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# 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≈51
- Had tried region with less QCD:
  - metsig$>$ 4, $min\Delta\phi(alljets, metnomu) > 1.5$
  - expected limit: 0.9102
- Added mjj$>$ 1000 and CJV
  - expected limit: 0.5371

# Recap - Scan through variables

- Had also scanned through mjj, met significance and jetmetdphi cut
- Best working point found was metsig$>$ 4, mjj$>$ 1000, 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
  - wenu: 0.32, wmunu: 0.38, wtau: 0 (clearly wrong), 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

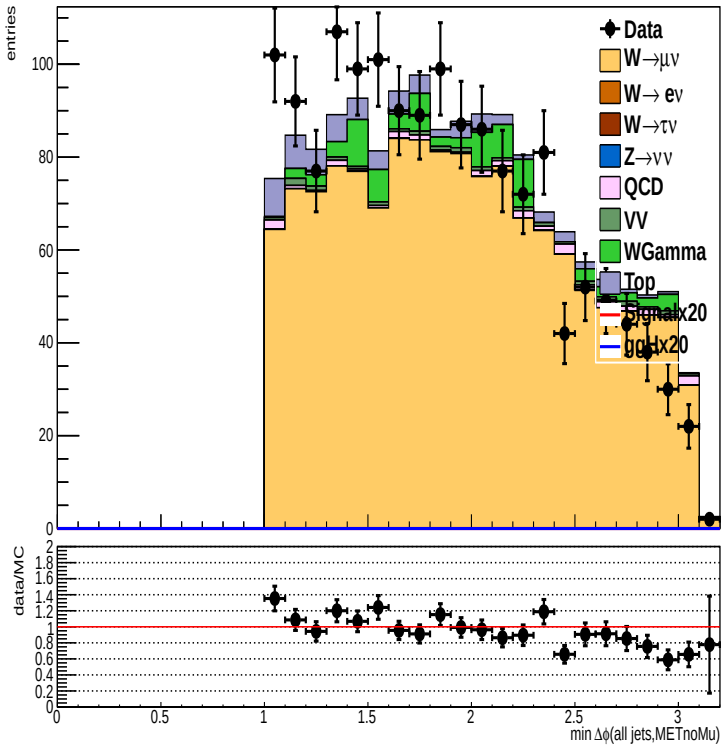
- W tau background weight is concerning
  - Only 2 events in data control region
- Added top reweighting and NCBkg became larger than NCData
- First remove CJV from all categories
  - Limit improved by a couple of percent on removal, seems redundant
- Doesn't change number of data events in tau control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

# Loosening jet met dphi - recap of slides last week

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

| Cut | NCData | 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 munu 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 WTau estimate to account for this
  - Expected limit goes to 0.2998

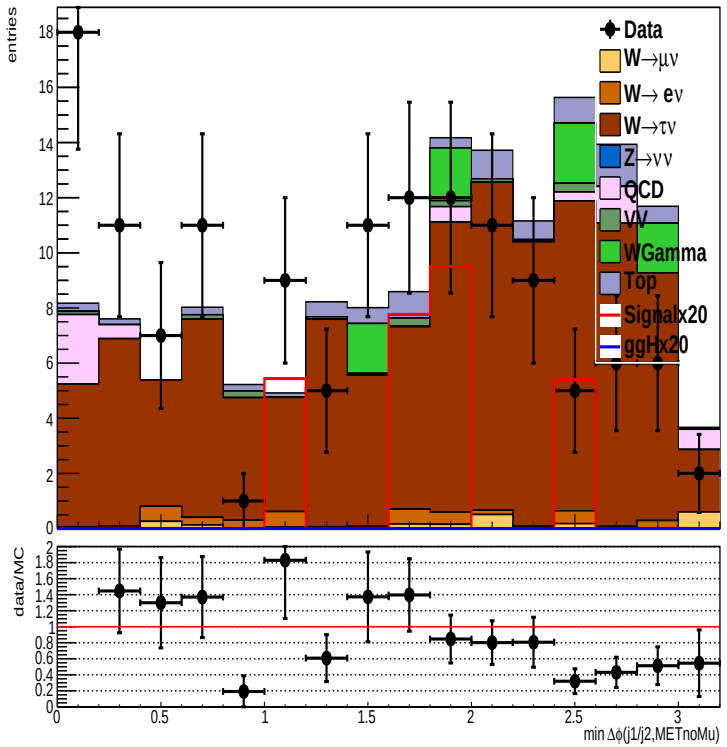


# Remaining QCD - new

- 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 | NCData | 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 wmunu:
  - wenu: 0.32, wmunu: 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

- New since yesterday: had forgotten to propagate data driven weight error through into NCBkg error:
  - expected limit goes from 0.2998 to 0.3018
- 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
  - metsig$>4$, $min\Delta\phi(alljets, metnomu) > 1.5$
- 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 mjj$>$ 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% |