# Status of
# ZH → vvbb analysis

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for the ZH team

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# Introduction
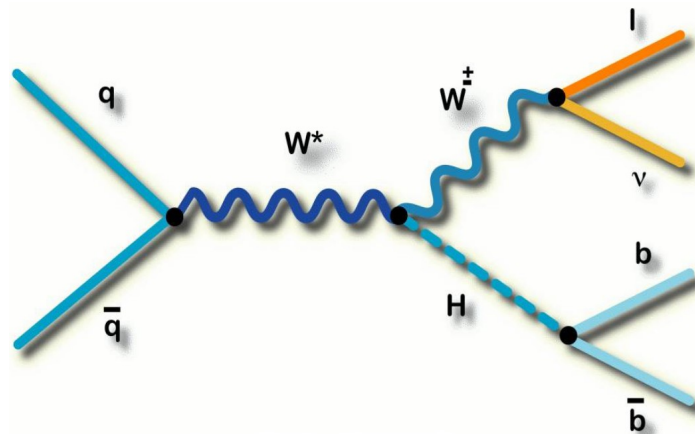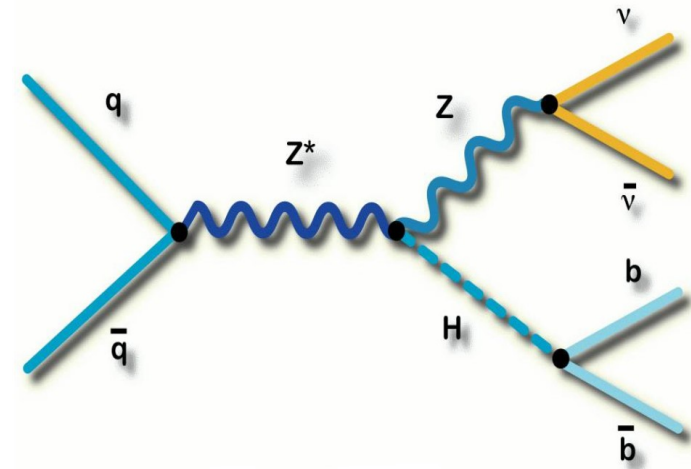
- Search for ZH→$\nu\nu$bb with 4 fb$^{-1}$

- Topology: 2 b-jets + MET
  - jets+MET triggers
  - b-tagging

- Also sensitive the WH
  - Lepton not reconstructed or identified

# Selection

- Selection:
  - jets+MET triggers
  - Veto on tight electrons and muons (orthogonal to WH)
  - 2 or 3 vertex confirmed & (direct) taggable jets
  - Veto on bad jets
    - Do not veto a bad jet, if the only jet-ID cut it fails is EMf

- Cut against instrumental background:
  - Veto jets back-to-back
  - Triangle cut : MET vs $\Delta\varphi_{min}$(MET, jets)
  - $\Delta\varphi$(MET, MET from tracks)$<\pi/2$
    - From events $\Delta\varphi>\pi/2 \rightarrow$ QCD estimation
      - EW contribution subtracted
  - Asymmetry(MET, MHT): -0.1<A<0.2
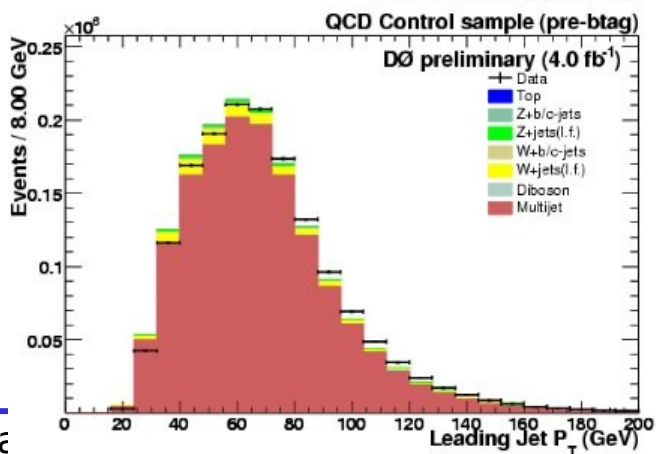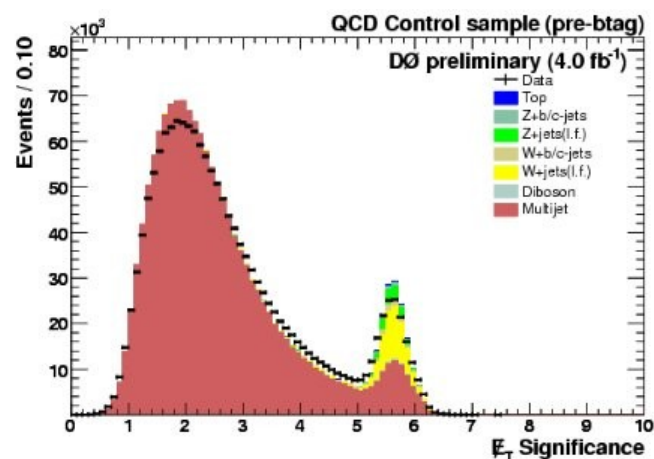  - METsignificance > 5
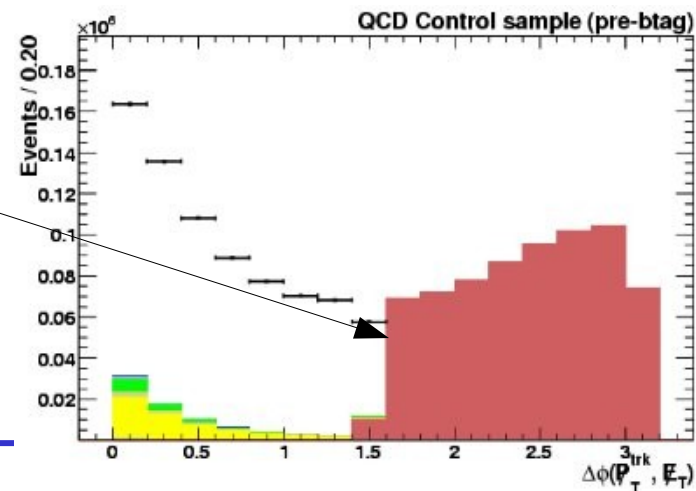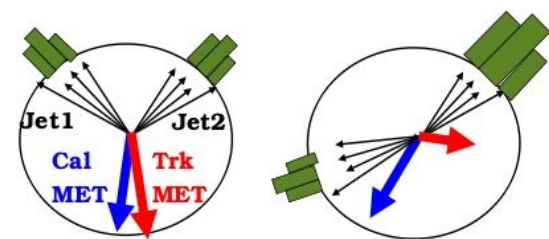
# EW MC normalization

- ◆ EW sample:
  - ► Remove cuts against inst. Background
  - ► Require 1 tight muon
- ◆ Use standard vjets k'-factors
- ◆ No need of an additional scale-factor
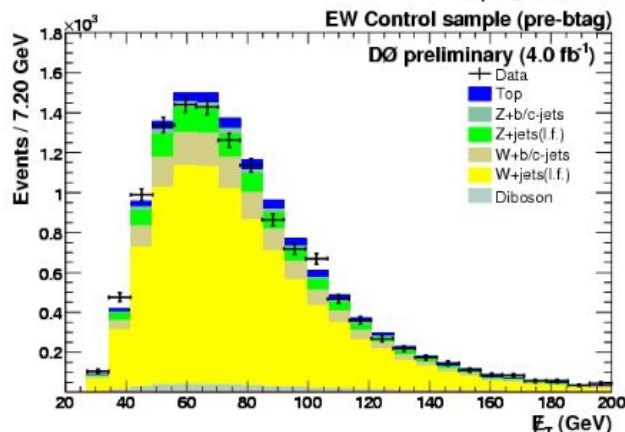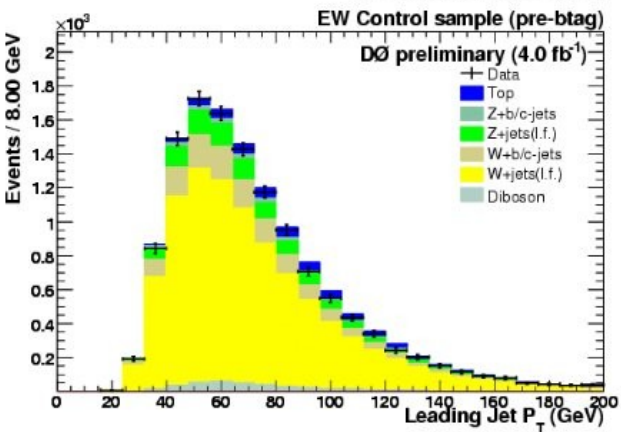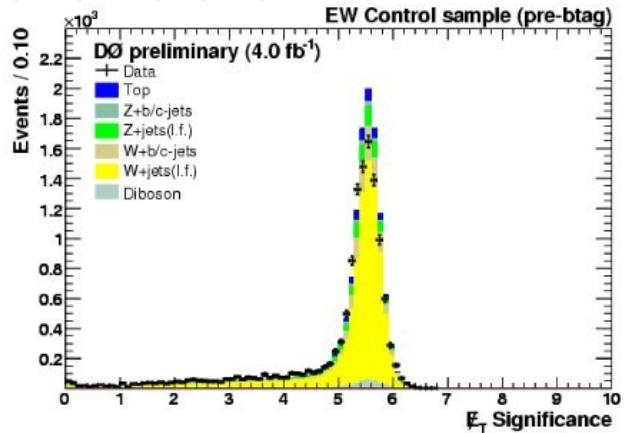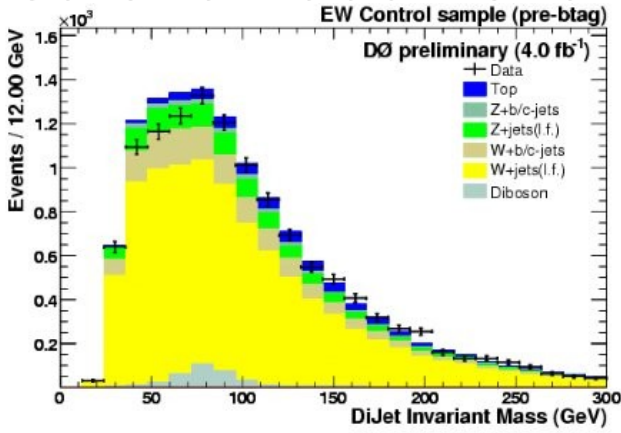
# QCD control sample

- Remove cuts against inst. background
- MET cut relaxed from 40 to 30 GeV
- In the signal sample: scaled to fill the gap between data and MC (before b-tagging)
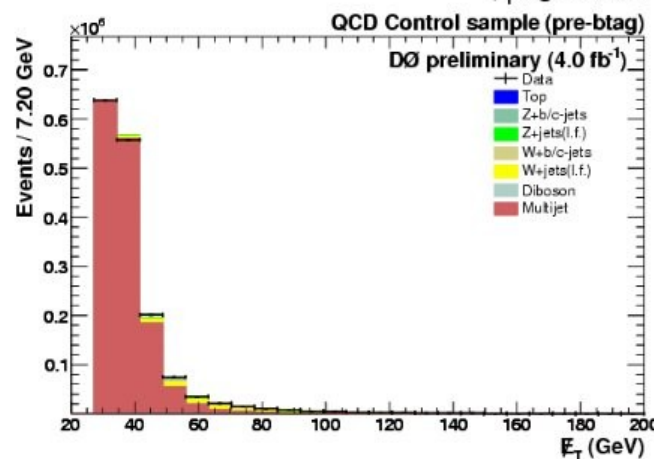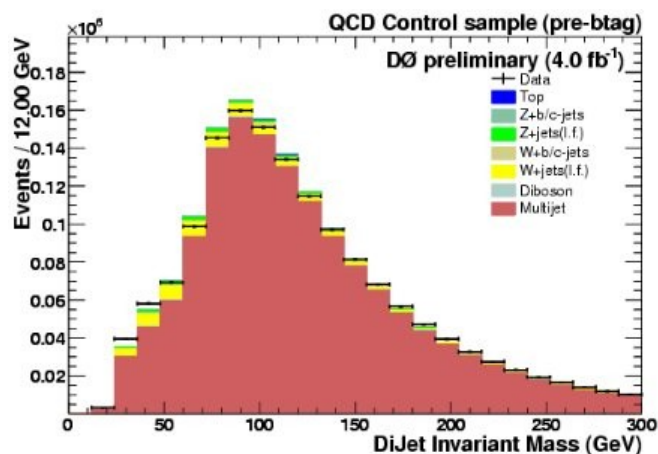
# Why not Moriond '09?

- Limit of Moriond '08 was better than the current one

- In particular, 40% of degradation due to systematics

  → now, working to understand/fix it

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One Background Stat Error Included

| NonZero Stat Err | Run2a | | Run2b | |
|---|---|---|---|---|
| | 1 L3 | 1 L3 and 1 VT | 1 L3 | 1 L3 and 1 VT |
| fast/none | 25.316 | 9.981 | 14.065 | 5.958 |
| all | 33.986 | 11.761 | 16.646 | 6.837 |
| diboson | 25.429 | 9.913 | 14.185 | 5.929 |
| qcd | 33.200 | 11.612 | 15.439 | 6.522 |
| top | 25.380 | 10.059 | 14.258 | 5.977 |
| wbb | 25.376 | 10.013 | 14.199 | 5.984 |
| wcc | 25.560 | 10.089 | 14.147 | 5.998 |
| wjj | 26.162 | 9.975 | 14.923 | 6.088 |
| zbb | 25.637 | 9.874 | 14.346 | 5.929 |
| zcc | 25.624 | 10.044 | 14.344 | 5.893 |
| zjj | 25.521 | 10.099 | 14.390 | 5.979 |

Our method to estimate the QCD part leads to a large statistical error
→ ~9% of degradation

Need more W+1lp

TABLE 3. Ratio of the expected limit to the Standard Model prediction for different Higgs masses using CLSyst with one background's statistical error turned on. QCD Smoothing was used. Also the BDT was divided into 16 equal width bins.

# QCD problem

- In 2 tag channel (1VT+1L3) of RunIIb
  - QCD is 10% of the events
  - Statistical uncertainties degrade the limit by 9%
  - "QCD normalization" systematic uncertainties (35%) degrade the limit by 14%

→ we are working on a slight change of the QCD sample definition to decrease these uncertainties

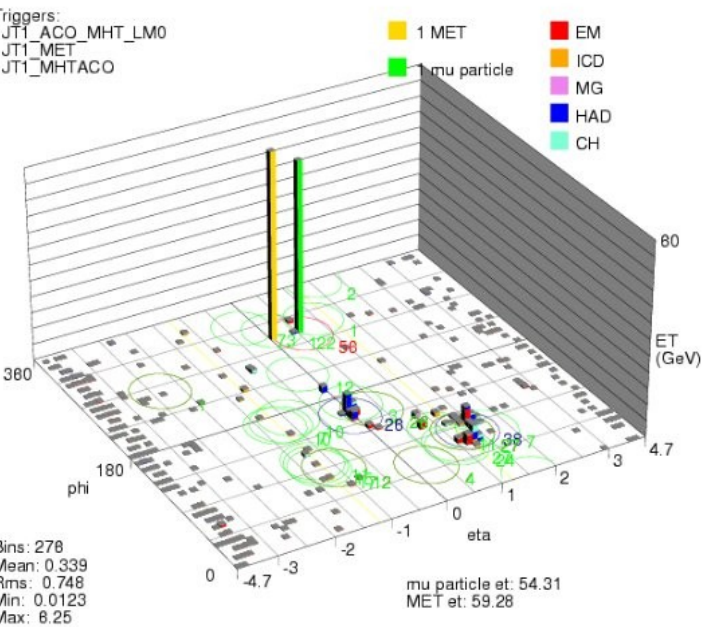# Other works in progress

# QCD sample: checks

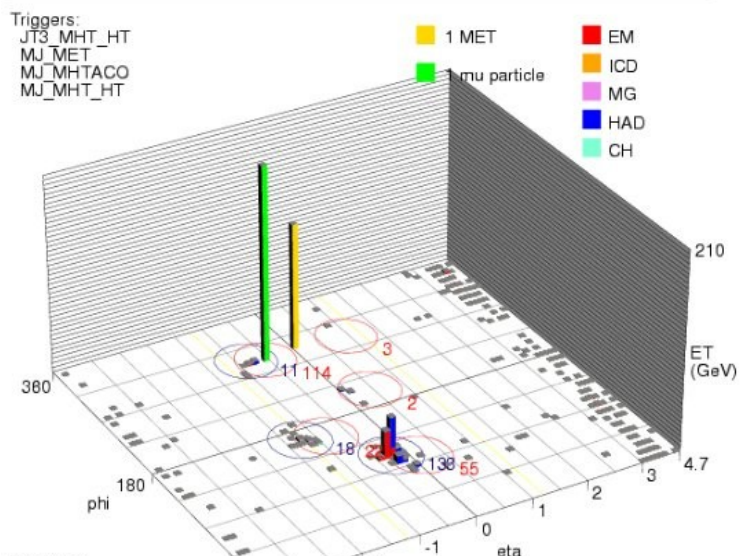◆ Is this bump expected in Metsignificance for QCD events
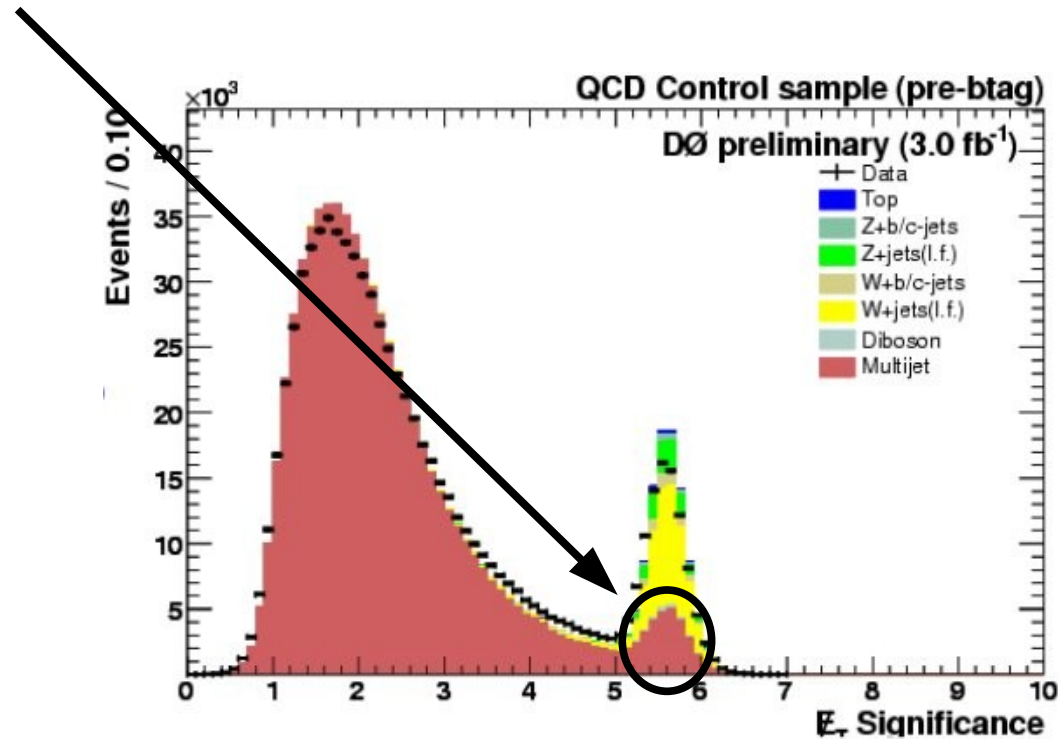


→ Event displays on the next slide

(events taken from analysis sample)
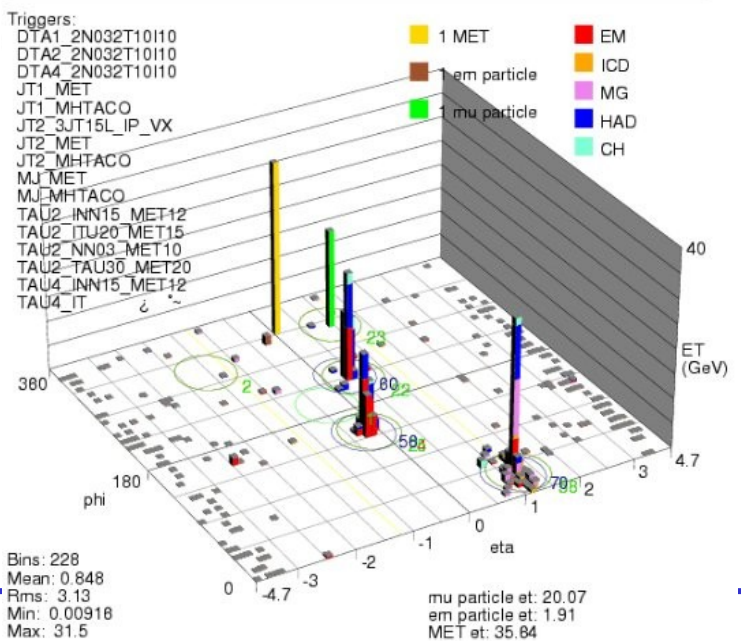
# Select events in the bump



Run 229475 Evt 25798594 Sun Jan 7 13:42:13 2007

- ◈ Found events with a muon in the bottom hole
  - ► Nice to see we are really complementary to WH ;)
  - ► In the analysis, this EW contribution is removed by subtracting the EW MC to the QCD sample
- ◈ Want to preform other studies to be sure the EW is fully removed from QCD estimation

Samuel Calvet        ZH → vvbb

# JESMU/JER impact

Di-jet invariant mass



WH(115)

ZH(115)
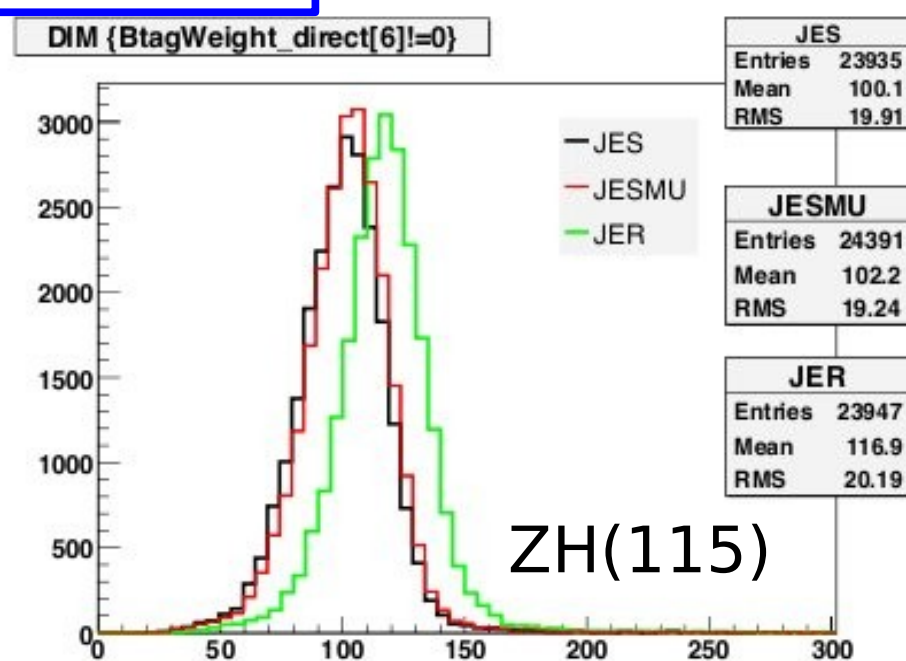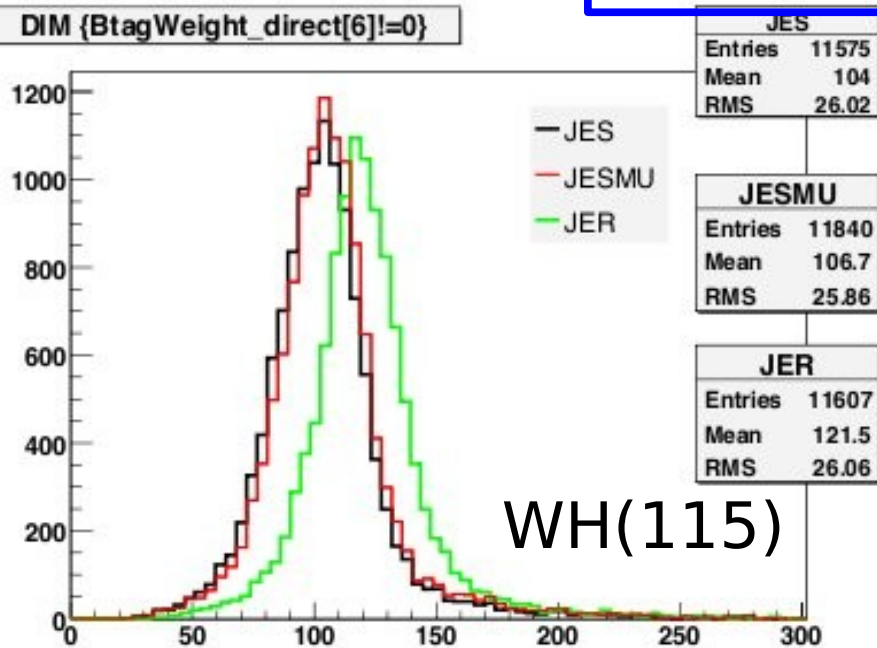
- ◆ JER does its job !
- ◆ Still need to see what happens to background

# Scale factor for V+HF: S_HF

(1)
$$S_{HF} = \frac{(\text{Data}' - X') * W'' - (\text{Data}'' - X'') * W'}{(\text{Data}'' - X'') * B' - (\text{Data}' - X') * B''}$$

where $W$ represents $(W/Z)_{lf}$ and $B$ represents $(W/Z)_{bb} + (W/Z)_{cc}$ and $X$ is all other backgrounds. The tag sample is denoted by the prime while the "anti-tag" is denoted by the double prime. The tag and anti-tag sample are chosen such that when combined they correspond to the full pre-tag sample. The result of the calculation is as follows:

| Tag | RunIIa EW | RunIIa Signl | RunIIb EW | RunIIb Signal |
|-----|-----------|-------------|-----------|---------------|
| 0 Tag | 1.16 | – | 1.49 | 1.02 |
| 1 Tag | 1.15 | – | 1.45 | 1.03 |
| 2 Tag | 1.18 | – | 1.61 | 0.97 |
| Average | $1.16 \pm 0.02$ | – | $1.52 \pm 0.09$ | $1.01 \pm 0.04$ |

TABLE 1. $S_{HF}$ calculated by J.-F. according to DØNote 5406

- Use event numbers in 0, 1 and 2-tag samples to determine S_HF
- Nice agreement for a given sample
- Disagreement between RunIIa and RunIIb EW control samples not yet understood
- Disagreement between EW and signal samples for RunIIb (effect of different cuts ?)
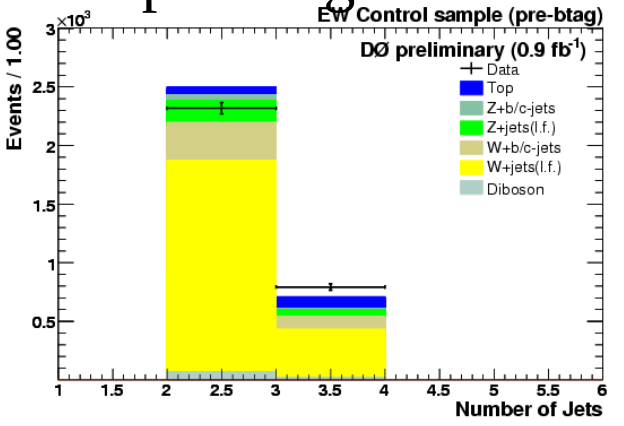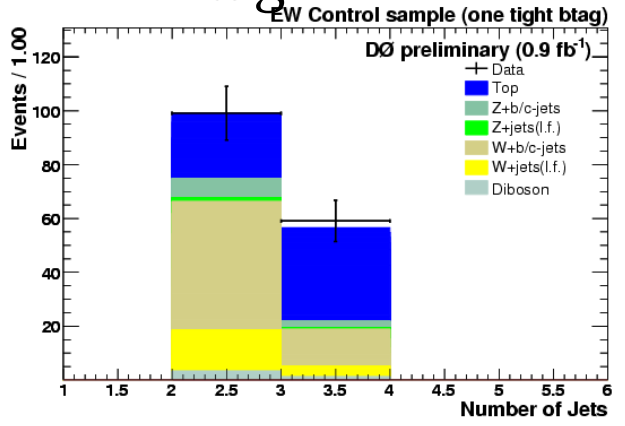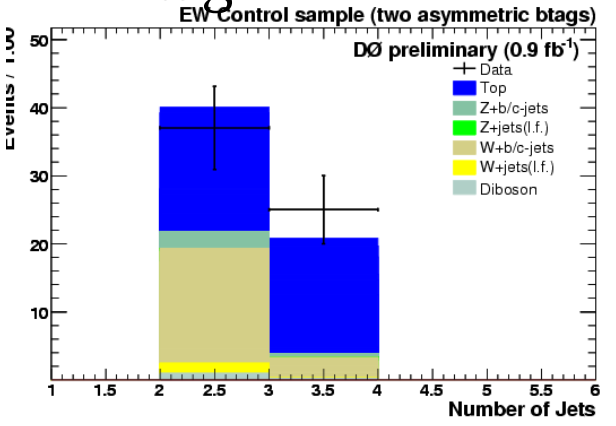
# Scale factor for V+HF: S_HF

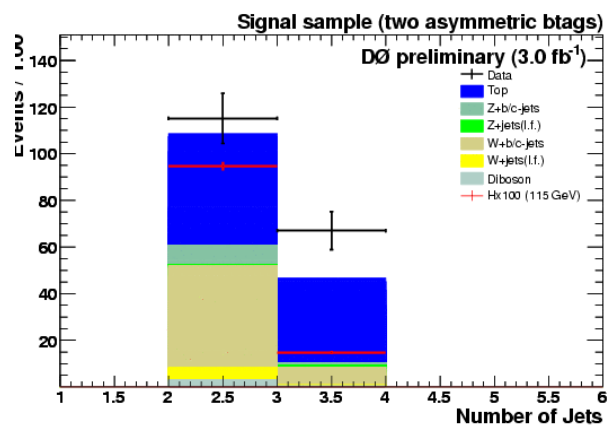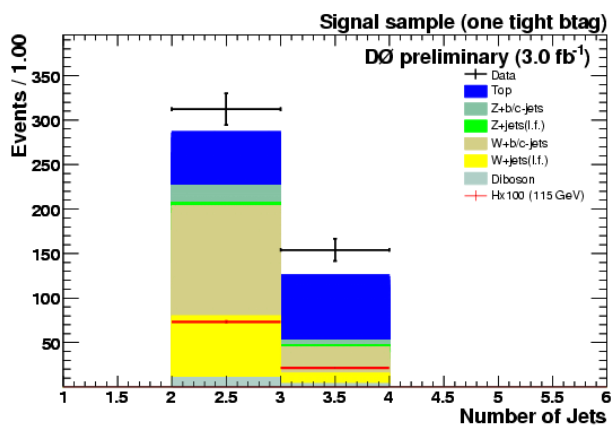RunIIa, EW control sample
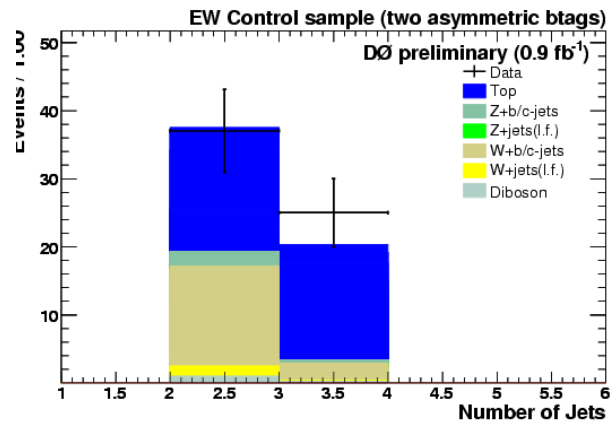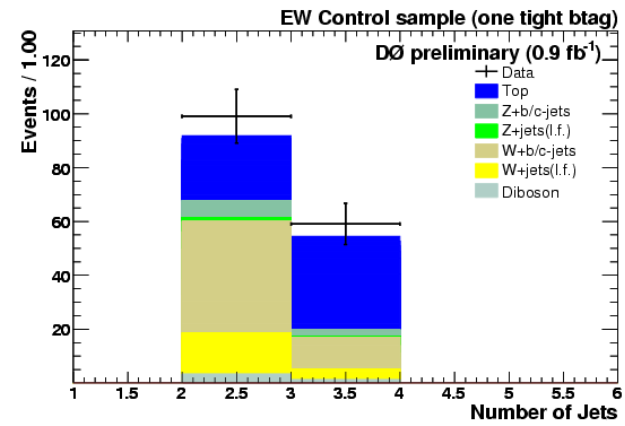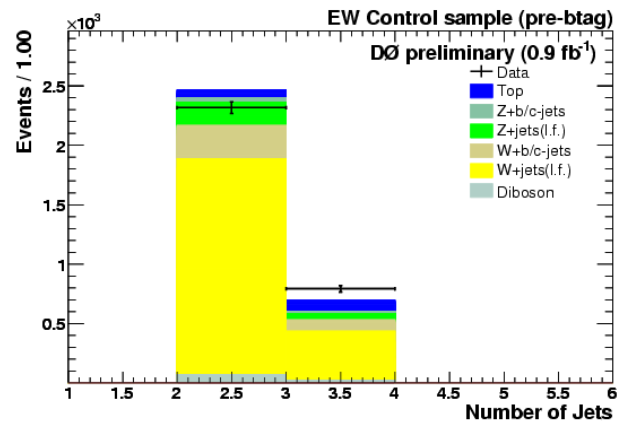
S_HF=1



pre-btag

1-tag

2-tag
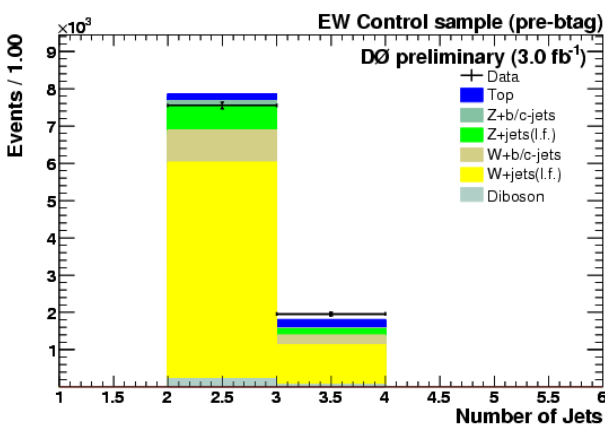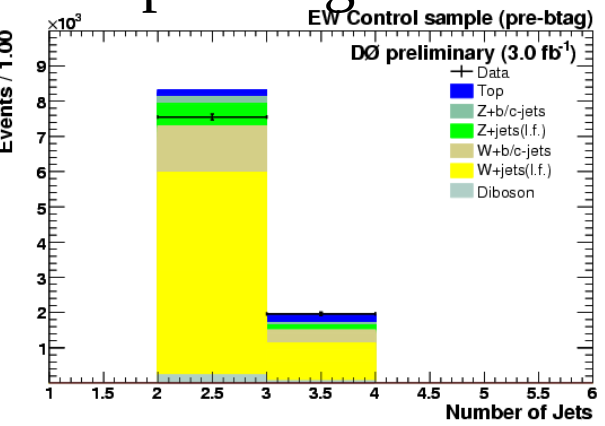


S_HF=1.16

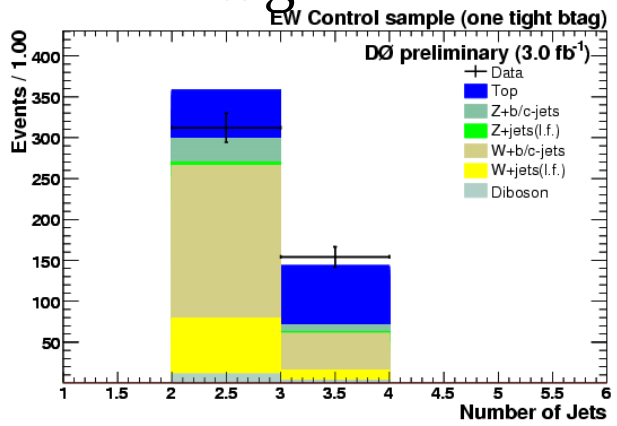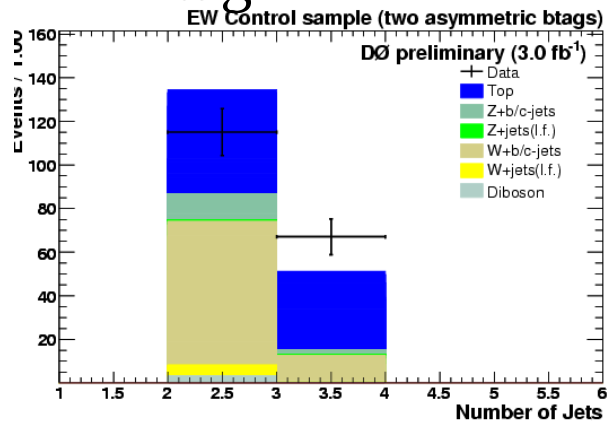# Scale factor for V+HF: S_HF

RunIIb, EW control sample

S_HF=1



pre-btag

1-tag

2-tag

S_HF=1.52

# Other incoming works

- Shapes in EW control sample of RunIIa could be improved
  - Check the trigger simulation (need of re-calibration?)

- Try to understand why there is so much QCD in RunIIa

- Try to understand the "so good" CDF limit

- Split the analysis according to the jet multiplicity

- Split the analysis according to the presence of an isolated track
  - Some work to do on the efficiency

- Aim publication ASAP !!

# Backup