Seedless Infrared Safe Cone Algorithm:

Performance Studies

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Work in collaboration with:

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CMS Physics & Trigger Week, 24 October 2007

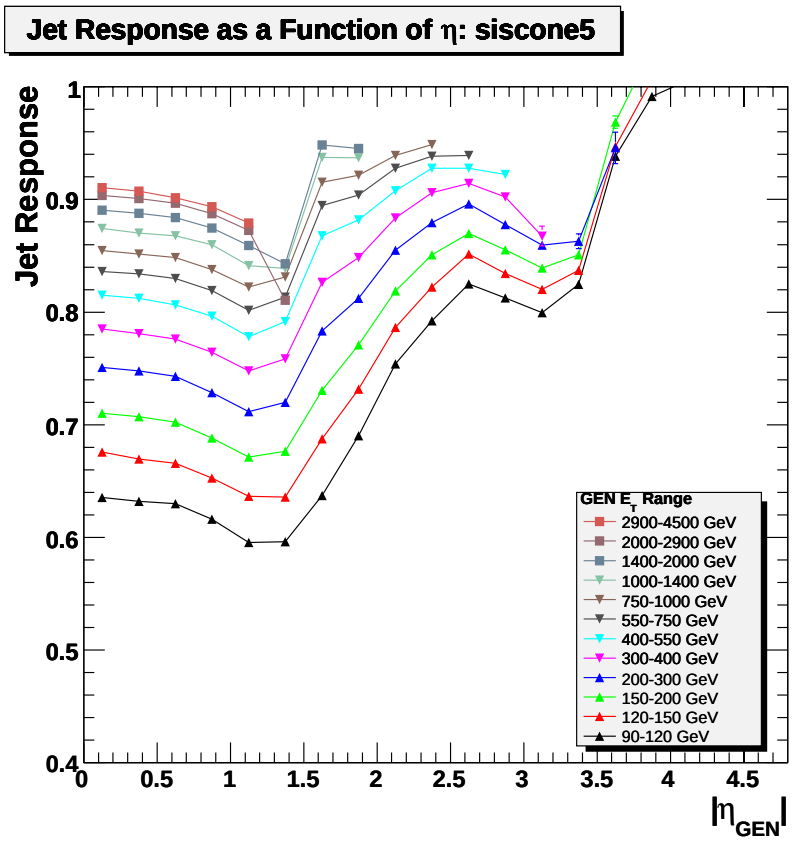
Outline

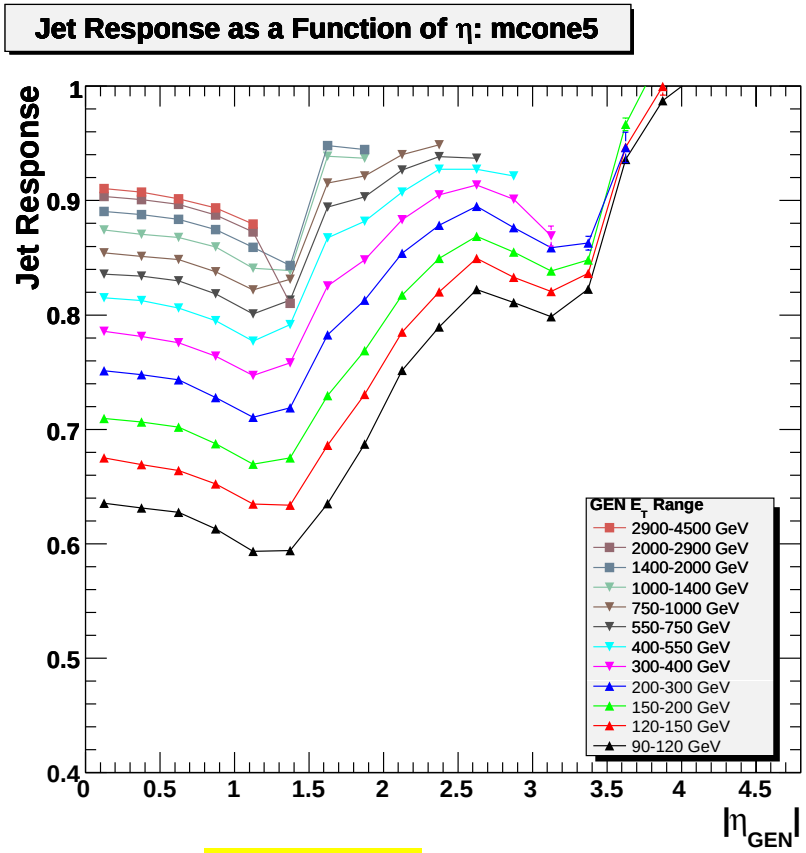
- Objective:

  Compare performance of Scone and Mcone algorithms
  - Performance for other algorithms is quite similar
- Quantities studied:
  - Jet energy response
  - Jet energy corrections
  - Energy resolutions for corrected jets
  - Jet position resolutions in η and ϕ
  - Jet matching in ΔR
  - Jet efficiencies vs p_T and η
- Summary and Proposal
  - Enable Siscone in the production path starting in CMSSW 170
  - Request feedback from PAGs
  - If no negatives found, switch to SISCone

Response vs η: R=0.5

- Just like for other algorithms, there is a strong dependence of Scone jets on ET and η – it is very similar to that of Mcone jets





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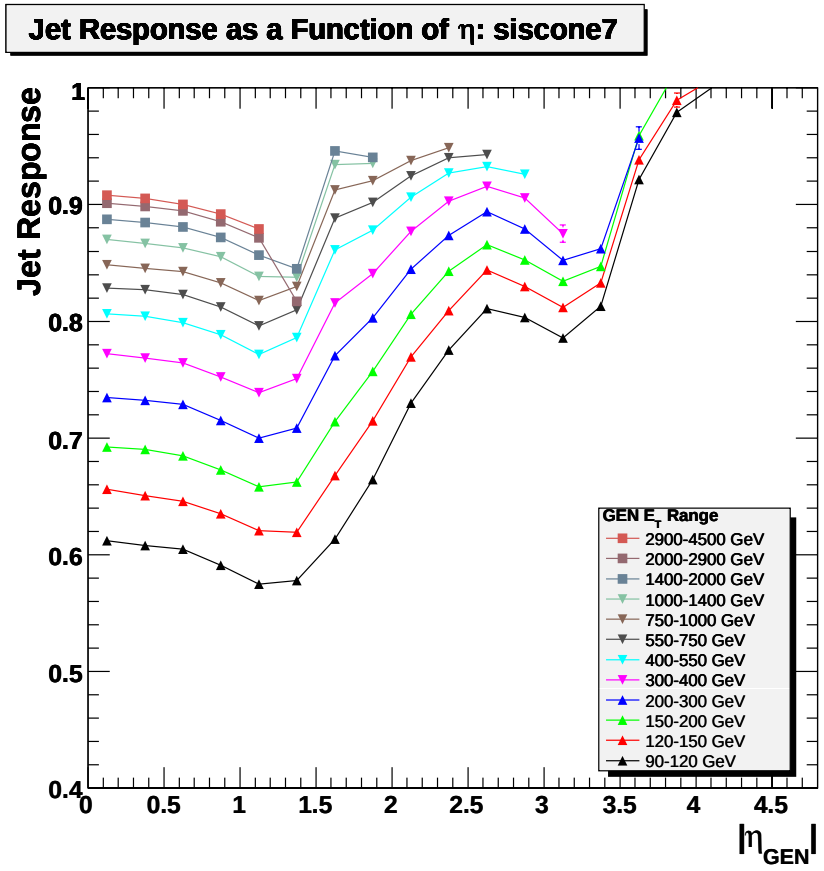
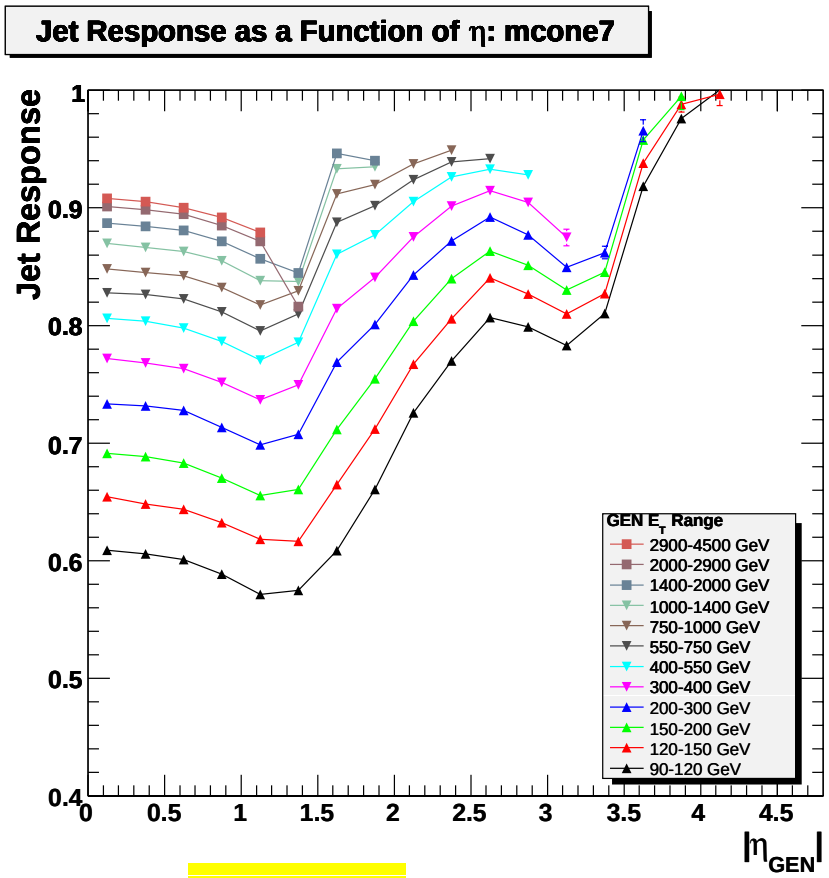
Response vs η: R=0.7

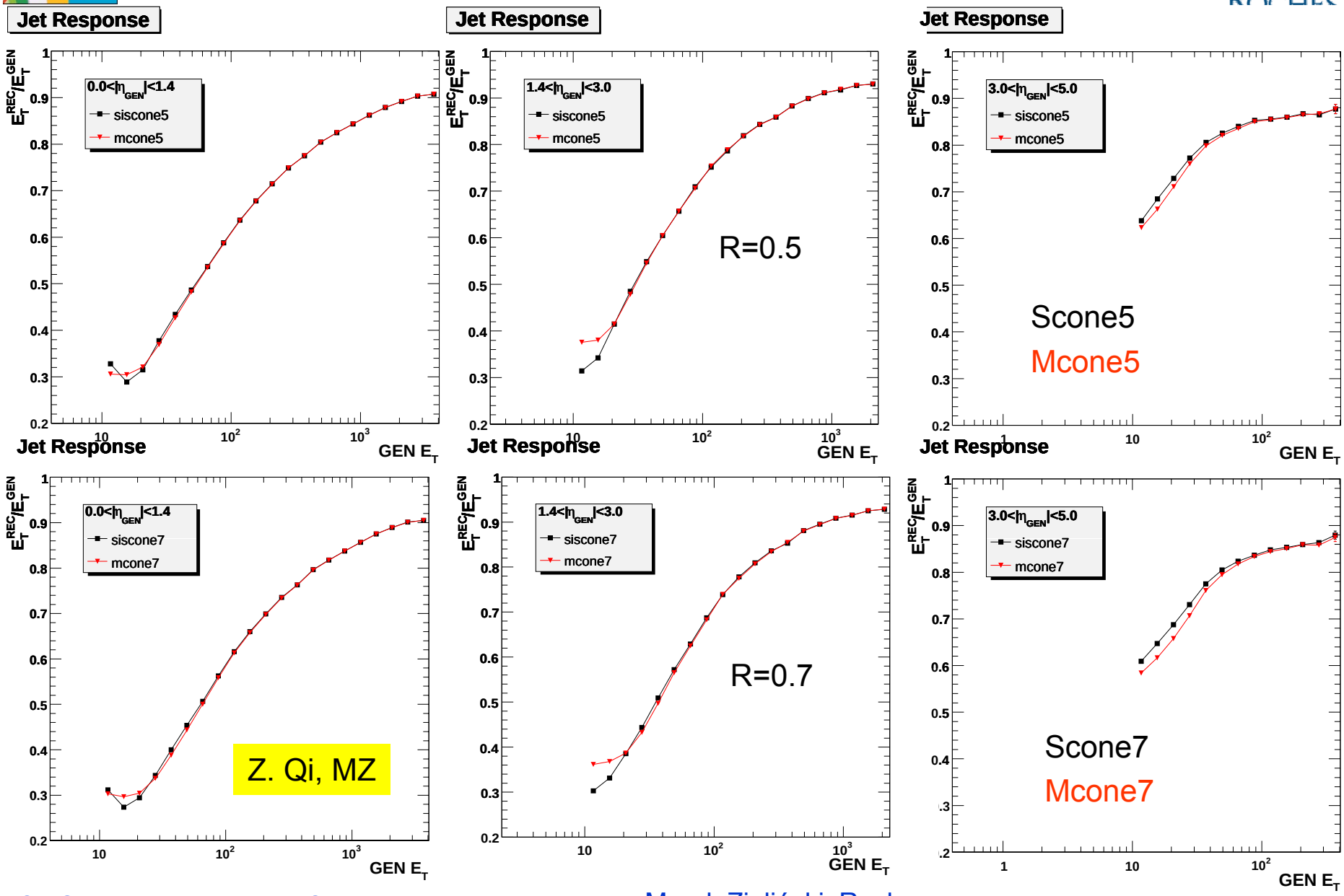
- Pretty close comparisons again





Z. Qi, MZ

Response vs E_T



MCJet Corrections for CMSSW 152

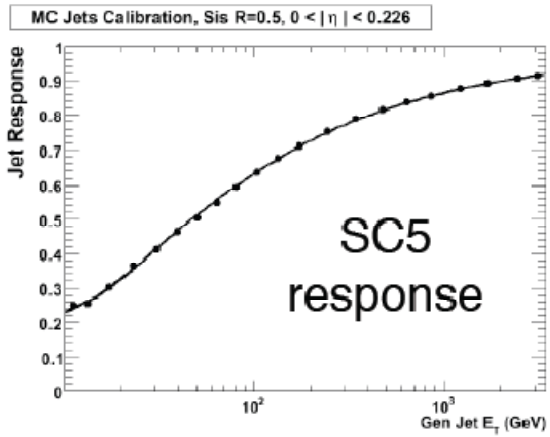
- Corrections to particle level based on QCD MC
  - ~1M events produced with CMSSW 152
- Corrections available for:
  - ICone5, ICone7, MCone5, MCone7, KT6
  - "Unofficially" for: SCone5 and SCone7 using same techniques
  - Accurate within a few %, except for ET<30 GeV

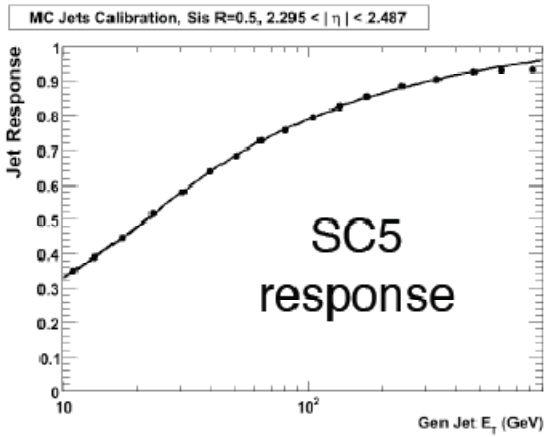
- Based on gaussian fits to the response:

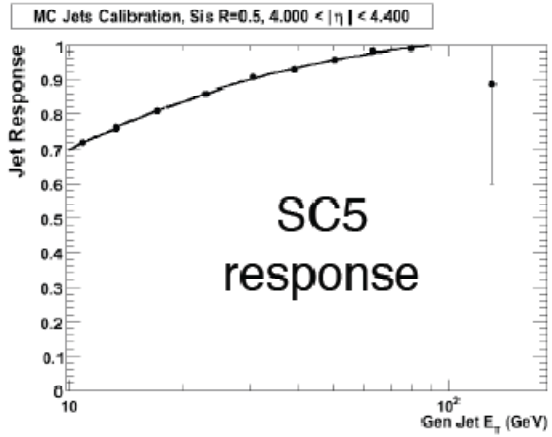
$$E_T^j(\text{Calo})/E_T^j(\text{Gen})$$

- Response functions are obtained for several $|\eta|$ bins as a function of $E_T(\text{Gen})$
  - Converted to corrections as a function of $E_T(\text{Calo})$

Scone MCJet Energy Corrections







Barrel
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Endcap
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Forward
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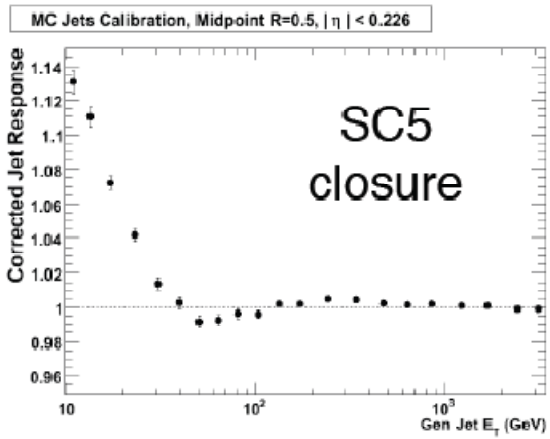

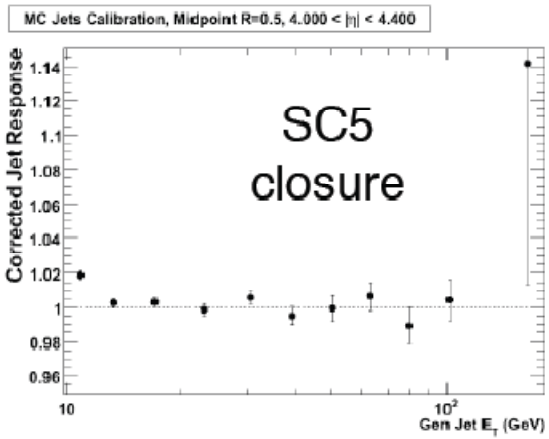

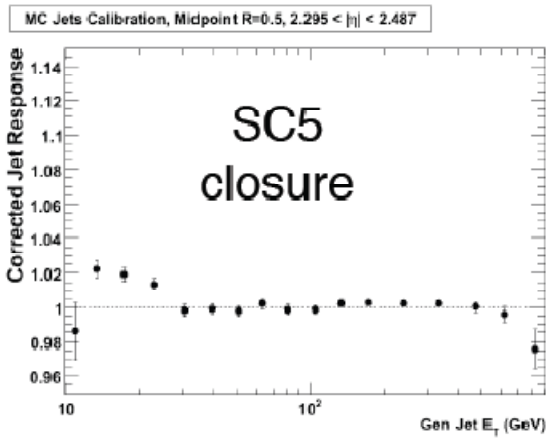

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Applying the Corrections

- source /uscmst1/prod/sw/cms/setup/cshrc prod
- scramv1 project CMSSW CMSSW_1_6_0
- cd CMSSW_1_6_0/src
- cmscvsroot CMSSW
- cvs co -r jet_corrections_16X JetMETCorrections/MCJet/data
- cvs co -r jet_corrections_16X RecoJets/JetAnalyzers
- scramv1 b
- eval `scramv1 runtime -csh`
- cd RecoJets/JetAnalyzers/test
- cmsRun CorJetsExample.cfg (for official jet algorithms)
- cmsRun CorJetsSisConeExample.cfg (including SisCone)

- See also
  - K. Kousouris talk in JetMET, 4 Oct 2007
  - https://hypernews.cern.ch/HyperNews/CMS/get/JetMET/207.html
  - The root files used for derivation of corrections are also available
    - Include Scone5 and Scone7, in addition to the usual algorithms

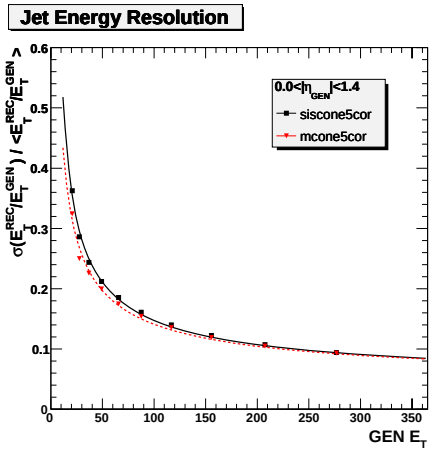
Scone vs Mcone: Methodology

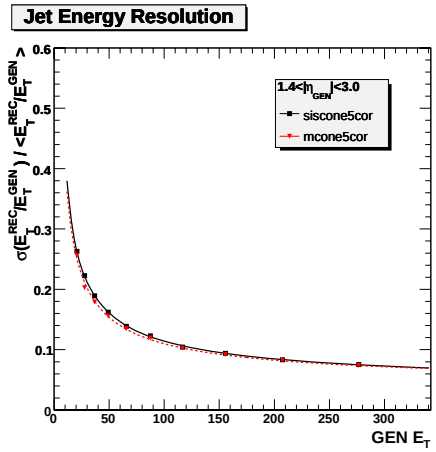
- Find matched pairs of Gen and Calo jets within $\Delta R<0.3$
- Obtain:
  - Raw energy response (already shown) and
  - Resolution of corrected energy
    - After respective MCJet corrections

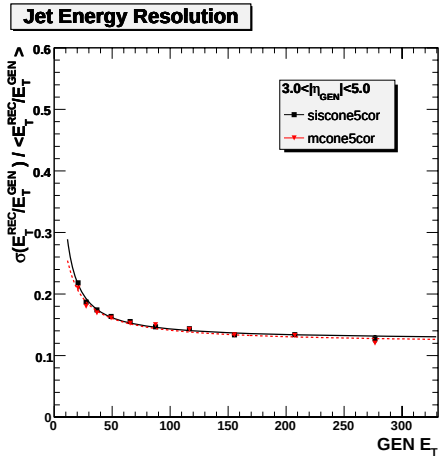
  from Gaussian fits to raw or corrected response
  - Over the range (mean-1.5*RMS, mean+1.5*RMS)
  - Low-ET distributions may have non-gaussian tails → use the gaussian core to compare performance
- Similarly, obtain position resolutions from fits to
  - $\Delta\phi = \phi_{calo} - \phi_{gen}$
  - $\Delta\eta = |\eta_{calo}| - |\eta_{gen}|$
- Resolutions vs ET were fit with the form $\text{Resolution} = \frac{a}{E_T} \oplus \frac{b}{\sqrt{E_T}} \oplus c$
  - But more important are comparisons of the data points

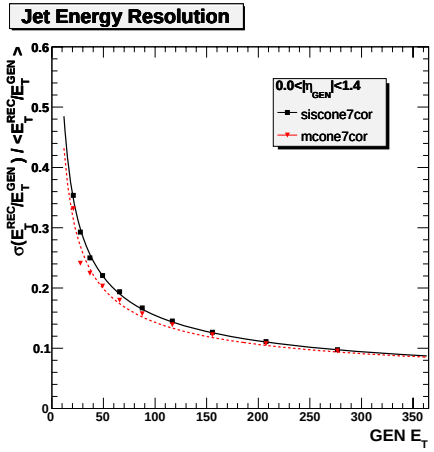
ET Resolutions

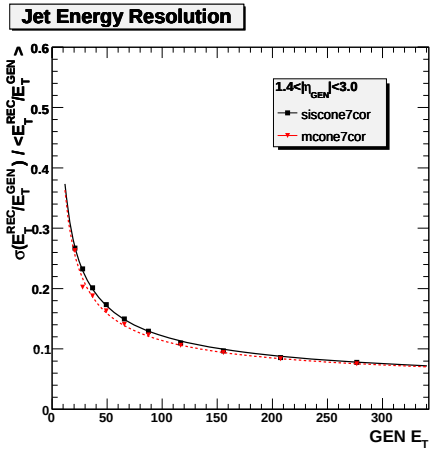
- Is Scone resolution slightly worse, esp. in the Barrel?

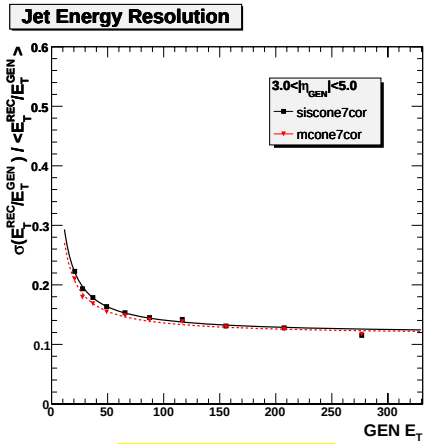






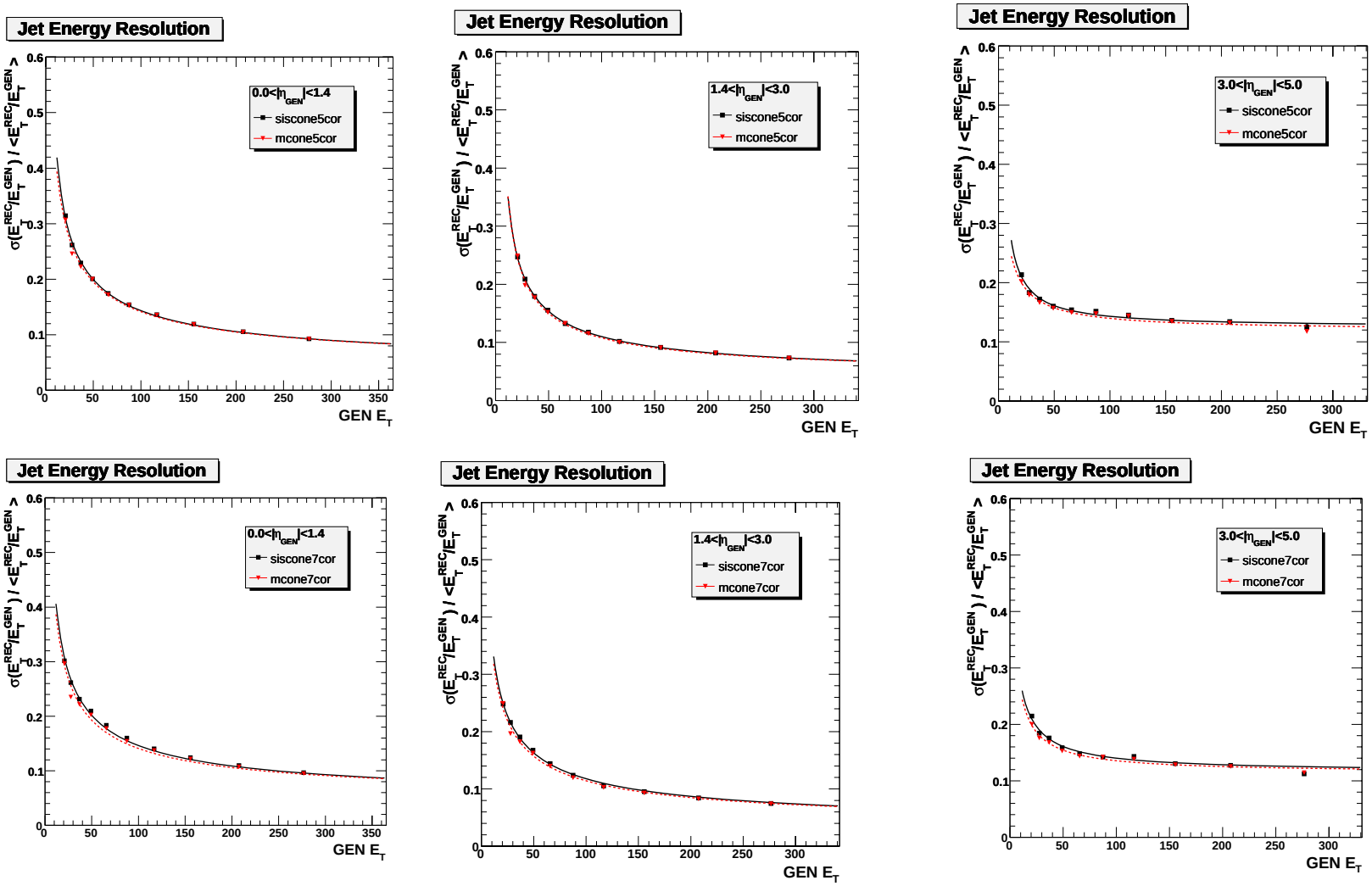






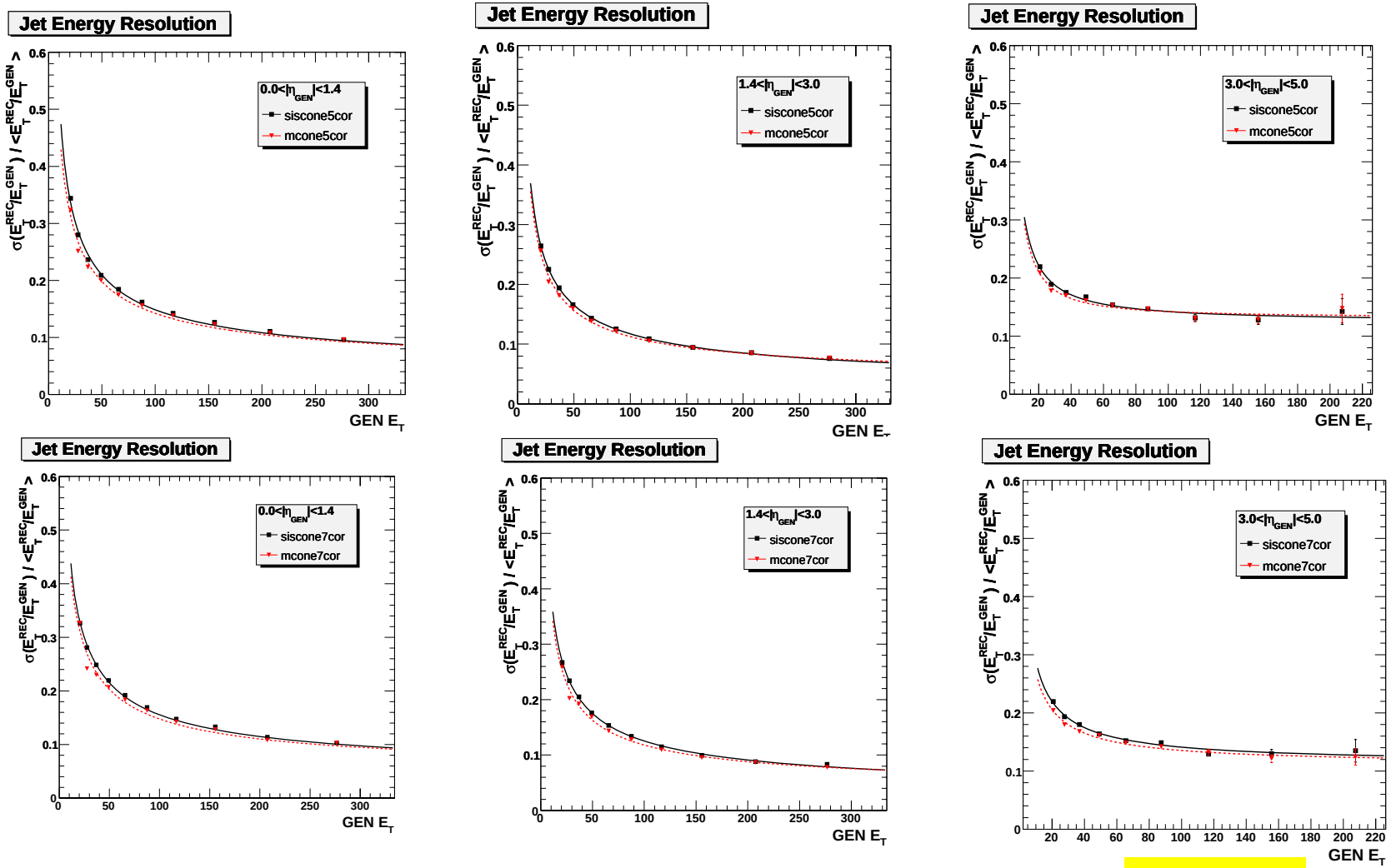
ET Resolution: Two Leading Jets

- Very close agreement for the leading jets



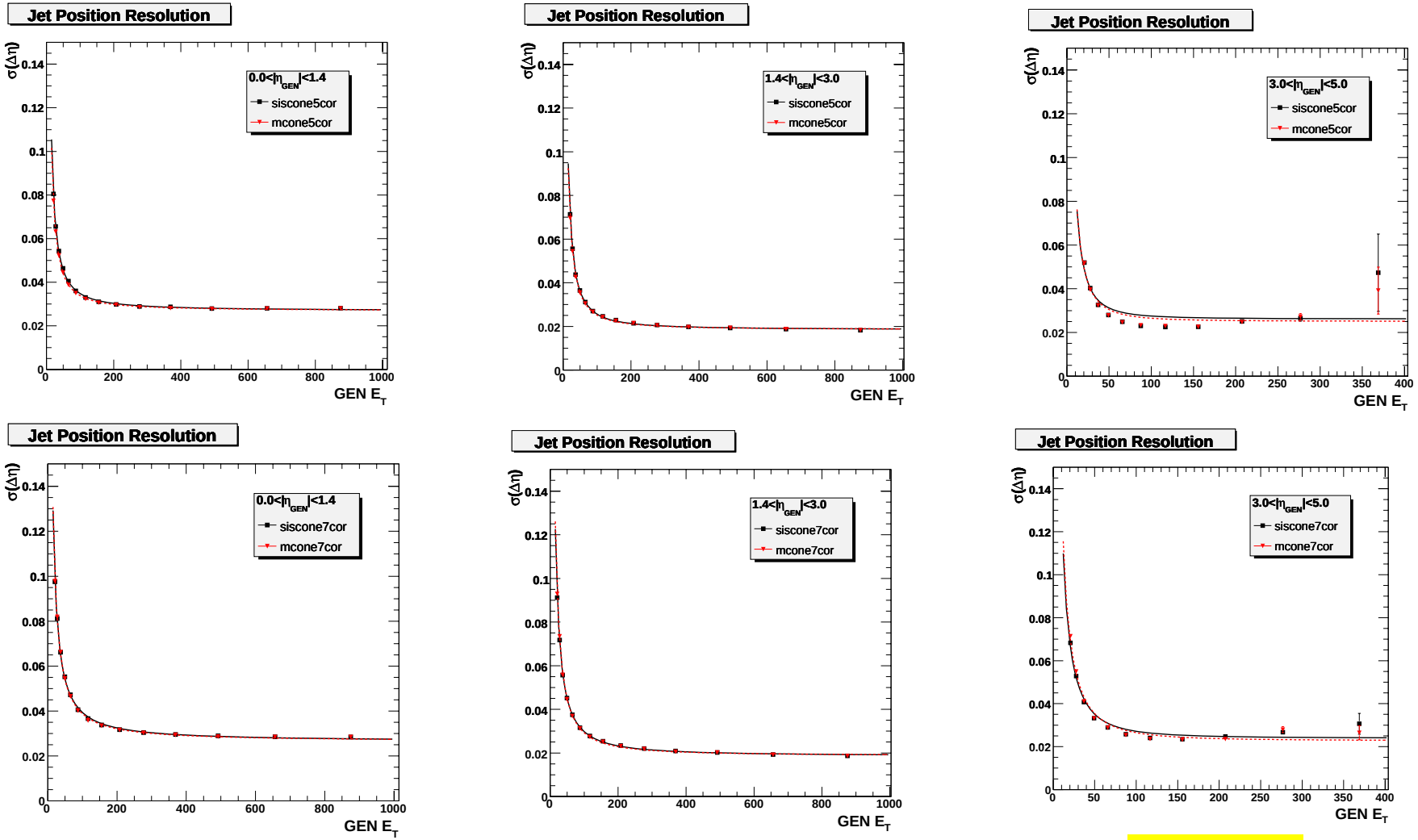
ET Resolution: 3rd Jet

- Slight difference seen for higher-rank jets



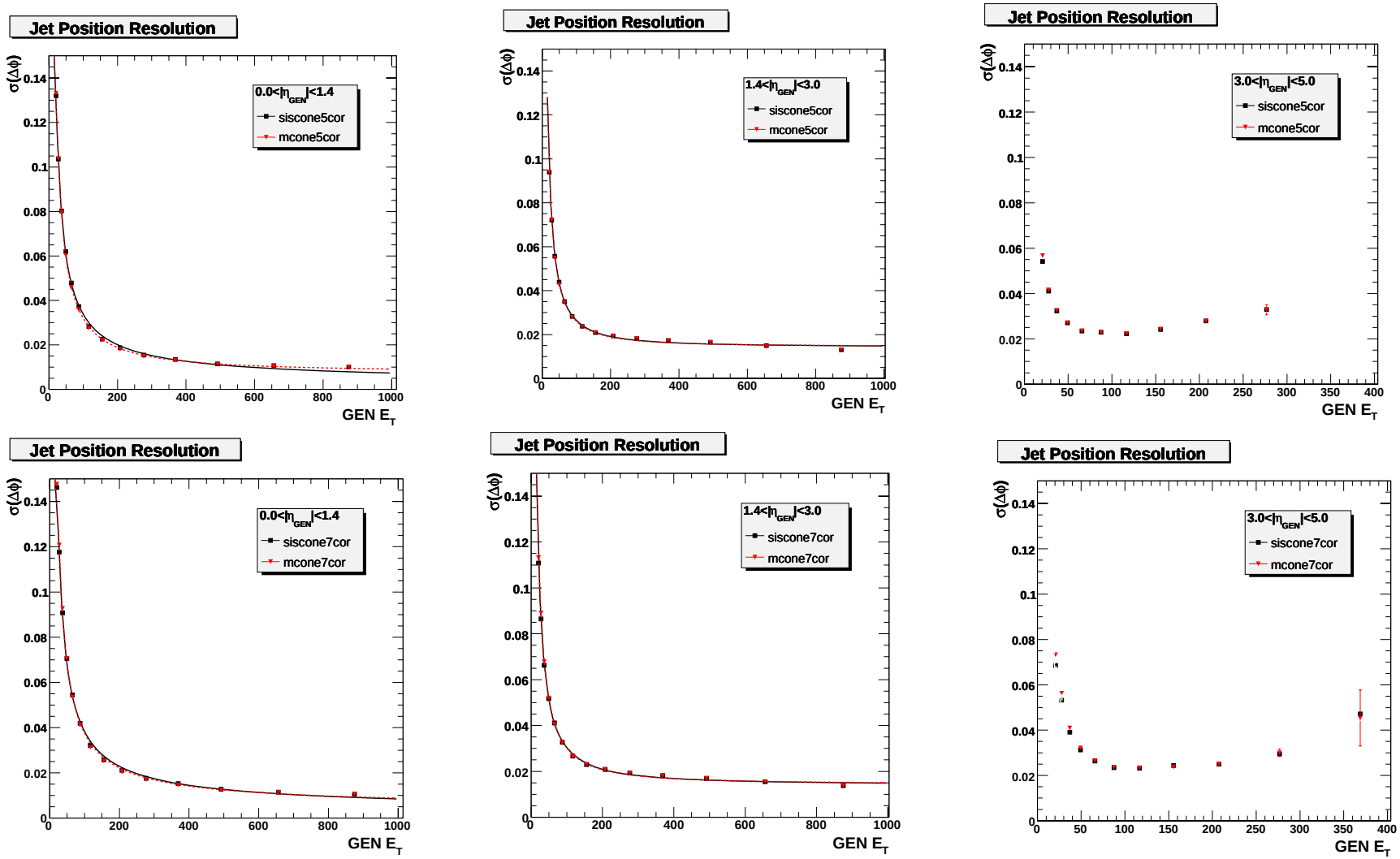
Position Resolution: η

- Very close comparison



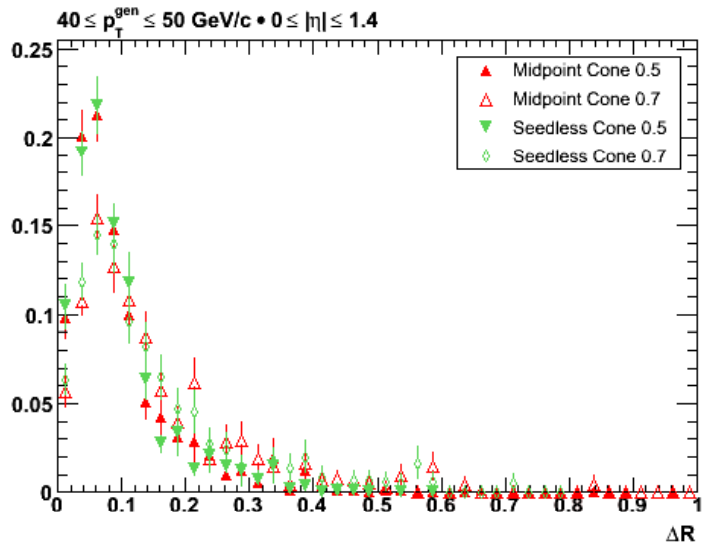
Position Resolution: ϕ

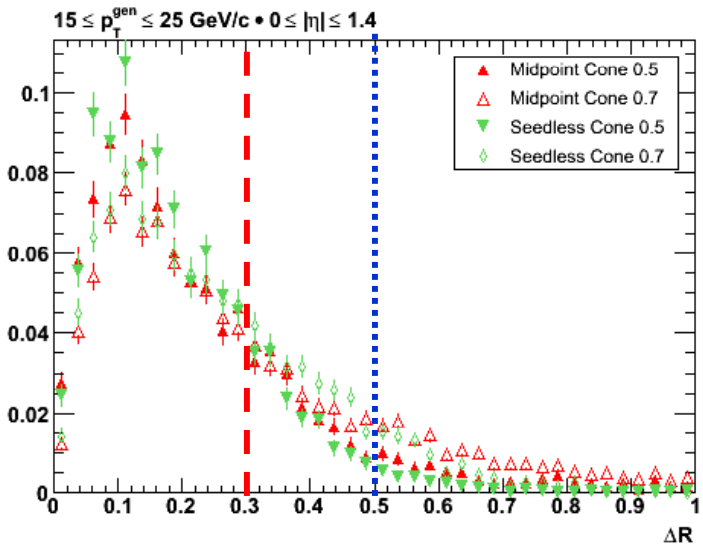
- Good agreement for ϕ resolutions as well

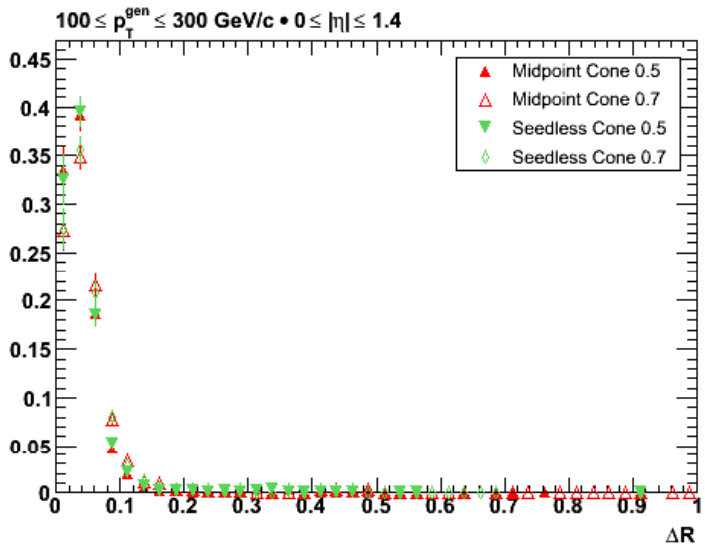


ΔR Matching Comparisons

- Jet "efficiencies" are usually derived as fraction of Gen jets matched to Calo jets within ΔR
  - ➔ "standard ΔR=0.3 works well for pT>50 GeV, but not at low pT, due to broad position resolutions
- ΔR distributions similar for Scone and Mcone

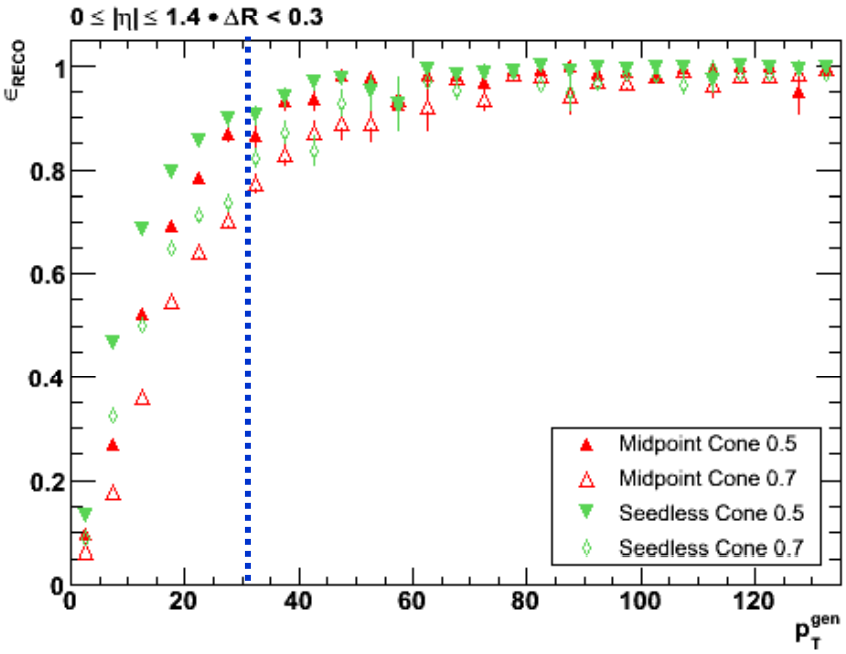


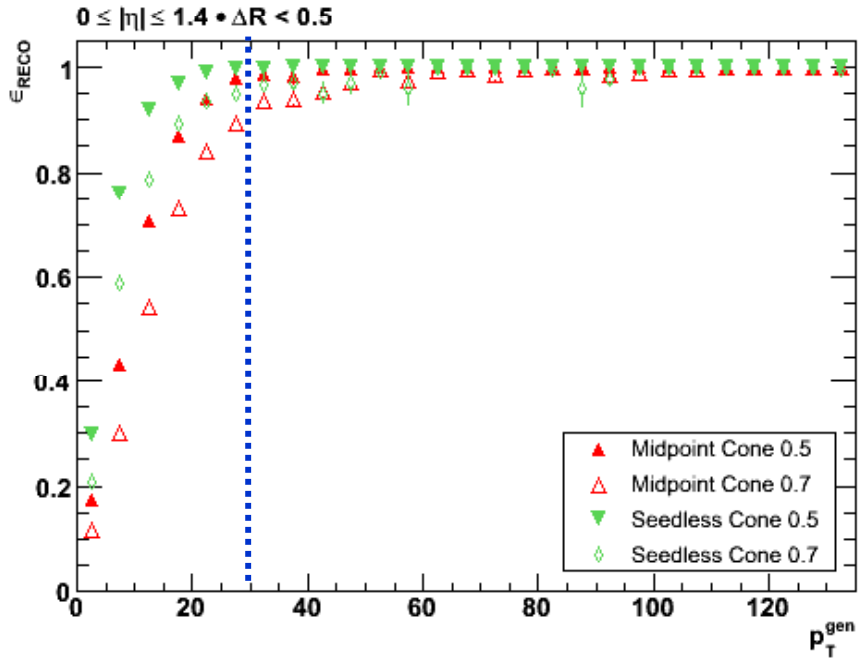




Efficiency vs p_T

- Scone efficiencies are higher than for Mcone
  - ➔ Absolute values higher for larger ΔR matching cut

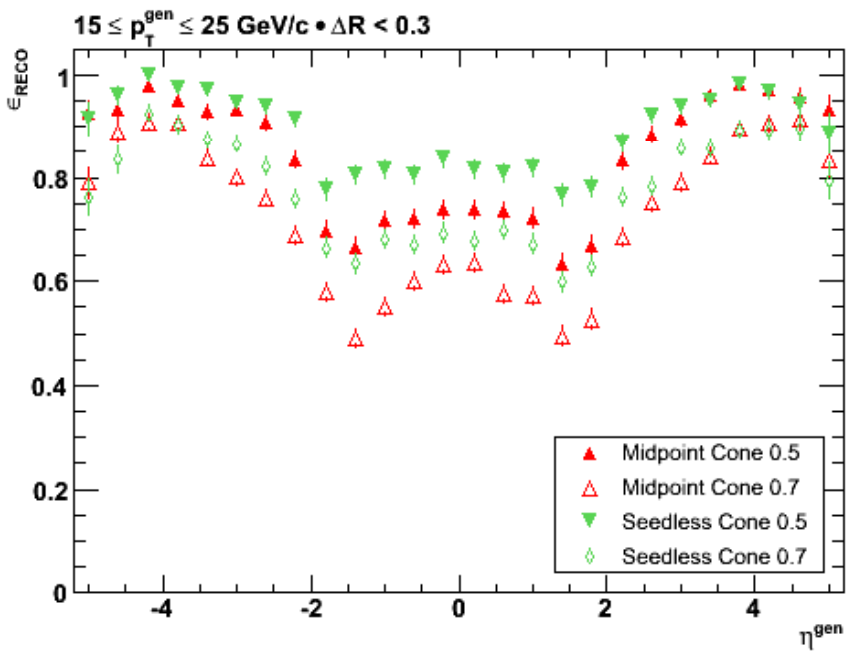


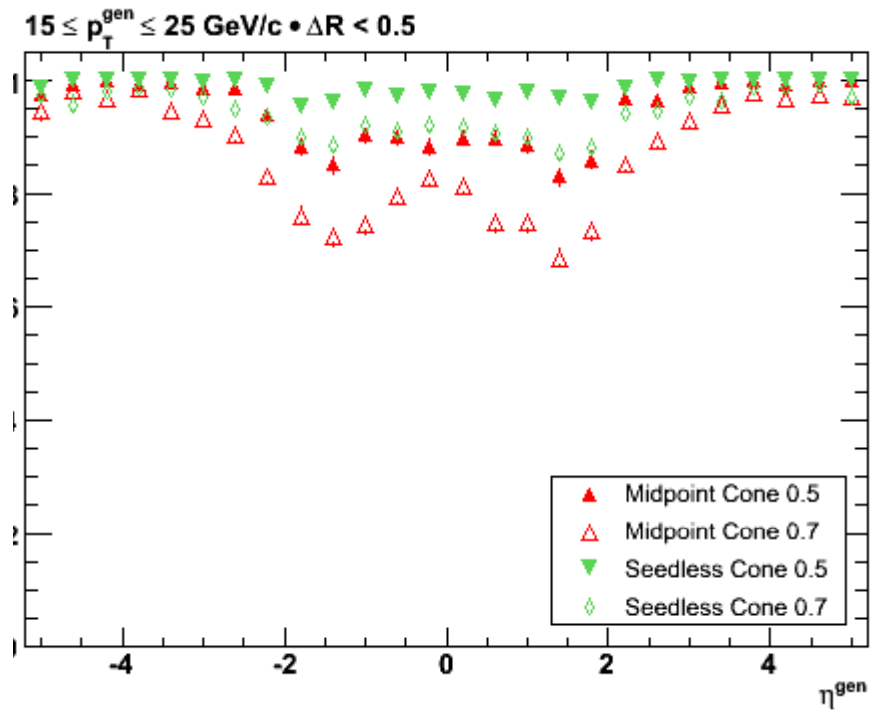


C. Dragoiu, NV

Efficiency vs η

- Scone efficiencies are higher than for Mcone
  - ➔ Is this due to reconstructing more low p_T jets?
  - ➔ Apply p_T cut on corrected calo jets → next





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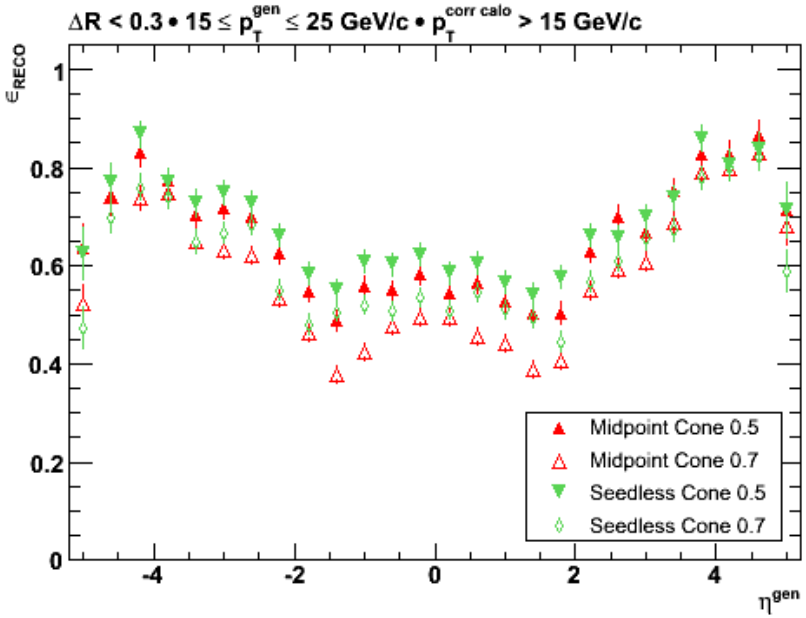
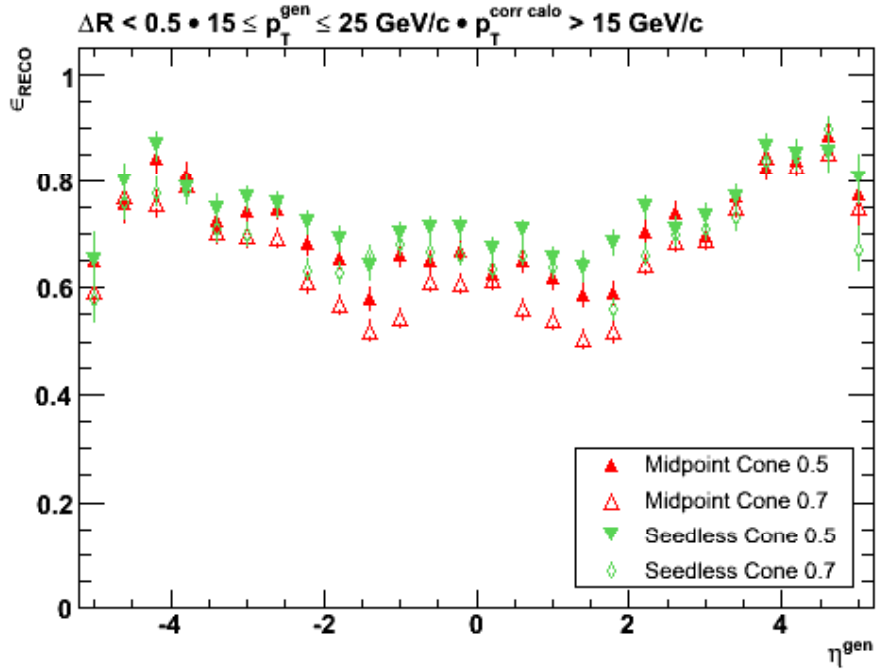
Efficiency vs η with p_T^{corr} > 15 GeV

- Scone efficiencies are still higher than for Mcone
  - ➔ Absolute values are lower than before due to the effects of the cut



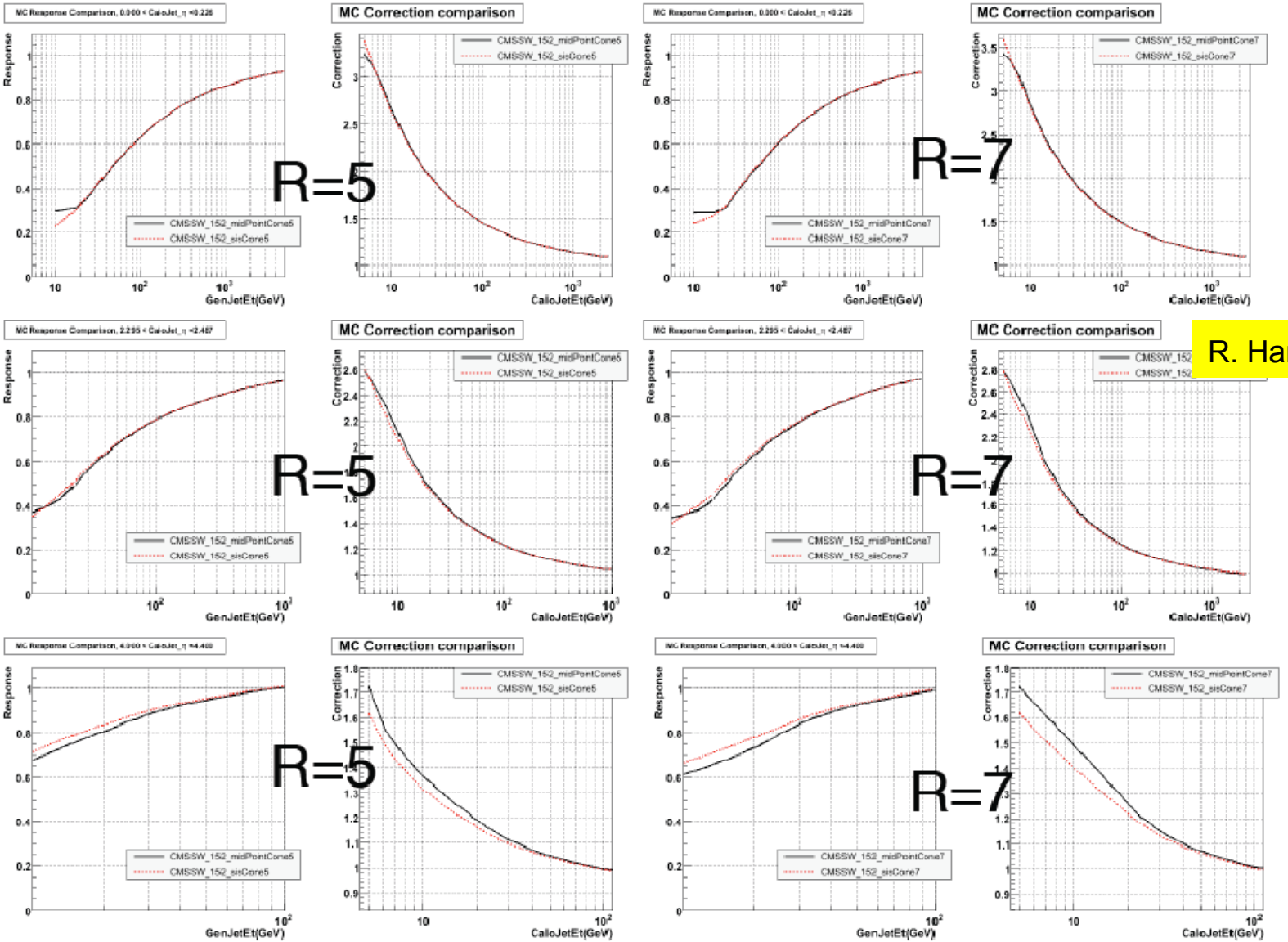


Summary and Proposal

- 152 jet energy corrections available for SISCone and several other algorithms
- SISCone performance similar to MidPoint (of same R)
  - ➔ Energy response
  - ➔ ET resolutions (SISCone seems slightly worse for 3rd jets and higher)
  - ➔ Position resolutions
  - ➔ Efficiencies (SISCone better without and with jet p_T cut)
- Proposal:
  1. Include SISCone in the production path from CMSSW 170
     - → This will provide RelVal and other limited samples for physics studies
  2. Collect feedback from PAG's
  3. Finally, decide which algorithms to keep in production
     - → If no negatives found, switch to SISCone

Extras

Response: Scone vs MCone



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R. Harris, K. Kousouris

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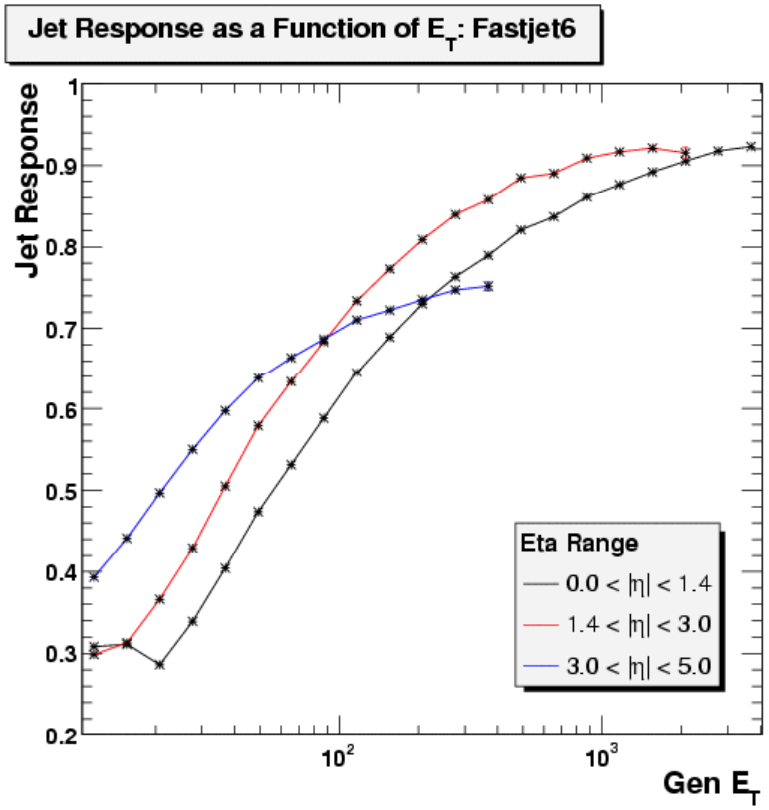
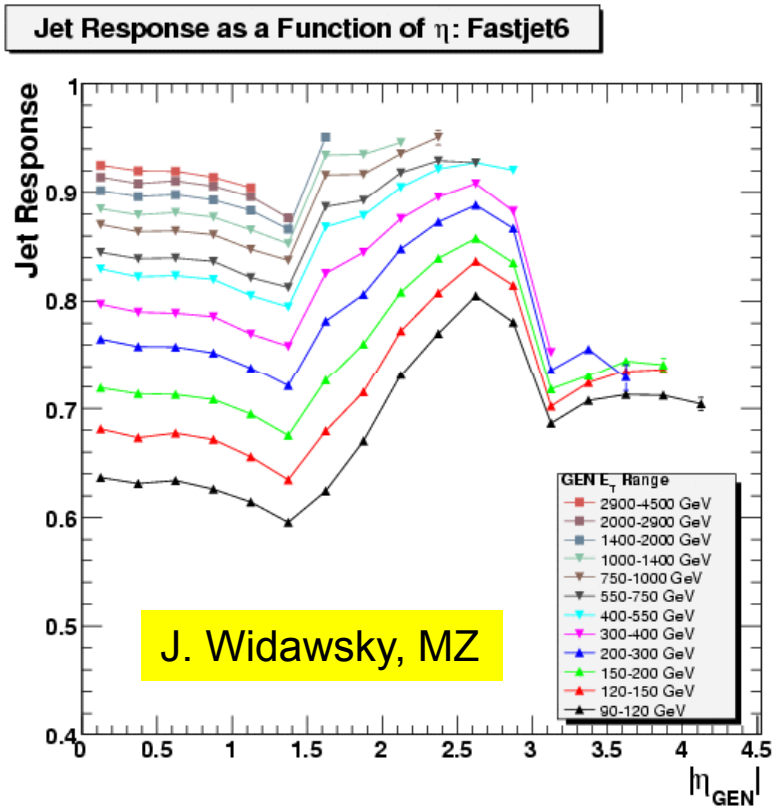
kT Response (131)

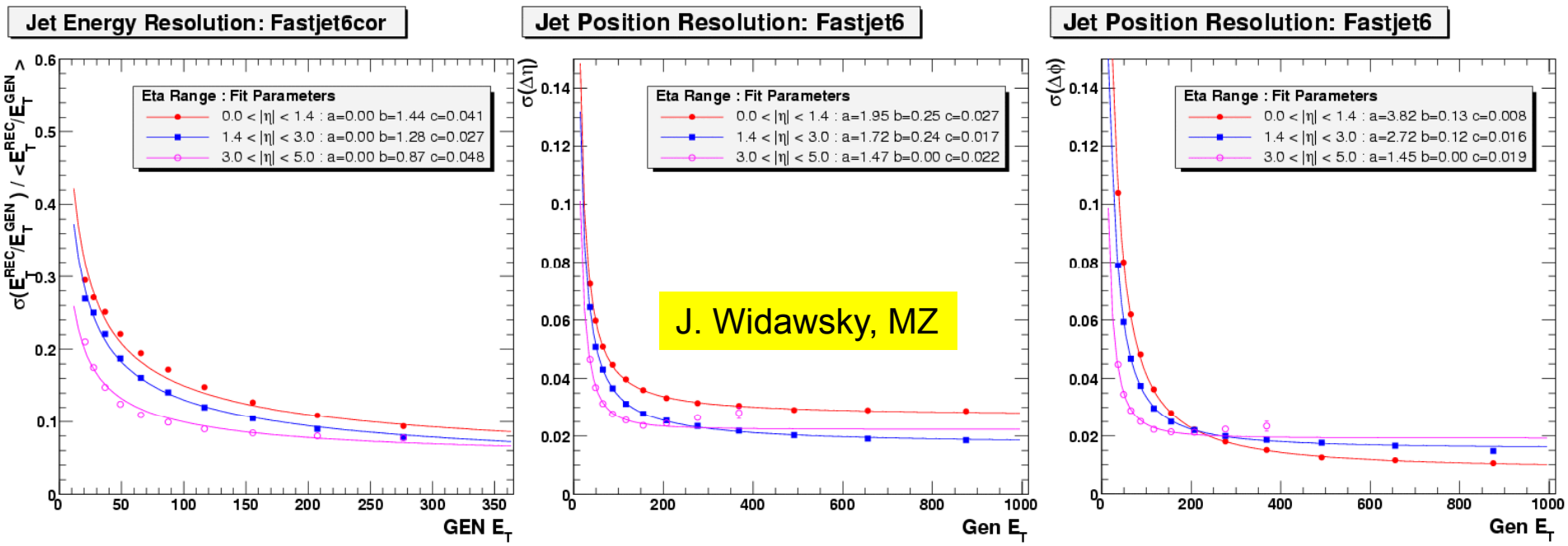
- (FastJET) kT performance in Spring07 QCD samples, D=0.6
  - Results provided for all algorithms in standard production
  - kT performance note in preparation (Monica et al.)





kT Resolutions (131)

$$\text{Resolution} = \frac{a}{E_T} \oplus \frac{b}{\sqrt{E_T}} \oplus c$$

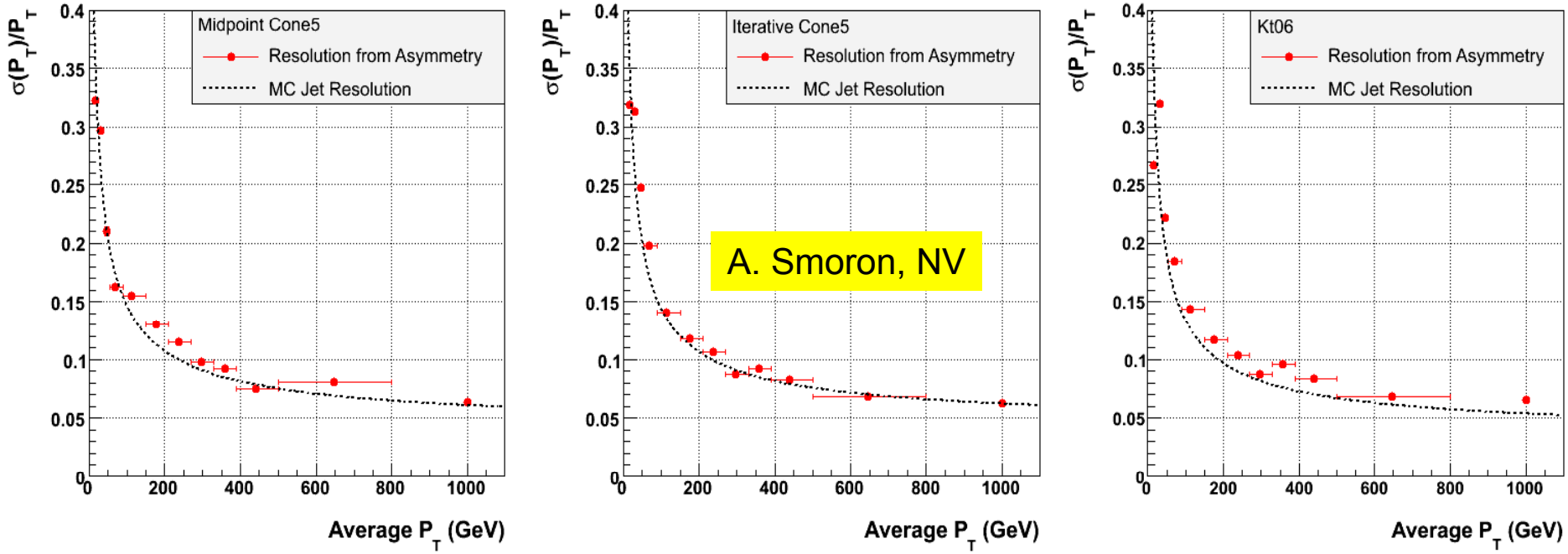


J. Widawsky, MZ

- Spring07 MCJet energy corrections applied
- Fit parameters for all resolution curves are provided
- Other aspects being studied by P. Schieferdecker

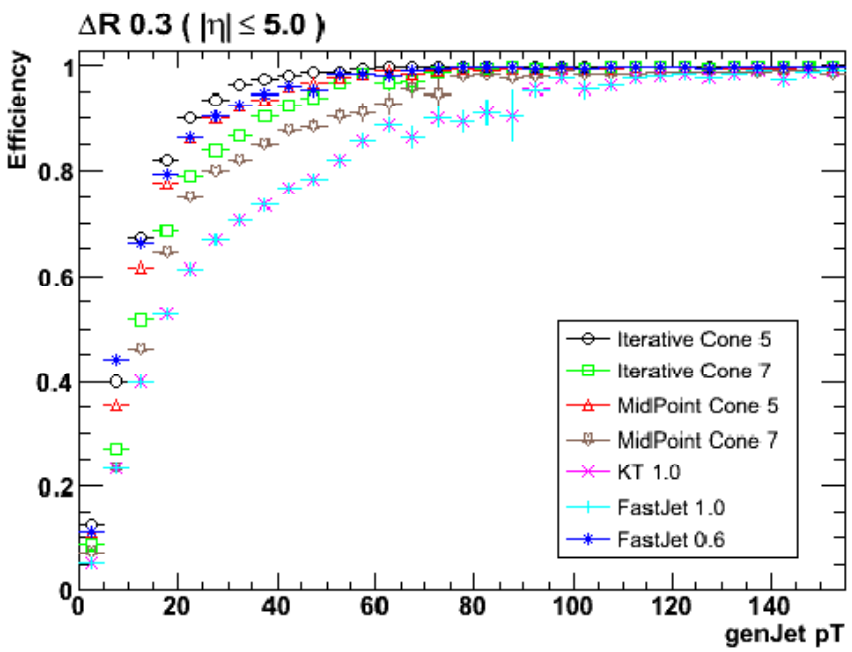
"Data-Based" Jet Resolutions (131)

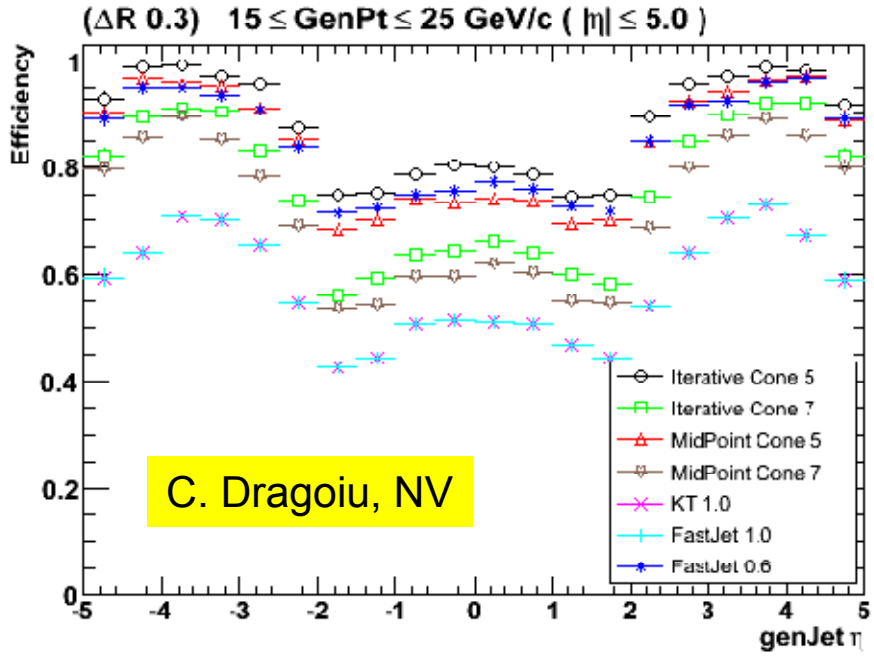
- Based on studies of "E_T asymmetry" of two leading jets
  - Can be applied to real data!
    - Asymmetry $A = (E_T^{jet1} - E_T^{jet2})/(E_T^{jet1} + E_T^{jet2})$
    - The fractional energy resolution: $\sigma(E_T)/E_T = \sqrt{2}\,\sigma_A$
    - The resolution is plotted vs 3rd jet E_T and extrapolated to $E_T^{jet3} = 0$
    - Finally, the particle level resolution is subtracted
  - Reasonable agreement with MC-truth results

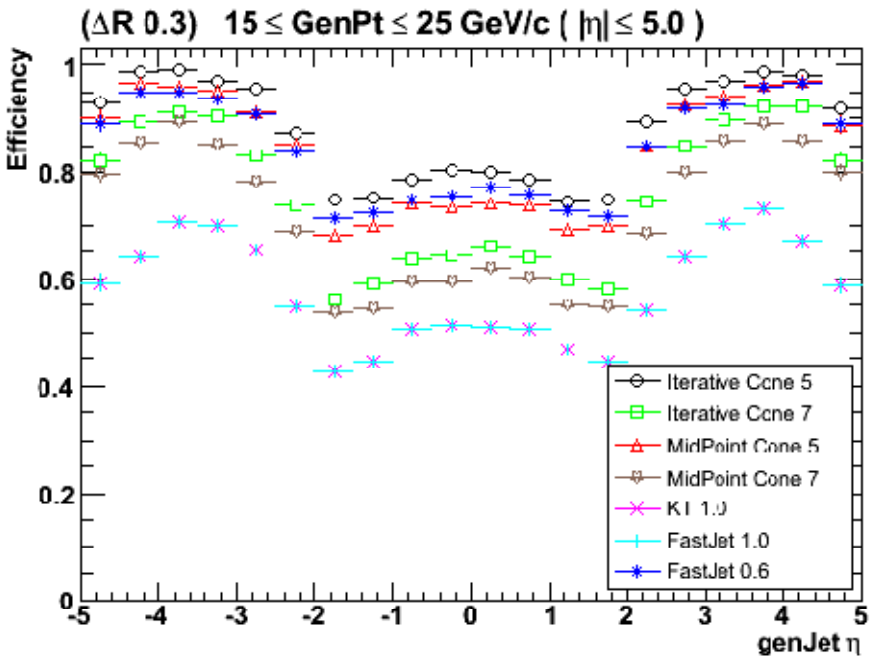
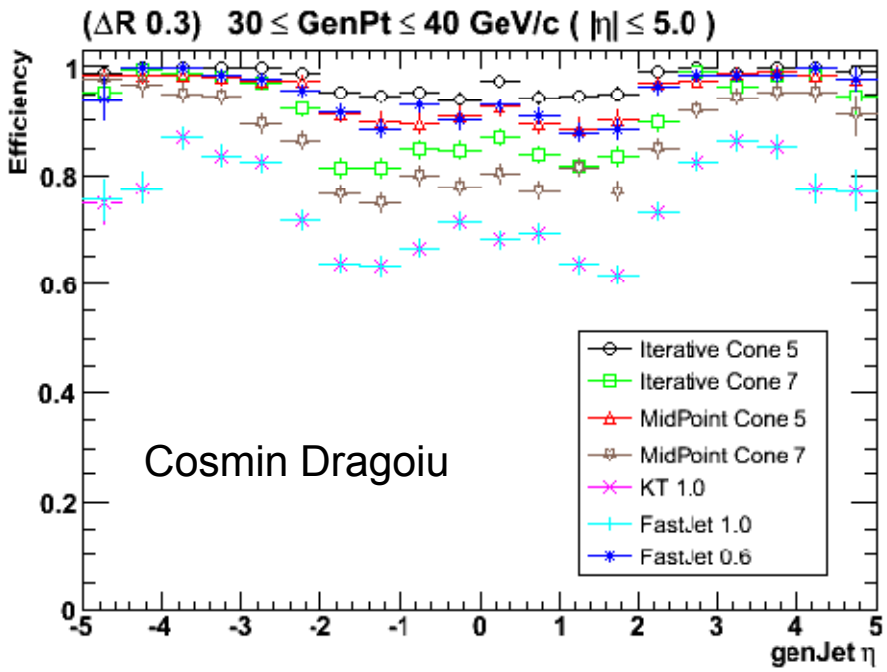


Jet Efficiency Studies (131)

- Differences of efficiencies between algorithms observed
  - Traced to different amount of energy collected (esp. for GenJets)
  - Efficiencies much more similar when using “common denominator”, ie. same genJet algorithm in matching to various CaloJets
  - Causes for efficiency loss in the Barrel under investigation
  - Studies of fake rates started





Jet Efficiency Studies (131)

- Reasons for lower efficiency in the Barrel under investigation
  - Above p_T ~ 100 GeV efficiencies flat at ~1.0