

# VBF Higgs to Invisible - Update

AN-14-243

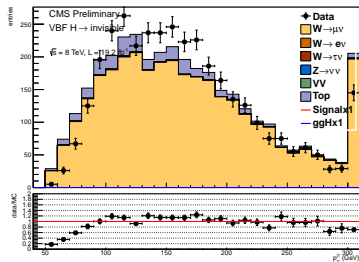
P. Dunne

## Introduction

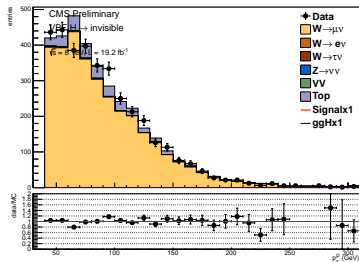
- ▶ Bug found which meant we weren't running properly over run C data:
  - meant background estimate was normalised only to part of the full luminosity
- ▶ Bug correction therefore increased background estimate
- ▶ Signal was already normalised to the full luminosity so didn't change
- ▶ Limit for old signal region is therefore worsened
- ▶ However increased background makes old signal region no longer optimum

## Check Data-MC - munu

### Jet 1 pt

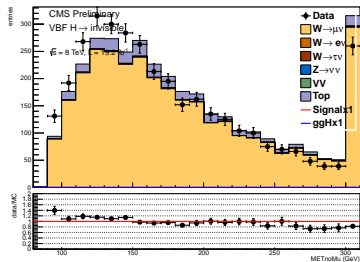


### Jet 2 pt

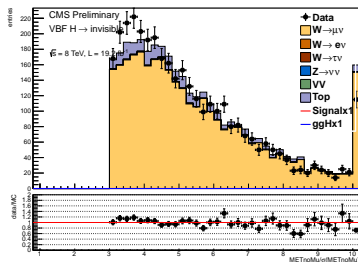


## Check Data-MC - munu

### METnomu

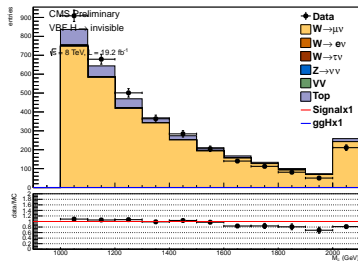


### METnomusig

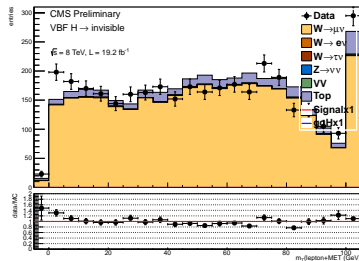


## Check Data-MC - munu

Mjj

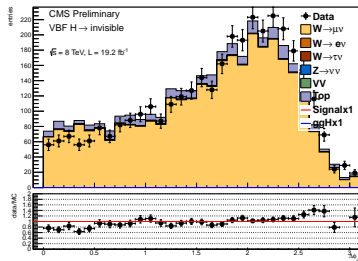


mt

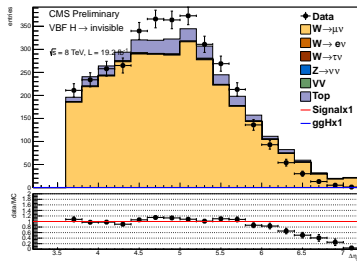


## Check Data-MC - munu

### Dijet Dphi

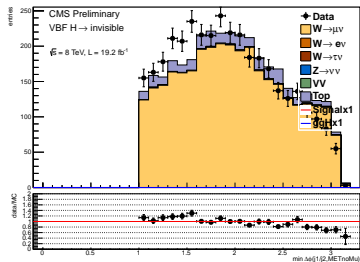


### Detajj

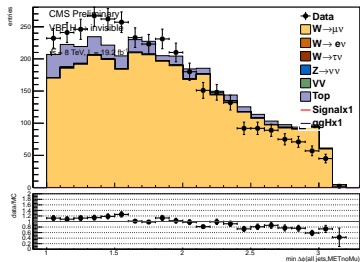


## Check Data-MC - munu

### Leading jets-met mindphi

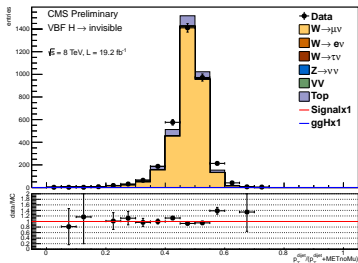


### All jets-met mindphi



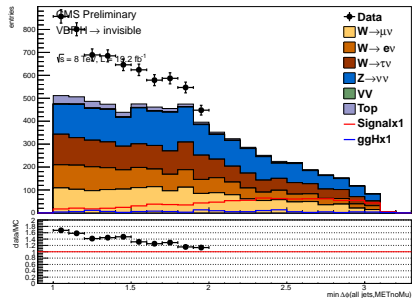
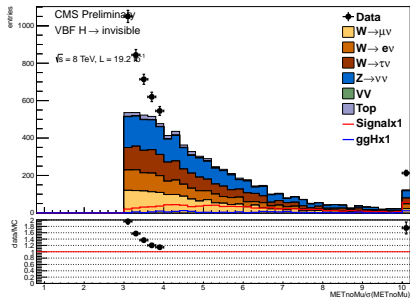
## Check Data-MC - munu

### dijet-metnomu pt fraction





## Check Data-MC -signal



## Signal region selection

- ▶ Redo signal region optimisation
- ▶ Start from “optimisation region”
  - Trigger driven presel +  $\text{metsig} > 4$  and  $\text{jetmetmindphi} > 2.0'$
- ▶ Scan through mjj, j2pt, jetmetmindphi and metsig
- ▶ Pick region with best expected limit
- ▶ All numbers use old QCD estimate - to be updated this week

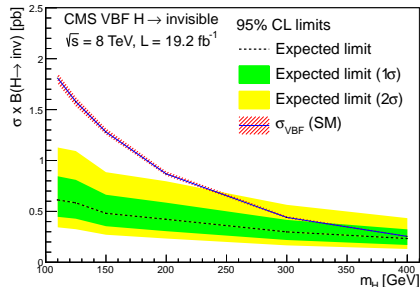
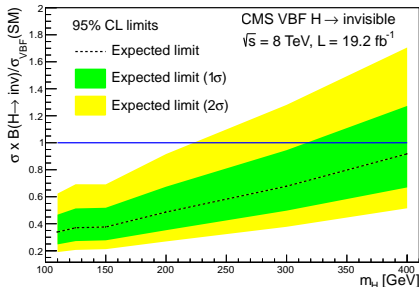
jetmetmindphi	cut	2.0	2.2	2.3	2.4
	limit	51.4	37.1	41.6	42.3
mjj	cut	1000	1100	1200	1300
	limit	41.6	38.8	37.8	40.0
j2pt	cut	40	45	50	55
	limit	37.8	37.0	37.4	38.8
metsig	cut	4.0	4.2	4.5	
	limit	37.0	37.6	39.1	

## Results

Background	$N_{est} \pm (stat) \pm (syst)$
$Z \rightarrow \nu\nu$	$157.315 \pm 37.5734 \pm 38.2847$
$W \rightarrow \mu\nu$	$101.017 \pm 6.11334 \pm 11.6106$
$W \rightarrow e\nu$	$54.7915 \pm 7.01662 \pm 6.03872$
$W \rightarrow \tau\nu$	$98.525 \pm 13.2759 \pm 25.1965$
top	$4.43021 \pm 0.980423 \pm 1.4235$
VV	$3.83666 \pm 0 \pm 0.701872$
QCD multijet	$14 \pm 0 \pm 10$
Total Background	$433.916 \pm 40.9338 \pm 54.0319$
Signal(VBF)	$273.375 \pm 0 \pm 31.1987$
Signal(ggH)	$22.5697 \pm 0 \pm 15.6106$

## Expected limits

- ▶ Ran all mass points for new signal region
- ▶ 95% C.L. Median limit on  $B(H \rightarrow \text{inv.})$  for  $m_H = 125$  GeV is: **37%**
- ▶ If QCD also goes up by 50% from 14 to 21 the limit would be 37.5%
  - assuming QCD relative error stays the same
- ▶ If QCD doubled to 28 limit would be 38%, if it quadrupled to 56 limit would be 41%



## Uncertainty impact table - impacts larger than 0%

Median expected limit with:	All Nuisances: 37.0%,	No Nuisances: 14.2%
Nuisance	Removal Effect	Addition effect
CMS_eff_m:	-0.5%	4.8%
CMS_scale_j:	-5.8%	9.6%
CMS_VBFHinv_zvv_norm:	-2.6%	24.7%
CMS_VBFHinv_zvv_stat:	-12.7%	67.0%
CMS_VBFHinv_wmu_norm:	-1.1%	6.2%
CMS_VBFHinv_wmu_stat:	-0.5%	3.4%
CMS_VBFHinv_wel_norm:	-0.5%	2.7%
CMS_VBFHinv_wel_stat:	-0.5%	4.1%
CMS_VBFHinv_tau_eff:	-0.5%	5.5%
CMS_VBFHinv_tau_extrapfacunc:	-4.2%	24.7%
CMS_VBFHinv_wtau_norm:	-1.6%	11.7%
CMS_VBFHinv_wtau_stat:	-2.1%	13.7%
CMS_VBFHinv_zvv_extrapfacunc:	-8.7%	53.3%
CMS_VBFHinv_qcd_norm:	-1.1%	4.8%

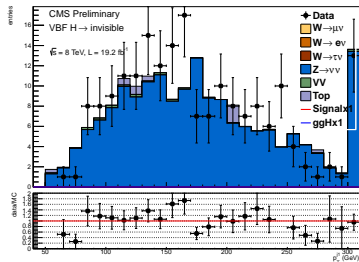
## Summary

- ▶ Bug found and fixed
- ▶ New expected limit is 37%
- ▶ AN updated apart from QCD
- ▶ Still need to answer Paolo's questions about the source of the gain
  - Will run light trees with prompt data and apply new selection
  - Should take 1-2 days

## Backup

## New control plots - mumu

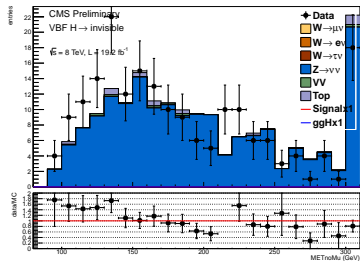
Jet 1 pt



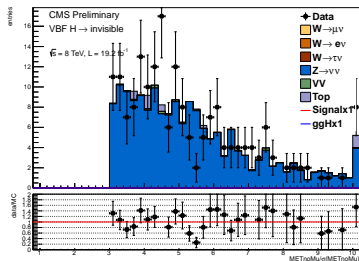


## New control plots - mumu

### MET<sub>nomu</sub>

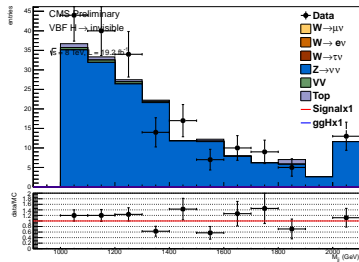


### MET<sub>nomu</sub>sig

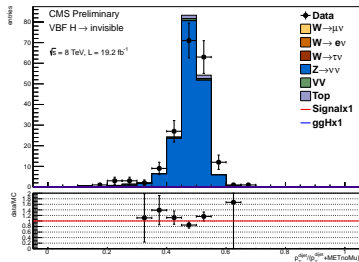


## New control plots - mumu

Mjj

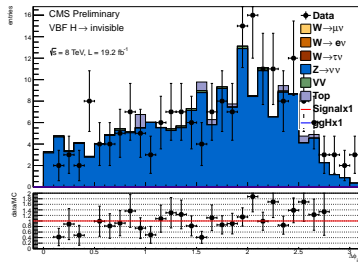


dijet-metnomu pt fraction

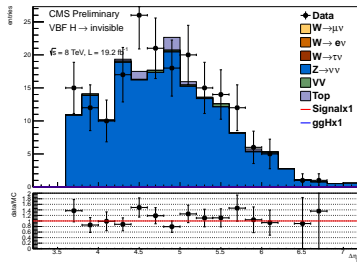


## New control plots -mumu

### Dphi\_jj

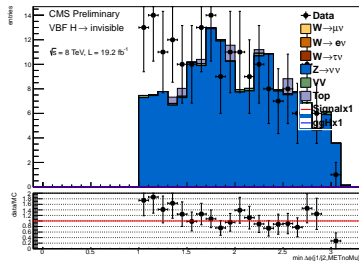


### Delta\_jj

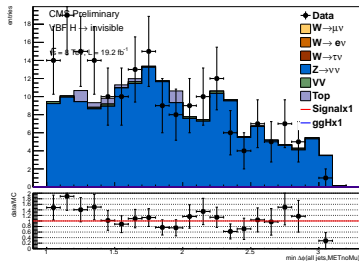


## New control plots -mumu

### Leading jets-met mindphi

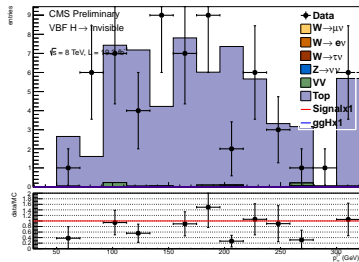


### All jet-met mindphi

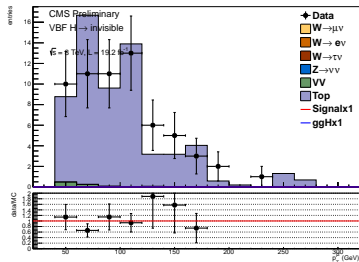


## New control plots - top

### Jet 1 pt

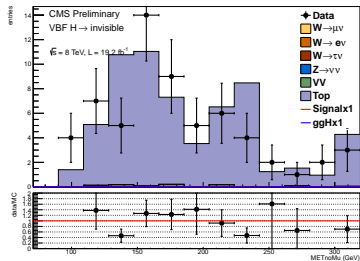


### Jet 2 pt

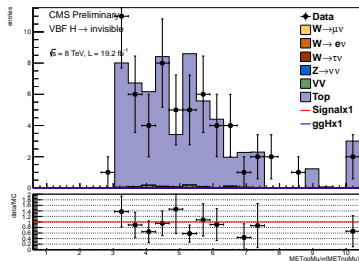


## New control plots - top

MET<sub>nomu</sub>

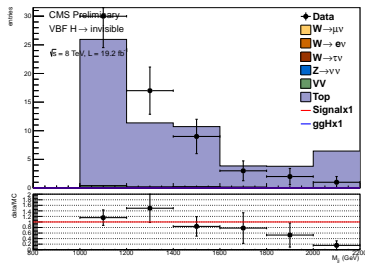


MET<sub>nomusig</sub>

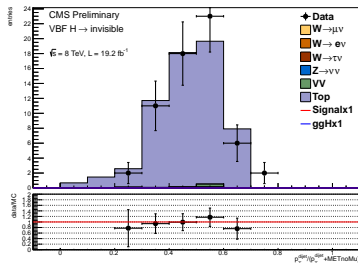


## New control plots - top

$M_{jj}$

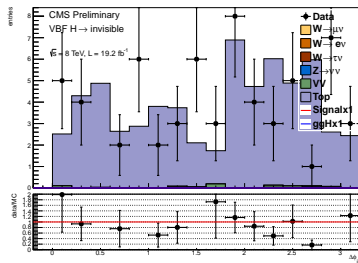


dijet-metnomu pt fraction

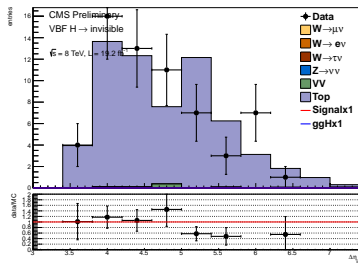


## New control plots -top

### Dphijj



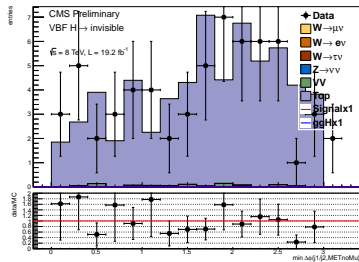
### Detajj



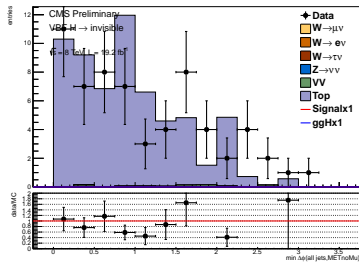


## New control plots -top

### Leading jets-met mindphi

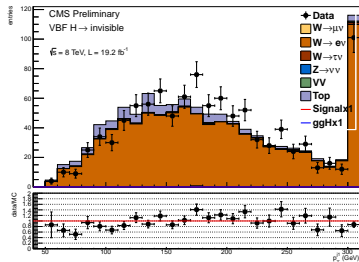


### All jet-met mindphi

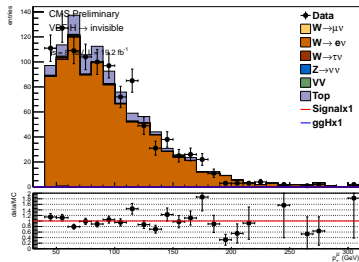


## New control plots -enu

### Jet 1 pt

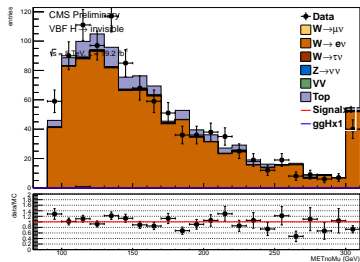


### Jet 2 pt

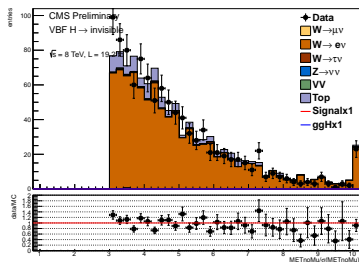


## New control plots -enu

### MET<sub>nomu</sub>

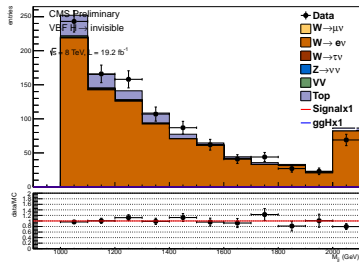


### MET<sub>nomusig</sub>

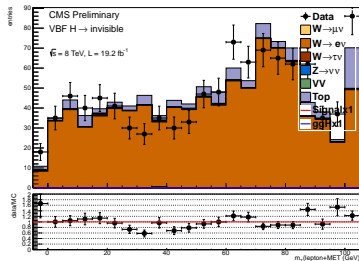


## New control plots - enu

Mjj

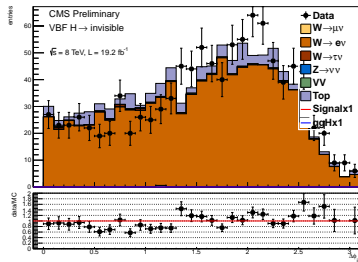


mt

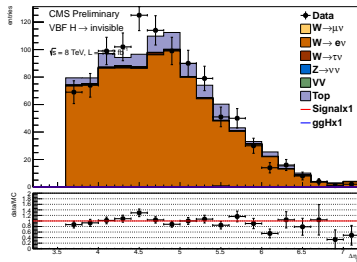


## New control plots - enu

### Dijet Dphi

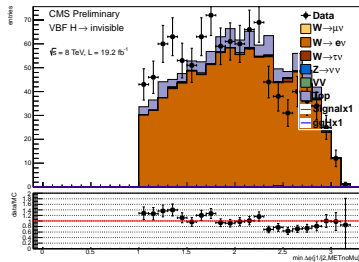


### Detajj

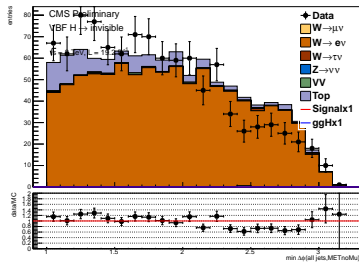


## New control plots - enu

### Leading jets-met mindphi

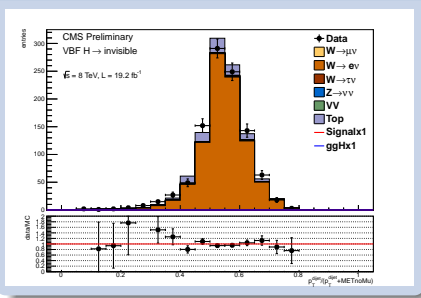


### All jets-met mindphi



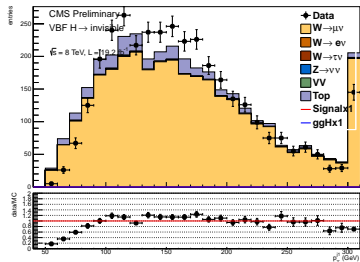
## New control plots - enu

### dijet-metnomu pt fraction

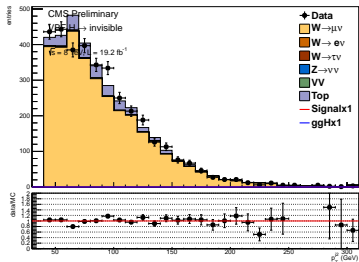


## New control plots - $\mu\mu$

### Jet 1 pt



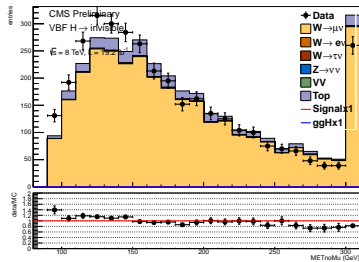
### Jet 2 pt



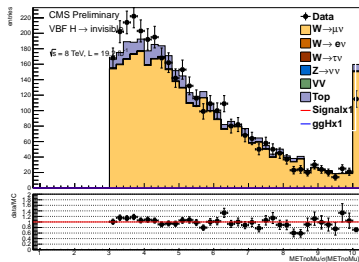


## New control plots - munu

MET<sub>nomu</sub>

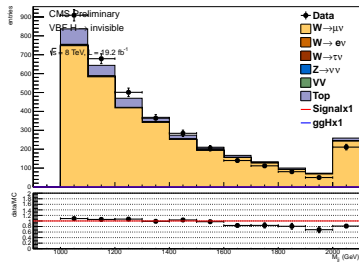


MET<sub>nomusig</sub>

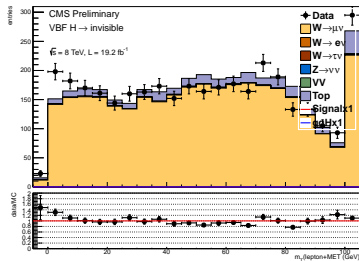


## New control plots - $\mu\mu$

$M_{jj}$

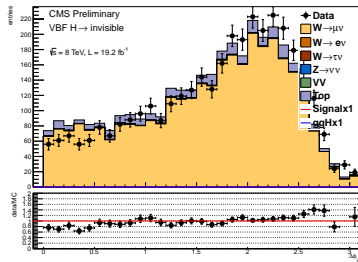


$m_T$

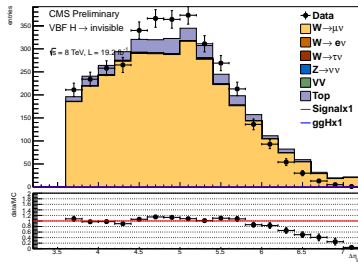


## New control plots - $\mu\mu$

### Dijet Dphi

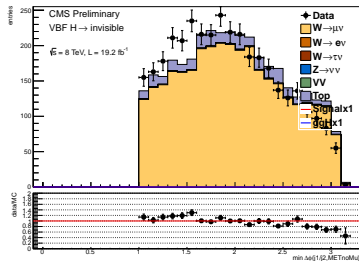


### Detajj

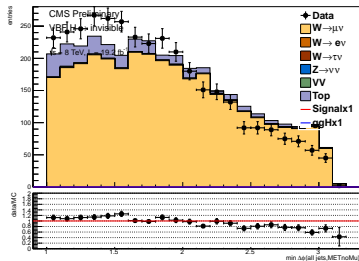


## New control plots - $\mu\mu$

### Leading jets-met mindphi

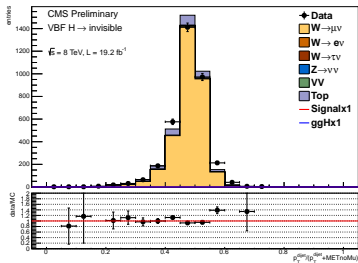


### All jets-met mindphi



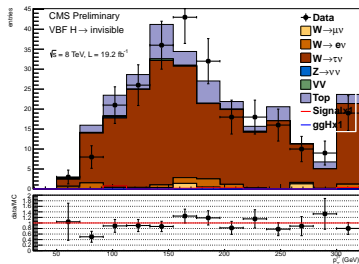
## New control plots - $\mu\mu$

### dijet-metnomu pt fraction

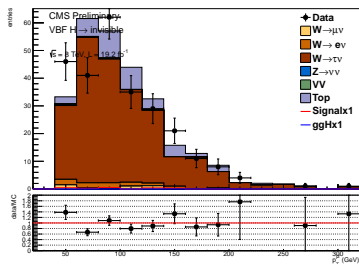


## New control plots - taunu

### Jet 1 pt

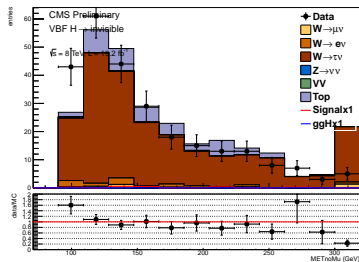


### Jet 2 pt

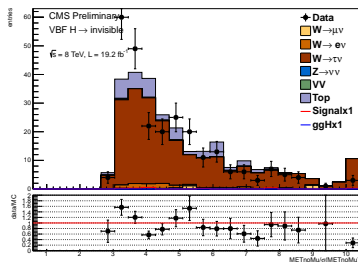


## New control plots - taunu

MET<sub>nomu</sub>

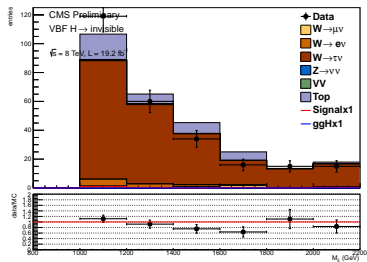


MET<sub>nomusig</sub>

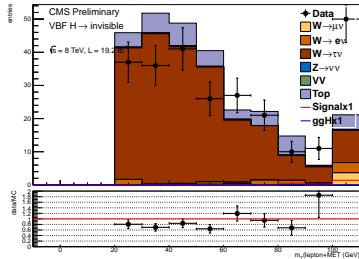


## New control plots - taunu

Mjj



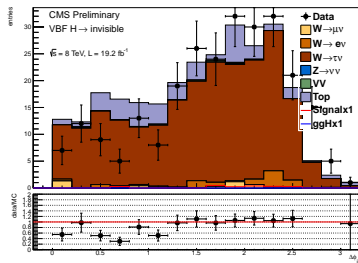
mt



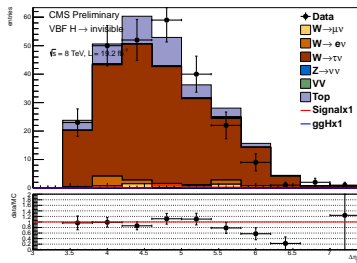


## New control plots - taunu

### Dijet Dphi

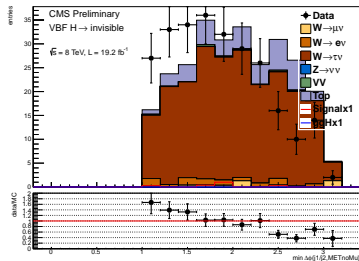


### Detajj

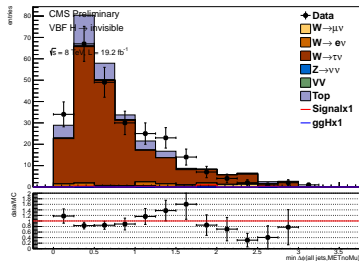


## New control plots - taunu

### Leading jets-met mindphi



### All jets-met mindphi



## New control plots - taunu

### dijet-metnomu pt fraction

