Hadronic resonance production with the ALICE experiment in pp and Pb-Pb collisions at LHC energies

Sergey Kiselev (ITEP Moscow) for the ALICE collaboration

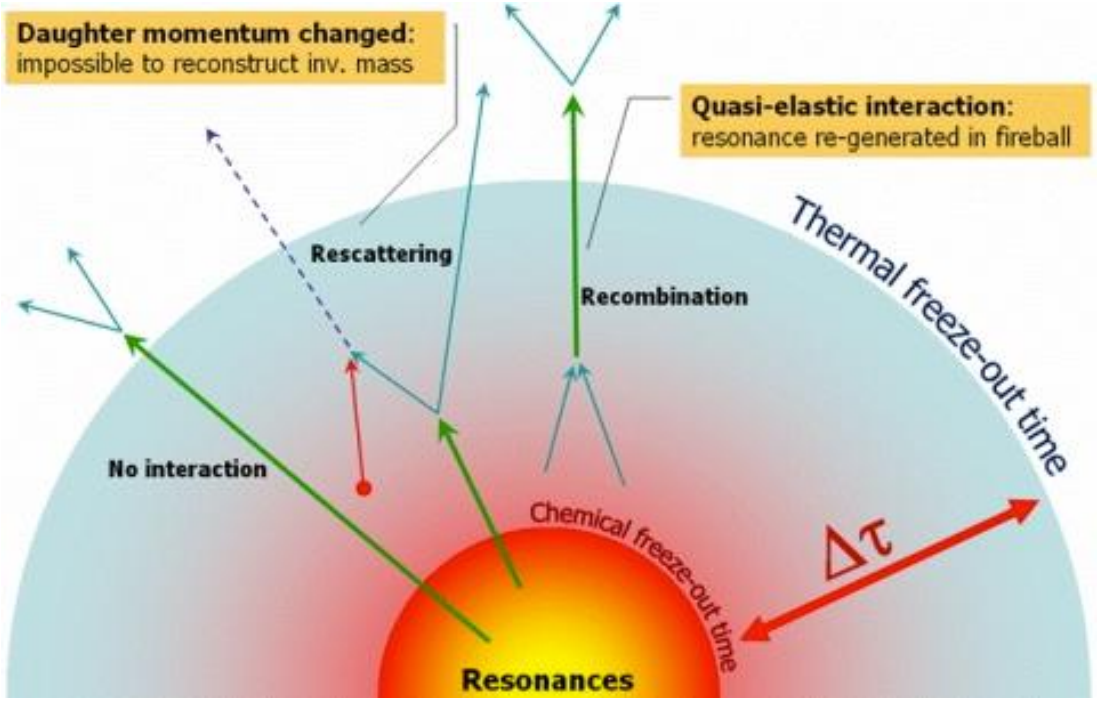
- Motivation
- Analysis details
- **pp@7 TeV**: $K^*(892)^0$, $\phi(1020)$, $\Sigma(1385)$
- **Pb-Pb@2.76 ATeV**: $K^*(892)^0$, $\phi(1020)$
- Summary

Motivation

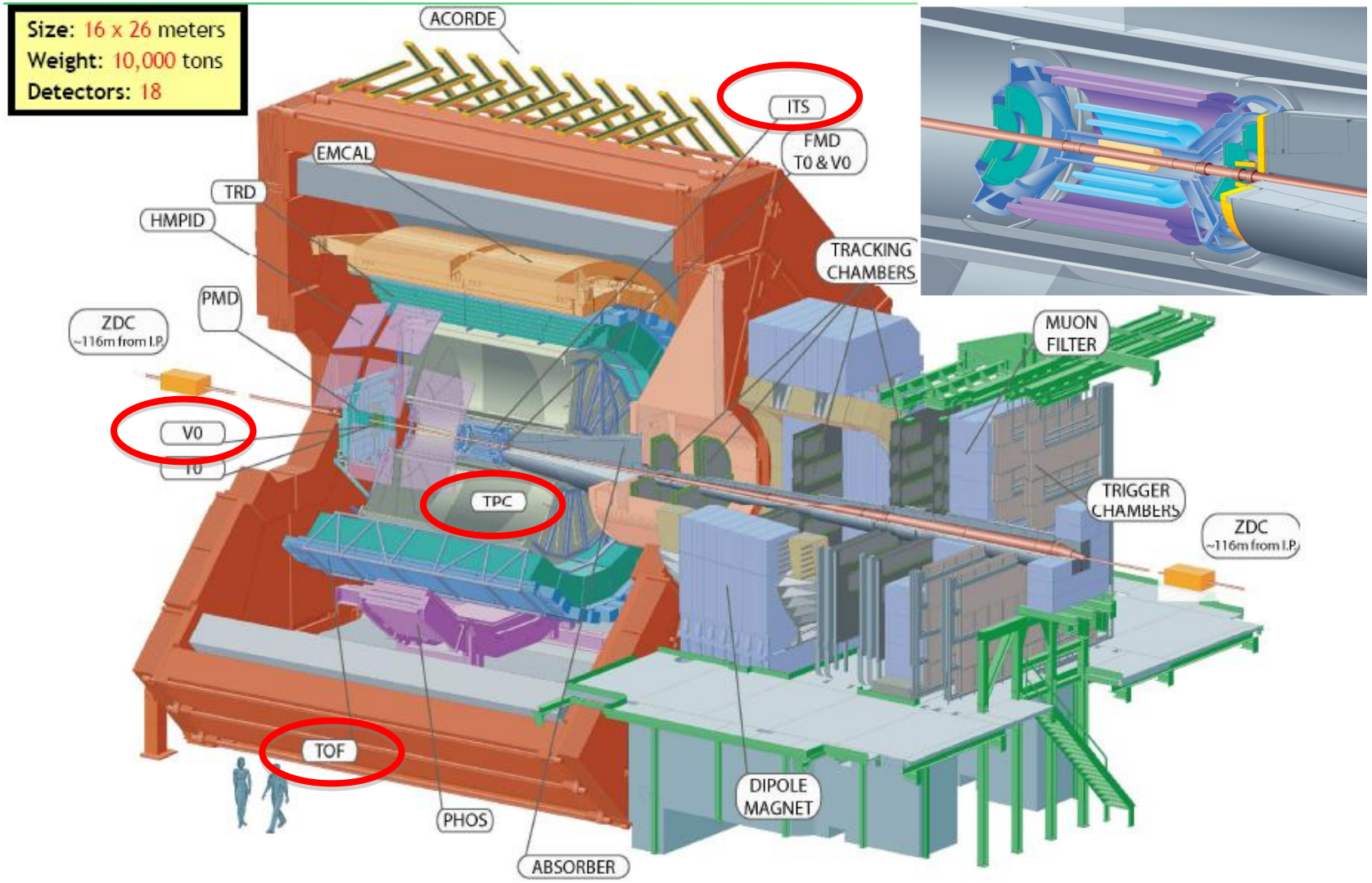
- **pp collisions:**
  - ✓ reference for tuning QCD-inspired event generators
  - ✓ the baseline for heavy-ion collisions

Resonance	Γ (MeV)	cτ (fm)	Decay
$K^*(892)^0$	50	4	**$\pi + K$**
$\phi(1020)$	4.3	46	**$K^+ + K^-$**
$\Sigma(1385)^{\pm}$	36	6	**$\Lambda + \pi^{\pm}$**

- **AA collisions:**
  - ✓ restoration of chiral symmetry
  - → modification of width, mass and branching ratio
  - ✓ regeneration and rescattering effects
  - → timescale between chemical and kinetic freeze-out

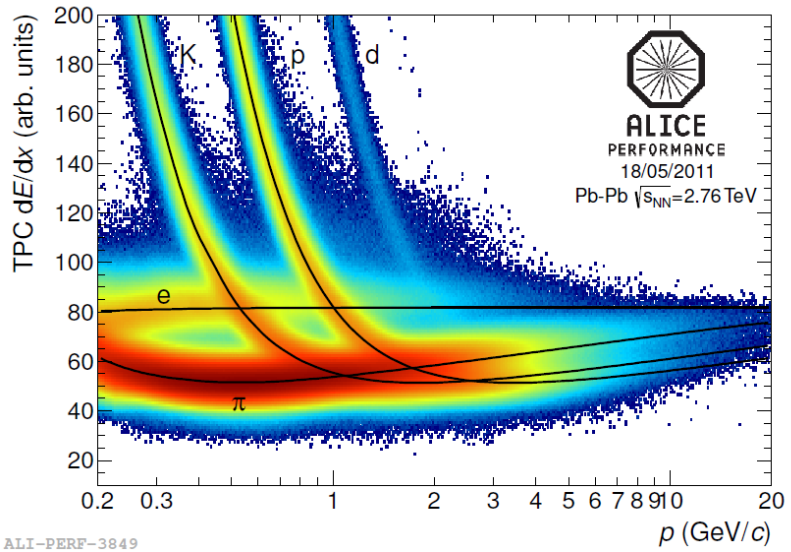


ALICE detector

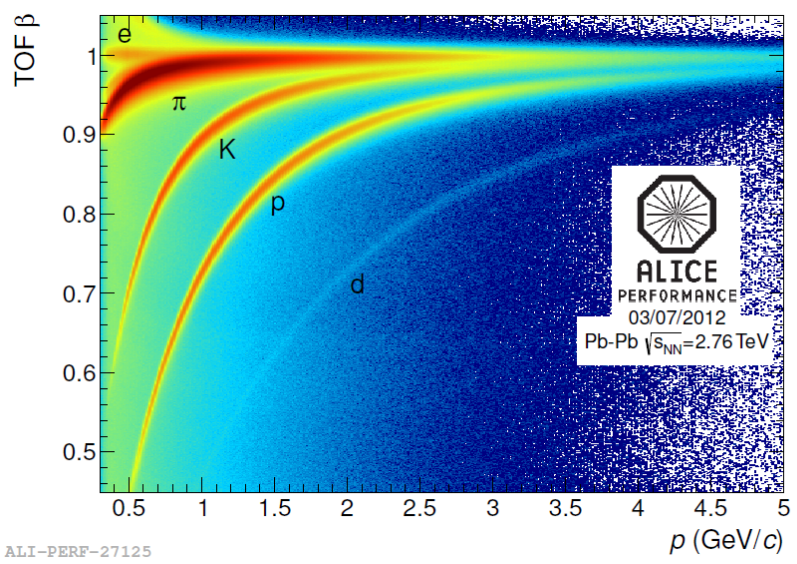


Particle identification, centrality in Pb-Pb

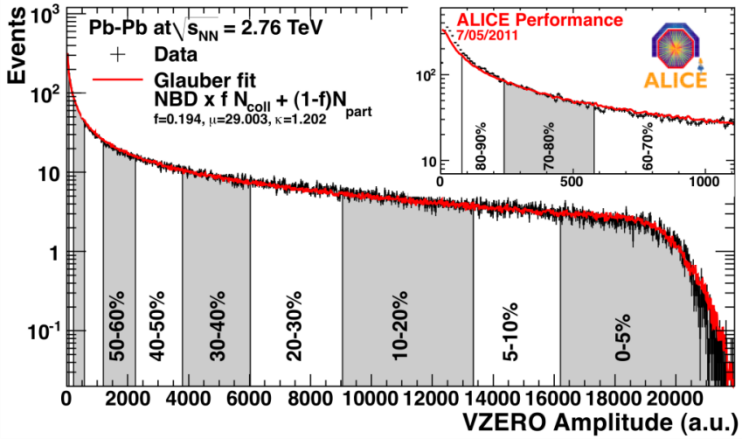
TPC resolution ~ 5 - 6%



TOF resolution ~ 90 ps



Pb-Pb: centrality selection using VZERO



data collected by ALICE during 2010
and used for resonance analyses:

pp@7 GeV: ~ 60 Mevents for K*, ϕ

~ 200 Mevents for Σ*

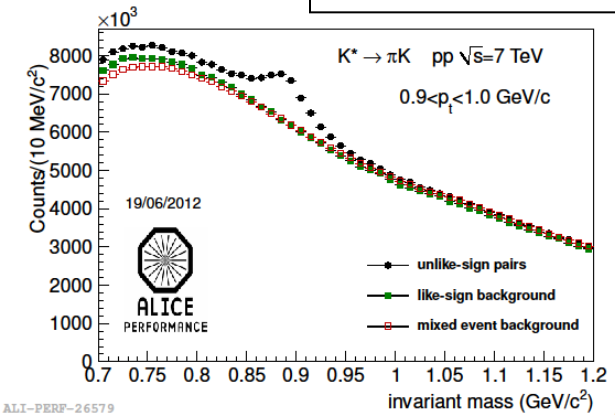
Pb-Pb@2.76 AGeV: ~ 10 Mevents

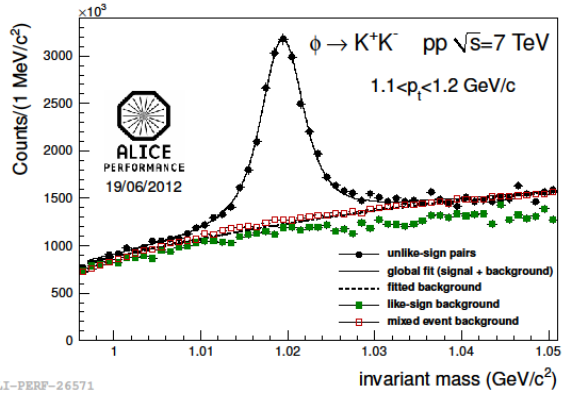
central rapidity region: $|y| < 0.5$

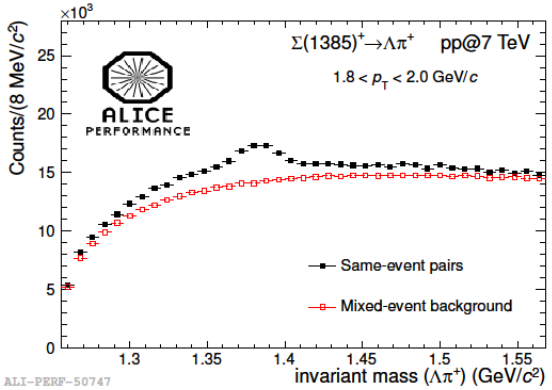
pp: signal extraction

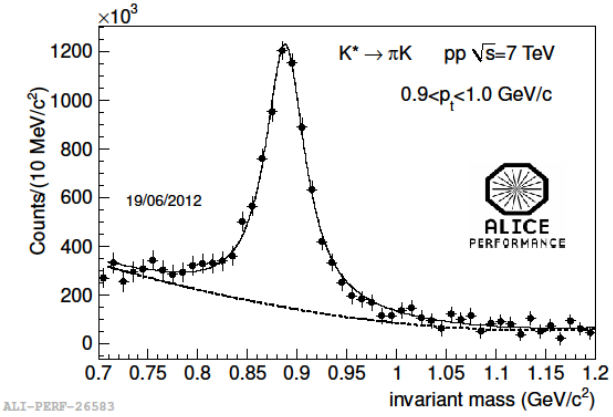
K* **ϕ** **Σ***

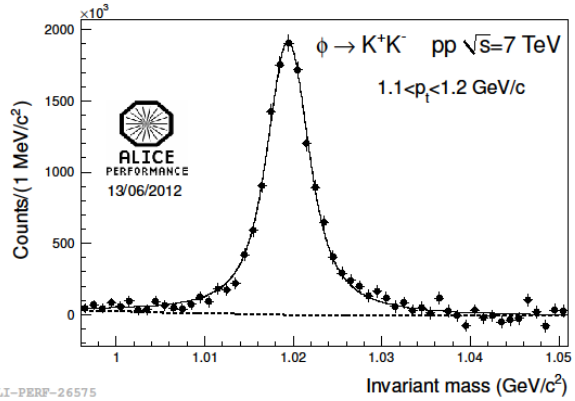
ALICE Coll. EPJ C72(2012)2183

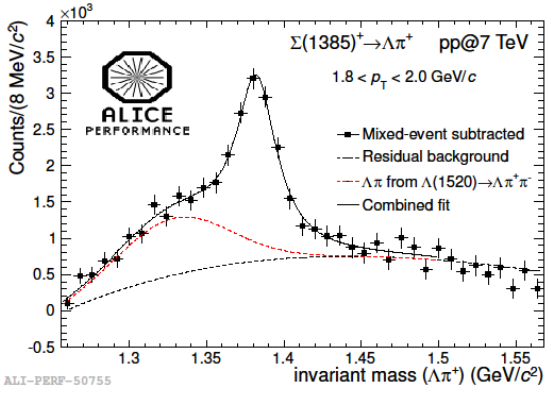












combinatorial background: mixed-event or like-sign techniques

fit: Breit-Wigner (Voigtian for ϕ) + polynomial

pp: p_T spectrum

K* **ϕ** **Σ***

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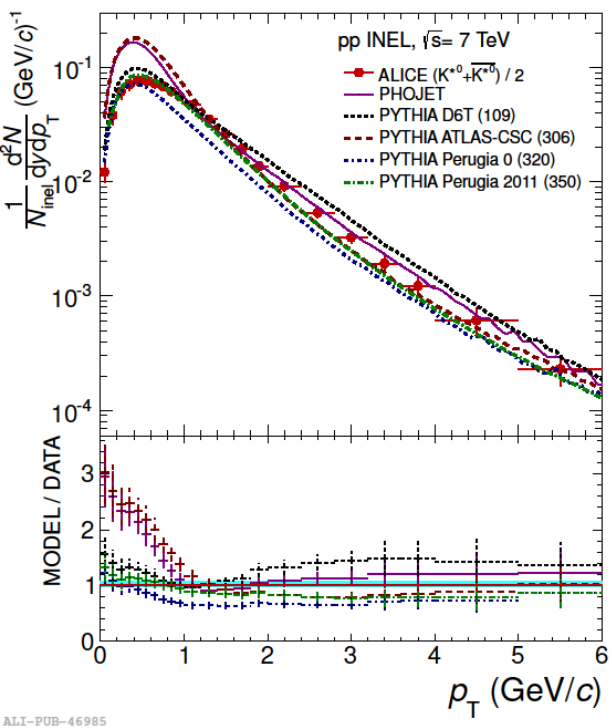
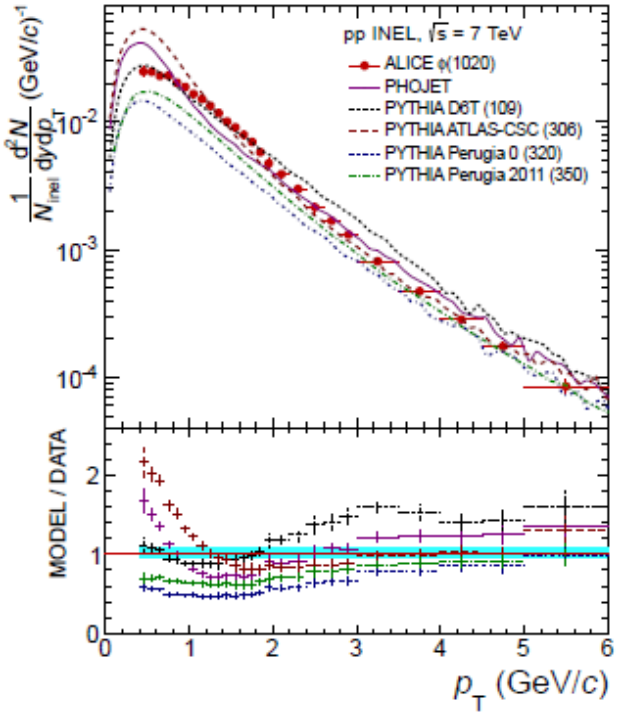
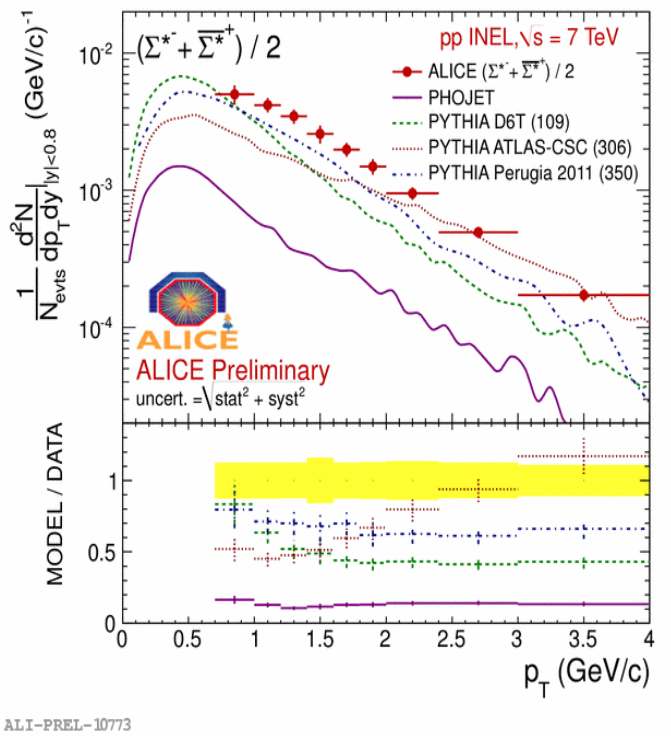




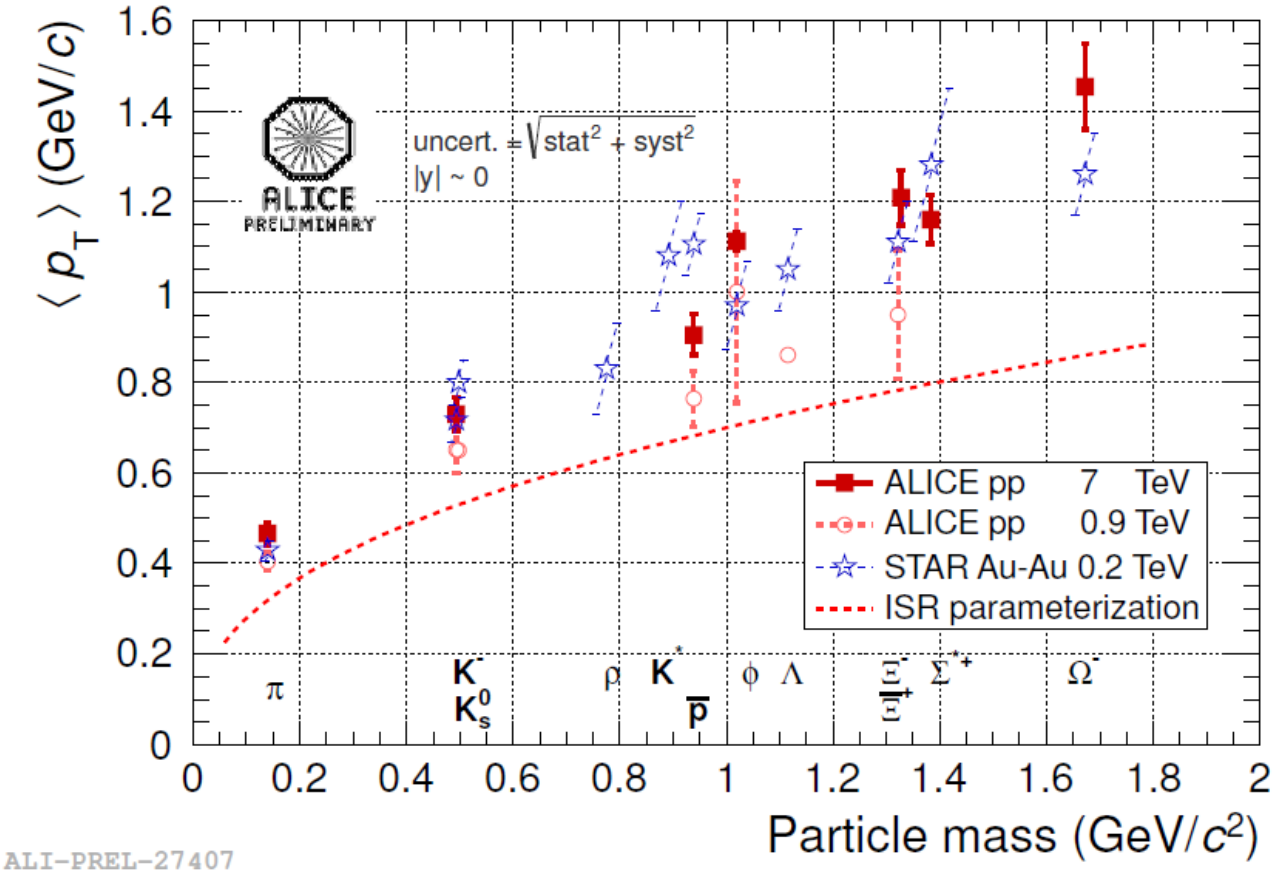


PYTHIA Perugia 2011

p_T < 2 GeV/c: PYTHIA D6T
p_T > 3 GeV/c: PYTHIA Perugia 2011

The models underpredict the data

pp: ‹ p_T ›



resonance ‹ p_T › in agreement with the trend drawn by other particles at 7 TeV

‹ p_T › for π, K and p in pp at √s = 200 GeV, Phys.Rev.C 79(2009)34909, is still compatible with ISR parameterization (√s = 25 GeV, Nucl.Phys.B 114(1976)334)

pp: particle ratios

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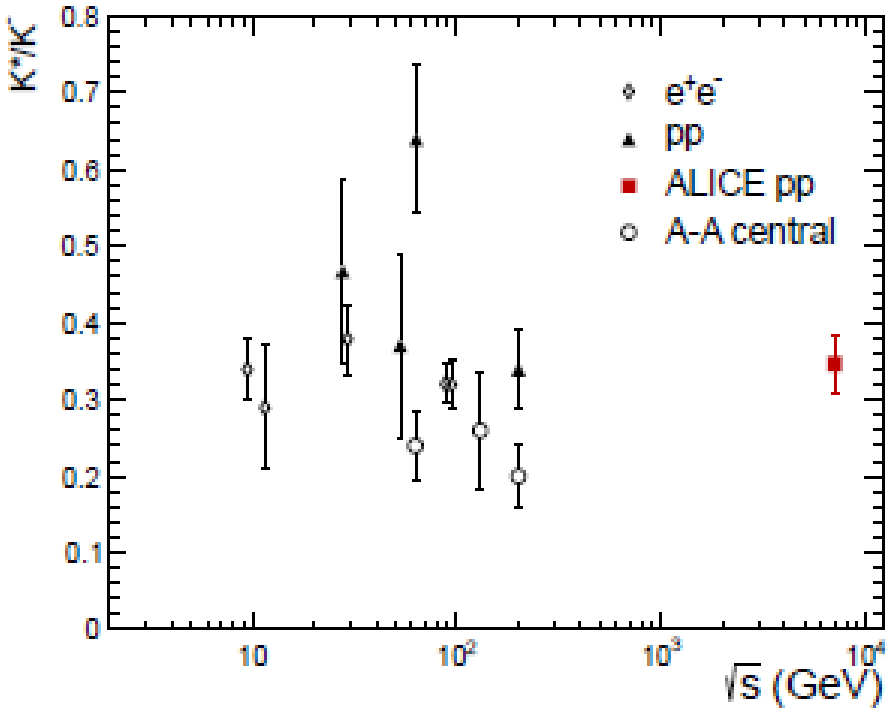
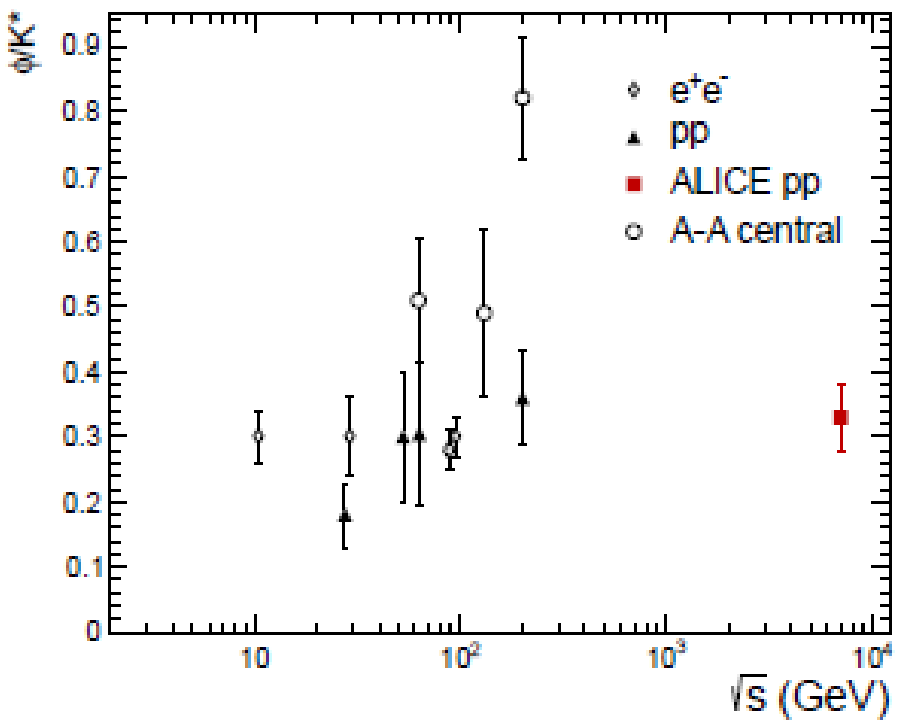
K*/K⁻



ϕ/K*



both K*/K⁻ and ϕ/K* independent of √s

pp: particle ratios

ϕ/π

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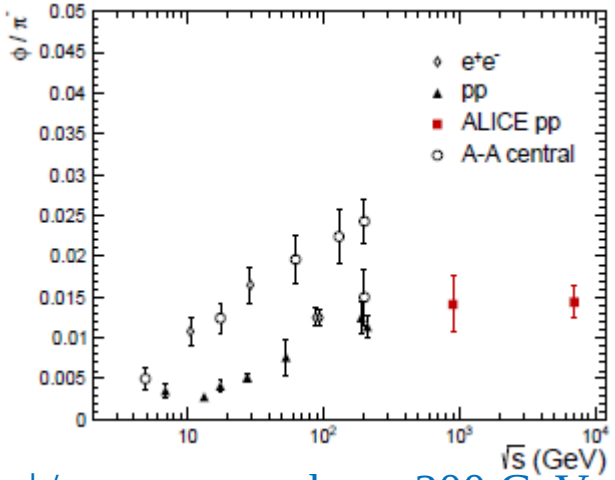
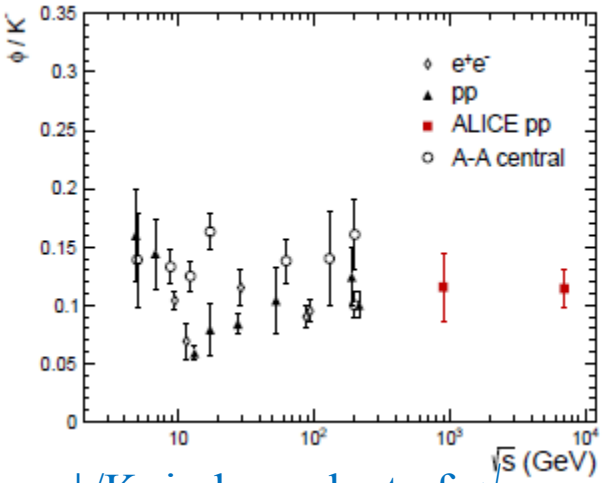
Ω/ϕ

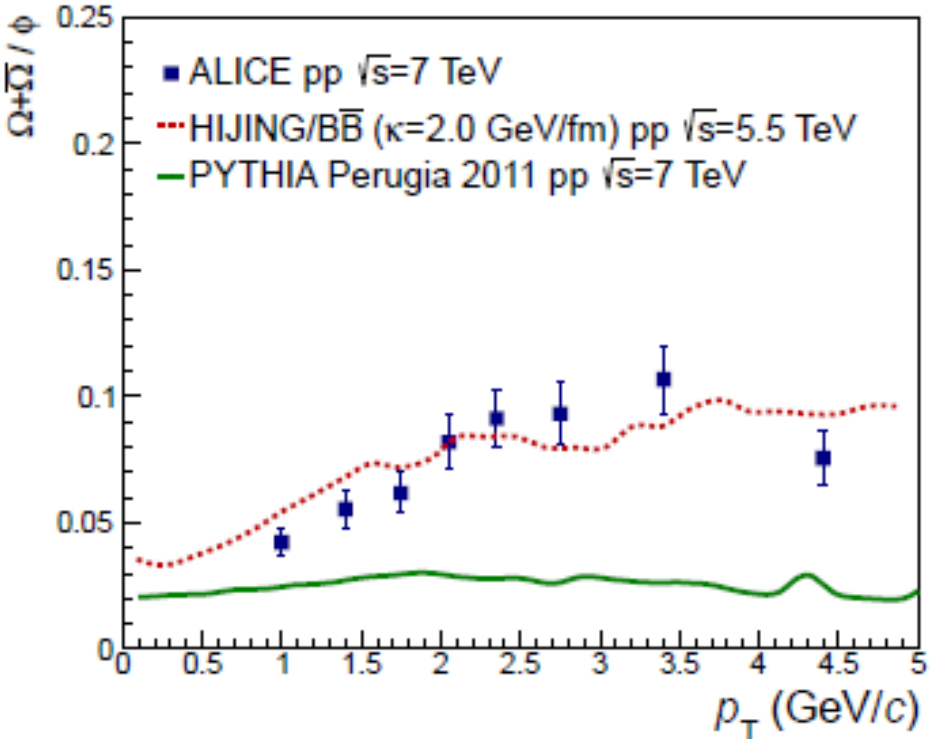


ϕ/π: saturates above 200 GeV

ϕ/K



ϕ/K: independent of √s

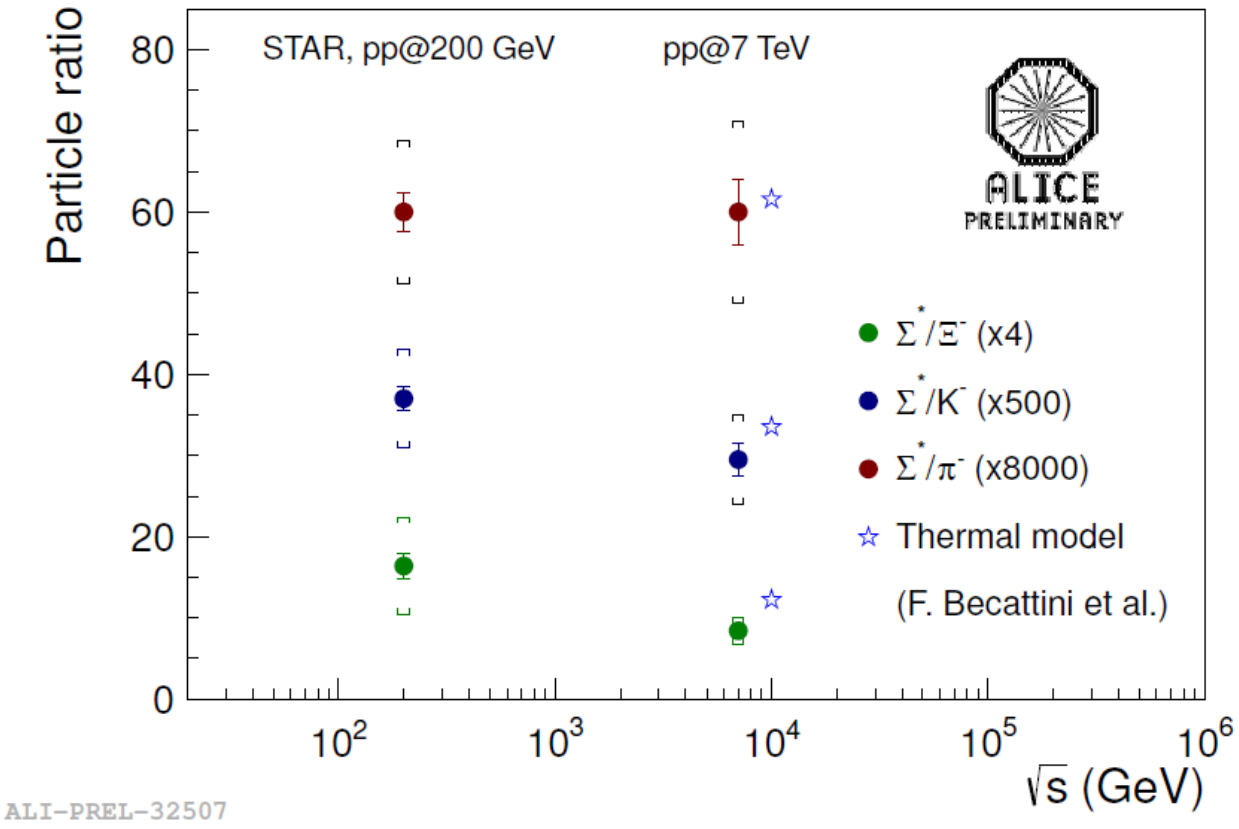


Ω/ϕ: not reproduced by Pythia Perugia 2011

agreement with a prediction of HIJING/BB model with a Strong Color Field modeled with increased string tension

pp: particle ratios

Σ*



Σ^*/π^- : independent of $\sqrt{s}$

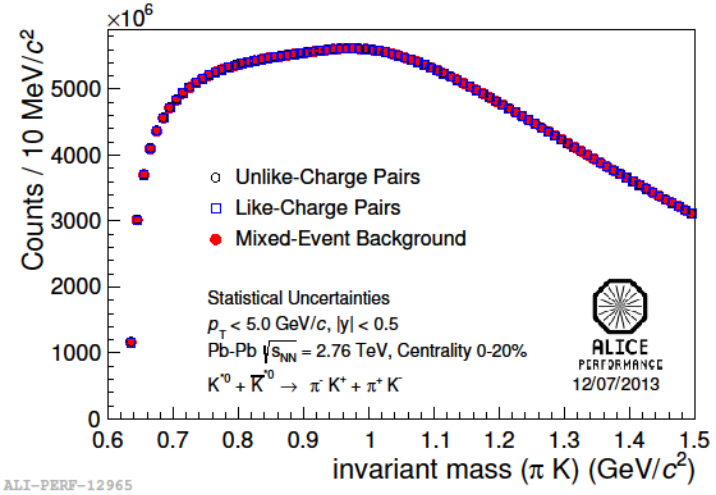
Σ^*/K^- : independent of $\sqrt{s}$

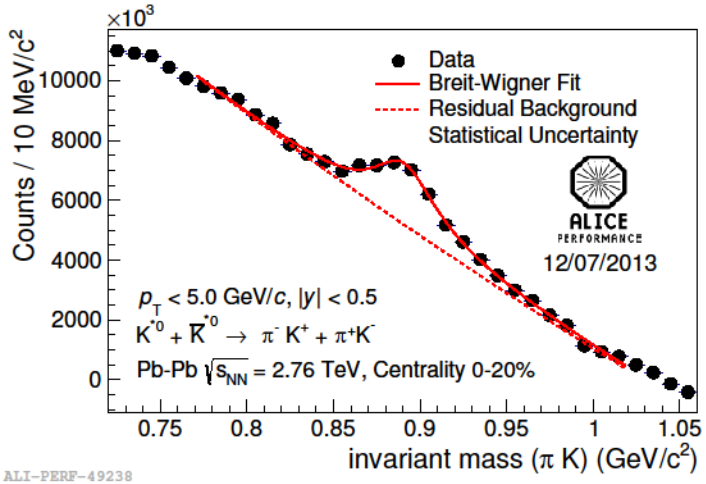
Σ^*/Ξ^- : hint of a decrease with $\sqrt{s}$

Σ^*/π^- and Σ^*/K^- :
agree with Becattini thermal model
(arXiv:0912.2855), $\gamma_s = 0.6$, T=170 MeV

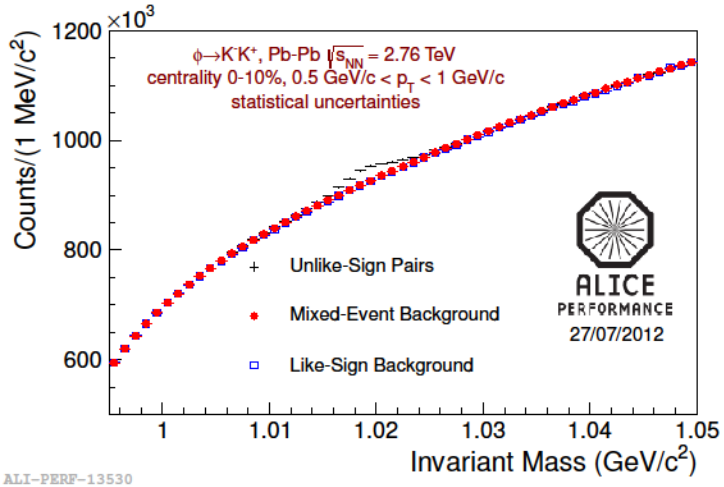
Pb-Pb: signal extraction

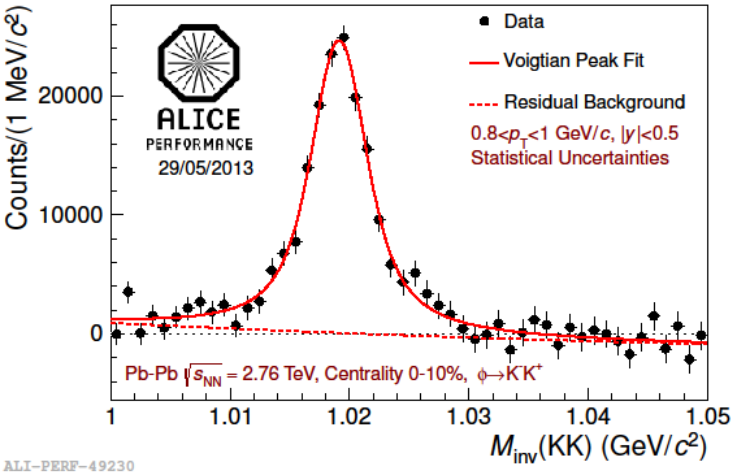
K*





ϕ



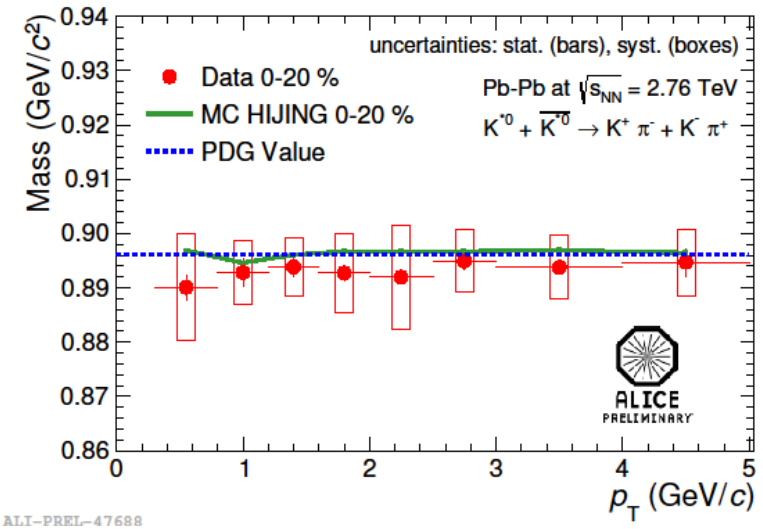


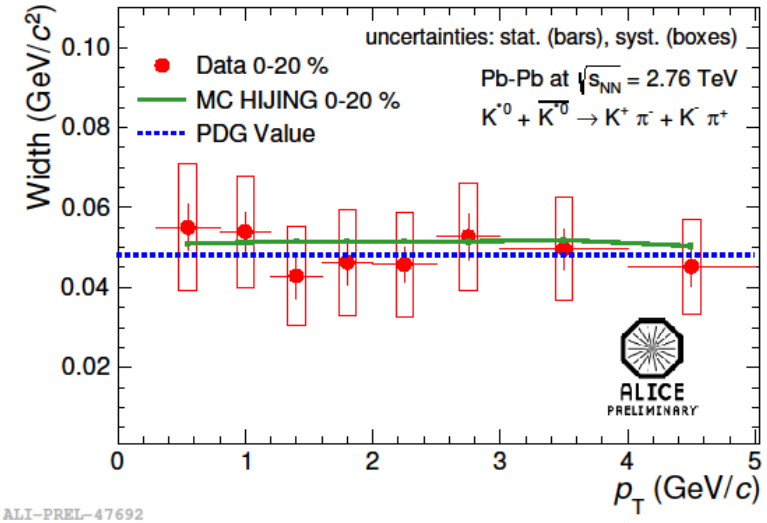
combinatorial background: mixed-event or like-sign techniques

fit: Breit-Wigner (Voigtian for ϕ) + polynomial

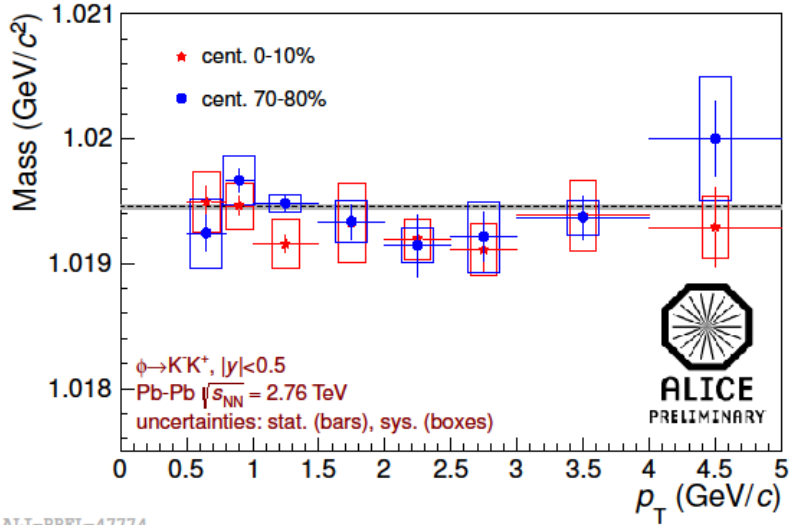
Pb-Pb: mass and width

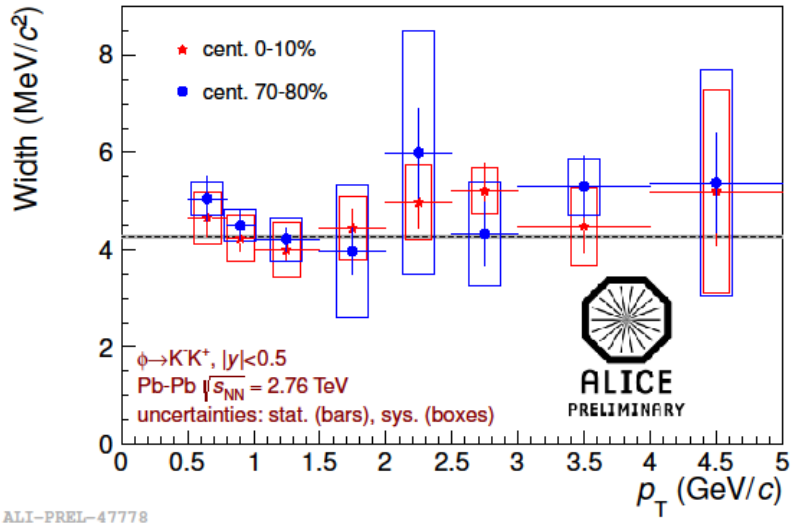
K*





ϕ

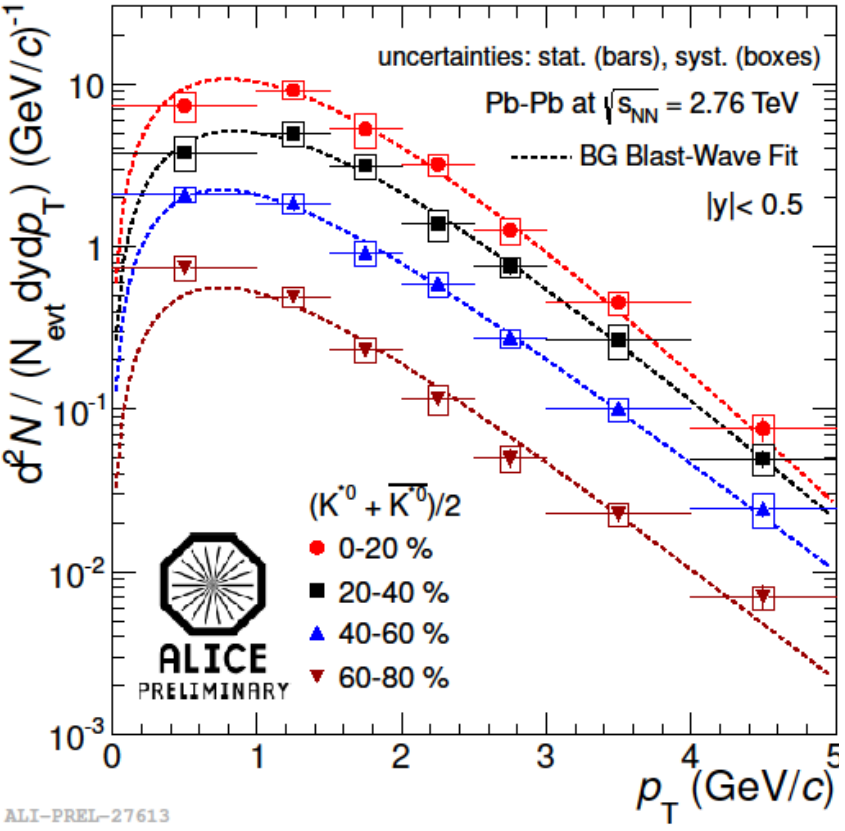




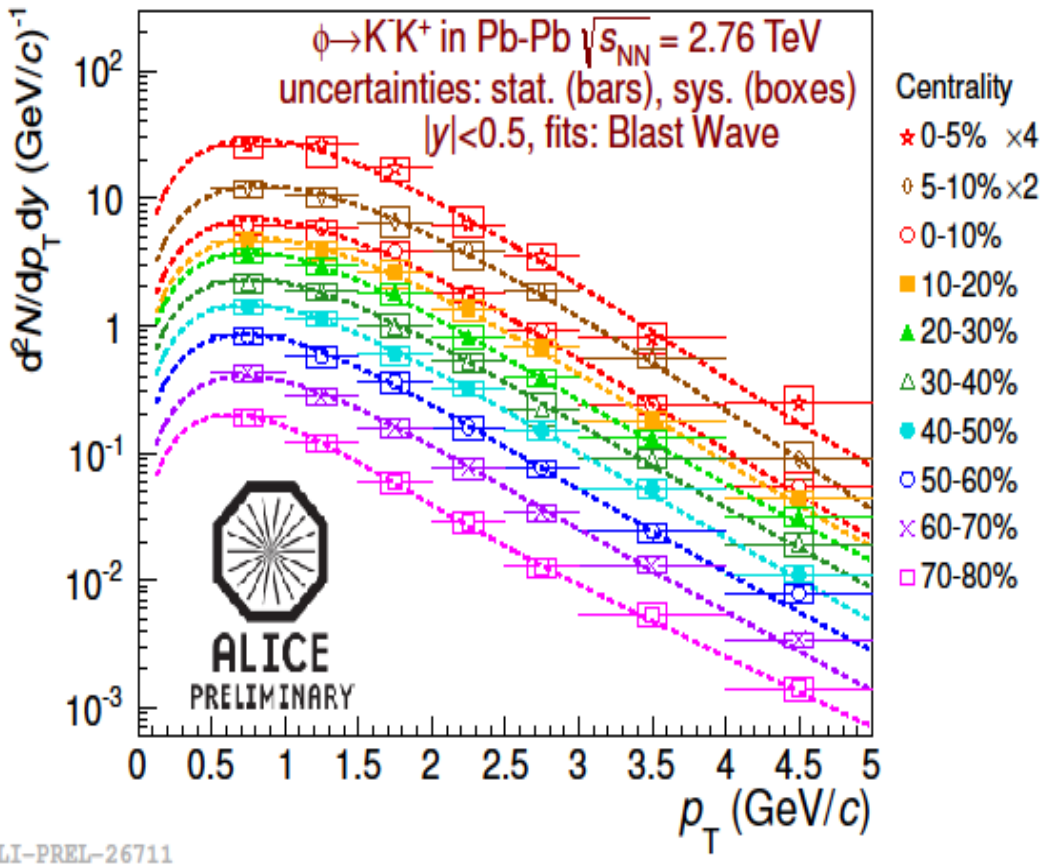
masses and widths compatible with PDG values

Pb-Pb: p_T spectrum

K*



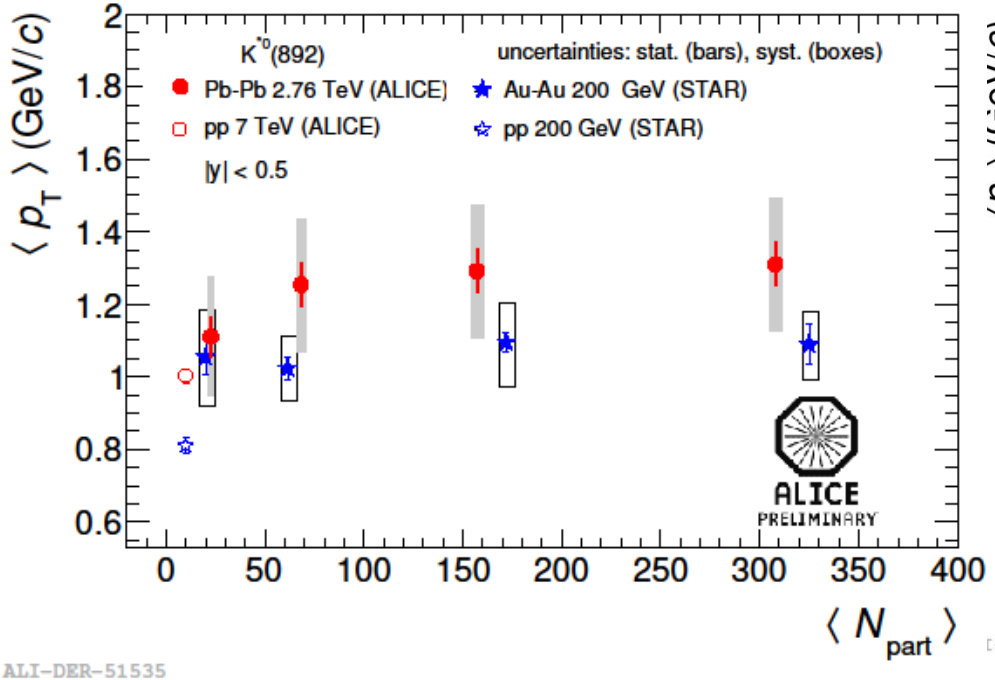
ϕ



fit: Blast-Wave function, Phys.Rev. C48(1993)2462

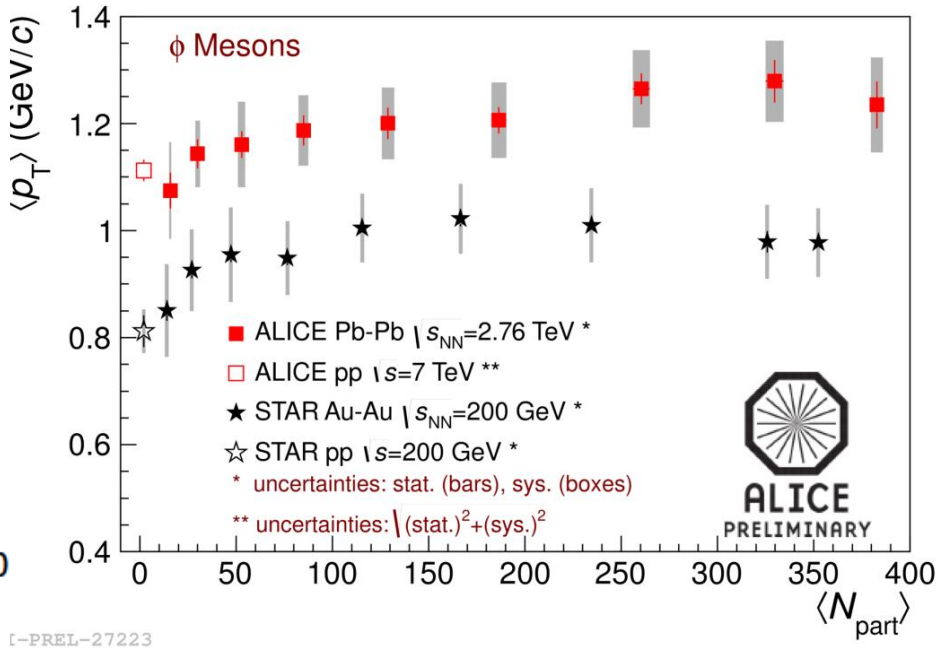
Pb-Pb: ‹ p_T ›

K*



ALI-DER-51535

ϕ



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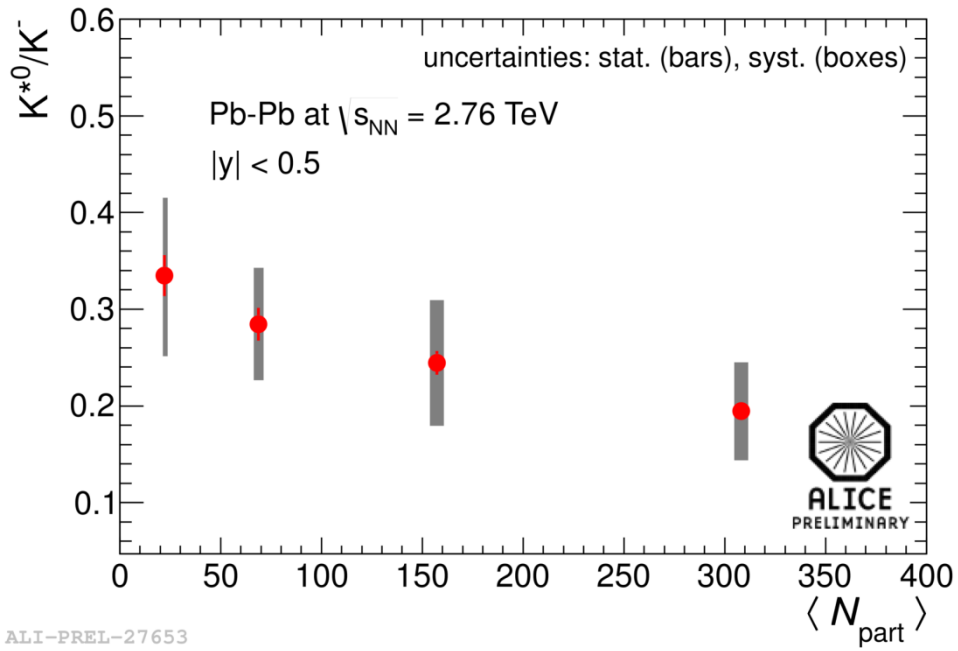
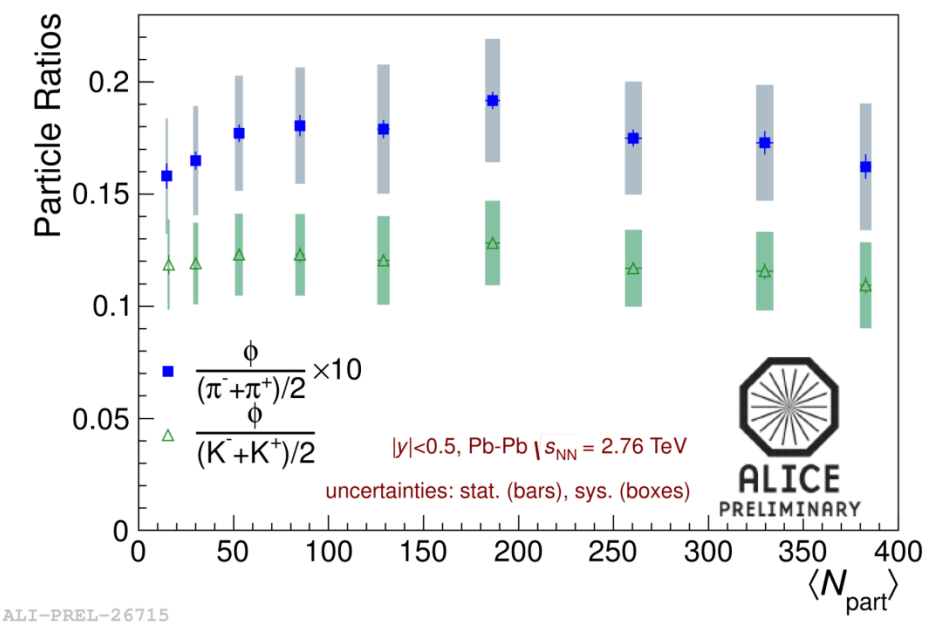
‹ p_T ›$_{LHC}$ > ‹ p_T ›$_{RHIC}$

Pb-Pb: particle ratios vs. ‹ N_{part} ›

K*



ϕ

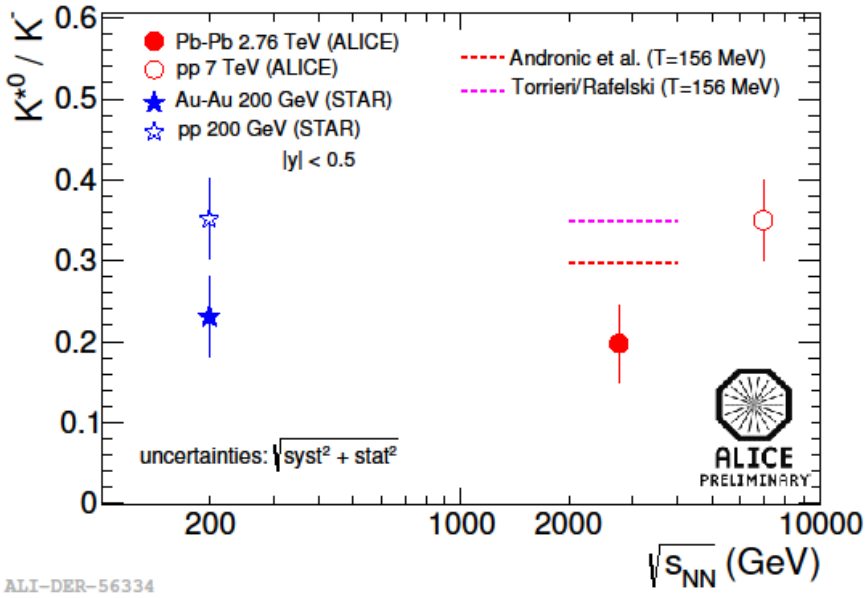


K^{*0}/K^- : hint for a decreasing trend
→ a possible increase in rescattering effects for central collisions

ϕ/π, ϕ/K : independent of collision centrality

Pb-Pb: particle ratios vs. $\sqrt{s_{NN}}$

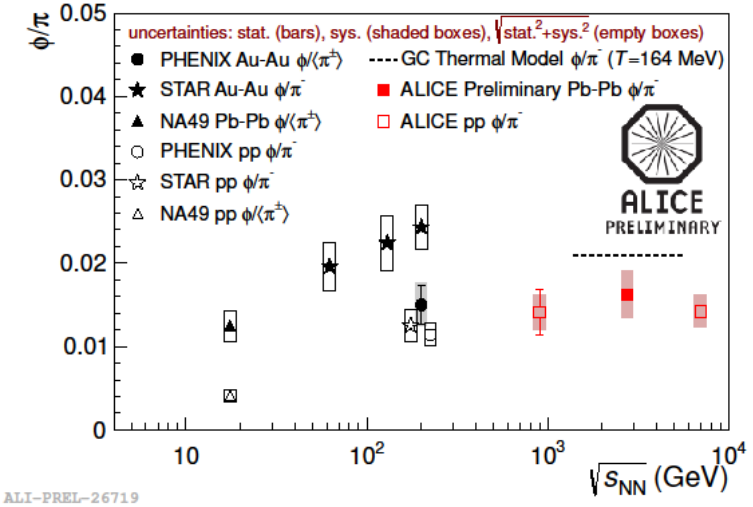
K*

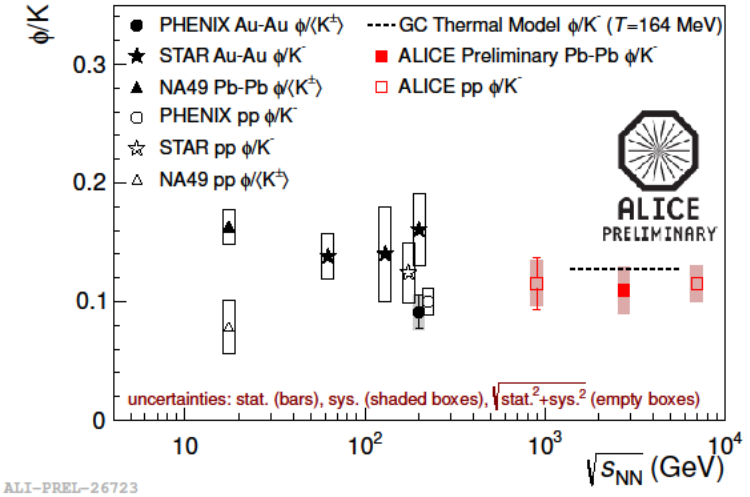


$(K^*/K)_{AA} < (K^*/K)_{pp}$
→ rescattering effects ?

Thermal models:
Andronic et al., Phys.Lett.B 673(2009)142
Torrieri/Rafelski, J.Phys.G 28(2002)1911
GC Thermal model, J.Phys.G 38(2011)124081

ϕ

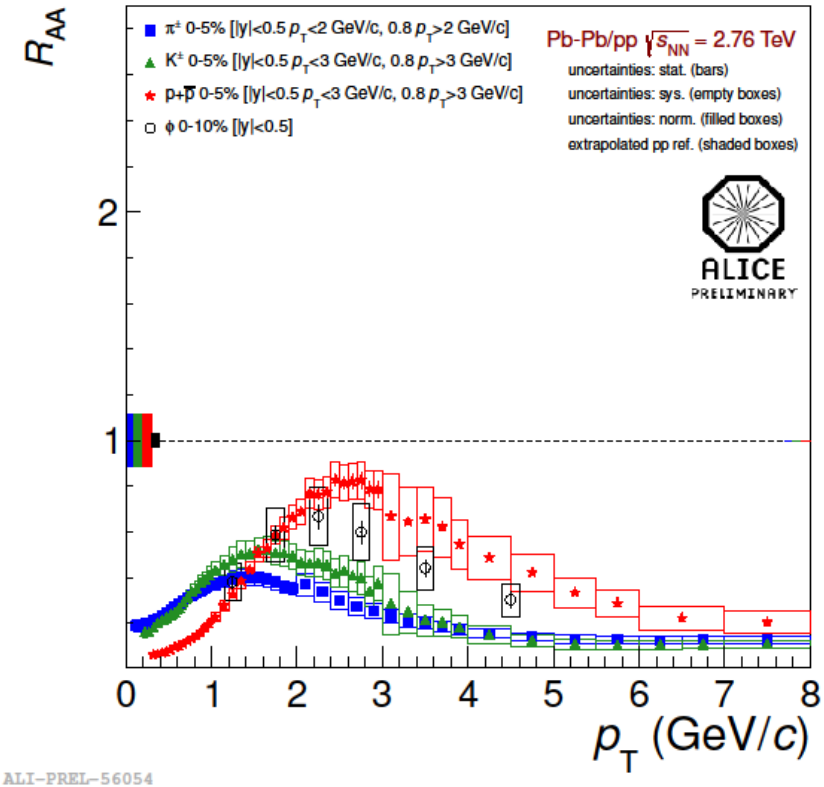




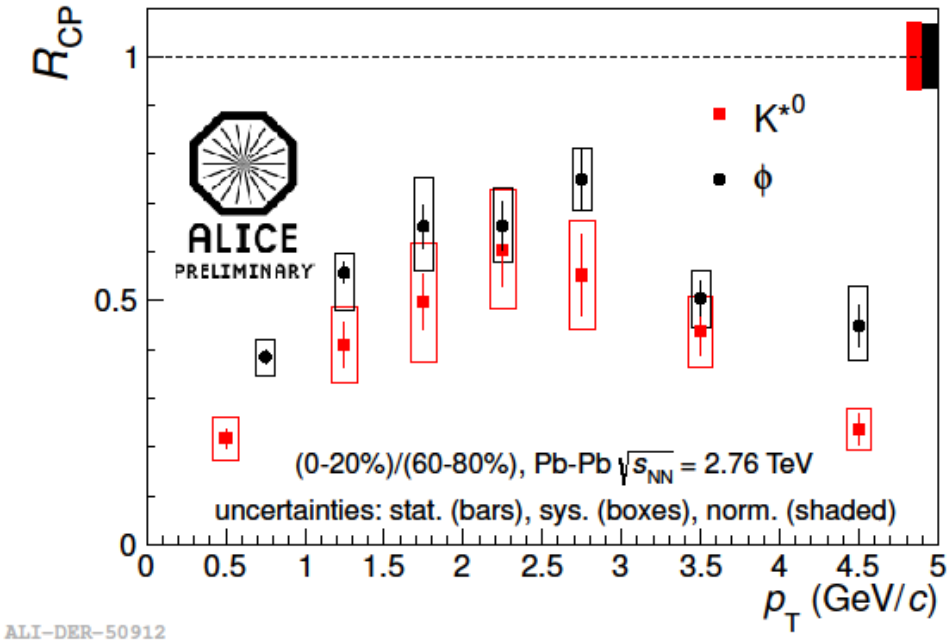
ϕ/π, ϕ/K : independent of $\sqrt{s}$

Pb-Pb: R_{AA} and R_{CP}

$$R_{AA} = \frac{1/N_{coll}\ d\sigma(AA)/dp_T}{d\sigma(pp)/dp_T}$$



$$R_{CP} = \frac{1/N_{coll}\ (0\text{-}20\%)\ d\sigma(0\text{-}20\%)/dp_T}{1/N_{coll}\ (60\text{-}80\%)\ d\sigma(60\text{-}80\%)/dp_T}$$



$R_{AA}(\pi,K) \leq R_{AA}(\phi) \leq R_{AA}(p)$

$R_{CP}(K^*)$ tends to be lower than $R_{CP}(\phi)$, but same within uncertainties

Summary: pp

pp@7 TeV: $K^*(892)^0$, $\phi(1020)$, $\Sigma(1385)$

- ✓ none of PHOJET and PYTHIA tunes give a fully satisfactory description of p_T spectrum. In particular they underestimate strange baryon resonances yields

- ✓ particle ratios:
  - K^*/K^-, K^*/ϕ and ϕ/K are independent of $\sqrt{s}$
  - ϕ/π: saturates above $\sqrt{s} = 200$ GeV
  - Ω/ϕ: not reproduced by PYTHIA, agrees with HIJING/BB model with a Strong Color Field modeled with increased string tension
  - Σ^*/π^- and Σ^*/K^- : independent of $\sqrt{s}$, agree with the thermal model
  - Σ^*/Ξ^- : hint of a decrease with $\sqrt{s}$, overpredicted by the thermal model

Summary: Pb-Pb

Pb-Pb@2.76 ATeV: $K^*(892)^0$, $\phi(1020)$

- ✓ masses and widths compatible with PDG values
- ✓ $\langle p_T \rangle_{LHC} > \langle p_T \rangle_{RHIC}$
- ✓ particle ratios:
  - ϕ/K , ϕ/π → independent of collision centrality and $\sqrt{s}$
  - K^*/K^- → hint of decrease with centrality
    → rescattering effects ?
  - $(K^*/K^-)_{AA} < (K^*/K^-)_{pp}$ → rescattering effects ?
- ✓ R_{AA} and R_{CP}:
  - high p_T suppression in central events
  - $R_{AA}(\pi,K) \leq R_{AA}(\phi) \leq R_{AA}(p)$