



**ALICE**

# Resonance production in pp collisions at ALICE

*Graham Richard Lee*

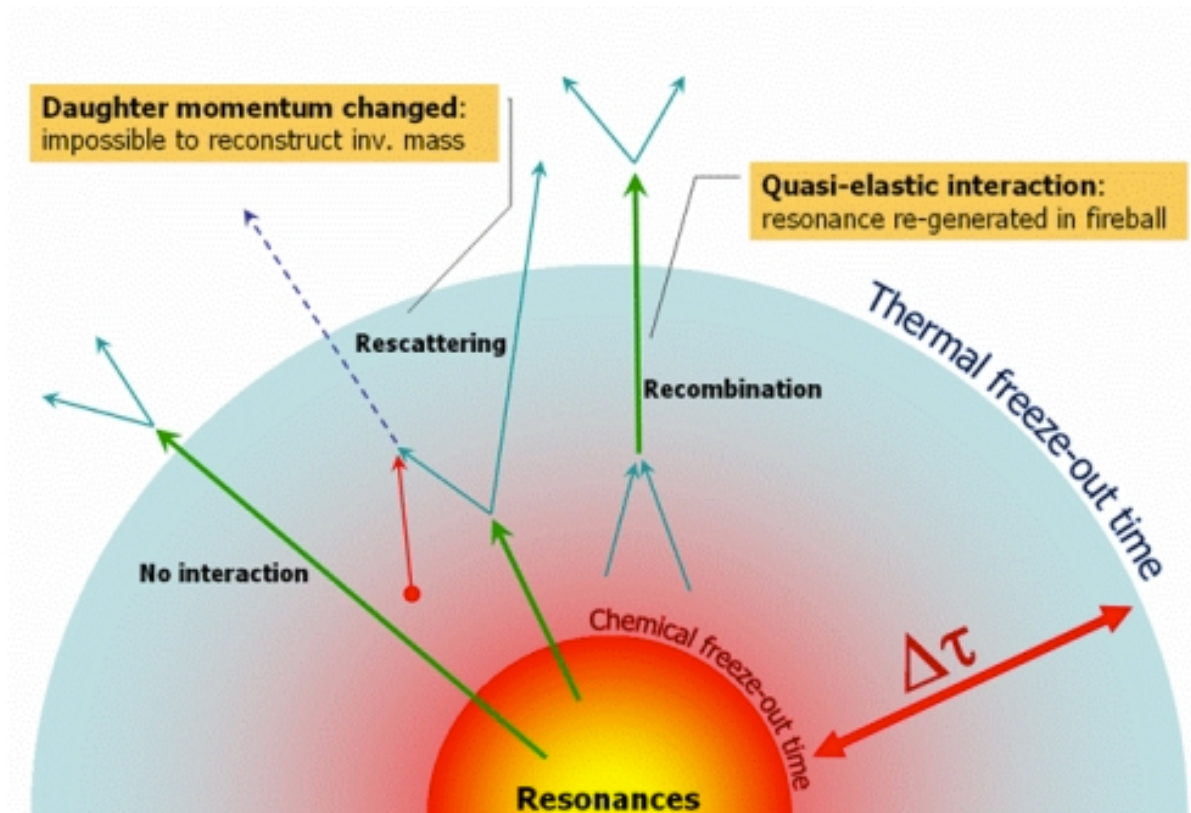
*University of Birmingham*

(on behalf of the ALICE Collaboration)



# Motivation

- Creates a baseline for heavy-ion collisions.
  - **Differential cross sections**
- Helps in establishing underlying event structure.
  - **Mean  $p_T$**
  - **Integrated yields**
- Constrains QCD-inspired models (eg. **Pythia** and **Phojet**).

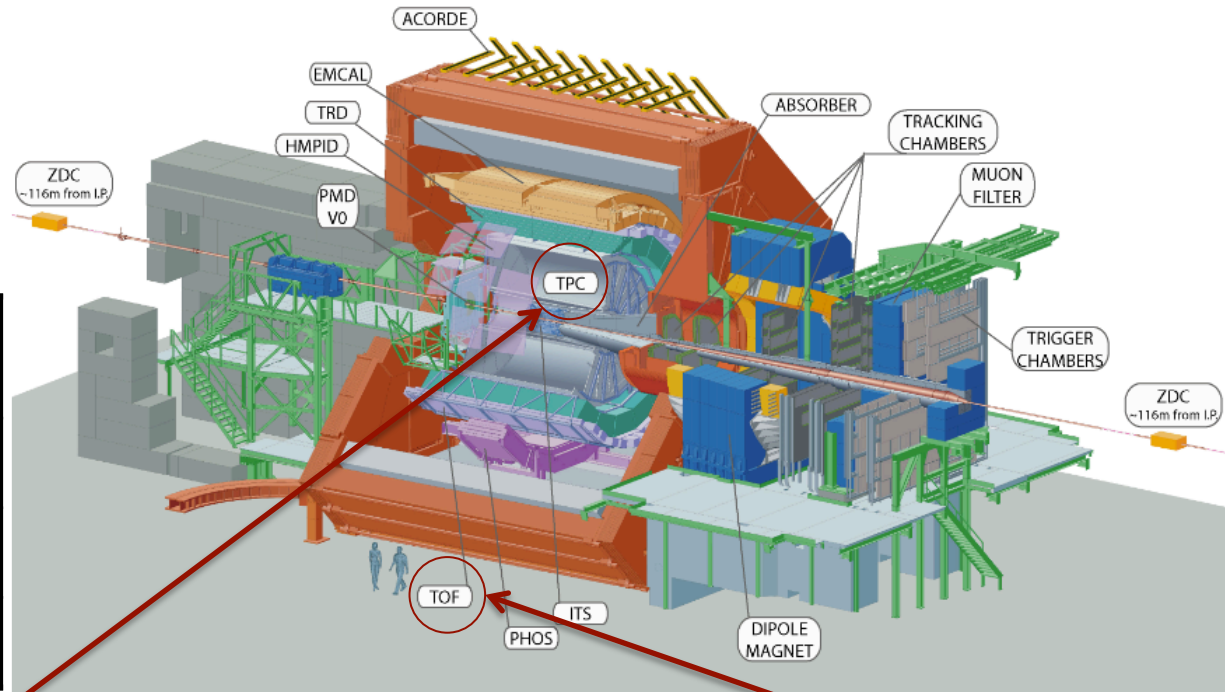


# What will be shown?

Particle	Lifetime (fm/c)	Energy pp (TeV)	Results
$K^{*0}$ (892)	$\sim 4.6$	7 TeV	$p_T$ spectrum Mean $p_T$
$\phi$ (1020)	$\sim 51.4$	7 TeV	$p_T$ spectrum Mean $p_T$
$\Sigma^*$ (1385)	$\sim 6$	7 TeV	Mass and Width $p_T$ spectrum Mean $p_T$ Particle ratios
$\rho$ (770)	$\sim 1.5$	7 TeV	Invariant mass
$\phi$ (1020)	$\sim 51.4$	2.76 TeV	Differential cross-section $\phi/\pi$

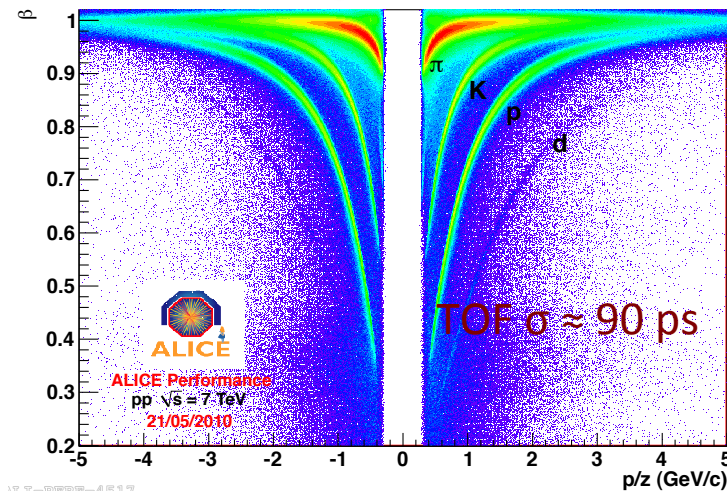
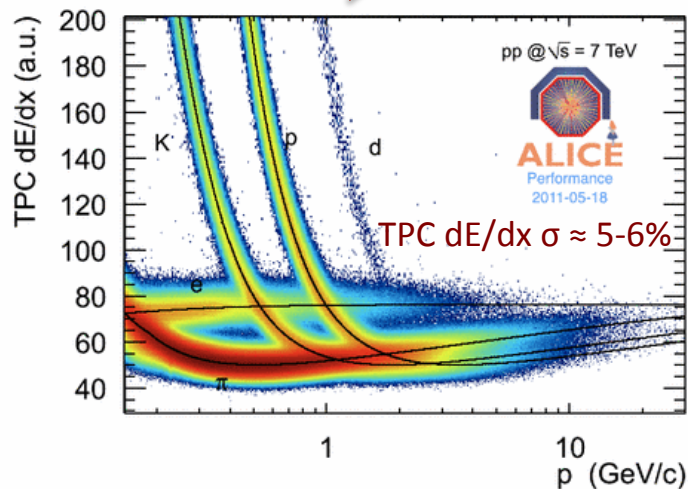
# ALICE

- Two methods of particle identification:  $dE/dx$  (TPC) and TOF.



$p_T$  range with  $3\sigma$  separation

	TPC Range (GeV/c)	TOF Range (GeV/c)
$\pi$	0.2 – 0.7	0.5 – 2.0
K	0.3 – 0.6	0.5 – 2.0
p	0.5 – 1.0	0.5 – 2.5



# Resonance reconstruction

## Mesonic resonances

$\varphi$  (1020)  $\rightarrow K^+ + K^-$

$K^*$  (892)  $\rightarrow \pi^\pm + K^\mp$

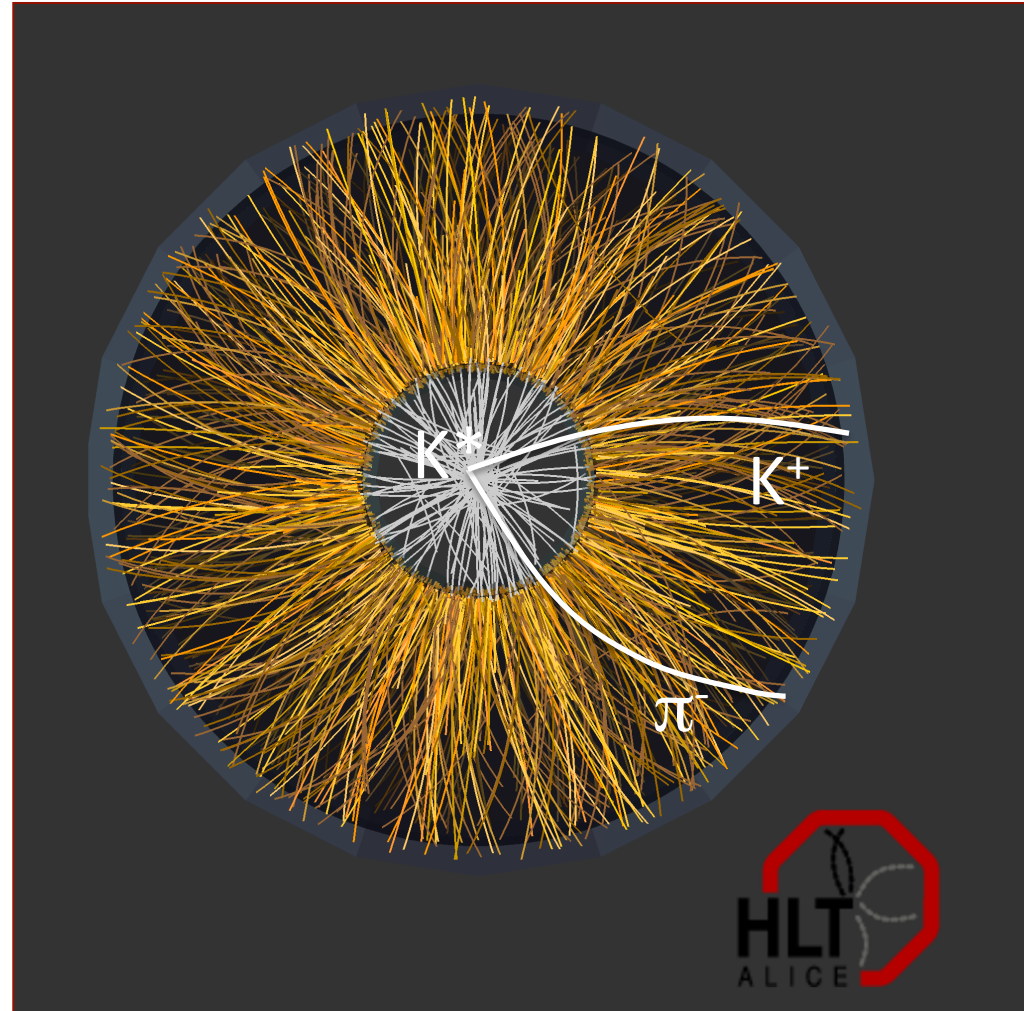
$\rho$  (770)  $\rightarrow \pi^+ + \pi^-$

- Reconstructed from primaries and using particle identification.

## Baryonic resonances

$\Sigma^{*\pm}$  (1385)  $\rightarrow \Lambda + \pi^\pm$

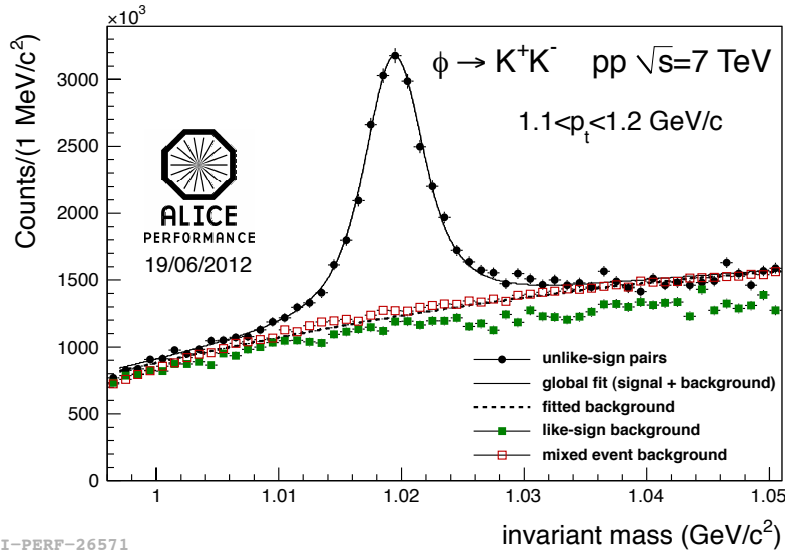
- $\Lambda$  from weak decay.



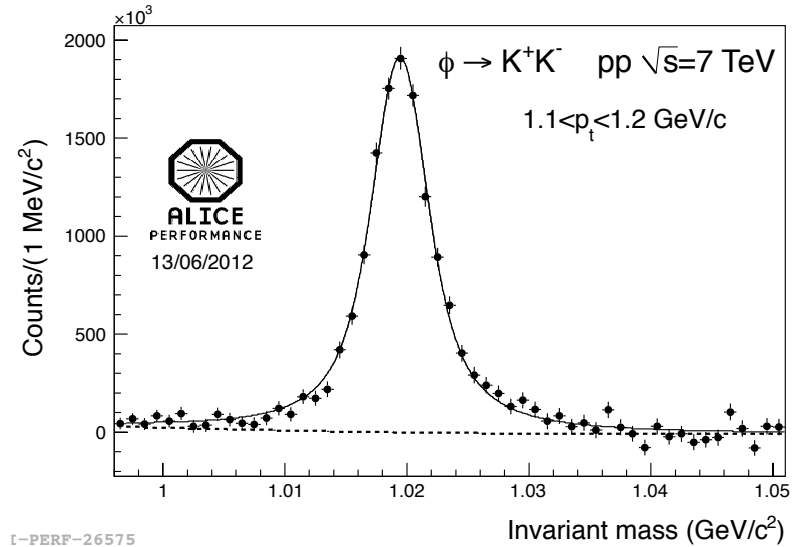
# Signal extraction of $\phi$ and $K^{*0}$ in 7 TeV

- Peak fitted with a Breit-Wigner ( $K^{*0}$ ) and a Voigtian ( $\phi$ ) + polynomial

$\phi$



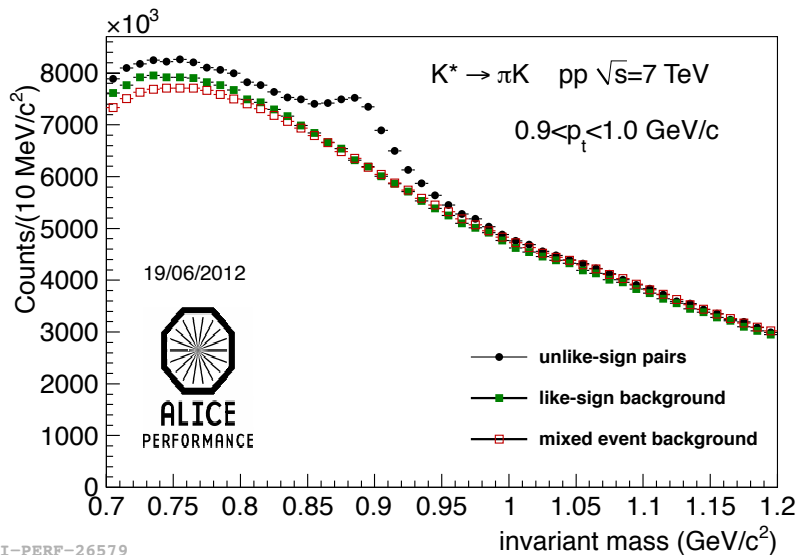
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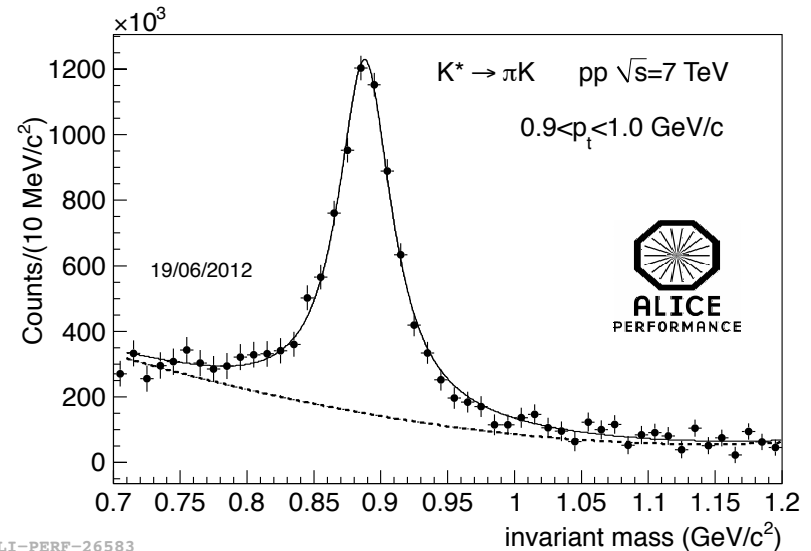
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$K^{*0}$

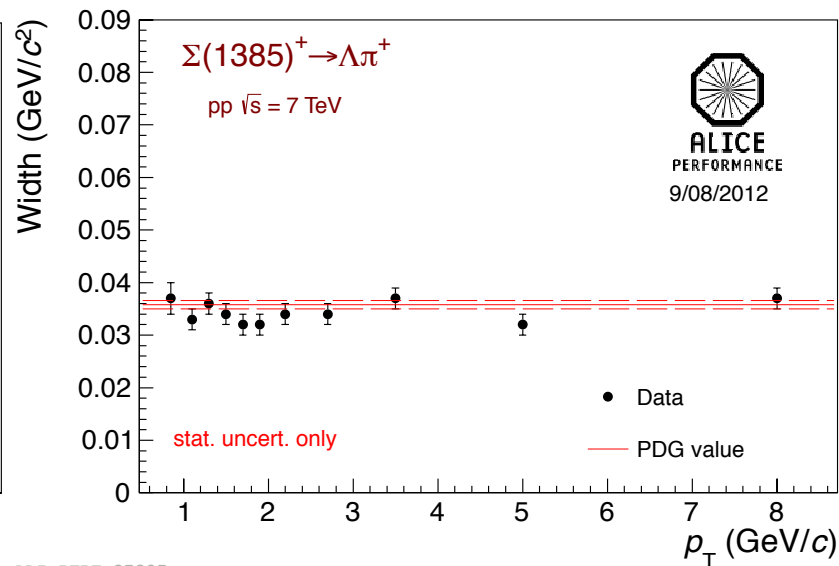
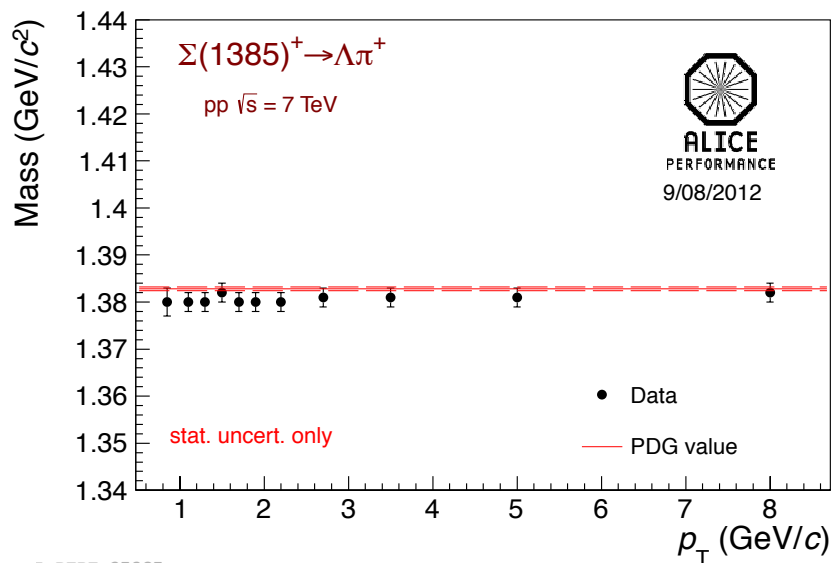
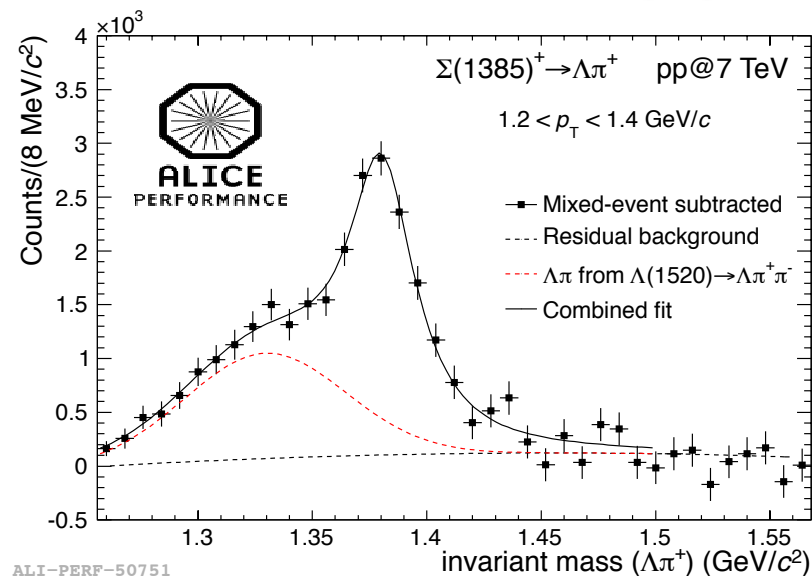
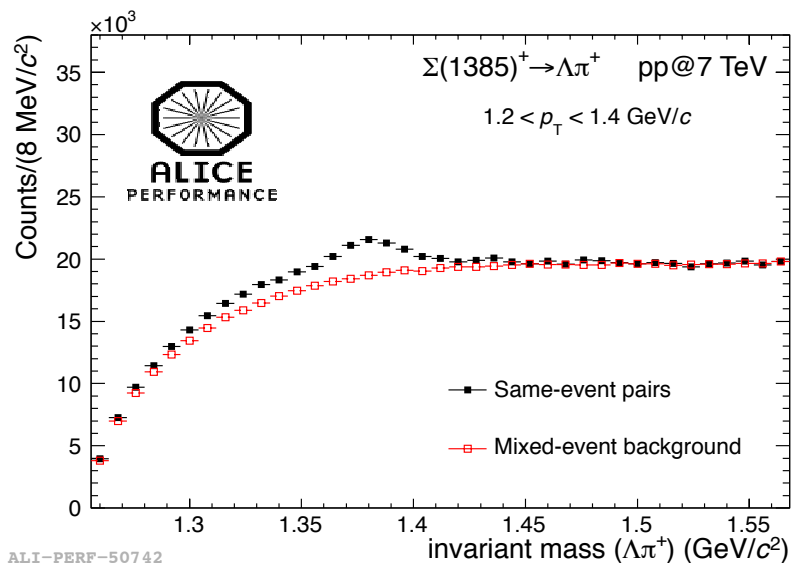


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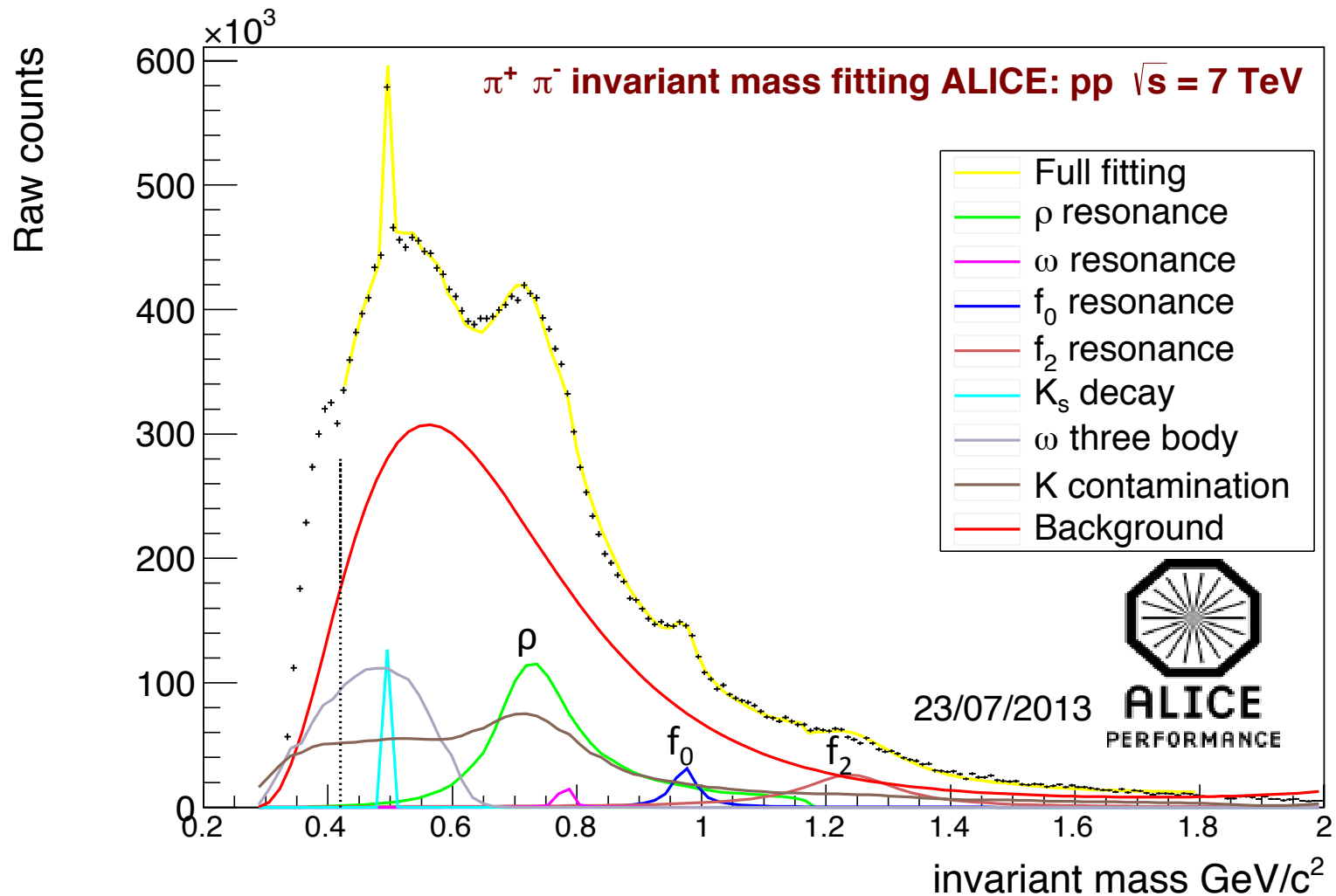
# $\Sigma^*$ resonance extraction in 7 TeV pp



Mass and width consistent with PDG values.

Resonance Production in 7 TeV pp Collisions at ALICE

# $\rho$ extraction in 7 TeV pp

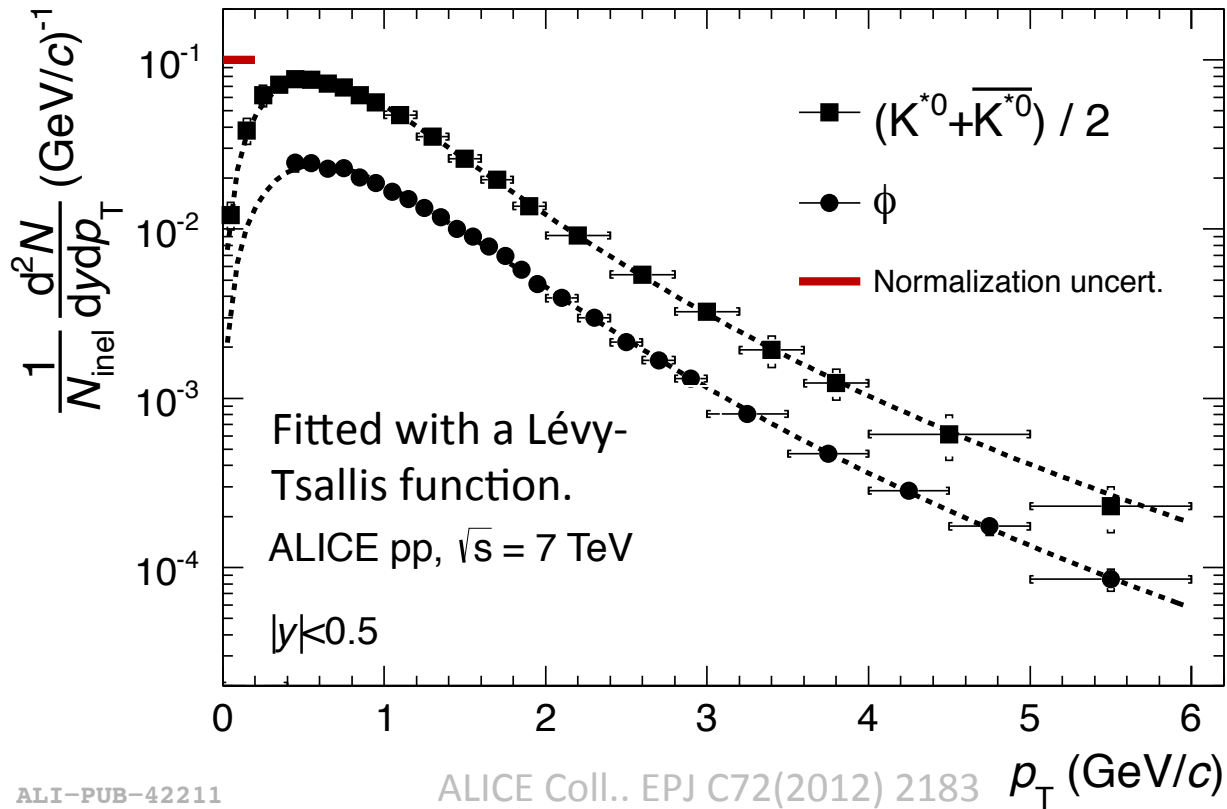


$\rho$  extraction is difficult due to the large number of overlapping components.

Work in progress.

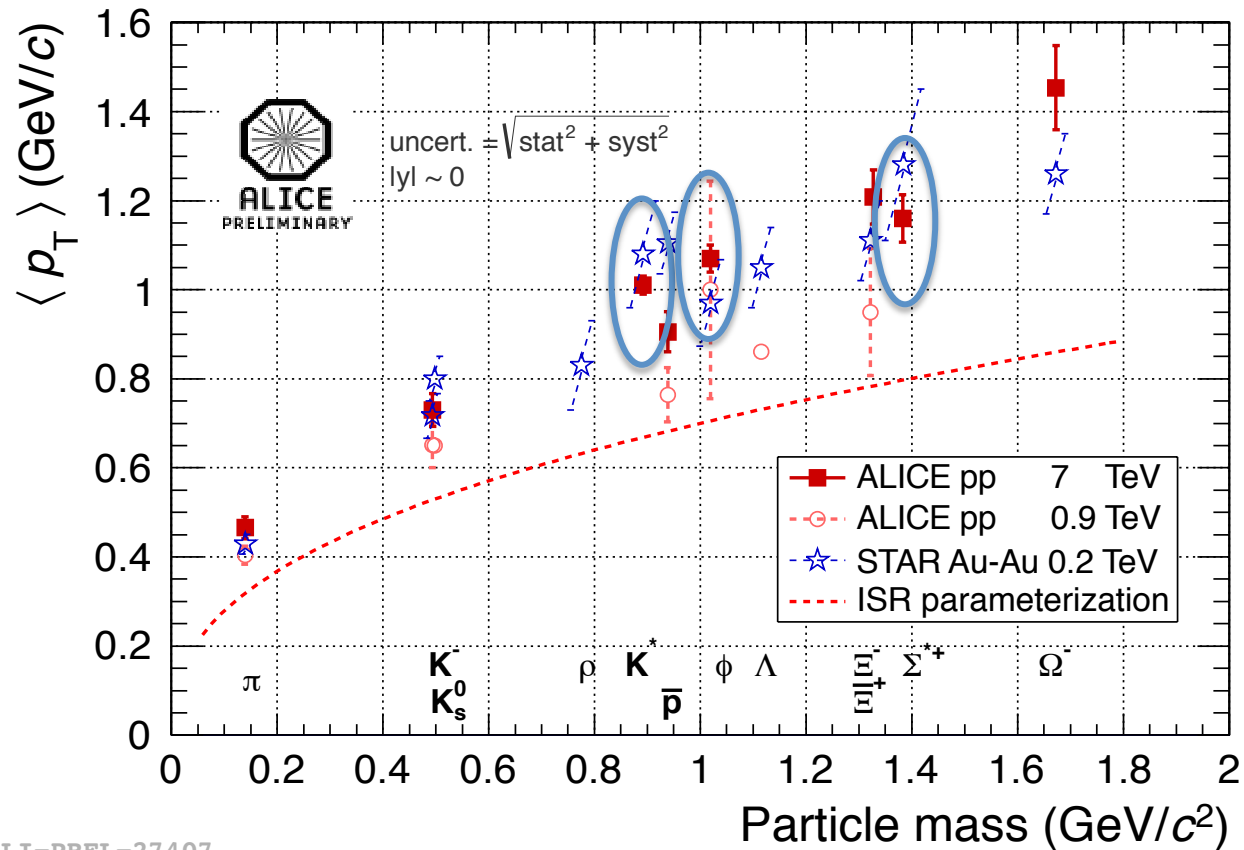


# $\phi$ & $K^*$ spectra for $\sqrt{s} = 7$ TeV



	T (MeV)	n
$K^*$	$254 \pm 2 \pm 18$	$6.2 \pm 0.07 \pm 0.8$
$\phi$	$272 \pm 4 \pm 11$	$6.7 \pm 0.20 \pm 0.4$

# $\langle p_T \rangle$ as a function of mass

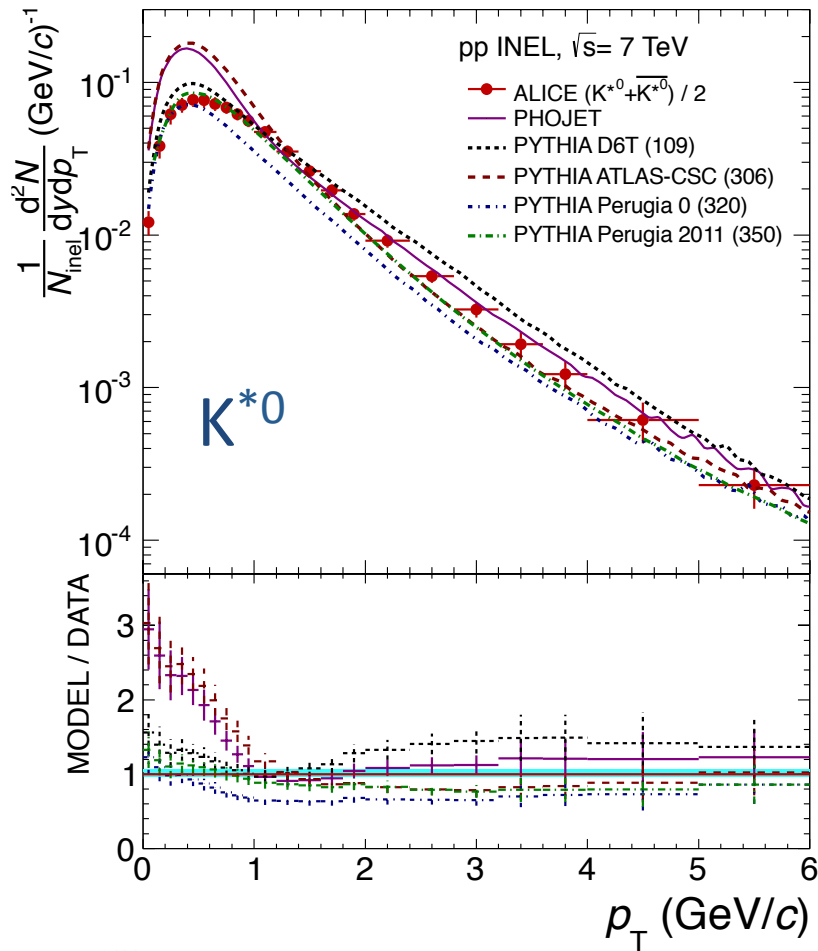


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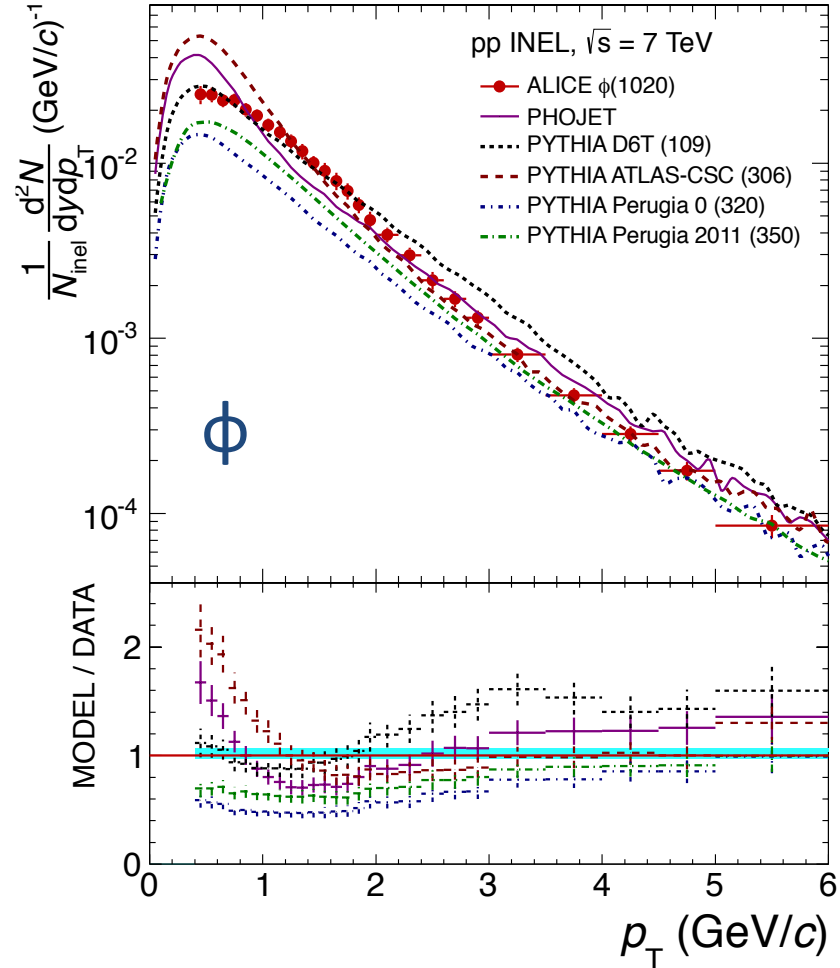
Observe mean  $p_T$  values above **ISR**.

Resonance mean  $p_T$  in agreement with trend observed stable particles  $\pi, K$  etc.

# Spectra compared with MC predictions



ALI-PUB-46985

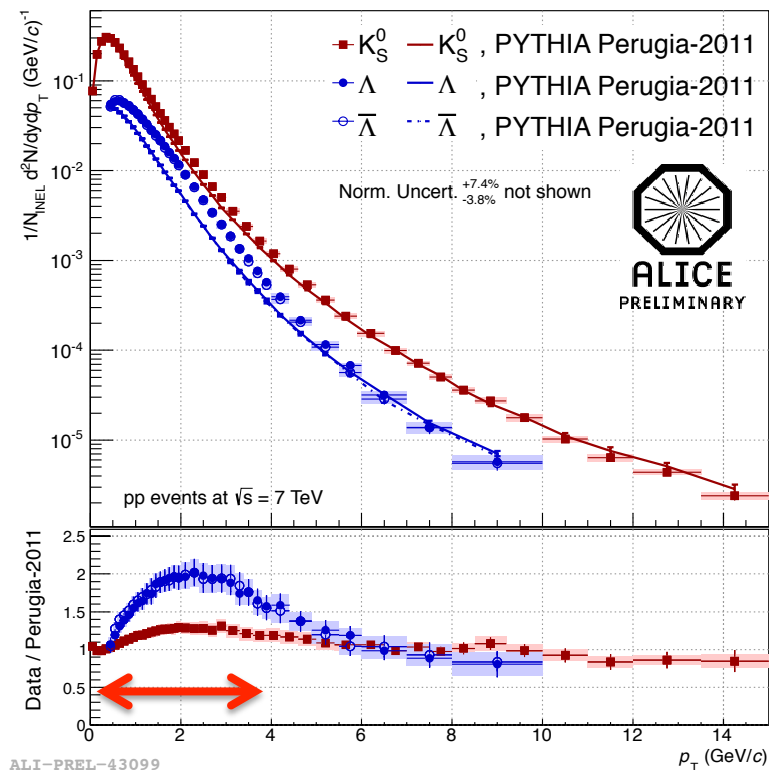
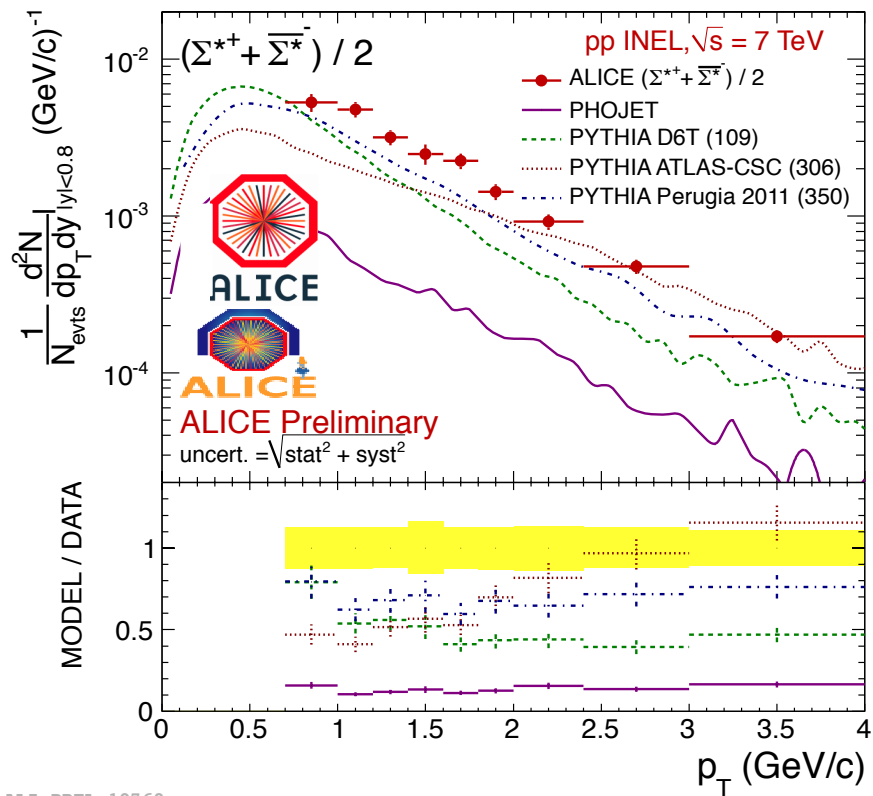


ALI-PUB-42223

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Better agreement between Monte Carlo and  $K^{*0}$ .

# Spectra compared with MC predictions

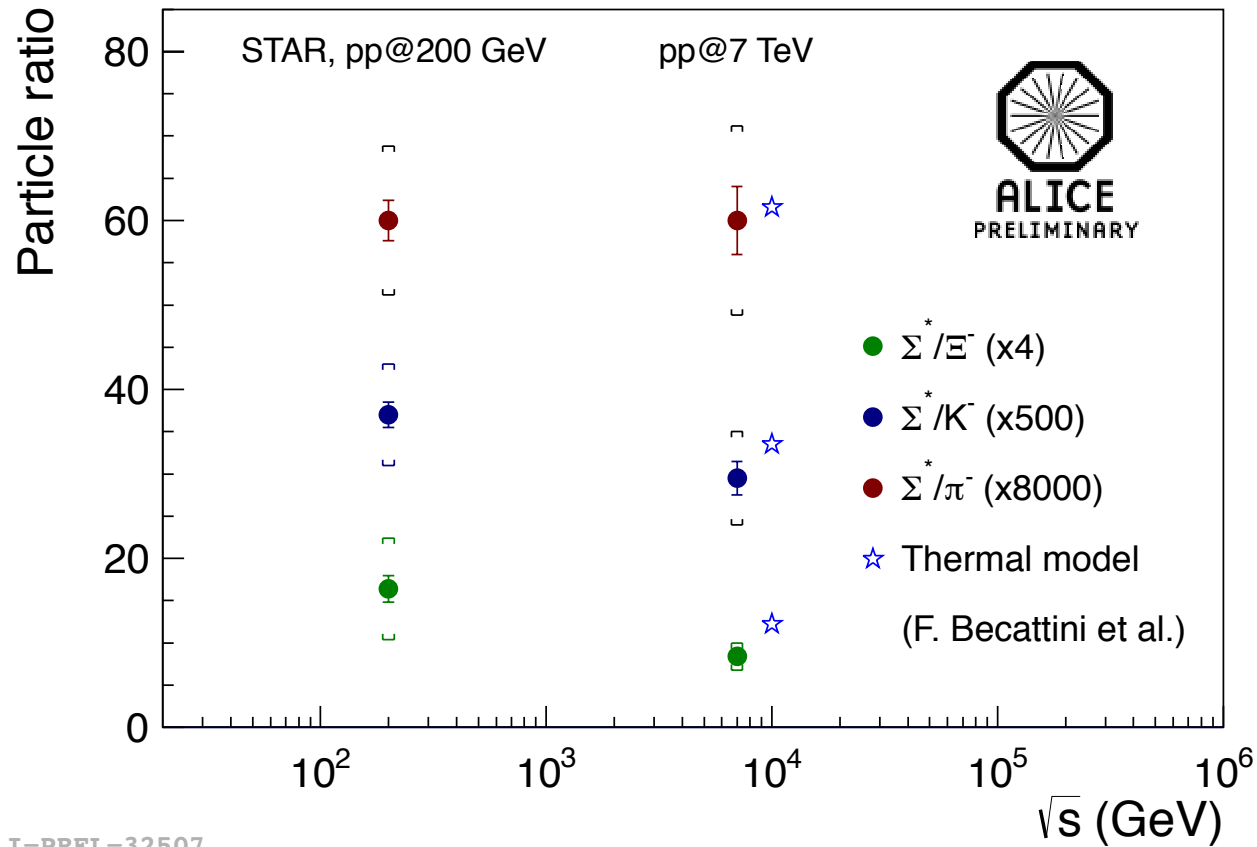


Better agreement between Monte Carlo and  $K^*0$ .

$\Sigma^*$  resonance under-predicted by factor of two ( $0 \leq p_T \leq 4$  GeV/c).

ALI-PREL-10769

# $\Sigma^*$ particle ratios in pp



ALI-PREL-32507

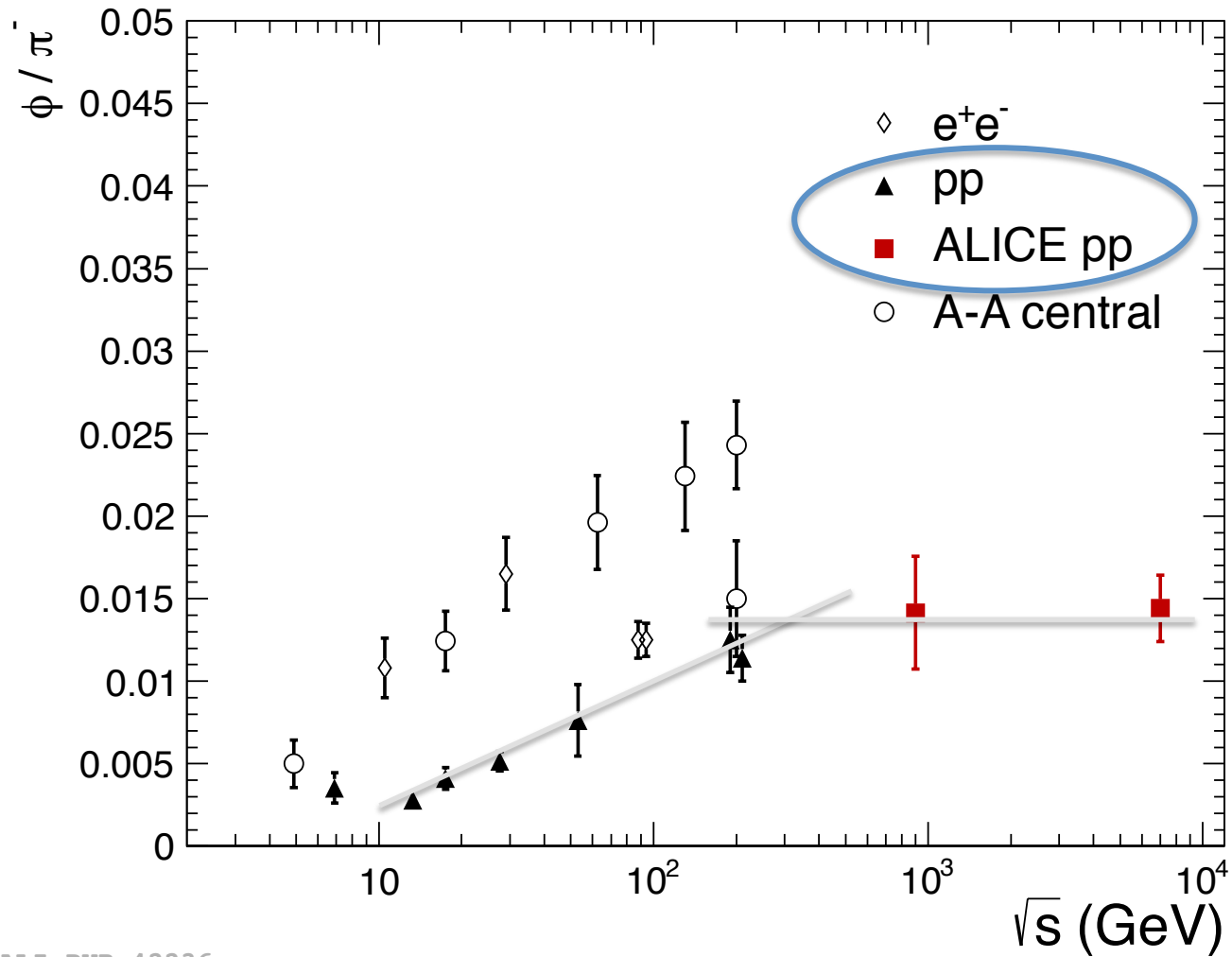
Good agreement with **Becattini thermal model (arXiv:0912.2855)**.

$$\gamma_s = 0.6, \text{ Temperature} = 170 \text{ MeV}$$

Also observe good agreement between STAR and ALICE.

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# $\phi/\pi$

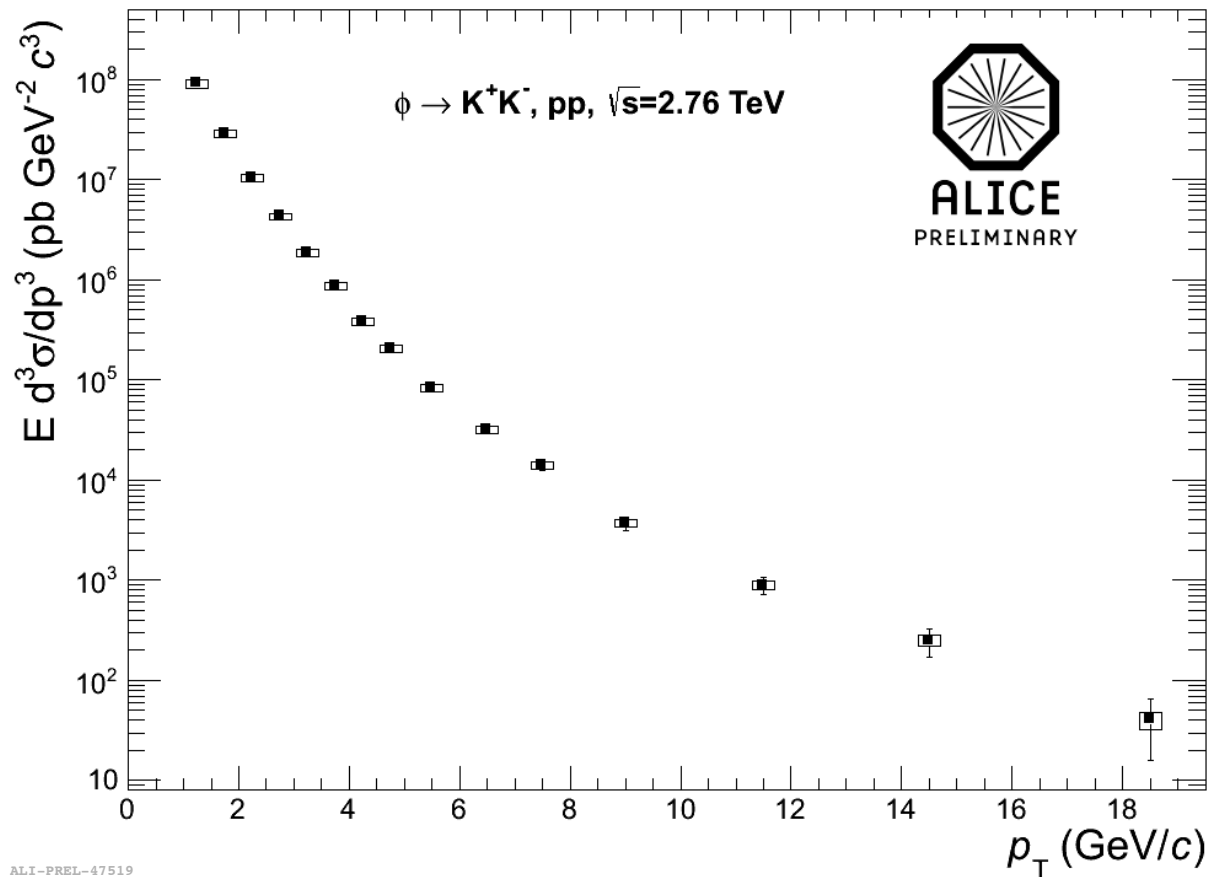


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At low energy ratio increases in pp and A-A.

At LHC energies we observe a **saturation** in pp.

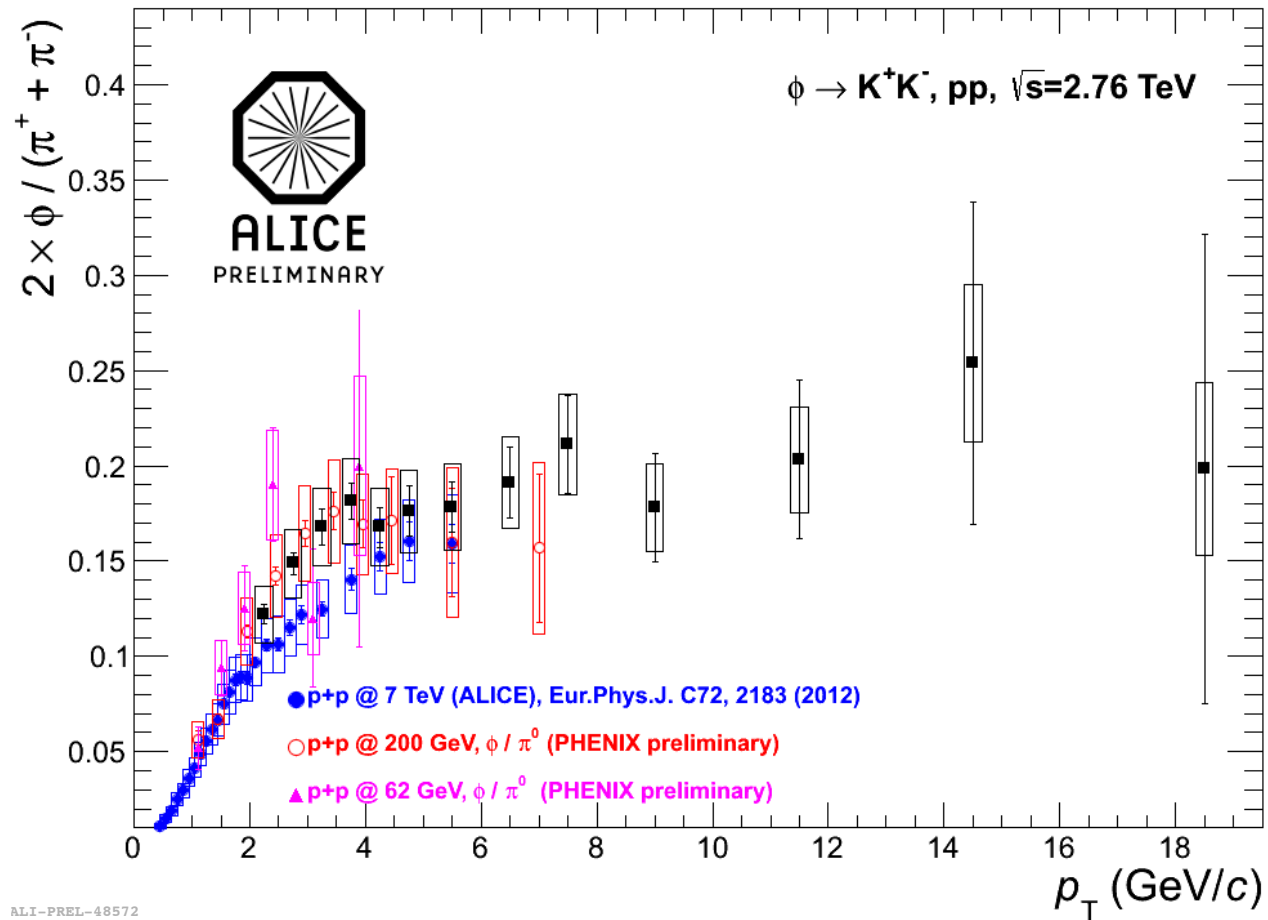
# $\phi$ differential cross-section in pp $\sqrt{s} = 2.76$ TeV



ALI-PREL-47519

- Extracted with **no PID**.
- Enables higher  $p_T$  range.
- Results obtained used as reference to create  $R_{AA}$  plots.

# $\phi/\pi$ as a function of $p_T$



New 2.76 TeV points in line with lower energies.

Able to reach > 18 GeV/c with new points where the ratio  $\phi/\pi$  saturates.



# Conclusions

Mass and width of the  $\Sigma^*$  consistent with PDG values.

$\phi$  &  $K^*$  in 7 TeV show same trend in mean  $p_T$  as stable particles.

$\phi$  &  $K^*$  in 7 TeV also agrees with QCD-inspired models.

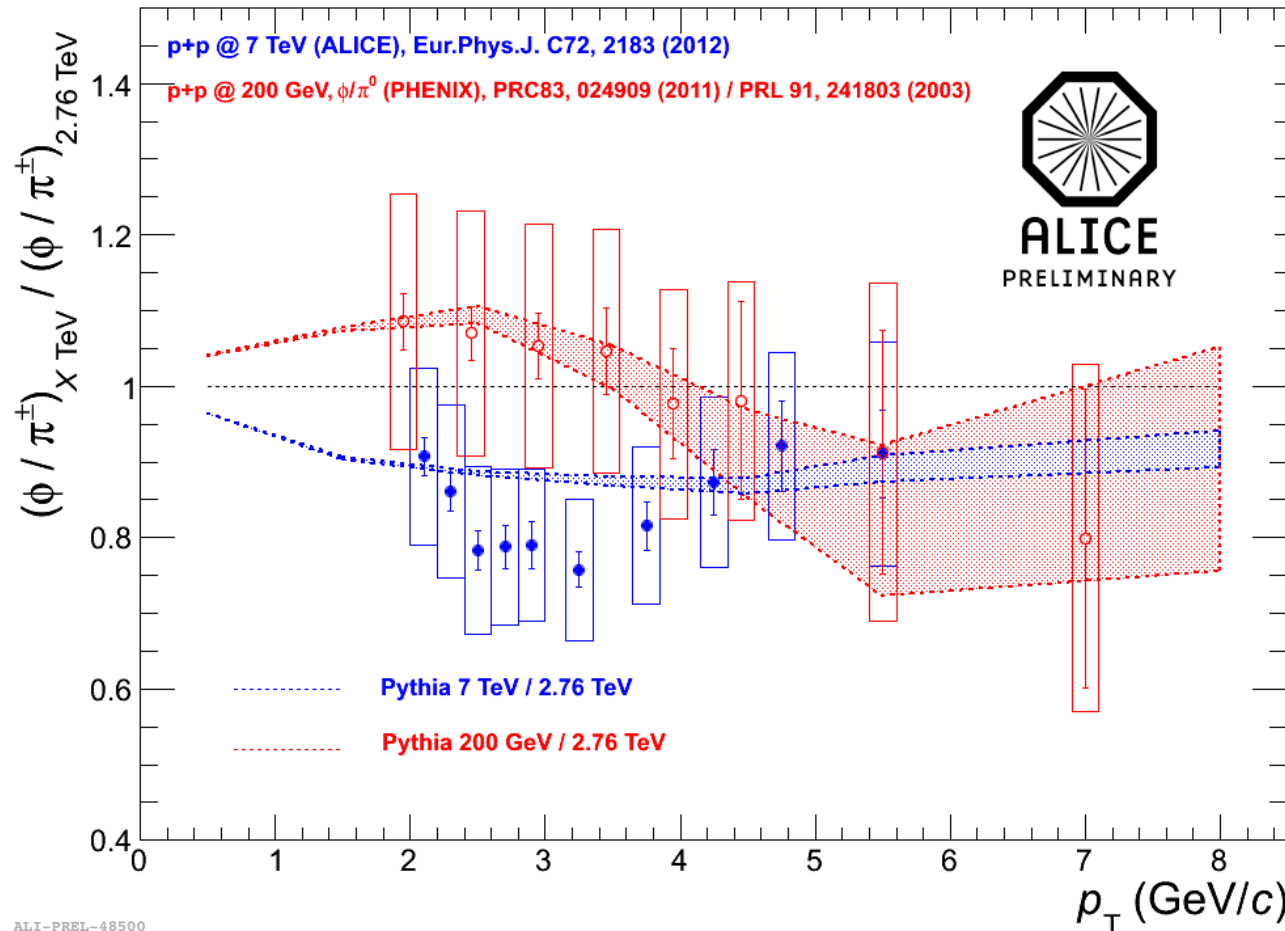
Strange Baryons appear to be less well reproduced by QCD-inspired models.

New  $\phi/\pi$  at 2.76 TeV go further in  $p_T$  and show as saturation at higher  $p_T$ .

$\rho$  analysis is on going.

# Backup

# Double ratios for $\phi/\pi$ compared with MC generators



ALI-PREL-48500

- Difference between 7 TeV (ALICE) and 200 GeV (PHENIX) studied further.
  - Double ratios used.
- Energy dependence observed, yet is predicted by Pythia.
  - Data is within 10% of simulation.