Imperial College London

VBF Higgs to Invisible

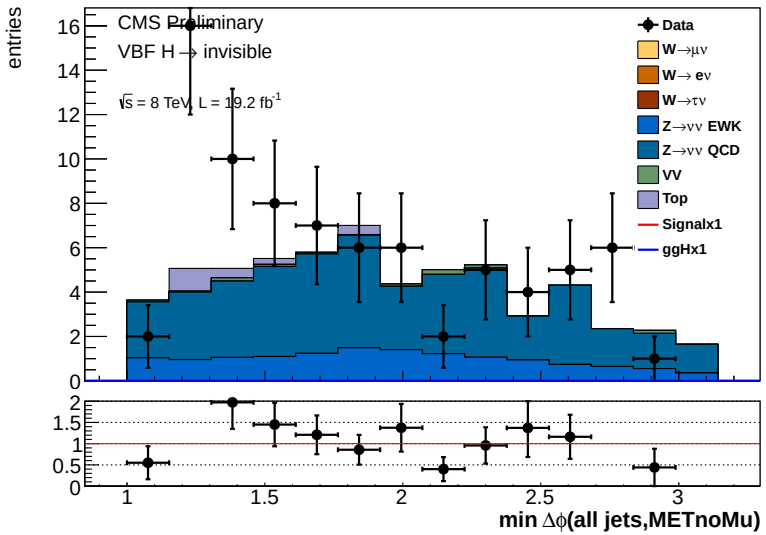
HIG-14-038, AN-14-243

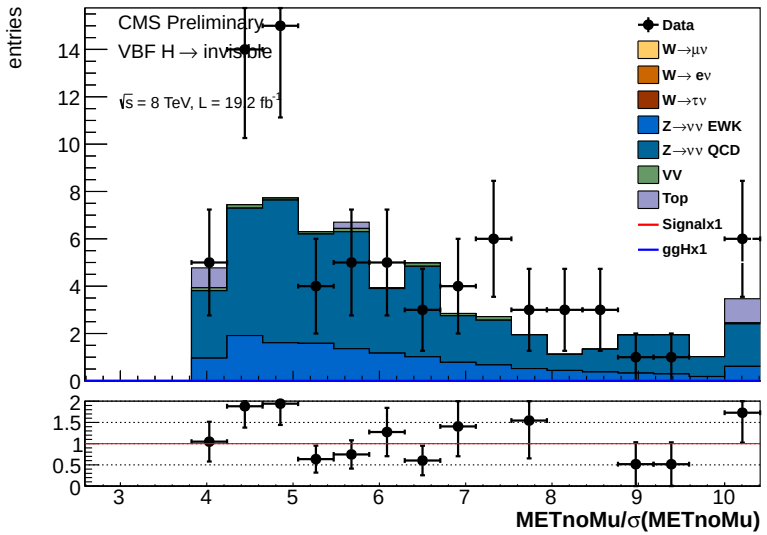
Overview

- ARC author twiki has complete answers to most questions
- There are a couple of outstanding items:
  - Lepton scale factor update and new PAS draft still "to do"
  - We would like clarification for a few questions
- We also request your approval to make two analysis changes
  - Z extrapolation error: was under investigation previously
  - Top background method: change does not affect final limit

Items answered since we sent the twiki

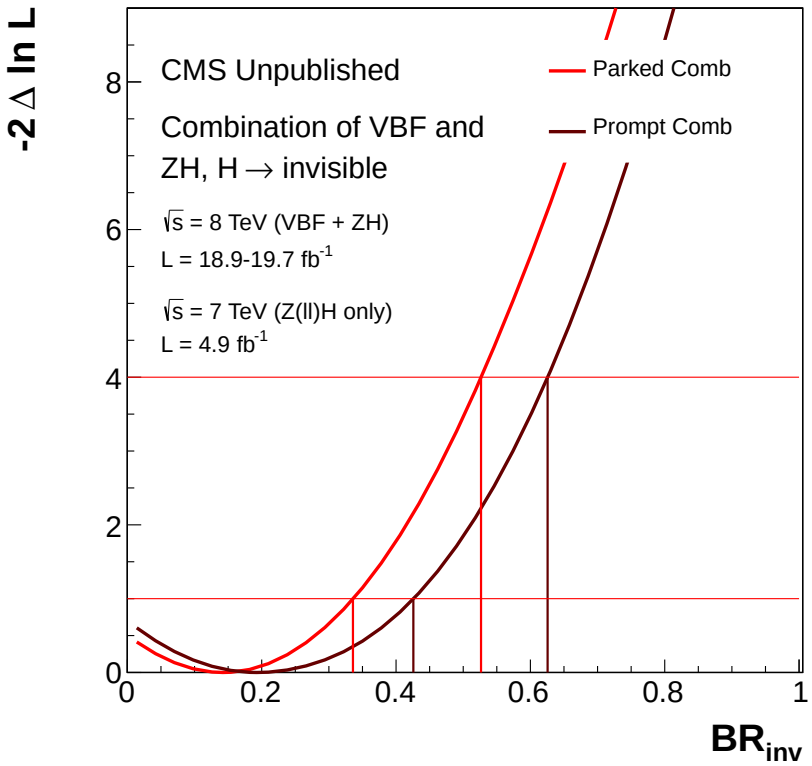
- Table of trigger fit parameters has been added
  - See backup
- EWK and QCD contributions to Z control region have been plotted separately

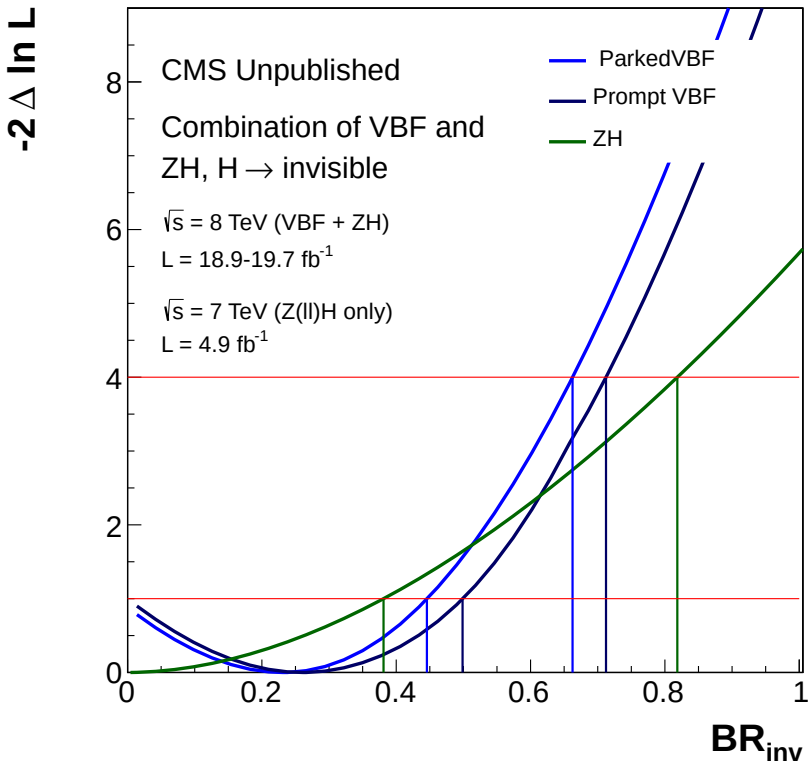




Items answered since we sent the twiki

- A separated version of the likelihood scan plot has been produced

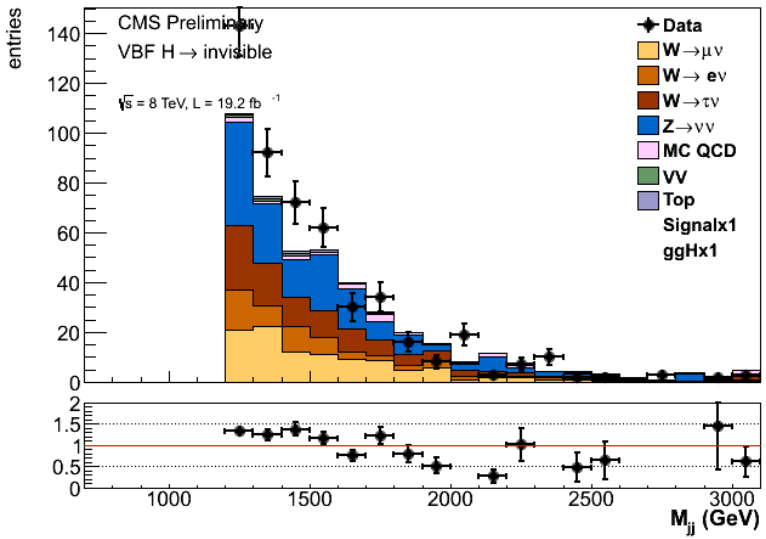


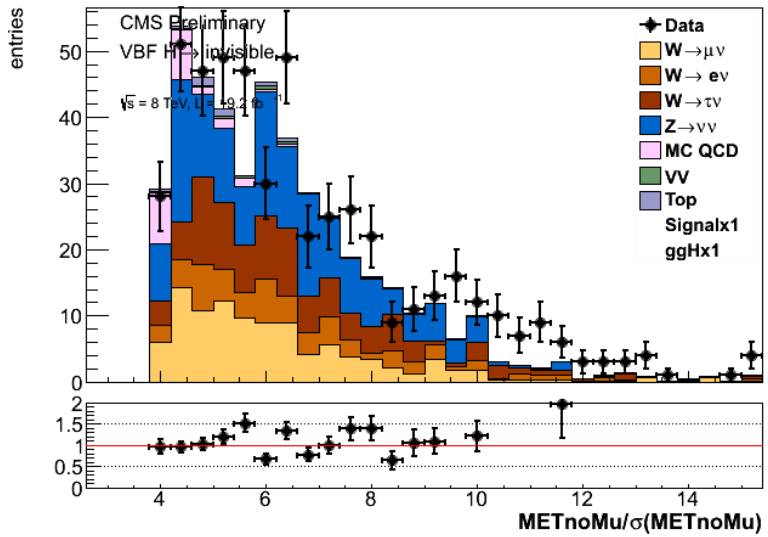


QCD in final plots

- Three options:

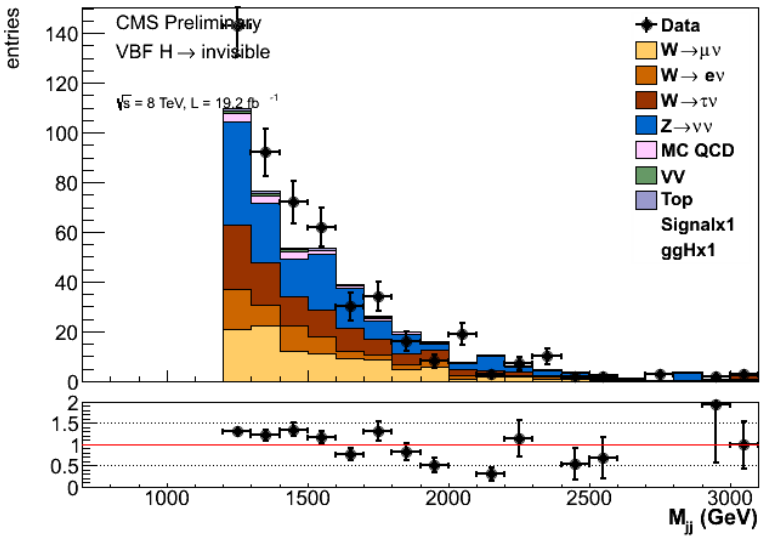
1) Just plot MC QCD "out of the box"
   - Gives 20 events, close to 17 predicted
   - Didn't seem to have good agreement earlier in selection so hard to trust

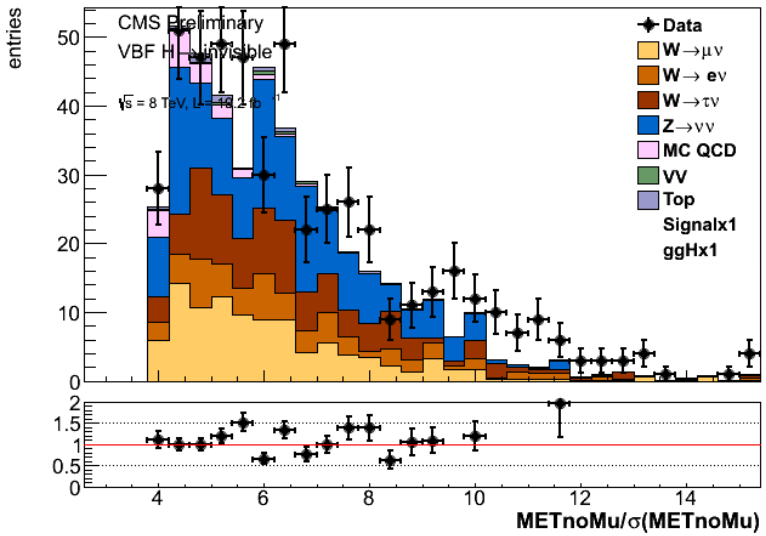




QCD in final plots

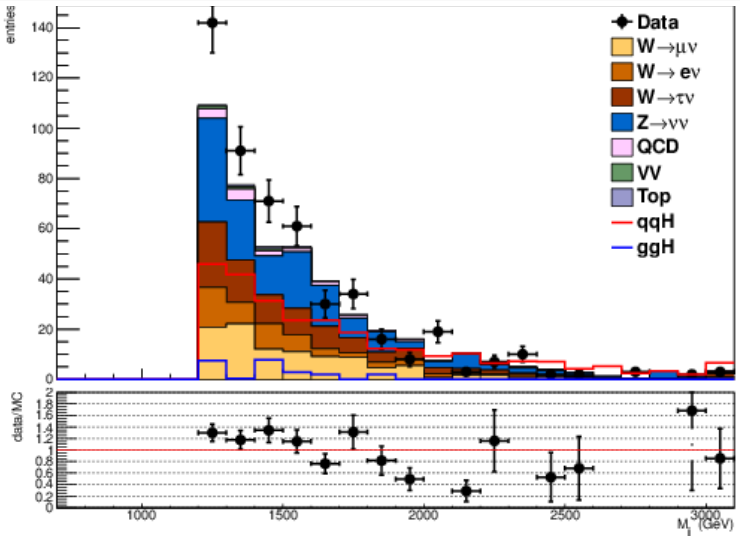
2) MC QCD with inverted allmindphi < 1.0 and mindphi(MET,j1/j2)>2.3, scaled to the expected 17 events (factor 0.04 scaling)
   - Still easy to produce
   - Looks very similar to full data driven method

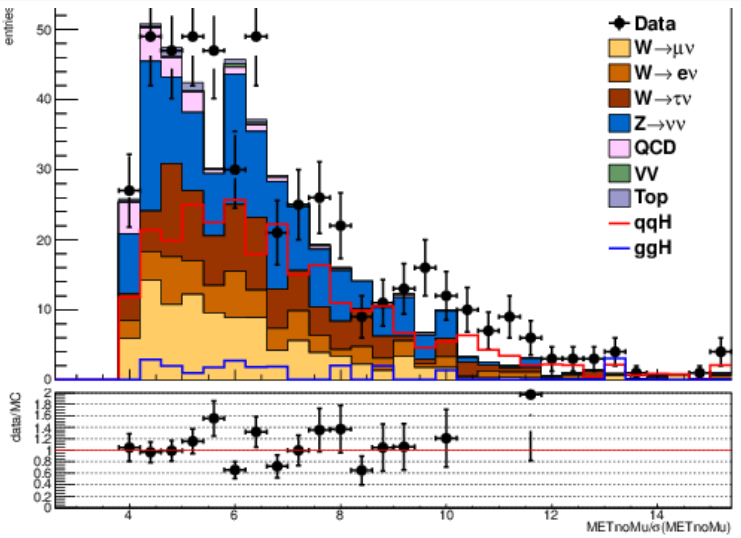




QCD in final plots

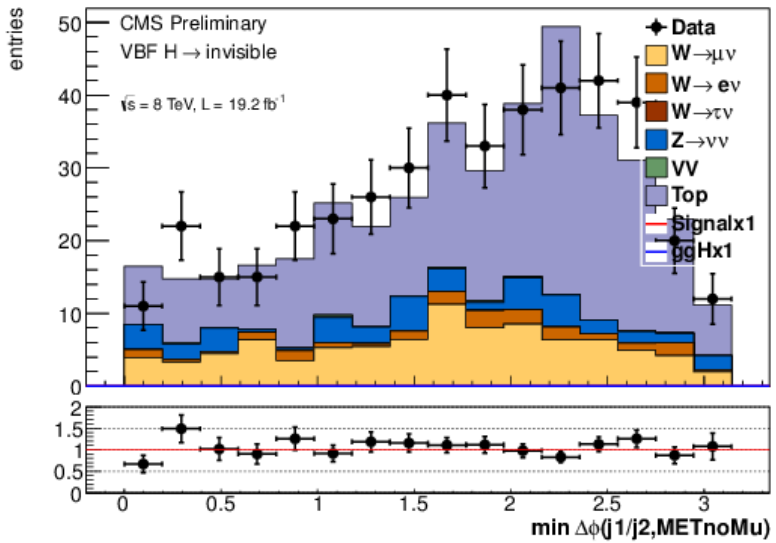
3) Data driven estimate of QCD background shape
   - (inverted allmindphi < 1.0 and mindphi(MET,j1/j2)>2.3), background subtracted and scaled with final scale factor (0.05)

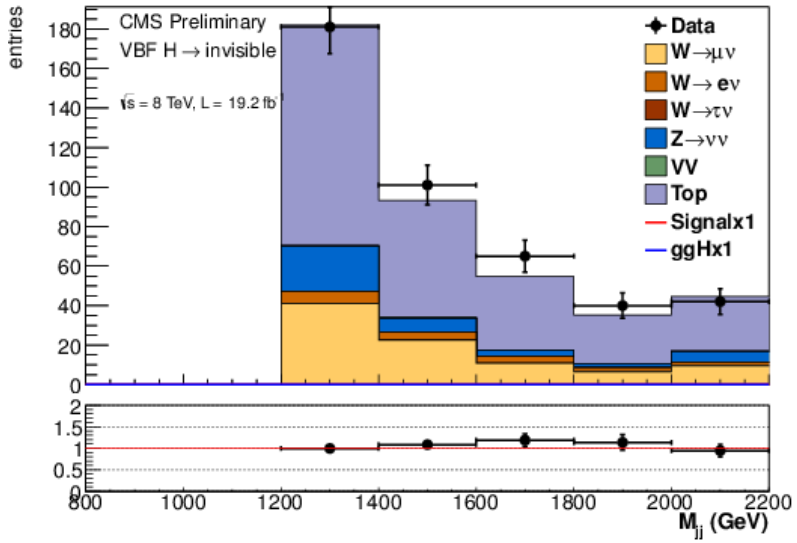




Top background

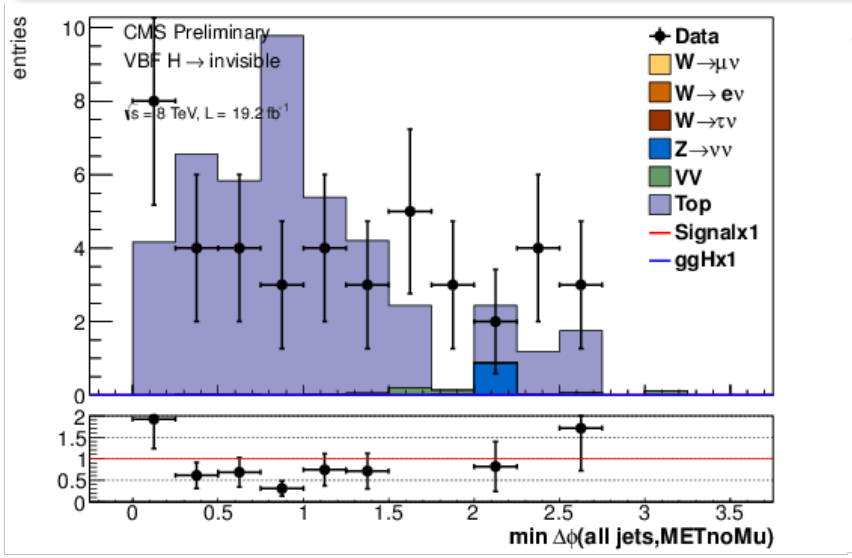
- We discovered that the ttbar vs single top make up of the top contribution to our control and signal regions was quite different
  - Signal region: 90% single top, $W \to \tau\nu$ region: 30% single top, top control region: $\sim$100% ttbar
- We therefore decided to investigate Wbb analysis based single top region
  - Signal region + 1 tight e or μ + 1 of the VBF jets having a CSVM b-tag
  - This region has 17% single top
  - Scale factor is compatible with 1: 0.88+-0.07(data stat.)+-0.08(MC stat.)

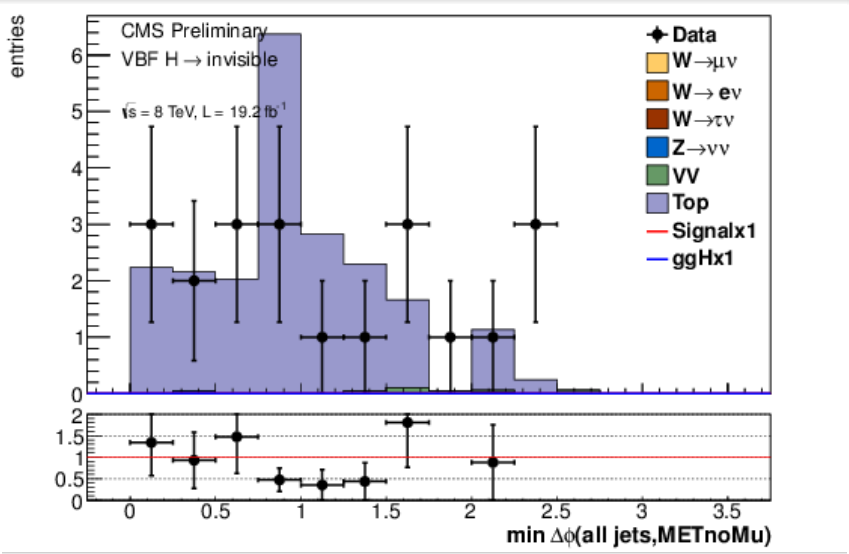




Top background

- We also investigated adding ee+mumu to our control region
- Added a Z mass window veto to avoid Z contamination
- Gives 22 extra events (shown below left) which does not reduce the top uncertainty much as signal region MC statistics dominate
  - 39% down to 35% not taking into account a systematic from Z mass window
- Weight compatible with 1: 1.21+-0.19(data stat.)+-0.16(MC stat.)
- For reference weight from emu region was also compatible with 1: 0.84+-0.19(stat.)+-0.14(MC stat.)





$Z/\gamma^* \to \mu\mu$ to $Z \to \nu\nu$ extrapolation uncertainty

- This was under study at the time of preapproval
- New studies with aMC@NLO_MG5 show no evidence of incompatibility with result from MadGraph: 4%
- Propose switching to stat uncertainty from MadGraph prediction
  - Already accounted for by MC stat uncertainty
- Details here: https://indico.cern.ch/event/365513/contribution/0/material/slides/1.pdf

Questions we have

- Could you point us to a recipe for madgraph ttbar reweighting
- Could you advise us how to check EWK+QCD interference in Z background method

Summary

- Almost all questions answered
- We request approval of our plans for the top background and Z uncertainty
- A couple of outstanding issues:
  - Lepton scale factors are being updated
  - PAS is being redrafted

Backup

Region and run (units: GeV)	Centre x_0 (GeV)	Width Γ (GeV)	Maximum eff. ε_{max}
A: j2pt 40-50 , mjj 800-900	133 ± 13	1465 ± 1101	0.58 ± 0.15
BC: j2pt 40-50 , mjj 800-900	101 ± 5	2351 ± 1018	0.61 ± 0.04
D: j2pt 40-50 , mjj 800-900	133 ± 22	14972 ± 9451	0.82 ± 0.12
A: j2pt 40-50 , mjj 900-1000	112 ± 42	38 ± 94580	0.38 ± 0.20
BC: j2pt 40-50 , mjj 900-1000	99 ± 6	1869 ± 1317	0.65 ± 0.06
D: j2pt 40-50 , mjj 900-1000	106 ± 6	1910 ± 1007	0.76 ± 0.05
A: j2pt 40-50 , mjj 1000-5000	115 ± 11	40 ± 508	0.58 ± 0.11
BC: j2pt 40-50 , mjj 1000-5000	119 ± 5	5503 ± 1502	0.84 ± 0.04
D: j2pt 40-50 , mjj 1000-5000	112 ± 6	6636 ± 2249	0.91 ± 0.05
A: j2pt 50-60 , mjj 800-900	88 ± 1	1 ± 78109	0.30 ± 0.02
BC: j2pt 50-60 , mjj 800-900	106 ± 9	9141 ± 4207	0.79 ± 0.07
D: j2pt 50-60 , mjj 800-900	108 ± 8	5267 ± 2795	0.74 ± 0.07
A: j2pt 50-60 , mjj 900-1000	111 ± 12	1583 ± 1518	0.73 ± 0.13
BC: j2pt 50-60 , mjj 900-1000	112 ± 6	19021 ± 6743	1.00 ± 0.99
D: j2pt 50-60 , mjj 900-1000	109 ± 9	21363 ± 9257	1.00 ± 0.76
A: j2pt 50-60 , mjj 1000-5000	117 ± 18	3154 ± 3282	0.87 ± 0.17
BC: j2pt 50-60 , mjj 1000-5000	111 ± 4	7182 ± 1801	0.95 ± 0.03
D: j2pt 50-60 , mjj 1000-5000	111 ± 4	5918 ± 1810	0.97 ± 0.03
A: j2pt 60-1000 , mjj 800-900	178 ± 158	100000 ± 51037	0.54 ± 0.32
BC: j2pt 60-1000 , mjj 800-900	89 ± 2	3437 ± 885	0.79 ± 0.02
D: j2pt 60-1000 , mjj 800-900	91 ± 5	7785 ± 2715	0.79 ± 0.04
A: j2pt 60-1000 , mjj 900-1000	92 ± 5	865 ± 835	0.64 ± 0.07
BC: j2pt 60-1000 , mjj 900-1000	86 ± 2	6737 ± 1440	0.97 ± 0.02
D: j2pt 60-1000 , mjj 900-1000	86 ± 2	2881 ± 803	0.90 ± 0.02
A: j2pt 60-1000 , mjj 1000-5000	89 ± 3	3025 ± 1091	0.96 ± 0.03
BC: j2pt 60-1000 , mjj 1000-5000	51 ± 4	11294 ± 1888	0.97 ± 0.01
D: j2pt 60-1000 , mjj 1000-5000	61 ± 3	12774 ± 1882	0.99 ± 0.01