

## Progress with Limits

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## Recap

- ▶ Some systematics were missing:
  - Now only missing ggH theory uncertainties, have emailed Yuta Takahashi who did them for us last time.
- ▶ Prompt selection had been applied to parked data
  - Expected limit 51%, ignoring top and QCD
  - Worse limit seems to be due to fewer data events in Z control region, but  $49 \approx 51$
- ▶ Had tried region with less QCD:
  - $m_{\text{tsig}} > 4$ ,  $\min \Delta\phi(\text{all jets}, \text{metnomu}) > 1.5$
  - expected limit: 0.9102
- ▶ Added  $m_{jj} > 1000$  and CJV
  - expected limit: 0.5371

## Recap - Scan through variables

- ▶ Had also scanned through  $m_{jj}$ , met significance and  $\text{jetmetdphi}$  cut
- ▶ Best working point found was  $\text{metsig} > 4$ ,  $m_{jj} > 1000$ ,  $\text{jetmetdphi} > 2.5$ 
  - Expected limit: 0.2764

Process	ggH	qqH	zvv	wmu	wel	wtau	top	wg	vv	total
Rate	21.5	316.0	143.8	71.9	47.7	10.2	4.4	3.6	5.4	287

- ▶ Weights for V+jets regions decrease further needed investigating
  - $w_{\text{enu}}$ : 0.32,  $w_{\text{munu}}$ : 0.38,  $w_{\text{tau}}$ : 0 (clearly wrong),  $\text{top}$ : 0.55
- ▶ Limits ignoring systematics 10.2%, was 16.6% for prompt
- ▶ 19 events in Z control region, was 12 for prompt

## The Wtau problem - recap of slides last week

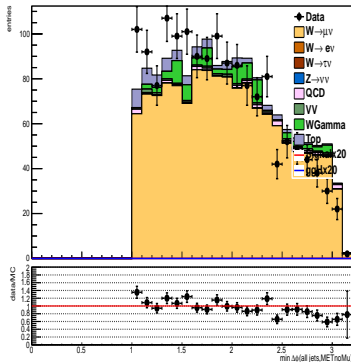
- ▶ W tau background weight is concerning
  - Only 2 events in data control region
- ▶ Added top reweighting and NCBkg became larger than NCData
- ▶ First remove CJV from all categories
  - Limit improved by a couple of percent on removal, seems redundant
- ▶ Doesn't change number of data events in tau control region

## Loosening jet met dphi - recap of slides last week

- ▶ Next step: try loosening jetmetdphi cut in tau control region

Cut	NCDData	NSMC	Exp. Limit
$>1.0$	24	$118 \pm 32 \pm 24$	0.3926
$>0.0$	136	$118 \pm 12 \pm 10$	0.2803

- ▶ Is this extrapolation valid?
  - Check difference in  $\mu\nu$  shape where we have enough events
- ▶ Weight changes from 0.48 to 0.39 when cut loosened to 1.0
- ▶ Apply a 20% systematic to  $W\tau$  estimate to account for this
  - Expected limit goes to 0.2998

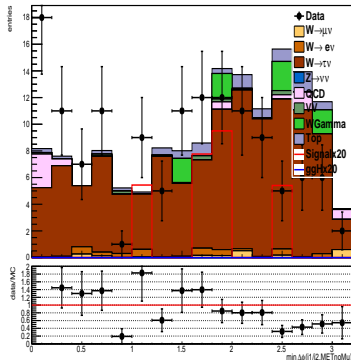


## Remaining QCD - new

- ▶ On checking Data-MC agreement in taunu region see data excess in low leading jet met dphi
- Put cut on leading jet met dphi

Cut	NCDData	NSMC	Exp. Limit
> 1.0	88	$87 \pm 12 \pm 9$	0.282

- ▶ Marginal change to limit
- ▶ Lower estimate seems valid due to less QCD contamination
- Weight now closer to wenu and wmuon:
- wenu: 0.32, wmuon: 0.38, wtaunu: 0.48 down from 0.65



## Updates

- ▶ WGamma dropped for later results on advice of the generator group
- ▶ Top reweighting fully added
  - Already accounted for in ISR/FSR of inclusive W+jets samples
- ▶ Lxplus5 shut down, limit code transferred to IC SL5 machines

## Limits with AMs QCD estimate and no WGamma

- ▶ Limit with Wgamma: 0.282
- ▶ Generator group advised us that Wgamma sample overlaps inclusive W+jets samples
  - As we don't use photons easiest course of action is to drop WGamma samples
- ▶ On removing Wgamma all W+jets estimates increase by a small amount:
  - New expected limit: 0.2939
- ▶ Next add AM's  $17 \pm 14$  QCD estimate

Process	ggH	qqH	zvv	wmu	wel	wtau	top	vv	QCD	total
Rate	23.1	322.6	141.7	81.1	59.2	95.7	6.1	6.2	17	407.0

- New expected limit: 0.2998



## Uncertainty impact checks - $< 0.1\%$ effects removed

Nuisance	% change from removal	% change from addition
CMS_eff_m:	-0.3%	3.3%
CMS_scale_j:	-6.5%	19.9%
CMS_VBFHinv_zvv_norm:	-2.0%	19.0%
CMS_VBFHinv_zvv_stat:	-13.0%	65.1%
CMS_VBFHinv_wmu_norm:	-0.6%	3.3%
CMS_VBFHinv_wmu_stat:	-0.6%	3.3%
CMS_VBFHinv_wel_norm:	-0.6%	3.3%
CMS_VBFHinv_wel_stat:	-1.3%	5.8%
CMS_VBFHinv_tau_eff:	-0.6%	5.8%
CMS_VBFHinv_tau_extrapfacunc:	-4.6%	25.7%
CMS_VBFHinv_wtau_norm:	-0.6%	7.5%
CMS_VBFHinv_wtau_stat:	-2.0%	13.3%
CMS_VBFHinv_zvv_extrapfacunc:	-7.2%	48.1%
CMS_VBFHinv_qcd_norm:	-2.0%	8.2%

## Conclusions

- ▶ Cut based analysis now only missing ggH theory uncertainties
  - Error from old analysis is in cards as a placeholder at the moment
  - No noticeable effect on limit
- ▶ Have started AN SVN area: AN-14-243
- ▶ Propose updating Higgs-EXO next week
- ▶ Next steps: BDT
- ▶ Still need to look at alternately binned trigger weights

## Backup

## First try at limits

► Haven't fixed on QCD estimation method yet:

- Pick region where QCD small/negligible
- $\text{metsig} > 4$ ,  $\min \Delta\phi(\text{alljets}, \text{metnomu}) > 1.5$

► Rates:

Process	ggH	qqH	zvv	wmu	wel	wtau	top	wg	vv	total bkg
Rate	146	930	1065	670	467	1207	76	84	41	3610

► Expected Limit: 0.9102

- Prompt expected was 0.49

► Wtau is dominant background

## Uncertainty Impact Check - Impacts above 0.5%

Nuisance	% change from removal	% change from addition
lumi_8TeV:	-0.9%	0.0%
CMS_eff_e:	-0.9%	3.5%
CMS_eff_m:	-0.9%	13.3%
CMS_scale_j:	-28.1%	487.0%
CMS_res_j:	-2.6%	121.2%
CMS_scale_met:	-0.9%	13.3%
CMS_VBFHinv_puweight:	-0.9%	48.6%
CMS_VBFHinv_zvv_norm:	-0.9%	23.8%
CMS_VBFHinv_zvv_stat:	-2.6%	86.0%
CMS_VBFHinv_wmu_norm:	-0.9%	3.5%
CMS_VBFHinv_wmu_stat:	-0.9%	3.5%
CMS_VBFHinv_wel_norm:	-0.9%	3.5%
CMS_VBFHinv_wel_stat:	-0.9%	7.9%
CMS_VBFHinv_tau_eff:	-0.9%	74.9%
CMS_VBFHinv_wtau_norm:	-3.4%	175.9%
CMS_VBFHinv_wtau_stat:	-5.2%	234.0%
CMS_VBFHinv_zvv_extrapfacunc:	-8.6%	188.2%
pdf_qqbar:	-0.9%	0.0%

## Scanned through variables

### ► Add CJV

- Expected limit: 0.7090

Process	ggH	qqH	zvv	wmu	wel	wtau	top	wg	vv	total
Rate	115	880	909	510	342	886	41	67	29	2783

### ► Add CJV and $m_{jj} > 1000$

- Expected limit: 0.5371

Process	ggH	qqH	zvv	wmu	wel	wtau	top	wg	vv	total
Rate	68	668	457	291	192	285	17	32	15	1288

## Uncertainty Impact Check - cjv mjj1000

Nuisance	% change from removal	% change from addition
lumi_8TeV:	-0.7%	0.5%
CMS_eff_m:	-0.7%	8.0%
CMS_scale_j:	-23.3%	289.8%
CMS_res_j:	-0.7%	30.1%
CMS_VBFHinv_puweight:	-0.7%	23.0%
CMS_VBFHinv_zvv_norm:	-0.7%	22.1%
CMS_VBFHinv_zvv_stat:	-5.1%	85.4%
CMS_VBFHinv_wmu_norm:	-0.7%	5.0%
CMS_VBFHinv_wmu_stat:	-0.7%	5.0%
CMS_VBFHinv_wel_norm:	-0.7%	5.0%
CMS_VBFHinv_wel_stat:	-0.7%	8.0%
CMS_VBFHinv_wtau_norm:	-2.2%	116.0%
CMS_VBFHinv_wtau_stat:	-2.9%	144.1%
CMS_VBFHinv_zvv_extrapfacunc:	-9.5%	120.1%
CMS_VBFHinv_top_stat:	-0.4%	2.0%
pdf_qqbar:	-0.4%	0.0%

## Uncertainty Impact Check- some low impact not listed

Nuisance	% change from removal	% change from addition
CMS_eff_m:	-0.7%	3.8%
CMS_scale_j:	-2.8%	3.8%
CMS_res_j:	0.0%	0.0%
CMS_scale_met:	0.0%	0.4%
CMS_VBFHinv_puweight:	-4.3%	29.6%
CMS_VBFHinv_zvv_norm:	-2.8%	27.7%
CMS_VBFHinv_zvv_stat:	-15.6%	84.1%
CMS_VBFHinv_wmu_norm:	-0.7%	4.7%
CMS_VBFHinv_wmu_stat:	-0.7%	3.8%
CMS_VBFHinv_wel_norm:	-0.7%	4.7%
CMS_VBFHinv_wel_stat:	-1.4%	6.7%
CMS_VBFHinv_tau_eff:	0.0%	0.0%
CMS_VBFHinv_wtau_norm:	0.0%	18.1%
CMS_VBFHinv_wtau_stat:	0.0%	17.1%
CMS_VBFHinv_zvv_extrapfacunc:	-9.2%	63.1%
CMS_VBFHinv_top_norm:	0.0%	0.0%
CMS_VBFHinv_top_stat:	0.0%	0.9%