

ECFA Summary

Higgs, $\gamma\gamma$, $e\gamma$, polarization

M.Krawczyk, Warsaw University

HEP2003 Europhysics Conference in Aachen, Germany



Higgs studies for an e^+e^- Linear Collider

Framework: ECFA/DESY study for physics and detectors

(Convenors: M.Battaglia, K. Desch, A Djouadi, E.Gross, B. Kniehl)

TESLA TDR: LC is the tool for Higgs precision physics

Why continue with these studies?

Goals:

- close remaining (but essential) corners
- keep up with new theoretical ideas
- further study relation to LHC (\Rightarrow G. Weiglein's talk)
- become more realistic in experimental simulation

Group was (and is) very active!

64 talks (35 exp/29 theo) in 4 workshops

(not all of them can be mentioned...)

A few examples of recent studies:

Higgs Quantum Numbers

TDR: Spin from threshold scan

TDR: CP from angular distributions of ZH

New Ideas: Spin from $H \rightarrow ZZ$ Miller et al

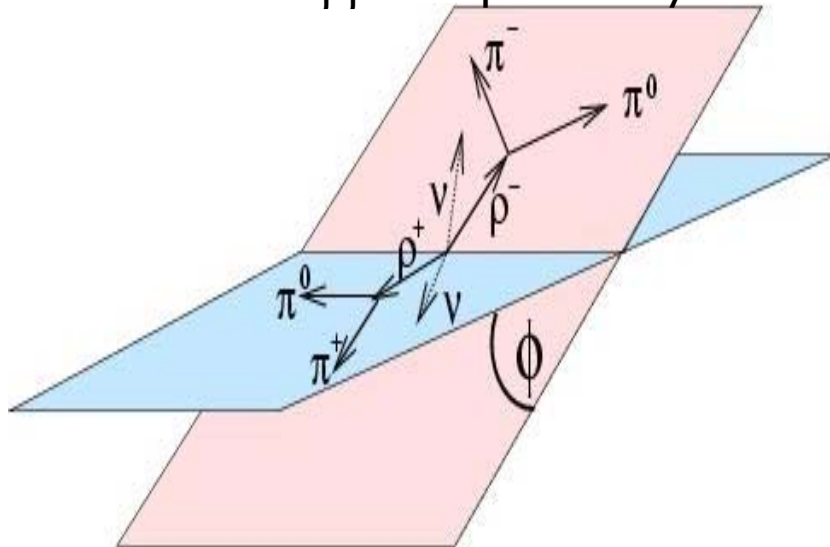
CP from transverse polarisation correlations in $H \rightarrow \tau\tau$

Was, Worek

Bower

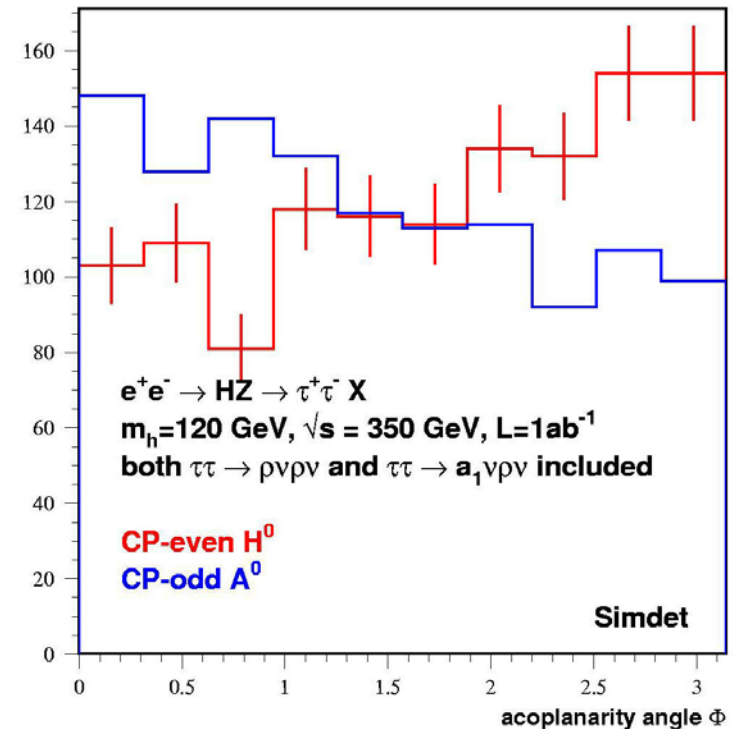
Imhof, Desch

Observable: $\rho\rho$ -acoplanarity:



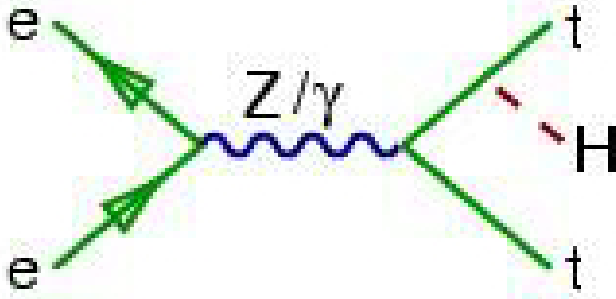
First estimate with detector simulation:

$> 8\sigma$ separation between CP+ and CP-
for 120 GeV Higgs ($350\text{GeV}/1\text{ ab}^{-1}$)



Top Yukawa coupling

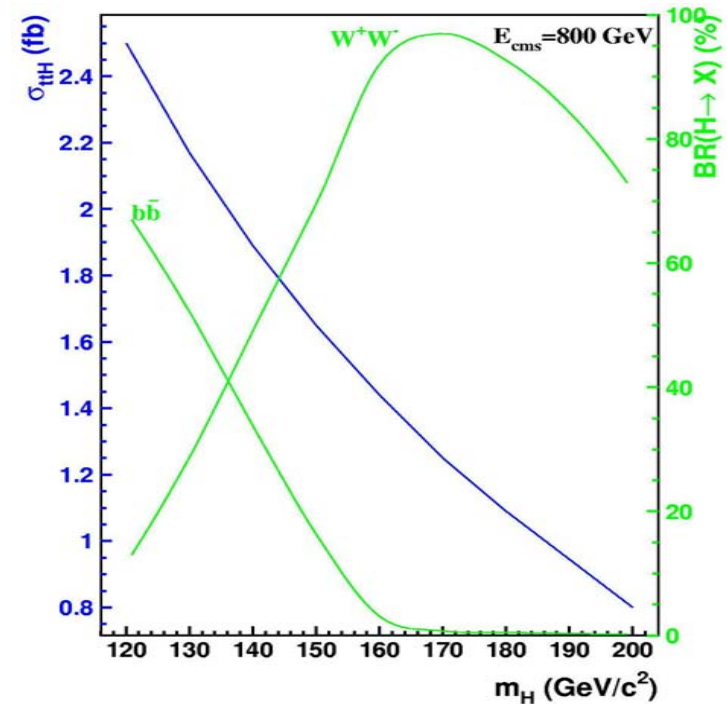
A. Gay



- extension to higher Higgs masses
- and inclusion of $H \rightarrow WW$
- ANN based selection
- event-wise impact parameter probability tag
- fast detector simulation
- full 6-fermion background (WHIZARD MC)

4 channels analysed:

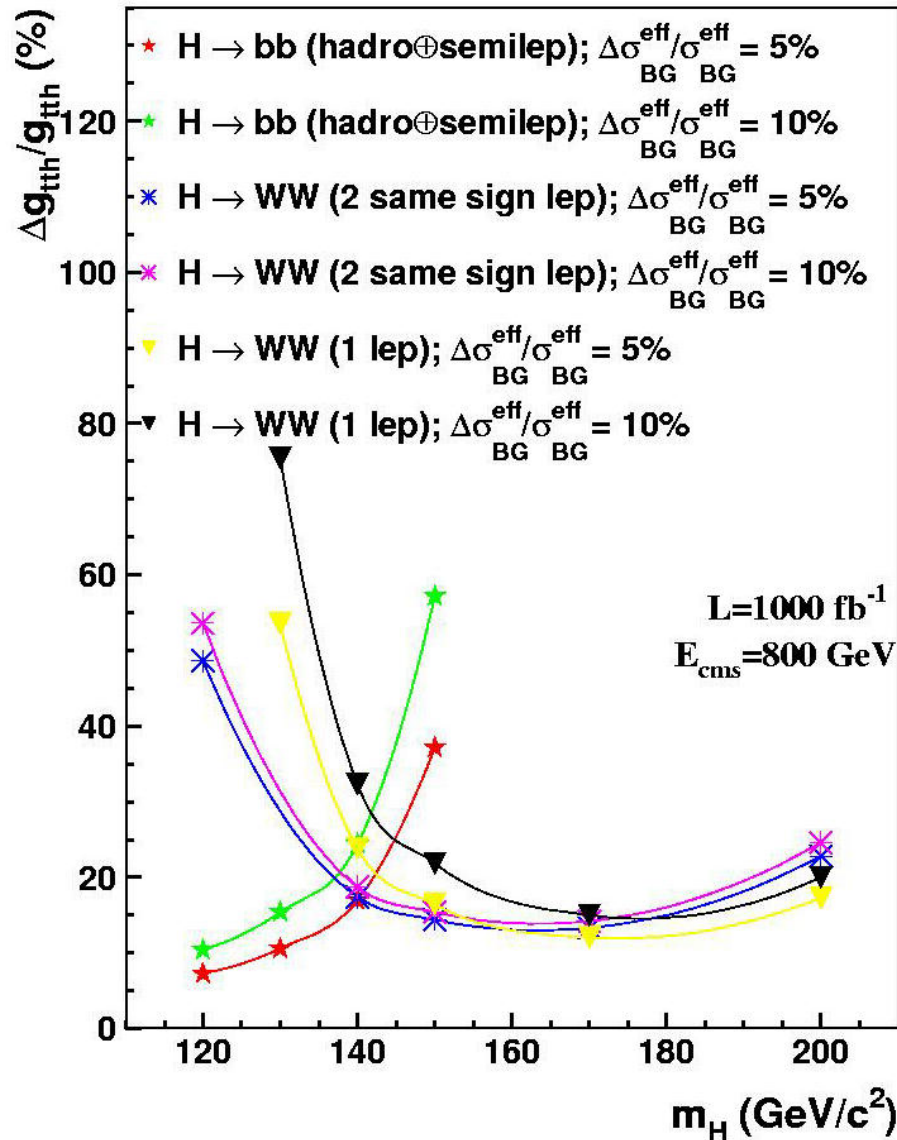
- semileptonic channel
 $e^+e^- \rightarrow t\bar{t}H(H \rightarrow b\bar{b}) \rightarrow 4b2ql\nu.$
- hadronic channel $e^+e^- \rightarrow t\bar{t}H(H \rightarrow b\bar{b}) \rightarrow 4b4q.$
- “2 same sign leptons + 6 jets” channel
 $e^+e^- \rightarrow t\bar{t}H(H \rightarrow W^+W^-) \rightarrow 2l^{+/-}2\nu4q2b$
- “1 lepton + 8 jets” channel
 $e^+e^- \rightarrow t\bar{t}H(H \rightarrow W^+W^-) \rightarrow l\nu6q2b$



Top Yukawa coupling

Result:

A. Gay



Precision on g_{ttH} for $1\text{ab}^{-1}@800 \text{ GeV}$	
m_H (GeV)	$\Delta g_{ttH}/g_{ttH}$
120	7 %
140	17 %
170	13 %
200	15 %

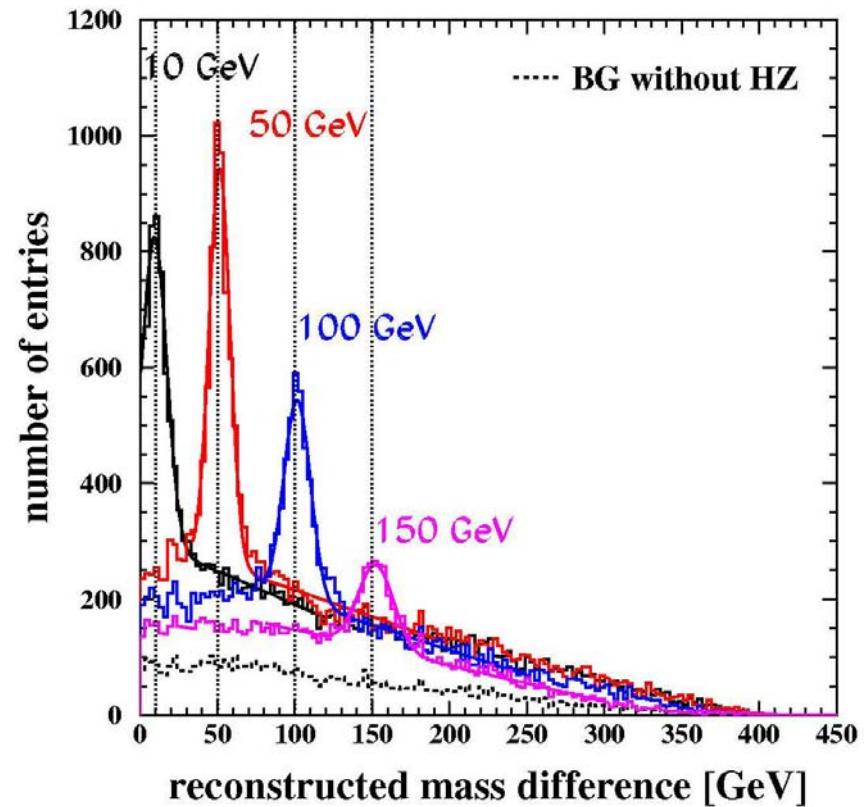
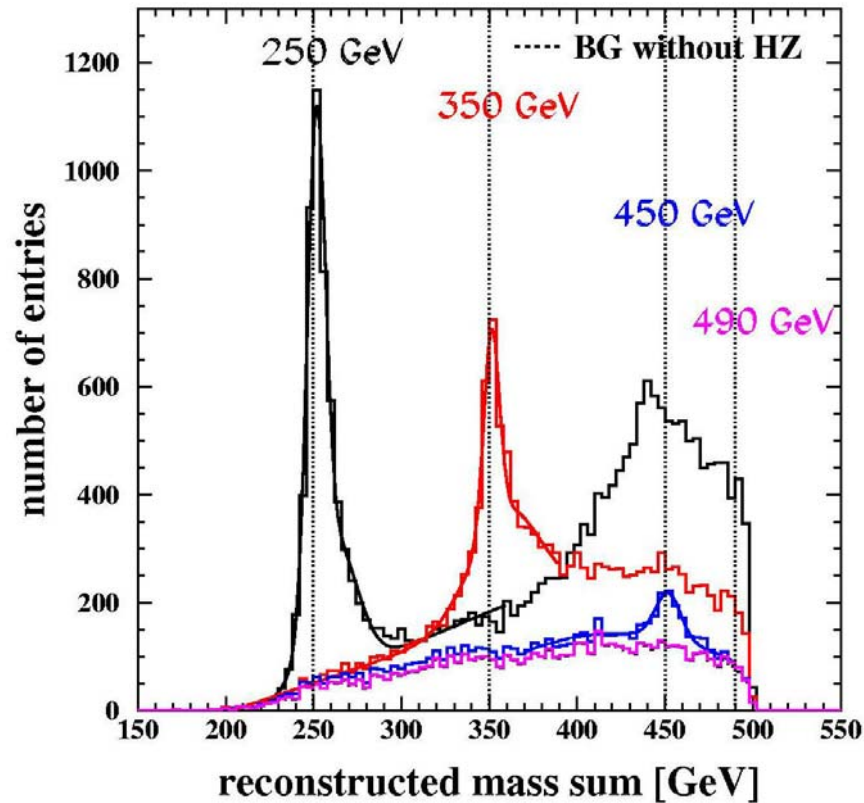
for 5% syst. Background uncertainty

Supersymmetric Higgs Bosons

realistic experimental analysis for $e^+e^- \rightarrow HA$

Signals for $\sin(\beta-\alpha)=1$ and $\text{BR}(H/A \rightarrow bb) = 85\%$:

Klimkovich
Kuhl
Raspereza
Desch



Achievable precisions with 500 fb^{-1} : $\Delta m \approx \text{few } 100 \text{ MeV}$
 $\Delta \sigma \approx \text{few } \%$
 $\Delta \Gamma \approx \text{few GeV}$

Supersymmetric Higgs Bosons

Various applications to theoretical models possible e.g.:

CP violation in SUSY *Frank, Heinemeyer, Hollik, Weiglein
Pilaftsis, Wagner, Carena, Ellis*

2HDM *Ginzburg, Krawczyk, Osland; Gunion*

NMSSM *Miller, Nevzorov, Zerwas*

Many more ideas and work which cannot be reported here.

Information about the new ECFA workshop at

<http://www.desy.de/conferences/ecfa-lc-study.html>

and many linear collider notes at

<http://www-flc.desy.de/lcnotes/>

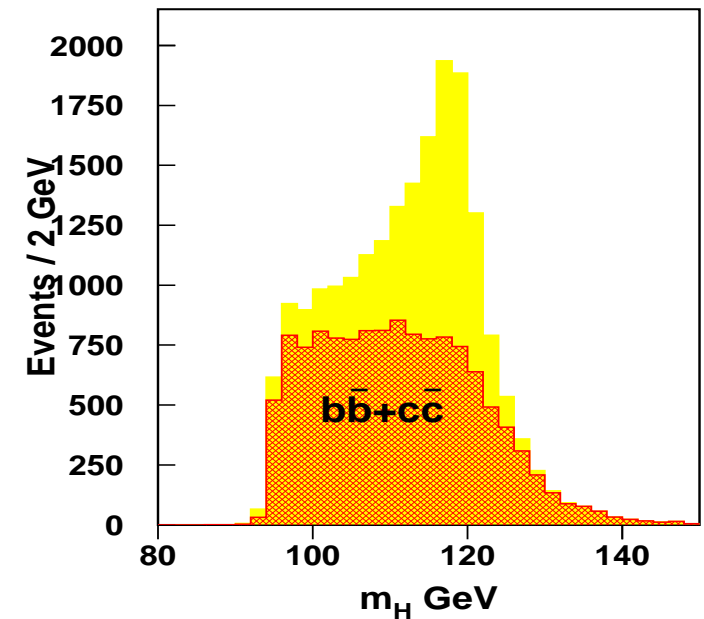
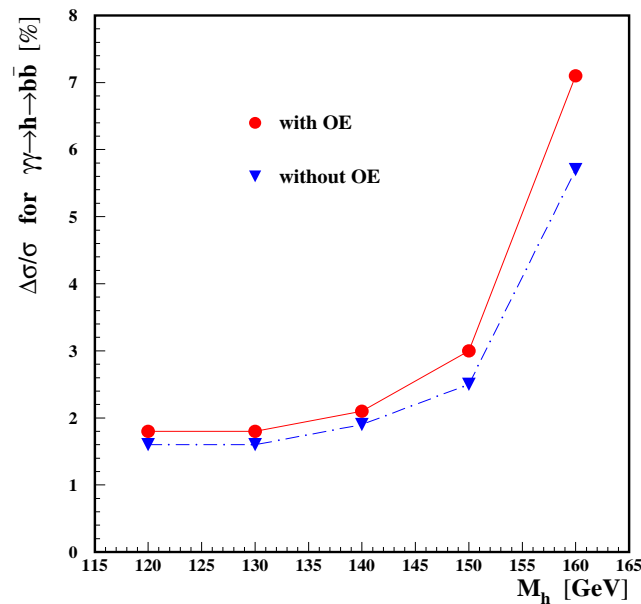
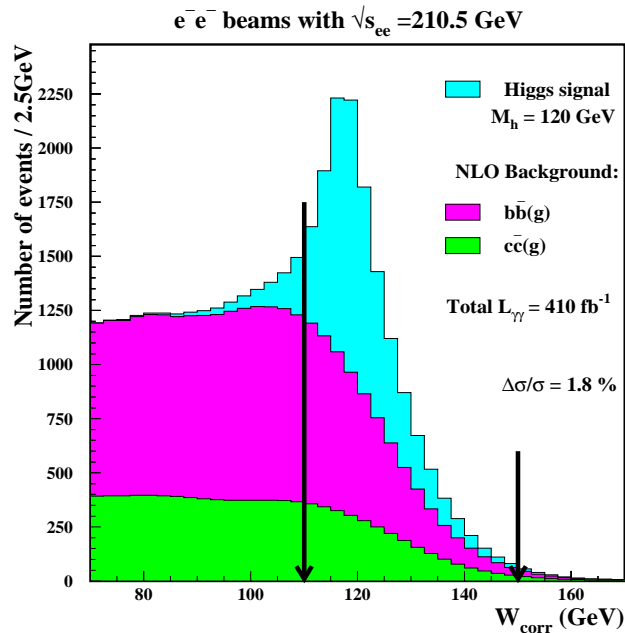
Next workshop: 13-16 November, Montpellier

$\gamma\gamma \rightarrow higgs \rightarrow b\bar{b}$ at Photon Collider at TESLA

Analyses include:

- Realistic photon-photon luminosity simulations.
- NLO background.
- Overlaying events $\gamma\gamma \rightarrow$ hadrons.
- Detector simulation.
- Realistic b -tagging.
- Correction for escaping neutrinos.

SM



P. Niezurawski, A. F. Żarnecki, M. Krawczyk; ABS 595; hep-ph/0307183
(Acta Phys. Pol. B 34 177-187 (2003); hep-ph/0208234)

A. Rosca, K. Mönig; ABS 595

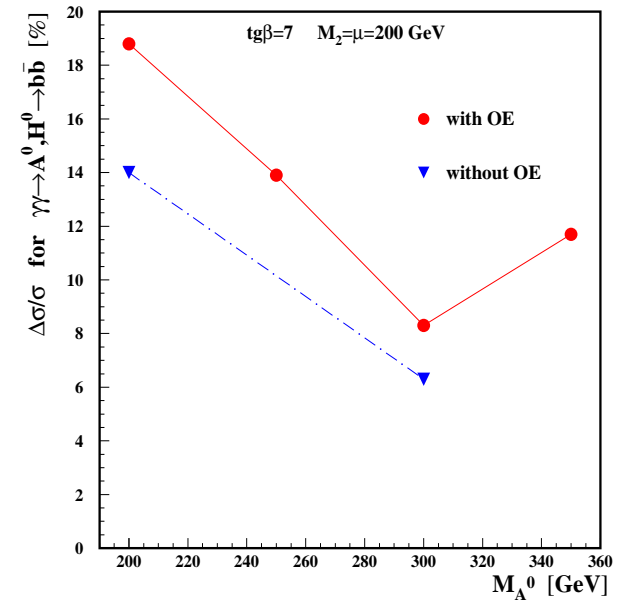
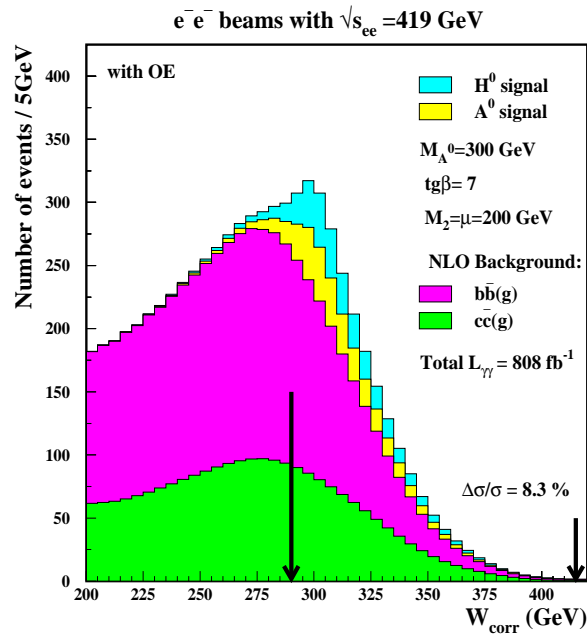
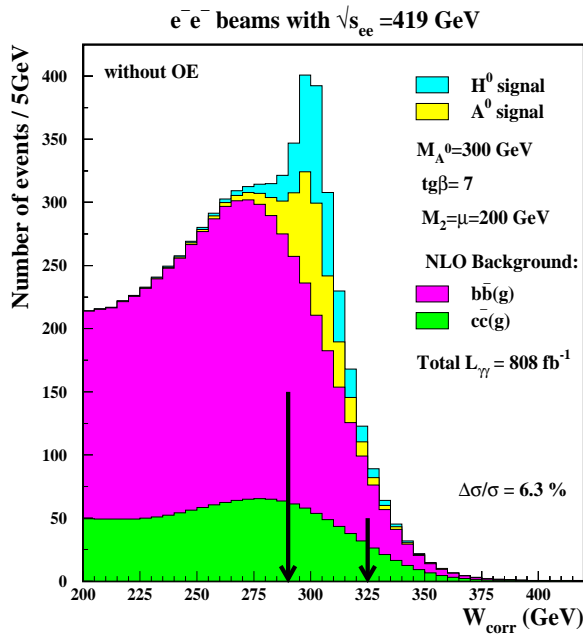
$\gamma\gamma \rightarrow higgs \rightarrow b\bar{b}$ at Photon Collider at TESLA

MSSM (*LHC wedge*)

- SM-like light Higgs boson
- $\tan\beta = 7$
- $M_2 = \mu = 200$ GeV
- $M_A = 200\text{--}350$ GeV

Following Mühleitner et. al.

(see also Asner et. al)

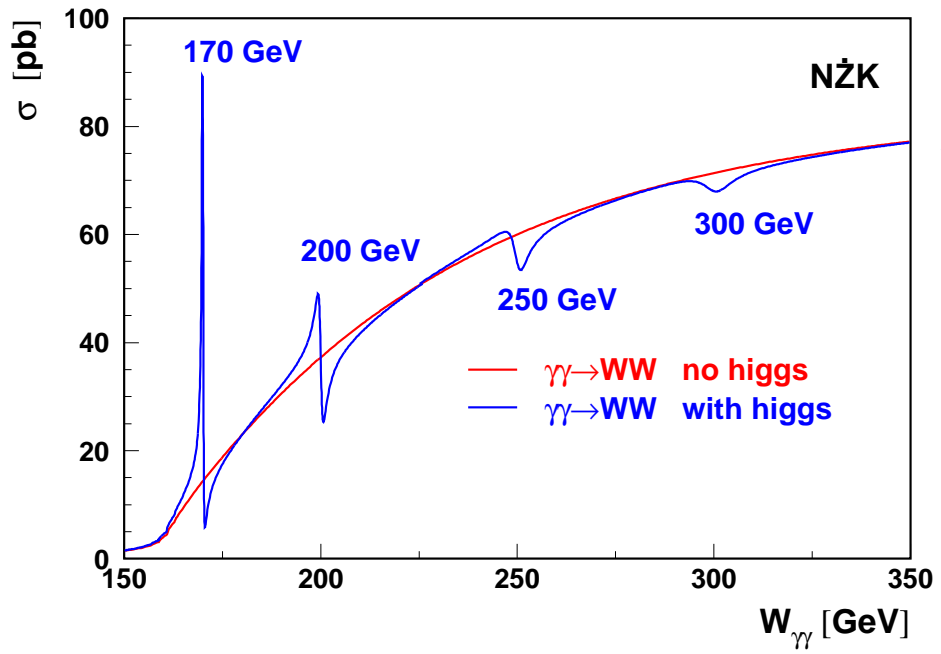


Testing higgs properties in $\gamma\gamma \rightarrow higgs \rightarrow ZZ / W^+W^-$

contribution #605

CP-conservation

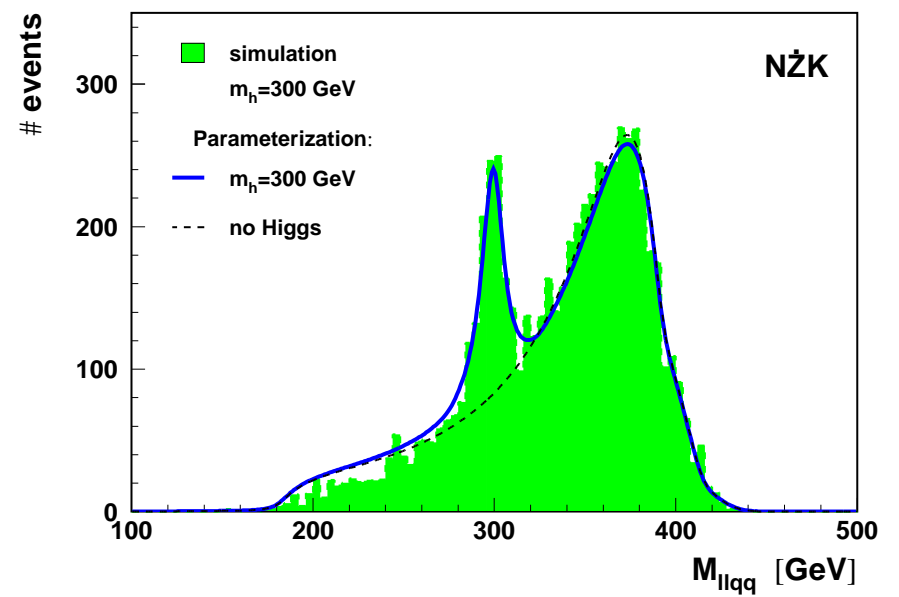
$$\gamma\gamma \rightarrow h \rightarrow W^+W^-$$



Interference with a large Standard Model background \Rightarrow sensitivity to the phase of the $h\gamma\gamma$ coupling, $\phi_{\gamma\gamma}$

\Rightarrow Realistic simulation for the Photon Collider at TESLA,
 \Rightarrow Combined ZZ and W^+W^- channels.
 JHEP'2002[hep-ph/0207294]; hep-ph/0307175

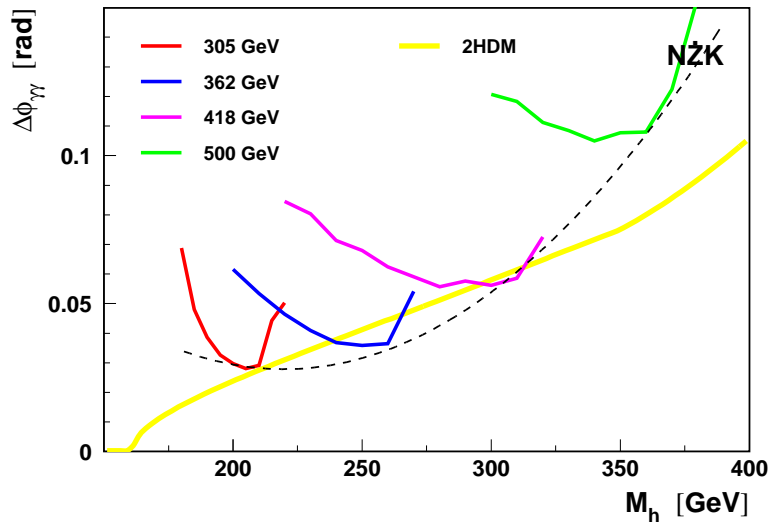
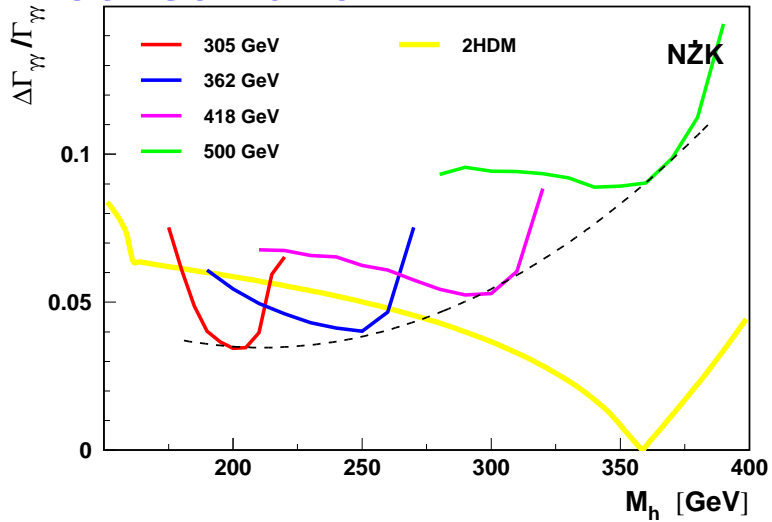
$$\gamma\gamma \rightarrow h \rightarrow ZZ$$



\Rightarrow combined $\Gamma_{\gamma\gamma}$ and $\phi_{\gamma\gamma}$ measurement !

ZZ and W^+W^- mass distributions

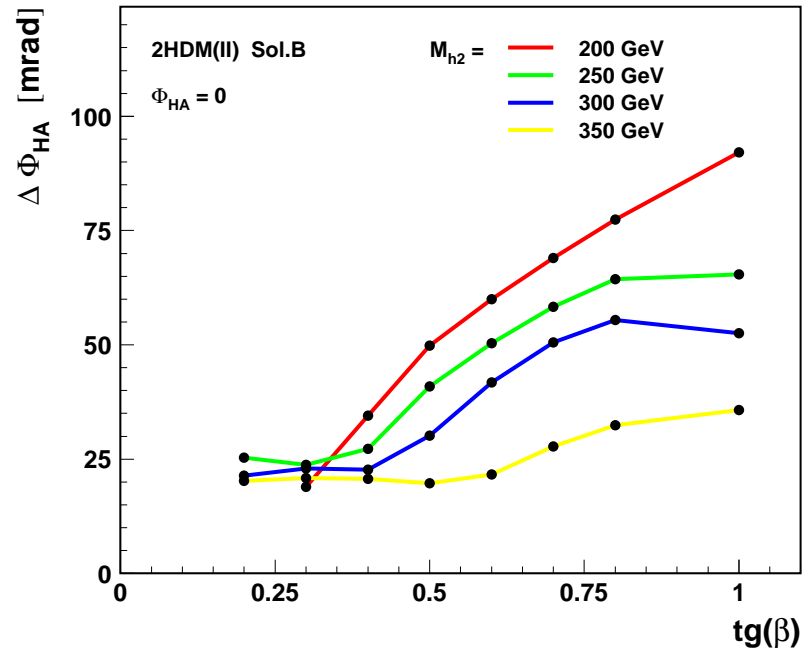
CP-conservation



$\Delta\phi_{\gamma\gamma} = 30 - 100 \text{ mrad}$

SM-like 2HDM (II) with small CP-violation

$m_{H^\pm} = 800 \text{ GeV}, \quad m_{h_1} = 120 \text{ GeV}$



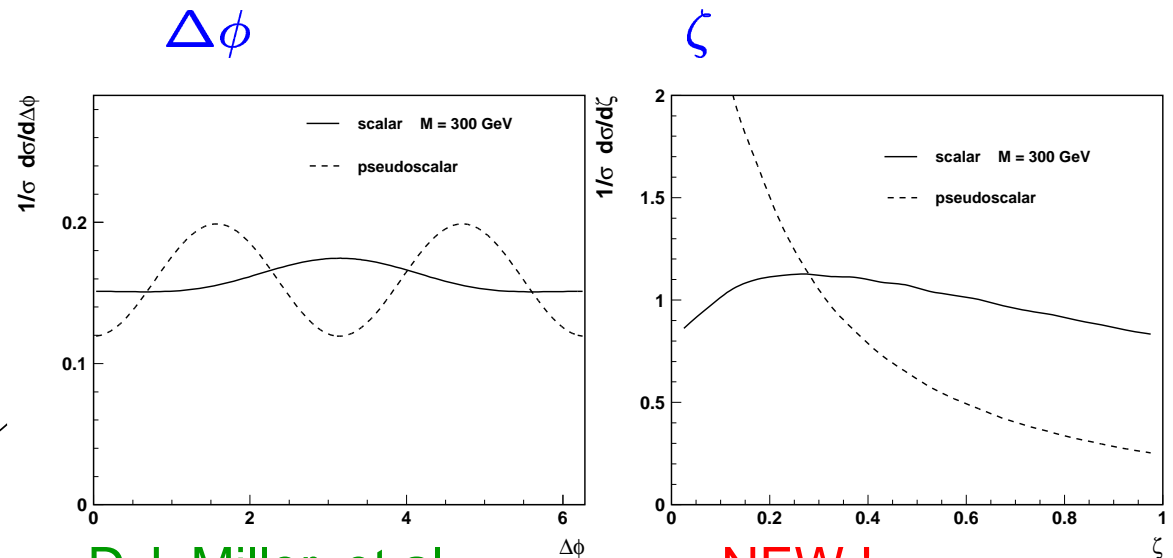
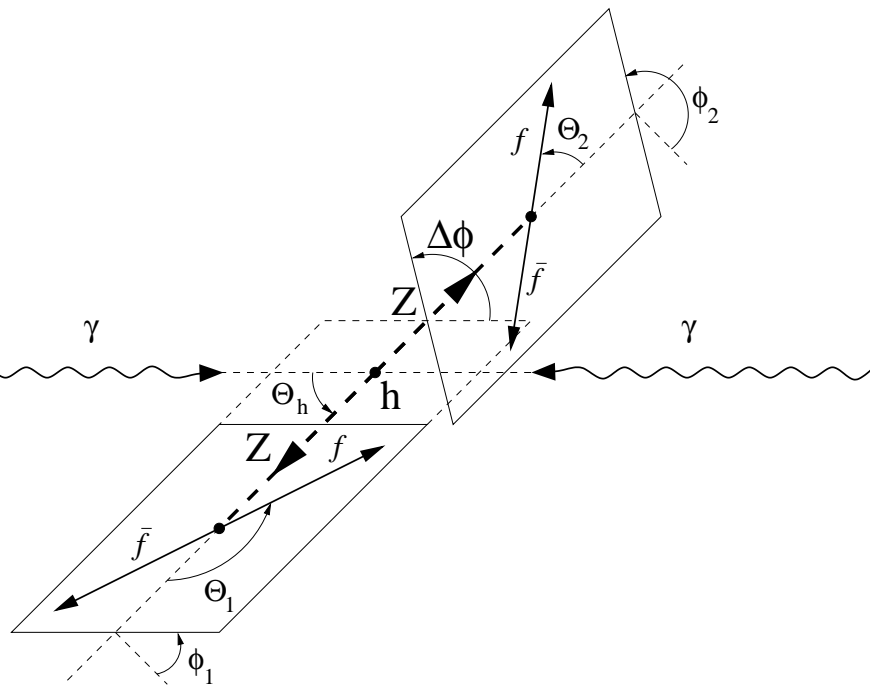
From $\Gamma_{\gamma\gamma}$ and phase $\phi_{\gamma\gamma}$ measurement
 $\Rightarrow H - A$ mixing angle with

$\Delta\Phi_{HA} = 20 - 90 \text{ mrad} > 10 \sigma$

Generic model with CP-violation: angular distributions

Combining various angular distributions for the W^+W^- and ZZ -decay products.

Expected distributions for scalar and pseudo-scalar higgs with generic couplings to WW/ZZ .



D.J. Miller, et al.

NEW !

⇒ parity of the Higgs-boson can be verified

$$\zeta = \frac{\sin^2 \Theta_1 \cdot \sin^2 \Theta_2}{(1 + \cos^2 \Theta_1) \cdot (1 + \cos^2 \Theta_2)}$$

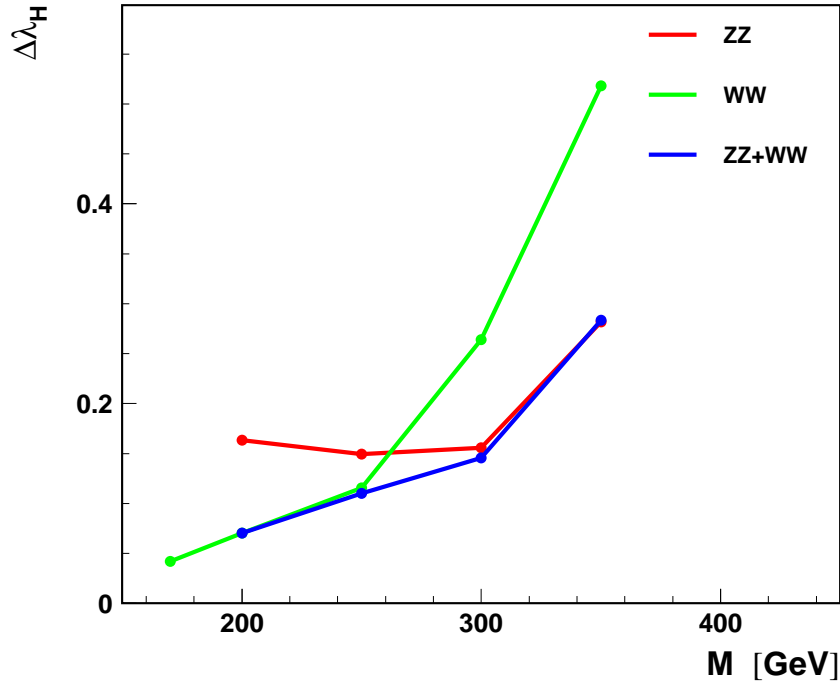
Generic model with CP-violation: results

Combined fit to all angular distributions for W^+W^- and ZZ events

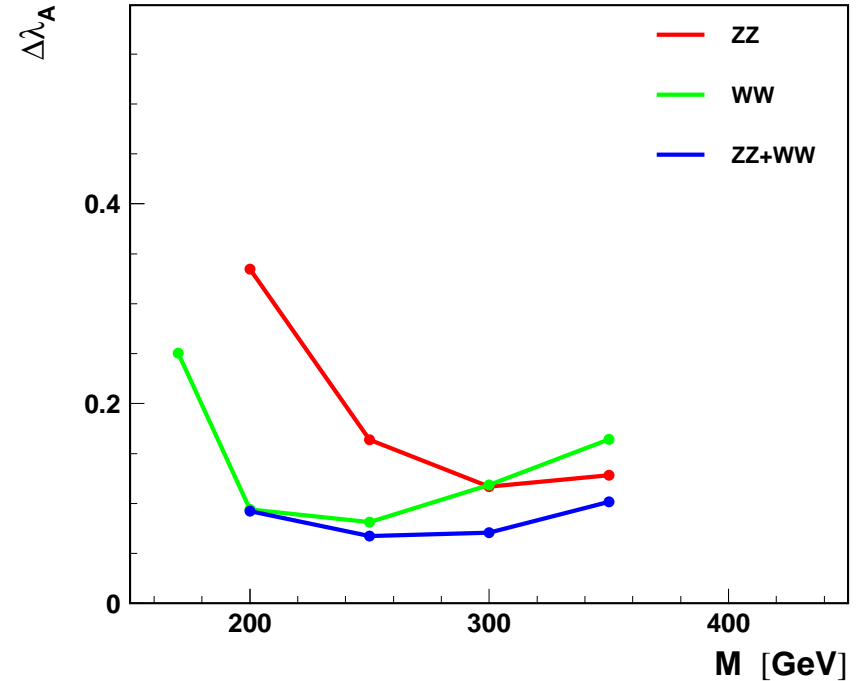
Error on coupling to vector bosons:

assuming SM-like case: $\lambda_H = 1$ $\lambda_A = 0$

scalar coupling λ_H



pseudoscalar coupling λ_A

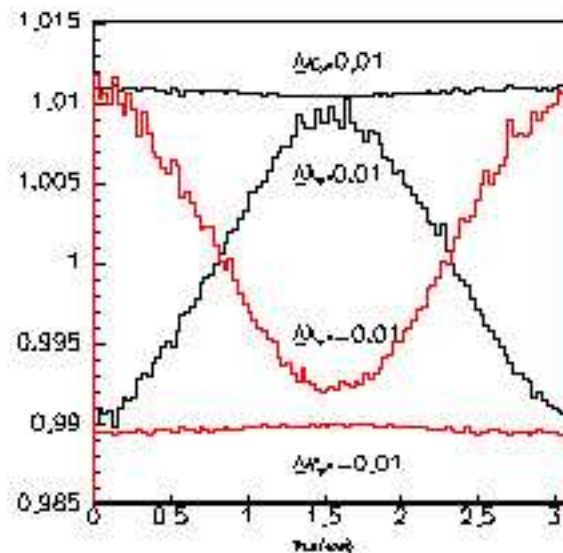
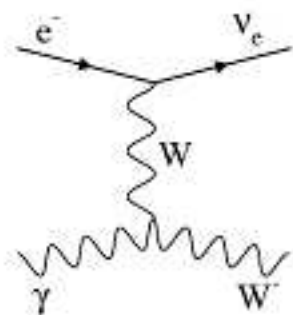


Even higher accuracy when combined with mass distribution ([hep-ph/0307175](https://arxiv.org/abs/hep-ph/0307175))

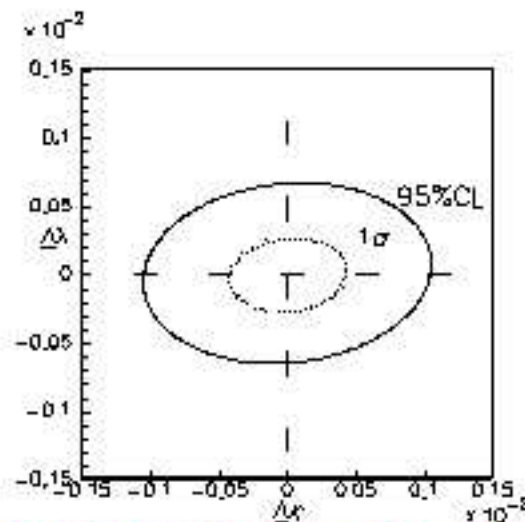
⇒ precise tests of higgs CP properties at Photon Collider !

Measurement of Trilinear Gauge Couplings in $e\gamma$ -collisions

Feynman diagram for $e\gamma \rightarrow \nu W$ with TGC contribution only through t -channel W -exchange



Deviations from SM event distribution over the φ angle due to the anomalous couplings $\Delta\kappa_\gamma$ and $\Delta\lambda_\gamma$



Estimated errors for $\Delta\kappa_\gamma$ and $\Delta\lambda_\gamma$ 95% CL and 1σ contour plots in $\Delta\lambda_\gamma/\Delta\kappa_\gamma$ plane

$E_{CM} = 450 \text{ GeV}$ $ \mathcal{L}\Delta t$	$e\gamma$ 110 fb^{-1}	$\tau\tau$ 110 fb^{-1}	e^+e^- 500 fb^{-1}
$\Delta\ell$	0.1%	0.1%	
$\Delta\kappa_\gamma \cdot 10^4$	10.1	6.7	3.1
$\Delta\lambda_\gamma \cdot 10^4$	2.6	6.0	4.3

Comparison of $\Delta\kappa_\gamma$ and $\Delta\lambda_\gamma$ for three different types of a collider

K.Mönig, J.Sekaric
Nr. 806

Power (Polarisation at Work in Energetic Reactions) Meeting

In order to finish our [Write-Up 'Beam Polarisation at a LC'](#) until the end of 2003 we will have a

Power meeting@SLAC on October ...!

Please, have a look on the outline of our planned paper (<http://www.ipp.dur.ac.uk/~gudrid/power/draft.html>), send your contributions or give a short summary of all your made polarisation studies and provide your list of references until

August, 31, 2003

to the contact persons (emails are given on the POWER home-page: <http://www.ipp.dur.ac.uk/gudrid/power/>) and a copy to Gudi (g.a.moortgat-pick@durham.ac.uk).

Together with the finish of our 'Write-Up' we would like to celebrate the approval for the project E-166, the 'Undulator-Based Production of Polarised Positrons' at the 50-GeV beam at the Final Focus Test Beam@Slac!

Everybody who is interested in the finish is very welcome at the meeting!

Please, let us (Johns email? Mikes email? And my email?) know, whether you would like to attend and – please – keep in mind **the deadline** for providing us with information about your polarisation studies!

Looking forward to meeting You

on October, ..., at SLAC!