

Optimal Jet Finder

A few results

Damir Lelas
Rolf Seuster

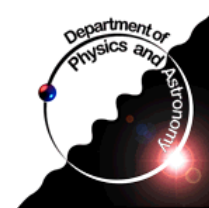
Michel Lefebvre, Rob McPherson, Frank Berghaus

TP week
19-22 March 2007

Physics and Astronomy
University of Victoria
British Columbia, Canada

Disclaimer

We use the OJF name as given by the authors. We do not necessarily agree with the name. If you do not agree with the name, contact the OJF author.



Optimal Jet Finder (OJF)

■ Documentation

- proposed by Fyodor Tkachov
- short introduction: Phys. Rev. Lett. 91, 061801 (2003)
- Int. Journal of Mod. Phys. A, Vol 17, No 21 (2002) 2783-2884.
- authors webpage (with links to source code, etc.)
 - <http://www.inr.ac.ru/~ftkachov/projects/jets/welcome.html>
- first presentation in the context of ATLAS: Damir Lelas 2007/01/10
 - <http://indico.cern.ch/conferenceDisplay.py?confId=7765>

■ Implementation in Athena in progress

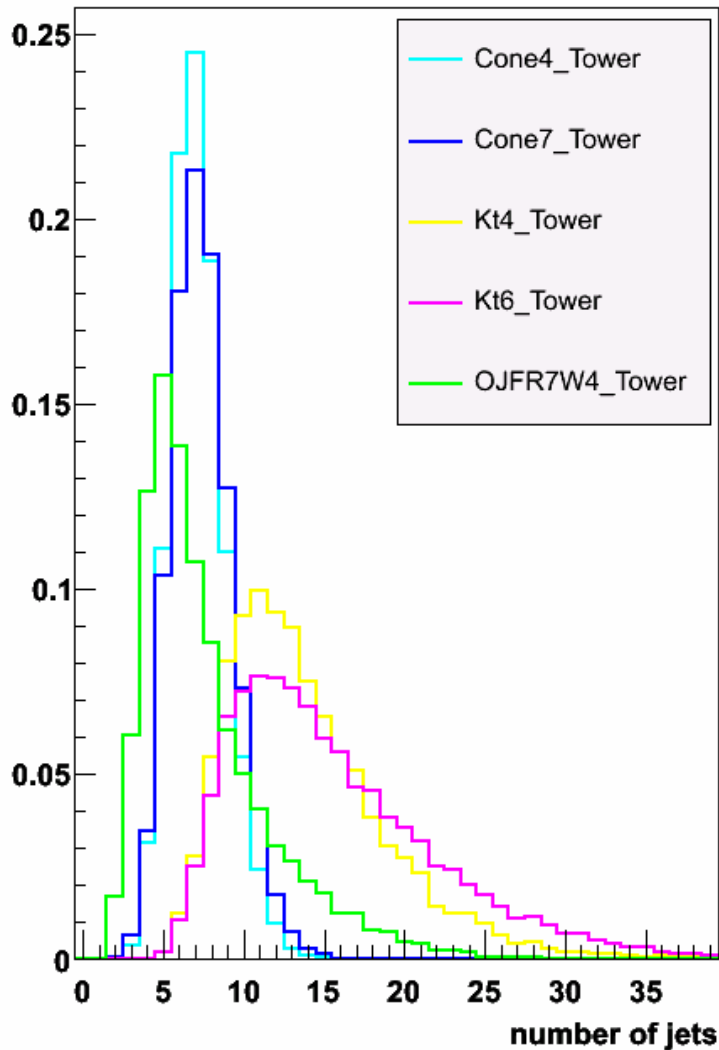
- Rolf Seuster, Damir Lelas
 - significant recent progress: many bugs have been corrected
- Discussion with other experts has started

fully hadronic t-tbar sample

- Small sample generated by Rolf Seuster
 - testing and debugging: Damir Lelas
- Sample 5204 CSC 12
 - MC@NLO fully hadronic t-tbar, full simulation, Athena 12.0.5
- AOD produced using Athena 12.0.5
 - 13000 events, $E_T > 7$ GeV filter on jets
 - JetCollection using OJF
 - no proper H1 weights available: use Cone $R = 0.7$ H1 weights
 - from Truth
 - from Towers
 - from topoClusters

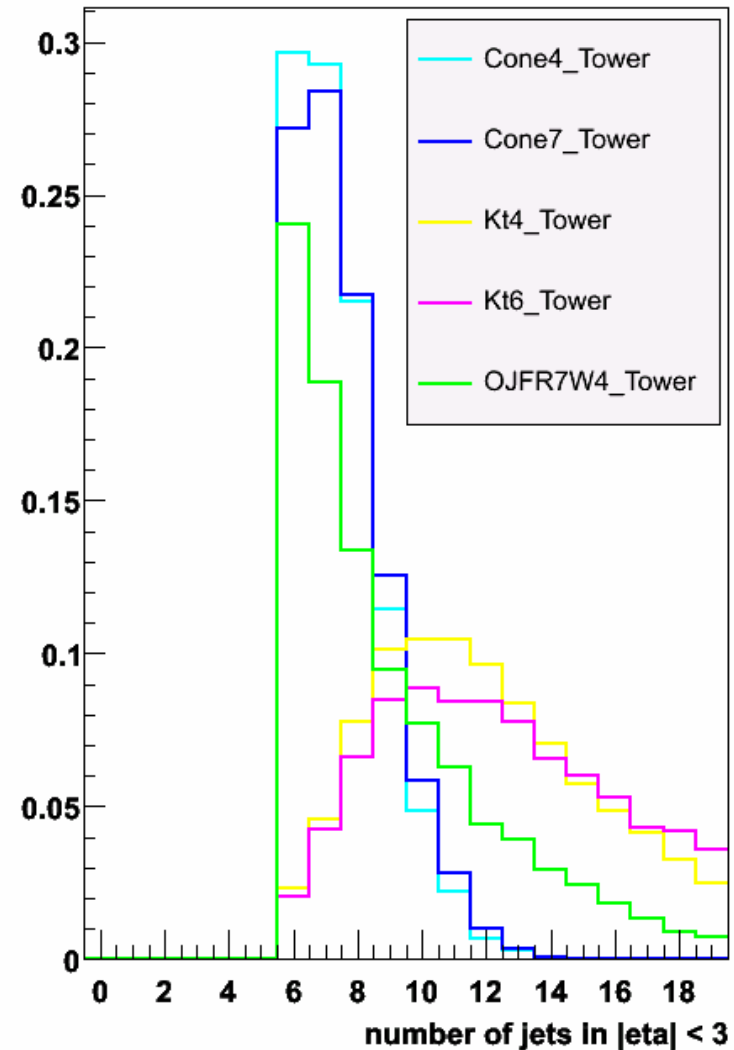
Jet multiplicity: towerJets

number of jets



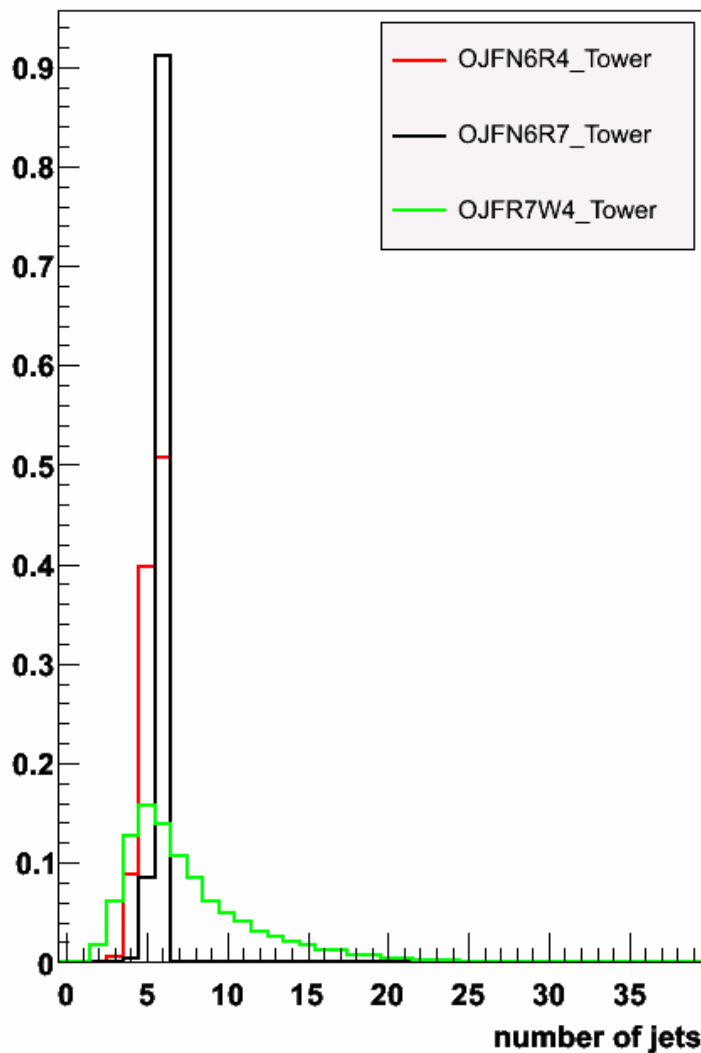
number of jets

at least 6 jets



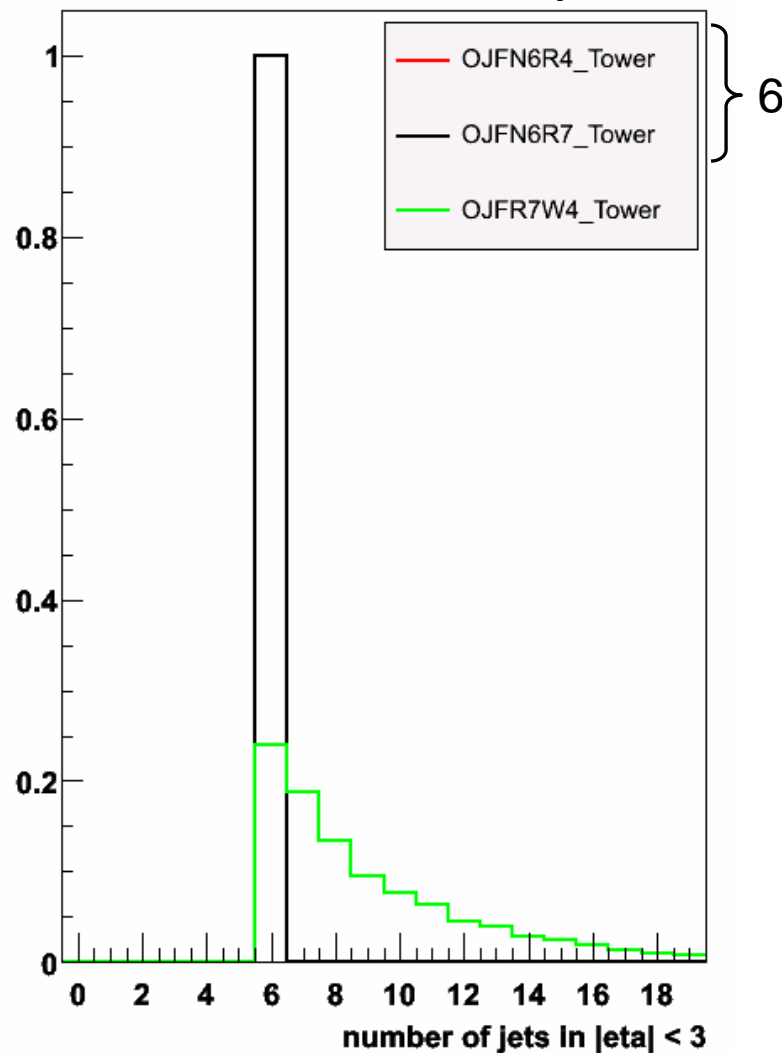
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number of jets



number of jets

at least 6 jets



Jet-parton matching

■ Matching criteria

- For each parton, look for a matching jet
 - restrict search in a region limited by ΔR_{\max}
 - keep the closest jet in this region
- Demand that a jet be matched only once
 - matched 1 to 1
 - one can then study matching efficiency

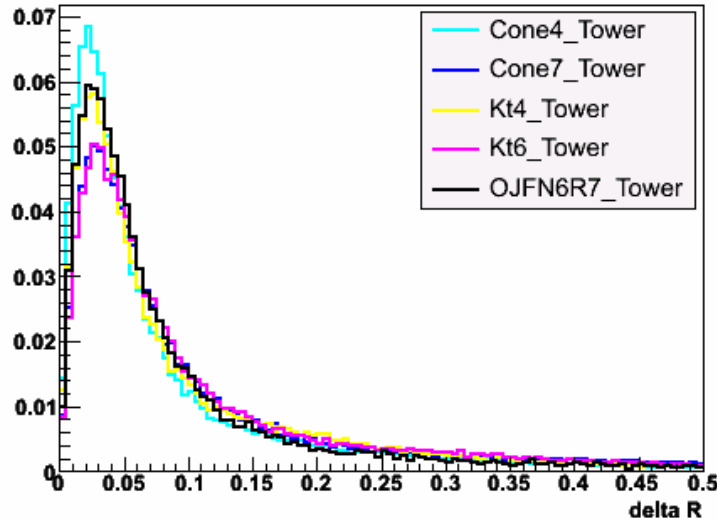
■ Study events with “true” jet hypothesis

- Require all 6 partons to be matched 1 to 1
 - this way we can study the top mass reconstruction performance for different jet algorithms

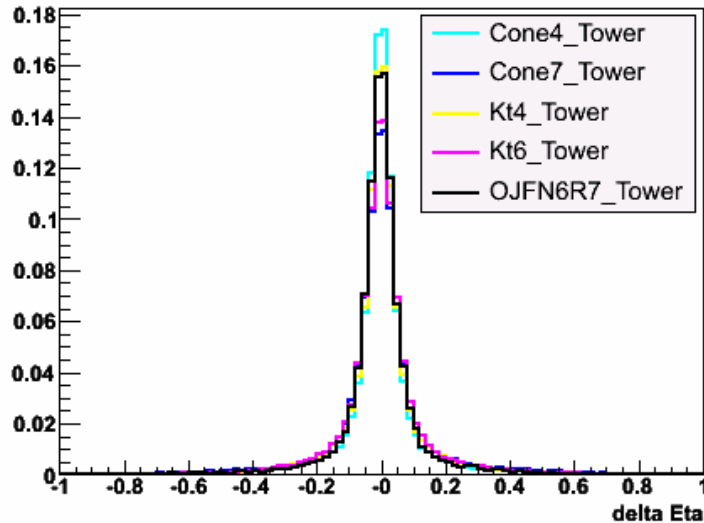
Normalized distributions: towerJets

matched 1 to 1 jet-parton in fully hadronic
t-tbar events with at least 6 jets in $|\eta| < 3$

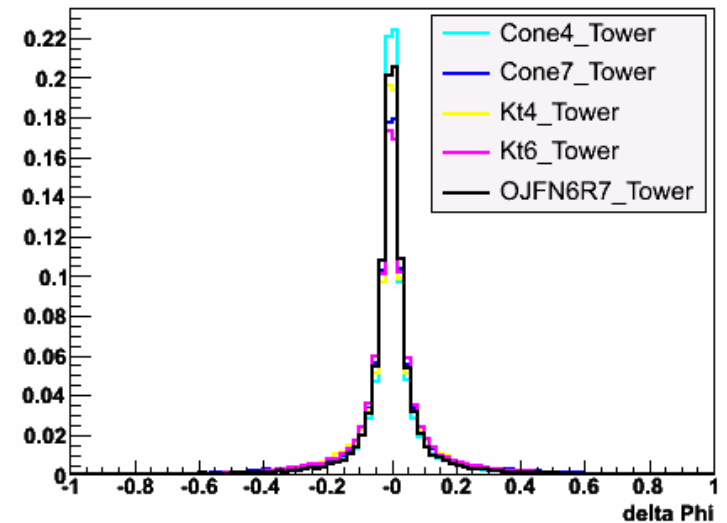
jet-parton match delta R



jet-parton match delta eta



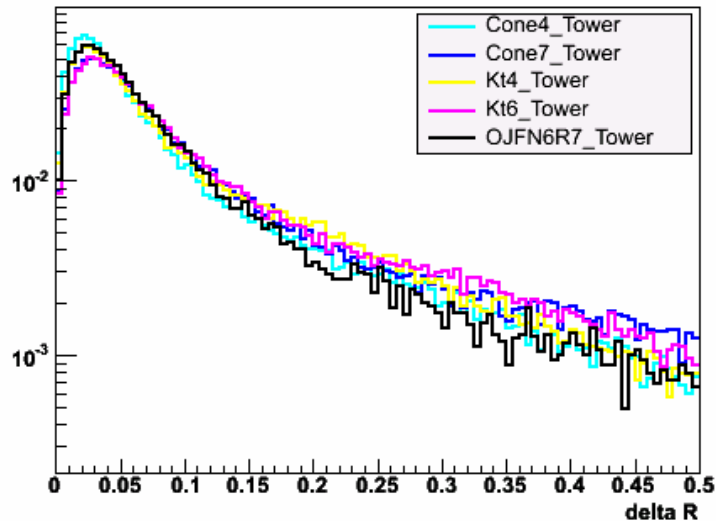
jet-parton match delta phi



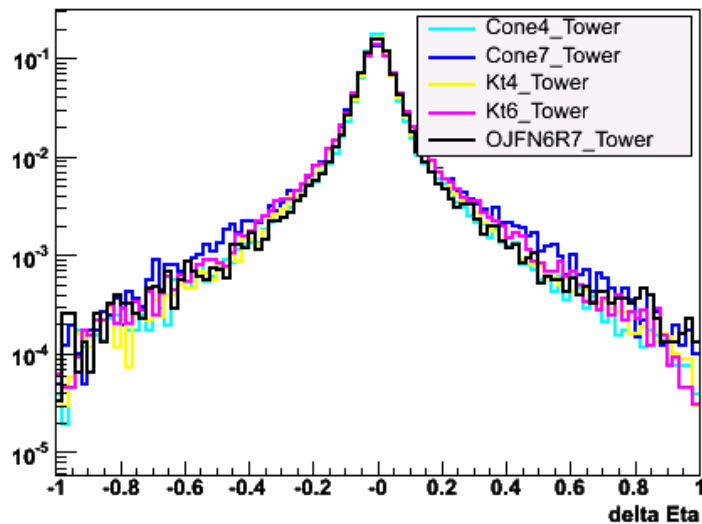
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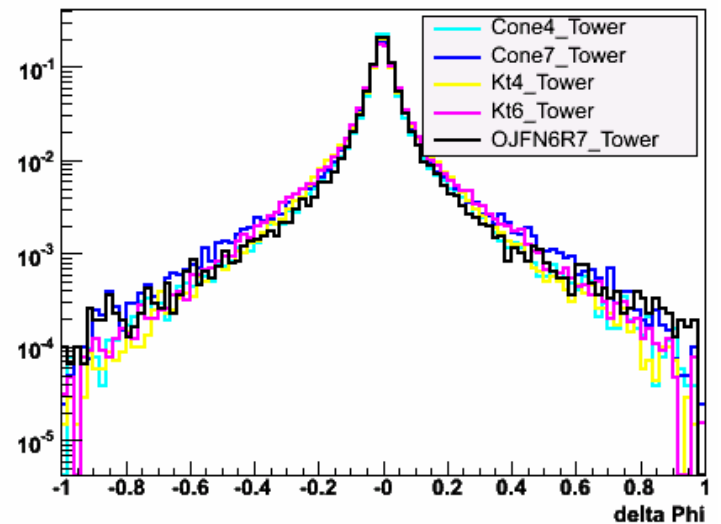
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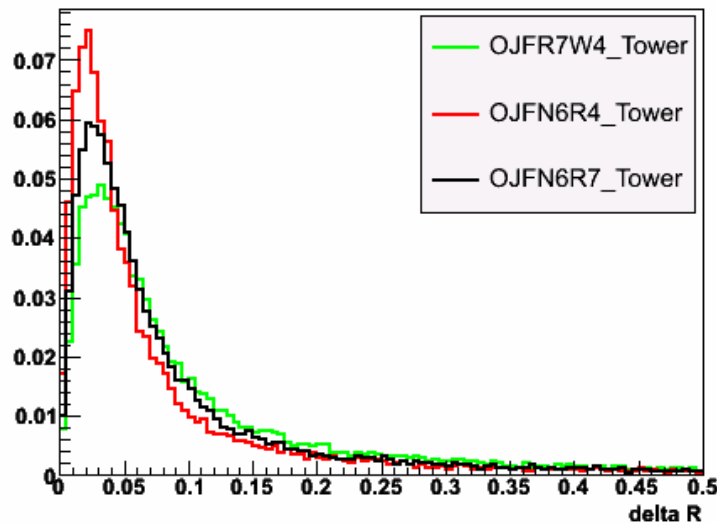
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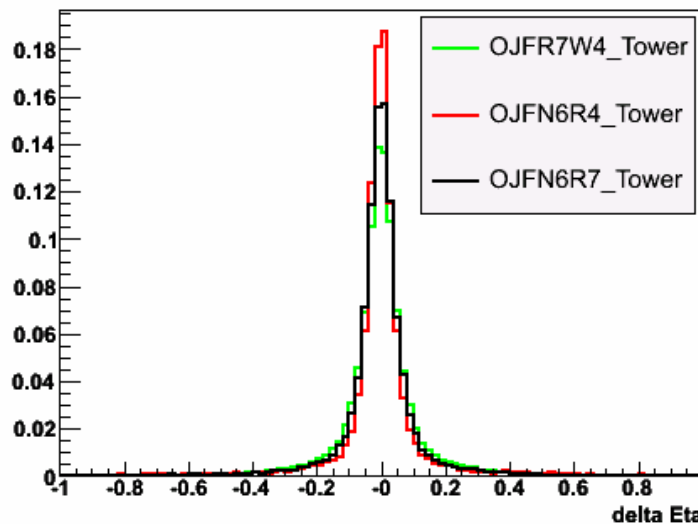
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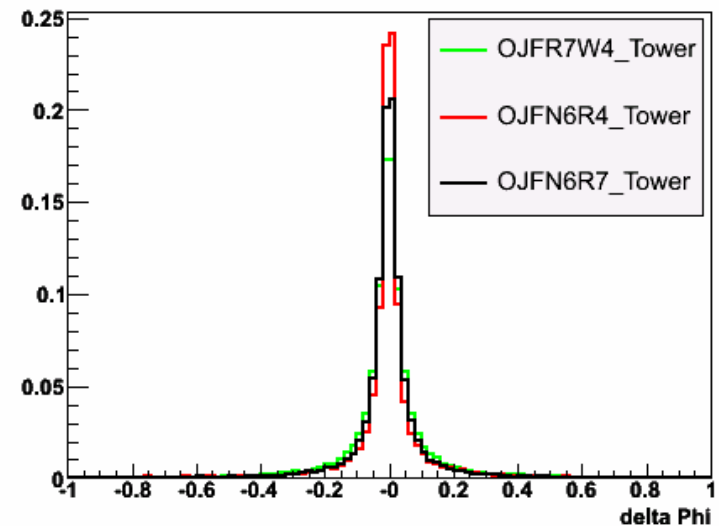
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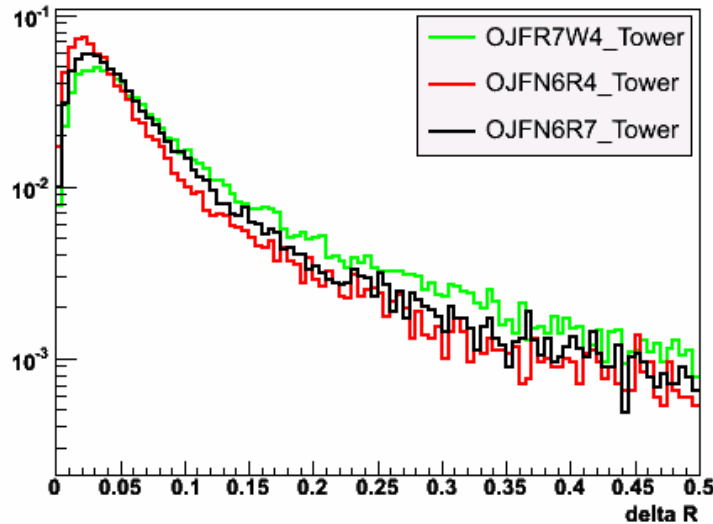
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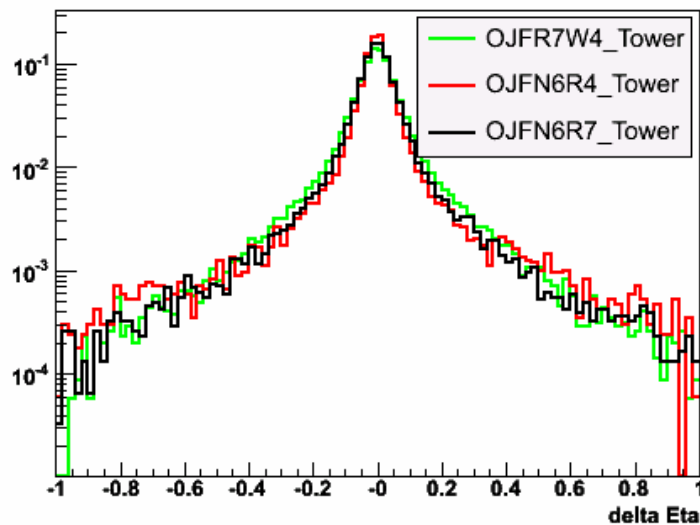
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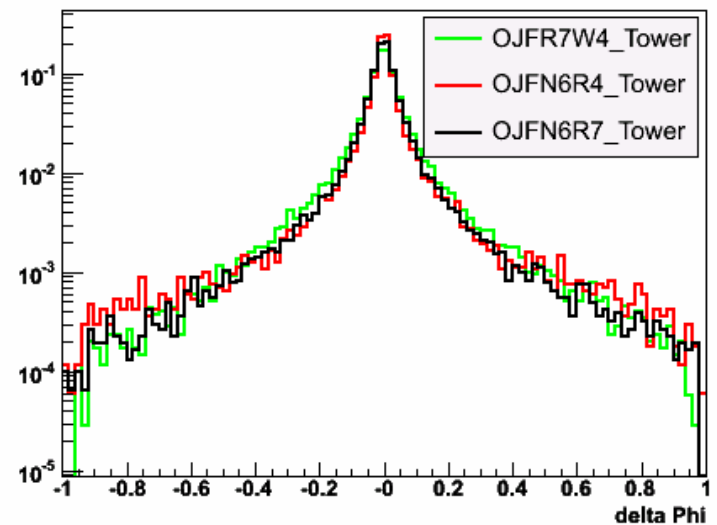
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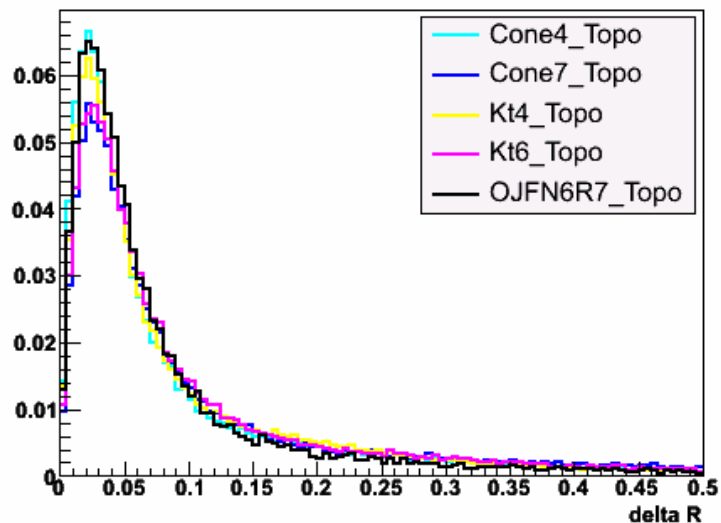
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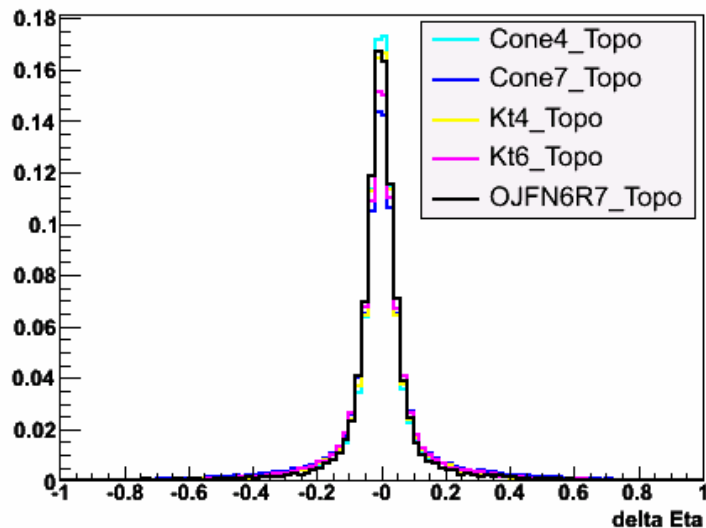
Normalized distributions: topoJets

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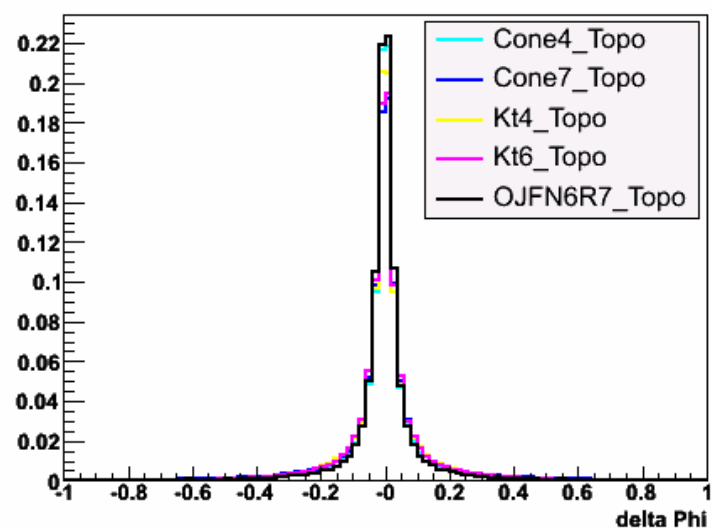
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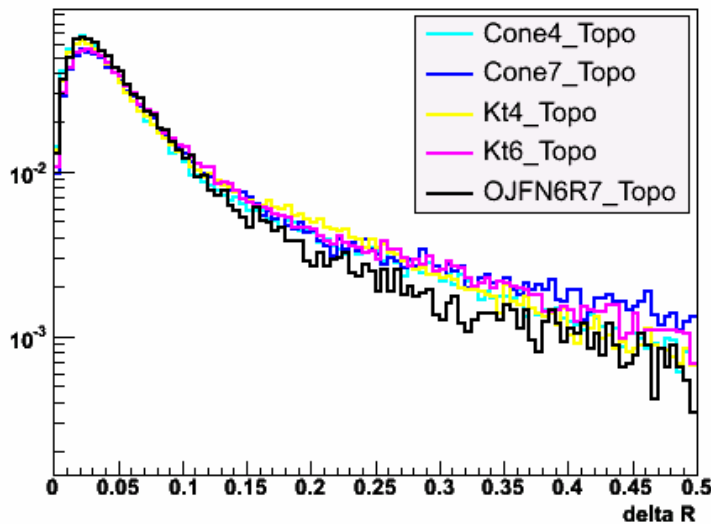
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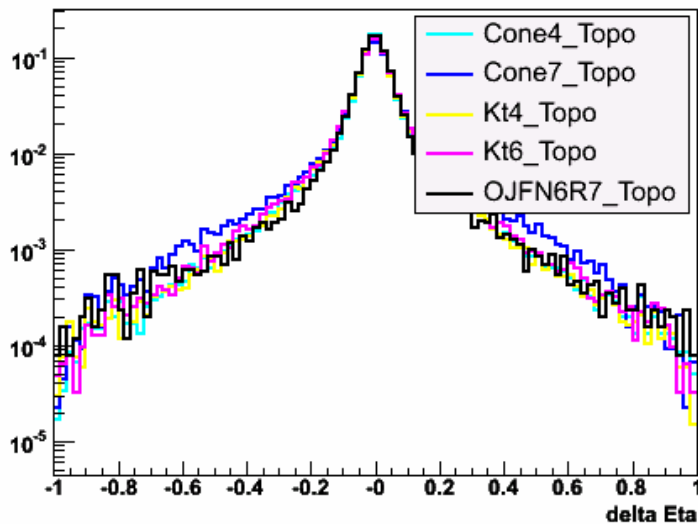
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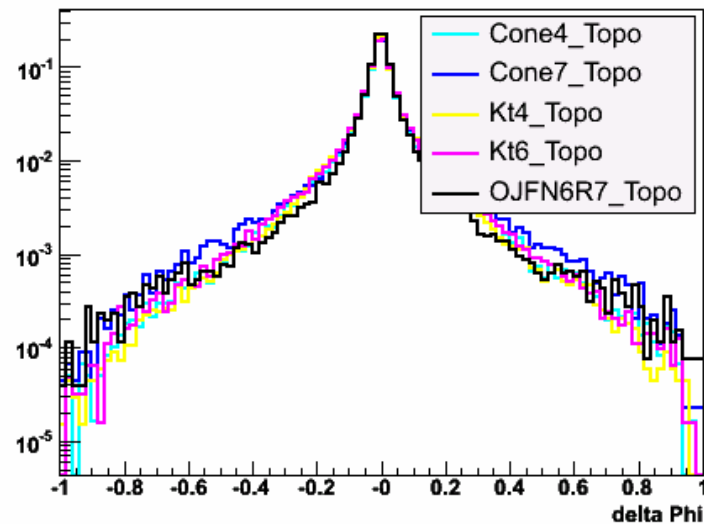
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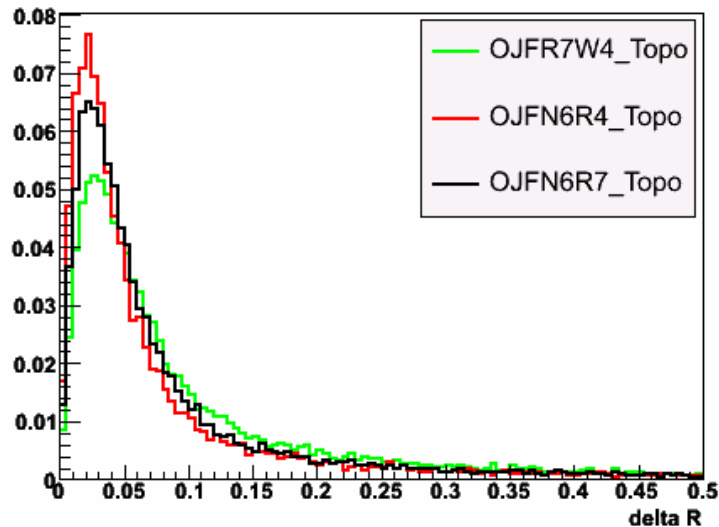
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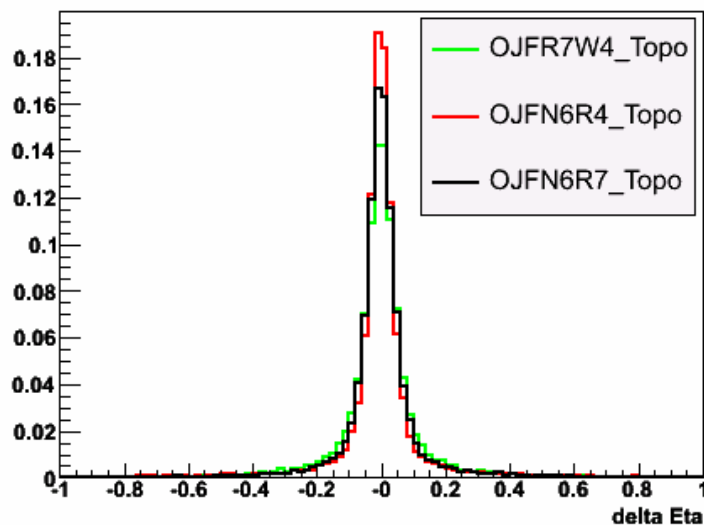
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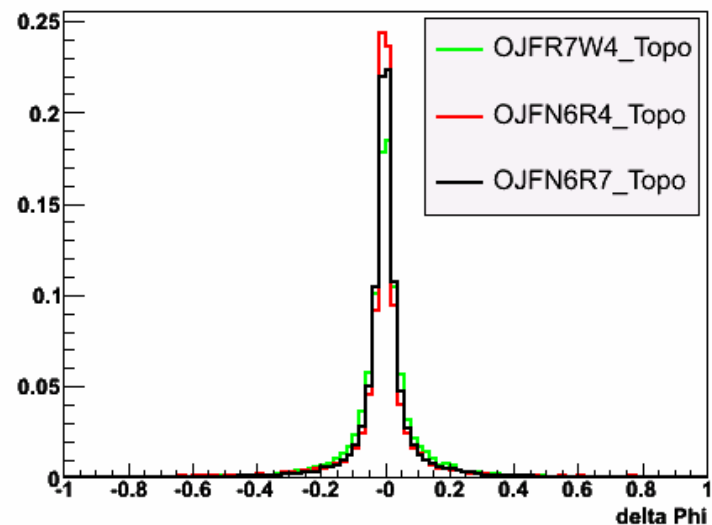
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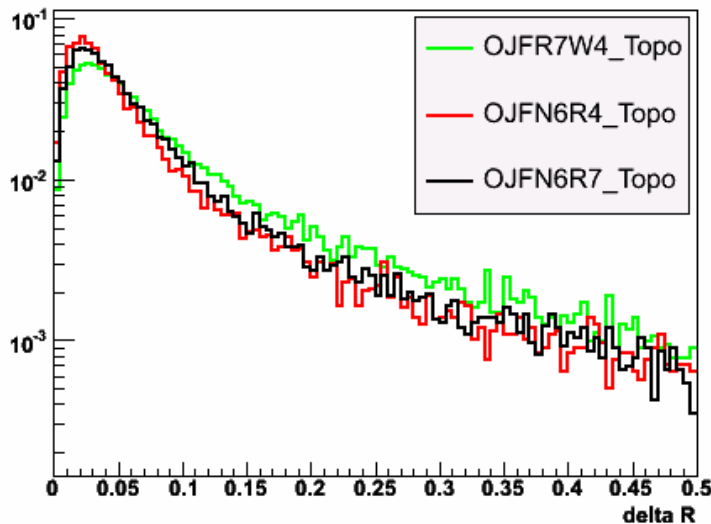
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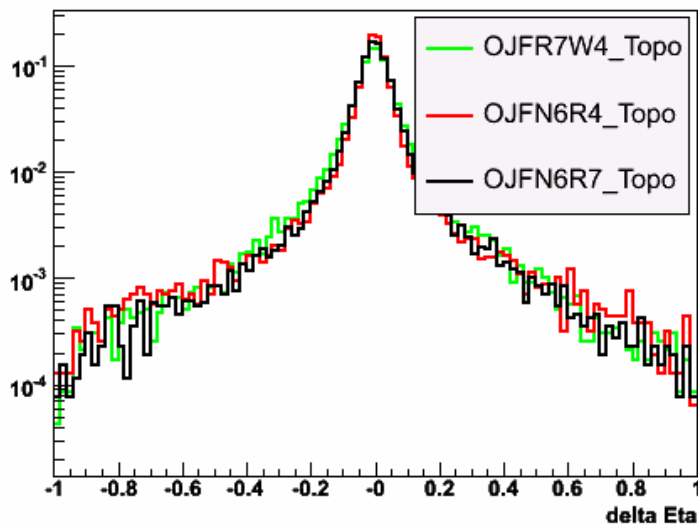
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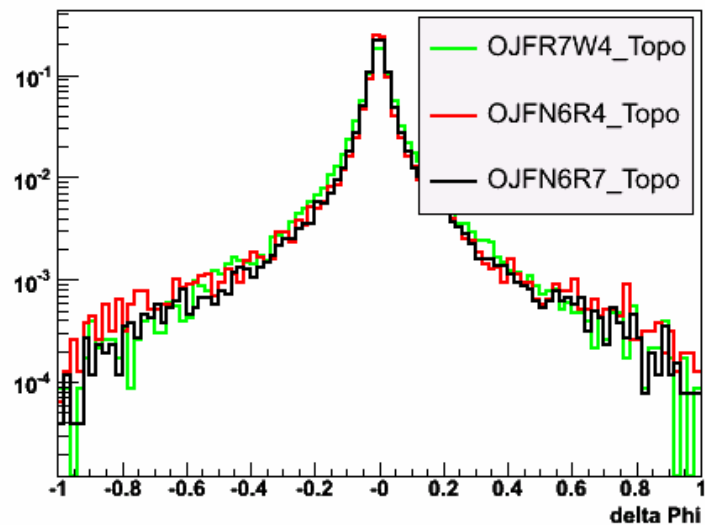
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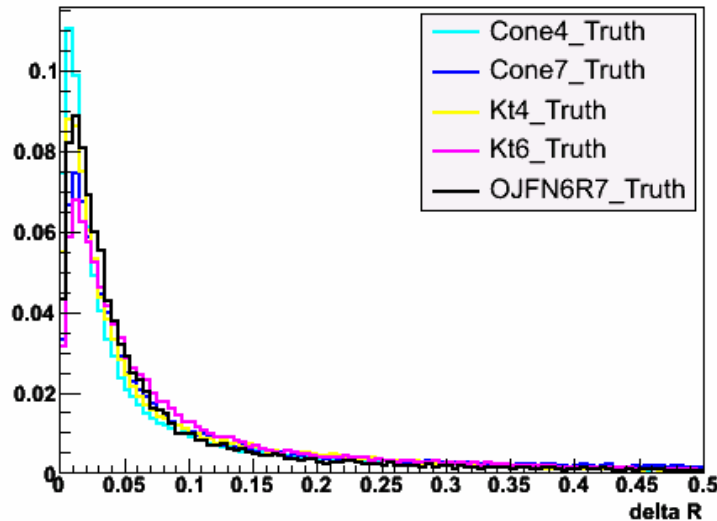
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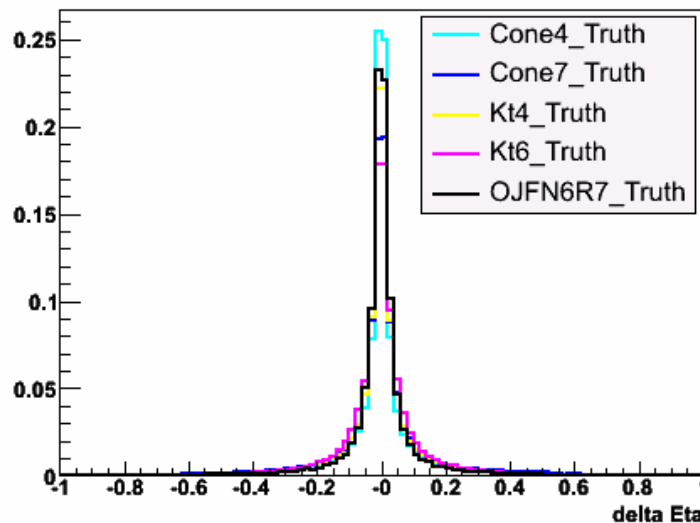
Normalized distributions: truthJets

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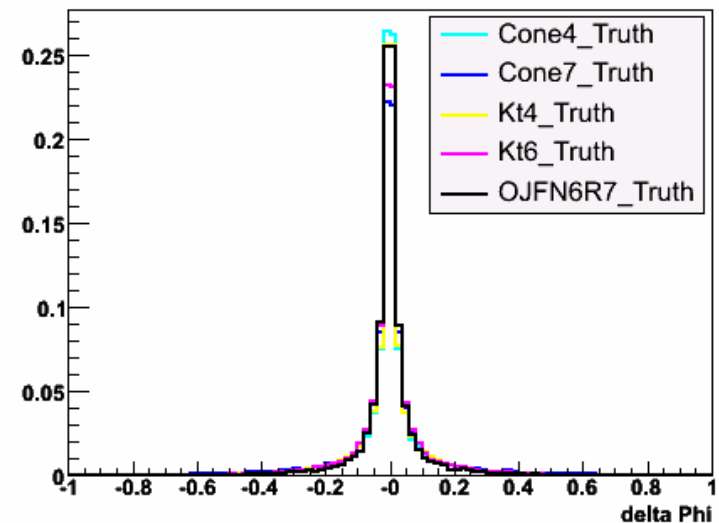
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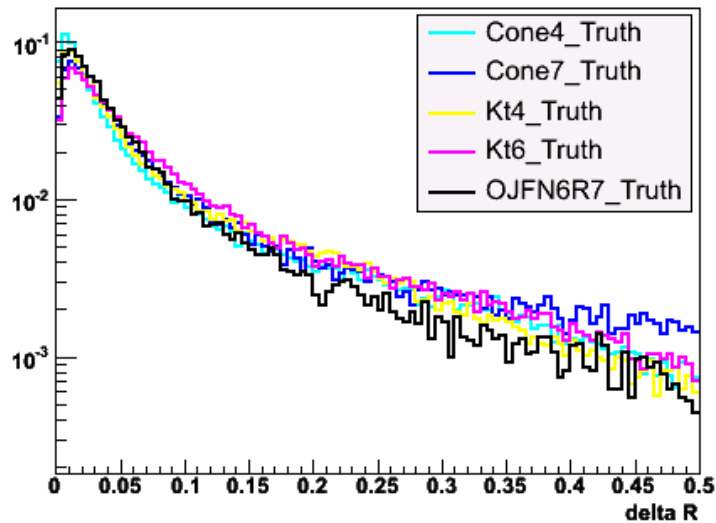
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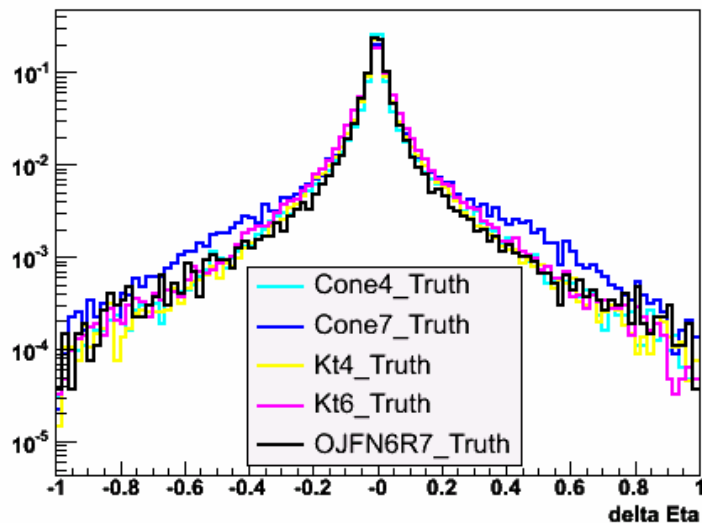
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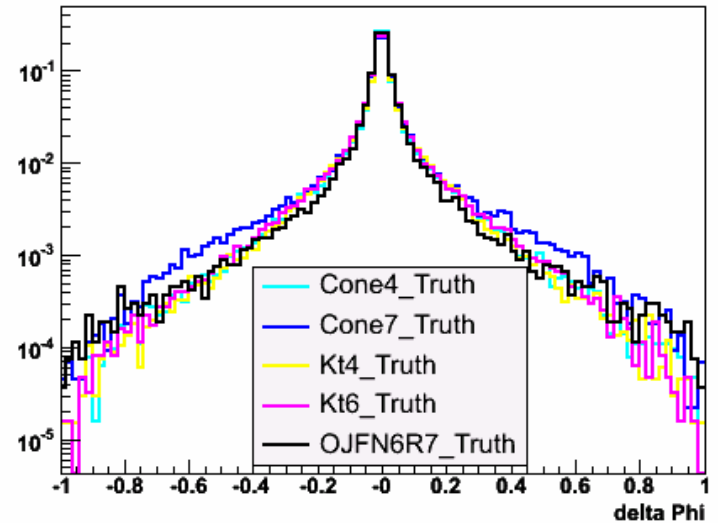
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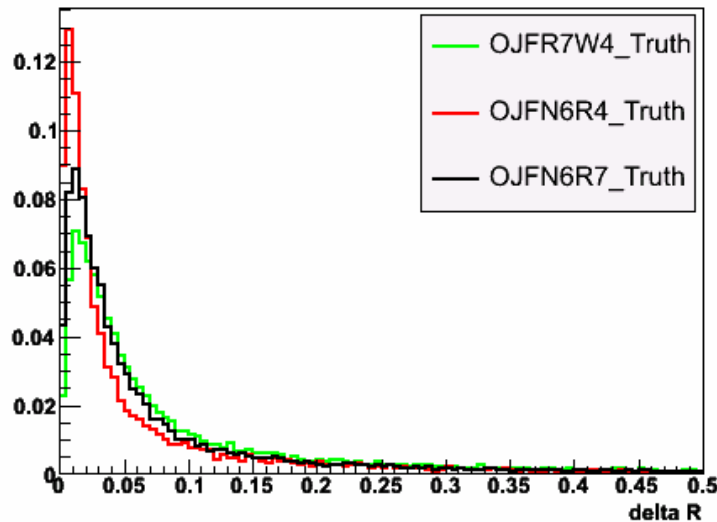
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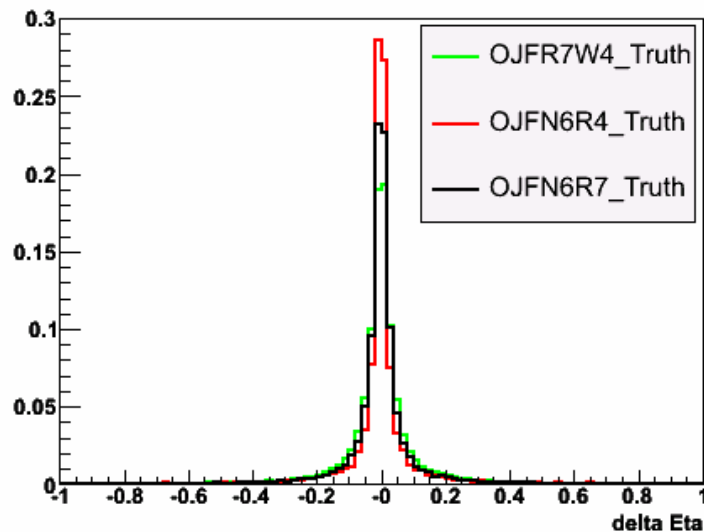
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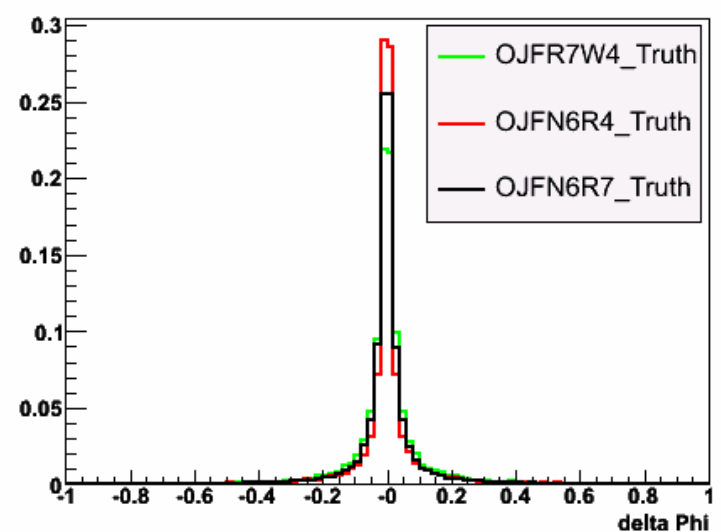
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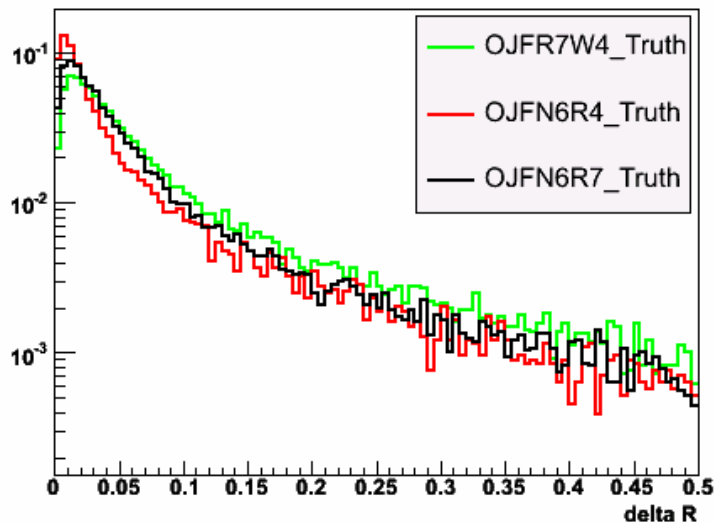
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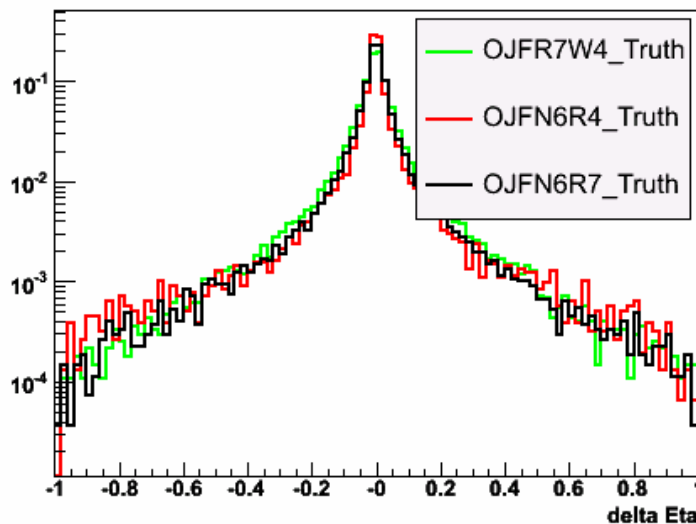
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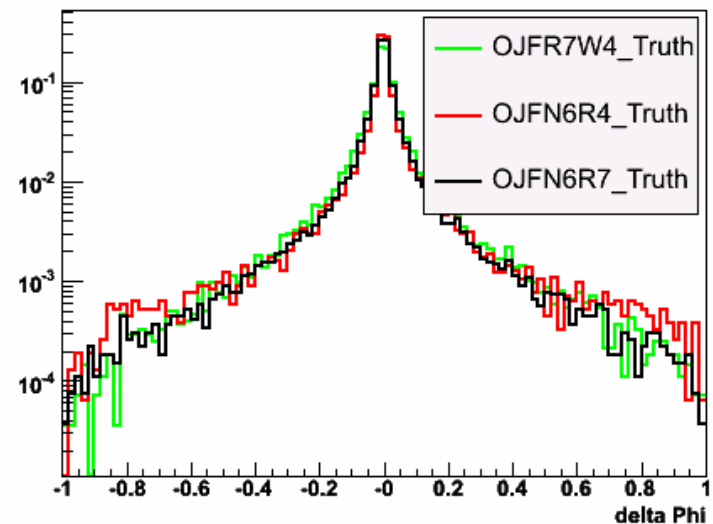
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jet-parton match delta phi



Jet-parton matching

■ Now restrict search in a region of $\Delta R_{\max} = 0.2$

- matching efficiencies depend on the jet algorithm
- matching efficiencies depend on inter-parton distances

- fully hadronic t-tbar

- same top combinations

$$\langle \Delta R(u-b) \rangle = 2.220 \pm 0.002$$

$$\langle \Delta R(\text{ubar-bbar}) \rangle = 2.219 \pm 0.002$$

$$\Rightarrow \langle \Delta R(u-d\text{bar}) \rangle = 2.008 \pm 0.002$$

$$\langle \Delta R(\text{ubar-d}) \rangle = 2.010 \pm 0.002 \leftarrow \Rightarrow$$

$$\Rightarrow \langle \Delta R(d\text{bar-b}) \rangle = 2.037 \pm 0.002$$

$$\langle \Delta R(d\text{bar-bbar}) \rangle = 2.036 \pm 0.002 \leftarrow \Rightarrow$$

- other 9 combinations

$$\langle \Delta R \rangle \approx 2.40$$

- matching efficiency is expected to be less when d and dbar quarks are involved

Event and jet hypothesis selection

- Try to compare jet matching efficiency for different jet algorithms
 - Fully hadronic t-tbar, choice of sample
 - Require at least 6 jets in $|\eta| < 3$
 - clearly, algorithms with more than 6 jets will have a better chance at 6 jet-parton matching
 - only consider the 6 highest p_T jets
 - algos with more than 6 jets still have a better chance at 6 jet-parton matching
 - only consider events with exactly 6 jets
 - perhaps a more fair way to compare 6 jet-parton matching given that OJF is here with fixed number of jets (= 6).
 - No jet p_T cuts applied

Jet-parton matching: towerJets

fully hadronic t-tbar 5204 sample 12.0.X	Cone4TowerParticleJets	ConeTowerParticleJets	Kt4TowerParticleJets	Kt6TowerParticleJets	OJFTowerJets (N6 R4)	OJFTowerJets (N6 R7)	OJFTowerJets (R7 W4)
number of events	12983	12983	12983	12983	12983	12983	12983
at least 6 jets in $ \eta < 3$ all matched partons 1 to 1	10471	10084	12834	12863	4625	8162	7617
matching efficiency	1804	673	2781	2014	91	242	606
selection efficiency	17.2%	6.7%	21.7%	15.7%	2.0%	3.0%	8.0%
	13.9%	5.2%	21.4%	15.5%	0.7%	1.9%	4.7%
at least 6 jets in $ \eta < 3$ all matched partons 1 to 1 assume 6 highest pt jets	10471	10084	12834	12863	4625	8162	7617
matching efficiency	1804	673	2781	2014	91	242	606
selection efficiency	833	379	899	796	91	242	321
	17.2%	6.7%	21.7%	15.7%	2.0%	3.0%	8.0%
	6.4%	2.9%	6.9%	6.1%	0.7%	1.9%	2.5%
at least 6 jets in $ \eta < 3$ exactly 6 jets all matched partons 1 to 1	10471	10084	12834	12863	4625	8162	7617
matching efficiency	3103	2738	297	262	4625	8162	1833
selection efficiency	375	107	41	20	91	242	59
	12.1%	3.9%	13.8%	7.6%	2.0%	3.0%	3.2%
	2.9%	0.8%	0.3%	0.2%	0.7%	1.9%	0.5%
matching efficiencies							
u	72%	57%	73%	66%	62%	62%	64%
dbar	65%	48%	64%	56%	54%	54%	54%
b	77%	63%	74%	69%	68%	67%	71%
ubar	74%	57%	72%	72%	62%	63%	65%
d	66%	49%	67%	61%	54%	53%	57%
bbar	77%	63%	73%	70%	68%	68%	68%

Jet-parton matching: topoJets

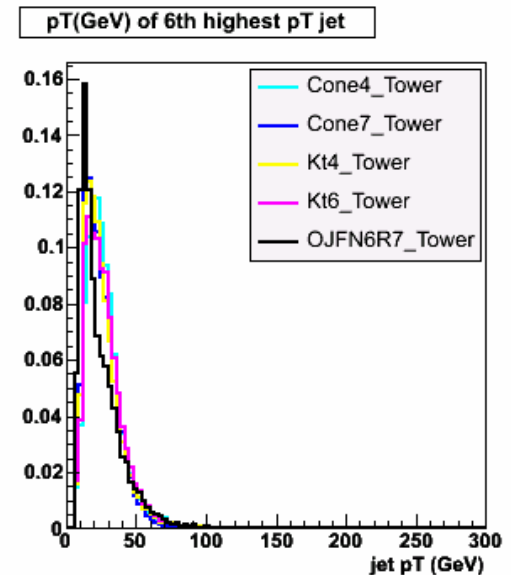
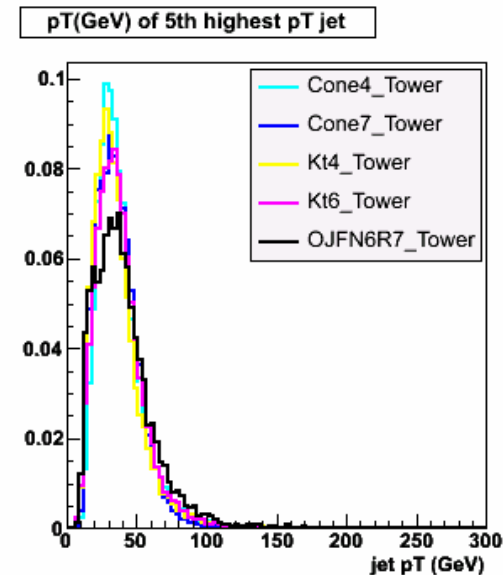
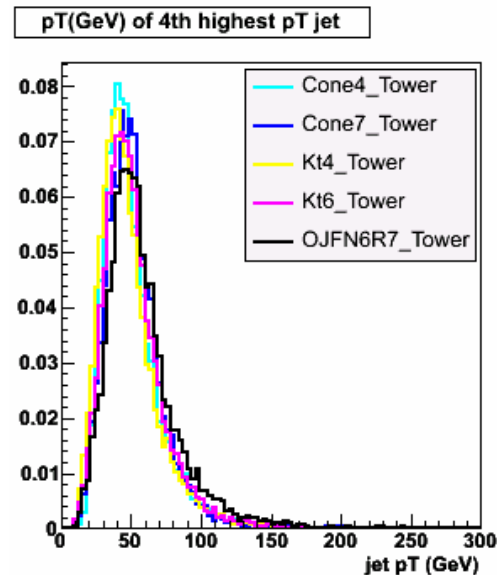
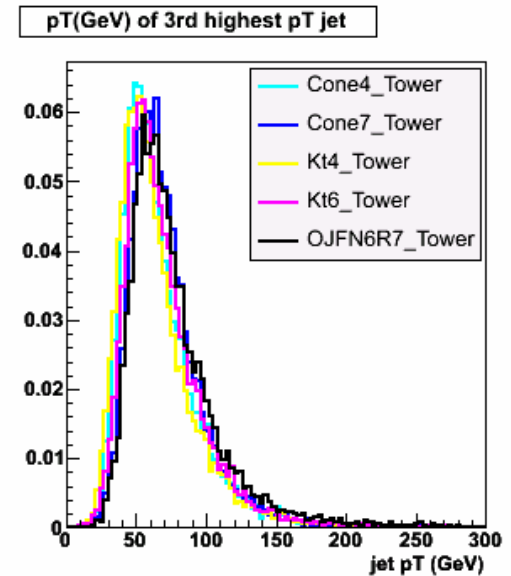
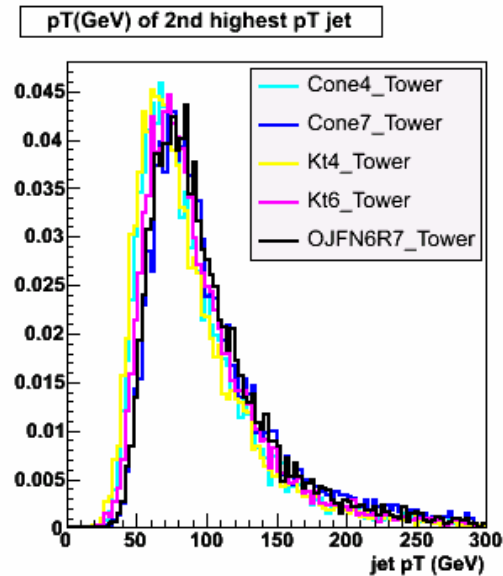
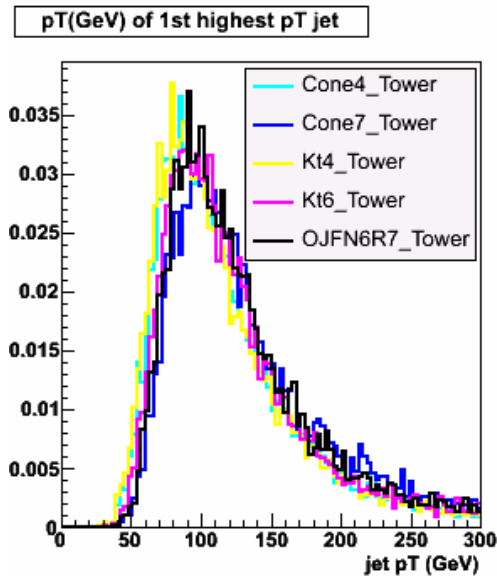
fully hadronic t-tbar 5204 sample 12.0.X	Cone4TopoParticleJets	ConeTopoParticleJets	Kt4TopoParticleJets	Kt6TopoParticleJets	OJFTopoJets (N6 R4)	OJFTopoJets (N6 R7)	OJFTopoJets (R7 W4)
number of events	12983	12983	12983	12983	12983	12983	12983
at least 6 jets in $ \eta < 3$ all matched partons 1 to 1	11977	11244	12700	12570	4182	6856	5312
matching efficiency	2195	748	2770	2096	111	209	320
selection efficiency	18.3%	6.7%	21.8%	16.7%	2.7%	3.0%	6.0%
at least 6 jets in $ \eta < 3$ all matched partons 1 to 1 assume 6 highest pt jets	11977	11244	12700	12570	4182	6856	5312
matching efficiency	2195	748	2770	2096	111	209	320
selection efficiency	910	392	939	877	111	209	186
	18.3%	6.7%	21.8%	16.7%	2.7%	3.0%	6.0%
	7.0%	3.0%	7.2%	6.8%	0.9%	1.6%	1.4%
at least 6 jets in $ \eta < 3$ exactly 6 jets	11977	11244	12700	12570	4182	6856	5312
all matched partons 1 to 1	1704	1908	618	805	4182	6856	1798
matching efficiency	211	81	94	116	111	209	49
selection efficiency	12.4%	4.2%	15.2%	14.4%	2.7%	3.0%	2.7%
	1.6%	0.6%	0.7%	0.9%	0.9%	1.6%	0.4%
matching efficiencies							
u	74%	55%	71%	74%	63%	62%	63%
dbar	63%	47%	69%	62%	55%	55%	55%
b	77%	62%	79%	77%	68%	68%	70%
ubar	73%	55%	77%	76%	64%	62%	62%
d	66%	48%	67%	64%	54%	54%	55%
bbar	75%	61%	77%	76%	70%	69%	69%

Jet-parton matching: truthJets

fully hadronic t-tbar 5204 sample 12.0.X	Cone4TruthParticleJets	ConeTruthParticleJets	Kt4TruthParticleJets	Kt6TruthParticleJets	OJFTruthJets (N6 R4)	OJFTruthJets (N6 R7)	OJFTruthJets (R7 W4)
number of events	12983	12983	12983	12983	12983	12983	12983
at least 6 jets in $ \eta < 3$	12481	11541	12612	12538	4058	7017	6165
all matched partons 1 to 1	2461	723	3026	2222	125	271	492
matching efficiency	19.7%	6.3%	24.0%	17.7%	3.1%	3.9%	8.0%
selection efficiency	19.0%	5.6%	23.3%	17.1%	1.0%	2.1%	3.8%
at least 6 jets in $ \eta < 3$	12481	11541	12612	12538	4058	7017	6165
all matched partons 1 to 1	2461	723	3026	2222	125	271	492
assume 6 highest pt jets	968	371	1057	924	125	271	289
matching efficiency	19.7%	6.3%	24.0%	17.7%	3.1%	3.9%	8.0%
selection efficiency	7.5%	2.9%	8.1%	7.1%	1.0%	2.1%	2.2%
at least 6 jets in $ \eta < 3$	12481	11541	12612	12538	4058	7017	6165
exactly 6 jets	984	1560	763	817	4058	7017	1895
all matched partons 1 to 1	145	67	135	129	125	271	56
matching efficiency	14.7%	4.3%	17.7%	15.8%	3.1%	3.9%	3.0%
selection efficiency	1.1%	0.5%	1.0%	1.0%	1.0%	2.1%	0.4%
matching efficiencies							
u	73%	55%	77%	75%	65%	62%	65%
dbar	67%	43%	69%	66%	56%	56%	56%
b	77%	60%	77%	76%	72%	70%	70%
ubar	74%	53%	77%	73%	64%	63%	63%
d	65%	46%	68%	66%	55%	55%	56%
bbar	74%	59%	77%	75%	71%	70%	70%

Normalized p_T distributions: towerJets

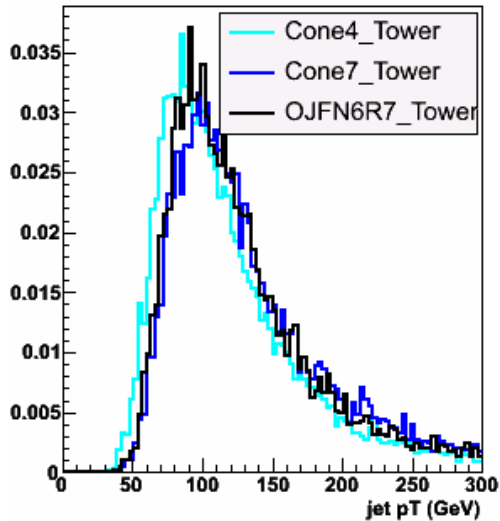
fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$



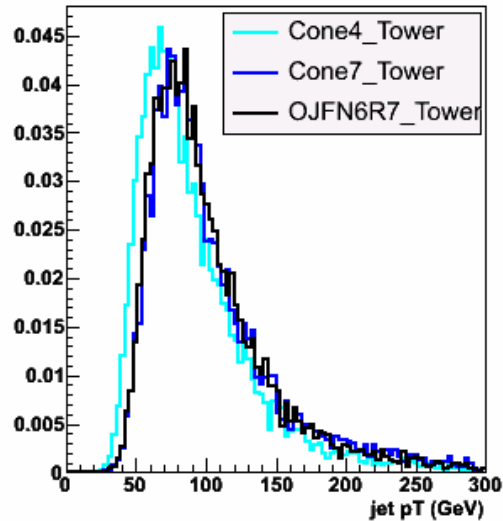
Normalized p_T distributions: towerJets

fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$

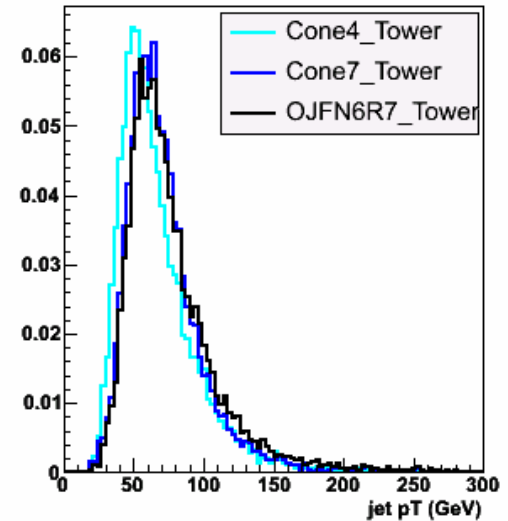
pT(GeV) of 1st highest pT jet



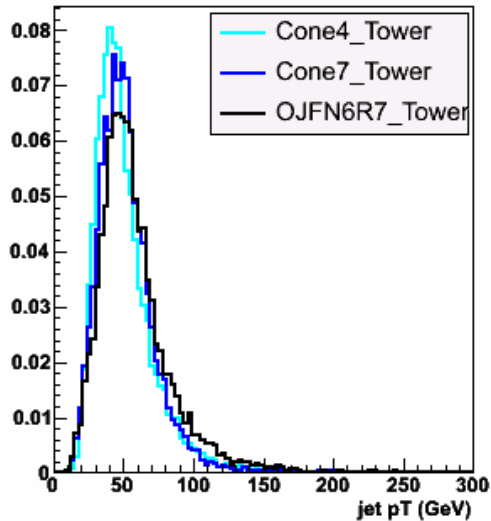
pT(GeV) of 2nd highest pT jet



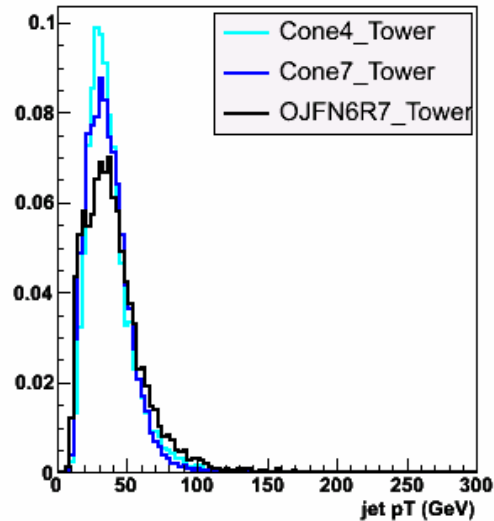
pT(GeV) of 3rd highest pT jet



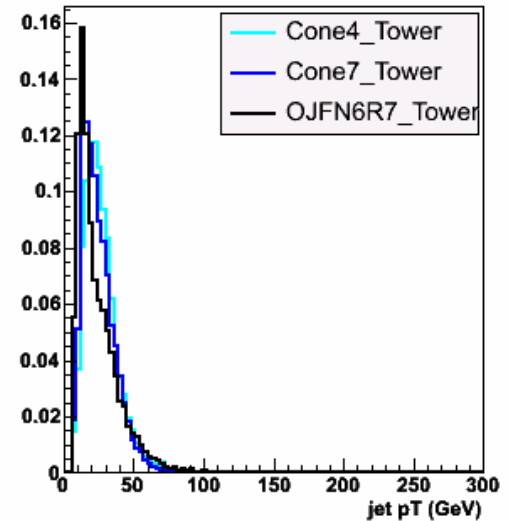
pT(GeV) of 4th highest pT jet



pT(GeV) of 5th highest pT jet



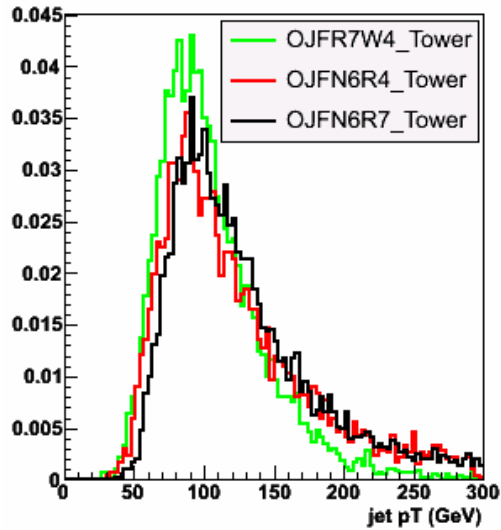
pT(GeV) of 6th highest pT jet



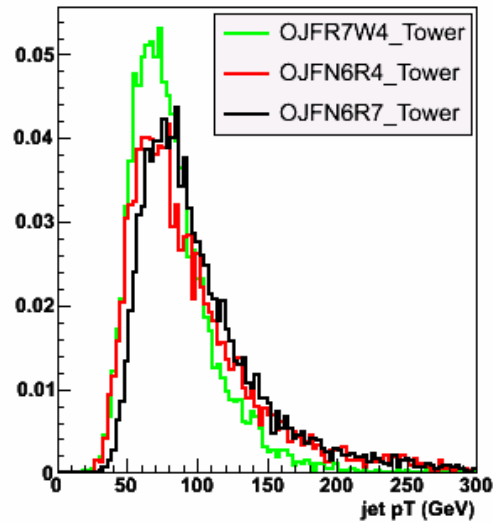
Normalized p_T distributions: towerJets

fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$

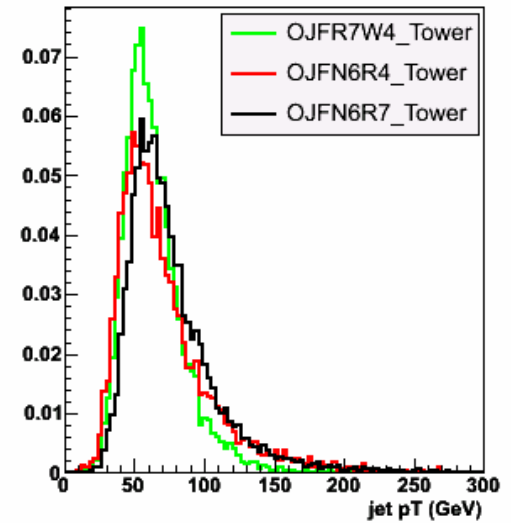
pt(GeV) of 1st highest pT jet



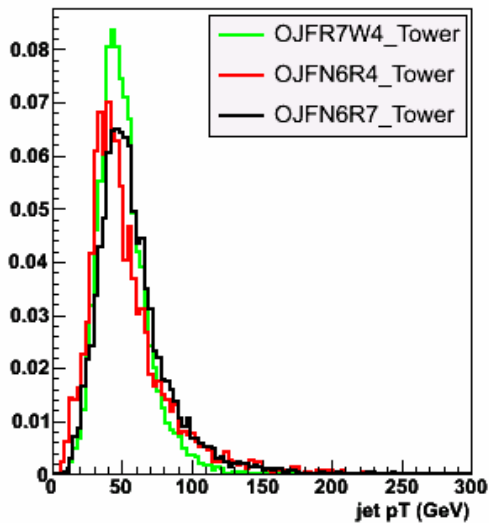
pt(GeV) of 2nd highest pT jet



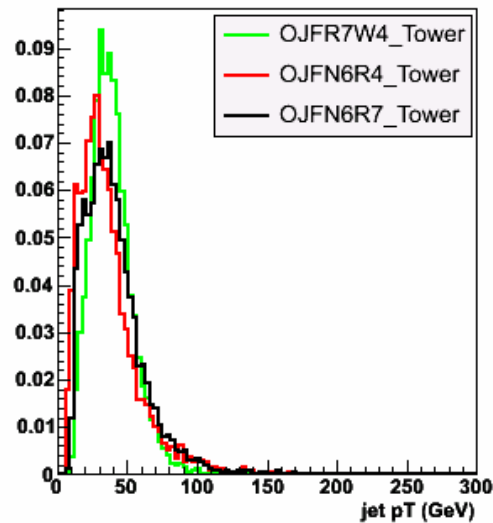
pt(GeV) of 3rd highest pT jet



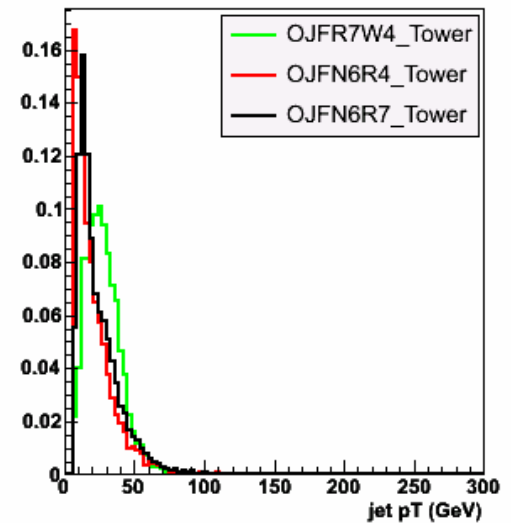
pt(GeV) of 4th highest pT jet



pt(GeV) of 5th highest pT jet



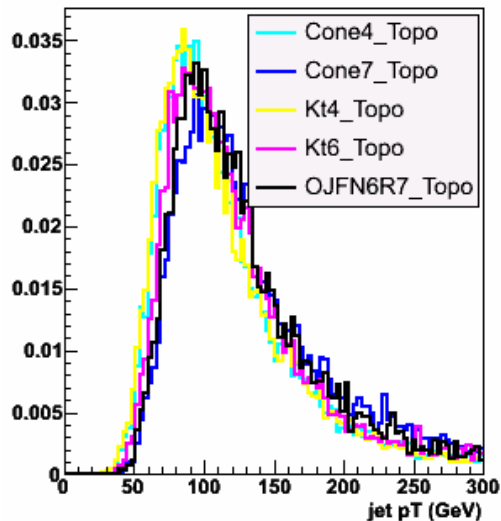
pt(GeV) of 6th highest pT jet



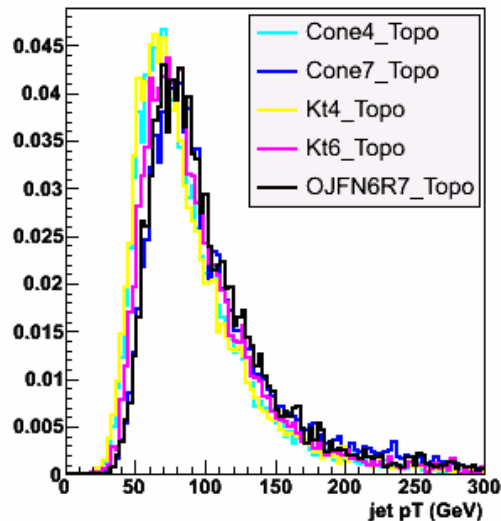
Normalized p_T distributions: topoJets

fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$

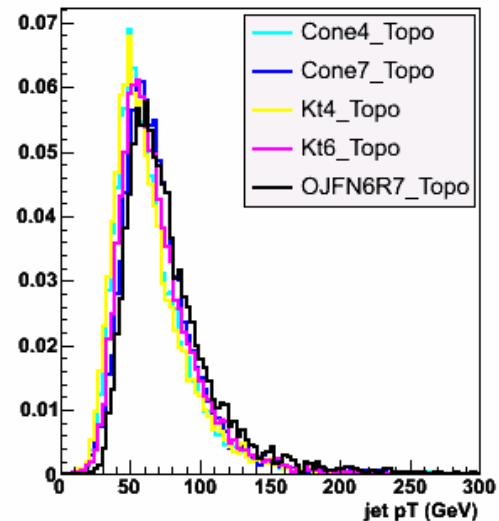
pT(GeV) of 1st highest pT jet



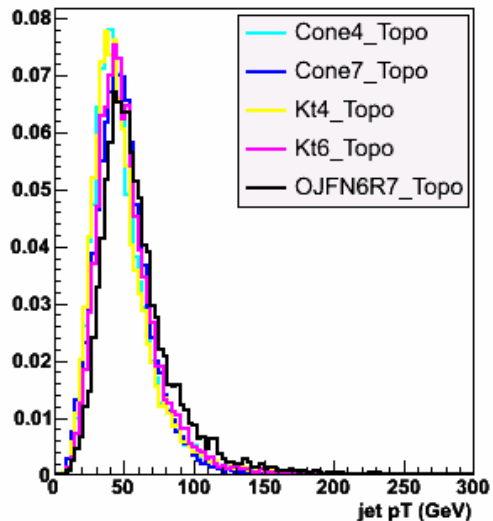
pT(GeV) of 2nd highest pT jet



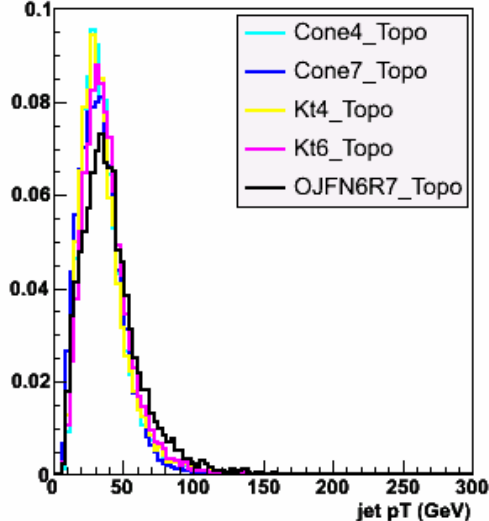
pT(GeV) of 3rd highest pT jet



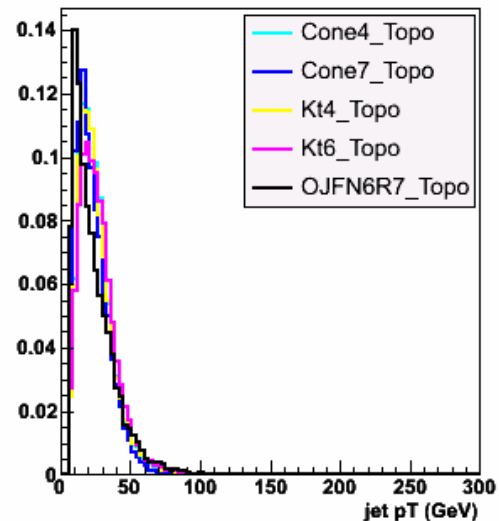
pT(GeV) of 4th highest pT jet



pT(GeV) of 5th highest pT jet



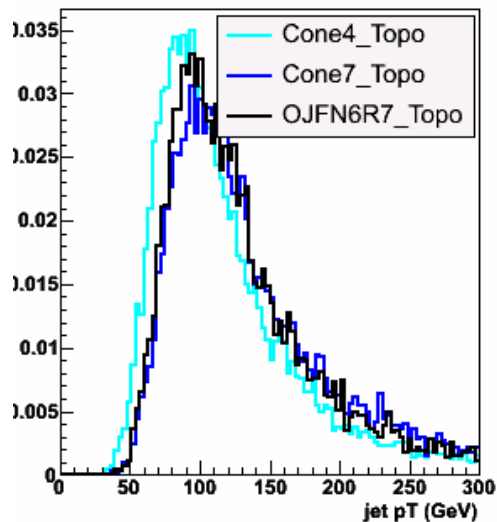
pT(GeV) of 6th highest pT jet



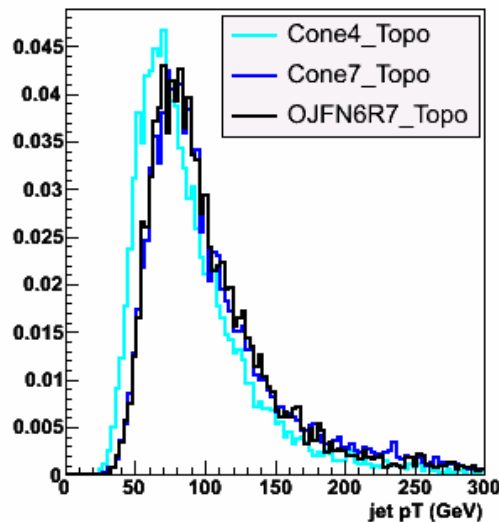
Normalized p_T distributions: topoJets

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with at least 6 jets in $|\eta| < 3$

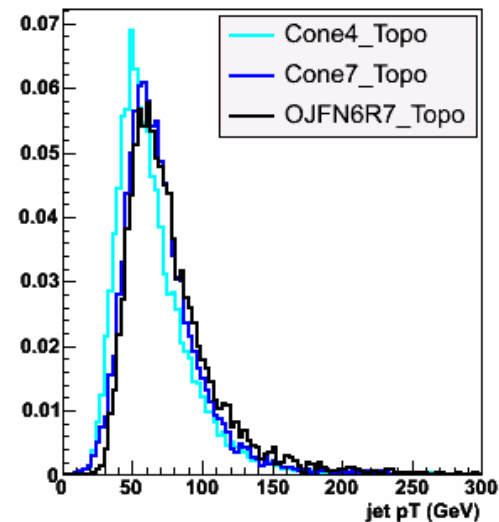
pt(GeV) of 1st highest pT jet



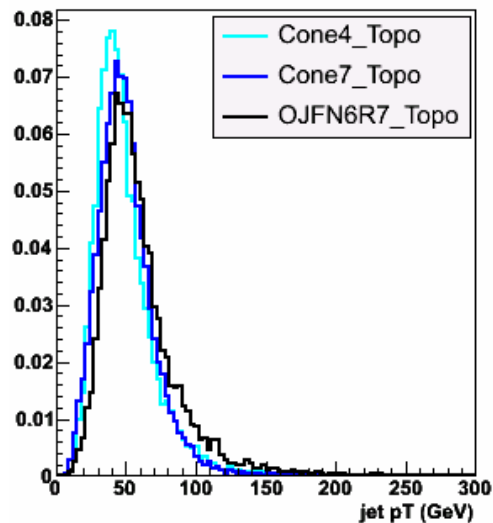
pt(GeV) of 2nd highest pT jet



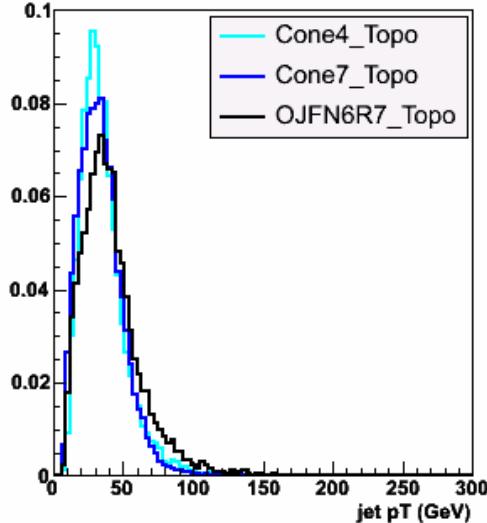
pt(GeV) of 3rd highest pT jet



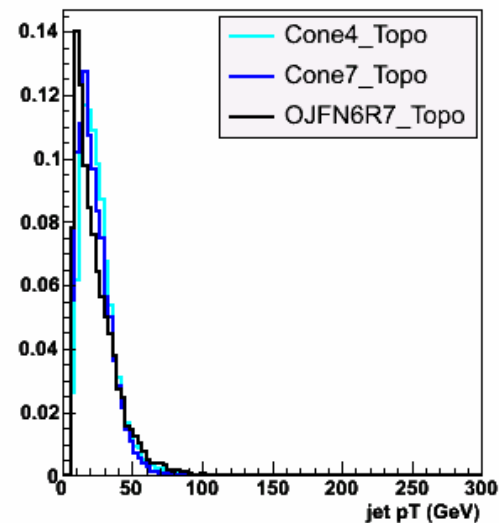
pt(GeV) of 4th highest pT jet



pt(GeV) of 5th highest pT jet

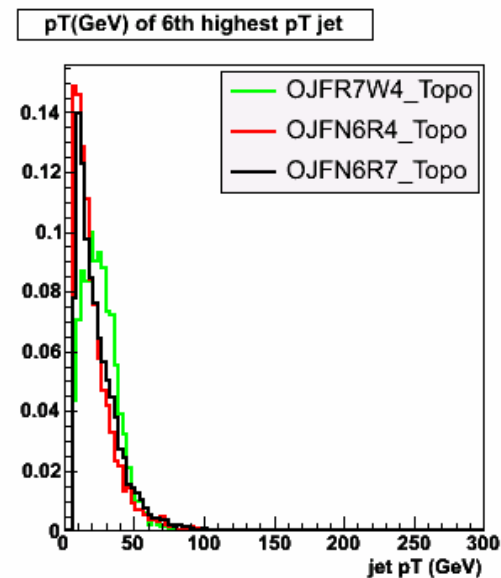
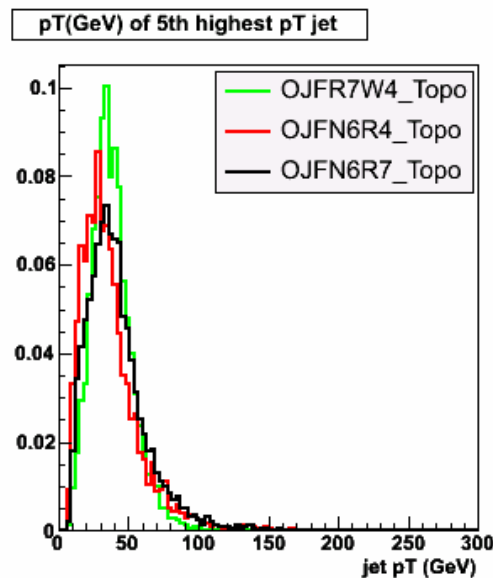
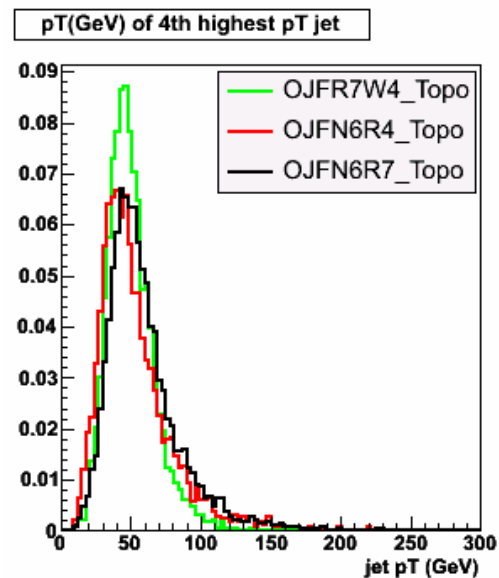
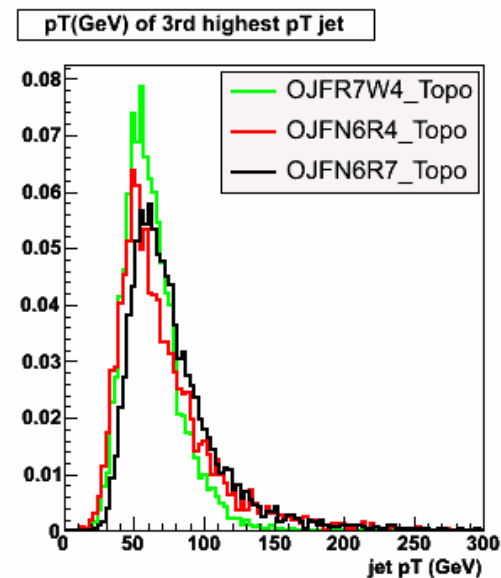
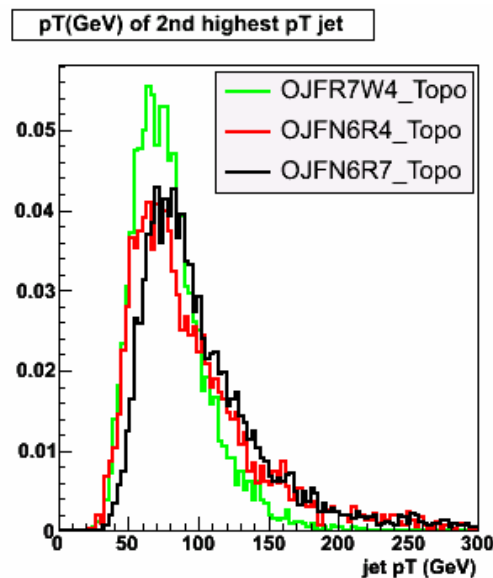
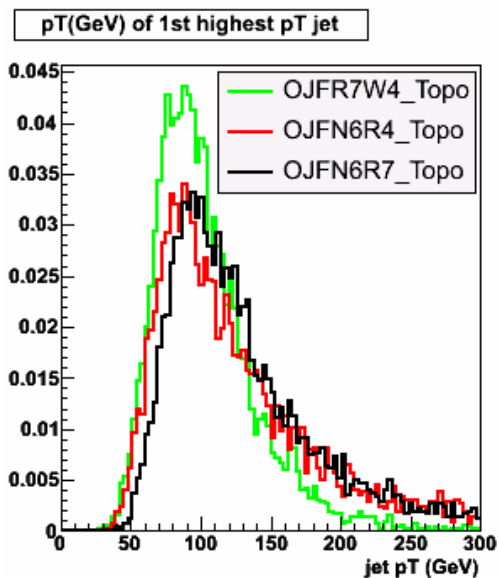


pt(GeV) of 6th highest pT jet



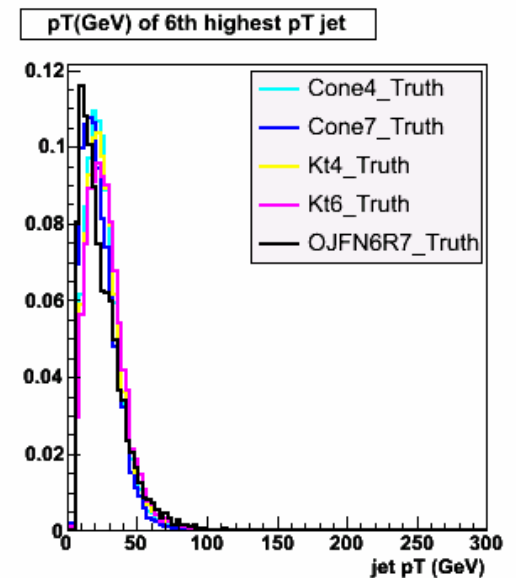
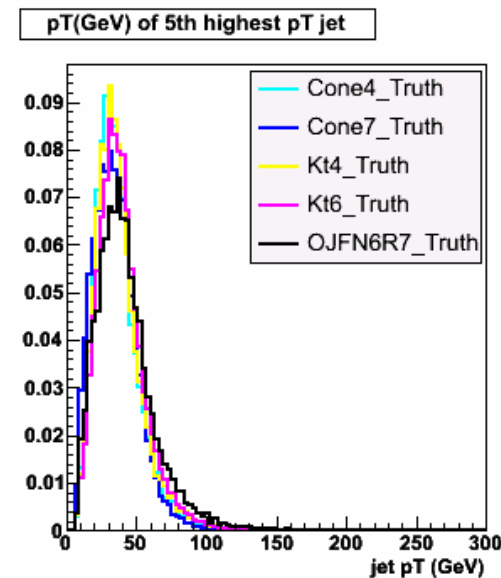
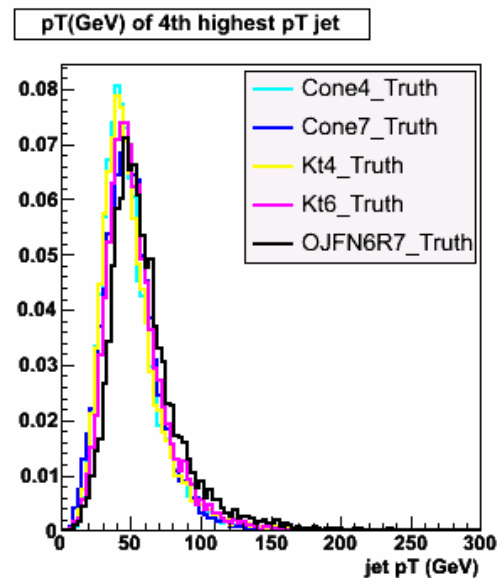
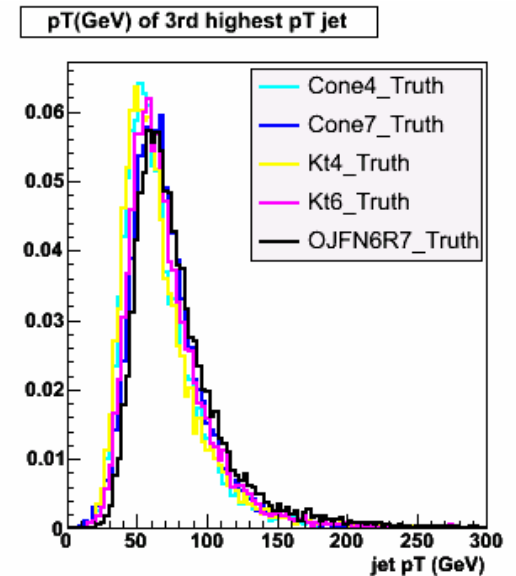
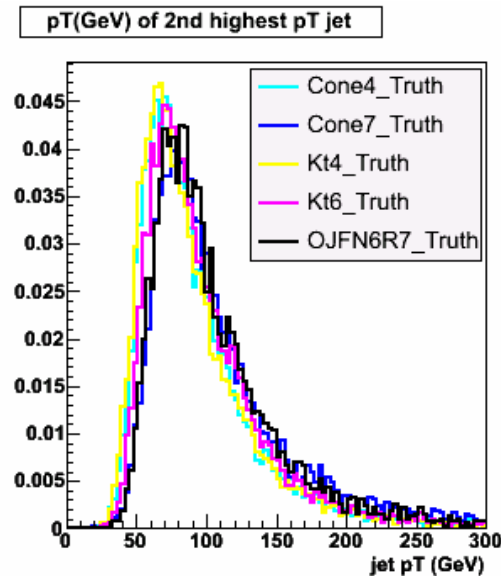
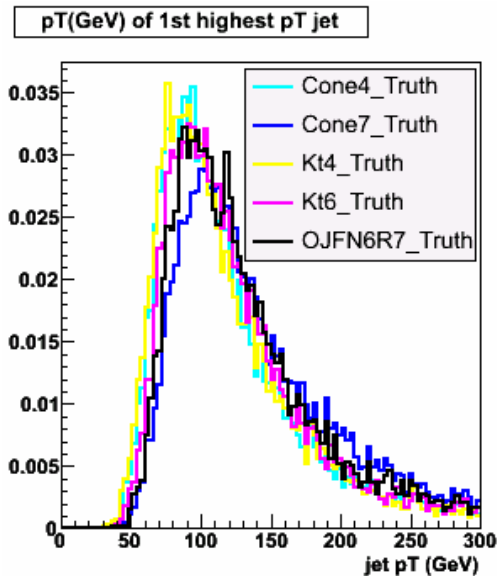
Normalized p_T distributions: topoJets

fully hadronic t - \bar{t} events
with at least 6 jets in $|\eta| < 3$



Normalized p_T distributions: truthJets

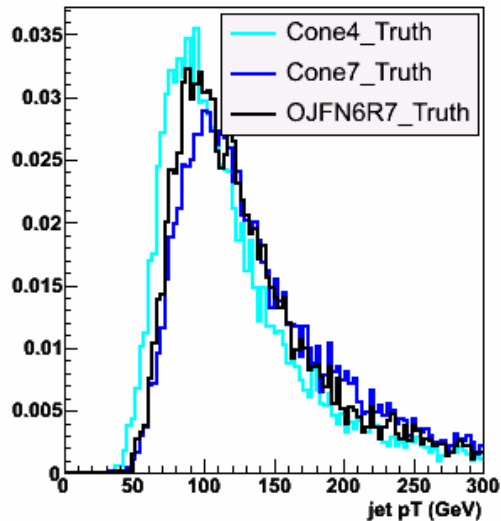
fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$



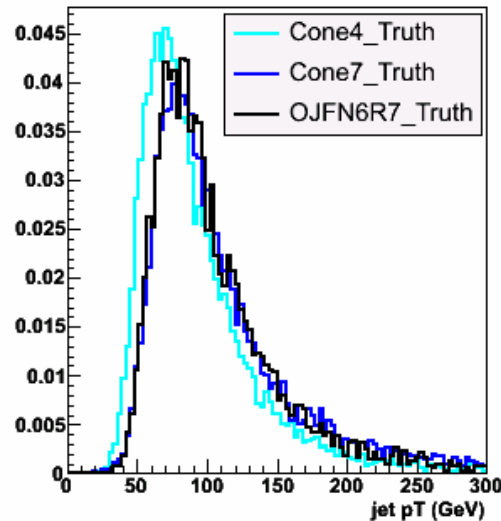
Normalized p_T distributions: truthJets

fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$

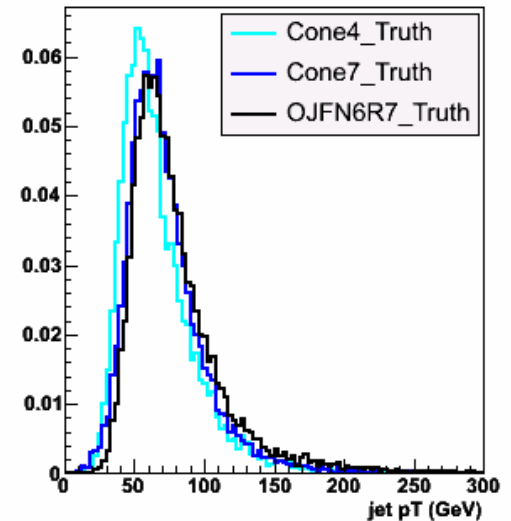
pt(GeV) of 1st highest pT jet



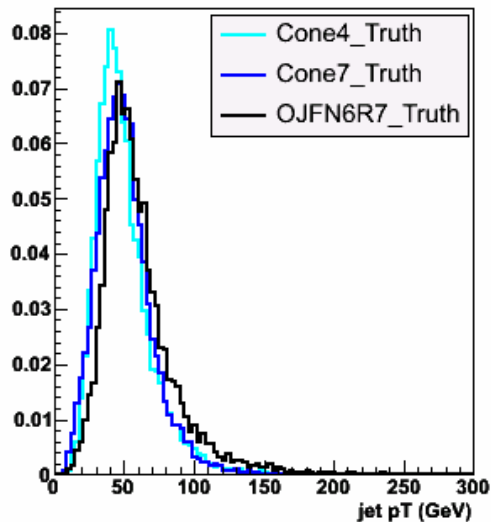
pt(GeV) of 2nd highest pT jet



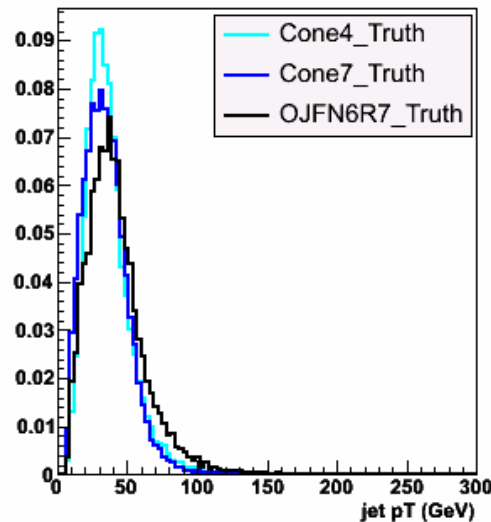
pt(GeV) of 3rd highest pT jet



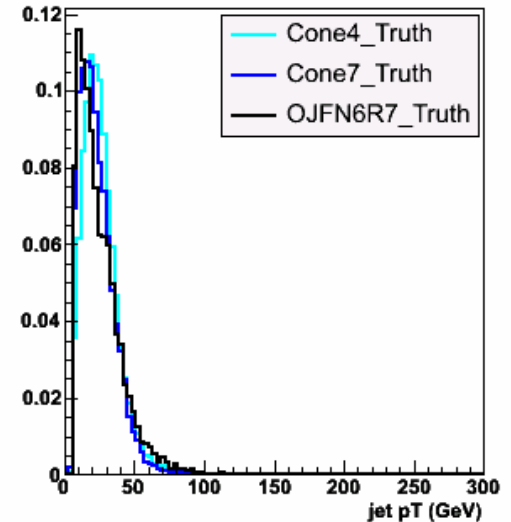
pt(GeV) of 4th highest pT jet



pt(GeV) of 5th highest pT jet



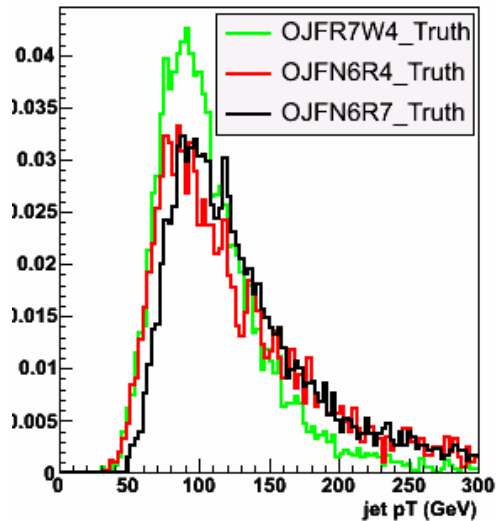
pt(GeV) of 6th highest pT jet



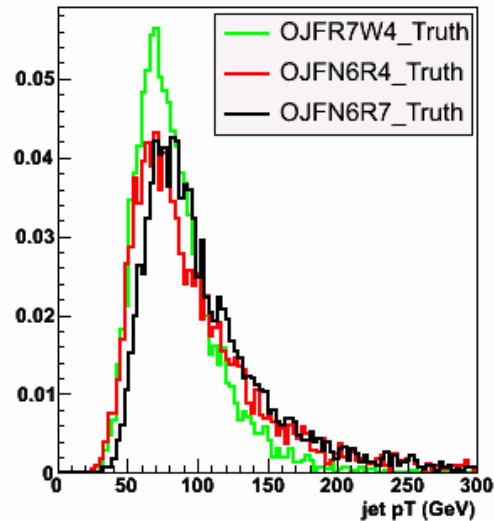
Normalized p_T distributions: truthJets

fully hadronic $t\text{-}\bar{t}$ events
with at least 6 jets in $|\eta| < 3$

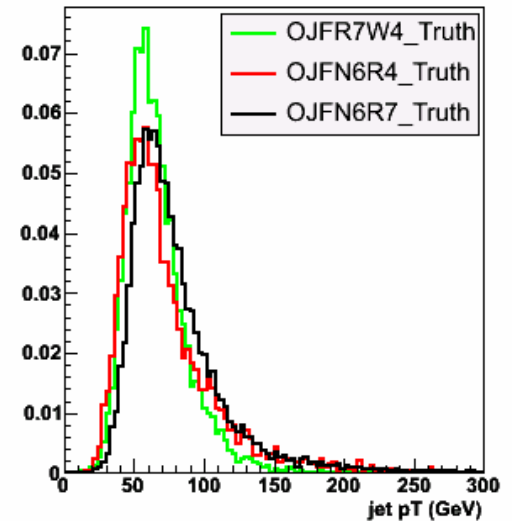
pT(GeV) of 1st highest pT jet



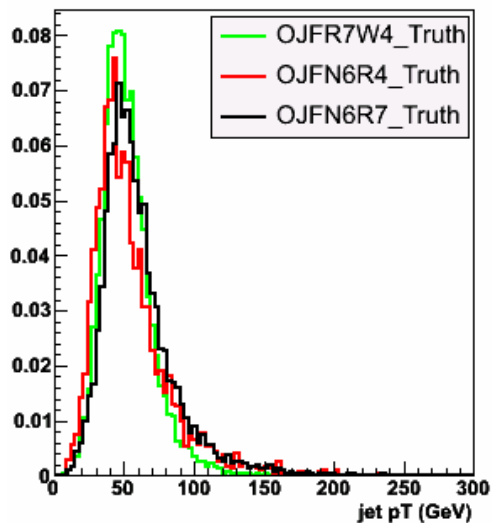
pT(GeV) of 2nd highest pT jet



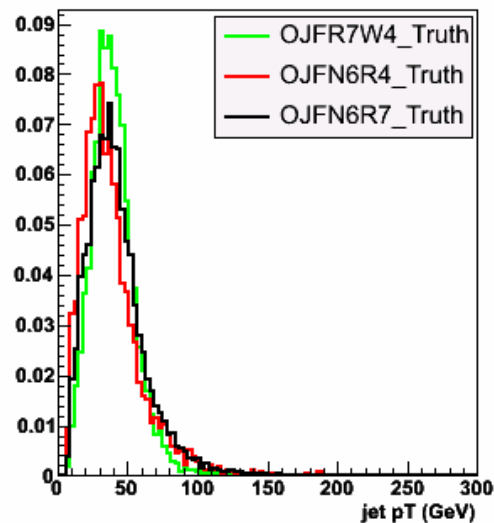
pT(GeV) of 3rd highest pT jet



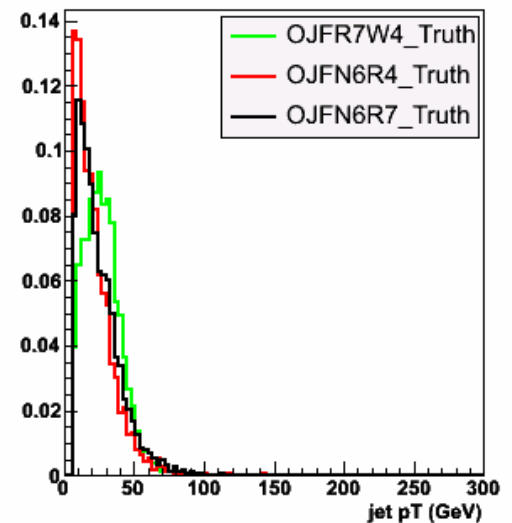
pT(GeV) of 4th highest pT jet



pT(GeV) of 5th highest pT jet



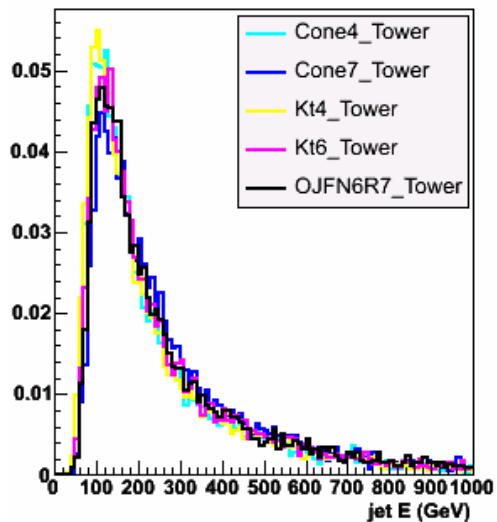
pT(GeV) of 6th highest pT jet



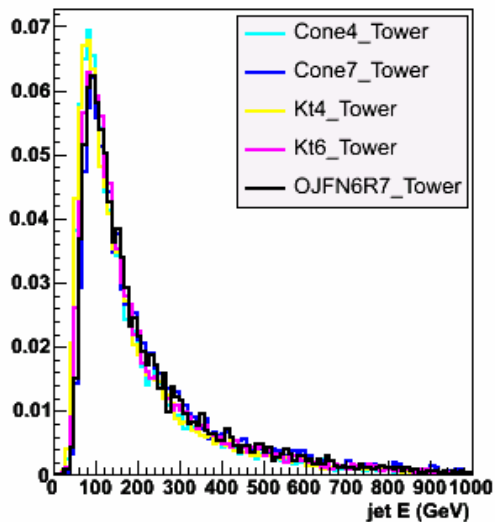
Normalized E distributions: towerJets

fully hadronic t - \bar{t} events
with at least 6 jets in $|\eta| < 3$

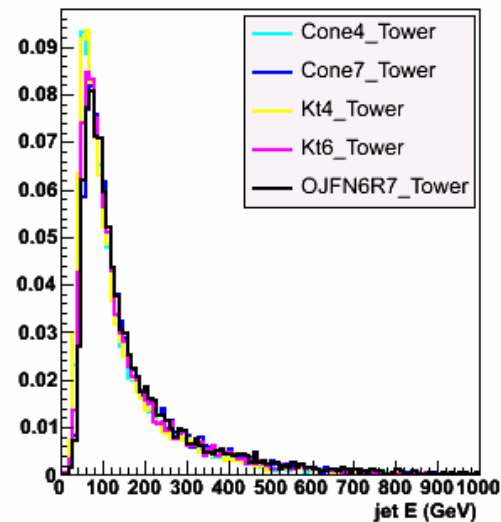
E(GeV) of 1st highest pT jet



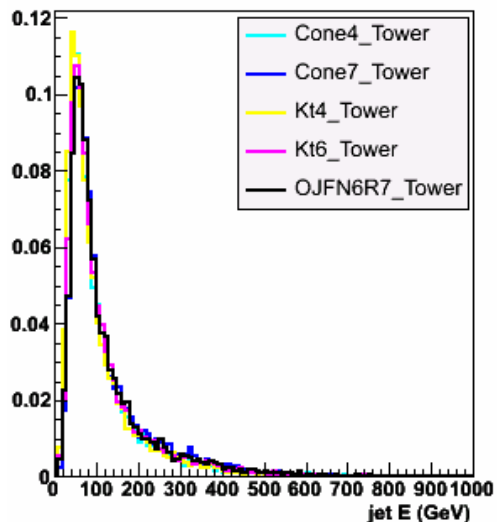
E(GeV) of 2nd highest pT jet



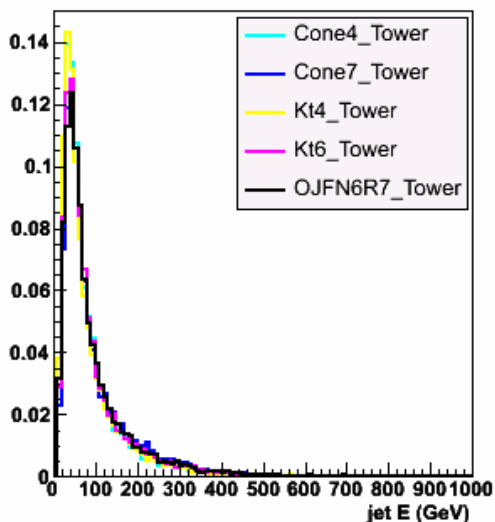
E(GeV) of 3rd highest pT jet



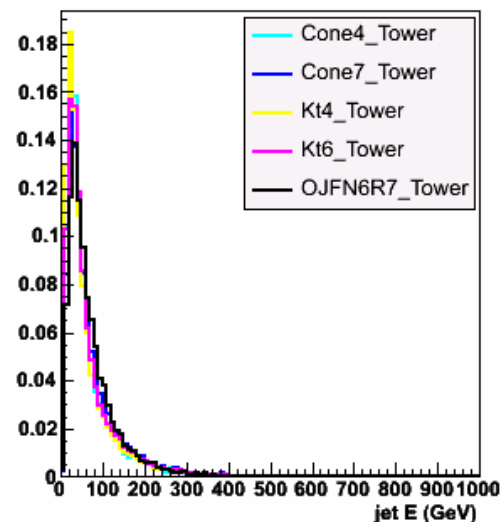
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



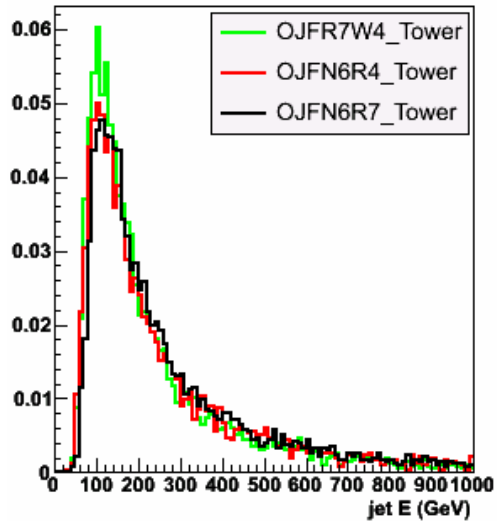
E(GeV) of 6th highest pT jet



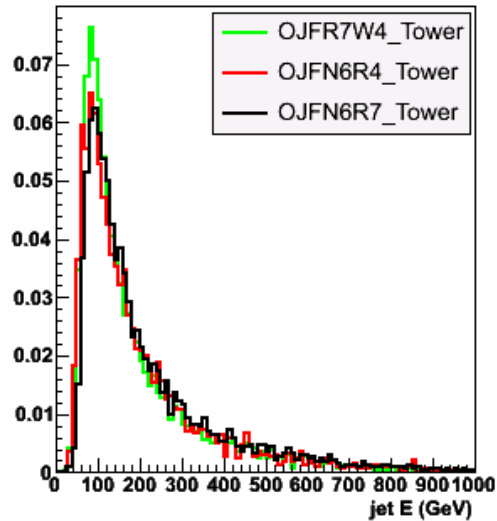
Normalized E distributions: towerJets

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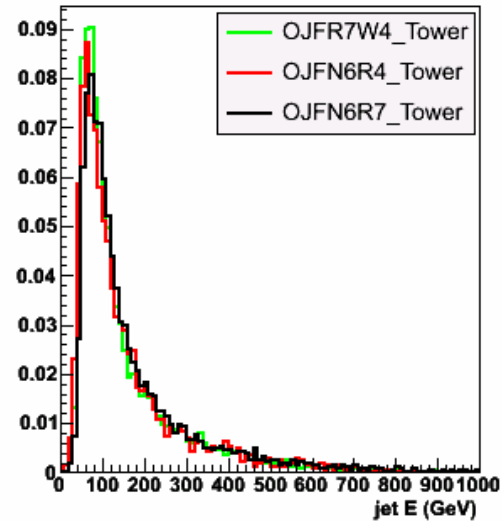
E(GeV) of 1st highest pT jet



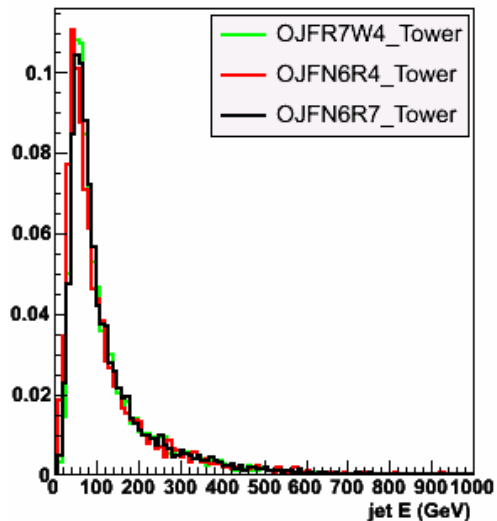
E(GeV) of 2nd highest pT jet



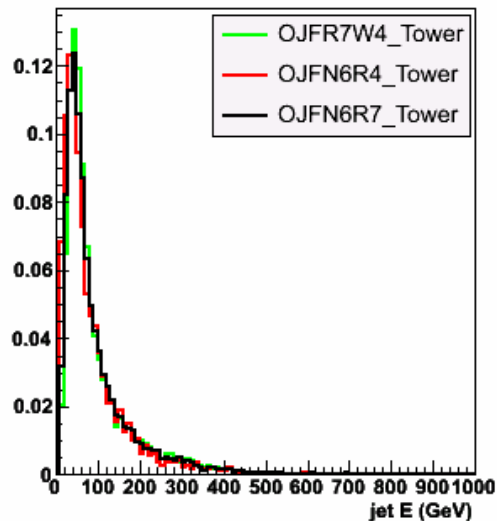
E(GeV) of 3rd highest pT jet



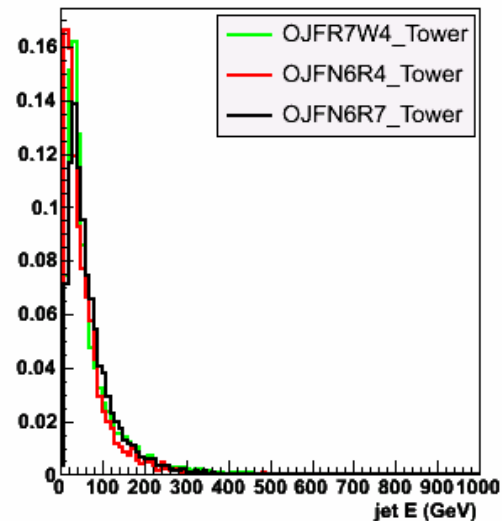
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



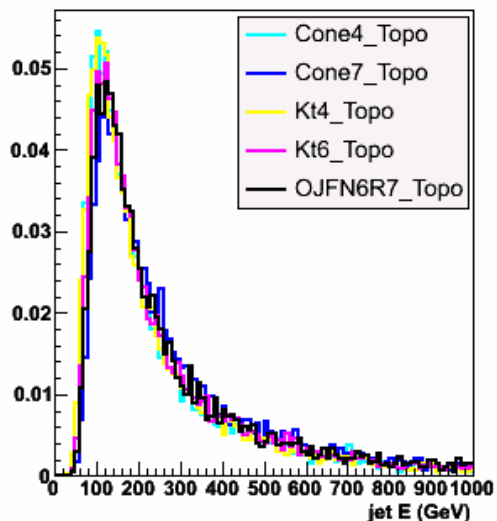
E(GeV) of 6th highest pT jet



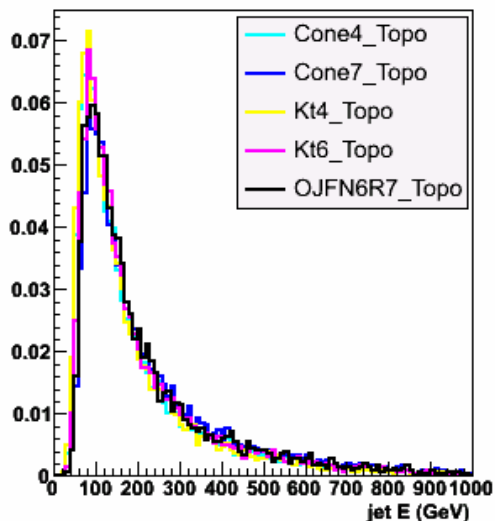
Normalized E distributions: topoJets

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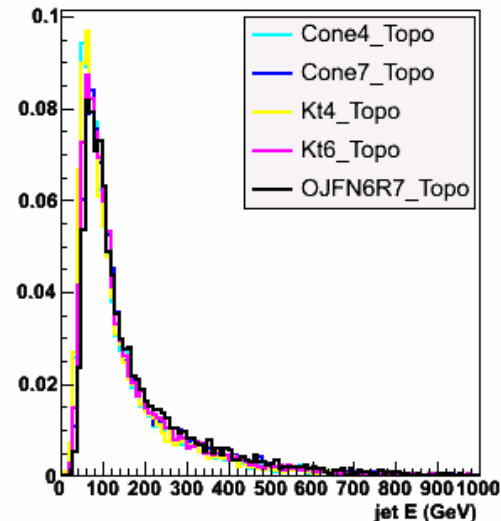
E(GeV) of 1st highest pT jet



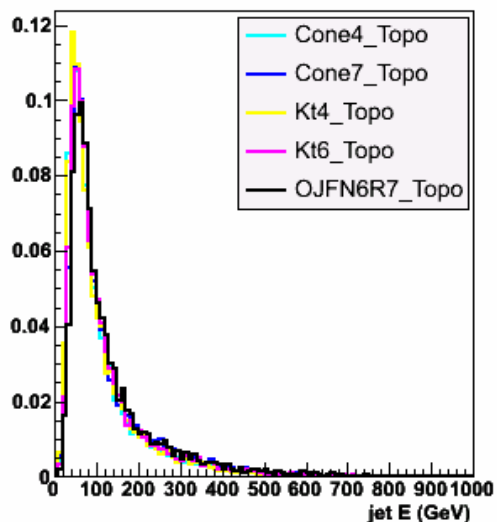
E(GeV) of 2nd highest pT jet



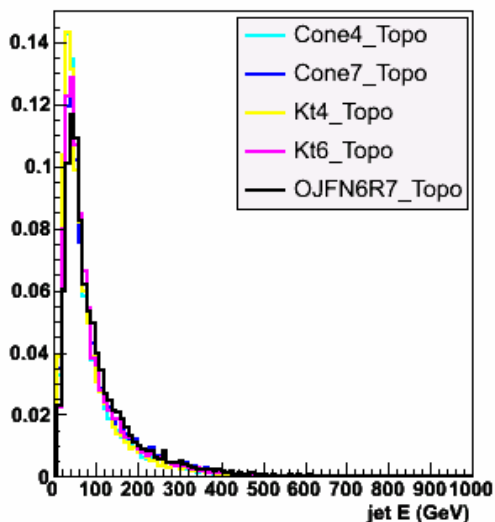
E(GeV) of 3rd highest pT jet



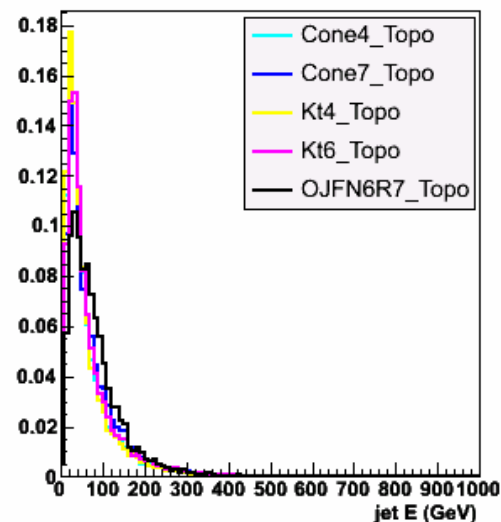
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



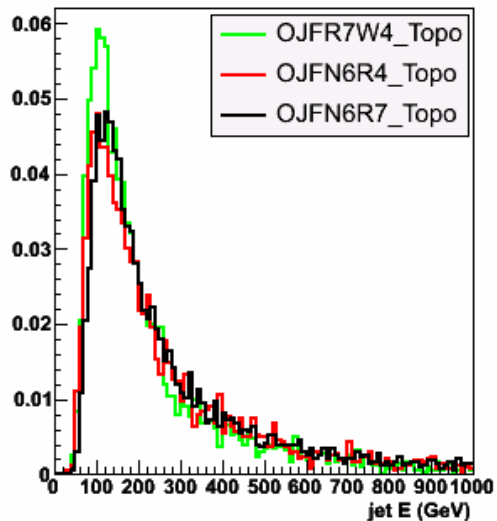
E(GeV) of 6th highest pT jet



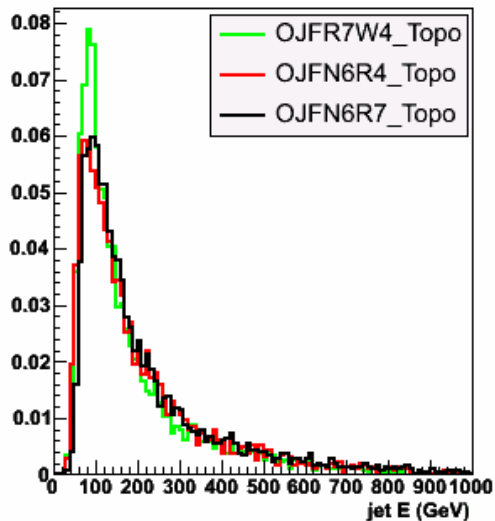
Normalized E distributions: topoJets

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with at least 6 jets in $|\eta| < 3$

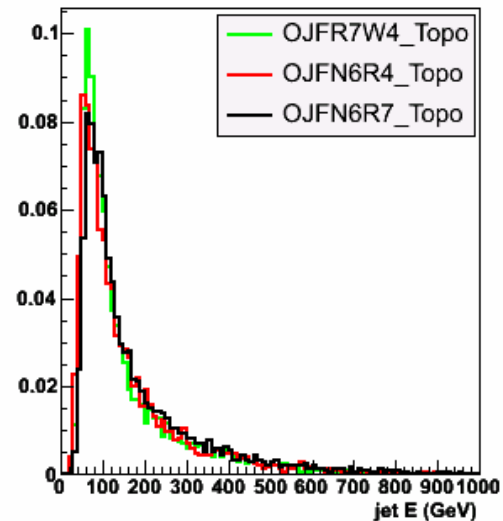
E(GeV) of 1st highest pT jet



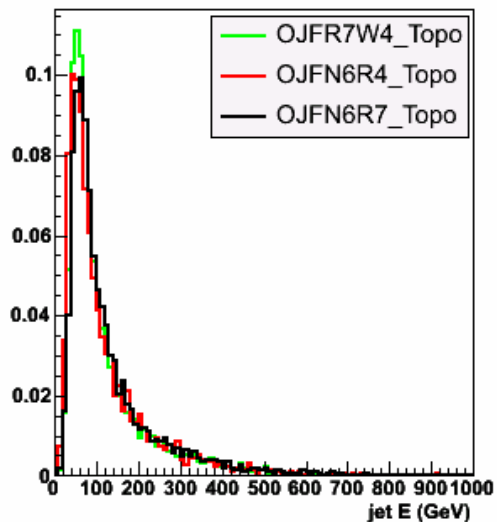
E(GeV) of 2nd highest pT jet



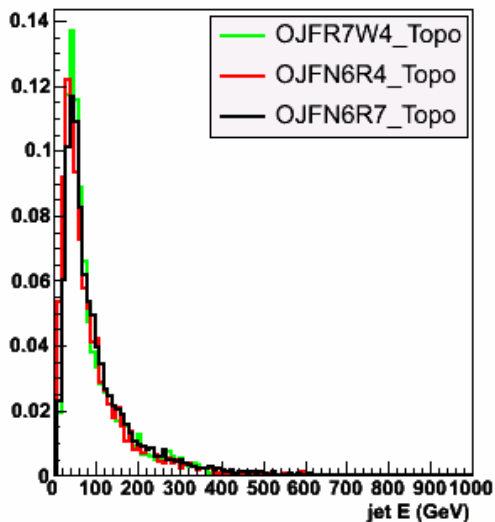
E(GeV) of 3rd highest pT jet



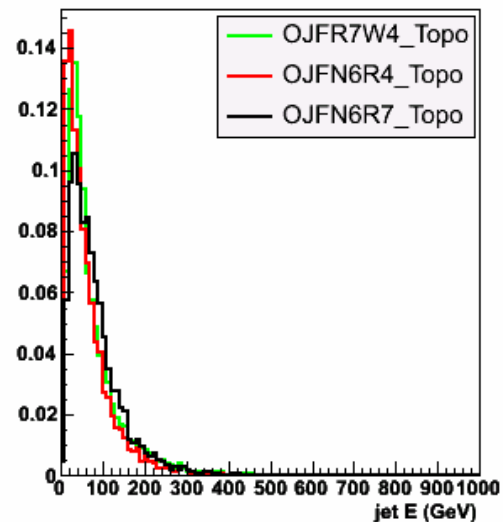
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



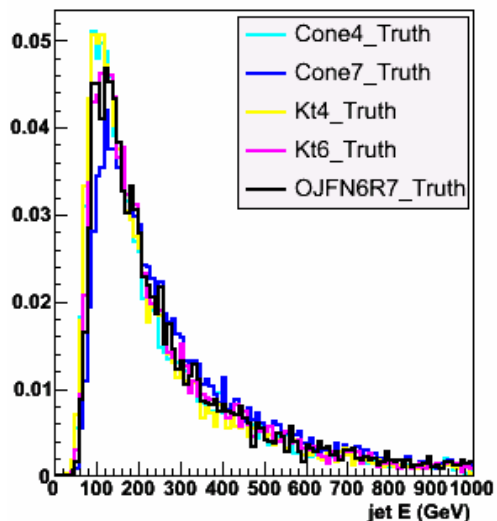
E(GeV) of 6th highest pT jet



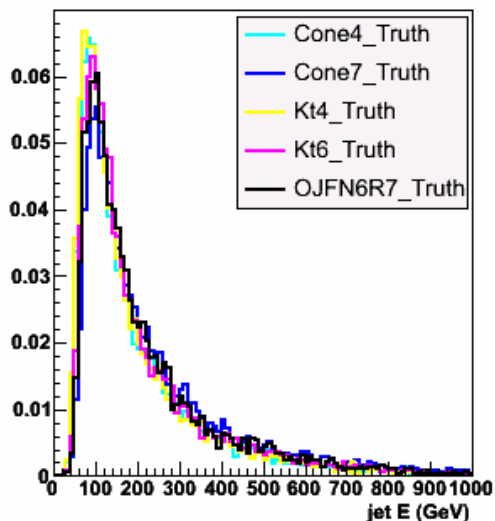
Normalized E distributions: truthJets

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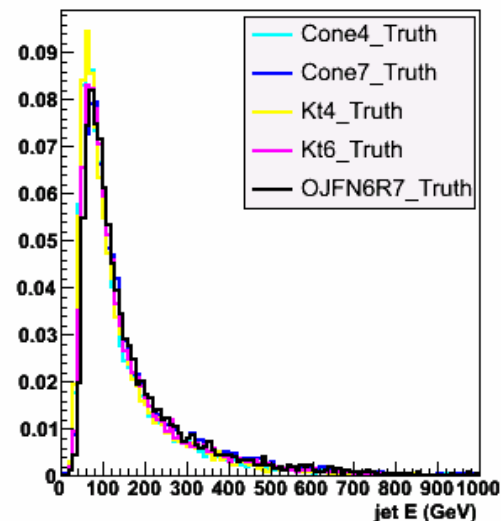
E(GeV) of 1st highest pT jet



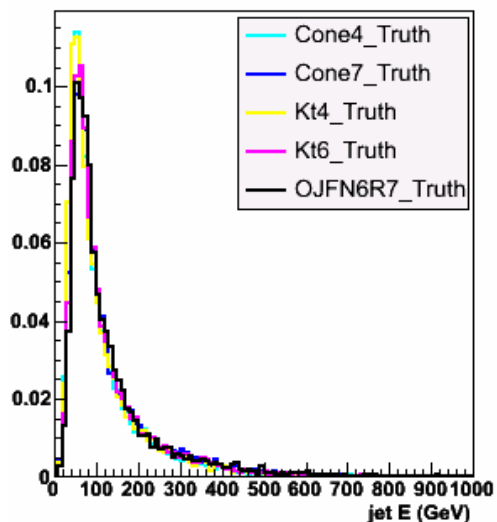
E(GeV) of 2nd highest pT jet



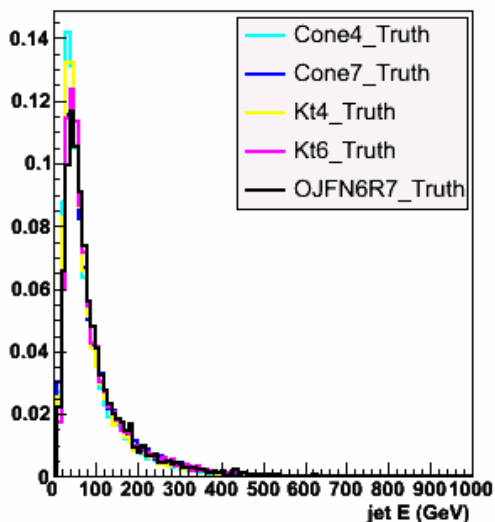
E(GeV) of 3rd highest pT jet



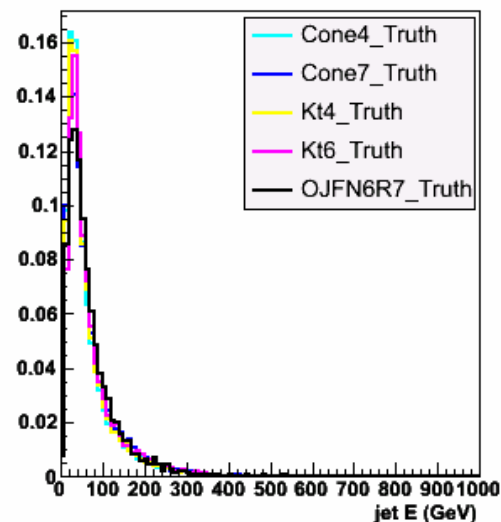
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



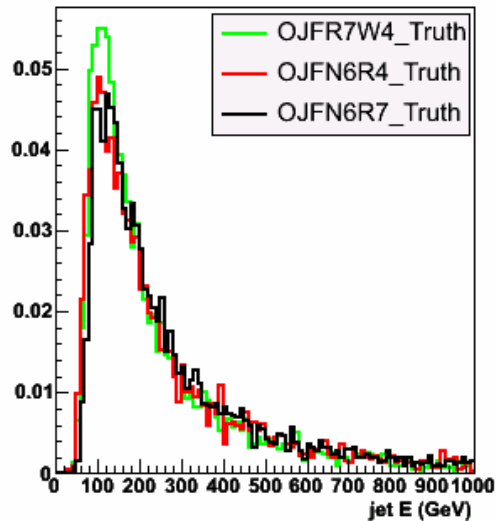
E(GeV) of 6th highest pT jet



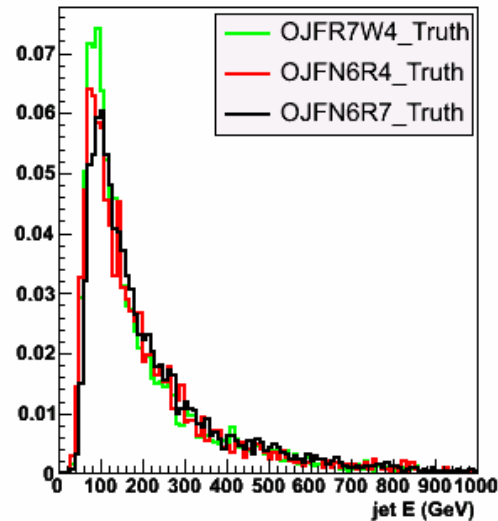
Normalized E distributions: truthJets

fully hadronic t - \bar{t} events
with at least 6 jets in $|\eta| < 3$

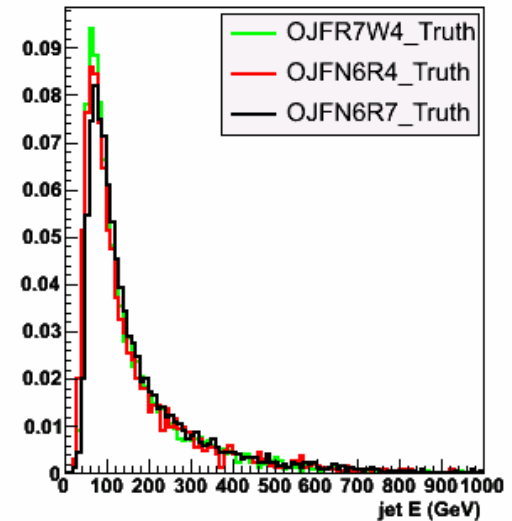
E(GeV) of 1st highest pT jet



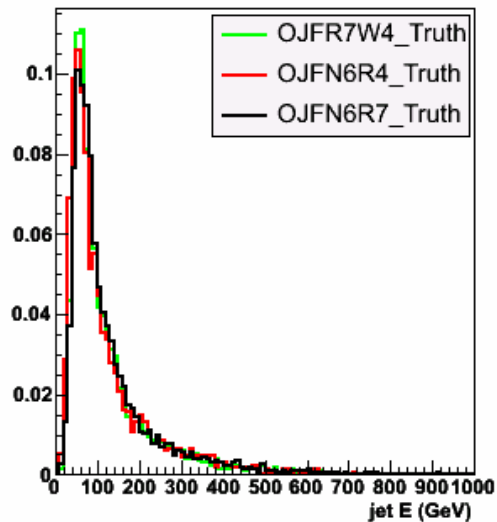
E(GeV) of 2nd highest pT jet



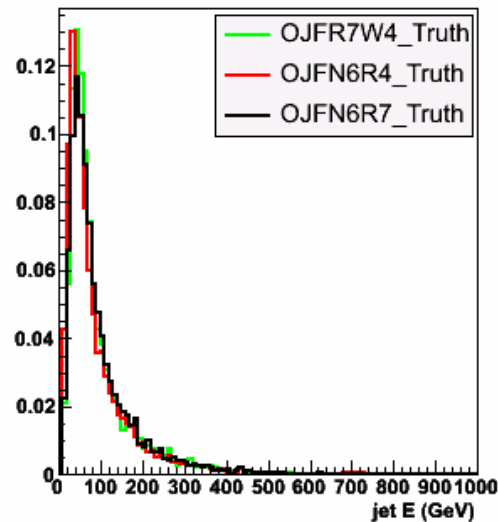
E(GeV) of 3rd highest pT jet



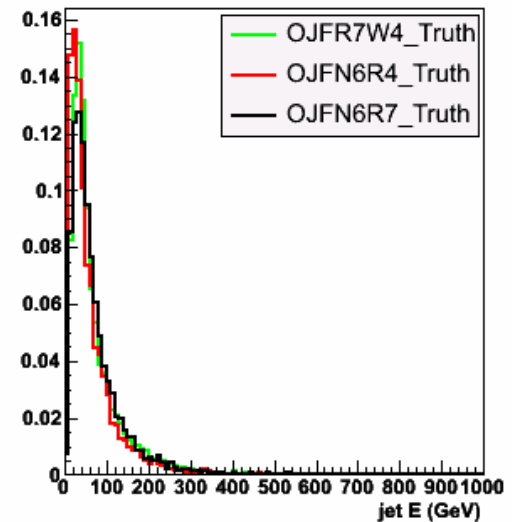
E(GeV) of 4th highest pT jet



E(GeV) of 5th highest pT jet



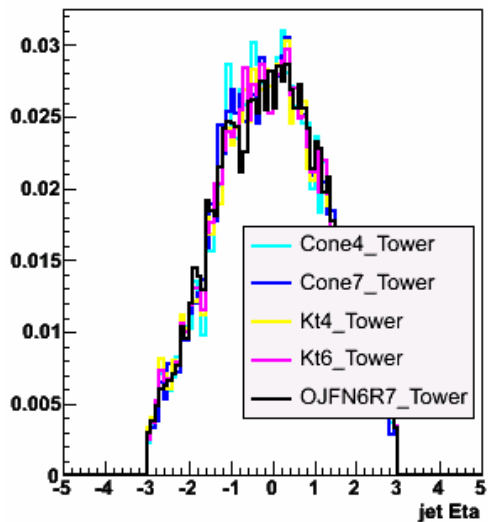
E(GeV) of 6th highest pT jet



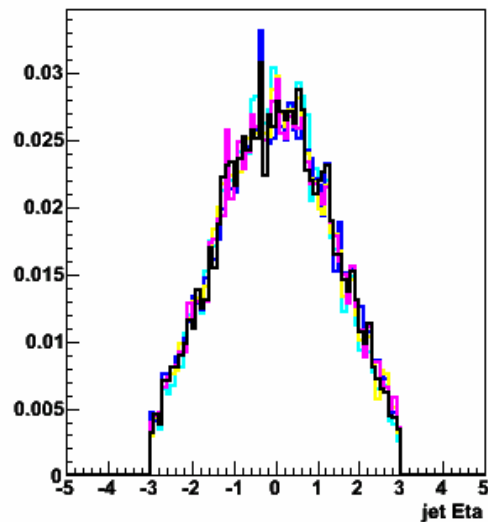
Normalized η distributions: towerJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

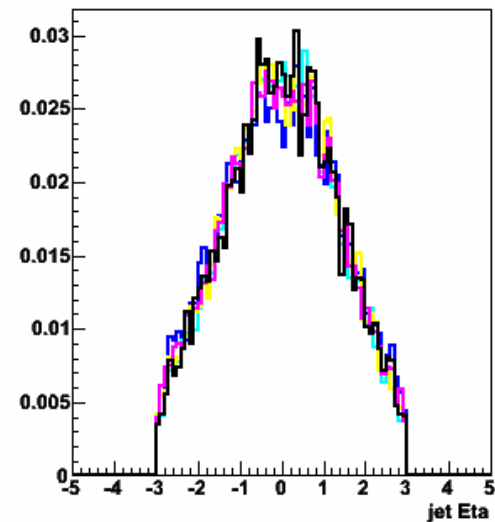
Eta of 1st highest pT jet



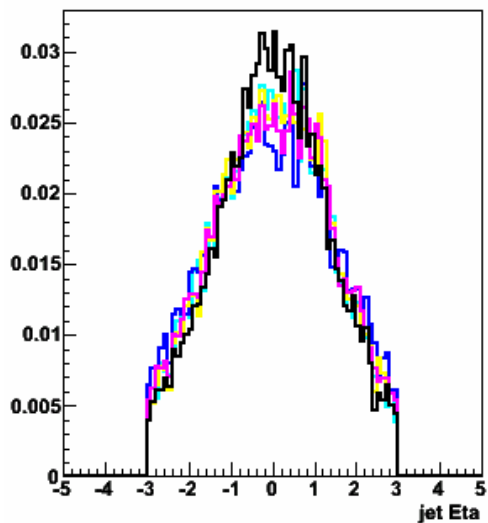
Eta of 2nd highest pT jet



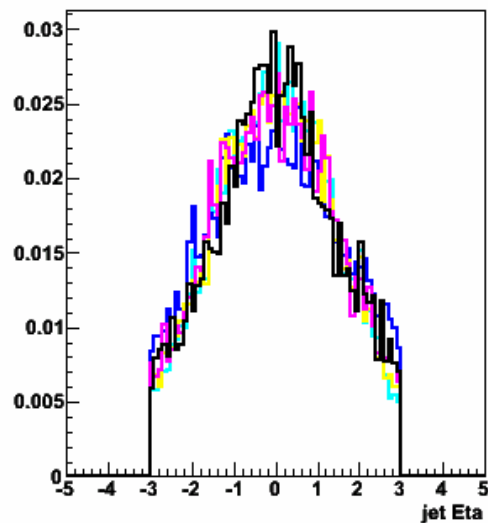
Eta of 3rd highest pT jet



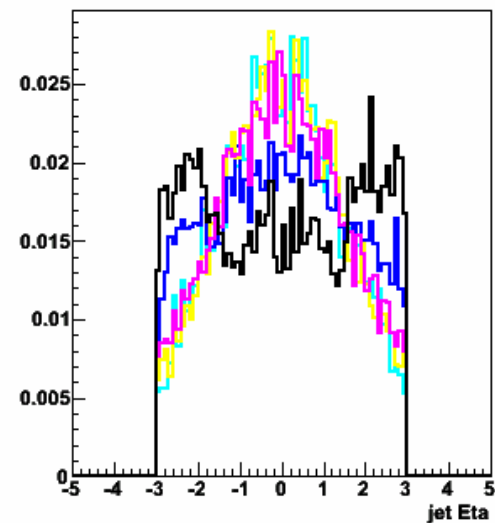
Eta of 4th highest pT jet



Eta of 5th highest pT jet



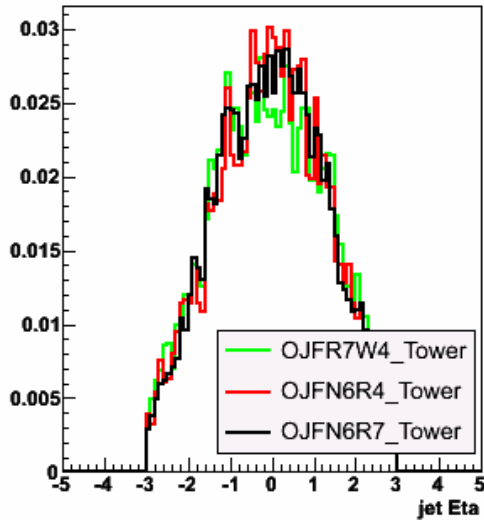
Eta of 6th highest pT jet



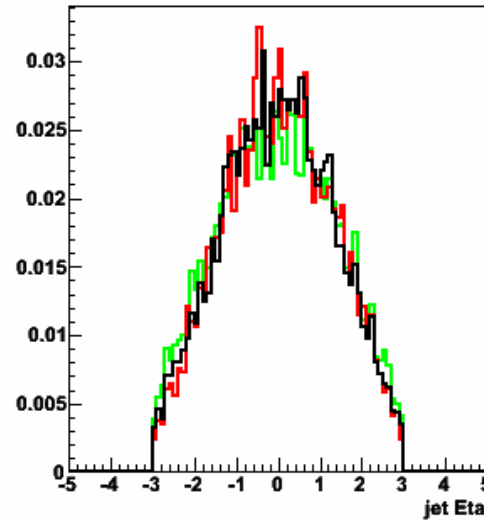
Normalized η distributions: OFJ towerJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

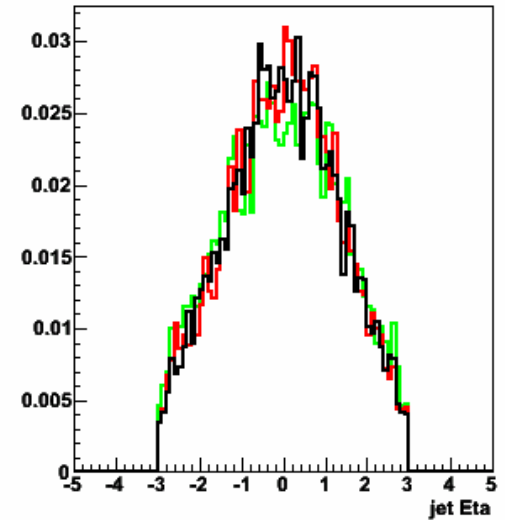
Eta of 1st highest pT jet



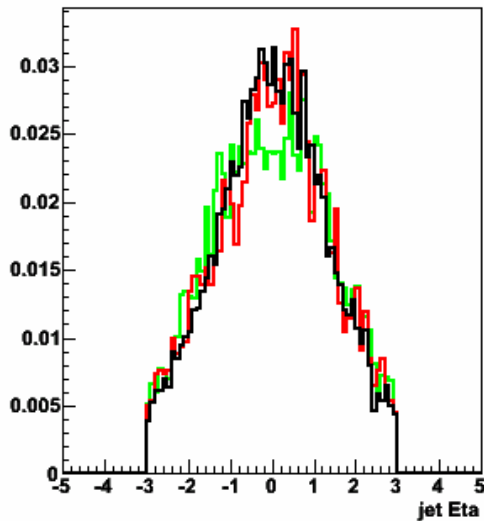
Eta of 2nd highest pT jet



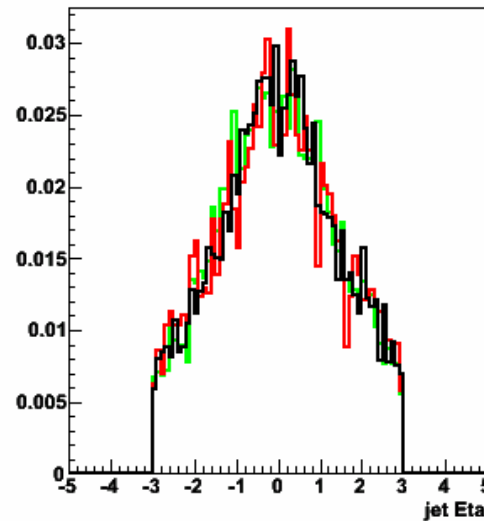
Eta of 3rd highest pT jet



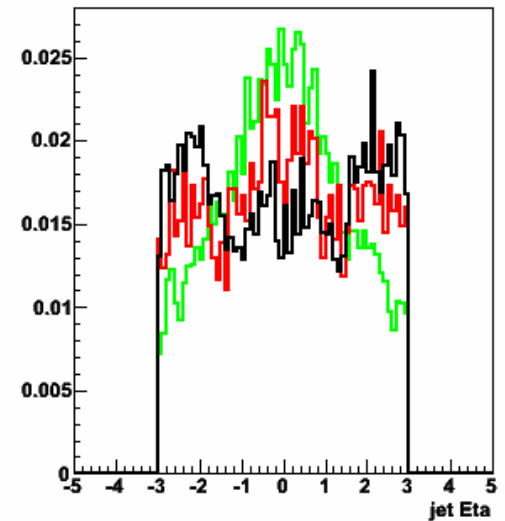
Eta of 4th highest pT jet



Eta of 5th highest pT jet



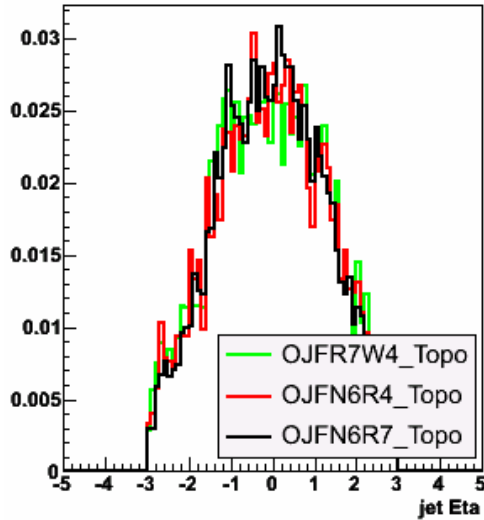
Eta of 6th highest pT jet



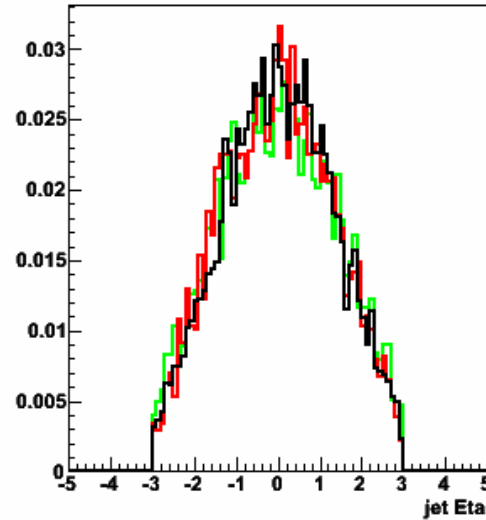
Normalized η distributions: OFJ topoJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

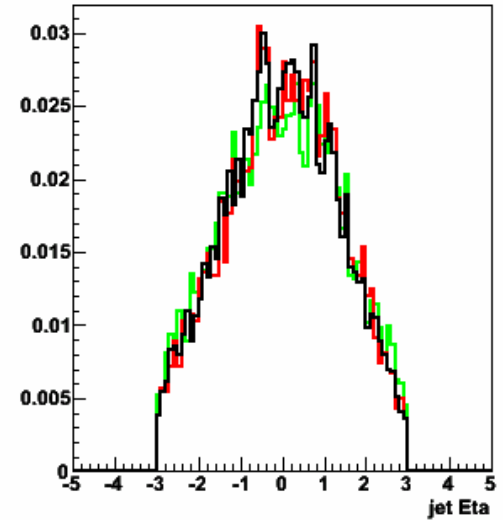
Eta of 1st highest pT jet



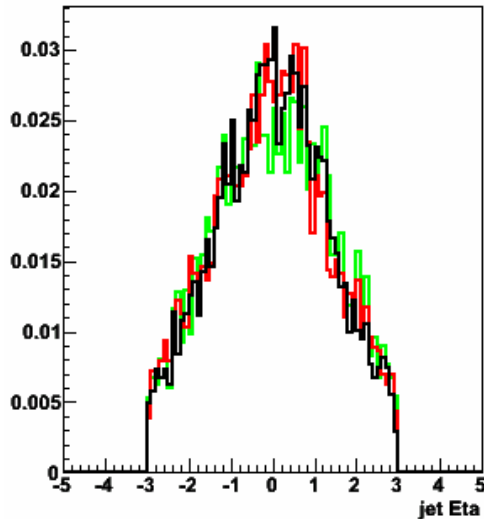
Eta of 2nd highest pT jet



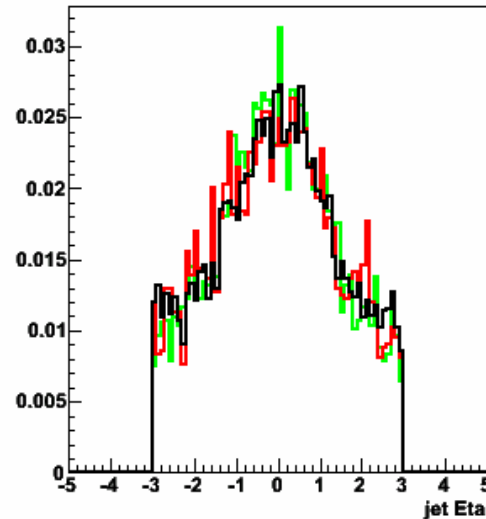
Eta of 3rd highest pT jet



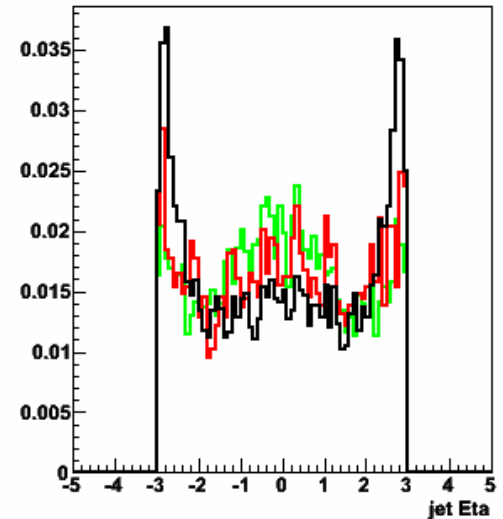
Eta of 4th highest pT jet



Eta of 5th highest pT jet



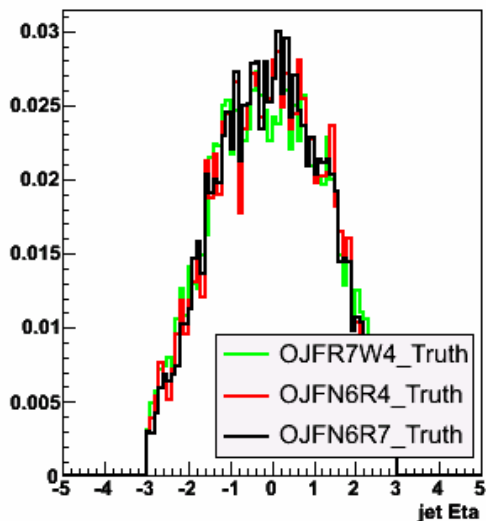
Eta of 6th highest pT jet



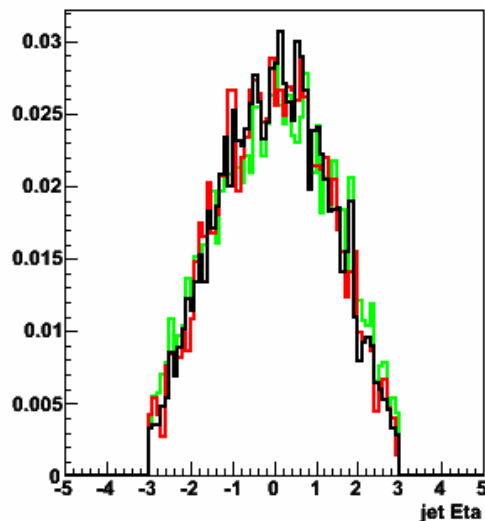
Normalized η distributions: OFJ truthJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

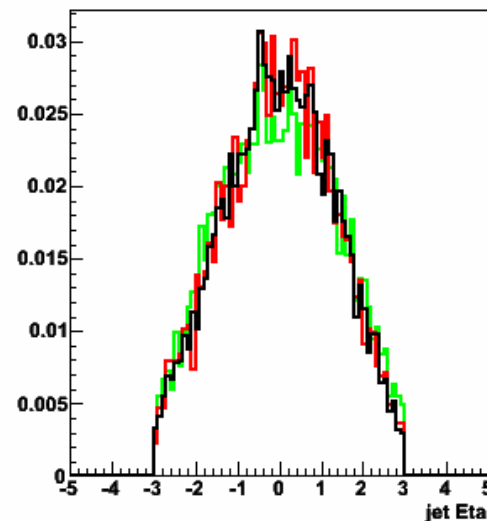
Eta of 1st highest pT jet



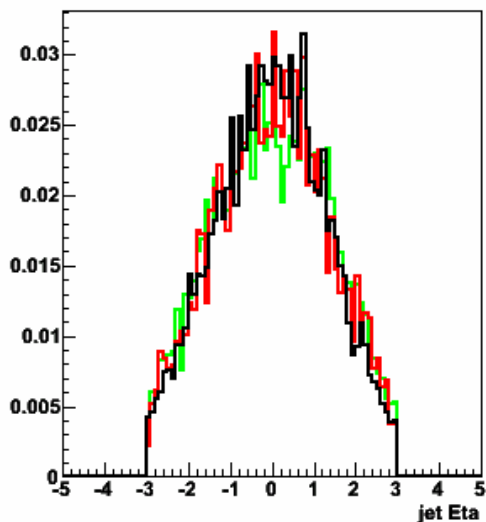
Eta of 2nd highest pT jet



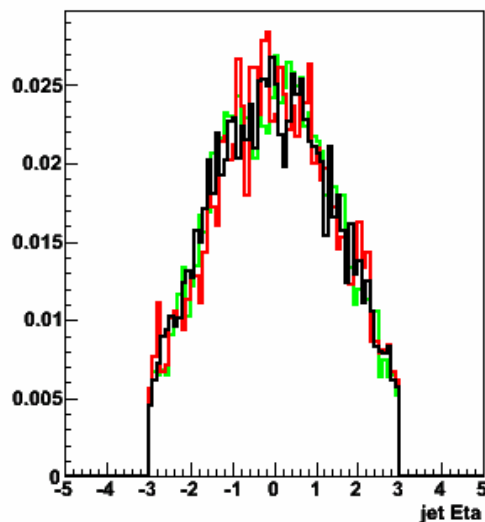
Eta of 3rd highest pT jet



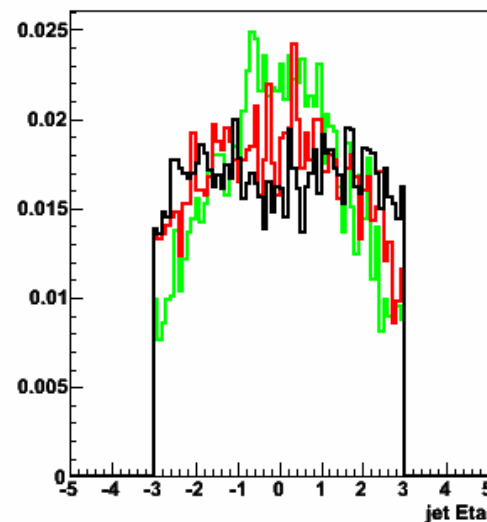
Eta of 4th highest pT jet



Eta of 5th highest pT jet

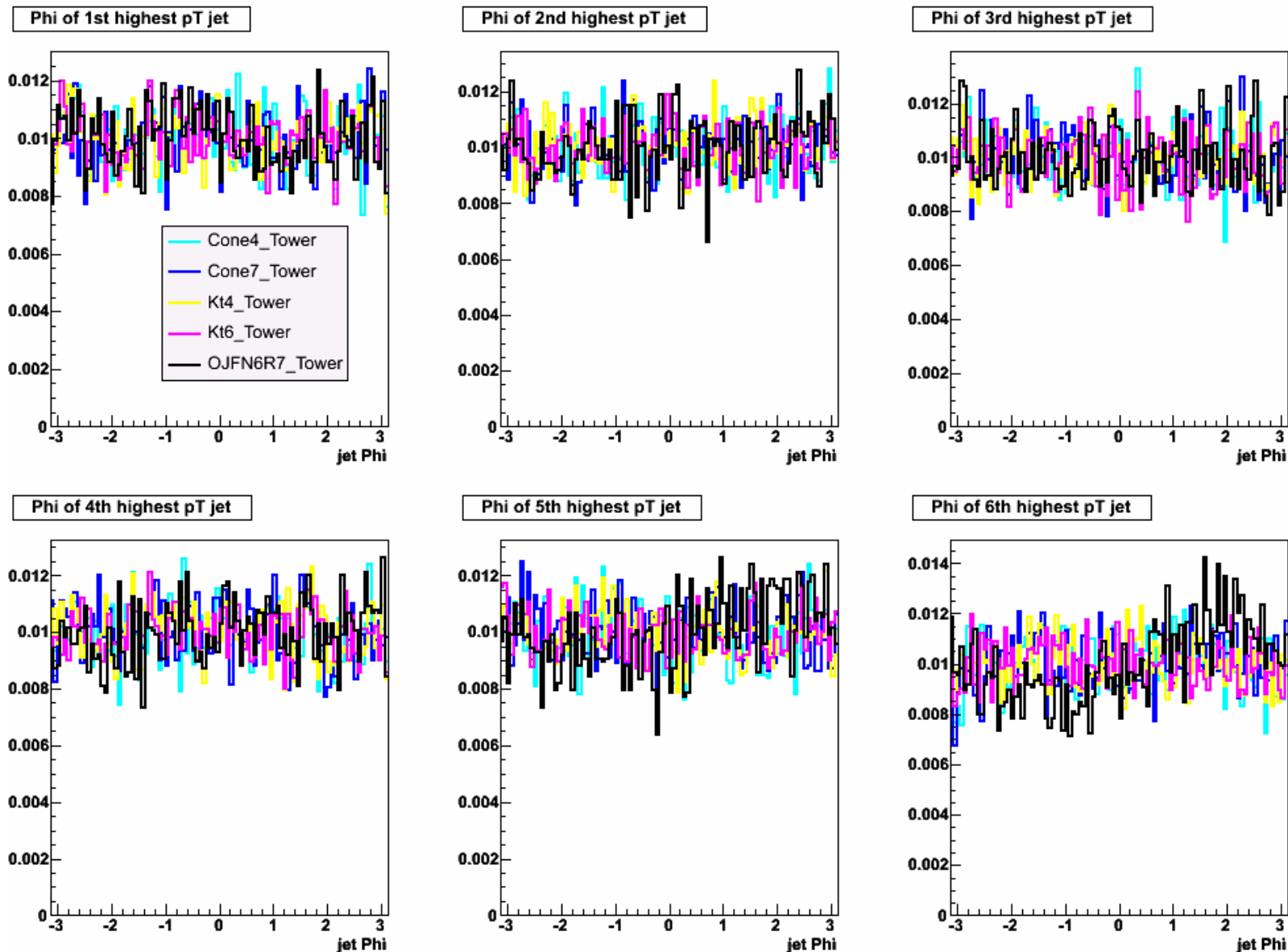


Eta of 6th highest pT jet



Normalized ϕ distributions: towerJets

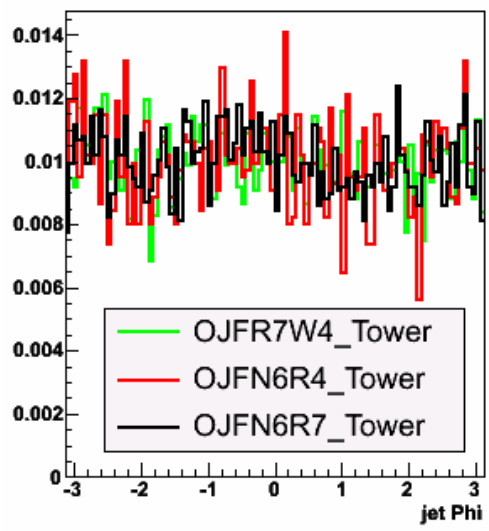
fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$



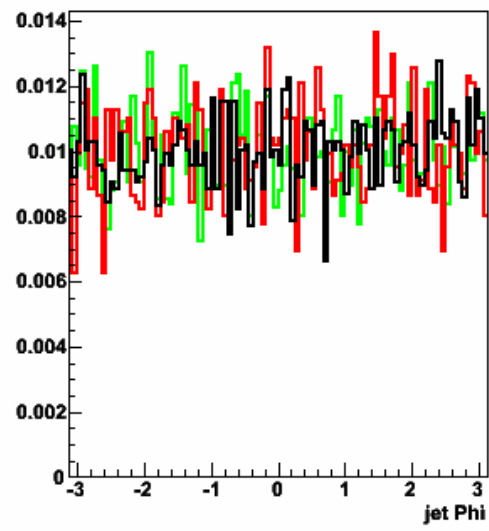
Normalized ϕ distributions: OFJ towerJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

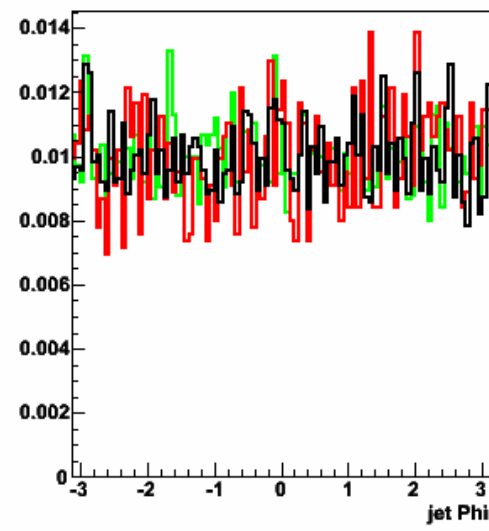
Phi of 1st highest pT jet



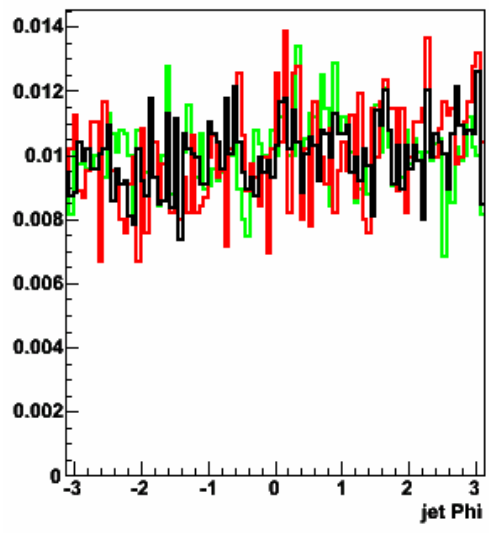
Phi of 2nd highest pT jet



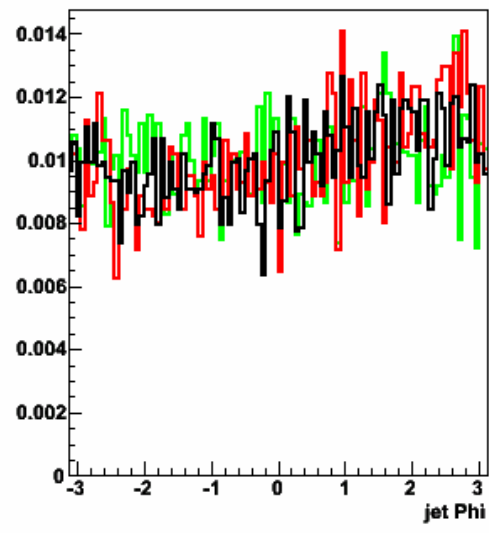
Phi of 3rd highest pT jet



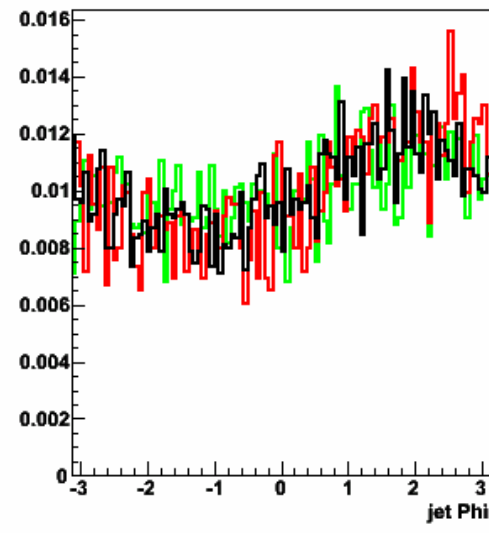
Phi of 4th highest pT jet



Phi of 5th highest pT jet



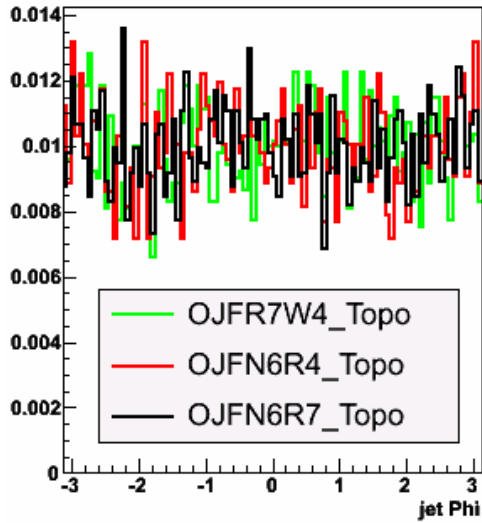
Phi of 6th highest pT jet



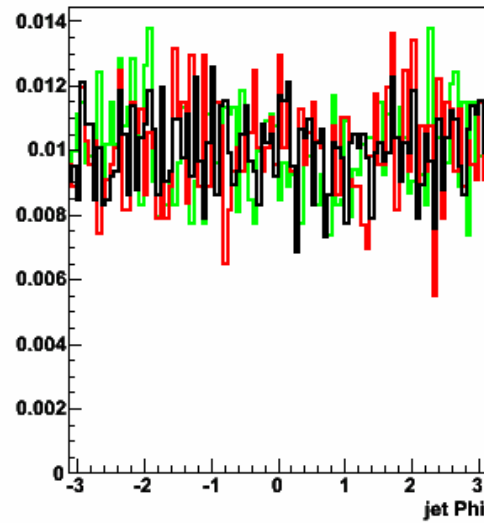
Normalized ϕ distributions: OFJ topoJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$

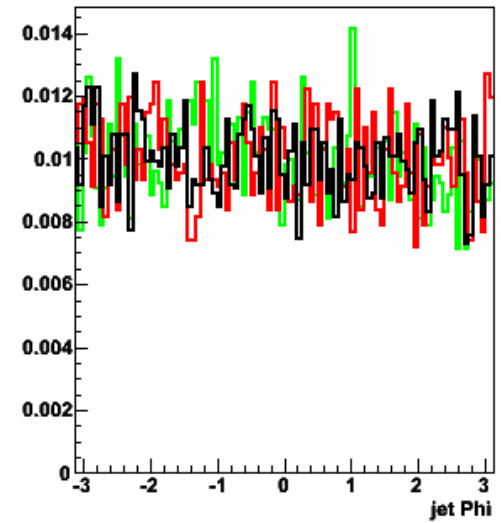
Phi of 1st highest pT jet



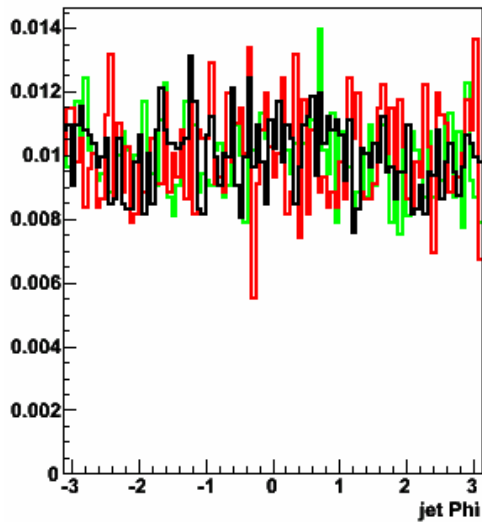
Phi of 2nd highest pT jet



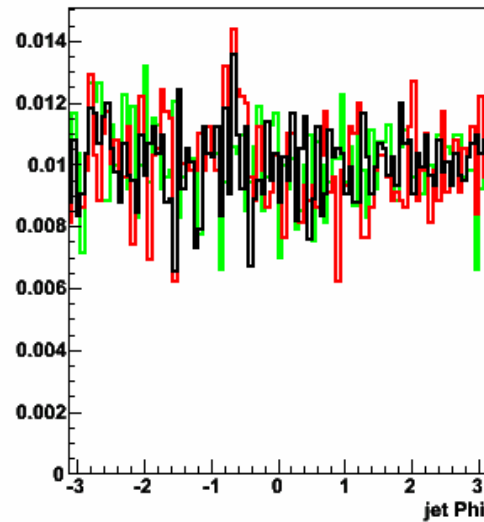
Phi of 3rd highest pT jet



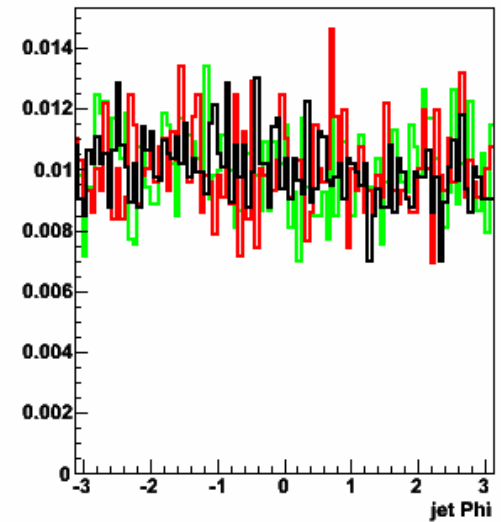
Phi of 4th highest pT jet



Phi of 5th highest pT jet

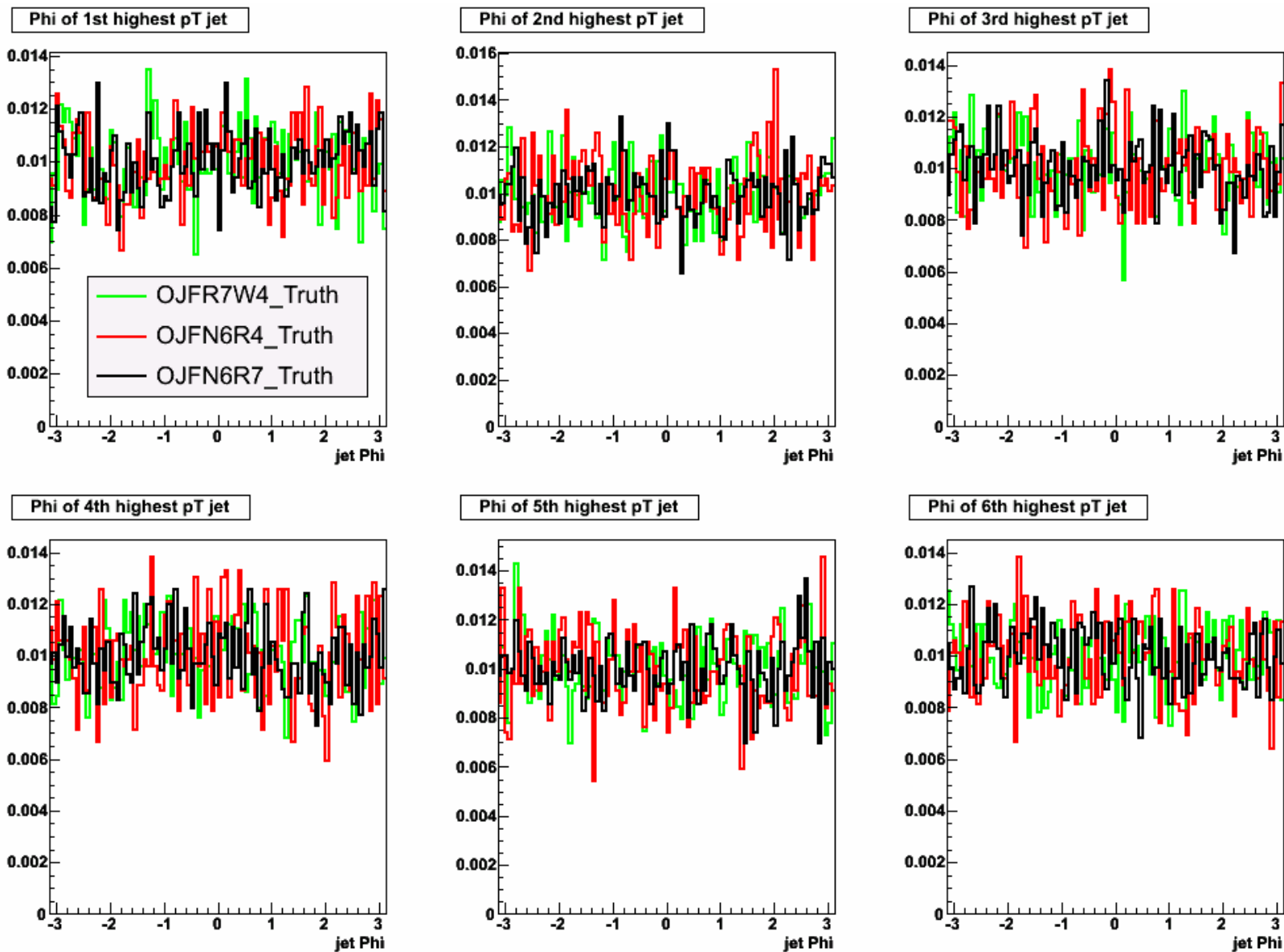


Phi of 6th highest pT jet



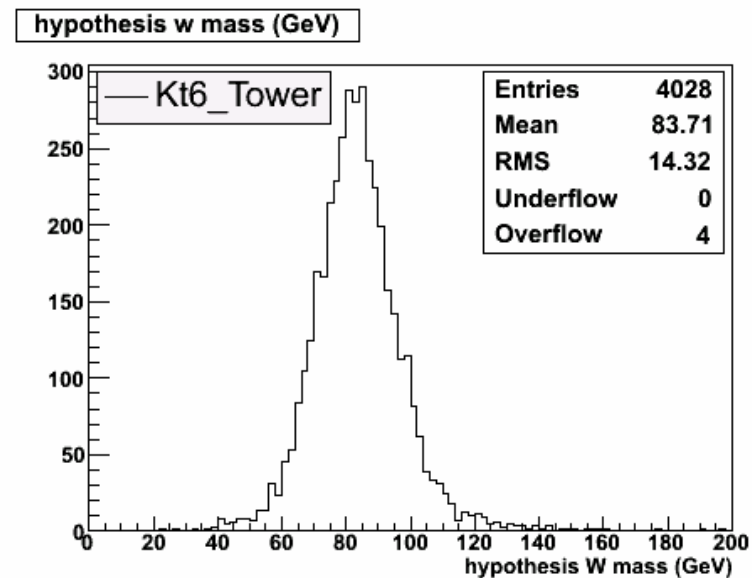
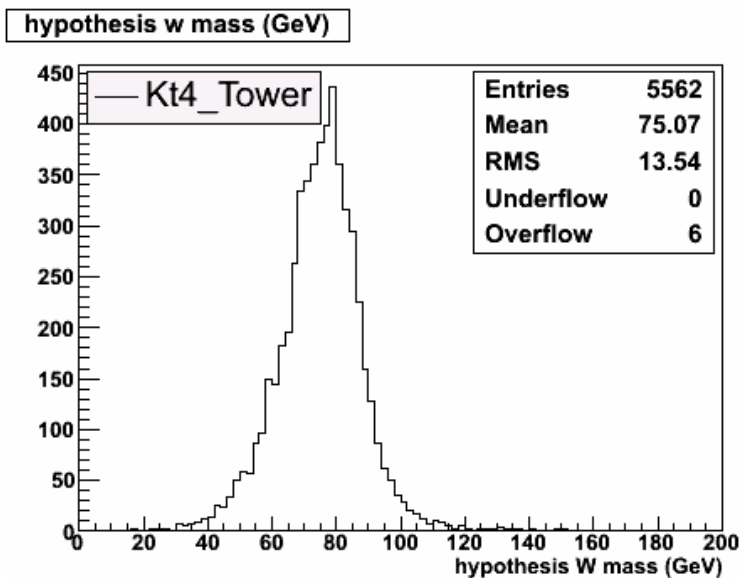
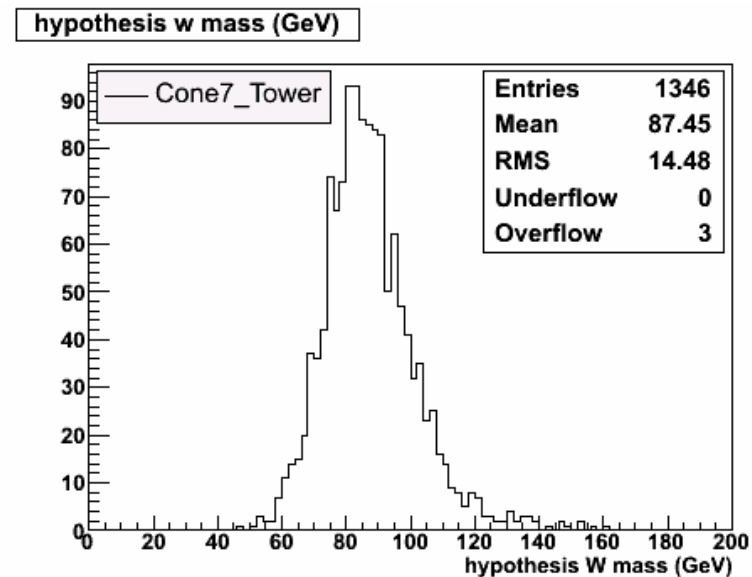
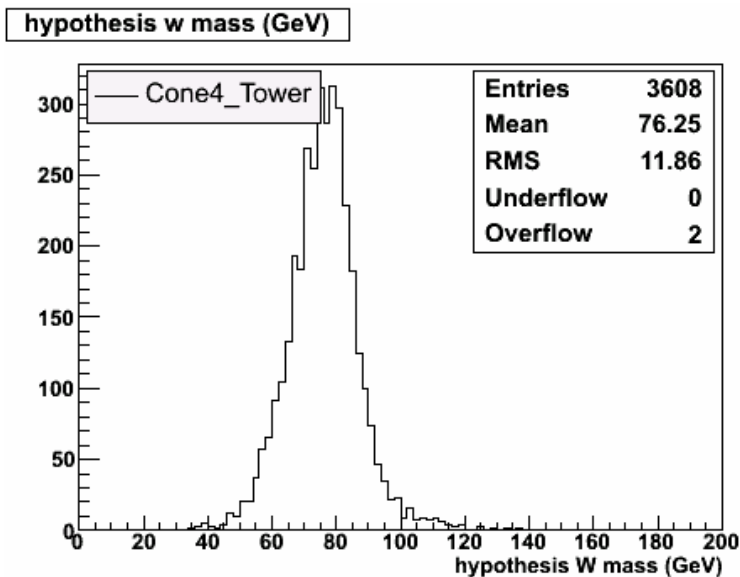
Normalized ϕ distributions: OFJ truthJets

fully hadronic t-tbar events
with at least 6 jets in $|\eta| < 3$



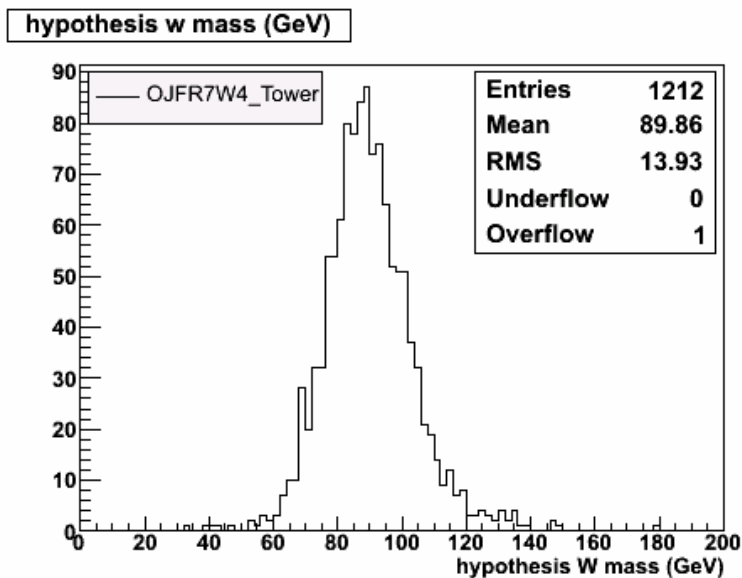
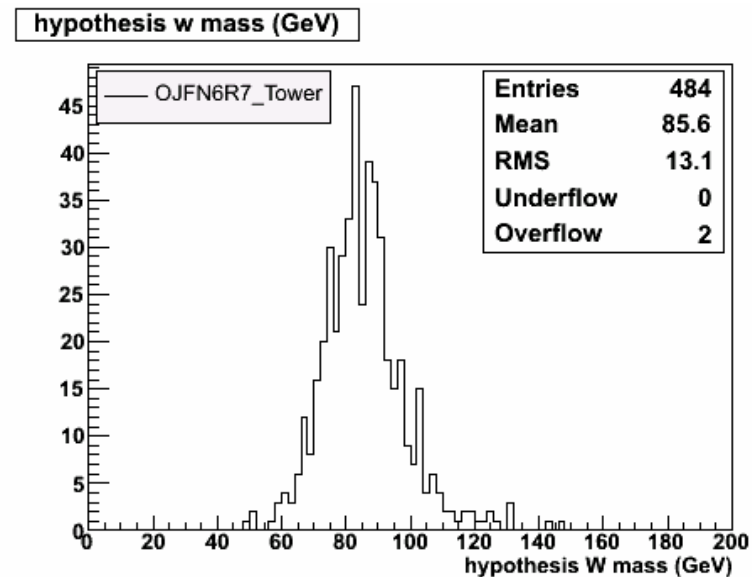
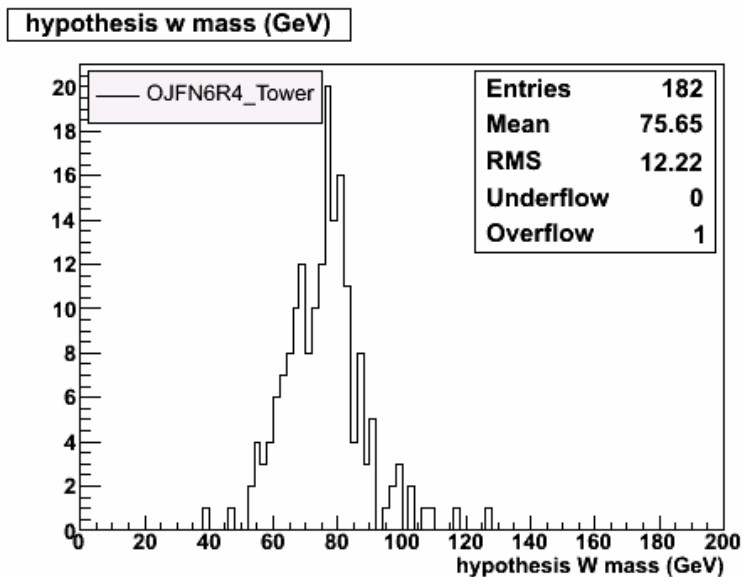
W mass plots: TowerJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



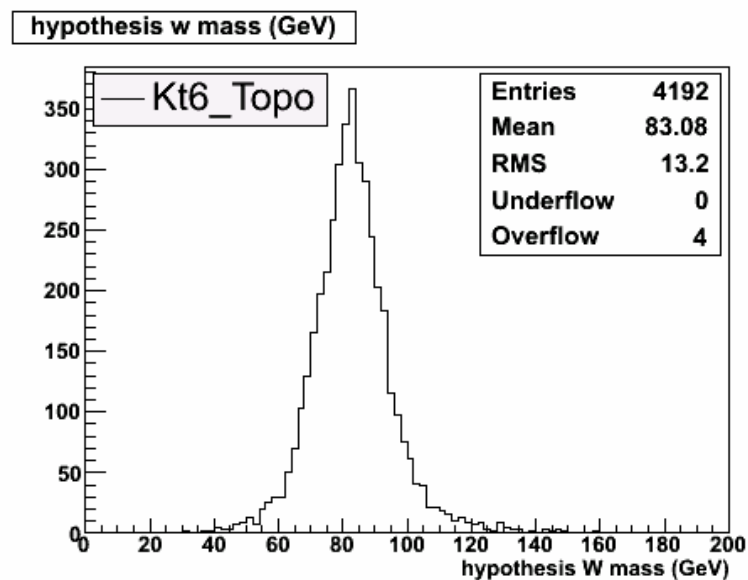
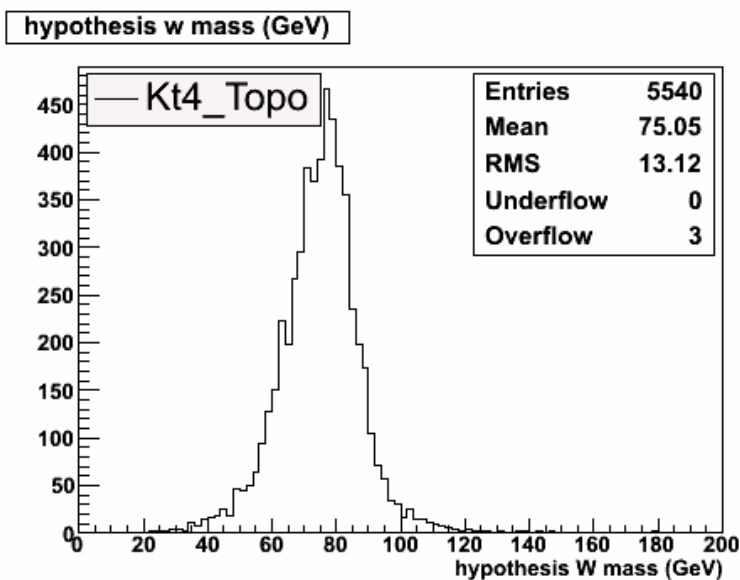
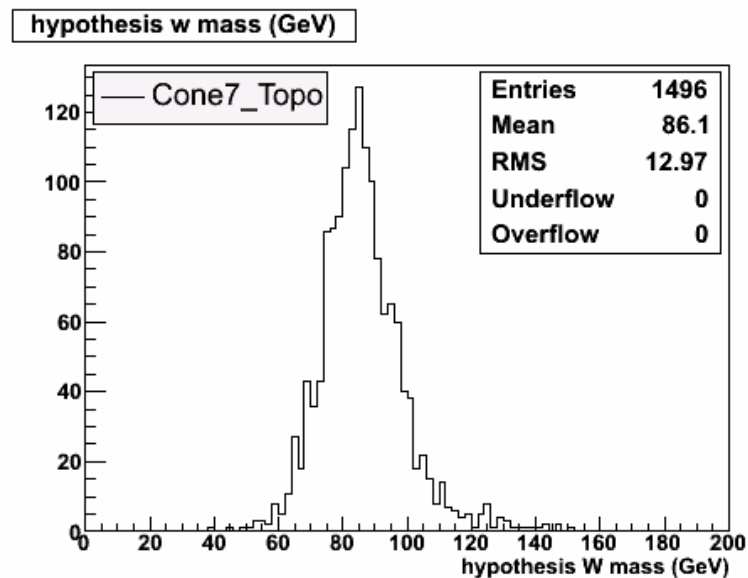
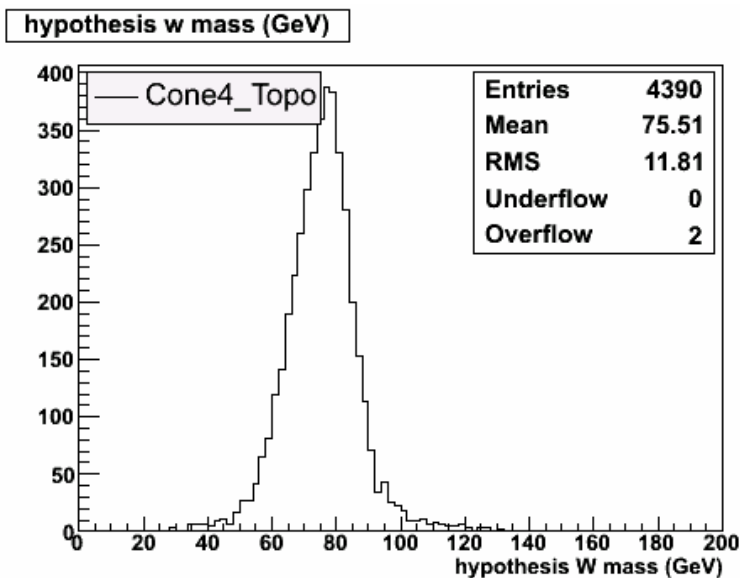
W mass plots: TowerJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



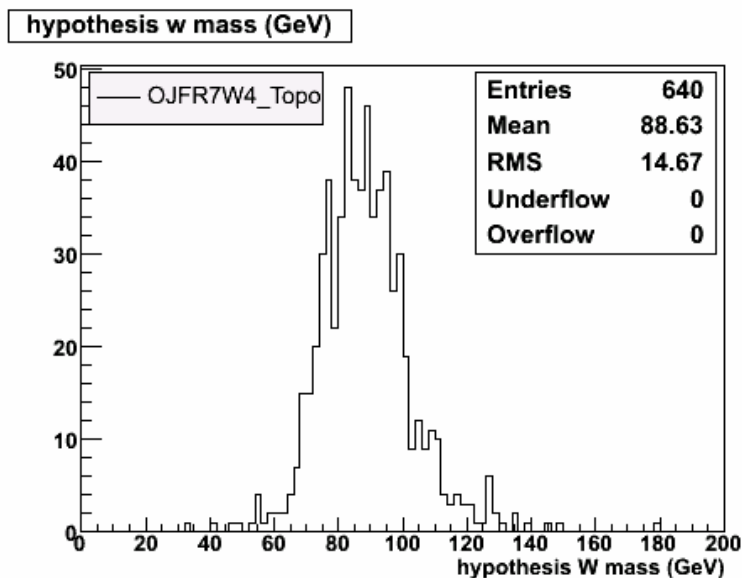
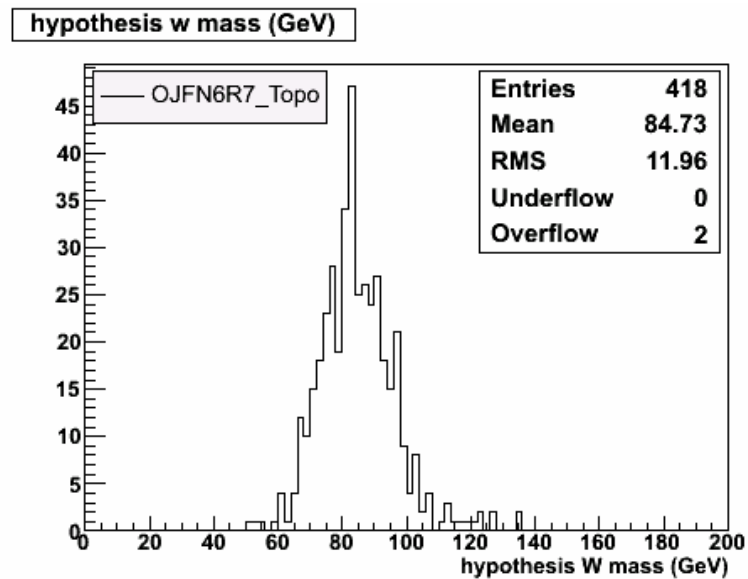
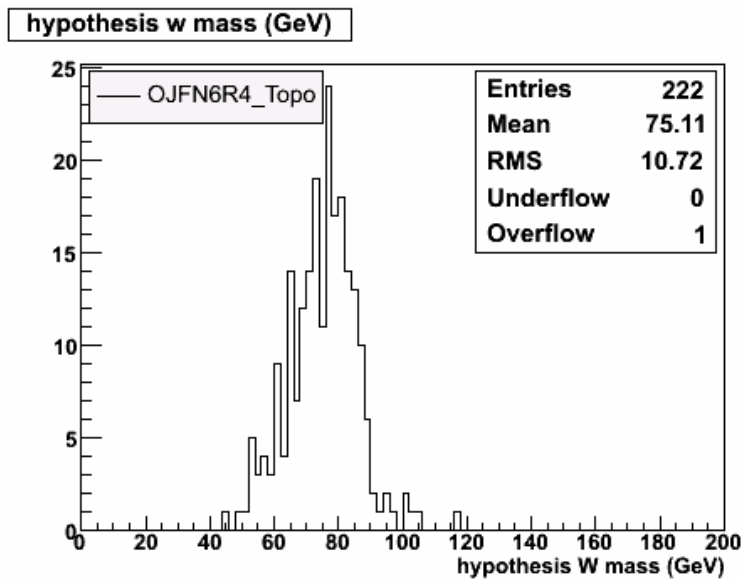
W mass plots: TopoJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



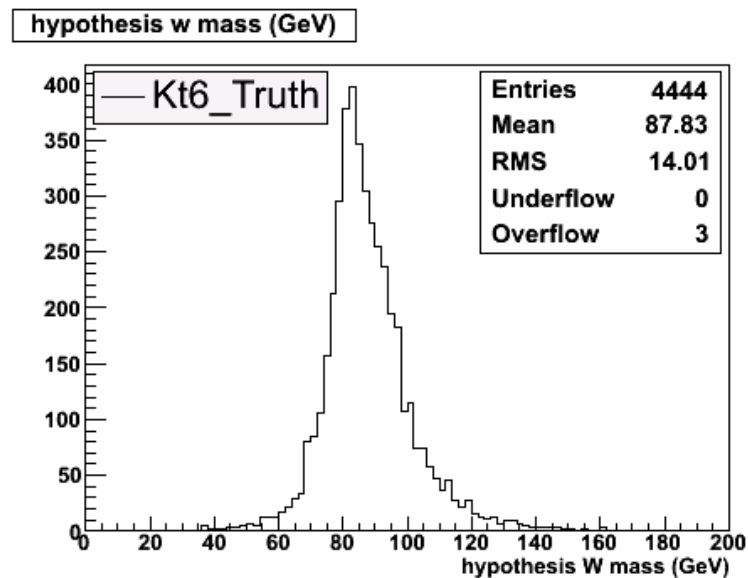
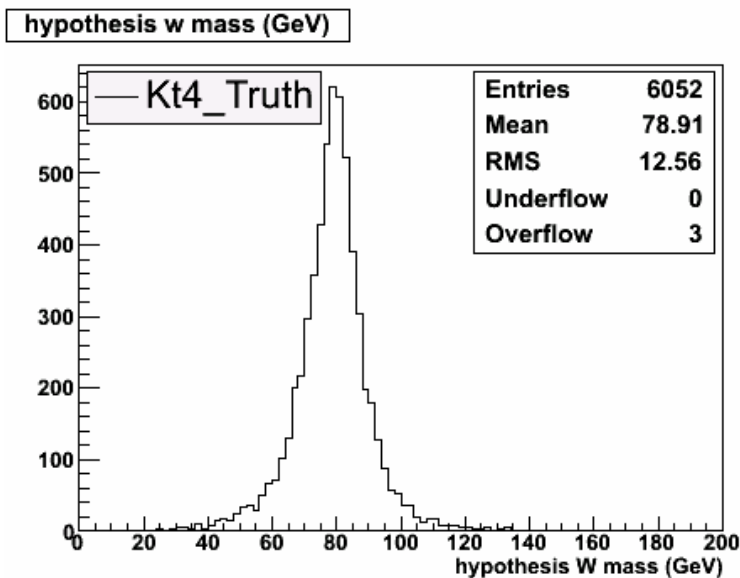
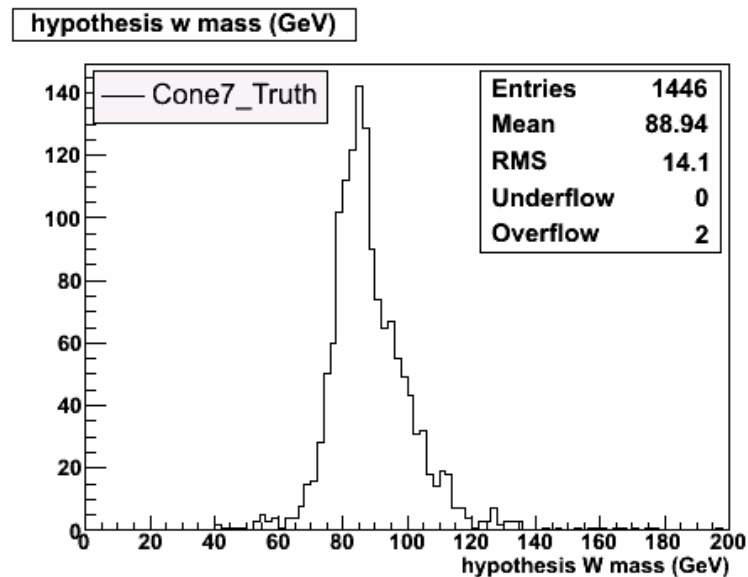
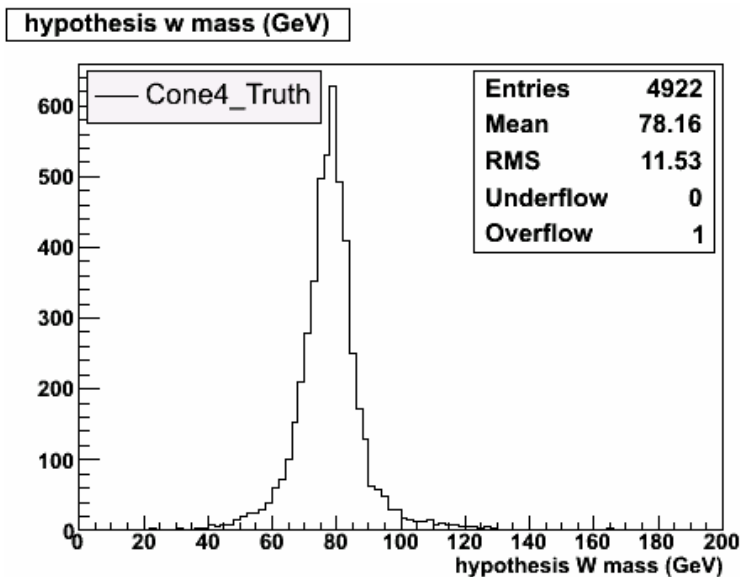
W mass plots: TopoJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



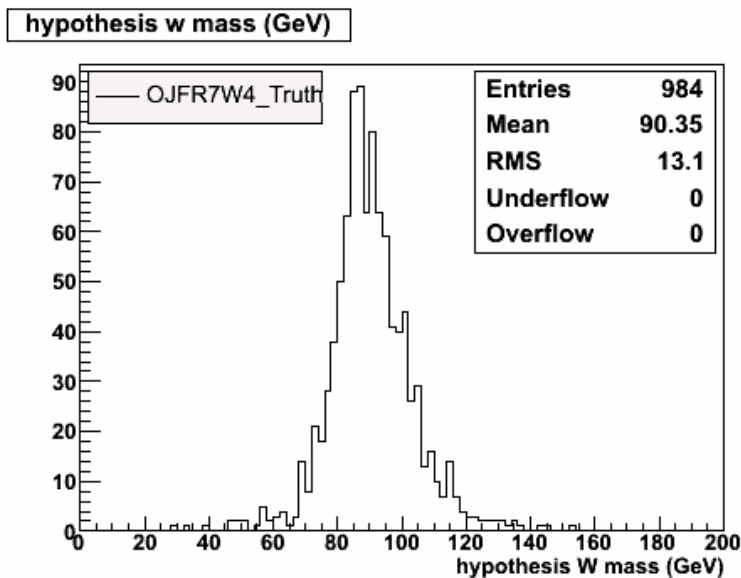
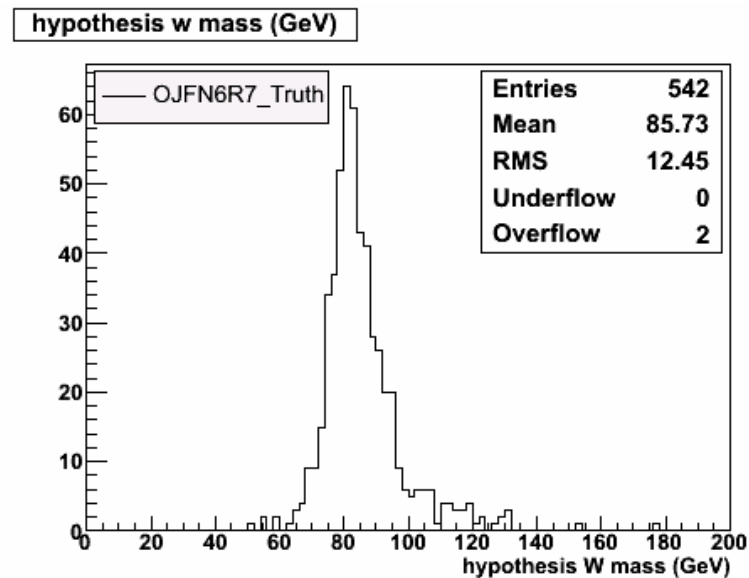
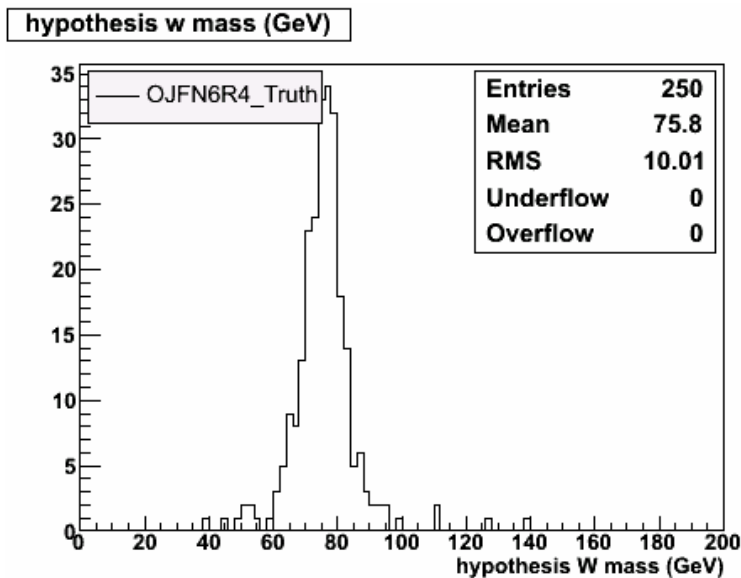
W mass plots: TruthJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



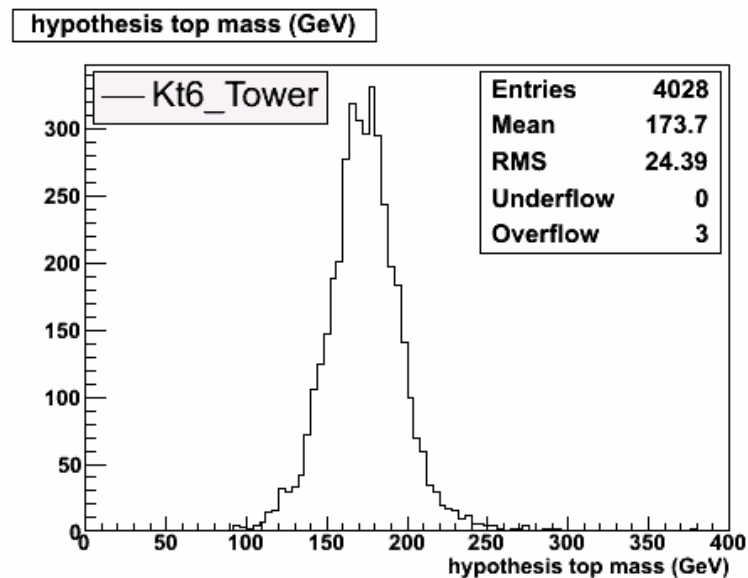
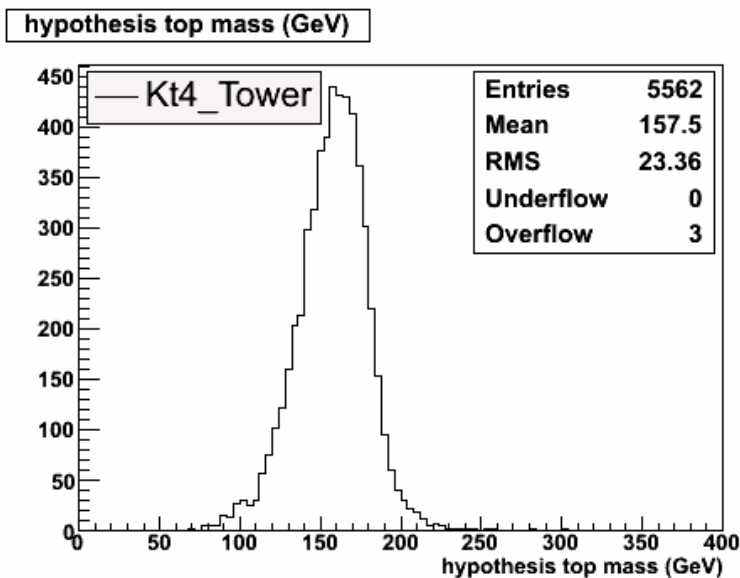
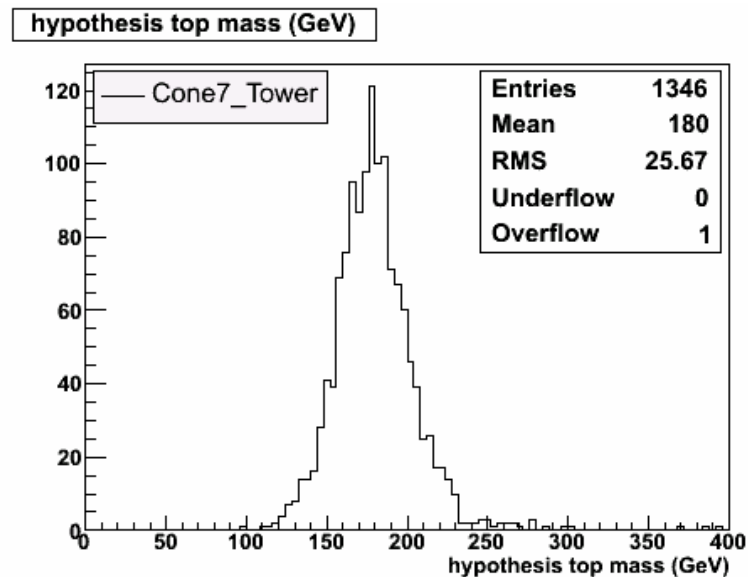
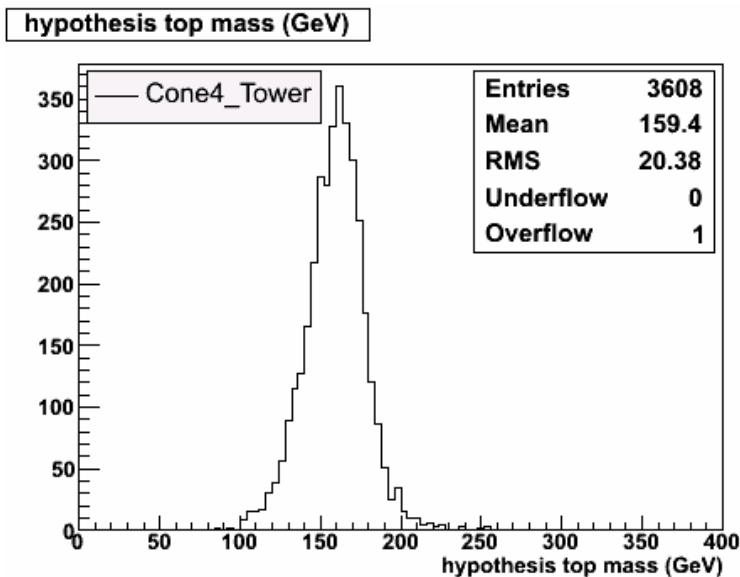
W mass plots: TruthJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



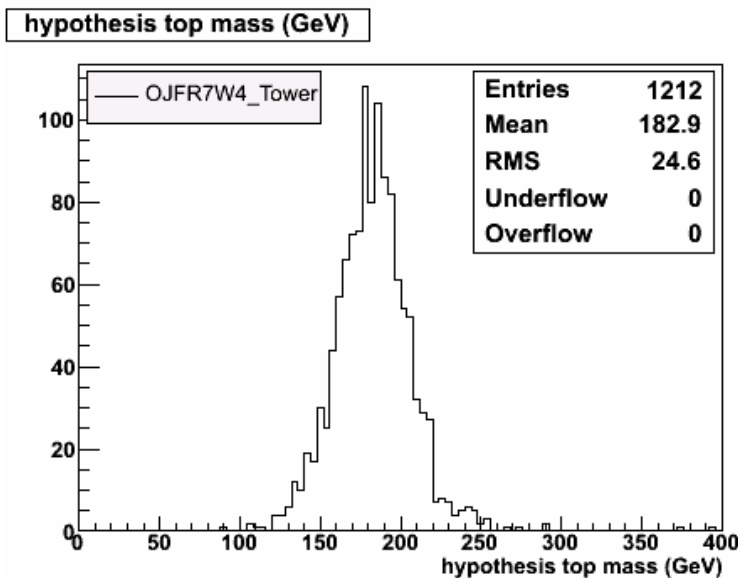
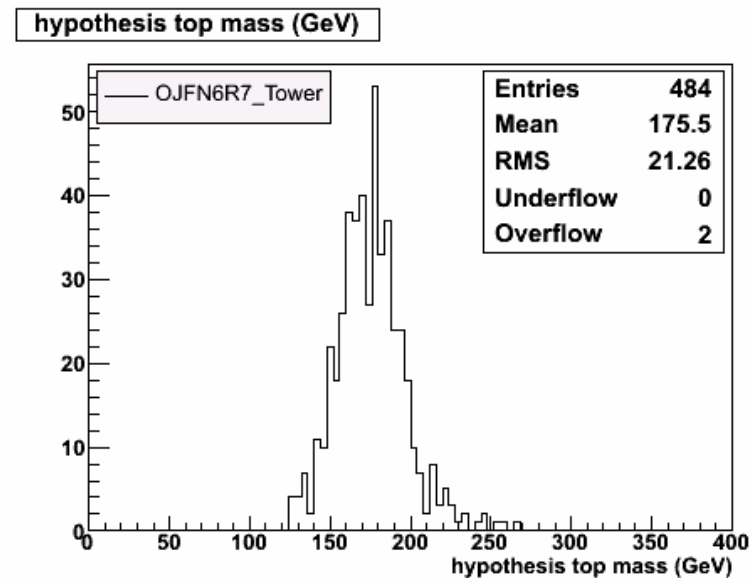
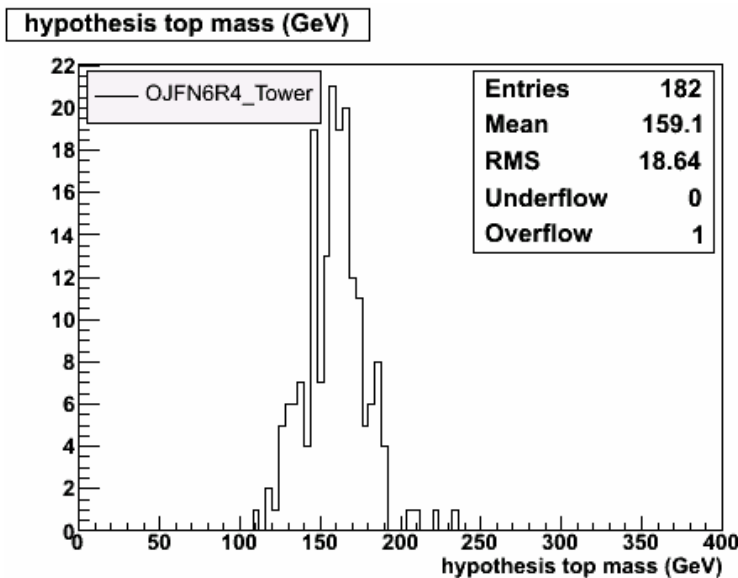
top mass plots: TowerJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



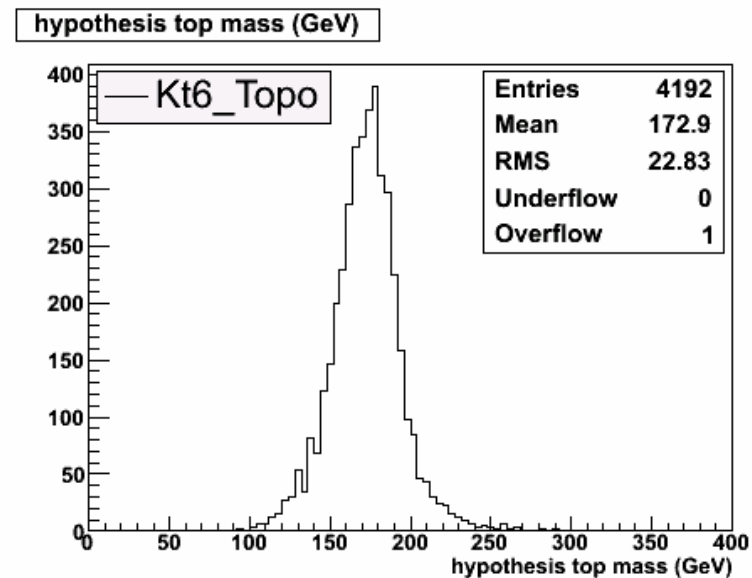
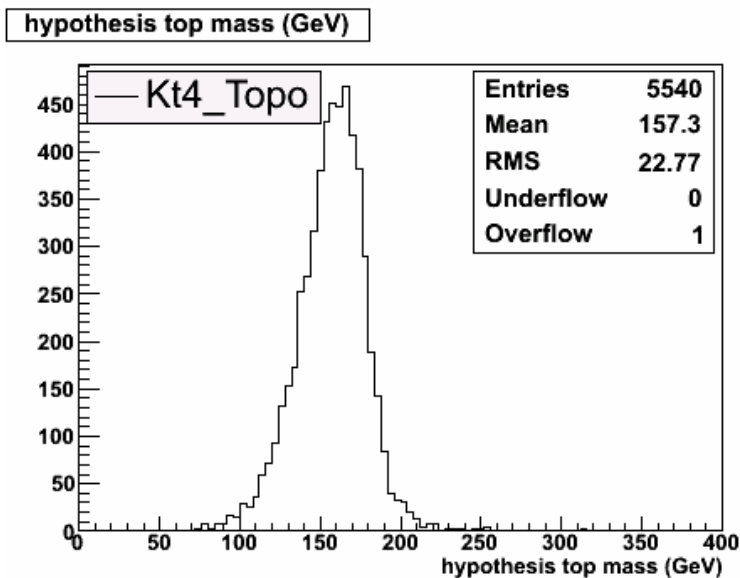
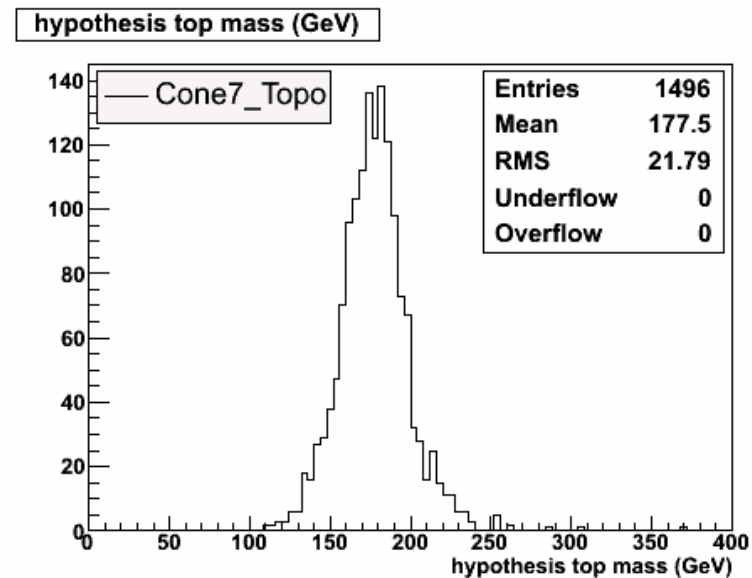
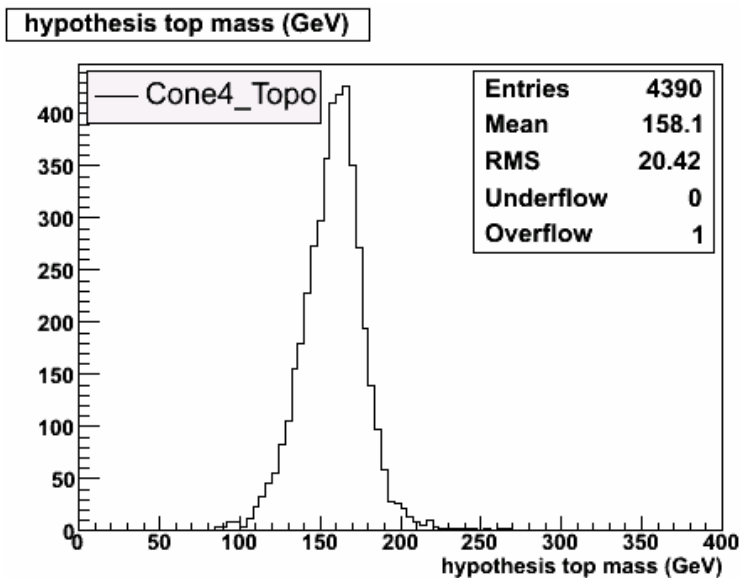
top mass plots: TowerJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



top mass plots: TopoJets

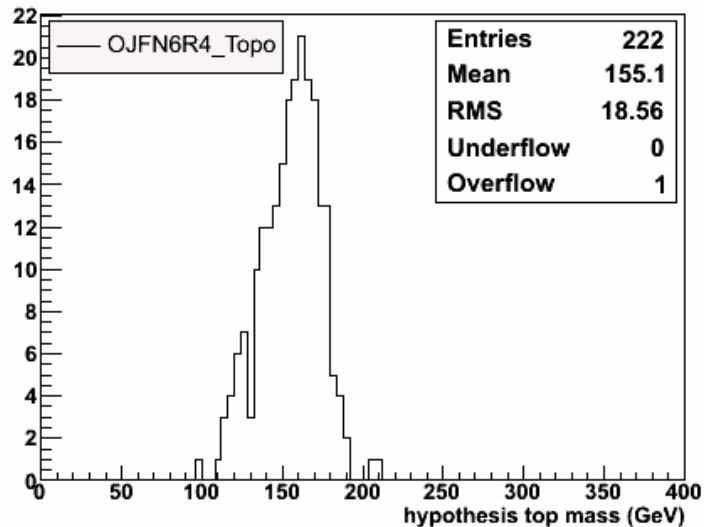
fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



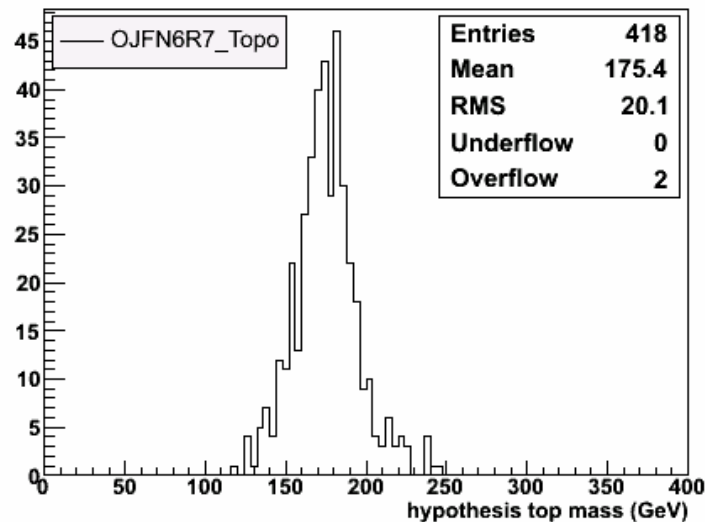
top mass plots: TopoJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1

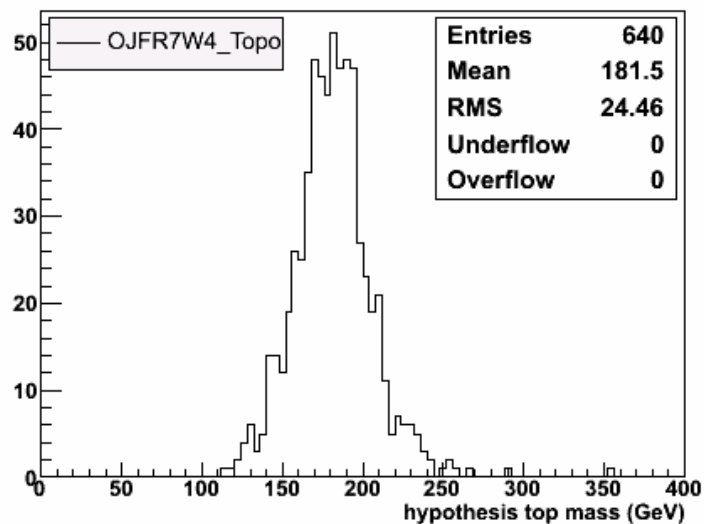
hypothesis top mass (GeV)



hypothesis top mass (GeV)

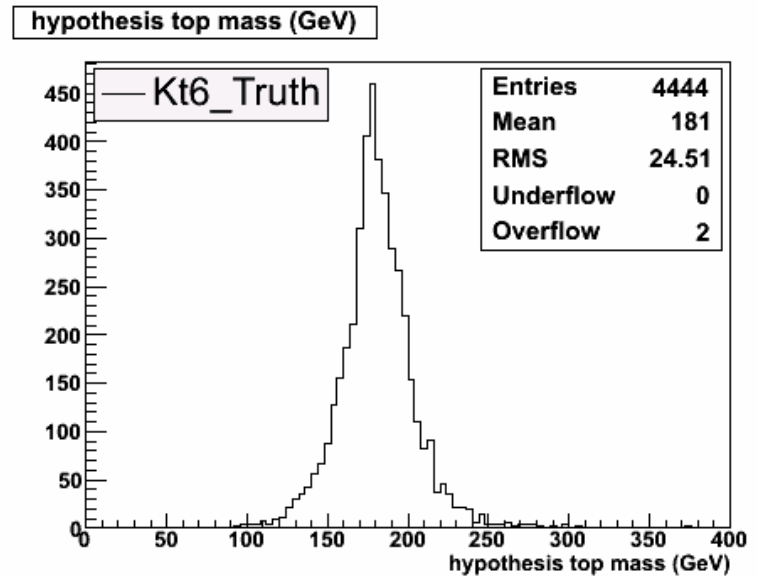
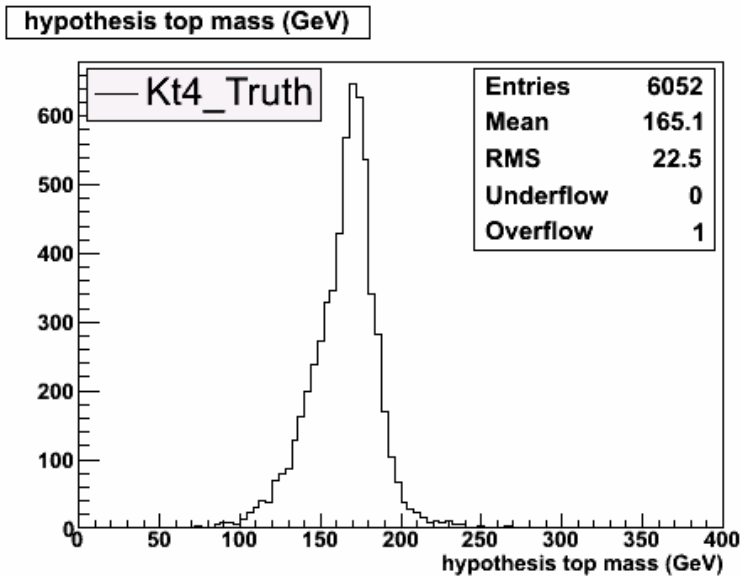
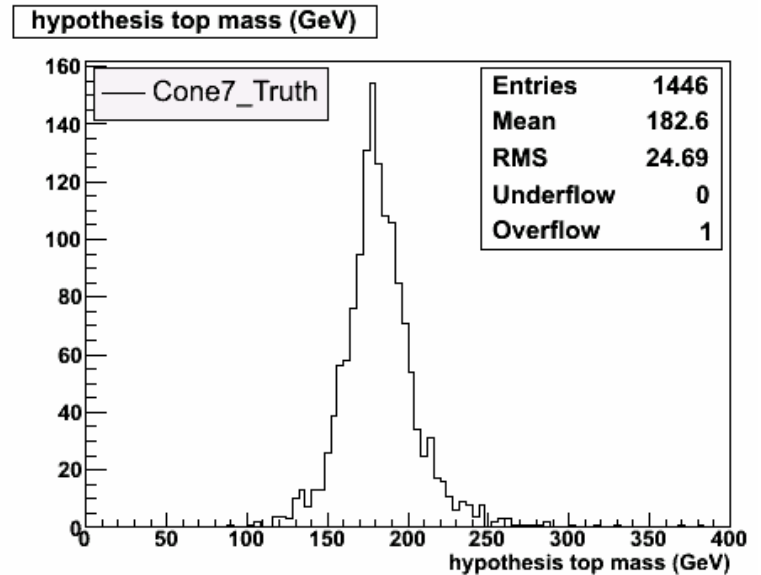
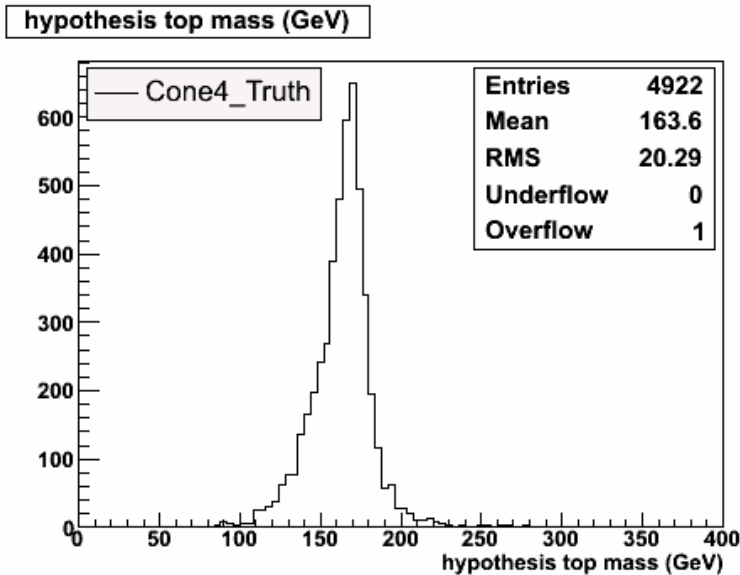


hypothesis top mass (GeV)



top mass plots: TruthJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1



top mass plots: TruthJets

fully hadronic t-tbar events with at least 6 jets in $|\eta| < 3$ with all partons matched 1 to 1

