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Update on Madgraph-Pythia Comparisons

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 *(according to arXiv:0710.3820)*
  - is rather good at handling the phase space of 2→1 and 2→2 processes
  - is more primitive for 2→3 ones and does not at all address higher multiplicities
  - 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:

$\hat{H}_T = \Sigma p_T$ over all final state partons

$H_T = \Sigma p_T$ over all jets

R_{32} = # events with **≥3** good jets / # events with **≥2** good jets

Pythia data

Datasets:

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

$\hat{p}_T$ slice	cross section (pb)	# of events
0015_0020	949441000.00000000000	129600
0020_0030	400982000.00000000000	101880
0030_0050	94702500.00000000000	169200
0050_0080	12195900.00000000000	103545
0080_0120	1617240.00000000000	51300
0120_0170	255987.00000000000	50085
0170_0230	48325.00000000000	51840
0230_0500	10623.20000000000	54000
0300_0580	2634.94000000000	60048
0380_0470	722.09900000000	93312
0470_0600	240.98300000000	27648
0600_0800	62.49230000000	30348
0800_1000	9.42062000000	20880
1000_1400	2.34357000000	24640
1400_1800	0.15685500000	27744
1800_2200	0.01381100000	22848
2200_2600	0.00129608000	22560
2600_3000	0.00011404000	28800
3000_3500	0.00008431800	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
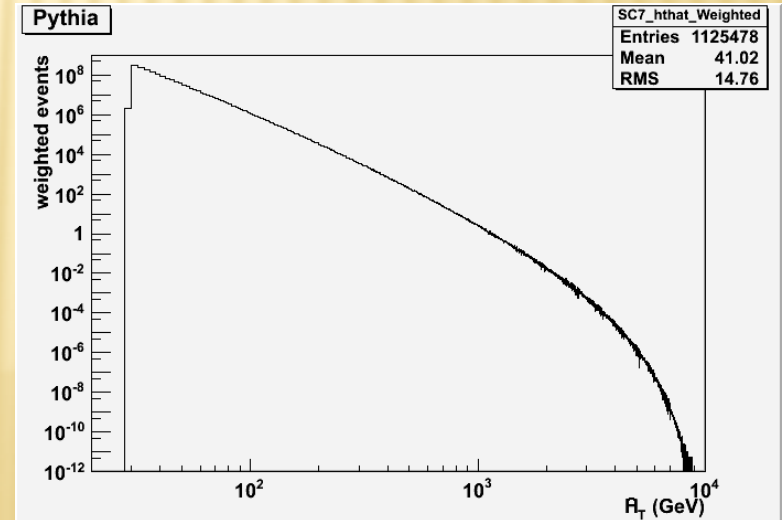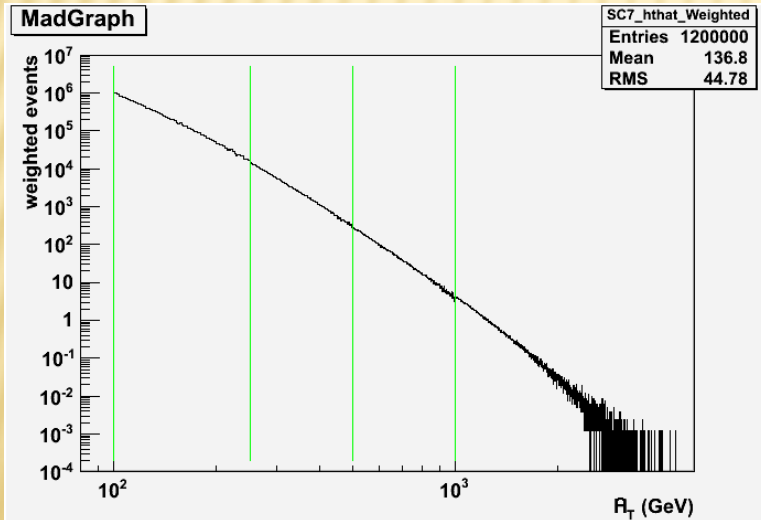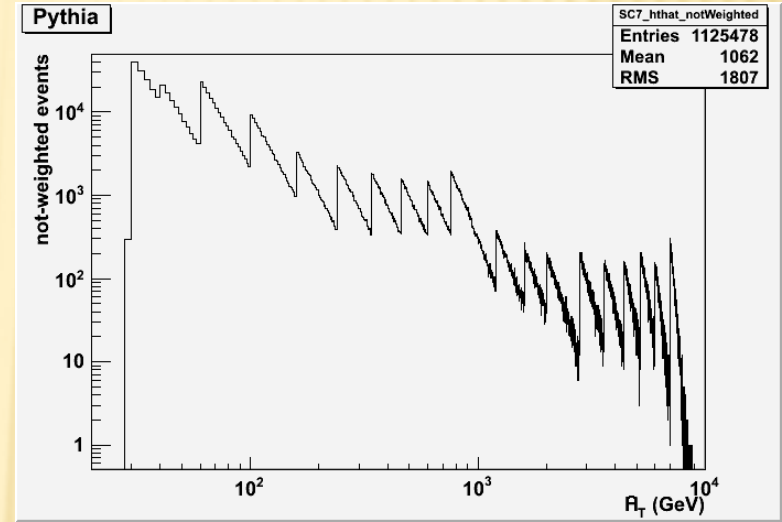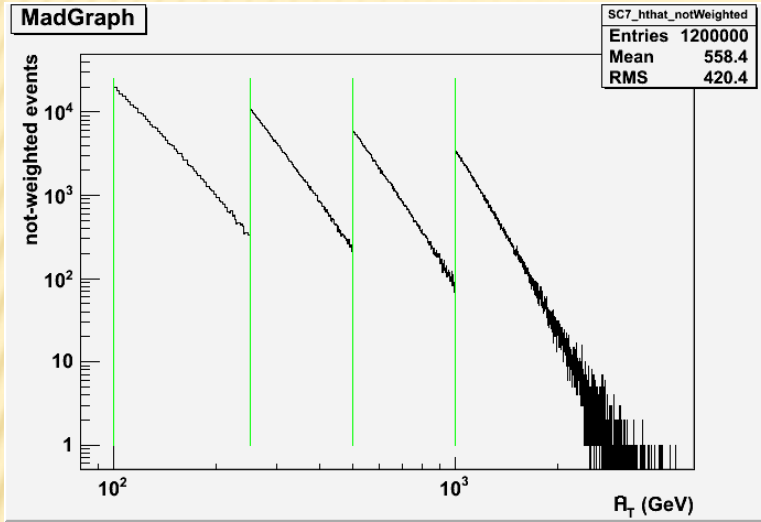
$\hat{H}_T$ distributions
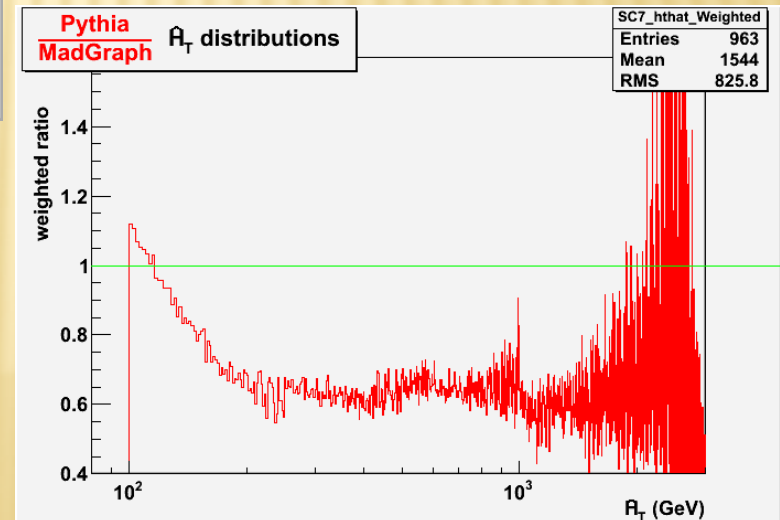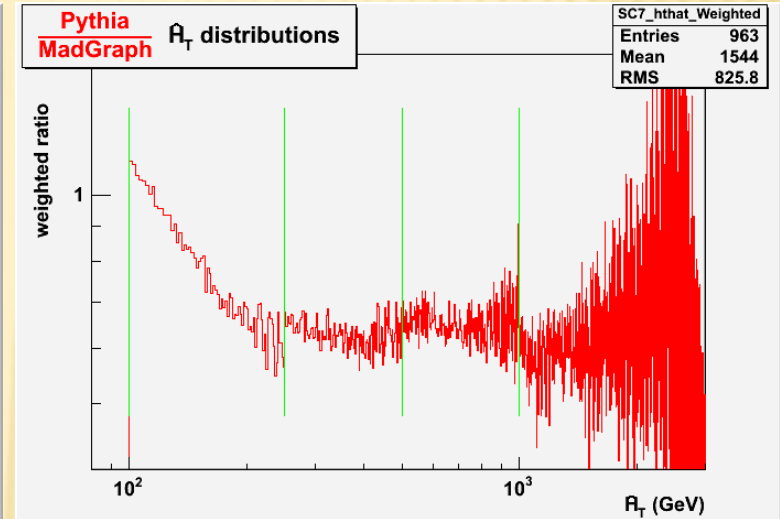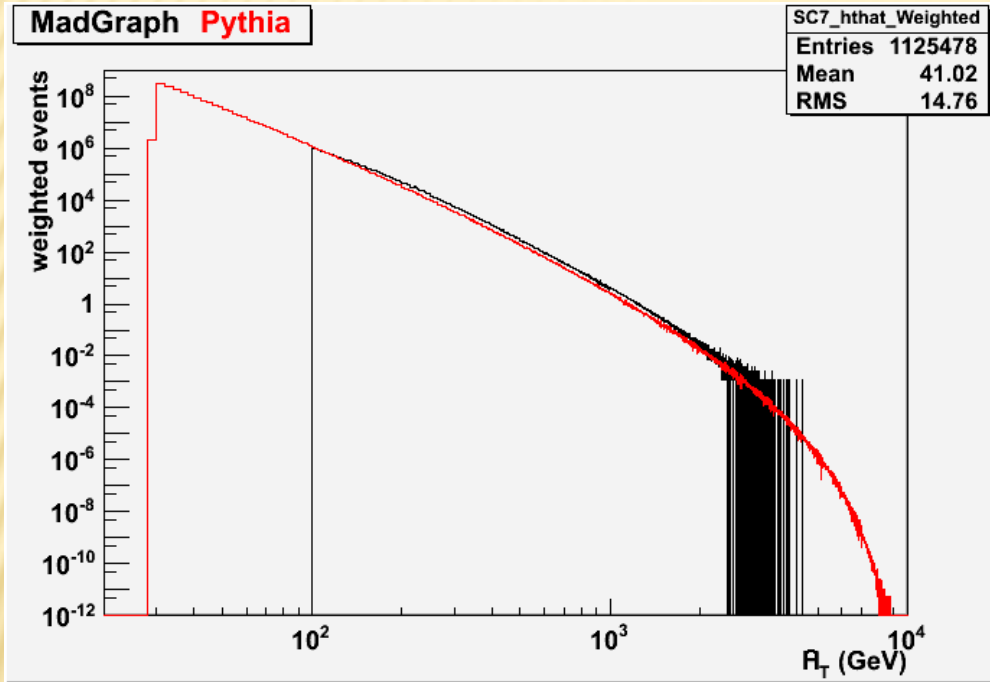
- ✗ $\hat{H}_T$ is not present in the MadGraph events
- ✗ it was calculated using code provided by Steve Mrenna
- ✗ the not-weighted $\hat{H}_T$ distribution is in perfect agreement with the MadGraph slice limits
  - ✛ the code was correctly imported

p$_T$ distributions of the 1st jet
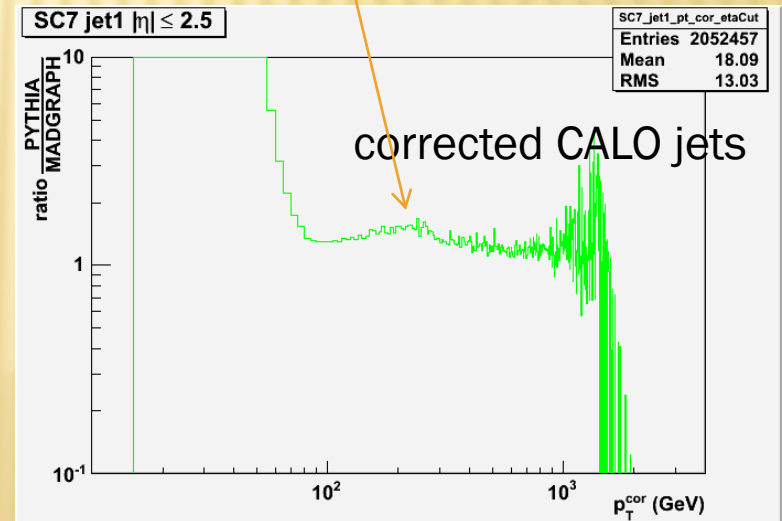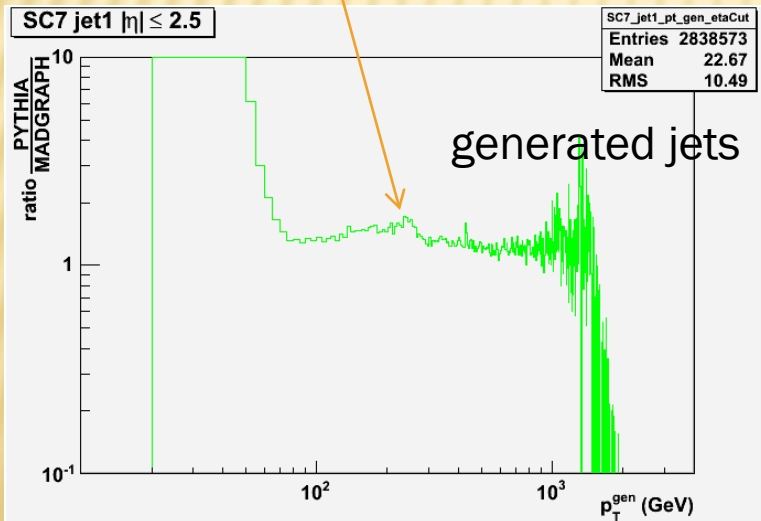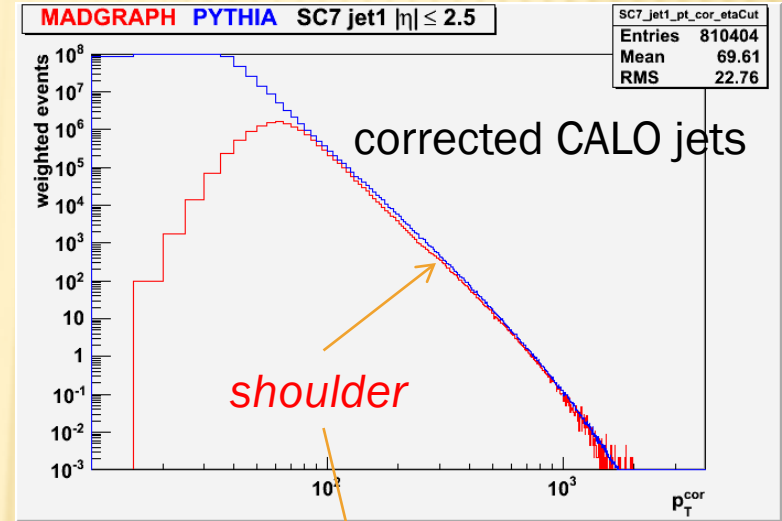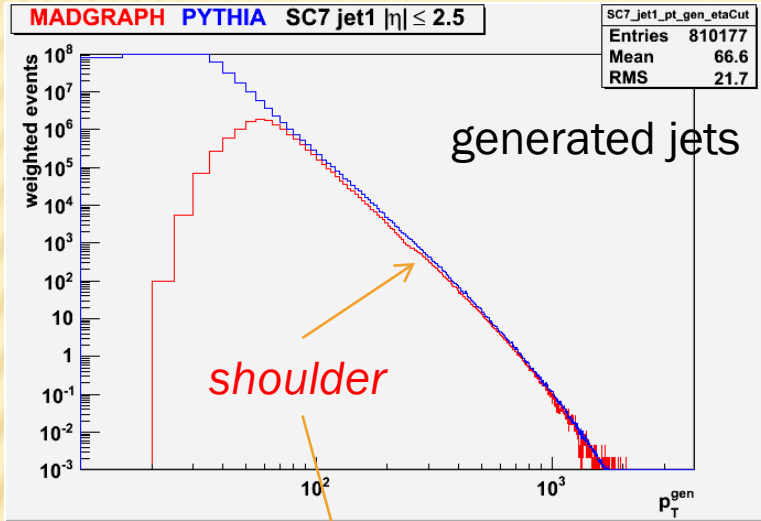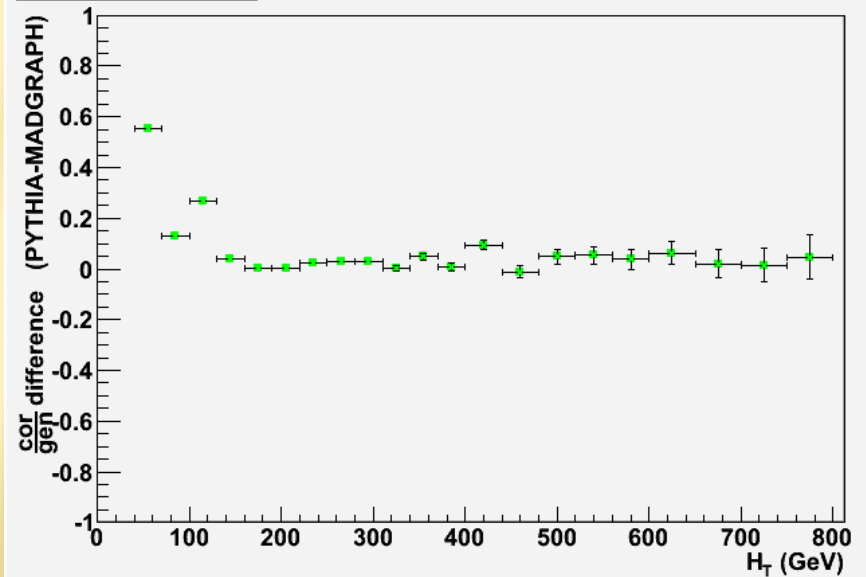
p_T distributions of the 2nd jet
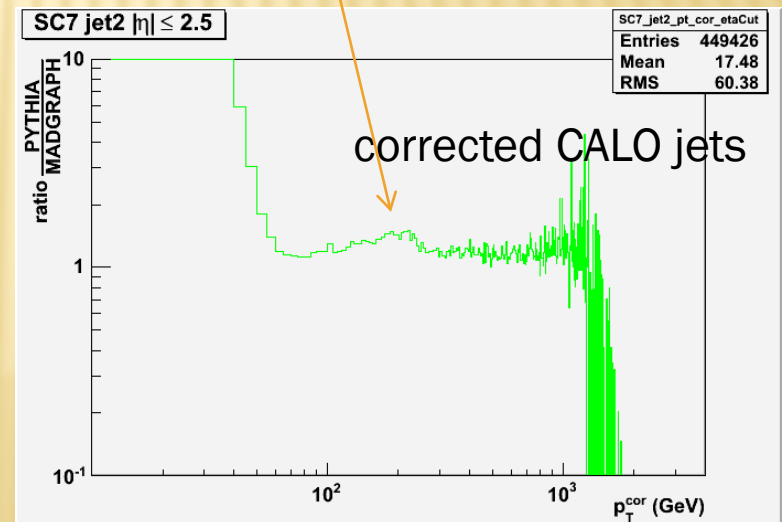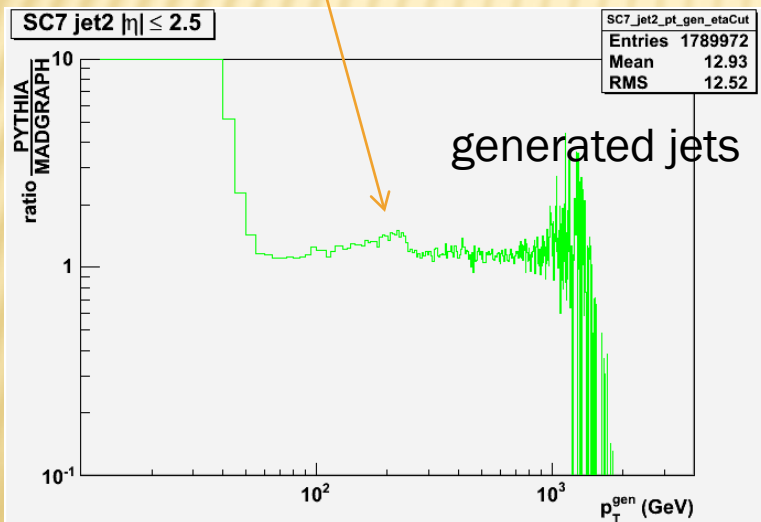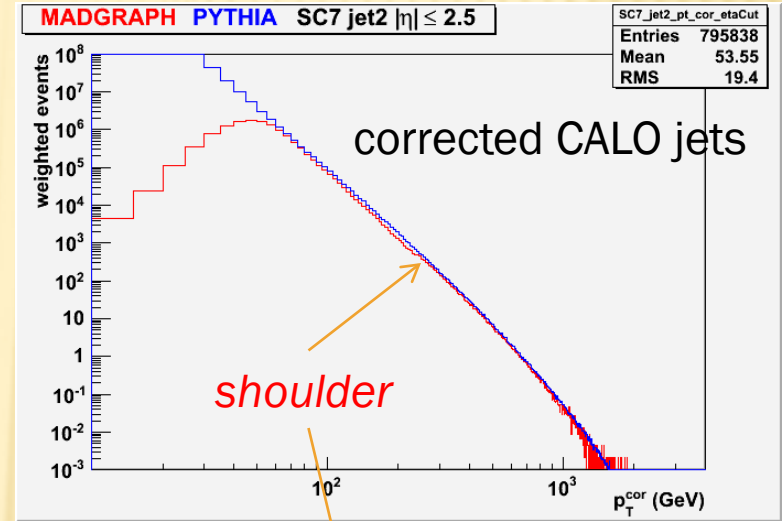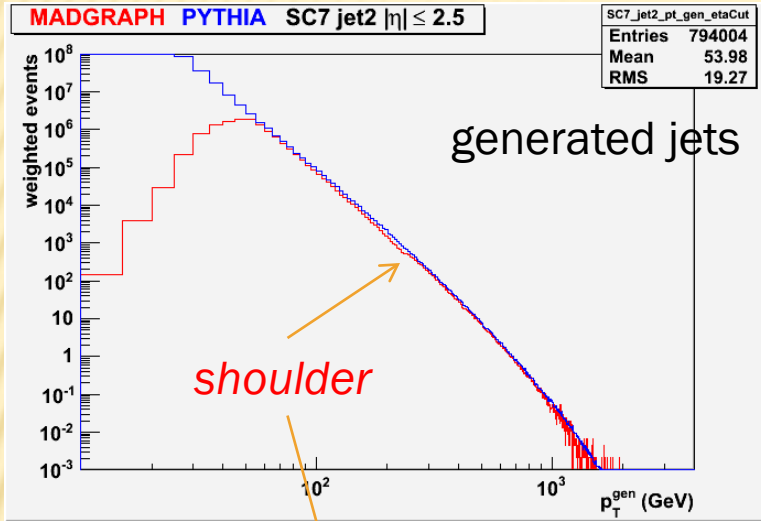
H$_T$ distributions
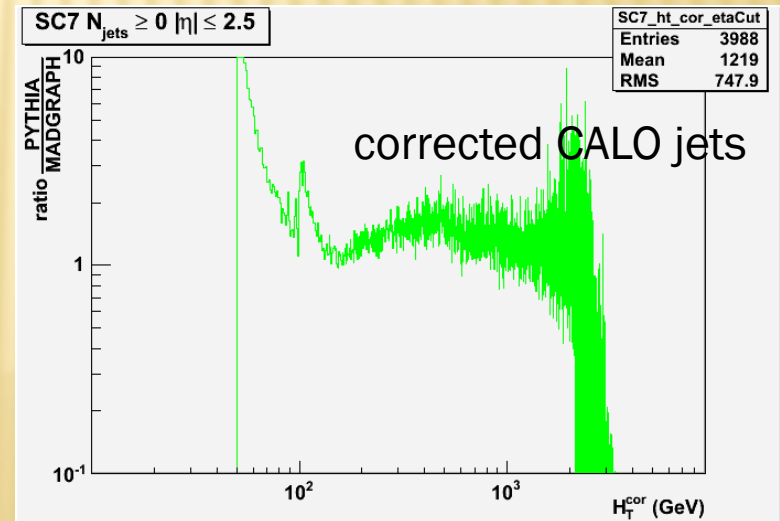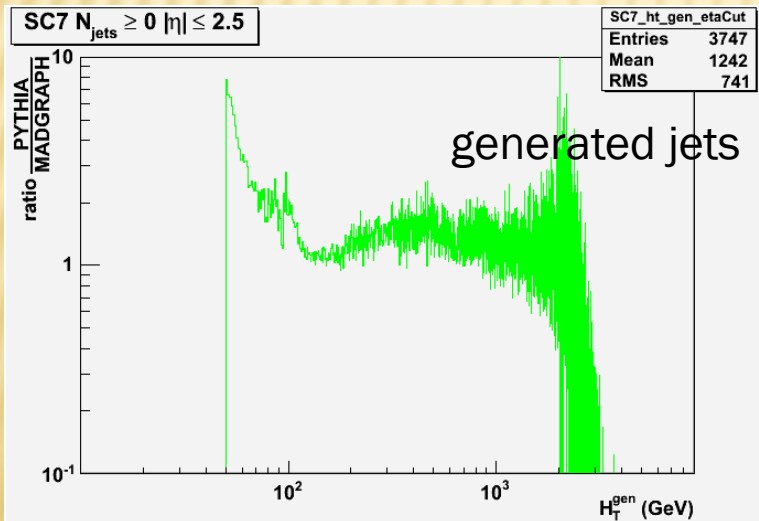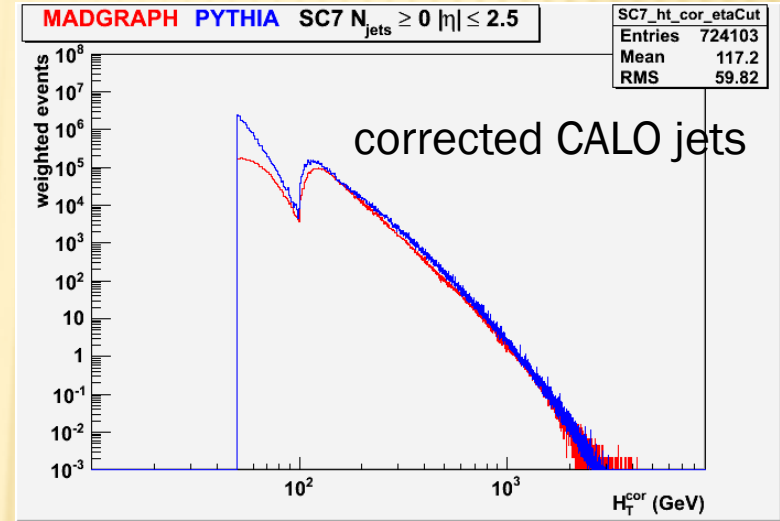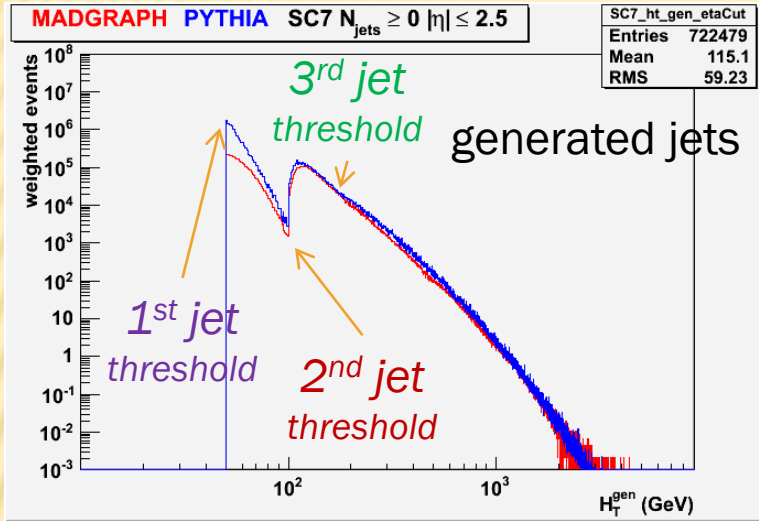
corrected/generated H_T ratio
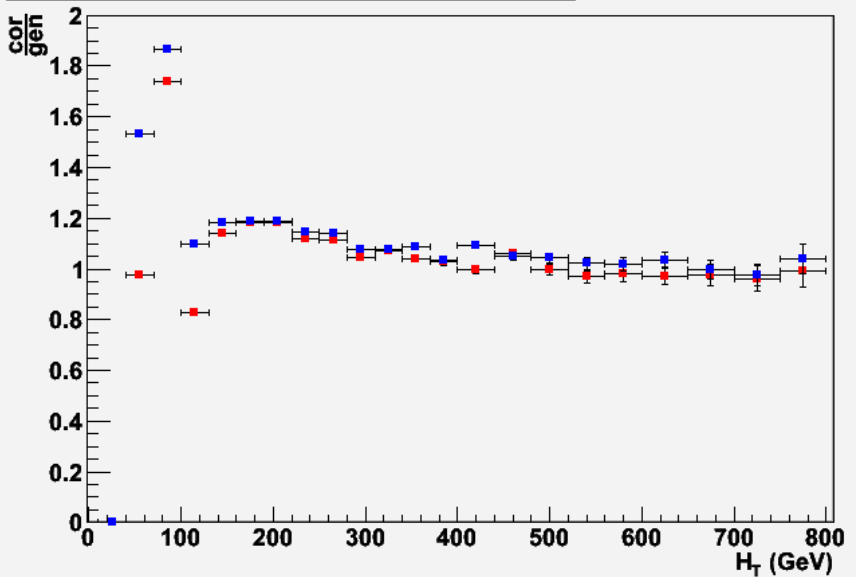
error bars not significant
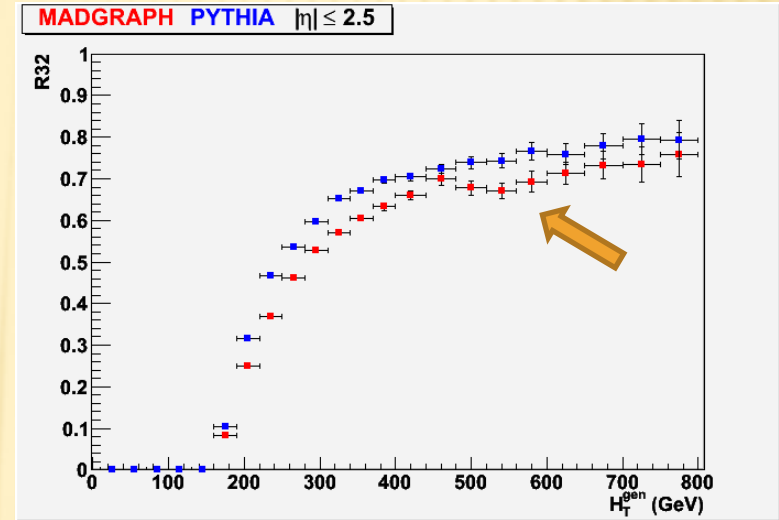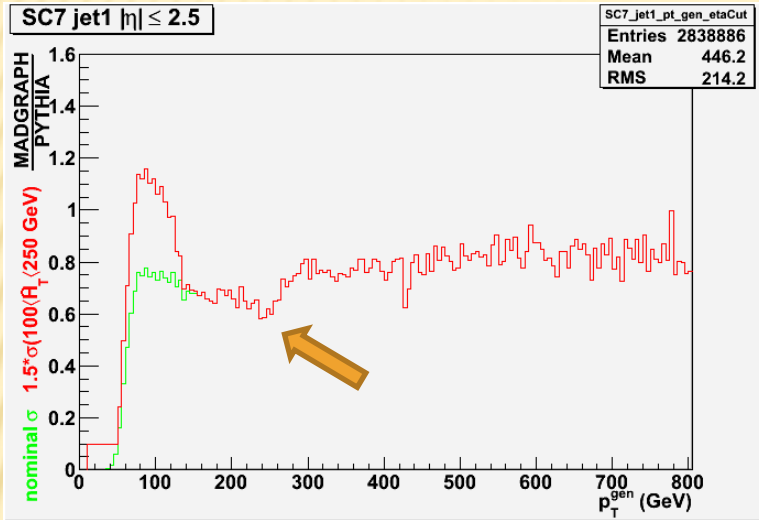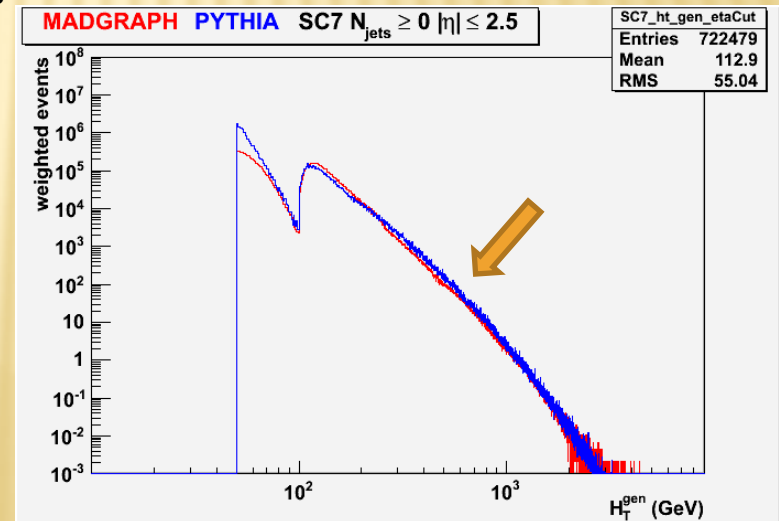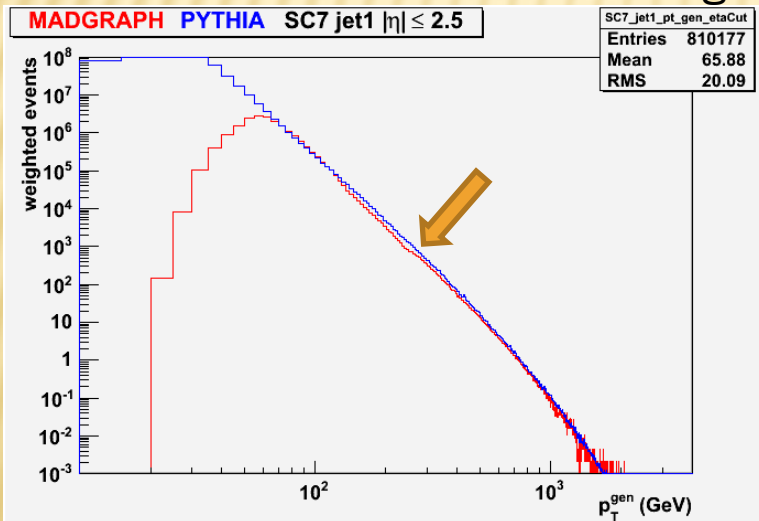(correlated errors were not taken into account)

ratio R$_{32}$
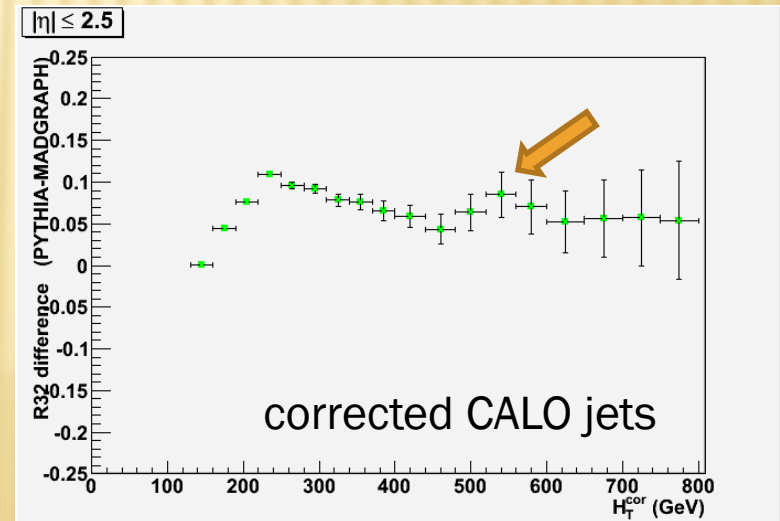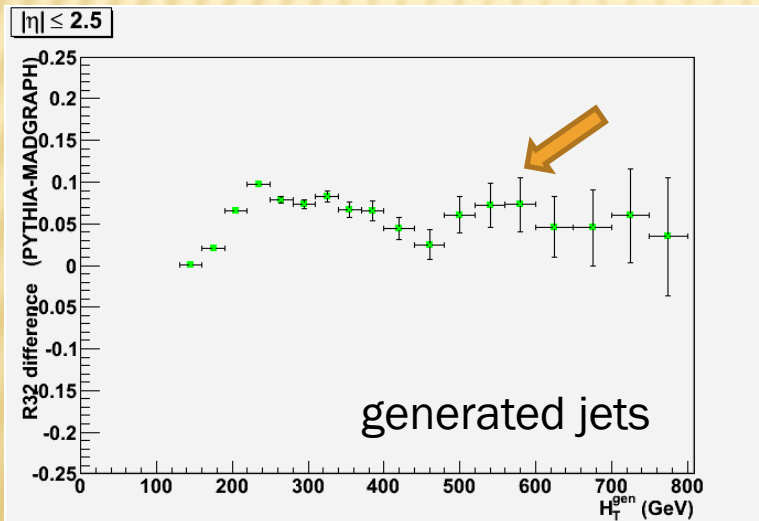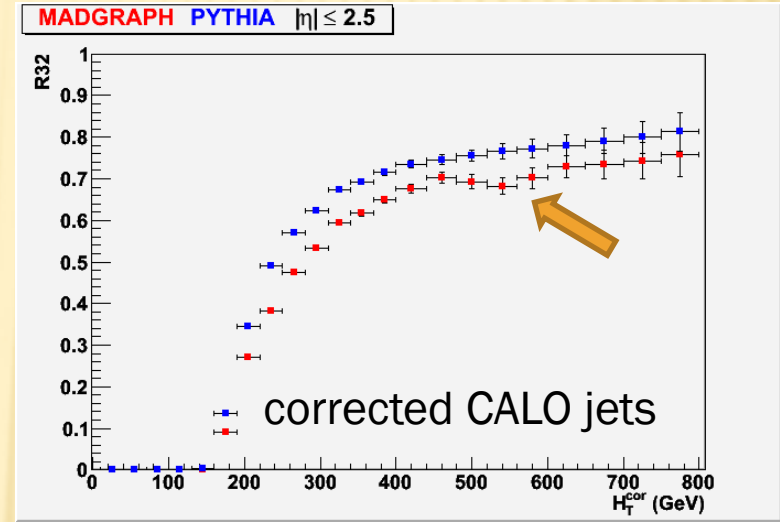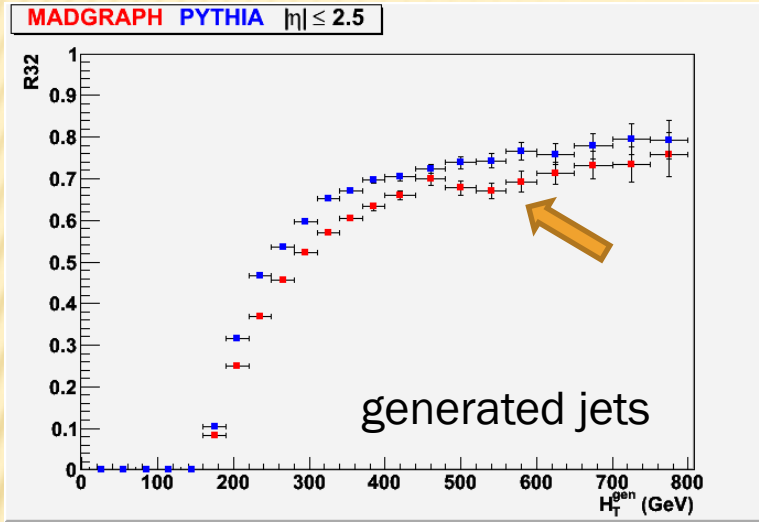
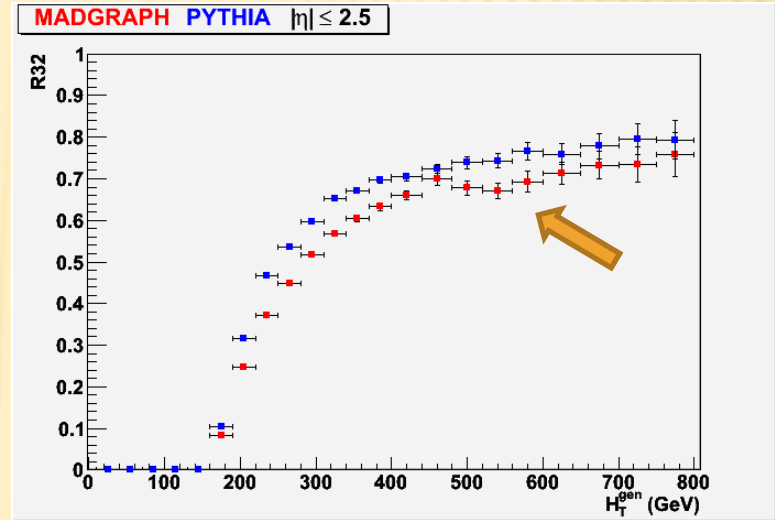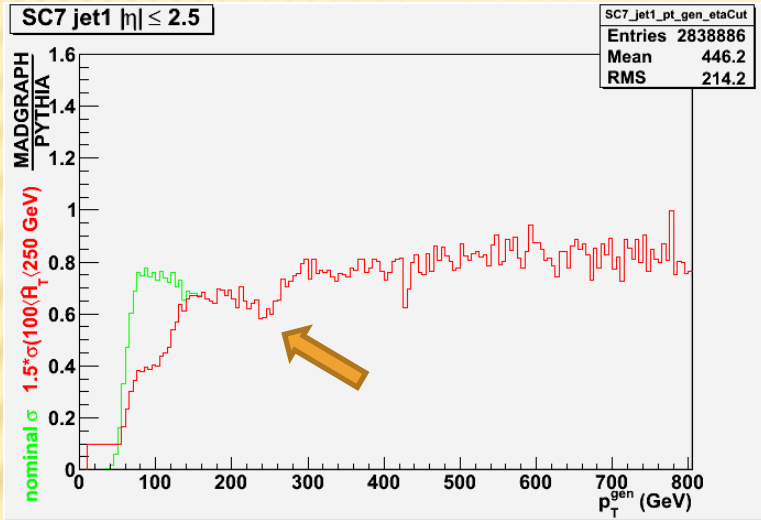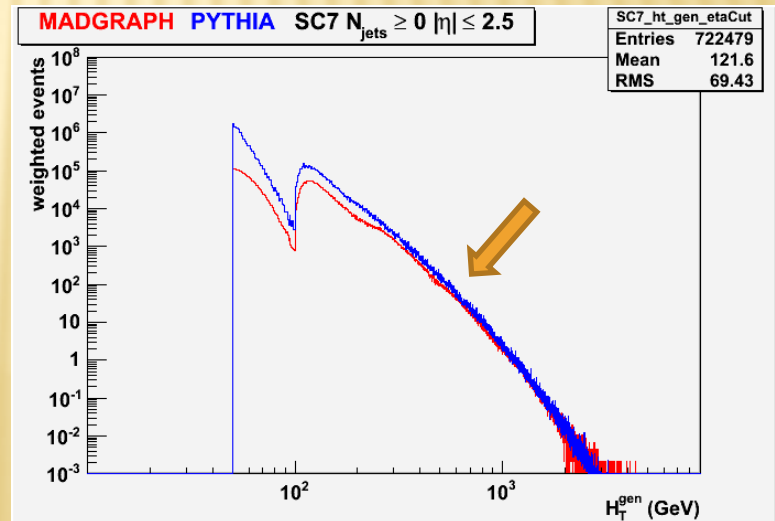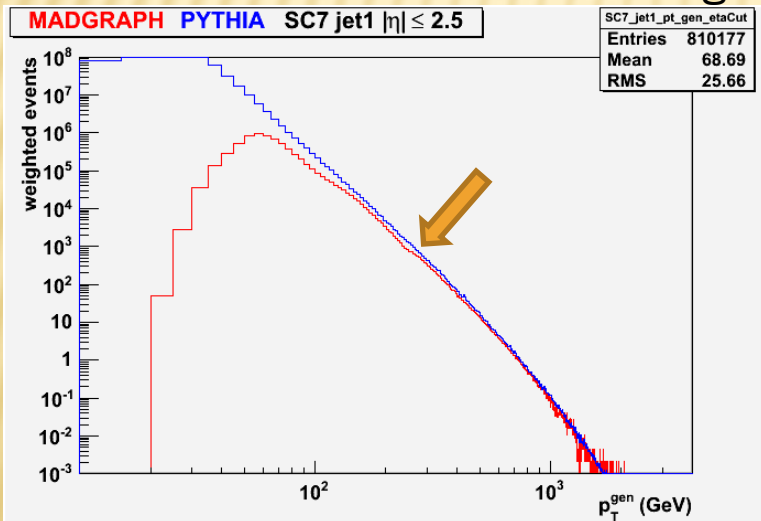# σ_{MG} +50% for $\hat{H}_T \in$ (100, 250) GeV

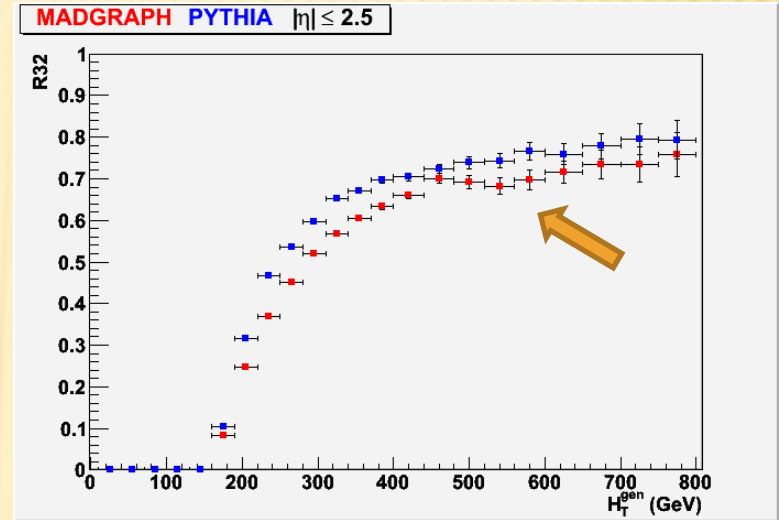generated jets
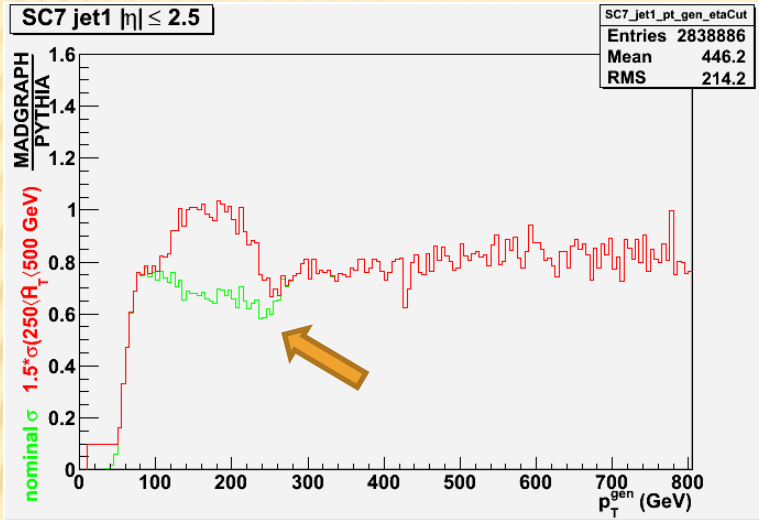
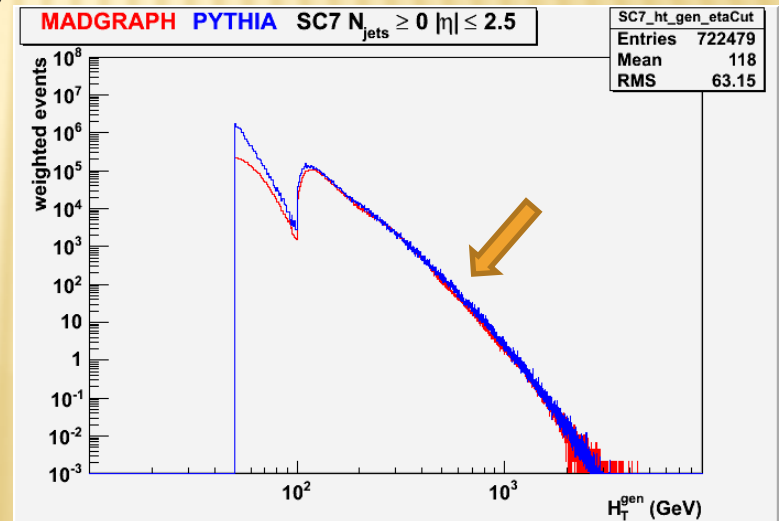# σ_{MG} −50% for $\hat{H}_T \in (100, 250)$ GeV
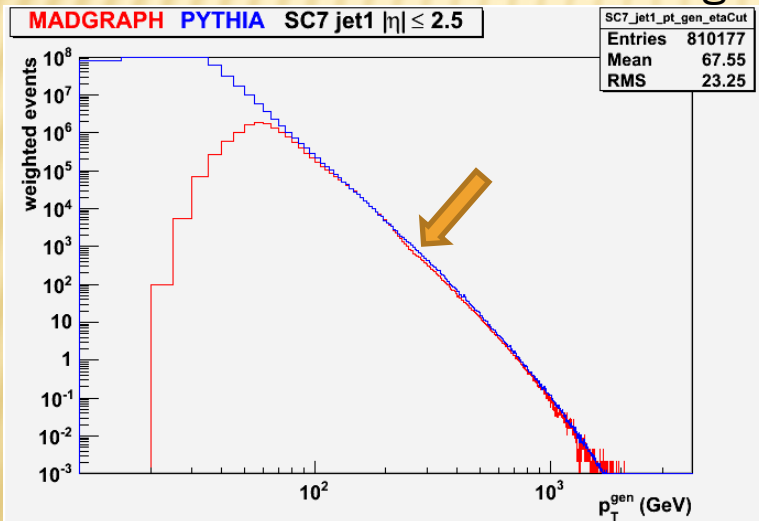

generated jets

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

generated jets

σ$_{MG}$ −50% for Ĥ$_T$ ∈ (250, 500) GeV

generated jets

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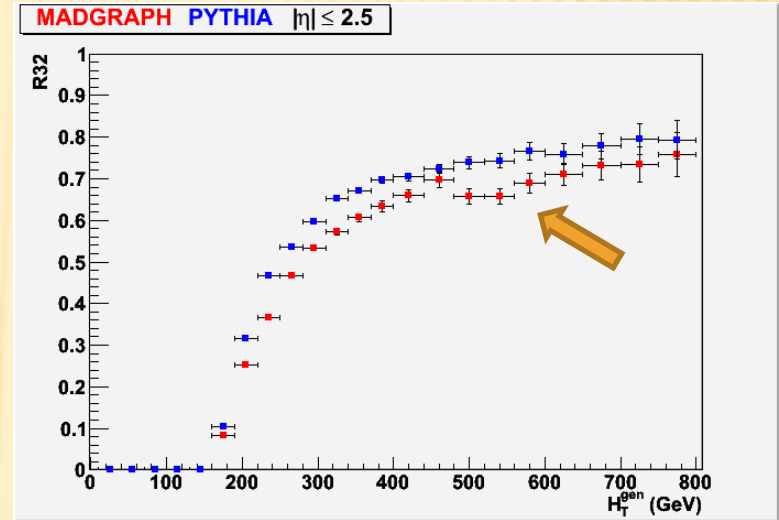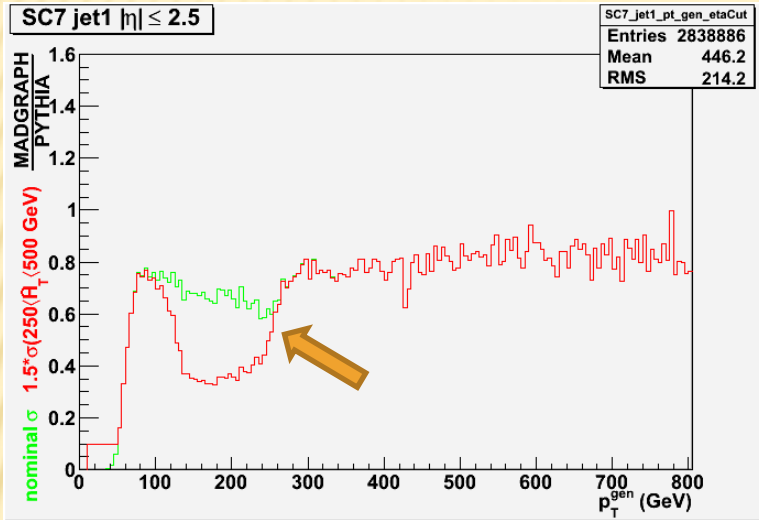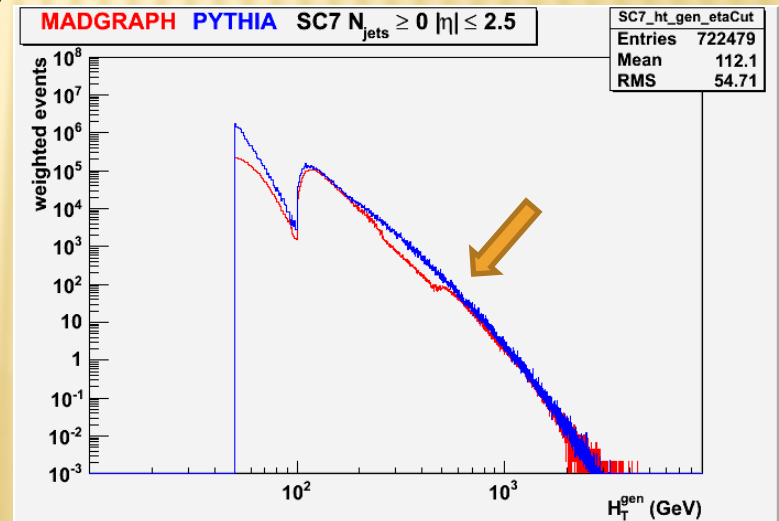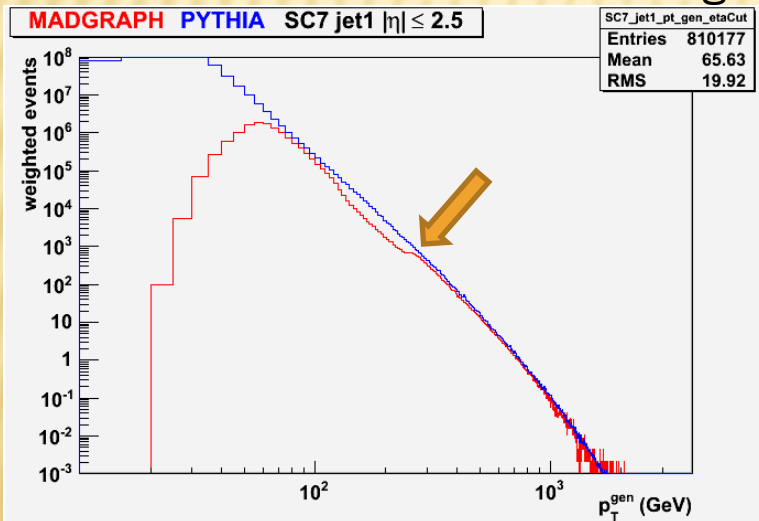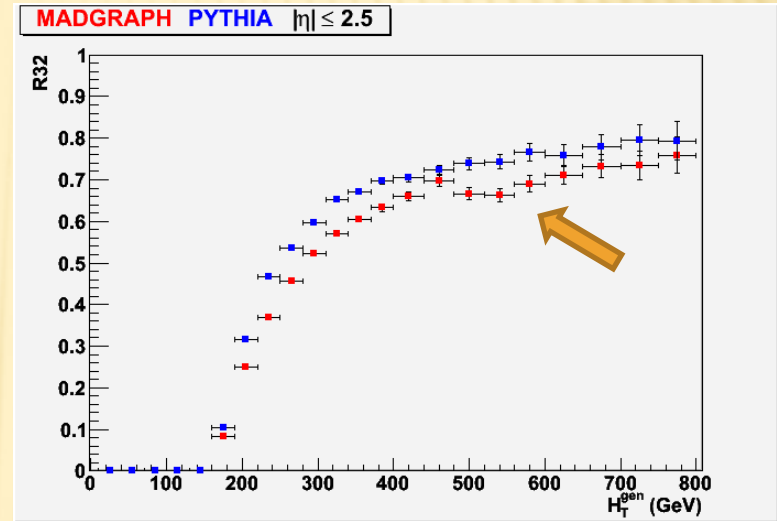

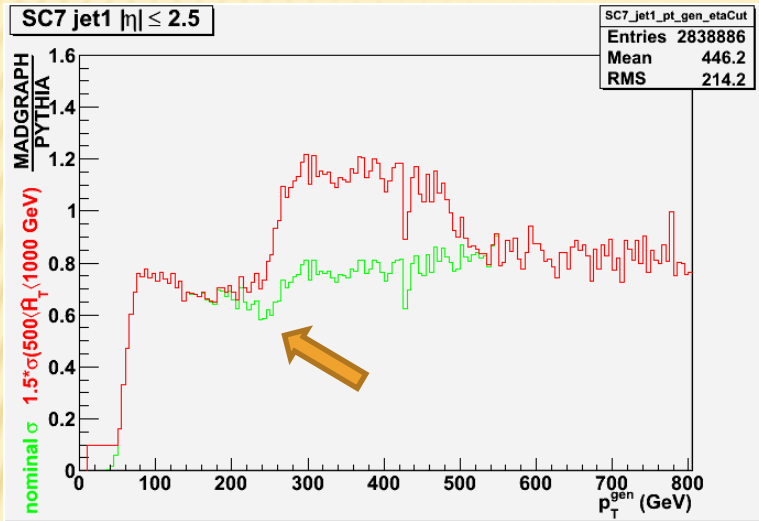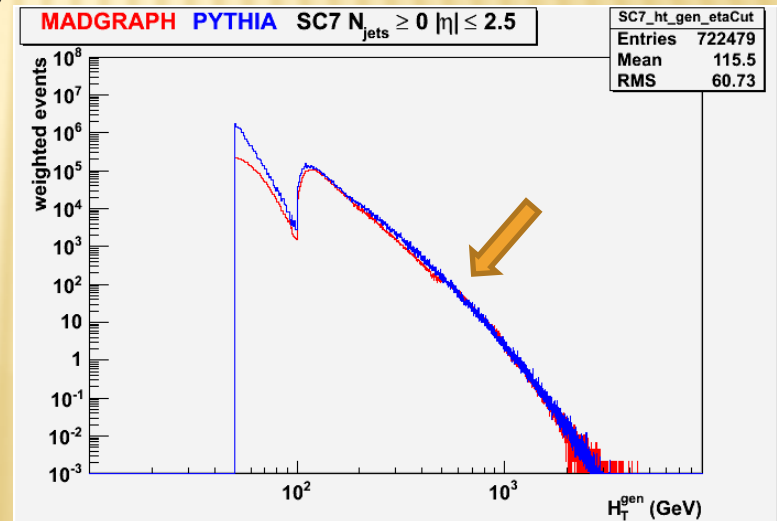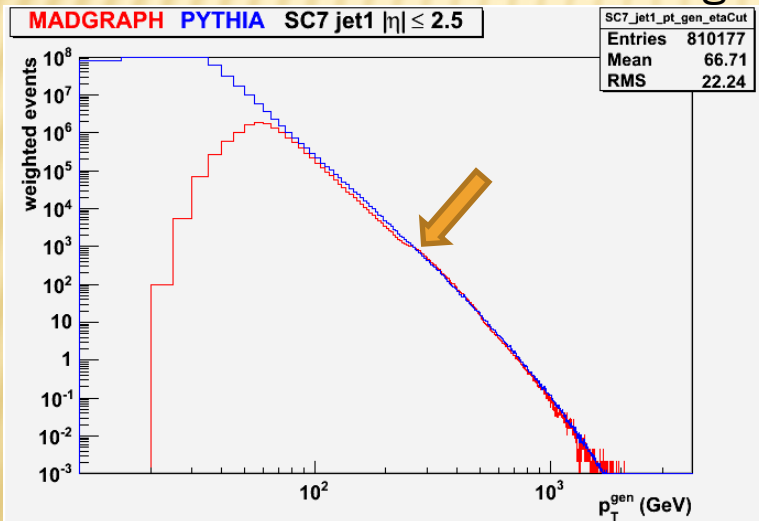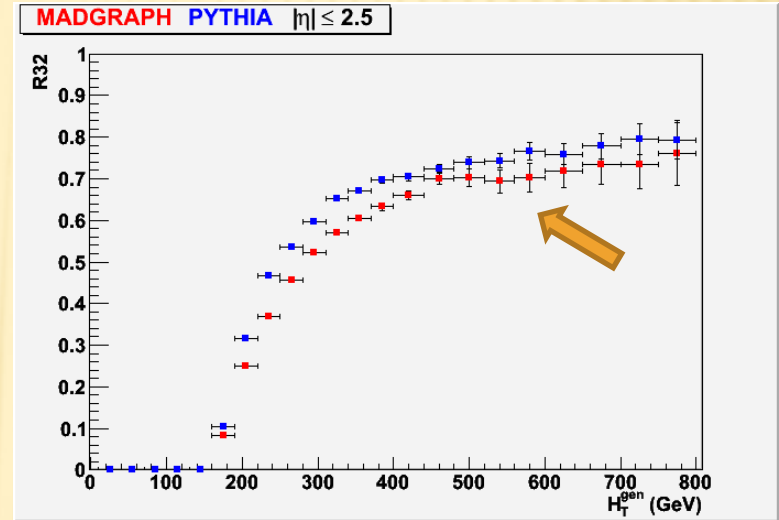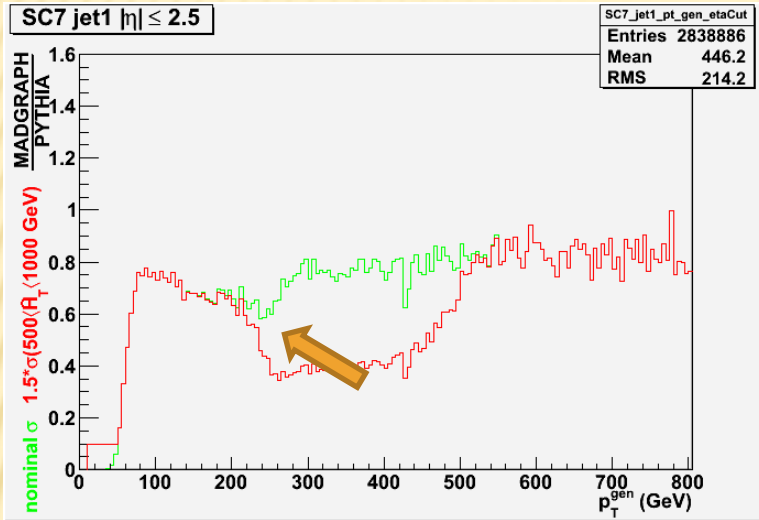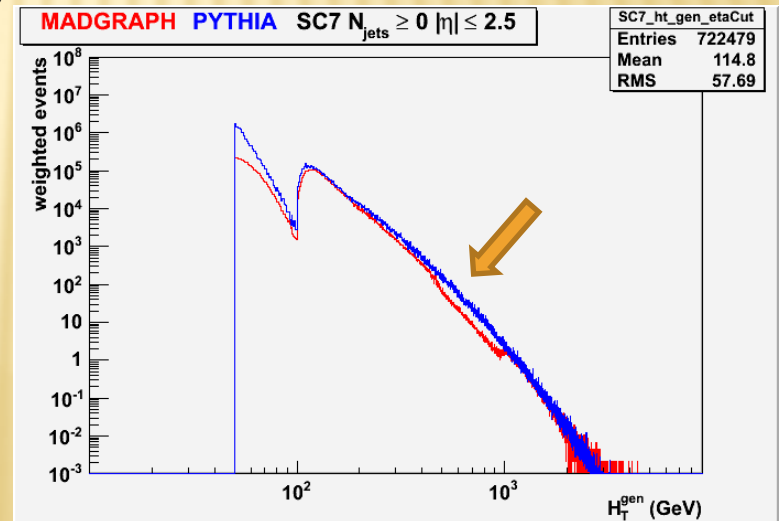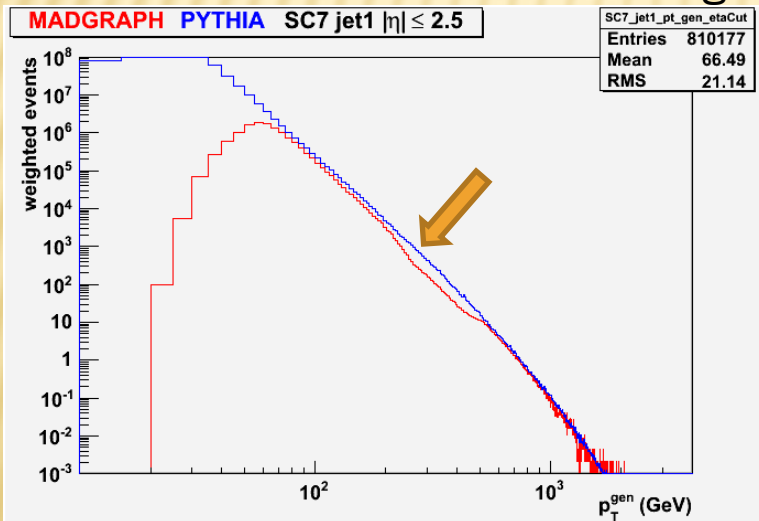generated jets

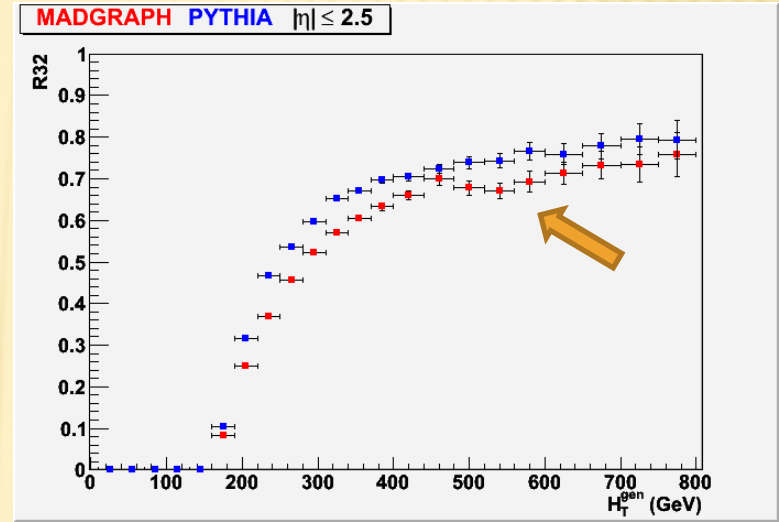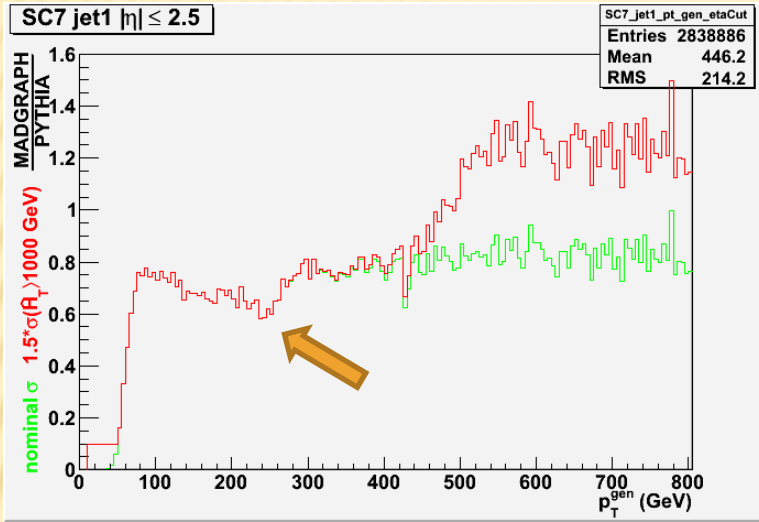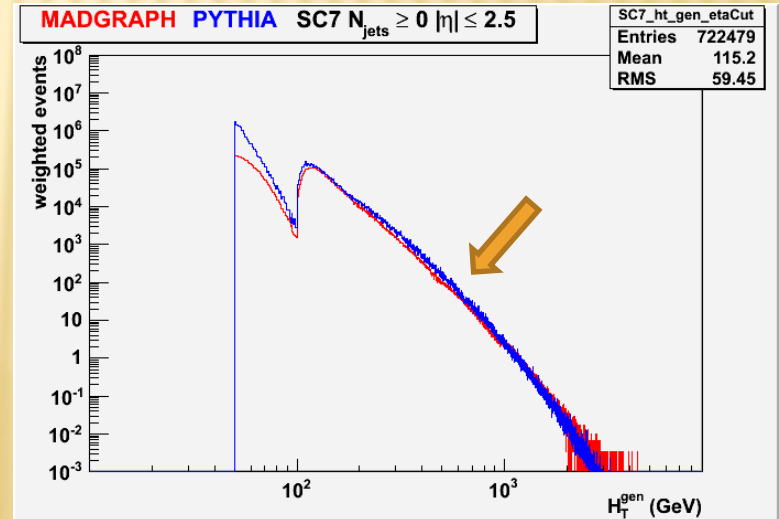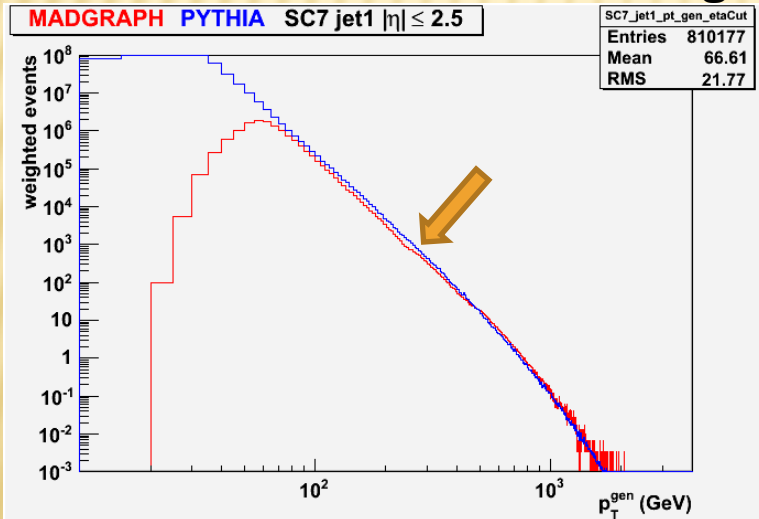# σ_{MG} −50% for $\hat{H}_T \in (500, 1000)$ GeV

generated jets

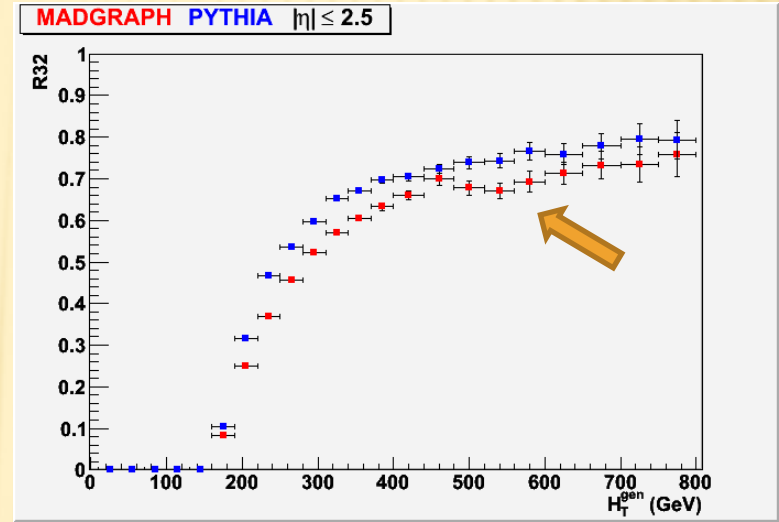# σ_{MG} +50% for $\hat{H}_T \in (1000, \infty)$ GeV

generated jets

σ_{MG} −50% for $\hat{H}_T \in (1000, \infty)$ GeV
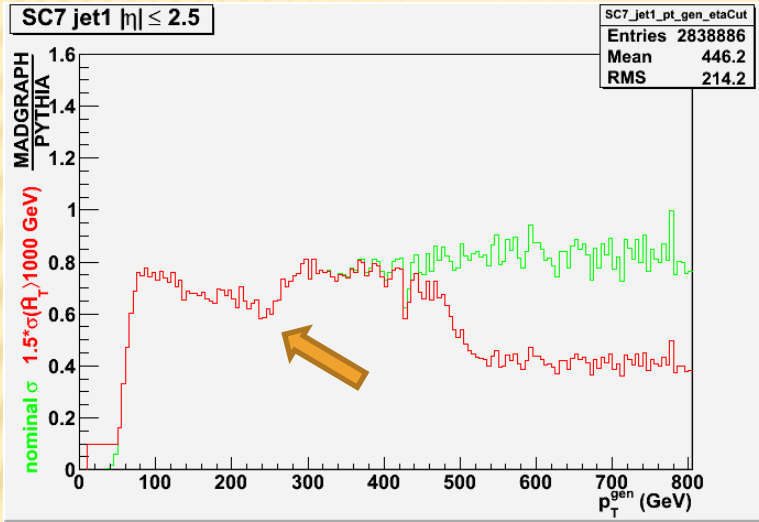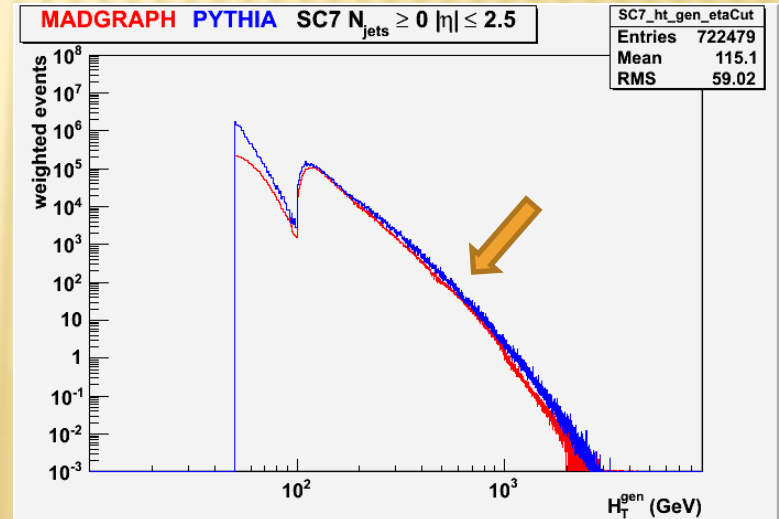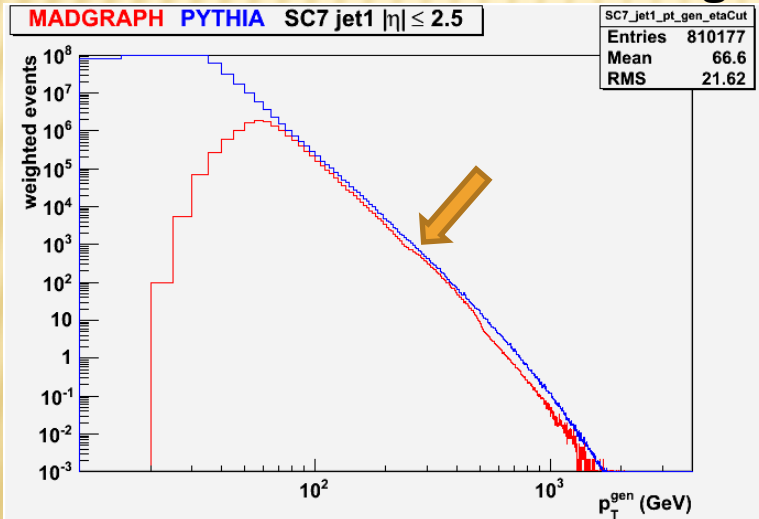
generated jets

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