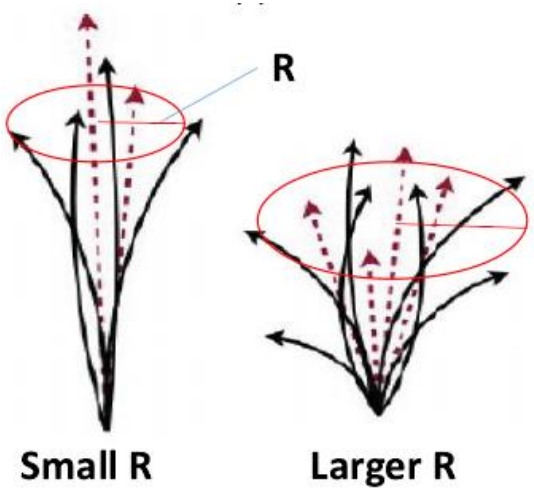
Measurements of charged jet production and modification in ALICE

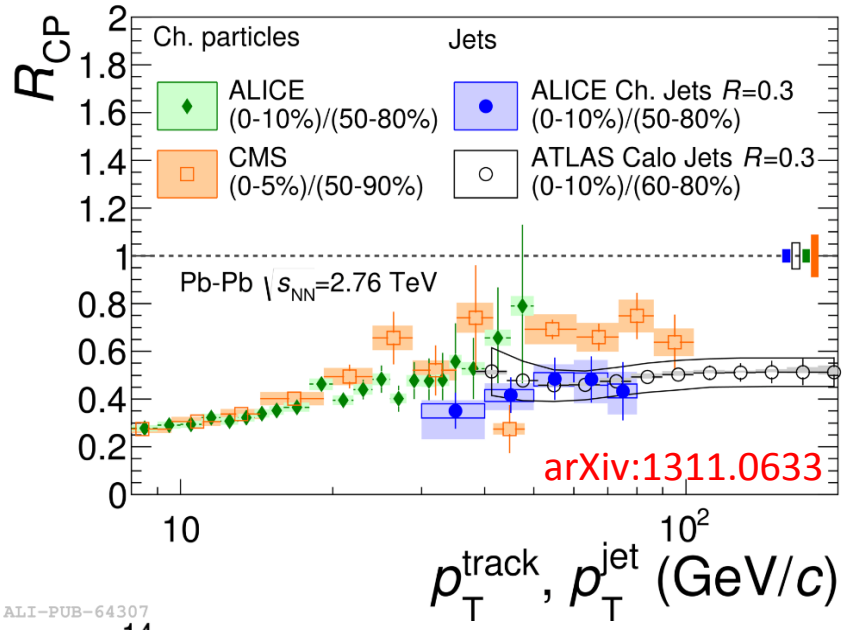
Yongzhen Hou for ALICE Collaboration

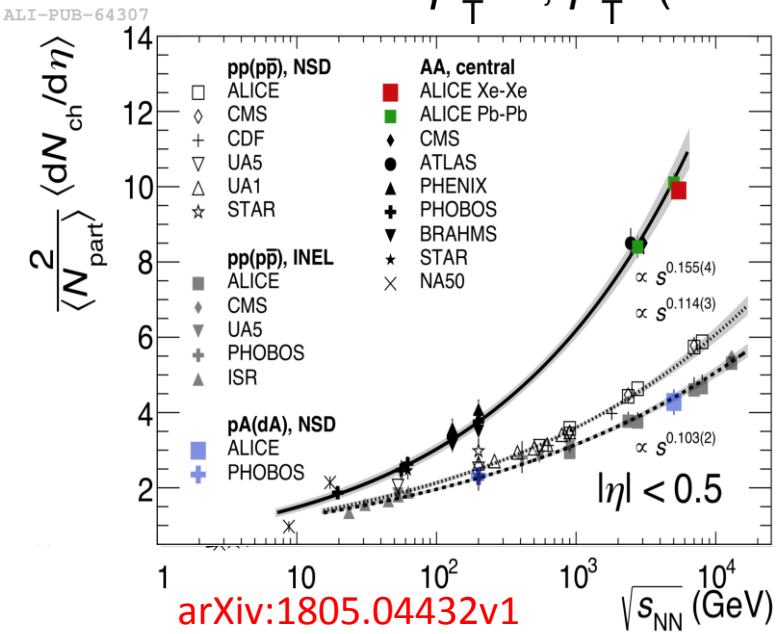
Central China Normal University

Motivation

- Provide constraints to pQCD calculations via the jet cross section.
- Investigate the splitting function of parton in vacuum: close to original collimation information.
- Study jet quenching effect in nucleus-nucleus collision.
- Study the jet production mechanism in high multiplicity environment: quenching? Enhancement?

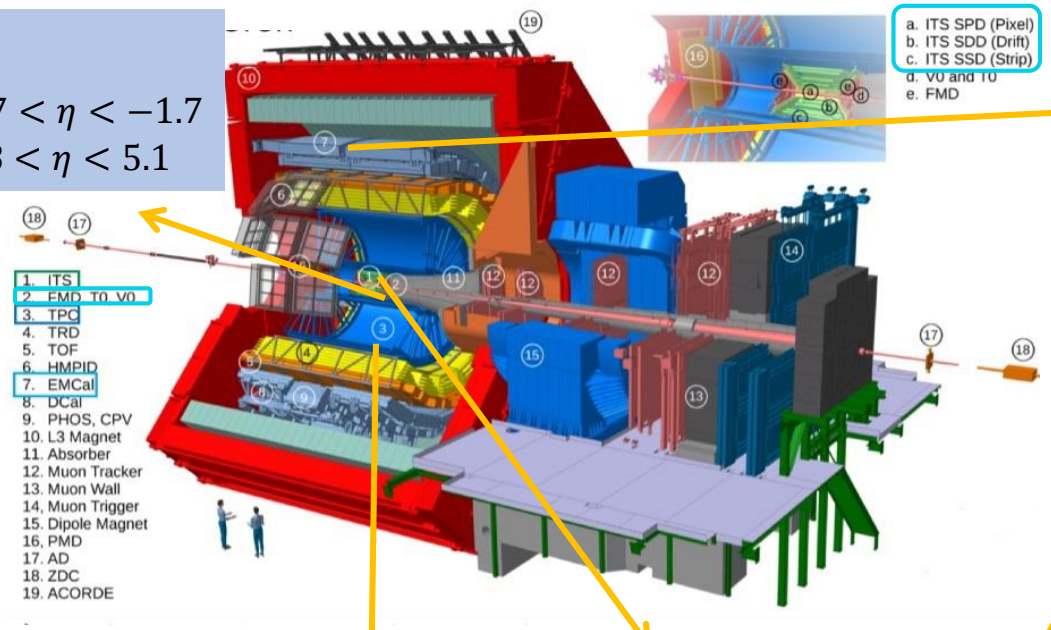






ALICE detector

- Event selection and multiplicity categorization: SPD, V0
- Track and jet reconstruction: ITS, TPC, EMCal and DCal



V0

$-3.7 < \eta < -1.7$

$2.8 < \eta < 5.1$

EM calorimeter

$|\eta| < 0.7,\ 80° < \varphi < 188°$

Remove charged particle contributions

Neutral constituents

$E_{cluster} > 0.3$ GeV

full jet

ITS(Inner Tracking System)

$|\eta| < 0.9,\ 0 < \varphi < 2\pi$

Charged constituents

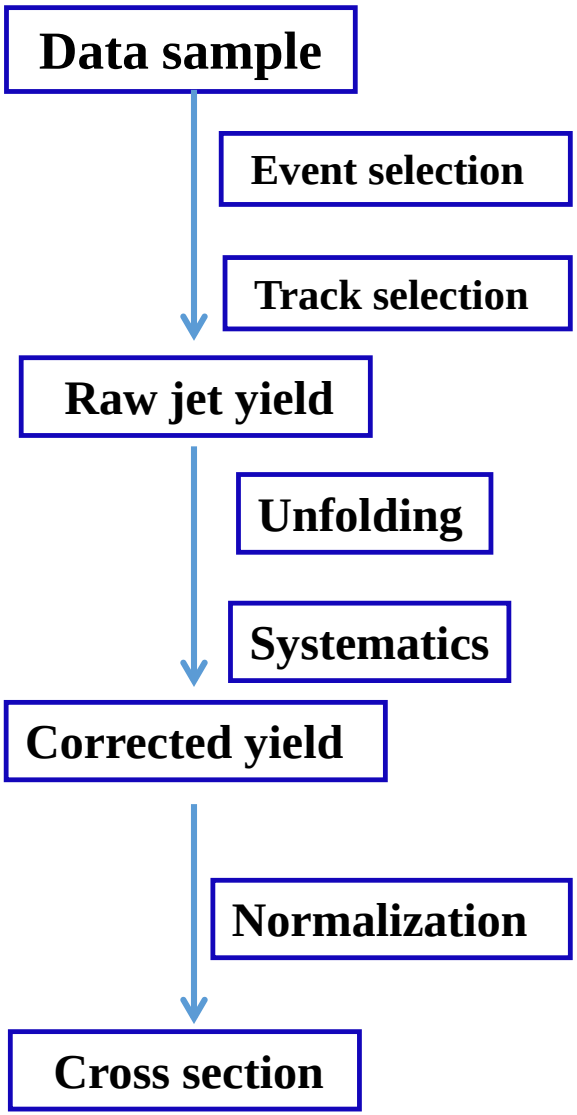
TPC (Time Projection Chamber)

$|\eta| < 0.9,\ 0 < \varphi < 2\pi$

$p_T^{track} > 0.15$ GeV/c

Charged jet

Analysis strategy



- Jet reconstruction: Anti-k_T algorithm, $R = 0.2$, 0.3, 0.4

$$p_{\mathrm{T}}^{\mathrm{jet}} > 1.0\ \mathrm{GeV}/c \quad |\eta_{\mathrm{jet}}| < 0.9 - R$$

- Background subtraction: $p_{\mathrm{T,jet}}^{\mathrm{corr}} = p_{\mathrm{T,jet}}^{\mathrm{raw}} - \rho * A_{\mathrm{jet}}$,

$$\rho = median\left\{\frac{p_{\mathrm{T,jet}}^{k_T}}{A_{\mathrm{jet}}}\right\} \quad A_{\mathrm{jet}} : \text{Jet area}$$

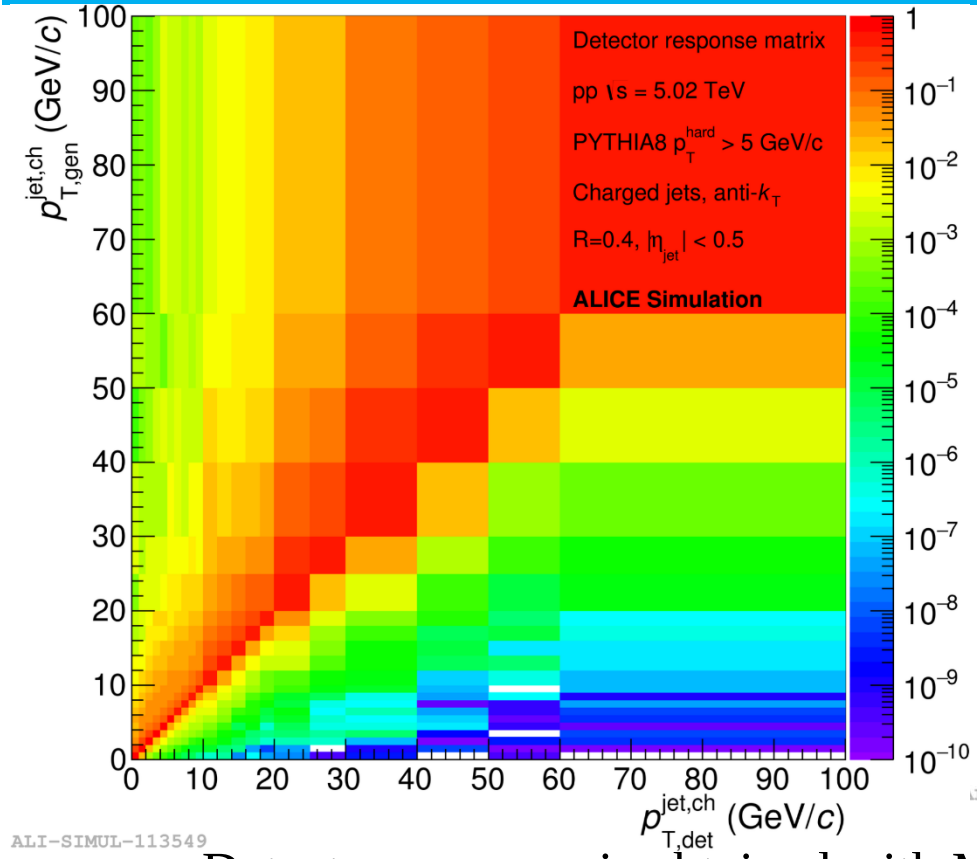
- Cross section normalization $(\sigma_{MB} = \mathcal{L}_{int} \cdot N_{evt})$

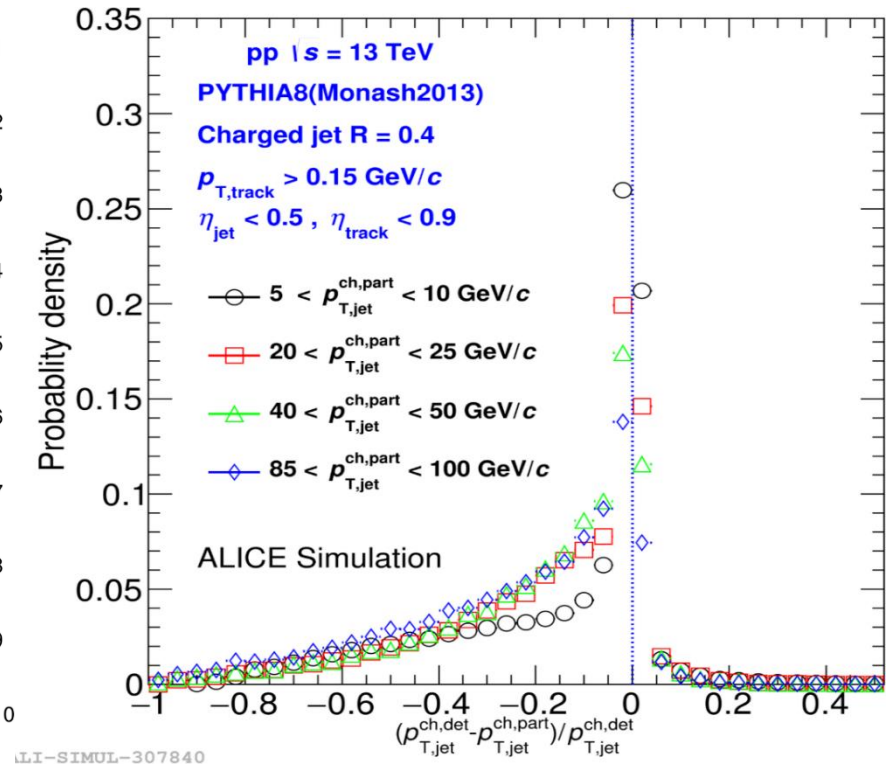
$$\frac{d^2\sigma^{\mathrm{ch,jet}}}{dp_{\mathrm{T}}d\eta}\left(p_{\mathrm{T}}^{\mathrm{ch,jet}}\right) = \frac{1}{\mathcal{L}_{int}}\frac{\Delta N_{\mathrm{jets}}}{\Delta p_{\mathrm{T}}\Delta\eta}\left(p_{\mathrm{T}}^{\mathrm{ch,jet}}\right)$$

- Nuclear modification factor R_{AA}

$$R_{AA} = \frac{dN_{jets}^{AA}/dp_T d\eta}{<T_{AA}>d\sigma_{jets}^{pp}/dp_T d\eta}$$

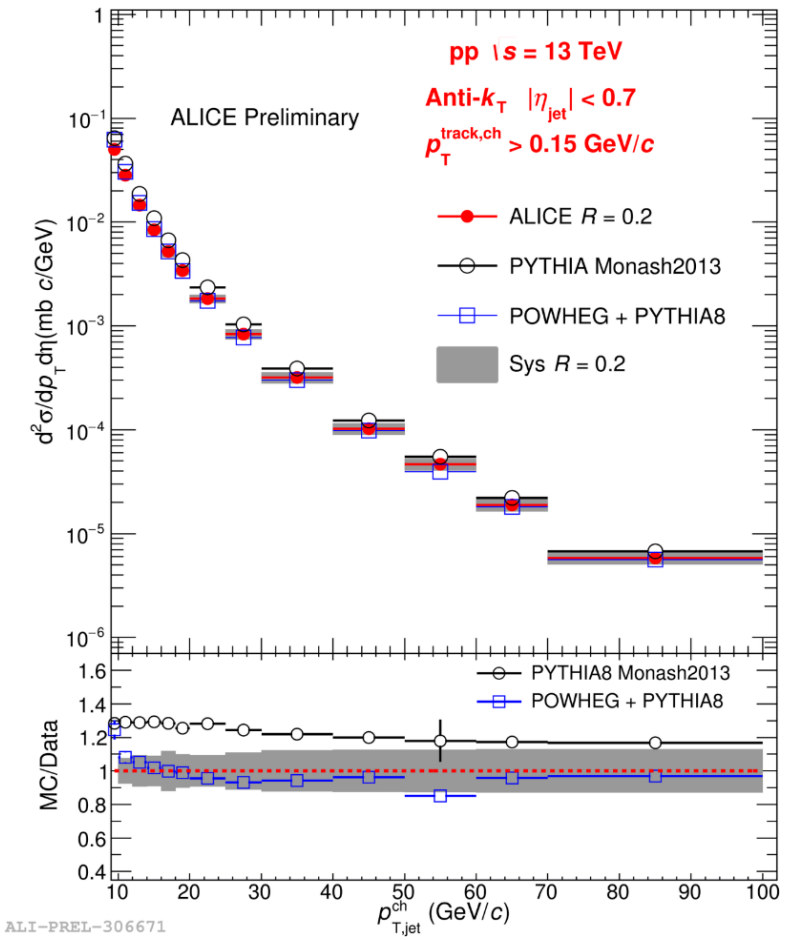
Unfolding correction for detector effects

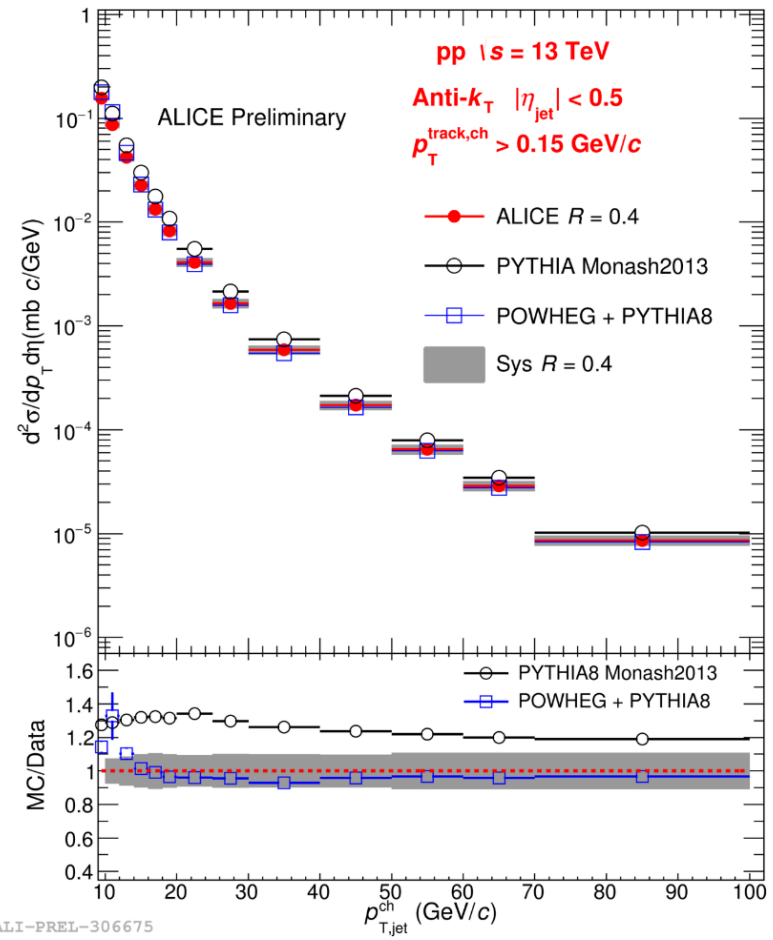




- Detector response is obtained with MC simulation for jet energy scale and resolution correction
- Residual distribution shows the relative p_T shift between particle and detector levels, in four particle jet p_T intervals.
- Using this response to perform unfolding correction

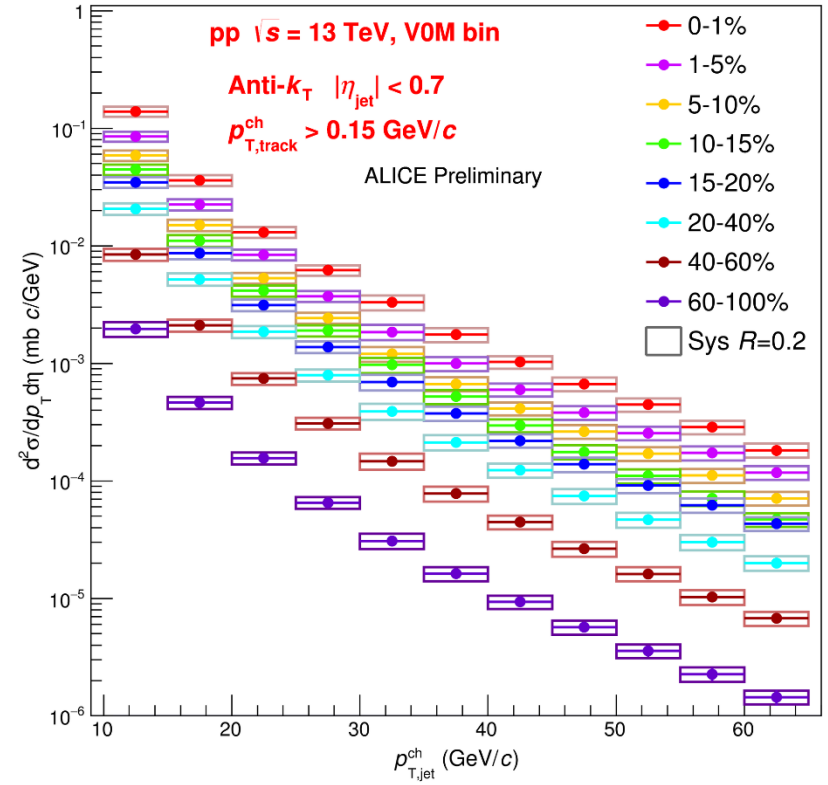
Charged jet cross section in pp@13 TeV

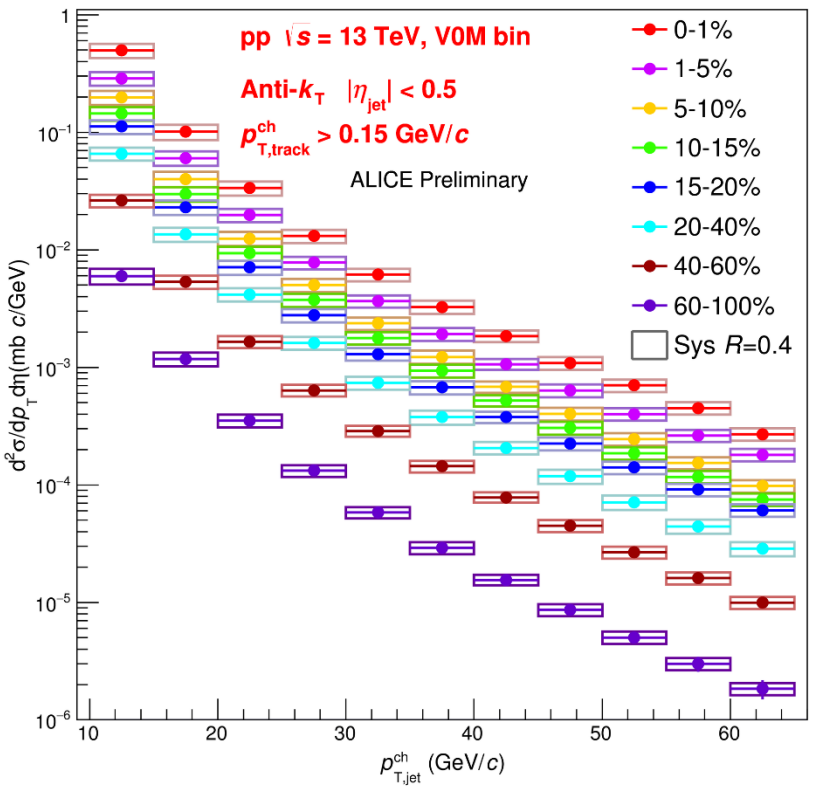




- Charged jet cross sections measured for R=0.2 and R=0.4
- Cross sections are compared with different MC calculations, POWHEG + PYTHIA8 (NLO pQCD+parton shower+hadronization) agrees with data

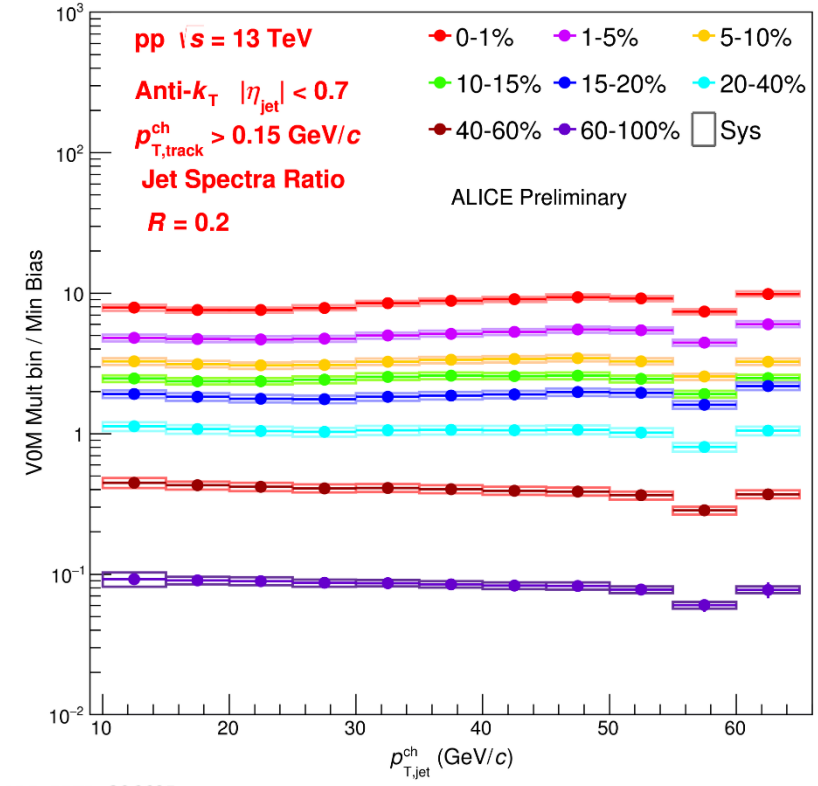
Multiplicity dependent charged jet production

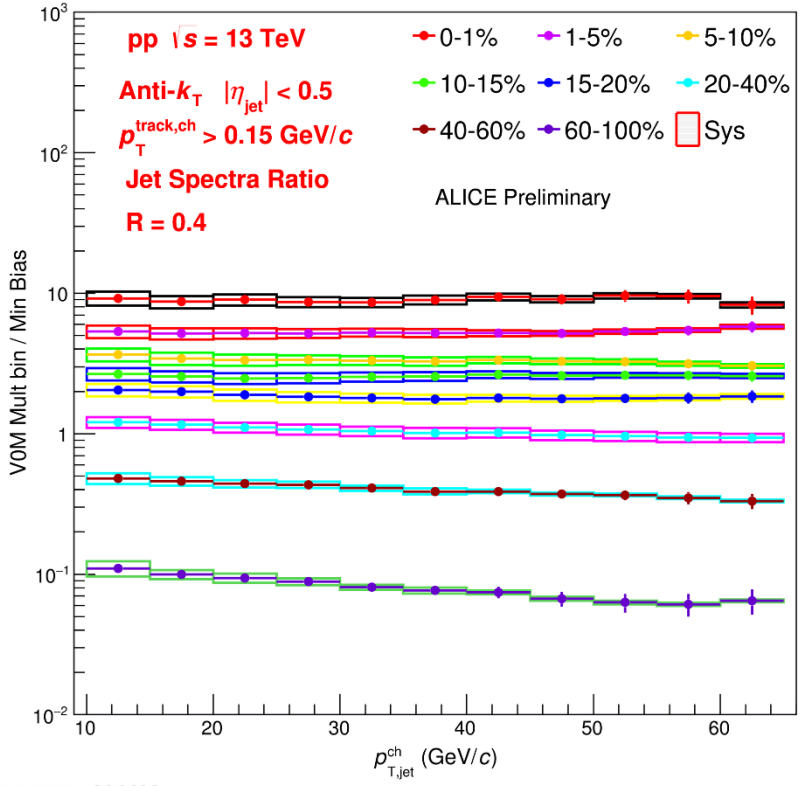




- Charged jet cross sections in different multiplicity bins for R = 0.2 and R = 0.4 in pp collisions
- More jets are produced in high multiplicity events compared to low multiplicity bins

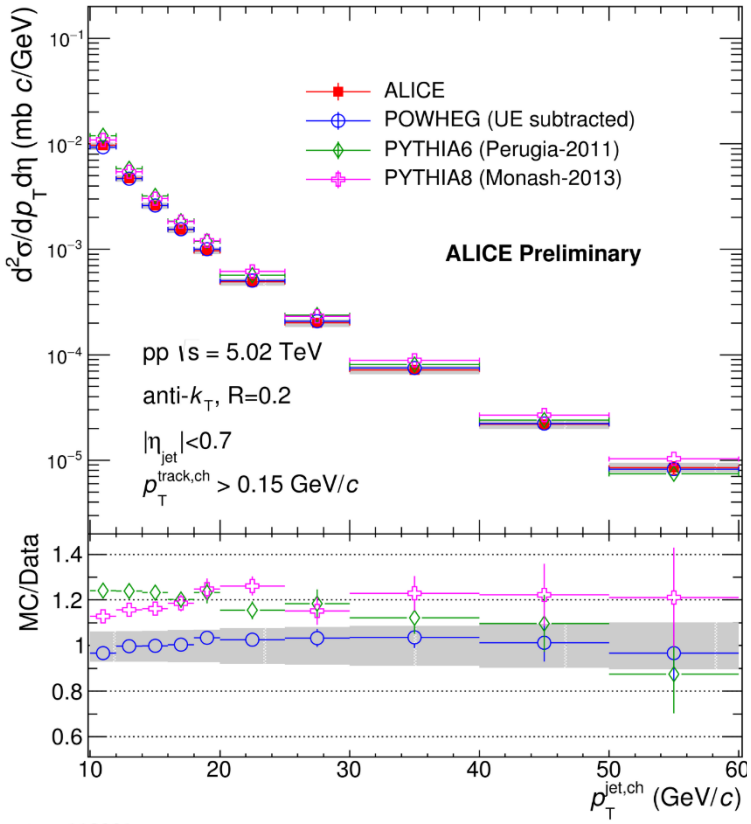
Jet spectra ratio in different multiplicity to MB one



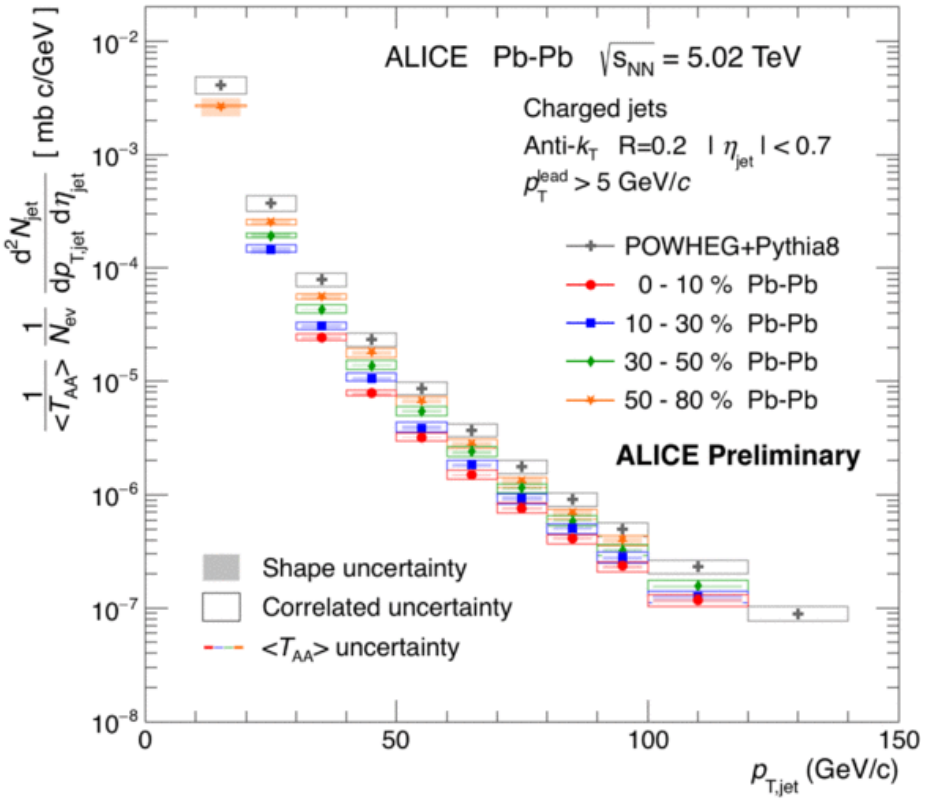


- Ratio for charged jet cross sections in different multiplicity intervals with respect to MB one in pp collision
- Cross section ratio has week p_T and resolution parameter R dependence in different multiplicity bins

Jet productions in 5.02 TeV pp & PbPb collisions



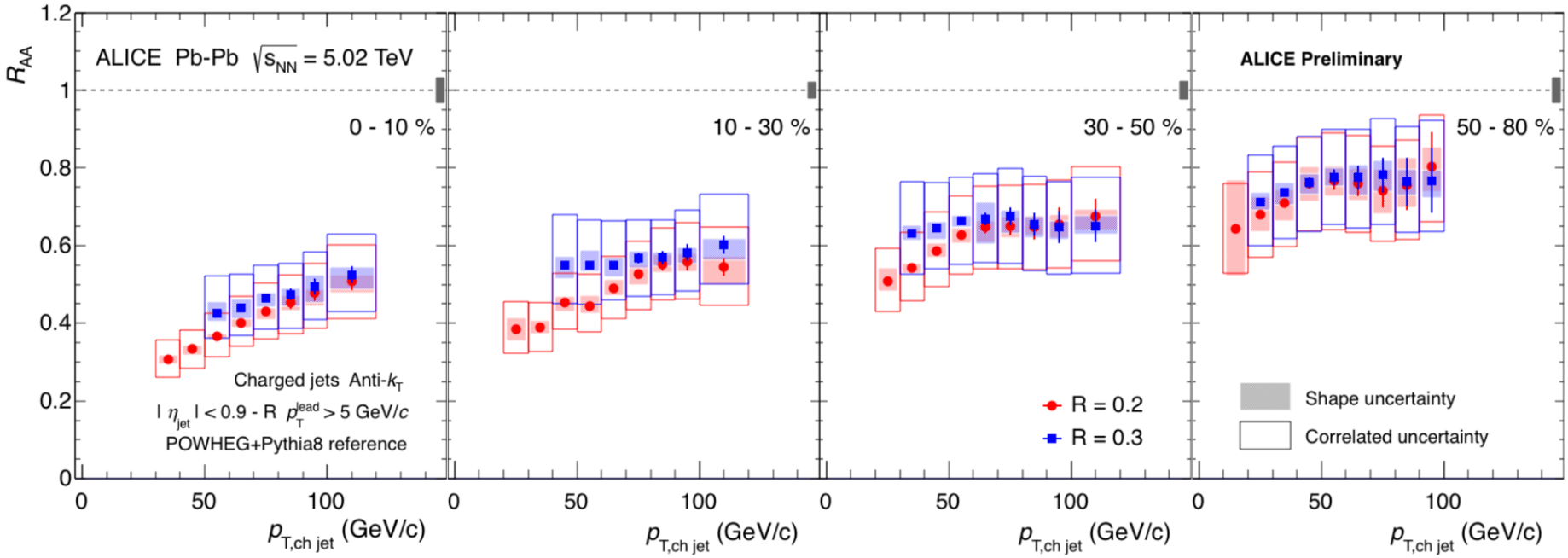
ALI-PREL-113801



ALI-PREL-156109

- Similar measurements are performed in pp and PbPb collisions at 5.02 TeV
- Jet cross section is well described by POWHEG+PYTHIA8 predictions (NLO pQCD+parton shower+hadronization) in pp collisions
- Centrality ordered jet production found in PbPb collisions

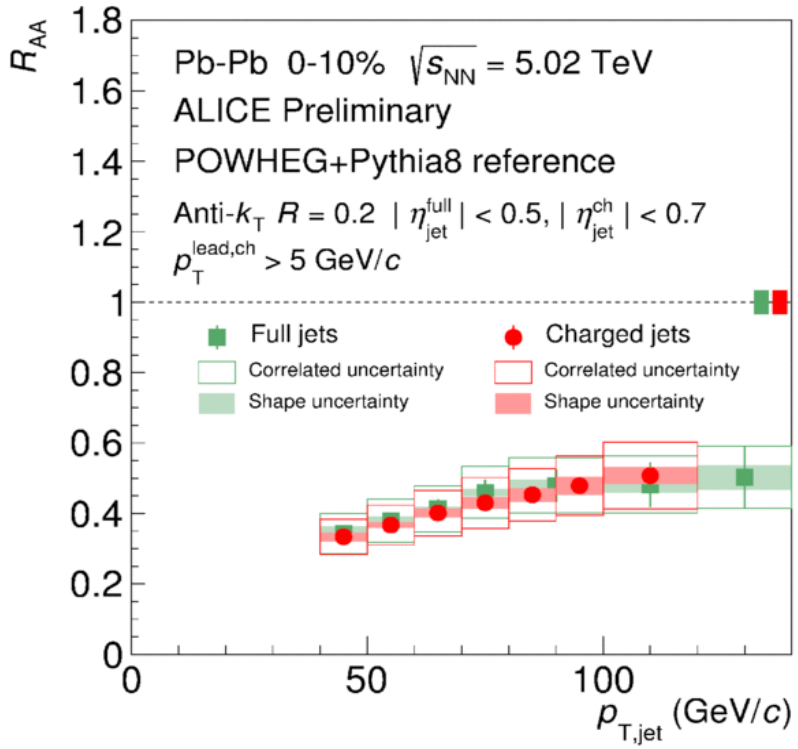
Jet nuclear modification factor R_{AA}

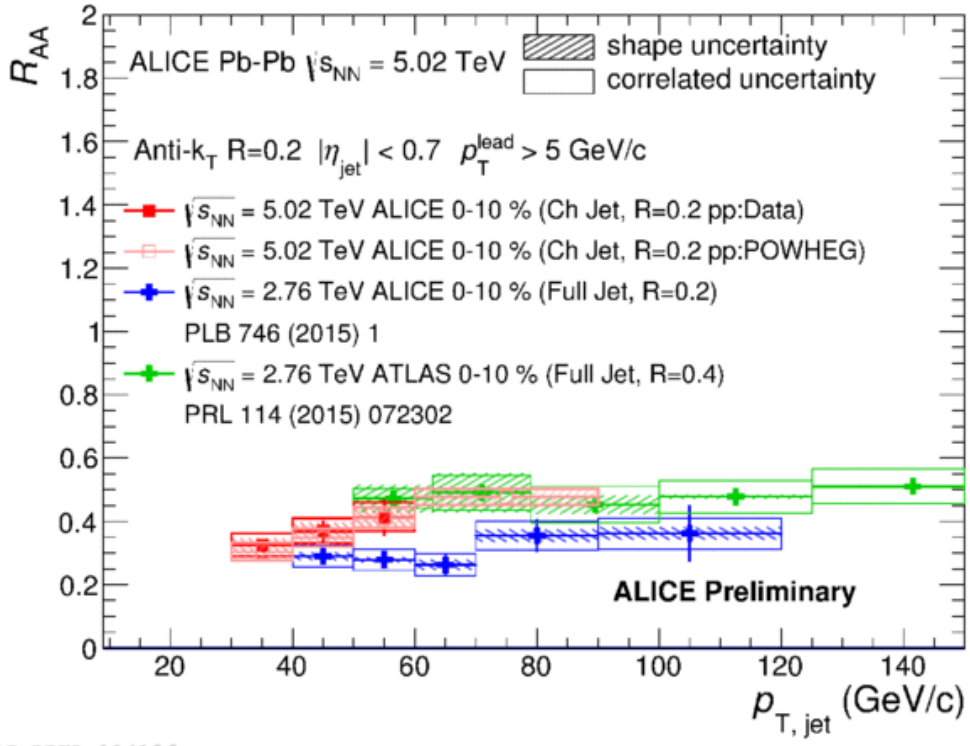


$$R_{AA} = \frac{dN_{jets}^{AA}/dp_T d\eta}{< T_{AA} > d\sigma_{jets}^{pp}/dp_T d\eta}$$

- Strong suppression is observed in central Pb-Pb collisions
- Less suppression for peripheral events
- R_{AA} of different radius jets are consistent with systematic errors

Jet R_{AA} comparison

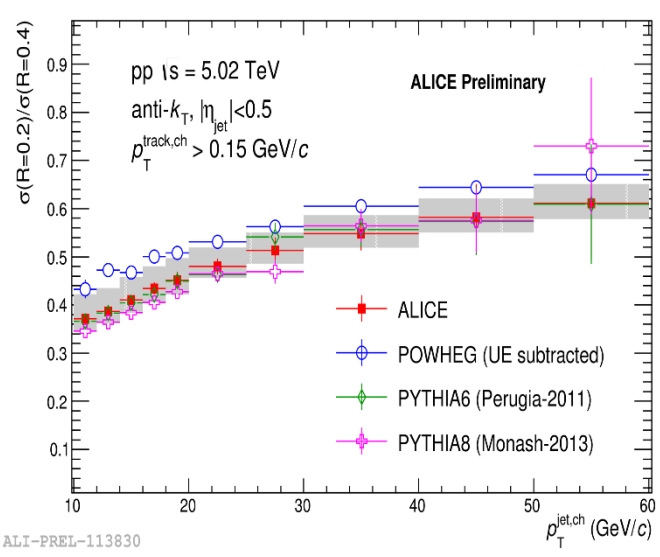


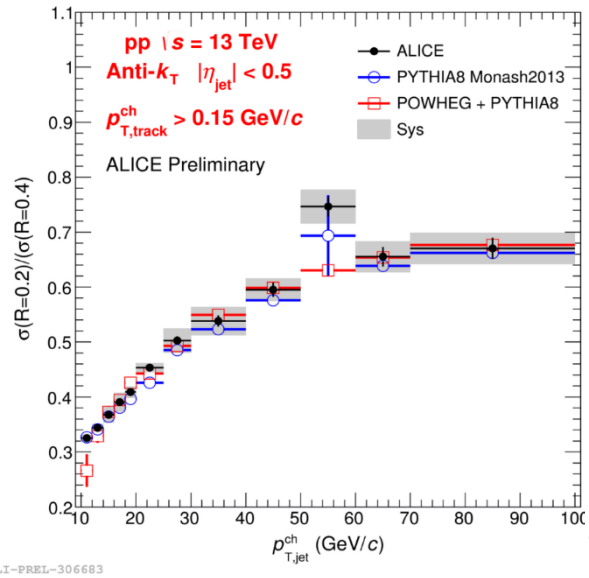


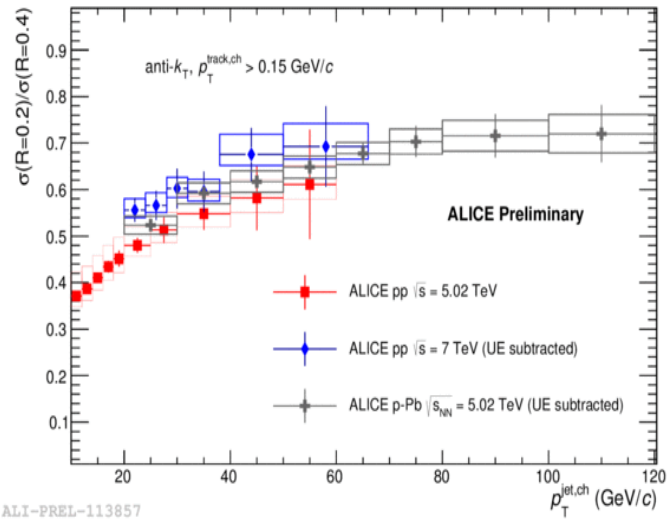
- Full jets and charged jets R_{AA} are consistent
- R_{AA} in different collision energies are similar
  - Compensating effect of flattening of the spectrum and stronger jet suppression in higher collision energy

$$R_{AA} = \frac{dN_{jets}^{AA}/dp_T d\eta}{< T_{AA} > d\sigma_{jets}^{pp}/dp_T d\eta}$$

Jet cross section ratio: R = 0.2/R = 0.4

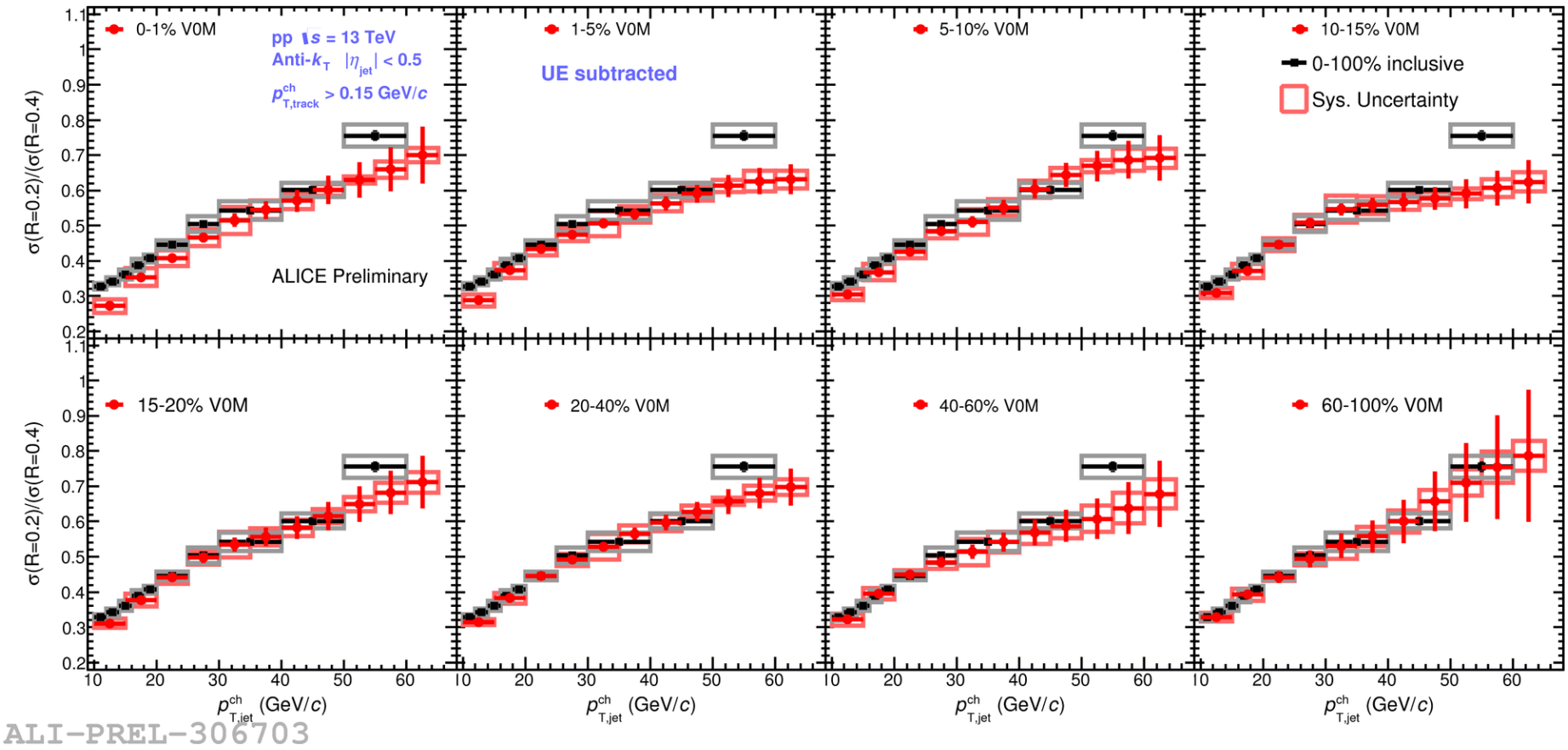






- Jet cross section ratio measurements reflect jet collimation information
- Different jet cross section ratio is slightly increasing with jet p_T , and consistent with Monte Carlo simulation
- Similar jet cross section ratios for different $\sqrt{s}$ and collision model

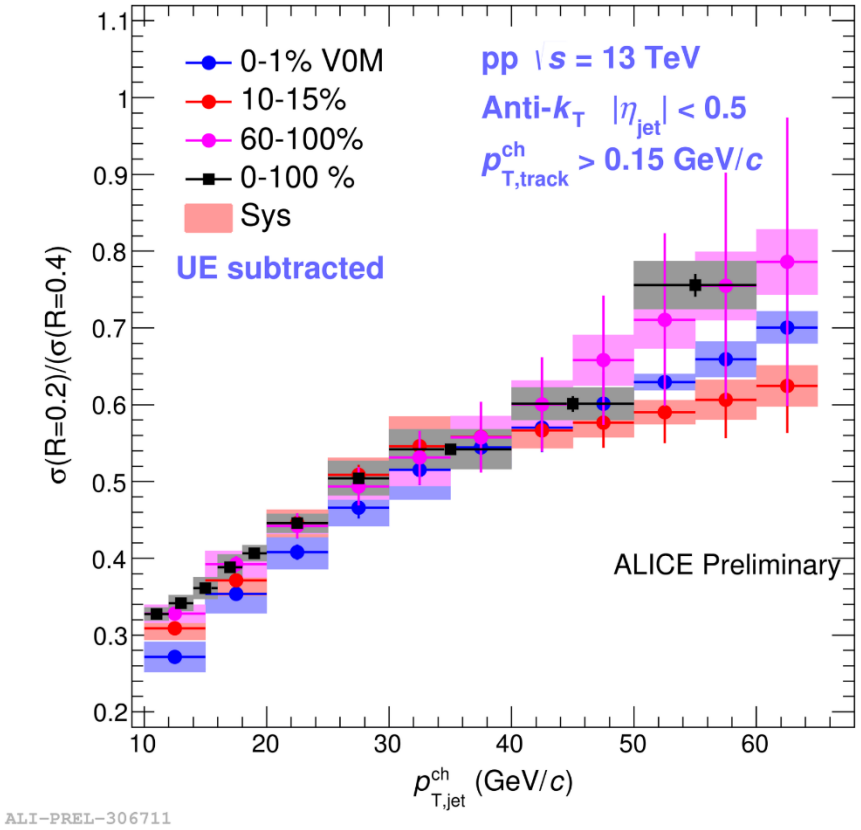
Jet cross section ratio in different multiplicity bins

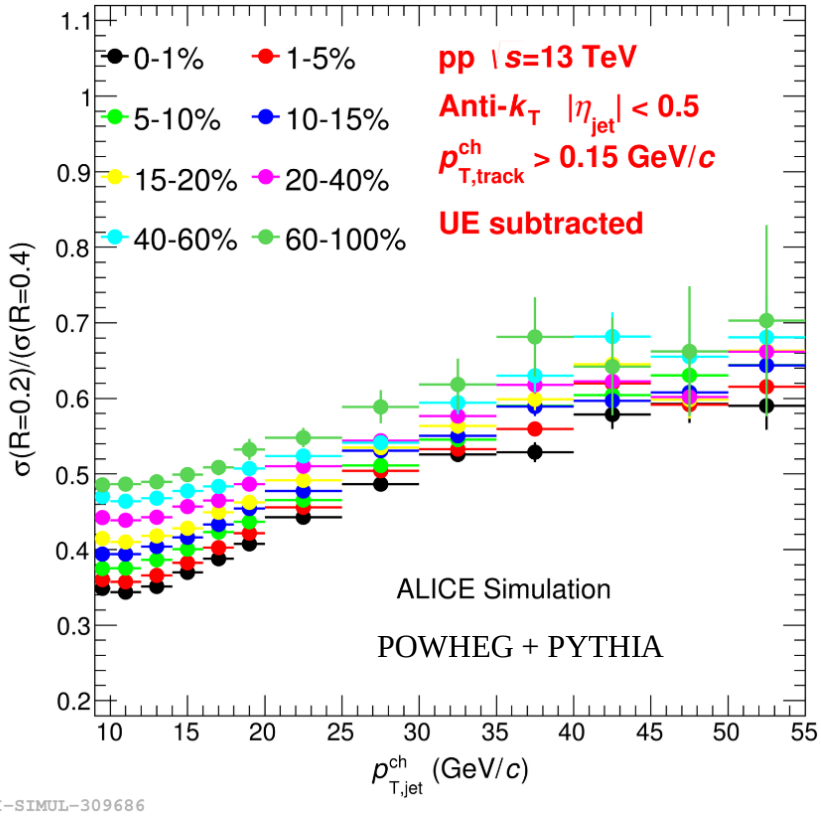


ALI-PREL-306703

- Jet cross section ratio between R=0.2 and R=0.4 in different multiplicity intervals
- No strong multiplicity dependence in ratio of the jet spectra

Cross section ratio from data and MC





- Jet cross section ratio from data shows no centrality dependence while MC indicates centrality ordering
  - Inclusive jet cross section can be reproduced by POWHEG calculation but not the centrality dependent cross section ratio in pp collisions

→ Multiplicity differences or other mechanism?

Summary

- Charged jet production studied in pp and Pb-Pb collisions
- Inclusive jet cross sections in pp collisions can be reproduced by POWHEG+PYTHIA8
- Multiplicity dependent jet cross section is measured
  - Higher(lower) jet yield in high(low) multiplicity events compared to inclusive one
  - Jet production ratios have no significant dependence of jet p_T and resolution parameters
- Nuclear modification factor (R_{AA}) has been measured
  - Centrality dependent jet suppression is observed in PbPb collisions
  - Full jets and charged jets R_{AA} are consistent
- Jet cross section ratio in different radii are studied
  - Slightly increasing with jet p_T, consistent with Monte Carlo simulation
  - No multiplicity dependence from data, show multiplicity dependent from MC

Thanks

BACKUP

Multiplicity percentile categories

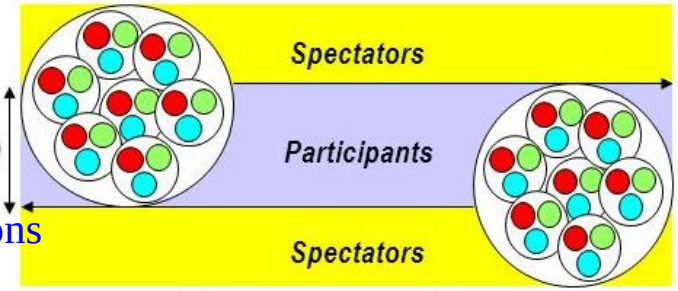
- Multiplicity and energy of produced particles are correlated with geometry of collisions

- Impact parameter (b)

  determines

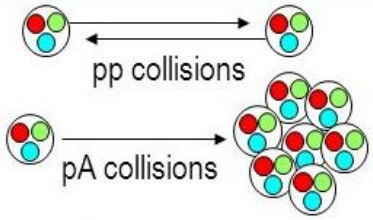
  N_{part} – 1 or more collisions

  N_{coll} – binary collision



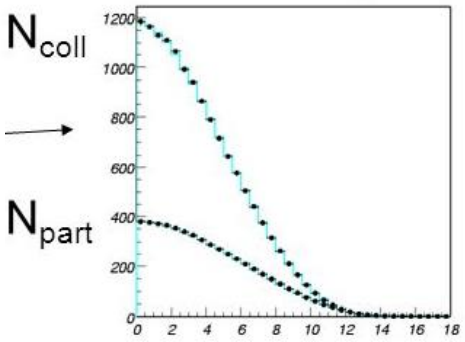
- Proton-nucleus:

  $N_{coll} = N_{part} + 1$ -

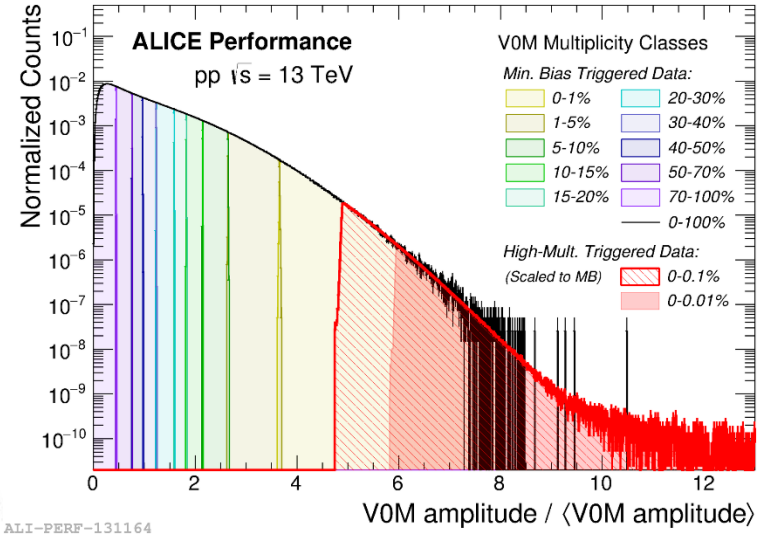


- Nucleus-Nucleus

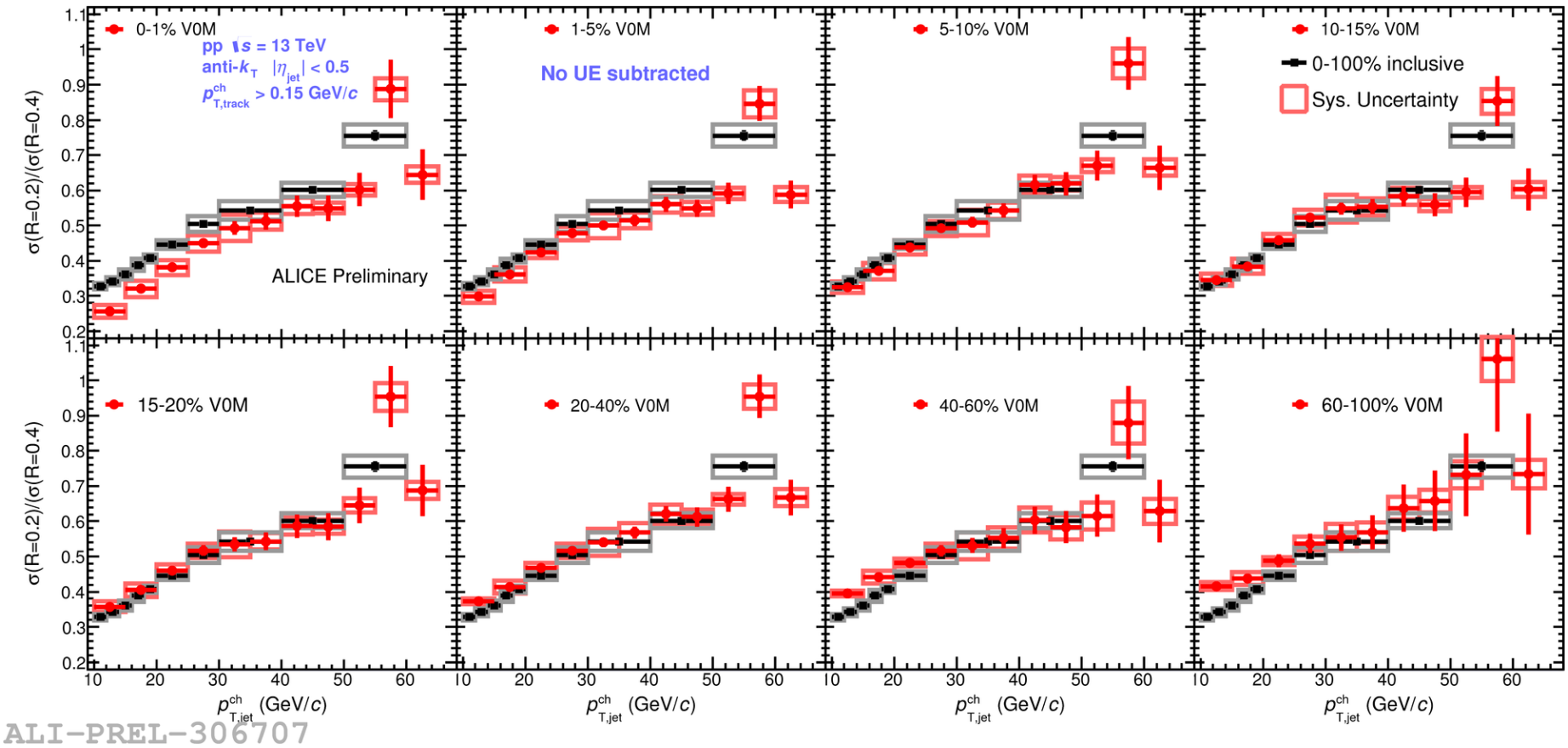
  $N_{coll} \propto N_{part}^{4/3}$



Useful quantities to compare Au + Au to N+N collision !



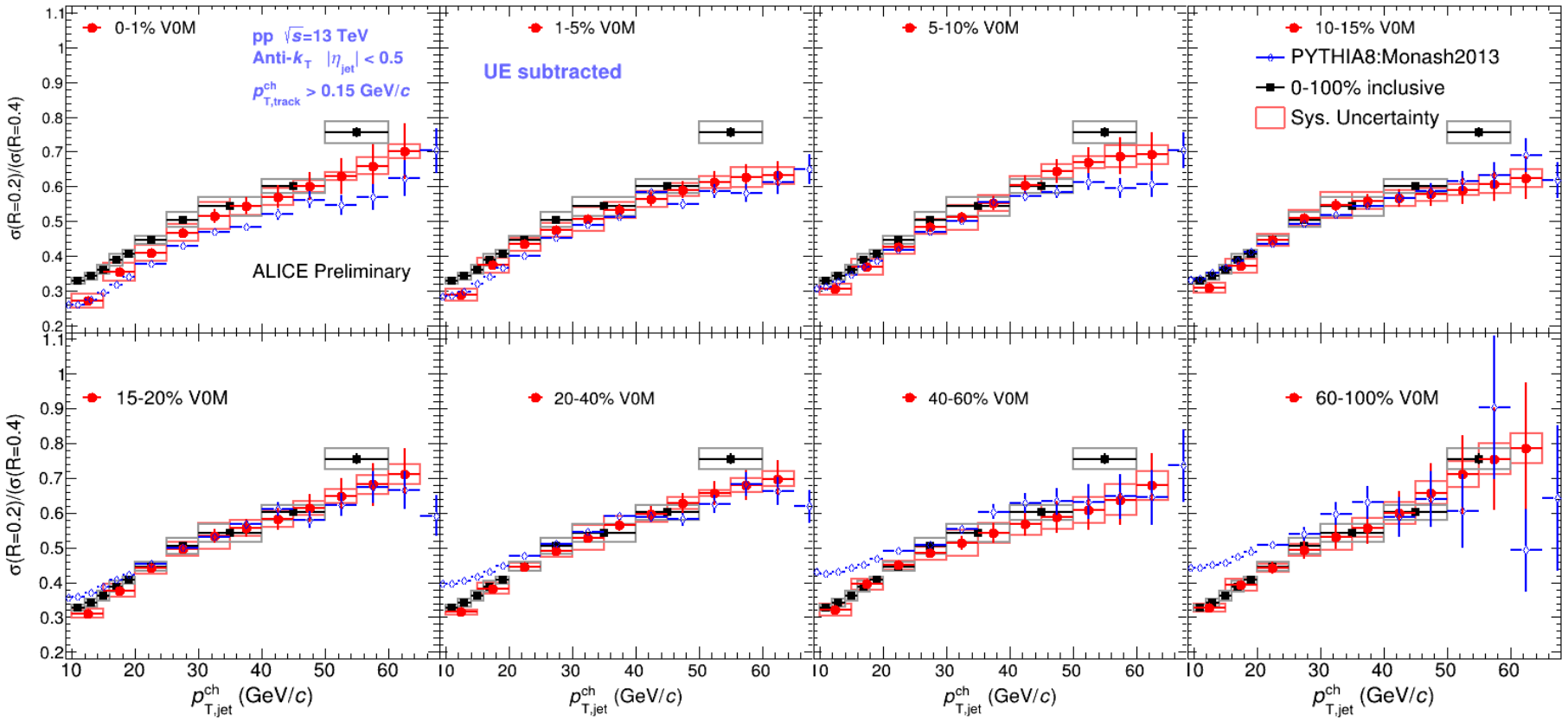
Jet spectra cross section ratio without UE subtracted



ALI-PREL-306707

- Without / with UE subtracted cross section ratio are similar
- Weak multiplicity dependence in ratio of the jet spectra

Comparison jet cross section ratio with model



- Weak multiplicity dependence in ratio of the jet spectra
- Similar trends observed with PYTHIA