TOP-HIGGS YUKAWA COUPLING MEASUREMENT AT LC : STATUS REPORT

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ECFA/DESY workshop
Amsterdam - april 2003

Outline

- Measurement of the coupling

- Results

Last update:

- SIMDET v.3 $\longrightarrow$ SIMDET v.4
  (for a more recent design of the detector)

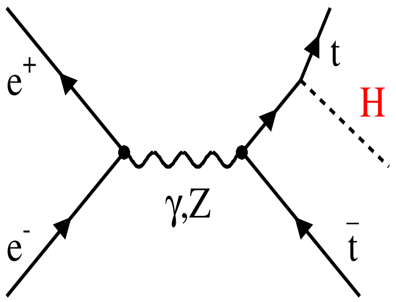
- More sophisticated b-tagging
  (implemented by T. Kuhl)

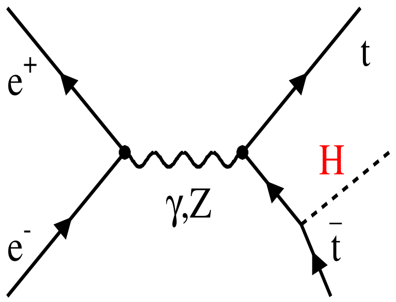
- 6 fermions BG study
  (using the Whizard program)

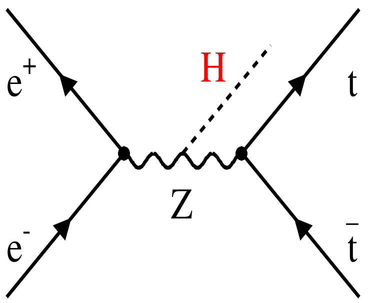
Conclusion

Measurement of the coupling

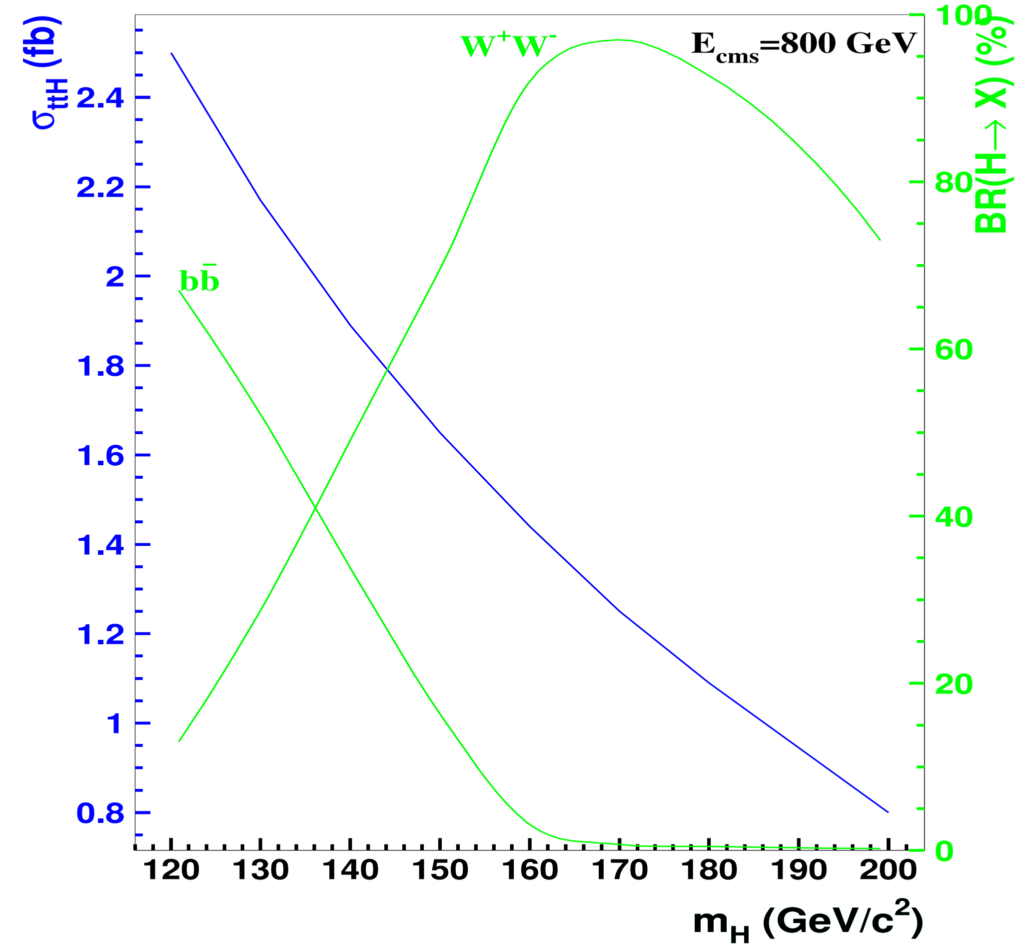
- $t\bar{t}H$: diagrams, σ and Higgs Branching ratios







$$\longrightarrow \sigma_{t\bar{t}h} \propto g^2_{tth}$$



Measurement of the coupling

- Uncertainty:

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} \approx \frac{1}{S_{stat}(g^2_{ttH})\sqrt{\epsilon\rho L}}$$

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{syst} \approx \frac{1}{S_{syst}(g^2_{ttH})} \frac{1-\rho}{\rho} \frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}}$$

with:

$$S_{stat}(g^2_{ttH}) = \frac{1}{\sqrt{\sigma_{t\bar{t}h}}} \left| \frac{d\sigma_{t\bar{t}h}}{dg^2_{ttH}} \right| \approx \frac{\sqrt{\sigma_{t\bar{t}h}}}{g^2_{ttH}}$$

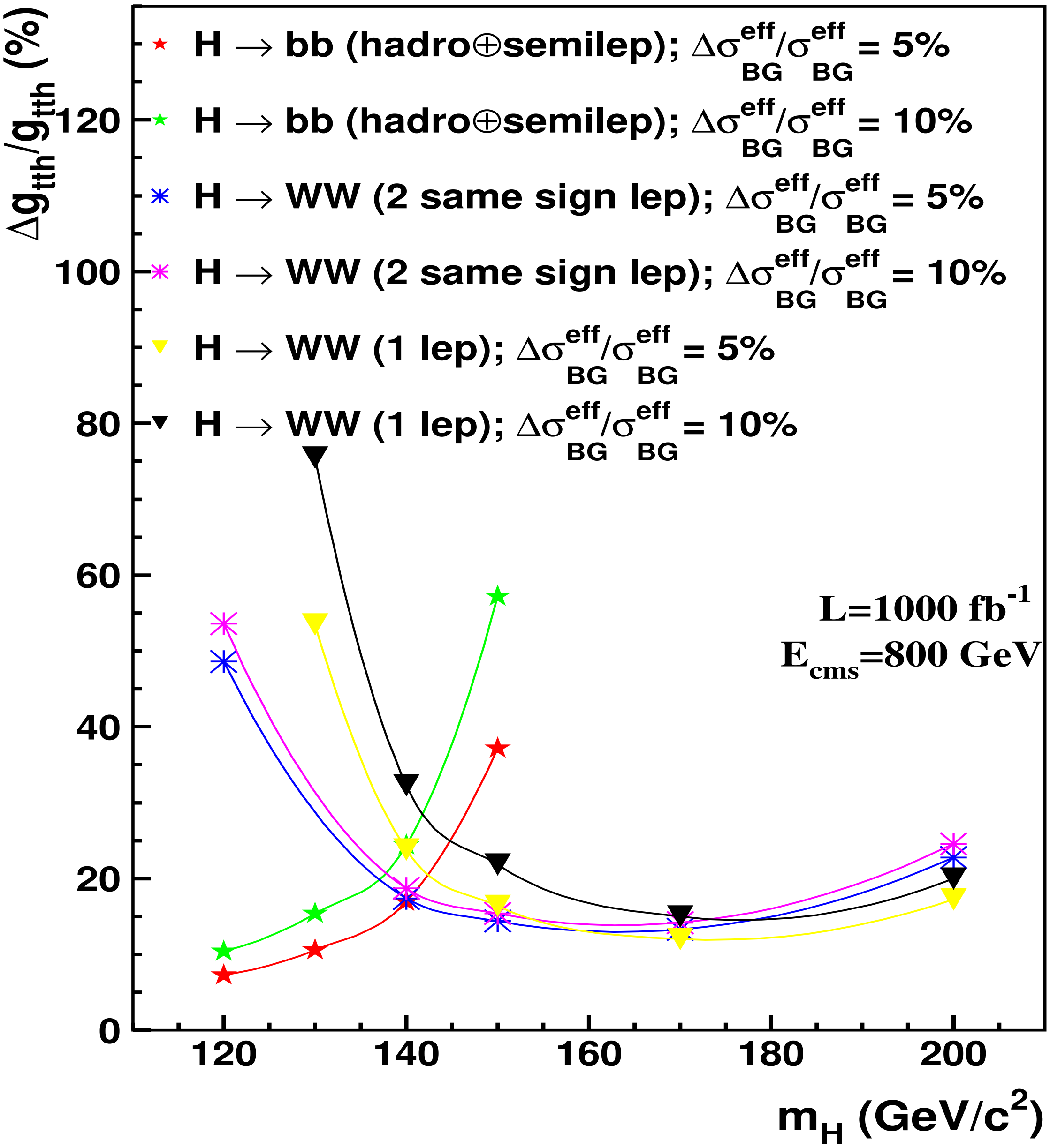
$$S_{syst}(g^2_{ttH}) = \frac{1}{\sigma_{t\bar{t}h}} \left| \frac{d\sigma_{t\bar{t}h}}{dg^2_{ttH}} \right| \approx \frac{1}{g^2_{ttH}}$$

- Simulation:
  - $t\bar{t}H$, $t\bar{t}Z$ with CompHEP v.41.10 +PYTHIA v.6.158. Other BG with PYTHIA v.6.136
  - Detector effects with SIMDET v.3
- b-tag: impact parameter joint probability tag
- BG:

Process	σ (fb)
$q\bar{q}$	$\approx$ 1600
$t\bar{t}$	$\approx$ 300
W^+W^-	$\approx$ 4300
ZZ	$\approx$ 200
$t\bar{t}Z$	$\approx$ 4

Results

- Semileptonic channel
  $e^+e^- \to t\bar{t}H(H \to b\bar{b}) \to 4b2ql\nu.$
- Hadronic channel
  $e^+e^- \to t\bar{t}H(H \to b\bar{b}) \to 4b4q.$
- “2 same sign leptons + 6 jets” channel
  $e^+e^- \to t\bar{t}H(H \to W^+W^-) \to 2l^{+/-}2\nu 4q2b$
- “1 lepton + 8 jets” channel
  $e^+e^- \to t\bar{t}H(H \to W^+W^-) \to l\nu 6q2b$



SIMDET v.4 and new b-tagging

- Re-analysis of the semileptonic, hadronic and 1 lepton + 8 jets channels with SIMDET v4.

- The precision of the measurement of g_{tth} remains the same for the 1 lepton + 8 jets channels

- For the hadronic and semileptonic channels:
  - With the same procedure (in particular, same algorithm for b-tagging), the precision of the measurement of g_{tth} is slighly worse (a few %) with SIMDET v4 than with SIMDET v3.

    This can be partly explained by the larger beam pipe radius (1 cm to 1.5 cm).

  - The more powerful b-tagging algorithm then improves the measurement but still, the precision is a few % worse.

- *The versions of SIMDET v.4 and b-tagging algorithm used here have bugs which were very recently corrected: these analysis should be reprocessed once more.*

6 fermions background

- Up to now, only the major part of the BG have been taken into account. What's the effect of the 6 fermions processes?

- Calculation of cross-sections and generation of events at the partonic level with Whizard , taking into account ISR and beamstrahlung. These partonic events are passed to PYTHIA for hadronization and FSR.

- Some processes receive contributions of resonant diagrams that we already took into account : $t\bar{t}$,WW,ZZ, $t\bar{t}Z$ and $t\bar{t}H$.

  In this case, and if the cross section is large, these diagrams are removed.

- The calculation of the cross section and the generation of 6 fermions events are difficult and time consuming tasks. Furthermore, some ambiguities arise when the partons pairs are defined for fragmentation.

  $\rightarrow$ *The degradation of the measurement of g_{ttH} due to the 6 fermions BG should be considered as an estimate.*

Hadronic channel: (m_H =120GeV/c^2)

process	$\sigma(fb)$	$\frac{\Delta\sigma}{\sigma}$	ϵ_{sel}
$b\bar{b}b\bar{b}b\bar{b}$	$6.4 * 10^{-3}$	18%	4.0%
$b\bar{b}b\bar{b}q\bar{q}(q = u, d)$	$1.2 * 10^{-1}$	1%	1.5%
$b\bar{b}b\bar{b}s\bar{s}$	$6.3 * 10^{-2}$	1%	1.6%
$b\bar{b}b\bar{b}c\bar{c}$	$5.1 * 10^{-2}$	5%	1.5%
$b\bar{b}c\bar{c}q\bar{q}(q = u, d)$	$9.8 * 10^{-2}$	2%	$7.5 * 10^{-2}$%
$b\bar{b}b\bar{b}t\bar{t}$	$6.9 * 10^{-3}$	8%	34.6%
$b\bar{b}q\bar{q}t\bar{t}$ (q=u,d,s)	$8.9 * 10^{-3}$	1%	17.5%
$b\bar{b}c\bar{c}t\bar{t}$	$3.5 * 10^{-3}$	3%	21.5%
$b\bar{b}t\bar{b}d\bar{u}$ *	$1.2 * 10^{-2}$	4%	15.8%
$b\bar{b}t\bar{b}\mu\bar{\nu}$ *	$3.4 * 10^{-3}$	11%	2.2%

* *Some diagrams were removed to avoid double counting*

(The selection efficiency is shown for $\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}} = 5\%$*)*

About 16(9) of these events pass the cuts if $\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}} = 5(10)\%$, leading to a very small loss of precision on g_{tth}

$\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}}$	$\frac{\Delta g_{ttH}}{g_{ttH}}$(without 6f)	$\frac{\Delta g_{ttH}}{g_{ttH}}$(with 6f)
5%	9.7%	10.0%
10%	13.0%	13.5%

Semilep. channel: (m_H =120GeV/c^2)

process	$\sigma(fb)$	$\frac{\Delta\sigma}{\sigma}$	ϵ_{sel}
$b\bar{b}b\bar{b}b\bar{b}$	$6.4 * 10^{-3}$	18%	3.4%
$b\bar{b}b\bar{b}q\bar{q}(q = u, d)$	$1.2 * 10^{-1}$	1%	0.9%
$b\bar{b}b\bar{b}s\bar{s}$	$6.3 * 10^{-2}$	1%	1.1%
$b\bar{b}b\bar{b}c\bar{c}$	$5.1 * 10^{-2}$	5%	1.5%
$b\bar{b}b\bar{b}t\bar{t}$	$6.9 * 10^{-3}$	8%	19.6%
$b\bar{b}q\bar{q}t\bar{t}$ (q=u,d,s)	$8.9 * 10^{-3}$	1%	8.7%
$b\bar{b}c\bar{c}t\bar{t}$	$3.5 * 10^{-3}$	3%	10.1%
$b\bar{b}t\bar{b}d\bar{u}$ *	$1.2 * 10^{-2}$	4%	6.8%
$b\bar{b}t\bar{b}\mu\bar{\nu}$ *	$3.4 * 10^{-3}$	11%	17.6%

* *Some diagrams were removed to avoid double counting*

(The selection efficiency is shown for $\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}} = 5\%$*)*

About 11(5) of these events pass the cuts if $\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}} = 5(10)\%$, leading as before to a very small loss of precision on g_{tth}:

$\frac{\Delta\sigma^{eff}_{BG}}{\sigma^{eff}_{BG}}$	$\frac{\Delta g_{ttH}}{g_{ttH}}$(without 6f)	$\frac{\Delta g_{ttH}}{g_{ttH}}$(with 6f)
5%	9.7%	9.9%
10%	13.2%	13.5%

Conclusion

- The precision on the measurement of g_{tth} obtained with the old (i.e: using SIMDET v3) and new (i.e: using SIMDET v4) design of the detector should globally be very close.

- The hadronic and semileptonic channels are only marginally affected by the 6-fermions BG. (true for 120 GeV/c^2 $\leq m_H \leq$ 150 GeV/c^2)

- Future:
  - Reprocessing of the 4 channels with (corrected) SIMDET v4 and sophisticated b-tagging algorithm.
  - 6 fermions BG in the two $H \rightarrow W^+W^-$ channels.