Results from particle identification in pp collisions measured with ALICE at the LHC

Antonio Ortiz Velasquez
(on behalf of ALICE Collaboration)

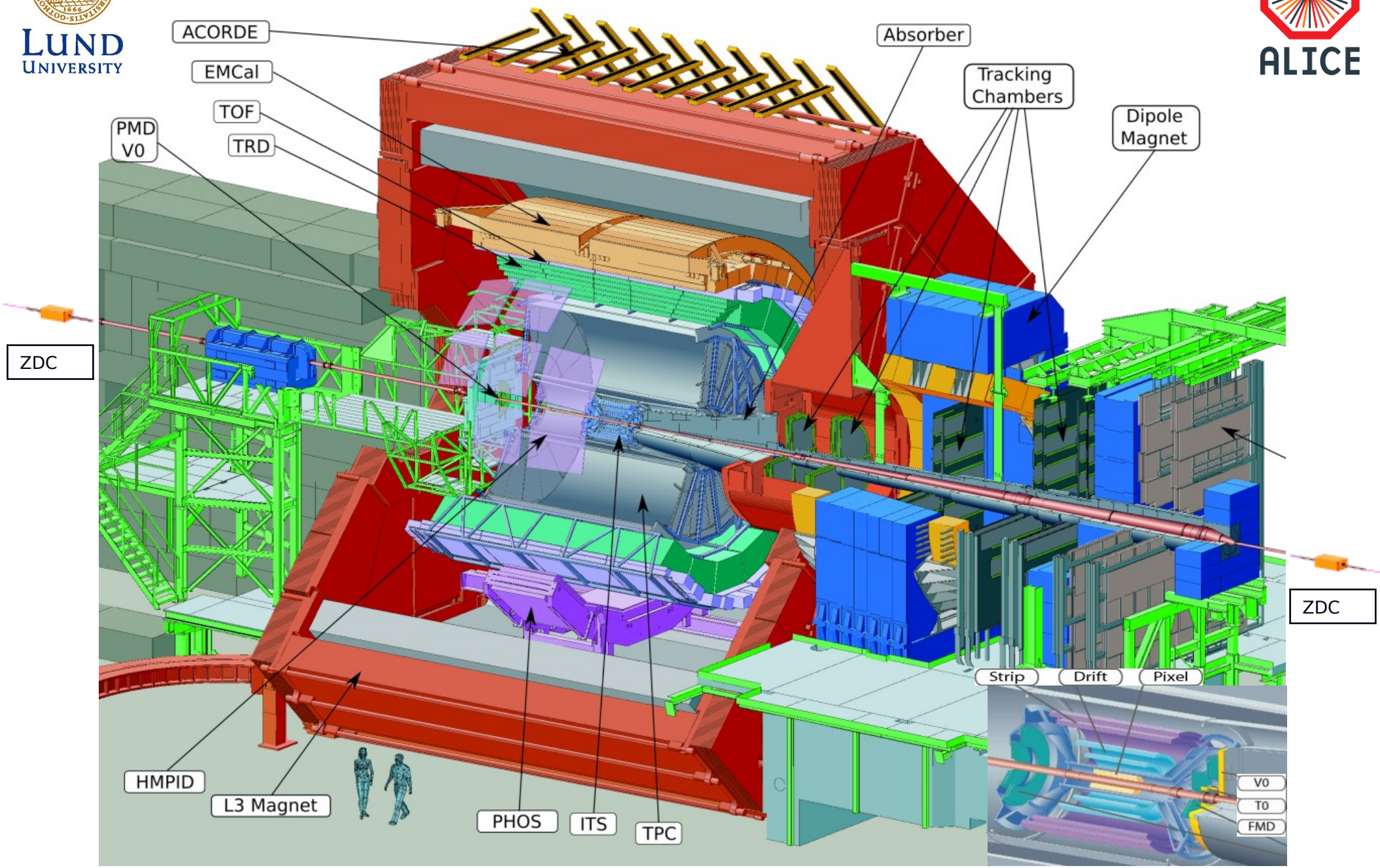
Lund University,
Department of Physics,
Div. of Particle Physics.

Outline

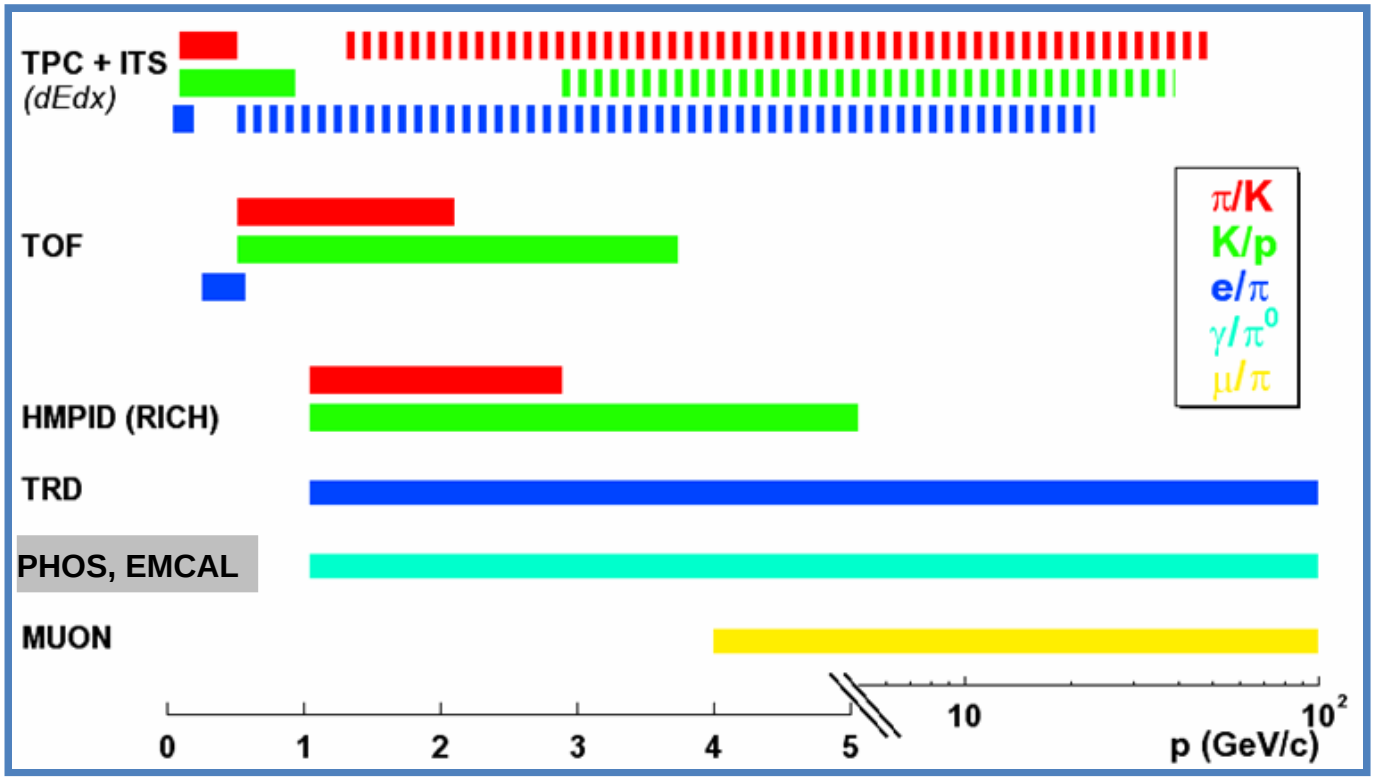
The plan of the talk is to show results on particle identification (light flavour) in proton-proton collisions.

- Description of ALICE experiment.
- Particle Identification in ALICE.
- Charged pions, (anti)protons and kaons at low-p_t. Prospects for high-p_t.
- Neutral pion production.
- Strange (K^0_s, Λ) and multi-strange (Ξ, Ω) particle production.
- Light vector meson production.
- Light nuclei and anti-nuclei production.
- Outlook.

Experimental Apparatus



Particle Identification in ALICE



- Light charged hadrons ($\pi^{\pm}$, $K^{\pm}$, p, anti-p): 100 MeV < p < 5 GeV (several 10 GeV)

  dE/dx in silicon (ITS) and gas (TPC) + time-of-flight (TOF) + Cherenkov (HMPID)

- Invariant mass and decay topologies (K^0_s, Λ, $\Omega^{\pm}$, $\Xi^{\pm}$, open charm, resonances, ...)

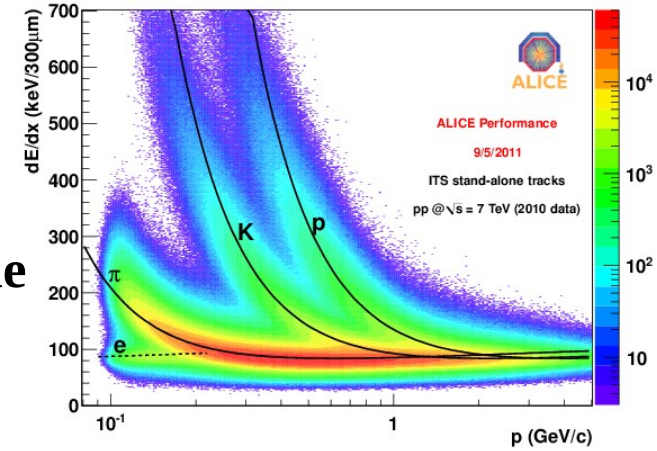
  TPC+ITS+TOF

Leptons (e, μ), photons, π^0, η.

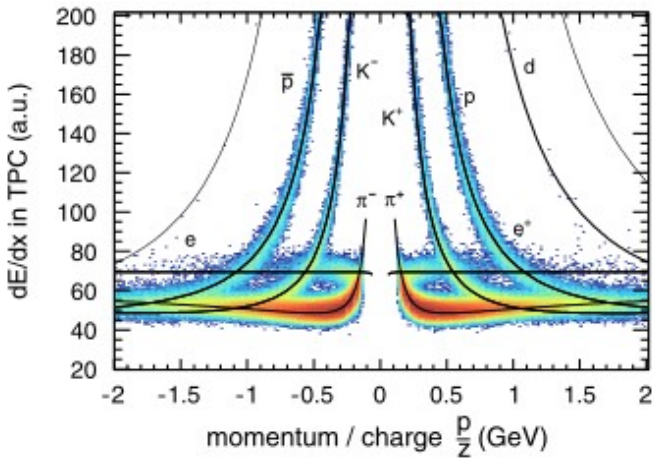
electrons TRD: p > 1 GeV, muons: p > 4 GeV (light vector mesons), π^0 in PHOS, EMCAL: 1 < p < 80 GeV

Low p_t p, K and π spectra, pp at √s=0.9 TeV

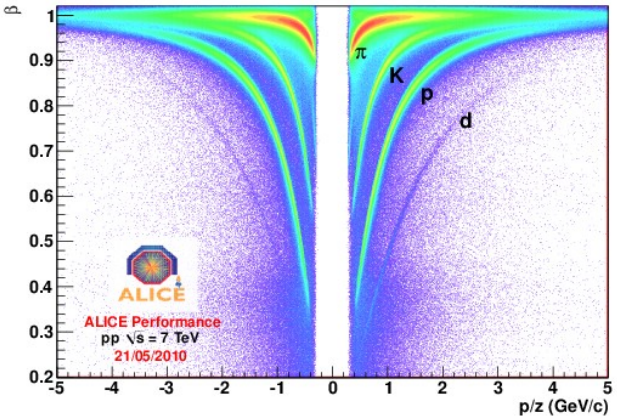
ITS standalone



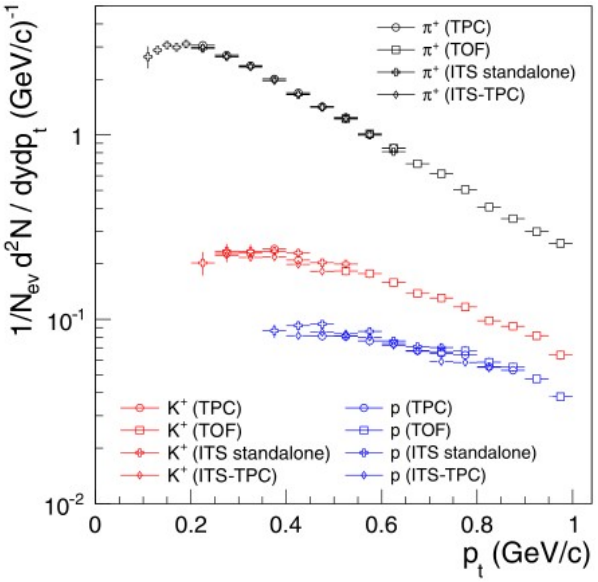
TPC

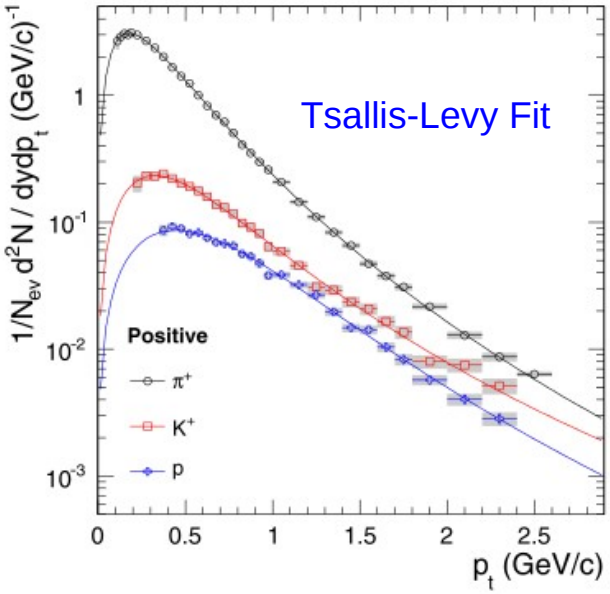


TOF



Results from different analyses





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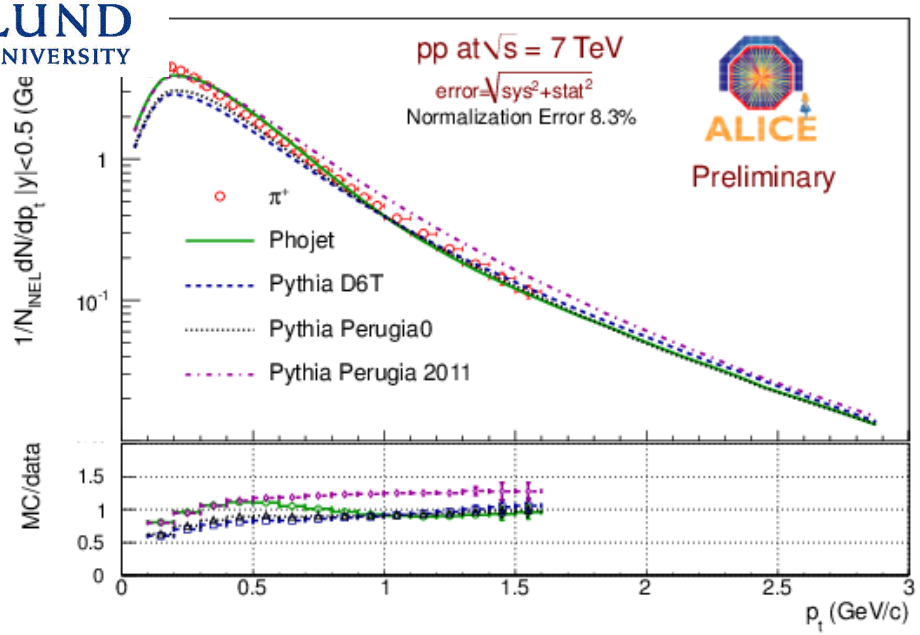
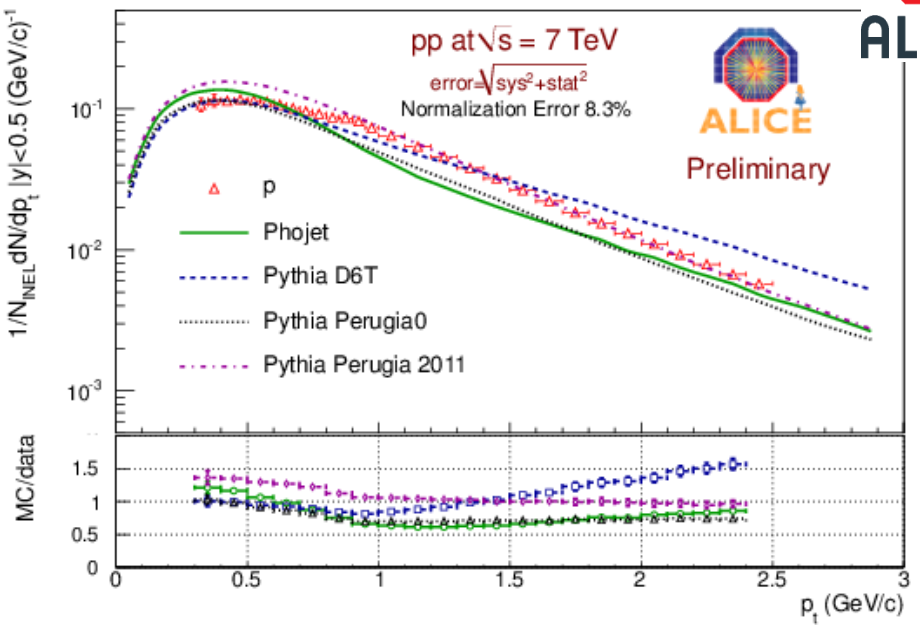
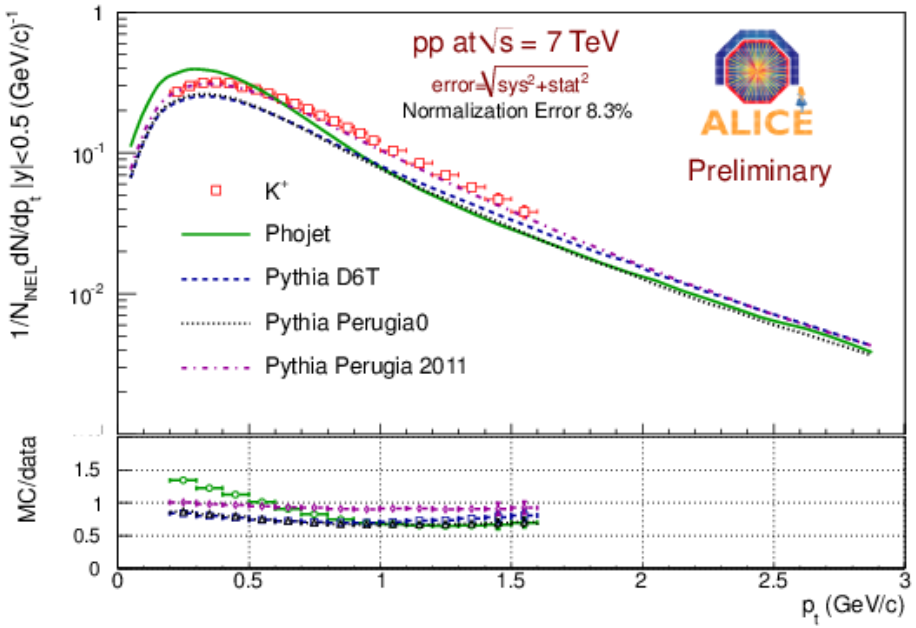
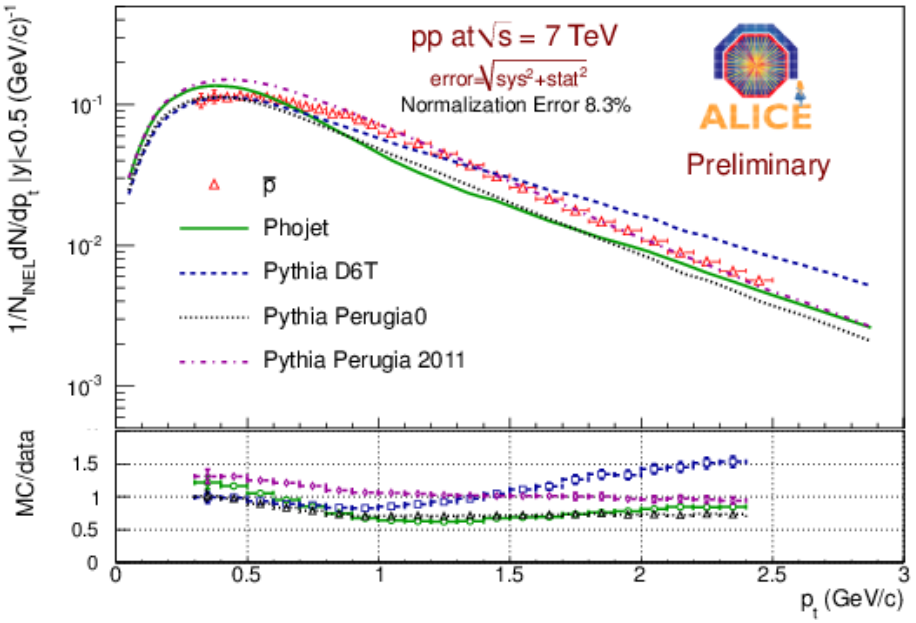
Low p_t p, K and π spectra, pp at √s=7 TeV



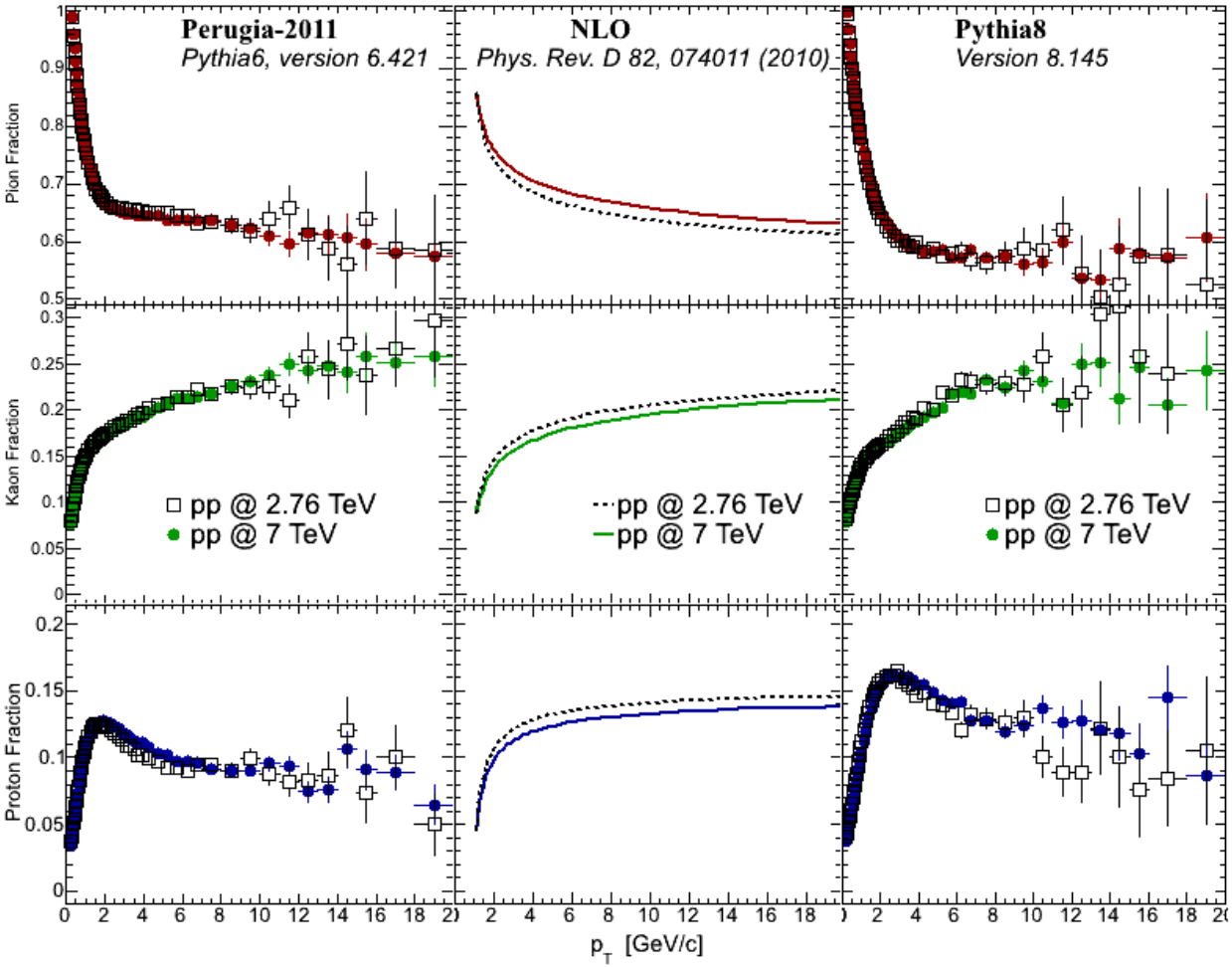




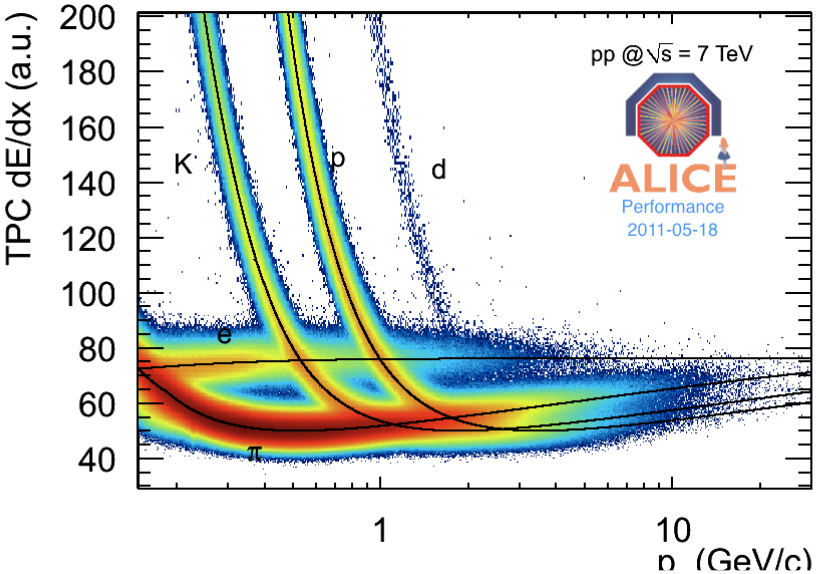


Prospects for $\pi^{\pm}$, $K^{\pm}$ and (anti)protons at high-p_t

$\pi^{\pm}$/all charged, $K^{\pm}$/all charged, (anti)p/all charged

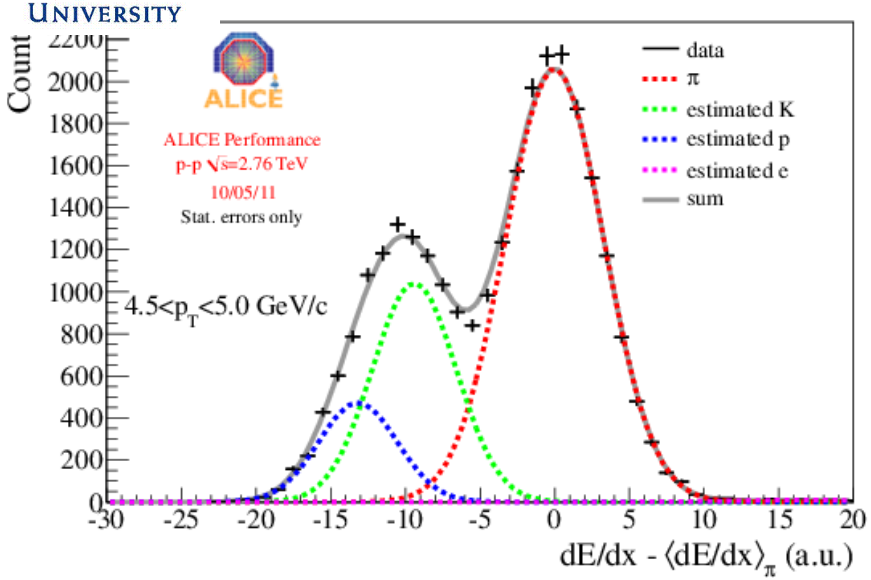


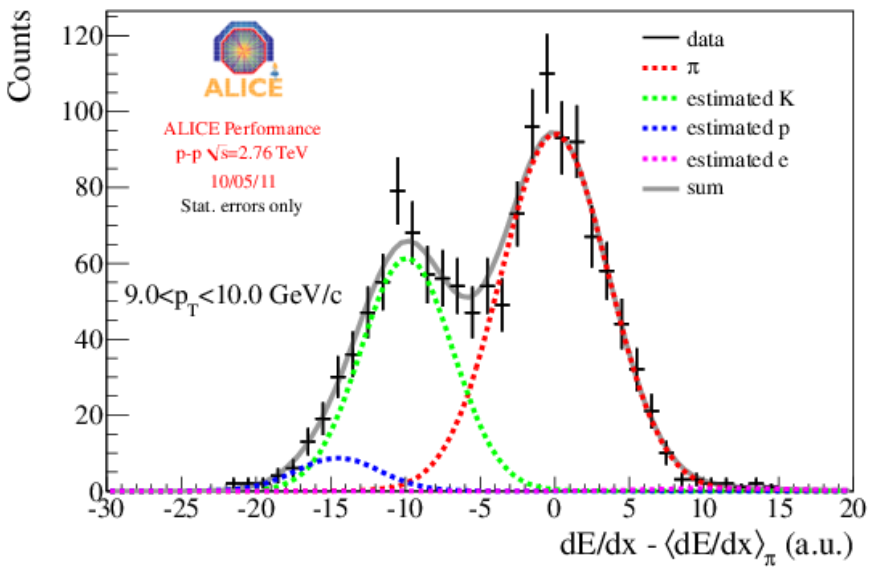
- Important test of pQCD and NLO calculations.
- Important tool to constrain the fragmentation functions in the non-perturbative domain.

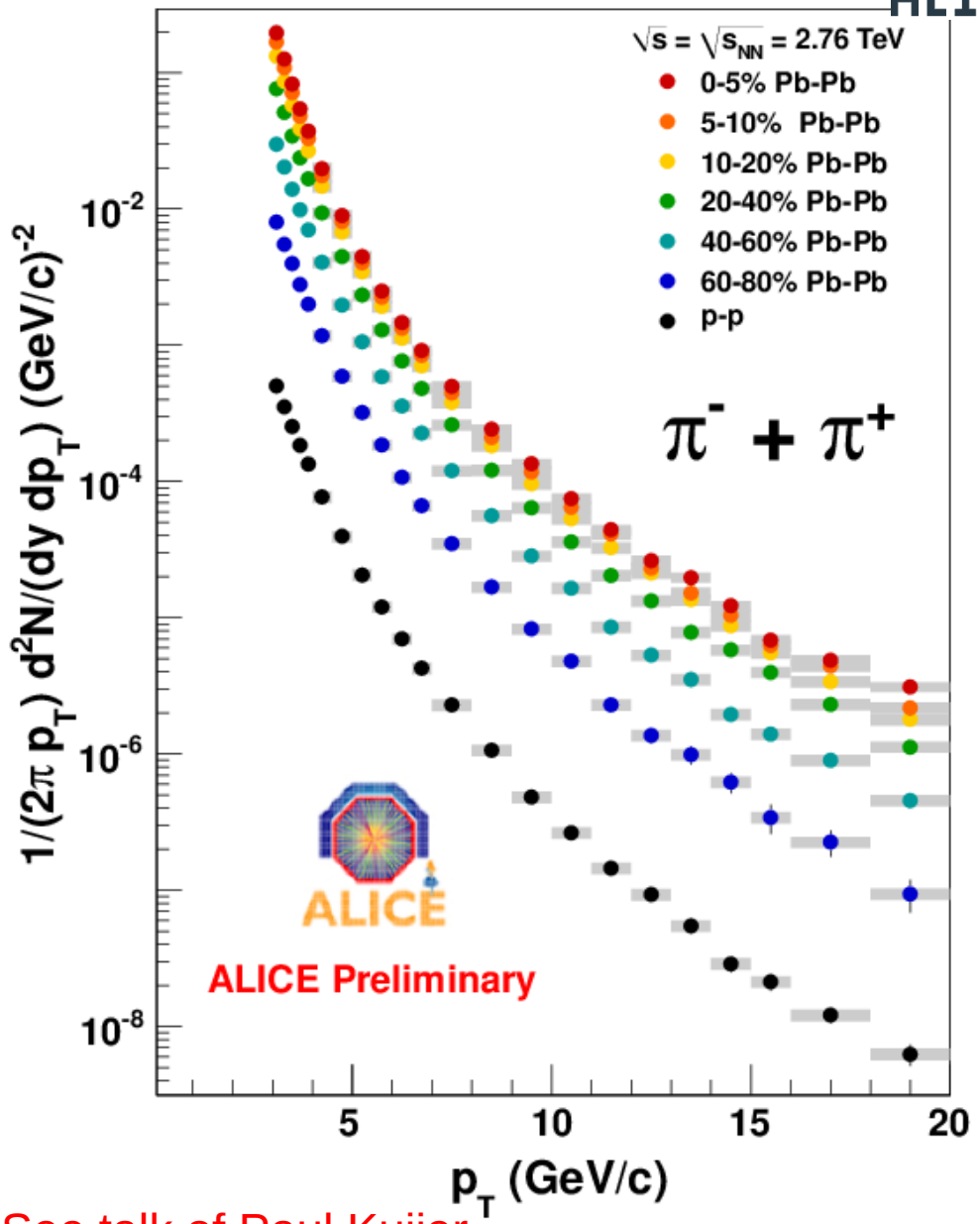


With the TPC, the separation of p, K, π can be done on statistical basis in the *dE/dx* relativistic rise ($\beta\gamma$~3.6-1000).

Preliminary results for pions at high-p_t







See talk of Paul Kuijer

π^0 production

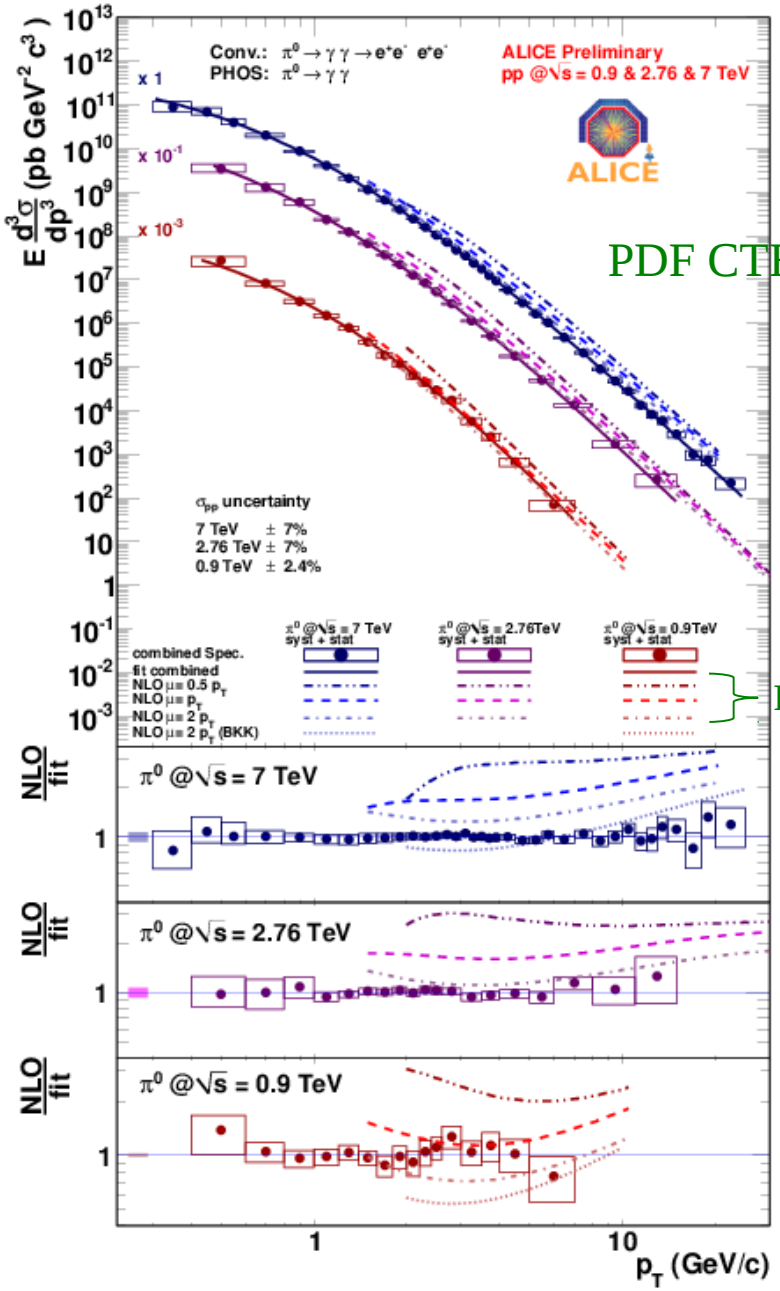
- Test pQCD, probe PDF and FF at low x and low z values.
- Constrain the gluon to pion fragmentation: at LHC energies, ~ 75% of pions are produced from gluon fragmentation.

Phys. Rev. D82, 074011 (2010)

Measurement via the two-photon decay channel.

- PHOS (Photon Spectrometer)
- ITS+TPC (Photon Conversion Method)

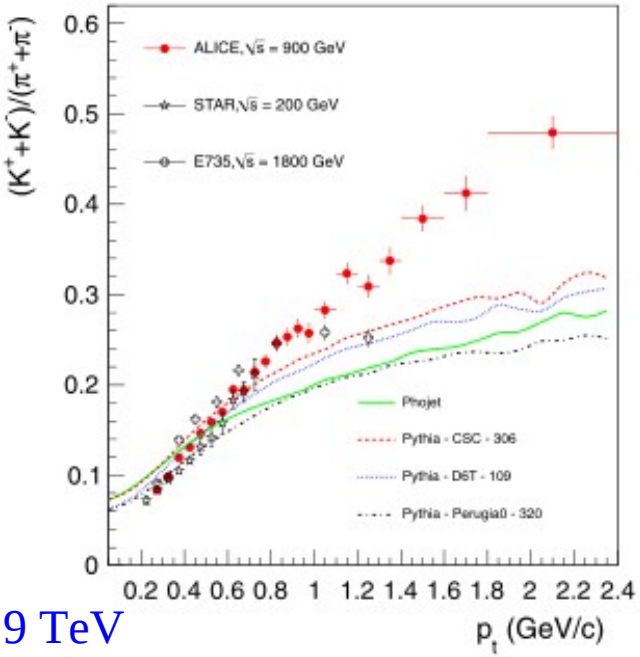
At 2.76 and 7 TeV, most NLO calculations overestimate the cross sections, better agreement at 0.9 TeV.



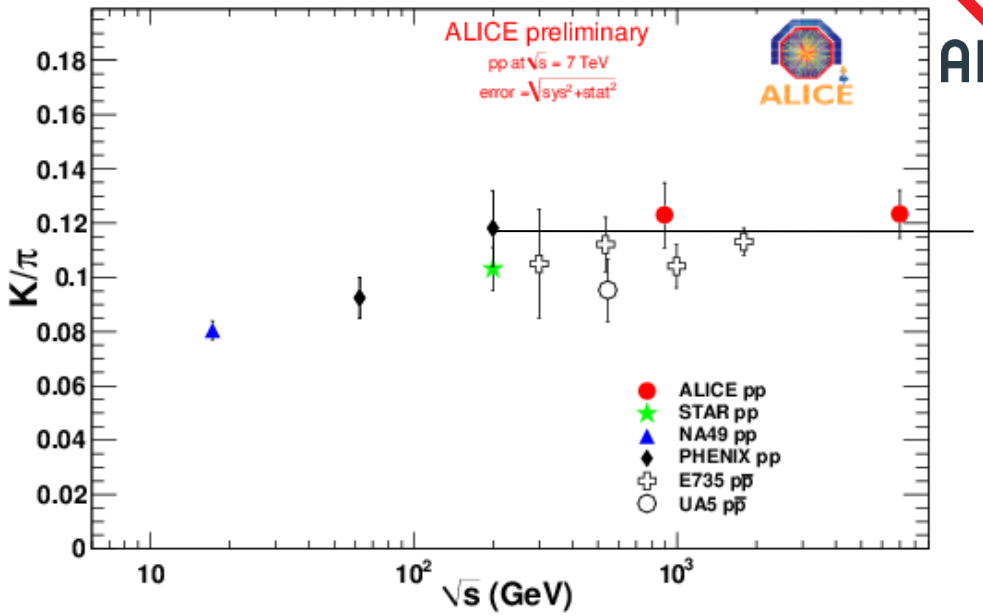
PDF CTEQ6M5

FF: DSS

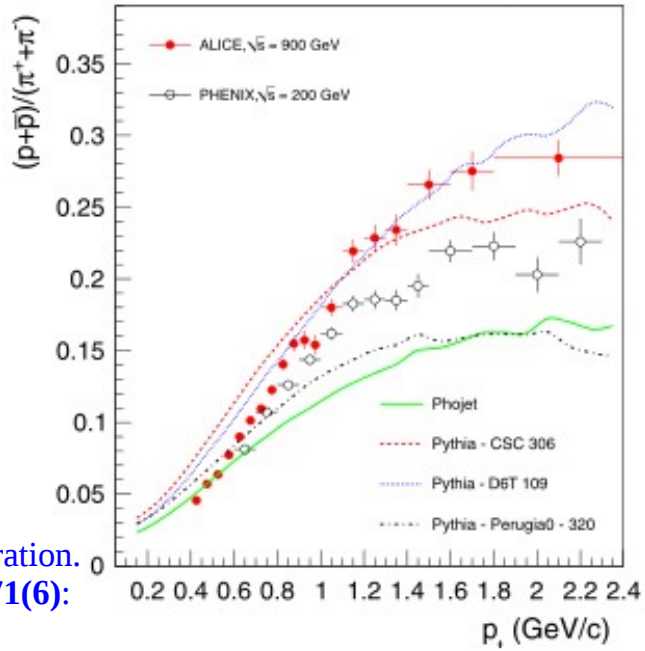
Particle Ratios

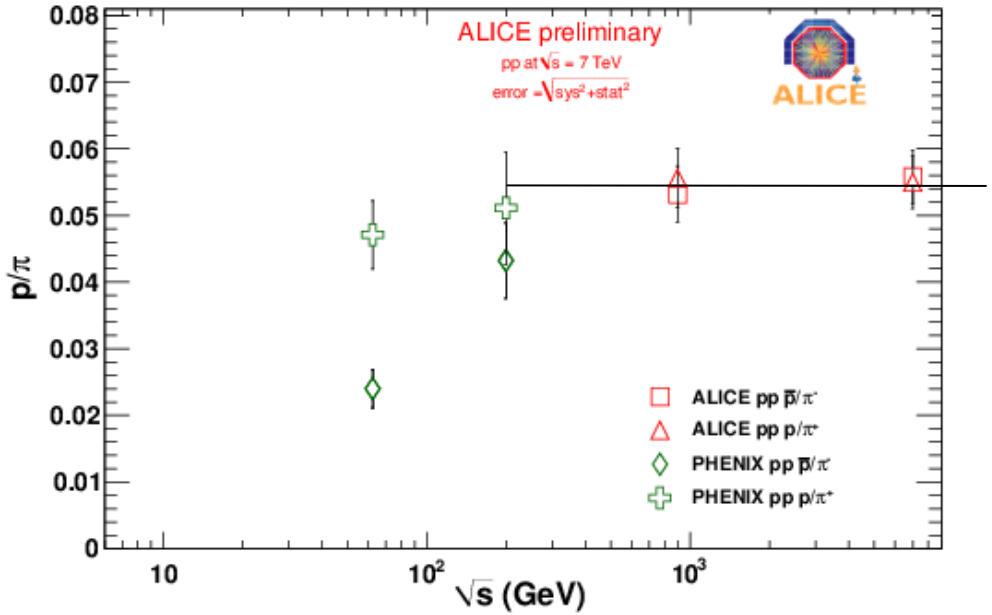


pp, √s=0.9 TeV



Ratios from integrated yields extracted from Lévy fits.





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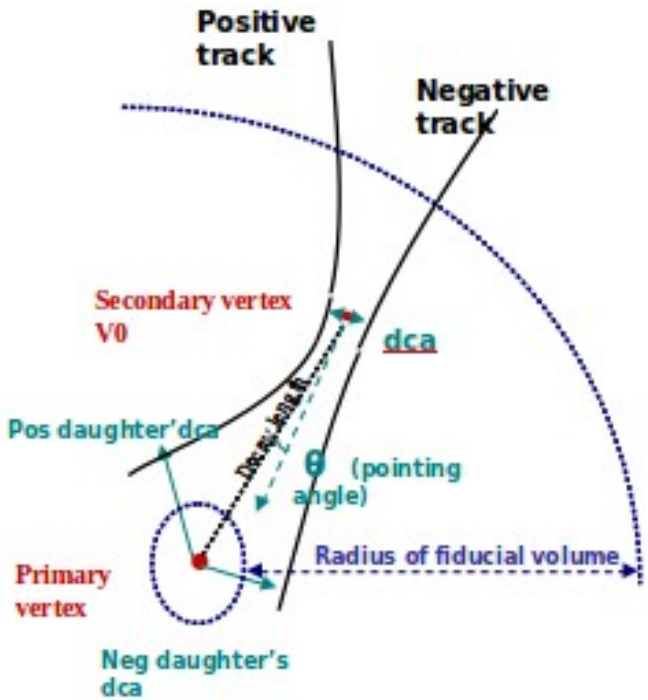
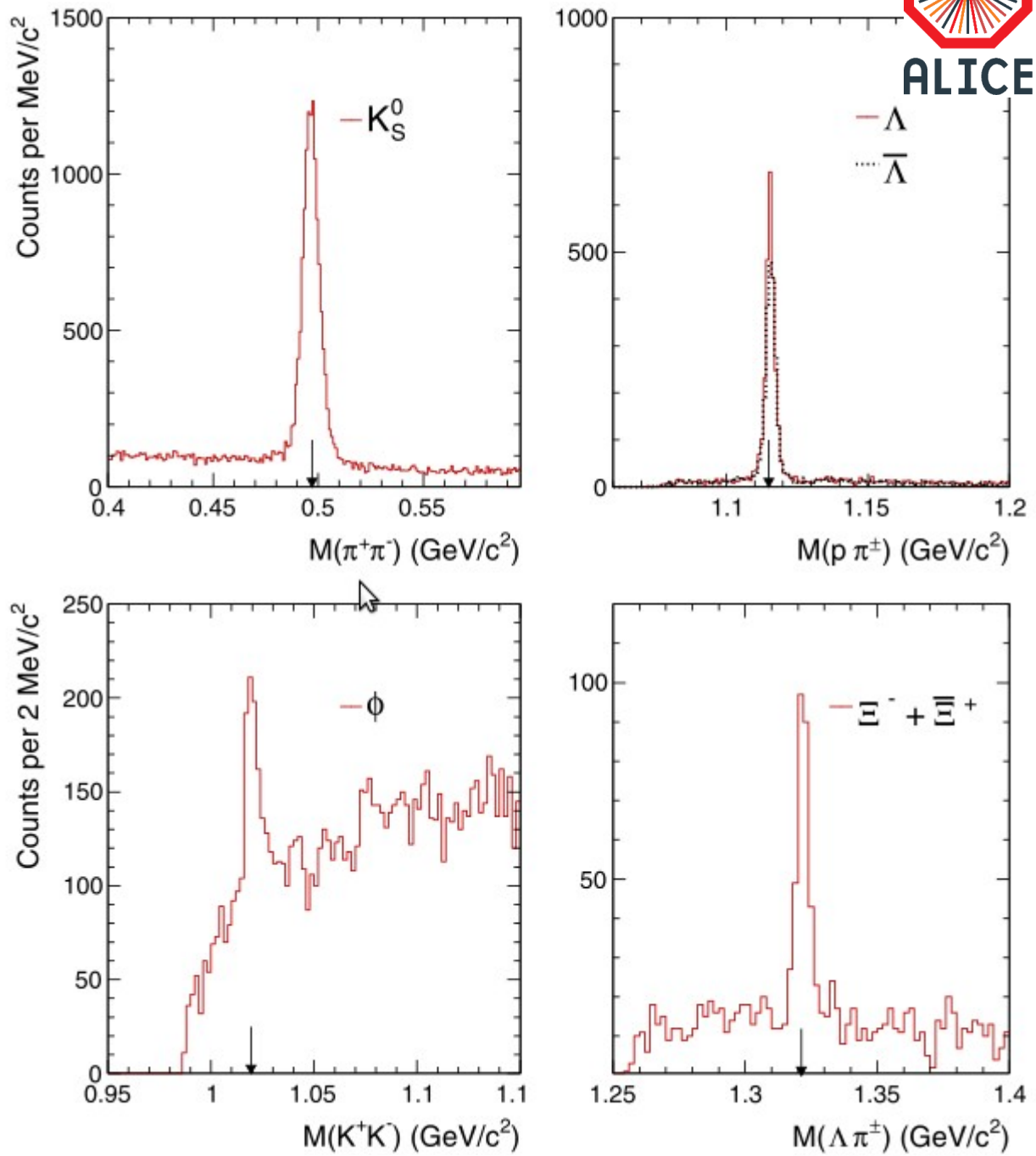
Measurement of strange particle production

V0s reconstruction (K^0_S, Λ)



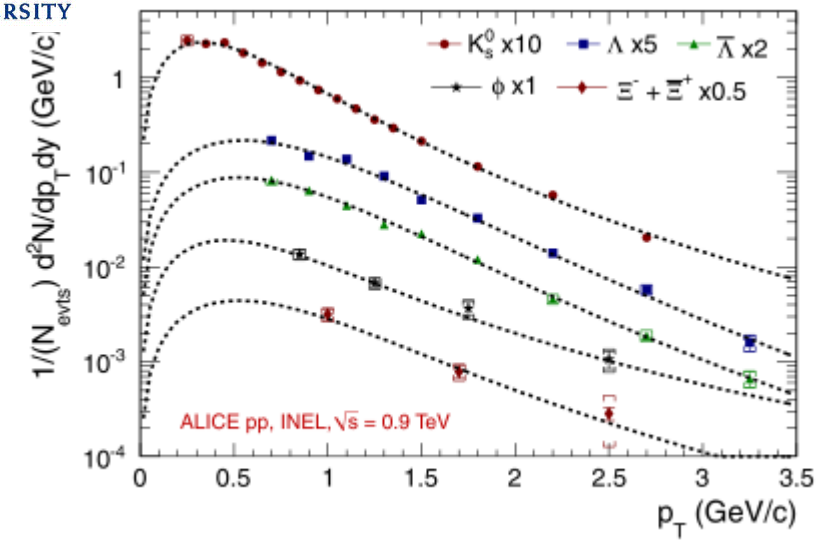
pp, √s=0.9 TeV.

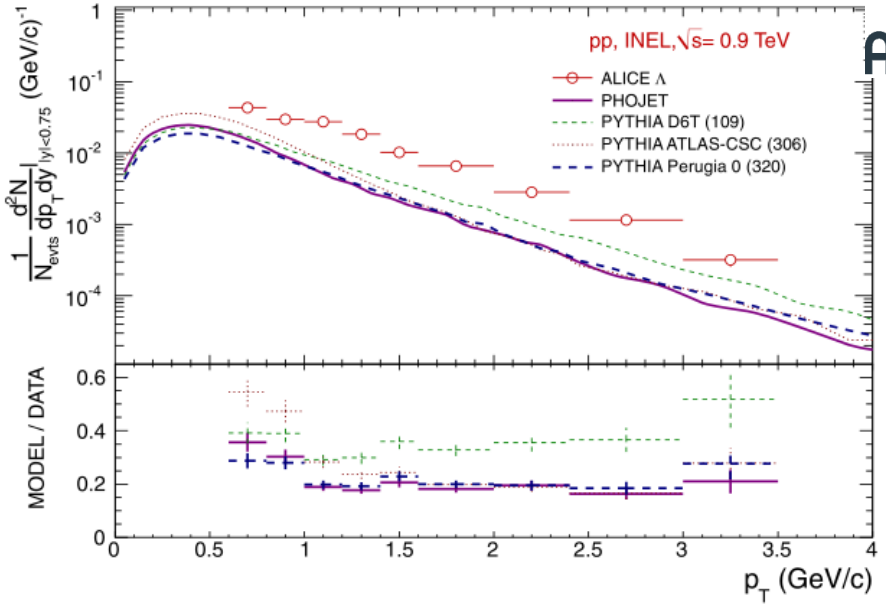
	Particles	Charged decay	B.R. (%)
Mesons	K^0_S	$K^0_S \to \pi^+ + \pi^-$	69.2
	ϕ ($s\bar{s}$)	$\phi \to K^+ + K^-$	49.2
Baryons	Λ (uds) and $\overline{\Lambda}$ ($\overline{uds}$)	$\Lambda \to p + \pi^-$ and $\overline{\Lambda} \to \bar{p} + \pi^+$	63.9
	Ξ^- (dss) and $\overline{\Xi}^+$ ($\overline{dss}$)	$\Xi^- \to \Lambda + \pi^-$ and $\overline{\Xi}^+ \to \overline{\Lambda} + \pi^+$	99.9

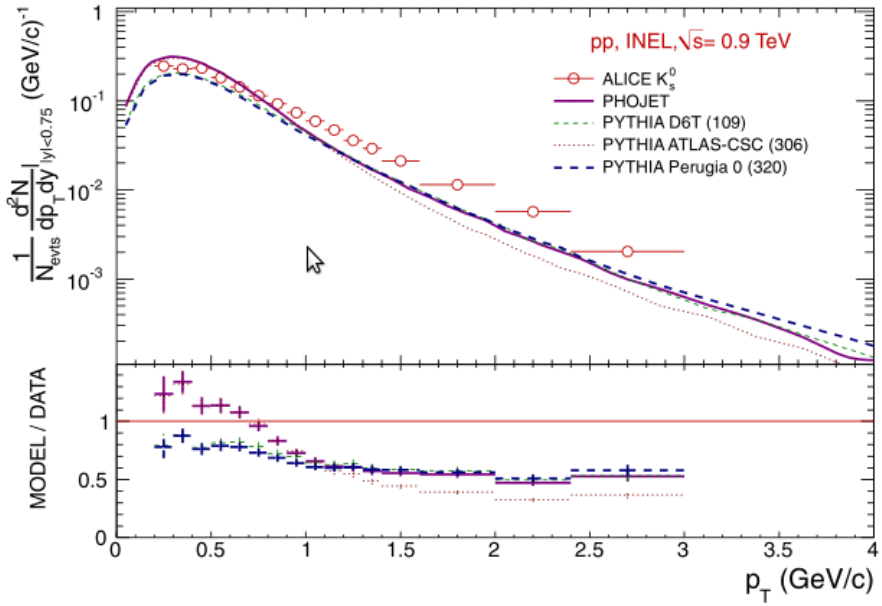


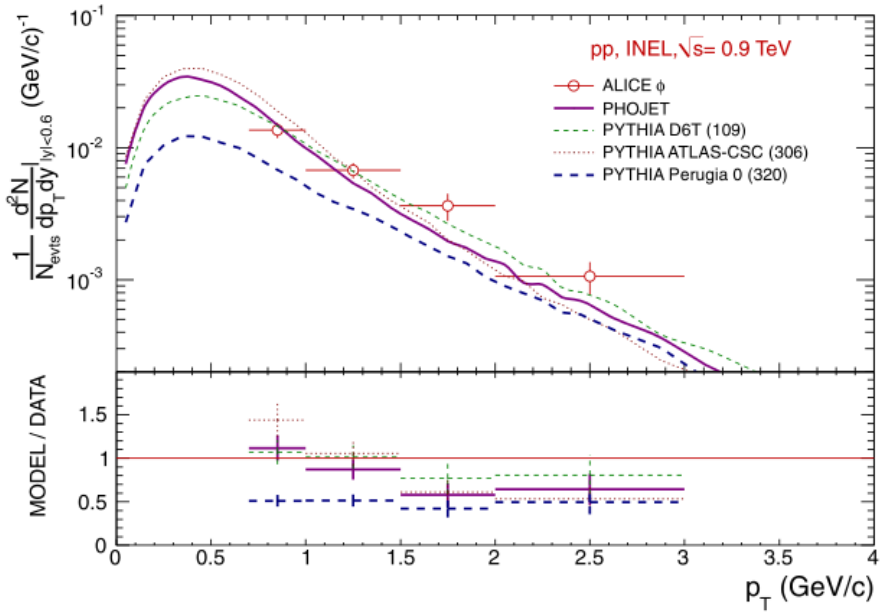
ALICE Collaboration, Eur. Phys. J. C **71(3)**, 1594 (2011)

pp, √s=0.9 TeV.









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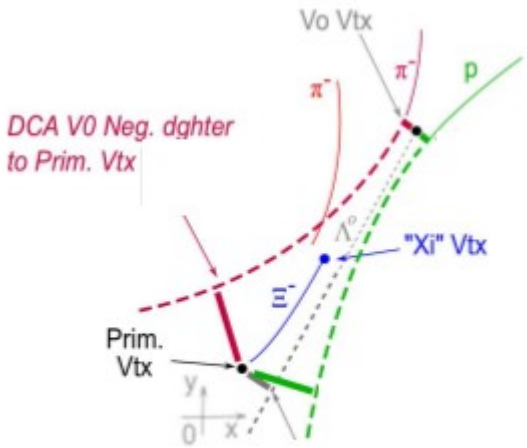
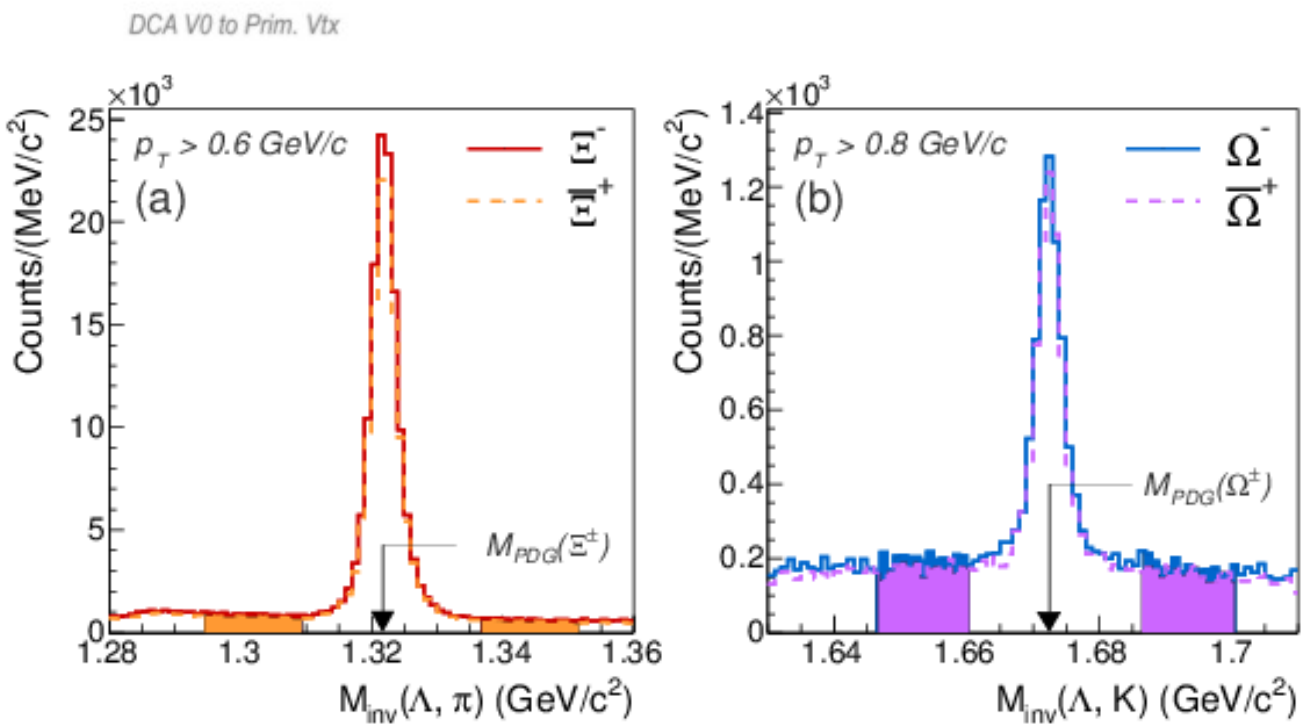
pp, √s=7 TeV.

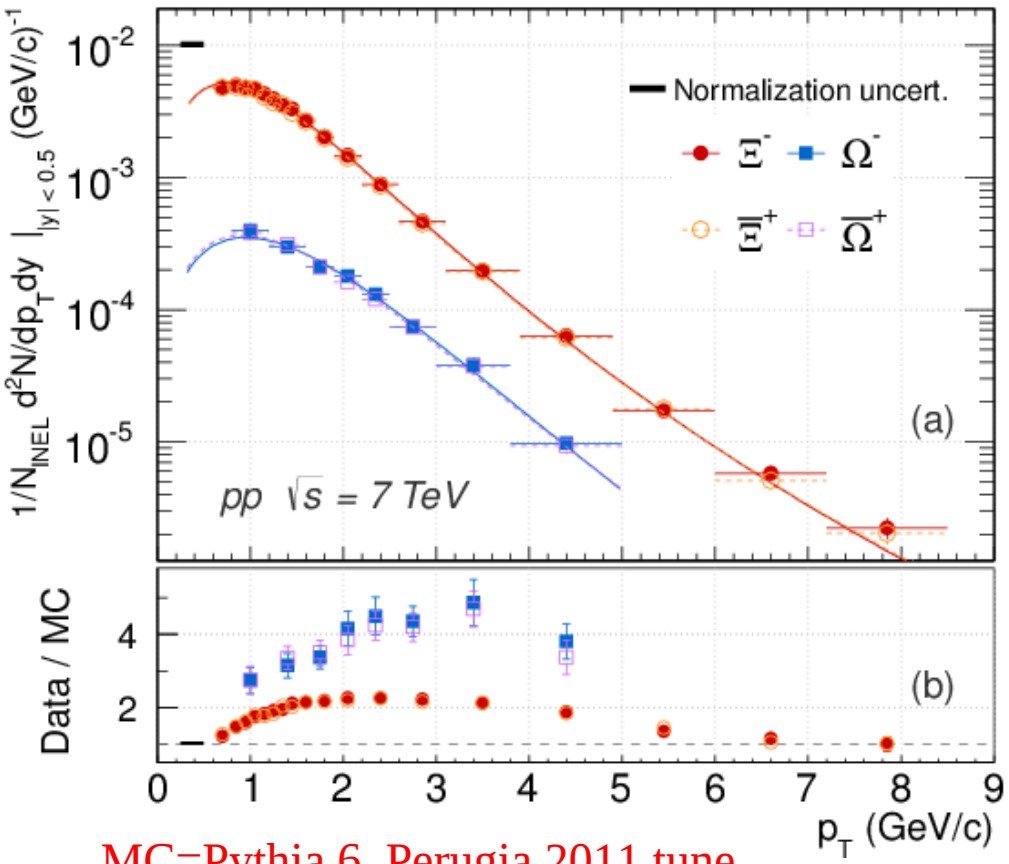


	BR
$\Xi^- \to \Lambda^0 + \pi^- \to p^+ + \pi^- + \pi^-$	99.9 %
$\bar{\Xi}^+ \to \bar{\Lambda}^0 + \pi^+ \to \bar{p}^- + \pi^+ + \pi^+$	
$\Omega^- \to \Lambda^0 + K^- \to p^+ + \pi^- + K^-$	67.8 %
$\bar{\Omega}^+ \to \bar{\Lambda}^0 + K^+ \to \bar{p}^- + \pi^+ + K^+$	



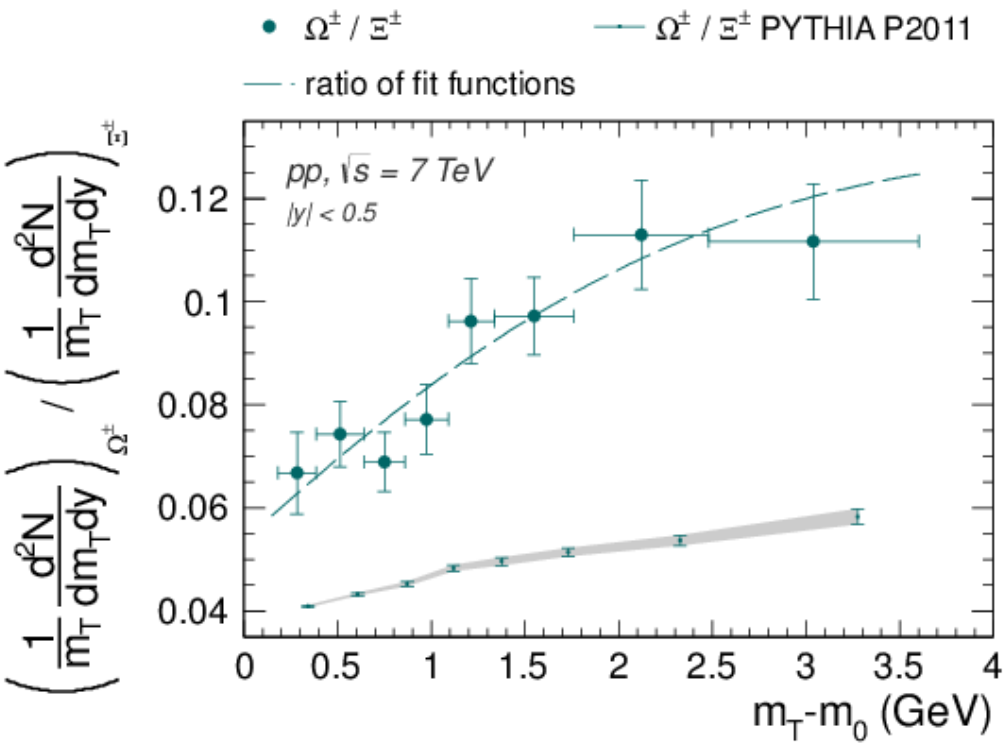
ALICE Collaboration, *"Multi-strange baryon production in pp collisions at √s=7TeV with ALICE"*, arXiv:1204.0282, 2012

Multi-strange baryon production



MC=Pythia 6, Perugia 2011 tune

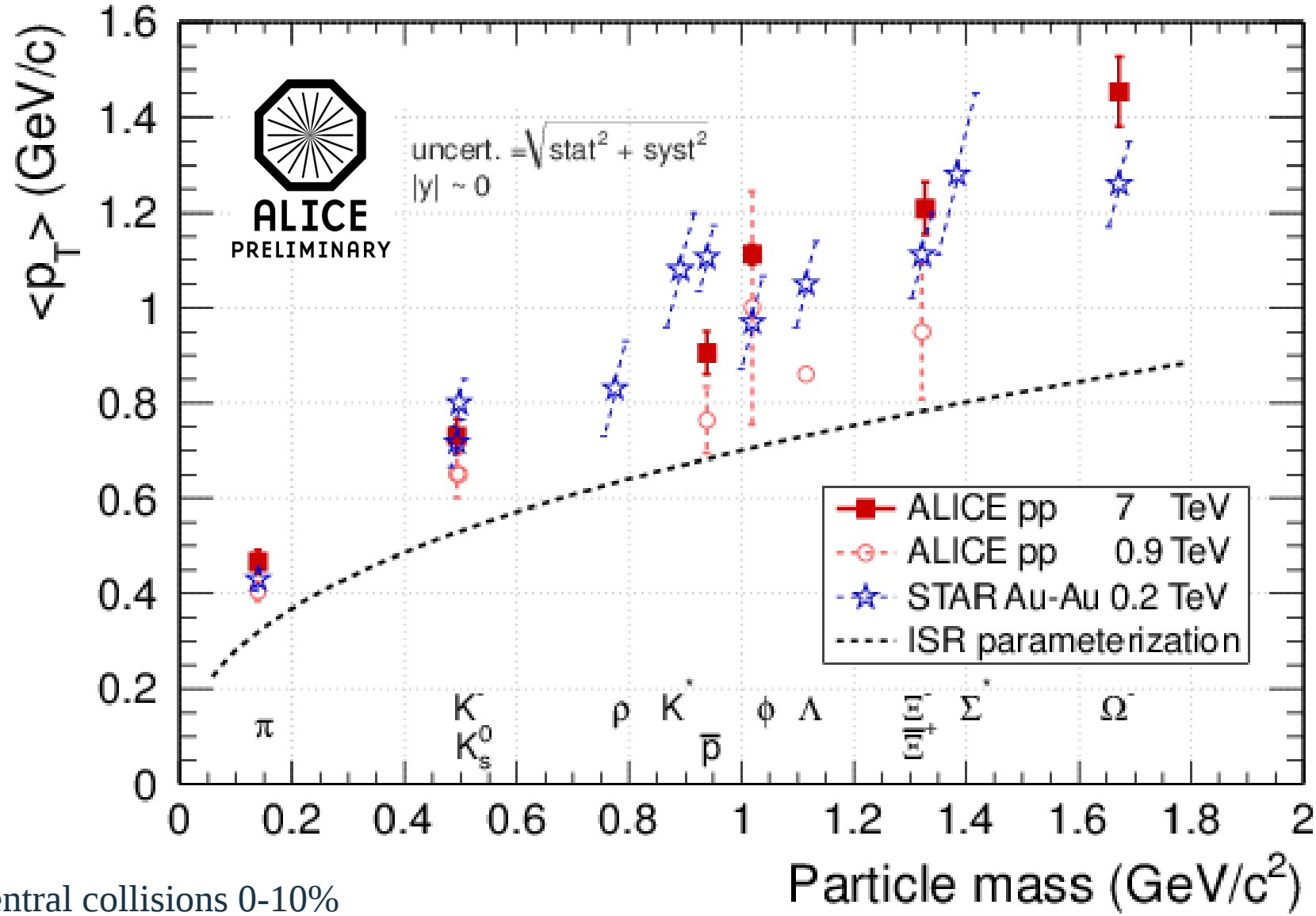
Studying the possible saturation of the s-quark production with respect to non-strange quark production ...



To reduce the dependence on particle mass.

ALICE Collaboration, *"Multi-strange baryon production in pp collisions at √s=7TeV with ALICE"*, arXiv:1204.0282, 2012

Mass dependence of mean p_t



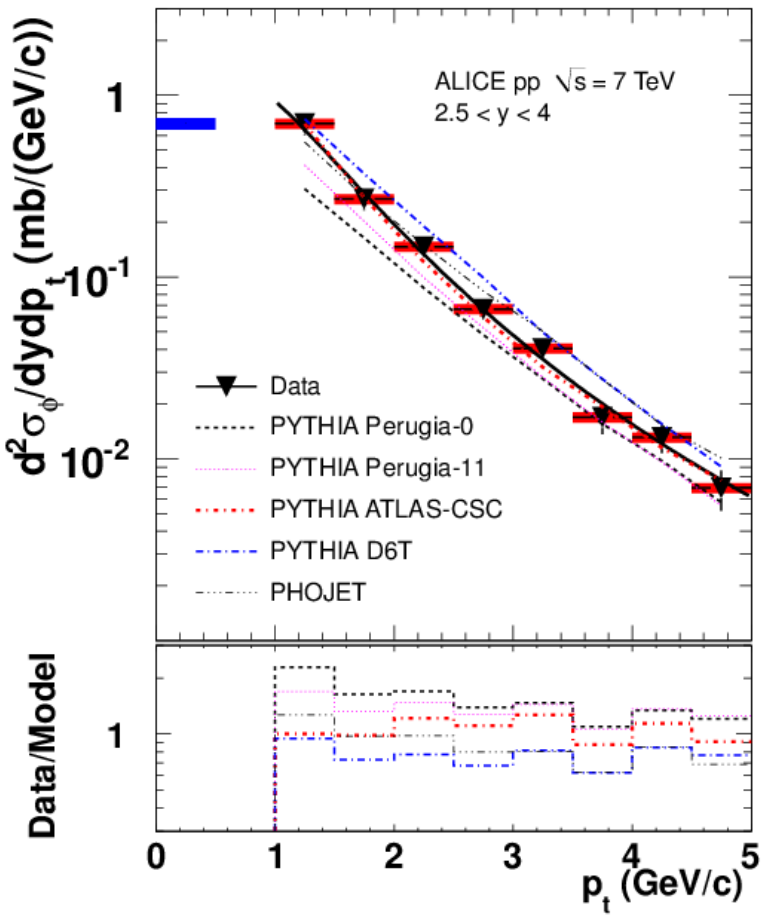
STAR: Central collisions 0-10%

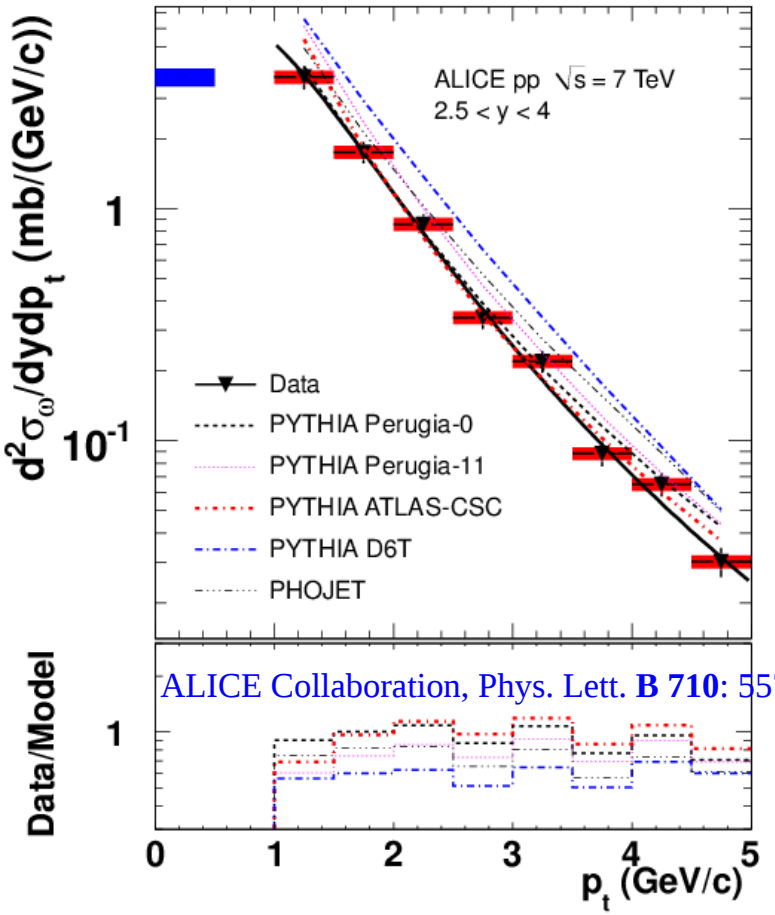
Light vector meson production

Measurement in the dimuon decay channel
($2.5<y<4$, $1<p_T<5$ GeV/c),

pp at
$\sqrt{s}$=7 TeV

	σ_ϕ (mb)	σ_ω (mb)
ALICE $\mu\mu$ measurement	$0.940 \pm 0.084 \pm 0.076$	$5.28 \pm 0.54 \pm 0.49$
PYTHIA/Perugia-0	0.50	5.60
PYTHIA/Perugia-11	0.62	7.81
PYTHIA/ATLAS-CSC	0.91	6.50
PYTHIA/D6T	1.12	9.15
PHOJET	0.87	6.89





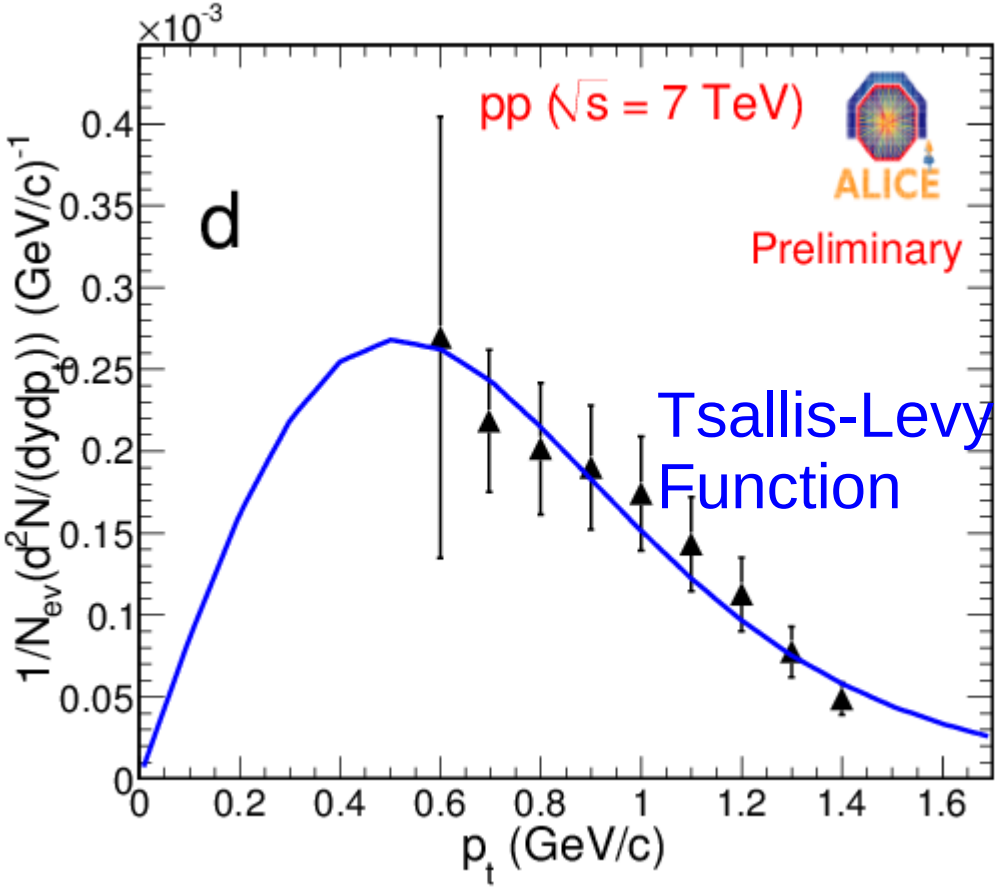
ALICE Collaboration, Phys. Lett. **B 710**: 557-568 (2012).

Light nuclei anti-nuclei production

The identification is done using dE/dx in the TPC.

The good statistics in pp @ 7 TeV (~380 M events) gives a nice sample of light nuclei and anti-nuclei.

The measurements allow one to study the production mechanisms.



Outlook

- Several measurements on particle identification using different techniques, results at 0.9, 2.76 and 7 TeV shown.
- Transverse momentum spectra for protons, anti-protons, charged kaons and pions have been measured in a wide range of p_t, we expect to reach p_t=20 GeV/c very soon.
- Neutral pion spectra show disagreements with NLO calculations, especially at 7 TeV.
- Multi-strange baryon production has been measured, the p_t reach of the data to model comparison is the highest ever achieved. Huge differences with MC models were found, even with recent Pythia tunes (e. g. Perugia-2011).
- ALICE is studying light nuclei and anti-nuclei production, final results on deuteron, Tritons, Helium3 and Helium4 soon.

Backup

Longitudinal FF

P(qq)/P(q), the suppression of diquark-antidiquark pair production in the colour field, compared with quark–antiquark production.

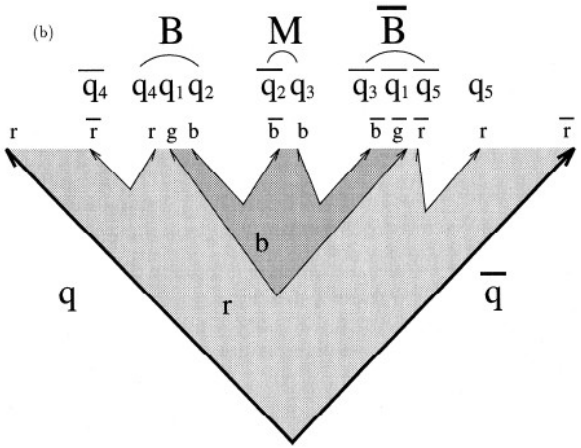
P(s)/P(u), the suppression of s quark pair production in the field compared with u or d pair production.

(P(us)/P(ud))/(P(s)/P(d)), the extra suppression of strange diquark production compared with the normal suppression of strange quarks.

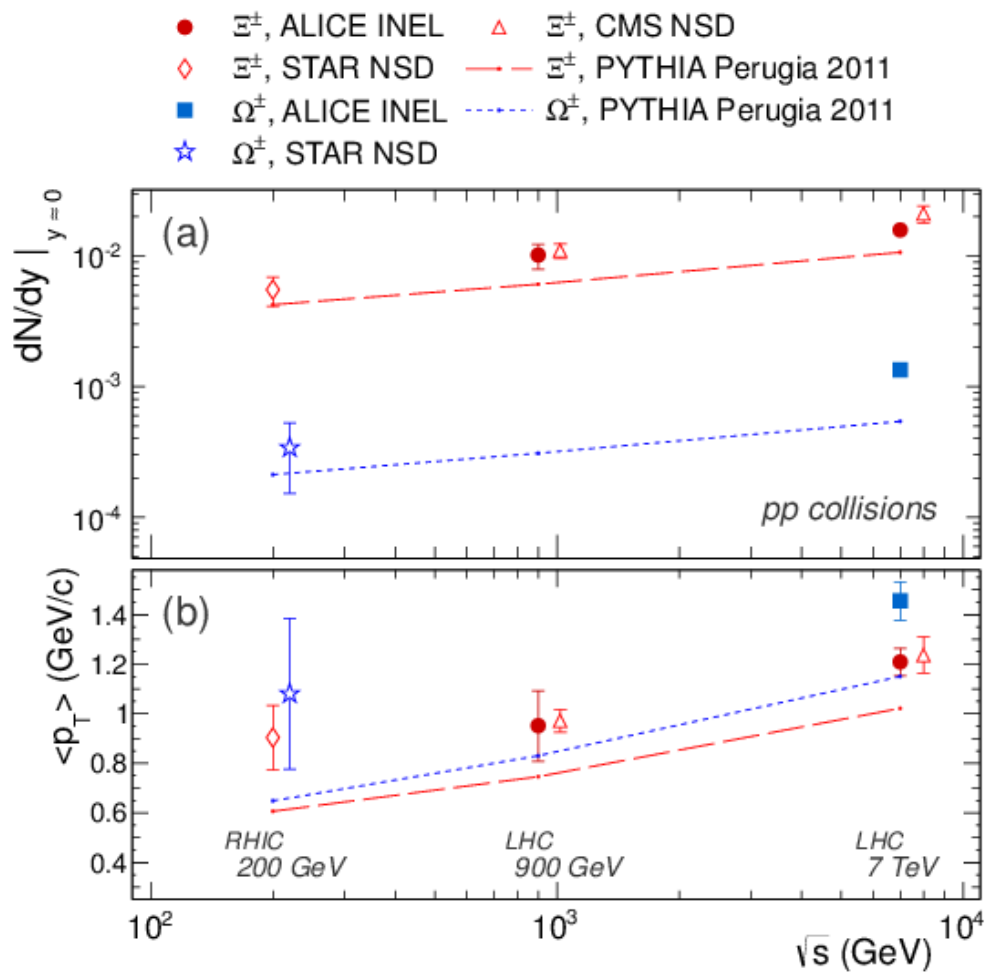
(1/3)P(ud1)/P(ud0), the suppression of spin 1 diquarks compared with spin 0 ones (excluding the factor 3 coming from spin counting).

extra suppression for having a s anti-s pair shared by the B and anti-B of a BM anti-B situation.

extra suppression for having a strange meson M in a BM anti-B configuration.



Parameter	Perugia 0	Perugia 2011 (All)
MSTP(5)	310	350 — 359
MSTJ(11)	5	5
PARJ(1)	0.073	More baryons 0.087
PARJ(2)	0.2	0.19
PARJ(3)	0.94	Increase: Λ/K 0.95
PARJ(4)	0.032	0.043
PARJ(6)	0.5	1.0
PARJ(7)	0.5	1.0
PARJ(11)	0.31	0.35
PARJ(12)	0.4	0.40
PARJ(13)	0.54	0.54
PARJ(21)	0.313	0.33
PARJ(25)	0.63	0.63
PARJ(26)	0.12	0.12
PARJ(41)	0.49	0.35
PARJ(42)	1.2	0.80
PARJ(45)	0.5	0.55
PARJ(46)	1.0	1.0
PARJ(47)	1.0	1.0



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