MEASUREMENT OF THE HIGGS MASS

VIA THE CHANNEL:

$e^+e^- \rightarrow Z\,H \rightarrow e^+e^- + X$

(Preliminary results)

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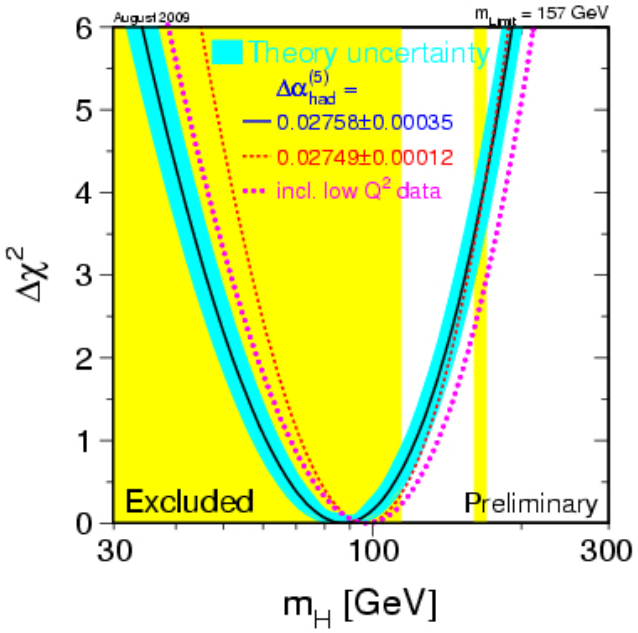
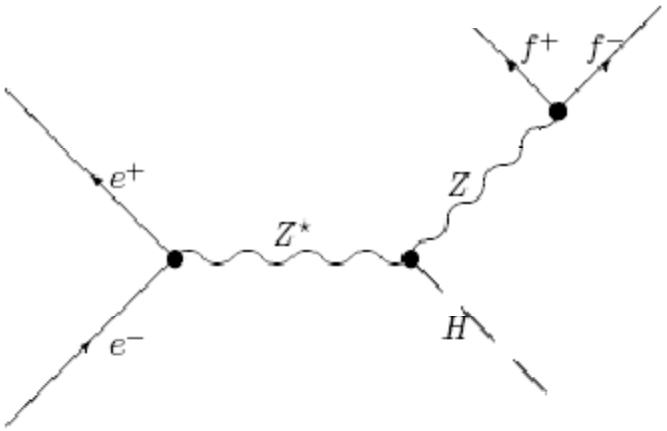
I. Constraints on the Higgs mass & Higgs-strahung process



From direct searches :

- LEP2: $M_H \geq 114$ GeV
- Recent combined D0 and CDF results: $M_H < 160$ GeV or $M_H > 170$ GeV at 95 % confidence level



At future ILC, the main production mechanism of Higgs are Higgs-strahlung process and WW fusion mechanism.

We will focus on the Higgs-strahlung process:

$$e^+e^- \rightarrow H\,Z \rightarrow e^+e^-\,H$$

II. Grid, VO & software

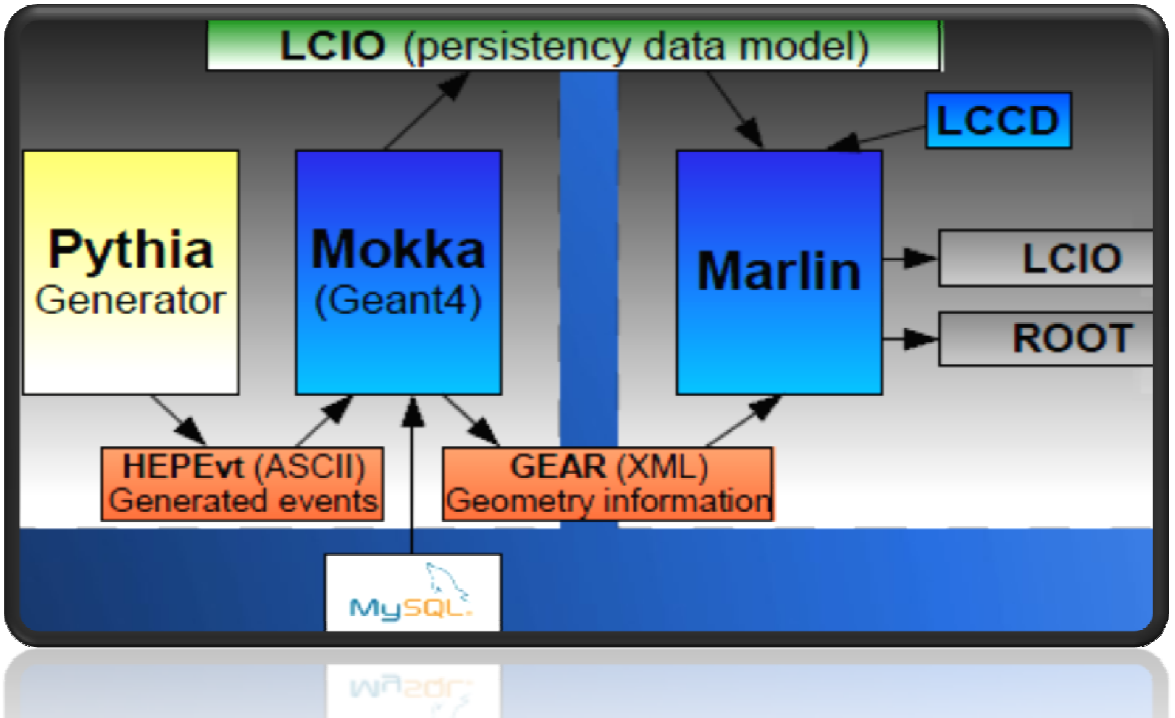
LCG Grid "LHC Computing Grid"

Virtual Organisation (VO) : « CALICE & ILC »

- ✓ hsttps://grid-voms.desy.de:8443/voms/calice
- ✓ https://grid-voms.desy.de:8443/voms/ilc

CCIN2P3 platform (in France)

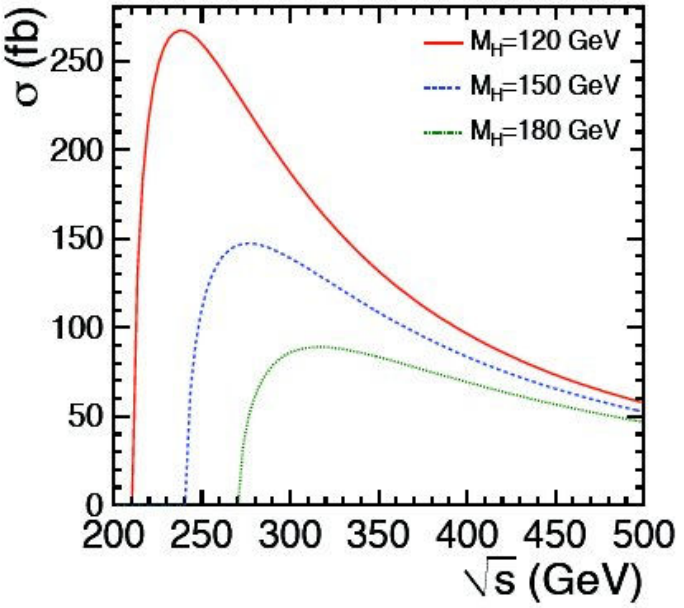
ILD data sample for LoI: fully simulated and reconstructed for the ILD_00 detector model



III. Parameters in simulations and analyses

ILD_00 detector:
M_H = 120 GeV
$\sqrt{s}$ = 250 GeV
e^+ polarization = 30%
e^- polarization = 80%
L= 250 fb^{-1}

Background:
- Bhabha scattering
- SM events with 4 fermions, including e^+e^-



Cross section (fb)	e^+e^- beam polarization mode (30%, 80%)			
Process	**(-,-)**	**(+,-)**	**(-,+)**	**(+,+)**
ZH → eeX	**6.77**	**11.11**	**7.48**	**5.12**
ee (Bhabha)	**17.28 10^6**	**17.30 10^6**	**17.28 10^6**	**17.28 10^6**
4f → eeff	**4 258**	**4 908**	**4 253**	**4 557**

IV. Event reconstruction

The Higgs mass is calculated from the well known formula:

$$M_H^2 = s + M_z^2 - 2 E_z \sqrt{s}$$

Identification of the Z boson:

- **Selection of the e^+e^- pair which gives the best mass for the Z boson :**

$$M_{Z\ reconstructed} = M_Z \pm 10\ GeV$$

- **Central leptons : $|\cos(\theta_i)| < 0.9$**
- **Opposite charges**

(+,-)	$L_{simulated}$ (fb^{-1})	$N_{simulated}$	$N_{reconstructed}$	$N_{expected}$ for 250 fb^{-1}
eeX (Signal)	1000	11 111	5 183	1 300
ee (Bhabha)	0.5123	8 866 734	48 201	$23\ 10^6$

$\Rightarrow$ **The Bhabha effect is strongly dominant**

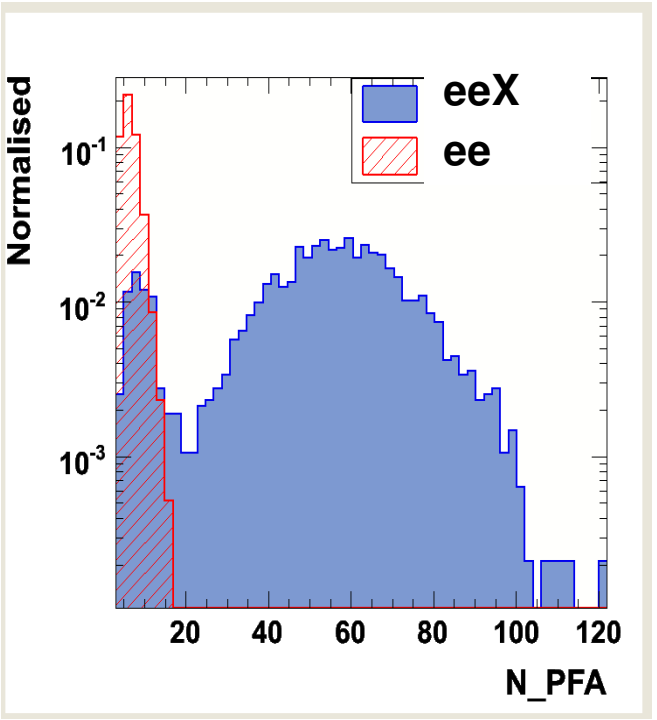
V. Event selection (Bhabha scattering)

Pre-selection : Cut on the number of reconstructed objets $N_{objets} > 21$

The measurement of the cut efficiency was limited by the MC event number

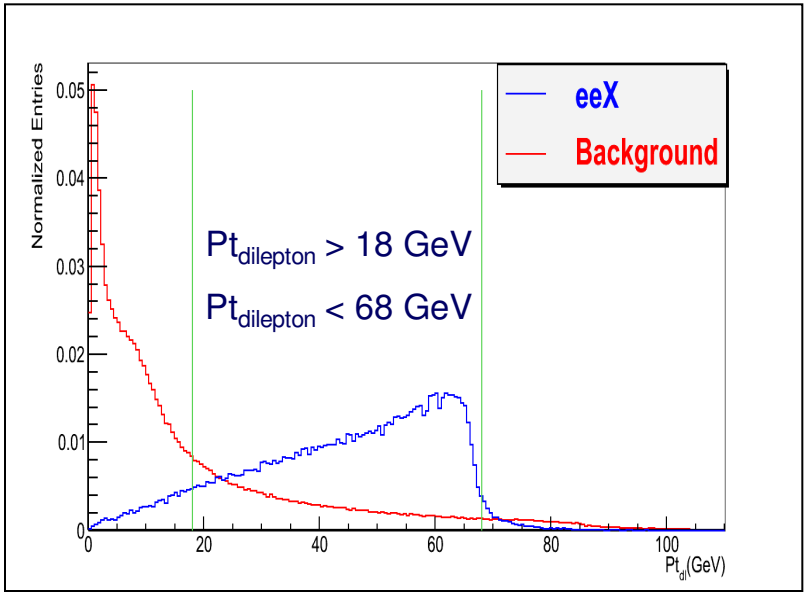
But the Bhabha background can be controlled

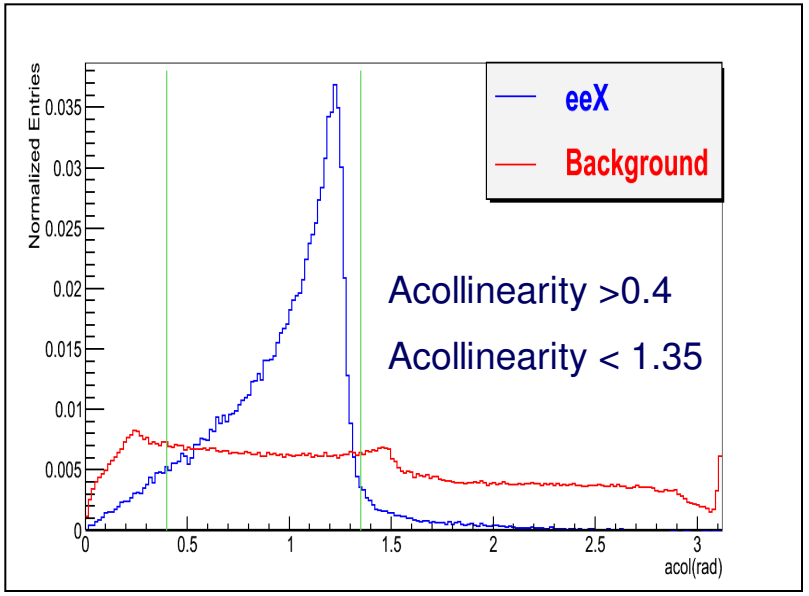
⇒ **The** Bhabha background will be neglected in the following part of this study

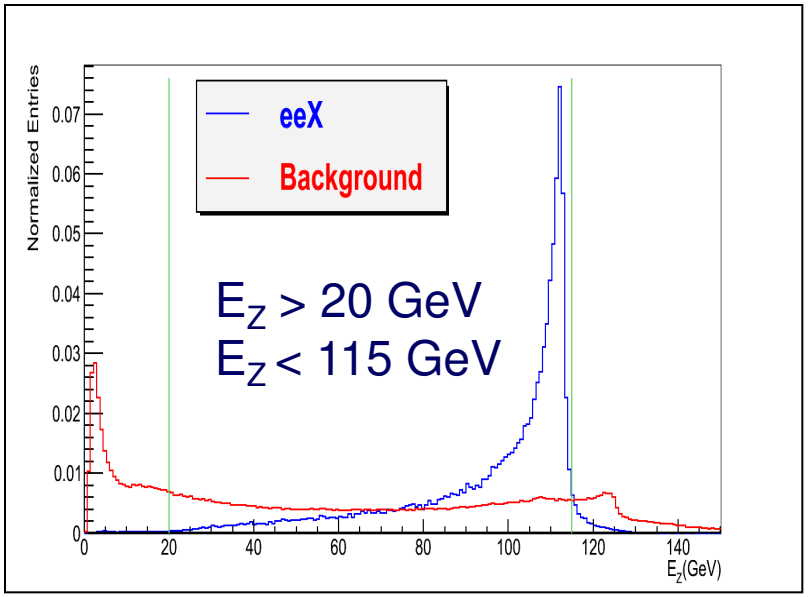


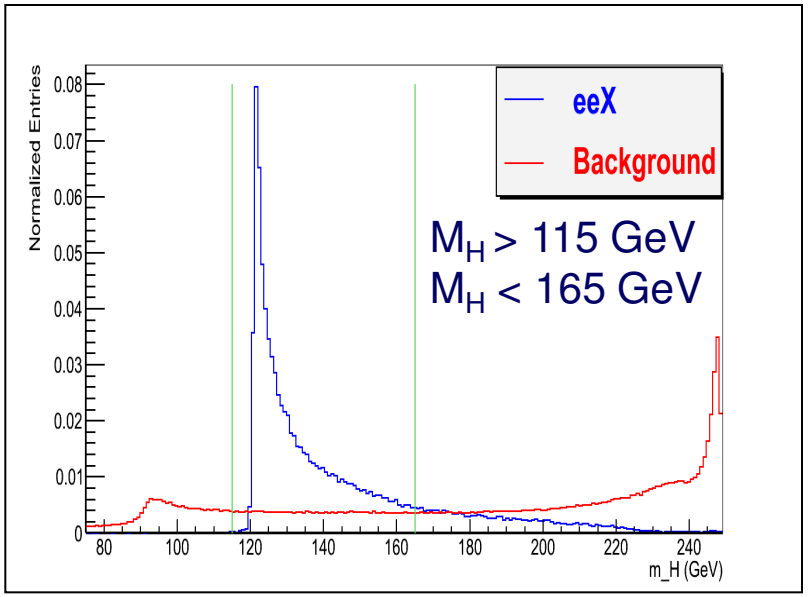
(+-)	$L_{simulated}$ (fb^{-1})	$N_{simulated}$	$N_{reconstructed}$	$N_{objets} > 21$	$N_{objets} > 21$ (250 fb^{-1})
eeX (Signal)	1 000	11 111	5 183	4 638	1 159
ee (Bhabha)	0.5123	$8.87\ 10^6$	48 201	1	487

VI. Event selection (cuts on kinematic variables)



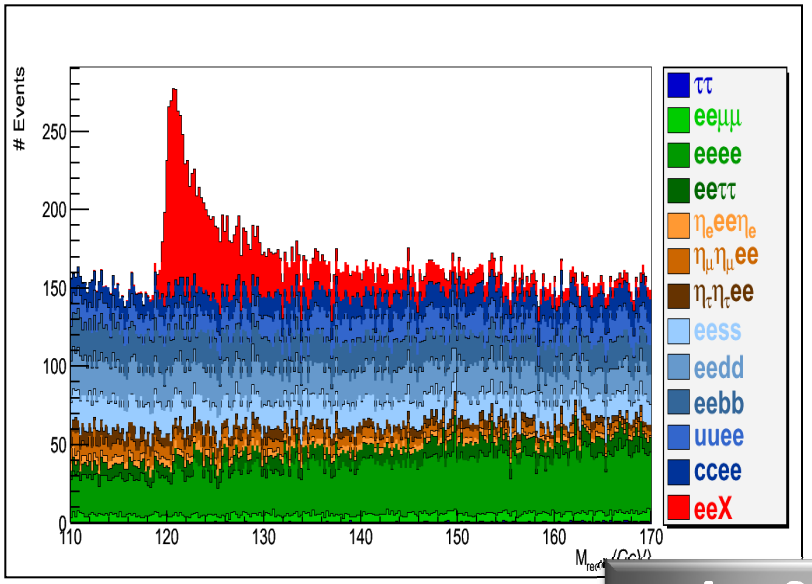


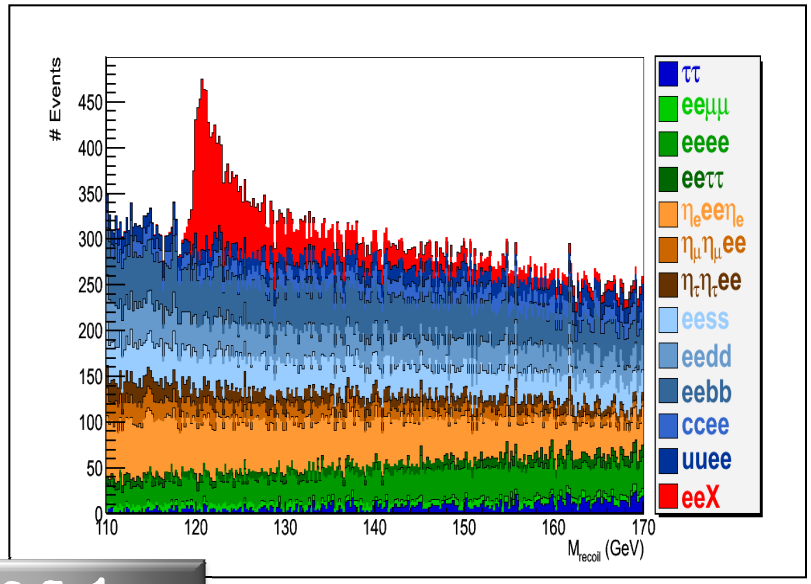




V. Event selection (results)

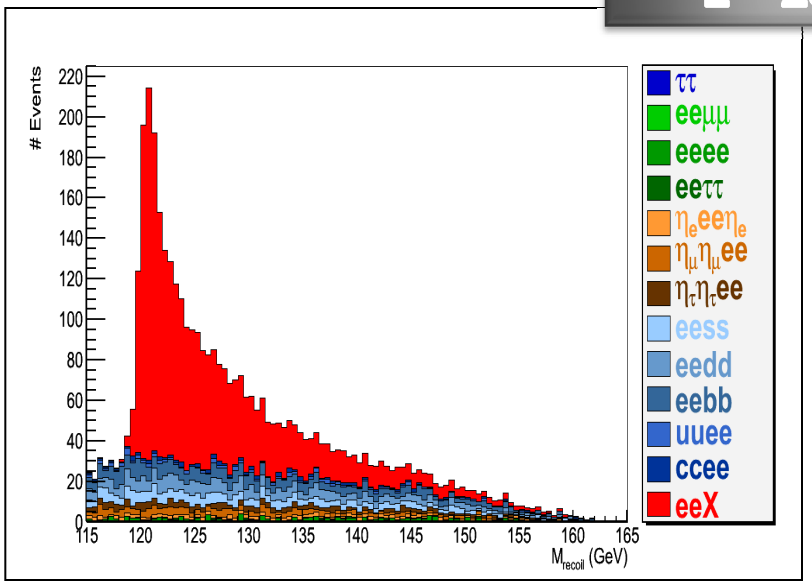
Before Cuts

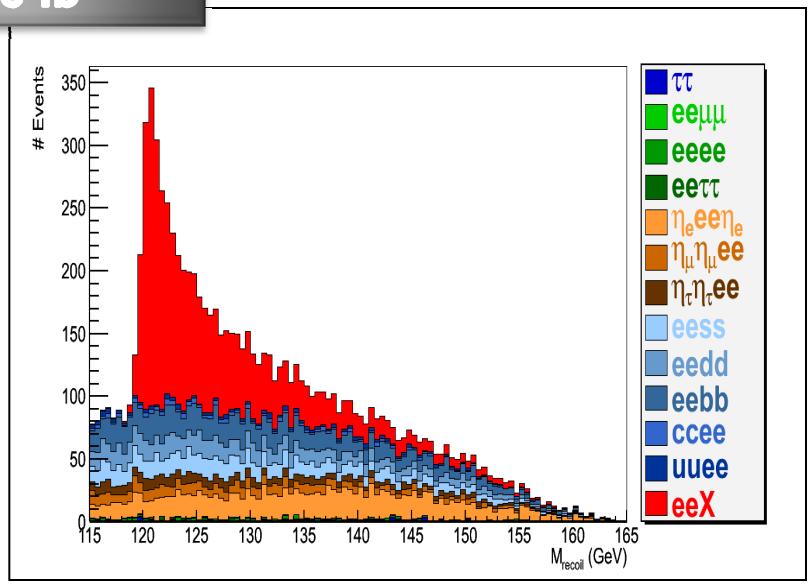




L = 250 fb^{-1}

After Cuts





Polarization mode (+,-)

Polarization mode (-,+)

VII. Reconstruction of the Higgs recoil mass

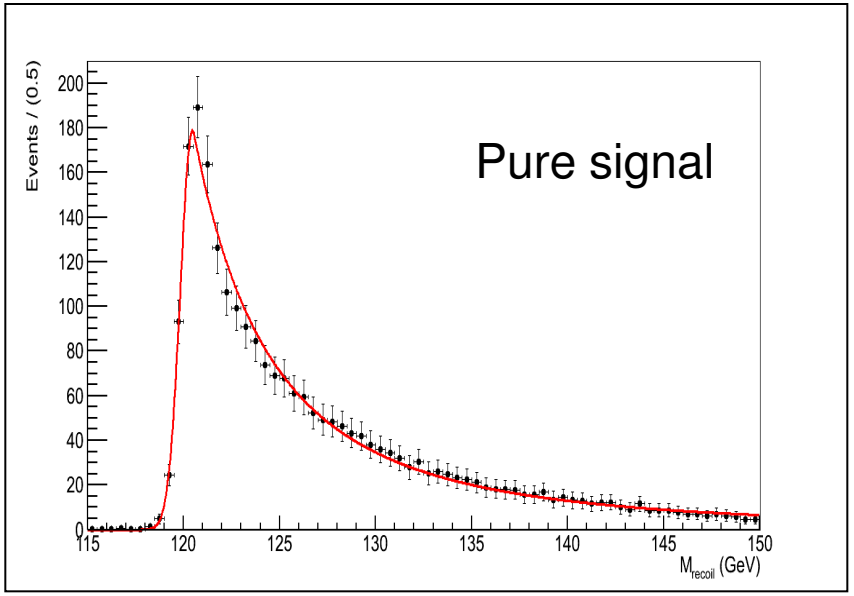
Signal measurement:

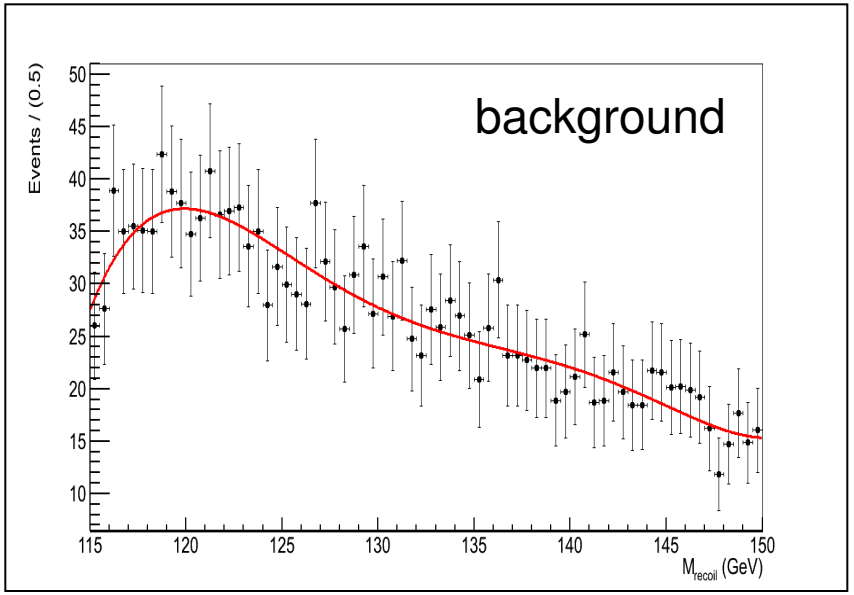
$$f(x;\alpha,n,\bar{x},\sigma) = N \begin{cases} e^{-\frac{(x-\bar{x})^2}{2\sigma^2}} & : pour \ \frac{x-\bar{x}}{\sigma} \leq \alpha \\ A\left(B - \frac{x-\bar{x}}{\sigma}\right)^{-n} & : pour \ \frac{x-\bar{x}}{\sigma} > \alpha \end{cases}$$

$$A = \left(\frac{n}{|\alpha|}\right)^n e^{-\frac{|\alpha|^2}{2}} \quad et \quad B = \frac{n}{|\alpha|} - |\alpha|$$

Background measurement:

Fitted by a sum of gaussians

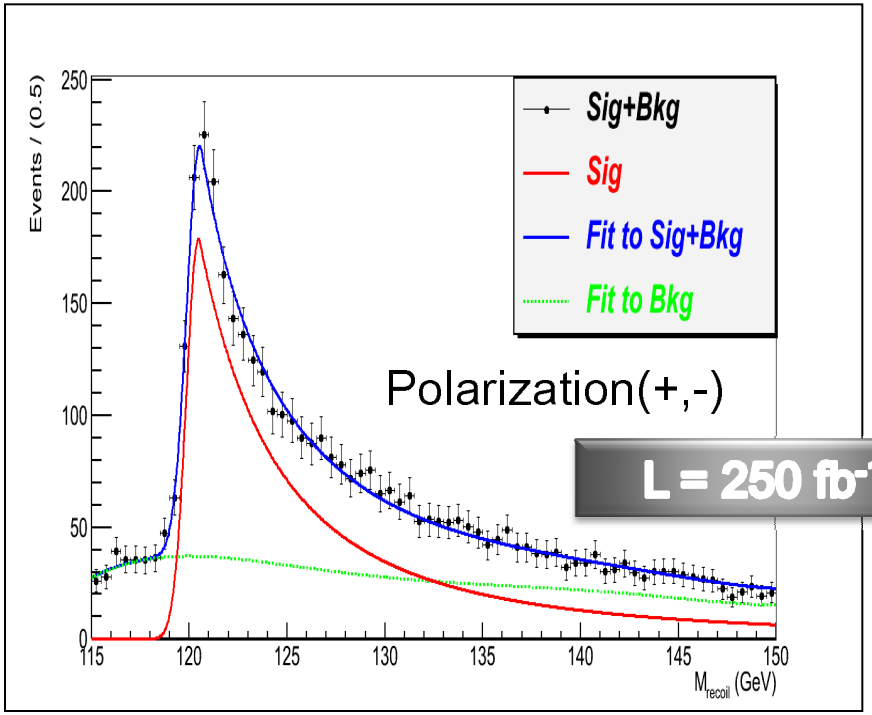


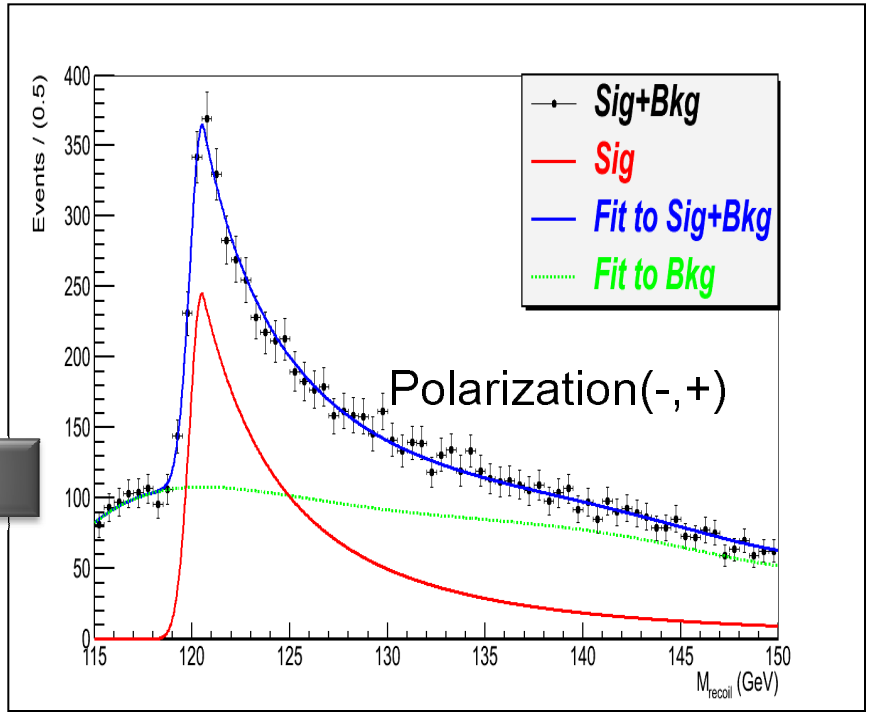


Polarization mode (+,-)

VIII. Reconstructed recoil mass

Measurement of the Higgs mass with signal and background:





L = 250 fb^{-1}

	e^+e^- polarization mode (30%, 80%)			
	(+,-)		(-,+)	
	Only signal	Signal + Bkgrd	Only signal	Signal + Bkgrd
M_H (GeV)	120.464 ± 0.095	120.523 ± 0,118	120,493 ± 0,081	120,513 ± 0.107
σ (MeV)	0.623 ± 0.058	0.634 ± 0.087	0.632 ± 0.050	0.629 ± 0,080

Conclusion

The measurement of the Higgs mass in the channel:

$e^+e^- \rightarrow ZH \rightarrow e^+e^- + X$:

- Illustrates the ILC potential for accurate measurements

- The effect of the background is to deteriorate the accuracy on M_H

- For M_H = 120 GeV:

M_{rec} = 120.523 ± 0.118 GeV (e^+e^- polarization (+,-))

M_{rec} = 120.513 ± 0.107 GeV (e^+e^- polarization (-,+))

- **For more information, other studies:**
  - ″HZ Recoil Mass and Cross Section Analysid in ILD″, H. Li, R. Pöschl and F. Richard; LAL 09-121, LC-PHSM-2009-006
  - H. Li's thesis: "Higgs Recoil Mass and Cross-Section Analysis at ILC and … "

http://tel.archivesouvertes.fr/index.php?halsid=3t3g7n01u9v1i57j7u7b5fd763&view_this_doc=tel-00430432&version=1