Color Reconnection systematics (1)

Our analyses use the PYTHIA V6.2 (tune A) Monte Carlo generator to calibrate the methods used for the top mass measurements.

The latest version (PYTHIA V6.4) includes new models for the parton shower, the Multiple Parton Interactions (MPI), ISR and FSR, the underlying event and the Color reconnection.

Tuning of the new generator to data is in progress.
(see Perugia MC meeting , October 2008)

We have looked at two recent tunes:

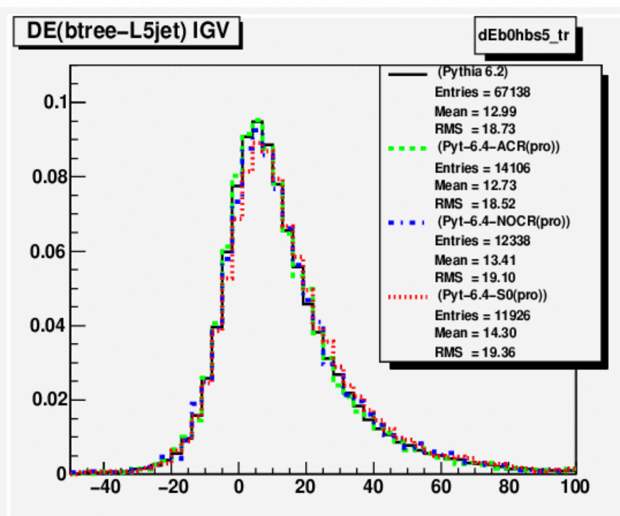
Tune ACR(pro) , which includes only the new color reconnection model, the rest is unchanged.

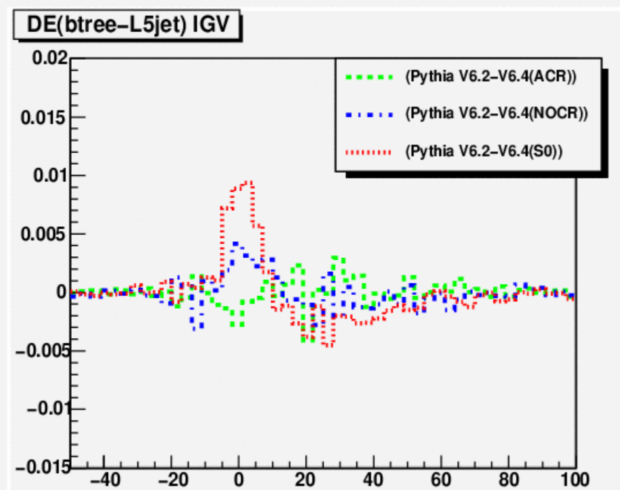
Tune S0(pro), which includes all of the above changes.

Color Reconnection systematics (2)

We have compared some jets properties after generation + detector simulation

δE = E(parton) – E(jet) in cone of radius $\Delta R=0.4$





P_T = jet P_T after simulation + reconstruction

M = mass of jet after simulation + reconstruction

δE = E(parton) – E(jet) after matching + simulation + reconstuction

Sample	Variable	W-jets	b-jets
Delta XX = PYTHIAV62 - PYTHIAV64(pro)			
Nominal-ACR(pro)	$\Delta(P_T)$ (GeV/c)	-0.21 ± 0.27	-0.07 ± 0.33
Nominal-ACR(pro)	$\Delta(M)$ (GeV/c^2)	-0.03 ± 0.03	+0.02 ± 0.04
Nominal-ACR(pro)	$\Delta(E_{parton} - E_{jet})$ (GeV)	+0.37 ± 0.13	-0.26 ± 0.17
Nominal-S0(pro)	$\Delta(P_T)$ (GeV/c)	+0.16 ± 0.30	-0.73 ± 0.33
Nominal-S0(pro)	$\Delta(M)$ (GeV/c^2)	+0.27 ± 0.03	+0.20 ± 0.04
Nominal-S0(pro)	$\Delta(E_{parton} - E_{jet})$ (GeV)	+0.31 ± 0.14	+1.33 ± 0.19

Comparing the old tune A with the ACR (pro) and S0(pro) we find that the S0(pro) tune differs the most from the Nominal tune (tune A). The b-jets are the most affected with a shift of 1.3 GeV

Color Reconnection systematics (3)

The S0(pro) tune differs the most from our Nominal sample. It has the most model changes. We need to have more comparison of this tune with data before we use it for our systematics.

Since it uses new modeling for ISR/FSR, parton shower, UE and CR, we have to investigate possible overlaps with the other systematic uncertainties.

At this stage of our studies we evaluate the CR systematics using the ACR(pro) tune, that includes only changes in the CR model.

Applying the top mass measurement method (MTM3) to this sample we obtain a shift in top mass of

$$\Delta M(top) = -0.33 \pm 0.31 \text{ GeV}/c^2$$

Top Mass Measurement and CR

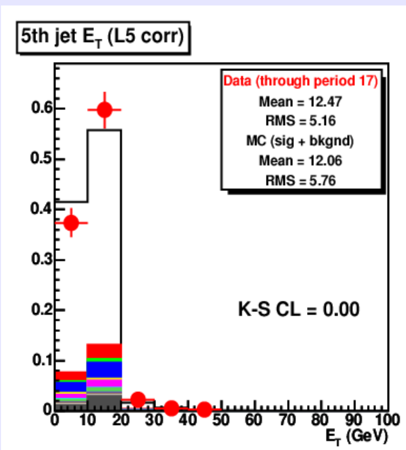
Studies shown at the CDF-D0 meeting on 01/14/09

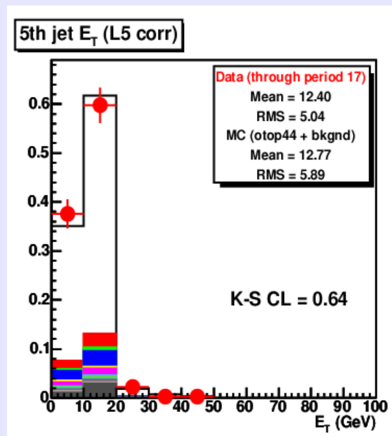
Plots added after talk of 01/14/09 (1)

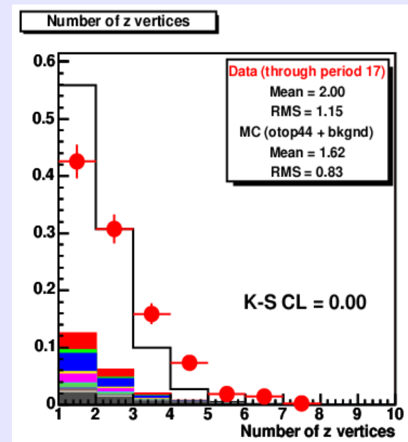
Compare ET5 for TuneA and Tune S0. Luminosity profile is the same for the MC plots (up to P8). Data gets to P17, so different Lumi profile

Tune A V6.2
MC-data comp

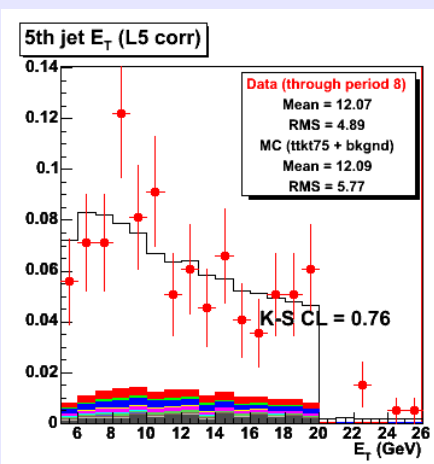
V6.4 S0-pro
MC-data comp

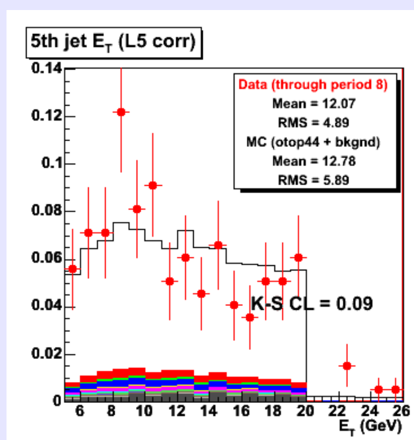


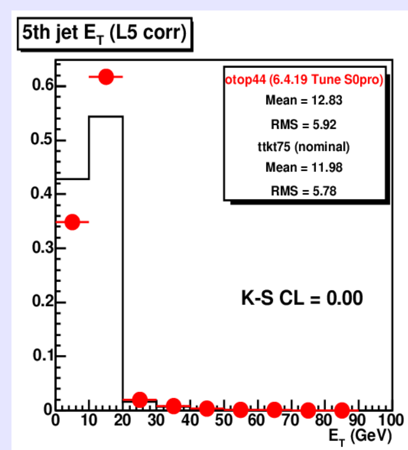




MC: Period 0-8
Data: P0-17





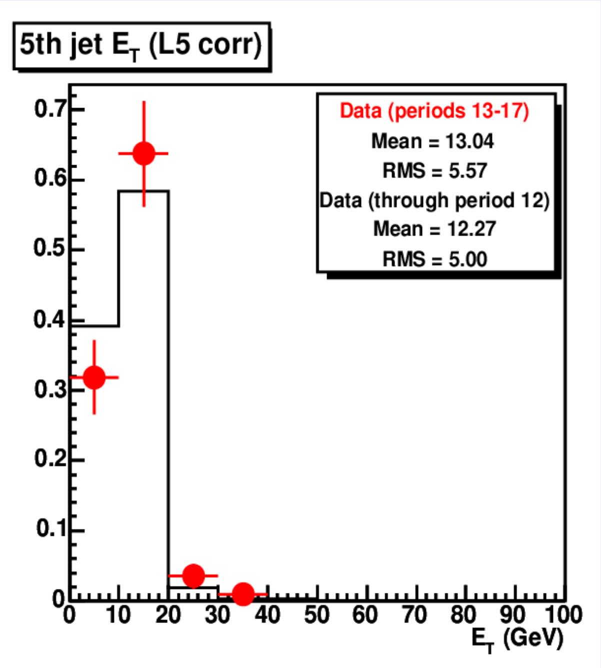


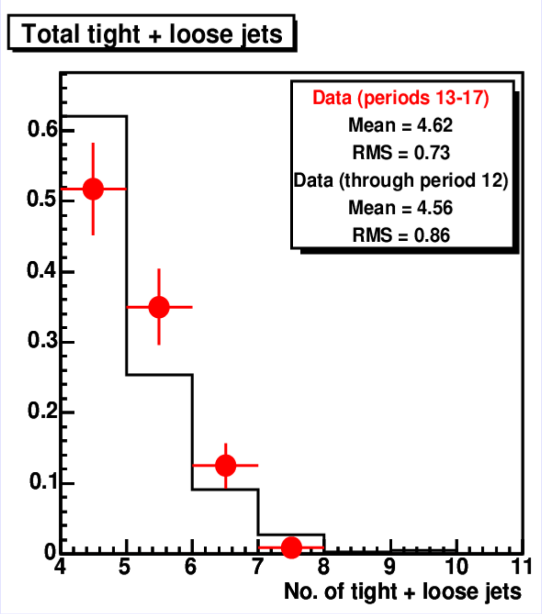
MC comparison
default and S0-pro

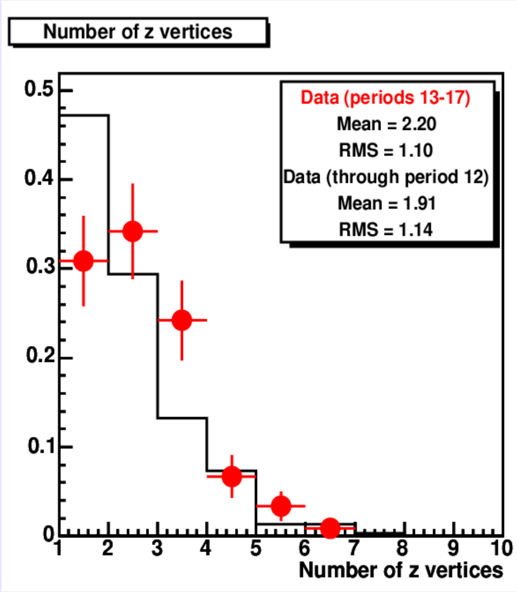
Data for P0-8
MC for P0-8

Plots added after talk of 01/14/09 (2)

Compare data: Periods 0-12 and Periods 13-17







Make averages here

Conclusions: for E_T of jet 5 and Njet distributions, we need to use the same luminosity profile, as the number of additional z vertices affects these distributions.

Procedures

Use the l+jets sample: events with 1 lepton + 4 jets (Et>20 GeV)

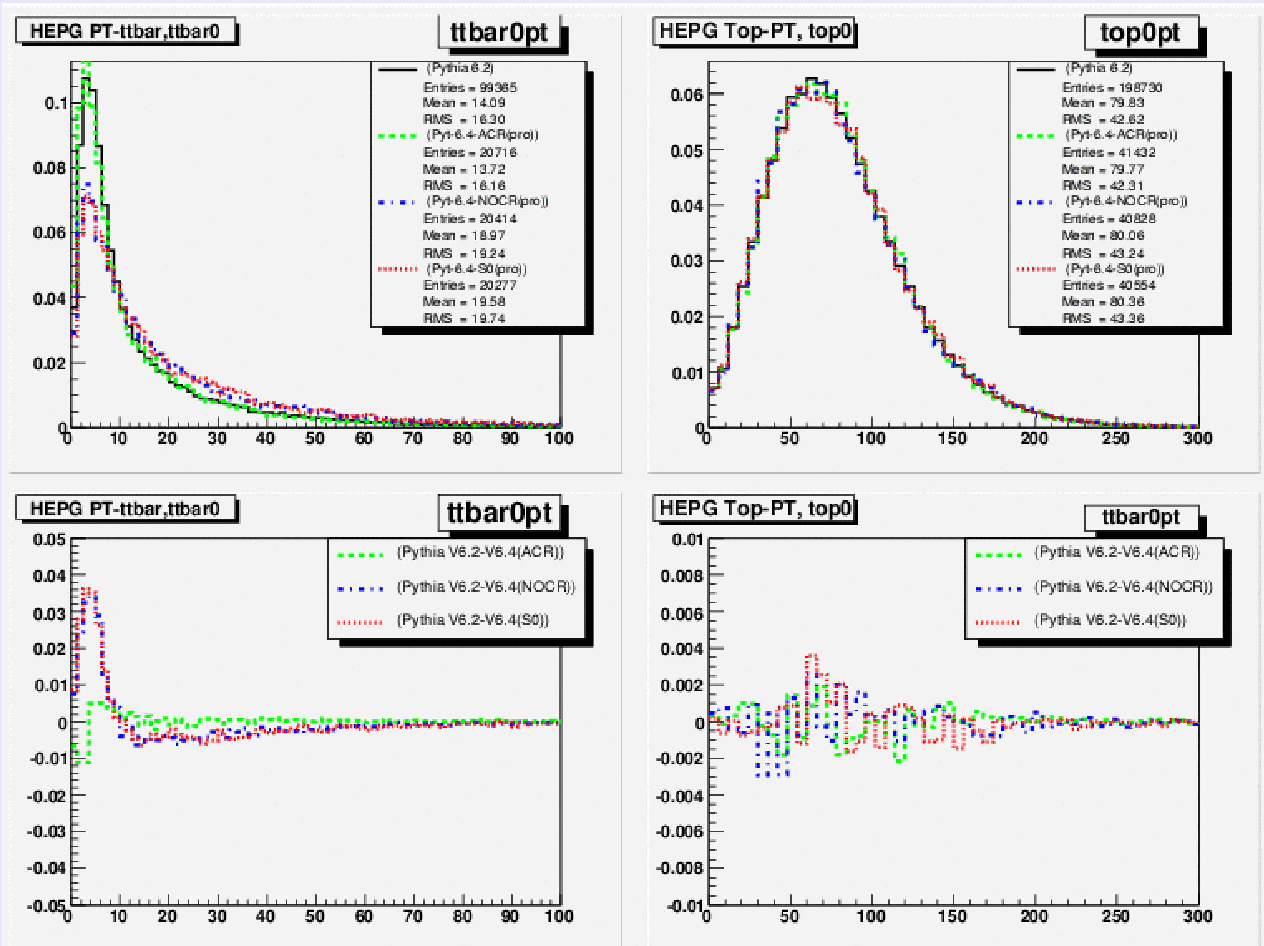
A. Given a MC sample, for each event we match the partons from top decays to the observed jets (Ntight = 4)
We then know which jet is light quark jet and which ones are b-jets.
We correct the jets at L5 (no out of cone correction)
To check the changes between the 2 MC's we do the following:

- Compare Pt5/Pt(parton) and dE in cone of R=0.4
- We calculate M(W) and M(top) using the matched jets

B. We apply to each sample the top mass measurement analysis to obtain a mass and an uncertainty.

- For methods A and B, we compare results obtained for
  V6.2(tune A) old MC (used for CDF measurements)
  V6.4 (tune ACR) only CR added to old shower
  V6.4 (tune NOCR, S0) new shower, wo/w CR

P_T(ttbar) and P_T(top) at parton level

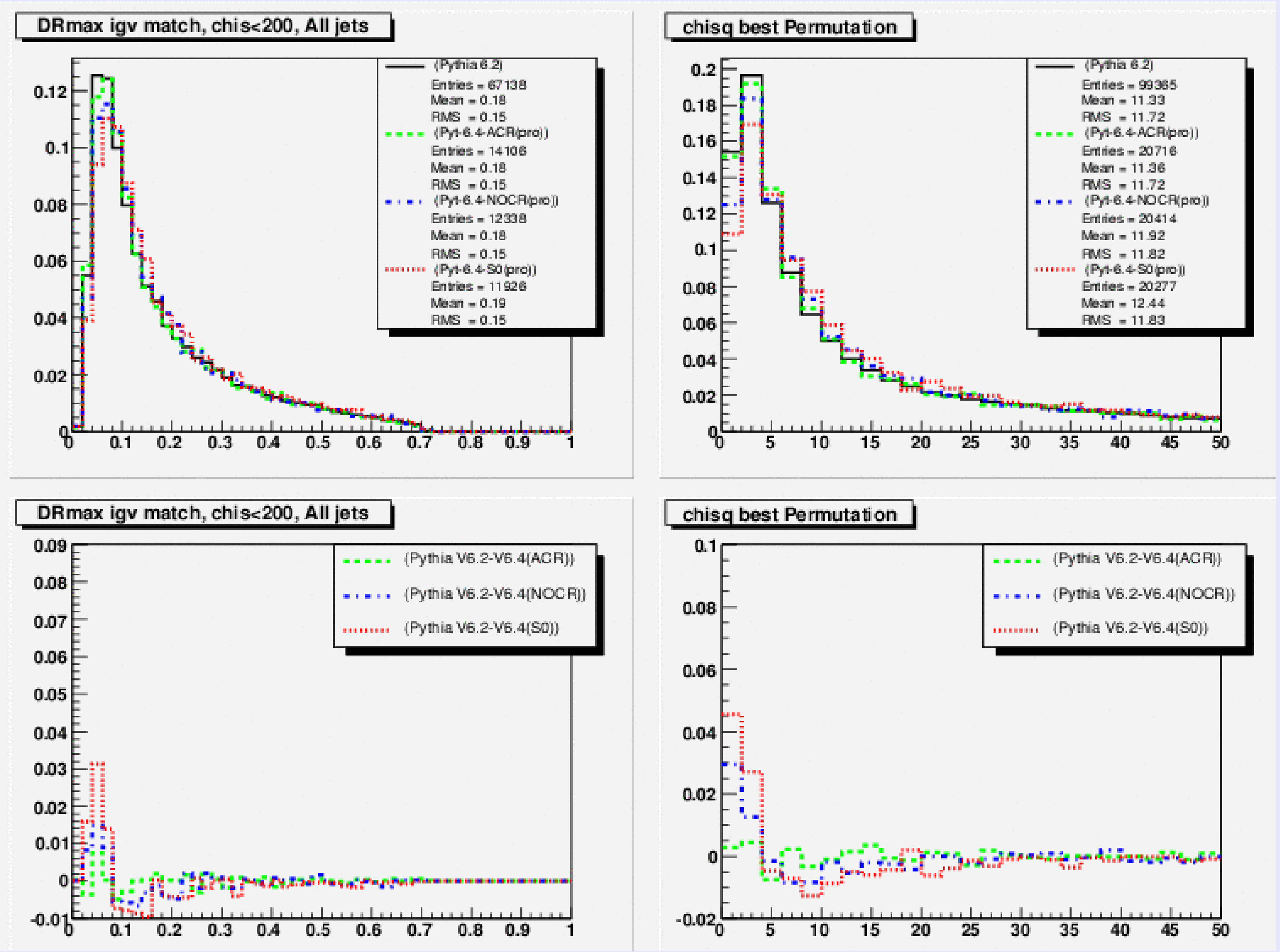


M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

P_T (ttbar) for the new shower tunes is wider as advertised, ACR is still close to the old distribution. Not clear if the parameters we use are correct
P_T(top) is not affected much by the new modeling.

Comparison of matching

The whole event is matched using ΔR for each parton-jet pair. An overall χ^2 is calculated, best $\chi^2 < 200$ are accepted as matched



M=175 GeV

V6.2 (tune A)	68%
V6.4 ACR	68%
V6.4 NOCR	60%
V6.4 S0	59%

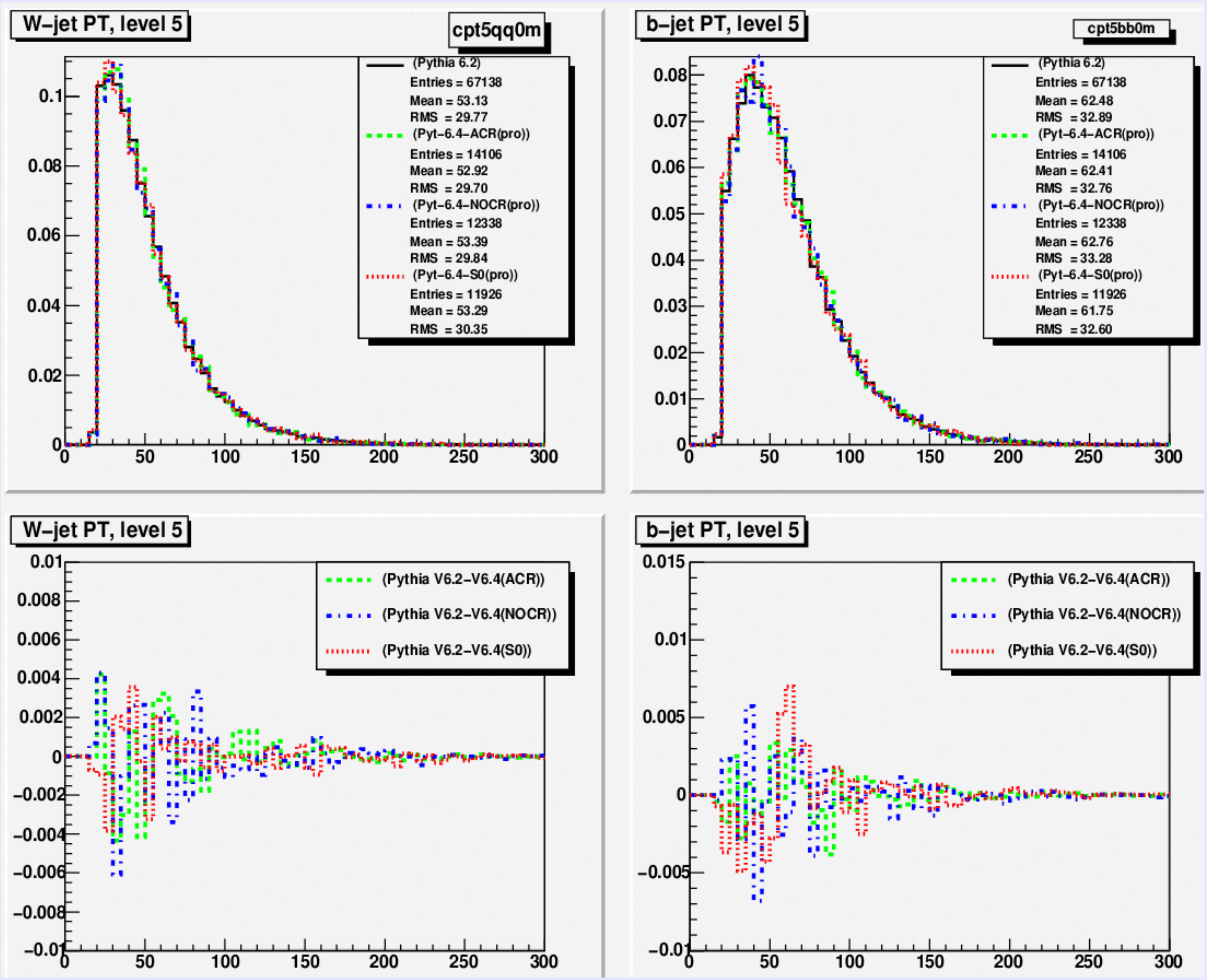
Samples with the newer tunes (NOCR and S0) have:

wider χ^2 distributions

wider ΔR "

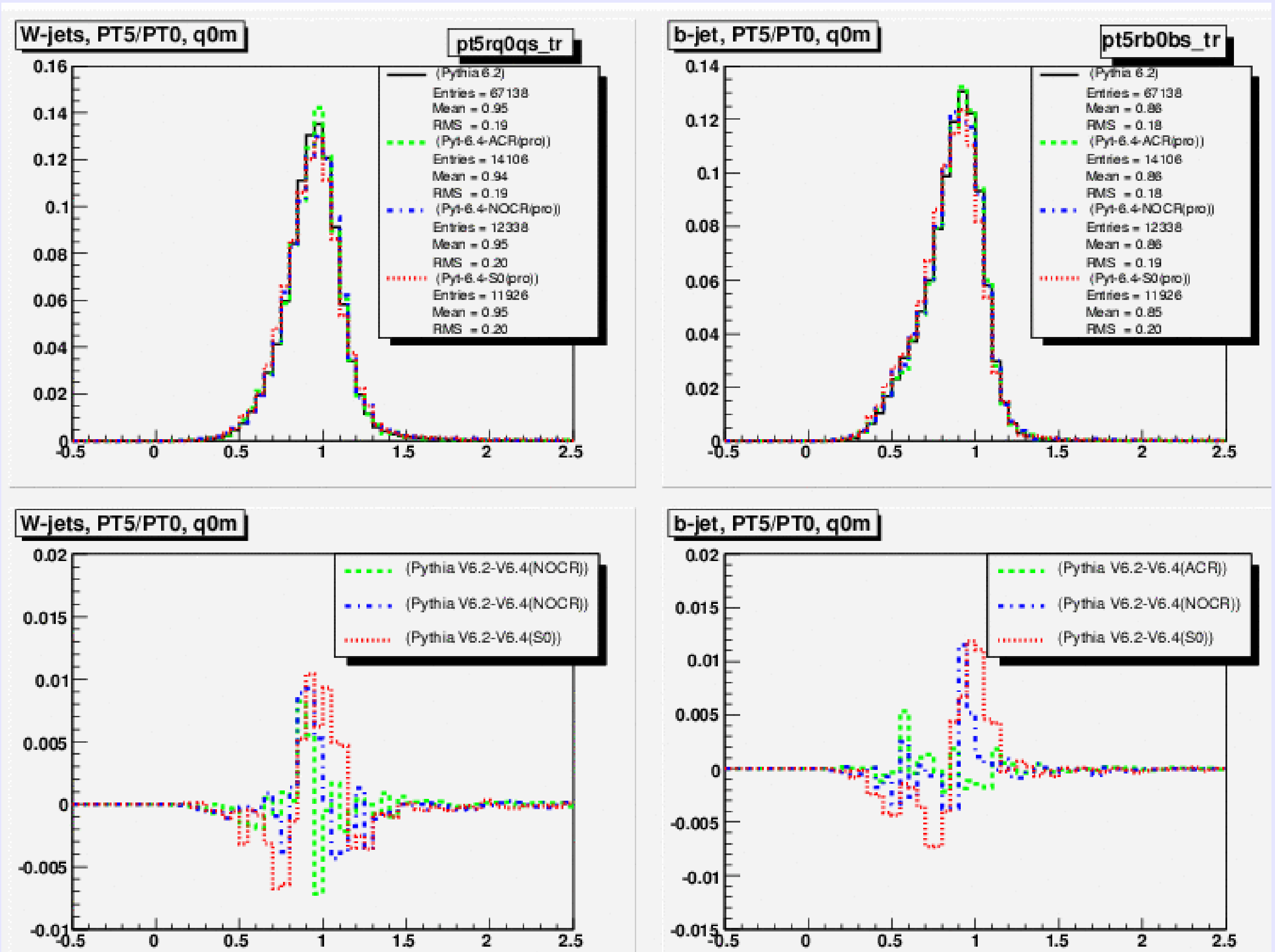
Jets in NOSR and S0 tunes are more displaced from the partons.

Comparison of Jet P_T



M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

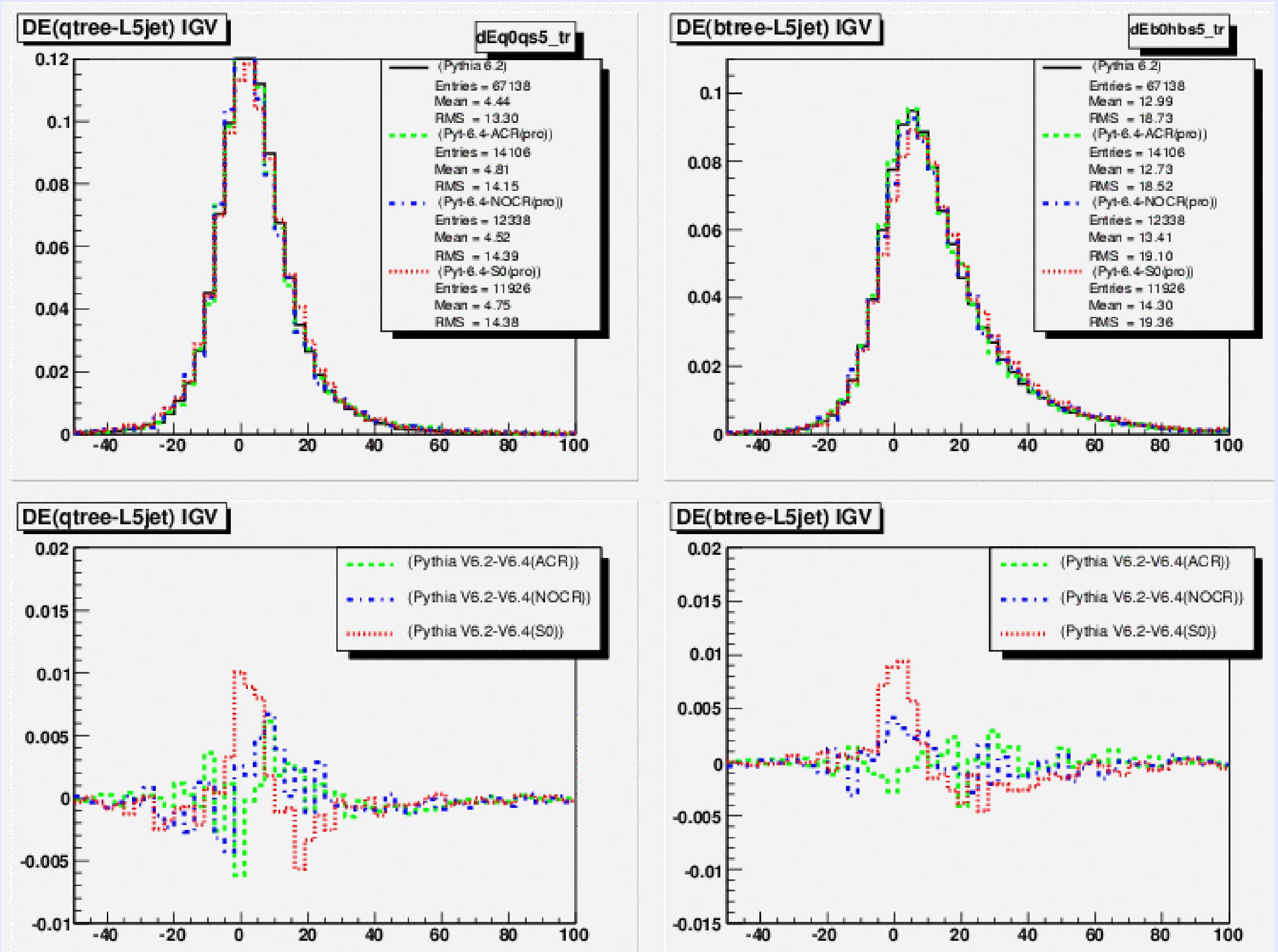
P_T(jet)/P_T(parton) for jets in top events



M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

Distributions for V6.4 tune S0 look a bit wider (PT(jet)/PT(parton) smaller) and shifted for the b-jets

δE= E(parton)-E(jet) in cone ΔR=0.4



M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

Plots show difference between the top curves:
δE(V6.12)
-δE(new tunes)

For the S0 tune, there is less energy in the cone of ΔR = 0.4

What did we learn about jets?

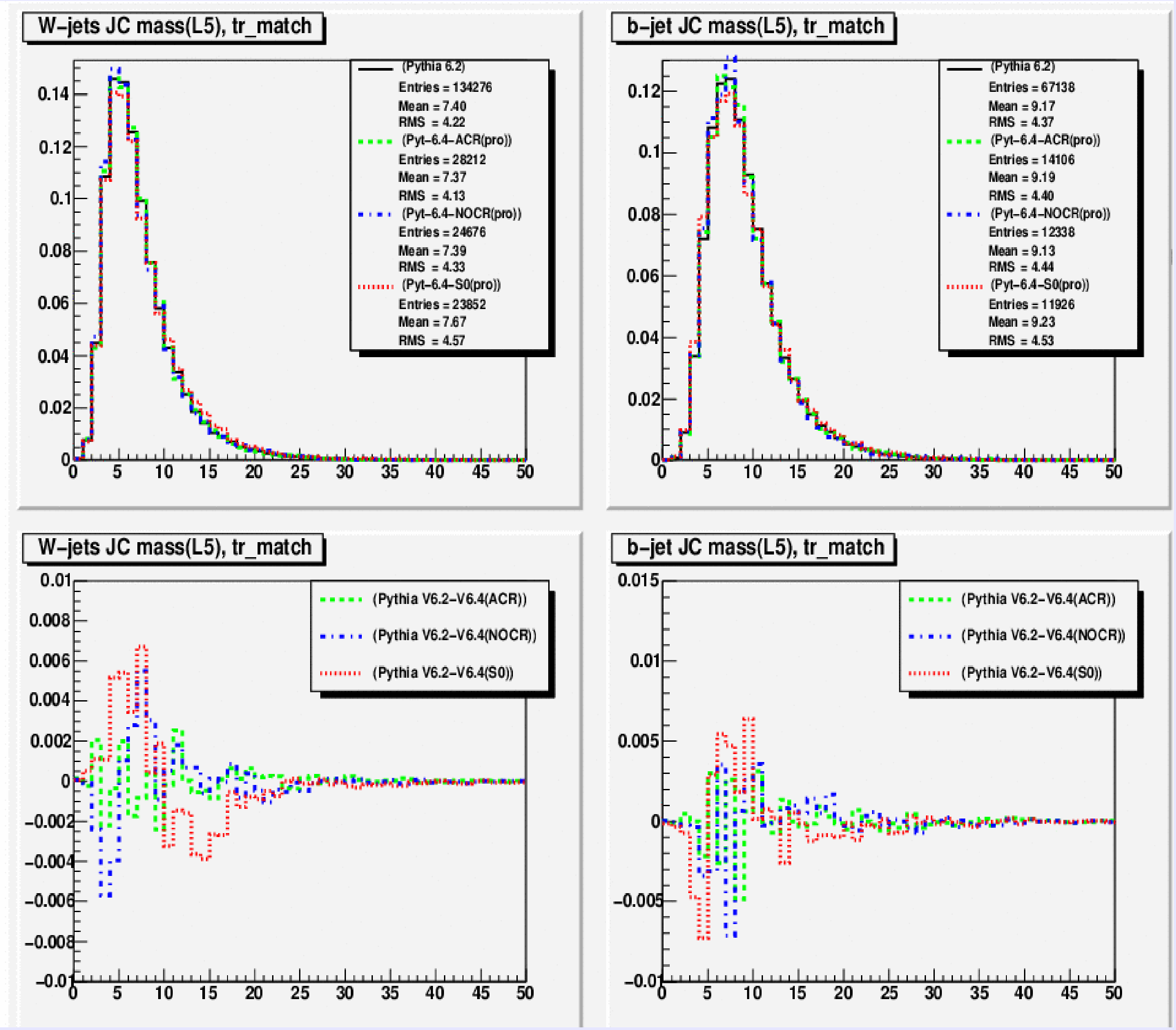
Largest discrepancies in the "pro" files found in the variable $\delta E = E_{parton} - E_{jet}$

	MC samples at M = 175 GeV/c^2					
Sample	Jets from W			b Jets		
	PT	dE(part-jet)	Δ(dE)	PT	dE(part-jet)	Δ(dE)
	GeV/c	GeV	GeV	GeV/c	GeV	GeV
V6.2 (nominal) (ttkt75)	56.0	4.44±0.05	–	71.6	13.0±0.07	–
V6.4 tune A (otop45)	56.5	4.69±0.11	0.25±0.13	71.6	13.13±0.16	+0.17±0.17
V6.4 ACR (otop46)	56.0	4.81±0.12	0.37±0.13	71.4	12.7±0.16	-0.26±0.17
V6.4 NOCR (otop47)	56.3	4.52±0.13	0.08±0.14	72.2	13.4±0.16	0.58±0.18
V6.4 S0 (otop44)	56.2	4.65±0.13	0.31±0.14	72.1	14.3±0.18	1.31±0.19

- The jets are wider in S0, i.e. less energy in a cone of 0.4 radius. We get on the average b-jets with a shift of -1.3 GeV.
- The ACR case has smaller effects than S0
- The NOCR shows less visible effects than S0 (-0.58 GeV b-jet shift)

Tunes with the new parton shower give jets with less energy in cone of ΔR =0.4

Comparing Jet mass



M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

Jet masses are different as well

Summary of jet findings

Shifts in P_T, E and jet mass in a cone of $\Delta R=0.4$

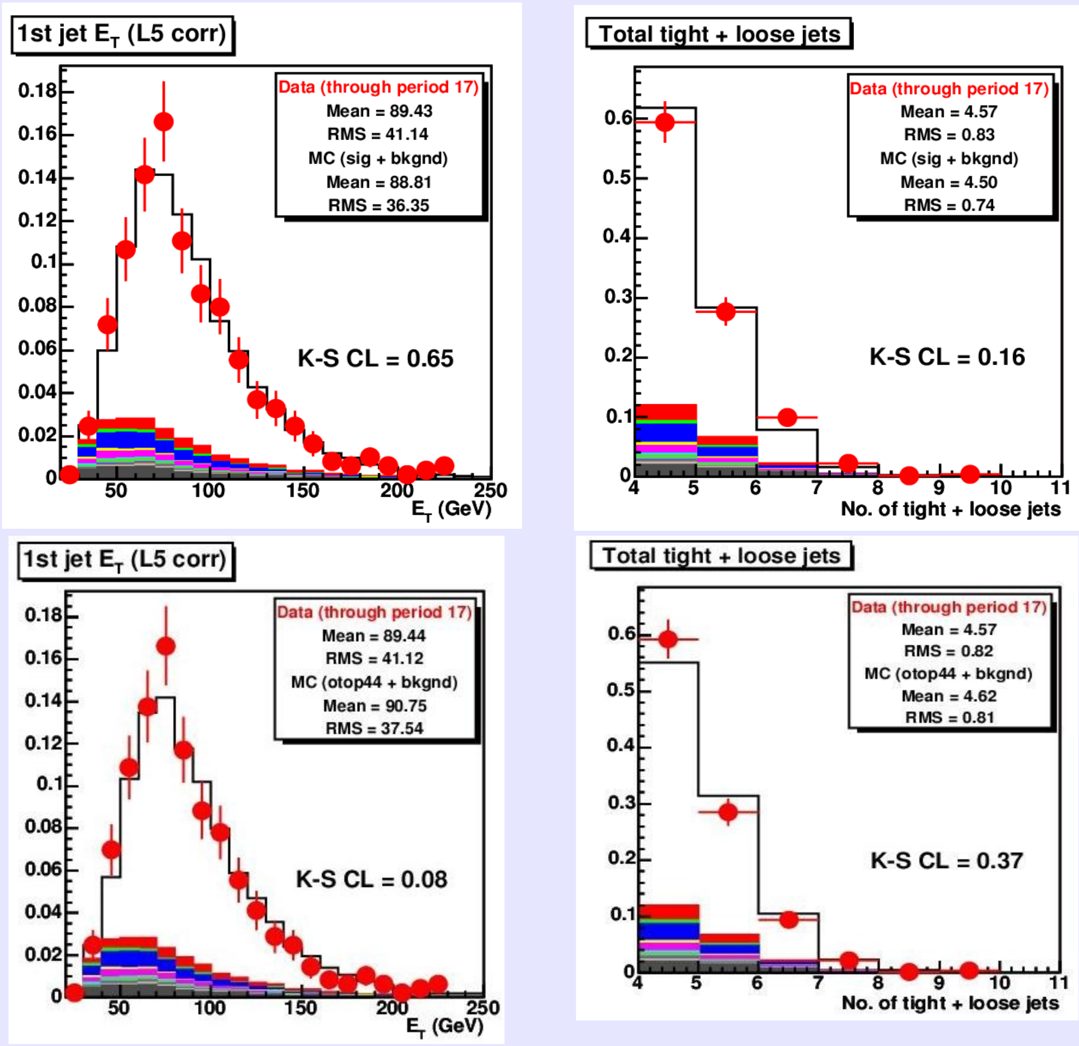
(values in red are shifted by $>2\sigma$)

	What	W-jets	b-jets
Nominal-S0-pro	$\Delta(P_T)$ (GeV)	$+0.16 \pm 0.30$	-0.72 ± 0.33
Nominal-S0-pro	$\Delta(E)$ (GeV)	-0.31 ± 0.14	-1.33 ± 0.19
Nominal-S0-pro	$\Delta(M)$ (GeV)	$+0.27 \pm 0.03$	$+0.20 \pm 0.04$

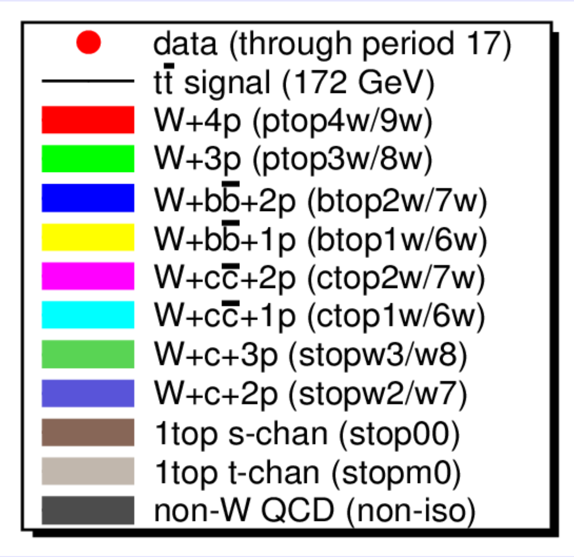
- For tune S0 we observe large shifts in the energy and mass of jets.
- The b-jets seem to be more affected than the light quark jets

Data-MC comparison V6.2 and 6.4

CDF Data (494 events in 2.7 fb-1), not enough to distinguish!



PYTHIA V6.2

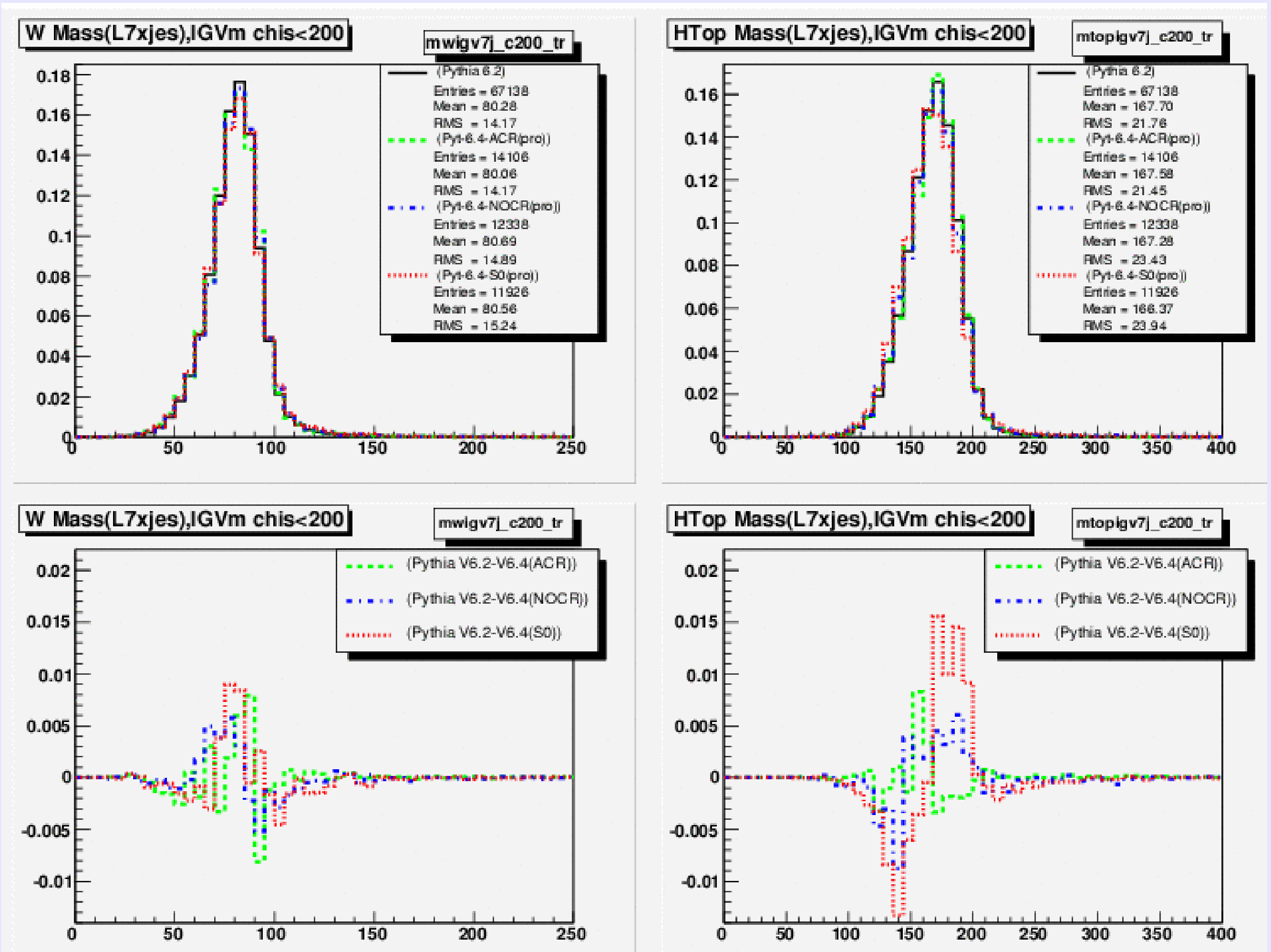


PYTHIA V6.4 (S0)

Highest E_T jet: there is a 2 GeV difference between the two MC samples

Reconstructed W and top masses

Using event matching we find:



M=175 GeV
V6.2 (tune A)
V6.4 ACR
V6.4 NOCR
V6.4 S0

M_W is somewhat shifted . M_{top} shifted for both the NOCR and the S0 samples

Summary of studies on M_{top}

Comparison of V6.2 (nominal) to V6.4 (the "pro" files)
Using both methods, i.e., reconstructing top mass with our ME method.

	MC event matching		MTM3 Pseudo-Exp		
Sample	Δm_W (GeV/c^2)	Δm_t (GeV/c^2)	m_t (GeV/c^2)	Δm_t (GeV/c^2)	Δ_{JES} (σ)
	MC samples at M = 175 GeV/c^2				
V6.2 (nominal) (ttkt75)	–	–	175.03±0.22	-	0.01±0.05
V6.4 tune A (otop45)	-0.13±0.13	-0.12±0.20	175.21±0.22	+0.18±0.31	0.03±0.05
V6.4 ACR (otop46)	-0.22±0.14	-0.12±0.21	174.70±0.22	-0.33±0.31	0.07±0.05
V6.4 NOCR (otop47)	+0.41±0.14	-0.42±0.22	173.75±0.23	-1.28±0.32	0.21±0.05
V6.4 S0 (otop44)	+0.28±0.15	-1.33±0.23	173.30±0.33	-1.73±0.30	0.11±0.05

- ACR (old shower+CR) shows little effect from CR = -0.33 $\pm$ 0.31 GeV
- NOCR: Event matching finds large ΔM_W, ME fit compensated for this with a large value of Δ_{JES}, resulting in ΔM_{top} = -1.3 GeV
- S0 : ΔM_{top} = -1.7 GeV, expected because of -1.3 GeV b-jet shift. comparing NOCR and S0, we find CR (sys)= -0.45 $\pm$ 0.46 GeV

Summary

- We find the following CR values :
  - -0.33 ± 0.31 GeV from ACR
  - -0.45 ± 0.46 GeV from S0-NOCR, consistent with zero, <0.46 GeV
- The S0 tune gives $\Delta M_{top} = -1.7$ GeV
  this is directly related to different jet shapes, i.e., different p-shower
- Tune S0 includes systematics that we are already taking into account ,i.e.
  - generator: $\Delta(m_t) = 0.51 \pm 0.37$ GeV
  - ISR/FSR: $\Delta(m_t) = 0.29 \pm 0.26$ GeV
  - OOC : $\Delta(m_t) = 0.52$
  - b-jets : $\Delta(m_t) = 0.38$

  that is, most MC related systematics (0.87 GeV)
- More comparison of the S0 tune with Tevatron data need to be done before we use it. We also need to disentangle the various sys contributions

Mass systematics for the MTM3 analysis

Residual JES is mostly due to OOC systematics

Without the calibration systematics, the MC Dependent sys are 0.87 GeV

Systematic source	Δm_t (GeV/c^2)
Calibration	0.14
MC generator	0.51
ISR and FSR	0.29
Residual JES	0.52
b-JES	0.38
Lepton P_T	0.18
Permutation weights	0.01
Pileup	0.09
PDFs	0.17
Background: fraction	0.36
Backg: composition	0.18
Backg: average shape	0.03
Backg: Q^2	0.08
Backgrounf:MC statistics	0.05
Total (MC Dependent)	1.01 (0.88)