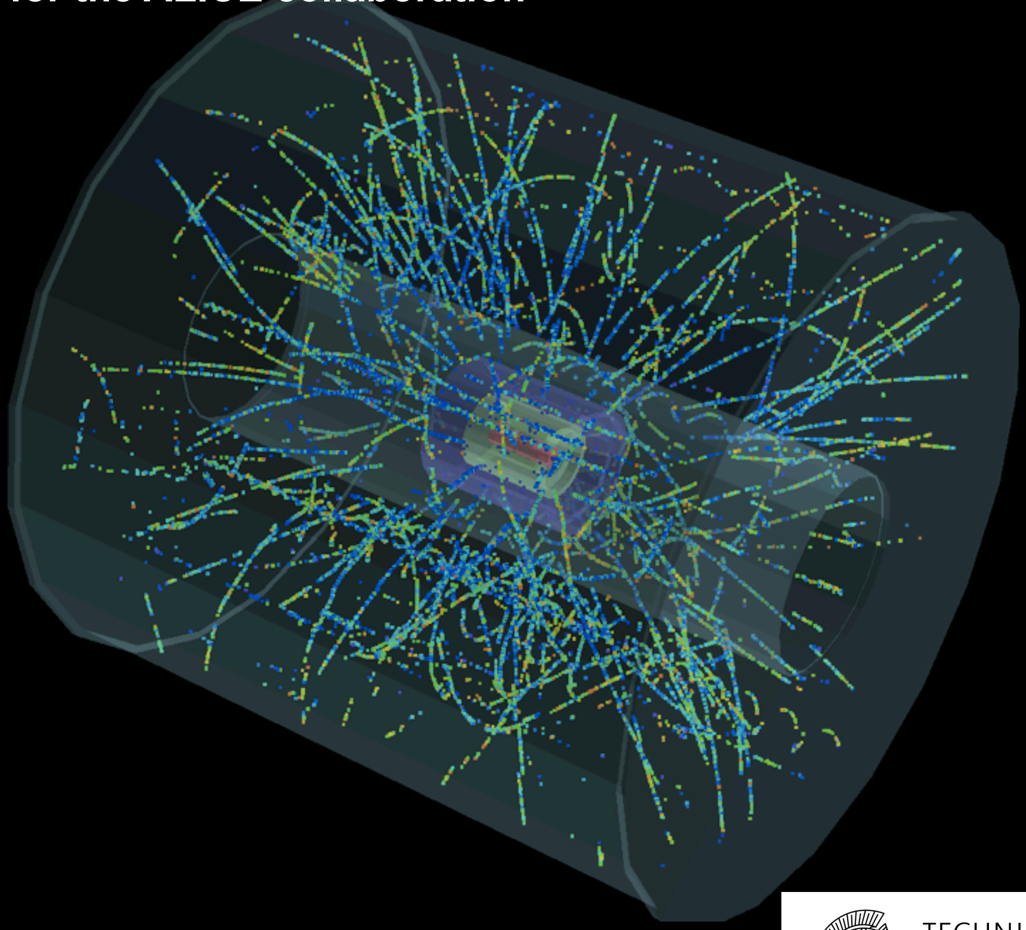
Particle identification in the ALICE central barrel

Alexander Kalweit, for the ALICE collaboration



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Introduction

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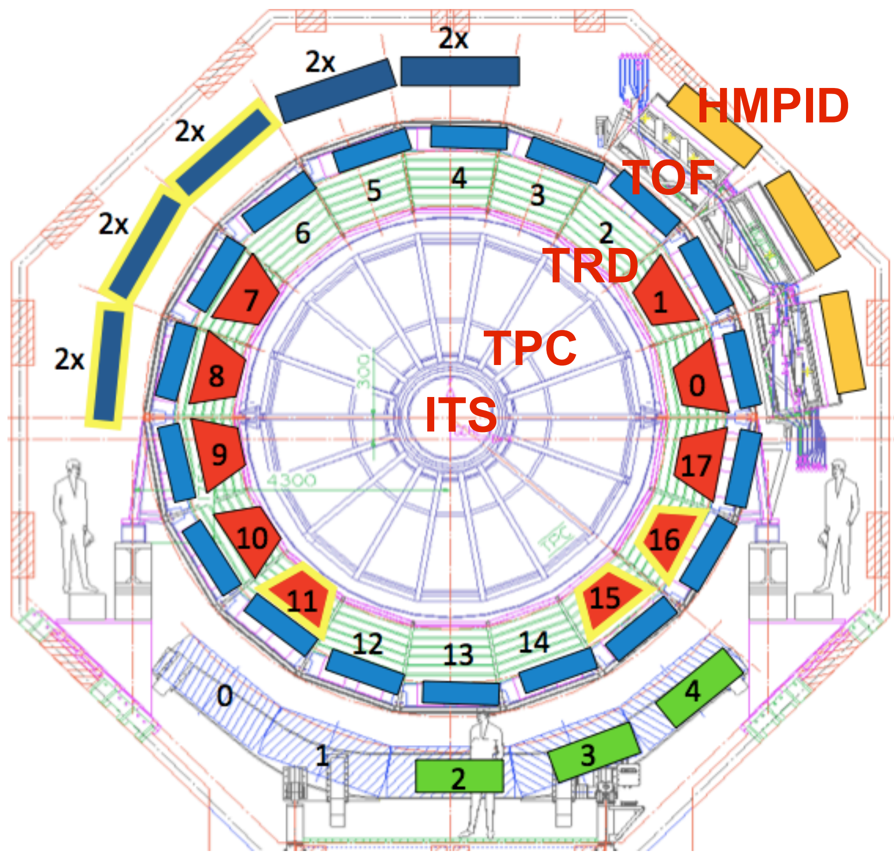
- The ALICE particle identification capabilities are unique among the four major LHC experiments.
- Almost all known techniques are exploited:
  - *dE/dx* measurements
  - Time-Of-Flight measurements
  - Transition Radiation
  - Cherenkov Radiation
- PID is used *directly*, e.g.:
  - p_t-spectra of $\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$
  - identification of anti- and hyper-nuclei
- PID is used *indirectly* to improve signal-to-backgr. ratios.



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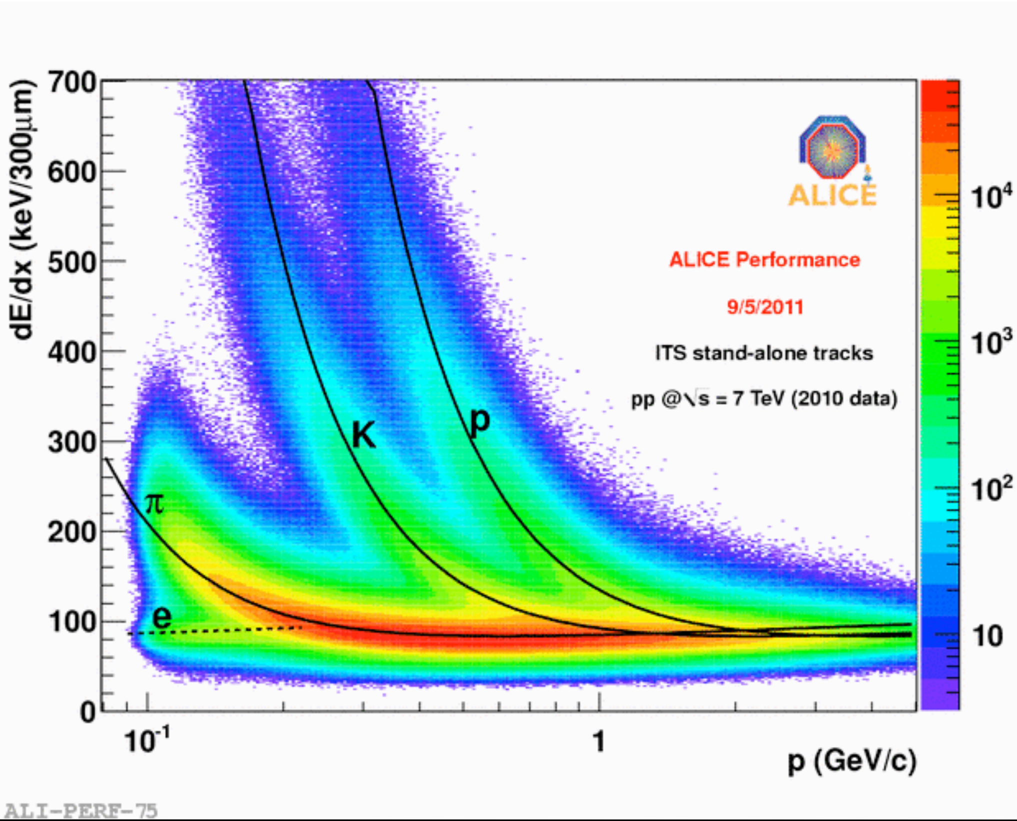
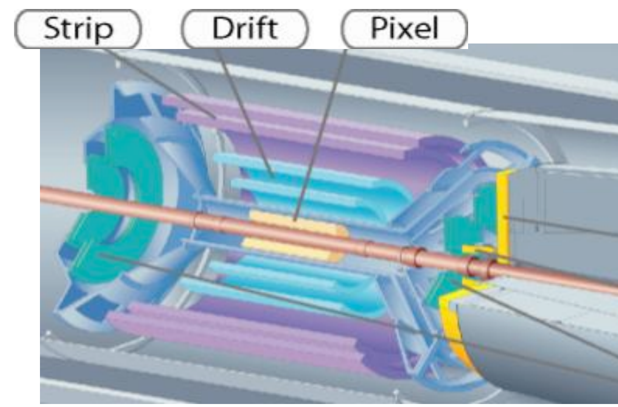
Detectors and Performance

dE/dx measurement in the Inner Tracking System

- Drift and strip detectors have analog read-out for up to 4 samples of specific energy loss with $\sigma \approx$ 10-15%.





Particle identification to very low p_t, e.g. π down to 100 MeV with stand-alone tracking.

=> reduces systematics for yield extraction.

ITS PID poster
L. Milano

dE/dx measurement in TPC

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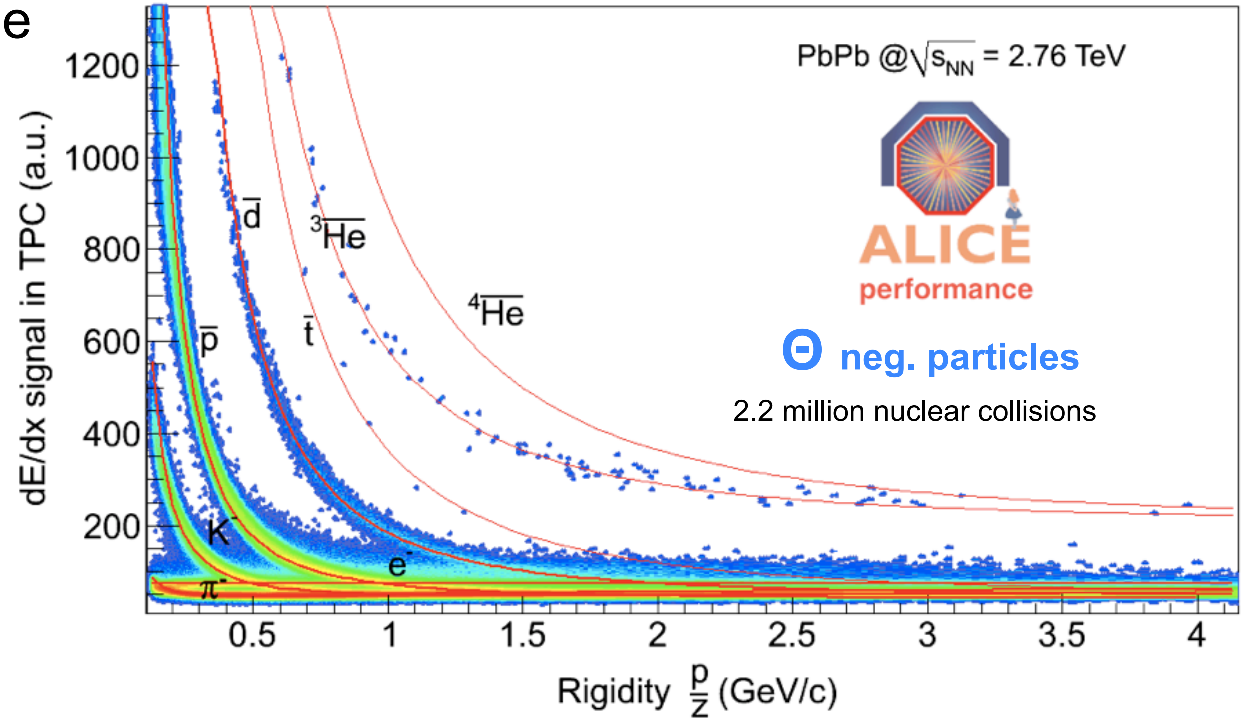
- Up to 159 samples in Ne-CO_2 gas mixture: $\sigma_{dE/dx} \approx 5\%$.

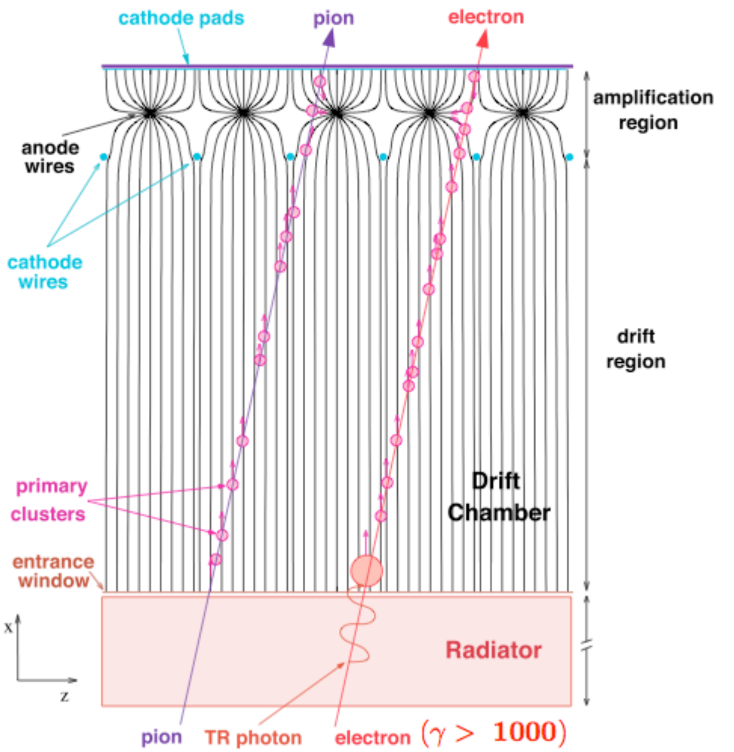
- Very large dynamic range (up to 26x min. ionizing) allows to identify light nuclei and separate their charge.

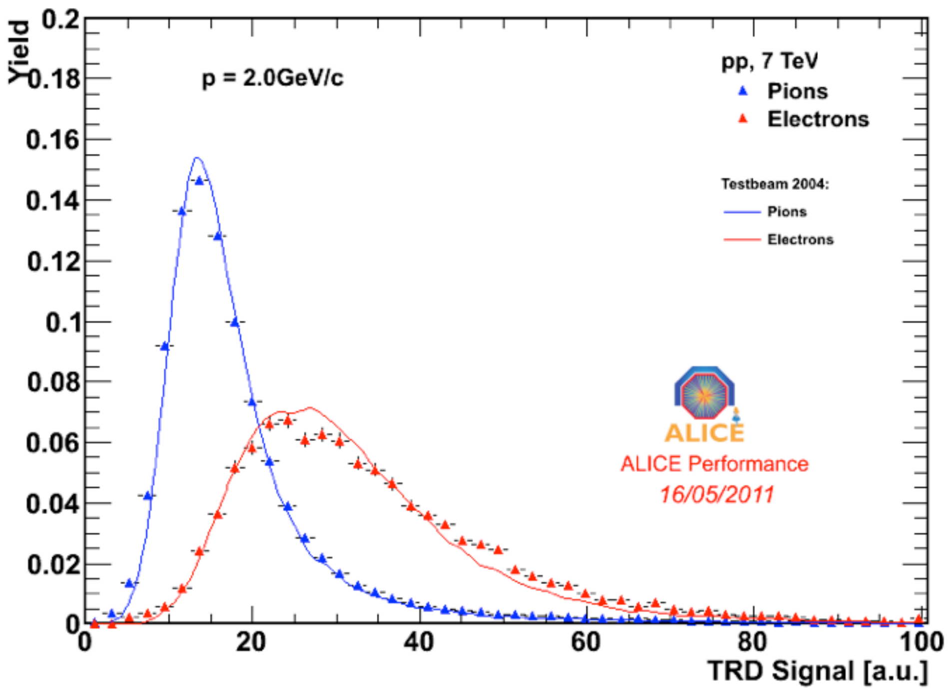
- PID can be extended to higher momenta on the relativistic rise using statistical unfolding.



Transition Radiation Detector

- Transition radiation is absorbed in a high Z gas mixture (Xe-CO_2).
- Hadron rejection above p > 1 GeV/c.





poster
M. Fasel

Time of Flight (TOF)

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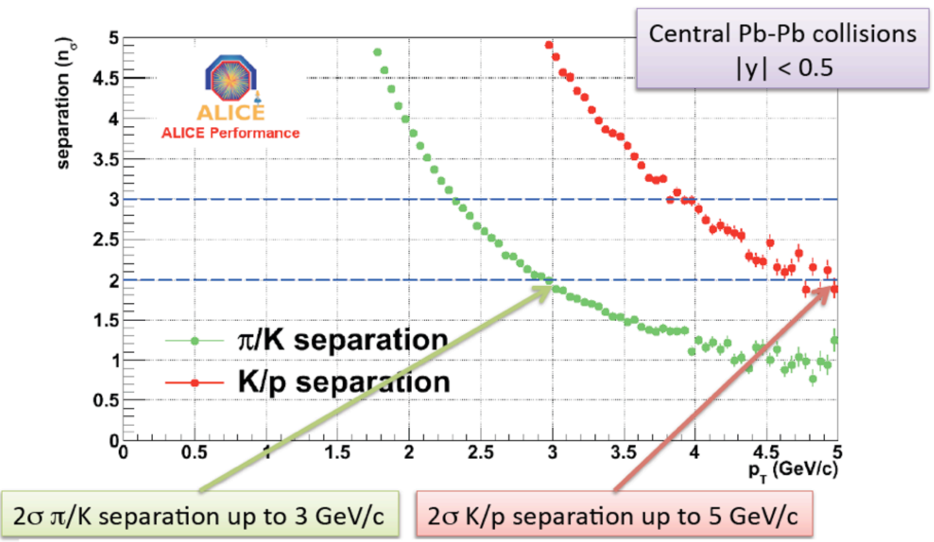
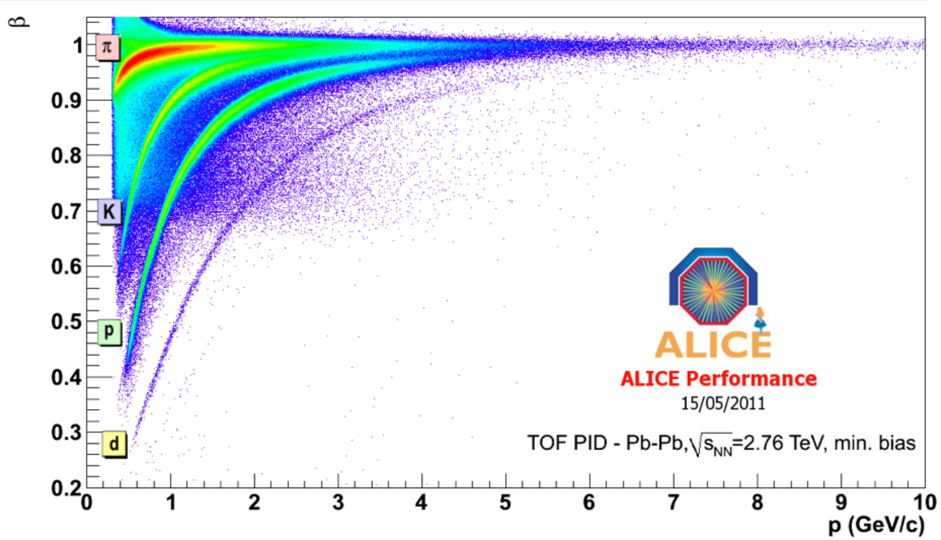
- Excellent particle identification over a large momentum range.
- Time-Of-Flight resolution close to design value (86ps in PbPb) allowing a 2σ p/K-separation up to 5 GeV/c.





$$\sigma_{PID}^{(i)} = \sqrt{\sigma_{TOF}^2 + \sigma_{time-zero}^2 + \sigma_{tracking}^2}$$

Cherenkov radiation -- HMPID

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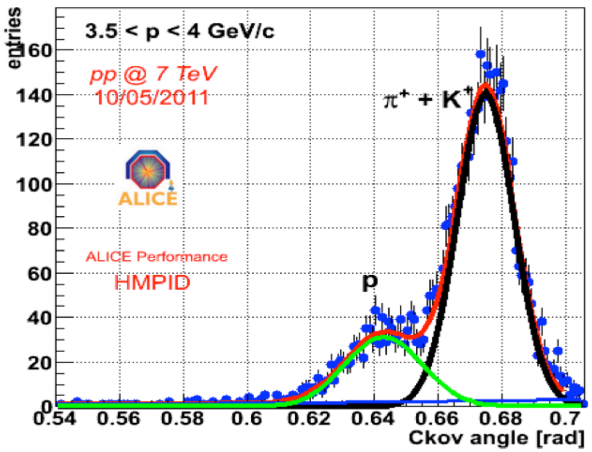
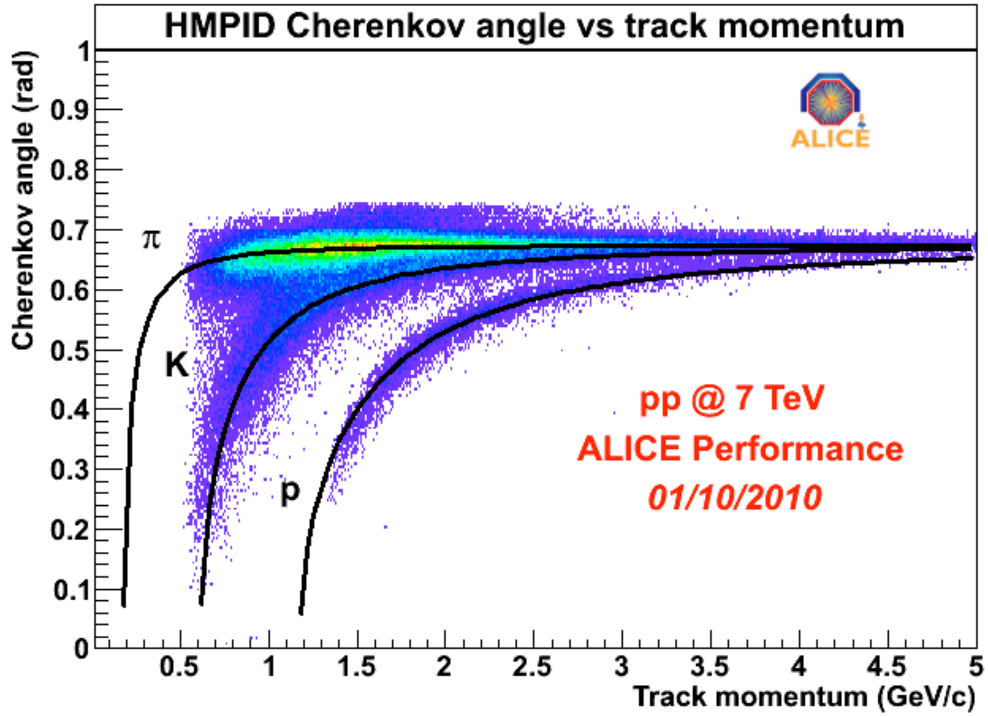
- The ALICE HMPID is a proximity focusing Ring Imaging Cherenkov.

- Cherenkov photons are emitted when a fast charged particle crosses the liquid C_6F_{14} radiator.

- Physics analysis in progress:





HMPID poster
F. Barile

Statistical vs. track-by-track PID

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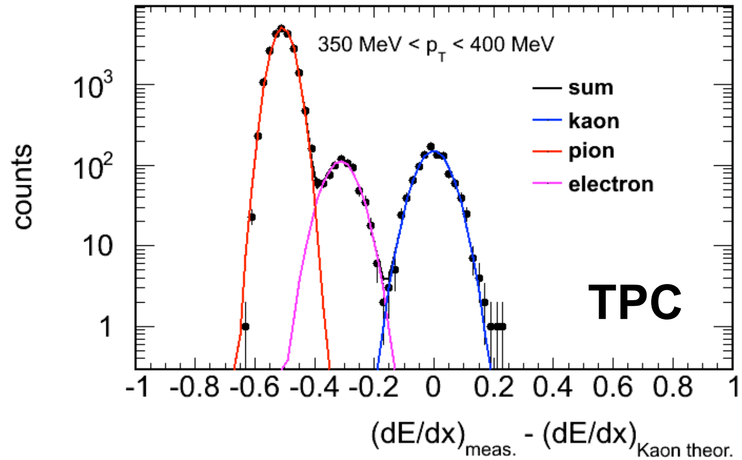
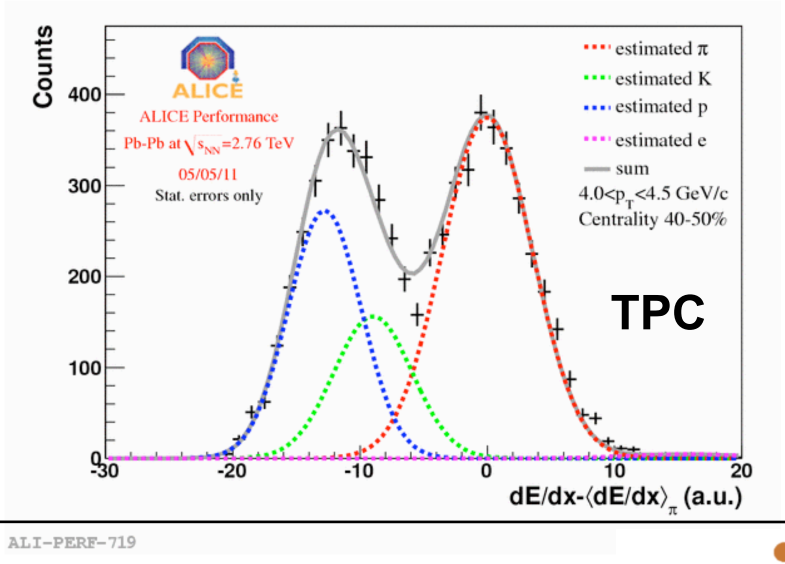
- In general for all detectors:
  - In regions of clean separation: a **track-by-track PID** is possible, e.g. based on nσ-bands.
  - For the direct extraction of spectra in region of limited separation, **statistical unfolding** has to be used, e.g. on the **relativistic rise** in the TPC or higher momenta in TOF.





rel. rise poster
P. Christiansen

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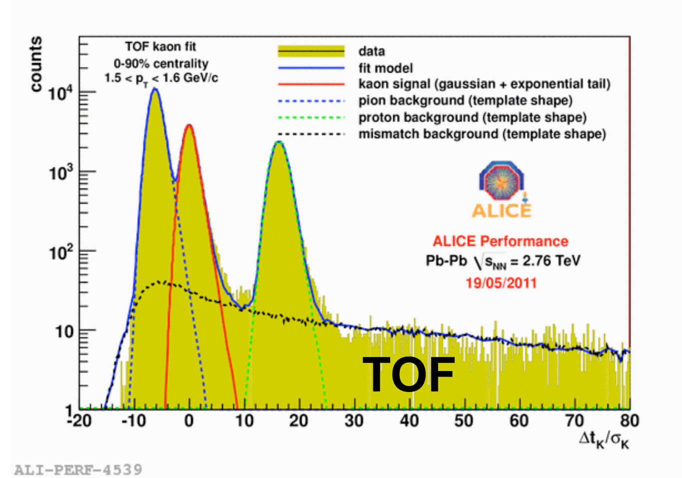
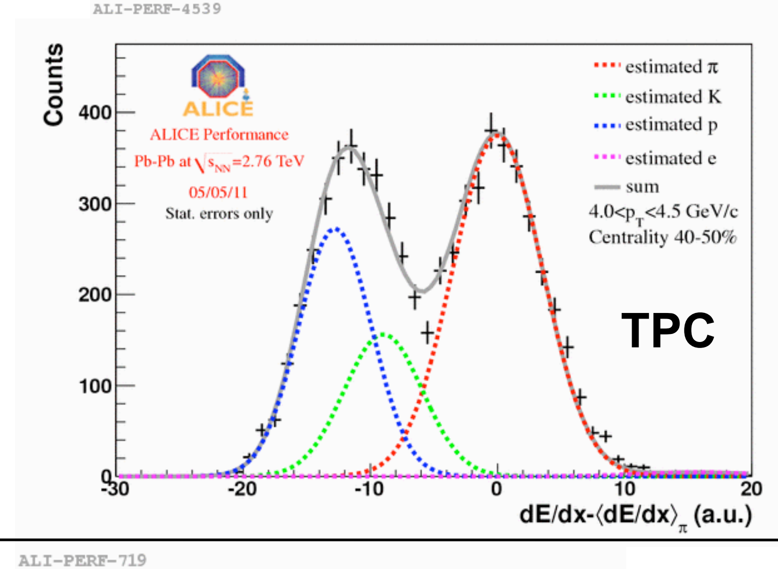
rel. rise poster
P. Christiansen





Topological particle identification

Topological identification

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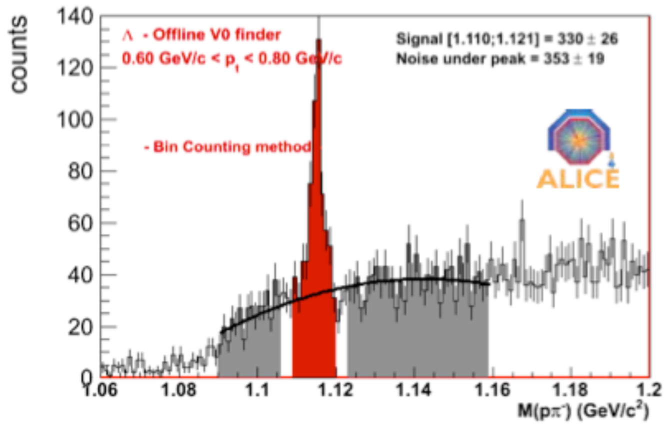
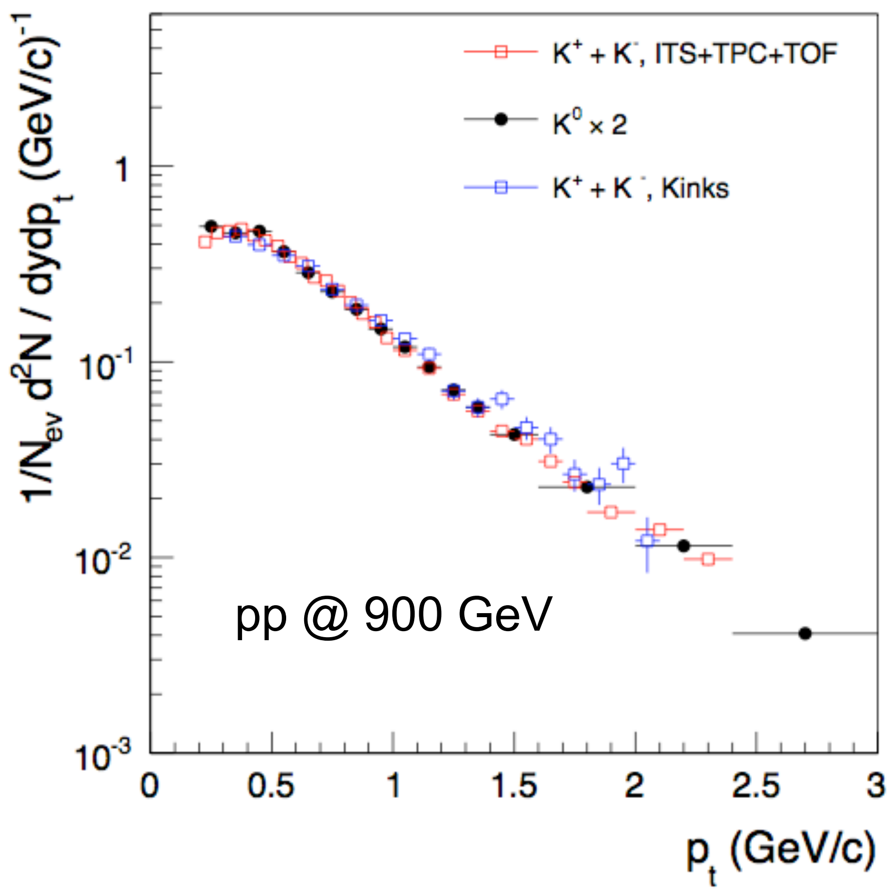
- E.g. Kaons are identified by three different methods:
  - direct PID: $K^{\pm}$
  - V^0s: $K^0 \rightarrow \pi^+\pi^-$
  - Kinks: $K^{\pm} \rightarrow \mu^{\pm}\, \nu$

- PID helps to improve sig.-to-backgr. ratio:





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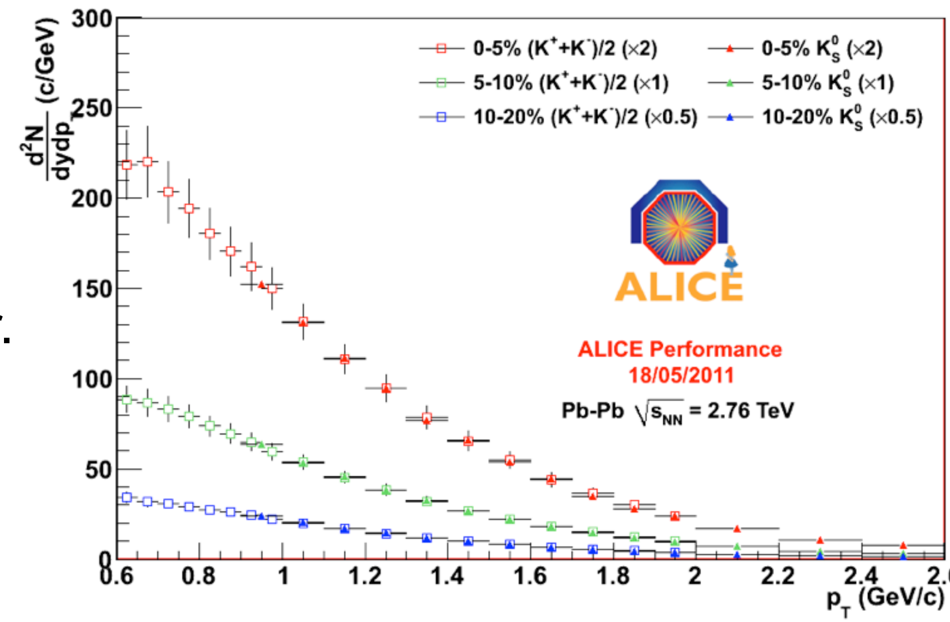

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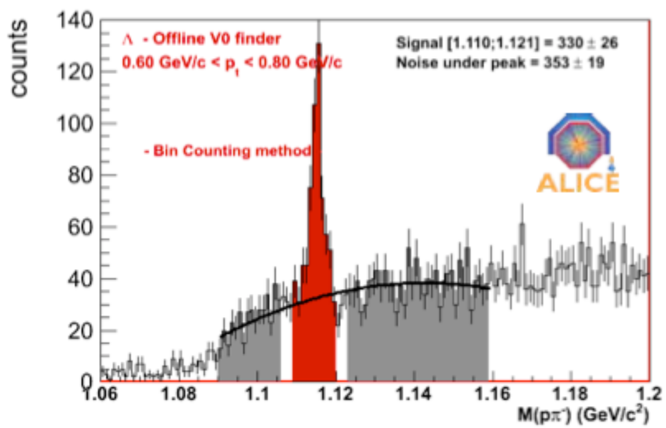

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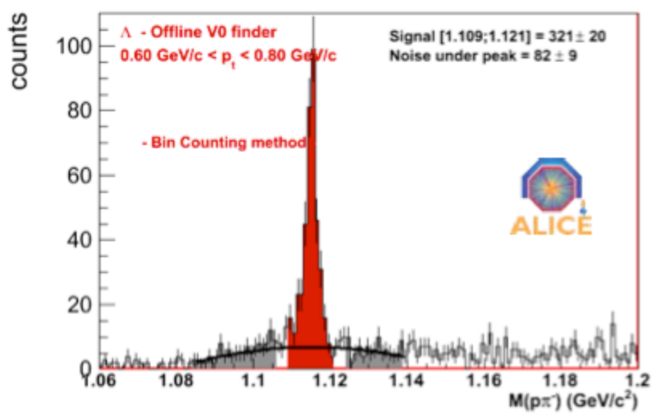

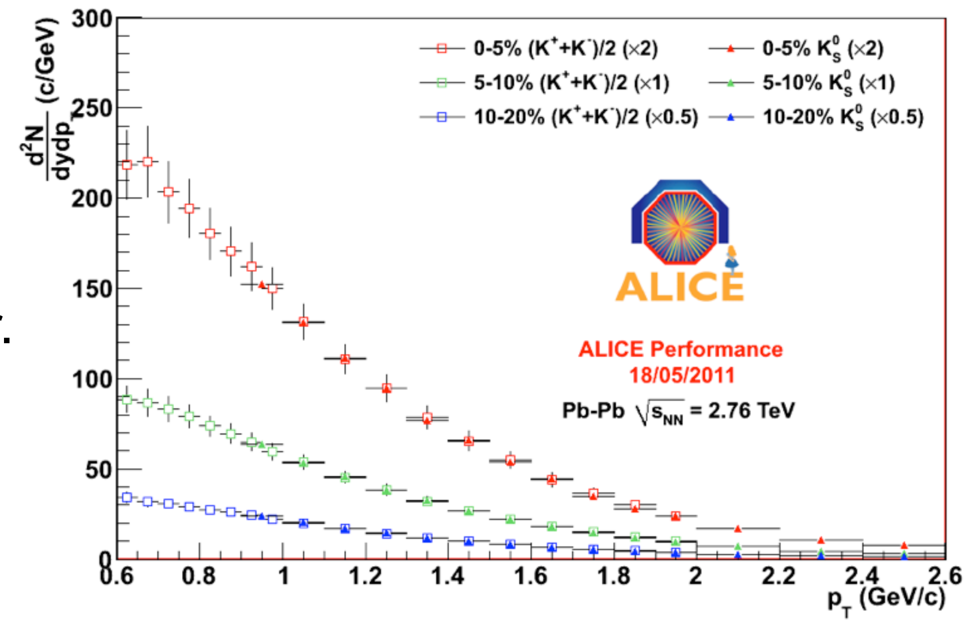

Physics example 1:
π,K,p spectra in pp and Pb−Pb

Spectra extraction

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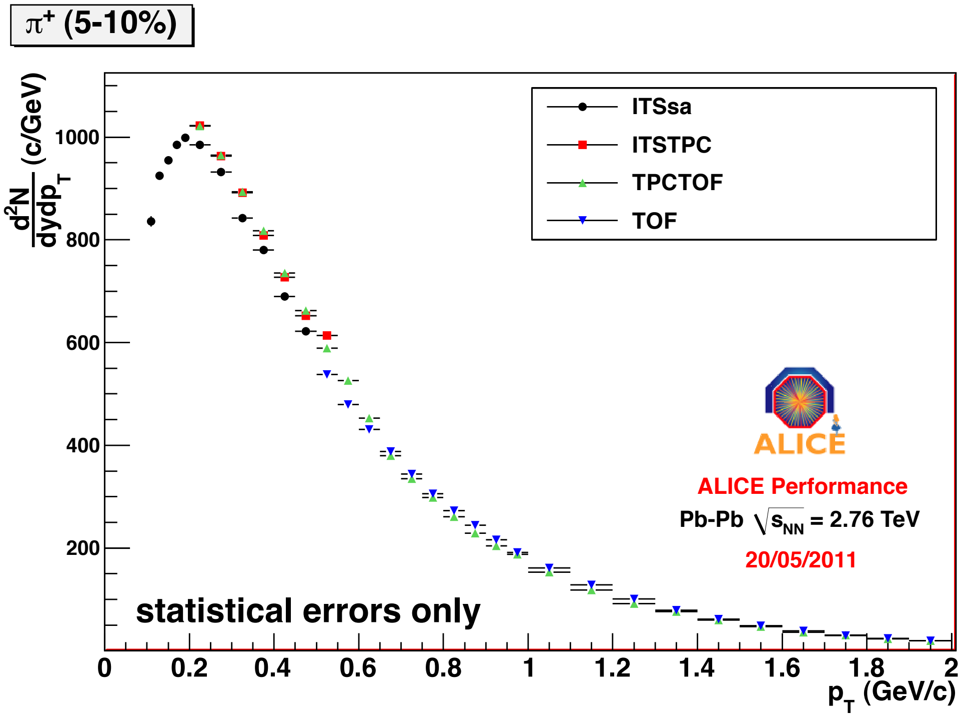
- Measurement with the different overlapping techniques which are combined to a common spectrum afterwards.



pp results: next talk M. Chojnacki

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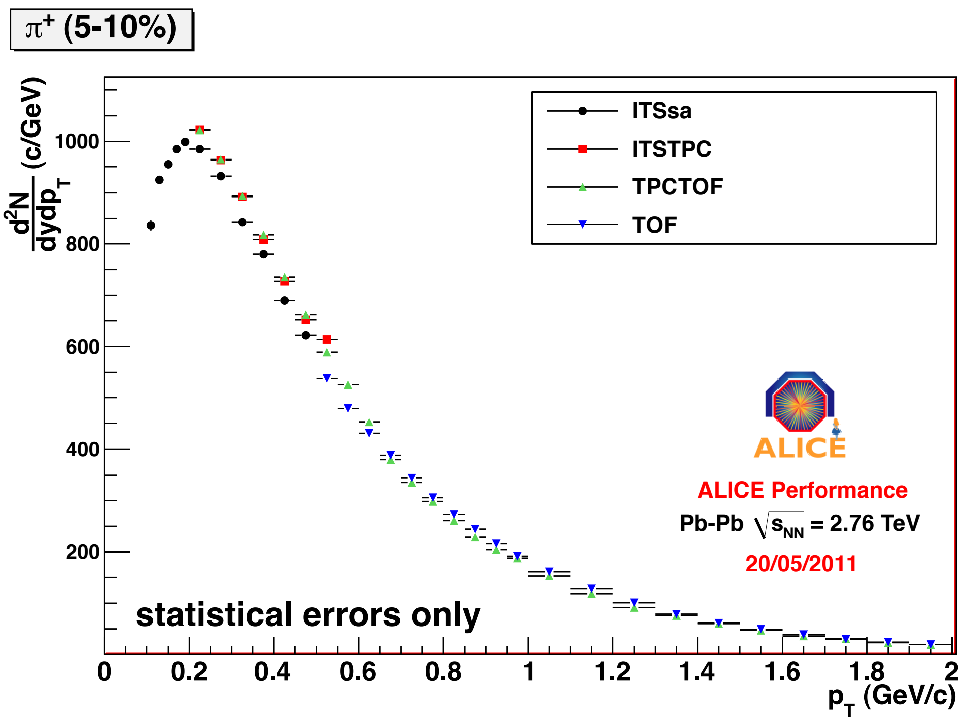

Definition: primary particle

Particles produced in the collision including products of strong and electromagnetic decay, but excluding feed-down from weak decays of strange particles.

=> That means

$\Lambda \rightarrow p\pi^-$

$\Sigma^+ \rightarrow p\pi^0$

....

have to be subtracted from the proton spectrum.

pp results: next talk M. Chojnacki

GSI

Spectra extraction

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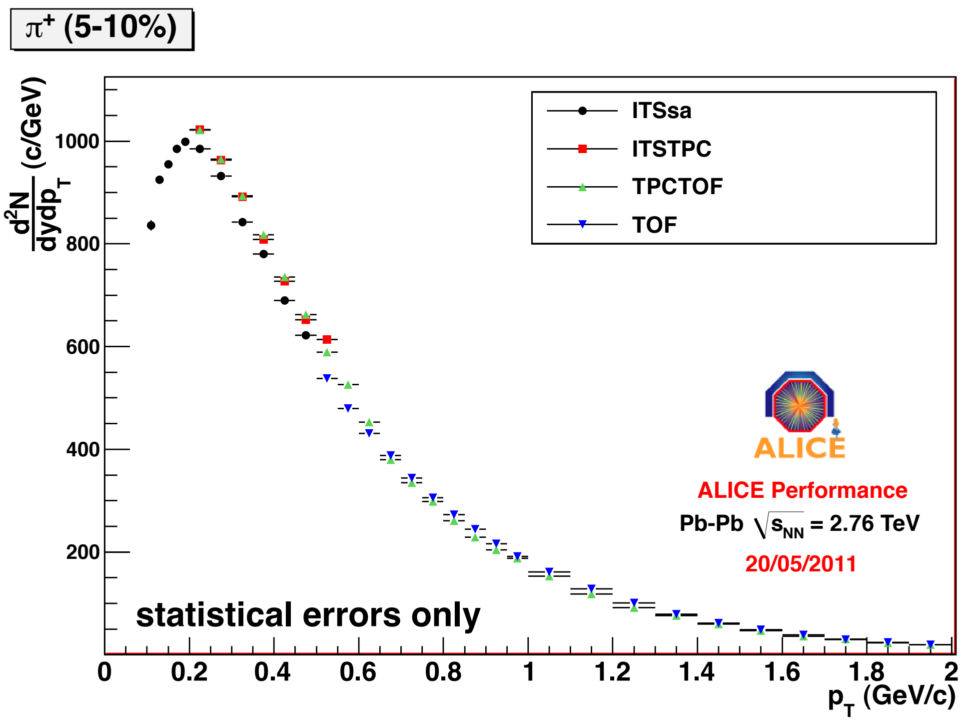
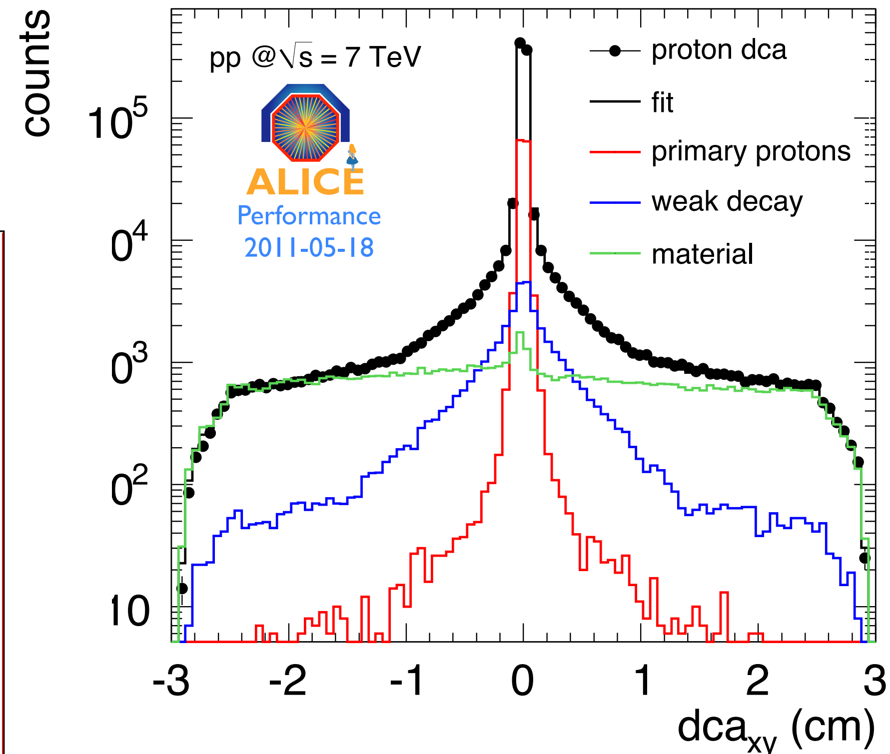


Feed-down correction



0.7 GeV < p_t < 0.75 GeV

pp results: next talk M. Chojnacki

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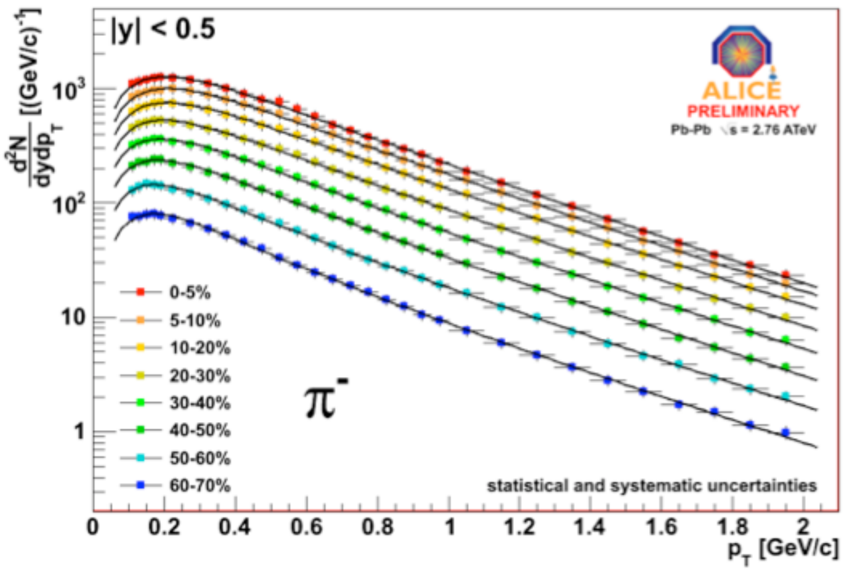
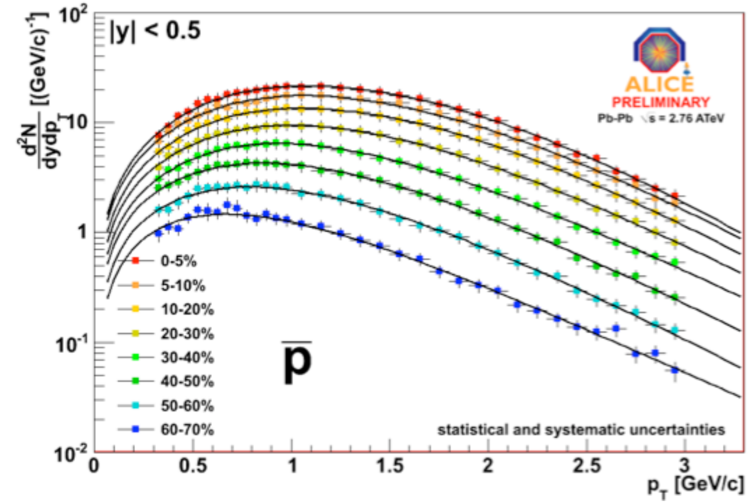
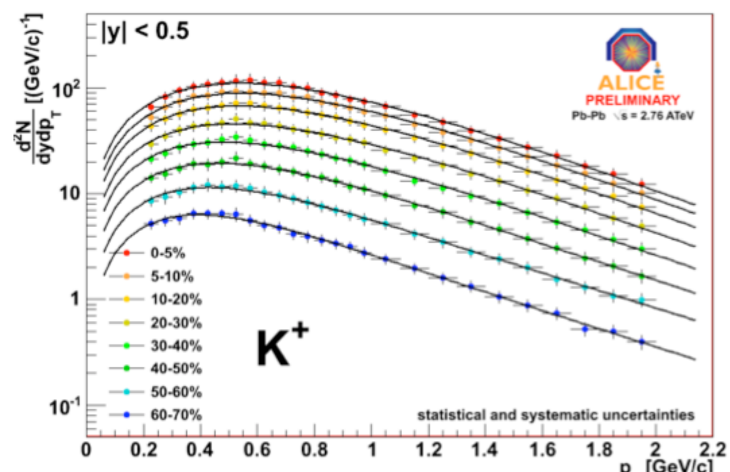
Results





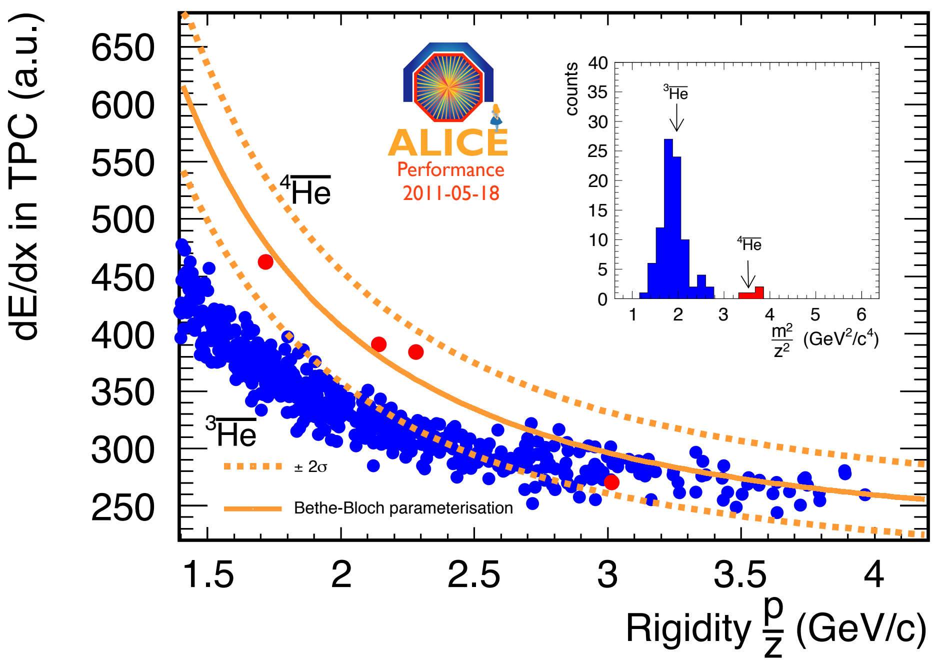


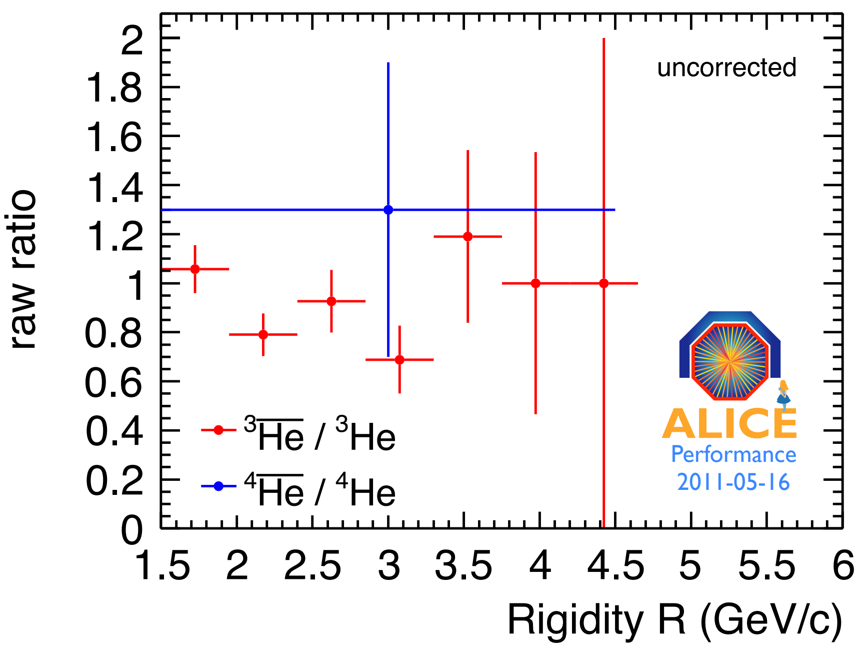
- Blast-wave fits to individual particles to extract yields, particle ratios and <p_t>.

PLENARY TALK
M. Floris

Physics example 2:
Anti- and Hyper-nuclei

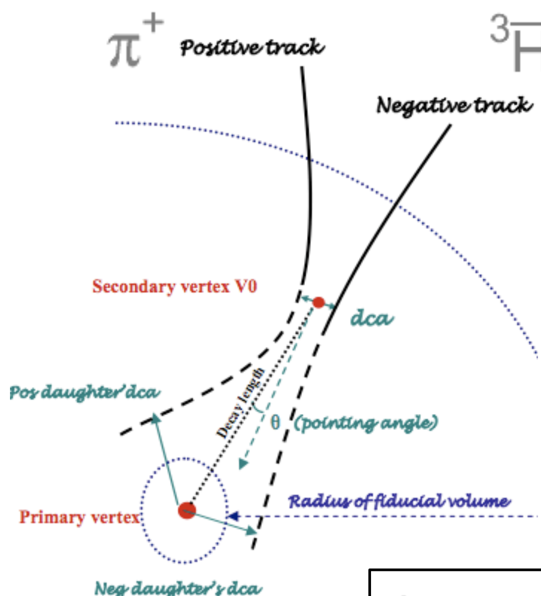
Anti-alpha observation

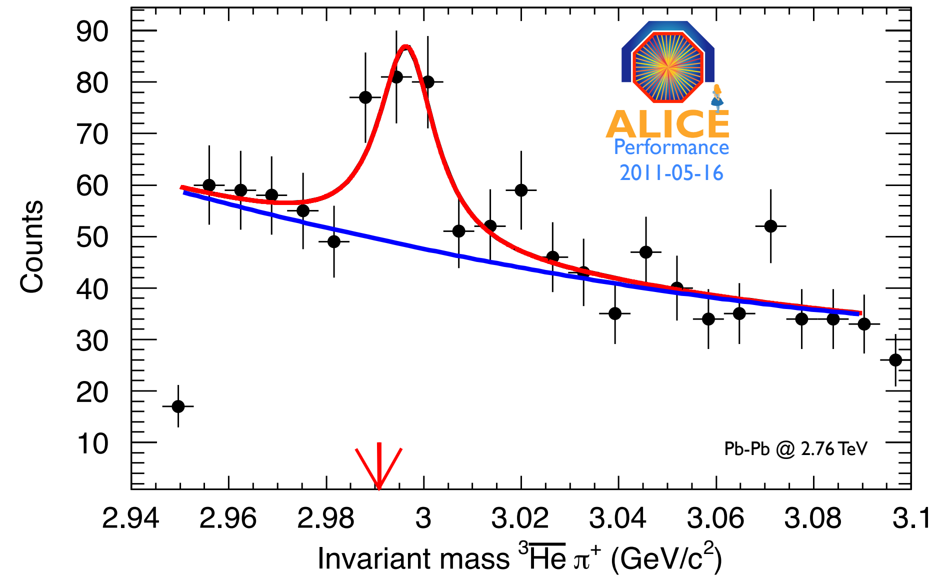




Antihypertriton reconstruction

- Identification of light nuclei which are daughter tracks and origin from displaced vertices.





$$^{3}_{\bar{\Lambda}}\overline{H} \rightarrow {}^{3}\overline{He} + \pi^{+}$$

anti-matter poster
N. Sharma

Summary

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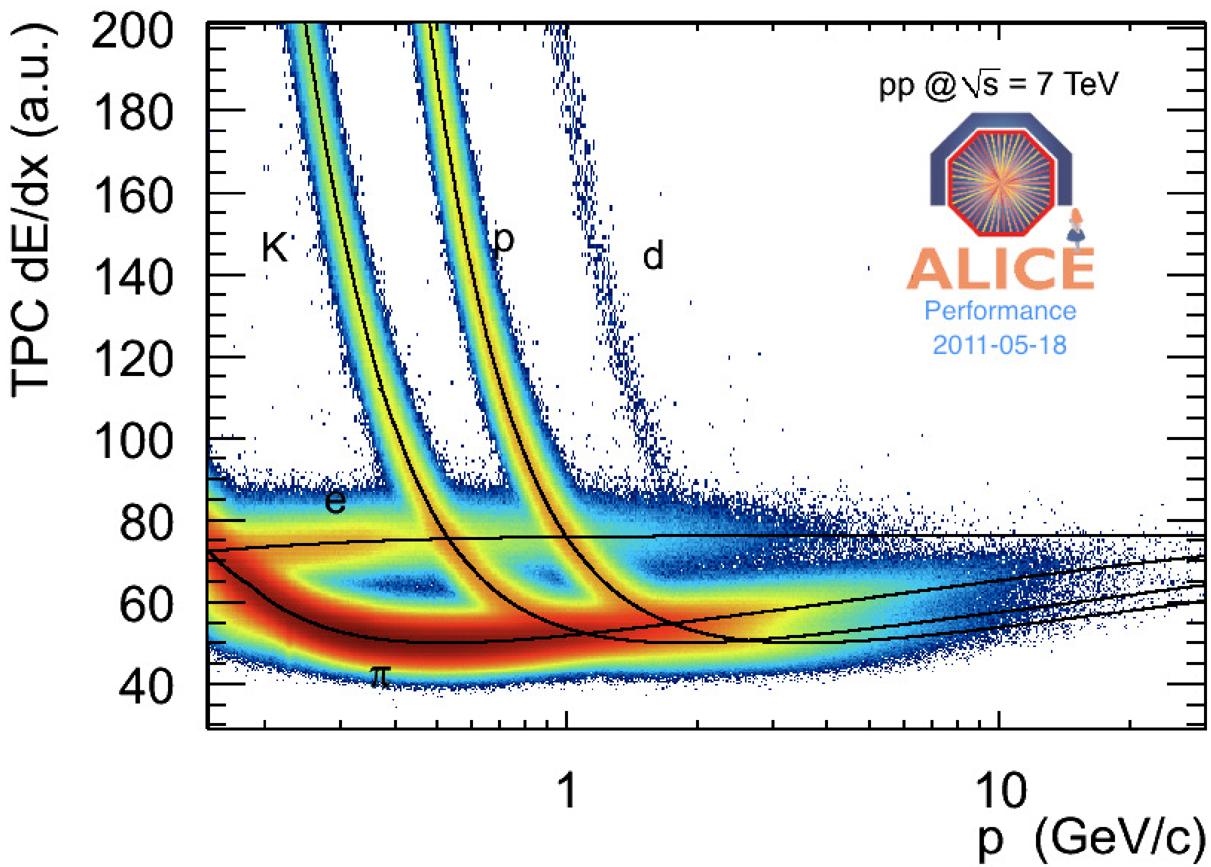
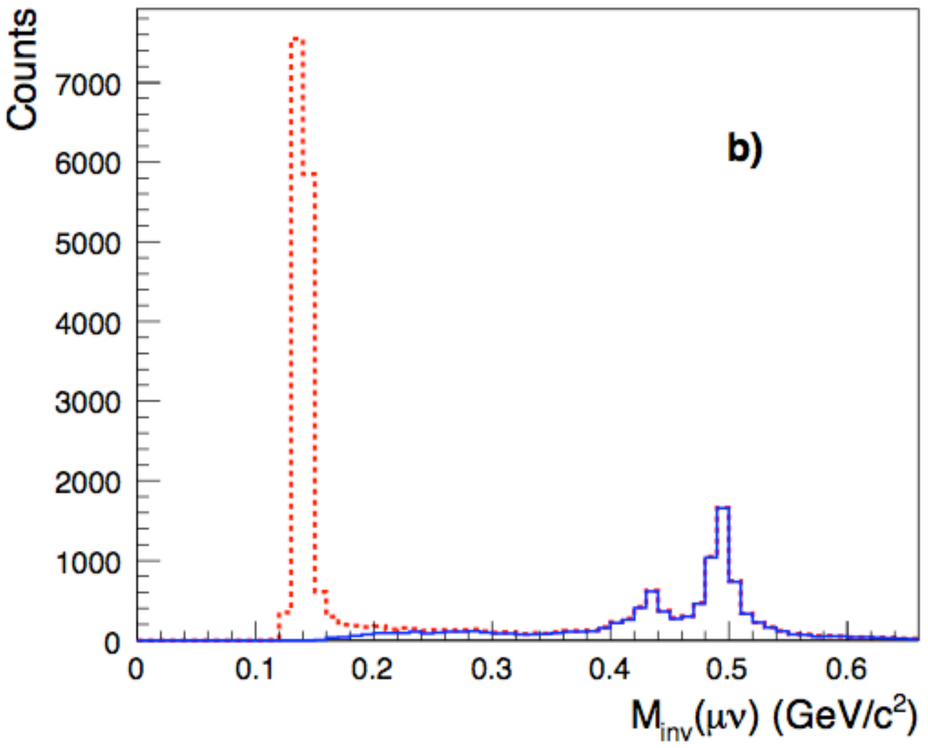
- ALICE particle identification shows an excellent performance.
- Particle spectra of various identified spectra have been extracted, e.g. charged pions, kaons, and protons in pp (900 GeV and 7 TeV) and Pb-Pb collisions.
- Various internal cross-checks between different detectors and identification techniques show consistent results.
- ALICE is also very well set up for the detection of rare stable particles, e.g. light anti- or hyper-nuclei.

BACKUP


TPC dE/dx (a.u.)
200
180
160
140
120
100
80
60
40
1
10
p (GeV/c)
K
e
π
p
d
pp @√s = 7 TeV
ALICE
Performance
2011-05-18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7000
6000
5000
4000
3000
2000
1000
0
b)
0
0.1
0.2
0.3
0.4
0.5
0.6
M_inv(μν) (GeV/c^2)