Update on PYTHIA V6.4 tunes

Trying to understand the new tunes

Investigating the new parton shower properties

1. Is there more gluon radiation in the events?

2. Are the jets shapes different?

Looking at some jet properties to see if the new tunes fit the data better than our default PYTHIA V6.2.

Data up to P23 (N(tagged) >=1)
739 events (880 jets) in the N(tight) = 4 sample (21 % back.)
1367 events (1450 jets) in the N(tight) = 3 sample (36% back)

Comparison of jet variables MC- Data

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

We have looked at jet variables and compare them to jets in top data.

Top events in the l+jet channel have four jets. Since b-jets and light quark jets have different shapes, we can compare data and MC only for b-tagged jets.

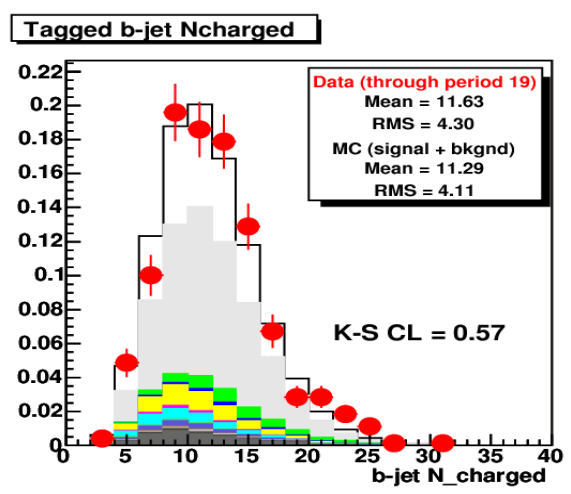
Variables:

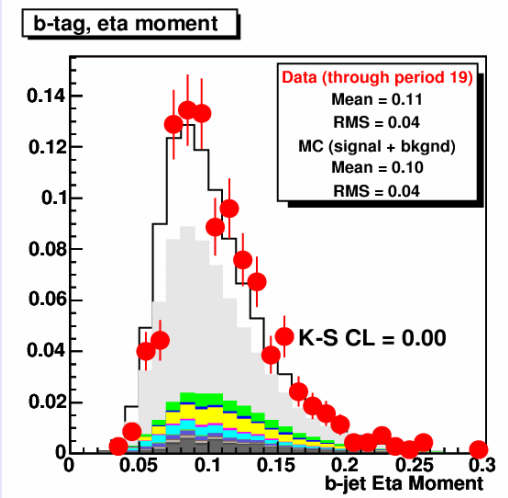
- PT of b-jets
- Number of charged particles
- Eta moments
- Phi moments

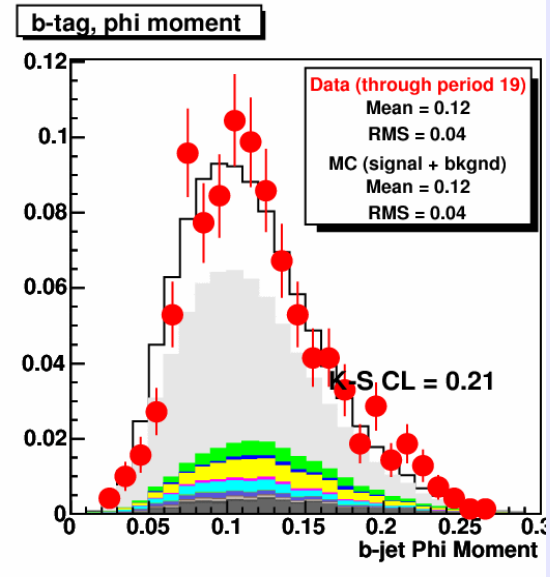
We have many histograms. I only show a few of them.

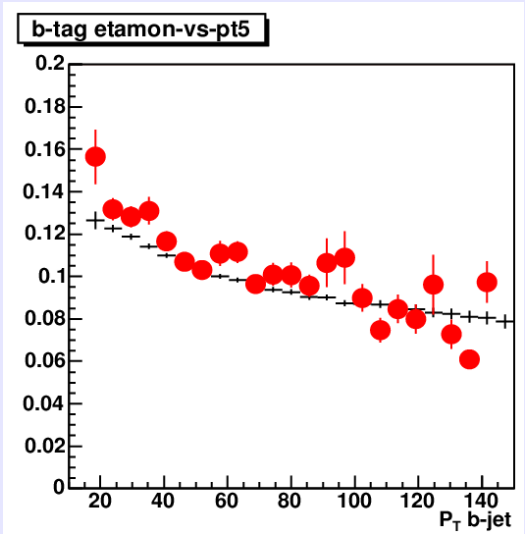
Jet Shapes Variables in b-jets (to P19)

V6.2 tune AV comparison of N(charged) in cone and φ and η Moments to P19









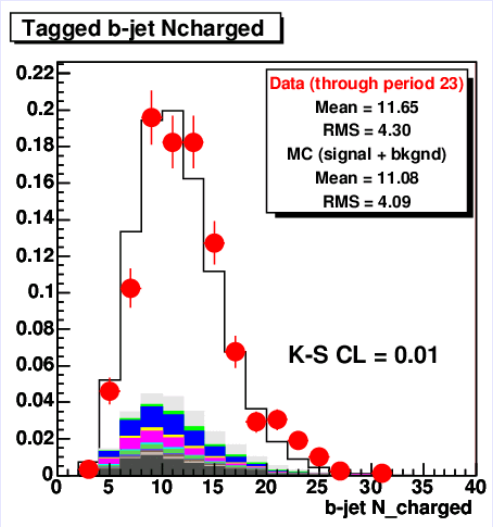
PYTHIA 6.2 agrees quite well with data for the N(charged) variable.

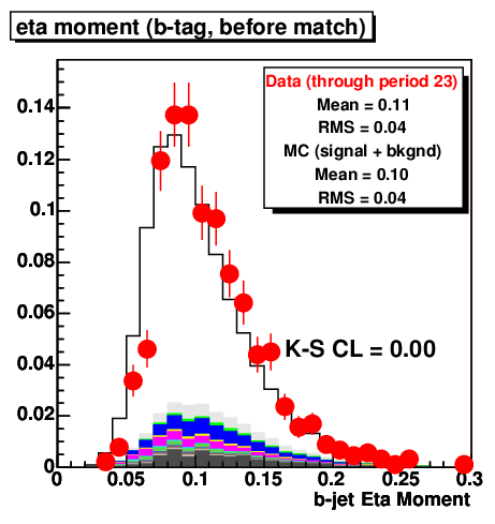
For the moments distributions, we have not normalized to 50 GeV, as the PT distributions for data and MC agree quite well and we are using only one mass point (175 GeV).

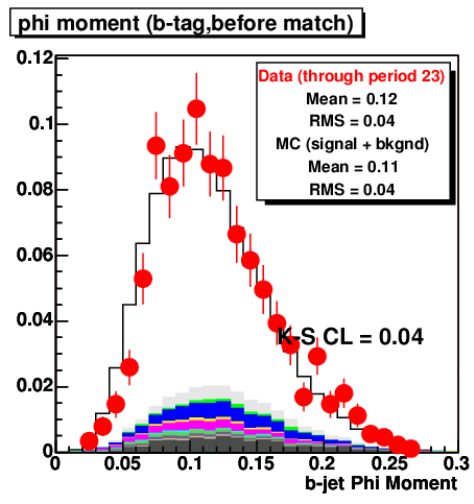
The φ moments agree well with the data.
The η moments do not agree at all as already observed by Andrea and Hyunsu. The Moment dependence on P_T(jet) is in clear disagreement with the data

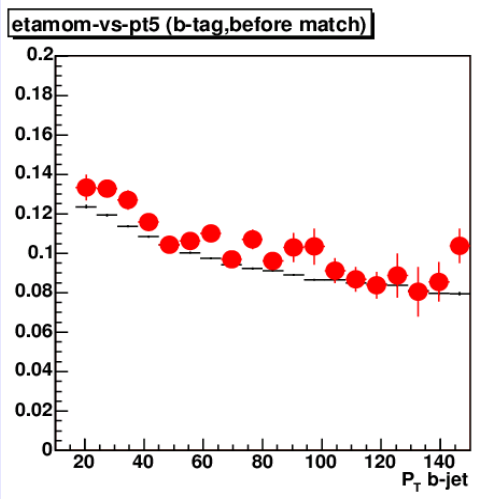
JETS up to P23

V6.2 tune AV comparison of N(charged) in cone and φ and η Moments
Only P0-P8 shown for the MC was used, same plots as previous page









N(charged) went from
KS= 0.57 to 0.01

φ Moment went from
KS=0.21 to 0.04

CLEARLY MC AND DATA SHOULD HAVE THE SAME LUMINISITY PROFILE

Comparison with other tunes to P19

Plots shown are for the default PYTHIA V6.2. The agreement is quantified by the KS value. A summary of the values for many samples is shown below.

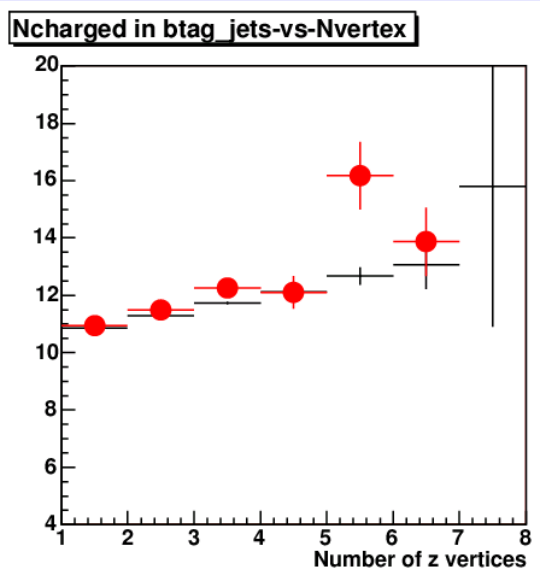
	V6.2-AV	Aprolhl	ACRlhl	S0pro	NOCRPg0	S0Pg0
b-jet PT	0.89	0.86	0.89	0.65	0.86	0.90
ET1 (b-tag)	0.85	0.71	0.74	0.93	0.85	0.88
N(charged)	0.57	0.13	0.84	0.20	0.18	0.30
η moments	0.00	0.00	0.01	0.00	0.00	0.00
φ moments	0.21	0.10	0.47	0.37	0.24	0.26

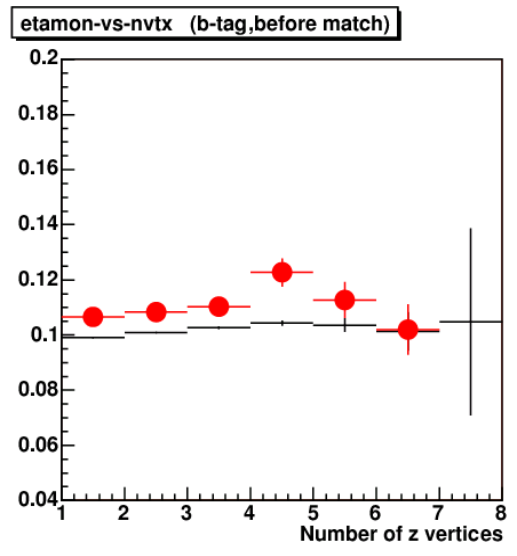
It is not clear on how to choose between the different tunes as none of the ones considered fair well on all of these variables. We need to do additional work to understand the situation. The S0 tunes MC was to P8.

Additional studies are being done and are now URGENTLY needed.

- quark jet shapes in di-jets events
- b-jet studies in di-jet events

Dependence on Nvertex

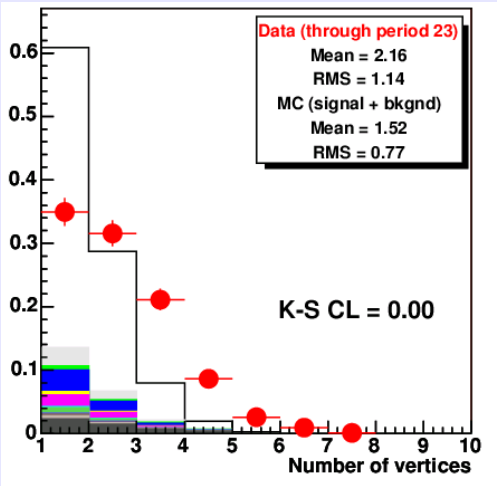




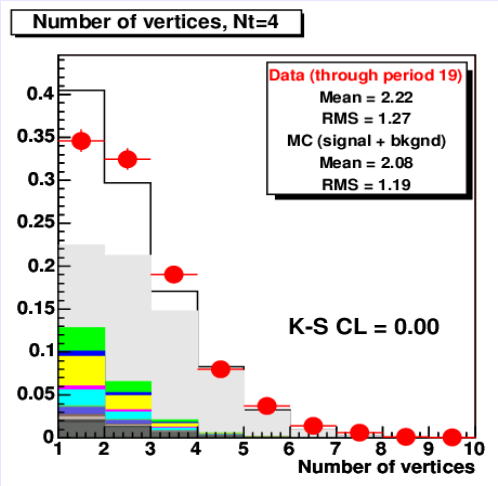
All data shown here is at Mt=175 GeV.
There is a strong dependence of N(charged) on Nvtx, as expected

The dependence of the moments on Nvtx is less pronounced, but it is there just the same, as we are adding towers without correction, whereas the jet ET is corrected.

MC to P8, data to P23



MC to P17, data to P23. Added with factor

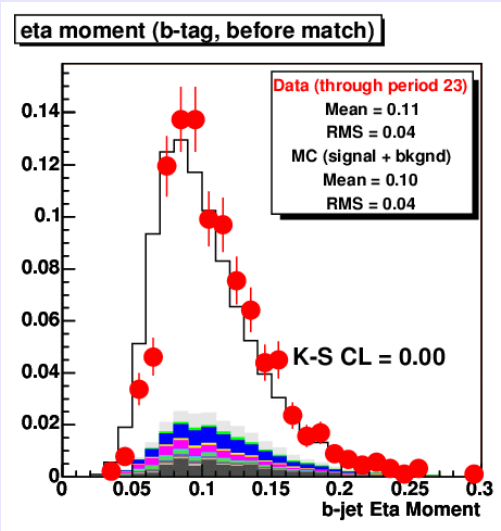


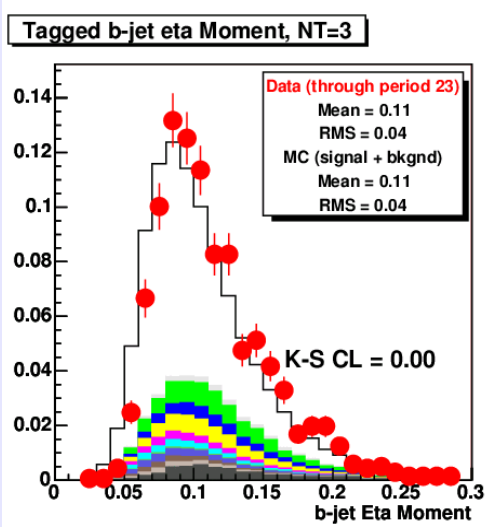
To understand these variables we need to have the correct luminosity profile for signal and background.
The S0 tunes have no high lum data for a mass of 175.

This means using the 172.5 MC samples

Problems with η and φ Moments

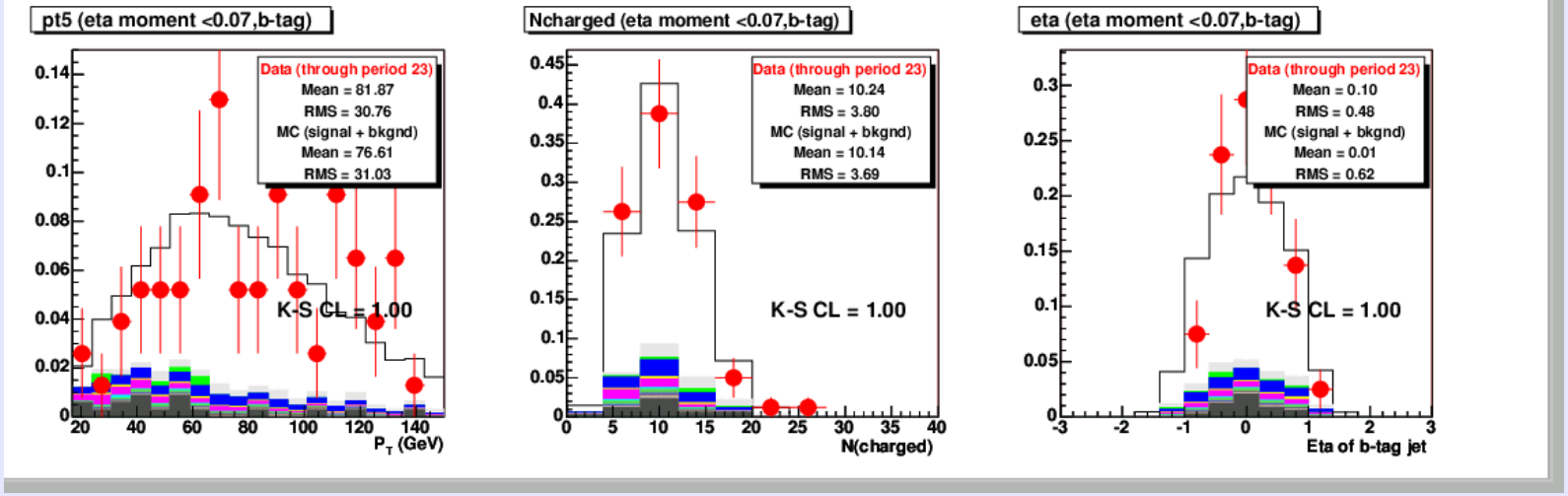
Bins below M(eta)=0.07 are low. Any detector effects ?





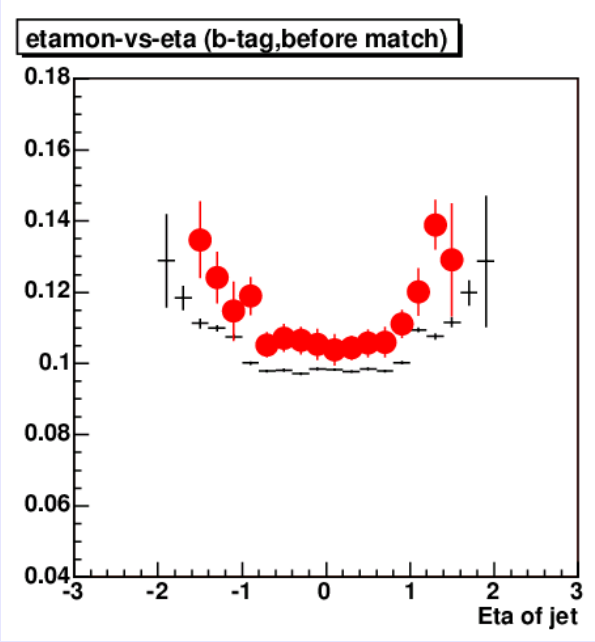
Look at PT jet, Ncharged, eta jet.

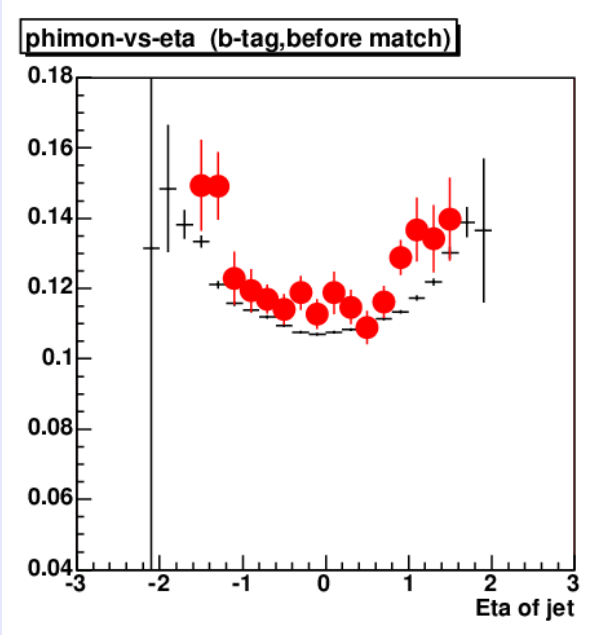
Add the Ntight =3 for statistics



Problems with η and φ Moments

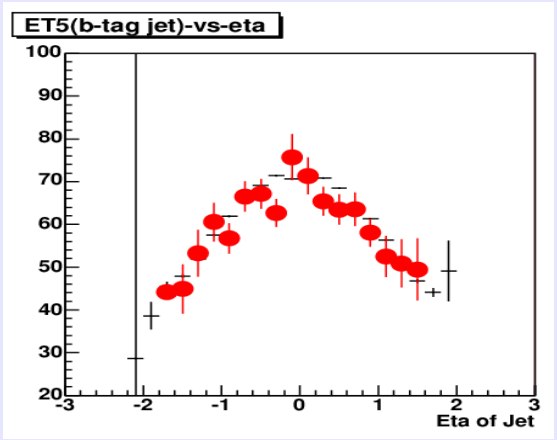
Large eta dependence for both eta and phi moments

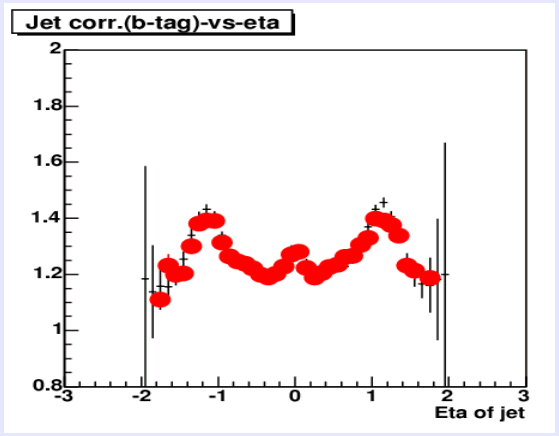




Add the Ntight =3 for statistics

This is also the behavior of the Ntight=3 jets.





Jet Et agrees with MC. Also the jet correction, as expected

Summary

Doing some studies to understand the PYTHIA V6.4 jets

Will not show results today, as we need to analyze each sample with a realistic luminosity profile

If the jets fit the data better we have to consider adding a systematic uncertainty due to the fact that the parton shower in PYTHIA V6.4 fits the data better

This systematic uncertainty could be as large as 1.5 GeV, or we need to sort out the many effects that come into this shift.

TO BE CONTINUED

What we have learned

The S0-Perugia 0 events differ from the PYTHIA V6.2 events in a number of ways:

- Events have more tight jets
- About 58% of the events have non-matching jets (compared with 68%)
- Events have less b-tagged jets in the N(tight)=4 sample

Jet Properties:

- The matching jets (light quarks and b quarks) have different energy in the cone of 0.4 then PYTHIA V6.2. This is at the origin of a large top mass shift
- The no-matching jets have more N(charged) particles in the jet
  - The eta moments and phi moments of the non-matching jets point to more radiation in the events

Eta Moments in PYTHIA V6.2

There are a number of holes in eta, larger then the holes in phi. We see that the moments are smaller in eta than in phi for this reason. Maybe the MC does not have all the holes properly reproduced

Top Mass Measurement and CR

Backup slides

Jet Shapes:moments

The eta and phi moments are sensitive to the width of the parton shower. We use calorimeter (both electromagnetic and hadronic components) information to evaluate the moments

We sum over all towers:

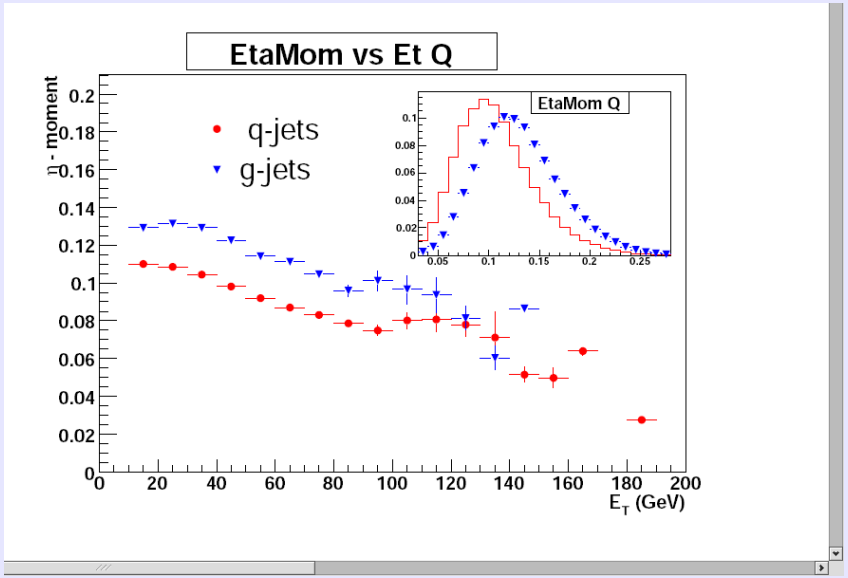
$$M_\eta \equiv \sqrt{\sum_{towers} \frac{E_T^{tower}}{E_T^{jet}} \eta_{tower}^2 - \eta_{jet}^2}$$

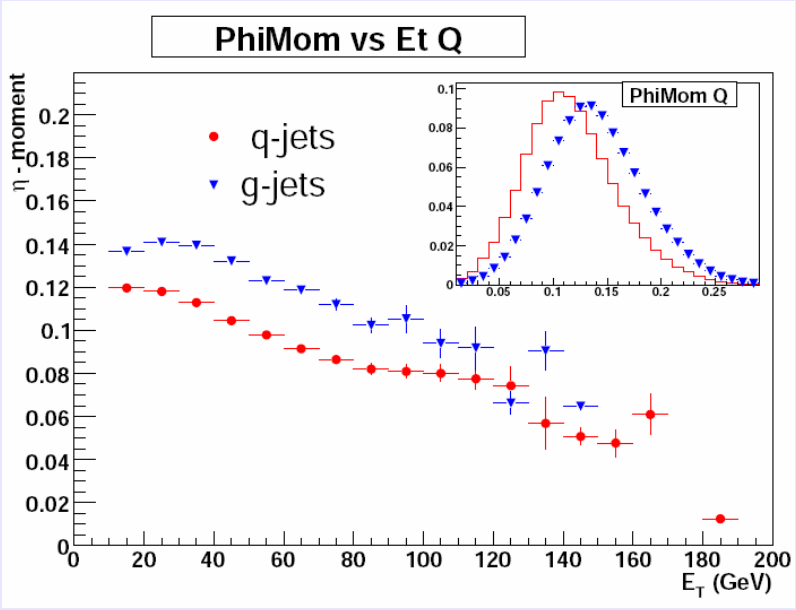
And similar expression for the phi moments,

Used in CDF to distinguish quark jets from gluon jets in ttbar production in the 6 jets topology

Moments for quark and gluon jets

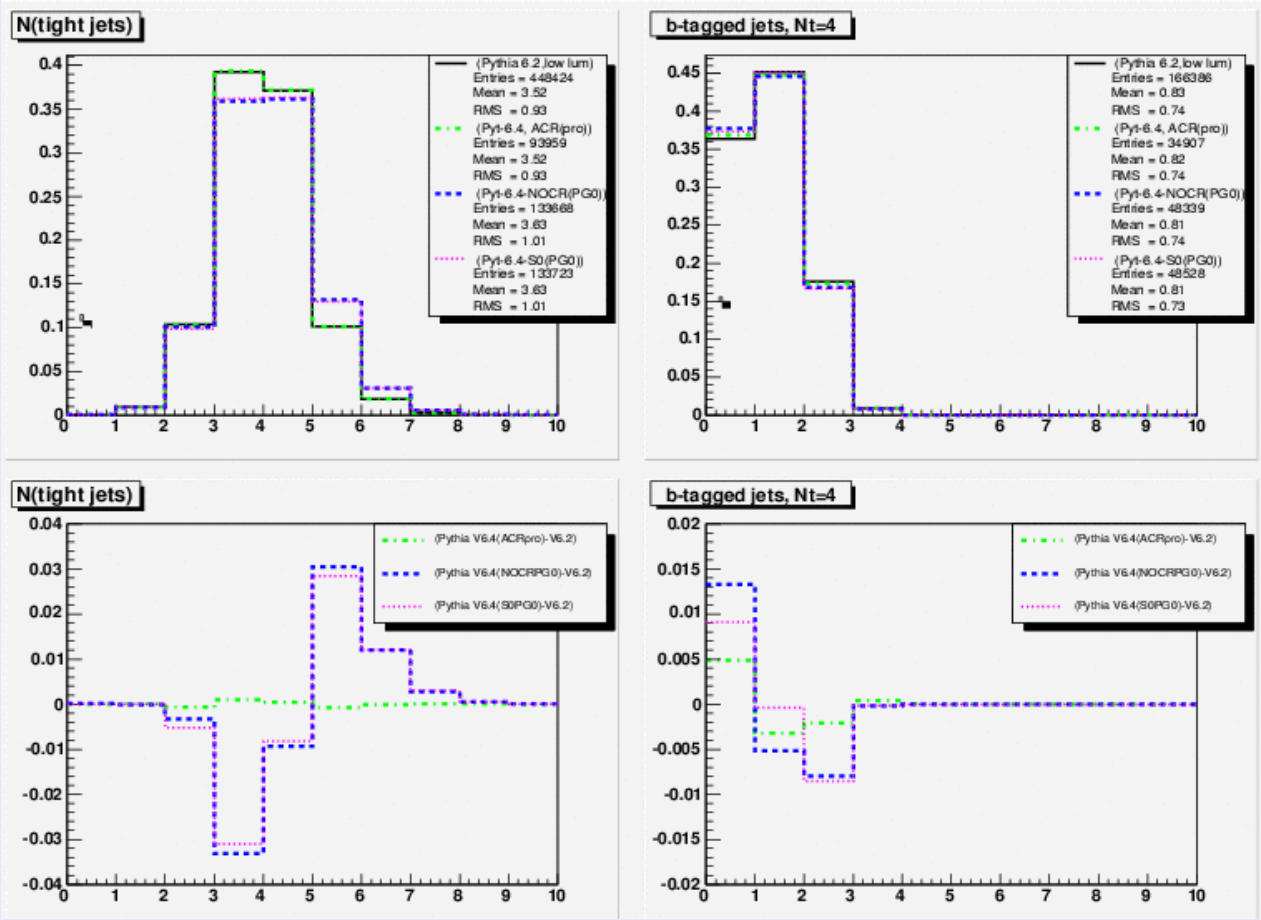
From Brigliadori, Castro, Margaroli's work we have the Expected moments for light quarks and gluons.





Matching studies: more ISR?

Comparison of Number of tight jets in the Perugia0 and PYTHIA V6.2.
Also comparison of number of tagged b jets in the N(tight)=4 sample



Matching events:

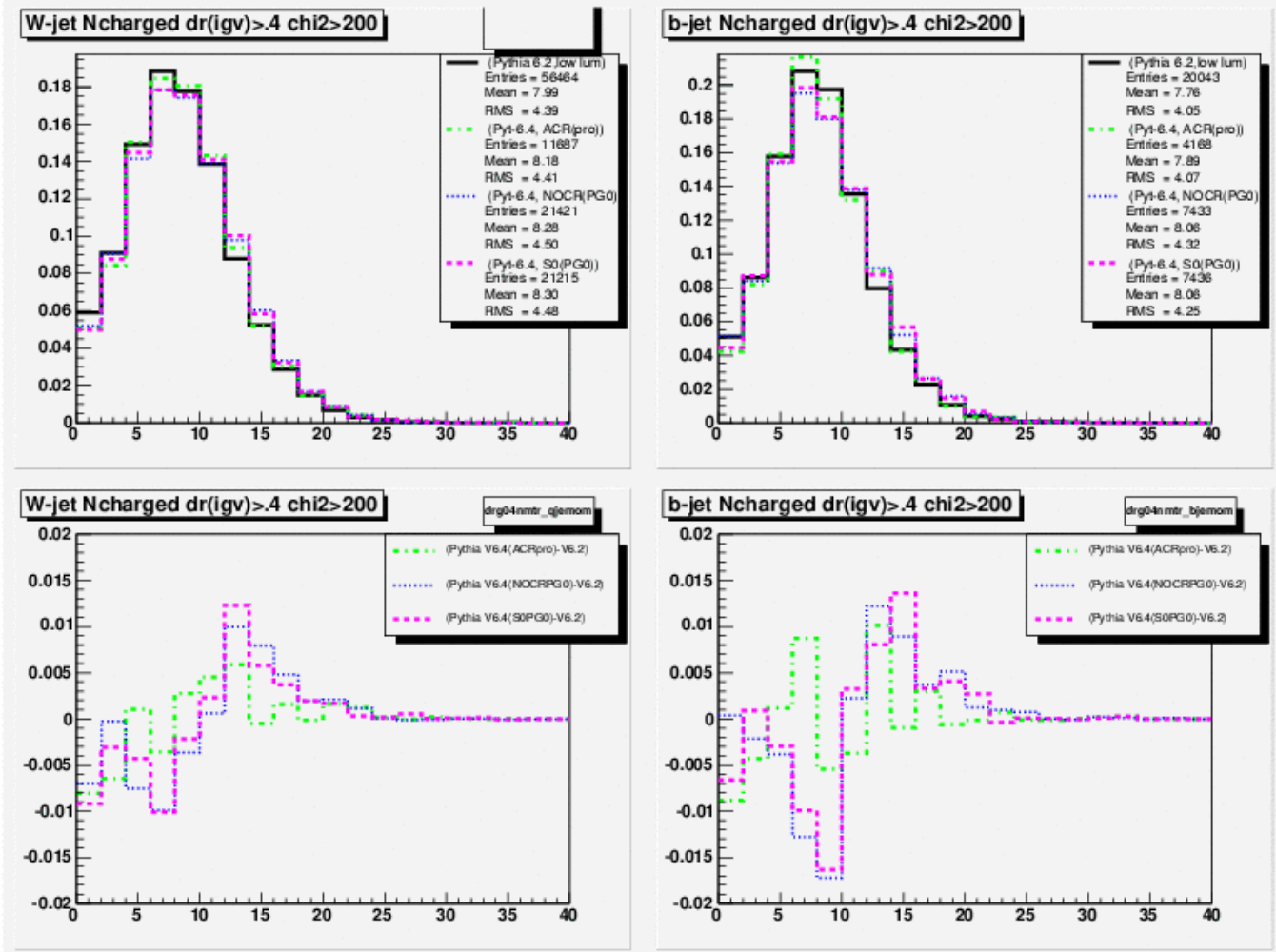
V6.2 (tune A)	68%
V6.4 ACR	68%
V6.4 NCR-Pg0	59%
V6.4 S0-Pg0	59%

Perugia0 :
- Less matching
- More N(tight)
- Less b-jets in 4 jet sample

These findings point to more ISR in the S0-Perugia0 samples

No match-jets properties: N(charged)

Comparison of Ncharged in no-matching jets for light (left) and b jets



V6.2 (tune A)
V6.4 ACR
V6.4 NCR-Pg0
V6.4 S0-Pg0

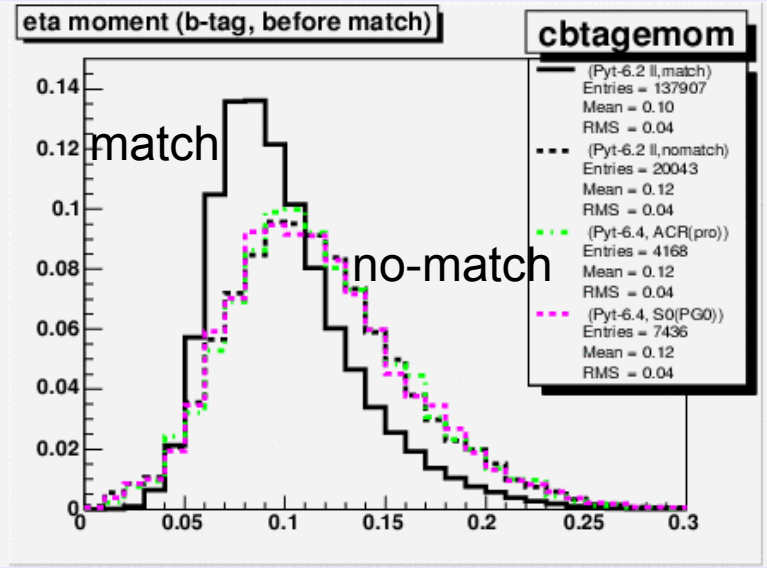
S0-Perugia0:

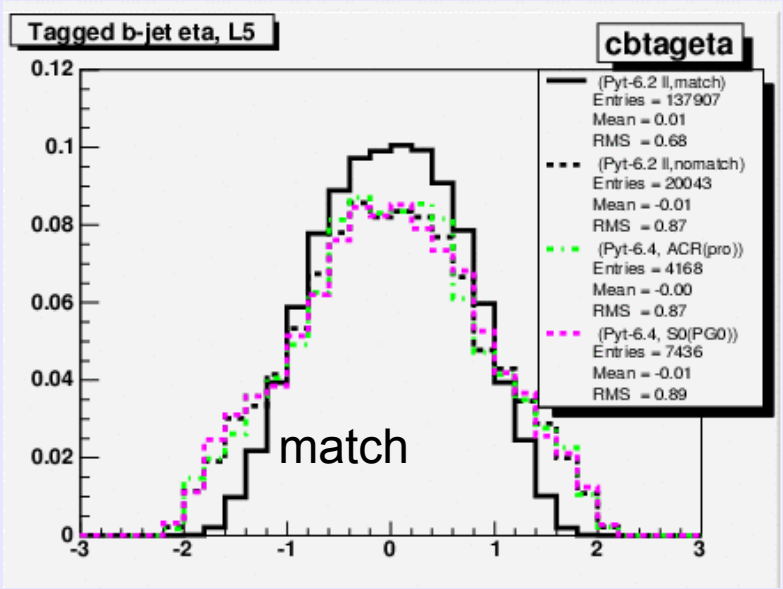
Non matching jets have more charged particles

This points to more more gluon jets. That is more ISR/FSR

No-matching jets properties

Compare eta moments and jet eta for matching and no-matching jets. Relative shapes depend on the matching cuts, of course.

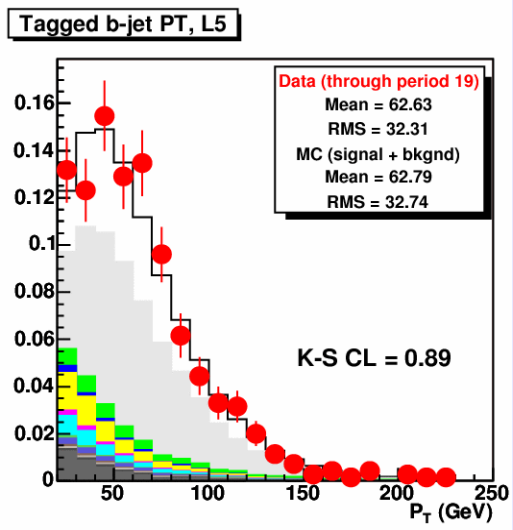


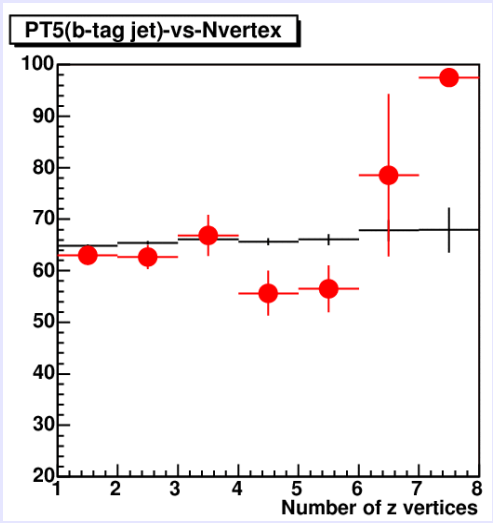


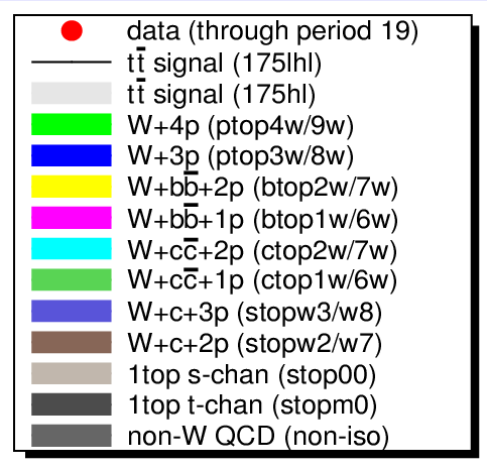
Wider distributions for eta moments and jet eta, point to the non matching jets to be gluon jets

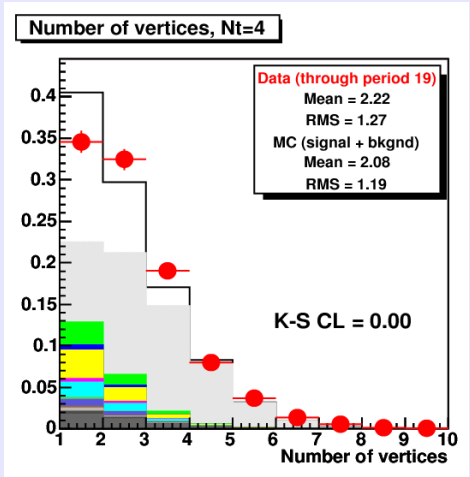
Tagged Jet PT

Comparison of data and MC for the default PYTHIA V6.2.
Only events with N(tight)=4 included (698 jets, of which 13% are non-b)









The measured b-jet P_T agrees with PYTHIA V6.2 tune AV, which is our default.

The dependence on Nvtx is minimal which means we are correcting the jets properly.

The lumi profile is not very good, as the background luminosity is limited to the first 1/3 of the data.

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 event matching and with our ME method.

Sample	Δm_W (GeV/c^2)	Δm_t (GeV/c^2)	Δm_t (GeV/c^2)	Δ JES σ
	MC event matching		MTM3 Pseudo-Experiments	
V6.2 (nominal) (ttkt75)	–	–	–	0.01±0.05
V6.4 tune A-pro (otop45)	-0.15±0.13	-0.05±0.20	-0.12±0.26	0.04±0.06
V6.4 ACR-pro (otop46)	-0.09±0.12	-0.14±0.20	-0.53±0.26	0.08±0.06
V6.4 NOCR-pro (otop47)	+0.53±0.14	-0.09±0.21	-1.46±0.27	0.22±0.06
V6.4 S0-pro (otop44)	+0.39±0.14	-1.18±0.22	-1.80±0.28	0.11±0.06
V6.4 NOCR-Pg0 (ctops4)	+1.07±0.09	+0.33±0.14	-1.60±0.32	0.34±0.07
V6.4 S0-Pg0 (ctops3)	+1.00±0.09	+0.32±0.14	-1.45±0.33	0.27±0.07

- ACR (old shower+CR) shows little effect from CR = -0.41 ± 0.37 GeV
- NOCR: Event matching finds large ΔM_W, ME fit compensates for this with a large value of ΔJES, resulting in ΔM_{top} = -1.5 GeV .
  For ΔJES= 0 we get ΔM_{top} = -0.7 ± 0.2 GeV