System and event activity dependent inclusive jet production with ALICE

Yongzhen Hou for ALICE Collaboration

Central China Normal University

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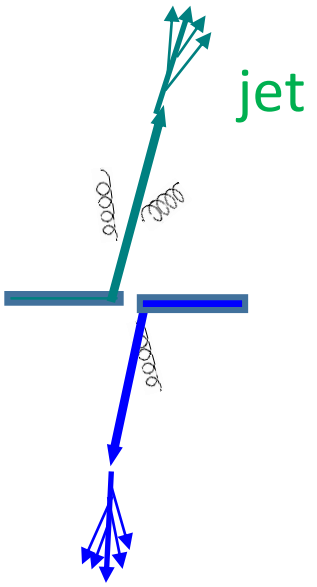
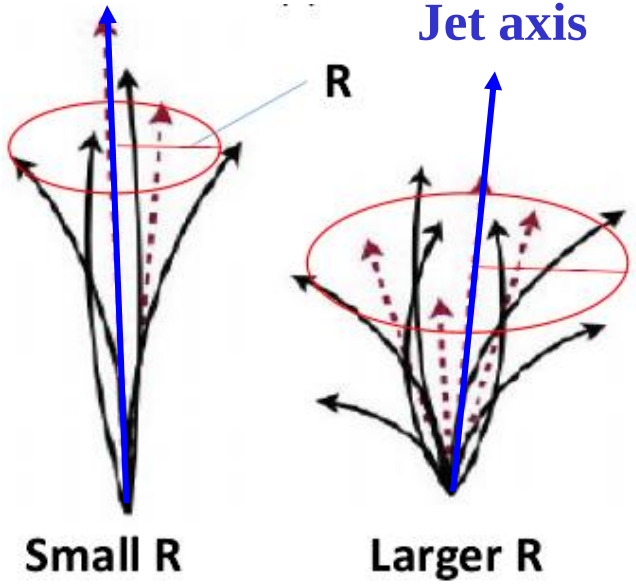
Why the study of jets at the LHC

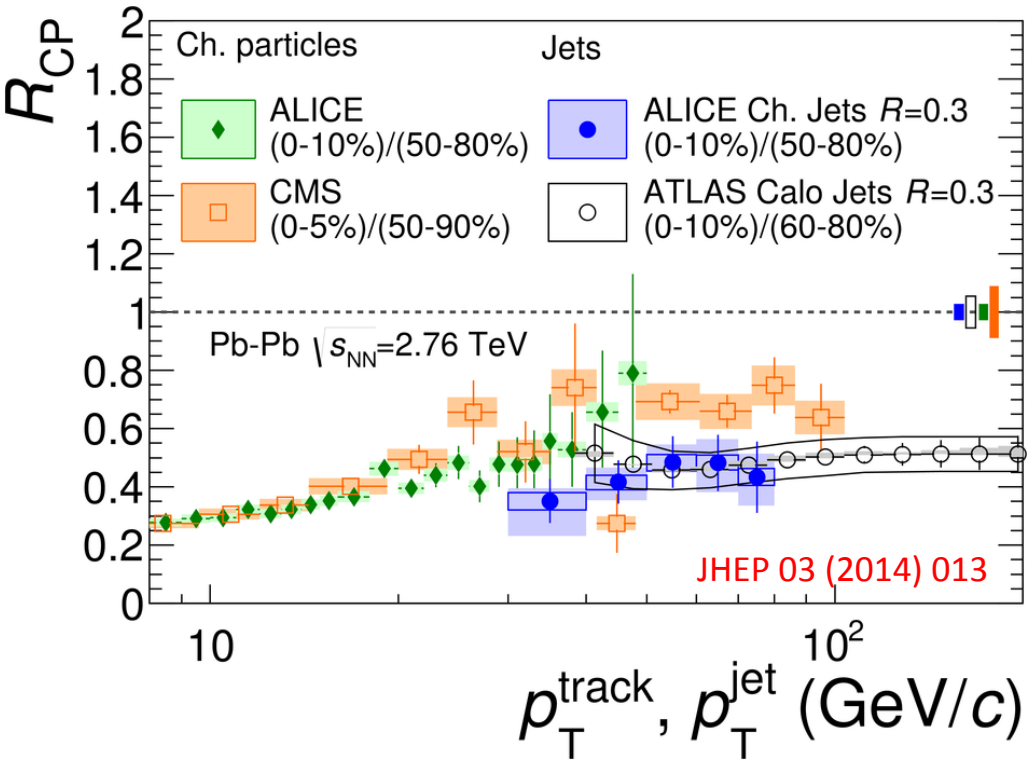
- Jet cross section provides constraints to pQCD calculations
- Investigate the splitting function of parton in vacuum: close to original collimation information.

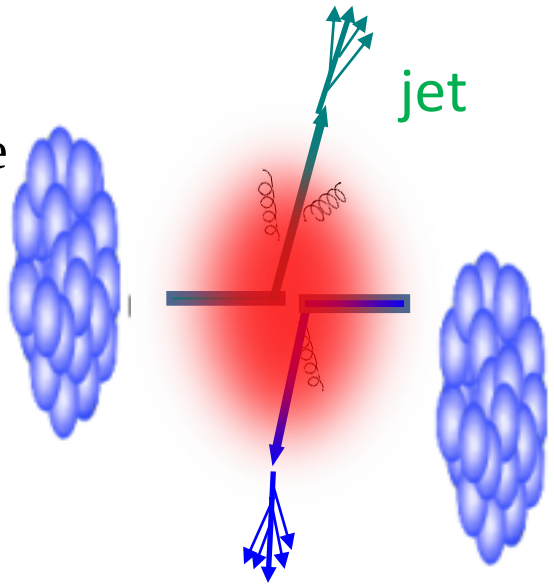


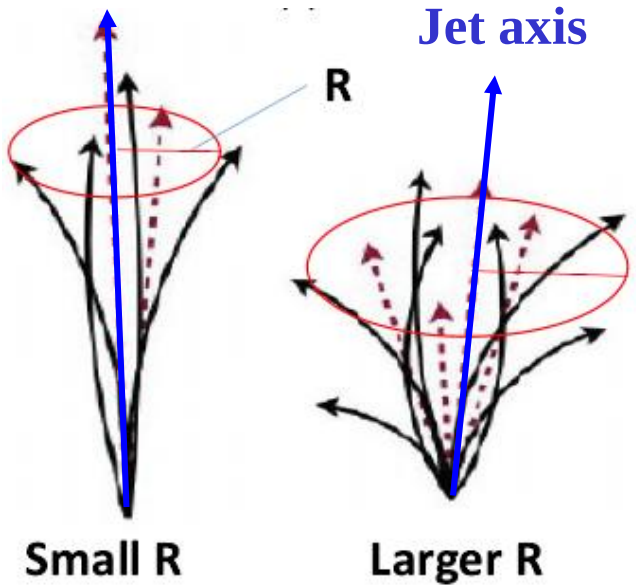


Why the study of jets at the LHC

- Jet cross section provides constraints to pQCD calculations
- Investigate the splitting function of parton in vacuum: close to original collimation information.
- Study jet quenching effect in nucleus-nucleus collision.

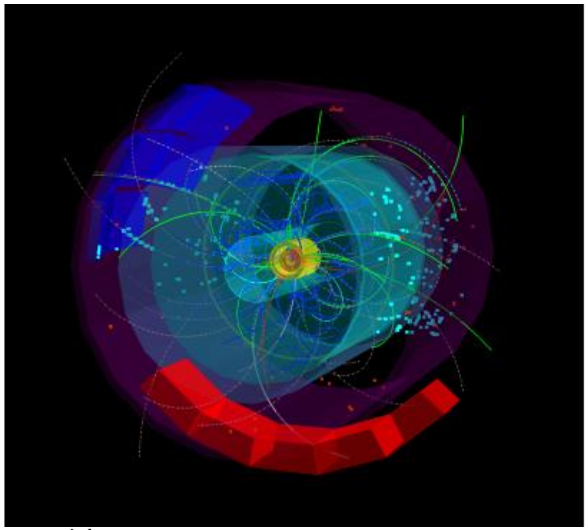




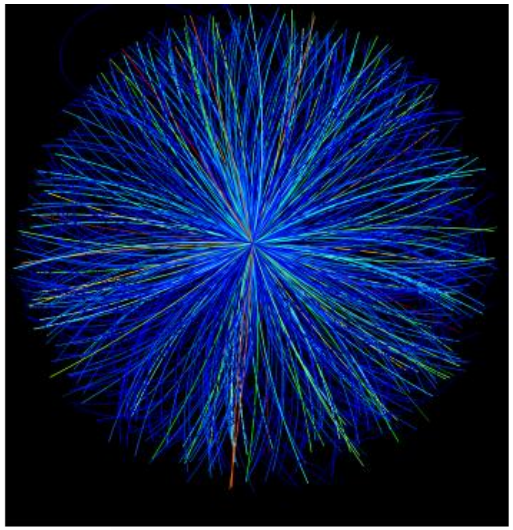


Why the study of high multiplicity jets

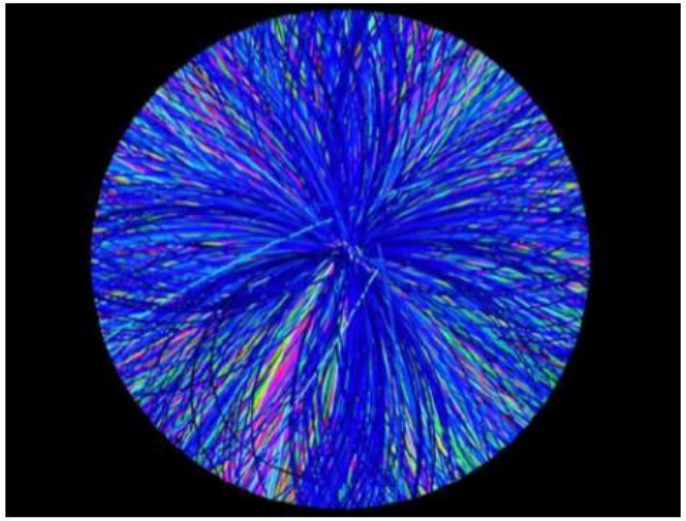
pp: Minimum bias

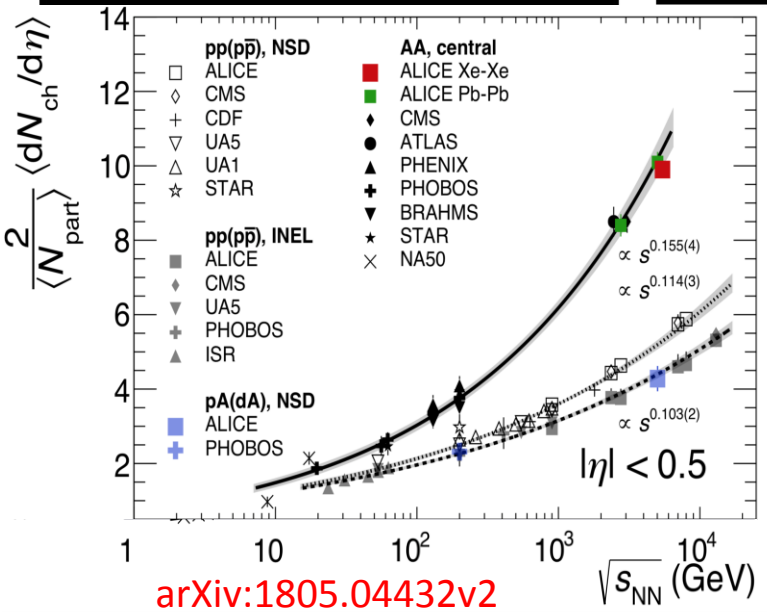


pp: high multiplicity



Pb-Pb





arXiv:1805.04432v2

- Charged particle density increases with $\sqrt{s}$ for different collision systems
- High particle multiplicity pp events can have similar particle multiplicity as in pA/AA collisions
  - What happens for jet production in high particle multiplicity environment: quenching? enhancement?

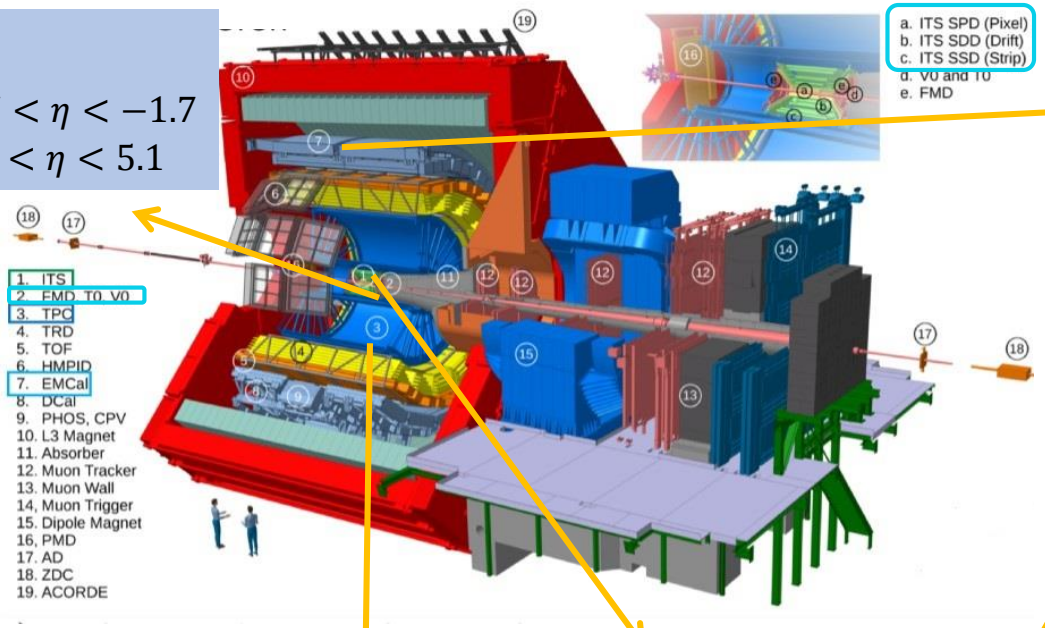
Jet measurements in ALICE

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

V0

$-3.7 < \eta < -1.7$

$2.8 < \eta < 5.1$



EM calorimeter

$|\eta| < 0.7,\ 80° < \varphi < 187°$

Remove charged particle contributions

Neutral constituents

$E_{\mathrm{cluster}} > 0.3$ GeV

full jet

ITS(Inner Tracking System)

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

Charged constituents

TPC (Time Projection Chamber)

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

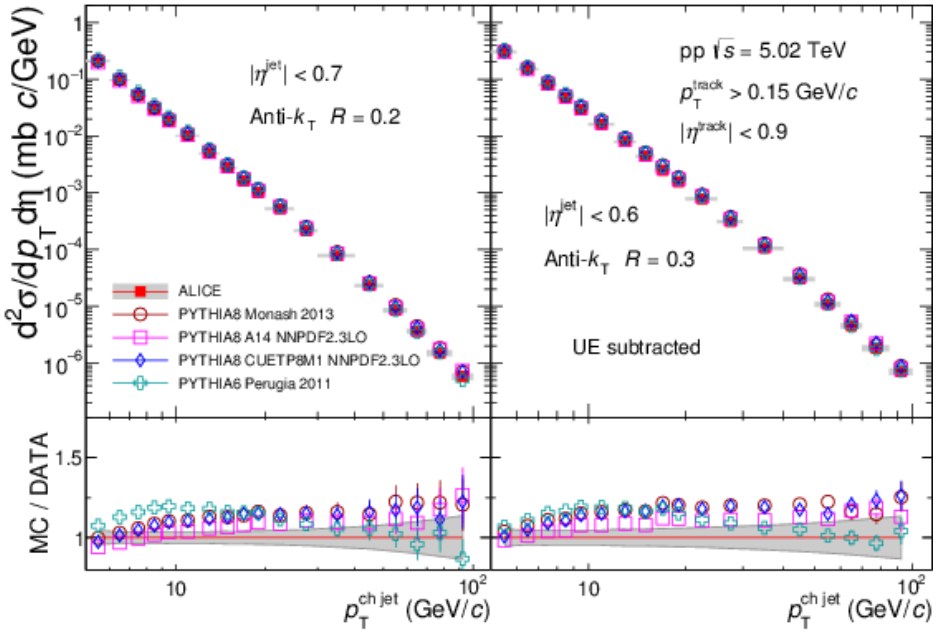
$p_{\mathrm{T}}^{\mathrm{track}} > 0.15$ GeV/c

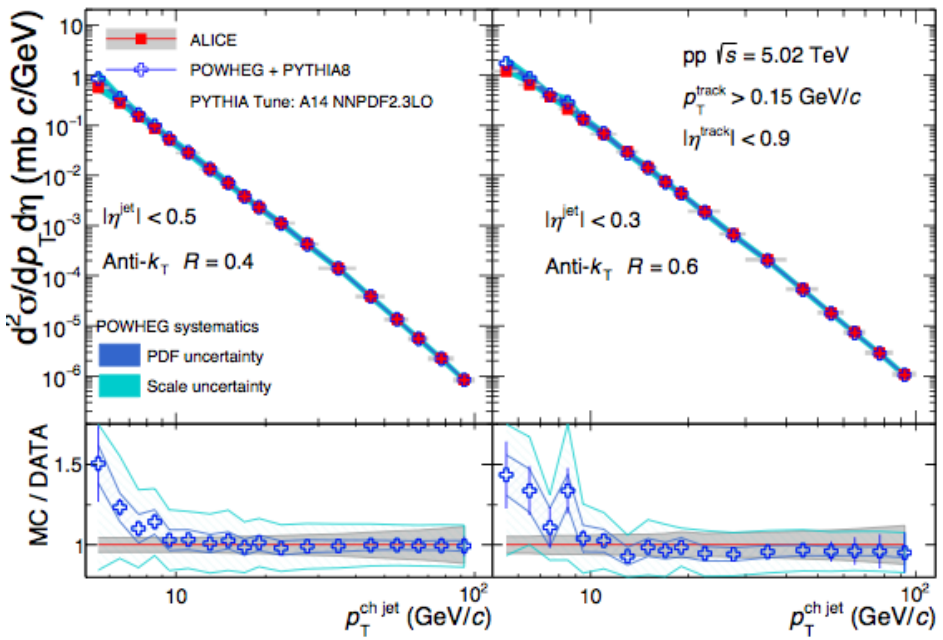
Charged jet

Measurement of charged jets in pp and Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV

Cross section in pp collisions

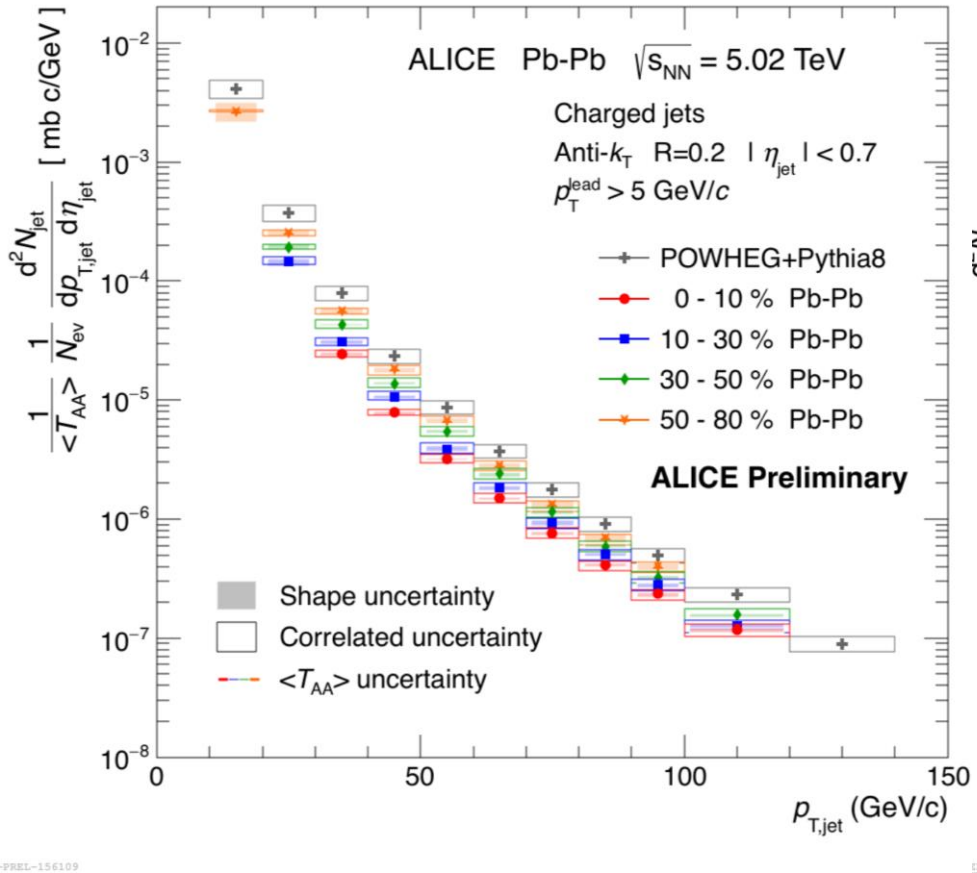
ALICE, arXiv:1905.02536

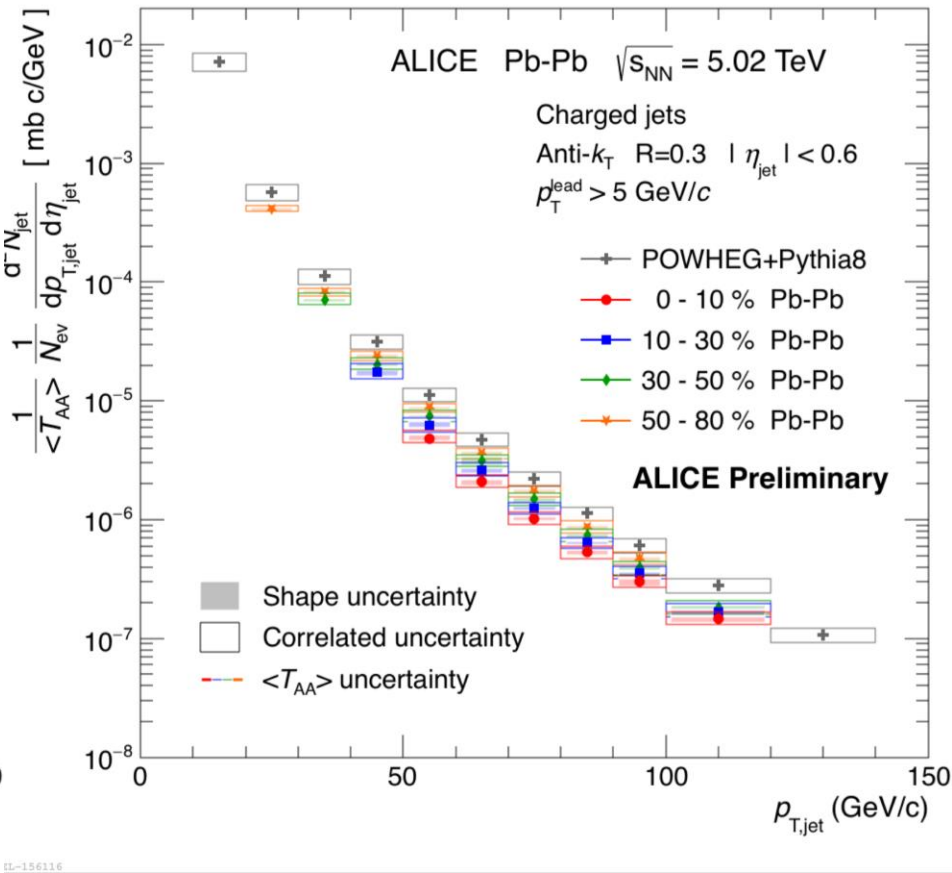




- Charged jets are reconstructed using different resolution parameters and down to very low p_T ($p_{T,jet}$ >5 GeV/c)
- Jet cross section is well described by POWHEG+PYTHIA8 predictions (NLO pQCD+parton shower+hadronization) within systematic uncertainties

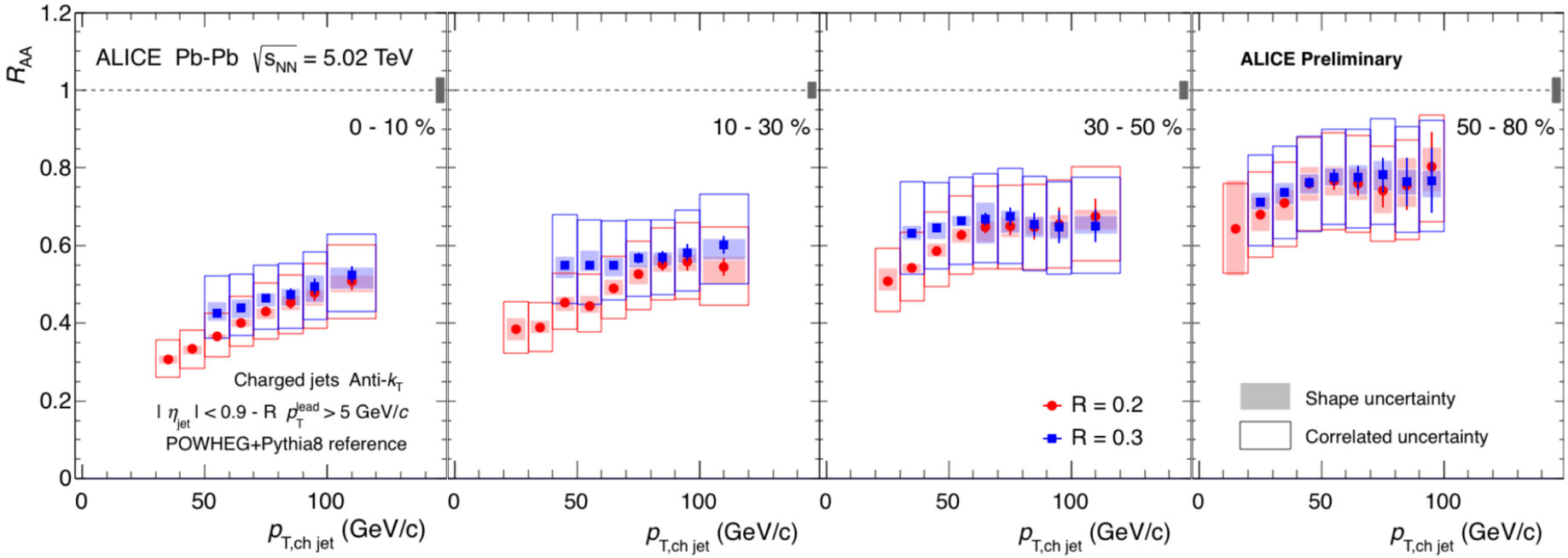
Spectrum in Pb-Pb collisions





- Charged jet spectra in different centrality intervals are measured in Pb-Pb collisions with different cone radii
- Centrality ordered jet production found in Pb-Pb collisions after T_{AA} scaling

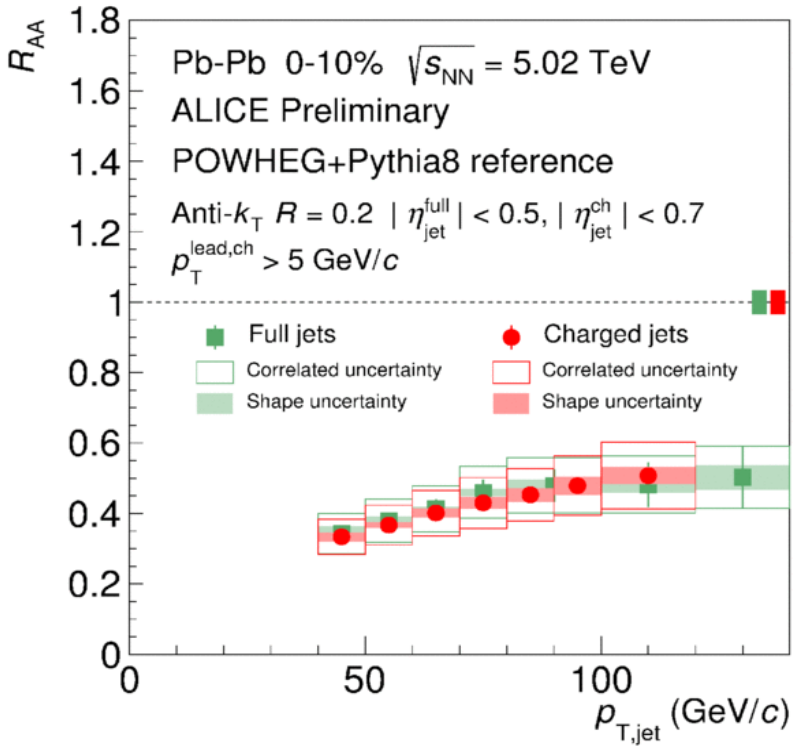
Jet nuclear modification factor R_{AA}

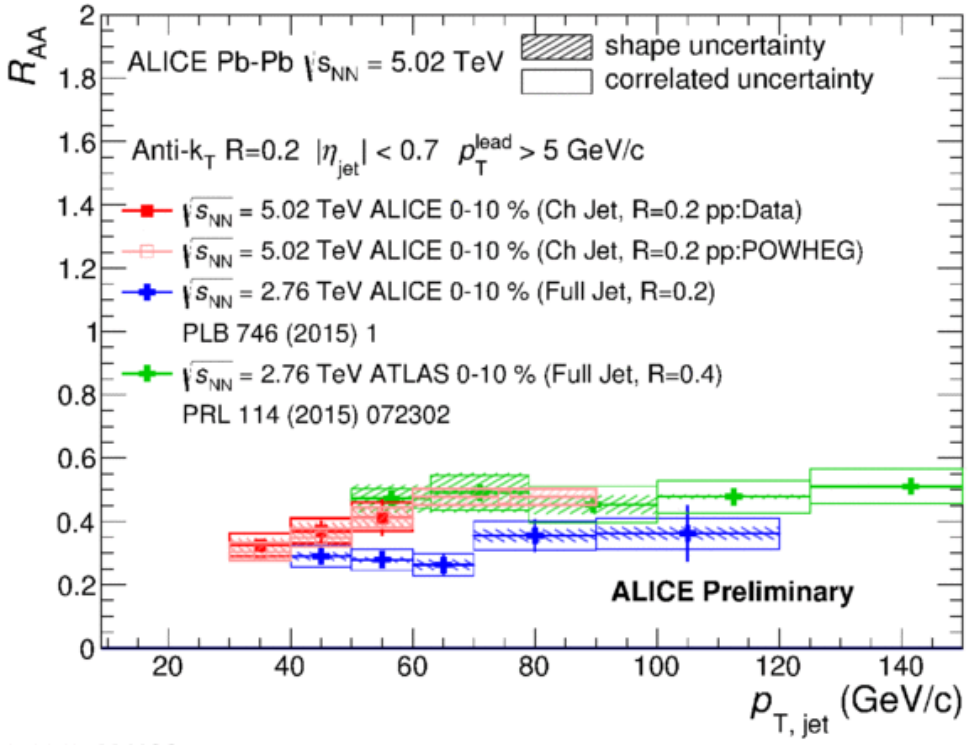


$$R_{\mathrm{AA}} = \frac{dN_{jets}^{\mathrm{AA}}/dp_T d\eta}{< T_{\mathrm{AA}} > d\sigma_{jets}^{\mathrm{pp}}/dp_T d\eta}$$

- Strong suppression is observed in central Pb-Pb collisions
- Less suppression for peripheral events
- R_{AA} of different radius jets agree with each other within uncertainties

Jet R_{AA} comparison





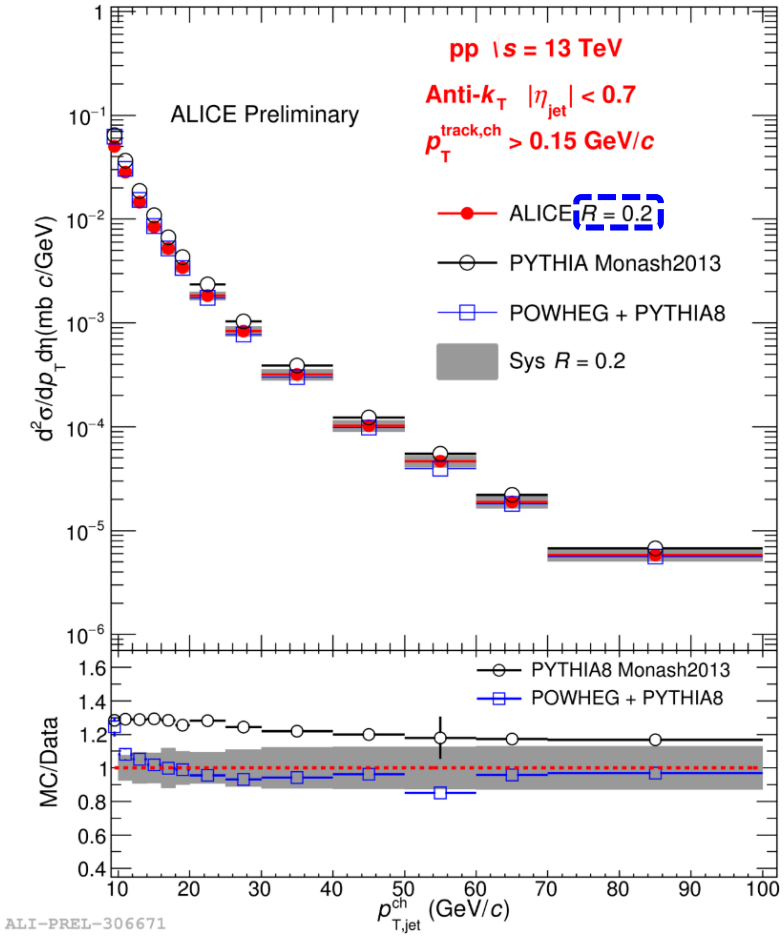
- Full jets and charged jets R_{AA} are consistent
- R_{AA} in different collision energies are similar
  - Compensating effect of flattening of the spectrum and stronger jet suppression in higher collision energy

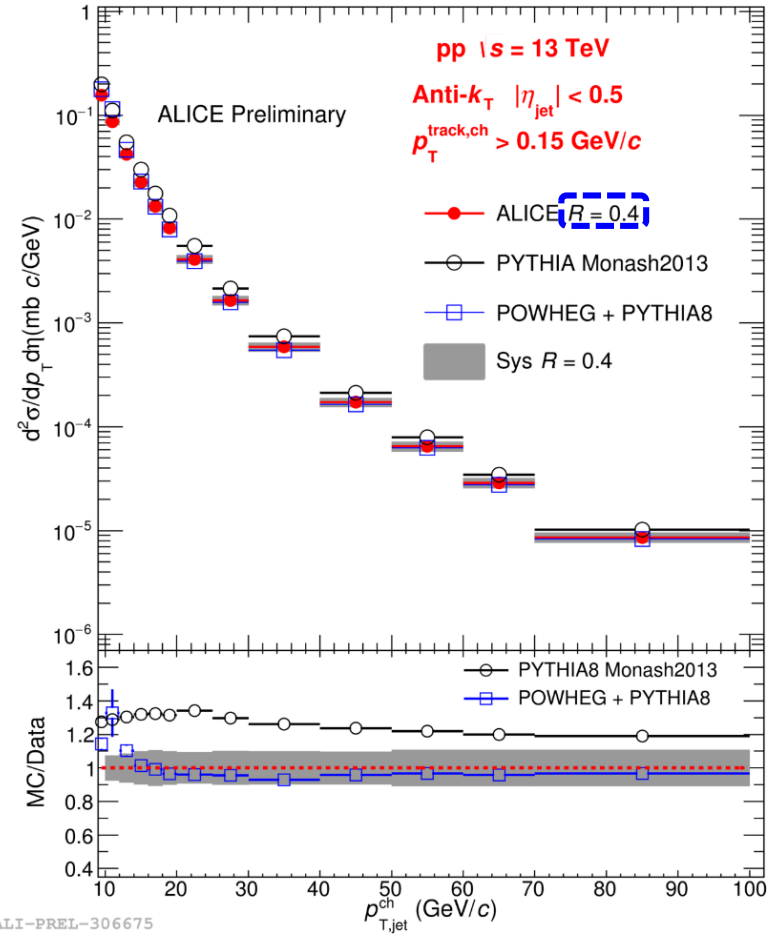
$$R_{AA} = \frac{dN_{jets}^{AA}/dp_T d\eta}{< T_{AA} > d\sigma_{jets}^{pp}/dp_T d\eta}$$

Charged jets measurements in pp collisions at

$\sqrt{s} = 13$ TeV

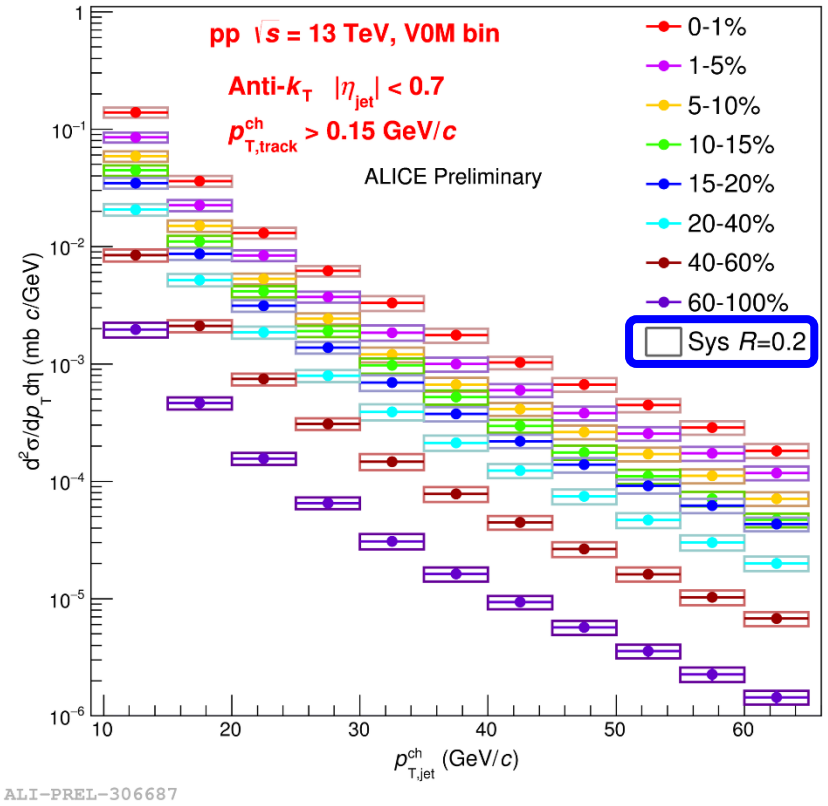
Charged jet cross section in pp collisions

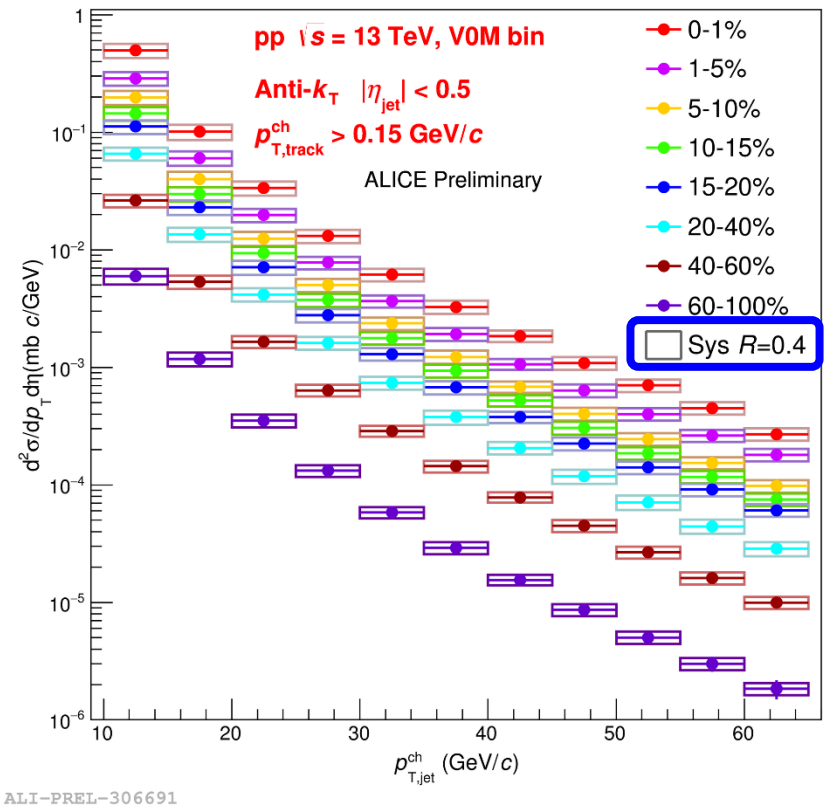




- Charged jet cross sections measured for R=0.2 and R=0.4
- Cross sections are compared with different MC calculations, POWHEG + PYTHIA8 (NLO pQCD+parton shower+hadronization) agrees with data

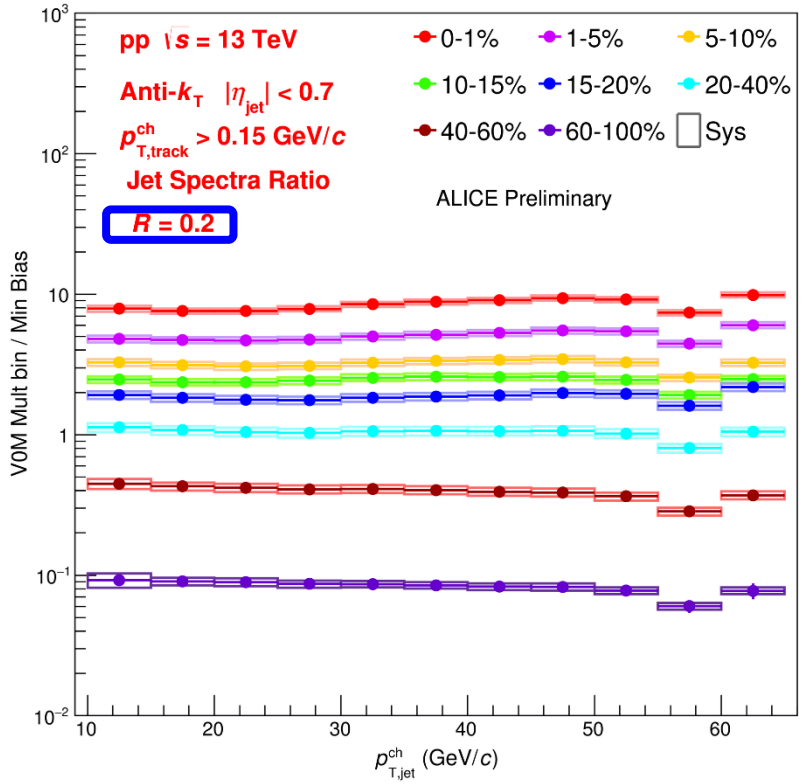
Multiplicity dependent jet production

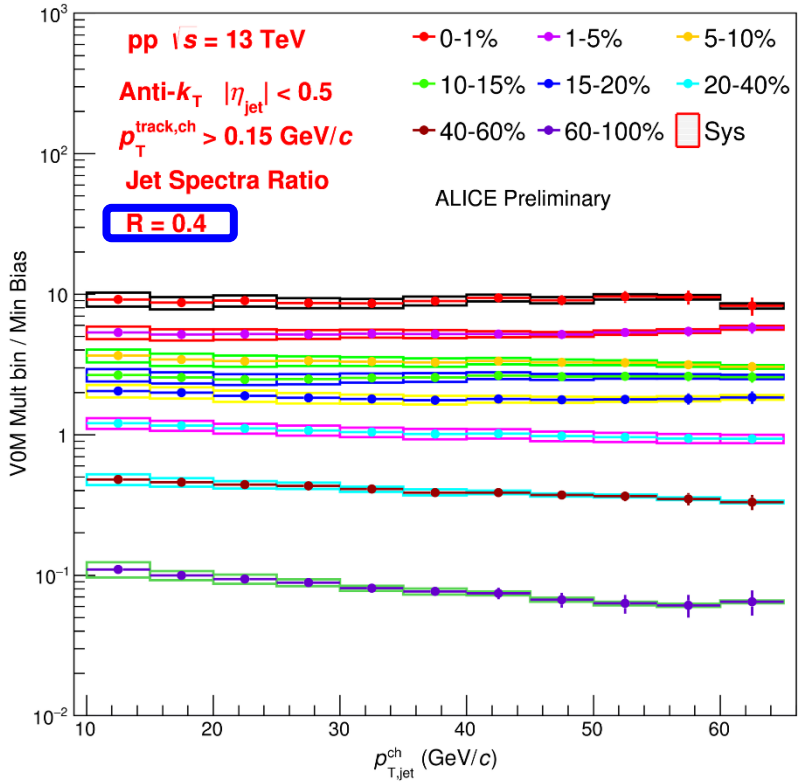




- Charged jet cross sections in different multiplicity bins for R = 0.2 and R = 0.4 in pp collisions
- More jets are produced in high multiplicity events compared to low multiplicity bins

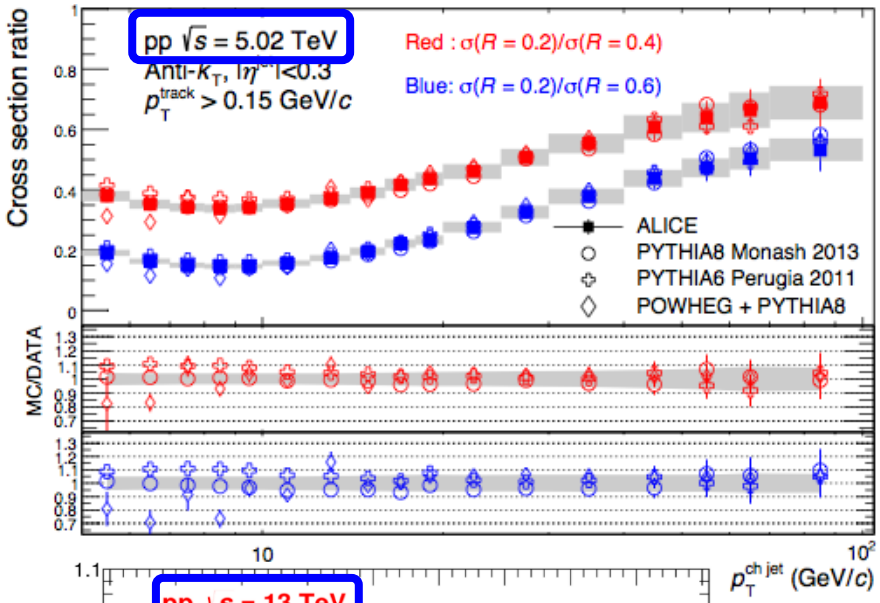
Multiplicity dependence of jet production ratio

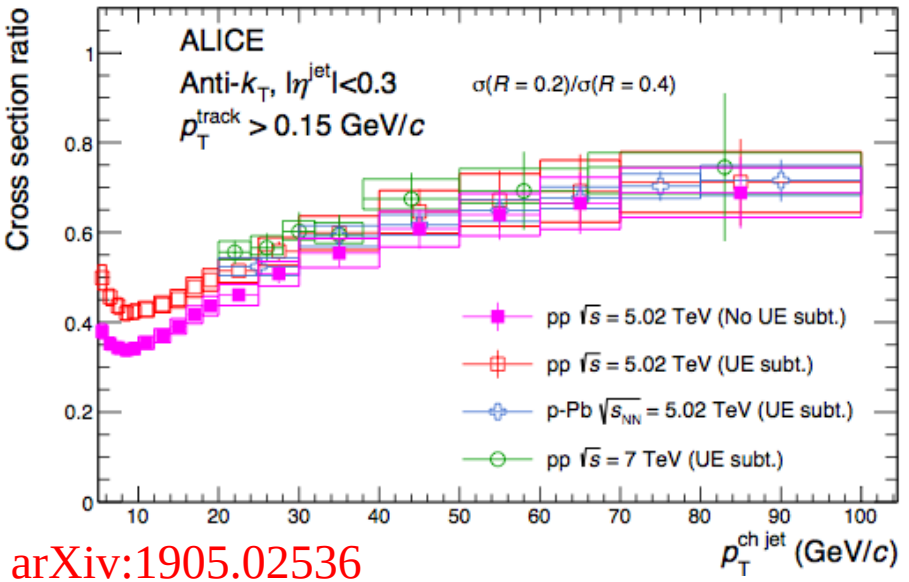




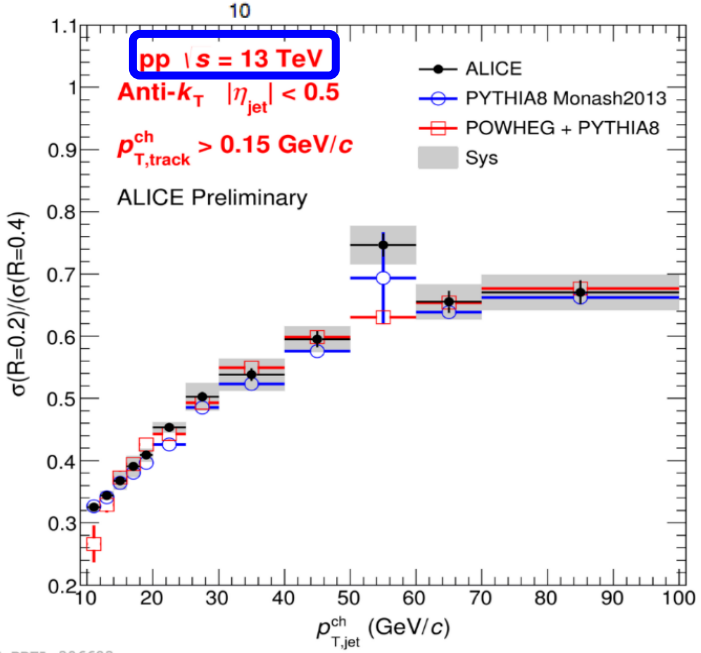
- Ratio of charged jet cross sections in different multiplicity intervals with respect to Min. bias one in pp collision
- Cross section ratio has week p_T and resolution parameter R dependence in different multiplicity bins

Jet cross section ratio: $R = 0.2/R = (0.4 \text{ or } 0.6)$



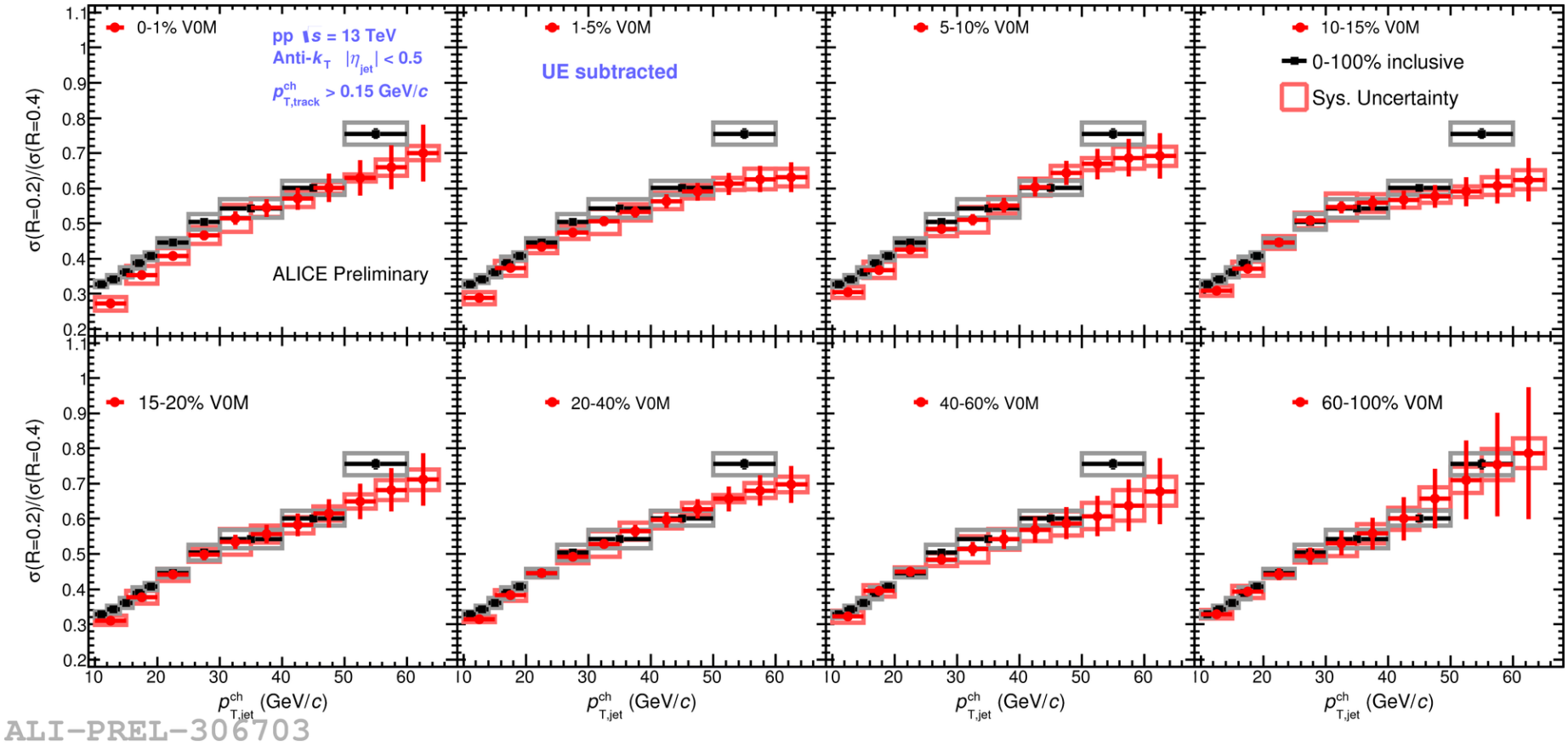


arXiv:1905.02536



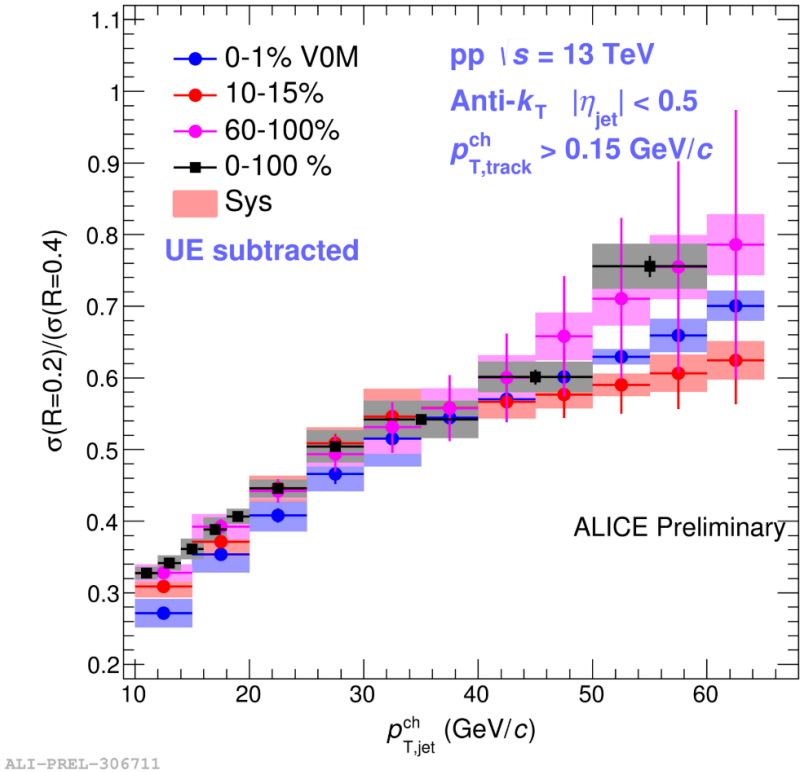
- Jet cross section ratio measurements reflect jet collimation information
- Different jet cross section ratio is slightly increasing with jet p_T, and consistent with Monte Carlo simulation
- Similar jet cross section ratios for different $\sqrt{s}$ and collision mode

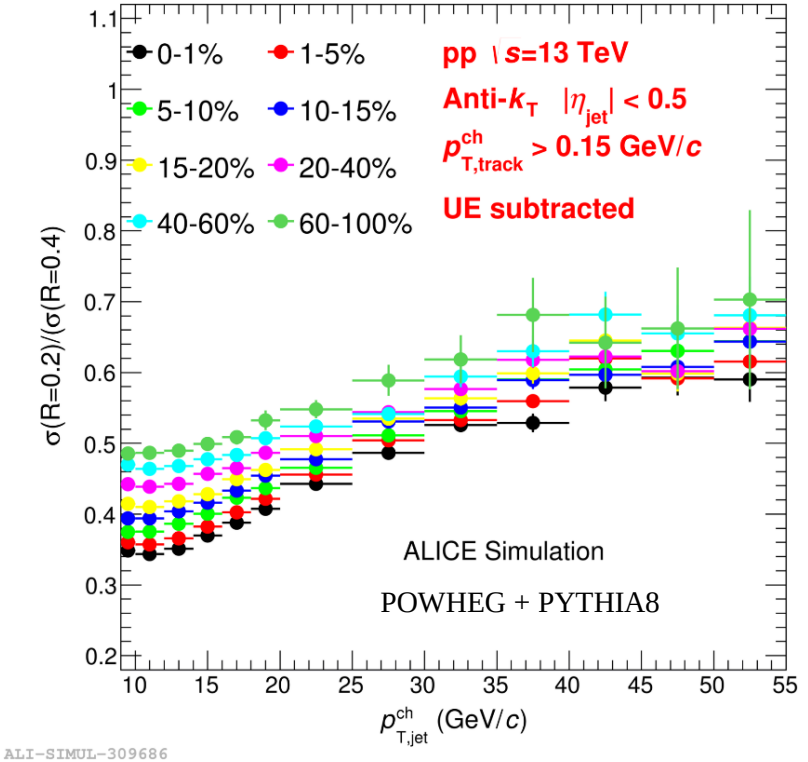
Multiplicity dependent jet cross section ratio



- 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 simulation





- Jet cross section ratio from data shows no centrality dependence while simulation 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 UE subtraction effect?

Summary and outlook

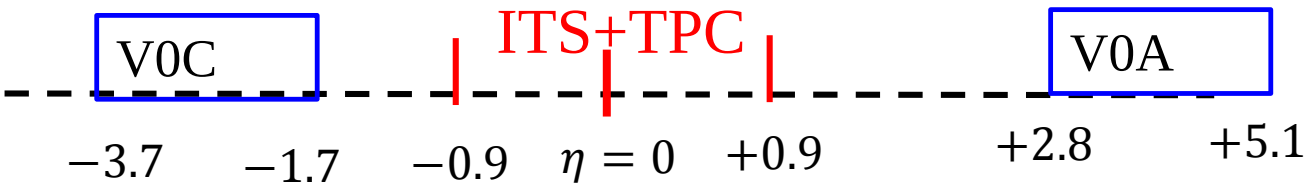
- **Charged jet production** studied in pp and Pb-Pb collisions
- **Inclusive** jet cross sections in pp collisions can be reproduced by **POWHEG+PYTHIA8**
- **Nuclear modification factor (R_{AA})** has been measured
  - Centrality dependent jet suppression is observed in Pb-Pb collisions
  - Full jets and charged jets R_{AA} are consistent
- **Multiplicity dependent jet cross section** is studied
  - Higher(lower) jet yield in high(low) multiplicity events compared to inclusive one
  - Jet production ratios have no significant jet p_T and resolution parameter dependence
- **Jet cross section ratio between R = 0.2/R = 0.4 (or 0.6)** have been measured
  - No strong dependence for different collision systems or collision energies
  - Weak dependence on multiplicities from data, while multiplicity ordering in simulation

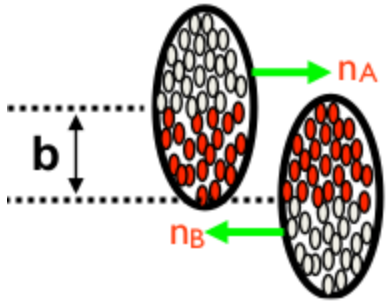
Thanks for your attention!

Backup

Multiplicity estimator in pp collisions

- Selecting different multiplicity events using forward detector (V0) to avoid auto correlations between event activities and jet measurements





Event activity categorization (V0M): V0A+V0C

Jet measurements: ITS+TPC

- Multiplicity percentile is determined using V0M amplitude distribution