Measurement of Higgs Mass at NLC

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Monte Carlo Generator & Simulation

* MC Generator: PANDORA-PYTHIA V2.1

Initial State Radiation

Beamstrahlung

Beam Polarization (P_{e^-} = -0.8)

Hadron fragmentation

Final-state QCD, QED radiation

Default seed numbers for PANDORA & PYTHIA

* MC Simulation: FAST MC

Large Tracking-volume Detector L2

No Beam Spot Constraint

* Analysis Platform: JAVA Analysis Studio V2.2.1

* $\sqrt{S} = 350,\ 500$ **GeV and** $\mathcal{L} = 500 fb^{-1}$

Signal and Background

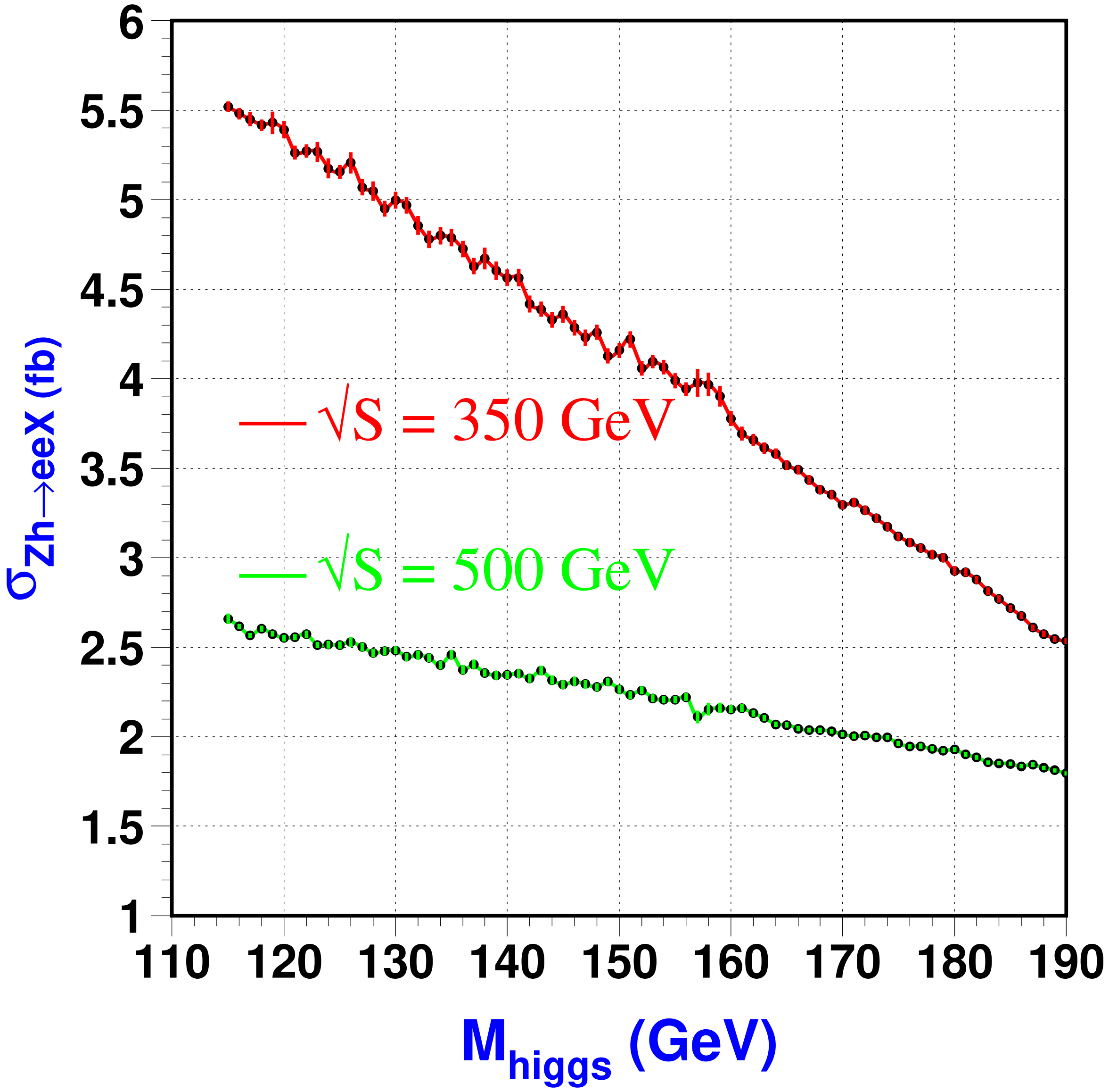
- Signal: $e^+e^- \rightarrow ZH \rightarrow e^+e^- X(\gamma)$

$\sqrt{S}(GeV)$	M_H	σ(fb)	Exp. Events
350	115	5.52	2760
350	120	5.39	2695
350	140	4.57	2285
350	160	3.78	1890
500	115	2.66	1330
500	120	2.55	1275
500	140	2.35	1175
500	160	2.15	1075

- Background: ZZ, WW

$\sqrt{S}(GeV)$	BKGD	σ(fb)	Exp. Events
350	ZZ	878.4	439K
500	ZZ	561.9	281K
350	WW	21.8K	11M
500	WW	14.3K	7M

Cross Sections of Signal



* Cross sections are calculated after a recent PANDORA bug was fixed.

Selection Cuts

1). Energy of $e^{\pm}$ from Track: $E_e > 10\text{GeV}$

2). Polar angle of $e^{\pm}$: $|\cos(\theta_e)| < 0.9$

3). No. of $e^{\pm}$ satisfy 1) & 2): $N_e \geq 2$

4). Inv. mass of e^+e^-: $|M_{e^+e^-} - M_{Z^0}| < 5\text{GeV}$

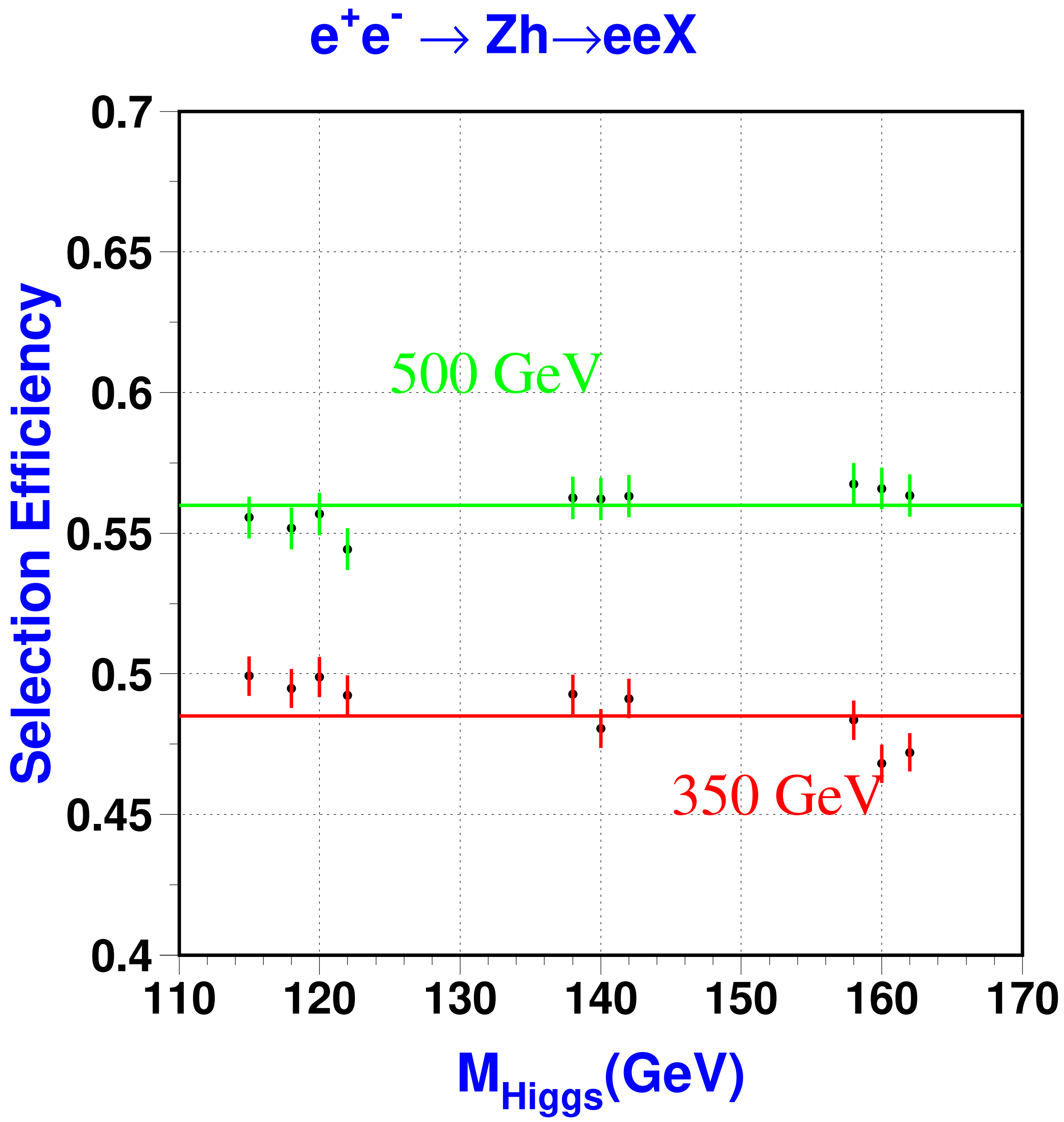
5). Polar angle of $Z^0(e^+e^-)$: $|\cos(\theta_{e^+e^-})| < 0.6$

6). Angle between e^+e^-: $\cos(\theta_{e^+ \leftrightarrow e^-}) > -0.7$

Recoil mass of e^+e^- system:

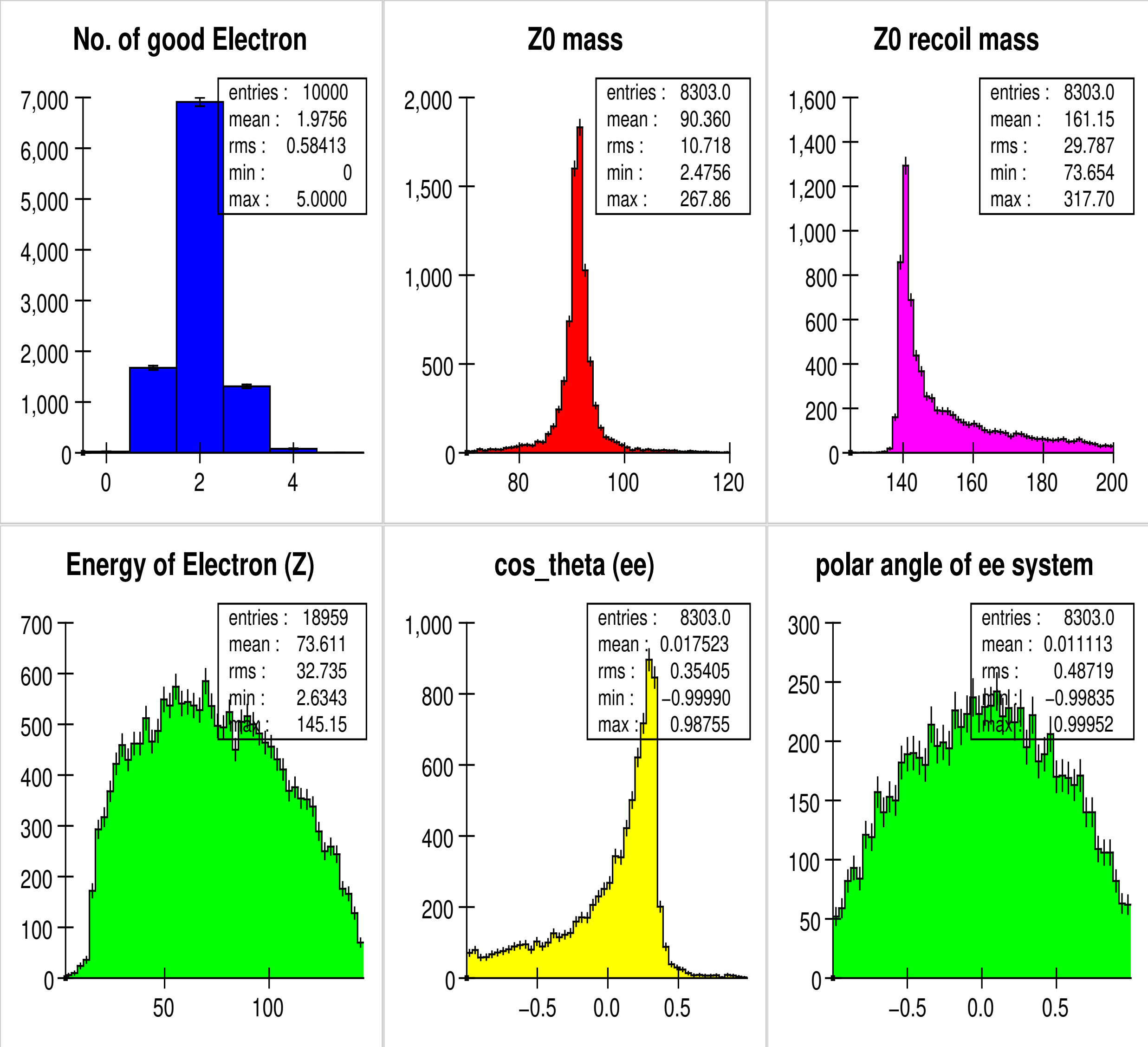
$$M_H = \sqrt{S - 2 \bullet \sqrt{S} \bullet E_{e^+e^-} + M^2_{e^+e^-}}$$

Selection Efficiency



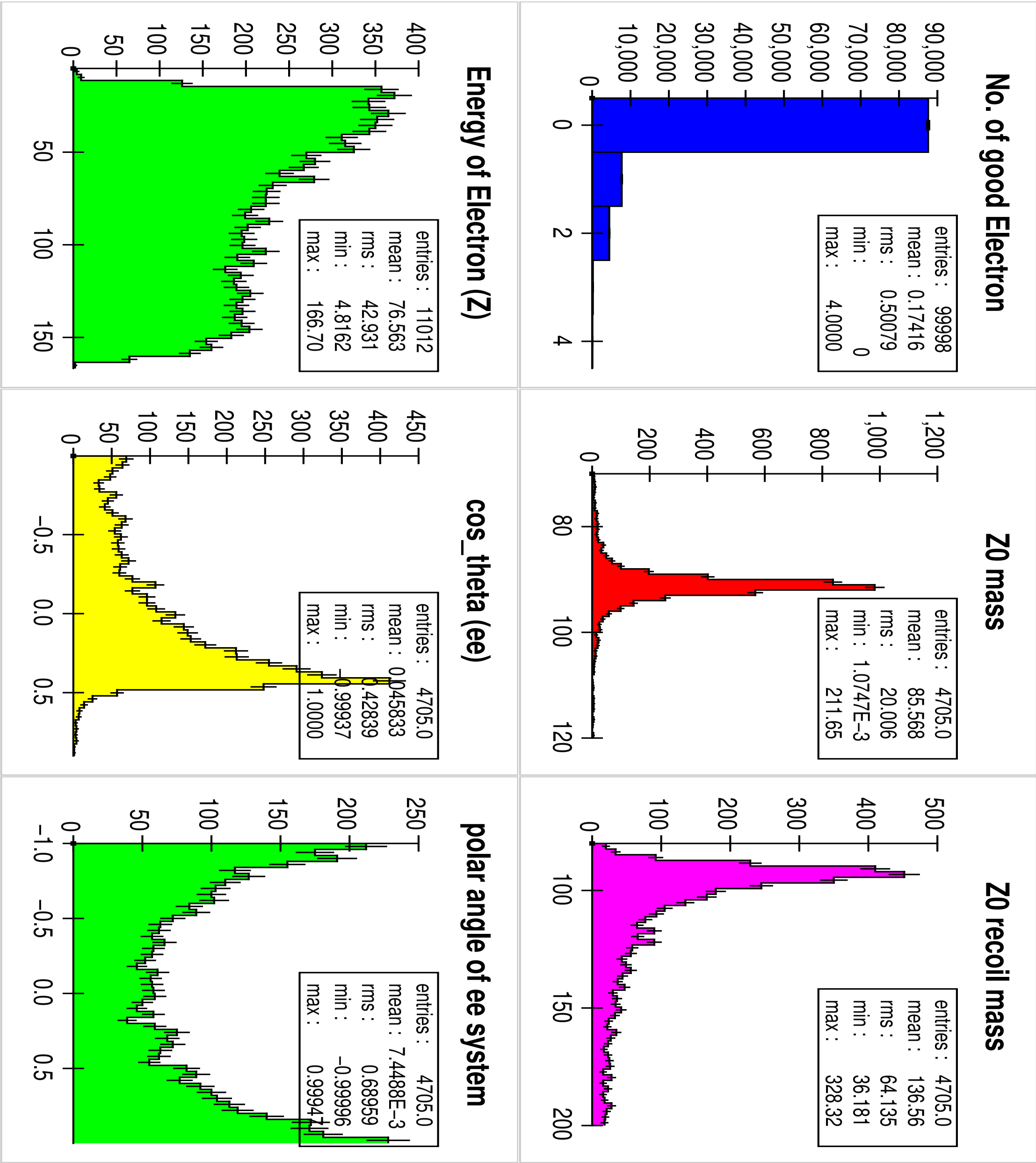
Selection Cuts(original) - Signal

$\sqrt{S} = 350GeV$ & $M_H = 140GeV$, Events=10000



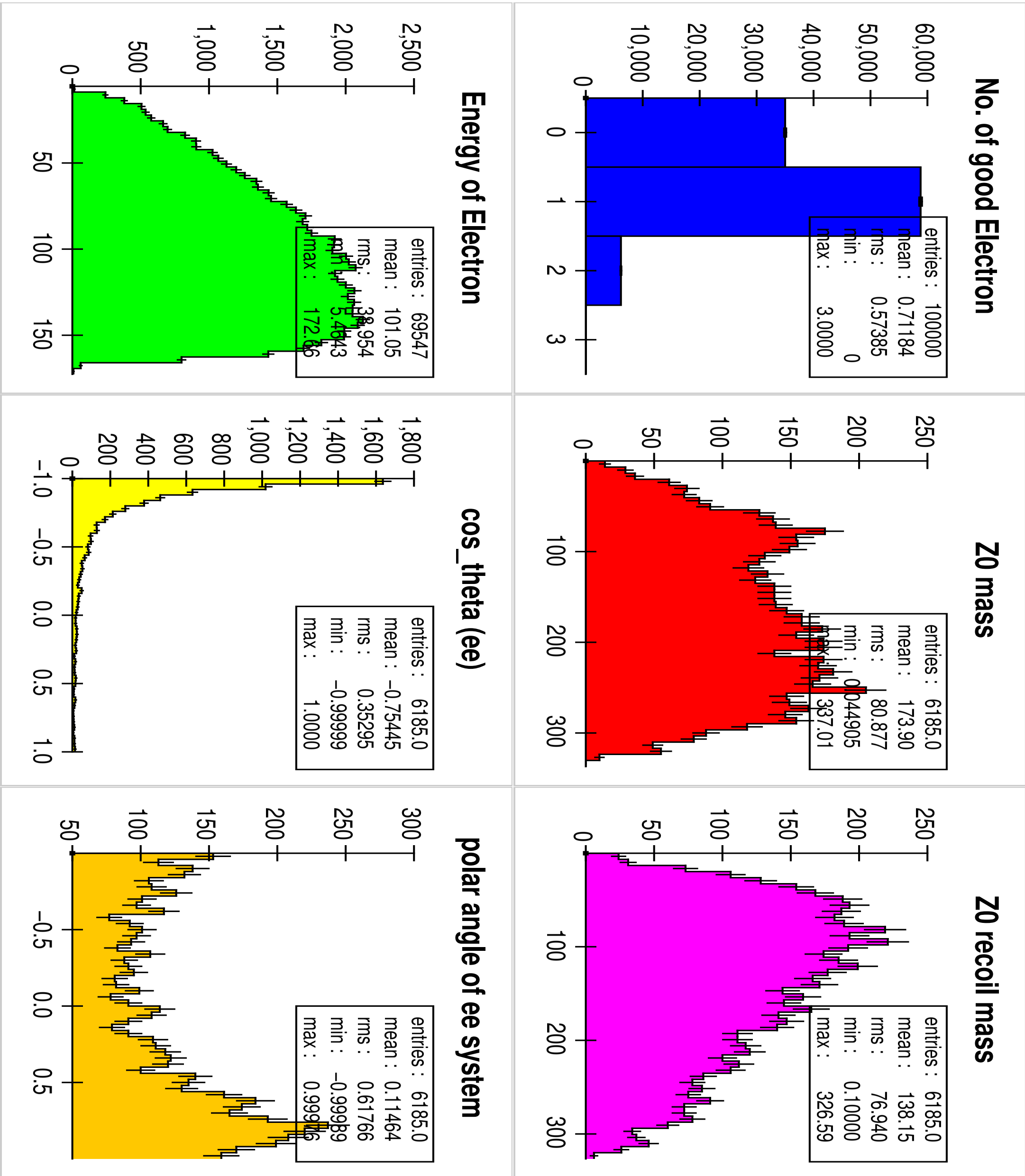
Selection Cuts(original) - Background (ZZ)

$\sqrt{S} = 350$GeV, $e^+e^- \rightarrow ZZ$, Events=100000



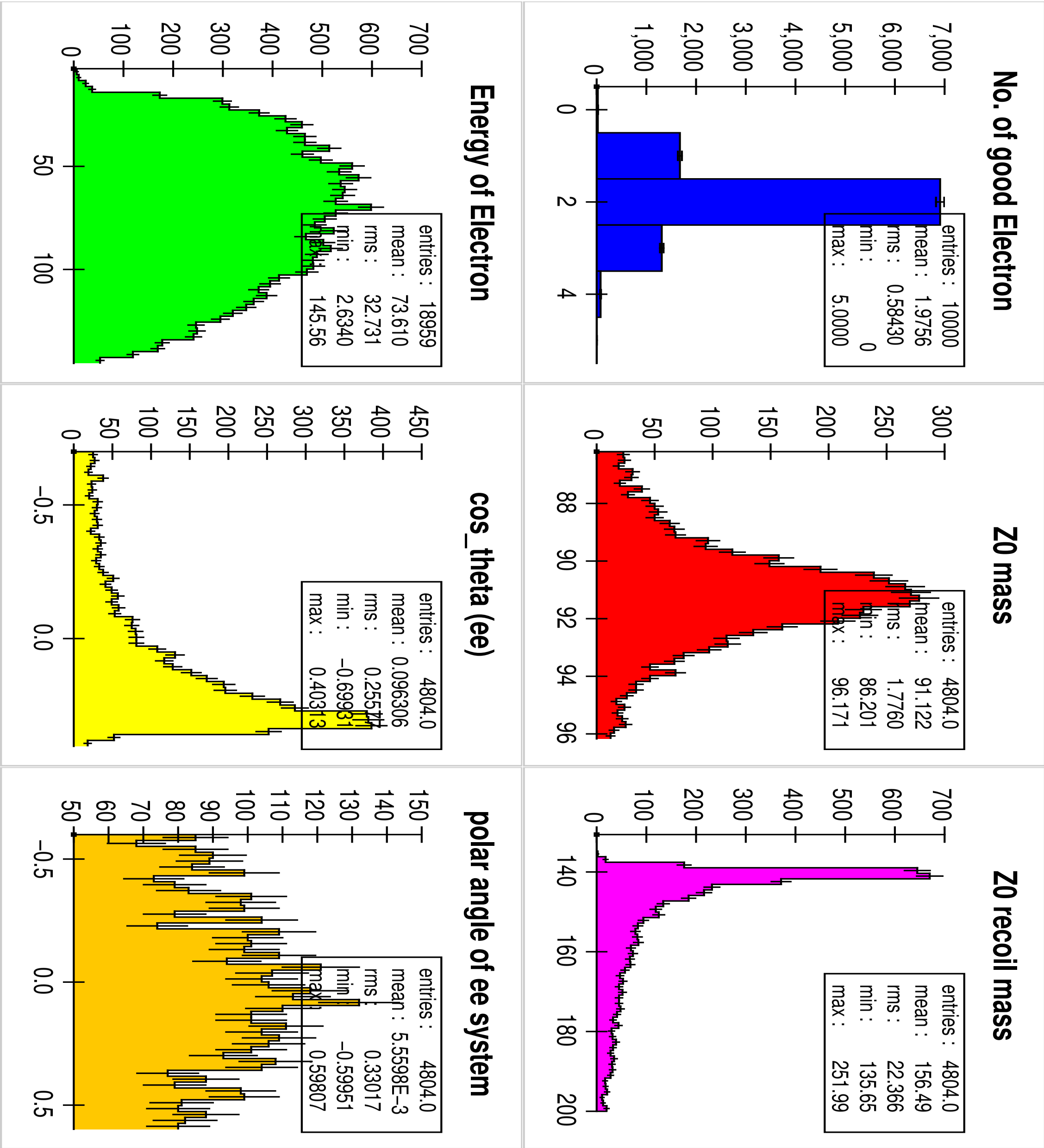
Selection Cuts(original) - Background (WW)

$\sqrt{S} = 350\text{GeV}$, $e^+e^- \rightarrow W^+W^-$,
$W^- \rightarrow e^-\bar{\nu}$, $W^+ \rightarrow X$, Events=100000



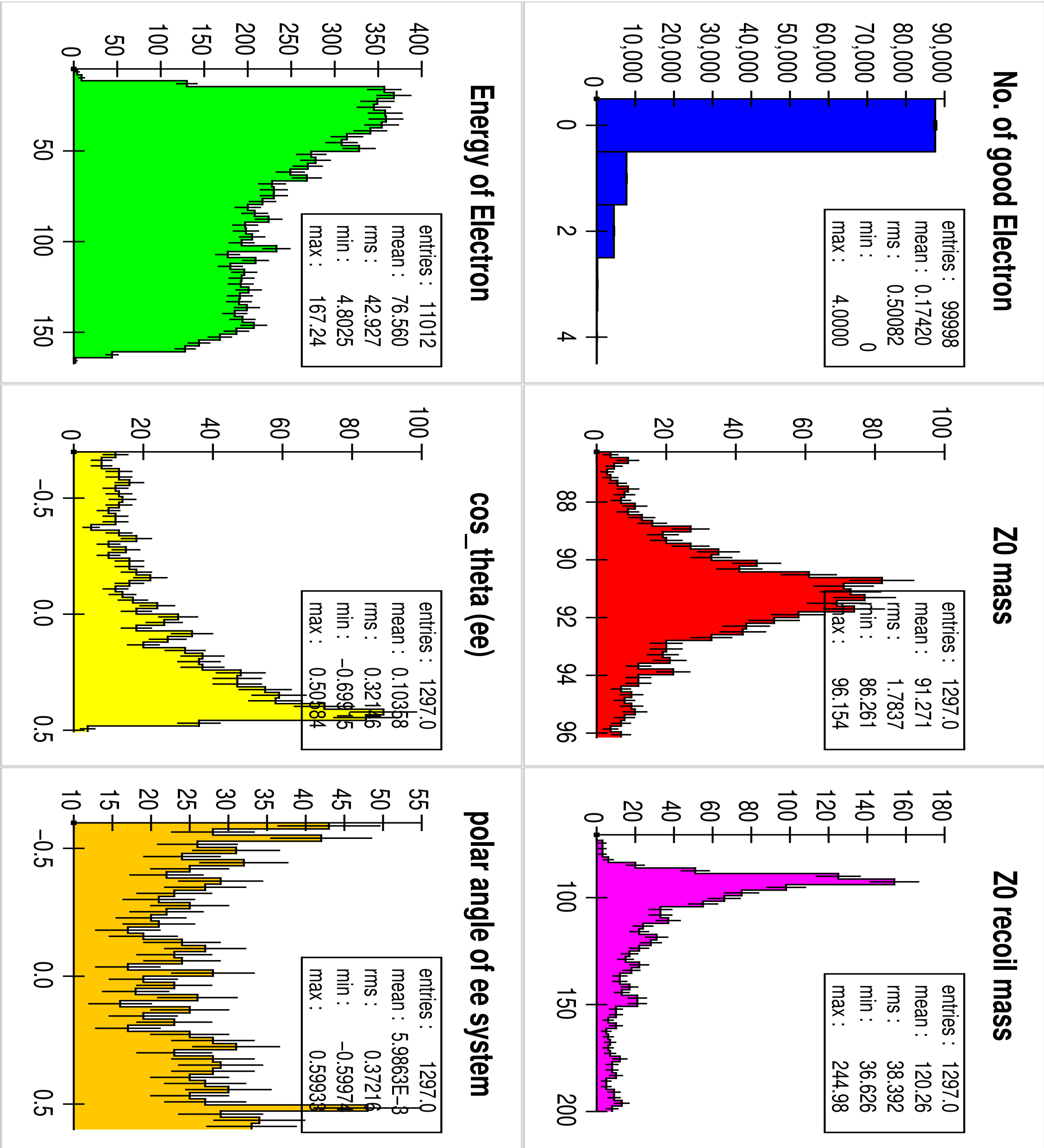
Results After Selection - Signal

$\sqrt{S} = 350\text{GeV} \ \& \ M_H = 140\text{GeV}$



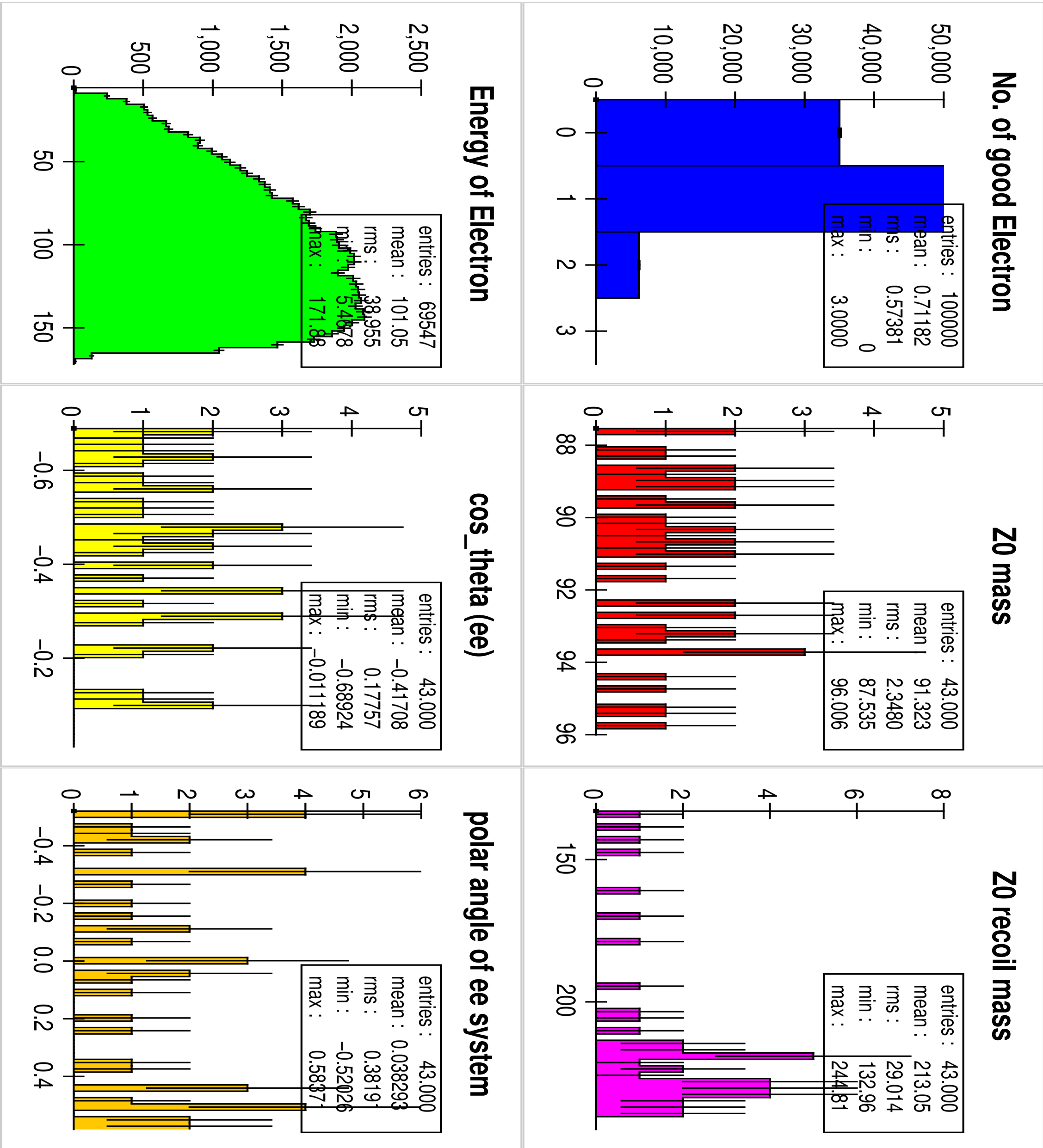
Results After Selection - Background (ZZ)

$\sqrt{S} = 350\text{GeV}, e^+e^- \rightarrow ZZ$



Results After Selection - Background (WW)

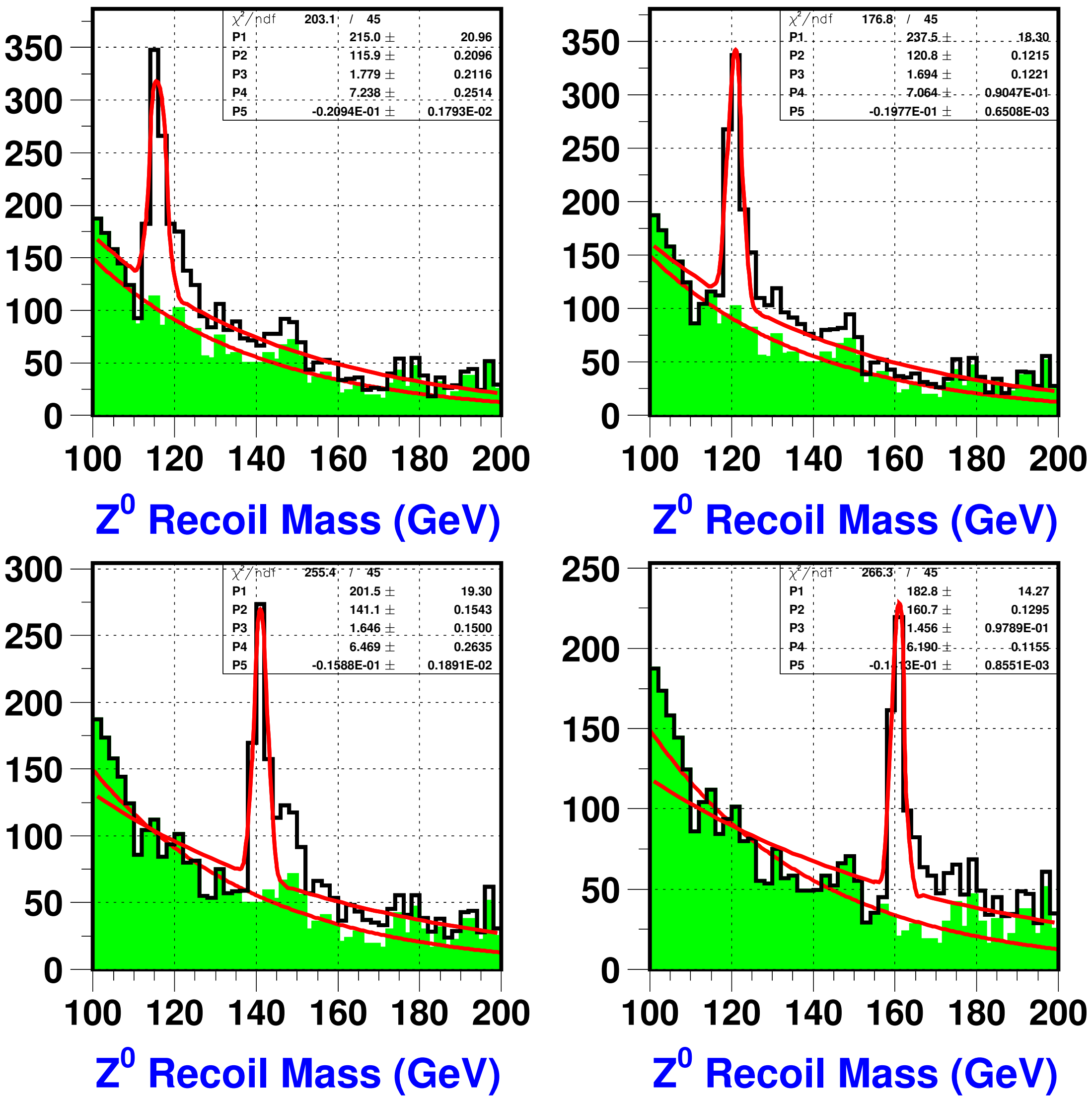
$$\sqrt{S} = 350\text{GeV}, e^+e^- \to W^+W^-,$$
$$W^- \to e^-\bar{\nu}, W^+ \to X$$



Measurement of Higgs Mass

* Fitting Function: Gaussian + Exponential

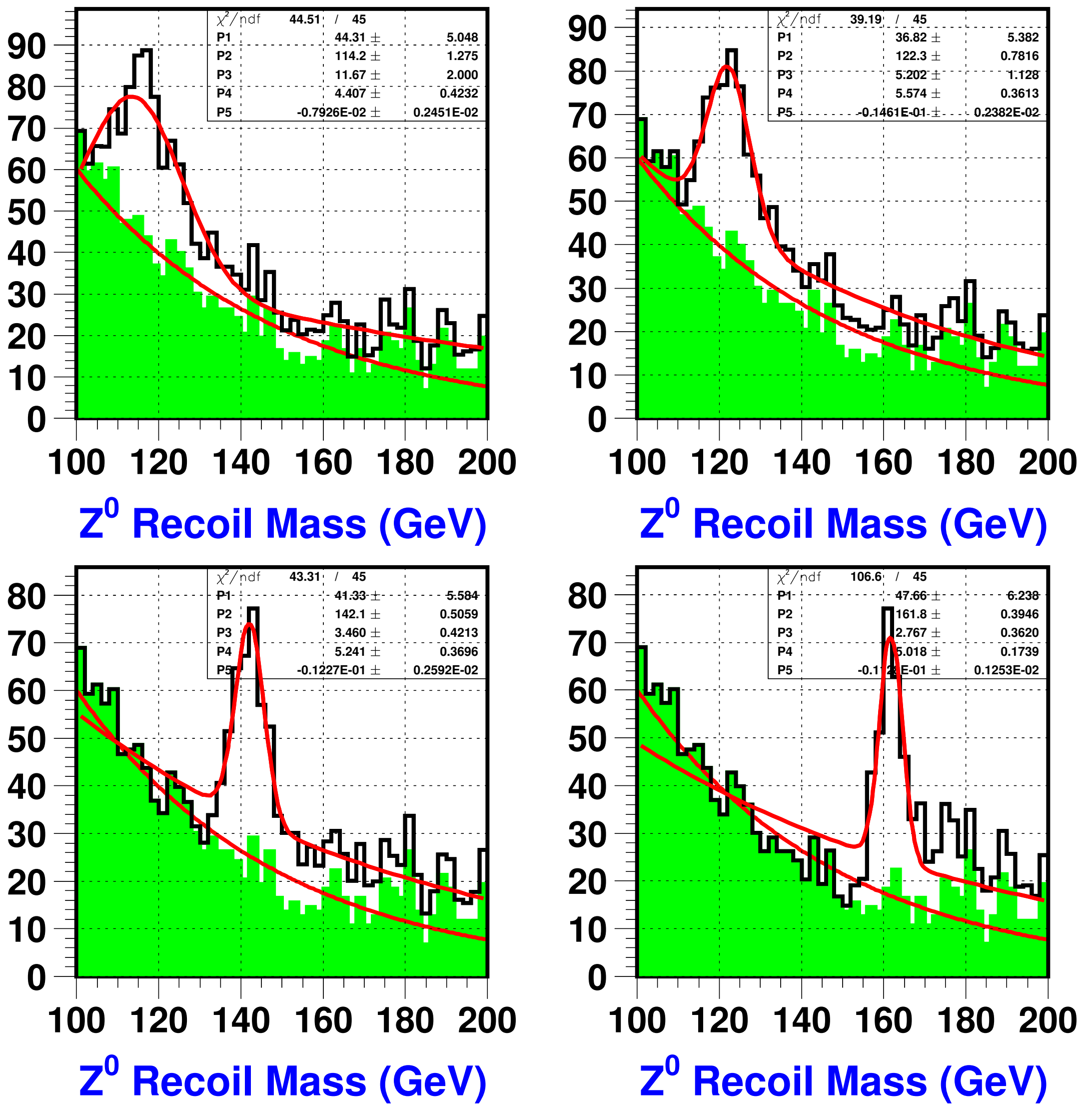
NLC at 350 GeV, ZH $\rightarrow e^+e^-X$



Measurement of Higgs Mass

* Fitting Function: Gaussian + Exponential

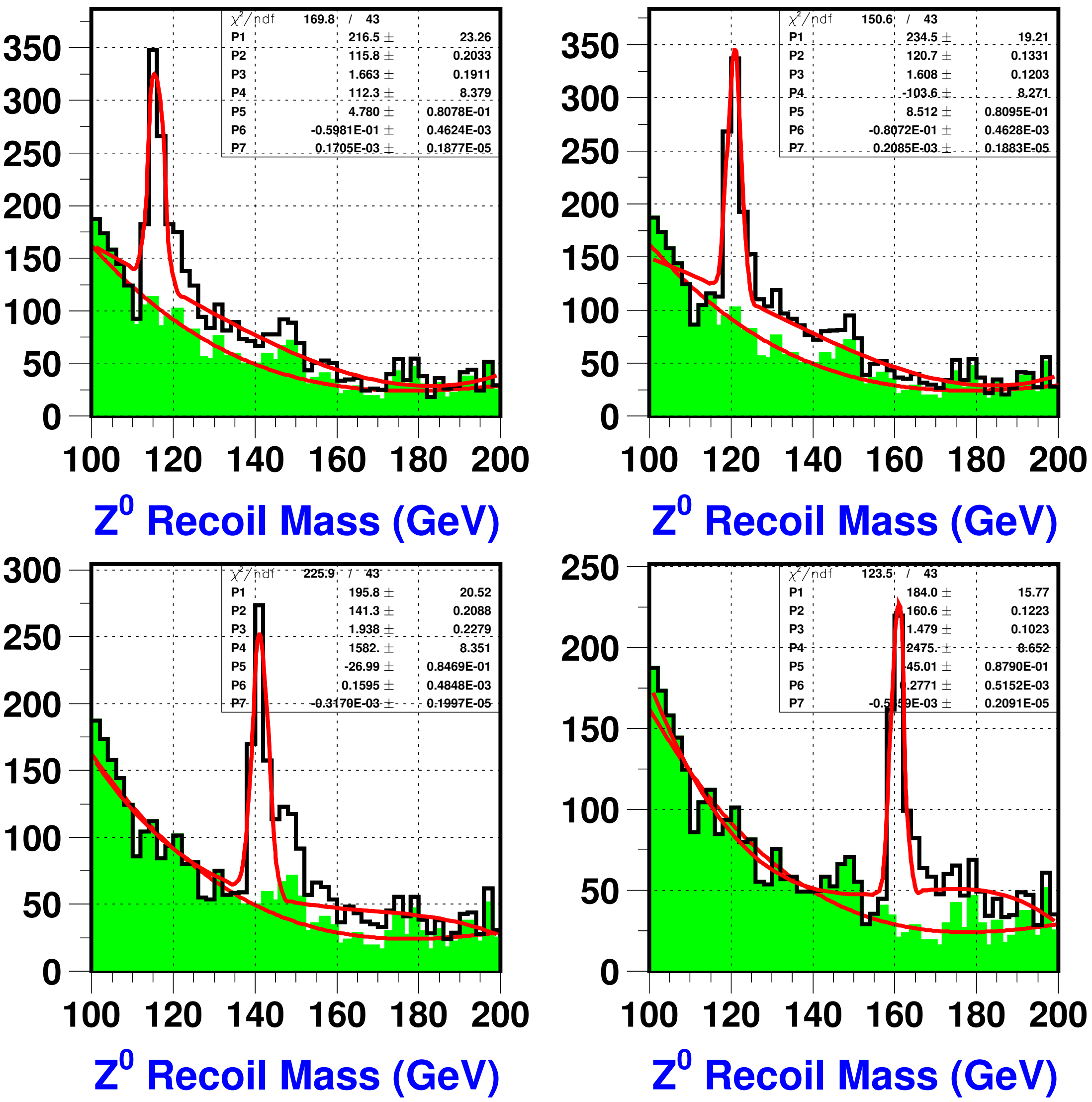
NLC at 500 GeV, ZH $\rightarrow e^+e^-X$



Measurement of Higgs Mass

* Fitting Function: Gaussian + Polynomial(P3)

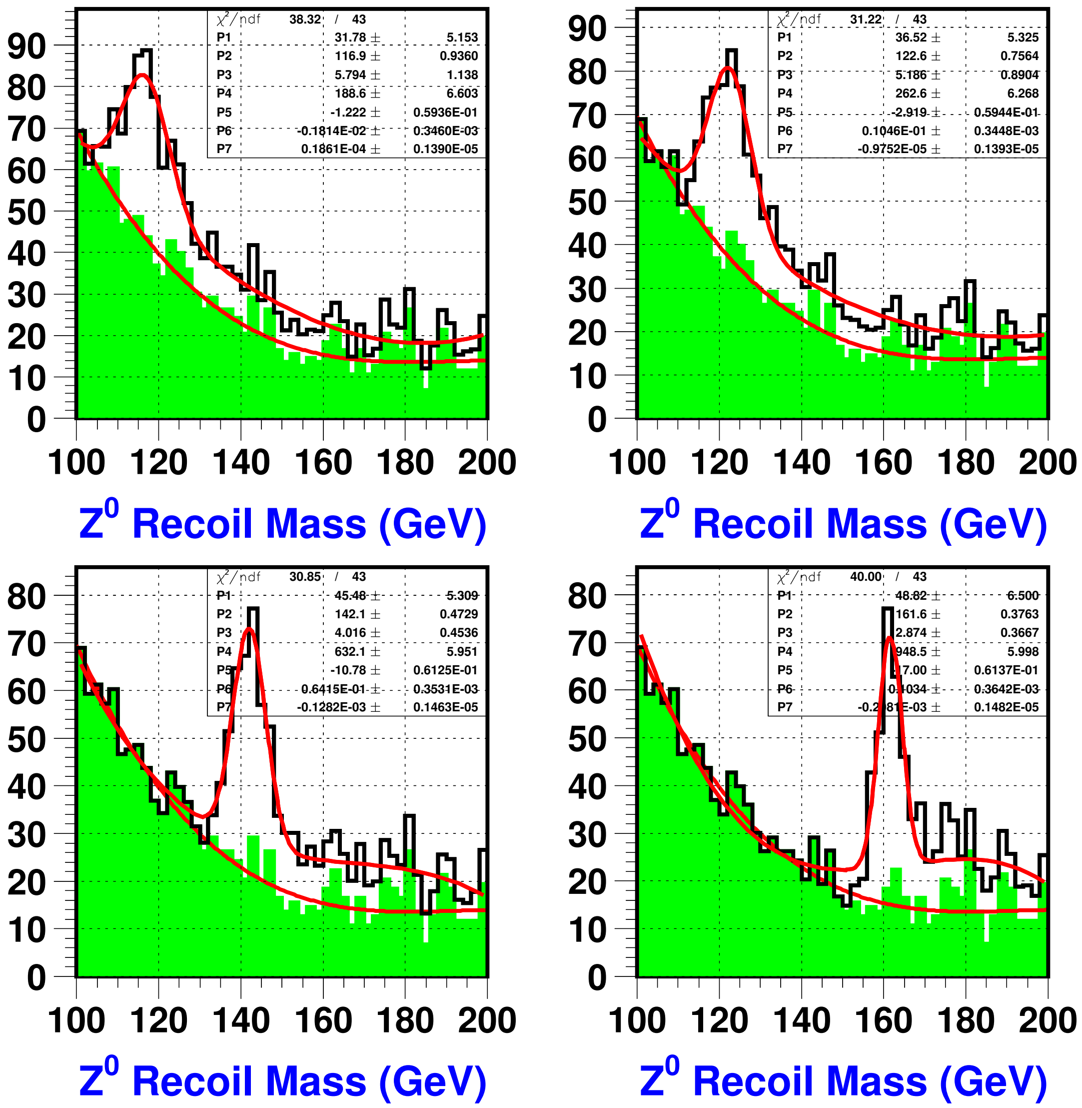
NLC at 350 GeV, ZH $\rightarrow e^+e^-X$



Measurement of Higgs Mass

* Fitting Function: Gaussian + Polynomial(P3)

NLC at 500 GeV, ZH $\rightarrow e^+e^-X$



Measurement of Higgs Mass

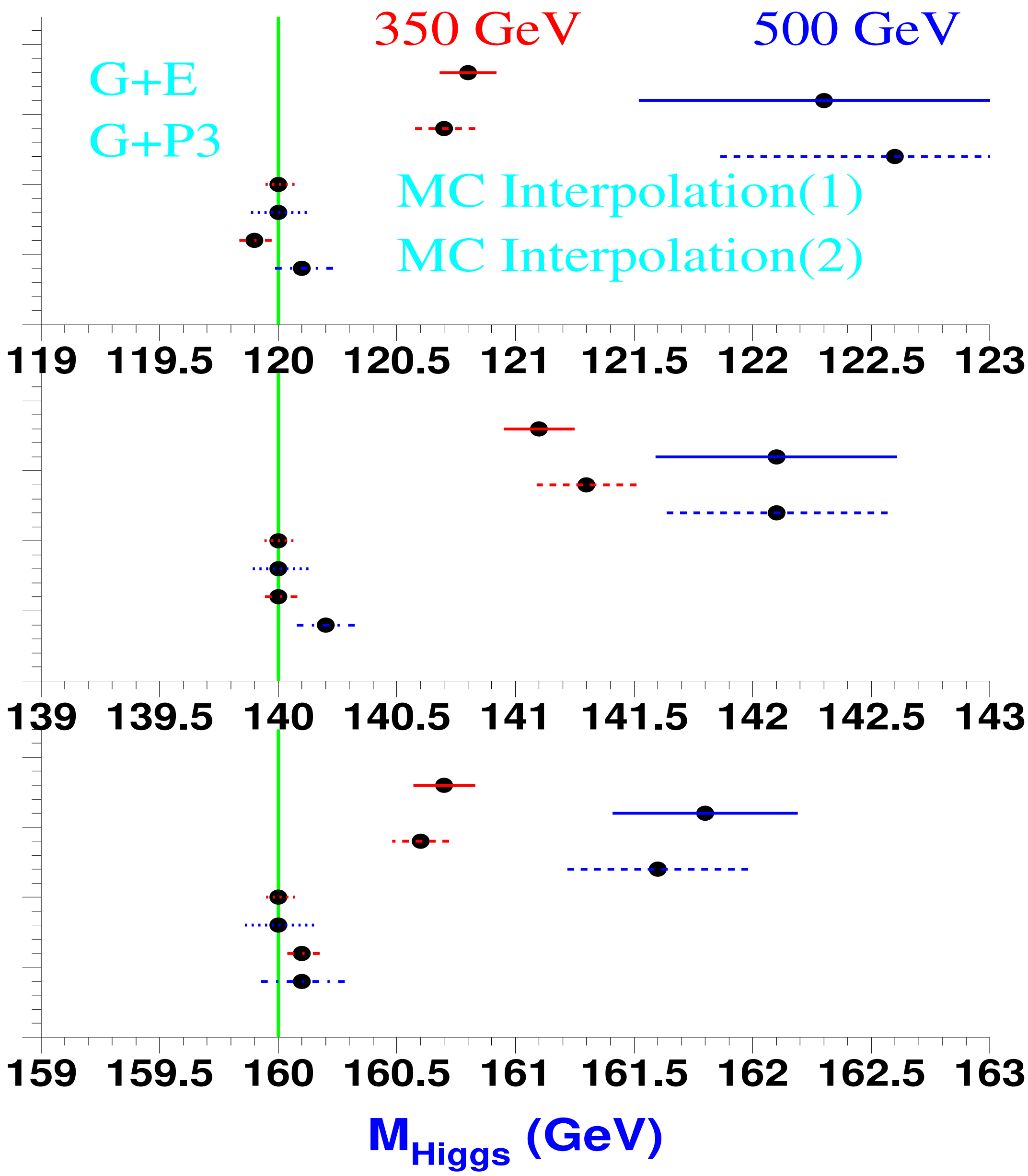
* Monte Carlo Interpolation

1. 5 MC samples with different M_H are simulated around the central value of M_H.
2. For different M_H hypothesis, we try to find the closest MC sample, and shift the distribution according to bias.
3. Interpolating selection efficiency.
4. Interpolating cross section of signal.
5. The compatibility of higgs mass distributions is calculated in terms of χ^2.
6. Minimising the χ^2 to find M_H and its accuracy ΔM_H.

$\Longrightarrow$ Ex.1: Signal distribution is same as that of MC interpolation events at same M_H

$\Longrightarrow$ Ex.2: Signal sample is different from MC interpolation sample at same M_H

Accuracy of Higgs Mass



Summary

- FAST MC Events at $\sqrt{S} = 350,\ 500$ GeV with $\mathcal{L} = 500 fb^{-1}$

- Signal: $e^+e^- \rightarrow ZH \rightarrow e^+e^-X(\gamma)$

- Accuracy of higgs mass measurements from different higgs mass hypothesis and techniques:

C.M.E (GeV)	350			500		
M_H (GeV)	120	140	160	120	140	160
G+Exp.(MeV)	122	154	130	782	506	395
G+P3 (MeV)	133	209	122	756	473	376
MC Interp.Ex.1(MeV)	69	64	71	121	127	151
MC Interp.Ex.2(MeV)	73	80	74	131	124	180

What's going on next ......

$\Longrightarrow$ Exploring new fitting method

$\Longrightarrow$ Measuring $e^+e^- \rightarrow ZH \rightarrow \mu^+\mu^- X(\gamma)$

$\Longrightarrow$ Exploring sensitivity to central tracker momentum resolution using fast Monte Carlo

$\Longrightarrow$ Using Full Detector Simulation Events

$\Longrightarrow$ TPC .vs. Silicon Tracker

$\Longrightarrow$ Robustness against machine backgrounds