Update in VBF Higgs CP test

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Optimal observable

Optimal observable:

- First order: $OO_1 = \frac{2\Re(\mathcal{M}^*_{SM}\mathcal{M}_{CP-odd})}{|\mathcal{M}_{SM}|^2}$ Mean value should be 0
- Second order: $OO_2 = \frac{|\mathcal{M}_{CP-odd}|^2}{|\mathcal{M}_{SM}|^2}$ Not used yet

Matrix element for VBF production:

$$\mathcal{M} = \mathcal{M}_{\text{SM}} + \tilde{d} \cdot \mathcal{M}_{\text{CP-odd}}.$$

$$|\mathcal{M}|^2 = |\mathcal{M}_{\text{SM}}|^2 + \tilde{d} \cdot 2\Re(\mathcal{M}^*_{\text{SM}}\mathcal{M}_{\text{CP-odd}}) + \tilde{d}^2 \cdot |\mathcal{M}_{\text{CP-odd}}|^2 .$$

Calculating package: HLeptonCPRW

- getOptObs():

  Input: 4-vector of 2 jets and Higgs, pdf value(Bjorken x+Q value),

  Return: OO value (1st and 2nd order)

- getWeightsDtilde():

  Input: 4-vector of 2/3 final state jets and higgs, Bjorken x, flavor of initial + final quarks

  Return: 2 weight parameters $\widetilde{w}$.

  final weight $w = 1 + \widetilde{w}_1\tilde{d} + \widetilde{w}_2\tilde{d}^2$

Optimal observable

MC sample: ATLAS official MC

- mc16d.PowhegPy8_NNPDF30_VBFH125.MxAODDetailed.e6636_s3126_r10201_p3665.h024.root

Initial parton

- Quark flavor: TruthEventsAuxDyn.PDGID1, TruthEventsAuxDyn.PDGID2
- System Q: TruthEventsAuxDyn.Q
- Bjorken x: TruthEventsAuxDyn.X1, TruthEventsAuxDyn.X2

Final state jets

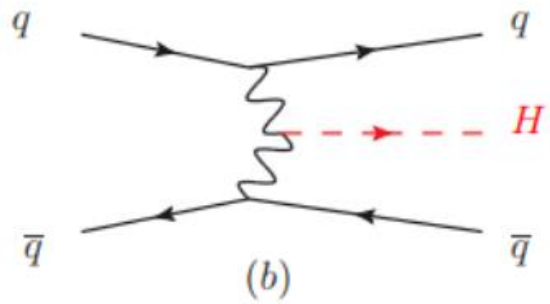
- Flavor: HGamAntiKt4EMTopoJetsAuxDyn.PartonTruthLabelID

Optimal observable

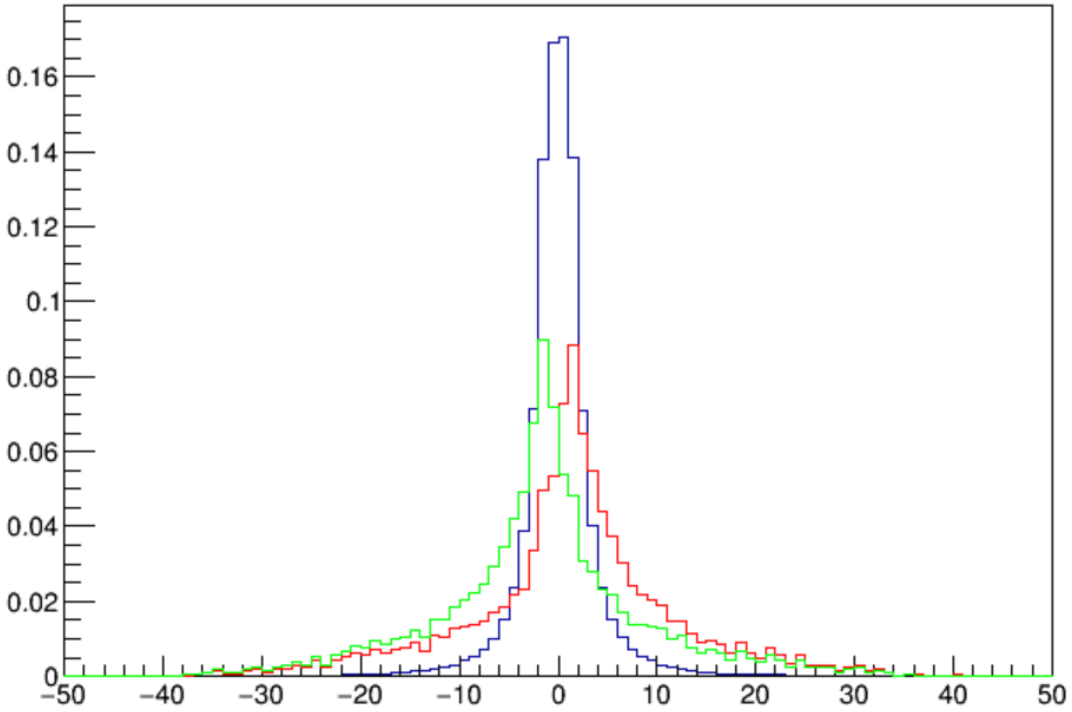
Some problem:

- VBF event is: $q_1 q_2 \rightarrow q_1 q_2 + \text{Higgs}$, the flavor of final state quark should be same as initial quark.

- But only ~1% events satisfy this requirement, so that I can calculate the weight value. This efficiency is much lower than selection efficiency(~7%)



Optimal observable



Blue: SM Higgs(d=0)
Red: d=0.5
Green: d=-0.5

The mean value and width of OO1 distribution might be both useful

OO1 distribution for different d value
CP mixing samples come from reweighting. Some large-weight events have been removed.

Optimal observable

Next step

- Check the flavor information in MxAOD
- Prepare hypothesis test sample and codes.