Inclusive Jet Cross Section

K_T Algorithm

Olga Norniella
IFAE-Barcelona

QCD Meeting November 12

Outline

- Inclusive Jet Cross Section using K_T algorithm

  Central and Plug Region

  → Trigger Efficiency Study

  → Comparison Data- MC

  → Average P_T^{Jet} corrections

  → Unfolding Procedure

  → Inclusive Jet Cross Section

  → Outlook

Analysis

➢ Inclusive Jet Cross Section using K_T algorithm
Central and Plug Region

→ Using v5.3.1 Data (analyzed using v5.3.3) and v5.3.3 MC

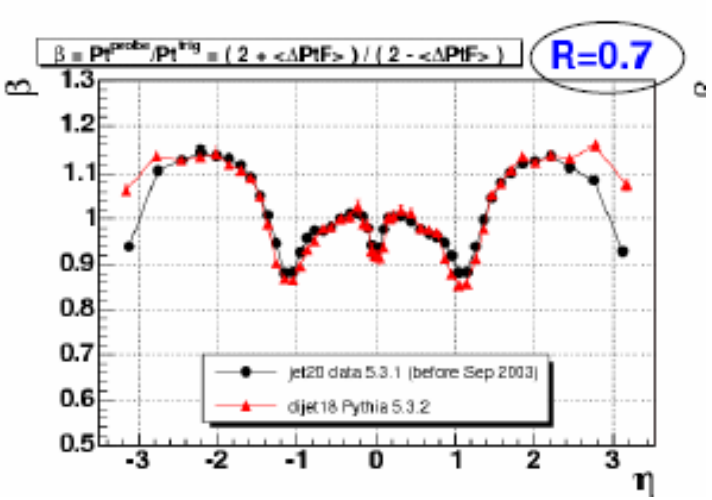
Data : Jet20, Jet50, Jet70 and Jet100 datasets-> L=271 pb^{-1}

Good Run list version 7

MC : Di-Jet Pythia "TuneA" (Pt min:0,10,18,40,60,90,120,150,200,300,400 and 500)

→ **5 different η region**

- Region 1 : $|\eta|< 0.1$ (Central crack)
- Region 2 : $0.1 < |\eta|< 0.7$ (Central Calorimeter)
- Region 3 : $0.7< |\eta|< 1.1$ (Central Cal. + crack)
- Region 4 : $1.1 < |\eta|< 1.6$ (Plug Cal. + crack)
- Region 5 : $1.6 < |\eta|< 2.1$ (Plug Calorimeter)

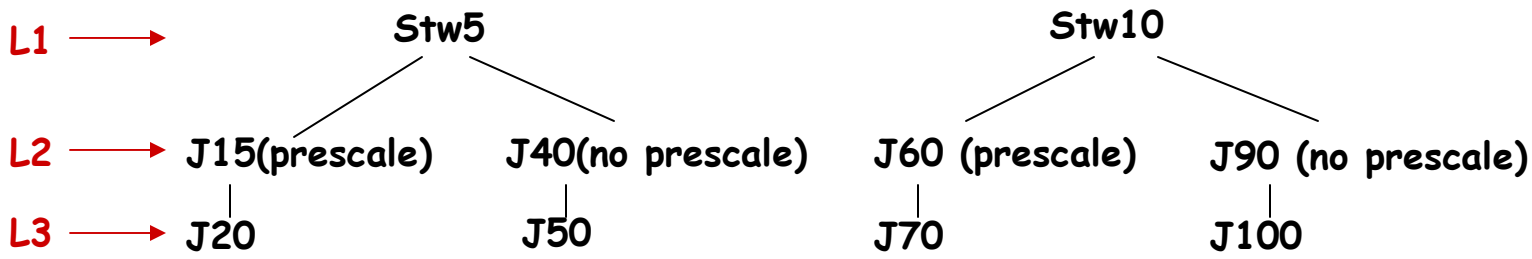


→ Event Selection

- Jets defined with K_T algorithm (D=0.7)
- No Rapidity cuts
- Vertex position $|V_Z| < 60$ cm
- E_T^{miss} significance $< F(P_T^{jet})$ where $F(P_T jet)=\min(2+0.018*P_T^{jet},11.5)$

Trigger Efficiency Studies

- Trigger Structure



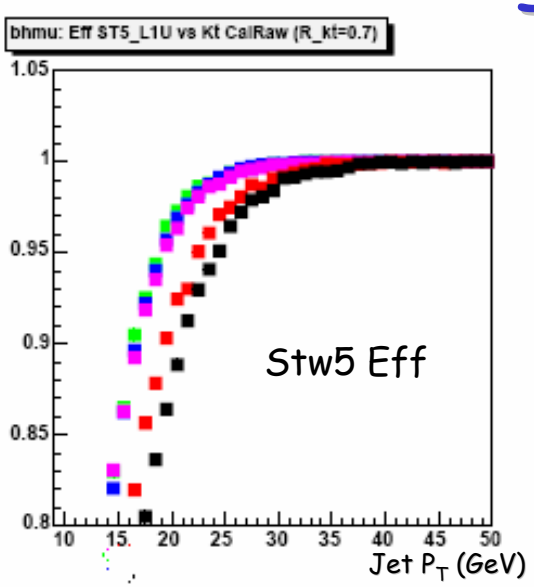
- Study the L1, L2 and L3 Trigger Efficiency from data

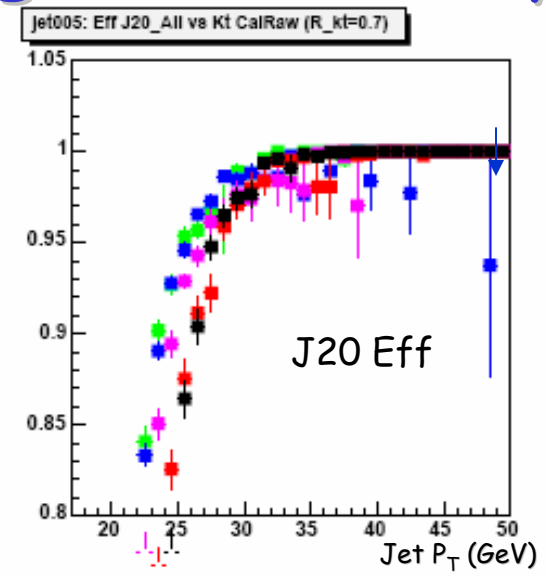
  → High P_T muons: Eff. Stw5(L1)
  → Stw5 data : Eff. J15(L2) and J20(L3)
  → Jet20 data : Eff. Stw10(L1) ,J40(L2) and J50(L3)
  → Jet50 data : Eff. J60(L2) and J70(L3)
  → Jet70 data : Eff. J90(L2) and J100(L3)

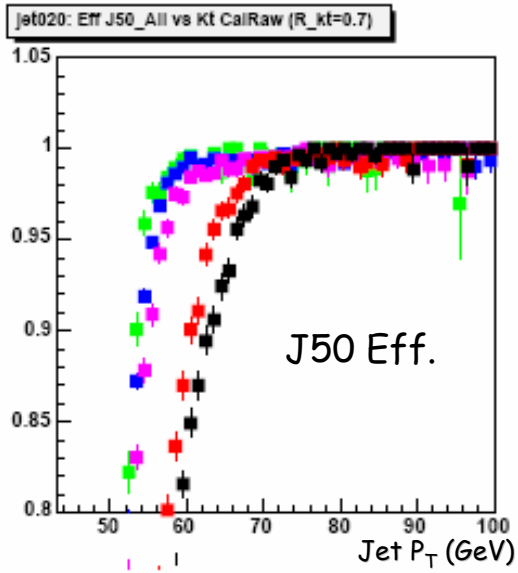
- Select Trigger Efficiency Threshold where the Efficiency is 99% ($L1^{\times}$ $L2^{\times}$ $L3^{\times}$)

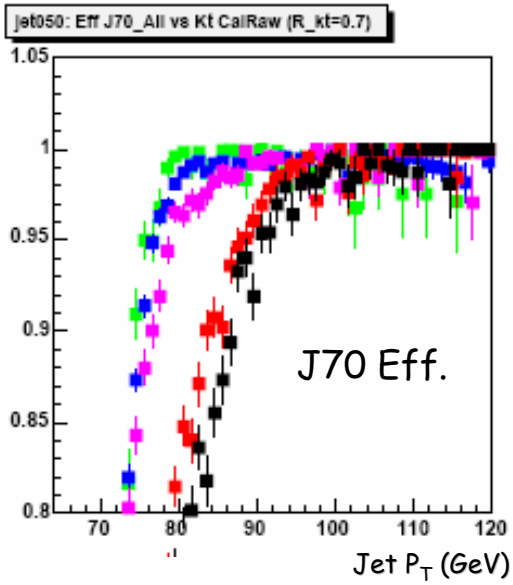
  → To avoid systematics due to energy scale uncertainties, the obtain thresholds are increased of 5%

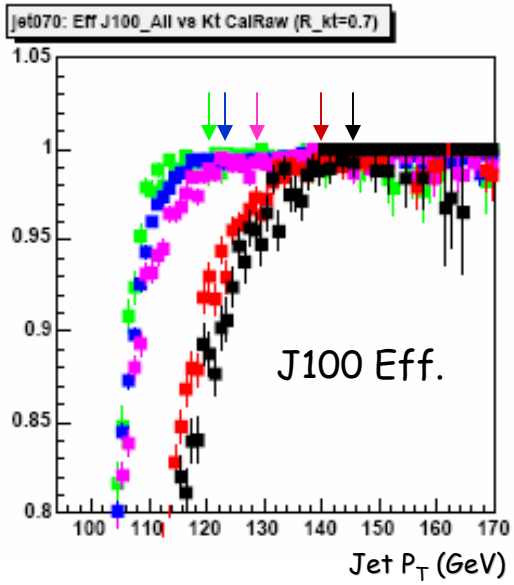
Trigger Efficiency Cuts











Rapidity Region 1 : $|\eta| < 0.1$
Rapidity Region 3 : $0.7 < |\eta| < 1.1$
Rapidity Region 2 : $0.1 < |\eta| < 0.7$
Rapidity Region 4 : $1.1 < |\eta| < 1.6$
Rapidity Region 5 : $1.6 < |\eta| < 2.1$

Minimum P_T^{Jet} Uncorrected (GeV) for each trigger

	Rap1	Rap2	Rap3	Rap4	Rap5
Stw5	26	26	28	31	32
J20	33	35	33	34	33
J50	63	64	68	72	75
J70	86	86	93	99	104
J100	119	124	129	139	146

Comparison Data-MC

- We will use Pythia MC to make the correction

- Comparison (Data-MC) of some raw variables

→ Some Jet variables distributions (normalized to 1) for the 5 η Regions and several range of P_T^{Jet}

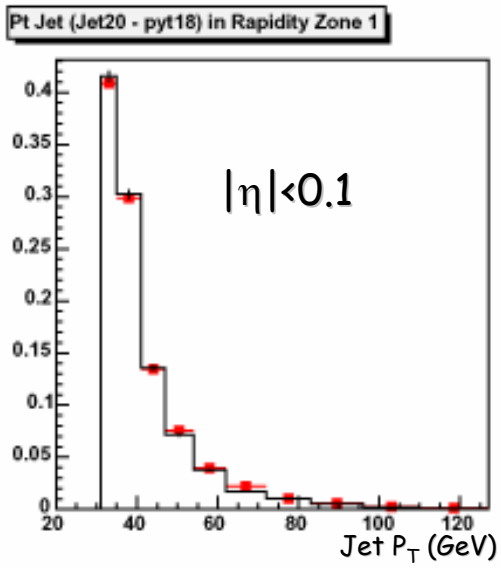
(P_T^{Jet} ,E^{Jet}, Phi, Rapidity, Sum P_T ^{Tracks} inside the jet, Vertex and Missing Et Significance)

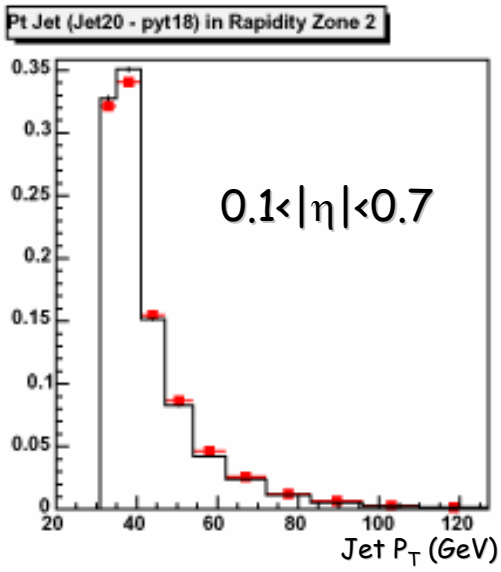
- Jet20 data compared to Pythia 18
- Jet50 data compared to Pythia 40 and Pythia 60
- Jet70 data compared to Pythia 60 and Pythia 90
- Jet100 data compared to Pythia 90 and Pythia 120

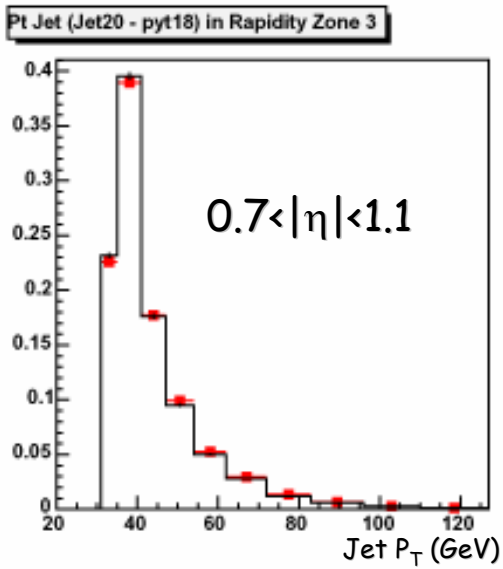
Plots for jets found with K_T algorithm (D=0.7)
(also with K_T D=0.5 and with JetClu algorithm but not in this talk)

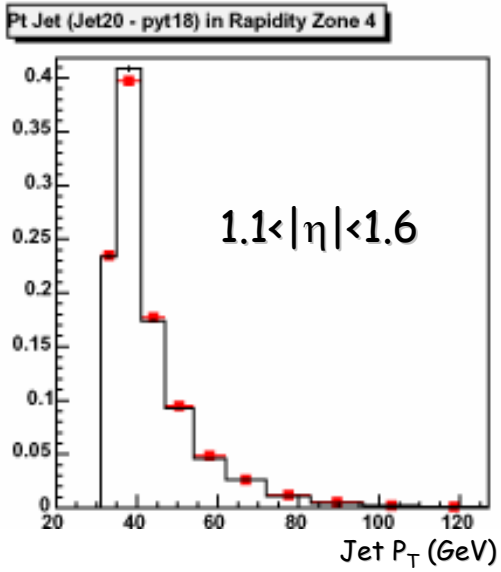
Jet20 – Pythia18

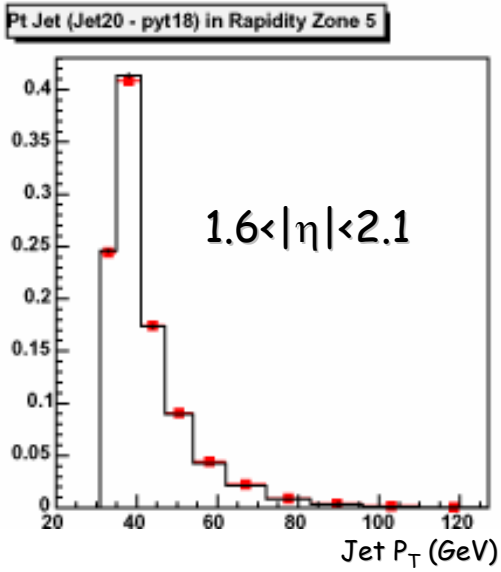
Jet P_T distribution









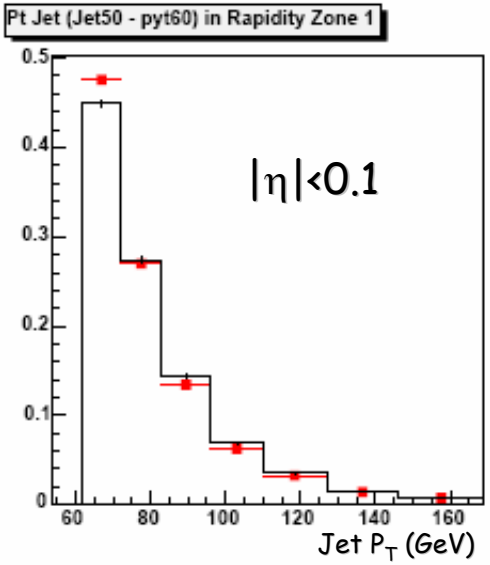


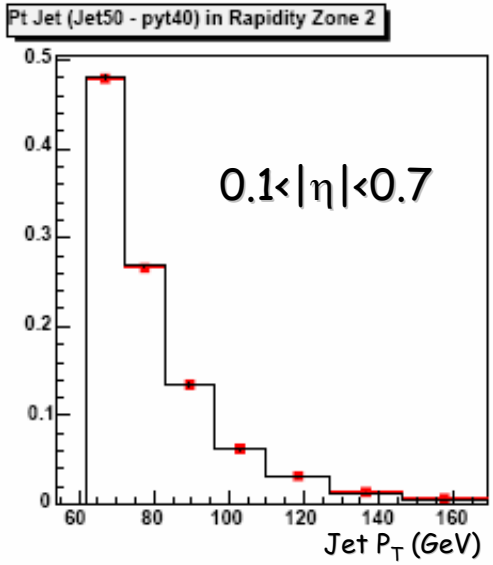
Data - MC

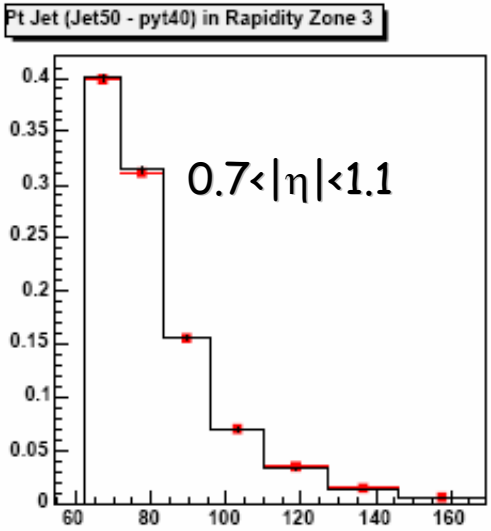
Good Agreement in the 5 Regions!

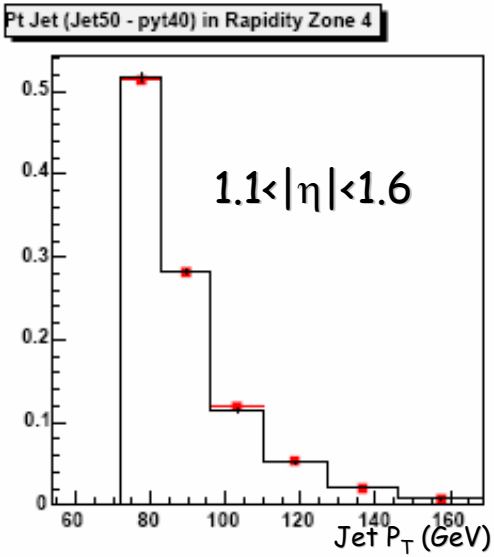
Jet50 – Pythia40/60

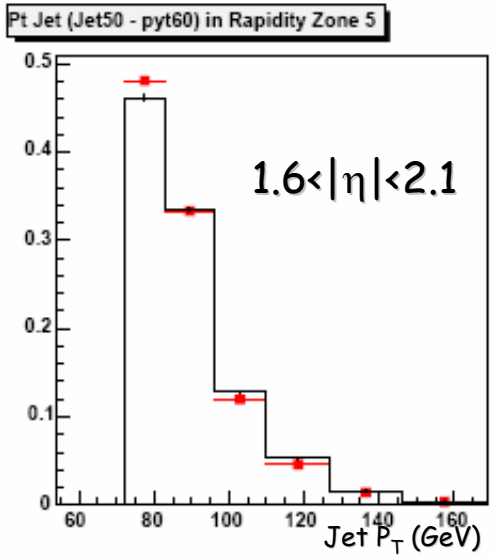
Jet P_T distribution







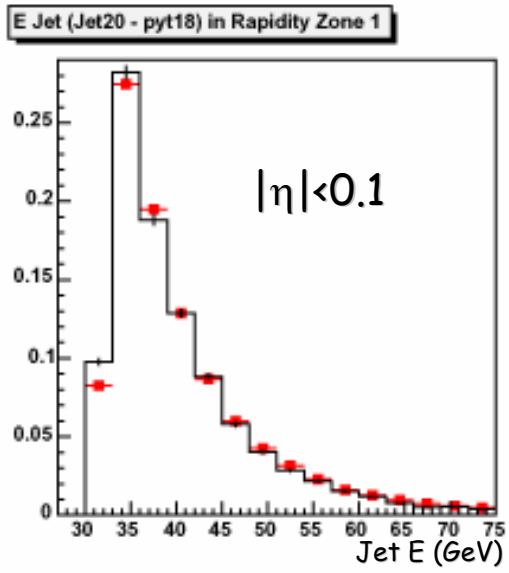


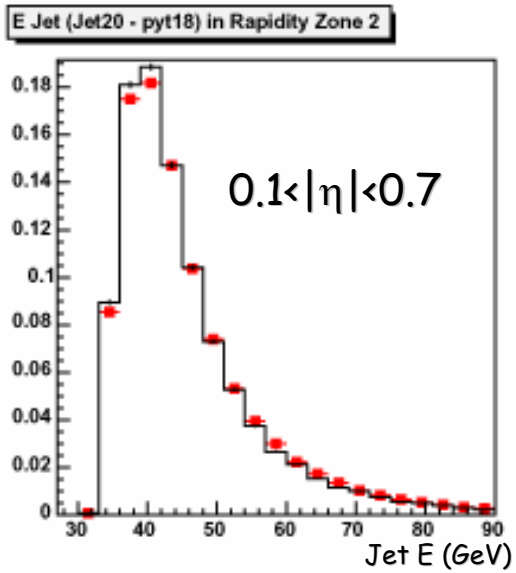


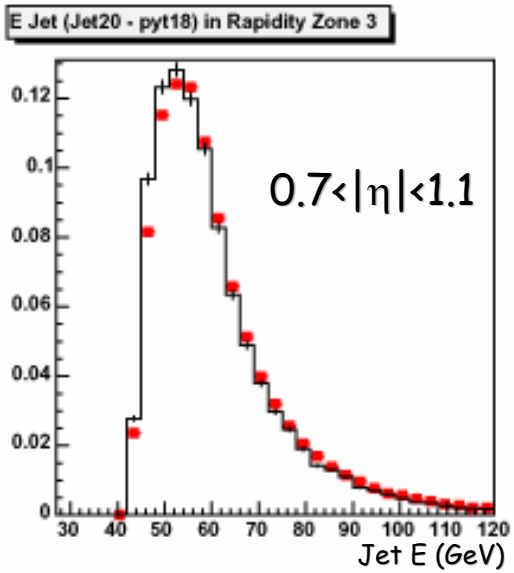
Data - MC
Good Agreement in the 5 Regions!

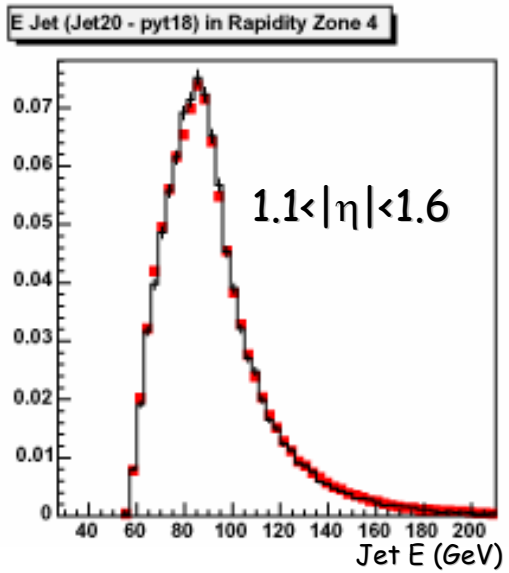
Jet20 – Pythia18

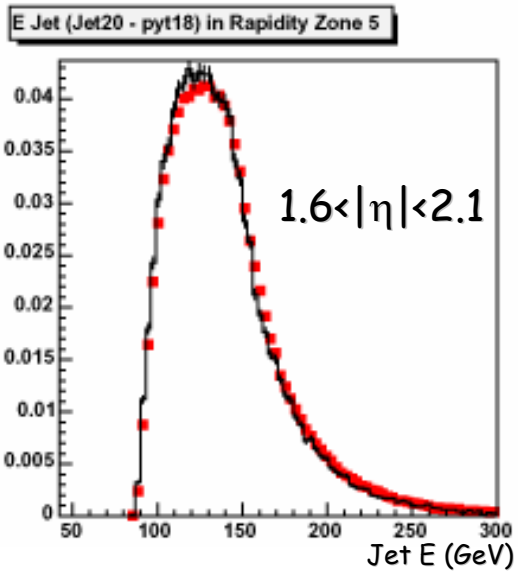
Jet Energy distribution









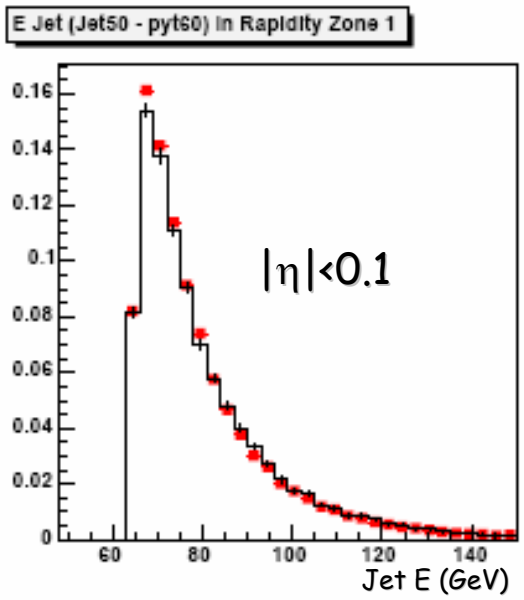


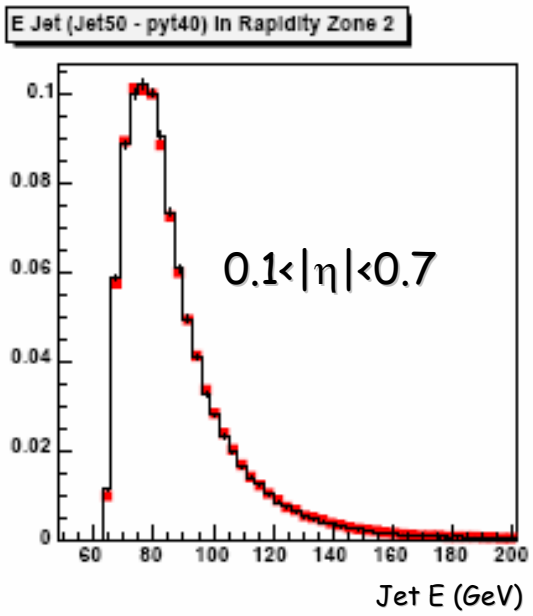
Data-MC

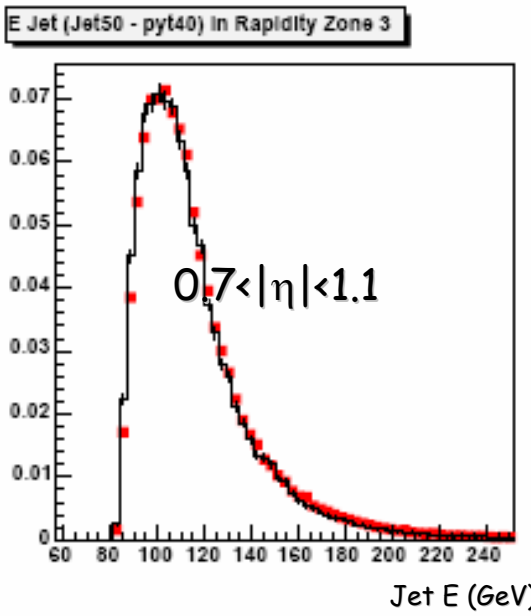
Good Agreement in the 5 Regions!

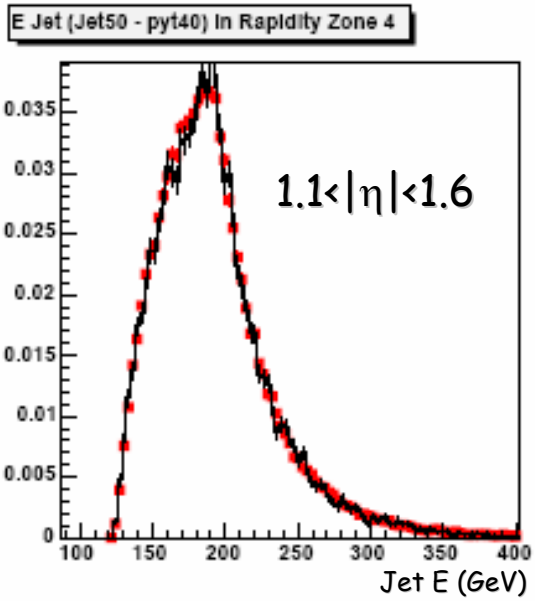
Jet50 – Pythia40/60

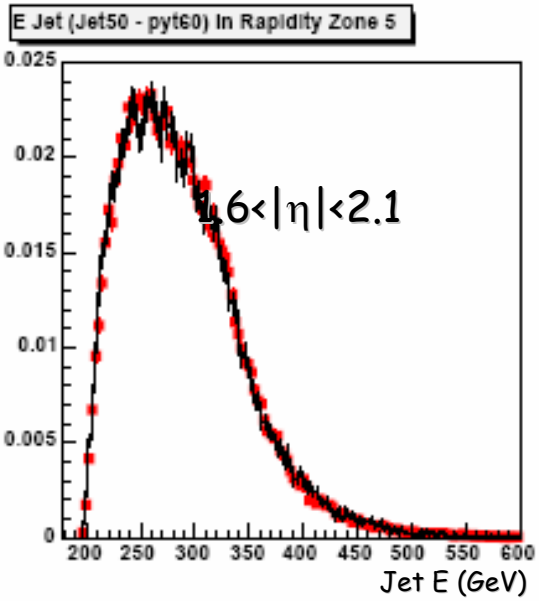
Jet Energy distribution









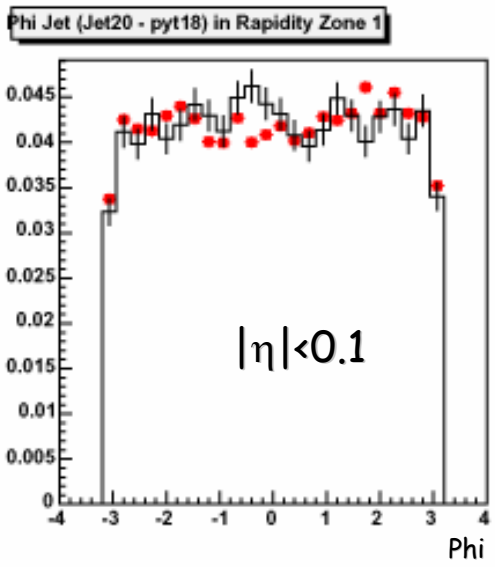


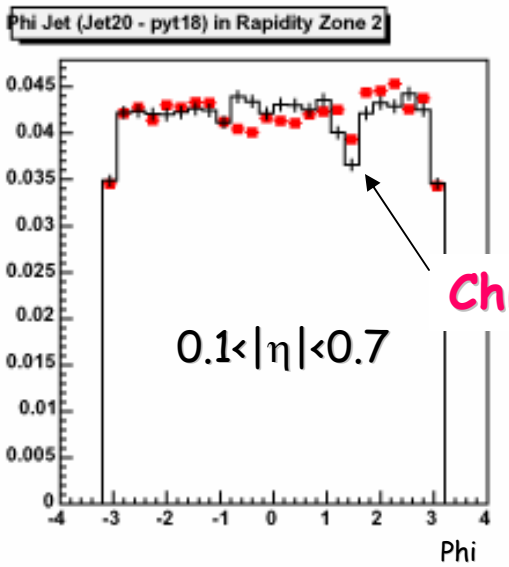
Data-MC

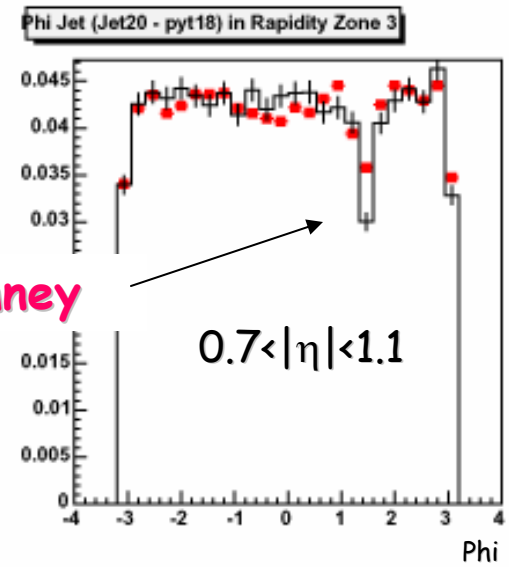
Good Agreement in the 5 Regions!

Jet20 – Pythia18

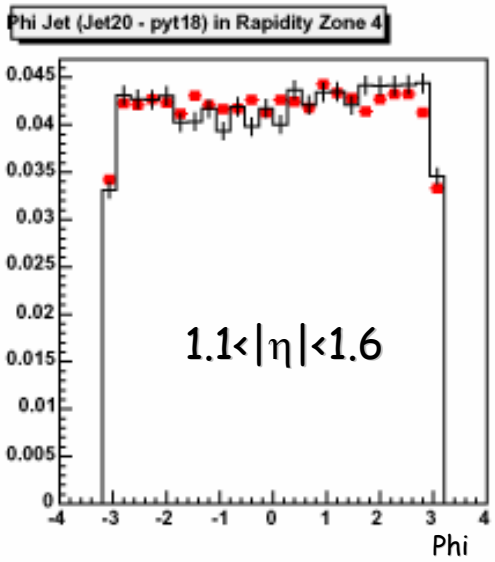
Phi distribution

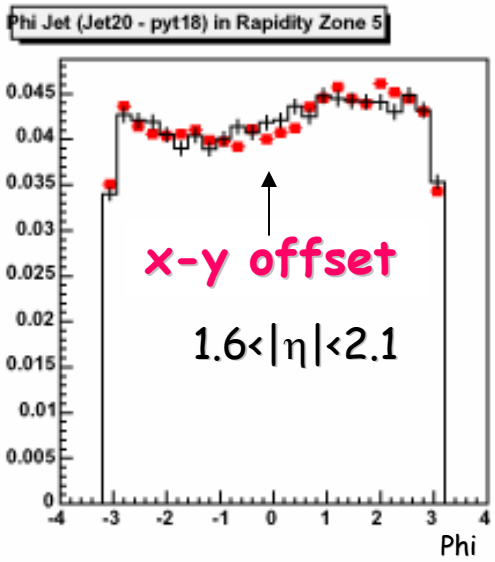






Chimney



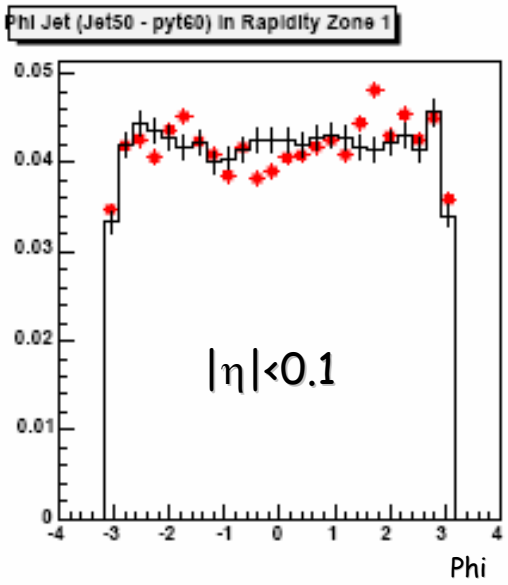


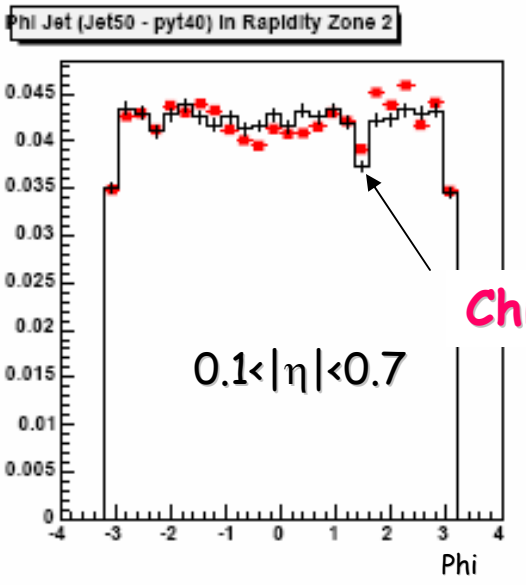
Data-MC

Reasonable Agreement in the 5 Regions!

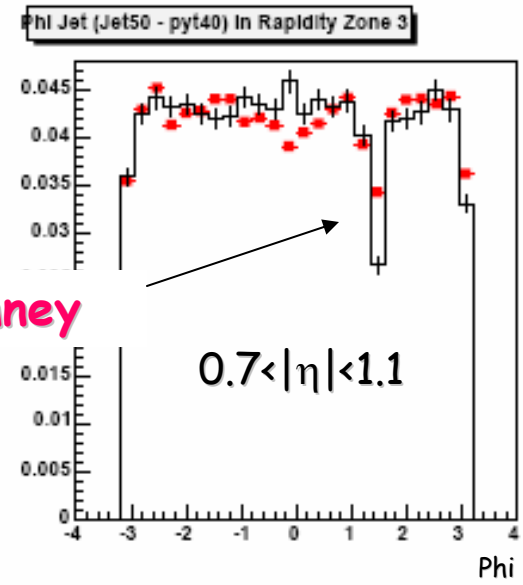
Jet50 – Pythia40/60

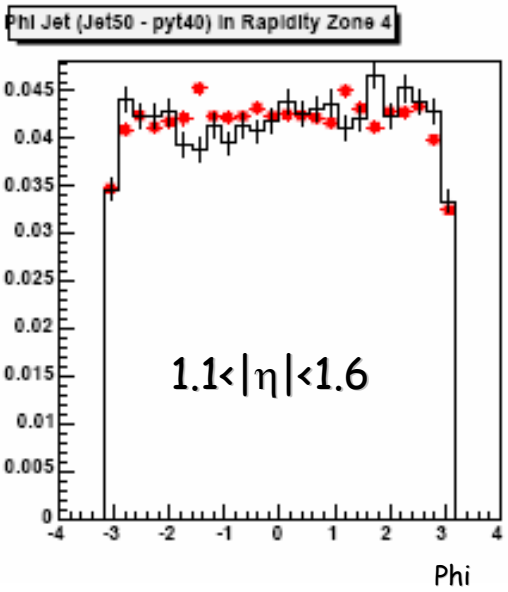
Phi distribution

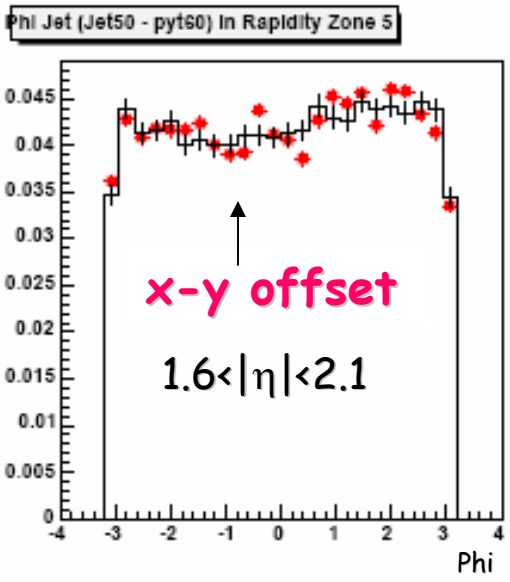




Chimney





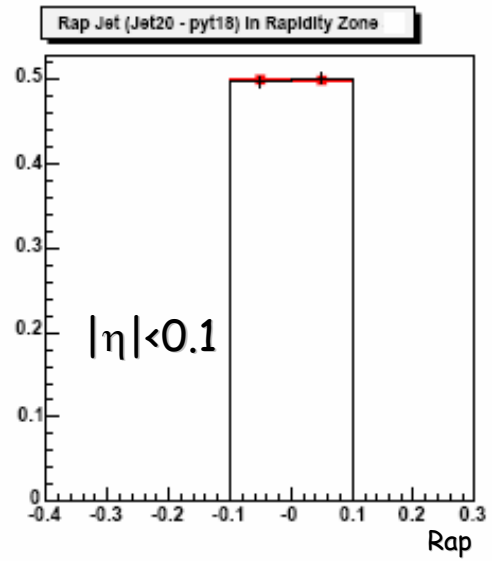


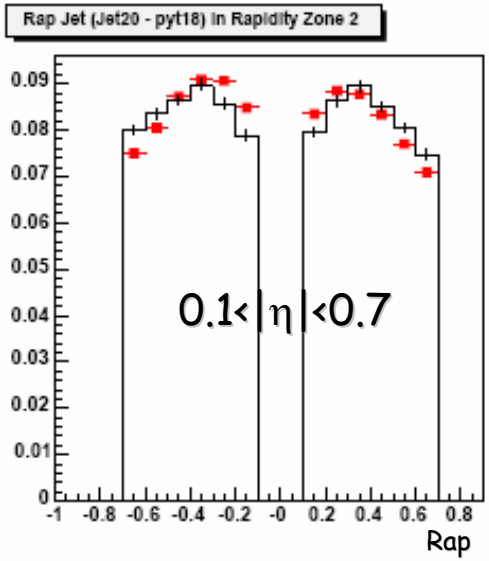
Data-MC

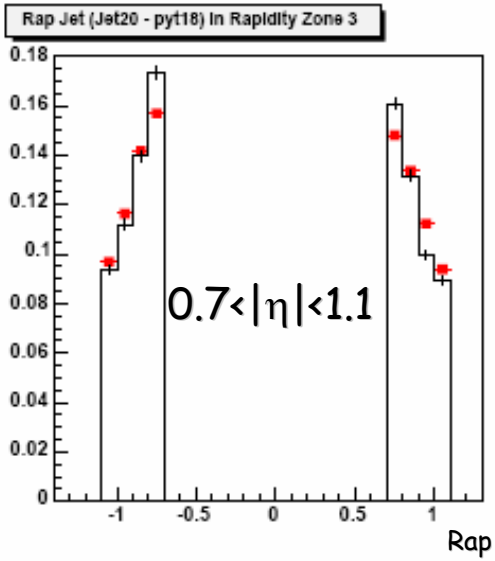
Reasonable Agreement in the 5 Regions!

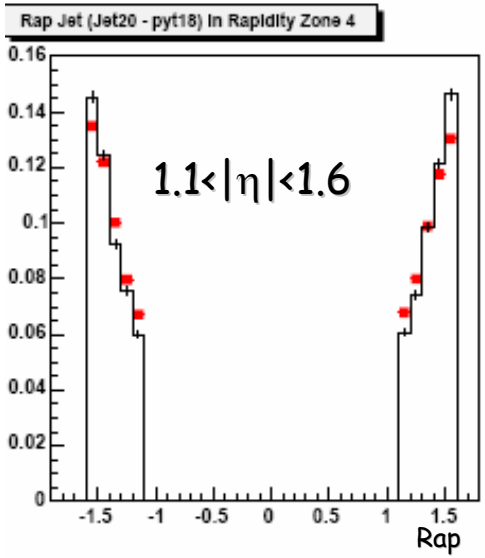
Jet20 – Pythia18

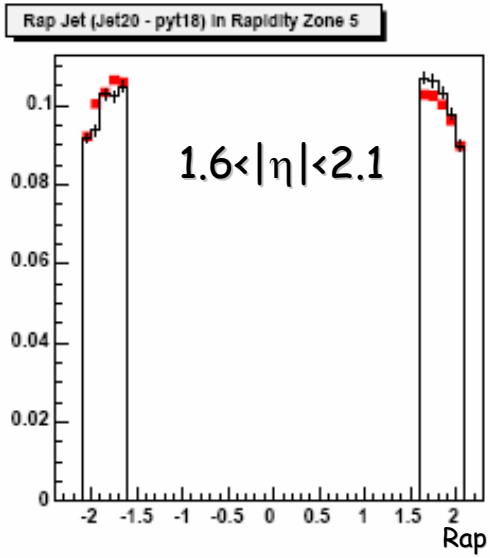
Rapidity distribution









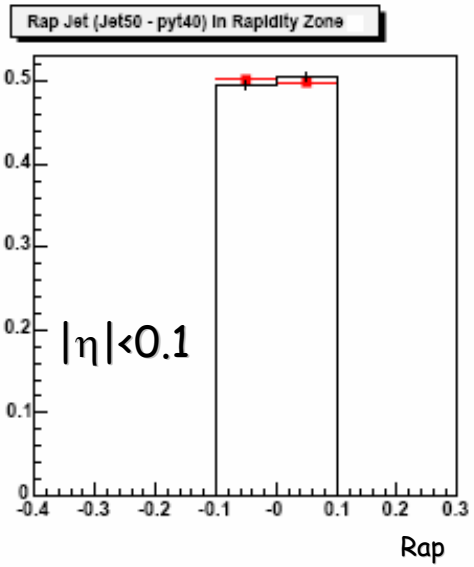


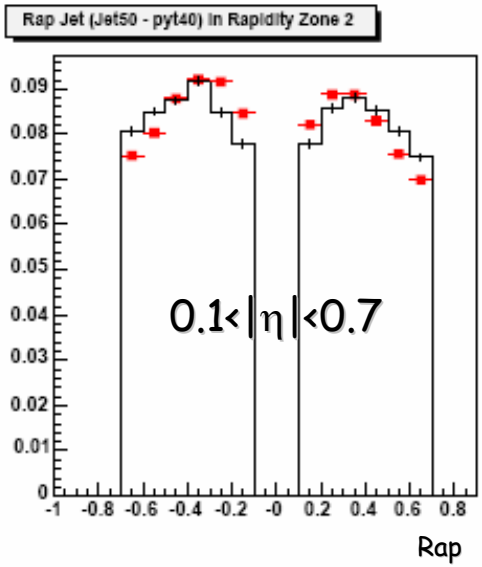
Data-MC

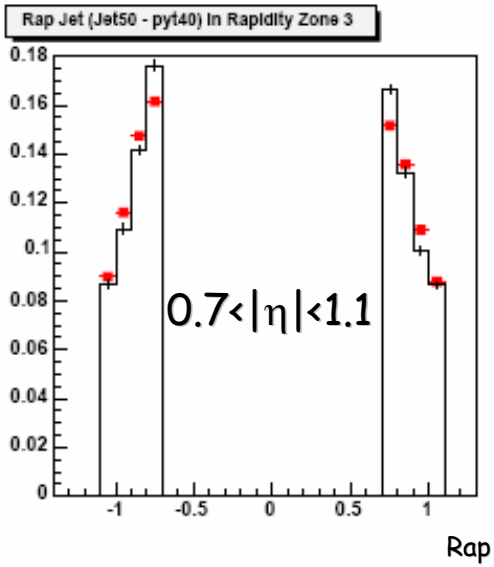
Reasonable Agreement in the 5 Regions!

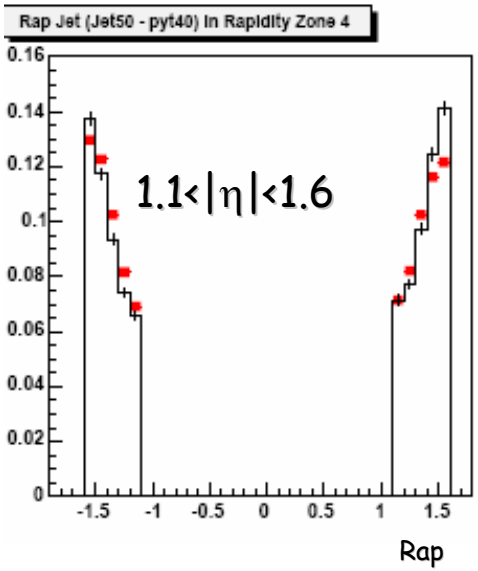
Jet50 – Pythia40/60

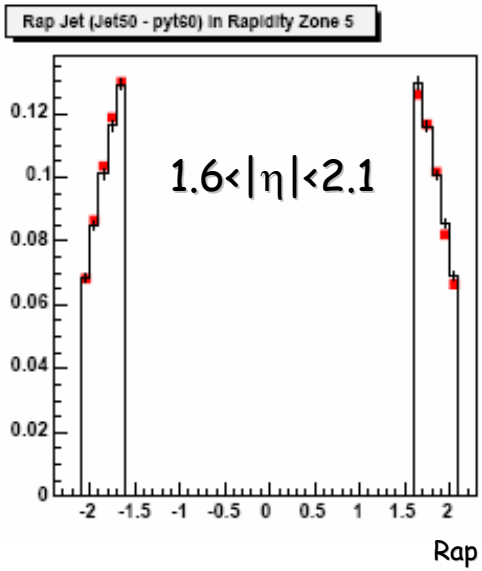
Rapidity distribution









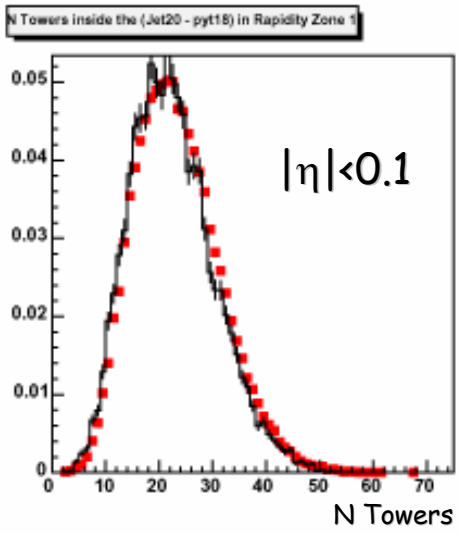


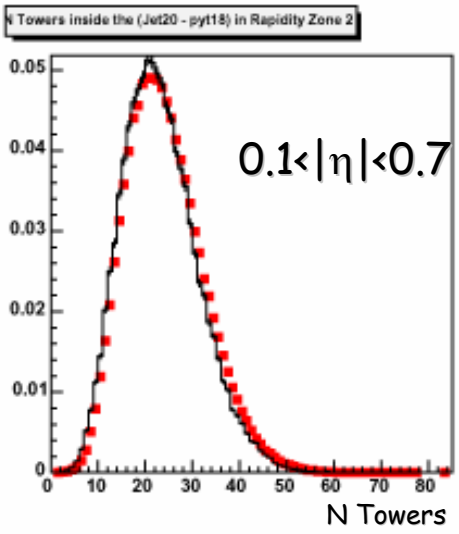
Data-MC

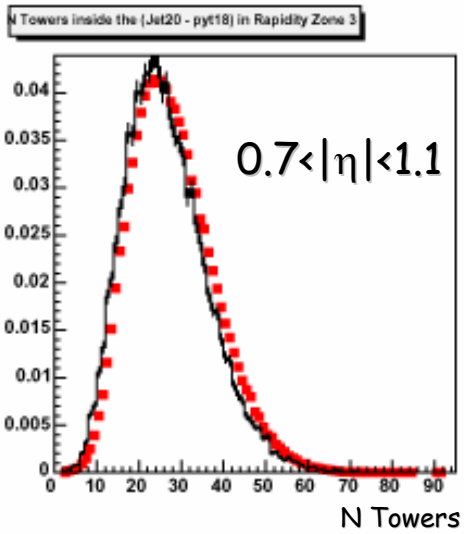
Reasonable Agreement in the 5 Regions!

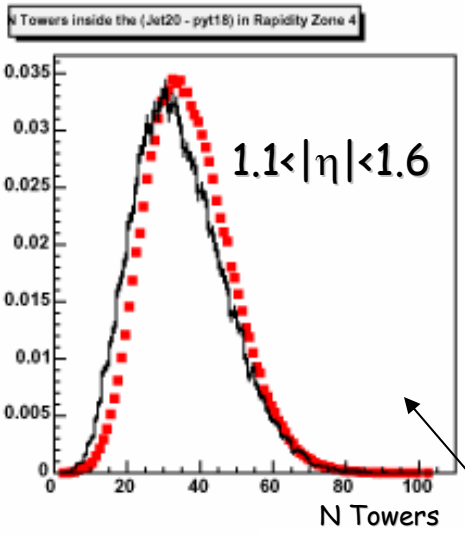
Jet20 – Pythia18

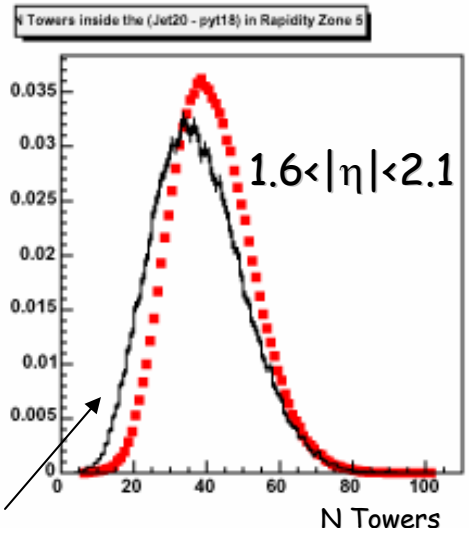
Number of Towers inside Jet











2-3 towers (~300 MeV)

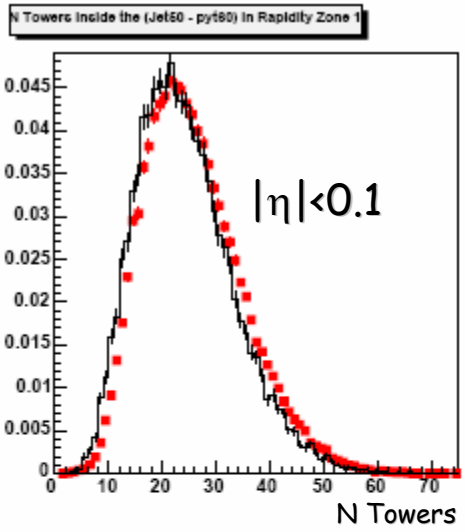
Data-MC

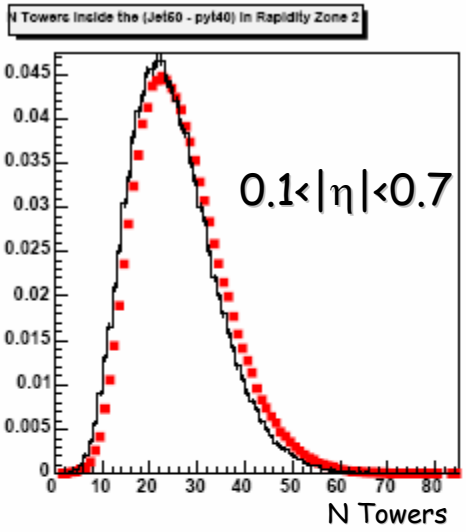
Good Agreement in the Central Regions

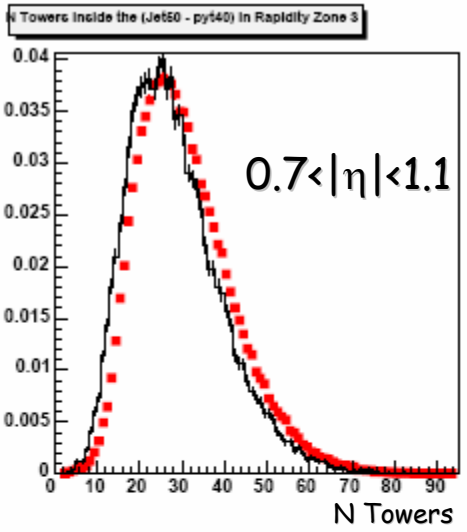
but not so good in the Plug Region!

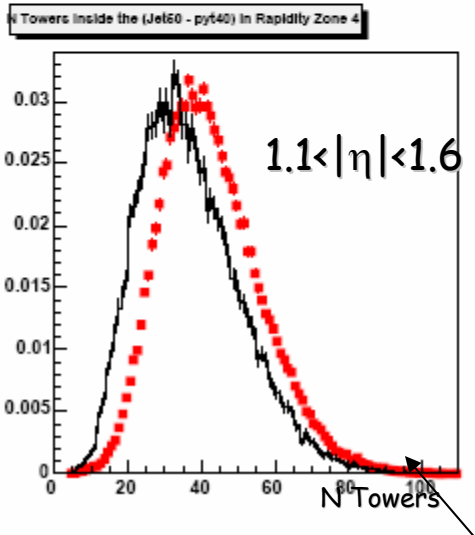
Jet50 – Pythia40/60

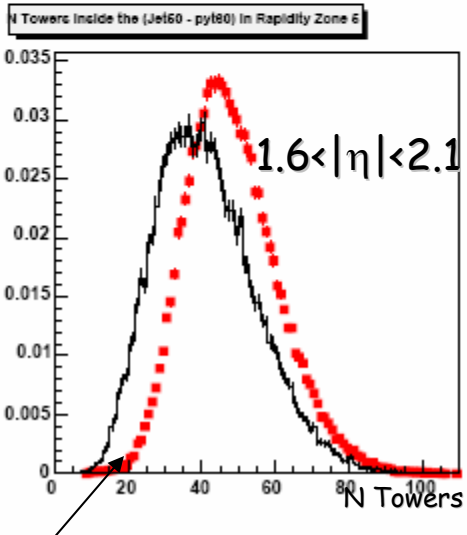
Number of Towers inside Jet











Data-MC

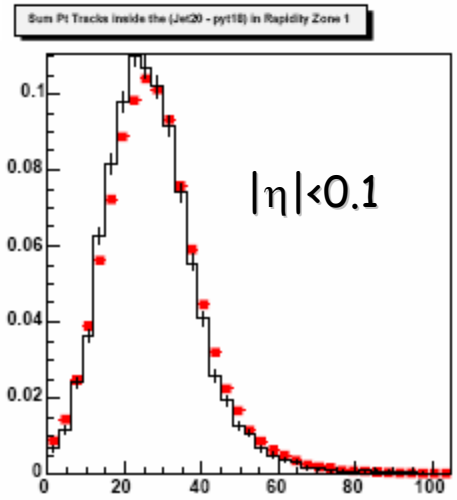
Reasonable Agreement in the Central Regions

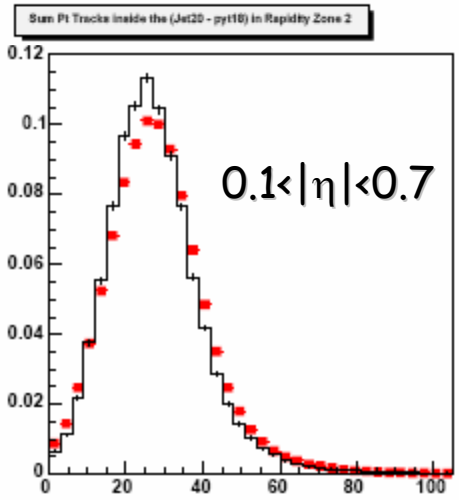
but not so good in the Plug Region!

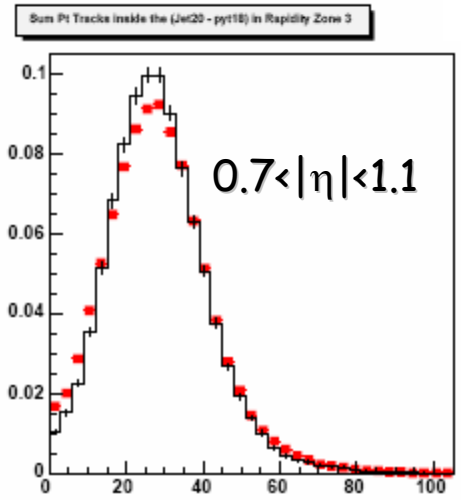
4 towers (~400 MeV)

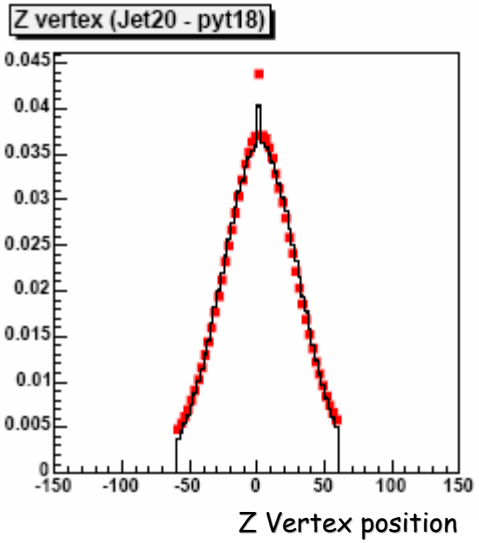
Jet20 – Pythia18

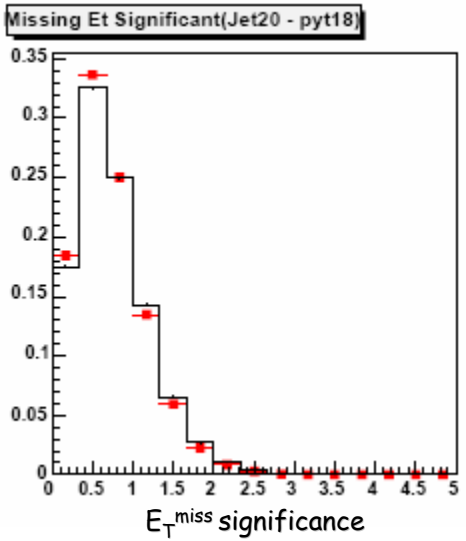
Sum Pt of the Tracks inside the Jet
Z vertex and E_T^{miss} significance











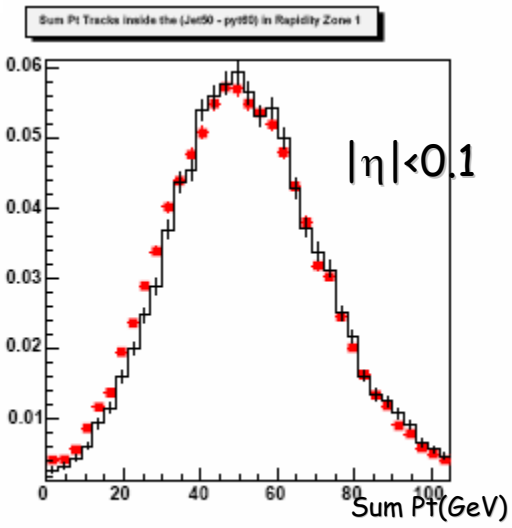
default COT Tracks
with pt>500 MeV/c

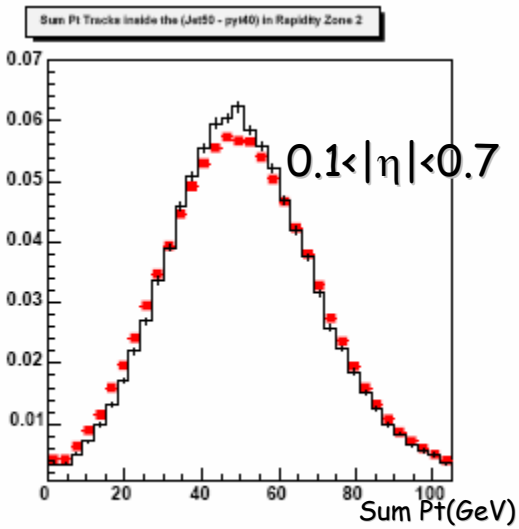
Data-MC
Good Agreement

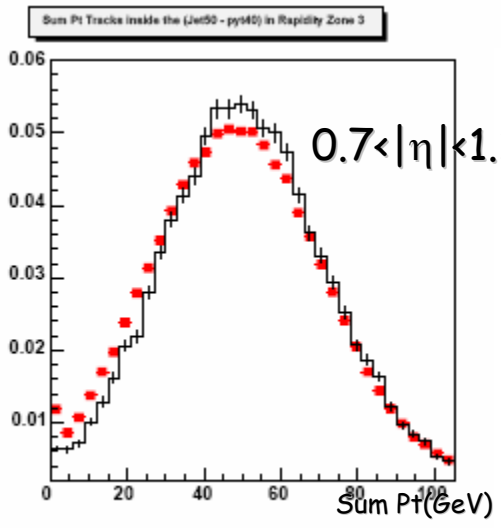
Simon's Data->MC COT
efficiency corrections applied

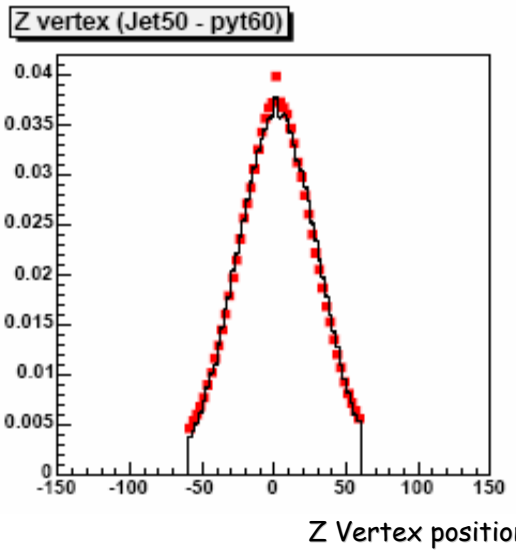
Jet50 – Pythia60

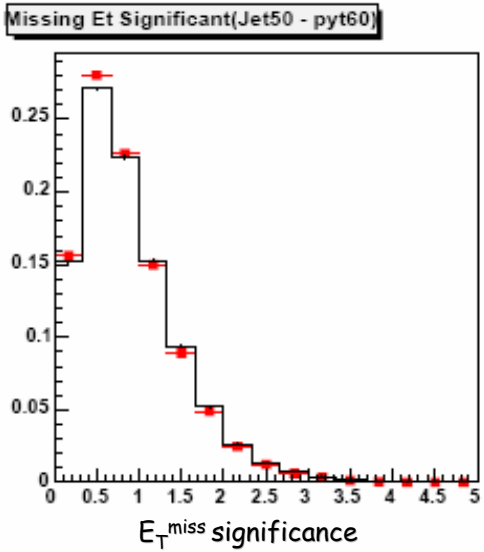
Sum Pt of the Tracks inside the Jet
Z vertex and E_T^{miss} significance











Conclusion

The MC is not perfect but there is a Reasonable Good Agreement

Average P_T^{Jet} Correction

- Use Pythia MC to make the average P_T^{Jet} Corrections

→ Reconstructed the Jets at Calorimeter(CAL) and Hadron (HAD) level

→ Pair CAL-HAD jets are matched in Υ - ϕ space $\Delta R < 0.7$

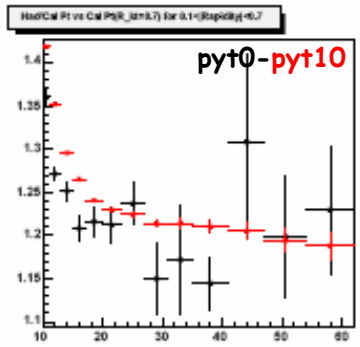
$$\Delta R = \sqrt{\Upsilon^2 + \phi^2}$$

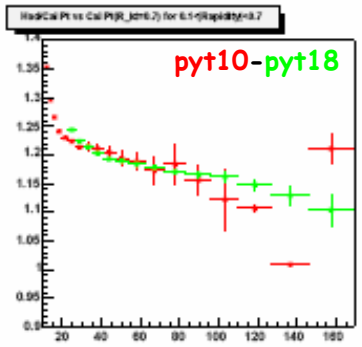
→ The correlation $< P_T^{Jet}(HAD) - P_T^{Jet}(CAL) >$ versus $P_T^{Jet}(CAL)$ for matched jets is reconstructed and fitted to a function form:

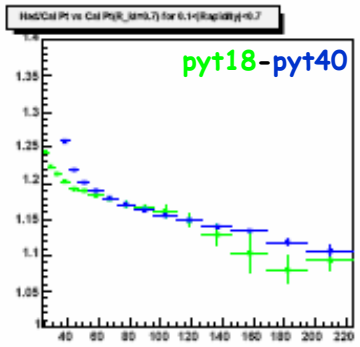
$$P_0 + P_1 * P_T^{jet}(CAL) + P_2 * P_T^{jet}(CAL)^2 + P_3 * P_T^{jet}(CAL)^3 + P_4 * P_T^{jet}(CAL)^4$$

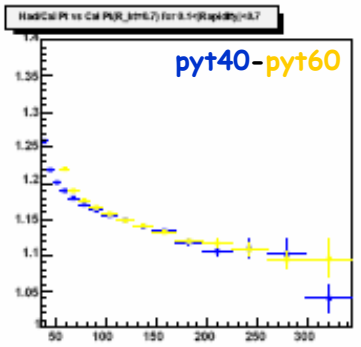
→ In order to chose the MC samples for each minimum P_t^{jet} (CAL) , we compare the distribution of $P_T^{Jet}(HAD)/P_T^{Jet}(CAL)$ vs $P_T^{Jet}(CAL)$ with the previous MC sample with lower p_t^{had} cut.
The minimum P_T^{jet} (CAL) is the point where both profiles are agreed.

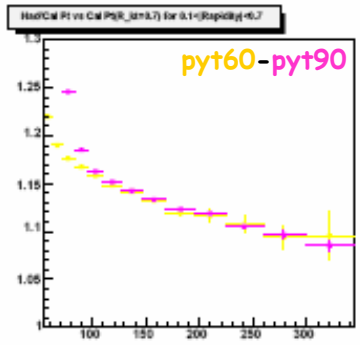
Average P_T^{Jet} Correction

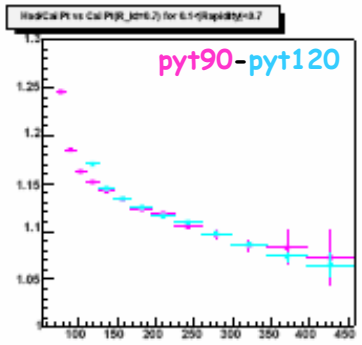


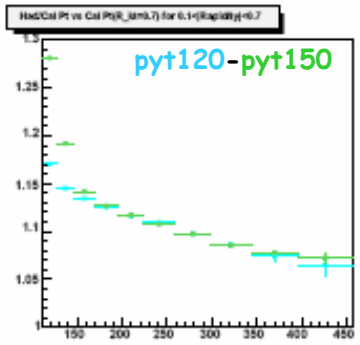


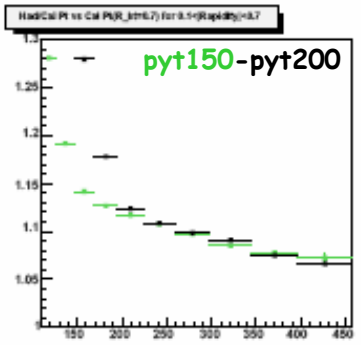


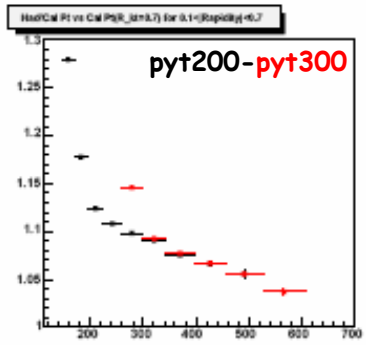


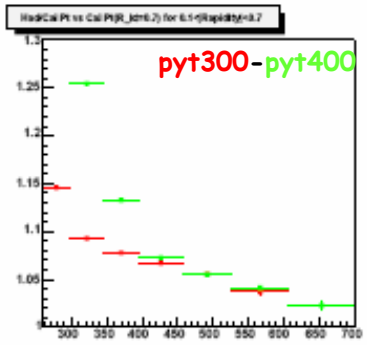


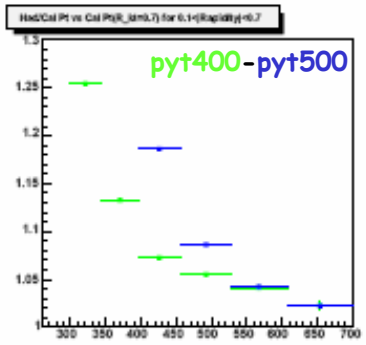








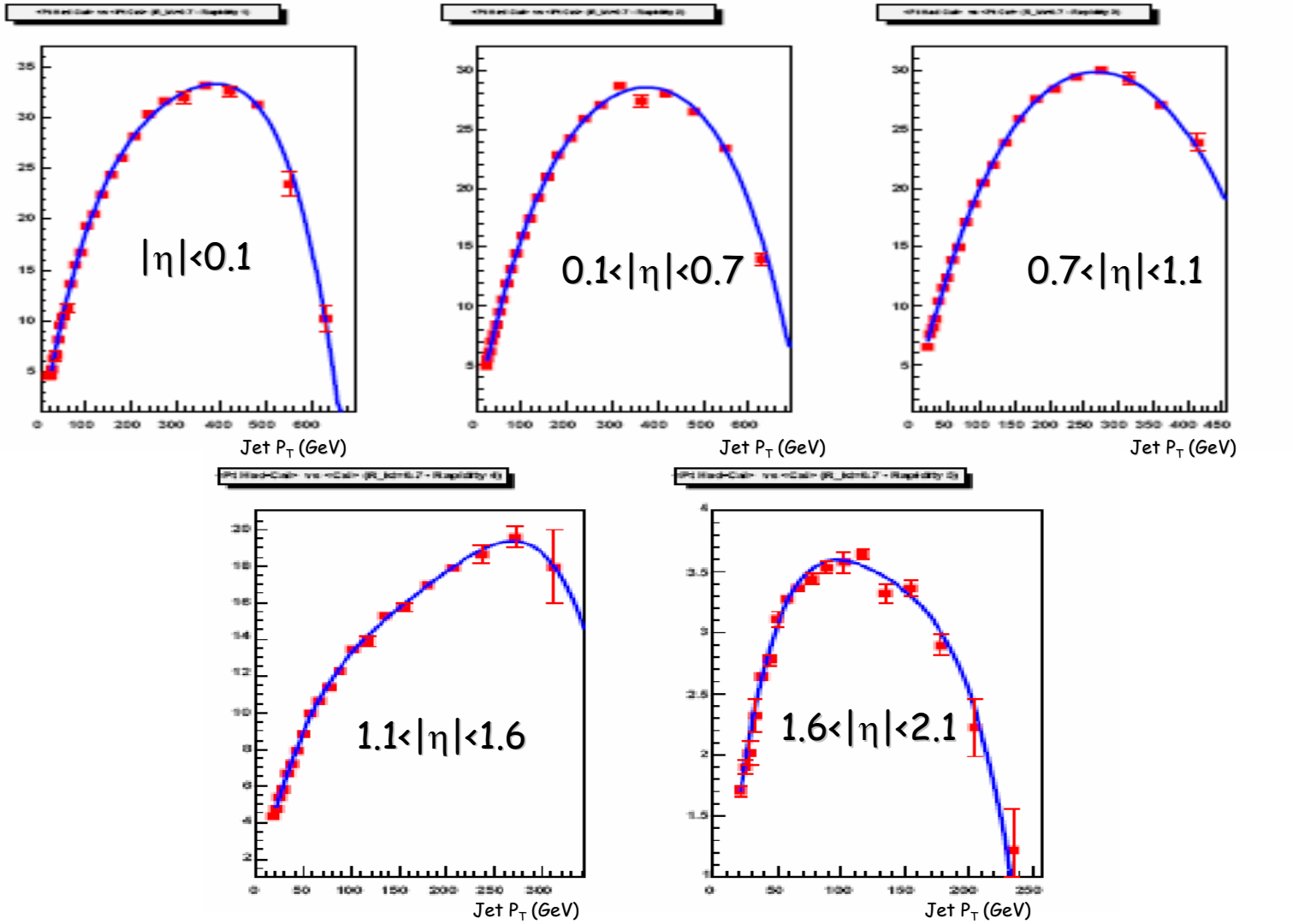




Used to chose the MC sample in the Data-MC comparison too.

Average P_T^{Jet} Correction

$< P_T^{Jet}(HAD)-P_T^{Jet}(CAL)>$ vs $P_T^{Jet}(CAL)$



$P_0+P_1 * P_T^{jet}(CAL)+P_2 * P_T^{jet}(CAL)^2 +P_3 * P_T^{jet}(CAL)^3+P_4 *P_T^{jet}(CAL)^4$

Unfolding Procedure

- Use Pythia MC to correct back the jet spectrum to the hadron level

→ Count: the N_{Jet} Calorimeter level (all cuts)
N_{Jet} Hadron (no cuts)

→ Bin-by-bin Corrections factors:

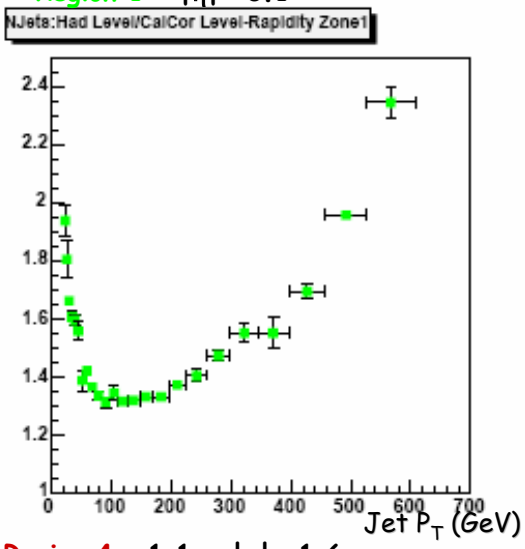
$$C_i = \frac{N_{Jet} \text{ Hadron level}}{N_{Jet} \text{ Calorimeter level}} \; (P_T^{jet} \text{ bin } i)$$

- Apply this bin-by-bin Corrections factors to the measured corrected P_T spectrum to unfold it to the hadron level.

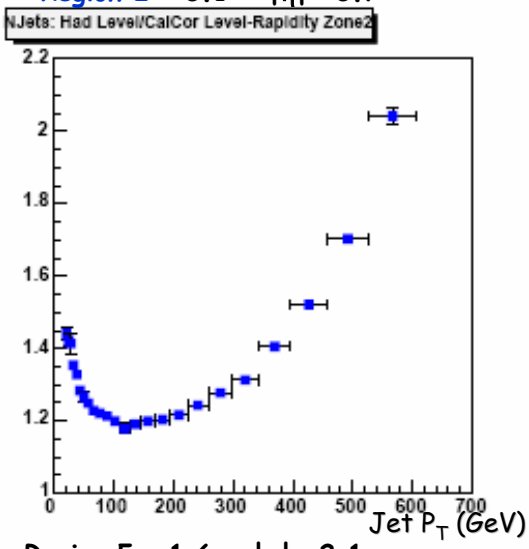
$$N_{jets \text{ (data unfolded)}} = C_i * N_{jets \text{ (data corrected)}} \; (P_T^{jet} \text{ bin } i)$$

Unfolding Factors

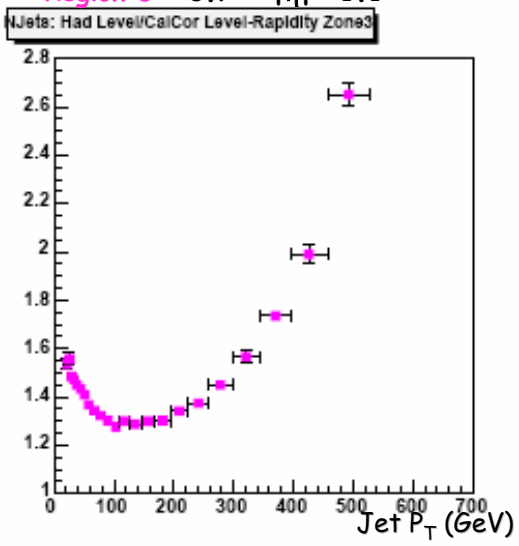
Region 1 : |η|< 0.1



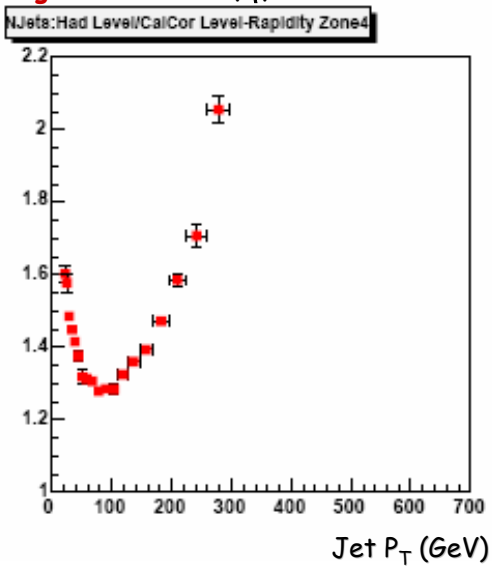
Region 2 : 0.1 < |η|< 0.7



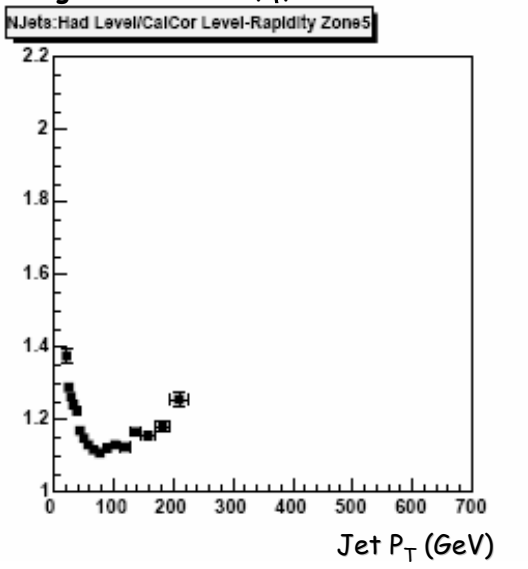
Region 3 : 0.7 < |η|< 1.1



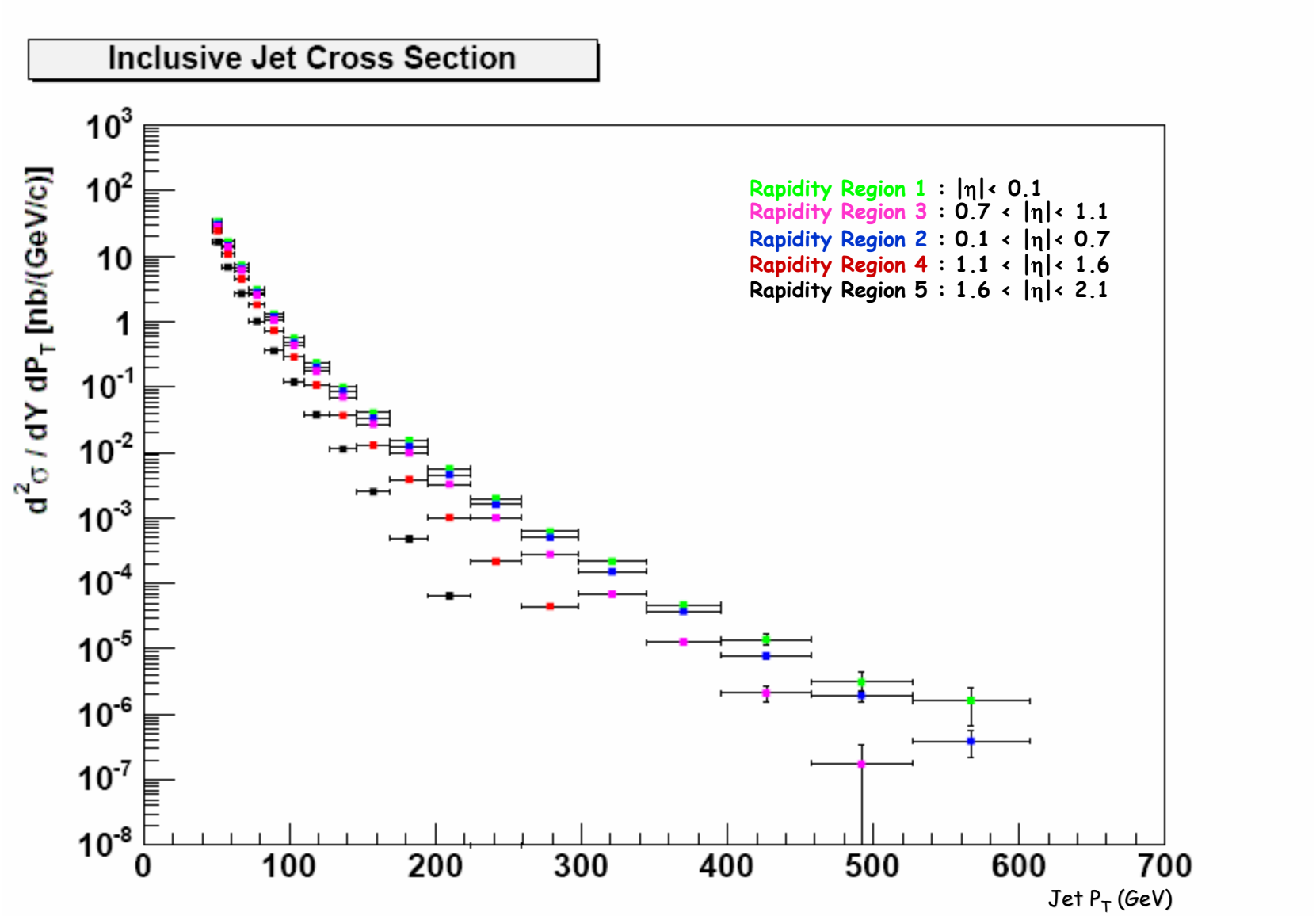
Region 4 : 1.1 < |η|< 1.6



Region 5 : 1.6 < |η|< 2.1

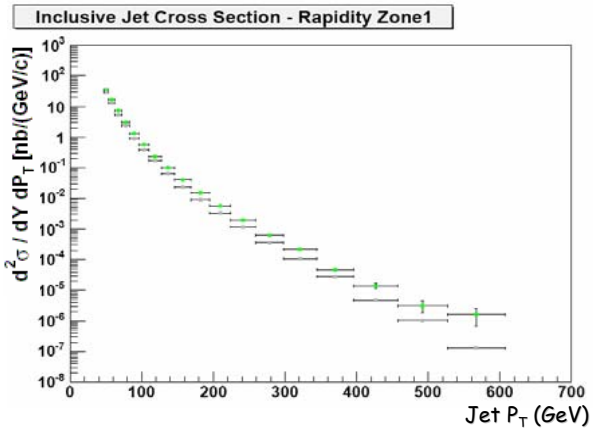


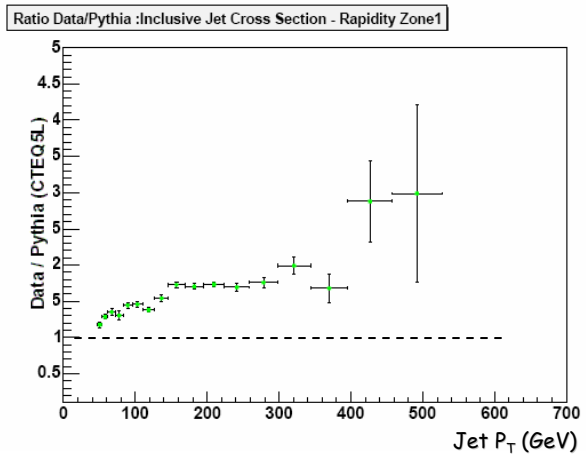
Cross Section



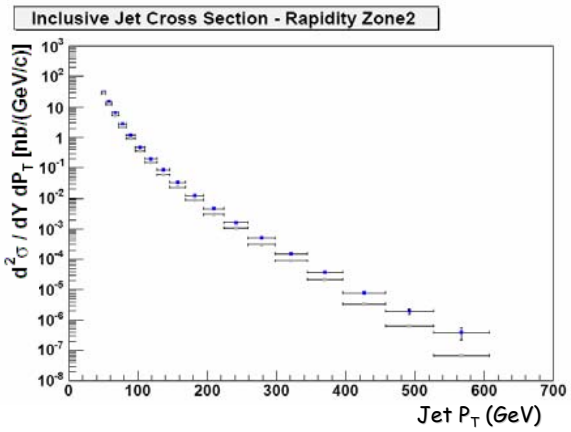
Cross Section Data-Pythia comparison

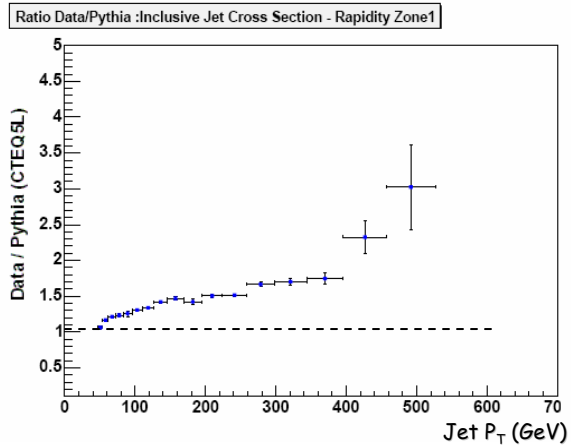
Rapidity Region 1 : $|\eta| < 0.1$



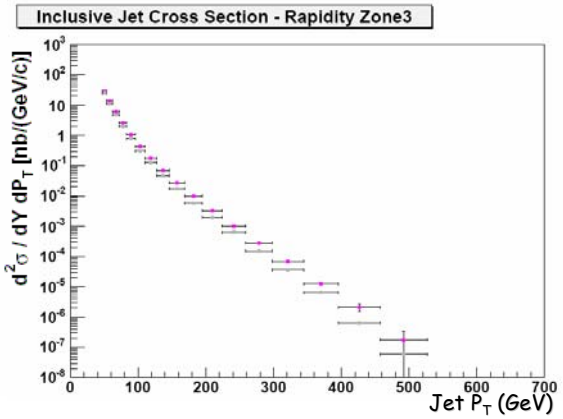


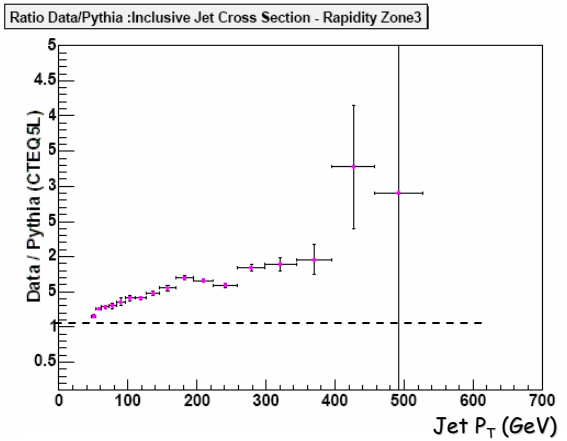
Rapidity Region 2 : $0.1 < |\eta| < 0.7$





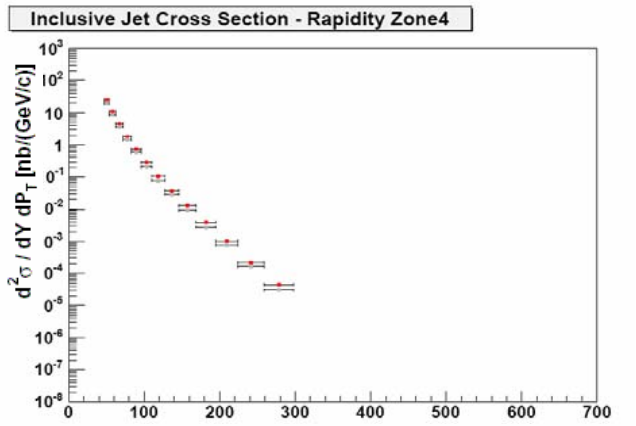
Rapidity Region 3 : $0.7 < |\eta| < 1.1$

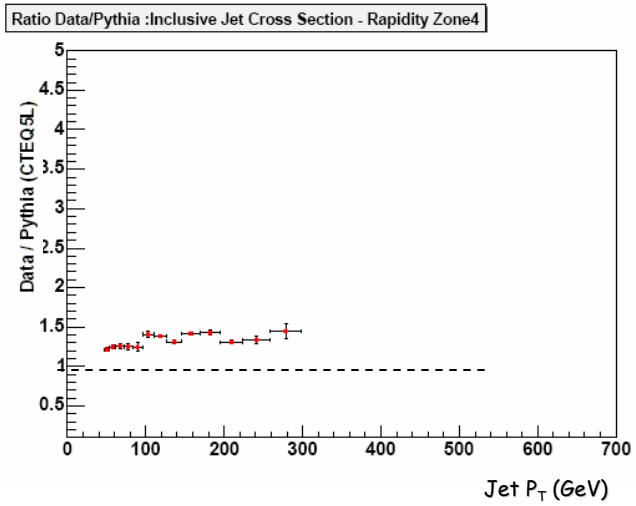




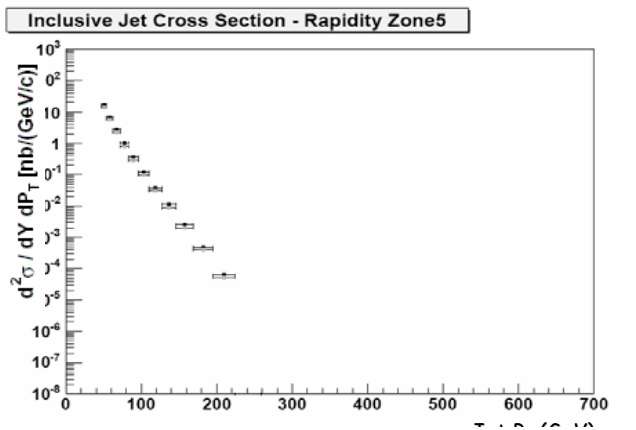
Cross Section Data-Pythia comparison

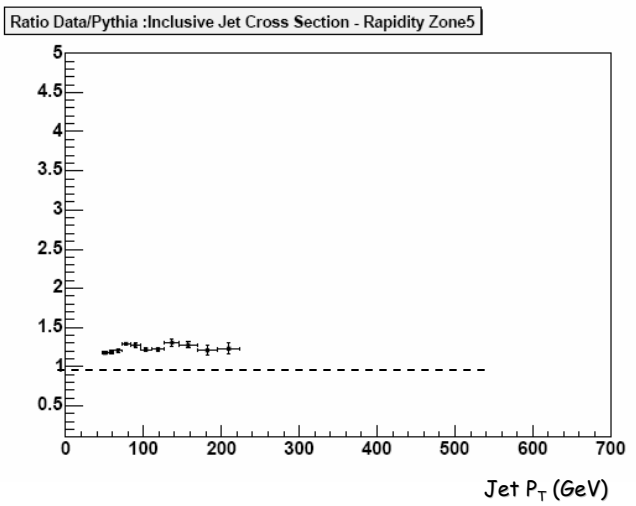
Rapidity Region 4 : 1.1 < |η|< 1.6





Rapidity Region 5 : 1.6 < |η|< 2.1





Outlook

- Work on:
  - →Unfolding
  - →Systematics
  - →Pileup Corrections
  - →Hadronization and Underlying events corrections
  - →…
- Next Update 3rd December