Study of the coupling constant $g_{HWW}$ at ILC250

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ILD

24 June 2021
Theoretical aspect

\[ M \propto g_{HWW} \]

- Interferences:
  - \( e_R p_L : \sigma_{RL} \propto g_{HZZ}^2 \)
  - \( e_L p_R : \sigma_{LR} = a_1 g_{HZZ}^2 + a_2 g_{HWW}^2 + a_3 g_{HZZ} g_{HWW} \)

- \( H \rightarrow WW^* : Br \propto g_{HWW}^2 \)

- There's 2 possibilities:
  1. \( \Lambda = \frac{\sigma_{RL} Br}{A} = (g_{HZZ} g_{HWW})^2 \) and \( g_{HWW}^4 + (\frac{a_3 \sqrt{\Lambda}}{a_2}) g_{HWW}^2 = \frac{\sigma_{LR} Br}{A a_2} - \frac{a_1 \Lambda}{a_2} \)
  2. \( g_{HWW}^4 + (\frac{a_3 g_{HZZ}}{a_2}) g_{HWW}^3 + (\frac{a_1 g_{HZZ}}{a_2}) g_{HWW} = \frac{\sigma_{LR} Br}{A a_2} \) 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`
- Angular 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 $y_{\text{cut}} = 0.002$ 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)

(reco_E4jets)

(reco_Pt4jets)

(reco_M4jets)
Pre-selection (nnh files only)

reco_WBigMass_Energy

reco_WBigMass_Pt

reco_WBigMass_Mass

reco_WBigMass_CosJets
Pre-selection (nnh files only)

**reco_WSmallMass_Energy**

**reco_WSmallMass_Mass**

**reco_WSmallMass_Pt**

**reco_WSmallMass_CosJets**
Pre-selection (nnh files only)

![Graphs of reco_Y12, reco_Y14, reco_Y23, reco_Y24, reco_Y34]
Pre-selection (nnh files only)

![Histogram of reco_njets](image1)

![Histogram of reco_Cos](image2)

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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**: \( \frac{\Delta(\sigma Br)}{\sigma Br} = S^{-1} \)

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

For \( e_{LP_R} \):
- 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

mc_NuMass

mc_NuMass

mc_NuMass

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24 june 2021
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 background with the signal and the other decays of
the Higgs boson with an integrated luminosity of $250\, fb^{-1}$.