MC Studies of Color Reconnection

PYTHIA V6.416 includes color reconnection effects

We now have many top samples to work with (thanks Sasha and Nathan)

- How do these samples differ from V6.216 ?
- Are the jet shapes different?
- Will show plots of jet shapes on

PYTHIA V6.216 default M=175
V6.416 S0 "
V6.416 ACR "
V6.416 NOCR "
V6.416 S0 M=170

Are the jets different?

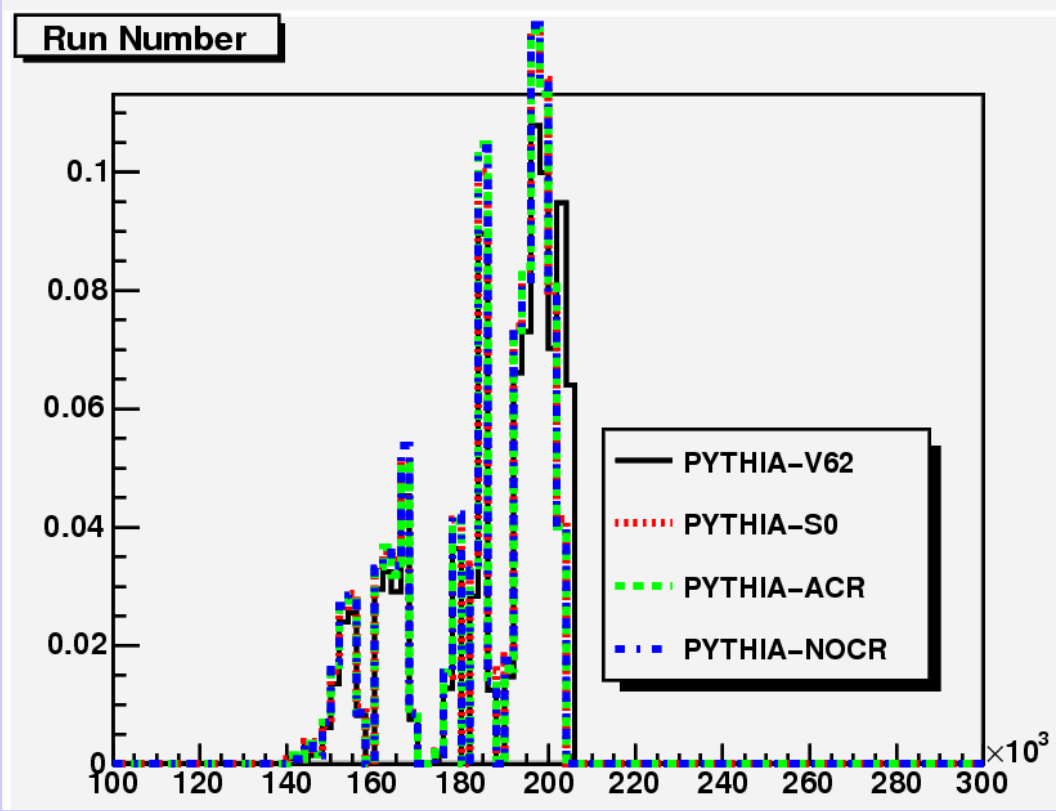
So far the model has been tuned on Minbias events
We need to look at other samples

Start to look at jets in top sample:

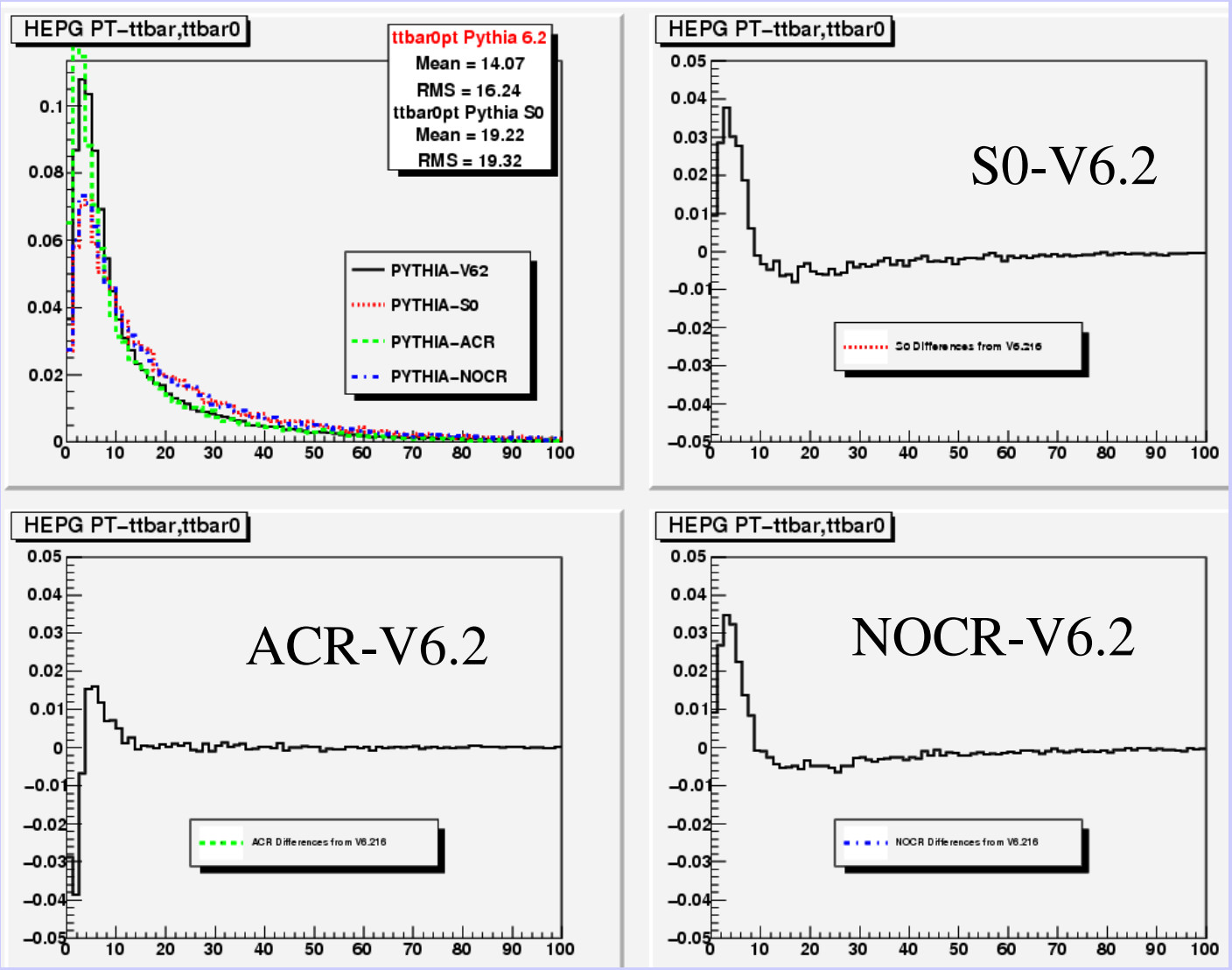
- usual cuts :PT>20 GeV , jet corrected at L5
- P lots: $P_T(\text{jet})/P_T(\text{parton})$ in cone of DR=0.4
- Compare old and new PYTHIA for jets from W-jets and b quarks. Compare
  V6.216 (tune A) and V6.416 (S0, tune ACR, NOCR)
- plan to look at more variables +add more cuts
- plan to look at corresponding jets with cone radius of 0.7

Luminosity profile

Put a cut on the run number so that lumi profile is very similar

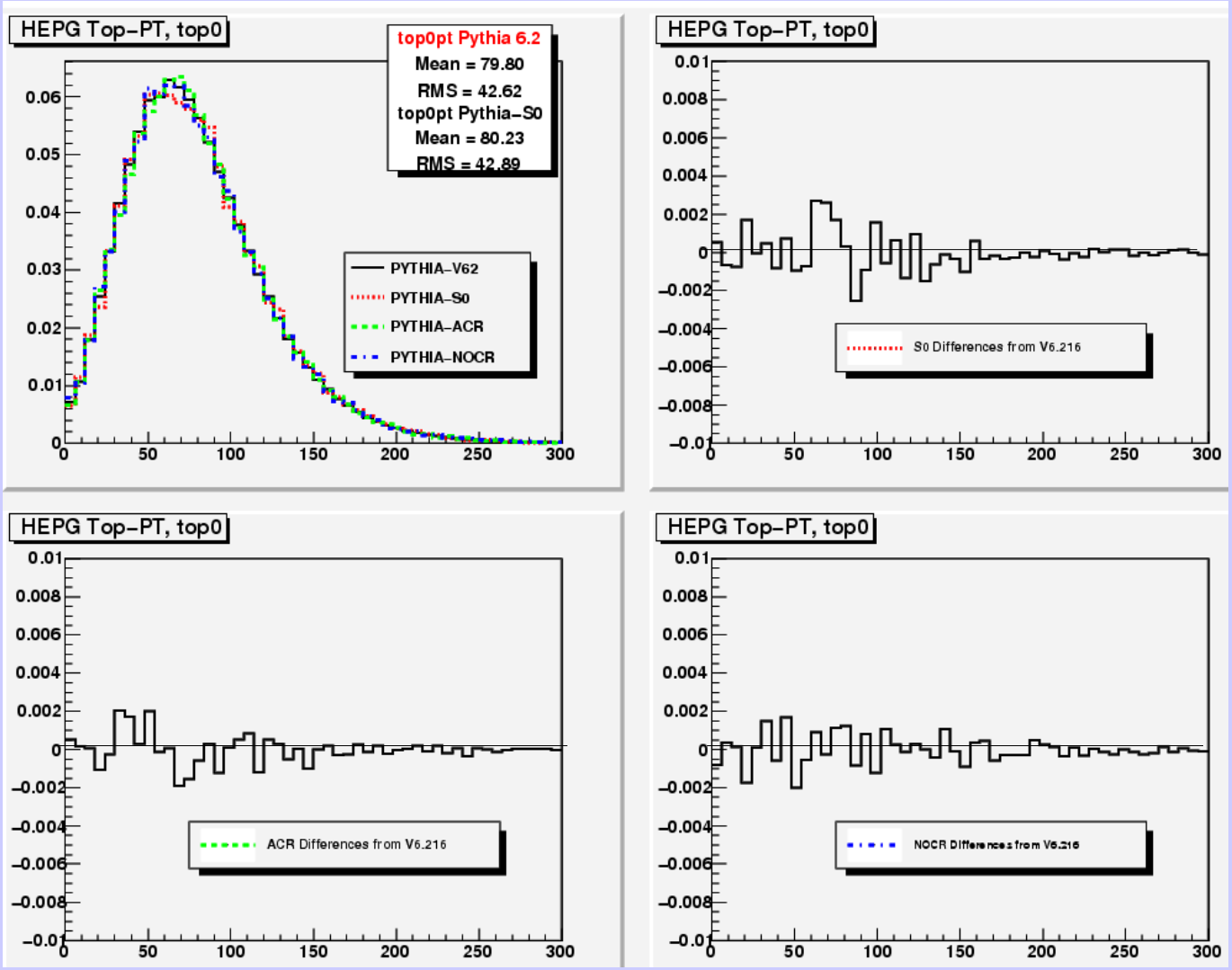


PT(ttbar) for 4 tunes



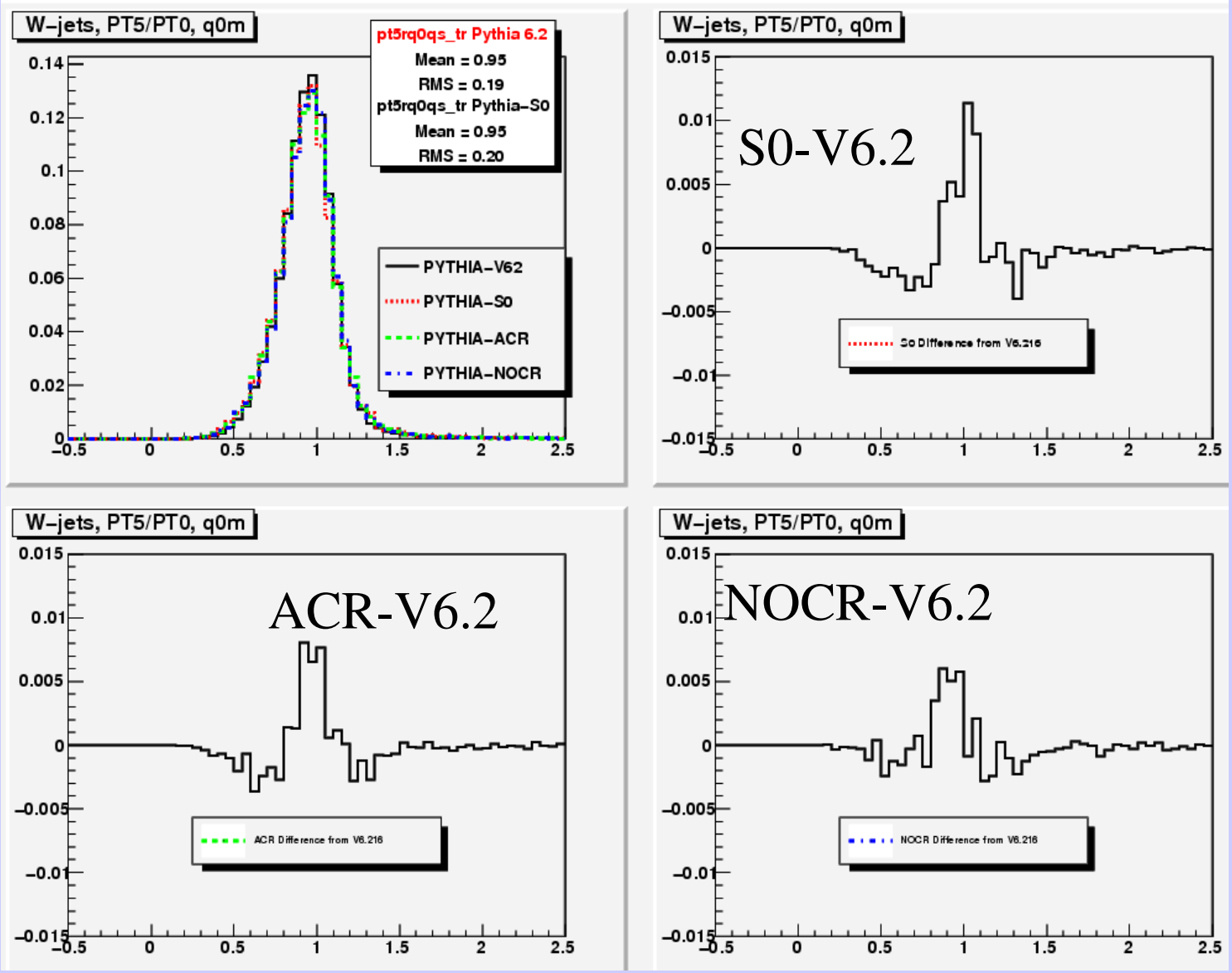
ACR case has PT(ttbar) similar to V6.216

P_T(top) at sim level



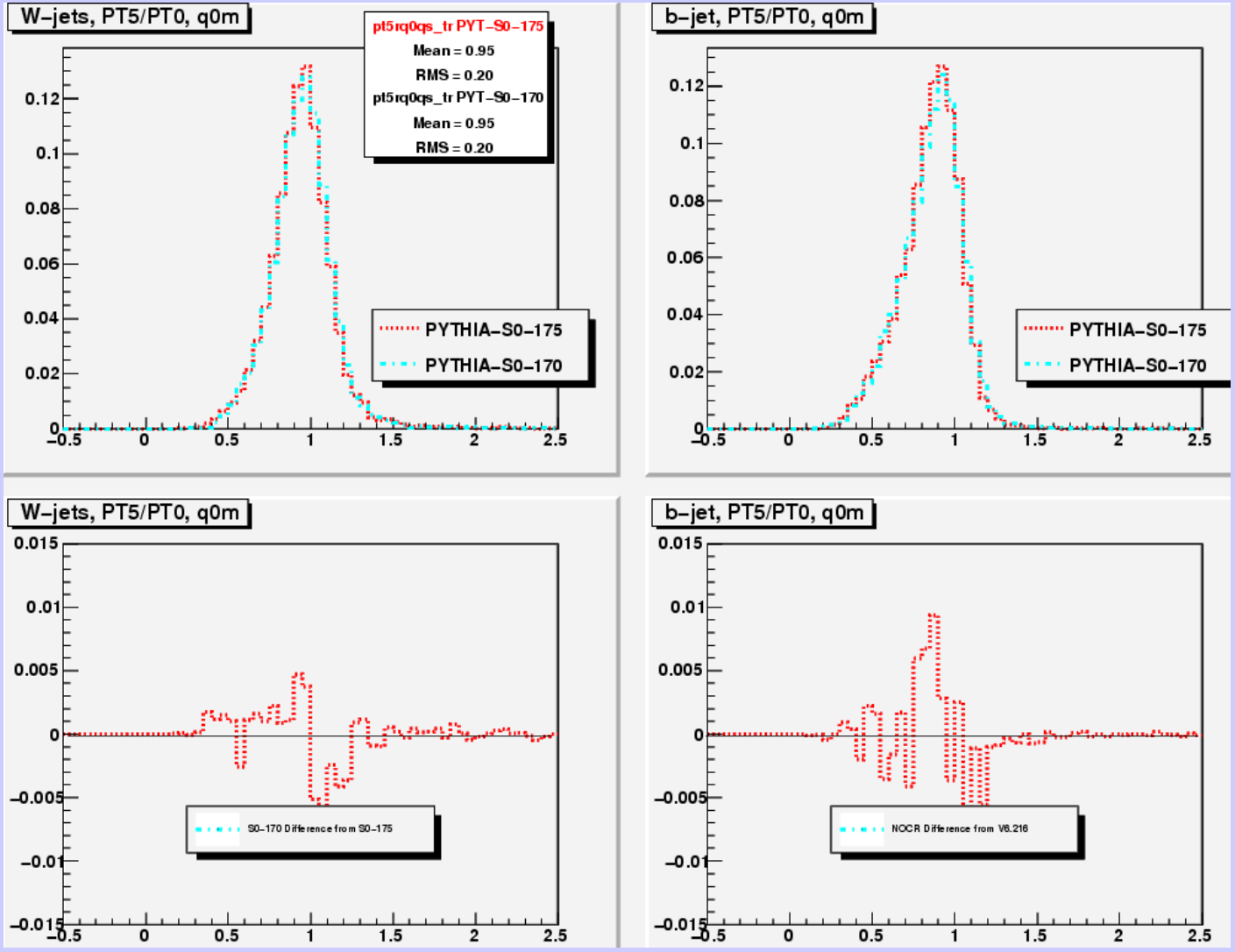
PT(top) is not affected much by the new parton shower or CR process

PT(jet)/PT(parton) for light jets



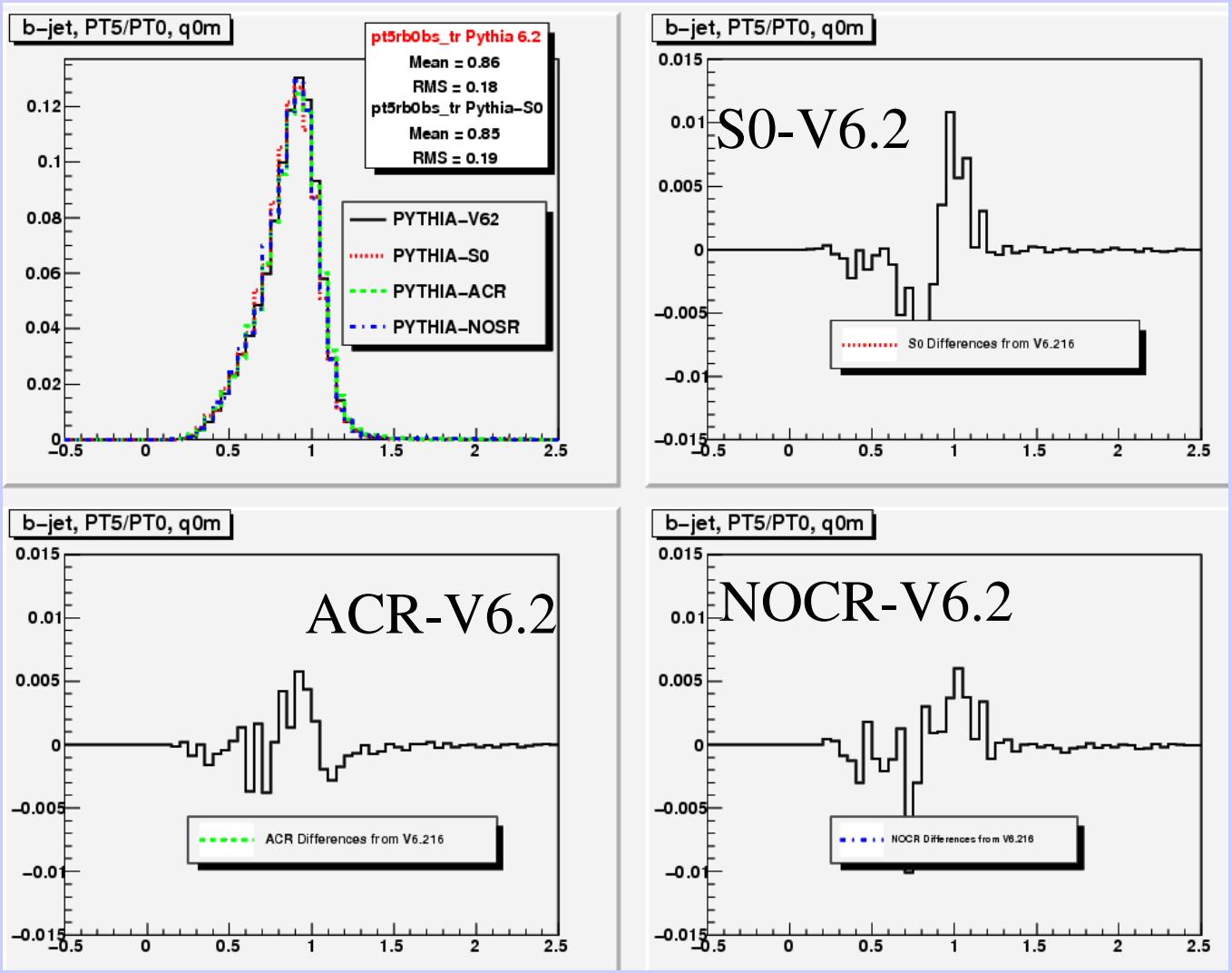
Distribution looks a bit wider for V6.4 tune S0

S0 Comparison of 170 and 175 GeV



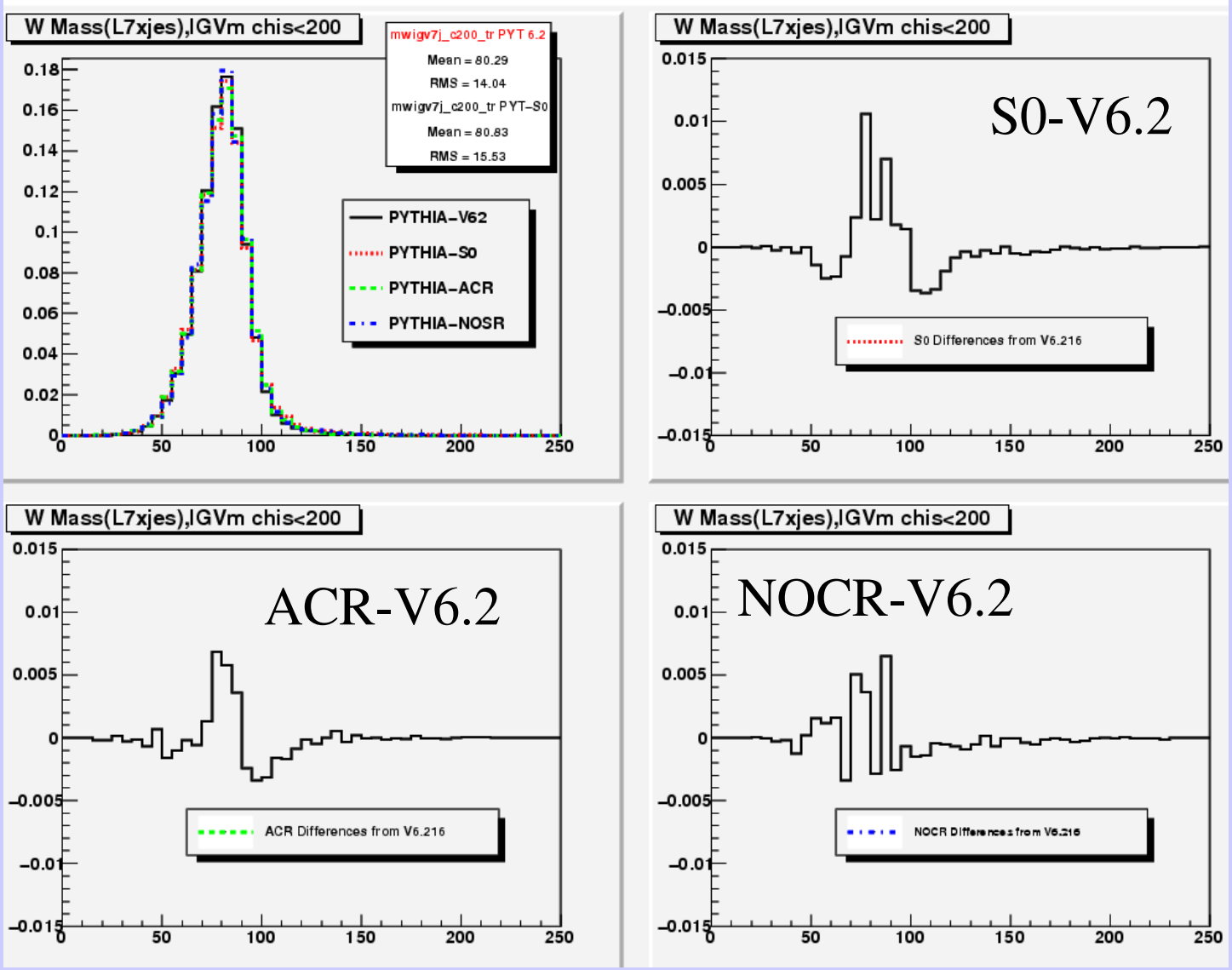
The jet shapes for light and b quarks are consistent

P_T(jet)/P_T(parton) for b jets



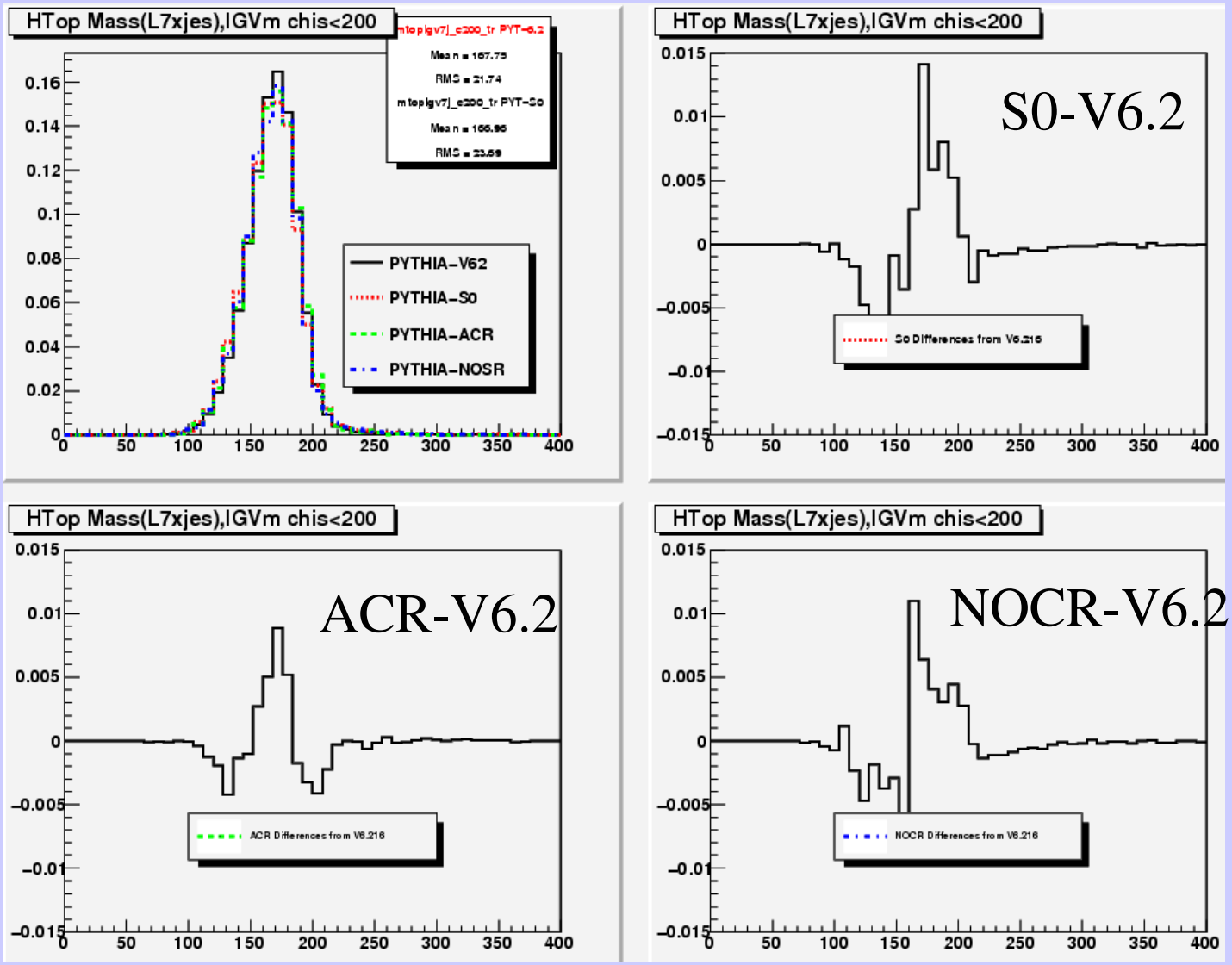
Distribution looks a bit wider and shifted for V6.4, tune S0

Reconstructed W mass at L7



MW shifted by 0.5 GeV, RMS is larger (14. vs 15.5 GeV) for S0

Reconstructed m(top)



In S0, Mtop is shifted by -0.8 GeV , RMS is 23.7-vs-21.7 GeV

What do we learn?

- The jets are wider in S0, so worse resolution.
- We see this in both the W mass and the top mass
- From other plots, not included here, I see that the jet widening happens mostly at low pT
- The ACR case has smaller effects than S0
- The NOCR shows less visible effects than S0
- Probably the combined effects on ACR and NOCR explain the S0 behavior. We should quantify this statement
- PYTHIA V6.4 is still being tuned by the authors

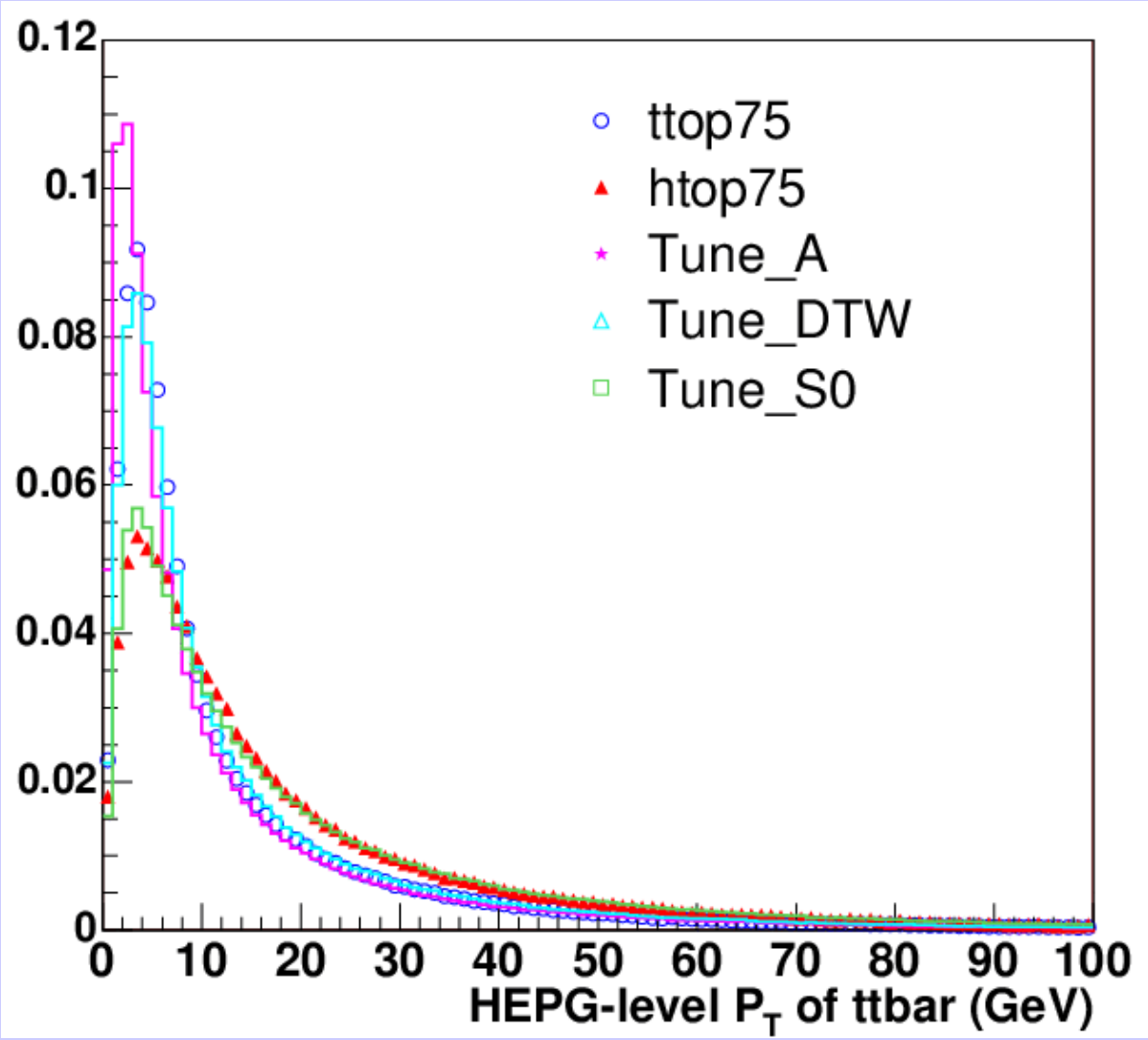
Color reconnection

Backup slides

Backup slides

P_T(ttbar)

Why change to V6.416 new tunes? PT(ttbar) now agrees with HERWIG. The PYTHIA authors believe this is what it should look like.



Courtesy of Mousumi Datta

PYTHIA V6.416 versus V6.216

Our top mass measurements have been done using V6.216 (2003)

Changes in V6.416

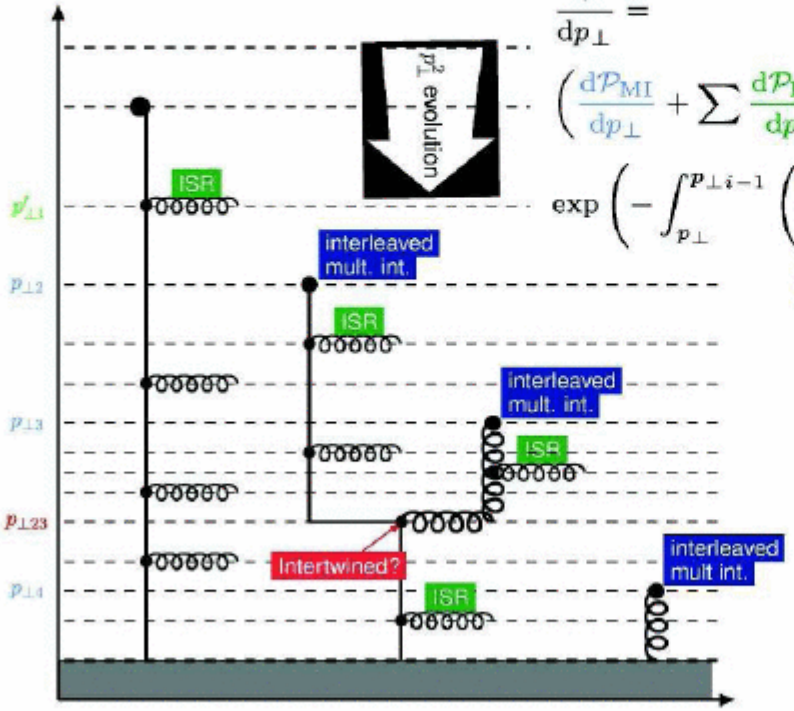
- Parton shower uses pt ordering rather then angular ordering
- Multiparton (MPI) interactions have been added
- ISR and FSR also have PT ordering algorithm
- New model for beam renmants, including baryon junctions
- Model interleaves MPI process with ISR evolution off the hard process
- Color reconnection added with an "annealing model" by P. Skands

P. Skands and D. Wicke hep-ph/0703081v1 (March 2007)
D. Wicke and P. Skands hep-ph/0807.3248 v1 (July 2008)
D. Wicke and P. Skands TOP08

New PYTHIA model (P. Skands etc.)

Pythias Underlying Event Models

- Old: UE generated after the ISR is done, i.e. uncorrelated.
- New: Parton showers interleaved with UE. (Requires p_T ordered shower).



$$\frac{d\mathcal{P}}{dp_\perp} = \left(\frac{d\mathcal{P}_{MI}}{dp_\perp} + \sum \frac{d\mathcal{P}_{ISR}}{dp_\perp} + \sum \frac{d\mathcal{P}_{JI}}{dp_\perp}\right) \times \exp\left(-\int_{p_\perp}^{p_{\perp i-1}} \left(\frac{d\mathcal{P}_{MI}}{dp'_\perp} + \sum \frac{d\mathcal{P}_{ISR}}{dp'_\perp} + \sum \frac{d\mathcal{P}_{JI}}{dp'_\perp}\right) dp'_\perp\right)$$

⇨ successive "finegraining" of all perturbative activity

+ correlated multiparton pdfs (with flavour/momentum cons)
+ Impact parameter dependence
+ String fragmentation developed for baryonic colour topologies ⇨ improved description of beam remn.

Daniel Wicke, Non-perturbative QCD and Top Mass, Modelling — Top2008, La Biodola, Elba, 18–24 May 2008 — 5

Color reconnection in PYTHIA

Current Tunes

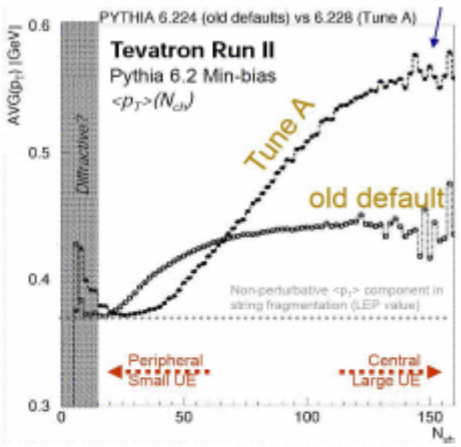
Tuning to min. bias data gave significant improvements

Several pythia tunes to min. bias data available

Tune A, Tune DW, Tune BW, ... (Rick Field)

These implicitly allow CR within UE to a high level:

PARP(85)	$0.33 \rightarrow 1.0$	Prob. for MPI w/ colour connection
PARP(86)	$0.66 \rightarrow 1.0$	to neighbours/ closed loop



Colour Reconnection

Is the colour-flow of the hard interaction preserved?

Proton remnants provide lots of (soft) gluons to interact with.

Most models were only available for $e^+e^- \rightarrow WW$

New Models by M. Sandhoff and P. Skands in Pythia 6.326+
Alternative models by Uppsala group / Webber not yet explored in this context.

Color reconnection in PYTHIA V6.4

New CR Models: Colour Annealing

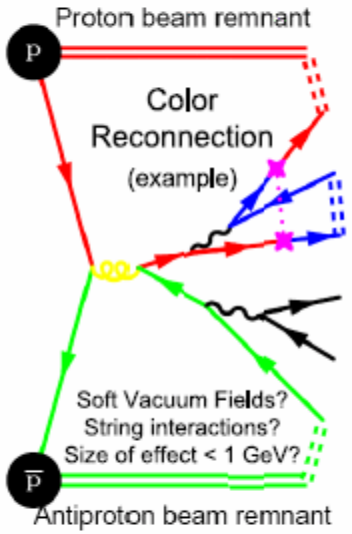
Allow CR also within the hard interaction.

- At hadronisation strings pieces may reconnect

$$P_{\text{reconnect}} = 1 - (1 - \chi)^n$$

χ — strength parameter
n — number of interactions
(counts number of possible interactions)

- New connection chosen to minimise string length, i.e. minimise potential energy in strings
- Model variations: $S0$, $S1$, $S2$ differ in suppression of gluon only string loops



These models of colour reconnection are applicable to any final state.

Effects on top mass

Wicke + Skands analysis (toy MC for top mass) conclude:

$\Delta(m_t) \sim 0.7$ from new shower effects

~ 0.5 from color reconnection effects

- We (MTM3 as an example) have the following systematics:
  generator: $\Delta(m_t) = 0.51 +- 0.37$ GeV
  ISR/FSR: $\Delta(m_t) = 0.29 +- 0.26$ GeV
- Using V6.416 (S0) to estimate systematics should cover most of these systematics, in addition to color reconnection.
- We have to avoid double counting, so we should try to separate the two effects . Not clear how to do this.