



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

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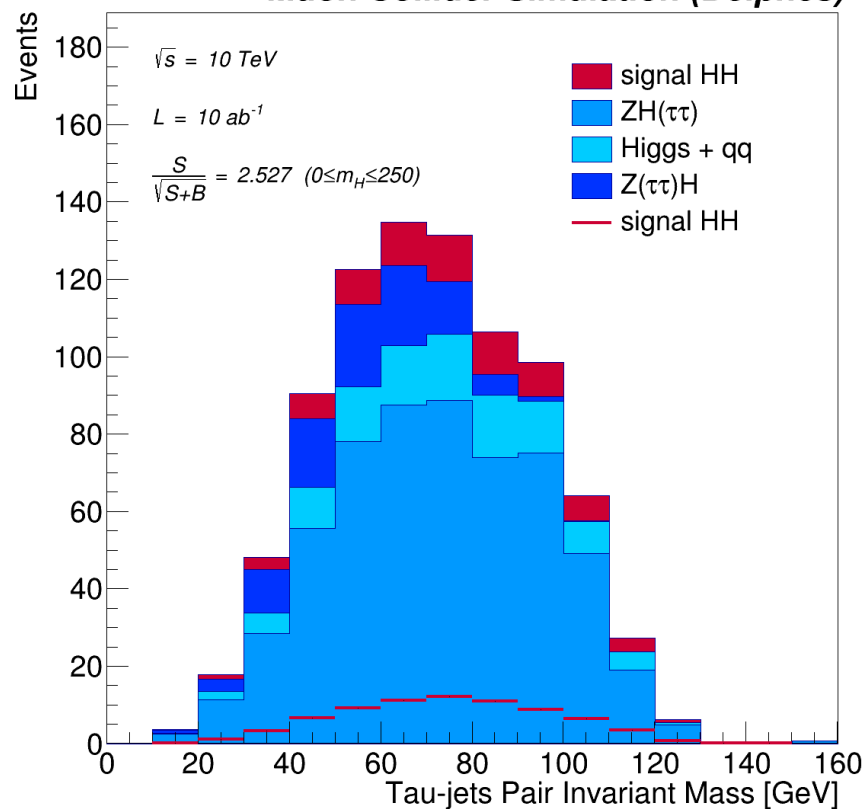


Reconstruction of hadronically decaying di- τ

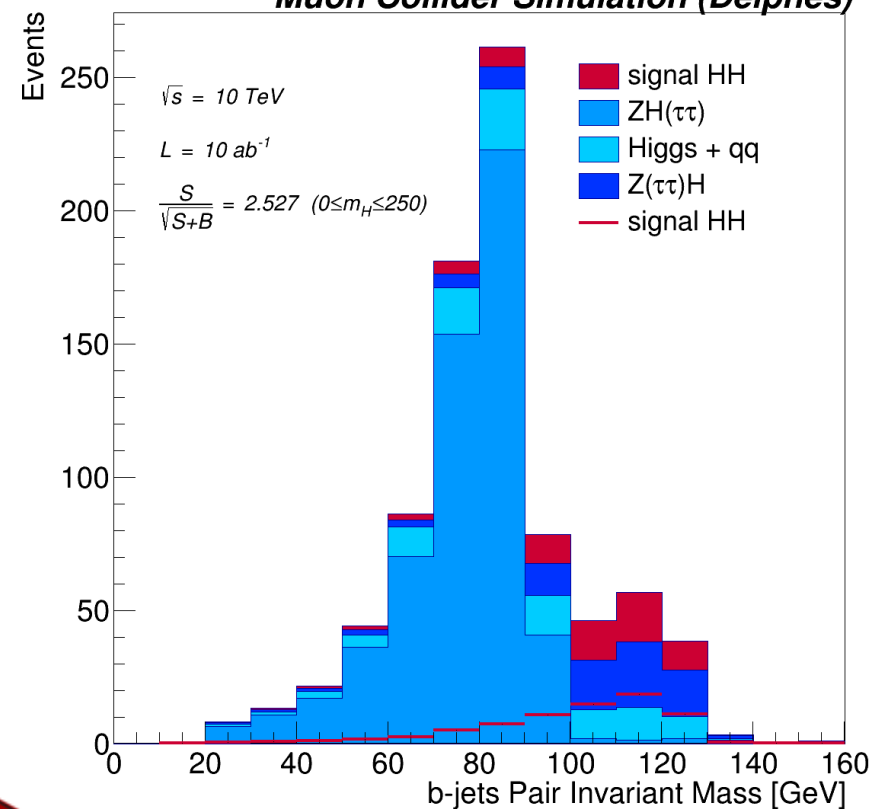
- For highly boosted Higgs to $\tau^+\tau^-$ pairs, we reconstruct two anti- k_t jet with cone size $R = 0.2$, and requiring the following criteria:
 - charge product Q of the two leading di- τ jets = -1;
 - $\Sigma\text{TauTag} = 2$ for the tau-tagged jets pair;
 - In order to avoid selecting b jet 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);



Muon Collider Simulation (Delphes)

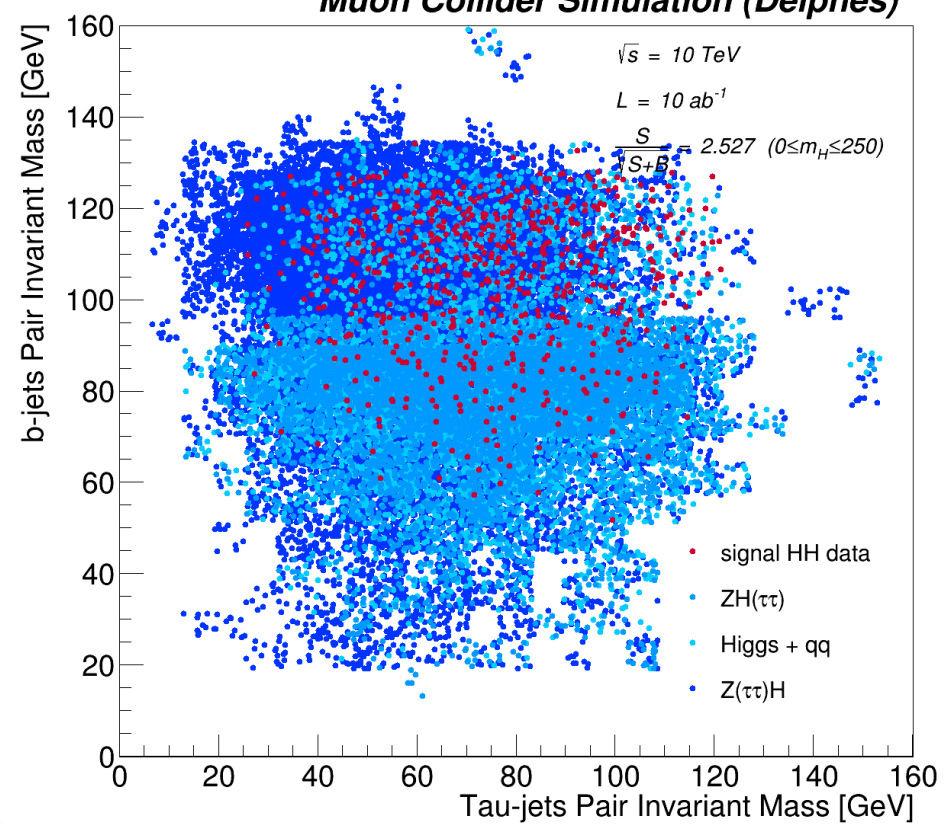


Muon Collider Simulation (Delphes)





Muon Collider Simulation (Delphes)



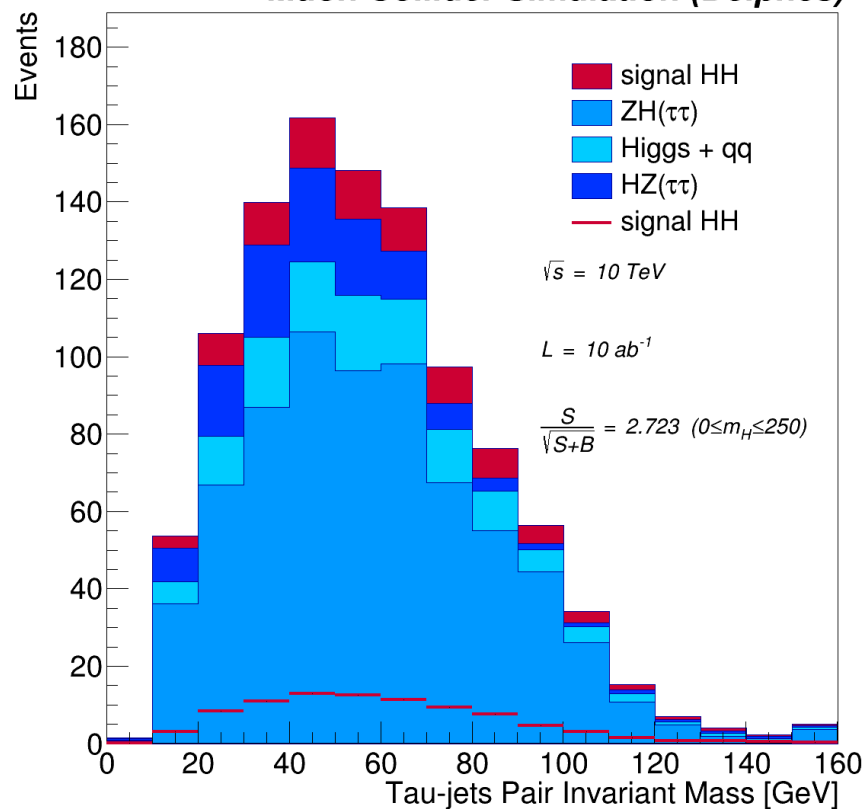


Reconstruction of one had one lep decaying di- τ

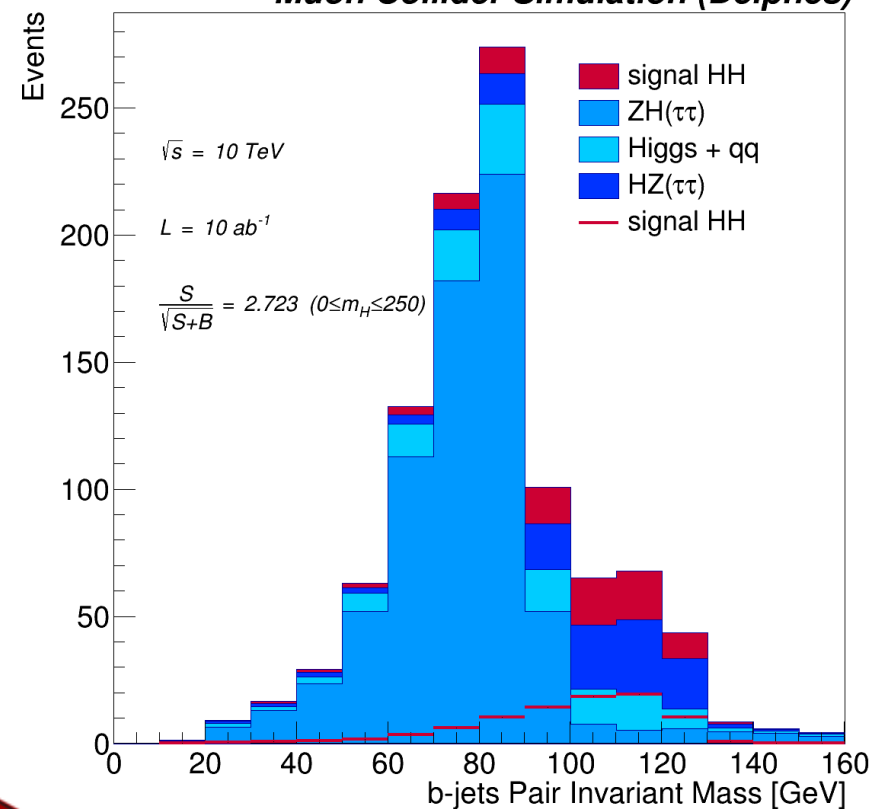
- Then for reconstructing the $b\bar{b}$ jets pair, we require:
 - $\Sigma\text{BTag} = 2$ for the $b\bar{b}$ jets pair;
- For highly boosted Higgs to $\tau^+\tau^-$ pairs, we find one anti- k_t jet with cone size $R = 0.5$ and an electron or muon, and requiring the following criteria:
 - charge product Q of the two leading di- τ jets = -1;
 - $\text{TauTag} = 1$ for the tau-tagged jet;
 - Tau-tagged jet is searched in the rest of the jet;
 - Requiring non-btag jet;

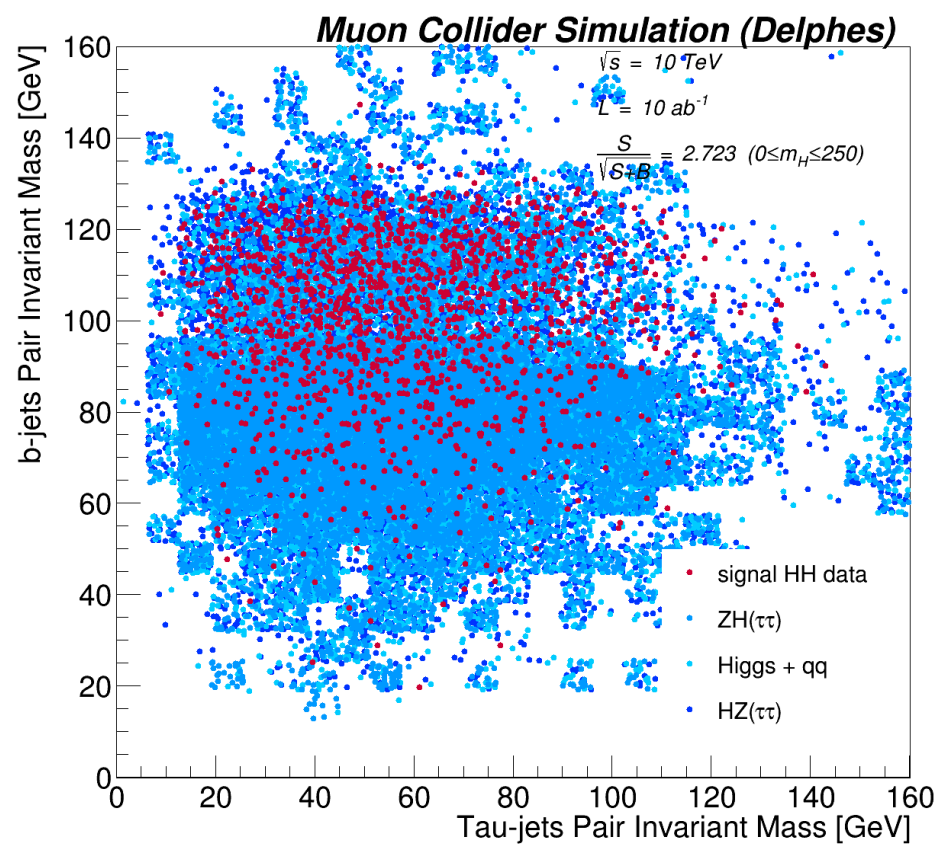


Muon Collider Simulation (Delphes)



Muon Collider Simulation (Delphes)

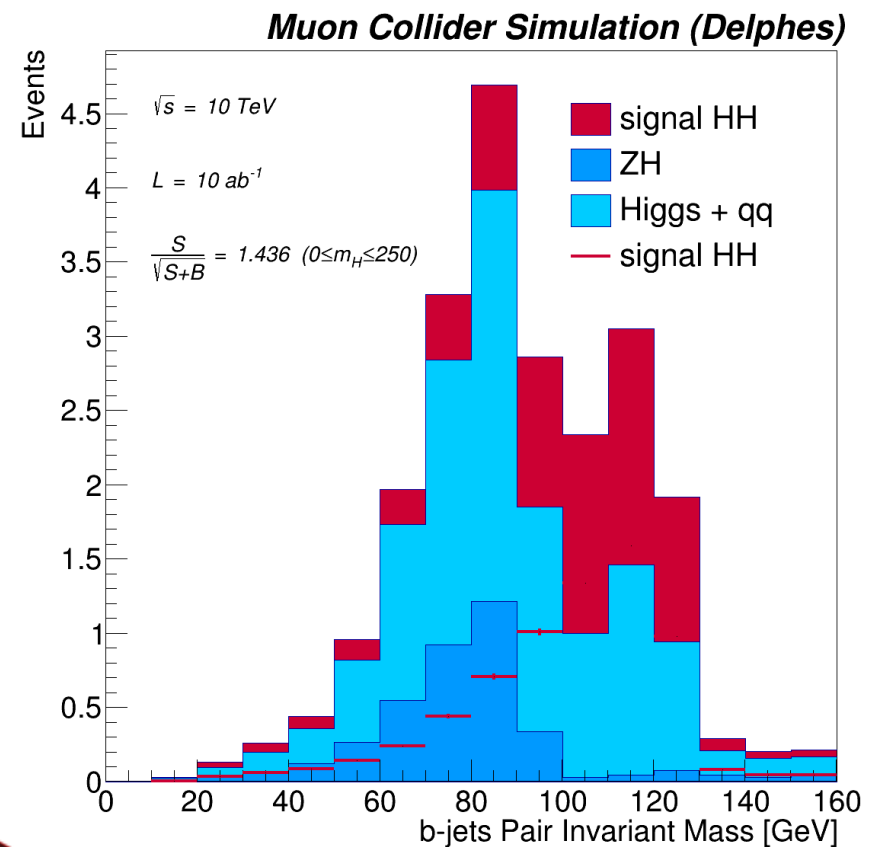
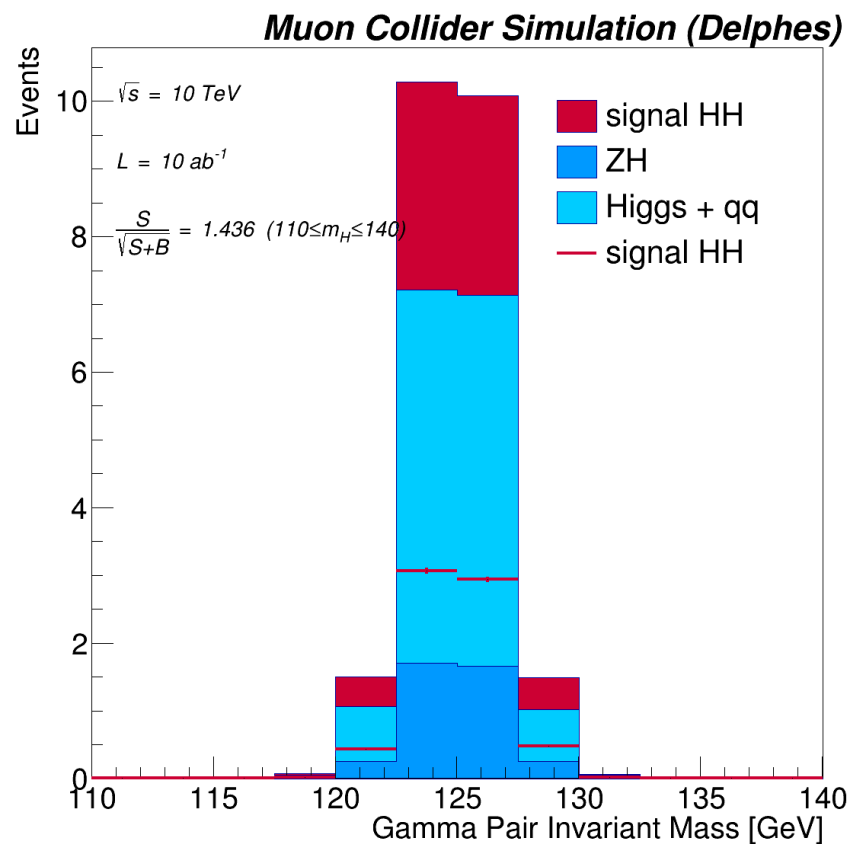


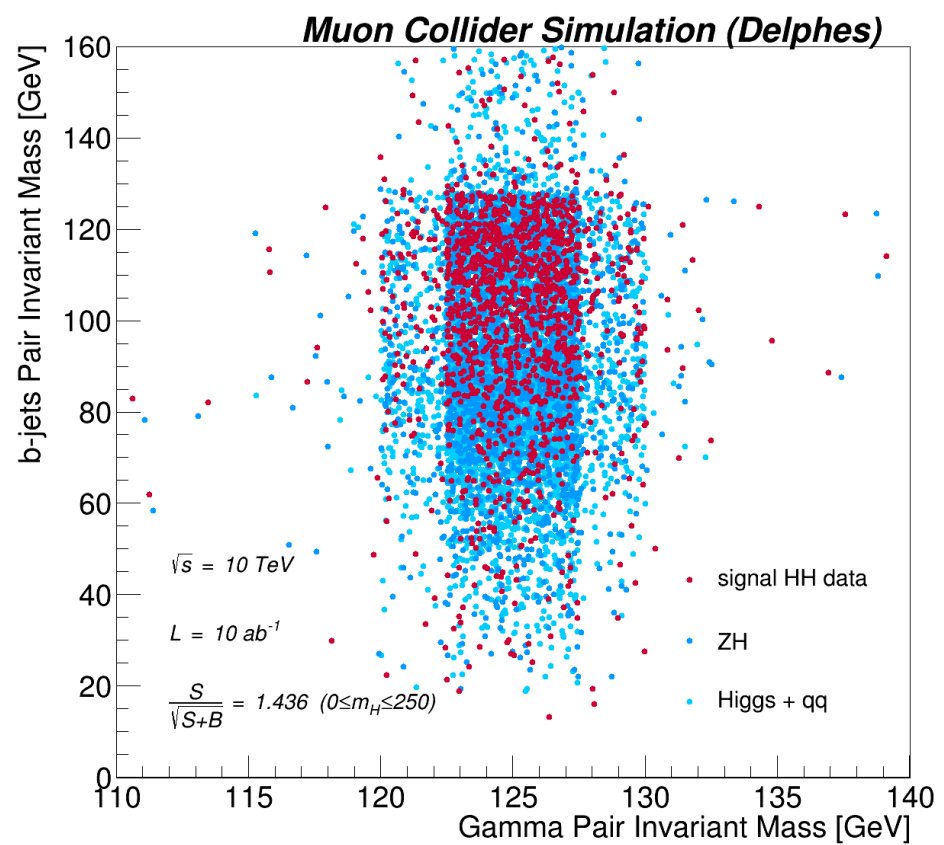




Reconstruction of $bb\gamma\gamma$

- For Higgs to $\gamma\gamma$ pairs, we reconstruct the Higgs with photon pairs which has the highest inv mass (requiring each photon with >15 pt avoiding selecting random photon). Cut on photon pair inv mass between 110 and 140.
- Then for reconstructing the $b\bar{b}$ jets pair, we require:
 - $\Sigma\text{BTag} = 2$ for the $b\bar{b}$ jets pair;
 - Require mass of each jet to be larger than zero since Delphes reconstruct high energy photon as jet too.







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
- Pairing algorithm for one had one lep decay:
https://github.com/cvuosalo/MuonCollider/blob/main/Delphes/src/Pairing_tau_mix.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