Open heavy flavour at midrapidity in ALICE

First ReteQuarkonii Workshop 25-28 October 2010

Chiara Bianchin *for the ALICE Collaboration*

Università and INFN - Padova

28/10/2010

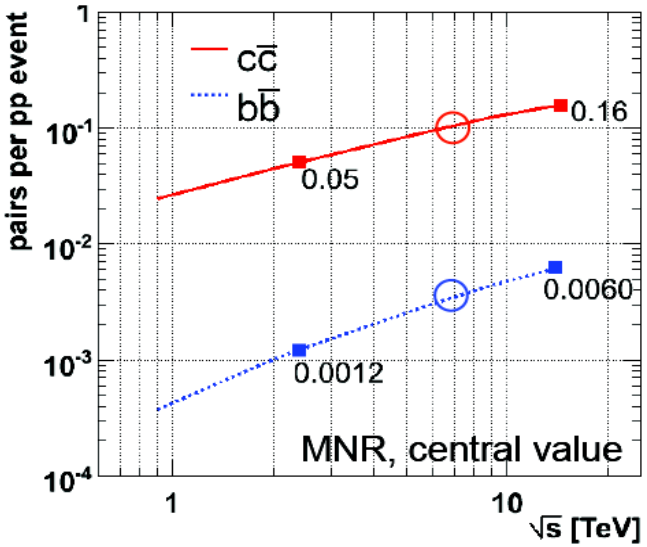
Outline

1. Introduction on Heavy Flavour physics
2. ALICE detector and performance
   - Data collected in p-p at 7 TeV
3. Heavy flavour physics results at mid-rapidity
   - D mesons
   - Electrons from heavy quark decays

Heavy flavour physics at LHC

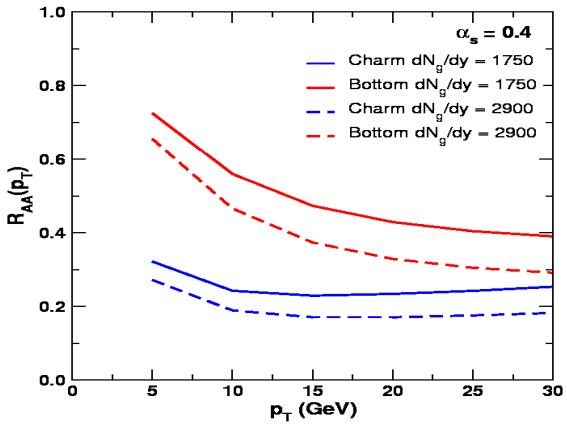
p-p

- Test pQCD in a new energy domain ($3.5 - 7 \times \sqrt{s_{Tevatron}}$)
  - * Factor 2 uncertainty in NLO predictions
- c and b factory
- Normalization for Pb-Pb HF yield



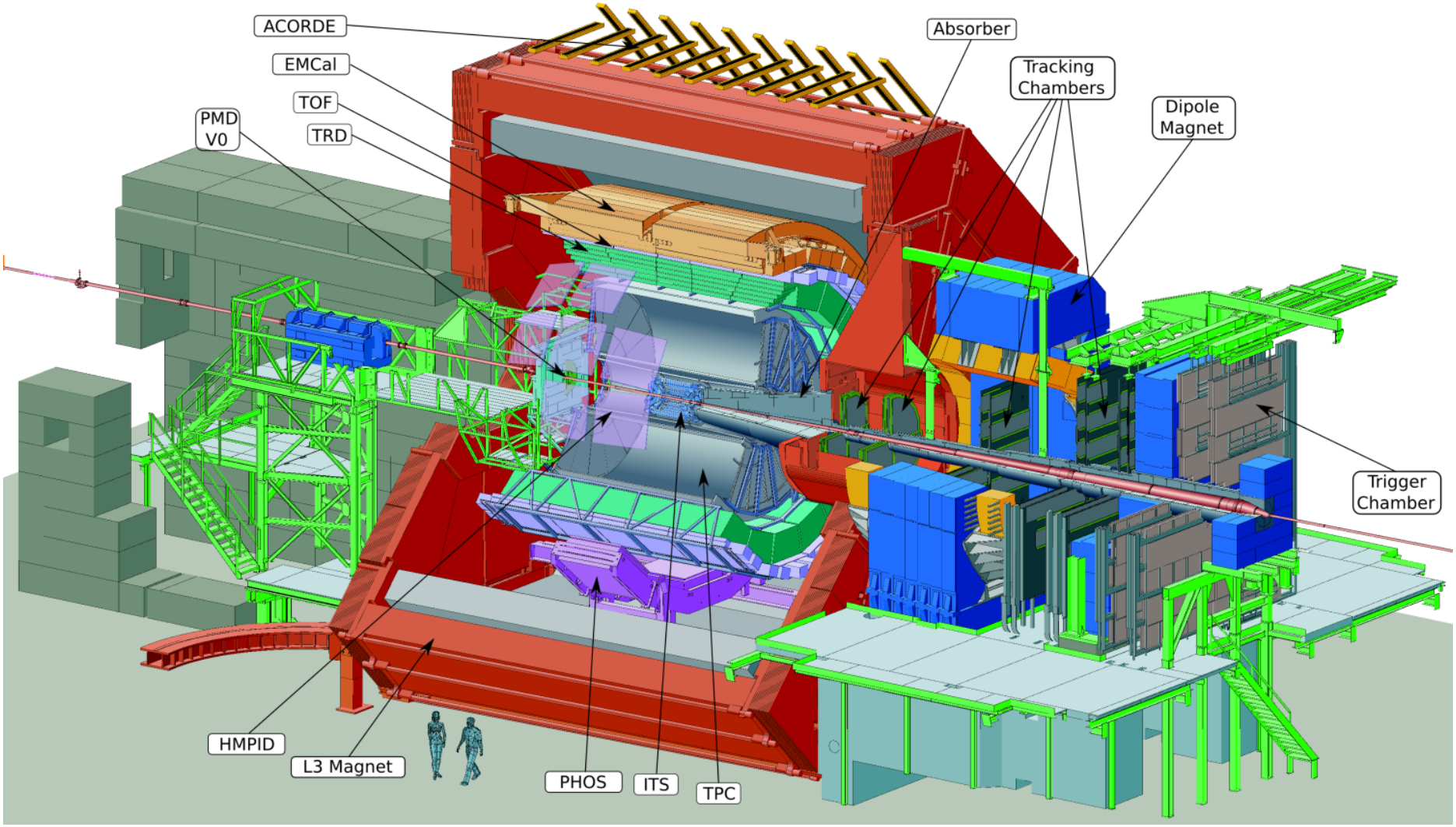
Pb-Pb

- Energy loss based predictions: factor 5 suppression for charm
- Smaller suppression for beauty ⇝ heavy-to-light ratio enhanced

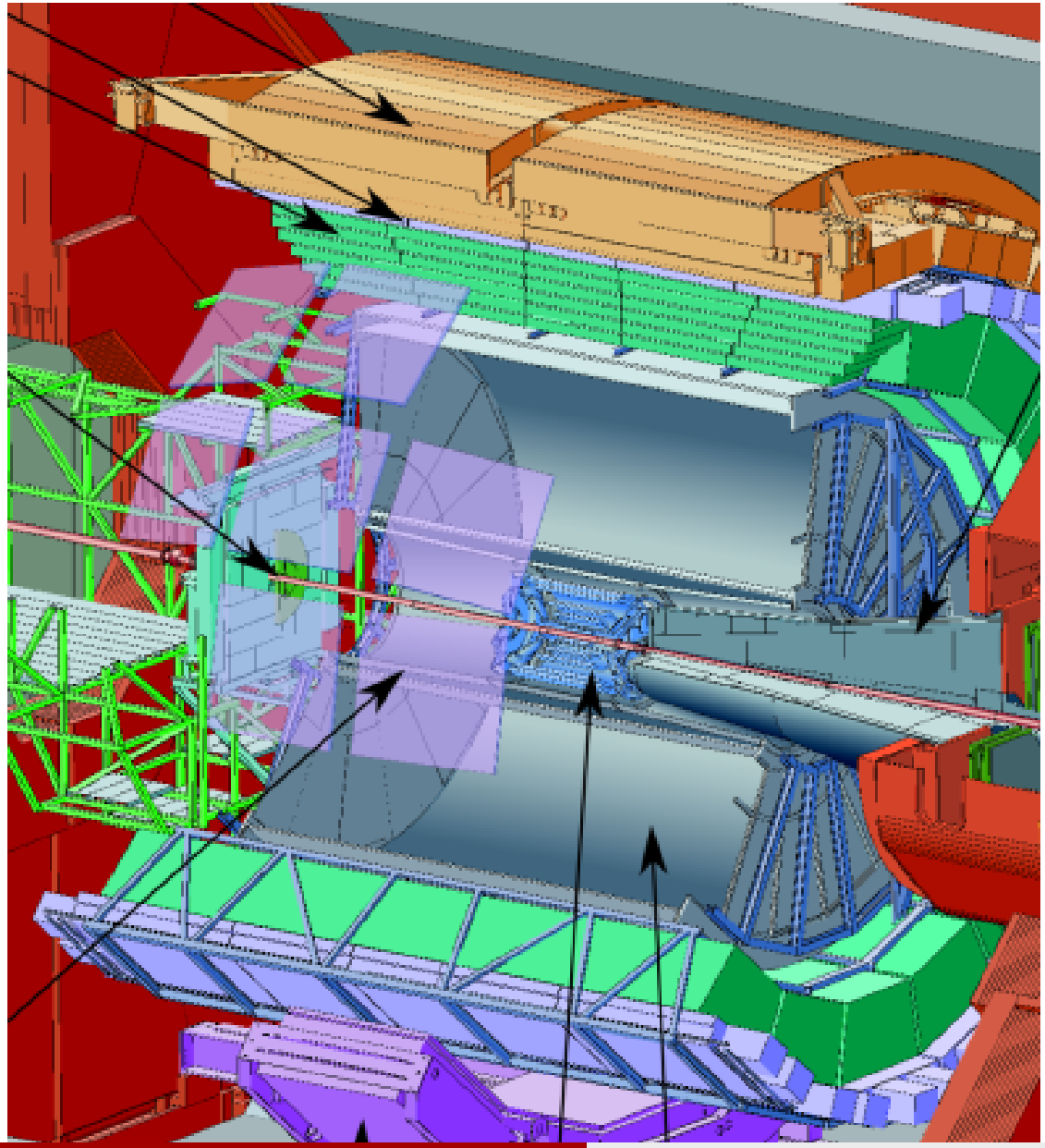


Wicks, Gyulassy, "Last Call for LHC Predictions" workshop

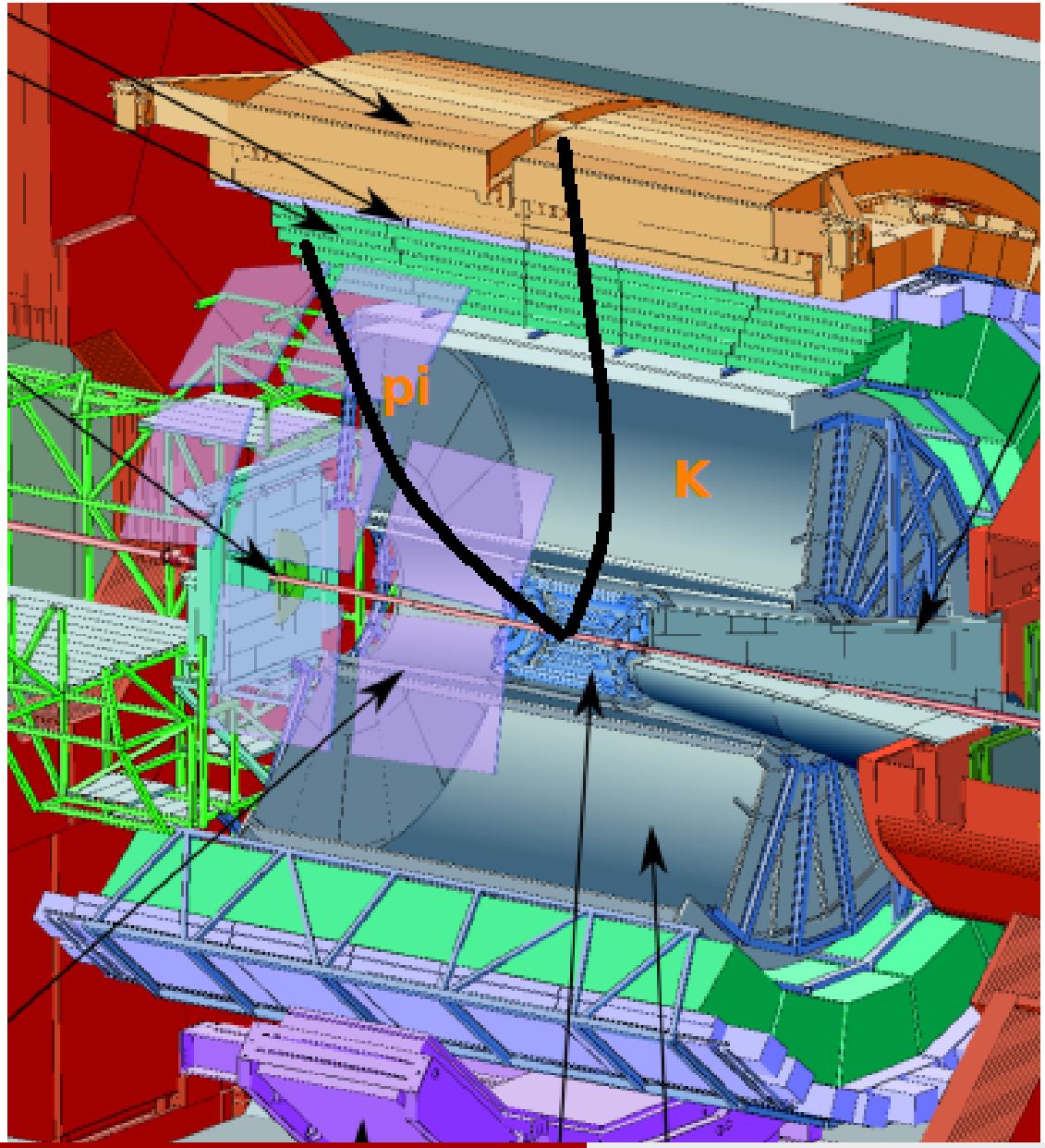
ALICE detector



ALICE detector

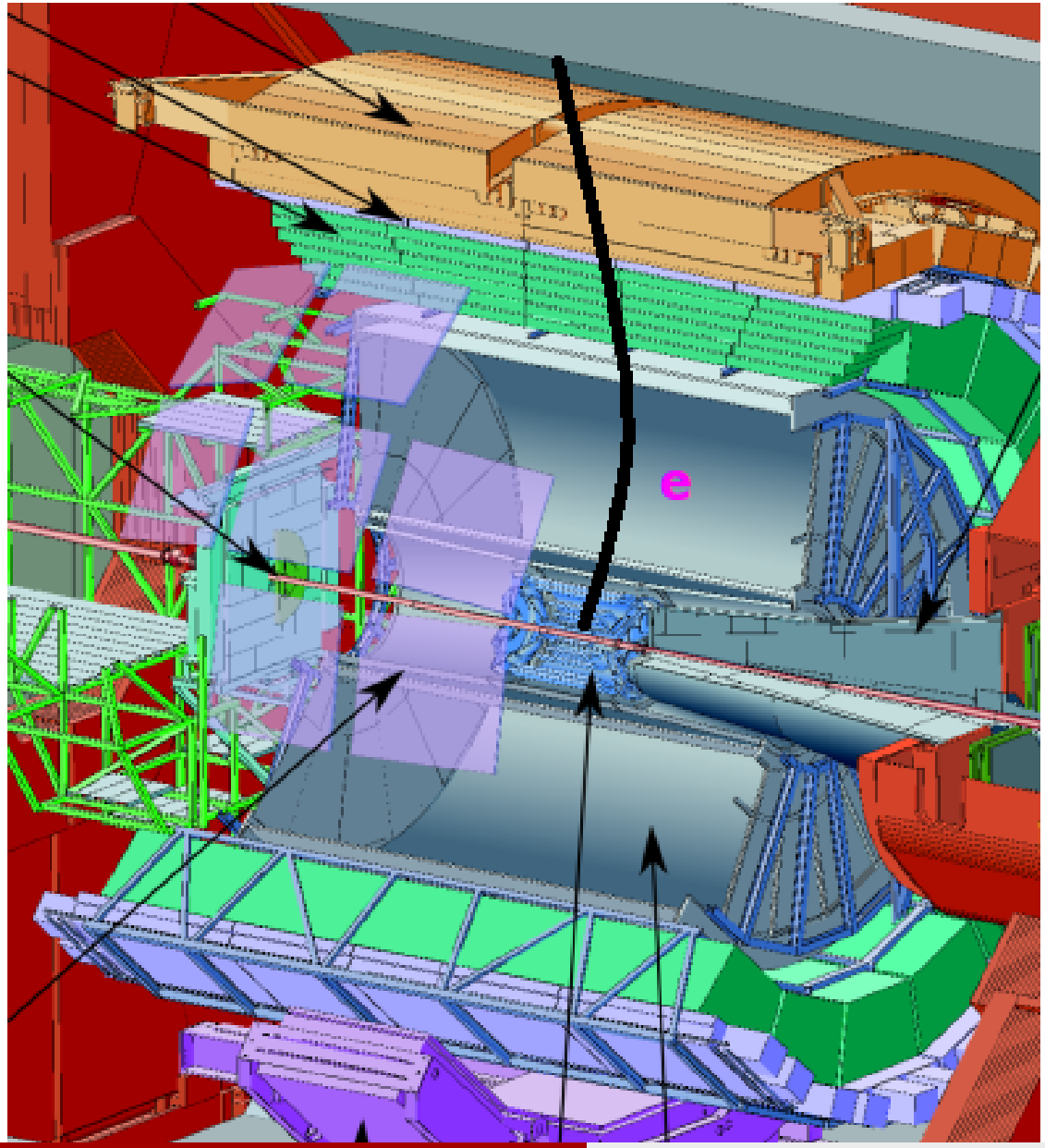


ALICE detector



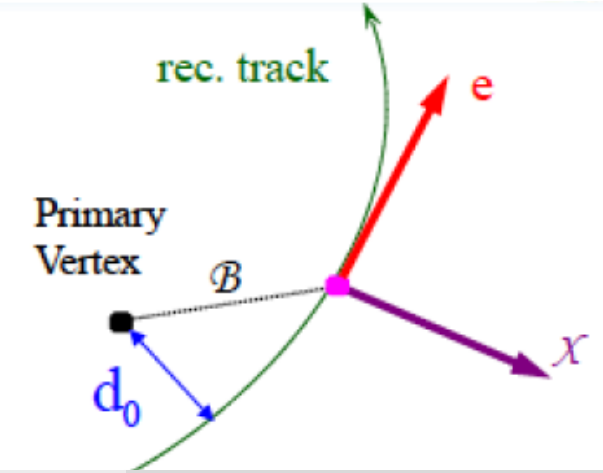
- $D \rightarrow hadrons$
  - ☑ $D^0 \rightarrow K^-\pi^+$
  - ☑ $D^+ \rightarrow K^-\pi^+\pi^+$
  - ☑ $D^{*+} \rightarrow D^0\pi^+_{soft}$
  - ☑ $D^+_s \rightarrow K^-K^+\pi^+$
  - ☑ $D^0 \rightarrow K^-\pi^+\pi^-\pi^+$
  - ☐ $\Lambda^+_c \rightarrow pK^-\pi^+$
- Invariant mass analysis
  - Secondary vertex separation (hundreds of μm)
  - Main tools for signal selection: Topological cuts & PID

ALICE detector

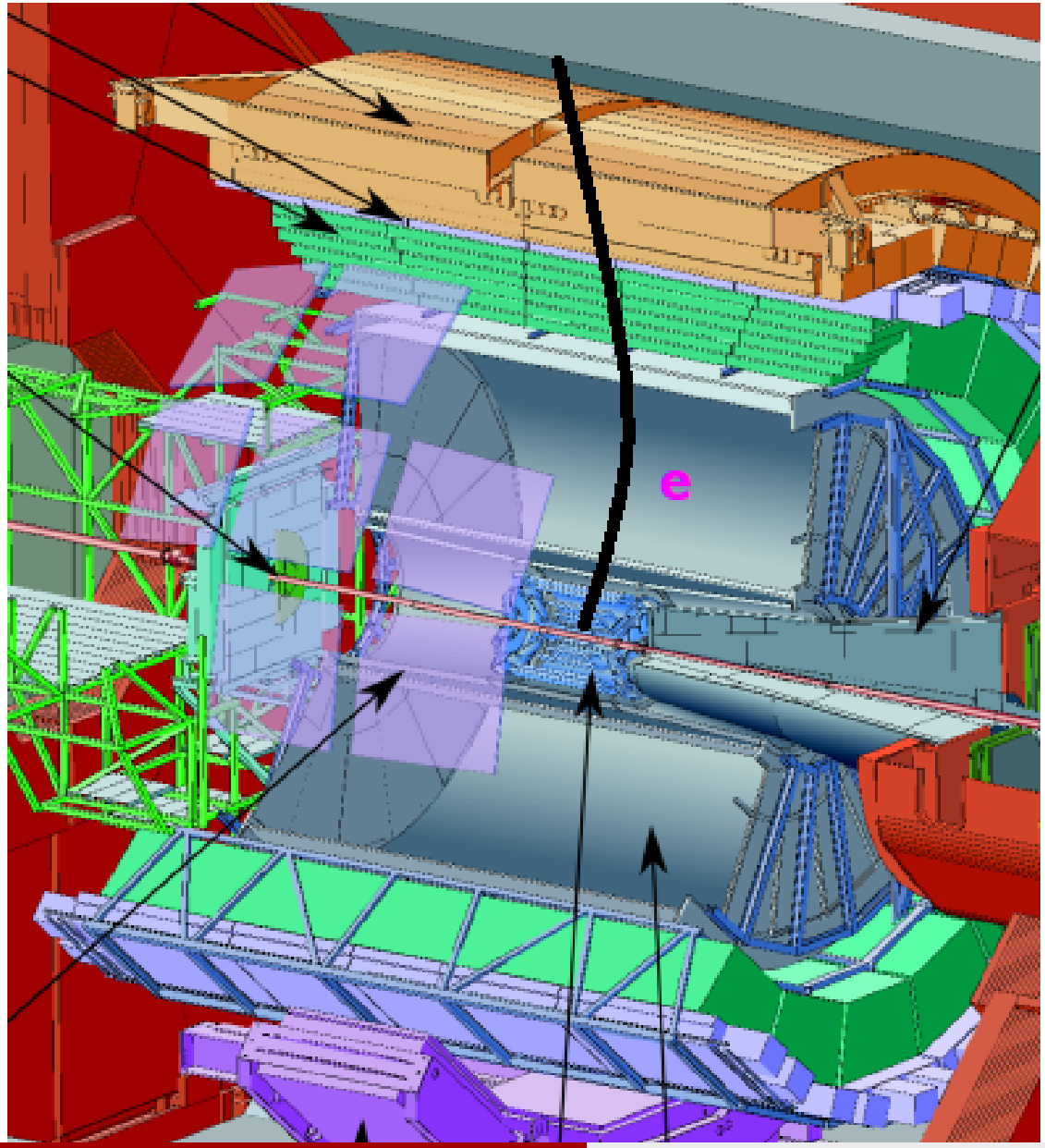


- $c/b \rightarrow$ *electrons*
  - ☑ $c/b \rightarrow e + X$
  - ☑ $b \rightarrow c \rightarrow e + X$

1. HF (beauty in particular) e have large ($\sim 500\mu$m) impact parameter to the primary vertex *(in preparation)*



ALICE detector

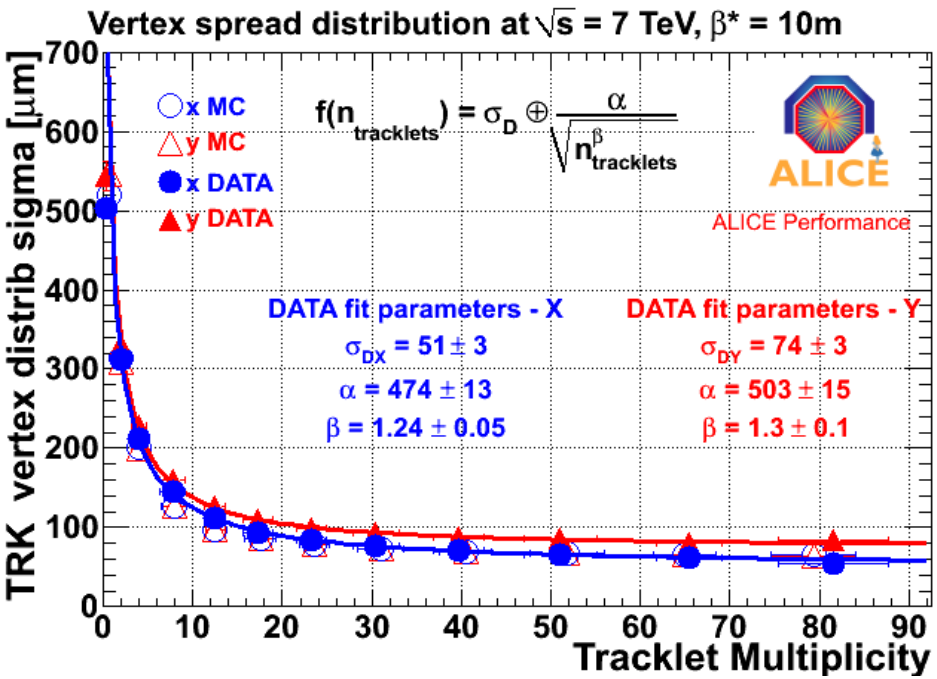


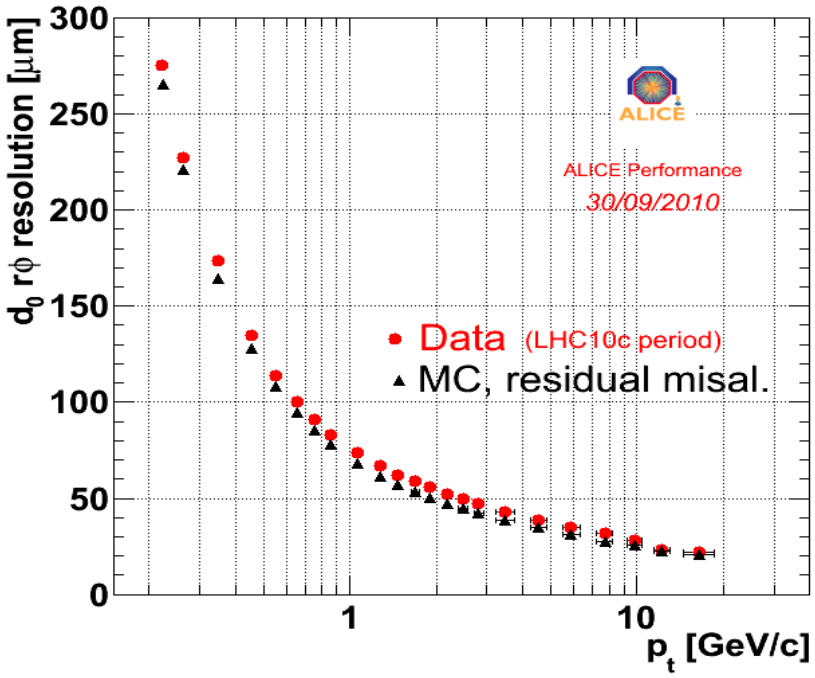
- $c/b \rightarrow$ *electrons*
  - ☑ $c/b \rightarrow e + X$
  - ☑ $b \rightarrow c \rightarrow e + X$

1. HF (beauty in particular) e have large ($\sim 500\mu$m) impact parameter to the primary vertex *(in preparation)*
2. Inclusive p_t e spectrum with subtraction of background contribution via e cocktail description

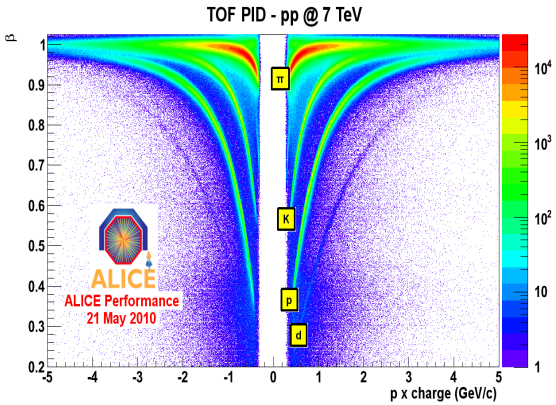
Tracking and vertexing performance

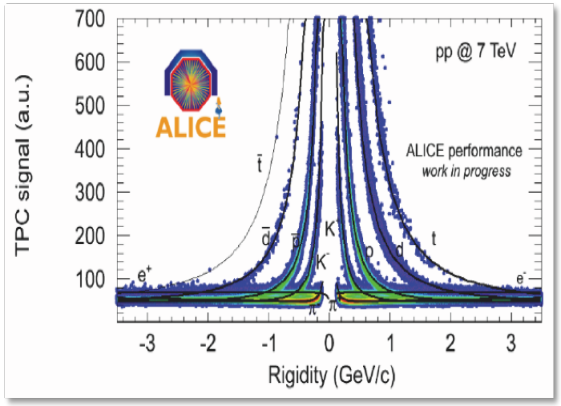
- Vertex resolution given by the Inner Tracking System and well described by MC
- Impact parameter resolution of $\sim 70\mu$m at 1 GeV/c (ITS + Time Projection Chamber)

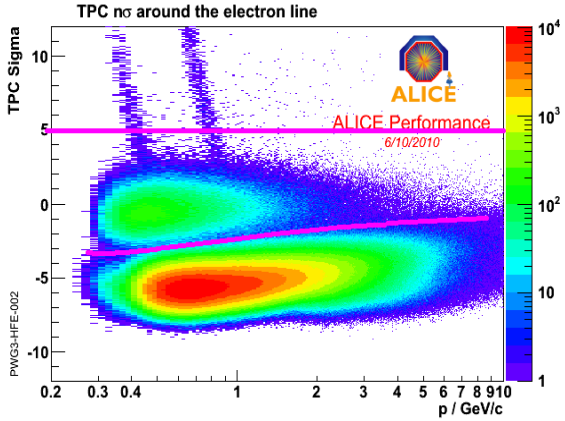




PID performance







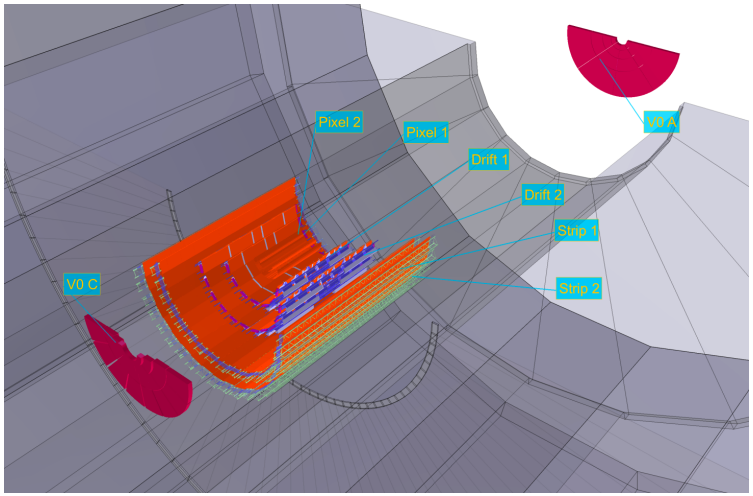
$D \rightarrow hadrons$

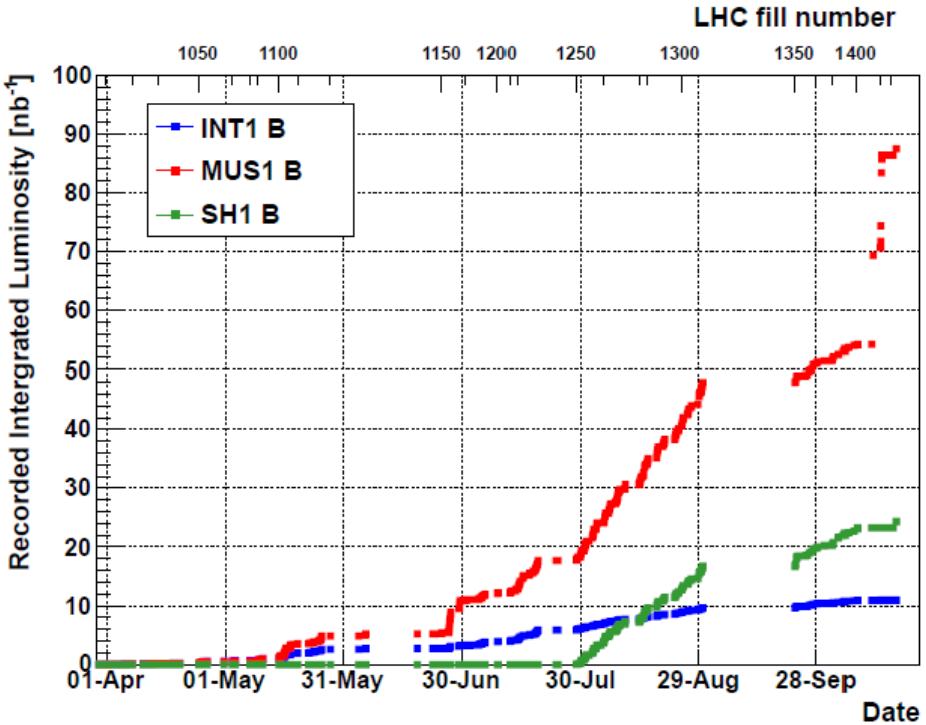
- Kaons identification with TPC & TOF $\rightsquigarrow$ rejecting bkg at low p_t

$c/b \rightarrow e + X$

- e identification with TOF & TPC dE/dx
  - ⋆ TOF to reject K ($p < 1.5$ GeV/c) and p ($p < 3$ GeV/c)
  - ⋆ TPC asymmetric cut around the e Bethe Bloch line (qualitatively shown)
  - ⋆ measure contamination by fitting with gaussians the dE/dx profile (π contamination of 0.1-15% in 0.5-4 GeV/c)

Trigger and data sample





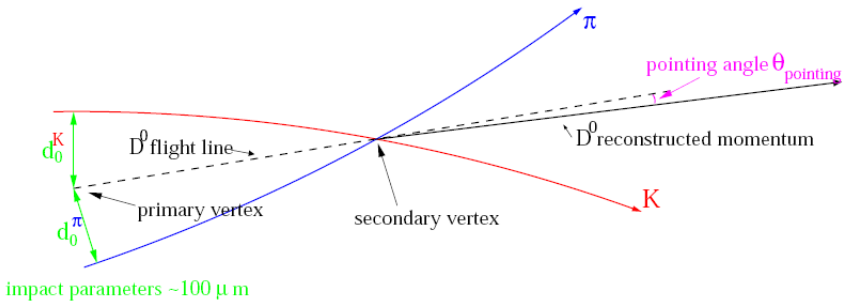
- Minimum bias trigger (CINT1B) based on Silicon Pixel Detector and V0 scintillators (SPD or V0A or V0C)
- At least one charged particle in 8 η units

★ $\sim$ 800 million minimum bias triggers collected, $\sim$ 100 million ($\sim 1.5 - 1.6$ nb^{-1}) minimum bias used in the analysis presented (optimal calibration)

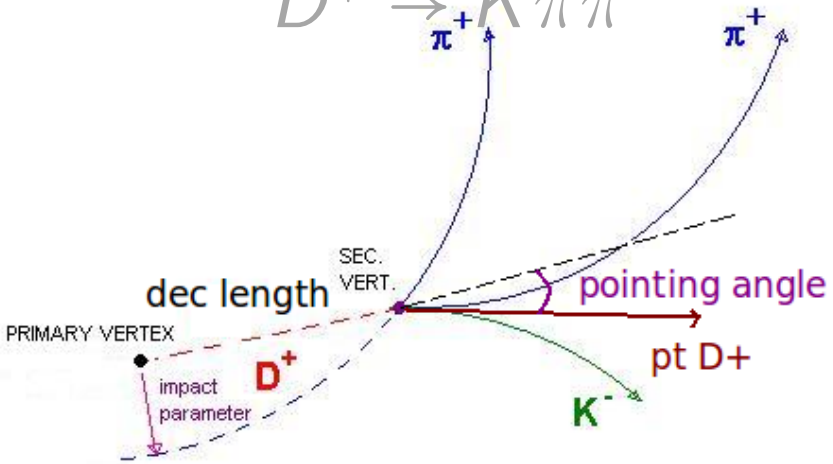
Heavy flavour physics results

D mesons signal extraction

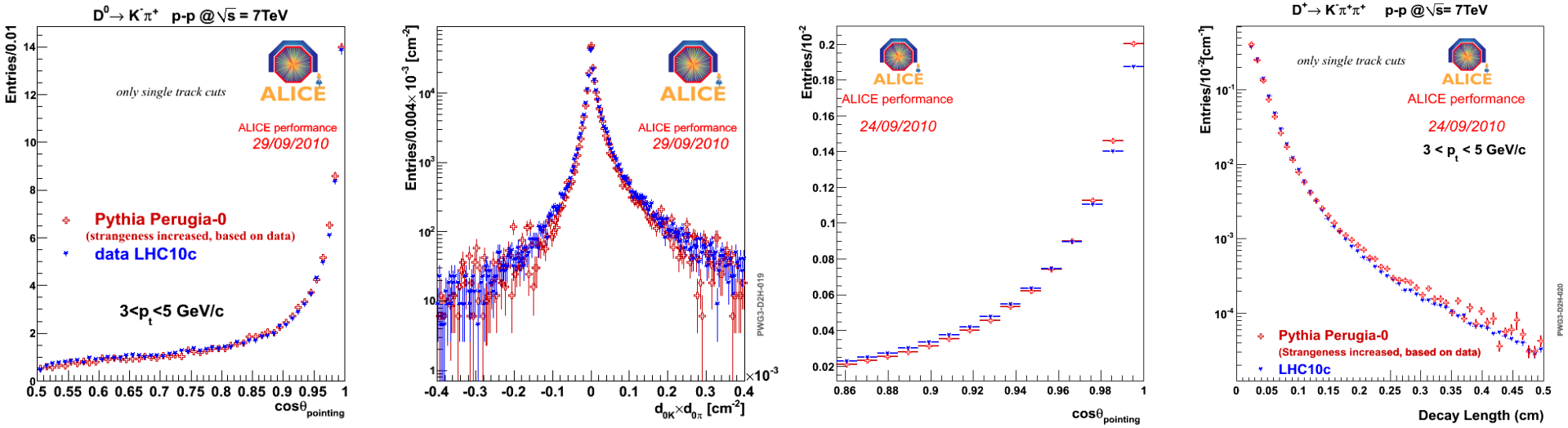
$D^0 \rightarrow K\pi$



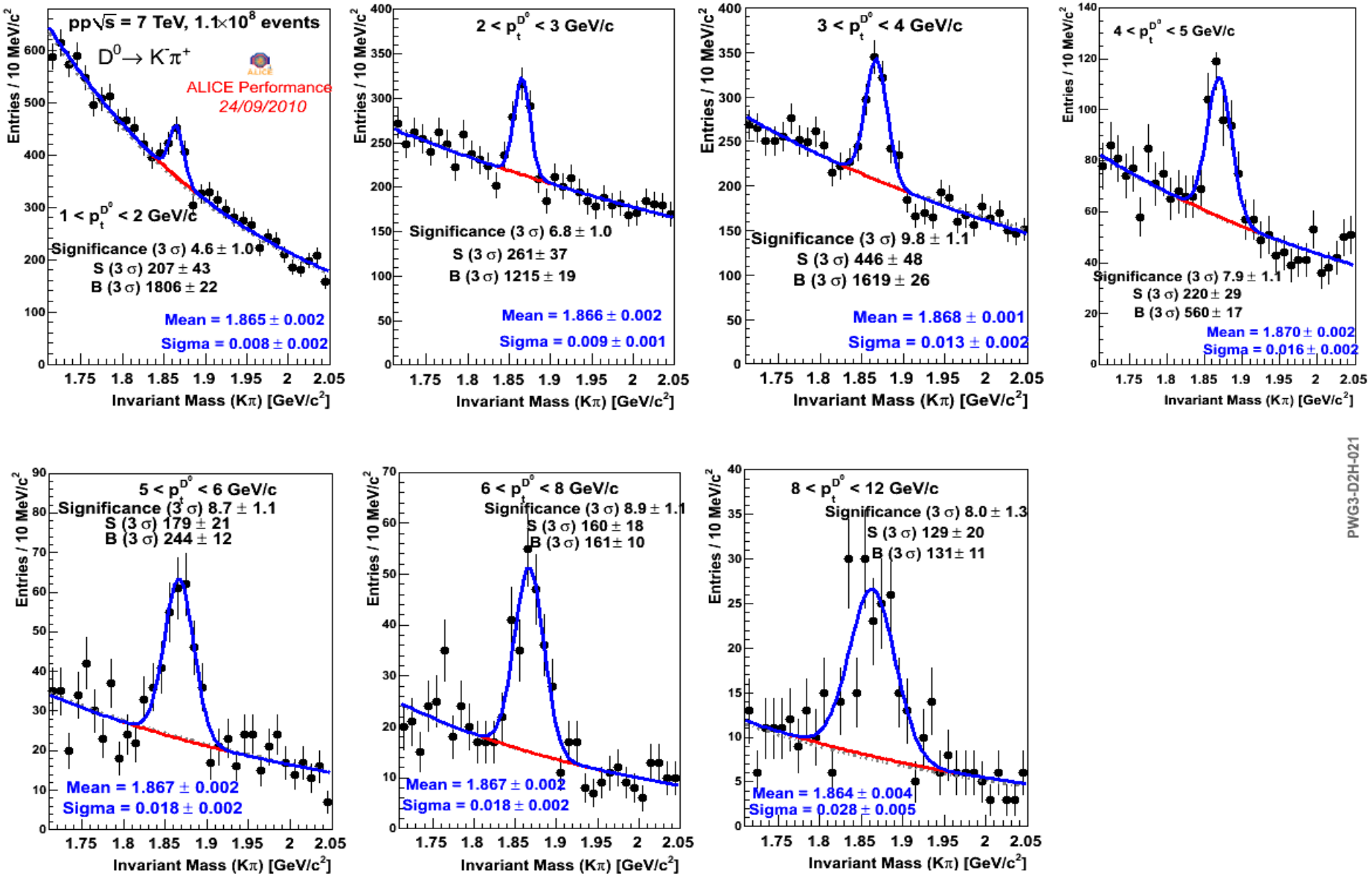
$D^+ \rightarrow K\pi\pi$



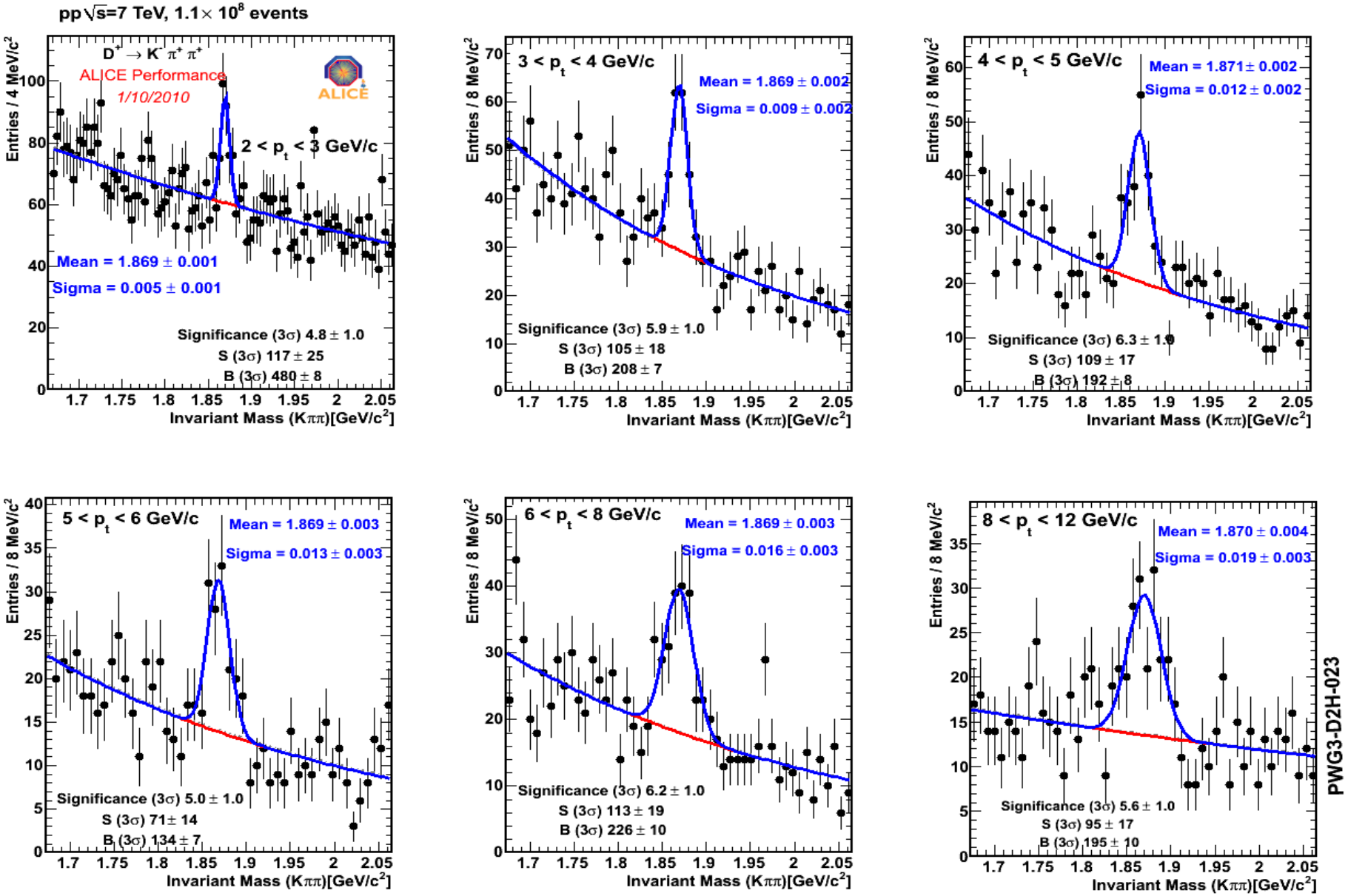
Cut Variables



D^0 invariant mass

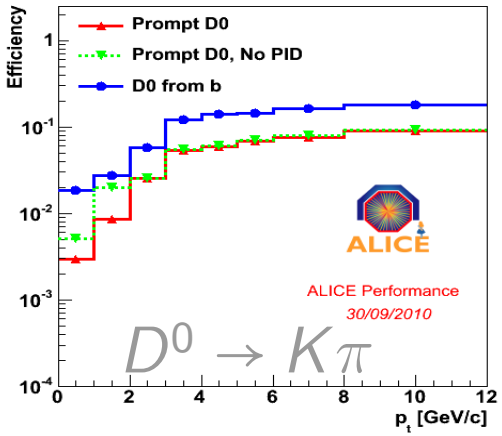


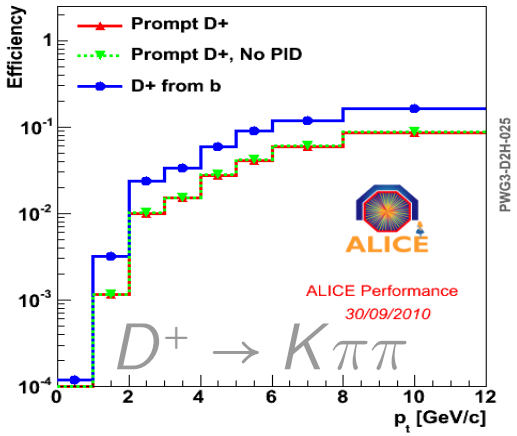
D^+ invariant mass



Signal correction

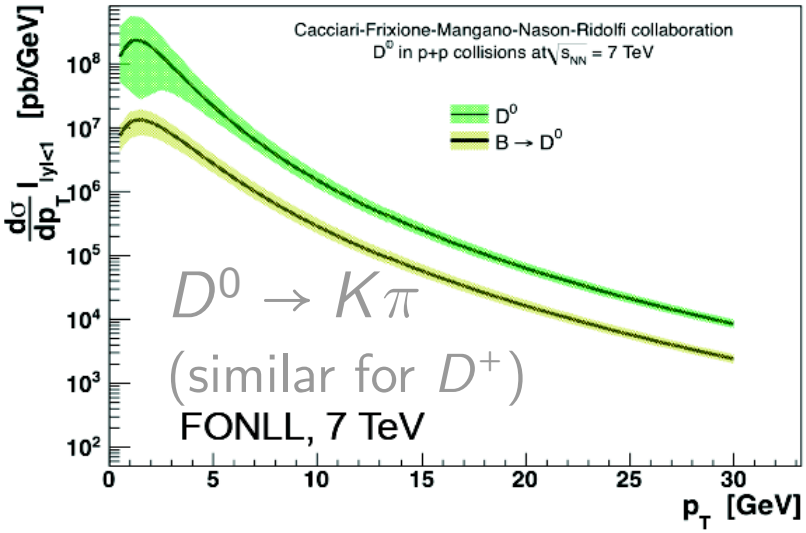
Efficiency





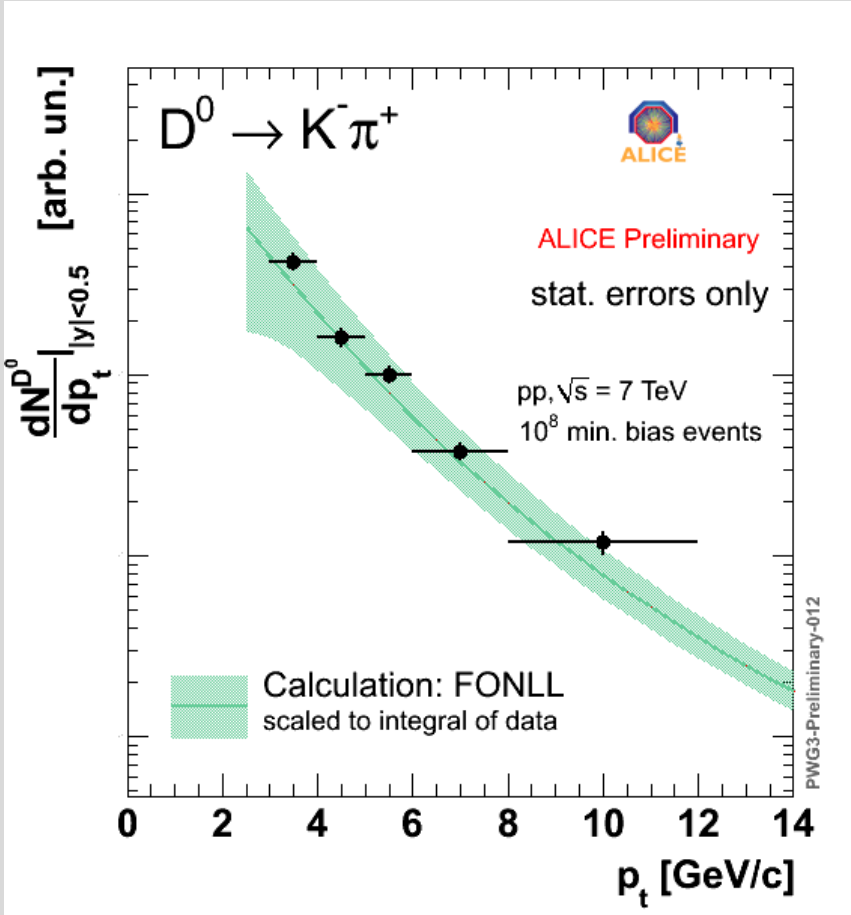
- Efficiency 1% – 10% from low to high p_t
- Factor 2 larger for B feed-down D mesons

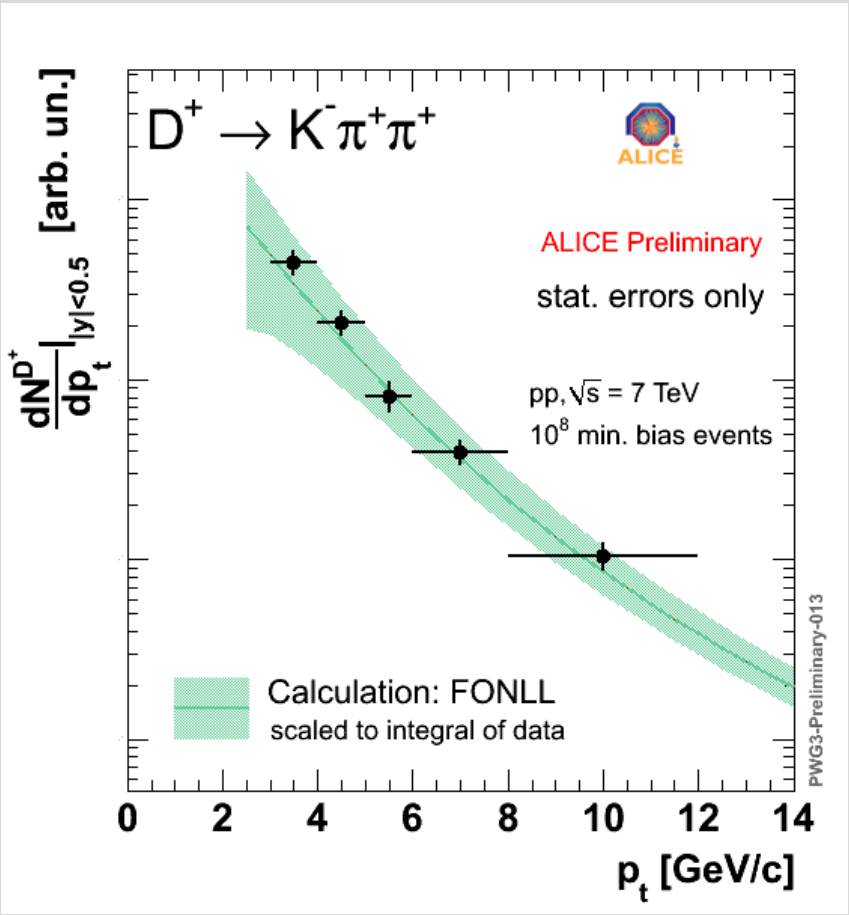
Feed-down $B \to D$



- 20-25%
- Subtract using FONLL predictions
- Data driven method when more statistics will be available (D vertex displacement exploited à la CDF)

D^0 and D^+ dN/dp_t

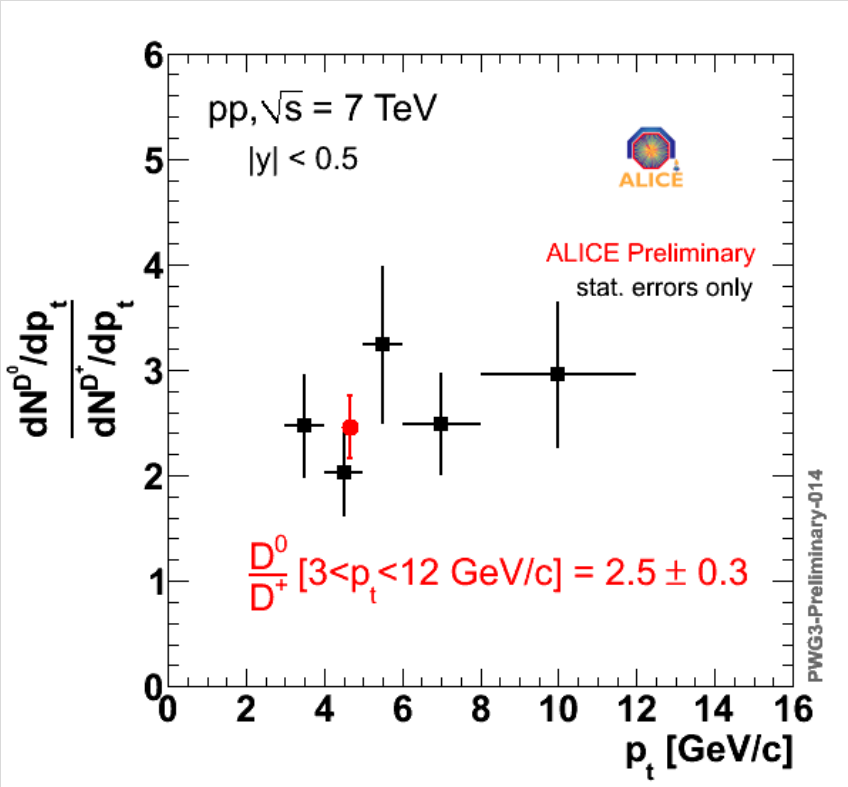




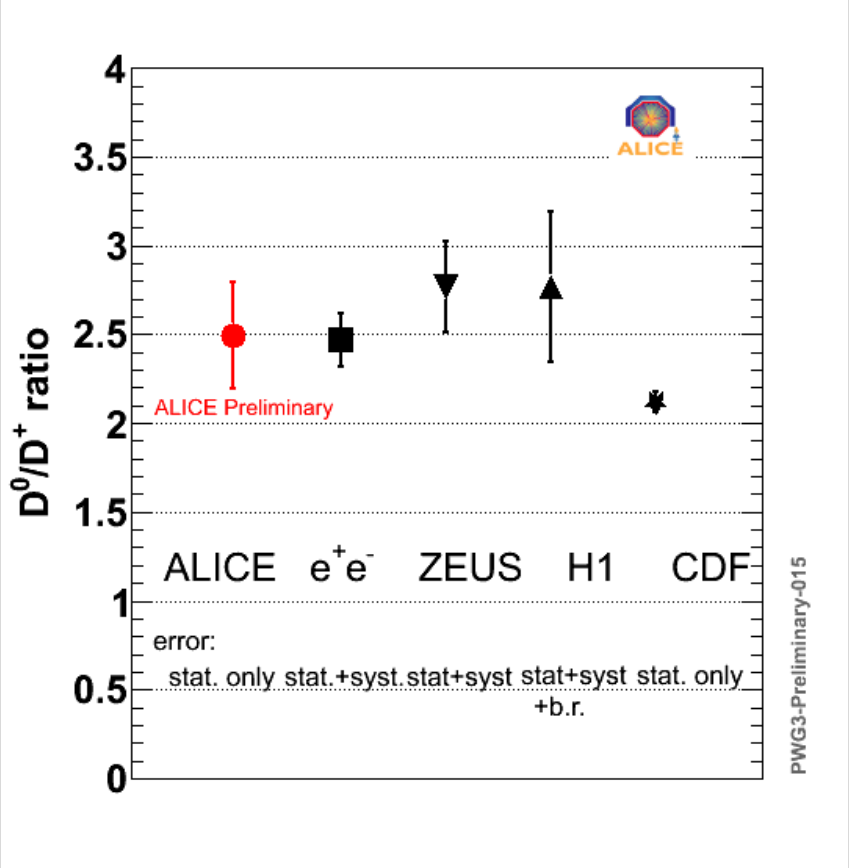
- Normalized to arbitrary units
- Compared to FONLL predictions normalized to the same integral of the data

D^0 over D^+ ratio

D^0/D^+ ratio

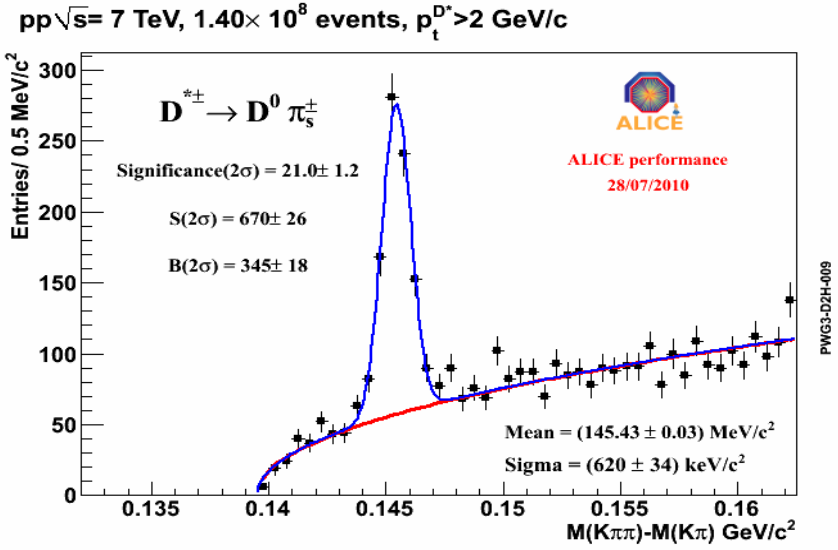


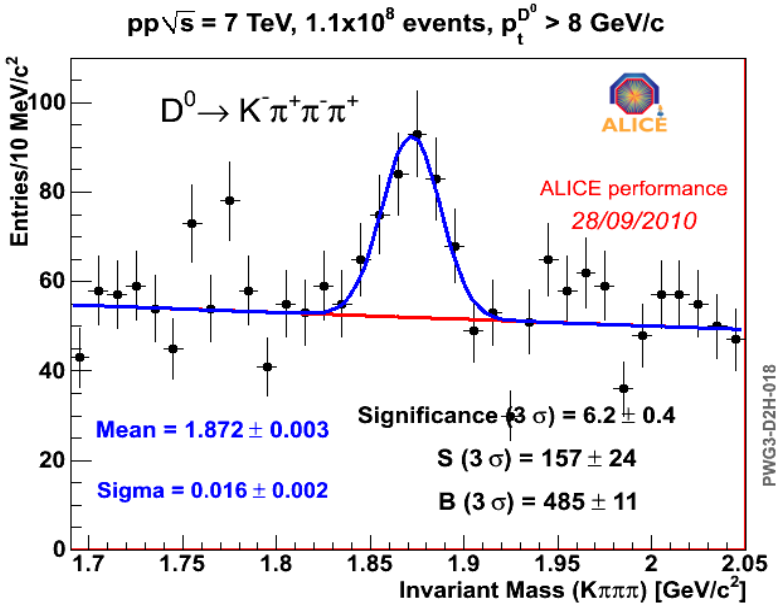
Comparison with other experiments

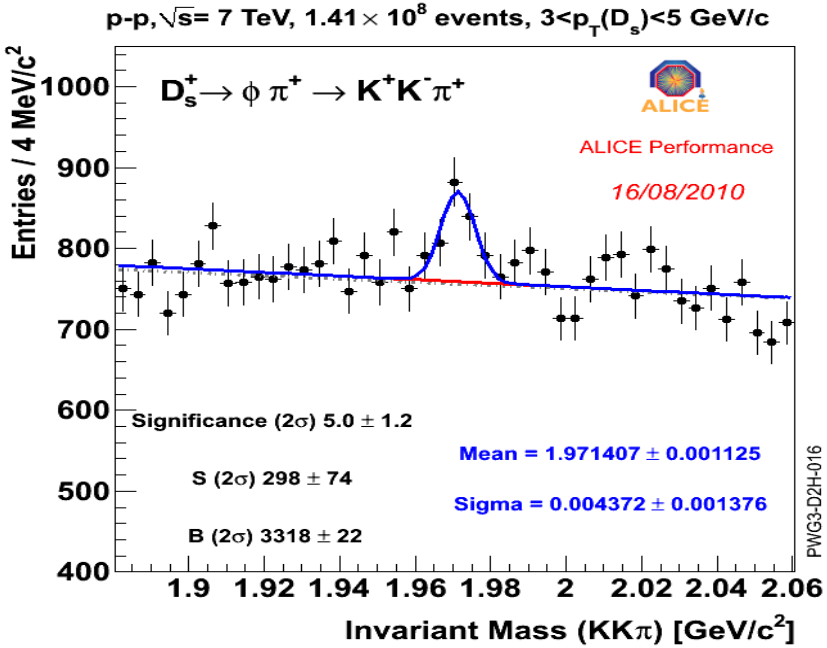


- Red: Ratio of the integral of dN/dp_t spectra

Other D signals



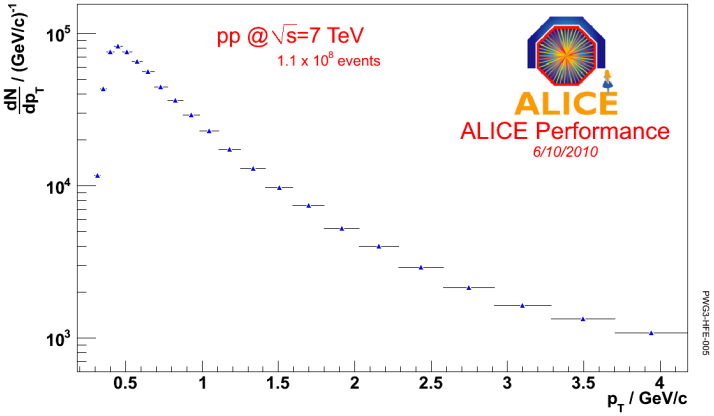




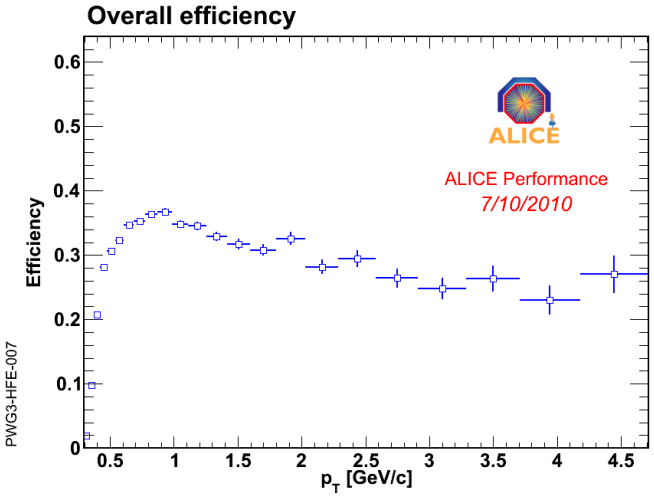
- 6 p_t bins for D^* ⇝ near to deliver dN/dp_t spectrum
- $D^0 \to K\pi\pi\pi$ very useful for comparison with 2 prongs decay
- D_s work in progress to improve significance

Electrons inclusive & corrected p_t spectrum

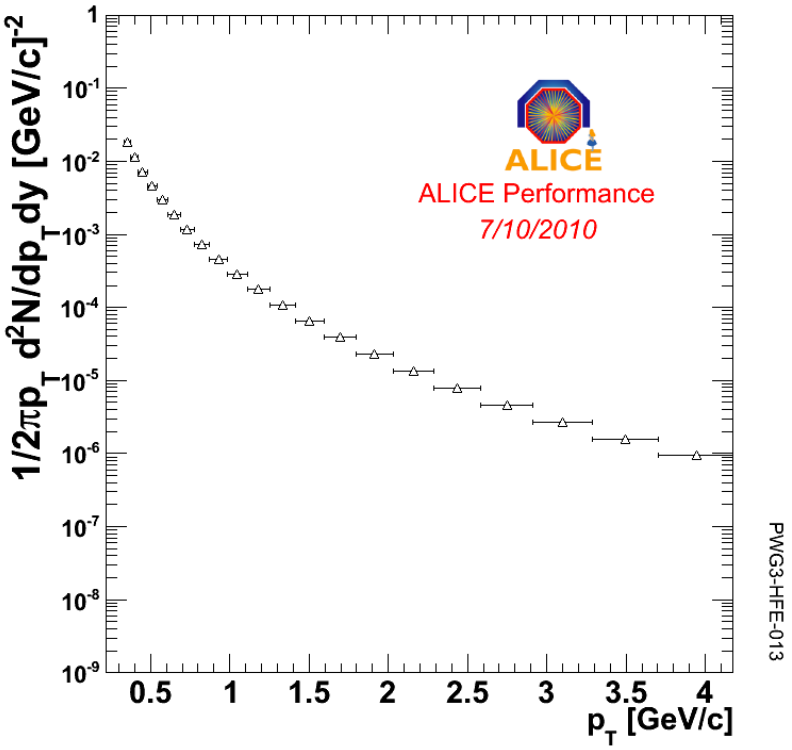
Uncorrected spectrum of identified electrons



Efficiency



Corrected spectrum



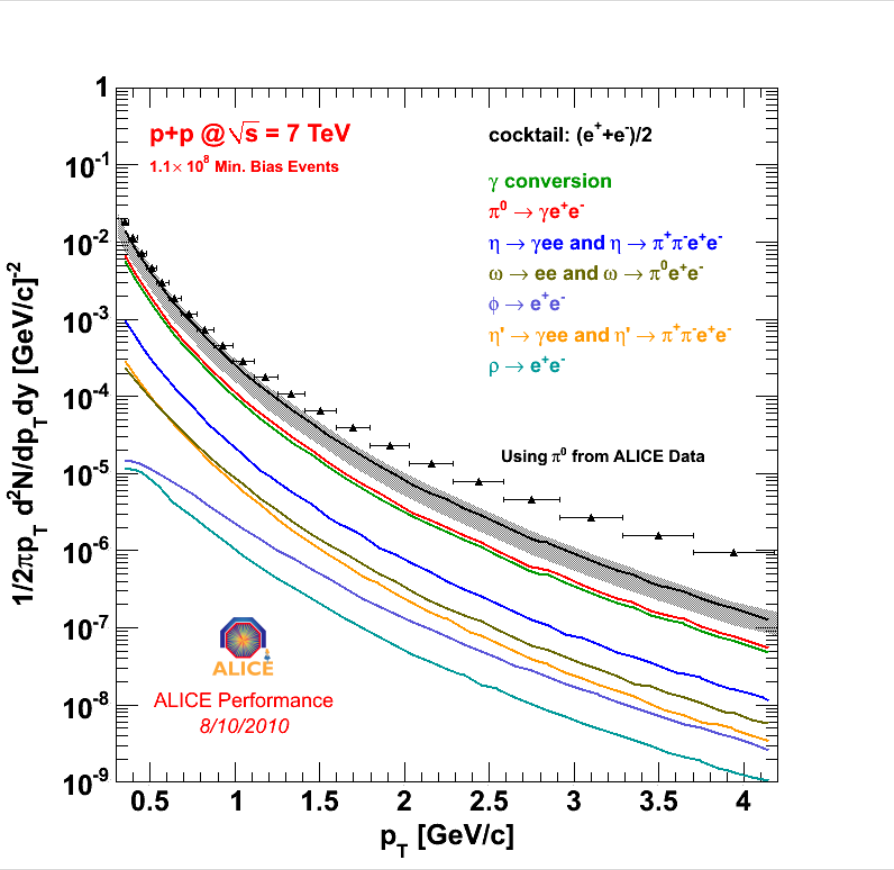
- Subtraction of residual hadronic contamination
- Correction for acceptance, efficiency and p_t unfolding

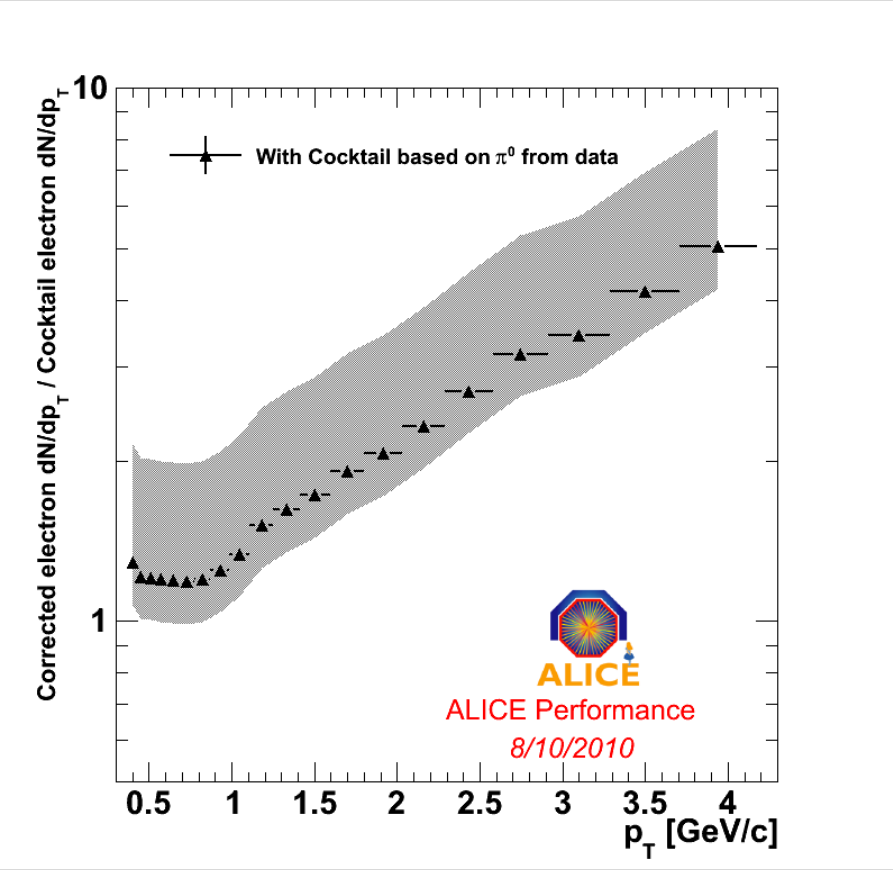
Cocktail ingredients

- Sources of e :
  - Dalitz decays of light neutral mesons
  - Photon conversion in the material
  - Direct radiation
  - Weak kaon decays
  - Dielectron decays of vector mesons
  - **Heavy flavour decays**

✓ What's in the current cocktail
  - ✓ Neutral pions (☺ based on measured π^0!)
  - ✓ Heavier mesons: η, ρ, ω, ϕ, η'
  - ✓ Photon conversion

Electrons spectrum & cocktail





- Observed excess in the ratio due $c/b \to e + X$
- Small contribution from J/ψ and direct radiation

Conclusions and Outlook

- Analysis for heavy flavour production measurement at midrapidity well under way!

★ **D → hadrons**

- ☑ D^0 and D^+ dN/dp_t shape measured in $3 < p_t < 10$ GeV/c
- ☑ D^0-to-D^+-ratio compatible with previous measurements
- → Towards exclusive D cross sections

★ **c/b → e + X**

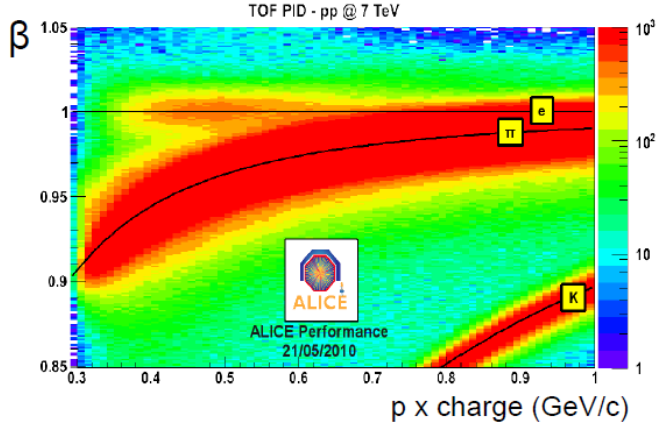
- ☑ An inclusive electron spectrum is compared to a cocktails of "photonic" electron sources
- ☑ A significant excess in the electron yield is observed, due to charm and beauty semileptonic decays
- → Towards c+b cross sections and later beauty contribution

☼ Looking forward to Pb-Pb collisions in November!

Extras

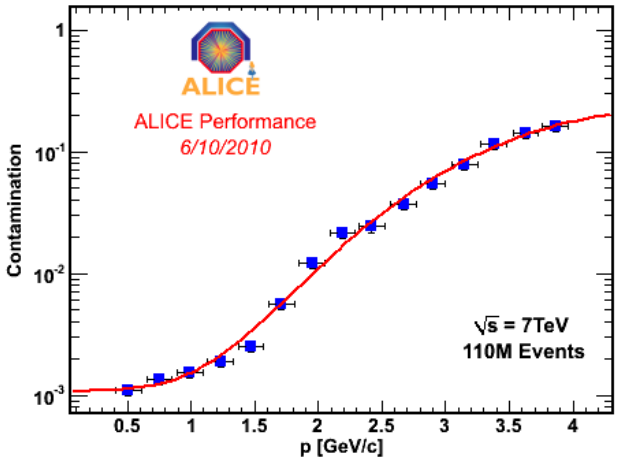
Electrons identification

Electron compatibility with TOF

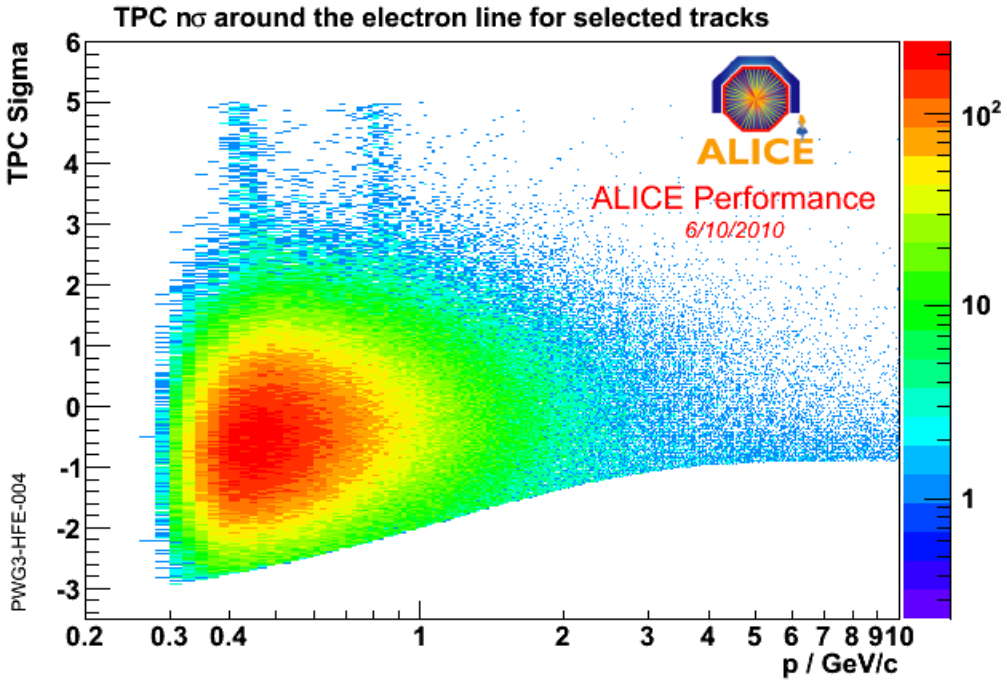


e compatibility cut at $\pm 3\sigma$

π contamination (TPC)



TPC signal after cut around the e Bethe Bloch line

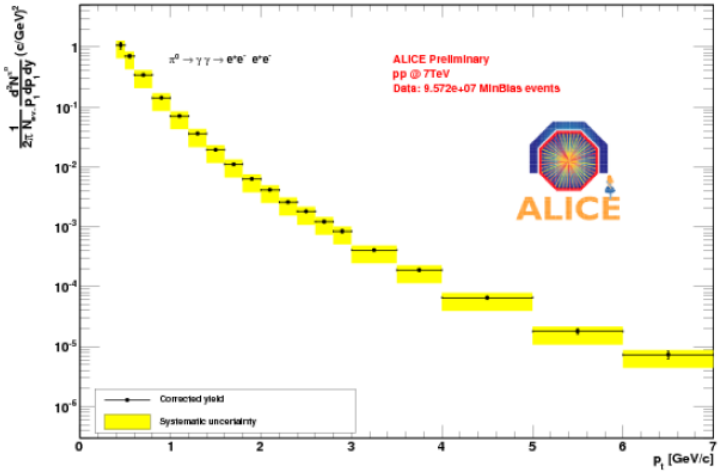


- Upper cut: $< 5\sigma$
- Lower cut depending on momentum

Ingredients for the cocktail

π^0 spectrum

1. Measured by ALICE:



2. NLO prediction:
   - B.Jager, A. Schaefer, M. Stratmann, W. Vogelsang *Phys. Rev.* D67 (2003) 054005

Heavier mesons (η, ρ, ω, ϕ, η')

- Implemented via m_T scaling
- Verified for η in ALICE

Photon conversion

- Analysis cuts reject e from photon conversion but not those from the beam pipe and from the first pixel layer ($\sim 1/3$)
- Ratio $\frac{e^-_{Conversion}}{e^-_{Dalitz}} = 0.739$