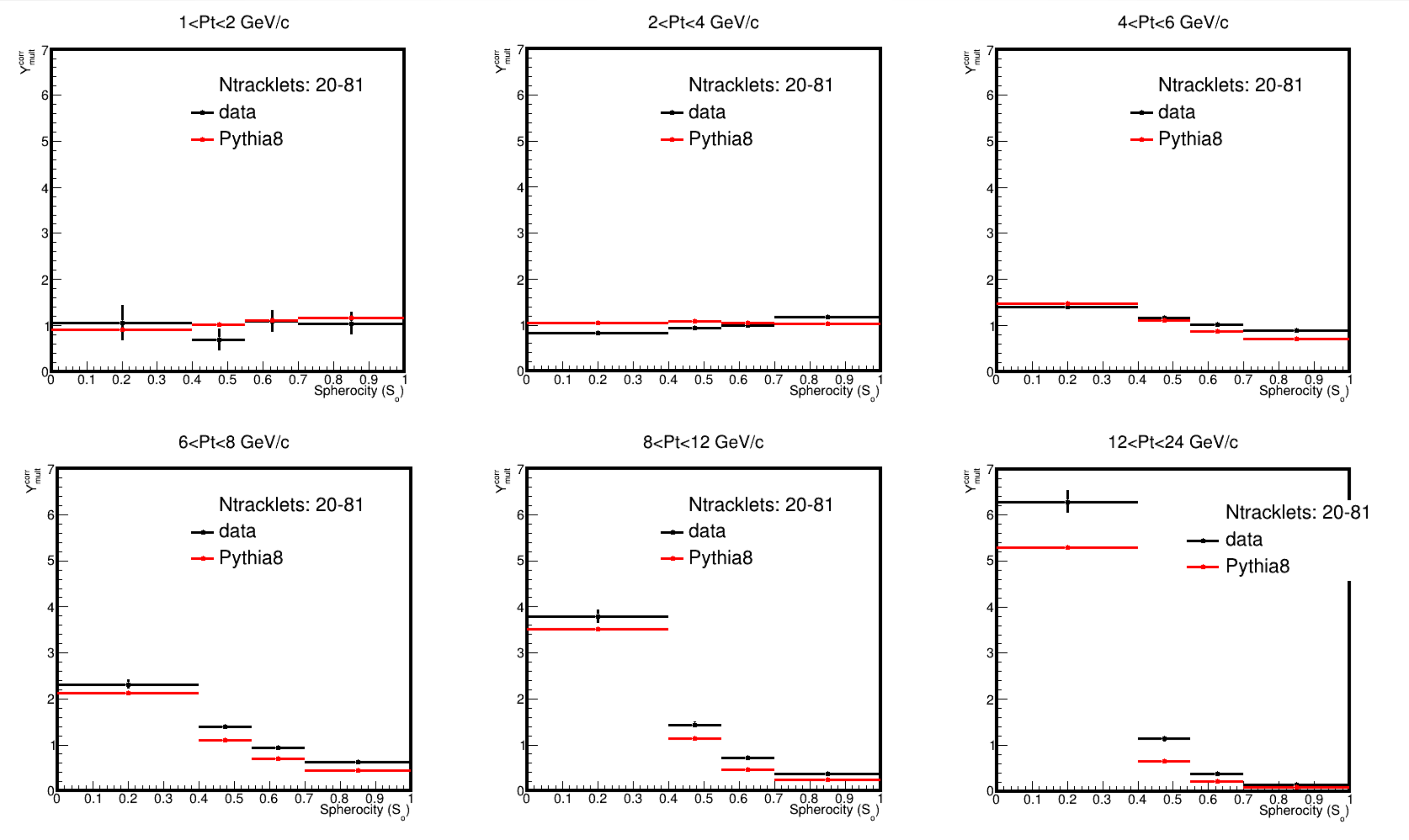
D+ vs spherocity

- D^+ are selected via their pdg codes in the central rapidity region $|\eta| < 0.5$.
- It can be seen that the lower p_T region is dominated by isotropic events over the jetty events. However, as we move towards higher p_T , the scenario changes .
- At a particular point, termed as ‘crossing point’, the jetty events dominate over the isotropic events.
- In case of self normalised yield as a function of charged multiplicity, low multiplicity region is dominated by jetty events and a similar reversal of nature of events os observed as we move towards high multiplicity.





Comparison of self normalised yield



Summary

From Data

- pp 13 TeV data has been analysed for D^+ vs spherocity analysis.
- Hybrid track (**Filterbit1, Filterbit 256 and Filterbit 512**) cuts are used for better reconstruction of event shape variable (spherocity).
- RawYield has been extracted fro data using Gaussian function for the signal and exponential function for the background.
- Analysis has been done in three different multiplicity bins and 6 different pT bins.
- RawYield has been corrected by efficiency to get the corrected yield.

Summary

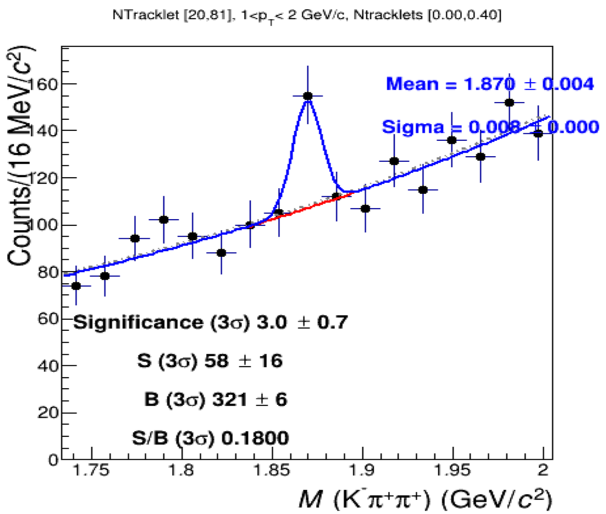
From PYTHIA

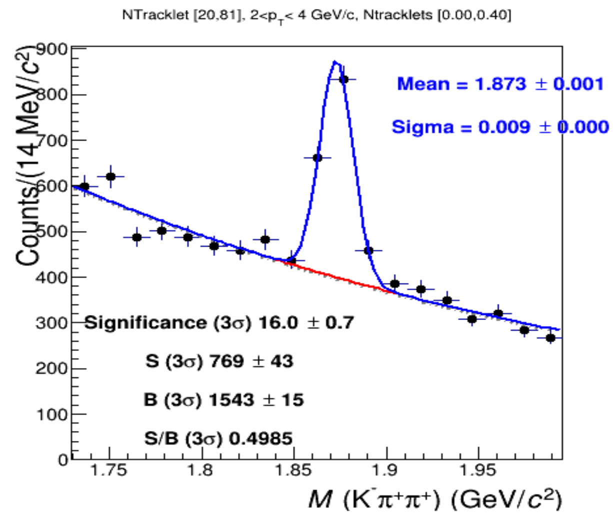
- We studied production of D-mesons with transverse spherocity in pp collisions at 13 TeV using PYTHIA8.
- At low pT, the isotropic events dominatewhereas at high pT jetty events takeover.
- At low charged multiplicity, jetty events dominate whereas at high multiplicity isotropic events dominate.

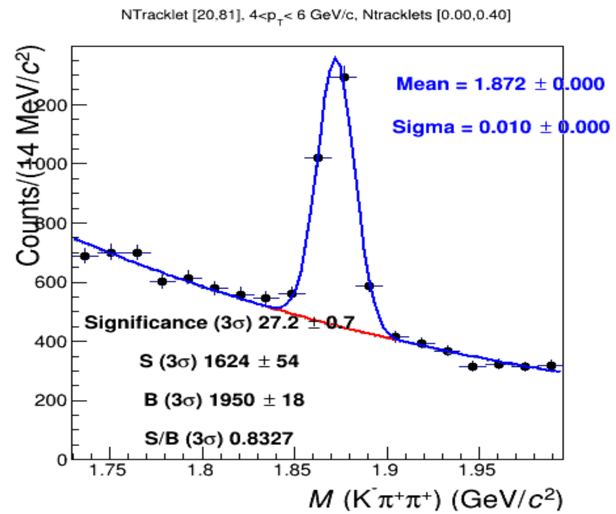
THANK YOU

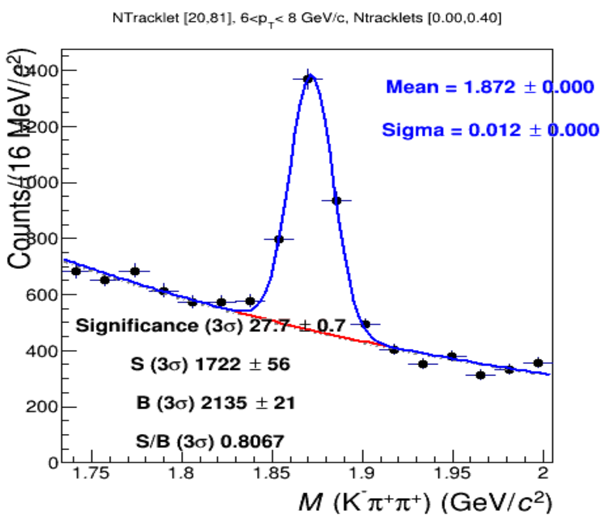
BACKUP

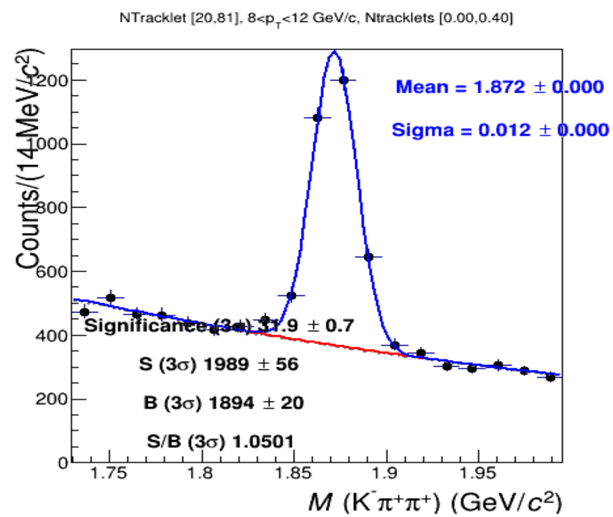
Mass Spectra: [mult:20-81 & Sph:0-0.4]

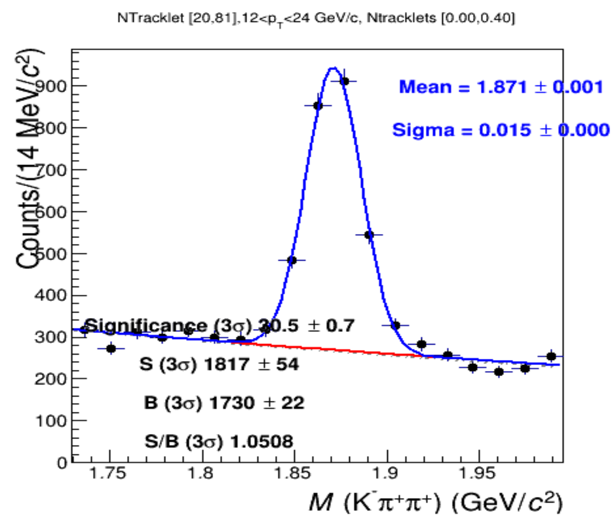




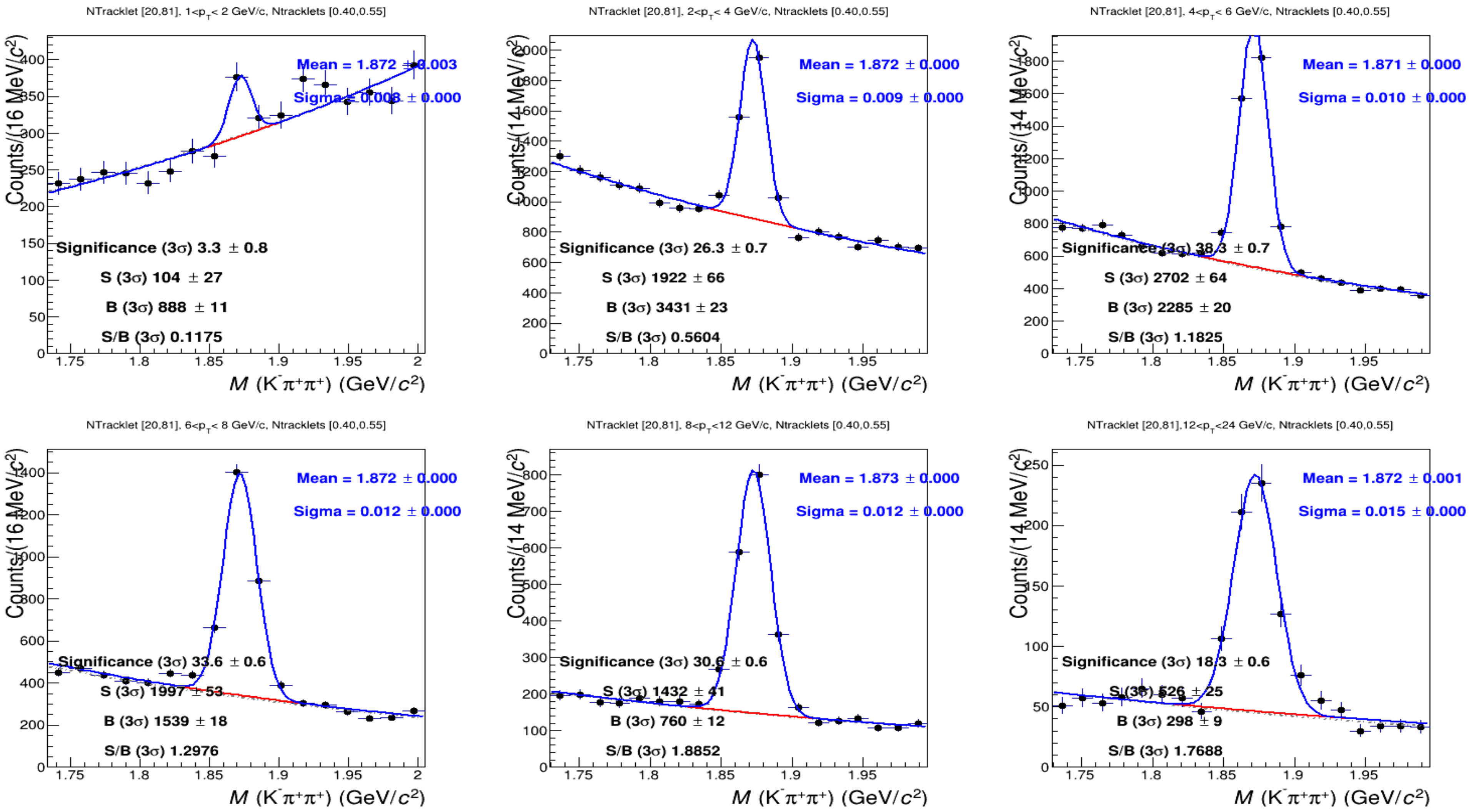




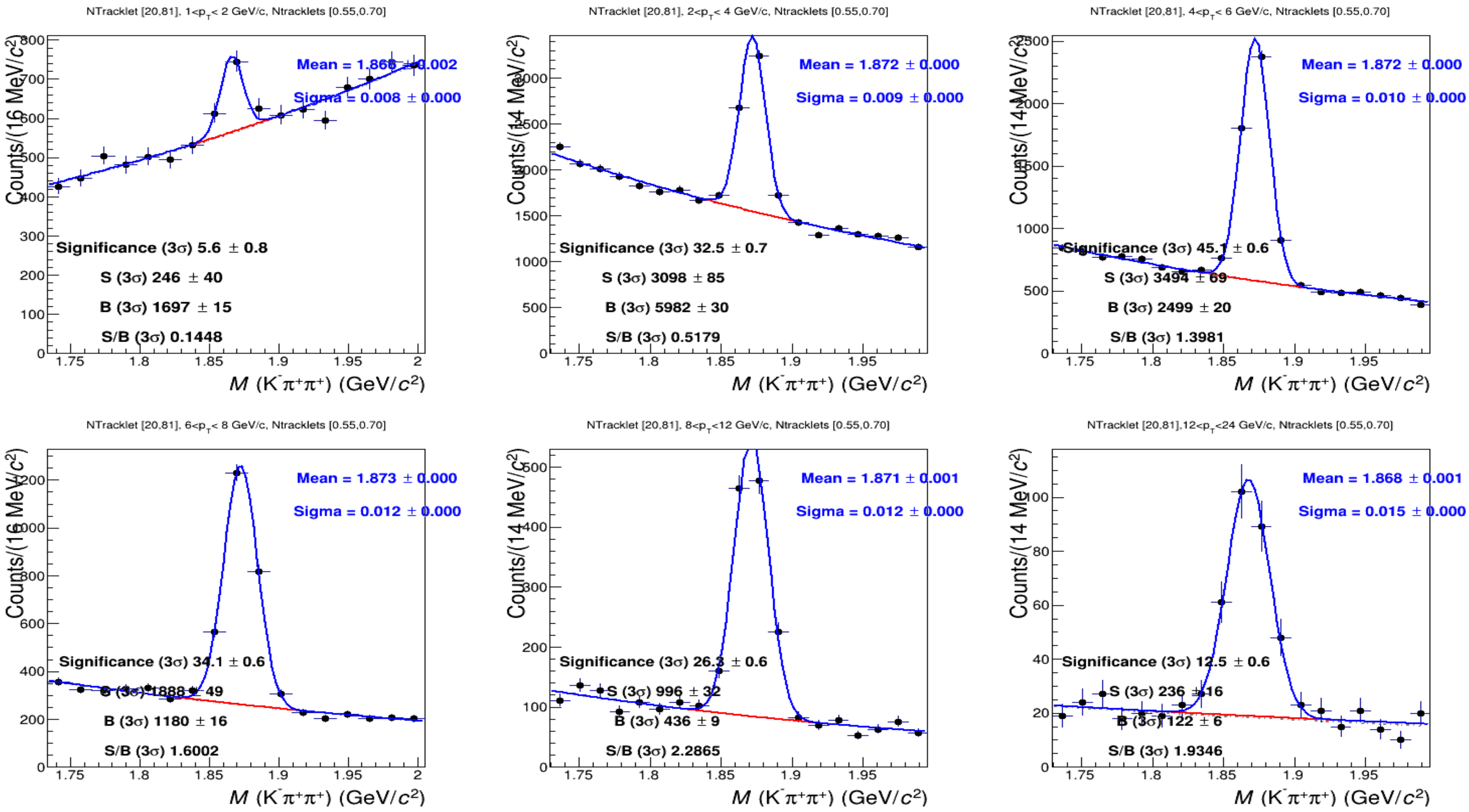




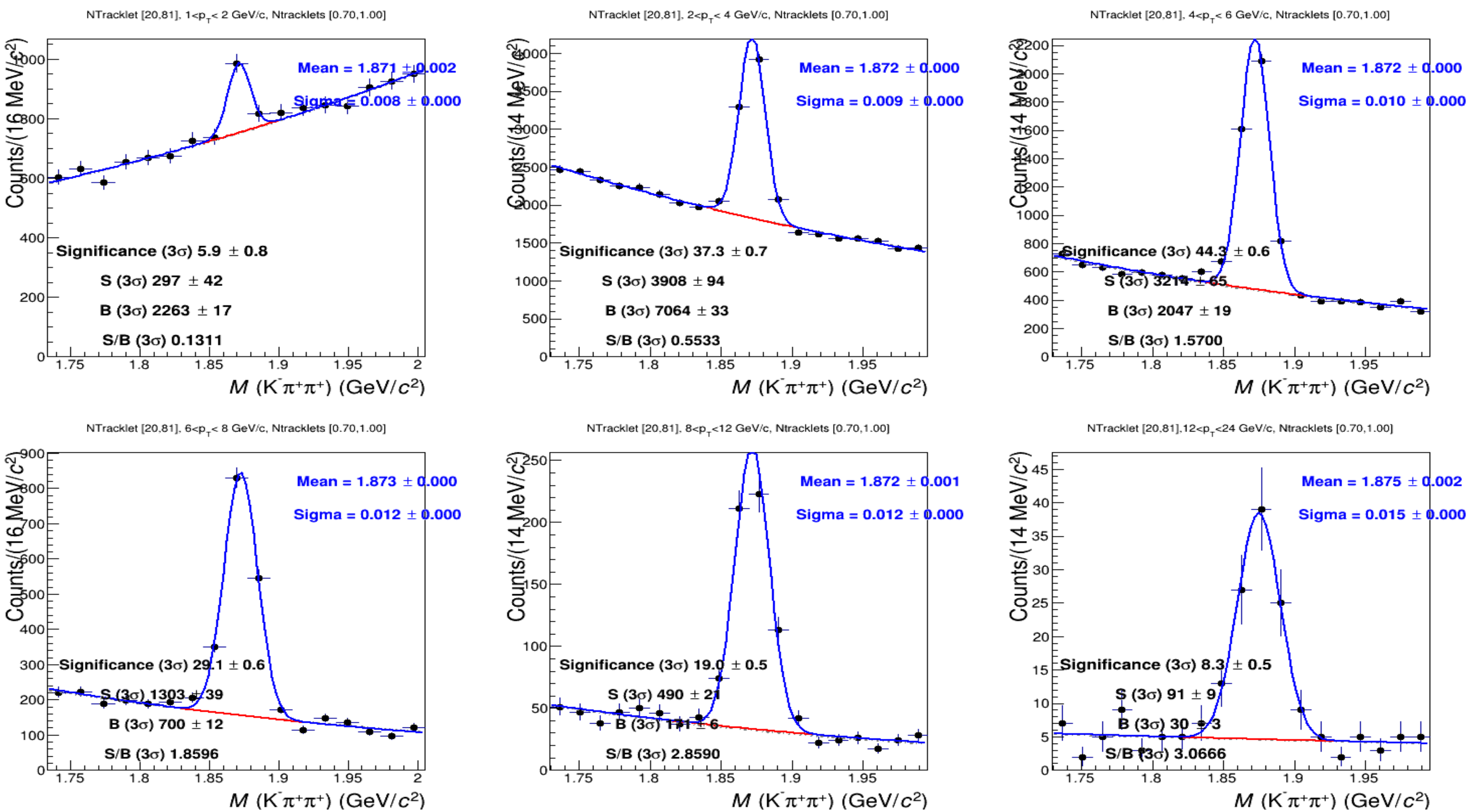
Mass Spectra: [mult:20-81 & Sph:0.4-0.55]



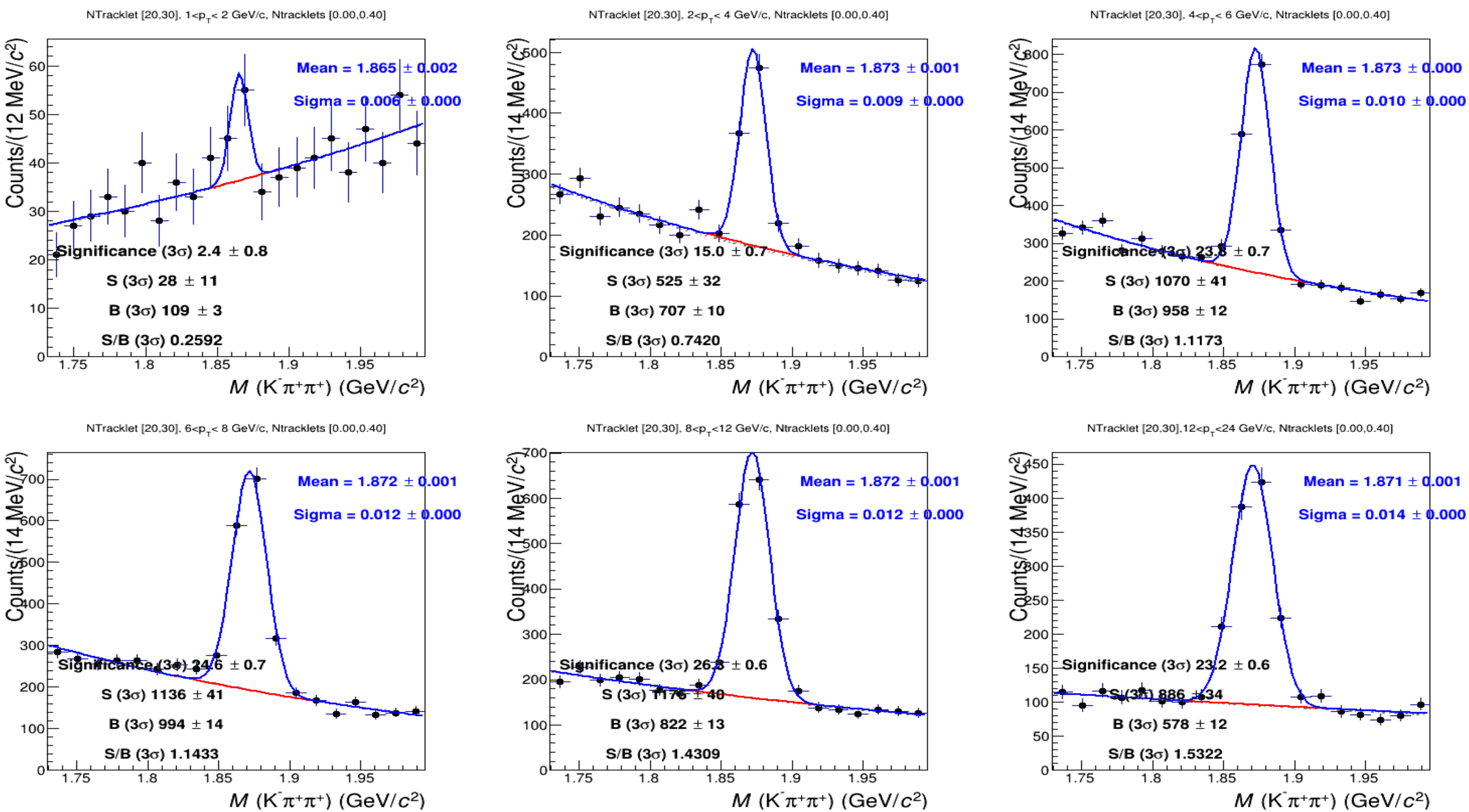
Mass Spectra: [mult:20-81 & Sph:0.55-0.70]



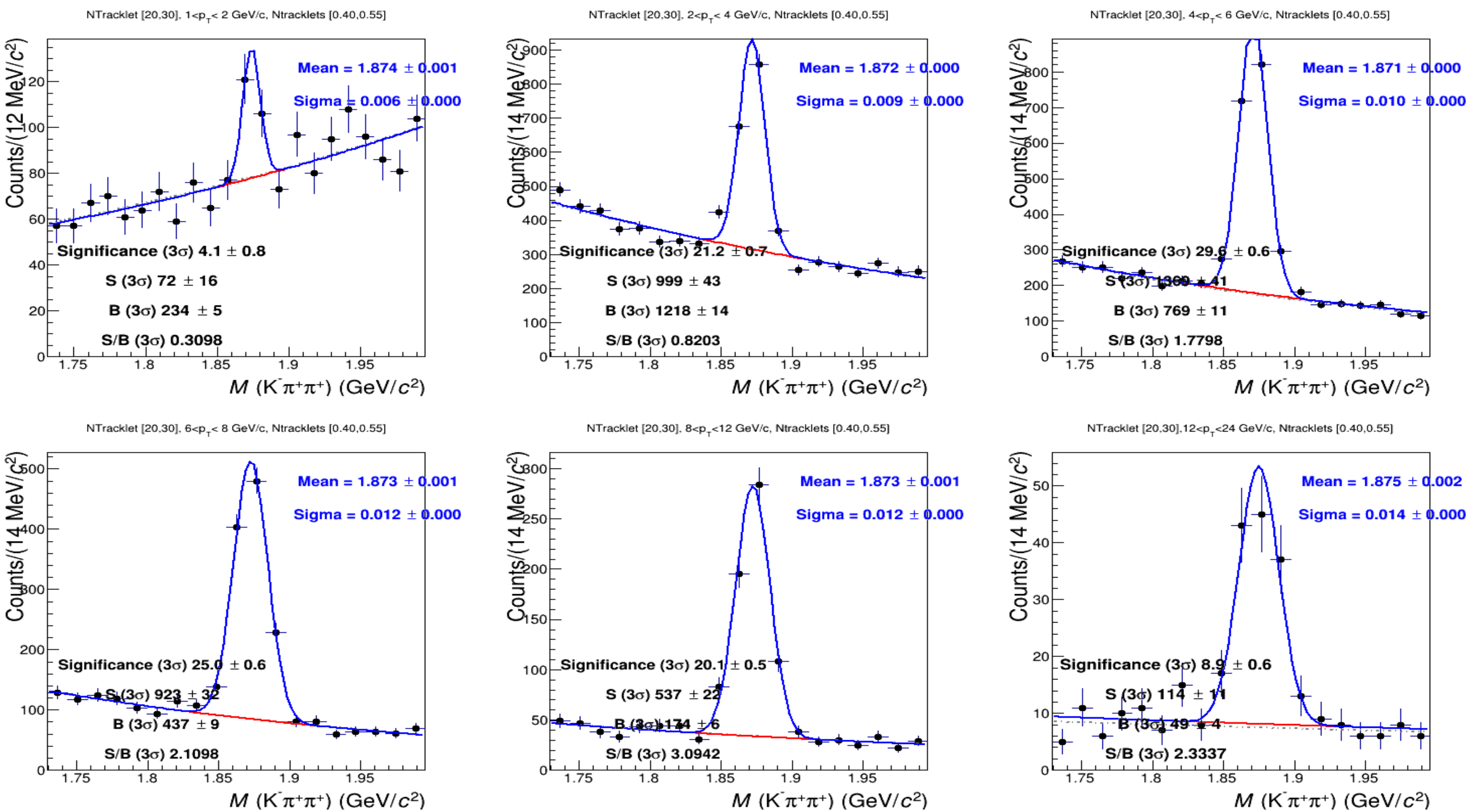
Mass Spectra: [mult:20-81 & Sph:0-0.4]



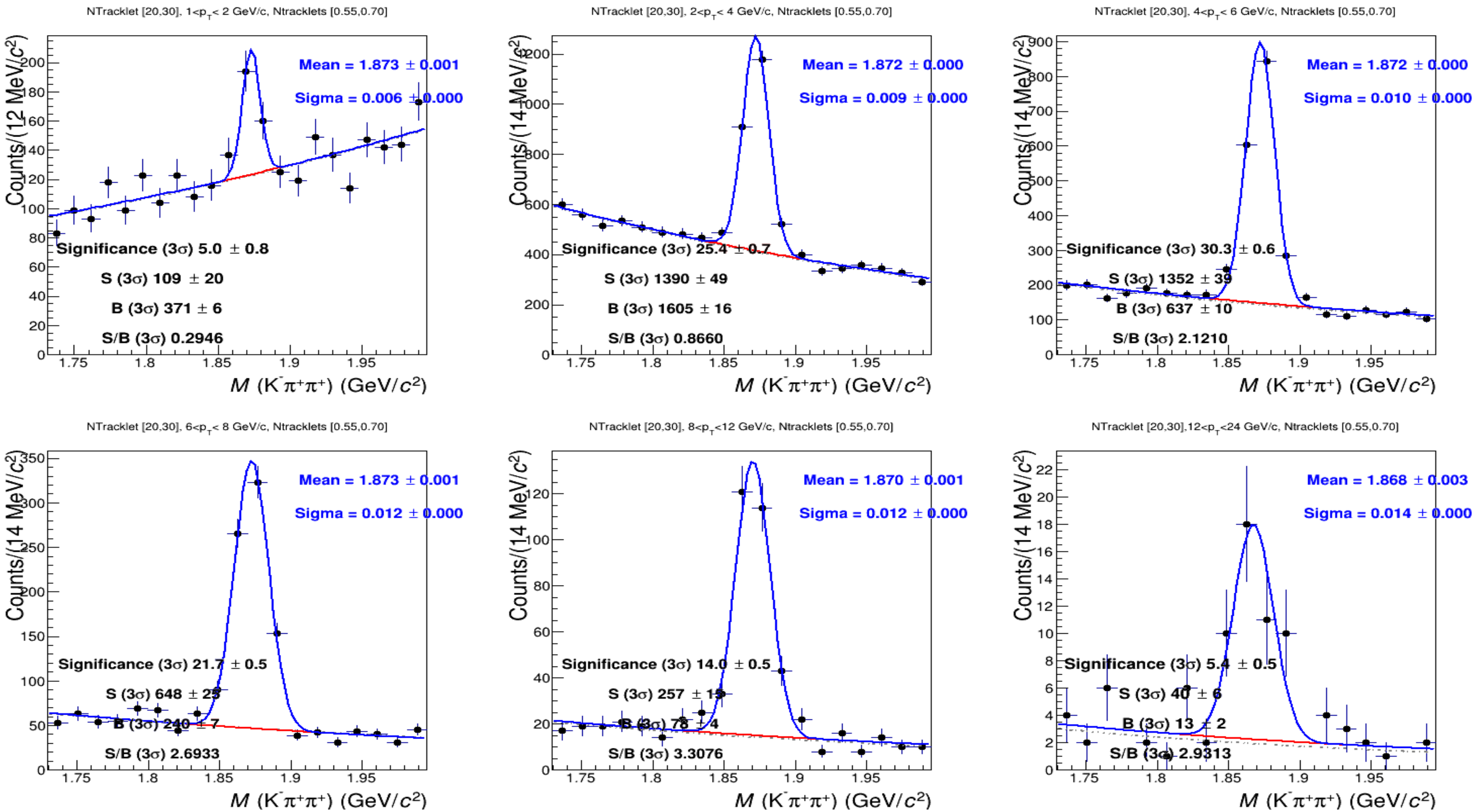
Mass Spectra: [mult:20-30 & Sph:0-0.4]



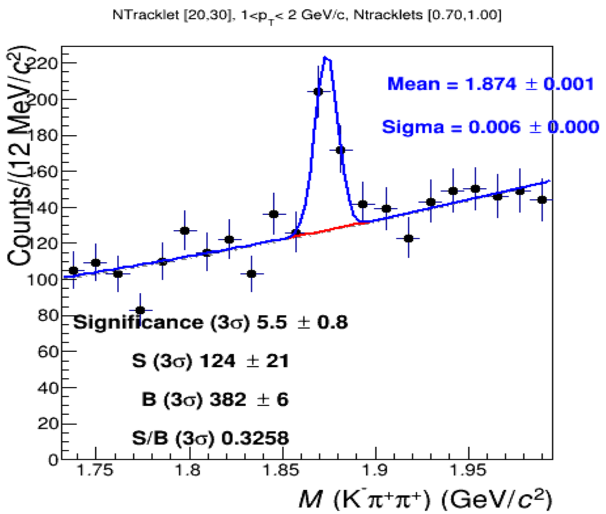
Mass Spectra: [mult:20-30 & Sph:0.4-0.55]

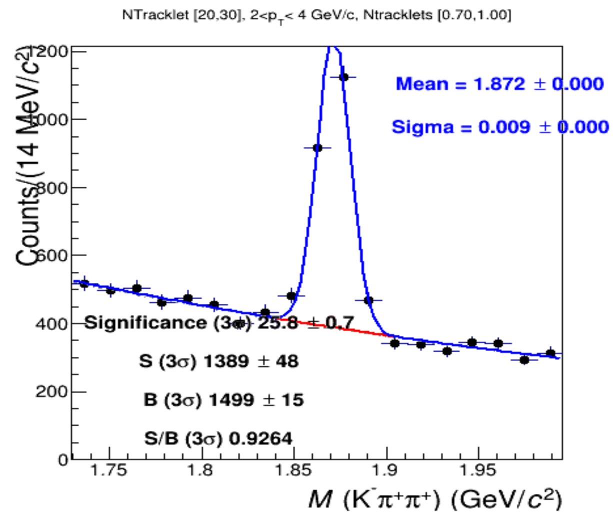


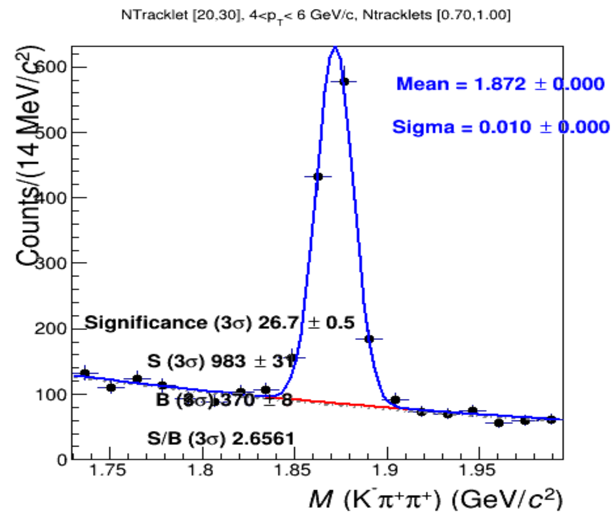
Mass Spectra: [mult:20-30 & Sph:0.55-0.70]

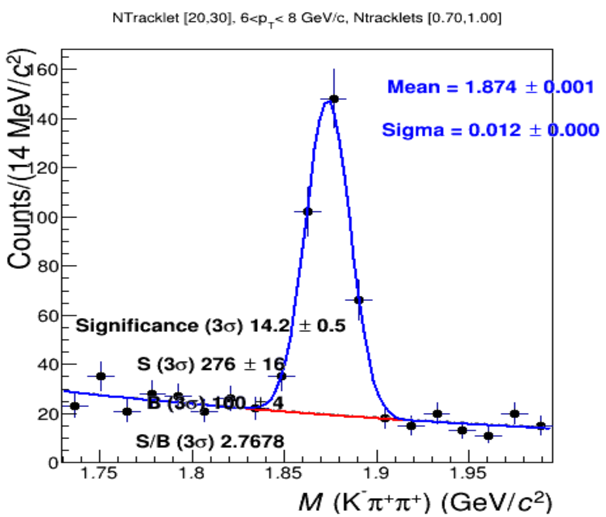


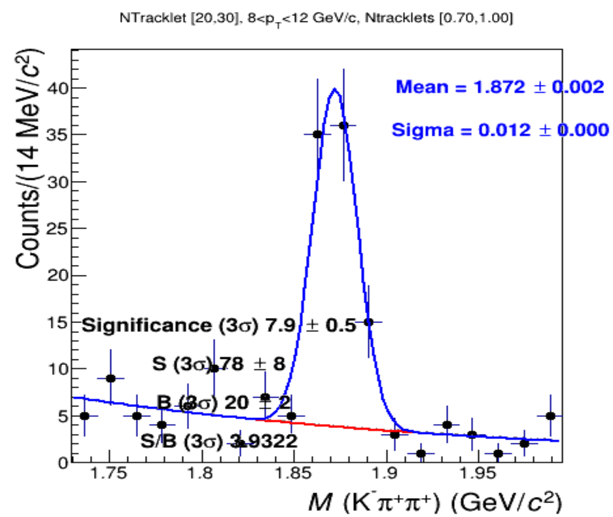
Mass Spectra: [mult:20-30 & Sph:0.7-1]



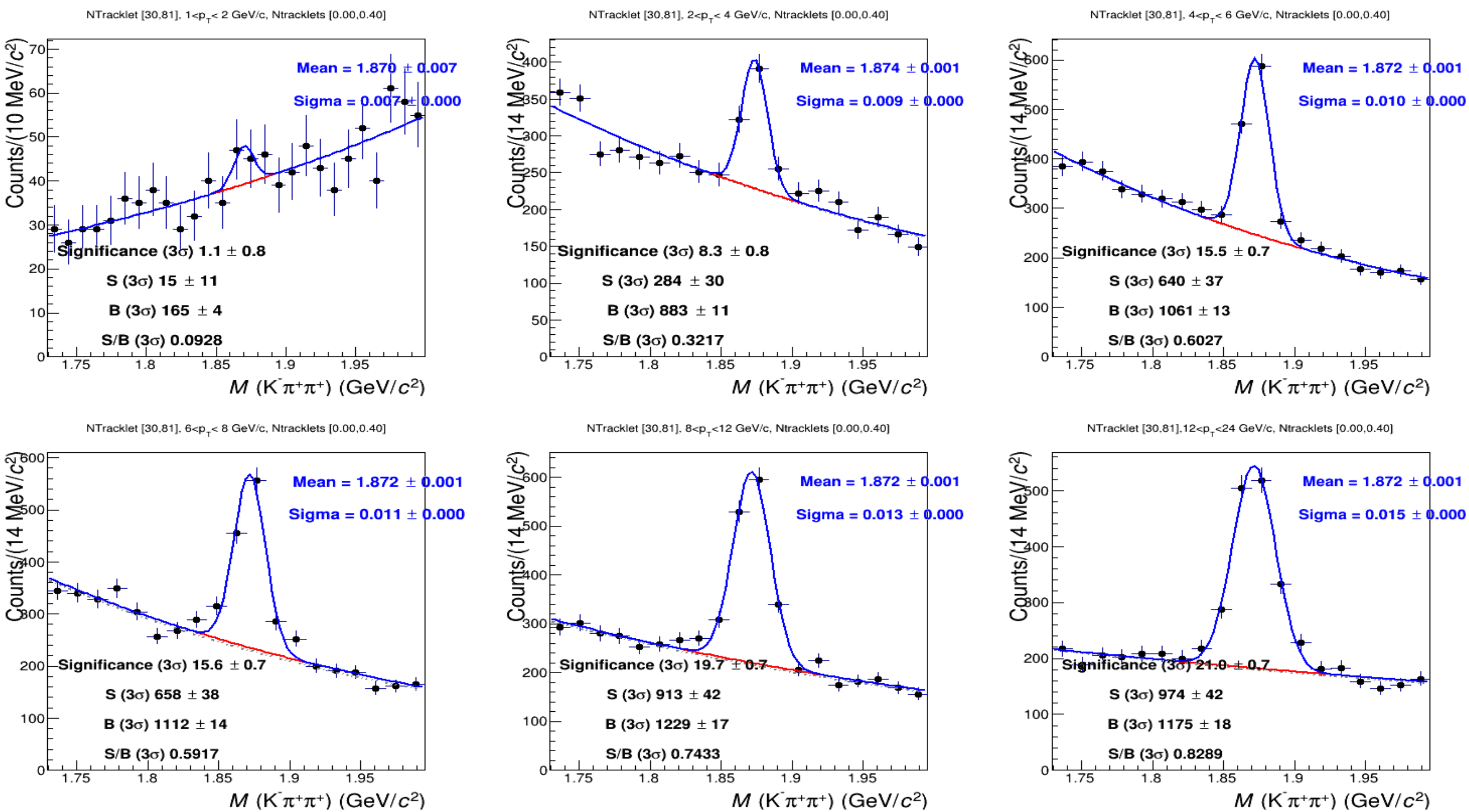




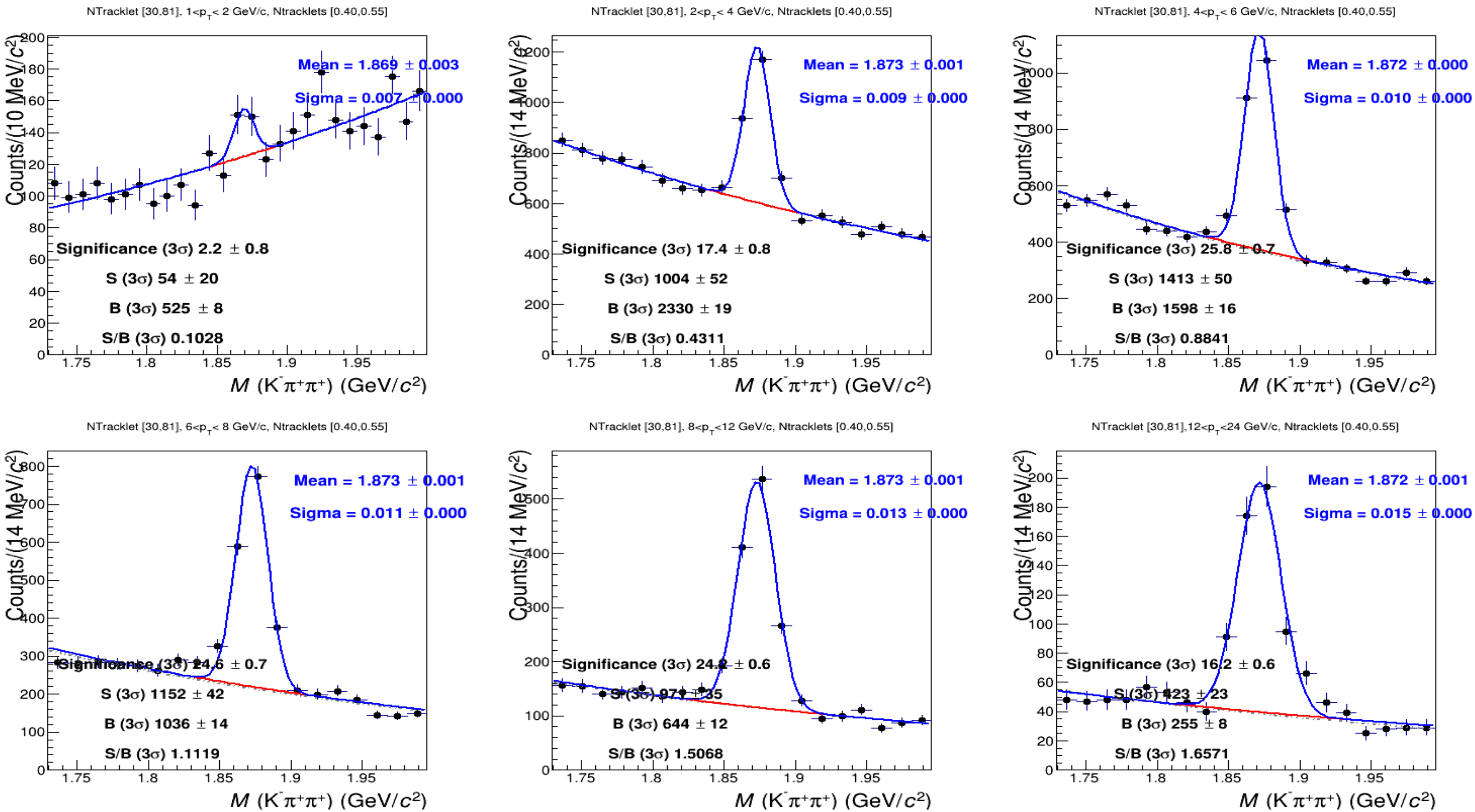




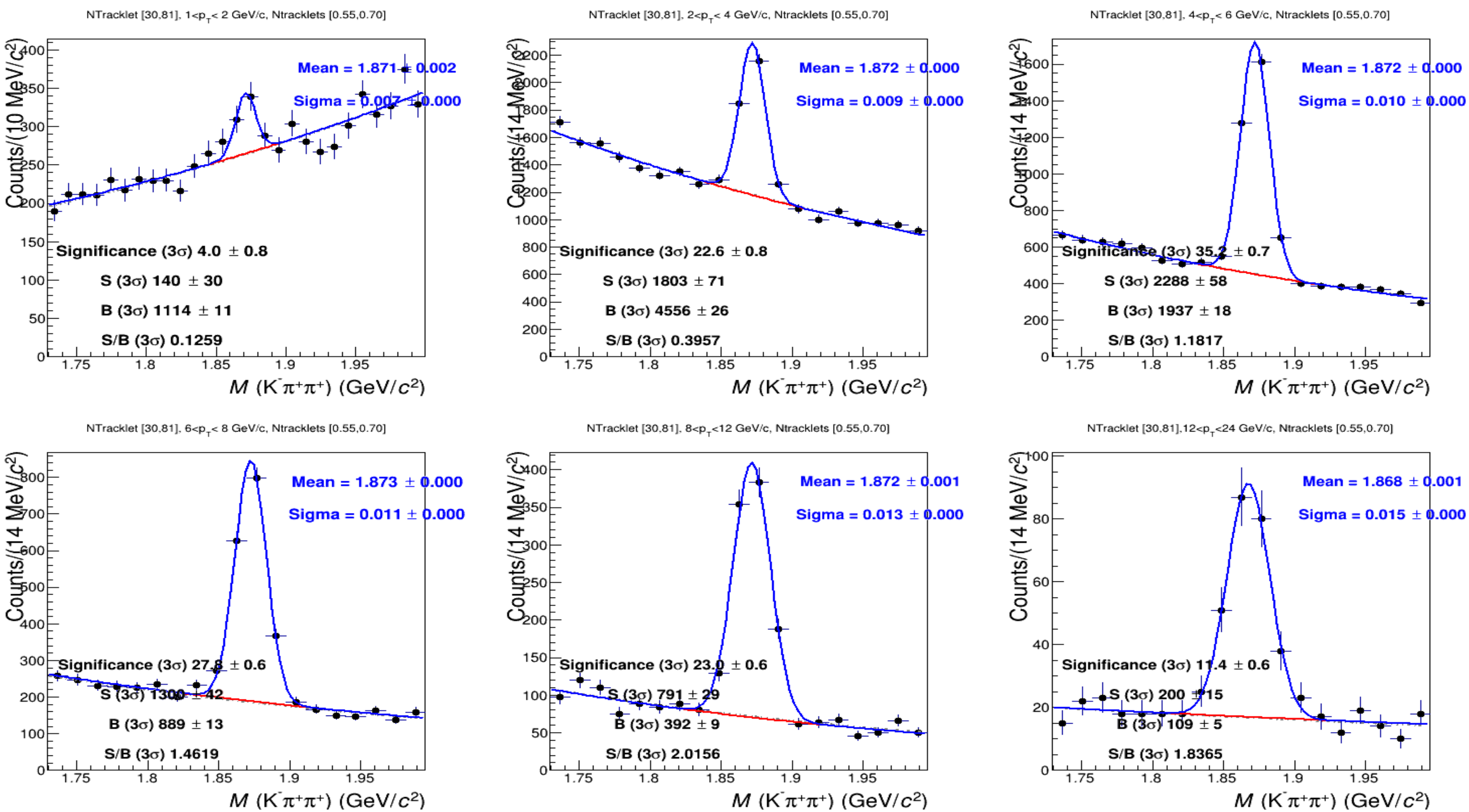
Mass Spectra: [mult:30-81 & Sph:0-0.4]



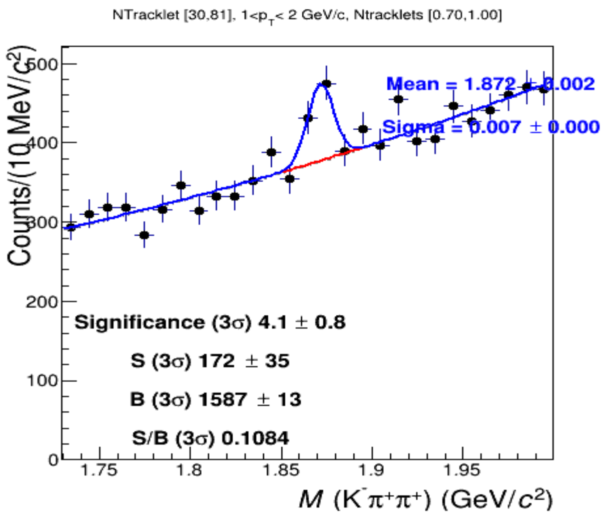
Mass Spectra: [mult:30-81 & Sph:0.4-0.55]

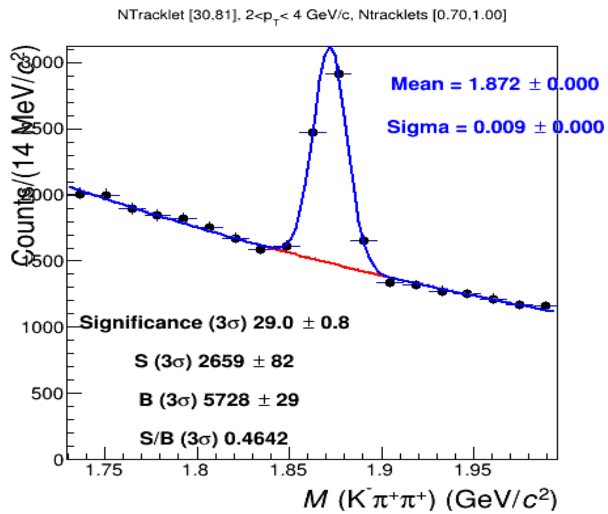


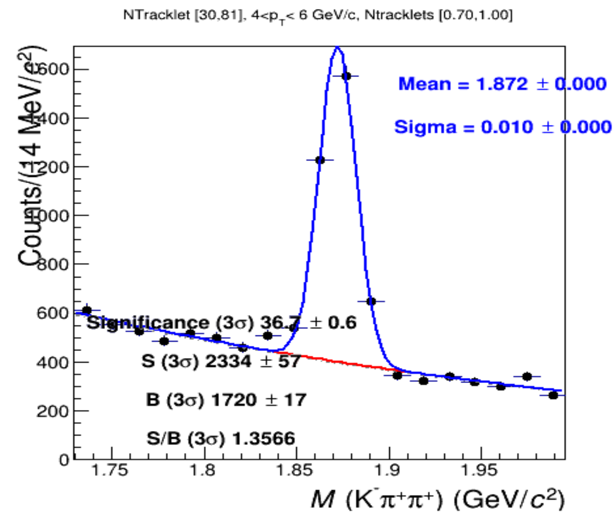
Mass Spectra: [mult:30-81 & Sph:0.55-0.7]

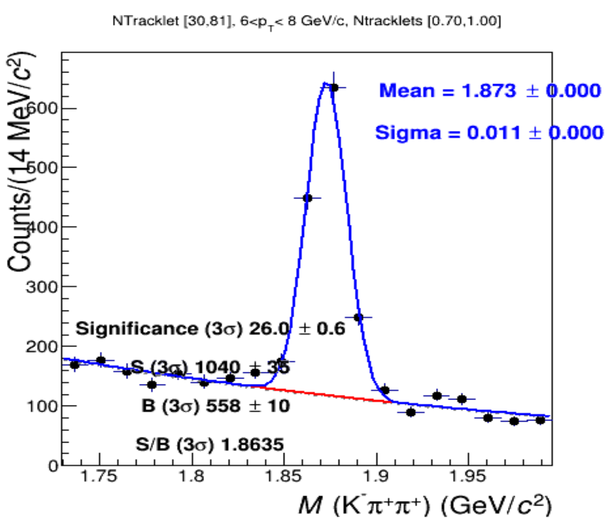


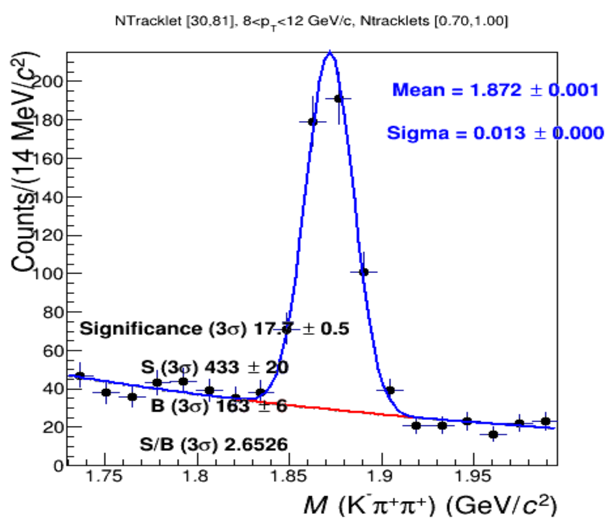
Mass Spectra: [mult:30-81 & Sph:0.7-1]

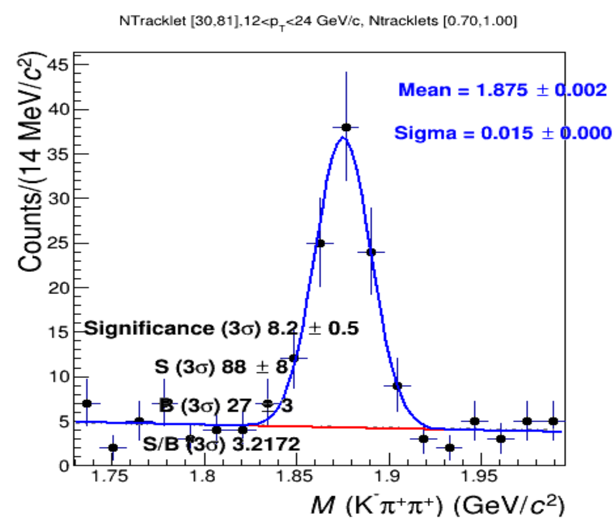




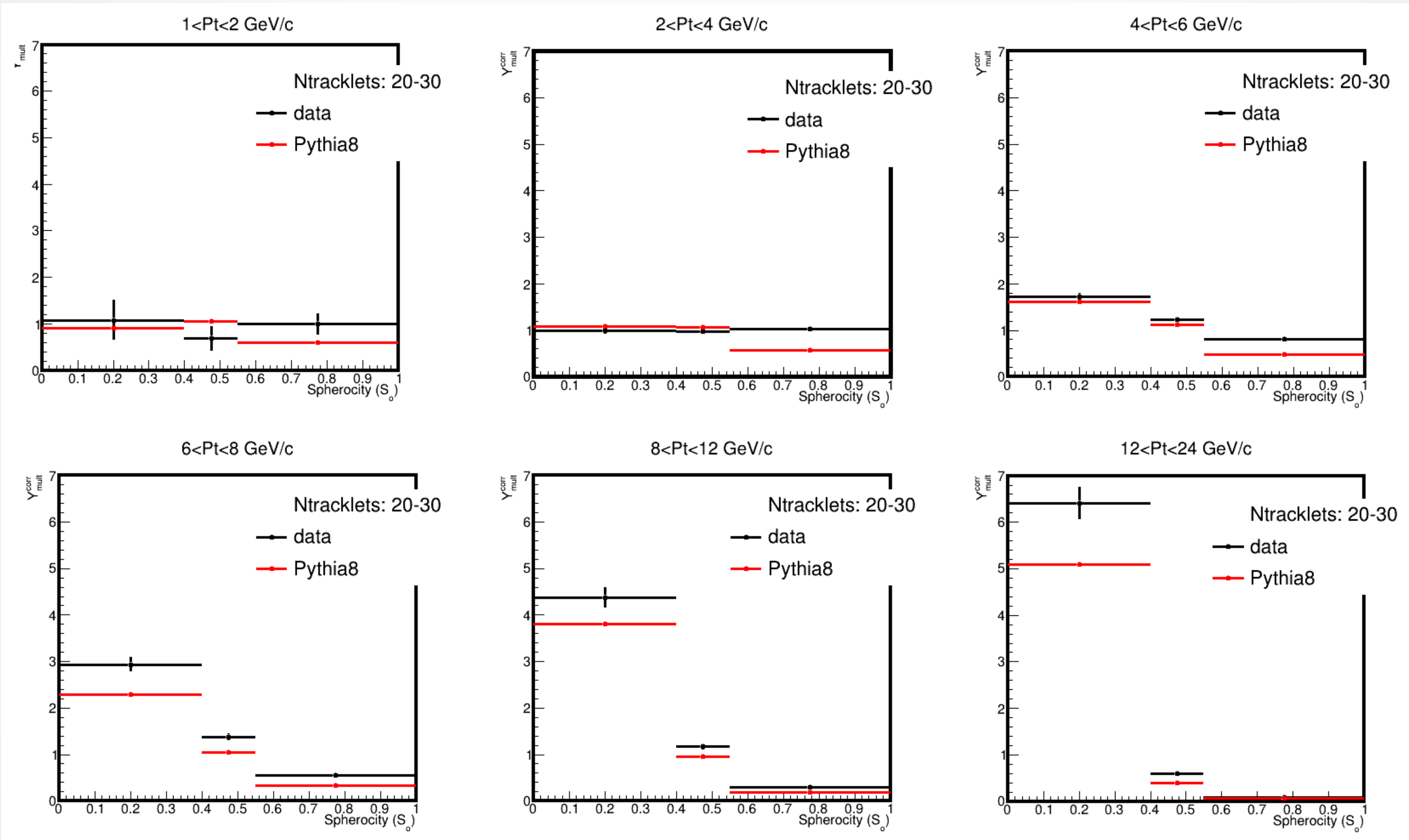


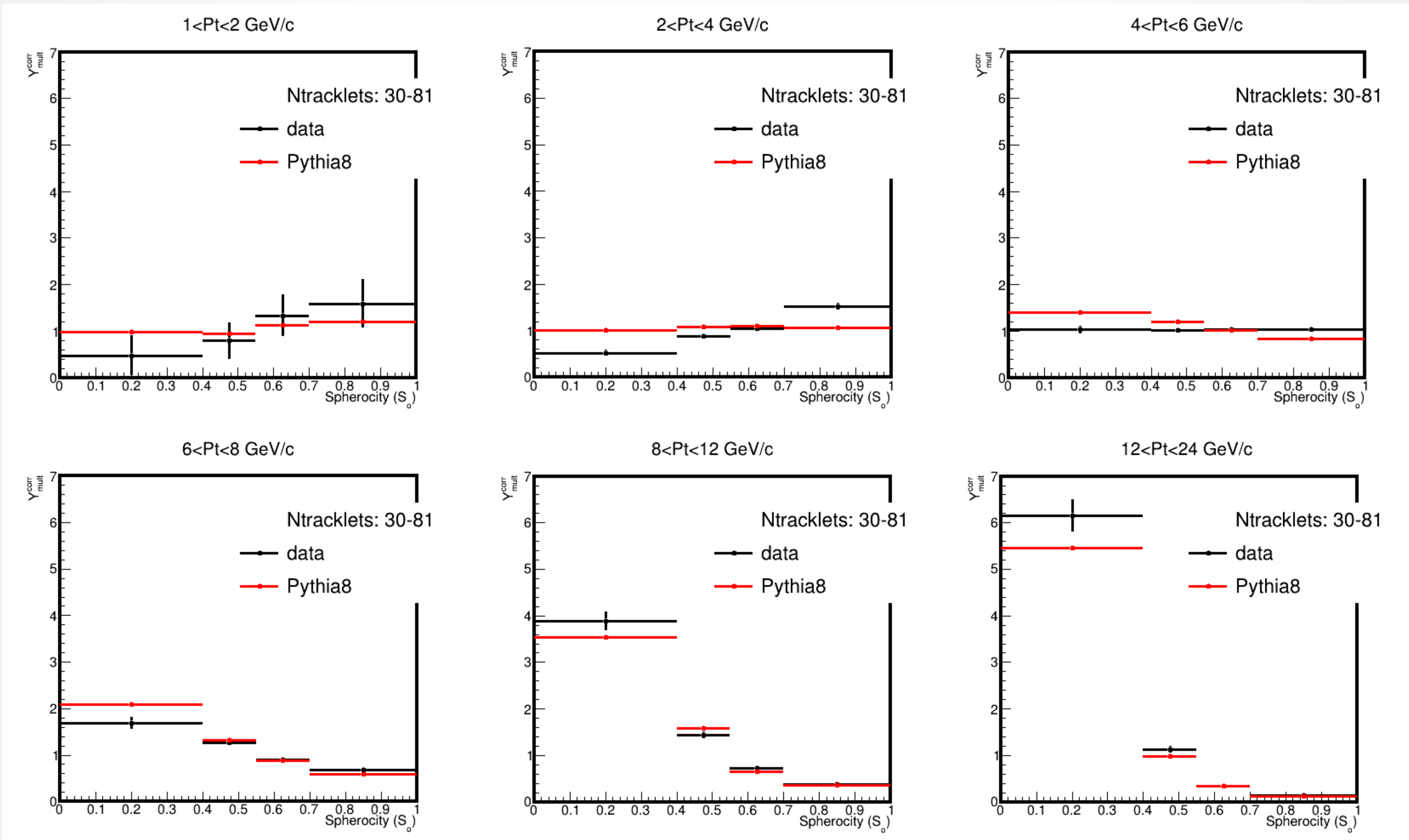






Backup


1<Pt<2 GeV/c
2<Pt<4 GeV/c
4<Pt<6 GeV/c
6<Pt<8 GeV/c
8<Pt<12 GeV/c
12<Pt<24 GeV/c
Ntracklets: 20-30
data
Pythia8
Spherocity (S_o)
Y^{corr}_{mult}


1<Pt<2 GeV/c
2<Pt<4 GeV/c
4<Pt<6 GeV/c
6<Pt<8 GeV/c
8<Pt<12 GeV/c
12<Pt<24 GeV/c
Ntracklets: 30-81
data
Pythia8
Y^{corr}_{mult}
Spherocity (S_o)