Jets with charged tracks

Jet Algorithms Workshop 24/10/07

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- Jets with charged tracks only - *P.A., D.Dobur*
- Jet + Track - *O.Kodolova, I.Vardanyan, A.Nikitenko*

Jets with tracks only

P.A., Didar Dobur

Expect the charged tracks picture of a busy multi-jet event to be 'cleaner' than the calo tower picture with more collimated true jets and less overlap interference & background

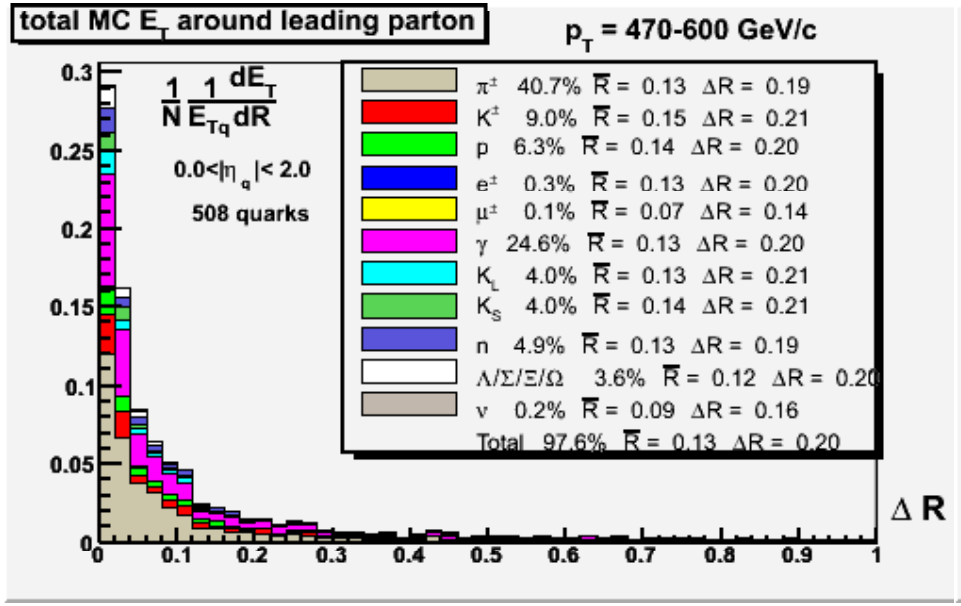
Jet finding with charged tracks only is completely independent from jet finding with calo towers and could prove a good way to find/count jets, and determine their directions

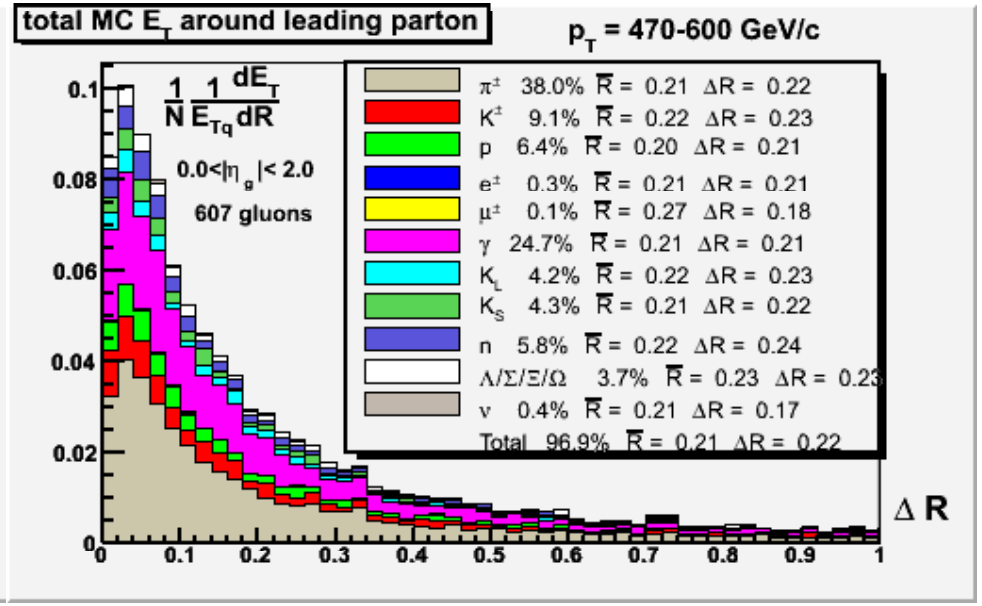
Look at QCD events with $15 < \hat{p}_T < 2.2 TeV$

Focus on partons with $|\eta| < 2$

MC truth particles around partons

Fraction of leading parton ET carried by MC truth particles





Visible charged particles carry ~60% of parton ET

Gluon Jets are different from quark Jets !

Jet finding

Running 1_6_5 on 1_5_2 QCD samples

- Standard GenJets (all stable particles) {icone 0.5 & kT 0.6 }
- Standard CaloJets {icone 0.5 & kT 0.6 }
- Reco charged tracks with {icone 0.5 & kT 0.6 }

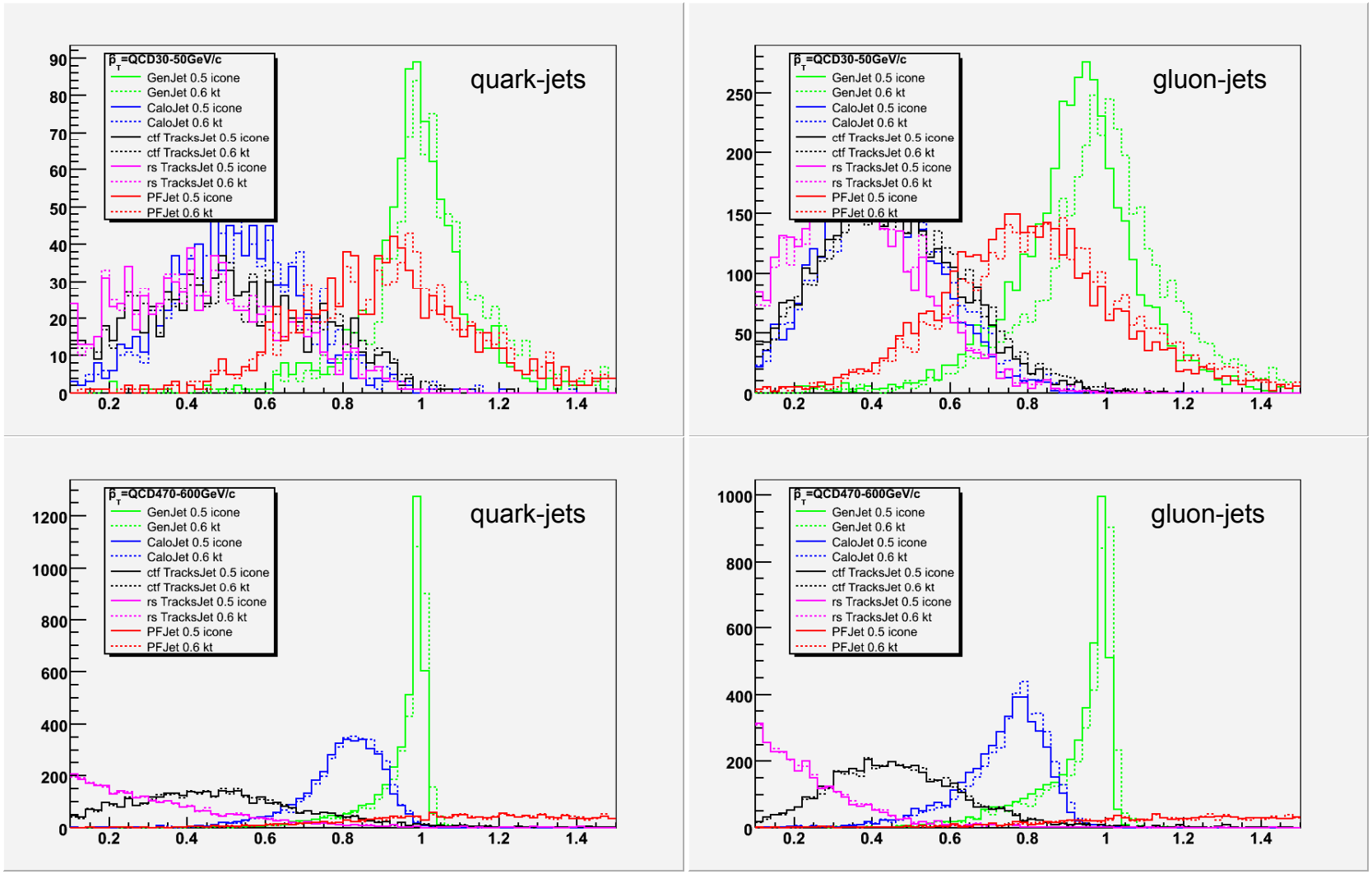
  $\text{hits} \geq 8$ $\quad$ $\text{fit } \chi^2/\nu < 100$

  $1\text{GeV} < p_T < 500\text{GeV}$

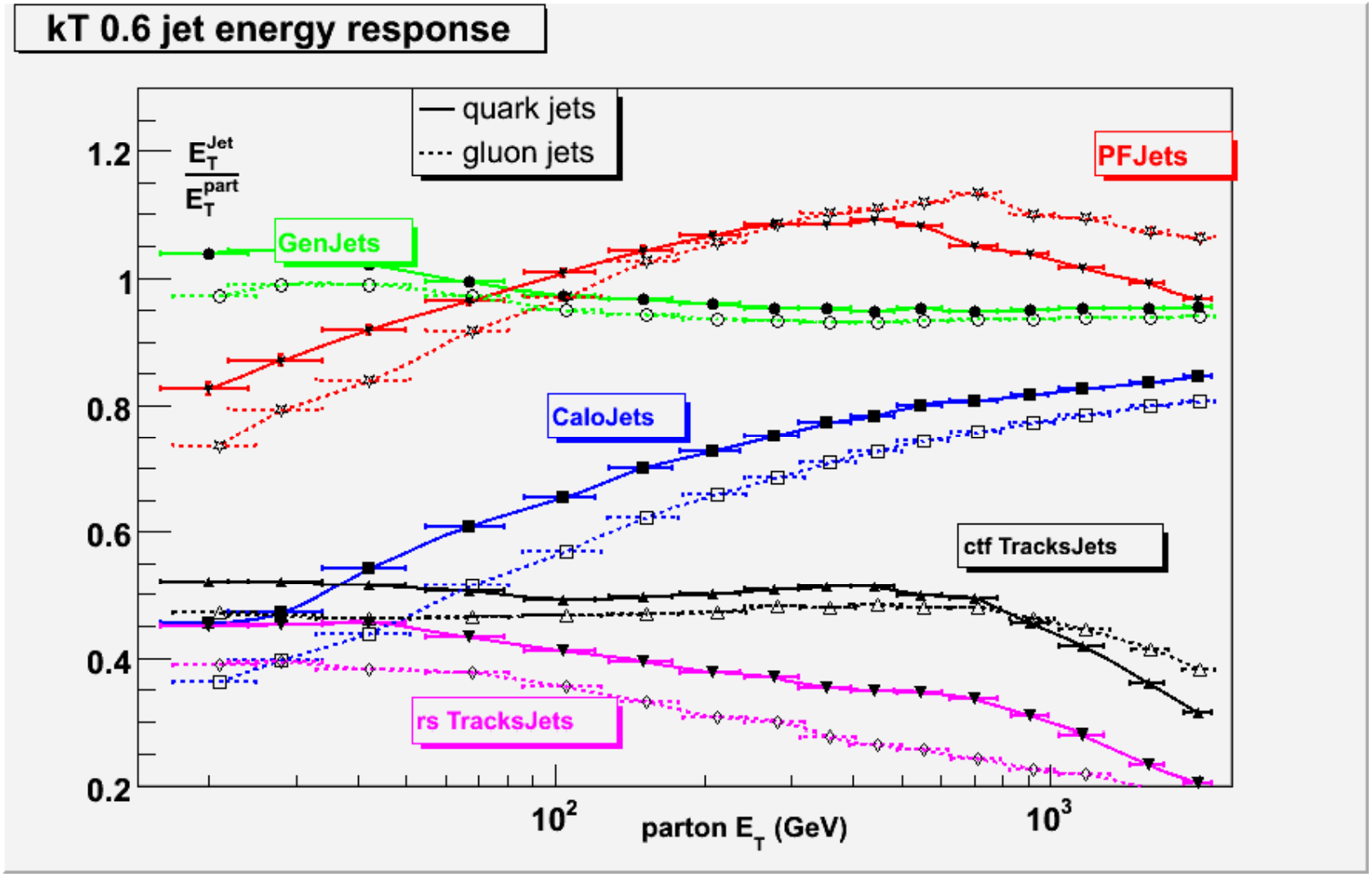
  using both *CTF* and *RoadSearch* reco tracks
- Particle Flow Jets (E_T>0.5 GeV) {icone 0.5 & kT 0.6 }

Select events with a icone 0.6 GenJet within $\Delta R<0.3$ of leading parton and with at least 20% of the parton p_T (no hard radiation).

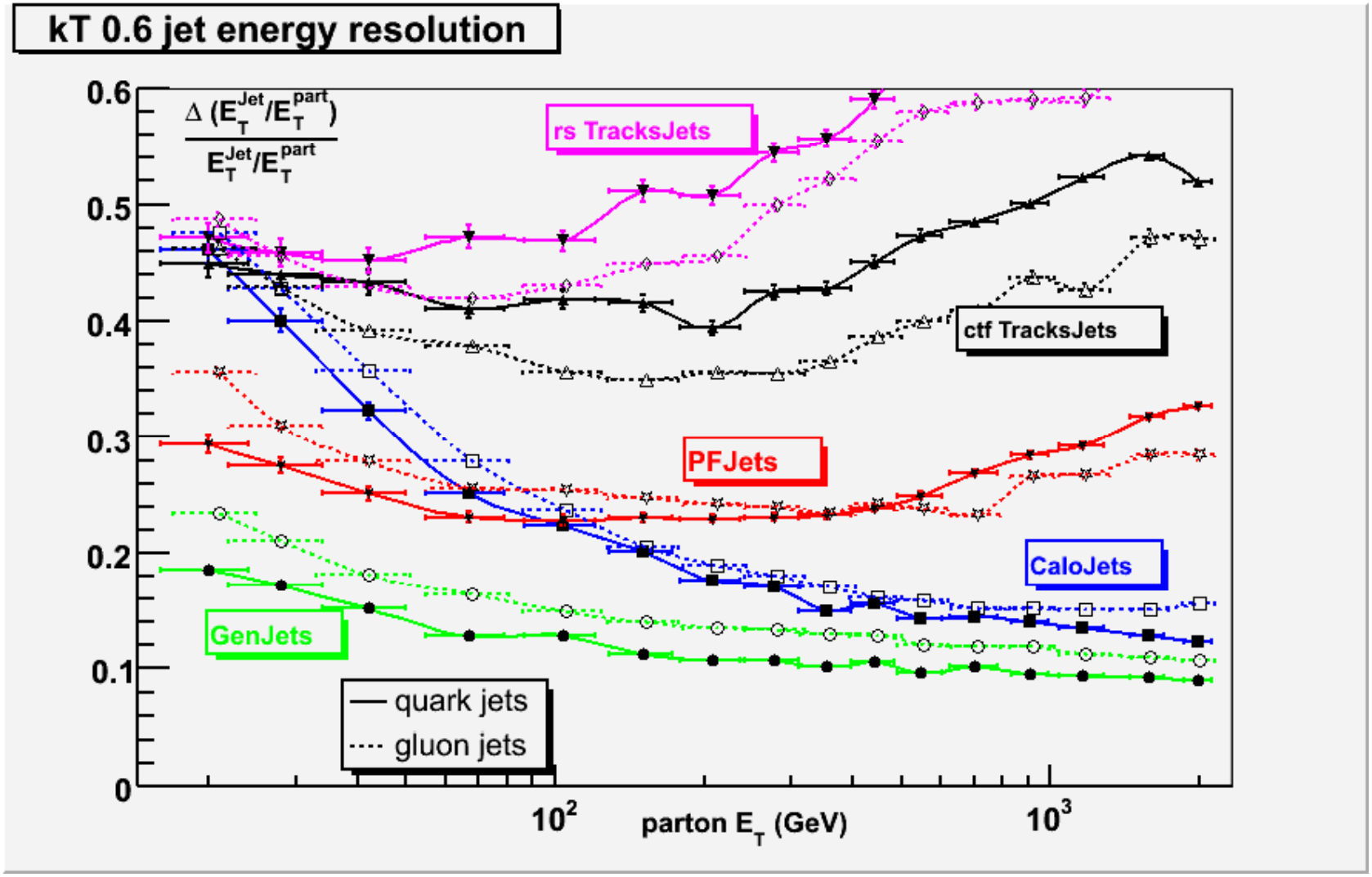
Jets response



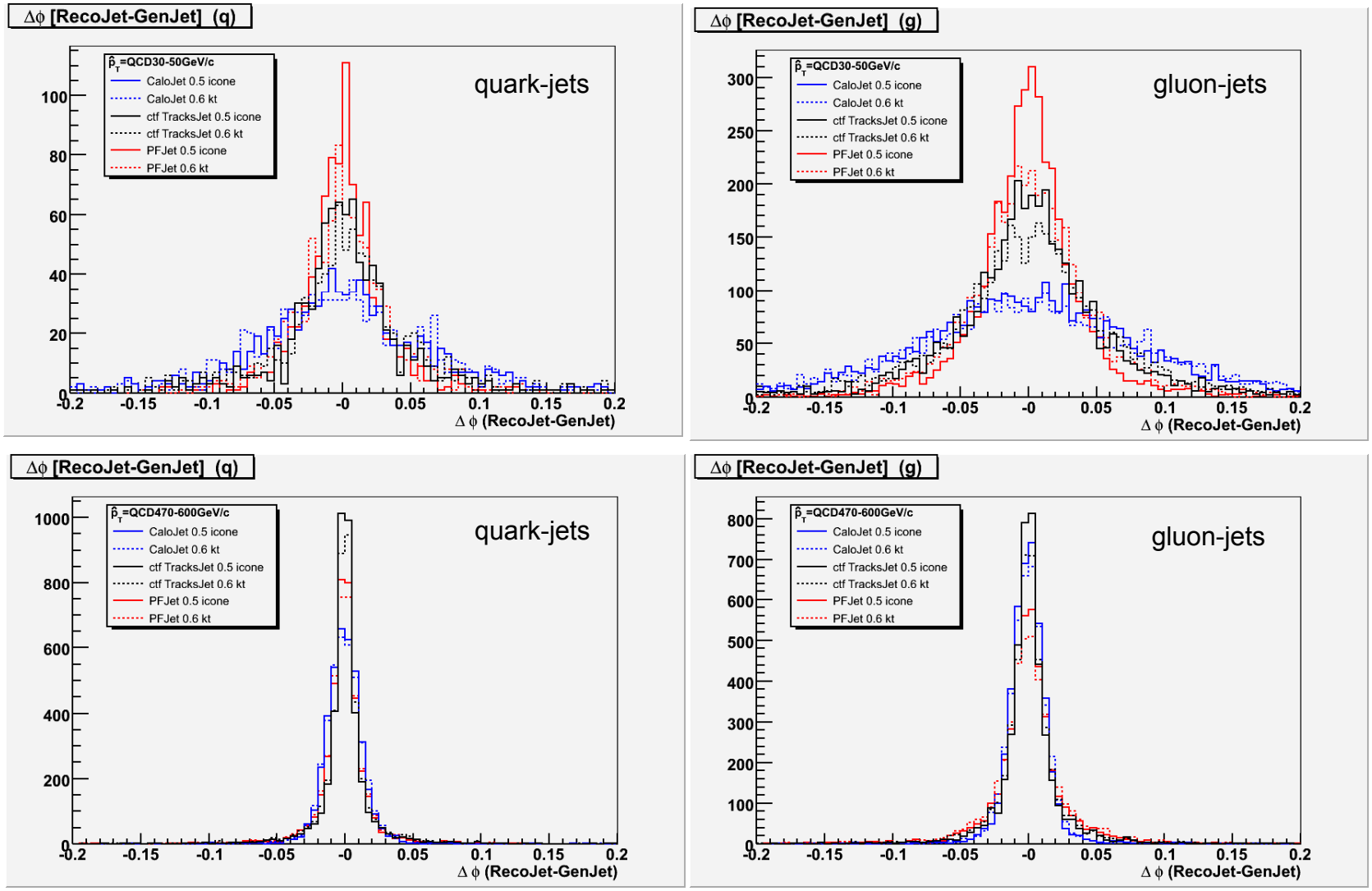
Jets response



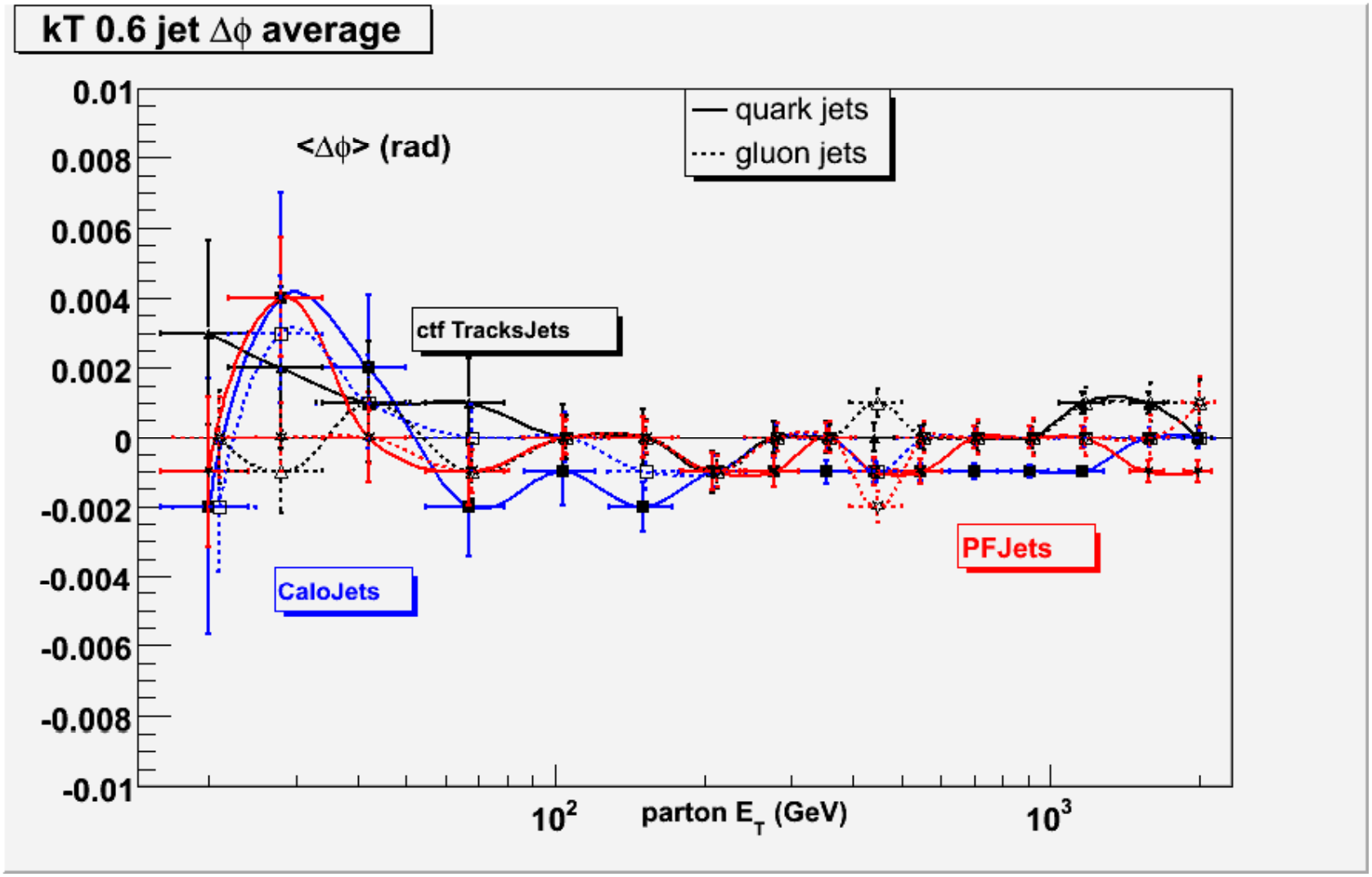
Jets resolution



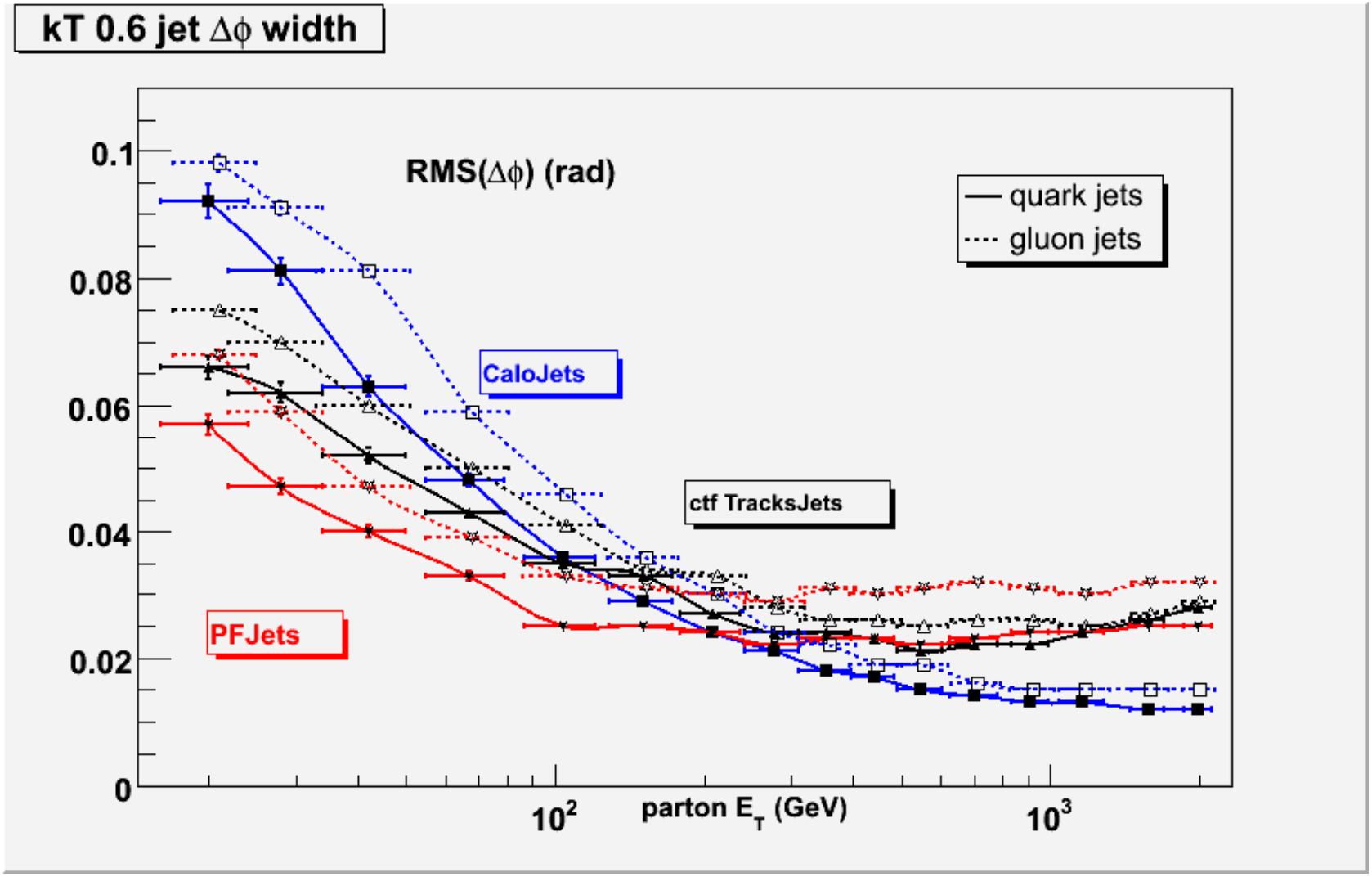
Phi resolution



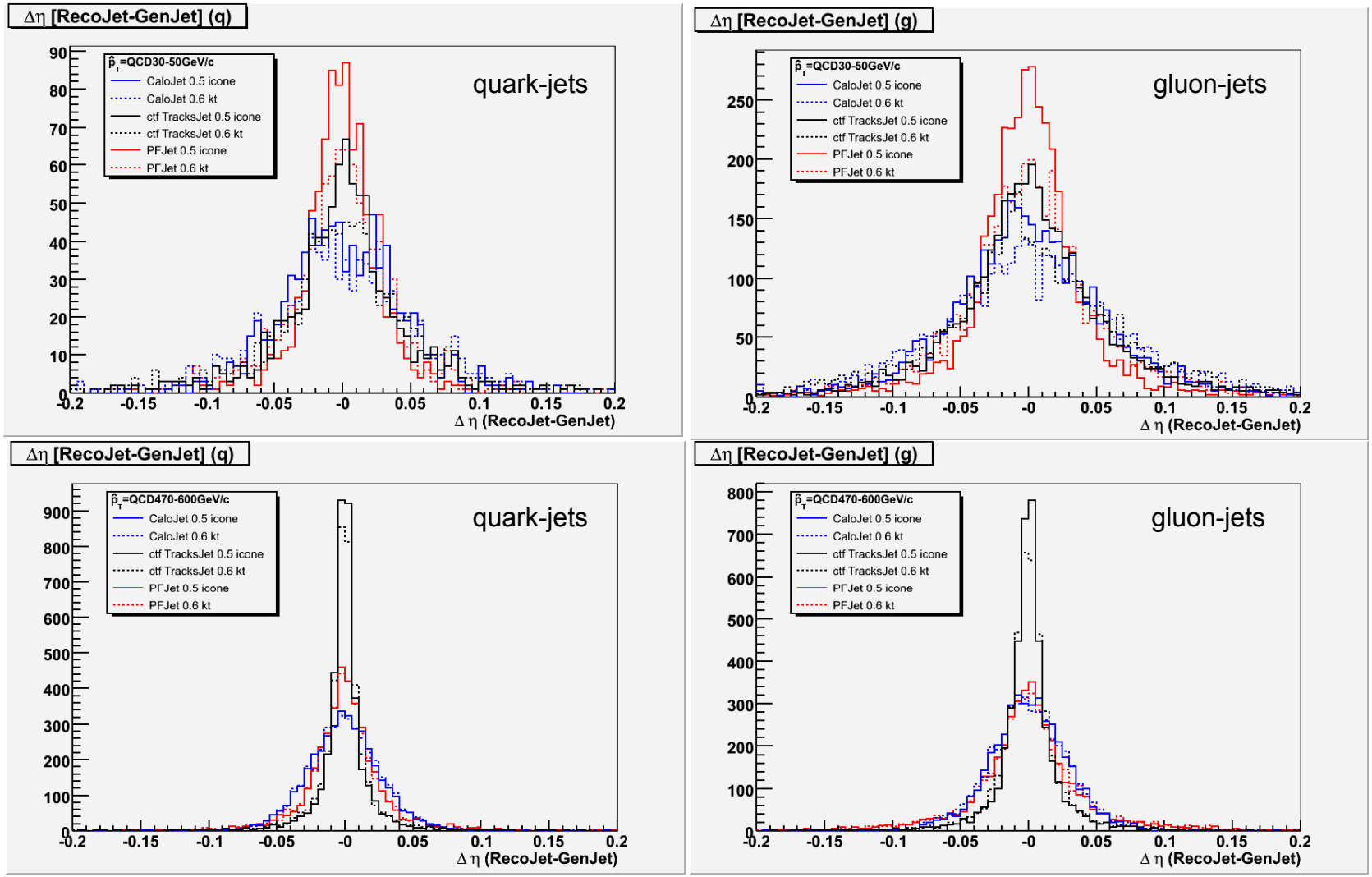
Phi bias


kT 0.6 jet Δϕ average
<Δϕ> (rad)
quark jets
gluon jets
ctf TracksJets
CaloJets
PFJets
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
10^2
parton E_T (GeV)
10^3

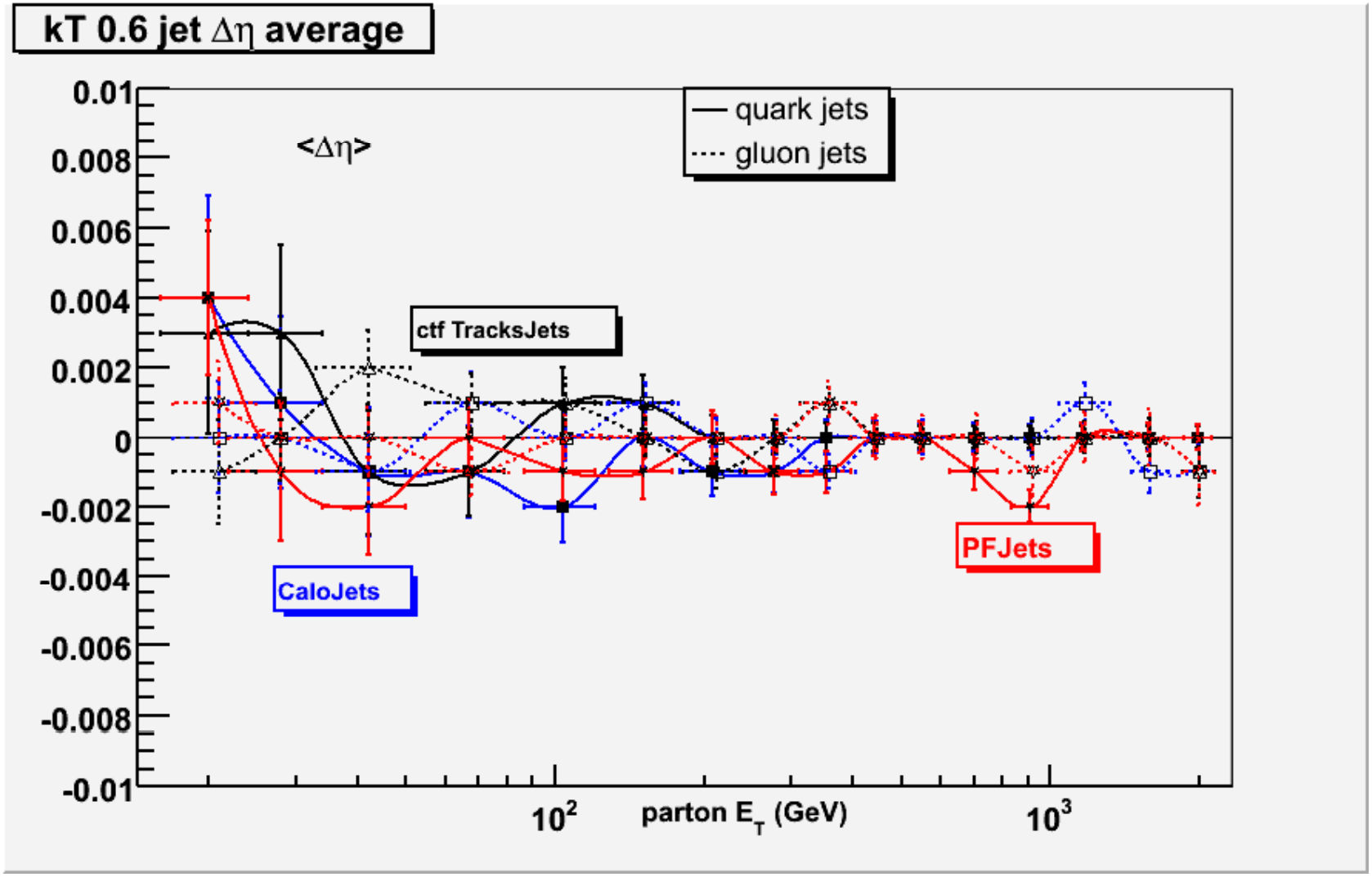
Phi resolution



Eta resolution



Eta bias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parton E_T (GeV)
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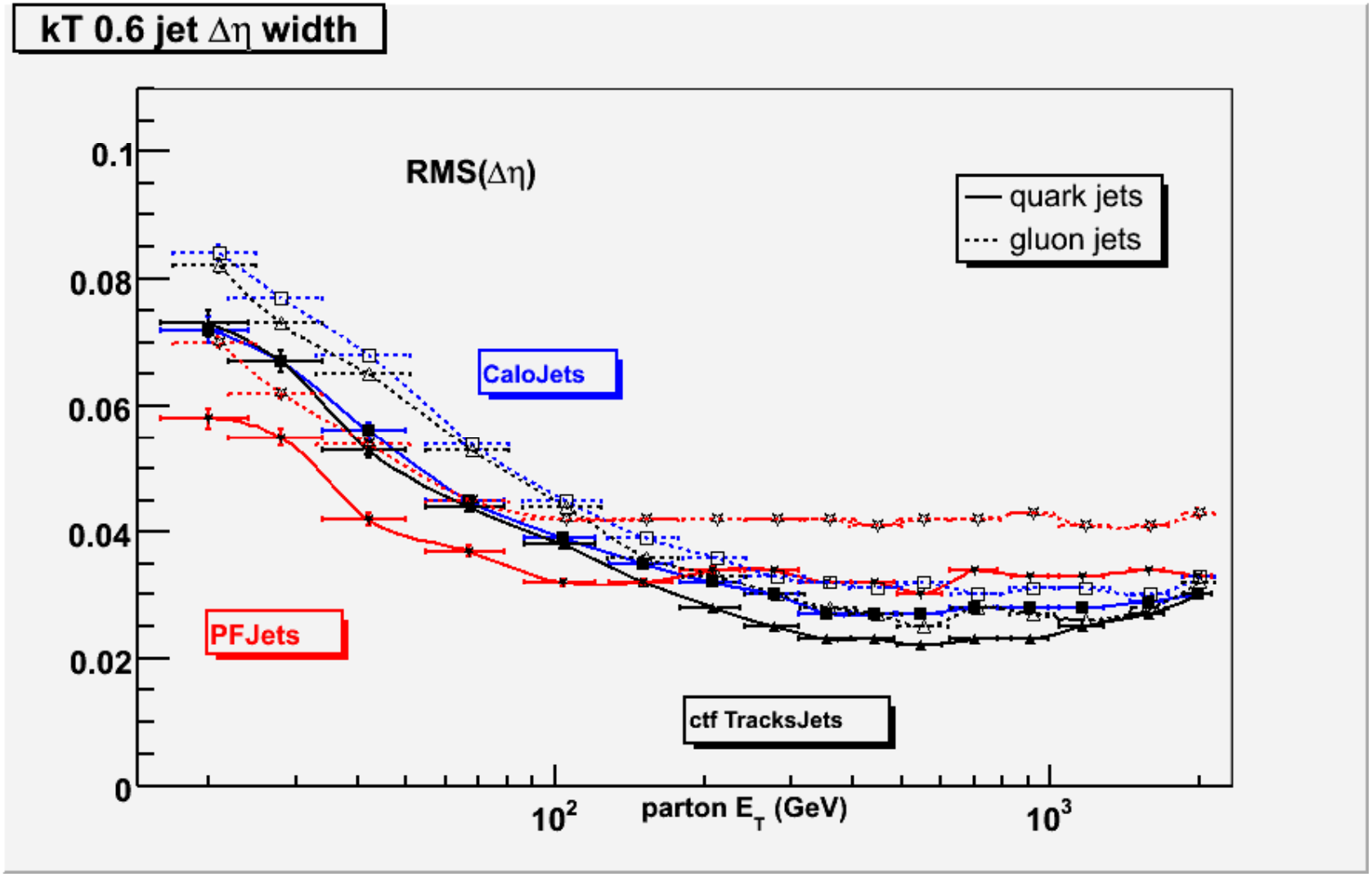
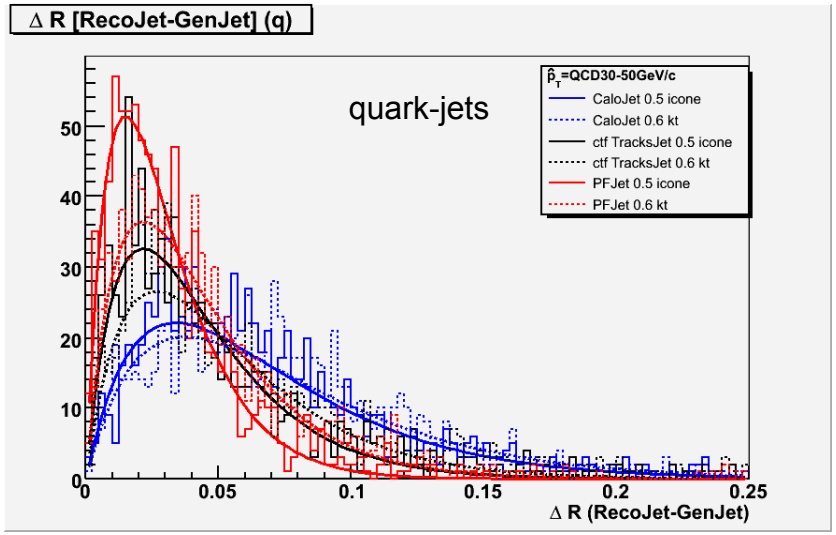
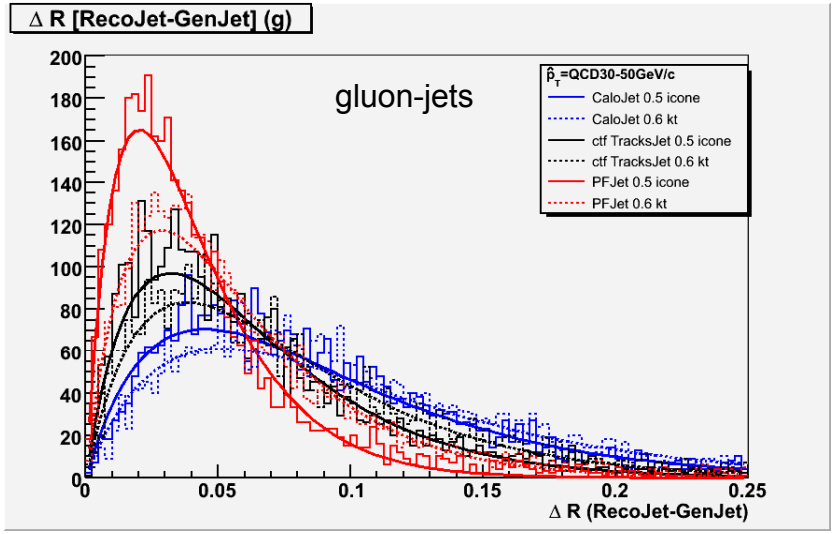
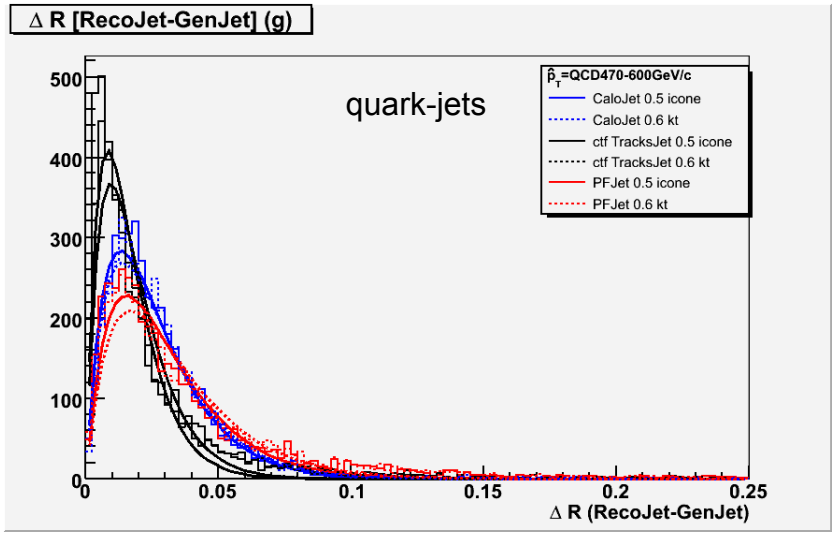
Eta resolution

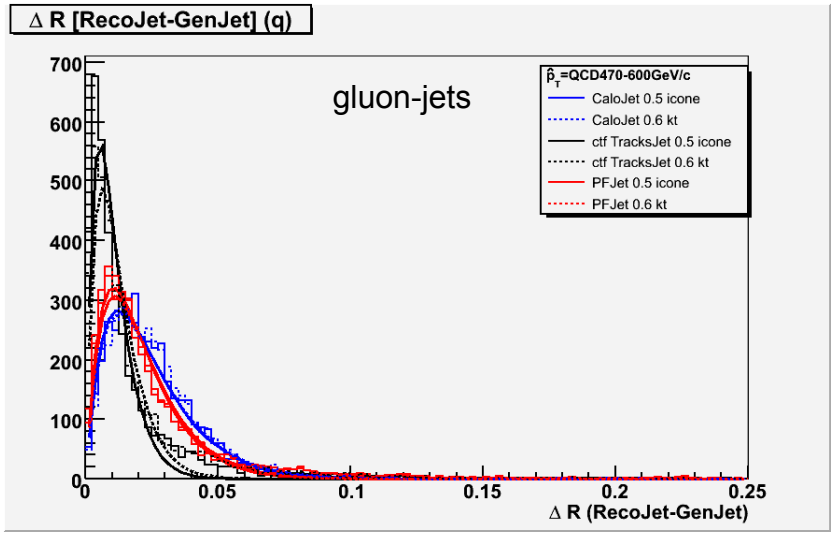


RecoJet-GenJet ΔR





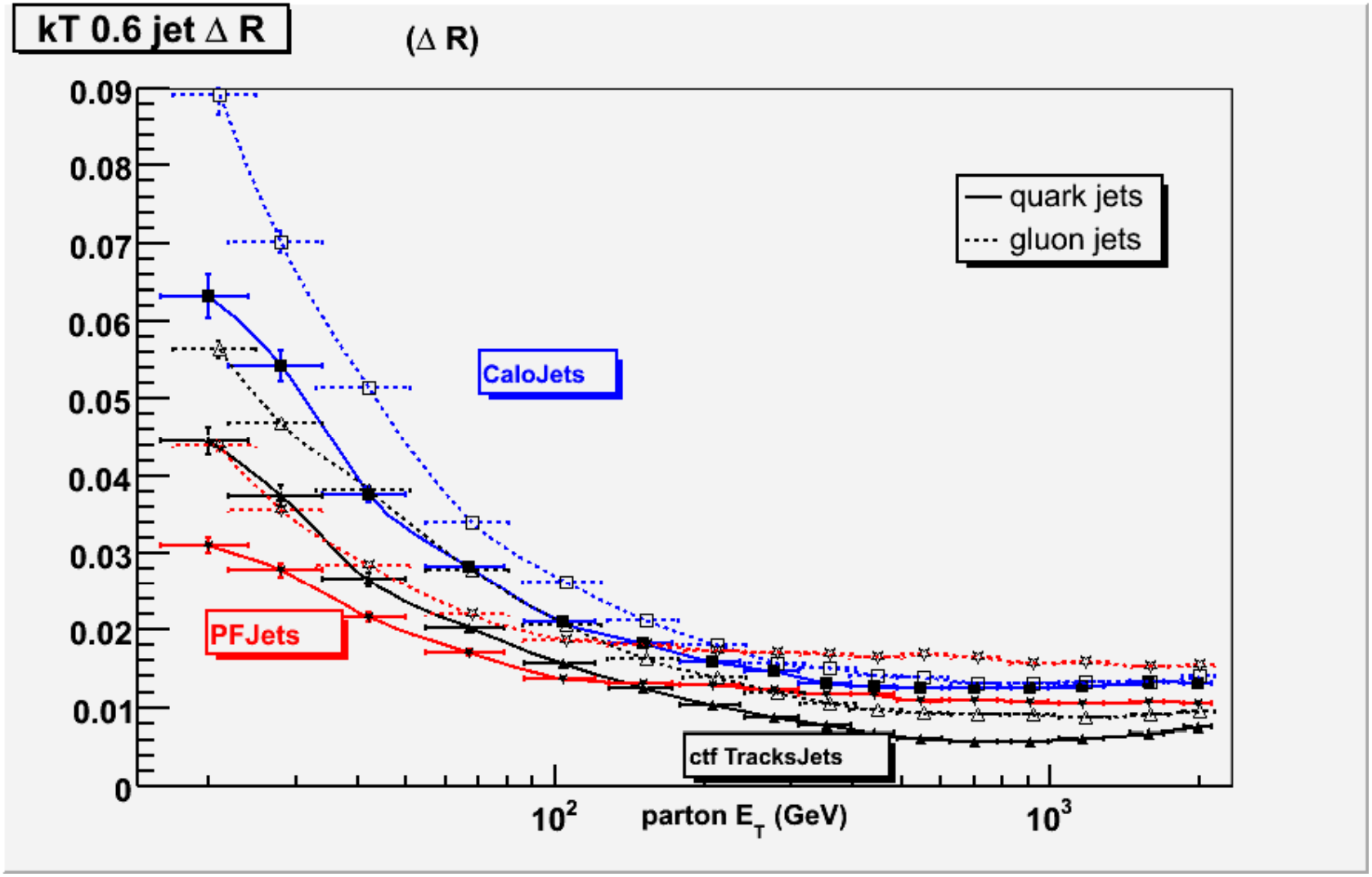




Jet Algo 24/10/07

fit to $f(x=\Delta R) = Ax\exp\left(-\frac{x}{x_0}\right)$ to find maximum $(x = x_0)$

RecoJet-GenJet ΔR



Summary on Jet response & resolution

The energy response of ctf track Jets is quite constant around 50% but drops at very high jet energies due to problems with the track finding algorithm in the jet core

Within the R<0.1 jet core track Jets are more collimated than Calo/PFJets but the angular resolution of PFJets is better at lower energies E_T<100 GeV.

Results in agreement with similar studies presented in Paris last week (J.Weng - L.Quertenmont - J.L.Agram)

Ongoing work to improve the track reconstruction and selection

Gluon jets are broader than quark jets: care should be taken when dealing with QCD samples

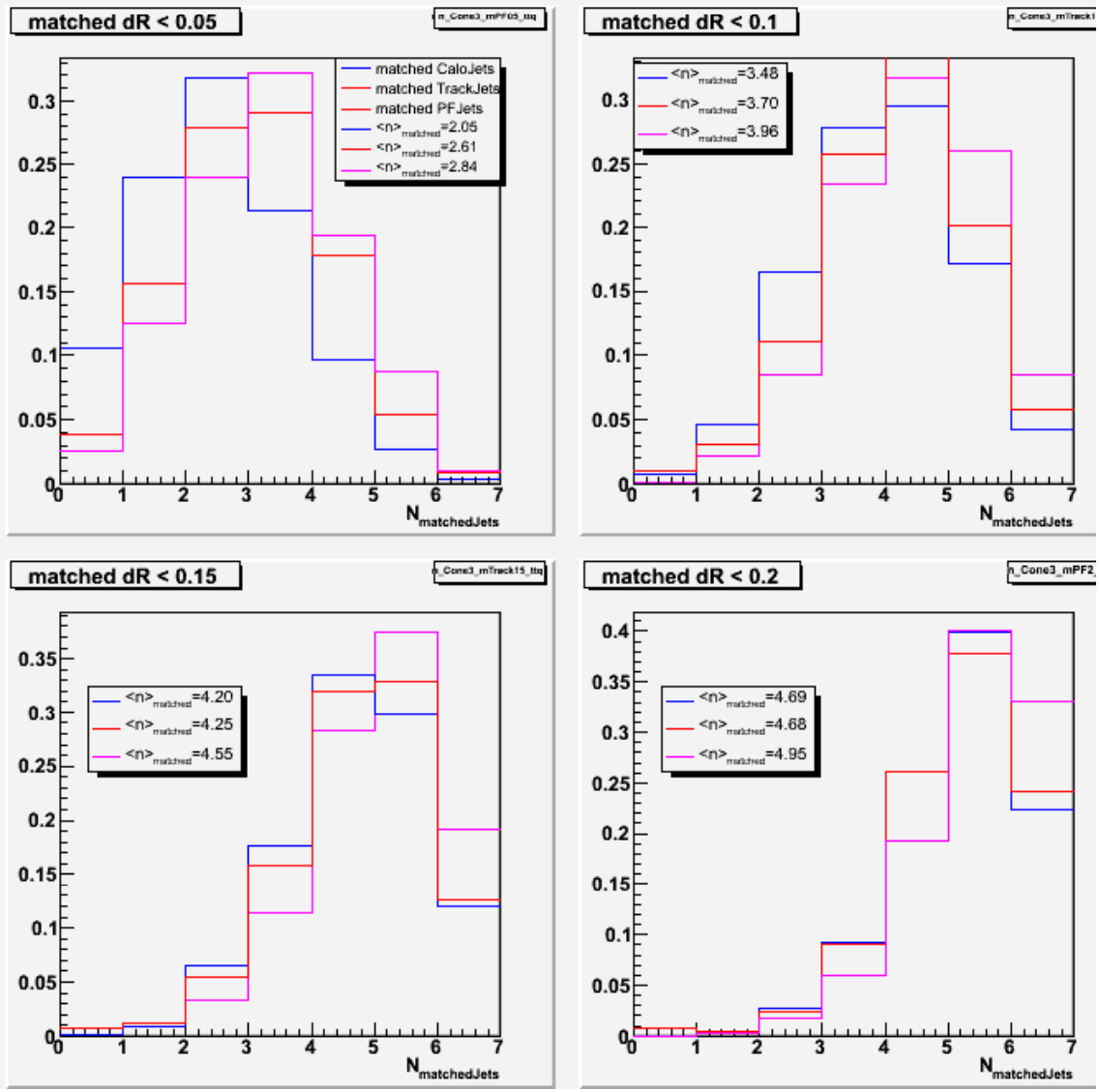
Jet finding in fully hadronic ttbar

Select hadronic decays $t\bar{t} \rightarrow b\bar{b}q\bar{q}q\bar{q}$ (45% of total)

with all six quarks within $\left|\eta_q\right| < 2$ (15% of total)

Check how well they match the six quarks.
Remove merged quarks (two q matched to the same Jet)
Remove splitted quarks (one q matched to different Jets)

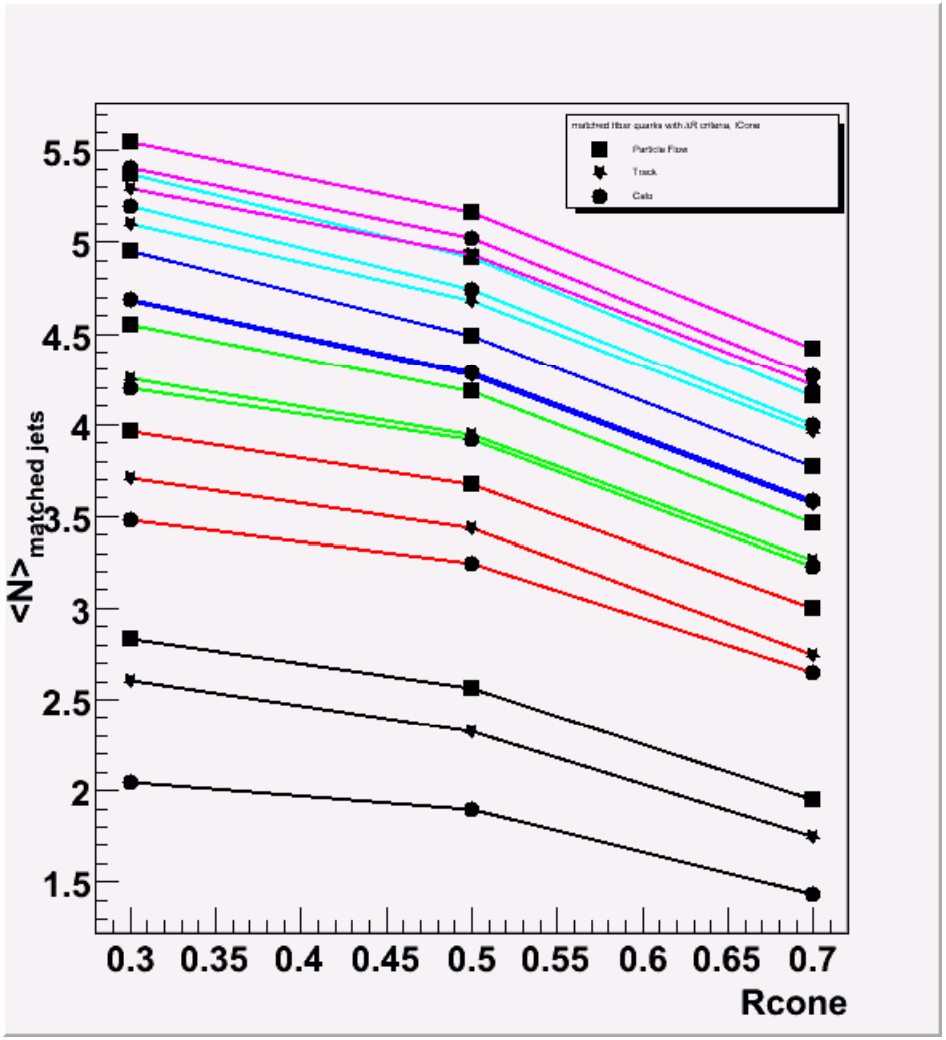
num of Jets matched to the quarks

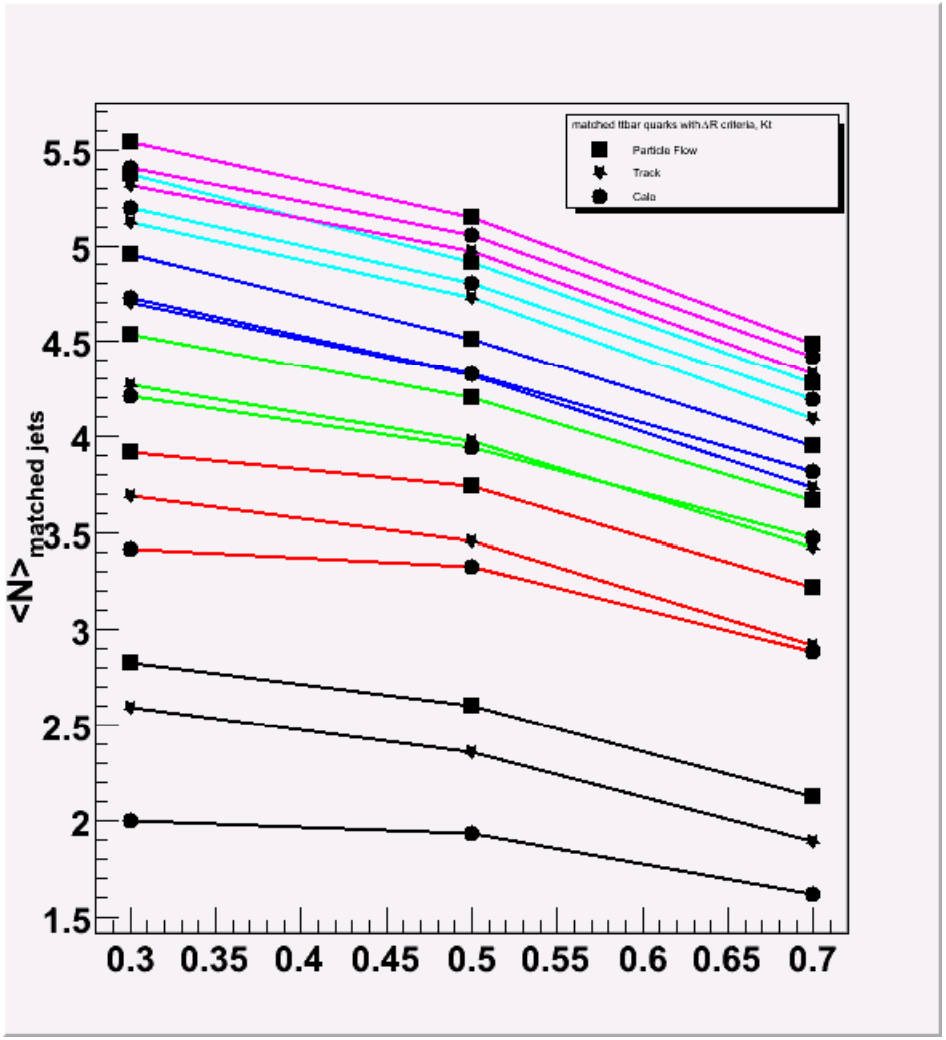


PF Jets appear to do the best job.

TrackJets match better to the quarks than the CaloJets

Jet matching efficiencies vs Rjet





Smaller Cones seem to work better

Jet + track

O.Kodolova, I.Vardanyan, A.Nikitenko

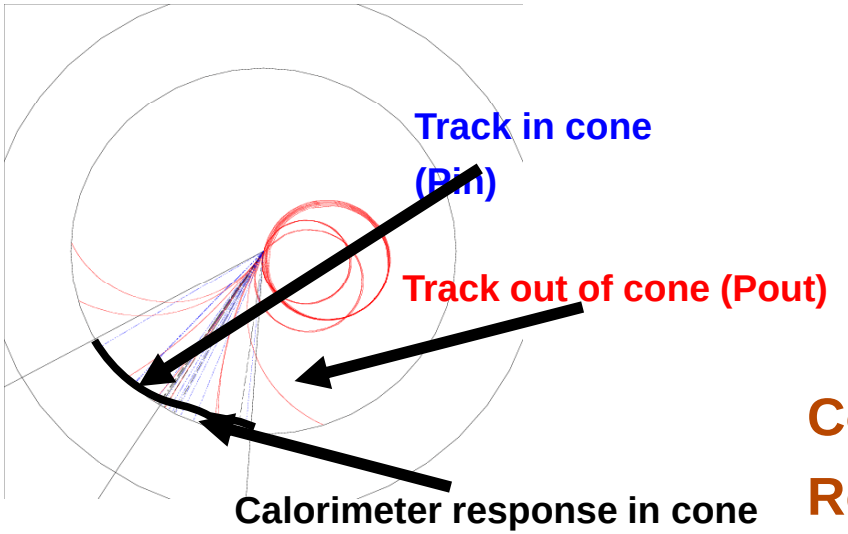
CMS NOTE-2002/036
CMS NOTE-2004/015
EPJC: http://dx.doi.org/10.1140/epjcd/s2005-02-004-2
CMS IN-2007/048

Method description (I): general description

DO NOT RESOLVE CLUSTERS IN CALORIMETER

Jet Response=Response(charged hadrons)+Response (e/γ)+Response (neutral hadrons)

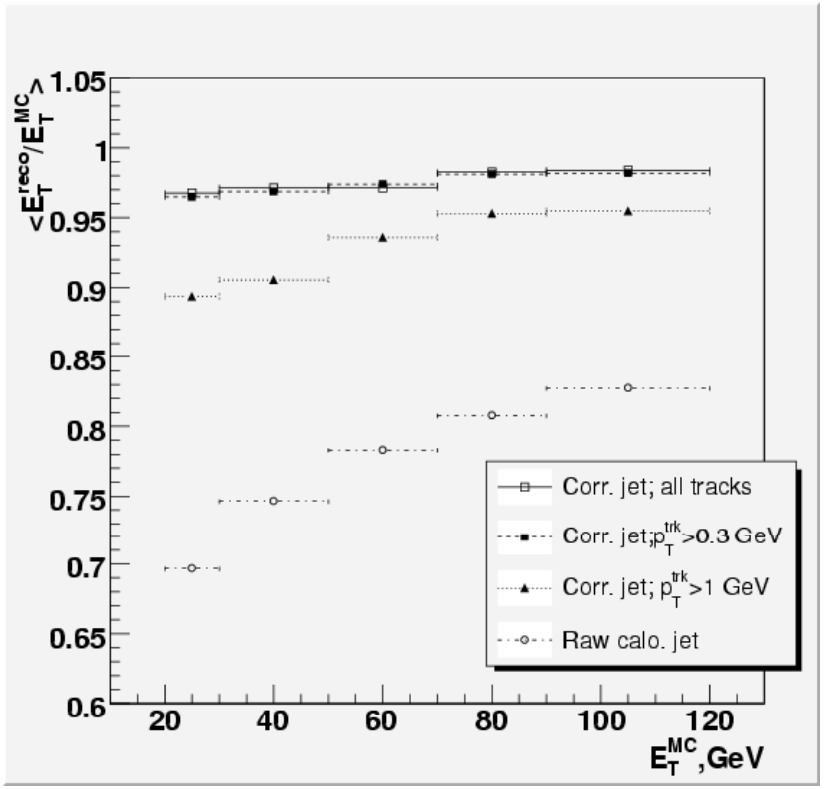
- **Replace expected response of charged hadrons inside calo jet cone at ECAL surface (expected response μ = mean energy deposited by charged hadron as a function of Etrack: μ = F (Etrack))**
- **Add energy of tracks out of calo jet cone at ECAL surface.**

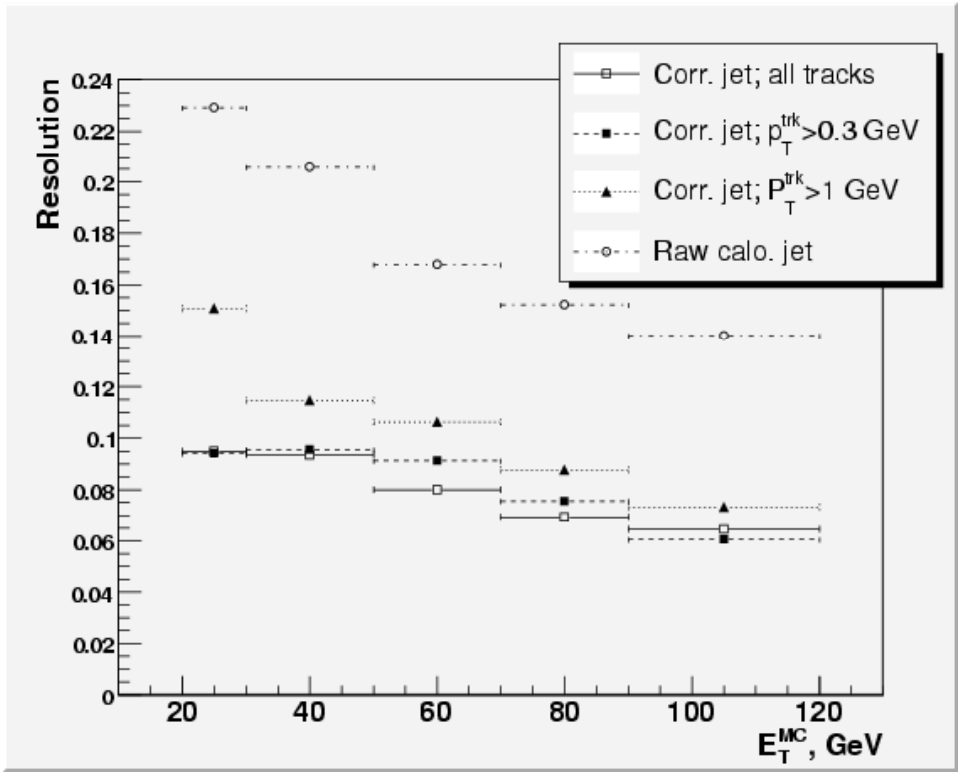


For each track: (E_{track}- μ) is added to Jet Response.
For track in cone: μ is calculated from F(Etrack).
For track out-of-cone: μ = 0, i.e. track energy is added.

CorrJet energy = sum(Pin) + sum(Pout)+ Response (e/γ+neutral hadrons)_ECAL + Response (neutral hadrons)_HCAL

Example II: PYTHIA jets with test-beam responses





Next idealization but closer to real jets: charged pions + photons (No neutral hadrons and no protons/Kaons)

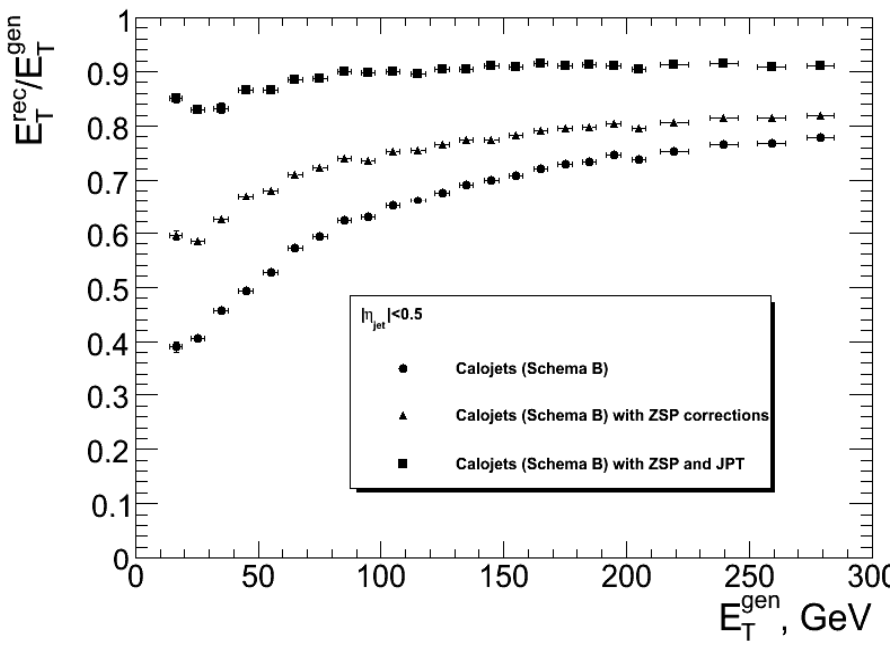
PYTHIA jets made with $\pi^{+/-}$ response from TestBeam and "ideal" tracks and photons

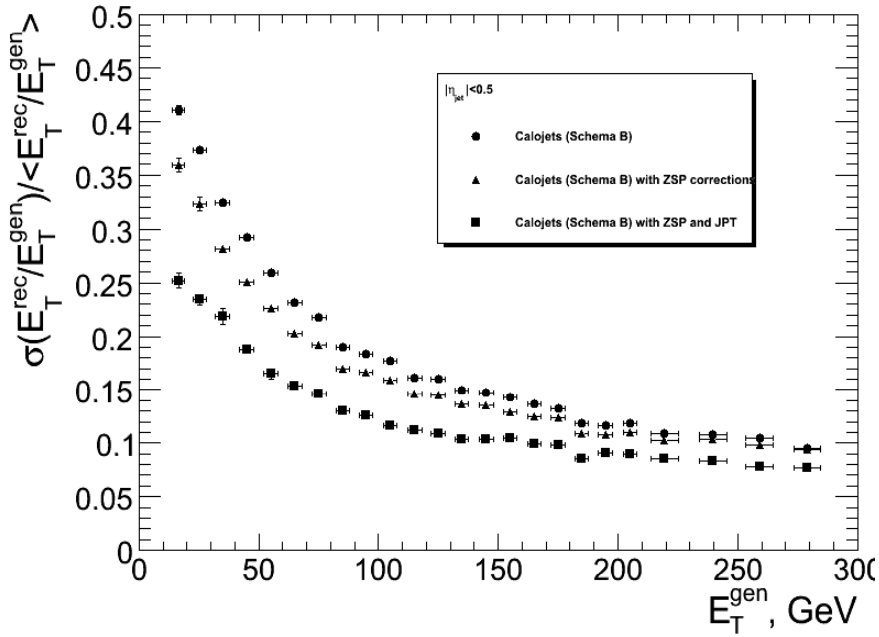
Example III: Description of procedure

- use Non Zero-Suppressed (Non-ZS) runs to obtain
  - a) Jet energy corrections due to Zero Suppression (ZS)
  - b) create Non-ZS single particle response library

- with "normal" ZS runs
  - a) find calo jet
  - b) correct energy for ZS
  - c) apply J+T using Non-ZS particle response

Combination of ZSP and JetPlusTrack (I)

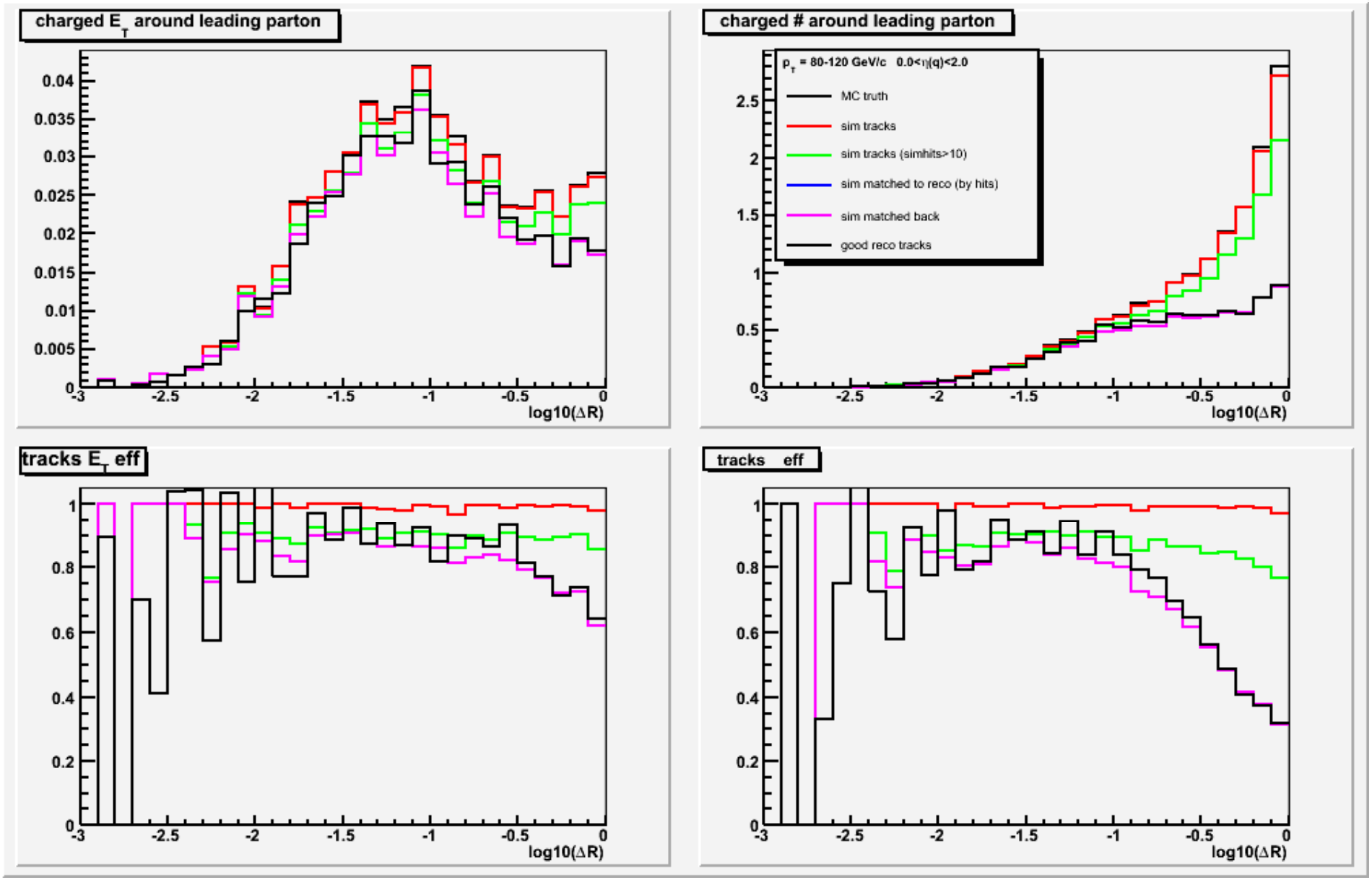




JetPlusTrack correction together with the correction for zero suppression gives essential improvement both in jet response linearity and resolution.

The further improvement can be achieved by:

- **The estimation of tracking inefficiency for tracks with p_T>0.9 GeV**
- **Low momentum particle identification and reconstruction (pixel track finder+low momentum particle ID, F.Sikler)**
- **Correction for the neutral hadrons with Z+jet**
- **Pile-up subtraction**

Backup

Reco Charged tracks in jets