

# Lightening-like interactions in nuclear collisions at CERN large hadron collider

**Part I: Results of proton+Pb at  $\sqrt{s_{NN}} = 5.02$  TeV**

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- ❑ Results of the improved HIJING code in non-single diffractive  $p + Pb$  collisions at  $\sqrt{s_{NN}} = 5.02$  TeV.

# HIJING code

## HIJING: Heavy Ion Jet Interaction Generator

Xin-Nian Wang and Miklos Gyulassy, Physical Rev. D 44, 3501(1991)

- it is a hadronic cascade model
- the interaction is considered as a set of binary nucleon-nucleon collisions
- In each collision
  - **Jet (Gluon) Production** ( $p_T > p_0$ ) (Main source of hadrons at LHC energies)
    - Jet cross section ( $\sigma_{jet}$ )
  - **string interactions**
    - soft parton cross section ( $\sigma_{soft}$ )

## HIJING uses

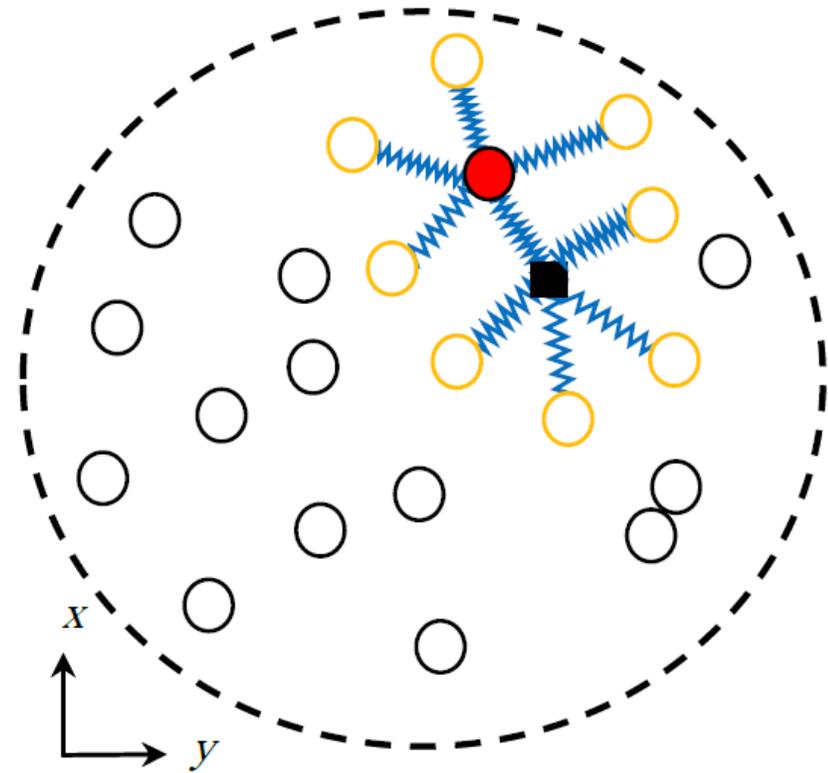
- **Eikonal formalism** to determine the number of wounded nucleons
- **PYTHIA 5.3** to generate kinetic variables for each hard scattering (high  $p_T$ ).
- **JETSET 7.2** for jet fragmentation.

# Parameters of HIJING code

- The jet cross section  $\sigma_{jet}$ .
    - cut off parameter  $p_0$ .
    - Parton Distribution function (**PDF**)
  - The soft parton cross section  $\sigma_{soft}$ .
  - Parton ( $\alpha_{g(q)}$ )Shadowing.
- $\sigma_{soft}$ ,  $p_0$  and **PDF** are determined by fitting  $p + p(\bar{p})$  collisions
  - For  $p + A$  and  $A + A$  collisions, we need to adjust  $p_0$  and  $\alpha_{g(q)}$

# The Improved HIJING code

- The Duke-Owen (1984) parameterizations of parton distribution functions are replaced by the Martin-Stirling-Throne-Watt (2009) ones.
- Parton Shadowing is replaced by Nucleon shadowing.



Nucleon shadowing

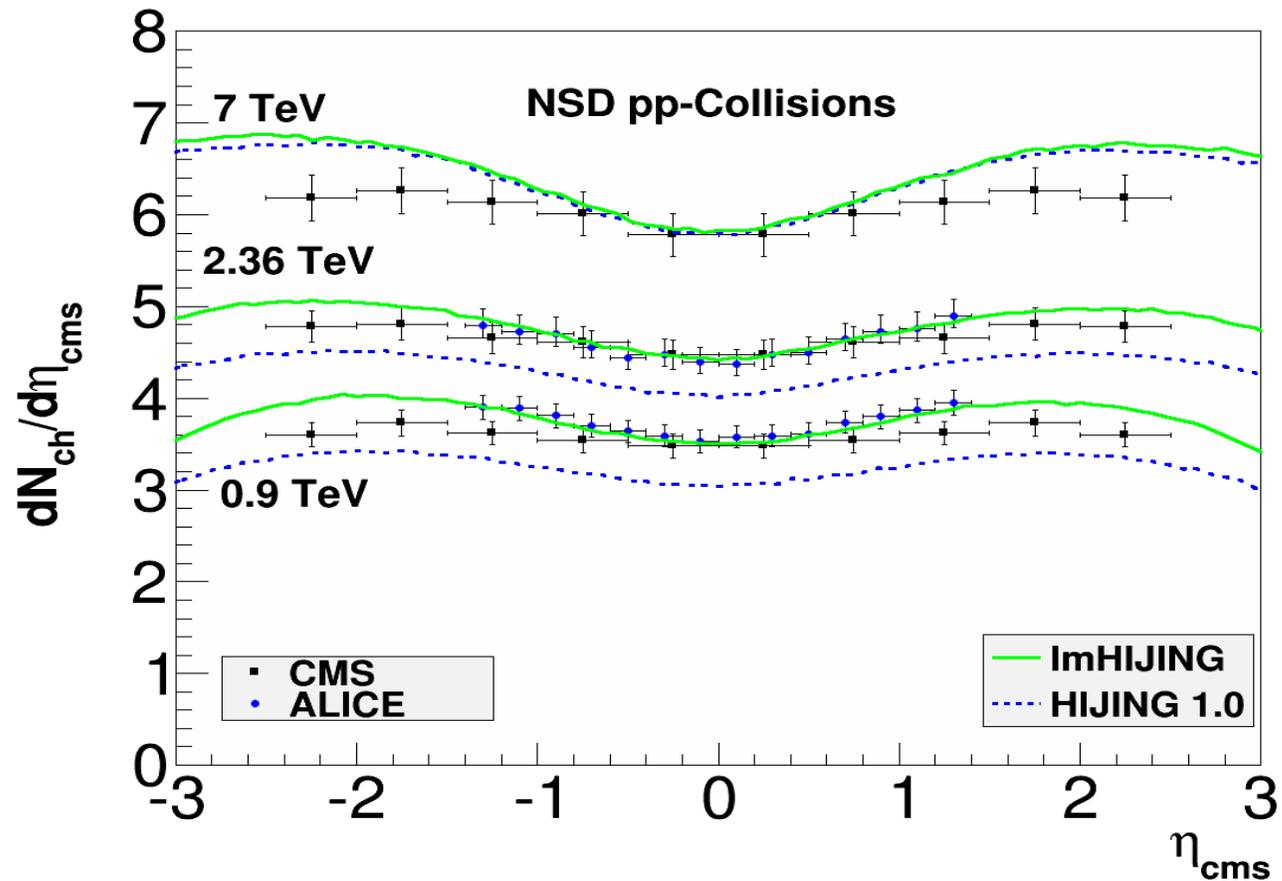
# The main improvement

- Lightening-like interactions at LHC energies!

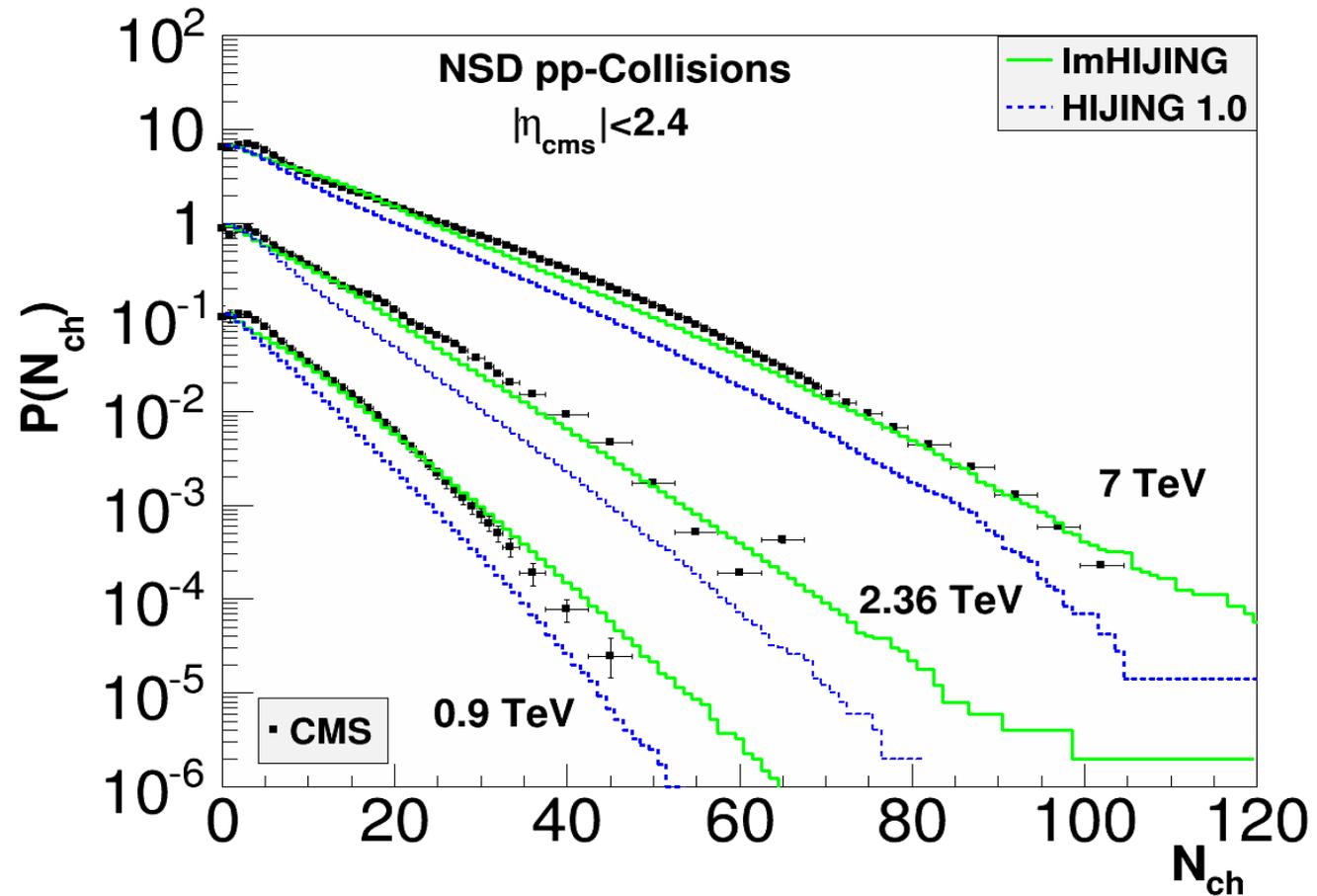


The results of the improved and standard HIJING codes in non-single diffractive  $p + p$  collisions

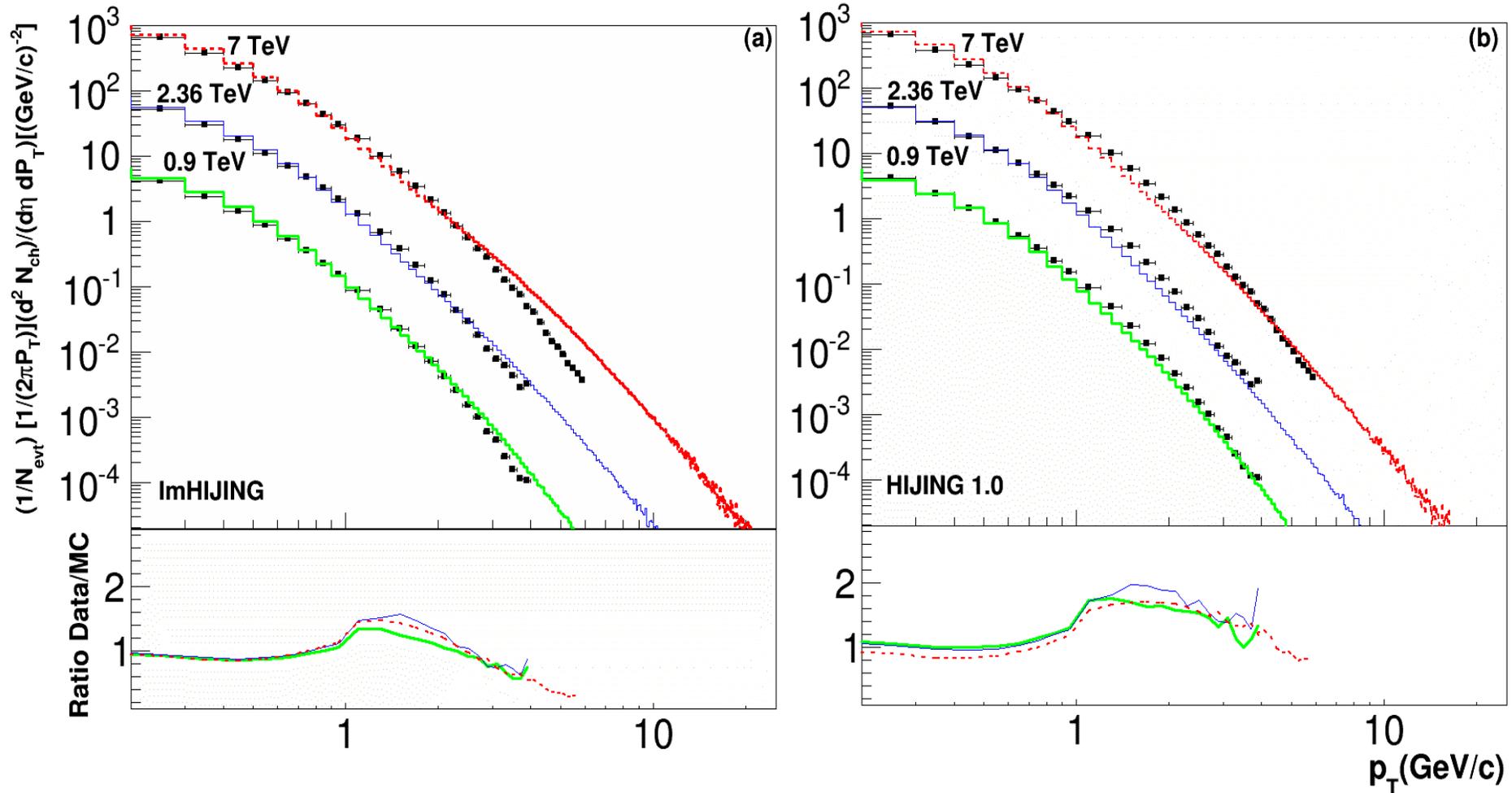
## Pseudorapidity density of charged particles

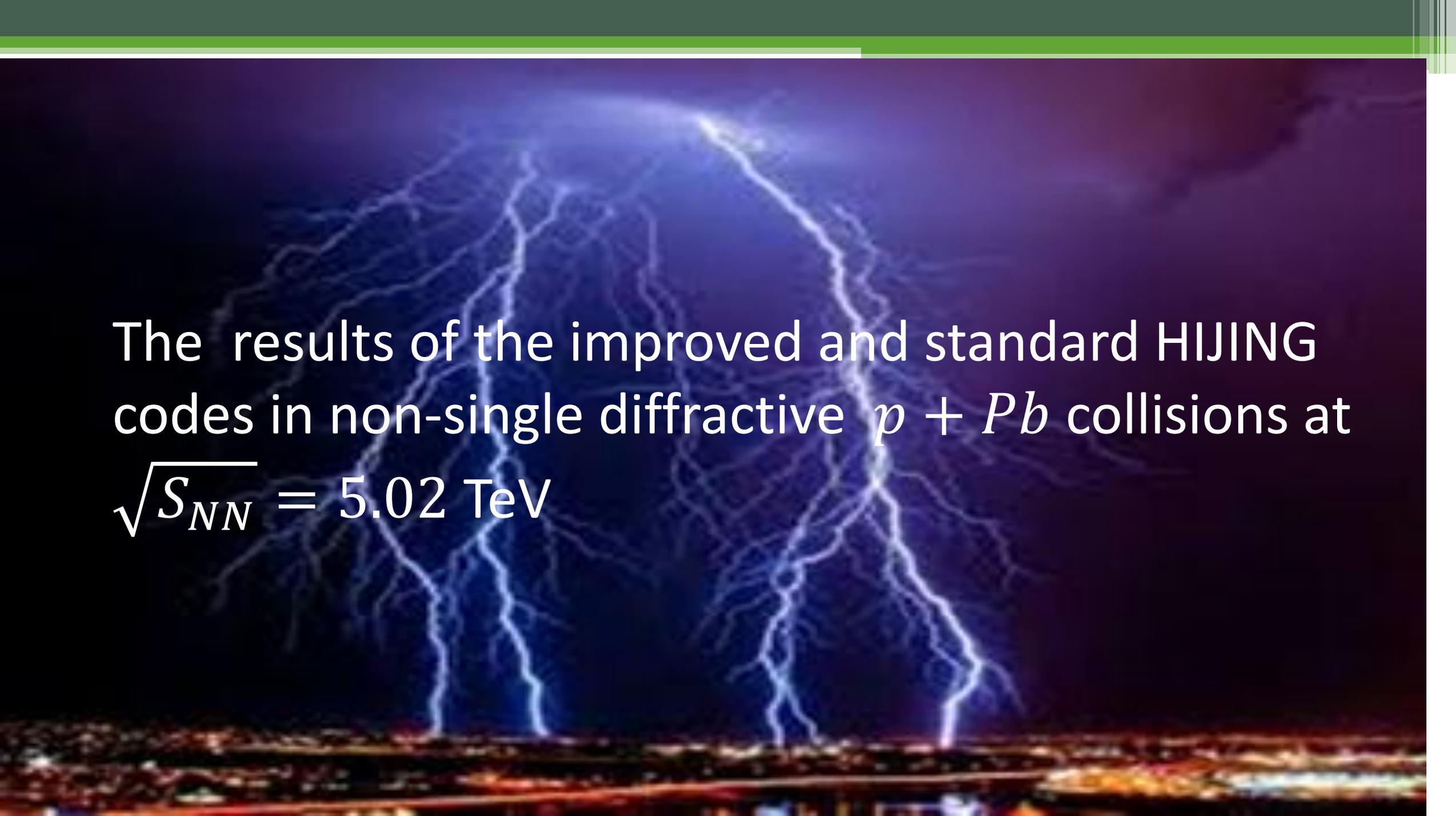


# Multiplicity distributions of charged particles



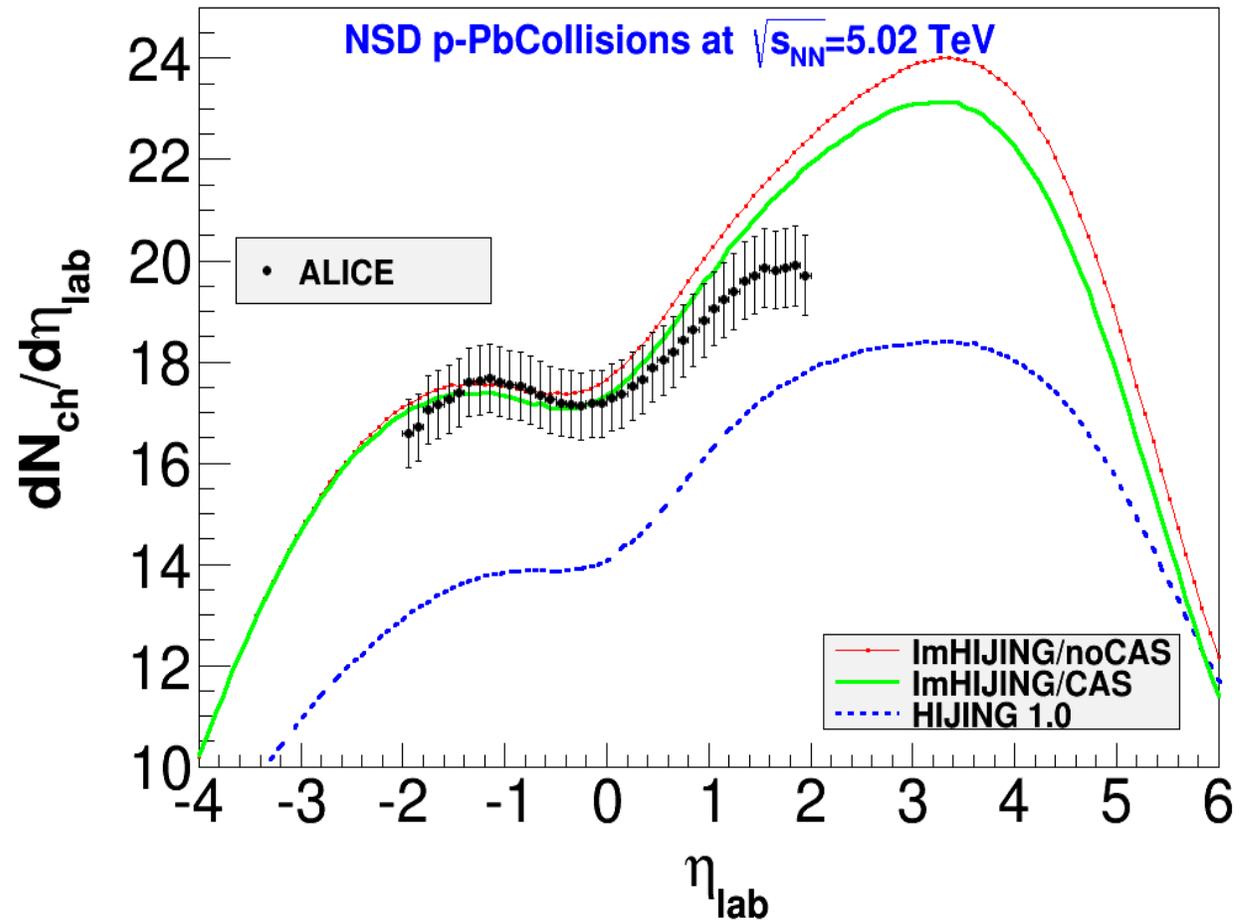
# Transverse momentum distributions of charged particles



A dramatic photograph of a bright blue lightning bolt striking a city at night. The city lights are visible in the foreground, and the lightning bolt is the central focus, illuminating the dark sky. The text is overlaid on the image.

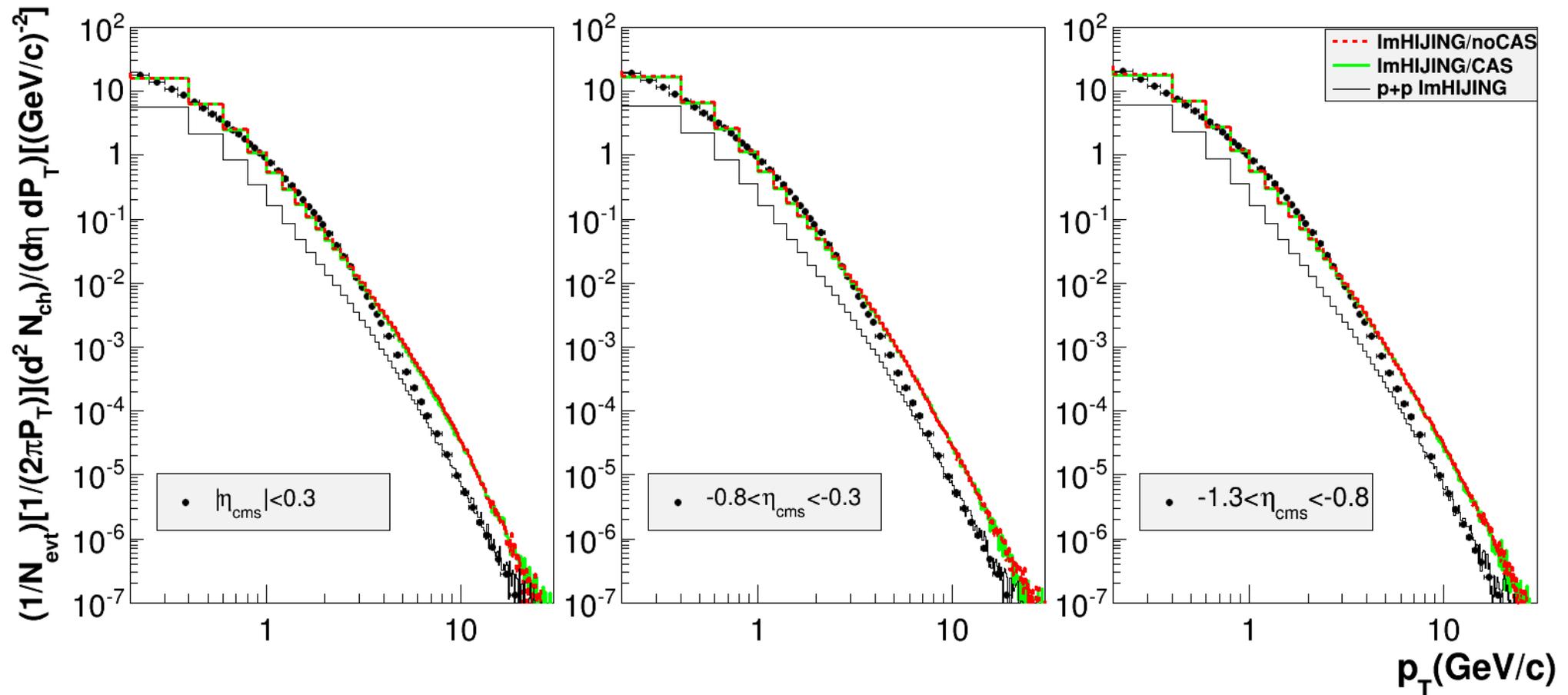
The results of the improved and standard HIJING codes in non-single diffractive  $p + Pb$  collisions at  $\sqrt{S_{NN}} = 5.02$  TeV

# Pseudorapidity density of charged particles in the Lab. system



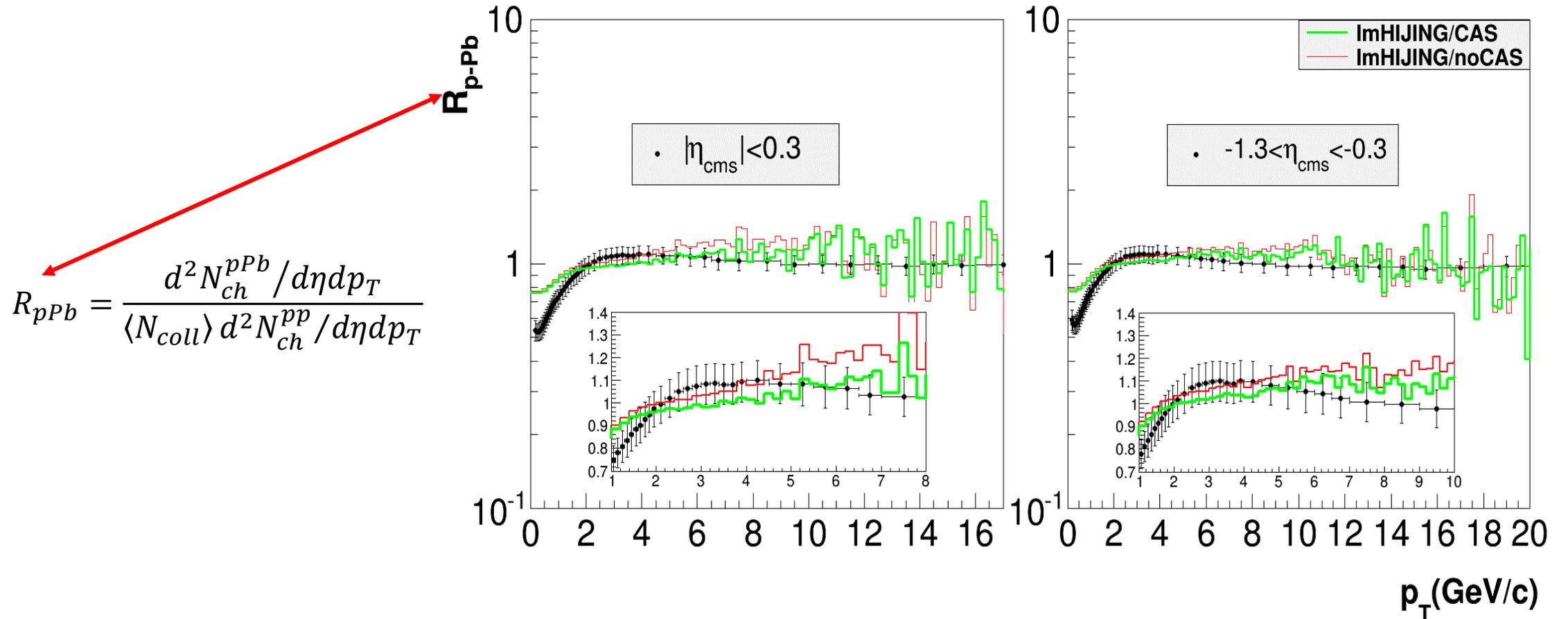
# The transverse momentum distribution of charged particles

NSD p-Pb Collisions at  $\sqrt{s_{NN}}=5.02$  TeV



# The transverse momentum dependence of nuclear modification factor

NSD p-Pb Collisions at  $\sqrt{s_{NN}}=5.02$  TeV



# Conclusions

- ✓ HIJING code is improved
  - **Tabulated Martin-Stirling-Throne-Watt (2009) parton distribution functions.**
  - **Nucleon shadowing.**
- ✓ Non-single Diffractive  $p + p$  collisions data at  $\sqrt{s_{NN}} = 0.9, 2.36$  and 7 TeV are well reproduced.
- ✓ Non-single Diffractive  $p + Pb$  collisions data at  $\sqrt{s_{NN}} = 5.02$  TeV are described.

A dramatic night sky filled with multiple bright, jagged lightning bolts striking down over a dark silhouette of a mountain range. The lightning bolts are a brilliant white-yellow color, contrasting sharply with the dark, stormy clouds. The word "Thanks" is centered in the upper half of the image in a large, white, sans-serif font.

Thanks