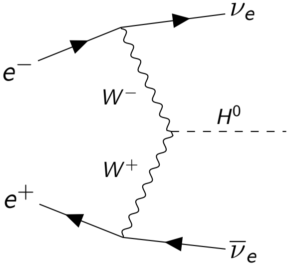
Study of the coupling constant g_{HWW} at ILC250

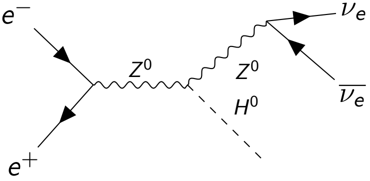
Nicolas Chadeau

23 june 2021

Theoretical aspect



$\mathcal{M} \propto g_{HWW}$



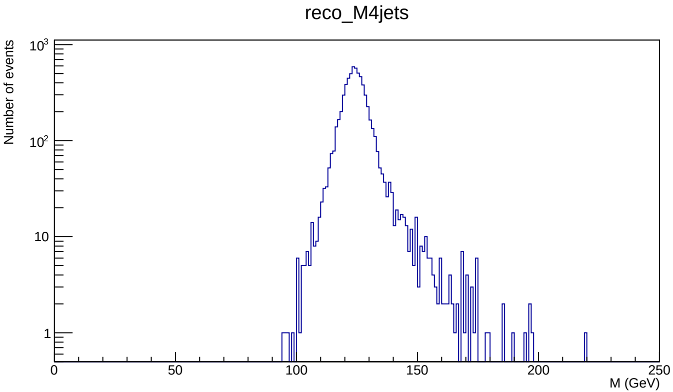
$\mathcal{M} \propto g_{HZZ}$

- Interferences :
  - $e_R p_L$: $\sigma_{RL} \propto g_{HZZ}^2$
  - $e_L p_R$: $\sigma_{LR} = a_1 g_{HZZ}^2 + a_2 g_{HWW}^2 + a_3 g_{HZZ} g_{HWW}$
- $H \to WW^*$: $Br \propto g_{HWW}^2$
- There's 2 possibilities :
  - $\Lambda = \frac{\sigma_{RL} Br}{A} = (g_{HZZ} g_{HWW})^2$ and $g_{HWW}^4 + (\frac{a_3\sqrt{\Lambda}}{a_2}) g_{HWW}^2 = \frac{\sigma_{LR} Br}{A a_2} - \frac{a_1 \Lambda}{a_2}$
  - $g_{HWW}^4 + (\frac{a_3 g_{HZZ}}{a_2}) g_{HWW}^3 + (\frac{a_1 g_{HZZ}^2}{a_2}) g_{HWW} = \frac{\sigma_{LR} Br}{A a_2}$ or $g_{HWW}^2 = \frac{\sigma_{RL} Br}{A g_{HZZ}^2}$

Pre-selection

2 cuts definitions :

- x values with more events than 5% of distribution's maximum are kept
- x values with more events than 10% of distribution's maximum are kept

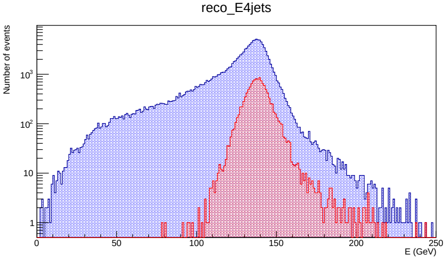


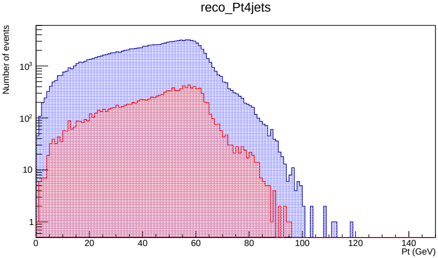
Pre-selection

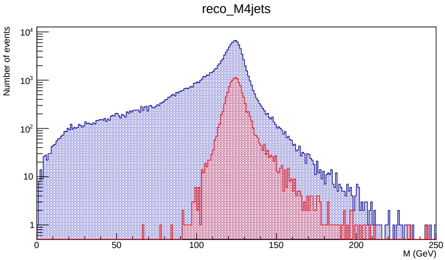
Based on a full hadronic process :

- Energy, transverse momentum and invariant mass of the 4 jets : reco_E4jets, reco_Pt4jets and reco_M4jets
- Energy, transverse momentum and invariant mass of the 2 W bosons :
  - reco_WBigMass_Energy, reco_WBigMass_Pt and reco_WBigMass_Mass
  - reco_WSmallMass_Energy, reco_WSmallMass_Pt and reco_WSmallMass_Mass
- Anglular distribution between the 2 jets coming from each W boson and the angular distribution between the 2 W bosons : reco_WBigMass_CosJets, reco_WSmallMass_CosJets and reco_Cos
- Number of jets with y_cut = 0.002 in the ee-kt-algorithm : reco_njets
- Jets parameters, $Y_{ij} = \frac{E_i E_j}{s}(1 - cos(\theta_{ij}))$: reco_Y12, reco_Y13, reco_Y14, reco_Y23, reco_Y24 and reco_Y34

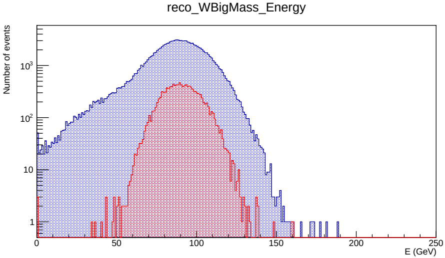
Pre-selection (nnh files only)

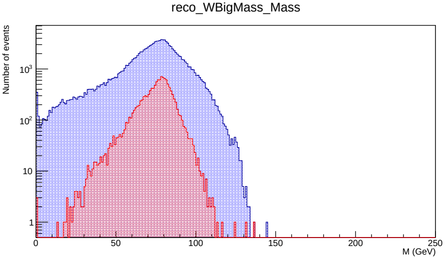


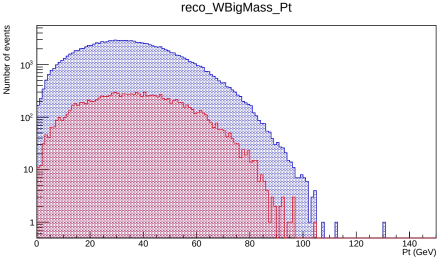


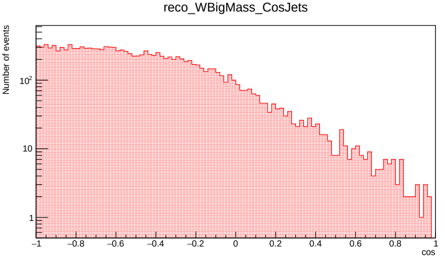


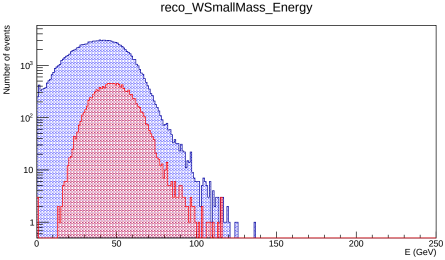
Pre-selection (nnh files only)

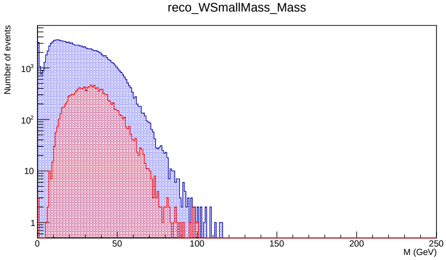


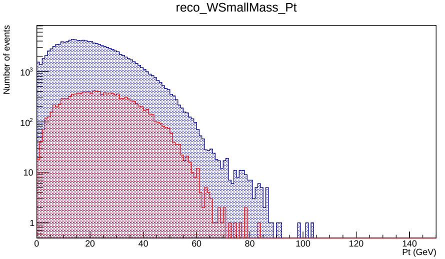


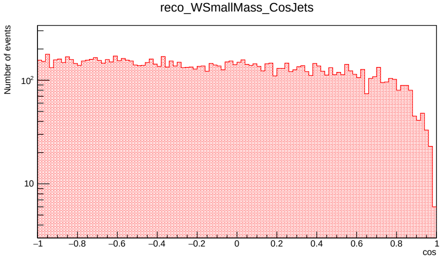




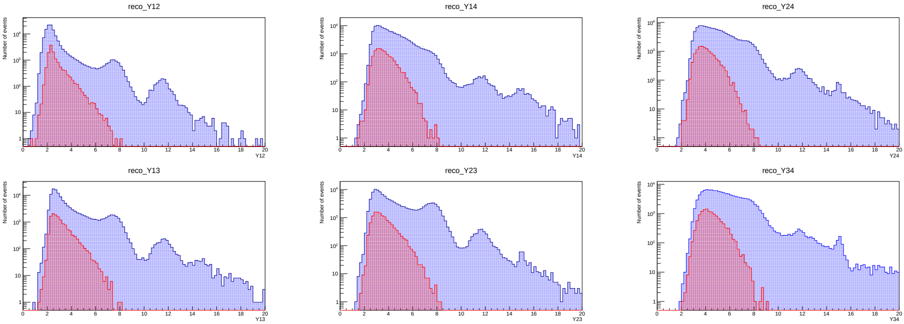

reco_WSmallMass_Energy
Number of events
E (GeV)


reco_WSmallMass_Mass
Number of events
M (GeV)

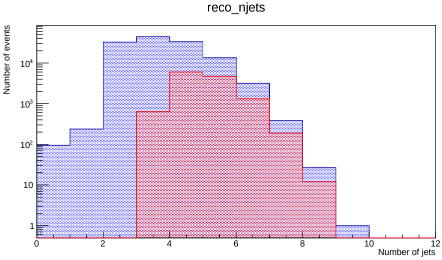

reco_WSmallMass_Pt
Number of events
Pt (GeV)

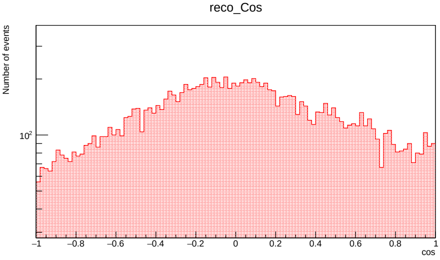

reco_WSmallMass_CosJets
Number of events
cos

Pre-selection (nnh files only)



Pre-selection (nnh files only)





Final selection

Only involving the signal and the 2 fermions background with the 5% cuts selectors :

Some formulas

- Efficiency : $\epsilon_E = \frac{\text{True signal kept}}{\text{True signal}}$
- Purity : $\epsilon_P = \frac{\text{True signal kept}}{\text{Signal kept}}$
- Significance : $S = \frac{\text{True signal kept}}{\sqrt{\text{Signal kept}}}$
- Error : $\frac{\Delta(\sigma Br)}{\sigma Br} = S^{-1}$

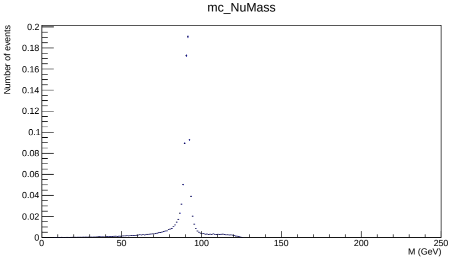
$e_R p_L$

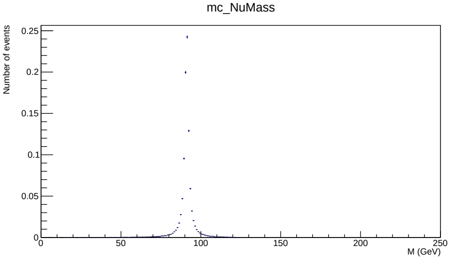
- Efficiency : $\epsilon_E = 70.12\%$
- Purity : $\epsilon_P = 2.48\%$
- Significance : $S = 7.483$
- Error : $\frac{\Delta(\sigma_{RL} Br)}{\sigma_{RL} Br} = 13.36\%$

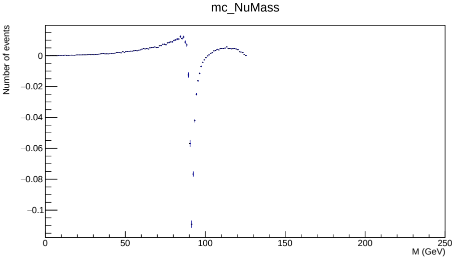
$e_L p_R$

- Efficiency : $\epsilon_E = 71.49\%$
- Purity : $\epsilon_P = 2.36\%$
- Significance : $S = 5.225$
- Error : $\frac{\Delta(\sigma_{LR} Br)}{\sigma_{LR} Br} = 19.14\%$

Neutrino study







Conclusion

- Firstly : I have to include the 4 fermions background to compute the error on the coupling constant g_{HWW}
- Secondly : We need the production of the t channel only (W fusion process), to study how it affect the selectors and how we could play with it to improve our selection

Here is the 2 fermions backgroung with the signal and the other decays of the Higgs boson with an itegrated luminosity of $250 fb^{-1}$