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Jet spectra comparisons: Pythia and MadGraph



outline

- × motivation
- × analysis configuration
- × data samples used
- × \hat{H}_T distributions
- × p_T distributions of the 1st and 2nd jet
- × H_T distributions
- × corrected/generated H_T ratio
- × ratio R_{32}
- × study of plots after modification of the nominal σ_{MG}
- × conclusions



motivation

✗ Pythia

- + can only handle $2 \rightarrow 2$ processes
- + no tree-level diagrams
- + uses $2 \rightarrow 2$ leading order matrix elements
- + higher orders are simulated via the parton shower model
- + not good at high p_T tails

✗ We need another MC tool that uses NLO calculations

✗ MadGraph

- + can handle tree-level processes
- + should be better at high p_T tails
- + may provide a better R_{32} (three to two jets ratio)



analysis configuration

- ✗ CMSSW version: **CMSSW_2_2_6**
running on our GRID site, **T3_GR Ioannina**
- ✗ Data used are stored on the SE of T3_GR_Ioannina :
<https://cmsweb.cern.ch/phedex/prod/Data::Subscriptions?node=761>
- ✗ jet algorithm: **SC7**
- ✗ good jets: **$p_T \geq 50$ GeV**
- ✗ eta cut applied: **$|\eta| \leq 2.5$**
- ✗ CALO jet corrections: **L2L3JetCorrectorSC7Calo**
- ✗ definitions:
 $H_T = \sum p_T$ over all jets
 $R_{32} = \# \text{ events with } \geq 3 \text{ good jets} / \# \text{ events with } \geq 2 \text{ good jets}$



Pythia data

Datasets:

/QCDDiJetPt nnn to nnn /Summer08_IDEAL_V9_v nnn /GEN-SIM-RECO

p_T slice	cross section (pb)	# of events
0015_0020	949441000.000000000000	129600
0020_0030	400982000.000000000000	101880
0030_0050	94702500.000000000000	169200
0050_0080	12195900.000000000000	103545
0080_0120	1617240.000000000000	51300
0120_0170	255987.000000000000	50085
0170_0230	48325.000000000000	51840
0230_0500	10623.200000000000	54000
0300_0580	2634.940000000000	60048
0380_0470	722.099000000000	93312
0470_0600	240.983000000000	27648
0600_0800	62.492300000000	30348
0800_1000	9.420620000000	20880
1000_1400	2.343570000000	24640
1400_1800	0.156855000000	27744
1800_2200	0.013811000000	22848
2200_2600	0.001296080000	22560
2600_3000	0.000114040000	28800
3000_3500	0.00000843180	20880
3500_inf	0.00000018146	34320

Cross sections from

<https://twiki.cern.ch/twiki/bin/view/CMS/ProductionSummer2008#Pythia6>



MadGraph data

Datasets:

/QCD nnn to nnn -madgraph/Fall08_IDEAL_V9_v nnn /GEN-SIM-RECO

(Used ~50 files per slice)

\hat{H}_T slice	cross section (pb)	# of events*
0100_0250	15000000.00	310155
0250_0500	400000.00	234160
0500_1000	14000.00	186032
1000_inf	370.00	167717

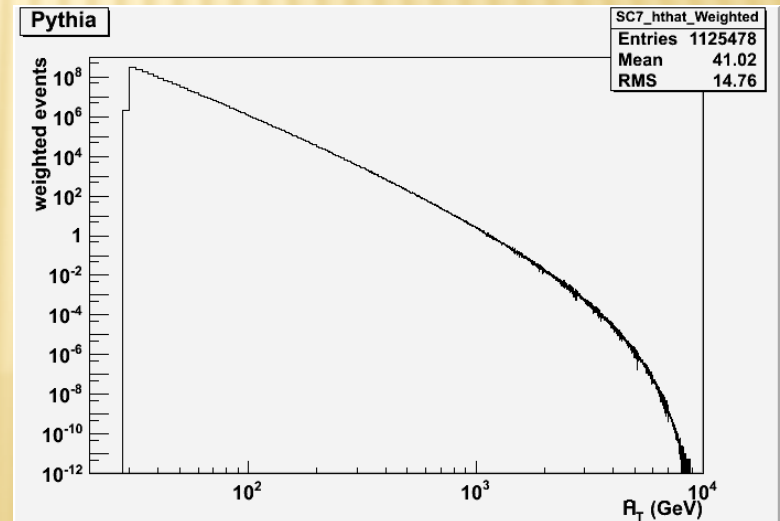
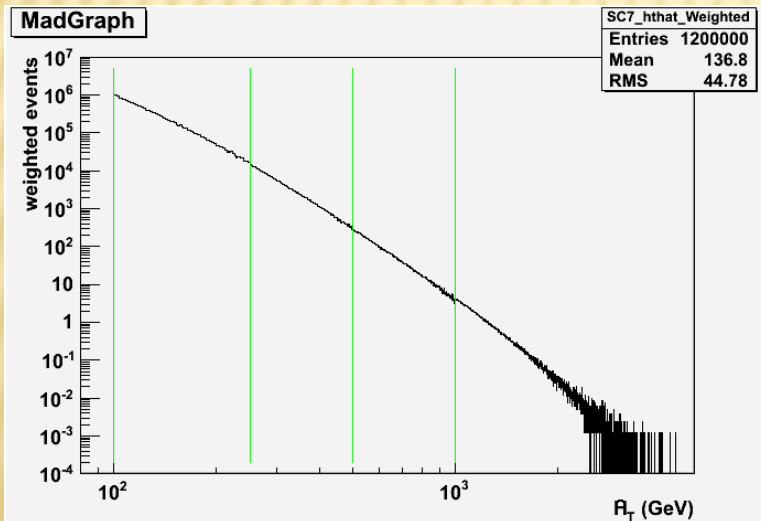
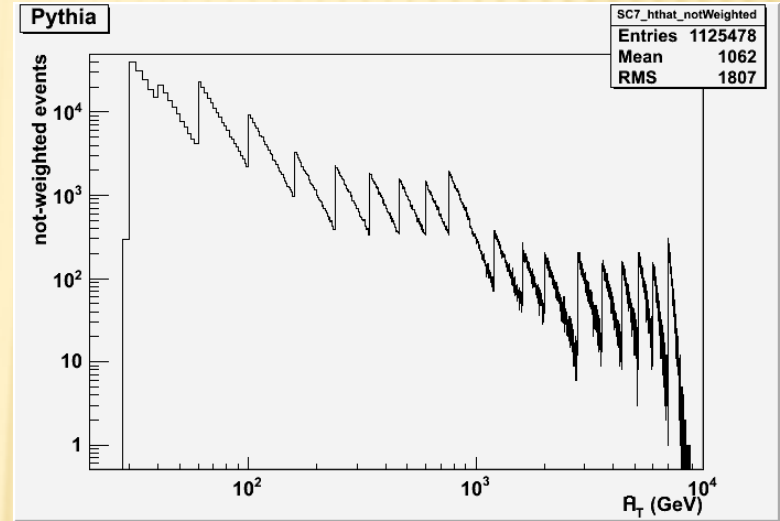
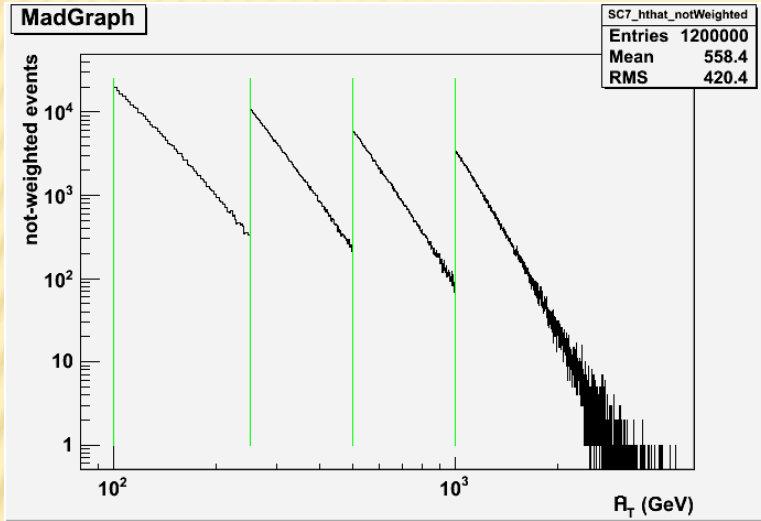
Cross sections from

<https://twiki.cern.ch/twiki/bin/view/CMS/ProductionSummer2008#MadGraph>

*for the \hat{H}_T distributions, 300k events per slice were used

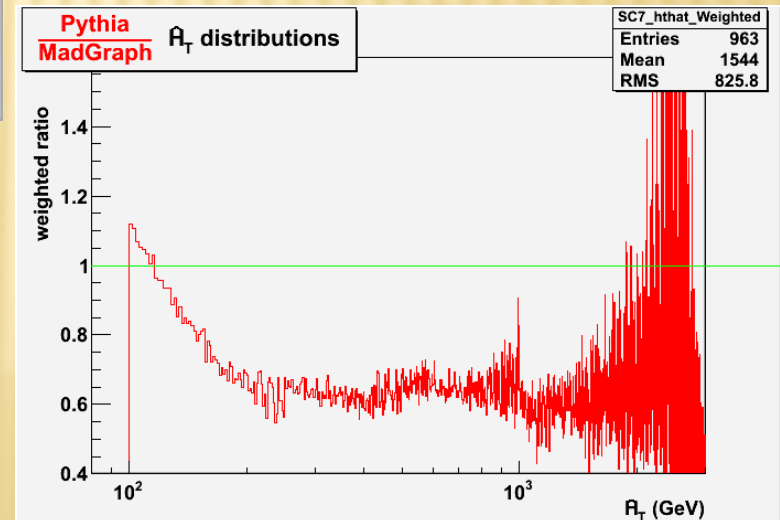
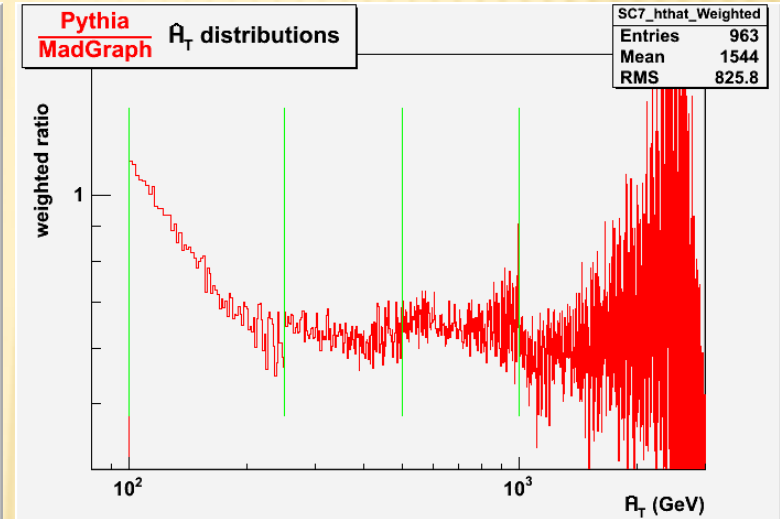
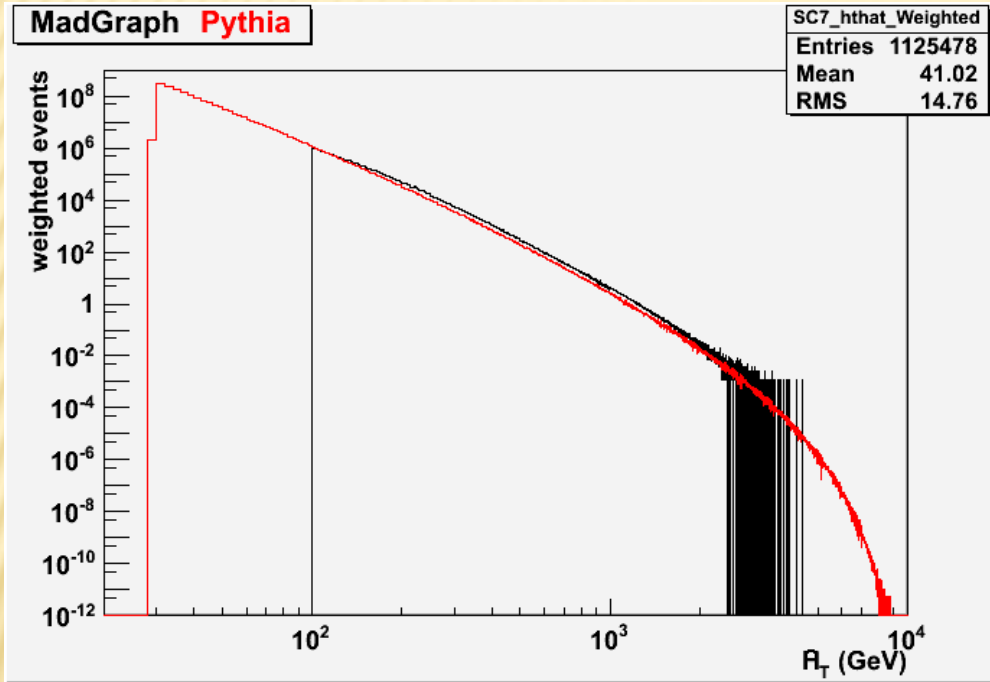


\hat{H}_T distributions





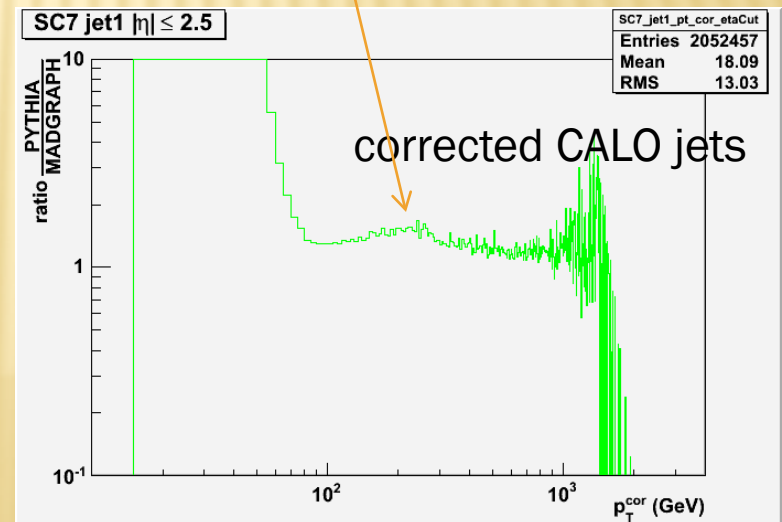
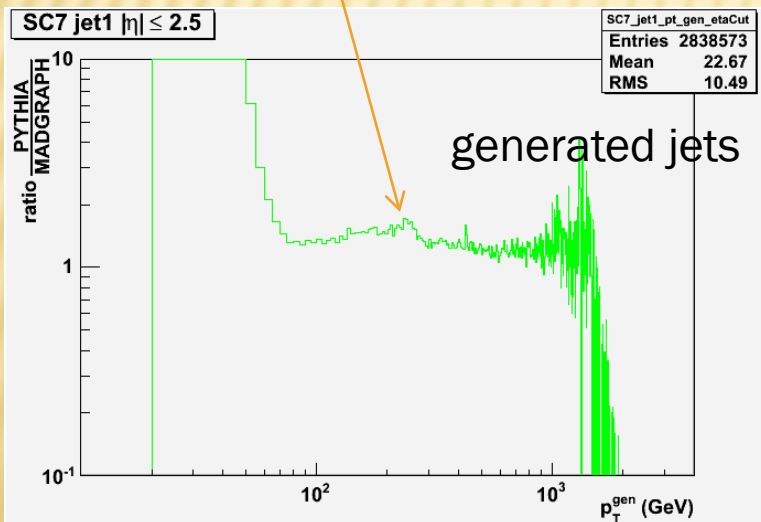
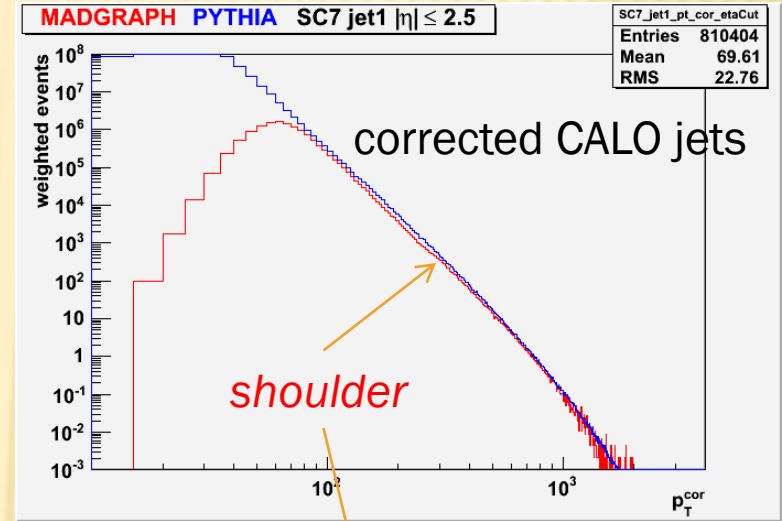
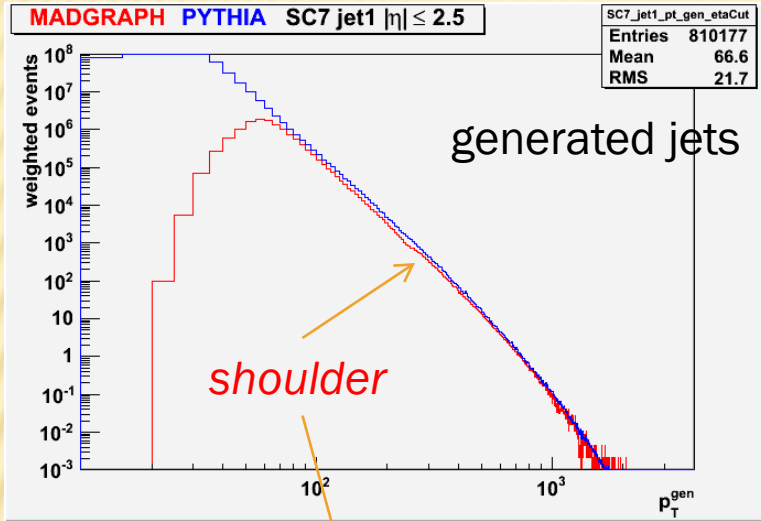
\hat{H}_T distributions



- ✗ \hat{H}_T is not present in the MadGraph events
- ✗ it was calculated using code provided by Steve Mrenna
- ✗ the not-weighted \hat{H}_T distribution is in perfect agreement with the MadGraph slice limits
 - + the code was correctly imported

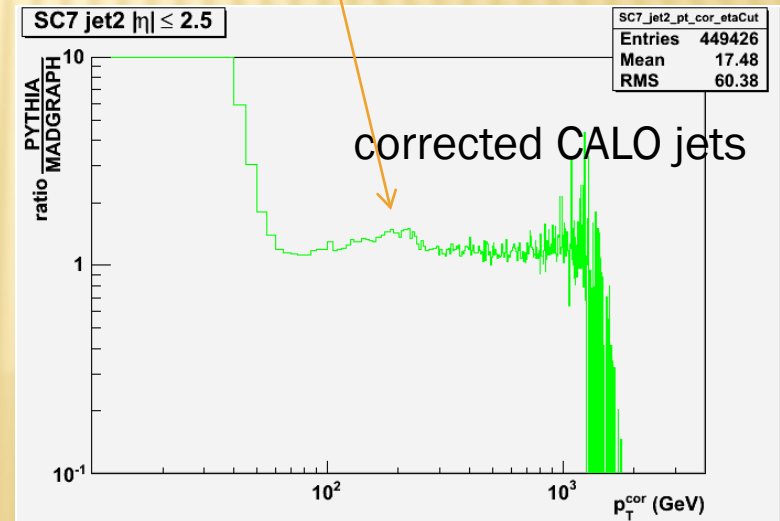
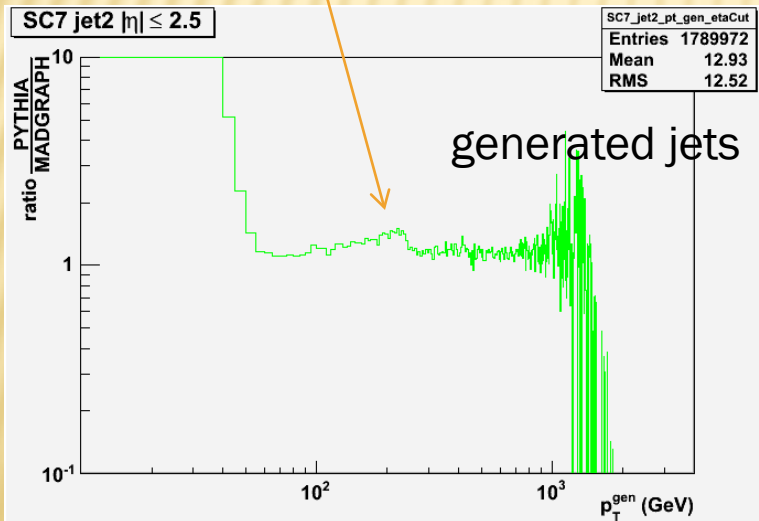
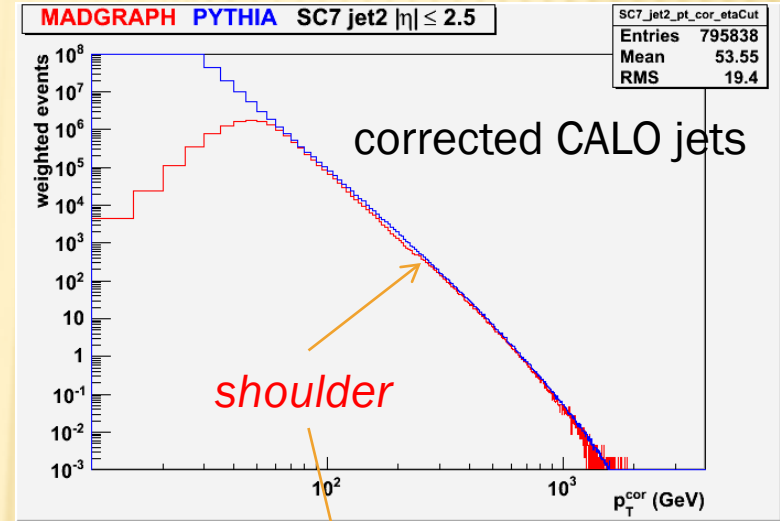
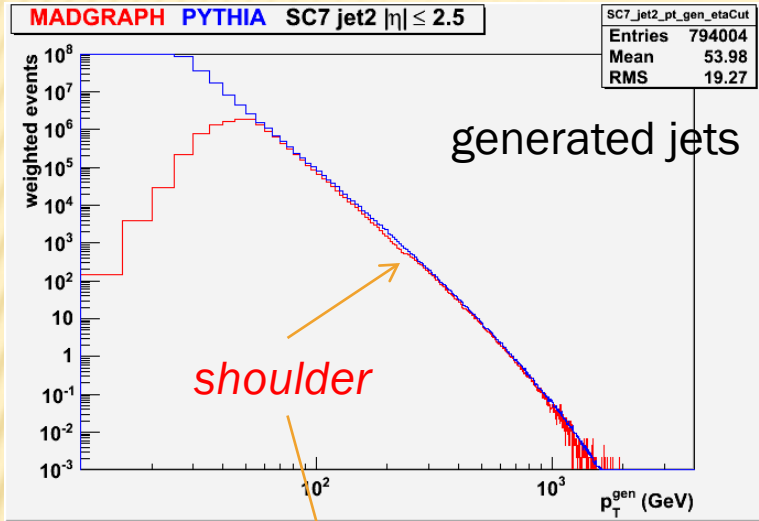


p_T distributions of the 1st jet



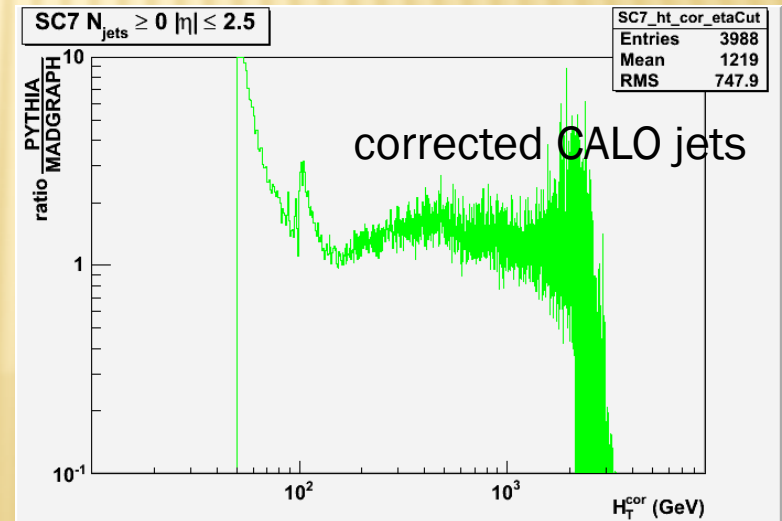
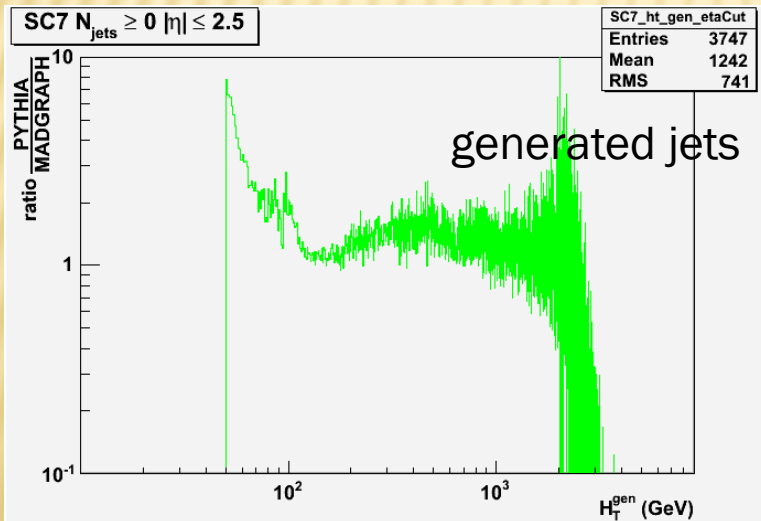
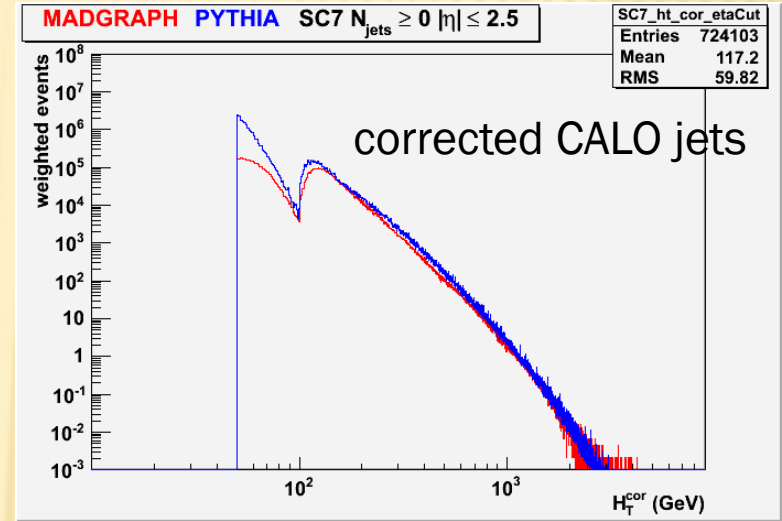
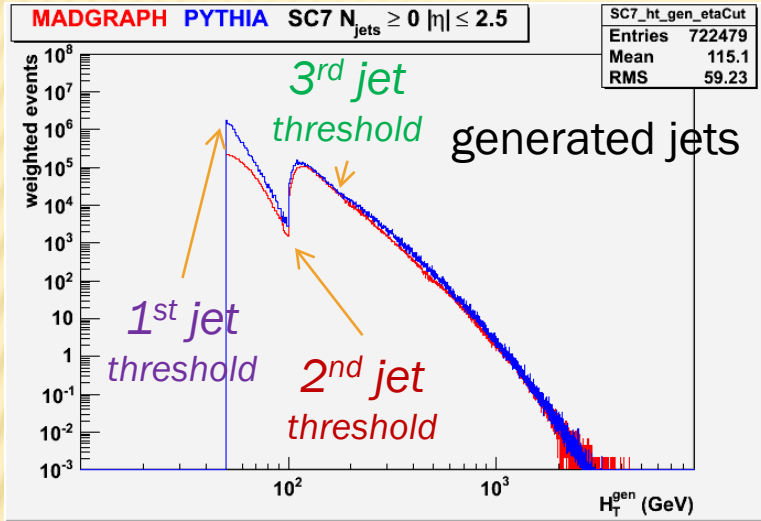


p_T distributions of the 2nd jet





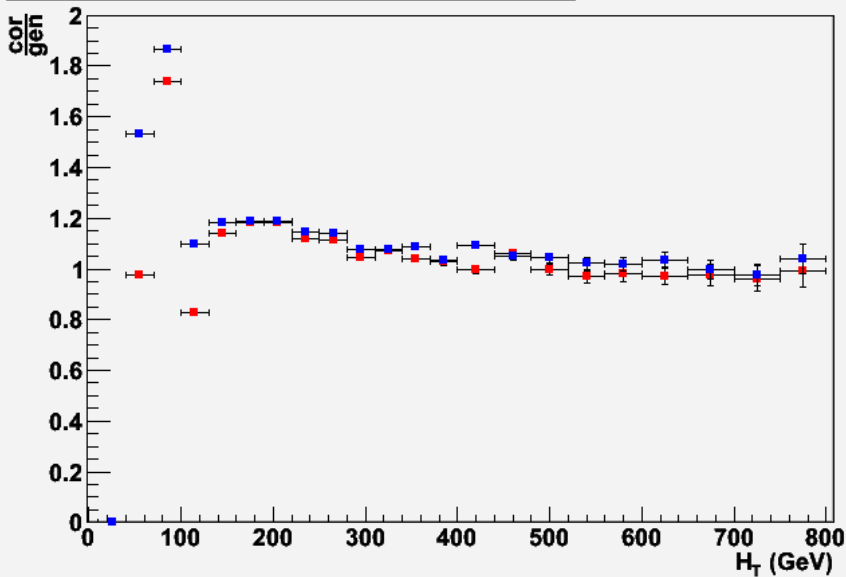
H_T distributions



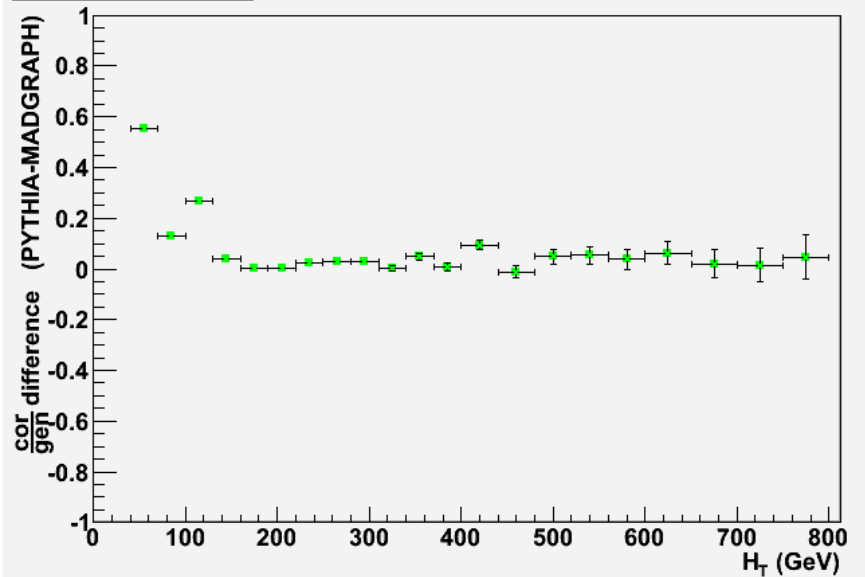


corrected/generated H_T ratio

MADGRAPH PYTHIA $N_{jets} \geq 0, |\eta| \leq 2.5$



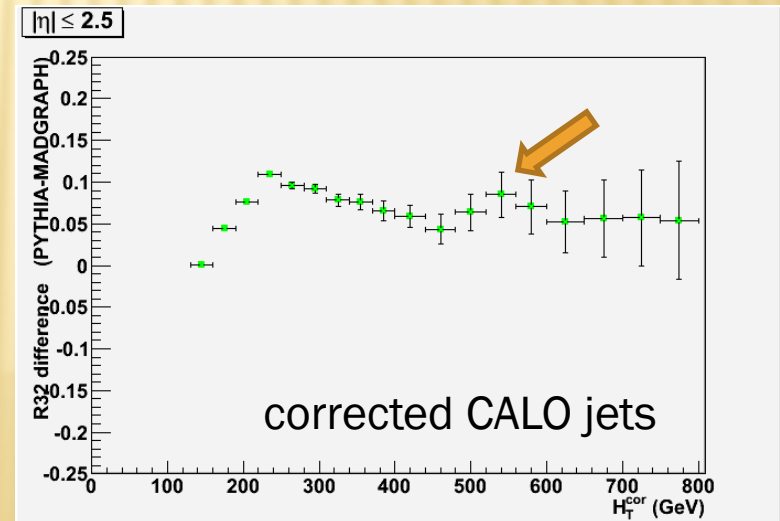
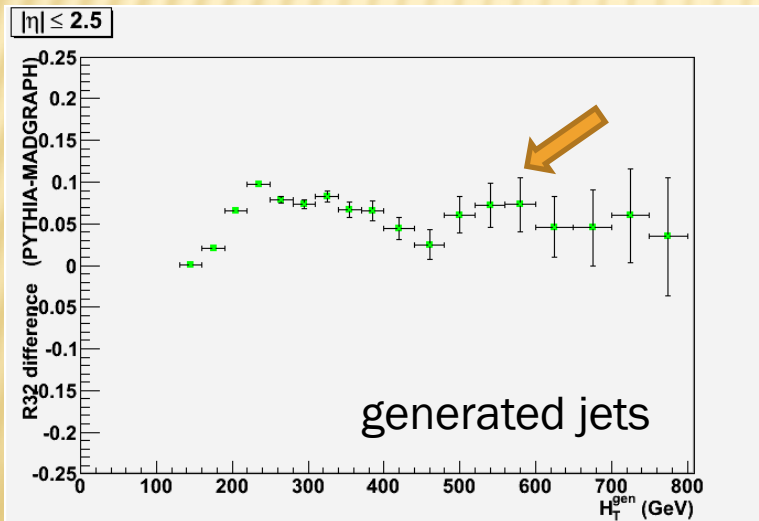
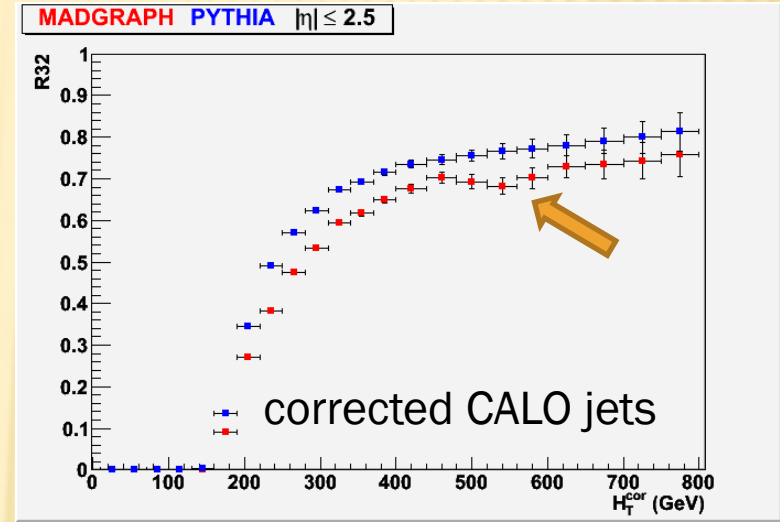
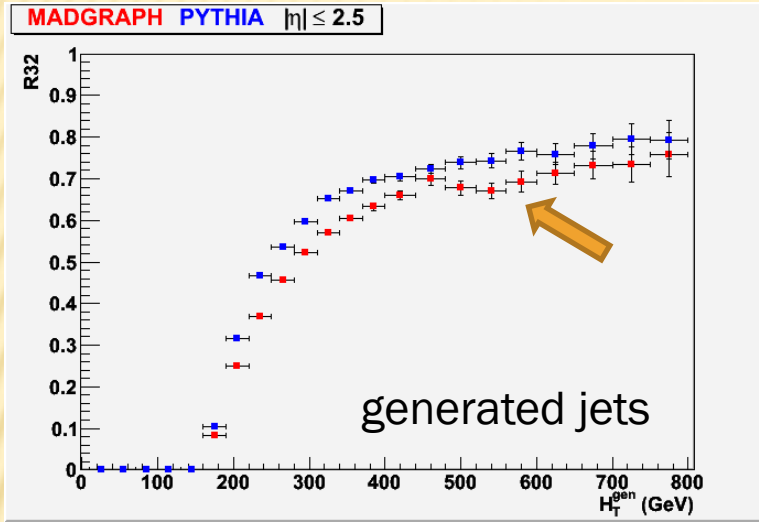
$N_{jets} \geq 0, |\eta| \leq 2.5$



error bars not significant
(correlated errors were not taken into account)

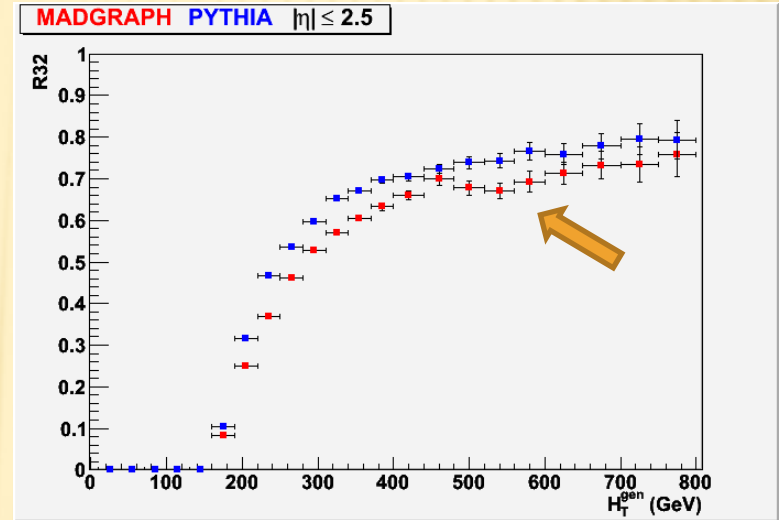
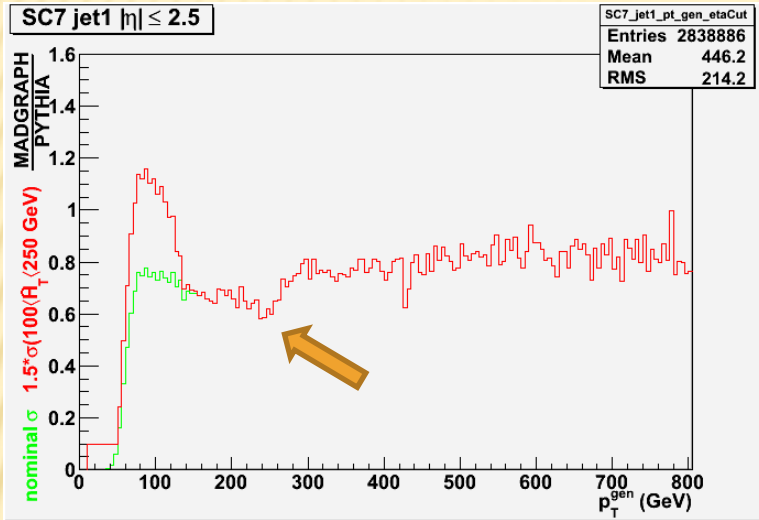


ratio R_{32}

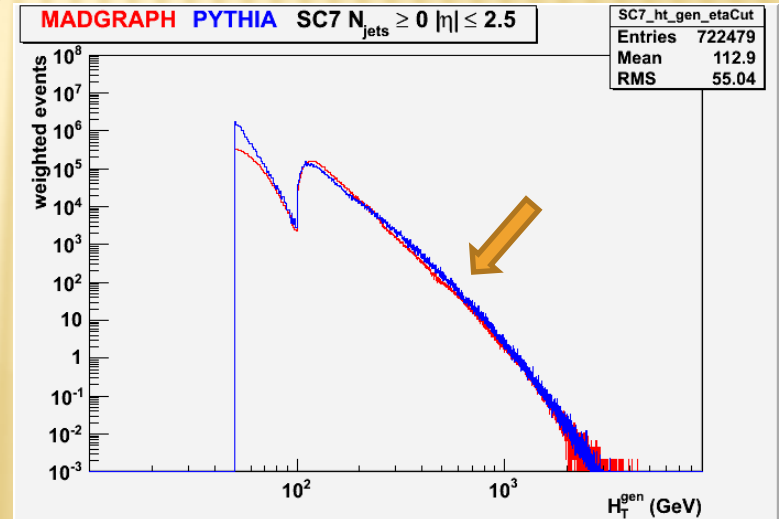
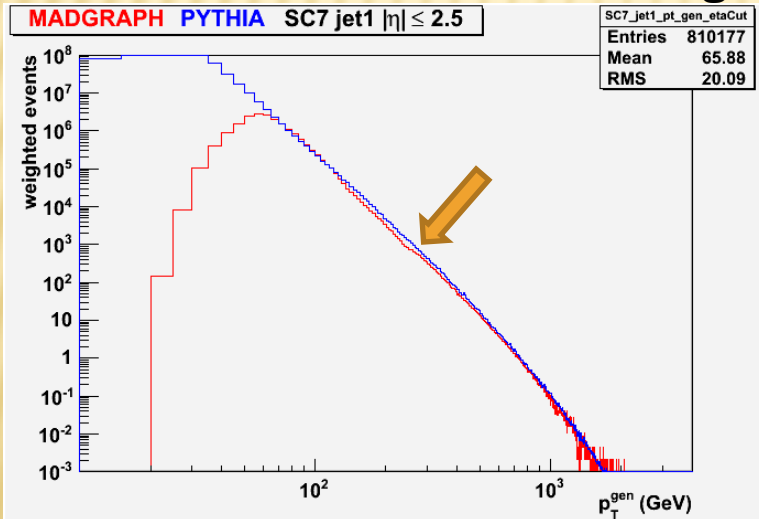




$\sigma_{MG} +50\%$ for $\hat{H}_T \in (100, 250)$ GeV

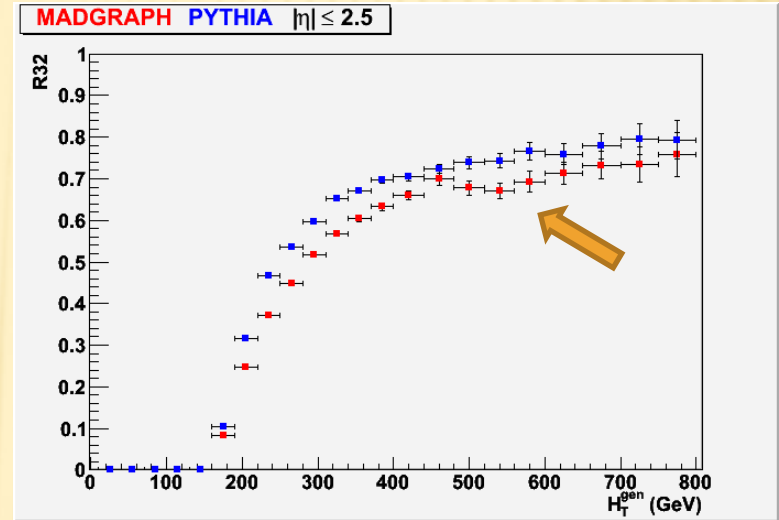
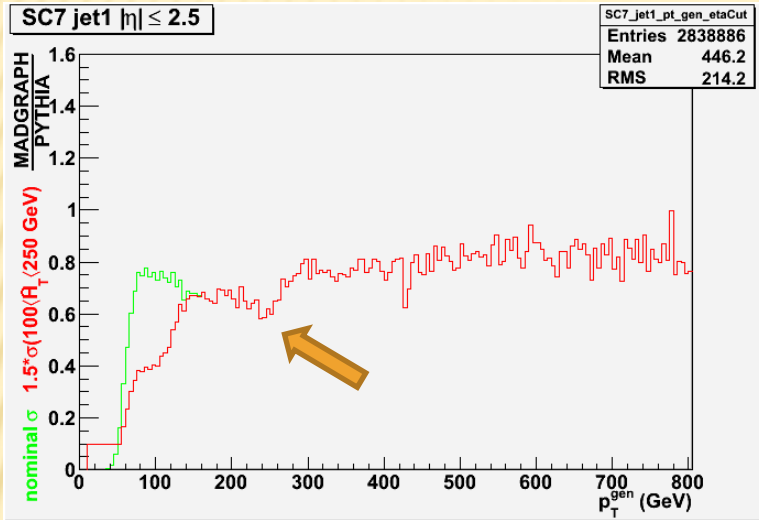


generated jets

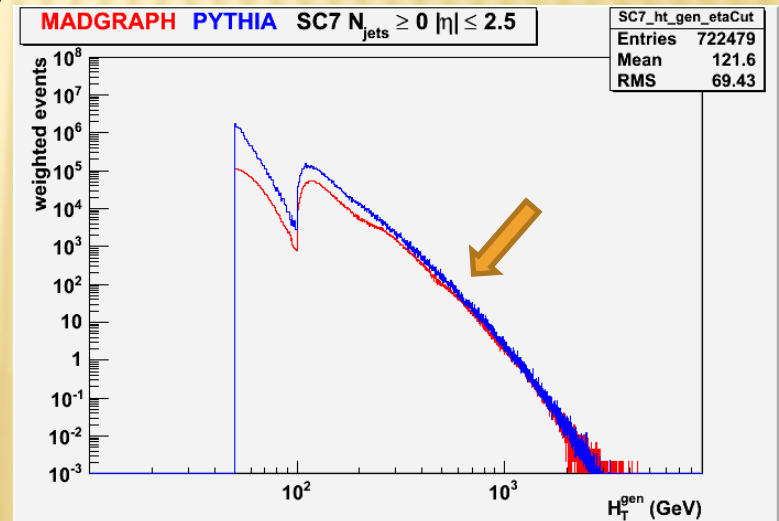
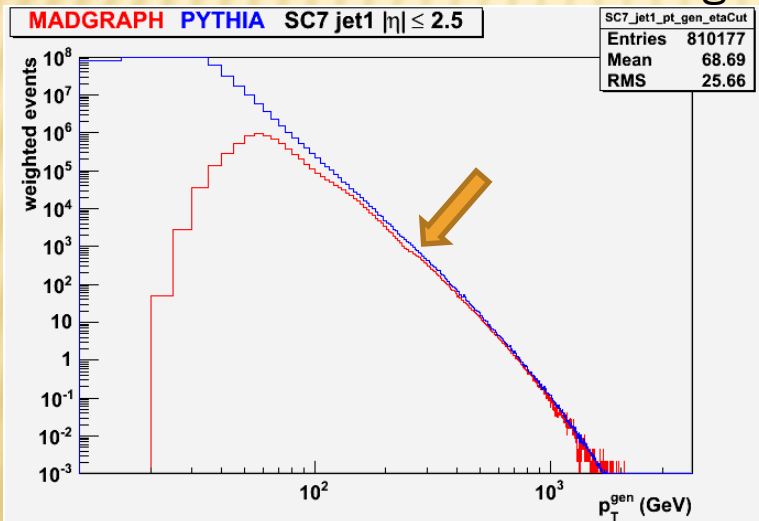




$\sigma_{MG} - 50\%$ for $\hat{H}_T \in (100, 250)$ GeV

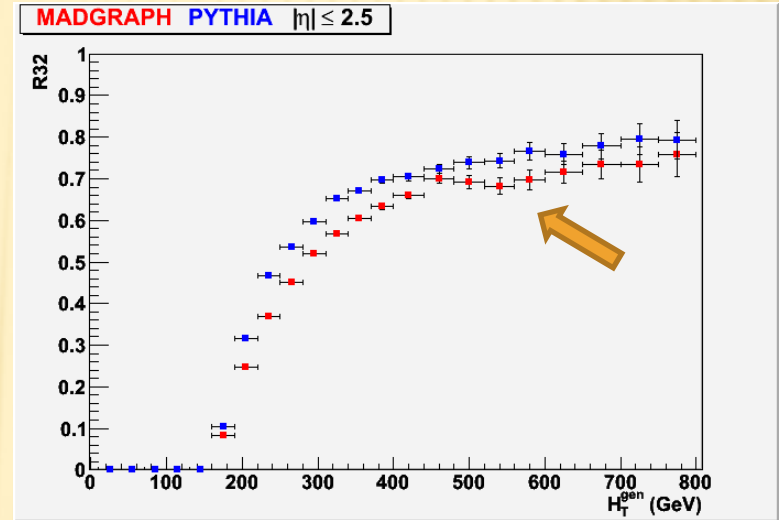
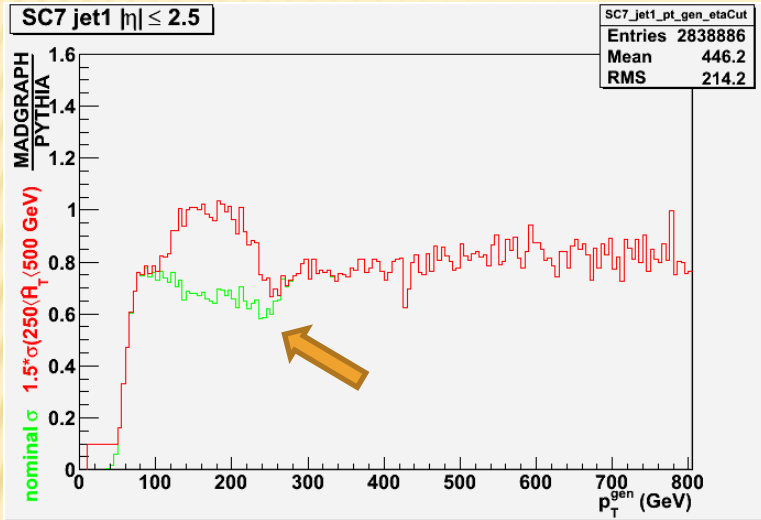


generated jets

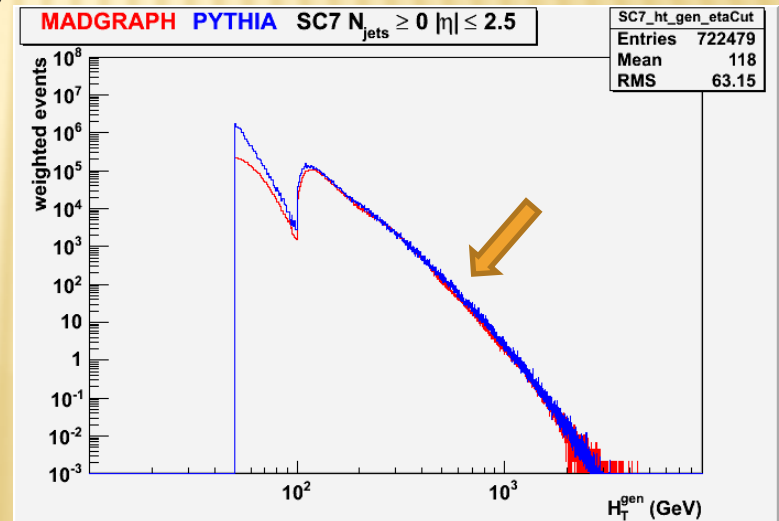
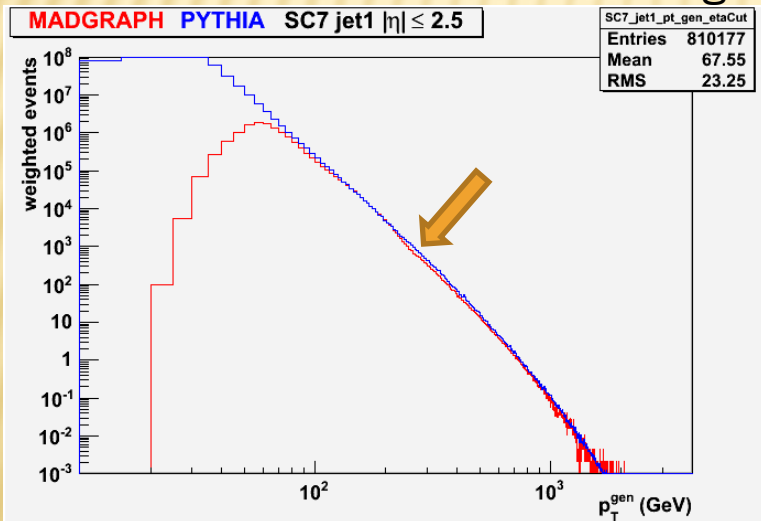




$\sigma_{MG} +50%$ for $\hat{H}_T \in (250, 500)$ GeV

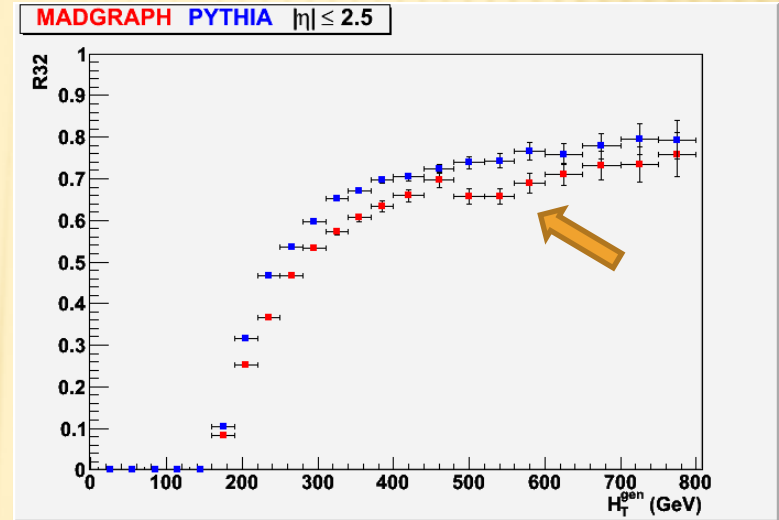
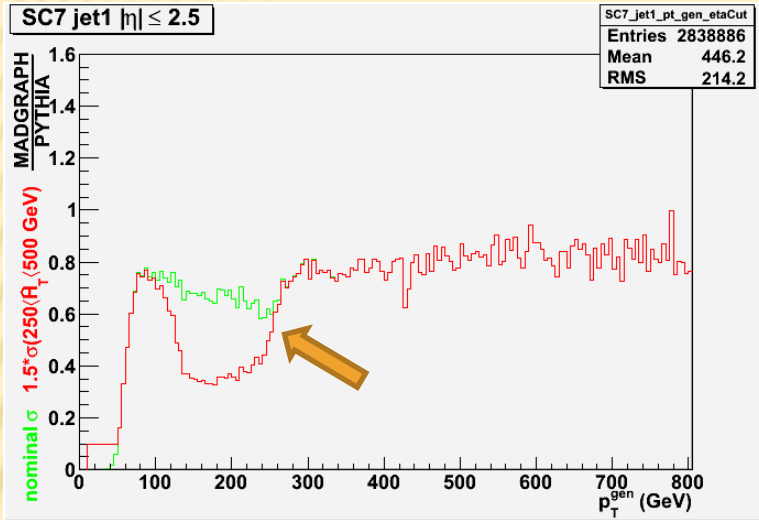


generated jets

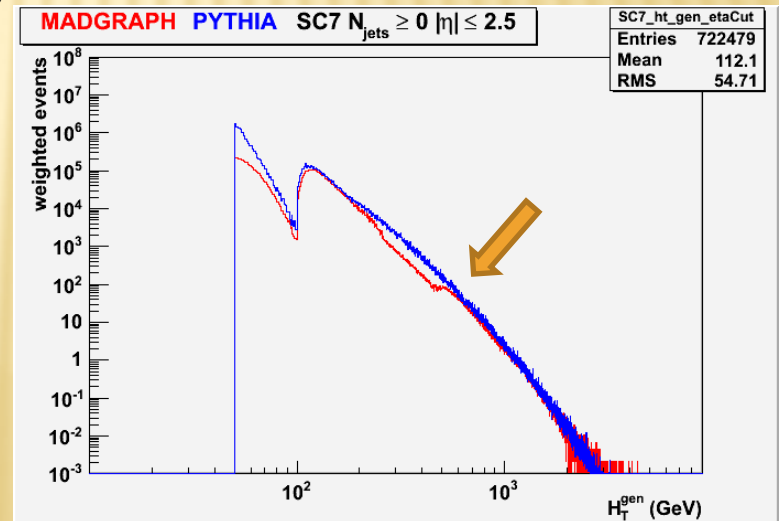
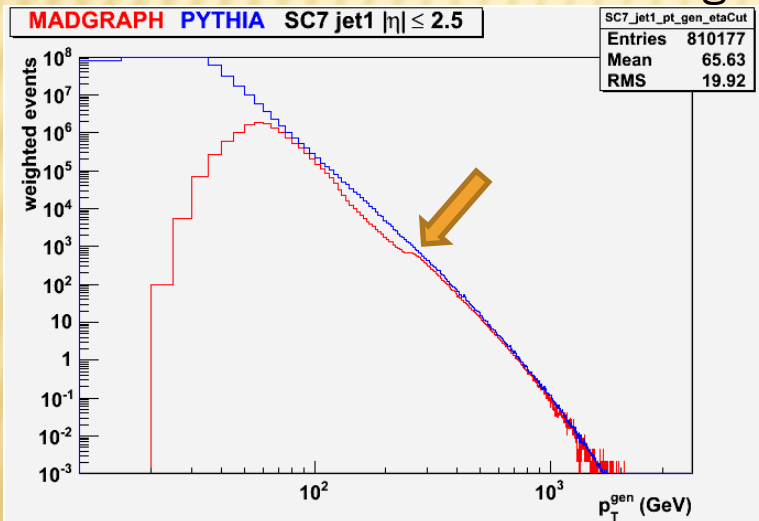




$\sigma_{MG} - 50\%$ for $\hat{H}_T \in (250, 500)$ GeV

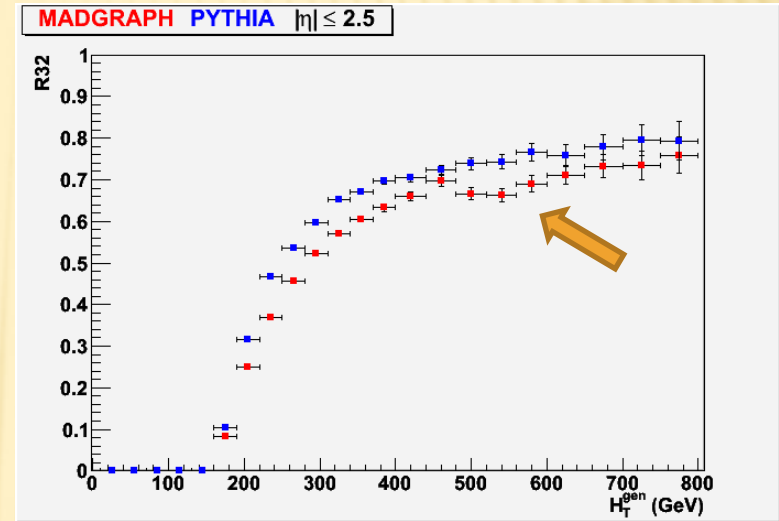
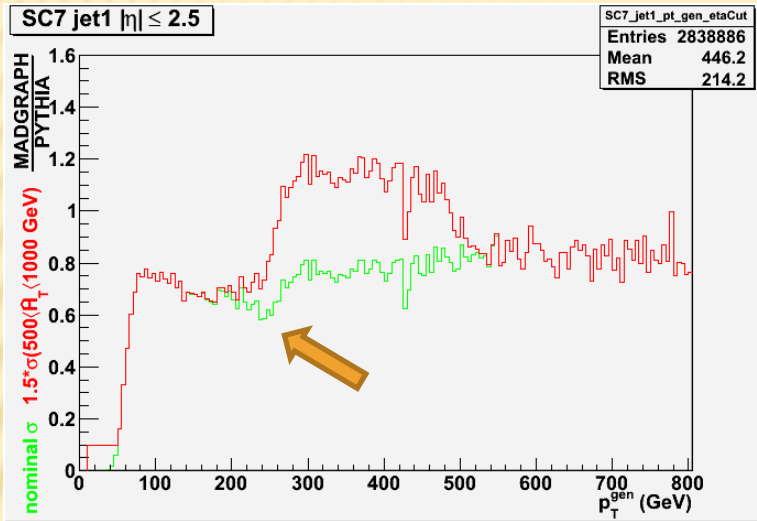


generated jets

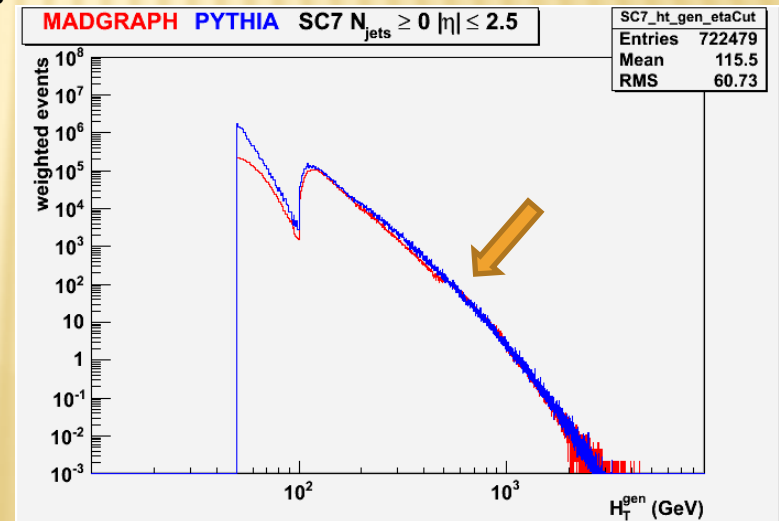
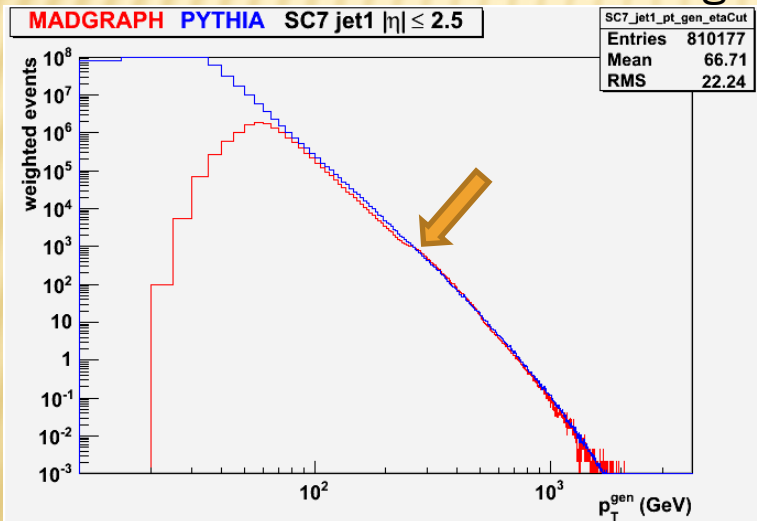




$\sigma_{MG} +50%$ for $\hat{H}_T \in (500, 1000)$ GeV

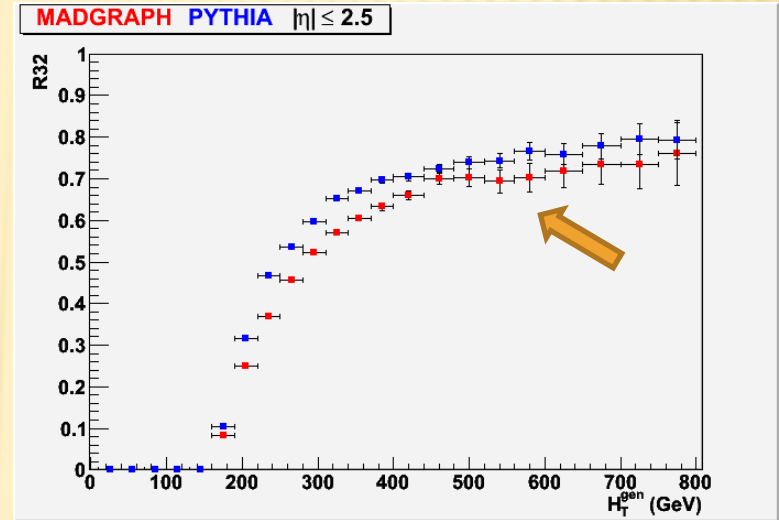
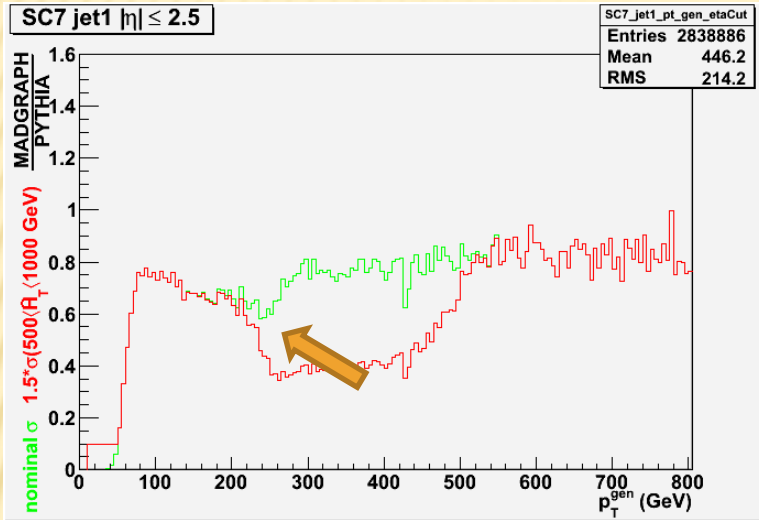


generated jets

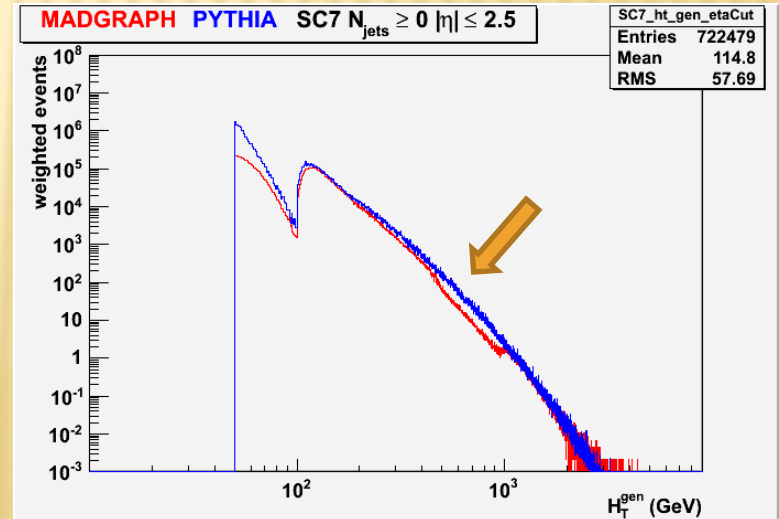
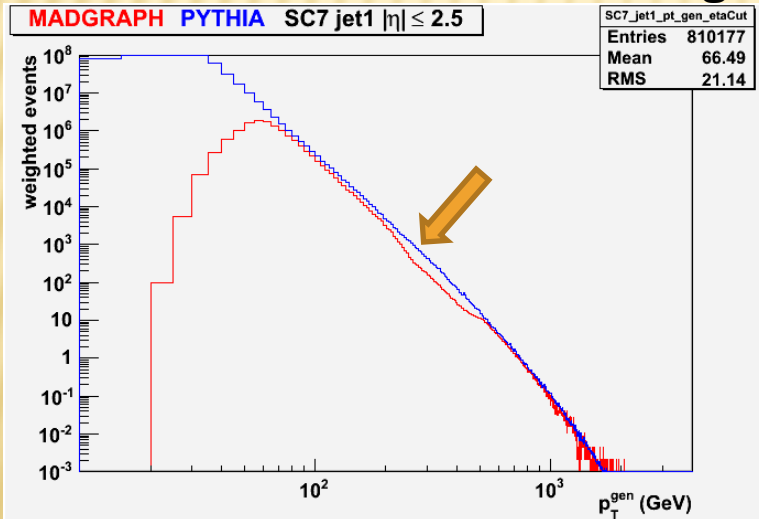




$\sigma_{MG} - 50\%$ for $\hat{H}_T \in (500, 1000)$ GeV

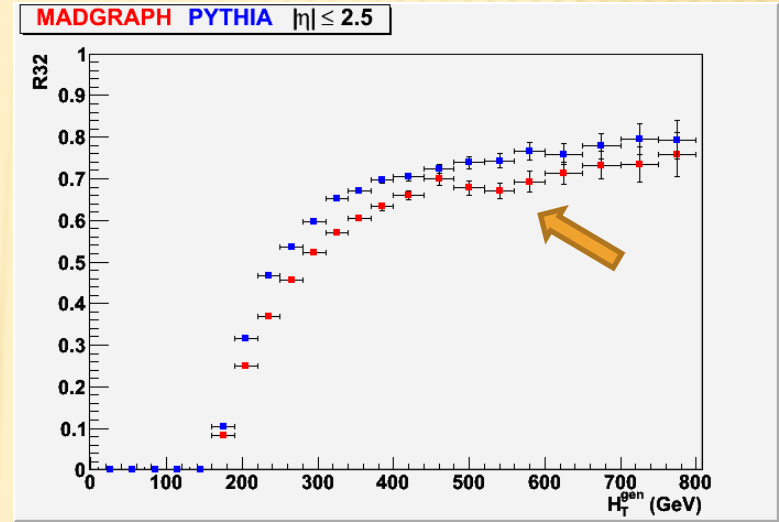
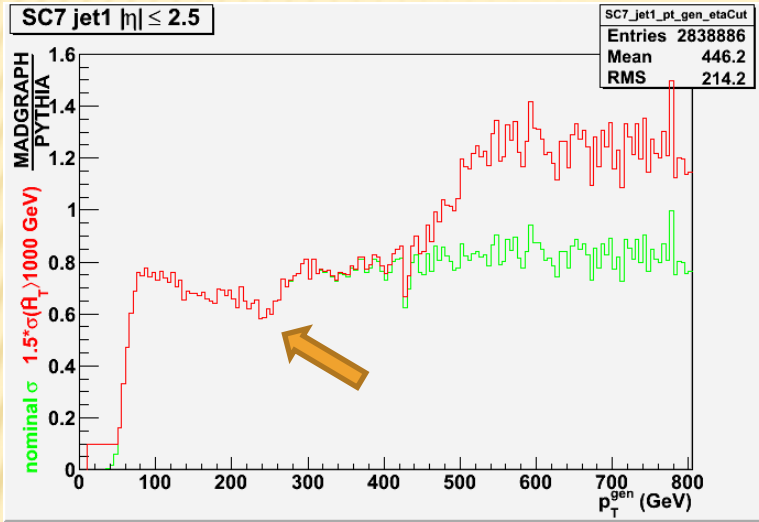


generated jets

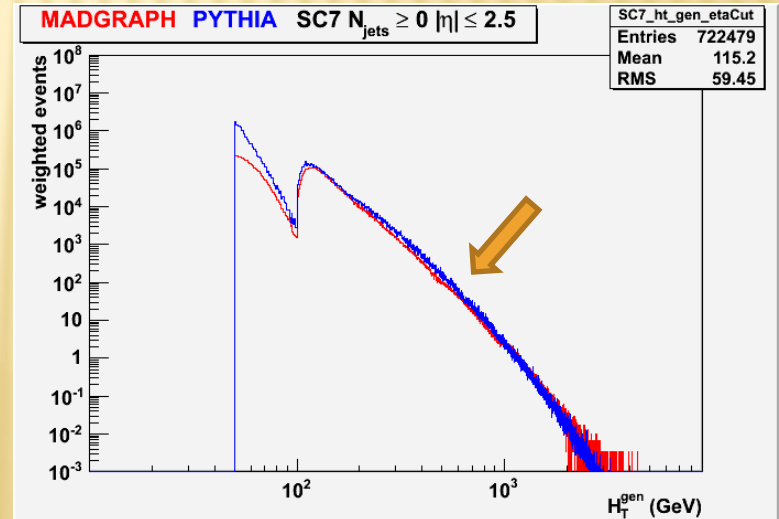
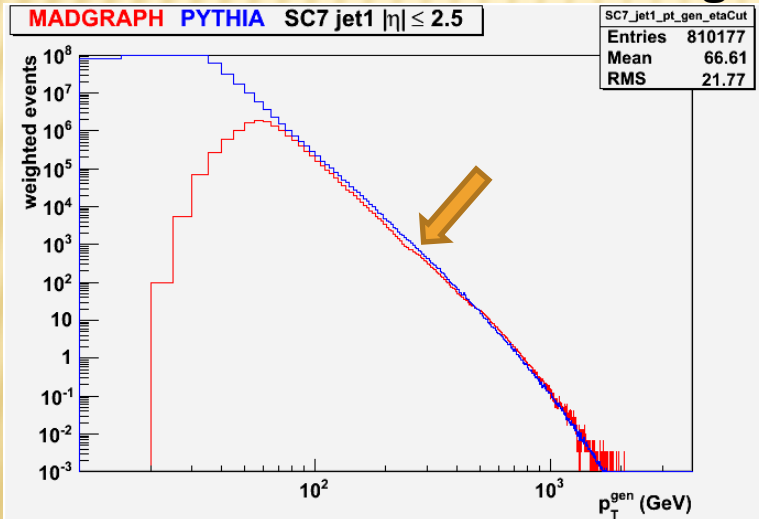




$\sigma_{MG} +50\%$ for $\hat{H}_T \in (1000, \infty)$ GeV

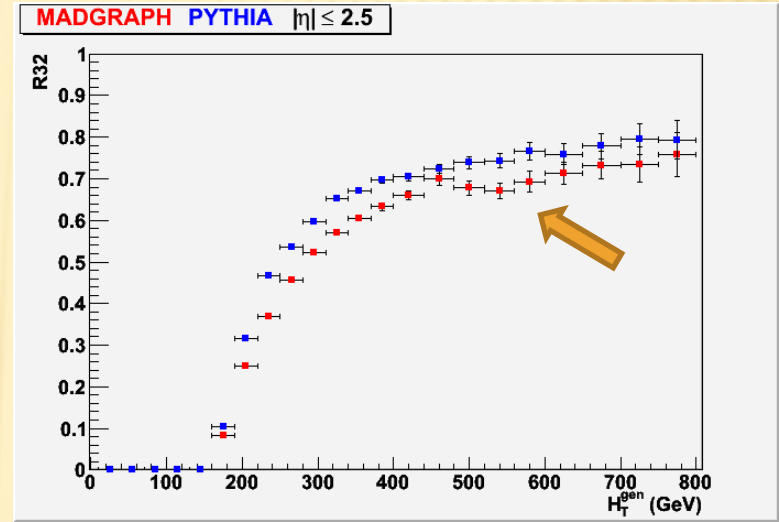
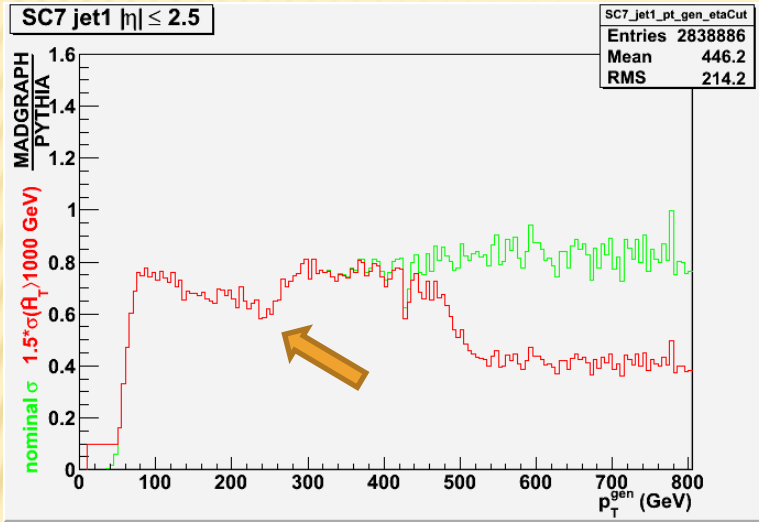


generated jets

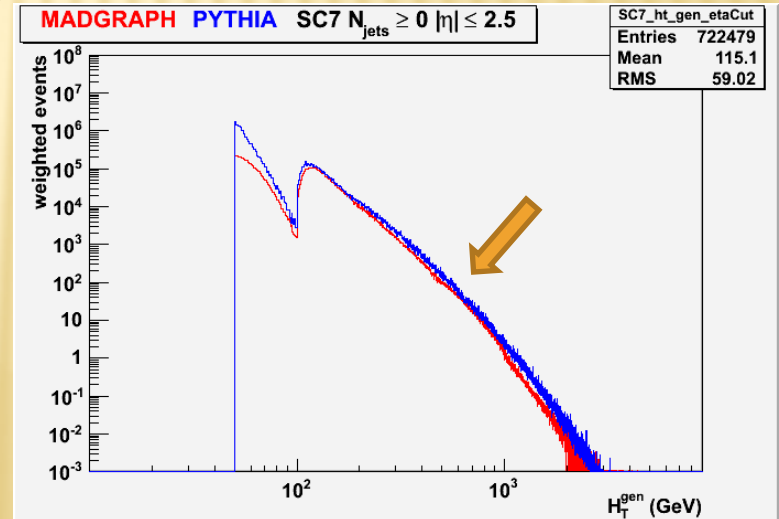
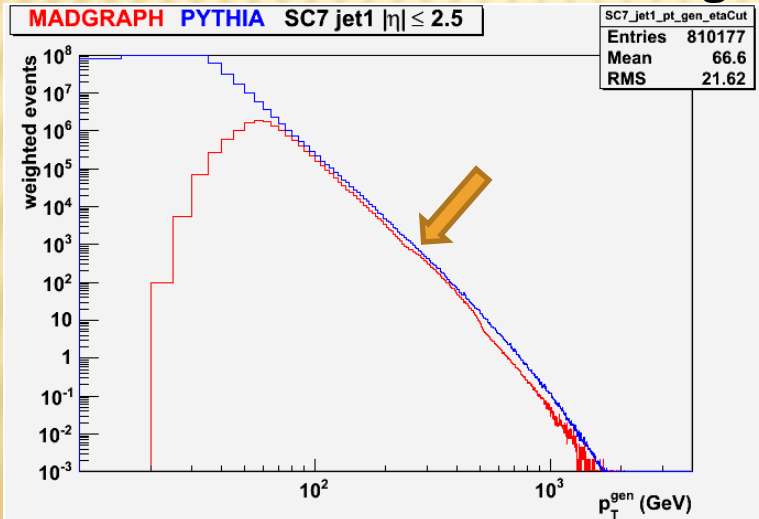




$\sigma_{MG} - 50\%$ for $\hat{H}_T \in (1000, \infty)$ GeV



generated jets





conclusions

- ✗ Data produced with Pythia and MadGraph differ
 - + p_T and H_T distributions
 - + *corrected/generated* and R_{32} ratios
- ✗ The plot differences are quite continuous, but
 - + there is a peak near $p_T \sim 200$ GeV in the jet p_T distributions
 - + there is a peak near $H_T \sim 550$ GeV in the R_{32} ratio
- ✗ From the *corrected/generated* ratio plots, the jet corrections seem to be the same for Pythia and MadGraph as expected
- ✗ MadGraph systematically underestimates ratio R_{32}
- ✗ Modifying the cross section of the MadGraph data slices (by $\pm 50\%$ for each \hat{H}_T slice), we studied the impact on the various plots
 - + the jet p_T distributions were modified as expected
 - + the R_{32} peak observed did not go away
 - + the “*problem*” is not coming from an overall cross section normalization error
- ✗ This attempt to compare MadGraph vs Pythia revealed that
 - + during Pythia data production, there was a setting somewhere in the CMSSW interface between PYTHIA and LHAPDF, which always sets Λ_{QCD} to 192 MeV, regardless of the PDF. Steve Mrenna and Klaus Rabbertz are investigating the issue.
- ✗ Once there is a new version of MadGraph datasets, this study we will repeated
 - + using the new 2009 Pythia datasets already produced and a more recent CMSSW version



backup slides



access to the analysis plots

- ✗ the analysis was rerun for each MadGraph cross section configuration and web pages containing all the plots were created

- ✗ main analysis plots:

http://pc139.physics.uoi.gr/madgraph-WWW/high_pT_20091015a.php

- ✗ modifying the nominal MadGraph cross section:

+50% for $\hat{H}_T \in (100, \infty)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/high_pT_20091015b.php

+50% for $\hat{H}_T \in (100, 250)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_07.php

-50% for $\hat{H}_T \in (100, 250)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_11.php

+50% for $\hat{H}_T \in (250, 500)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_08.php

-50% for $\hat{H}_T \in (250, 500)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_12.php

+50% for $\hat{H}_T \in (500, 1000)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_09.php

-50% for $\hat{H}_T \in (500, 1000)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_13.php

+50% for $\hat{H}_T \in (1000, \infty)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_10.php

-50% for $\hat{H}_T \in (1000, \infty)$ GeV: http://pc139.physics.uoi.gr/madgraph-WWW/madgraph_14.php



\hat{H}_T distributions ratio

