Measurement of charged jet spectra in pp and PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE

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Abstract

Jets originate from hard scattered partons at the initial stage of collisions. Jets are sensitive probes of the hot and dense medium created in head-on heavy ion collisions. The jet nuclear modification factor R_{AA} helps quantifying partonic energy loss in central Pb-Pb collisions. For this a precise pp baseline measurement at the same centre-of-mass energy is crucial. In this contribution, we present charged jet spectra in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and charged jet cross section in pp collisions at $\sqrt{s}$ = 5.02 TeV measured with the ALICE detector at the LHC. The pp measurements are compared to pQCD calculations at LO and NLO accuracy. The cone radius dependence of the pp cross sections and the dependence on the leading constituent bias of the Pb-Pb spectra are shown. We compare the nuclear modification factor R_{AA} to similar measurements at $\sqrt{s_{NN}}$= 2.76 TeV[1],[2].

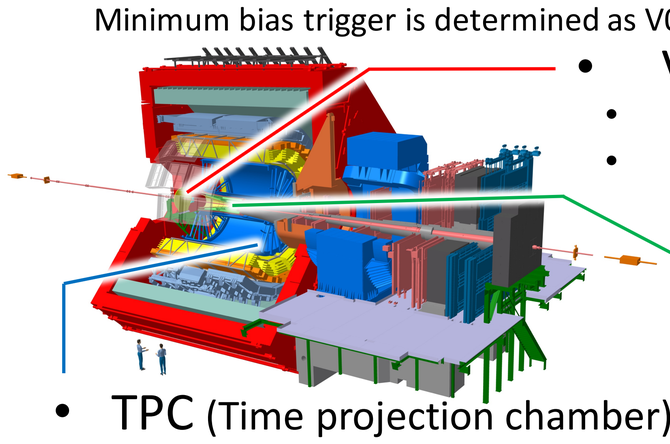
Physics motivation

- **Jets in pp collisions**
  - Good tests of pQCD calculations and MC generators for high energy physics
  - Provide a references for heavy ion collisions at same collision energy
- **Jets in heavy ion collisions**
  - Jets are well established probe for Quark-Gluon Plasma (QGP) properties
    - Jets are modified while traversing the QGP → Jet quenching effect
      - QGP properties can be probed by evaluating the quenching effect
      - QGP lifetime in heavy ion collisions is very short (~ 10^{-23} s)
        - Self produced probes, like jets, allow to access QGP properties
      - Jets are produced at very early stage of collisions
        - Entire QGP evolution can be probed

ALICE Detector

The ALICE detector is a multipurpose detector dedicated to heavy ion physics at the LHC.

- Key detectors for charged jet measurement
  - ➢ Central barrel tracking system (ITS + TPC) for charged particle track reconstruction.
  - ➢ The V0 detector for event trigger and centrality determination. In this analysis, Minimum bias trigger is determined as V0 AND trigger (V0A AND V0C).



- V0
  - 32+32 scintillators
  - Acceptance: $2.8<\eta<5.1$ (V0A), $-3.7<\eta<-1.7$ (V0C)
- ITS (Inner Tracking System)
  - Consists of 3 type silicon detectors
    - SPD (Silicon Pixel Detector)
    - SDD (Silicon Drift Detector)
    - SSD (Silicon Strip Detector)
  - Acceptance
    Full tracking w/ TPC: $|\eta|<0.9$
- TPC (Time projection chamber)
  - Filled with Ar-CO_2 (9:1)
  - Max drift time: 92 μs
  - Acceptance (Full tracking): $|\eta|<0.9$

Analysis details

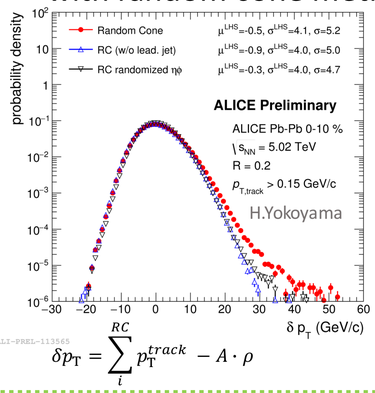
Common | pp collisions | Pb-Pb collisions

Event selection
- pp collisions
  - 25.5 M minimum bias events
- Pb-Pb collisions
  - 3.36 M minimum bias events

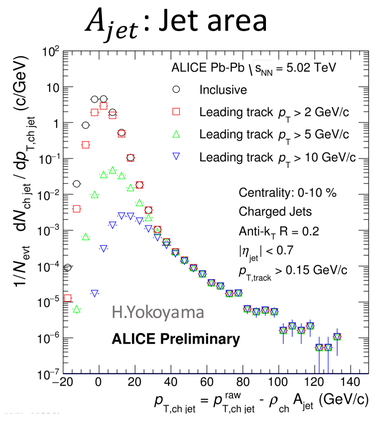
Track selection
- Charged tracks by ITS + TPC
  - $|\eta_{track}| < 0.9$, $p_{T,track} > 0.15$ GeV/c

Jet reconstruction
- Anti-kt clustering algorithm[3],[4] (Signal jets for pp,Pb-Pb)
- kt clustering algorithm (Background for Pb-Pb)
  - Jet cone radii R = 0.2 (pp, Pb-Pb), 0.4 (pp)
  - $|\eta_{jet}| < 0.9 - R$
  - $p_{T,leading} > 5$ GeV/c (Pb-Pb)

Underlying Event(UE) subtraction
- $p_{T,jet}^{corr} = p_{T,jet}^{raw} - \rho \cdot A_{jet}$
- $\rho = median\left\{\frac{p_{T,jet}^{kt}}{A_{jet}}\right\}$
  A_{jet}: Jet area
- UE fluctuations are estimated with random cone method

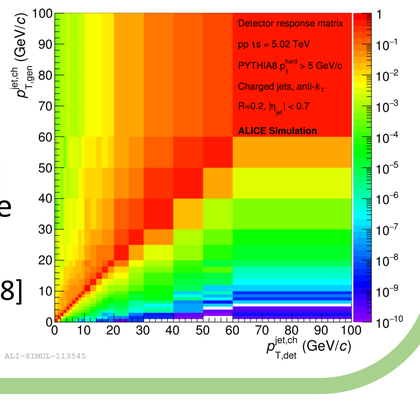


$$\delta p_T = \sum_i^{RC} p_T^{track} - A \cdot \rho$$



Detector effects correction

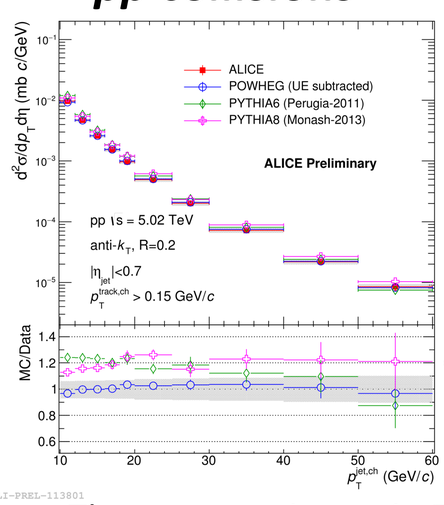
Detector & UE effects correction
- Corrected by the SVD unfolding method[5],[6]
  - Detector responses are extracted from PYTHIA8[7] + GEANT3[8] MC simulations

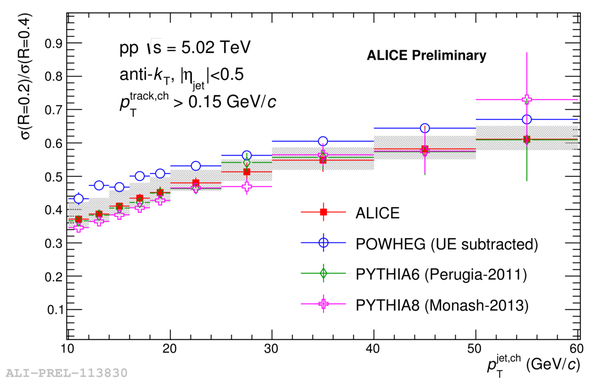


Jet Spectrum

Results

- ***pp collisions***





- The charged jet cross section shows good agreement with the POWHEG NLO-pQCD prediction[9].

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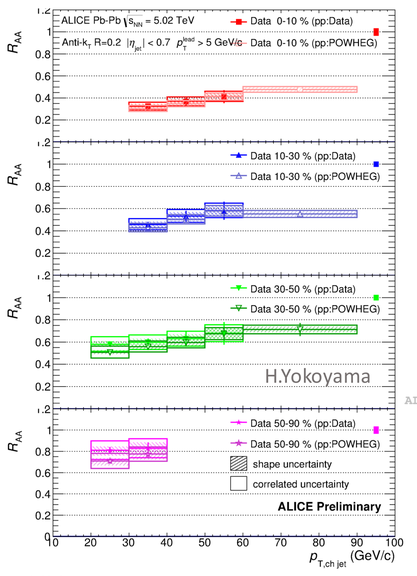
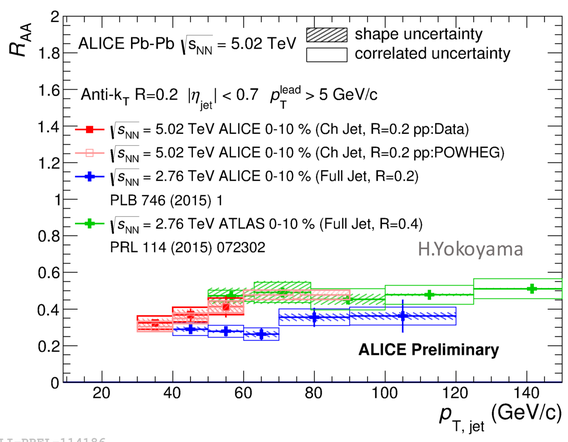
- The cross section ratio R=0.2 / R = 0.4 is sensitive to the jet structure and rises as function of jet p_T, indicating stronger collimation at higher p_T. The ratio is well described by PYTHIA6[10], PYTHIA8 and POWHEG.

- ***Pb-Pb collisions***





$$R_{AA} = \frac{\frac{1}{\langle T_{AA}\rangle}\frac{1}{N_{event}}\frac{dN_{jet}}{dp_T d\eta}}{\frac{d\sigma_{pp}}{dp_T d\eta}}$$

- Strong jet suppression is observed
  - Jet suppression strength increases from peripheral to central collisions
- Jet R_{AA} is comparable with previous results

- At higher collision energies...
  - ➢ Harder collision → jet spectrum becomes flatter → larger R_{AA}
  - ➢ Hotter/denser medium → strong suppression → smaller R_{AA}

➡ Spectrum flattening is compensated by stronger jet suppression

Summary

- First measurements of charged jet spectra and R_{AA} have been performed for LHC Run2 data at ALICE
- **pp collisions**
  - Inclusive charged jet differential cross section is well described by NLO-pQCD calculation
  - Jet cross section ratio is well described by POWHEG and PYTHIA
  - Reference charged jet spectra for Pb-Pb collisions are established (~60 GeV/c)
- **Pb-Pb collisions**
  - Charged jet nuclear modification factors (R_{AA}) are estimated
    - Strong suppression is observed at central collisions
    - Comparable with the results in $\sqrt{s_{NN}}$= 2.76 TeV collisions
    - Effect of spectrum flattening is compensated by the stronger jet suppression at higher collision energy

References

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