ttH Status report

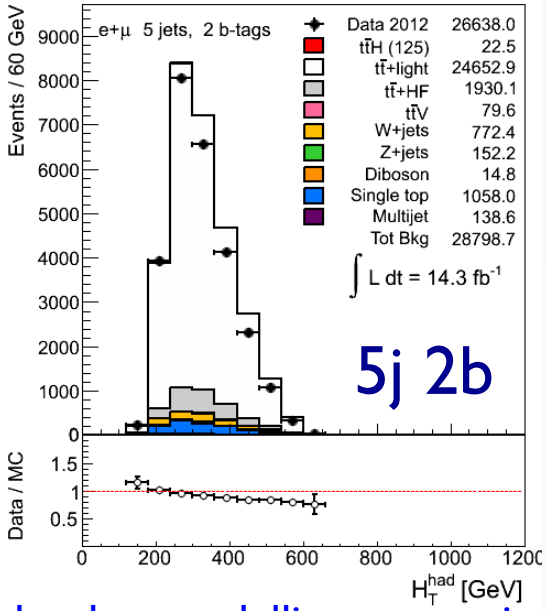
On behalf of the HSG5 ttH group

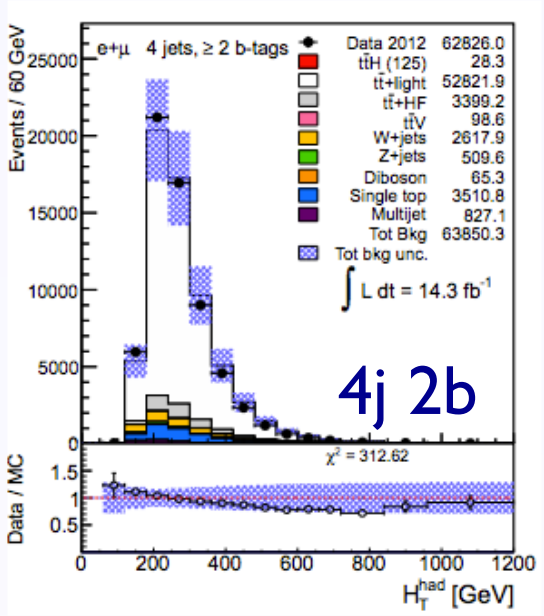
Issues & Status

- HT discrepancy
  - LC vs EM+JES
- Latest fits for SVA
- Dilepton analysis
  - 8TeV fits

The issue

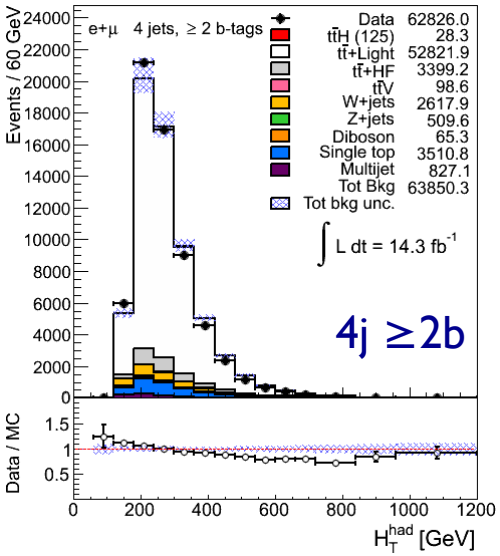
- ttH analysis for Moriond is performed using two options
  - single variable fit (exactly same approach as used in the approved CONF note)
    - HT and m_{bb} variables
  - fit to NN discriminant in signal bins and HT in other bins
- For both approaches good modelling of data by MC model is critical
- We observe slopes in data/MC ratio in all analysis bins with at least one tag

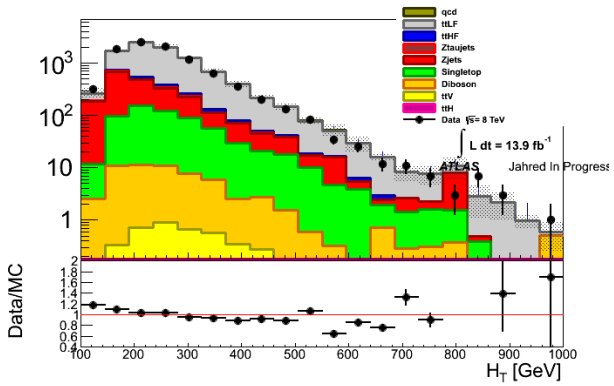




only ttbar modelling uncertainties

≥2j ≥1b



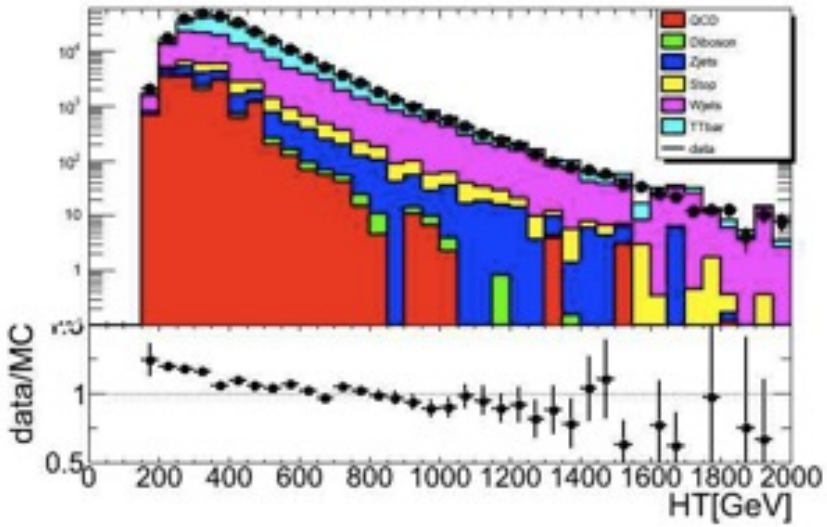


Same trend in dilepton channel!

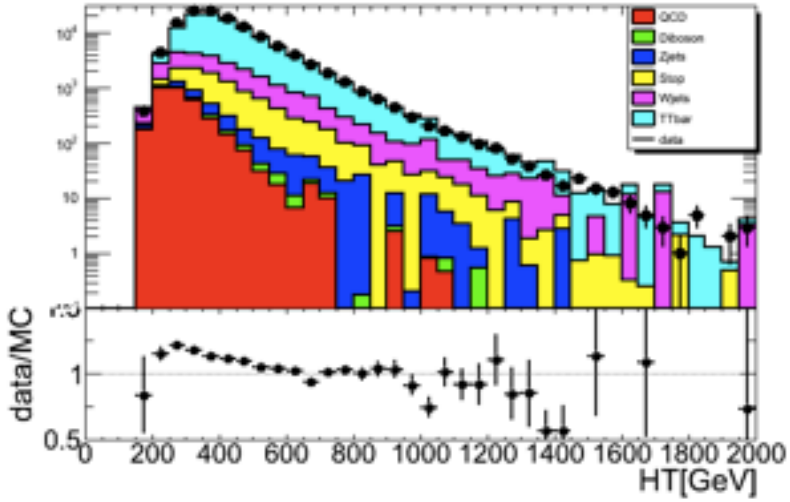
Other top analysis

4j+5j

≥0 b



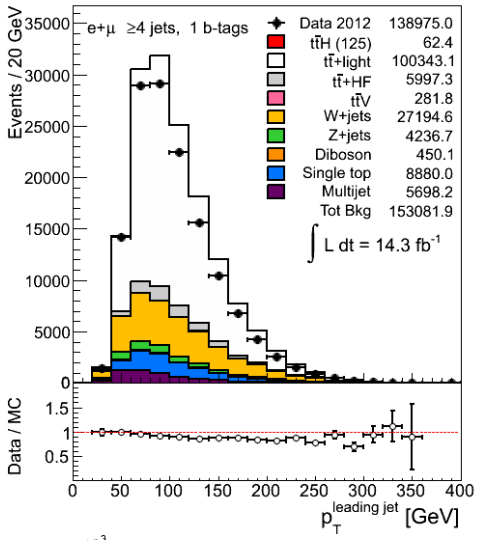
≥ 1b

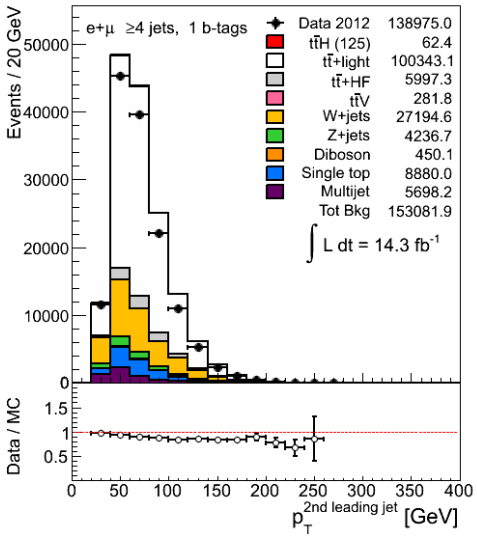


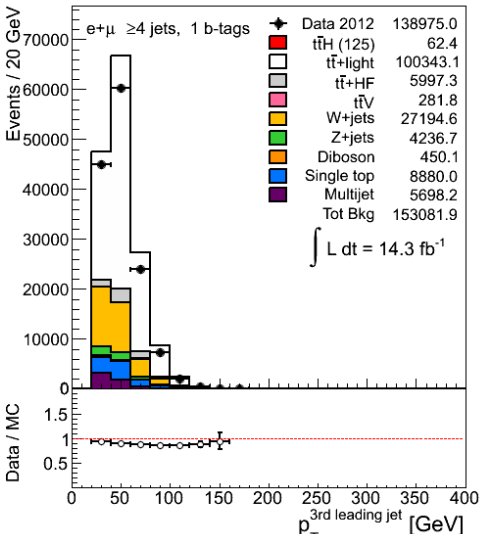
- the first plot produced outside ttH group
  - uses the same TopRootCore package
- similar trend
  - could be a problem in TopRootCore, but at least this shows it's not just a bug in our code

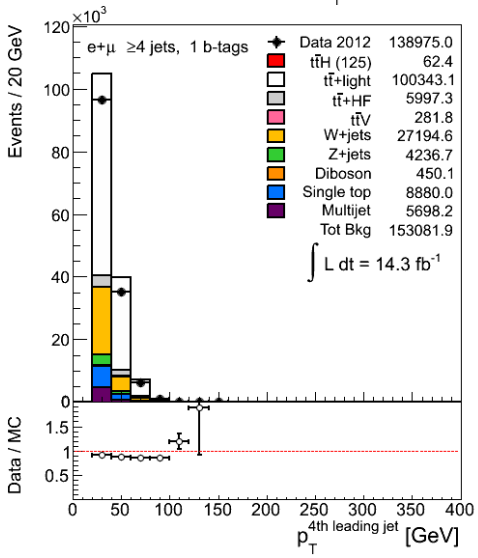
More distributions

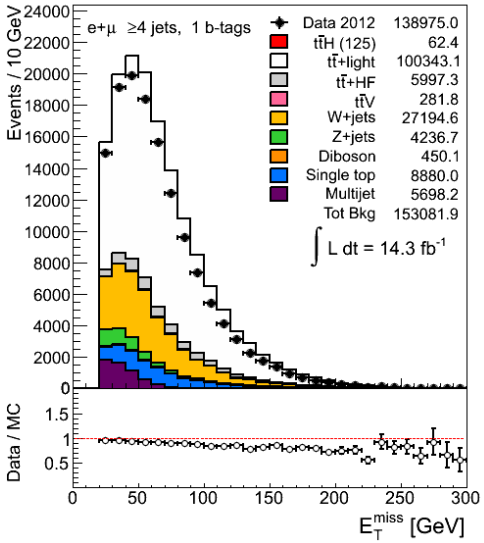
- Mismodelling of HT comes from mismodelling of jet PTs and ηs

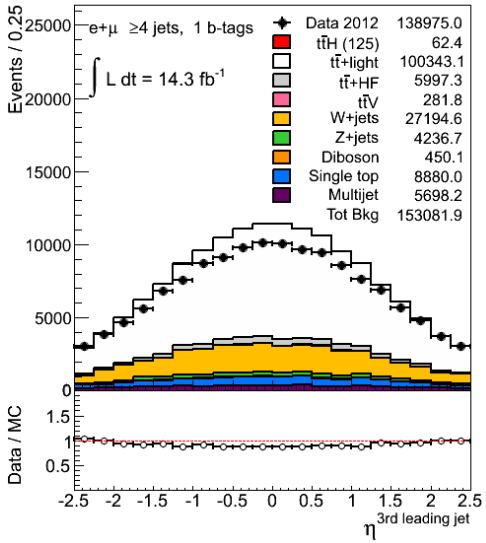












4j1b

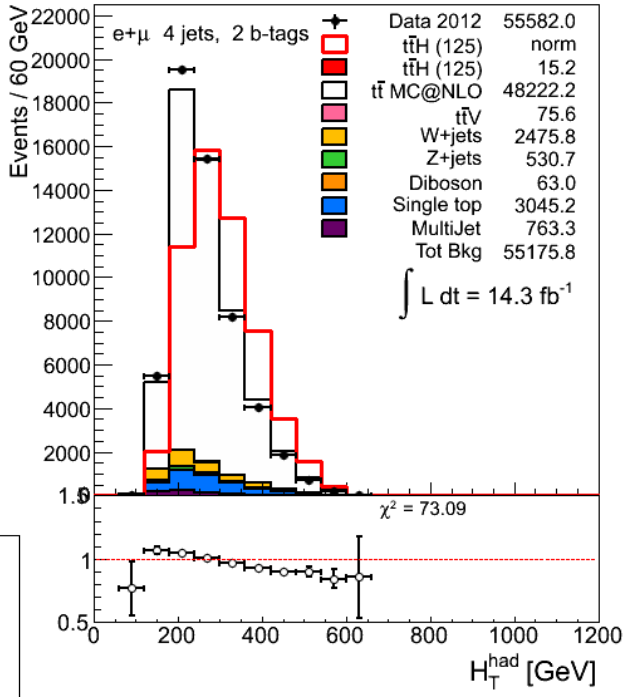
Same features are observed in other jet and tag multiplicity bins

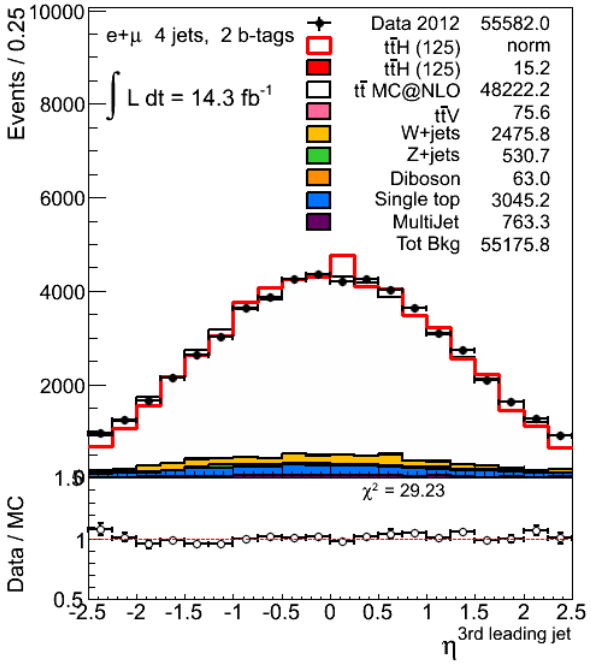
What is it?

- ttbar modelling
- pileup modelling
- effect of various scale factors
  - b-tagging (we are using pTrel calibration)
  - JVF
- test of b-tagging SFs
  - try SFs from ttbar calibration
- p_T^W reweighting
  - Top W reweighting?
- do we see this somewhere else? VH cuts
- multiparton interactions?
- jets - JES?
  - tried EM+JES instead of the default LC jets

ttbar modelling - I

- Given that the problem is seen in ttbar dominated regions we suspected ttbar modelling
- Default: Alpgen+Herwig
- Tried
  - MC@NLO
  - Powheg+Herwig (AFII)
  - Powheg+Pythia (AFII)

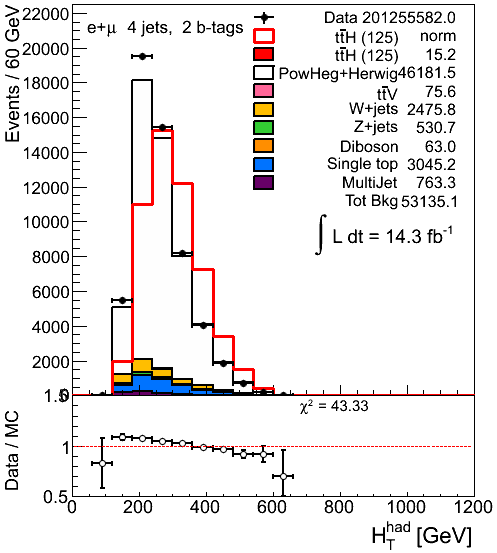


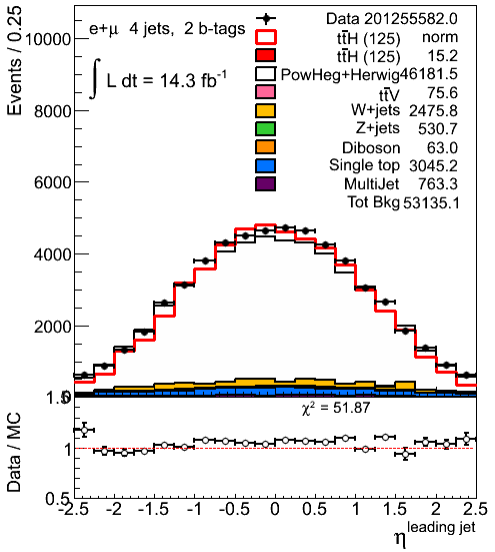


MC@NLO
- same slope in HT
- jet η looks better

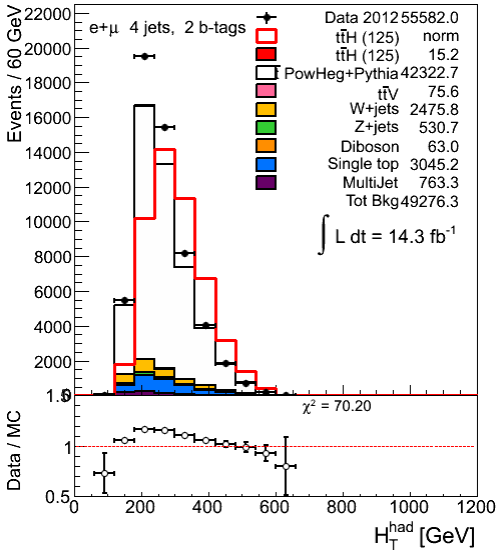
ttbar modelling - II

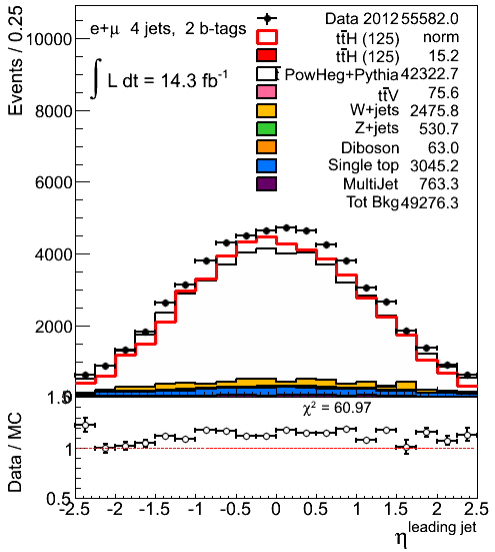
Powheg+Herwig



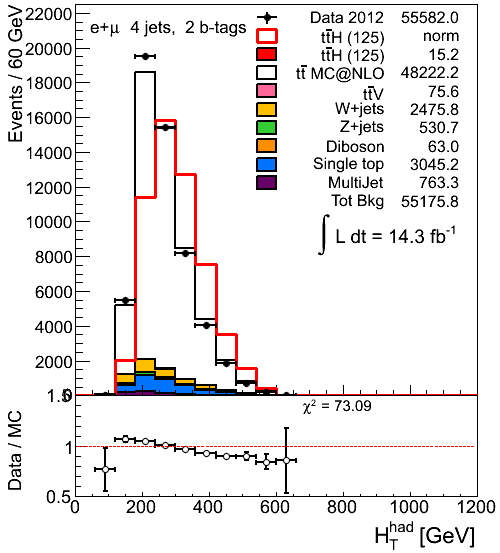


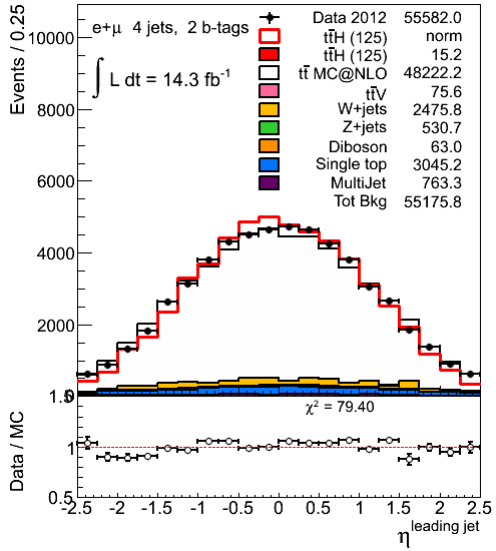
Powheg+Pythia





MC@NLO

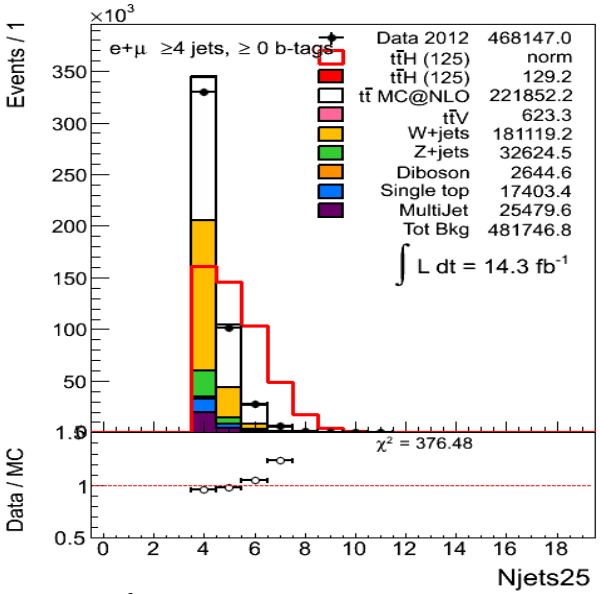


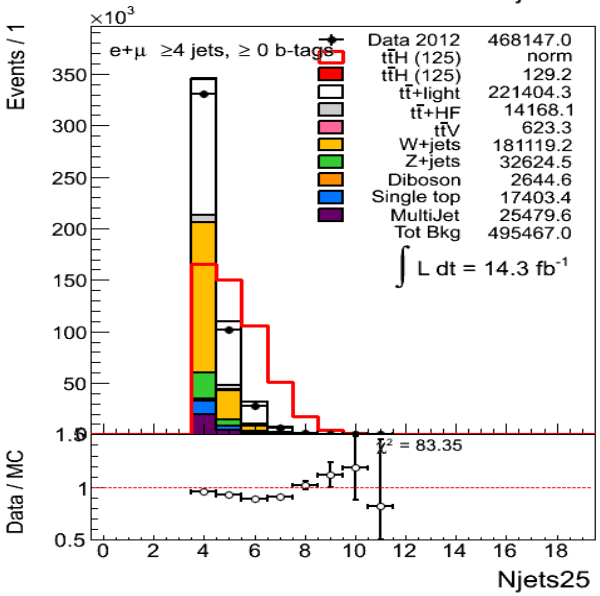


NLO MC describes jet η distribution better

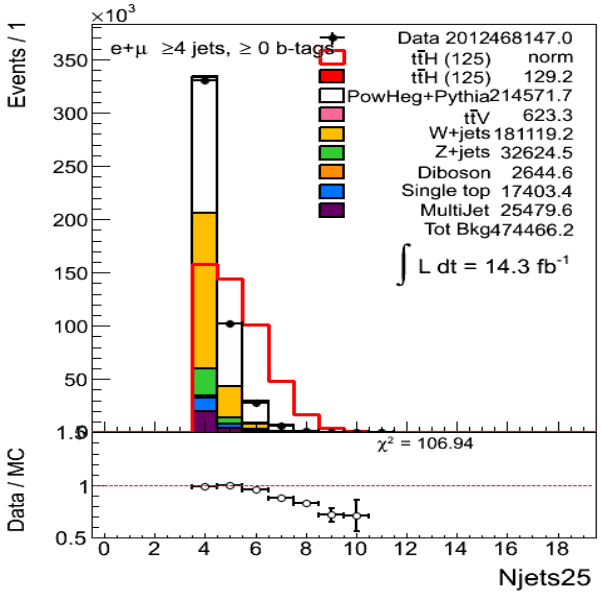
Jet multiplicity

MC@NLO

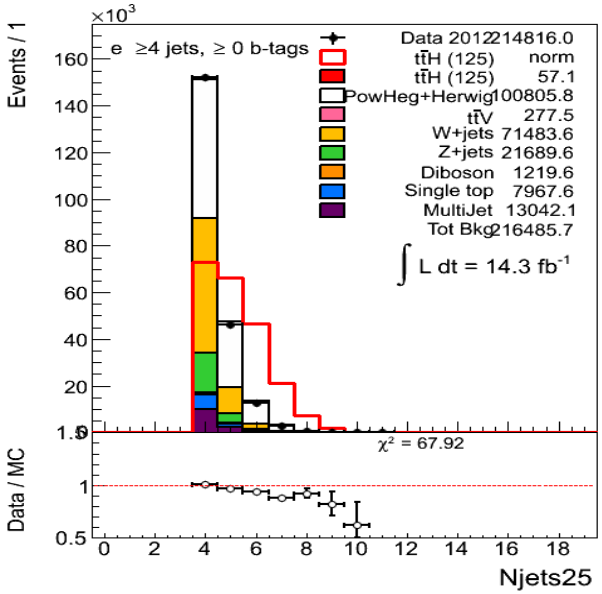




Powheg+Pythia



Powheg+Herwig

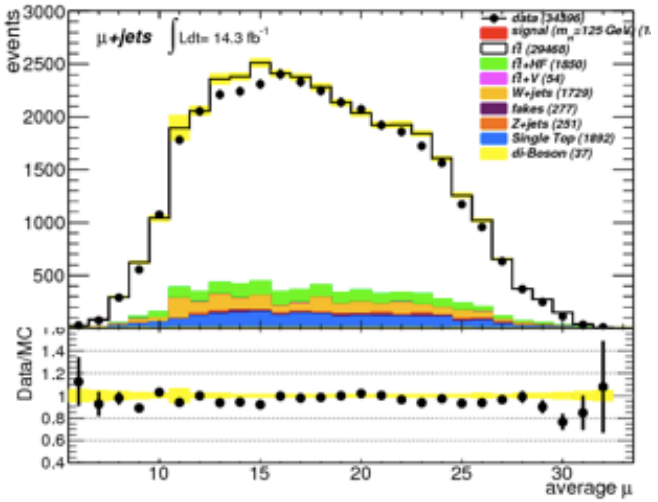


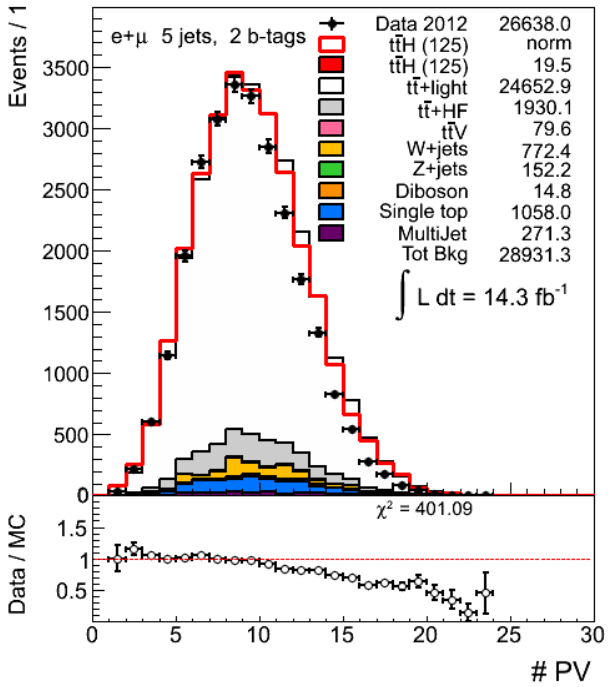
Alpgen+Herwig default

4 jets inclusive pretag

Pileup

- We perform luminosity reweighting following recommendations but the NPV distribution in data is not well described
- MC overestimates NPV in data
- However the twiki says that agreement in NPV is not expected to be perfect even after μ reweighting

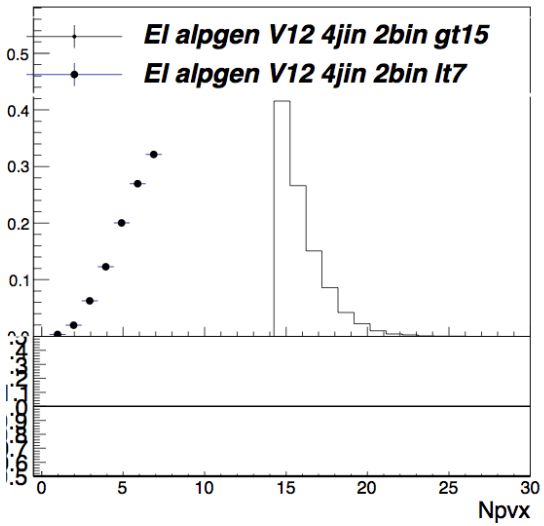


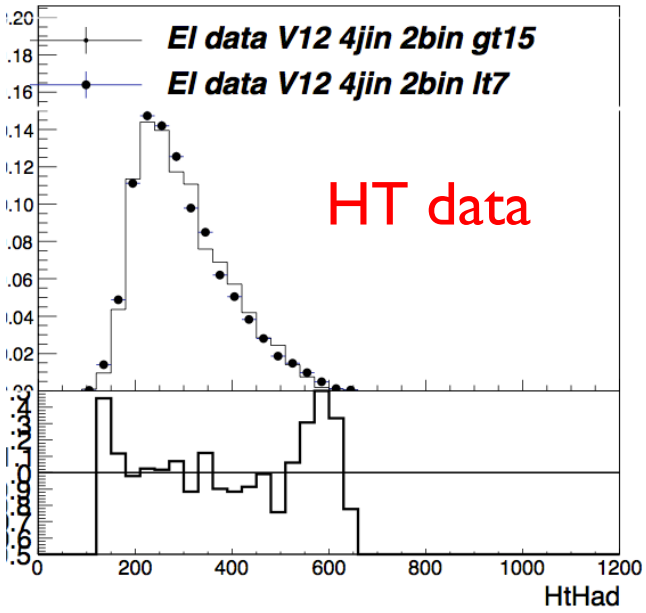


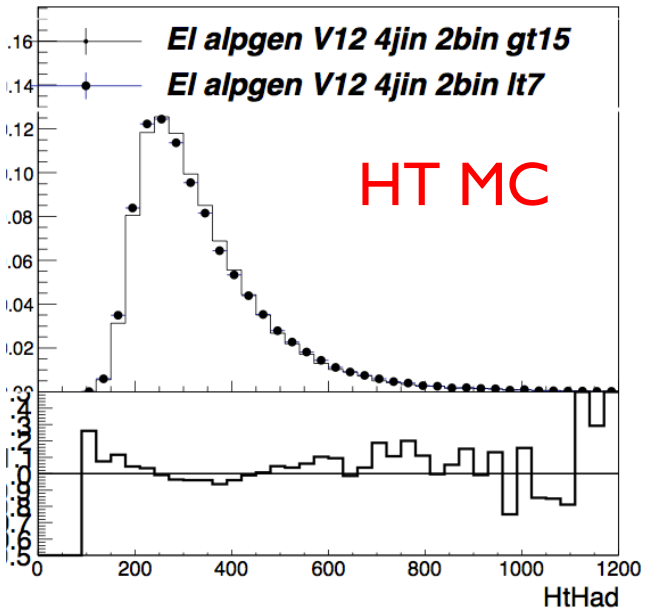
https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/InDetTrackingPerformanceGuidelines#Analyses_based_on_Athena_release

NPV<7 vs NPV>15

- e+jets, 4 jet incl 2b incl



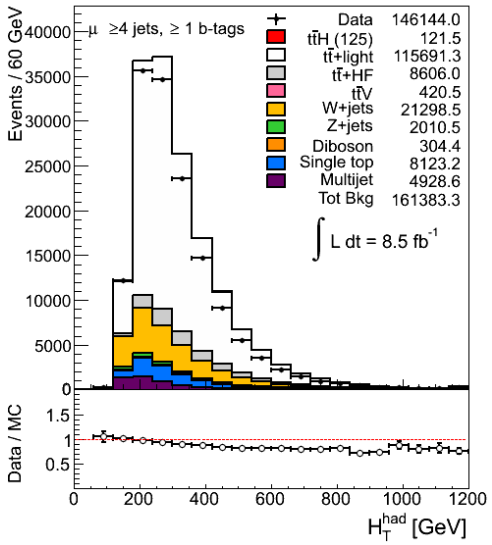




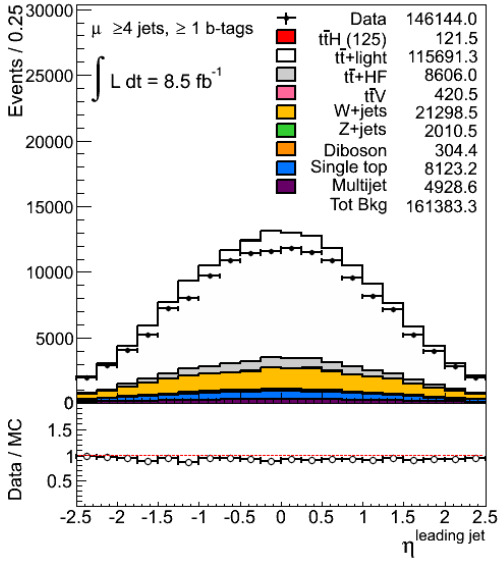
- NPV<7 - points, NPV>15 - histogram
- shape does not change significantly between low and high NPV
- trend in MC follows trend in data
- does not seem to explain the problem

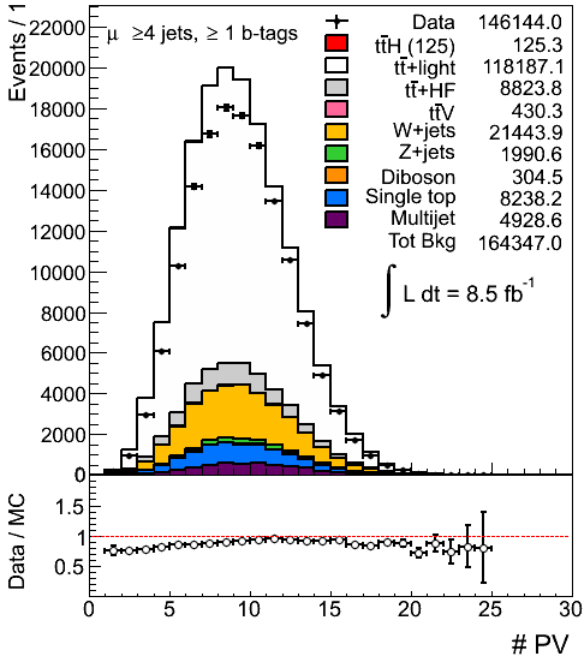
NPV reweighting

- Although effect is expected to be small let's reweight NPV to match data better



before NPV reweighting

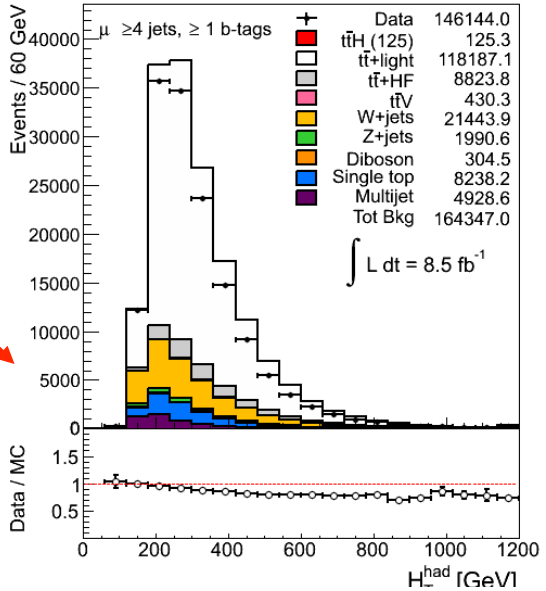


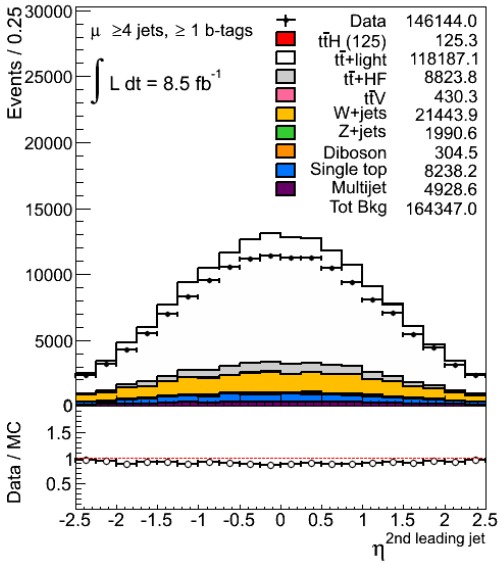


reweighted in 2j inclusive

does not help!

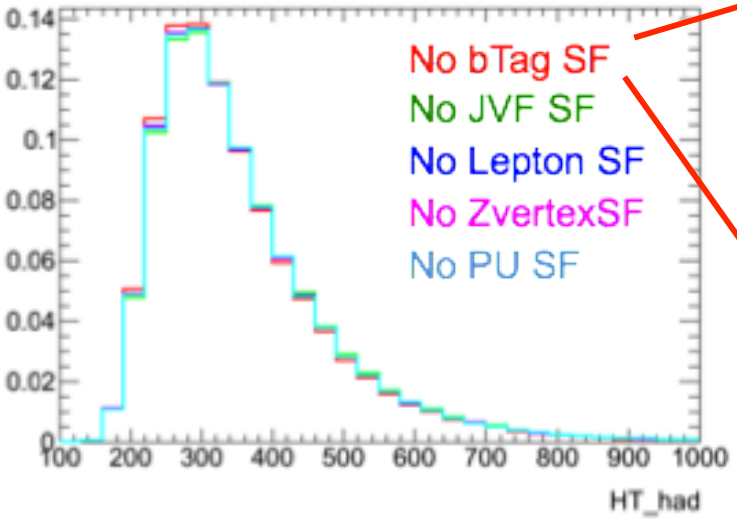
after NPV reweighting

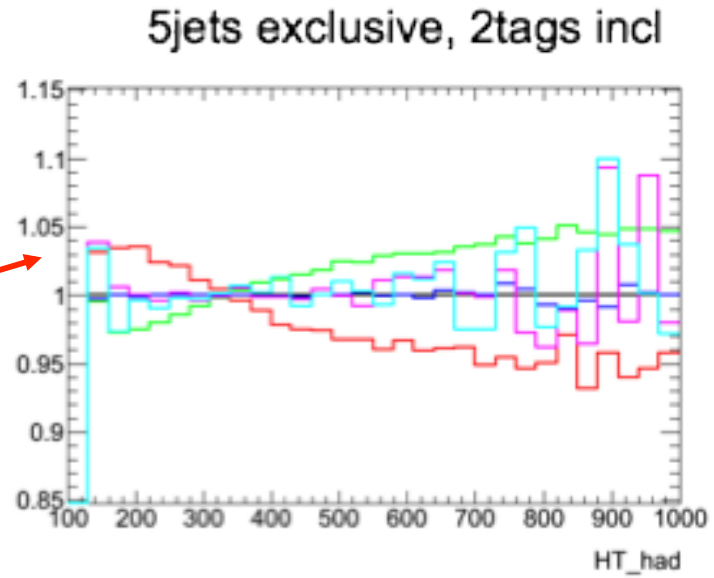


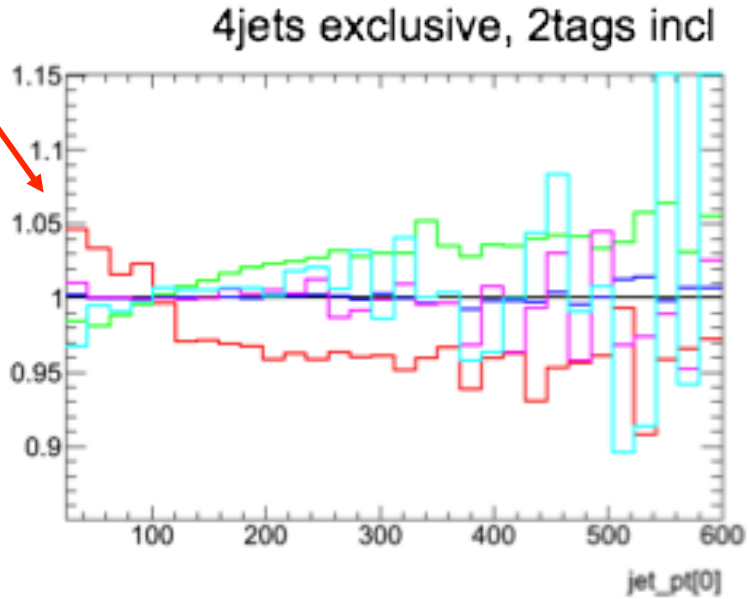


Impact of SFs on HT shape

- remove various SFs one by one and look at the effect on HT shape
- study on ttbar MC
  - tt+light and tt+HF



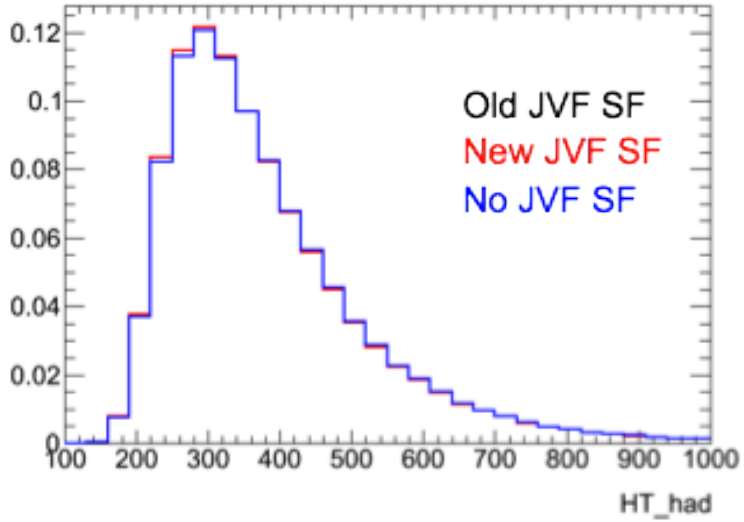


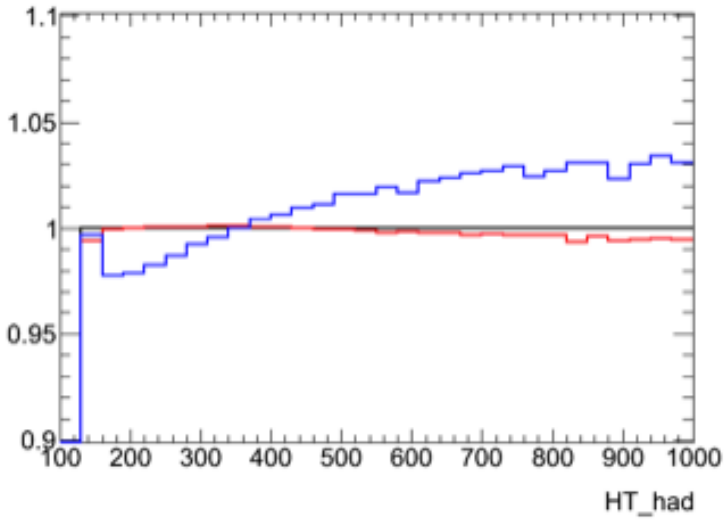


- removing bTag SF: this seems to have a pretty large impact and goes in the direction we would like (increasing low side, decreasing high side)
- bTag SF: largest effect on nuisance parameters in the fit

JVF SF

- We use "old" JVF SF derived for EMJES jets
- In the meantime new JVF SFs were announced
  - derived for LC jets!
- blue: no scale factor
- red: new JVF SF
  - effect seems to be small but it goes in the right direction
- black: old JVF SF

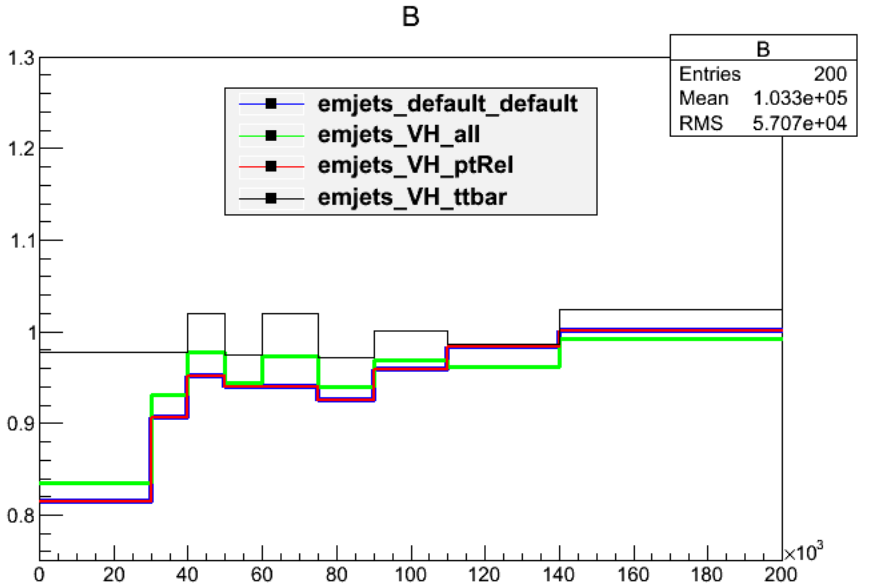


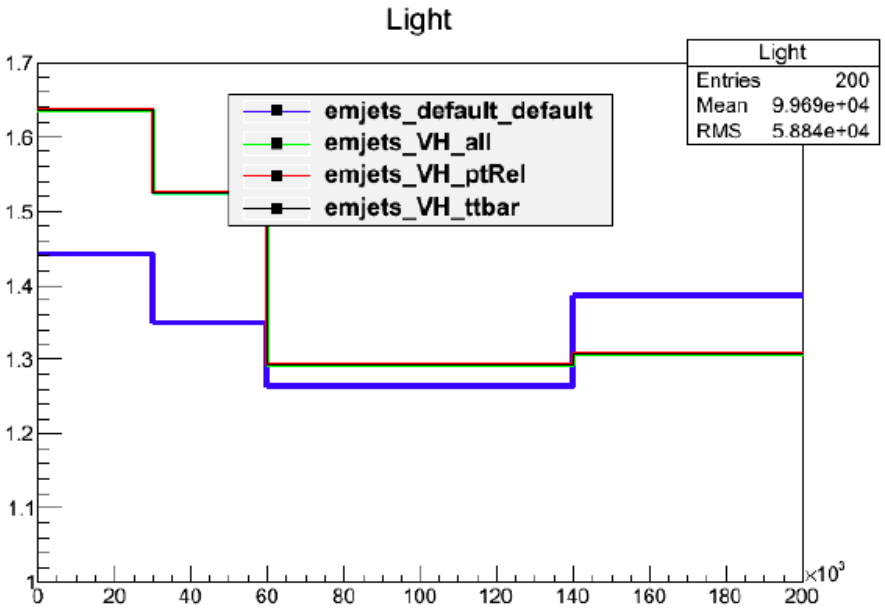


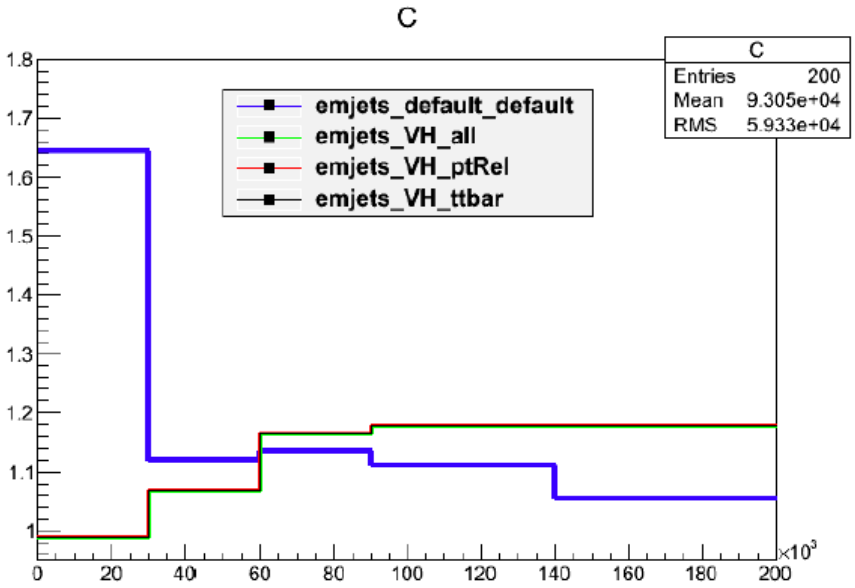
5jets exclusive, 2tags inclusive

Study of b-tagging

- So far using 2011 pTrel calibration
- Need to get HCP recommended file:
  - 2011+2012(a) pTrel calibration
  - 2011 ttbar calibration
- Note:
  - VH_all is the one we should use
  - We don't understand what the c and light calibrations are showing



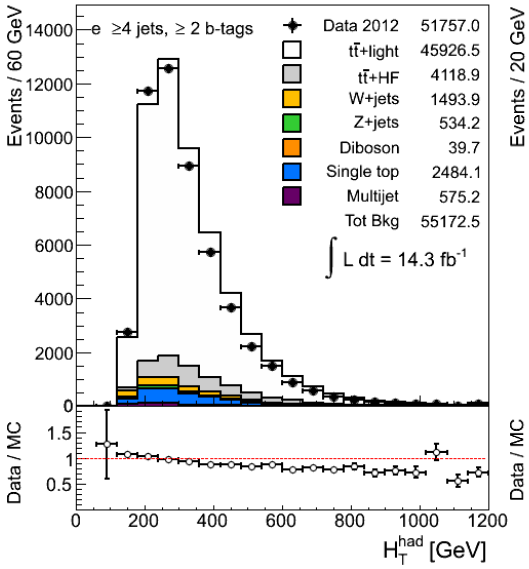


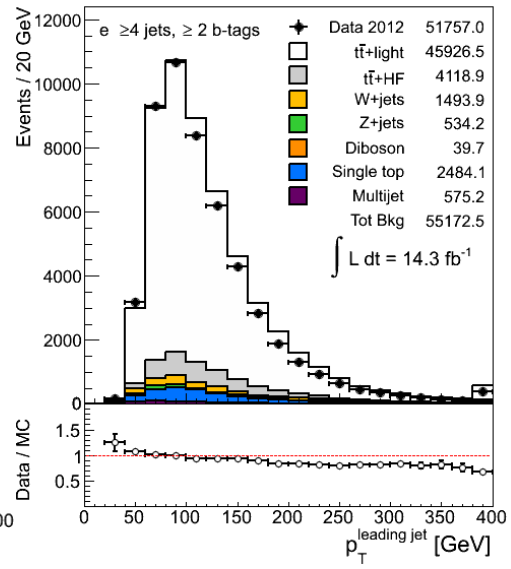


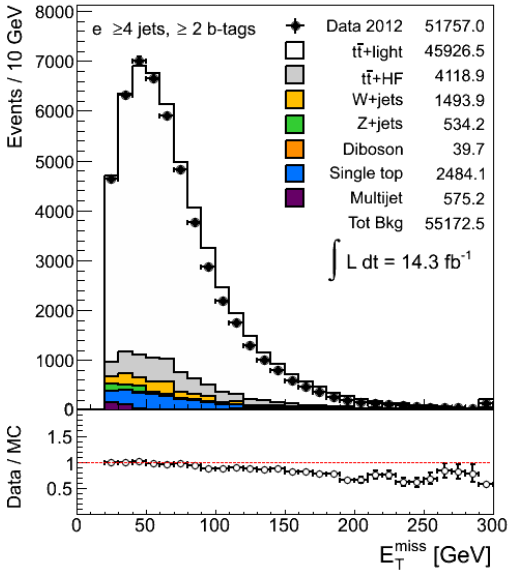
Comparison: ttbar control region

- Electron channel, 4jet inclusive, 2tag inclusive

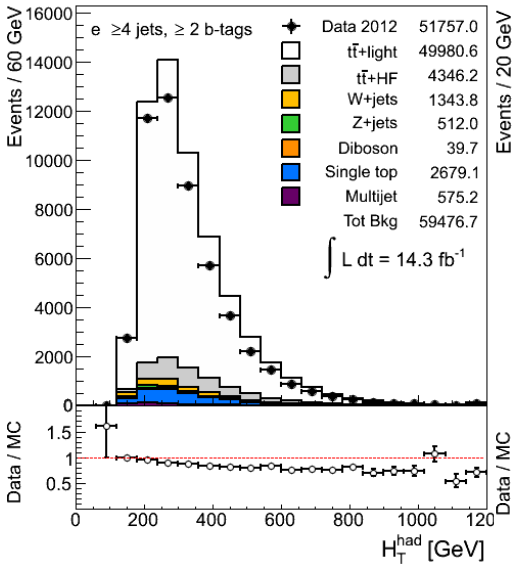
PtRel calibration

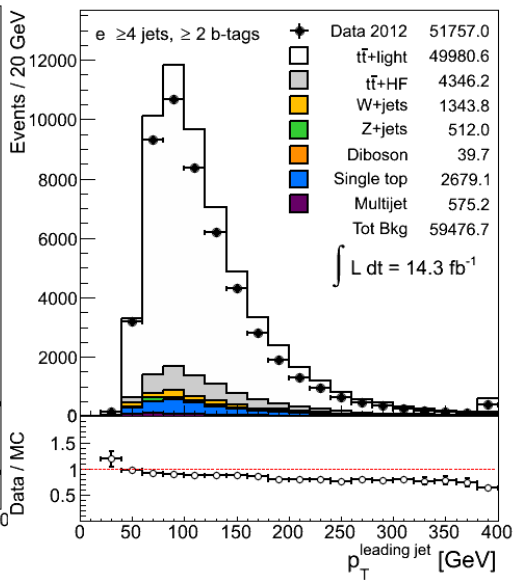


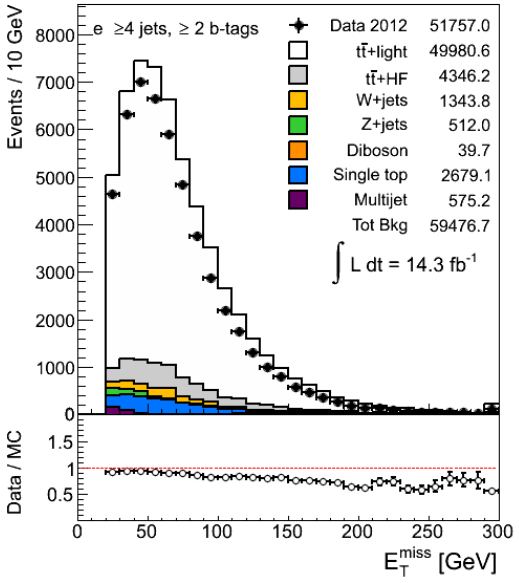




ttbar calibration

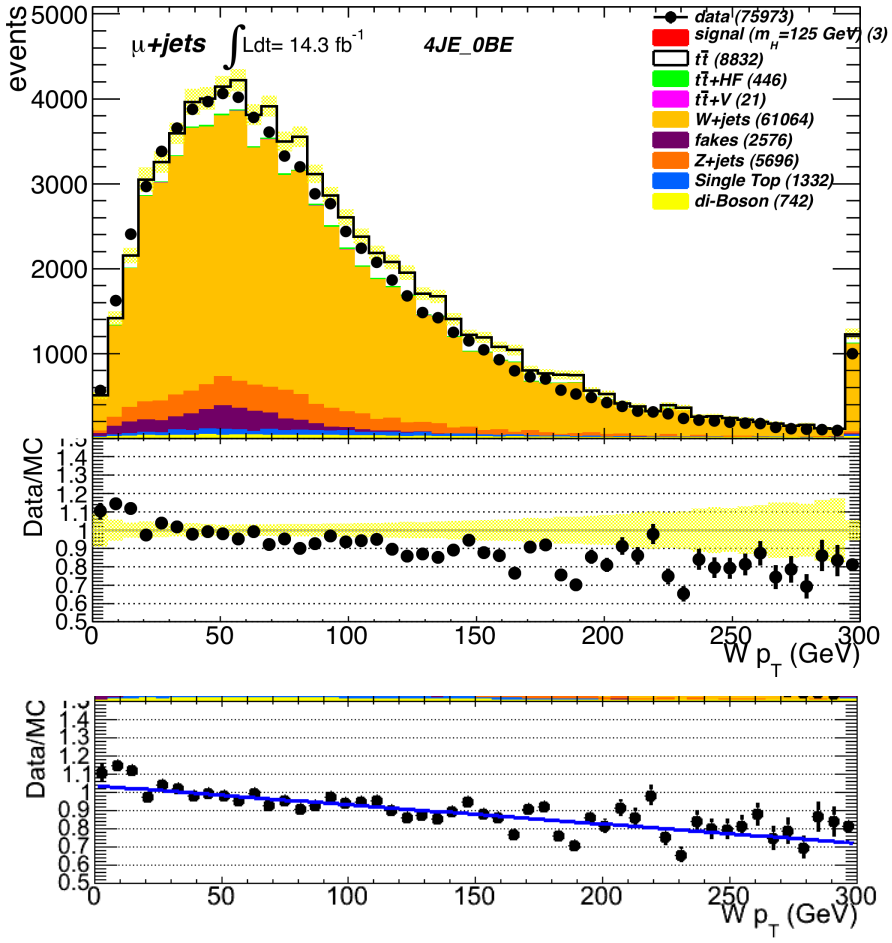




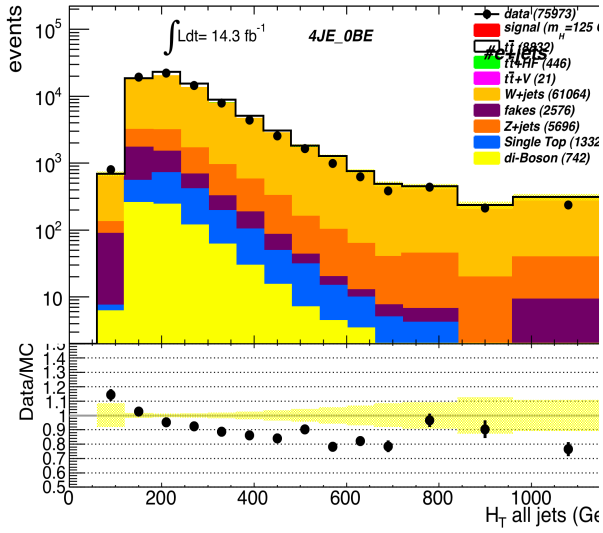


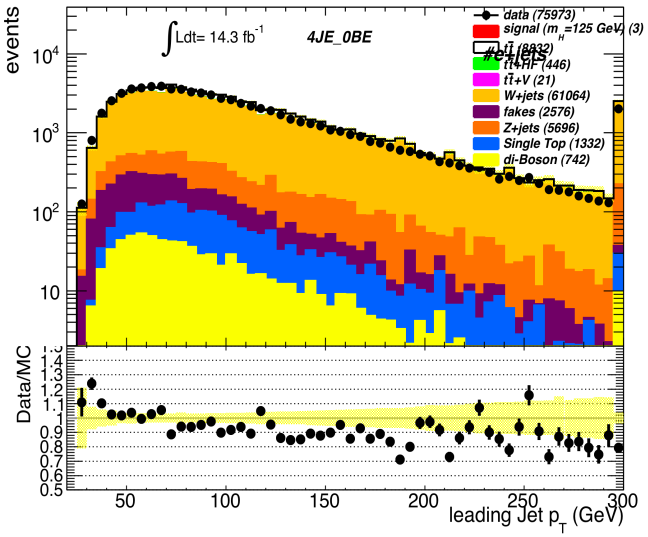
p_T^W reweighting

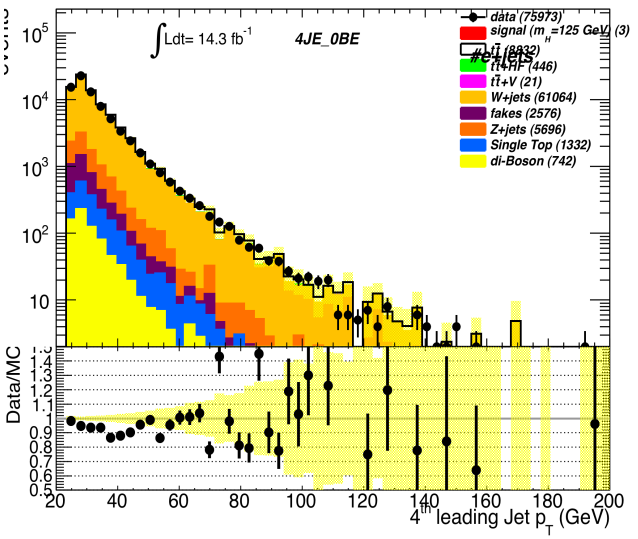
- 4 jet (exclusive) no b-tags
- Reweight p_T^W as done by VH analysis for HCP

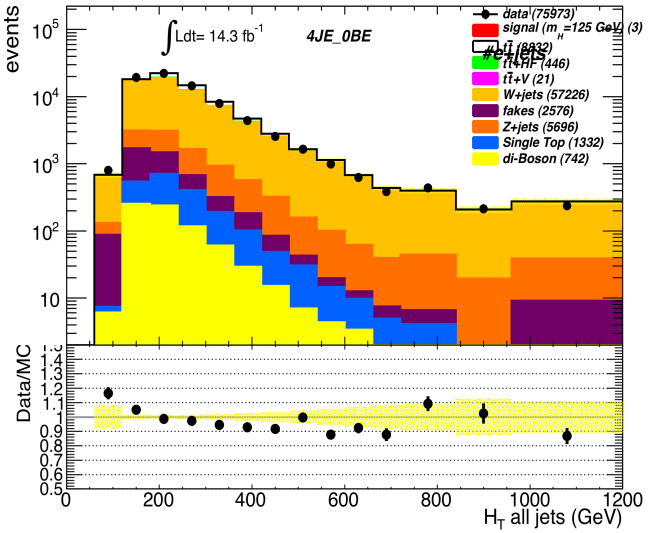


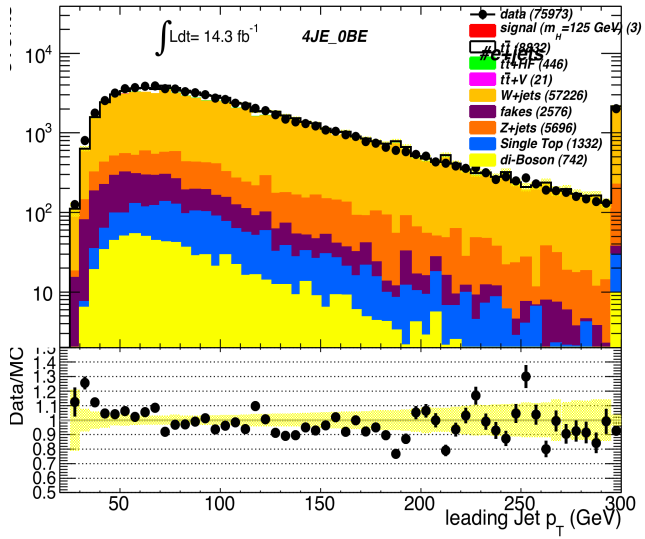
No reweight (up) , reweight (down)

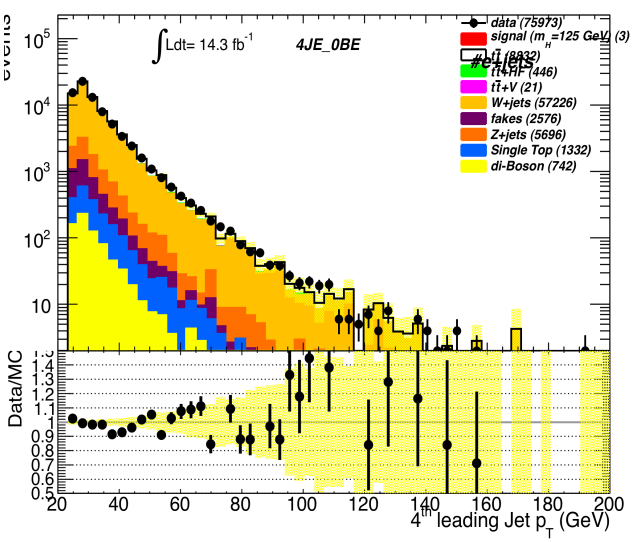






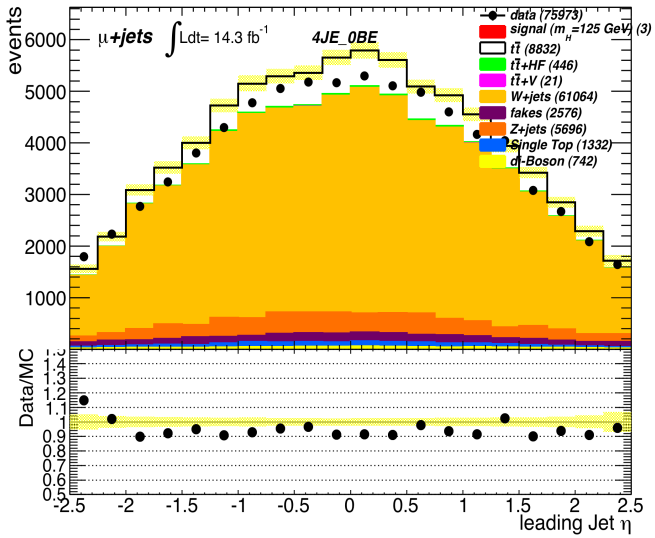


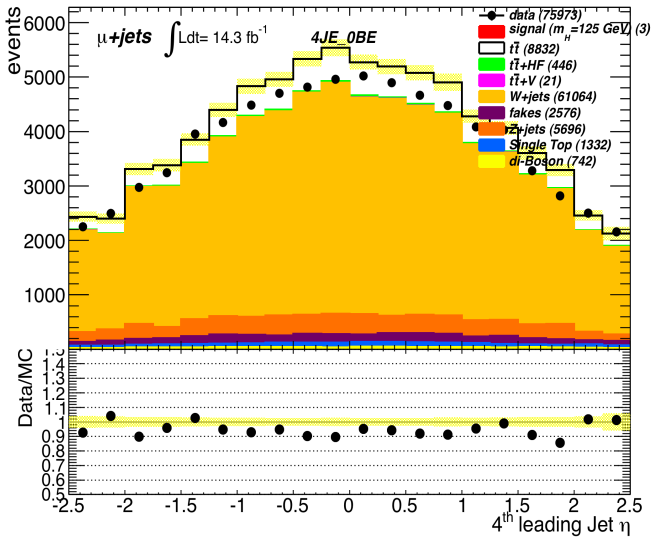


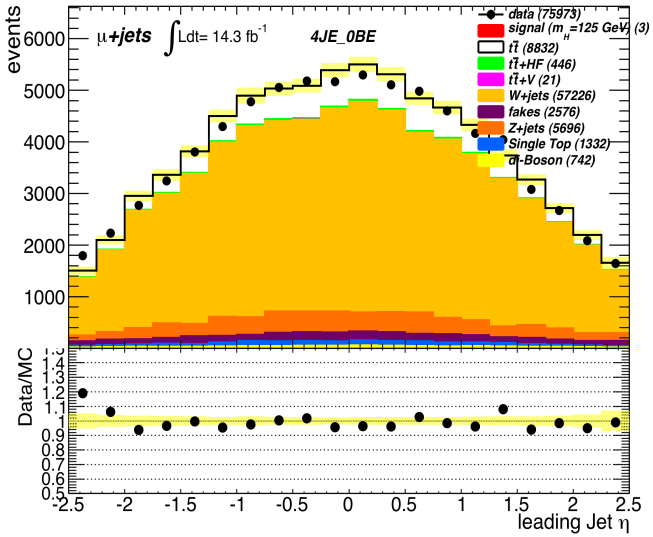


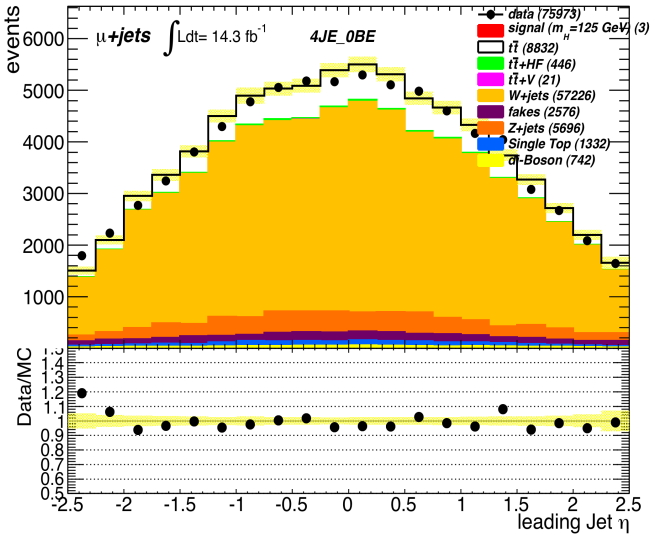
- Some improvement but features are still there

No reweight (up) , reweight (down)





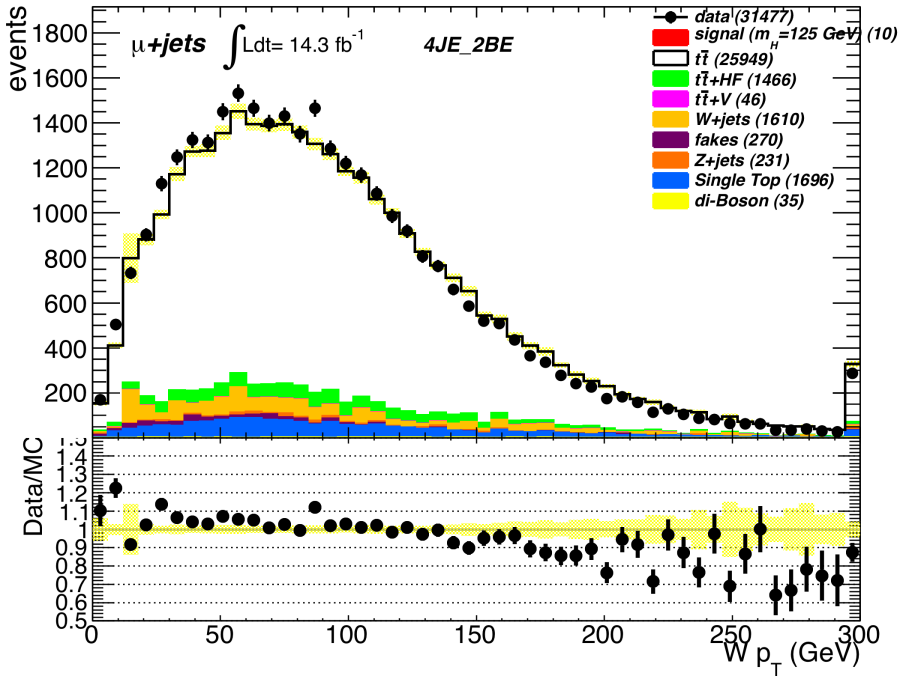




- Improvement in Jet eta …

Ttbar reweighting?

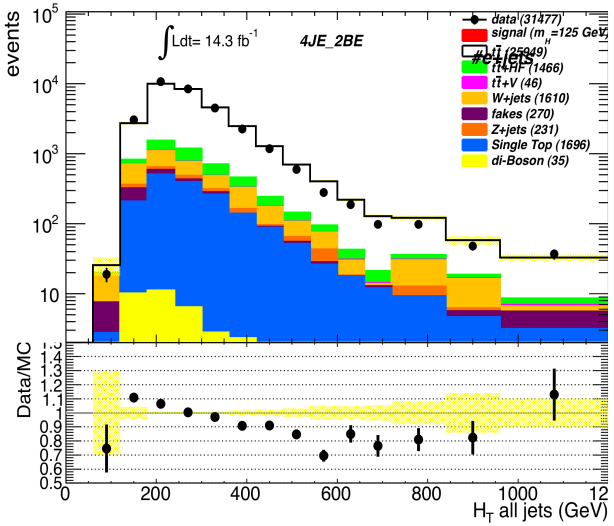
- In progress… we want to test it to see what we get
- BUT not clear we should do it when we use the modeling nuisance parameters from Alpgen

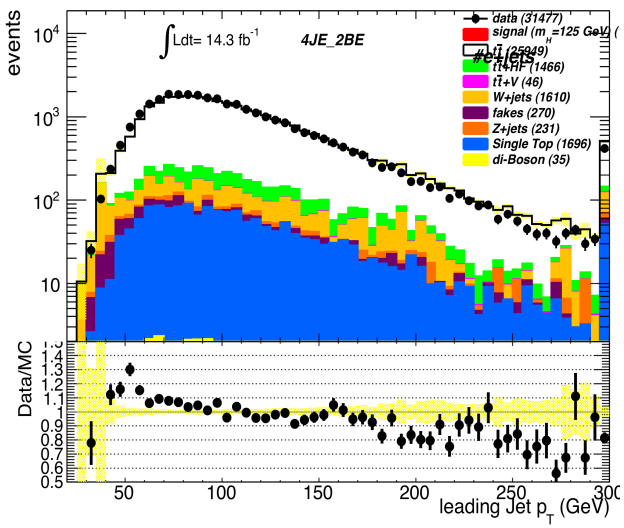


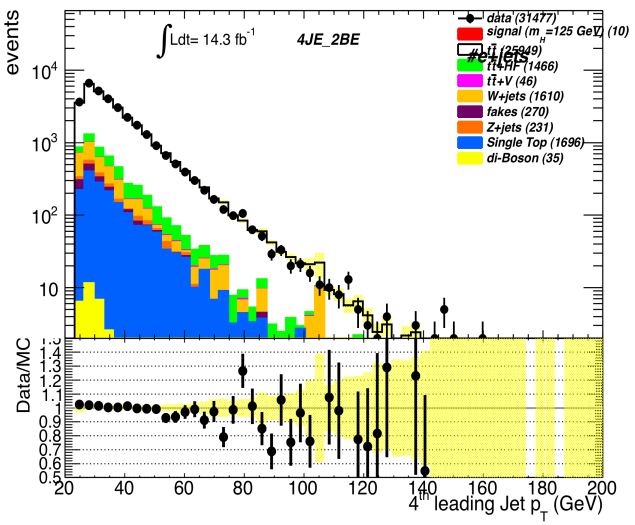
Do we see this in VH analysis?

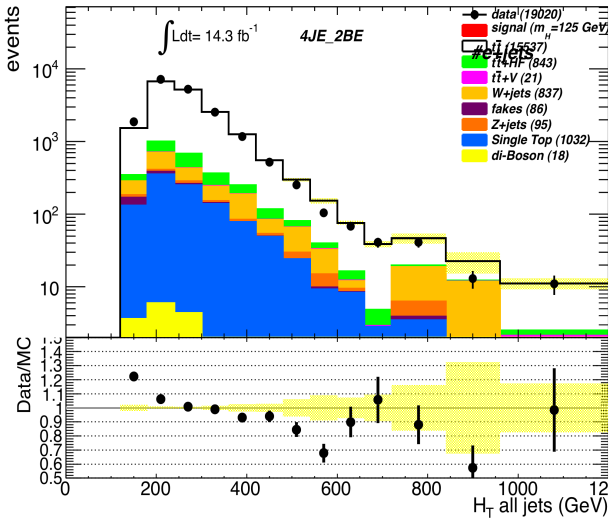
pT bin	0-60	60-120	120-160	160-200	>200
MET	>25	>25	>25	>25	>50
MTW	>40	>40	>40	-	-
MTW	<120	<120	<120	<120	<120
DeltaR(b.b)	>0.7	>0.7	>0.7	>0.7	-
DeltaR(b,b)	-	-	< 1.9	<1.7	<1.5

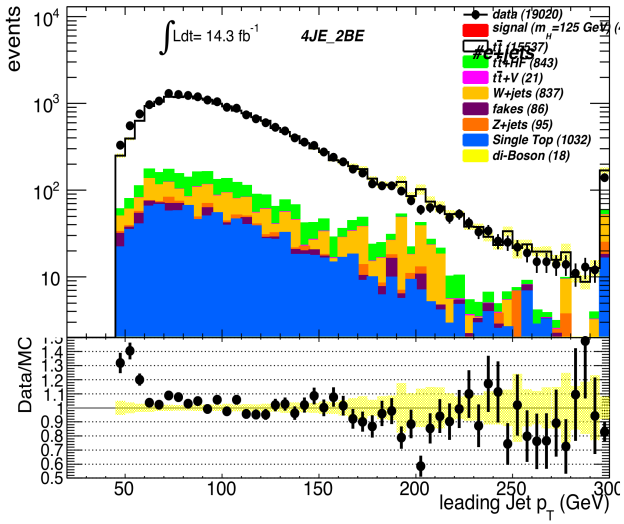
ttH cuts (top)/ VH cuts (bottom)

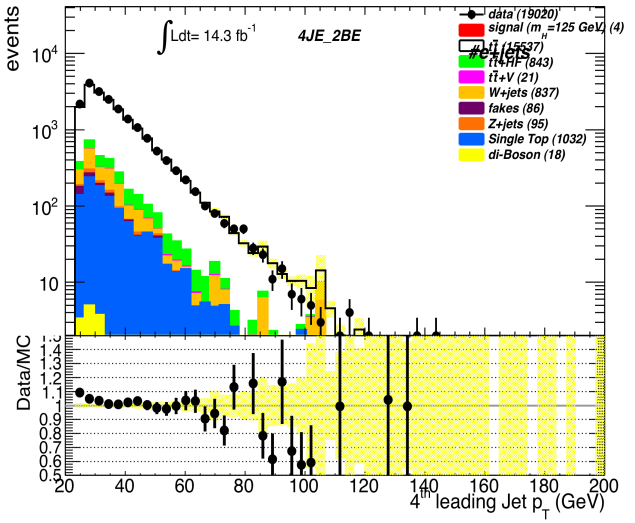










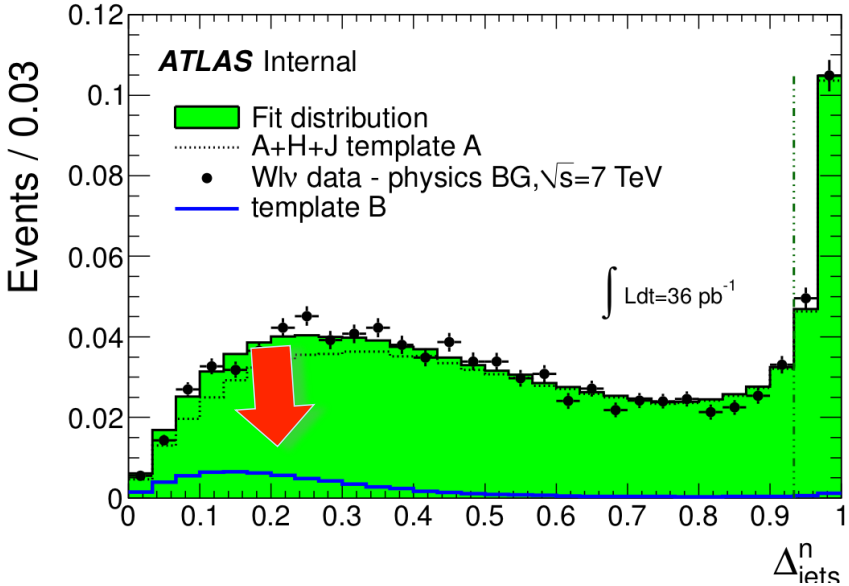


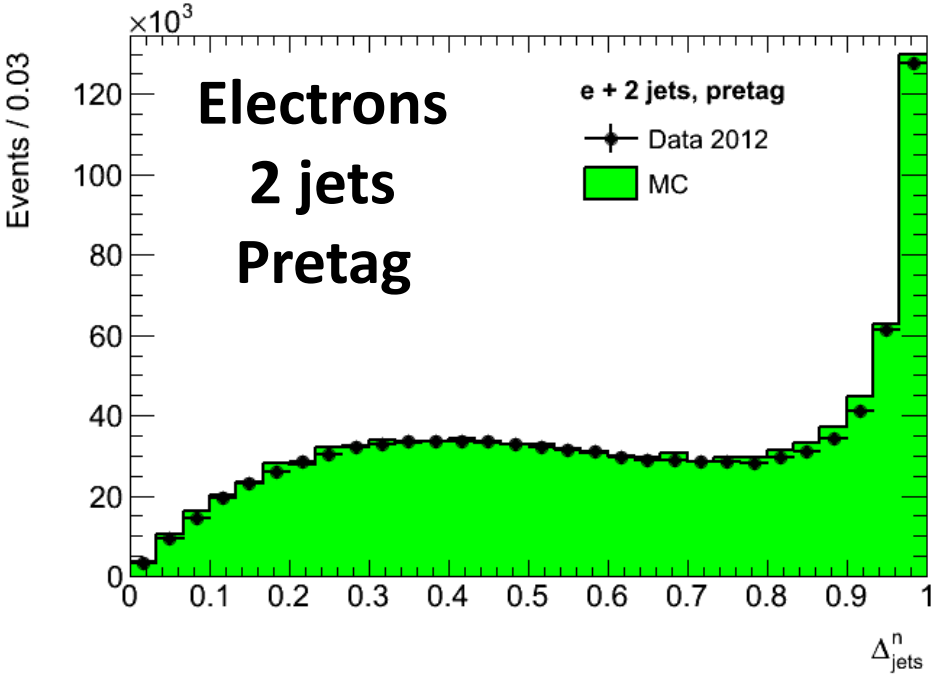
- Can't tell if it's really better (low jet pt can be QCD)

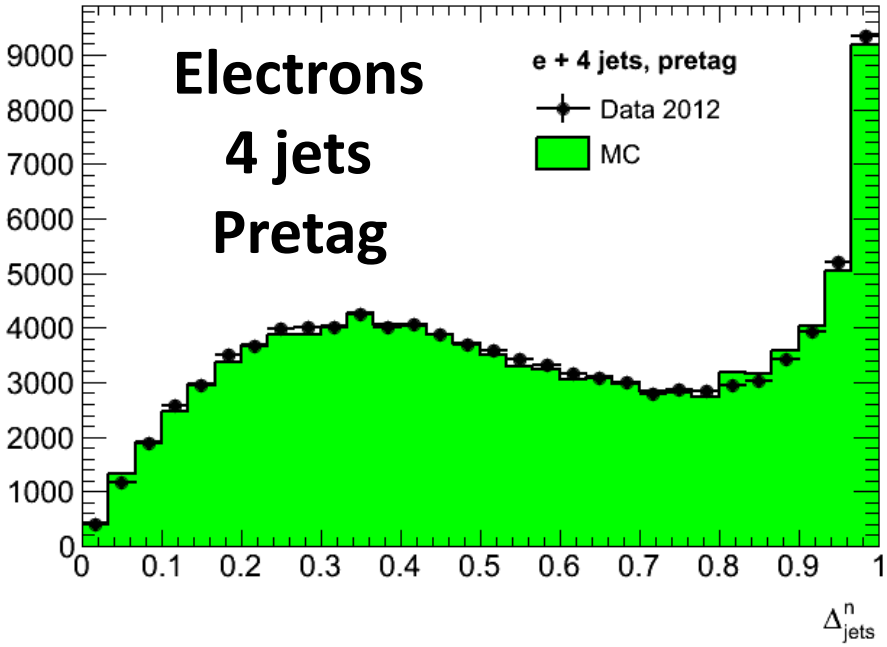
MultiParton Interaction Study

STDM-2012-11: http://cdsweb.cern.ch/record/1456092

- Two independent scattering
- 2 parton pairs: W, dijet.
- ∀ $\Delta_{jets}=|\mathbf{p}_{T1}-\mathbf{p}_{T2}|/|\mathbf{p}_{T1}|+|\mathbf{p}_{T2}|$
- JES ≈cancels, should be 0
- No indication of missing contribution in e+2jet.

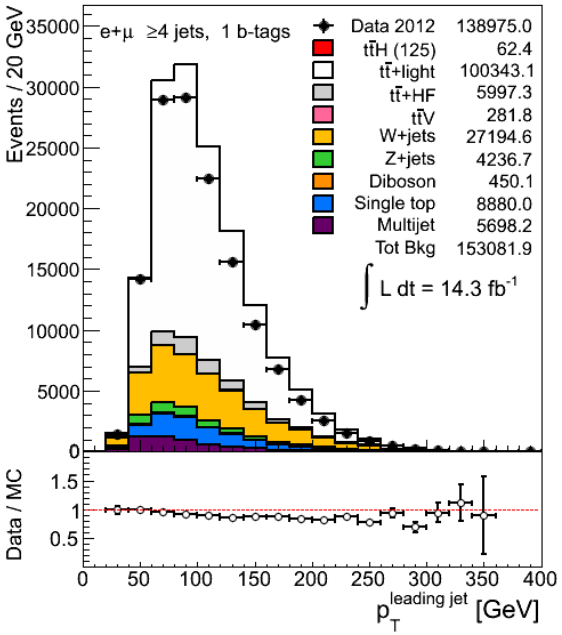


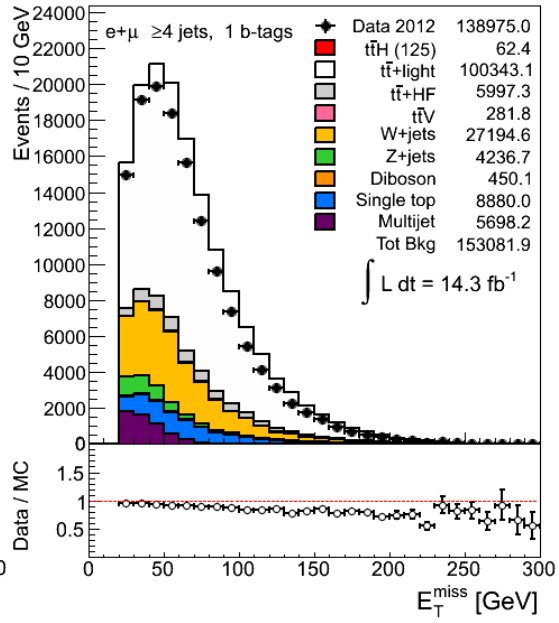


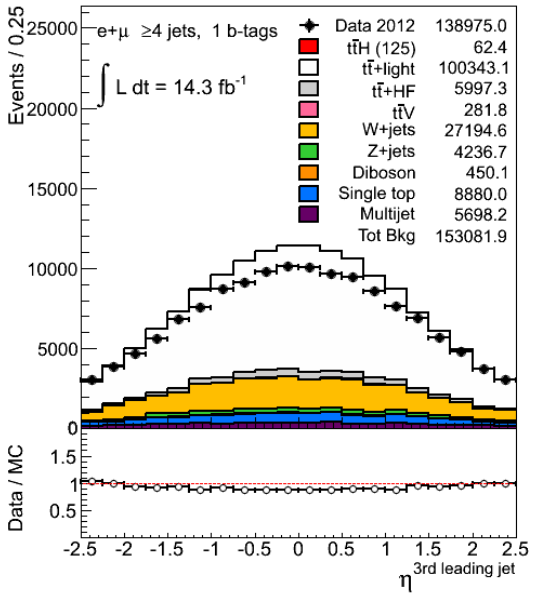


LC jets vs EM+JES

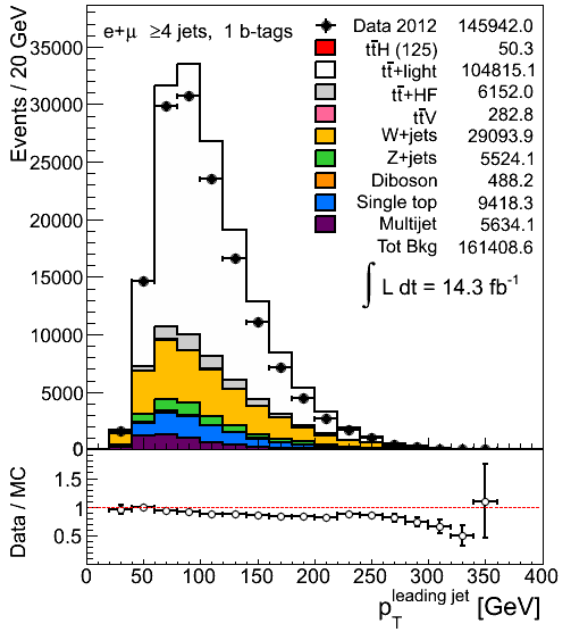
- EM+JES seem to give better description of data, but same features as LC

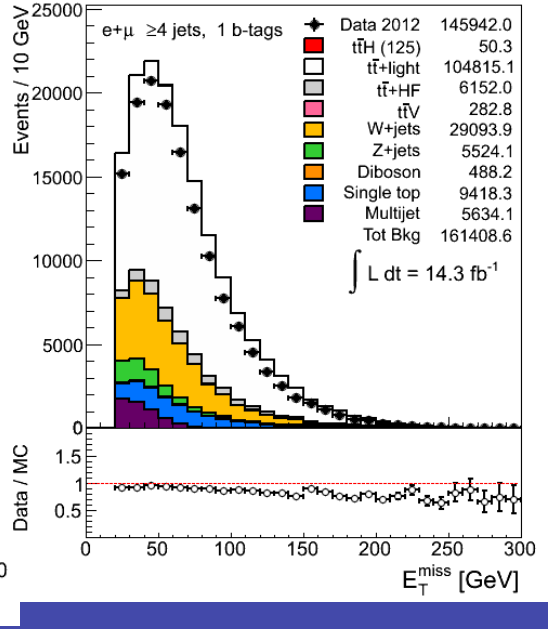


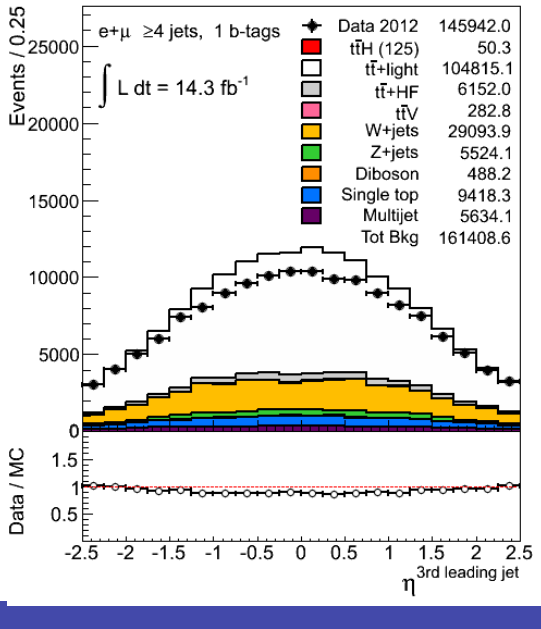




.C jets







M+JES

ts

Old fit result

Nuisance par	$\alpha \pm \Delta\alpha$
QCDnorm_corr	+3.88 ± +0.257
QCD_5jetex2btagex	-0.192 ± +0.95
QCD_5jetex3btagex	+0.04 ± +0.952
QCD_5jetex4btagin	+0.0602 ± +0.966
QCD_6jetin2btagex	+0.0357 ± +0.956
QCD_6jetin3btagex	+0.04 ± +0.961
QCD_6jetin4btagin	-0.00606 ± +0.969
iqopt2	-0.812 ± +0.59
qfac	+0.285 ± +0.959
ktfac	-0.418 ± +0.656
BTAGBREAK8	-0.166 ± +0.113
BTAGBREAK7	-2.05 ± +0.44
BTAGBREAK6	-0.366 ± +0.99
BTAGBREAK5	-1.75 ± +0.784
BTAGBREAK4	+0.663 ± +0.758
BTAGBREAK3	+0.616 ± +0.818
BTAGBREAK2	+0.263 ± +1.02
BTAGBREAK1	+0.0334 ± +0.997
BTAGBREAK0	-0.613 ± +0.988
CTAGBREAK4	+0.662 ± +0.544
CTAGBREAK3	+0.0264 ± +0.862
CTAGBREAK2	+0.0849 ± +1
CTAGBREAK1	+1.34 ± +0.874
CTAGBREAK0	-0.782 ± +0.868
LTAG	+1.07 ± +0.608

Nuisance par	$\alpha \pm \Delta\alpha$
Lepton ID, Reco, Trigger	-0.0562 ± +0.599
JVFSF	+0.319 ± +0.87
JES	-0.182 ± +0.0882
Luminosity	-0.143 ± +0.83
WJETSHFCSCALE	-1.31 ± +0.637
WJETSHFLIGHTNORM	-0.581 ± +0.697
WJETSHFBBCCSCALE	-1.92 ± +0.619
WJETSHFBBCCNORM	-2.41 ± +0.642
ttbar_XS	-0.111 ± +0.323
Vjets_XS_jet6	+0.417 ± +0.976
Vjets_XS_jet56	-0.329 ± +0.93
Vjets_XS_jet456	-0.404 ± +0.0865
singleTop_XS	-0.301 ± +0.965
Dibosons_XS	+0.107 ± +0.979
ttbarV_XS	+0.123 ± +0.986

Changes

- Switched from a theoretical uncertainty in W+4jets production (48%) to the experimental one given by the charge asymmetry normalization
- Implemented latest prescription (from 7TeV) for W+HF systematics, they should be uncorrelated against Njets
- All systematics are shape+normalization
  - For simplicity JVFSF and Xtag were normalization only for the small backgrounds
- Introduced jet energy resolution
- Introduced the breakdown of JES into 8 components
- Rebinned the JES breakdown so that the relative error per bin is 2% or less
- Corrected a discrepancy in electron QCD in the forward region for 0tag
- Rescaled the MC for the missing luminosity (-3% muon, -0.5% electron)

New fit result

Nuisance par	$\alpha \pm \Delta\alpha$
QCDnormalization	+1.68 ± 0.29
LEPTONSYS	-0.43 ± 0.76
ttbarHF	-0.03 ± 0.25
iqopt2	-0.88 ± 0.77
qfac	-0.10 ± 0.86
ktfac	-0.22 ± 0.88
BTAGBREAK8	+0.34 ± 0.09
BTAGBREAK7	-1.23 ± 0.33
BTAGBREAK6	-0.02 ± 0.95
BTAGBREAK5	-1.55 ± 0.61
BTAGBREAK4	+1.09 ± 0.48
BTAGBREAK3	+0.22 ± 0.61
BTAGBREAK2	+0.07 ± 0.98
BTAGBREAK1	+0.04 ± 0.96
BTAGBREAK0	-0.15 ± 0.91
CTAGBREAK4	+0.03 ± 0.47
CTAGBREAK3	+0.27 ± 0.57
CTAGBREAK2	-0.42 ± 0.96
CTAGBREAK1	+0.16 ± 0.87
CTAGBREAK0	-0.73 ± 0.90
LTAG	-0.63 ± 0.82
JVFSF	-2.20 ± 0.48
JER	+0.43 ± 0.13

Nuisance par	$\alpha \pm \Delta\alpha$
JESBREAK8	-0.90 ± 0.30
JESBREAK7	+0.05 ± 0.15
JESBREAK6	+0.36 ± 0.16
JESBREAK5	+0.05 ± 0.49
JESBREAK4	+0.66 ± 0.44
JESBREAK3	+0.44 ± 0.46
JESBREAK2	+0.05 ± 0.38
JESBREAK1	-0.23 ± 0.06
ttbar_XS	-0.06 ± 0.12
Luminosity	-0.61 ± 0.73
WJETS-C6	+0.07 ± 0.99
WJETS-BBCC6	+0.14 ± 0.94
WJETS-BBCCC	+0.01 ± 0.44
WJETS-BBCC	-0.28 ± 0.25
WJETS-CAN	-0.60 ± 0.21
Wjets_XS_jet6	+0.47 ± 0.93
Zjets_XS_jet6	+0.11 ± 0.99
Zjets_XS_jet56	-0.32 ± 0.95
singleTop_XS	-0.27 ± 0.67
Dibosons_XS	+0.05 ± 1.00
ttbarV_XS	+0.12 ± 0.99
WJETS-C5	-0.39 ± 0.97
WJETS-BBCC5	-2.20 ± 0.79
WJETS-C4	-1.55 ± 0.69
WJETS-BBCC4	-0.47 ± 0.41

Electron vs Muon

Electron	
Nuisance par	$\alpha \pm \Delta\alpha$
QCDnormalization	+0.43 ± 0.24
LEPTONSYS	-0.56 ± 0.67
ttbarHF	+0.66 ± 0.25
iqopt2	-1.06 ± 0.81
qfac	-0.13 ± 0.98
ktfac	-0.34 ± 0.90
BTAGBREAK8	+0.30 ± 0.13
BTAGBREAK7	-1.12 ± 0.30
BTAGBREAK6	+0.13 ± 0.96
BTAGBREAK5	-1.31 ± 0.72
BTAGBREAK4	+1.36 ± 0.54
BTAGBREAK3	-0.25 ± 0.69
BTAGBREAK2	-0.00 ± 0.96
BTAGBREAK1	+0.05 ± 0.95
BTAGBREAK0	-0.01 ± 0.89
CTAGBREAK4	-0.69 ± 0.72
CTAGBREAK3	-0.14 ± 0.93
CTAGBREAK2	-0.18 ± 0.95
CTAGBREAK1	-0.76 ± 0.92
CTAGBREAK0	-0.06 ± 0.93
LTAG	-0.21 ± 0.85
JVFSF	-1.04 ± 0.67
JER	+0.44 ± 0.15
JESBREAK8	-1.16 ± 0.42
JESBREAK7	+0.01 ± 0.53
JESBREAK6	+1.43 ± 0.44
JESBREAK5	+0.22 ± 0.52
JESBREAK4	-0.27 ± 0.64
JESBREAK3	-0.19 ± 0.79
JESBREAK2	-0.54 ± 0.50
JESBREAK1	-0.27 ± 0.34
ttbar_XS	-0.11 ± 0.16
Luminosity	-0.75 ± 0.61
WJETS-C6	+0.10 ± 0.97
WJETS-BBCC6	-0.18 ± 0.95
WJETS-BBCCC	-0.27 ± 0.39
WJETS-BBCC	-0.06 ± 0.33
WJETS-CAN	-0.54 ± 0.17
Wjets_XS_jet6	+0.23 ± 0.96
Zjets_XS_jet6	+0.14 ± 0.98
Zjets_XS_jet56	-0.37 ± 0.92
singleTop_XS	-0.20 ± 0.27
Dibosons_XS	-0.01 ± 0.98
ttbarV_XS	+0.07 ± 0.99
WJETS-C5	-0.28 ± 0.96
WJETS-BBCC5	-1.26 ± 0.90
WJETS-C4	-0.56 ± 0.22
WJETS-BBCC4	-0.73 ± 0.57

Muon	
Nuisance par	$\alpha \pm \Delta\alpha$
QCDnormalization	+1.68 ± 0.42
LEPTONSYS	-0.15 ± 0.98
ttbarHF	+0.14 ± 0.71
iqopt2	-0.47 ± 0.62
qfac	+0.04 ± 0.98
ktfac	+0.48 ± 0.82
BTAGBREAK8	+0.47 ± 0.14
BTAGBREAK7	-1.30 ± 0.47
BTAGBREAK6	-0.21 ± 0.97
BTAGBREAK5	-1.21 ± 0.69
BTAGBREAK4	+0.72 ± 0.74
BTAGBREAK3	+0.31 ± 0.73
BTAGBREAK2	+0.18 ± 0.97
BTAGBREAK1	-0.05 ± 0.96
BTAGBREAK0	-0.29 ± 0.93
CTAGBREAK4	+0.99 ± 0.71
CTAGBREAK3	+0.07 ± 0.88
CTAGBREAK2	-0.19 ± 0.97
CTAGBREAK1	+1.11 ± 0.89
CTAGBREAK0	-1.32 ± 0.92
LTAG	+0.30 ± 0.86
JVFSF	-2.99 ± 0.79
JER	+0.51 ± 0.12
JESBREAK8	-1.20 ± 0.41
JESBREAK7	-0.06 ± 0.10
JESBREAK6	+0.48 ± 0.29
JESBREAK5	+0.10 ± 0.49
JESBREAK4	-0.02 ± 0.40
JESBREAK3	+0.30 ± 0.42
JESBREAK2	+0.13 ± 0.31
JESBREAK1	+0.01 ± 0.25
ttbar_XS	+0.10 ± 0.45
Luminosity	-0.21 ± 0.96
WJETS-C6	-0.01 ± 0.99
WJETS-BBCC6	+0.10 ± 0.95
WJETS-BBCCC	-0.21 ± 0.63
WJETS-BBCC	-0.38 ± 0.59
WJETS-CAN	-1.26 ± 0.55
Wjets_XS_jet6	+0.14 ± 0.94
Zjets_XS_jet6	+0.06 ± 0.99
Zjets_XS_jet56	-0.07 ± 0.98
singleTop_XS	-0.08 ± 0.97
Dibosons_XS	+0.11 ± 0.99
ttbarV_XS	+0.04 ± 0.99
WJETS-C5	-0.23 ± 0.98
WJETS-BBCC5	-1.77 ± 0.82
WJETS-C4	-1.19 ± 0.78
WJETS-BBCC4	-0.43 ± 0.72

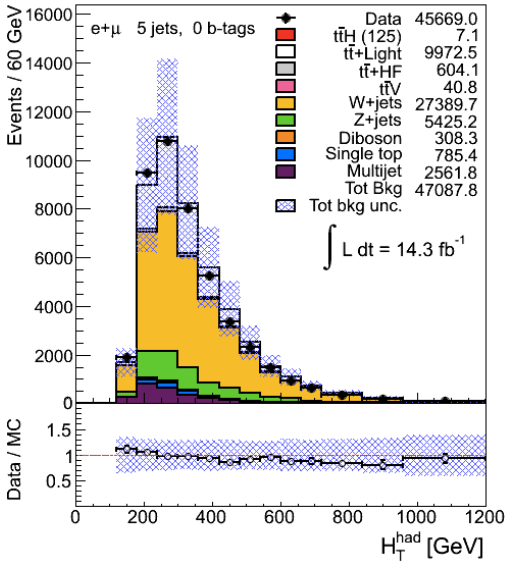
Electron vs Muon

Electron	
Nuisance par	$\alpha \pm \Delta\alpha$
QCDnormalization	+0.43 ± 0.24
LEPTONSYS	-0.56 ± 0.67
ttbarHF	+0.66 ± 0.25
iqopt2	-1.06 ± 0.81
qfac	-0.13 ± 0.98
ktfac	-0.34 ± 0.90
BTAGBREAK8	+0.30 ± 0.13
BTAGBREAK7	-1.12 ± 0.30
BTAGBREAK6	+0.13 ± 0.96
BTAGBREAK5	-1.31 ± 0.72
BTAGBREAK4	+1.36 ± 0.54
BTAGBREAK3	-0.25 ± 0.69
BTAGBREAK2	-0.00 ± 0.96
BTAGBREAK1	+0.05 ± 0.95
BTAGBREAK0	-0.01 ± 0.89
CTAGBREAK4	-0.69 ± 0.72
CTAGBREAK3	-0.14 ± 0.93
CTAGBREAK2	-0.18 ± 0.95
CTAGBREAK1	-0.76 ± 0.92
CTAGBREAK0	-0.06 ± 0.93
LTAG	-0.21 ± 0.85
JVFSF	-1.04 ± 0.67
JER	+0.44 ± 0.15
JESBREAK8	-1.16 ± 0.42
JESBREAK7	+0.01 ± 0.53
JESBREAK6	+1.43 ± 0.44
JESBREAK5	+0.22 ± 0.52
JESBREAK4	-0.27 ± 0.64
JESBREAK3	-0.19 ± 0.79
JESBREAK2	-0.54 ± 0.50
JESBREAK1	-0.27 ± 0.34
ttbar_XS	-0.11 ± 0.16
Luminosity	-0.75 ± 0.61
WJETS-C6	+0.10 ± 0.97
WJETS-BBCC6	-0.18 ± 0.95
WJETS-BBCCC	-0.27 ± 0.39
WJETS-BBCC	-0.06 ± 0.33
WJETS-CAN	-0.54 ± 0.17
Wjets_XS_jet6	+0.23 ± 0.96
Zjets_XS_jet6	+0.14 ± 0.98
Zjets_XS_jet56	-0.37 ± 0.92
singleTop_XS	-0.20 ± 0.27
Dibosons_XS	-0.01 ± 0.98
ttbarV_XS	+0.07 ± 0.99
WJETS-C5	-0.28 ± 0.96
WJETS-BBCC5	-1.26 ± 0.90
WJETS-C4	-0.56 ± 0.22
WJETS-BBCC4	-0.73 ± 0.57

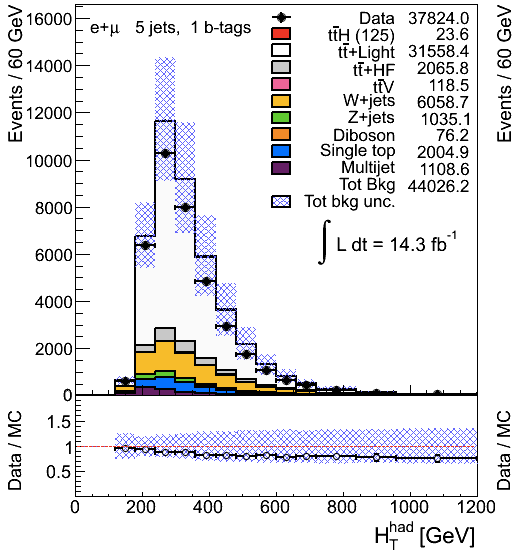
Muon	
Nuisance par	$\alpha \pm \Delta\alpha$
QCDnormalization	+1.68 ± 0.42
LEPTONSYS	-0.15 ± 0.98
ttbarHF	+0.14 ± 0.71
iqopt2	-0.47 ± 0.62
qfac	+0.04 ± 0.98
ktfac	+0.48 ± 0.82
BTAGBREAK8	+0.47 ± 0.14
BTAGBREAK7	-1.30 ± 0.47
BTAGBREAK6	-0.21 ± 0.97
BTAGBREAK5	-1.21 ± 0.69
BTAGBREAK4	+0.72 ± 0.74
BTAGBREAK3	+0.31 ± 0.73
BTAGBREAK2	+0.18 ± 0.97
BTAGBREAK1	-0.05 ± 0.96
BTAGBREAK0	-0.29 ± 0.93
CTAGBREAK4	+0.99 ± 0.71
CTAGBREAK3	+0.07 ± 0.88
CTAGBREAK2	-0.19 ± 0.97
CTAGBREAK1	+1.11 ± 0.89
CTAGBREAK0	-1.32 ± 0.92
LTAG	+0.30 ± 0.86
JVFSF	-2.99 ± 0.79
JER	+0.51 ± 0.12
JESBREAK8	-1.20 ± 0.41
JESBREAK7	-0.06 ± 0.10
JESBREAK6	+0.48 ± 0.29
JESBREAK5	+0.10 ± 0.49
JESBREAK4	-0.02 ± 0.40
JESBREAK3	+0.30 ± 0.42
JESBREAK2	+0.13 ± 0.31
JESBREAK1	+0.01 ± 0.25
ttbar_XS	+0.10 ± 0.45
Luminosity	-0.21 ± 0.96
WJETS-C6	-0.01 ± 0.99
WJETS-BBCC6	+0.10 ± 0.95
WJETS-BBCCC	-0.21 ± 0.63
WJETS-BBCC	-0.38 ± 0.59
WJETS-CAN	-1.26 ± 0.55
Wjets_XS_jet6	+0.14 ± 0.94
Zjets_XS_jet6	+0.06 ± 0.99
Zjets_XS_jet56	-0.07 ± 0.98
singleTop_XS	-0.08 ± 0.97
Dibosons_XS	+0.11 ± 0.99
ttbarV_XS	+0.04 ± 0.99
WJETS-C5	-0.23 ± 0.98
WJETS-BBCC5	-1.77 ± 0.82
WJETS-C4	-1.19 ± 0.78
WJETS-BBCC4	-0.43 ± 0.72

Pre- and Post-fit in validation regions: H_T

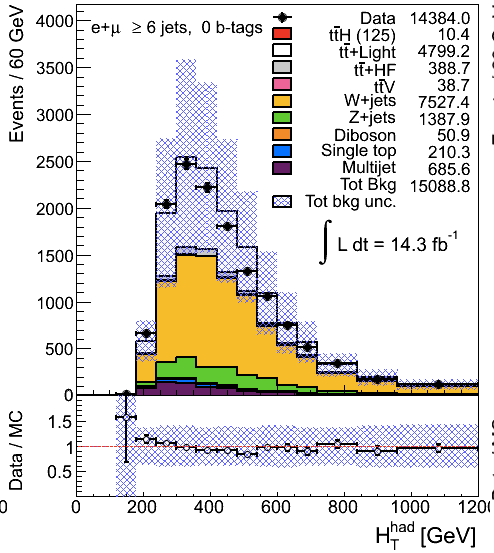
Pre-fit



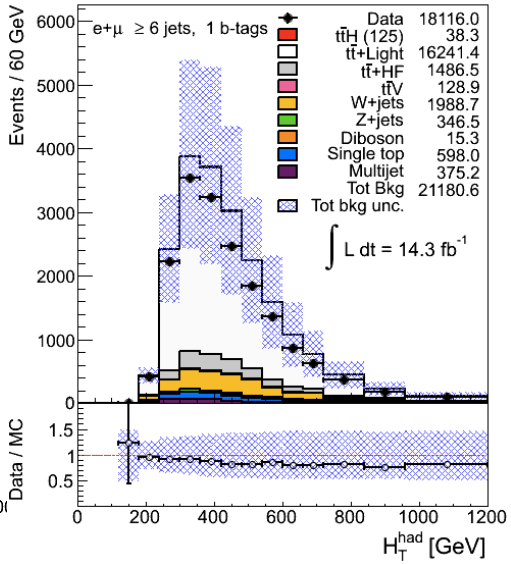
5 jets 0 btags



5 jets 1 btags

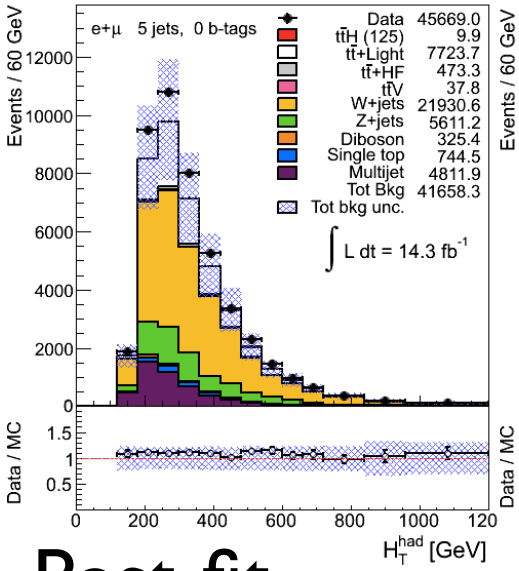


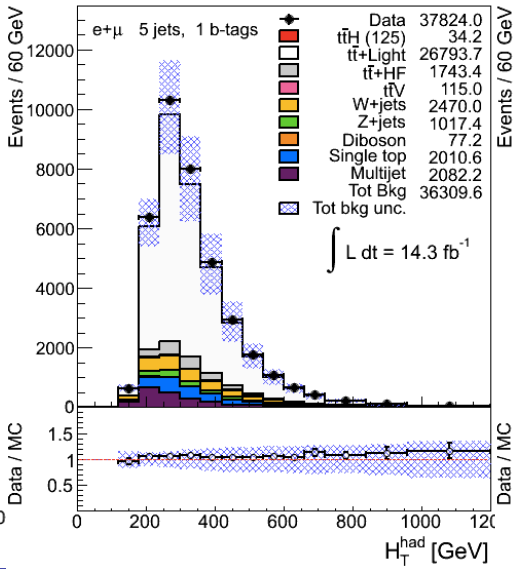
6 jets 0 btags

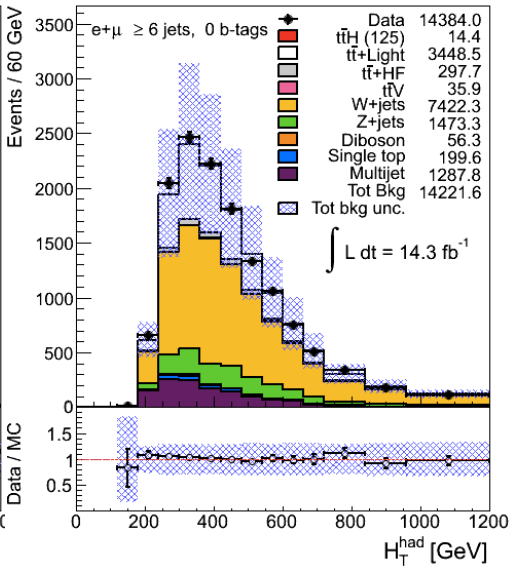


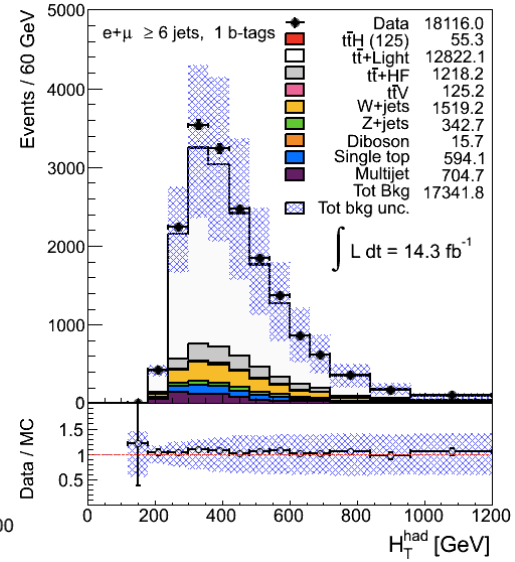
6 jets 1 btags

Post-fit









Further updates

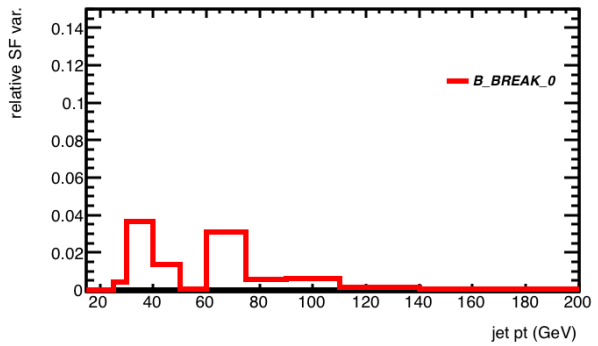
- Derive our own W+jets SF from 8TeV data
- Introduce Z+jets SF and uncertainty derived from the dilepton analysis
- Introduce the recent JVF SF derived for LCjets, there were only available for EMjets until recently.

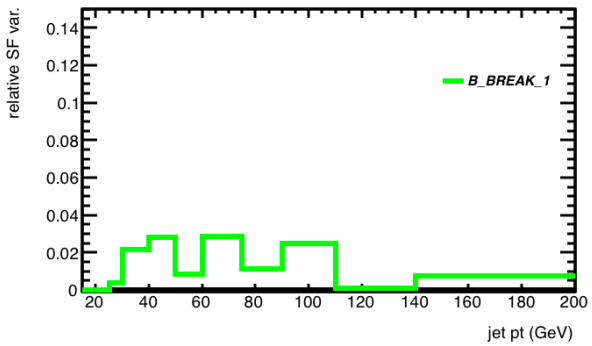
Conclusions

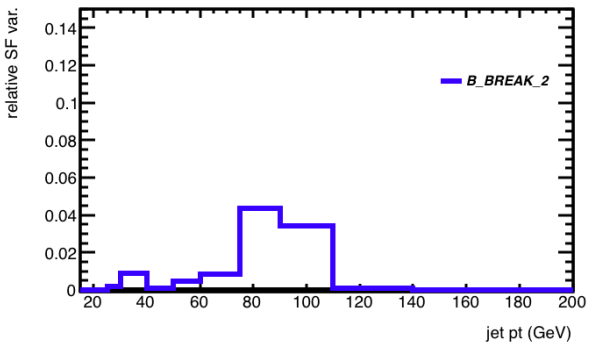
- Still stuck on HT problem
- Fits looking better
- To do (fits):
- p_T^W reweighting for 8TeV data
- Compare with Z+jets p_T^Z reweighting and uncertainty derived from the dilepton analysis
- Introduce the recent JVF SF derived for LCjets, there were only available for EM+JES jets until recently
- Other to-do:
- Run limits with MVA (easy once happy with SVA)

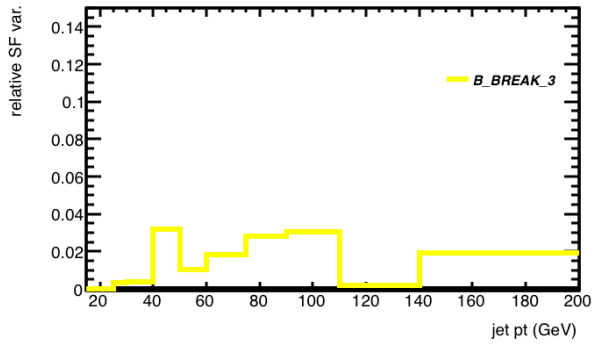
Backup

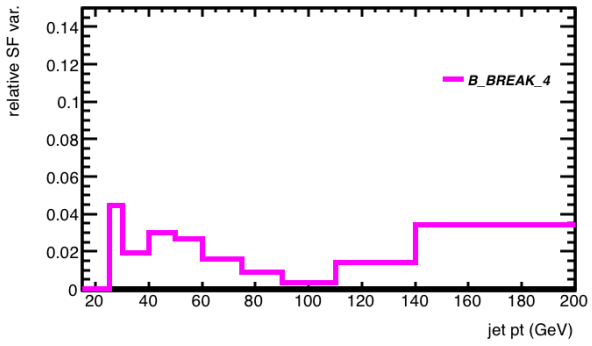
- B-tagging eigenvectors

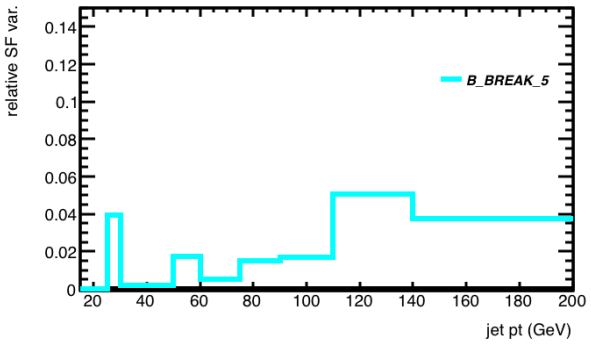


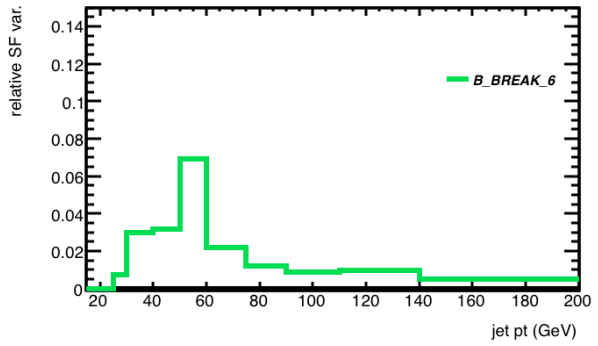


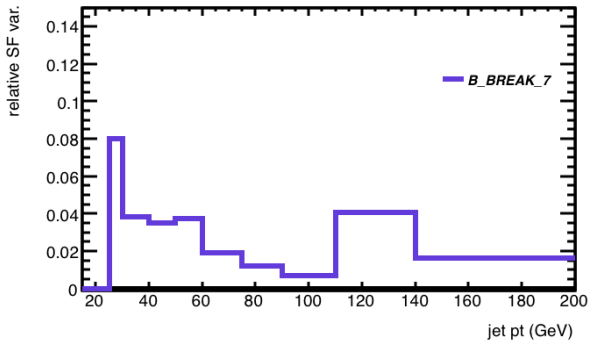


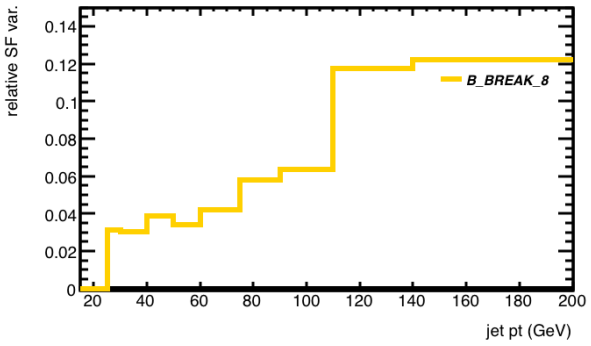












Backup

- C-tagging eigenvectors