ZH Analysis – Recoil Mass

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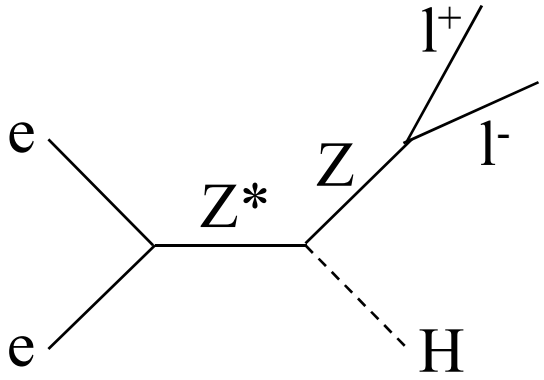
Introduction

Goal of ZH recoil mass studies

- Measurement of the Higgs coupling to Z.
- Determination of precise Higgs mass.



Today's topic

- Reconstruction of recoil mass distribution
- Estimation of the measurement accuracy for the ZH cross-section and Higgs mass at GLD and GLD'.

This result is very preliminary!

Simulation procedure

Simulation procedure

1. Full-simulation
   - Jupiter G4-simulator
   - Geometry of GLD and GLD' is implemented.
2. Reconstruction
   - MarlinReco is used for the event reconstruction.
   - LCIO-file is converted to ROOT-file by the interface program.
3. Analysis
   - Root-based analysis is performed.

Analysis outline

MC-data set

- Signal : ZH→ee/μμ X
  - Luminosity : 335 fb^{-1} (2500 x 2 events)
- B.G. : ZH→ee/μμ qq
  - Luminosity : 252 fb^{-1} (20000 x 2 events)
  - The number of events are scaled to 335 fb^{-1}.

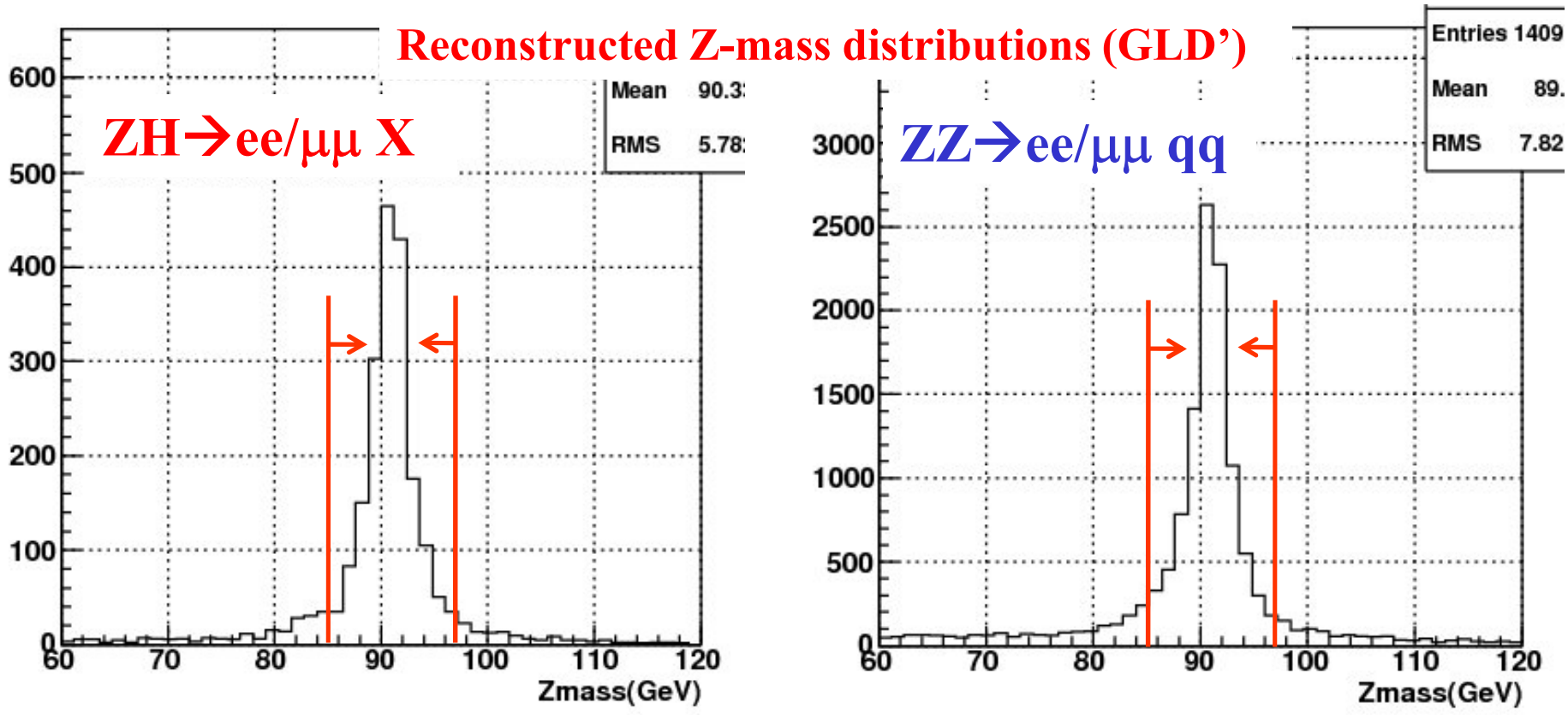
Analysis procedure

1. Selection of 2 tracks from Z
   - The tracks has the least χ^2 value for M_Z.
2. Selection of well-reconstructed events
3. Reconstruction of Higgs recoil mass
4. Estimation of measurement accuracy for $\sigma(ZH)$ and M_H

The selection of well-reconstructed events is shown.

Reconstructed Mz cut

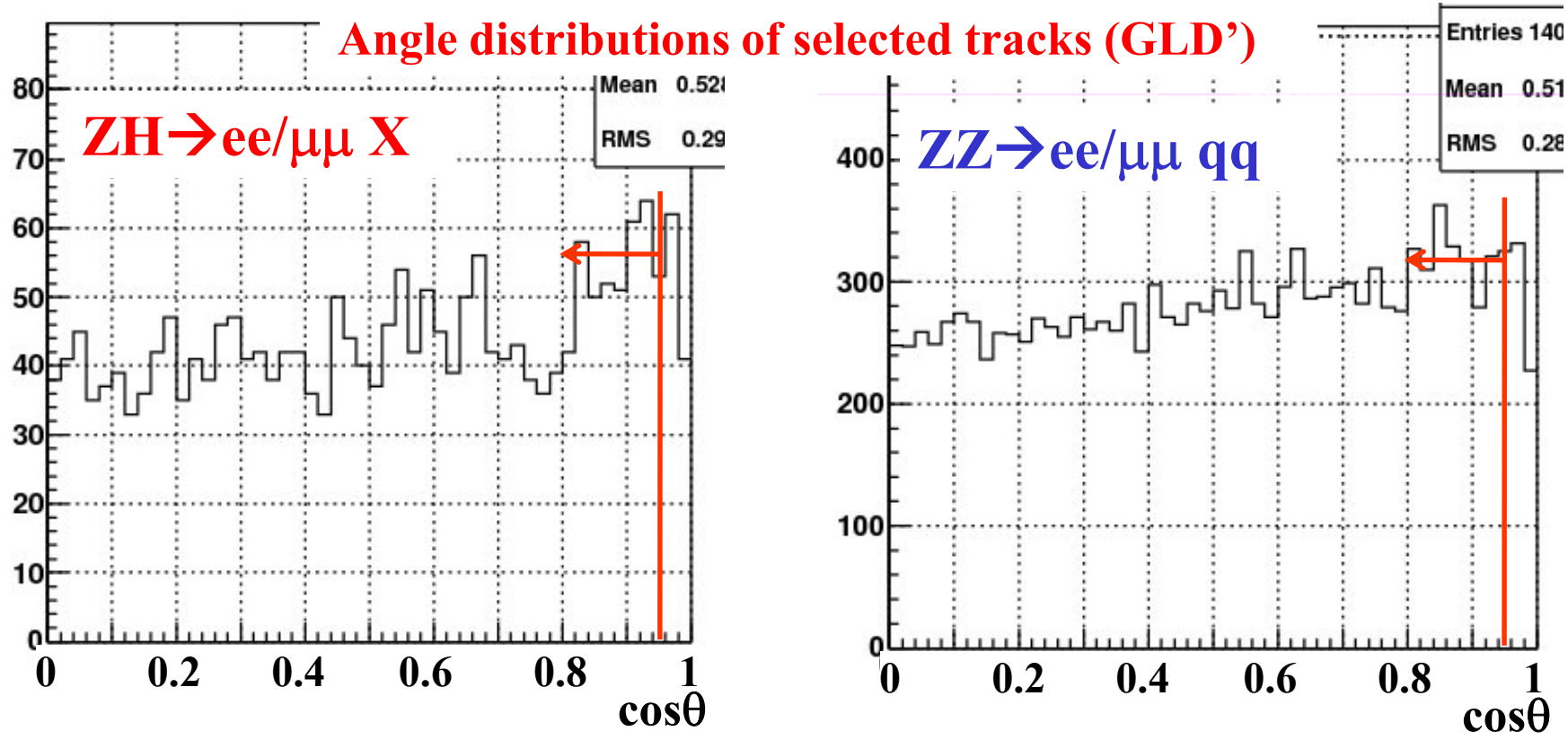
- M_Z is reconstructed with the selected two tracks.
- Events with M_Z of 85~97 GeV are selected.
  - The cut corresponds to 3 sigma range of the distributions.



Track angle cut

The track angle cut is applied for two tracks to select well-reconstructed tracks.

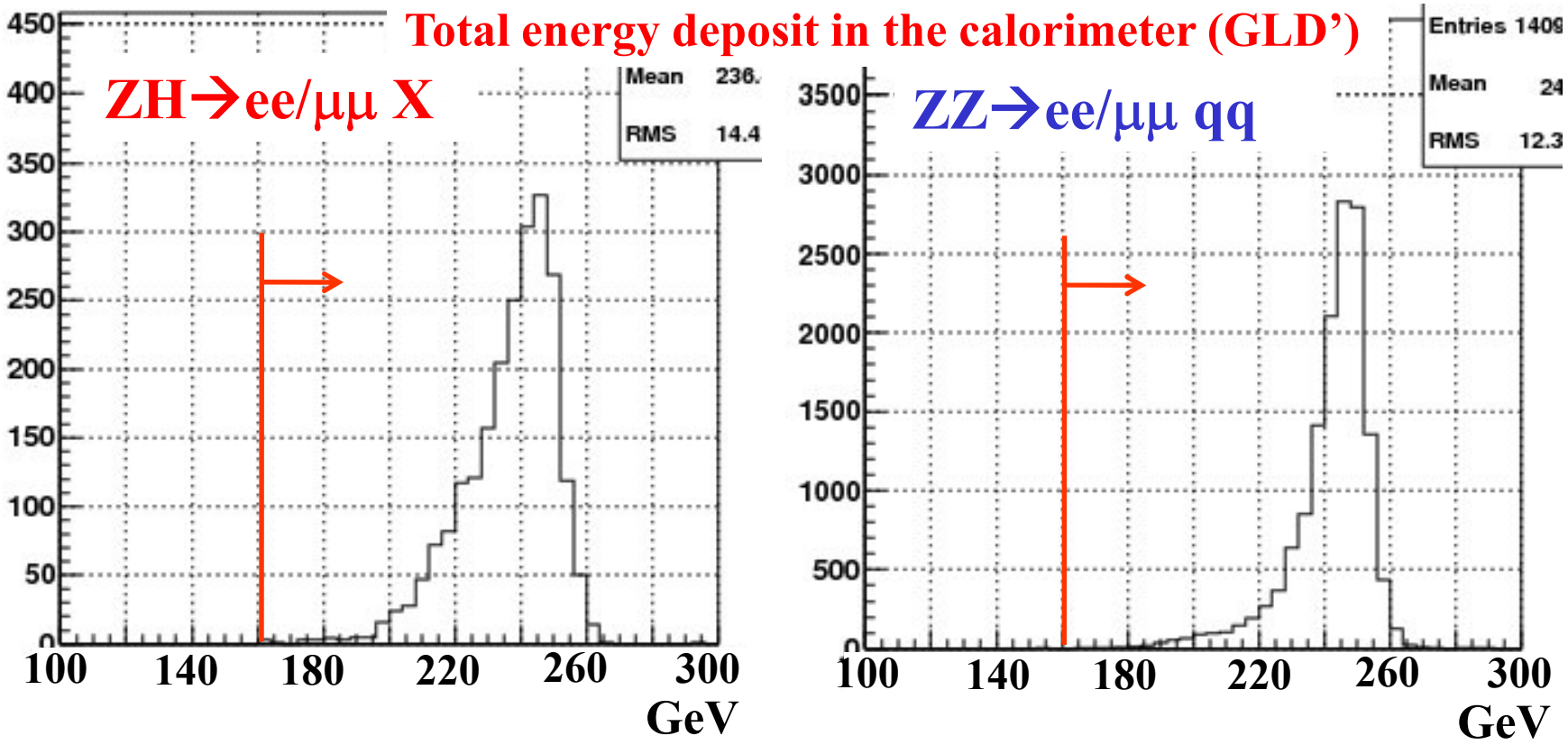
- TPC coverage : $\cos\theta < 0.98$
- The track angle is required to be $\cos\theta < 0.95$.



Cut for total energy deposit

- The total energy deposit in the calorimeter is checked.
- The event of the total energy above 160GeV is selected.
  - $E_{CM} - M_Z \sim 160$GeV

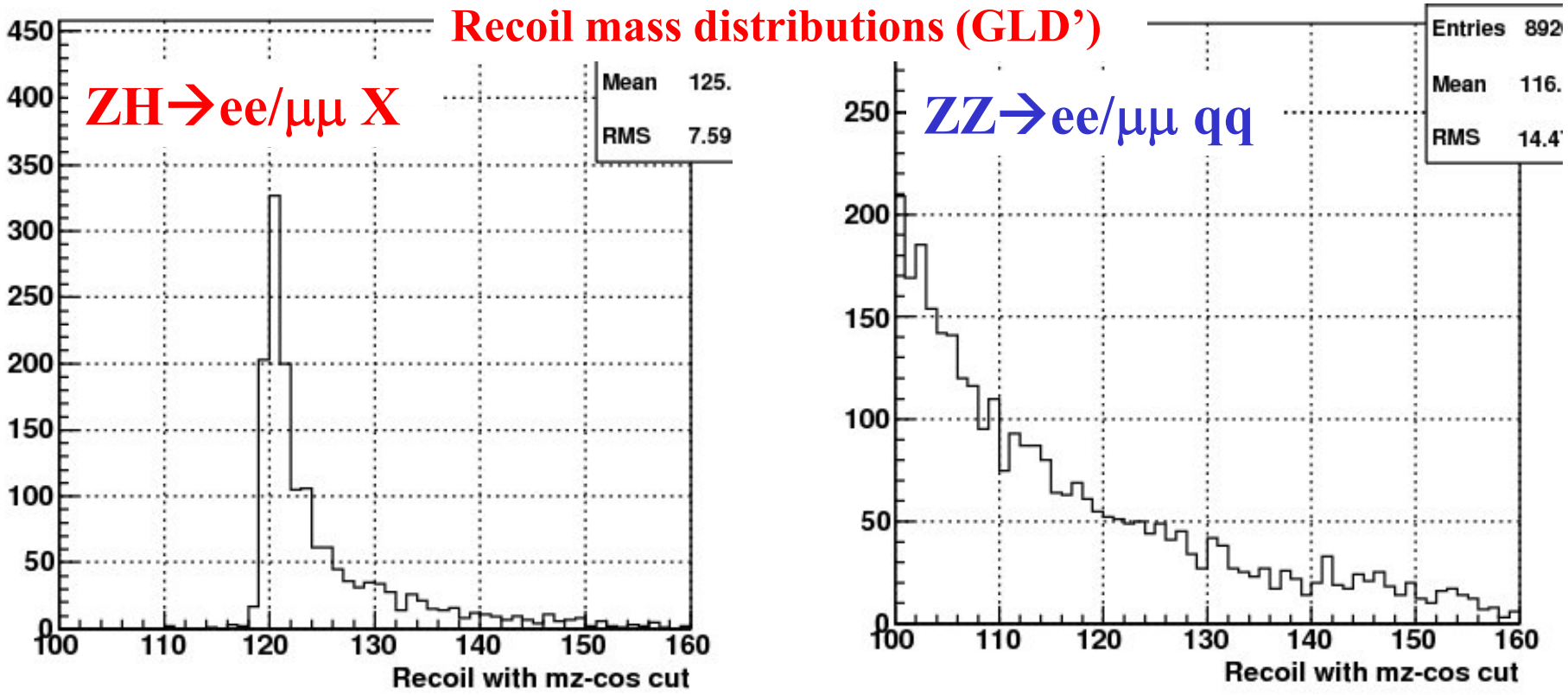
The recoil mass is reconstructed after all the cuts.



Reconstructed recoil mass

The recoils mass is reconstructed.

- A peak is observed at 120GeV for the signal events.
- There is a tail from the ee→ZZ at Higgs mass.



Reduction summary

The reduction rate is summarized for each cut.

	GLD' $ZH \rightarrow ll\,X\,(ZZ \rightarrow llqq)$	GLD $ZH \rightarrow llX\,(ZZ \rightarrow llqq)$
• No cut :	5,000 (53,000)	5,000 (53,000)
• 2 tracks from Z :	2,201 (18,677)	2,231 (18,671)
• 85GeV < Mz < 97GeV :	1,831 (13,254)	1,859 (13,257)
• $\cos\theta < 0.95$:	1,657 (12,137)	1,686 (12,169)
• Total energy > 160 GeV :	1,657 (11,673)	1,666 (11,706)

~1650 signal events are obtained for 335 fb^{-1}.

- Signal acceptance : ~33%
- B.G. acceptance : ~20%

The measurement accuracy for $\sigma(ZH)$ and M_H is estimated by using the selected events.

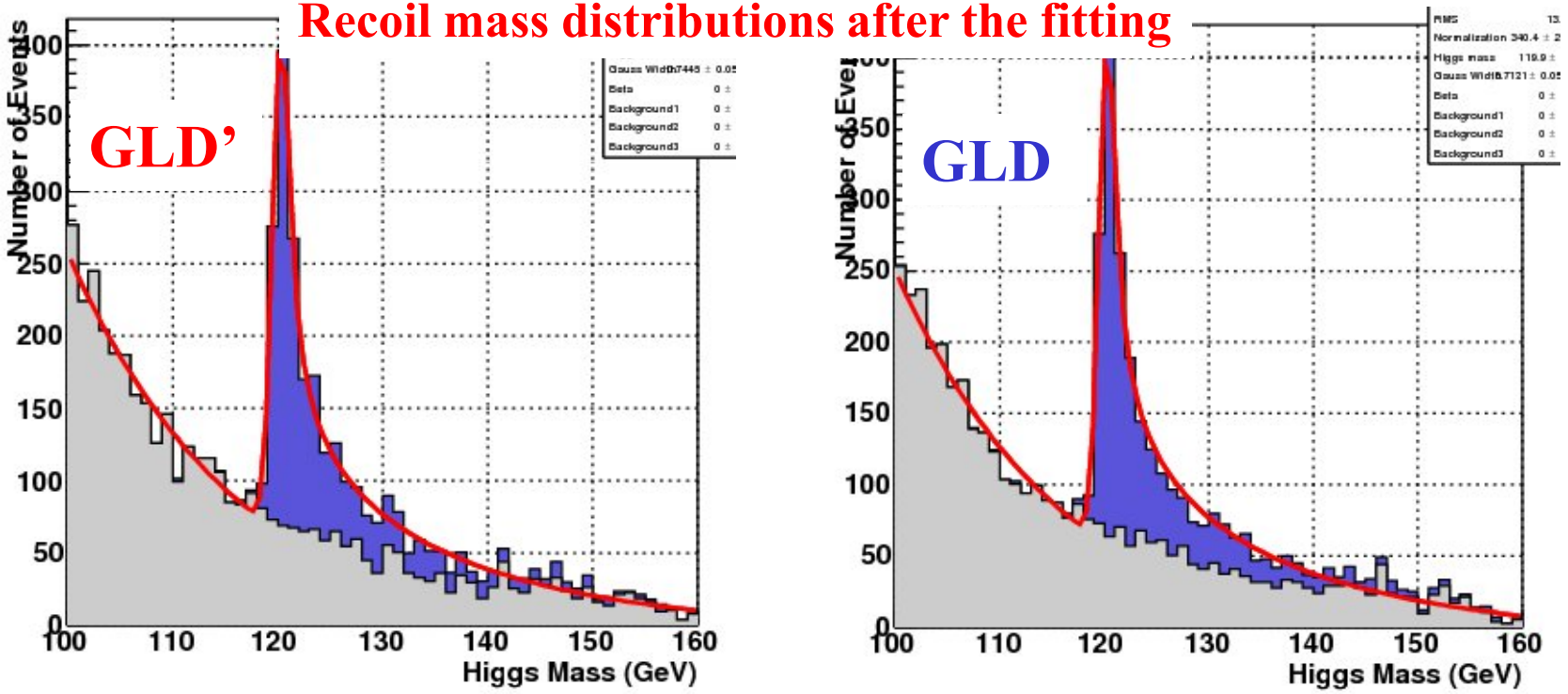
Fitting function

The distribution of the recoil mass is fitted by a function:

$$F(m) = N_H \int F_H(m,t) e^{-\frac{t^2}{2\sigma^2}} dt + F_Z(m)$$

$$\begin{cases} F_H(m,t) = \left(\frac{m+t-M_h}{\sqrt{s}-M_h}\right)^{\beta-1} \\ \beta = \frac{2\alpha}{2\pi \log \sqrt{s}/m_e - 1} \end{cases}$$

Recoil mass distributions after the fitting

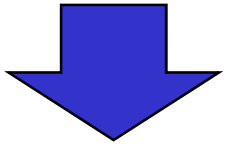


Measurement accuracy of $\sigma(ZH)$ and M_H is evaluated from the fitting result.

Estimation of measurement accuracy

Measurement accuracy for 335fb^{-1}

- ZH cross-section : 2.0% (GLD')
  1.8% (GLD)
- Higgs mass : 49.1 MeV (GLD')
  46.8 MeV(GLD)



- The resolution of Higgs mass deteriorates for GLD'.
  - Dose that come from worse momentum resolution of GLD' than GLD?
- Dose worse cross-section resolution for GLD' come from the poor Higgs mass resolution?

→ To be checked!

Summary

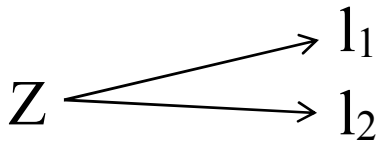
- Study of HZ recoil mass is ongoing for GLD' and GLD.
- The recoil mass distribution is reconstructed after the selection cuts.
- The measurement accuracy of ZH cross-section and Higgs mass is estimated for 335fb^{-1}.
  - Cross-section : 2.0% (GLD'), 1.8%(GLD)
  - Higgs mass : 49.1MeV(GLD'), 46.8MeV(GLD)
- The reason of worse cross-section and Higgs mass resolution for GLD' should be checked.

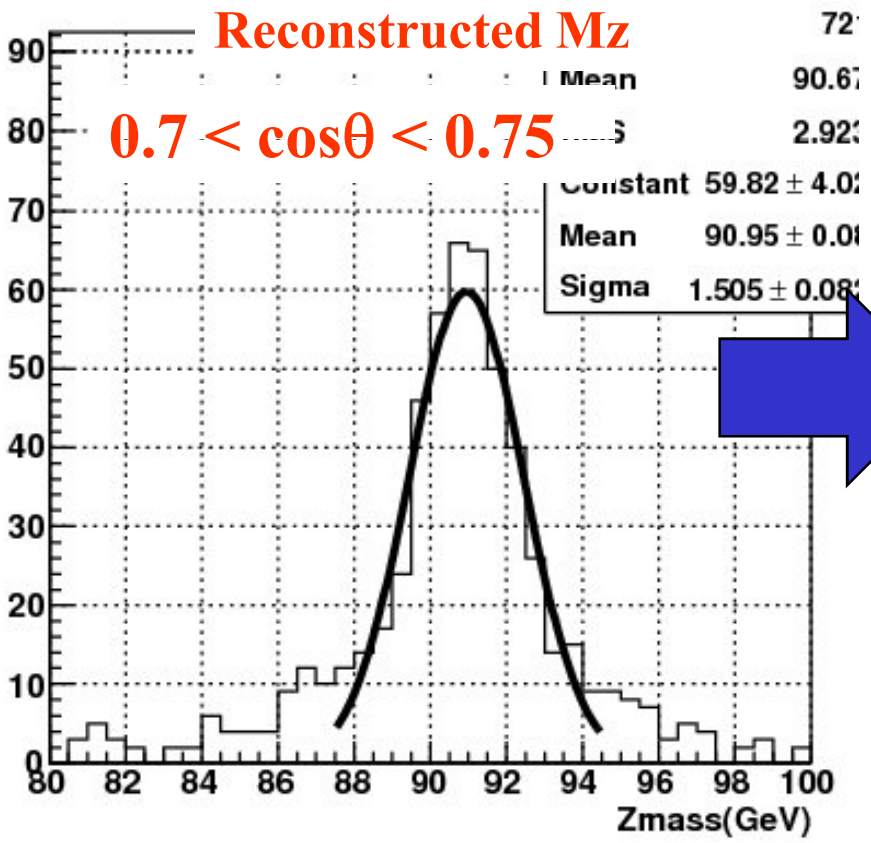
GLD v.s. GLD'

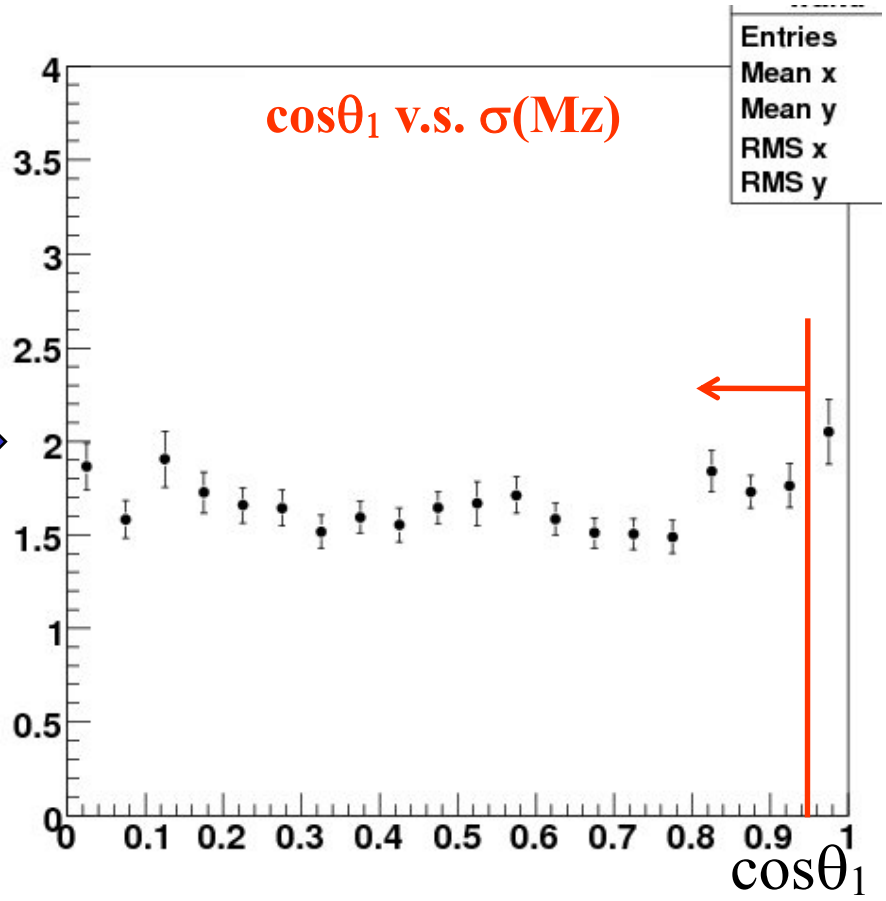
			GLD	LDC	GLD'	LDC'
TPC		Rin (m)	0.45	0.3	0.45	0.3
		Rout (m)	2.0	1.58	1.8	1.8
		Zmax (m)*	2.5	2.16	2.35	2.35
Barrel	ECAL	Rin (m)**	2.1	1.6	1.85	1.82
		Material	Sci/W	Si-W	Sci/W	Si-W
	HCAL	Material	Sci/W	Sci/Fe	Sci/W	Sci/Fe
EndCap	ECAL	Zmin (m)***	2.8	2.3	2.55	2.55
B-Field (T)			3	4	3.5	3.5
VTX		Inner Layer (mm)	20	16	18	18

Track angle v.s. Tracking performance

- The width of the M_Z-distribution is checked as a function of $\cos\theta_1$.
  - $\cos\theta_1$ is the angle of the first lepton.
- Events with $\cos\theta < 0.9$ is used.







Detail reduction summary

GLD'

	ZH→μμX	ZH→eeX	ZZ→ μμ qq	ZZ→eeqq
No cut	2500	2500	26500	26500
2 tracks from Z	1381	820	11819	6858
85GeV < M_Z < 97GeV	1180	651	8593	4688
cosθ < 0.95	1068	589	7844	4293
Evis > 160GeV	1068	589	7844	4293

GLD

	ZH→μμX	ZH→eeX	ZZ→ μμ qq	ZZ→eeqq
No cut	2500	2500	26500	26500
2 tracks from Z	1406	825	11948	6723
85GeV < M_Z < 97GeV	1203	656	8632	4624
cosθ < 0.95	1087	579	7945	4224
Evis > 160|GeV	1087	579	7945	4224