Color Reconnection Systematics(1)

New models of Color Reconnection (CR) have been introduced in recent versions of PYTHIA starting with V6.3. In our analyses we have been using PYTHIA V6.2 (tune A).

The latest version (PYTHIA V6.4) includes, in addition to a new model for color reconnection, new models for the parton shower (ISR and FSR), and the Underlying Event, UE, (Multiple Parton Interaction (MPI) and beam remnants).

Tunes which include LEP data (called "pro") and many CDF Min Bias data, Z-P_T, Drell-Yan etc. are now available in PYTHIA V6.4.20.
(see "Perugia MC meeting", October 2008.
"Energy Scaling Workshop, FNAL April 27-2009)

We have looked at recent tunes:
A-pro , ACR(pro), S0Pg0(320) and NOCR

Color Reconnection systematics (2)

Tune ACR(pro): includes only the new color reconnection model.

Tune S0Pg0(pro): uses new modeling for the parton shower, UE and CR. For this tune, 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. We compare ACR(pro) to the A(pro) (tune A in V6.4) tune.
Also the difference between S0Pg0 and NOCR

This has been done in the di-lepton, the lepton+jets and the all hadronic channels. The three mass shifts agree within statistics

$\Delta M_{top} = M_{top}(A(pro)) - M_{top}(ACR(pro)) = 0.4 \pm 0.3$ GeV/c^2

Work is in progress to compare jet shapes in PYTHIA V6.4 with data from various samples to isolate the effects of the new parton shower from the CR contribution.

What we have learned (7/15/09)

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

- Events have more tight jets
- About 59% 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

Comparison of PYTHIA V6.2-V6.4

Comparison at the event level (talk of 111709)

Given a MC sample of lepton +jets top events, we can match the simulated jets with the initial partons. The algorithm uses only the DR between the parton and the jets, calculates an overall chisq for the event and applies some chisq cut. (Used by the MTM3 analysis).

From event matching we get the following results:

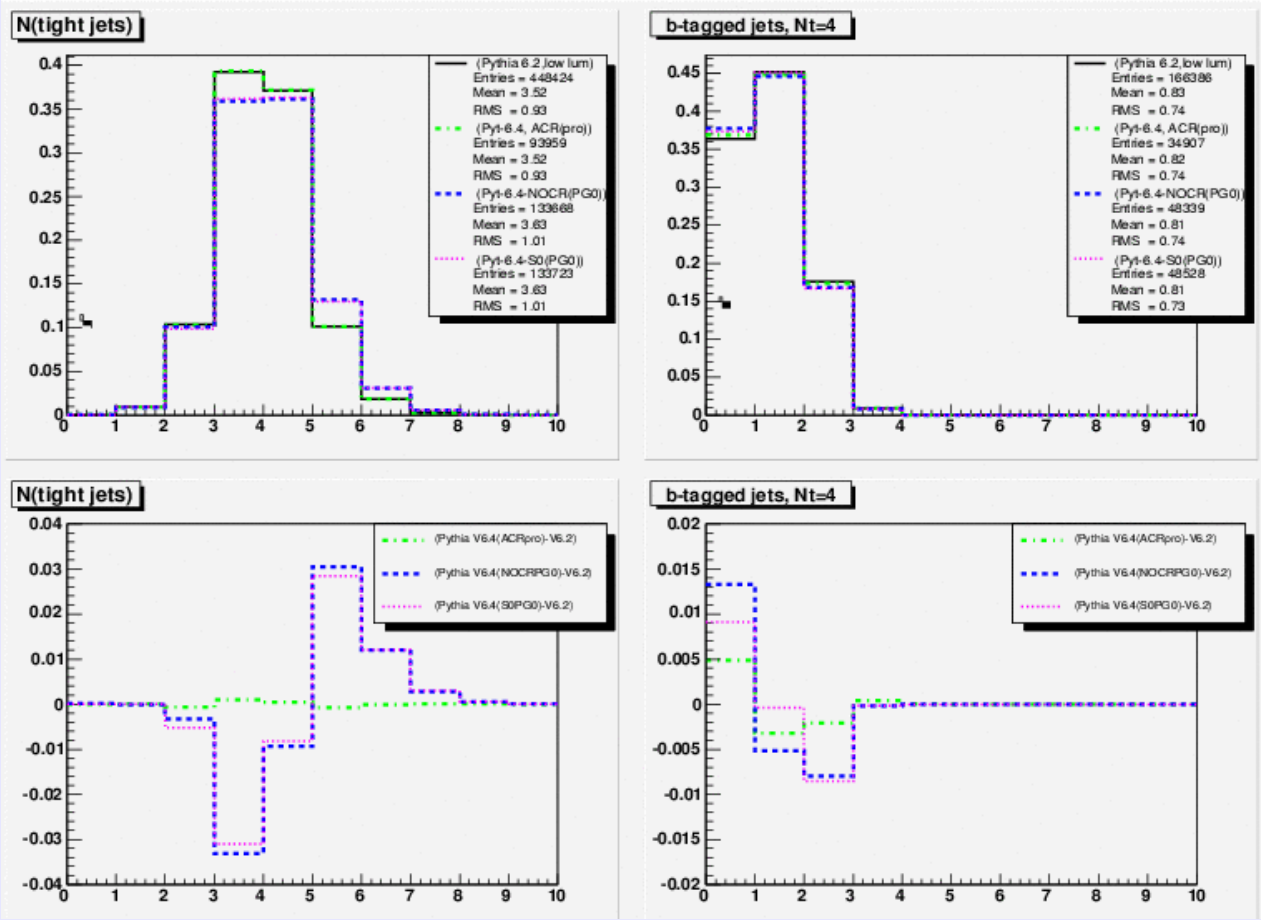
Matching events:

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

The event topology for tunes with new parton shower is different than the V6.2 one. More ISR or FSR?

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%
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V6.4 NCR-Pg0	59%
V6.4 S0-Pg0	59%

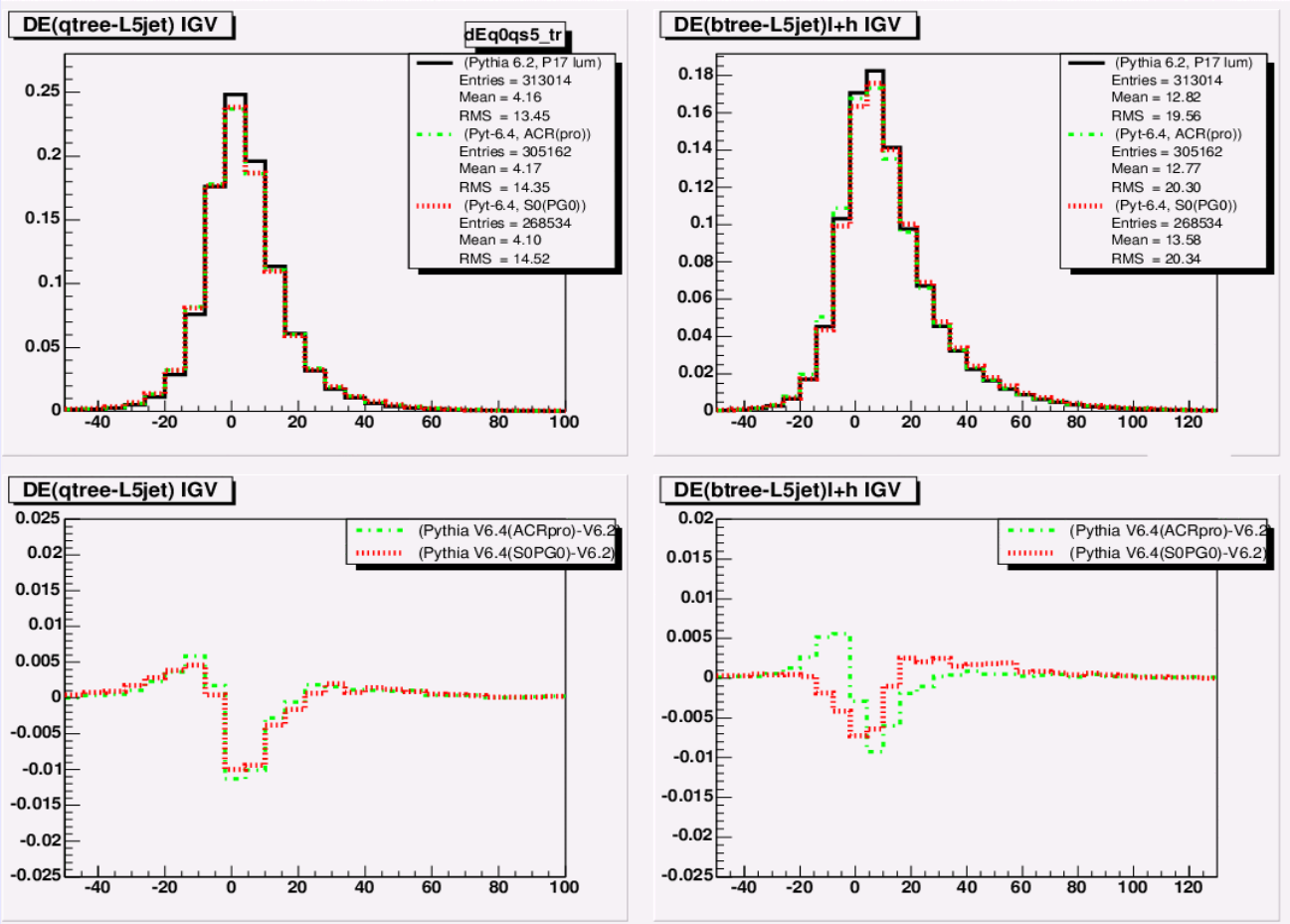
Perugia0 :
- Less matching
- More N(tight)
- Less b-jets in 4 jet sample

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

Comparison: E in cone of 0.4

Using the matching we can compare the difference of the energy in a cone of 0.4 that we obtain for the different MC.

D E = D (E(parton)-E(cone))



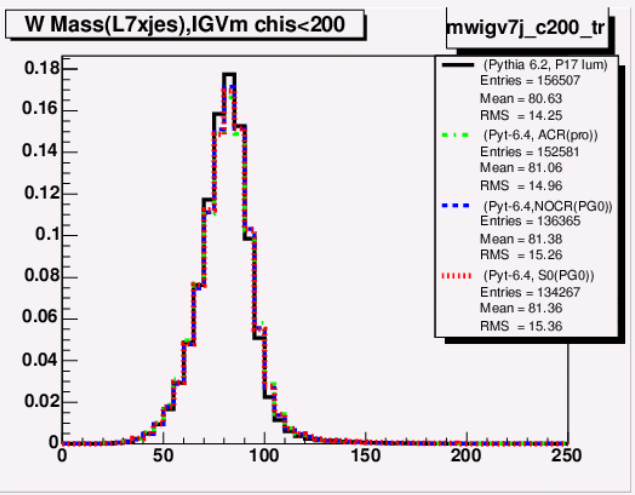
S0Pg0 -Nominal
175 GeV(less stat)
Δ (ΔE) (cone) GeV
W-jets -0.40+-0.12
b-jets -1.20+-0.16

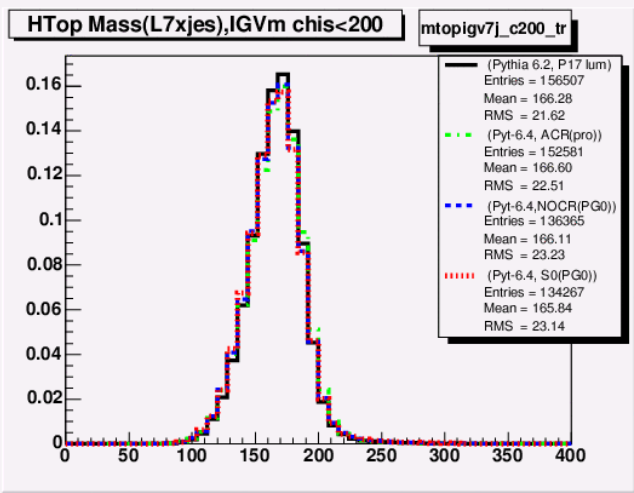
S0Pg0 -Nominal
172.5 GeV(6M ev.)
Δ (ΔE) (cone) GeV
W-jets +0.06 ± 0.04
b-jets -0.76 ± 0.05

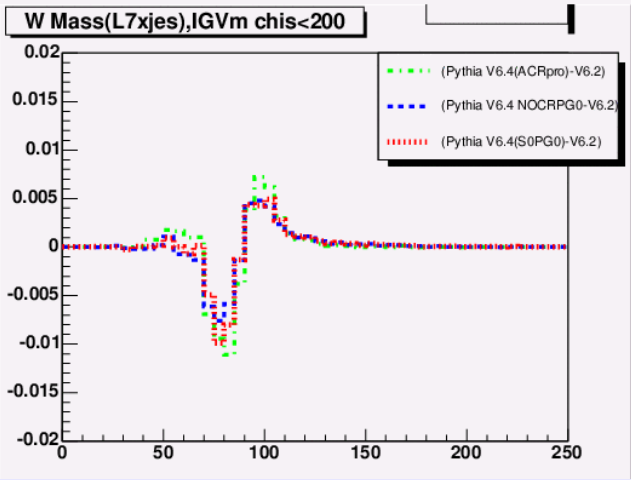
The S0-Perugia0 tune has less energy in cone of 0.4 for the b-jets

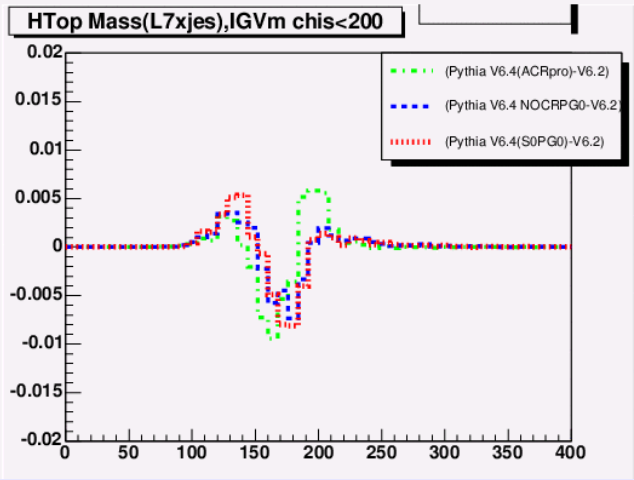
S0-Perugia0 W and Top mass shifts

Reconstructed MW and M(top) using the matched jets









S0Pg0 -Nominal
175 GeV(less stat)

ΔMw = +0.38 ± 0.12
ΔMtop = -1.18 ± 0.18

S0Pg0 -Nominal
172.5 GeV(6M ev.)

ΔMw = +0.27± 0.05
ΔMtop = -0.42 ± 0.08

The S0- Perugia0 obtains a top mass shift of 0.42 GeV with 6M events

The S0- Perugia0 obtains a top mass shift of 0.42 GeV with the large statistics sample

Top mass measured by MTM3

Using the machinary of the MTM3 analysis (ME integration) we obtain a significant shift (1.6 GeV) for the PG0 sample.

The value of the previous page refers to events perfectly matching (58% for the PG0 sample), while the MTM3 is using all events as well as the background.

Sample	Measured m_t (GeV/c^2)	Measured $\Delta_{\rm JES}$ (σ)	Δm_t (GeV/c^2)
Nominal 6.2 (`ttop25`)	172.90 ± 0.17	0.03 ± 0.04	—
6.4 Tune Apro (`ctopsd`)	172.77 ± 0.18	0.05 ± 0.04	-0.13 ± 0.25
6.4 Tune ACRpro (`ctopse`)	172.45 ± 0.18	0.17 ± 0.04	-0.45 ± 0.25
6.4 Tune S0 Pg0 (`ctopsb`)	171.35 ± 0.24	0.21 ± 0.05	-1.55 ± 0.29
6.4 Tune NOCR Pg0 (`ctopsc`)	171.20 ± 0.24	0.37 ± 0.05	-1.70 ± 0.29

It is not surprising that the 0.42 is now 1.6 GeV.

Systematics from color reconnection is taken to be (4.3 fb-1)
(ACR(pro)-A(pro))=0.32 +-0.25 GeV

Summary (11/17/09)

We have about 6M events in 7 samples that we can use to study the new PYTHIA tunes.

There are a number of variables that may be more sensitive to the parton shower than the Pt of the tagged jet, that we are studying

We need to use a luminosity weighted background.
We need to apply a luminosity weight to go from P17 to P25
We need to add the NT=4 and the NT=3 samples.

Top Mass Measurement and CR

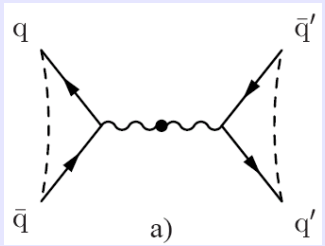
Backup slides

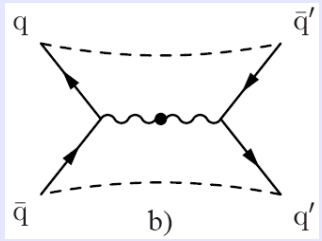
Color Reconnection Systematics

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

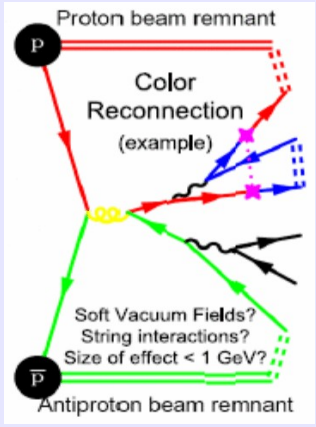
CR(sys) = 8 MeV

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