Study of D mesons at LHC with the ALICE detector in p+p @ 7 TeV

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on behalf of the ALICE Collaboration

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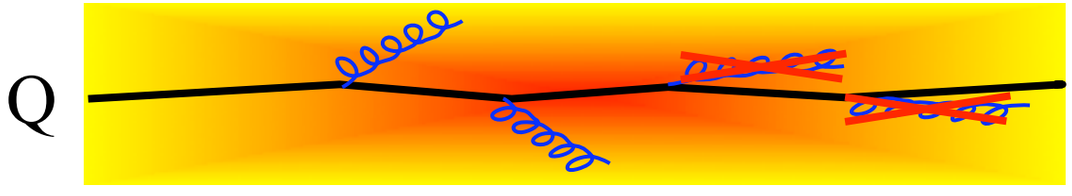
Heavy Flavour in ALICE

- **the goal is to study charm (beauty) in Pb-Pb :**

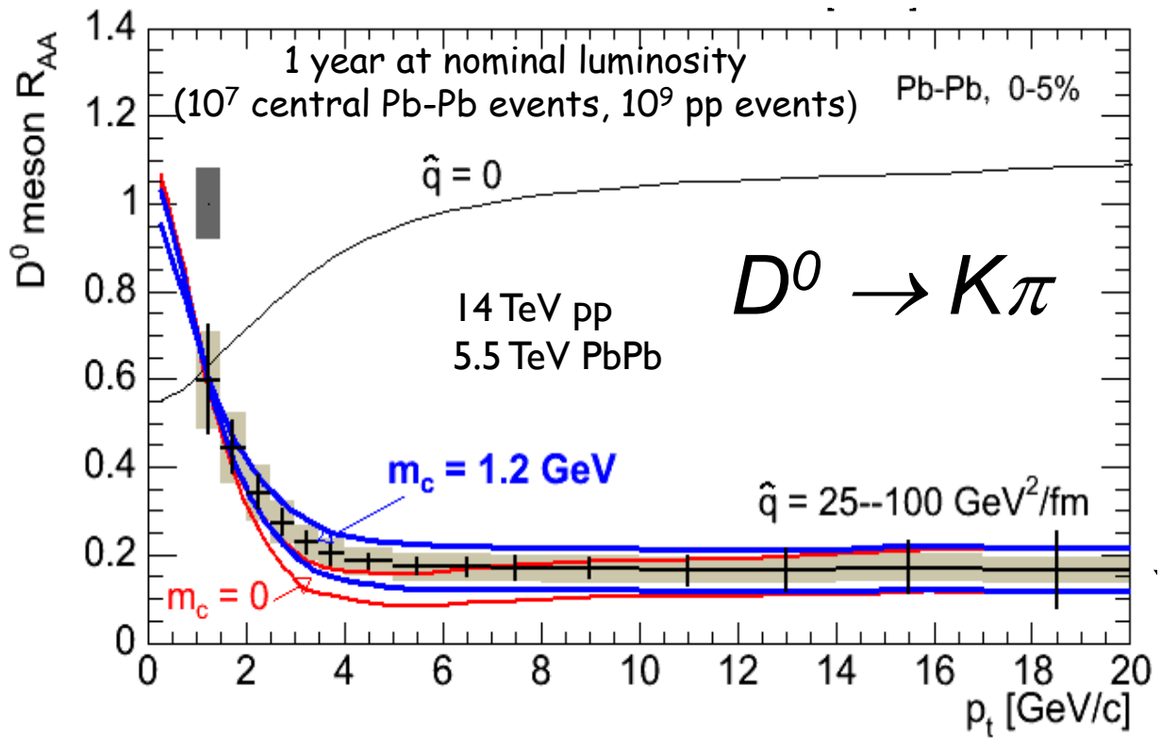
1) Less energy loss expected *Y. Dokshitzer & D. Kharzeev PLB 519(2001)199*
2) Small interaction cross section → difficult to thermalize → heavy flavour elliptic flow is more stringent test of thermalization.
3) Is temperature high enough for thermal production?

$$R_{AA}^{D,B}(p_t) = \frac{1}{N_{coll}} \times \frac{dN_{AA}^{D,B}/dp_t}{dN_{pp}^{D,B}/dp_t}$$

yield in PbPb / *yield in pp*



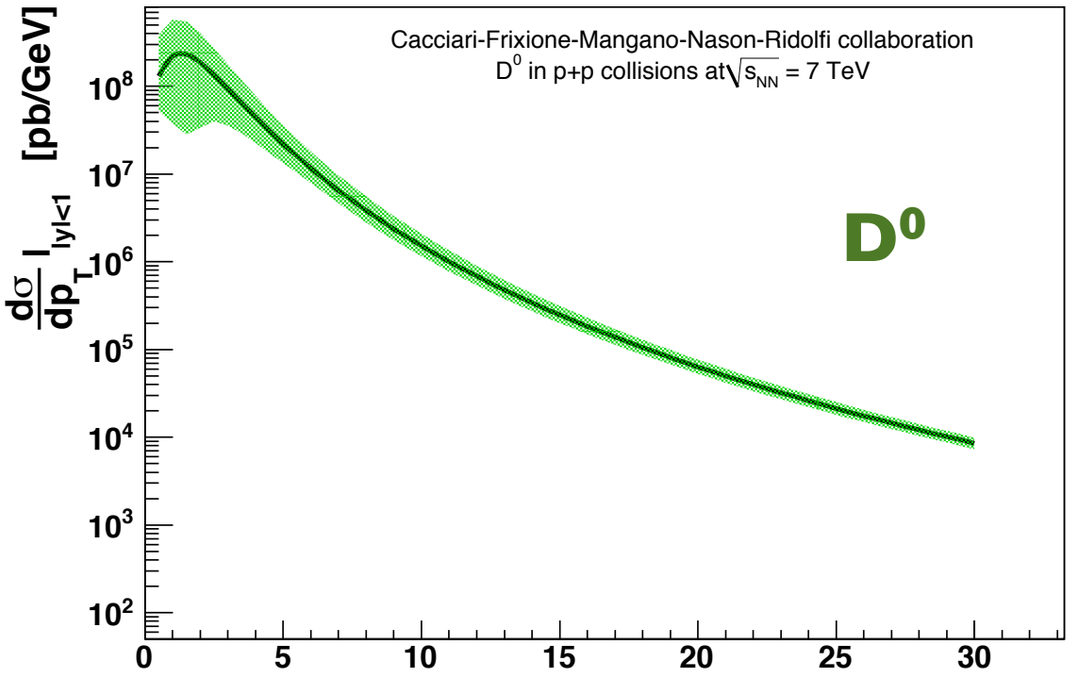
gluon radiation suppressed $\theta < m_Q/E_Q$
→ less energy loss in medium



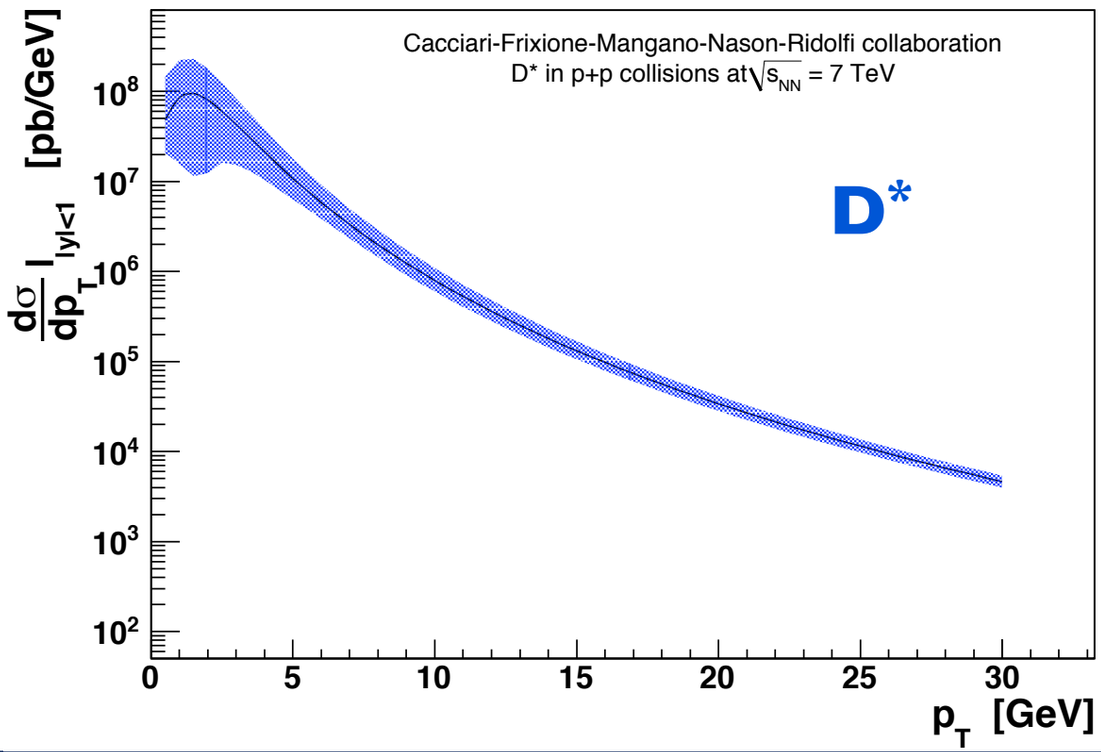
Heavy Flavour in ALICE

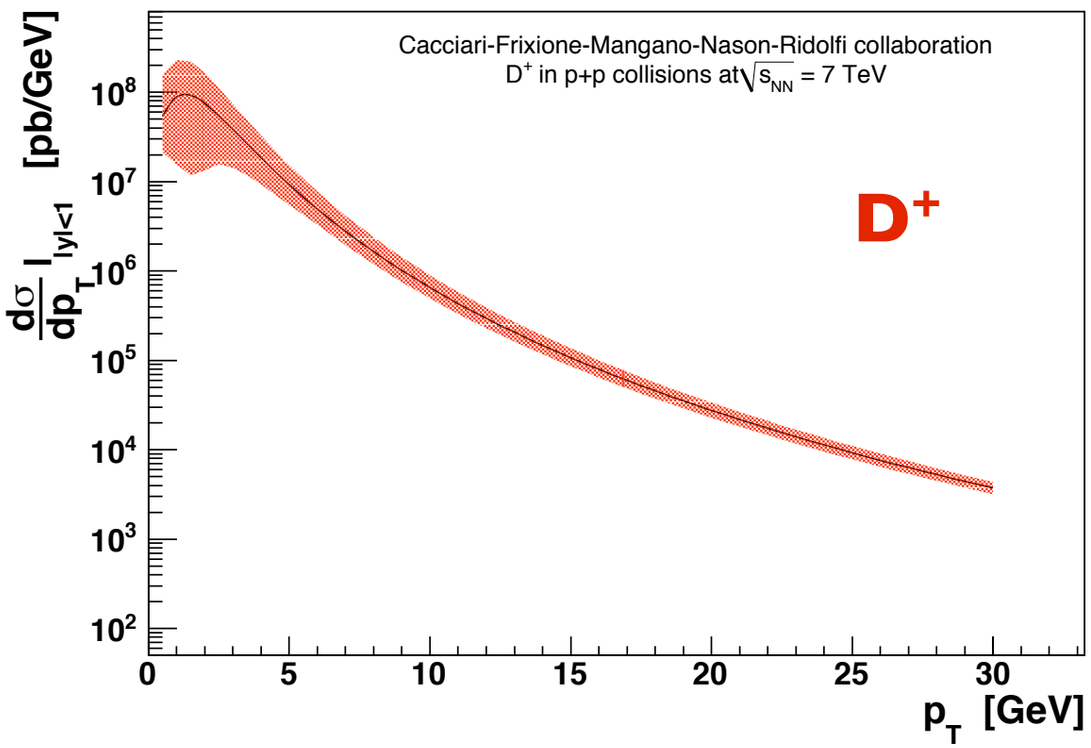
than why p-p?

1) Baseline for Pb-Pb, we need a solid understanding of the cross sections. Test the QCD predictions and initial state effects.



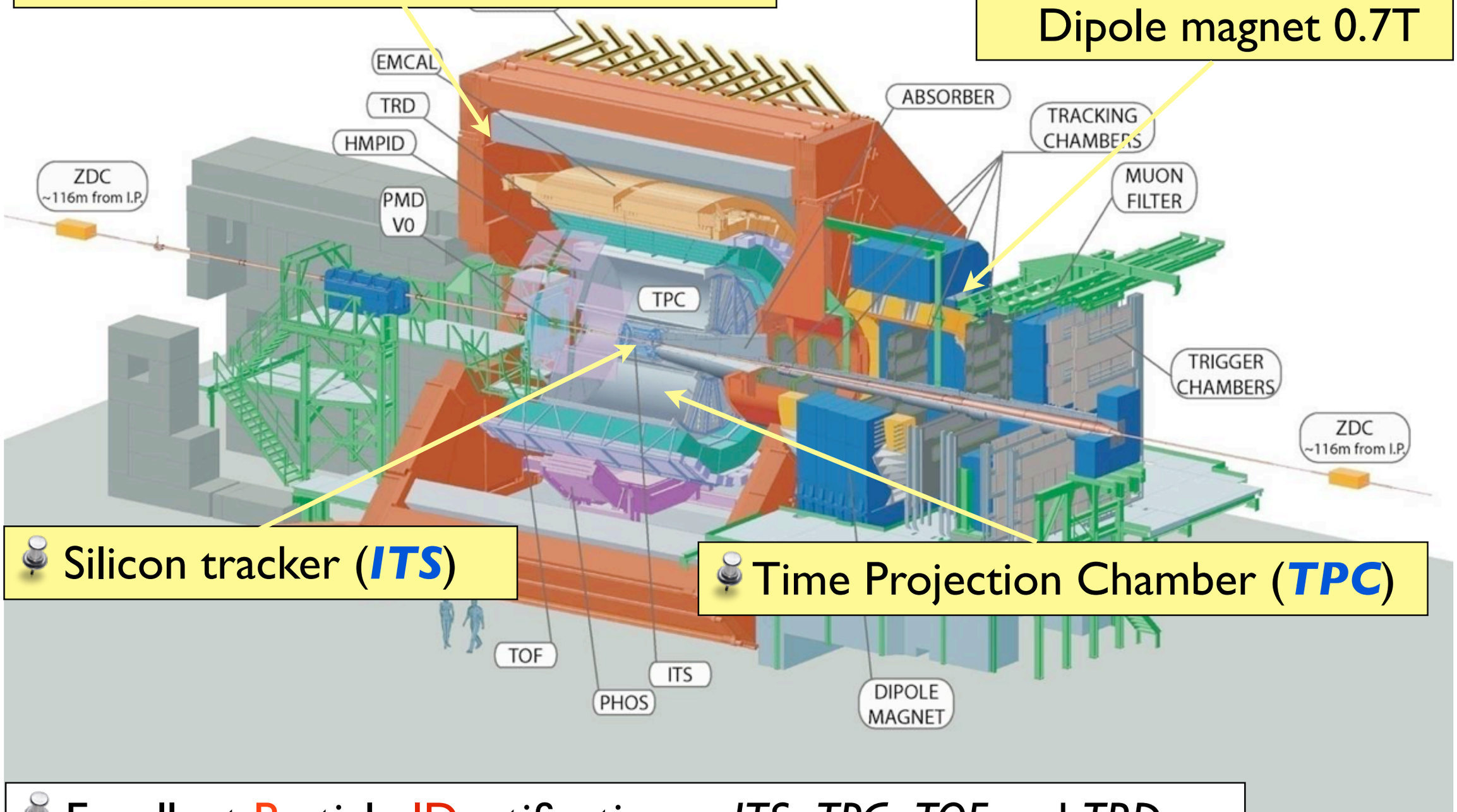
Cacciari, Frixione, Mangano, Nason, Ridolfi





The ALICE detector

- Central barrel acceptance $|\eta| < 0.9$.
  Magnetic field B=0.5T
- Forward muon arm.
  Dipole magnet 0.7T

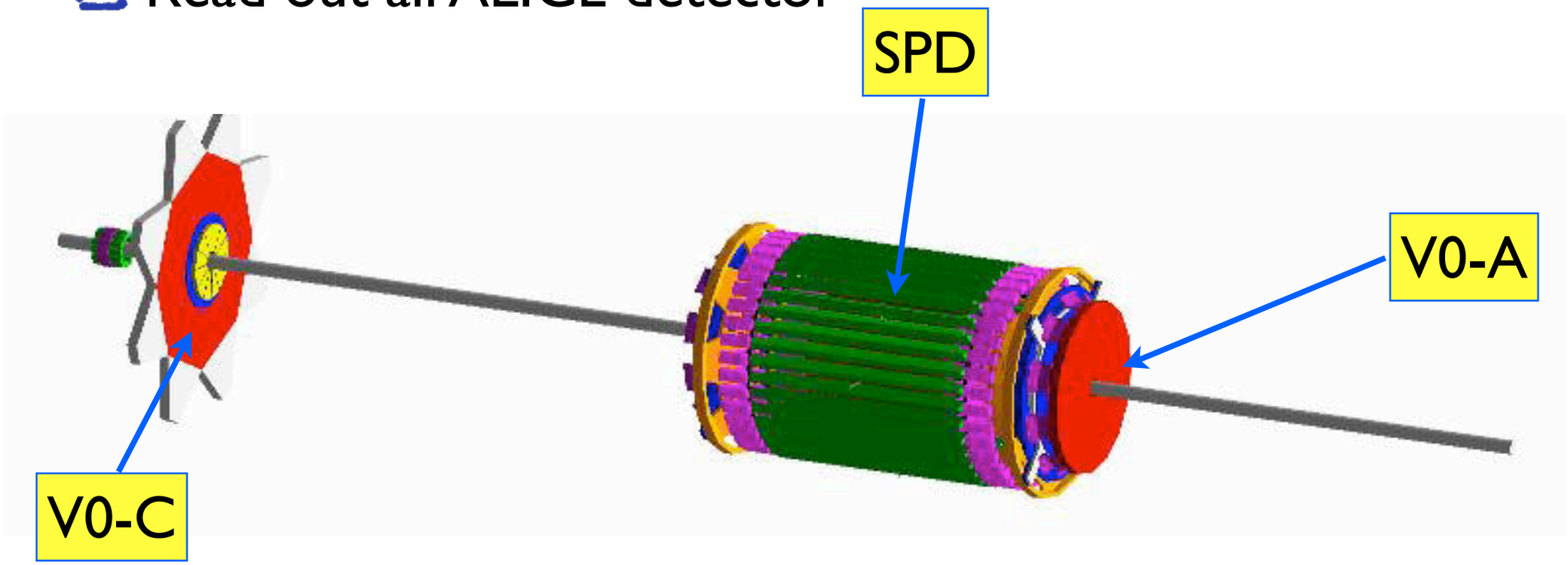


- Silicon tracker (***ITS***)
- Time Projection Chamber (***TPC***)

- Excellent Particle IDentification: *ITS, TPC, TOF* and *TRD*.

Trigger and sample

- **Minimum bias** based on interaction trigger:
  - *SPD(pixels)* or *V0-A(scintillators)* or *V0-C(scintillators)*
  - At least one charged particle in 8 η units
  - Read out all ALICE detector



- By 7th of July ~ 3×10^8 minimum bias events @ 7 TeV recorded.

Open charm analysis channels

- Many channels under study:

  - ☑ $D^0 \rightarrow K^-\pi^+$ *(BR = (3.89±0.05)%, cτ = 123 μm)*
  - ☑ $D^{*+} \rightarrow D^0\pi^+_s$ *(BR = (67.7±0.5)%)*
  - ☑ $D^+ \rightarrow \pi^+ K^-\pi^+$ *(BR = (9.22±0.21)%, cτ = 311.8 μm)*
  - ☑ $D^0 \rightarrow K^-\pi^+ \pi^- \pi^+$ *(BR = (8.10±0.20)%, cτ = 123 μm)*
  - ☐ $D_s \rightarrow KK\pi$
  - ☐ $\Lambda_c \rightarrow \pi Kp$
  - ☐ ...

- Let's concentrate on the first four

Selection strategy

☑ Single track selections similar for each channel (>70 points in TPC, ≥4 clusters in ITS *(>=1 SPD)*, π_s from D^* also with ITS stand-alone).

📌 **$D^0 \rightarrow K^-\pi^+$**

✓ topological selections based on displaced vertex reconstruction

📌 **$D^{*+} \rightarrow D^0\pi^+_s$** *(strong decay, seconday vertex not resolved)*

$\hookrightarrow D^0 \rightarrow K^-\pi^+$

✓ topological selection on D^0 (similar as for D^0 analysis)

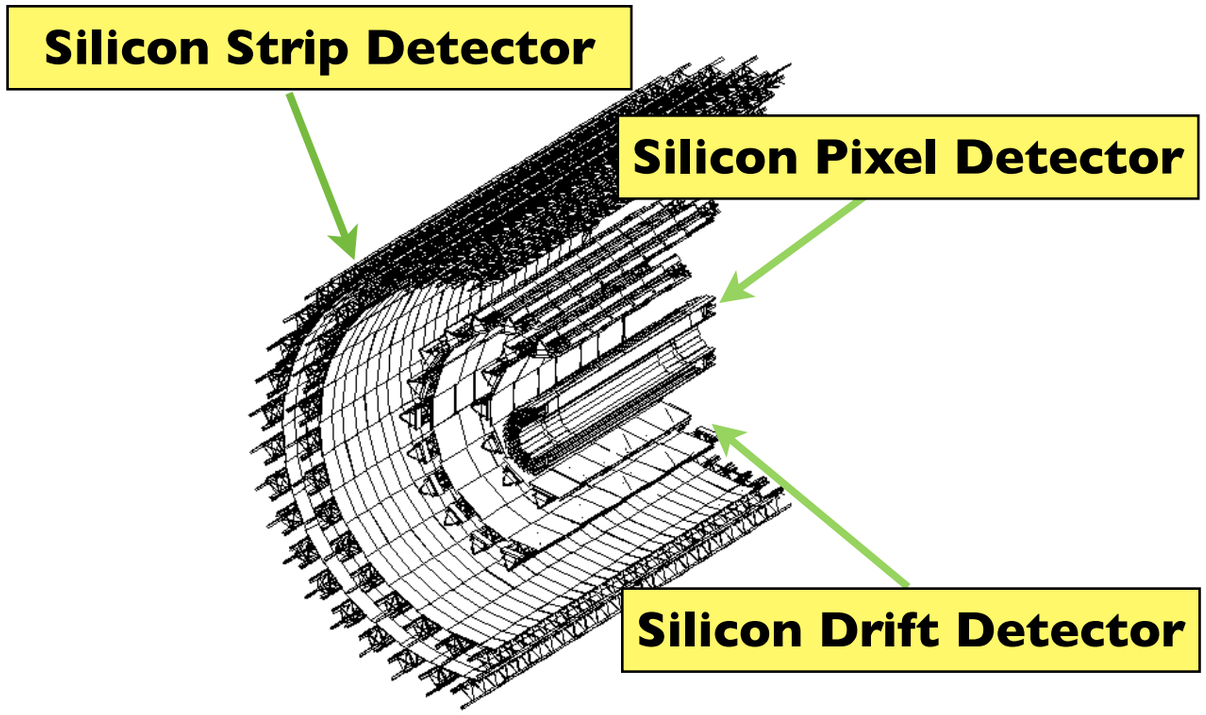
📌 **$D^+ \rightarrow K^-\pi^+\pi^+$, $D^0 \rightarrow K^-\pi^+\pi^-\pi^+$**

- topological selection based on 3(4) prong displaced vertex reconstruction

☑ In each one of the four channels PID used to identify kaons and pions.

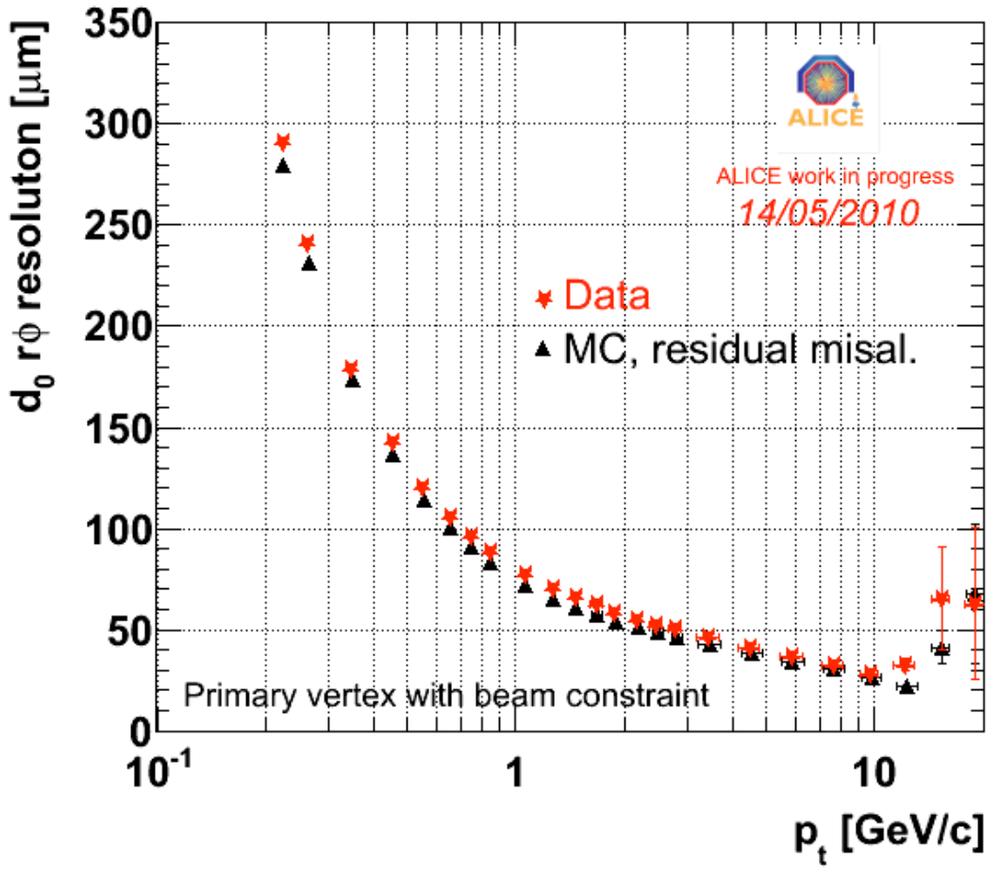
Silicon Tracker for vertexing

- Main vertex detector for Heavy flavour is the Inner Tracking System



Layer	Technology	Radius (cm)	±z (cm)	Spatial resolution (μm)	
				rϕ	z
1	Pixel	4.0	14.1	12	100
2	Pixel	7.2	14.1	12	100
3	Drift	15.0	22.2	38	28
4	Drift	23.9	29.7	38	28
5	Strip	38.5	43.2	20	830
6	Strip	43.6	48.9	20	830

impact parameter (d_0)



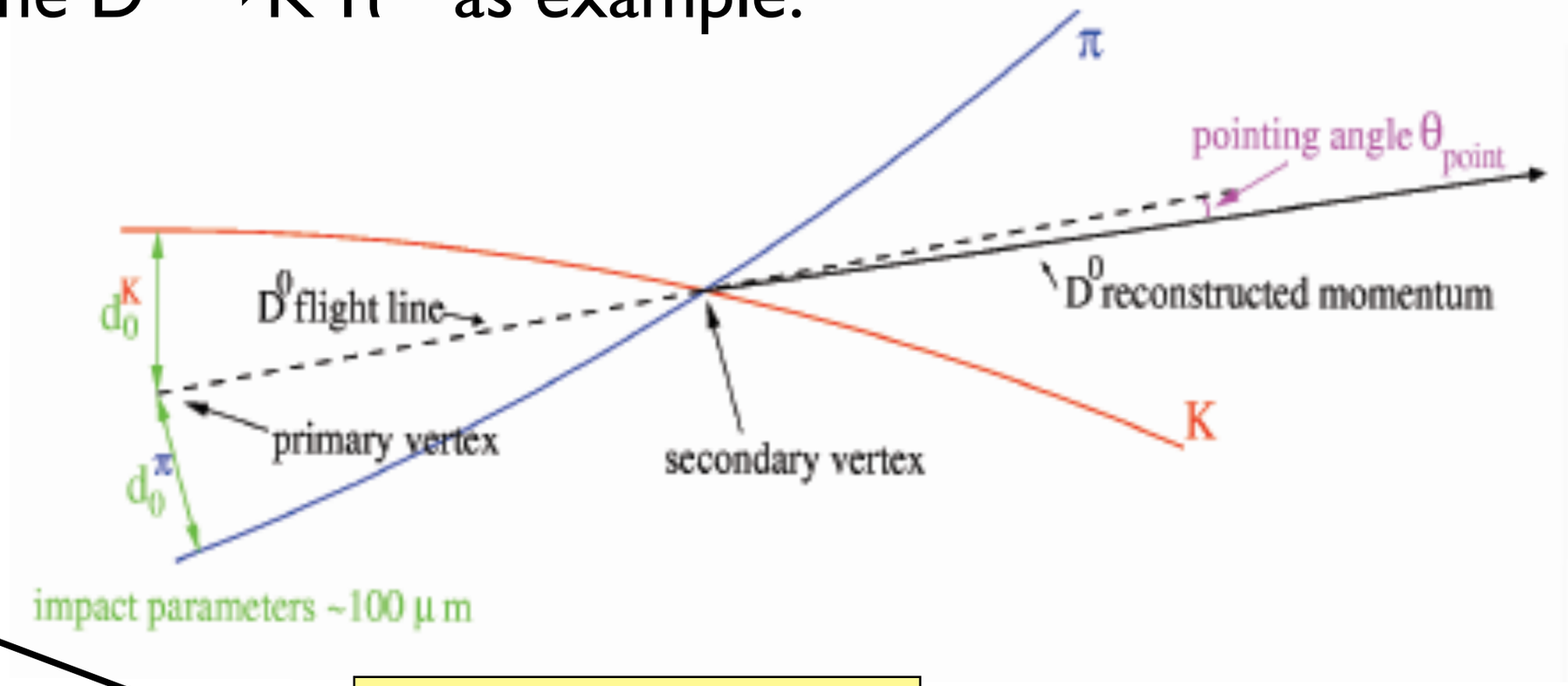
<d0(rφ)> ~cτ~100-300 μm

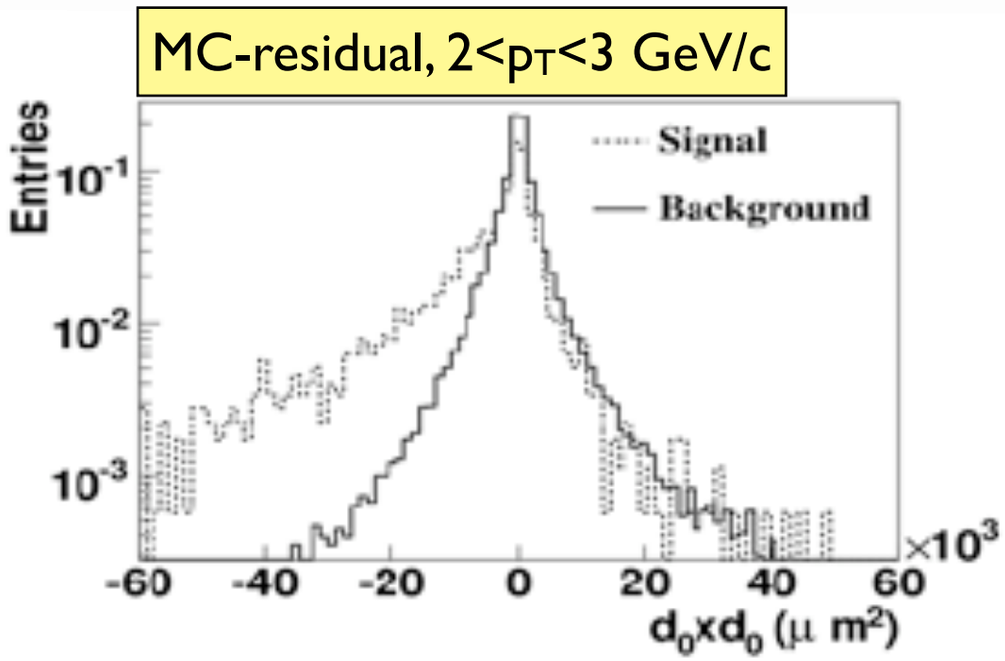
- 6 silicon layers, three different technologies. (*SPD*, *SDD*, *SSD*)

Topological selections: Hints

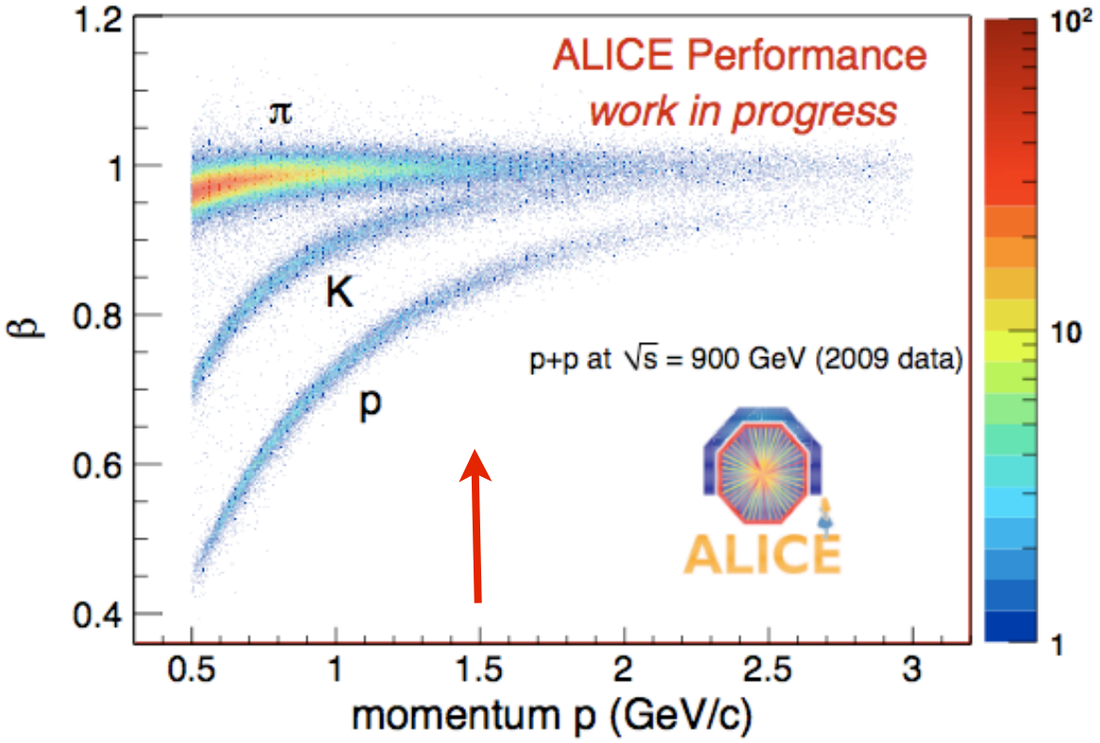
☑ let's take the $D^0 \rightarrow K^-\pi^+$ as example.

d_{0K}
$d_{0\pi}$
$d_{0K} \times d_{0\pi}$
p_{TK}
$p_{T\pi}$
$\cos(\theta_{point})$
$\cos(\theta^*)$
DCA
.....



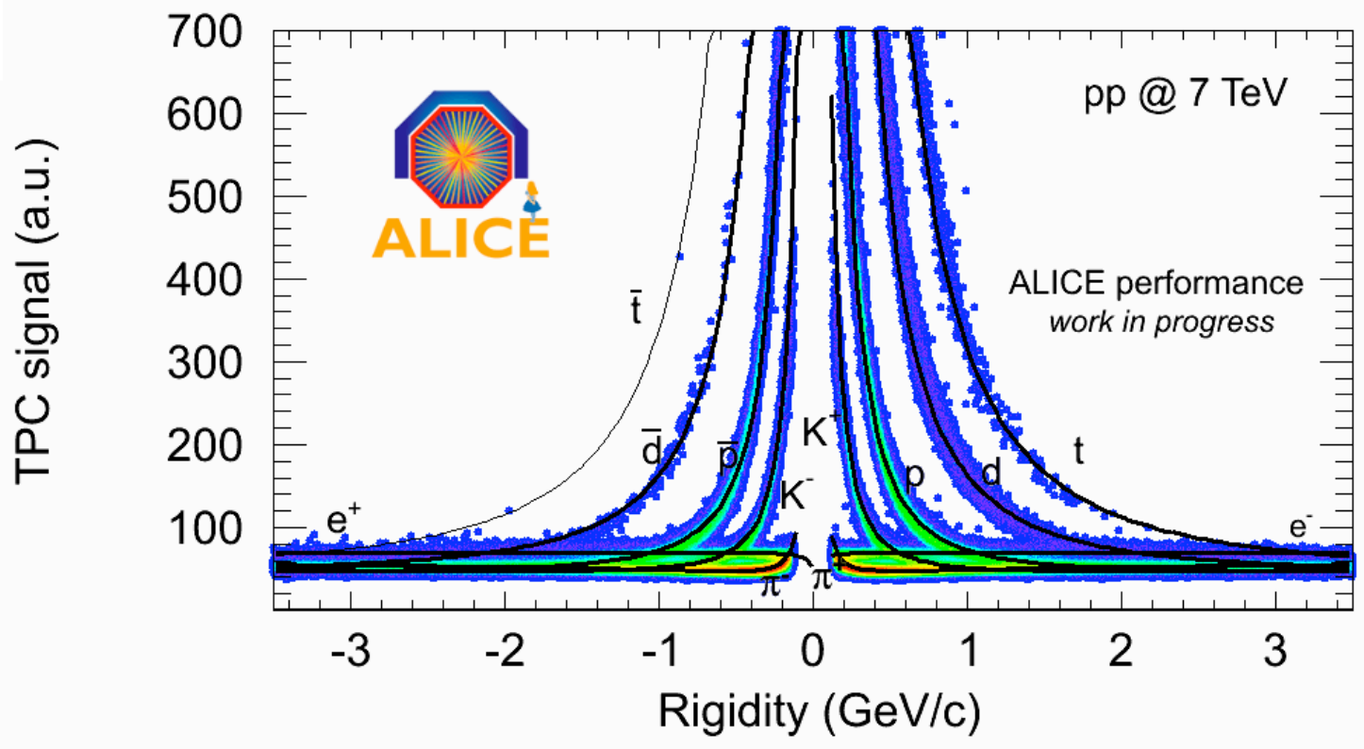


PID for open charm analysis

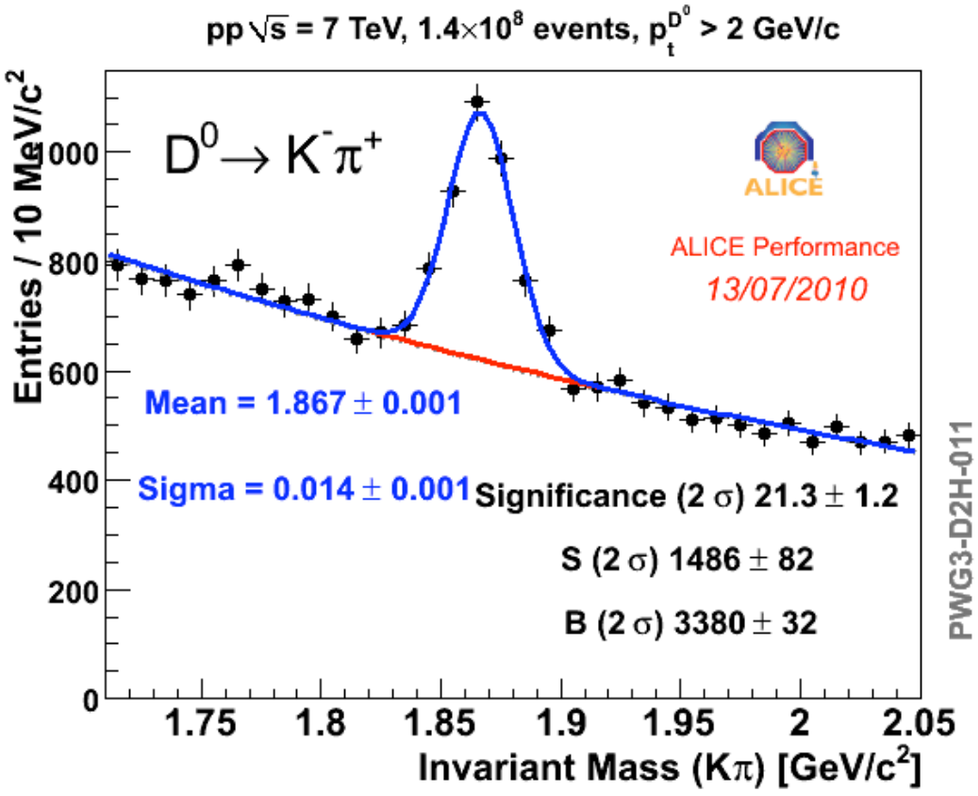


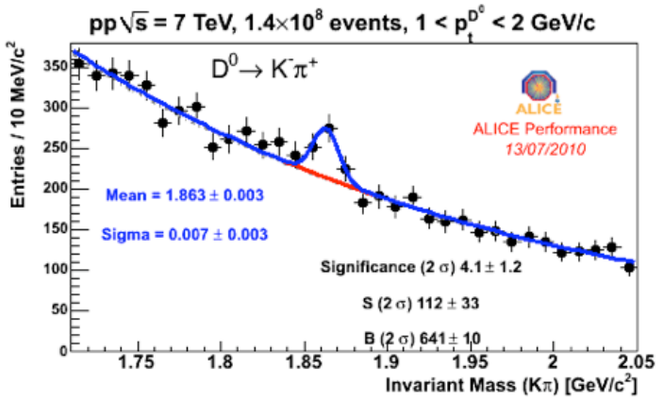
- Measured t_M = TOF-T0. Kaon compatible if $t_M - t_k < 3\sigma$ where t_k is the integrated time with K mass hypothesis and σ is the TOF/T0 resolution (~160 ps at this stage)

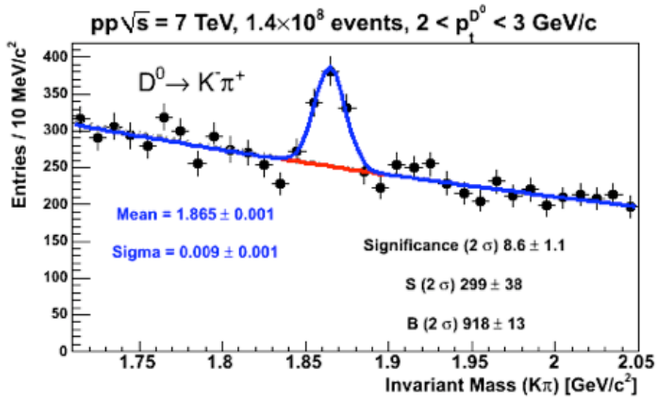
- TPC: identified particle if its energy loss is compatible with Bethe Bloch for a given species within *N*xσ

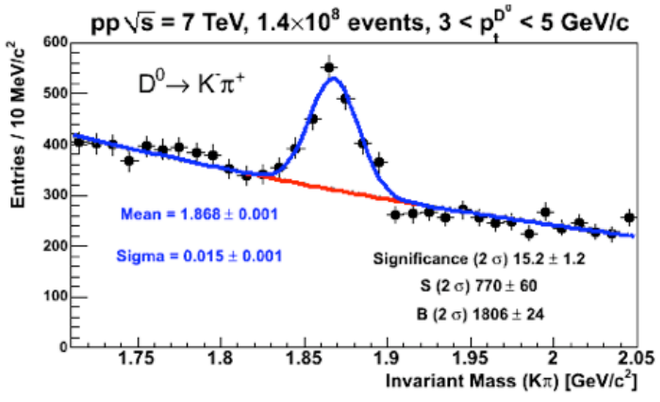


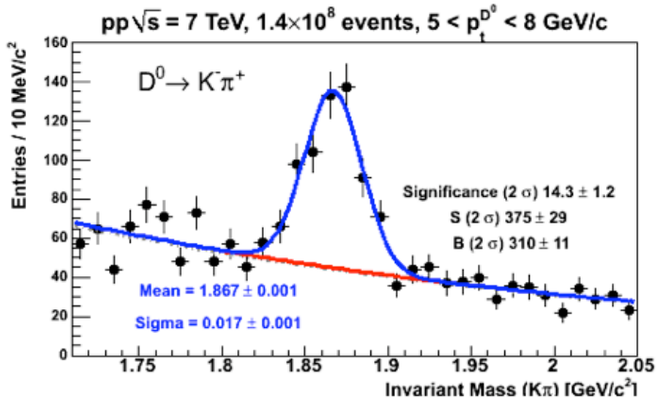
$D^0 \rightarrow K^-\pi^+$

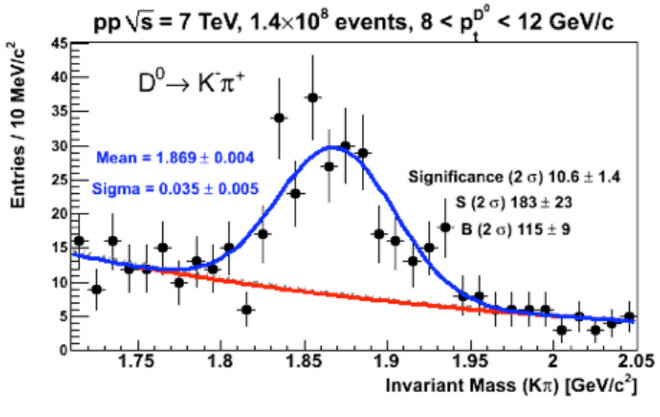






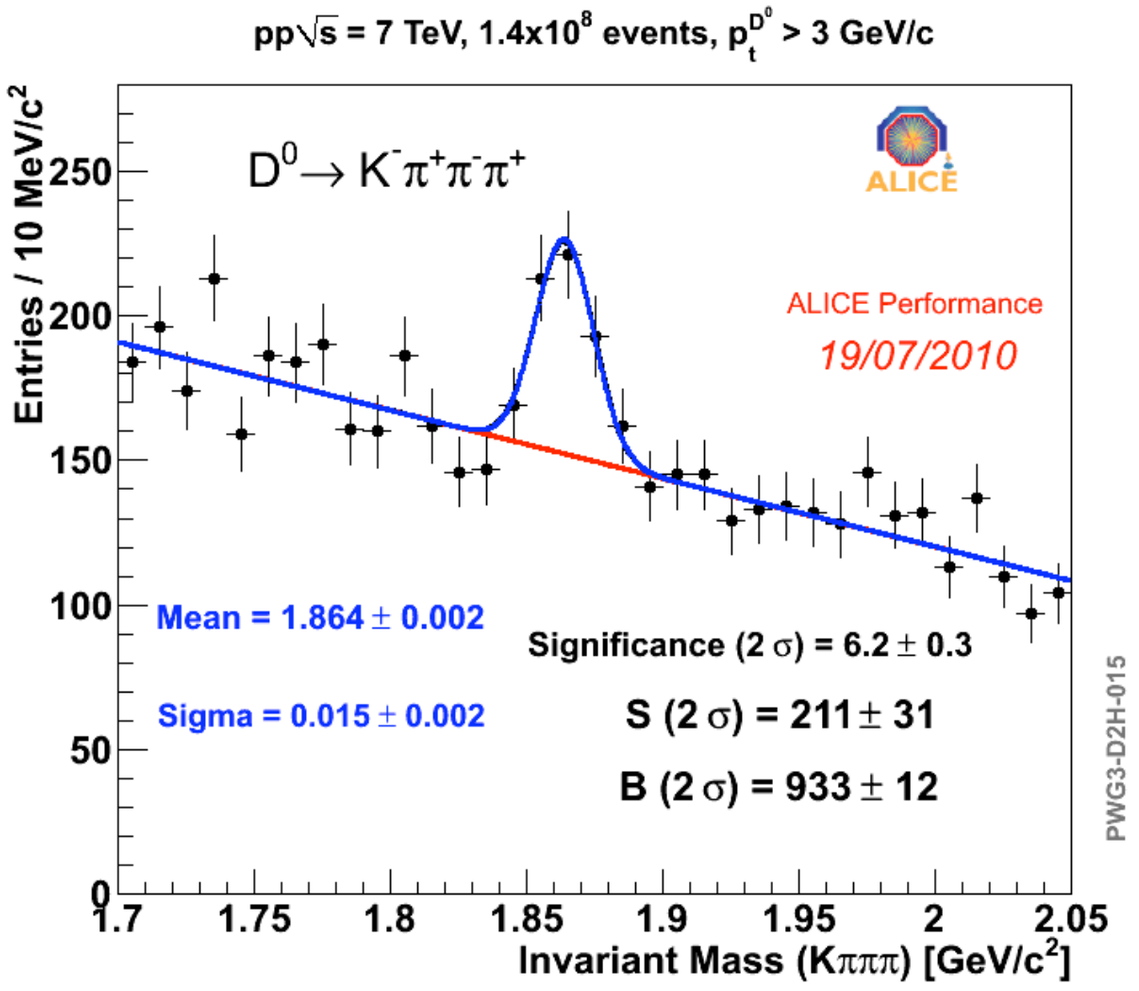






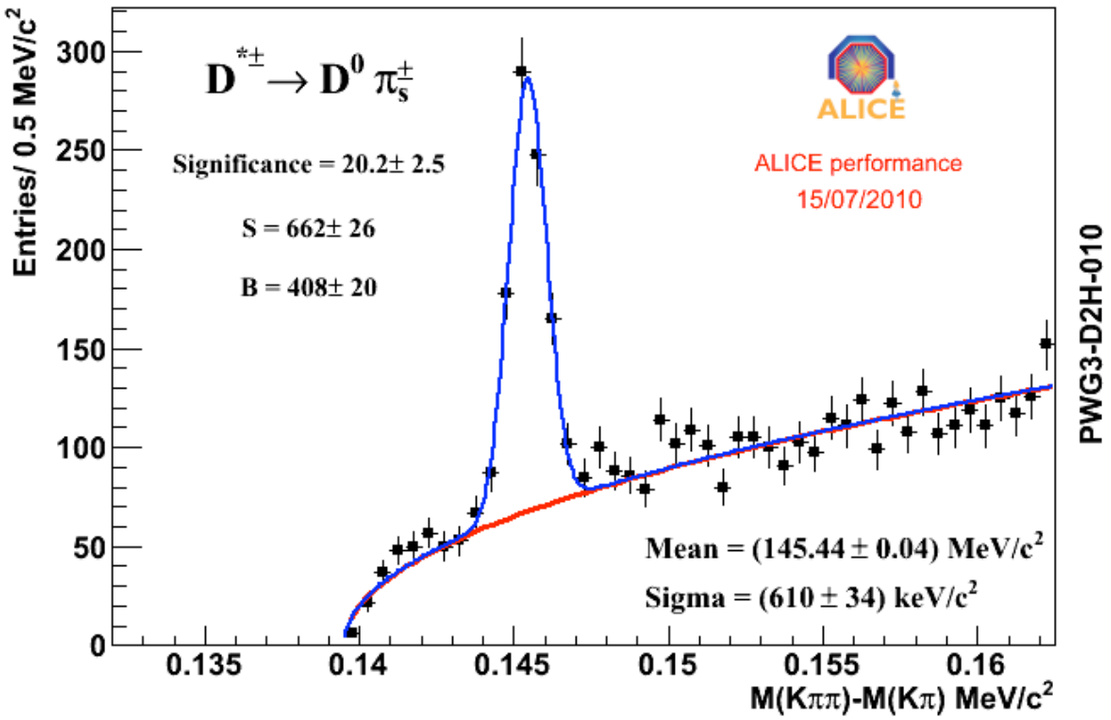
- Signal p_T integrated >1 GeV/c. Seen in the range $1<p_T<12$ GeV/c
- Position: (1867±1) MeV/c^2 .
  Width: (14±1) MeV/c^2

$D^0 \rightarrow K^-\pi^+\pi^-\pi^+$

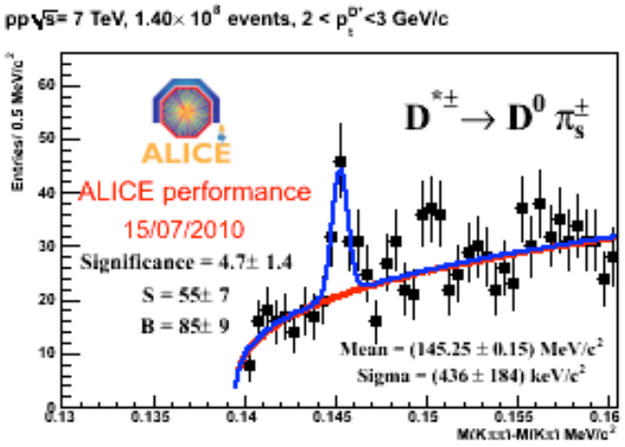


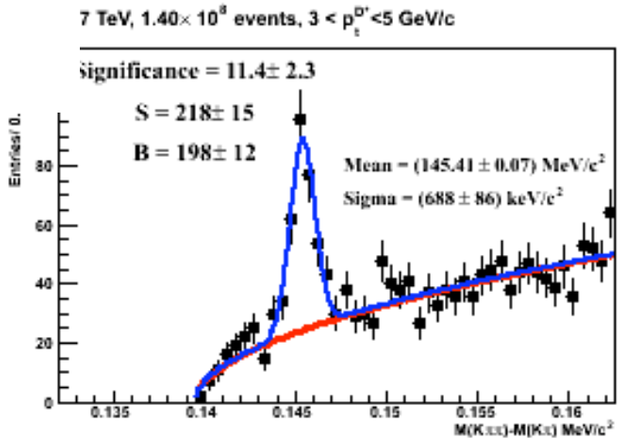
- ☑ Signal p_T integrated >3 GeV/c.
- ☑ Position: (1864±2) MeV/c^2 .Width: (15±2) MeV/c^2

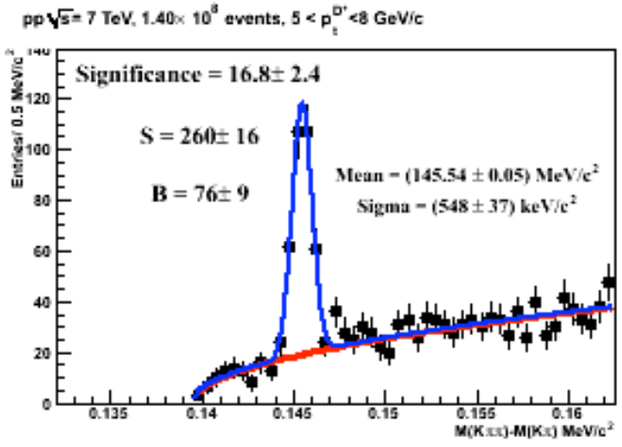
$D^{*+} \rightarrow D^0 \pi^+_s$

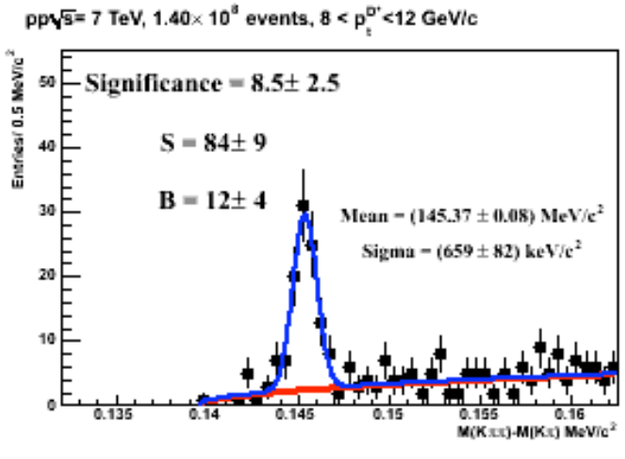


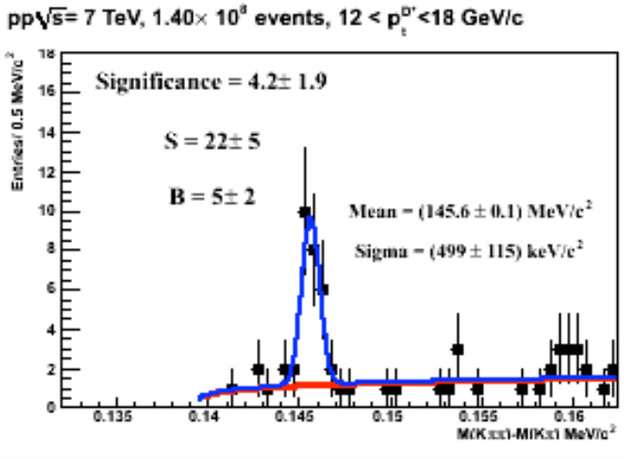
- Signal p_T integrated >2 GeV/c. Seen as $\Delta M(K\pi\pi - K\pi)$.
- Wide pt range already available $2<p_T<18$ GeV/c
- Position: (145.44±0.04) MeV/c^2
  Width: (610±34) keV/c^2



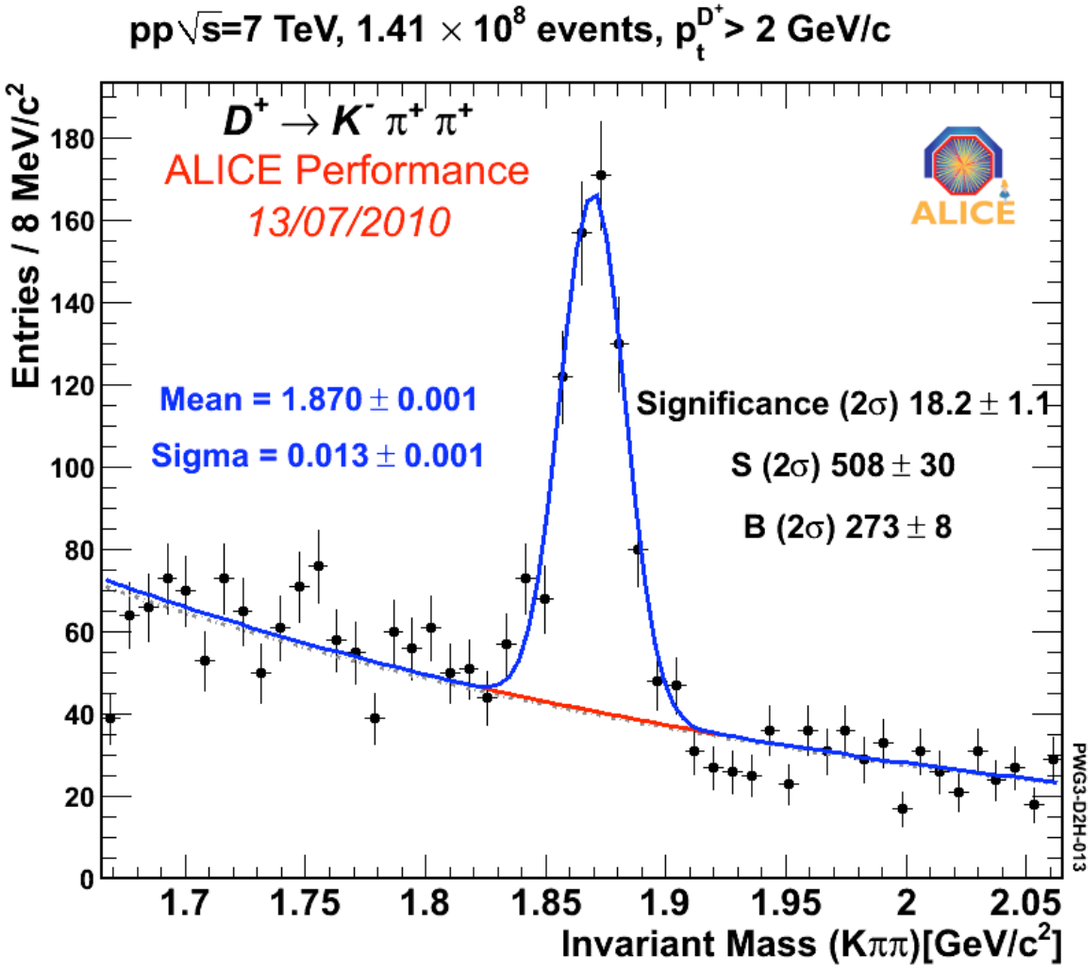


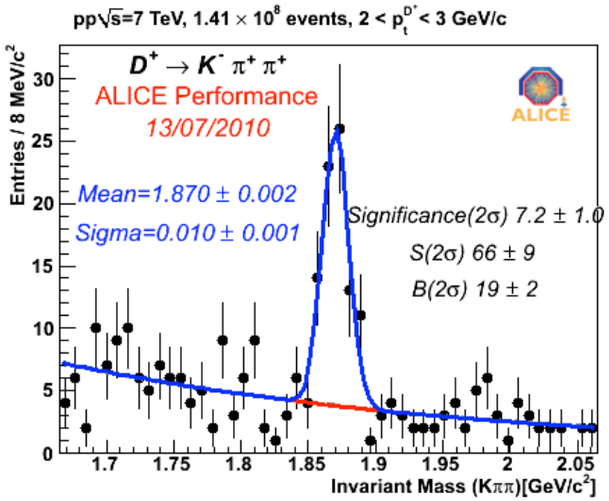


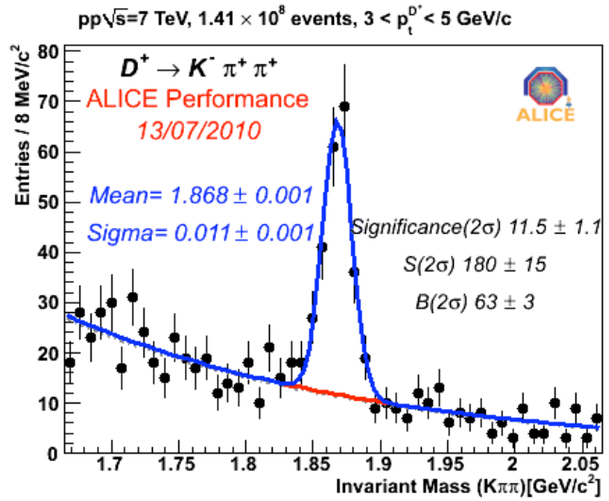


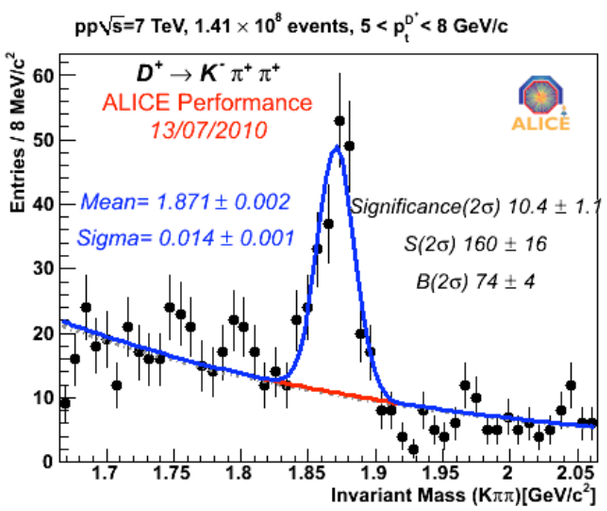


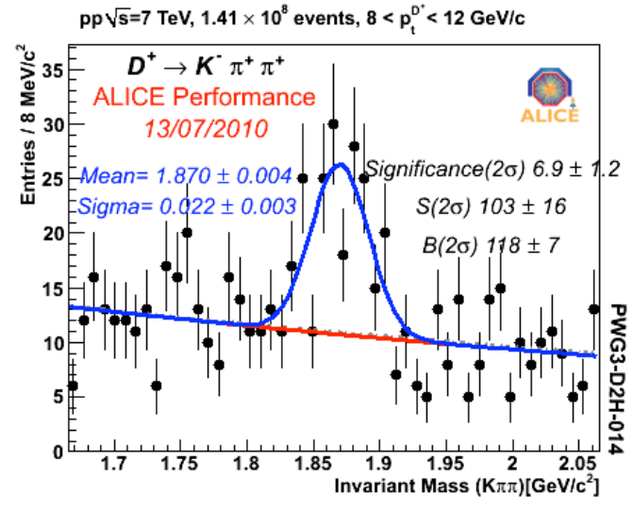
$D^+ \rightarrow K^- \pi^+ \pi^+$











- ☑ Signal p_T integrated >2 GeV/c, already available $2<p_T<12$ GeV/c.
- ☑ Position: (1870±1) MeV/c^2 .Width: (13±1) MeV/c^2

Corrections and systematic from corrections

- ☑ Common infrastructure for corrections for all the channels
- ☑ Multiple steps correction, multidimensional grid created, 8 reconstruction steps, 13 variables per step.

→ At each step efficiencies can be computed

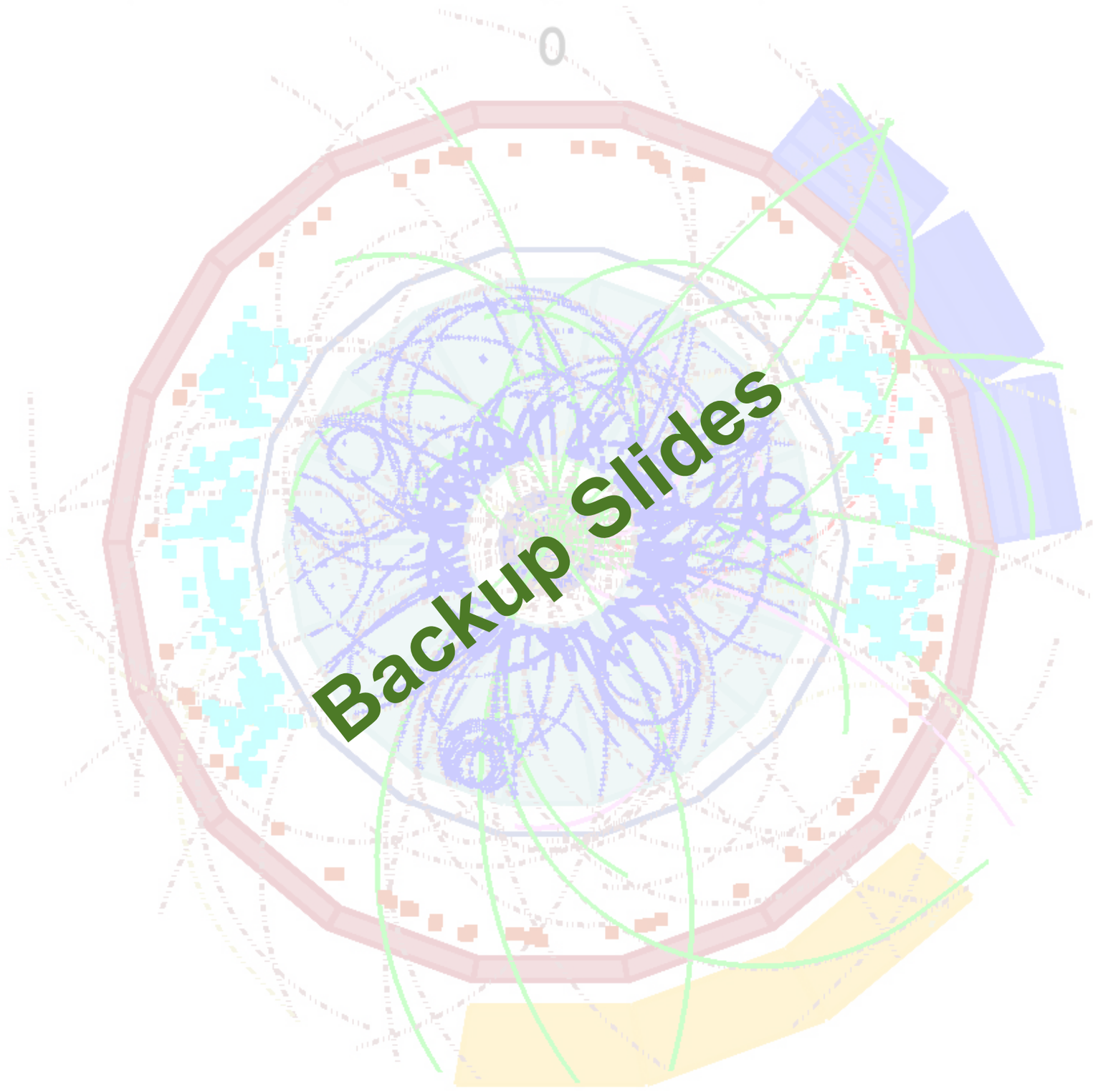
- ☑ A systematic from cut stability inferred using correction framework

Variation of corrected yields → systematic

- ☑ A systematic from misalignment estimated with montecarlo with different alignment conditions (effect on efficiency from corrections)

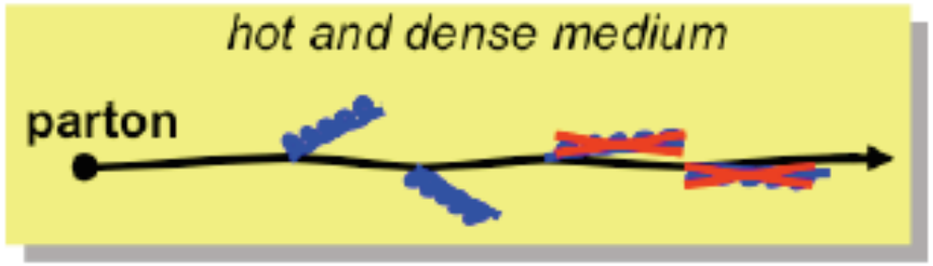
Conclusions

- ☑ ALICE goal is to have a solid measurement of charm cross-section in p+p to be used as reference for Pb+Pb
- ☑ Many open charm channels are under study to better constraint the cross section.
- ☑ Results with first 140M p+p events for D^*, D^0 and D^+ very promising signal seen in range $1<p_T<12$ GeV/c (*several pt bins*).
- ☑ Correction framework ready and systematic estimations on going
- ☑ Pb-Pb run scheduled for November 2010



Backup Slides

Energy Loss: dead cone effect



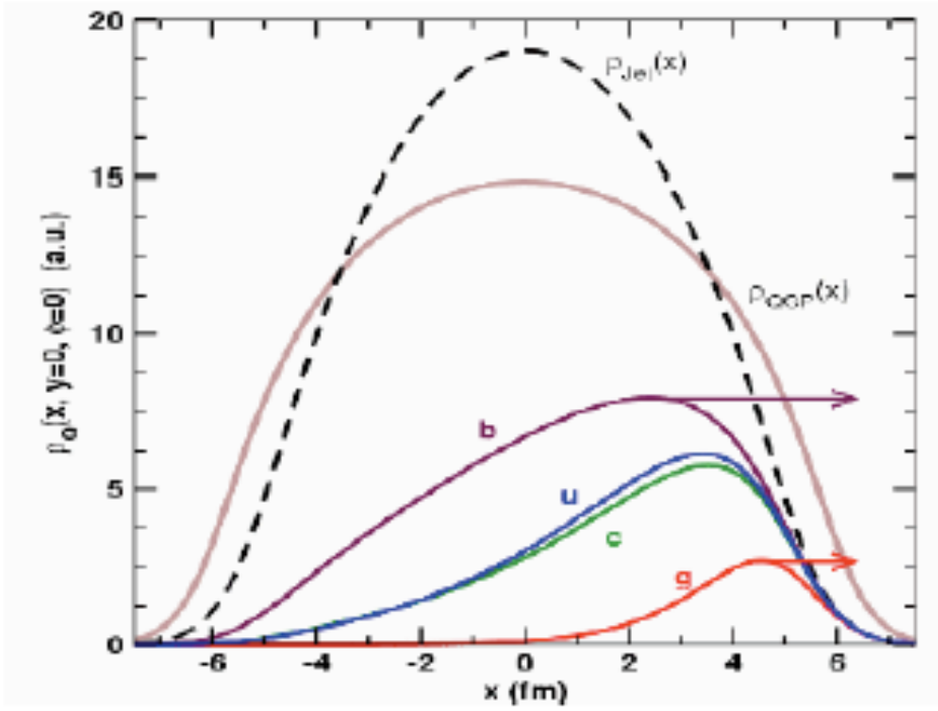
Gluon radiation probability

$$\omega \left.\frac{\mathrm{d}I}{\mathrm{d}\omega}\right|_{HEAVY} = \frac{\omega \left.\frac{\mathrm{d}I}{\mathrm{d}\omega}\right|_{LIGHT}}{\left(1+\left(\frac{m_Q}{E_Q}\right)^2 \frac{1}{\theta^2}\right)^2}$$

Gluon radiation suppressed at $\theta < m_Q/E_Q$
(dead-cone effect) *Dokshitzer & Kharzeev, PLB 519, 199 (2001)*

- Created in the early stage of the collision.
- For **c** and **b** less energy loss is expected.
- Probe deeper into the QCD medium

Probe deeper into the medium



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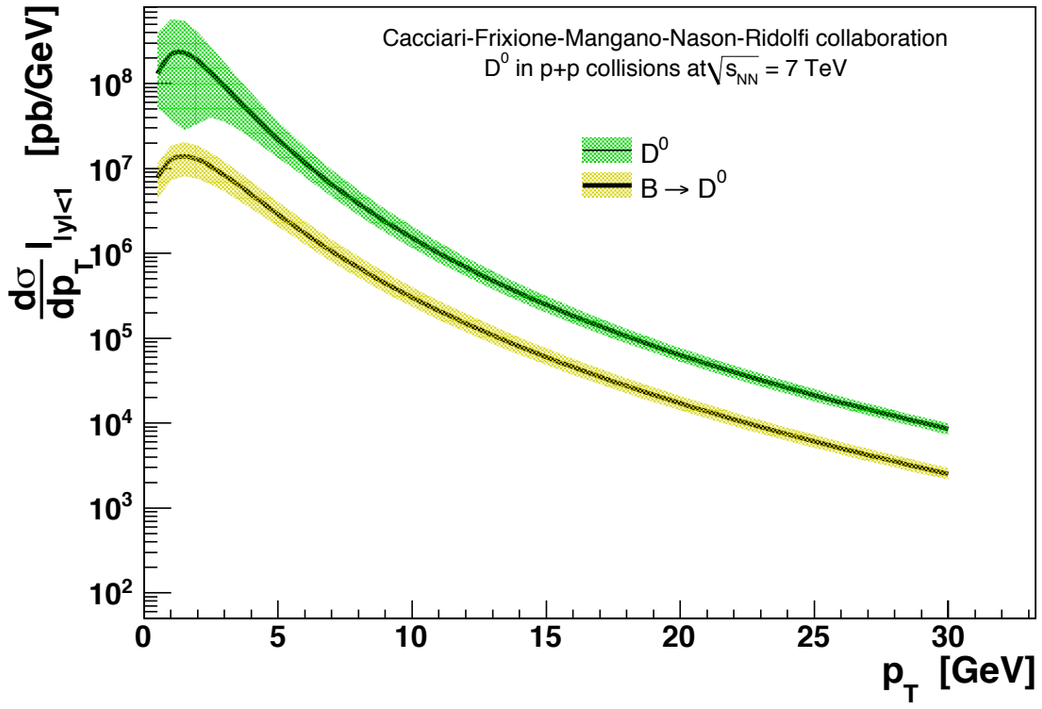
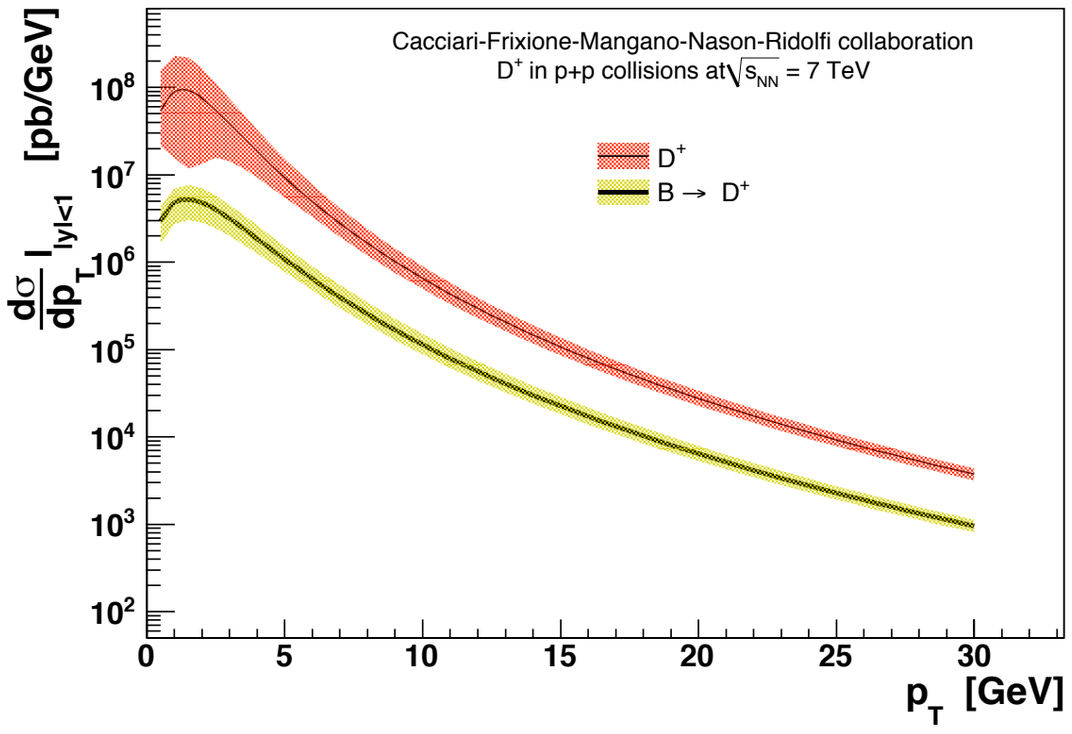
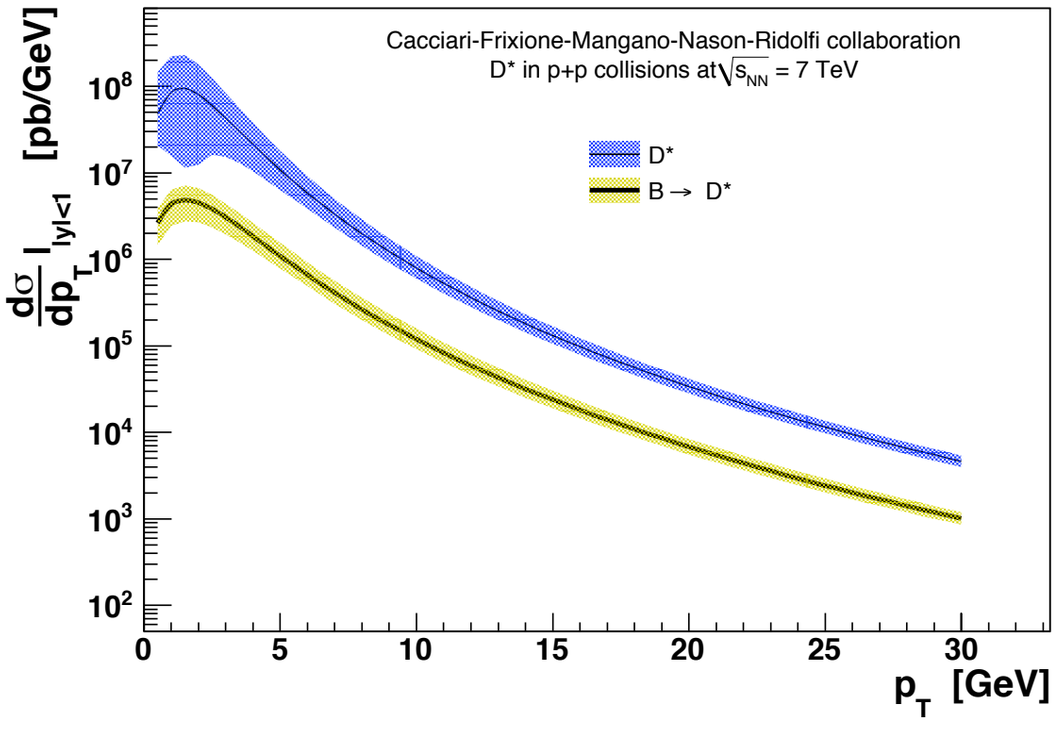
B feed-down predictions

- ☑ p+p @ 7 TeV
- ☑ FONLL predictions for B feeddown







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