

Progress in HH Cross Section Measurements

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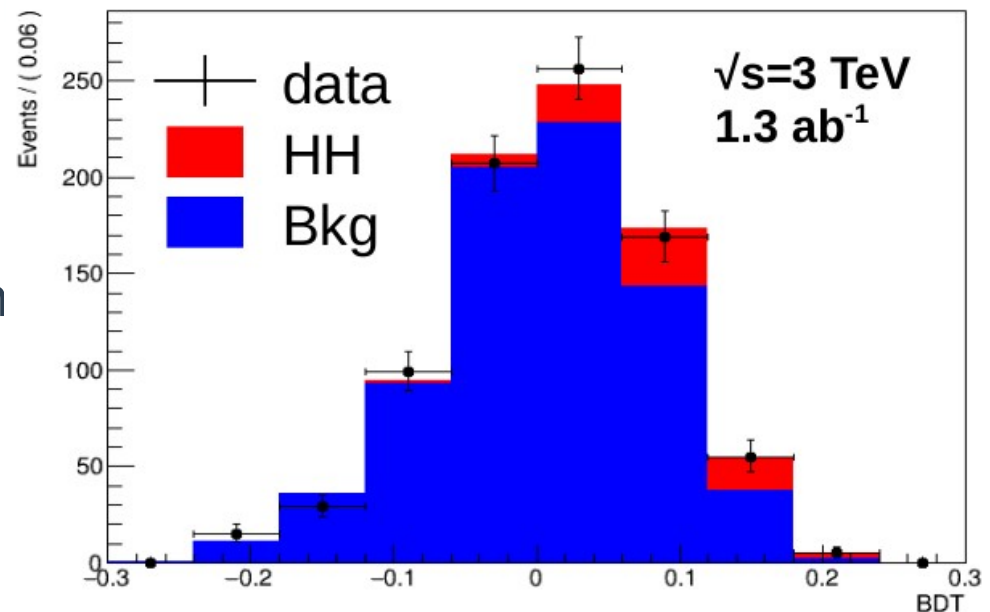
HH cross section measurement

- First attempt to estimate the HH cross section uncertainty at 3 TeV
- A 5-observable Boosted Decision Tree has been trained to separate signal ($\mu^+\mu^- \rightarrow HH\nu\bar{\nu} \rightarrow b\bar{b}b\bar{b}\nu\bar{\nu}$) from background ($\mu^+\mu^- \rightarrow b\bar{b}b\bar{b}\nu\bar{\nu}$).
- With **1.3 ab⁻¹** (4 years of data taking) at **3 TeV** we expect to select 67 HH events and 745 background events.

With a fit to the BDT

→ An **uncertainty of 33%** on the cross section has been obtained.

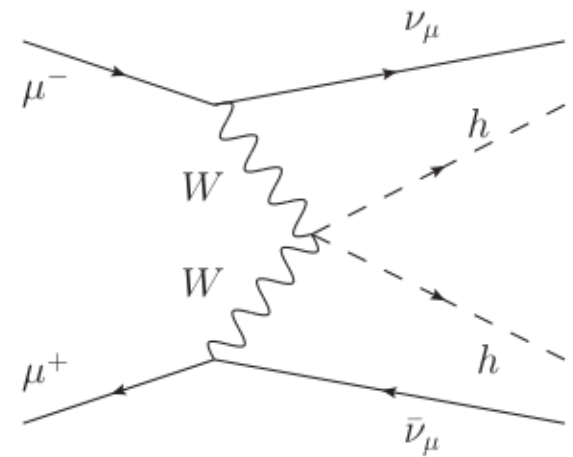
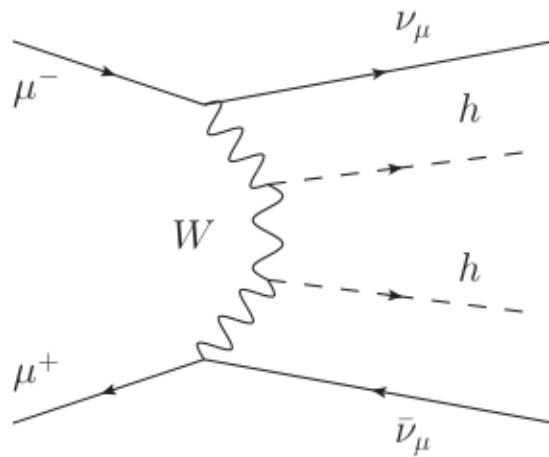
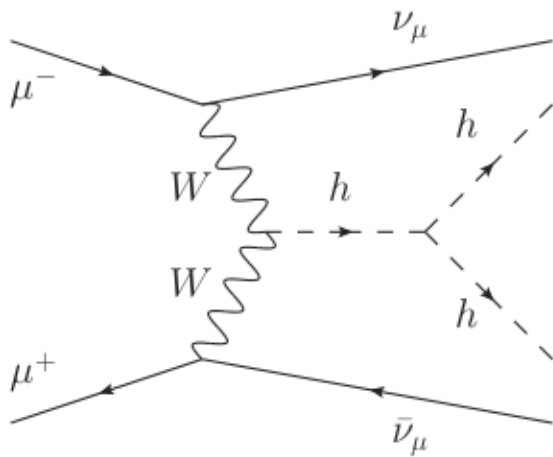
PRELIMINARY!



HH studies at Monte Carlo level

First comparison at Monte Carlo level of:

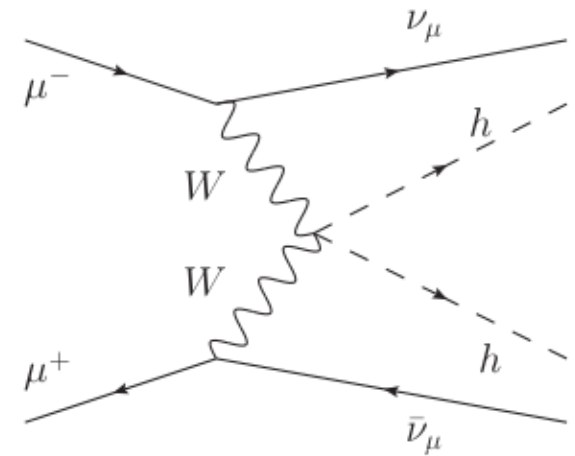
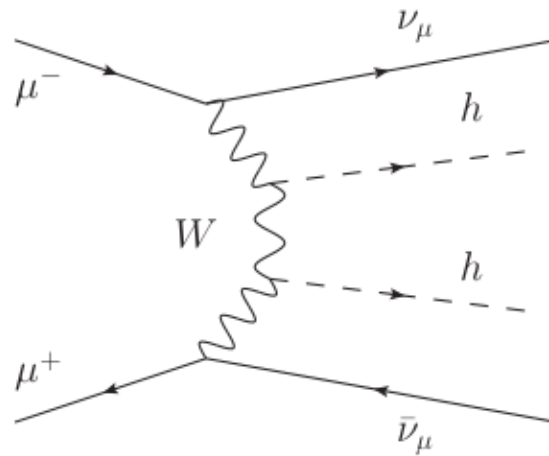
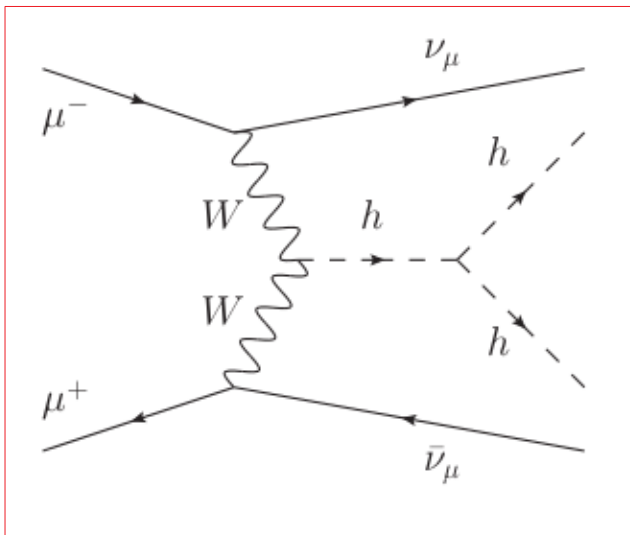
- 1000 events of $\mu^+\mu^- \rightarrow HH\nu\bar{\nu} \rightarrow b\bar{b}b\bar{b}\nu\bar{\nu}$ at 3 TeV from **all diagrams** (WHIZARD):



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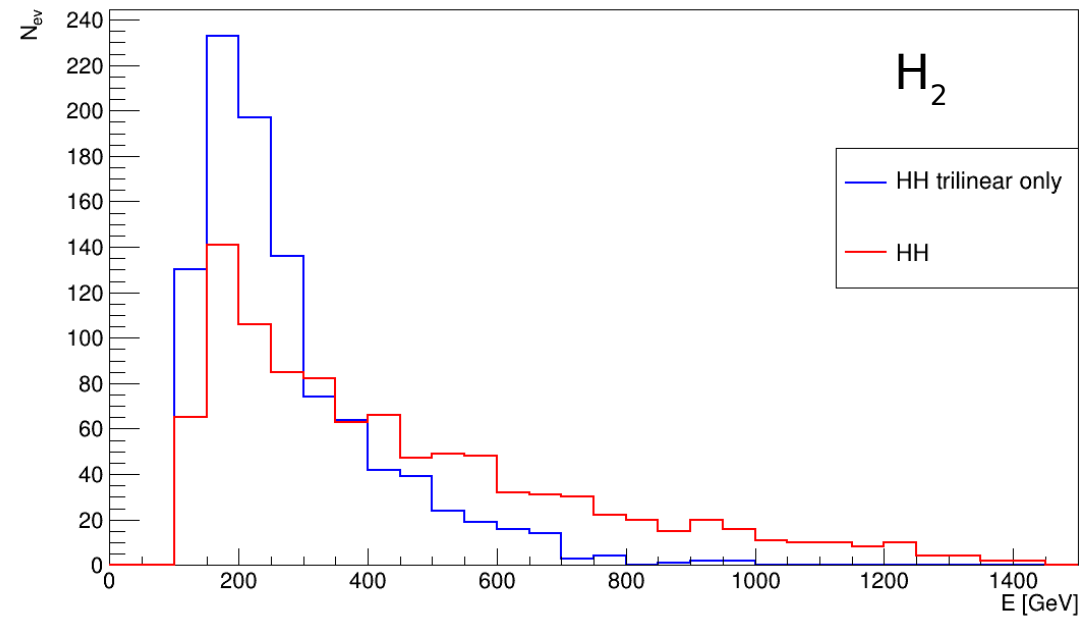
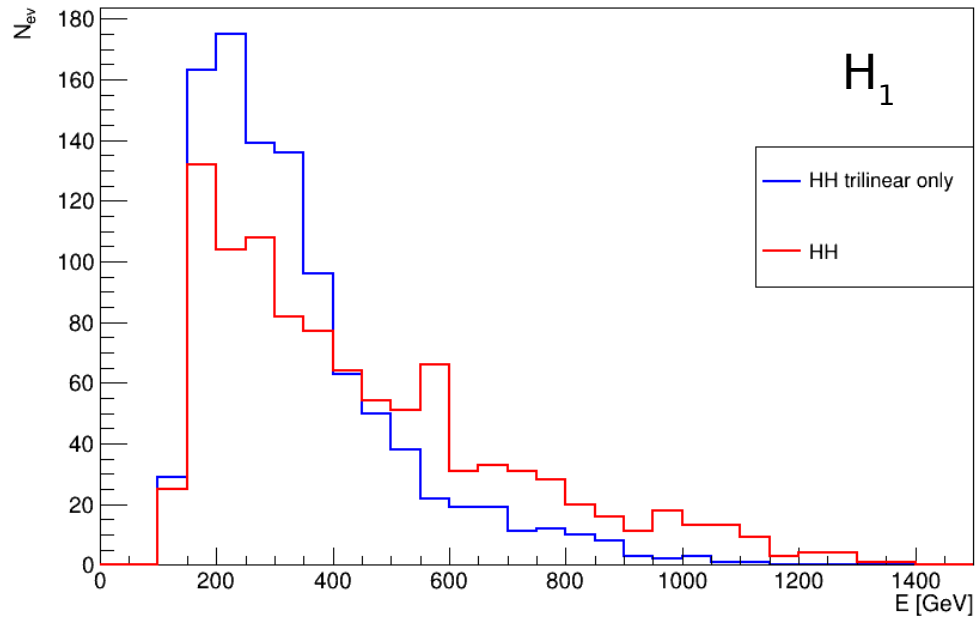
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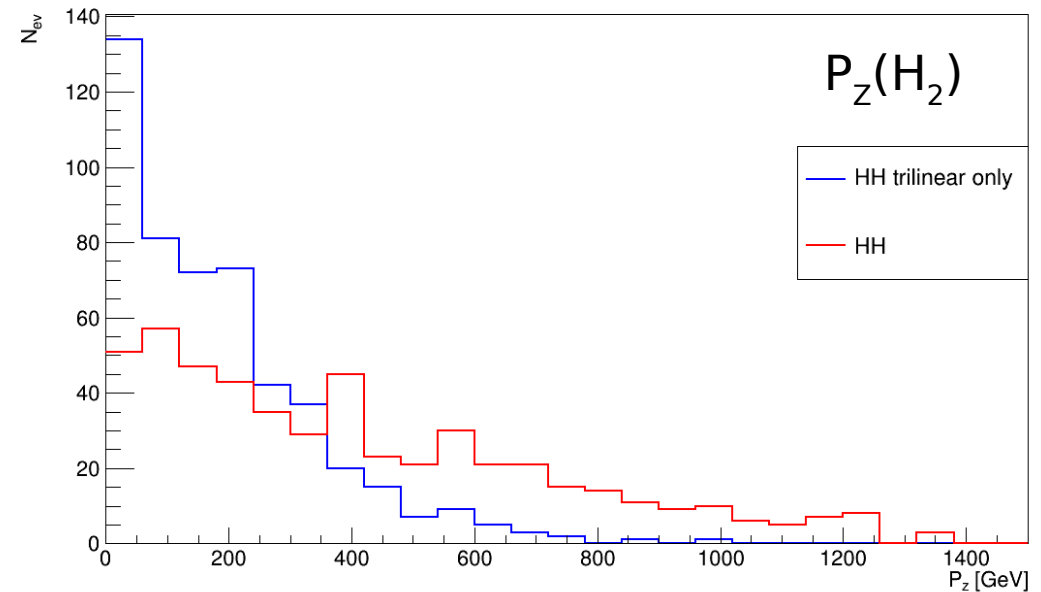
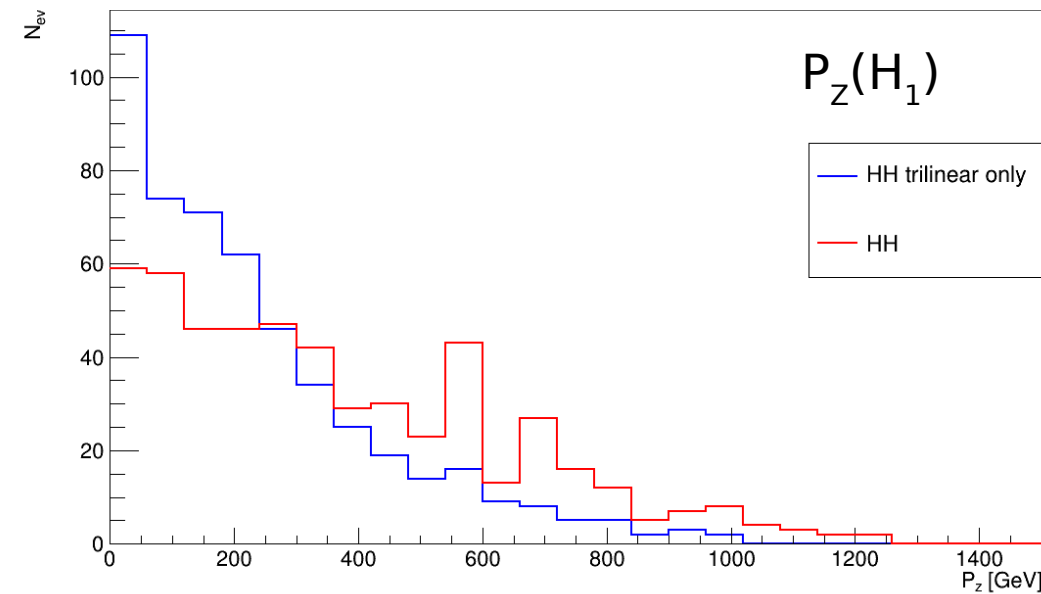
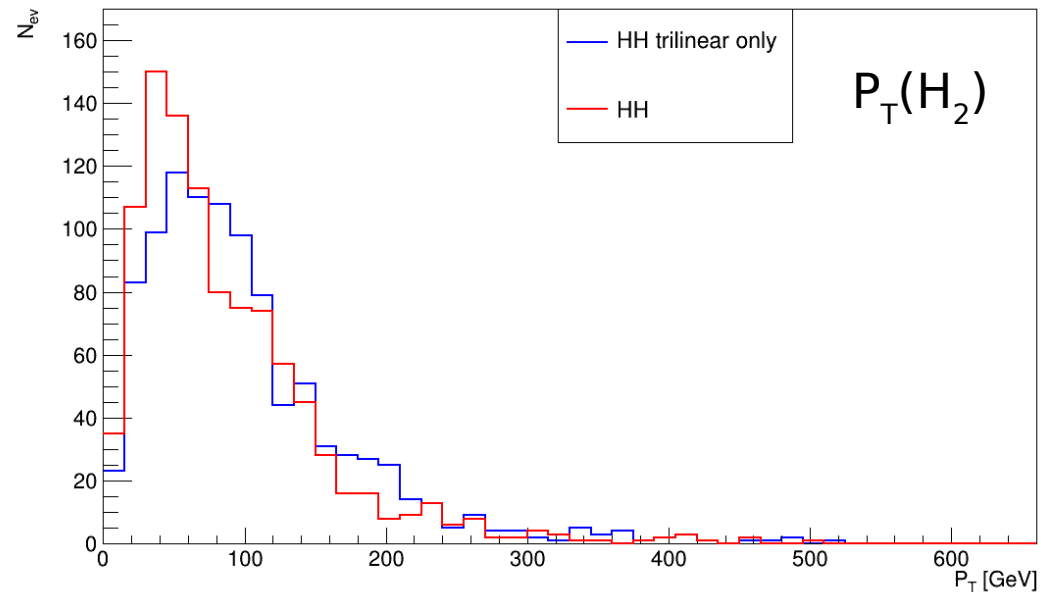
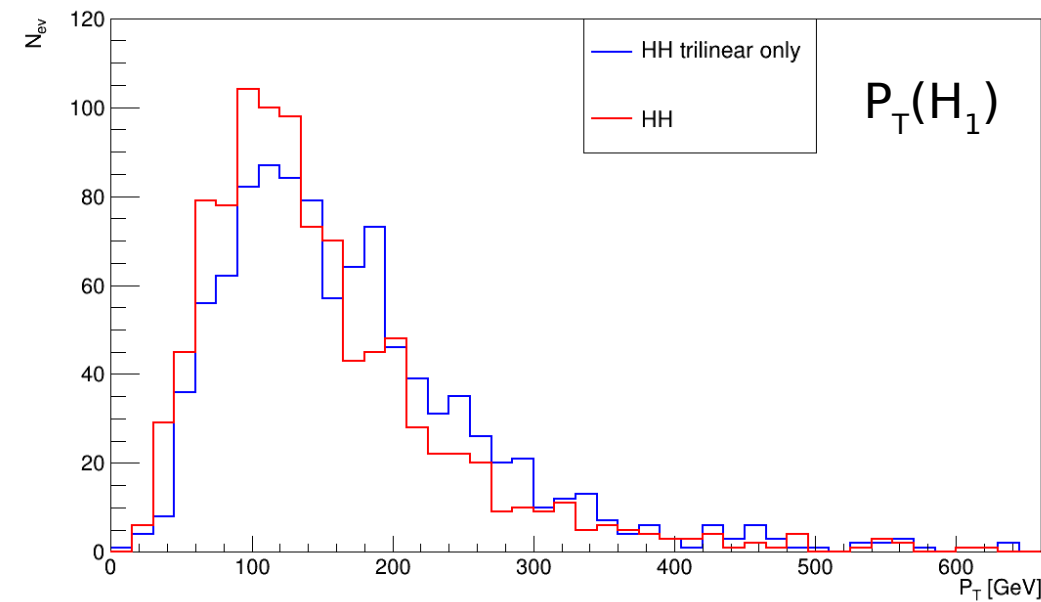
- 1000 events of $\mu^+\mu^- \rightarrow HH\nu\bar{\nu} \rightarrow b\bar{b}b\bar{b}\nu\bar{\nu}$ from **trilinear coupling** only (WHIZARD)

Higgs bosons energy

- H_1 is the Higgs with the **highest** P_T
- H_2 is the Higgs with the **lowest** P_T

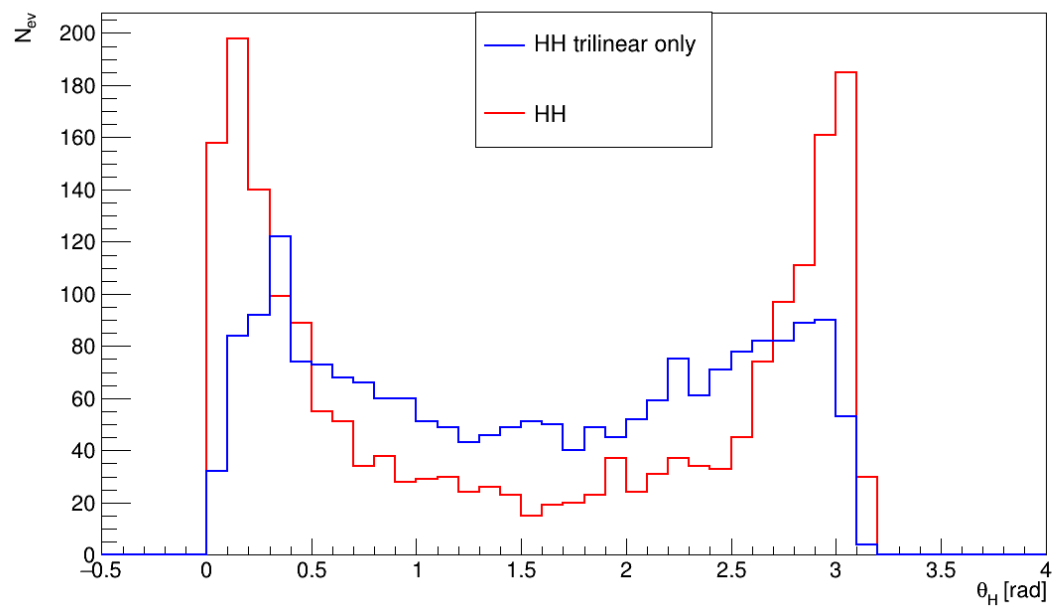


Higgs bosons momentum

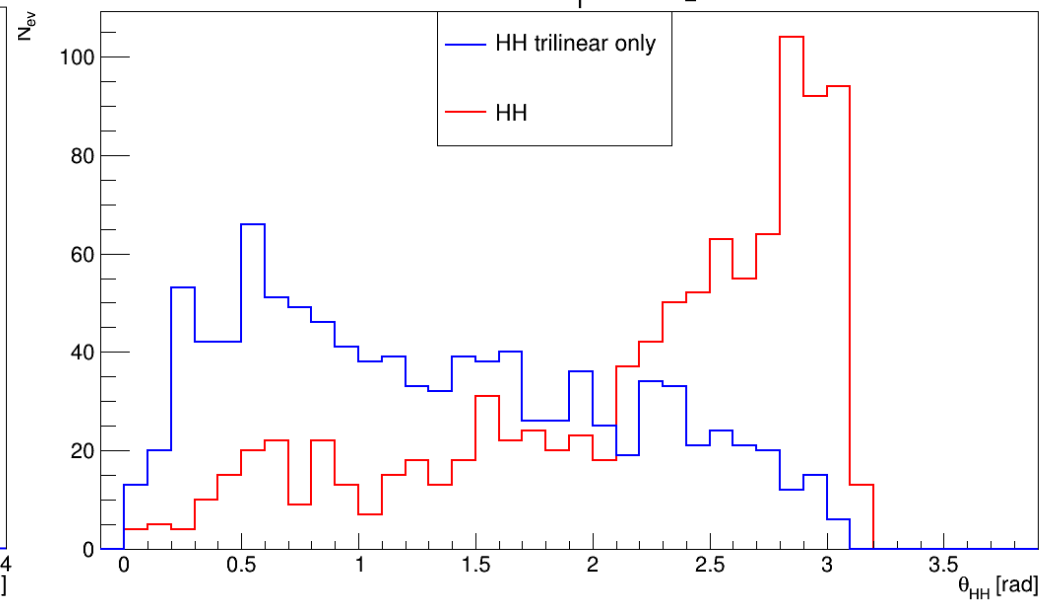


Angular variables relative to the Higgs bosons

Angle between Higgs bosons and z axis



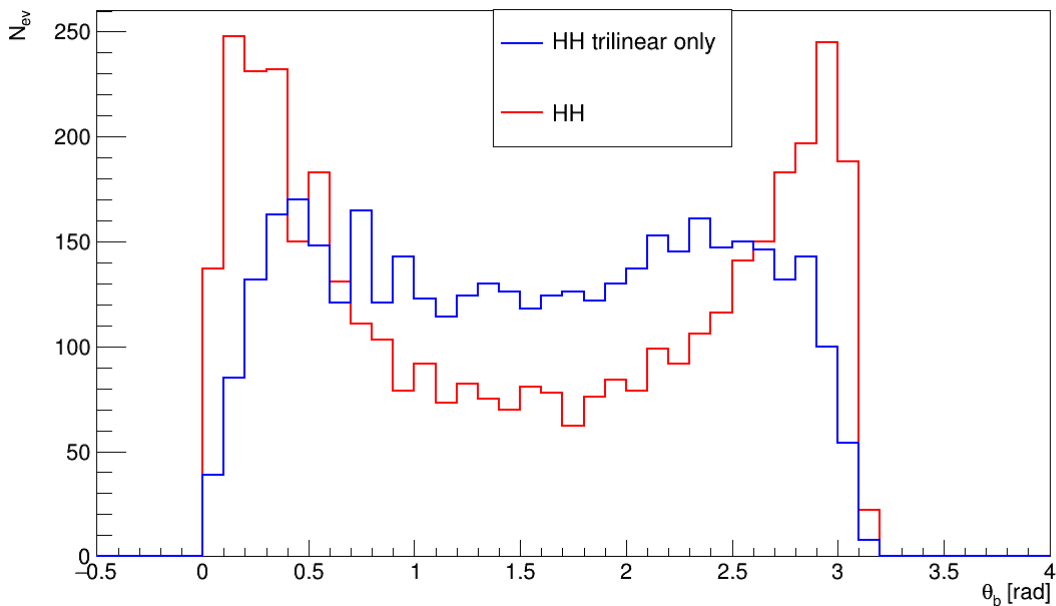
Angle between H_1 and H_2



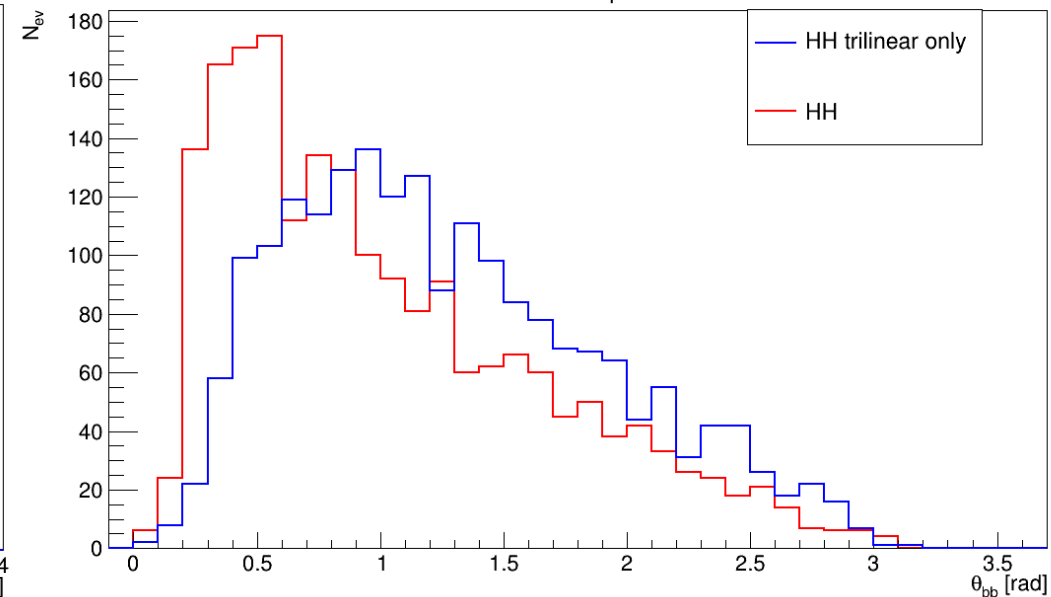
Angular variables relative to b quarks

- $b_1 b_2$ from the decay of the H_1 Higgs boson
- $b_3 b_4$ from the decay of the H_2 Higgs boson

Angle between b quarks and z axis



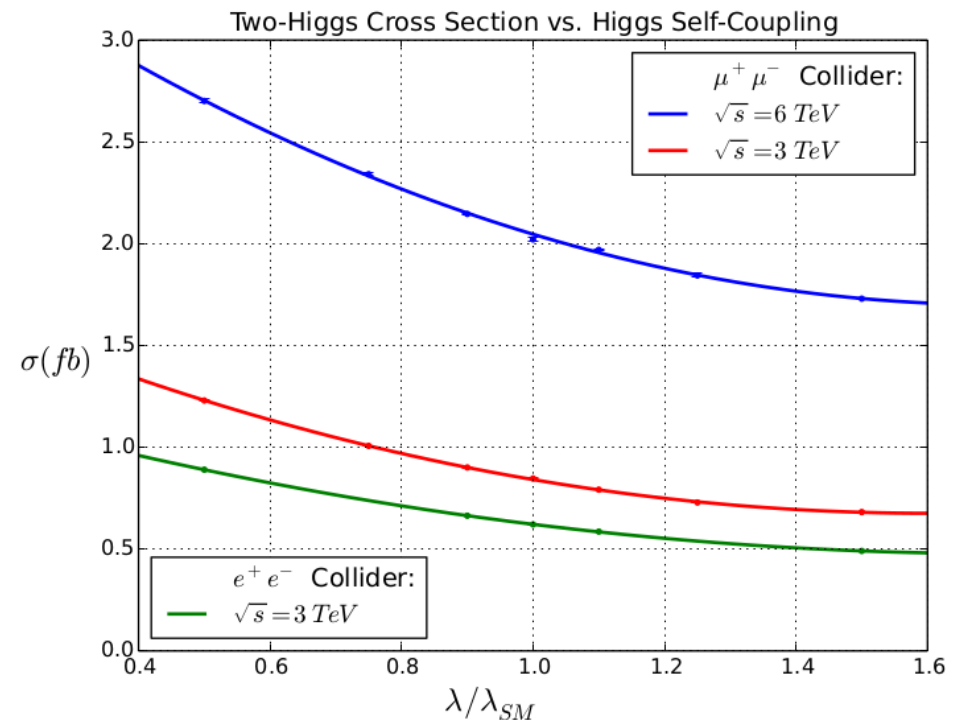
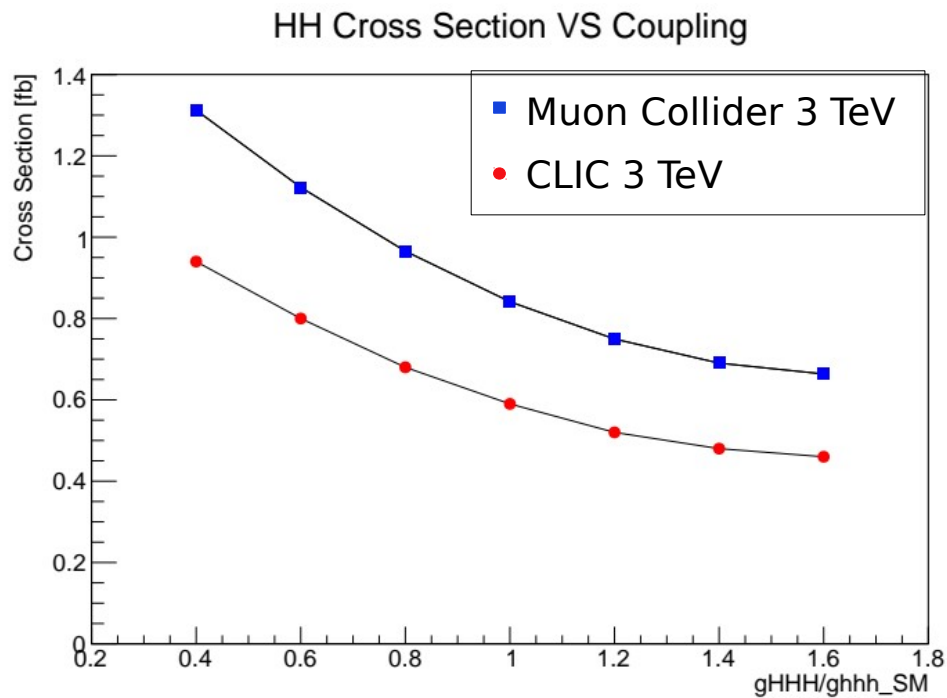
Angle between $b_1 b_2$ and $b_3 b_4$



HH cross section as a function of κ

- Set of $\mu^+\mu^- \rightarrow HH\nu\bar{\nu} \rightarrow b\bar{b}b\bar{b}\nu\bar{\nu}$ samples generated with WHIZARD Monte Carlo for different $\kappa=(0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6)$

$$\kappa = \frac{g_{HHH}}{g_{HHH, SM}}$$



Forward steps

- Full simulation and reconstruction of these events
- Comparison of the reconstructed jets for the “only trilinear” case and HH
- Think about **strategies** that exploits the differences between the distributions to:
 - 1) improve the sensitivity on the cross section measurement
 - 2) complete the analysis and extract the sensitivity on the trilinear Higgs self-coupling

