Jet properties in Pb-Pb collisions with ATLAS

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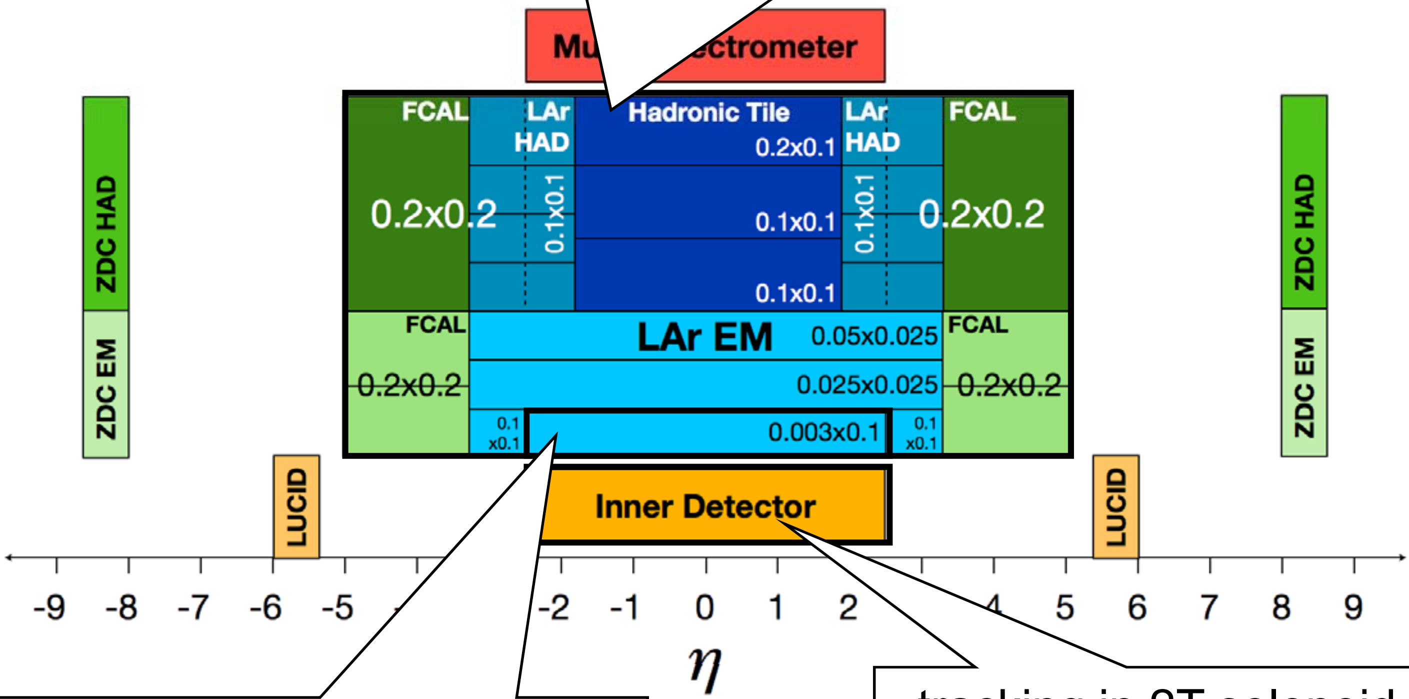
for the ATLAS collaboration

Outline

- Jet reconstruction strategy
- Basic performance (jet energy resolution, efficiency)
- Fragmentation function and j_T
  - expected perfomance
  - expected modifications from Pyquen simulations
- Jet shapes
  - expected performance
  - expected modifications from Pyquen simulations
- Summary

Reconstruction strategy

jet reconstruction using calorimeter, full azimuth, 10 units of pseudorapidity

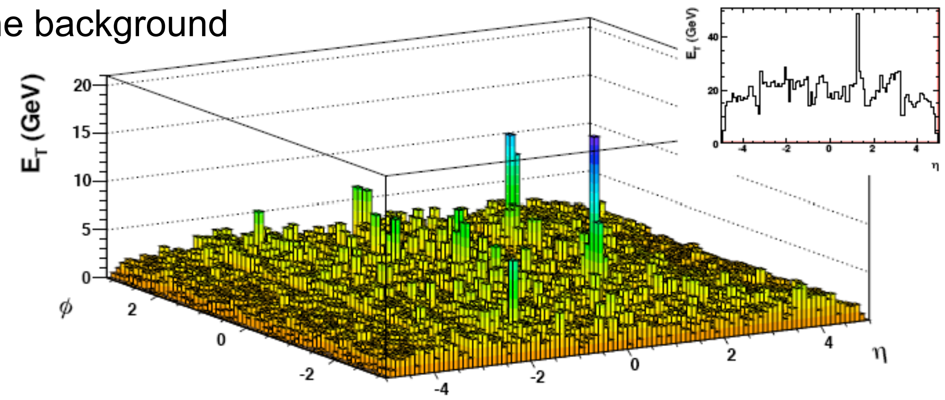


first layer of LAr EM calorimeter excellent for photon isolation

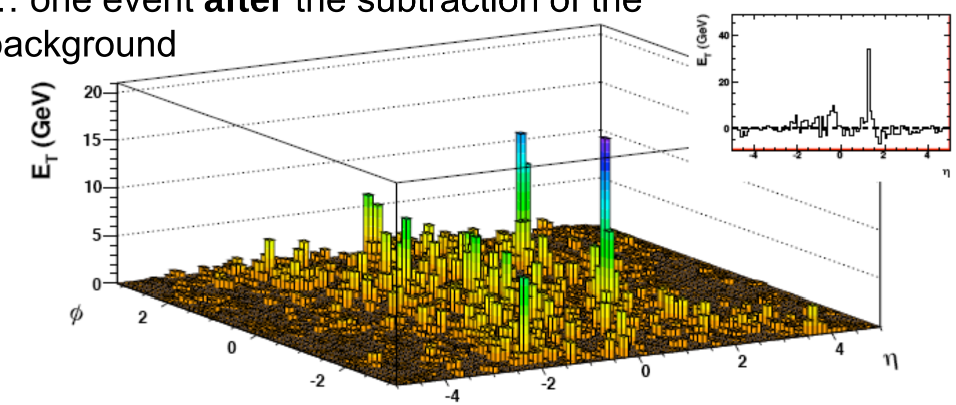
tracking in 2T solenoid – fragmentation studies

Reconstruction strategy

… one event **before** the subtraction of the background



… one event **after** the subtraction of the background

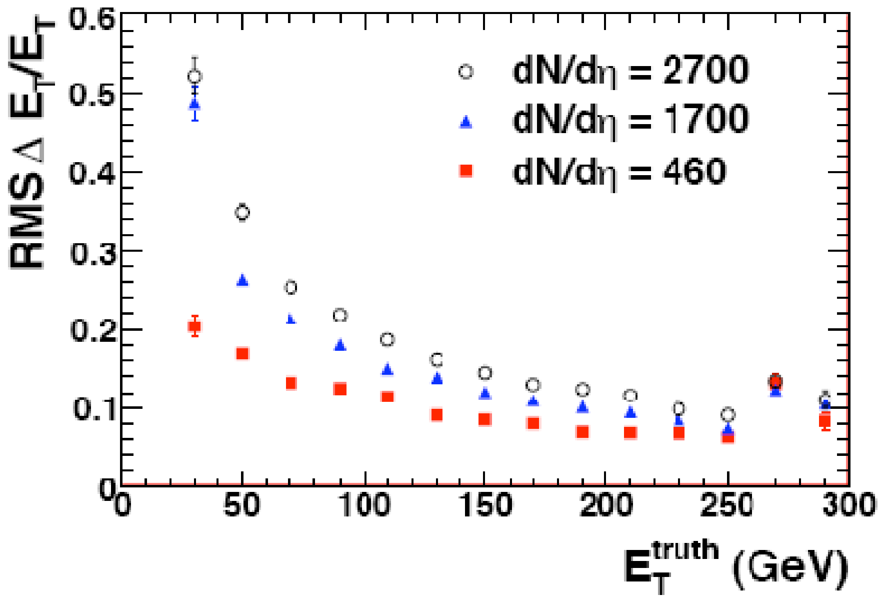


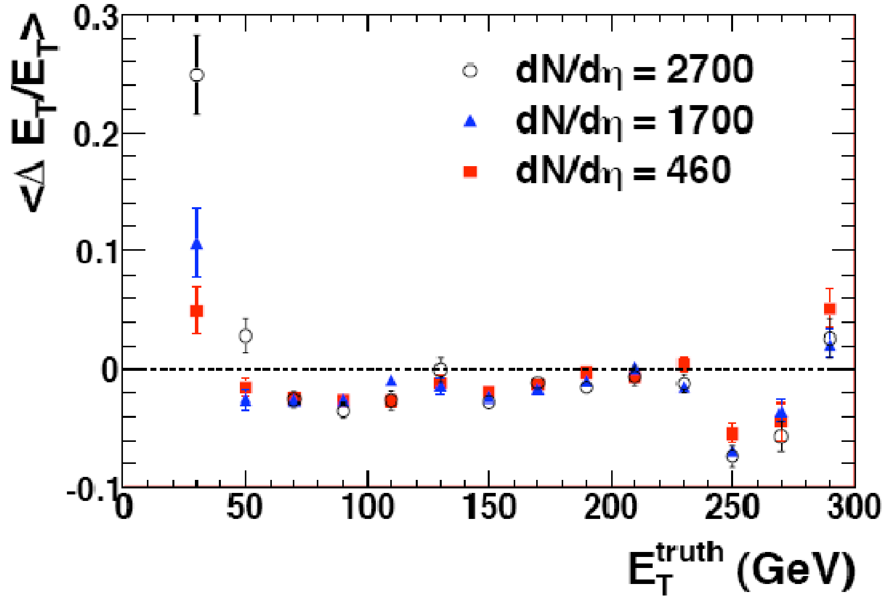
General strategy:
For the evaluation of reconstruction performance we use PYTHIA dijet events (J2,J3,J4) that are embedded to unquenched HIJING

Jet reconstruction algorithm:

- regions of interest found (seed regions) – fast sliding window algorithm used
- eta-dependent, segmentation-dependent background computed excluding the seed-regions
- subtraction of the background
- standard *pp* jet finding algorithm used

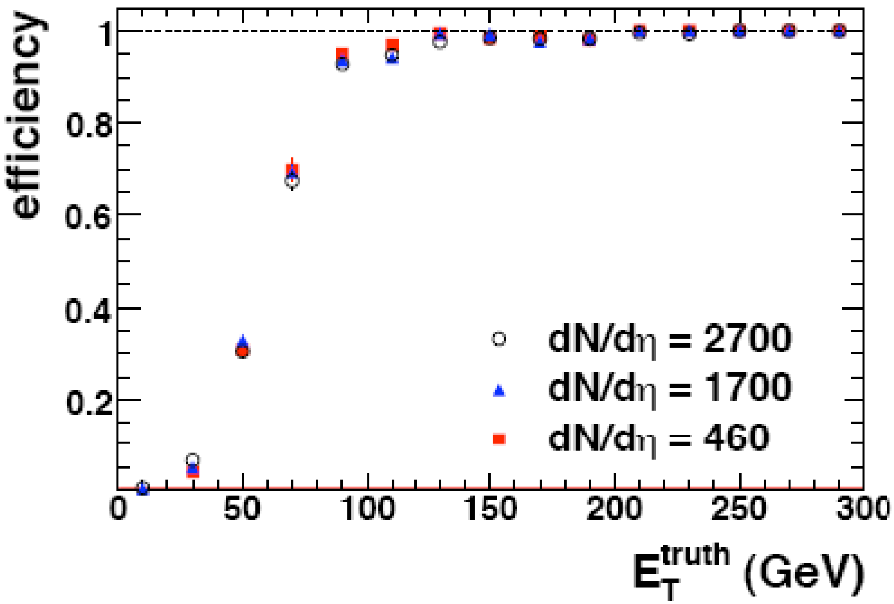
Jet energy resolution

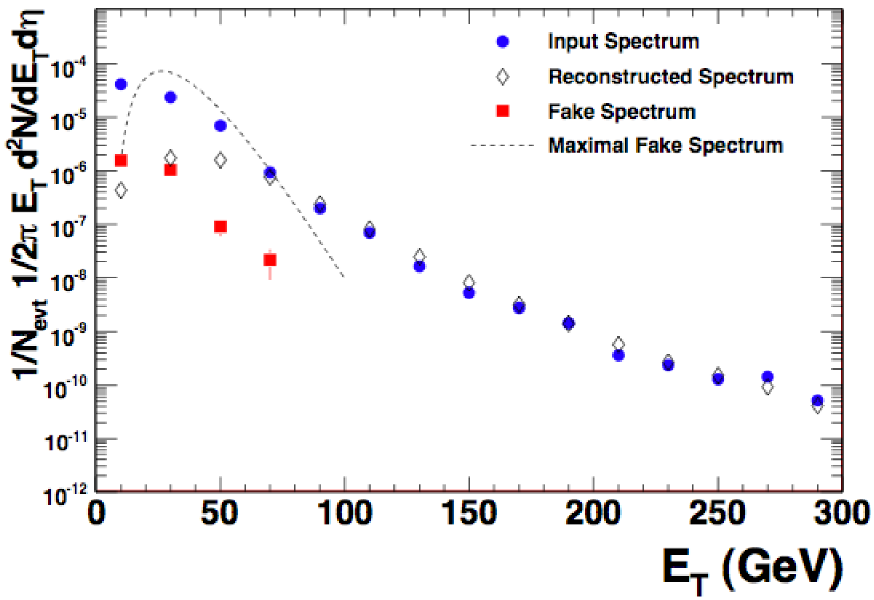




- cone algorithm R=0.4, 5 GeV seed, reconstructed jets matched to truth jets using ΔR=0.2 cut
- jet energy scale within 5% above 50 GeV, default *pp* calibration used
- jet energy resolution bellow 25% for 70 GeV jets in the most central collisions (dN/dη~2700 – unquenched HIJING)

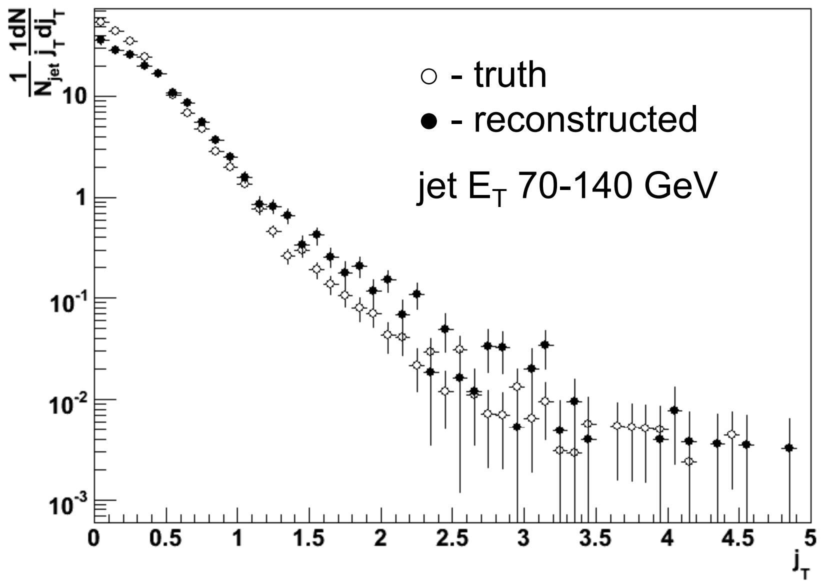
Efficiency and fake-rate

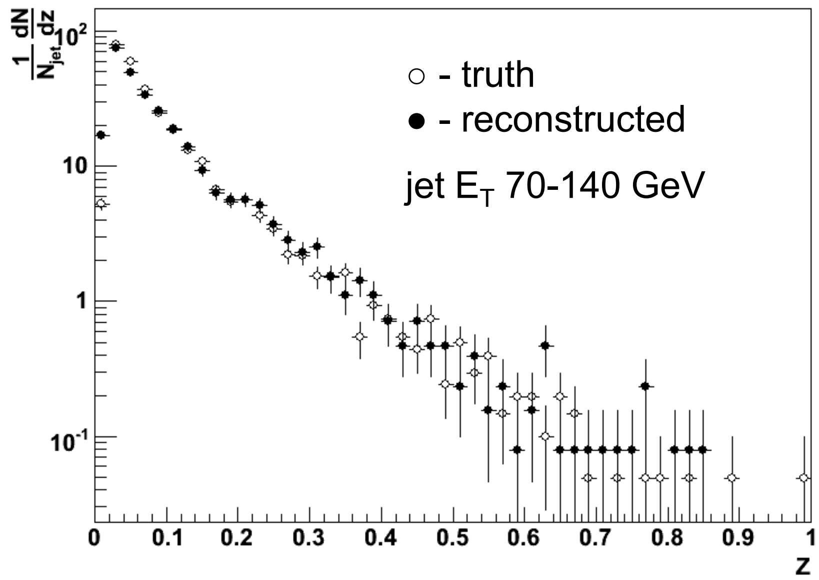




- efficiency is almost centrality independent – easier interpretation of jet properties vs. centrality
- above 70 GeV the efficiency is above 90%
- above 70 GeV practically no fake jets (after the fake rejection)

Fragmentation function and j_T



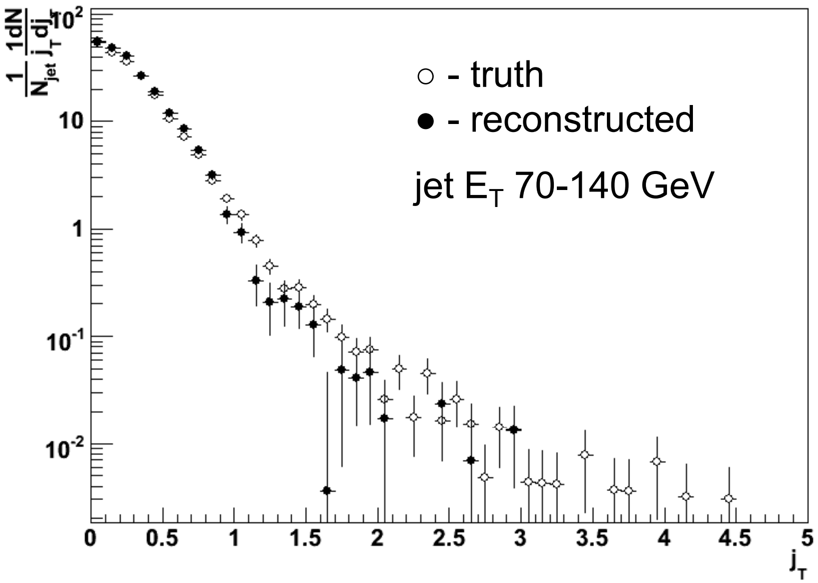


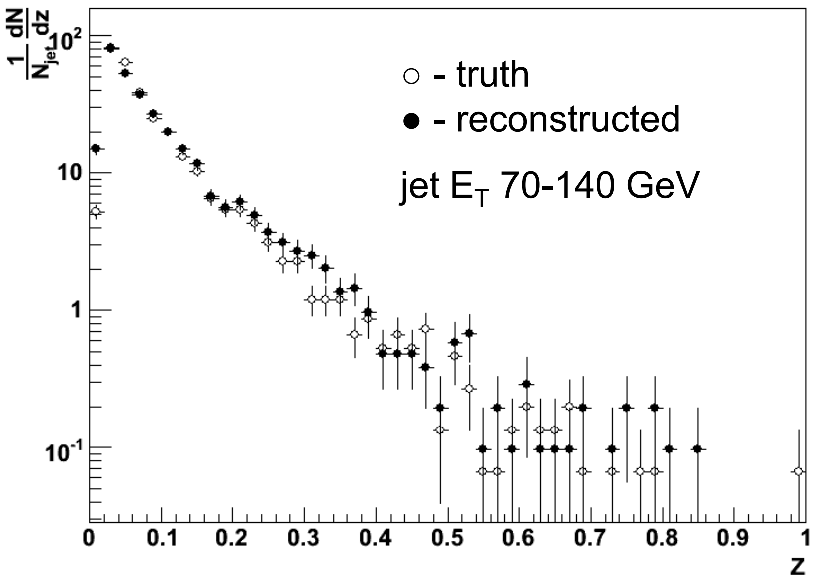
Reconstruction procedure:

- tracks are matched to calorimeter towers of jets
- j_T and z for tracks above 2 GeV is computed
- background distributions of j_T and z are computed using tracks that match with HIJING particles, these distributions are subtracted

… visibly an underestimation at small j_T, this discrepancy is due to jet position resolution, but nice agreement between truth and reconstructed z

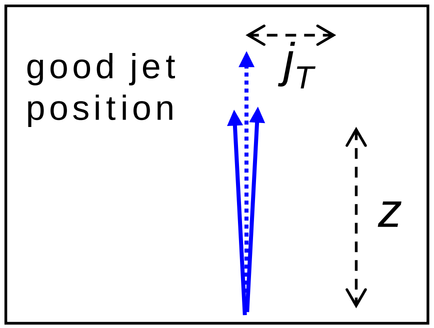
Fragmentation function and j_T

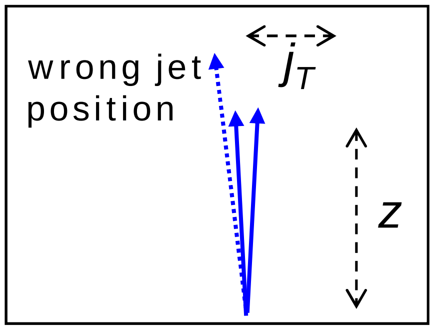




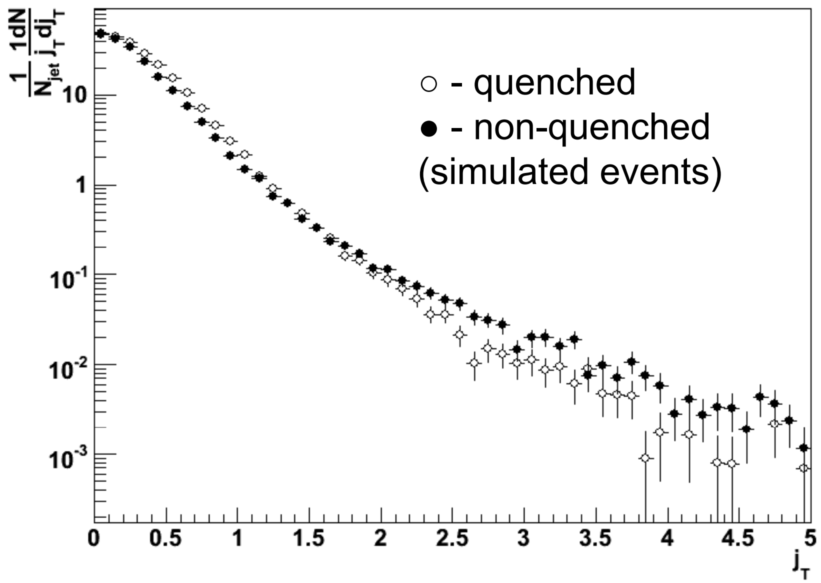
To restore the jet position jet axis of jet determined using smaller cone (0.2) was used instead of the original jet axis. The original jet energy remains unaffected.

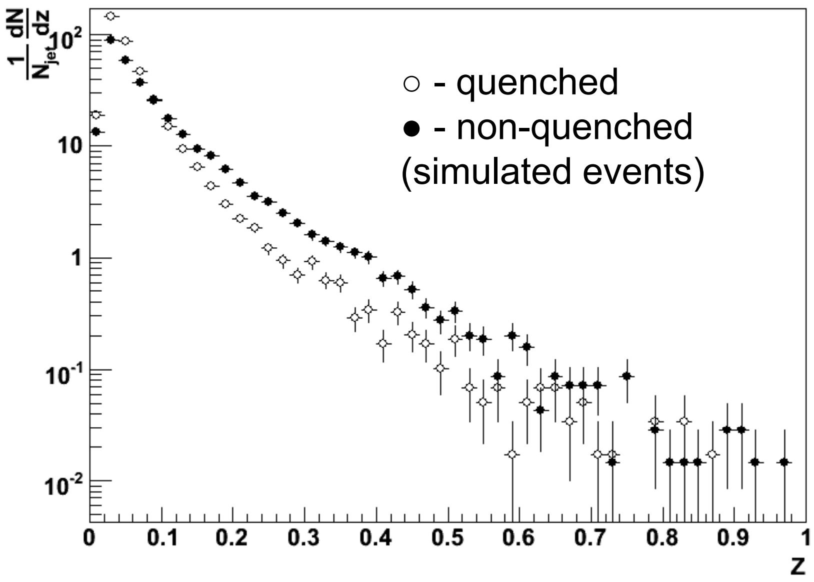
… we can well reproduce j_T, fragmentation function is not sensitive to the precise jet position





Fragmentation function and j_T from Pyquen





Low *z* strongly enhanced, higher *z* suppressed

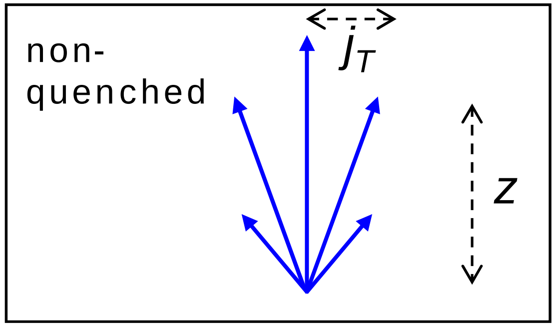
⇔

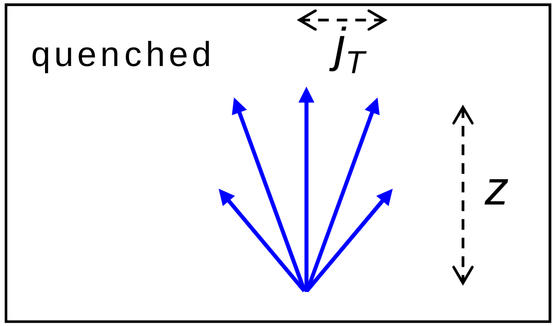
Suppression of the leading particle, redistribution of the energy out of the jet core

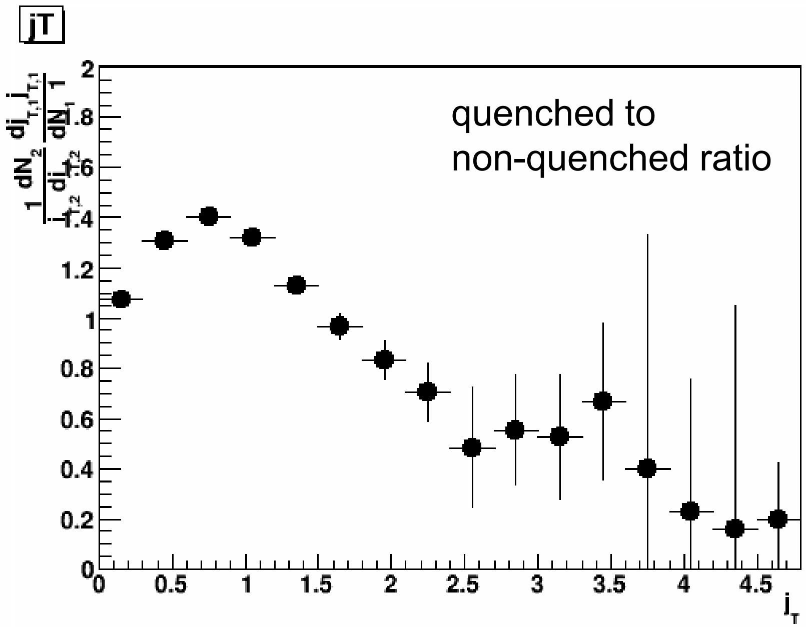
- result at the generator level – not yet reconstructed (!)
- Pyquen settings: default setting for quenching, b=0, $p_{T,min}$=70 GeV, PbPb, LHC energy

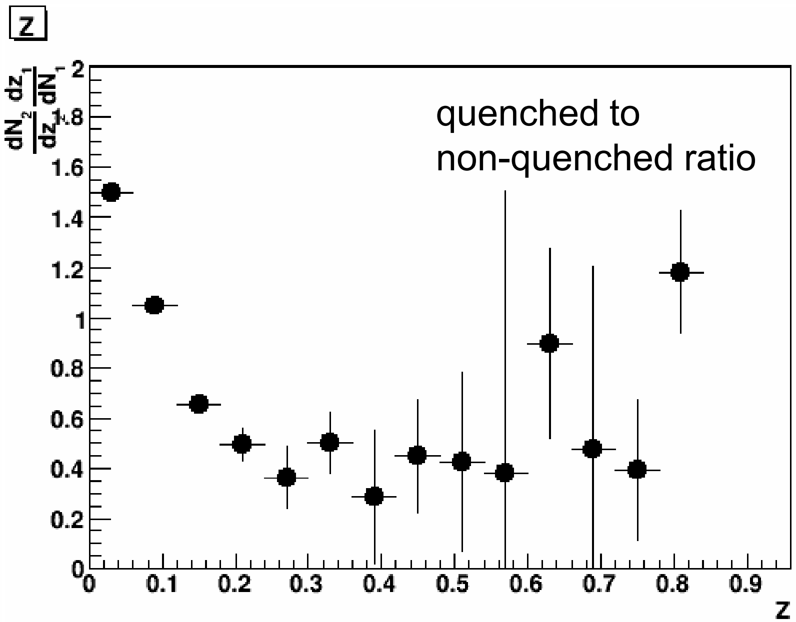
Fragmentation function and j_T from Pyquen

illustration …



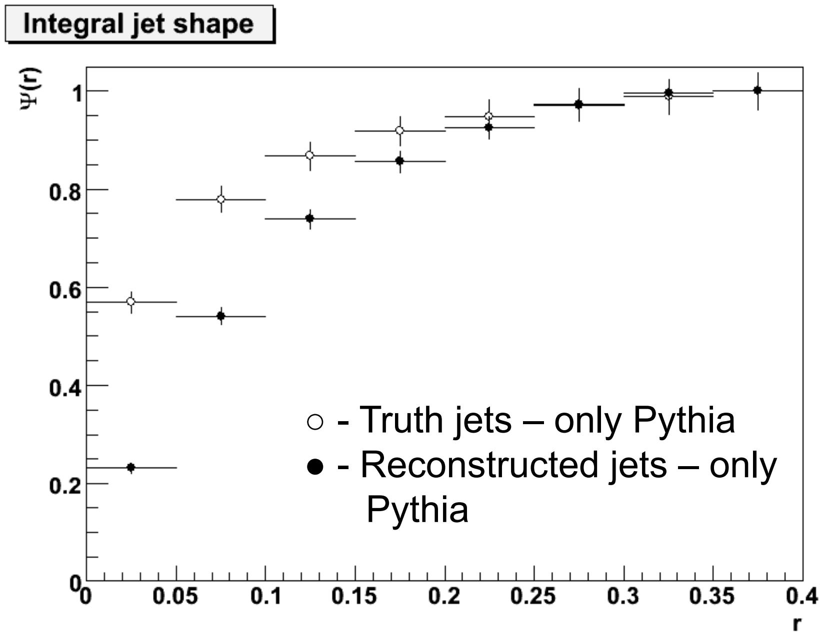


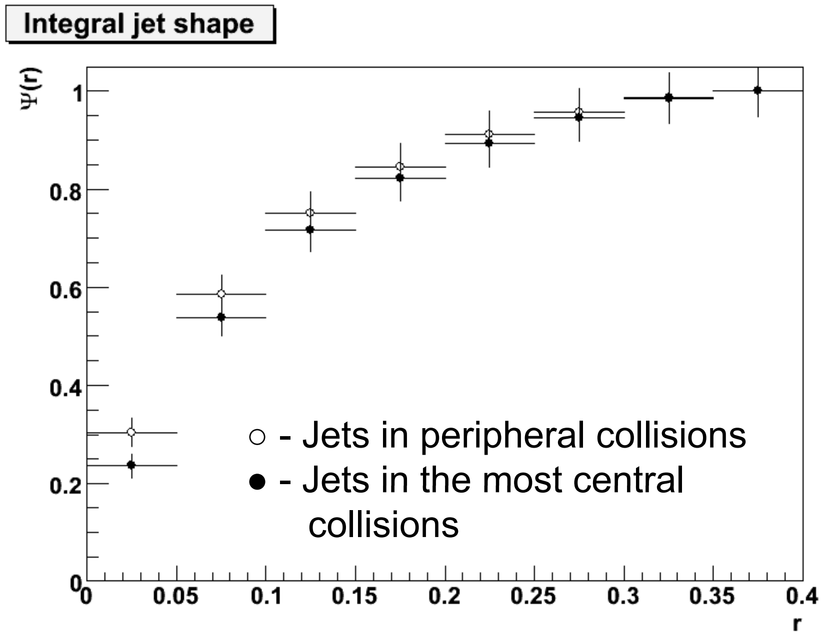




… if the quenching is of such order we should be able to measure it

Jet shapes

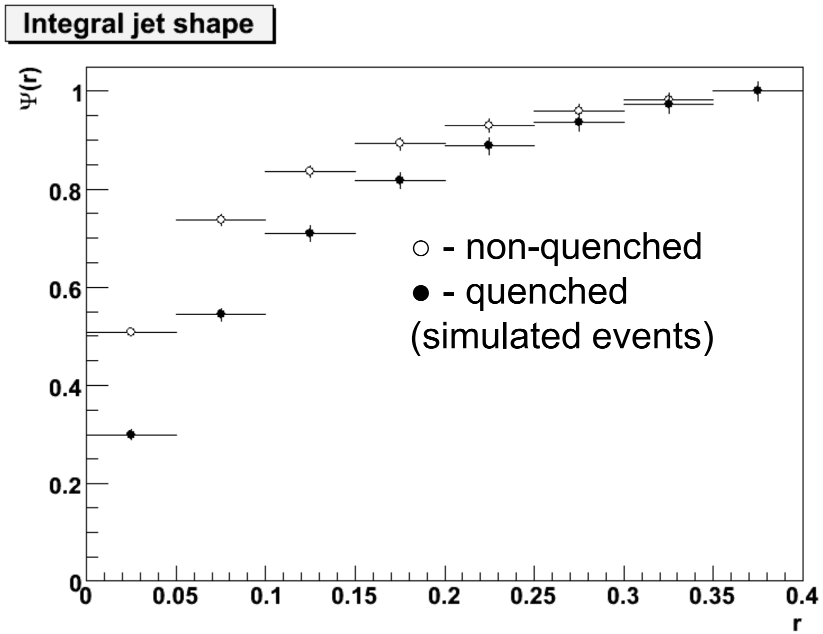


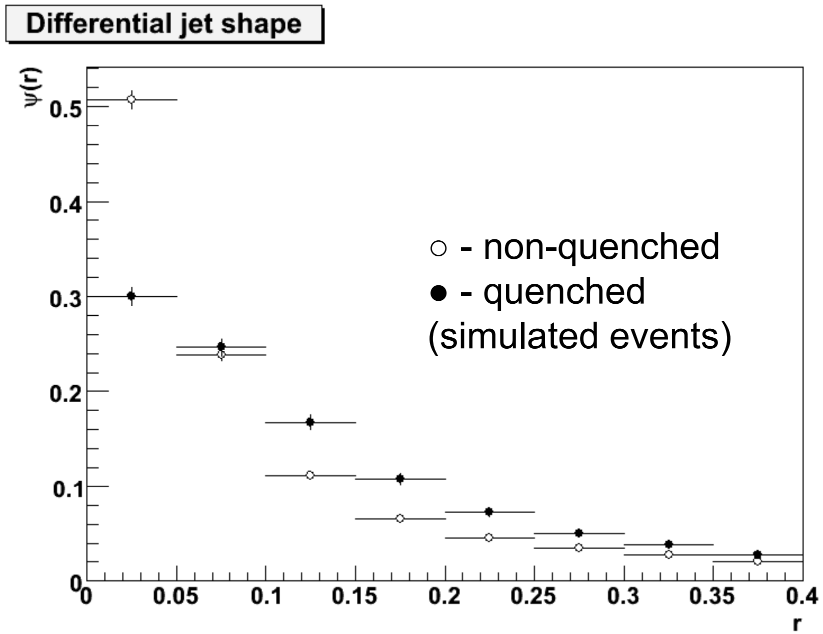


… truth jet shapes are much more narrow than calorimeter jet shapes resulting from calorimeter resolution

… we are able to reconstruct jet shapes in the most central collisions with good accuracy, a small difference at low *r* is due to position resolution and it should be possible to correct it using jets reconstructed with smaller cone size

Jet shapes from Pyquen simulations





- result at the generator level – not yet reconstructed (!)
- almost factor of two in the jet core
- differential jet shape can show better the flow of the energy – energy is redistributed out of center of the jet

… if the quenching is of that order we should be able to measure it

Conclusion

- ATLAS heavy ion jet reconstruction
  - studies extend over E_T, eta, centrality
  - good position, energy resolution, reconstruction efficiency
  - possibility to measure fragmentation properties, jT, D(z), jet energy profiles and their modification
- Also have extensive results on
  - k_T algorithm
  - γ-jet, jet-jet correlations, b-tagging
- ATLAS expects to make a significant impact on understanding of parton energy loss with our ability to reconstruct jets and their properties

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Backup slides

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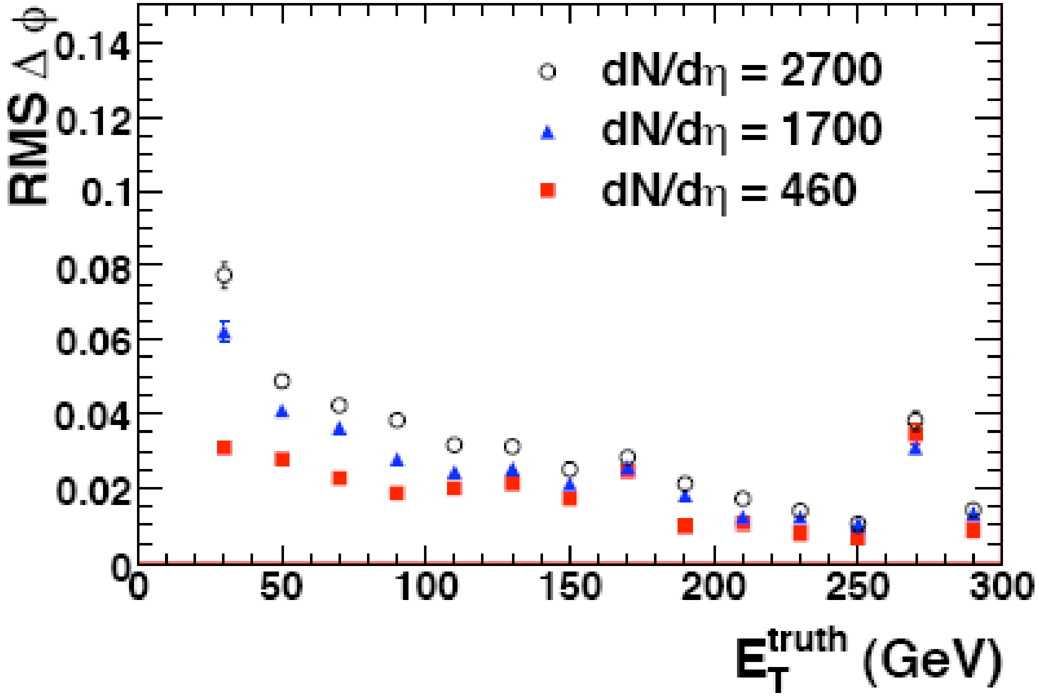
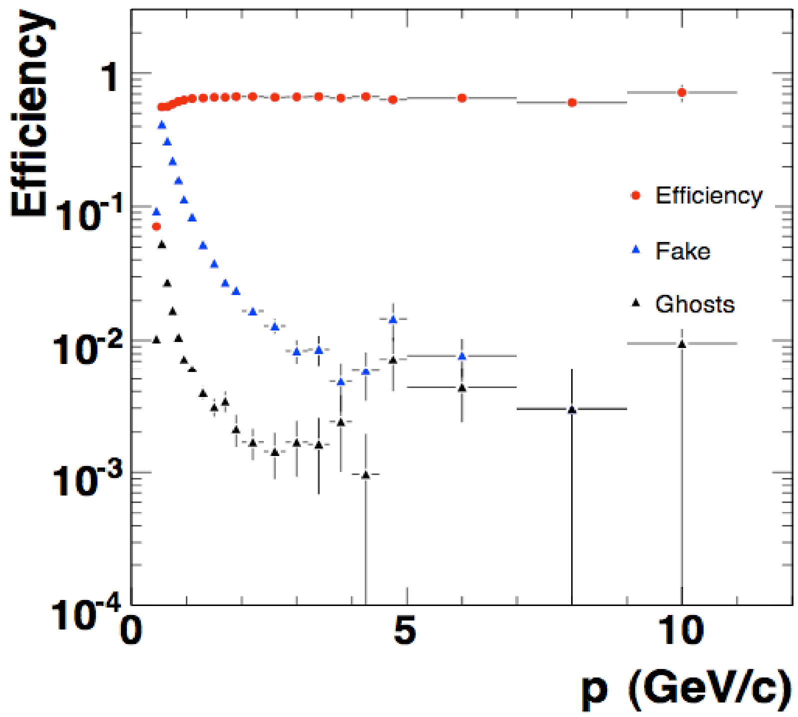


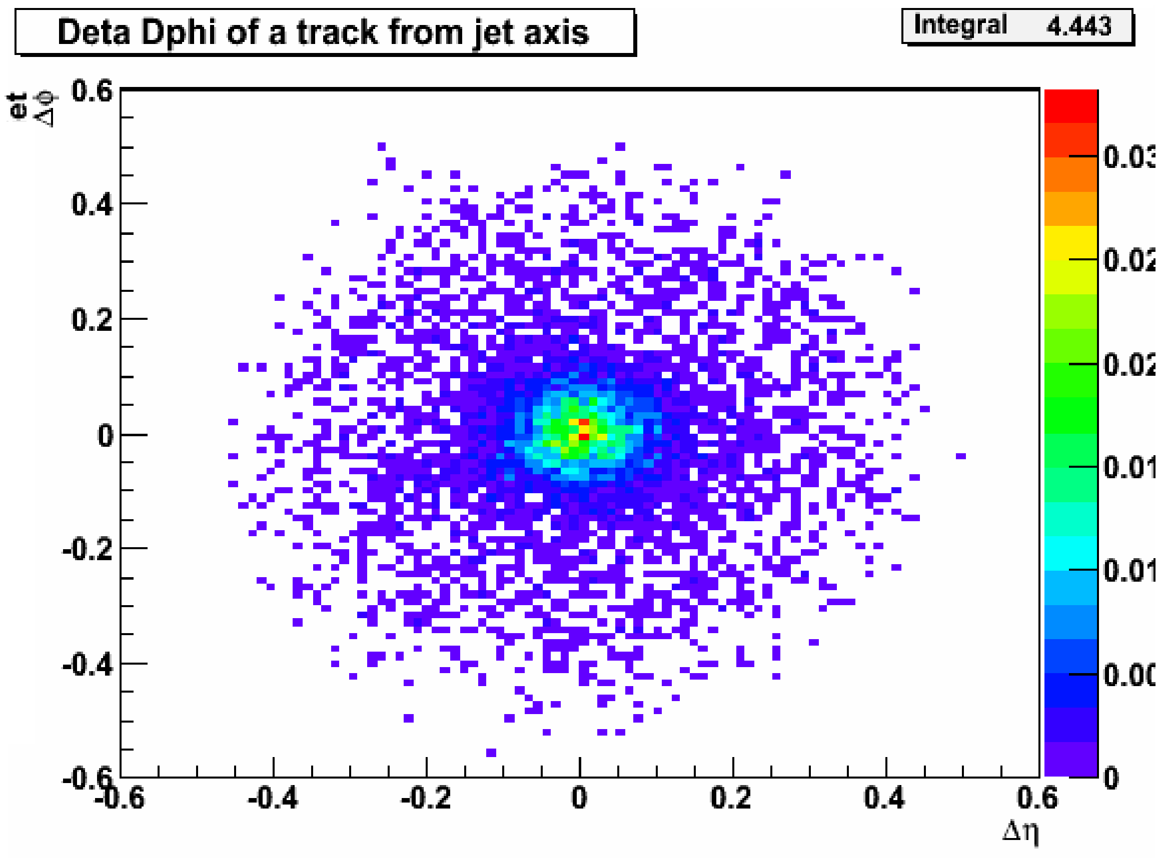
Position resolution as a function of truth jet energy

Backup slides

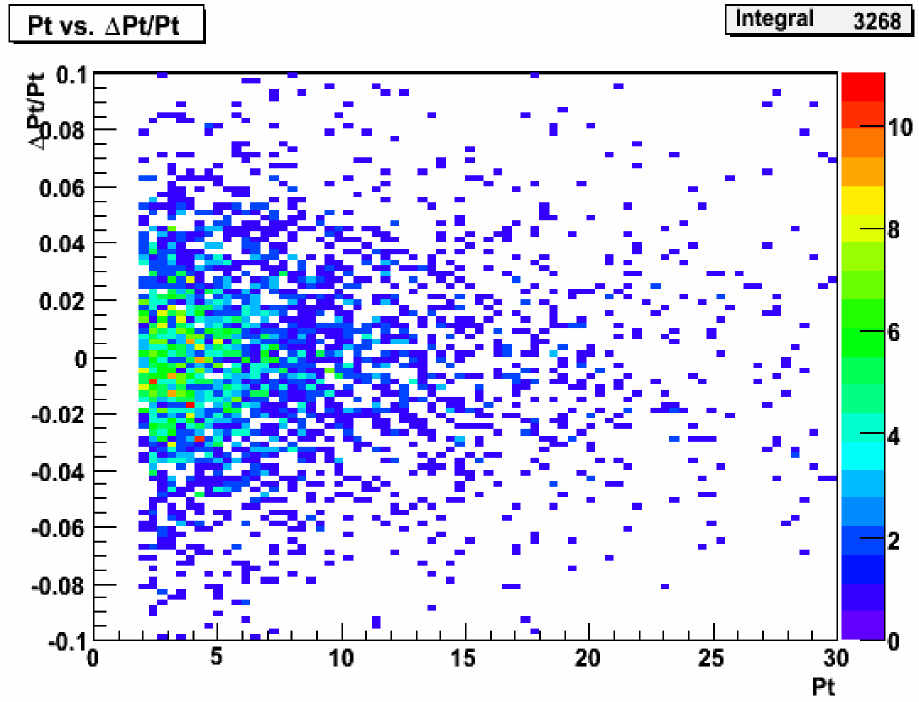


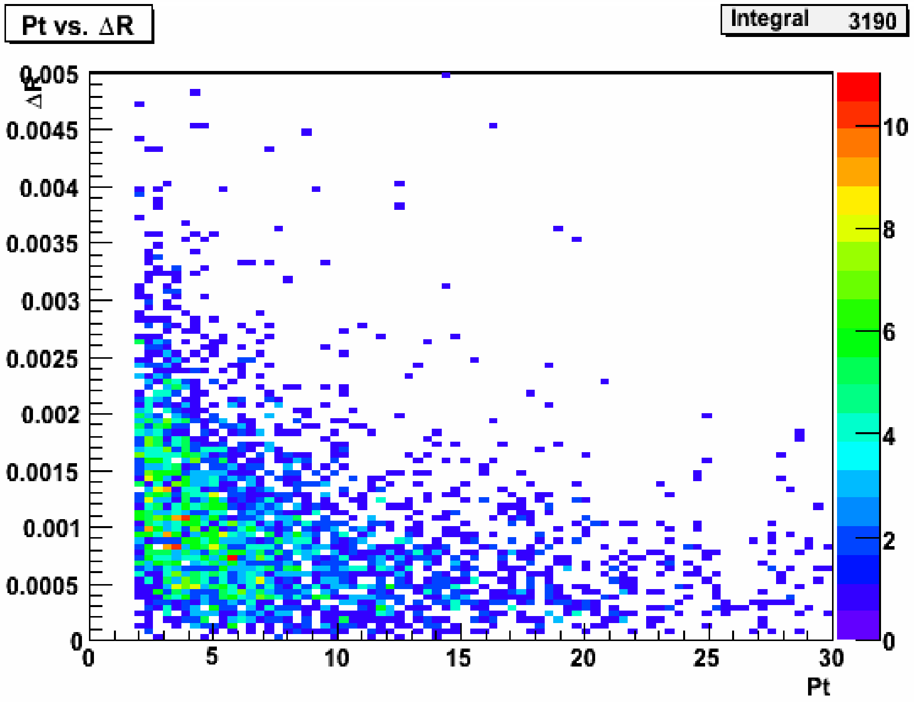
Tracking efficiency ~ 70% for the most central collisions

Backup slides



Shape of the jet from tracking

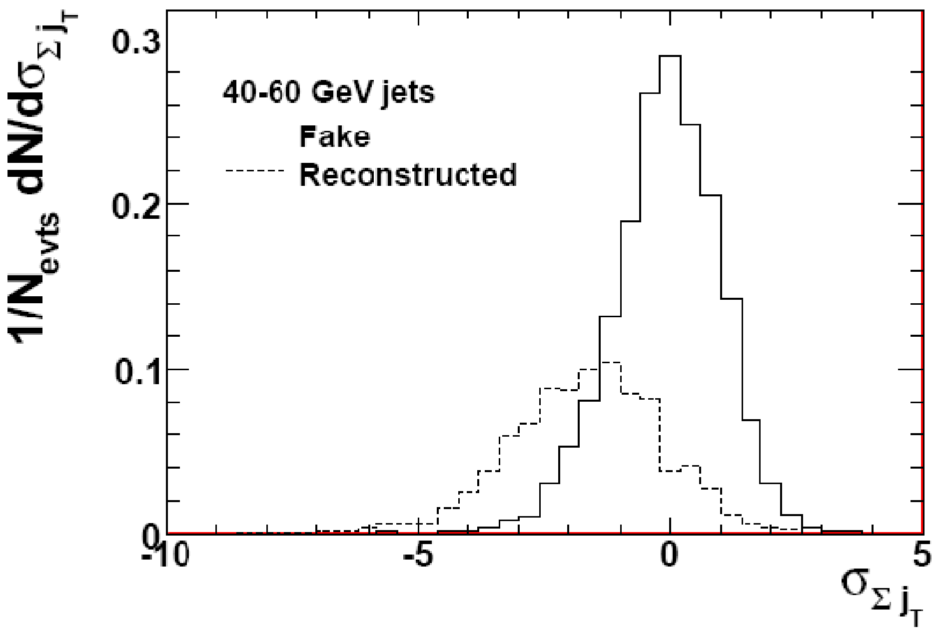


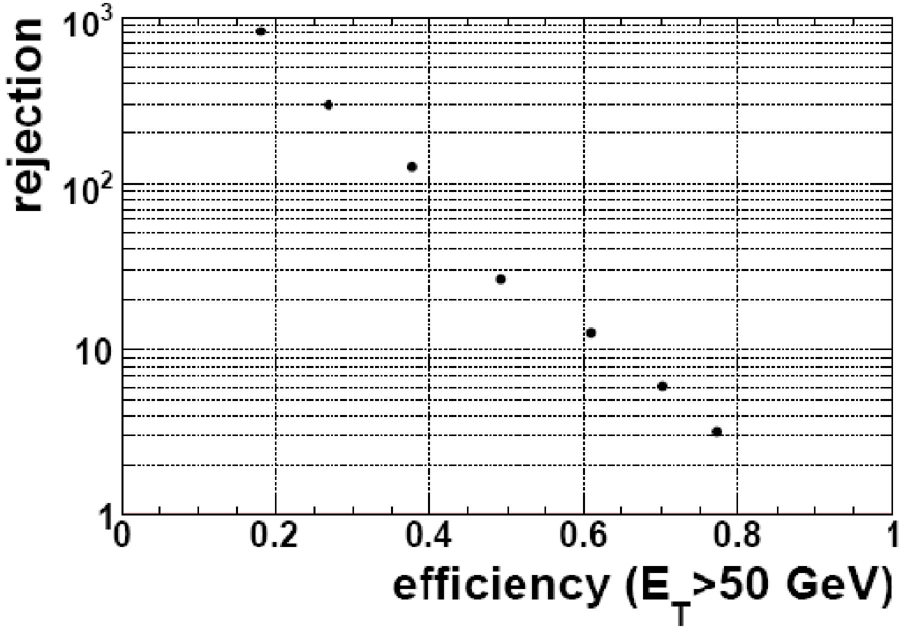


Track reconstruction performance

(tracking efficiency ~ 70%)

Backup slides





$$\Sigma j_T = \sum_{\mathrm{cell}\in\mathrm{jet}} E_{T,\mathrm{cell}} \sin R_{\mathrm{cell}}$$

$$\sigma_{\Sigma j_T} = \frac{\Sigma j_T - \langle \Sigma j_T \rangle (E_T)}{\sigma(E_T)}$$