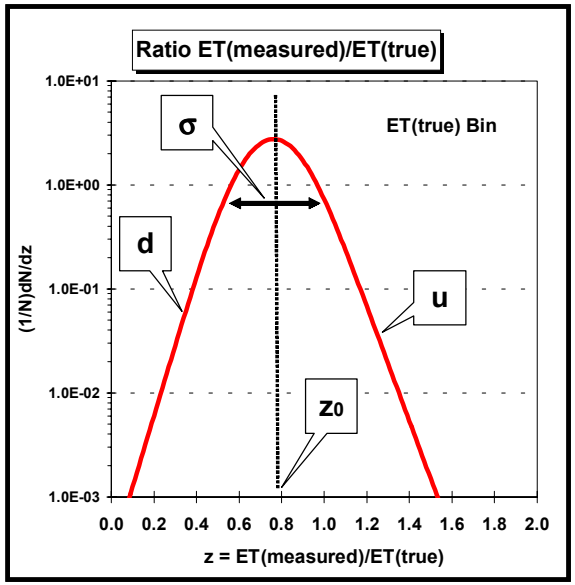
More Run 2 Response Functions

"Response Function"



- **Look at the "probability density", R(z, ET(true)), where z = ET(measured)/ET(true) as a function of ET(true).**
- **For a given bin in ET(true) parameterize R(z) according to (*as described by Jay Dittmann*)**

$$R(z) = \frac{1}{2|u|} e^{\frac{\sigma^2}{2u^2}} e^{-(z-z_0+d/2)/u-\frac{1}{2}} \left[1 - Erf\left(\frac{\sigma}{u} - \frac{z-z_0}{\sigma} - \frac{u+d}{2\sigma} \right) \right]$$

$$+ \frac{1}{2|d|} e^{\frac{\sigma^2}{2d^2}} e^{-(z-z_0+u/2)/d-\frac{1}{2}} \left[Erf\left(\frac{\sigma}{d} - \frac{z-z_0}{\sigma} - \frac{u+d}{2\sigma} \right) \right]$$

- **Note that σ > 0, u > 0, d < 0 and**

$$\int_{-\infty}^{\infty} R(z)dz = 1 \qquad \int_{-\infty}^{\infty} zR(z)dz = z_0$$

Average value of z!

- **Fit z_0, s, u, and d as a function of ET(true) to get an analytic representation of R(z,ET(true)).**
- **First use PYTHIA Tune A (and then HERWIG) to determine R(z,ET(true)).**

ET(true) and ET(measured)

Have the other rapidity ranges as well!

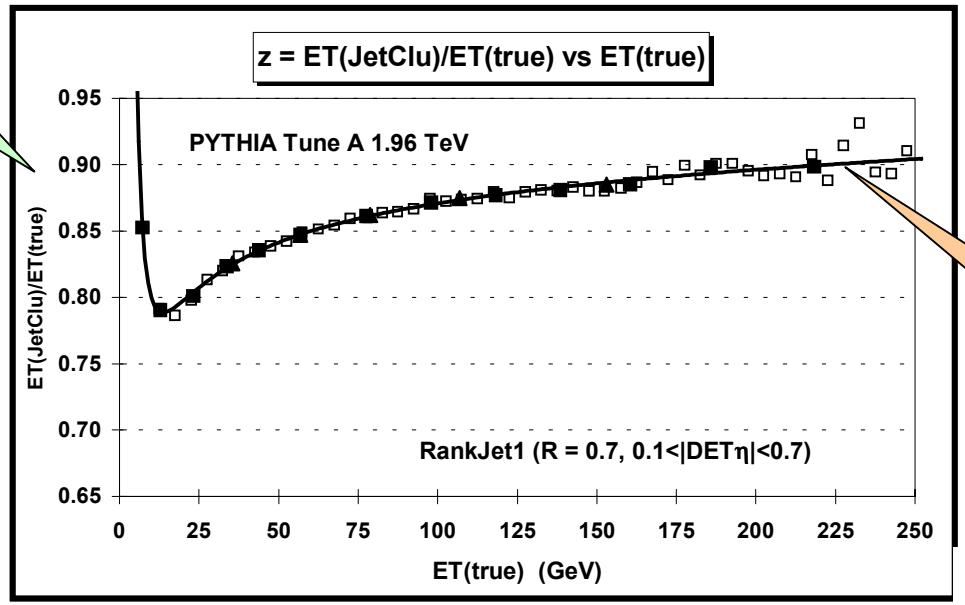
Inclusive Cross-Section

- In this analysis ET(measured) = ET(jetclu, R = 0.7).
- Case I: ET(true) = Scalar PTsum of all particles (charged + neutral, all pT) in R = 0.7 cone around a calorimeter JetClu Jet.
  - RankJet1 = highest ET(jetclu) jet in the calorimeter, but only include the event if it is in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet1 = highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet2 = 2nd highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet3 = 3rd highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - All GoodJets = all calorimeter jets in the rapidity range 0.1 < |DETη|<0.7.
- Case II: ET(true) = Scalar PTsum of all partons in R = 0.7 cone around a calorimeter JetClu Jet.
  - RankJet1 = highest ET(jetclu) jet in the calorimeter, but only include the event if it is in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet1 = highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet2 = 2nd highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - GoodJet3 = 3rd highest ET(jetclu) in the rapidity range 0.1 < |DETη|<0.7.
  - All GoodJets = all calorimeter jets in the rapidity range 0.1 < |DETη|<0.7.
- Case III: Construct "particle jets" at the generator level (*i.e.* GenJets) using "Field-Stuart" cone algorighm and ET(true) = GenJetPT = Scalar PTsum of all particles (charged + neutral, all pT) in the "jet".
  - GenMatch1-2 = calorimeter jets in the rapidity range 0.1 < |DETη|<0.7 that match (*i.e.* closest and within R = 0.4) the leading two GenJets.

Case I RankJet1: Average value of z = ET(JetClu)/ET(true)

Previous results were for Case I RankJet1!

Shows z_0 = <z> versus ET(true)



Solid curve is a fit!

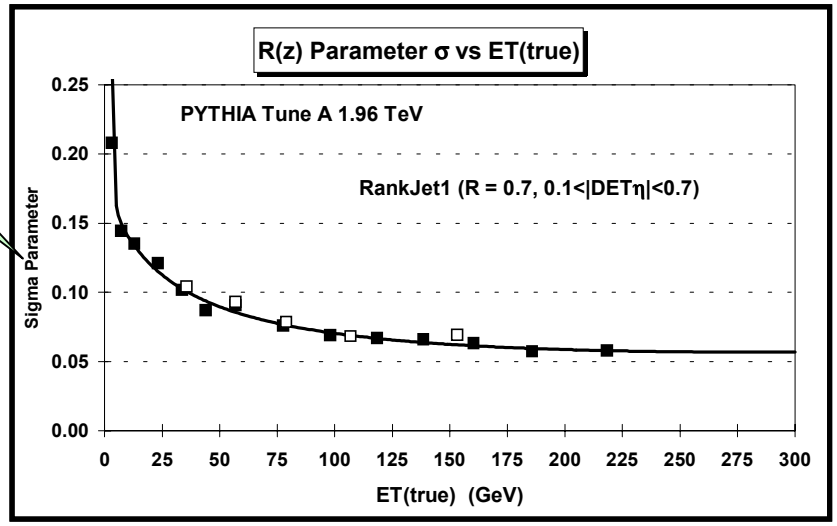
The solid triangles (above) correspond to the old 5 bins and the solid squares correspond to the new 14 bins:

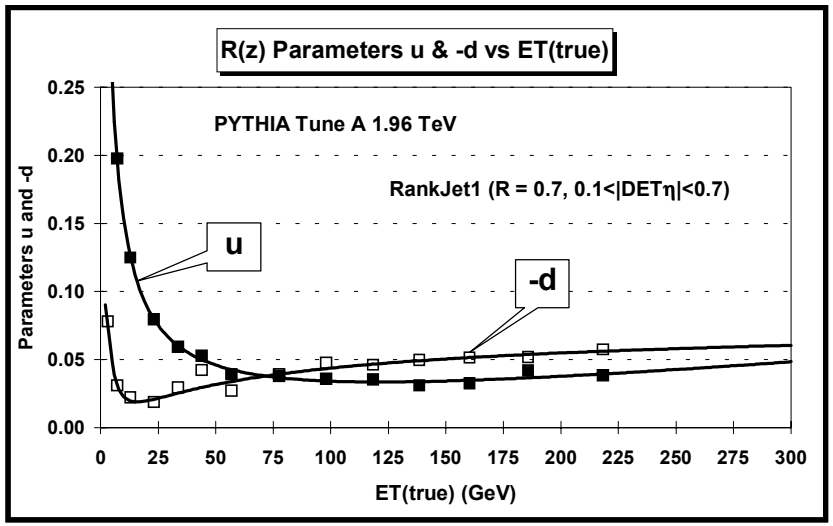
Old ET(true) Bins
30 – 50 GeV
50 – 70 GeV
70 – 95 GeV
95 – 135 GeV
135 – 250 GeV

New ET(true) Bins
0 - 5 GeV
5 – 10 GeV
10 – 20 GeV
20 – 30 GeV
30 – 40 GeV
40 – 50 GeV
50 – 70 GeV
70 – 90 GeV
90 – 110 GeV
110 – 130 GeV
130 - 150 GeV
150 – 175 GeV
175 – 200 GeV
200 – 250 GeV

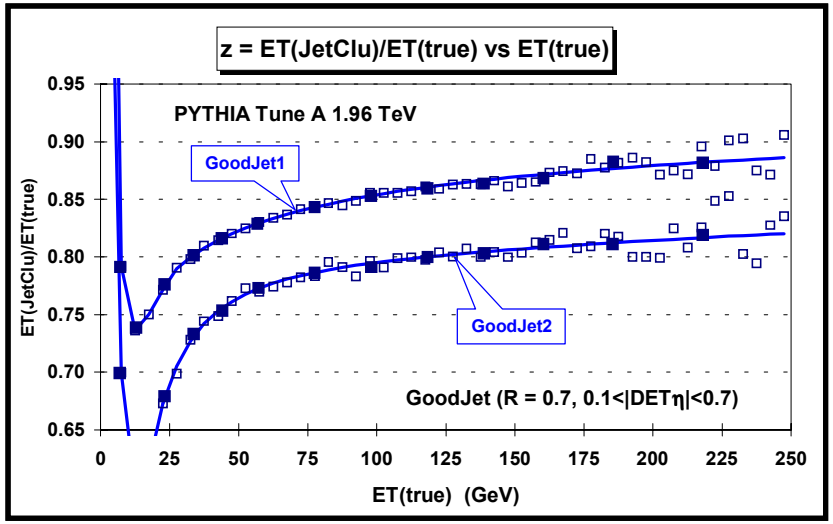
Case I RankJet1: Other "Response Function" Parameters

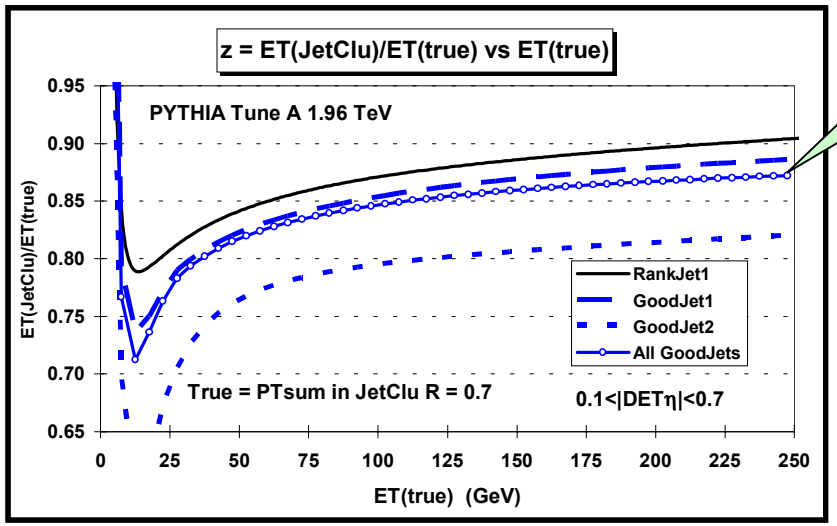
Parameter σ





Case I GoodJet1-2: Average value of z = ET(JetClu)/ET(true)

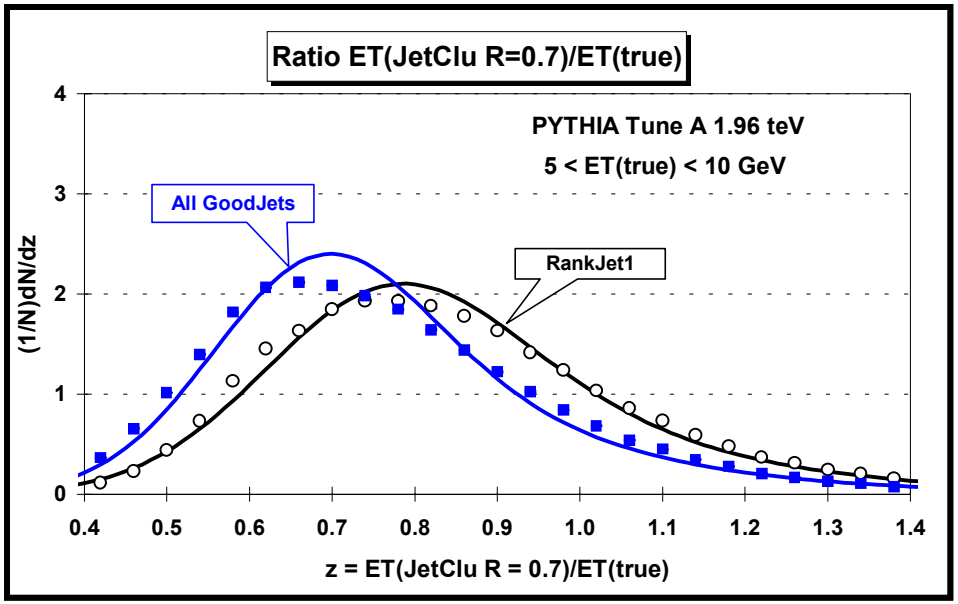


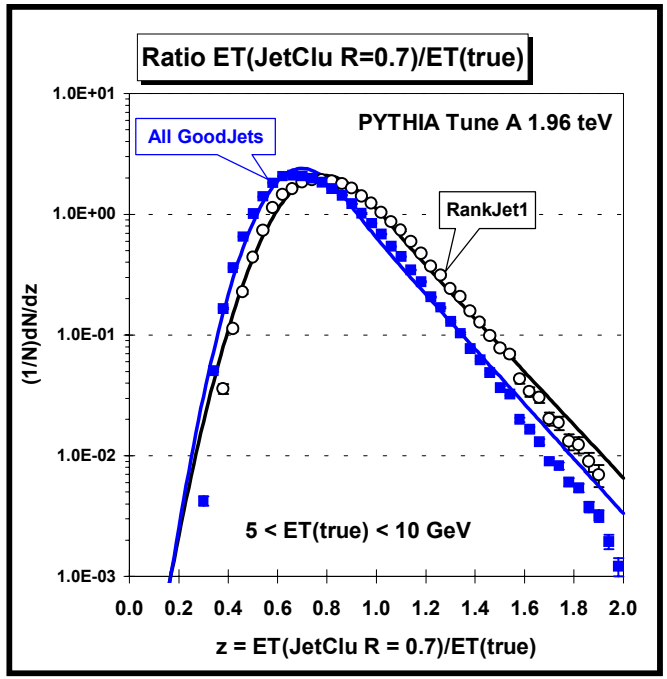


Case 1 All GoodJets!

Case I All GoodJets: "Response Function" for 5 < ET(true) < 10 GeV

<ET(true)> = 7.2 GeV



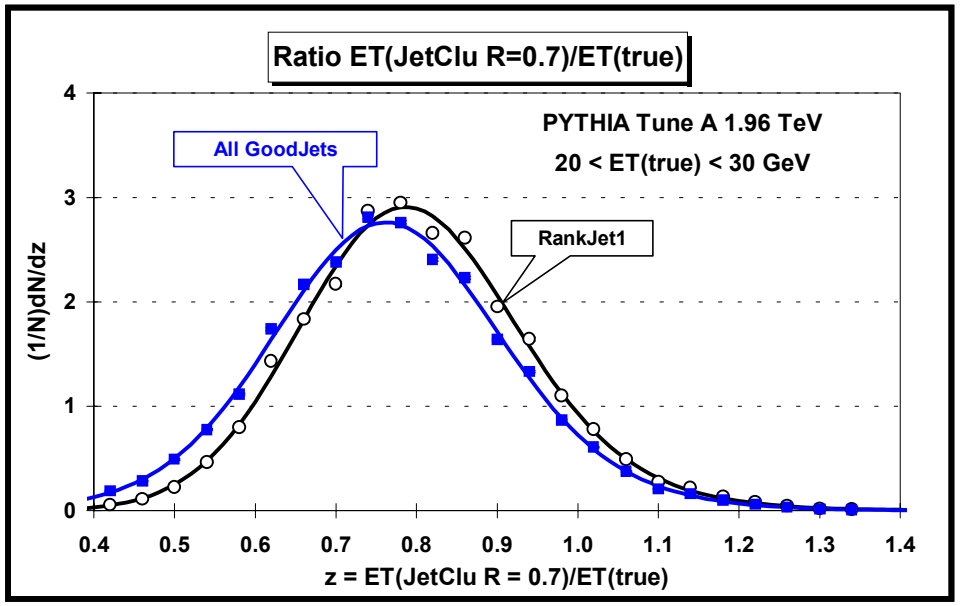


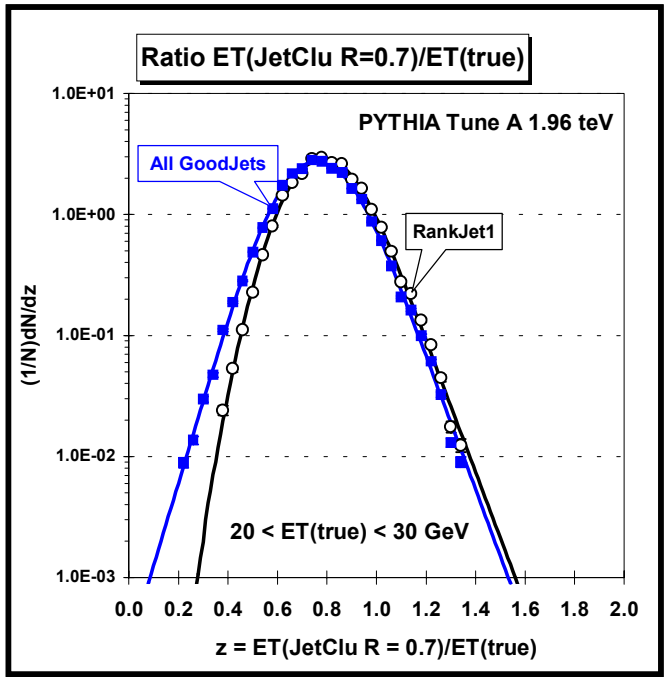
The All GoodJets fit corresponds to R(z) with z_0 = 0.767, σ = 0.124, u = 0.191, d = -0.025.

The RankJet1 fit corresponds to R(z) with z_0 = 0.853, σ = 0.144, u = 0.198, d = -0.031.

Case I All GoodJets: "Response Function" for 20 < ET(true) < 30 GeV

<ET(true)> = 23.2 GeV



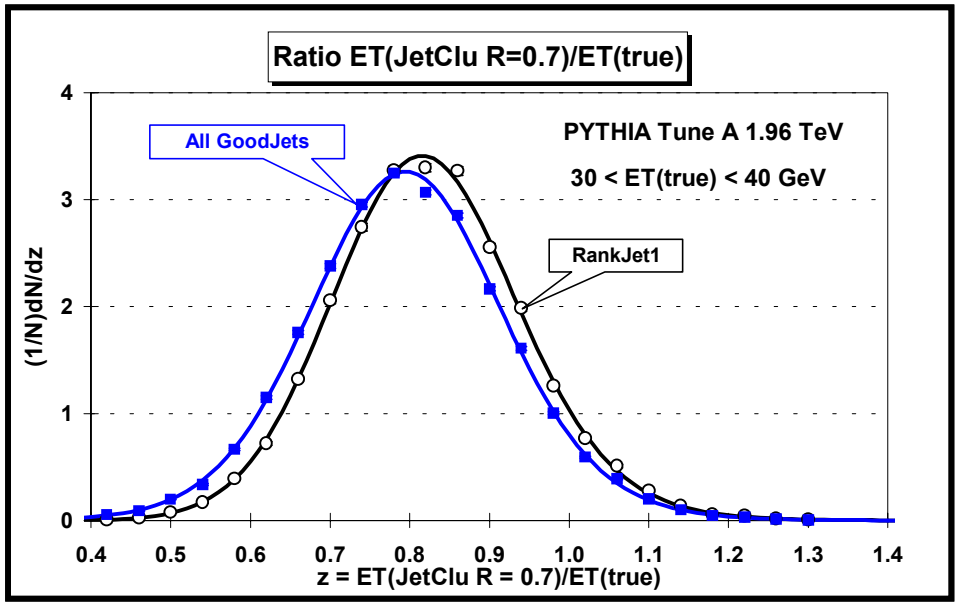


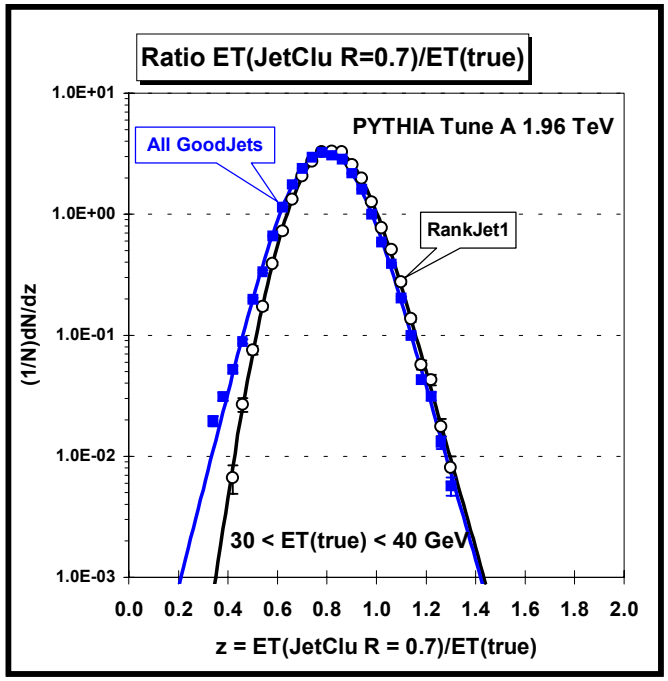
The All GoodJets fit corresponds to R(z) with z_0 = 0.768, σ = 0.114, u = 0.079, d = -0.064.

The RankJet1 fit corresponds to R(z) with z_0 = 0.801, σ = 0.121, u = 0.080, d = -0.019.

Case I All GoodJets: "Response Function" for 30 < ET(true) < 40 GeV

<ET(true)> = 33.6 GeV



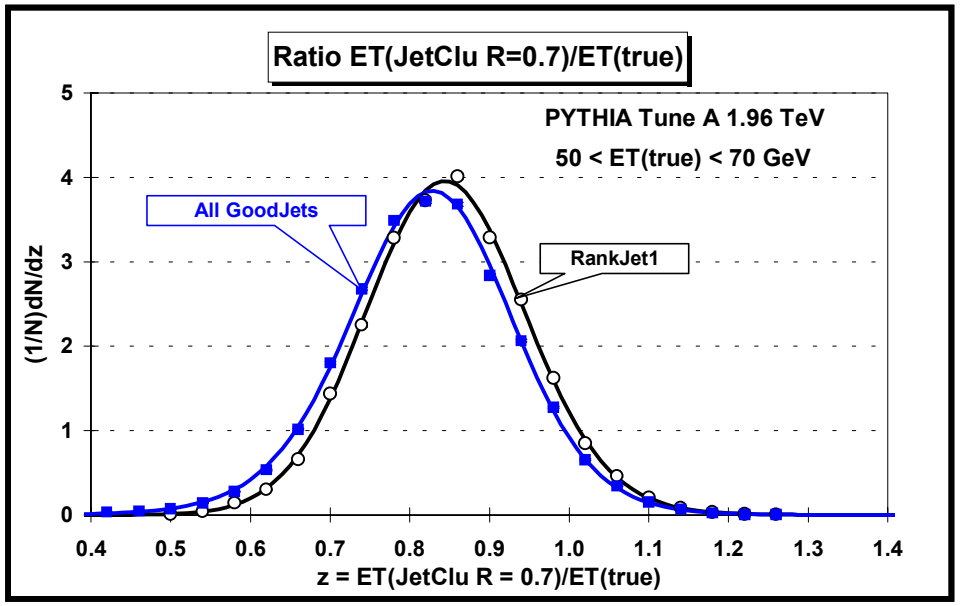


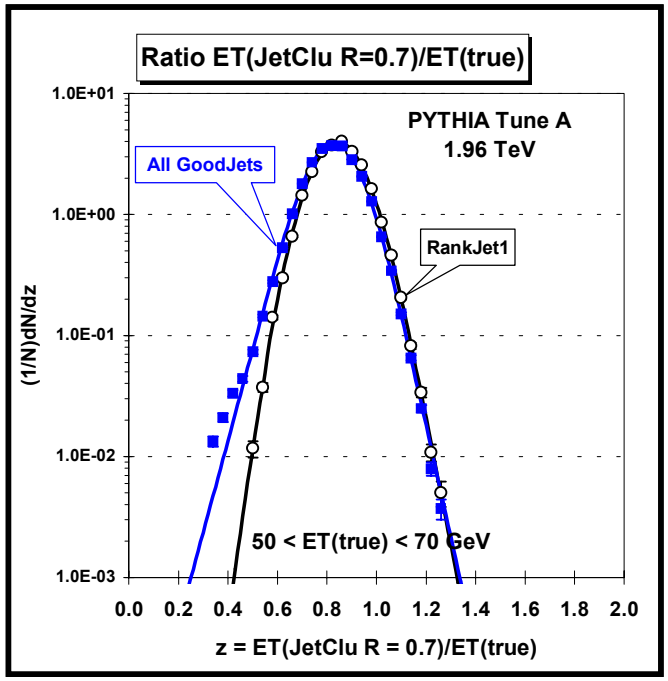
The All GoodJets fit corresponds to R(z) with z_0 = 0.797, σ = 0.099, u = 0.061, d = -0.054.

The RankJet1 fit corresponds to R(z) with z_0 = 0.824, σ = 0.102, u = 0.060, d = -0.030.

Case I All GoodJets: "Response Function" for 50 < ET(true) < 70 GeV

<ET(true)> = 56.8 GeV



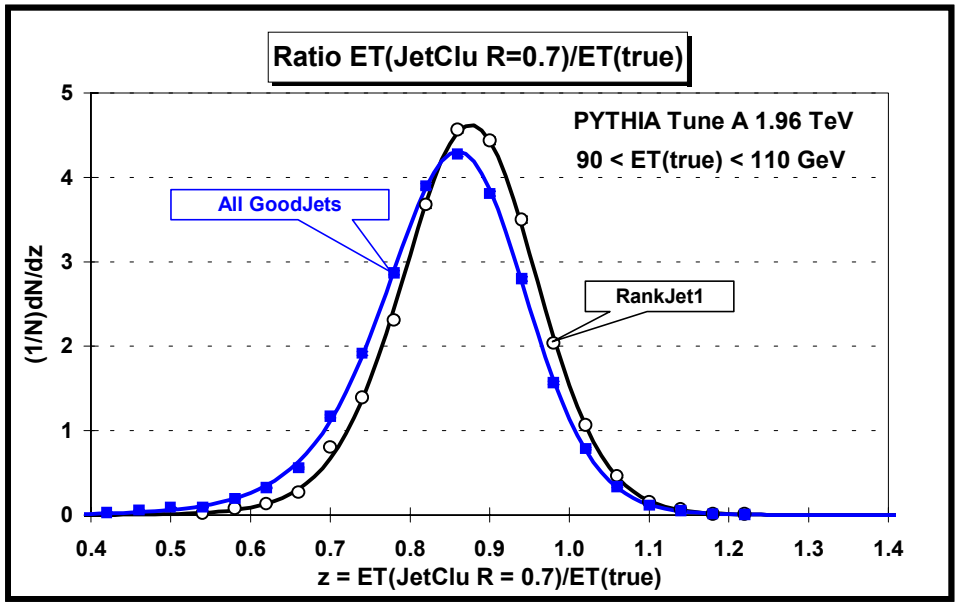


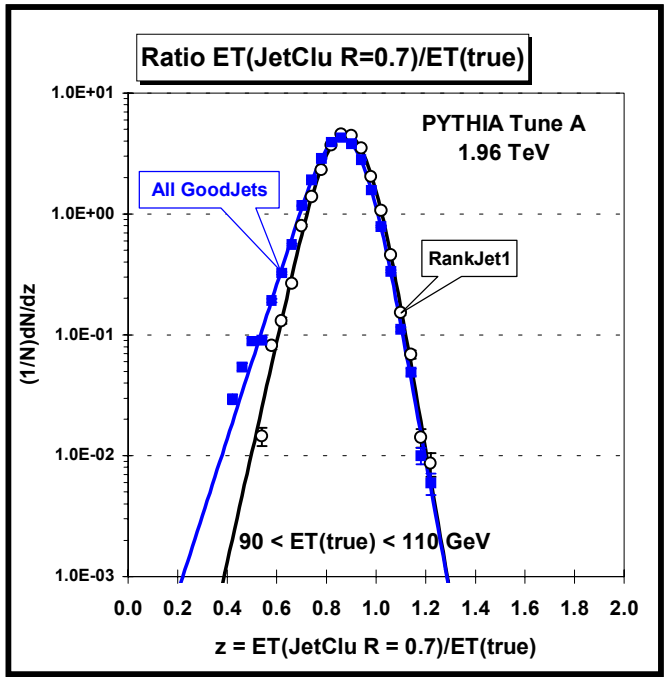
The All GoodJets fit corresponds to R(z) with z_0 = 0.824, σ = 0.081, u = 0.047, d = -0.057.

The RankJet1 fit corresponds to R(z) with z_0 = 0.847, σ = 0.090, u = 0.041, d = -0.028.

Case I All GoodJets: "Response Function" for 90 < ET(true) < 110 GeV

<ET(true)> = 97.9 GeV



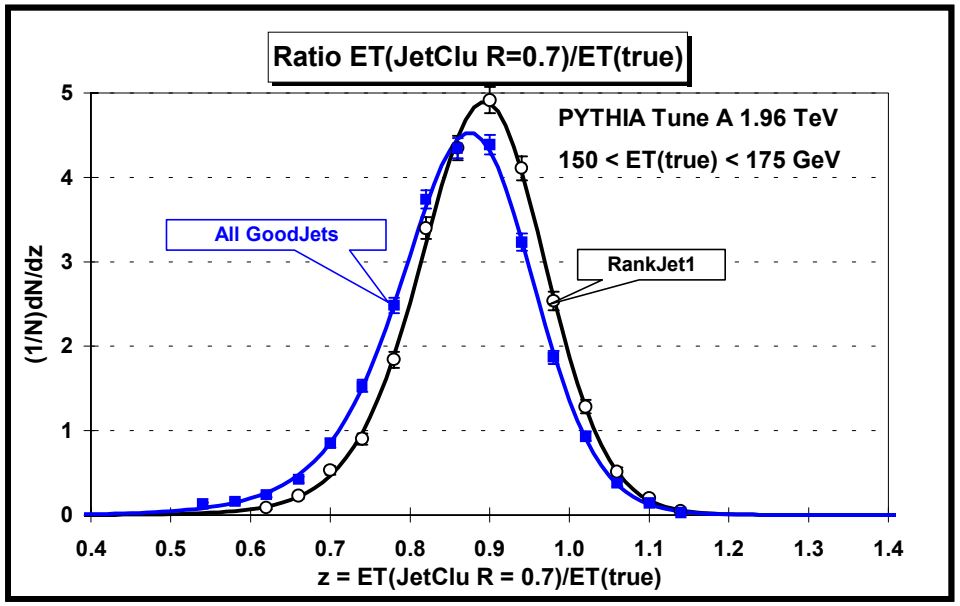


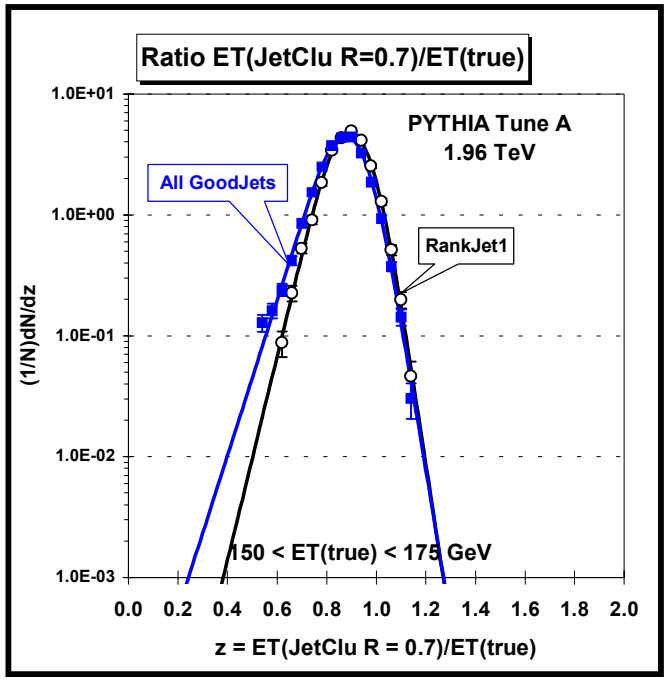
The All GoodJets fit corresponds to R(z) with z_0 = 0.846, σ = 0.068, u = 0.038, d = -0.068.

The RankJet1 fit corresponds to R(z) with z_0 = 0.872, σ = 0.069, u = 0.036, d = -0.048.

Case I All GoodJets: "Response Function" for 150 < ET(true) < 175 GeV

<ET(true)> = 160.4 GeV



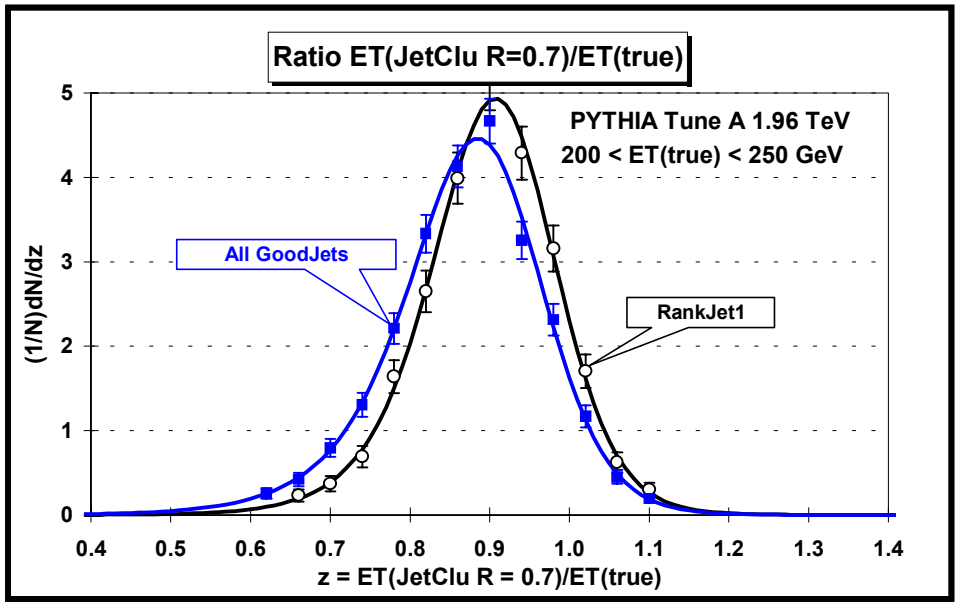


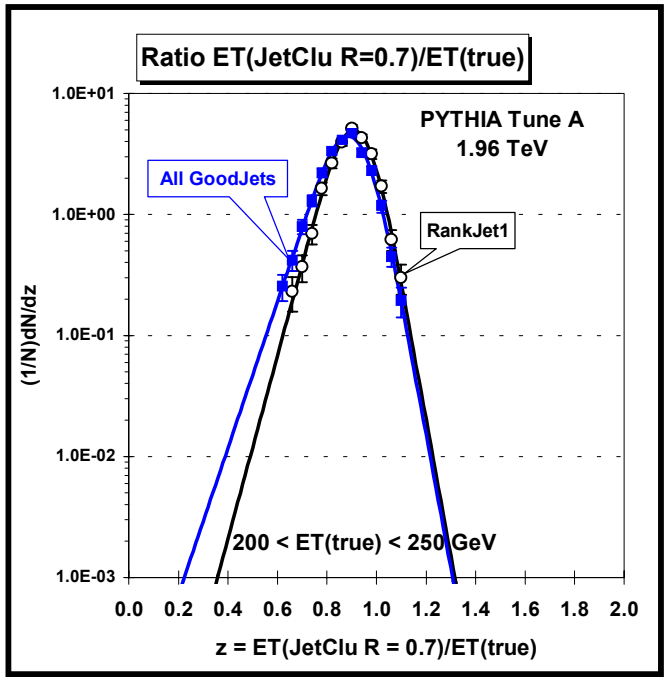
The All GoodJets fit corresponds to R(z) with z_0 = 0.860, σ = 0.064, u = 0.035, d = -0.068.

The RankJet1 fit corresponds to R(z) with z_0 = 0.886, σ = 0.063, u = 0.033, d = -0.052.

Case I All GoodJets: "Response Function" for 200 < ET(true) < 250 GeV

<ET(true)> = 218.3 GeV



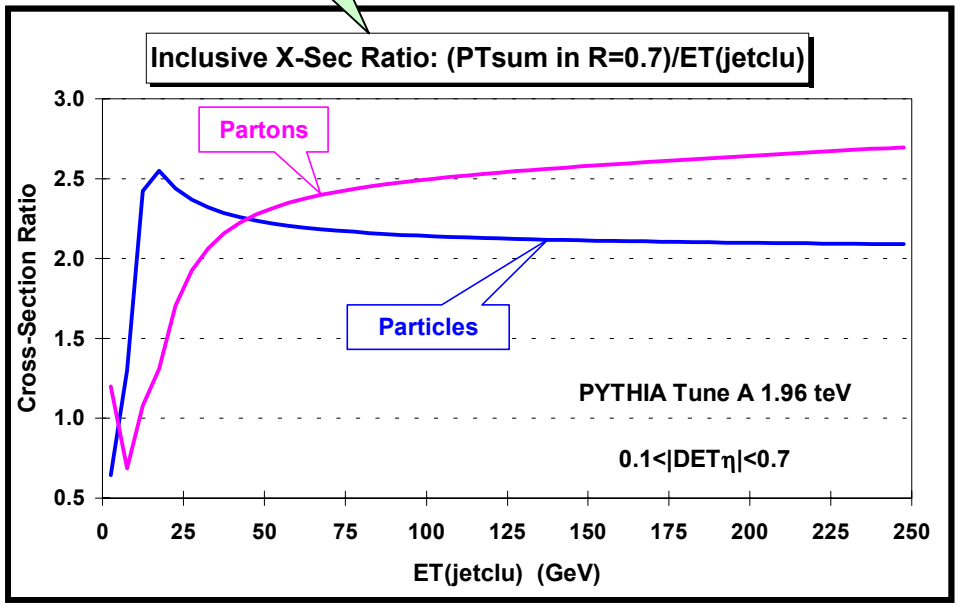


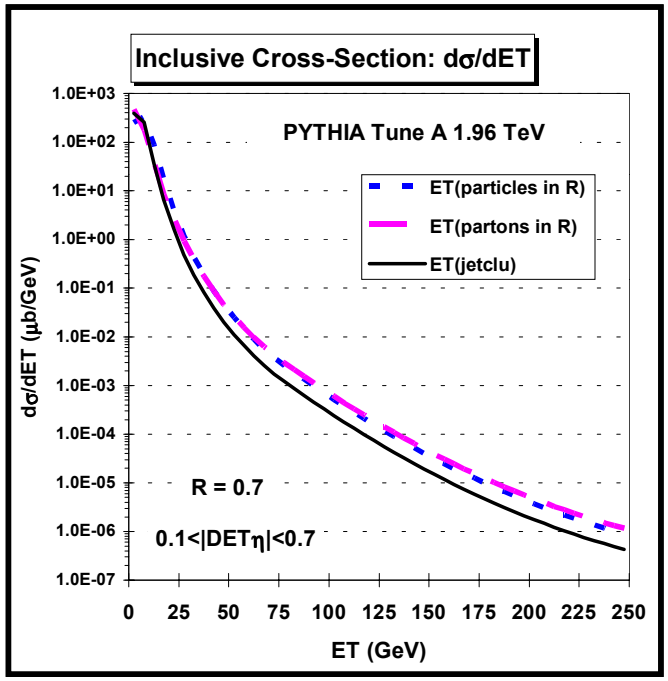
The All GoodJets fit corresponds to R(z) with z_0 = 0.869, σ = 0.063, u = 0.039, d = -0.072.

The RankJet1 fit corresponds to R(z) with z_0 = 0.898, σ = 0.058, u = 0.039, d = -0.057.

Case I & II All GoodJets: Inclusive Cross-Section "Correction Factors"

Correction Functions!

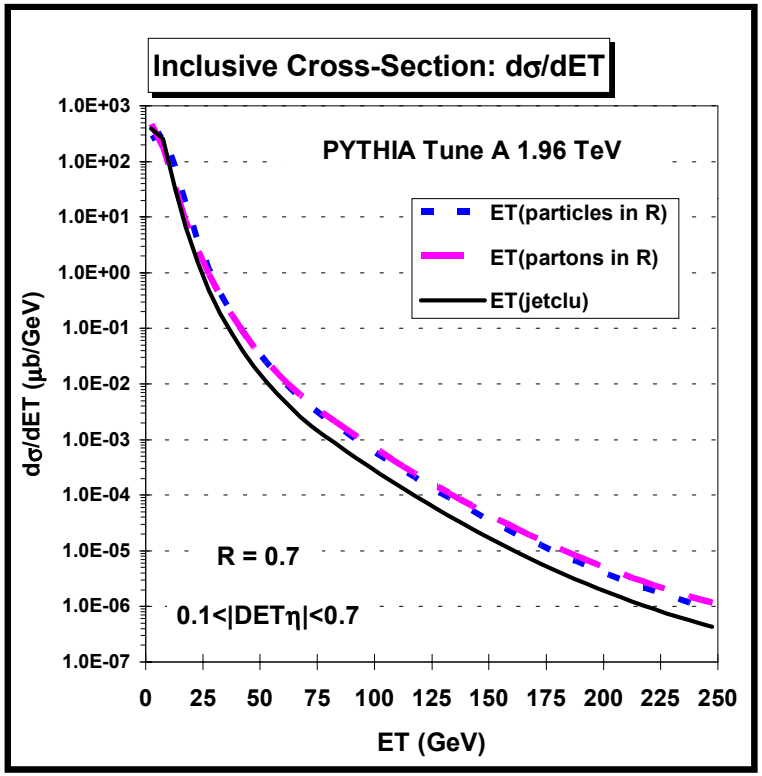


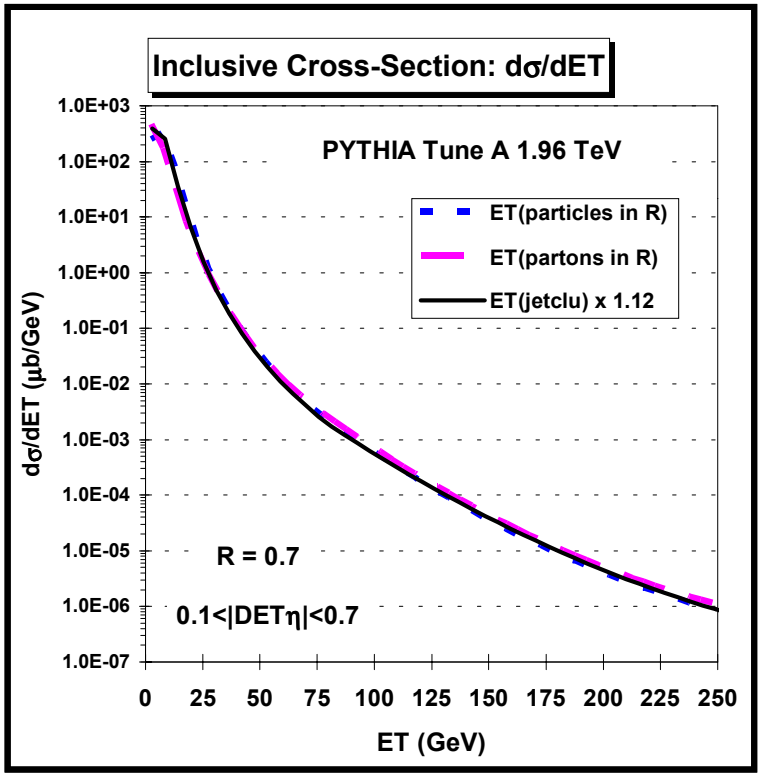


To correct the observed inclusive cross-section back to the particle or parton level multiply by the "correction factor"!

Case I & 2 All GoodJets: Inclusive Cross-Section "Scale Factor"

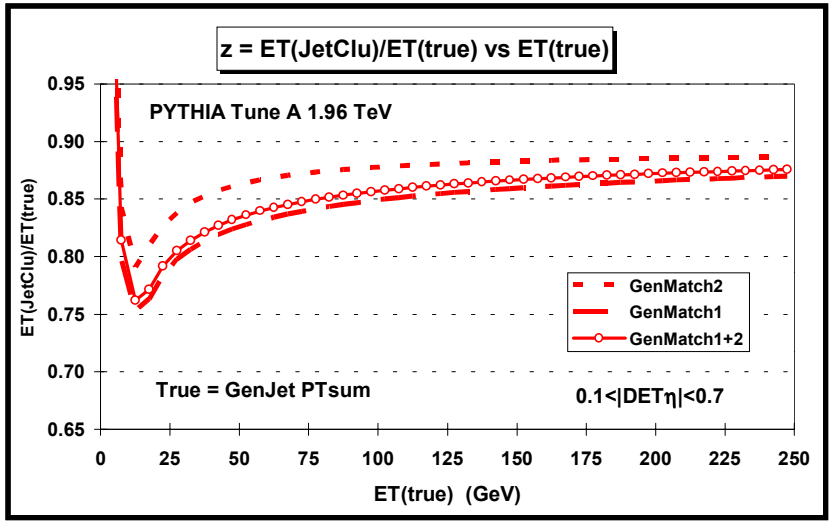
Only approximate!

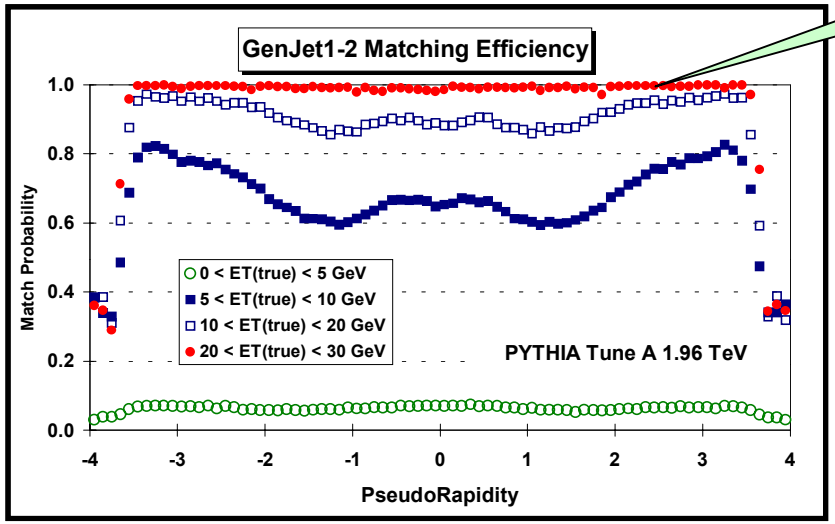




To correct the observed inclusive cross-section back to the particle level multiply ET(jetclu) by a "scale factor" of 1.12! Warning!.. this is only a crude estimate. The "correction function" shows that there is a "shape change" as well.

Case III GenMatch1-2: Average value of z = ET(JetClu)/ET(true)

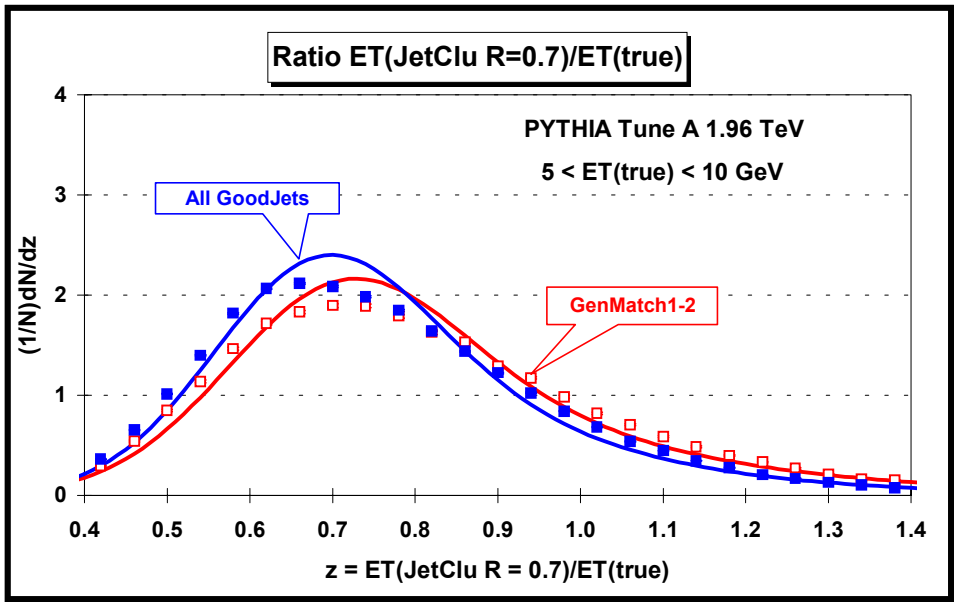


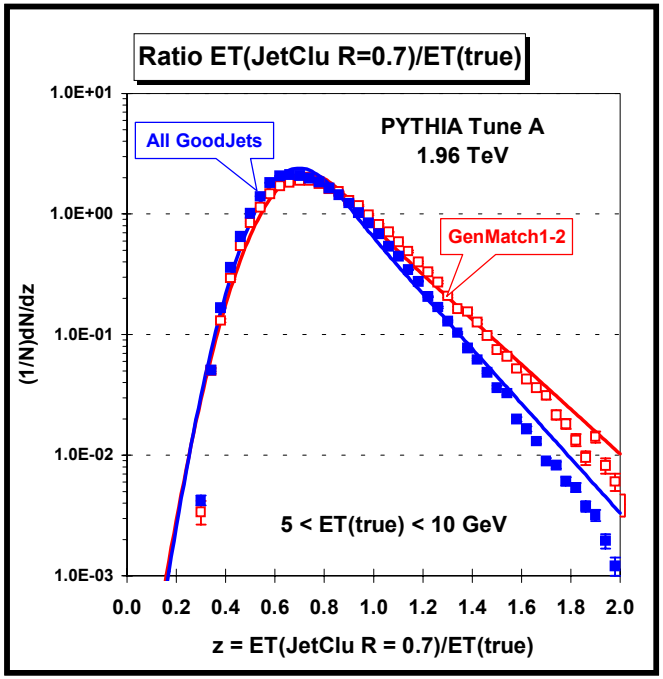


100% efficient for ET(true) > 20 GeV!

Case III GenMatch1-2: "Response Function" for 5 < ET(true) < 10 GeV

<ET(true)> = 7.2 GeV



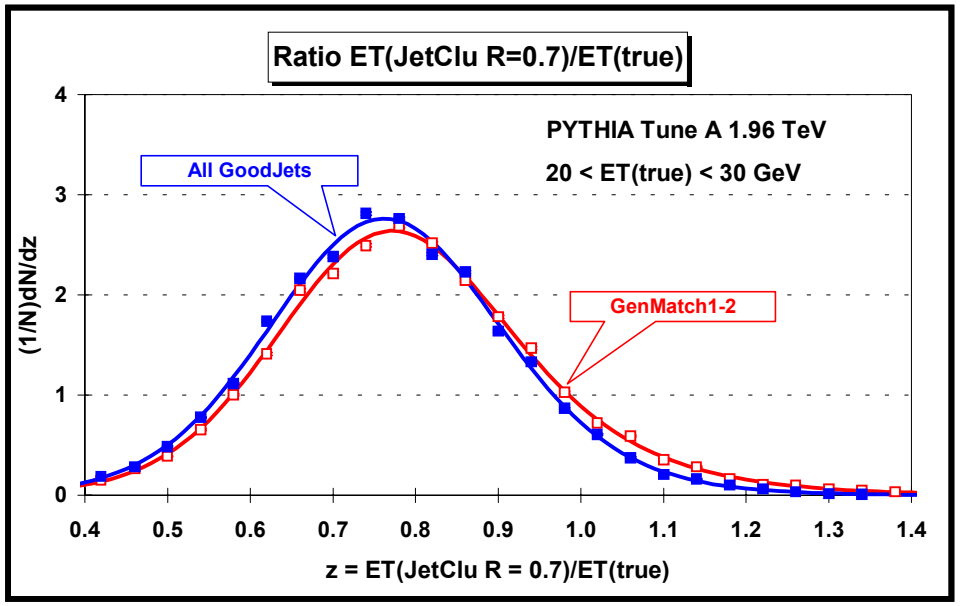


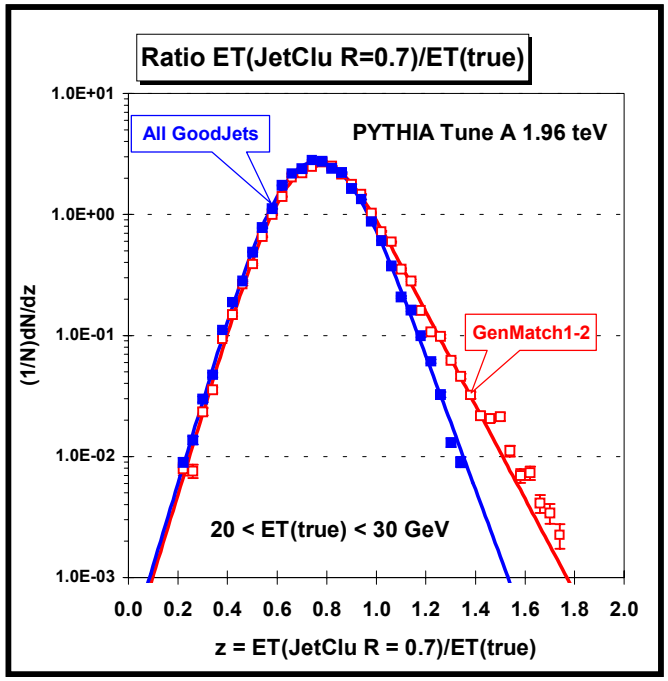
The All GoodJets fit corresponds to R(z) with $z_0 = 0.767$, $\sigma = 0.124$, u = 0.191, d = -0.025.

The GenMatch1-2 fit corresponds to R(z) with $z_0 = 0.817$, $\sigma = 0.134$, u = 0.234, d = -0.027.

Case III GenMatch1-2: "Response Function" for 20 < ET(true) < 30 GeV

<ET(true)> = 23.2 GeV



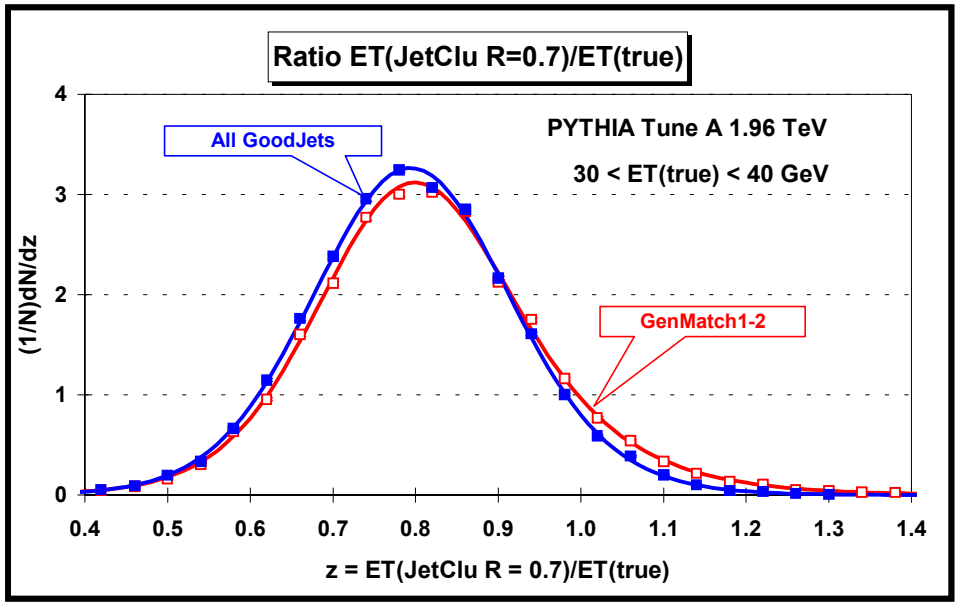


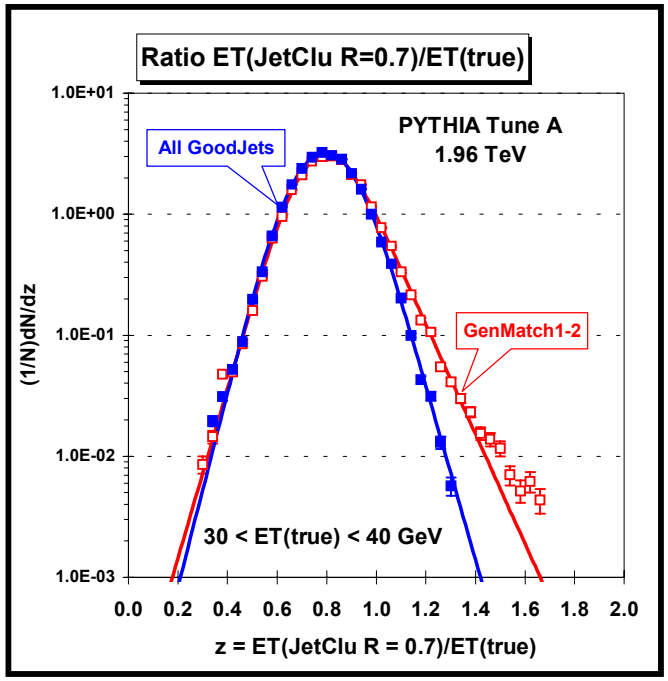
The All GoodJets fit corresponds to R(z) with z_0 = 0.768, σ = 0.114, u = 0.079, d = -0.064.

The GenMatch1-2 fit corresponds to R(z) with z_0 = 0.794, σ = 0.110, u = 0.112, d = -0.065.

Case III GenMatch1-2: "Response Function" for 30 < ET(true) < 40 GeV

<ET(true)> = 33.6 GeV



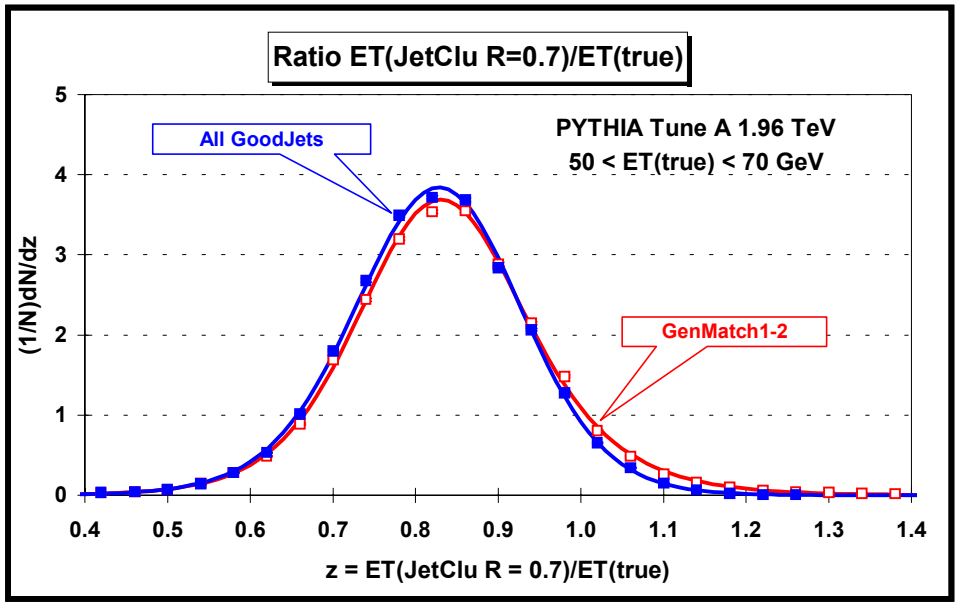


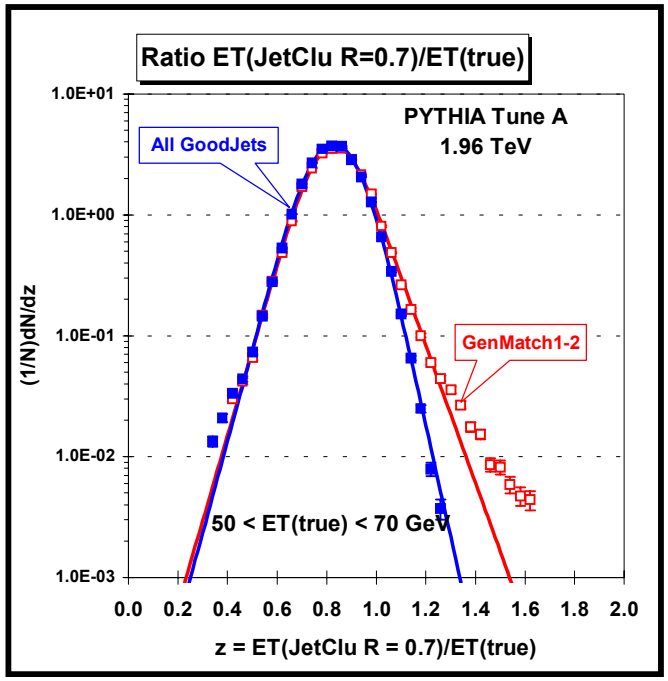
The All GoodJets fit corresponds to R(z) with $z_0 = 0.797$, $\sigma = 0.099$, u = 0.061, d = -0.054.

The GenMatch1-2 fit corresponds to R(z) with $z_0 = 0.816$, $\sigma = 0.089$, u = 0.096, d = -0.062.

Case III GenMatch1-2: "Response Function" for 50 < ET(true) < 70 GeV

<ET(true)> = 56.8 GeV



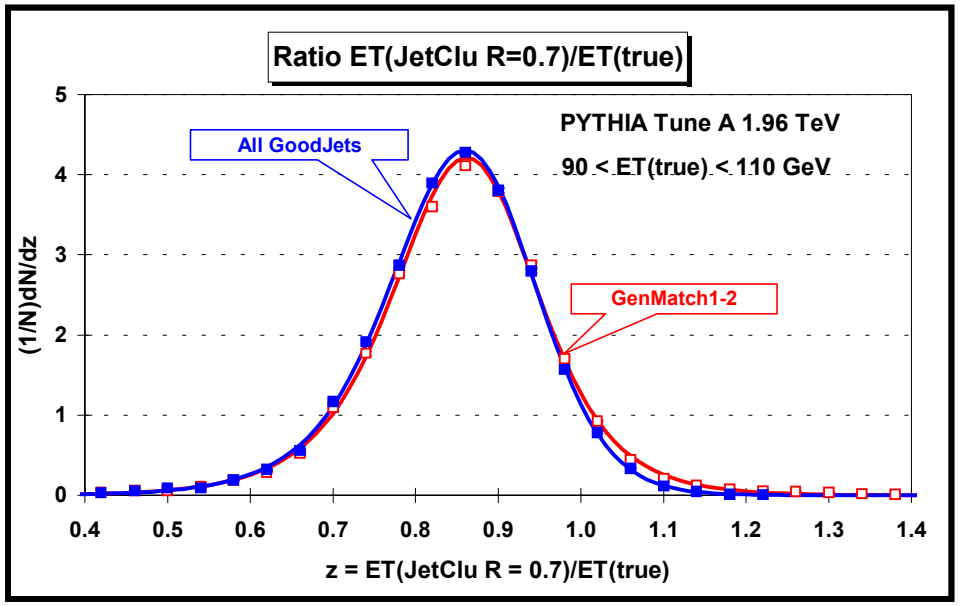


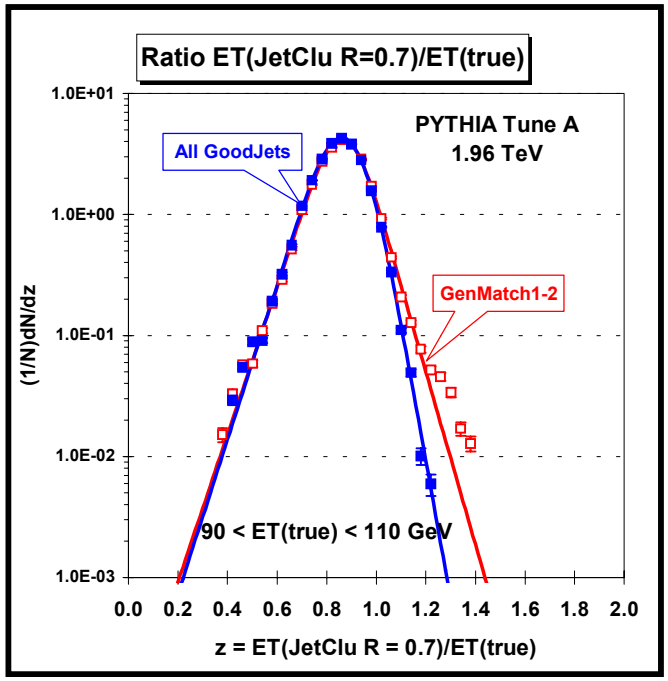
The All GoodJets fit corresponds to R(z) with $z_0 = 0.824$, $\sigma = 0.081$, u = 0.047, d = -0.057.

The GenMatch1-2 fit corresponds to R(z) with $z_0 = 0.839$, $\sigma = 0.073$, u = 0.077, d = -0.062.

Case III GenMatch1-2: "Response Function" for 90 < ET(true) < 110 GeV

<ET(true)> = 97.9 GeV



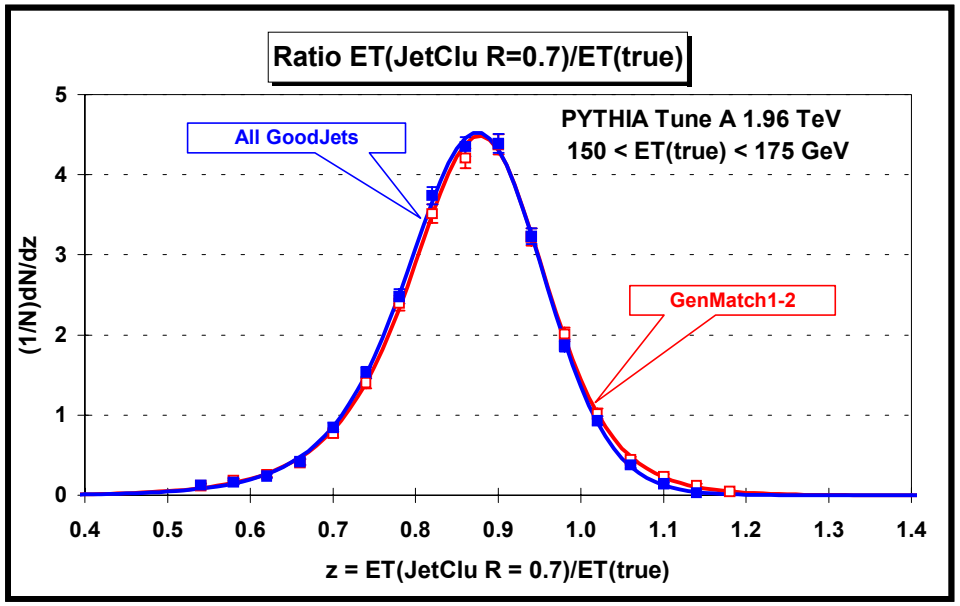


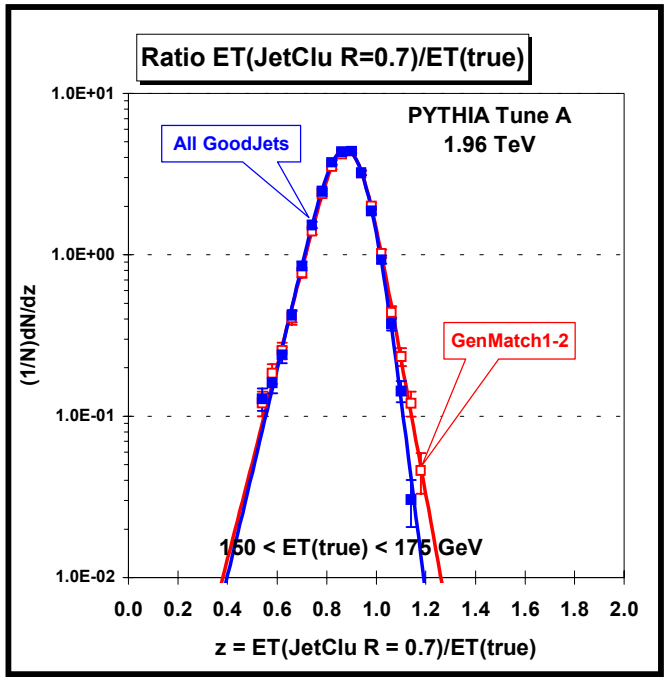
The All GoodJets fit corresponds to R(z) with $z_0 = 0.846$, $\sigma = 0.068$, u = 0.038, d = -0.068.

The GenMatch1-2 fit corresponds to R(z) with $z_0 = 0.856$, $\sigma = 0.059$, u = 0.061, d = -0.071.

Case III GenMatch1-2: "Response Function" for 150 < ET(true) < 175 GeV

<ET(true)> = 160.4 GeV



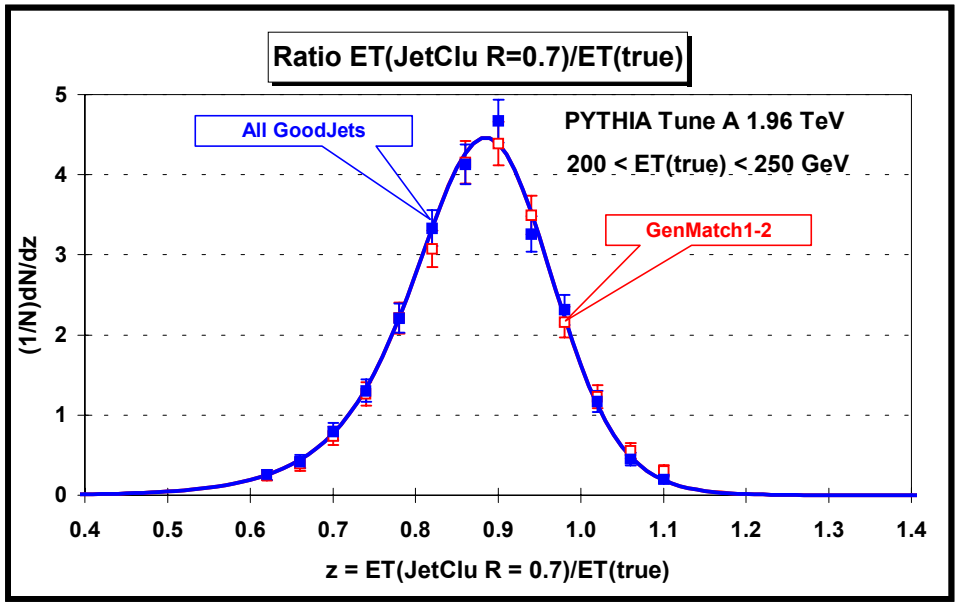


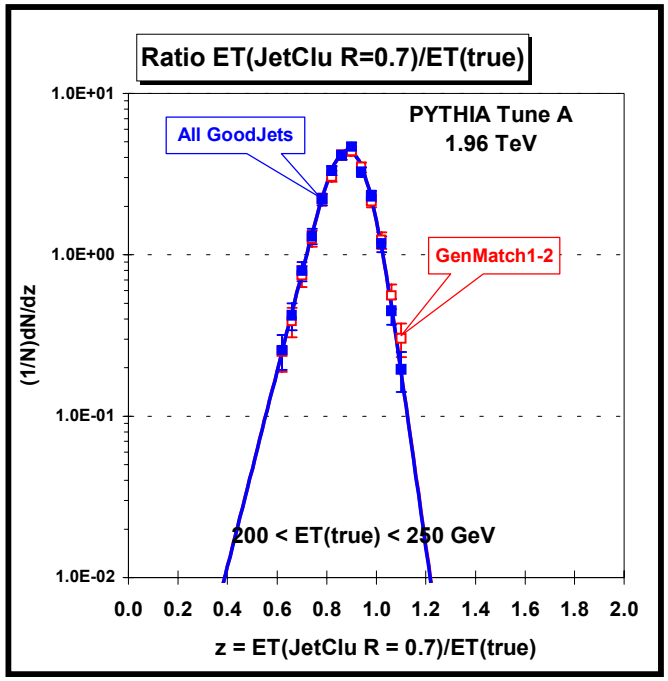
The All GoodJets fit corresponds to R(z) with z_0 = 0.860, σ = 0.064, u = 0.035, d = -0.068.

The GenMatch1-2 fit corresponds to R(z) with z_0 = 0.866, σ = 0.056, u = 0.052, d = -0.073.

Case III GenMatch1-2: "Response Function" for 200 < ET(true) < 250 GeV

<ET(true)> = 218.0 GeV

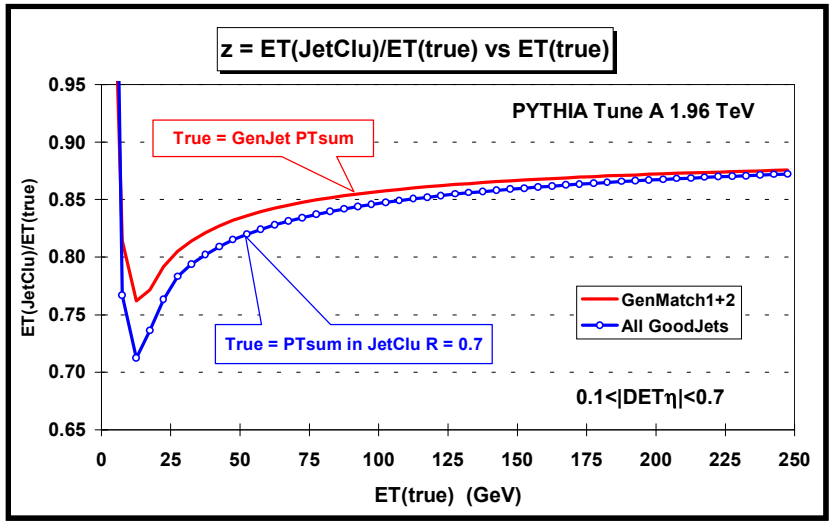


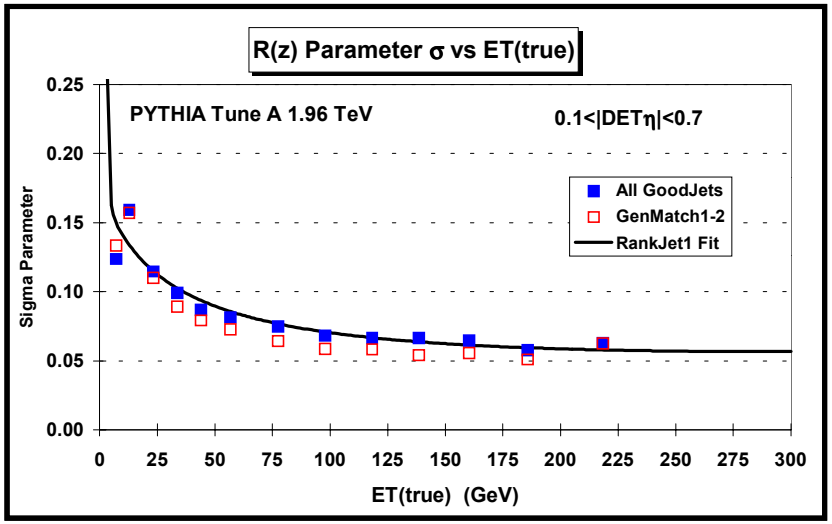


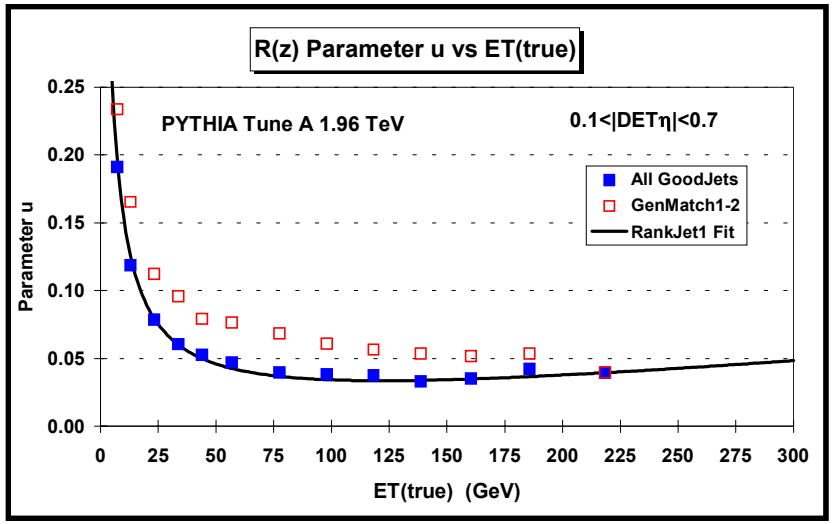
The All GoodJets fit corresponds to R(z) with $z_0 = 0.869$, $\sigma = 0.063$, u = 0.039, d = -0.072.

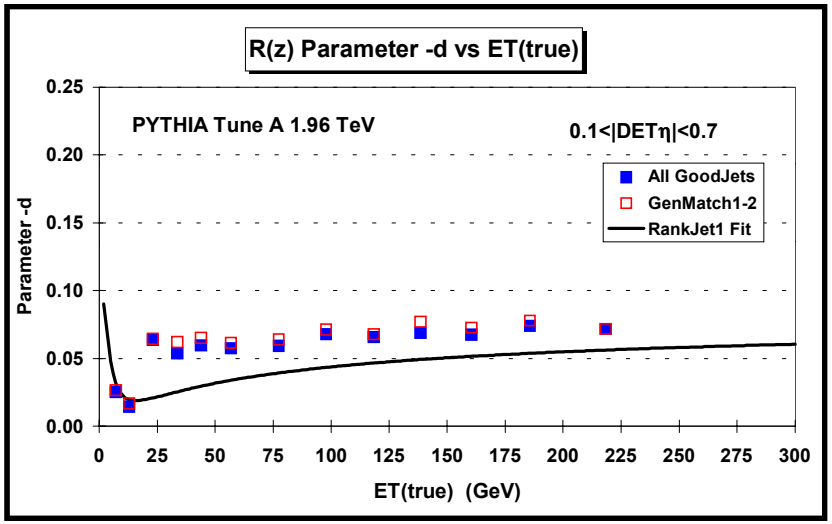
The GenMatch1-2 fit corresponds to R(z) with $z_0 = 0.869$, $\sigma = 0.062$, u = 0.040, d = -0.072.

"Response Function" Parameters









"Response Function" Parameters: Summary

Fit Parameters for Case I All GoodJets: **True = scalar PTsum of all particles in R = 0.7 cone around the calorimeter (jetclu, R = 0.7) jets.**

True Bin	<True>	z_0	σ	u	d
5-10 GeV	7.2 GeV	0.767	0.124	0.191	-0.025
10-20 GeV	12.9 GeV	0.715	0.159	0.119	-0.014
20-30 GeV	23.2 GeV	0.768	0.114	0.079	-0.064
30-40 GeV	33.6 GeV	0.797	0.099	0.061	-0.054
40-50 GeV	43.9 GeV	0.811	0.087	0.053	-0.060
50-70 GeV	56.8 GeV	0.824	0.081	0.047	-0.057
70-90 GeV	77.5 GeV	0.838	0.075	0.040	-0.059
90-110 GeV	97.9 GeV	0.846	0.068	0.038	-0.068
110-130 GeV	118.3 GeV	0.852	0.066	0.038	-0.066
130-150 GeV	138.6 Gev	0.856	0.066	0.033	-0.069
150-175 GeV	160.4 GeV	0.860	0.064	0.035	-0.068
175-200 GeV	185.8 GeV	0.870	0.058	0.042	-0.074
200-250 GeV	218.3 GeV	0.869	0.063	0.039	-0.072

Fit Parameters for Case III GenMatch1-2: **True = GenJetPT = Scalar PTsum of all particles in the generator level "particle jet".**

True Bin	<True>	z_0	σ	u	d
5-10 GeV	7.2 GeV	0.817	0.134	0.234	-0.027
10-20 GeV	12.9 GeV	0.765	0.157	0.165	-0.017
20-30 GeV	23.2 GeV	0.794	0.110	0.112	-0.065
30-40 GeV	33.6 GeV	0.816	0.089	0.096	-0.062
40-50 GeV	43.9 GeV	0.827	0.079	0.079	-0.065
50-70 GeV	56.8 GeV	0.839	0.073	0.077	-0.062
70-90 GeV	77.5 GeV	0.850	0.064	0.068	-0.064
90-110 GeV	97.9 GeV	0.856	0.059	0.061	-0.071
110-130 GeV	118.3 GeV	0.860	0.058	0.056	-0.068
130-150 GeV	138.6 GeV	0.862	0.054	0.054	-0.077
150-175 GeV	160.4 GeV	0.866	0.056	0.052	-0.073
175-200 GeV	185.8 GeV	0.876	0.051	0.054	-0.078
200-250 GeV	218.3 GeV	0.869	0.062	0.040	-0.072

** Plans **

- **Give the parameterizations to Jay Dittmann to compare with the Run 1 results.**
- **Look at the other rapidity bins. I have done the runs but I need to make the plots.**
- **Redo everything using HERWIG!**
- **Determine which Monte-Carlo (PYTHIA Tune A or HERWIG) fits the data on the jet characteristics best.**
- **Give a talk at the QCD meeting in 2 weeks (*I will be at Fermilab*) showing how well PYTHIA Tune A fits the properties of the calorimeter jets including the inclusive cross-section.**
- **Look at other definitions of ET(true) and at other jet definitions!**