

Short status report about subsequent CMS jet charge analysis

Dong Ho Moon, Hyunchul Kim (Chonnam National University)

*Miniworkshop on CMS gluon charge analysis and ALEPH results
Feb. 28th. 2024, MIT*



Motivation of the study

then

- then
 - lose color neutral gluons
 - ✓ may not be reconstructed as jets
 - need to save those jets
 - show an excess in the small number of tracks
 - ✓ check this easily by seeing # of track of jets
 - Jet shapes can be different
 - ✓ narrow jet (neurons) .vs. broad jet (chromons)
 - Energy shares of tracks
 - ✓ high share (neurons) .vs. low share (chromons)

Copied from Inkyu's slide

2/25/24

Gluon jet study

10

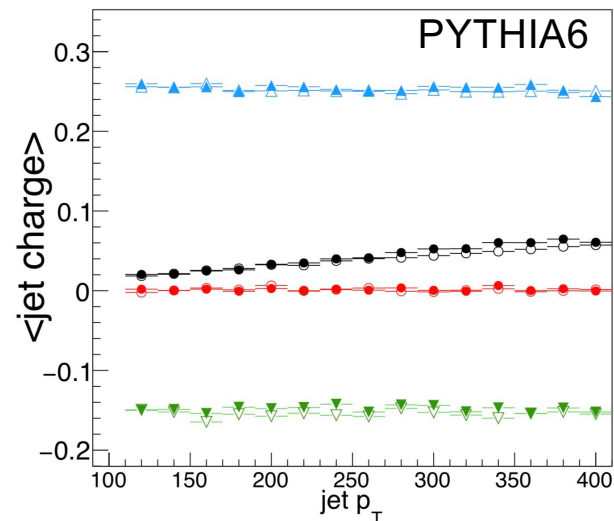
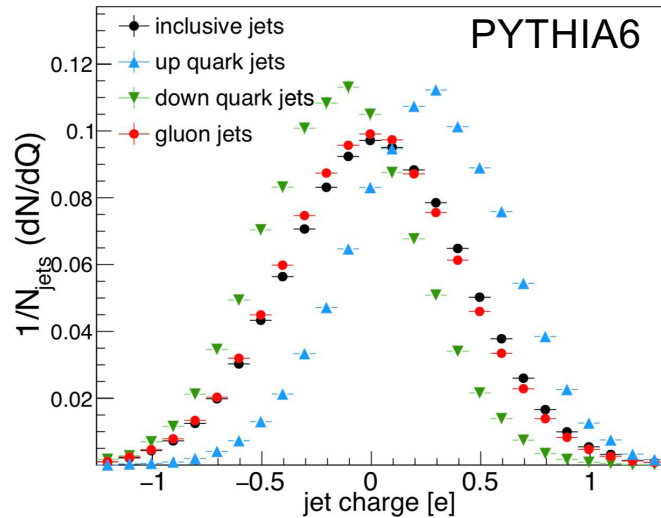
- In heavy ion physics, another way to find Chromons : interaction of QGP (quark gluon plasma)
- Previous theory and model have expected the suppression of gluon jet compared to quark jet in PbPb collision
- Except in jet charge analysis

- Jet charge : momentum-weighted sum of the electric charges of the particles in a jet

$$Q^\kappa = \frac{1}{(p_T^{\text{jet}})^\kappa} \sum_{i \in \text{jet}} q_i (p_T^i)^\kappa$$

Charge of the particle

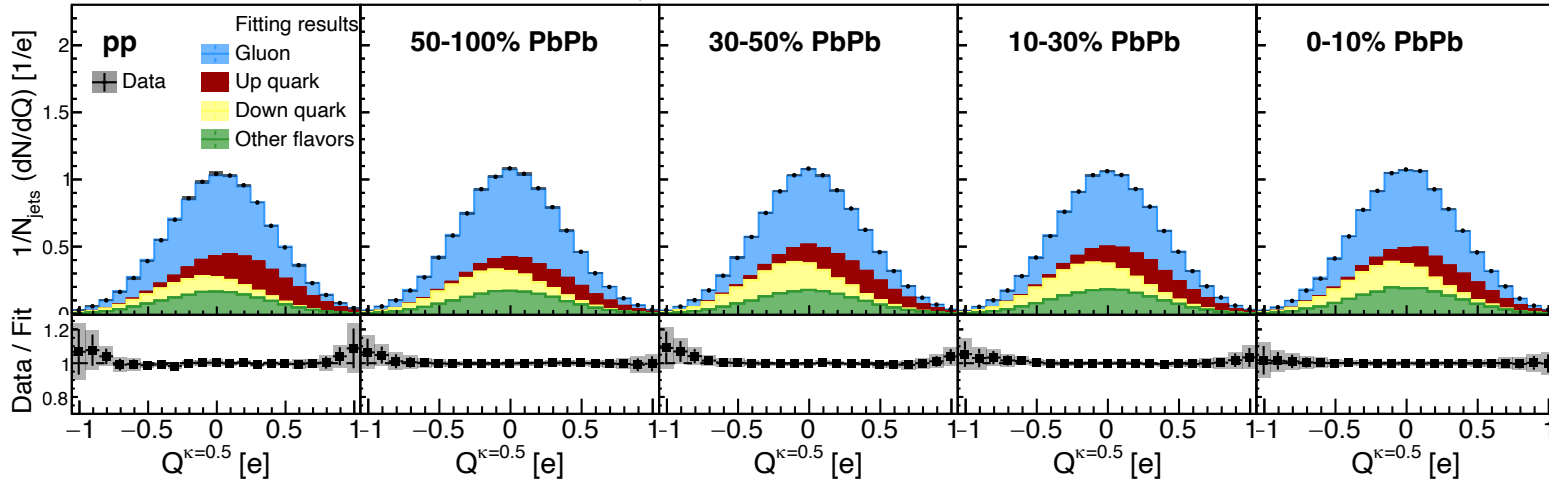
controls the sensitivity to the soft particles within the jet



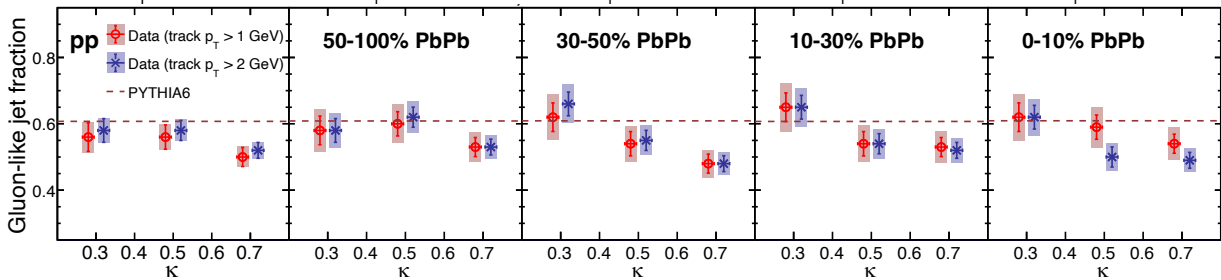
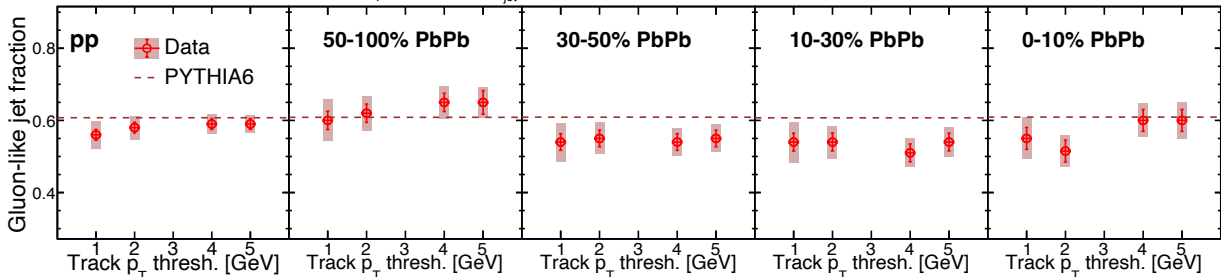
Main plots in the analysis

HIN-18-018
JHEP 07 (2020) 115

CMS anti- k_T $R = 0.4$ jets, $p_T^{\text{jet}} > 120$ GeV, $|\eta_{\text{jet}}| < 1.5$ $\kappa = 0.5$, track $p_T > 1$ GeV pp 27.4 pb $^{-1}$, PbPb 404 μb^{-1} (5.02 TeV)



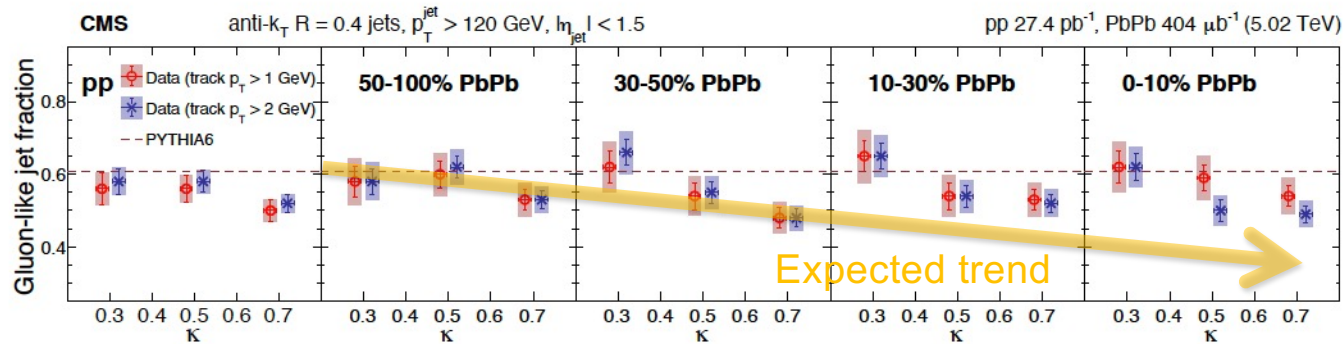
CMS anti- k_T $R = 0.4$ jets, $p_T^{\text{jet}} > 120$ GeV, $|\eta_{\text{jet}}| < 1.5$ $\kappa = 0.5$ pp 27.4 pb $^{-1}$, PbPb 404 μb^{-1} (5.02 TeV)



- Gluon-like jet fraction is not decreased in central PbPb collision
- Trend is independent on κ and track p_T threshold



Puzzle in CMS jet charge analysis – Hint of the Cho-gluon existence



$$Q^\kappa = \frac{1}{(p_T^{\text{jet}})^\kappa} \sum_{i \in \text{jet}} q_i (p_T^i)^\kappa.$$

No significant modification of quark/gluon jet fraction in PbPb
 Contradicts expectations of some jet quenching models

Do gluons lose more energy than the quarks?
 If yes : Gluon jet to quark jet ratio will decrease

HIN-18-018
 JHEP 07 (2020) 115

If we confirm the anomaly with larger statistics again, Cho-gluon could be the way to explain it

From Yen-Jie's slides for previous workshop



Proposal for the subsequent analysis

- **Reproduce the result with 2023 PbPb data**
 - HIN-18-018 : 5.02 TeV, 404 μb^{-1} (in 2015) + (pp : 27.4 pb^{-1})
 - New in 2023 : 5.36 TeV, 1.7 nb^{-1} (> x4), not yet pp
 - With 2023 data, try to analyze more precisely
 - MC with PYTHIA8 (PYTHIA6 in 2015)
- **Reference analysis**
 - HIN-18-018 (Dhanush Anil Hangal (left CMS)) : [JHEP 07 \(2020\) 115](#)
 - previous jet charge analysis
 - HIN-21-002 (Jussi Vinikainen (CHICAGO)) : [JHEP 07 \(2023\) 139](#)
 - Jet v2 and v3 from dijet events in PbPb collisions at 5.02 TeV
 - Get the technique for dijet analysis
- **Look into the correlation between jet charge and other jet substructure observables (idea by Yen-Jie)**
 - Jet charge vs. jet width
 - Jet charge vs. jet constituent multiplicity
 - With pp, could vary the gluon jet fraction by comparing pp and HI results
- **Not yet planned conference, try to go forward step by step**

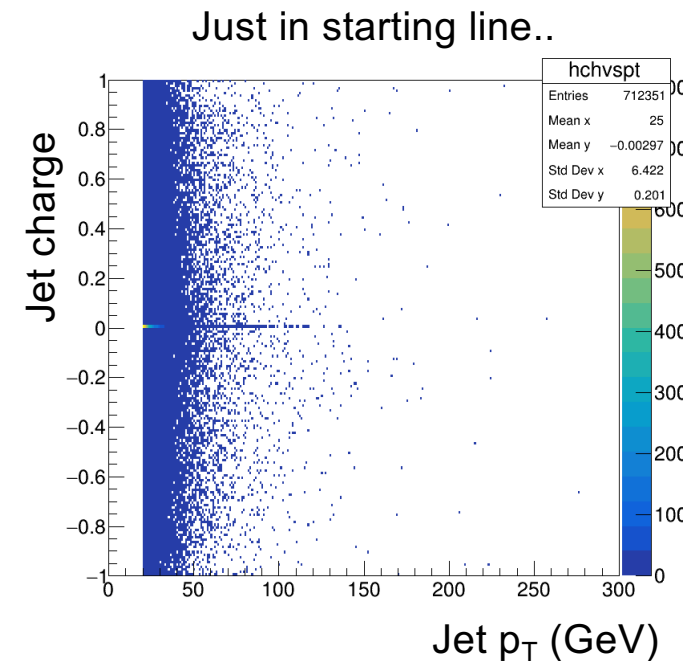
Status of the analysis

- Try to contact previous analyzer Dhanush with help from Jussi, but no reply yet..
- Try to make macros to get with HIForest
- Check the needed MC

Table 3: Summary of MC simulation statistics

AN2017/328

Generator	Process	Cross section (mb)	Number of events
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 50 \text{ GeV}/c$	3.778×10^{-3}	2M
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 80 \text{ GeV}/c$	4.412×10^{-4}	2.99M
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 120 \text{ GeV}/c$	6.147×10^{-5}	3M
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 170 \text{ GeV}/c$	1.018×10^{-5}	2.99M
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 220 \text{ GeV}/c$	2.477×10^{-6}	3M
PYTHIA+HYDJET(CYMBAL)	$\hat{p}_T > 280 \text{ GeV}/c$	6.160×10^{-7}	3M



– Collect GEN fragment for dijet MC

- We would like to ask some helps from high pT PING and experts

Thank you for your attention