

Higgs Analysis : $WH \rightarrow l\nu b\bar{b}$

The analysis so far.

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Higgs Analysis

Outline

- Motivation.
- Strategy.
- Event selection.
- μ and Missing E_T plots.
- Resolutions.
- W transverse mass + n jets.

Environment

- Athena Release 14.1.0
- MC : WH120bb sample :
- *valid1.005850.WH120bb_pythia.recon.AOD.e322_s412_r386*

Motivation

Motivation

- Looking for light Higgs $110 \rightarrow 140$ GeV
- Looking at the channel $WH \rightarrow l\nu b\bar{b}$.

Top is a large background

- Need to explicitly reject top events.
- To do this effectively \Rightarrow need to identify top events.

$$t\bar{t} \rightarrow W^+b + W^-\bar{b}$$

$$t \rightarrow Wb$$

$$Wt \rightarrow Wb + \text{jets}$$

- $H \rightarrow b\bar{b}$ will be a background to top.
- Overlap of tools required.
- I want some of your background, you want some of mine.

strategy

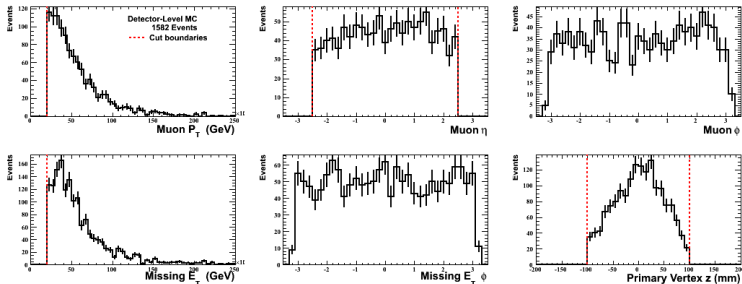
Analysis plan

- 2 different analysis:
 - Analyse the Detector-Level MC - treat as “data”
 - Analyse the Hadron-Level MC
- Useful strategy to test and tune algorithms.

Selection Cuts - μ channel only (for now)

- **No trigger implemented yet.**
- Require good primary vertex with $|Z_{vtx}| \leq 100mm$
- Require Missing $E_T > 20$ GeV (using MET_RefFinal)
- Require only 1 μ with: (using StacoMuonCollection)
 - $E_T > 20$ GeV; $|\eta| < 2.5$;
 - **No isolation cut yet.**
- Reconstruct W transverse mass and measure how many jets.
- **Need to tag b jets and then reconstruct Higgs mass.**

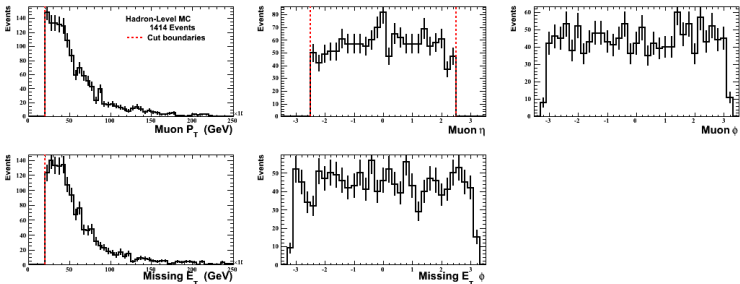
Detector-Level MC : μ Channel



Detector-Level plots

- 1582 μ events passed the selection cuts.
- Cut boundaries shown by red dashed lines.
- The μ and Missing E_T are reconstructed into a W .

Hadron-Level MC : μ Channel

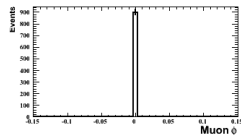
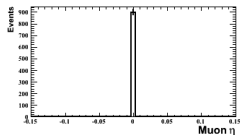
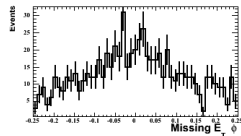
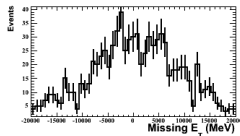
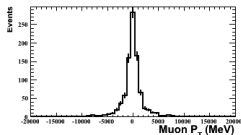


Hadron-Level plots

- 1414 μ events passed the selection cuts.
- Cut boundaries shown by red dashed lines.
- The μ and Missing E_T are reconstructed into a W .

Resolution of μ and Missing E_T . DL - HL

Resolutions DL - HL

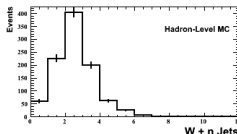
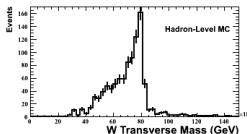
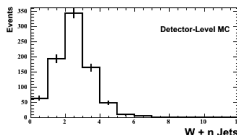
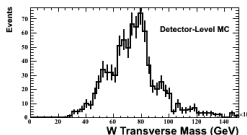


Resolutions give information about the detector response

- Missing E_T and ϕ^{ME_T} not always matched to ν^μ very well.
- $\sigma_{ME_T} = 9.0 \pm 0.4 \text{ GeV}$ $\sigma_{ME_T\phi} = 0.14 \pm 0.008$
- Excellent η , ϕ resolution for μ . $\sigma_{\mu P_T} = 1.09 \pm 0.005 \text{ GeV}$
- Want more stats to get a better idea of resolutions.

W Transverse Mass + n Jets

$$M_W^{\text{trans}} = 2 \cdot E_T^{ME_T} \cdot E_T^\mu \cdot (1.0 - \cos(\phi^{ME_T} - \phi^\mu))$$



W Transverse Mass + n Jets

- **No background.**
- W boson transverse mass measured using the above formula.
- W transverse mass found to be correct range.
- Large resolution of missing E_T leads to W transverse mass being broader at the detector-level than at the hadron-level.

Purity and efficiency of W sample

Quality of W sample

- Any given event may fall into 3 categories:
 - Passes DL cuts and passes HL cuts;
 - Passes DL cuts and fails HL cuts;
 - Fails DL cuts and passes HL cuts.
- I am defining the purity(π) and efficiency(ϵ) of a sample as:

$$\pi = \frac{\# \text{ Events Pass DL \& Pass HL}}{\text{Total \# Events Passing DL}}$$

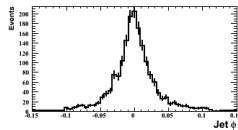
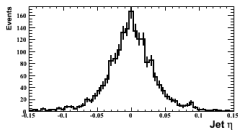
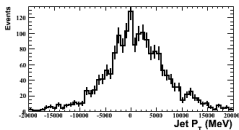
$$\epsilon = \frac{\# \text{ Events Pass DL \& Pass HL}}{\text{Total \# Events Passing HL}}$$

π and ϵ of W sample

- # events passing both DL and HL cuts = 644
- # events passing DL cuts and failing HL cuts = 185
- # events failing DL cuts and passing HL cuts = 334

$$\pi = 78\% \quad \epsilon = 67\%$$

Jet resolutions. DL - HL



Jet resolutions

- Jets are collections of particles with area on the η, ϕ plane.
- The η, ϕ is on the jet primary axis, according to Snowmass.
- \therefore The resolution of jets is much broader than that of leptons.

$$\mu_{P_T^{\text{Jet}}} = 1.11 \pm 0.14 \text{ GeV}; \sigma_{P_T^{\text{Jet}}} = 5.65 \pm 0.13 \text{ GeV}$$

$$\mu_{\eta^{\text{Jet}}} \approx \mu_{\phi^{\text{Jet}}} \approx 0.0; \sigma_{\eta^{\text{Jet}}} = 0.03 \pm 0.001; \sigma_{\phi^{\text{Jet}}} = 0.02 \pm 0.001$$

I am using the following Jet finders

- For the Detector-Level jets : Cone4H1TowerParticleJets
- For the Hadron-Level jets : Cone4TruthParticleJets

The next steps

An analysis in progress. Still much to do.

- Implement Trigger.
- Isolation cuts around leptons.
- Tag b jets.
 - Essential to Higgs measurement.
 - Implement tools from b physics group.
- Tag top jets for rejection.
- Study backgrounds.
- Get more sample MC.