

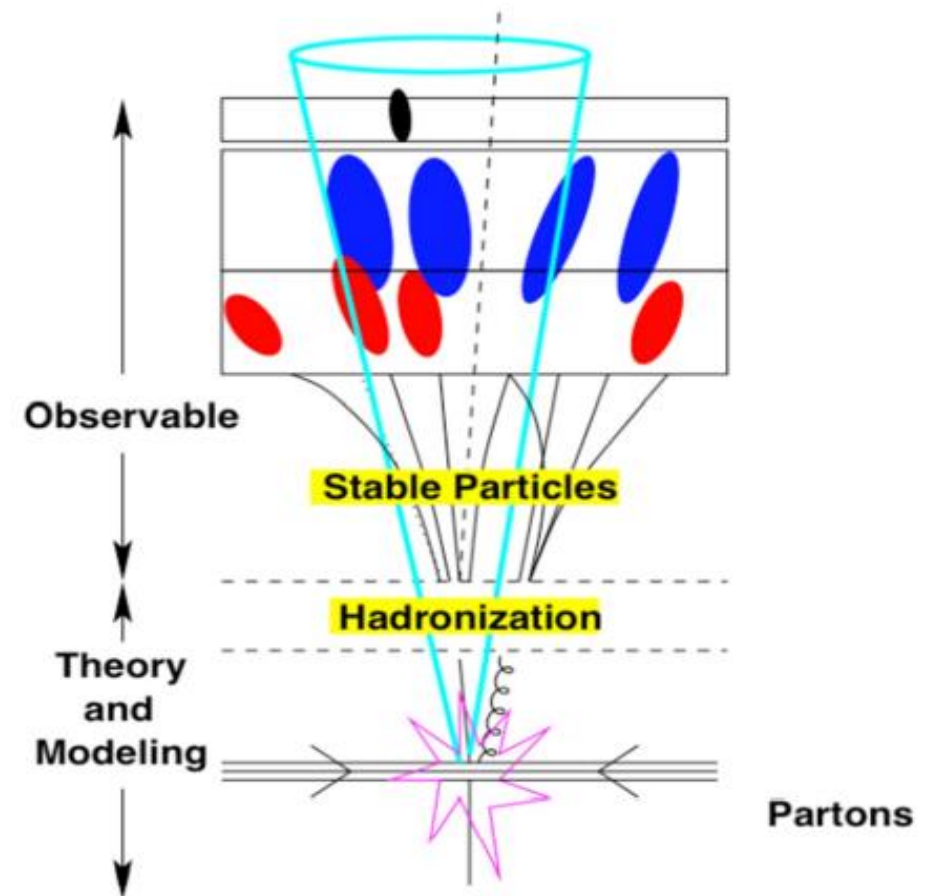
Study of jet reconstruction in the high-energy heavy-ion collision experiment sPHENIX

Nara Women's University
M2 Mai Watanabe

What is JET?

In high-energy heavy-ion collisions, a physical phenomenon called jet can occur.

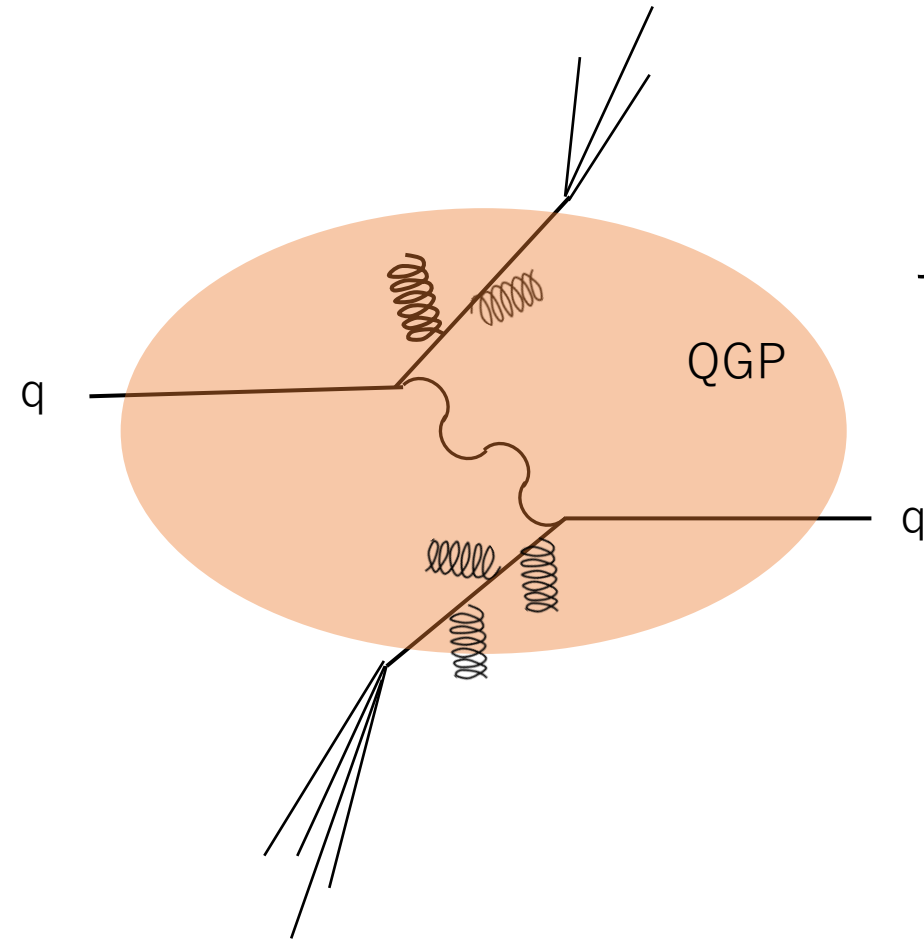
jet...A group of particles ejected in the same direction created by the breakup of high-momentum partons created in the early stages of a collision.



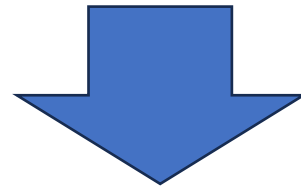
Why is jet important?

Jet is an important tool to understand the nature of QGP

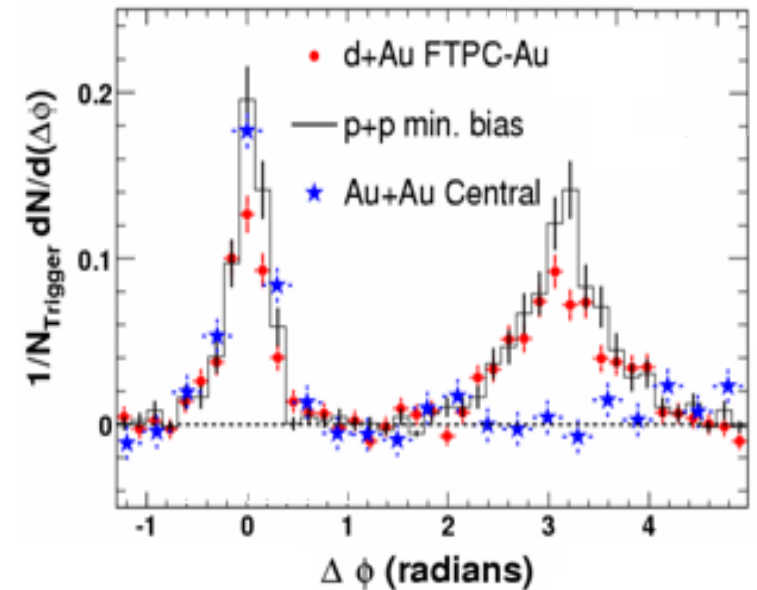
jet quenching : Strong interaction with QGP causes Jet energy loss



Jet quenching occurs



Evidence of QGP

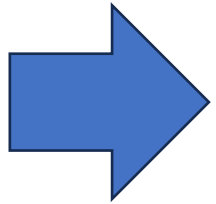


From The STAR experiment at the Relativistic Heavy Ion Collider, Brookhaven National Laboratory ([STAR: STAR](http://STAR.bnl.gov)
[Focus: Jets in nuclear collisions \(bnl.gov\)](http://STAR.bnl.gov))

Jet reconstruction algorithm

In order to analyze the JET...

We need to extract only the JET from the various particles after collision.



Jet reconstruction algorithm

jet reconstruction algorithm

- K_t
- *anti- K_t* ← best
- Cambridge/Aachen
- Iterative cones(IC-PR,IC-SM)
- SIScone

Anti- K_t algorithm

Distance between two particles d_{ij}

momentum space distance between the beam axis and the detected particle d_{iB}

$$d_{ij} = \min\left(\frac{1}{p_{ti}^2}, \frac{1}{p_{tj}^2}\right) \times \frac{R_{ij}^2}{R}$$
$$d_{iB} = \frac{1}{p_{ti}^2}$$

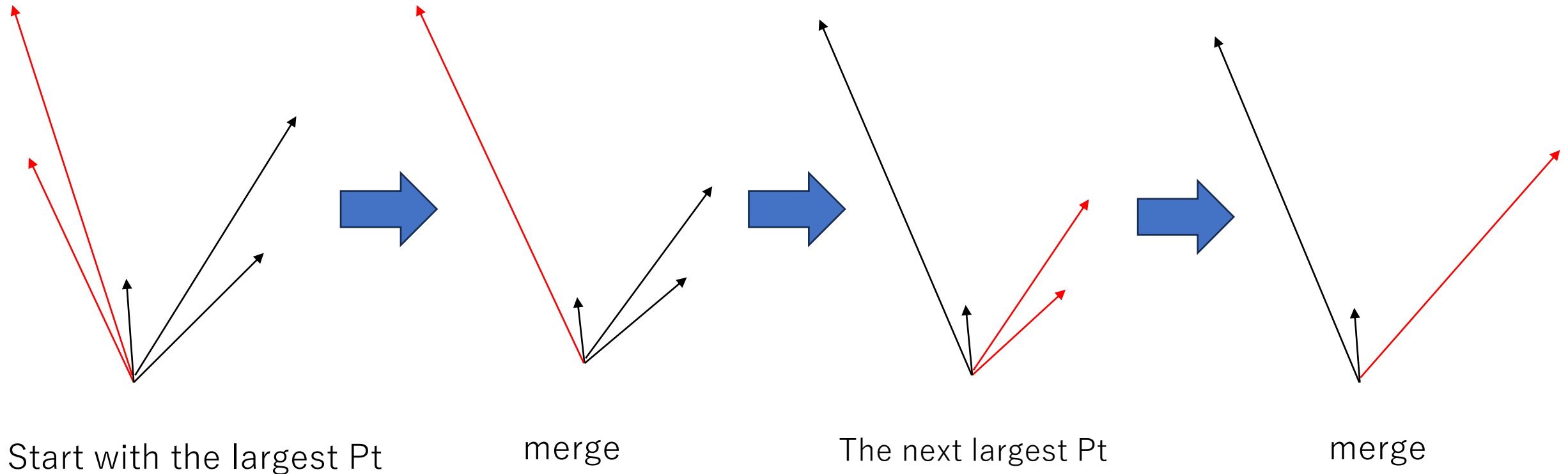
$R_{ij}^2 = (\eta_i - \eta_j)^2 + (\phi_i - \phi_j)^2$ is the $(\eta - \phi)$ space distance between the two particles

R is the radius parameter which determines the final size of the jet

Find the smallest d

Anti- K_t algorithm

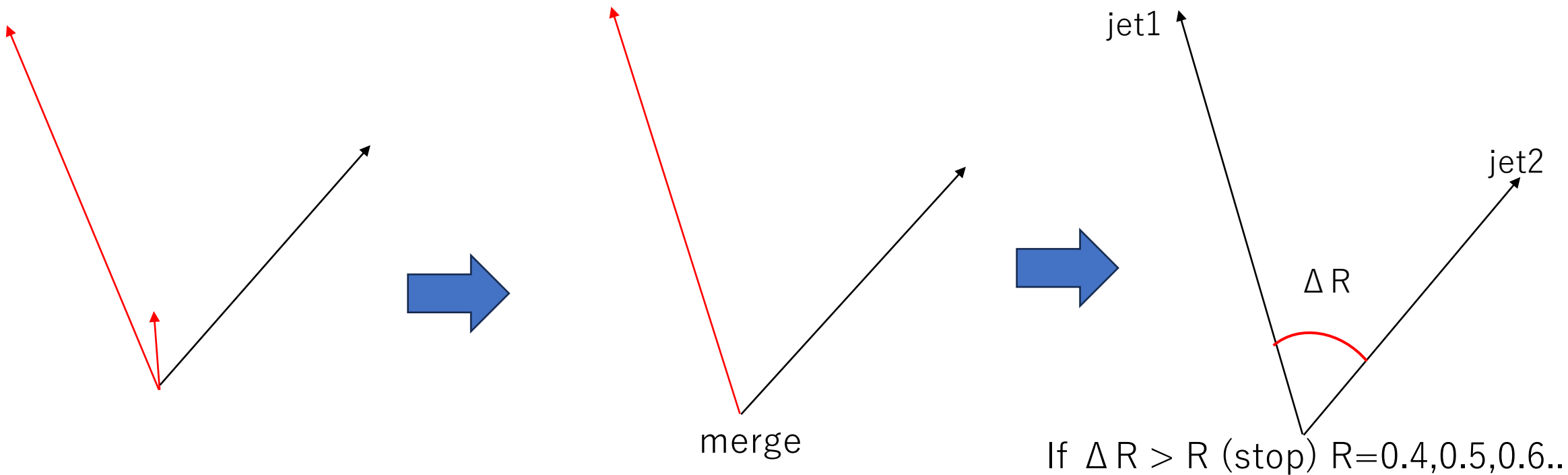
- ① {
- If d_{ij} is minimal, remove particles i and j from the list of particles and sum the four- dimensional vectors to make one particle
 - If d_{iB} is minimal, set i as final jet and remove it from the list of particles



Anti- K_t algorithm

Repeat ① until ②

- ② {
- All particles are part of a jet where the distance R_{ij} between the jet axes is greater than R
 - or
 - Find the amount of jets we want



What I actually do

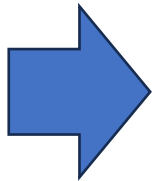
Jet reconstruction

- MB HIJING simulation data embedded with 30GeV Pythia dijet
- using an external tool FastJet
- $R=0.4$ and cut of $P_t > 30$ GeV for jet

FastJet

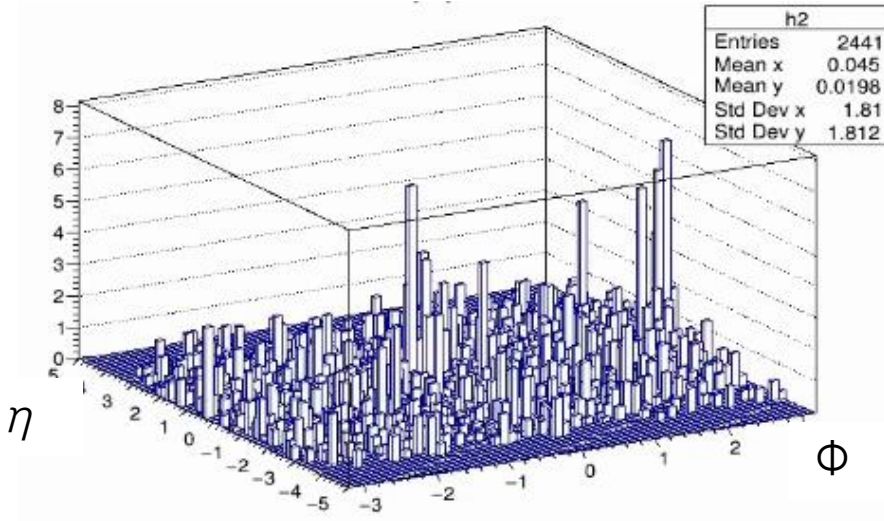
Jet reconstruction can be performed with various jet reconstruction algorithms, including background (pileup/UE) subtraction and jet substructure analysis tools.

We know the TRUTH jet because I use simulated data.



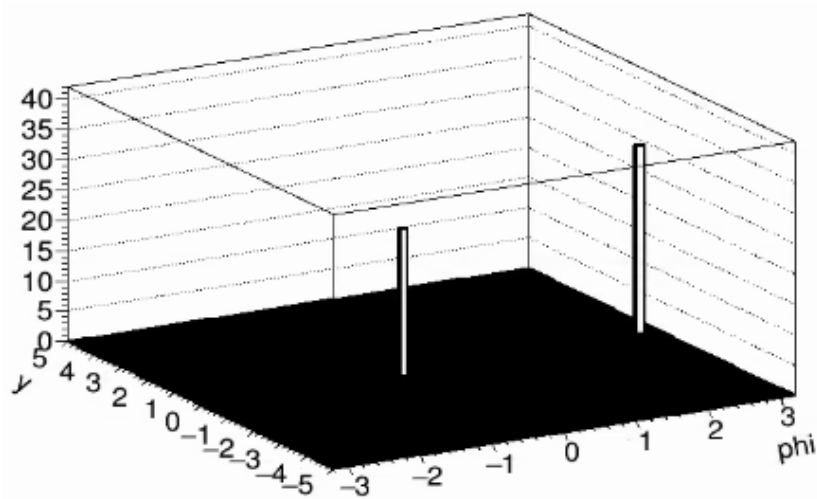
I would like to improve the reconstruction code in fastjet so that only the truth jet can be reconstructed more accurately.

state of progress

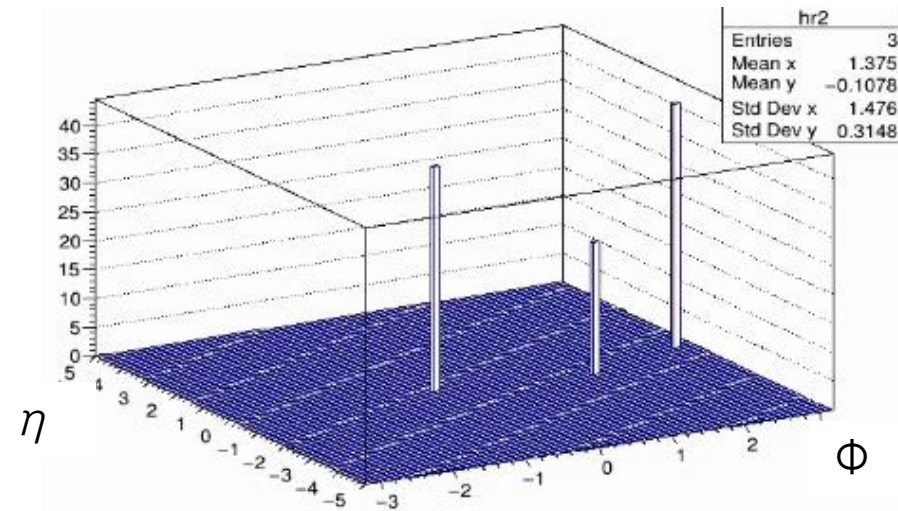


All particles of 1 event

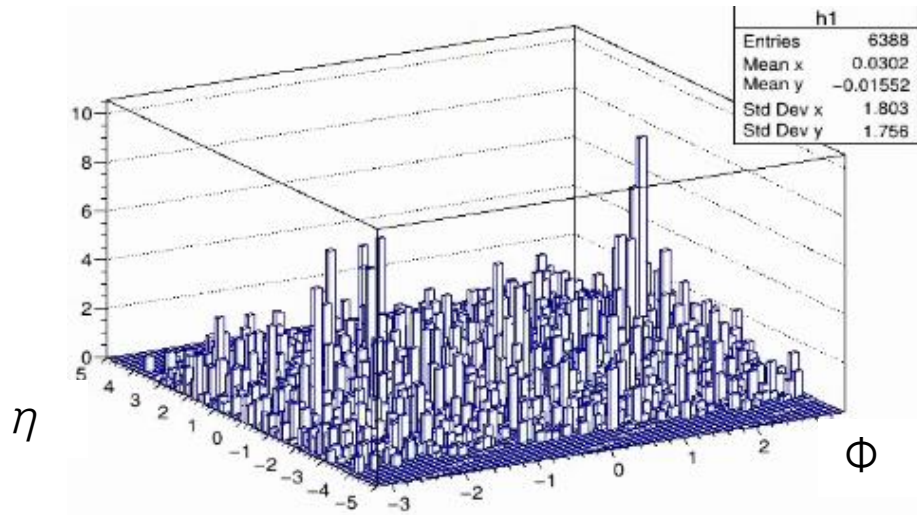
Less background is not perfect, but it can be reconstructed to some extent.



Truth jet



JET reconstructed with my macro



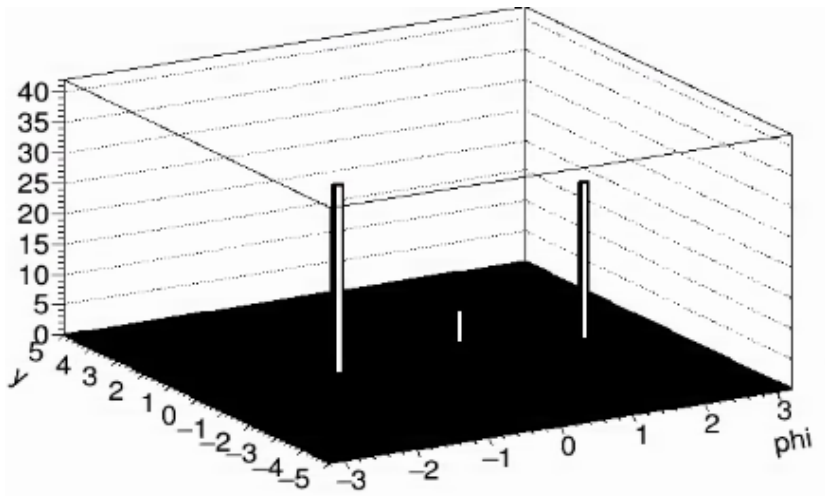
All particles of 1 event

Still needs to be improved for events with a lot of background.

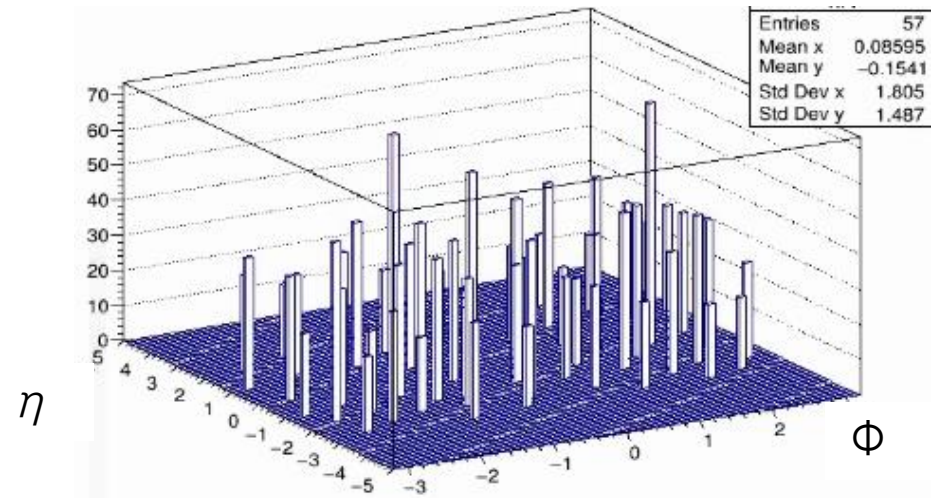
Since the Pt of reconstructed jet is larger than the Truth jet, it is possible that background unrelated to the jet is also counted as a jet.



It might be better to cut each particle before reconstruction.



Truth jet



JET reconstructed with my macro

summary

I'm making a code that can reconstruction jet accurately.

Room for improvement in events with large backgrounds.



Try the cut condition not only on the Jet after reconstruction but also on the particles before reconstruction, so that the truth jet can be reconstructed more accurately.

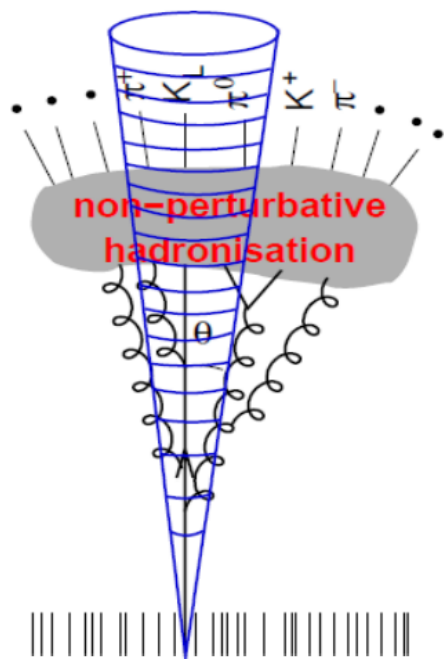
Important Aspects

参考文献：CERNのRyan Atkinさんのプレゼン

jetの大きさ

[3]

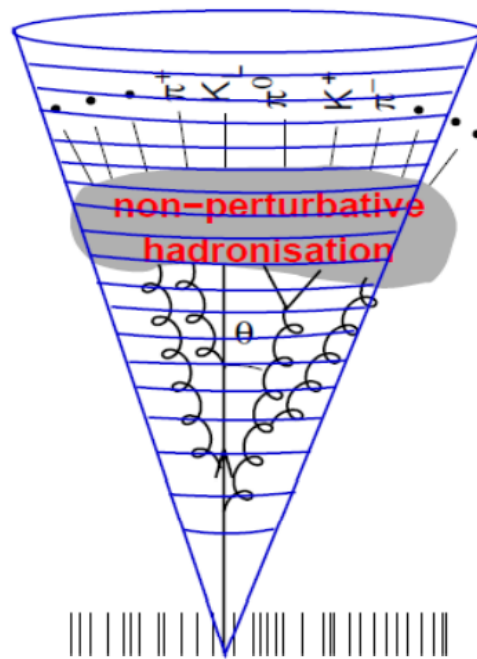
Small jet radius



UE & PU

Underlying event(UE)：ハードな衝突でできたもの以外全て
Pile-up(PU)：多重衝突

Large jet radius



大きいjet

ハドロン化された粒子を多く含む
→jetの質量とエネルギーを
正確に計算できる

小さいjet

Underlying eventとPile-upの数を減らす
→質量とエネルギーを多く見積もることを防ぐ