

Inclusive Jet Cross Section in the Forward Region using the K_T algorithm

Blessing Talk - CDF Note 7771

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Outline

➤ Review of the analysis

→ Trigger Study

→ Event Selection

→ MC simulation

→ Jet P_T Corrections

→ Unfolding

→ Systematic Uncertainties

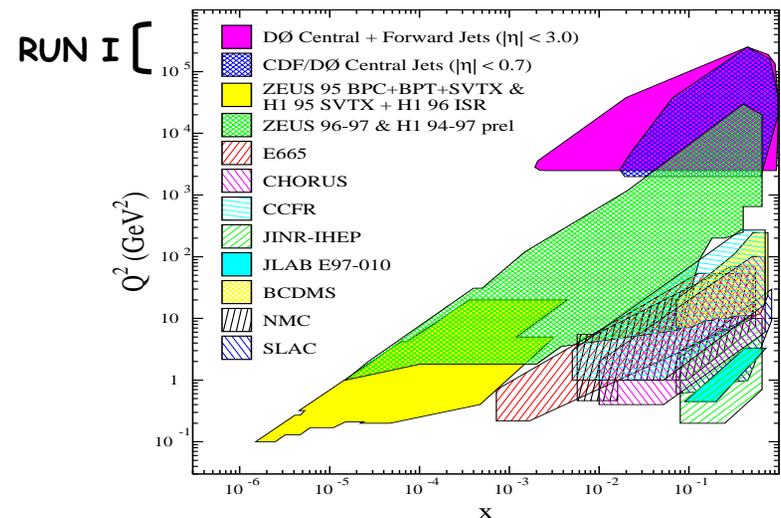
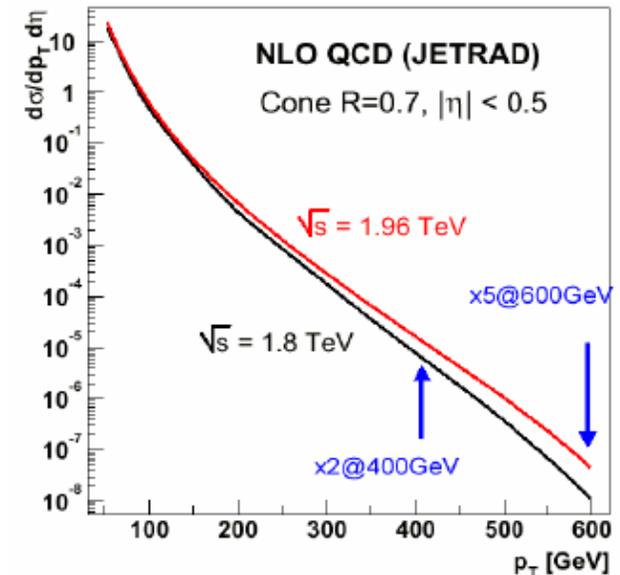
⇒ Systematic associated to Dijet Balance

→ NLO Calculations

➤ Results

Motivation

- Measure inclusive jet cross section
 - ✓ Stringent test of pQCD
 - Over 9 order of magnitude
 - ✓ Tail sensitive to New Physics and PDFs
 - Sensitivity to distances $\sim 10^{-19}$ m
 - ✓ Measurements in the forward region allow to constrain the gluon distribution
 - Enhance sensitivity to New Physics in the central region
- K_T algorithm preferred by theory
 - ✓ Infrared/collinear safe to all order in pQCD
 - ✓ No merging/splitting feature
 - No R_{SEP} issue comparing to pQCD



Event Selection

→ Data collected in: Jet20, Jet50, Jet70 and Jet100 datasets

- Using v5.3.1 Data (analyzed using v5.3.3nt)
- Good Run list version 7
- Runs [155368,155742] excluded
 - Cross section drop of about ~40%

→ $L=385 \text{ pb}^{-1}$

→ Event Selection

- Jets defined with K_T algorithm ($D=0.7$)
- Primary vertex position $|V_z| < 60 \text{ cm}$
- Missing E_T significance $E_T^{\text{miss}} / \sum E_T < \min(2+5/400 \cdot P_T^{\text{jet}} (\text{leading jet}), 7)$
- Jets in different Y regions:

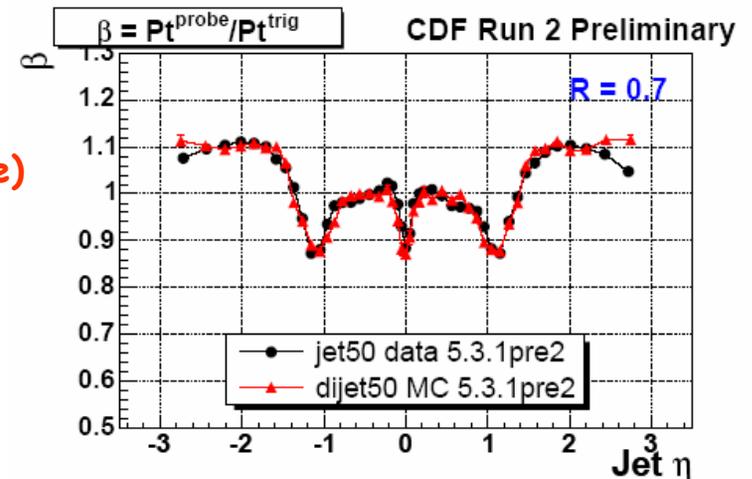
Region 1 : $|Y| < 0.1$ (90° crack)

Region 2 : $0.1 < |Y| < 0.7$ (Central Cal.) (Not presented here)

Region 3 : $0.7 < |Y| < 1.1$ (Central Cal. + 30° crack)

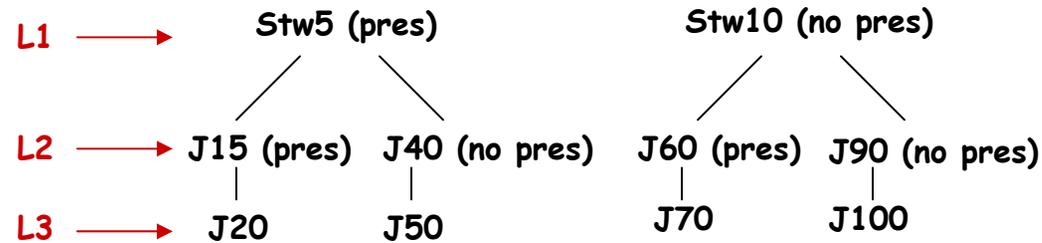
Region 4 : $1.1 < |Y| < 1.6$ (30° crack + Plug Cal.)

Region 5 : $1.6 < |Y| < 2.1$ (Plug Cal.)



Trigger Study

→ Trigger Structure



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

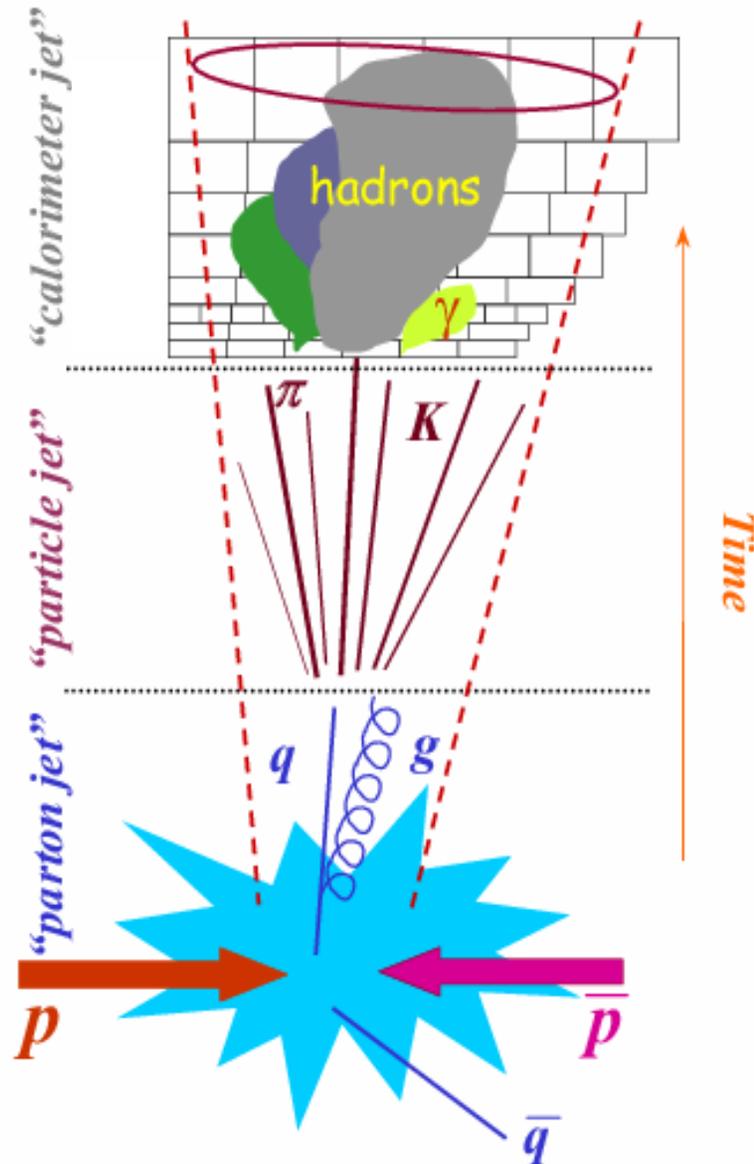
→ Use data only where trigger fully efficient: thresholds defined by $L1 \times L2 \times L3$ efficiencies $> 99\%$

• To avoid trigger related systematic due to energy scale uncertainties, the obtain thresholds are increased by 5%

	Rap1	Rap3	Rap4	Rap5
Stw5	26	27	32	33
J20	32	33	34	33
J50	60	65	72	74
J70	81	91	97	101
J100	117	124	138	140

Minimum $P_{T,RAW}$
(uncorrected $P_{T,Jet}$, GeV/c)
for each dataset

Corrections strategy



From calorimeter to hadron level

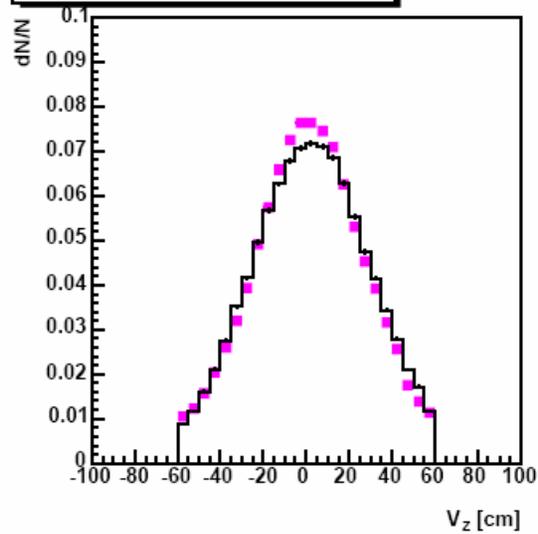
- Pile-up correction (data based)
- Average P_T^{Jet} correction (MC based)
To correct the average energy lost in the calorimeter
- Unfolding (MC based)
To account for smearing/resolution effects

The MC simulation is good in the central part of the detector... what about the forward region?

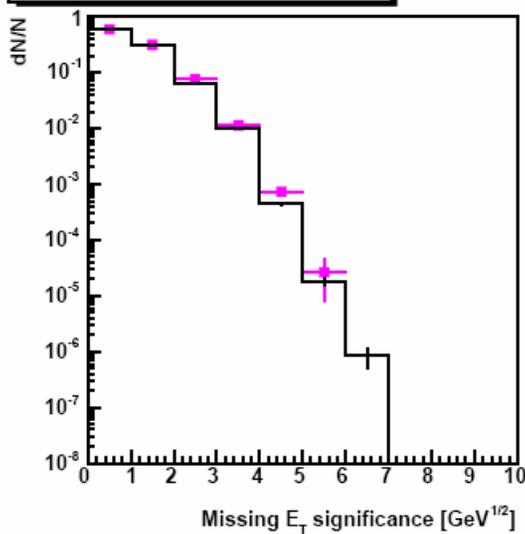
- Comparison of Raw Quantities
- Bisector Method -> study the resolution
- Dijet Balance -> understand the energy scale relative to central jets

Comparison of Raw Quantities: $0.7 < |Y^{\text{jet}}| < 1.1$

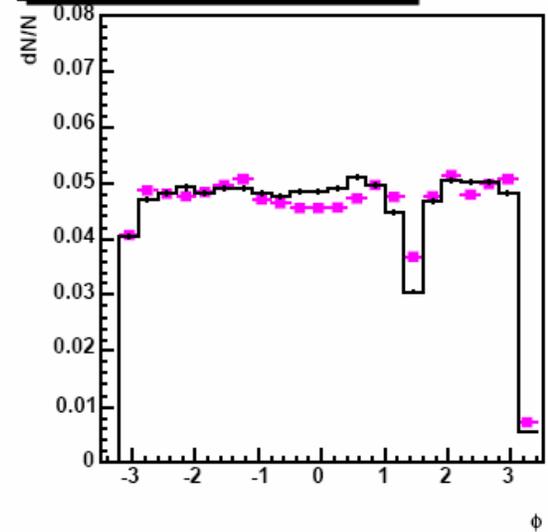
J70: $P_T^{\text{RAW}} > 96 \text{ GeV}/c$ for $0.7 < |Y^{\text{jet}}| < 1.1$



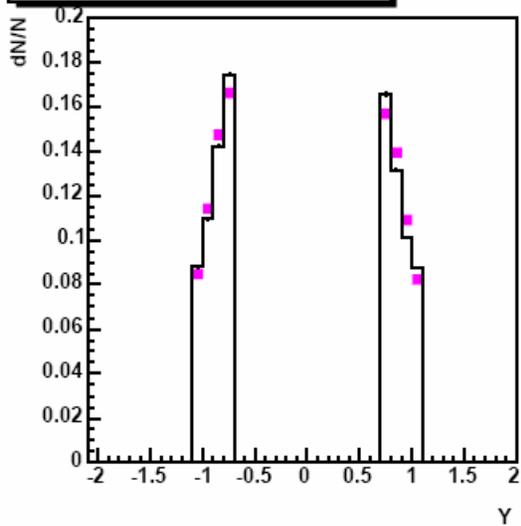
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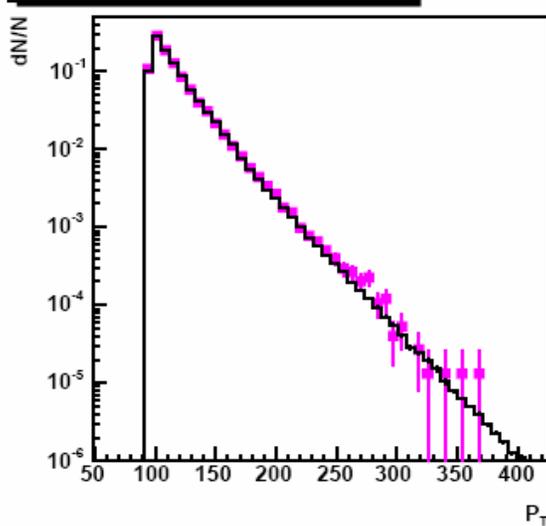
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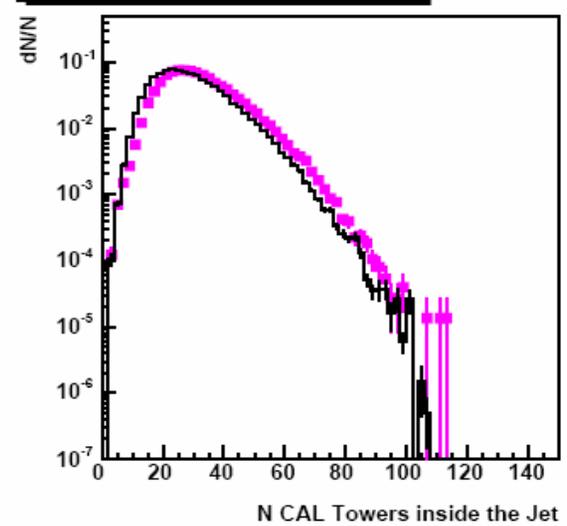
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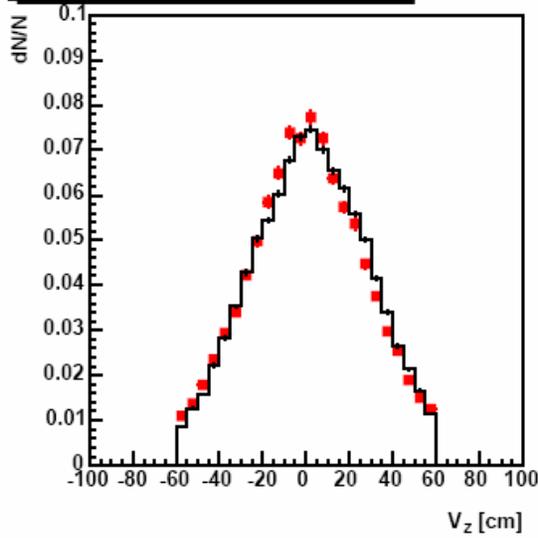


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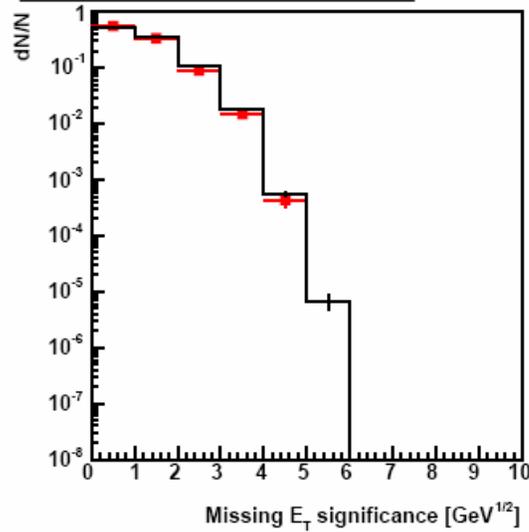


Comparison of Raw Quantities: $1.1 < |Y^{\text{jet}}| < 1.6$

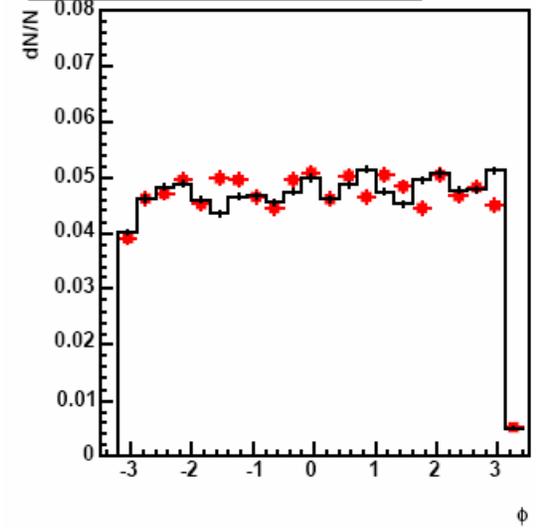
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.1 < |Y^{\text{jet}}| < 1.6$



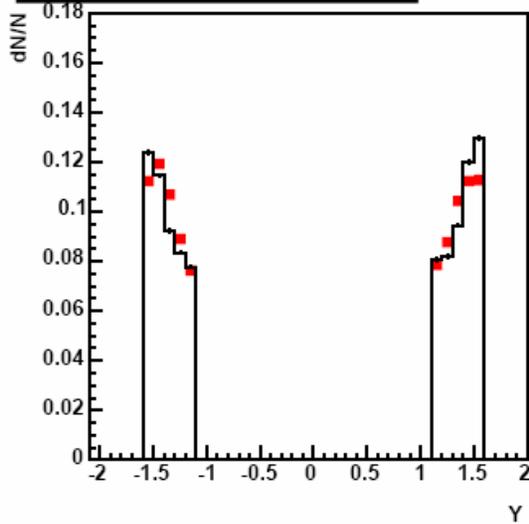
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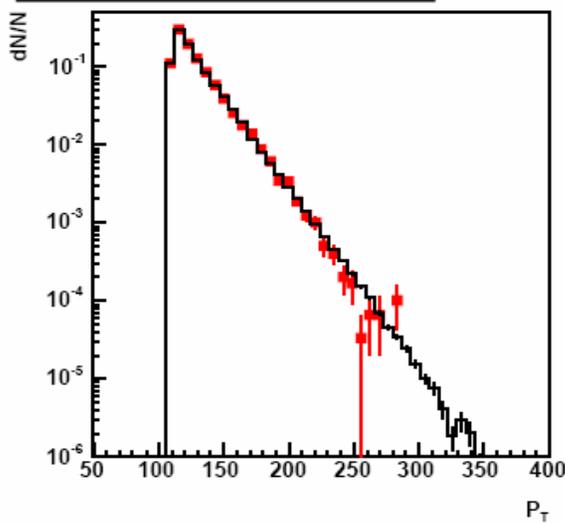
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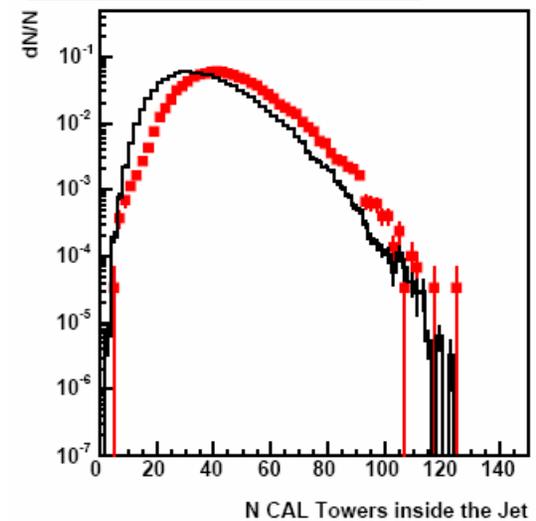
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Test simulation of P_T^{Jet} reconstruction

Raw comparisons show

- General good agreement between Data and MC
- But MC is not perfect (Number of Towers inside jets)

- Need to test accuracy of the simulation of the P_T^{Jet} reconstruction in the MC

 - Bisector Method -> study the resolution

 - Dijet Balance -> understand the energy scale

- General Event Selection

 - 2 and only 2 jets with $P_T^{\text{Jet}} \geq 10 \text{ GeV}/c$

 - 1 and only 1 primary vertex ($|V_z| < 60\text{cm}$)

 - Missing E_T significance cut applied in both jets

Bisector Method

- Event Selection

- One jet (Jet 1) with $0.1 < |Y^{\text{Jet}}| < 0.7$

- The other jet (Jet 2) with

- $|Y^{\text{Jet}}| < 0.1$; $0.7 < |Y^{\text{Jet}}| < 1.1$; $1.1 < |Y^{\text{Jet}}| < 1.6$; $1.6 < |Y^{\text{Jet}}| < 2.1$

- Definitions

- > $P_{\text{T}}^{\text{Mean}} = (P_{\text{T}}^{\text{Jet1}} + P_{\text{T}}^{\text{Jet2}})/2$

- > $\gamma = |(\phi^{\text{Jet1}} - \phi^{\text{Jet2}})/2|$

- > $\Delta P_{\text{T}}^{\text{//}} = \pm (P_{\text{T}}^{\text{Jet1}} - P_{\text{T}}^{\text{Jet2}}) \cos(\gamma)$

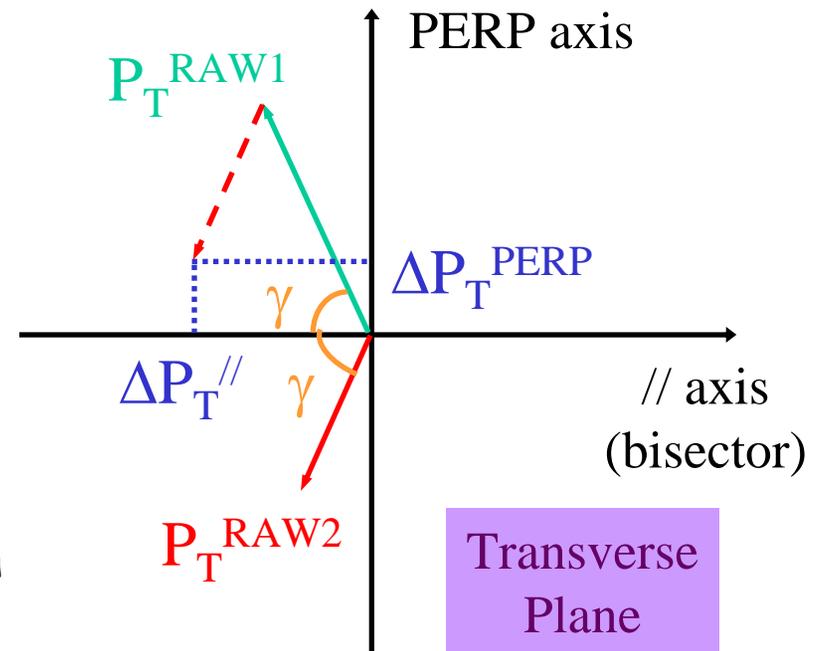
- > $\Delta P_{\text{T}}^{\text{PERP}} = (P_{\text{T}}^{\text{Jet1}} + P_{\text{T}}^{\text{Jet2}}) \sin(\gamma)$

- Relevant variables (in bin of $P_{\text{T}}^{\text{Mean}}$)

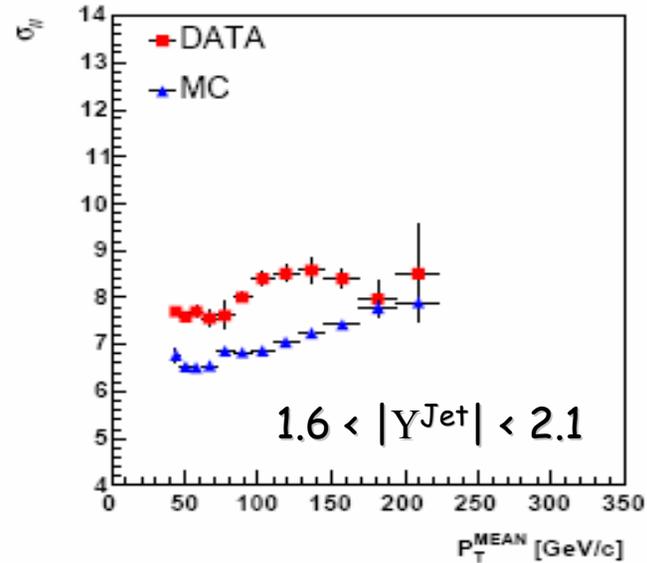
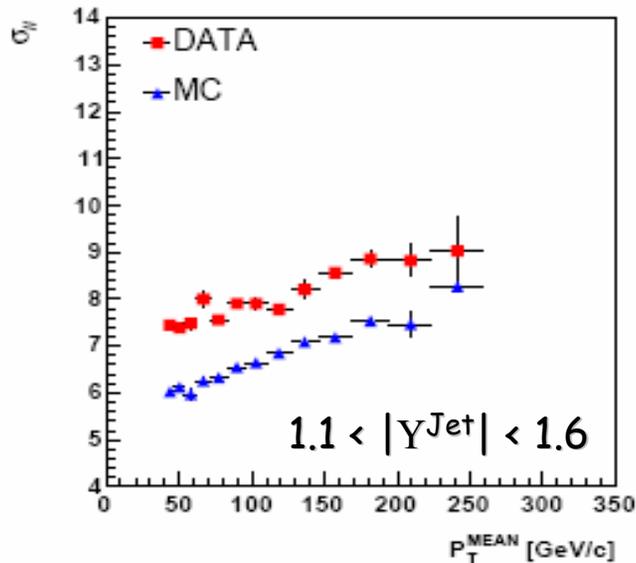
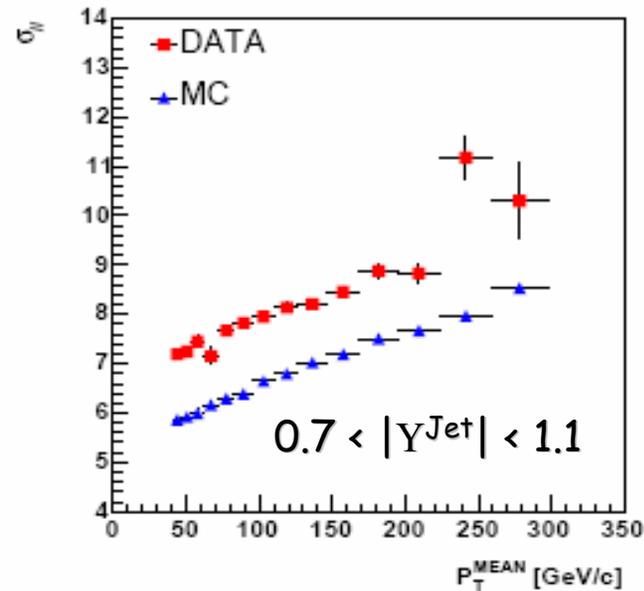
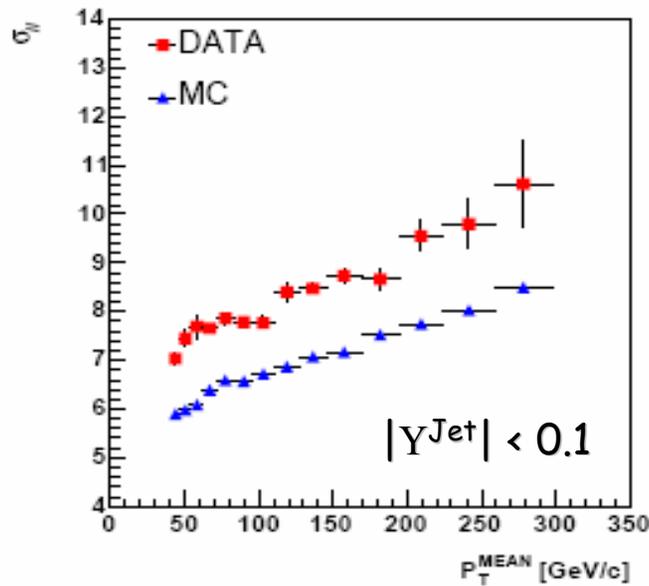
- $\sigma_{\text{//}} = \text{rms of } \Delta P_{\text{T}}^{\text{//}} \text{ distribution}$

- $\sigma_{\text{PERP}} = \text{rms of } \Delta P_{\text{T}}^{\text{PERP}} \text{ distribution}$

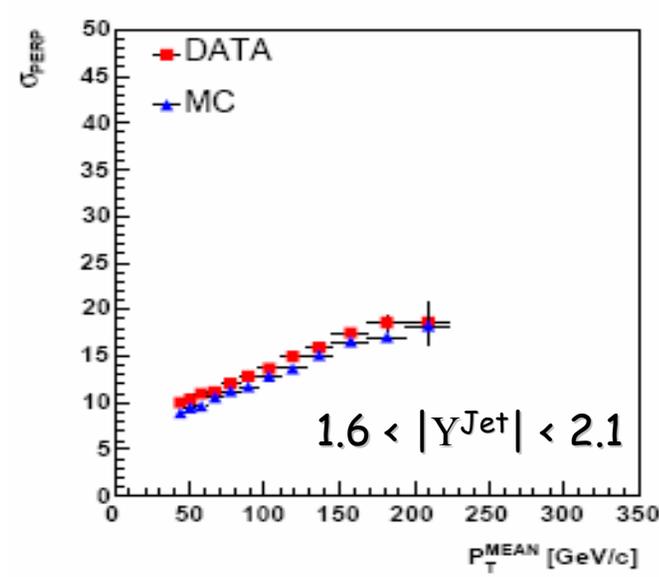
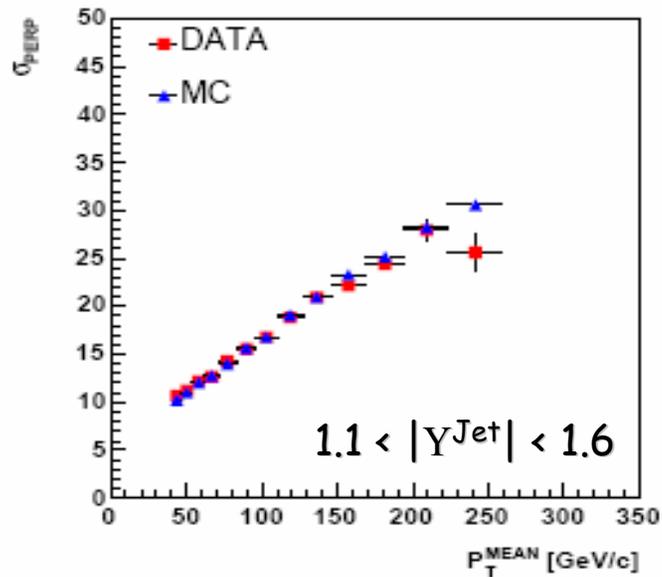
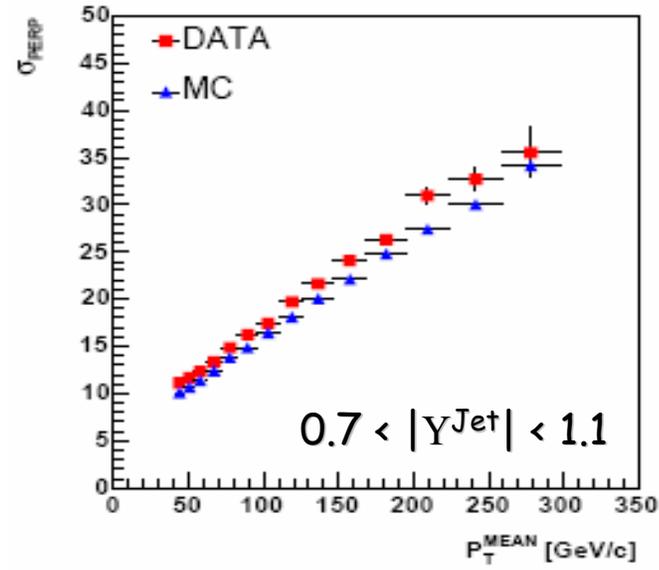
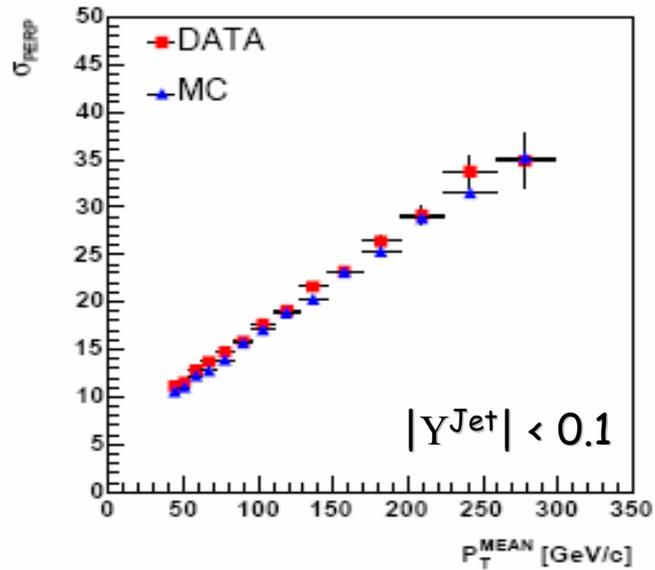
- $\sigma_{\text{D}} = \sqrt{(\sigma_{\text{PERP}}^2 - \sigma_{\text{//}}^2)}$



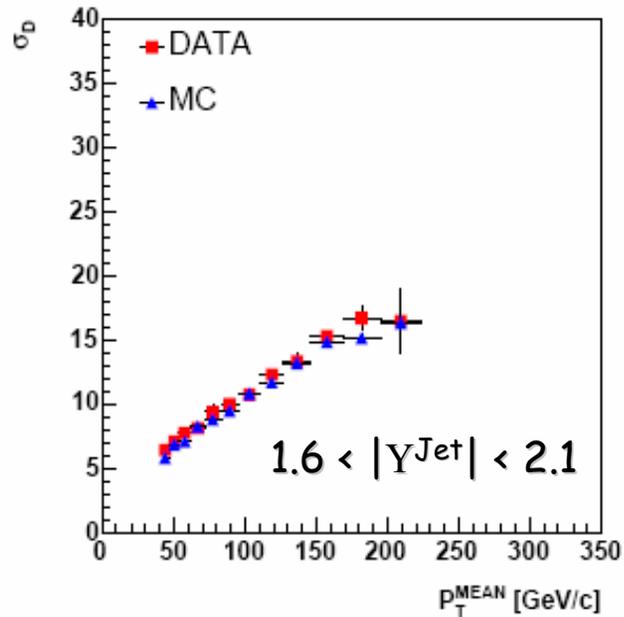
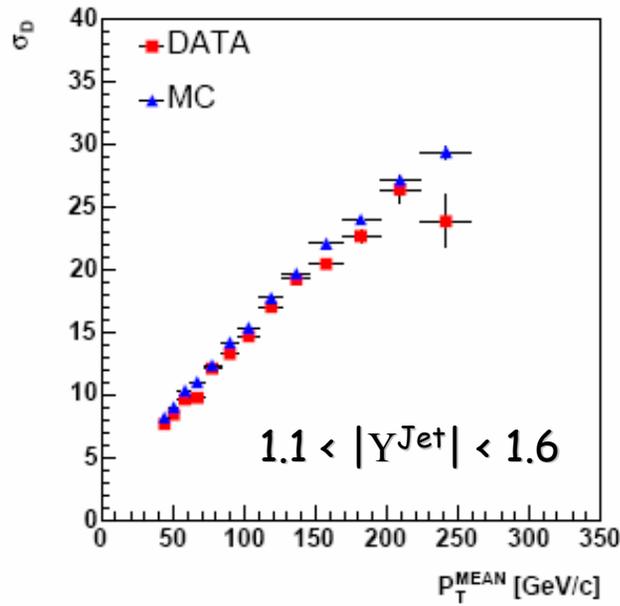
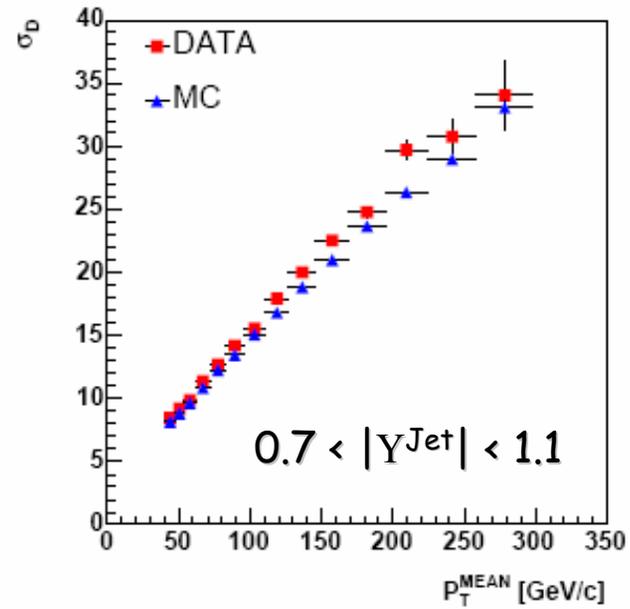
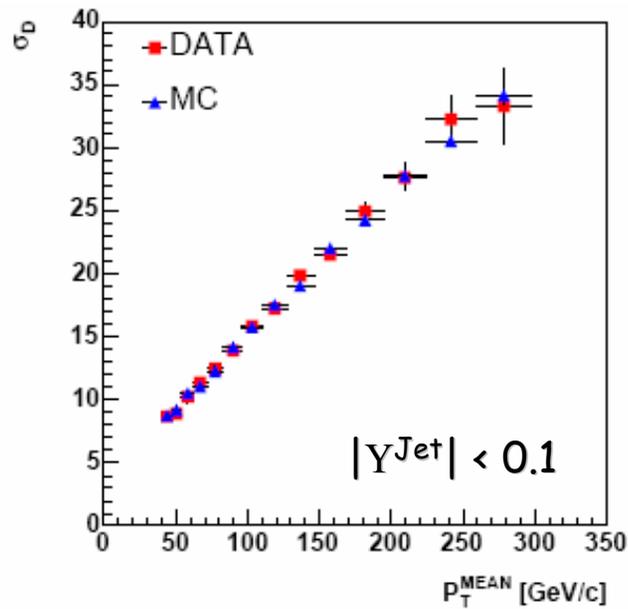
Bisector Method: $\sigma_{//}$ in DATA and MC



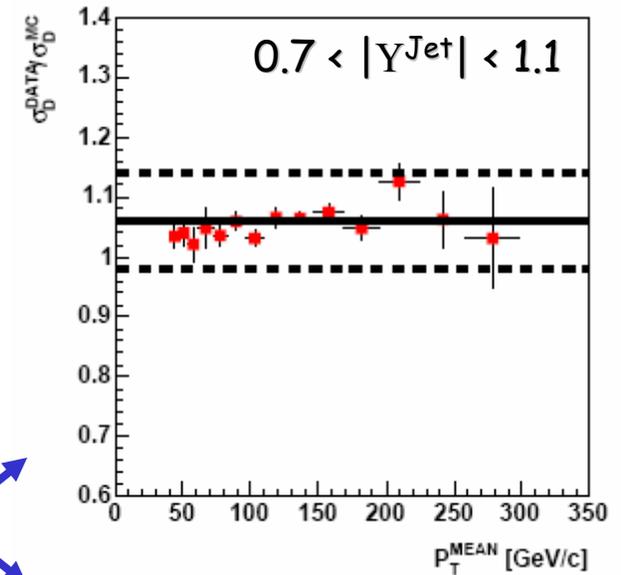
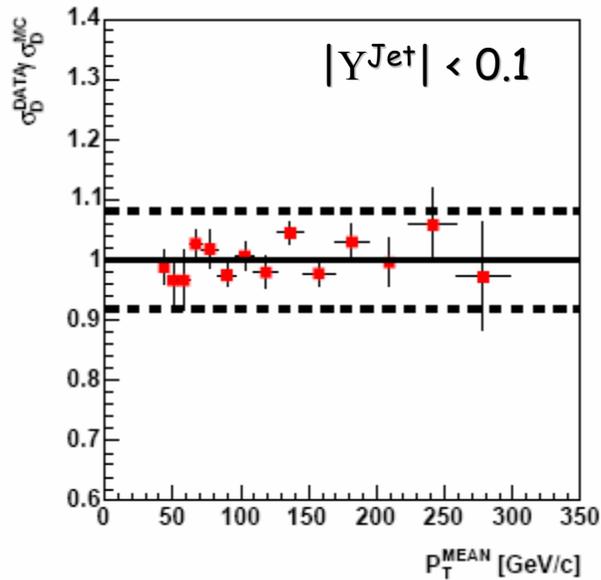
Bisector Method: σ_{\perp} in DATA and MC



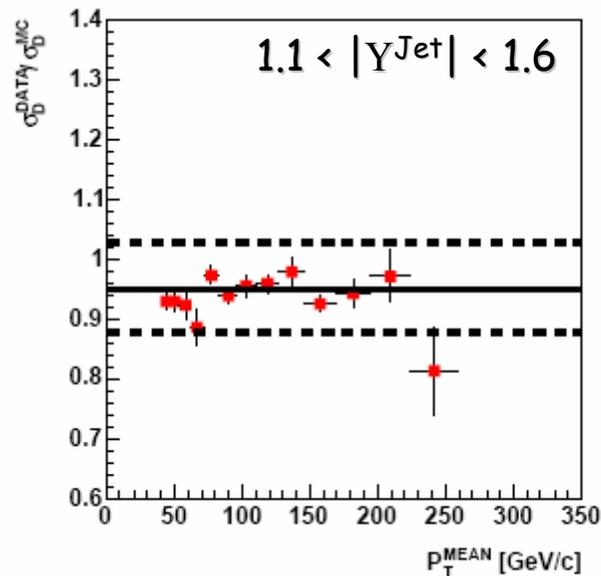
Bisector Method: σ_D in DATA and MC



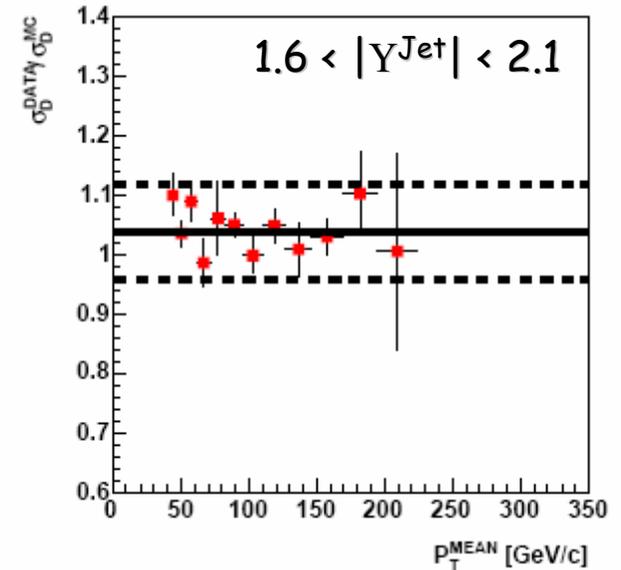
Bisector Method: Data/MC



Data/MC > 1
Resolution underestimated in MC



Data/MC < 1
Resolution overestimated in MC



The two cases must be treated differently

Resolution Corrections

Case 1: Resolution underestimated in the MC

- Correct the resolution by smearing P_T^{RAW} in the MC with a Gaussian ($0, \sigma_G$):

$$P_T^{\text{RAW}}_{\text{Smeared}} = P_T^{\text{RAW}} + \Delta P_T^{\text{RAW}}$$

$$\sigma_{\text{corr}} = \sigma_{\text{MC}} \oplus \sigma_G = F \cdot \sigma_{\text{MC}} \quad \text{where } F > 1$$
$$\Rightarrow \sigma_G = \sigma_{\text{MC}} \cdot \sqrt{(F^2 - 1)}$$

$$0.7 < |Y^{\text{Jet}}| < 1.1 \rightarrow F = 1.06$$

$$1.6 < |Y^{\text{Jet}}| < 2.1 \rightarrow F = 1.10$$

Case 2: Resolution overestimated in the MC

- The method based on the smearing of P_T^{RAW} in the MC cannot be applied
- The correction will be applied later: slightly modified unfolding factors
- To know the difference between Data and MC
 - Smear P_T^{RAW} in the data this time (**ONLY FOR THIS**) using same definition of σ_G

$$1.1 < |Y^{\text{Jet}}| < 1.6 \rightarrow F = 1.05$$

\Rightarrow Correction to apply to the resolution in the MC is 1/1.05

Dijet Balance: method

After the P_T resolution has been adjusted in the MC (wherever possible)

- Event Selection

- One jet (Trigger Jet) with $0.2 < |\eta_D| < 0.6$

- The other jet (Probe Jet) with

- $|Y^{\text{Jet}}| < 0.1$; $0.7 < |Y^{\text{Jet}}| < 1.1$; $1.1 < |Y^{\text{Jet}}| < 1.6$; $1.6 < |Y^{\text{Jet}}| < 2.1$

- Definitions

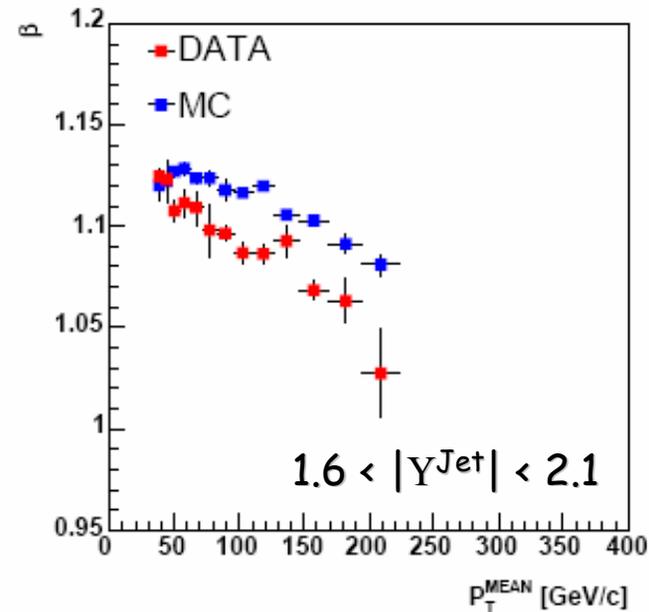
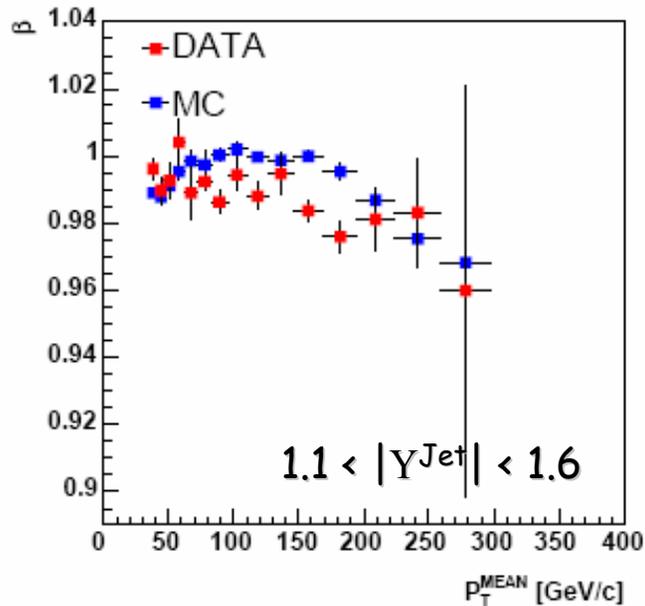
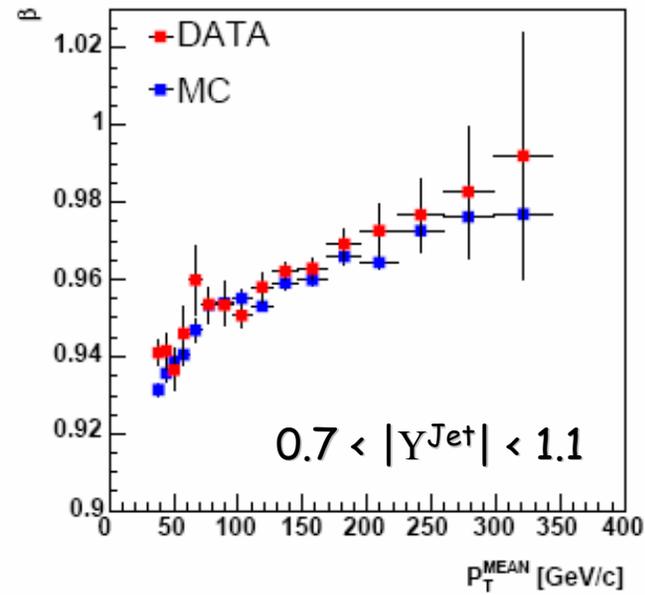
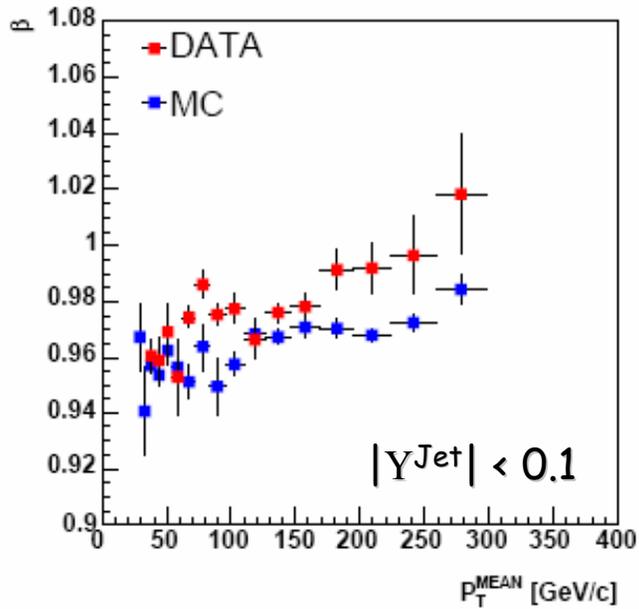
- > $P_{T^{\text{Mean}}} = (P_{T^{\text{Trig}}} + P_{T^{\text{Prob}}})/2$

- > $\Delta P_{T^{\text{F}}} = (P_{T^{\text{Prob}}} - P_{T^{\text{Trig}}})/P_{T^{\text{Mean}}}$

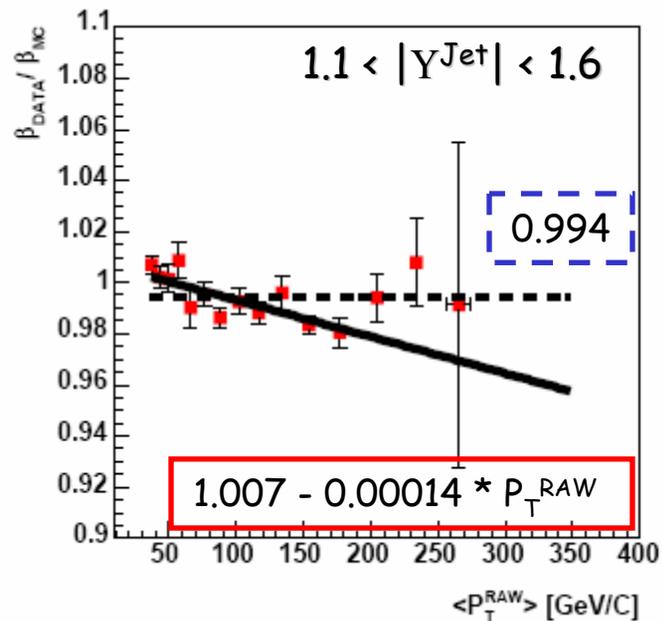
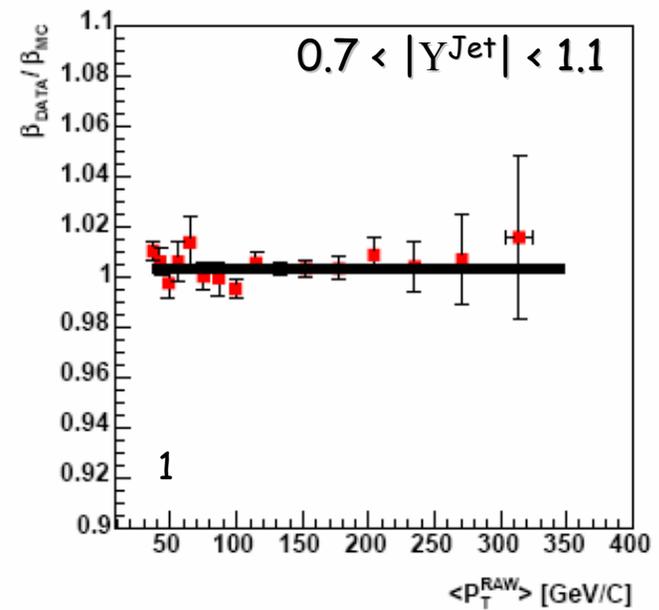
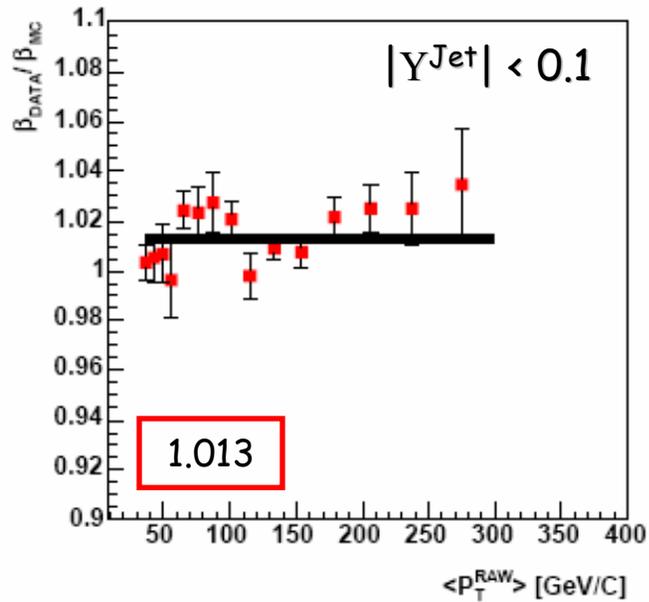
- > In bin of $P_{T^{\text{Mean}}}$: $\beta = (2 + \langle \Delta P_{T^{\text{F}}} \rangle) / (2 - \langle \Delta P_{T^{\text{F}}} \rangle)$

Event by event: $\beta = P_{T^{\text{Prob}}} / P_{T^{\text{Trig}}}$

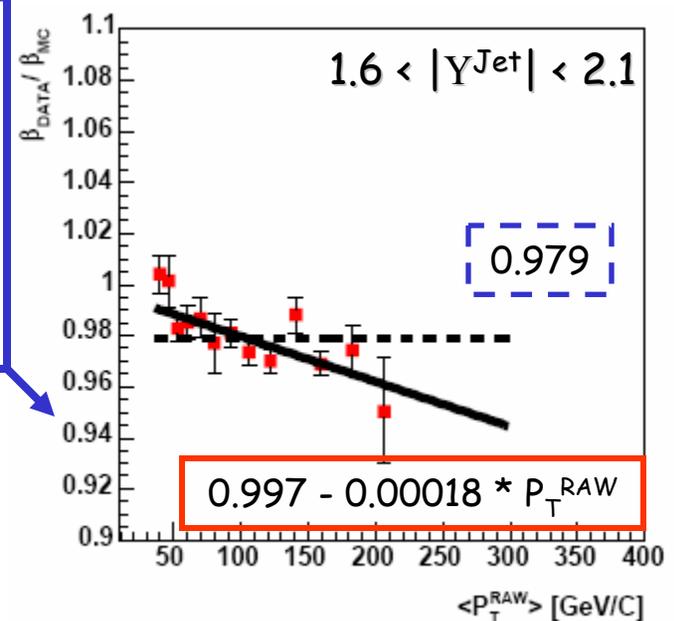
Dijet Balance: β in Data and MC



Dijet Balance: Data/MC

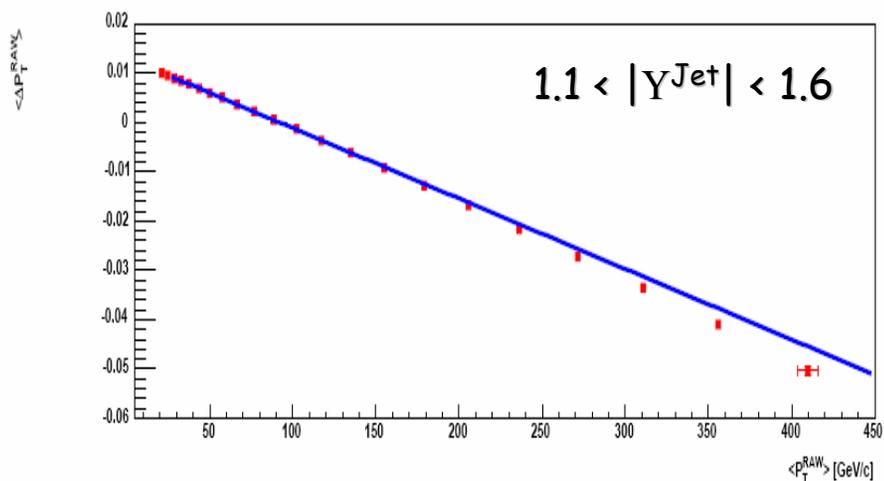


ΔP_T^{RAW} coming from the different corrections have been evaluated

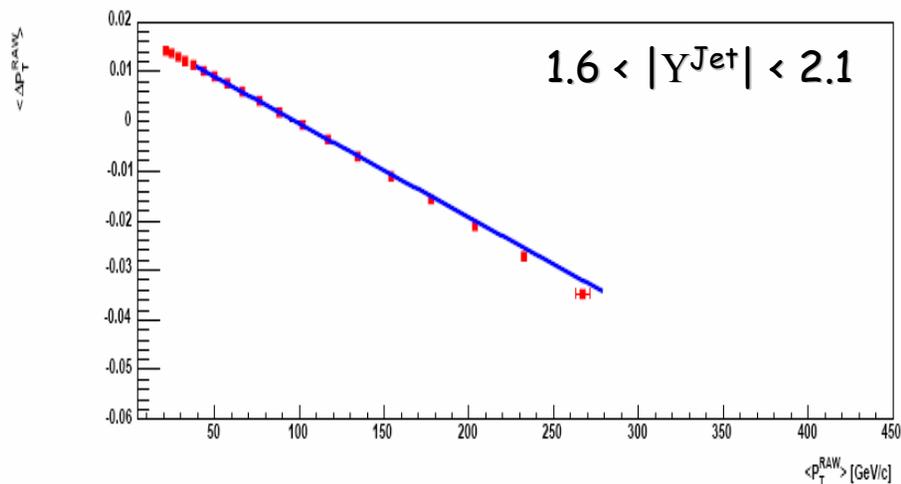


Dijet Balance: Systematic

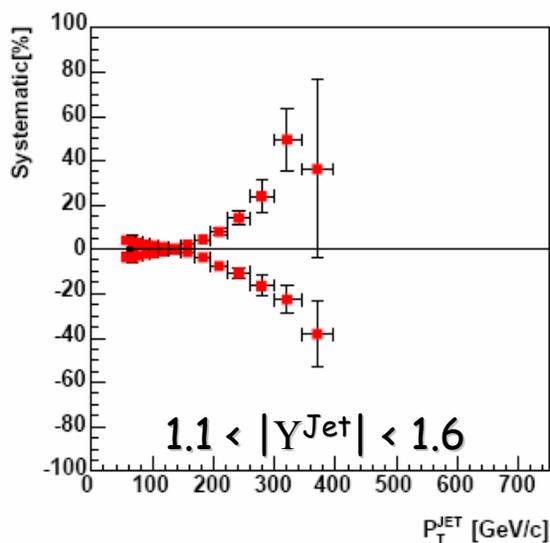
$\langle \Delta P_T^{\text{RAW}} \rangle$ vs $\langle P_T^{\text{RAW}} \rangle$ ($1.1 < |Y^{\text{Jet}}| < 1.6$)



$\langle \Delta P_T^{\text{RAW}} \rangle$ vs $\langle P_T^{\text{RAW}} \rangle$ ($1.6 < |Y^{\text{Jet}}| < 2.1$)



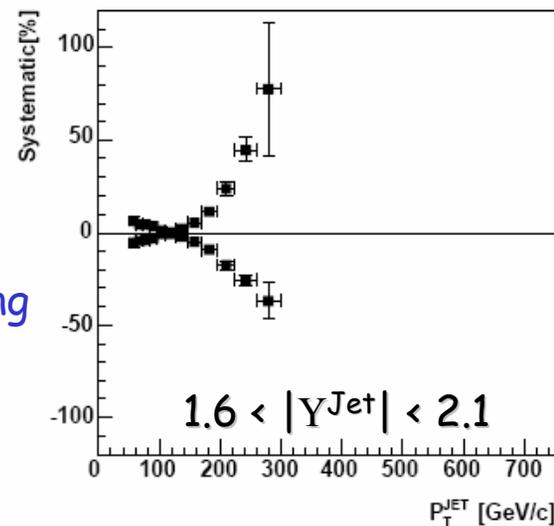
JES uncertainties coming from Dijet Correction ($1.1 < |Y^{\text{Jet}}| < 1.6$)



The associated JES uncertainty coming from the ΔP_T^{RAW}

We are rather overestimating the associated systematic uncertainty

JES uncertainties coming from Dijet Correction ($1.6 < |Y^{\text{Jet}}| < 2.1$)



Jet P_T corrections

➤ Pile Corrections

→ Correction : $P_T^{\text{RAW}}(\text{Pile-up corrected}) = P_T^{\text{RAW}} - \varepsilon_{0.7} \times (\text{NVQ12} - 1)$

→ $\varepsilon_{0.7}$ extracted from data for jets in the central region :

$$\varepsilon_{0.7} = 1.62 \pm_{-0.46}^{+0.70} \text{ GeV}/c$$

➤ Use PYTHIA MC to extract the average absolute P_T^{Jet} corrections

After applying corrections to the MC based on
Bisector Method and Dijet Balance studies

→ Reconstruct jets at Calorimeter (P_T^{RAW}) and Hadron (P_T^{HAD}) level

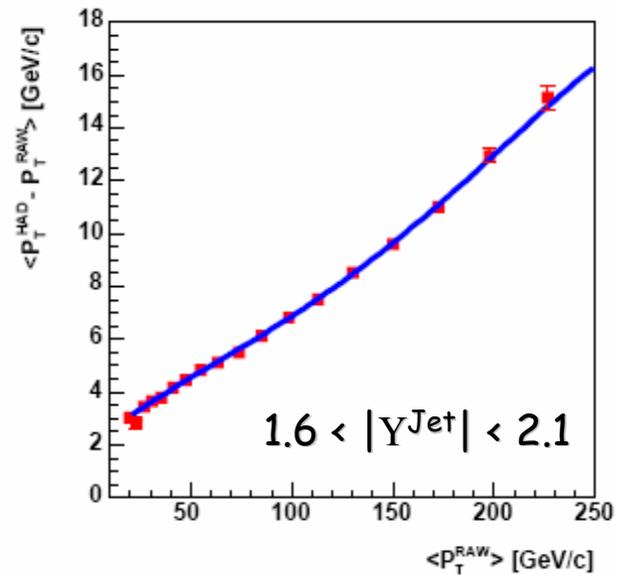
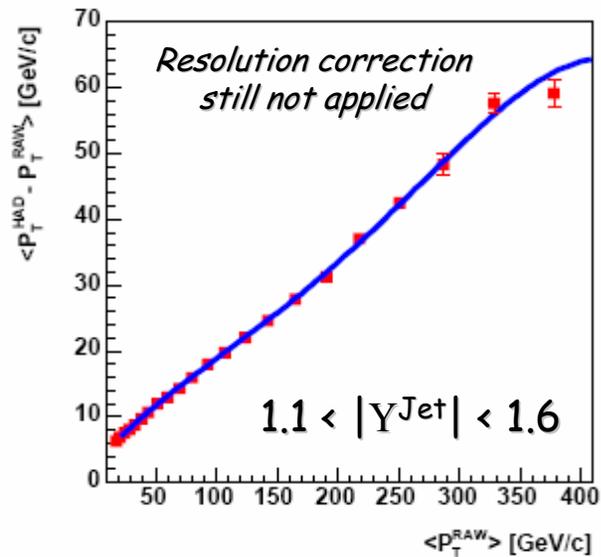
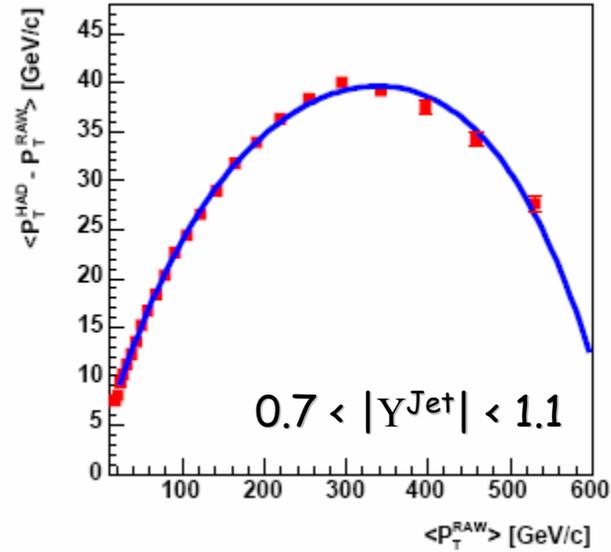
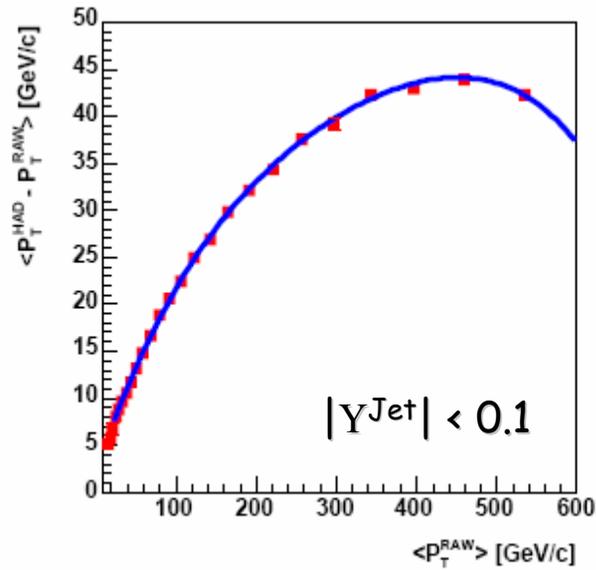
→ Match pair of CAL-HAD jets in $Y - \phi$ space

$$\Delta R = \sqrt{Y^2 + \phi^2} < 0.7$$

→ The correlation $\langle P_T^{\text{HAD}} - P_T^{\text{RAW}} \rangle$ versus $\langle P_T^{\text{RAW}} \rangle$ for matched jets is reconstructed and fitted to a 4th order polynomial

- In bins of $(P_T^{\text{HAD}} + P_T^{\text{RAW}})/2$ to less bias the $P_T^{\text{HAD}} - P_T^{\text{RAW}}$ distribution

Average P_T^{Jet} Correction



Unfolding Procedure

- Use Pythia MC to correct the jet spectrum back to the hadron level
 - Count: the N_{Jet} Calorimeter level (all cuts & $P_{\text{T}}^{\text{Jet}}$ corrected)
 - N_{Jet} Hadron (no cuts)
 - Bin-by-bin unfolding factors

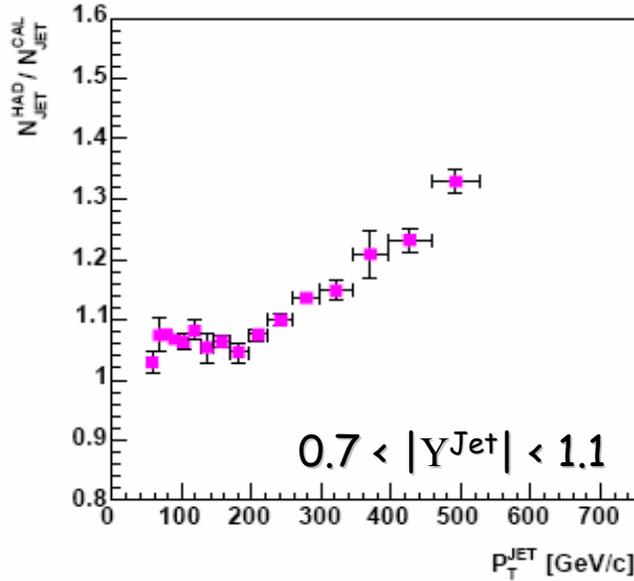
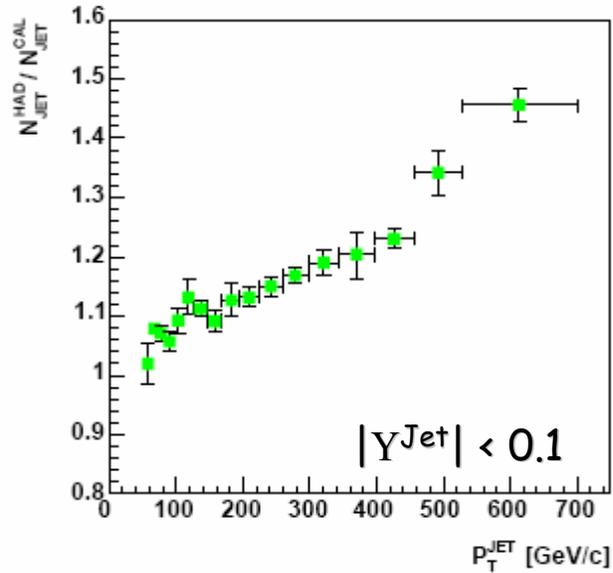
$$C_i = \frac{N_{\text{Jet}} \text{ Hadron level}}{N_{\text{Jet}} \text{ Calorimeter level}} (P_{\text{T}}^{\text{Jet}} \text{ bin } i)$$

- Apply corrections factors to the measured P_{T} spectrum ($P_{\text{T}}^{\text{Jet}}$ corrected) to unfold it to the hadron level.

$$N_{\text{jets}}^{\text{DATA UNFOLDED}} (P_{\text{T}}^{\text{Jet}} \text{ bin } i) = C_i \times N_{\text{jets}}^{\text{DATA}} (P_{\text{T}}^{\text{Jet}} \text{ bin } i)$$

- The MC is re-weighted to make the measurements independent of the jet P_{T} spectrum in the MC which is related to the PDF used

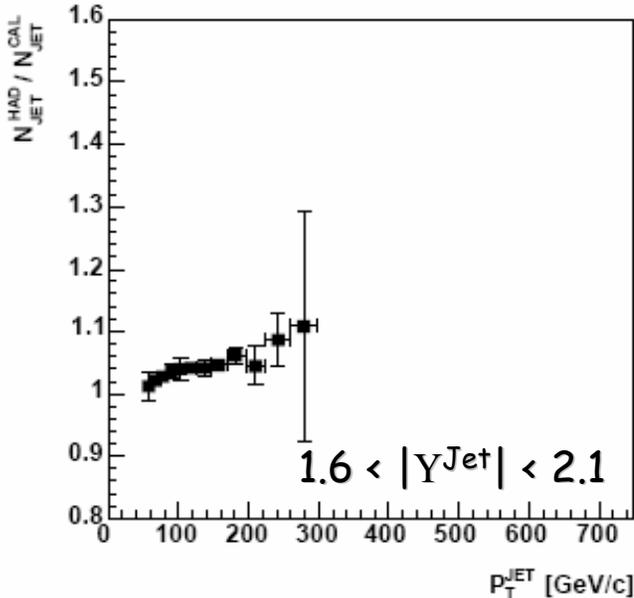
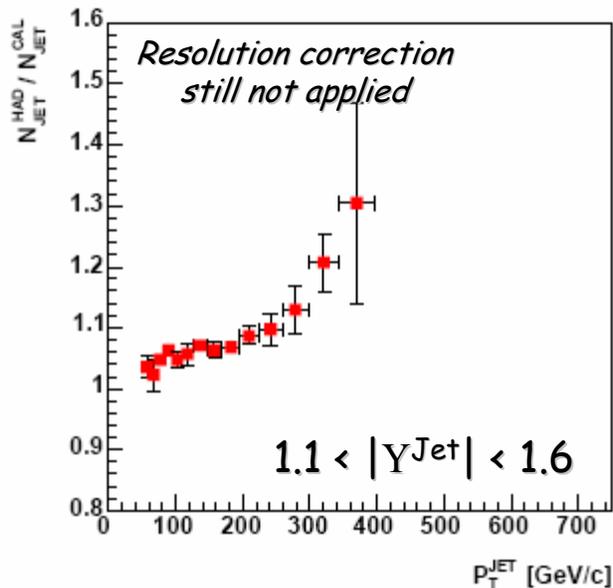
Unfolding Factors (weighted PYTHIA)



After reweighting the MC

- Unfolding factors are almost unchanged up to ~ 400 GeV/c

- Biggest changes $< 10\%$ (very high P_T^{JET})



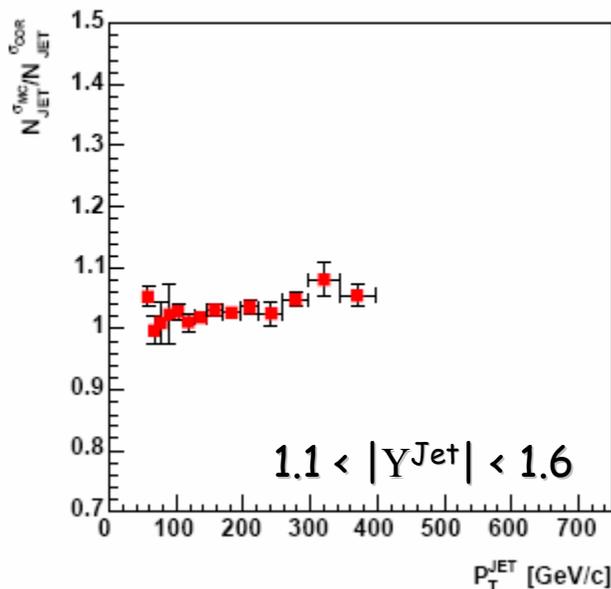
Resolution correction for case 2 ($1.1 < |Y^{\text{Jet}}| < 1.6$)

Reminder: case 2 = Resolution overestimated in the MC

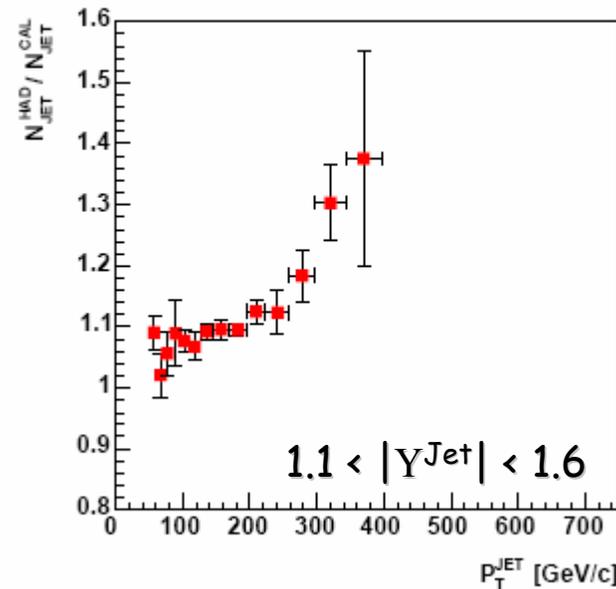
- Correct the unfolding factors to take into account the discrepancy between data and MC on the jet energy resolution
- Corrections factors extracted from the ratio of the hadron level spectrum smeared by σ_{MC} and $\sigma_{\text{corr}} = \sigma_{\text{MC}} \times (1/1.05)$

$\Rightarrow \sim 3\%$

Resolution correction Factors ($1.1 < |Y^{\text{Jet}}| < 1.6$)



Final unfolding ($1.1 < |Y^{\text{Jet}}| < 1.6$)



The systematic related to the application of the dijet balance before correcting for the resolution has been evaluated: $\sim 3\%$

Systematic Uncertainties

→ Jet Energy Scale

- Energy scale varied in MC according to uncertainty estimated by Jet Energy and Resolution Group

→ Unfolding

- Sensitivity to P_T spectrum : ratio of unfolding factors obtained from unweighted and weighted PYTHIA
- Sensitivity to fragmentation model: ratio of unfolding factors obtained from weighted HERWIG and weighted PYTHIA

→ Jet Energy Resolution

- 8% uncertainty on the jet momentum resolution

→ Pile-Up

- Pile-up corrections are changed within uncertainties obtained on ε_D

→ p^{Jet} cut

- The lowest edge of each bin is varied by $\pm 3\%$ → effect $\sim 2\%$

→ Missing E_T significance cut

- Vary at the same time missing E_T scale by $\pm 10\%$ and jet energy scale by $\pm 3\%$
→ effect $< 1\%$

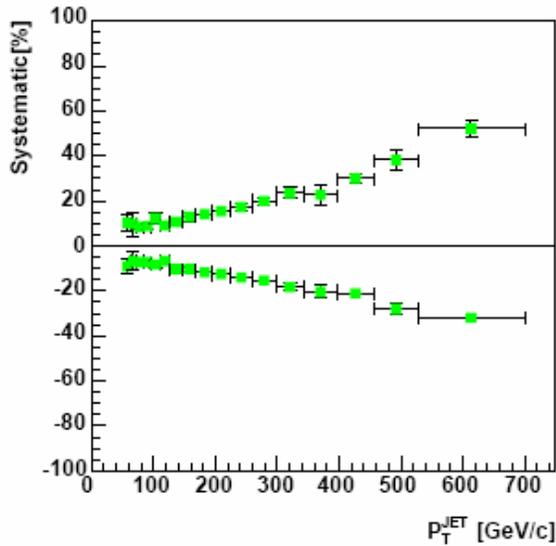
→ V_Z cut

- Cut is varied by $\pm 5\text{cm}$ → effect $\sim 0.3\%$

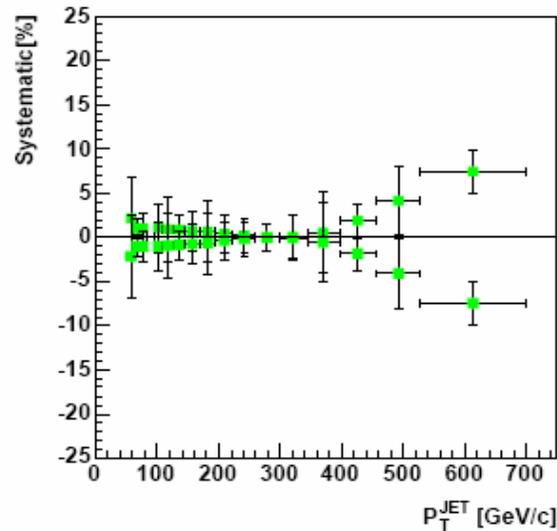
→ NEW : β function in Data/MC (flat against P_1 polynomial)

Systematic uncertainties $|Y^{\text{jet}}| < 0.1$

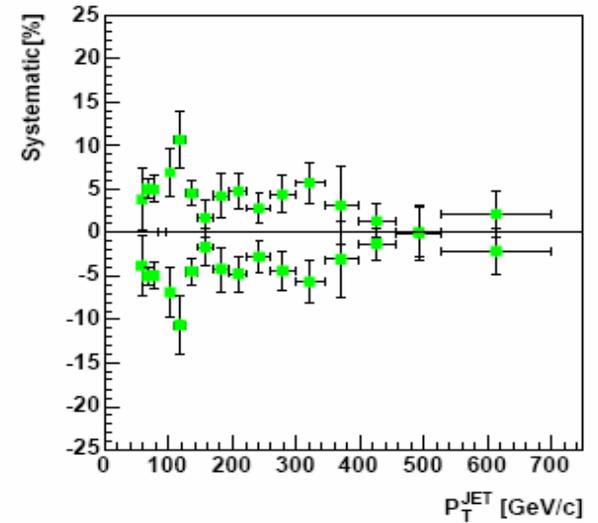
ES uncertainties using JERG curve ($|Y^{\text{jet}}| < 0.1$)



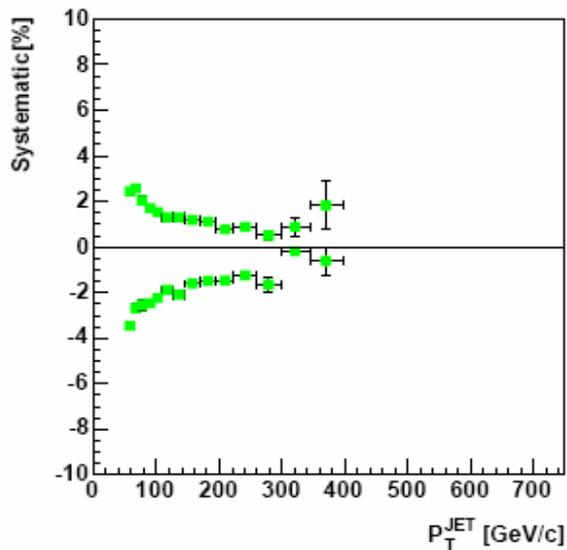
Unfolding sensitivity to P_T spectrum ($|Y^{\text{jet}}| < 0.1$)



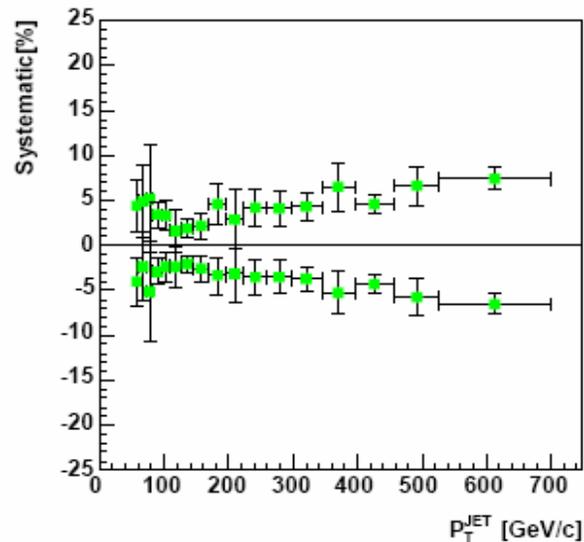
Fragmentation Systematic ($|Y^{\text{jet}}| < 0.1$)



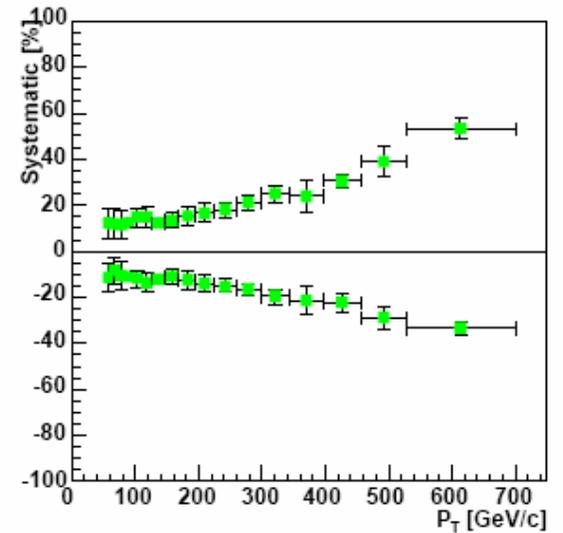
Uncertainty on Pile-Up Correction ($|Y^{\text{jet}}| < 0.1$)



8% uncertainty of resolution ($|Y^{\text{jet}}| < 0.1$)

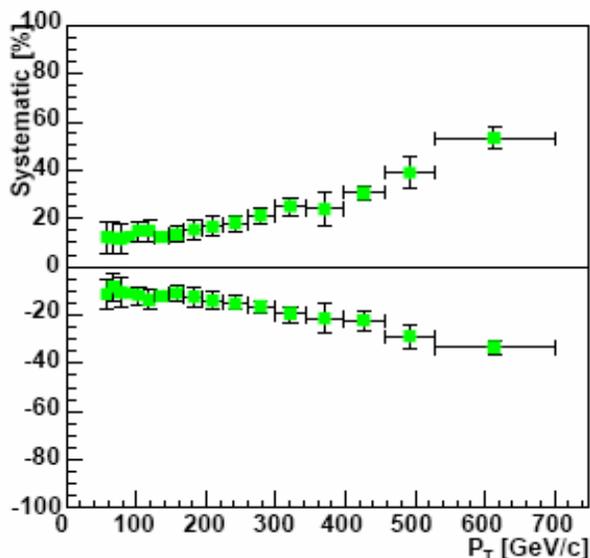


Global systematic ($|Y^{\text{jet}}| < 0.1$)

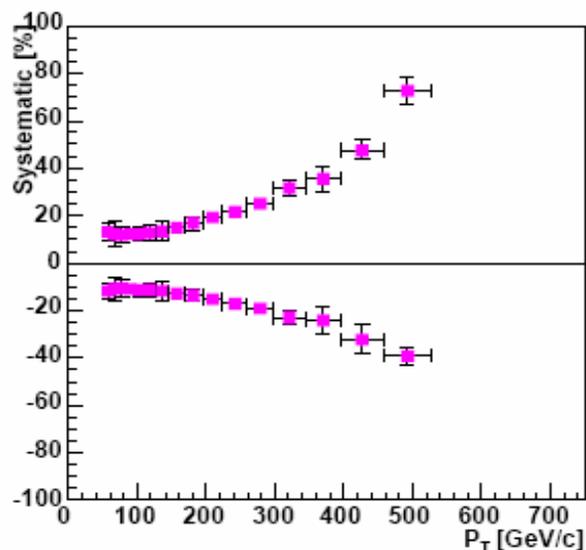


Global Systematic uncertainties

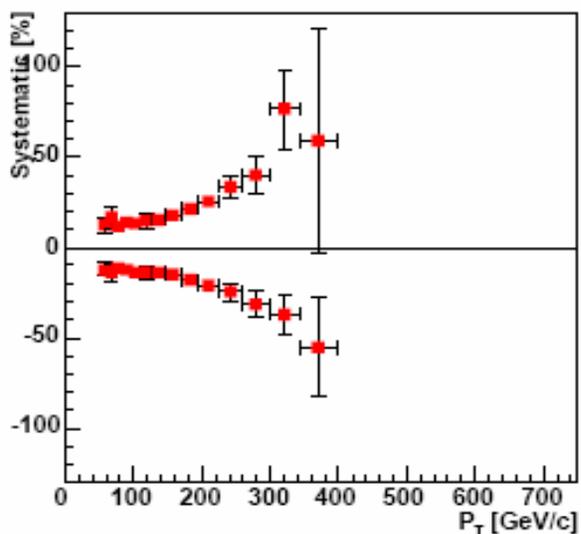
Global systematic ($|Y^{\text{Jet}}| < 0.1$)



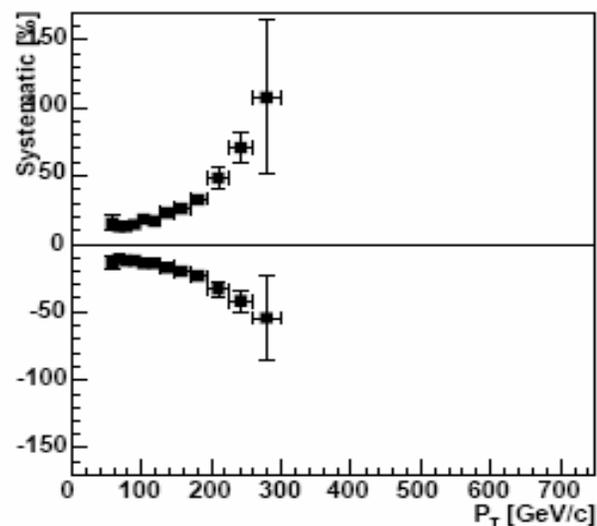
Global systematic ($0.7 < |Y^{\text{Jet}}| < 1.1$)



Global systematic ($1.1 < |Y^{\text{Jet}}| < 1.6$)



Global systematic ($1.6 < |Y^{\text{Jet}}| < 2.1$)



NLO calculations

→ JETRAD CTEQ61 package

- $\mu_R = \mu_F = \text{Maximum Jet } P_T/2$

→ NLO uncertainties

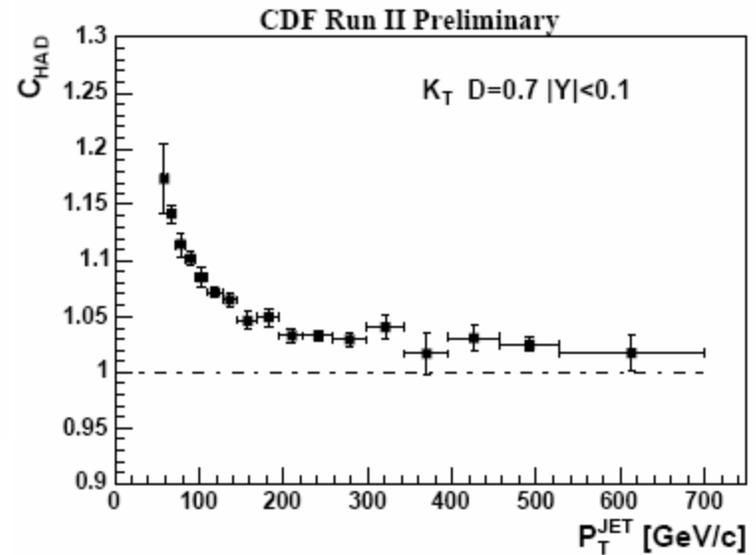
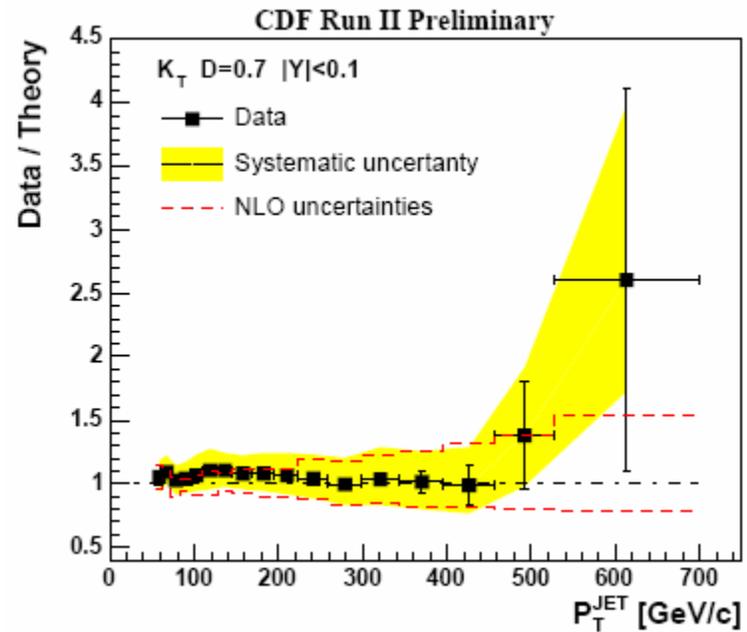
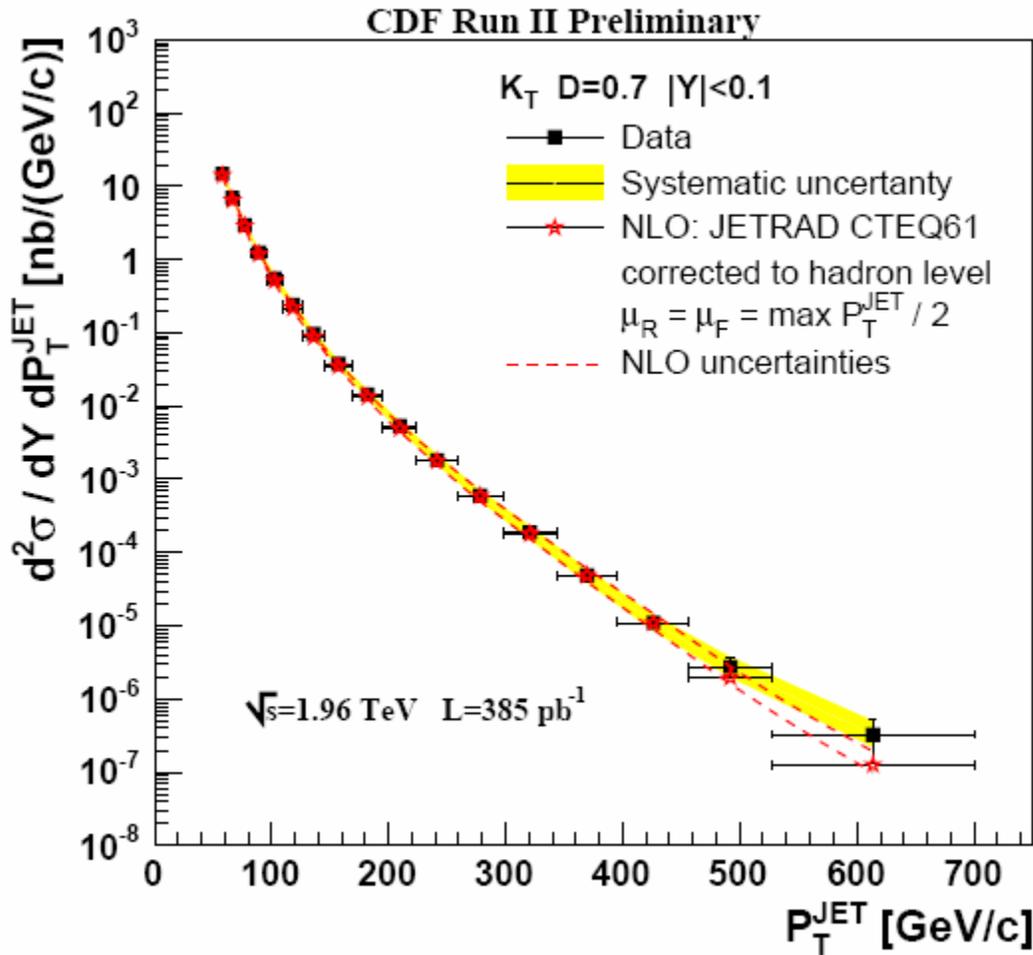
- Scale $\mu_R = \mu_F = \text{Maximum Jet } P_T$
- Preliminary estimation of the uncertainties associated to the PDFs
 - Use the four sets corresponding to plus and minus deviations of eigenvectors 5 and 15
 - ⇒ Eigenvector 15 related to gluon PDF which dominates the uncertainty
 - Uncertainties obtained by considering the maximal positive and negative deviations with respect to nominal set
 - Final uncertainties will be computed taking into account all the 40 PDF sets and procedure as explained in hep-ph/0201195

→ UE / Hadronization corrections

- Correct the NLO pQCD calculations for Underlying Event and Fragmentation in order to compare to data

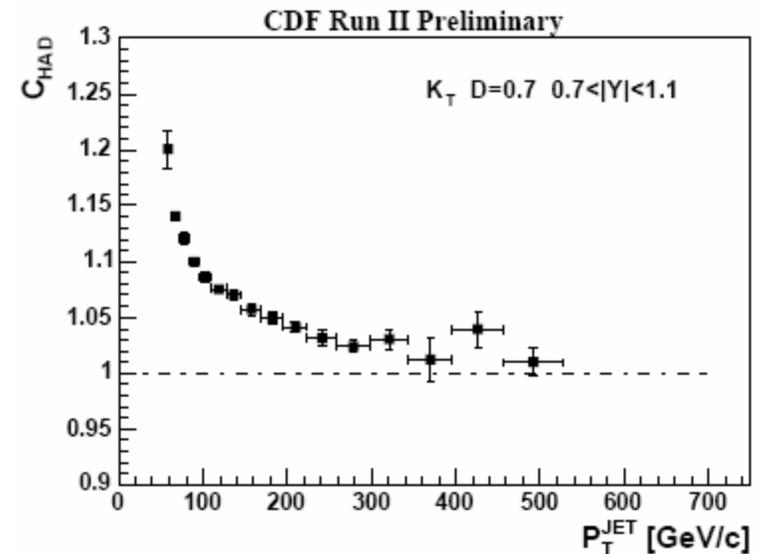
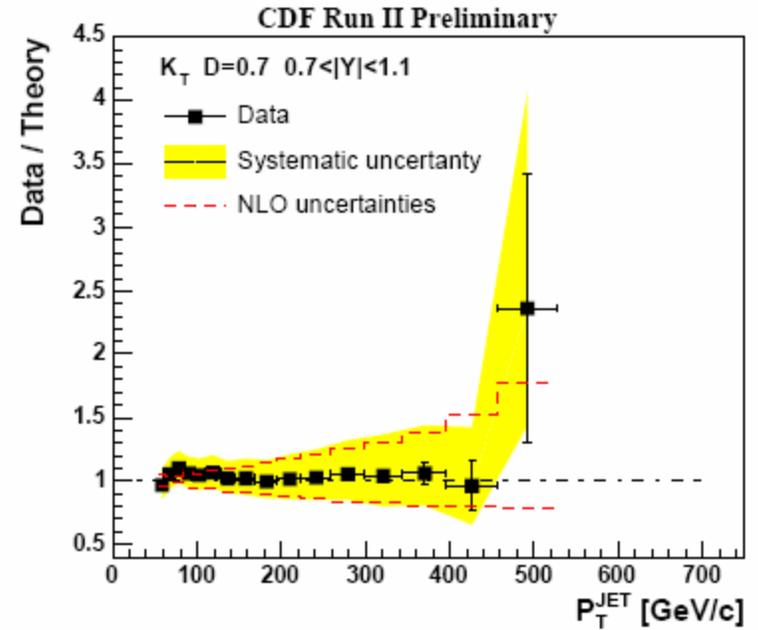
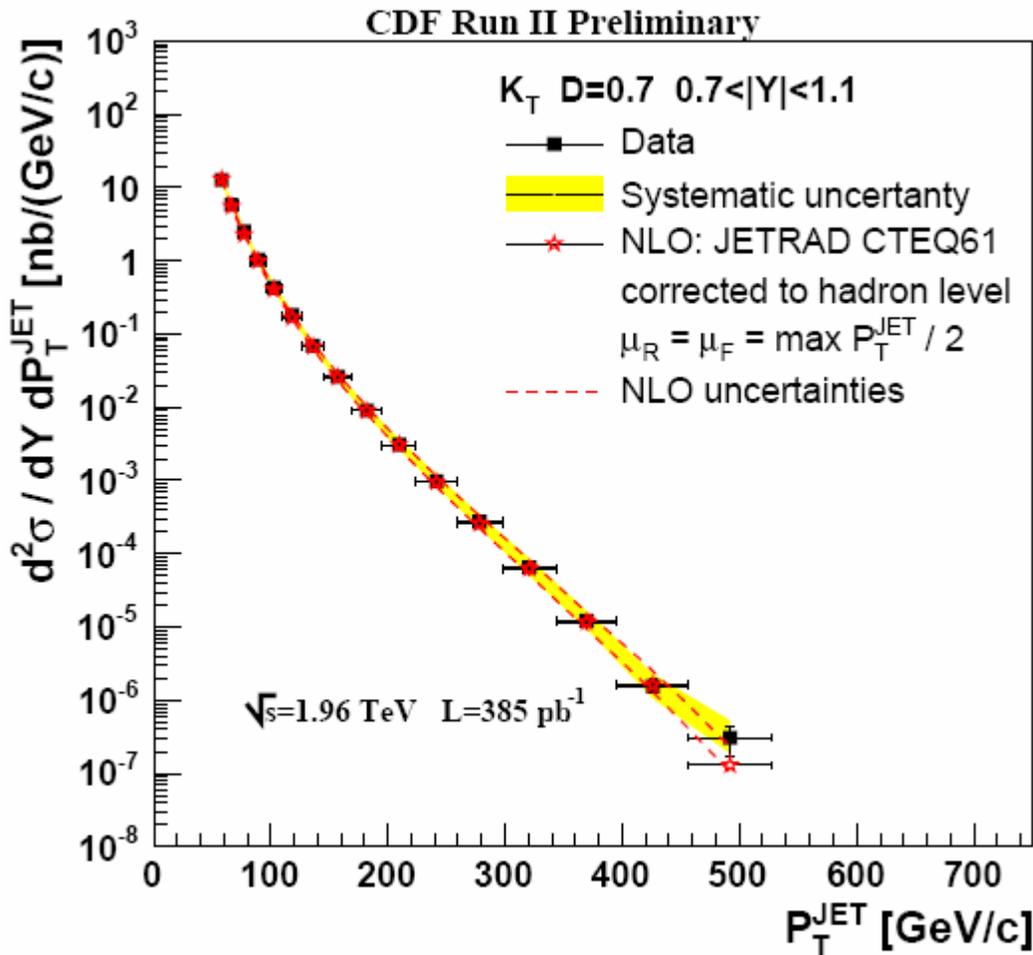
$$C_{\text{HAD}}(P_T^{\text{Jet}}, Y^{\text{Jet}}) = \frac{\sigma(\text{Hadron Level Pythia Tune A with MPI})}{\sigma(\text{Parton Level Pythia Tune A no MPI})}(P_T^{\text{Jet}}, Y^{\text{Jet}})$$

Results: $|Y_{jet}| < 0.1$



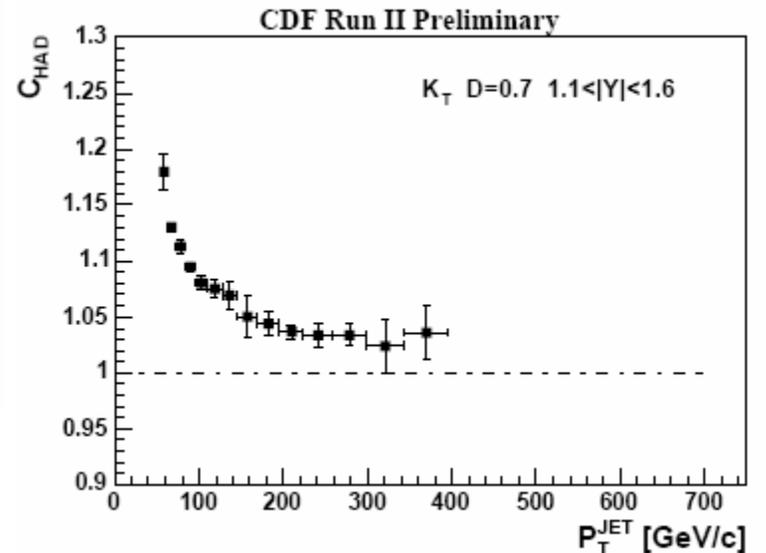
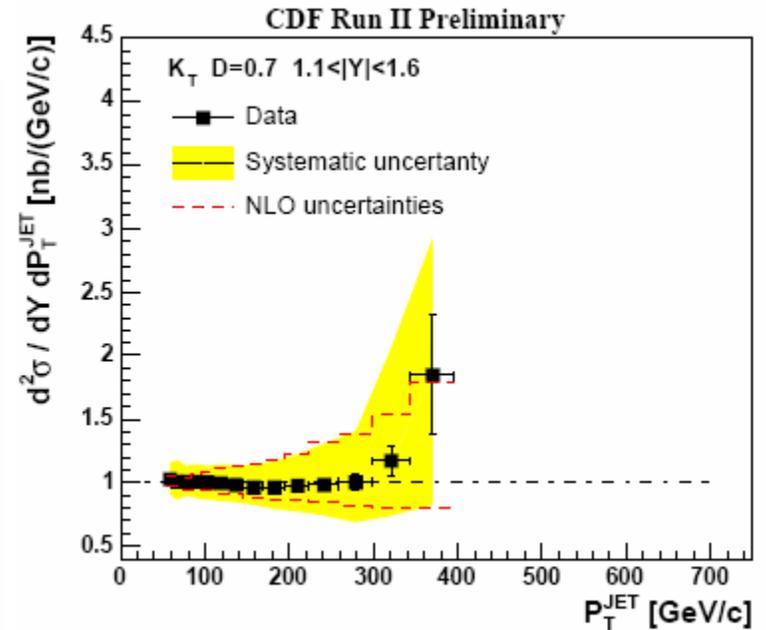
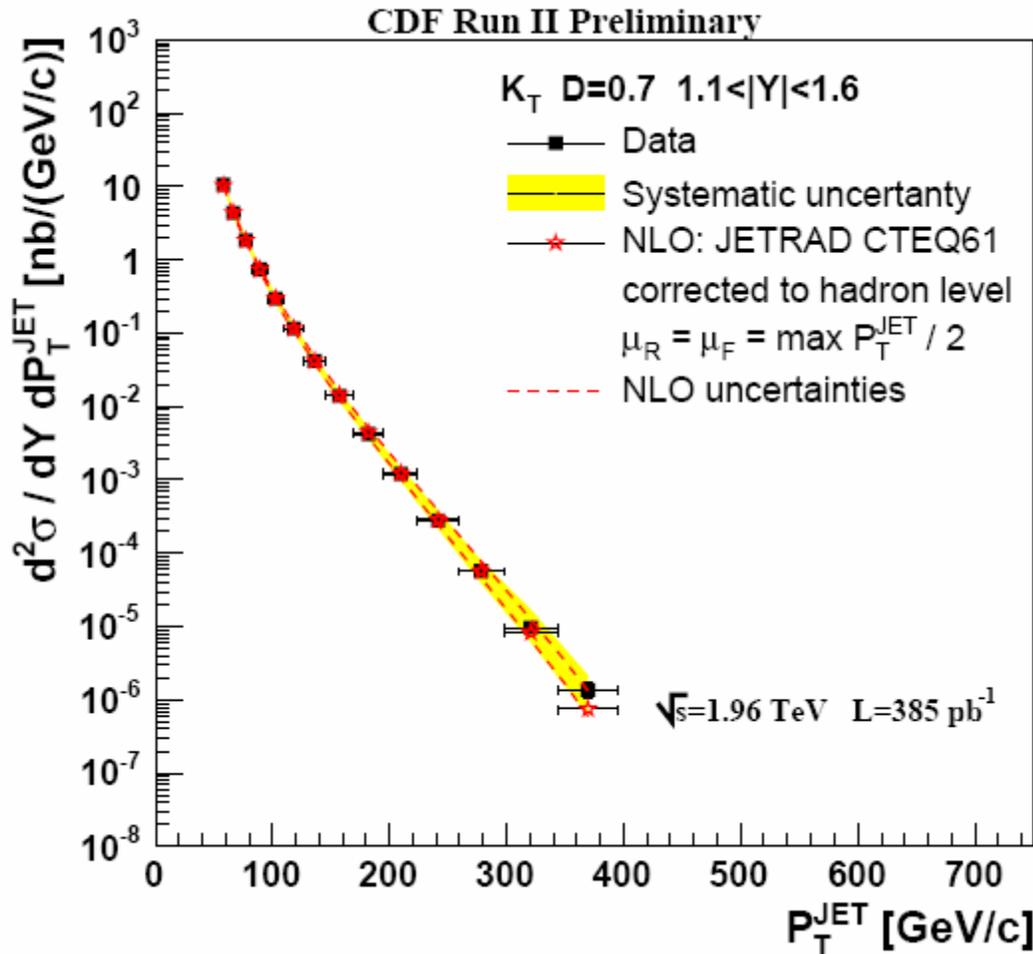
For blessing

Results: $0.7 < |Y^{\text{jet}}| < 1.1$



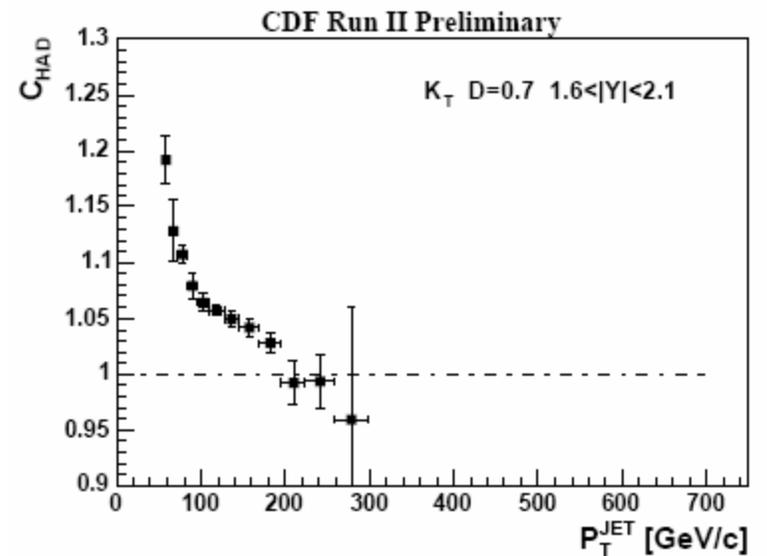
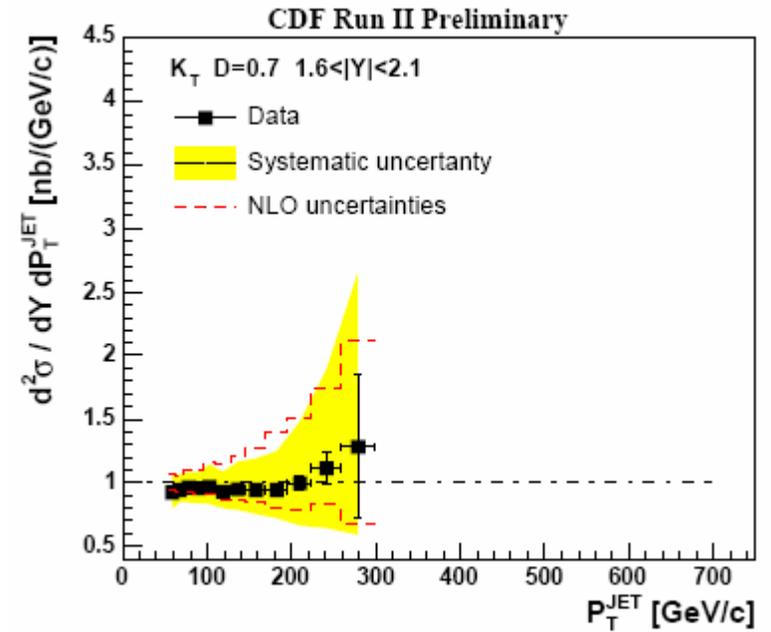
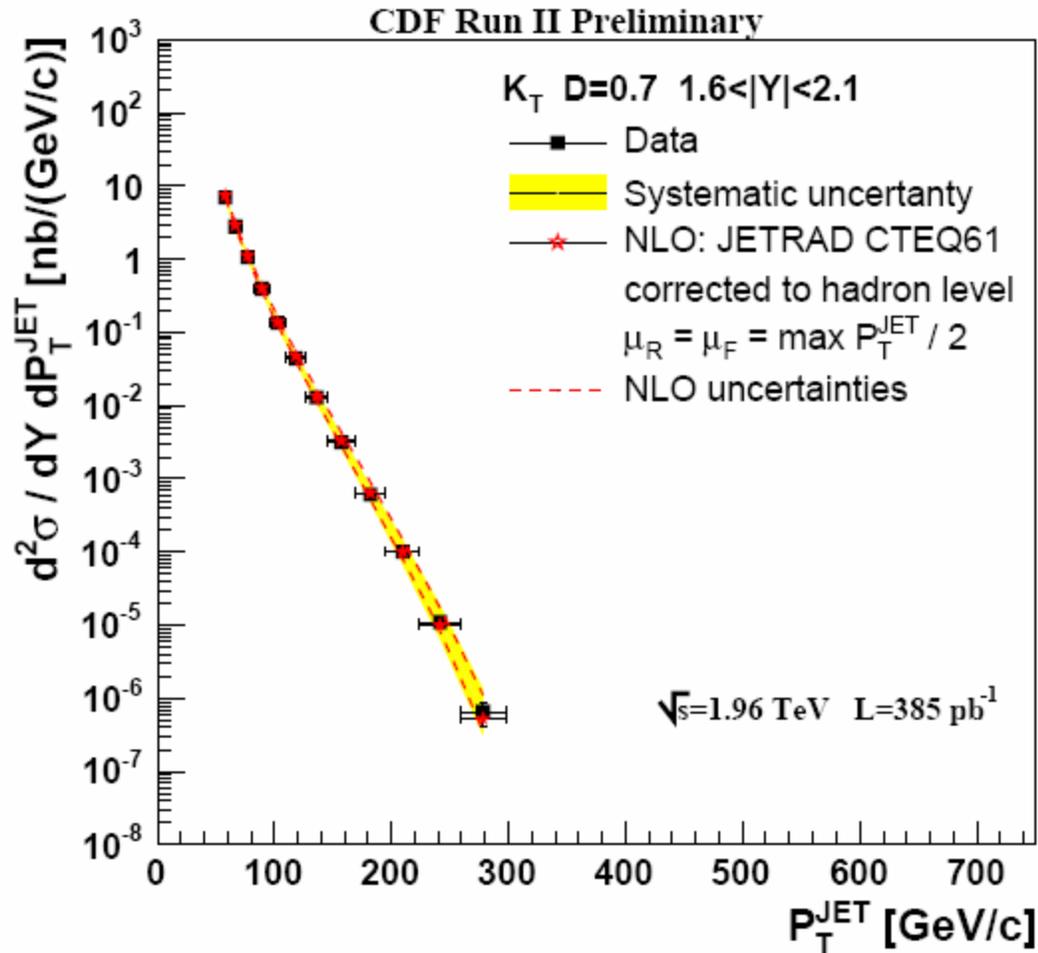
For blessing

Results: $1.1 < |Y_{jet}| < 1.6$



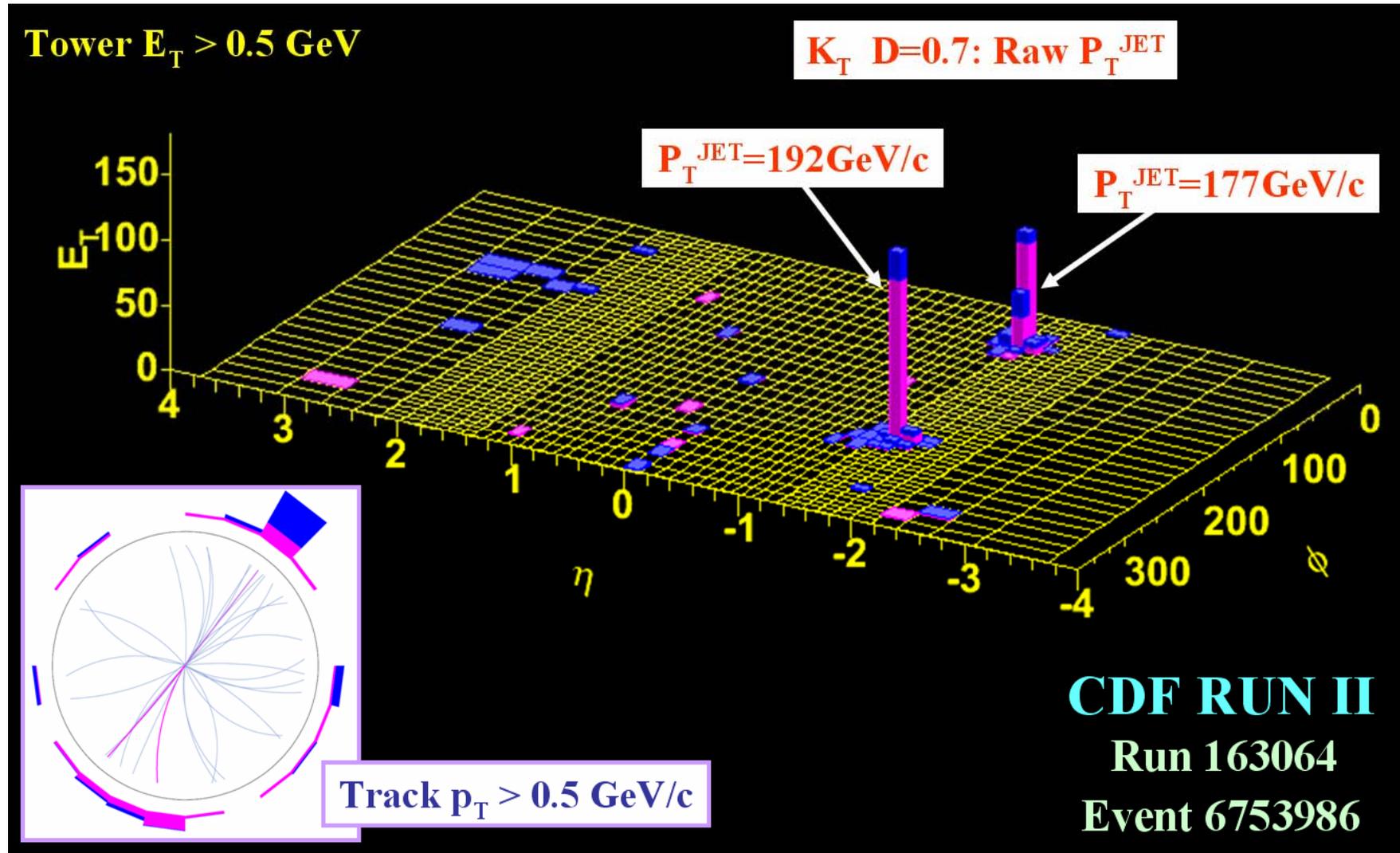
For blessing

Results: $1.6 < |Y^{\text{jet}}| < 2.1$



For blessing

Event

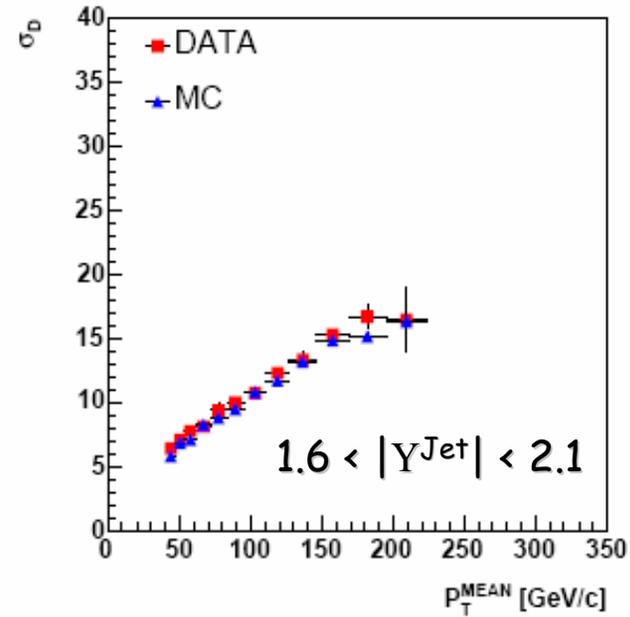
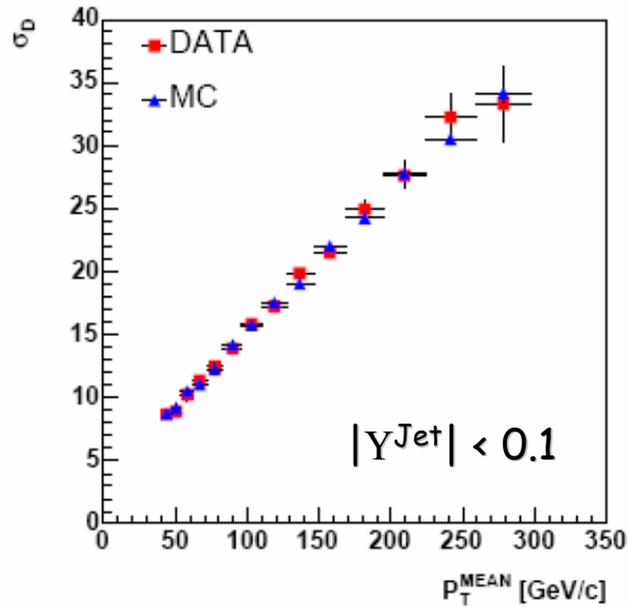


For blessing

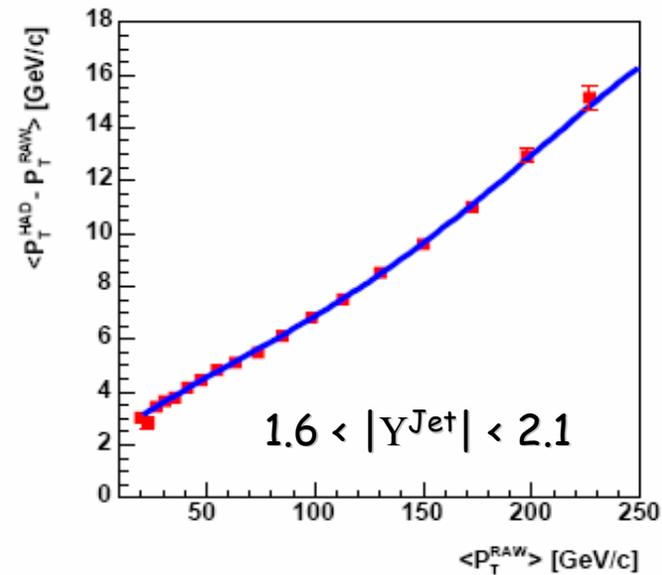
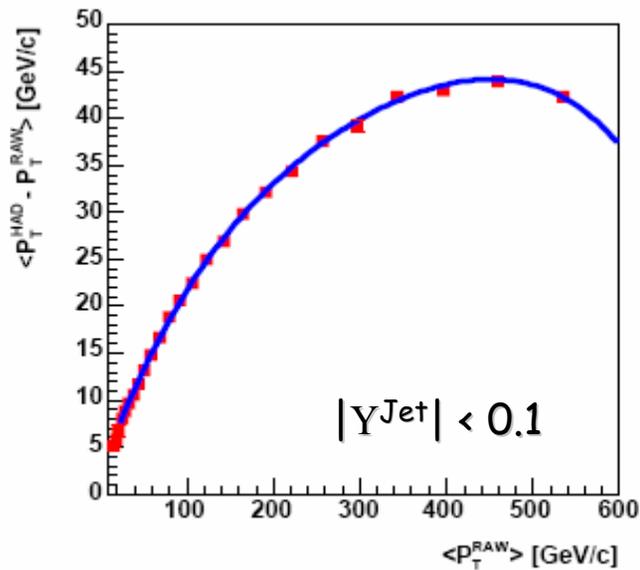
PR plots

For blessing

• Bisector method



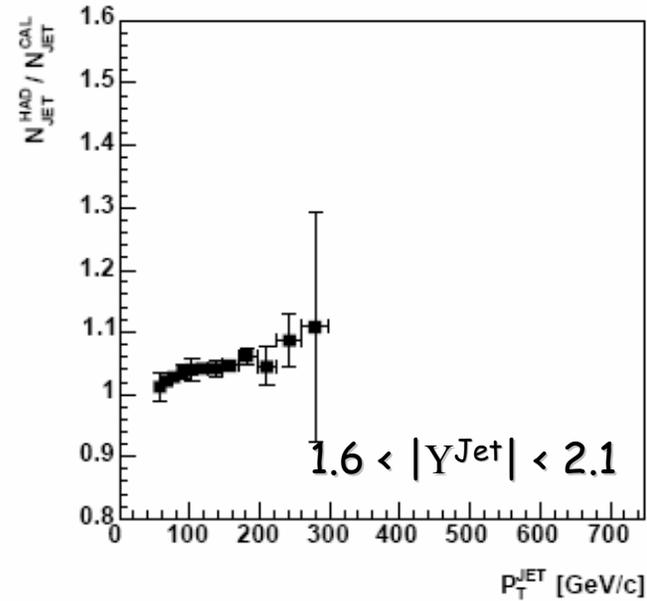
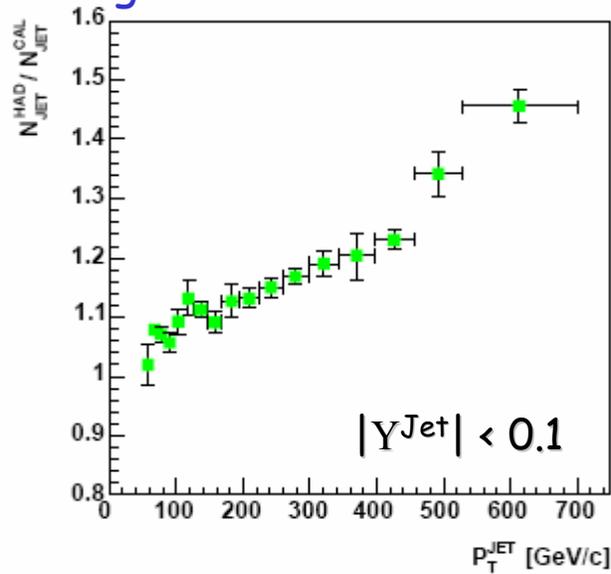
• Average P_T correction



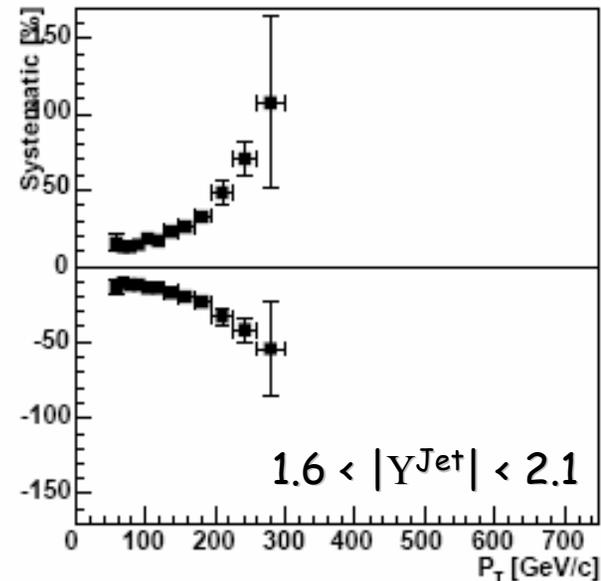
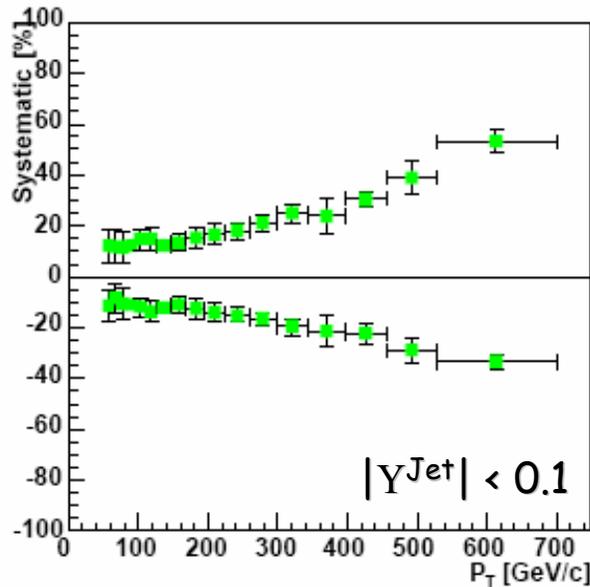
PR plots

For blessing

• Unfolding factors



• Systematic uncertainties



Summary and plans

Inclusive jet cross section measured using 385 pb⁻¹ of CDF RunII data for jets with $P_T \geq 54$ GeV/c in four rapidity regions:

$$|Y^{\text{Jet}}| < 0.1 ; 0.7 < |Y^{\text{Jet}}| < 1.1 ; 1.1 < |Y^{\text{Jet}}| < 1.6 ; 1.6 < |Y^{\text{Jet}}| < 2.1$$

- Using the K_T algorithm
- Fully corrected to the hadron level
- Good agreement with theory, NLO pQCD corrected for UE / Hadronization
- Complement previous measurements for central K_T jets, $0.1 < |Y^{\text{Jet}}| < 0.7$

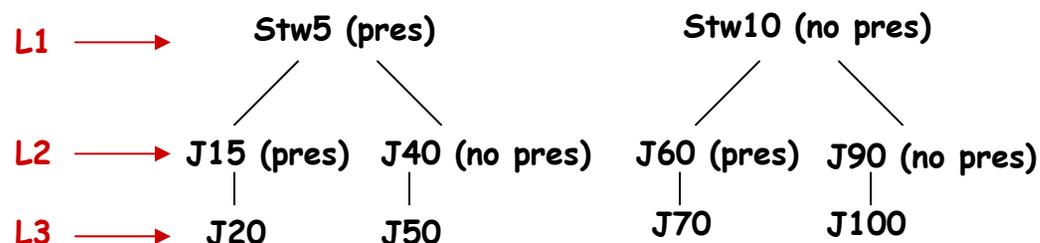
Final results (final theoretical uncertainties) in a few weeks

- Start preparation of PRD
- Godparent Committee has already been assigned
 - The same Committee than for the central K_T jets PRL
- Both PRL and PRD now going in parallel

Back Up

Trigger Study: method

→ Trigger Structure



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

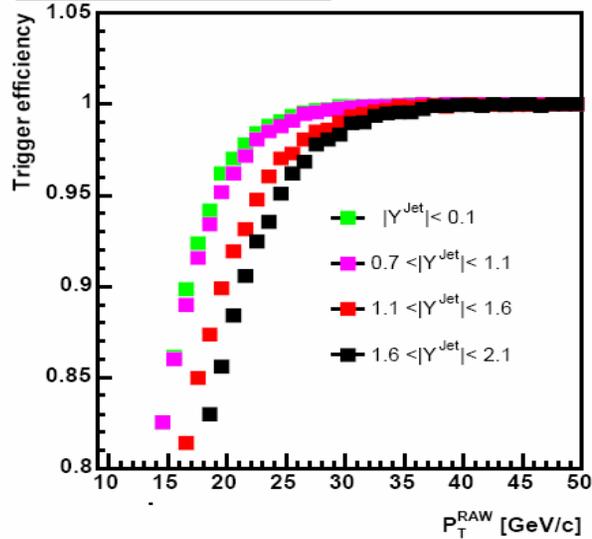
- High P_T muons: Eff. Stw5(L1)
- Stw5 data : Eff. J15(L2) and J20(L3)
- Jet20 data : Eff. Stw10(L1), J40(L2) and J50(L3)
- Jet50 data : Eff. J60(L2) and J70(L3)
- Jet70 data : Eff. J90(L2) and J100(L3)

→ Use data only where trigger fully efficient: thresholds defined by $L1 \times L2 \times L3$ efficiencies $> 99\%$

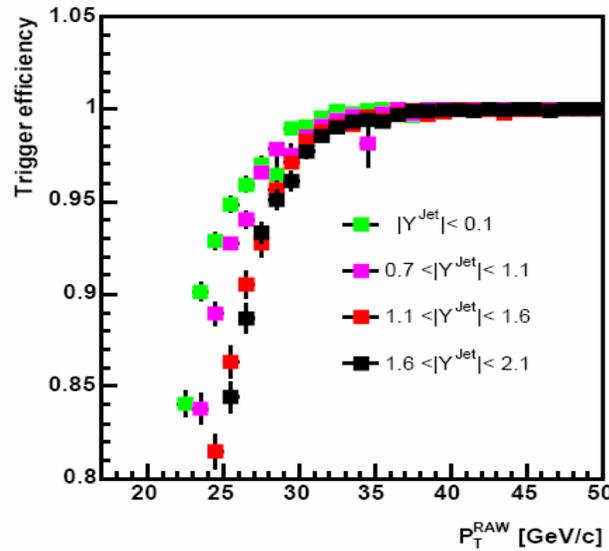
- To avoid trigger related systematic due to energy scale uncertainties, the obtain thresholds are increased by 5%

Trigger Study: results

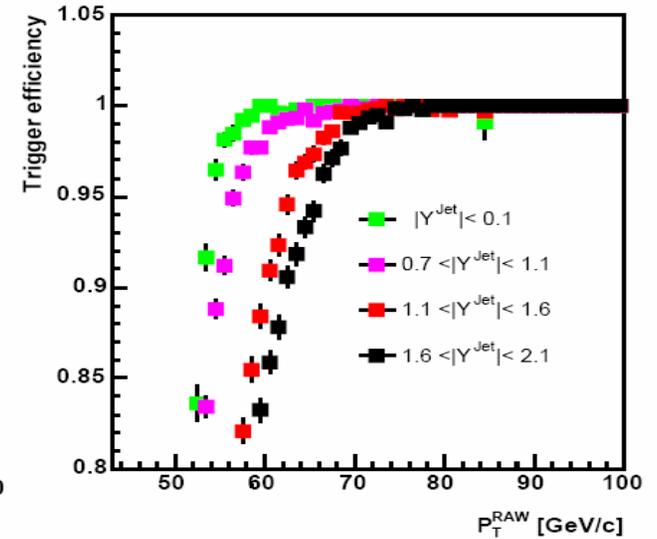
ST5 (L1) / High P_T muon



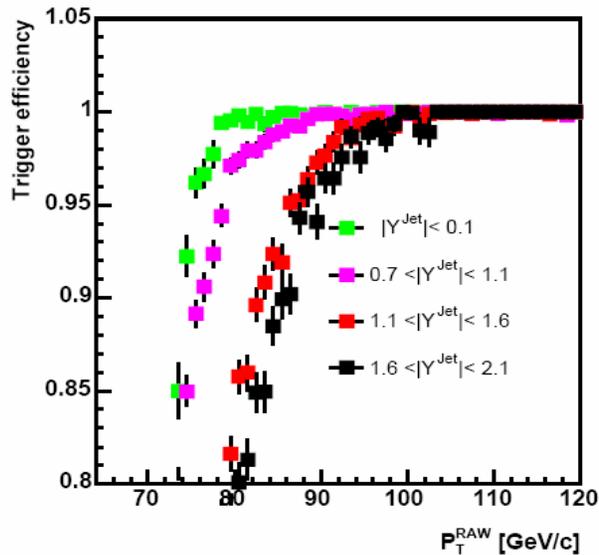
L1*L2*L3 efficiencies for Jet 20



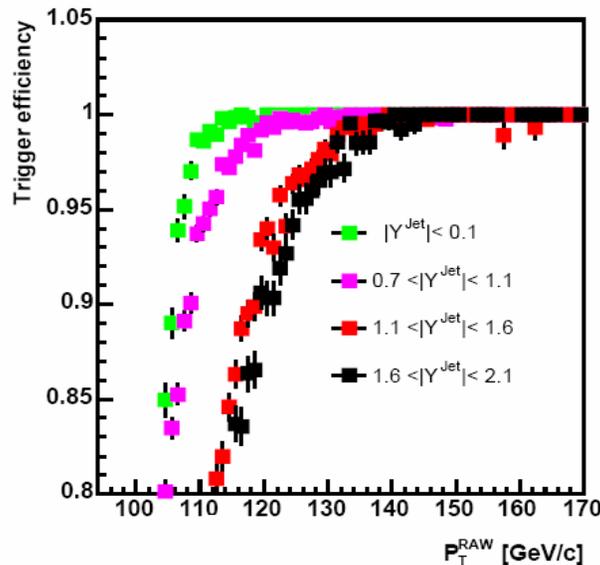
L1*L2*L3 efficiencies for Jet 50



L1*L2*L3 efficiencies for Jet 70



L1*L2*L3 efficiencies for Jet 100

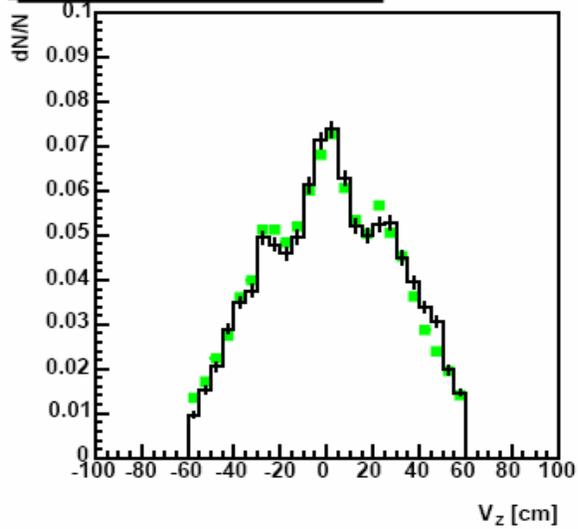


Minimum P_T^{RAW}
(uncorrected P_T^{Jet} , GeV/c)
for each dataset

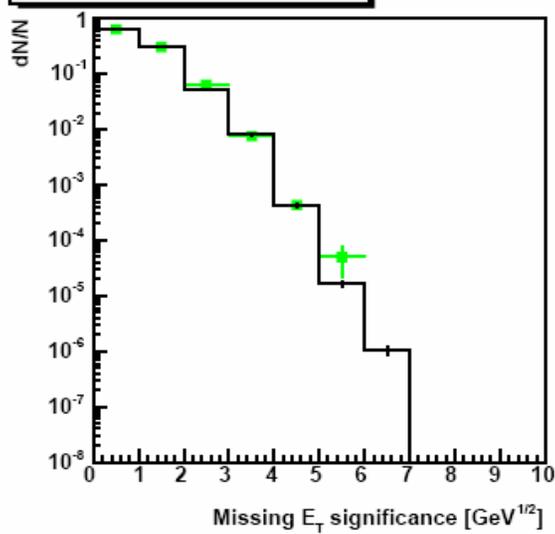
	Rap1	Rap3	Rap4	Rap5
Stw5	26	27	32	33
J20	32	33	34	33
J50	60	65	72	74
J70	81	91	97	101
J100	117	124	138	140

Comparison of Raw Quantities: $|Y^{\text{jet}}| < 0.1$

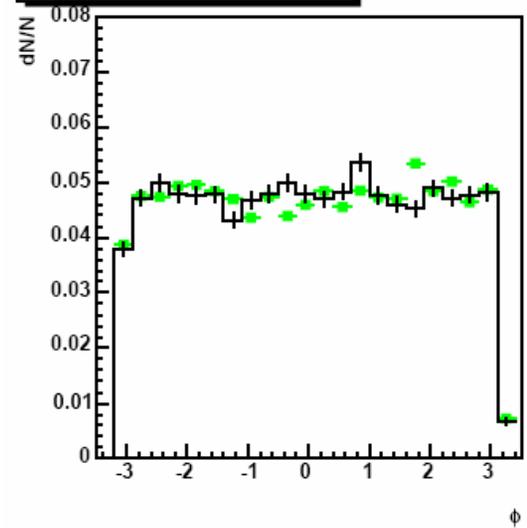
J70: $P_T^{\text{RAW}} > 83 \text{ GeV}/c$ for $|Y^{\text{jet}}| < 0.1$



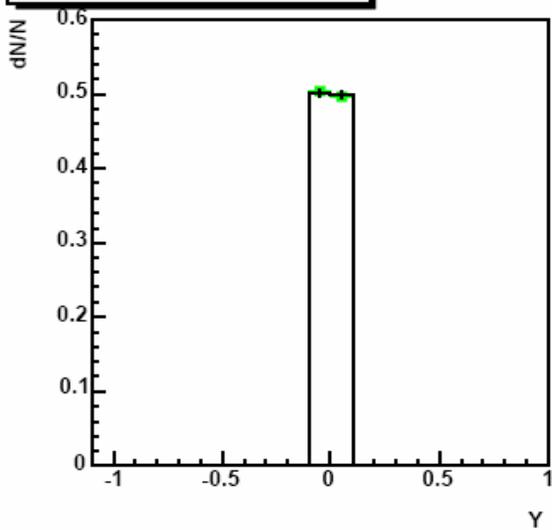
J70: $P_T^{\text{RAW}} > 83 \text{ GeV}/c$ for $|Y^{\text{jet}}| < 0.1$



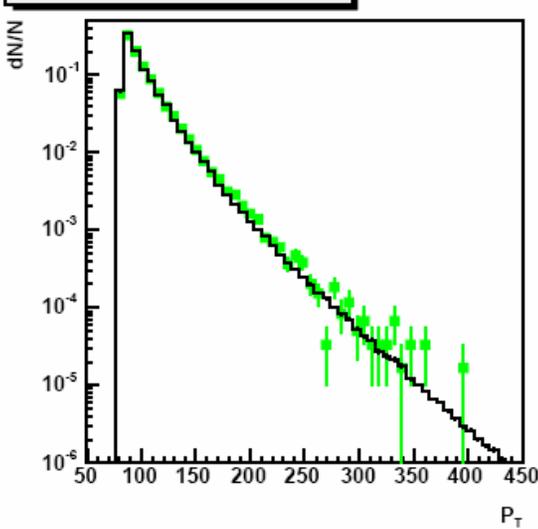
J70: $P_T^{\text{RAW}} > 83 \text{ GeV}/c$ for $|Y^{\text{jet}}| < 0.1$



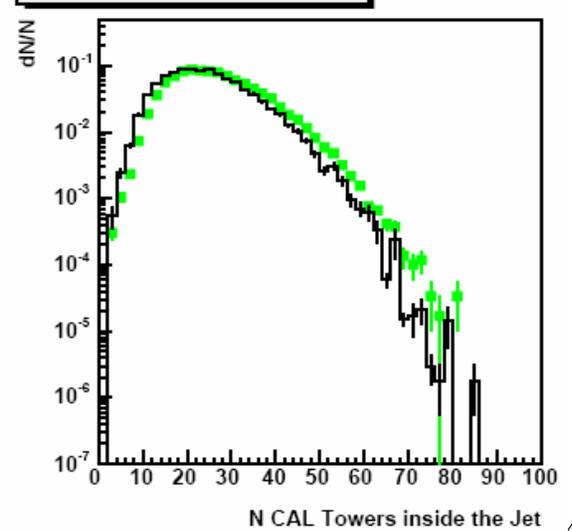
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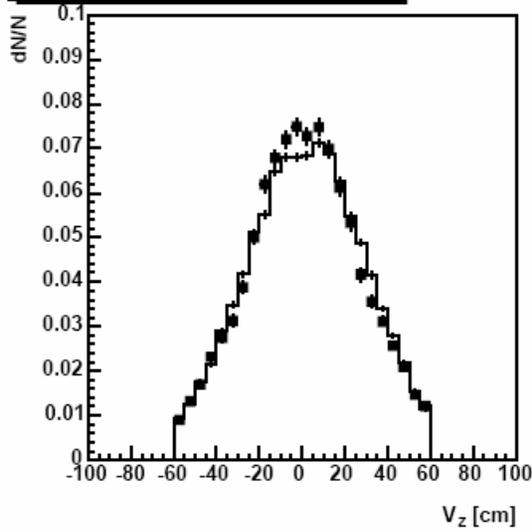


J70: $P_T^{\text{RAW}} > 83 \text{ GeV}/c$ for $|Y^{\text{jet}}| < 0.1$

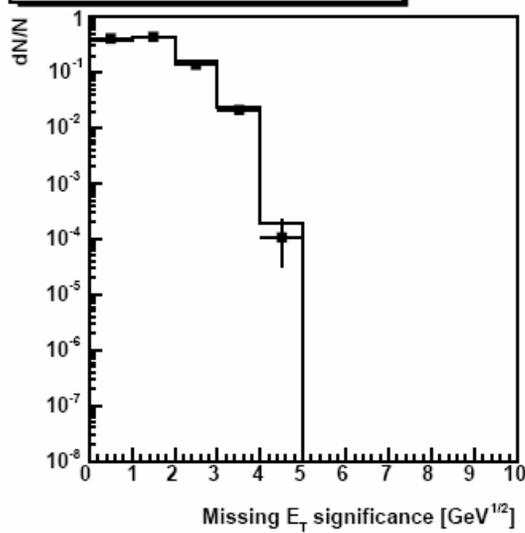


Comparison of Raw Quantities: $1.6 < |Y^{\text{jet}}| < 2.1$

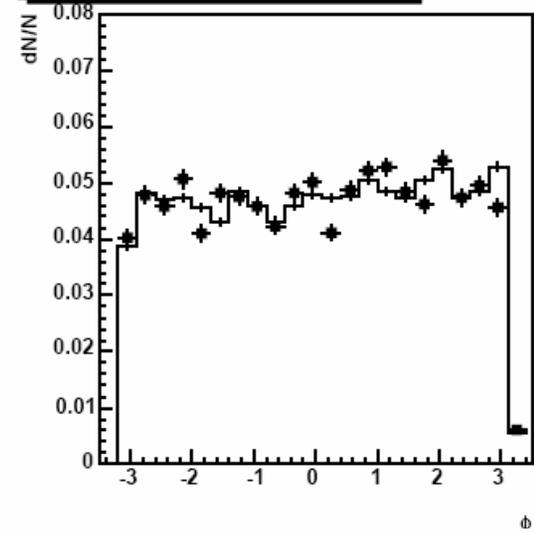
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.6 < |Y^{\text{jet}}| < 2.1$



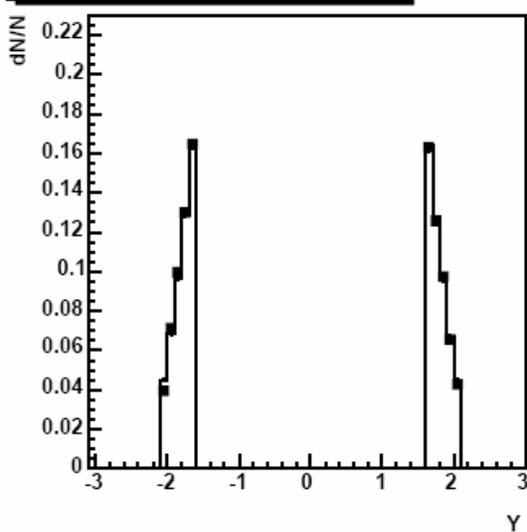
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.6 < |Y^{\text{jet}}| < 2.1$



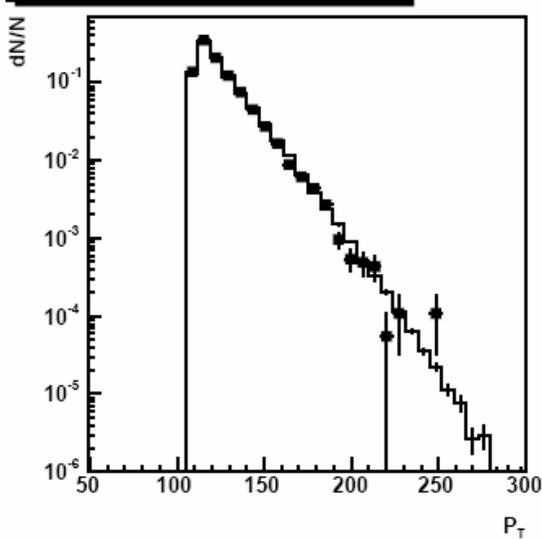
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.6 < |Y^{\text{jet}}| < 2.1$



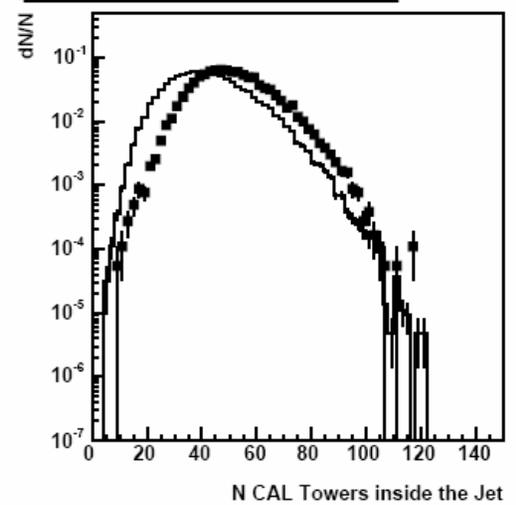
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.6 < |Y^{\text{jet}}| < 2.1$



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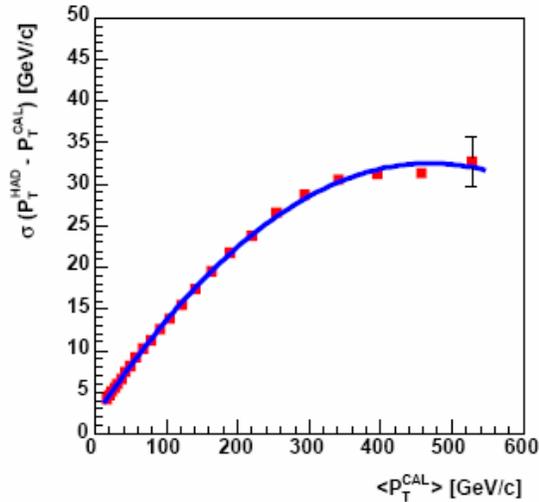
J70: $P_T^{\text{RAW}} > 110 \text{ GeV/c}$ for $1.6 < |Y^{\text{jet}}| < 2.1$



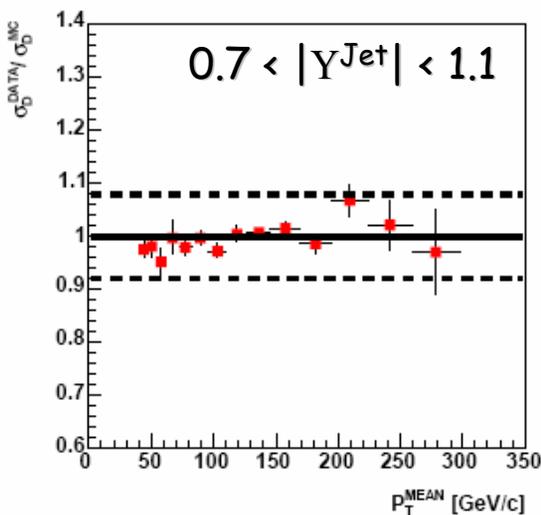
Resolution Corrections (I)

Case 1: Resolution underestimated in the MC

$\sigma(\text{HAD-CAL})$ vs $\langle p_T^{\text{CAL}} \rangle$ ($0.7 < |Y^{\text{Jet}}| < 1.1$)



$F=1.06: \sigma_D^{\text{DATA}} / \sigma_D^{\text{MC}}$ ($0.7 < |Y^{\text{Jet}}| < 1.1$)



- Correct the resolution by smearing P_T^{RAW} in the MC with a Gaussian ($0, \sigma_G$): $P_T^{\text{RAW}}_{\text{Smeared}} = P_T^{\text{RAW}} + \Delta P_T^{\text{RAW}}$

$$\sigma_{\text{corr}} = \sigma_{\text{MC}} \oplus \sigma_G = F \cdot \sigma_{\text{MC}} \quad \text{where } F > 1$$

$$\Rightarrow \sigma_G = \sigma_{\text{MC}} \cdot \sqrt{F^2 - 1}$$

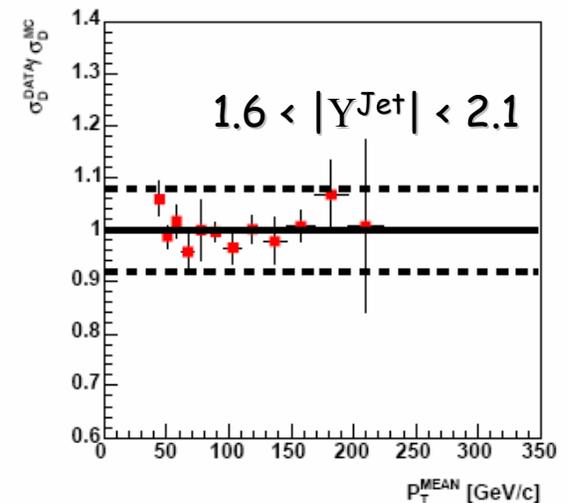
- Calculate the σ_{MC} matching CAL-HAD pair of jets
 $\Rightarrow \sigma(P_T^{\text{HAD}} - P_T^{\text{CAL}})$ vs P_T^{CAL}

- Try different values of F
- Keep the one for which $\sigma_D^{\text{Data}} = \sigma_D^{\text{MC}}$

$$0.7 < |Y^{\text{Jet}}| < 1.1 \rightarrow F = 1.06$$

$$1.6 < |Y^{\text{Jet}}| < 2.1 \rightarrow F = 1.10$$

$F=1.10: \sigma_D^{\text{DATA}} / \sigma_D^{\text{MC}}$ ($1.6 < |Y^{\text{Jet}}| < 2.1$)



Resolution Corrections (II)

Case 2: Resolution overestimated in the MC

- The method based on the smearing of P_T^{RAW} in the MC cannot be applied
- The correction will be applied later: slightly modified unfolding factors
- To know the difference between Data and MC
 - Smear P_T^{RAW} in the data this time (**ONLY FOR THIS**) using same definition of σ_G

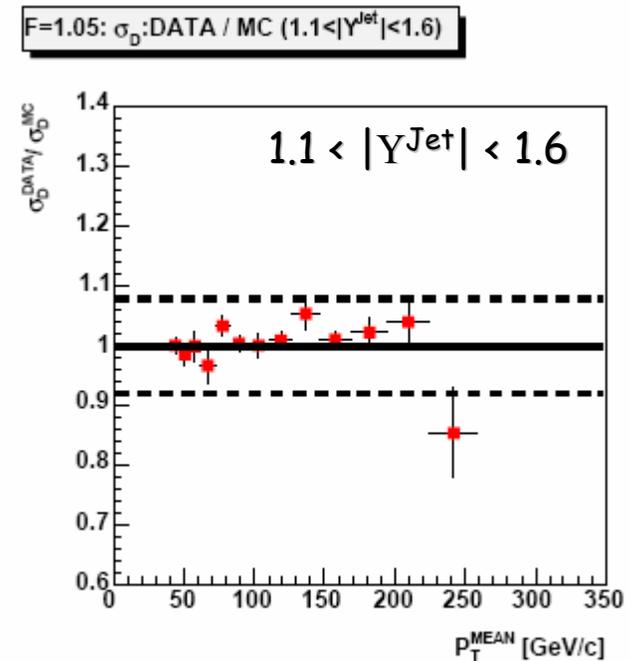
$$\sigma_G = \sigma_{MC} \cdot \sqrt{(F^2 - 1)}$$

- Try different values of F
- Keep the one for which

$$\sigma_D^{\text{Data}} = \sigma_D^{\text{MC}}$$

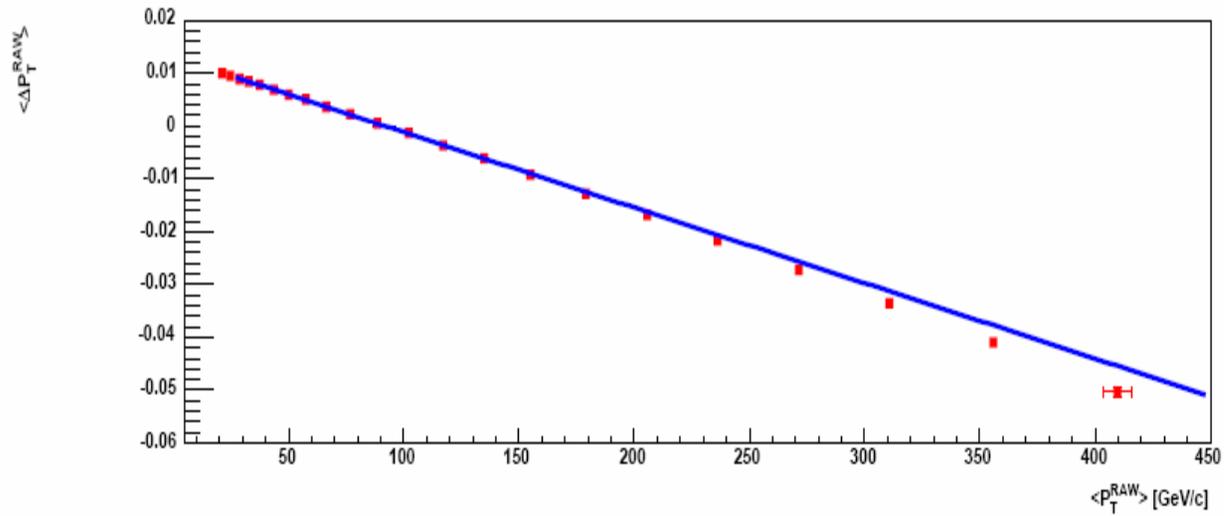
$$1.1 < |Y^{\text{Jet}}| < 1.6 \rightarrow F = 1.05$$

⇒ Correction to apply to the resolution in the MC is 1/1.05

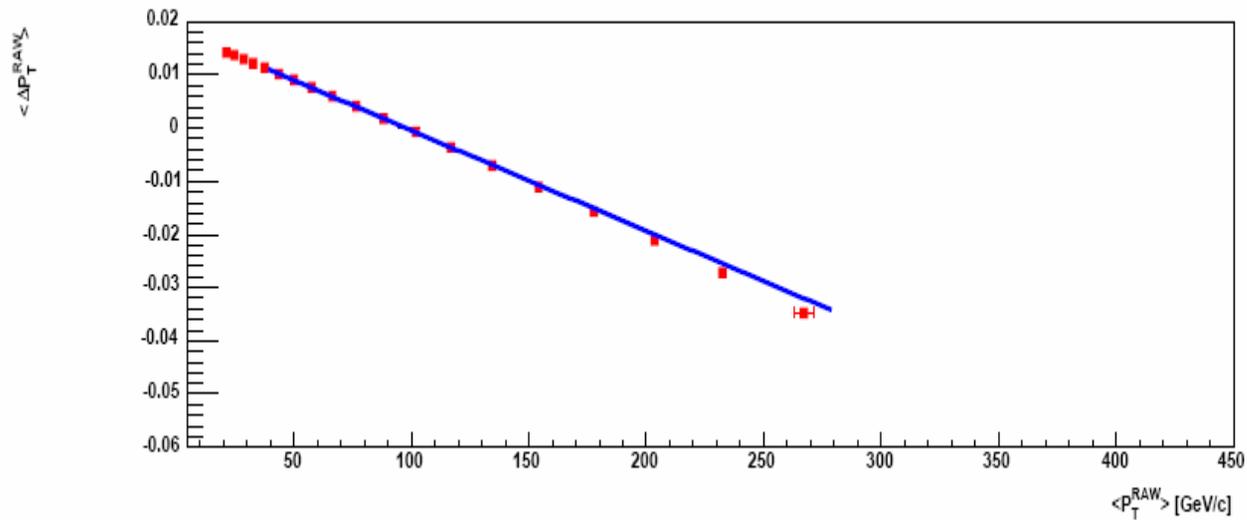


Dijet Balance: ΔP_T^{RAW}

$\langle \Delta P_T^{\text{RAW}} \rangle$ vs $\langle P_T^{\text{RAW}} \rangle$ ($1.1 < |Y^{\text{Jet}}| < 1.6$)



$\langle \Delta P_T^{\text{RAW}} \rangle$ vs $\langle P_T^{\text{RAW}} \rangle$ ($1.6 < |Y^{\text{Jet}}| < 2.1$)

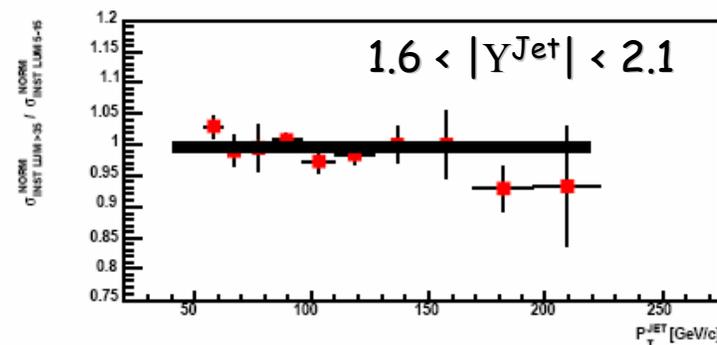
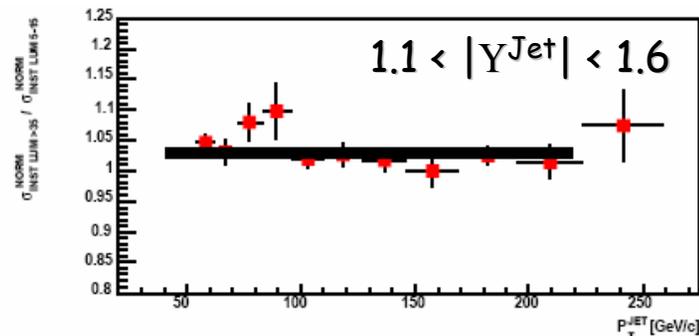
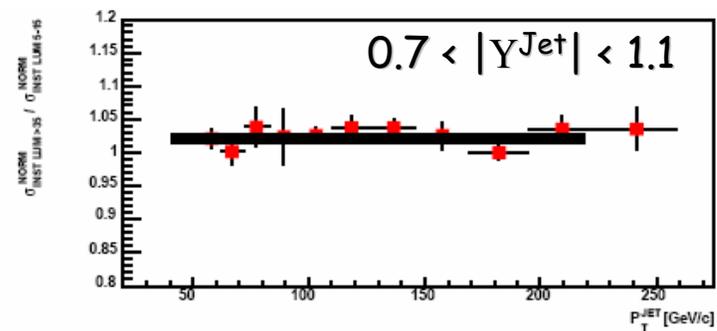
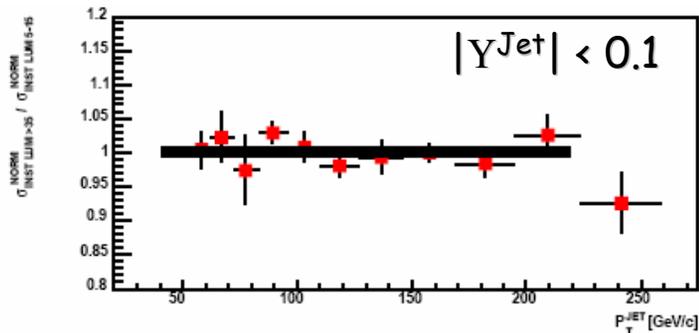


Pile-up correction (based on data)

→ Correction : $P_T^{\text{RAW}}(\text{Pile-up corrected}) = P_T^{\text{RAW}} - \varepsilon_{0.7} \times (\text{NVQ12} - 1)$

→ $\varepsilon_{0.7}$ extracted from data for jets in the central region : $\varepsilon_{0.7} = 1.62 \pm_{0.46}^{0.70} \text{ GeV/c}$

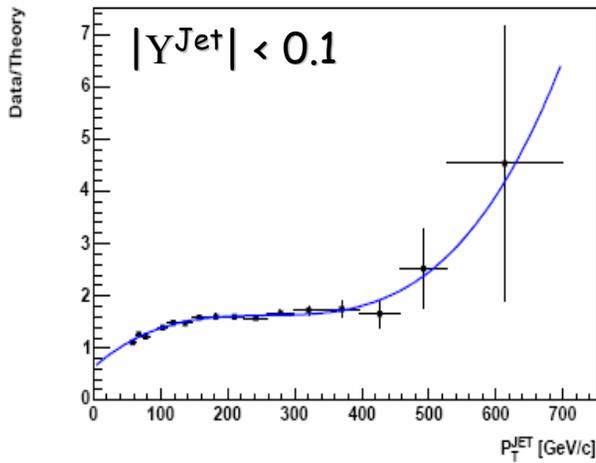
- Shape of cross sections vs P_T^{JET} for two subsamples
⇒ high luminosity/low luminosity normalized ratio
 - Low luminosity: $5 \text{ to } 15 \times 10^{30} \text{ cm}^{-2}\text{s}^{-1}$
 - High luminosity: $> 35 \times 10^{30} \text{ cm}^{-2}\text{s}^{-1}$
- Same study performed for the different rapidity regions used
⇒ results consistent with a single factor independent of Y^{Jet}



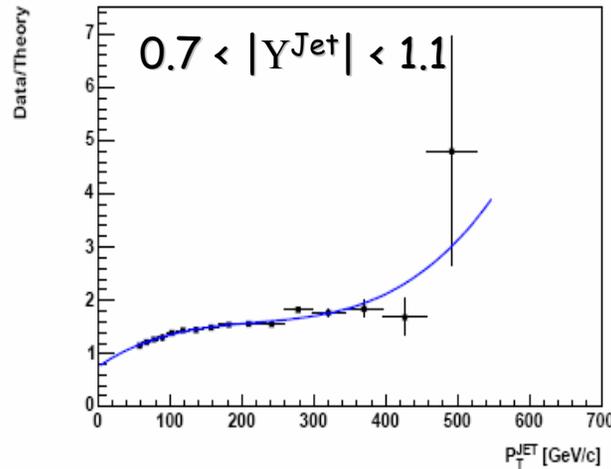
Re-weighting Pythia

- To make the measurements independent of the jet P_T spectrum in the MC which is related to the PDF used

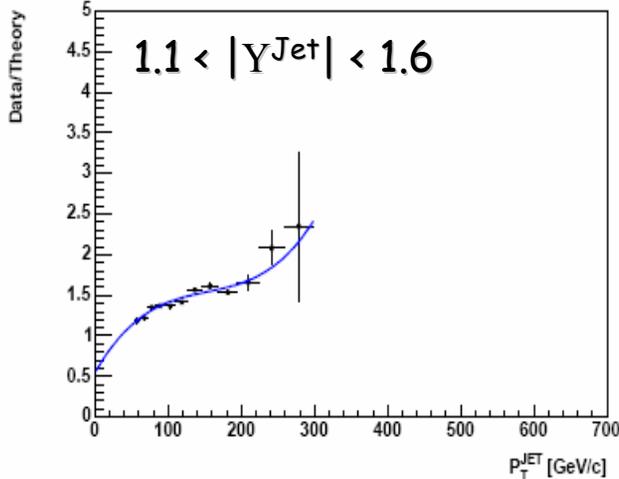
Data / Unweighted Pythia ($|Y^{Jet}| < 0.1$)



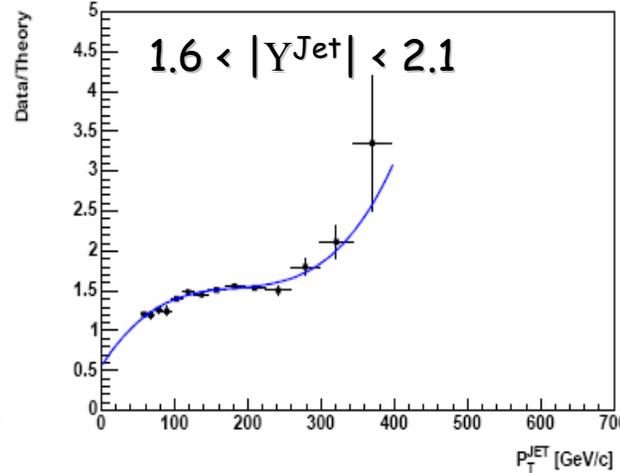
Data / Unweighted Pythia ($0.7 < |Y^{Jet}| < 1.1$)



Data / Unweighted Pythia ($1.6 < |Y^{Jet}| < 2.1$)



Data / Unweighted Pythia ($1.1 < |Y^{Jet}| < 1.6$)

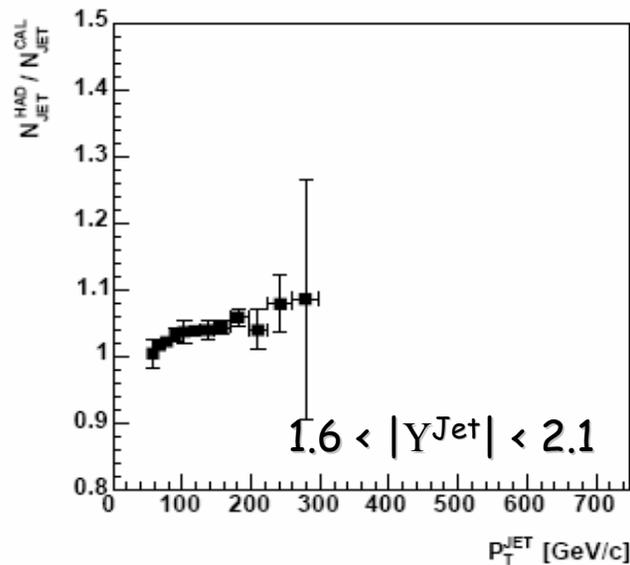
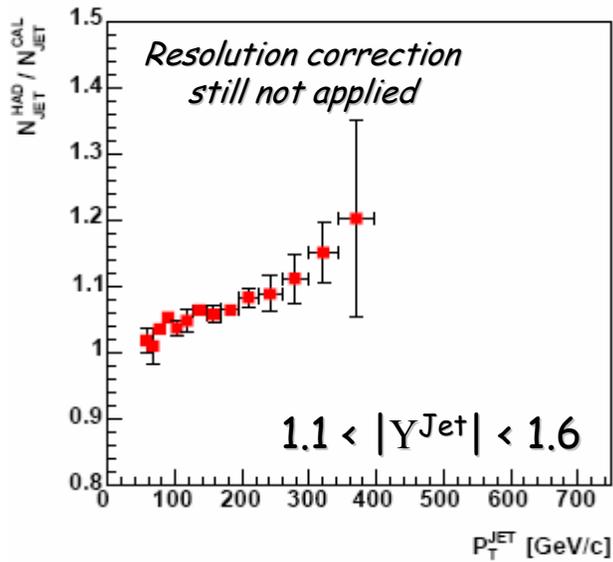
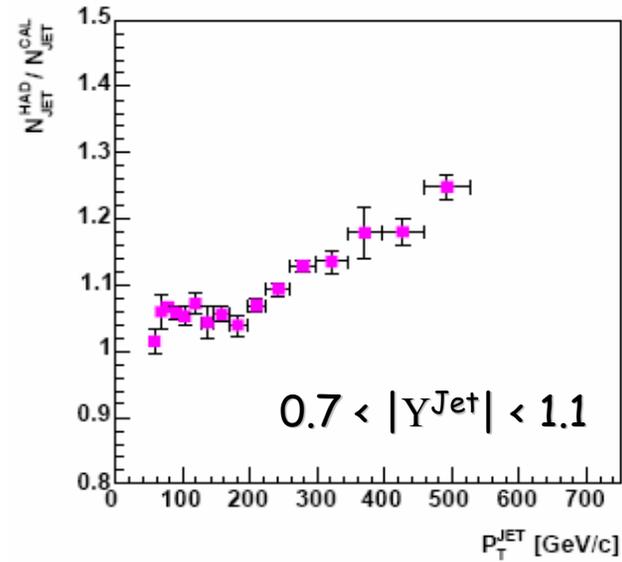
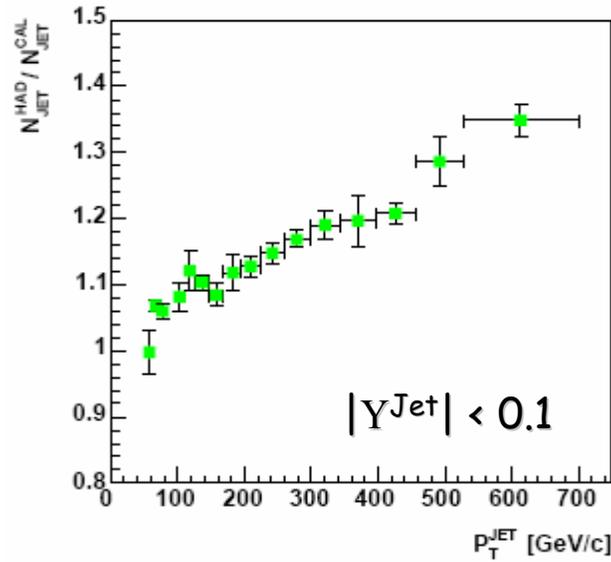


Look at ratio between data corrected to the hadron level and hadron level predictions using PYTHIA-Tune A

The trend at high P_T might be explained by the fact that in PYTHIA-Tune A uses CTEQ5L PDF

- Ratio Data/PYTHA vs P_T^{Jet}
 - Fit by a 3rd order polynomial
 - PYTHIA reweighted applying this polynomial to p_T hat

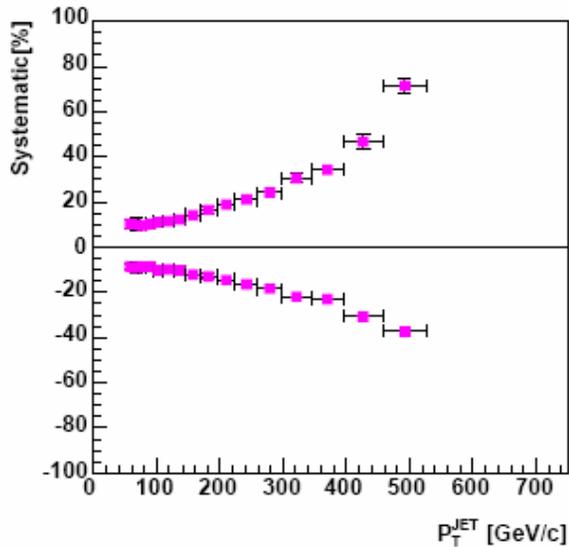
Unfolding Factors



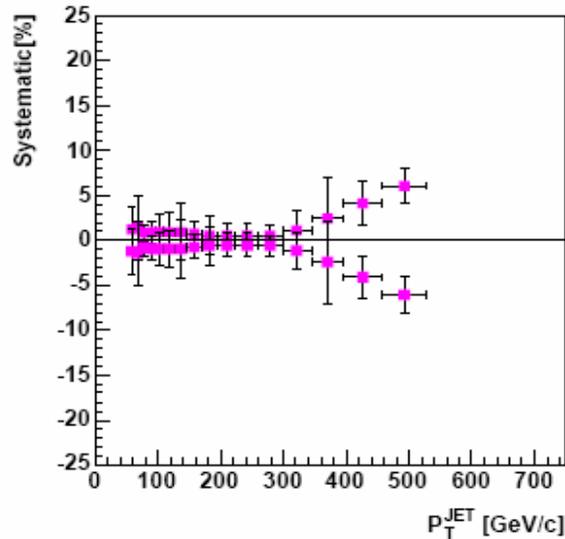
PYTHIA- Tune A
(not reweighted)

Systematic uncertainties $0.7 < |Y^{\text{jet}}| < 1.1$

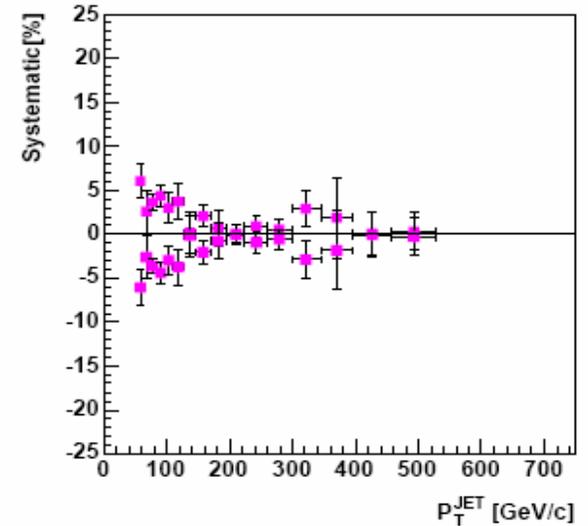
JES uncertainties using JERG curve ($0.7 < |Y^{\text{jet}}| < 1.1$)



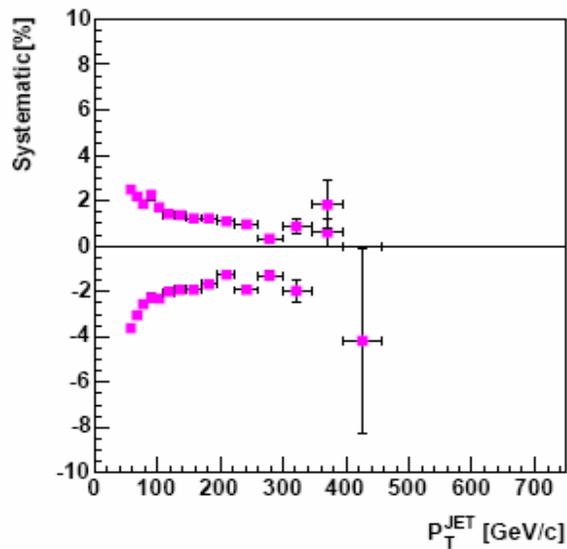
Unfolding sensitivity to P_T spectrum ($0.7 < |Y^{\text{jet}}| < 1.1$)



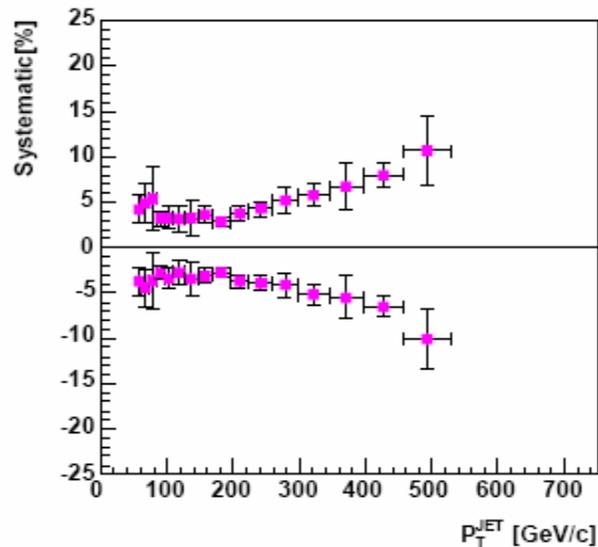
Fragmentation Systematic ($0.7 < |Y^{\text{jet}}| < 1.1$)



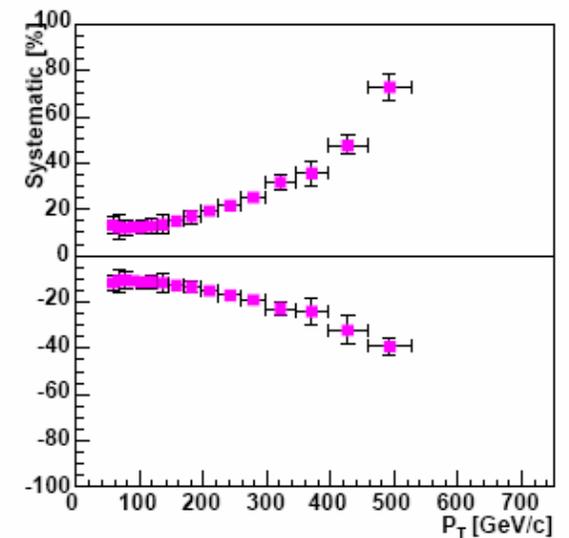
Uncertainty on Pile-Up Correction ($0.7 < |Y^{\text{jet}}| < 1.1$)



8% uncertainty of resolution ($0.7 < |Y^{\text{jet}}| < 1.1$)

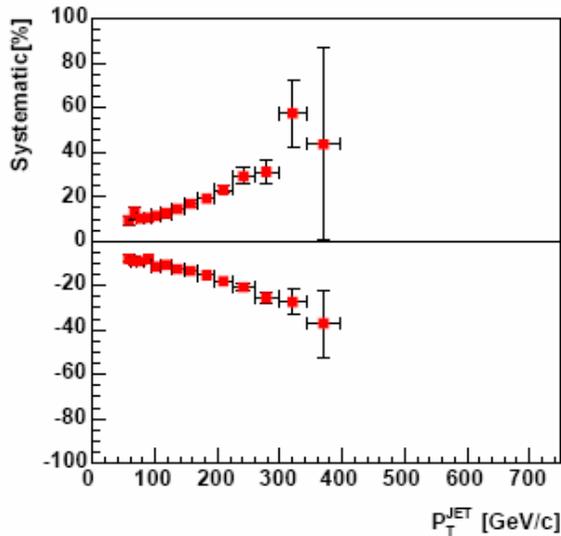


Global systematic ($0.7 < |Y^{\text{jet}}| < 1.1$)

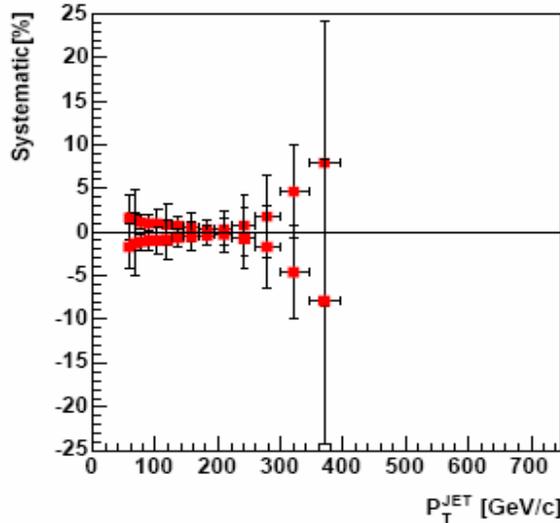


Systematic uncertainties $1.1 < |Y^{\text{jet}}| < 1.6$

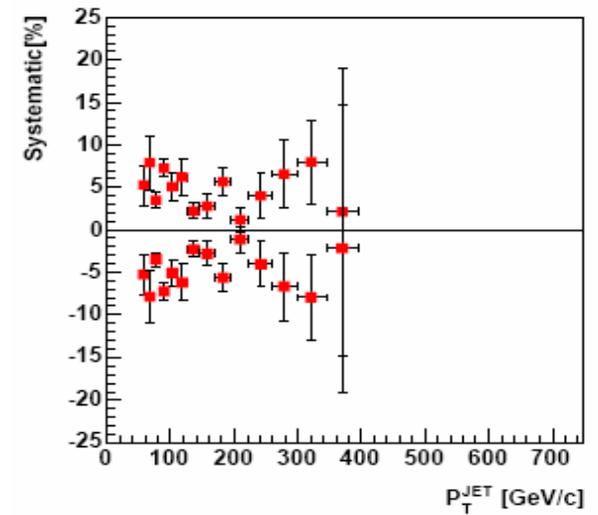
JES uncertainties using JERG curve ($1.1 < |Y^{\text{jet}}| < 1.6$)



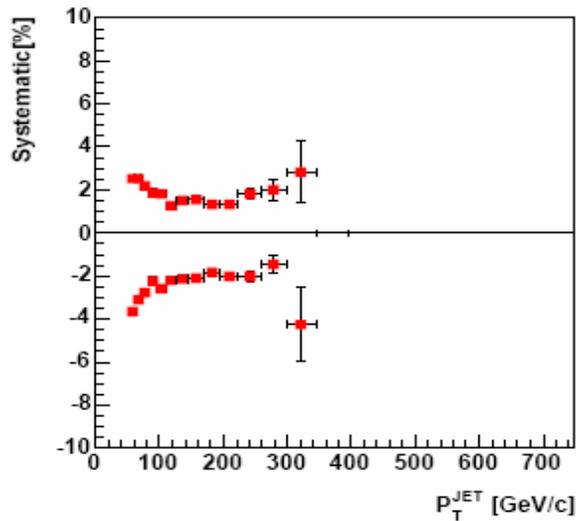
Unfolding sensitivity to P_T spectrum ($1.1 < |Y^{\text{jet}}| < 1.6$)



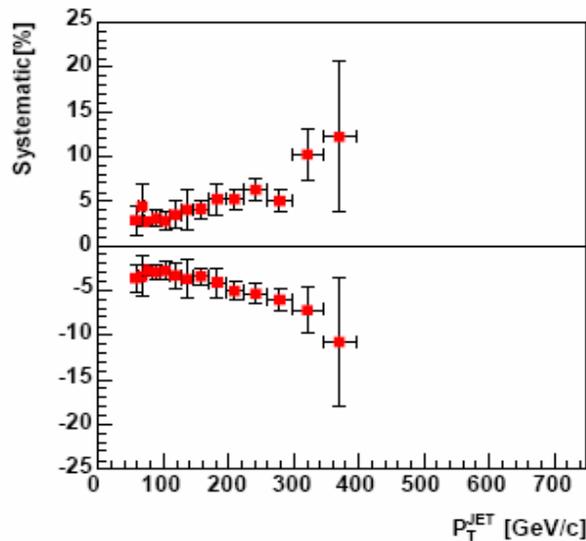
Fragmentation Systematic ($1.1 < |Y^{\text{jet}}| < 1.6$)



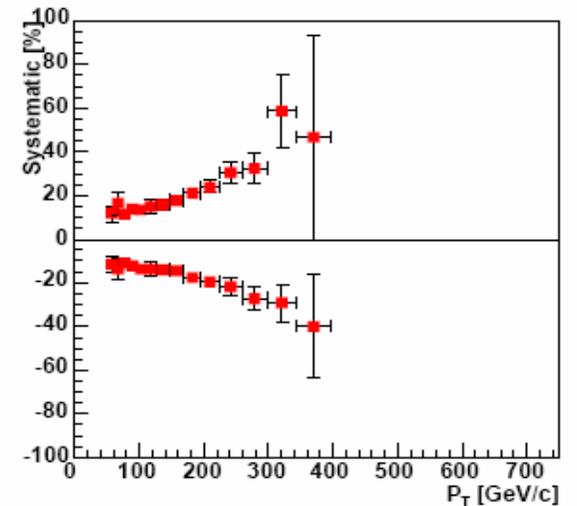
Uncertainty on Pile-Up Correction ($1.1 < |Y^{\text{jet}}| < 1.6$)



8% uncertainty of resolution ($1.1 < |Y^{\text{jet}}| < 1.6$)

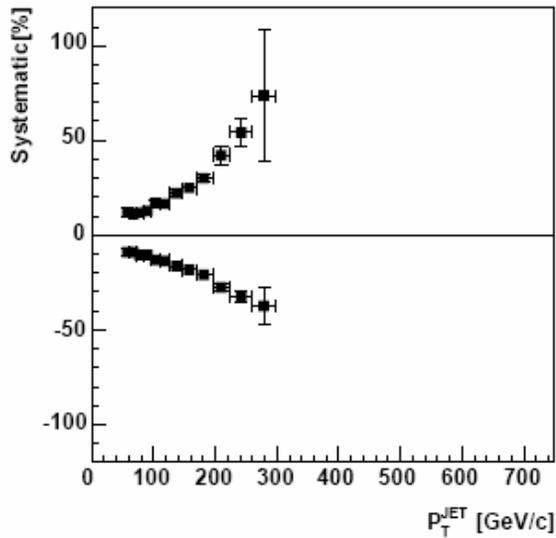


Global systematic ($1.1 < |Y^{\text{jet}}| < 1.6$)

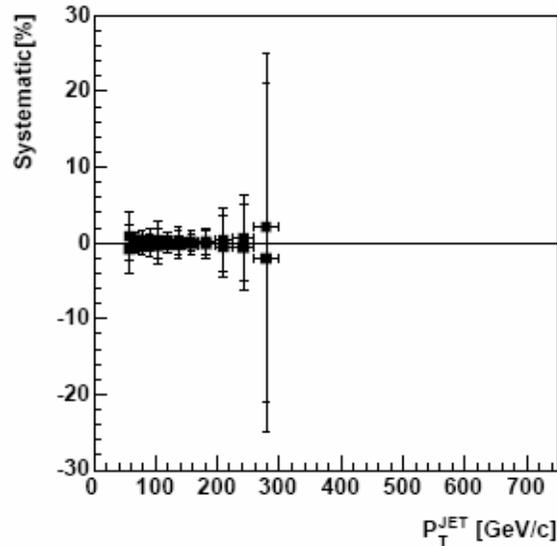


Systematic uncertainties $1.6 < |Y^{\text{jet}}| < 2.1$

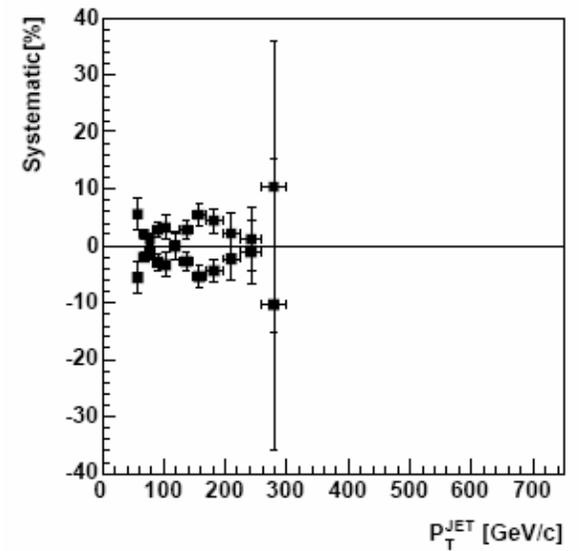
JES uncertainties using JERG curve ($1.6 < |Y^{\text{jet}}| < 2.1$)



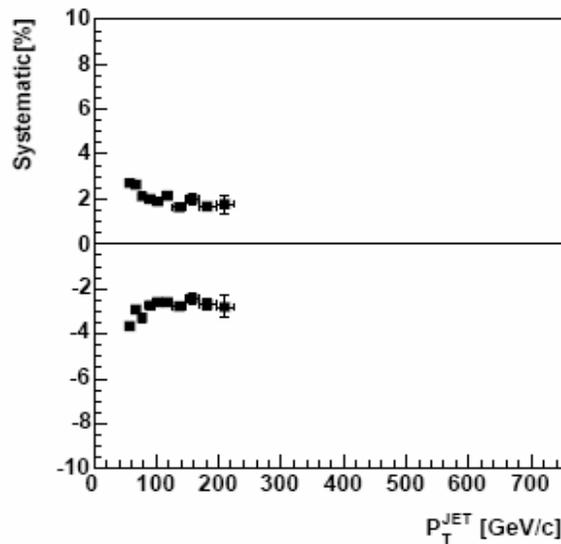
Unfolding sensitivity to P_T spectrum ($1.6 < |Y^{\text{jet}}| < 2.1$)



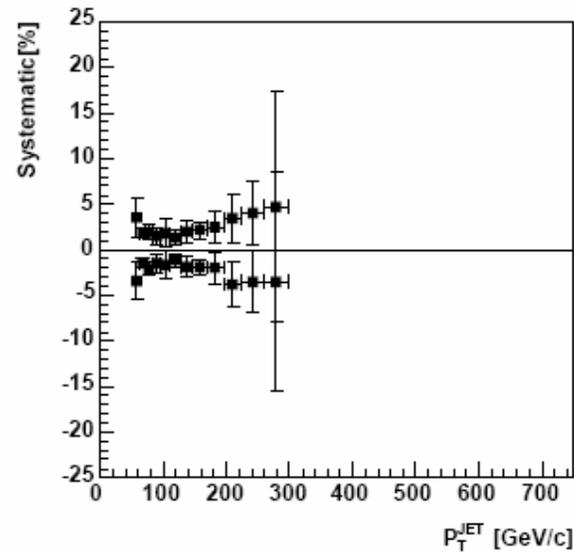
Fragmentation Systematic ($1.6 < |Y^{\text{jet}}| < 2.1$)



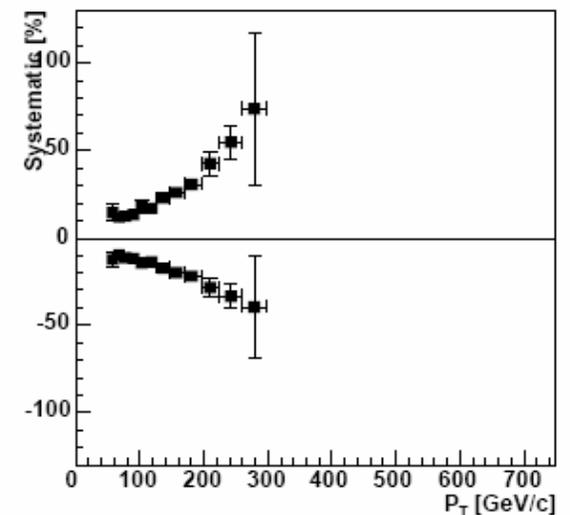
Uncertainty on Pile-Up Correction ($1.6 < |Y^{\text{jet}}| < 2.1$)



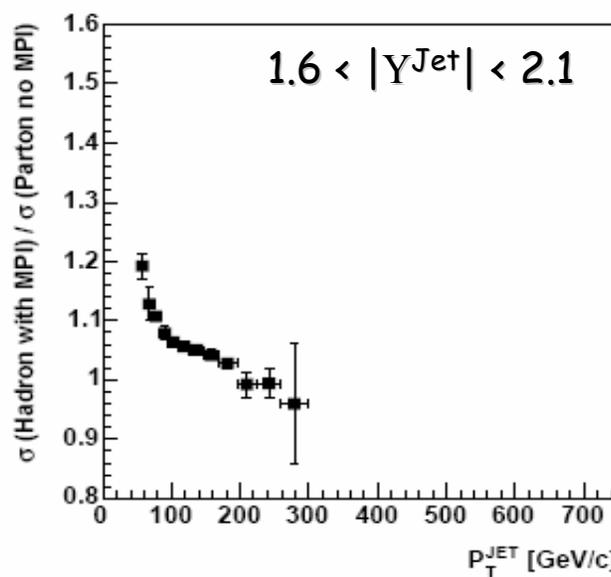
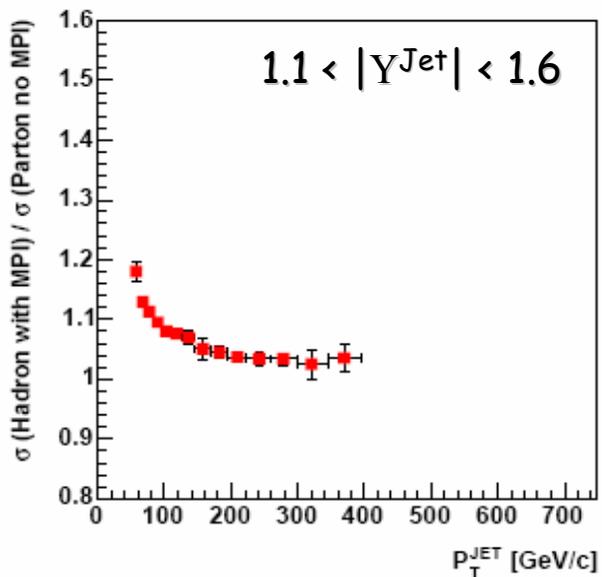
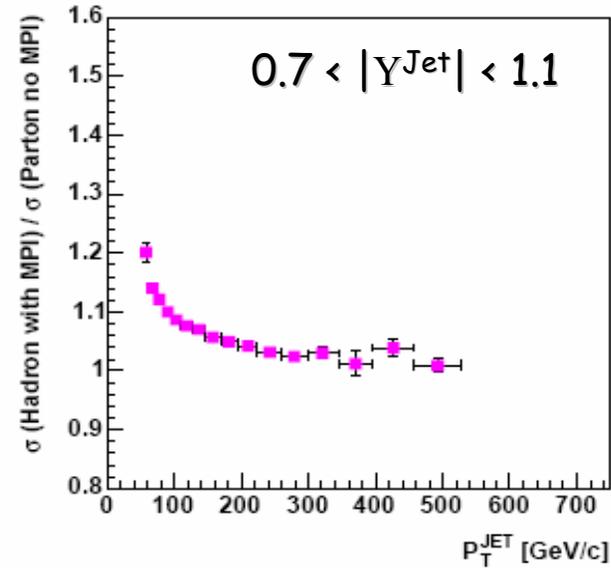
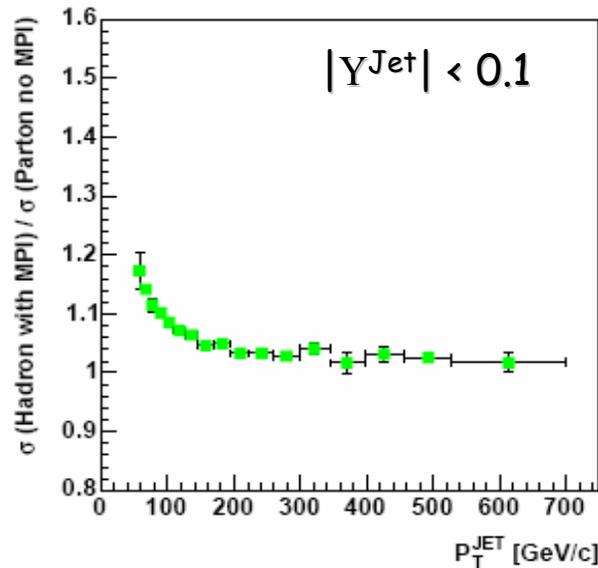
8% uncertainty of resolution ($1.6 < |Y^{\text{jet}}| < 2.1$)



Global systematic ($1.6 < |Y^{\text{jet}}| < 2.1$)



UE / Hadronization Correction



Systematic for this correction will be estimated using HERWIG (+ JIMMY eventually)