Intrajet two particle correlations in proton-proton collisions

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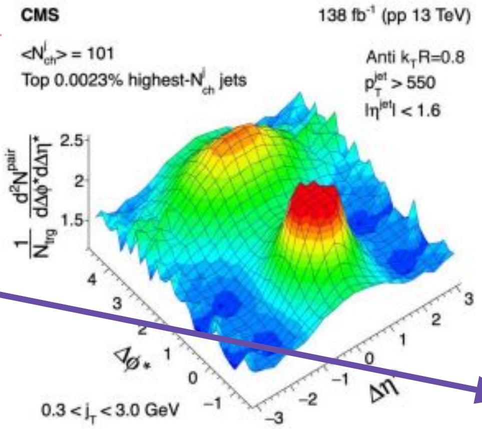
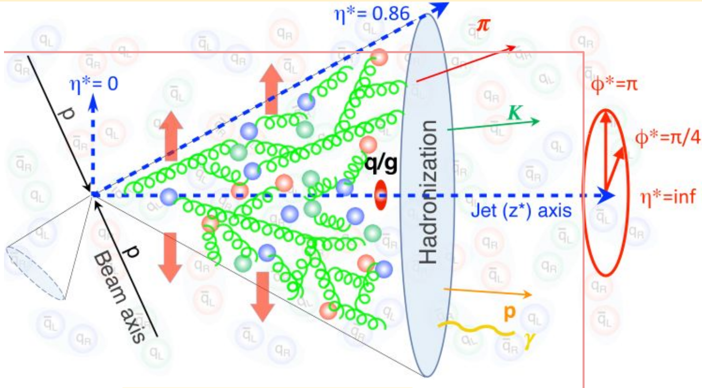
Workshop on medical and high energy physics
Sonora, Mexico
May 21-24 2024

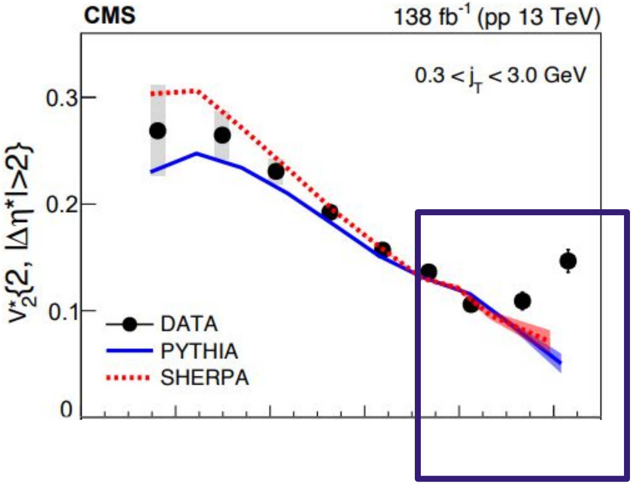
Outline

- Collectivity features and probes in small system
- Elliptic anisotropies within jets in pp collisions
- Phenomenological work
- Summary

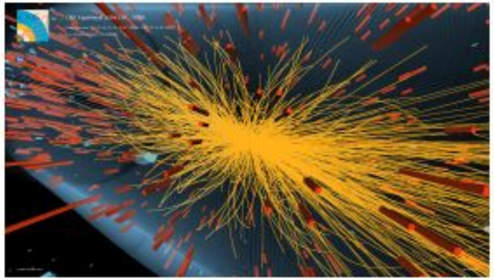


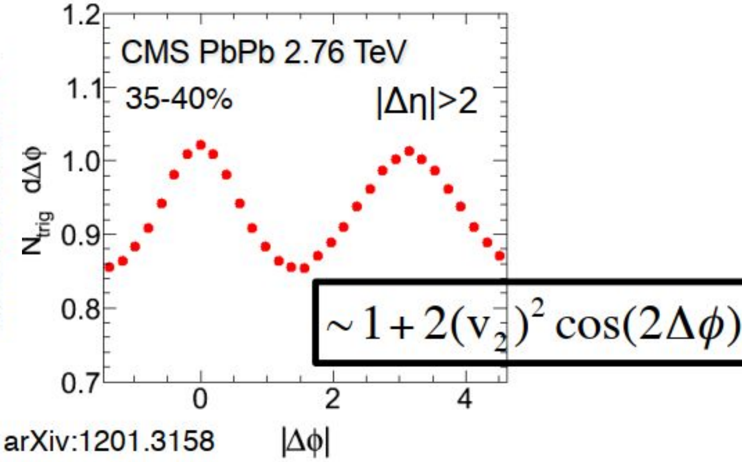


arXiv.2312.17103



high-multiplicity pp event

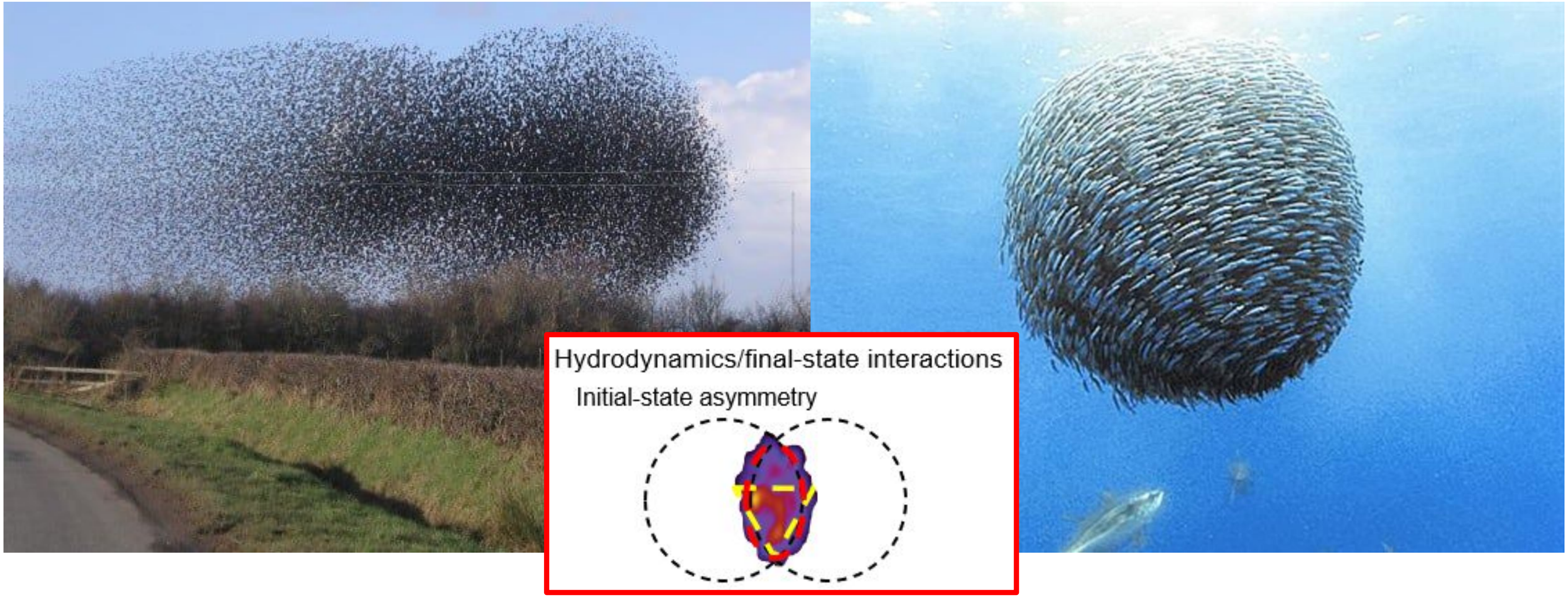




arXiv:1201.3158

What is collectivity?

Many examples in nature of collective behavior

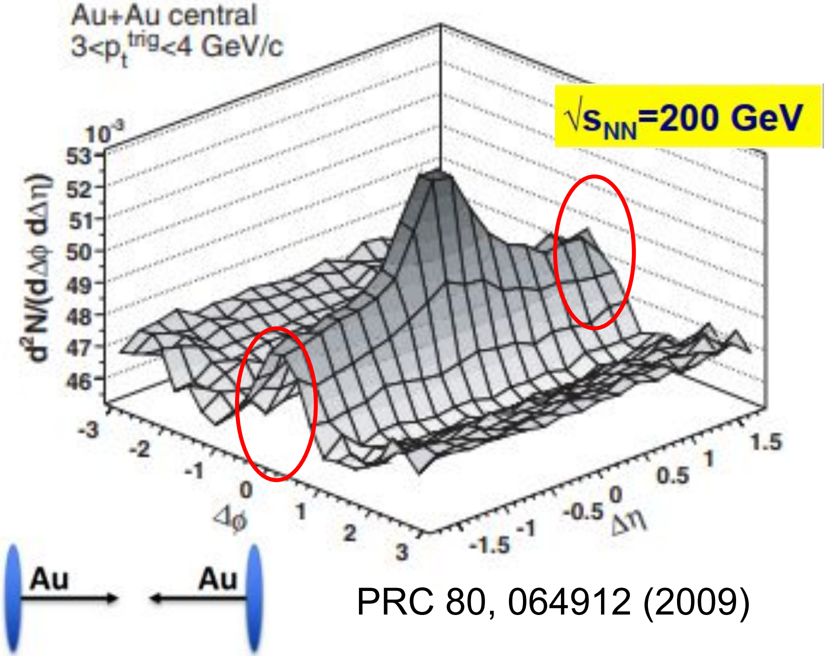


Definition of collectivity:

- Many bodies present in the FS are the product of 1 body in the IS
- Objects in final-state (FS) far from each other are correlated by amechanism in the initial-state (IS)

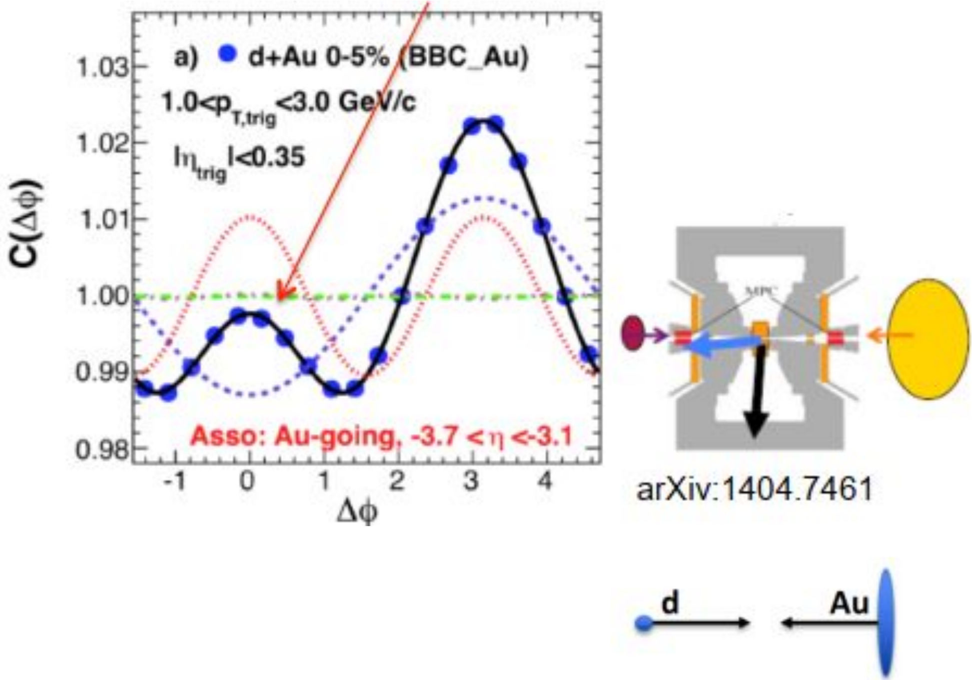
Emerges in the two-particle correlation functions

- Long-range spatial correspondence → [collective behaviour of final-state particles]
- Observed long-range near-side correlations large collision systems (AA) at RHIC → [Ridge = Long-range near-side correlation]
- First probes over smaller collision systems (dAu)



PRC 80, 064912 (2009)

Ridge in dAu at RHIC!



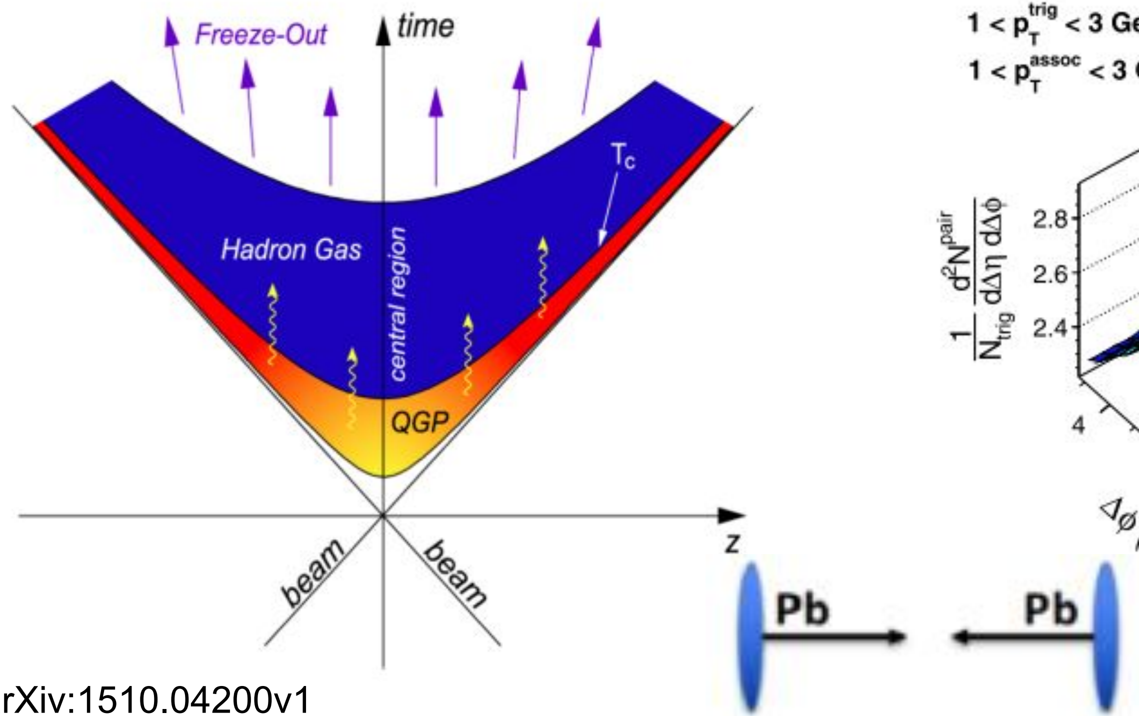
arXiv:1404.7461

Evidence of collectivity one of the features of QPG

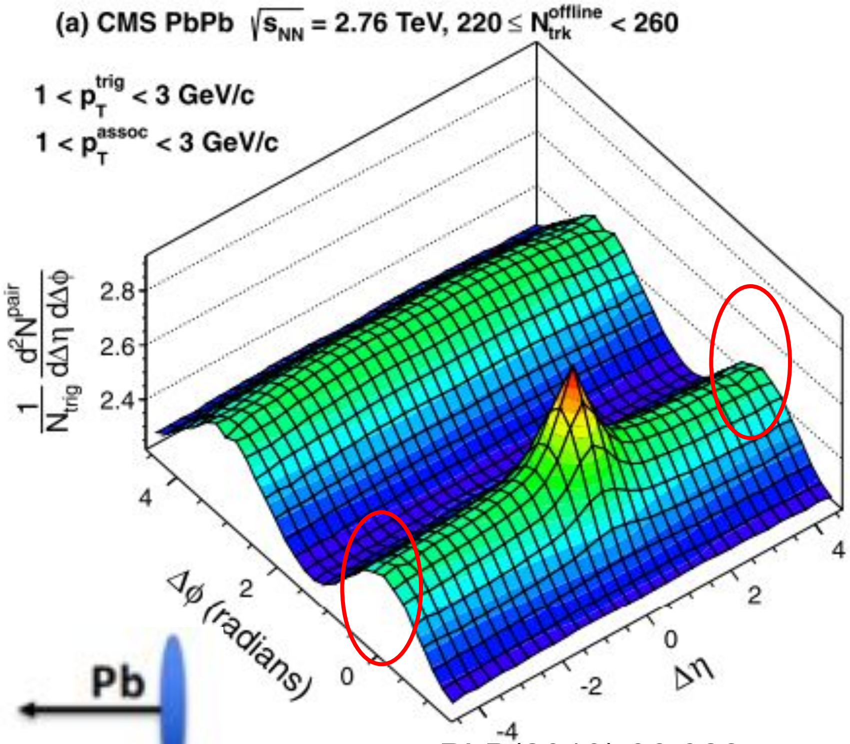
Relativistic fluid dynamics → Quark gluon plasma (QGP) and collectivity

Medium properties and hydrodynamic behavior → Look into **smaller systems**

Initial and final state effects: **gluon saturation in the initial state?**



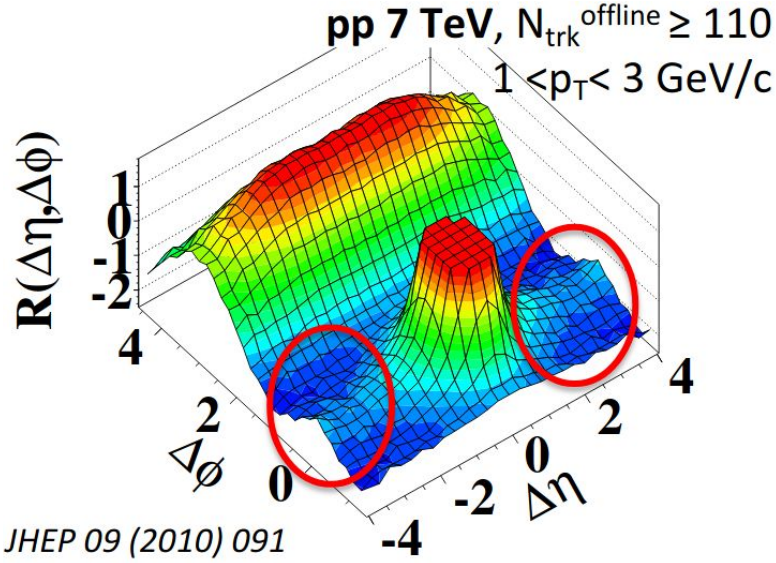
arXiv:1510.04200v1



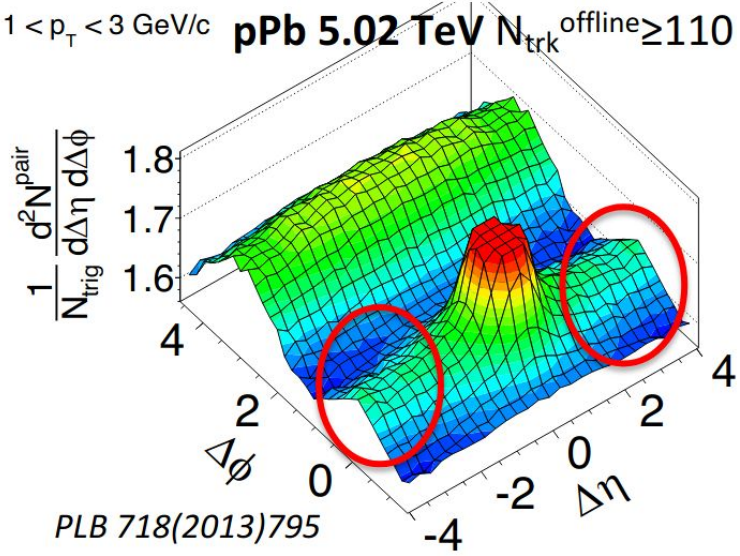
PLB(2013).06.028

First collectivity probes in small systems at the LHC

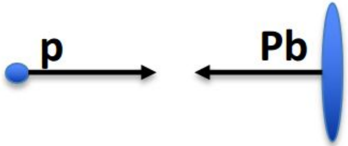
- ❑ Unexpected signs of collectivity seen in **pp and pPb**
- ❑ **Too small and simple** to develop QGP-like collective behaviour?
- ❑ Breaking news in 2010 : A near-side ridge in pp at the LHC



JHEP 09 (2010) 091

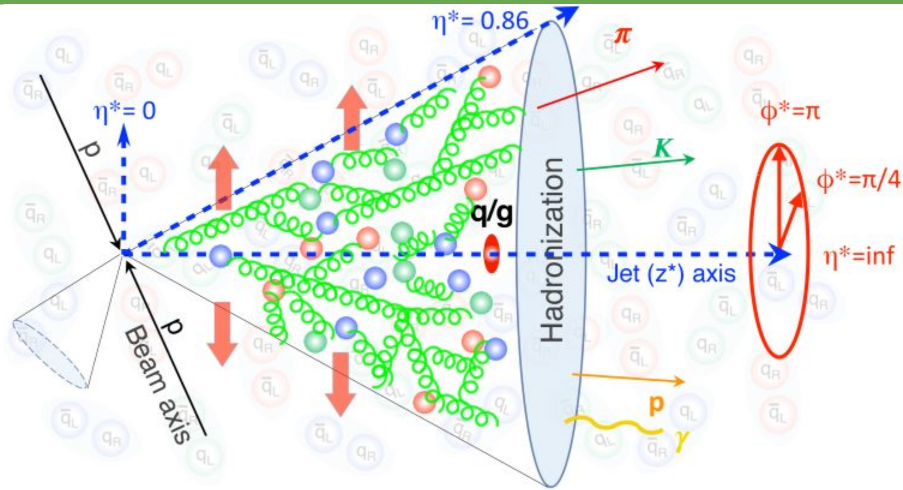


PLB 718(2013)795



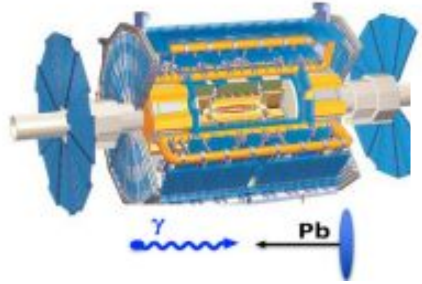
Recent collectivity probes in small systems

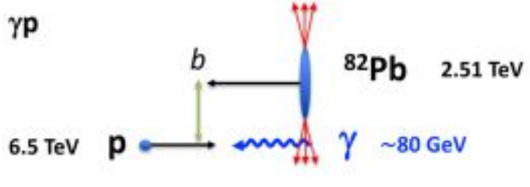
- **Inside jets** → CMS (13 TeV [pp])
  DOI:10.48550/arXiv.2312.17103

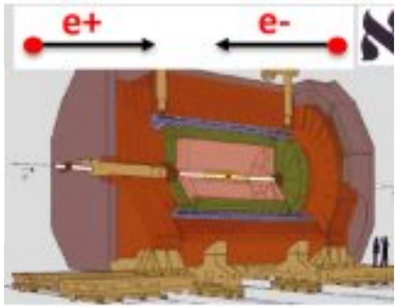


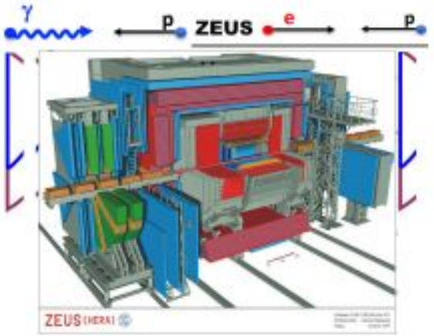
- γPb → **ATLAS** (5.02 TeV [PbPb])

- γp
  - **ZEUS** (318 GeV [ep])(JHEP 12 (2021) 102)
  - **CMS** (8.16 TeV [pPb])(PLB 844 (2023) 137905)





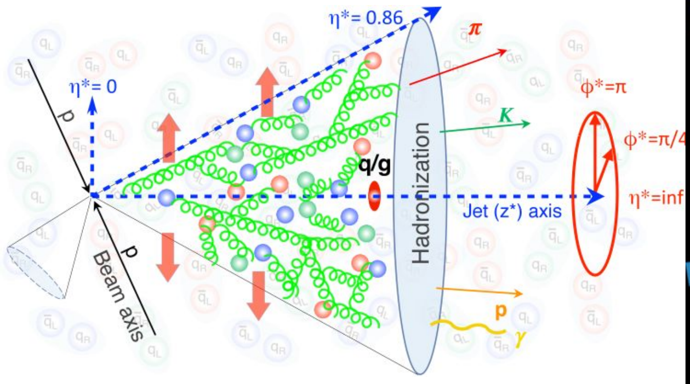


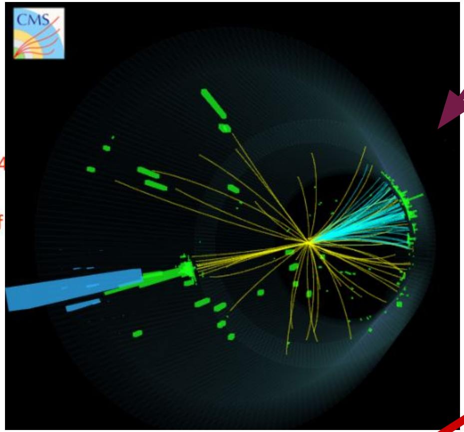


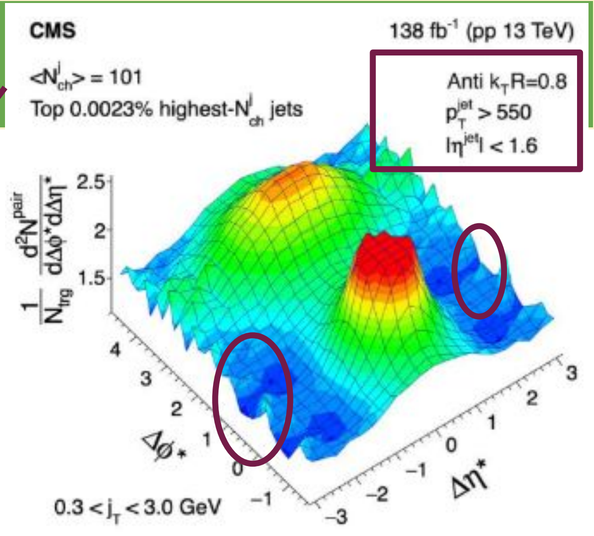
- e +e− → **ALEPH** (91 GeV, 208 GeV) and **Belle** (10.52 GeV)
- ep → **ZEUS** and H1 at HERA (318 GeV)

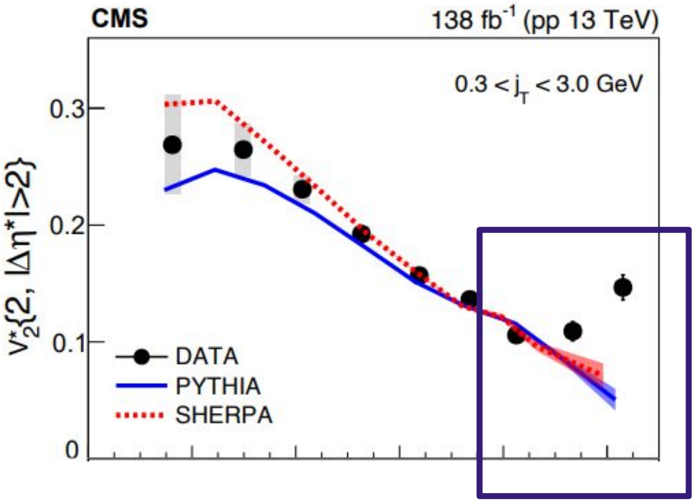
Motivation : Recent collectivity probes in small system

- **inside high multiplicity jets** in pp collisions at 13 TeV
  DOI:10.48550/arXiv.2312.17103









- Inside jets the constituents change of tends for **Nch > 80**, **not expected from models** using Monte-Carlo as Pythia with **CP5 tune** and Sherpa
- This tends was reproduced phenomenology this tends with other tunes, alternative of CP5 tune using Pythia.

Nch:charged particle inside jet

Tunning

- Parameters which cannot be determined from first principles in the event generator
  - Set using data distributions **sensitive** to that specific physics aspects
  - Pythia **Monash tune** are the default parameters

- CP ≈ CMS Pythia
  - **Which have a progressive number from 1 to 5**
  - **Some parameters:**
    - **Color reconnection range 1.8 -> 5.17**
    - **Multiparton Interaction: CoreRadios 0.4->0.76**
    - **Spaceshower: alphaSvalue 1.36 ->1.18**
    - **Timeshower: alphaSvalue 1.36 ->1.18**

These have effects on showering and hadronization!!!

Montecarlo

pp collisions at √s=13 TeV

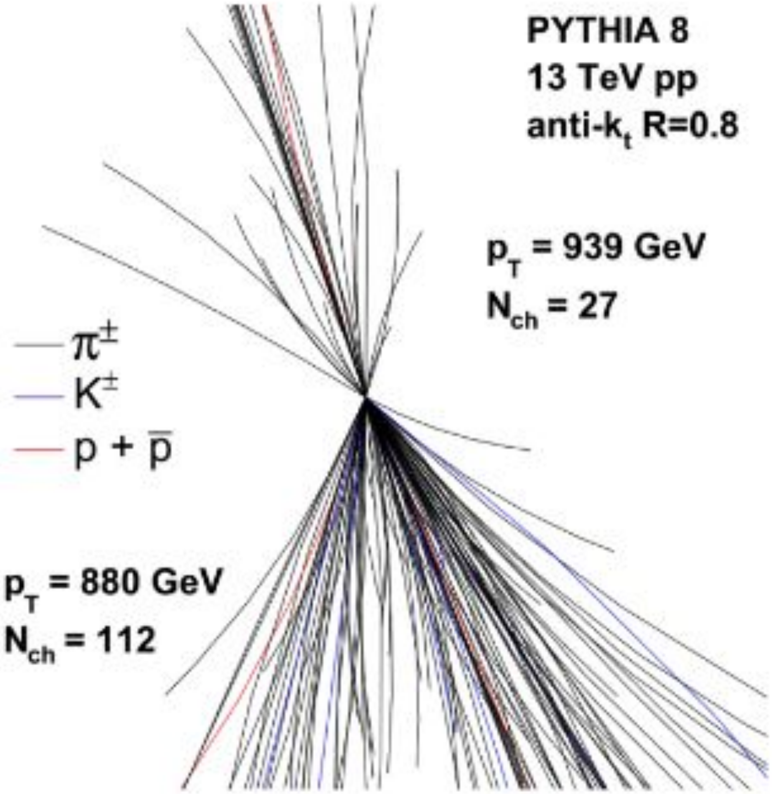
- **PYTHIA8.309 was used**
  - **Monash Tune [default pythia]**
  - **CP5 Tune [CMS Pythia Tune]**

  DOI:10.1140/epjc/s10052-019-7499-4

Jet cuts,

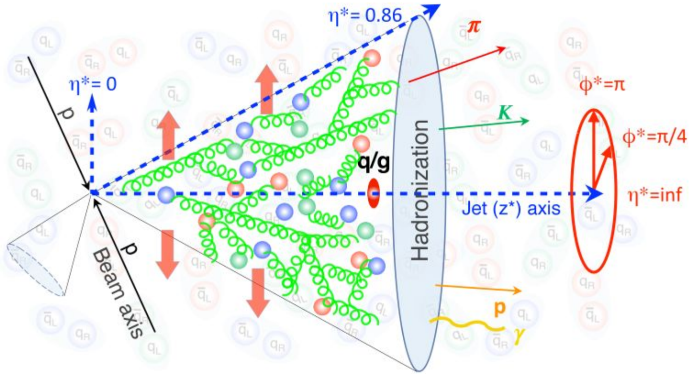
Jet pt	> 500 GeV
Jet η	|η|< 1.6

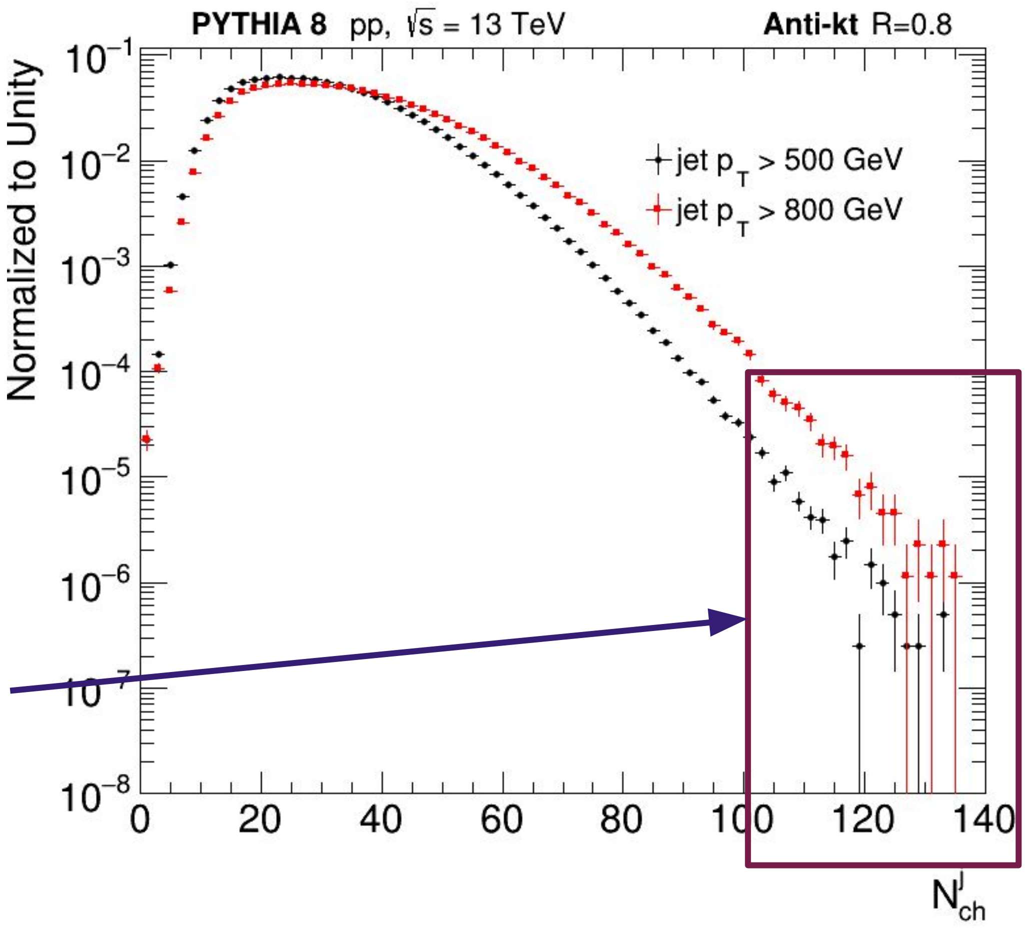
N^{j}_{ch}



DOI:10.1103/PhysRevC.107.064908

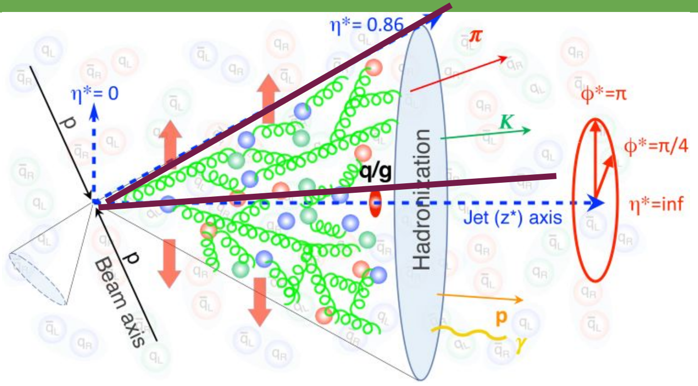
Limited high-multiplicity jets

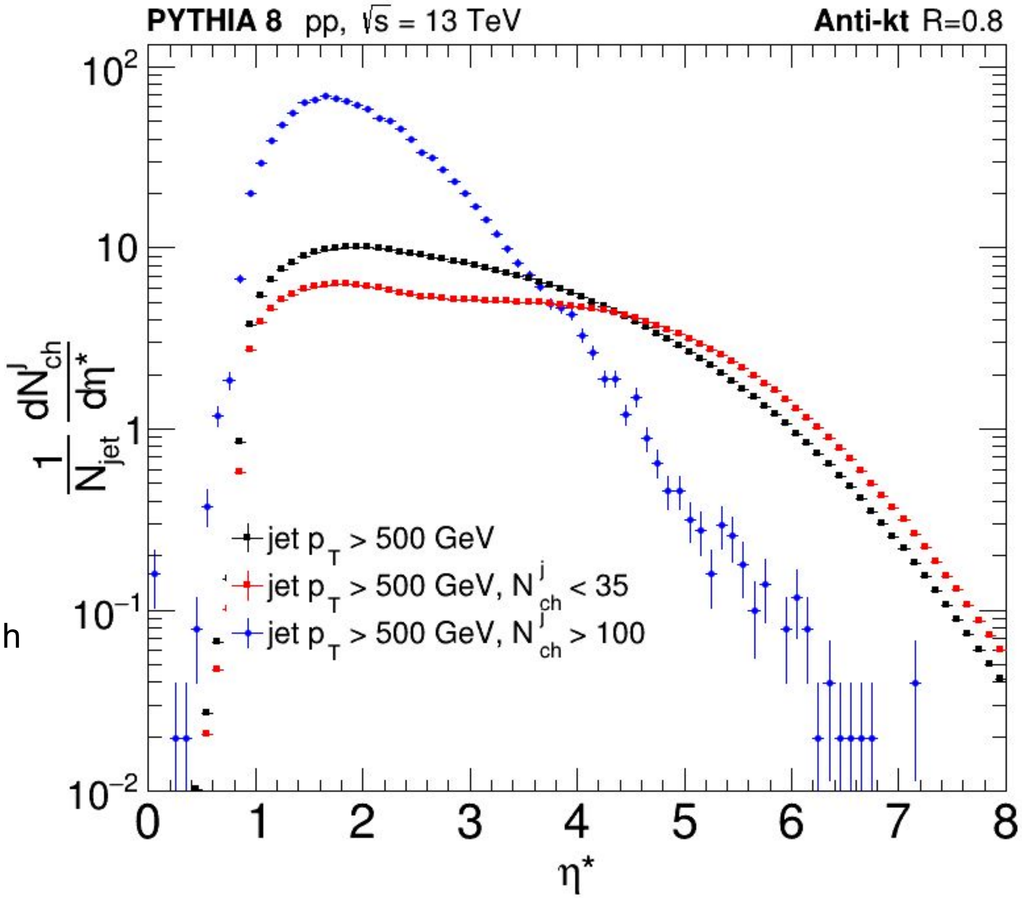




- multiplicity distribution of charged particles within an **AK8 jets**
- The most probable value are around 25 for both jet selections
- For our interest in ***high-multiplicity jets,*** it's indicated that the occurrence of high pT jets is limited

Review of angular coordinate



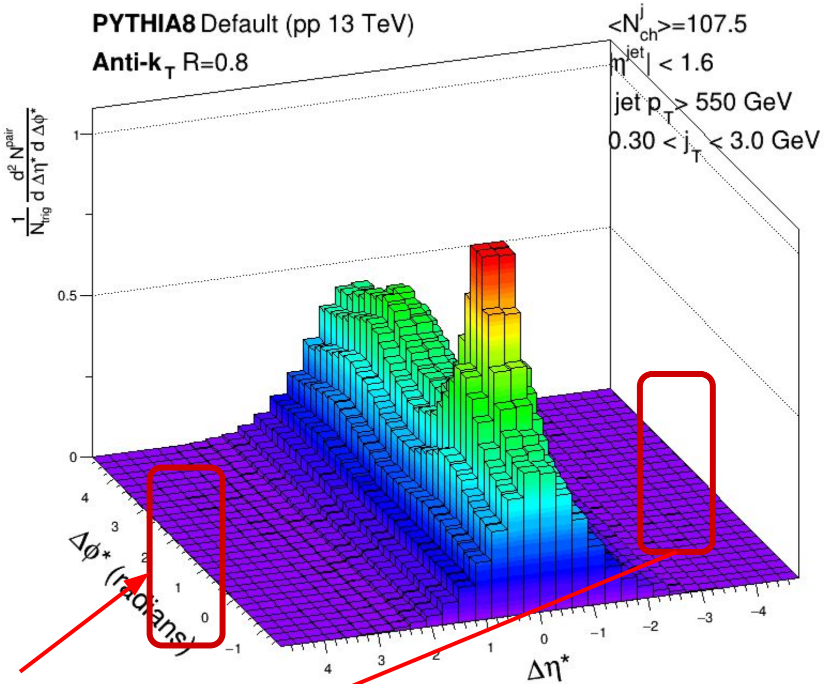


Angular coordinate in the jet basis (η^*):

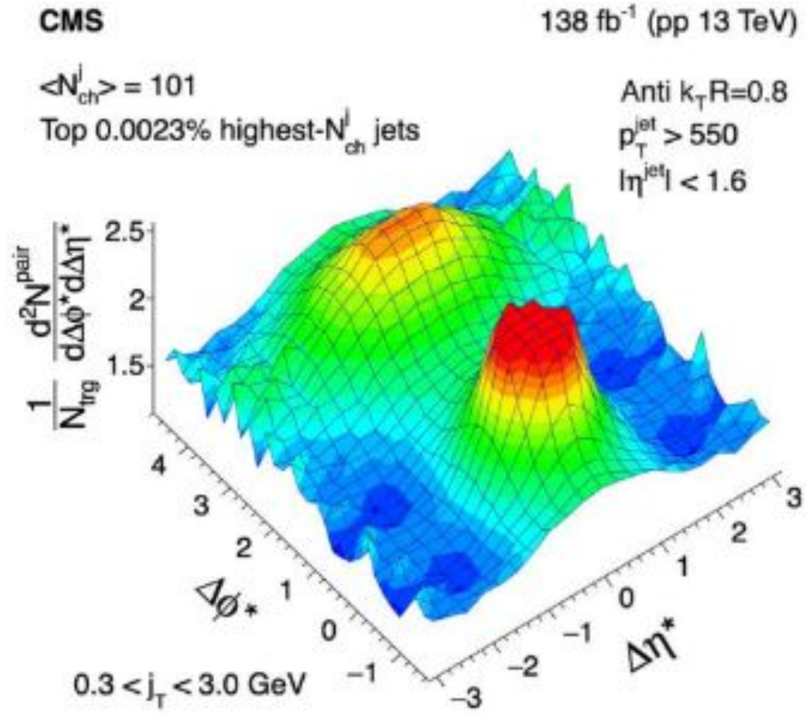
- Low values corresponds to particles that are separated from the jet axis.
- The distribution tends to lower values for the high multiplicity selection

Long range correlations

- **Expected result by MC was verify:**
  - Pythia8 not include collectivity behavior

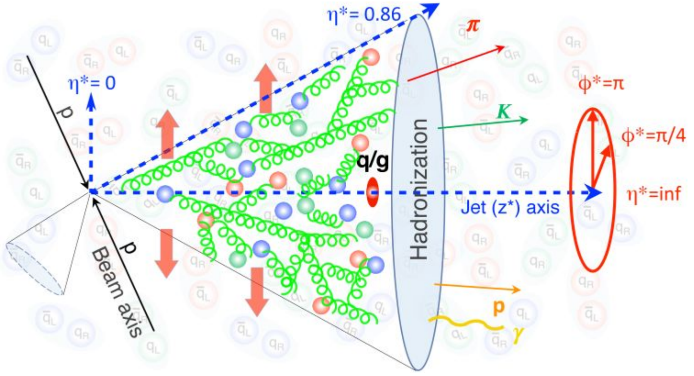


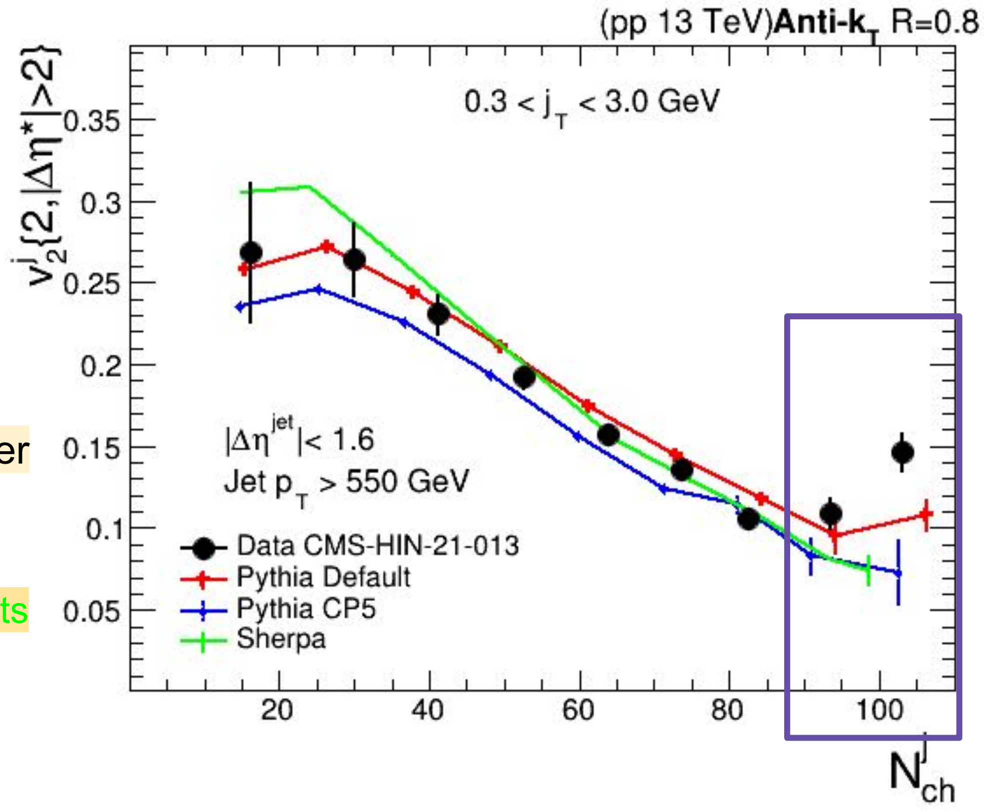
No ridge



DOI:10.48550/arXiv.2312.17103

v2 elliptic anisotropy with |η| > 2.0

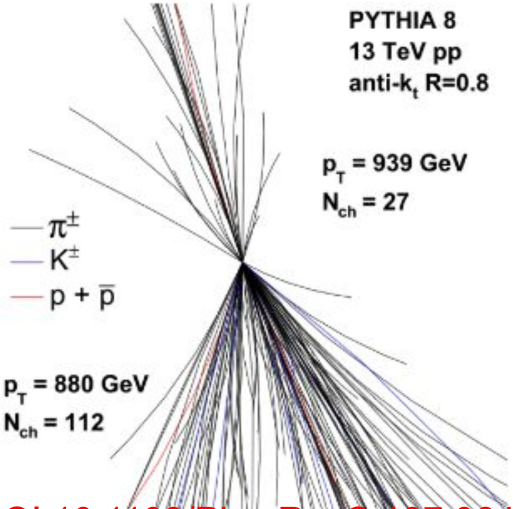


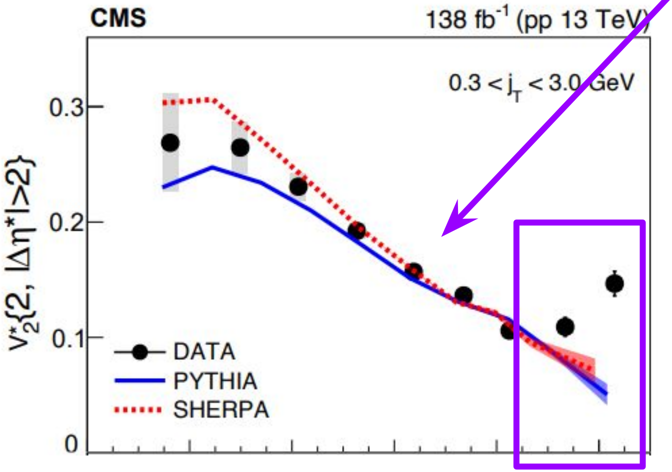


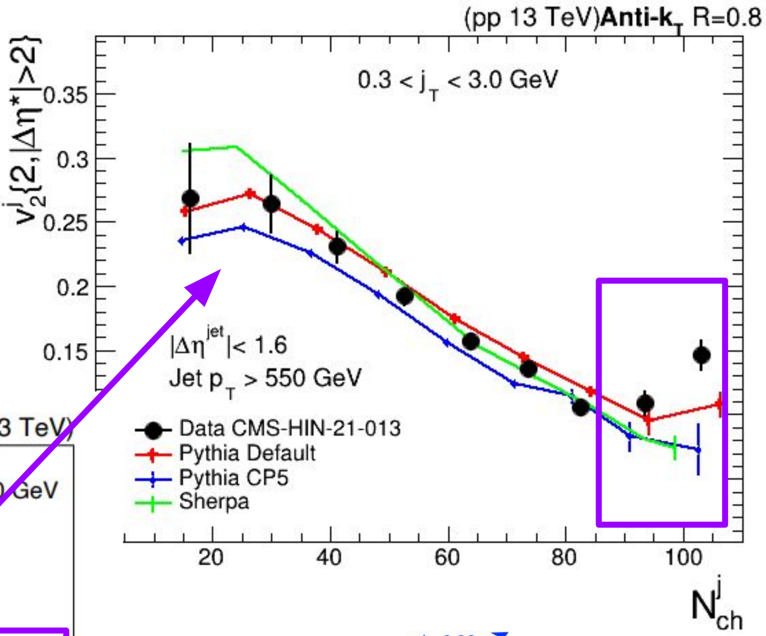
- ❖ Now the Pythia **Monash** have better agreement with data
- ❖ Could this behavior be attributed to QCD effects resulting from hadronization/fragmentation?

Summary

- The methodology was tested by reproducing the trends of v2 elliptic anisotropy with |η| > 2.0 using Pythia CP5
- Instead of CP5 tune, Pythia Default which showed better agreement with the data.
- Suggested that this behavior could be possible effects of showering and hadronization.







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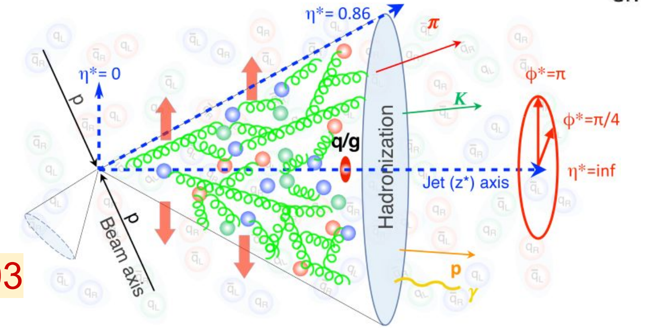
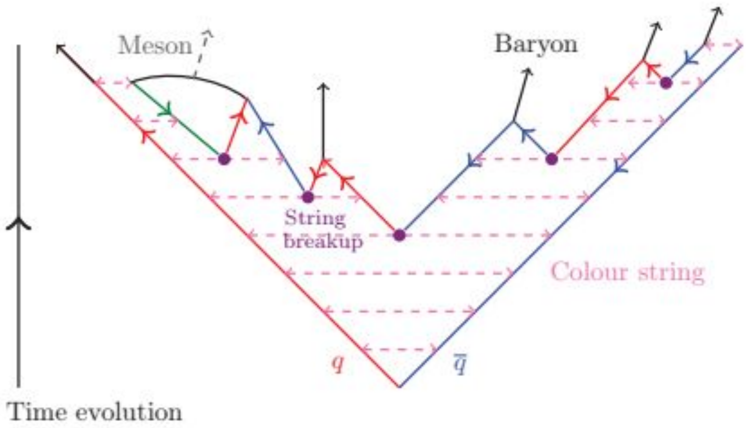


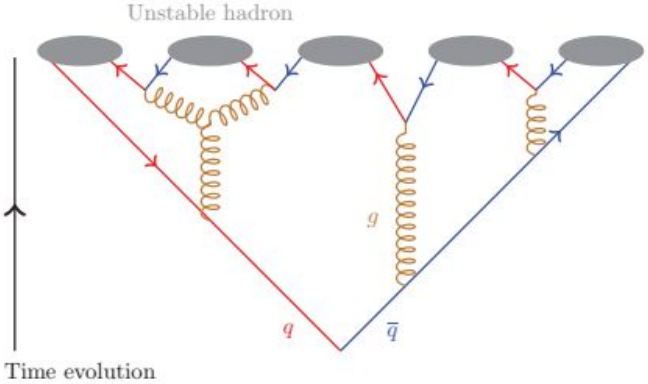
Bkup

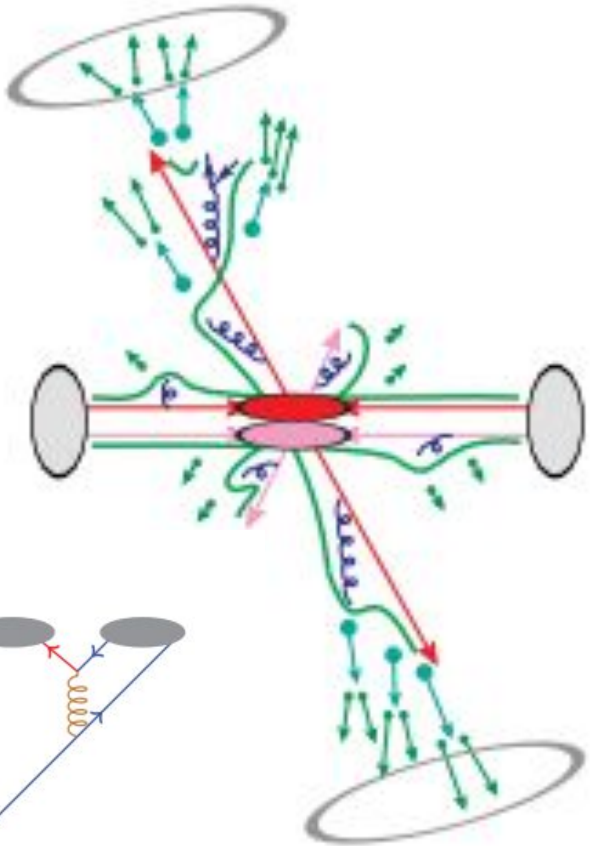
Lund Model

Pythia Hadronization model

- The string model takes a high-energy perspective on hadronization
- Simulate the particle production process in various collision scenarios



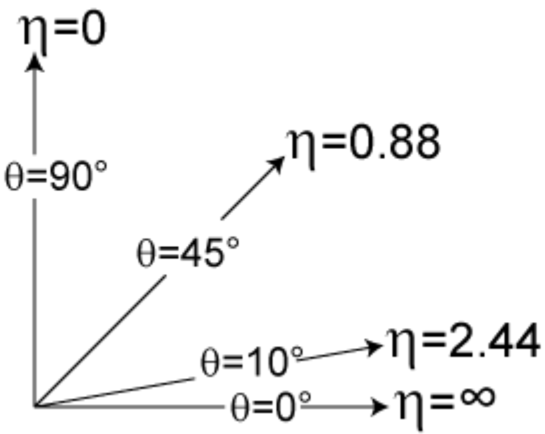




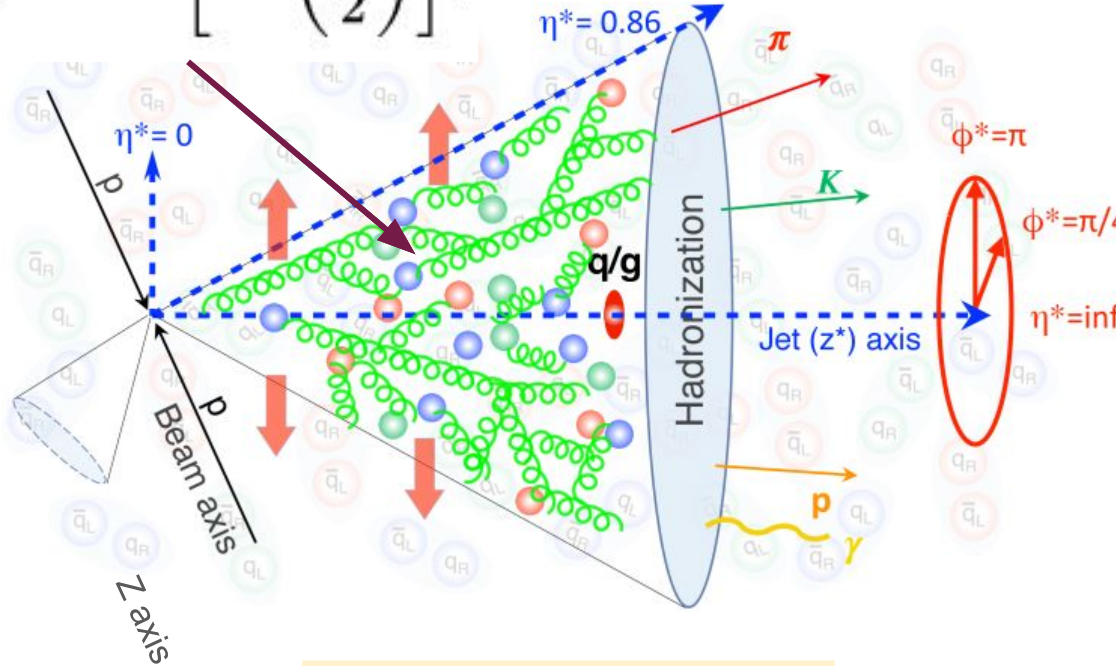
DOI: 10.1088/2053-2563/ab1be6

Redefining the coordinate system to Jet basis

- **For an individual jet:**
  - Define a new coordinate frame
  - The **new z-axis** is aligned with the direction of jet momentum



$$\eta \equiv -\ln\left[\tan\left(\frac{\theta}{2}\right)\right],$$



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