



Feasibility Study of Measuring the Higgs Self-coupling Using the Muon Collider

Kenny Jia

Jun 27th, 2022



Reconstruction of hadronically decaying di- τ

- For highly boosted Higgs to $\tau^+ \tau^-$ pairs, we reconstruct two anti- k_t jet with cone size $R = 0.2$, and requiring the following criteria:
 - charge product Q of the two leading di- τ jets = -1;
 - $\Sigma\text{TauTag} = 2$ for the tau-tagged jets pair;
 - In order to avoid selecting b jet fake tau, require $\Sigma \text{Btag} = 0$;
- Then for reconstructing the $b\bar{b}$ jets pair, we require:
 - $\Sigma\text{BTag} = 2$ for the $b\bar{b}$ jets pair;
 - Require $\Sigma\text{TauTag} = 0$, (Each b-tagged jets has $\Delta R > 0.5$ with each tau-tagged jet);

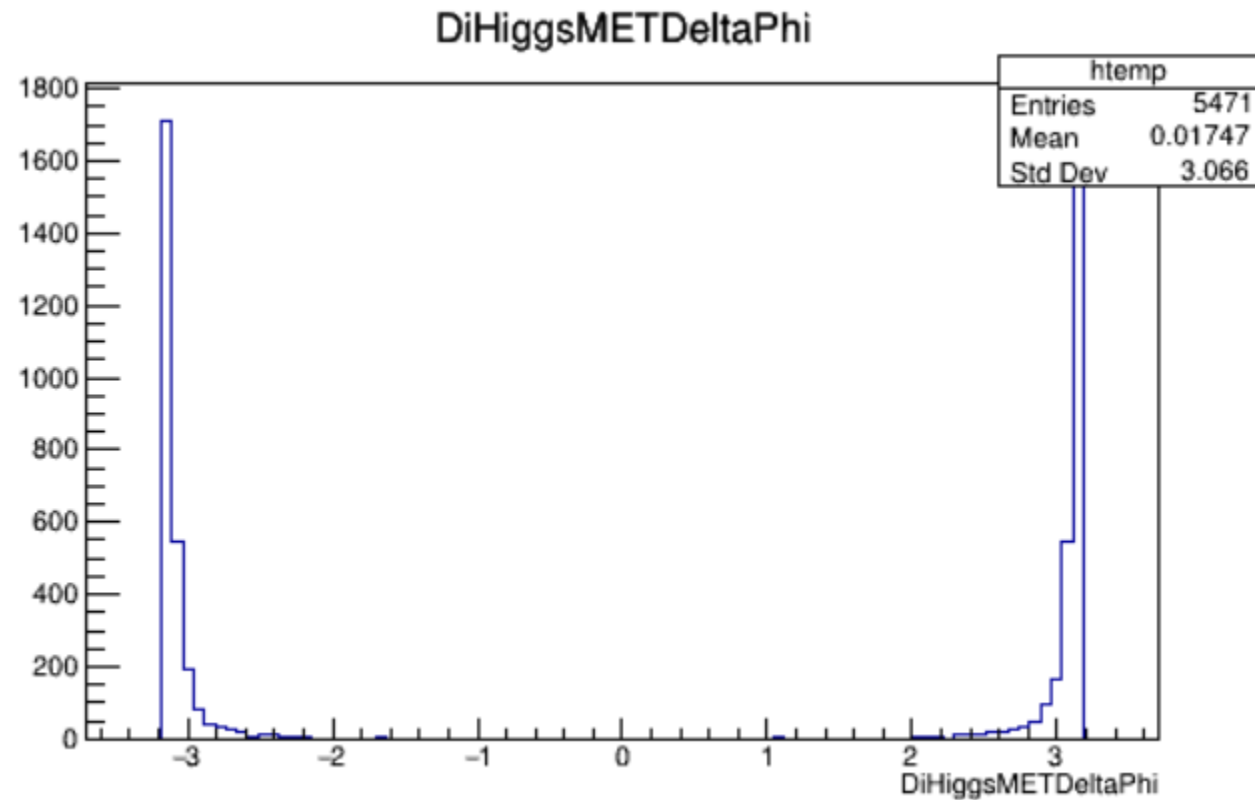


Result of selection

	vvHH	vvZH	vvqqH
Has three R02 jet and three R05 jet	37197	38615	49819
Two tau with opposite charge (expect 26.2%)	12535 22.7%	1141	979
Has two B jet (expect 33.2%)	6342 17%	206	143
Two b two tau (expect 21.3%)	5471 14.7%	166	111

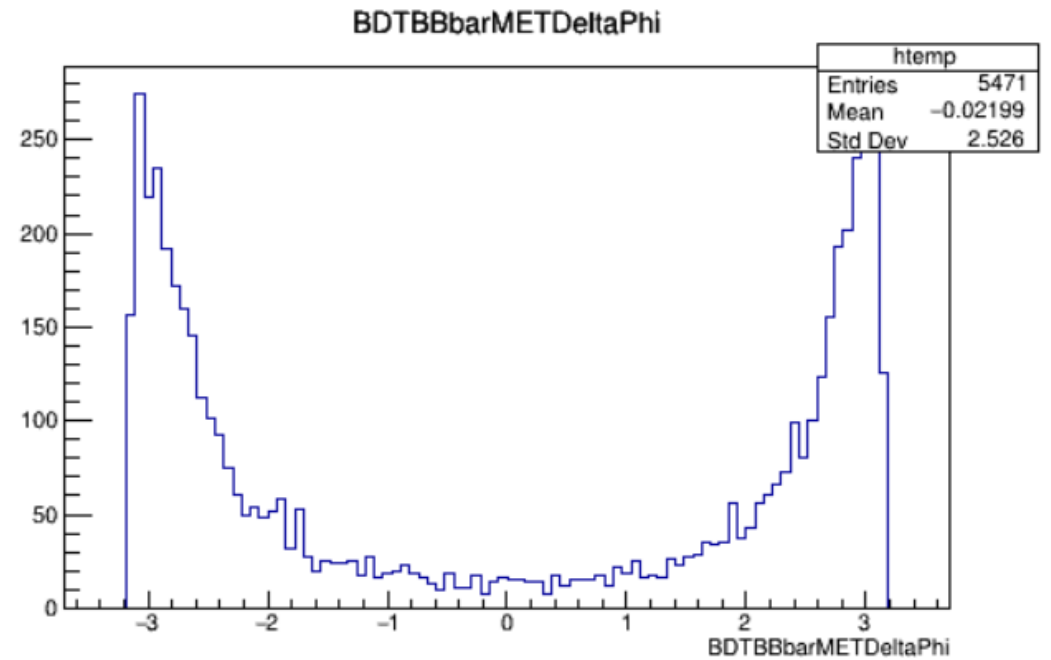
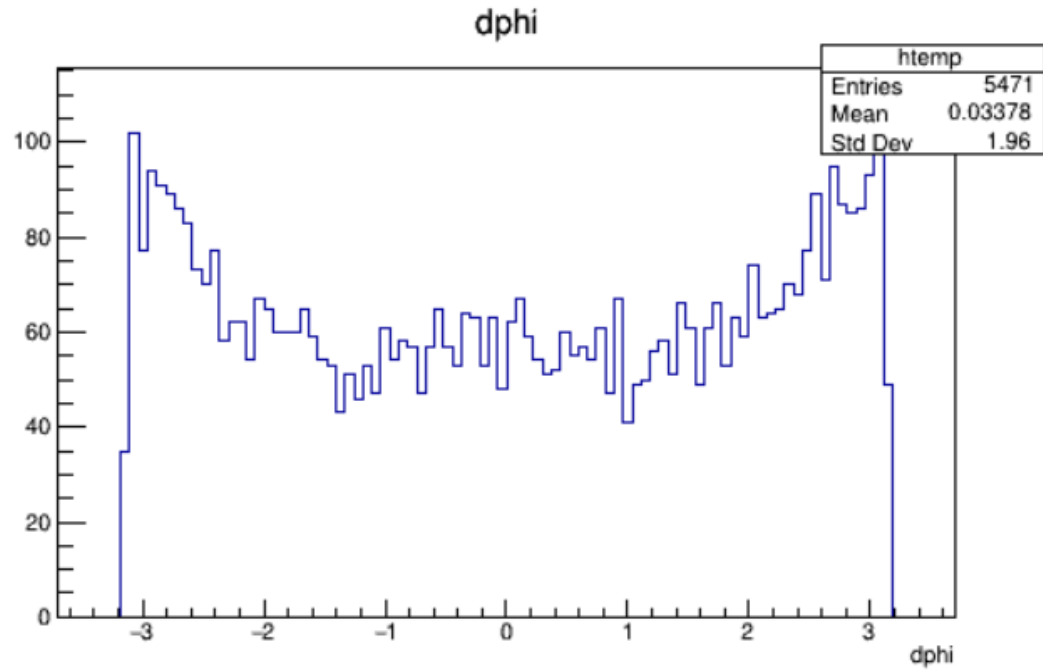


Deltaphi between MET and di-Higgs



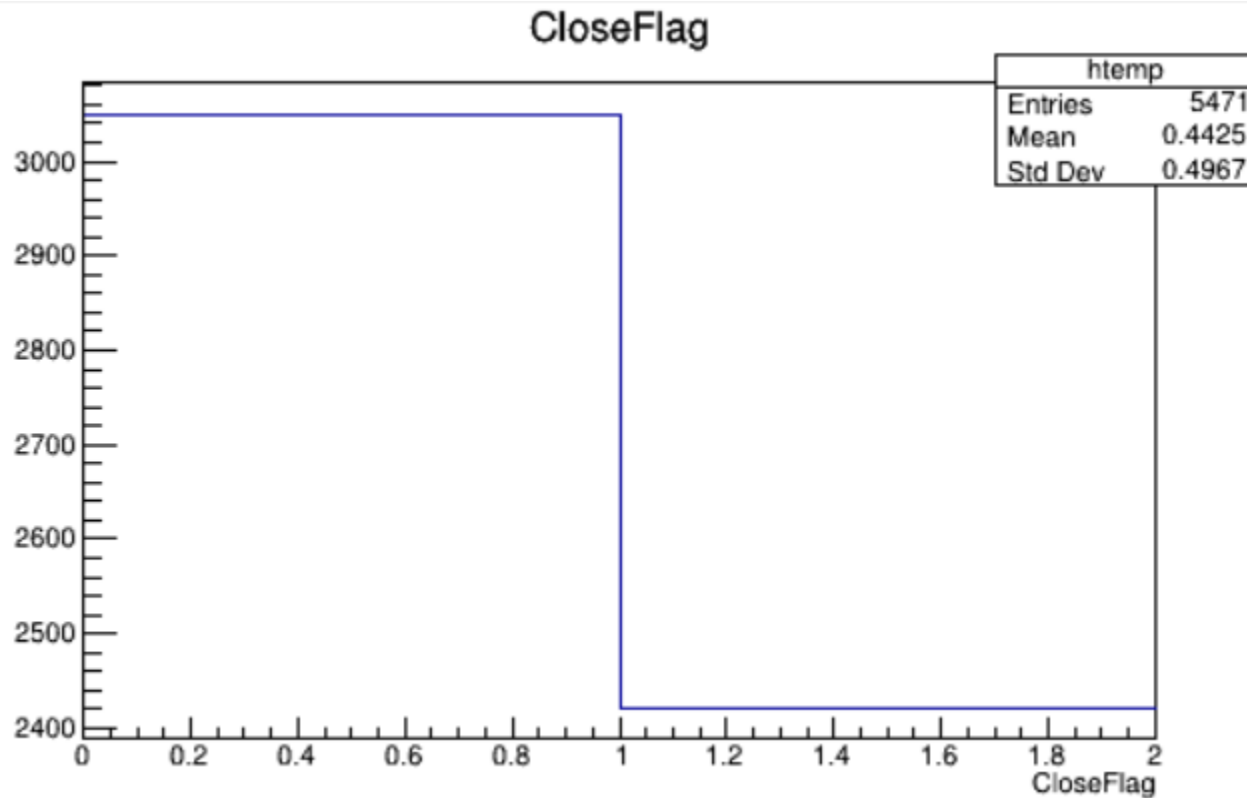


Deltaphi between MET and higgs





It's hard to tell with only phi





Should we use collinear mass for hadronic decay?

- Nice shift of mean value
- Very poor resolution
- Lost more than 50% events
- For more than half of the events MET are closer to $B\bar{B}$ bar
- But we could try for the reconstruction on leptonic decay.

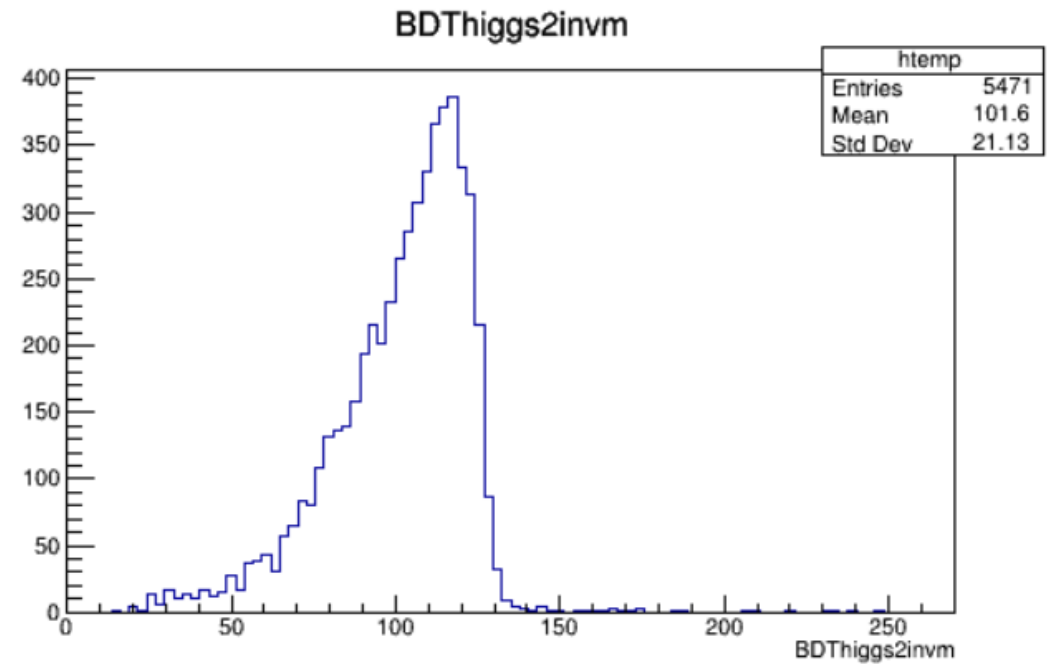
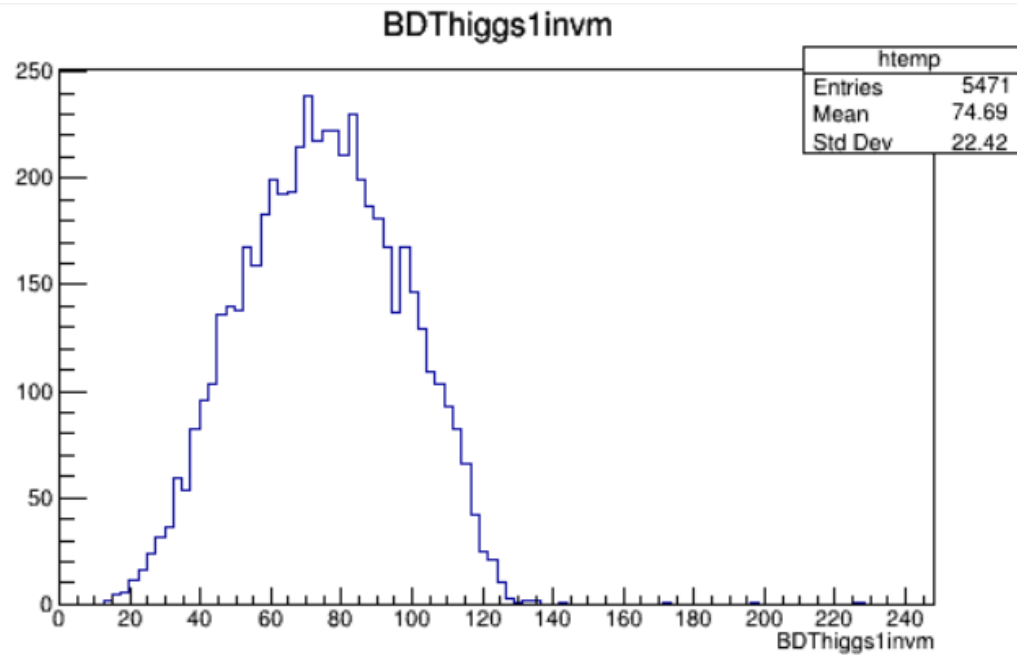


Ideas on reconstruct hadronic di-tau

- Use $H \rightarrow \tau\tau$ to approximate fraction of visible mass as a function of measurable variables like MET, MET direction, higgs p_T ?



Result of vvHH





Next step

- Write leptonic decay algo? Might need help on bugs



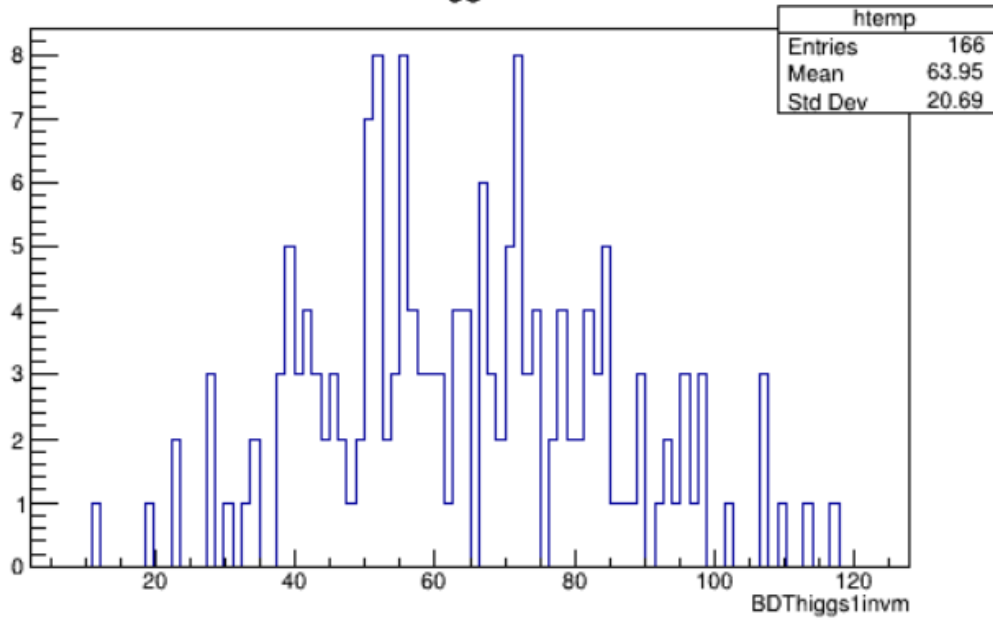
Where to access my code and result

- Pairing algorithm for both hadronic decay:
https://github.com/cvuosalo/MuonCollider/blob/main/Delphes/src/Pairing_tau_had.C
- Script for event generation:
 - https://github.com/cvuosalo/MuonCollider/blob/main/runMGjobs/runMG_job/delphes_card_MuonColliderDet_HHstudy.tcl
 - Other sub-script are in:
https://github.com/cvuosalo/MuonCollider/tree/main/runMGjobs/runMG_job/MuonCollider
- Result are accessible at:
 - root -l
/afs/hep.wisc.edu/home/hjia38/Delphes/delphes_dhiggs_sig+bkg_pairmass_tau_had_10TeV.
root

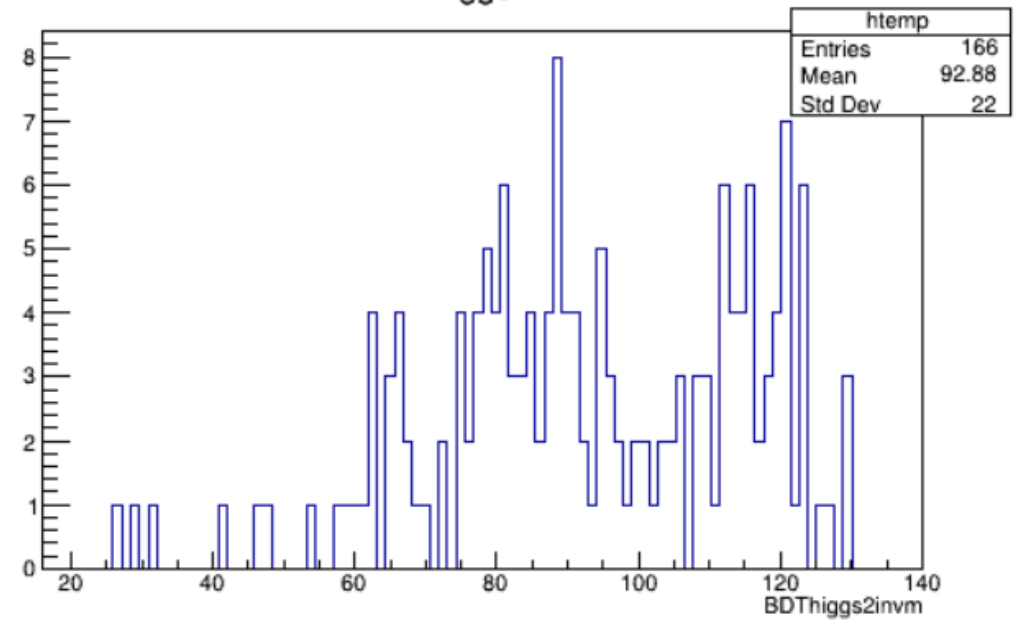


Result of vvZH

BDThiggs1invm



BDThiggs2invm





Result of vvqqH

