Update on PYTHIA V6.4 Studies

This is an update over my talk of July 1

A number of plots were not understood.
Will revisit them today

On going studies: try to evaluate the color reconnection contributions to our top mass systematics.

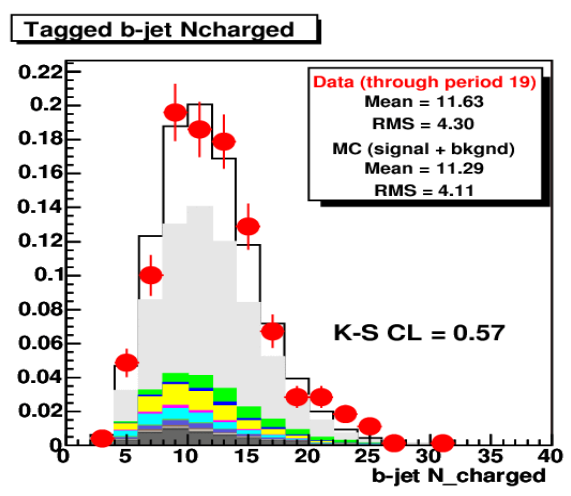
PYTHIA V6.4 has a lot of new features:

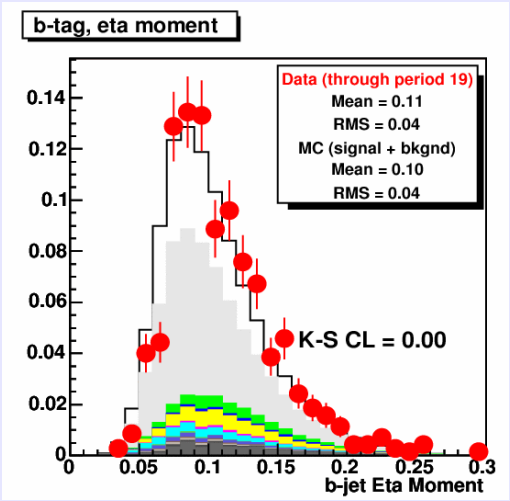
new parton shower algorithm
different way of treating ISR
different underlying event
inclusion of Color reconnection effects

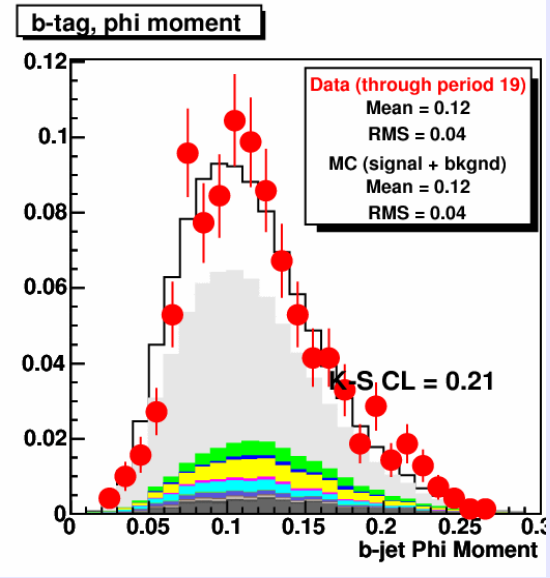
Presently studying the difference in jet shapes in V6.2 and V6.4

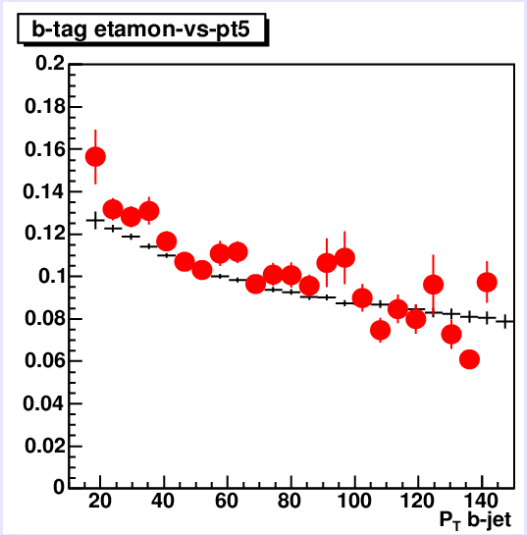
Jet Shapes Variables in b-jets

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









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

Comparison among different tunes

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

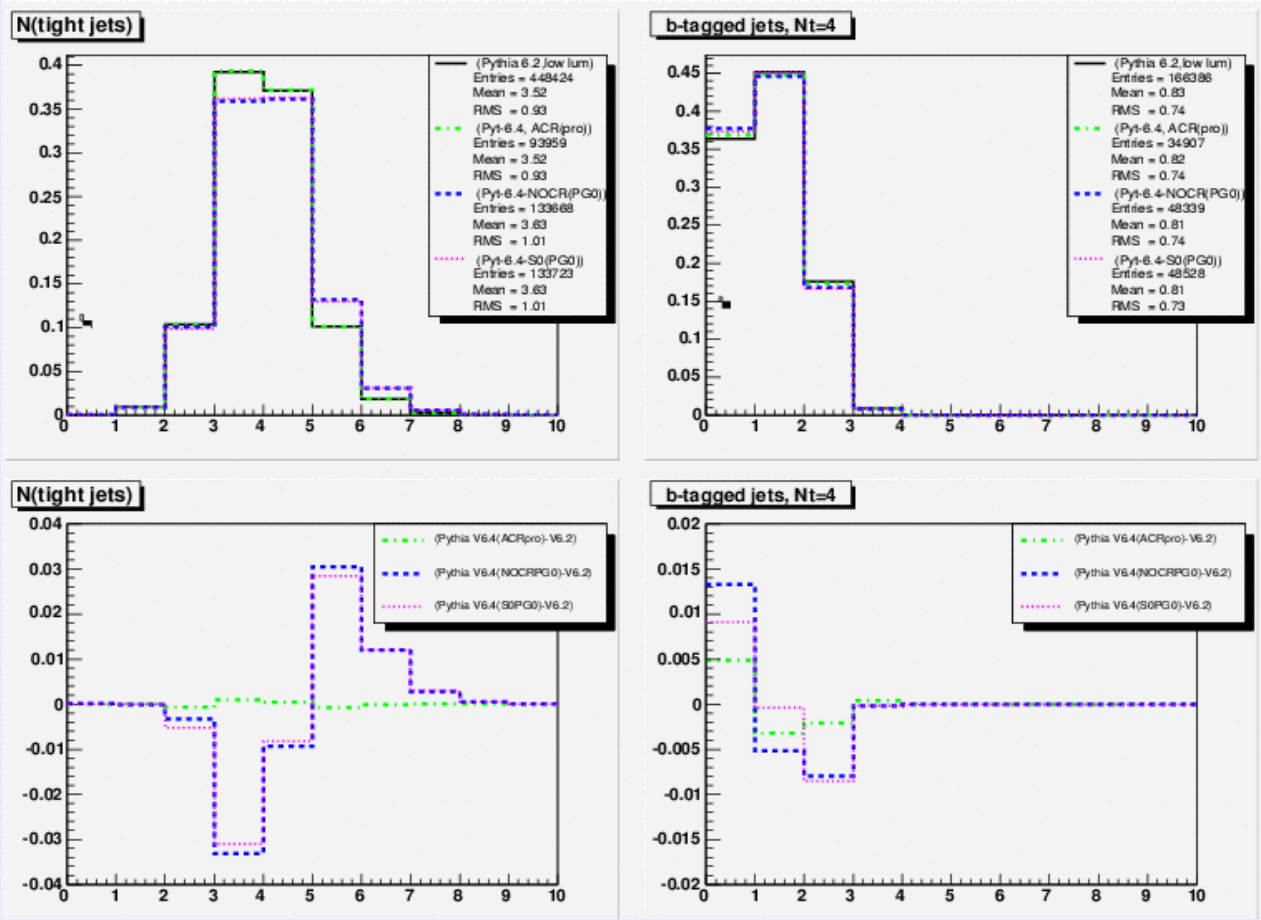
It is not clear on how to choose between the different tunes as none of the ones considered fair well on all of these variables. We need to do additional work to understand the situation.

Additional studies are being done and are now URGENTLY needed.

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

MC 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%

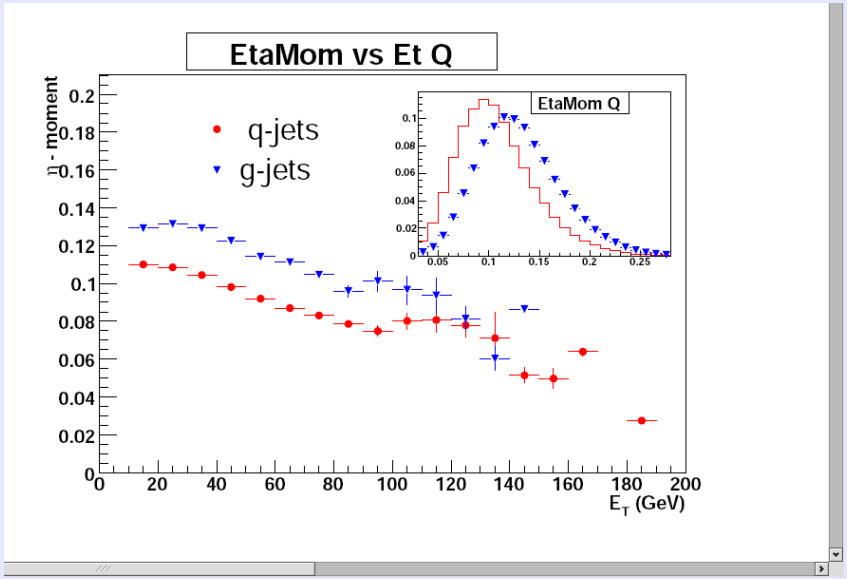
Perugia0 :
- Less matching
- More N(tight)
- Less b-jets in 4 jet sample

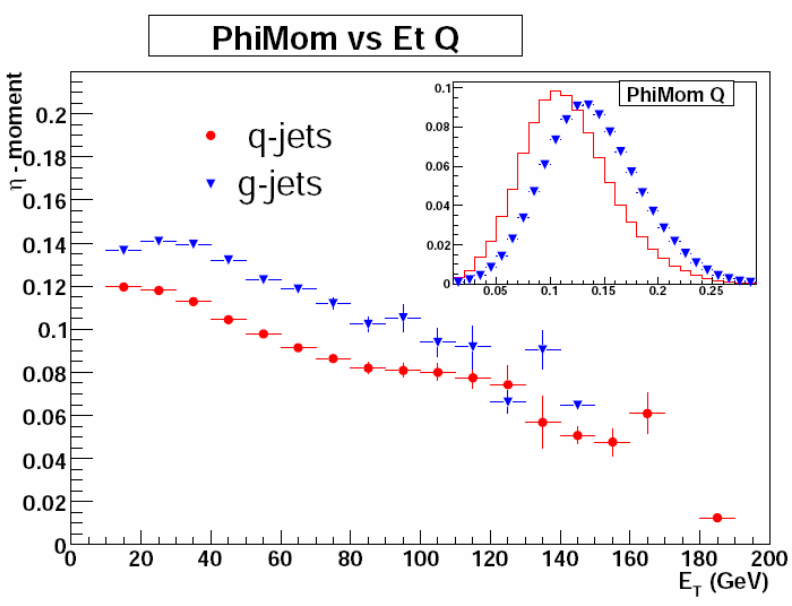
These findings point to more ISR in the S0-Perugia0 samples.
Looking into this.

Moments for quark and gluon jets

Jet shapes studies have been around in CDF for a while

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

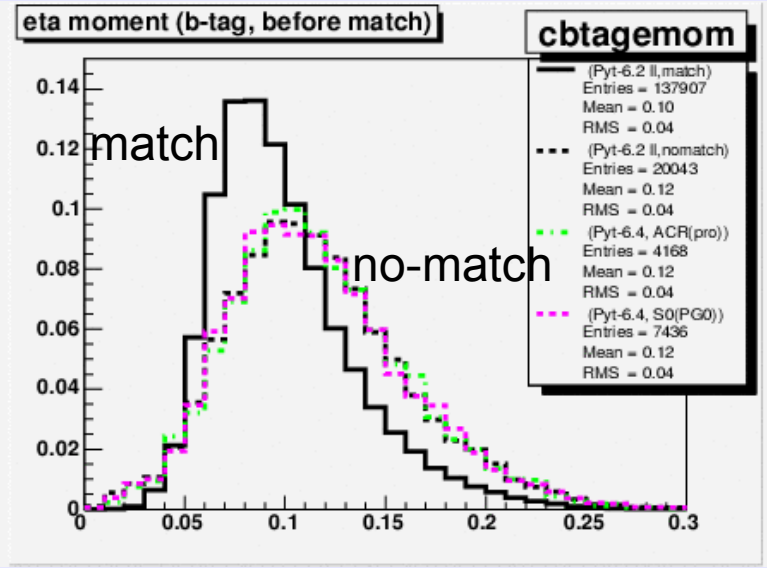


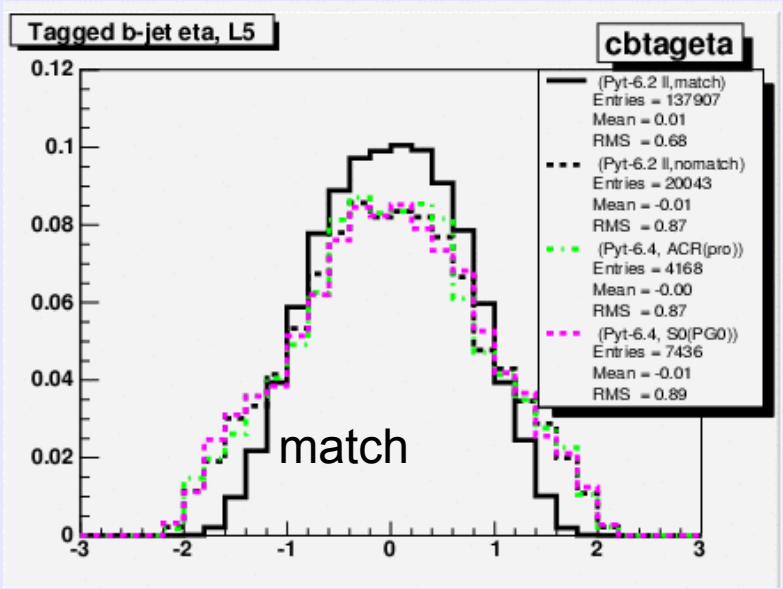


We have been looking at these variables and the distributions of N(charged) in jets, in an effort to understand the new tunes.

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.

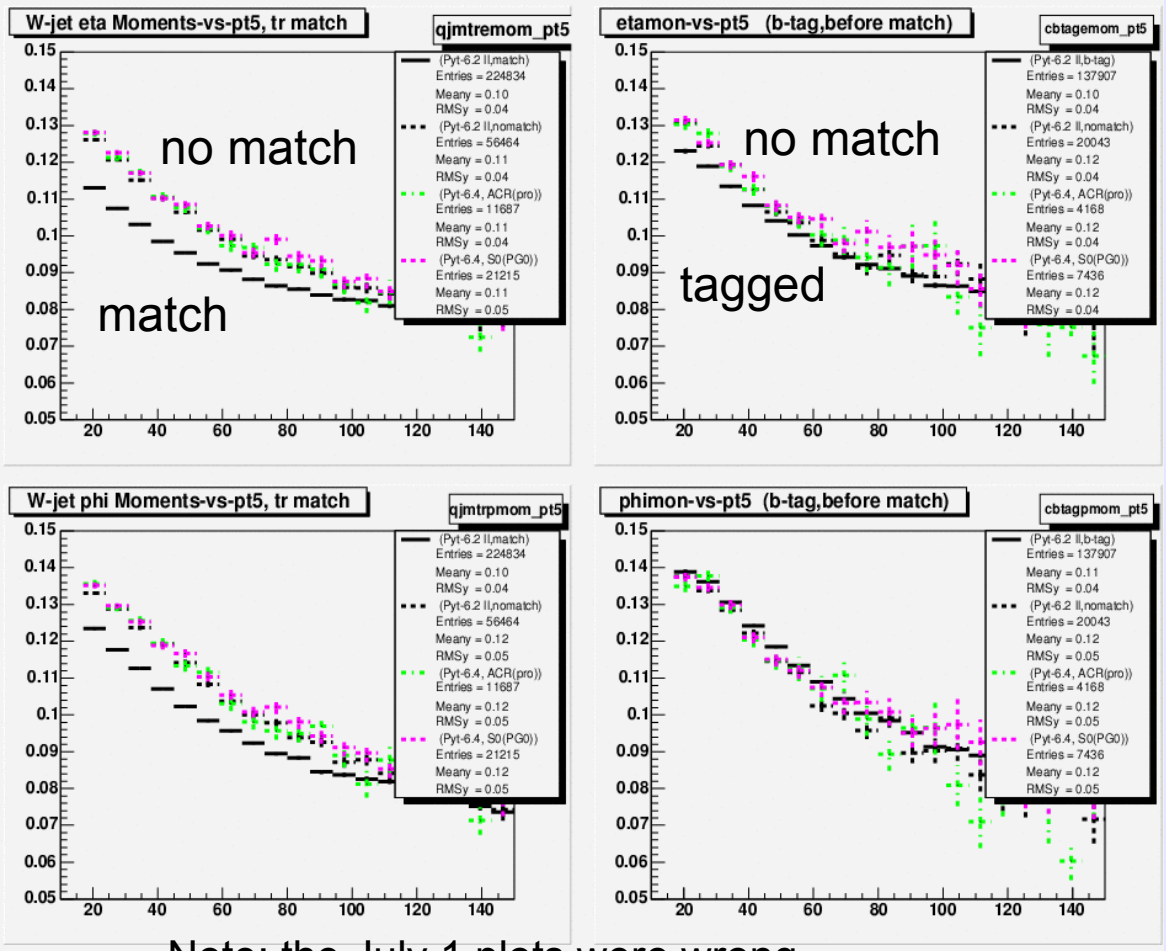




Wider distributions for eta moments and jet eta, point to the non matching jets to be gluon jets

η and φ Moments in no-match jets

Moments-vs- PT(jet)



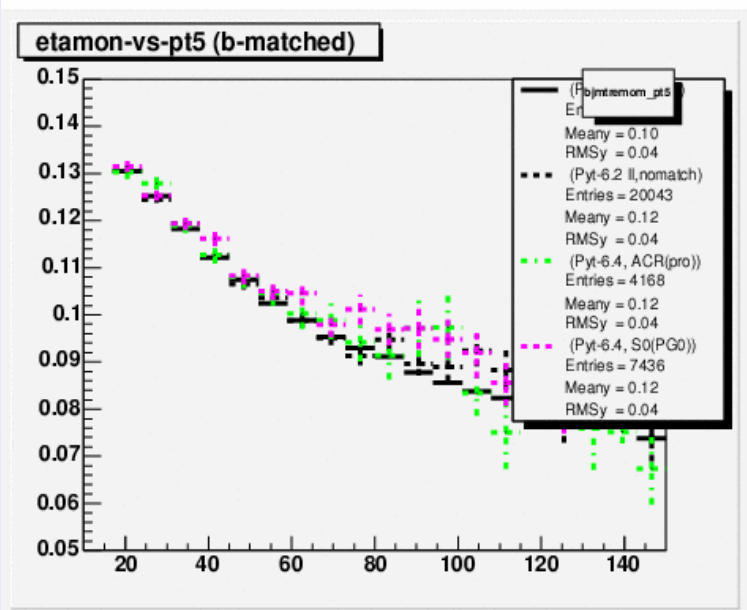
Note: the July 1 plots were wrong

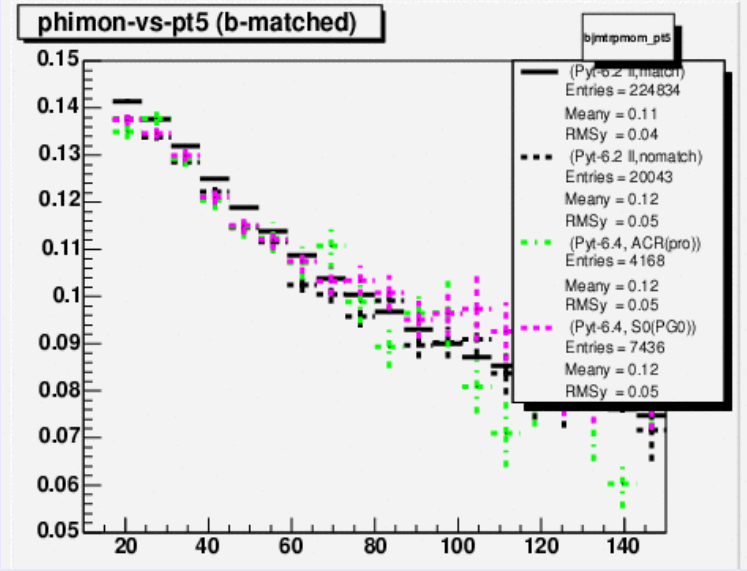
For he light quark jets the no-match distributions look more like gluon jets.

The b-jets moments are different than the no-match moments at low PT. The phi moments look the same. Maybe there is some bias in the eta moments for tagged jets at low PT

The Perugia0 tunes have more no-match jets, hence more gluons in the light quark sample (includes c quarks). It is harder to see a difference between the b jets and the gluon jets (right plots)

Eta moments no-tag





b-jets, no tag requirements:

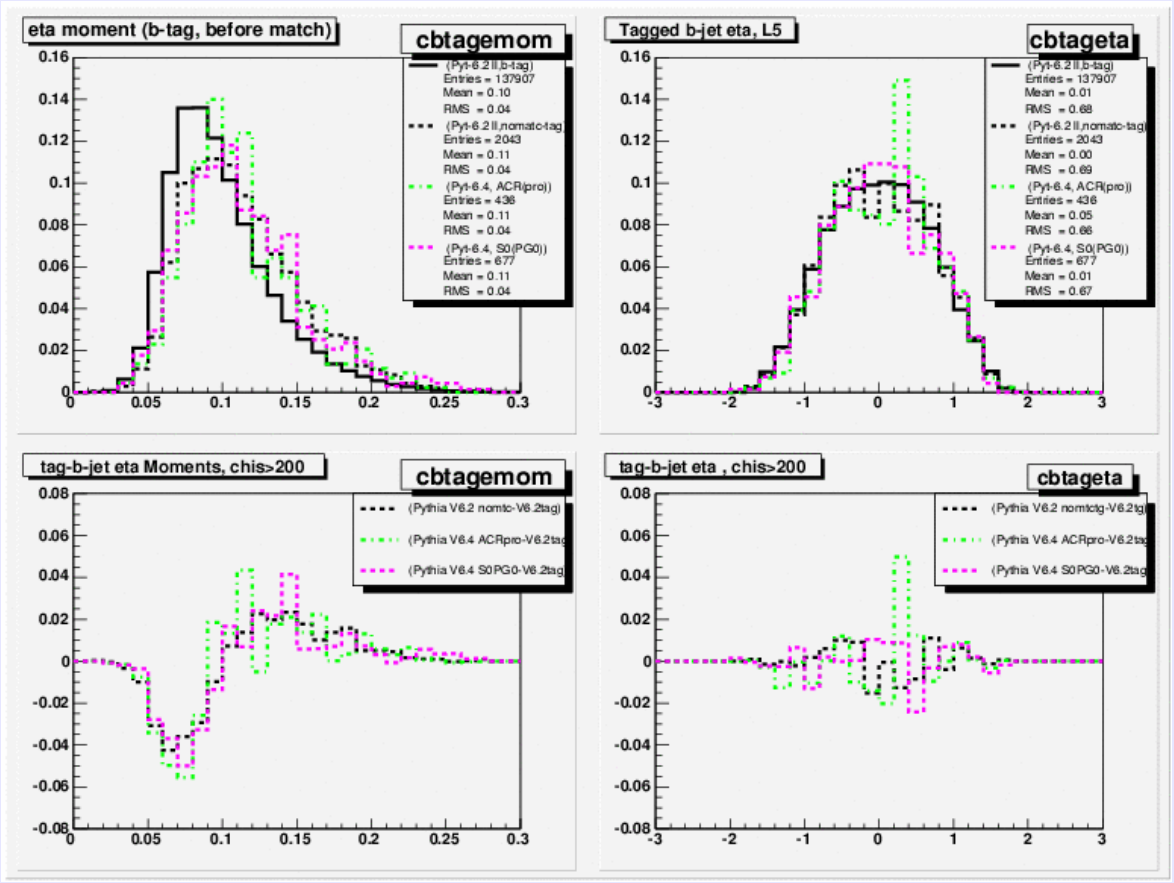
the matching and non matching jets show the same behavior.

This tells that distinguishing between b-jets and gluon jets from the moments is very difficult.

New variables should be investigated, such as N(charged)

Tagged b-jets eta moments

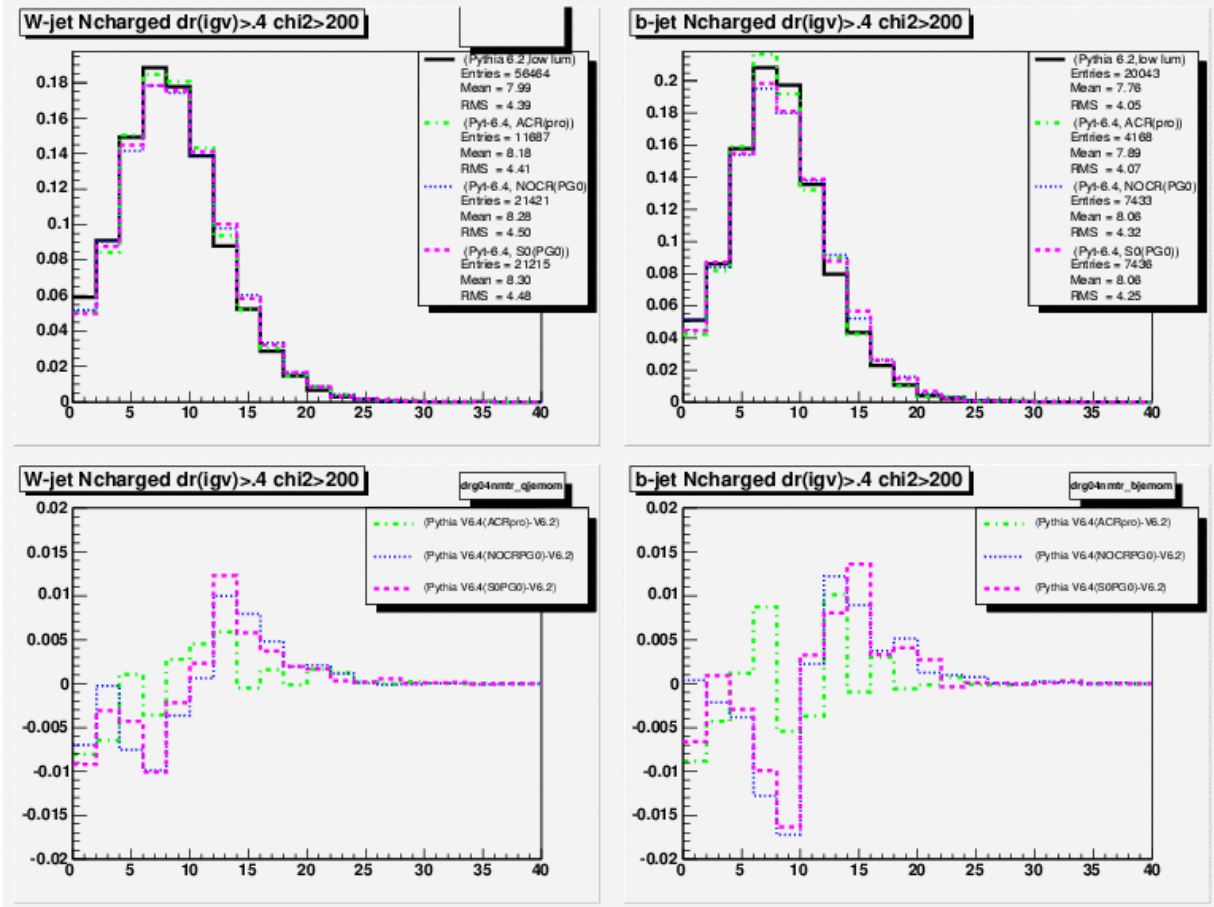
This shows that the eta of the tagged jets is what we expect. The eta moments, as seen in the previous plots, for the no match-jets are larger.



The tagged no match-jets jets have a very similar distribution.

Studies of non-matching jets properties

Previous studies have shown that the new tunes (S0-Perugia0) have more events for which the jets we see do not match the partons.
Also we see a difference in the N(charged particle in jets)



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

S0-Perugia0:
More non matching events

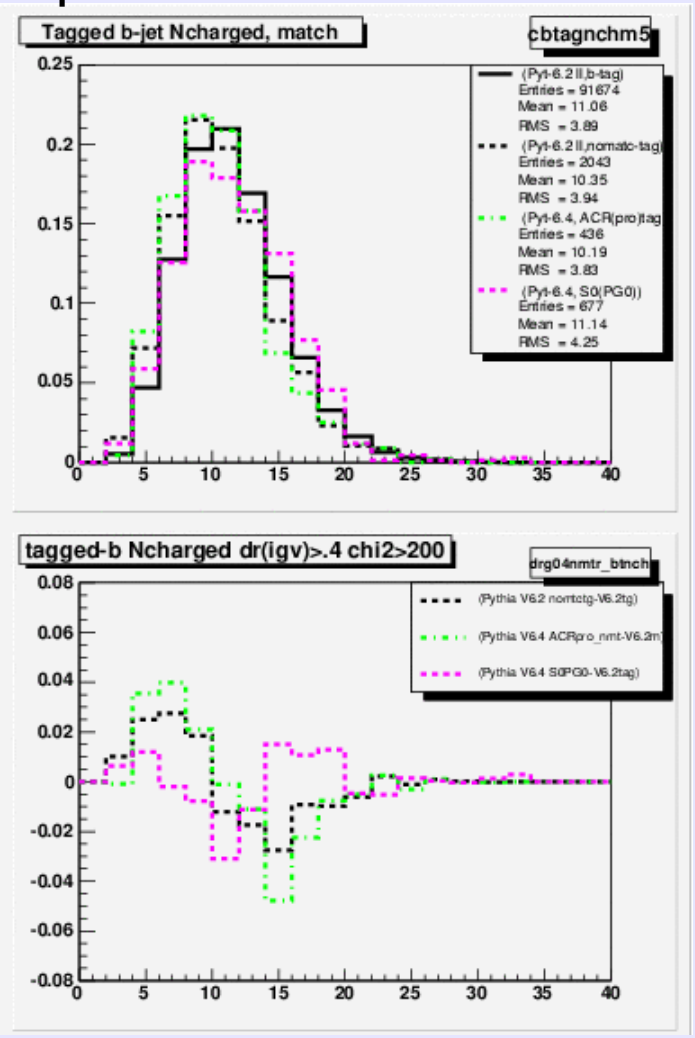
More N(tight) jets

Non matching jets have more charged particles

Need to understand better these differences

Studies on N(charged) in jets

We have seen earlier that the no-match-jets have more charged particles. For the light quarks it is easy to explain, as we have concluded that the jet shapes show that the no-match jets have a large component of gluons.



What about the b-jets? Jet shapes cannot distinguish between b-jets and gluons. Are there other variables to look at/

Does N(charged) help?

This plot shows the no-match jets that are tagged. Very few events that are consistent with the mismatch rate.

It is intesting to see that the tune S0-Perugia0 has more charge particles than V6.2 and ACR-pro

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 jet shapes of the non-matching jets in light quarks have a very large contamination of gluon jets

- For b-jets the moments cannot distinguish between b-jets and gluon jets

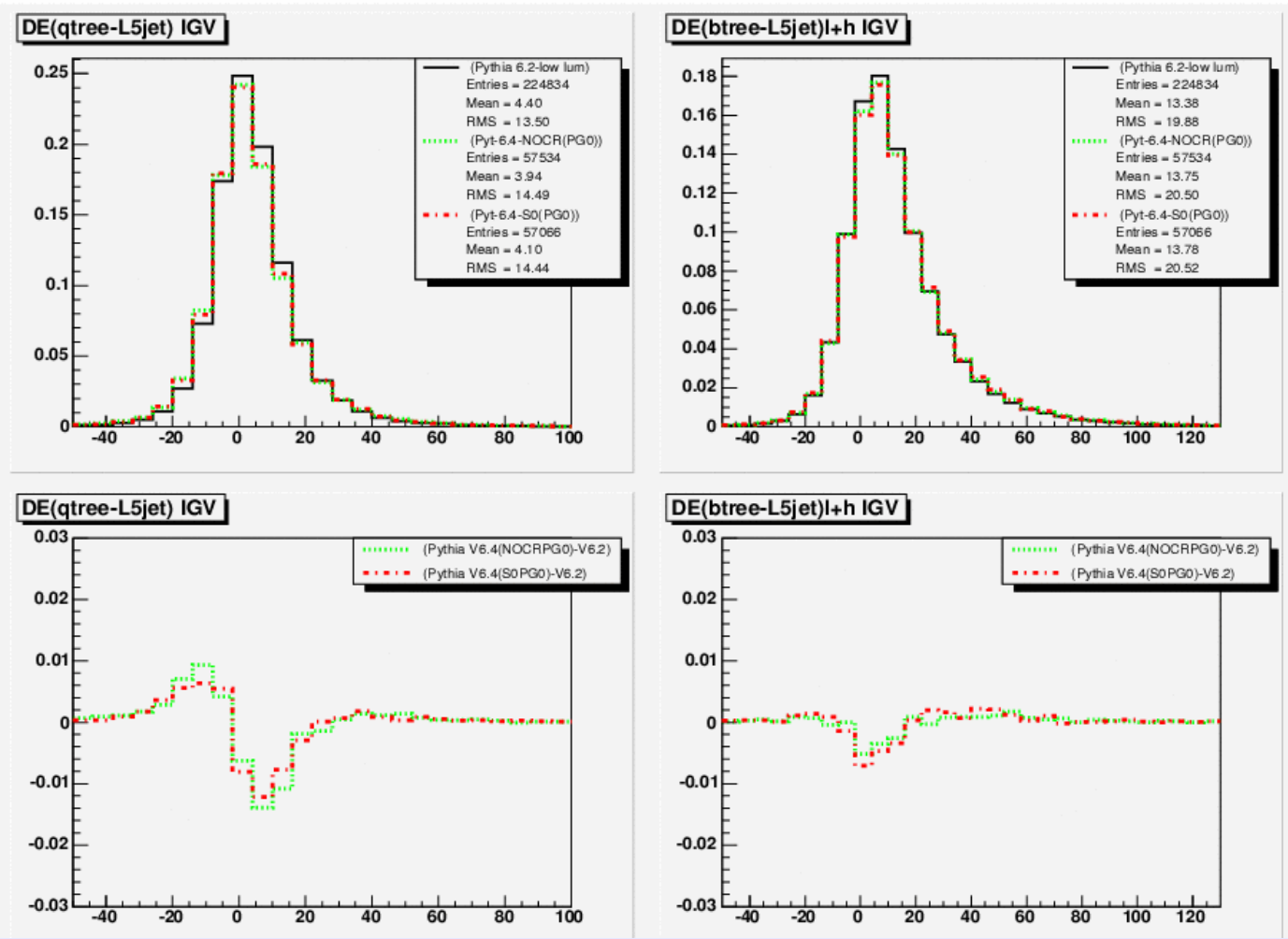
- The no-matching jets have more N(charged) particles in the jet
  - Looking at this variable to see if it can help separating gluon jets from b-jets

Top Mass Measurement and CR

Backup slides

Comparison: E in cone of 0.4

S0Pg0 (S0Perugia0) compared with our default (V6.2 tune A)



S0Pg0 -Nominal

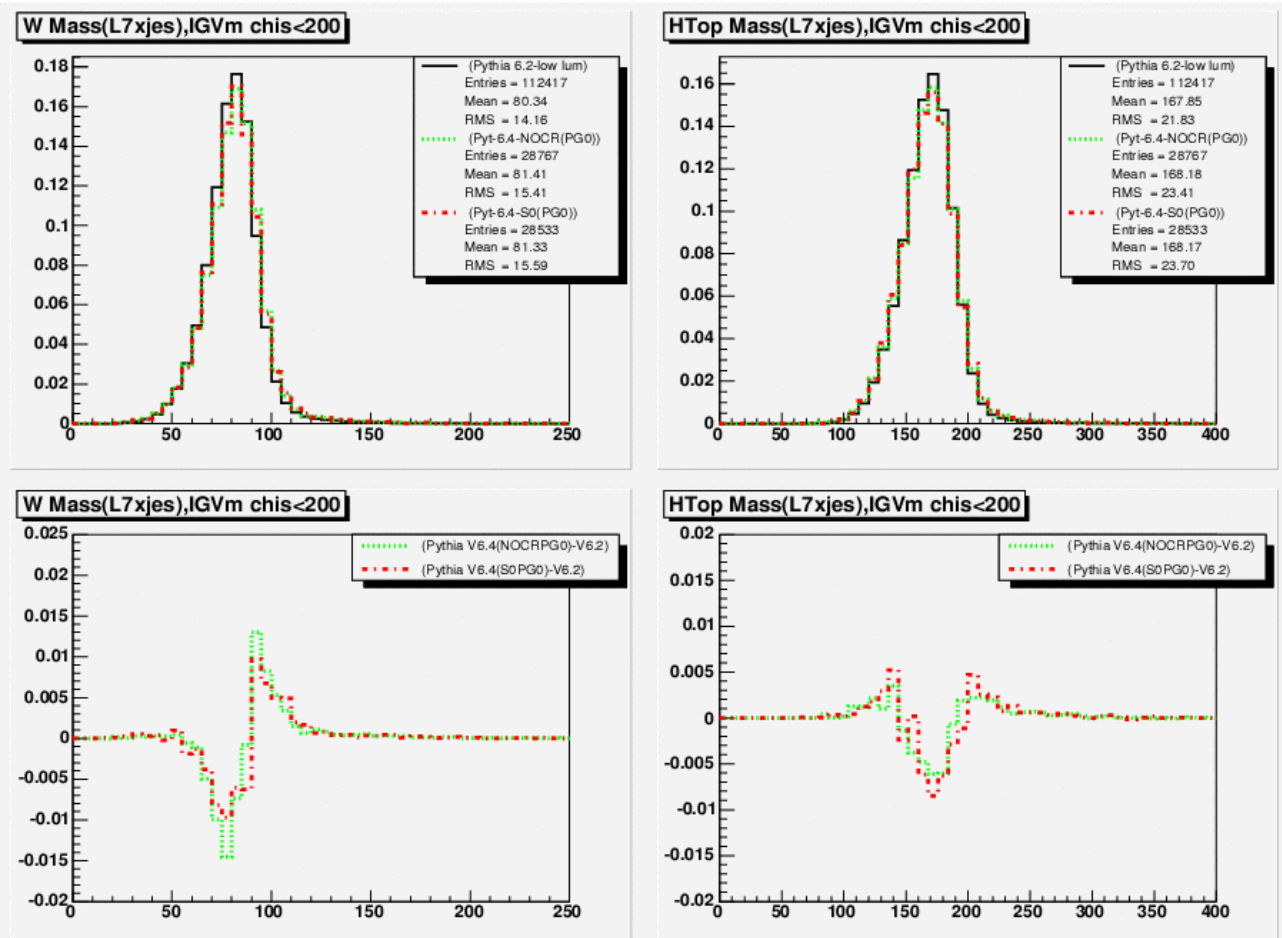
Δ E (cone) GeV

W-jets +0.30 ± 0.15

b-jets -0.40 ± 0.15

The S0-Perugia0 tune has different behavior for the b-jets

S0-Perugia0 W and Top mass shifts



M=175 GeV ΔMw

V6.4 NCR-Pg0 +1.07

V6.4 S0-Pg0 +1.00

M=175 GeV ΔMtop

V6.4 NCR-Pg0 +0.33

V6.4 S0-Pg0 +0.33

The S0- Perugia0 and corresponding NOCR have a small top mass shift

Summary of Matching and ME fits

- We find the following CR values from the "pro" tune files:
  CR--> -0.41 ± 0.37 GeV from ACR (-0.4 ± 0.3 GeV, Winter Conf)
- CR --> -0.34 ± 0.38 from S0-NOCR,
  CR --> +0.15 ± 0.45 from the Perugia0 tunes
- The S0-pro (S0Pg0) tune gives ΔM_{top} = -1.8 GeV (-1.5 GeV)
  this is directly related to different jet and events shapes, due to a different p-shower
- Tune S0 tunes include systematics that we are already taking into account ,i.e.

  generator : $\Delta(m_t)$ = 0.51 +- 0.37 GeV

  ISR/FSR : $\Delta(m_t)$ = 0.29 +- 0.26 GeV

  OOC : $\Delta(m_t)$ = 0.52 GeV

  b-jets : $\Delta(m_t)$ = 0.38 GeV

  that is 0.88 GeV, most of the MC related systematics.

- More comparison of the S0 tune with Tevatron data needs to be done URGENTLY. We need to disentangle the various contributions

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. Only b-tagged jets are considered in this comparison.

There are 698 jets tagged by our secondary vertex algorithm.
N(events)= 578 with the topology lepton+4 jets (PT>20 GeV) .
N(background)= 134 ± 34 events.

Variables:

- Number of charged particles
- Eta moments
- Phi moments

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

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). This is match of the 4 partons to the 4 jets in the event.
We then know which jet are light quark jets and which ones are b-jets.
To check the changes between MC's we compare a number of variables for the different tunings, for example:

- Compare E(parton) and E(jet) in cone of R=0.4
- Compare 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

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

Color Reconnection Systematic

- S0-pro : ΔM_{top} = -1.8 GeV, expected because of -1.3 GeV b-jet shift.
- S0-Perugia0 : the light quark jets are more shifted then the b-jets. This shifts the W mass considerably (~ 1GeV). The top mass goes up for this reason. The ME fit gets a large DJES to reconstruct the W mass properly, this moves the jets down resulting in a large DMtop
- NOSR-Pg0: same as above .
- Bottom line: what is the CR systematics?

From ACR (pro)-A(pro) CR = -0.41 $\pm$ 0.37
From S0(pro) and NOCR CR = -0.34 $\pm$0.38
From the Perugia0 tunes CR = +0.15$\pm$ 0.45

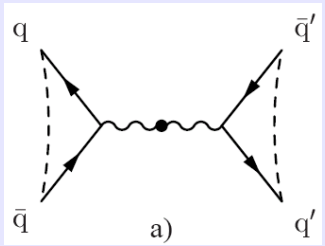
- More statistics will help. At this point it seems that CR ~0.5 GeV

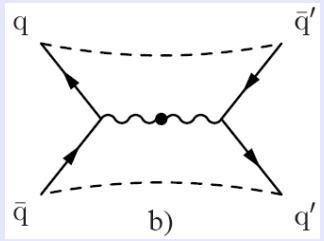
Color Reconnection Systematics

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

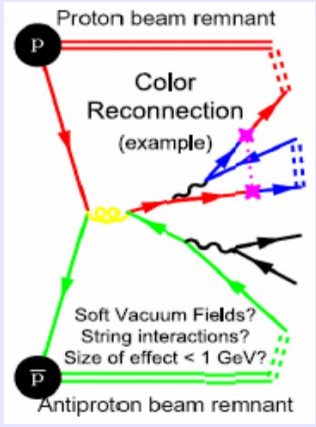
CR(sys) = 8 MeV

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)≈ 0.5 GeV

D. Wicke and P. Skands arXiv:0807.3248V1

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