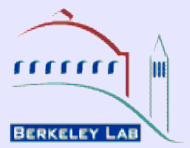




# Color Reconnection: Jet Shapes



Continuing studies on color reconnection systematics require the understanding of jets from PYTHIA V6.4

This talk: will look at jet variables and compare them to jets in top data. Only b-tagged jets are considered in this comparison.

Variables:

Jet mass

Number of charged particles

EM Fraction

Eta moments

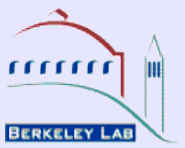
Phi moments

We have thousands of histograms. We only show a few of them.

Lina Galtieri with Paul Lujan, Igor Volobouev, Jeremy Lys + other top mass group members



# Color Reconnection: jet shapes



In the past we have shown (Lina 02/18/09) studies using **matching of partons** to simulated jets and other variables.

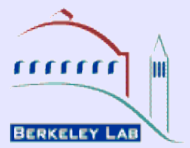
They indicate that the new PYTHIA samples V6.4, S0 tunes, generate events with wider b-jets and that the PT in a cone of 0.4 is about 1 GeV less than for the old Tune A.

Andrea Castro (01/21/09) has shown studies of **eta moments**, that confirm these findings. However, there is no agreement between data and MC for the eta moments of the b-jets for any of the tunes, except for tune S0 generated by Nathan at 170 GeV.

Hyun Su (03/25/09) **has confirmed** Andrea's findings.



# Samples used



We have looked at all the old and new samples. Too many to discuss here.

I will show results on a few of them, to illustrate the situation.

PYTHIA (tkt75) 175 GeV, V6.2.16 tune AV. Low + high lum  
APROhl (ctops1) 175 GeV, V6.4.20, tuneA-pro. Low + high lum  
ACRIhl (ctops2) 175 GeV, V6.4.20, tuneApro-CR. Low + high lum

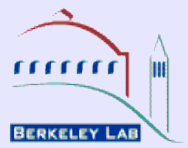
S0Pg0 (ctops3) 175 GeV, V6.4.20, S0-Perugia0  
NOCRPg0 (ctops4) 175 GeV, V6.4.20, NOCR-Perugia0

S0pro-170 (ctops0) 170 GeV, V6.4.20, S0-pro  
S0pro-175 (otop44) 175 GeV, V6.4.20, S0-pro

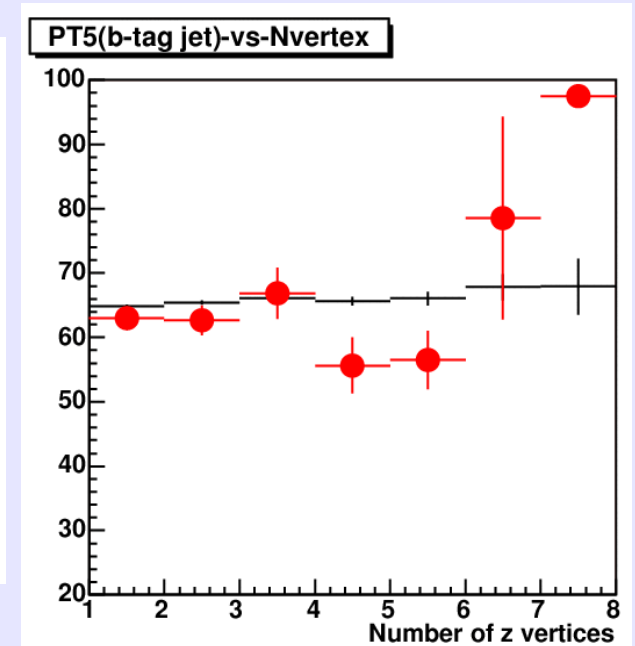
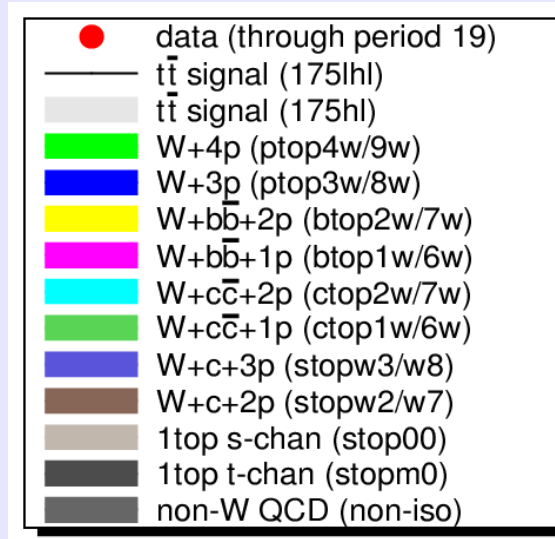
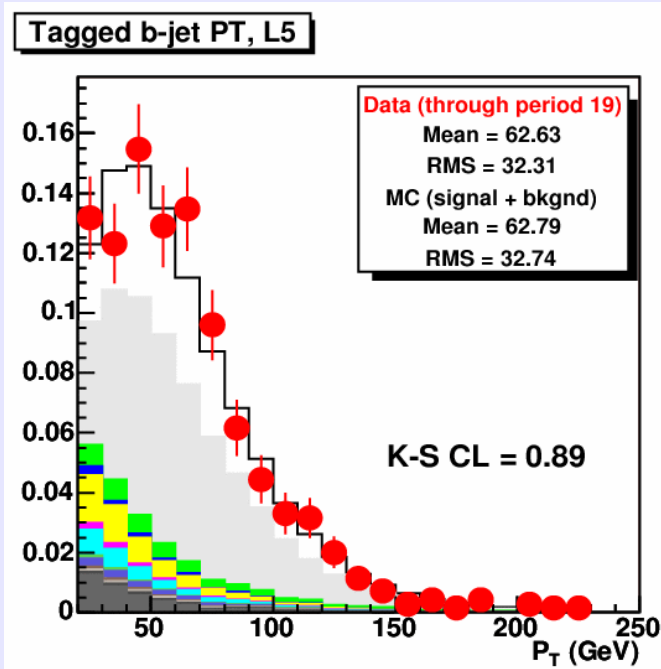
SashaA (otopt5) 170 GeV, V6.4.16 Sasha's tune A parameters  
SashaS0 (otopt6) 170 GeV, V6.4.16 Sasha's S0 parameters



# Tagged Jet PT

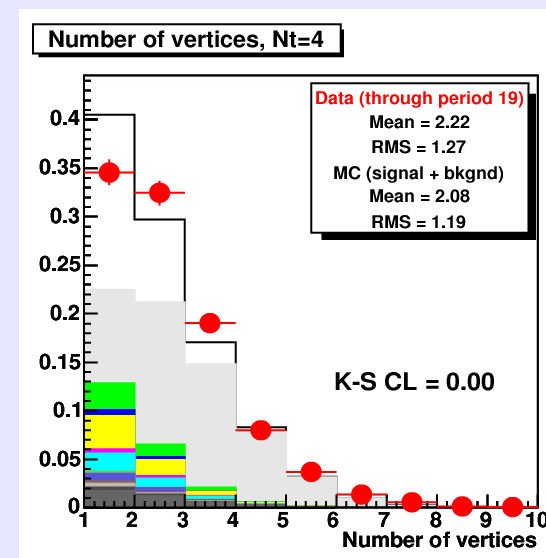
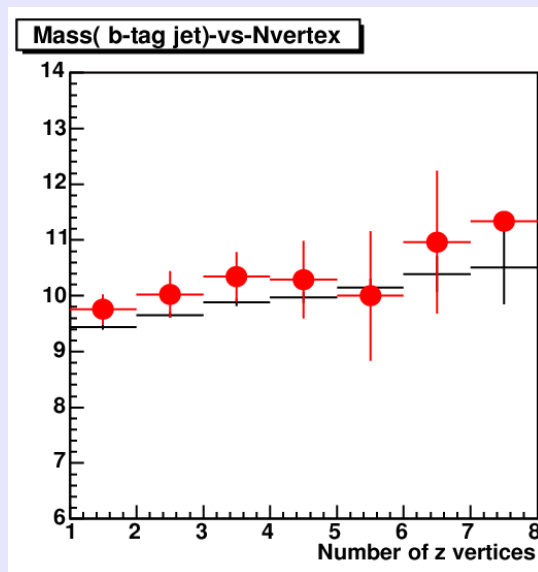
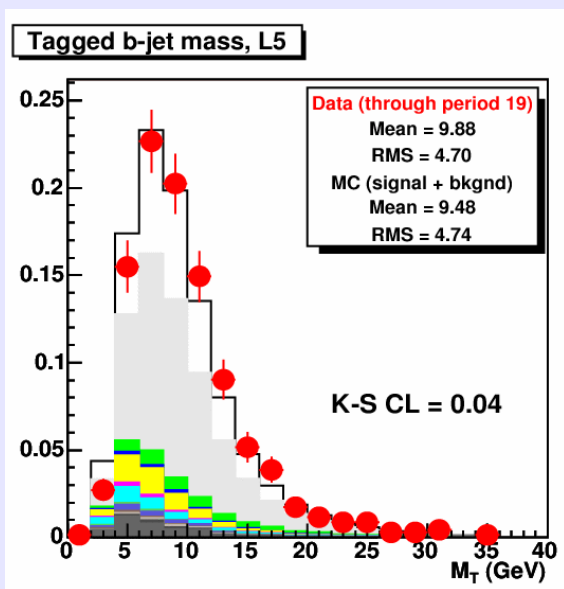


Comparison of data and MC for the default PYTHIA V6.2.  
Only events with  $N_{\text{tjet}}=4$  included



The measured jet  $P_T$  agrees with the PYTHIA tune AV which is our default. The dependence on  $N_{\text{vtx}}$  is minimal which means we are correcting the jets properly. The lumi profile is not very good, as the background luminosity is limited to P8. (see next page).

Jet mass agrees poorly with MC. Dependence on Nvtx is strong.  
 Jet corrections are based on PT, do they correct the mass properly?  
 Can we use this variable to distinguish between different tunes?

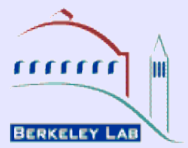


MC expects the average jet mass to vary from 9.6 to 11.0 for 1-7 vertices. We notice, however, that the data is higher than MC for the first three points where there is more data.

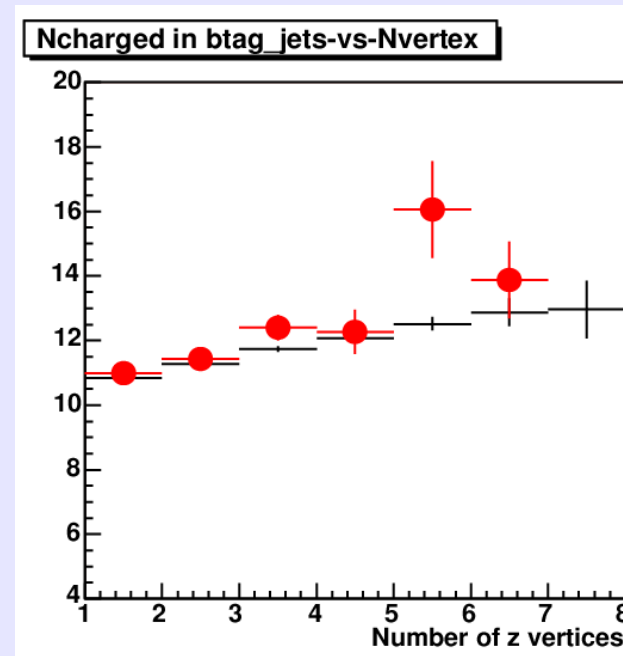
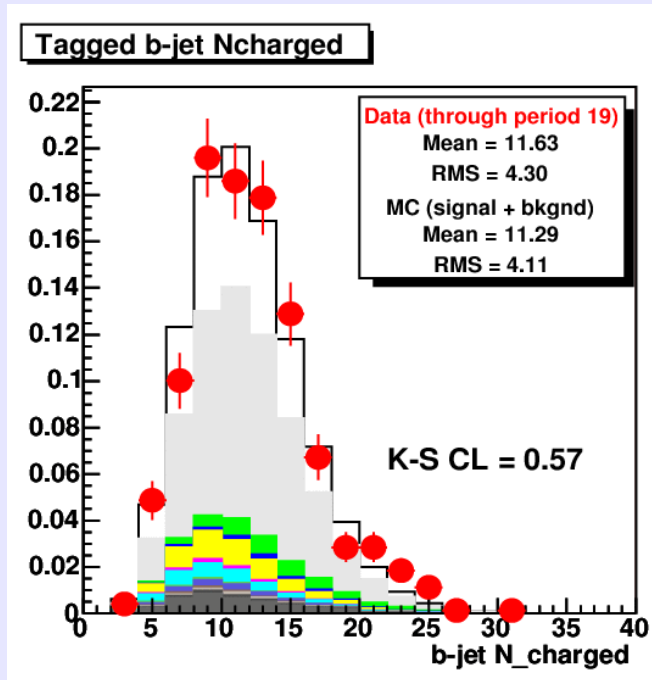
All other samples (with one exception) have a smaller KS value.



# Charged tracks in tagged b-jets



Expect large dependence on luminosity. V6.2 tune AV does well



KS values for other samples:

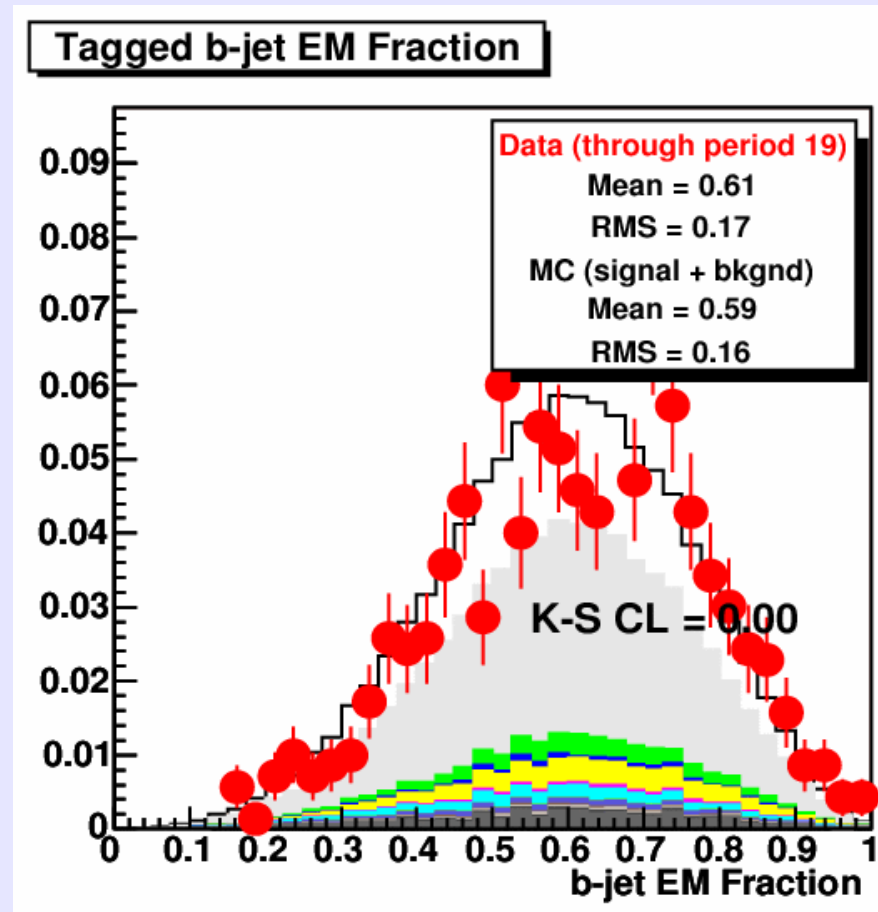
APROIhI	ACRIhI	S0Pg0	NOCRPG0	S0p170	S0p175	SashaA	SashaS0
0.13	0.84	0.18	0.30	0.04	0.20	0.00	0.06



# Jet Electromagnetic Fraction

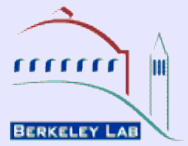


There seems to be a problem with the EMF value associated to the tagged b-jet. Needs to be investigated

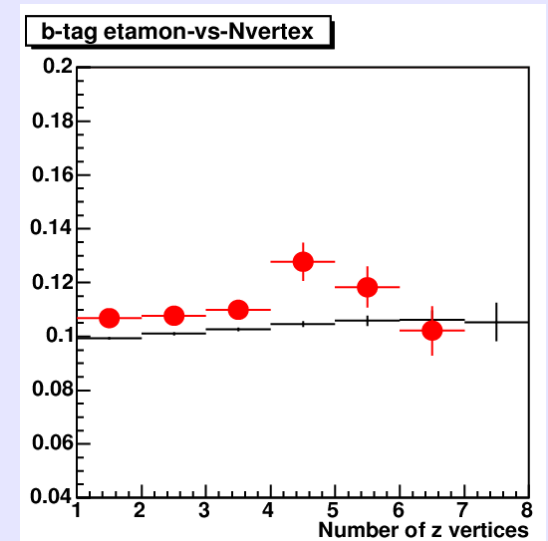
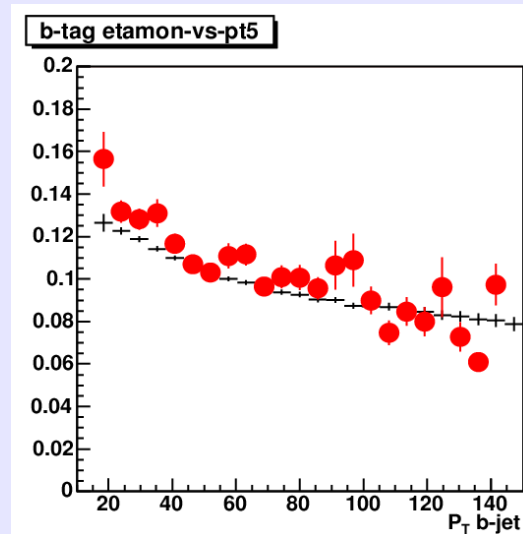
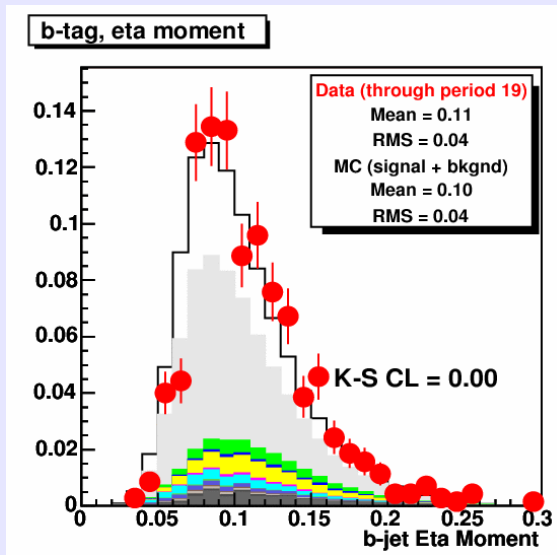




# Eta Moments for b-tagged jets



PYTHIA V6.2 , our default is shown here. As noted by Andrea and Hyunsu, they do not fit the data. Here we have not normalize to  $PT=50$  GeV, as the  $PT$  distributions for data and MC agree quite well.



The Moment dependence on  $PT(\text{jet})$  is in clear disagreement with the data and very likely is at the origin of the disagreement on the left.

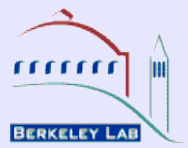
KS values for other samples:

APROlh	ACRIlh	S0Pg0	NOCRPG0	S0p170	S0p175	SashaA	SashaS0
0.00	0.01	0.00	0.00	0.02	0.00	0.46	0.21

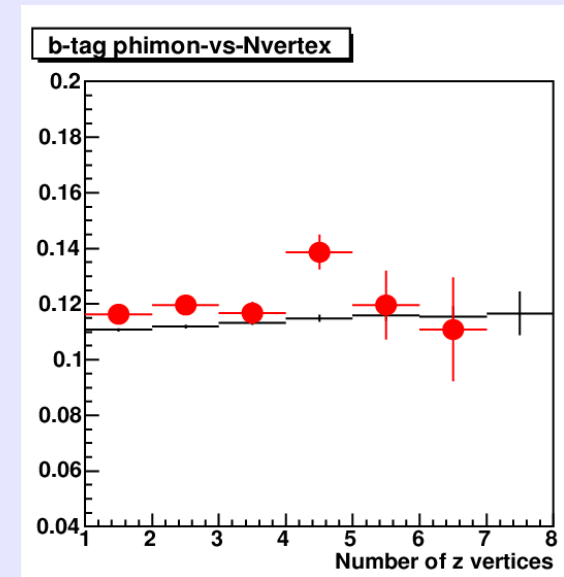
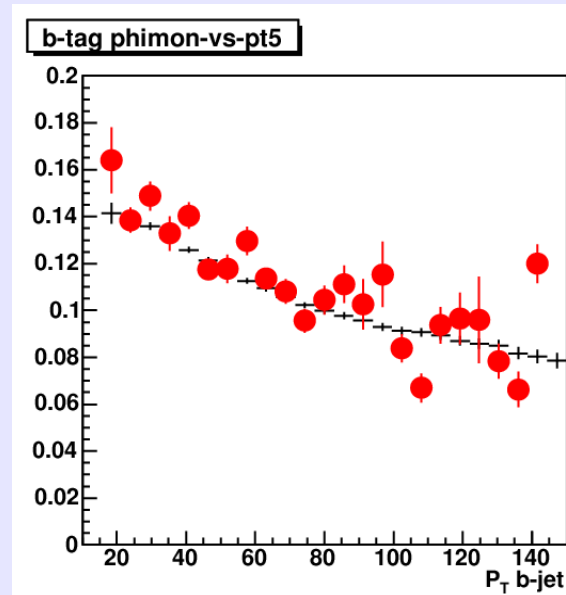
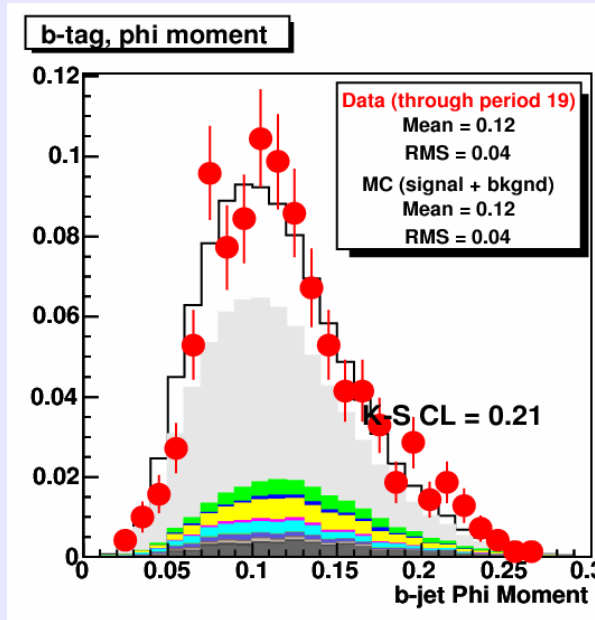




# PHI Moments for b-tagged Jets



The Moment dependence on  $P_T(\text{jet})$  has a better agreement with the data than the eta moment of the previous page. This is reflected in the KS value.

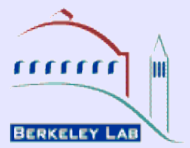


KS values for other samples:

AproIhI	ACRIhI	S0Pg0	NOCRPG0	S0p170	S0p175	SashaA	SashaS0
0.10	0.47	0.26	0.24	0.73	0.37	0.96	0.55



# Summary



Color reconnection systematics depend on the Version of PYTHIA and Tunes used.

We have looked at a number of variables to explore the possibility to distinguish between different PYTHIA tunes by making comparisons with the b-tagged jet data.

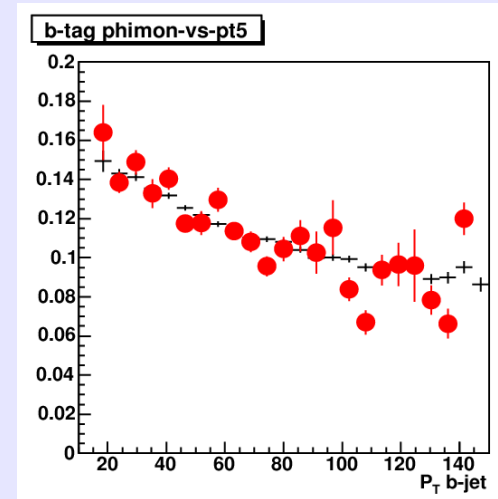
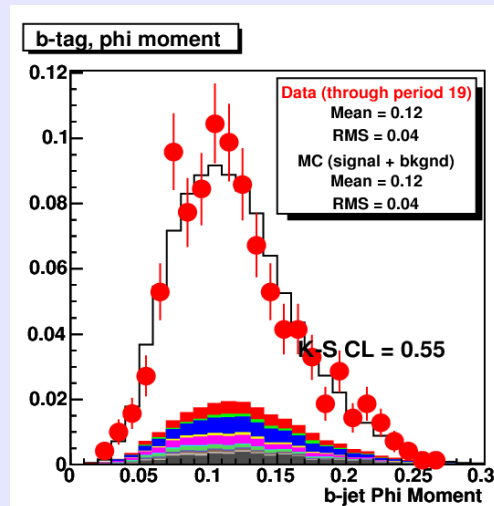
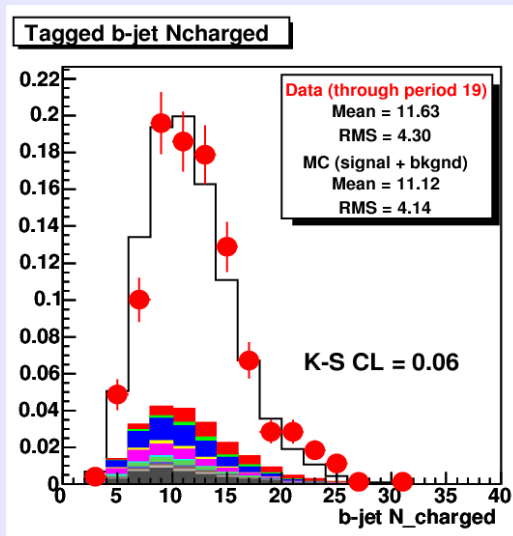
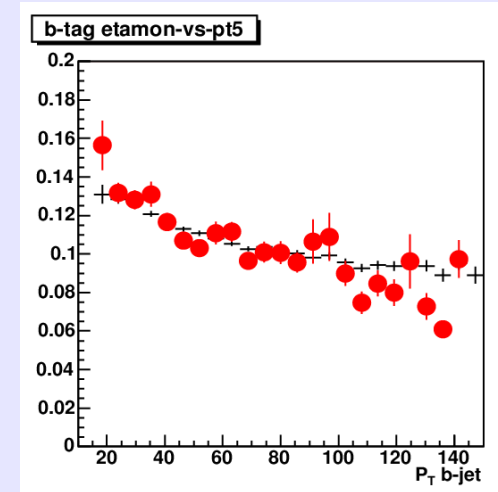
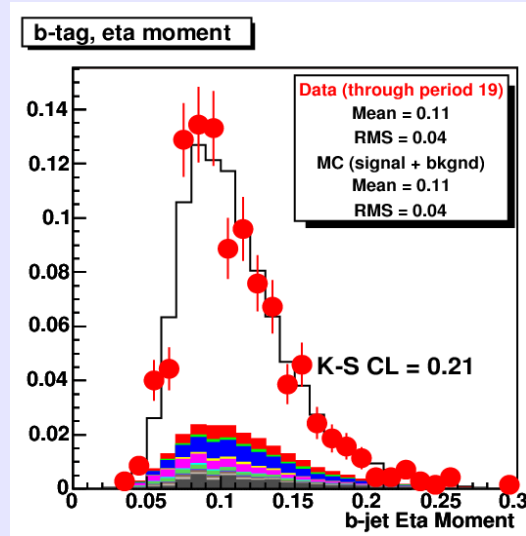
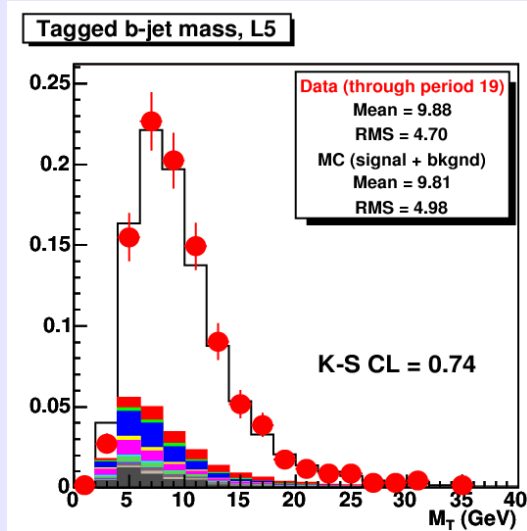
At this point we have 698 b-tagged jets in l+jets with  $N_{\text{tight}}=4$

The top Mass, Ncharged, Eta Moment and Phi Moment seem to be possible variables to use.

It is not clear at this point how to choose between the different tunes as none of the ones considered fair well on all of these variables. We need to do additional work to understand the situation.

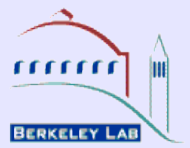
More plots on Sasha's samples follow

## Plots of 4 variables





# Sasha's samples (2)



By looking at the previous plots one conclusion could be:

The longitudinal fragmentation for the b-jets is different than that for the other samples. This improves the PT dependence of the eta moments, as well as the integral.

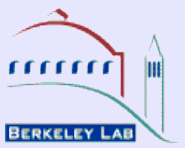
It is not clear if the jet mass improvement with respect to the other samples has the same origin.

We have also looked at the S0-pro moments at 170 GeV. As shown in the KS values on page 8, the eta moment disagrees with the data, so it is not a question of which top mass we are looking at.

**MORE WORK NEEDS TO BE DONE!!!!**



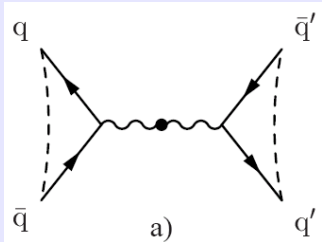
# Back Up Slides



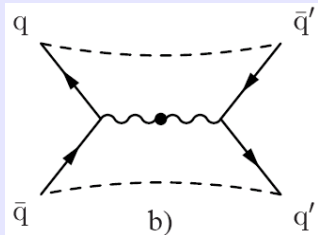
Strong color correlations between the hard process and the underlying event are implied by tune A and similar tunes. These effects may be interpreted as sign for color reconnection.

The issue has been studied at LEP for the  $W$  mass measurement

## LEP



CR effects on the  $M_W$  measurement at LEP contribute to systematics

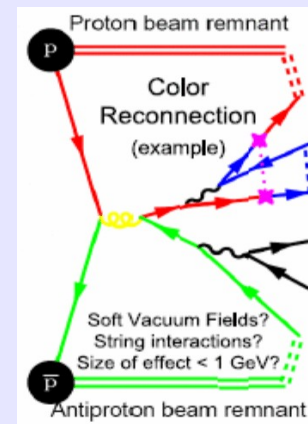


CR(sys) = 8 MeV  
out of 22 MeV (total sys)

(LEPEWWG hep-ex/061203)

## Tevatron

Preliminary MC studies have indicated possible contributions



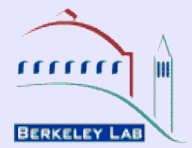
to the top mass systematics of order

CR(sys)  $\approx$  0.5 GeV

D. Wicke and P. Skands arXiv:0807.3248V1



# Comparison of Different MC Versions

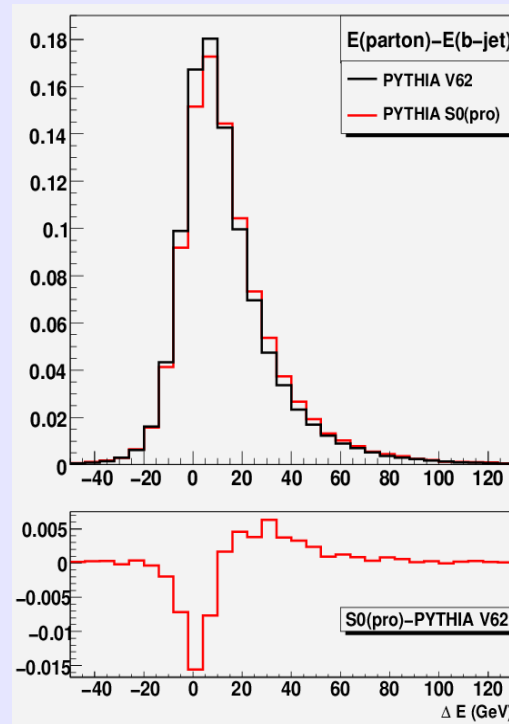
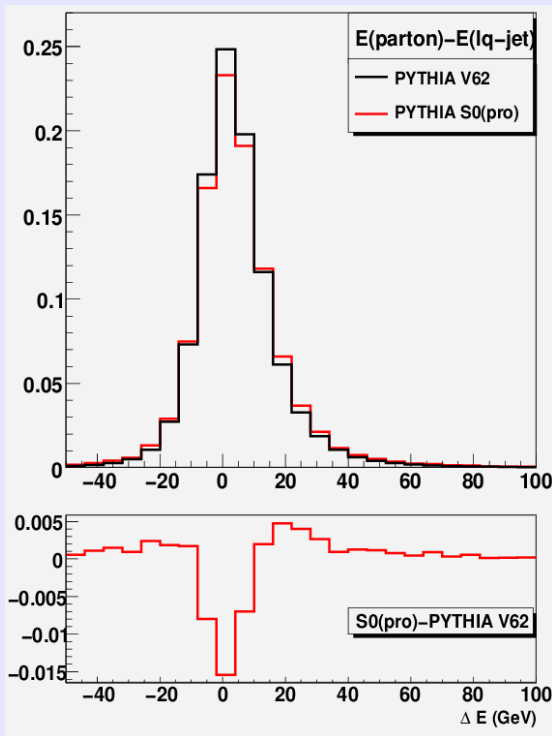


We have compared jet properties after generation + detector simulation. Preliminary studies find the ACR(pro) jets agree with PYTHIA V6.2, but:

**E ( $\Delta R=0.4$  cone) S0 sample < E ( $\Delta R=0.4$  cone) PYTHIA V6.2 sample**

Light quark jets

b-quark jets



Jets in the S0(pro) sample are wider and shifted

S0(pro) -Nominal

$\Delta E$  (cone) GeV

W-jets  $-0.38 \pm 0.15$

b-jets  $-1.43 \pm 0.15$

**Energy in the cone affects the top mass directly. Studies are continuing**