D^{*+} CROSS SECTION IN MINIMUM BIAS PROTON-PROTON COLLISIONS AT $\sqrt{s} = 13.6\ TeV$ USING RECTANGULAR CUT APPROACH IN ALICE AT THE LHC

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OUTLINE

- Physics Motivation
  - ❑ Why Heavy Quarks?
  - ❑ Production and Decay of D^* Mesons
- Methodology
  - ❑ D^* Reconstruction in ALICE (Run 3)
  - ❑ The Fitting Procedure
- Results
  - ❑ Normalised p_T Spectrum
  - ❑ Acceptance x Efficiency
  - ❑ Prompt Fraction
  - ❑ Systematic Uncertainties
  - ❑ Prompt D^{*+} Cross-Section
- Summary

Physics Motivation

PHYSICS MOTIVATION

HEAVY QUARKS

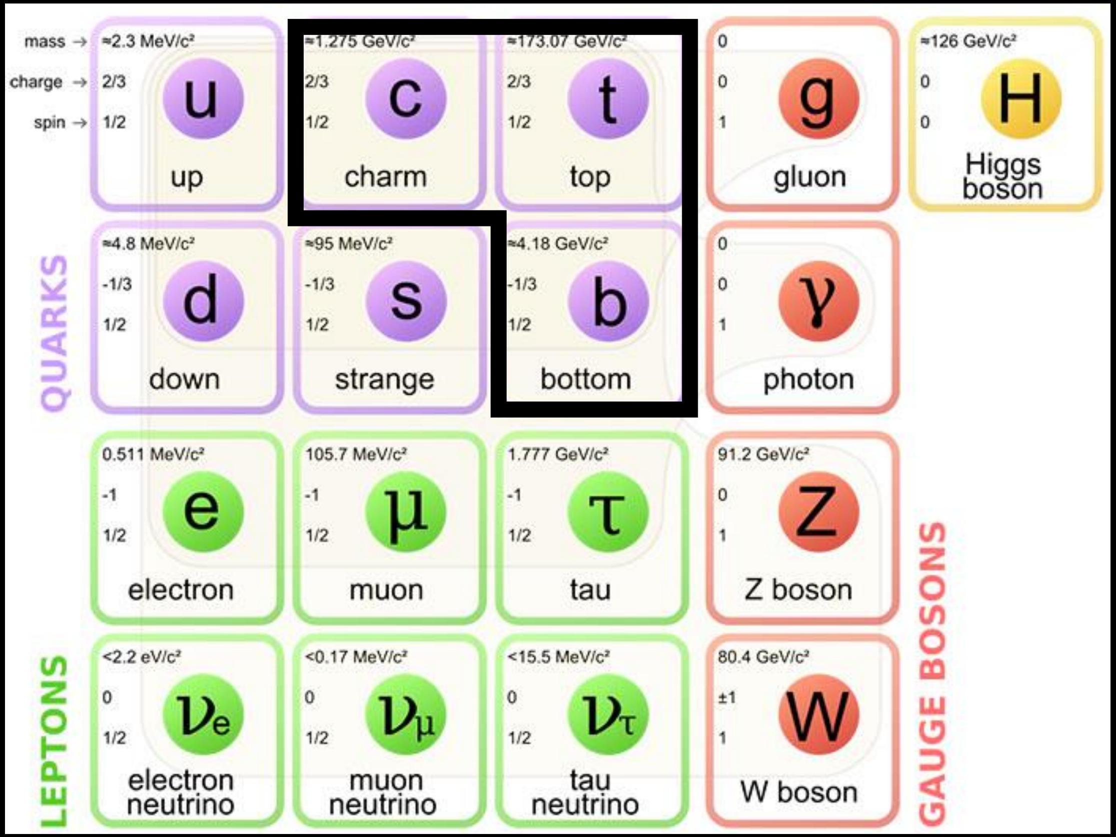


Fig. 1

Charm (c)

Mass : 1.2730 ± 0.0046 GeV/c^2

Bottom / Beauty (b)

Mass : 4.183 ± 0.007 GeV/c^2

PHYSICS MOTIVATION

HEAVY QUARKS

In pA and Heavy-ion collisions

- *Produced during the initial hard scattering processes, before the formation of the QGP*
- *Lose energy while interacting with the medium*
- *Sensitive probes to investigate the properties of the QGP*

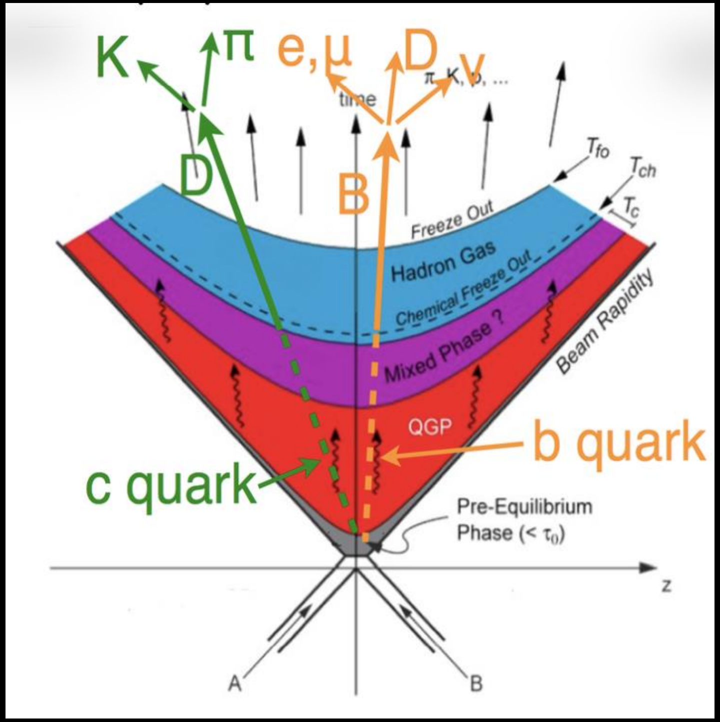


Fig. 2

In pp collisions

- *Provide good reference for Pb-Pb and p-Pb measurements*
- *Test of pQCD calculations*

PHYSICS MOTIVATION

D MESONS

Mesons containing a Charm Quark

Prompt

The c-quarks hadronise to produce D mesons

Non-prompt

B mesons (mesons containing b-quarks) decay to produce D mesons

D* MESONS

Excited D mesons

PHYSICS MOTIVATION

DECAY OF D*± MESONS

$$D^{*+} \rightarrow \; D^0 + \pi_s{}^+, \quad BR = 67.7 \; \pm 0.5 \; (Strong\ Decay)$$

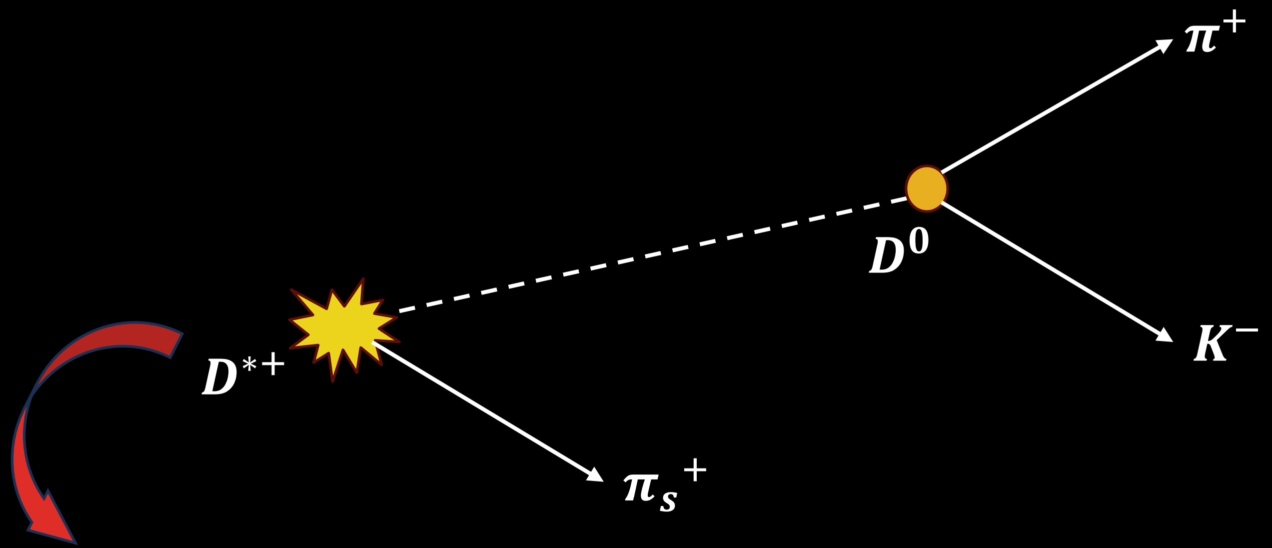
$$D^0 \rightarrow \; K^- + \pi^+ , \quad BR = 3.93 \pm 0.04 \; (Weak\ Decay)$$

Our Objective : To study D+ cross section in minimum bias proton-proton collisions at $\sqrt{s} = 13.6\ TeV$ using ALICE at the LHC*

Methodology

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)



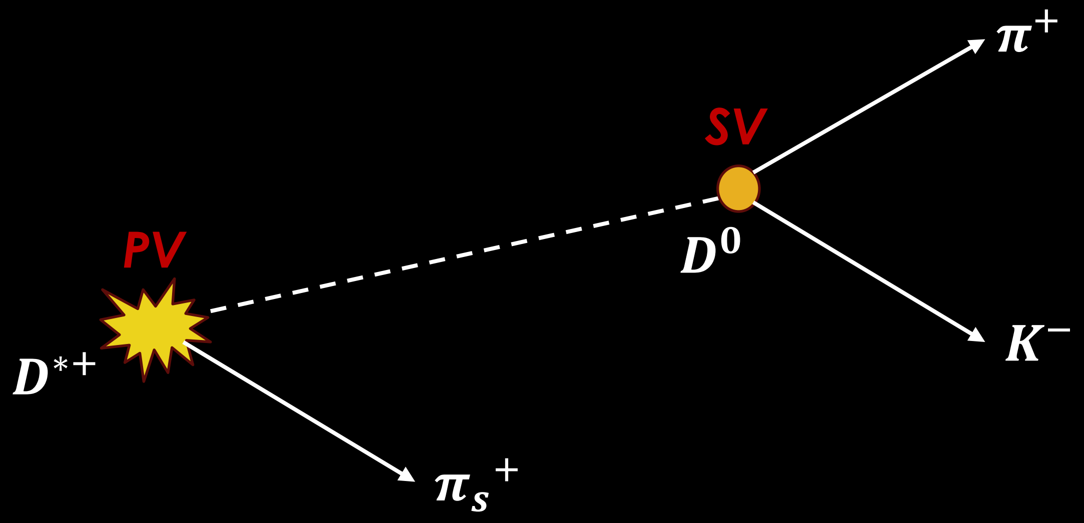
Decays strongly, soon after formation

Decay Vertex cannot be resolved from its Production Vertex

*Production-cum-Decay vertex of D** ≡ D* Vertex ≡ *Primary Vertex (PV)*

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)



Decay vertex of the resulting D^0 ≡ *Secondary Vertex (SV)*

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)

Candidate ≡ A combination of particles that might form a particular parent particle

- *In each event, pairs of tracks from oppositely charged particles are selected*
- *PID is done using TPC and TOF; only oppositely charged K and π tracks are selected*

→ **D^0 candidate**

- *PID is performed over additional tracks to select those π tracks which have opposite charge as the K track*

→ **D* candidate**

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)

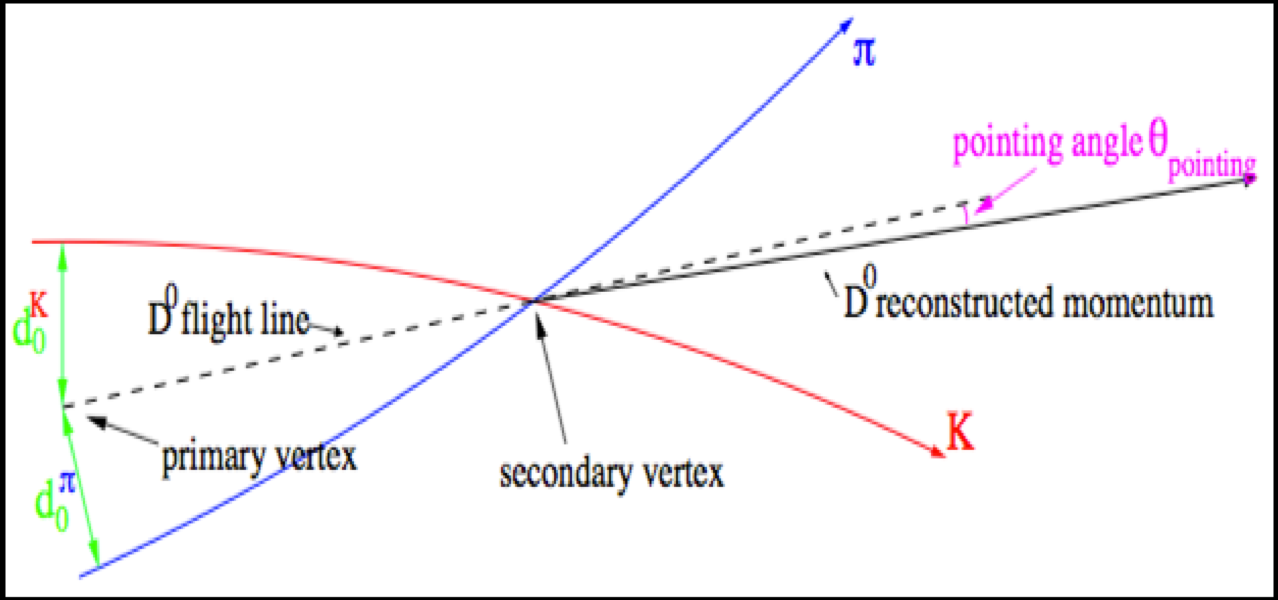


Fig. 3

Combinatorial Background

∴ *Topological Cuts*

Conditions imposed on Impact Parameters, Angles, Transverse Momenta etc.

Rectangular Cut Approach !

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)

- *Known kaon and pion masses are assigned to the members of the track pairs, and pion mass to the 3rd track*
- *The Invariant Mass $m(K\pi)$ of the D^0 candidate is calculated using the assumed K and π masses*
- *The 3-particle Invariant Mass $m(K\pi\pi_s)$ is computed for the D* candidate*
- *The mass difference $\Delta M = m(K\pi\pi_s) - m(K\pi)$ is calculated*
- *D* candidates that pass all the selections are used to fill Invariant Mass histogram of candidate p_T vs ΔM*

Invariant Mass Distribution for all candidates !

METHODOLOGY

D* MESON RECONSTRUCTION IN ALICE (RUN 3)

Entire p_T range of candidates is divided into intervals, or p_T bins

1.5-2, 2-2.5, 2.5-3 GeV/c and so on !

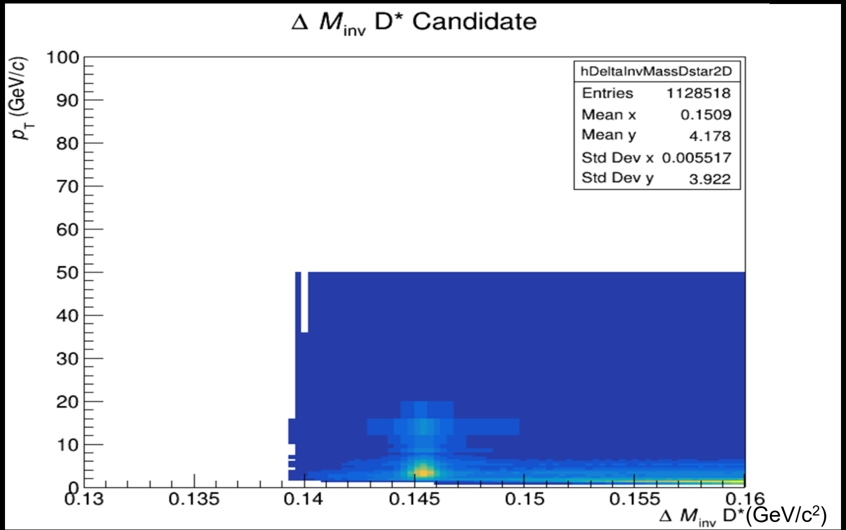


Fig. 4

Projection taken on ΔM axis for each given p_T bin

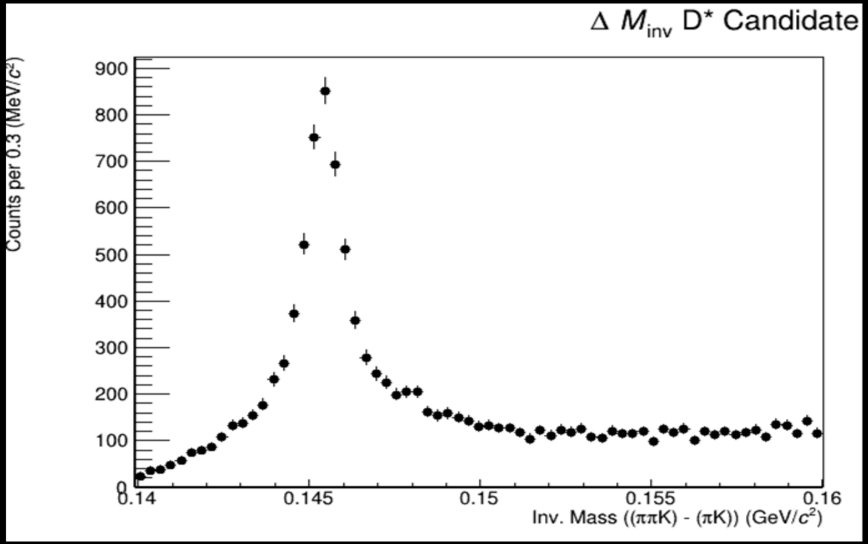


Fig. 5

2D Invariant Mass Distribution
(p_T vs ΔM)

1D Invariant Mass Distribution
in a particular p_T bin

METHODOLOGY

The Fitting Procedure

1. To each invariant mass distribution, a background function is fitted, excluding the signal region.

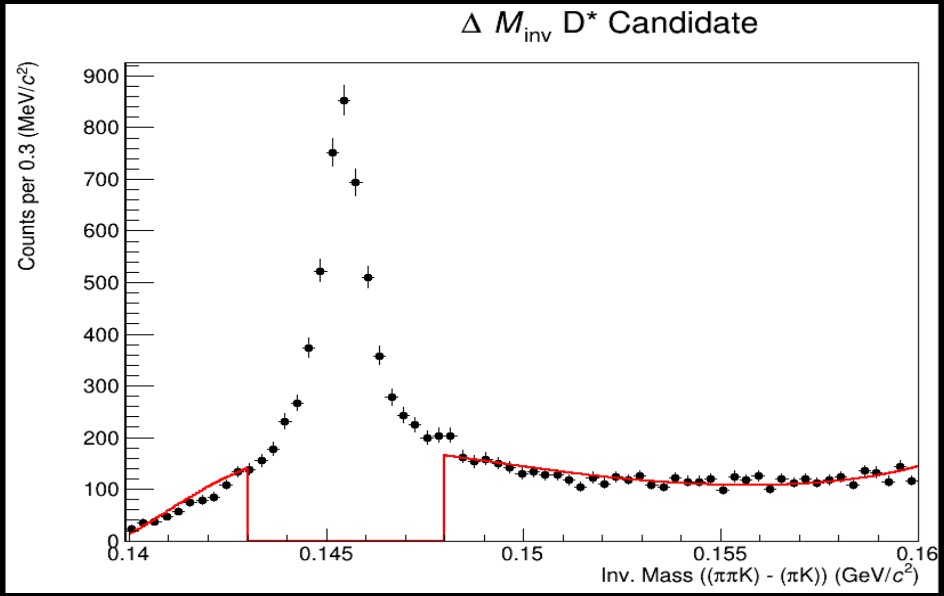


Fig. 6

Parameters for the background function are kept free.

2. A single gaussian function, of the following form, is used as the signal function :

$$f(x;\,\bar{x},\sigma) = N\,exp\left(-\frac{(x-\bar{x})^2}{2\sigma^2}\right)$$

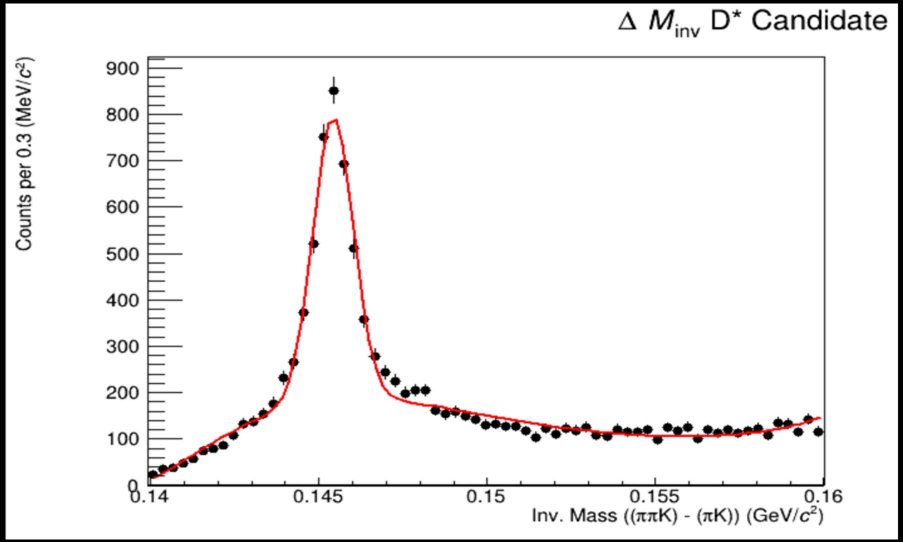


Fig. 7

METHODOLOGY

The Fitting Procedure

3. This step is the same as Step 2, except that the single Gaussian function is replaced by the modified Double Crystal Ball function, which is of the following form :

$$f(x;\ \alpha_L, \alpha_R, \bar{x}, \sigma) = A \begin{cases} e^{\frac{\alpha_L^2}{2} + \alpha_L\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \leq (-\alpha_L) \\ e^{-\frac{(x-\bar{x})^2}{2\sigma^2}}, & if\ (-\alpha_L) < \frac{x-\bar{x}}{\sigma} < \alpha_R \\ e^{\frac{\alpha_R^2}{2} - \alpha_R\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \geq \alpha_R \end{cases}$$

The mass and width are initiated by parameter values from the Gaussian fit in Step 2, while the tail parameters are kept free.

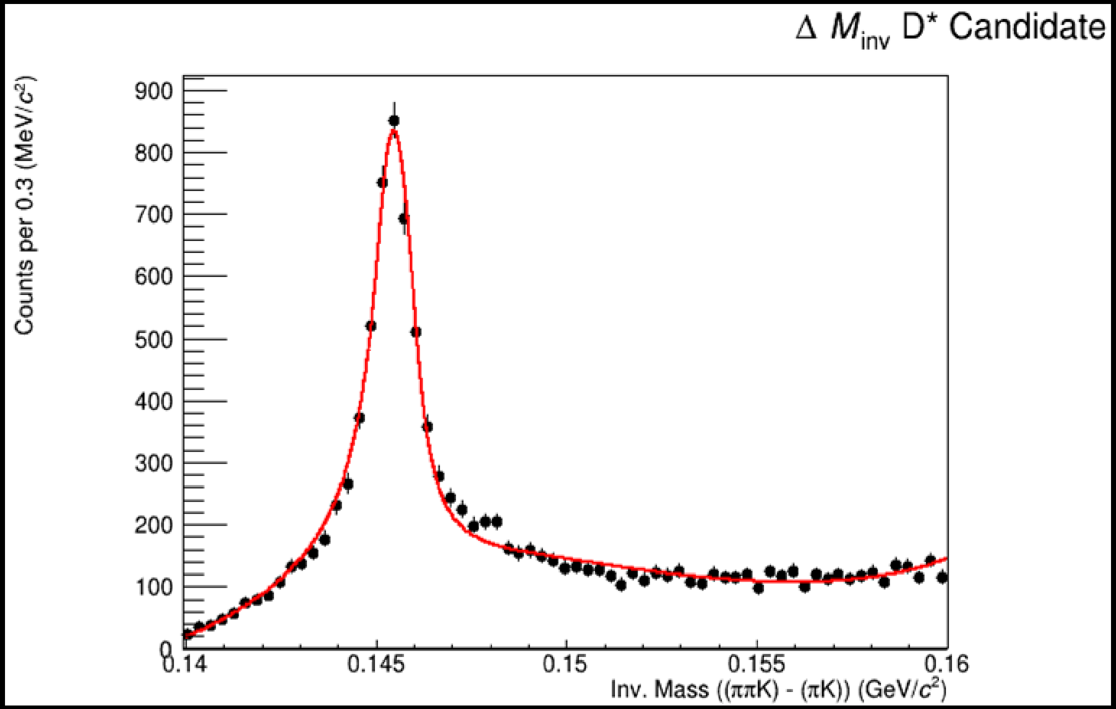


Fig. 8

METHODOLOGY

The Fitting Procedure

Finally, the Invariant Mass Distribution is refitted with Signal + Background functions, with parameters initialised from Step 3. The signal component is integrated to get the Raw Yield.

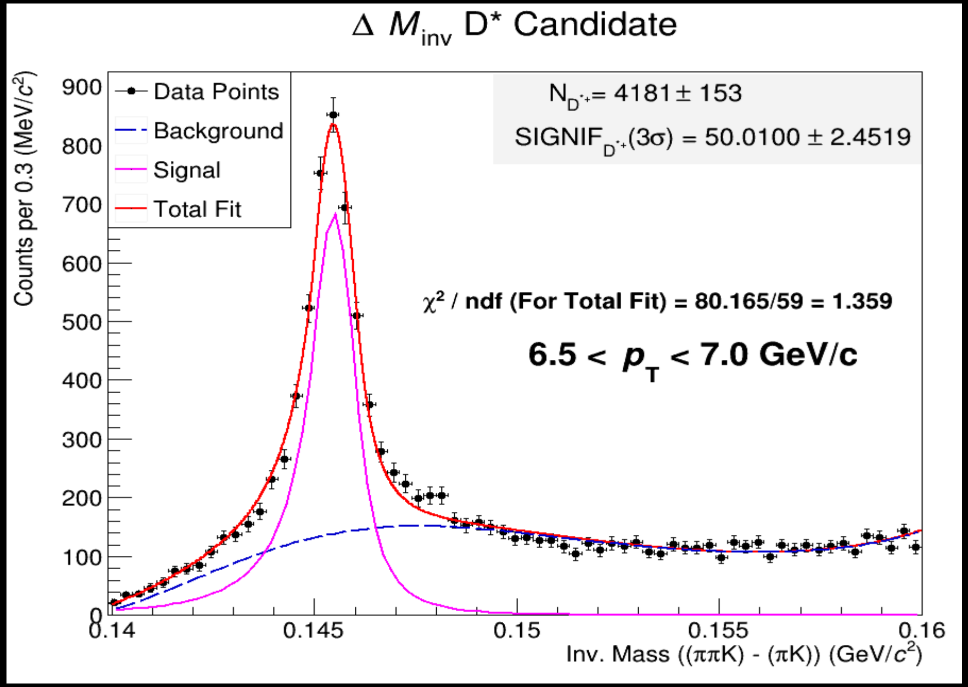


Fig. 9

Results

RESULTS

ENERGY

13.6 TeV (Run 3)

DATASETS

Run 3 Data : HF_LHC22_pass7_minBias_medium_2P3PDstar (Total no. of events : 1.62×10^{10})

MC Sample : HF_LHC_24g5_All

RESULTS

Fit Functions Used

Background Functions

1. $N(\Delta M - M_\pi)^\lambda e^{p_1(\Delta M - M_\pi) + p_2(\Delta M - M_\pi)^2 + p_3(\Delta M - M_\pi)^3}$, used for upto p_T 20 GeV/c

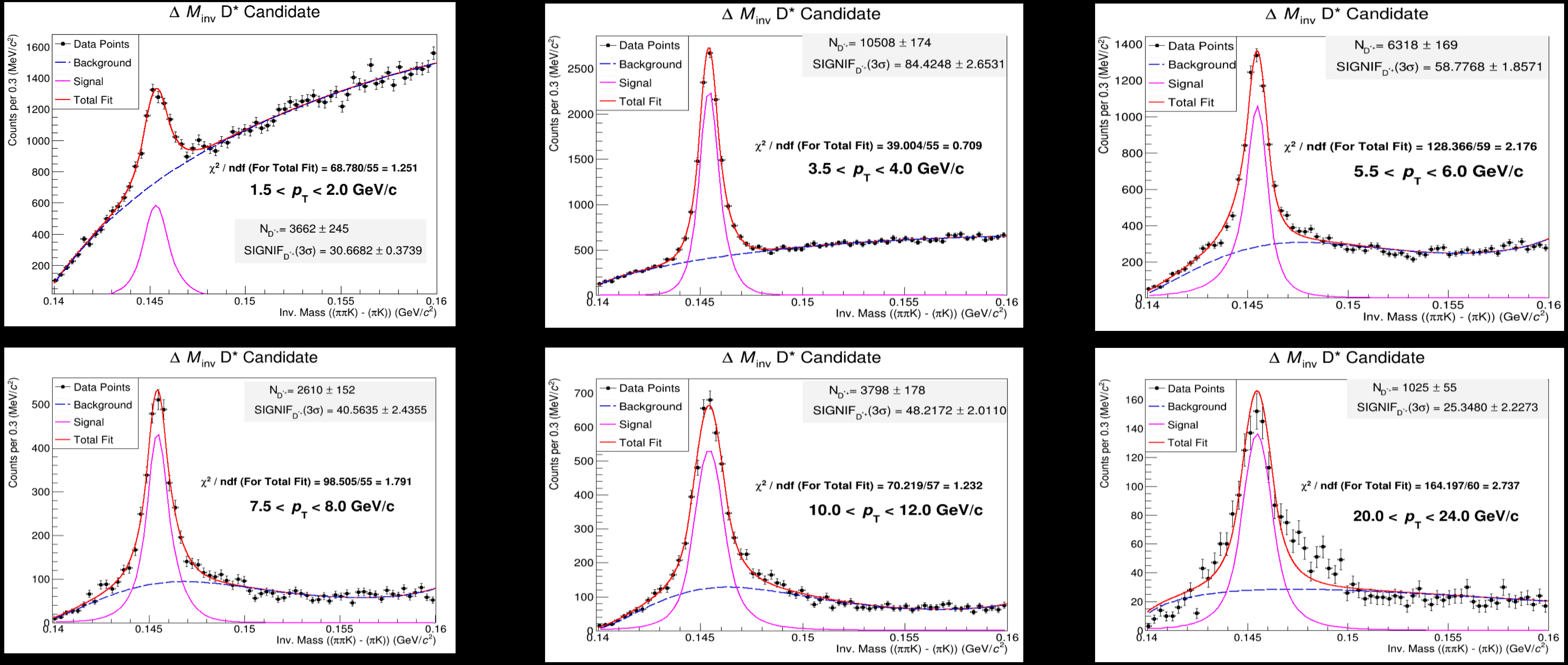
2. $a(\Delta M - M_\pi)^{0.5} e^{b(\Delta M - M_\pi)}$, used for p_T > 20 GeV/c

Signal Function

$$f(x;\ \alpha_L, \alpha_R, \bar{x}, \sigma) = A \begin{cases} e^{\frac{\alpha_L{}^2}{2} + \alpha_L\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \le (-\alpha_L) \\ e^{-\frac{(x-\bar{x})^2}{2\sigma^2}}, & if\ (-\alpha_L) < \frac{x-\bar{x}}{\sigma} < \alpha_R \\ e^{\frac{\alpha_R{}^2}{2} - \alpha_R\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \ge \alpha_R \end{cases}$$

RESULTS

FITTED INVARIANT MASS DISTRIBUTIONS



Figs. 10

RESULTS

Mean ΔM vs p_T

σ vs p_T

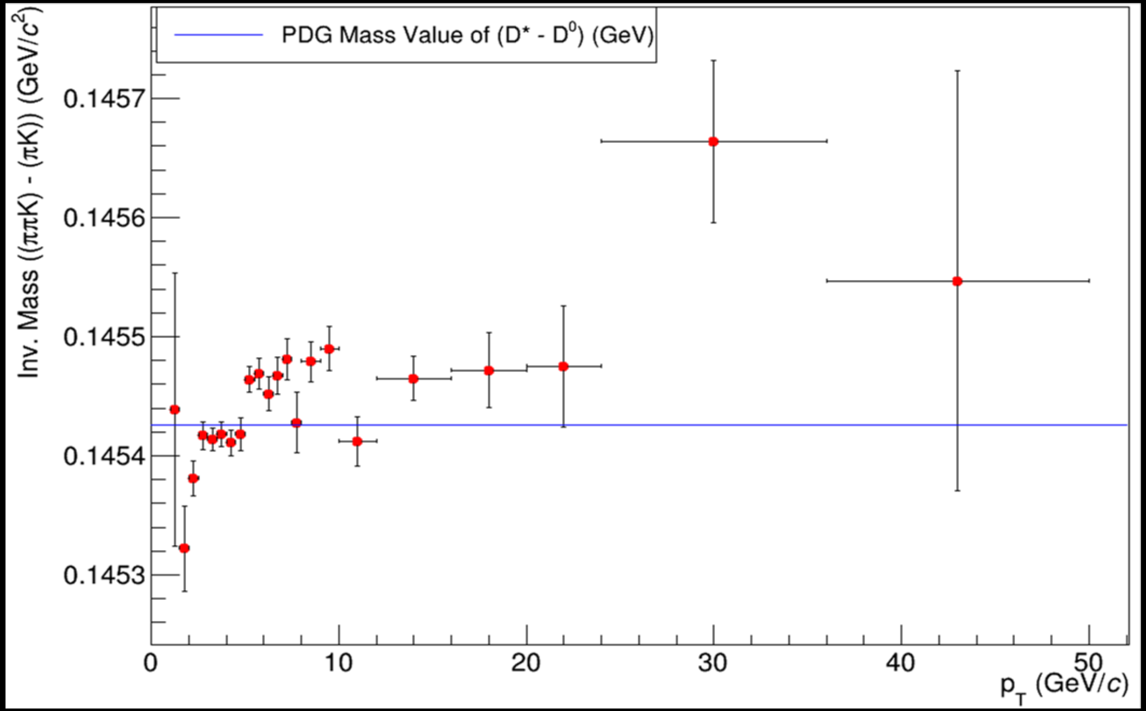


Fig. 11

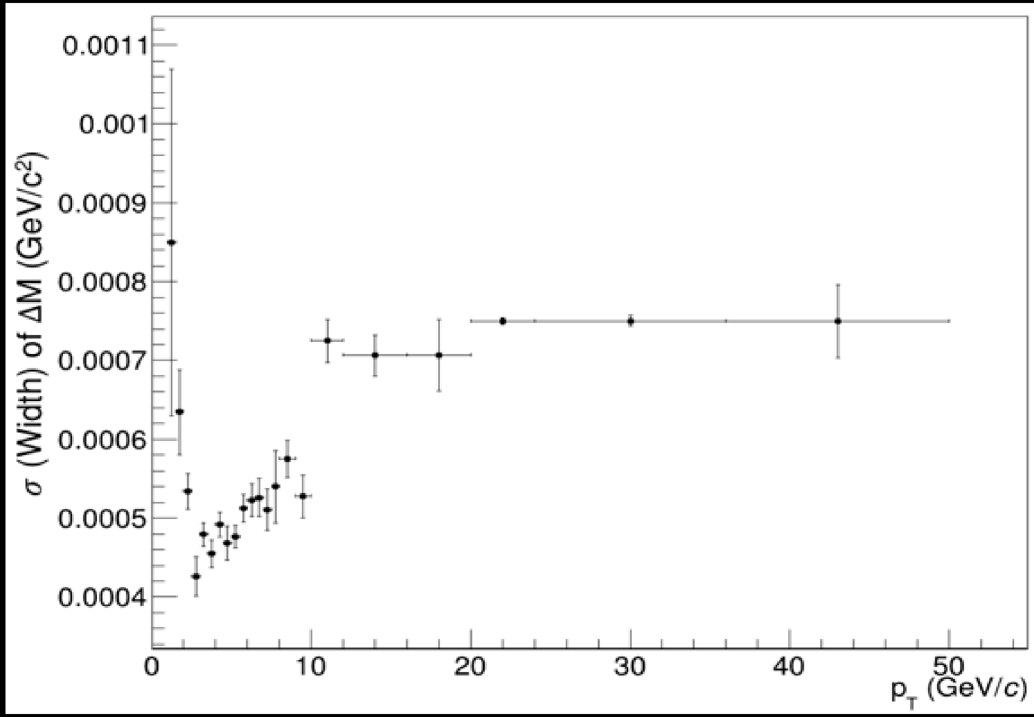


Fig. 12

PDG Mass Value of (D* - D⁰) : $145.4258 \pm 0.0017\ MeV$

RESULTS

NORMALISED p_T SPECTRUM

Normalised p_T Spectrum ≡

Normalised Raw Yield vs p_T

$$Normalised\ raw\ yield = \frac{1}{N_{evt}} \frac{d^2N}{dp_T\,dy}$$

where, N_{evt} : total no. of events
N : raw yield of D*± mesons
dp_T : transverse momentum interval of D*± candidates
dy : rapidity interval of D*± candidates

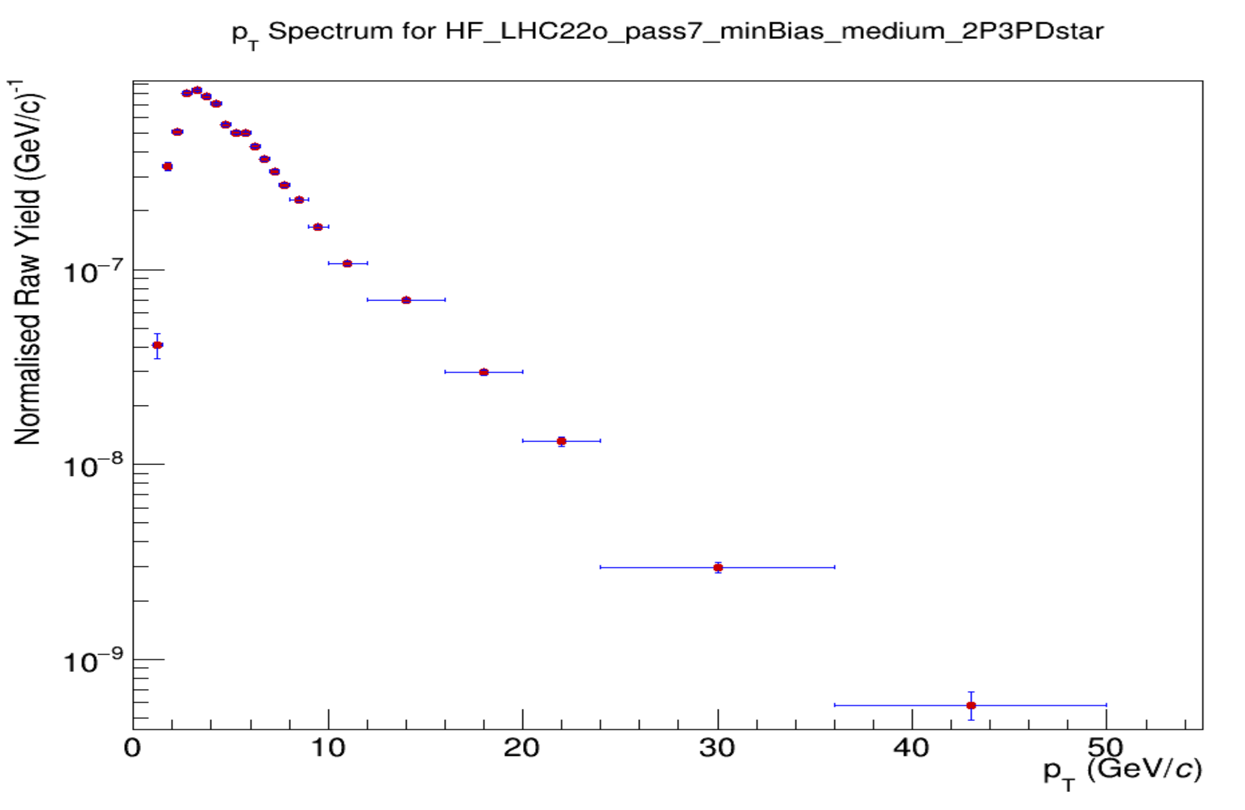


Fig. 13

RESULTS

ACCEPTANCE x EFFICIENCY

Not all particles produced in a collision get detected

Detector Acceptance

Reconstruction Inefficiency

Acceptance times Efficiency correction ensures that the measured p_T spectrum accurately reflects the true spectrum of particles produced in the collisions

$$(Acc \times \epsilon) = \frac{N_{rec}}{N_{gen}}$$

$$\Delta(Acc \times \epsilon) = \frac{1}{N_{gen}} \sqrt{N_{rec}\left(1 - \frac{N_{rec}}{N_{gen}}\right)}$$

RESULTS

ACCEPTANCE x EFFICIENCY

Computed from the Monte Carlo sample

: (Acc x Eff)$_{Inclusive}$

: (Acc x Eff)$_{Prompt}$

: (Acc x Eff)$_{Non\text{-}Prompt}$

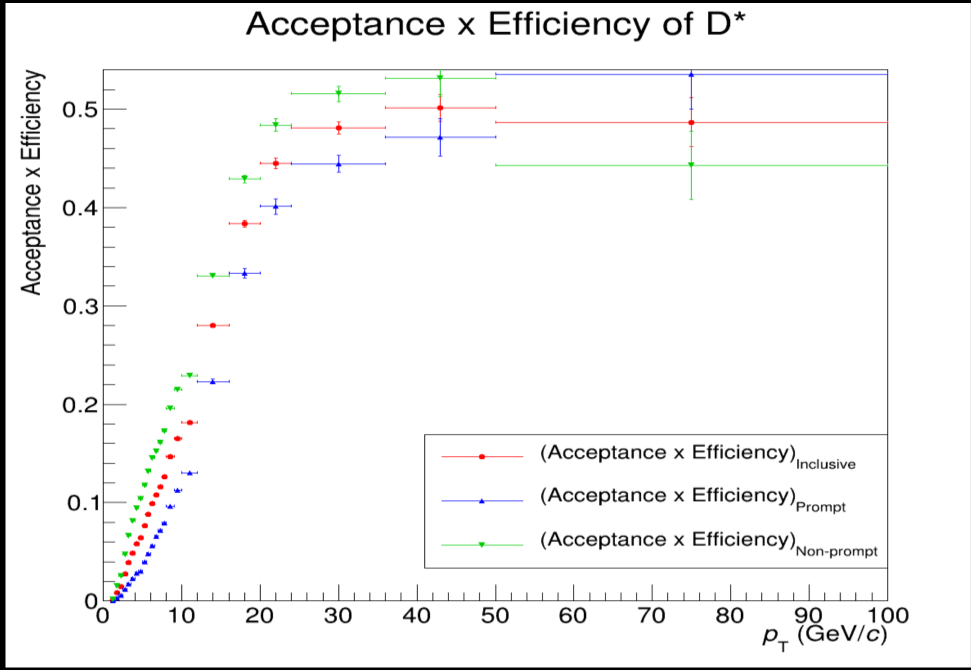


Fig. 14

These corrections are incorporated in later results

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING THEORY-DRIVEN METHOD

$$f_{prompt} = \frac{No.\ of\ prompt\ D^{*+}\ mesons\ produced}{Total\ no.\ of\ D^{*+}\ mesons\ produced},$$

$$or, \qquad f_{prompt} = 1 - \frac{No.\ of\ non-prompt\ D^{*+}\ mesons\ produced}{Total\ no.\ of\ D^{*+}\ mesons\ produced}$$

$$= 1 - \frac{N^{D^{*}\,non-prompt}{}_{raw}}{N^{D^{*}}{}_{raw}}$$

$$= 1 - \left(\frac{d^2\sigma}{dy\,dp_T}\right)^{FONLL}_{non-prompt} \cdot \frac{(Acc \times \epsilon)_{non-prompt} \,.\, \Delta y \Delta p_T \,.\, BR.\, L_{int}}{N^{D^{*}}{}_{raw}/2}$$

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING THEORY-DRIVEN METHOD

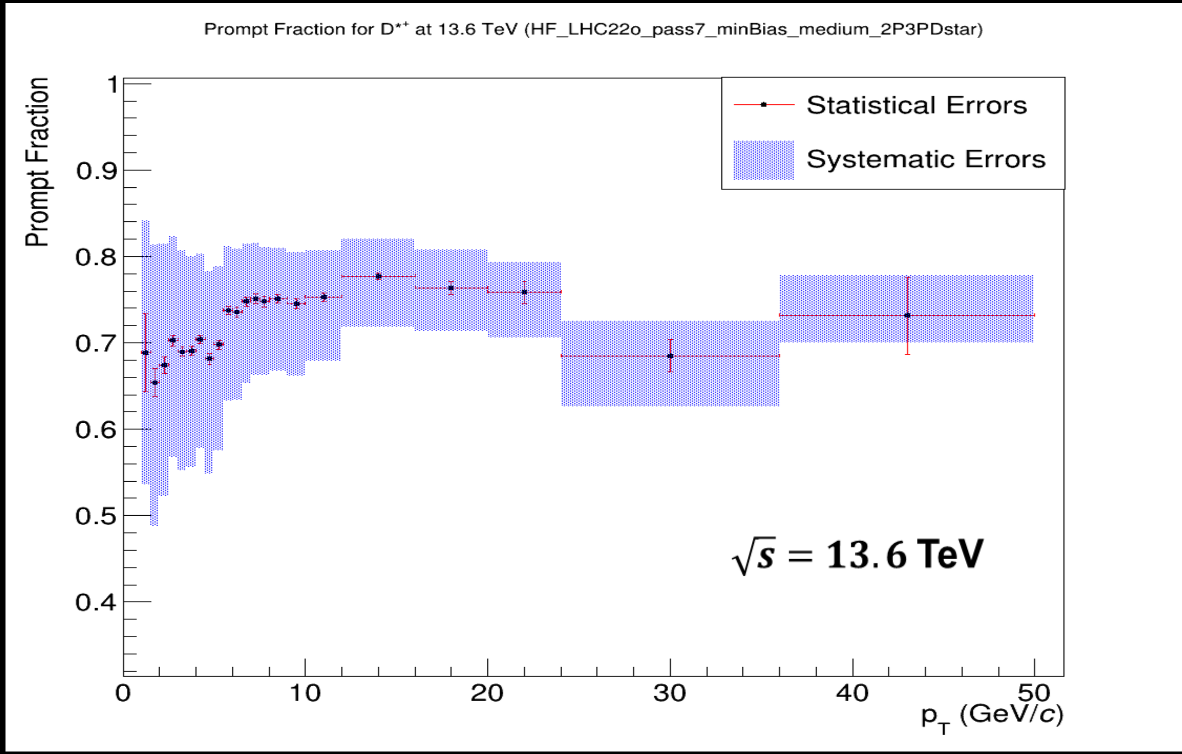


Fig. 15

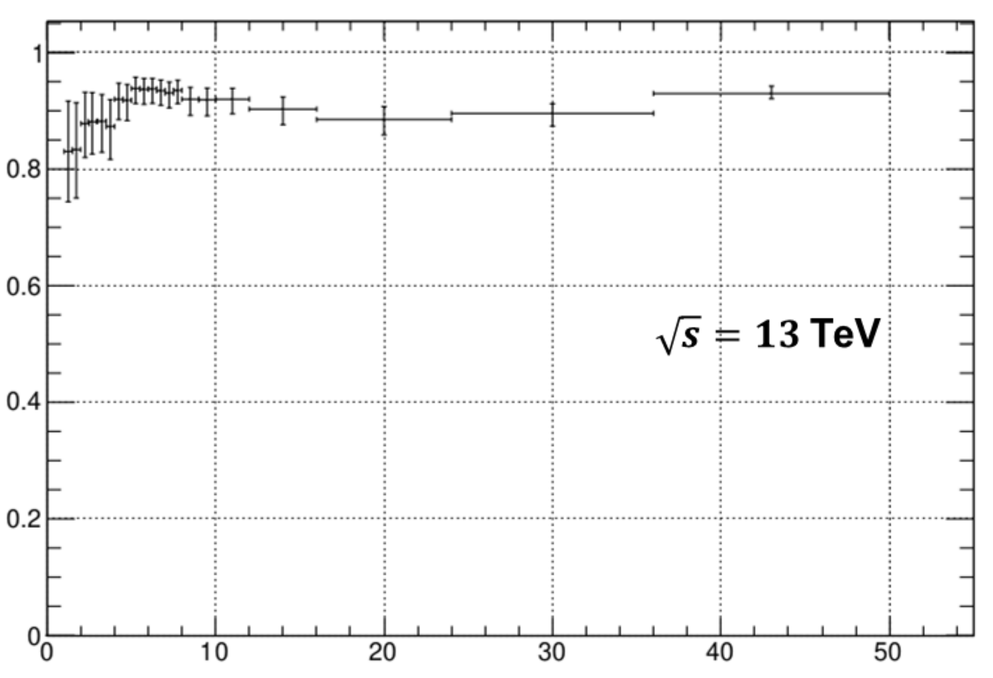


Fig. 16

[Result from ALICE Analysis Note : ALICE-ANA-2022-xxx, January 3, 2023]

Shows agreement with Run 2 result within uncertainty limits !

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING DATA-DRIVEN METHOD

The Cut-Variation Method

Based on the variation of a topological cut, e.g. Decay Length, 'm' sets of selections are defined.

For the ith set, the raw yield Y_i is related to the prompt and non-prompt Acceptance times Efficiencies as:

$$(A \times \epsilon)_i^{p} \, . \, N_p + (A \times \epsilon)_i^{np} \, . \, N_{np} \cong Y_i$$

where, N_p : true prompt D^* yield

N_{np} : true non-prompt D^* yield

$(A \times \epsilon)_i^{p}$: Acceptance x Efficiency of prompt D^* mesons for the i^{th} set

$(A \times \epsilon)_i^{np}$: Acceptance x Efficiency of non-prompt D^* mesons for the i^{th} set

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING DATA-DRIVEN METHOD

The Cut-Variation Method

$$(A \times \epsilon)_i^{p} \,.\, N_p + (A \times \epsilon)_i^{np} \,.\, N_{np} \cong Y_i$$

The 'm' sets of such equations can be written in matrix form as :

$$\epsilon_{m\times 2}\, N_{2\times 1} - Y_{m\times 1} = \delta_{m\times 1}$$

where,
- ϵ : the Acceptance-Efficiency matrix
- N : the matrix of true prompt and non-prompt yields (unknown)
- Y : the raw yield matrix
- δ : the matrix of the uncertainties associated

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING DATA-DRIVEN METHOD

The Cut-Variation Method

The χ^2 of this system is defined as :

$$\chi^2 = \boldsymbol{\delta}^T \boldsymbol{C}^{-1} \boldsymbol{\delta}$$

where, $\boldsymbol{C}$ is the covariance matrix from the uncertainties.

On minimizing the χ^2, i.e, on doing

$$\frac{d\chi^2}{dN} = 0,$$

N is obtained as a function of $\boldsymbol{\epsilon}$, $\boldsymbol{C}$ and $\boldsymbol{Y}$. Hence, $\boldsymbol{N_p}$ and $\boldsymbol{N_{np}}$ are found.

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING DATA-DRIVEN METHOD

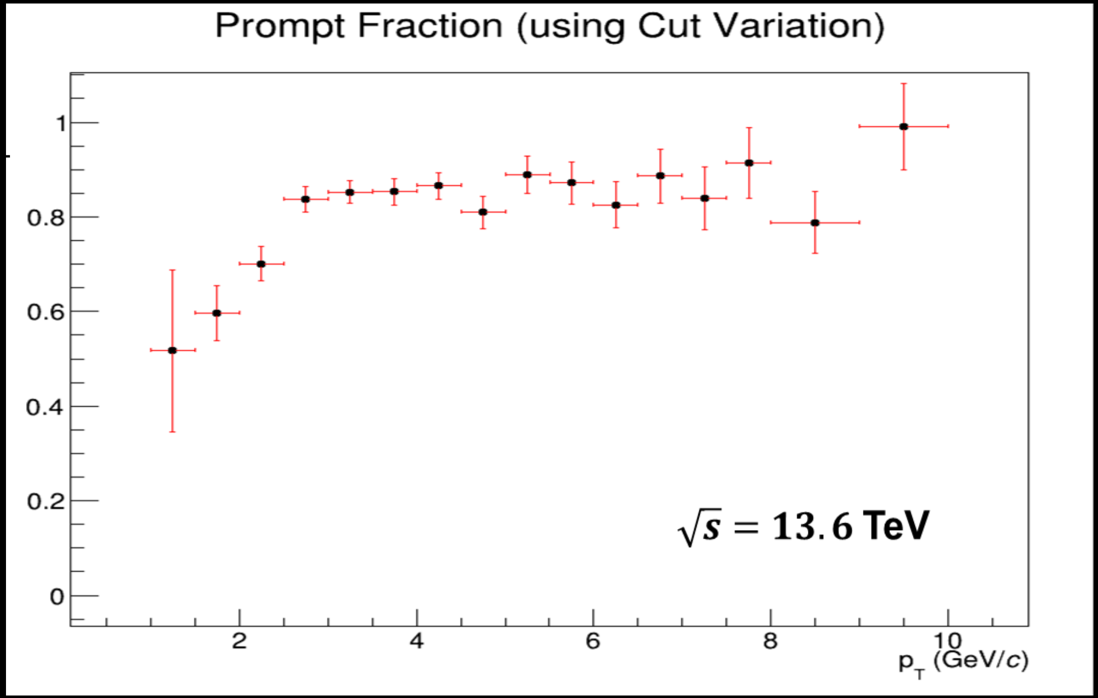
The Cut-Variation Method

Hence, on considering one of the 'm' sets as the default set, the Prompt Fraction for that ith set is calculated as :

$$f^{i}_{prompt} = \frac{(A \times \epsilon)^{p}_{i} \, . \, N_{p}}{(A \times \epsilon)^{p}_{i} \, . \, N_{p} + (A \times \epsilon)^{np}_{i} \, . \, N_{np}}$$

RESULTS

PROMPT FRACTION OF D*+ MESONS : USING DATA-DRIVEN METHOD



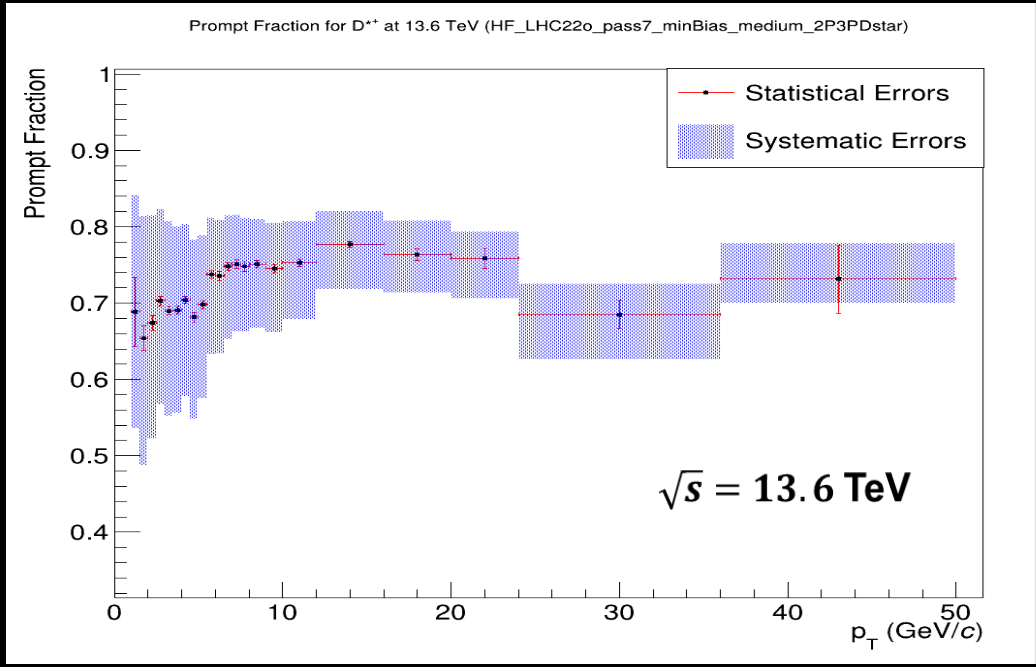


Fig. 17

(To be obtained for the higher p_T bins)

Data-driven and theory-driven Prompt Fractions are compatible within uncertainty limits

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

Different fit ranges

(2 x 6 = 12 sets)

Lower limit : 0.14, 0.1405 GeV/c^2 → ***2 sets***

Upper limit : 0.154, 0.156, 0.158, 0.16, 0.162, 0.164 GeV/c^2 → ***6 sets***

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

Different methods for computing raw yield

(2 sets)

- Integration method
- Bin Counting method

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

$$N(\Delta M - M_\pi)^{\lambda} e^{p_1(\Delta M - M_\pi) + p_2(\Delta M - M_\pi)^2 + p_3(\Delta M - M_\pi)^3}$$

$$a(\Delta M - M_\pi)^{p} e^{b(\Delta M - M_\pi)}$$

Different background functions

(2 sets)

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

$$f(x;\ \alpha_L, \alpha_R, \bar{x}, \sigma) = A \begin{cases} e^{\frac{\alpha_L{}^2}{2} + \alpha_L\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \leq (-\alpha_L) \\ e^{-\frac{(x-\bar{x})^2}{2\sigma^2}}, & if\ (-\alpha_L) < \frac{x-\bar{x}}{\sigma} < \alpha_R \\ e^{\frac{\alpha_R{}^2}{2} - \alpha_R\left(\frac{x-\bar{x}}{\sigma}\right)}, & if\ \frac{x-\bar{x}}{\sigma} \geq \alpha_R \end{cases}$$

$$f(x;\ \alpha_L, n_L, \alpha_R, n_R, \bar{x}, \sigma) = N \begin{cases} A_L\left(B_L - \frac{x-\bar{x}}{\sigma}\right)^{-n_L}, & if\ \frac{x-\bar{x}}{\sigma} \leq (-\alpha_L) \\ e^{-\frac{(x-\bar{x})^2}{2\sigma^2}}, & if\ (-\alpha_L) < \frac{x-\bar{x}}{\sigma} < \alpha_R \\ A_R\left(B_R + \frac{x-\bar{x}}{\sigma}\right)^{-n_R}, & if\ \frac{x-\bar{x}}{\sigma} \geq \alpha_R \end{cases}$$

Different signal functions

(2 sets)

RESULTS

SYSTEMATIC UNCERTAINTIES

Inherently present in the analysis process

By variation of fit parameters and fit functions, Systematic Uncertainties have been computed.

- **Different fit ranges** *(2 x 6 = 12 sets)*
- **Different methods for computing raw yield** *(2 sets)*
- **Different background functions** *(2 sets)*
- **Different signal functions** *(2 sets)*

12 x 2 x 2 x 2 = 96 sets (or 'options')

In each p_T bin, 96 values of raw yields and their corresponding statistical uncertainties are obtained

RESULTS

SYSTEMATIC UNCERTAINTIES

Not all options get selected !

Selection Criteria :

- $\chi^2/ndf \leq 3$
- *Statistical uncertainty corresponding to raw yield ≥ 0 and $\leq$ the raw yield*

RESULTS

SYSTEMATIC UNCERTAINTIES

In each p_T bin, for the i^{th} option, we define and compute the following :

- **Average Yield :**

$$\bar{Y} = \frac{1}{N}\sum_{i=1}^{N} Y_i$$

where, Y_i is the raw yield for the i^{th} option,

N is the no. of selected options

RESULTS

SYSTEMATIC UNCERTAINTIES

In each p_T bin, for the i[th] option, we define and compute the following :

- $$Y_{rms} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Y_i - \bar{Y})^2}$$

  where, Y_i is the raw yield for the i[th] option,

  N is the no. of selected options

- $$Y_{shift} = Y_{default} - \bar{Y}$$

  where, $Y_{default}$ is the default value of raw yield used to compute the final result

RESULTS

SYSTEMATIC UNCERTAINTIES

In each p_T bin, for the i^{th} option, we define and compute the following :

- **Systematic uncertainty :**

$$\sigma_{sys} = \sqrt{(Y_{rms})^2 + \left(Y_{shift}\right)^2}$$

RESULTS

SYSTEMATIC UNCERTAINTIES

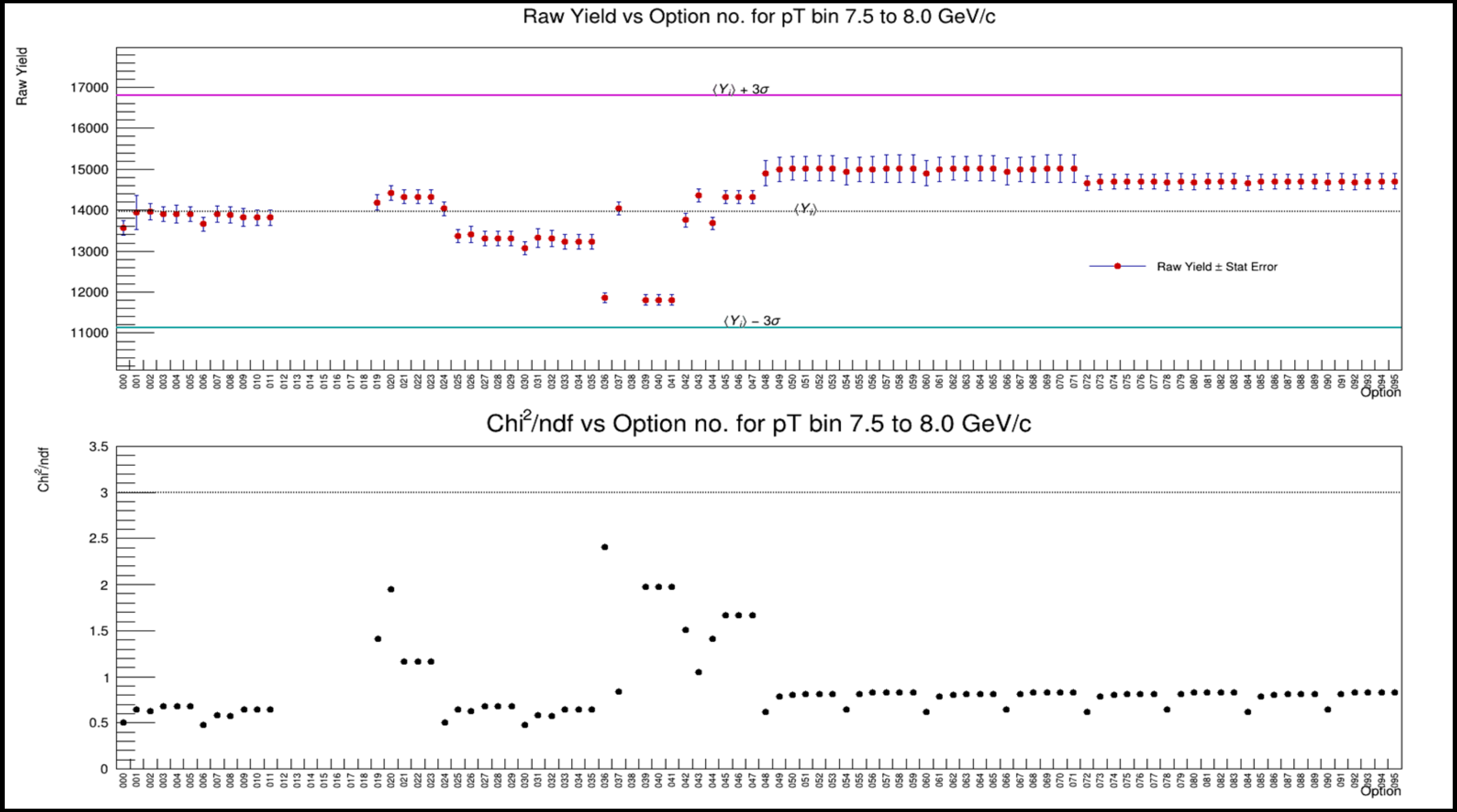


Fig. 18

This figure shows the raw yields and χ^2/ndf's for all the selected options in p_T bin 7.5-8 GeV/c. Such selections were performed over all p_T bins.

RESULTS

SYSTEMATIC UNCERTAINTIES

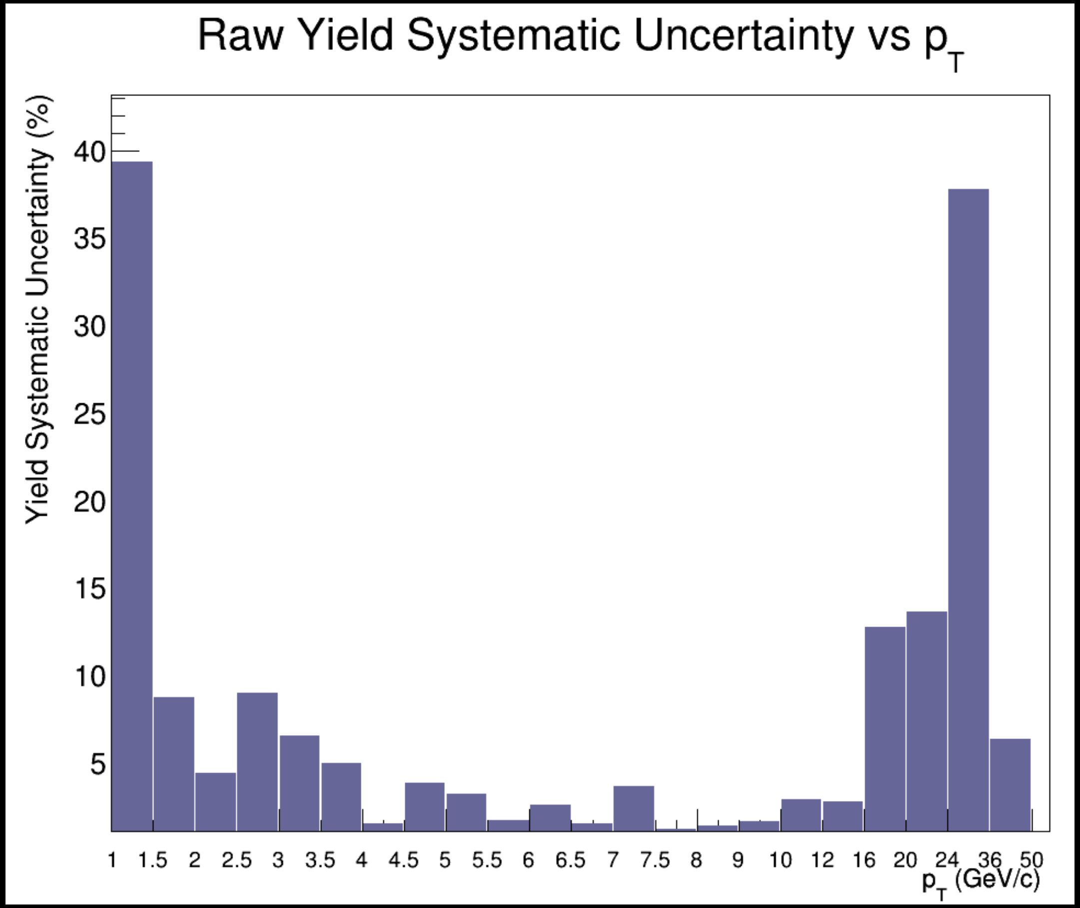


Fig. 19

Summary of Systematic Uncertainties computed by Variation of Fit Functions and Fit Parameters :

This figure shows the percentage of systematic uncertainty in raw yield in each of the p_T bins.

RESULTS

PRODUCTION CROSS SECTION OF PROMPT D*+ MESONS

$$\left.\frac{d\sigma^{D^{*+}}}{dp_T}\right|_{|y|<0.5} = \frac{1}{\Delta p_T}\frac{1}{BR\,.\,L_{int}}\frac{f_{prompt}(p_T)\cdot\frac{1}{2}N^{D^{*\pm}}_{raw}(p_T)\Big|_{|y|<y_{fid}}}{2\,y_{fid}(p_T)(Acc\times\epsilon)_{prompt}(p_T)}$$

where, $y_{fid} \equiv y_{fiducial}$; $\Delta y = 2y_{fid}$

$(Acc \times \varepsilon)_{prompt}$: (Acceptance x Efficiency) of Prompt D* mesons

RESULTS

PRODUCTION CROSS SECTION OF PROMPT D*+ MESONS

✓ *Obtained using* ***Theory-driven prompt fraction***

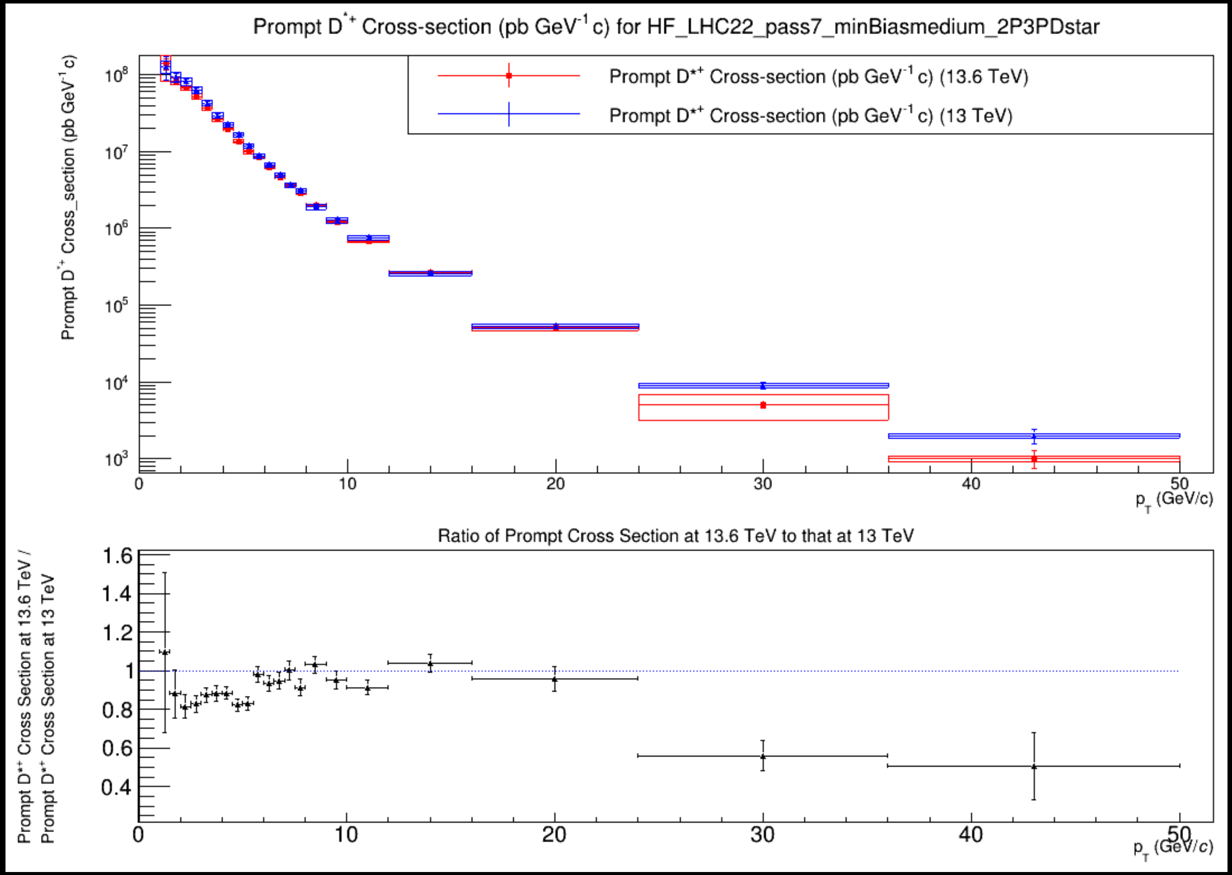


Fig. 20

Shows agreement with Run 2 result within uncertainty limits !

RESULTS

PRODUCTION CROSS SECTION OF PROMPT D*+ MESONS

- ✓ *Obtained using* ***Data-driven prompt fraction***

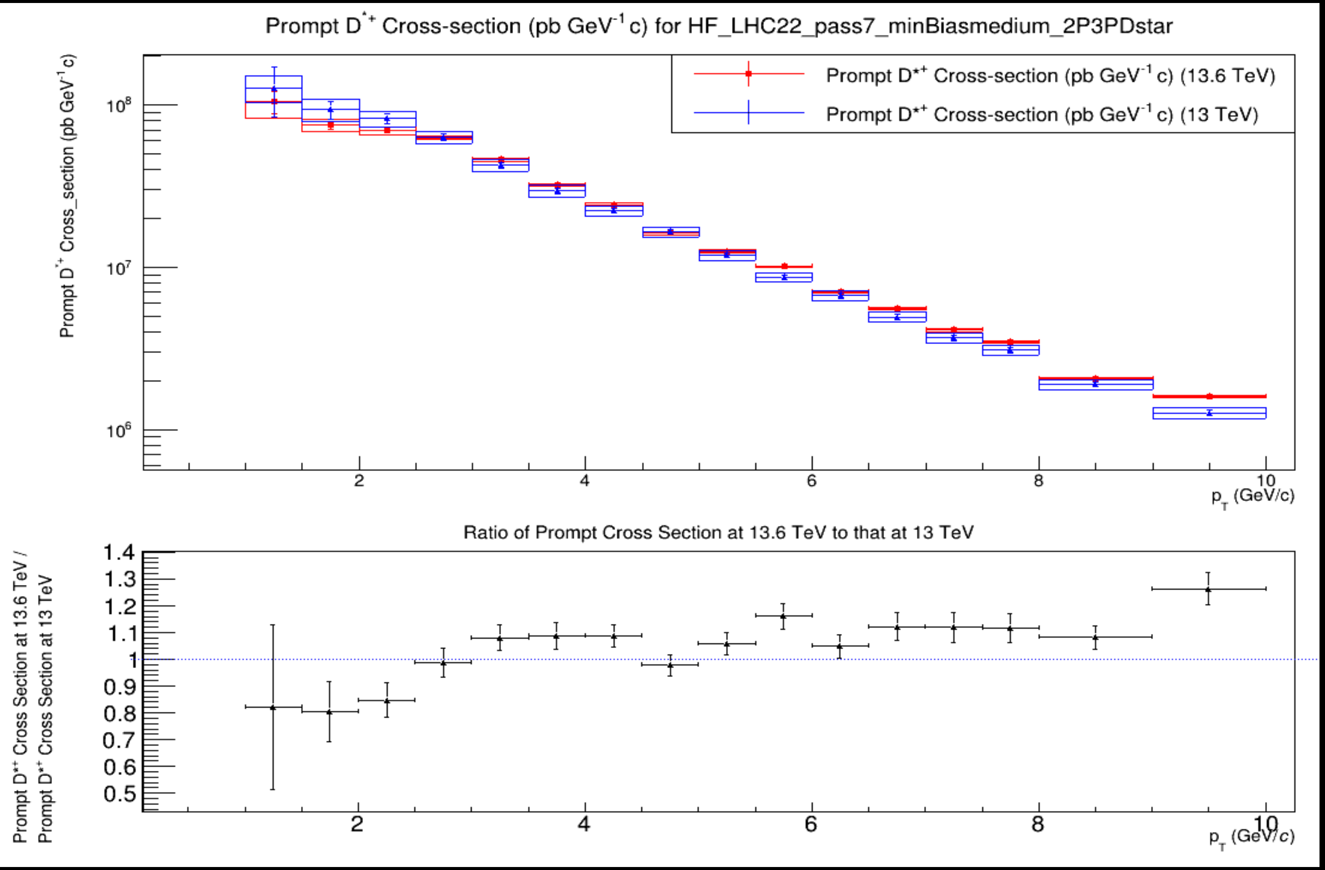


Fig. 21

Shows agreement with Run 2 result within uncertainty limits !

RESULTS

ALICE Performance Plots

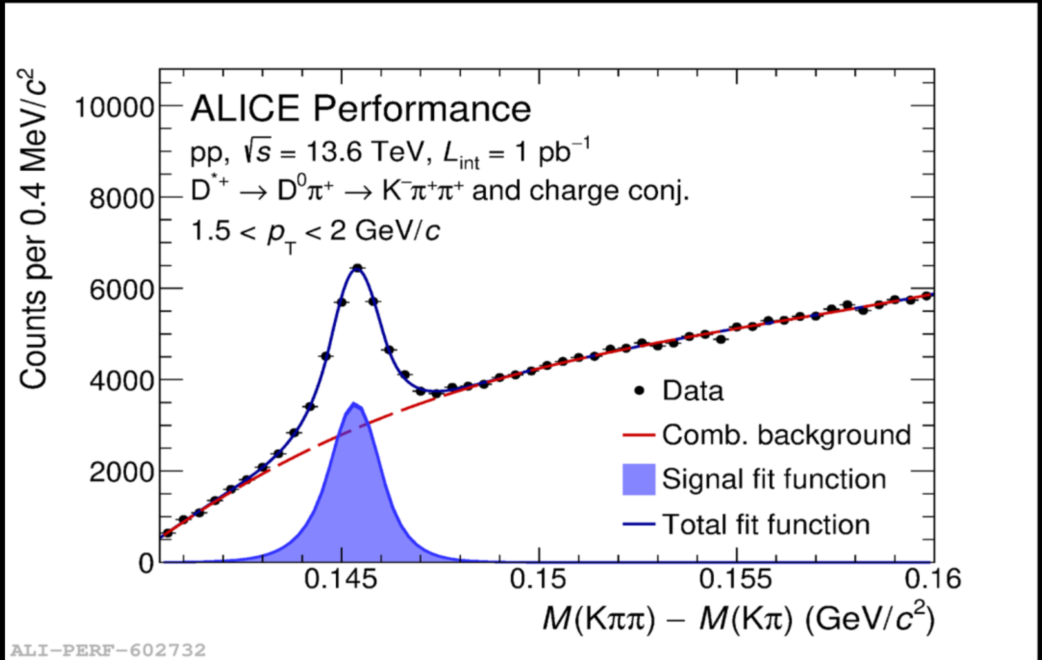


Fig. 22

https://alice-figure.web.cern.ch/node/34377

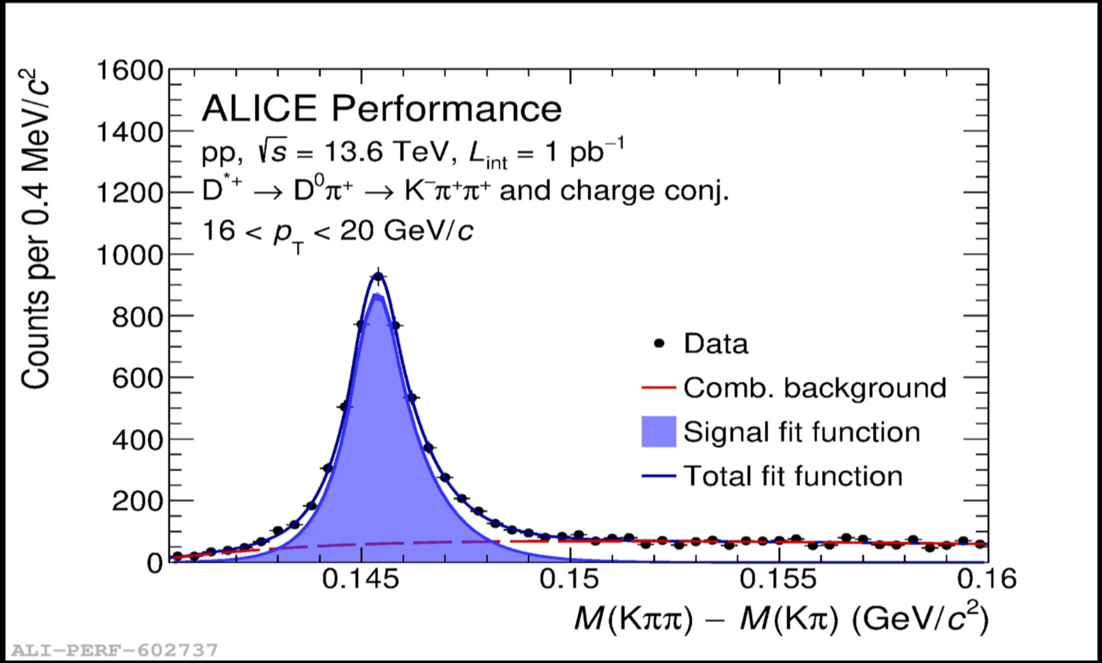


Fig. 23

https://alice-figure.web.cern.ch/node/34378

SUMMARY

- ❑ *First measurement of D* meson cross section in Run 3 in ALICE*
- ❑ *D* mesons have been reconstructed in $K\pi\pi$ decay channel using optimal set of topological cuts*
- ❑ *Signal peak position and width are consistent with PDG values within uncertainty*
- ❑ *Efficiency-corrected inclusive and prompt cross sections of D^{*+} have been obtained as a function of p_T*
- ❑ *Results are found to be consistent with Run 2 measurement at 13 TeV pp collision*

OUTLOOK

- *The D^{*+} cross-section study shall be targeted for ALICE Preliminary approval*
- *Planning to study the same using ML techniques in future. Currently learning such techniques*

Thanks to Deependra Sharma for the collaborative work !

Thank you !

Backup

D* Reconstruction (D^0 Cuts)

pT Bins (GeV/c)	m	DCA	Cos theta*	pT K	pT pi	d0 K	d0 pi	d0d0	Cos pointing angle	Cos pointing angle xy	Min Norm Decay Length xy	Max decay length	Max decay length XY	Min decay length	Norm dauImpPar XY
0-0.5	0.07	0.035	0.8	0.5	0.5	0.1	0.1	-0.00005	0.8	0	0	10	10	0.02	0.5
0.5-1	0.07	0.035	0.8	0.5	0.5	0.1	0.1	-0.00005	0.8	0	0	10	10	0.02	0.5
1-1.5	0.07	0.030	0.8	0.4	0.4	0.1	0.1	-0.00025	0.8	0	0	10	10	0.03	0.5
1.5-2	0.07	0.030	0.8	0.4	0.4	0.1	0.1	-0.00025	0.8	0	0	10	10	0.03	0.5
2-2.5	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.0002	0.9	0	0	10	10	0.04	0.5
2.5-3	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.0002	0.9	0	0	10	10	0.04	0.5
3-3.5	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.00012	0.85	0	0	10	10	0.05	0.5
3.5-4	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.00012	0.85	0	0	10	10	0.05	0.5
4-4.5	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5
4.5-5	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5
5-5.5	0.07	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5
5.5-6	0.12	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5

D* Reconstruction (D^0 Cuts)

pT Bins (GeV/c)	m	DCA	Cos theta*	pT K	pT pi	d0 K	d0 pi	d0d0	Cos pointing angle	Cos pointing angle xy	Min Norm Decay Length xy	Max decay length	Max decay length XY	Min decay length	Norm dauImpPar XY
6-6.5	0.12	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5
6.5-7	0.12	0.030	0.8	0.7	0.7	0.1	0.1	-0.00008	0.85	0	0	10	10	0.06	0.5
7-7.5	0.12	0.030	0.8	0.7	0.7	0.1	0.1	-0.00007	0.85	0	0	10	10	0.06	0.5
7.5-8	0.12	0.030	0.8	0.7	0.7	0.1	0.1	-0.00007	0.85	0	0	10	10	0.06	0.5
8-9	0.12	0.030	0.9	0.7	0.7	0.1	0.1	-0.00005	0.85	0	0	10	10	0.06	0.5
9-10	0.12	0.030	0.9	0.7	0.7	0.1	0.1	-0.00005	0.85	0	0	10	10	0.06	0.5
10-12	0.12	0.030	0.9	0.7	0.7	0.1	0.1	-0.00005	0.85	0	0	10	10	0.06	0.5
12-16	0.12	0.030	1	0.7	0.7	0.1	0.1	0.0001	0.85	0	0	10	10	0.06	0.5
16-20	0.12	0.030	1	0.7	0.7	0.1	0.1	0.00999999	0.85	0	0	10	10	0.06	0.5
20-24	0.12	0.030	1	0.7	0.7	0.1	0.1	0.00999999	0.85	0	0	10	10	0.06	0.5
24-36	0.12	0.030	1	0.7	0.7	0.1	0.1	0.00999999	0.85	0	0	10	10	0.06	0.5
36-50	0.12	0.030	1	0.7	0.7	0.1	0.1	0.00999999	0.85	0	0	10	10	0.06	0.5
50-100	0.12	0.030	1	0.6	0.6	0.1	0.1	0.00999999	0.8	0	0	10	10	0.06	0.5

D* Reconstruction (D* Cuts)

pT Bins (GeV/c)	pTSoftPiMin	pTSoftPiMax	d0SoftPi	d0SoftPiNormalised	deltaMInvDstar	chi2PCA	d0Prong0Normalised	d0Prong1Normalised
0-0.5	0.1	0.2	0.1	1000	0.2	300	0	0
0.5-1	0.1	0.2	0.1	1000	0.2	300	0	0
1-1.5	0.1	0.3	0.1	1000	0.2	300	0	0
1.5-2	0.1	0.3	0.1	1000	0.2	300	0	0
2-2.5	0.1	0.4	0.1	1000	0.2	300	0	0
2.5-3	0.1	0.4	0.1	1000	0.2	300	0	0
3-3.5	0.1	0.6	0.1	1000	0.2	300	0	0
3.5-4	0.1	0.6	0.1	1000	0.2	300	0	0
4-4.5	0.1	100	0.1	1000	0.2	300	0	0
4.5-5	0.1	100	0.1	1000	0.2	300	0	0
5-5.5	0.1	100	0.1	1000	0.2	300	0	0
5.5-6	0.1	100	0.1	1000	0.2	300	0	0

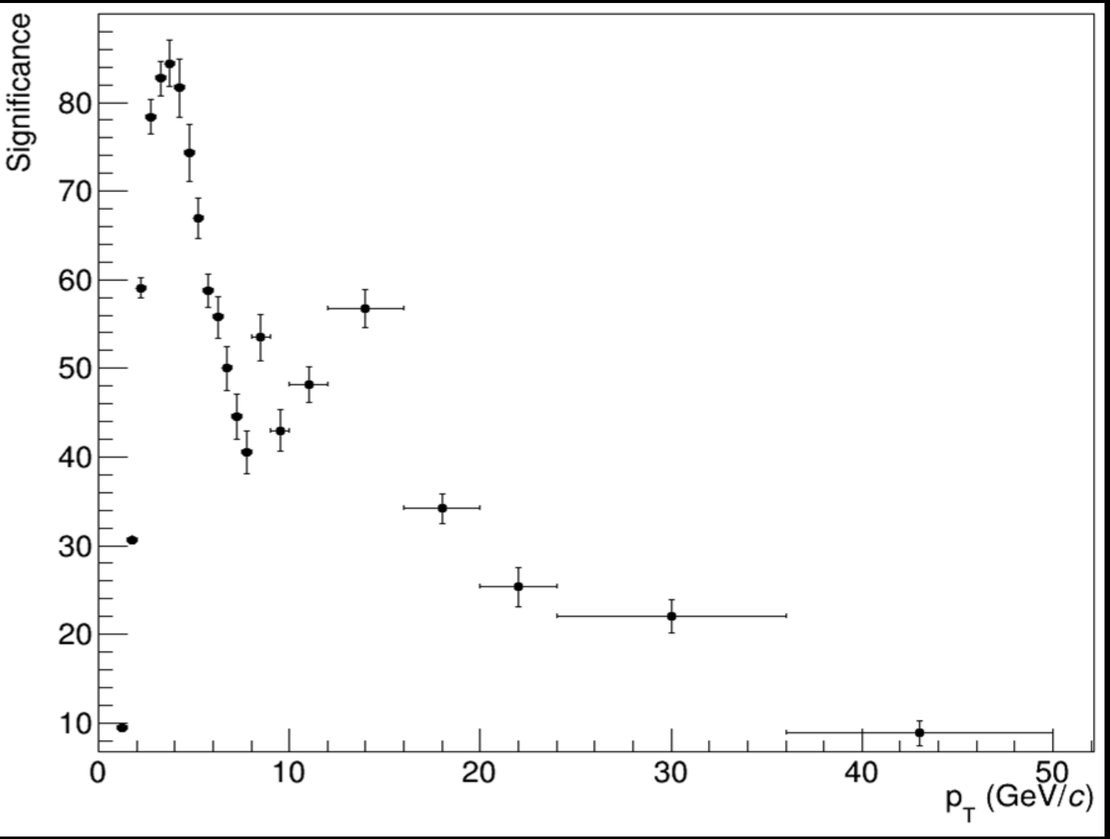
D* Reconstruction (D* Cuts)

pT Bins (GeV/c)	pTSoftPiMin	pTSoftPiMax	d0SoftPi	d0SoftPiNormalised	deltaMInvDstar	chi2PCA	d0Prong0Normalised	d0Prong1Normalised
6-6.5	0.1	100	0.1	1000	0.2	300	0	0
6.5-7	0.1	100	0.1	1000	0.2	300	0	0
7-7.5	0.1	100	0.1	1000	0.2	300	0	0
7.5-8	0.1	100	0.1	1000	0.2	300	0	0
8-9	0.1	100	0.1	1000	0.2	300	0	0
9-10	0.1	100	0.1	1000	0.2	300	0	0
10-12	0.1	100	0.1	1000	0.2	300	0	0
12-16	0.1	100	0.1	1000	0.2	300	0	0
16-20	0.1	100	0.1	1000	0.2	300	0	0
20-24	0.1	100	0.1	1000	0.2	300	0	0
24-36	0.1	100	0.1	1000	0.2	300	0	0
36-50	0.1	100	0.1	1000	0.2	300	0	0
50-100	0.1	100	0.1	1000	0.2	300	0	0

Statistical Significance vs p_T

$$\boldsymbol{Stat.\ Significance} = \frac{\boldsymbol{S}}{\sqrt{\boldsymbol{S}+\boldsymbol{B}}}$$

where, $\boldsymbol{S}$ and $\boldsymbol{B}$ are the extracted signal and background respectively, obtained from the fit procedure integrated within 3$\boldsymbol{\sigma}$ around the peak



Systematic Uncertainties Summary

p_T Bins (GeV/c)	Default Raw Yield	Average Raw Yield	Y_{rms}	Y_{shift}	Y_systematic_error
1-1.5	332	271.57	115.82 (34.89%)	60.43 (18.20%)	130.64 (39.35%)
1.5-2	2742	2697.48	236.92 (8.64%)	44.52 (1.62%)	241.06 (8.79%)
2-2.5	4121	4087.24	178.83 (4.34%)	33.76 (0.82%)	181.99 (4.42%)
2.5-3	6518	6437.49	582.51 (8.94%)	80.51 (1.24%)	588.05 (9.02%)
3-3.5	6732	6759.21	439.80 (6.53%)	-27.21 (0.40%)	440.64 (6.55%)
3.5-4	6233	6223.82	310.80 (4.99%)	9.18 (0.15%)	310.94 (4.99%)
4-4.5	5739	5778.30	78.36 (1.37%)	-39.30 (0.68%)	87.66 (1.53%)
4.5-5	4464	4521.13	163.06 (3.65%)	-57.13 (1.28%)	172.78 (3.87%)
5-5.5	4070	4119.09	123.80 (3.04%)	-49.09 (1.21%)	133.18 (3.27%)
5.5-6	4047	4088.21	58.56 (1.45%)	-41.21 (1.02%)	71.61 (1.77%)
6-6.5	3474	3515.83	80.73 (2.32%)	-41.83 (1.20%)	90.92 (2.62%)
6.5-7	2992	3023.13	35.27 (1.18%)	-31.13 (1.04%)	47.05 (1.57%)
7-7.5	2573	2637.99	69.98 (2.72%)	-64.99 (2.53%)	95.51 (3.71%)
7.5-8	2194	2209.64	22.69 (1.03%)	-15.64 (0.71%)	27.56 (1.26%)

Systematic Uncertainties Summary

p_T Bins (GeV/c)	Default Raw Yield	Average Raw Yield	Y_{rms}	Y_{shift}	Y_systematic_error
8-9	3674	3703.74	43.03 (1.17%)	-29.74 (0.81%)	52.31 (1.42%)
9-10	2665	2669.24	44.79 (1.68%)	-4.24 (0.16)	44.99 (1.69%)
10-12	3471	3473.02	101.99 (2.94%)	-2.02 (0.06%)	102.01 (2.94%)
12-16	4498	4434.51	109.64 (2.44%)	63.49 (1.41%)	126.70 (2.82%)
16-20	1919	1980.29	237.79 (12.39%)	-61.29 (3.19%)	245.57 (12.79%)
20-24	850	869.94	114.16 (13.43%)	-19.94 (2.35%)	115.89 (13.63%)
24-36	575	739.43	141.79 (24.66%)	-164.43 (28.59%)	217.12 (37.76%)
36-50	132	127.19	6.94 (5.26%)	4.81 (3.64%)	8.44 (6.39%)

PROMPT FRACTION OF D^{*+} MESONS : USING THEORY-DRIVEN METHOD

$$f_{prompt} = 1 - \left(\frac{d^2\sigma}{dy\, dp_T}\right)^{FONLL}_{non-prompt} \cdot \frac{(Acc \times \epsilon)_{non-prompt} \cdot \Delta y \Delta p_T \cdot BR \cdot L_{int}}{N^{D^*}{}_{raw}/2}$$

Beauty production cross section (pb/GeV), obtained from FONLL calculations

(Acceptance x Efficiency) of Non-Prompt D* mesons

Raw Yield of D* Mesons (sum of D^{*+} and D^{*-})

To get the average from contribution of both particles and antiparticles

Rapidity Interval

p_T Interval (GeV)

Decay Channel Branching Ratio

Integrated Luminosity (pb^{-1})

ALICE Performance Plot : https://alice-figure.web.cern.ch/node/34377

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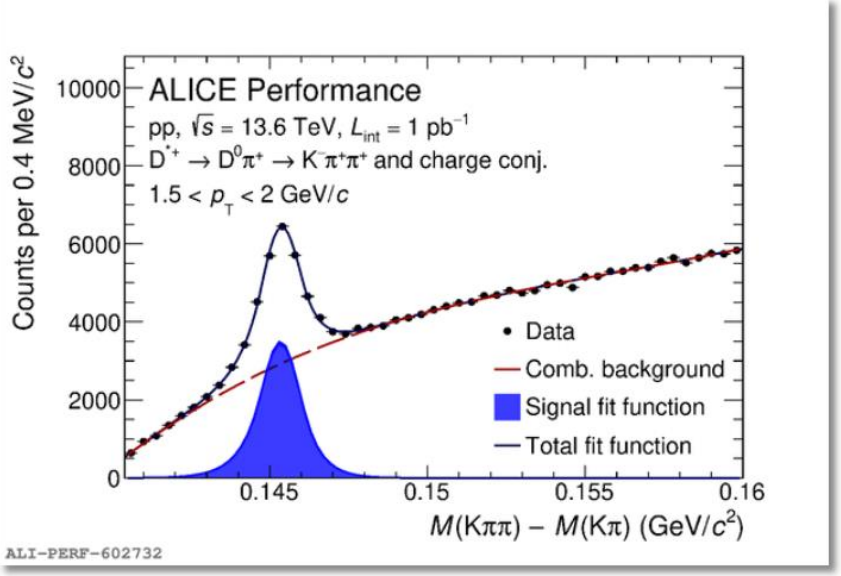
Type: Performance
Scope: PWG: PWG-HF (Heavy Flavour)
Scope: PAG: PAG-HF-D2H
Energy: 13.6 TeV
System: p-p
Figure Group: Minimum Bias $D^{*\pm}$ production in pp collisions at $\sqrt{s}$ = 13.6 TeV with ALICE at LHC
ID number: ALI-PERF-602732
Figure Image:



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Scope: PAG: PAG-HF-D2H

Energy: 13.6 TeV

System: p-p

Figure Group: Minimum Bias $D^{*\pm}$ production in pp collisions at $\sqrt{s}$ = 13.6 TeV with ALICE at LHC

ID number: ALI-PERF-602737

Figure Image: