Top Higgs Yukawa coupling from

$e^+ e^- \rightarrow \bar{t}\, tH \rightarrow \bar{b}W^- bW^+ \bar{b}\, b$

(Status of the Analysis)

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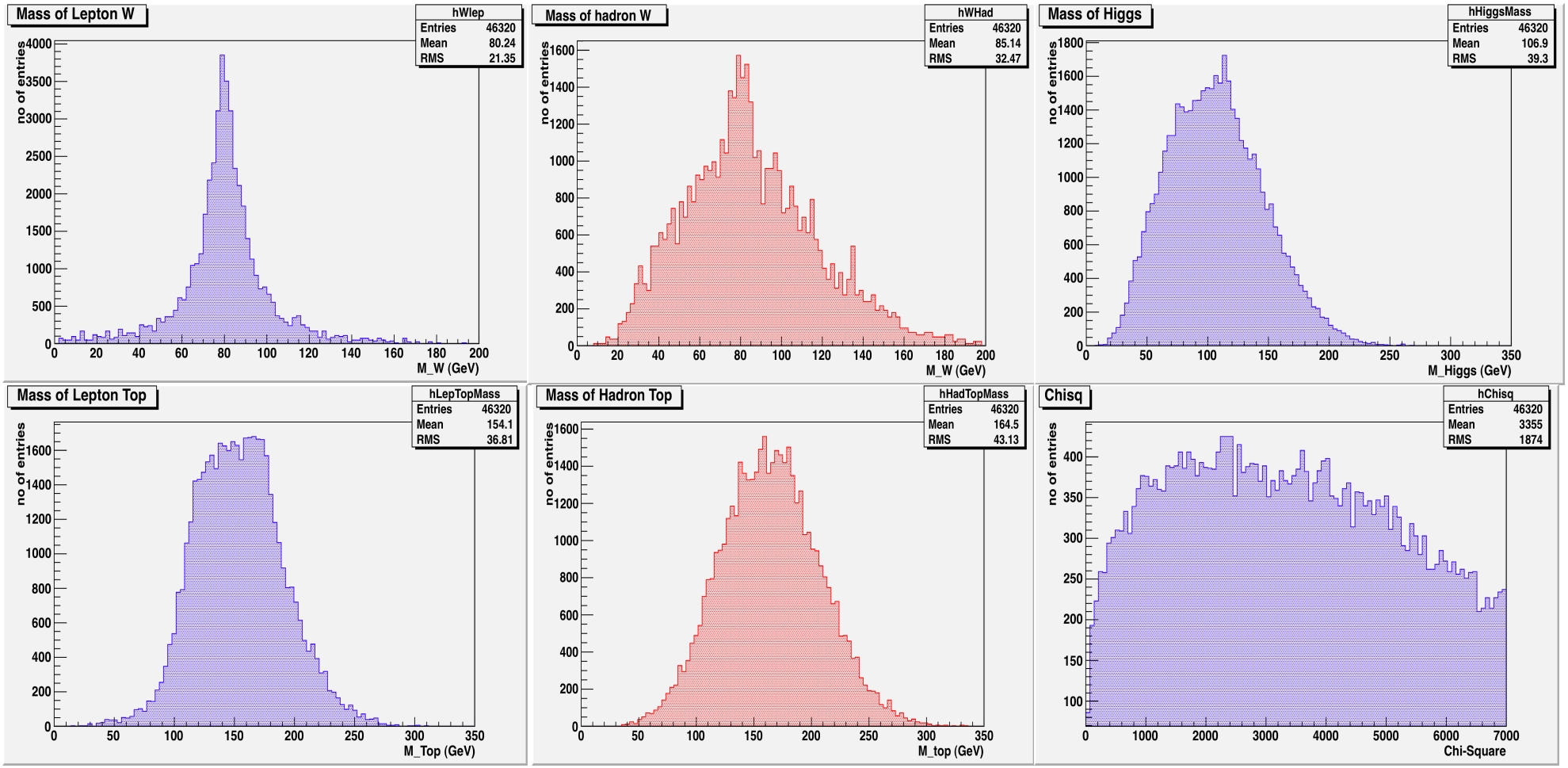
Samples

- ILD_00 centrally reconstructed sample with center of mass energy √s = 500 GeV.
- $t\bar{t}$-Higgs events with M_h = 120 GeV/c^2, M_t = 175 GeV/c^2.

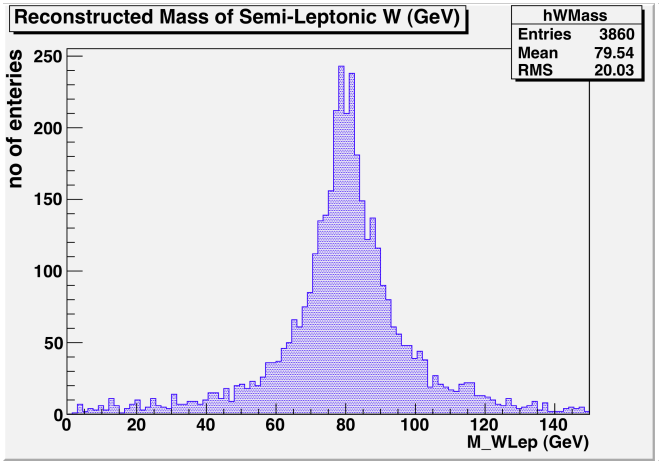
Process	σ (fb)	Sample	L (ab^{-1})
$e^+ e^- \rightarrow t\bar{t}H$	0.577 [arXiv:hep-ph/0604166v2]	20,000	34
$e^+ e^- \rightarrow t\bar{t}$	521	1800000	34
$e^+ e^- \rightarrow t\bar{t}Z$	0.58	24,000	41
$e^+ e^- \rightarrow ZZ$	577.2		
$e^+ e^- \rightarrow W^-W^+$	7890		
$e^+ e^- \rightarrow q\bar{q}$	3951.8		

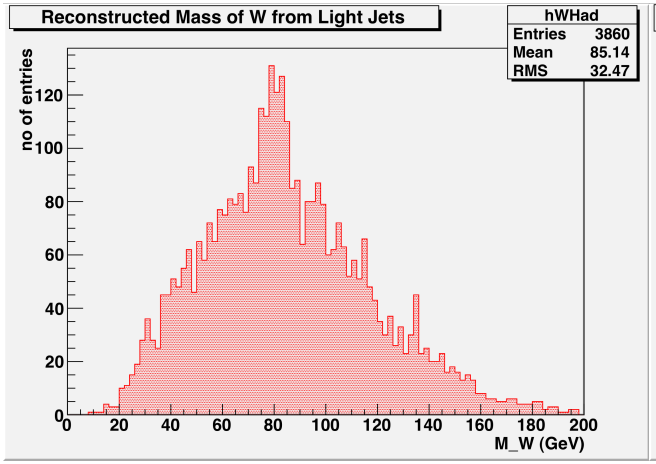
Reconstructed Final State

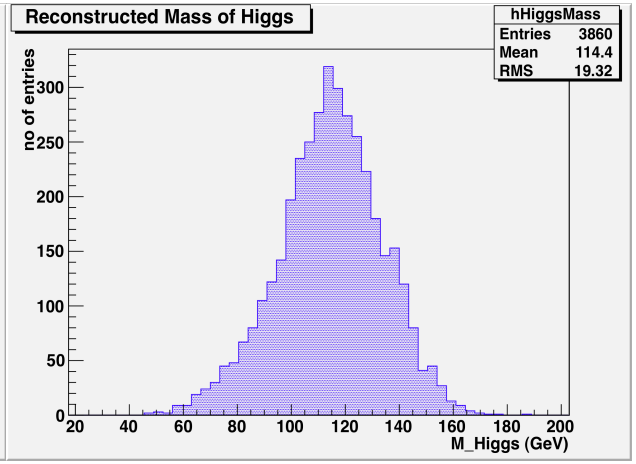


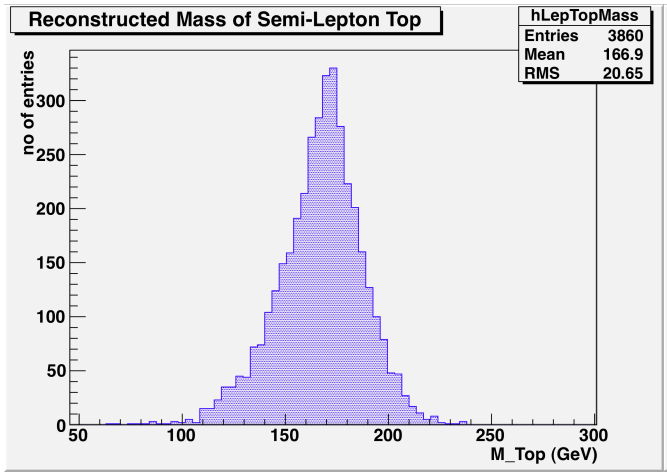
There are 12 entries for each event due to different combinations

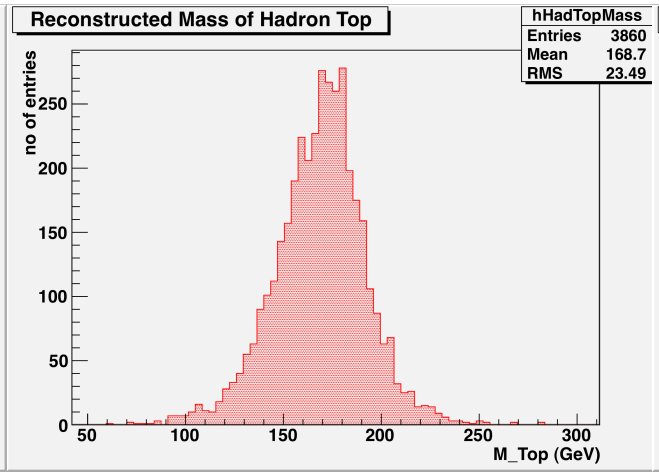
Reconstructed Final State after Minimizing χ^2

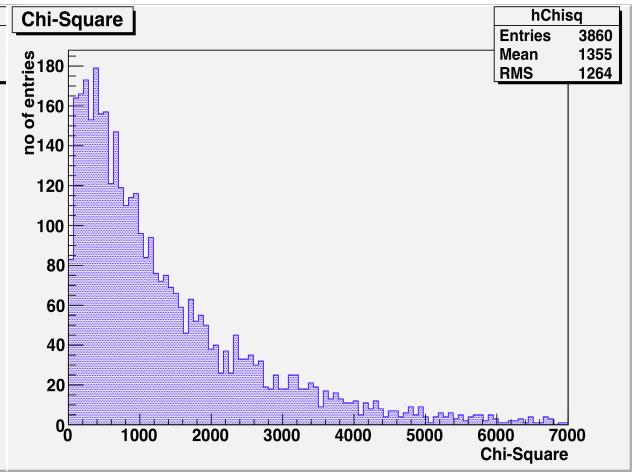




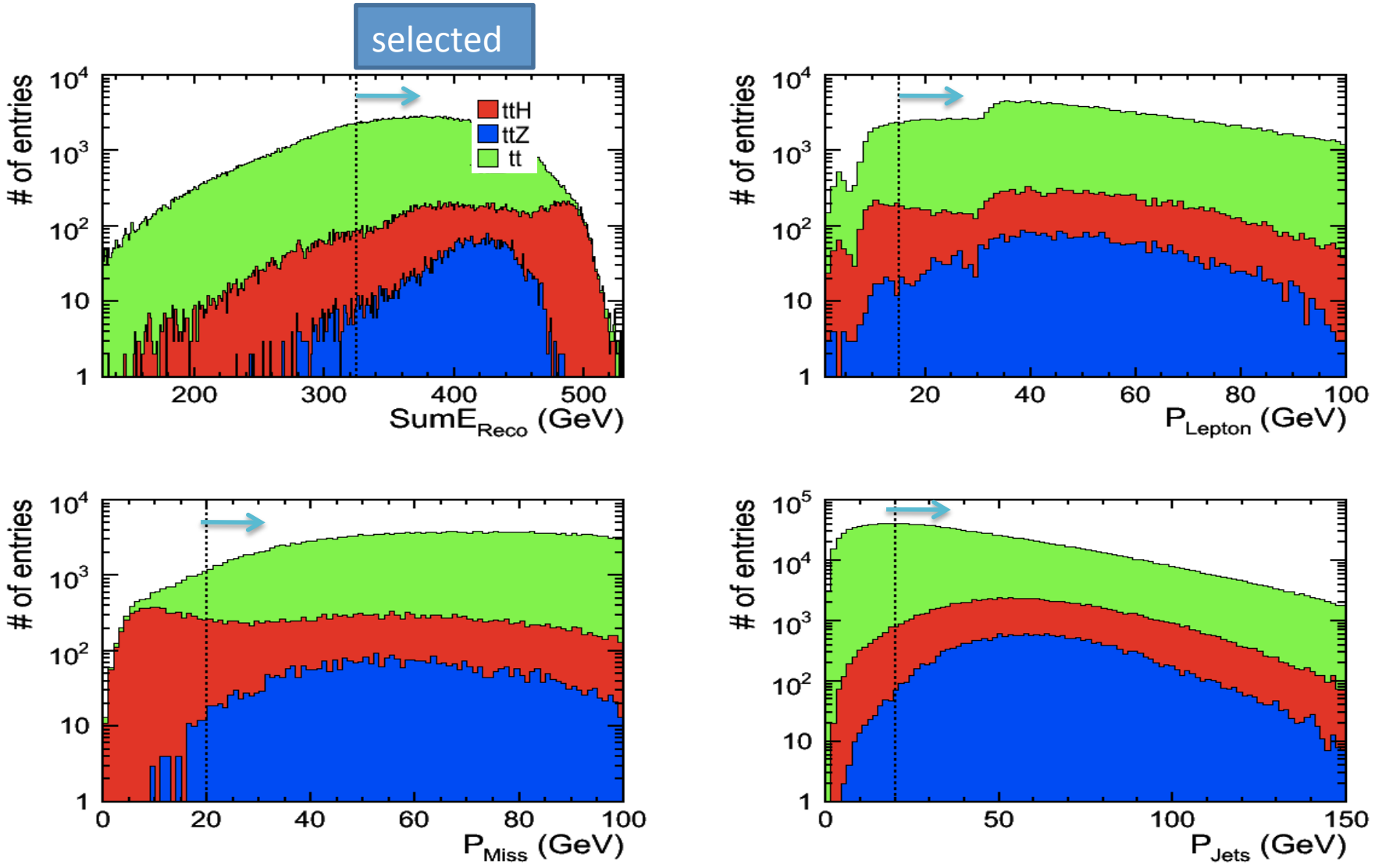




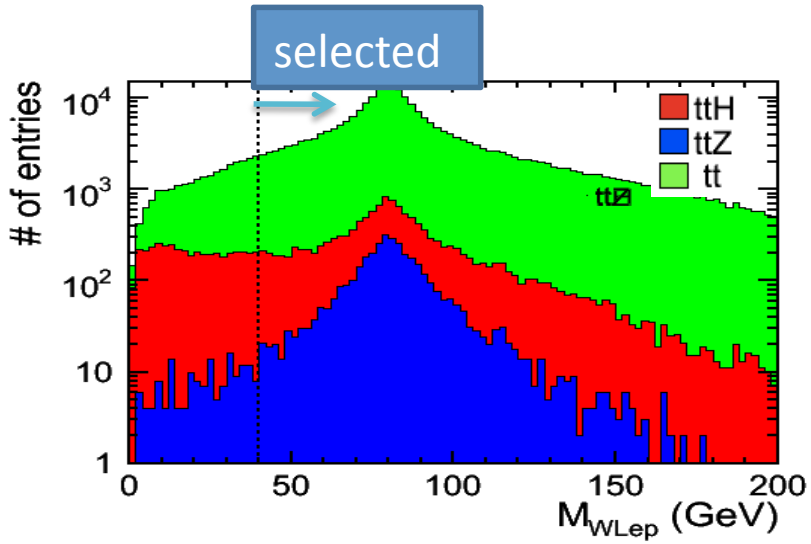


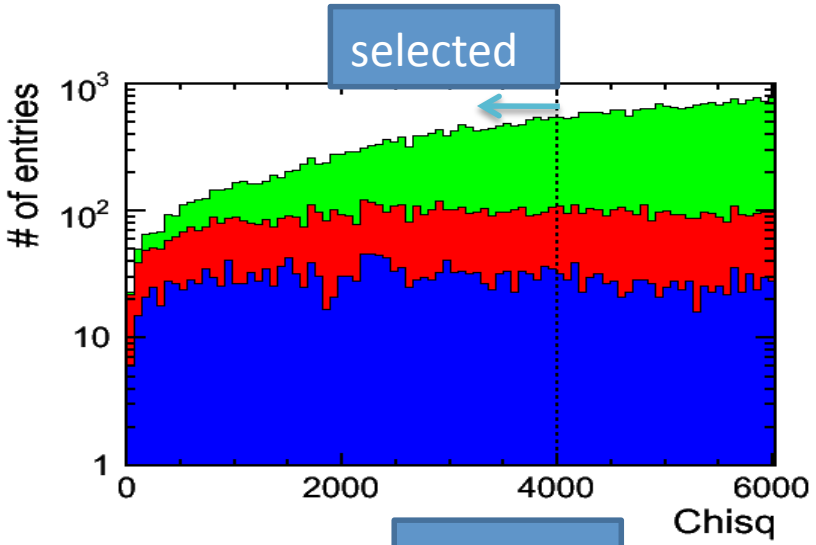


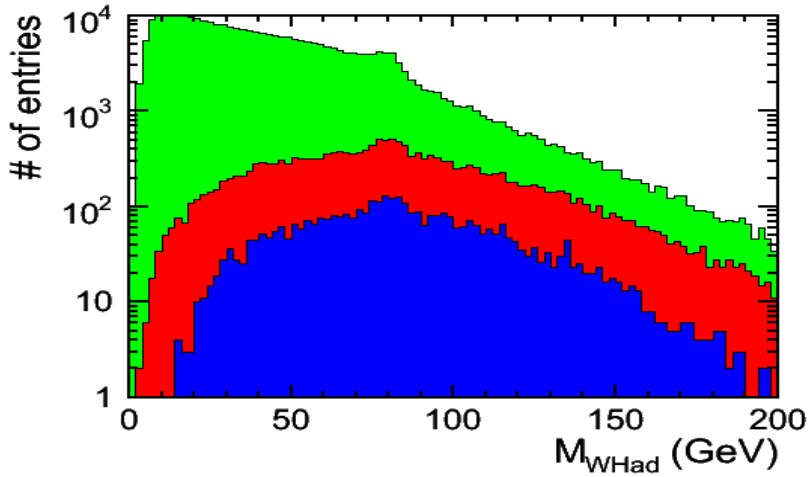
Selection variables (I)

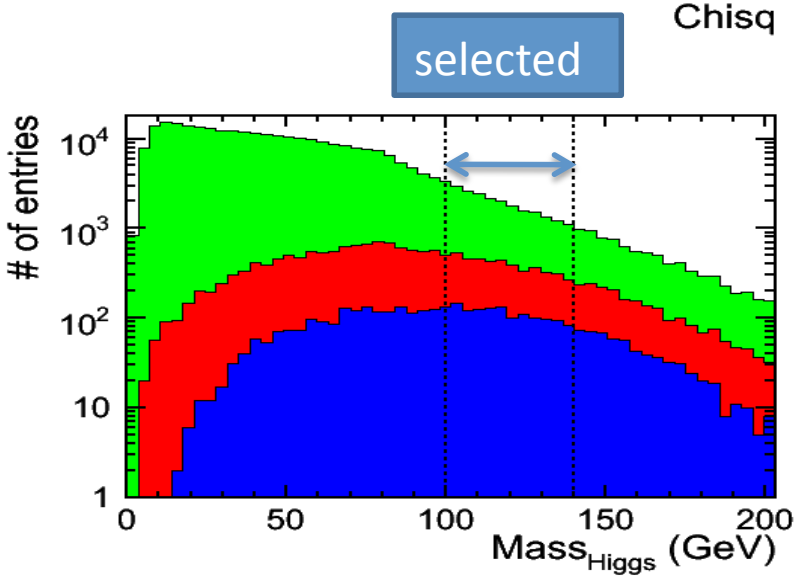


Selection variables (II)





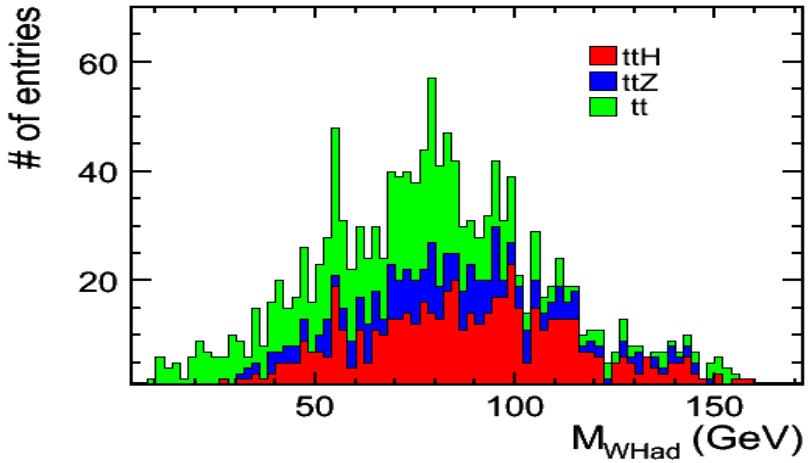


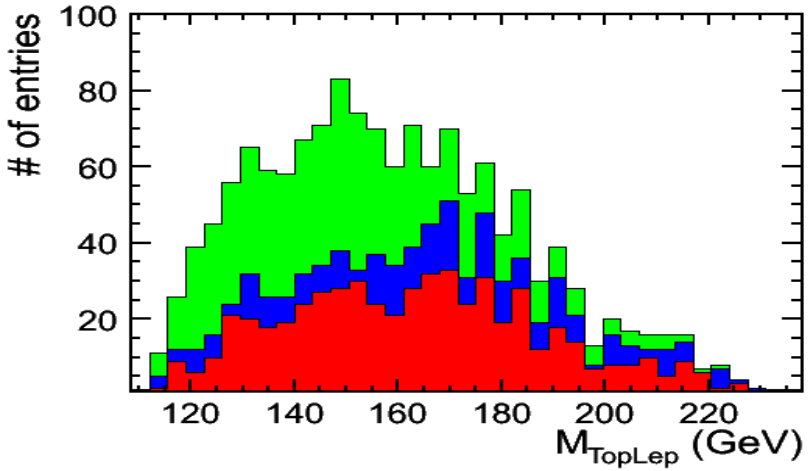


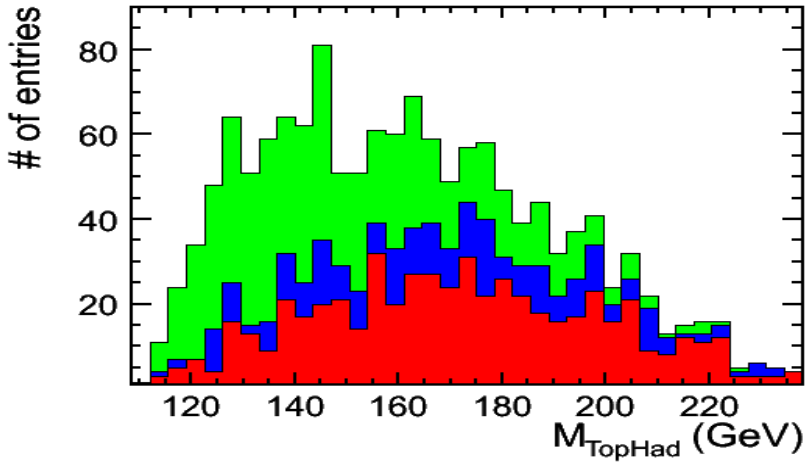
Signal and Background separation

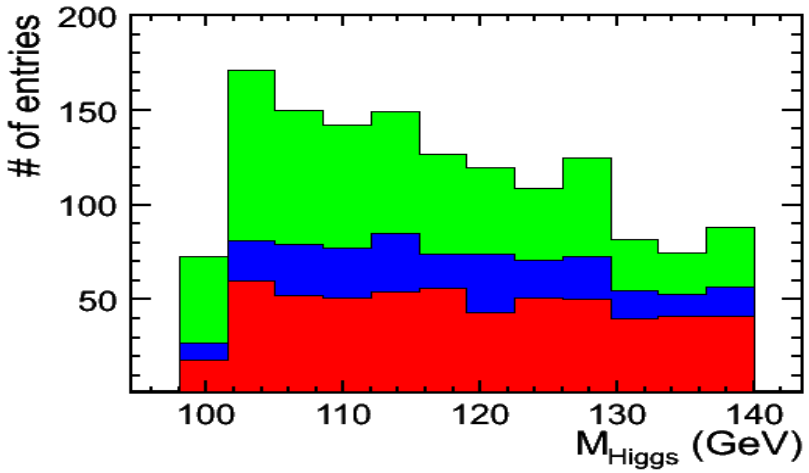
Cuts	$t\bar{t}H$	$t\bar{t}Z$	$t\bar{t}$
initial	20000	24000	376276
# Lep > 0	3860 ** After semi-leptonic selection	14536	282404
E_Reco > 325 GeV	3600	8021	68439
P_Lep > 15 GeV	3167	7128	55206
P_miss > 20 GeV	3119	5610	54488
P_Jet >20 GeV	2978	4837	33909
3^{rd} & 4^{th} jet b-tag > 0.09	2215	1544	11017
Chisq < 4000	2161	1487	1822
M_Lep > 40 GeV	2135	1330	1778

Signal and Background Final State after applying selection cuts









Measuring top-Higgs Yukawa coupling (Eur.Phys.J.C 49, 489-497(2007))

- The Yukawa coupling is scaled to the fermion mass: $g_{ffH} = \frac{m_f}{v}$, v is the vacuum expectation value of the Higgs field = 246 GeV
- For selection efficiency of the signal (ε) and purity of the selected sample), systematic and statistical uncertainties are given by:

$$(\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}})_{stat} \approx \frac{1}{S_{stat}(g^2_{t\bar{t}H})\sqrt{\epsilon^{sel}_{signal}\rho^{sel}_{sample}L}} \quad (\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}})_{syst} \approx \frac{1}{S_{syst}(g^2_{t\bar{t}H})}\frac{1-\rho^{sel}_{sample}}{\rho^{sel}_{sample}}\frac{\Delta\sigma^{BG}_{eff}}{\sigma^{BG}_{eff}}$$

- Δσ/σ is the uncertainty in the residual background normalisation mainly from tt pairs. In our case it is 5%
- The sensitivity factors $S_{stat}(g^2_{t\bar{t}H}) = \frac{1}{\sqrt{\sigma_{t\bar{t}H}}}\left|\frac{d\sigma_{t\bar{t}H}}{d(g^2_{t\bar{t}H})}\right|$ and $S_{syst}(g^2_{t\bar{t}H}) = \frac{1}{\sigma_{t\bar{t}H}}\left|\frac{d\sigma_{t\bar{t}H}}{d(g^2_{t\bar{t}H})}\right|$ express dependence of cross section on the coupling square which is inversely proportional to the square of g^2_{ttH} due to small cross section of the Higgs radiating off the Z

Coupling Results

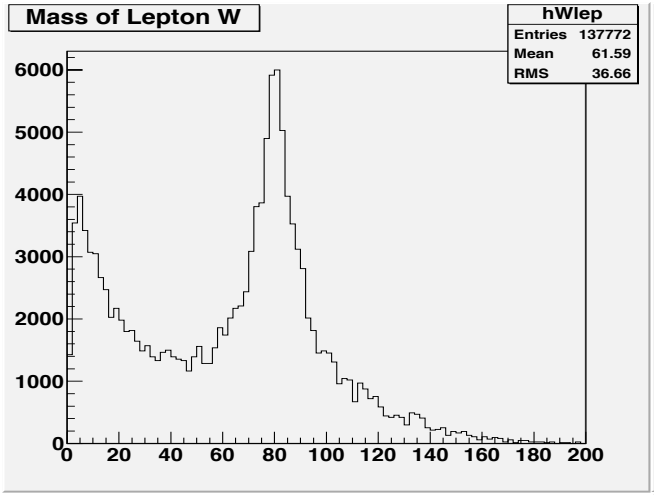
- Expected uncertainty on the coupling measurement. We used $S_{stat} = 1.5\ fb^{1/2}$ and $S_{syst} = 1.98$ with Luminosity $L = 3400 fb^{-1}$

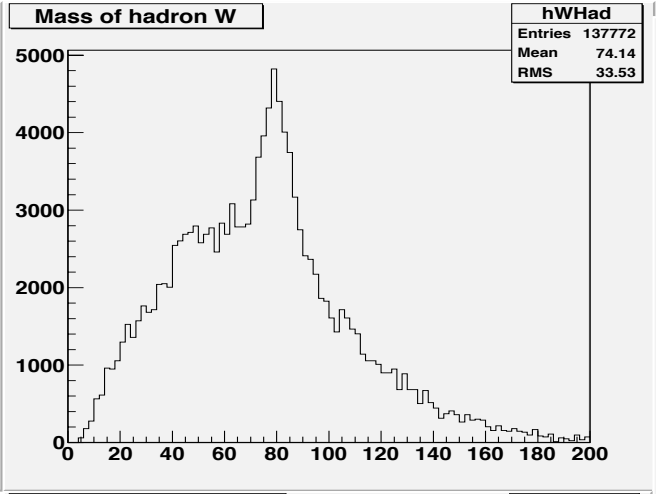
Final State	ϵ_{sel} (%)	σ_{eff}
$t\bar{t}H$	10.68	0.017
$t\bar{t}$	0.423	2.204
$t\bar{t}Z$	5.54	0.032

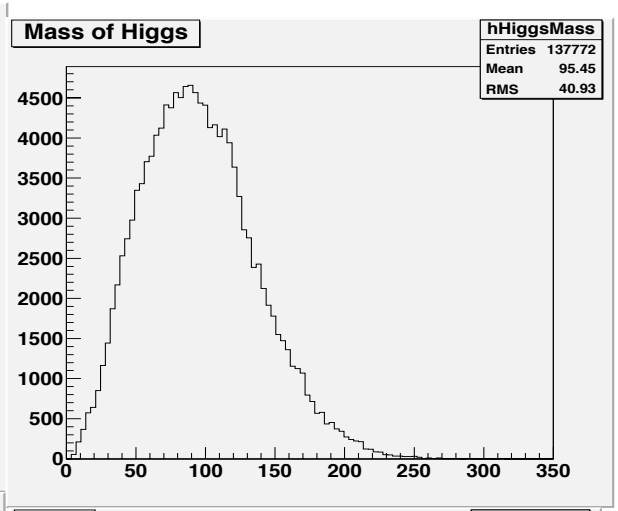
Higgs Mass	$\frac{\Delta\sigma_{eff}^{BG}}{\sigma_{eff}^{BG}}$	ϵ_{signal}^{sel}	ρ_{sample}^{sel}	$(\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}})_{stat}$	$(\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}})_{syst}$	$\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}}$
120 GeV	5%	10.6%	29.52%	6.7%	6.02%	9.0%

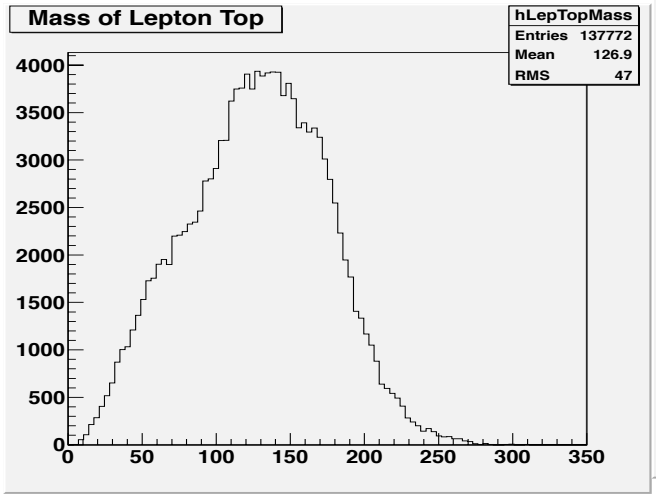
- **New ILC Software installed successfully**
- **Reconstructed the final state of the signal and background**
- **Plots of the Signal final state are in next slide**

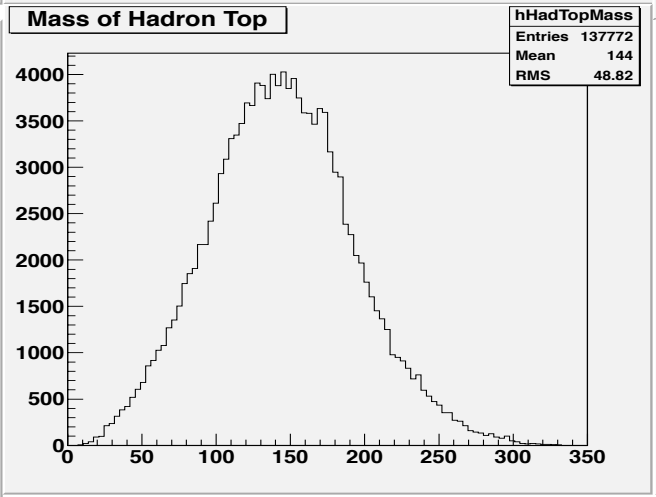
Reconstructed Final State

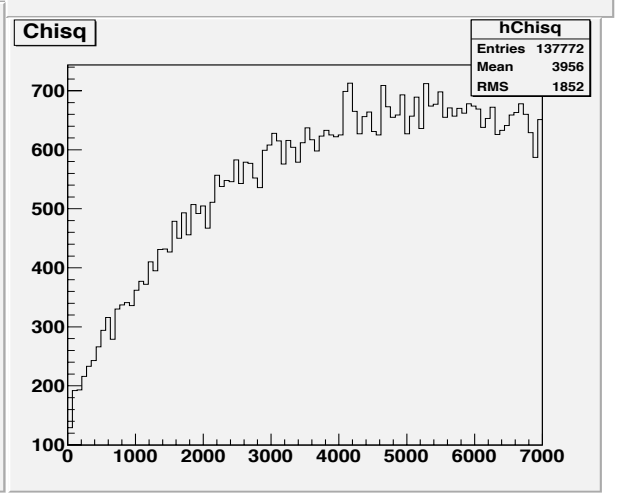












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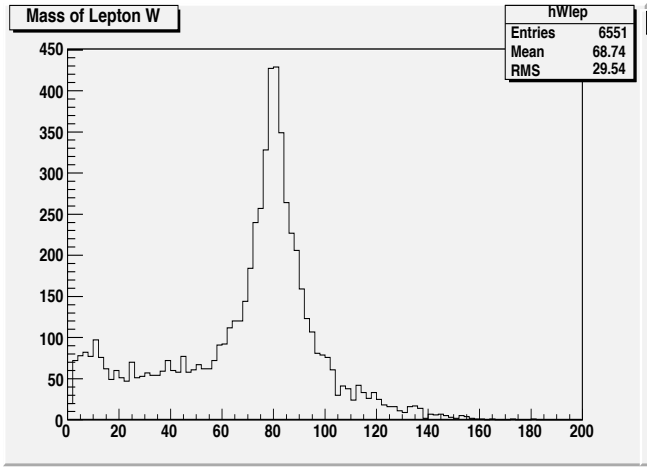

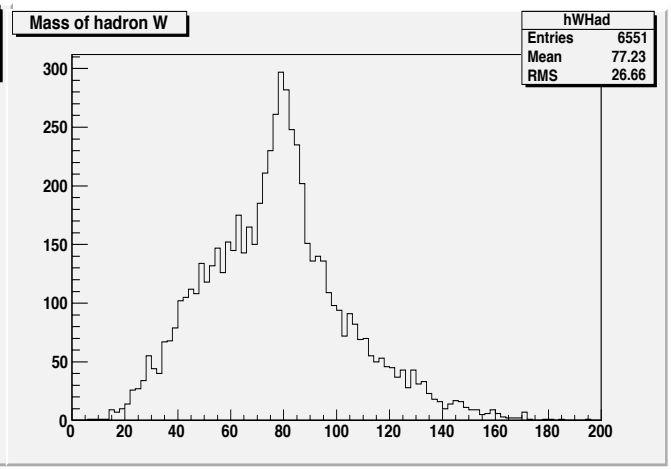

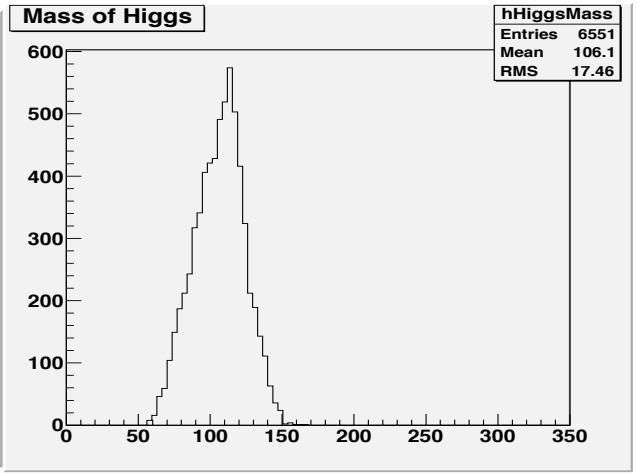

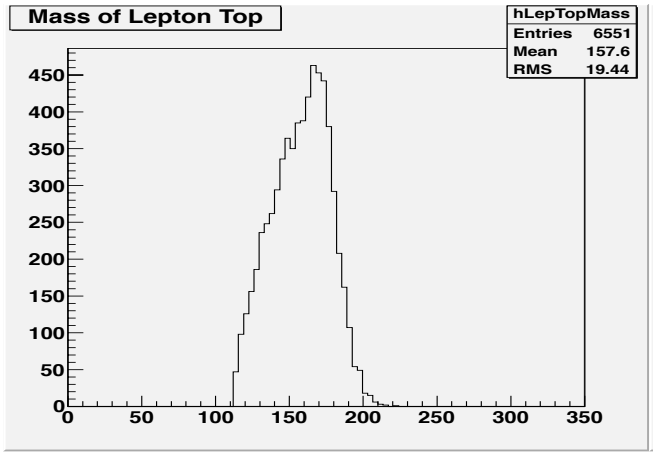

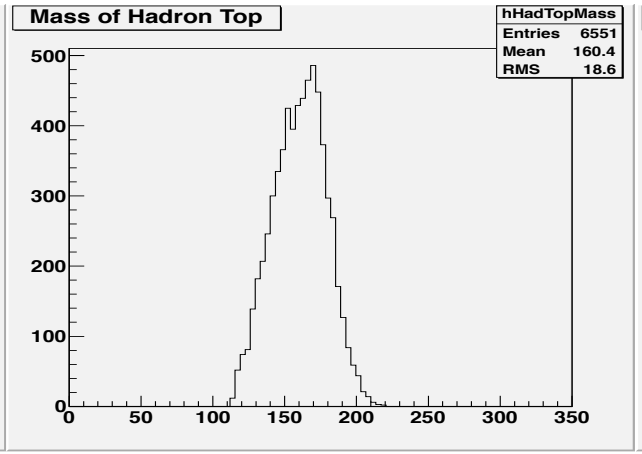

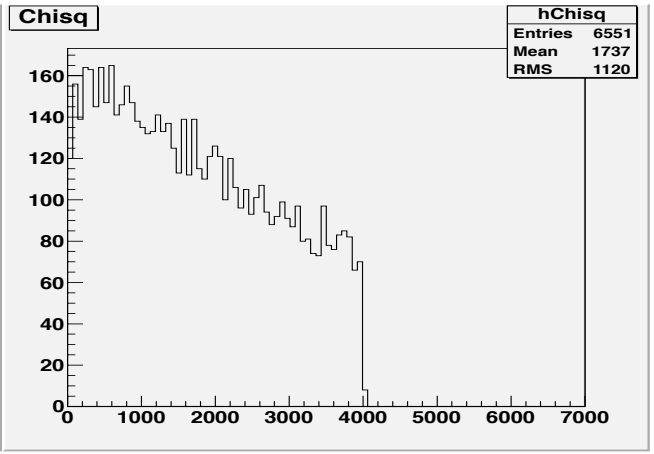

Summary/Future Plans

- Results for top Higgs Yukawa (with old ILCSoft) coupling are presented
- Improvements are still going on to reduce more $t\bar{t}$ backgrounds.
- Plots for the reconstructed data with new ILCSoft are presented.
- Results for these plots are near ready.