LC-PHSM-2000-049- TESLA
Nov. 2000

Measurement of the Higgs Mass and $e^+e^- \rightarrow$ ZH cross section at Linear Colliders

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Abstract

The process $e^+e^- \rightarrow$ ZH, with Z decays to e^+e^-, has been studied for an e^+e^- linear collider operating at 340 GeV/c^2 with a luminosity of $500 fb^{-1}$. It is shown that previous study have underestimated the background in this channel. Using a 120 GeV Higgs mass as a good example, and after a special care of the Bhabha background, it is shown that the Higgs mass could be obtained with a precision on ΔM/M of 1.4 10^{-3} while the cross section could be measured with a precision on $\Delta\sigma/\sigma$ of 4.2 10^{-2}

1 Introduction

The recoil mass technique (r.m.t) consists in selecting a good Z decay into a di-leptons and to search for a corresponding Higgs signal in the recoil mass to the di-leptons. A previous analysis [1] is shown to have an underestimated amount of background. A more carefull analysis of the background is performed and results are given. The events are generated at 340 GeV/c^2 center-of-mass energy. The ISR are generated by PYTHIA[2], while beamstrahlung are taken into account using the CIRCE program. [3].

2 Signal and background Monte Carlo

The signal is simulated with the version 6.115 of PYTHIA, but normalised to the cross section given by HPROD [5], and the total width and branching ratio are taken from HDECAY [6]. The signal and the background considered are presented in table 1, together with the programm used to generate the events and the statistics of simulated events.

Final state	Program	Statistic Monte Carlo
Z H	Pythia 6.115	$1.\ 10^4$
Z Z	Pythia 6.115	$1\ 10^6$
W^+W^-	Pythia 6.115	$1\ 10^6$
$Z(\gamma)$ ($Z\not\to e^+e^-$)	Pythia 6.115	$6\ 10^5$
Bhabha s+t channel	BHWID	$8\ 10^6$

Table 1: Statistic of the generated sample

3 Detector simulation

The detector simulation is made as follows. For the tracks, the reconstruction efficiency and momentum resolution are taken from SIMDET [7]. The electron identification efficiency and the rate hadron to electron misidentification, is taken from a study concerning the tungsten-silicon calorimeter option as proposed for the TESLA detector. [8]

4 A study of the background

The analysis presented in reference [1] has been performed with $e^+e^- \to e^+e^-$ background as given by Z decays using PYTHIA. It neglect the t-channel contribution, which has a large cross section, even with a cut on polar angle of the electron-positron pair at $\cos\theta_{e^+e^-} < 0.6$, due to ISR photon emission(s). Since the set of cuts in the analysis of reference [1] is relatively simple, a similar selection is performed, using this time the program BHWID[4] for the Bhabha background. The recoil mass distribution for this selection is shown on figure 1, which exhibit a dramatic change in the signal/background as compared to the one shown in reference [1] .

5 A new selection and results

First a pre-selection is performed in order to reduce the amount of events to simulate.

- a e^+e^- pair is identified in the event
- the cosine of the di-leptons is smaller than 0.85

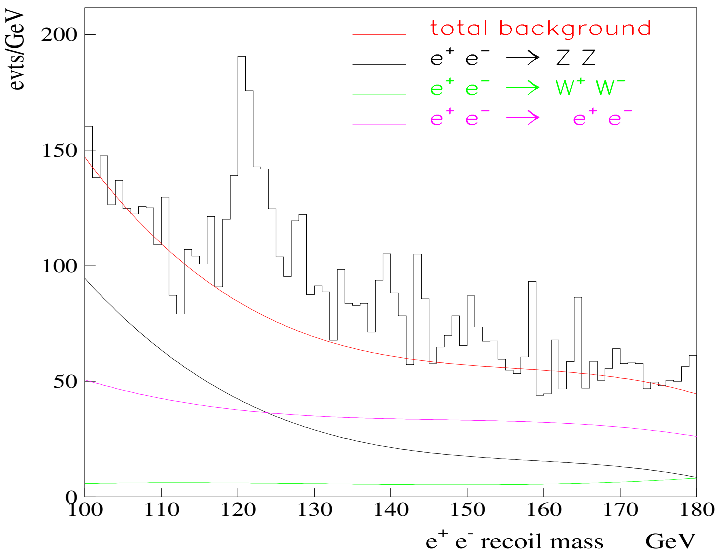

Figure 1: The recoil mass distribution with the correct amount of Bhabha background after the selection of ref [1]

- the di-leptons mass is closer than 5 GeV to the Z pole.

The selection is then based on likelihood estimator for signal vs Bhabha background, first. The estimator used a set of variables such as the missing Pt, the acollinearity, the electron-positron mass and direction, the cosine of the polar angle of the electron, and the one of the positron. The estimator distribution is shown on figure 2. A cut at 0.95 is performed, which eliminates most of the Bhabha background.

Then a second estimator is built for the separation of the signal and the di-boson background, using similar variables. The estimator distribution is shown on figure 3. A cut at 0.2 is performed to reject the background region (close to zero).

After this final cut, the efficiency, including angular acceptance, is about 52%. The mass of the Higgs is fitted on the e^+e^- recoil mass distriubtion, as shown on figure 4, together with the cross section. For the case of 120 GeV Higgs mass, a precision of 166 MeV is reached on the mass and about 4% on the cross section.

6 conclusion

By using a dedicated generator for the t+s channel Bhabha background, which is not the case of ref [1], a more reliable precision is estimated for the Higgs mass and Higgsstrahlung cross section is obtained. The selection efficiency on the signal is about 52%. Using the

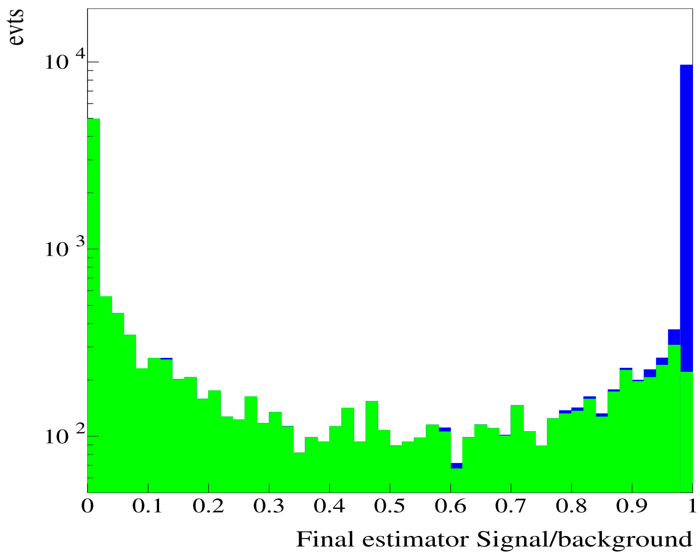

Figure 2: The likelihood estimator of Bhabha background. The blue histogram shows all the considered process, while the green one shows the distribution for the Bhabha events.

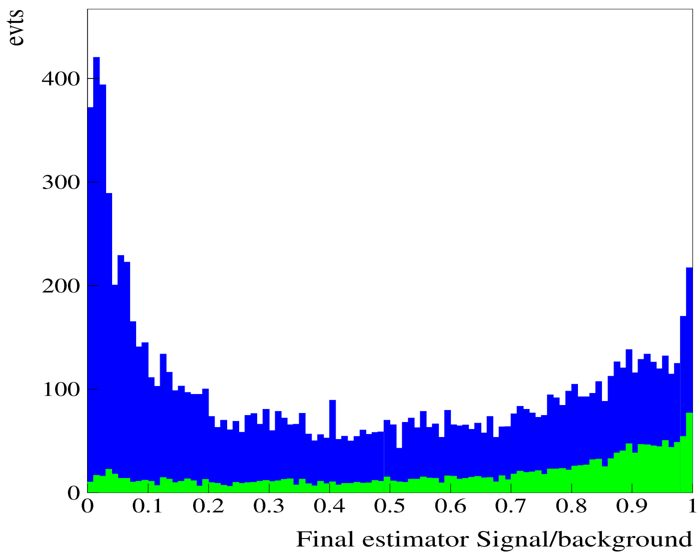

Figure 3: The likelihood estimator of signal/background after the Bhabha rejection. The green hisstogram show the signal , while the blue one shows the total of signal and background.

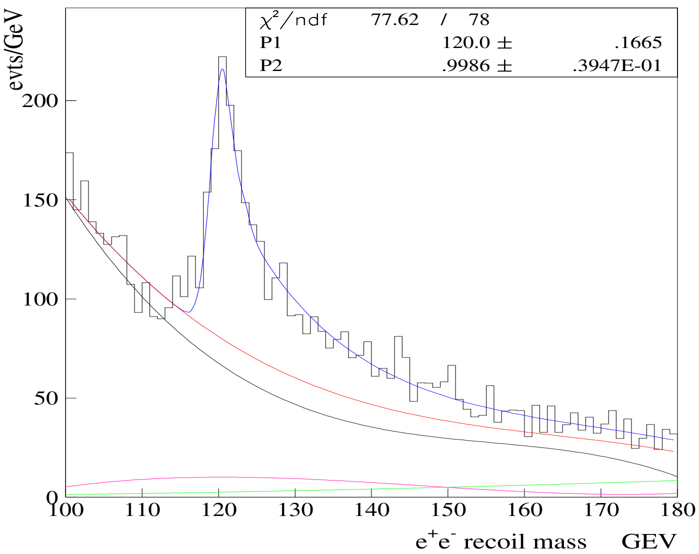

Figure 4: The recoil mass distribution as obtained in the present analysis. The color code follows the one of figure 1

example of a Higgs mass of 120 GeV, a precision of 166 MeV on the Higgs mass is observed, while for the cross section, fitted on the estimator signal/di-boson background, a precision of 4.2 10^{-2} is expected on $\Delta\sigma/\sigma$.

References

[1] W.Lohmann et al, hep-ex/9908065

[2] PYTHIA V6.115, T. Sjostrand
Comp. Phys. Comm. 82(1994), 74

[3] CIRCE program, T. Ohl, hep-ph/9607454

[4] BHWID program, S. Jadach et al, hep-ph/9608412

[5] HPROD program, A.Djouadi, PM/98-17

[6] HDECAY program, A.Djouadi et al, hep-ph/9704448

[7] SIMDET program, fast detector simulation for TESLA.
M.Pohl et al, DESY-99-030 (1999)

[8] J-C Brient talks given at the 7th ECFA/DESY workshop.
http://www.desy.de/ ecfadesy/transparencies/