JET ORIGIN IDENTIFICATION AT THE LHC ENERGY

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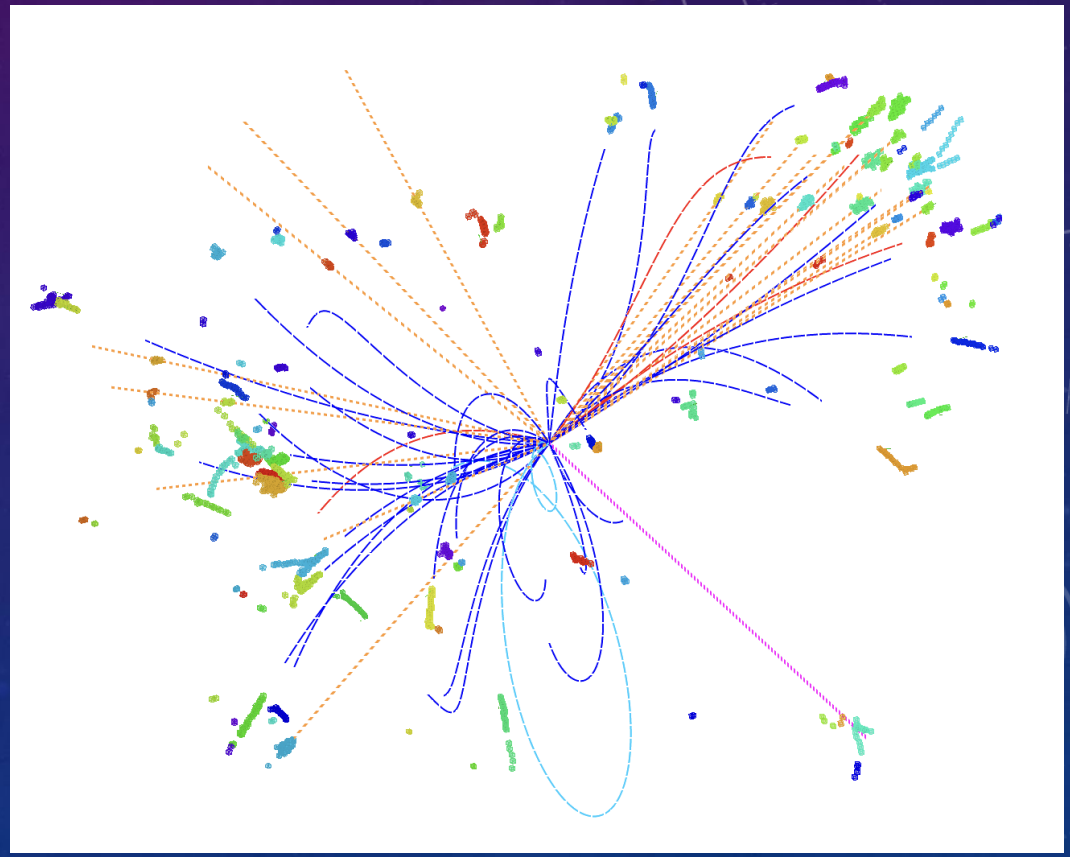
Opportunities and Ideas at the QCD Frontier, CCAST, 2025

JET ORIGIN

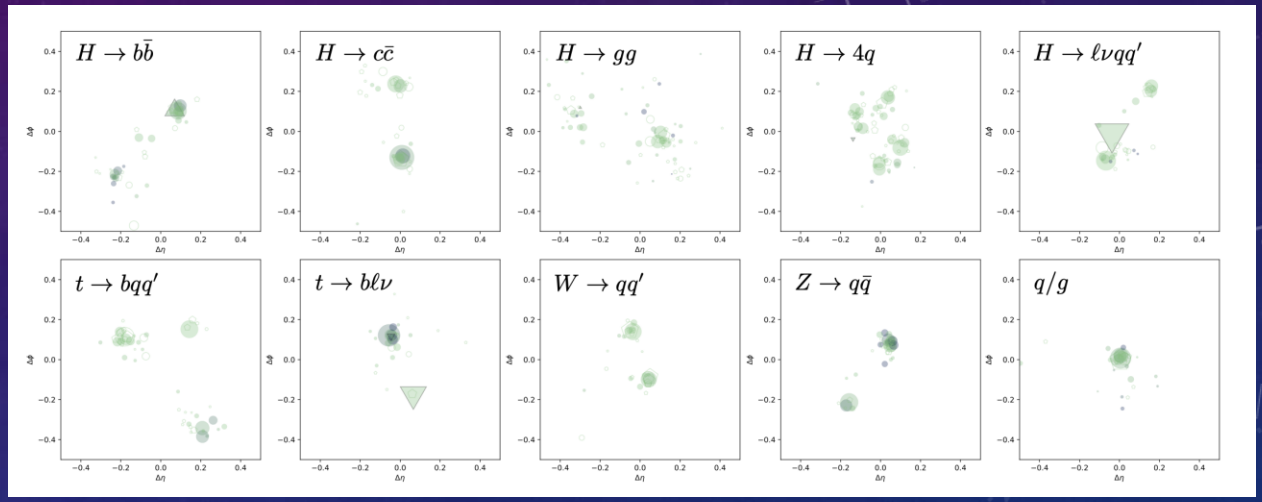
- Quarks and gluons carry color charge, and they can not travel freely.
- Once generated in high-energy collisions, quarks, and gluon would fragment into numerous particles, which are called jet.

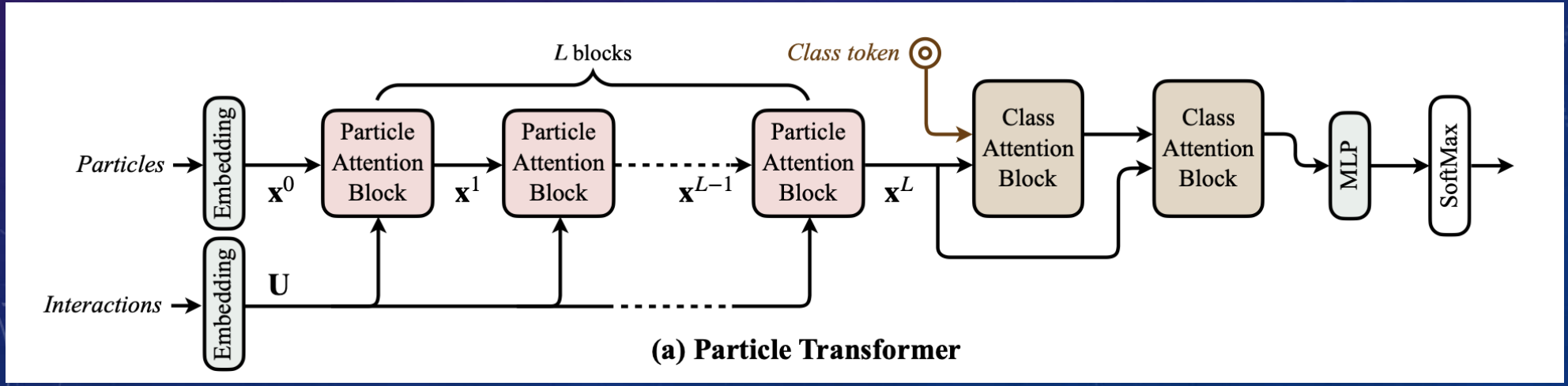
- Jet Origin Identification: categorizes jets into 5 quarks, 5 anti-quark, and gluon.
- It comprises the concepts of jet flavor tagging, jet charge measurement, s-quark tagging, and gluon finding.



PARTICLE TRANSFORMER

- A new Transformer-based architecture for jet tagging.
- Identify the “signal jets”: those arising either from the top quarks (t), or from the W , Z or Higgs (H) bosons. (Mostly studied at ATLAS and CMS)





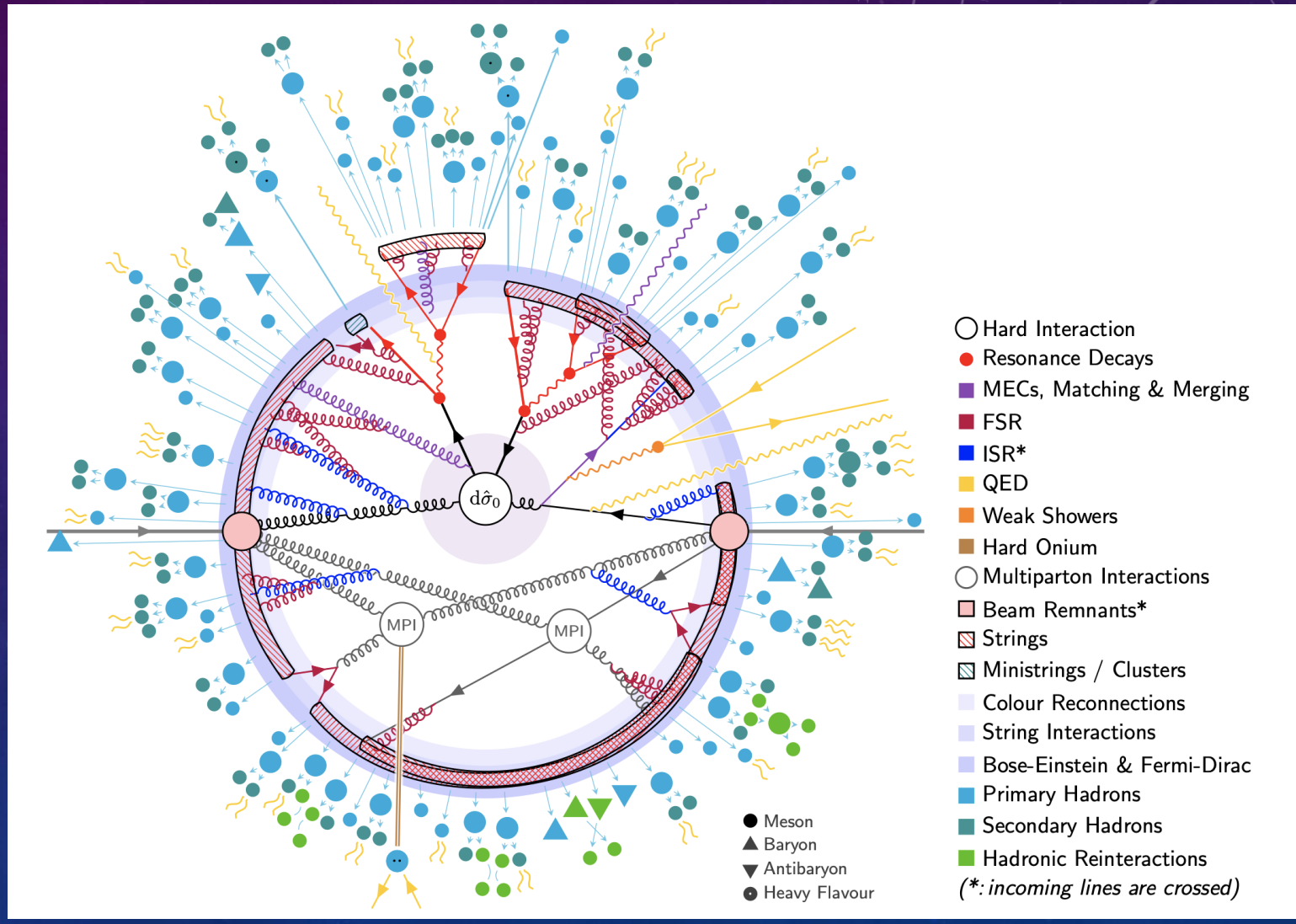
BACKGROUND JETS IDENTIFICATION

- “Background” jets are initiated by light quarks or gluons (q/g) and are ubiquitously produced at the LHC.
- They are the signal of many physics at ALICE and LHCb:
  - CP measurements.
  - Flavour tagged jet suppression.

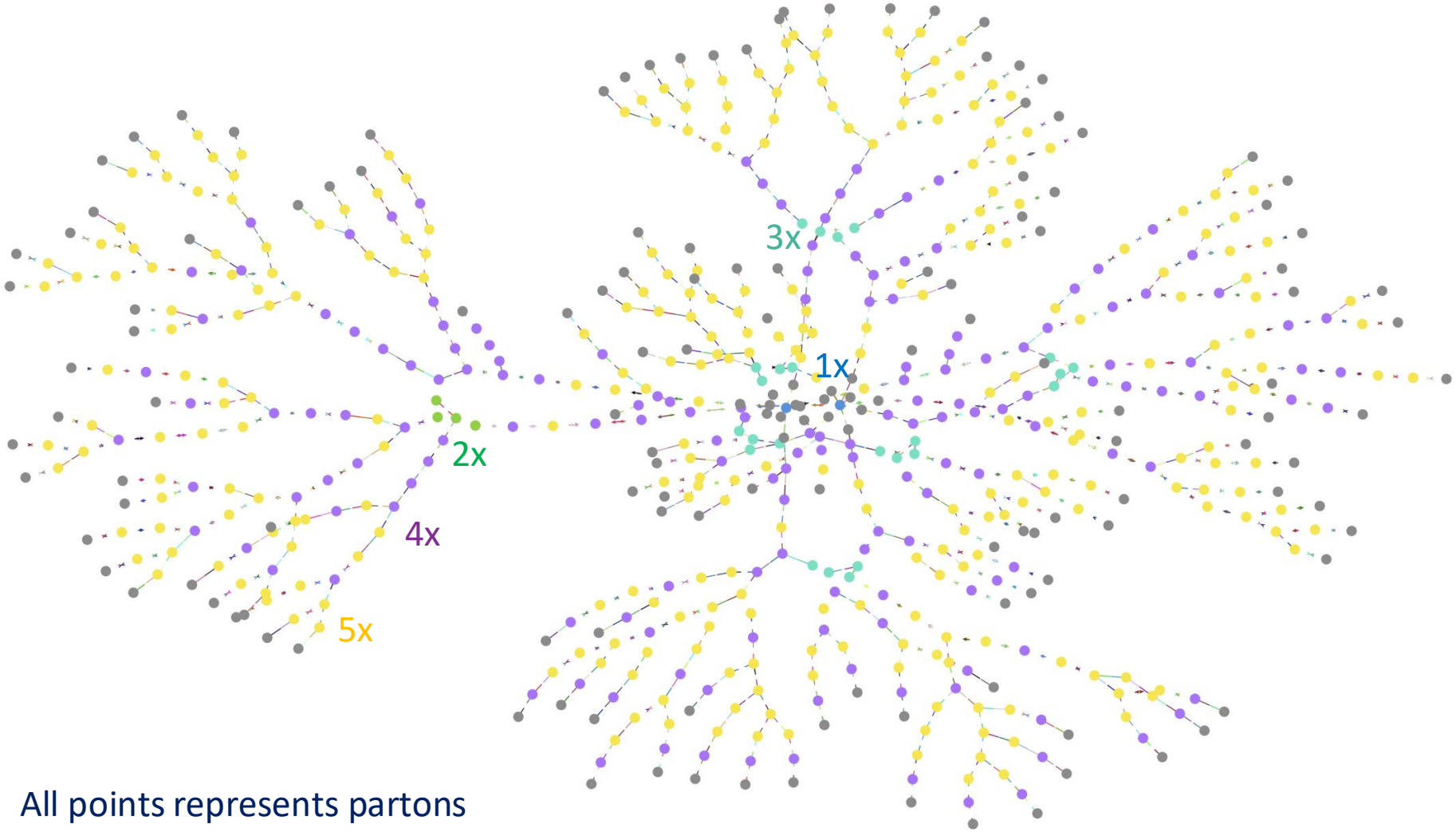
- This work try to identify the origin of these background jets.

JETS IN PYTHIA8

- Pythia 8: one of the state-of-the-art event generator at LHC energy.
- From hard scattering to hadron.
- Lund string hadronization model.



INFORMATION FLOW FROM QUARK/GLUON TO HADRON



All points represents partons

- 11 - 19 : beam particles
- 21 - 29 : particles of the hardest subprocess
- 31 - 39 : particles of subsequent subprocesses
- 41 - 49 : particles produced by initial-state-showers
- 51 - 59 : particles produced by final-state-showers
- 61 - 69 : particles produced by beam-remnant treatment

INFORMATION FLOW FROM QUARK/GLUON TO HADRON

- 71 - 79 : partons in preparation of hadronization process
- 81 - 89 : primary hadrons produced by hadronization process

Lost information

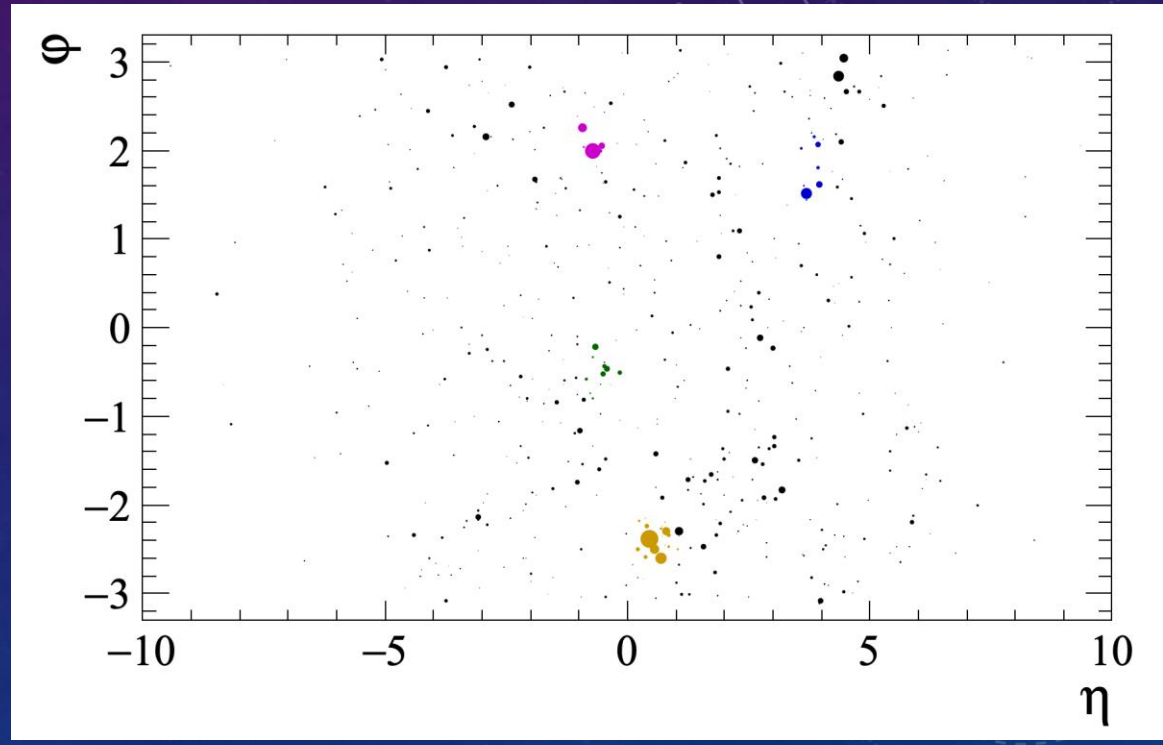
JET CLUSTERING

- Cluster with FASTJET package, with anti-kT algorithm, R=0.4

anti-k_t: repeatedly recombine pair of objects with smallest $d_{ij} = \frac{\Delta R_{ij}^2}{\max(k_{ti}^2, k_{tj}^2)}$

anti-k_t gives cone-like jets without using cones

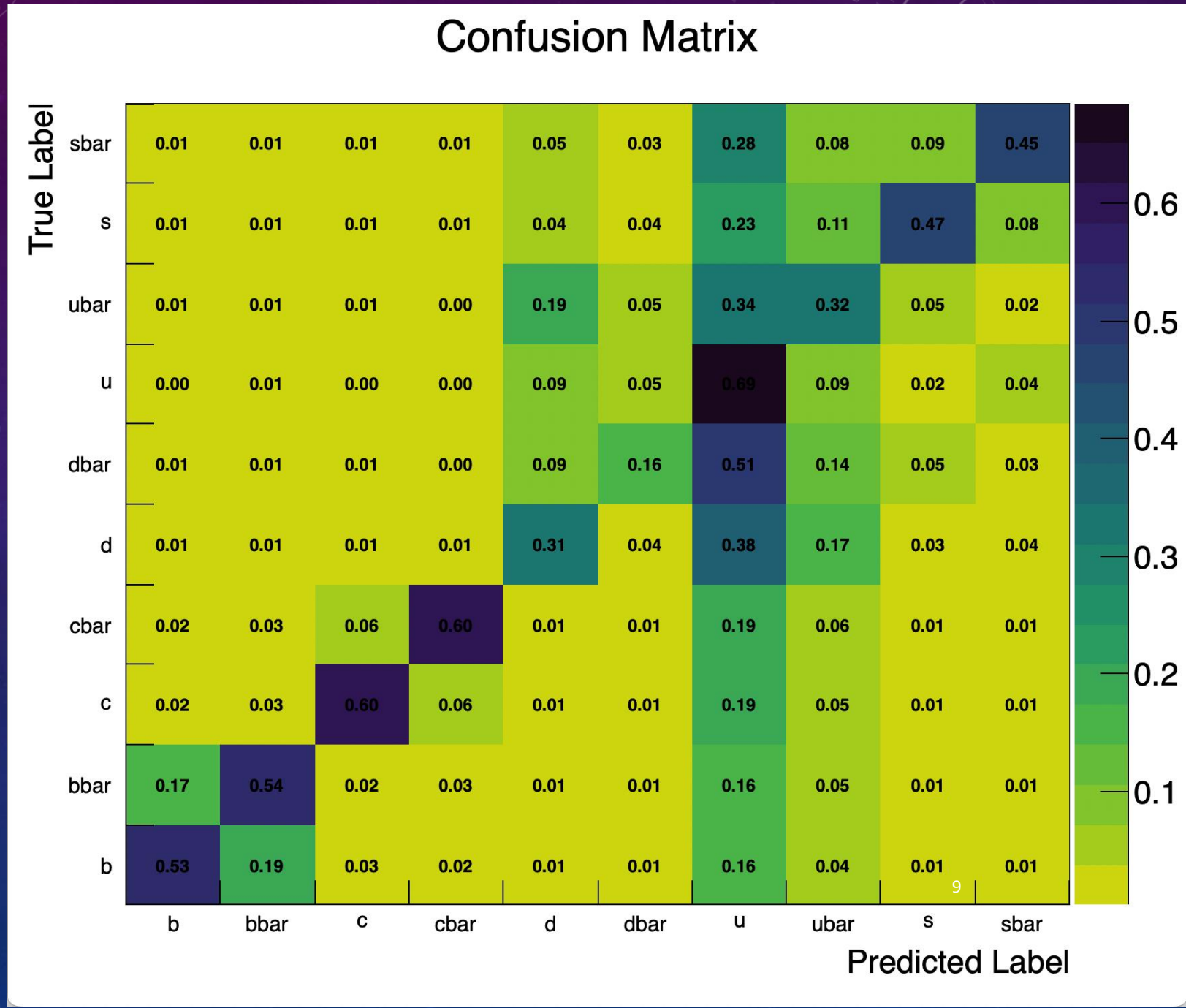
And is infrared & collinear safe



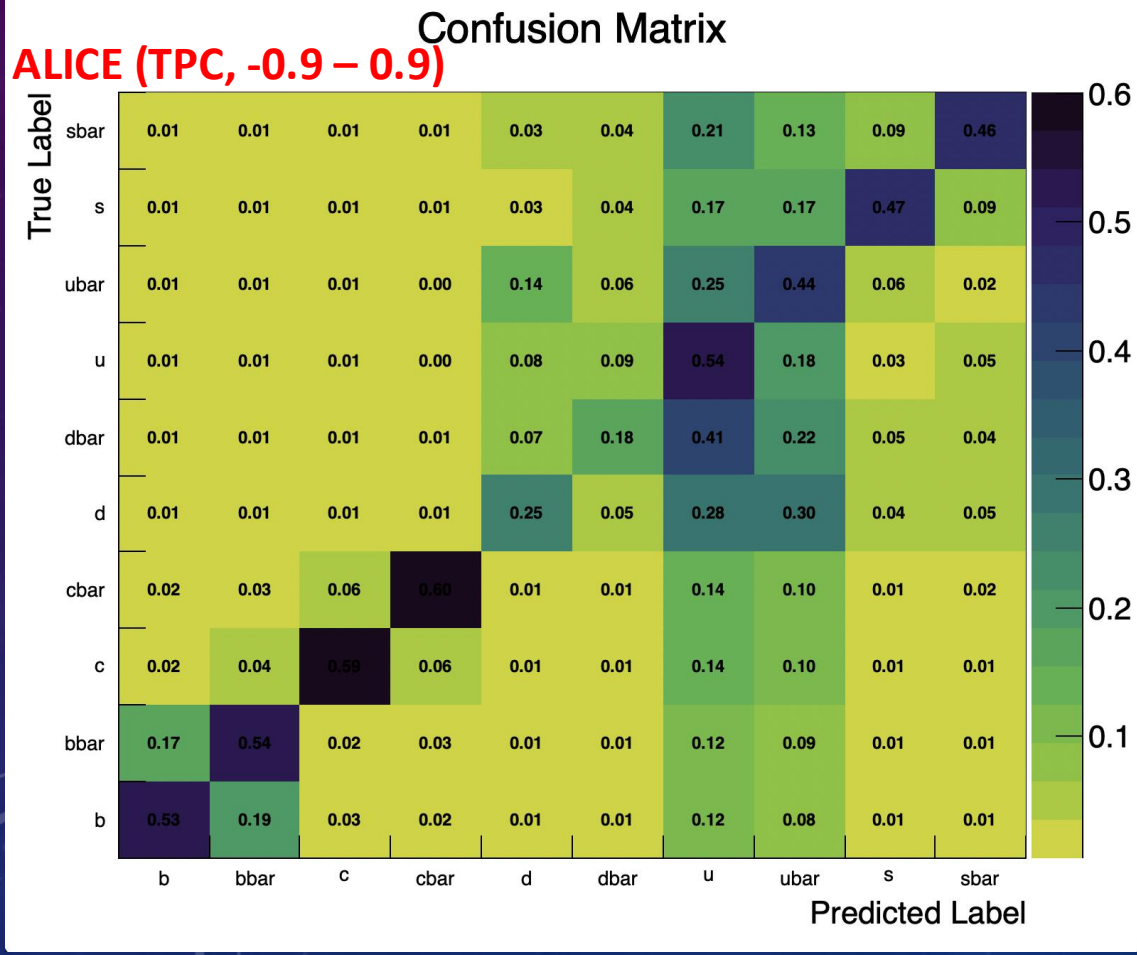
Tag assignment: calculate the ΔR of leading pårton and jet assign the flavour of the smallest ΔR parton to the jet

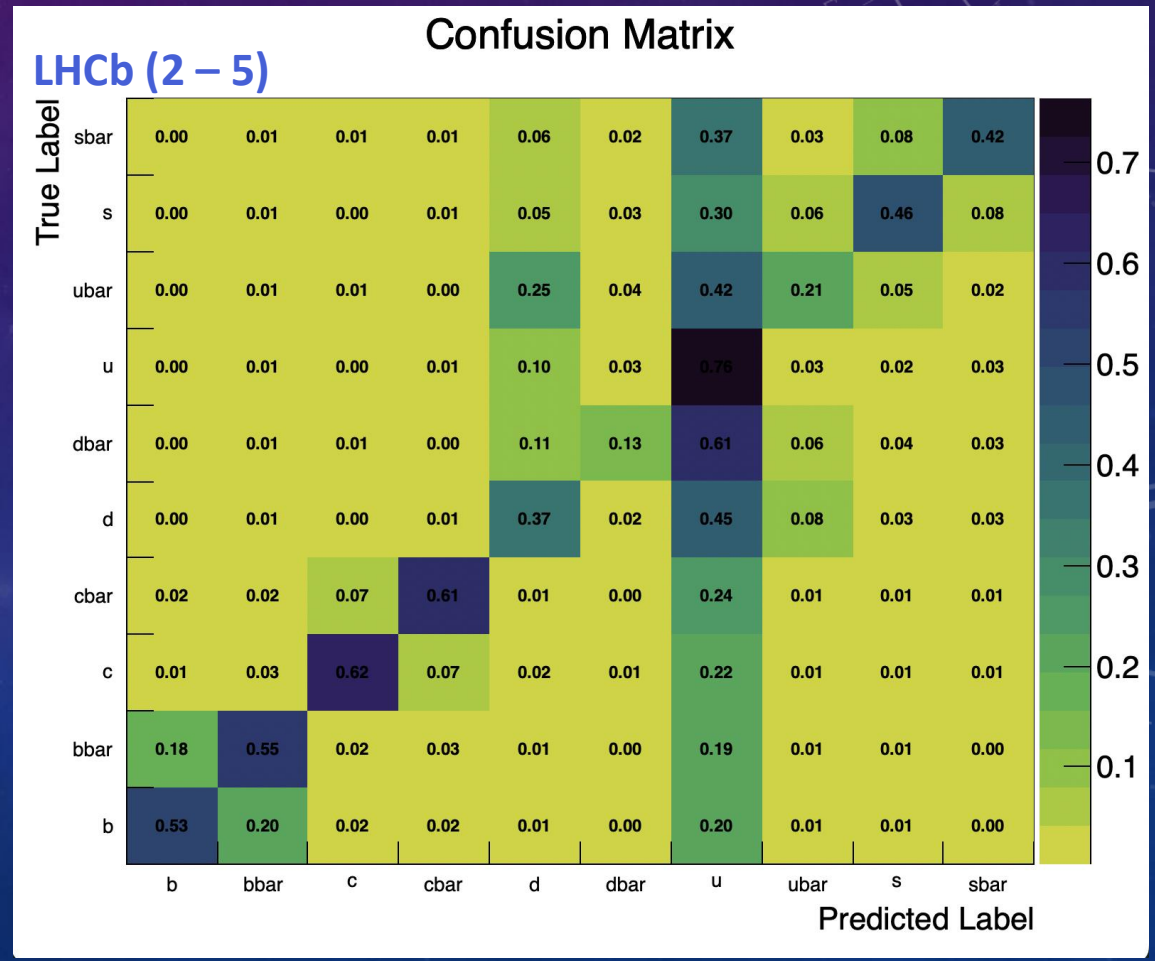
PERFORMANCE

- Truth level information:
  - PID
  - Kintematics
  - Vertex
- Round 200,000 jets used for training
- Asymmetry between u/ubar, d/dbar



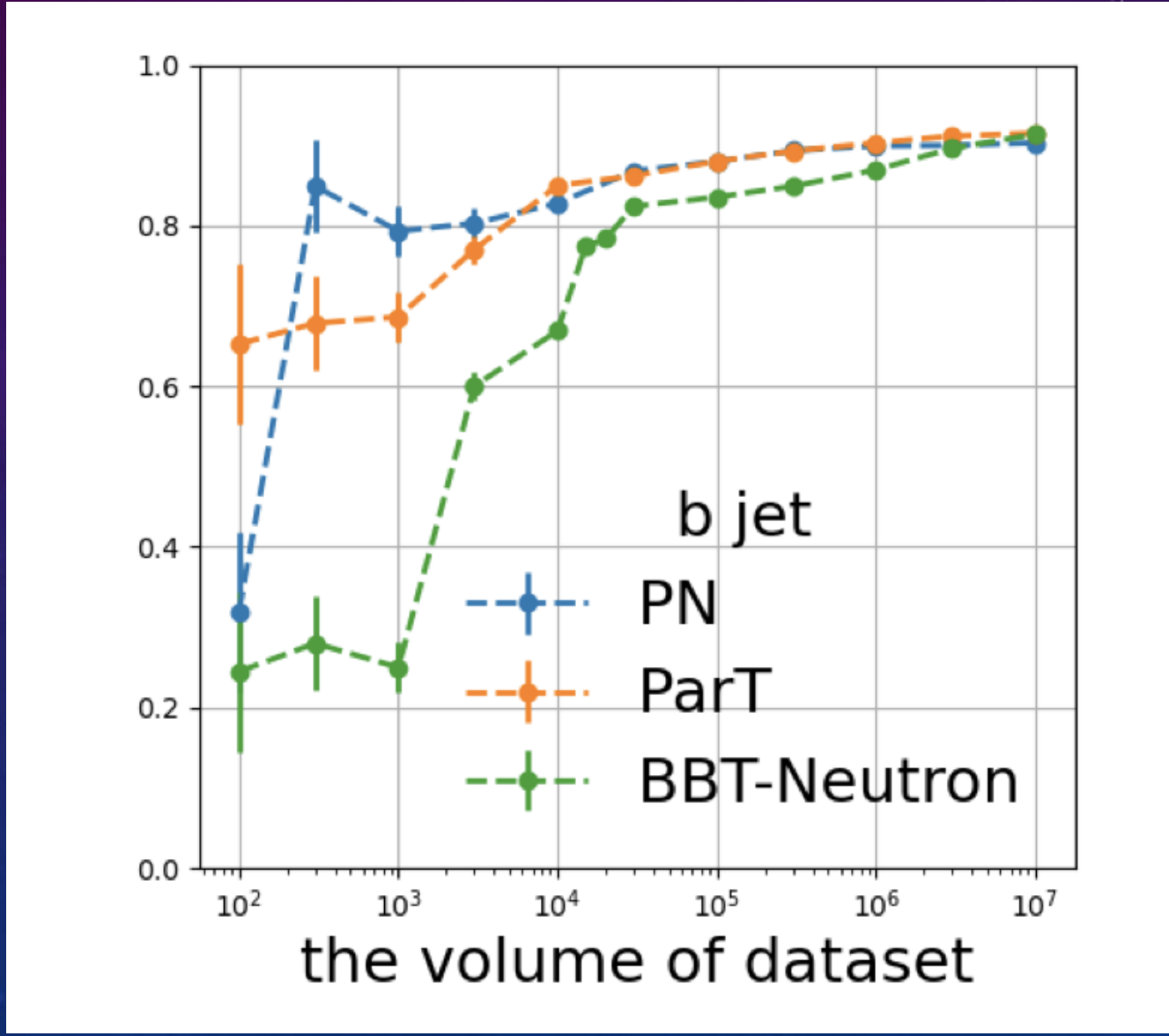
PERFORMANCE





IMPROVEMENT

- More training sample
- Sample size balance



SUMMARY

- Information flow breaks from leading particles -> jets.
- Jet (with defined flavour) could be identified with relative high efficiency.
- Detector simulation is required: LHCb model already in Delphi.
- Expected good performance for benchmark studies, e.g., phis measurements.