Jet Shapes using MidPoint

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QCD Meeting 2nd April 2004 (pre-blessing)

Outlook

- Motivation
- Event Selection
- Comparison of Raw Variables
- Jet Pt corrections using MC
- Uncorrected Jet Shapes
- Jet Shapes Unfolding
- Systematic Uncertainties
- Results
- Outlook

CDF-NOTE 6952 (I updated plots)

http://www-cdf.fnal.gov/internal/physics/qcd/shapes/shapes.html

Motivation

- Jet shape dictated by multi-gluon emission form primary parton
- Test of parton shower models and their implementations
- Sensitive to underlying event structure
- Sensitive to running of strong coupling

Event Selection

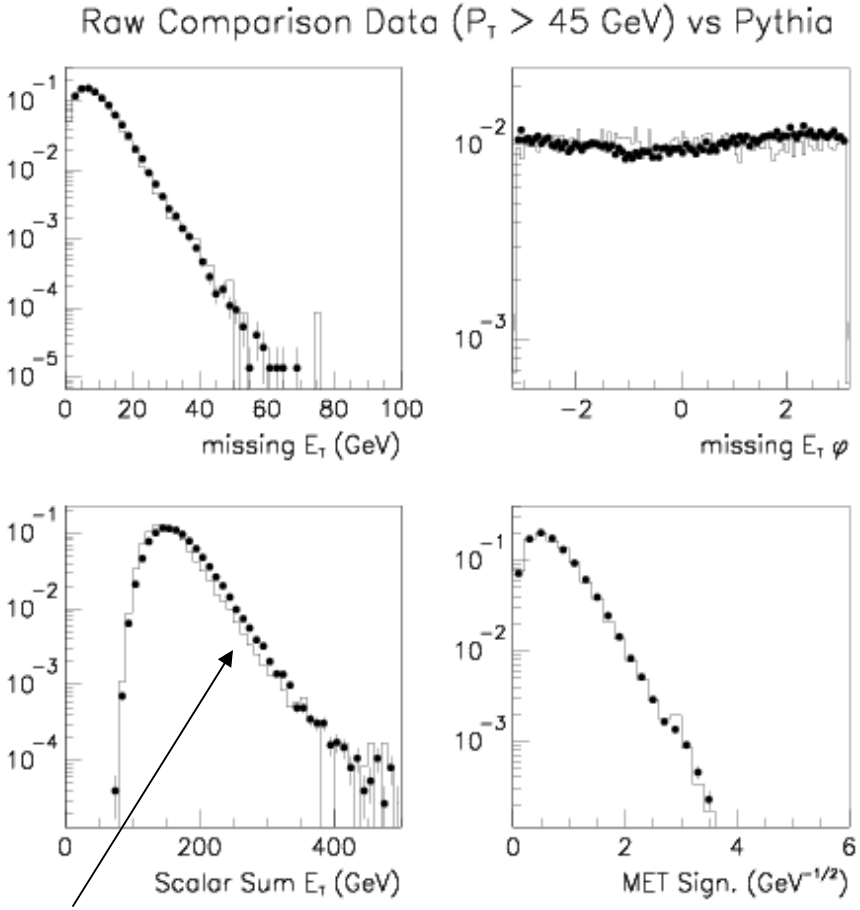
- Using MidPoint Algorithm (R=0.7) (merging at 75%)

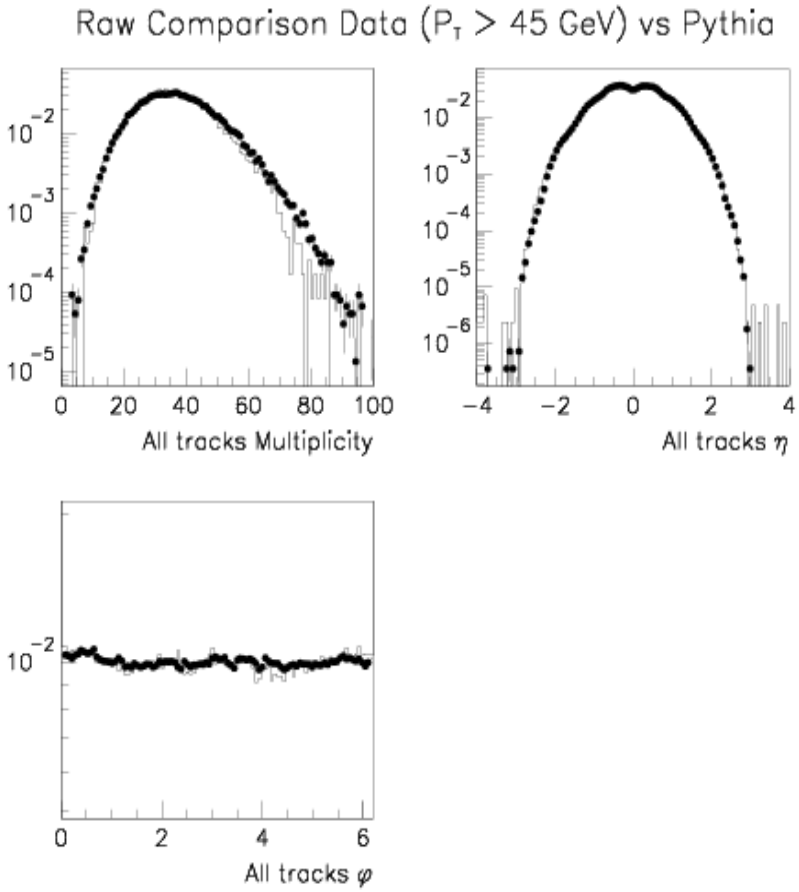
- Using all Jet Data before Shutdown (200 pb-1)
  - J5 (for Pt > 30 GeV)
  - J20 (for Pt > 45 GeV)
  - J50 (for Pt > 70 GeV)
  - J70 (for Pt > 95 GeV)
  - J100(for Pt > 130 GeV)

  } No trigger bias

- Selection Cuts
  - At least one central jet (0.1 < |Y| < 0.7) with Pt> 30 GeV
  - MET_significance < 3.5 GeV^-1/2
  - |V_z| < 60 cm
  - N(vxt) = 1
- Comparison DATA (5.3.1pre4) with MC Pythia & Herwig

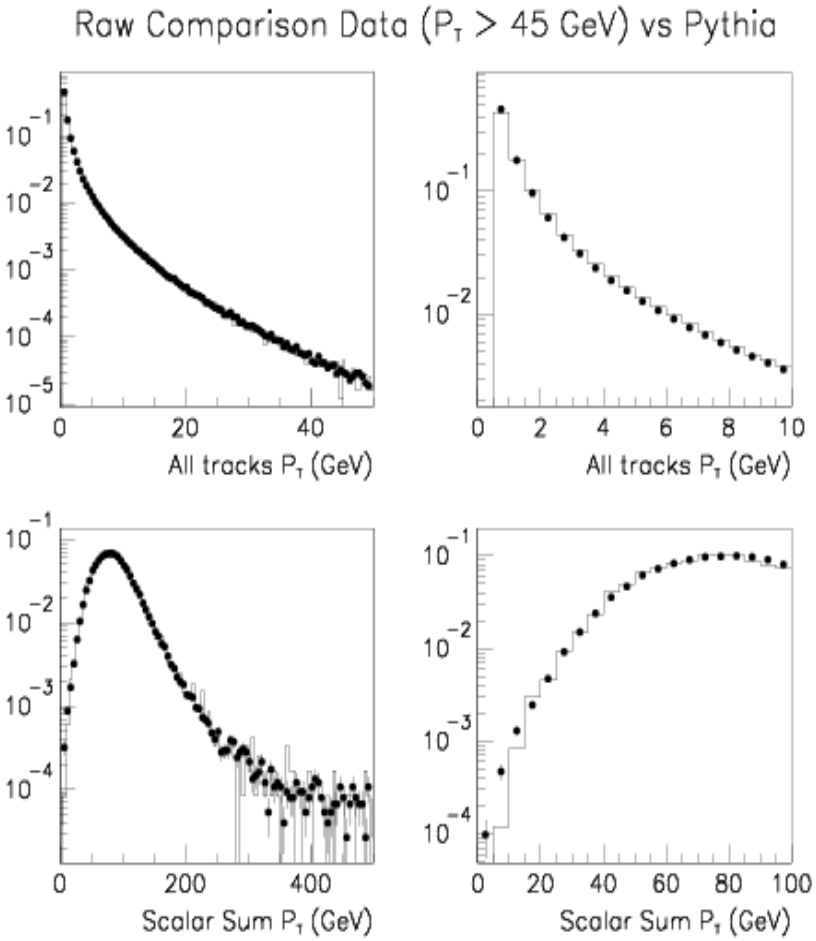
Some Control Plots (Ia)

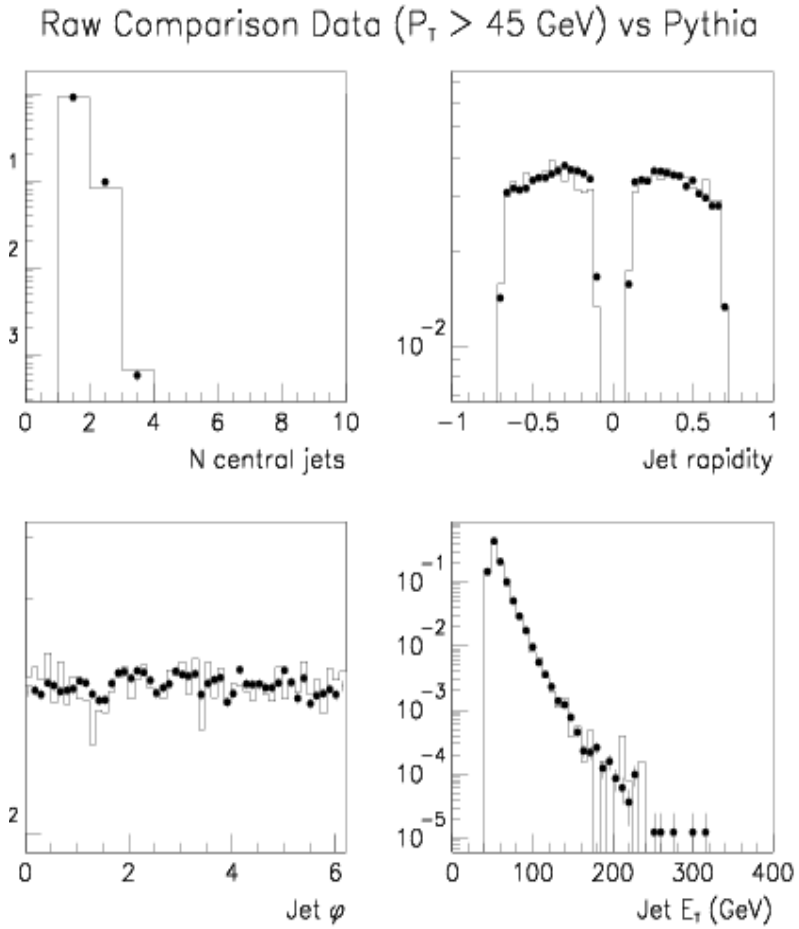




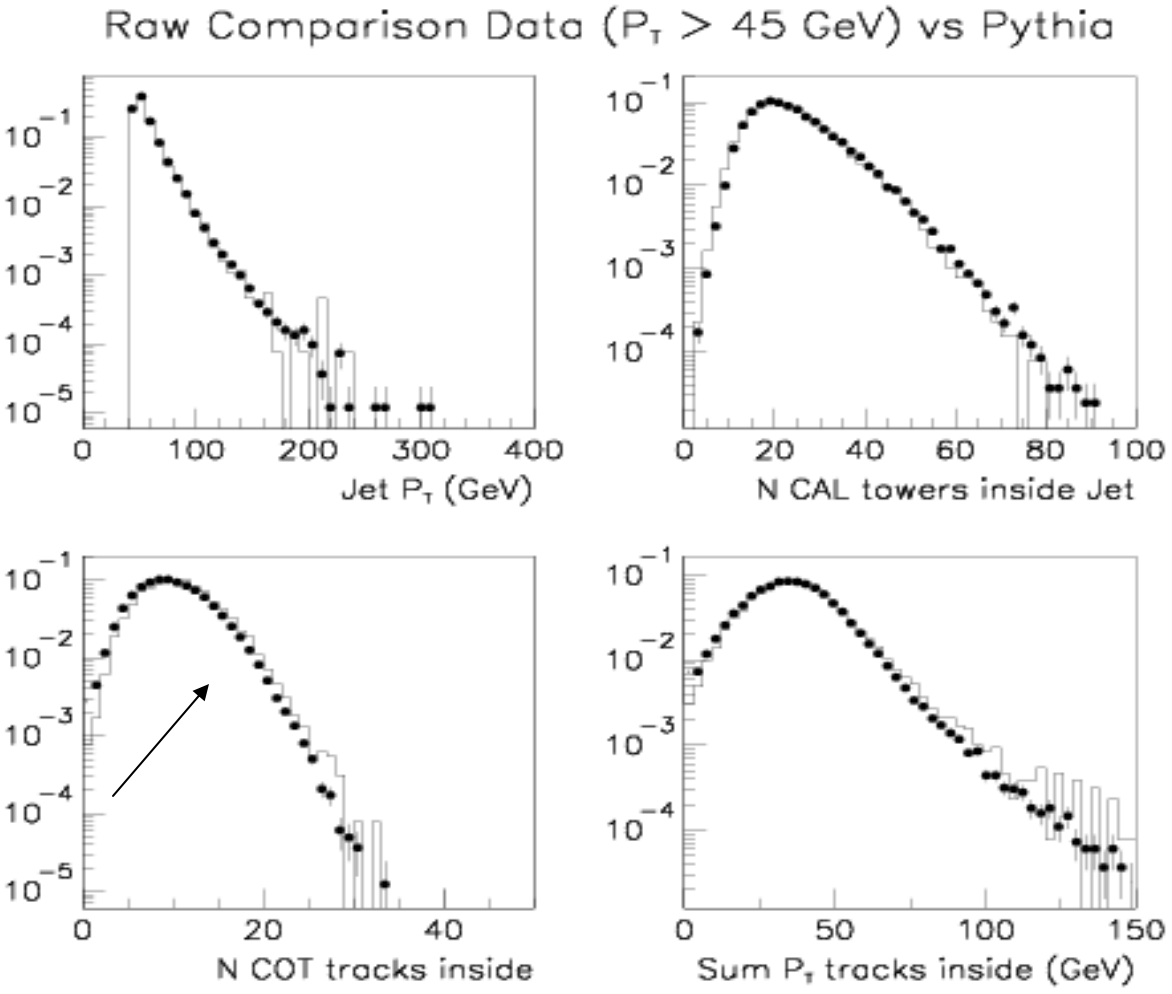
..energy in plug CAL not fully described…

Some Control Plots (Ib)



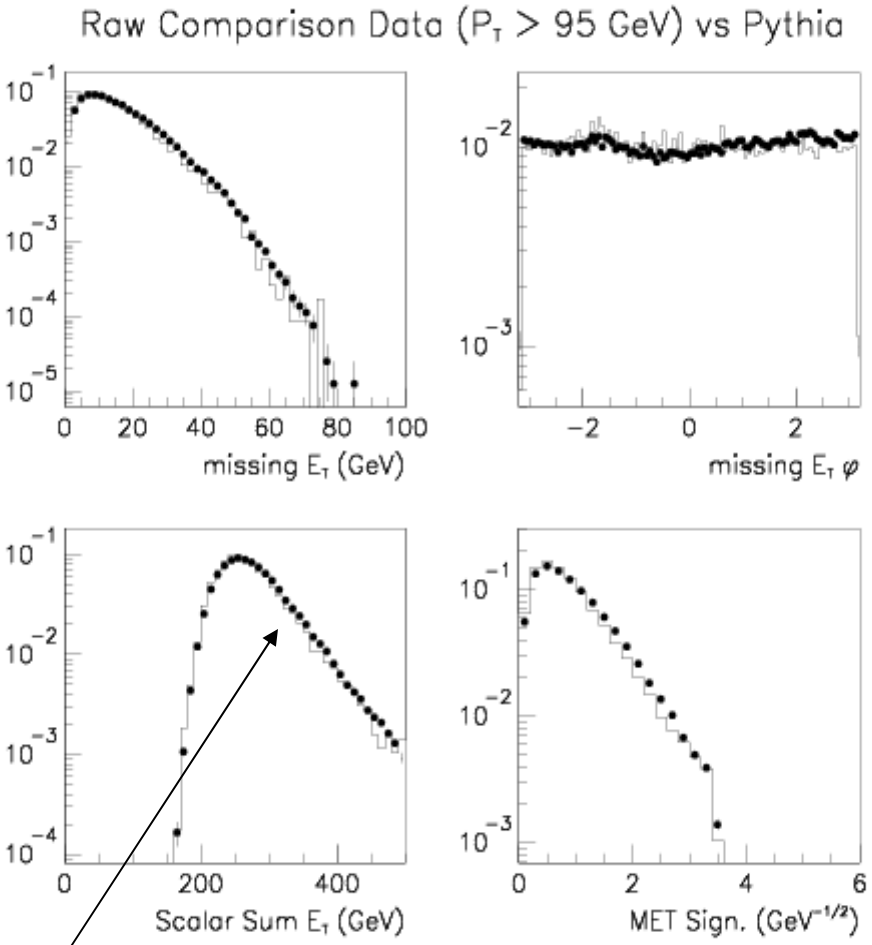


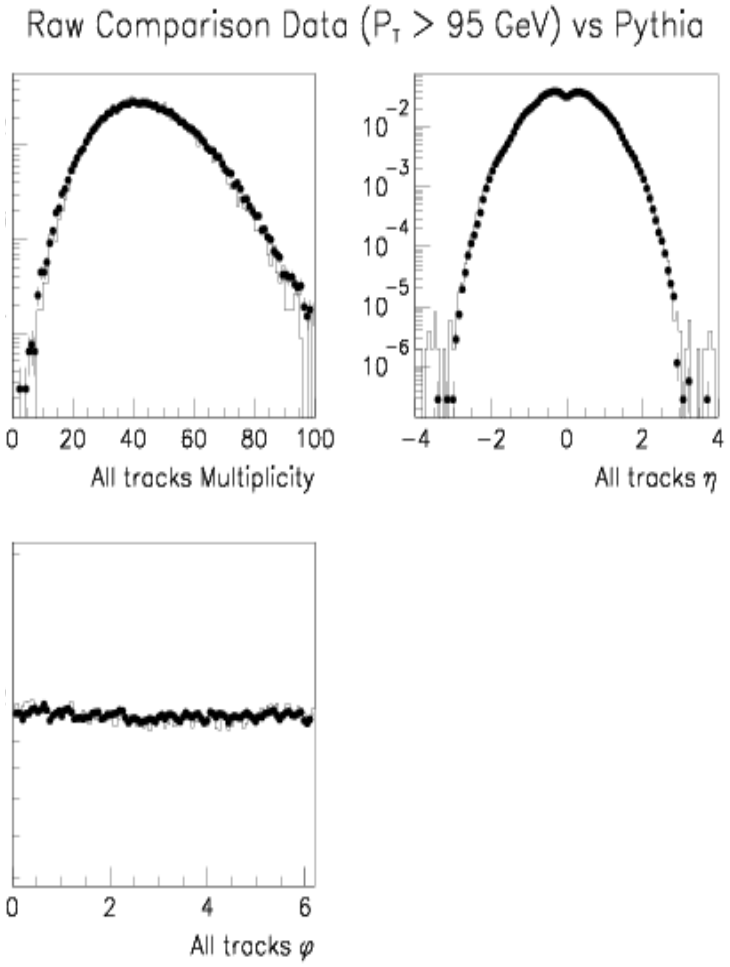
Some Control Plots (Ic)



Comparison Data/MC is satisfactory

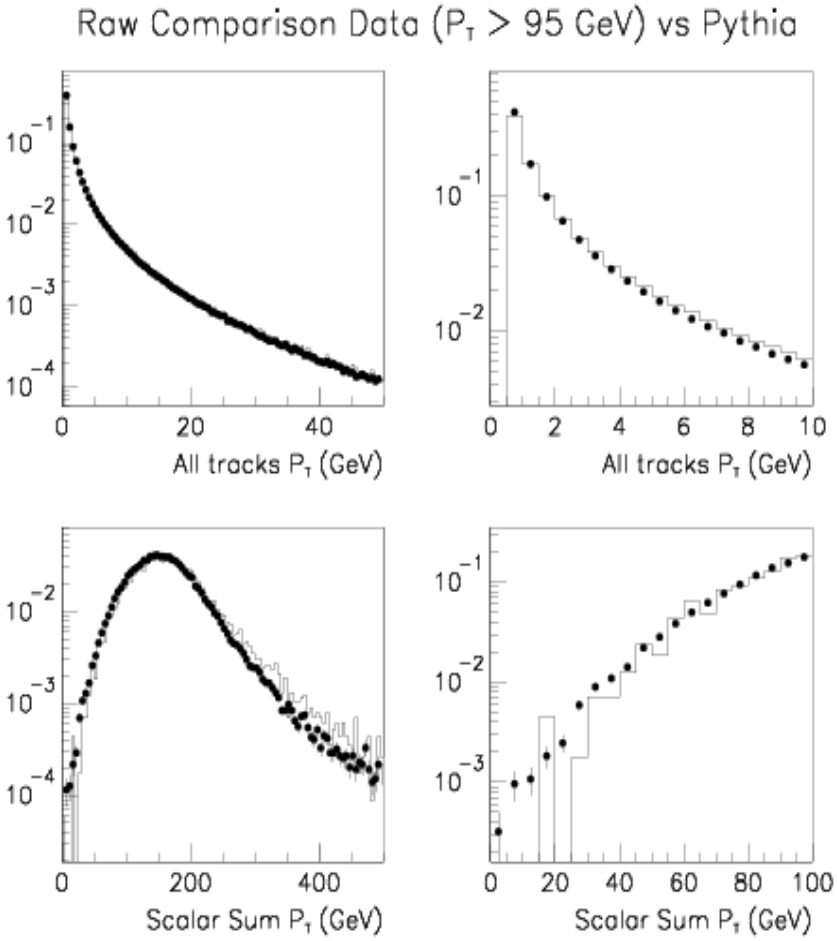
Some Control Plots (IIa)

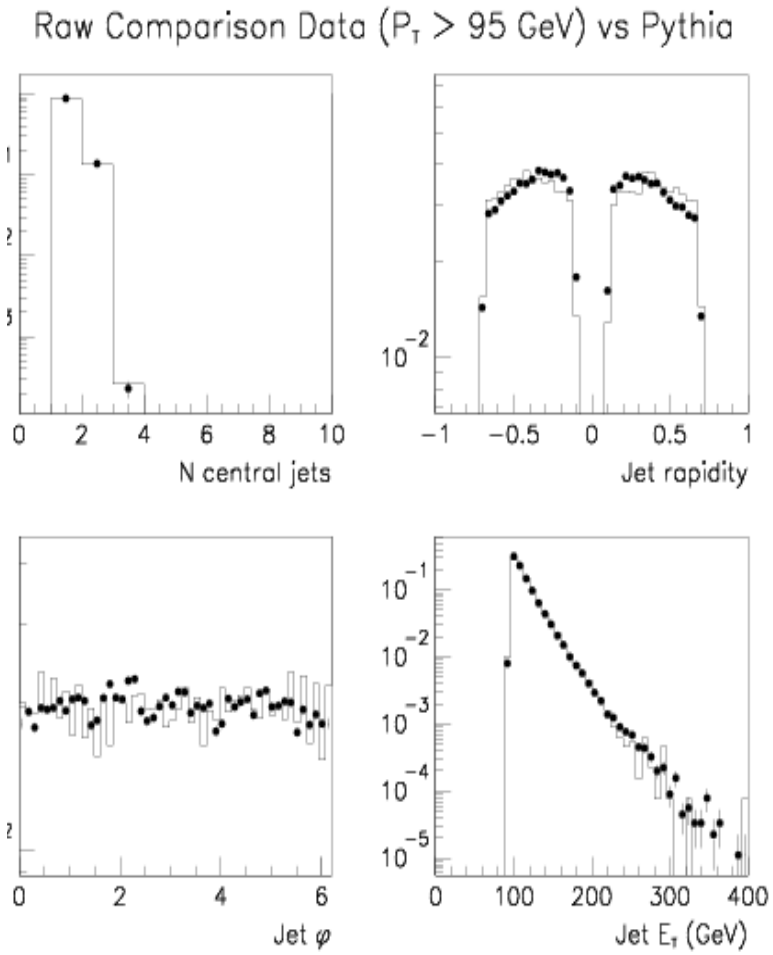




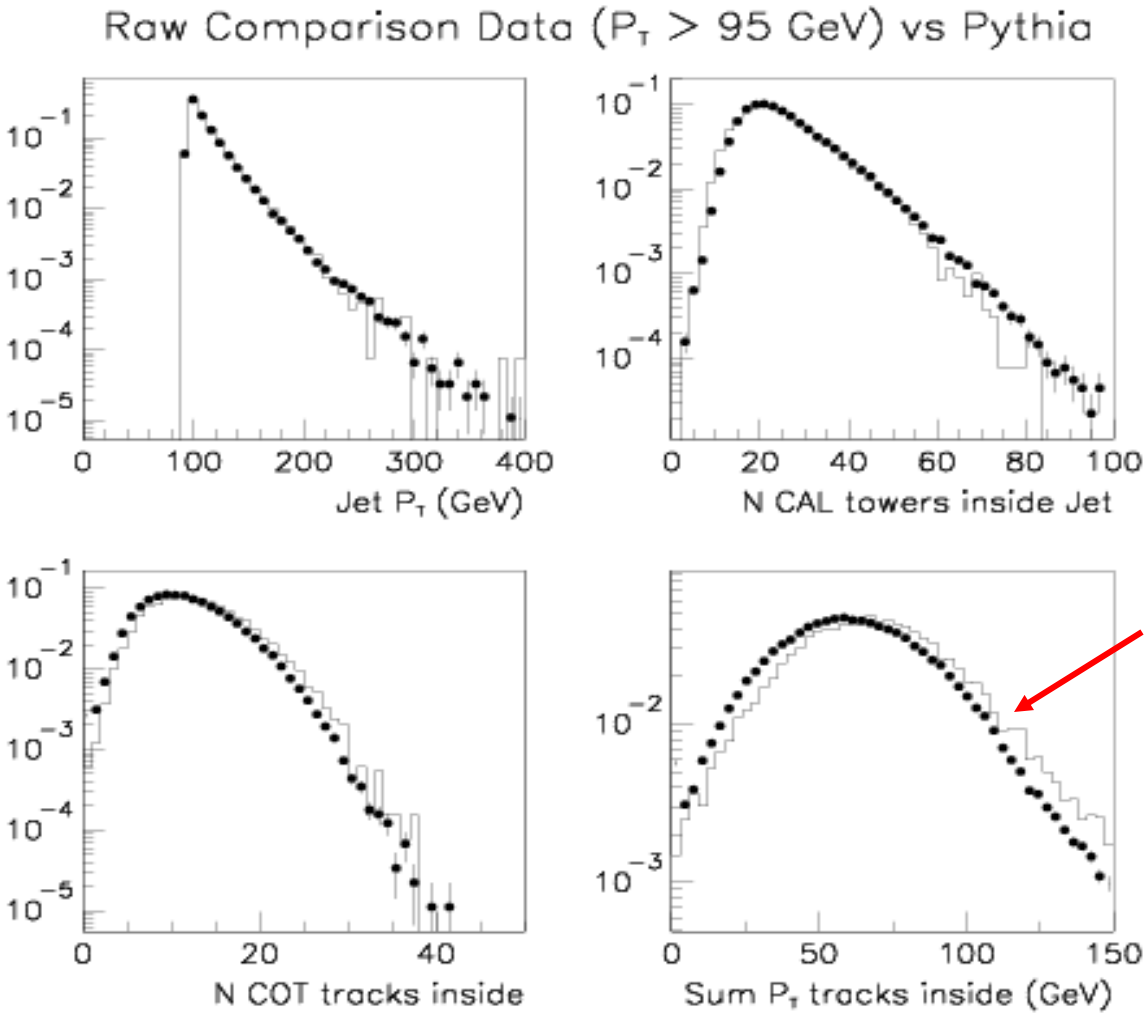
..more central…better agreement…

Some Control Plots (IIb)





Some Control Plots (IIc)



Effect of tracking inefficiency at high Pt(jet)

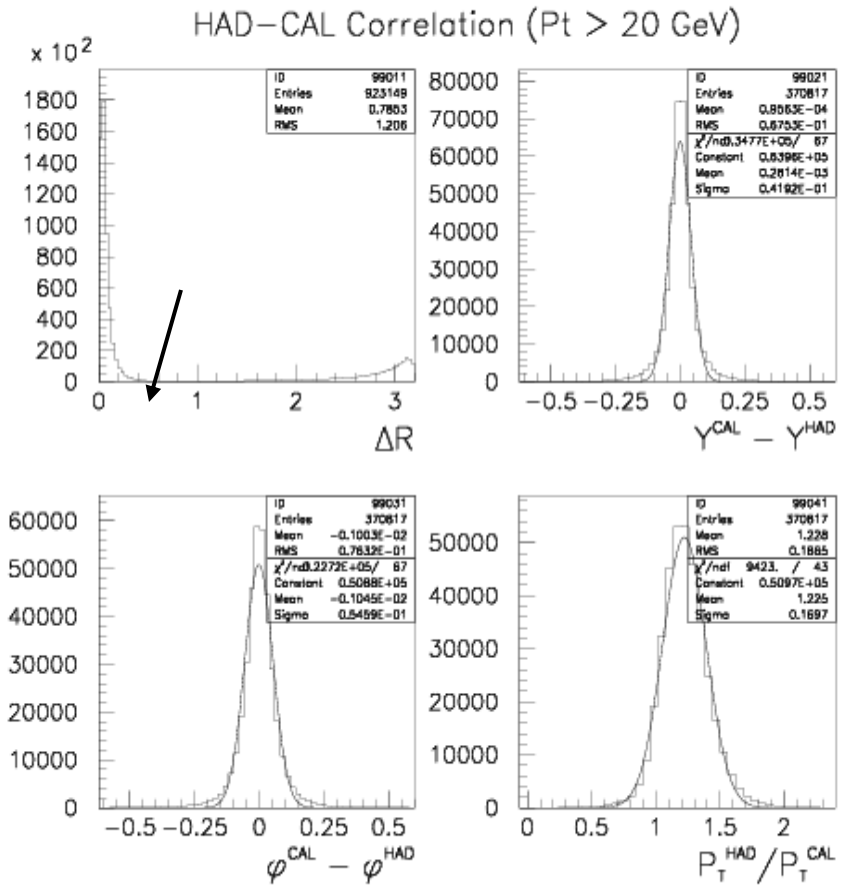
Global reasonable agreement….use MC to correct data in central region

Jet Energy Correction

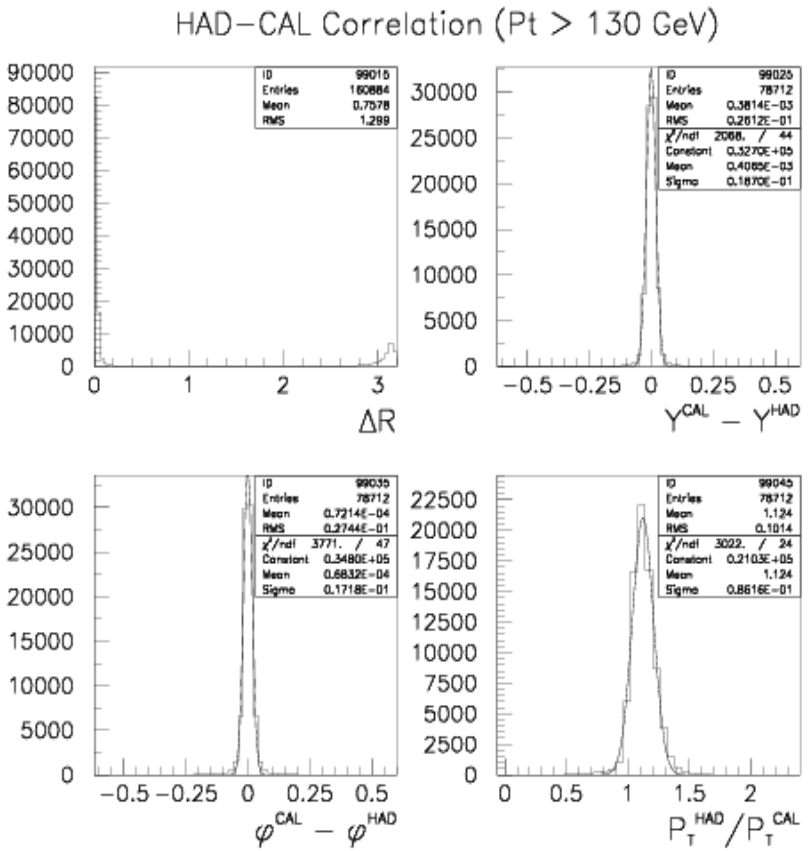
- We intend to use the MC simulation to extract corrections to the hadron level
  - Run MidPoint at CAL and Particle Levels
  - Matching of pairs of leading jets (Y-phi)
  - Fit correlation HAD % CAL
- Be careful with choosing thresholds !
- Apply correction factor to data jet pt's….

…Matching jets….

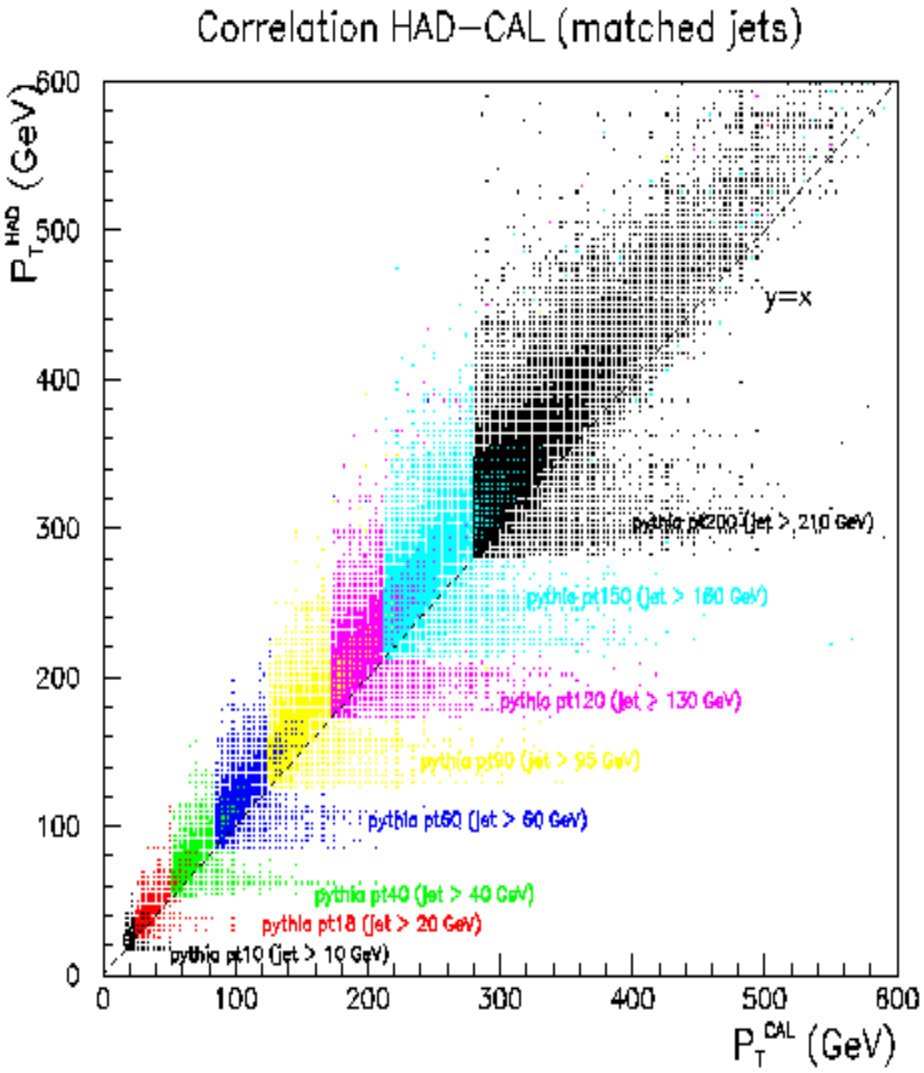
Pythia 18

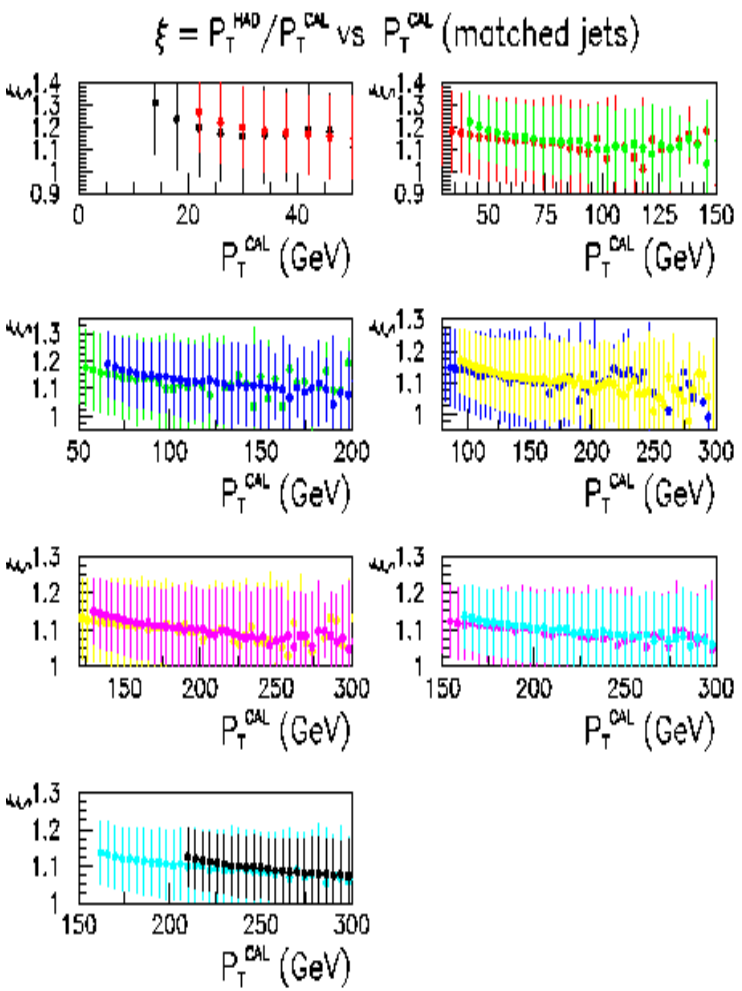


Pythia 120

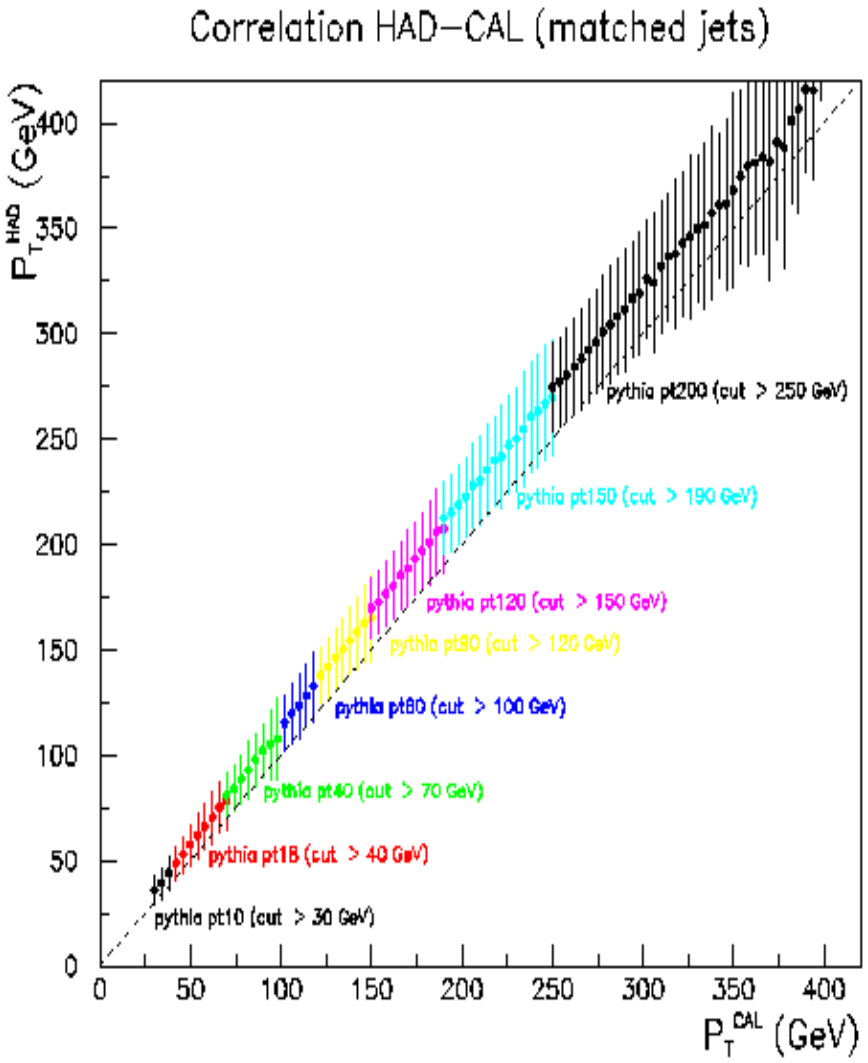


HAD-CAL Correlations (Ia)

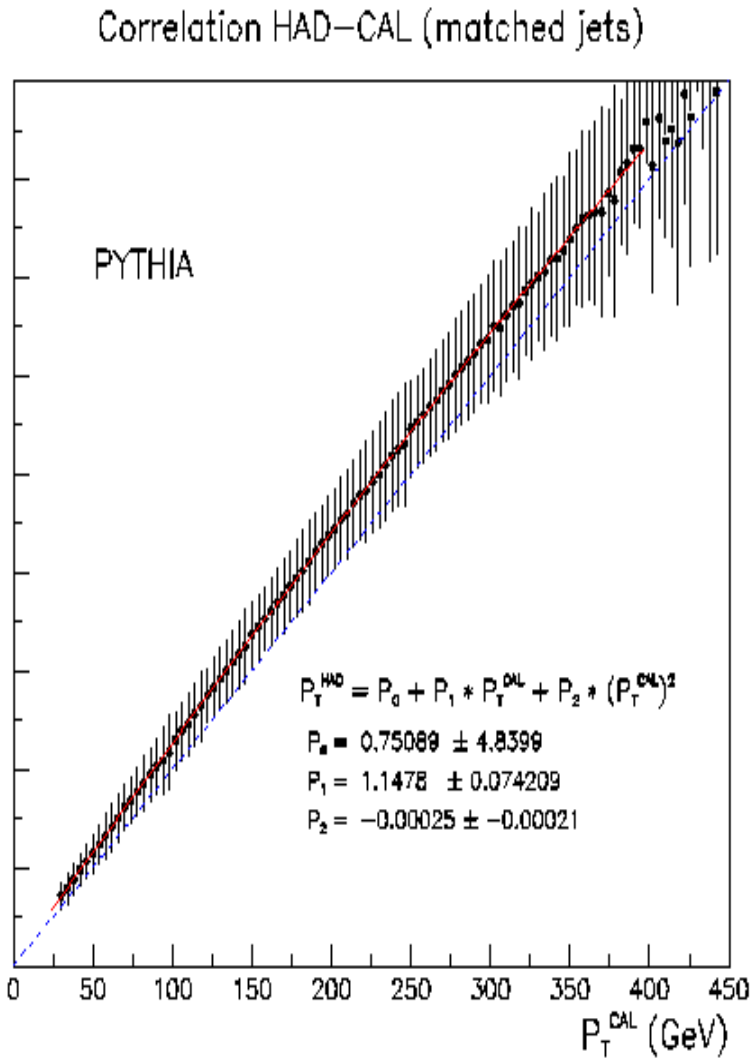




HAD-CAL Correlations (Ib)



pt10 used to validate pt18 GeV



…function applied to data..

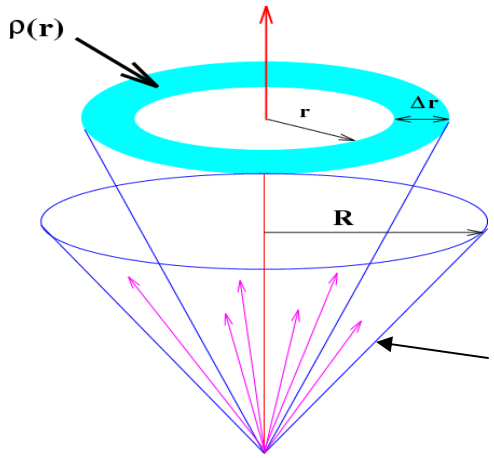
Pt - Binning

Jet Pt range (GeV)	Data Sample	MC pt hard (GeV)
37-45	ST5	18
45-55	ST5	18
55-63	J20	18
63-73	J20	18
73-84	J20	18
84-97	J50	40
97-112	J50	40
112-128	J70	60
128-148	J70	60
148-166	J70	90
166-186	J100	90
186-208	J100	120
208-229	J100	120
229-250	J100	150
250-277	J100	150
277-304	J100	200
304-340	J100	200
340-380	J100	200

Bin sizes according to resolution….and very safe selection of MC thresholds

Jet Shape Definition

Differetial Jet Shape



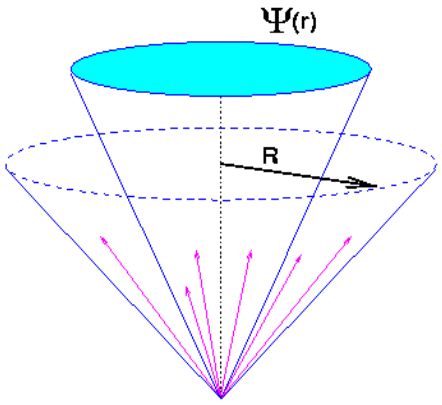
$0.5\,\mathrm{GeV} < P_T^{track} < 100\,GeV$

$|\eta^{track}| < 1.5$

$|z^{track} - V_z| < 2\,\mathrm{cm}$

$\Delta R(\mathrm{track - jet}) < 0.7$

Integrated Jet Shape Definition



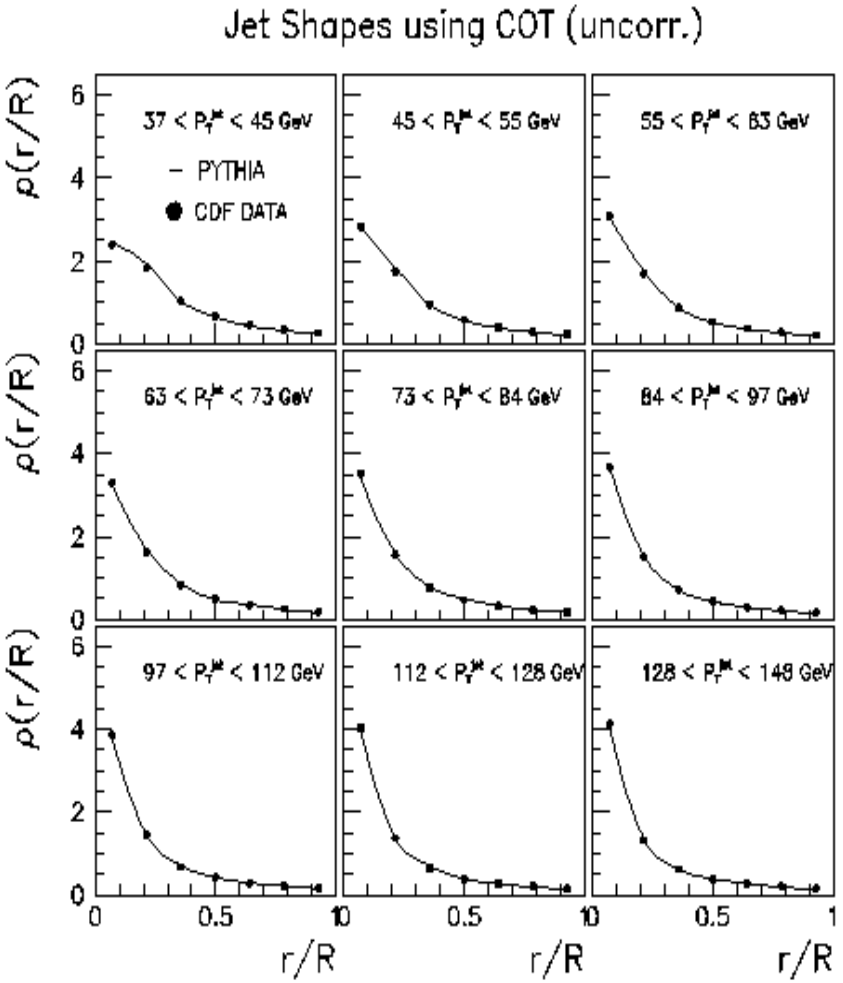
$$\rho(r) = \frac{1}{\Delta r}\frac{1}{N_{jet}}\sum_{jets}\frac{P_T(r \pm \Delta r/2)}{P_T(0,R)}$$

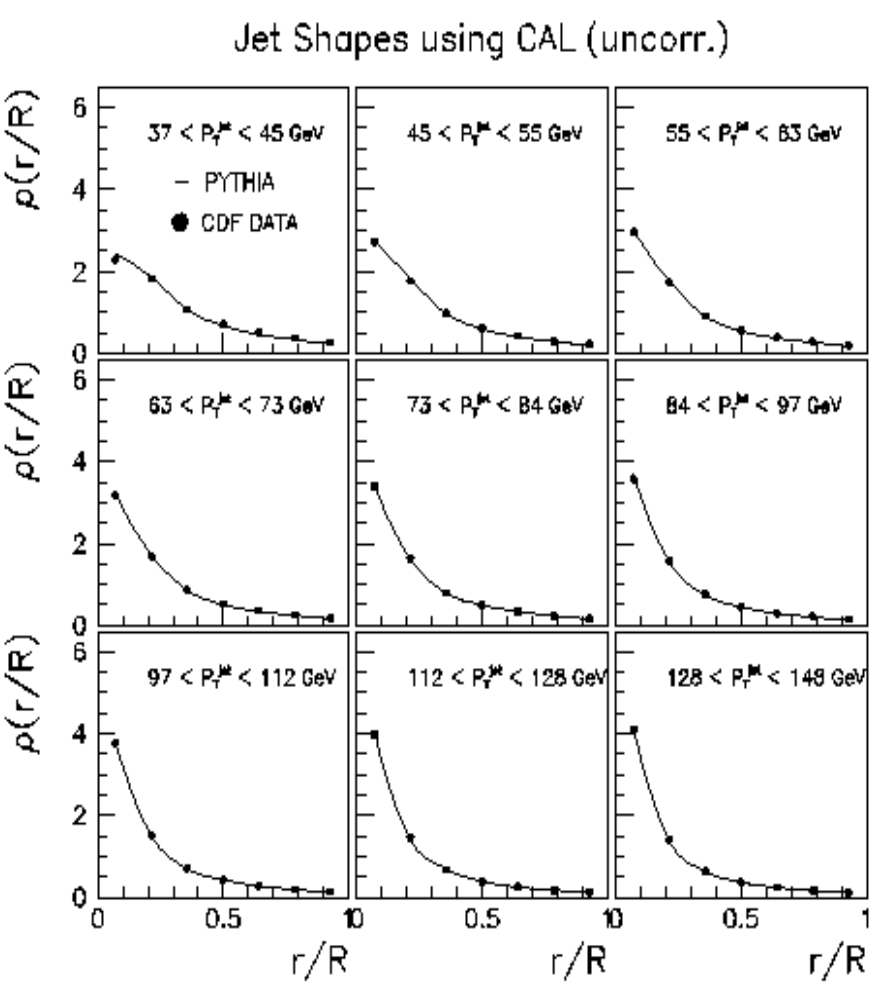
$$\Psi(r) = \frac{1}{N_{jets}}\sum_{jets}\frac{P_T(0,r)}{P_T(0,R)}$$

$$\pi(r) = \frac{1}{\Delta r}\frac{1}{N_{jet}}\sum_{jets}\frac{N^{tracks}(r \pm \Delta r/2)}{N^{tracks}(0,R)}$$

using both CAL and COT

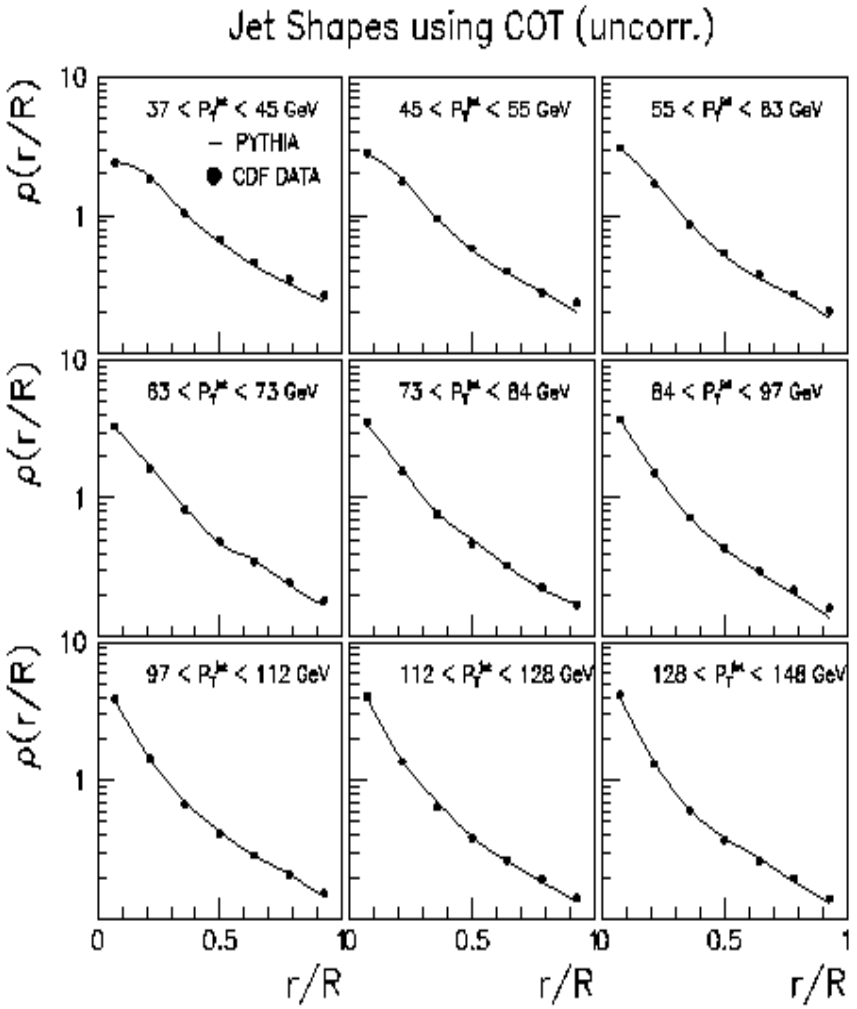
Uncorrected Jet Shapes(I)

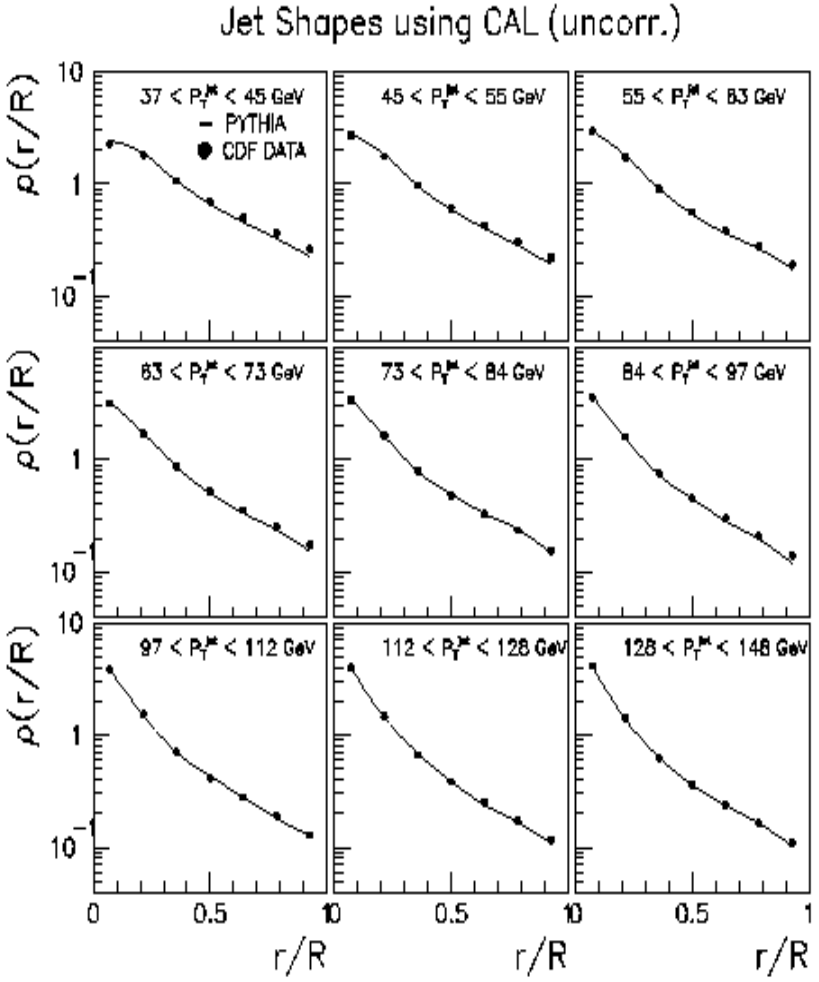




Good agreement data versus pythia…….let's look at jet tails…

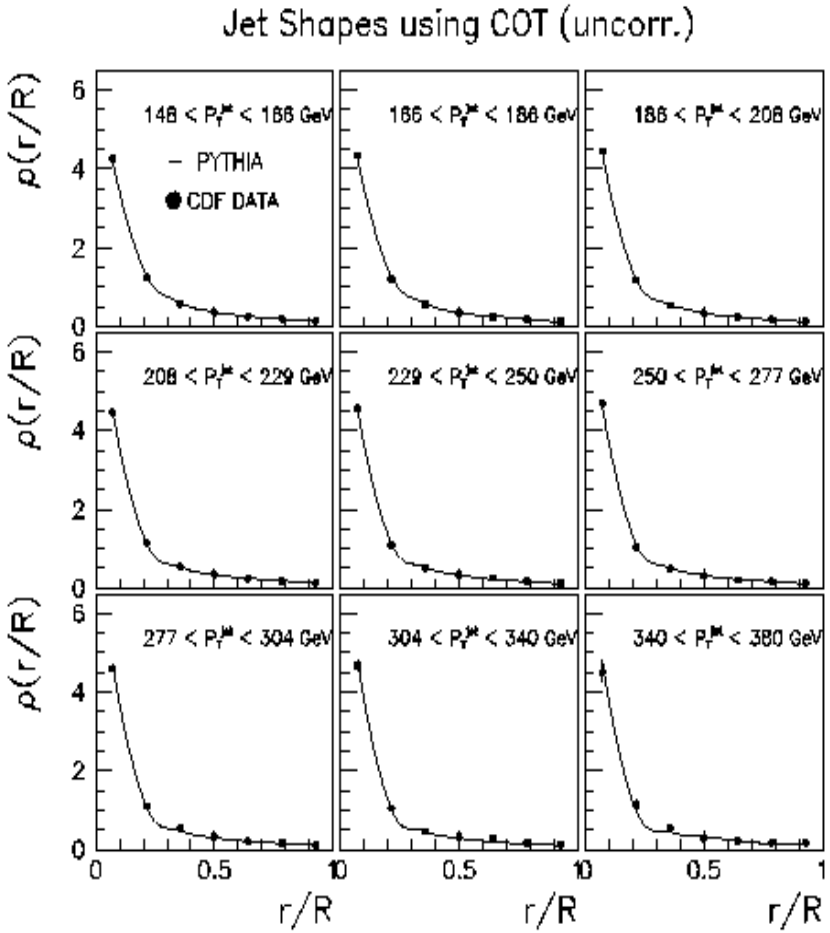
Uncorrected Jet Shapes(II)

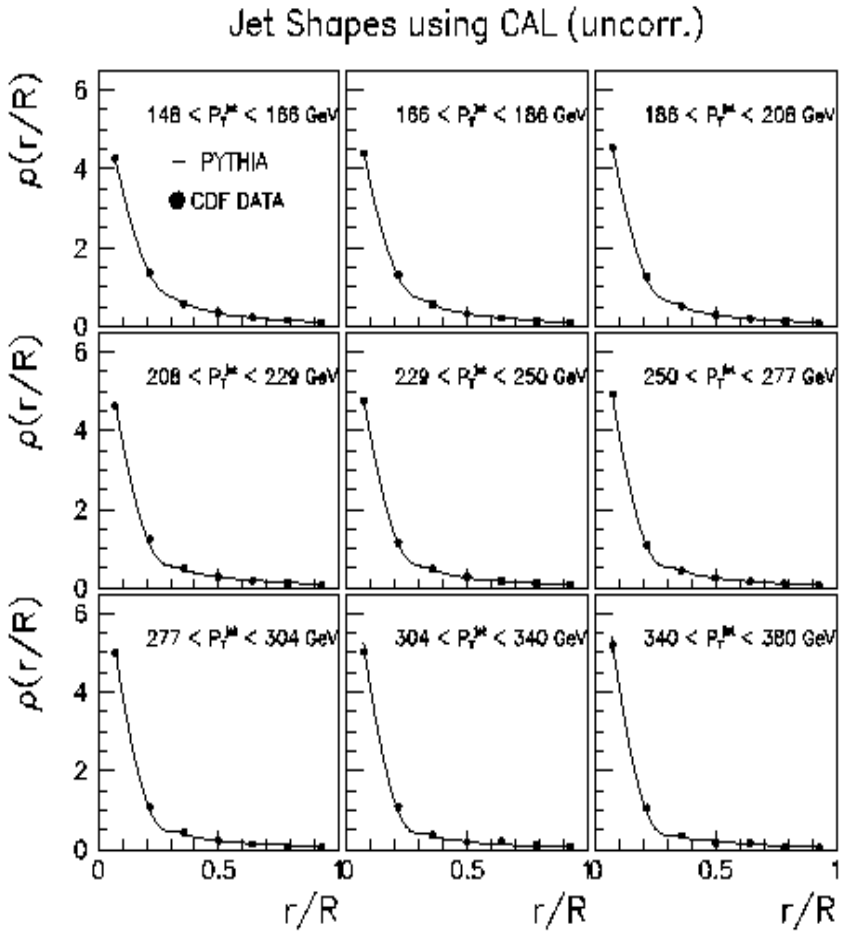




Good agreement data versus pythia…we will use pythia for unfolding…

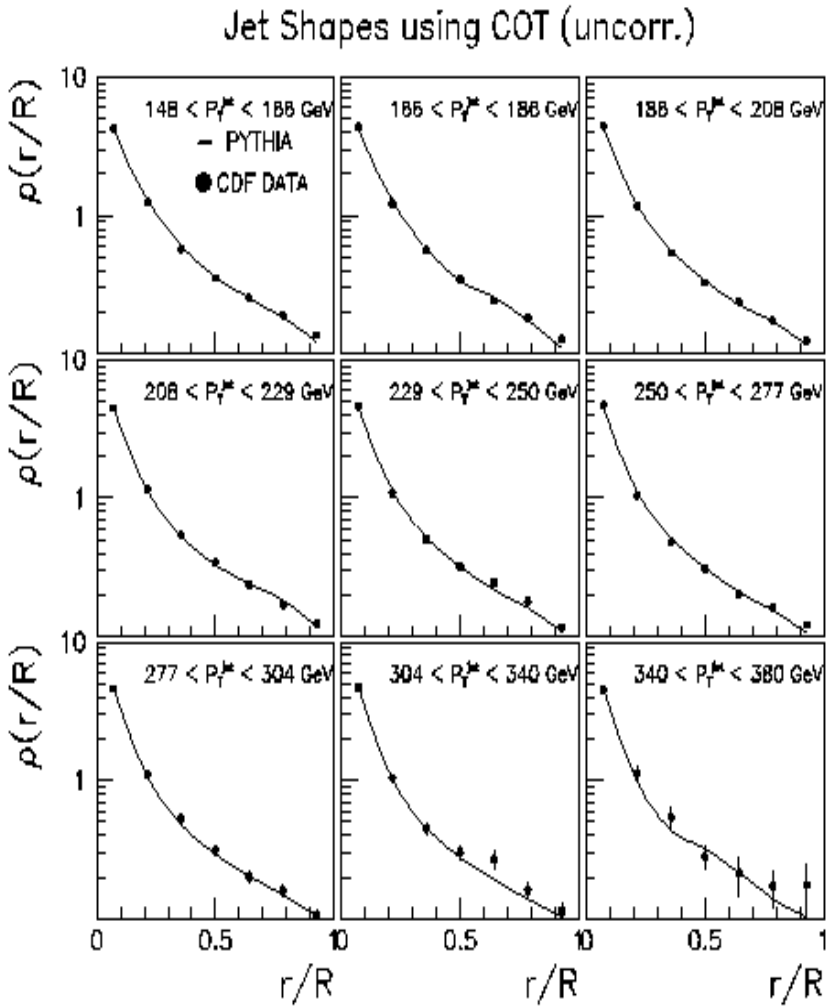
Uncorrected Jet Shapes (III)

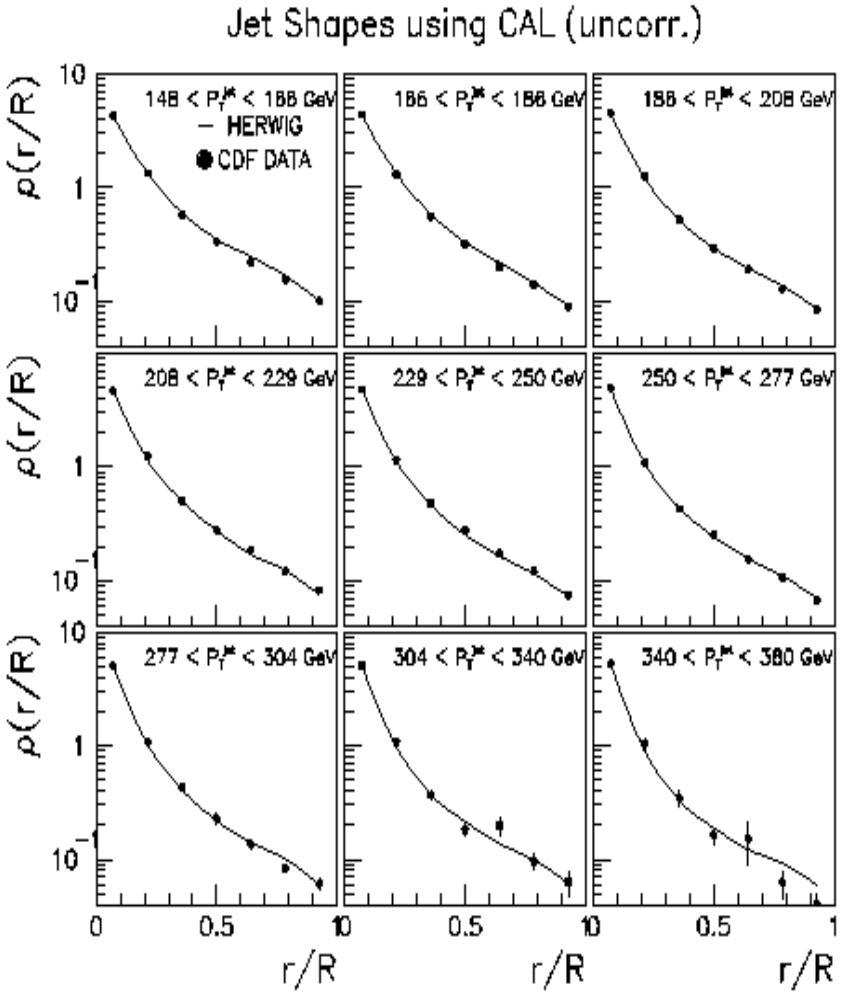




Good agreement data versus pythia…….let's look at jet tails…

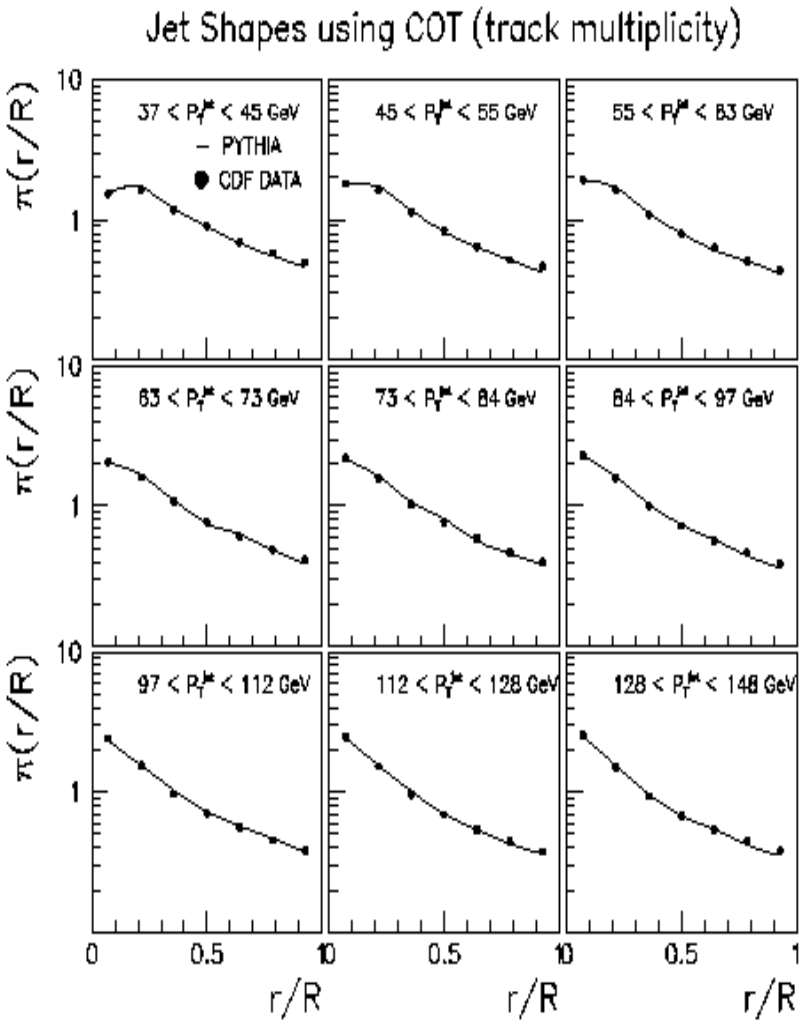
Uncorrected Jet Shapes (IV)

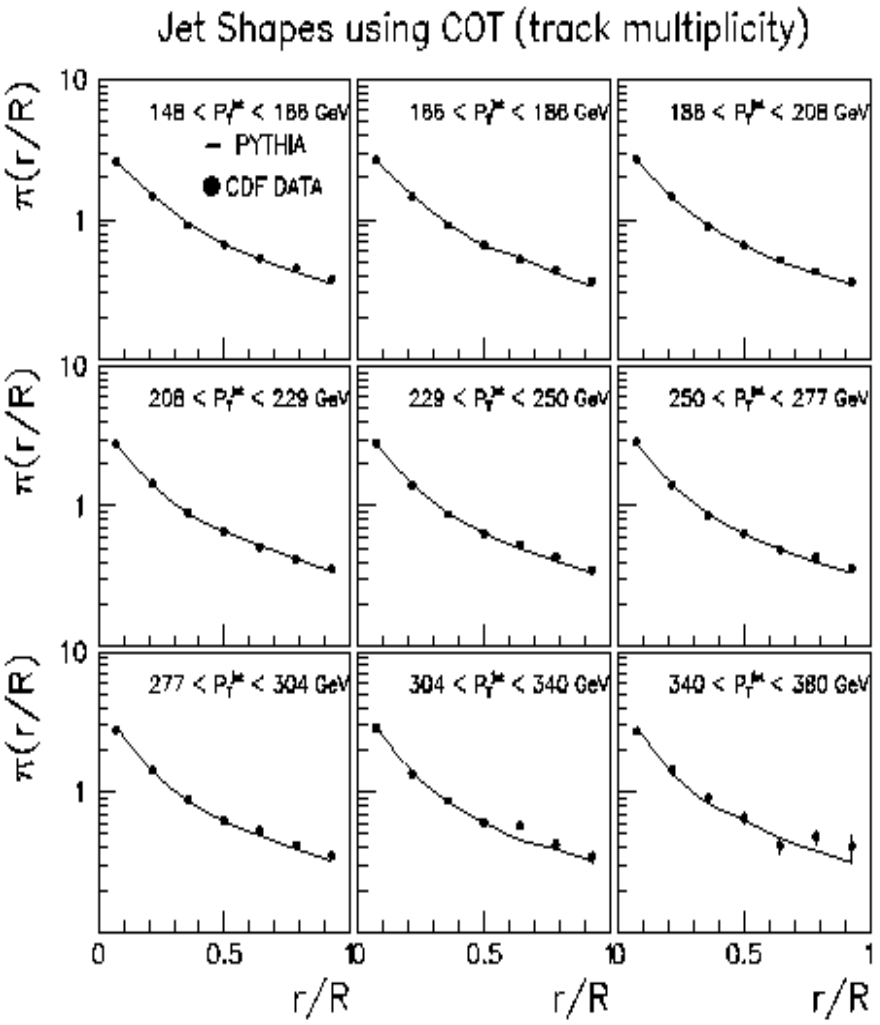




Good agreement data versus pythia…we will use pythia for unfolding…

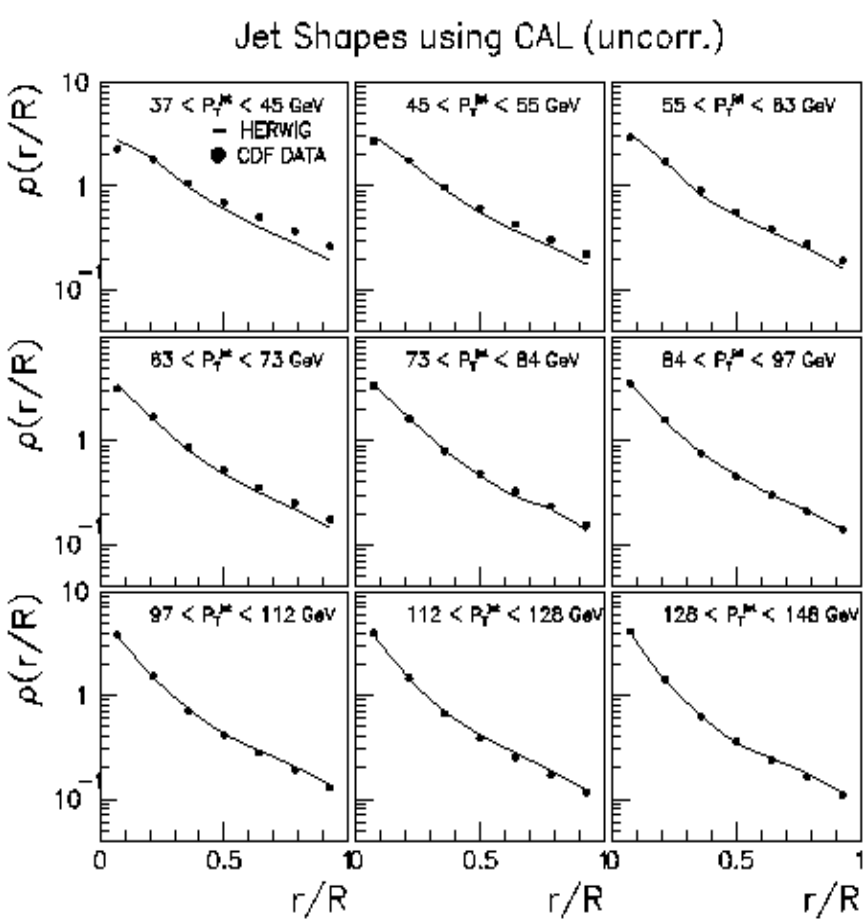
Uncorrected Jet Shapes (V)

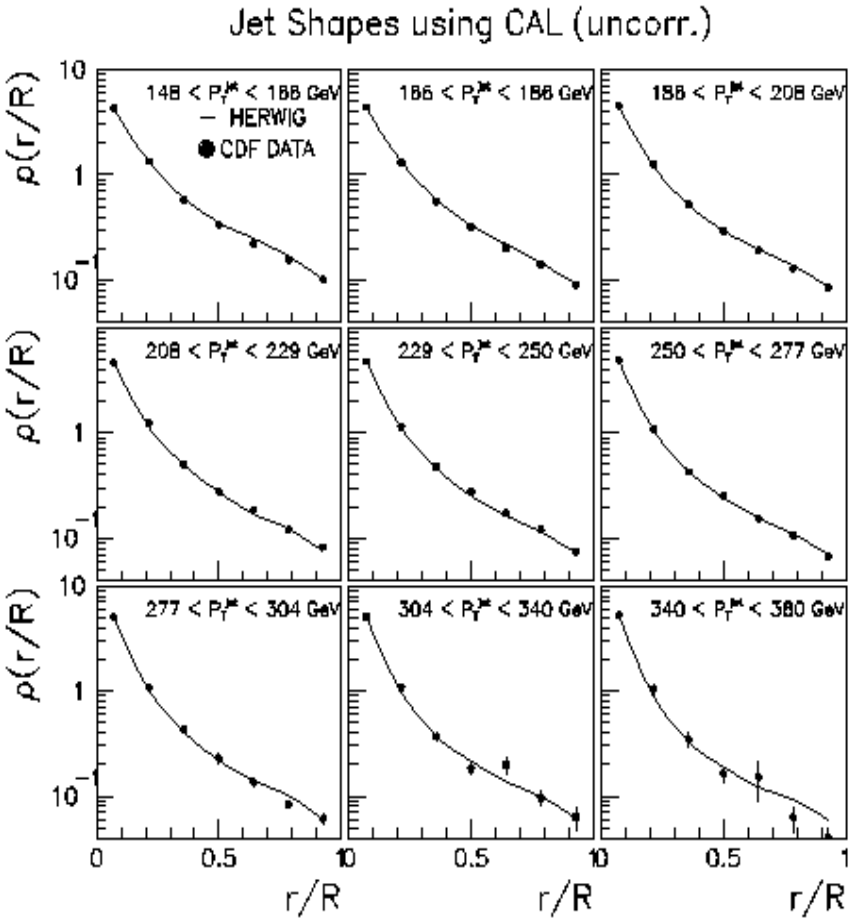




…not sensitive to track efficiency differences….

Comparison with HERWIG





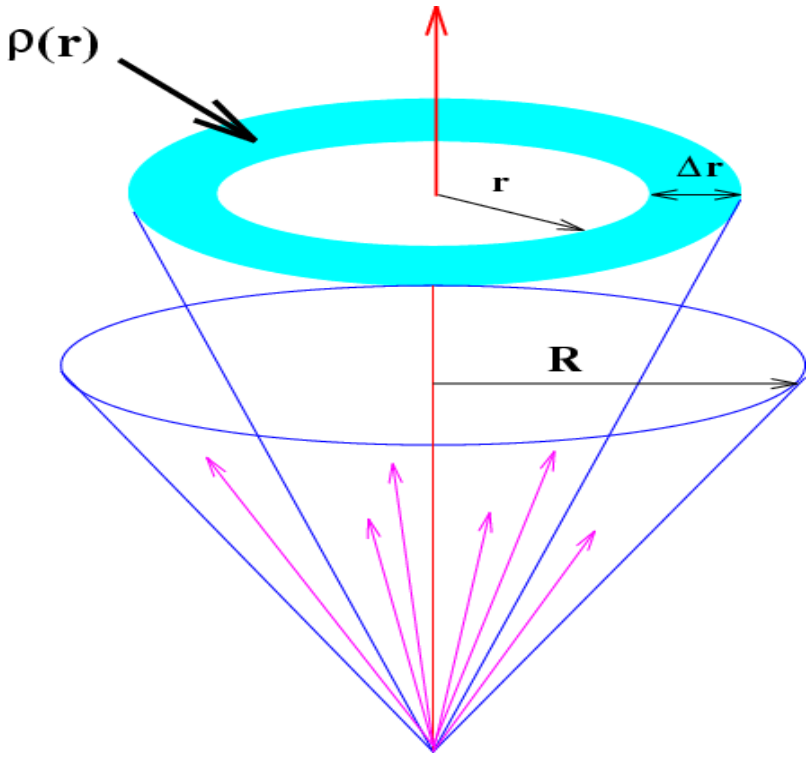
HERWIG produces narrower jets at low Pt

Unfolding Procedure

- Bin-by-bin unfolding correction extracted from MC Pythia

$$C(r, P_T^{jet}) = \frac{\rho^{\text{detector}}(r, P_T^{jet}(cal \text{ corrected}))}{\rho^{hadrons}(r, P_T^{jet}(hadron \text{ level}))}$$

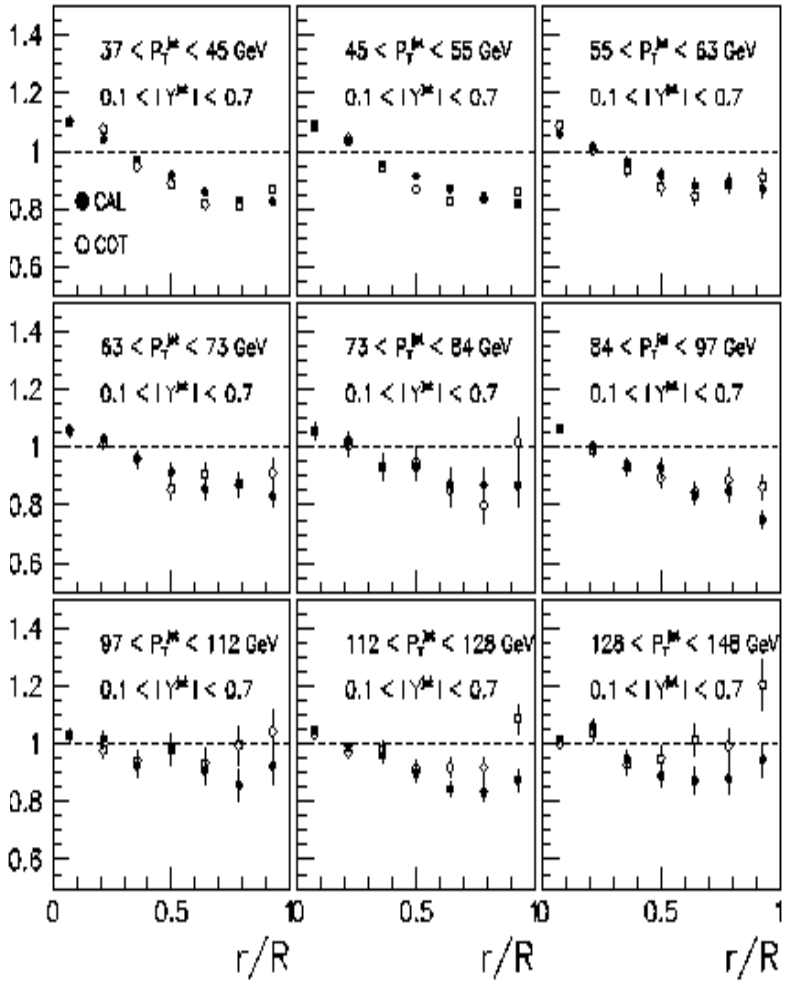
- Jets and jet shapes reconstructed at particle level from HEPG stable particles and using MidPoint Algorithm



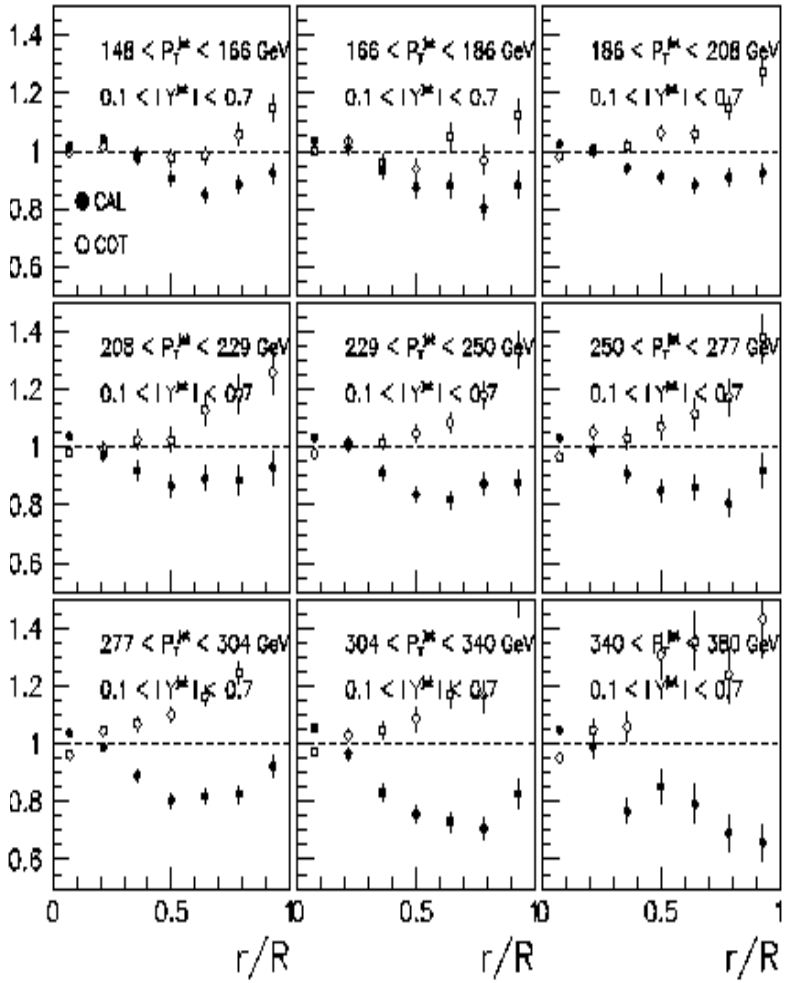
$$\rho(r) = \frac{1}{\Delta r}\frac{1}{N_{jet}}\sum_{jets}\frac{P_T(r \pm \Delta r/2)}{P_T(0,R)}$$

Corrections to hadron Level (I)

Det/Had correction to hadron level (pythia)



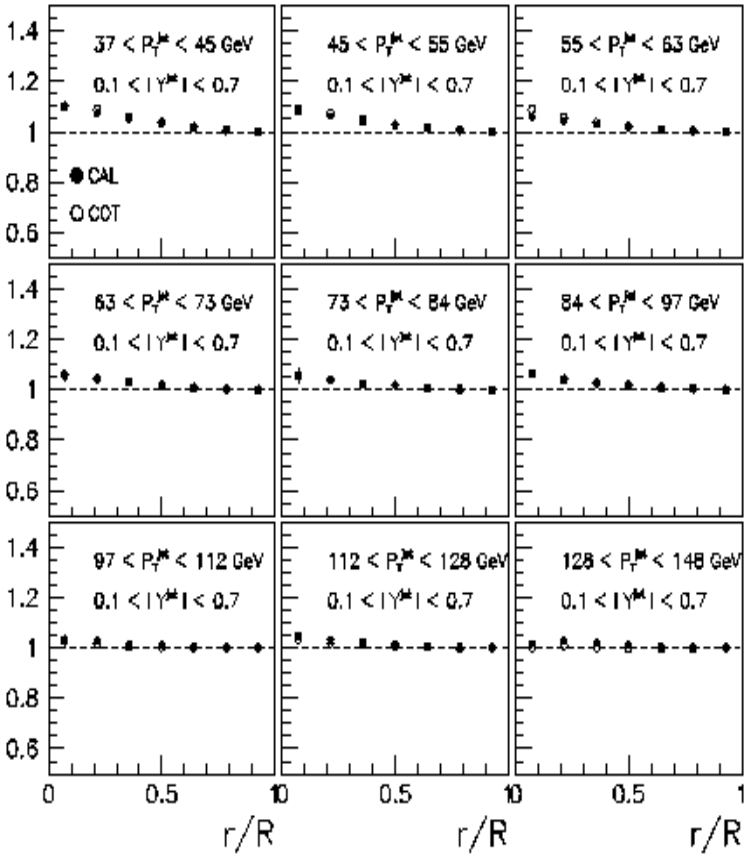
Det/Had correction to hadron level (pythia)



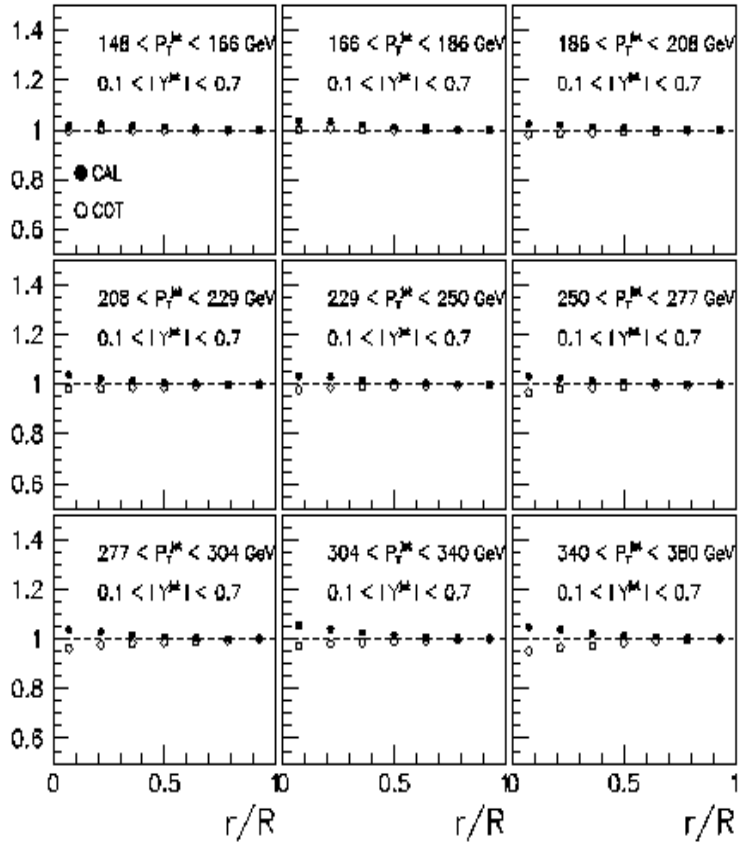
…lost of track efficiency at very high Pt…

Correction to hadron level (II)

Det/Had correction to hadron level (pythia)



Det/Had correction to hadron level (pythia)

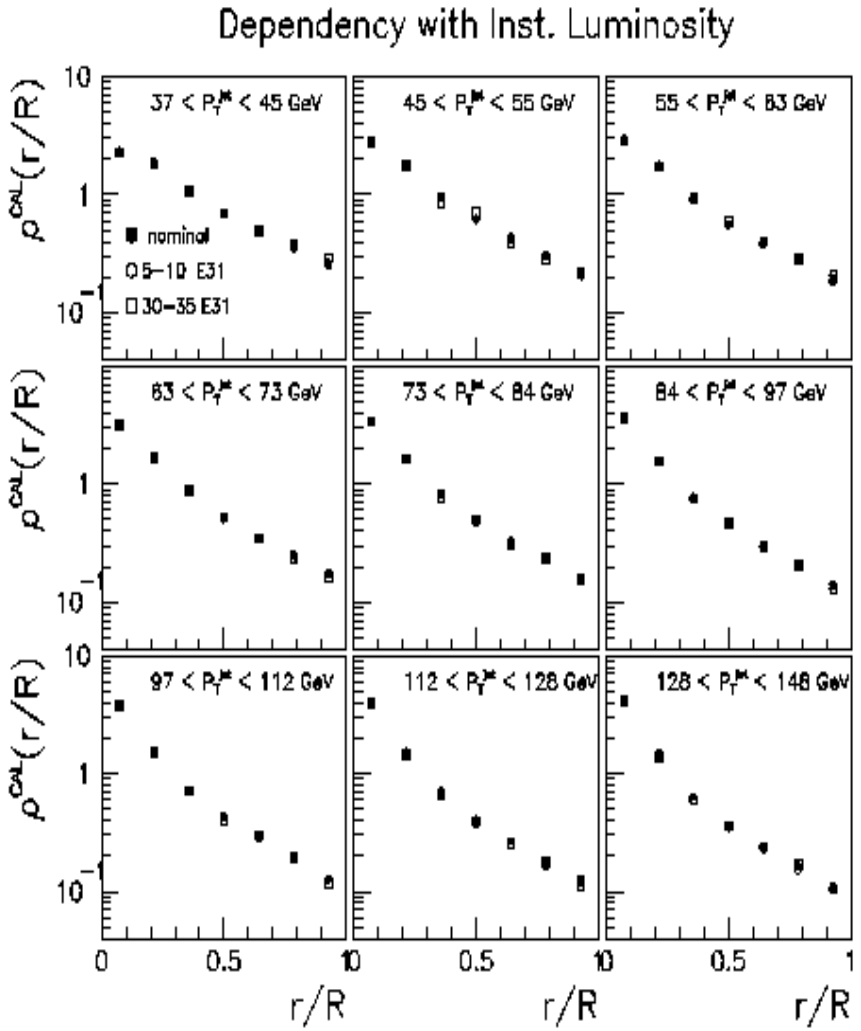


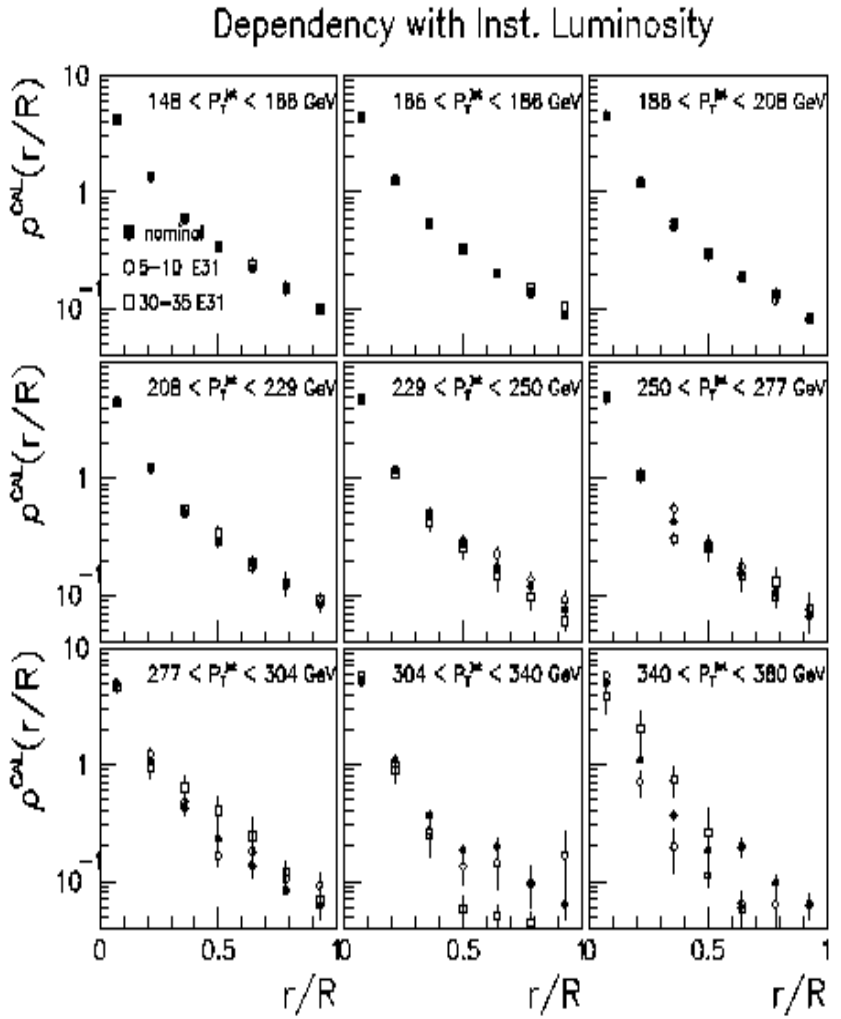
Corrections go to 1 at r=1 by definition….

Systematic Uncertainties

- Instantaneous Luminosity
  - Investigate possible dependence on Inst. Lumi (possible remaining effects on pile-ups ?)
- Jet Energy Scale:
  - 5% variation on measured jet energy
- Parton Shower Modeling
  - Unfolding using Herwig instead of Pythia
- CDF Simulation
  - Compute CAL/COT ratio of raw measurements and compare it with CAL/COT ratio in MC…if double ratio is not = 1 → included in systematics

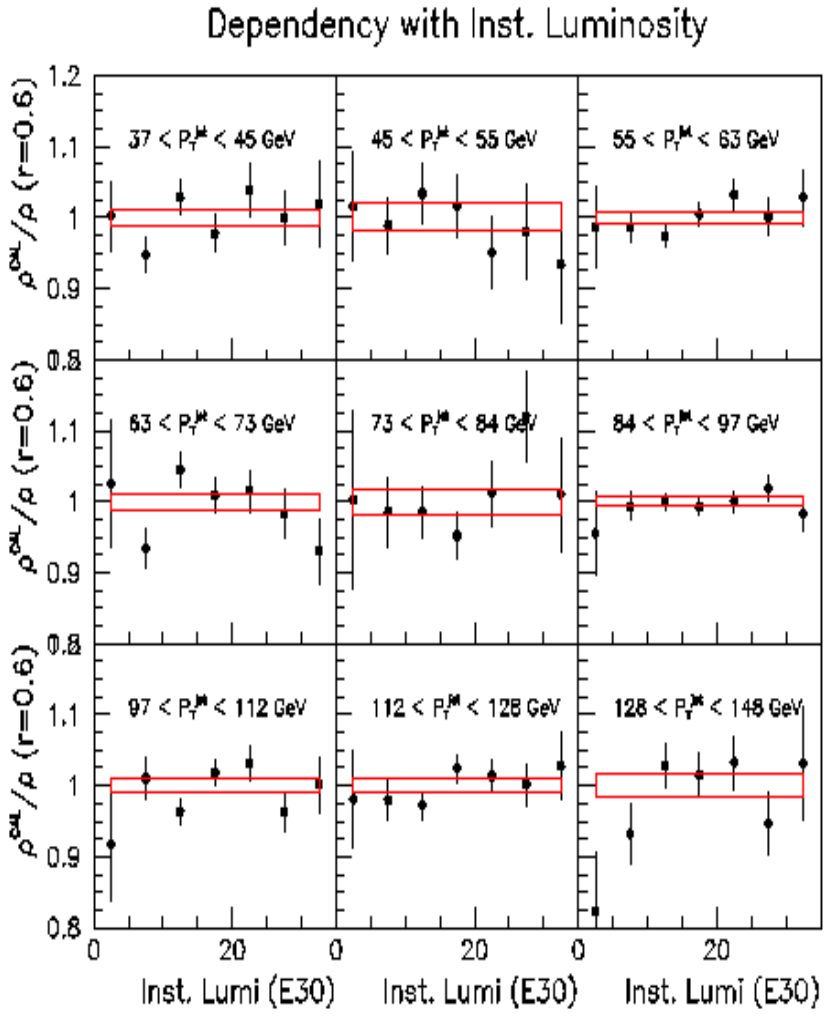
Inst. Luminosity Study (I)

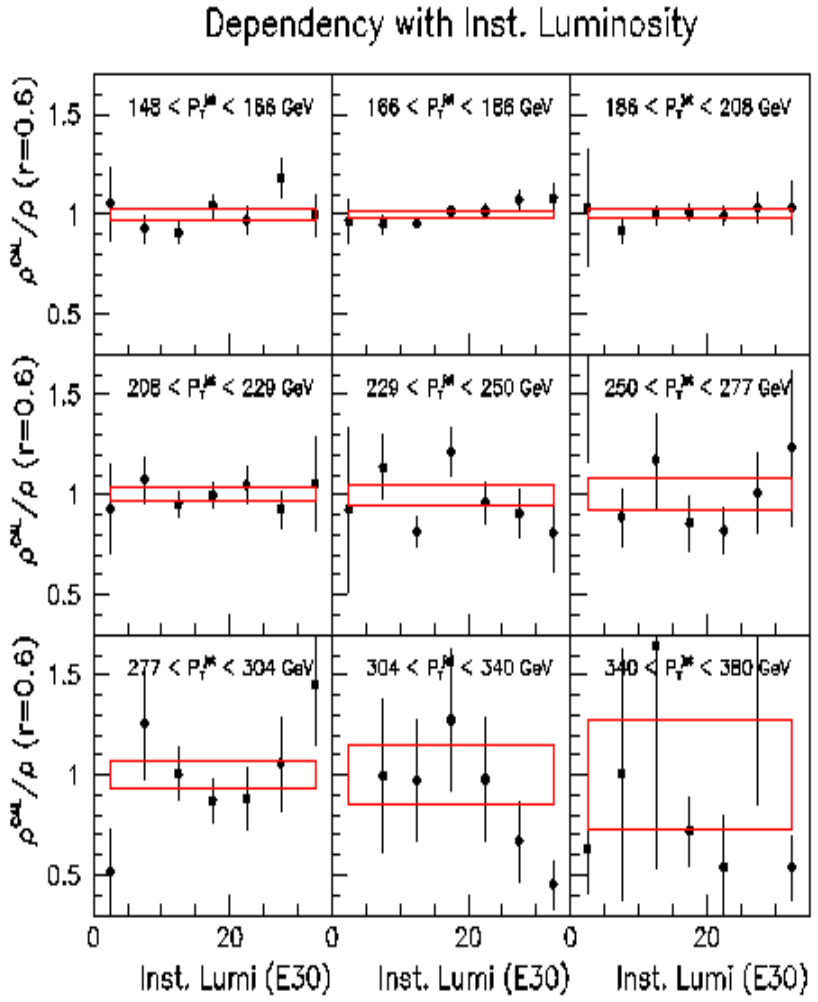




Points at tails …in principal sensitive to pedestals due to pile-ups..

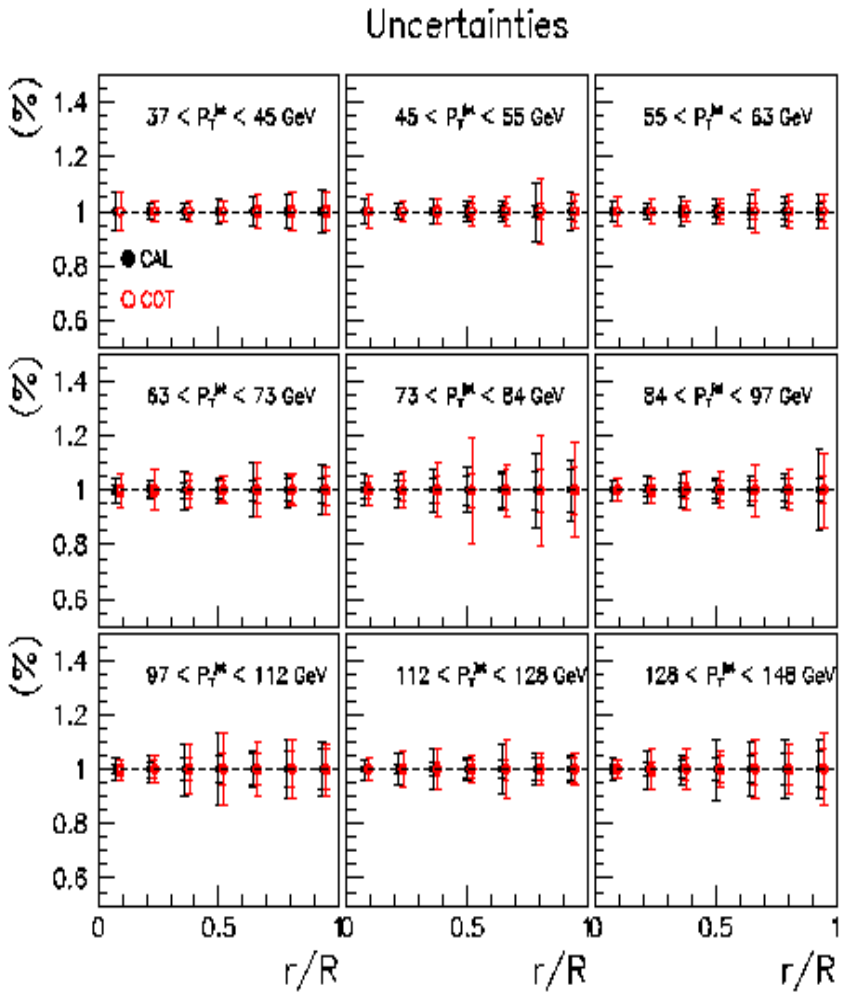
Inst. Luminosity Study (II)

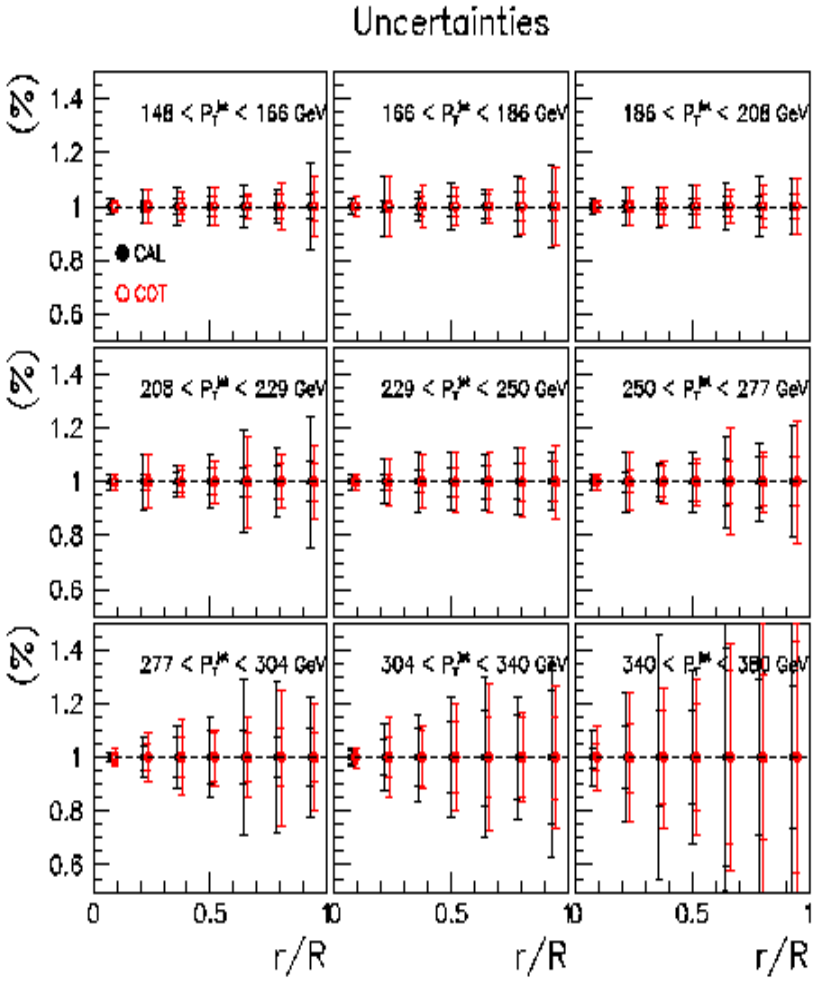




No systematic trend found ….no remaining effects from pile-ups..

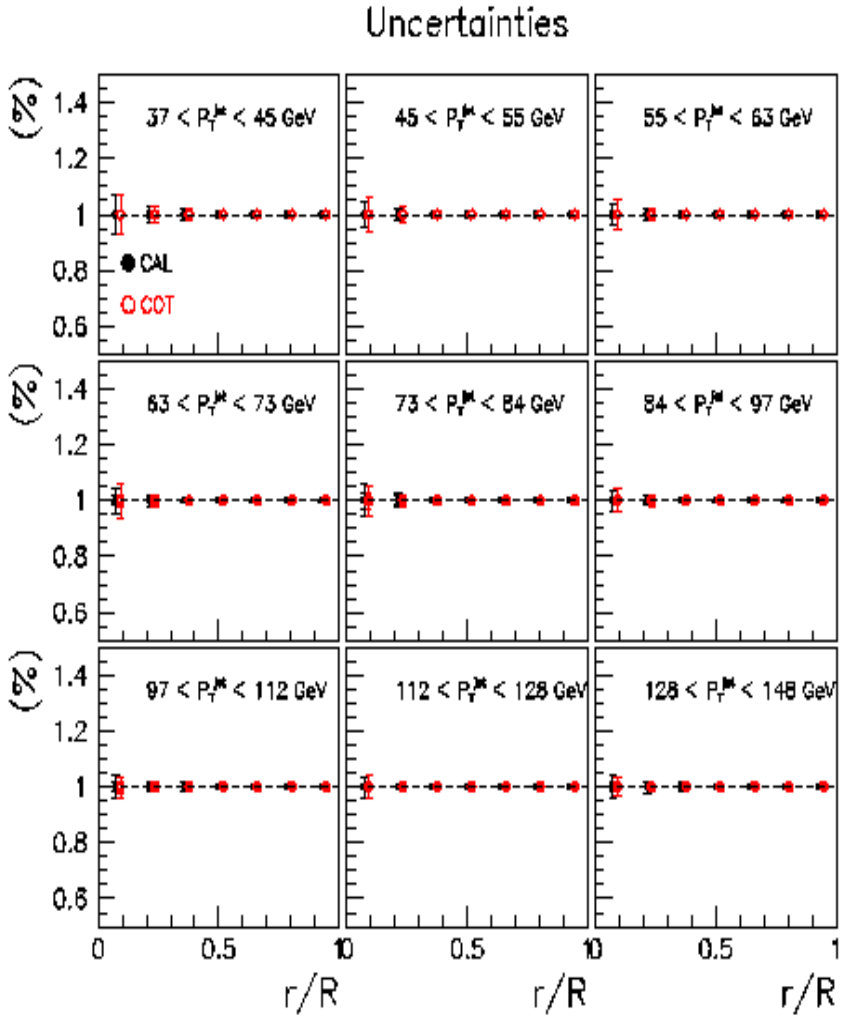
Total Uncertainty in ρ(r)

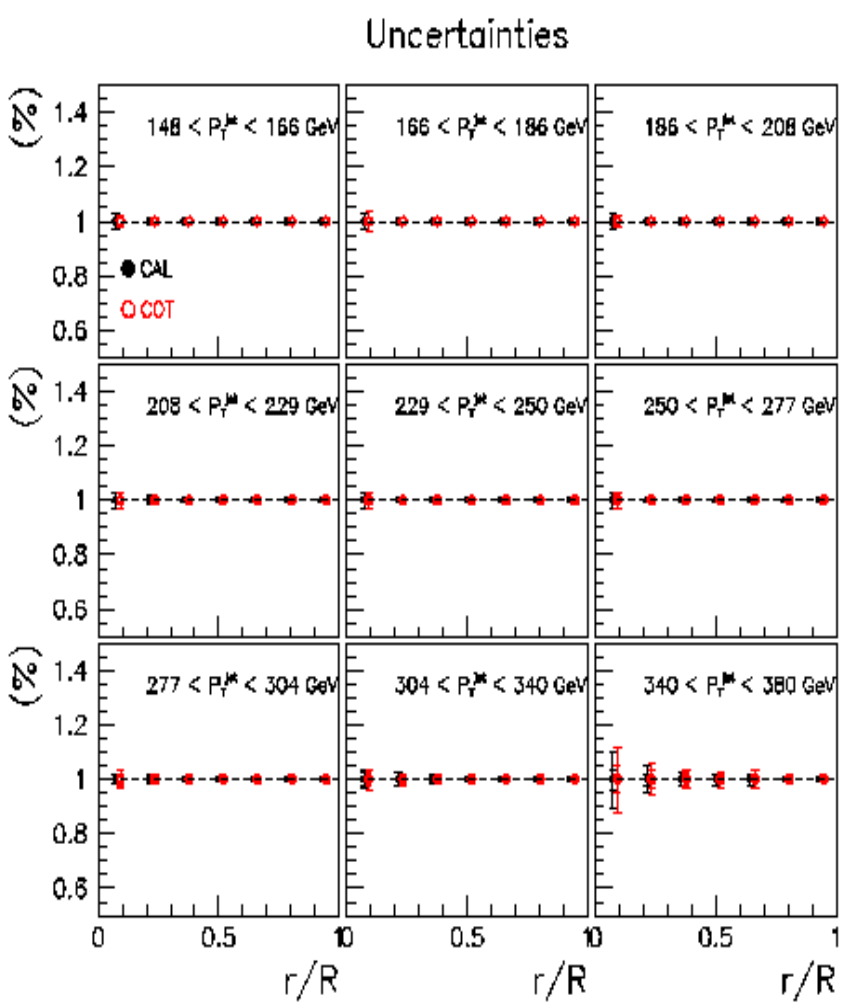




Systematics….some coupling with available MC & DATA statistics...☹

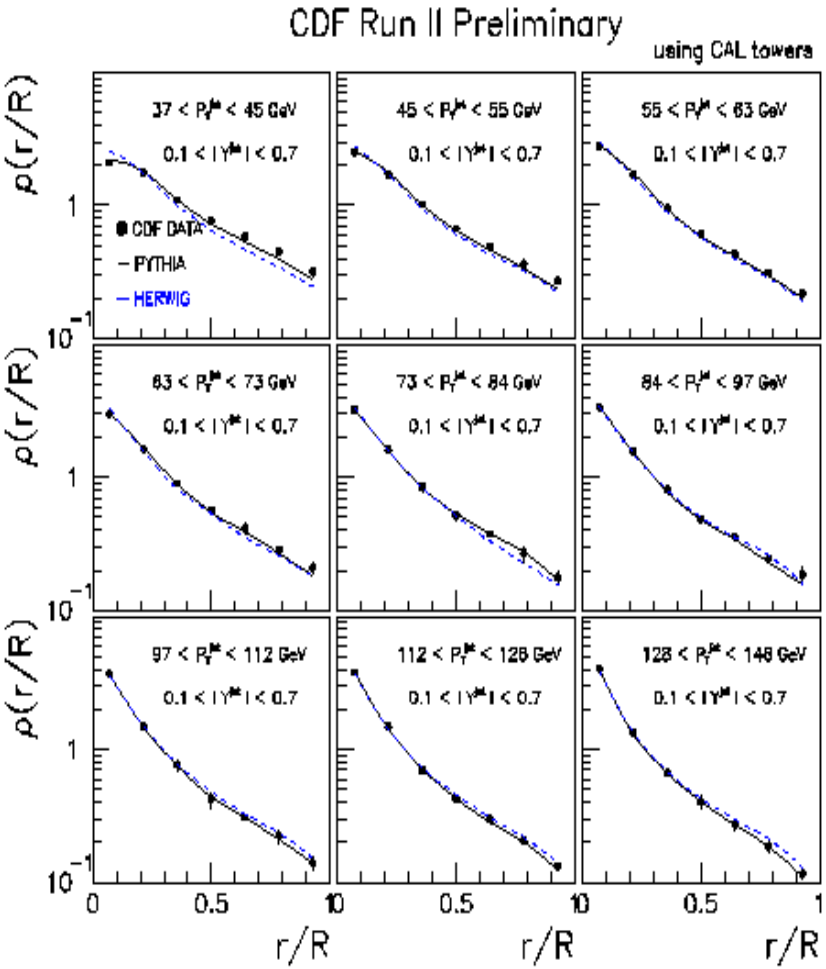
Total Uncertainty on $\Psi(r)$

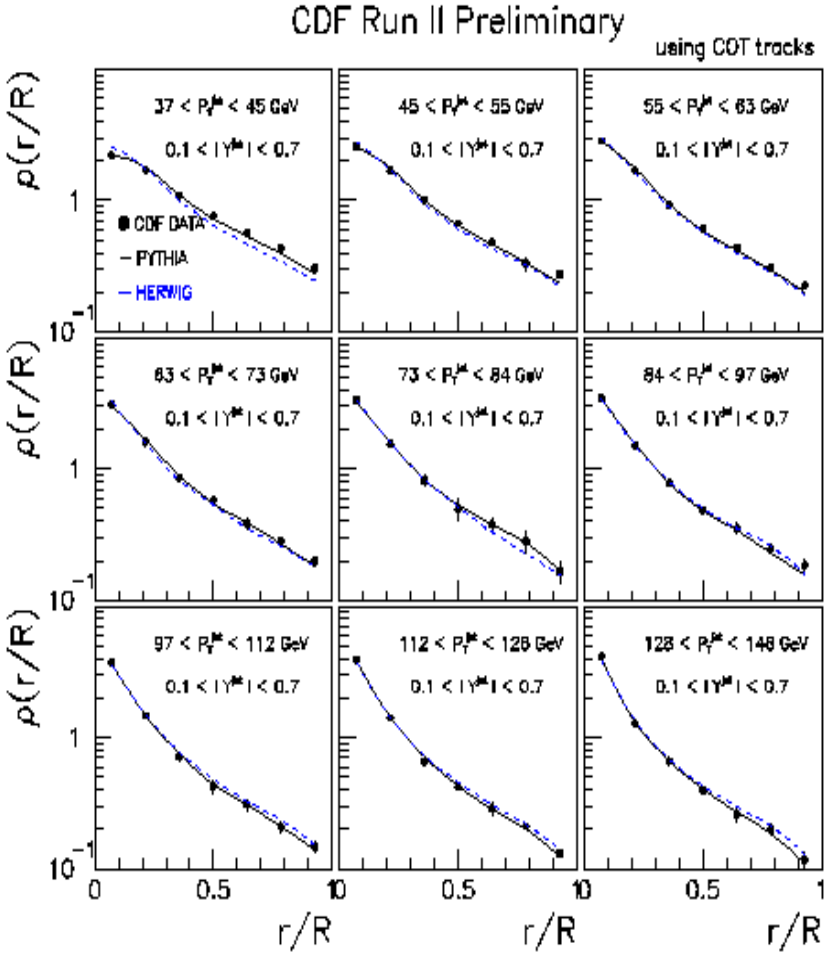




Only affects first points…by definition…

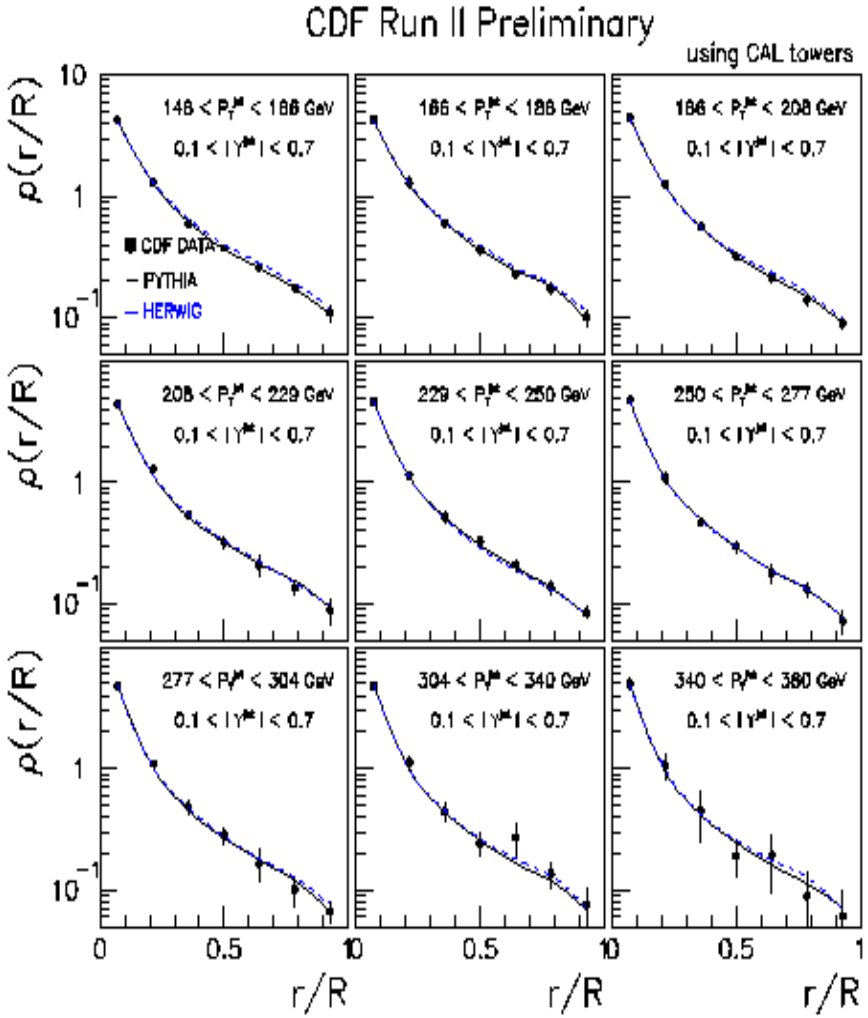
Results (I)

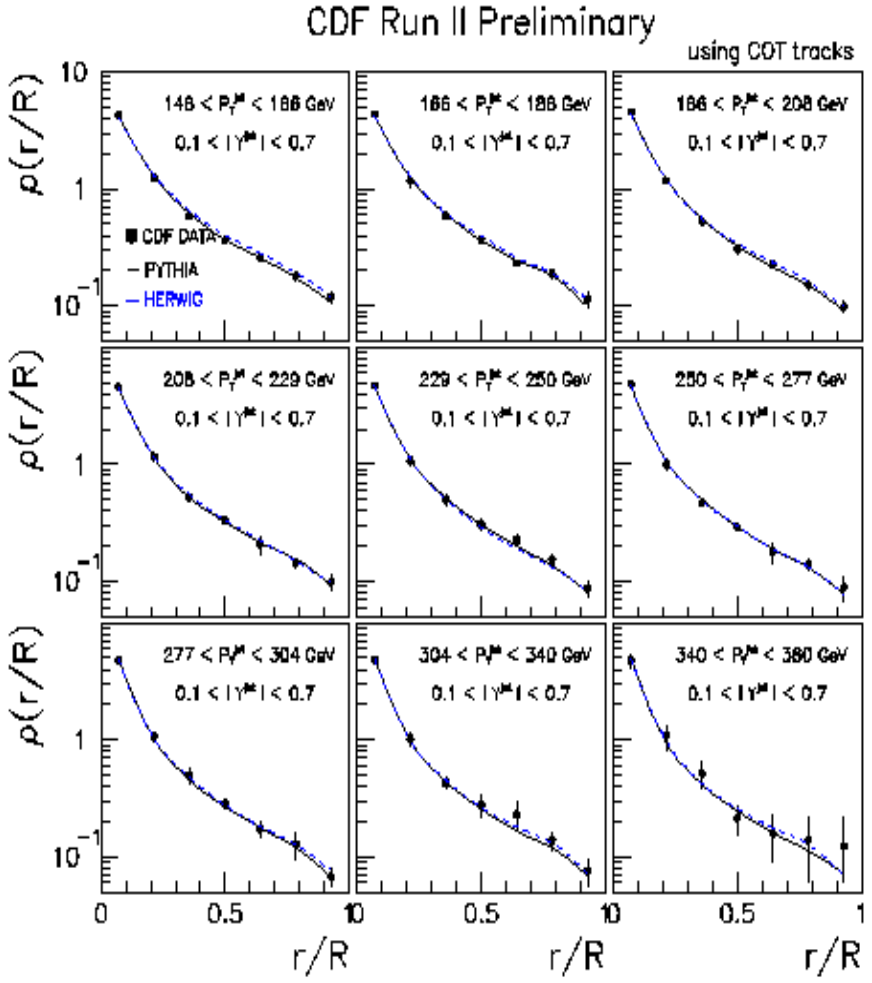




Good description by Pythia Tune A…Herwig narrower at low Pt

Results (II)





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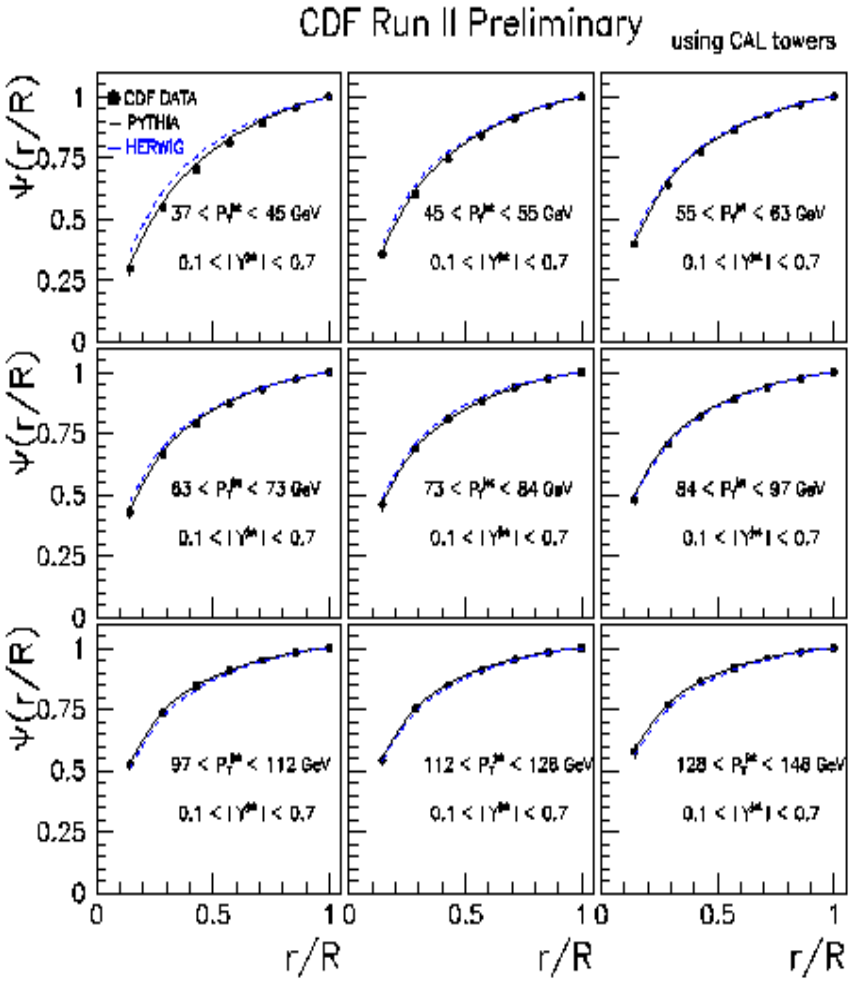
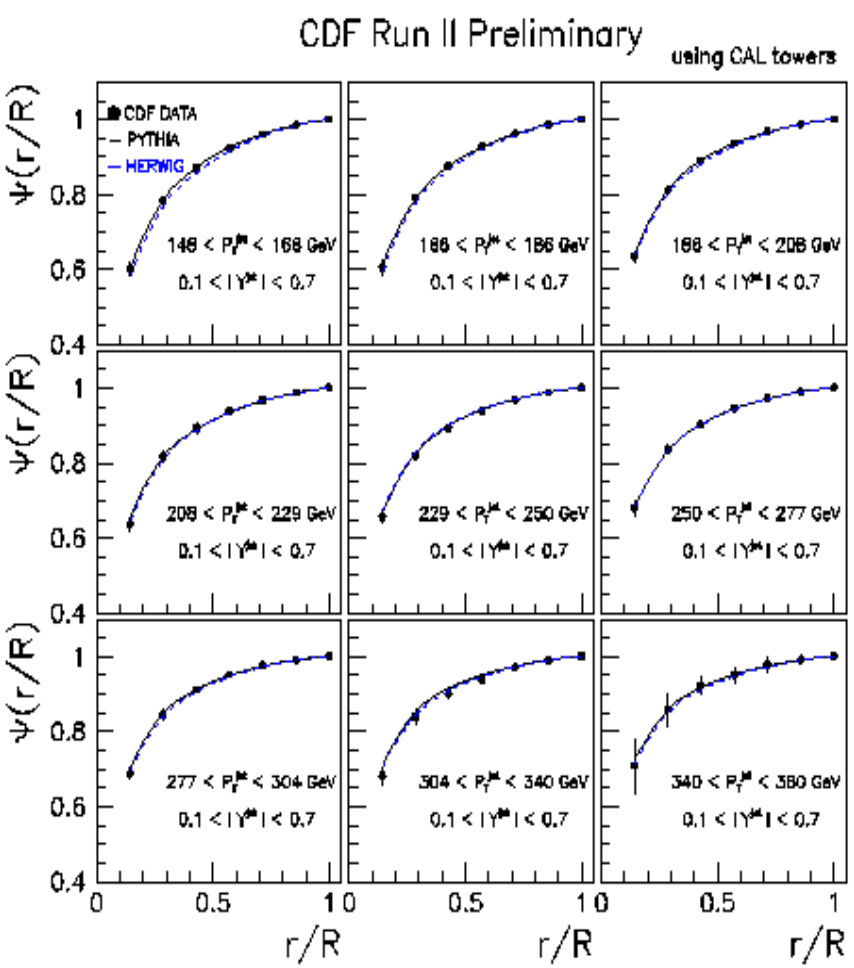
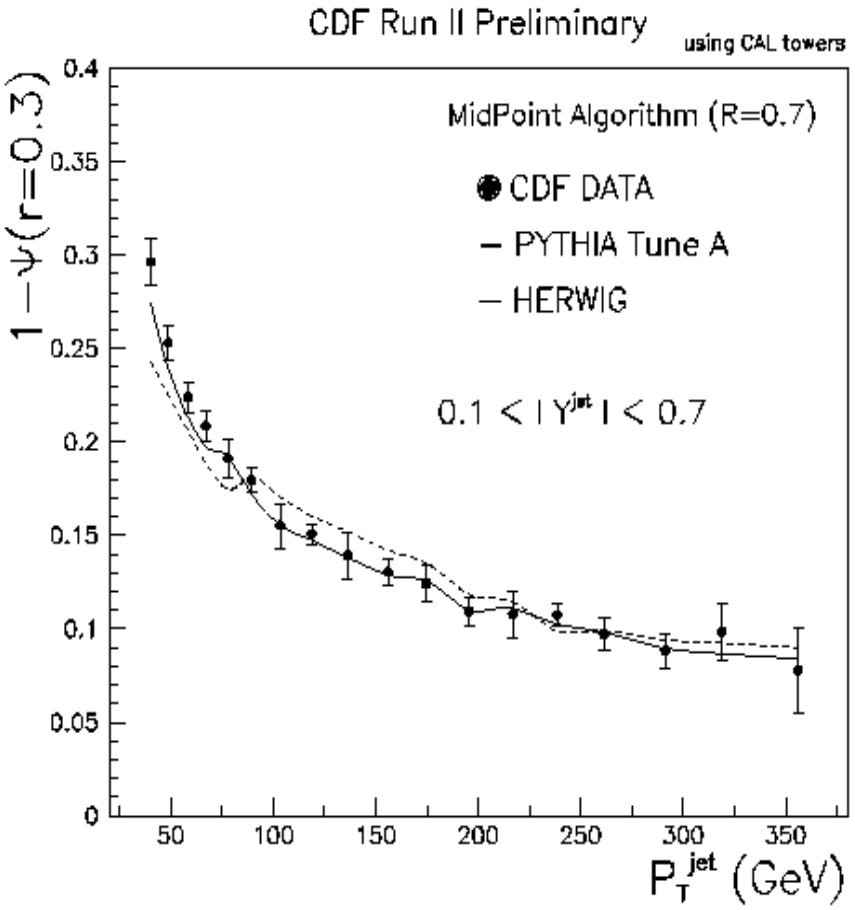
Results (III)

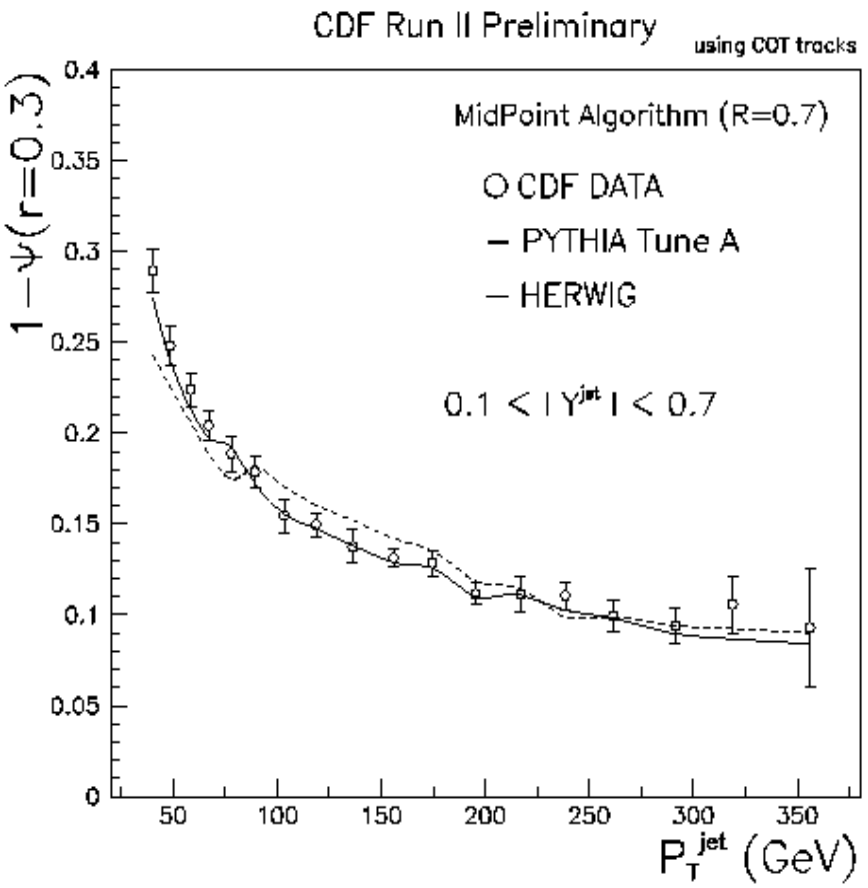




Good description by Pythia Tune A…Herwig narrower at low Pt

Results (IV)





Jets getting narrower as Pt increases…….running coupling..

Plans and Prospects

- Working on the paper draft and comparison with NLO parton level calculations…..