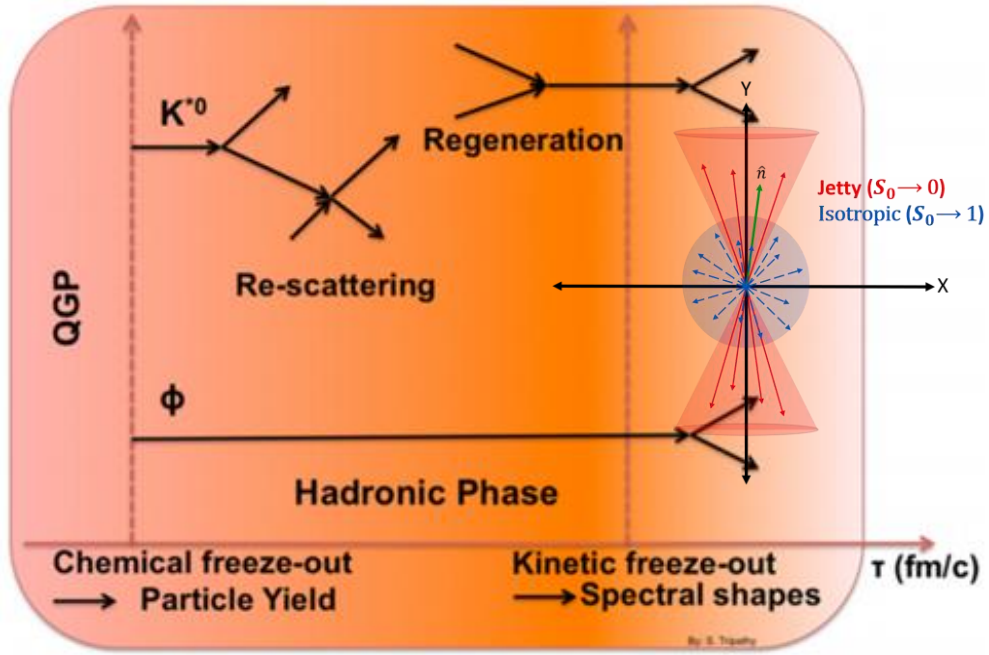
Event shape and multiplicity dependence of **K*(892)$^{\pm}$** at midrapidity in pp collisions at $\sqrt{s} = 13$ TeV with **ALICE** at the LHC

Antonina Rosano[(1)] and Suman Deb[(2)] on behalf of the ALICE collaboration

1. *Università di Messina and INFN sezione di Catania, Italy*
2. *Indian Institute of Technology Indore, India*

- Resonances are the perfect probes to characterize the system formed in heavy-ion collisions at ultrarelativistic energies.
- K*$^{\pm}$ resonance is particularly interesting because of its very short lifetime (~ 4 fm/c), comparable to the one of the hadronic phase → it may be sensitive to the competing rescattering and regeneration mechanisms.
- An event shape observable like transverse spherocity (S_0) is sensitive to hard (S_0 = 0) and soft processes (S_0 = 1). Such an observable can be used as a tool to disentangle pp collisions into isotropic (dominated by soft QCD) and jetty (dominated by hard QCD) events.
- Although pp collisions are used as a baseline for heavy-ion collisions, recent preliminary results for K*$^{\pm}$ production as a function of multiplicity and spherocity in pp collisions at $\sqrt{s}$ = 13 TeV show the onset of phenomena typical of heavy-ion collisions, like collective behaviour and suppression of the yield ratios of resonances to stable particles.



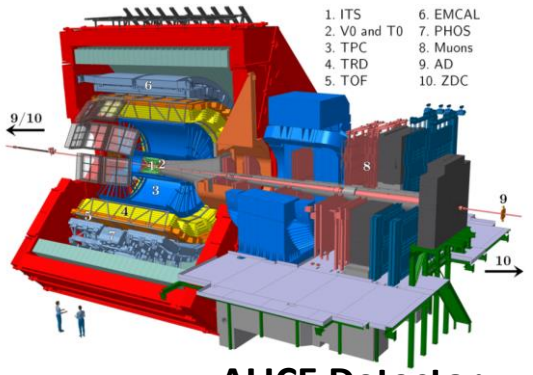
$K^{*\pm}$ resonance reconstruction

Used sub-detectors:

ITS – Tracker / Trigger / Vertexer

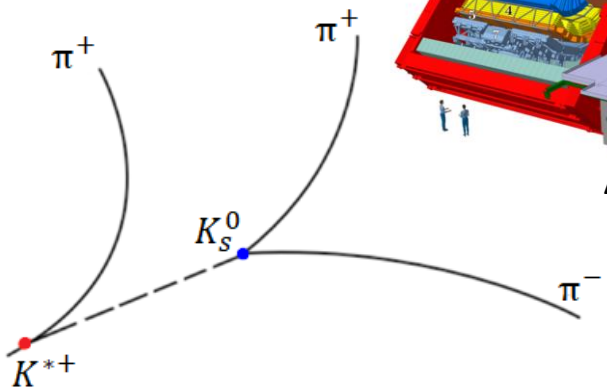
TPC – Tracker / PID (dE/dx)

V0 – Trigger / Multiplicity estimator



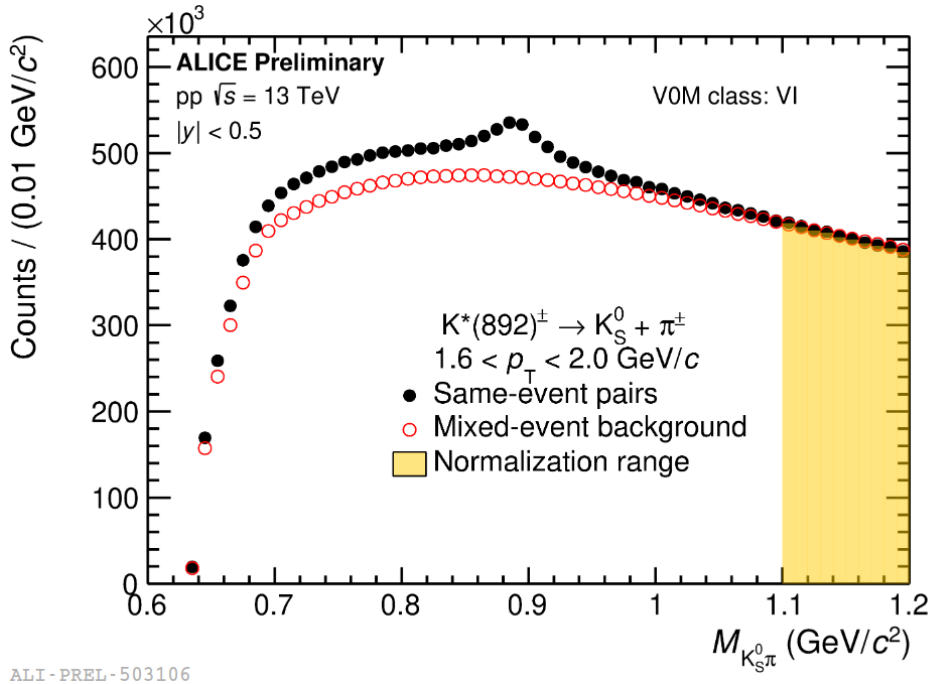
ALICE Detector

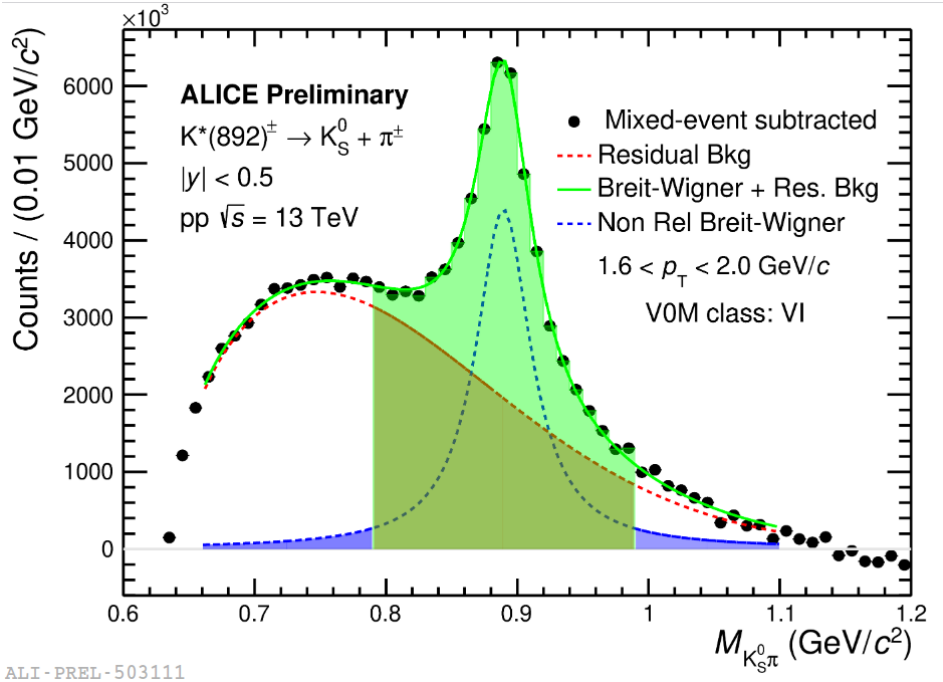
- Signal reconstructed via **invariant mass distribution** of the decay daughters: $K^{*\pm} \rightarrow \pi^{\pm} + K^0_S$; K^0_S identified via $K^0_S \rightarrow \pi^+ + \pi^-$, and $\pi^{\pm}$ via d*E*/d*x* in the TPC
- **Uncorrelated background** estimated via event mixing technique
- After the uncorrelated background subtraction, the remaining distribution is fitted with a **NR Breit-Wigner** + **residual backgroud** (expol) function F_{BG}:



$$\frac{A}{2\pi}\frac{\Gamma_0}{(M_{K\pi}-M_0)^2+\frac{\Gamma_0^2}{4}}+F_{BG}$$

$$F_{BG}(M_{K\pi}) = [M_{K\pi}-(m_\pi+m_K)]^n exp(A+BM_{K\pi}+CM^2_{K\pi})$$

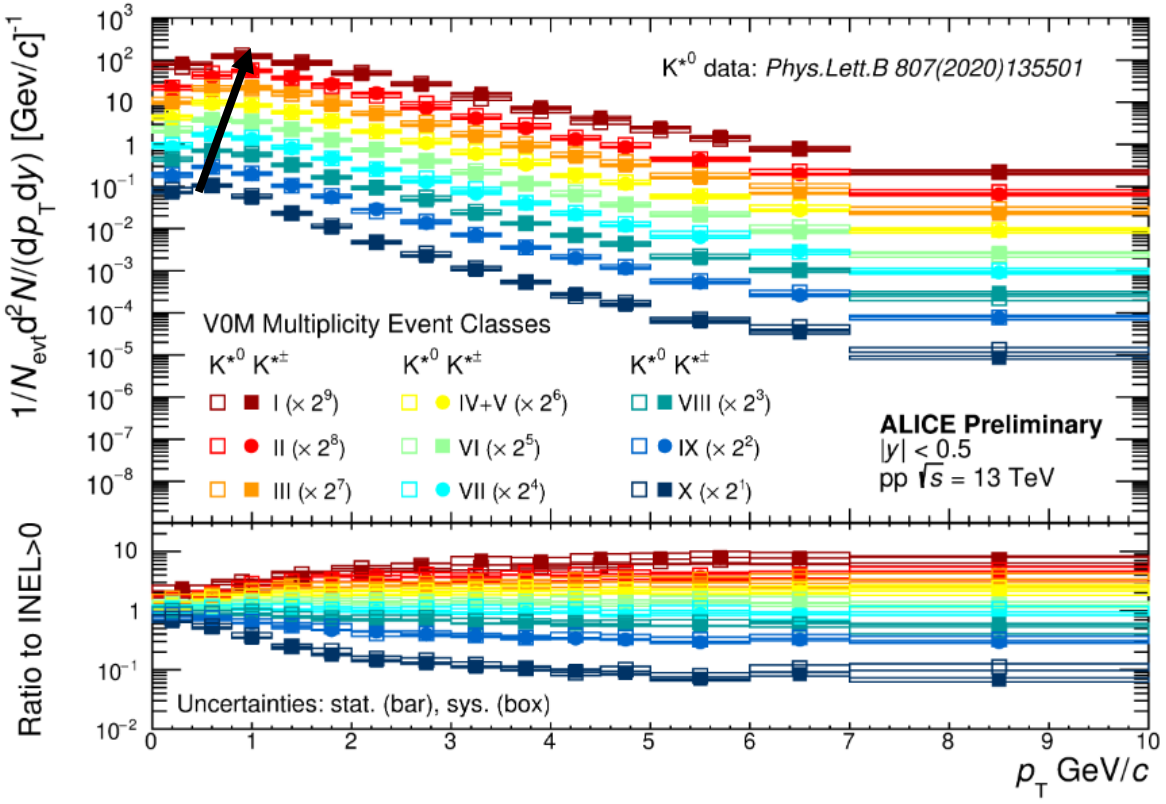




ALI-PREL-503106

ALI-PREL-503111

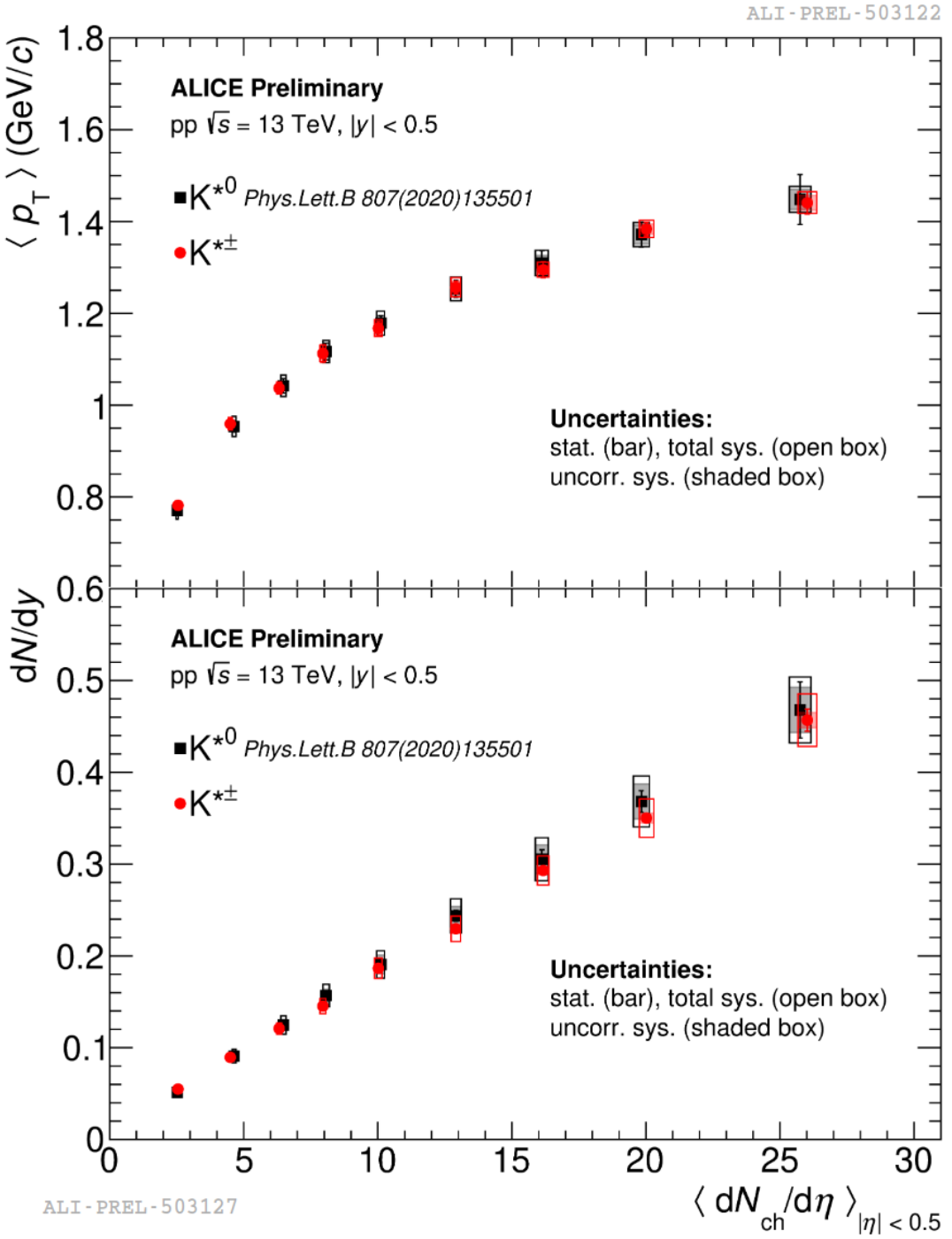
$K^{*\pm}$ p_T spectra, $\langle p_T \rangle$, and dN/dy



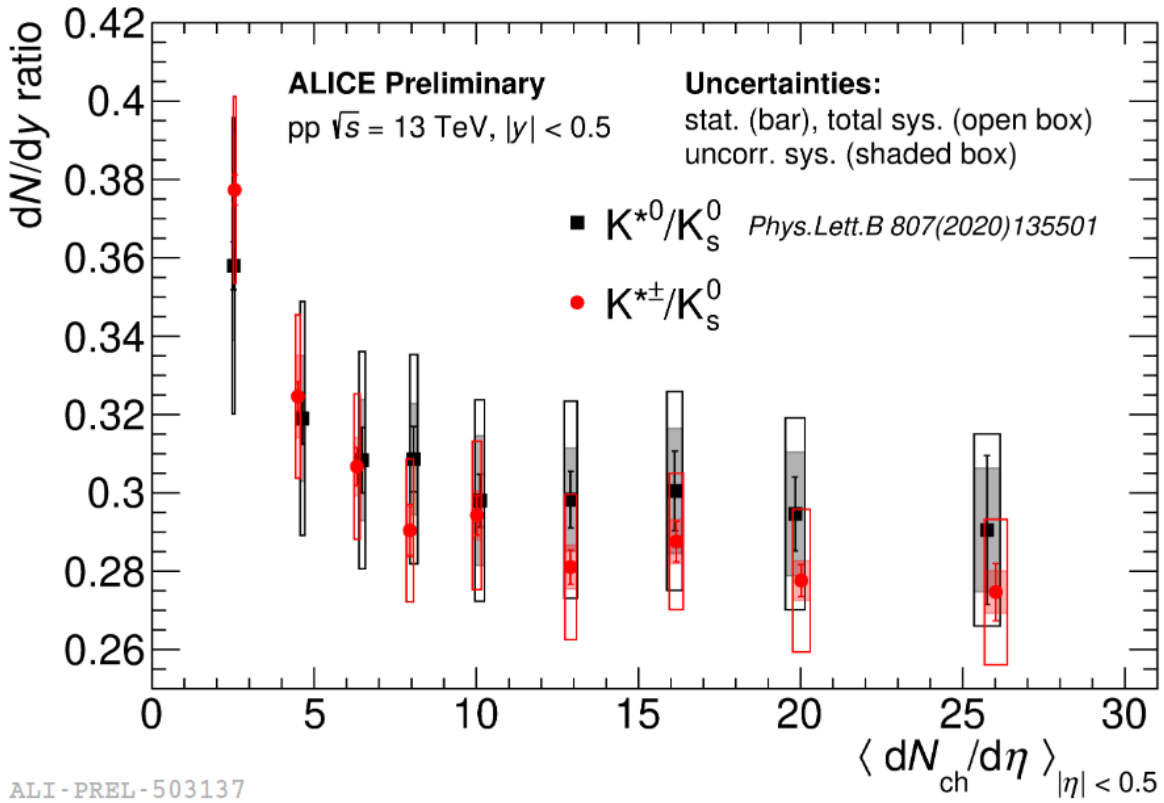
ALI-PREL-503116

- p_T spectra **get harder** with increasing multiplicity → **flow-like** effect
- **Lower panel:** ratios of p_T spectra to INEL>0. For p_T < 5 GeV/c spectra increase from low to high multiplicity classes. Same spectral shape for p_T > 5 GeV/c → Process dominant at low p_T

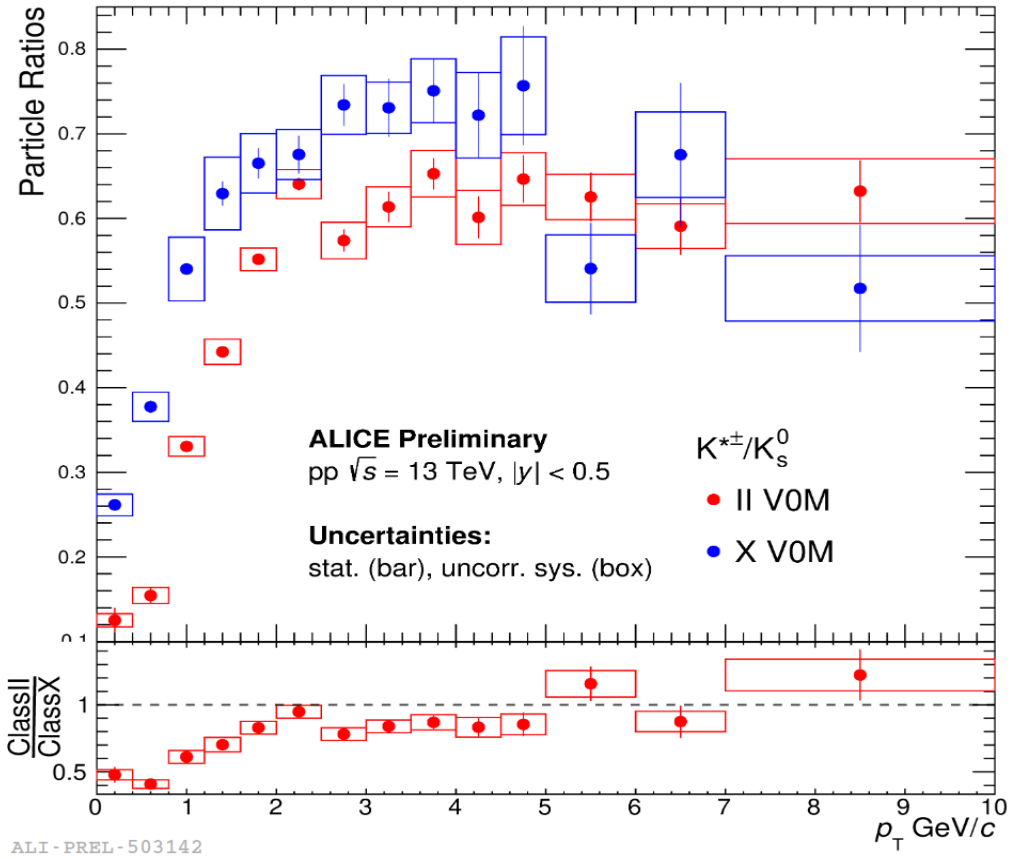
Comparable results for $K^{*\pm}$ and K^{*0} with **lower** systematic uncertainties for $K^{*\pm}$measurements



Ratio of particle yields: $K^{*\pm}/K^0_s$



The $K^{*\pm}/K^0_S$ **trend** in pp collisions at $\sqrt{s} = 13$ TeV **confirmes** the K^{*0}/K^0_S suppression even **within the systematic uncertainties → rescattering effects in small systems?**

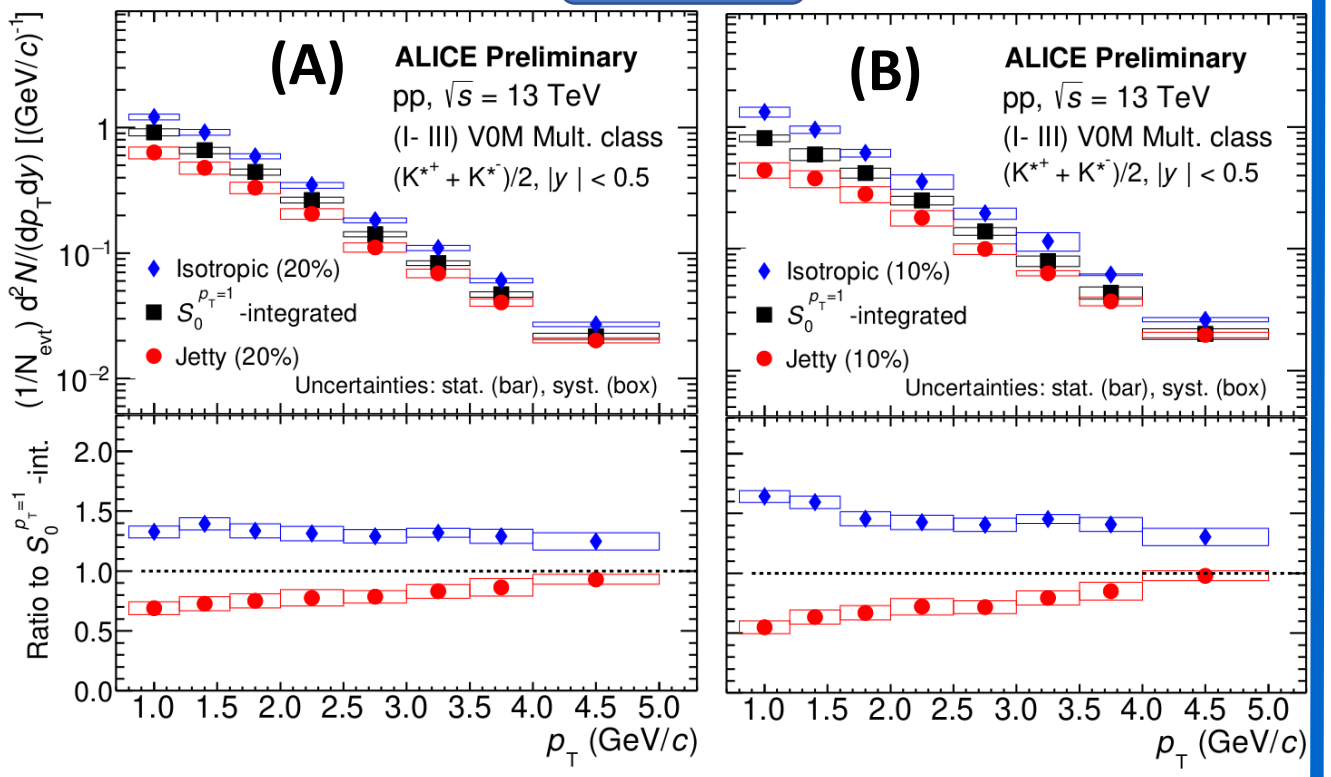


- **Upper panel:** p_T dependence of the particle ratios $K^{*\pm}/K^0_S$ for **low (X)** and **high (II)** multiplicity classes.
- **Lower panel (double ratios)**: high multiplicity values divided by the low multiplicity ones.
- For $p_T < 2.5$ GeV/c, the suppression of the $K^{*\pm}/K^0_S$ ratio from low to high multiplicity is clearly noticeable

K^{*0} ($K^{*0} \rightarrow K^{\mp} + \pi^{\pm}$) results have been confirmed and even improved by $K^{*\pm}$ measurements thanks to the **higher precision** reached. In the inclusive analysis of $K^{*\pm}$ production in pp collisions (*Phys.Lett.B 828 (2022) 137013*) this has been attributed to the different strategies used for K^0_S and $K^{\pm}$ identification in ALICE

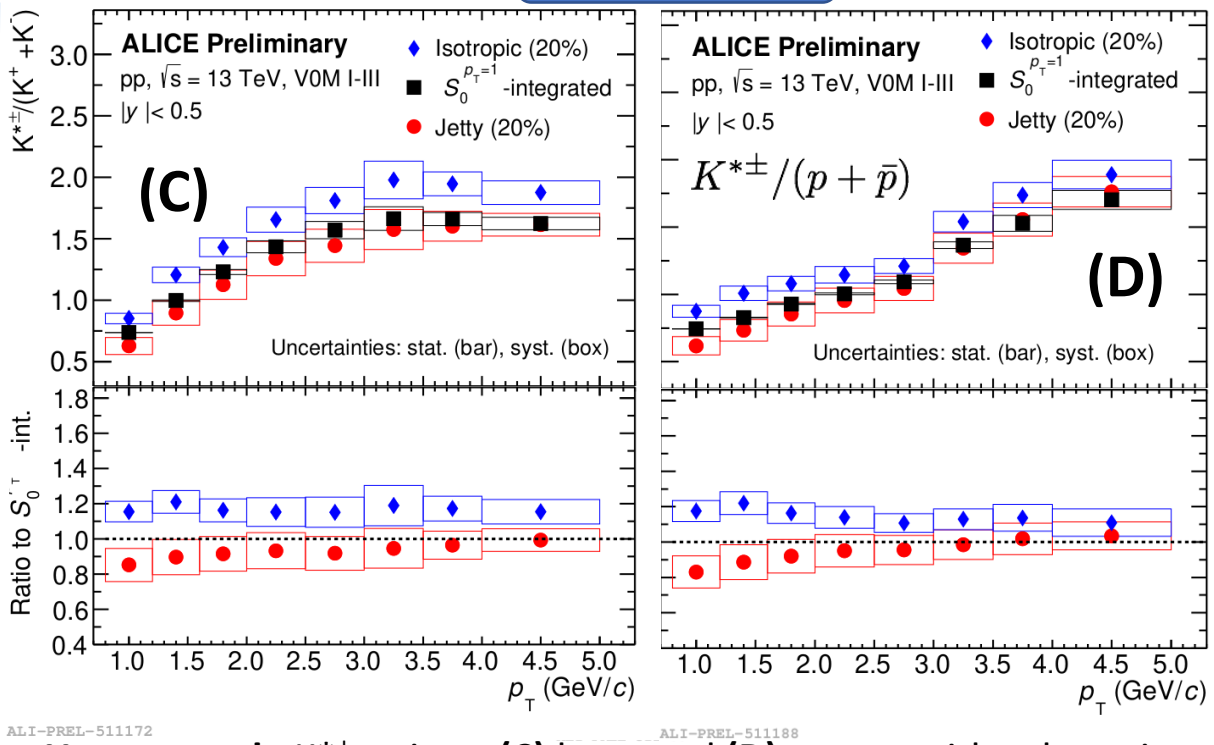
Transverse spherocity results for high multiplicity events

p_T spectra



- **Upper panel :** p_T spectra considering 20% **(A)** and 10% **(B)** spherocity classes; **Lower Panel :** Ratio with integrated events.
- **Observation**: Clear dominance of isotropic events for both **(A)** and **(B)**. This dominance seems to decrease with increasing p_T within systematic uncertainties and jetty events take over at high p_T

Particle ratios



- **Upper panel :** $K^{*\pm}$ ratio to **(C)** kaon and **(D)** proton with spherocity class; **Lower panel :** Ratio of event shape with integrated event.
- **Observation**: No significant dependence on the event shape classes except the first three p_T bins for both **(C)** and **(D)**.

Summary and Conclusions

- First measurements of $K^{*\pm}$ production at $|y| < 0.5$ in pp collisions at $\sqrt{s}$ =13 TeV at different S_0 and V0M classes have been reported here.
- Preliminary results show the typical onset of **collective-like phenomena** (hardening of the p_T spectra and suppression of $K^{*\pm}/K^0_S$) → possible **hadronic phase** in **small systems** too?