CR studies: first look at data

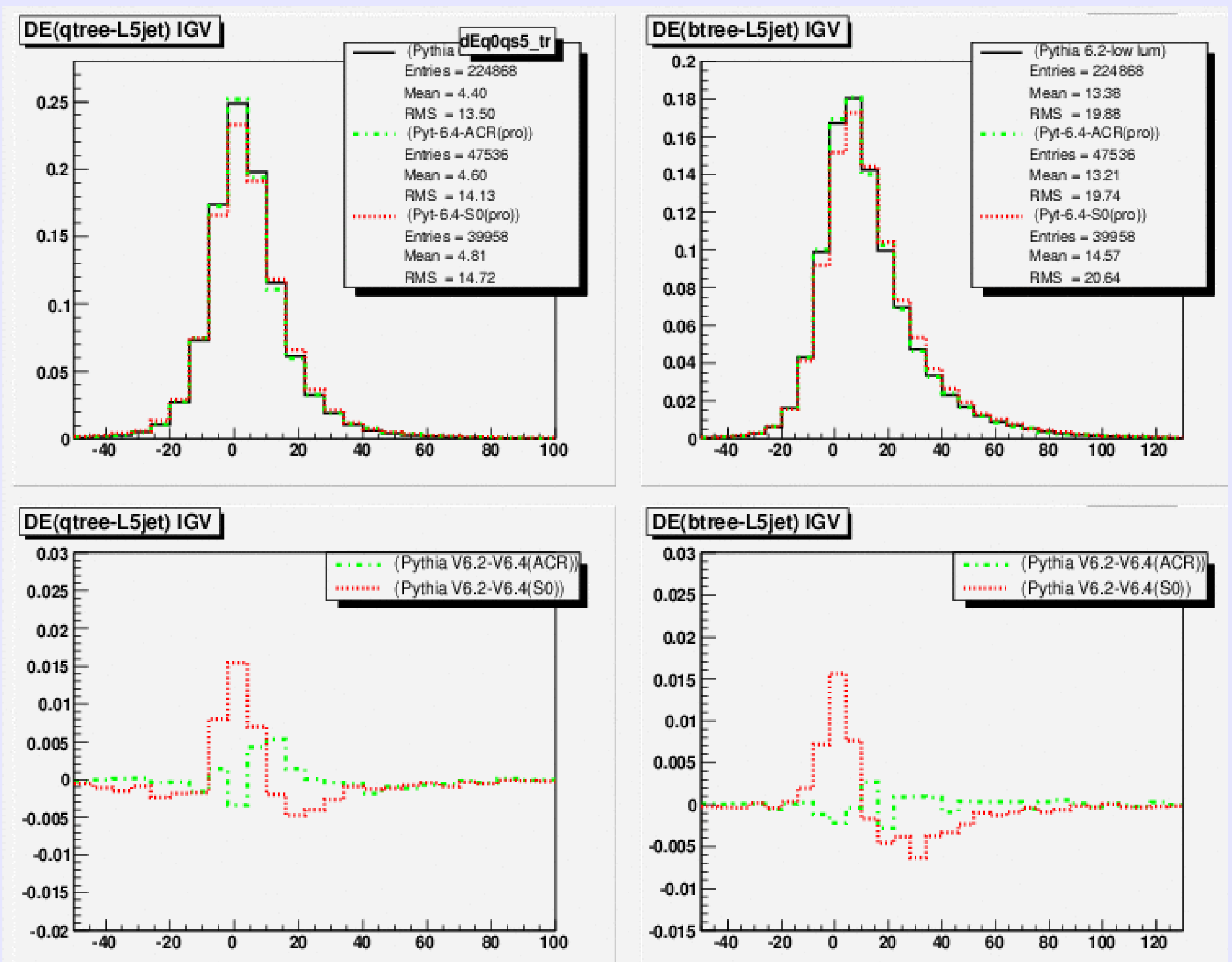
Summary of findings so far
- LBL studies
- Andrea Castro's studies

Comparison of tagged b jets in data with MC

Thanks to Paul for help with the data + background work

Previous MC studies (LBL)

Studies have shown that the difference between the parton energy and the jet energy in a DR=0.4 cone is larger for the new tunes. That is, the predicted energy of the b-jets is lower in the S0 tune.



Nominal- S0-pro

$\Delta(E_{OOC})$ in GeV

lquarks	0.38	± 0.15
b-jets	1.43	± 0.15

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

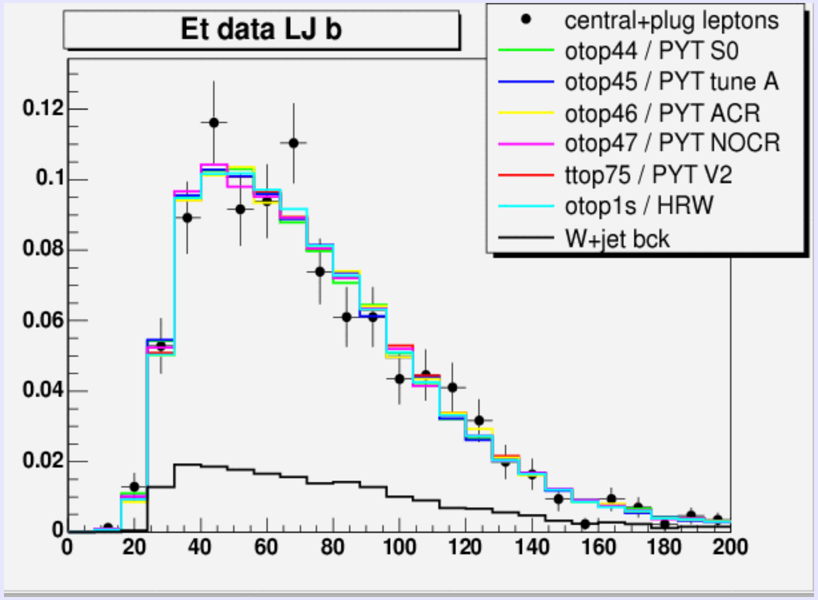
Comparison made for same lumi profile (to P8)

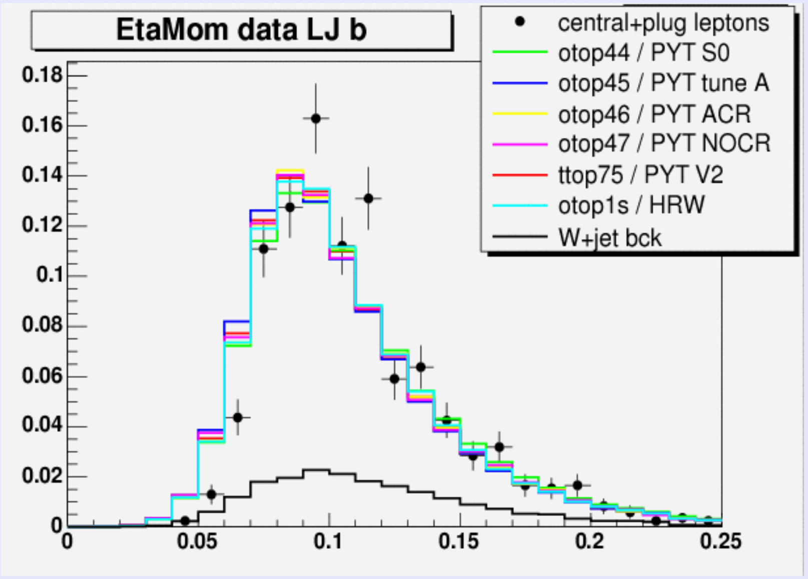
Andrea Castro's plots

Plots for the L+jets data and MC for different MC samples

1.9 fb-1, N(tight jets) >=3 (700 events). Only W+jets background shape used. These plots have been revised from the talk of January 21. Reweighting the events for the difference in Nvertices 1,2 and Nzvertices>=3.

The Et of the jets seems to agree with the MC, the eta-moments do not agree with any MC samples.





Comparison of data and MC

Use Lepton+jet mass sample.
Up to period P19 = 3.2 fb^{-1}

$P_T$jet > 20 GeV at L5

We have 577 events.
N(1 b-tag) = 458, N(> 1tag) = 119
698 tagged b-jets

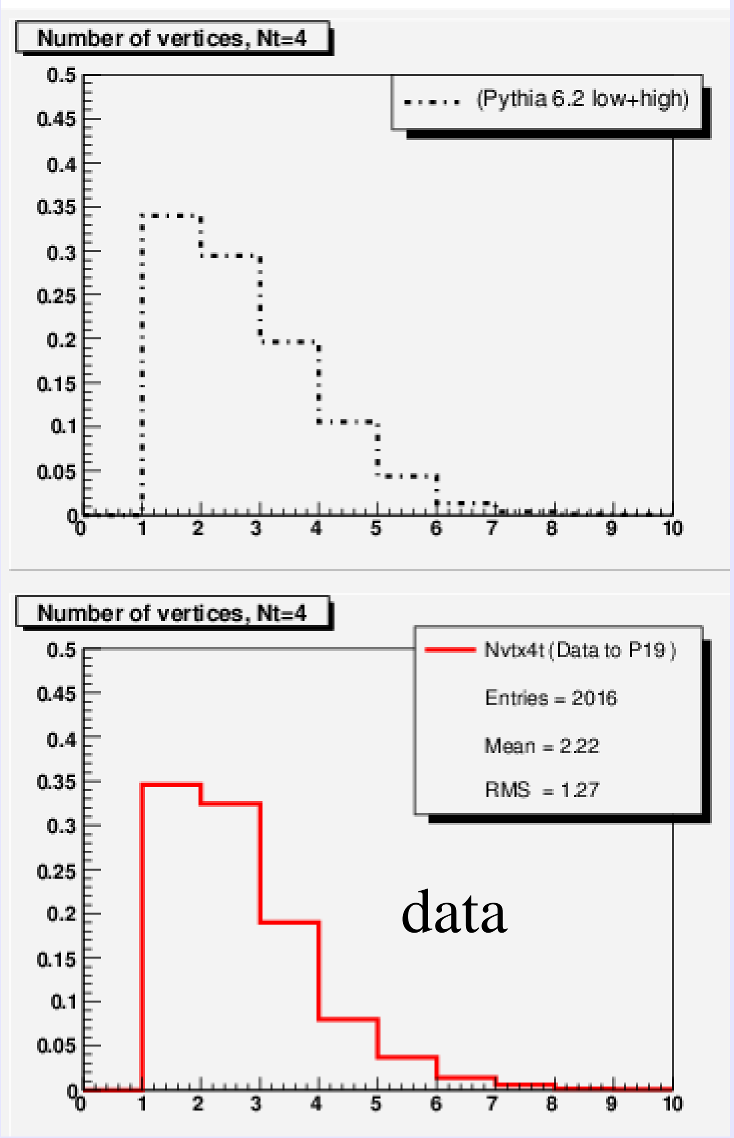
We compare data and MC.
Luminosity profile :

For the CR sample (S0-pro), ACR-pro
lumi up to P8

Default PYTHIA V6.2: we have two samples, low lum and high lum, mid-lum is missing.

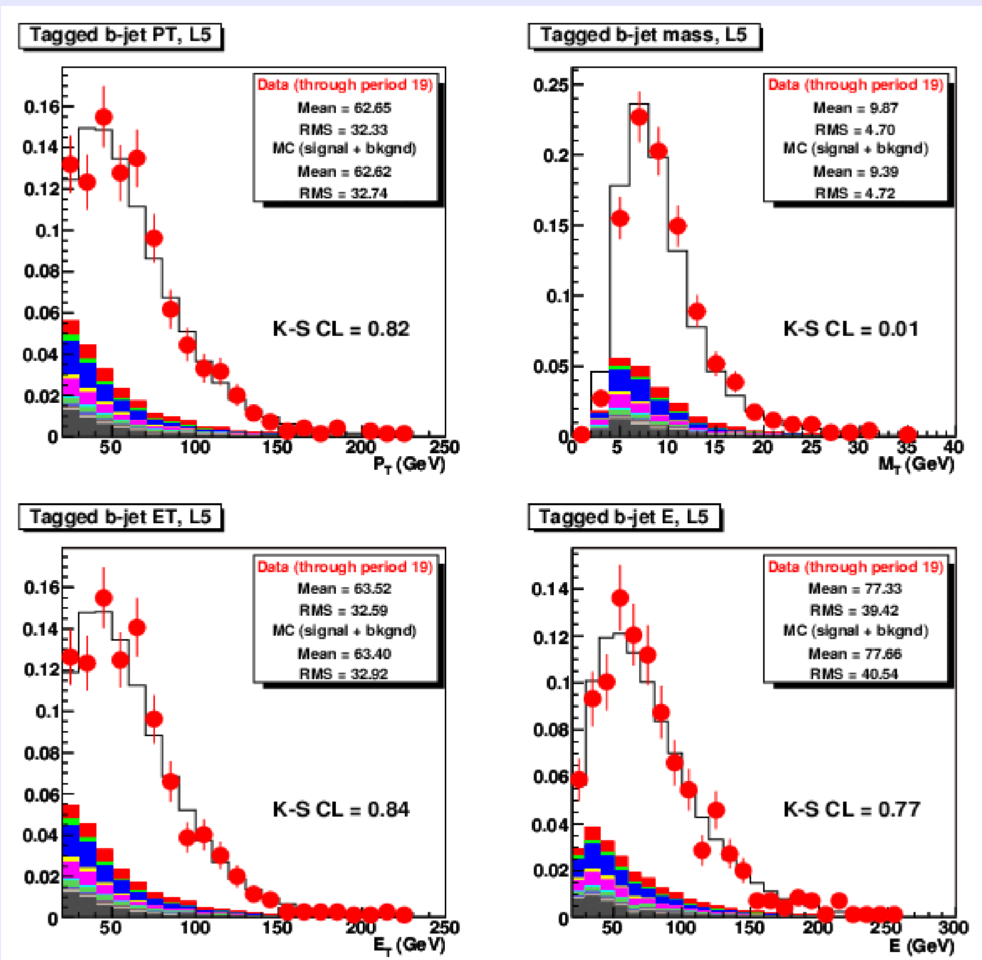
I have added the two with 0.45,0.55 ratio

Preliminary lumi profile
0.45ttop75+0.55 otop40

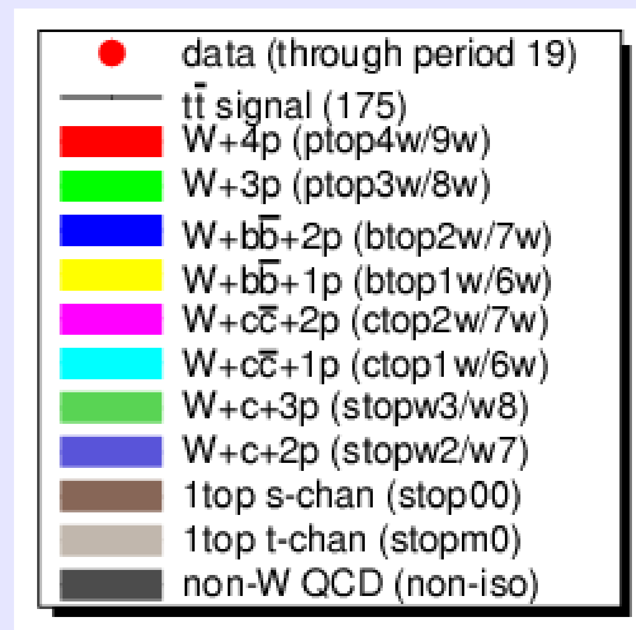


Comparison of data and MC (2)

b-tagged jets in lepton+jets up to period 19 (698 jets). MC:M(top)=175 GeV
variables shown are: jet P_T, E_T, E, and Mass. Jet Mass is bad (KS=0.01)
Low lumi sample used for ttkt75

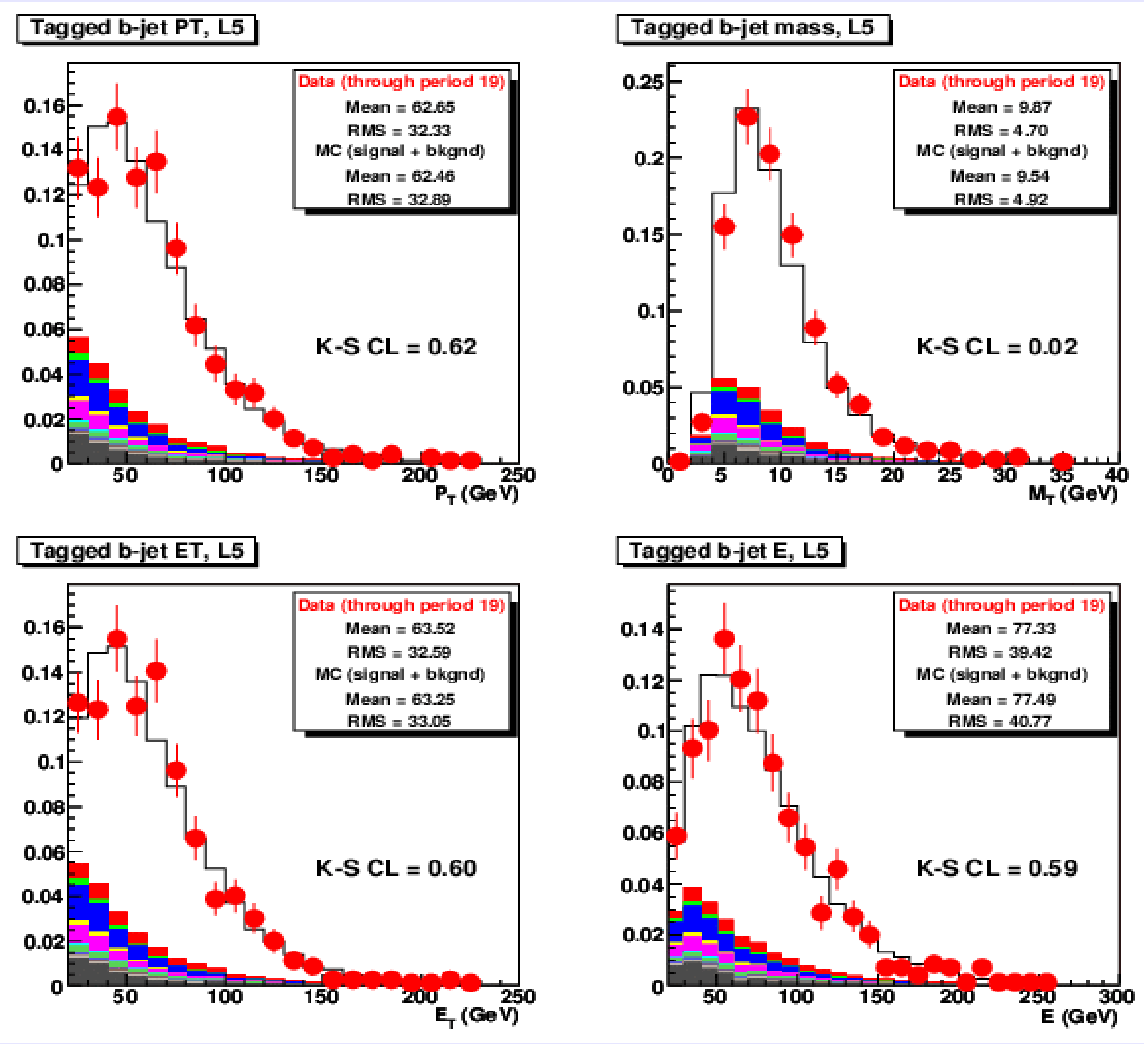


KS test shows that all distributions, except for jet Mass, agree with data



Comparison of S0-pro with b-jets data

Luminosity for data up to P19, for S0-pro up to P8

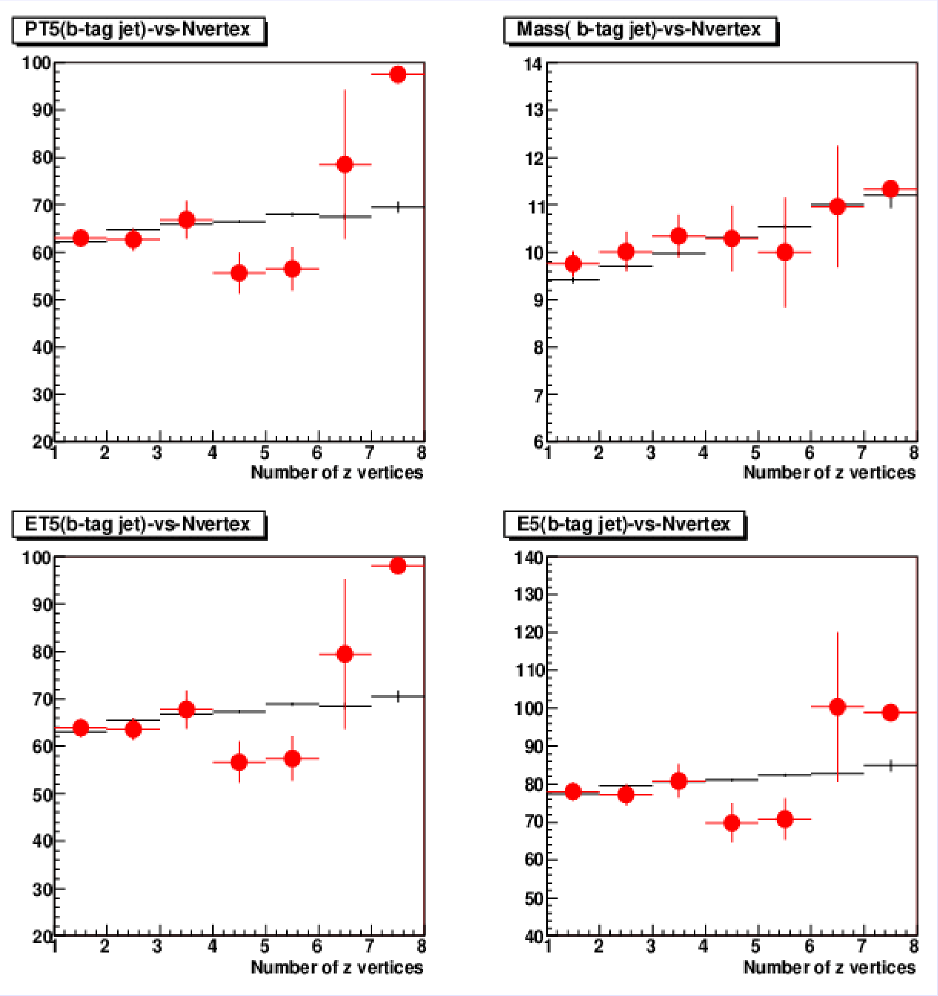


Jet PT, ET, E agree with data

Jet mass has
KS value = 0.02

Luminosity profiles

Can the bad KS for the reconstructed jet mass be due to the luminosity profile?

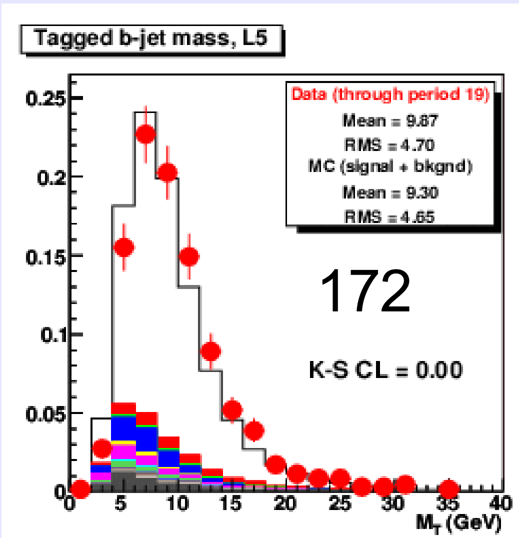


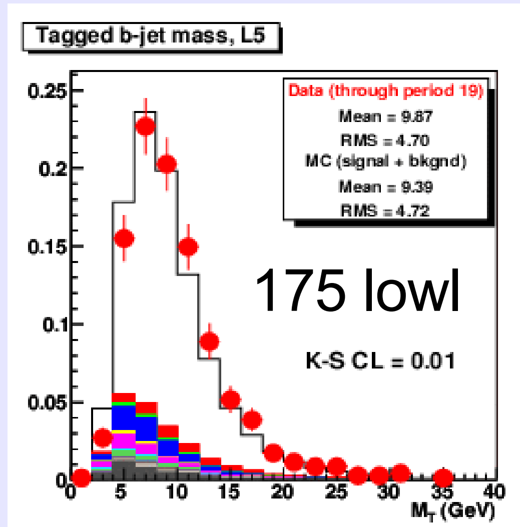
The average mass value depends on the Number of Z vertices.

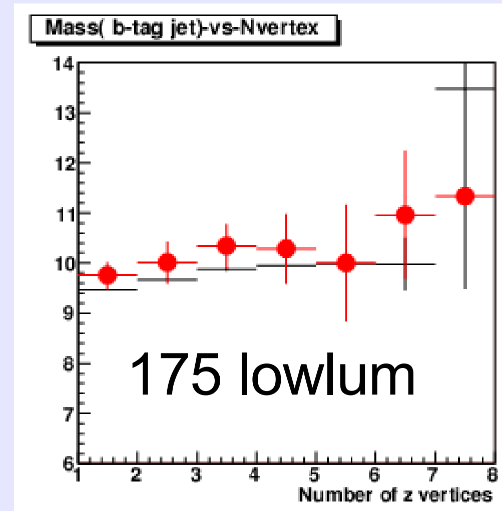
The effect is less pronounced for E_T,P_T,E of the b-jet, in both data and MC.

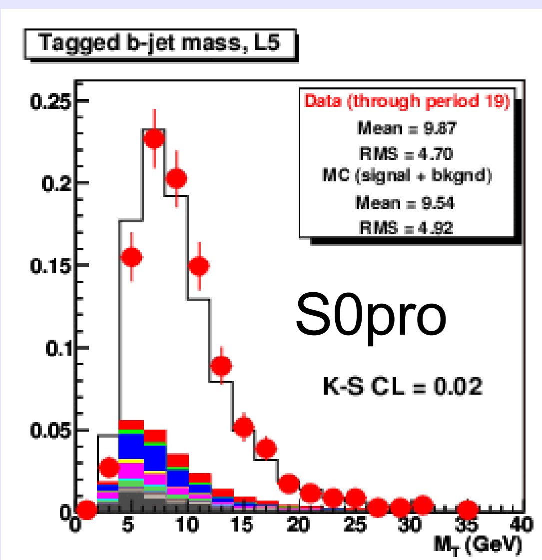
Jet Mass data and MC

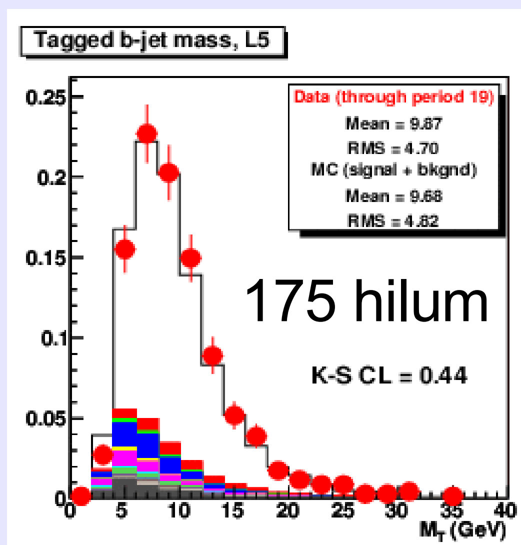
Results of the jet-mass from different samples. The hilum MC gives KS=0.44, the low lum case gives KS=0.01

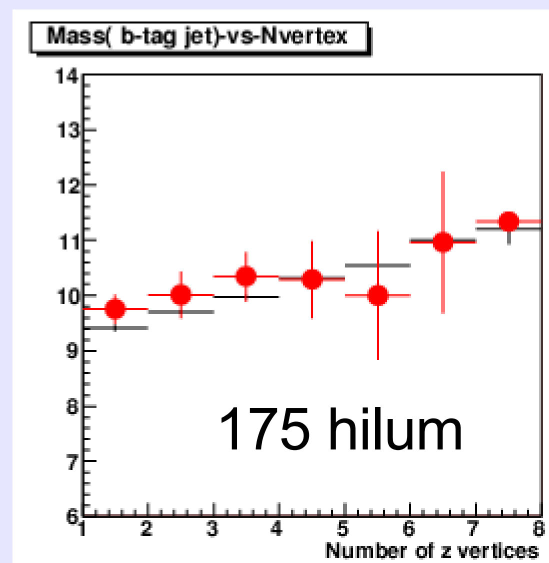






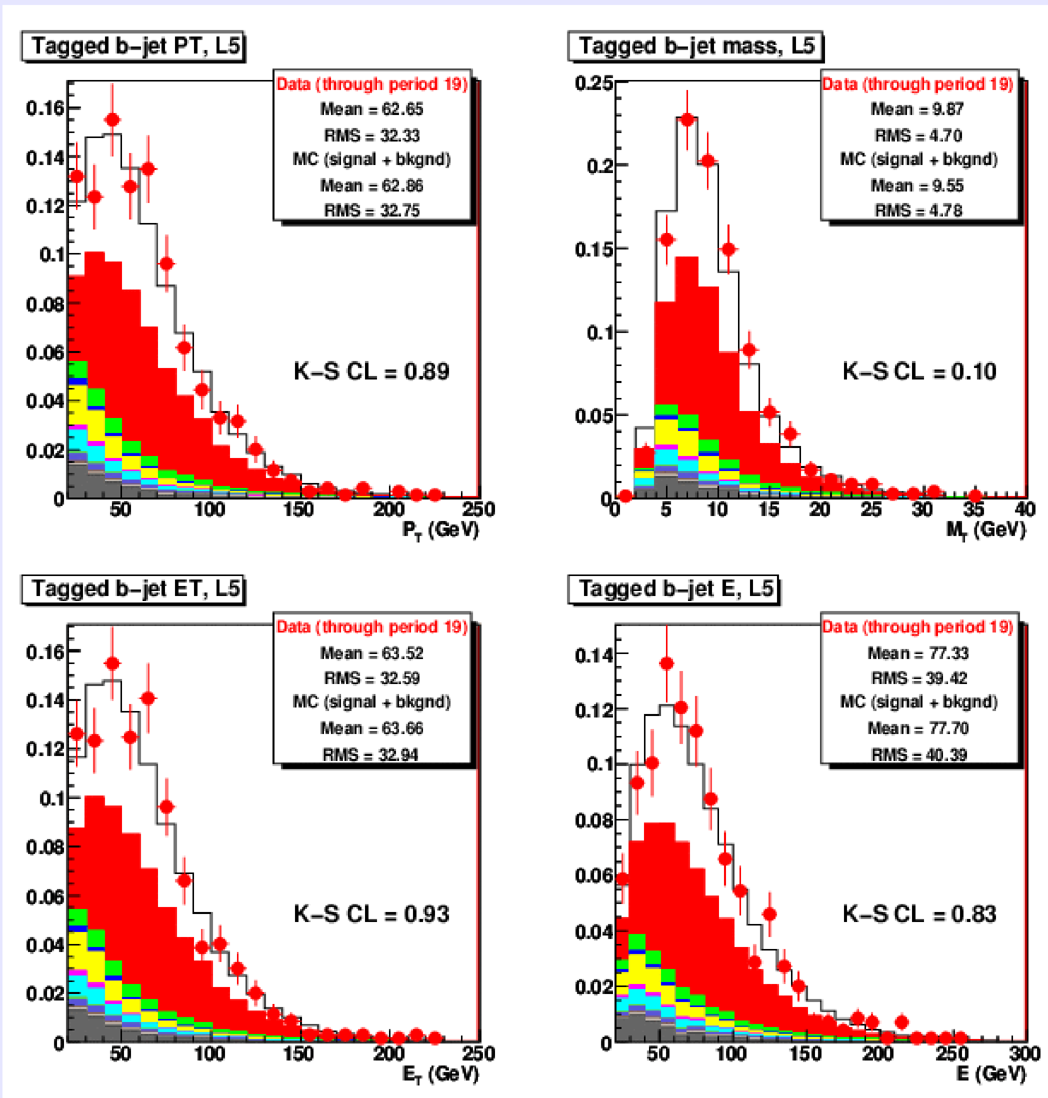


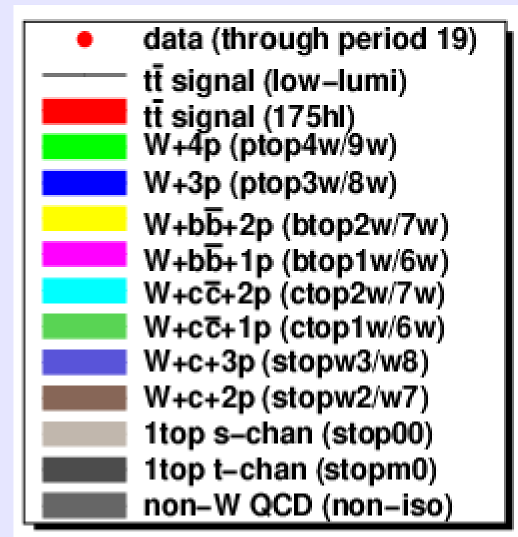




Jet Mass with better lumi profile

Using the new “preliminary” lumi profile the KS for the jet mass improves





Summary

We have compared some jet variables obtained in b-tagged jets with predictions from MC.

We do not observe deviations of the b-jets variables we looked at from PYTHIA V6.2 nominal MC, except for the jet mass.

There is a dependence of the measured jet mass on the observed number of z vertices. Taking this into account the discrepancy disappears.

WARNING: we need to use the correct lumi profile!! It is too dangerous to keep using the MC up to P8!!

Table 11: Color reconnection studies. All samples have a nominal m_t of 175 GeV/c^2 and use 16k integrated events.

Sample	Measured m_t (GeV/c^2)	Measured Δ_{JES} (σ)	Δm_t (GeV/c^2)
Nominal 6.2 (ttop75)	175.07 ± 0.22	0.01 ± 0.05	—
6.4 Tune Apro (otop45)	175.23 ± 0.22	0.04 ± 0.05	0.16 ± 0.31
6.4 Tune ACRpro (otop46)	174.83 ± 0.22	0.05 ± 0.05	-0.24 ± 0.31
6.4 Tune S0pro (otop44)	173.37 ± 0.24	0.10 ± 0.05	-1.70 ± 0.33
6.4 Tune NOCRpro (otop47)	173.73 ± 0.24	0.22 ± 0.05	-1.34 ± 0.33

From CDF-9691

MTM3 with 3.2 fb^{-1}

ΔM=0.40 ± 0.31 GeV

Some old slides as backup

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:

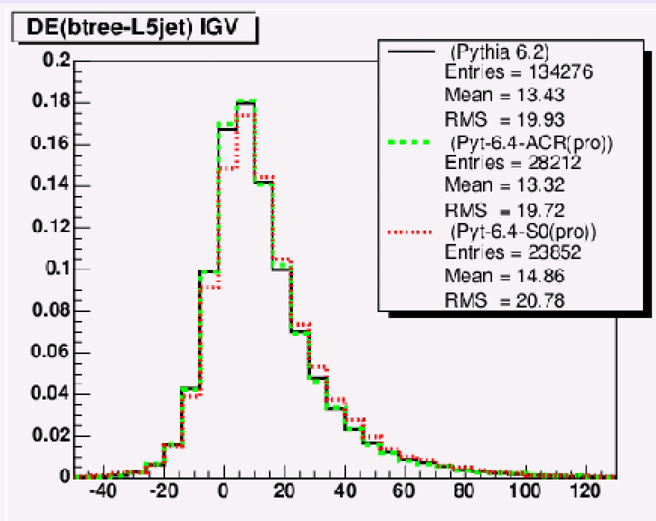
Tune ACR(pro) , which includes only the new color reconnection model, the rest is unchanged.

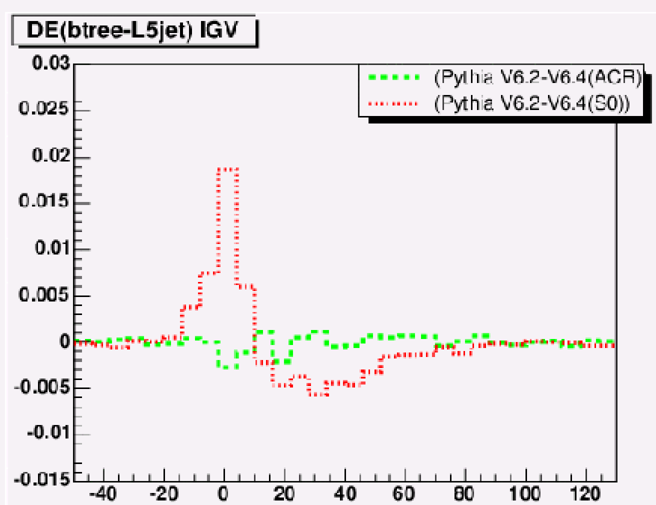
Tune S0(pro), which includes all of the above changes.

Color Reconnection systematics (2)

We have compared some jets properties after generation + detector simulation

$\delta E = E(\text{parton}) - E(\text{jet})_{R=0.4}$
$= E(\text{Out of Cone}) = E_{OOC}$





P_T = jet P_T(R=0.4) after simulation + reconstruc.
M_j = mass of jet (R=0.4) after sim+ reconstruc.
E_{OOC}= E(Out of Cone of 0.4) after matching + simulation + reconstuction

Sample	Jet Variable	W-jets	b-jets
Delta XX = PYTHIAV62 - PYTHIAV64(pro)			
ACR(pro)	$\Delta(P_T)$ (GeV/c)	-0.21 ± 0.27	-0.07 ± 0.33
ACR(pro)	$\Delta(M_j)$ (GeV/c^2)	-0.03 ± 0.03	+0.02 ± 0.04
ACR(pro)	$\Delta(E_{OOC})$ (GeV)	+0.37 ± 0.13	-0.26 ± 0.17
S0(pro)	$\Delta(P_T)$ (GeV/c)	+0.16 ± 0.30	-0.73 ± 0.33
S0(pro)	$\Delta(M_j)$ (GeV/c^2)	+0.27 ± 0.03	+0.20 ± 0.04
S0(pro)	$\Delta(E_{OOC})$ (GeV)	+0.31 ± 0.14	+1.30 ± 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 seems that the b-jets are at the origin of the discrepancy. The tuning done so far did not specifically look at heavy flavor jets. This should be done next.

In addition, since S0(pro) uses new modeling for ISR/FSR, parton shower, UE and CR, we have to investigate possible overlaps with the systematic uncertainties we are now using.

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

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

Work is in progress to compare the b-jets in top events with MC.

Procedures for MC Studies

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

What did we learn about jets?

Largest discrepancies in the "pro" files found in the variable ΔE_{OOCt}

Sample	MC samples at M = 175 GeV/c^2					
	Jets from W			b Jets		
	P_T	E_{OOC}	$\Delta(E_{OOC})$	P_T	E_{OOC}	$\Delta(E_{OOC})$
	GeV/c	GeV	GeV	GeV/c	GeV	GeV
V6.2 (nominal) (ttkt75)	56.0	4.44±0.05	–	71.6	13.00±0.07	–
V6.4 tune A (otop45)	56.5	4.69±0.11	0.25±0.13	71.6	13.16±0.16	+0.16±0.17
V6.4 ACR (otop46)	56.0	4.81±0.12	0.37±0.13	71.4	12.73±0.16	-0.27±0.17
V6.4 NOCR (otop47)	56.3	4.52±0.13	0.08±0.14	72.2	13.41±0.16	+0.41±0.17
V6.4 S0 (otop44)	56.2	4.75±0.13	0.31±0.14	72.1	14.30±0.18	+1.30±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 $\Delta R = 0.4$

Summary of jet findings

Shifts in P_T, jet mass and E in a cone of ΔR=0.4

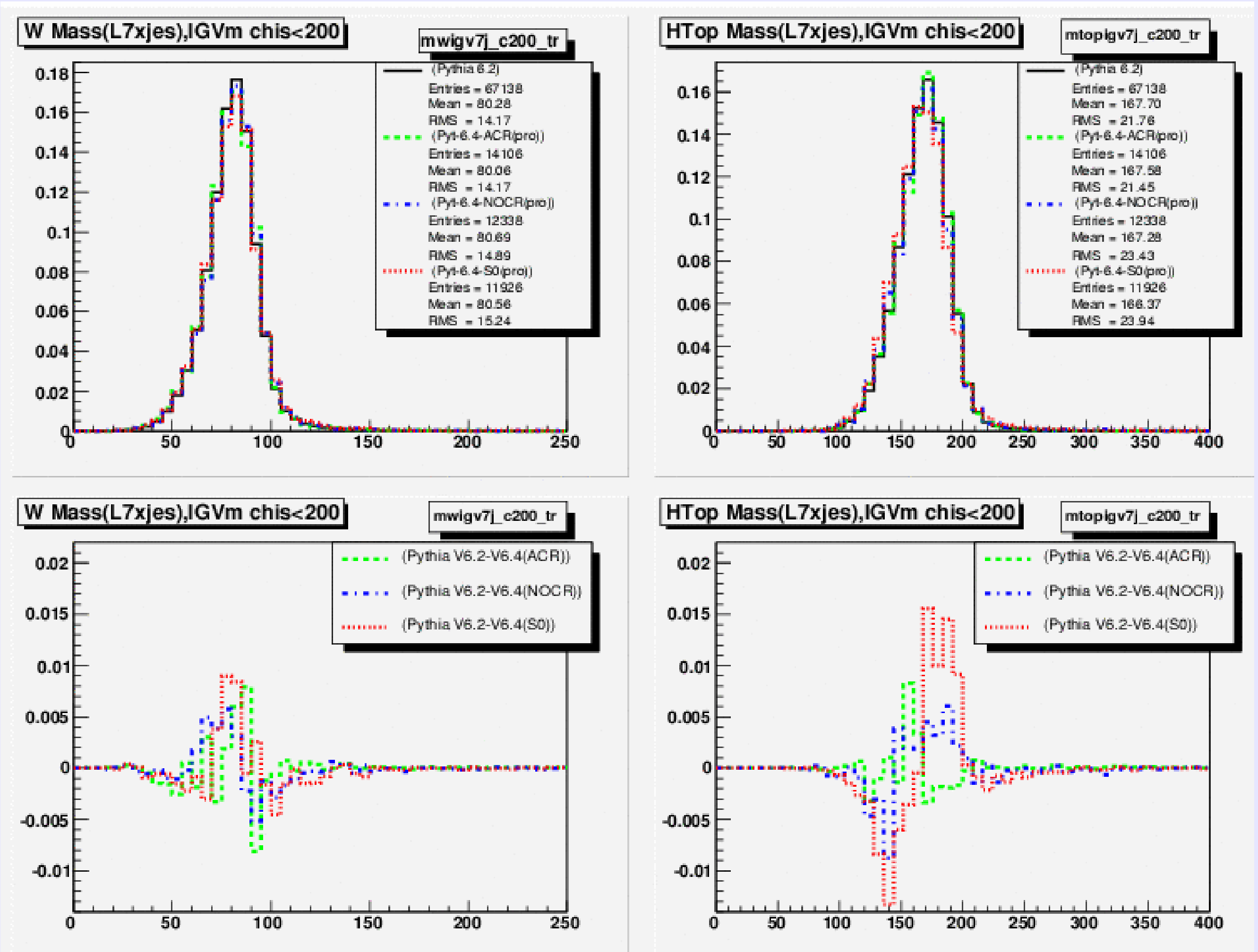
(values in red are shifted by >2σ)

Sample	Jet Variable	W-jets	b-jets
Delta XX = PYTHIAV62 - PYTHIAV64(pro)			
ACR(pro)	$\Delta(P_T)$ (GeV/c)	-0.21 ± 0.27	-0.07 ± 0.33
ACR(pro)	$\Delta(M_j)$ (GeV/c^2)	-0.03 ± 0.03	+0.02 ± 0.04
ACR(pro)	$\Delta(E_{OOC})$ (GeV)	+0.37 ± 0.13	-0.26 ± 0.17
S0(pro)	$\Delta(P_T)$ (GeV/c)	+0.16 ± 0.30	-0.73 ± 0.33
S0(pro)	$\Delta(M_j)$ (GeV/c^2)	+0.27 ± 0.03	+0.20 ± 0.04
S0(pro)	$\Delta(E_{OOC})$ (GeV)	+0.31 ± 0.14	+1.30 ± 0.19

- 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. The energy in a cone of DR=0.4 is smaller by -1.3 GeV.

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 ± 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 ± 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. , for the MTM3 analysis:
  - generator: $\Delta(m_t) = 0.51$ GeV
  - ISR/FSR: $\Delta(m_t) = 0.29$ GeV
  - OOC : $\Delta(m_t) = 0.28$ GeV
  - b-jets : $\Delta(m_t) = 0.38$ GeV

  that is, most MC related systematics (0.75 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