

## VBF Higgs to Invisible

## W & Z MC

### Run 1 Reminder

- ▶ In run 1 we split  $W \rightarrow \ell\nu$  samples by lepton at generator level
- ▶  $W \rightarrow \tau\nu$  events were classified according to  $\tau$  decay:
  - e.g.  $W \rightarrow \tau\nu \rightarrow \mu\nu\nu\nu$  put in muon category etc.
- ▶  $Z \rightarrow \mu\mu$  samples split into high and low generated  $Z$   $p_T$
- ▶ All of the above done by looking at status 3 particles

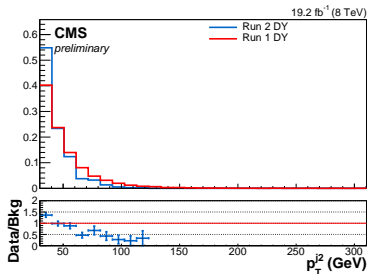
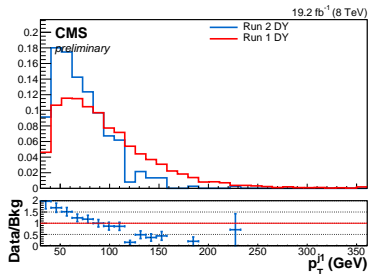
### Run 2

- ▶ Phys 14 only has one Z MC sample so don't need to split
- ▶ W still needs splitting by lepton flavour
  - No more status 3, need a replacement

## DY Comparison

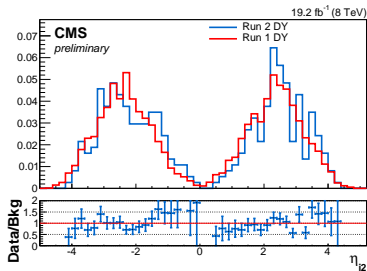
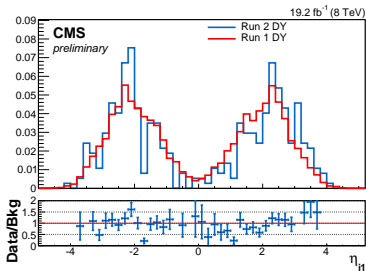
- ▶ As recommended weights now removed to make it clearer if difference is from gen/reconstruction
- ▶ Distributions still normalised to 1
- ▶ Same set of plots as for QCD and signal included for reference
- ▶ Selection as for QCD is:  $\eta_{j1} \cdot \eta_{j2} < 0$ ,  $\eta_{j1} < 4.7$ ,  $\eta_{j2} < 4.7$ ,  $p_T^{j1} > 50 \text{ GeV}$ ,  $p_T^{j2} > 40 \text{ GeV}$ ,  $\Delta\eta_{jj} > 3.6$ ,  $M_{jj} > 800 \text{ GeV}$ ,  $MET > 90 \text{ GeV}$ ,  $MET_{sig} > 3$ .

## DY Comparison: run 1 vs run 2: Jet $p_T$



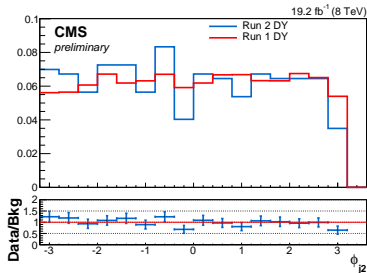
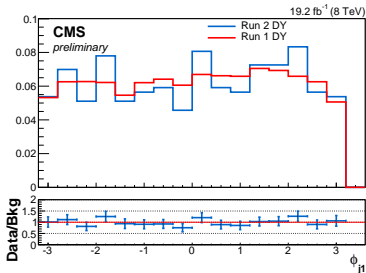
- Low statistics in run 2 MC but appears higher in pt

## DY Comparison: run 1 vs run 2: Jet $\eta$



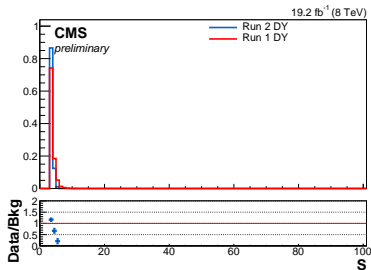
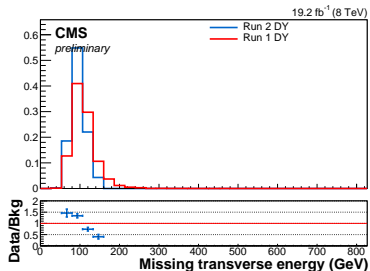
► Ears still apparent

## DY Comparison: run 1 vs run 2: Jet $\phi$



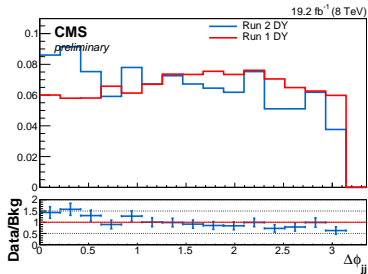
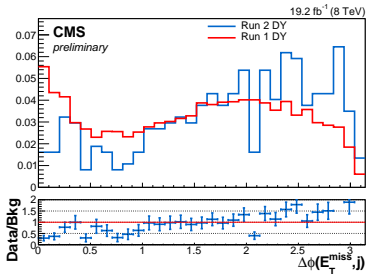
- $\phi$  distributions look similar within stat error

## DY Comparison: run 1 vs run 2: Met



- ▶ Metnomu lower for run 2
- ▶ Met significance is a different variable in miniAOD to the one we used in run 1

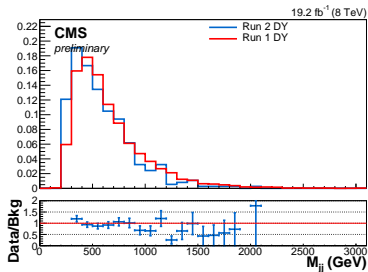
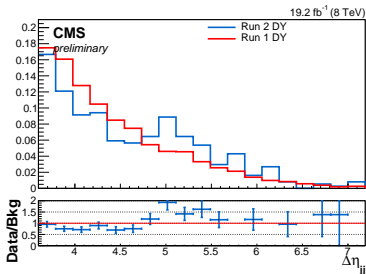
## DY Comparison: run 1 vs run 2: $\Delta\phi$ variables



► Limited by low stats

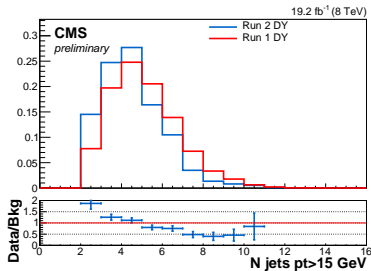
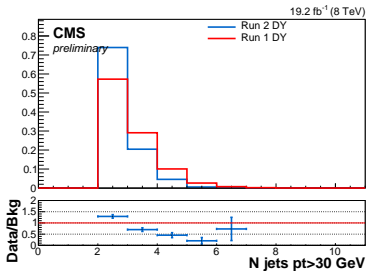


## DY Comparison: run 1 vs run 2: dijet variables



► Limited by low stats

## DY Comparison: run 1 vs run 2: N jets



## W MC: replacing status 3

- ▶ According to [pythia 8 documentation](#) status 21-29 replaces status 3
- ▶ Check for status 3 lepton → check for status 21-29 lepton

| Channel | Inclusive | Split   |
|---------|-----------|---------|
| enu     | N/A       | 1880521 |
| munu    | N/A       | 1772078 |
| taunu   | N/A       | 738104  |
| total   | 10017462  | 4390703 |

- ▶ Over half of the events are missing

## W MC: replacing status 3

- ▶ Check lists of gen particles in events
- ▶ All events have a status 22 W as expected:
  - status 22 means hard scatter incoming
- ▶ Naively expect one status 23 lepton:
  - status 23 means hard scatter outgoing
- ▶ All events have at least one lepton but often not status 23
- ▶ From GEN hypernews it appears status 23 particles with no FSR replaced with status 1
- ▶ Often many status 1 and 2 leptons need to find one from W

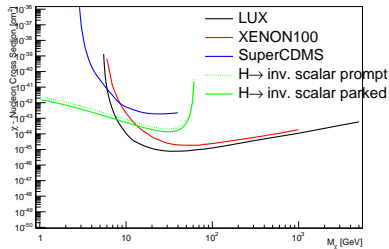
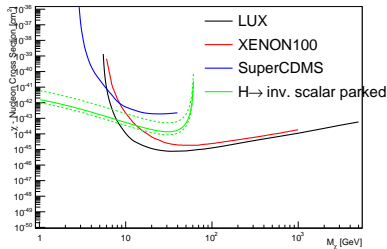
## W MC: replacing status 3

### New strategy

- ▶ Use list of W daughters to find lepton flavour
- ▶ If a  $\tau$  is found check its daughters to determine  $\tau$  decay
  - $\tau$  often radiates, need to check recursively until a decay is found
- ▶ This correctly classifies most events, still trying to find out what happens to the others

## Higgs Portal DM interpretation - update

- ▶ Vector line removed after discussion last week
- Bjoern asking theorists if there are other models with  $\mathcal{B}(H \rightarrow inv)$  expressions
- ▶ Left plot has three values of fN as in paper
- ▶ Right plot is prompt (dashed) vs parked (solid)



## Summary

- ▶ W and Z MC processed
- ▶ Z control plots available
- ▶ W generator level information studies are ongoing
- ▶ Parked interpretation work is ongoing

## Backup