Measurement of charm production cross section in pp collisions at $\sqrt{s}$ = 2.76 TeV

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Outline

- Motivation
- Data Sample Used
- Analysis Strategy
- Plots
- Summary

Motivation

- ✓ Due to their large mass heavy (charm & beauty) quarks are mainly produced at the very beginning of the collision in the scatterings between the partons of the colliding nucleons that are enough energetic to create a pair of heavy partons. The produced heavy quarks travel through the medium experiencing all the stages of the medium evolution and finally hadronize inside or outside the fireball.

- ✓ Time scale for a $c\bar{c}$ pair production is ~ 0.1 fm/c, which is much smaller than the expected lifetime of the Quark Gluon Plasma ~ 10 fm/c. Thus, heavy quarks are expected to provide information about the hottest initial phase.

- ✓ Measurement of D mesons can be used to extract the charm production cross section.

- ✓ Measurement of charm production cross section in **pp** is also an essential requirements in order to have a baseline to perform measurement in **Pb-Pb**.

Data Sample Used

Data

- LHC11a
  - pass3_withoutSDD/AOD067

For MC

- LHC11b10b
  - AOD046
- LHC10f6a
  - AOD041
- LHC10d4
  - AOD056

Analysis Strategy

- ✓ Open heavy-flavours are studied at ALICE in the mid-rapidity region through hadronic decay channels. Open charm particles studied at ALICE: **D^+**, **D^0**, **D^***, and **D_s**.

- ✓ For the reconstructed candidates the invariant mass distribution is built and then fitted in the region of the hadron mass value to extract the yields of signal and background.

- ✓ The invariant mass of each candidate is calculated using the following formula (in natural units):

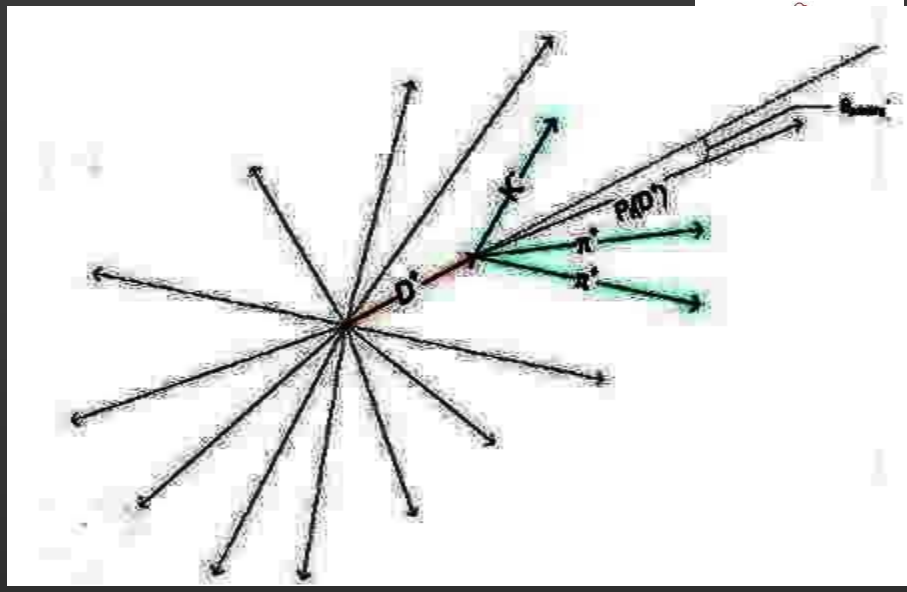
$$M^2 = (\sum_i E_i)^2 - \|\sum_i \vec{p}_i\|^2$$

- ✓ To improve the fit results & **to maximize the statistical significance**, the candidates must pass several analysis cuts.

Cut variables

Cos(Θ_{point})

Θ_{point} is pointing angle b/w the direction of the reconstructed D meson momentum and the line connecting the primary and secondary vertices.

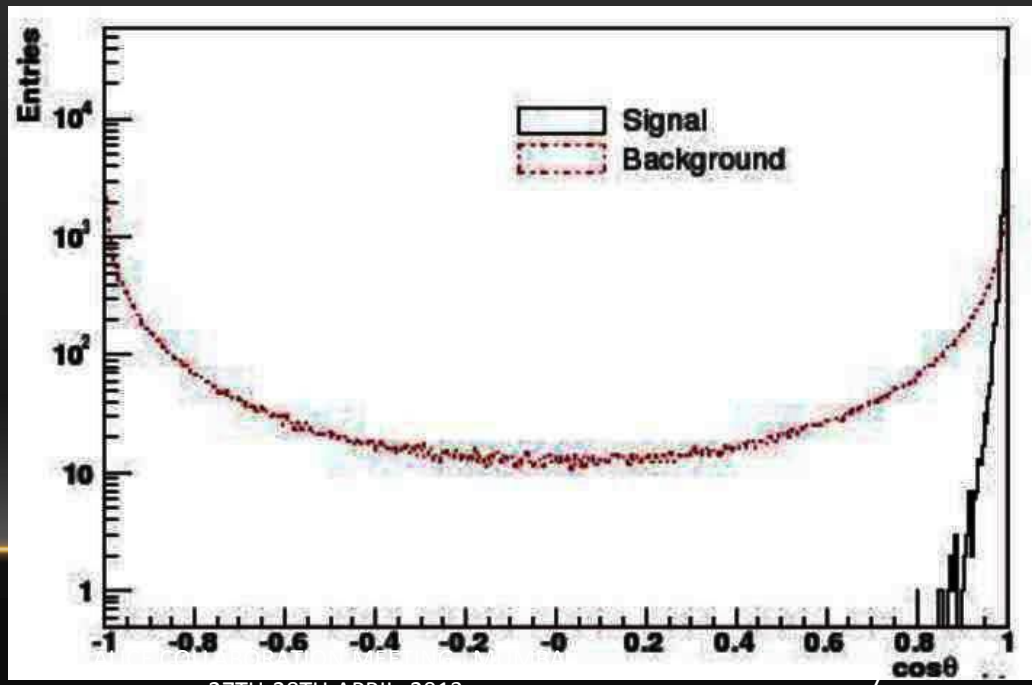


If the found vertex really corresponds to a D-meson decay vertex, then

$\Theta_{point} \sim 0$ and

$\cos(\Theta_{point}) \sim 1$

as shown in the fig.



Sum of the squares of the three impact parameters with respect to the primary vertex given as;

$$Sumd_o^2 = \sum_{i=1,2,3} d_{0,i}^2 = d_{0,K}^2 + d_{0,\pi}^2 + d_{0,\pi}^2$$

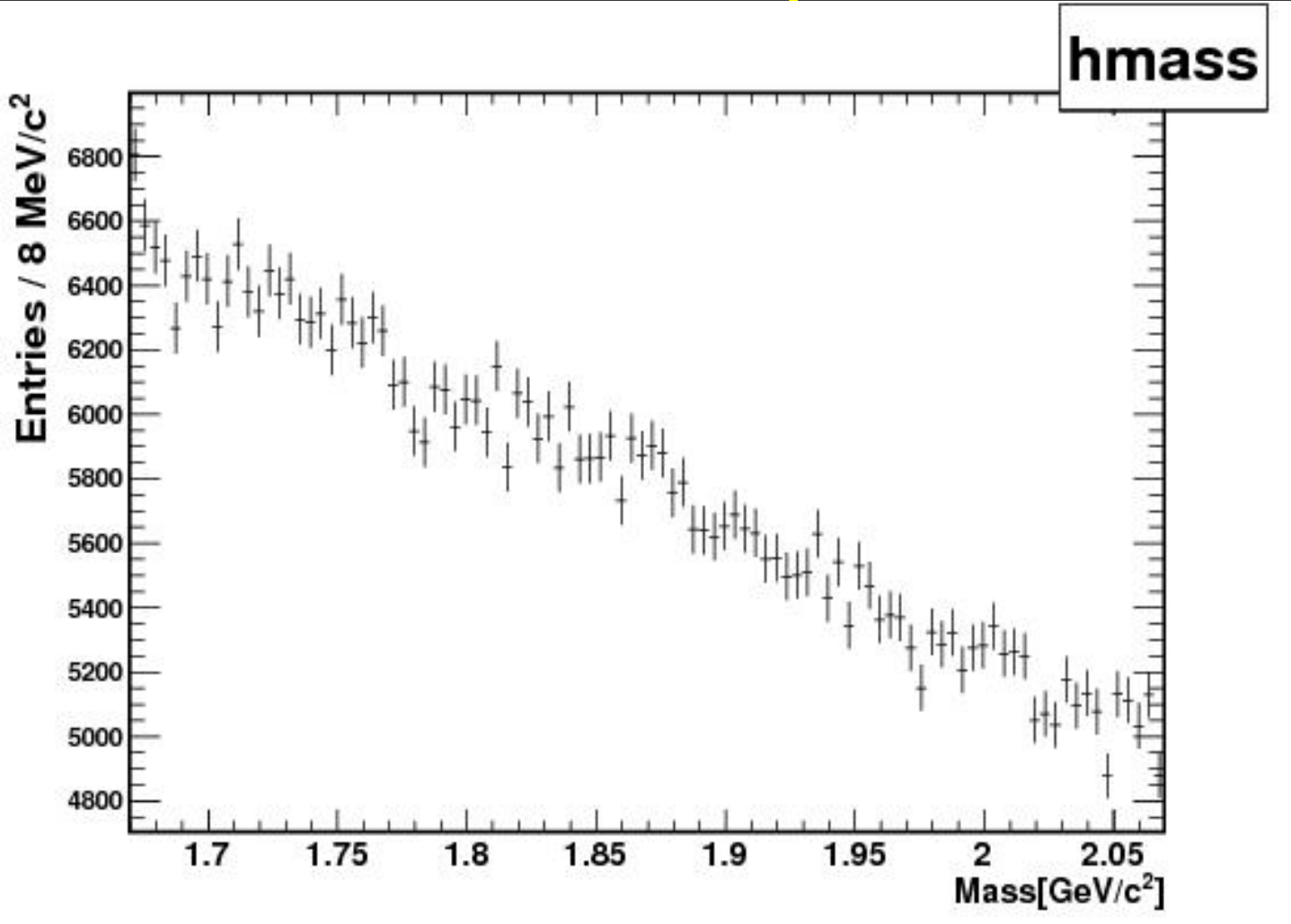
where $d_{0,i}$ is the distance of closest approach of the track to the primary vertex in the transverse plane .

- Quality of the found secondary vertex is defined as:

$$\sigma_{SecVert}^2 = d_1^2 + d_2^2 + d_3^2$$

- Transverse momentum, $p_T > p_{Tcut}$ & p_{Tcut}=0.3Gev/c

Invariant Mass Spectrum



Invariant mass spectrum for $D^+ \longrightarrow K^-\pi^+\pi^+$ decay without cuts achieved from Monte Carlo sample of 60 millions minimum bias *p-p* events

Invariant Mass Spectrum

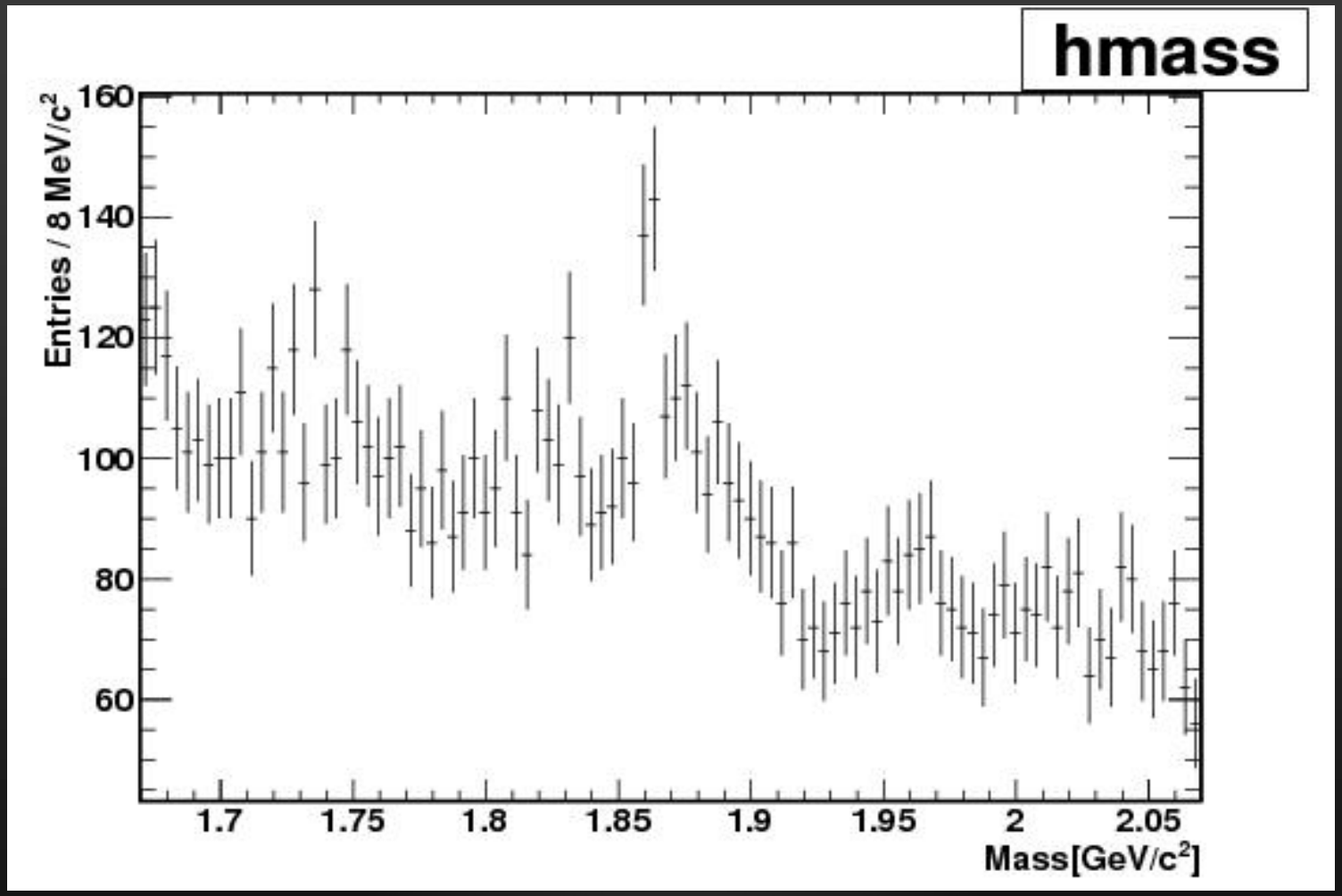


Fig3: Invariant mass spectrum for $D^+ \longrightarrow K^-\pi^+\pi^+$ decay with cuts achieved from Monte Carlo sample of 60 millions minimum bias *p-p* events

The Production Cross-Section of Prompt Charmed Mesons is calculated as (e.g. for D^+)

$$\left.\frac{d\sigma^{D^+}}{dp_t}\right|_{|y|<0.5} = \frac{1}{2}\frac{1}{\Delta y \Delta p_t}\frac{\left. f_{\text{prompt}}(p_t)\cdot N^{D^\pm \text{ raw}}(p_t)\right|_{|y|<y_{\text{fid}}(p_t)}}{(\text{Acc}\times\varepsilon)_{\text{prompt}}(p_t)\cdot \text{BR}\cdot \mathcal{L}_{\text{int}}}.$$

$\Delta y = 2y_{\text{fid}}$ — the fiducial acceptance

$(\text{Acc}\times\varepsilon)_{\text{prompt}}(p_t)$ — Experimental acceptance & reconstruction efficiency

$\mathcal{L}_{\text{int}}$ — Luminosity = 1.1nb^{-1}

$f_{\text{prompt}}(p_t)$ — Prompt fraction

$N^{D^\pm \text{ raw}}(p_t)$ — Raw yield

BR — Branching ratio

For Cut 1

Cut variables	Ptbins								
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-12
Inv.mass(GeV/c^2)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ptK(GeV/c^2)	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	
ptPi(GeV/c)	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
d0K(cm)	0	0	0	0	0	0	0	0	0
doPi(cm)	0	0	0	0	0	0	0	0	0
dist12(cm)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sigma vertex(cm)	0.0221	0.0221	0.034	0.0207	0.0233	0.0233	0.0233	0.0233	0.04
dist prim-sec	0.08	0.08	0.09	0.095	0.095	0.115	0.115	0.115	0.09
PMax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
costheata	0.95	0.95	0.95	0.92	0.92	0.90	0.90	0.90	0.87
Sumdo^2(cm^2)	0.0055	0.0055	0.0028	0.00088	0.00088	0.00088	0.00088	0.00088	0.0003
Dca cut(cm)	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10
declenXY(cm)	0	0	0	0	0	0	0	0	0
costhetapointXY	0	0	0	0	0	0	0	0	0

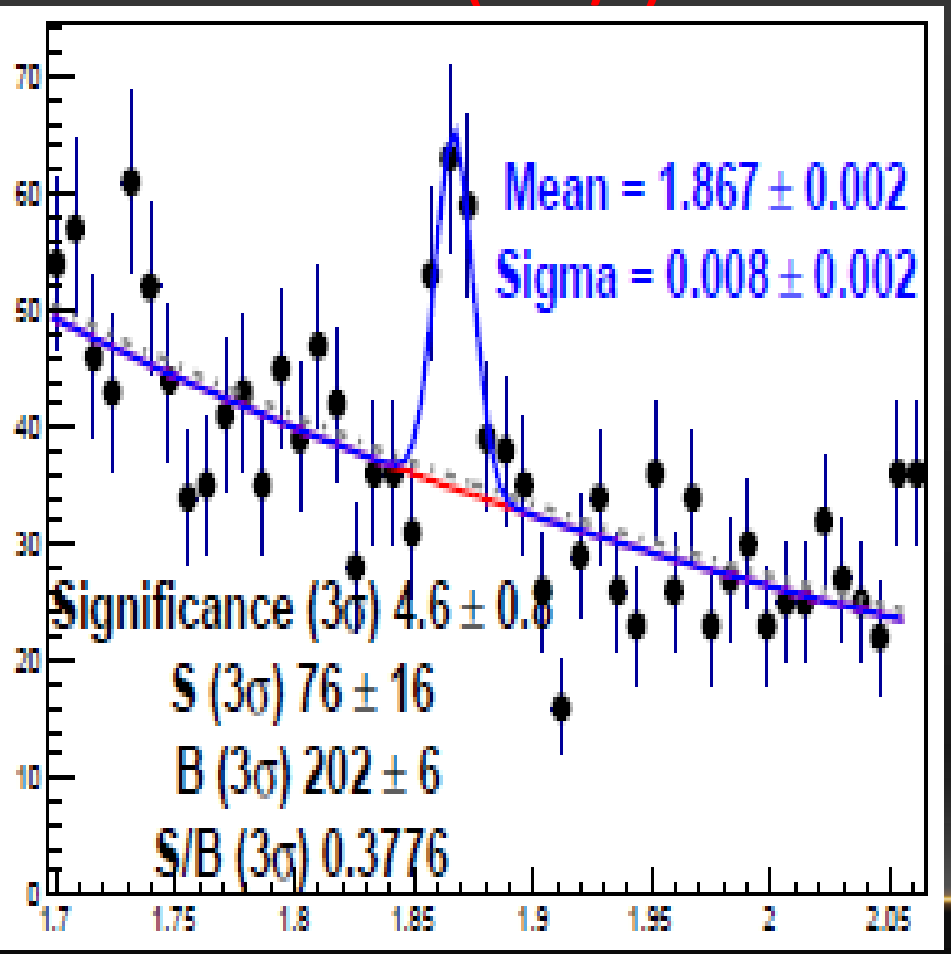
Table: cut values used for set1

Invariant Mass Spectrum OF D^+

Number of events=58.74M

2<PT<4(G

GeV/c)



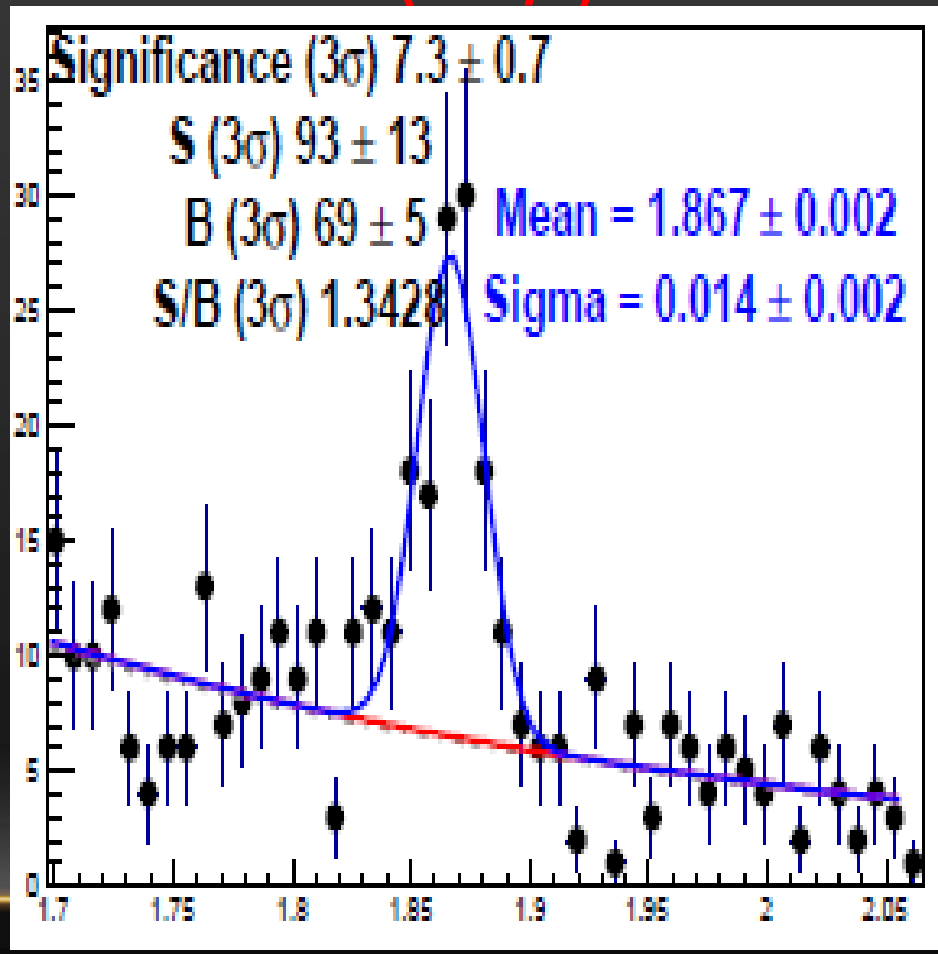
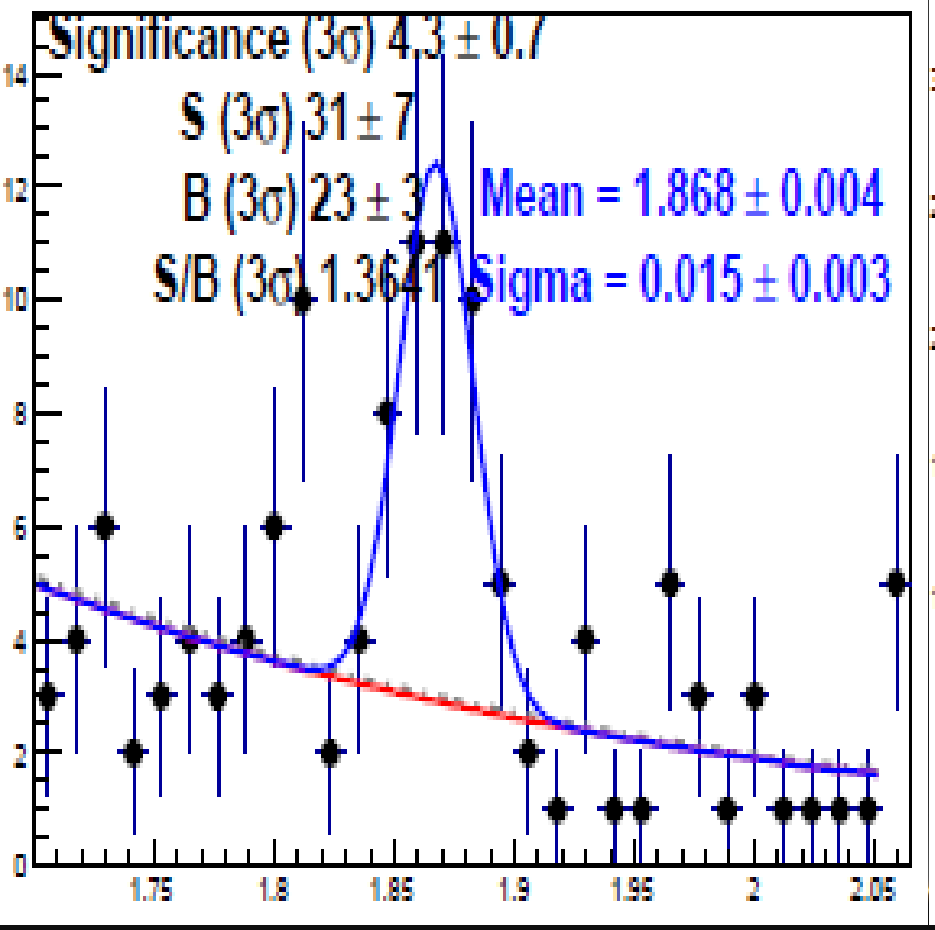


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis

Invariant Mass Spectrum of D^+

6<PT<8 (GeV/c)



8<PT<12(GeV/c)

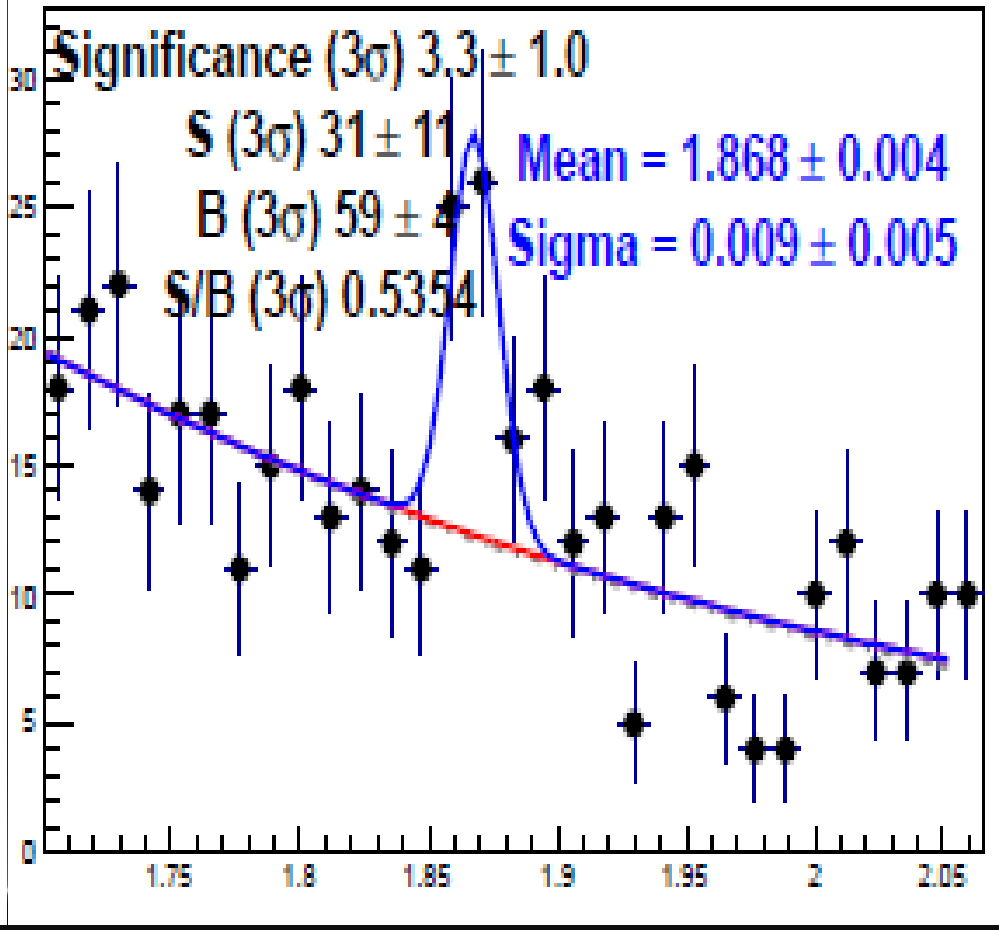
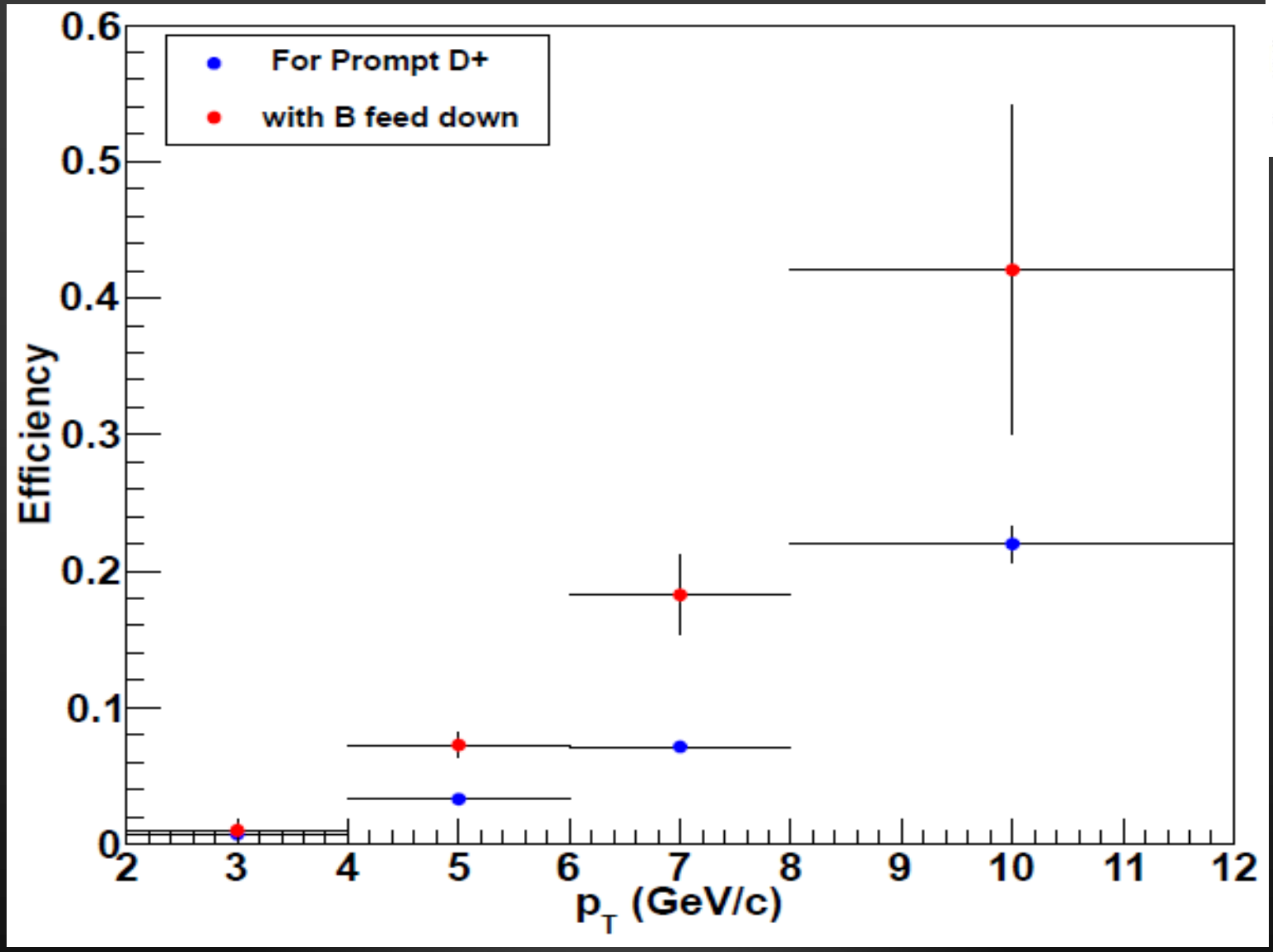


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis



Efficiency vs P_T

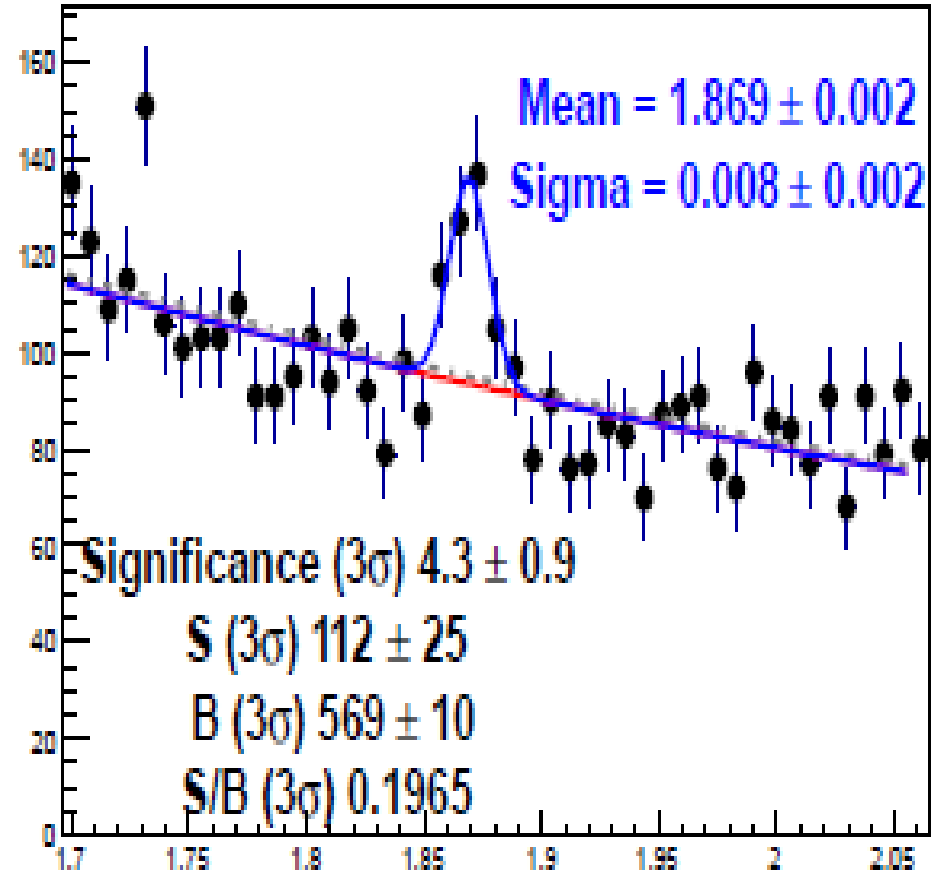
For Cut 2

Cut variables	Ptbins								
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-12
Inv.mass(GeV/c^2)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ptK(GeV/c^2)	0.38	0.38	0.4	0.32	0.3	0.3	0.3	0.3	
ptPi(GeV/c)	0.38	0.38	0.4	0.32	0.3	0.3	0.3	0.3	0.3
d0K(cm)	0	0	0	0	0	0	0	0	0
doPi(cm)	0	0	0	0	0	0	0	0	0
dist12(cm)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sigma vertex(cm)	0.03	0.03	0.038	0.0321	0.034	0.034	0.031	0.031	0.045
dist prim-sec	0.08	0.08	0.09	0.095	0.095	0.115	0.115	0.115	0.09
PMax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
costheata	0.96	0.96	0.95	0.93	0.92	0.92	0.91	0.91	0.87
Sumdo^2(cm^2)	0.0055	0.0055	0.0028	0.00088	0.00088	0.00088	0.00088	0.00088	0.0003
Dca cut(cm)	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10
declenXY(cm)	0	0	0	0	0	0	0	0	0
costhetapointXY	0	0	0	0	0	0	0	0	0

Table:1 cut values used for set2

Invariant Mass Spectrum OF D^+

2<PT<4(GeV/c)



4<PT<6(GeV/c)

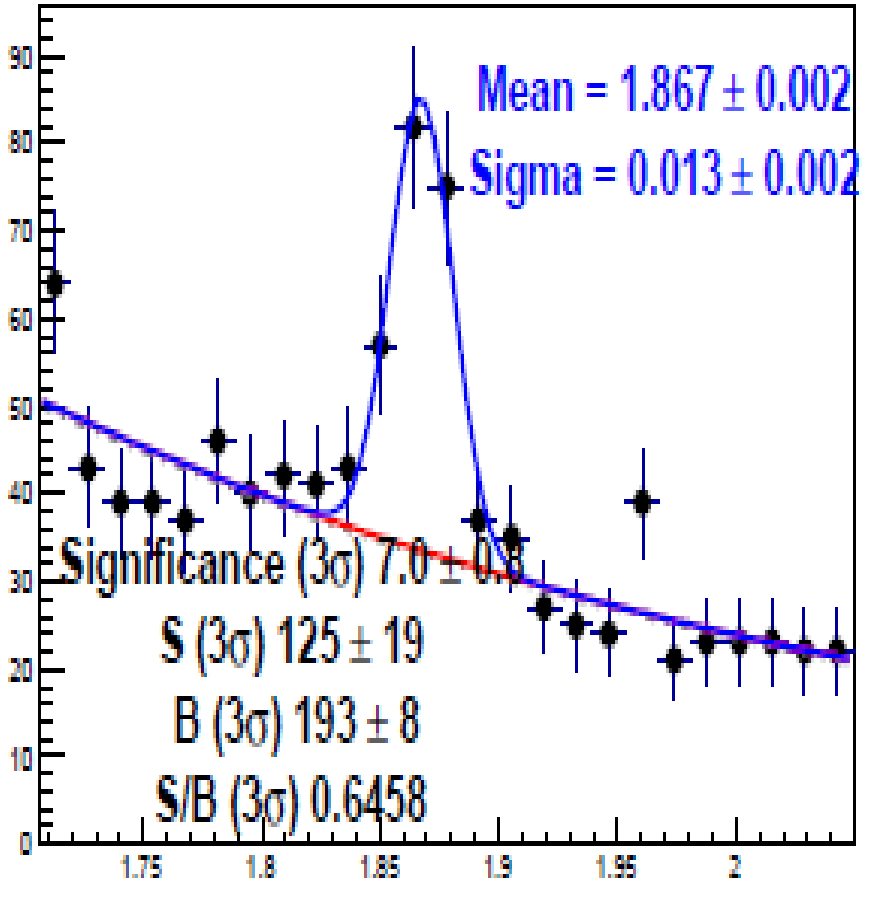
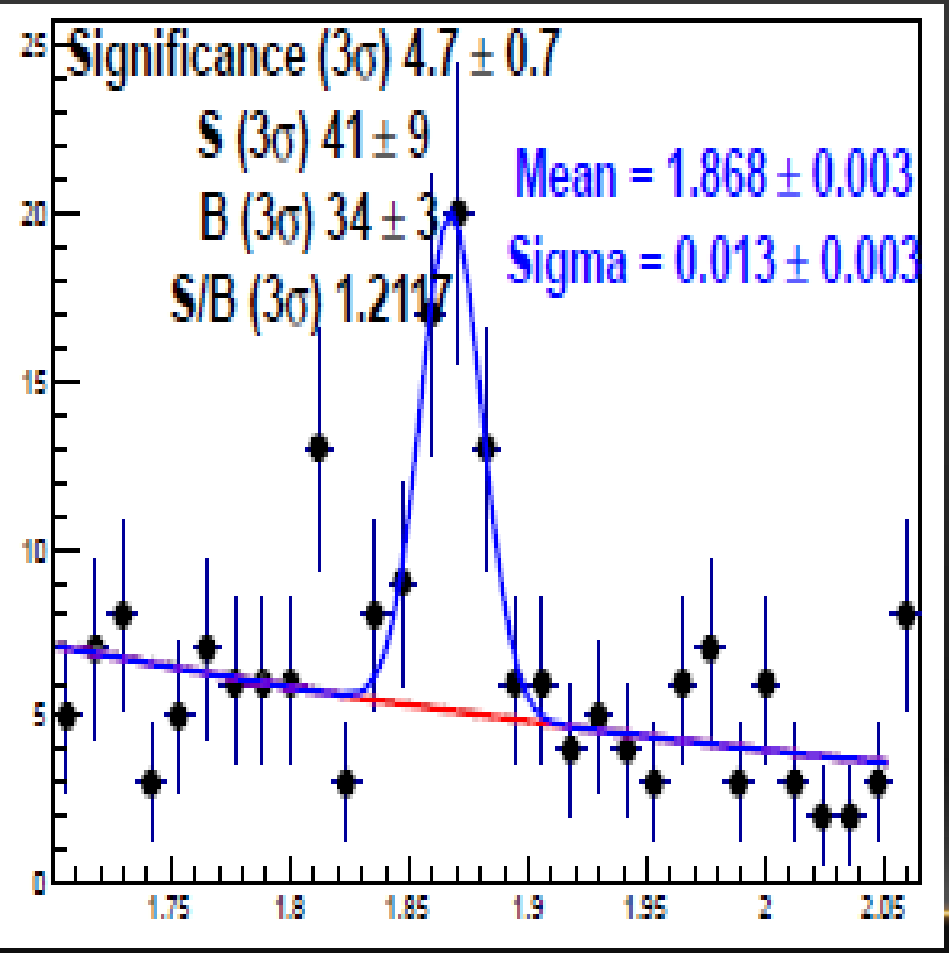


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis

Invariant Mass Spectrum of D^+

6<PT<8(GeV/c)



8<PT<12(GeV/c)

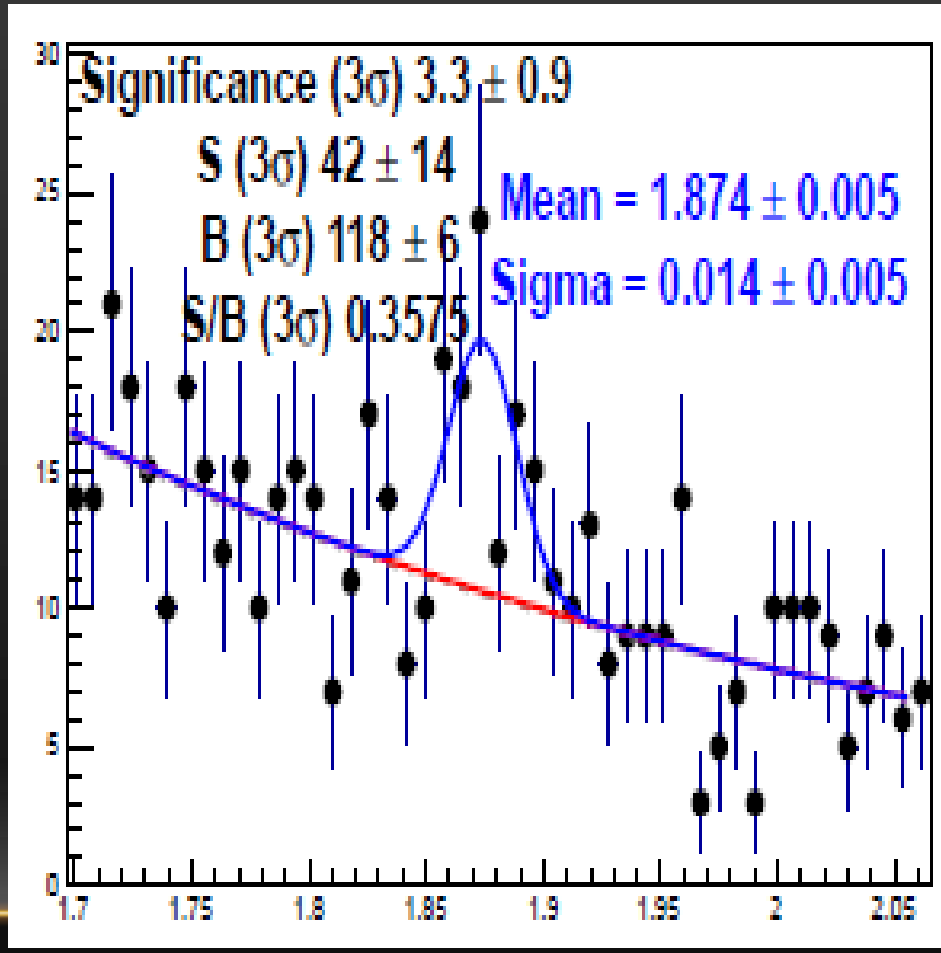
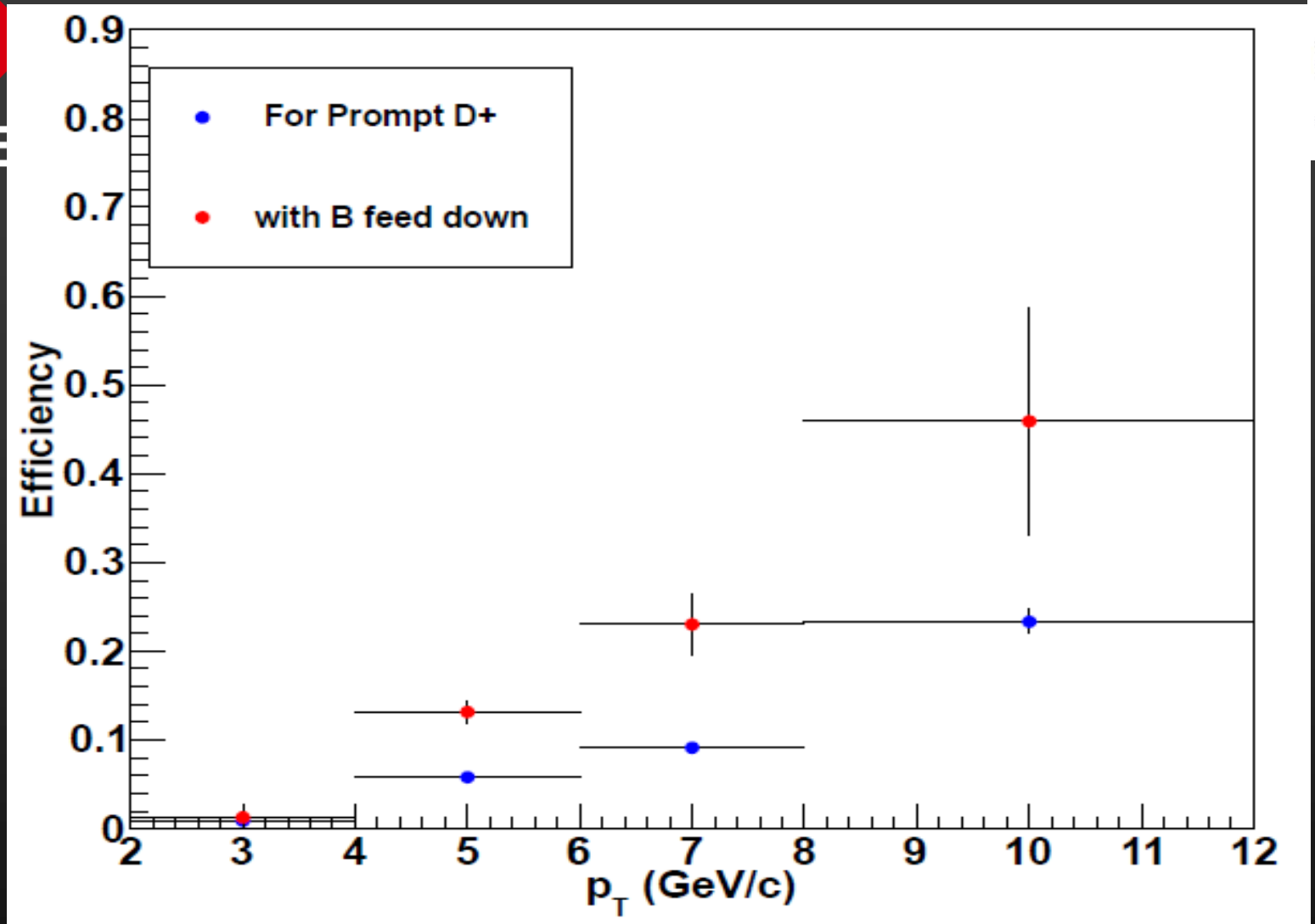


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis



Efficiency vs p_T

For Cut 3

Cut variables

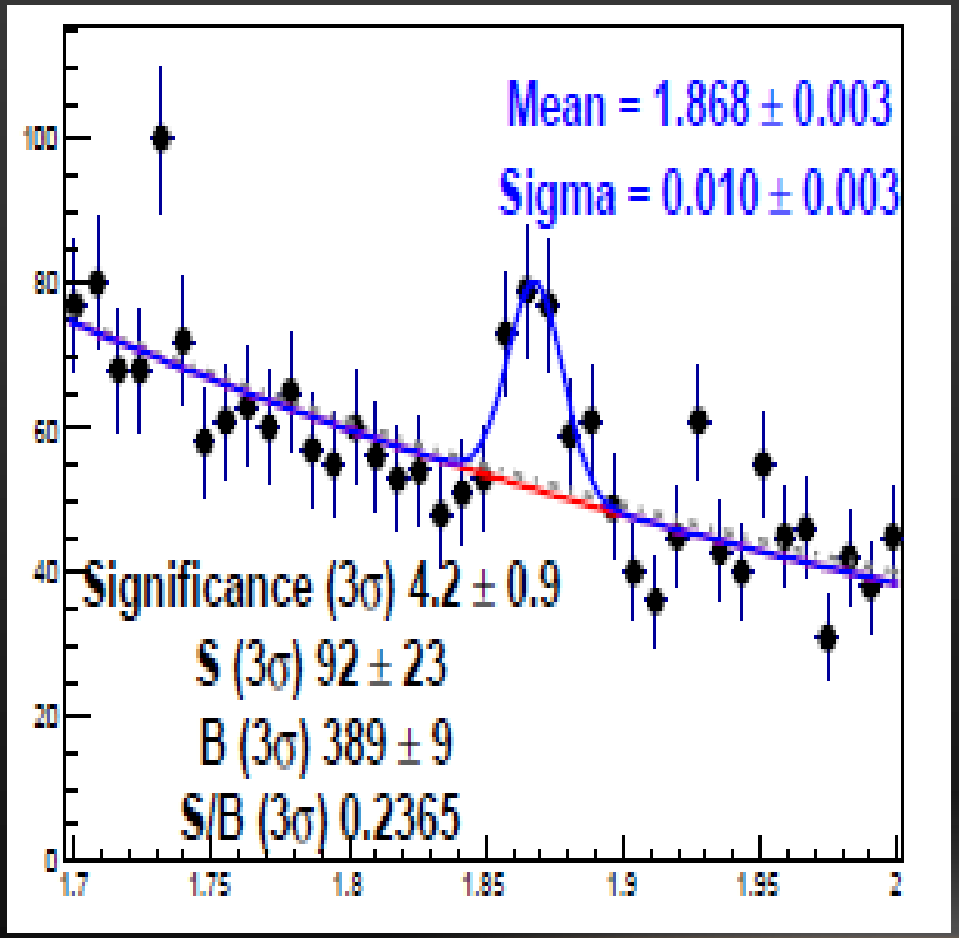
ALICE

	Ptbins								
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-
Inv.mass(GeV/c^2)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ptK(GeV/c^2)	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
ptPi(GeV/c)	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
d0K(cm)	0	0	0	0	0	0	0	0	0
doPi(cm)	0	0	0	0	0	0	0	0	0
dist12(cm)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sigma vertex(cm)	0.041	0.041	0.04	0.028	0.026	0.026	0.042	0.042	0.0392
dist prim-sec	0.08	0.08	0.09	0.095	0.095	0.115	0.115	0.115	0.09
PMax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
costheata	0.97	0.97	0.96	0.93	0.92	0.92	0.89	0.89	0.87
Sumdo^2(cm^2)	0.0055	0.0055	0.0028	0.00088	0.00088	0.00088	0.00088	0.00088	0.0003
Dca cut(cm)	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10	10^10
declenXY(cm)	0	0	0	0	0	0	0	0	0
costhetapointXY	0	0	0	0	0	0	0	0	0

Table:1 cut values used for se3

Invariant Mass Spectrum of D^+

2<PT<4(GeV/c)



4<PT<6(GeV/c)

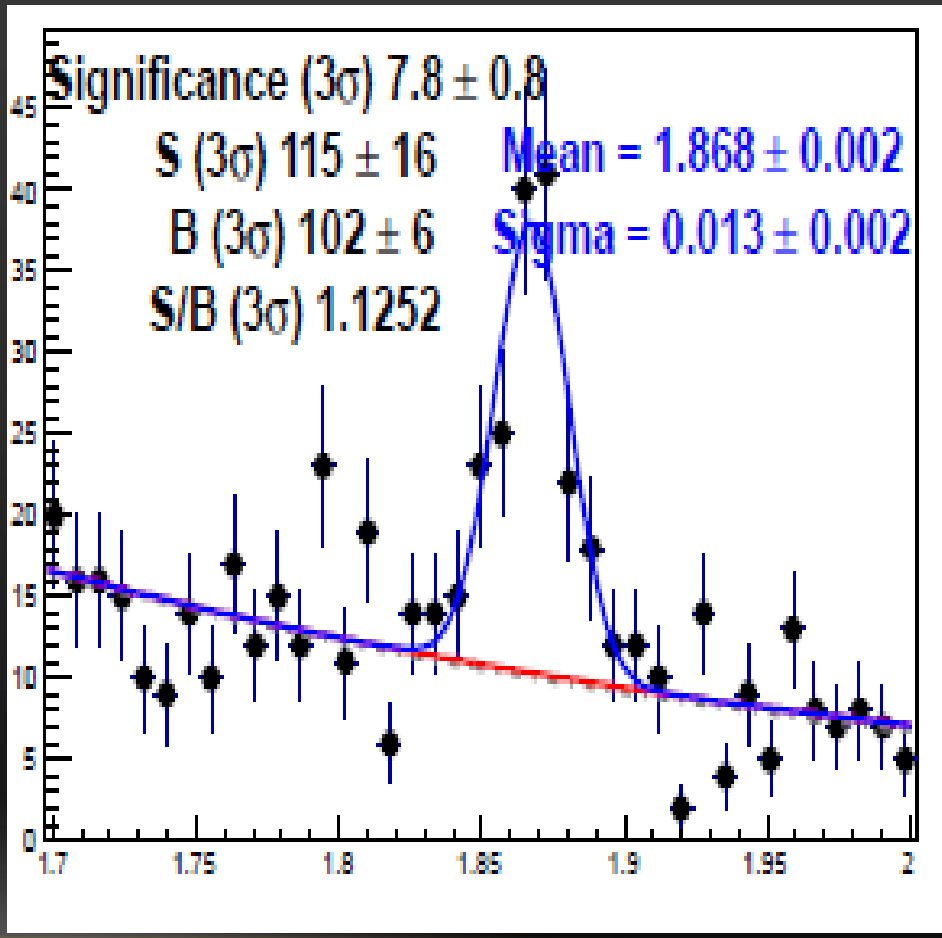
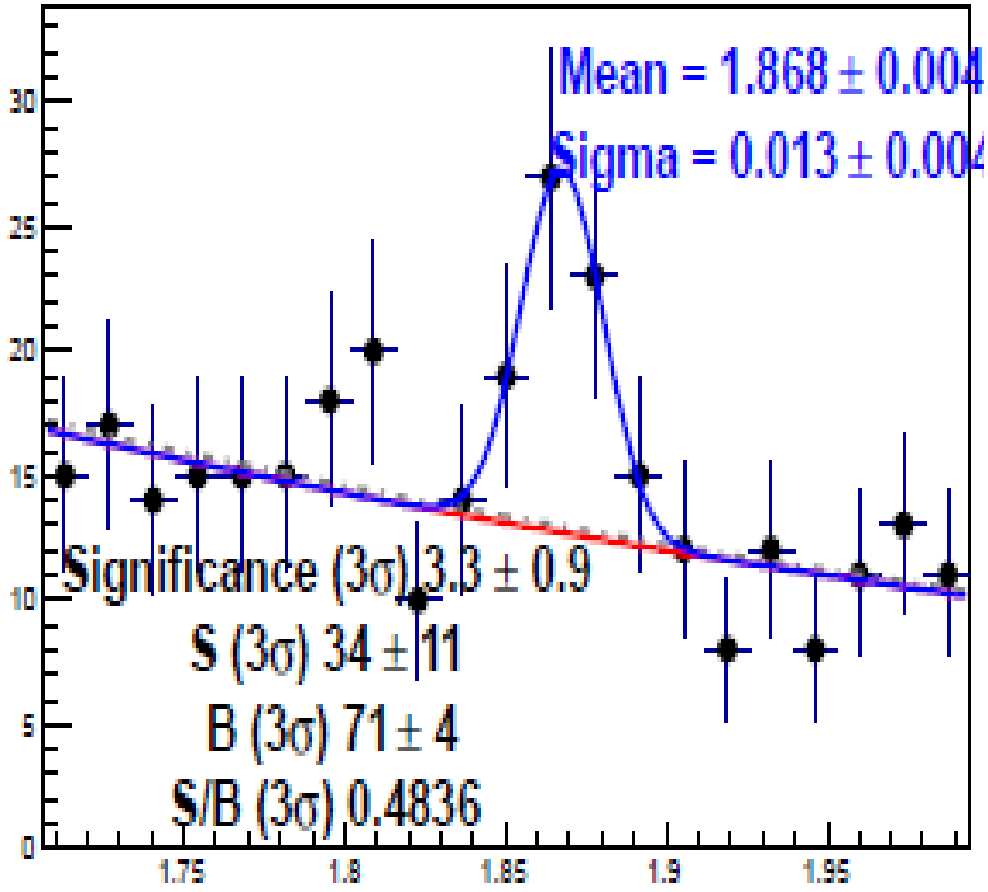


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis

Invariant Mass Spectrum of D^+

6<PT<8(GeV/c)



8<PT<12(GeV/c)

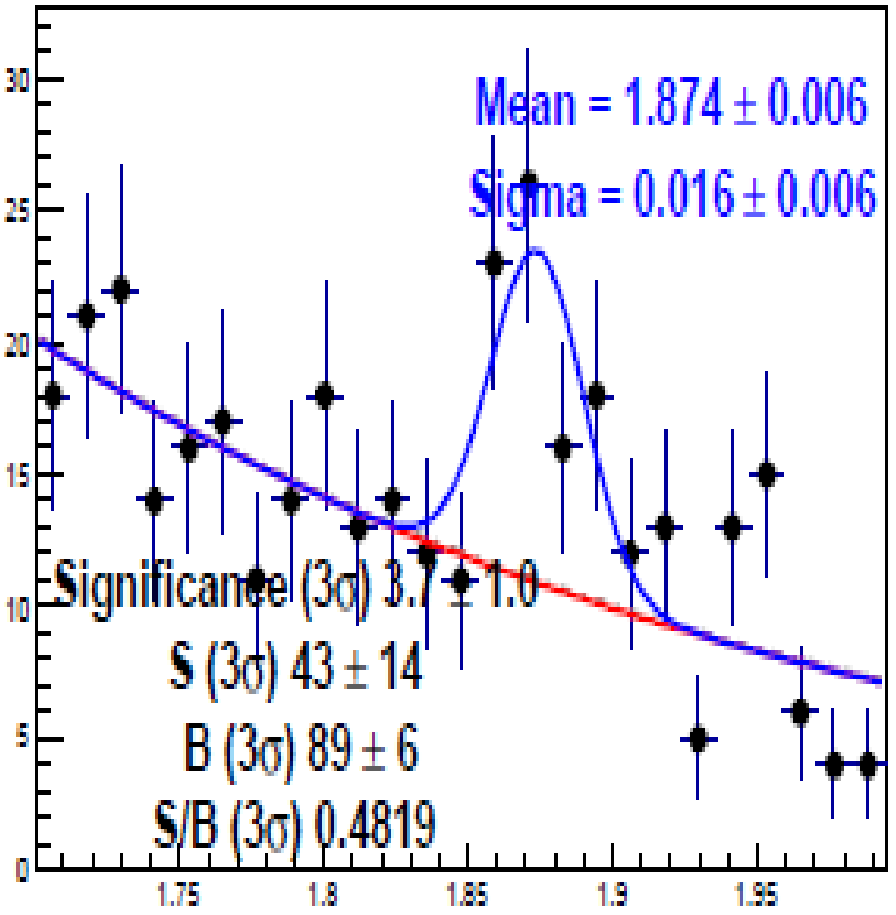
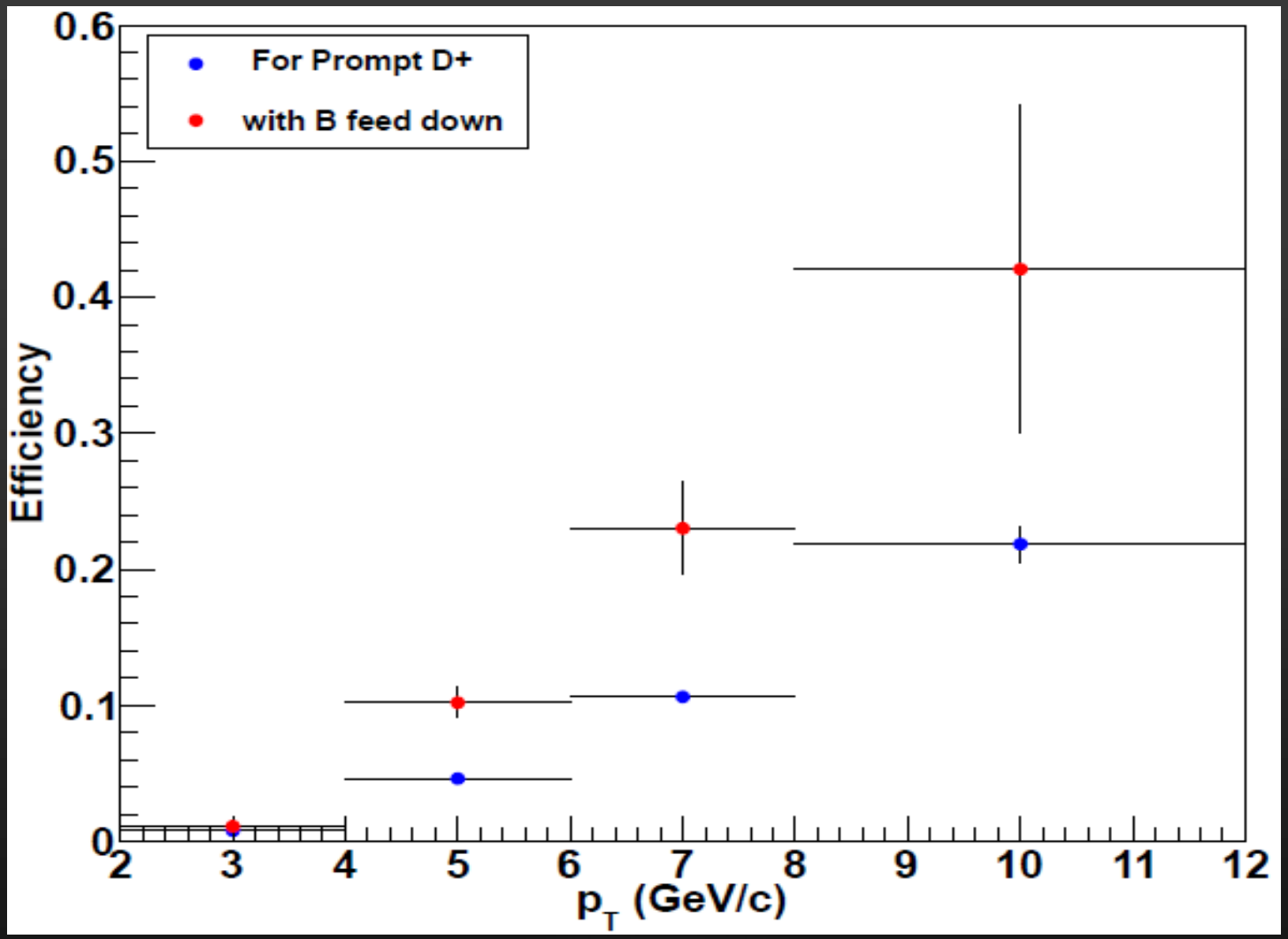


Fig: Invariant mass spectrum of D^+. Entries have been plotted along y-axis and invariant mass (GeV/c^2) along x-axis



Efficiency vs P_T

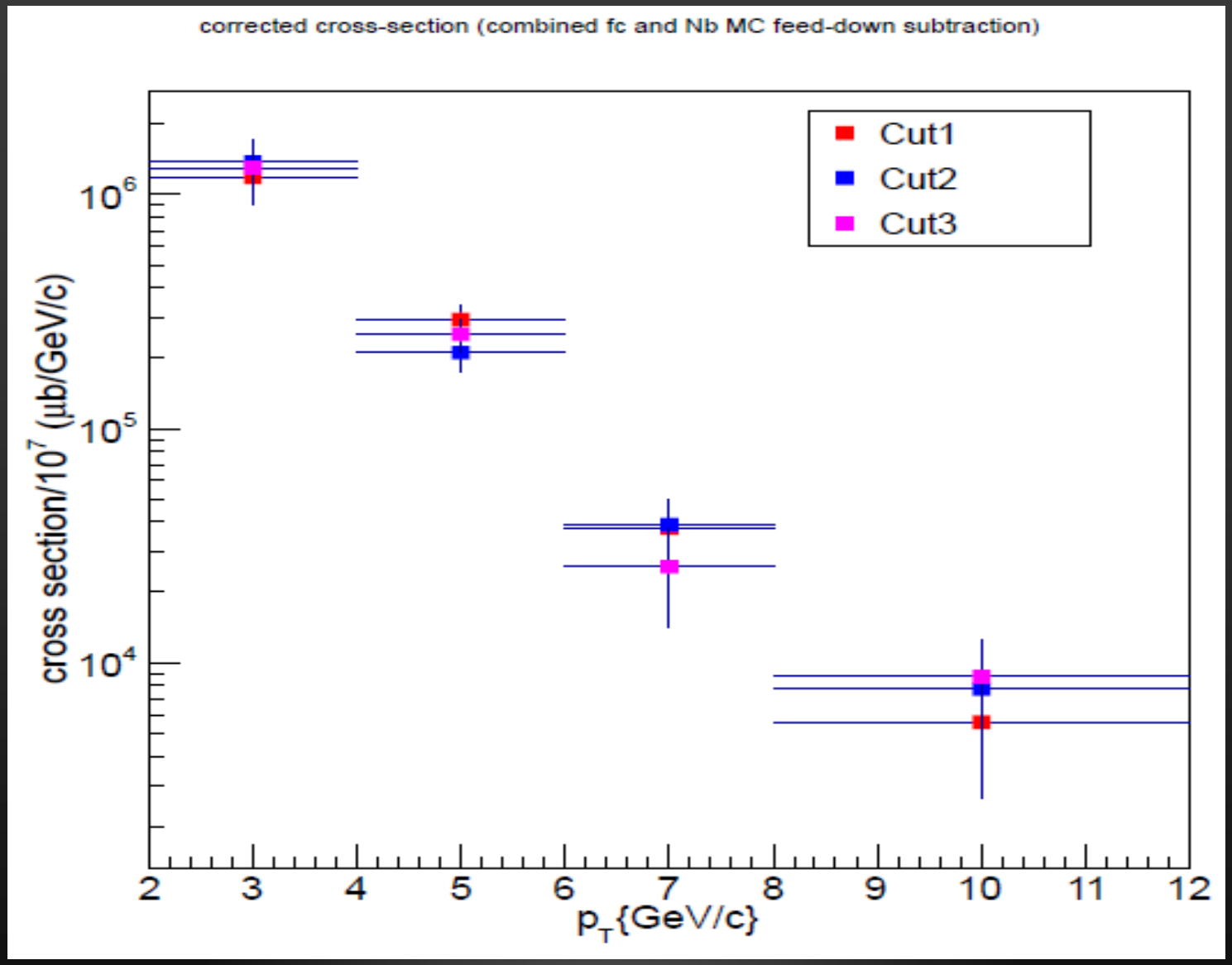
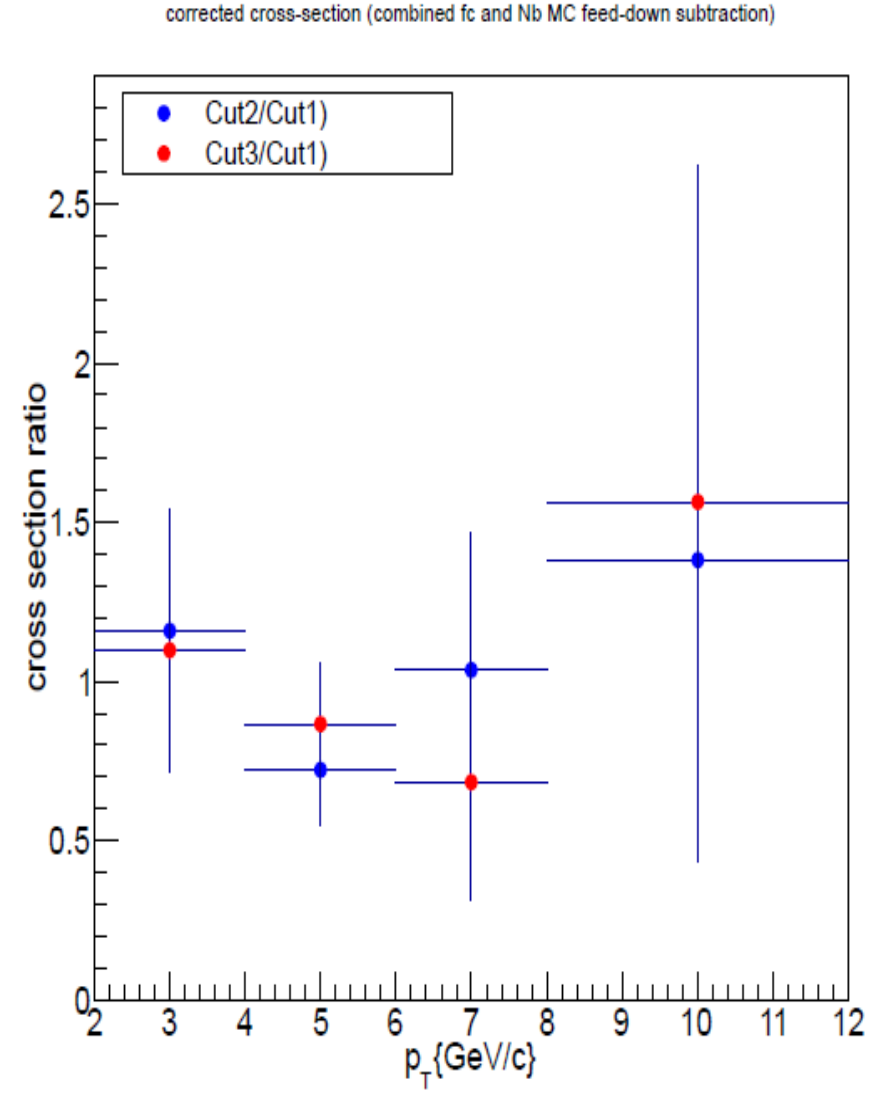
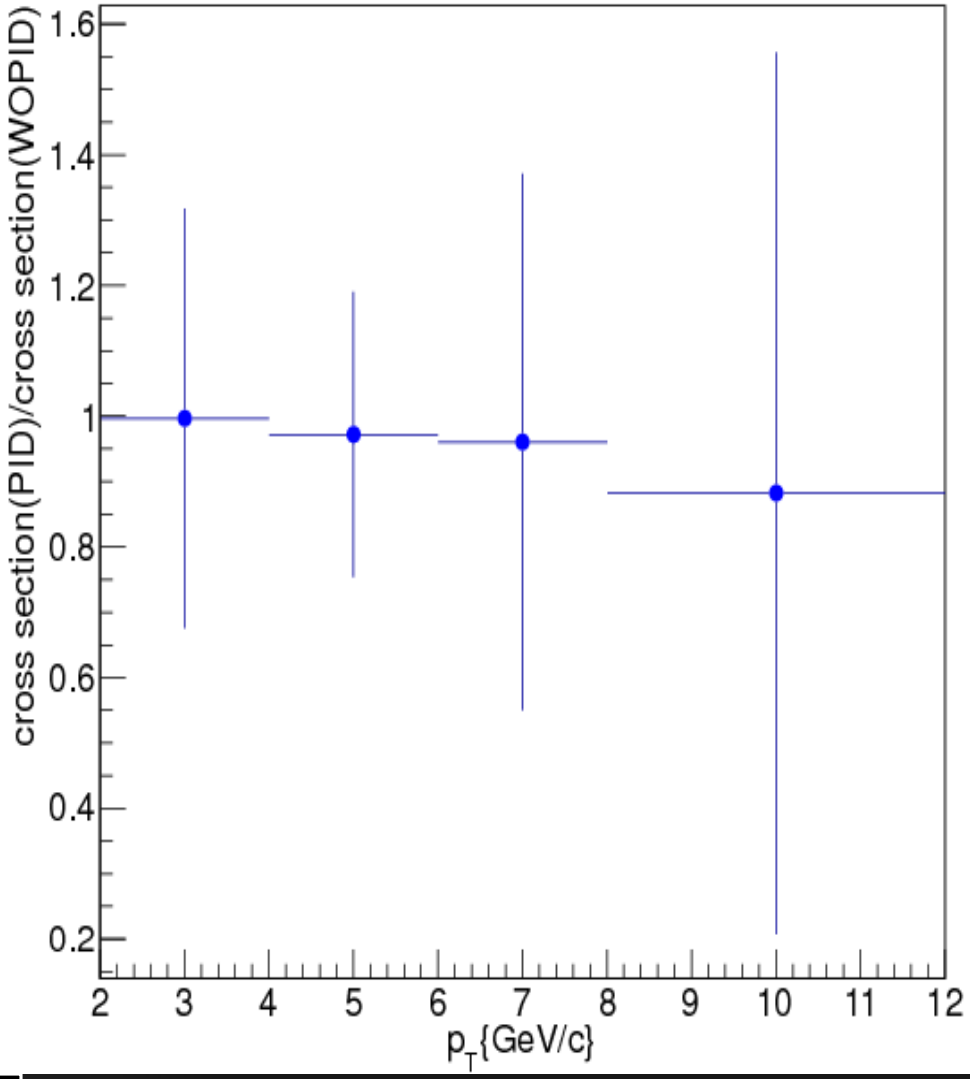


Fig: Cross section vs pt for three different cuts



Comparison of cross section calculated from Cut2and Cut3 with Cut 1 cross section of D^+ in different p_T intervals.



Ratio of cross section calculated with PID and WOPID in different p_T intervals.

Summary

- Cut optimization done in three sets for D^+ signal in different p_t intervals.
- Cross section calculated for these sets .
- Cross section is compared for the three different sets and found to be compatible within the error.

THANKS...