Precise Measurements of SM Higgs at the ILC Simulation and Analysis

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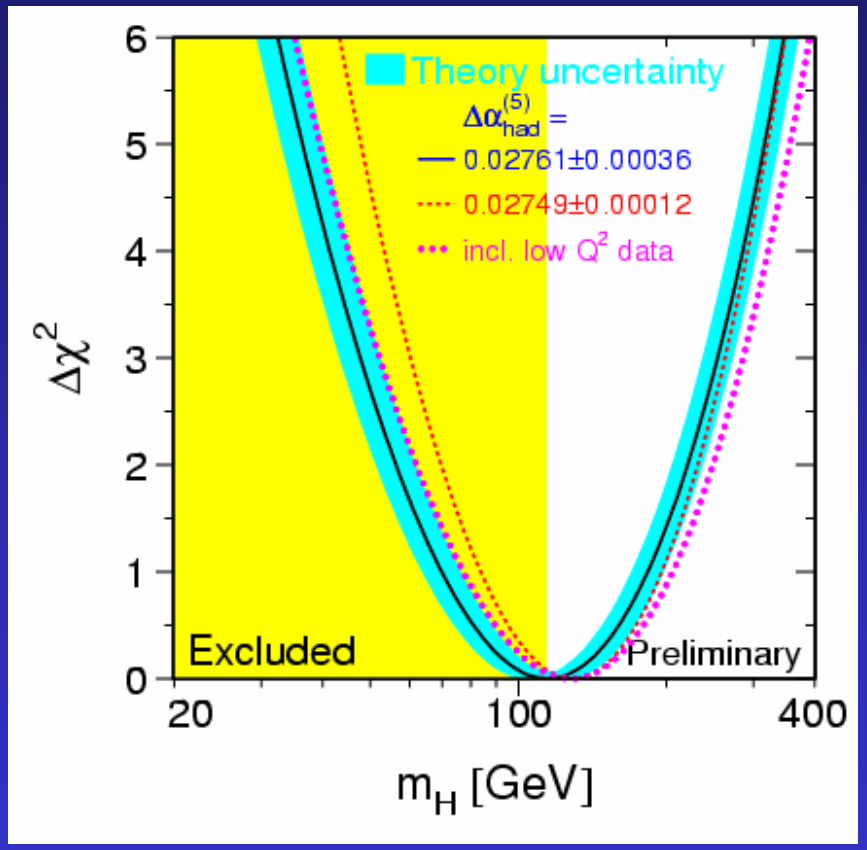
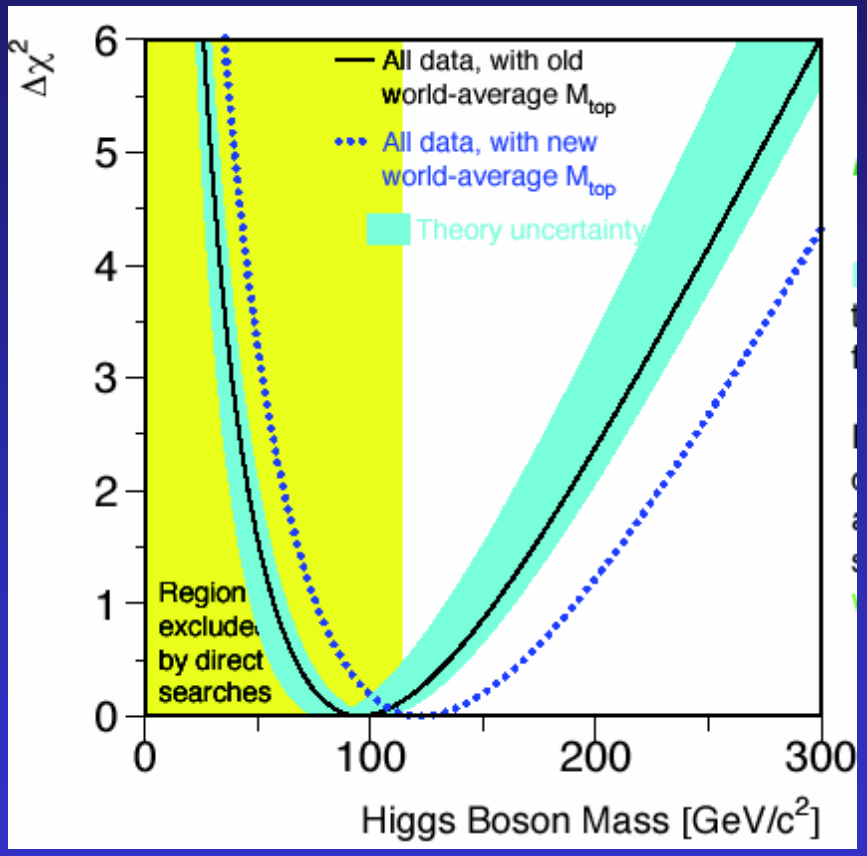
ECFA Study Workshop, Valencia

SM Higgs Study at ILC

- The Higgs boson plays the central role in the electroweek symmetry breaking and the generation of masses for quarks, leptons, and vector bosons.
- In the Standard Model, Higgs is scalar particle which couples to each fermion and boson species proportionally to its mass.
- If the Standard Model is not correct, the unexpected could come at many different points.

SM Higgs Study at ILC





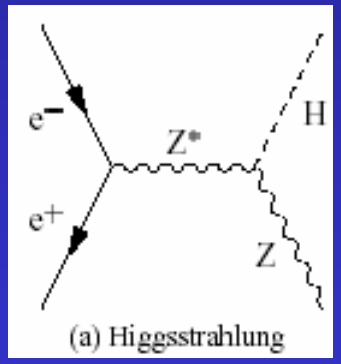
The Global Fit: Limits on the Higgs mass (Robert Clare talk)

SM Higgs Boson Study at ILC

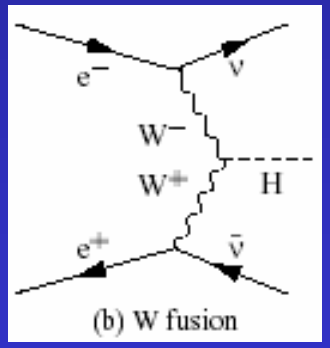
The main goal this Study is define the Significance of Detecting of SM Higgs at ILC on base of full MC simulation including realistic spectrometer on base Mokka(G4), and full reconstruction chain, with the Particle Flow Algorithm

SM Higgs Production at ILC

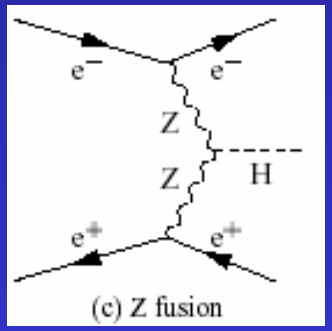
Dominant processes for the SM Higgs Boson at 500 GeV Center Mass Energy and Higgs mass 120-180 GeV is Higgsstrahlung process, others are by fusion of WW and ZZ bozons.



(a) Higgsstrahlung



(b) W fusion

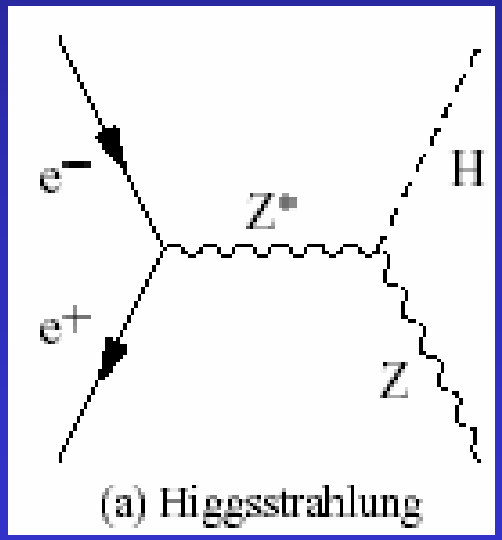


(c) Z fusion

SM Higgs in Higsstrahlung (Generator)

Pythia 6. – version

- CM Energy is 500 GeV...
- Higgs mass is 140 GeV...
- ISR processes is included,
- Z^0 is forced decay to l^+,l^- (ee, mm),
- h^0 is forced decay to b, bbar (for further investigations),

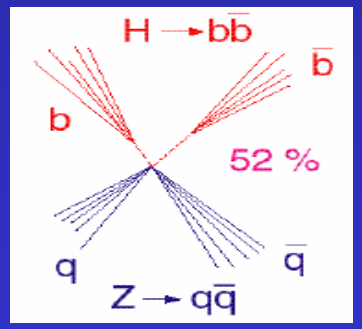


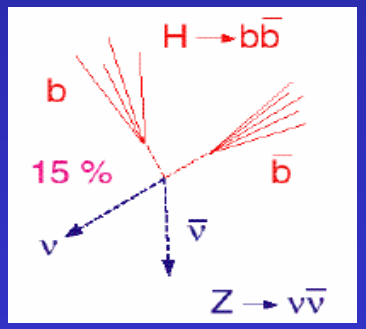
(a) Higgsstrahlung

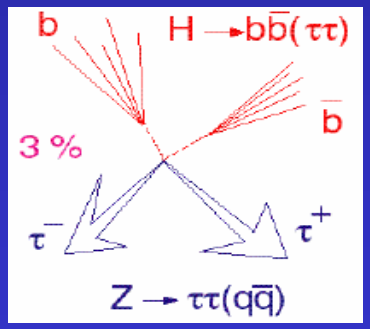
SM Higgs Strahlung Final States

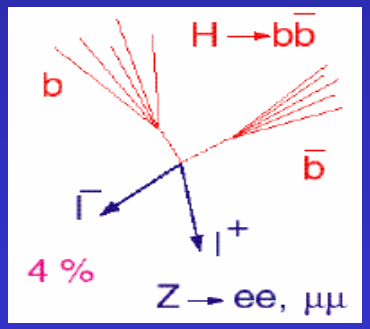
Final States with Good Sensitivity to SM Higgs Boson:
at cms 500 GeV and Higgs mass 120-180 GeV

$h^0 \to b\bar{b}$	WW	$\tau\bar{\tau}$	$c\bar{c}$	gg
77%	6.8%	6.4%	4.9%	4.1%
$Z^0 \to q\bar{q}$	$\nu\bar{\nu}$	ee	$\mu\mu$	$\tau\bar{\tau}$
70%	13.4%	3.4%	3.4%	3.4%







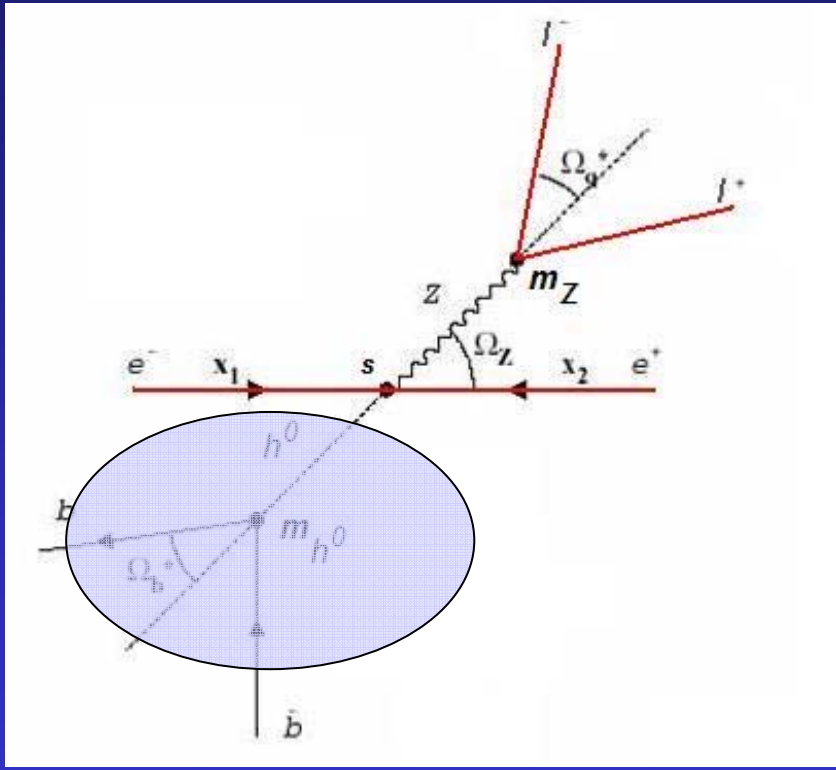


Statistics

cms 500GeV, m_h 140 GeV

Processes	σ [fb]	σ x Br(Z->l l) [fb]	Statistics (one year)
$f_i f_j \to Z^0 h^0$	58.5	2.04	256
$f_i f_j \to f_k f_l h^0 (W^+W^-)$	58.9		
$f_i f_j \to f_i f_j h^0 (Z^0Z^0)$	5.83		

Method of Analysis



Analysis of the Invariant Mass of Invisible System (the Recoil Mass):

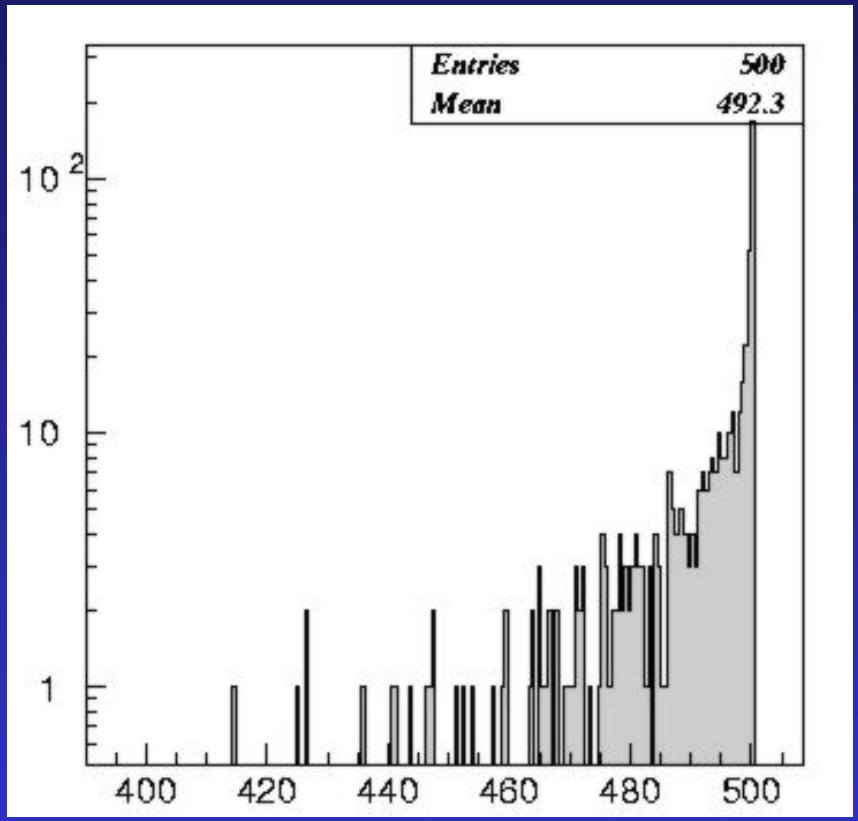
The Recoil Mass is determined by requiring energy and momentum conservation and by constraining the invariant mass of the visible system to the Z mass.

$$m^2_{rec} = s - 2\sqrt{s}(E_{l^+} + E_{l^-}) + m_z^2$$

which is independent of assumption about SM Higgs decay, and the direct reconstruction of the mass of the Higgs from decay final states

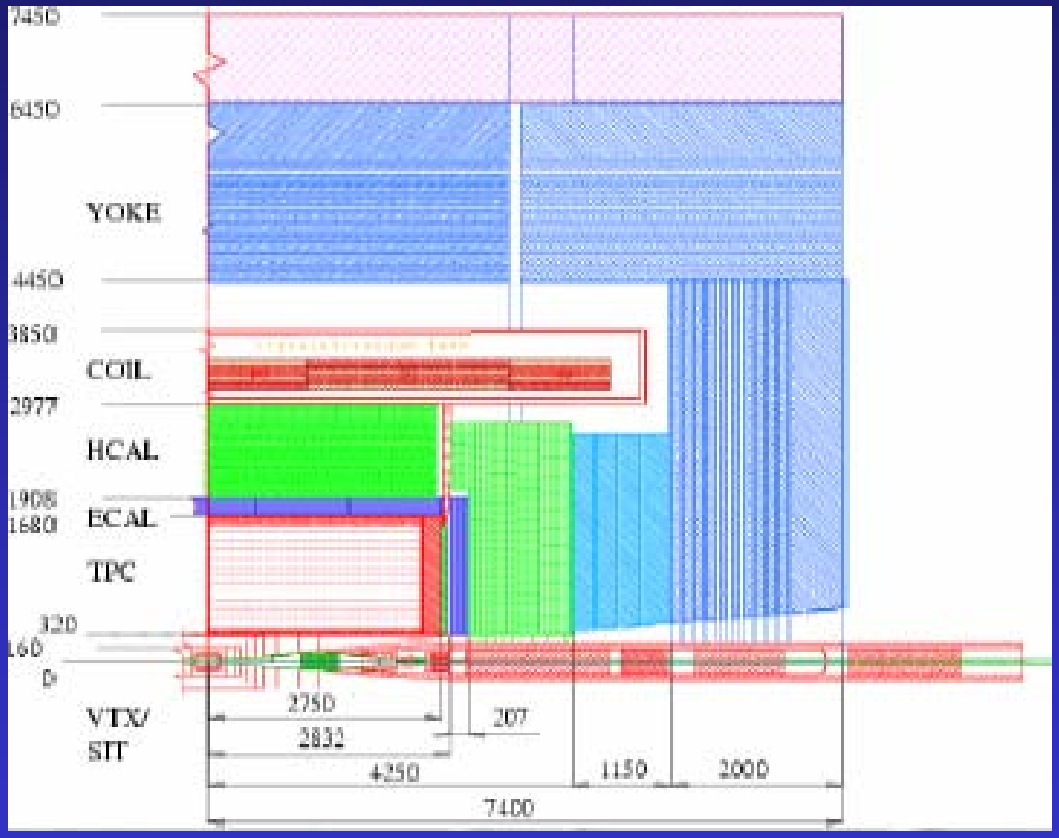
Experimental Environment at the ILC

- Tunable e e collisions at S = 0.5TeV-1TeV, L = 3-5x10^34 cm^-2 s^-1,
- Polarisation: P_electron ~80%, P_positron ~60%
- “Giga-Z option for Z^0 –pole, W W threshold runs
- Beamstrahlung energy spread delta_B=2.4-3.7 % (Accurate spectrum measurement is crucial to LC physics)



Full Simulation included the realistic beamstrahlung processes on base CIRCE – Beam Spectra Simulation.

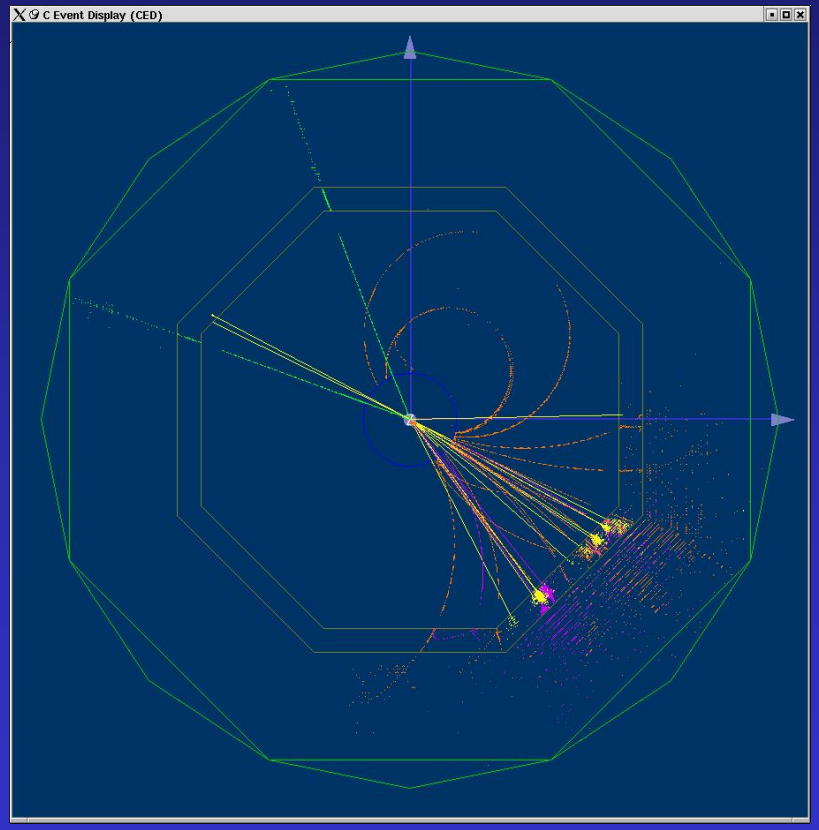
ILC Detector (LCD)

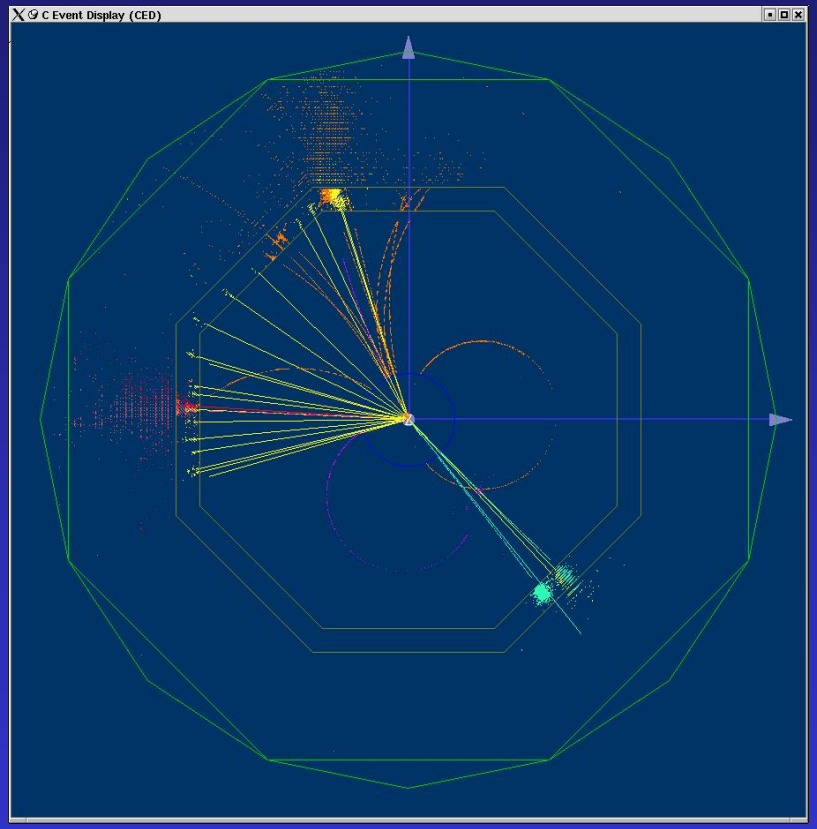


- Zh ->ll+h - Precise momentum Resolution
- Br h ->bb,cc,gg - Excellent Vertexing/Flavor Identification
- Zhh ->qqbbbb - Excellent Calorimetry, Particle Flow Algorithm;
- Ee ->νν h - Excellent Hermeticity, Missing Mass Resolution

MOKKA G4 Event Simulations

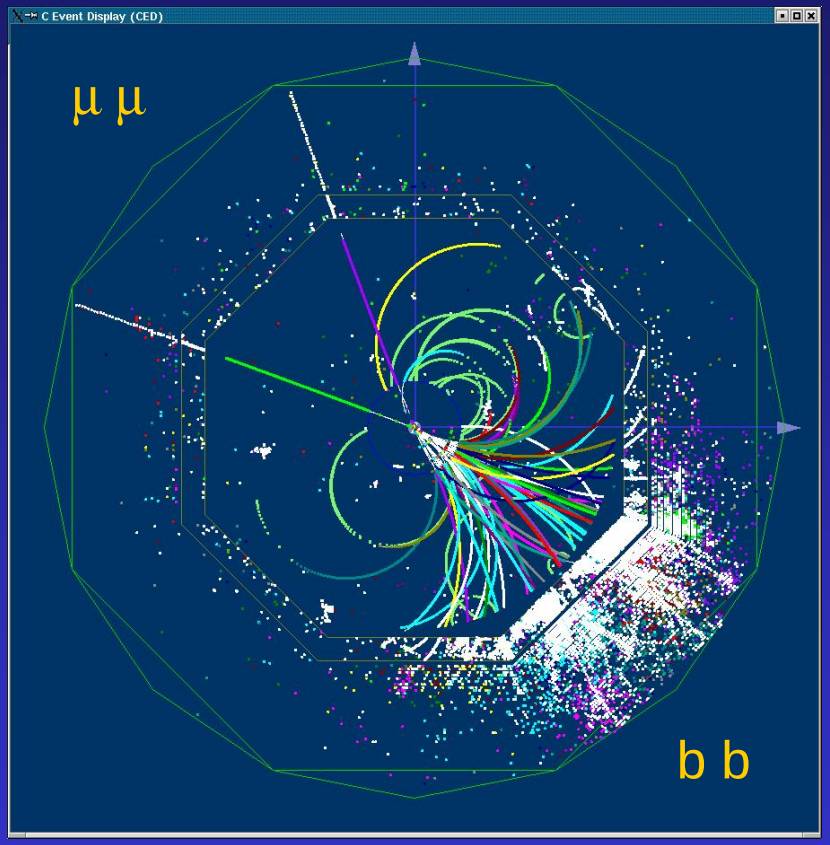
LDC D12 version of Geometry

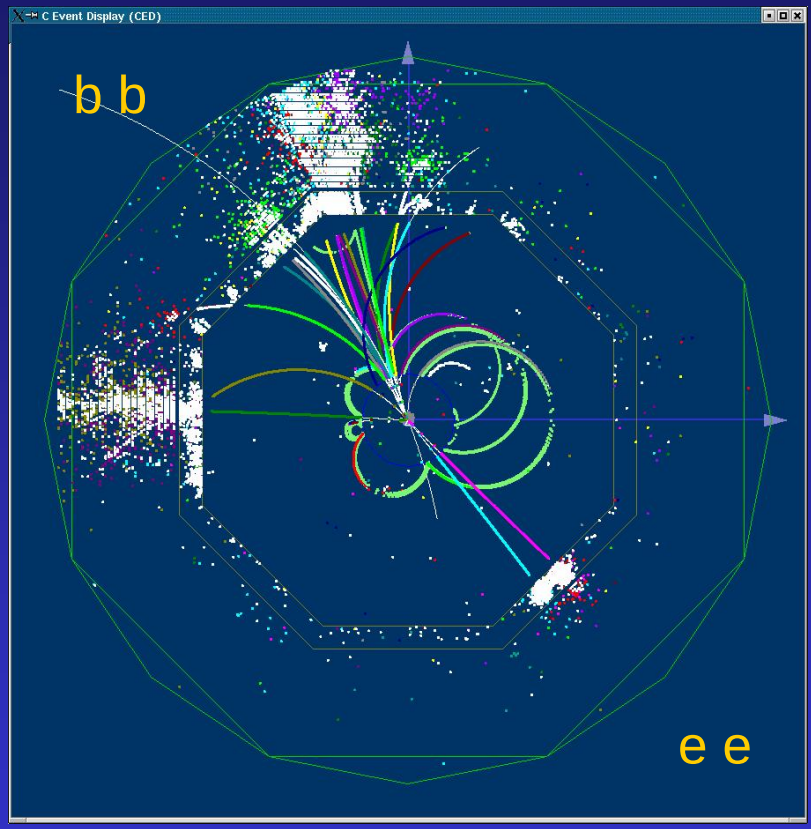




Event Display of Full Simulation of the h^0 Z^0 (h ->bbar, Z-> mumu, e e)

Marlin Events Reconstruction

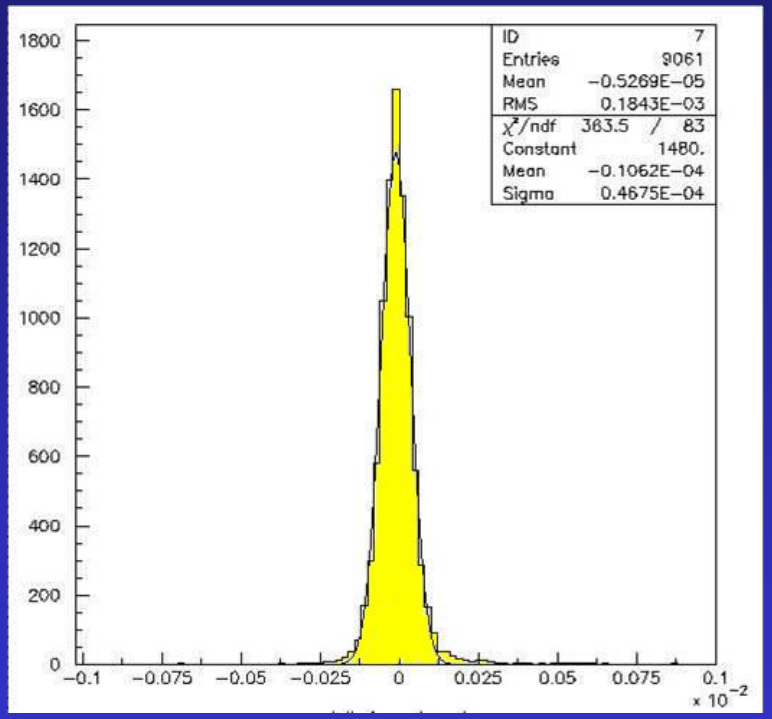


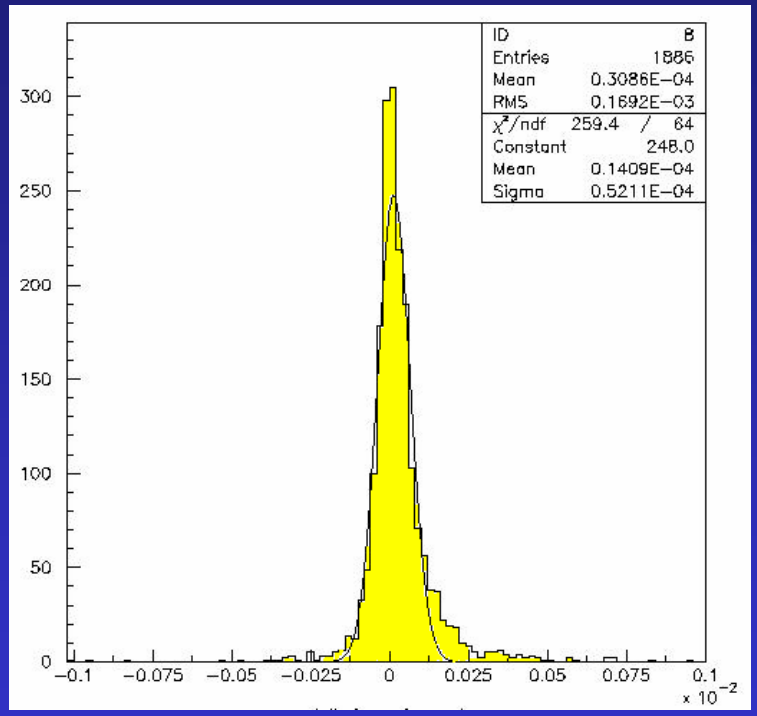


Marlin Processor for the Recoil Mass Reconstruction of the h^0 Z
(h ->bbar, Z-> mumu, e e)

Reconstruction MARLIN Framework

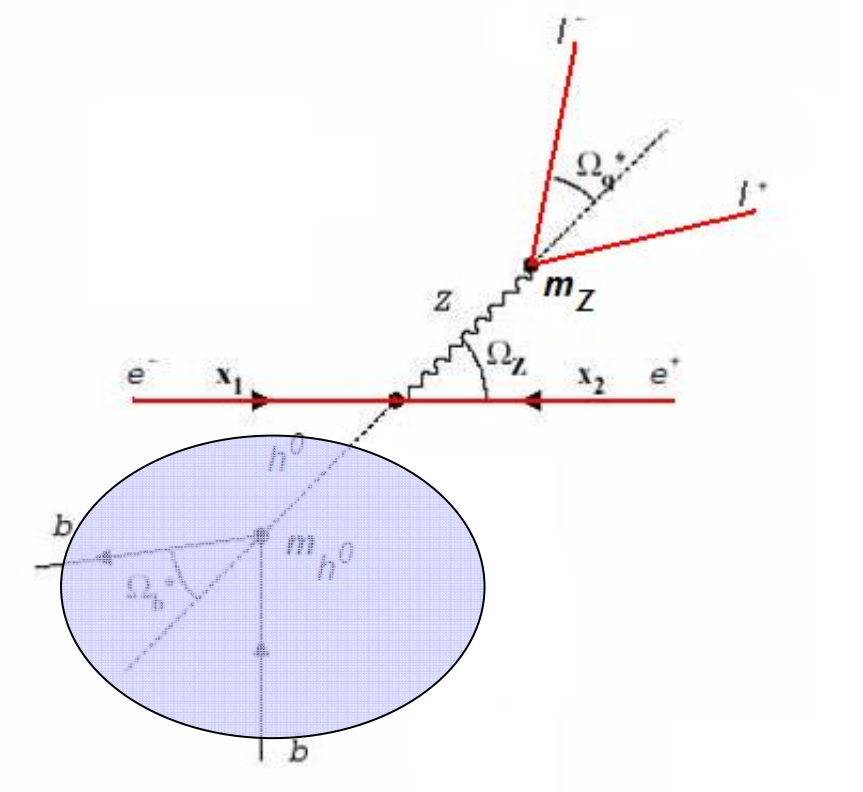
Marlin Tracking (LEP algorithms)





Momentum reconstruction resolution for barel and endcup tracking for muons 30 GeV: central region 4.7×10^{-5}, forward region 5.2×10^{-5}

Analysis Cuts

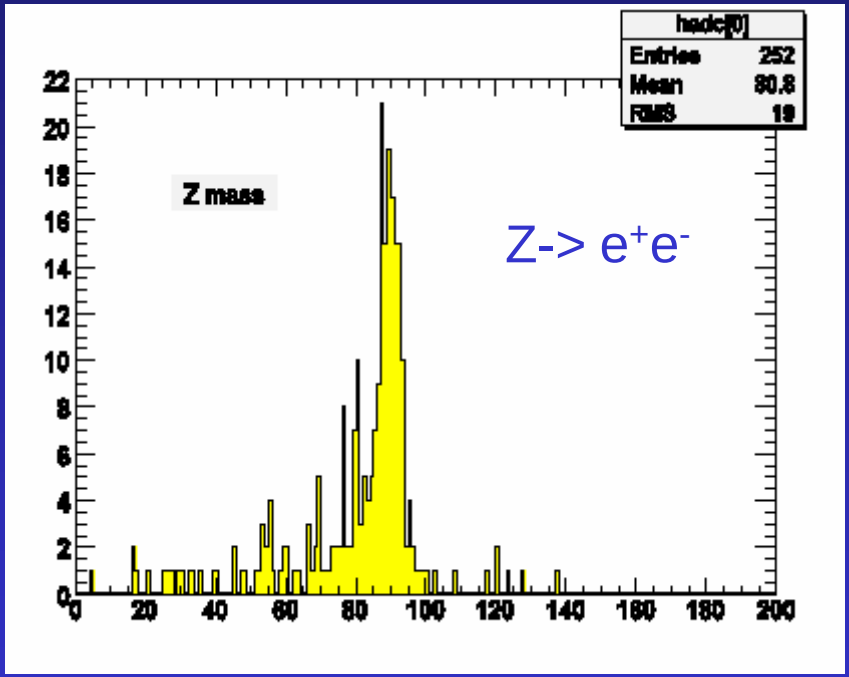


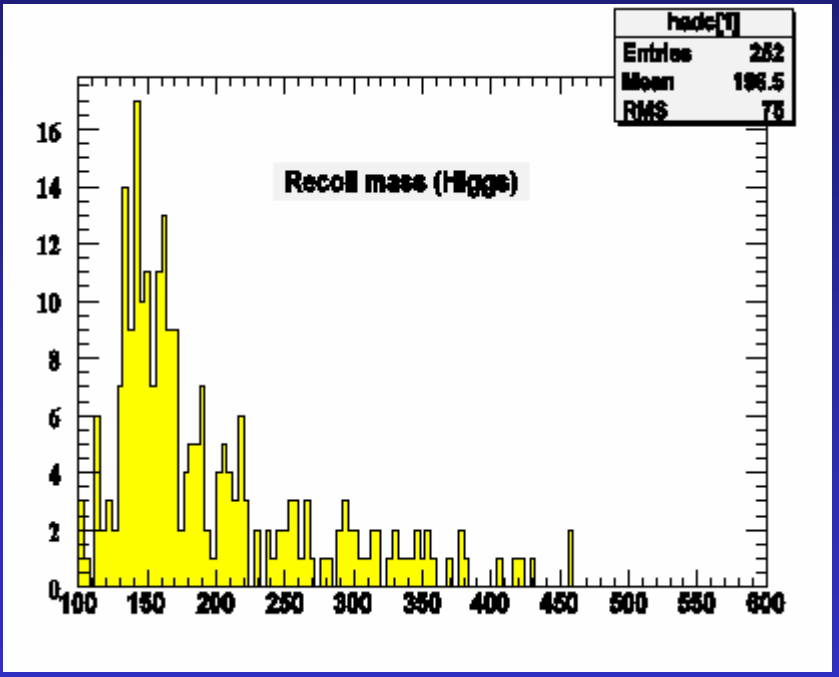
Cuts:

- Algorithm of single lepton search – cone +/- 15º ,
- A lepton candidates must have an energy >10 GeV,
- At least 2 leptons candidates in the event,
- The polar angle between leptons (Z^0) cos -0.85 - +0.85,
- The invariant of the lepton pairs (constraints to the Z^0) lie within -+ 5 GeV of the Z mass.

Z and Higgs Signal Reconstruction

Statistics for the one year of running of ILC with nominal Luminosity

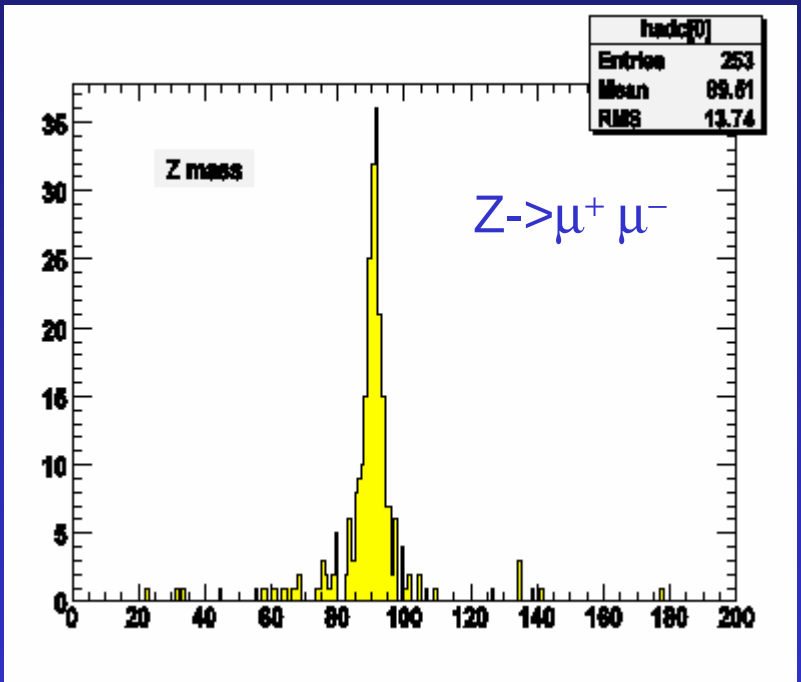


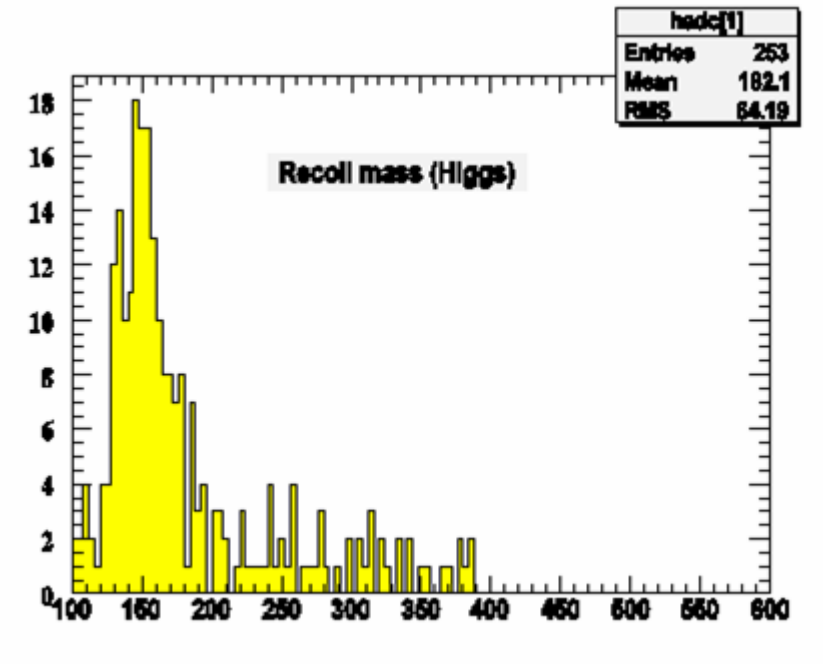


Geometry acceptance (Efficiency) of the LDC detector is very high 98%
(Lost 4 events from 256) for the electrons channel of Z decay

Z and Higgs Signal Reconstruction

Statistics for the one year of running of ILC with nominal Luminosity

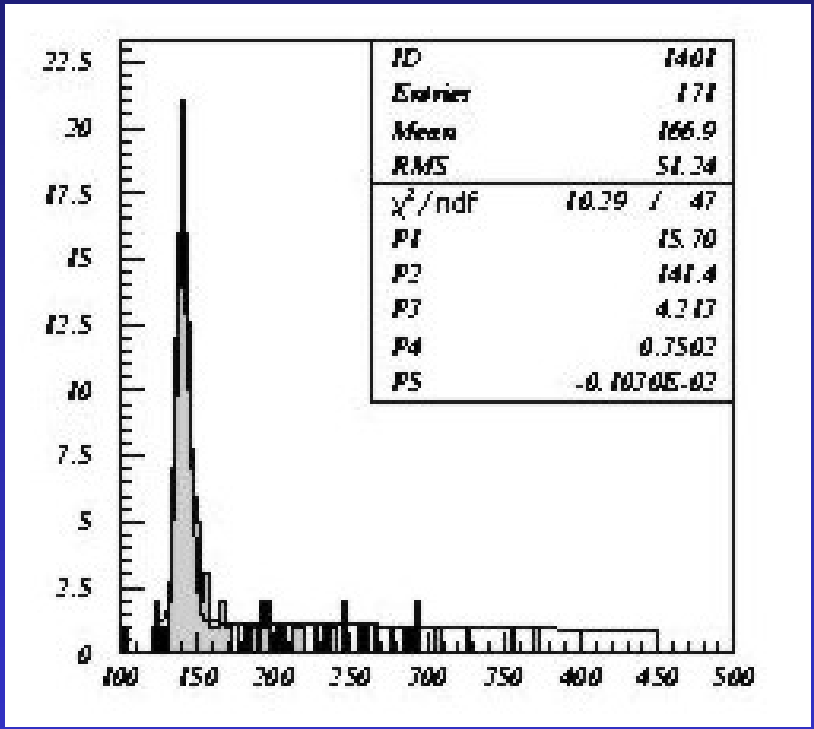


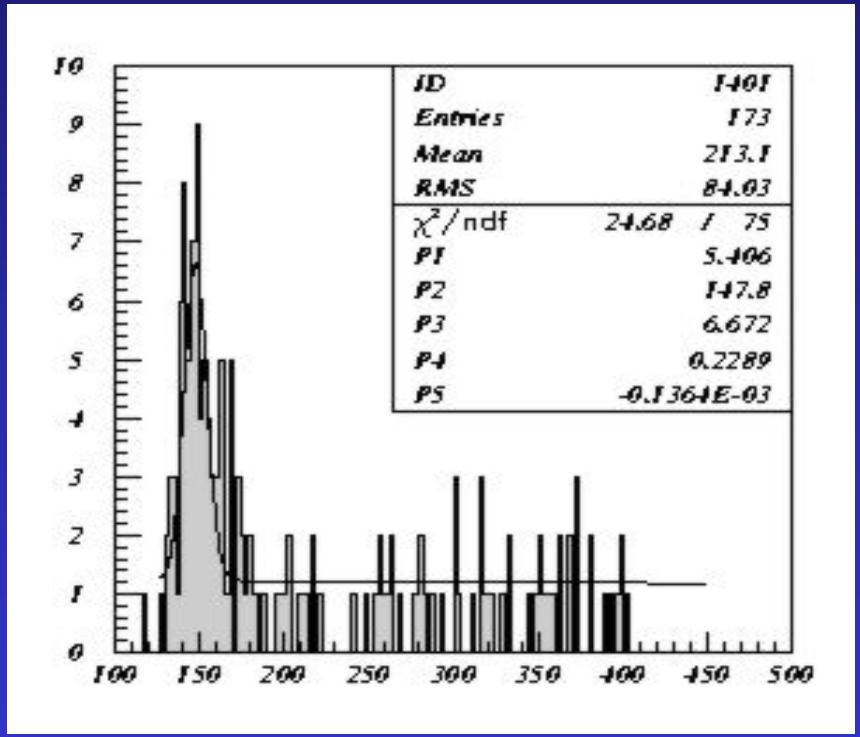


Geometry acceptance (Efficiency) of the LDC detector is very high 98%
(3events from 256) for the muons channel of Z decay

Preliminary Analysis GEANT3

The Invariant Mass of Invisible System (the Recoil Mass Method)
Including the ISR and beamstrahlung





SM Higgs Signal Reconstruction Z -> mu+mu- Final State 100 fb^{-1}
SM Higgs Signal Reconstruction Z -> e+e- Final State 100 fb^{-1}

Summary

- Preliminary analysis of SM Higgs Measurements at ILC with Marlin Reconstruction Framework is done,
- Necessary optimization of the analysis,
- Background simulation and analysis,
- Confident Level Method (CL_s) developed at LEP for the Sensitivity Study.