Physics Results with the ALICE TOF detector

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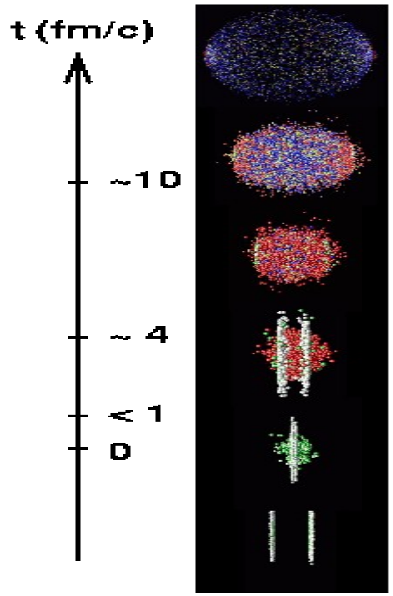
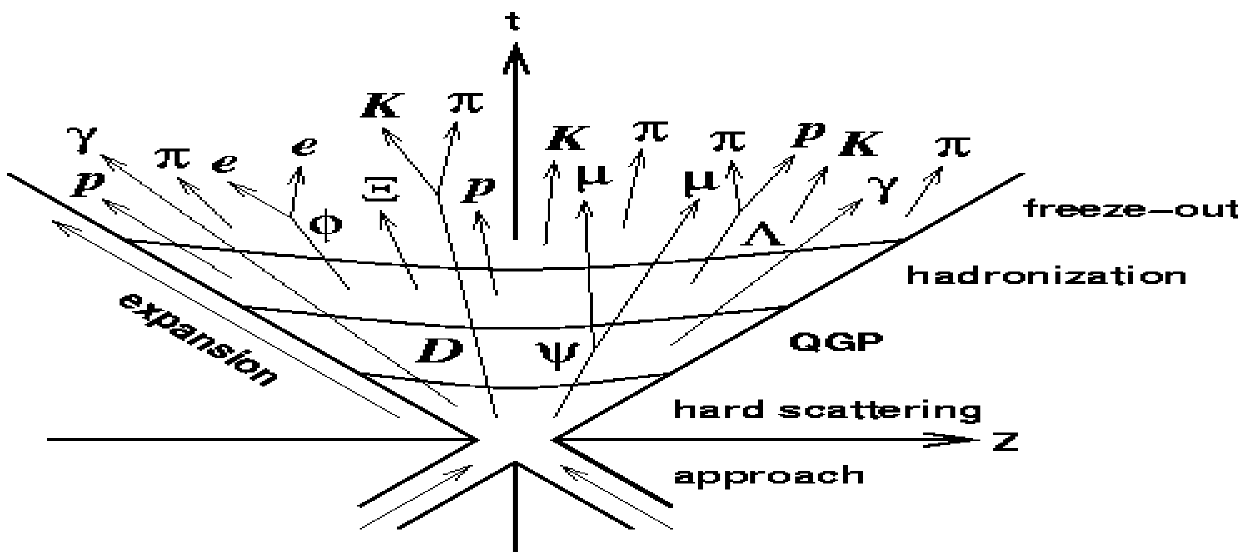
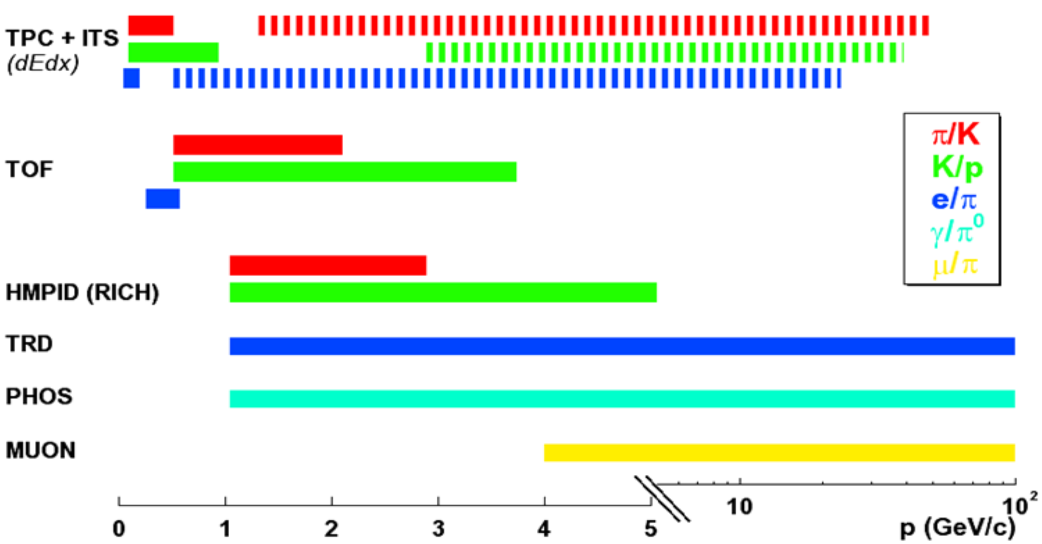
QGP Studies→Particle Identification





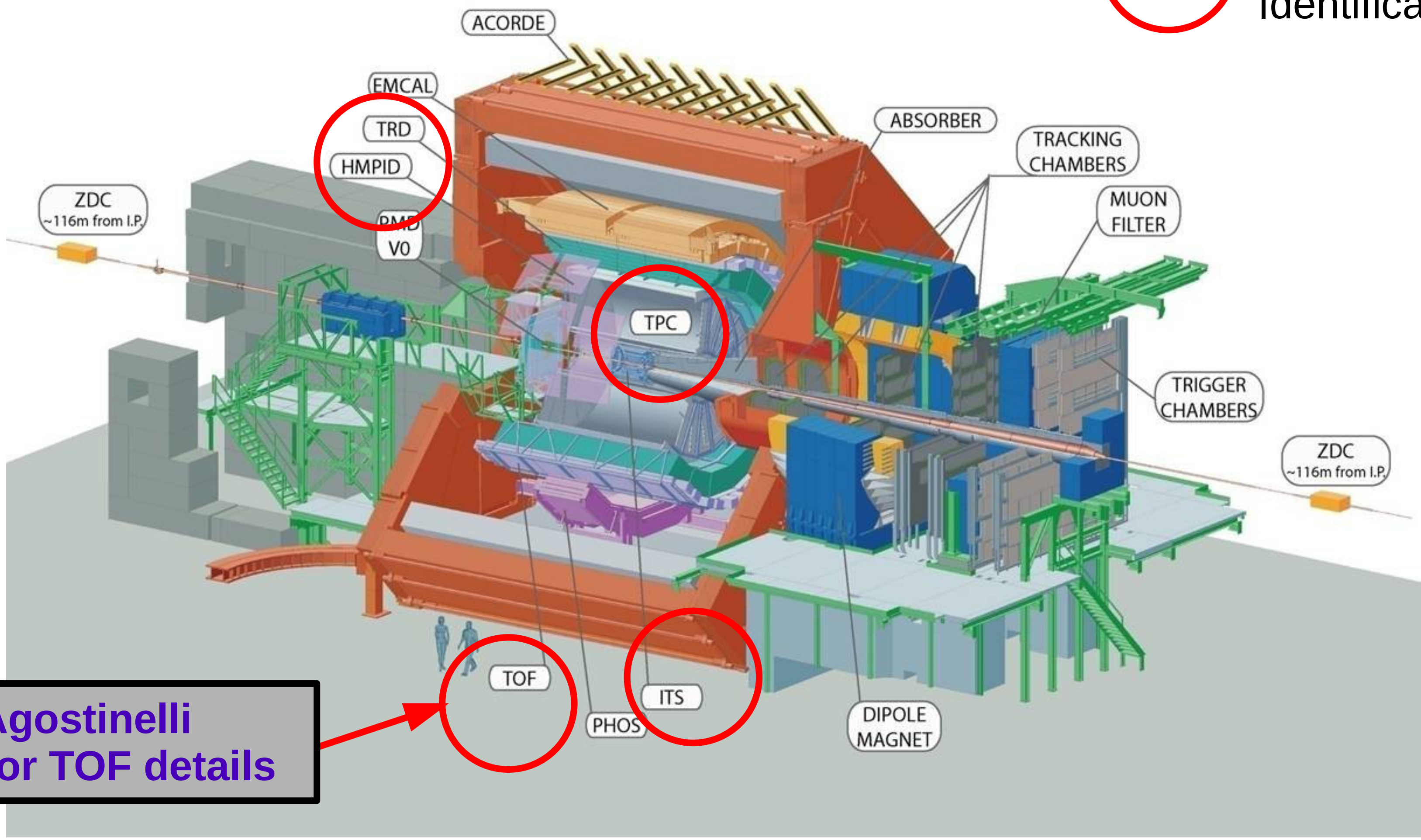


TOF: hadrons PID thanks to the definition of the time taken by a particle to reach TOF

$$m = p\sqrt{\frac{t^2}{L^2} - \frac{1}{c^2}}$$

ALICE Experiment

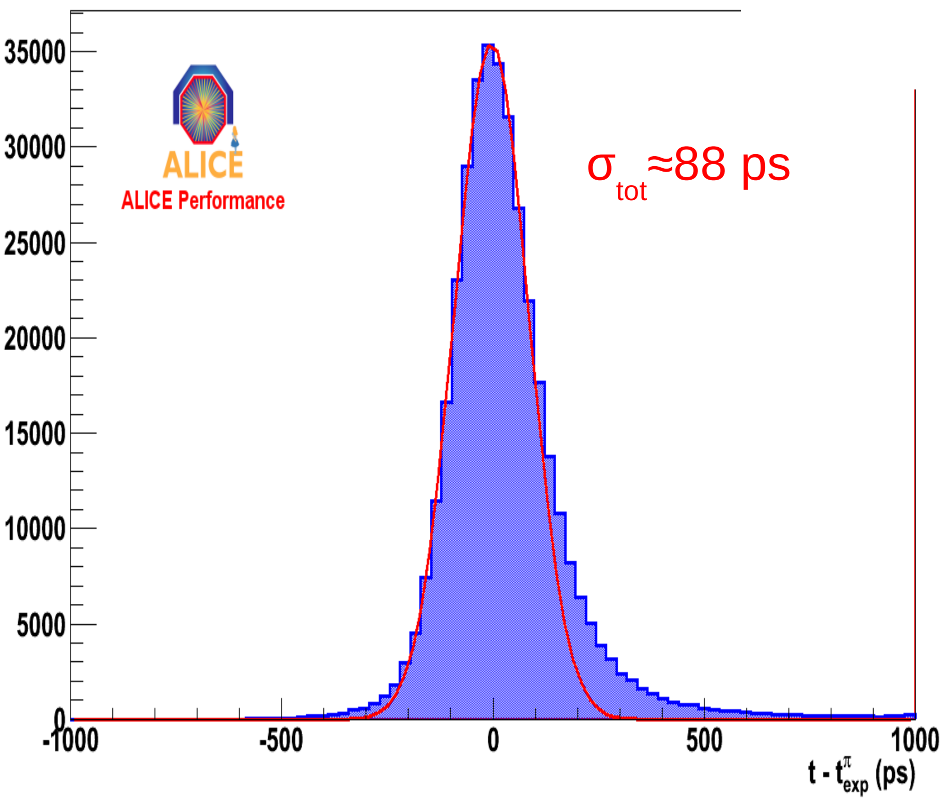
Main Detectors Used to Particle Identification



See A. Agostinelli poster for TOF details

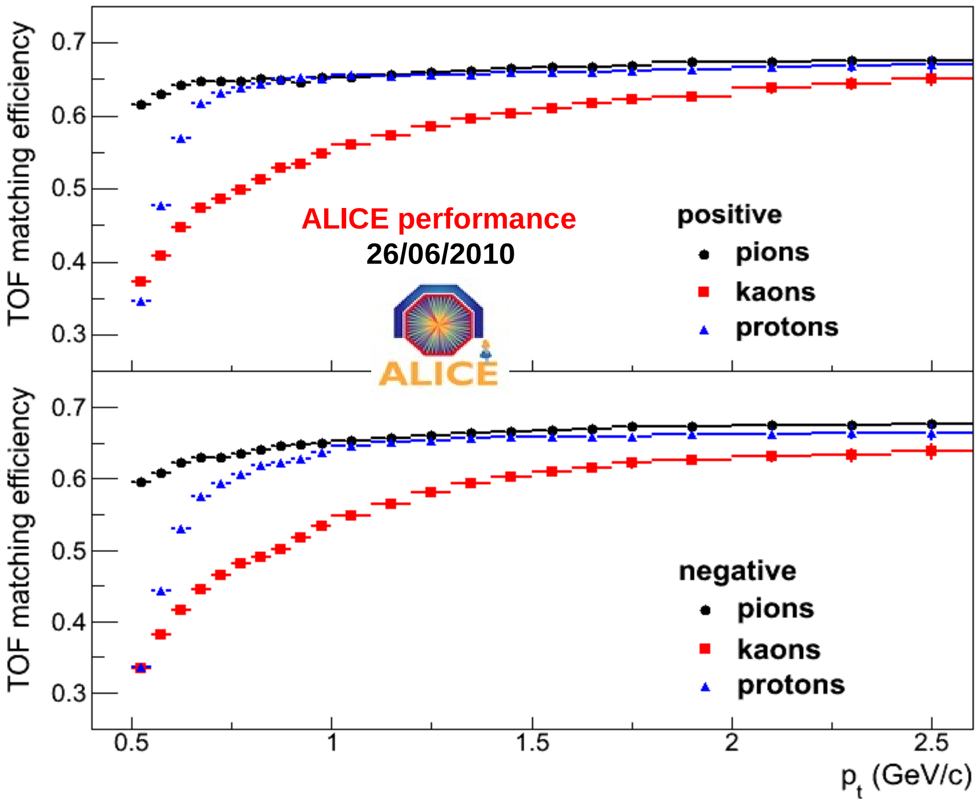
TOF PID

Time resolution in PbPb @ 2.76 TeV

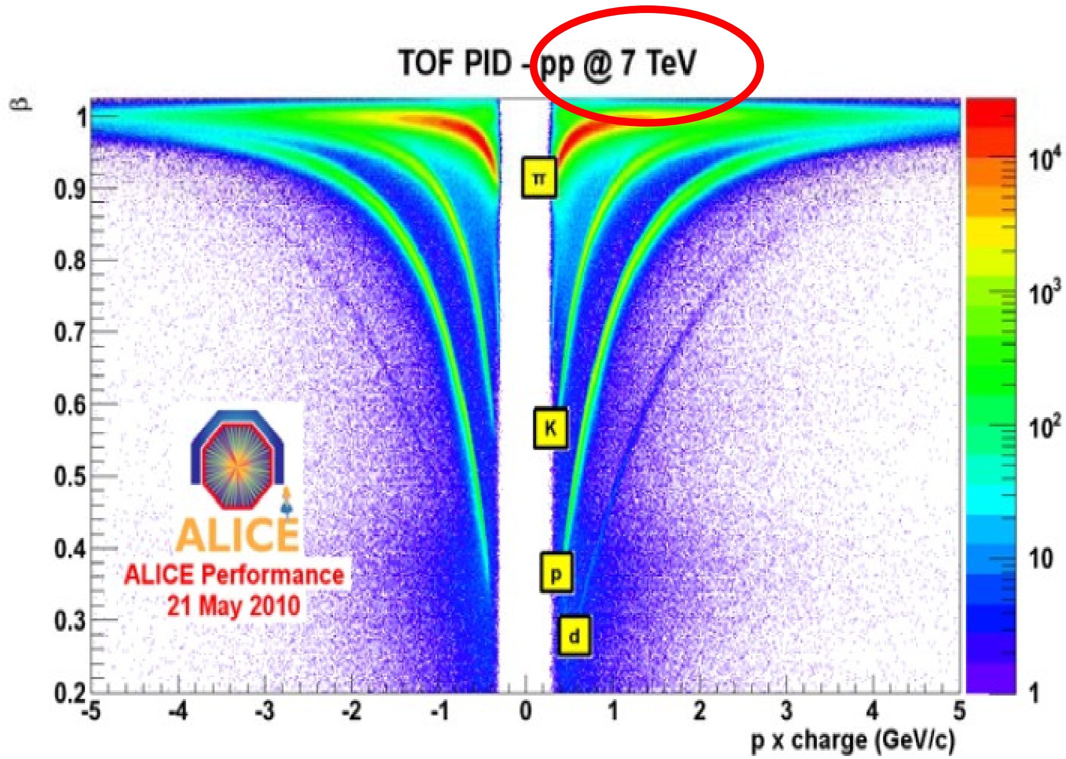


See A. Agostinelli poster for more details on time resolution

Matching efficiency in pp @ 900 GeV

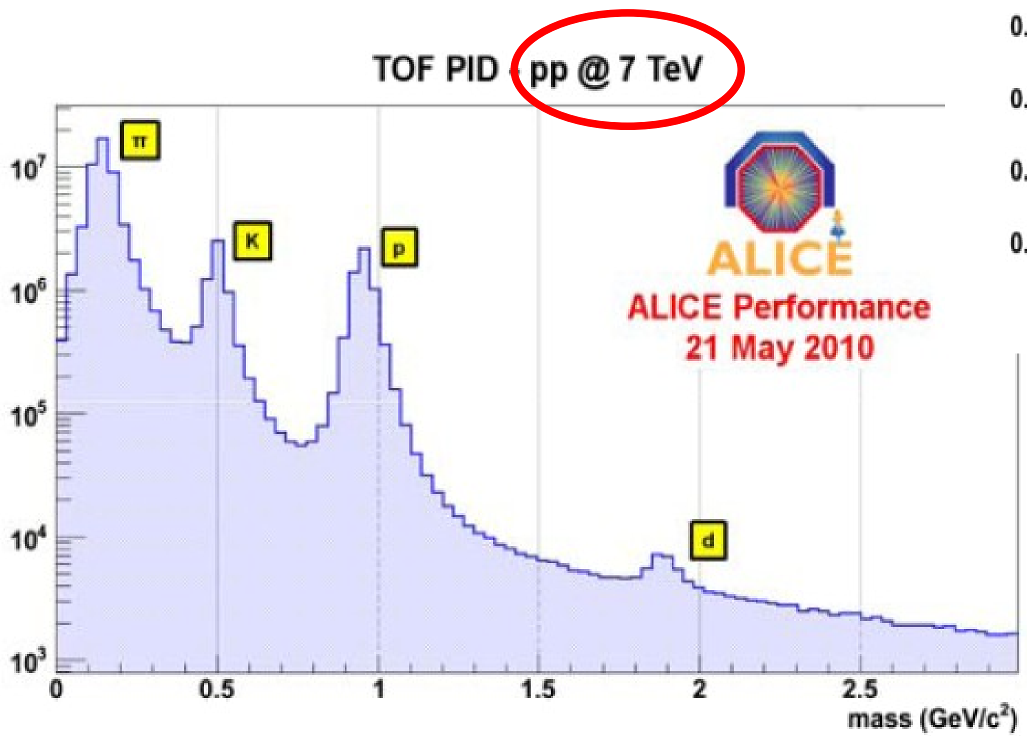


TOF PID performance



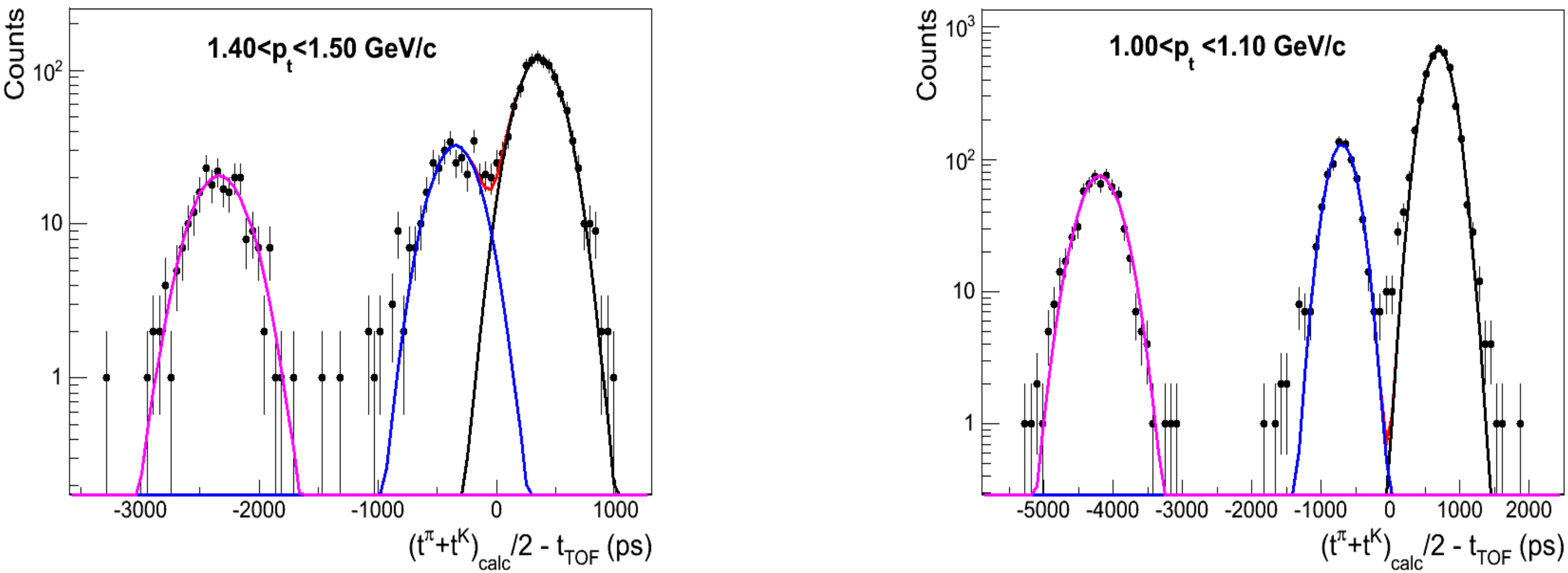
Distribution of the particle masses calculated as:

$$m = p\sqrt{\frac{t^2}{L^2} - \frac{1}{c^2}}$$



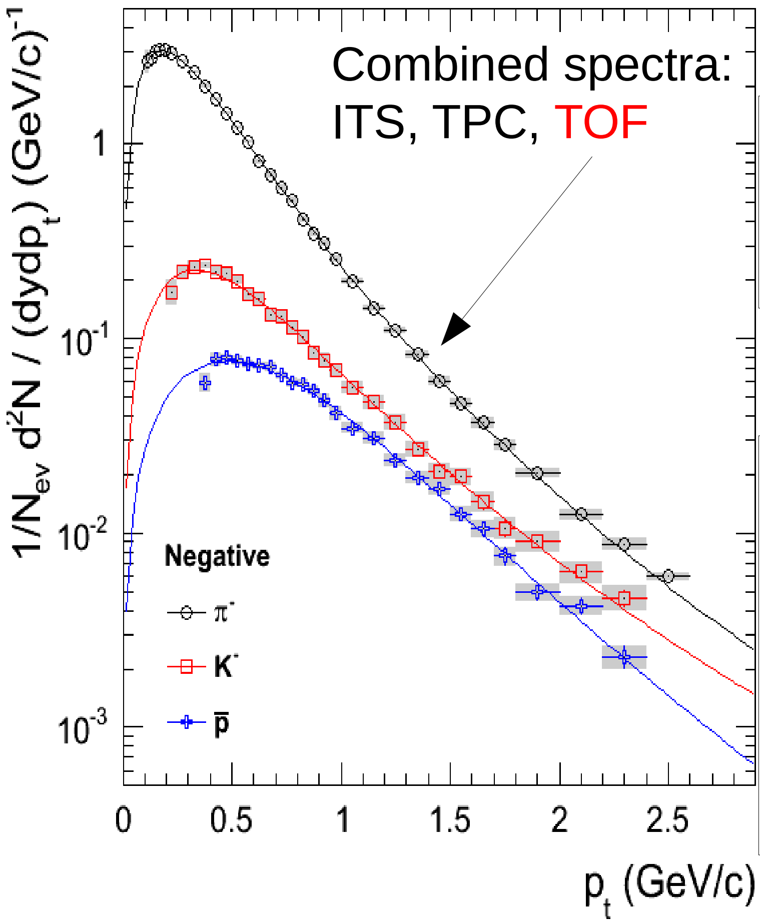
Some Physics Results

P_t Spectra for pp collisions @ $\sqrt{s}$ = 900 GeV: TOF PID Strategy



Particle species separation using the Time-of-Flight measured by the TOF detector (t_{TOF}) and calculated during the tracking procedure (t_{calc}) assuming different mass hypothesis

P_t Spectra for pp collisions @ $\sqrt{s}$ = 900 GeV

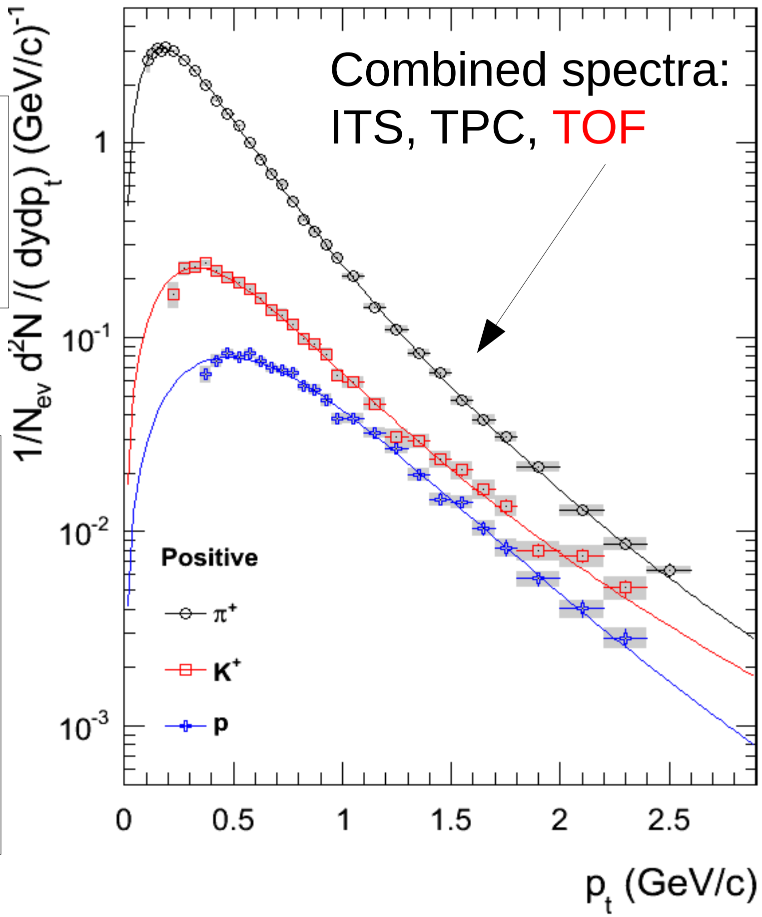


TOF used for

- π, K: p_t>0.5 GeV/c
- p: p_t>0.7 GeV/c

Production of pions, kaons and protons in pp collisions at sqrt(s)= 900 GeV with ALICE at the LHC.

By ALICE Collaboration
Submitted to Eur. Phys J. C.

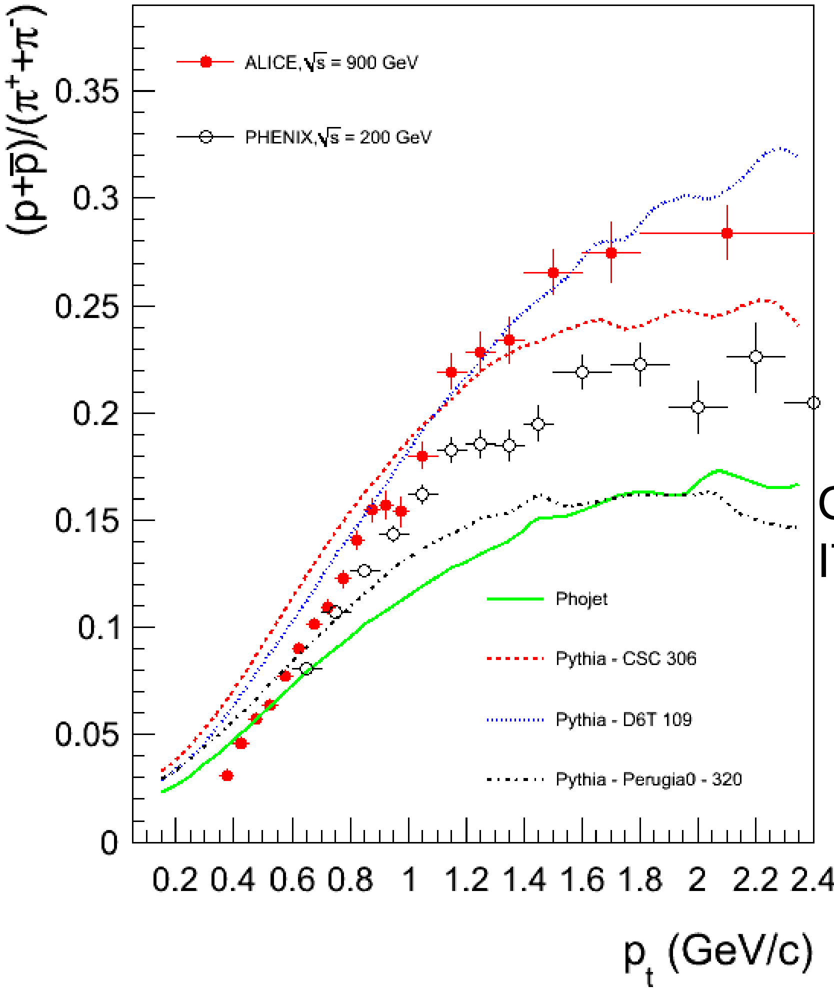


Fit = Levi function

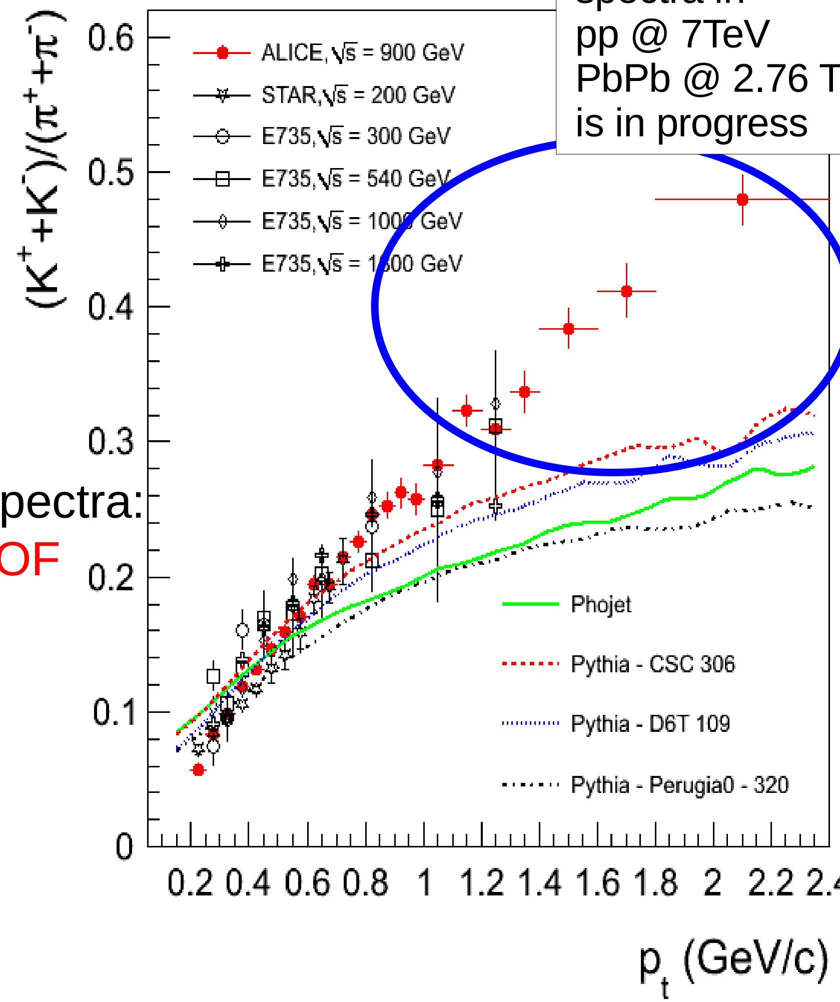
$$\frac{d^2N}{dp_t dy} = p_t \times \frac{dN}{dy} \frac{(n-1)(n-2)}{nC(nC+m_0(n-2))} \left(1+\frac{m_t - m_0}{nC}\right)^{-n}$$

P_t Spectra for pp collisions @ $\sqrt{s}$ = 900 GeV

Comparison with spectra in
pp @ 7TeV
PbPb @ 2.76 TeV
is in progress

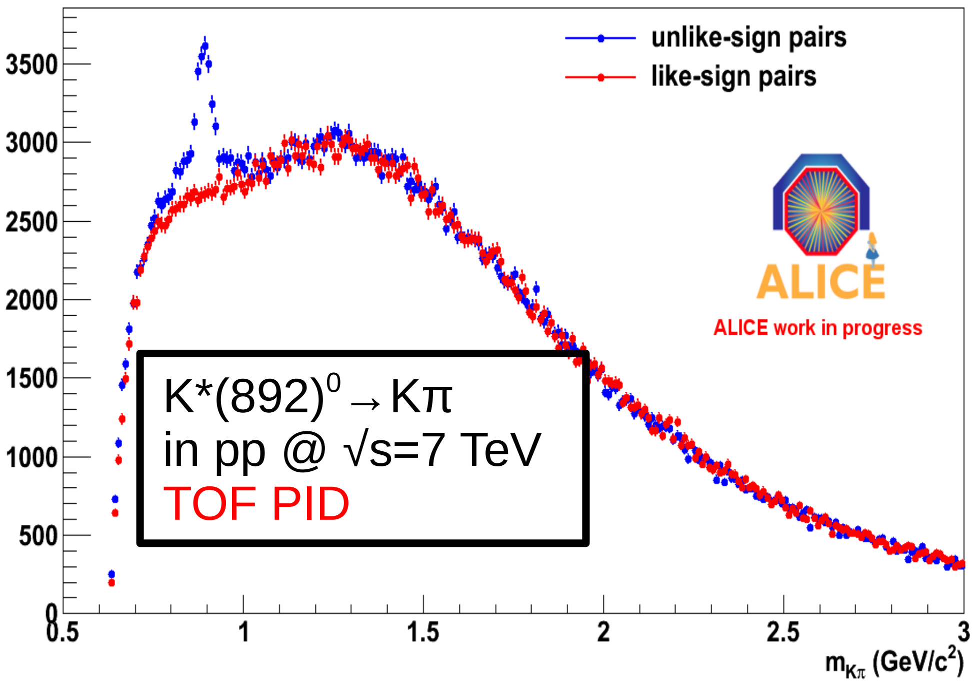


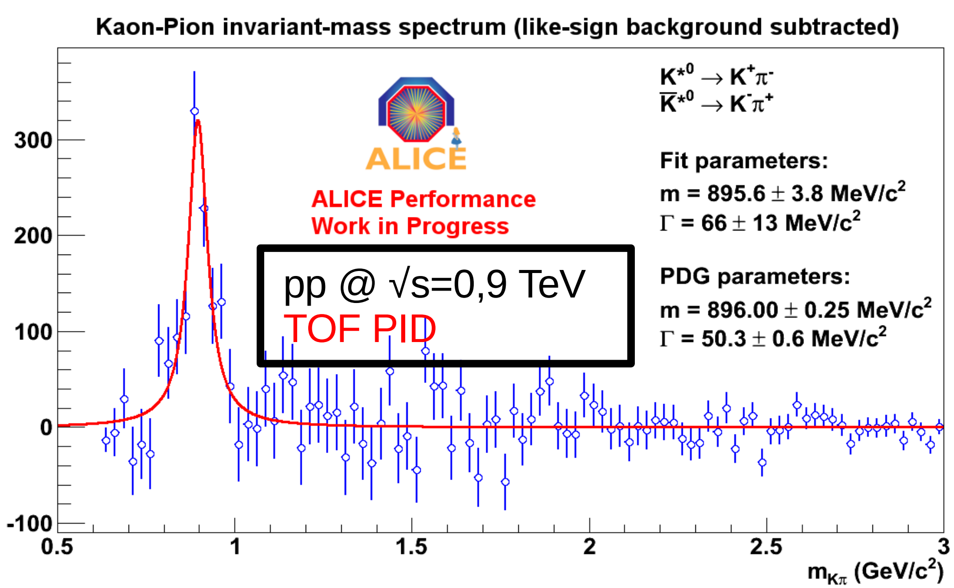
Combined spectra:
ITS, TPC, TOF



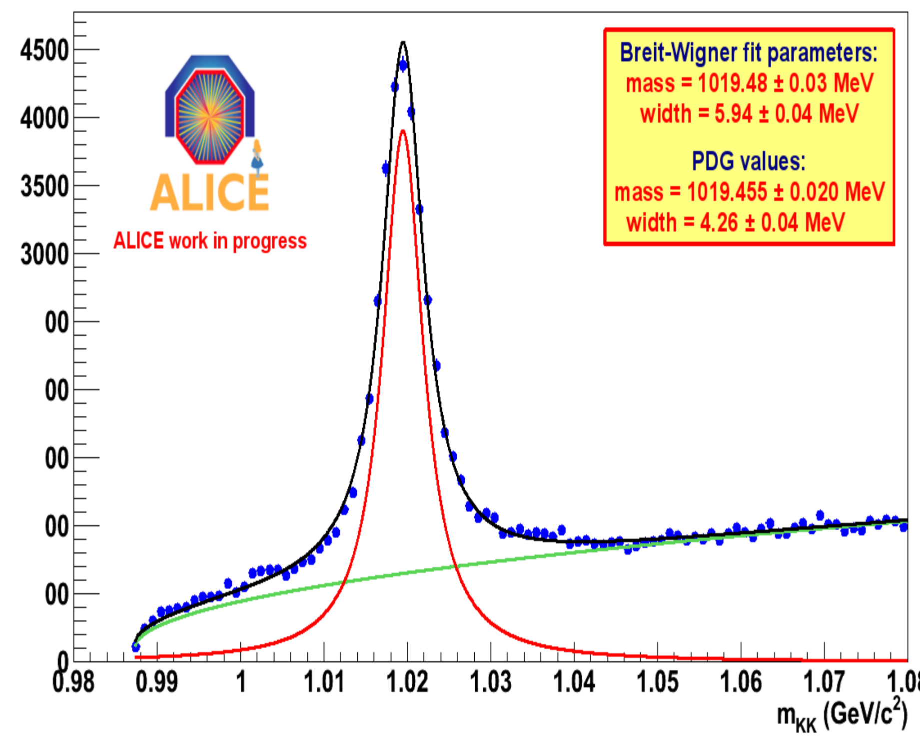
Production of pions, kaons and protons in pp collisions at sqrt(s)= 900 GeV with ALICE at the LHC. By ALICE Collaboration. Submitted to Eur. Phys J. C.

Resonances

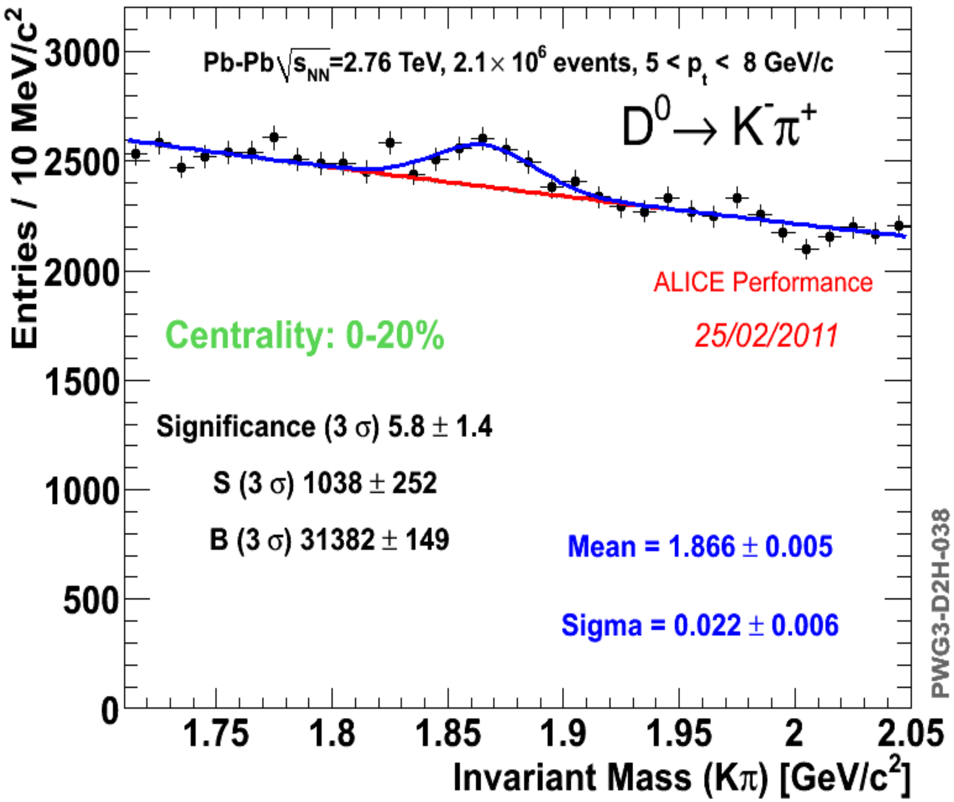


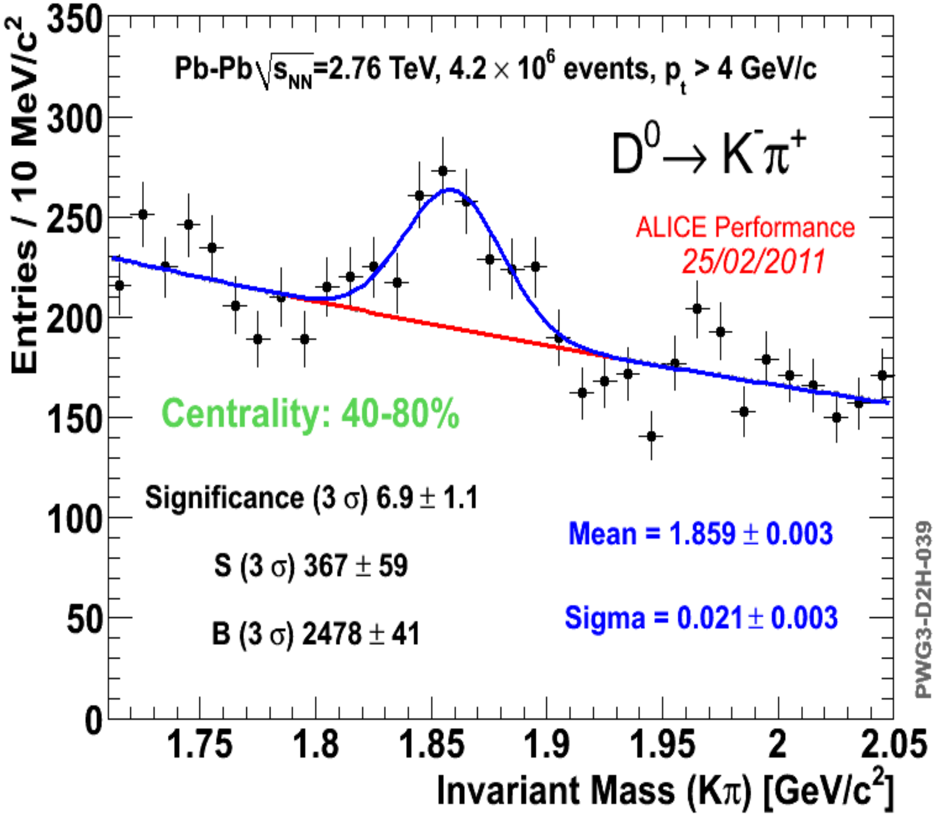


φ → K^+K^- in pp @ √s=7 TeV
TOF PID



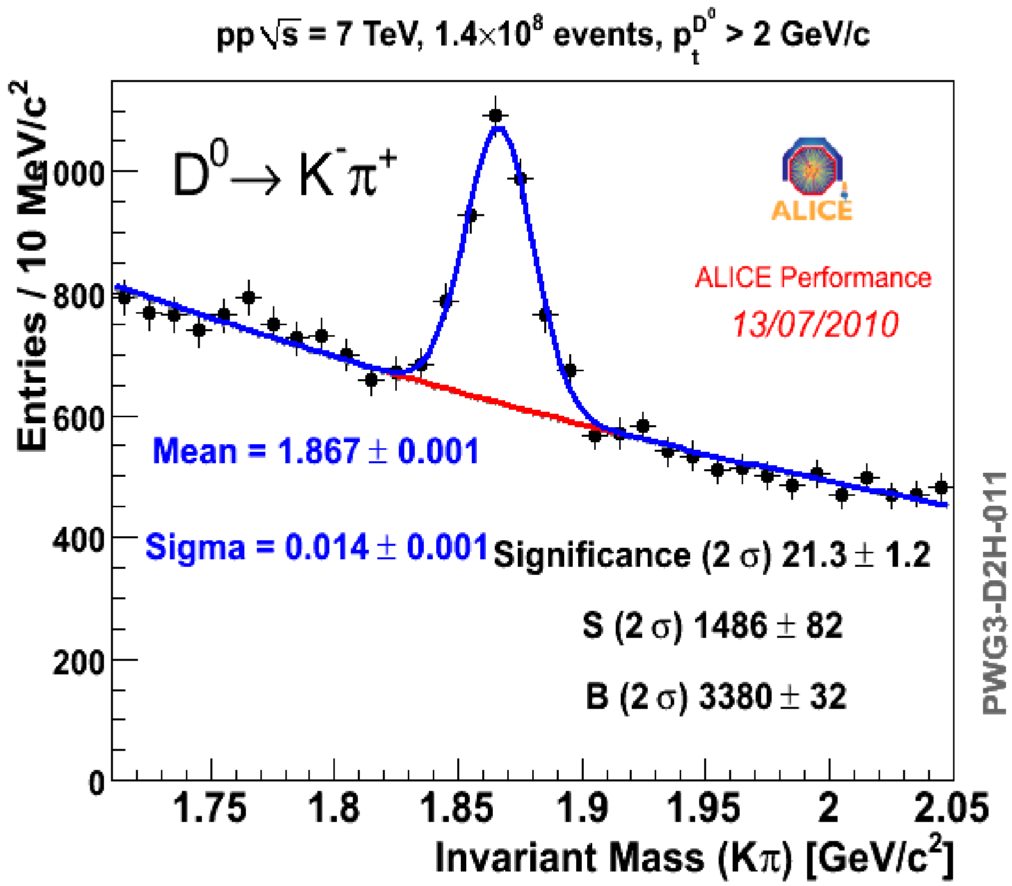
Heavy flavours: $D^0 \rightarrow K^- \pi^+$ in PbPb





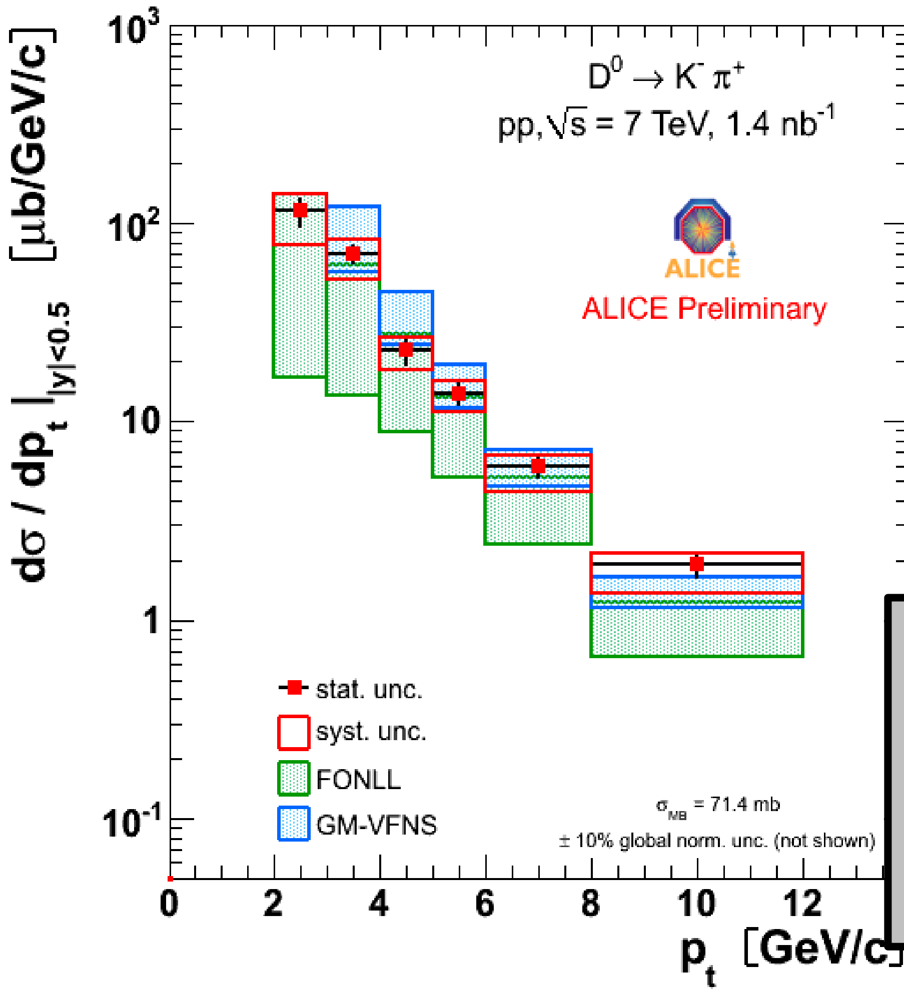
Invariant mass spectrum of 2.76 TeV Pb-Pb data. TOF and TPC PID are applied.
The fit function corresponds to the sum of a gaussian (signal) and an exponential (background).

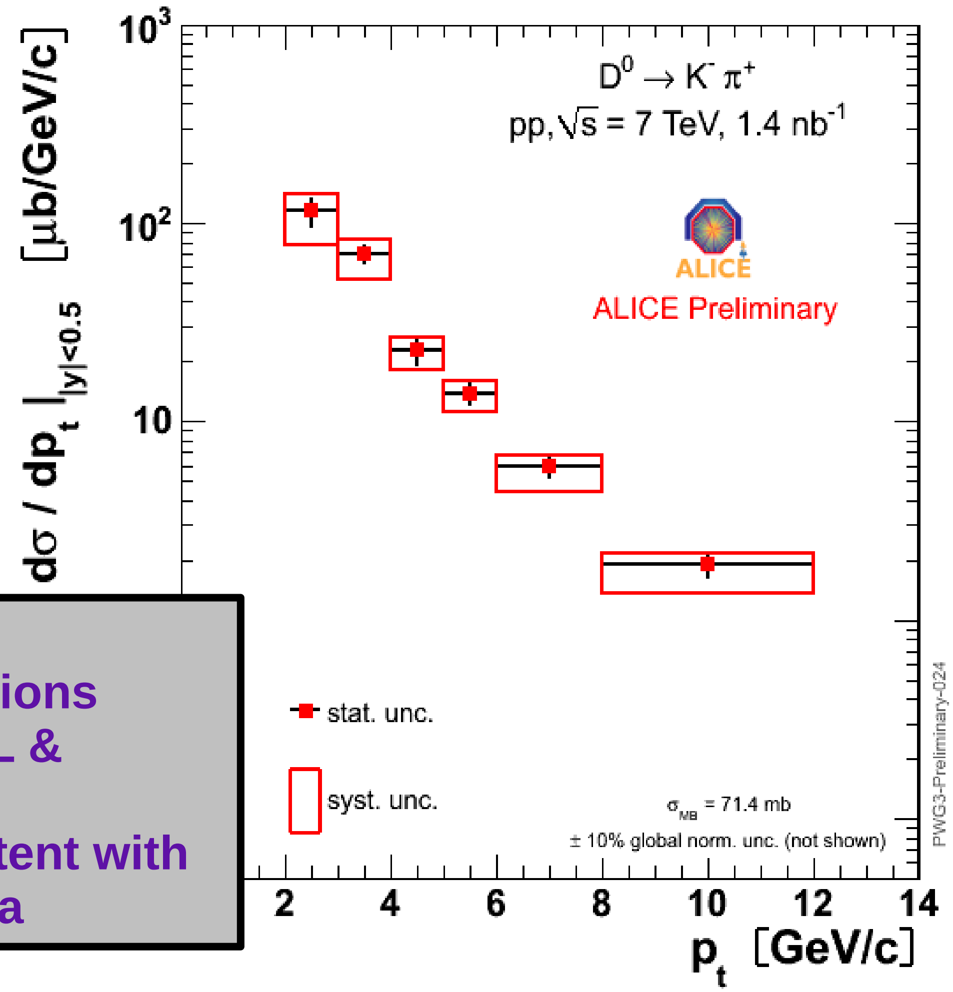
Heavy flavours: $D^0 \to K^- \pi^+$ in pp



Invariant mass difference spectrum of 7 TeV data collected in April-May 2010. TOF and TPC PID is applied. The background is estimated using D0 candidates with invariant mass falling in the side-bands (4-8 sigma range) of the D0 mass region.

Heavy flavours: $D^0 \rightarrow K^- \pi^+$ in pp preliminary cross-section

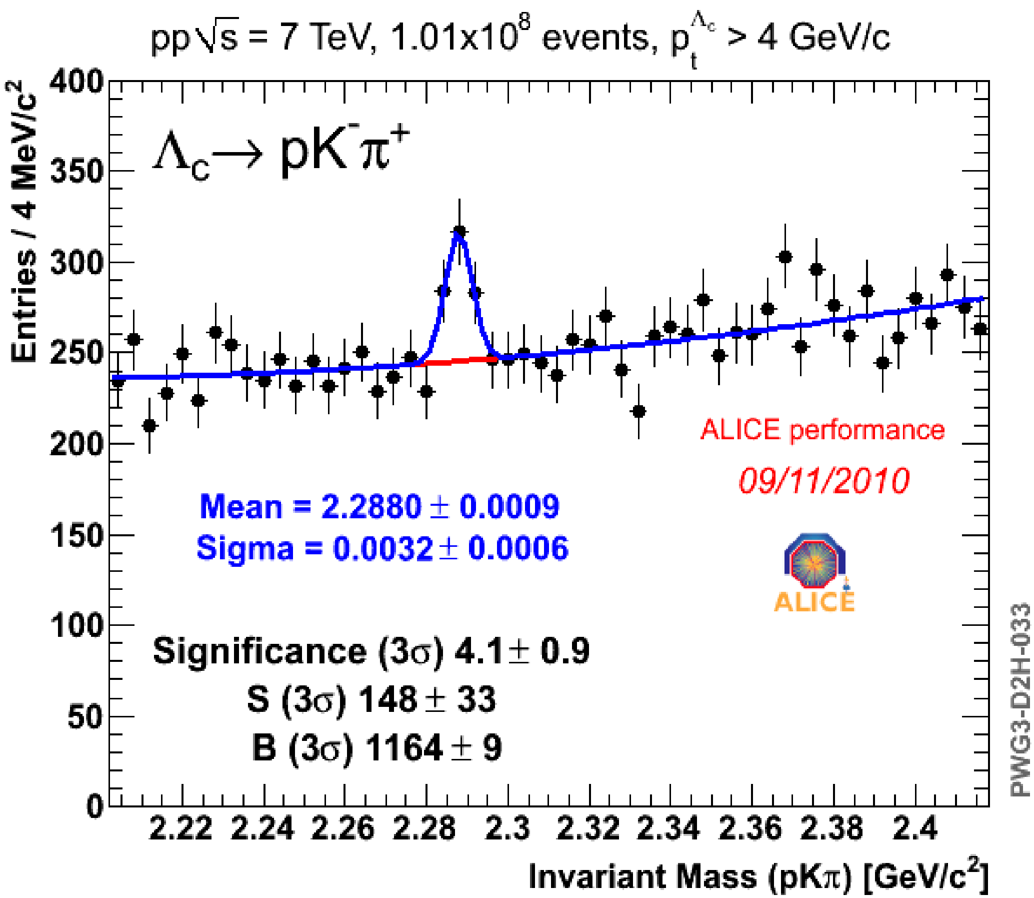




pQCD predictions (FONLL & VFNS) consistent with the data

Production cross section for D0 mesons in pp at 7 TeV. The cross section is given for D0 (obtained as 0.5*(D0+D0bar)) scaled to |y|<0.5 and compared to predictions from FONLL (Cacciari et al.) and GM-VFNS (Kramer et al.).

Heavy flavours: $\Lambda_c \rightarrow pK^-\pi^+$

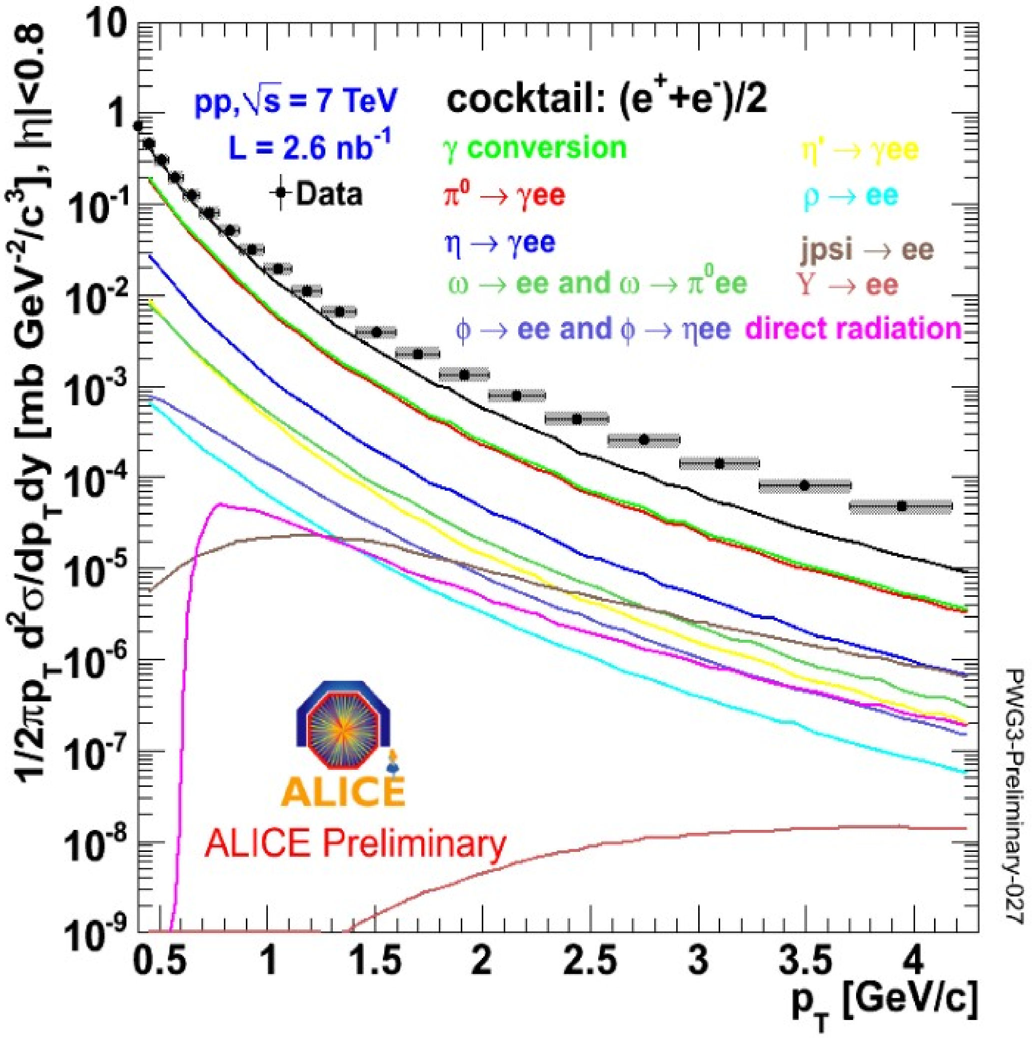


Invariant mass spectrum corresponding to 7 TeV data collected in April-May 2010. TPC, TOF and ITS PID are applied.
The fit function corresponds to the sum of a gaussian (signal) and an exponential (background).

Electrons from HF decay in pp

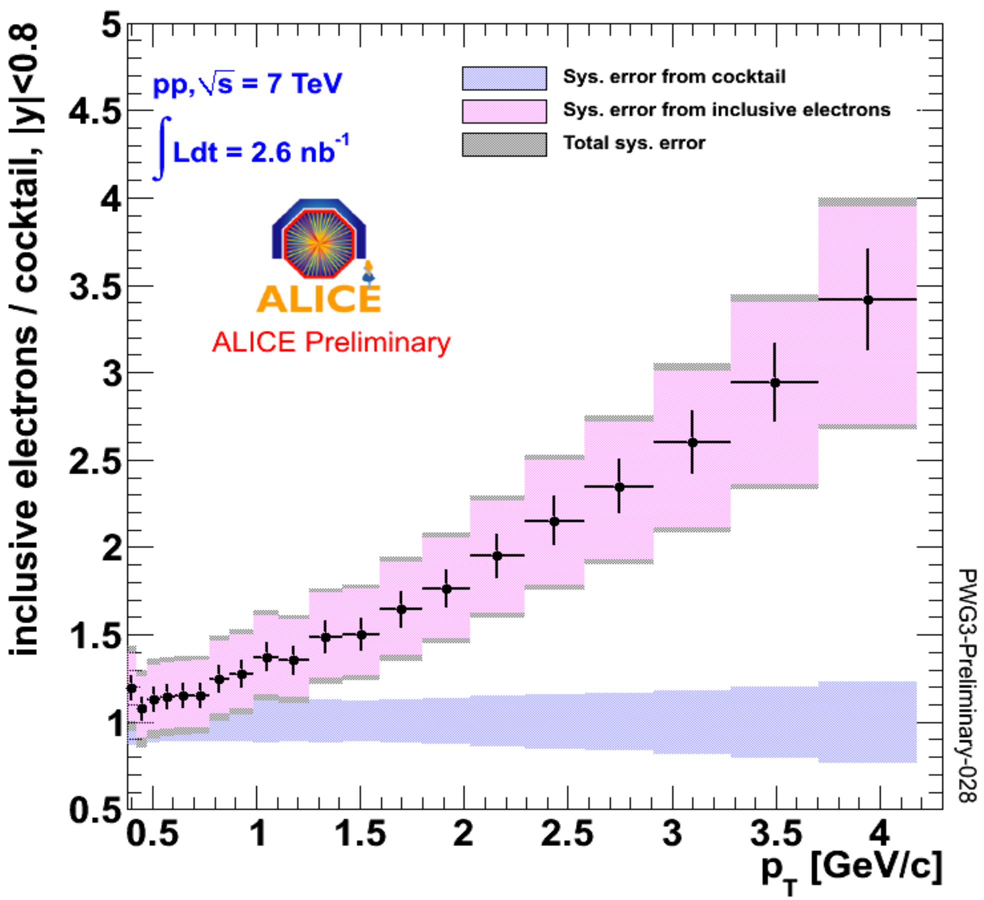
Electron inclusive spectrum

Electron identification with TPC+TOF

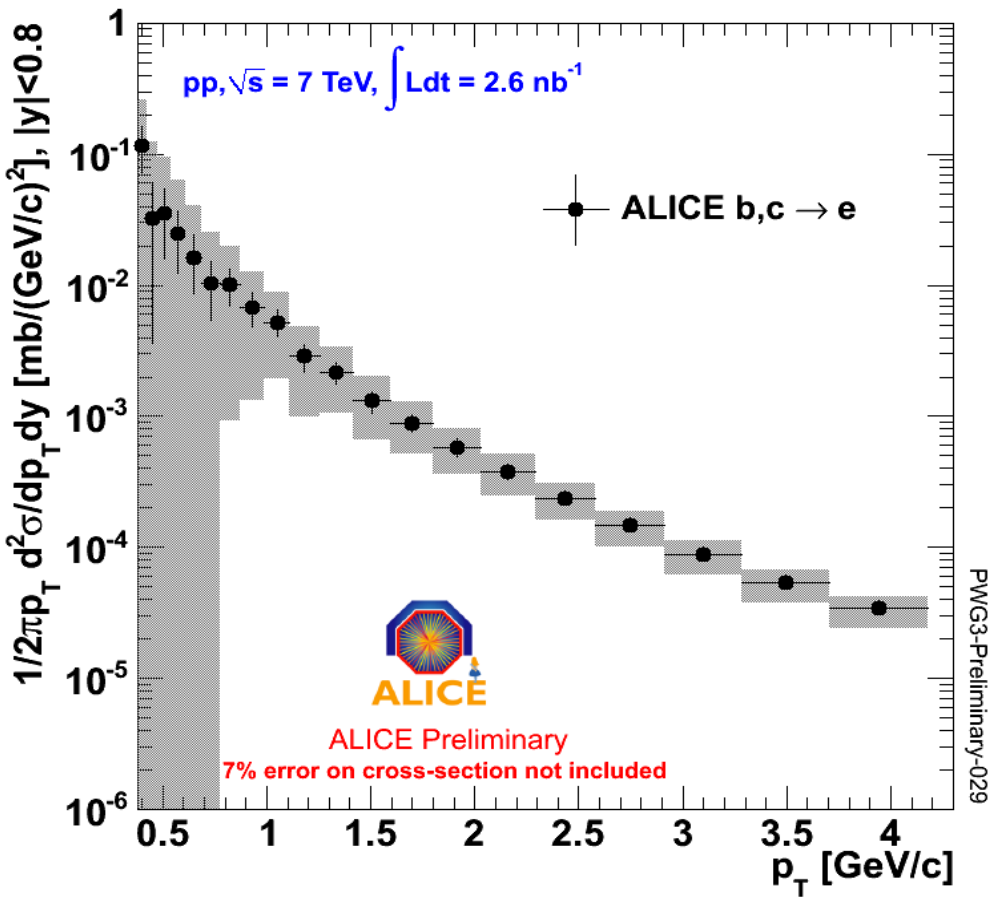


Electrons from HF decay in pp

Ratio between the inclusive electron spectrum and the electron cocktail.
Increasing significance of the heavy flavor electron signal over the inclusive background description.

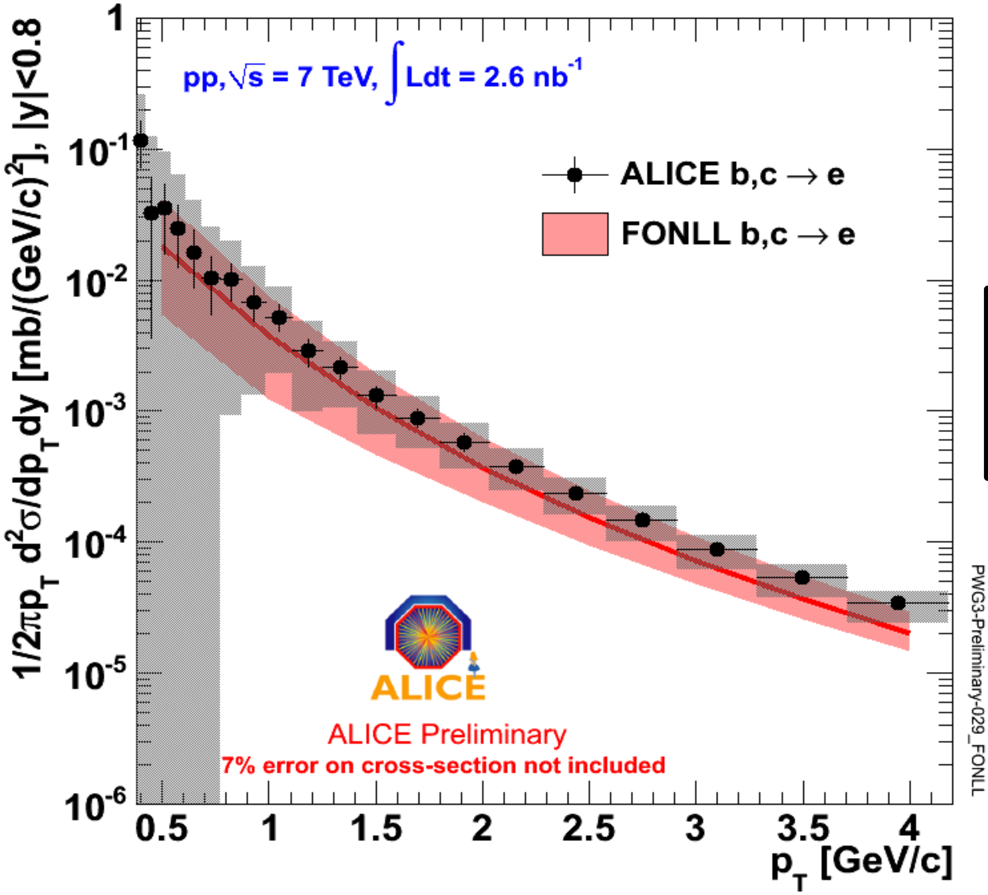


When we subtract the cocktail from the inclusive electron spectrum, we are left with the transverse momentum distribution of electrons coming from the semileptonic decays of hadrons with charm and beauty.



Electrons from HF decay in pp

The Heavy Flavor Electron spectrum (inclusive-cocktail) is compared to the FONLL prediction for both charm and beauty semileptonic decays summed.

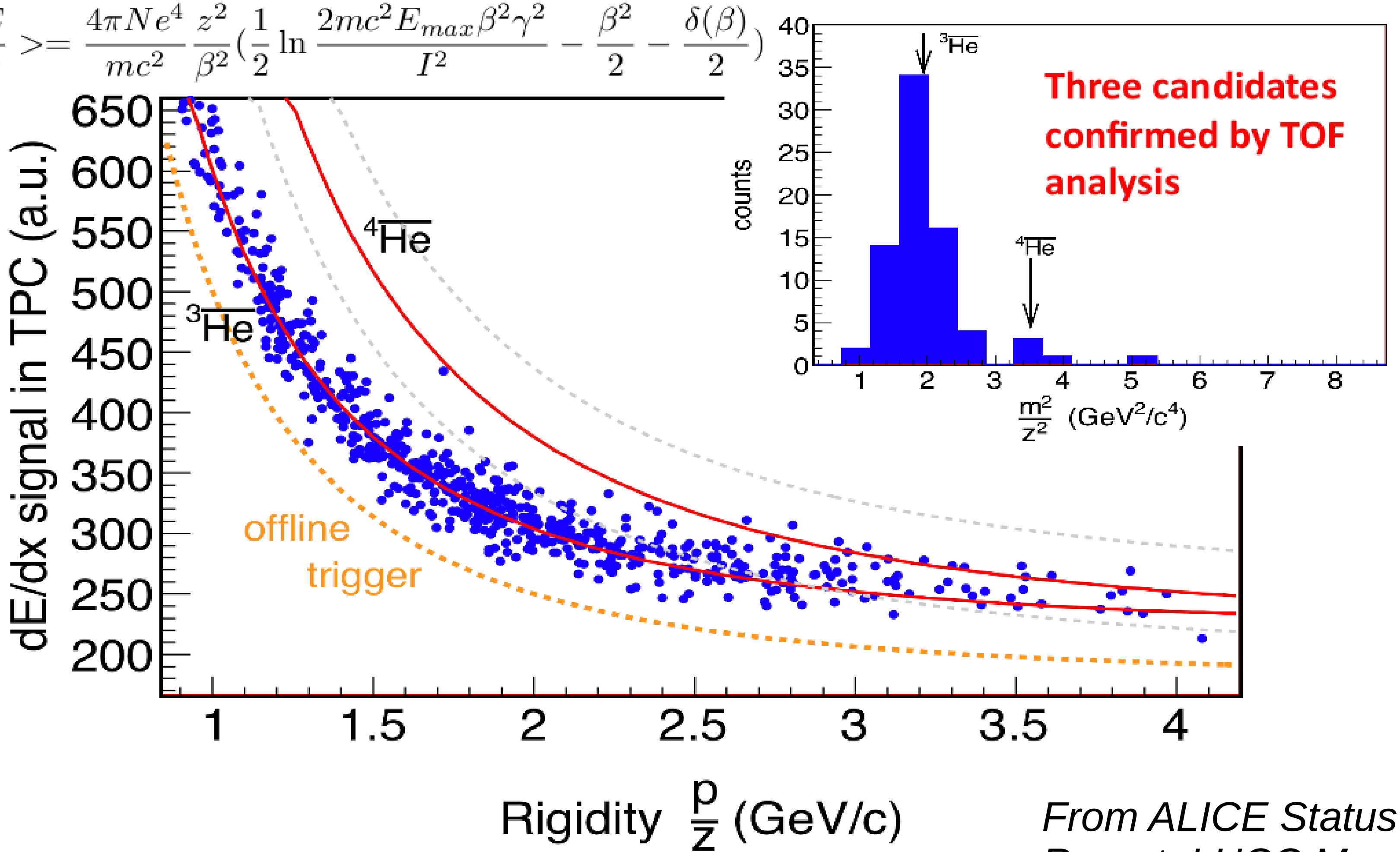


Good agreement with pQCD FONLL

Anti-Alpha candidates in Pb-Pb

Time of flight (sensitive to m/z-ratio): $m = \frac{z \cdot R}{\sqrt{\gamma^2 - 1}}$

$$< \frac{dE}{dx} >= \frac{4\pi N e^4}{mc^2}\frac{z^2}{\beta^2}\left(\frac{1}{2}\ln\frac{2mc^2 E_{max}\beta^2\gamma^2}{I^2} - \frac{\beta^2}{2} - \frac{\delta(\beta)}{2}\right)$$



From ALICE Status Report, LHCC Meeting, 23 March 2011

Conclusions

- Since the first LHC collisions the TOF detector has played a relevant role in the ALICE particle identification thanks to its good performance in terms of time resolution and efficiency.

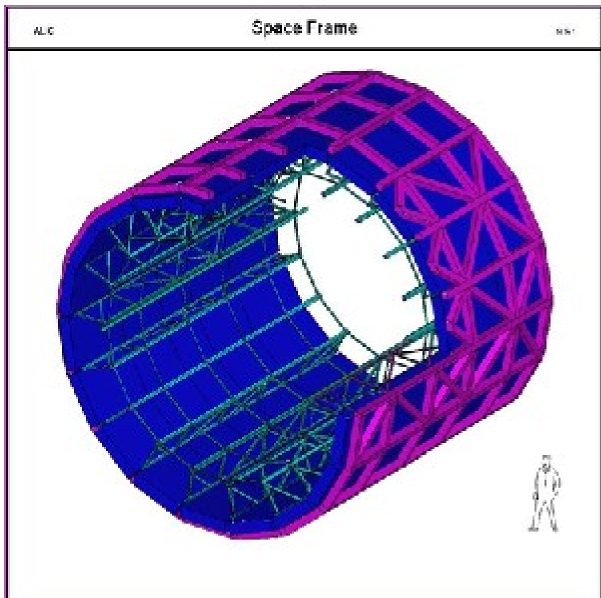
- Thanks to this excellent PID performances TOF detector is used in many physical pp and PbPb analysis as:

  - ✗ Transverse momentum spectra of charge hadrons produced in p-p collisions
  - ✗ Reconstruction of invariant masses
  - ✗ Electrons from HF decay
  - ✗ Search for Anti-Alpha

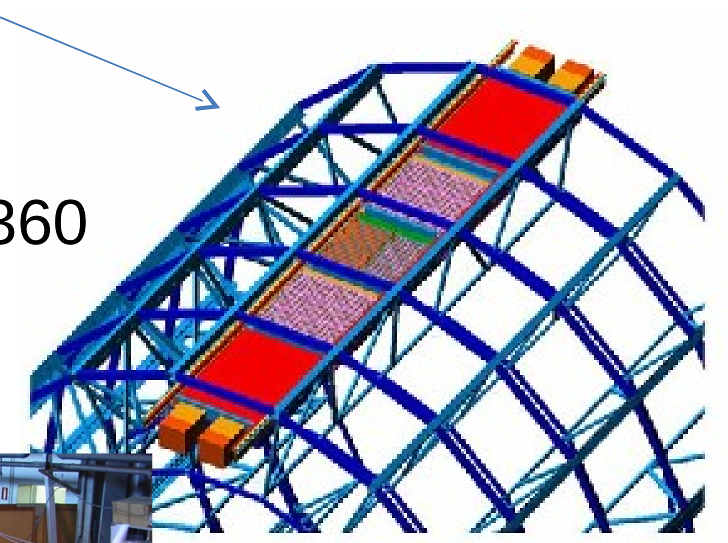
Backup

TOF Detector: SuperModule

Space frame



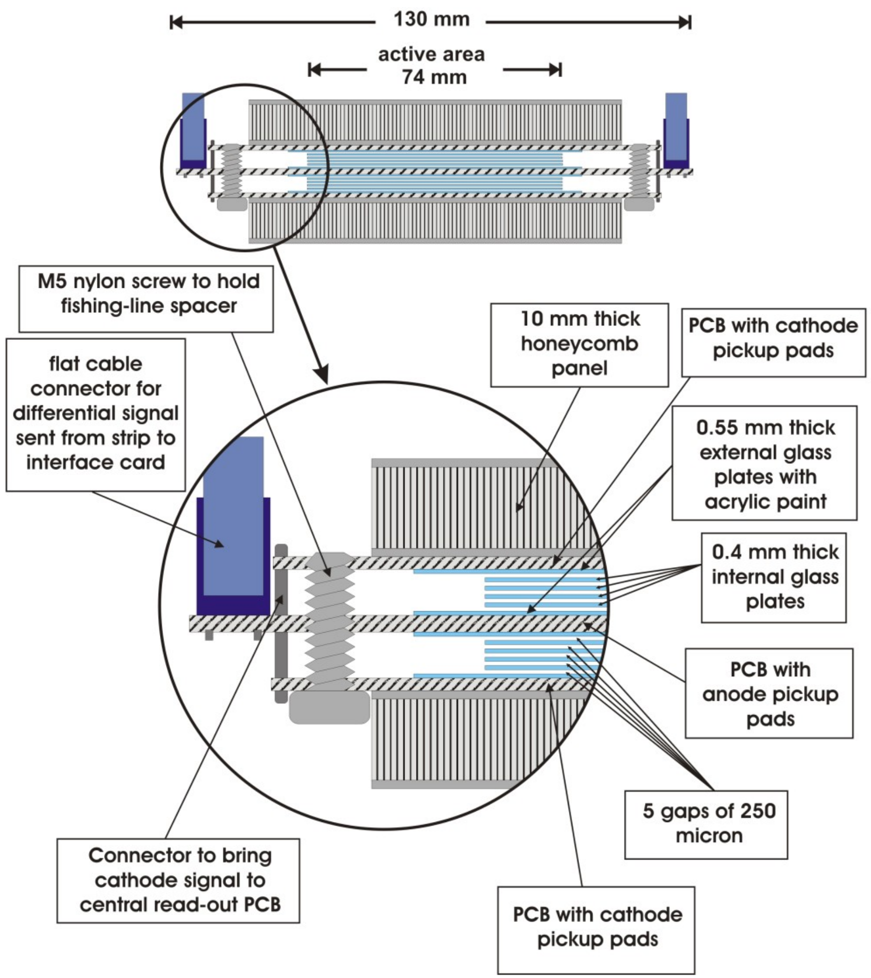
R=3.5 m
18 SM$\rightarrow$0<φ <360
$|\eta|$<0.9



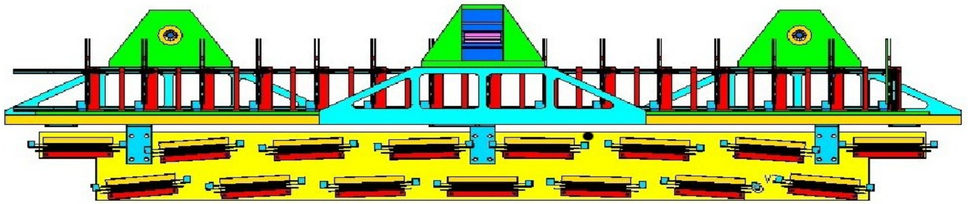
SM active area:
Length: 7.50 m
Width: 1.28 m

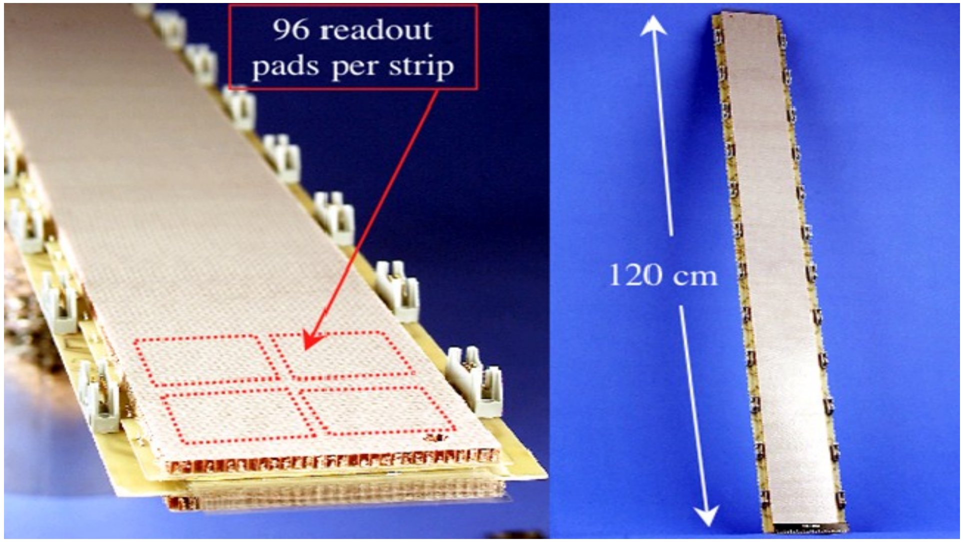
SuperModule
(91 MRPC)

TOF Detector: strip



Cross section of a central module

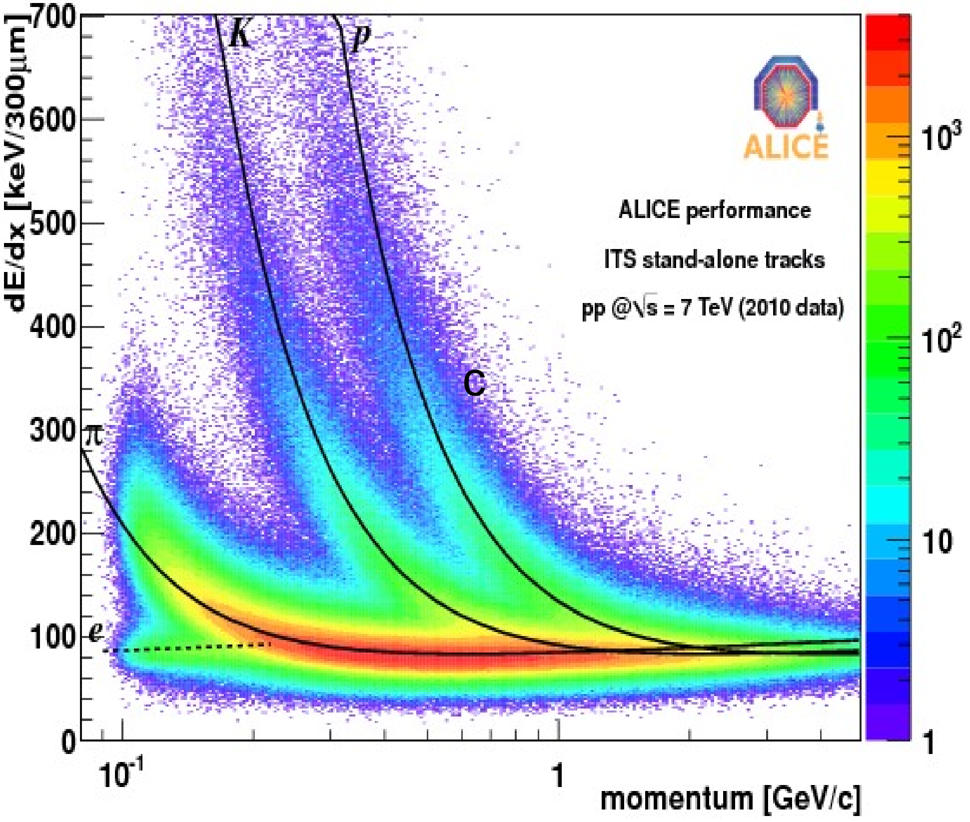


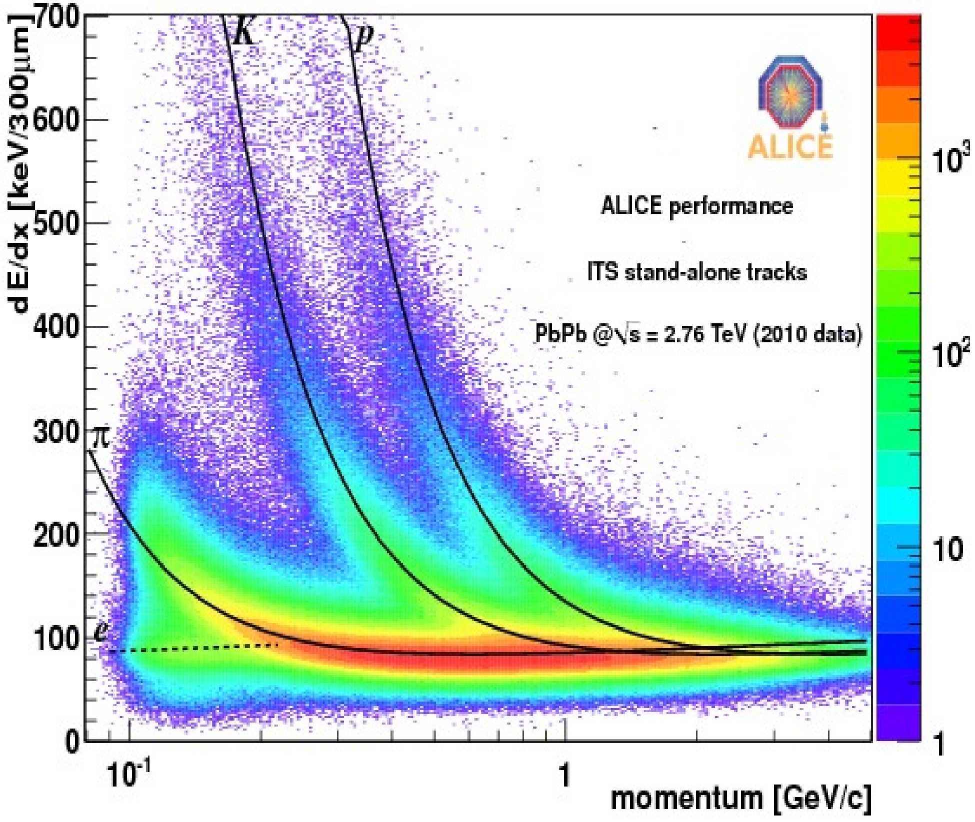


Pad dimension: 3.7x2.5 cm^2

TOF: ~ 153K redout channels

dE/dx Performance of the ALICE ITS

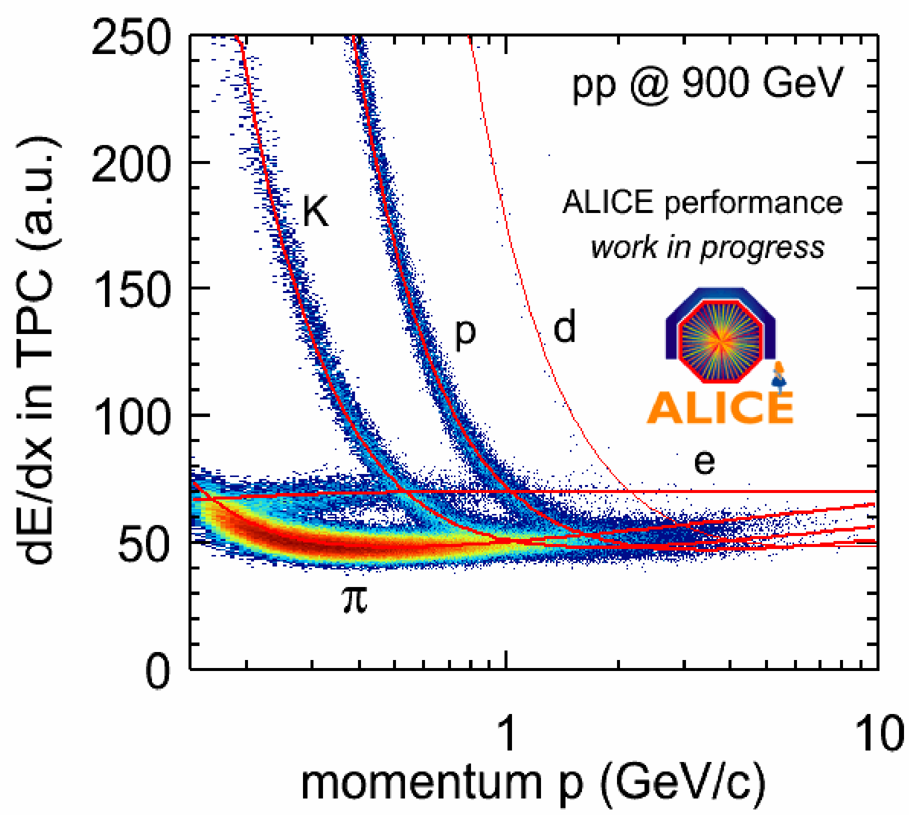




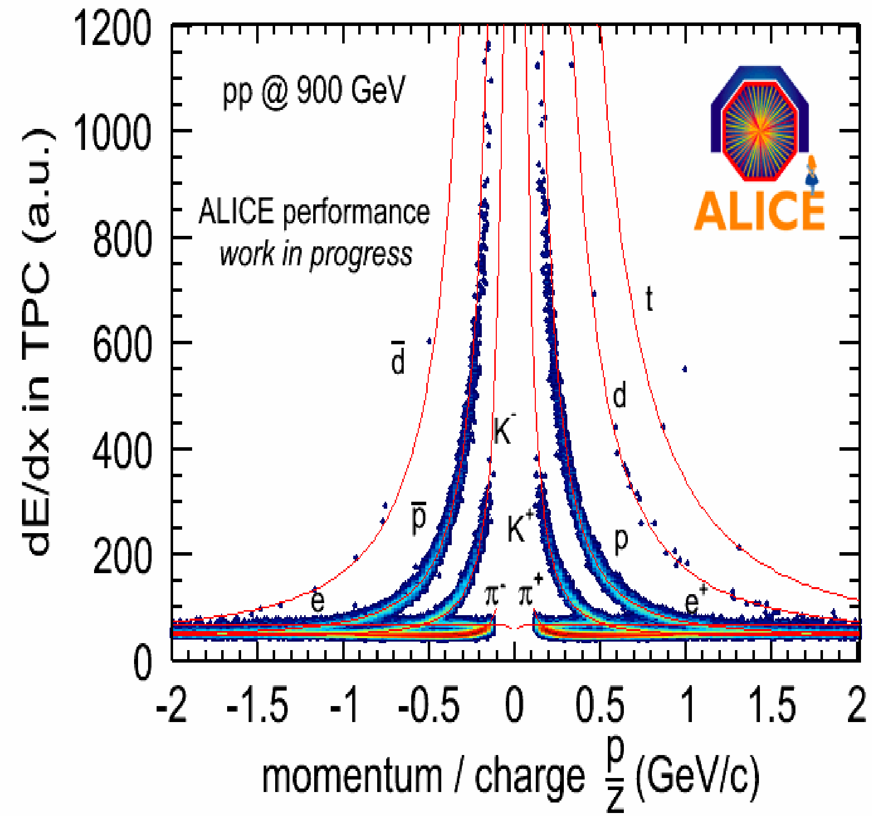
dE/dx of charged particles vs their momentum, both measured by the ITS alone, in PbPb collisions at 2.76 TeV.

dE/dx of charged particles vs their momentum, both measured by the ITS alone, in pp collisions at 7 TeV

dE/dx Performance of the ALICE TPC

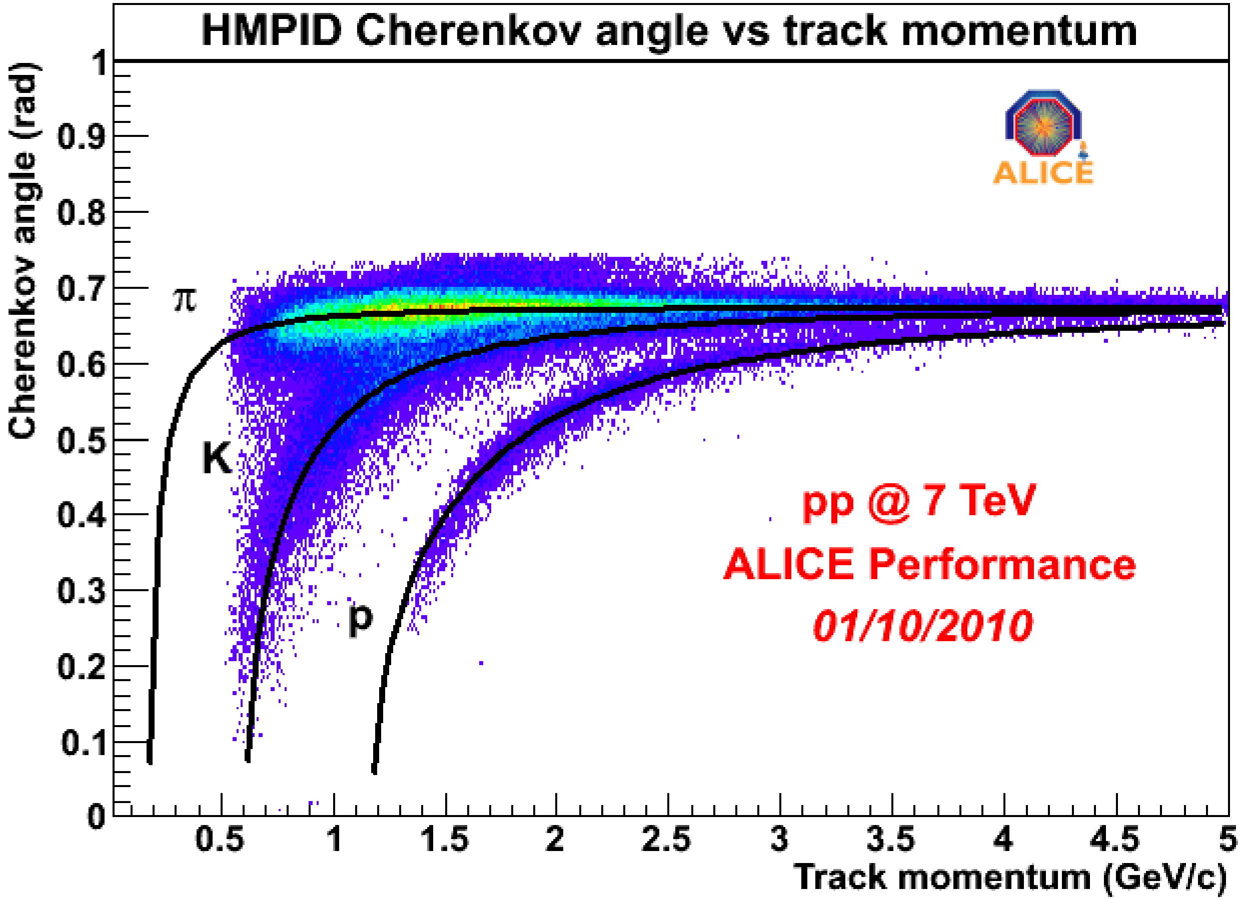


Measured energy-deposit of charged particles vs. their momentum in the TPC. Pions, kaon, electrons, protons, and deuterons are visible. Lines= ALEPH parameterization of the Bethe-Bloch curve.



Measured energy-deposit of charged particles vs. the rigidity of the track for positive and negative particles. Anti-Deuterons are visible in the data. Lines = ALEPH parameterization of the Bethe-Bloch curve.

dE/dx performance of the ALICE HMPID



Physical motivation for studying hadron spectra

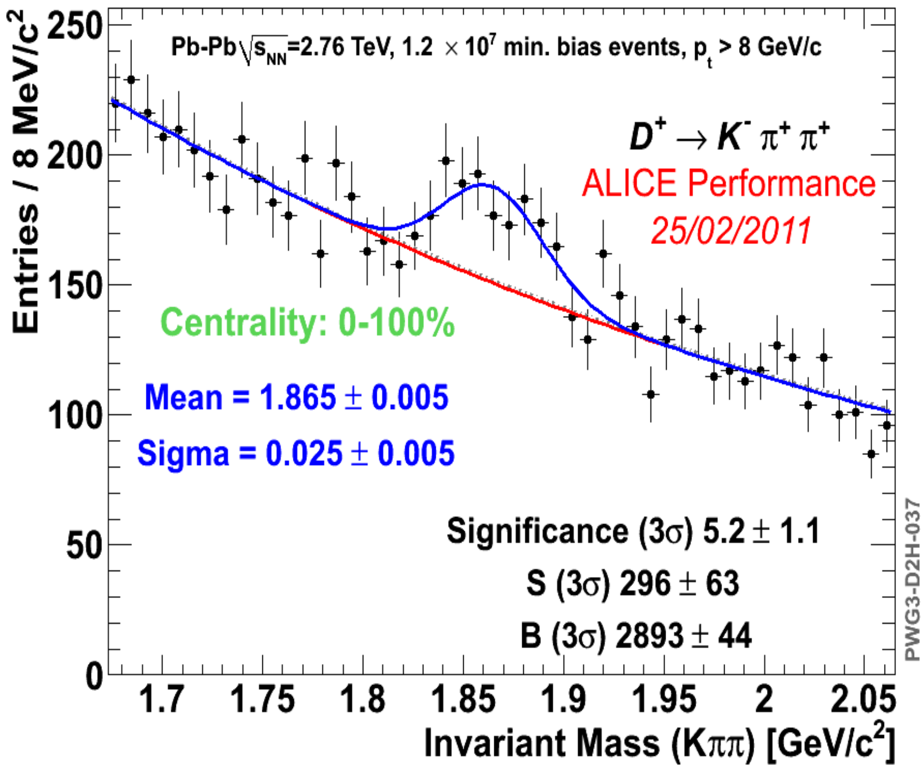
In heavy ions collisions the transverse momentum (p_t) hadron spectra give informations about the system produced at the kinetic freeze-out .
If a deconfined phase at thermal equilibrium is produced we expect:

$$\frac{d^2N}{dp_t dy} \propto \sqrt{m_t}\, e^{-\frac{m_t}{T}}$$

- m_t=transverse mass $m_t = \sqrt{m^2 + p_t^2}$;
- m= rest mass;
- T=function of the kinetic freeze-out temperature.

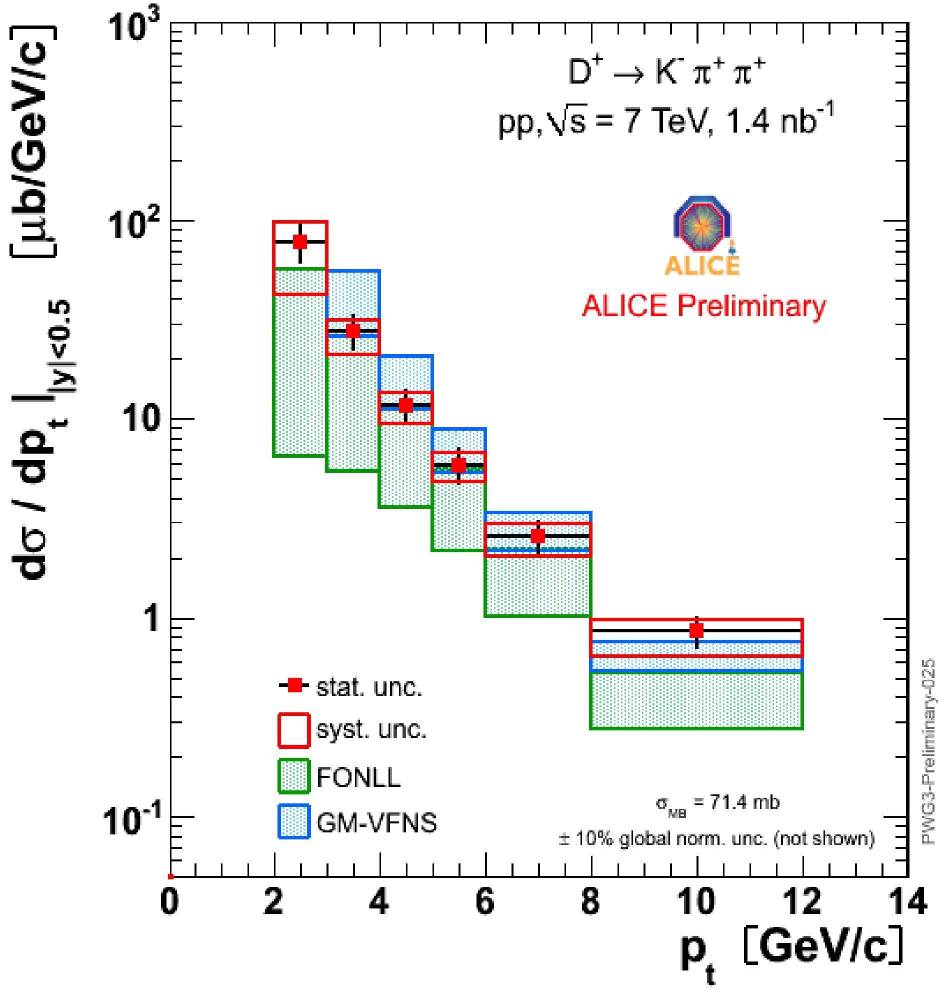
We expect that the slope of the spectra is different in *pp* and heavy ions collisions so the importance of the knowledge of *pp* spectra.

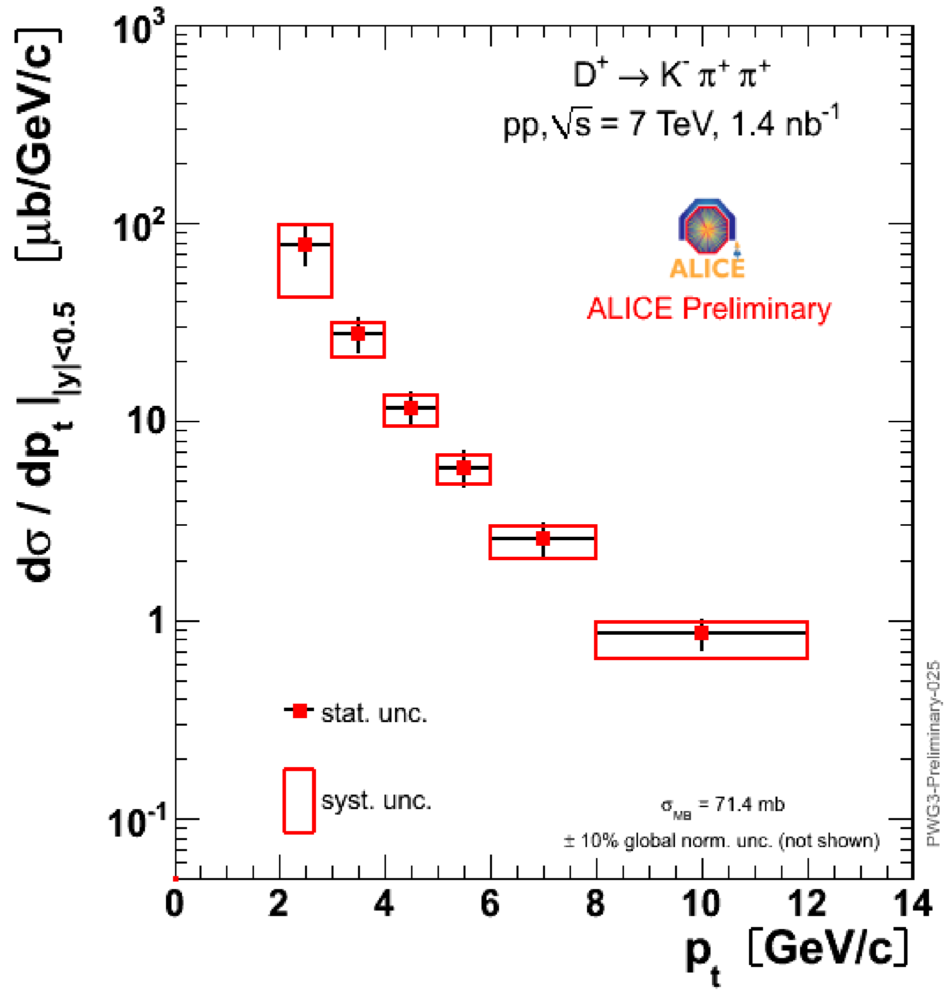
Heavy flavours: $D^+ \rightarrow K^- \pi^+ \pi^+$



Invariant mass spectrum of 2.76 TeV Pb-Pb data collected in November 2010.
TPC+TOF PID is applied.
Topological cuts are applied.
The fit function corresponds to the sum of a gaussian (signal) and an exponential (background).

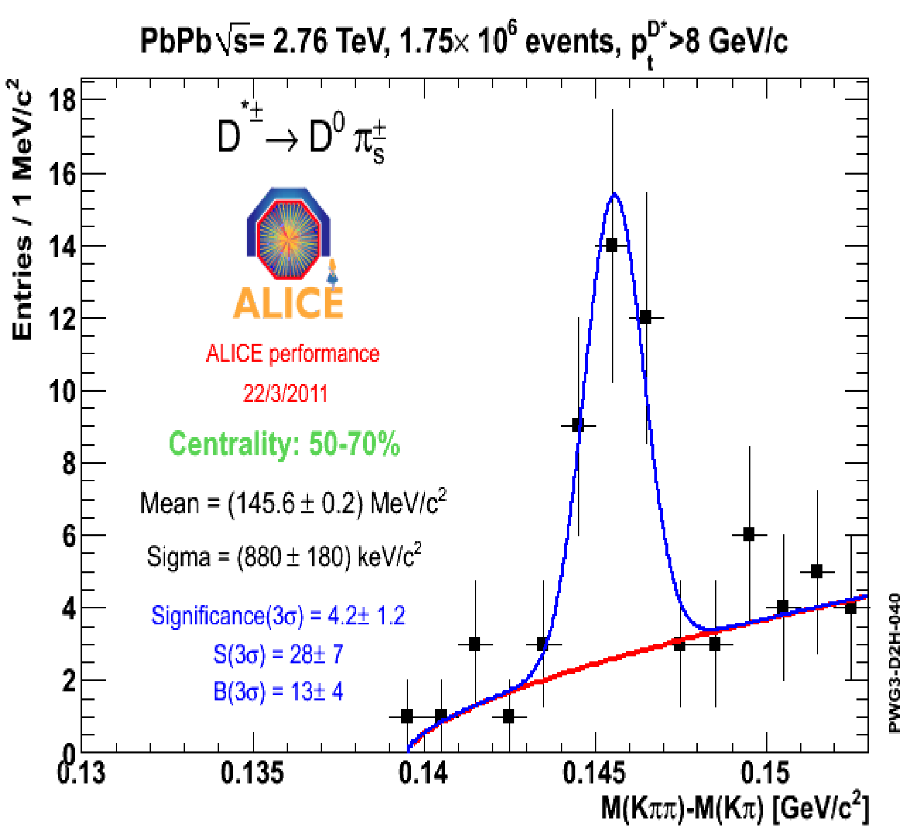
Heavy flavours: $D^+ \to K^- \pi^+ \pi^+$ preliminary cross-section

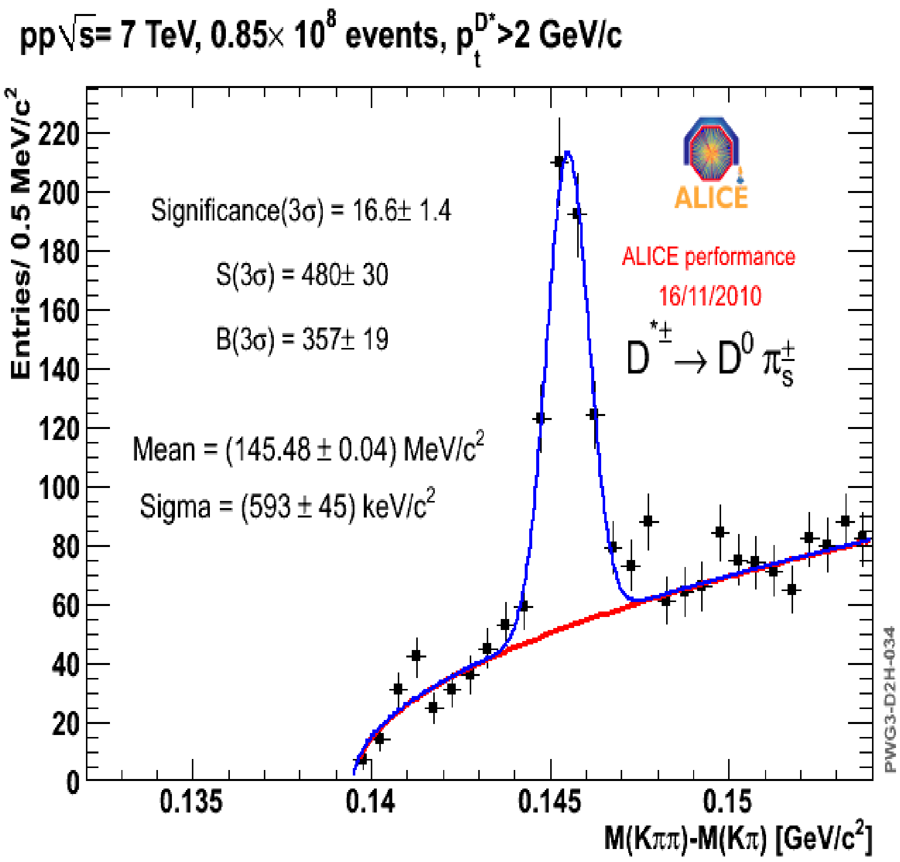




Production cross section for D+ mesons in pp at 7 TeV. The cross section is given for D+ (obtained as 0.5*(D+ + D-)) and scaled to |y|<0.5, and compared to predictions from FONLL (Cacciari et al.) and GM-VFNS (Kramer et al.).

Heavy flavours: $D^{*\pm} \rightarrow D^0\pi^{\pm}_s$





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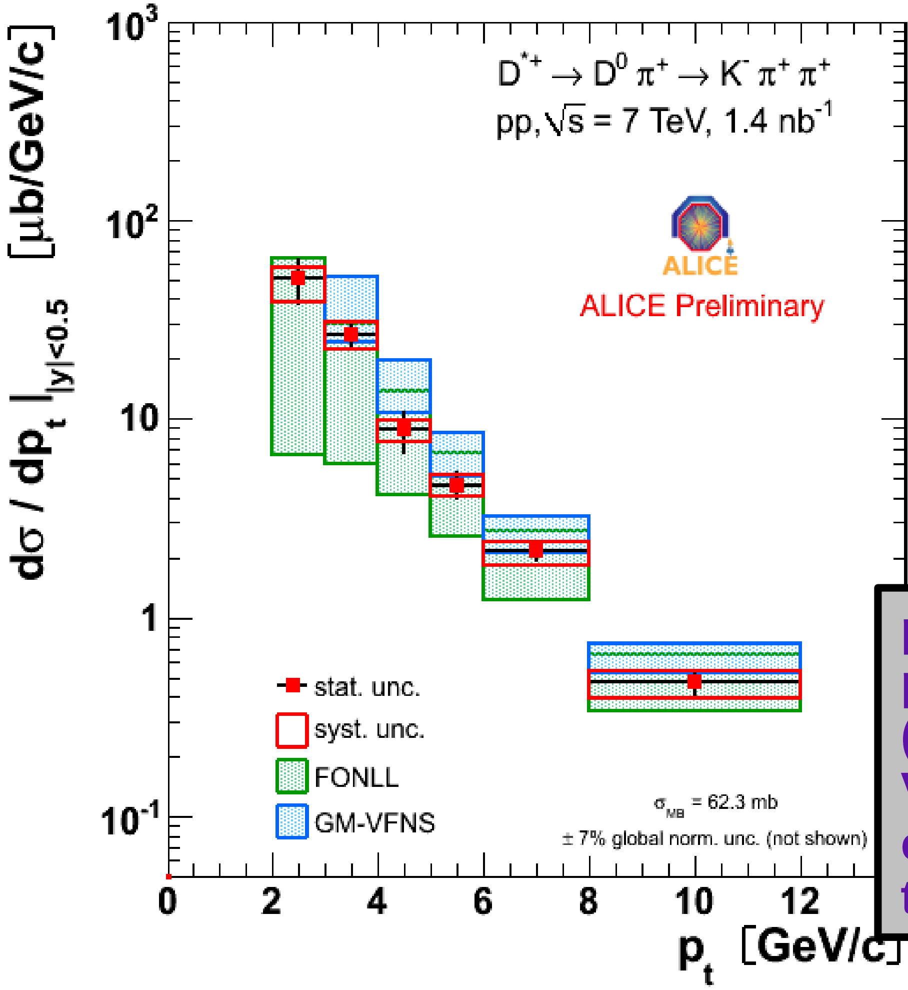
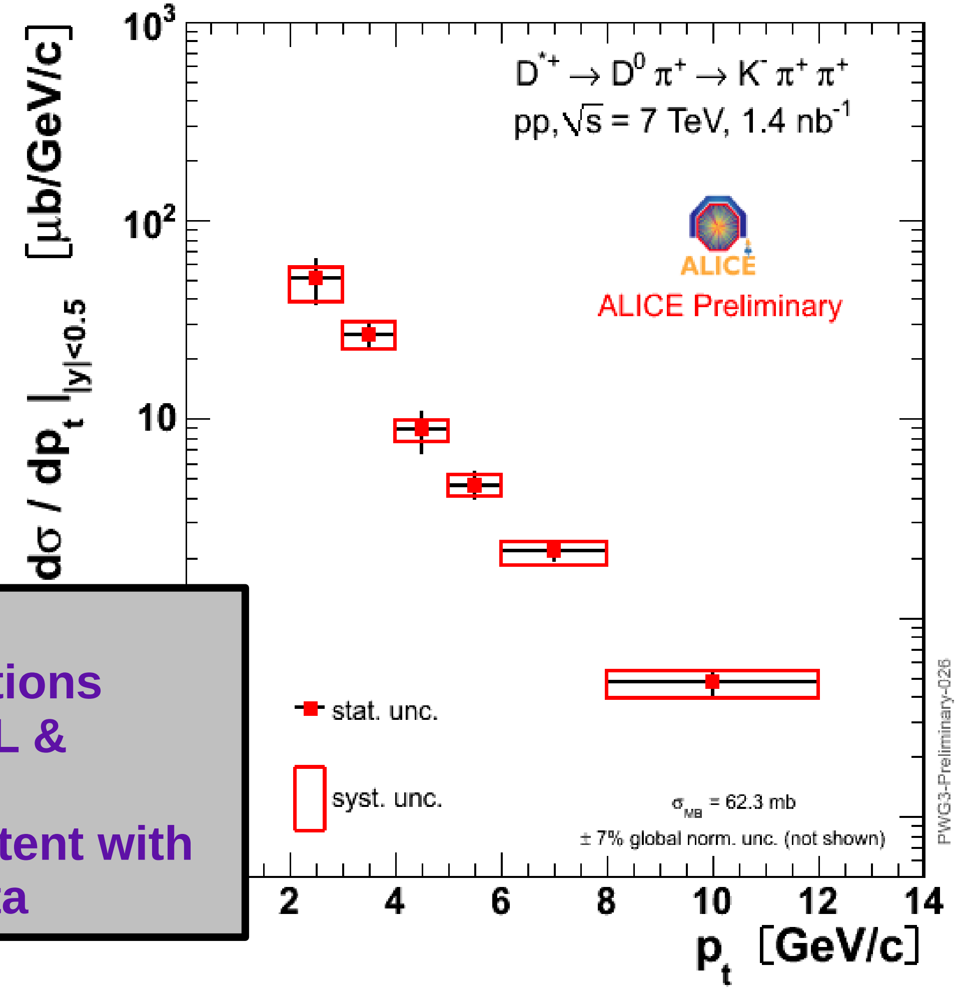
Invariant mass spectrum of 7 TeV data collected in April-May 2010. TOF and TPC PID are applied. The fit function corresponds to the sum of a gaussian (signal) and an exponential (background).

Heavy flavours: $D^{*+} \rightarrow D^0\pi^+_s$ preliminary cross-section

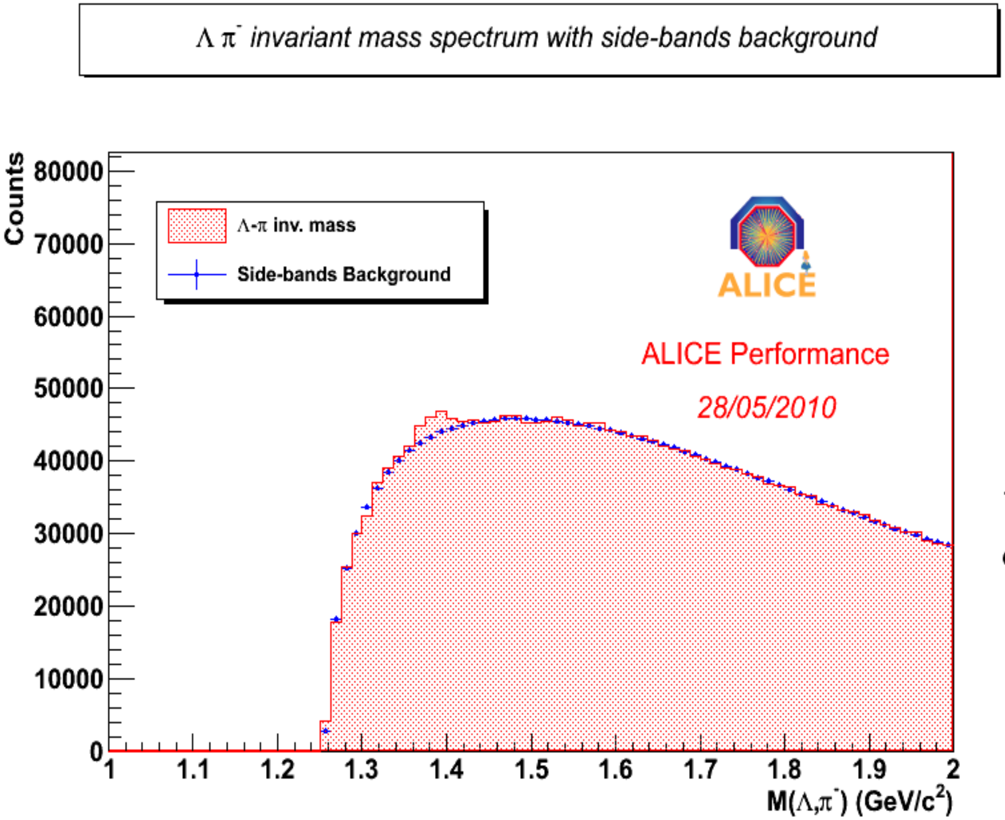


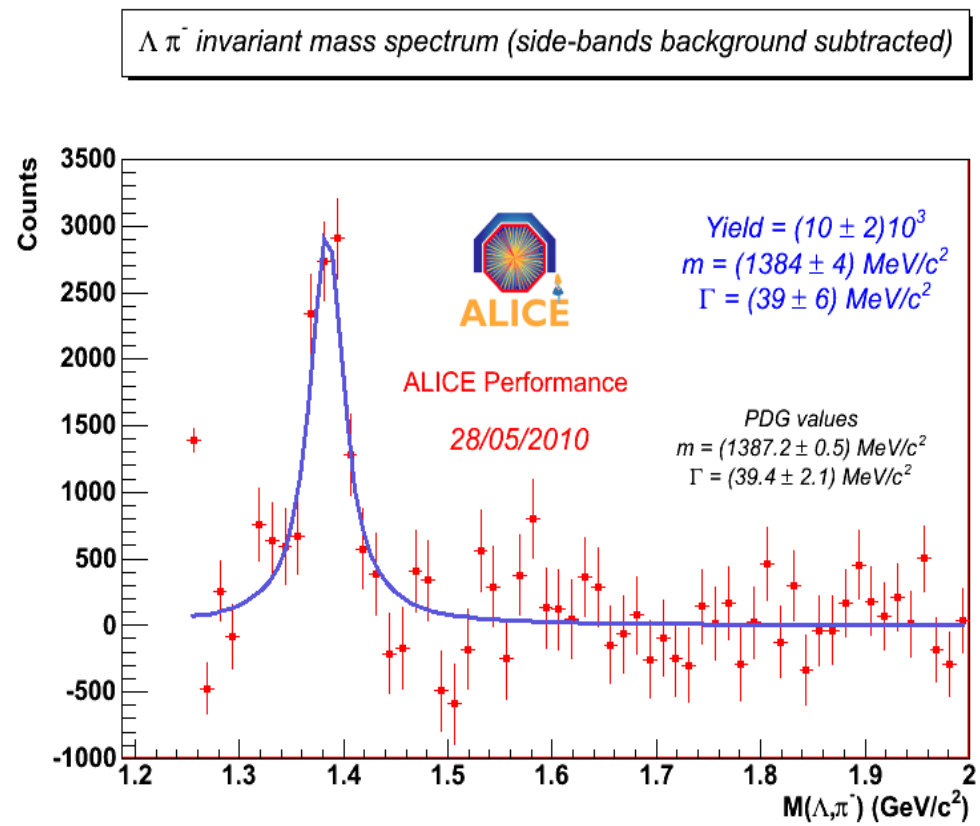
pQCD predictions (FONLL & VFNS) consistent with the data



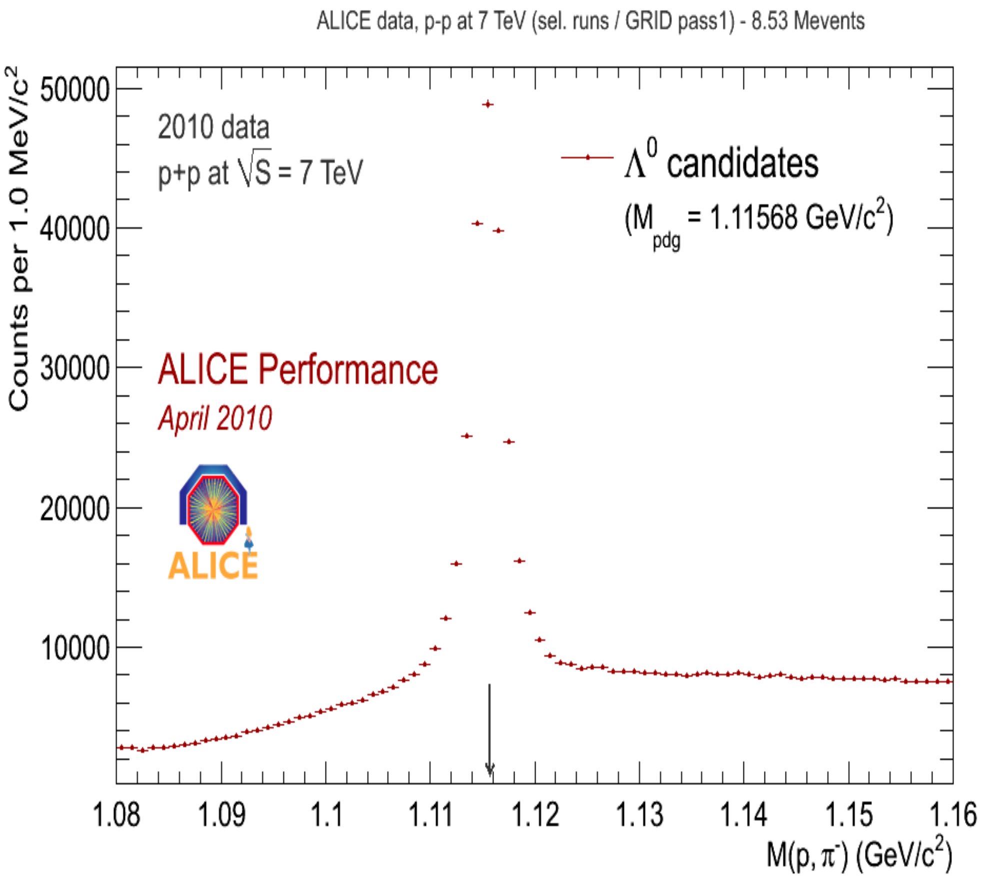
Production cross section for D*+ mesons in pp at 7 TeV. The cross section is given for D*+ (obtained as 0.5*(D*+ + D*-)) and scaled to |y|<0.5, and compared to predictions from FONLL (Cacciari et al.) and GM-VFNS (Kramer et al.)

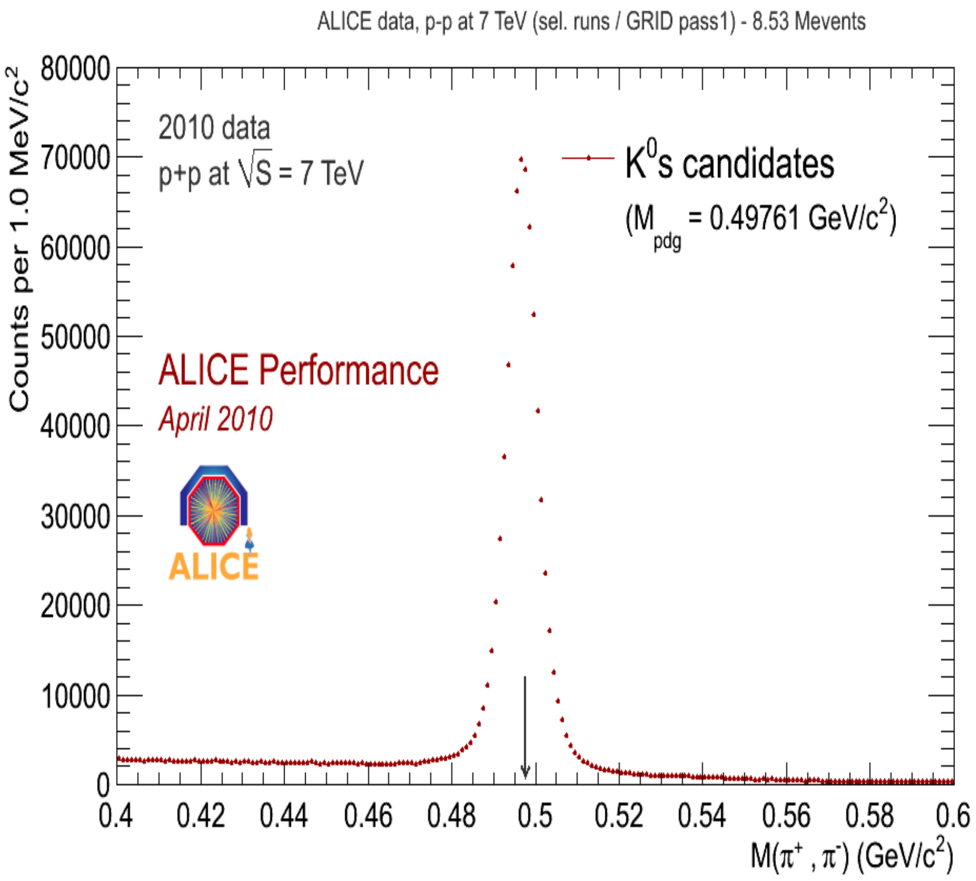
Resonances: $\Sigma^* \rightarrow \Lambda\pi$ @ $\sqrt{s}$=7TeV





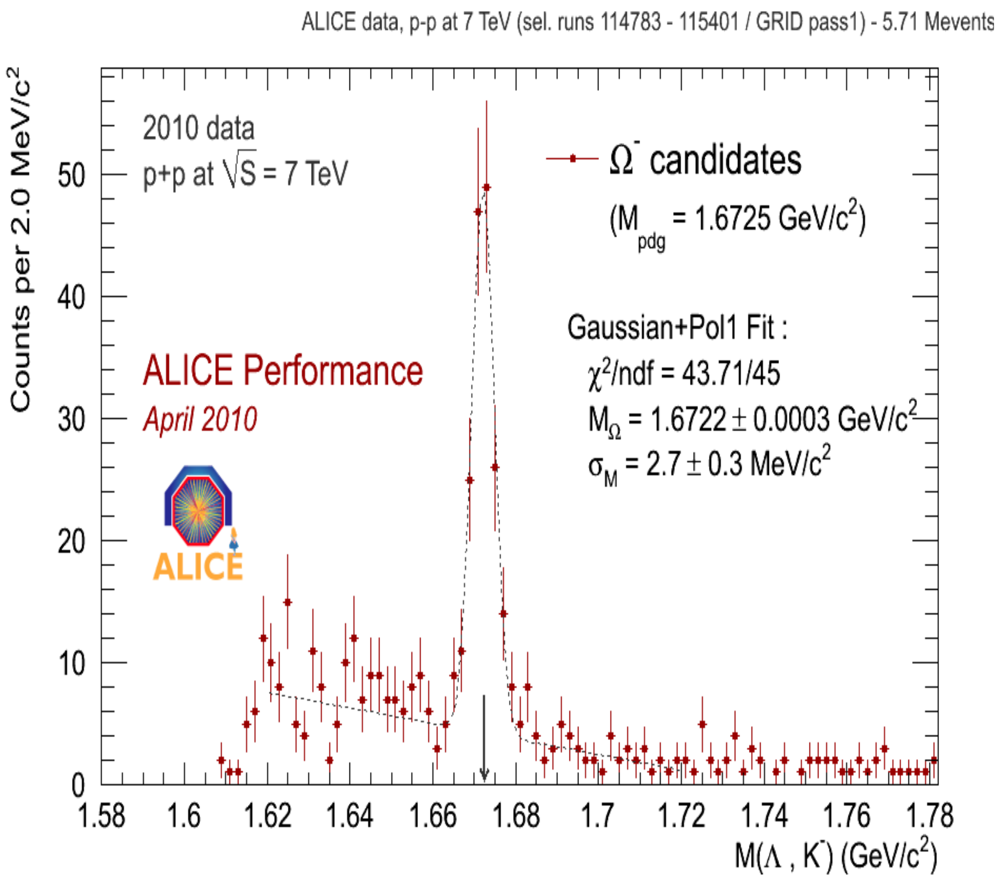
Topological decay

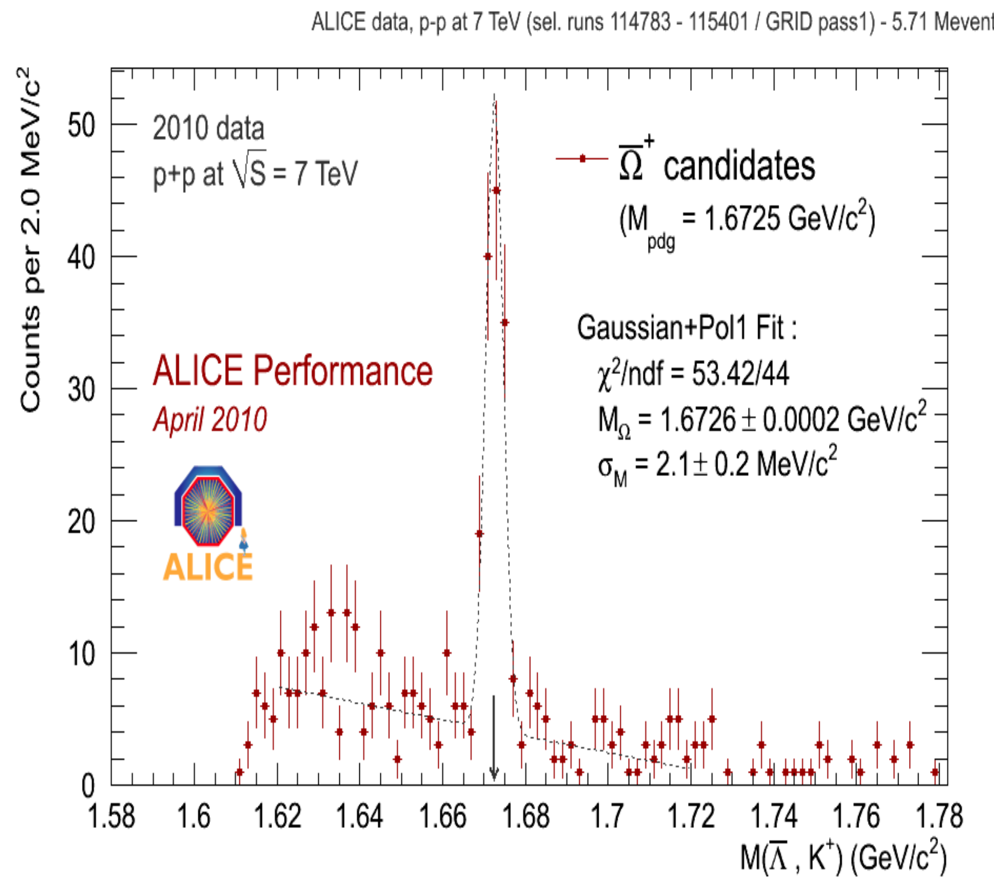




Topological decay

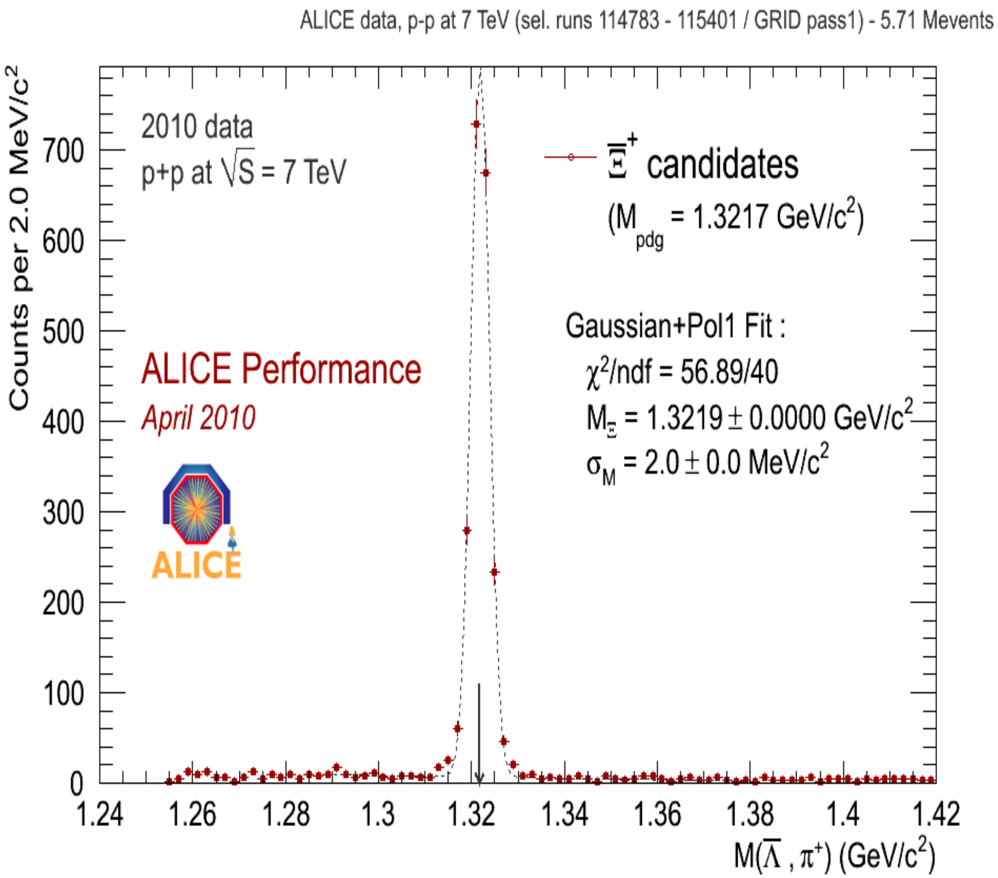
$\Omega \rightarrow \Lambda K$

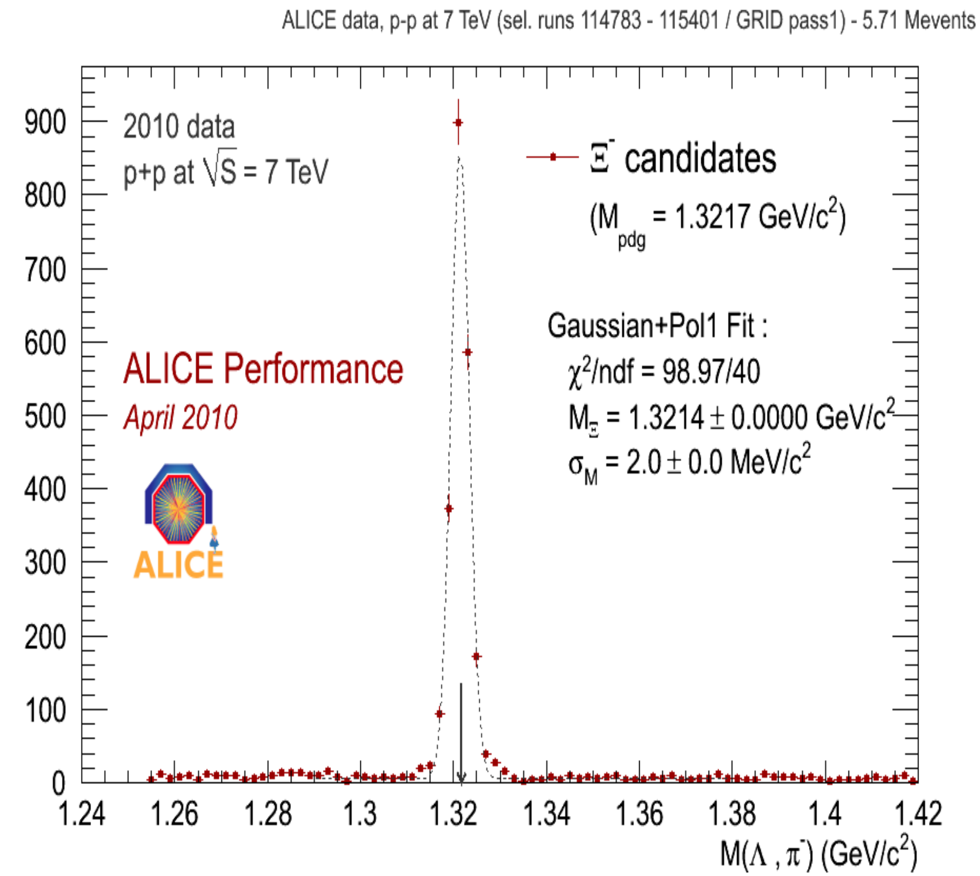




Topological decay

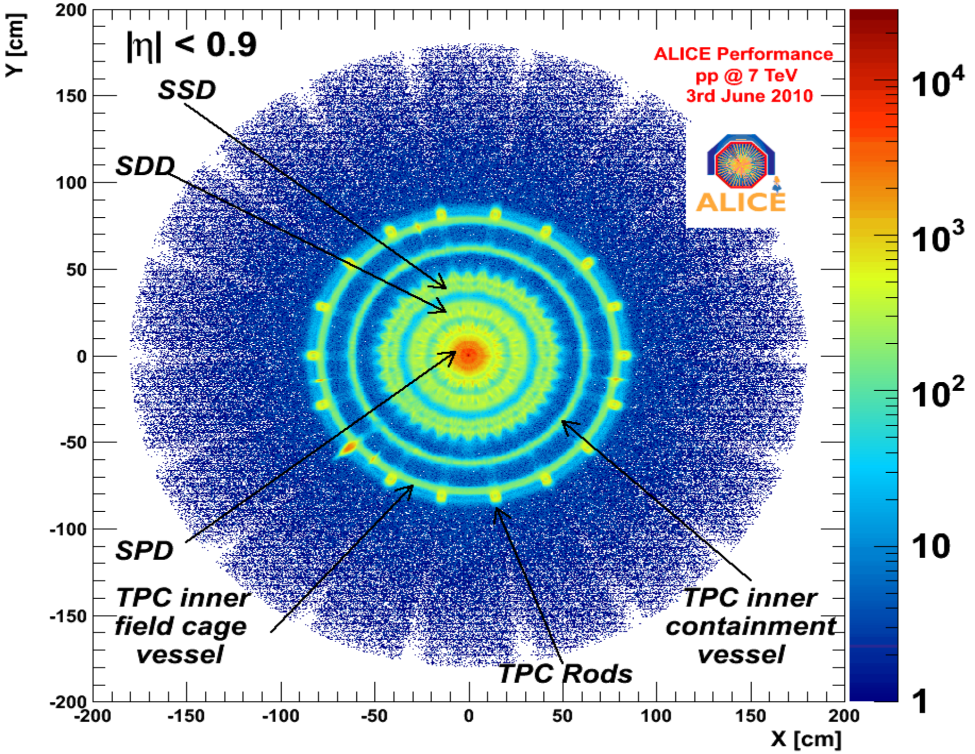
$\Xi \rightarrow \Lambda\pi$





Identification of gamma conversions with the ALICE TPC

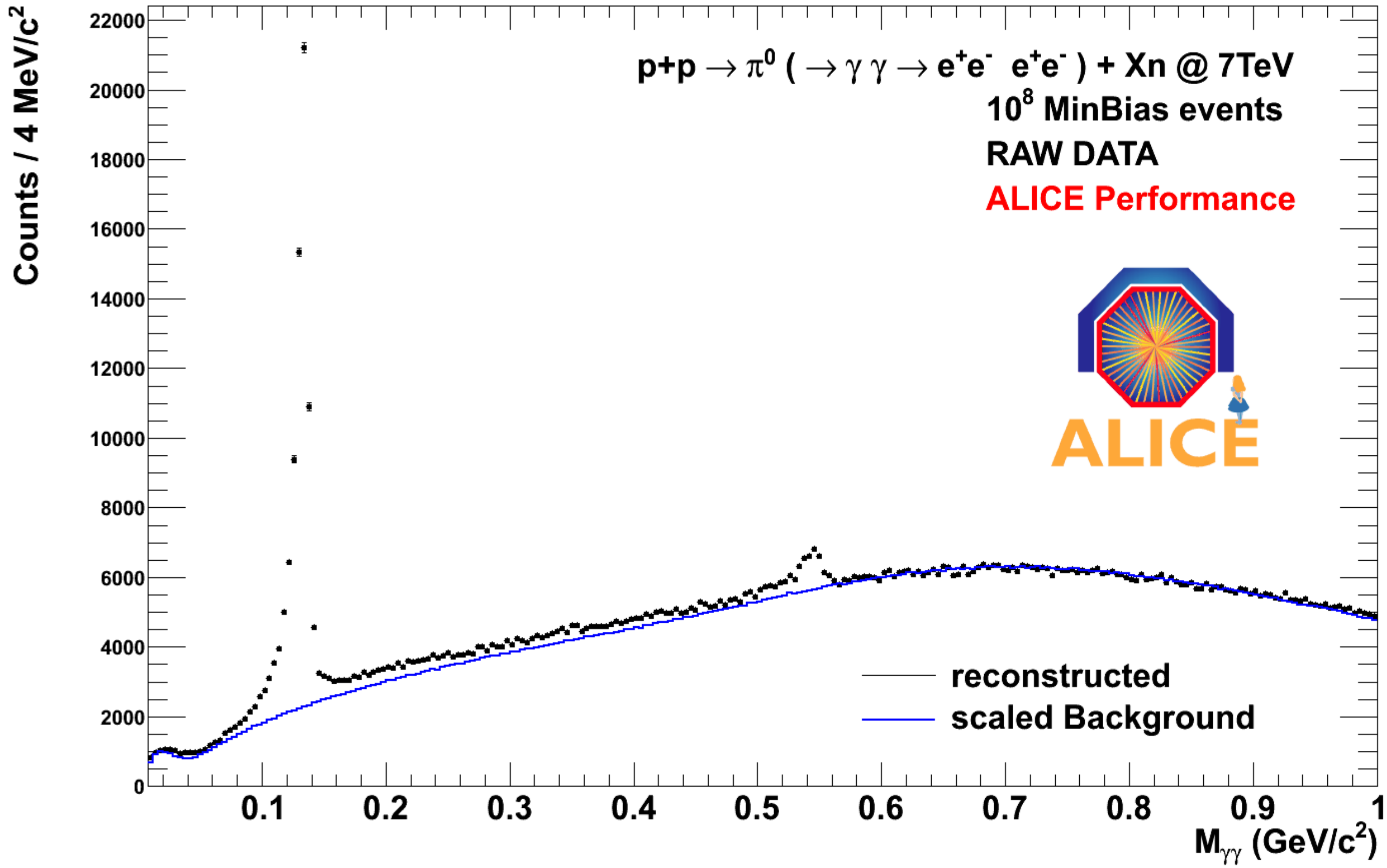
Two-dimentional (XY) distribution of gamma conversions. Gamma conversion candidates are obtained via a V0 topology identification which is performed during the track reconstruction. The electron and positron daughters tracks are further selected by requiring a (-3,+10) number of sigmas with respect to the Bethe-Bloch parameterization describing the linear energy loss in the ALICE TPC. Potential contamination is suppressed with rejecting tracks compatible with the lowest half band of the pions. A vertex and mass constraint is applied as well.



Invariant mass distribution of 2 gamma

The peaks at the pi0 and eta masses are seen.
The blue histogram is the combinatorial background calculated using mixed events.

Electron ID in TPC



Armenteros-Podolanski's plot