D^+ meson yield as a function of Event Shape variables in pp collisions at 7 TeV

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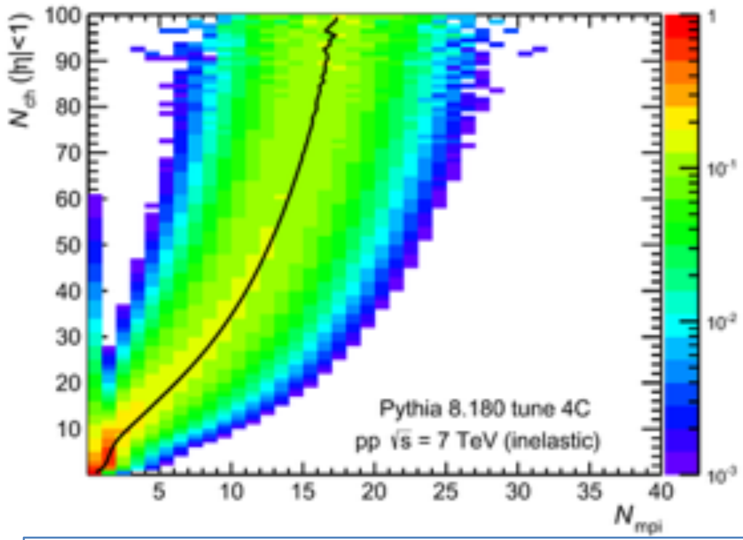
Outline

- ➢Motivation
- ➢Introduction (Spherocity and Sphericity)
- ➢D^+ mass plots
- ➢Summary & Outlook

Motivation

➢ In the analysis of D mesons production vs charged particle multiplicity, D-meson yield increases with multiplicity-> faster than the linear at higher multiplicities.
➢ Comaprison with models gives a hint of the contribution of MultiPartonic Interactions (MPIs). *(JHEP 1509 (2015) 148)*

A. Ortiz et al. / Nuclear Physics A 941 (2015) 78–86



Width of distribution of MPI prevents use of multiplicity alone to study the effect of MPI on the D meson yield.

We will be interested in finding,
Where does this increase in D meson as functon of multiplicity come from?
High Q^2 processes (jetty-like events) or lower Q^2 processes (large number of MPI = ISOTROPIC events).

➢Event shape analysis isolates hard and soft event[*].

➢ Study of heavy flavor meson as a function of event shape variables and multiplicity simultaneously will be interesting.

** Nuclear Physics A 941 (2015) 78–86*

Event Shape Variables

Spherocity(S_o):

Transverse Spherocity is an event shape variable defined as

$$S_o = \frac{\pi^2}{4}\left(\frac{\sum_i \overrightarrow{p_{Ti}} \times \hat{n}}{\sum_i p_{Ti}}\right)^2$$

The above ratio is minimized using the transverse unit vector $\hat{n}$

➢ The limit of this variable is between 0 and 1.

✓ S_o =0 corresponds to pencil like events

✓ S_o =1 corresponds to isotropic events.

Andrea Ban et al., "Phenomenology of the event shapes at hadron colliders", arXiv: 1001.4082

Event Shape Variables

Sphericity(S_T) :

Transverse Sphericity variable is defined by :

$$S_T = \frac{2\lambda_2}{\lambda_2 + \lambda_1}$$

where λ_1 and λ_2 are the eigen values of the transverse momentum matrix. ($\lambda_2 < \lambda_1$)

$$\mathbf{S_{xy}} = \frac{1}{\sum_j p_{\mathrm{T}j}} \sum_i \frac{1}{p_{\mathrm{T}i}} \begin{pmatrix} p_{\mathrm{x}i}^2 & p_{\mathrm{x}i} p_{\mathrm{y}i} \\ p_{\mathrm{y}i} p_{\mathrm{x}i} & p_{\mathrm{y}i}^2 \end{pmatrix}$$

➢ The restriction along the transverse direction is to avoid the boost along the beam direction.

➢ The limit of this variable is between 0 and 1.

✓ S_T =0 corresponds to pencil like events

✓ S_T =1 corresponds to isotropic events.

* ***http://arxiv.org/abs/1404.2372***

Why Event Shape Variables

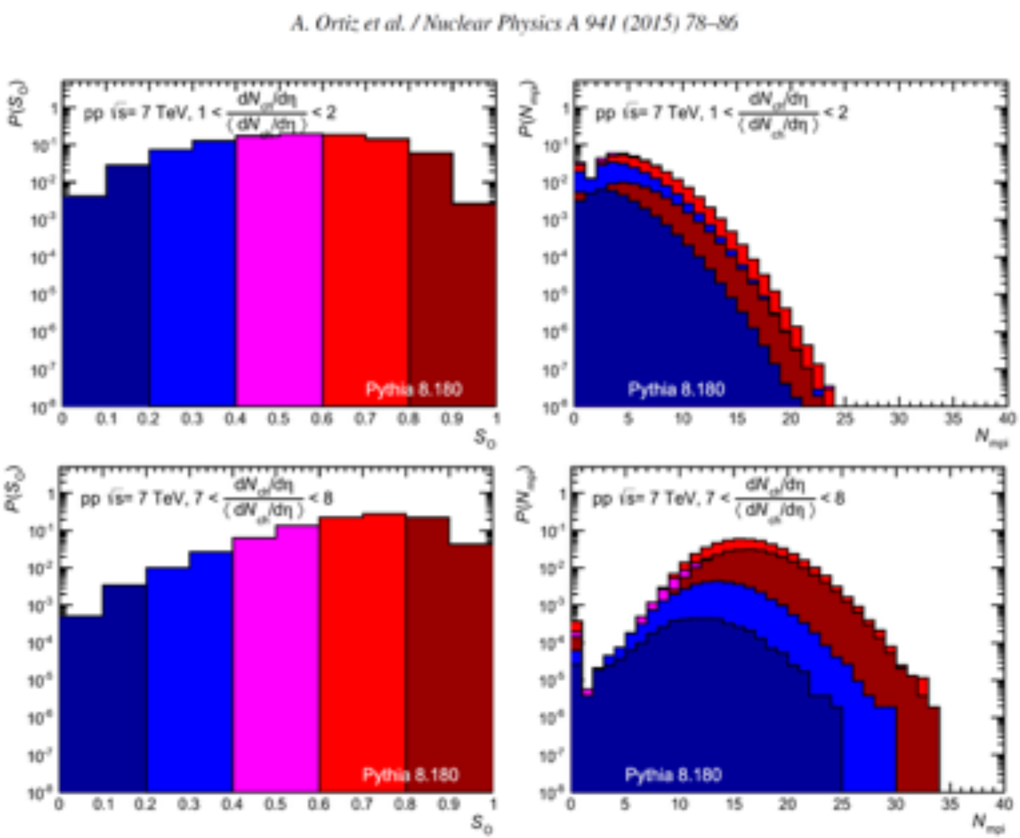


Figure shows the S_o and N_{mpi} distributions for $\sqrt{s} = 7$ TeV pp collisions producing low (upper) and high (bottom) mid-rapidity charged hadron multiplicity.

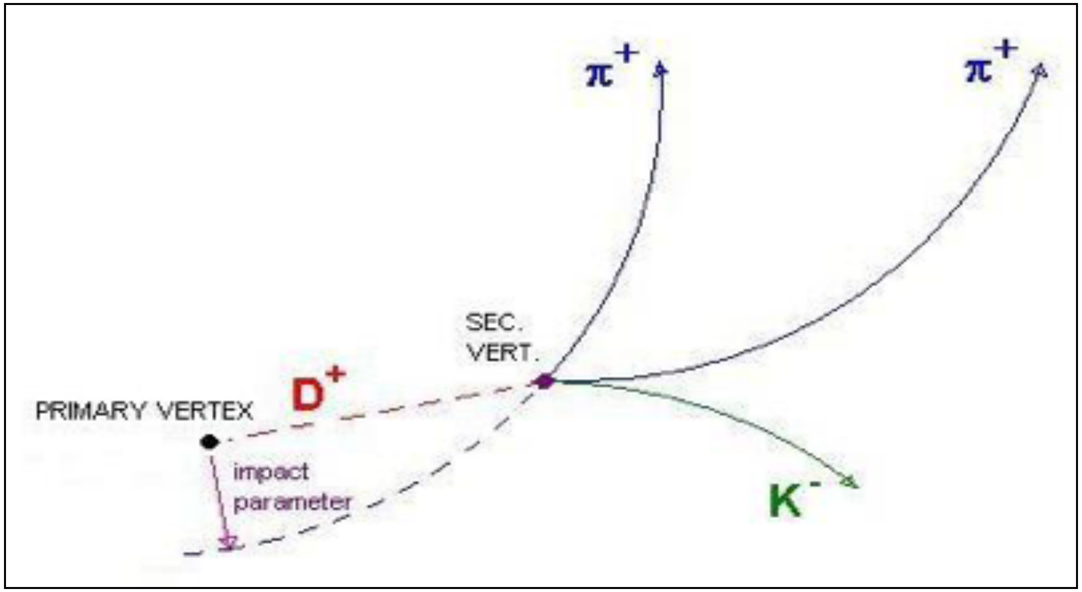
✓ A depletion of the low S_0 part in the high multiplicity events compared with the low multiplicities observed.

✓ For isotropic events a greater average number of MPIs obtained than for jetty-like events.

✓ Dividing a given multiplicity bin into S_o bins, the width of correlation distribution can be reduced.

D^+ reconstruction through invariant mass calculation

Mass (D^+) = 1.869 ± 0.20 (GeV/c^2)
Branching Ratio = 9.22 ± 0.21%



D^+ mesons signal extraction is based on the Invariant mass analysis of fully reconstructed decay topologies displaced from primary vertex

$$M = \sqrt{\left(\sum E\right)^2 - \left(\sum p\right)^2}$$

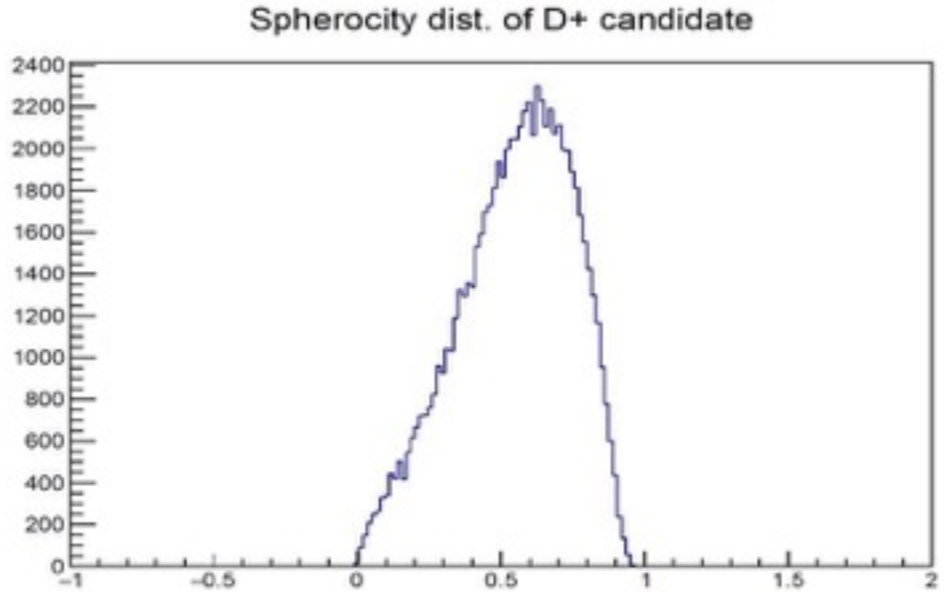
Data Sample

Data: 2010 (7 TeV pp collisions)
Reconstruction Pass: Pass4 (AOD)

No. of Events: 349 M

No. of events in So bins:

0.0-0.2: 34.95 M
0.2-0.4: 62.26 M
0.4-0.6: 71.56 M
0.6-0.8: 49.6 M
0.8-1.0: 7.35 M



Cuts Used:

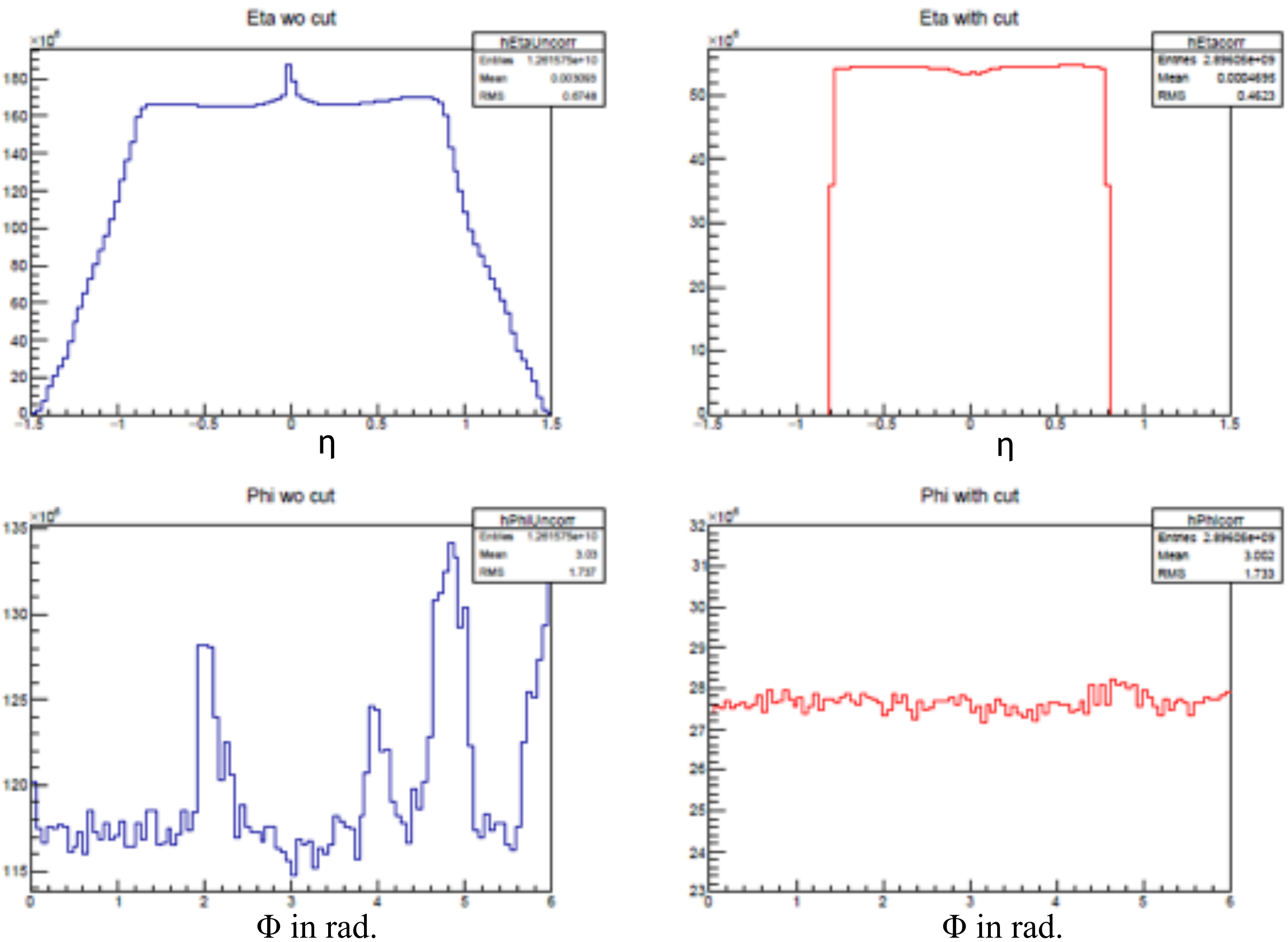
✓ Hybrid track cuts for S_o calculation.

✓ Only events which have no. of tracks passing these cuts >2 are selected.

✓ p_T<10 GeV, |η|<0.8

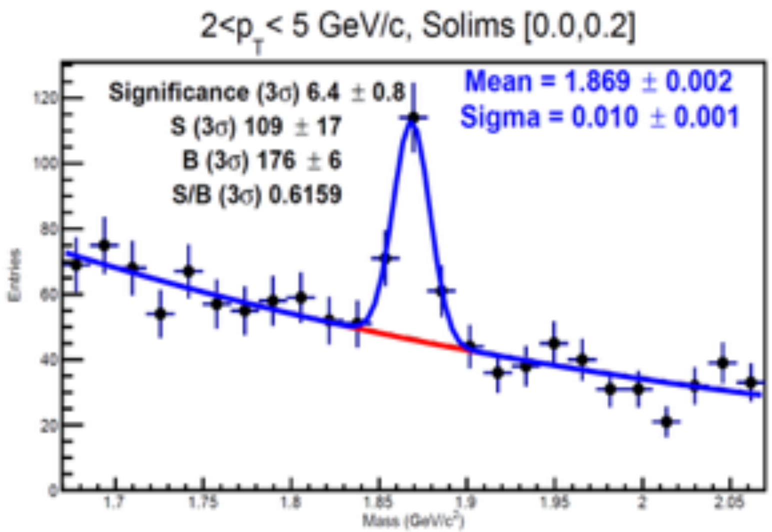
✓ For D^+ meson reconstruction, standard pp cuts(2010) are used.

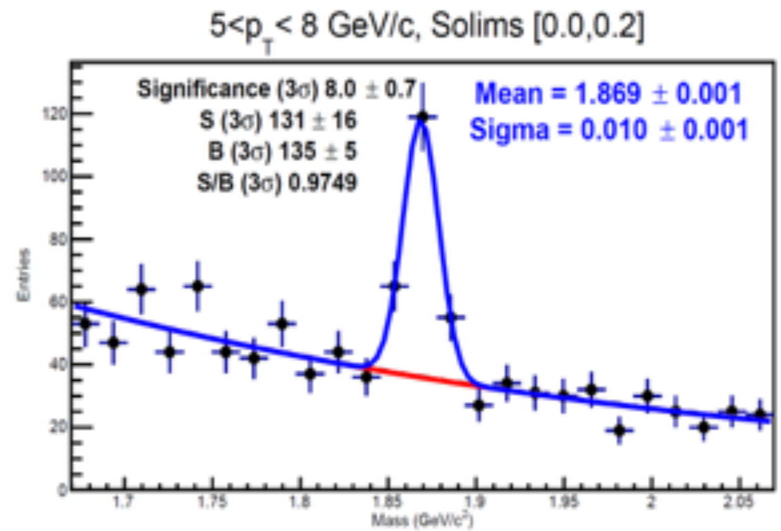
Eta and Phi distributions of tracklets

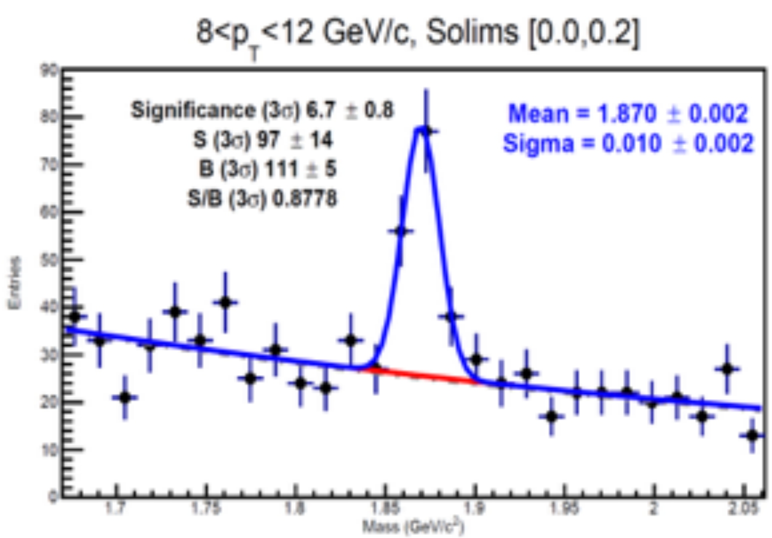


Phi distribution of tracklets smooth after applying hybrid cuts.

D^+ Yield in p_T bins (0.0<So<0.2)

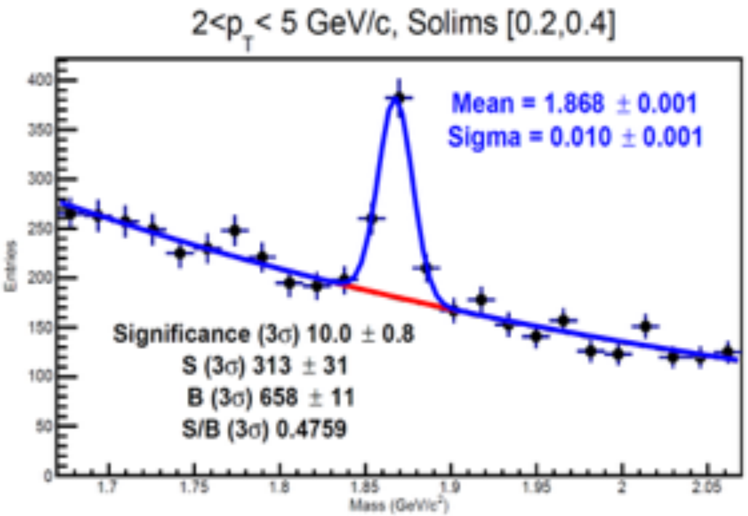


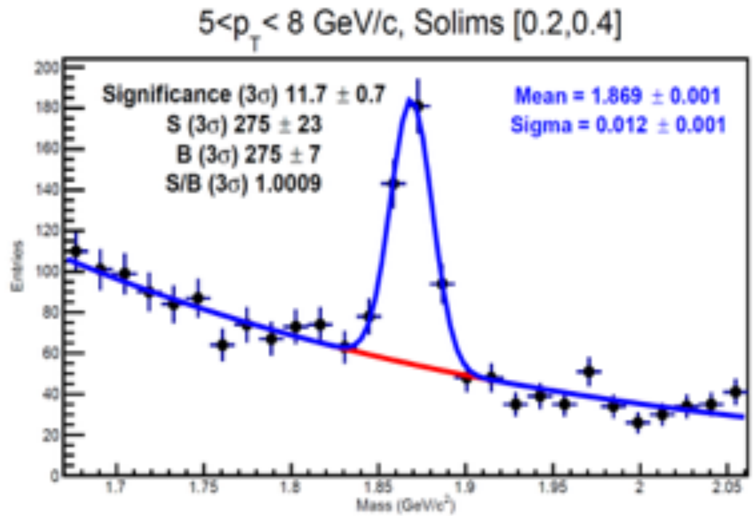


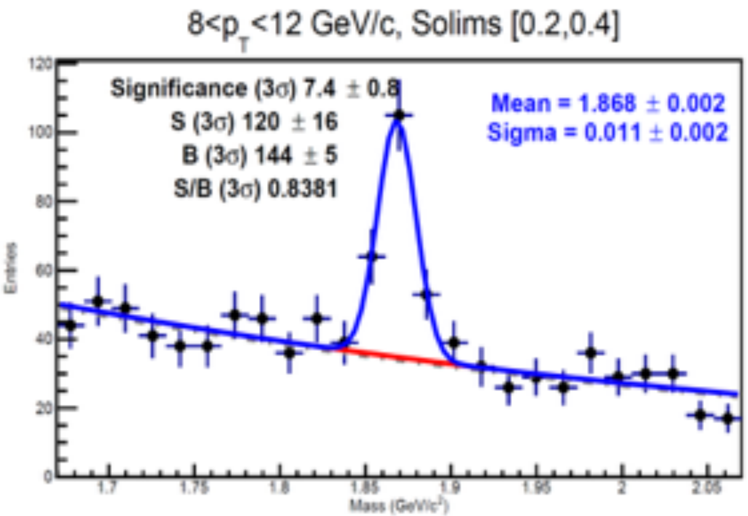


Fit Functions:
Exponential for Backgroung
Gaussian for Signal+Background

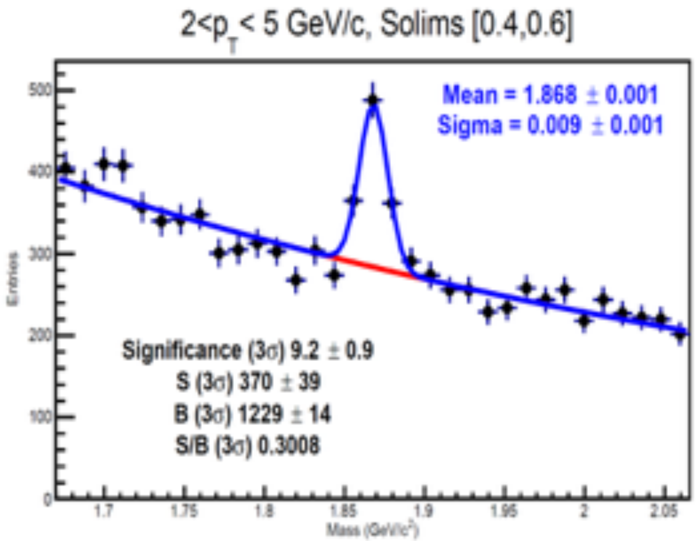
D^+ Yield in p_T bins (0.2<So<0.4)

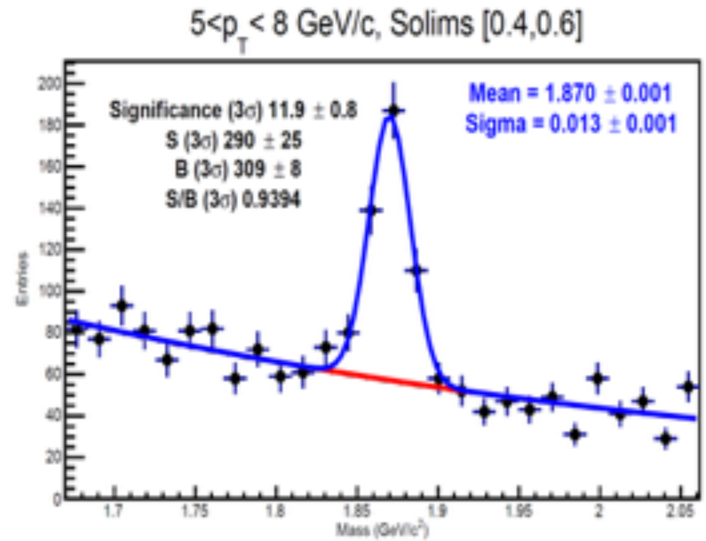


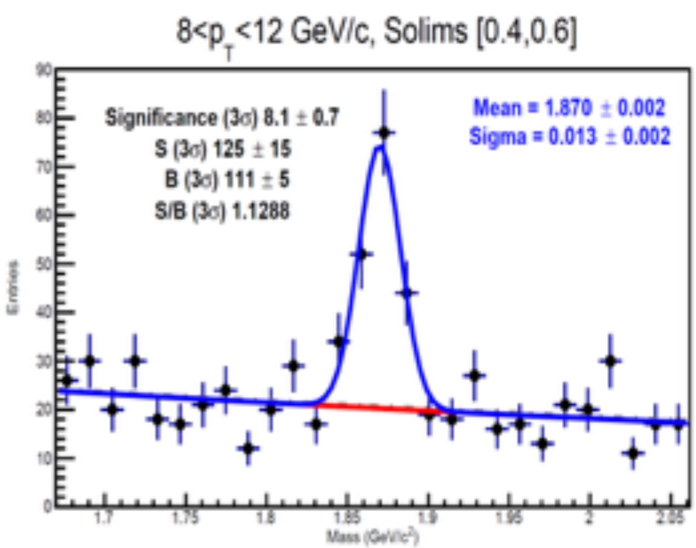




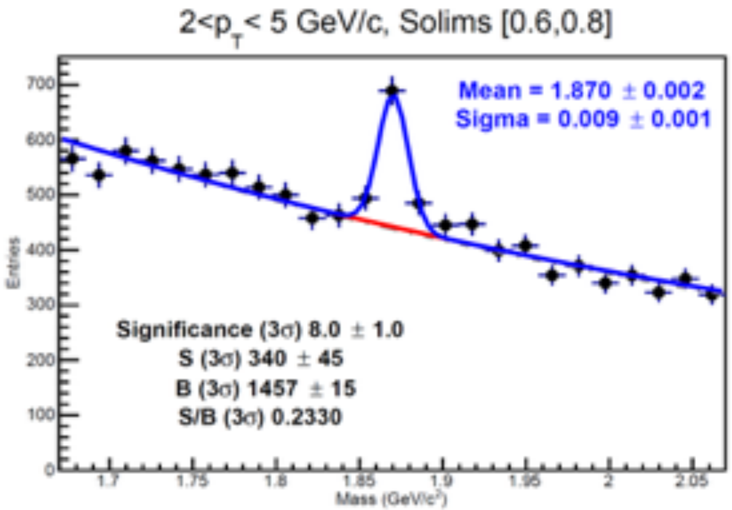
D^+ Yield in p_T bins (0.4<So<0.6)

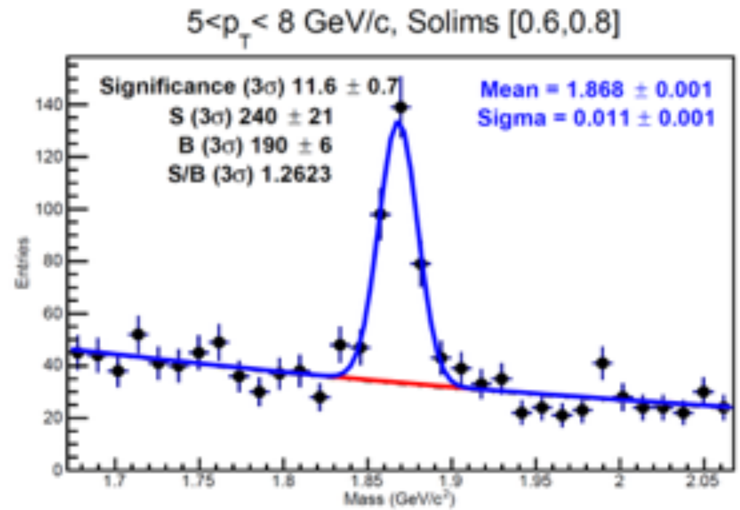


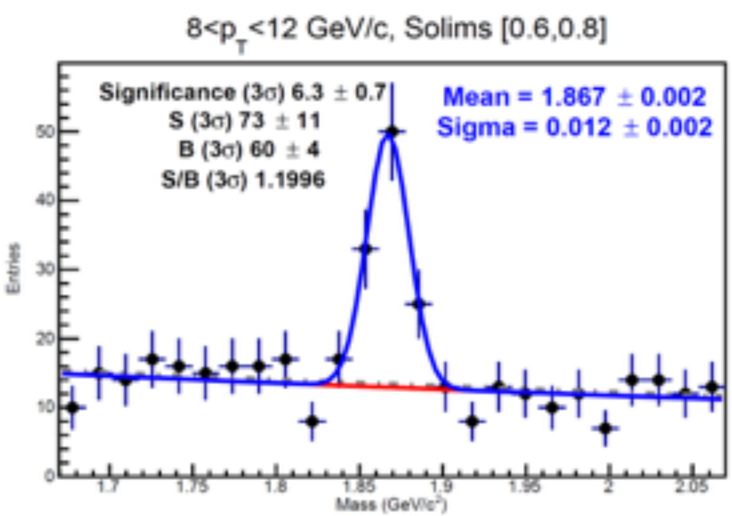




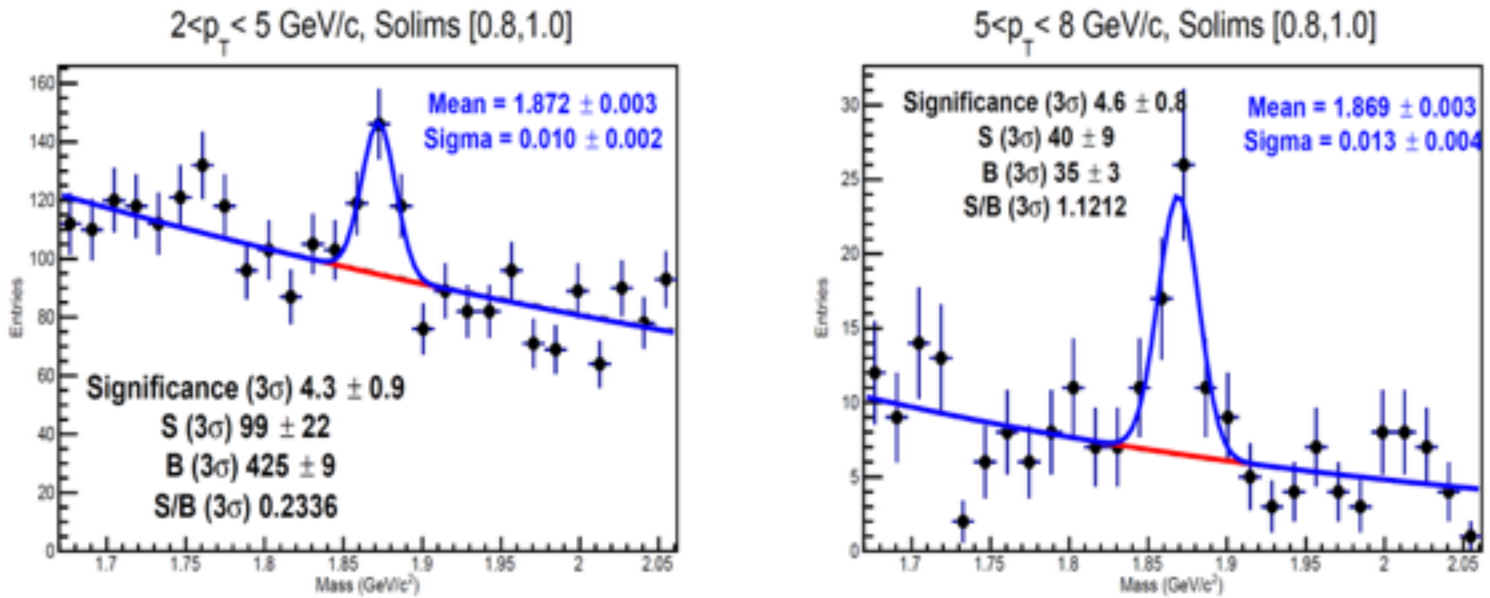
D^+ Yield in p_T bins (0.6<So<0.8)



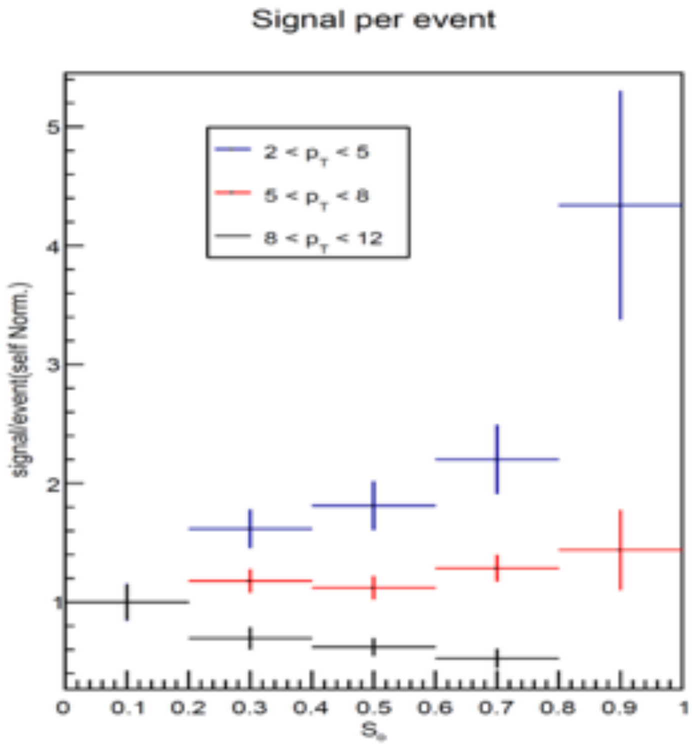


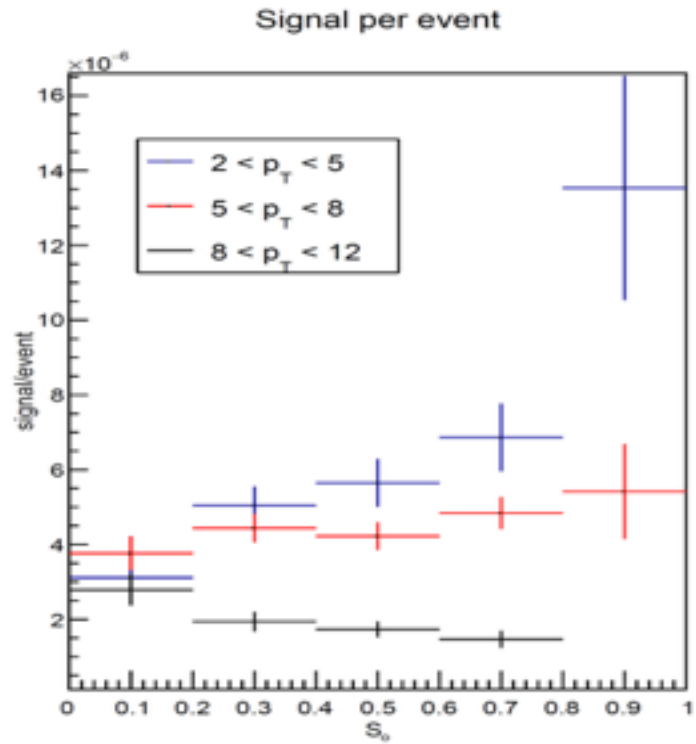


D^+ yield in p_T bins (0.8<So<1.0)



Signal/Event vs S_o

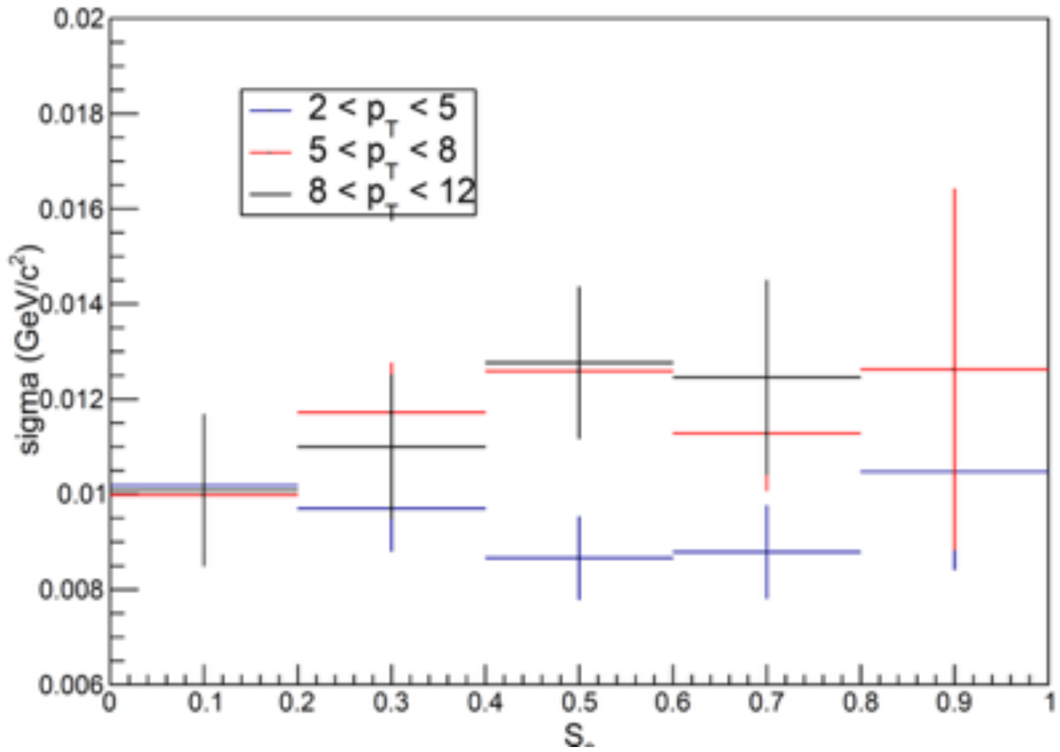




✓ In left plot, for a given multiplicity bin, yield in each S_o bin is self normalized (divided by first bin content) .

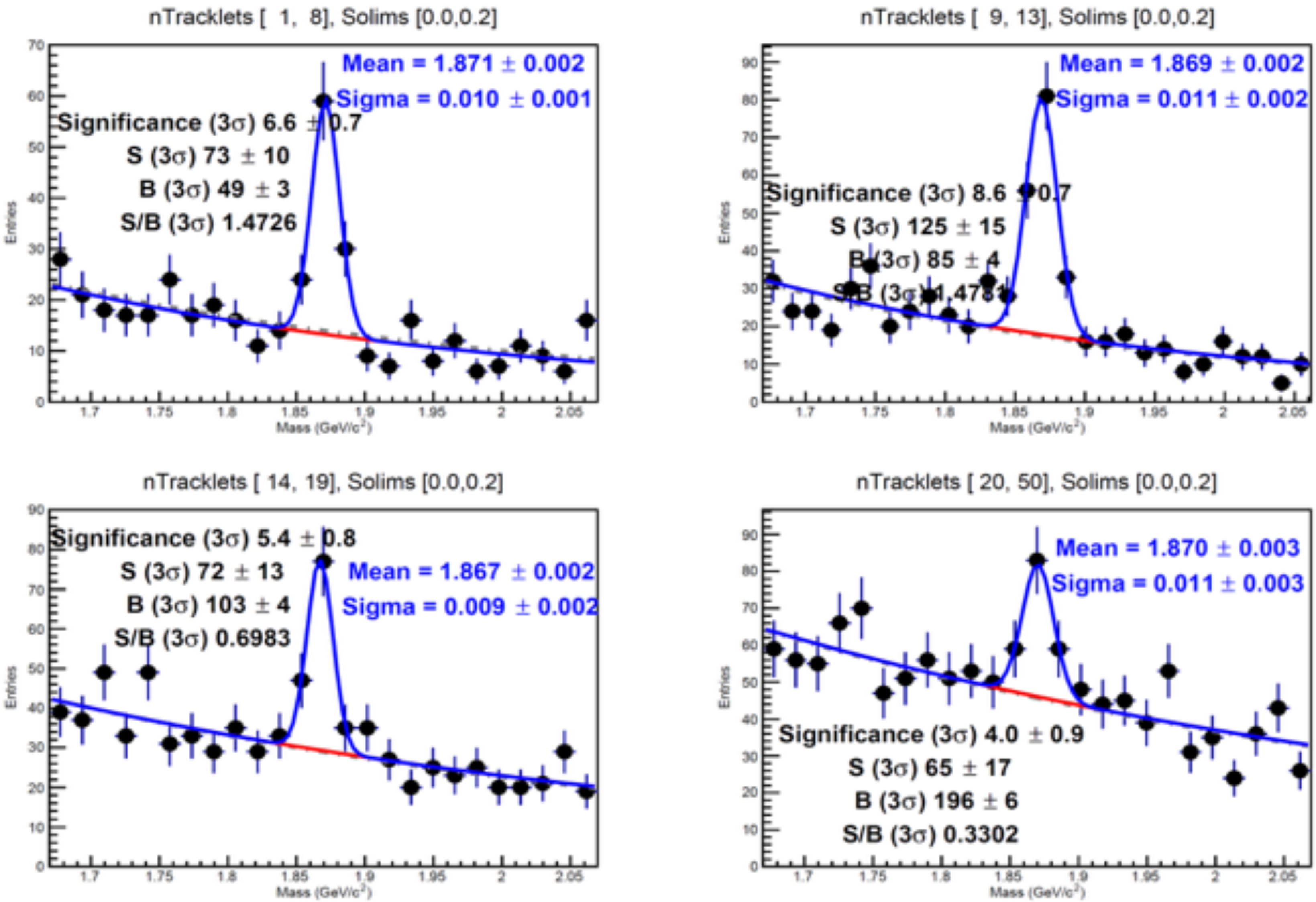
✓ Most contribution to D^+ comes from low p_T isotropic events.

D^+ mass peak width vs S_o

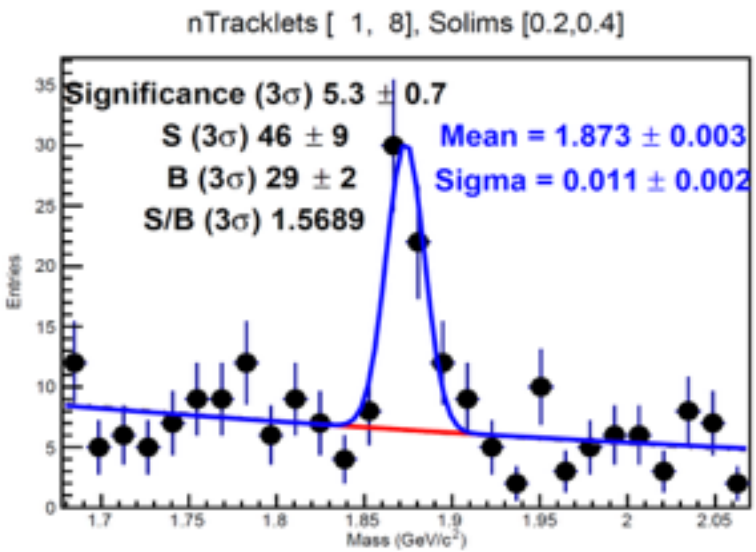


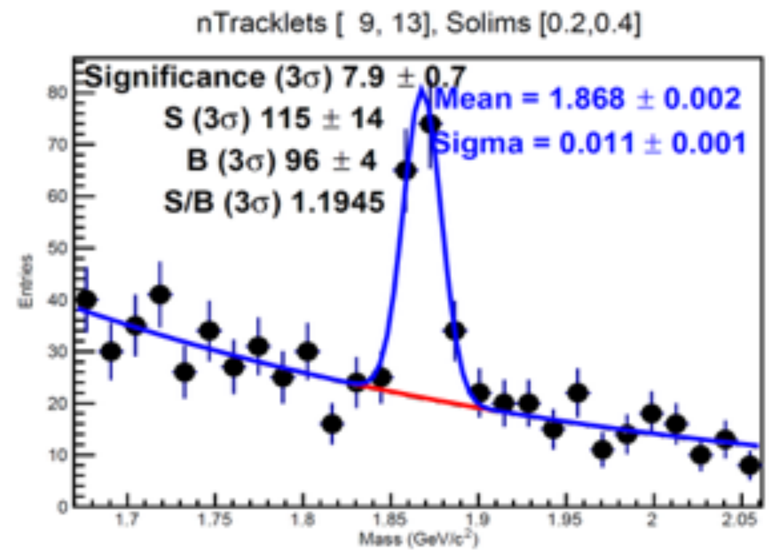
Width of the Invariant Mass Distribution vs. S_o is fluctuating

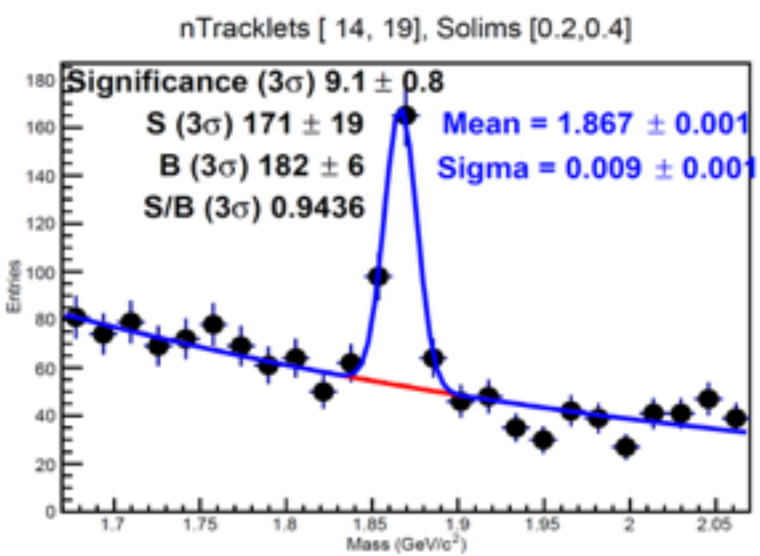
D^+ yield in multiplicity bins (0.0<So<0.2)

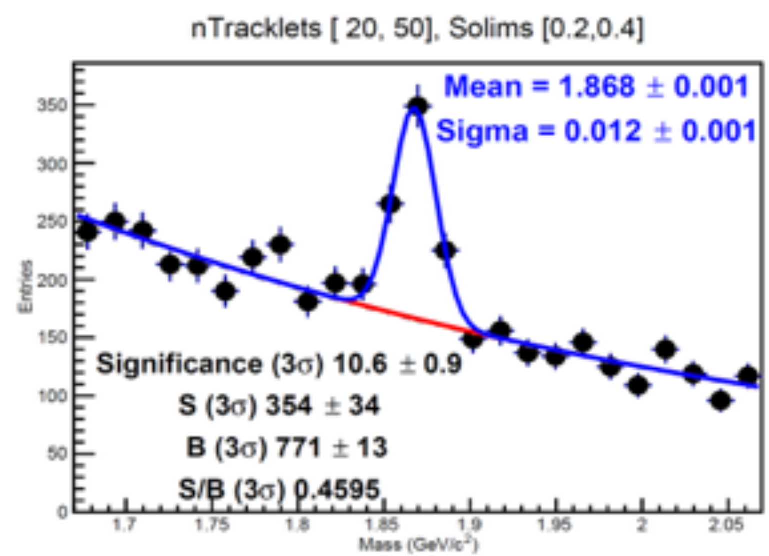


D^+ yield in multiplicity bins (0.2<So<0.4)

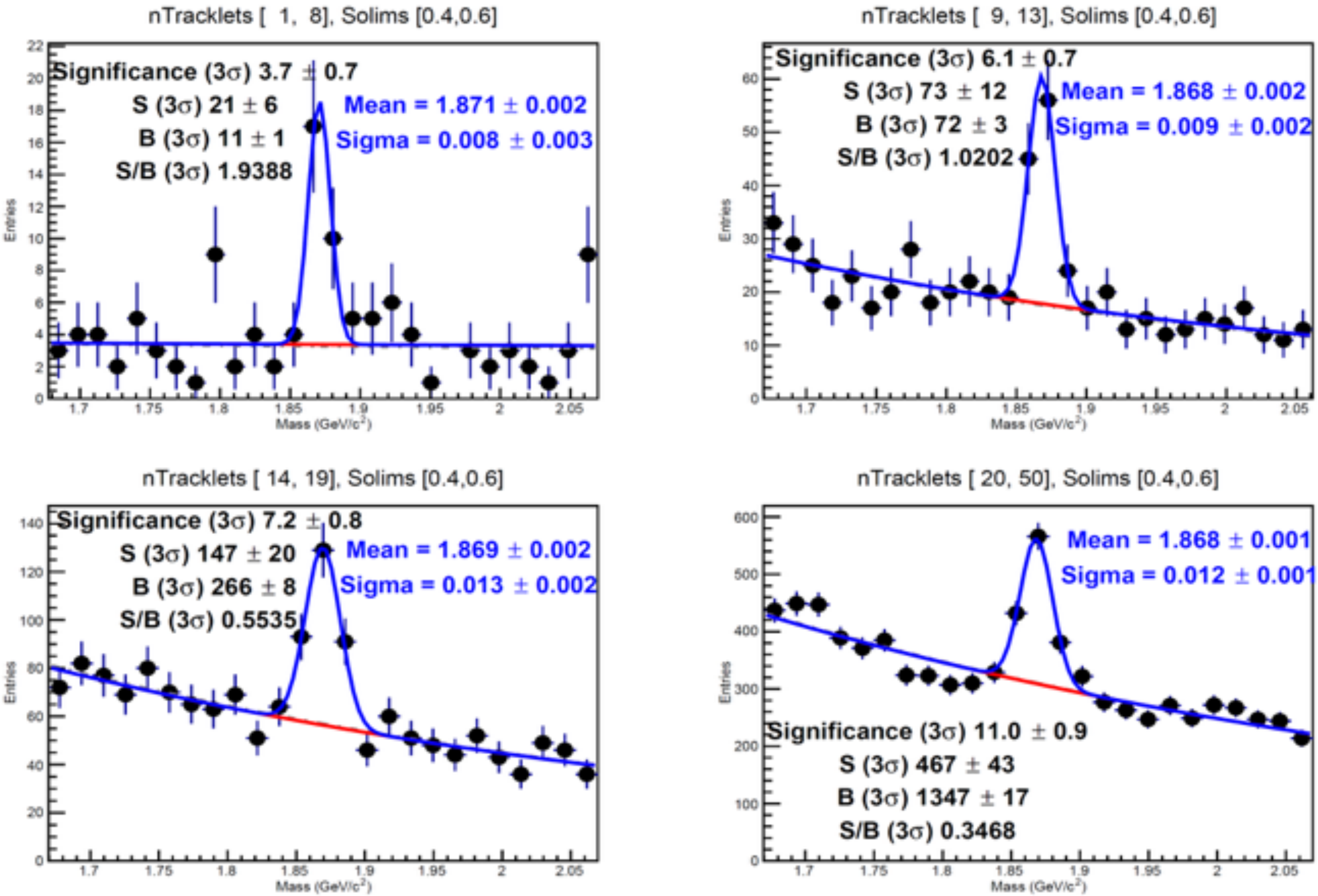




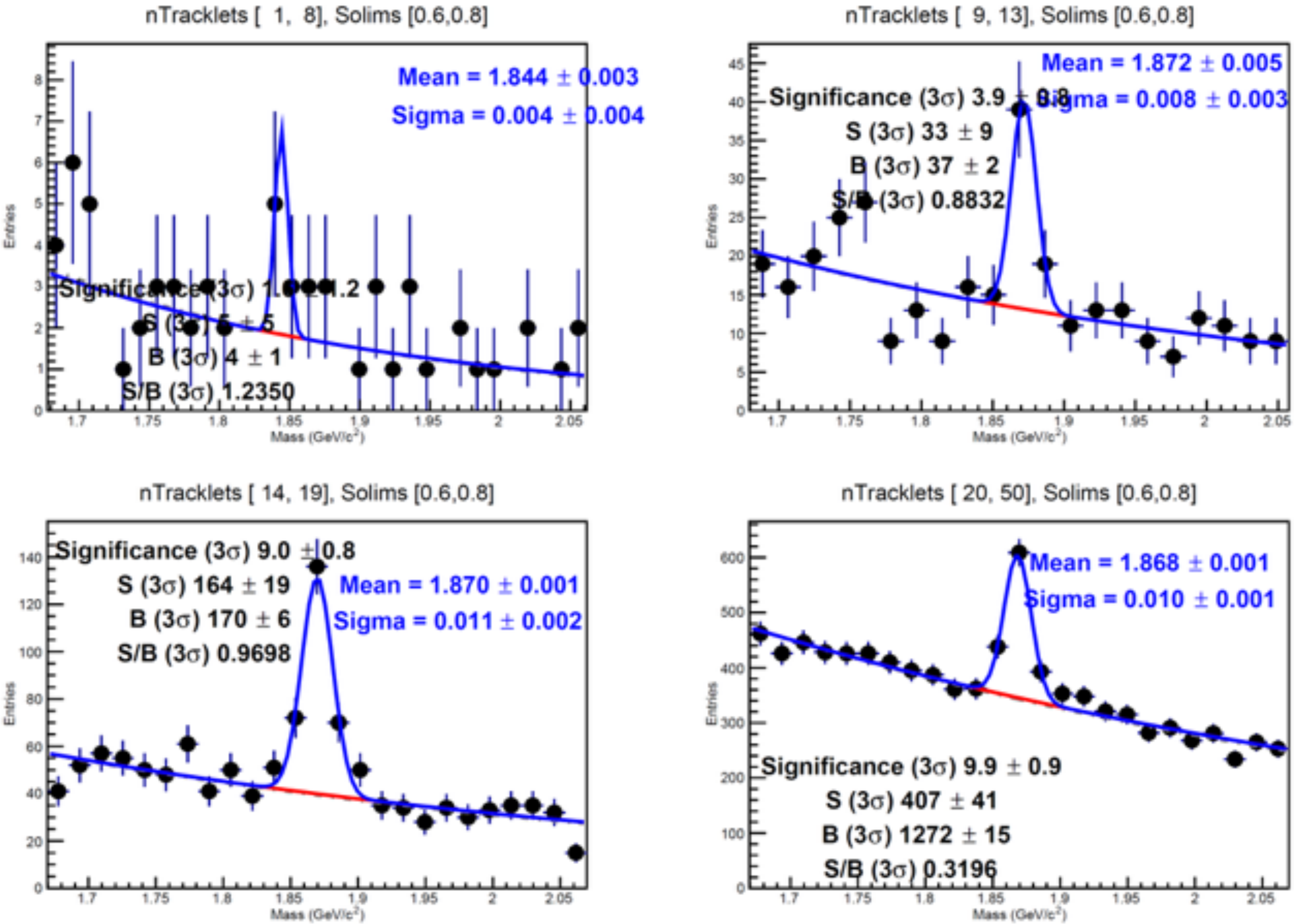




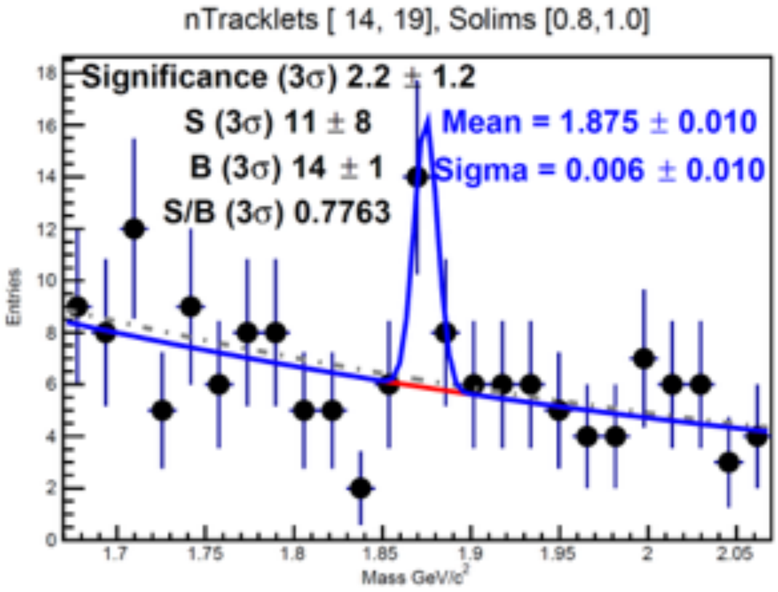
D^+ yield in multiplicity bins (0.4<So<0.6)

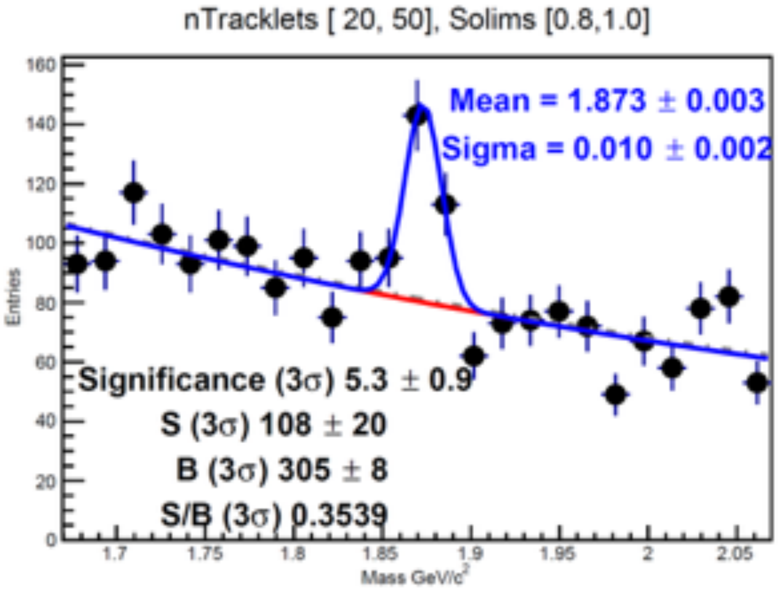


D^+ yield in multiplicity bins (0.6<So<0.8)

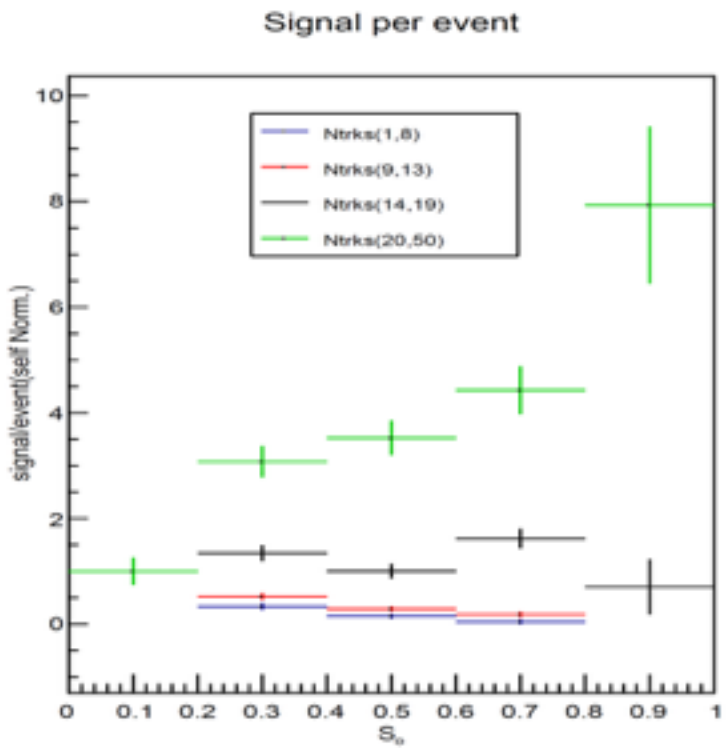


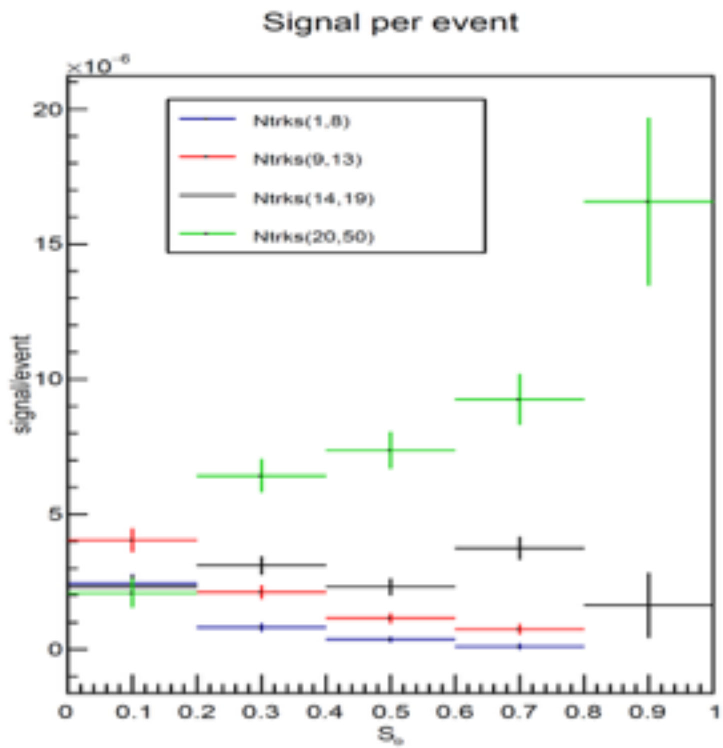
D^+ yield in multiplicity bins (0.8<So<1.0)





Signal/Event vs S_o





✓ In left plot, for a given multiplicity bin, yield in each S_o bin is self normalized (divided by first bin content) .

✓ Most contribution to D^+ comes from high multiplicity isotropic events.

Summary & OutLook

✓Analysed the pass4 (2010) pp data for D^+ meson reconstruction.

✓Good Signal/Background and Significance of the Invariant mass plots.

✓ D^+ meson yield calculated as a function p_T and multiplicity in various S_o bins.

Next to do:

✓Check the D^+ yield in $S_o(S_T)$, p_T and the multiplicity bins simultaneously.

✓Optimize the bins for further analysis.

✓To do the corrections to D^+ yield.

Thank You

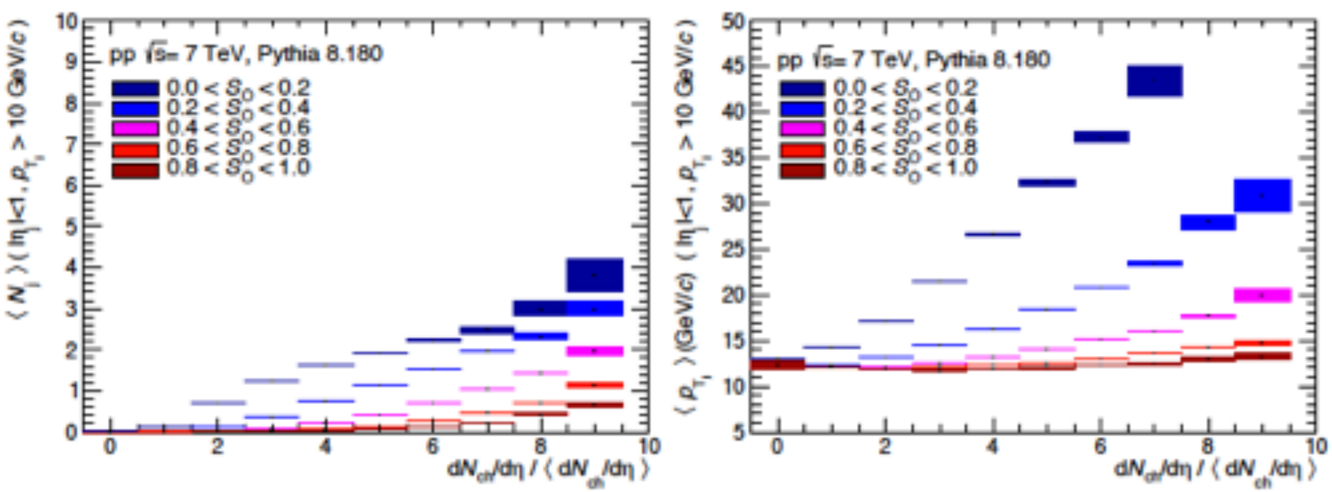
Back Up

Why event shapes?

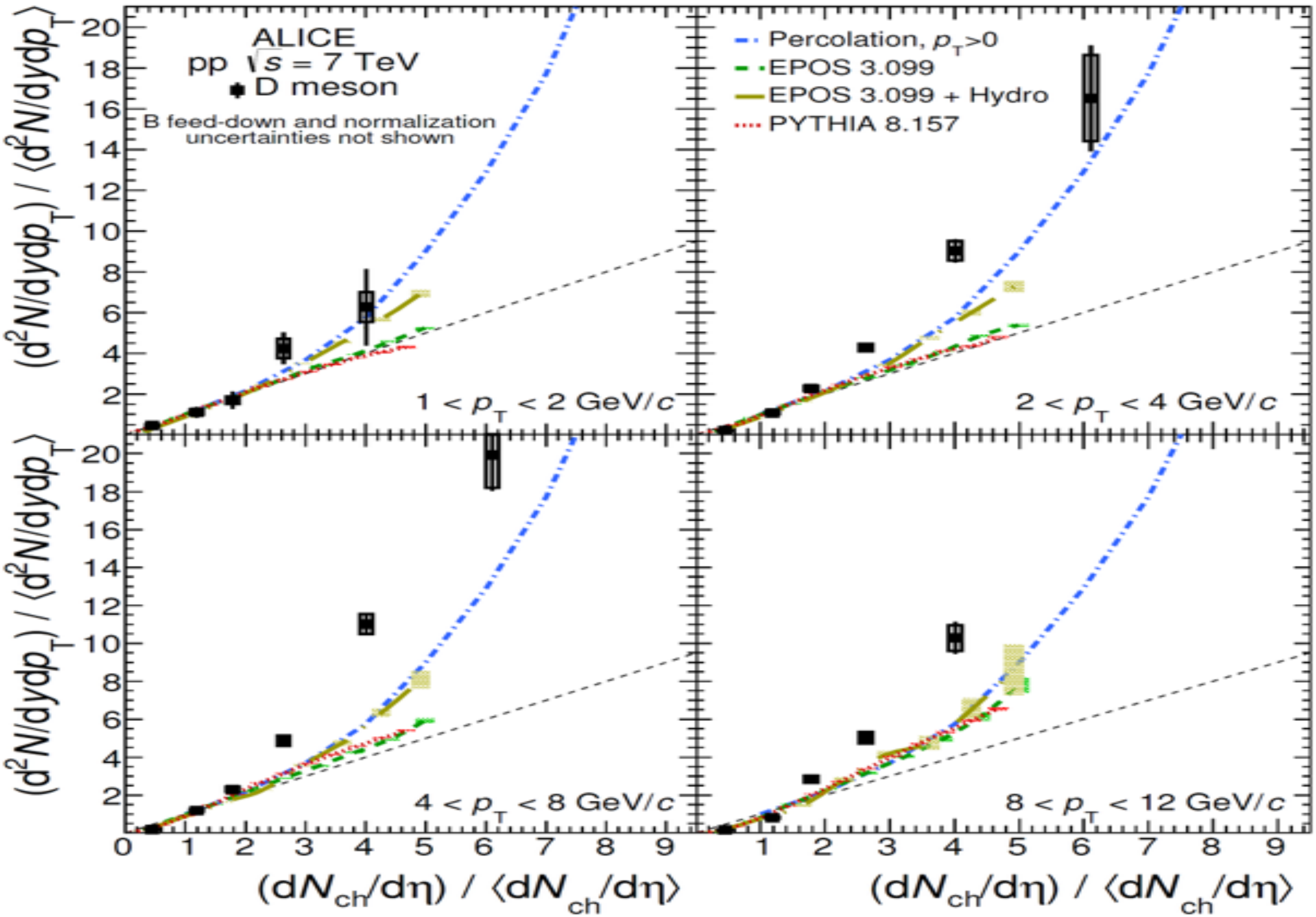
✓For isotropic events (S0 > 0.8), the average no. of jets is below 1 and jet production is largest for jettylike events ($S_0 < 0.2$) (left figure)

✓ Small fraction of jet shows flat trend close to 10 GeV for isotropic events (minimum jet p_T was set to 10 GeV/c). For jetty-like events, the average p_T is above 30 GeV/c (right figure)

✓Expect to observe the same trend for charged hadrons instead of jets.



Measurement of D mesons as a function of charged particle multiplicity



Cuts filter bits

Bit	Cuts	Methods
Bit 0 (001)	Standard cuts on primary tracks	GetStandardTPCOnlyTrackCuts() (*)
Bit 1 (002)	ITS stand-alone tracks(ESD Track Cuts)	SetRequireITSStandAlone(kTRUE)
Bit 2 (004)	Pixel OR (necessary for the electrons) AND Standard track cuts (SetFilterMask(1) of AliESDtrackCuts)	SetClusterRequirementITS(AliESDtrackCuts::kSPD, AliESDtrackCuts::kAny)
Bit 3 (008)	PID for the electrons AND Pixel Cuts (SetFilterMask(4) of AliESDpidCuts)	SetTPCnSigmaCut(AliPID::kElectron, 3.5)
Bit 4 (016)	Standard Cuts with very loose DCA	GetStandardITSTPCTrackCuts2011(kFALSE) SetMaxDCAToVertexXY(2.4) SetMaxDCAToVertexZ(3.2) SetDCaToVertex2D(kTRUE)
Bit 5 (032)	Standard Cuts with tight DCA cut	GetStandardITSTPCTrackCuts2011()
Bit 6 (064)	Standard Cuts with tight DCA but with requiring the first SDD cluster instead of an SPD cluster tracks selected by this cut are exclusive to those selected by the previous cut	GetStandardITSTPCTrackCuts2011() SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kNone) SetClusterRequirementITS(AliESDtrackCuts::kSDD,AliESDtrackCuts::kFirst)
Bit 7 (128)	TPC only tracks,constrained to SPD vertex in the filter	GetStandardTPCOnlyTrackCuts **esdfilter->SetTPCOnlyFilterMask(128)**
Bit 8 (256)	Extra cuts for Hybrids: - first the global tracks we want to take	AliESDtrackCuts::GetStandardITSTPCTrackCuts2011(kFALSE) SetMaxDCAToVertexXY(2.4) SetMaxDCAToVertexZ(3.2) SetDCAToVertex2D(kTRUE) SetMaxChi2TPCConstrainedGlobal(36) SetMaxFractionSharedTPCClusters(0.4) **esdfilter->SetHybridFilterMaskGlobalConstrainedGlobal((1<<8));** // these normal global tracks will be marked as hybrid
Bit 9 (512)	Than the complementary tracks which will be stored as global constraint, complement is done in the ESDFilter task	SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kOff) SetRequireITSRefit(kTRUE) **esdfilter->SetGlobalConstrainedFilterMask(1<<9);** // these tracks are written out as global constrained tracks esdfilter->SetWriteHybridGlobalConstrainedOnly(kTRUE); // write only the complement
Bit 10(1024)	Standard Cuts with tight DCA cut, using cluster cut instead of crossed rows	GetStandardITSTPCTrackCuts2011(kTRUE,0) (**)

Hybrid: Good global tracks if available, otherwise global constrained tracks.

Cuts for good global tracks:

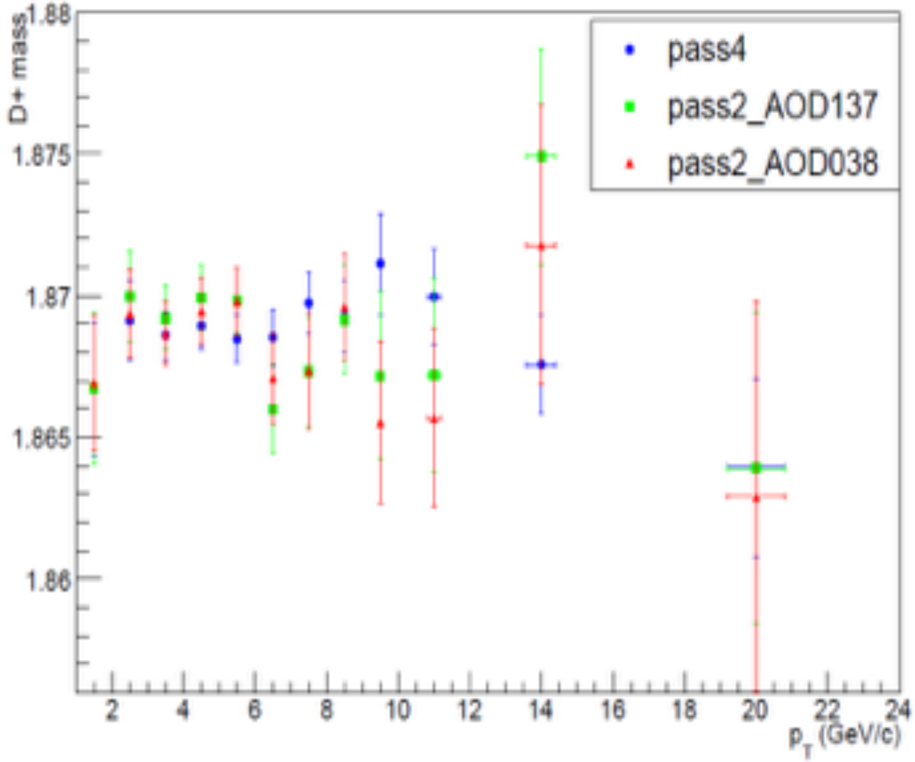
- pT dependent cut on # of TPC clusters in 1st it.
- χ^2 p/ TPC cluster in 1st it. < 4
- No kink daughters
- Require TPC refit
- Frac. of shared TPC clusters < 0.4
- Require ITS refit
- Chi2 per ITS cluster < 36
- $DCA_x y$ < 2.4cm
- DCA_z < 3.2cm
- At list one hit on SPD
- χ^2 between TPC constrained and global < 36

- **Cuts for global constrained tracks:**
  - Same cuts as for the good global tracks shown above except no ITS refit or SPD hits requirement
  - Constrained to primary vertex to improve pT resolution

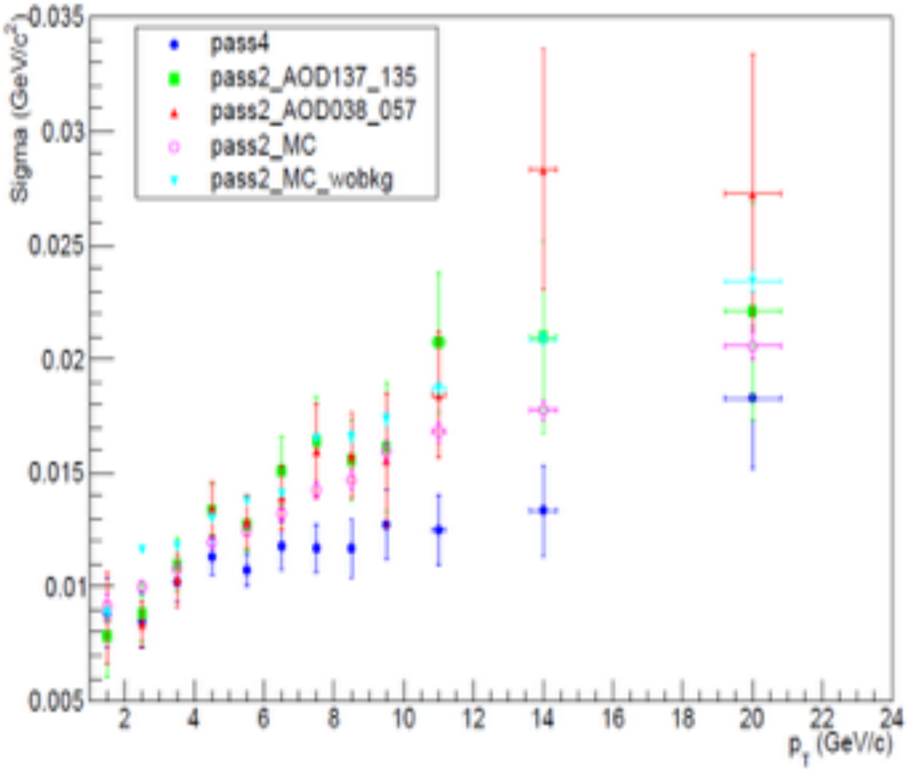
Good track pT resolution, uniform phi distribution, but track quality is mixed.

Pass2-Pass4 comparison

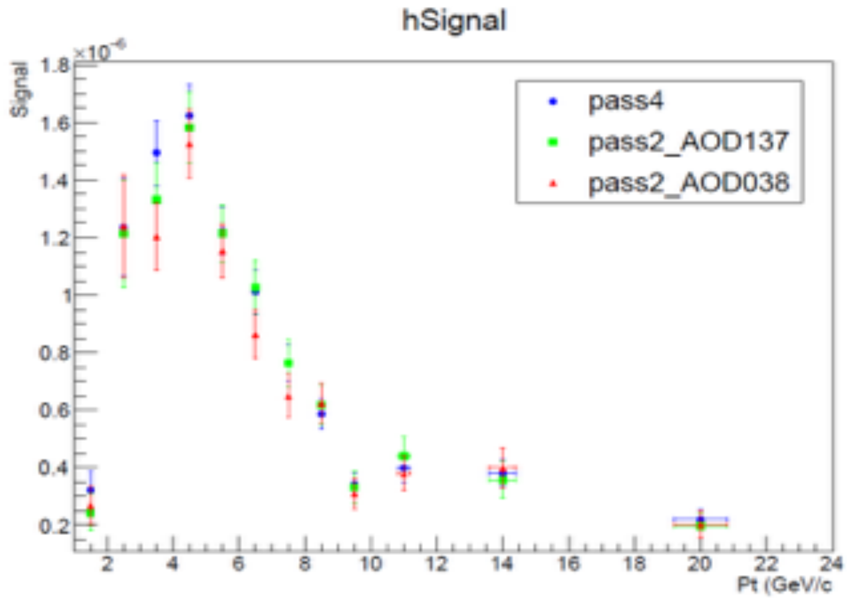
D^+ mass peak



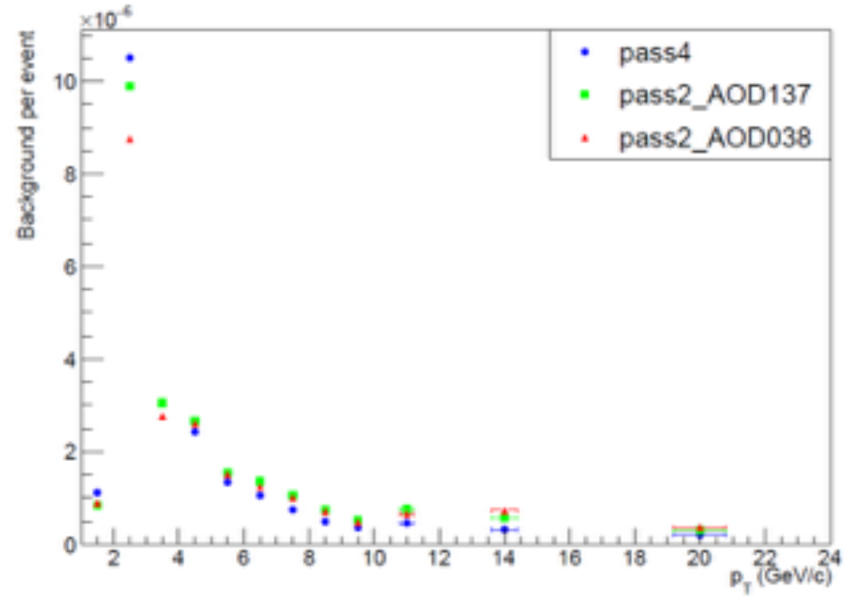
D^+ peak width



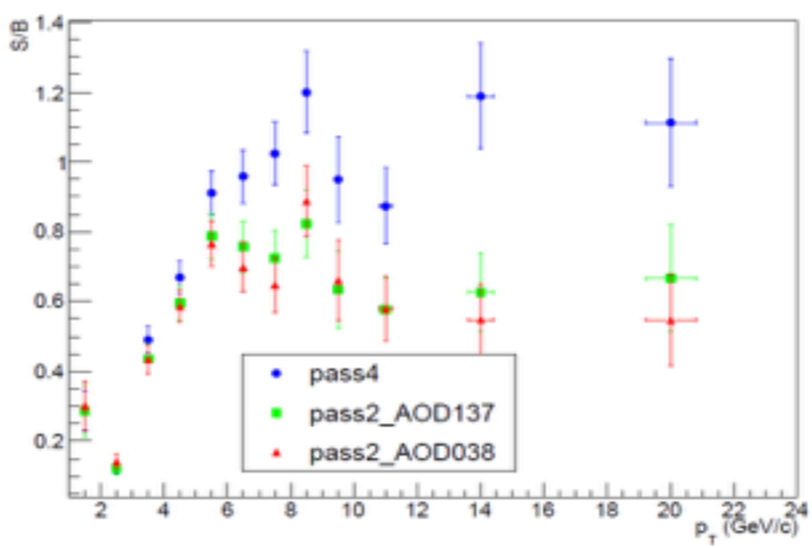
Signal/Event



Background/Event



Signal/Background



Significance