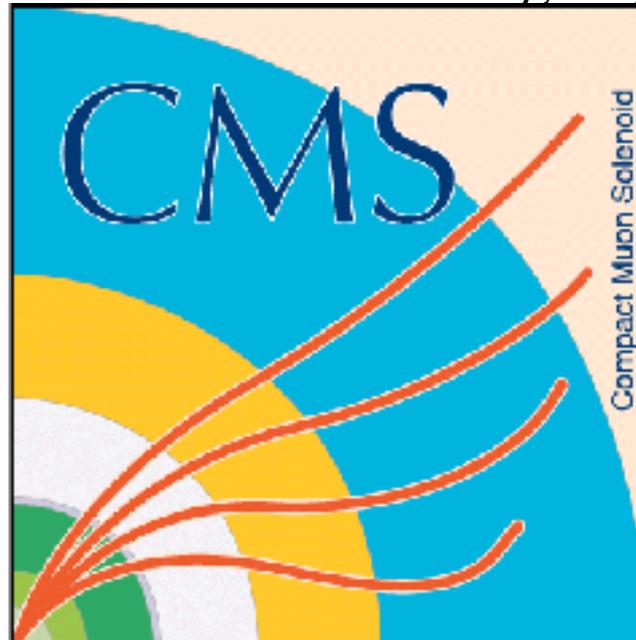


Jet Reconstruction and Software Release Validation for the CMS at the LHC

John Novak (Western Michigan University)

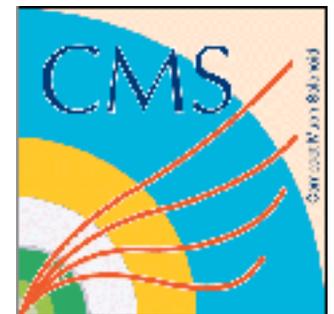
SULI Final Presentation

WH2E Commitium Tuesday, July 29



Outline of Presentation:

- The Big Picture:
 - LHC
 - CMS
- The Physics
 - Hadronization and Jets
- Jet Analysis and Software Release Validation
- Conclusions



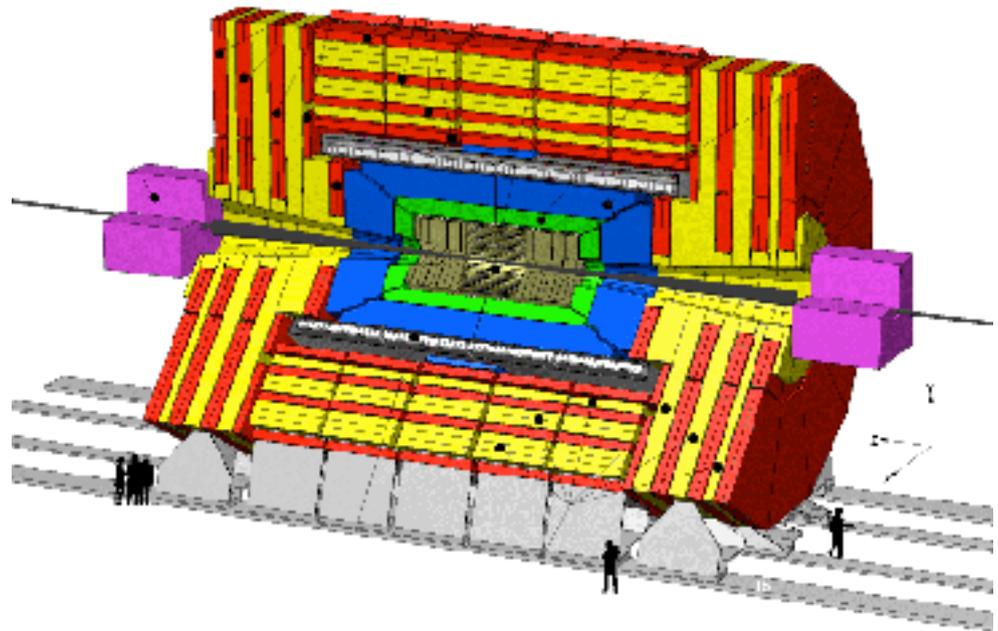
Large Hadron Collider (LHC)



- Worlds highest energy accelerator. 14 TeV collisions
- Proton-proton collisions
- Located in near Geneva, Switzerland
- Built by an international collaboration. 85+ countries

Compact Muon Solenoid (CMS)

- Detector at the LHC
- 4T Solenoid- largest ever built
- The silicon tracking comprises ~250 square meters of silicon detector
- There is about as much iron in the magnetic return yoke as in the Eiffel tower.

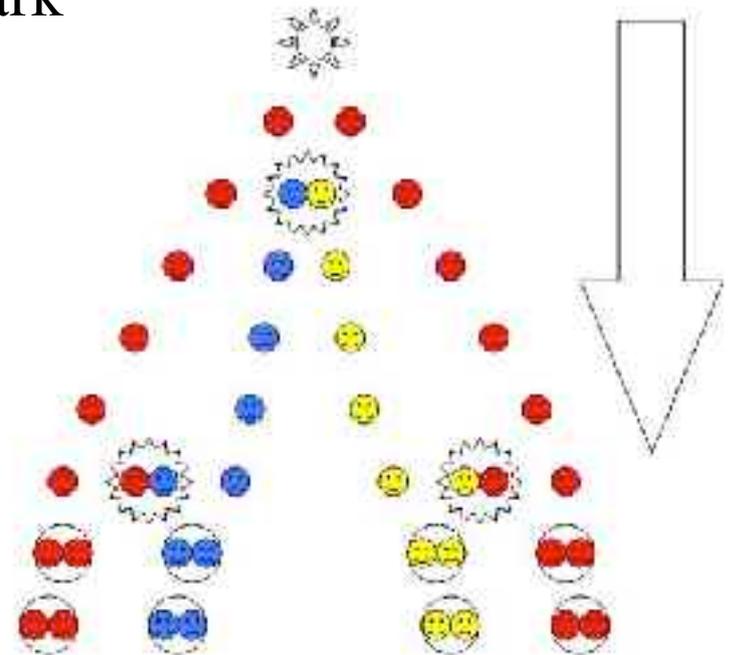


Hadronization

Quarks are asymptotically bound- the force between them gets stronger as they get further apart.

When there is enough energy in the bond, a quark anti-quark pair will form from the energy. This process is called hadronization.

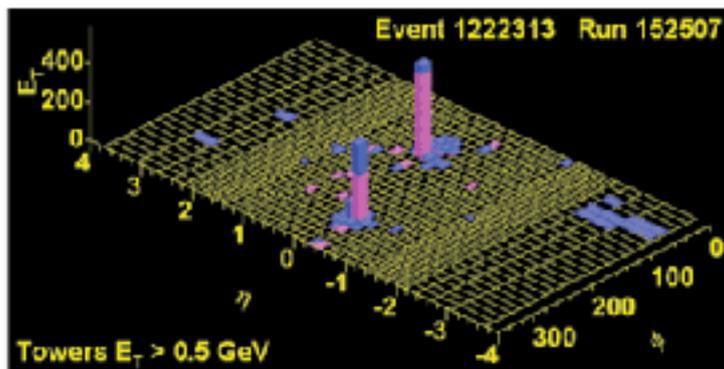
As long as there is enough energy hadronization will continue. The new quarks and anti-quarks will take the form of particles.



Jets

“Jet” is a term for a collated group of particles coming from an interaction, or a collated group of energy deposits in a detector.

Jets have properties such as momentum, energy, size, and position in the detector.

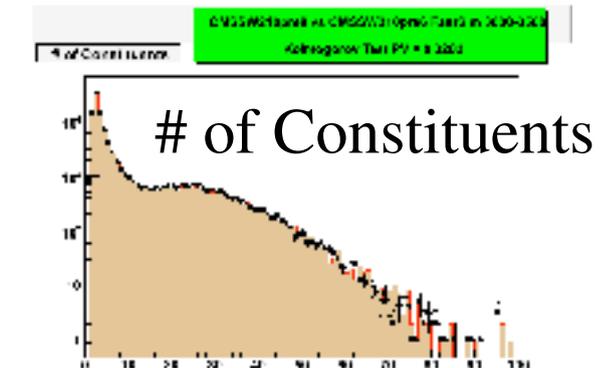
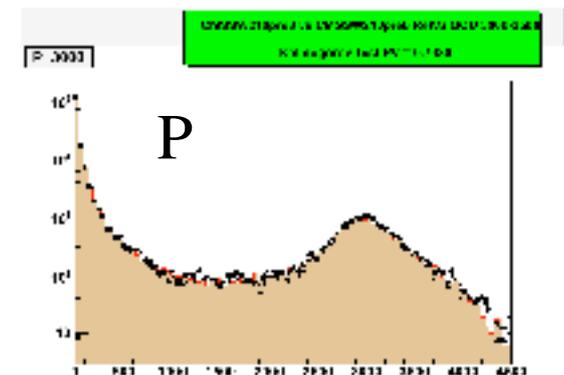
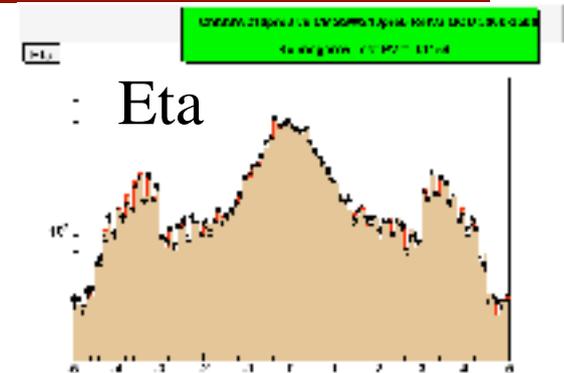


Jet Reconstruction

We use software to analyze jet properties. The software uses simulations of the detector and algorithm to define and reconstruct jets.

In this case, our software outputs about 50 histograms of various Jet properties.

The histograms to the right are of Eta, Momentum, and the number of constituents.



Validation

Why Validation:

Different software releases use different detector simulations.

What is Validation:

Validation is done by comparing histograms against a standard reference sample and looking for disagreements.

My Project:

- To create a framework for release validation.
- To validate releases using a standard reference samples
- To build an online repository of comparisons

Index of CMSSW Validation Samples - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

File:///usrns_data/d1/famr/Database/index.html

Famr Linux FamrLab FamrLinux Linux District

CS&M - Communication Services Index of CMSSW Validation Sa...

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CMSSW206 vs CMSSW200

[80-120](#)
[3000-3500](#)

CMSSW 2 1 0 pre3

[CMSSW210pre3 index](#)

CMSSW210pre3 vs CMSSW200

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CMSSW210pre3 vs CMSSW206

[80-120](#)
[3000-3500](#)

CMSSW 2 1 0 pre5

[CMSSW210pre5 index](#)

CMSSW210pre5 vs CMSSW200

[80-120](#)
[3000-3500](#)

CMSSW210pre5 vs CMSSW206
 file:///usrns_data/d1/famr/Database/CMSSW_2_0_6/CMSSW_2_1_5 vs CMSSW

Index of CMSSW210pre8 Validation Samples - Mozilla Firefox

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CMSSW210pre8 vs CMSSW210pre3

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CMSSW210pre8 vs CMSSW210pre3

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CMSSW210pre8 vs CMSSW210pre3

RelValQCD
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 FastSim
[80-120](#)
[3000-3500](#)

CMSSW210pre8 RelValQCD vs FastSim

[80-120](#)
[3000-3500](#)

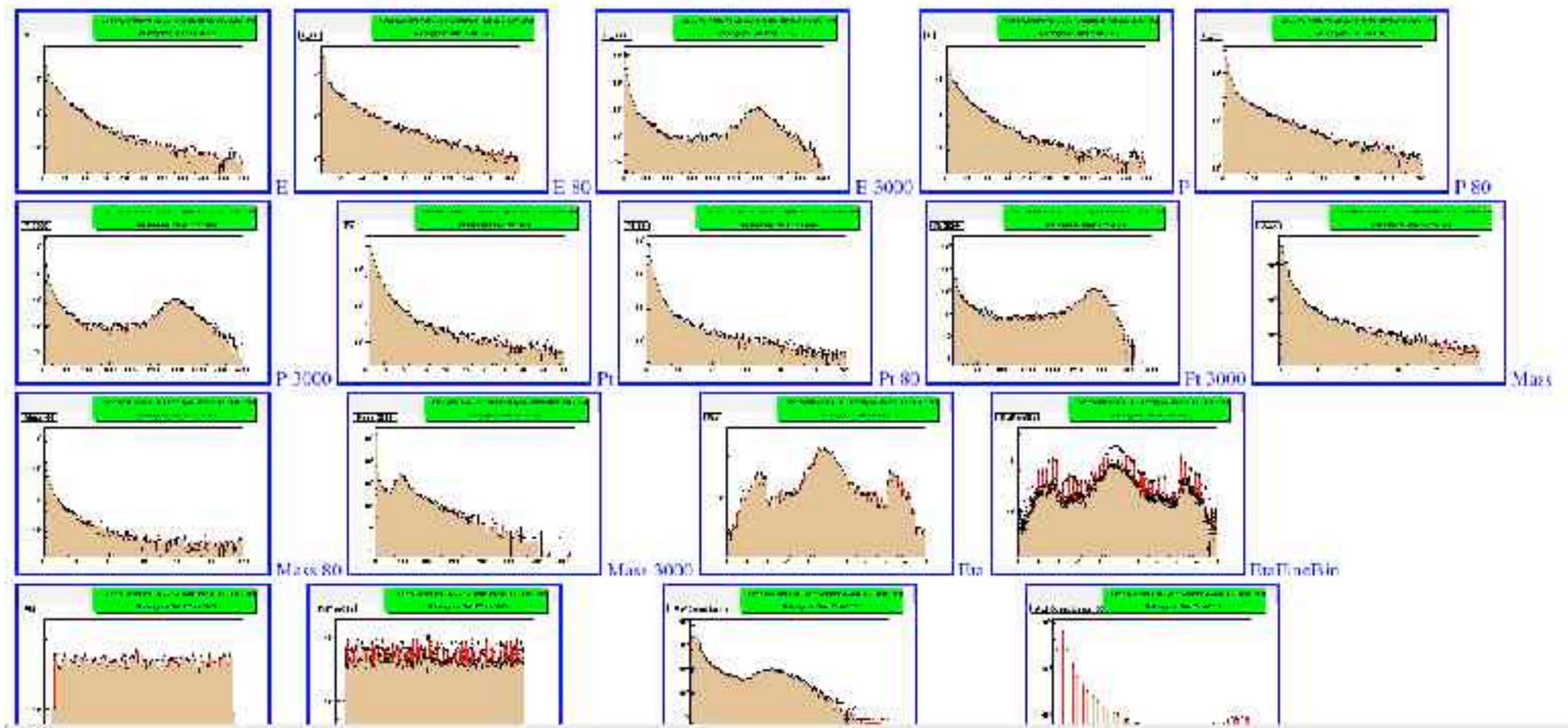
Done

CMSSW210pre8 vs CMSSW210pre6 ReValQCD 3000-3500

Samples

[ROOT File](#)

General Distributions



My Project

Transverse momentum is a measure of how much momentum a particle has orthogonal to the plane of the detectors.

For validation, we used two standard physics samples. One with a transverse momentum of 80–120 GeV and another of 3000–3500 GeV, so that we could see how the softwares behaves at low and at high energies and transverse momenta.

My Project Cont.

The code that I have written has been committed to the CMS repository.

The framework built for software release validation has also proved to be useful for other things, such as comparing simulations which are slightly different. For example: different magnetic field, different detector simulations.

Simulation Validation

FastSim- Fast Simulation: events are generated using parameterizations of physics processes and simplified particle response in the detector. Takes a few seconds per event.

FullSim- Full Simulation: events are generated by simulating the interactions of the particles with the detectors in detail. Takes a few minutes per event.

A complete simulation is on the order of 50,000 events, so there has been a push for more FastSim. But one conclusion was that FastSim didn't reflect FullSim well in some respects.

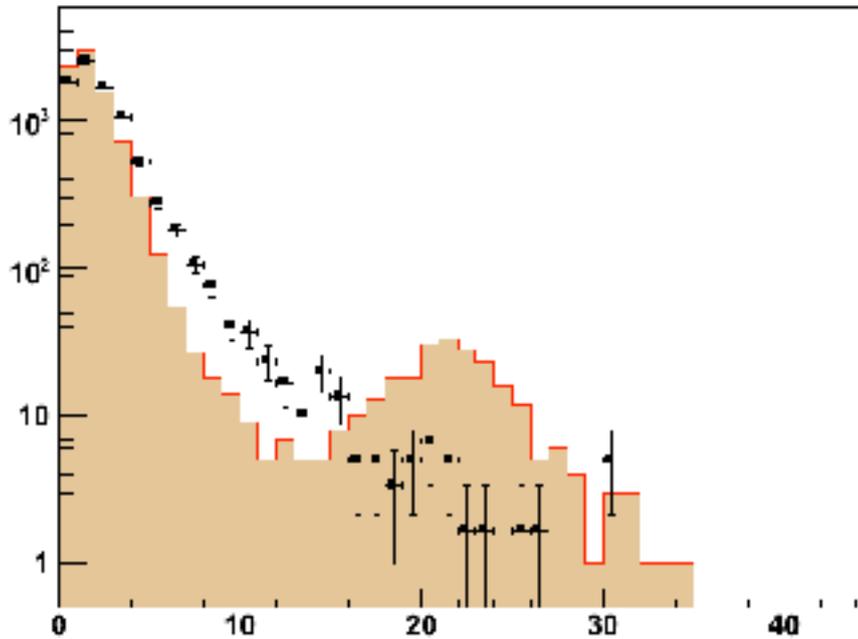
CMSSW210pre8 ReValQCD vs FastSim 3000-3500

Kolmogorov Test PV = 0.0000

CaloMETSig

210 pre8 FullSim vs FastSim

This Histogram is a distribution of the missing ET significance

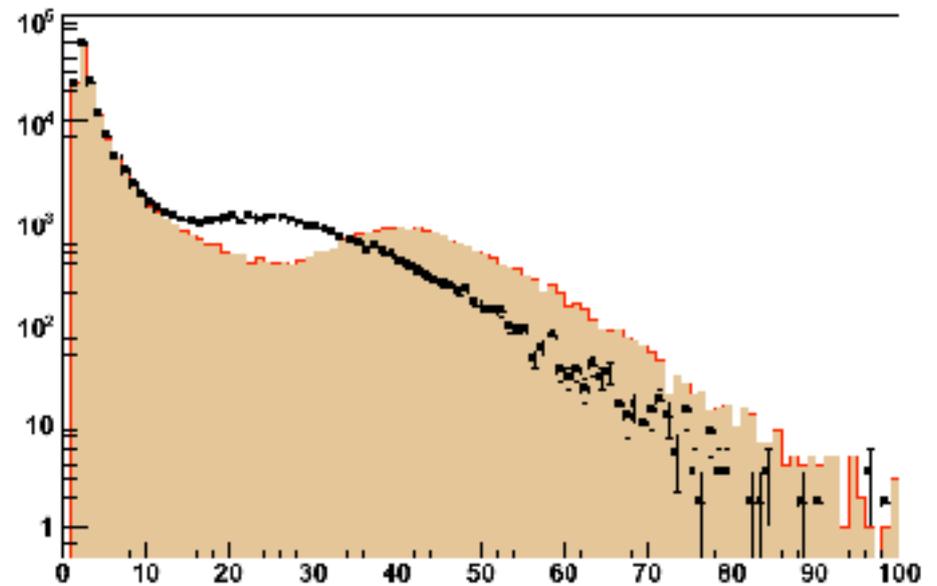


This Histogram is a distribution of the number of constituents in the jets.

CMSSW210pre8 ReValQCD vs FastSim 3000-3500

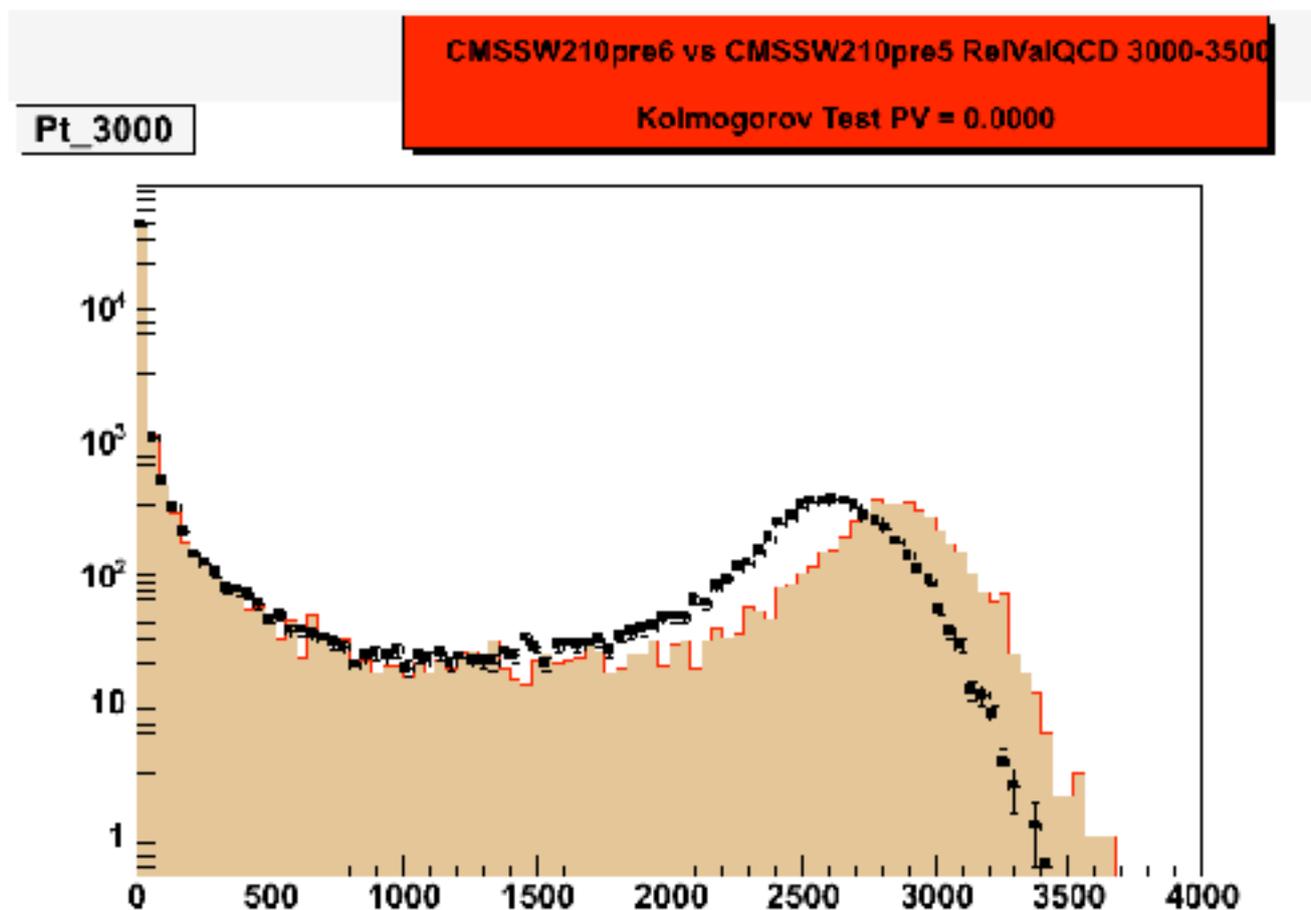
Kolmogorov Test PV = 0.0000

of Constituents



Release Validation

There were some unexpected changes between some releases:



This is a distribution of the transverse momentum

Summary

- We have built a framework for software release validation.
- The code used has been committed to the repository, and all CMSSW releases from 200 through 210pre8 have been compared
- The output has been made web browse-able.

Credits

Image credits:

http://qd.typepad.com/6/2005/02/color_radiation.html

http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-97332007000500044&lng=en&nrm=iso&tlng=en

http://images.iop.org/objects/cern/cern/43/1/14/cerntev3_1-03.jpg

http://www.phys.ufl.edu/hee/cms/images/CMS_3D_Detector_50.gif

http://physics.syr.edu/~lhcb/public/alignment/LHCAlignmentWorkshop/_borders/cms.gif

http://cosmicvariance.com/wp-images/LHC_arial.JPG

<http://qd.typepad.com/.shared/image.html?/photos/uncategorized/zdeca y.jpg>

<http://www.scielo.br/img/revistas/bjp/v37n2c/a44fig01.gif>