Tips of VBF analysis in CAF

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VBF CAF Cheat Sheet

- To reproduce Moriond VBF analysis, set the following flags to "true" in CAF:

  (In Read*config:)
  doVBFStyle
  applyVBFSFcorr
  useVBFSFABCD

  (In Run*config)
  doVBFSF

  (In both configs)
  doVBFZttCF

VBF CAF Cheat Sheet

- (In Run*config) Use the following cut definition files
  `HWWAnalysis.cutDefinitions: definitions/HWW_Cuts_2012.txt,definitions/HWW_Cuts_2012_VBFTopZCR.txt`
- For more information, search these options in Run*cxx for VBF-related blocks of codes.
- Today I will walk you through these options.

doVBFStyle

- This is the "fundamental" flag that sets up the VBF analysis.
  - → Print 2-jet cutflows
  - → Separate VBF+VH and ggF
  - → Add ggF to total bkg (in NF calculations too!)
  - → Separate $Z \to ee/\mu\mu$ and $Z \to \tau\tau$ (more later)

doVBFSF

- This is needed for running over same flavor channels.

  → Automatically add the file HWW_Cuts_2012_VBFSFCorr.txt into cut definitions.

  → Include Sherpa EW Z+jets samples *to a different sample folder* "ZjetsEW"

  → Generalize histograms at the level of Zjets/*/ee (mm,tt) instead of Zjets/, due to different treatment of Z NF's (more later).

Interlude: NF's in VBF

Applying NF's

- There are three kinds of NF's used in VBF: SF Z/DY NF's (applied on $Z \rightarrow ee/\mu\mu$), $Z \rightarrow \tau\tau$ NF and "Correction Factor" (CF), and Top NF's.
- They are calculated in the following order:

  1) SF Z/DY NF's and $Z \rightarrow \tau\tau$ CF (derived from SF Z CR's)

  2) Top NF from Top CR (*including* NF/CF's from 1))

  3) $Z \rightarrow \tau\tau$ NF from $Z \rightarrow \tau\tau$ CR (*with* Top NF applied).

SF Z/DY NF's

- The background used in the calculation is defined as *Alpgen* $Z \rightarrow$ ee/μμ contribution in *SF* channel ("Z_eemm_path" in Run*cxx), and therefore only applied on these processes.
- In other words, no Sherpa EW Zjets and $Z \rightarrow \tau\tau$ involved.
- Reasons:

  1) The (MET) mis-modeling is known in Alpgen

  2) $Z \rightarrow \tau\tau$ contributes to ~25% bkg in SF in VBF. Correct $Z \rightarrow \tau\tau$ separately.

SF Z/DY NF's

- We correct for two sources of mis-modeling: MET and VBF cuts.
- Two Z (+ 2-jet) CR's: Z-peak Z CR and inverted-MET Z CR (MET<45 GeV and MET_STVF<35 GeV).
- Derive MET NF in the Z-peak Z CR. Applied in SR until the Mll<60 GeV cut. This NF = 0.77 +/- 0.01 from 20.7 fb-1

  → For Mll<60 GeV and ΔΦll<1.8, use ABCD method (next slide).
- Derive VBF cut efficiency "correction factor" (CF) in the inverted-MET Z CR.

  → CF = NF_cut/NF_MET applied at each cut in SR.
  → For Top CR, using the same procedure with exact 1-btag in Z CR.

SF Z/DY NF's: The ABCD method

- Baseline selection: 2-jet, b-veto, Pttot<45 GeV, and Mjj>500 GeV (due to correlation between Mjj and MET).
- $$NF_{ABCD} = f_{corr} \cdot B_{data} \cdot \frac{C_{data}}{D_{data}} / A_{MC\ prediction} \text{ or } \frac{B_{data} \cdot \frac{C_{data}}{D_{data}}}{B_{MC} \cdot \frac{C_{MC}}{D_{MC}}} \text{ with } f_{corr} = \frac{A_{ZMC}/B_{ZMC}}{C_{zMC}/D_{zMC}}$$

A (SR): $m_{\ell\ell} < 60$GeV high MET	B: $\lvert m_{\ell\ell} - mz \rvert < 15$GeV high MET
C : $m_{\ell\ell} < 60$GeV low MET	D: $\lvert m_{\ell\ell} - mz \rvert < 15$GeV low MET

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0.81 +/- 0.06

1.03+/- 0.10

A (SR): $m_{\ell\ell} < 60$GeV high MET	B: $\lvert m_{\ell\ell} - mz \rvert < 15$GeV high MET
C : $m_{\ell\ell} < 60$GeV low MET	D: $\lvert m_{\ell\ell} - mz \rvert < 15$GeV low MET

$Z \rightarrow \tau\tau$

- Two factors used in $Z \rightarrow \tau\tau$ correction, in *both* SF and DF.

  1) $Z \rightarrow \tau\tau$ NF derived from $Z \rightarrow \tau\tau$ CR (b-veto, Pttot, Mll<80 GeV and $\Delta\varphi$_ll>2.8, with Top NF at Pttot cut applied. *DF only*.)

  2) $Z \rightarrow \tau\tau$ Correction Factor ("CF") for VBF cuts (DYjj/Mjj/CJV/OLV): CF = NF_cut/NF_Pttot

  – using SF Z-peak CR (most $Z \rightarrow \tau\tau$ bkg comes from "Z-peak")

  – the low-MET Z CR is used for systematics

Back to CAF: How to get Z NF's?

SF Z/DY NF's

- (In Read*config)
  Set applyVBFSFcorr to true: VBF cut CF from low-MET Z CR
  Set useVBFSFABCD to true: MET correction w/ ABCD method

doVBFZttCF

- (In Run* and Read*config)
  Set doVBFZttCF to true: calculate the default and systematic Ztautau CF from SF Z CR's.
- Will print both values when producing cutflows:

  HWWAnalysisCode 2012: Ztautau(incl)2jet CF for SR and Top CR from SF Z CR = ...
  → The value from Z-peak Z CR. Applied in Top CR and SR.

  HWWAnalysisCode 2012: Ztautau(incl)2jet CF for SR and Top CR from Alternative SF Z CR = ...
  → The value from low-MET Z CR.

doVBFZttCF

- Must include ee/mm channels.
- If set to false, use the hard-coded value 1.297 from HCP.

Outlook

- One remark: Currently the $Z \rightarrow ee/\mu\mu$ and $Z \rightarrow \tau\tau$ are corrected separately in SF (e.g. `bkg/ee/Zjets/?/?/tt`). In DF $Z \rightarrow \tau\tau$ NF/CF are applied on all (Alpgen) Zjets (e.g. `bkg/em/Zjets`).

  $\rightarrow$ Negligible $Z \rightarrow ee/\mu\mu$ MC predictions in DF.
  $\rightarrow$ May still modify DF for consistency.

- The Moriond procedure is bound to modified with the improvements foreseen. Your involvement is welcome!

Backup

Other tips

- Other tips: Comment out most 0/1-jet cut definitions for faster running; doPlots to false for only cutflows; changes made in signal stack.