Study on associated low p_T hadron production with di-jet in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV in LHC-ALICE

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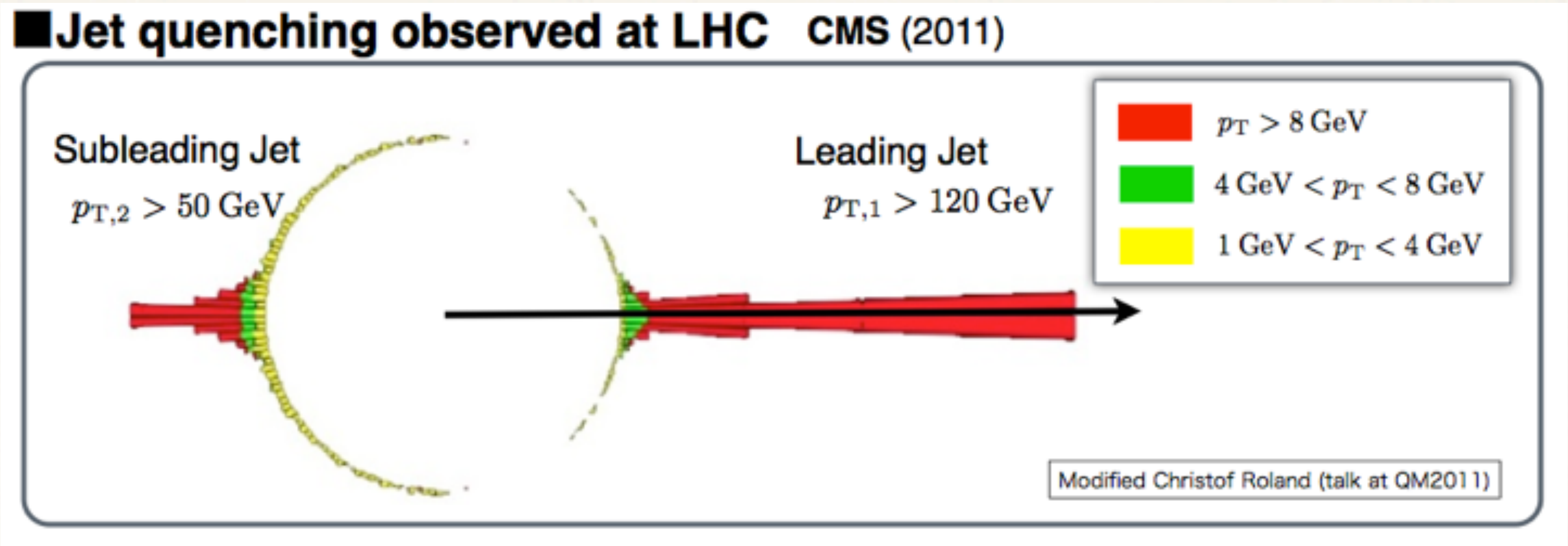
Low P_T particle production with di-jets



- Lost energy of jets: distributed to the large angle of the away-side of the jet and it produces low momentum particles at large angle (CMS).

↓

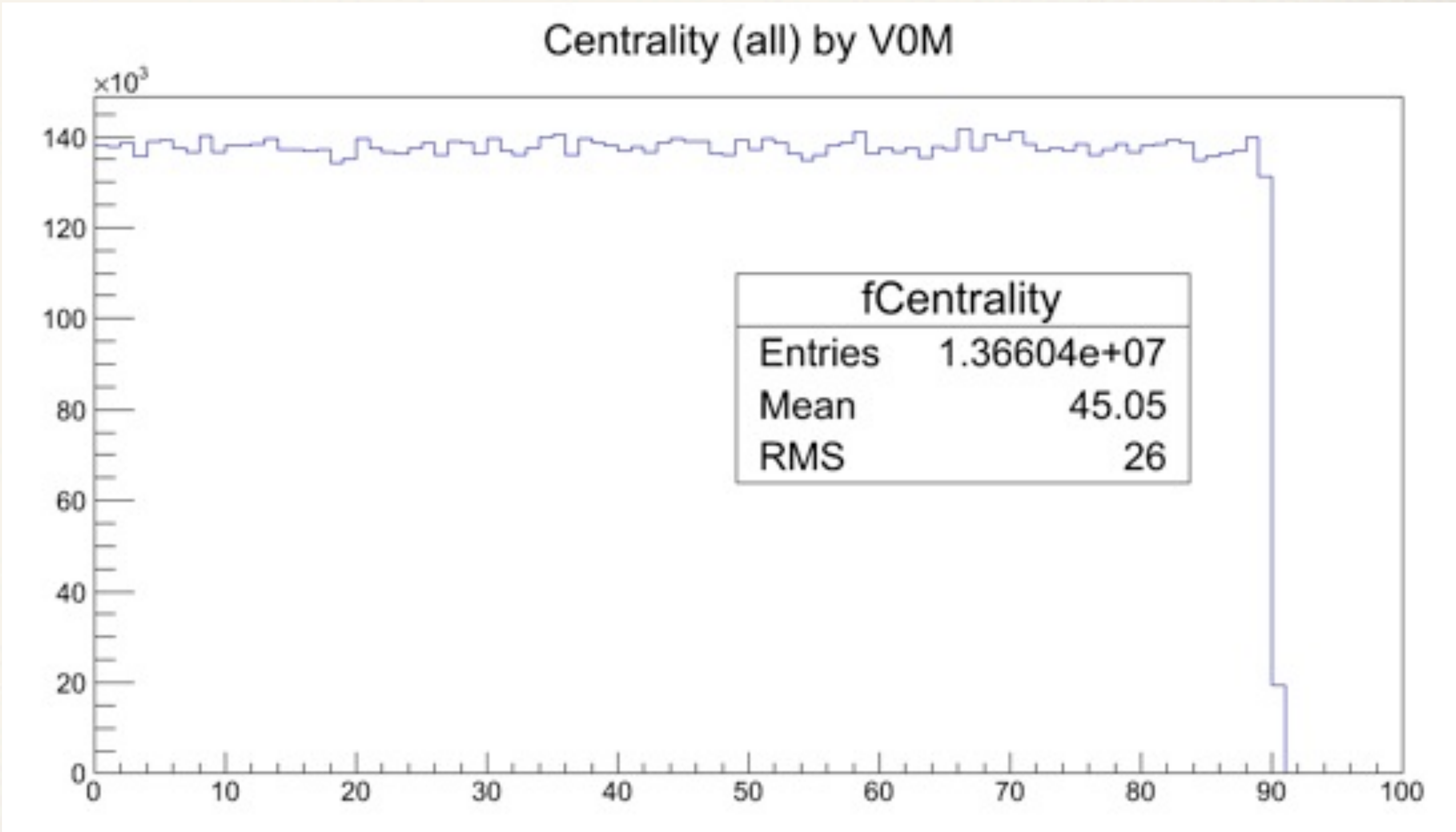
Advantage of ALICE: one can measure low p_T particles down to 150 MeV/c (w/ PID), together with jets.

→ Detailed study of medium response by quenched jets.

Disadvantage of ALICE: limited statistics of high energy di-jet sample in Pb-Pb.
(need to wait Run-2)

Data set

- **Event Selection:**
  - PbPb, 2.76TeV, 13.6 M MB events, $|V_z| < 10$ [cm]
- **Track Selection:**
  - TPC+ITS (Hybrid track cut), $|\eta| < 0.9$
- **Jet Reconstruction:**
  - Charged jet only
  - Used FASTJET package.
  - Jet cone radius(R) = 0.2.
  - $p_T^{min} > 0.15$ GeV/c.
- **Centrality classes:**
  - Used V0 detector
    - Central: 0-10 [%]
    - Semi central: 20-40 [%]
    - Peripheral: 60-90 [%]



Centrality (%)

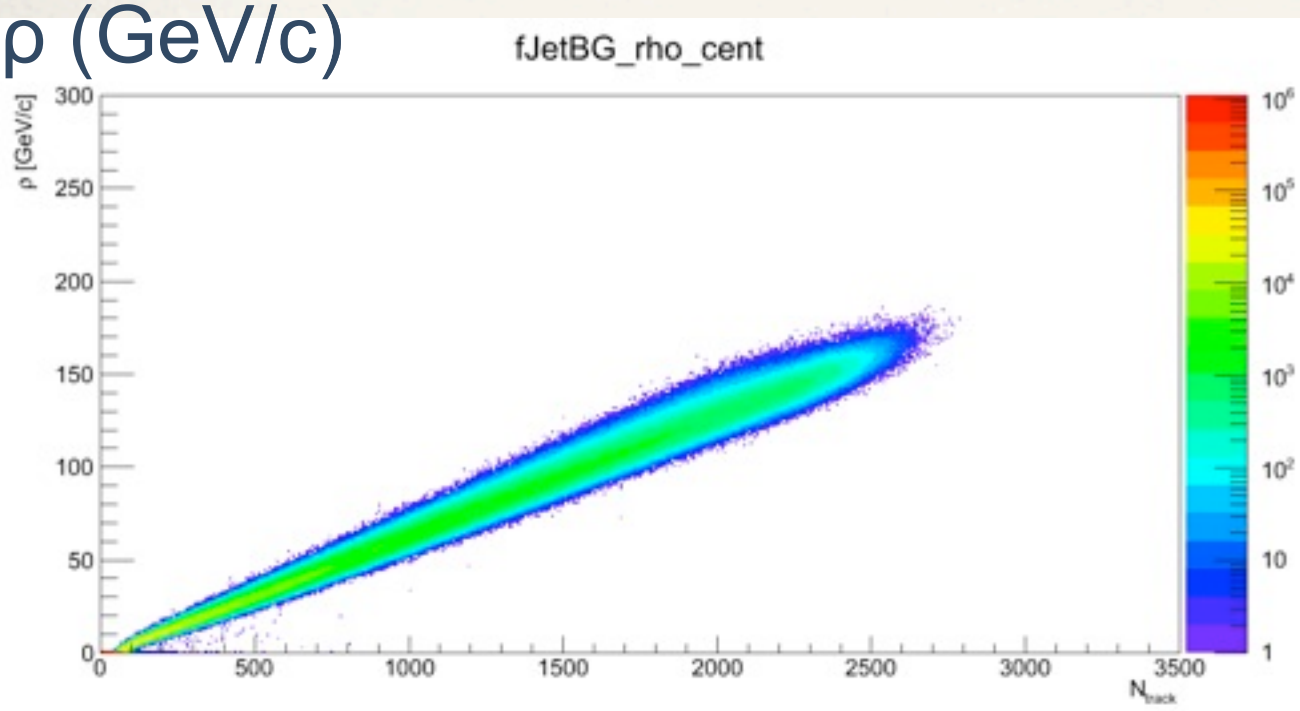
Jet background in Pb-Pb

★ Used event-by-event jet BG subtraction method for ρ calculations

$$\rho(\mathrm{GeV/c}) = \mathrm{median}\left(\frac{p_T^{jet,i}}{A^{jet}}\right)$$

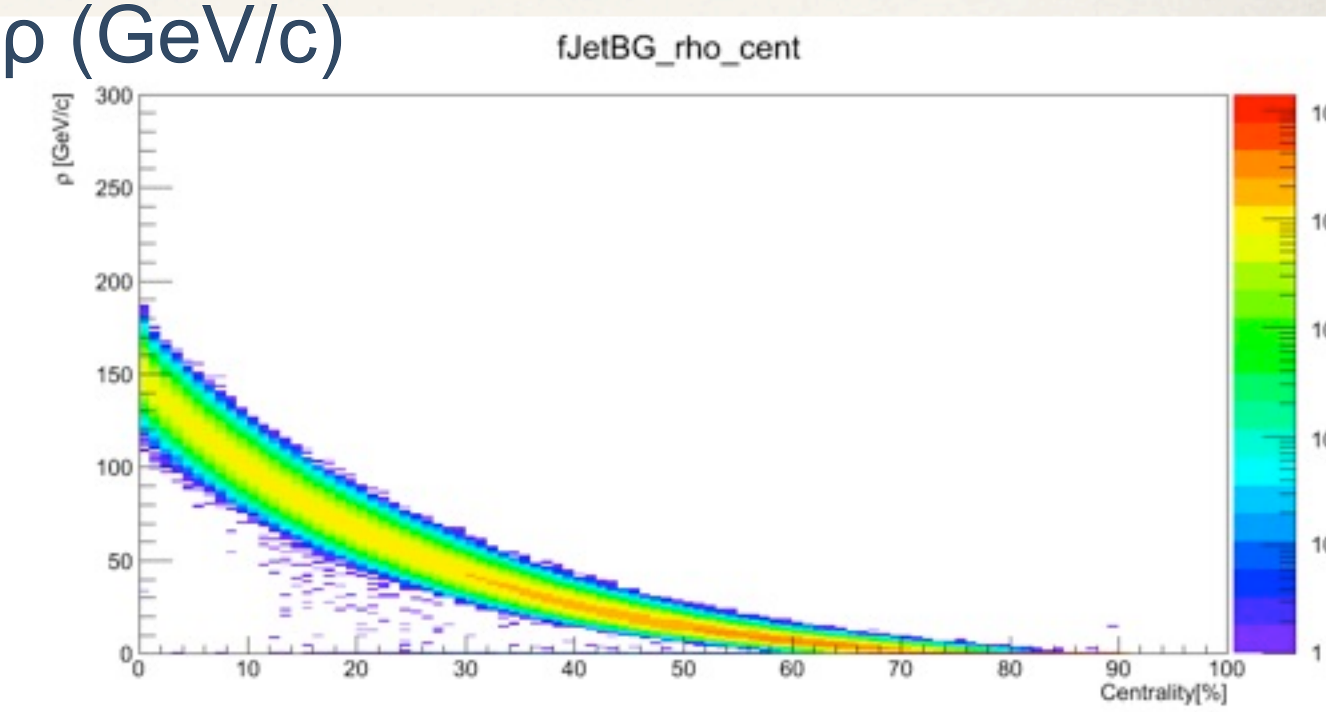
← jet cone area

ρ (GeV/c)



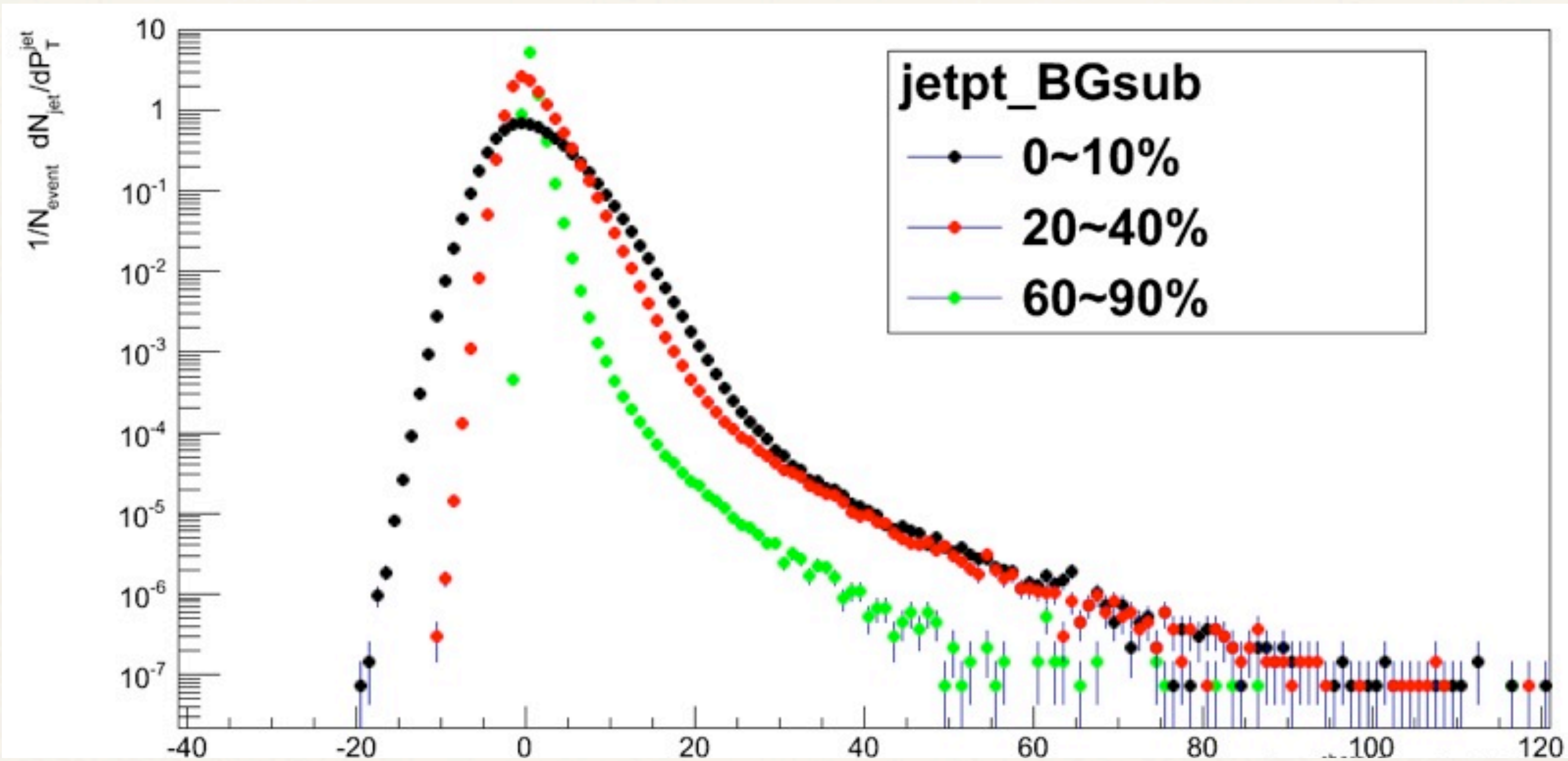
# of TPC tracks

ρ (GeV/c)



Centrality (%)

BG subtracted jet p_T spectra

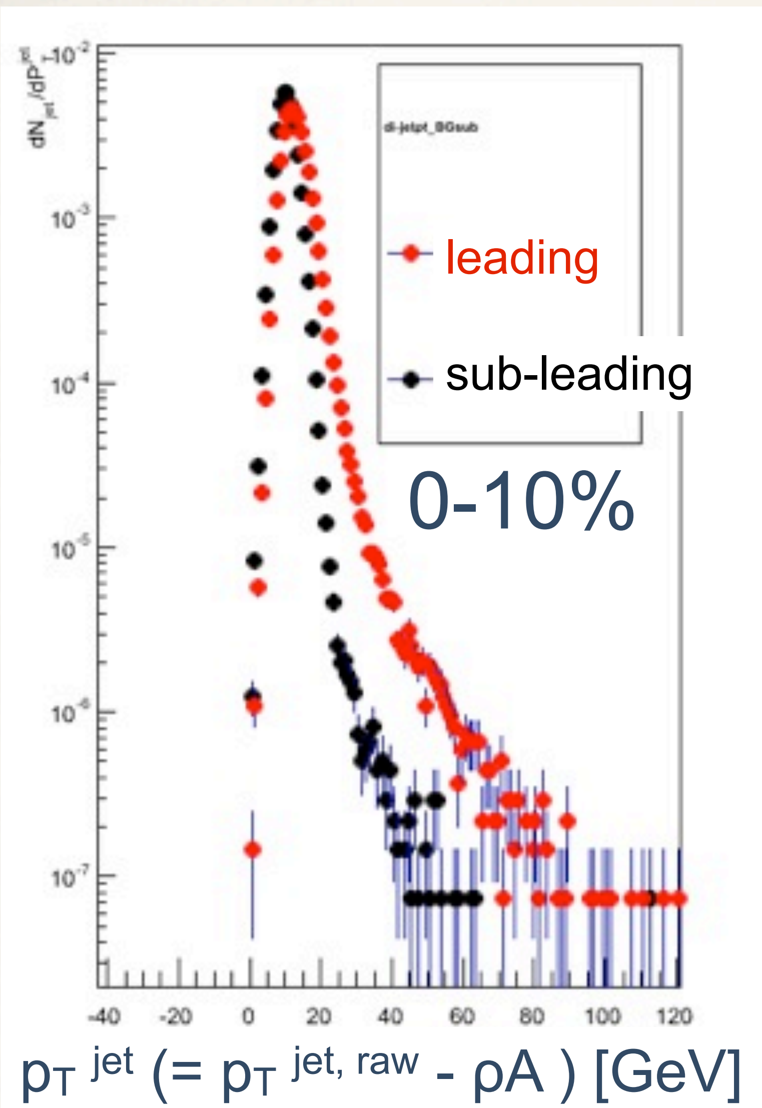


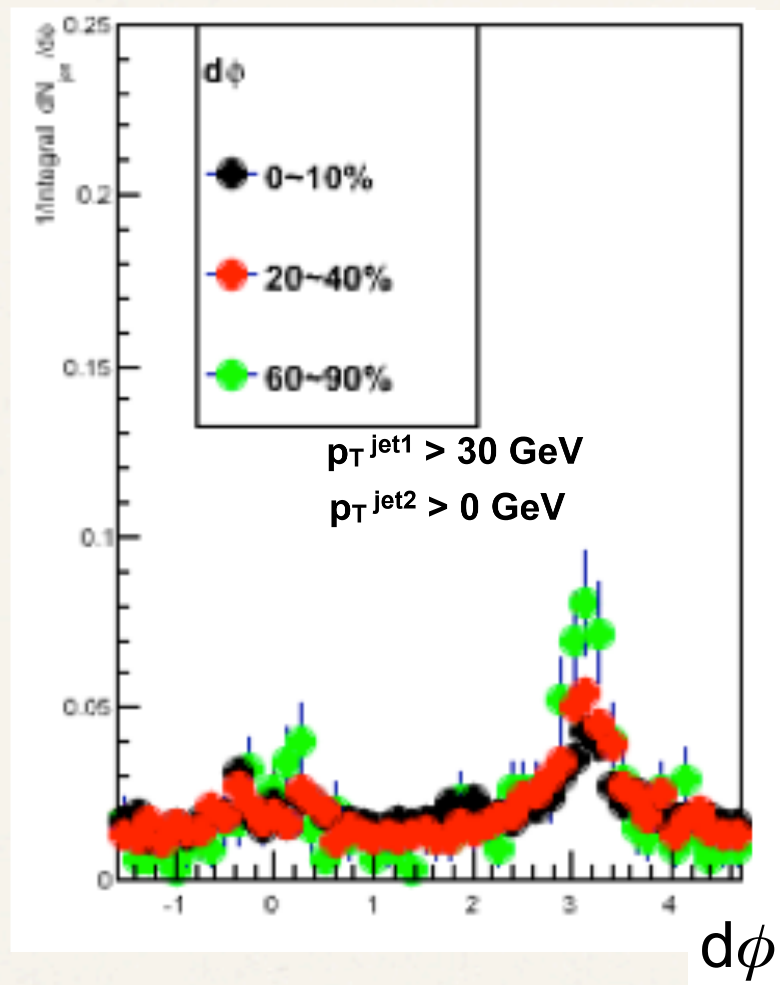
p_T ^{jet} (= p_T $^{jet, raw}$ - ρA) [GeV]

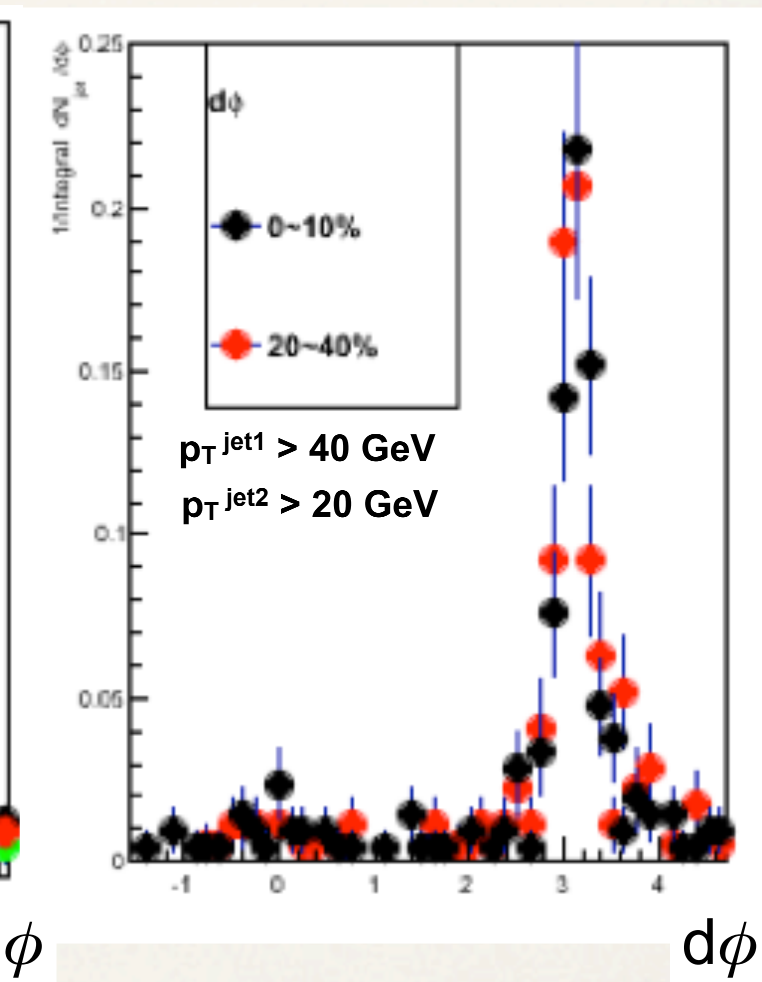
Leading jet, sub-leading jet

$$\Delta\phi = \phi_{p_T^{jet1}} - \phi_{p_T^{jet2}}$$

p_T^{jet1} = leading jet p_T
p_T^{jet2} = sub-leading jet p_T







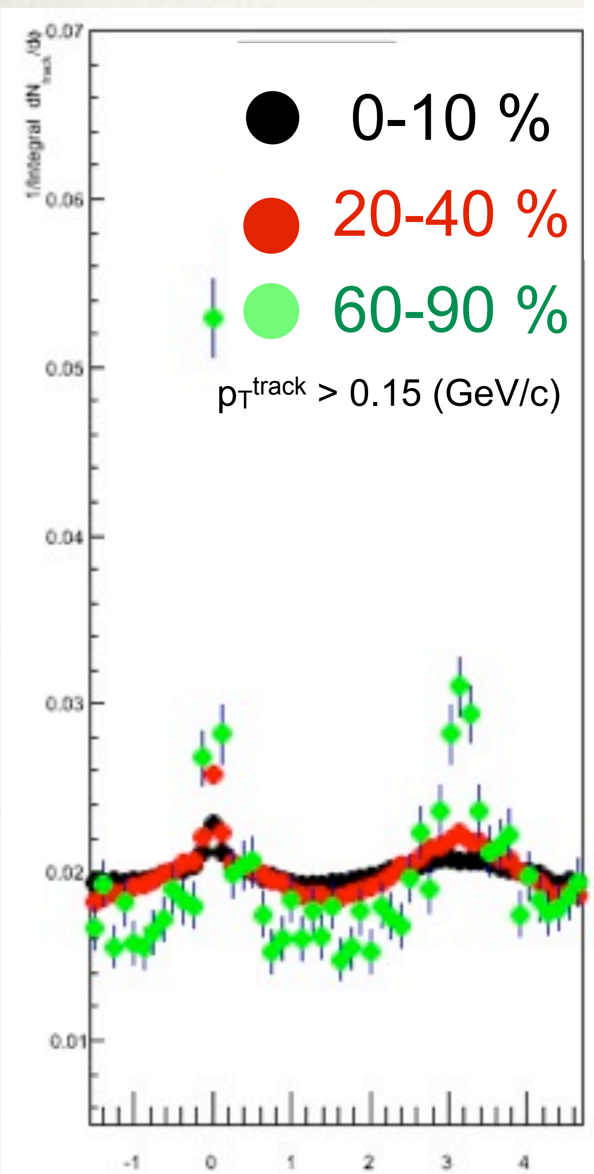
The lower jet p_T selection has Many Back ground.

Hadron distribution (w.r.t. jet axis)

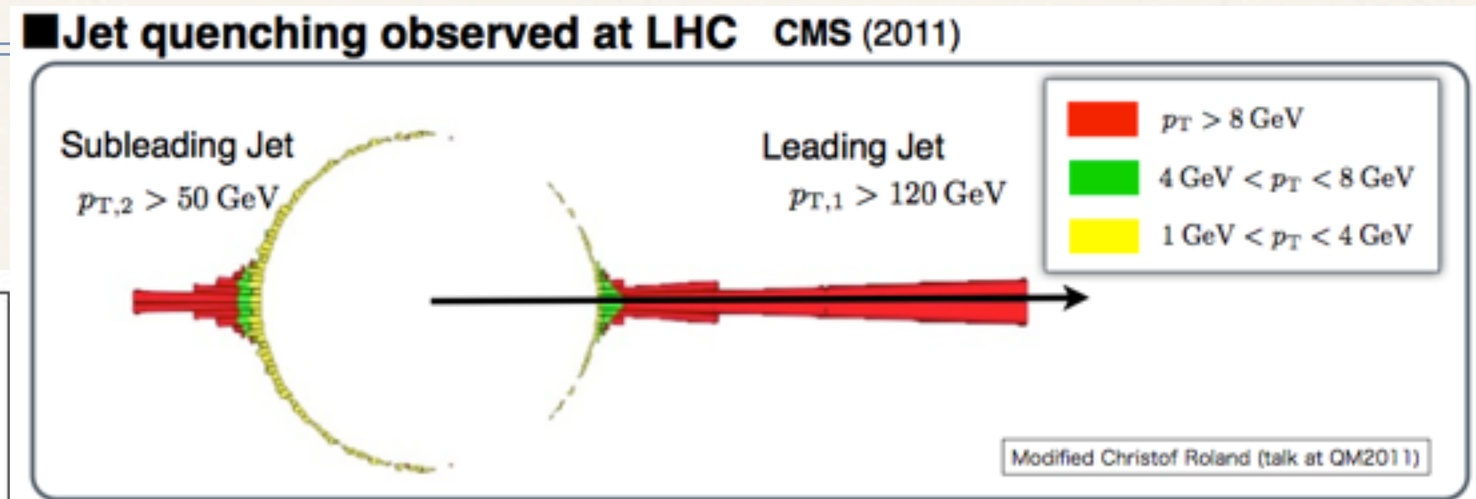
$p_T^{jet1} > 30$ GeV
$p_T^{jet2} > 10$ GeV

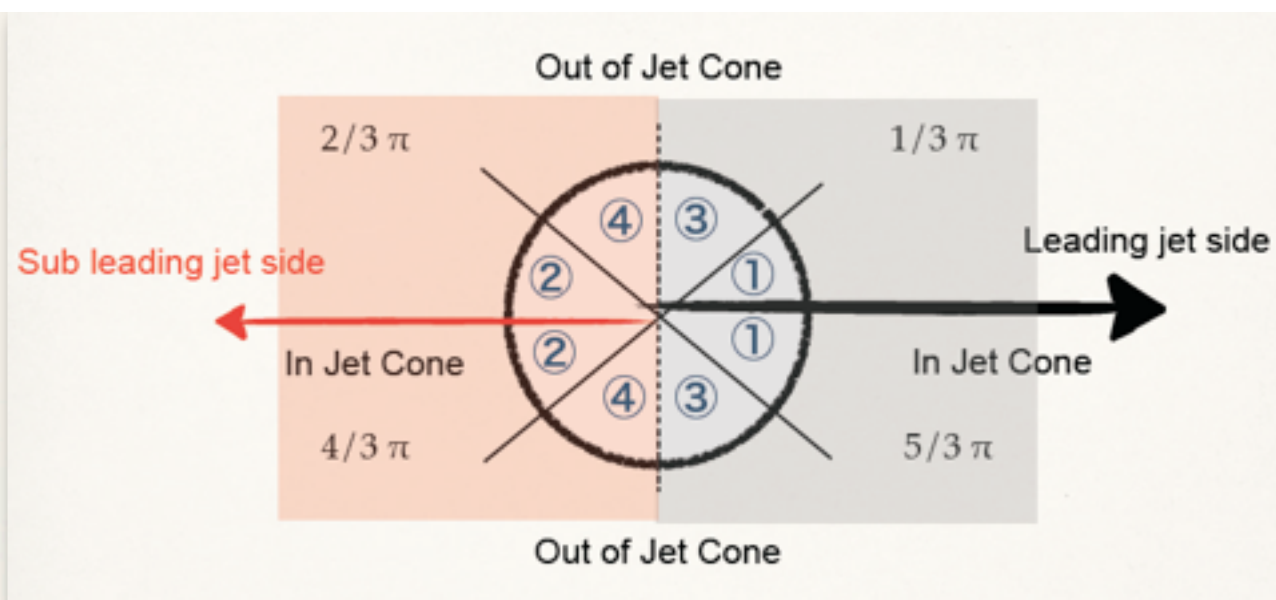
$$A_j = \frac{p_T^{jet1} - p_T^{jet2}}{p_T^{jet1} + p_T^{jet2}}$$

No cut on A_j
Centrality dep.

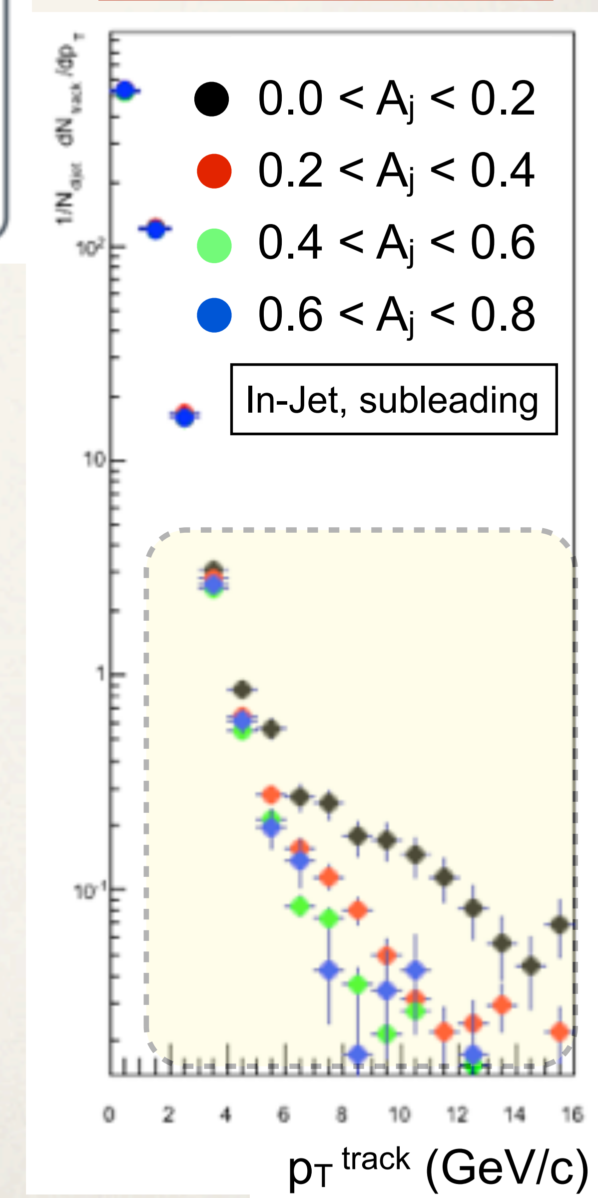


$d\phi = \phi_{jet1} - \phi_h$





Central 0-10%
A_j dep.



- If we can select many higher jet p_T (jet p_T > 40,50...)event in ALICE, we will under stand lost energy of jets.

Summary and outlook

- **Studied low p_T hadron production with di-jet in Pb-Pb collisions.**

- Seen a effect of the background of di-jet $\Delta\varphi$ distribution.
  -The lower jet p_T selection has many background.

- **Low p_T hadron production with di-jets:**
  - I will use event cuts by (1) jet axis, (2) A_j, I think.
    - The jet p_T > 30 GeV sample used in the first, But these sample may contain a large fraction of back ground.
    ➡So It is necessary for us to use higher jet p_T sample.

[Outlook]
- Comparison with other p_T^{jet1} threshold. I have to check “fake jets”(BG) completely removed.
- Comparison with MC data, p-p data.
- Study of particle composition of “In-jet, sub-leading side”.
- Need Run-2 data for better statistics.

Backup slides

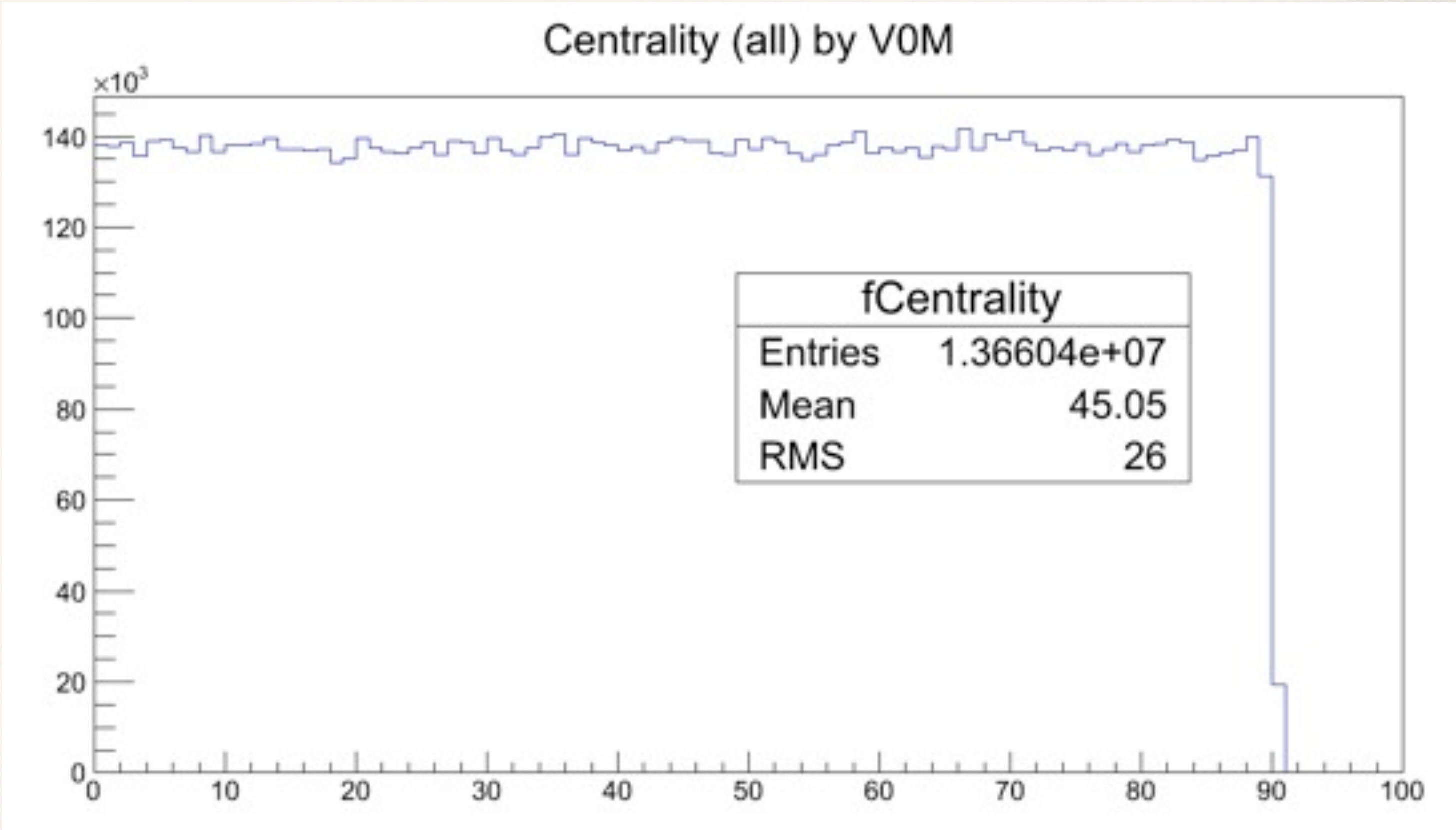
2. Data set

- **Event Selection:**
  - LHC10h (PbPb, 2.76TeV), pass2, AOD file (AOD086)
  - Minimum bias Trigger (13.6 M MB events), $|V_z| < 10$ [cm]

- **Track Selection:**
  - TPC+ITS (Hybrid track cut), $|\eta| < 0.9$

- **Jet Reconstruction:**
  - Charged jet only
  - Used FASTJET package.
  - Anti-k_T algorithm, R = 0.2.
  - $p_T^{min} > 0.15$ GeV/c.

- **Centrality classes:**
  - Used V0 detector
    - Central: 0-10 [%]
    - Semi central: 20-40 [%]
    - Peripheral: 60-90 [%]



Centrality (%)

Run list (LHC10h)

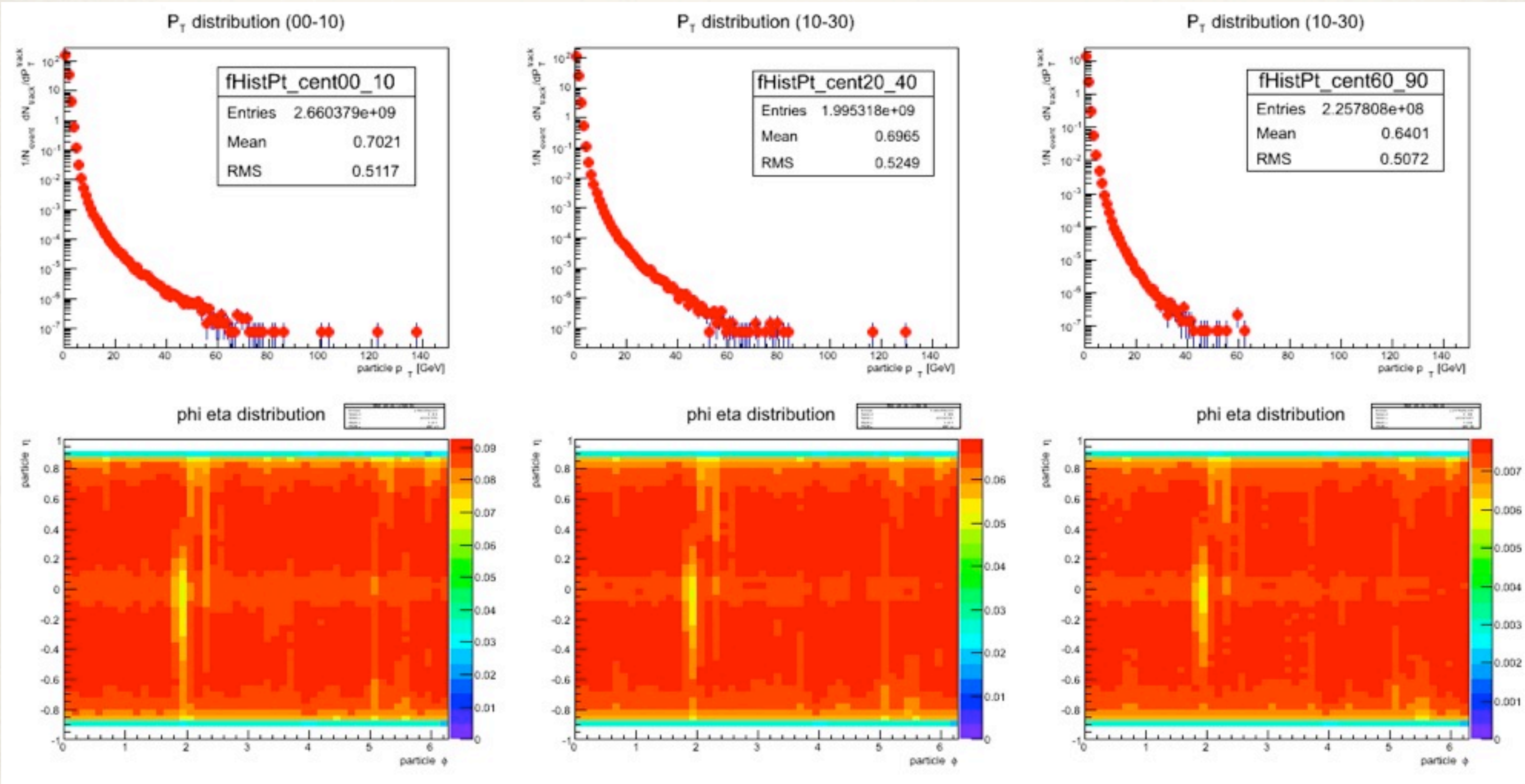
139510,139507,139505,139503,139465,139438,139437,139360,139329,139328,
139314,139310,139309,139173,139107,139105,139038,139037,139036,139029,
139028,138872,138871,138870,138837,138732,138730,138666,138662,138653,
138652,138638,138624,138621,138583,138582,138579,138578,138534,138469,
138442,138439,138438,138396,138364,138275,138225,138201,138197,138192,
138190,137848,137844,137752,137751,137724,137722,137718,137704,137693,
137692,137691,137686,137685,137639,137638,137608,137595,137549,137546,
137544,137541,137539,137531,137530,137443,137441,137440,137439,137434,
137432,137431,137430,137366,137243,137236,137235,137232,137231,137230,
137162,137161,137135

Hybrid Track Cut

Table 1: Overview of the hybrid track cuts.

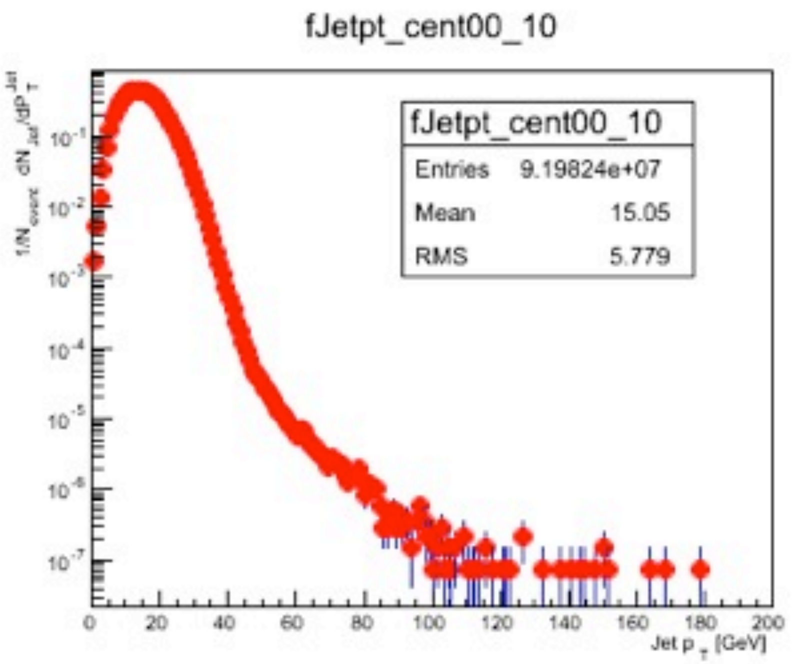
AliESDtrackCuts function	Value	Comment
Global and complementary tracks		
SetMinNClustersTPCPtDep	$70 + 30/20 \cdot p_T, 20$	linear rise from 70 ($p_T = 0$) to 100 ($p_T = 20\mathrm{GeV}/c$), 100 for $p_T > 20\mathrm{GeV}/c$
SetMaxChi2PerClusterTPC	4	Maximum χ^2 per TPC cluster in the first iteration
SetRequireTPCStandAlone	kTRUE	Enable cut on TPC clusters in the first iteration
SetAcceptKinkDaughters	kFALSE	Reject tracks with kink
SetRequireTPCRefit	kTRUE	Require TPC refit
SetMaxFractionSharedTPCClusters	0.4	Maximum fraction of shared TPC clusters
SetMaxDCAToVertexXY	2.4	Maximum Distance of Closest Approach (DCA) to the main vertex in transverse direction
SetMaxDCAToVertexZ	3.2	Maximum DCA in longitudinal direction
SetDCAToVertex2D	kTRUE	Cut on the quadratic sum of DCA in XY- and Z-direction
SetMaxChi2PerClusterITS	36	Maximum χ^2 per ITS cluster
SetMaxChi2TPCConstrainedGlobal	36	Maximum χ^2 between global and TPC constrained tracks
SetRequireSigmaToVertex	kFALSE	No sigma cut to vertex
SetEtaRange	-0.9,0.9	Pseudorapidity cut
SetPtRange	0.15, 1E+15	Minimum $p_T > 150\mathrm{MeV}/c$

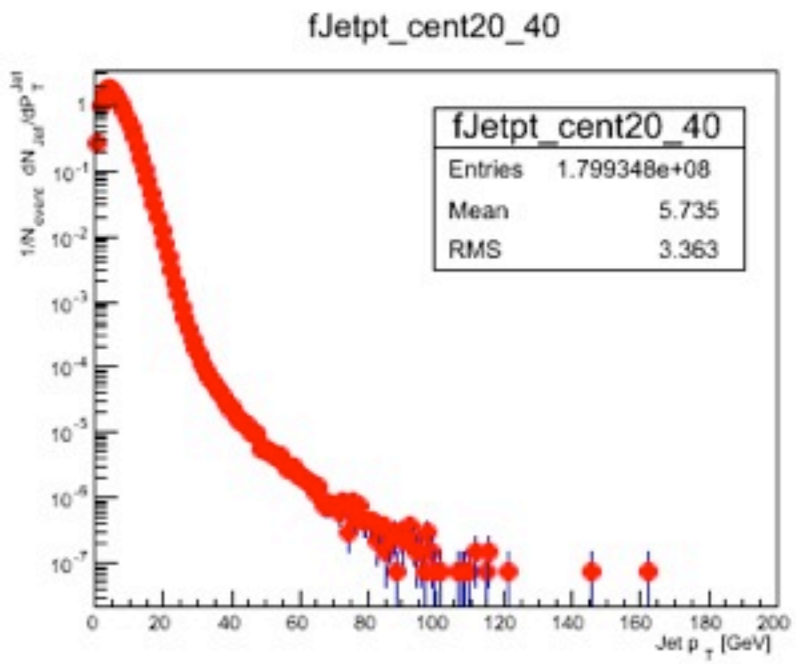
TPC acceptance

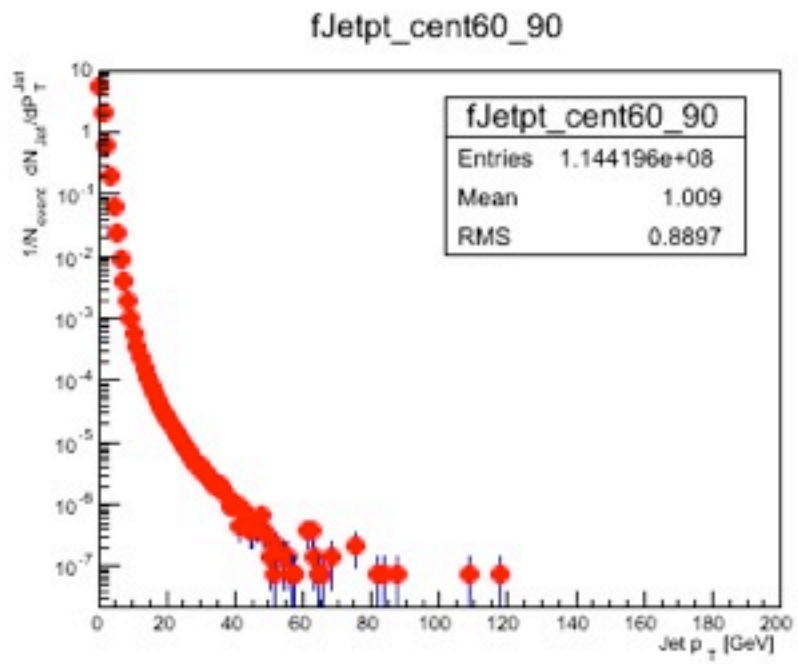


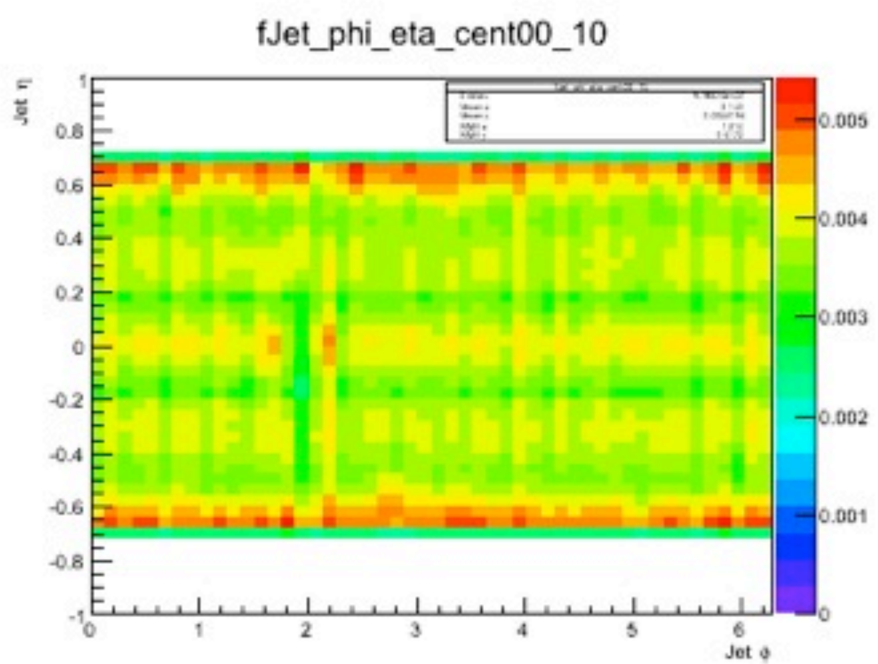
Raw charged jet p_T spectra, η vs. φ for jets

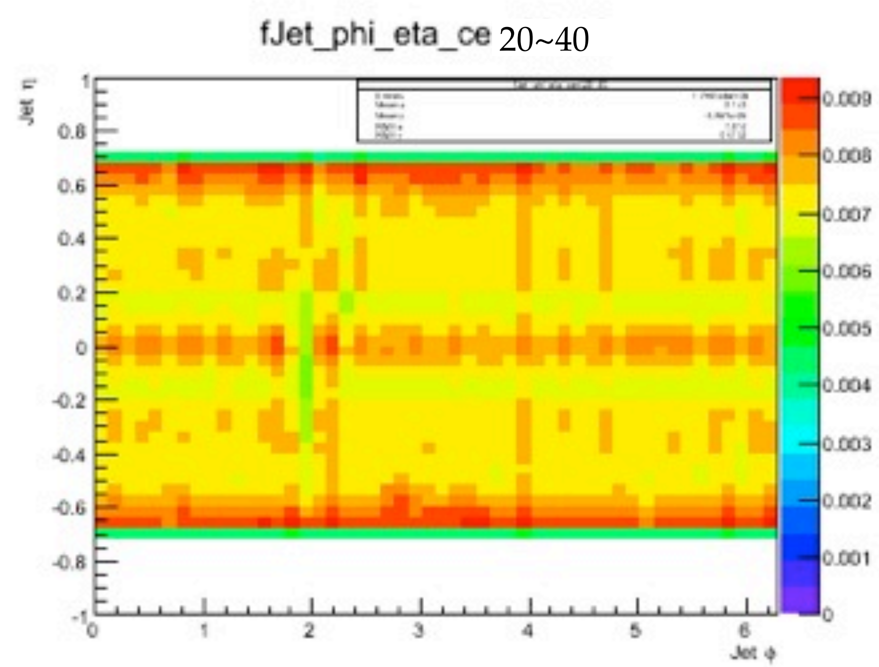
0-10% | 20-40% | 60-90%

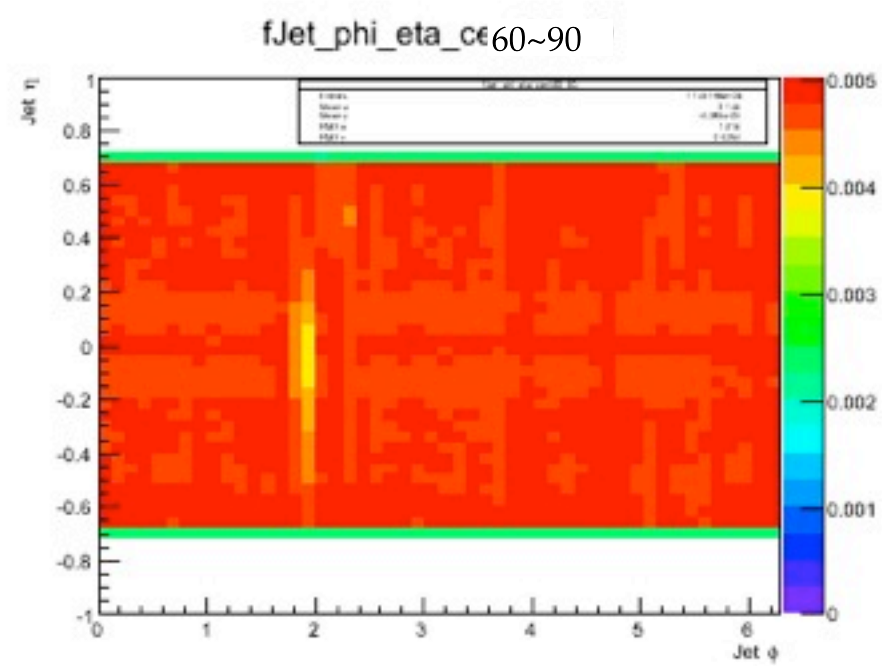








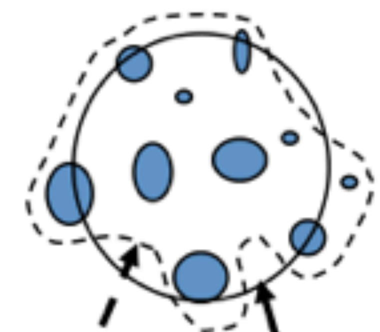




FASTJET algorithm

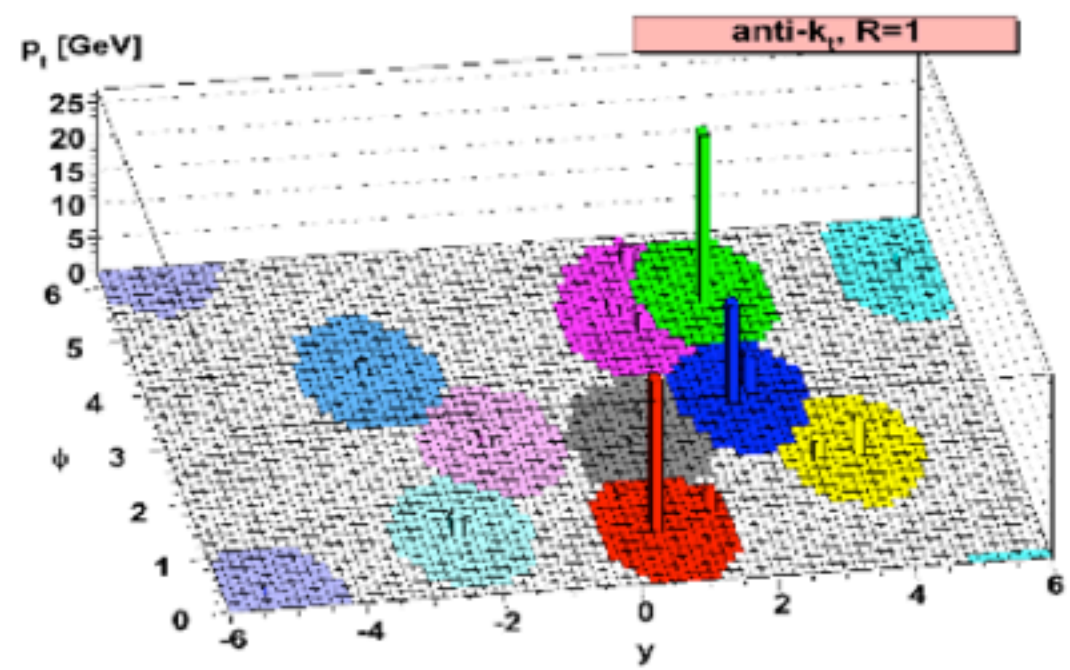
FastJet: sequential clustering algorithms http://www.lpthe.jussieu.fr/~salam/fastjet/

$$d_{ij} = \min(k_{ti}^{2p}, k_{tj}^{2p}) \frac{\Delta R^2}{R^2} \begin{cases} p=1 & k_T \text{ algorithm} \\ p=0 & \text{Cambridge/Aachen algorithm} \\ p=-1 & \text{anti-}k_T \text{ algorithm} \end{cases}$$



Procedure of Jet Finding
Calculate particle distance : d_{ij}
Calculate Beam distance : $d_{iB}=k_{ti}^{2p}$
Find smallest distance (d_{ij} or d_{iB})
If d_{ij} is smallest combine particles
If d_{iB} is smallest
and the cluster momentum
larger than threshold
call the cluster a Jet.

arXiv:0802.1189v2 [hep-pn] (2008)

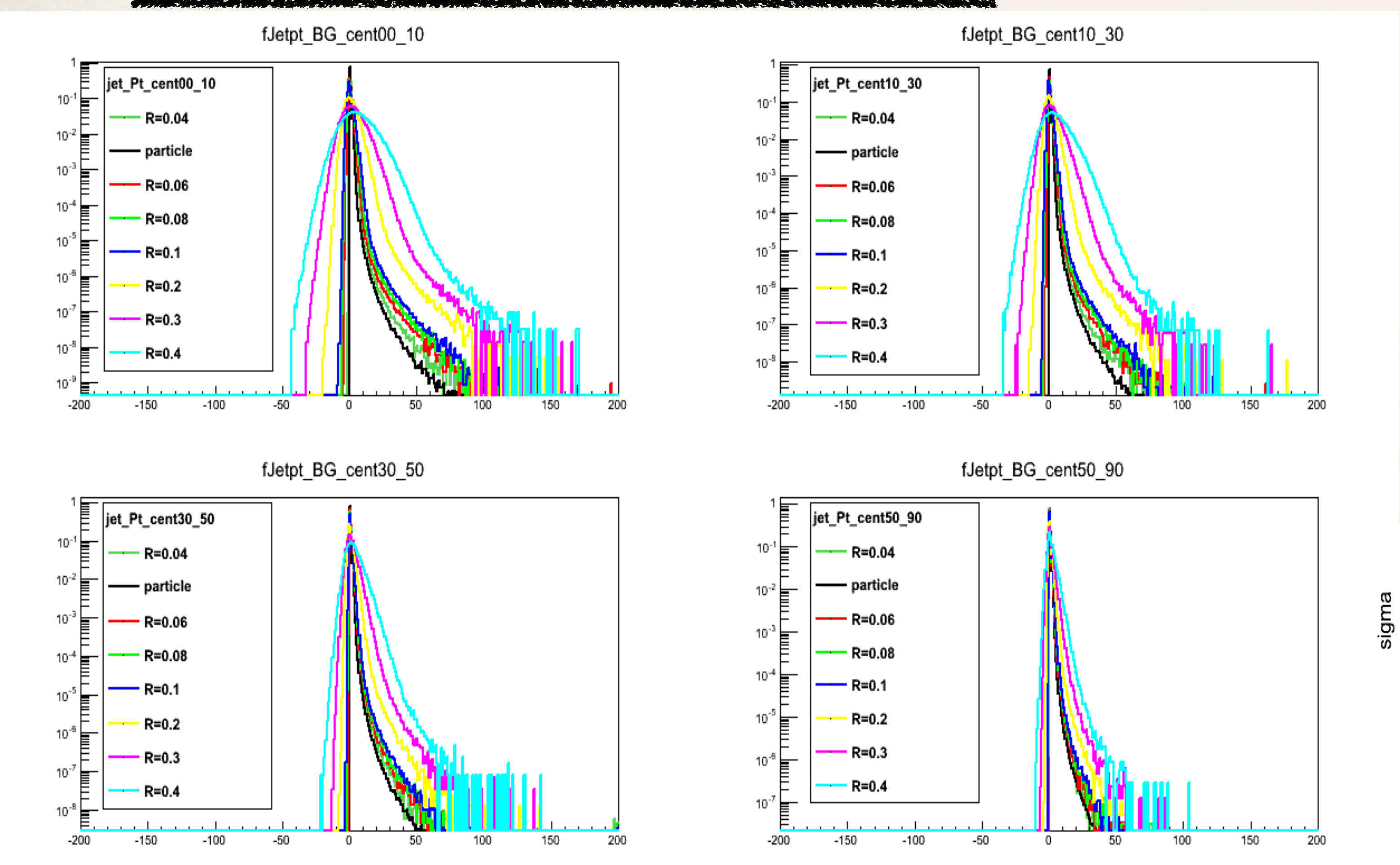


Parameters

- R size $(=\sqrt{d\phi^2+d\eta^2})$: 0.4
- p_T cut of single particle : 0.15 GeV/c
- Jet enregy threshold : 10 GeV/c

BG jet p_T (Divide Cone Radius)

$$real\ P_T^{jet} = p_T^{jet} - \rho * A$$



- The result of Gaussian fit.