

Simple UE studies in $gg \rightarrow H+2$ jets

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gluon fusion (ggF) as
“background” to
VBF 2-jet selection

The Contamination of ggF in VBF (ATLAS)

- **Current event selection applies moderate cuts on topological variables. Unlikely that cuts will become much tighter because of loss of signal rate**
- **Typical contamination from ggF+2j is ~30%**
 - **Contamination gets reduced to about 25% with CJV**
- **Theory error/systematics on ggF+2j large now:**

Source	Error (%)
QCD scale uncertainty	25 (30 with cjv)
Underlying event	30
JES	19

Leading total systematic of ~45% on ggF+2j → 13% on the extraction of VBF signal (leading systematic)

Simulation & cuts:

- ▶ 8 TeV pp collisions, Higgs production by gluon fusion
- ▶ Jet-finding with anti- k_t , $R = 0.4$
- ▶ At least two jets with $|\eta_j| < 5$, $p_{tj} > 25$ GeV
- ▶ VBF cuts: $\Delta y_{jj} > 2.8$, $m_{jj} > 400$ GeV, tagging jets defined as two highest p_t jets; 3rd jet considered if $p_{tj} > 20$ GeV.

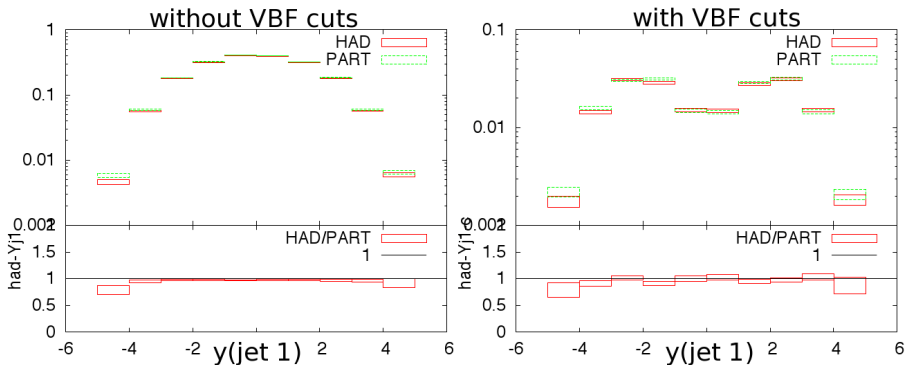
Histograms:

1. p_{tj1} : 25 ... 200 GeV, 25 GeV steps
2. p_{tj2} : 25 ... 150 GeV 25 GeV steps
3. y_{j1} : -5 ... 5 in steps of 1
4. y_{j2} : -5 ... 5 in steps of 1
5. $|\Delta y_{jj}|$: 0 ... 8, in steps of 1
6. m_{jj} : 0 ... 800 GeV, 40 GeV steps
7. $\Delta\phi_{jj}$: 0 ... π , 10 bins
8. p_{tj3} : 20 ... 100, 10 GeV steps
9. y_{j3} : -5 ... 5, steps of 1

Comparison plots: Sherpa (20 GeV matching); MC@NLO (30 GeV matching); MINLO: Hjj sample; all at parton level, without MPI (UE)

Impact of UE — is it really 30%?

Impact of UE and hadronisation in MINLO + Pythia



impact of UE+hadronisation seems small in MINLO studies

But: Paolo Nason cautioned that full UE modelling may not take place when Pythia reads in LHE files from POWHEG

+ One should separate hadronisation and UE

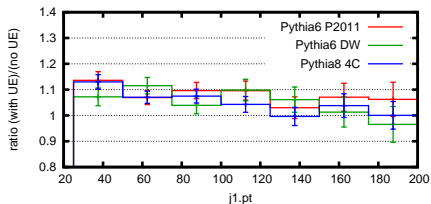
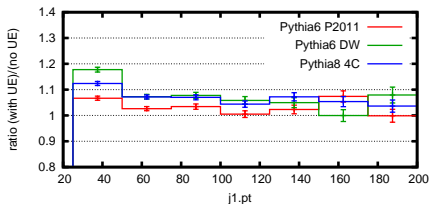
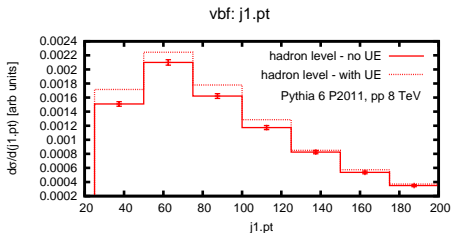
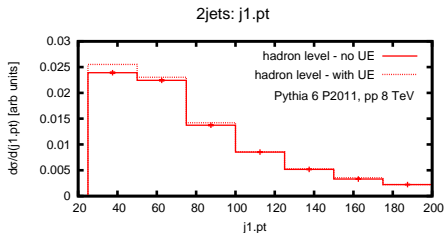
my quick & dirty study: Pythia, VBF cuts, scaled to NNLO σ_{tot}

	partons, no UE	hadrons, no UE	hadrons + UE
Py 6 DW (virt. ord. shower)	0.259 pb	0.243 pb	0.259 pb
Py 6 P2011 (p_t ord. shower)	0.300 pb	0.292 pb	0.318 pb
Py 8 4C (p_t ord. shower)	0.320 pb	0.310 pb	0.330 pb

- ▶ hadronisation and UE are often similar in magnitude, but of opposite sign (as in almost every other case studied)
- ▶ UE alone seems to be $\lesssim 10\%$.

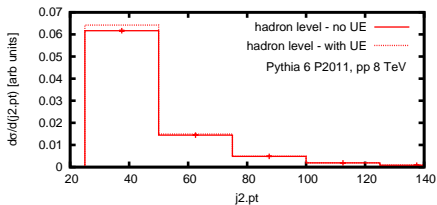
Plots that follow are basically a core dump from that study

More statistics would be desirable, but also wouldn't change the picture

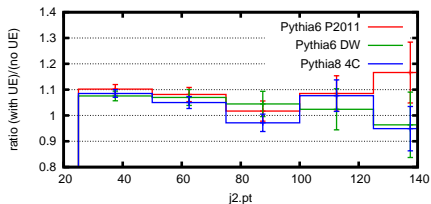
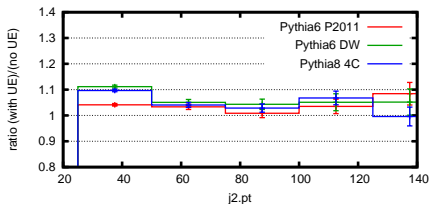
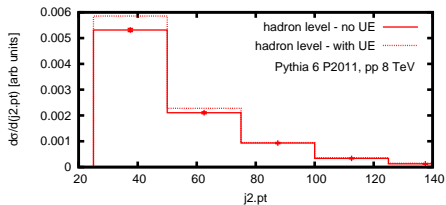


NB: low bin plain 2-jet cuts appear to be more affected by UE (maybe because jets are more central, where UE is larger)?

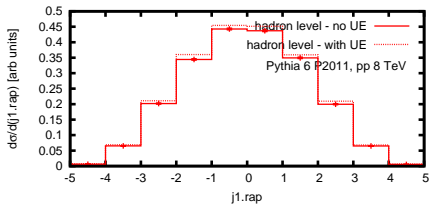
2jets: j2.pt



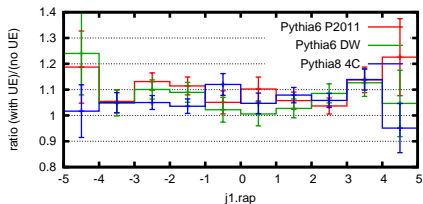
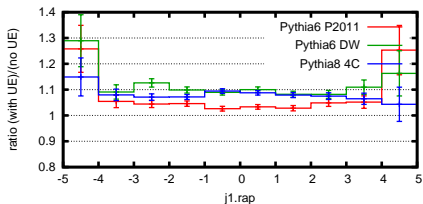
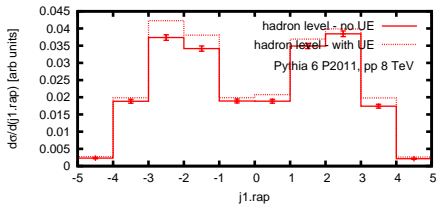
vbf: j2.pt



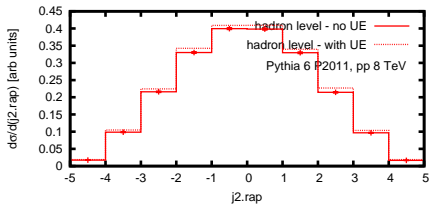
2jets: j1.rap



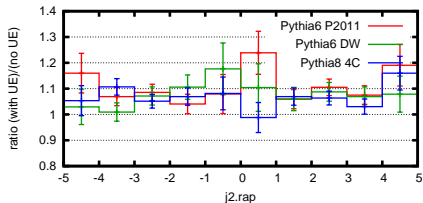
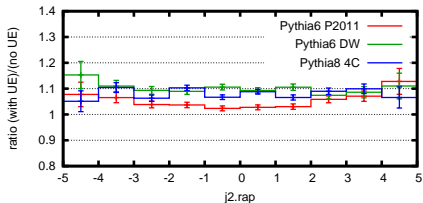
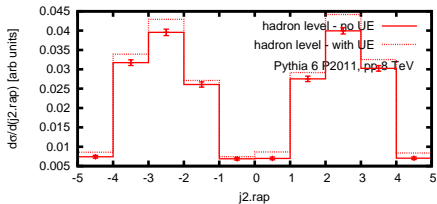
vbf: j1.rap



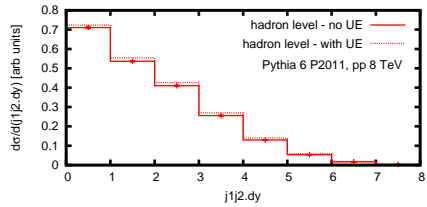
2jets: j2.rap



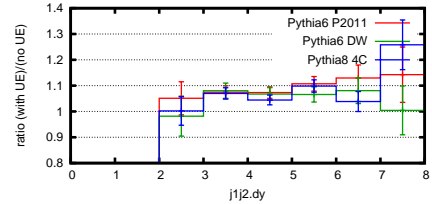
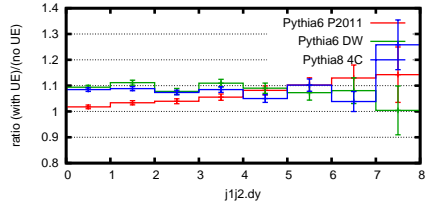
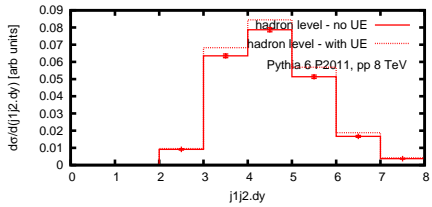
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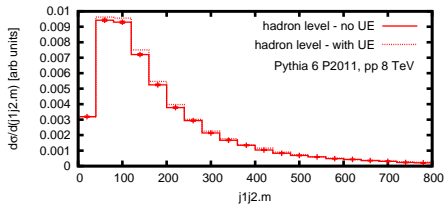
2jets: j1j2.dy



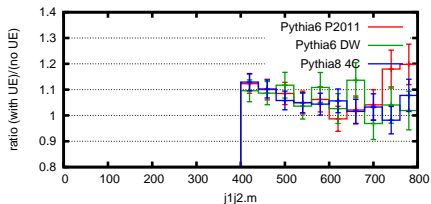
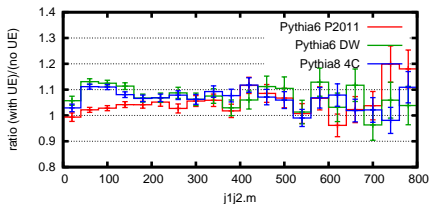
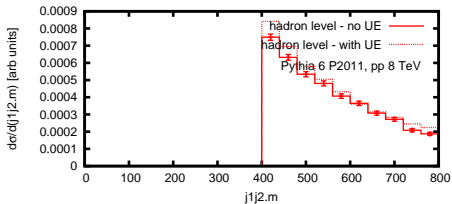
vbf: j1j2.dy



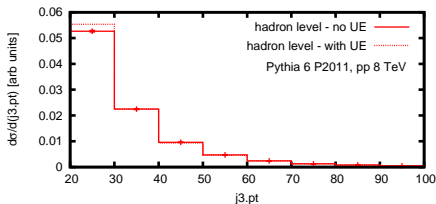
2jets: j1j2.m



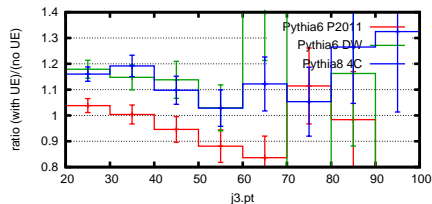
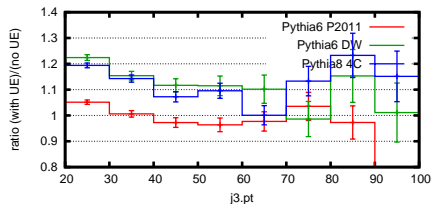
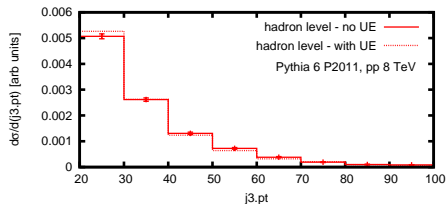
vbf: j1j2.m



2jets: j3.pt

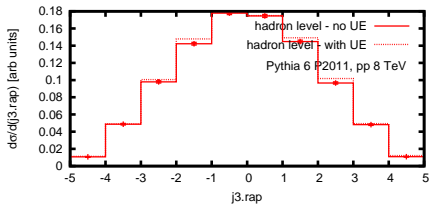


vbf: j3.pt

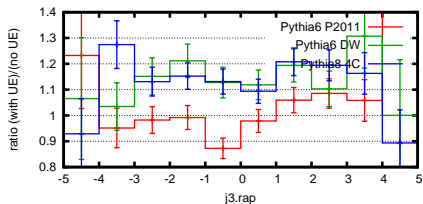
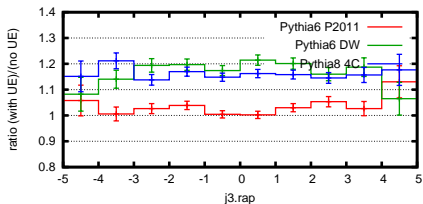
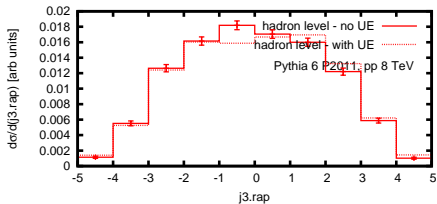


NB: quantities involving 3rd jet have up to 20% corrections, with large differences between the generators.

2jets: j3.rap



vbf: j3.rap



- ▶ Switching UE on and off brings $\lesssim 10\%$ effect for VBF selection cuts and most distributions (except those for 3rd jet)
- ▶ is this a fair estimate of UE?
 - ▶ Possibly too conservative? Some kind of difference between tunes might be fairer? What's the right choice of tunes to use for this?
 - ▶ Possibly not conservative enough? How well constrained are the UE tunes in the forward region?

EXTRAS