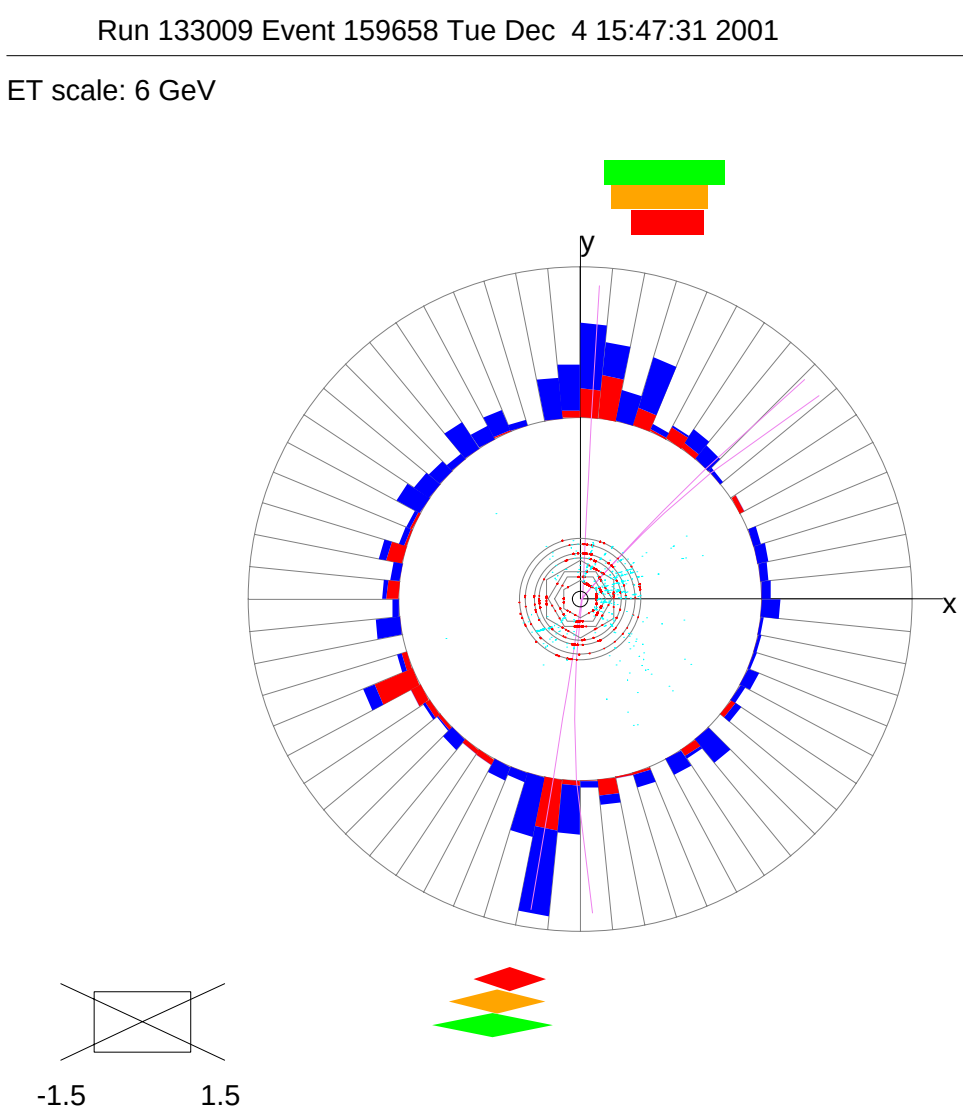
B-jet tagging using a μ-tag

All-DØ meeting, December 7 2001

O. Peters, NIKHEF



Soft muon tag for b-jets

- Inputs
- Mu+jet cross section
- B-tagging input variables
- PtRel line shape fits – proof of b-content
- B-tagging efficiencies

Data Sample

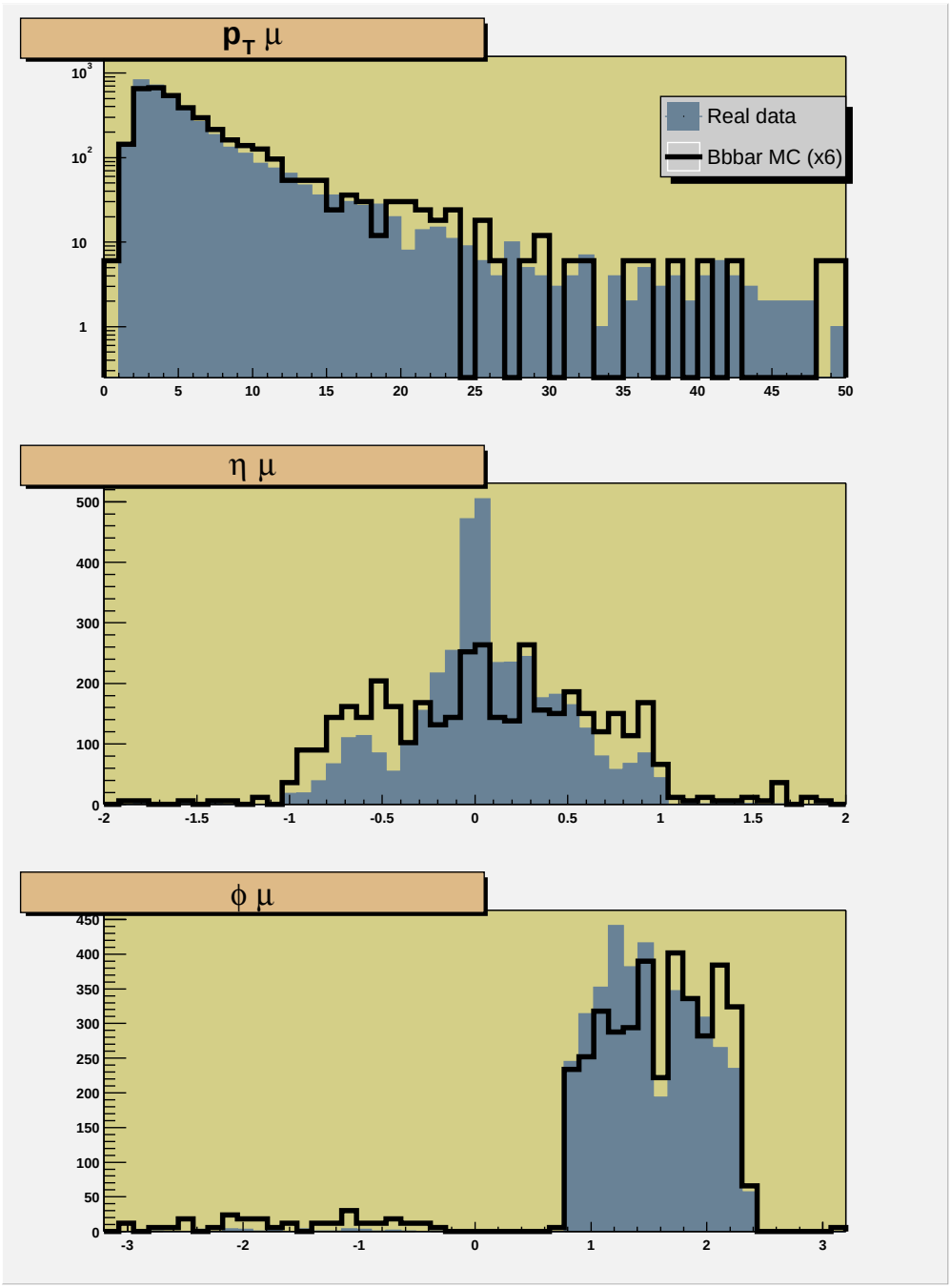
- All data events, starting with run 131776
  - 3248489 events
  - Reconstructed with p10.07.01
- Required L1 trigger: mu1cmsc_j5_fz
    - A+C scintillator coincidence
    - 5 GeV deposit in calorimeter
  - Total exposed luminosity: 742.337 nb^{-1}
  - Events passing trigger: 816260
    - 1099.58 nb
- Required >0 jet (0.5 RunII Cone)
  - Require tight Jet ID
- Required >0 muons:
  - Require tight Muon ID
    - Including $p_T > 3$
  - $|\eta| < 1$
  - $\pi/4 < \varphi < 3\pi/4$ (understood region)
- Events passing: 3872
    - 5.22 nb

ID Criteria

- <u>Muon ID</u>
  - Event selection in top quarter of central system
    - Muons reconstructed in other regions
  - No central tracks used – muon system only
  - Electronics one half A-layer top chamber flipped
    - $\eta < 0$, $\pi/2 < \varphi < 3\pi/4$
  - ID criteria:
    - Wire hits A-layer > 2
    - Wire hits BC-layer > 1
    - Scintillator hits A-layer > 0
    - Scintillator hits C-layer > 0

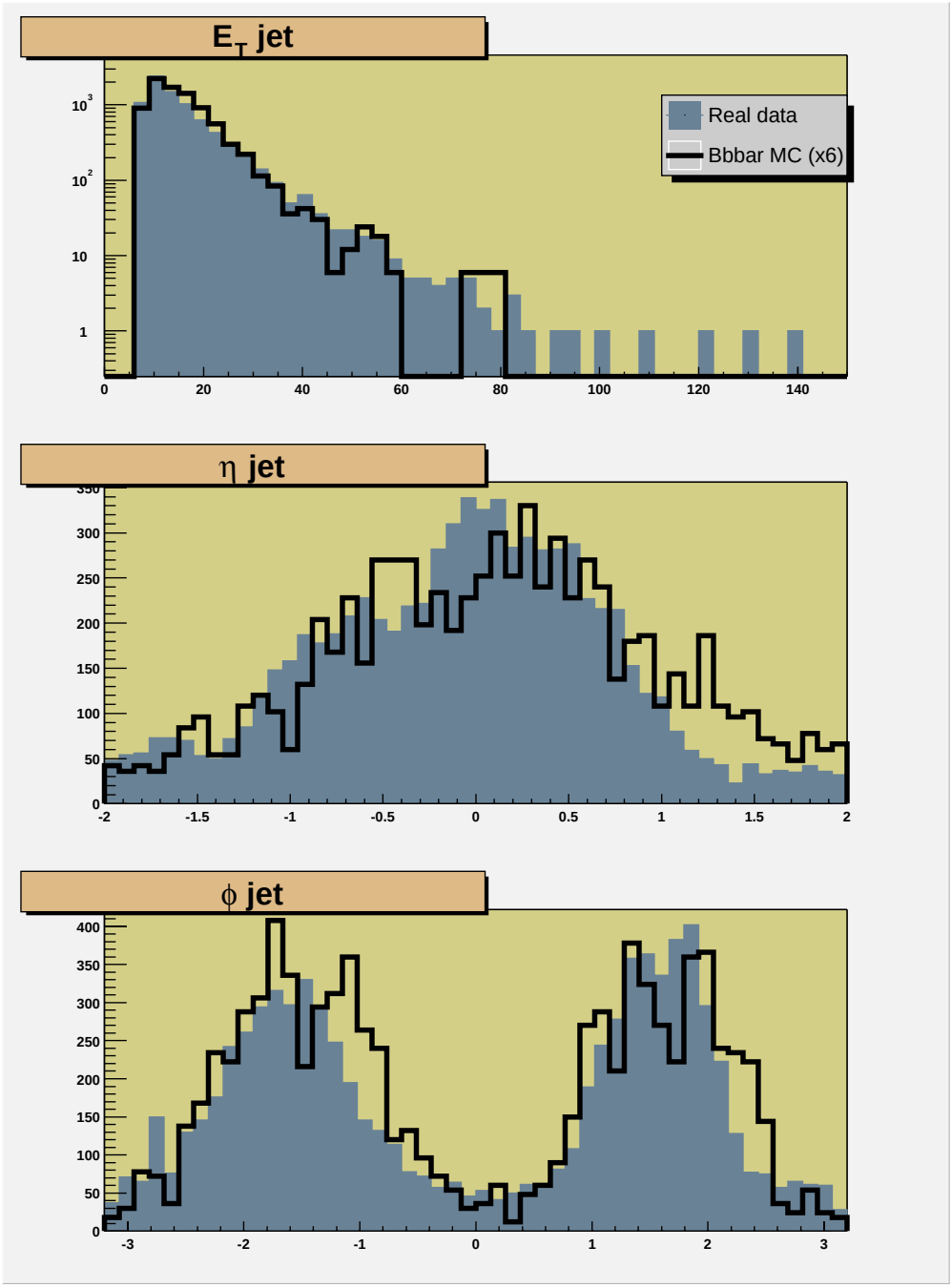
- <u>Jet ID</u>
  - Run II, 0.5 Cone algorithm
  - No range criteria
  - ID criteria:
    - 0.05 < EMF < 0.95
    - CHF < 0.4
    - Hot Fraction < 10
    - n90 > 1

Local Muon Reconstruction



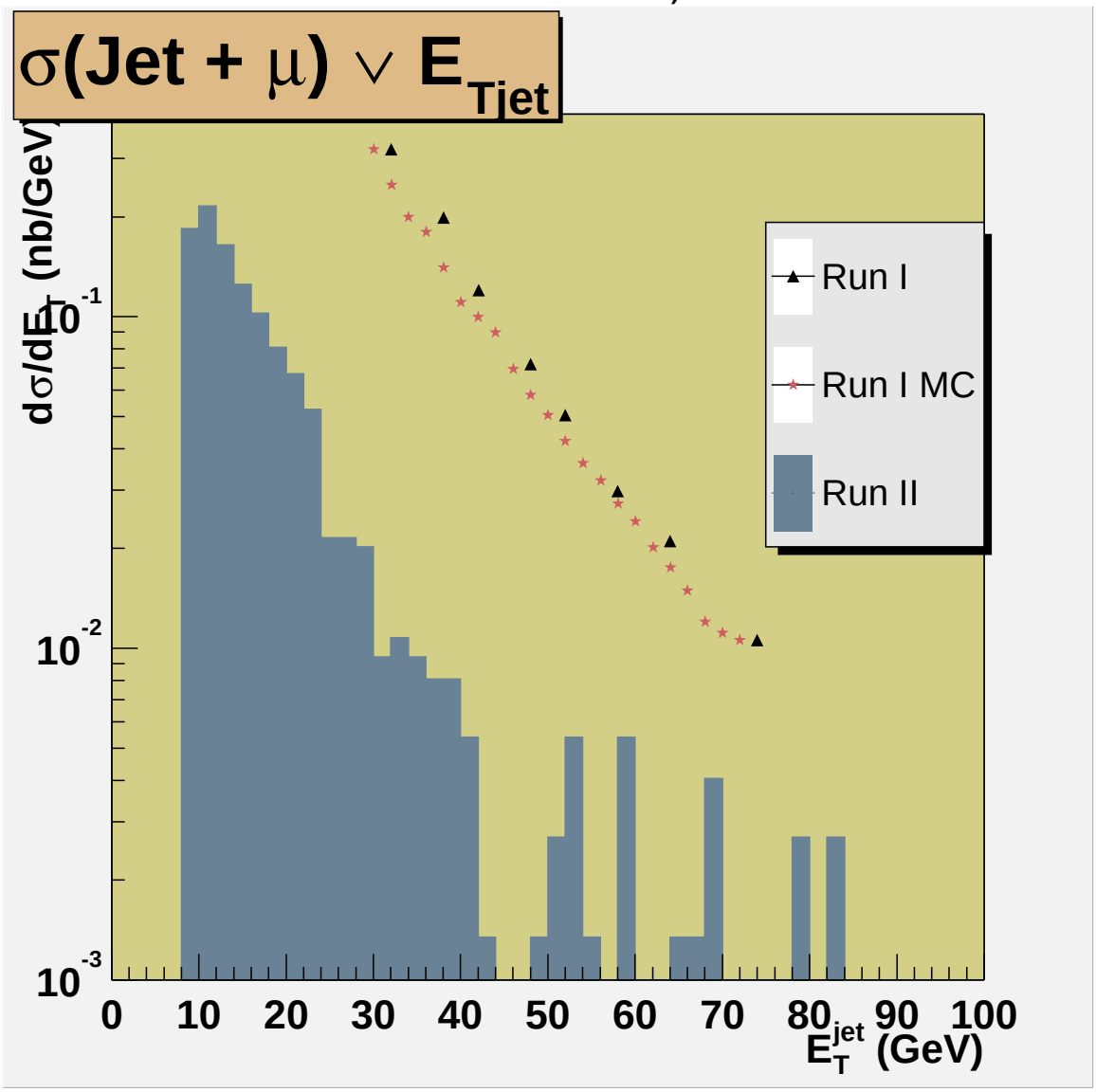
- Multiplied bb-bar MC by 6
- η: Physics η
- Flipped electronics at φ>1.57, η<0
- φ ok
- η too high at η≈0, too low at |η|≈0.5

Jet Reconstruction



- Multiplied bb-bar MC by 6
- Excess at $0 < \varphi < 0.5$

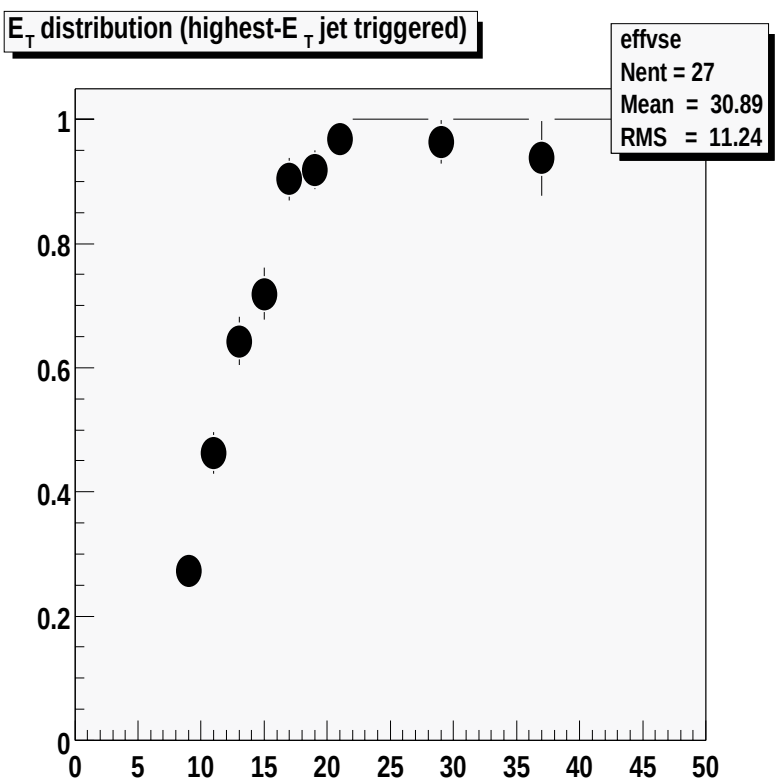
Muon + Jet Cross Section, uncorrected



- $|\eta_{jet}| < 0.6$
- $|\eta_{\mu}| < 0.8$
- $p_T^{\mu} > 6$ GeV/c
- $\delta R(\text{jet}, \mu) < 0.7$

Correction factors

Correction	Value	Estimated Error Ballpark estimates!
Muon Acceptance	0.25	0.02
Flipped muon chamber	0.92	0.05
Muon Trigger Efficiency	0.98	0.02
Muon Reconstruction Efficiency	0.35	0.08
Jet Trigger Efficiency	0.25 – 1	0.10
Jet Reconstruction Efficiency	0.76 – 0.98	0.10
Jet Energy Scale	$E_T/0.75$	0.10 (0.2 – 0.5)

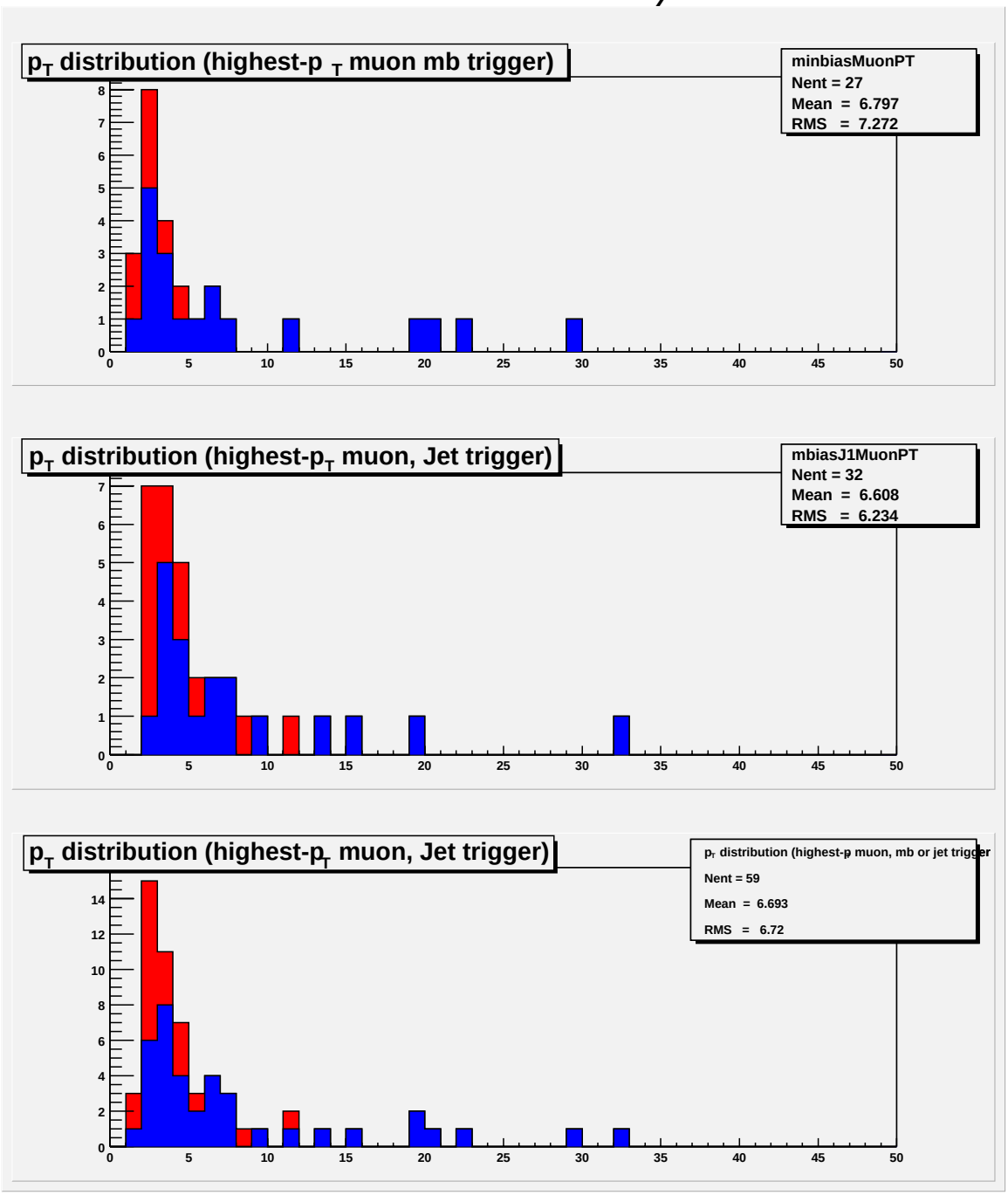


Jet L1 Trigger Efficiency from data

Jet Reco Efficiency (from MC)

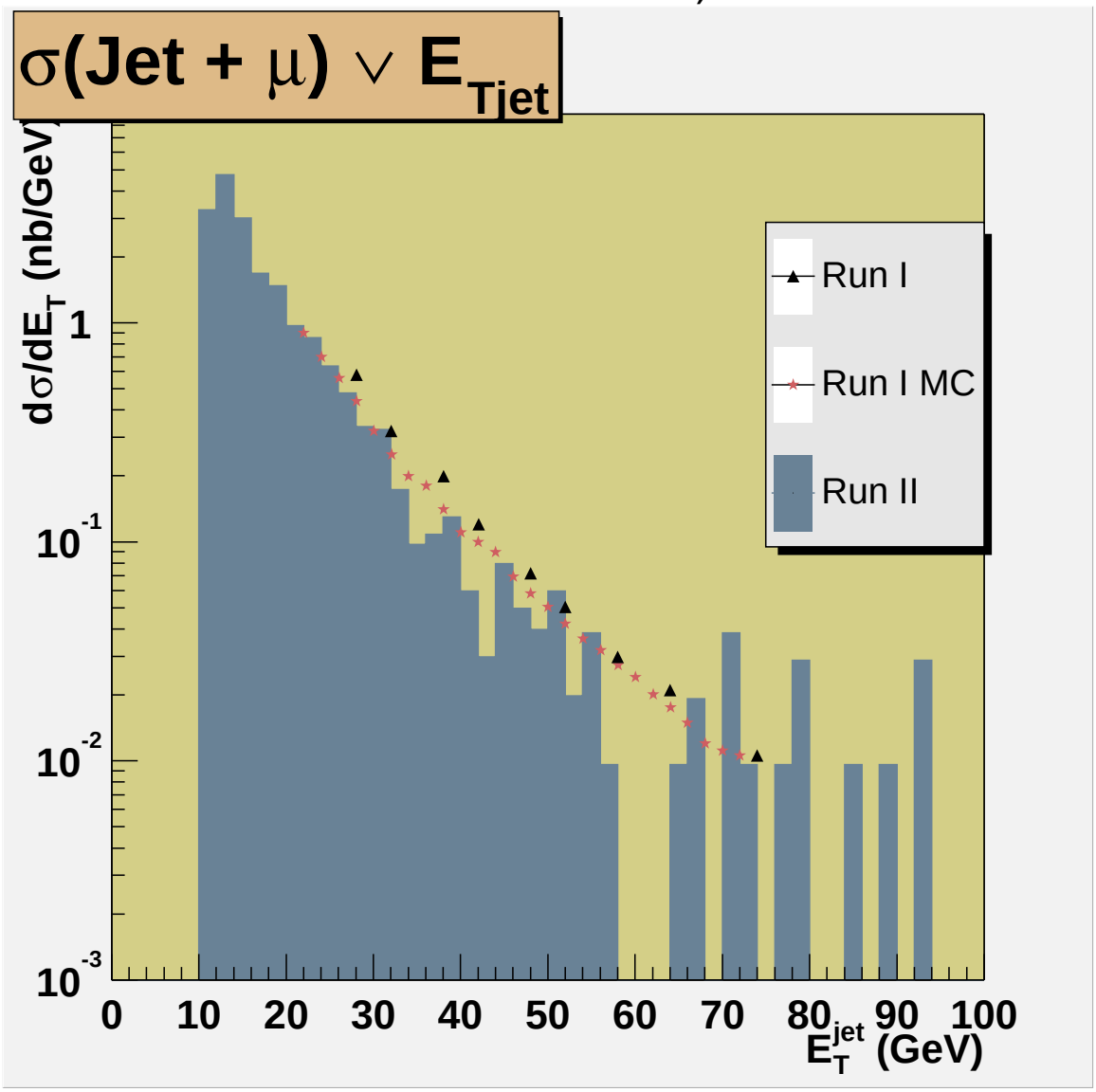
Jet p_T	Efficiency
0-20	0.76
20-30	0.87
30-40	0.95
>40	0.98

Muon L1 efficiency



L1 muon trigger gets ~100% efficient above p_T^{μ} > 5 GeV/c

Muon + Jet Cross Section, corrected

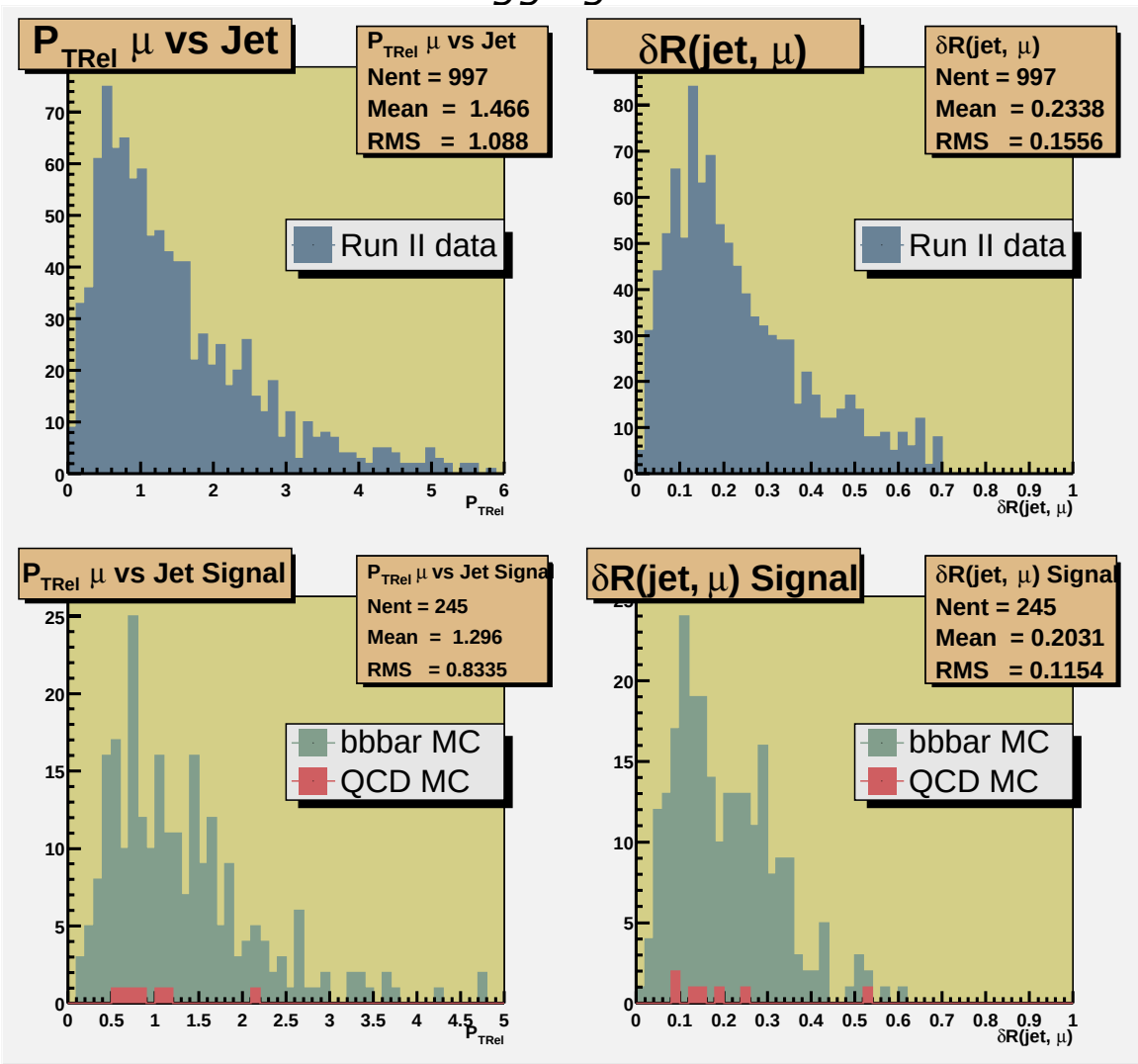


- $|\eta_{jet}| < 0.6$
- $|\eta_{\mu}| < 0.8$
- $p_T^{\mu} > 6$ GeV/c
- $\delta R(\text{jet}, \mu) < 0.7$

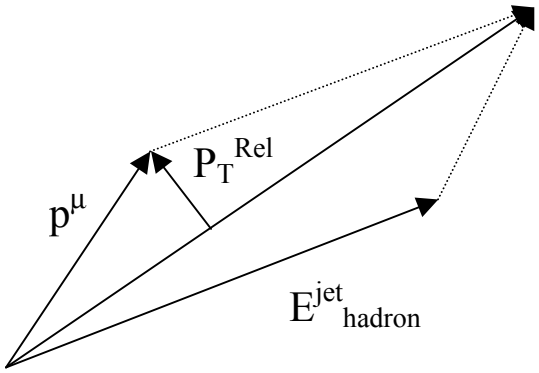
<u>Run 1 Integrated Cross Section</u>
Jet $p_T > 20$ GeV: 12.9 nb
Jet $p_T > 30$ GeV: 4.27 nb

<u>Run 2 Integrated Cross Section</u>
Jet $p_T > 20$ GeV: 9.31 nb (39% low)
Jet $p_T > 30$ GeV: 2.77 nb (54% low)

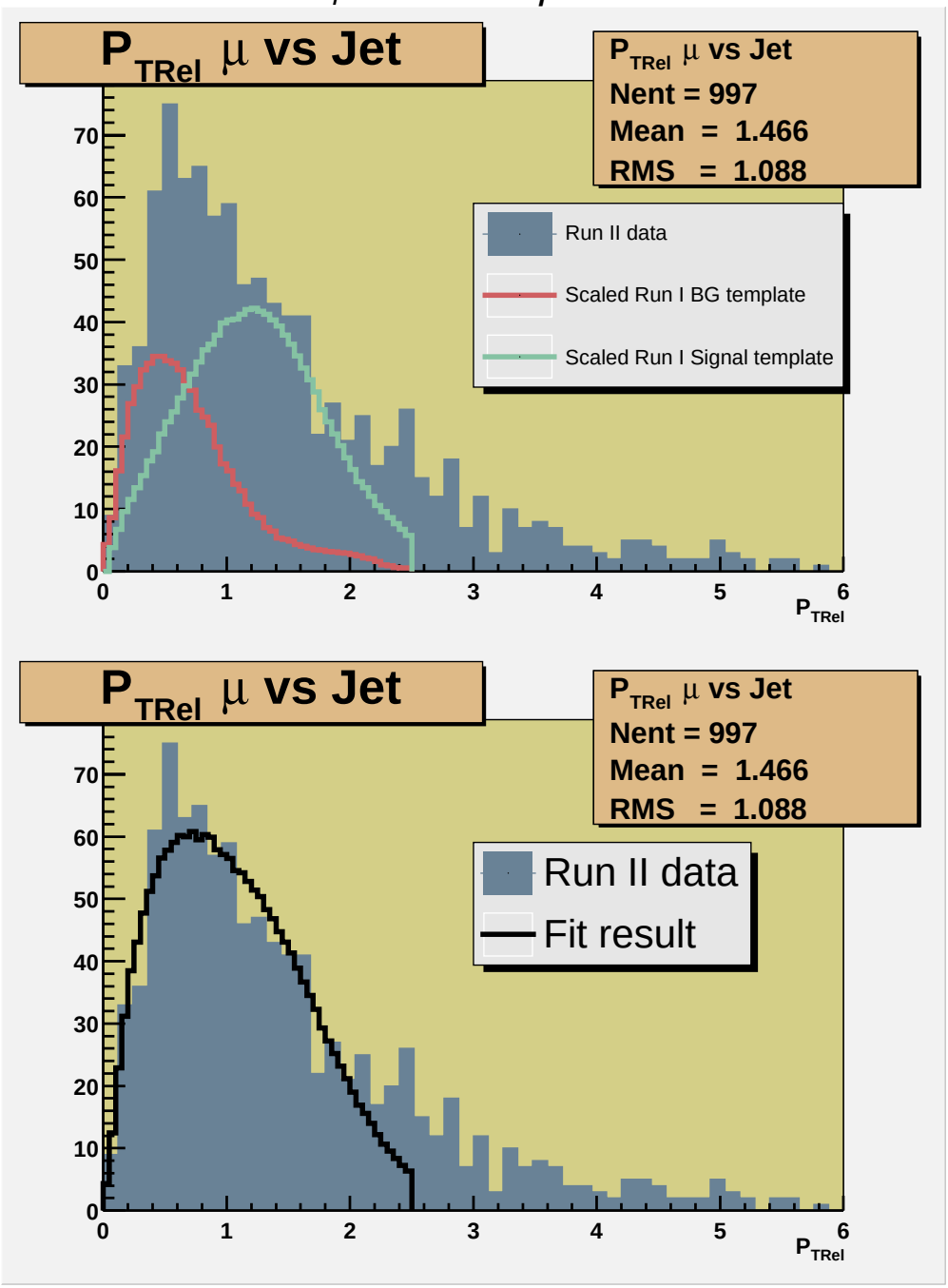
B Jet Tagging Variables



- Not enough MC statistics
  - Bbbar ~ ok
  - Need millions of QCD
- Revert back to Run I templates



P_T^{Rel} Lineshape Fit



- Background contains QCD→μ, c→μ, b→c→μ
- B-jet fraction: 0.65
- Error on fit: ~10%

DØ Note 3705 (A. Sznajder & A. Maciel), page 3

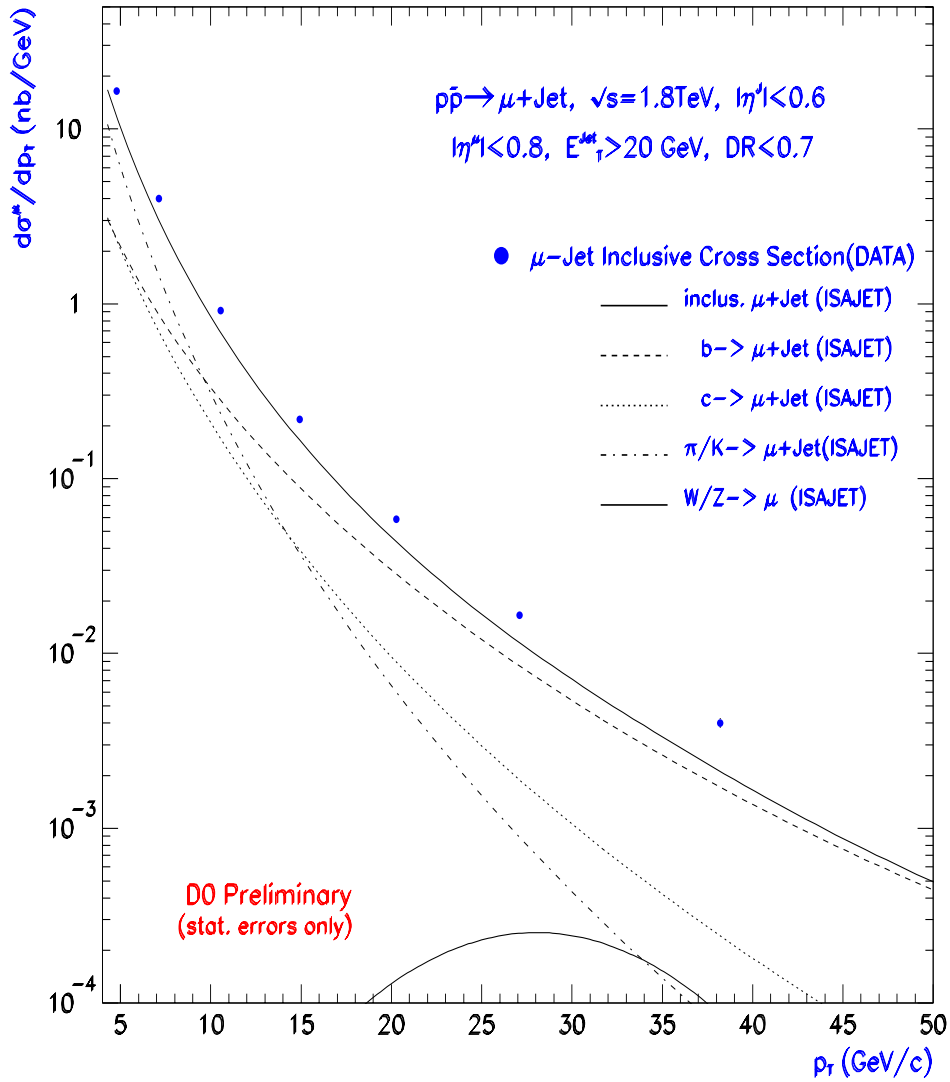


Figure 1: Muon tagged jet cross section as a function of muon p_T. Lines represent the various sources of muons acc. to the Isajet(v7.37) generator.

3

B-jet content of sample is increasing with muon p_T

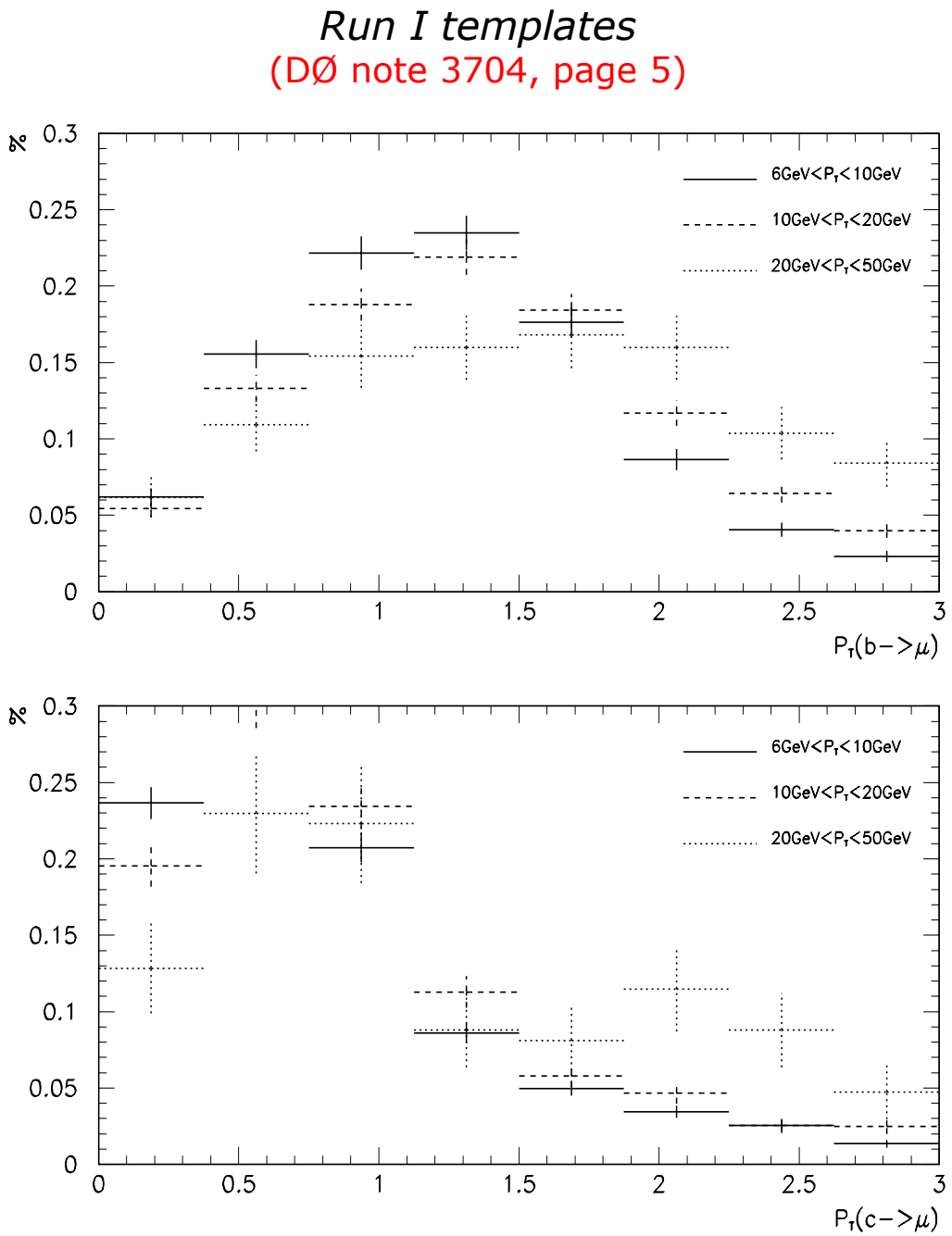
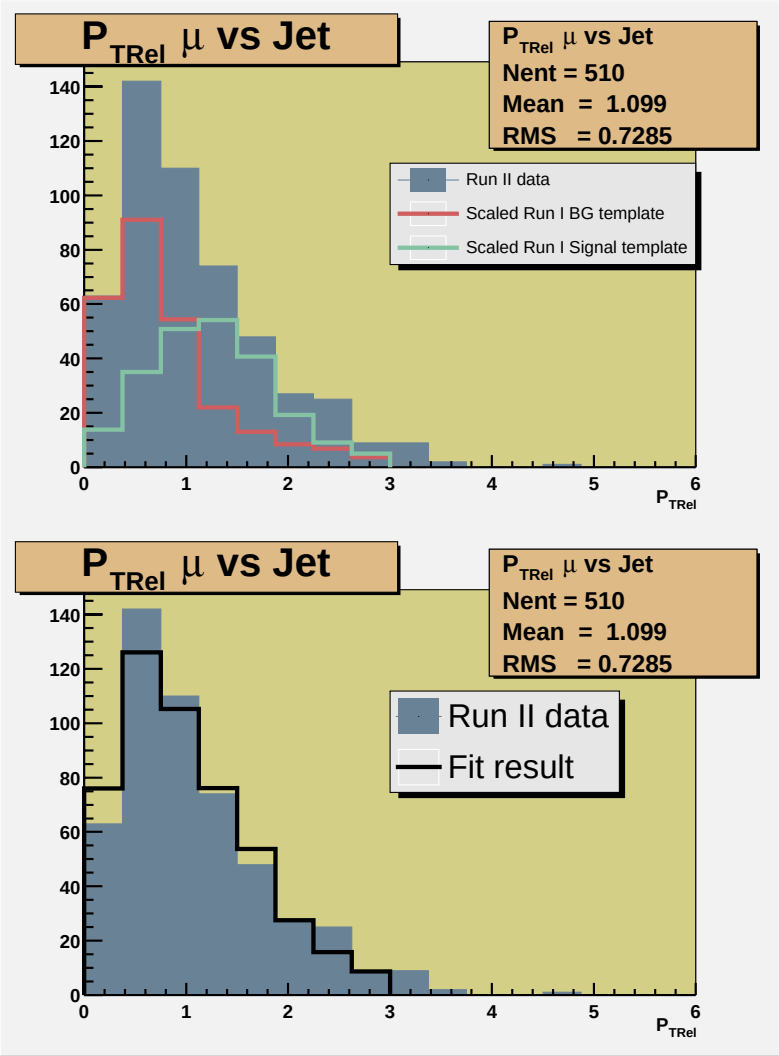
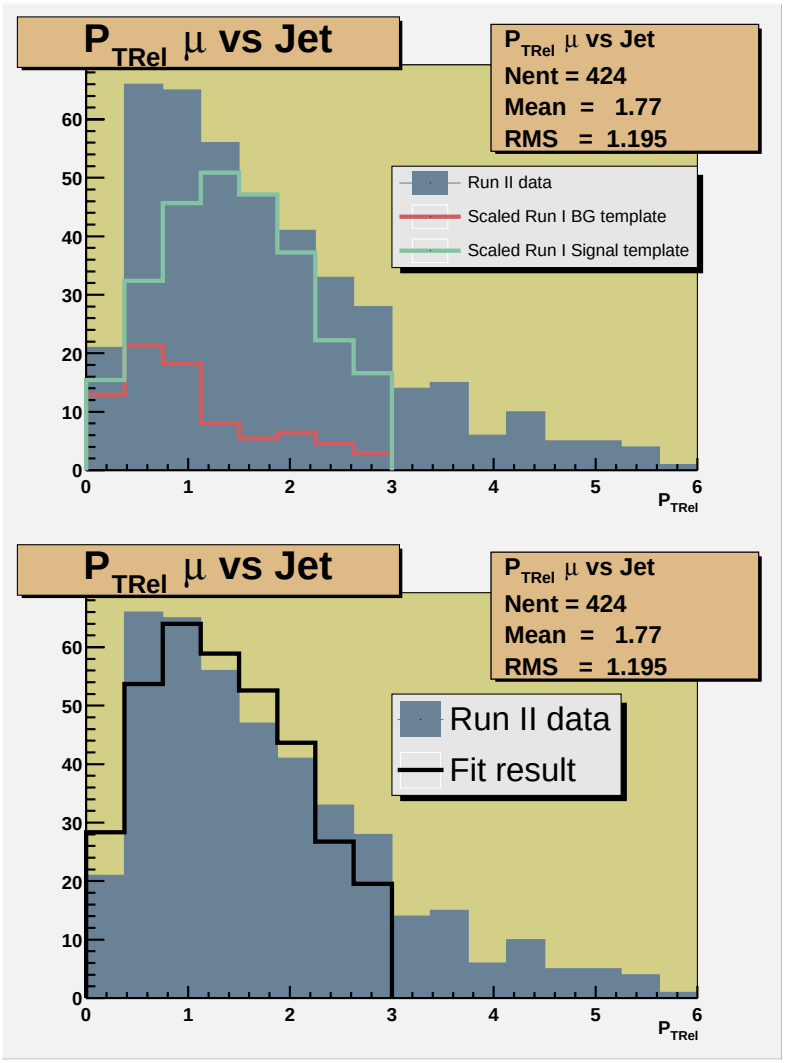


Figure 3: P_T^{rel} shape dependence with P_T^{μ}

P_T^{Rel} fit - p_T^{μ} dependence

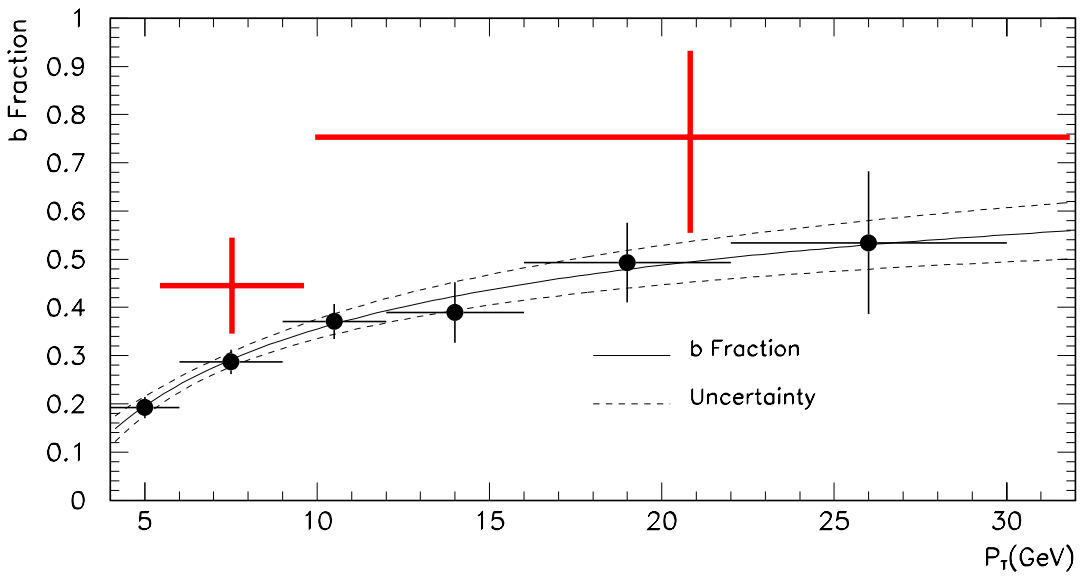




$6 < p_T^{\mu} < 10$
B-jet fraction: 0.47
Error on fit: ~10%

$10 < p_T^{\mu} < 50$
B-jet fraction: 0.77
Error on fit: ~33% (max)

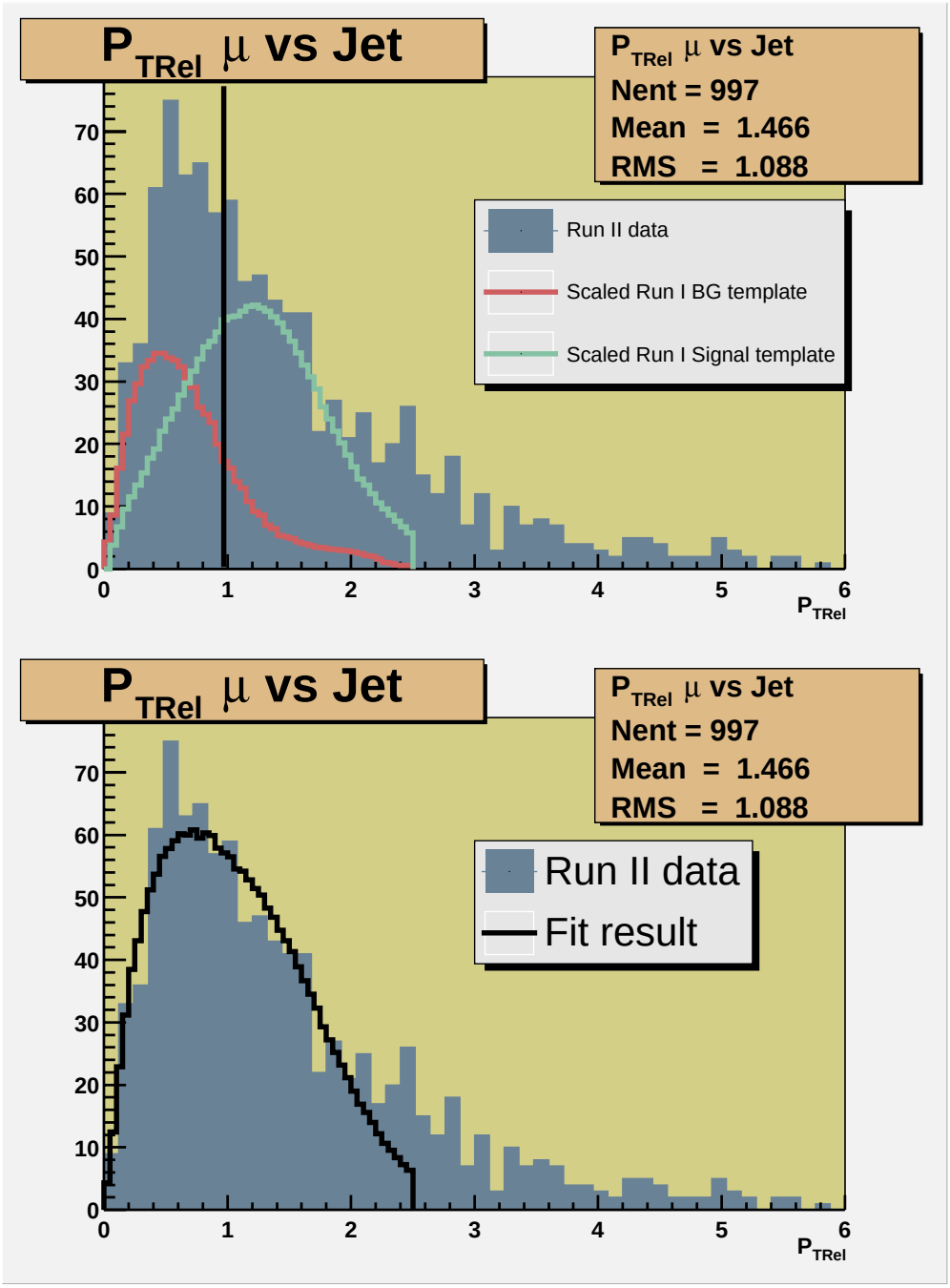
P_T^{Rel} Ratio



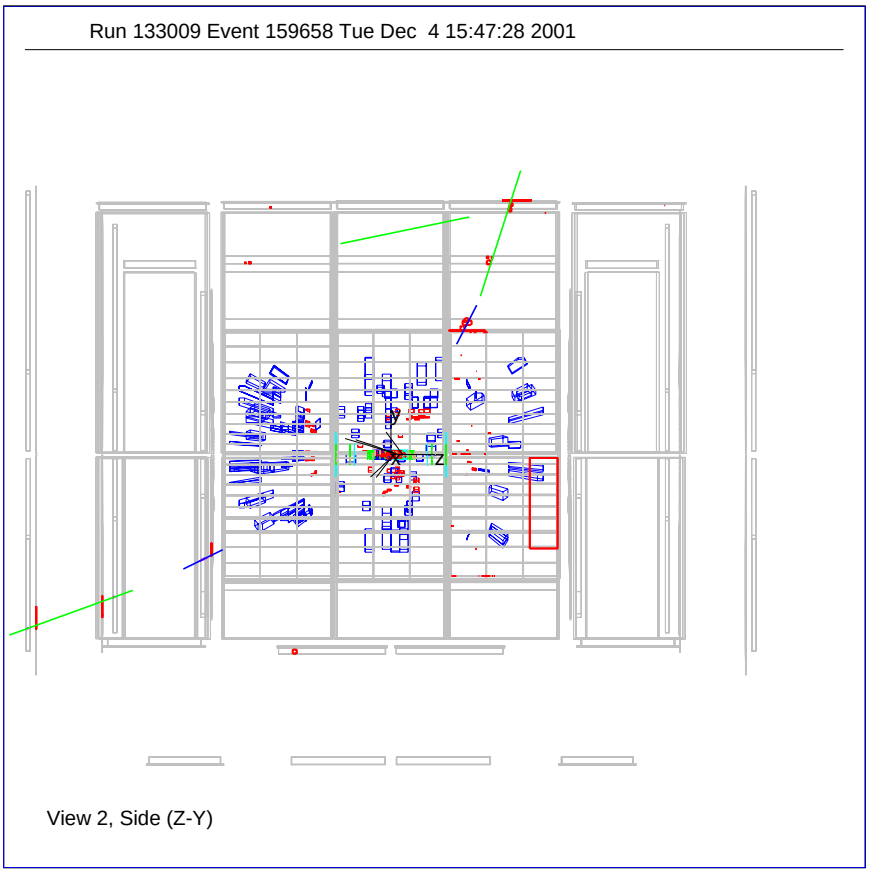
(d0note #3704, page 22)

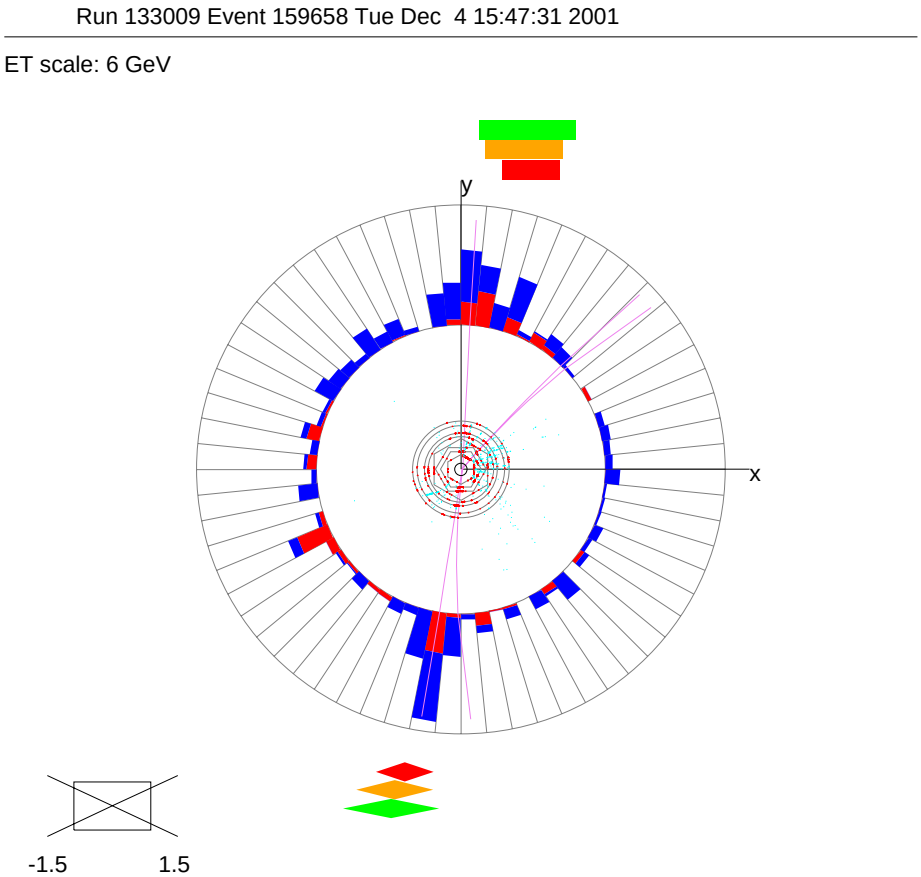
B-jet fraction is rising but high

P_T^{Rel} cuts



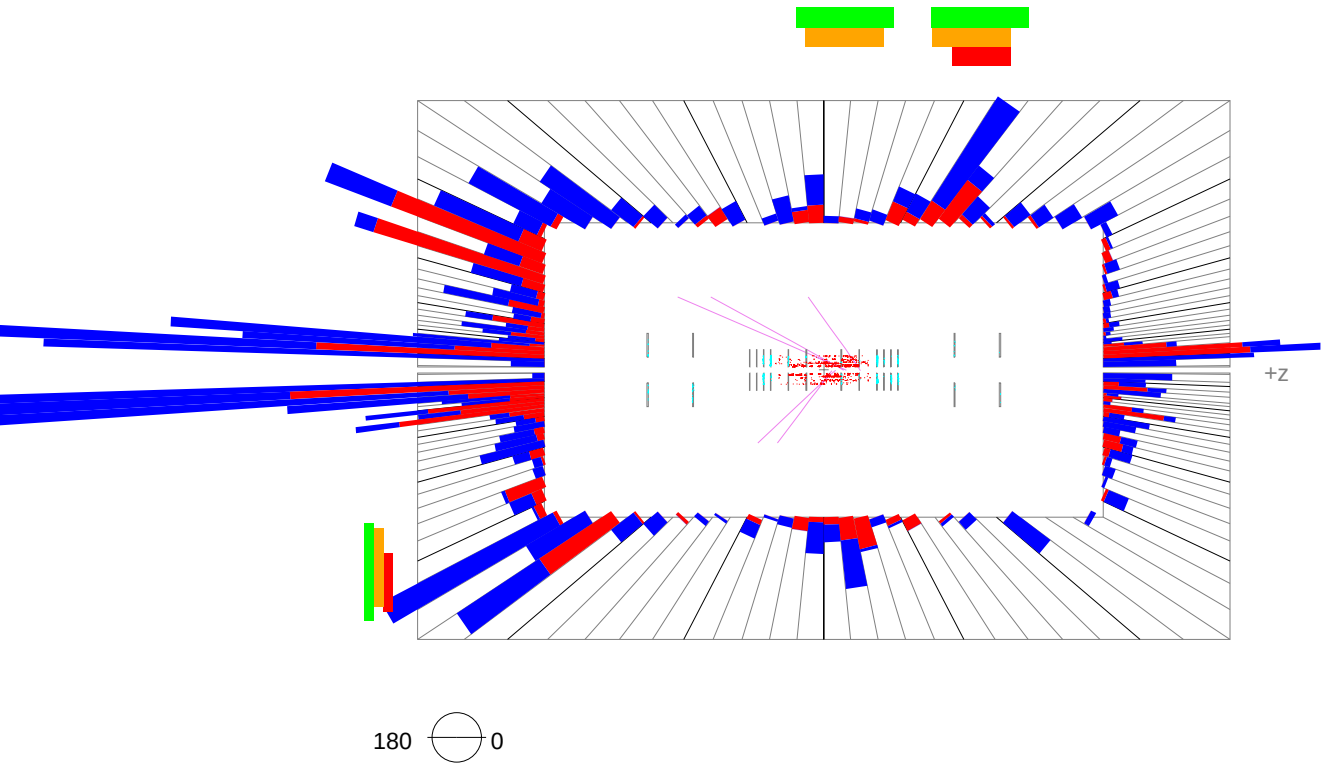
B-ID: Cut at $P_T^{Rel} > 1$
Signal events: 64% → 6.4% b-jet tagging efficiency
Background events: 22.2% → 0.06% QCD jet tagging efficiency
Purity (S/(S+B)): 84.3%


Run 133009 Event 159658 Tue Dec 4 15:47:28 2001
y
z
View 2, Side (Z-Y)

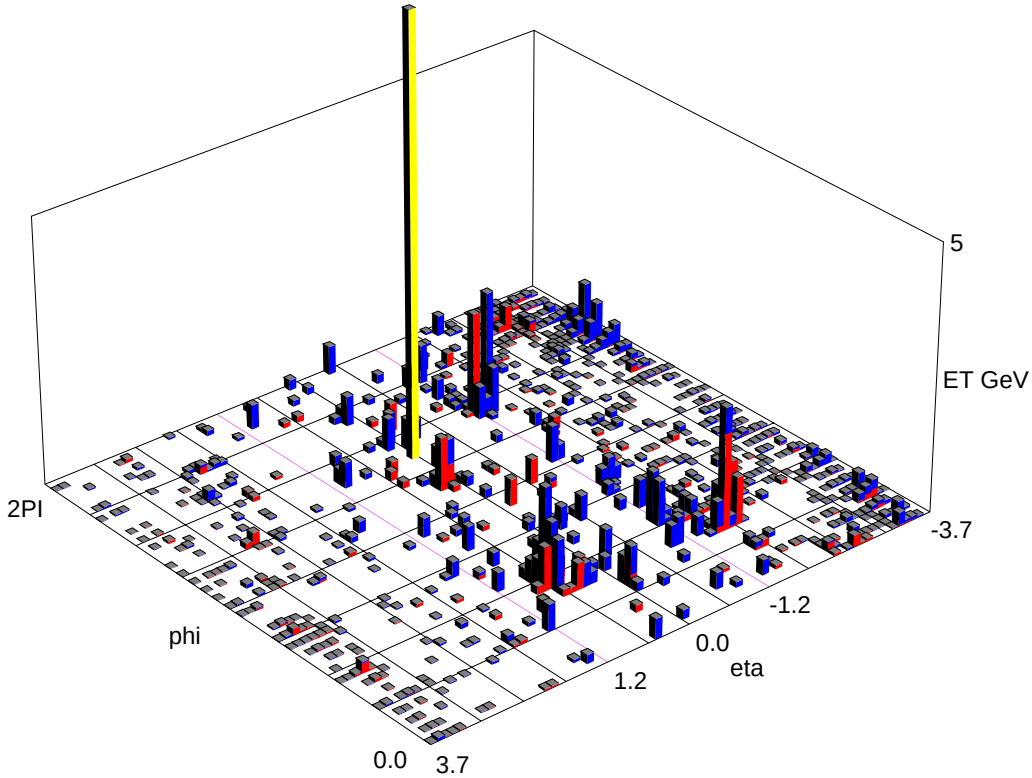

Run 133009 Event 159658 Tue Dec 4 15:47:31 2001
ET scale: 6 GeV
y
x
-1.5
1.5

Run 133009 Event 159658 Tue Dec 4 15:47:30 2001

E scale: 5 GeV



Run 133009 Event 159658 Tue Dec 4 15:47:29 2001



Conclusions

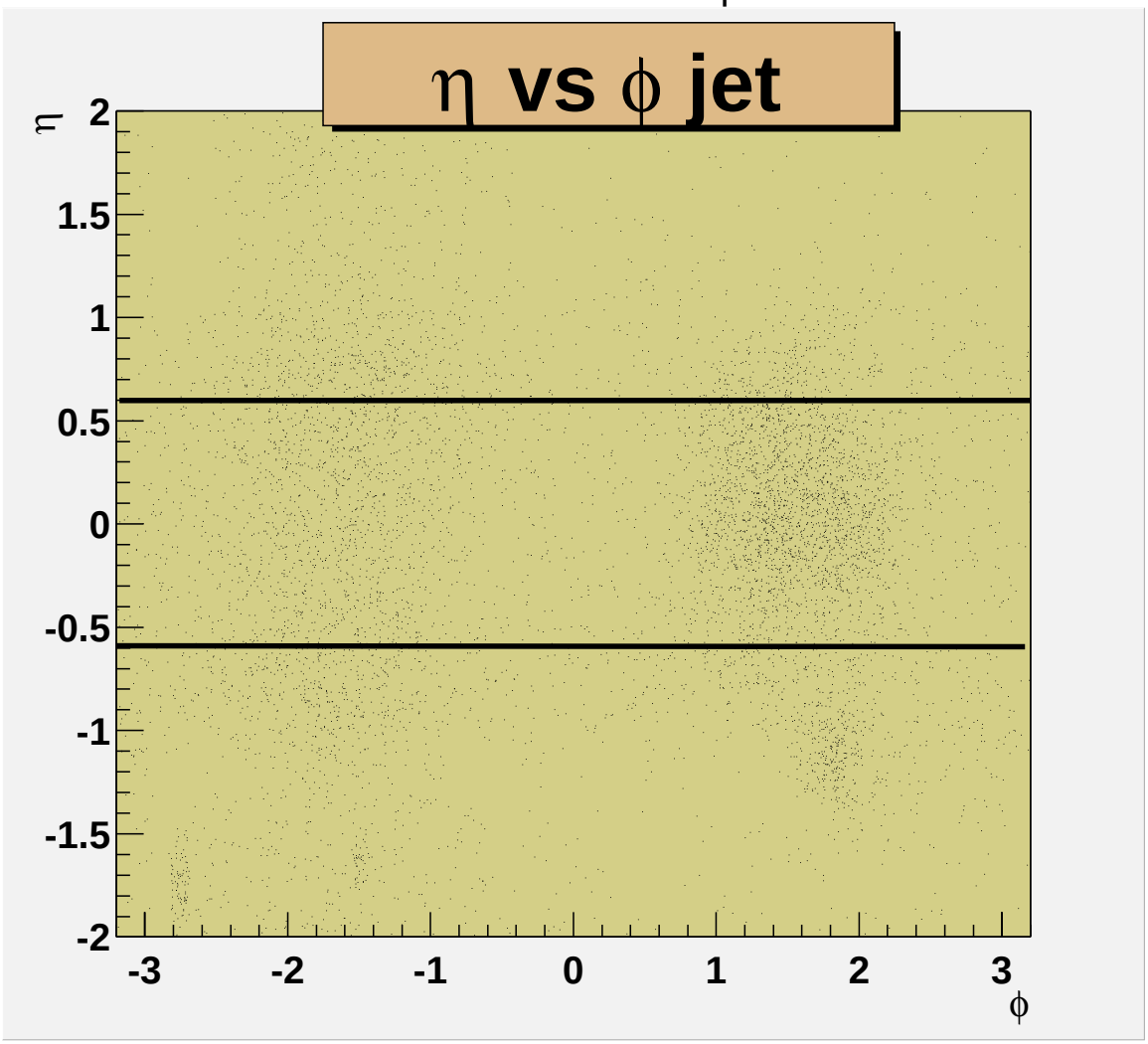
- Pre-shutdown data can give us interesting information!
- Measurements are in the correct range
- Errors are still large
- Good times ahead:
    - Post-shutdown detector
    - More data
    - Ever increasing understanding of the detector and its physics

A Final Word…

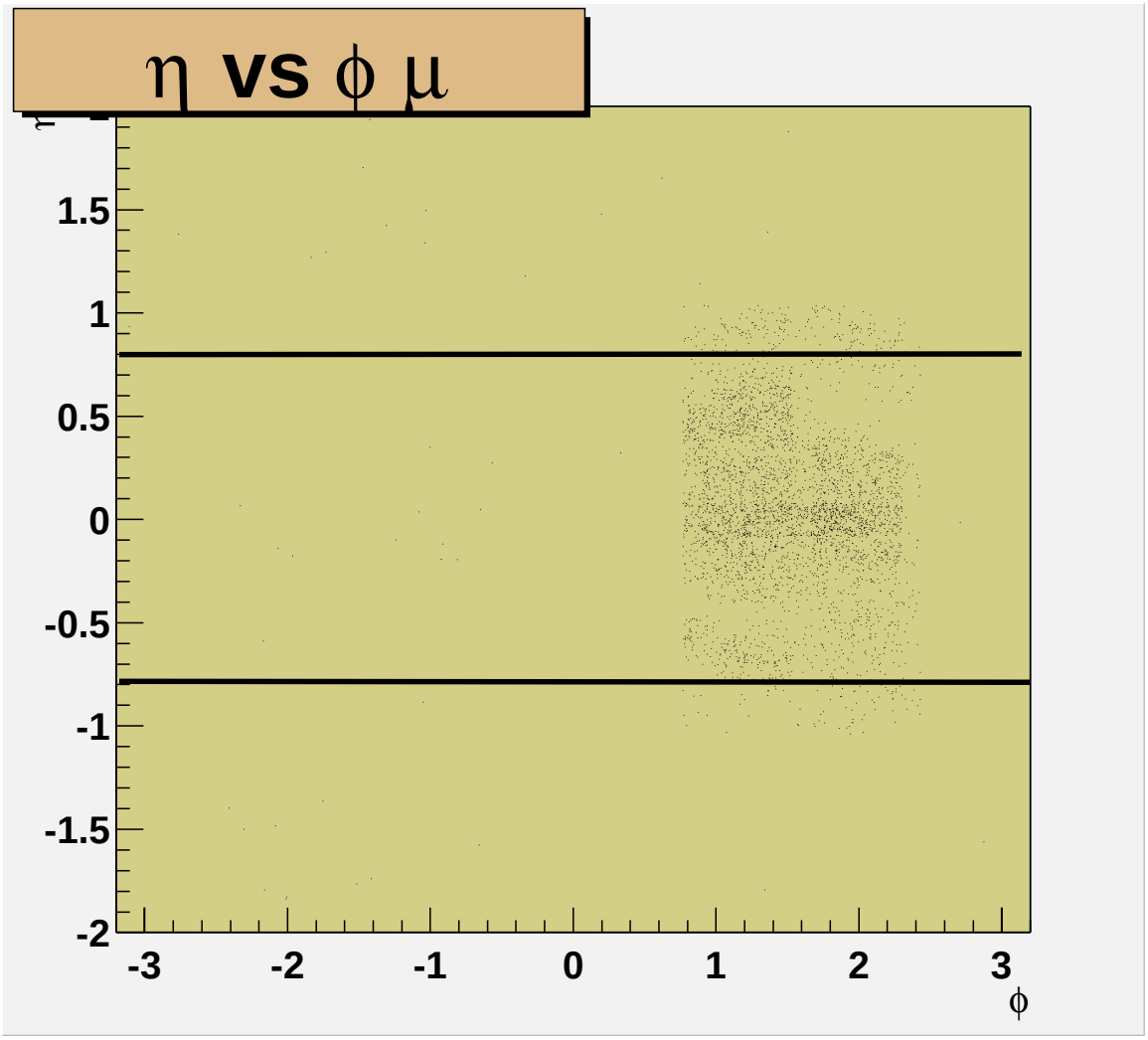
This work represents the work of a lot of people – I just combined it

(The following plots are only for added information –if required)

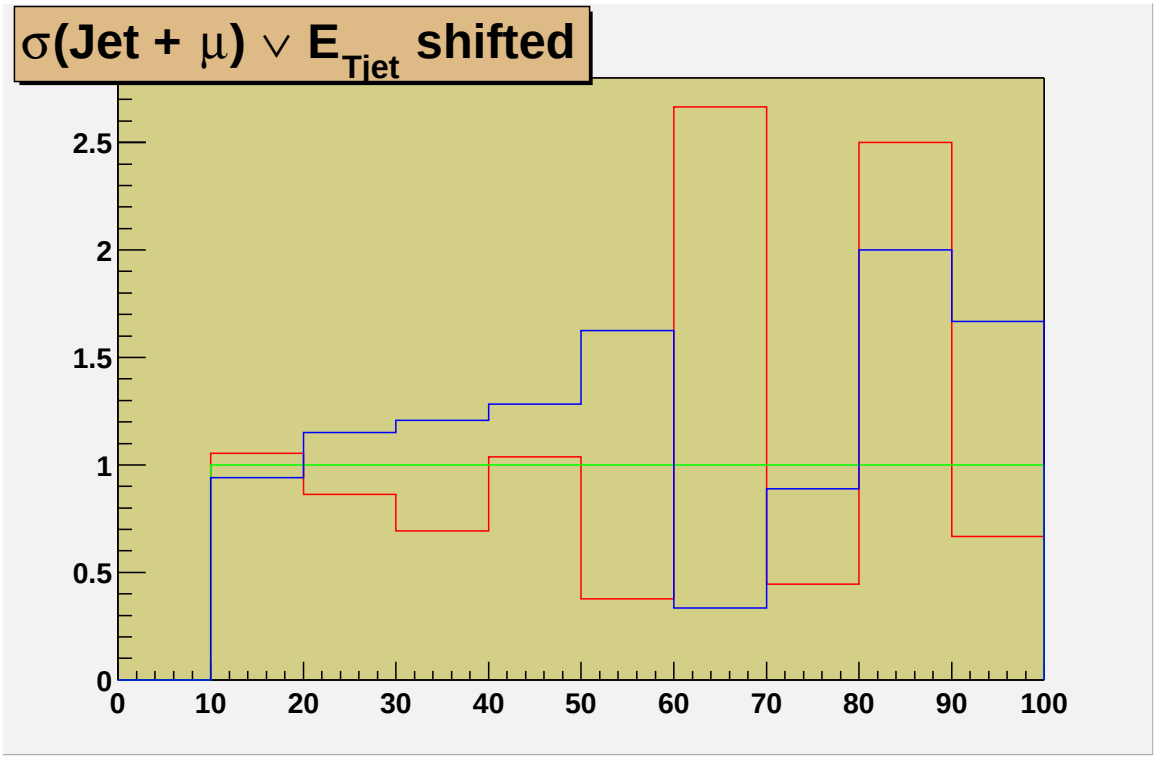
Jet Eta-Phi Scatter plot



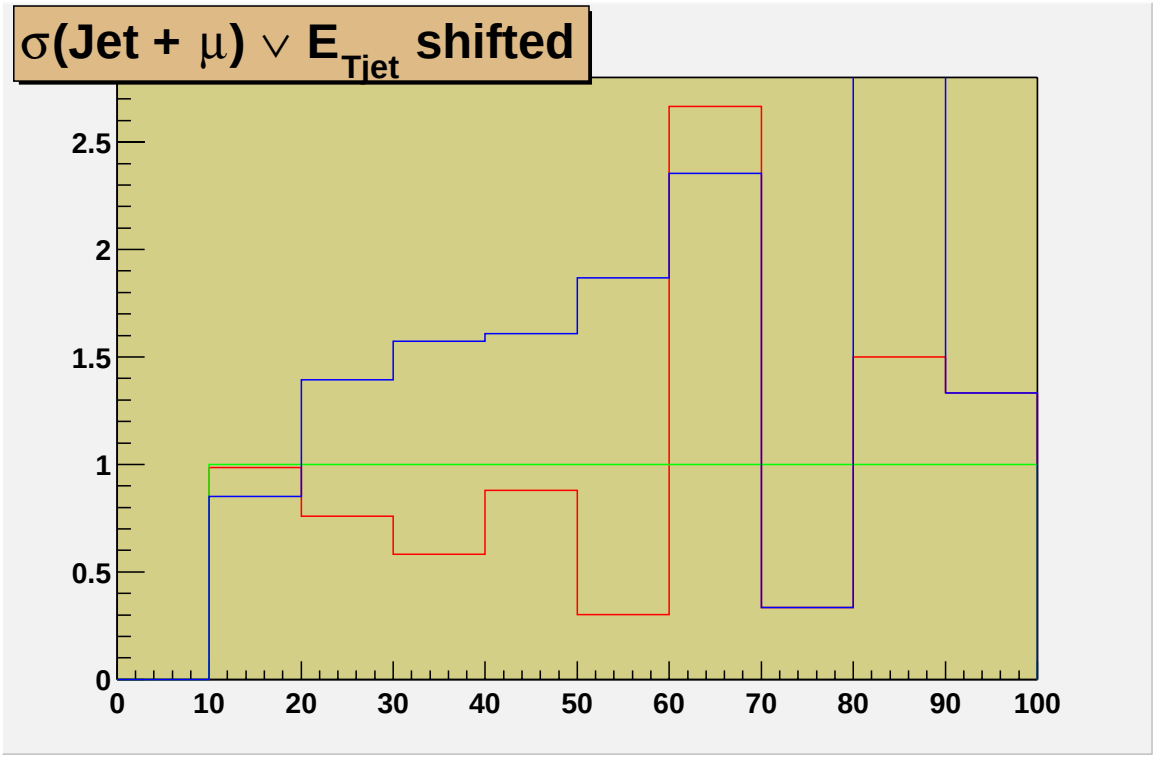
Muon Eta-Phi Scatter plot



JES correction



JES +5% (blue), -5% (red)



JES +10% (blue), -10% (red)