

Higgs self-coupling measurement at ILC.

Status and overview

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Quick overview

Past analysis:

- DESY-THESIS-2016-027

$$\frac{\Delta\lambda_{HHH}}{\lambda_{HHH}} = c \cdot \frac{\Delta\sigma_{HHx}}{\sigma_{HHx}}$$

- cross section measurement

Precision reach

After full ILC running scenario ($HH \rightarrow bbbb + HH \rightarrow bbWW$)

$$\rightarrow \Delta\sigma_{ZH}/\sigma_{ZH} = 16.8\% \text{ (ILC500)}$$

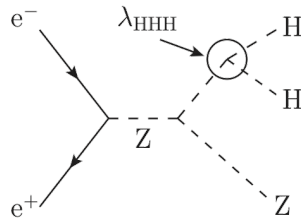
$$\rightarrow \Delta\lambda_{SM}/\lambda_{SM} = 26.6\% \text{ (ILC500)}$$

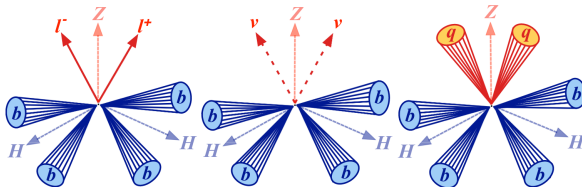
$$\rightarrow \Delta\lambda_{SM}/\lambda_{SM} = 10\% \text{ (ILC500+ILC1000)}$$

+ strategy for further improvements

Past talks:

- IDT Open Meeting on the Higgs self-coupling
- First ECFA workshop on e+e- Higgs/EW/Top Factories





Event reconstruction

Overlay removal

- > $\gamma\gamma \rightarrow$ low- p_T hadrons
- > Expect $\langle N_{\text{overlay}} \rangle = 1.05$ particles/event

Isolated lepton tagging

- > identify leptons for selection or rejection

Jet reconstruction

- > cluster together remaining event

Flavor tagging

- > look for b-jets

Event selection

Cut-based preselection

- > $ZHH \rightarrow \ell\ell bbbb$
- > $ZHH \rightarrow \nu\nu bbbb$
- > $ZHH \rightarrow qq bbbb$

Kinematic fitting

- > hypotheses testing to separate ZHH from ZZH background

Event selection

- > based on MVAs

Code on github

Github repository

The screenshot shows the GitHub interface for the repository **ILDAnaSoft / ZHH**. The repository is public and has 12 commits, 0 stars, 2 watchers, and 0 forks. The main branch is **main**. The repository contains a **scripts** directory, a **source** directory, a **.gitignore** file, a **README.md** file, a **compile_from_scratch.sh** script, and a **setup.sh** script. The **README.md** file is selected and shows the following content:

ZHH

Code for ZHH analysis with ILD

Setup library paths

From the top level of the repository execute

```
source setup.sh
```

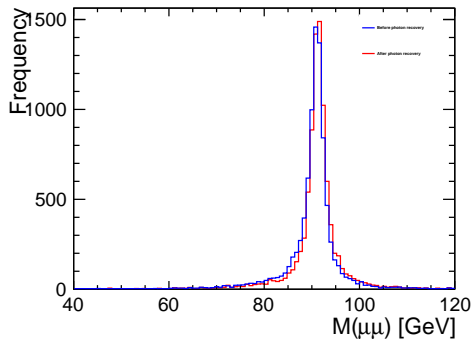
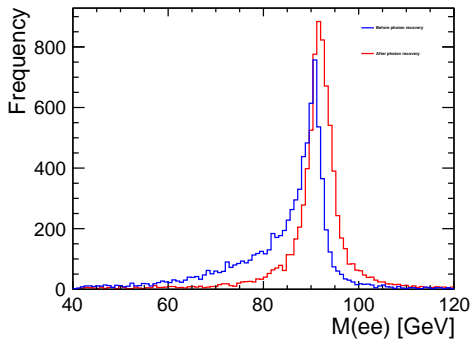
You can verify the path by doing

```
echo $MARLIN_DLL
```

The right sidebar shows the **About** section with the description "code for ZHH analysis with ILD", the **Releases** section with "No releases published" and a link to "Create a new release", the **Packages** section with "No packages published" and a link to "Publish your first package", the **Contributors** section with 2 contributors (Torndal Julie Torndal and gaede Frank Gaede), and the **Languages** section with a bar chart showing the distribution of languages: C++ (91.1%), CMake (8.4%), and Shell (0.5%).

LeptonPairing

- closest to Z-mass + opposite charge requirement
- followed by BS/FSR recovery



Preselection

- 3 hardcoded preselections
- Option to customize cuts

Lepton channel

Selection

Initial

$$\#\ell_{ISO} \geq 2$$

$$|M_{\ell\ell} - M_Z| < 40 \text{ GeV}$$

$$|M_{jj} - M_H| < 80 \text{ GeV}$$

$$60 \text{ GeV} < M_{jj} < 180 \text{ GeV}$$

$$p_T < 70 \text{ GeV}$$

$$\text{thrust} < 0.9$$

Neutrino channel

Selection

Initial

$$\#\ell_{ISO} = 0$$

$$|M_{jj} - M_H| > 80 \text{ GeV}$$

$$b_{\text{max}3} > 0.2$$

$$60 \text{ GeV} < M_{jj} < 180 \text{ GeV}$$

$$10 \text{ GeV} < p_T < 180 \text{ GeV}$$

$$\text{thrust} < 0.9$$

$$E_{\text{vis}} < 400 \text{ GeV}$$

$$M(HH) > 220 \text{ GeV}$$

Hadron channel

Selection

Initial

$$\#\ell_{ISO} = 0$$

$$b_{\text{tag}} > 0.16$$

$$60 \text{ GeV} < M_{jj} < 180 \text{ GeV}$$

$$p_T < 70 \text{ GeV}$$

$$\text{thrust} < 0.9$$
