Study of ZH recoil mass

Kazutoshi Ito
Tohoku Univ.
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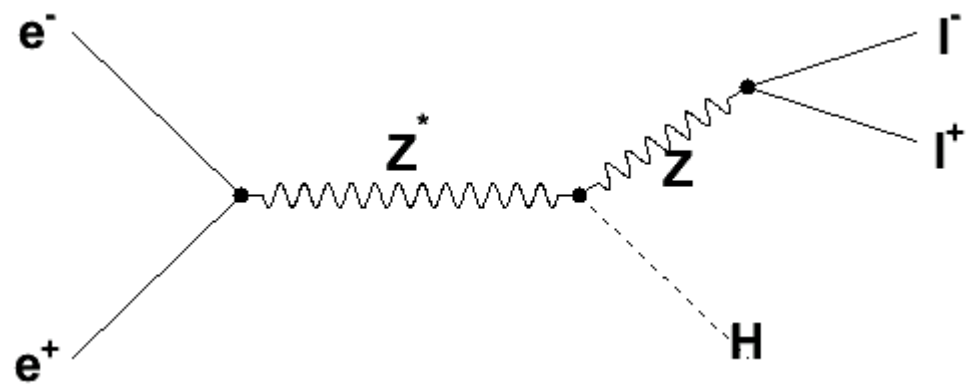
Introduction

- **Motivation**
  - $e^+ e^-$ -> ZH -> $l^+ l^-$ H is golden channel for measurement of Higgs Mass and coupling of ZH.



- **Today's topic**
  - Using e^+e^- -> ZH -> $\mu^+\mu^-$H, reconstruction of recoil mass distribution.
  - Estimation of the measurement accuracy for the ZH cross-section and Higgs mass at GLD and GLD'.

Simulation setup

- **Full-simulator : Jupiter (GLD and GLD')**
- **Reconstruction : MarlinReco**
  (event reconstruction)
  - LCIO-file is converted to ROOT-file by interface program.
- **Analysis : ROOT**
- **CM energy : 250 GeV**
- **Higgs mass : 120 GeV**

Analysis outline

- **data samples**
  - signal : ee -> ZH -> μμ X
    - Luminosity : 335 fb^{-1} (2500 events)
  - B.G. : ee -> ZZ -> μμ qq
    - Luminosity : 252 fb^{-1} (20000 events)
    - The number of events are scaled to 335 fb^{-1}.

- **Analysis procedure**

1. Selection of 2 muon tracks form Z.

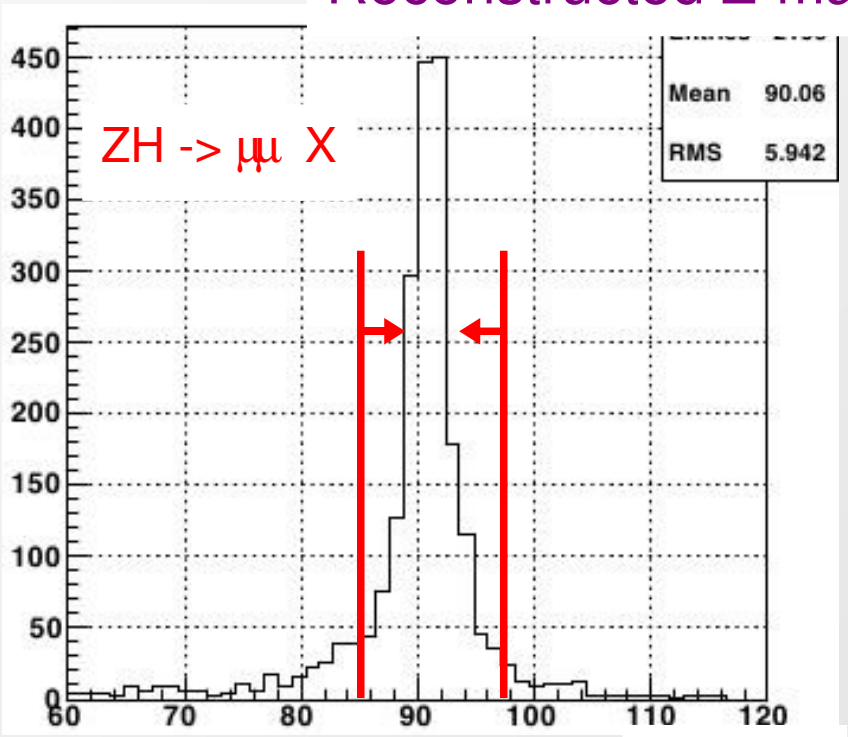
   The tracks has the least χ^2 value for M_Z.

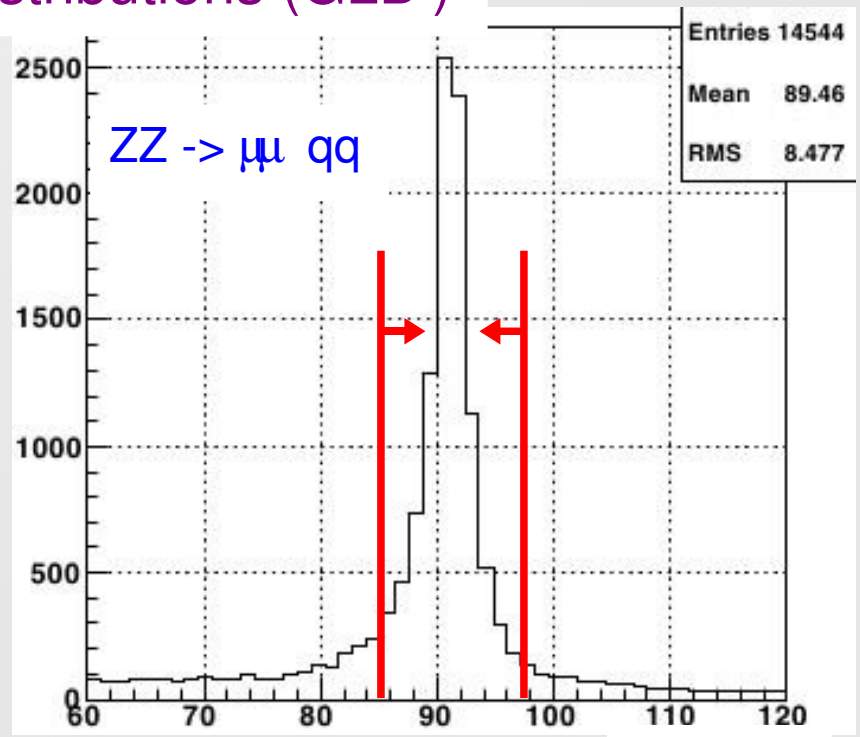
2. Selection of well-reconstructed events.
3. Reconstruction of Higgs recoil mass.
4. Estimation of measurement accuracy for $\sigma(ZH)$ and M_H.

Reconstructed Mz cut

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

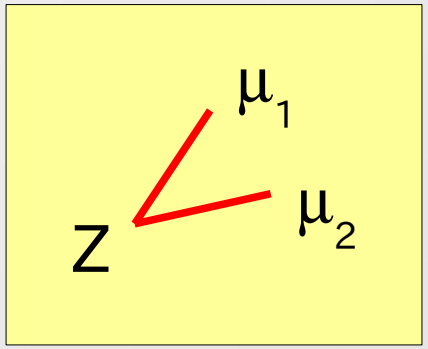
Reconstructed Z-mass distributions (GLD')



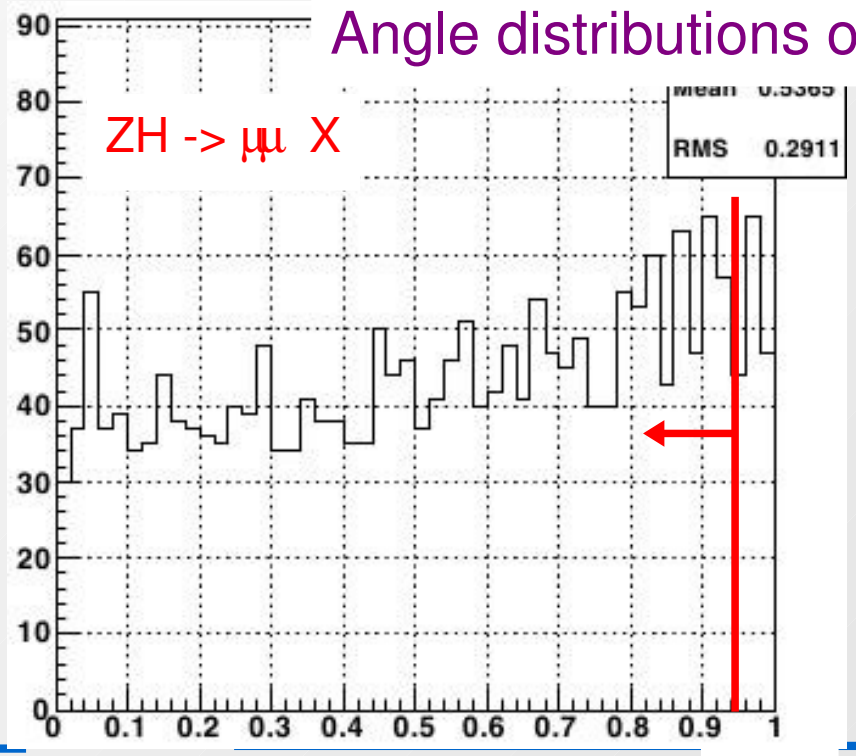


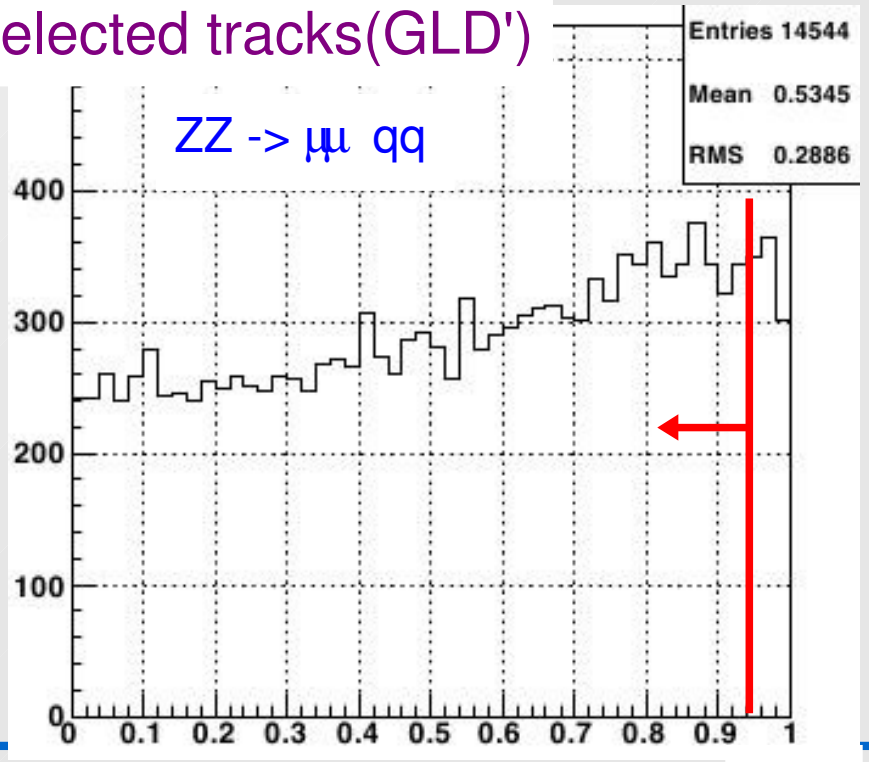
Track angle cut

- **The track angle cut is applied for two muon tracks to select well reconstructed tracks.**
  - TPC coverage : $\cos\theta < 0.98$
  - The track angle is required to be $\cos\theta < 0.95$



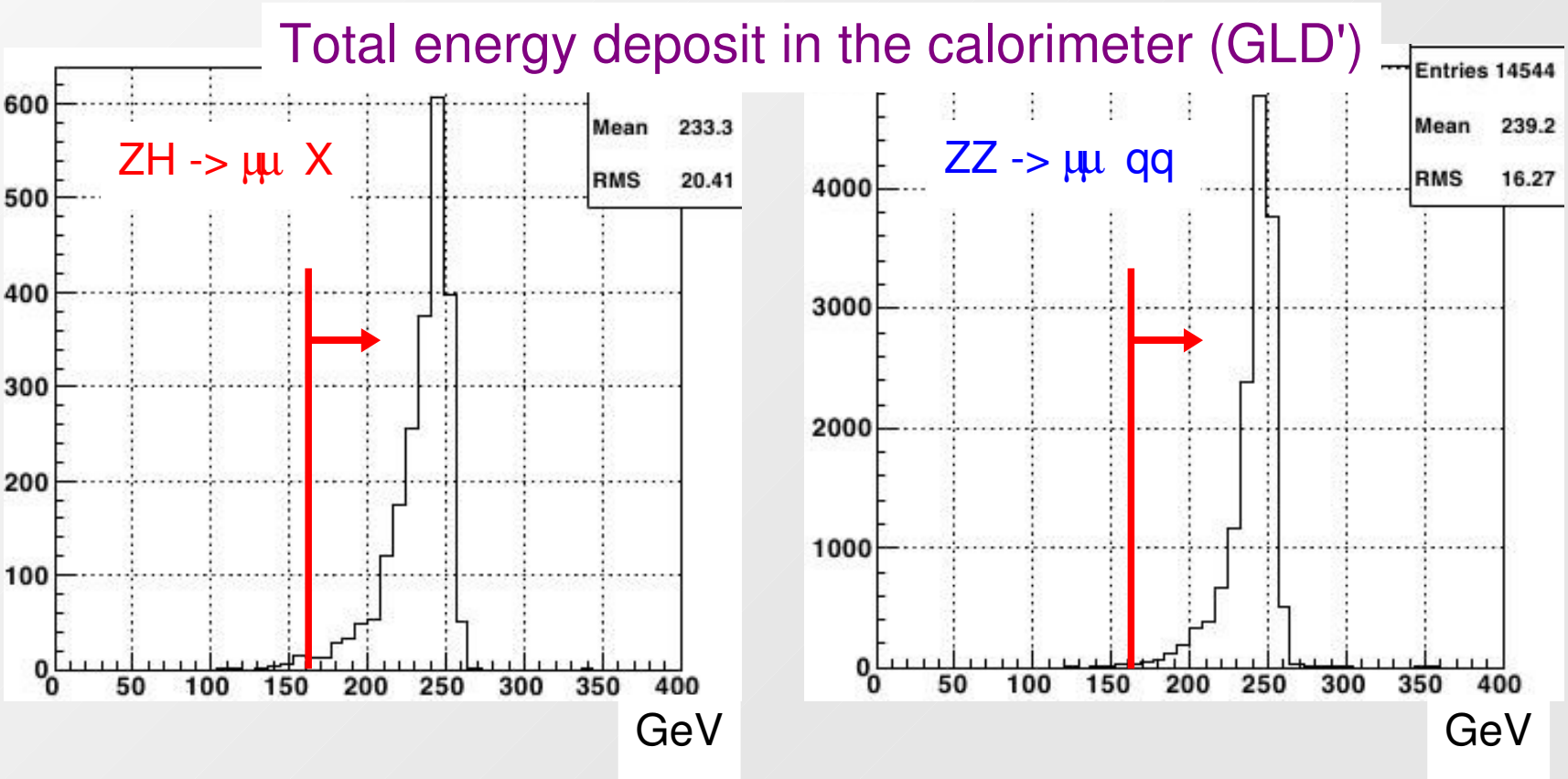
Angle distributions of selected tracks(GLD')





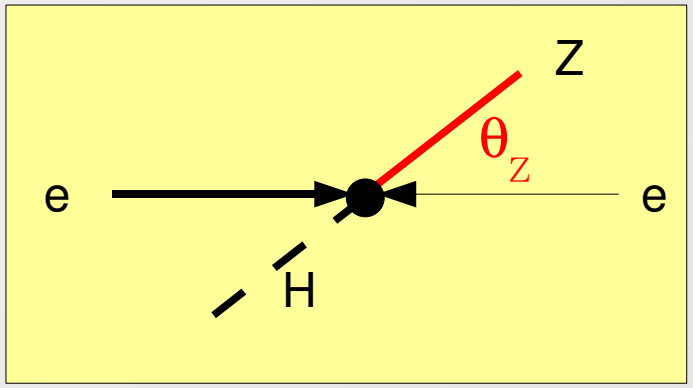
Cut for total energy deposit

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

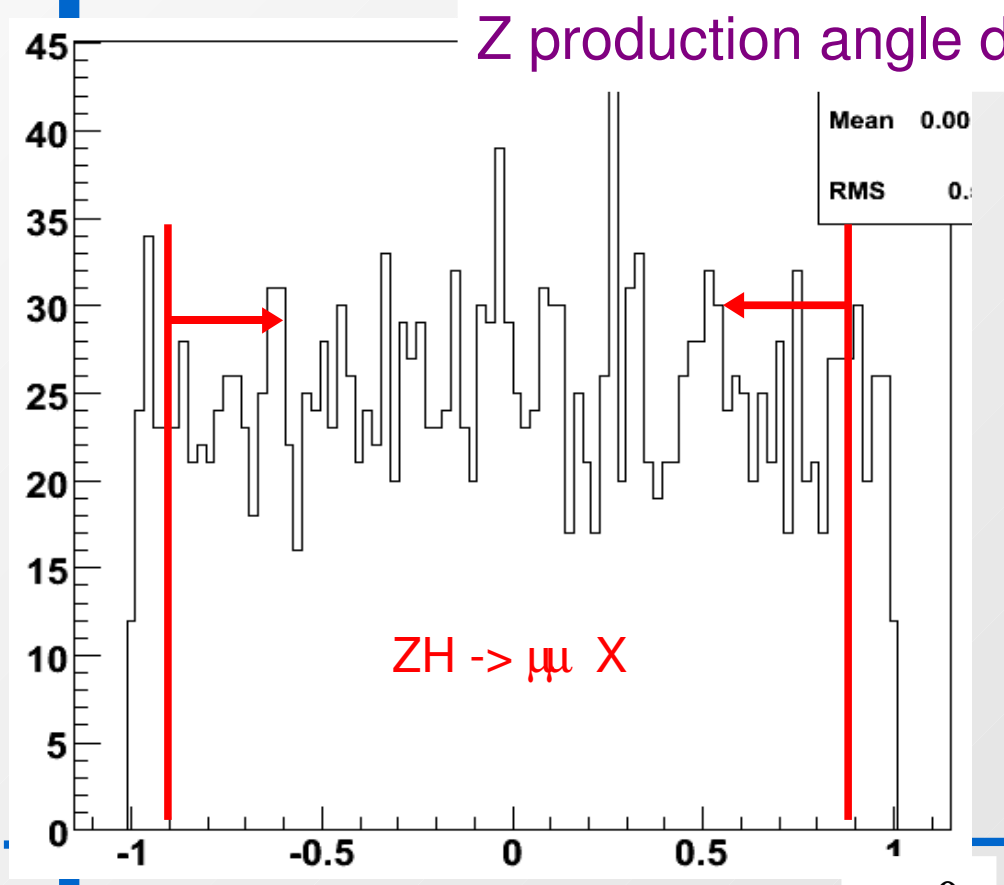


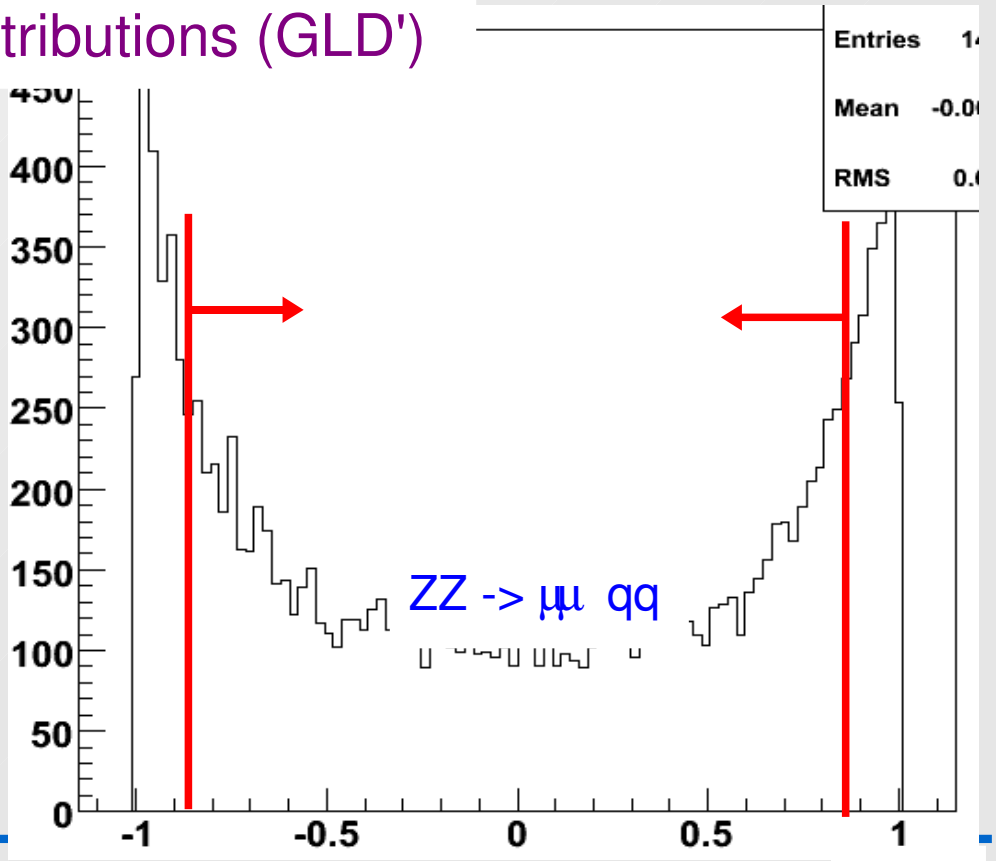
Z production angle cut

- The Z production angle cut is applied.
  - The Events in the range of -0.88 < $\cos\theta_z$ < 0.88 are selected.



Z production angle distributions (GLD')

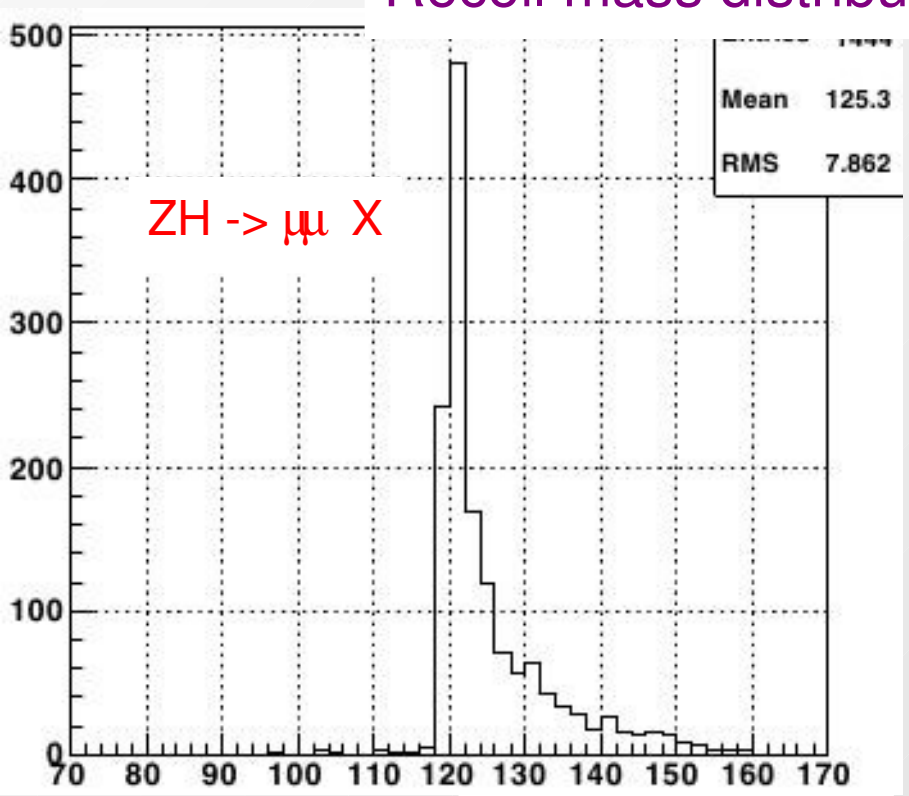


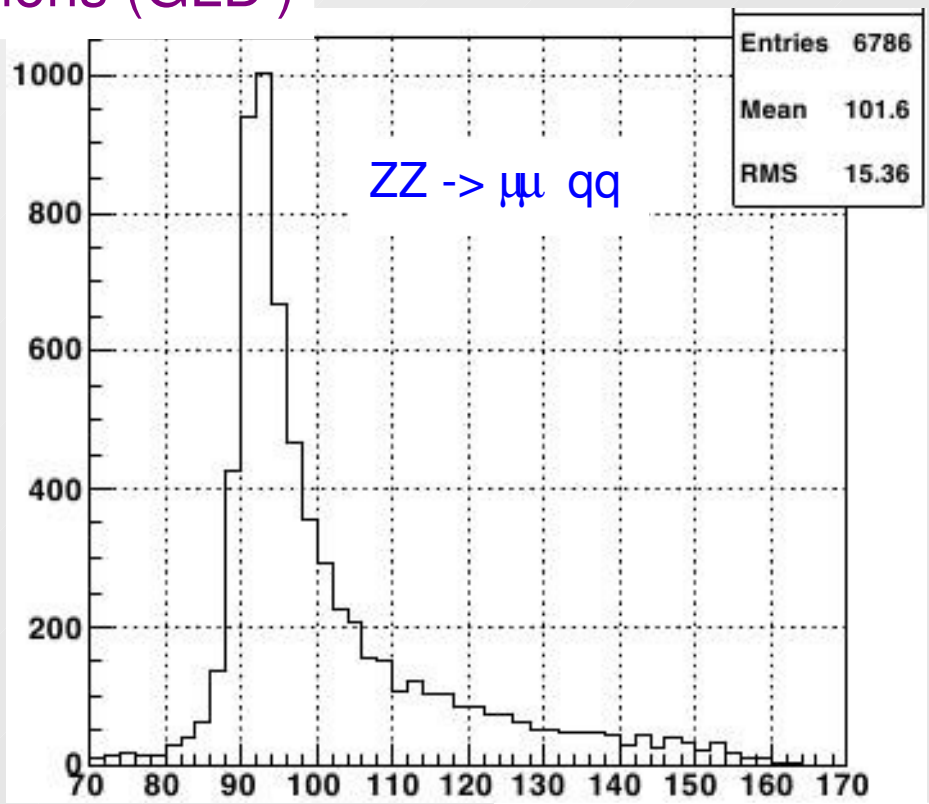


Reconstructed recoil mass

- The recoil mass is reconstructed after all the cuts.
  - A peak is observed at 120 GeV for the signal events.
  - There is a tail from the ee -> ZZ at Higgs mass.

Recoil mass distributions (GLD')





Reduction summary

- **The reduction rate is summarized for each cut.**
  - Luminosity : 335fb^{-1}

	GLD' ZH -> μμ Z (ZZ -> μμ qq)	GLD ZH -> μμ Z (ZZ -> μμ qq)
No cut	2,500(26,500)	2,500(26,500)
2 muon tracks from Z	2,199(19,271)	2,246(19,515)
85GeV < Mz < 97GeV	1,817(13,118)	1,857(13,273)
cosθ < 0.95	1,625(11,921)	1,668(12,122)
Total energy > 160GeV	1,610(11,906)	1,656(12,104)
cosθz < 0.88	1,444(8,991)	1,482(9,099)

- Signal acceptance : ～58%
- B.G. acceptrance : ～34%

Fitting function

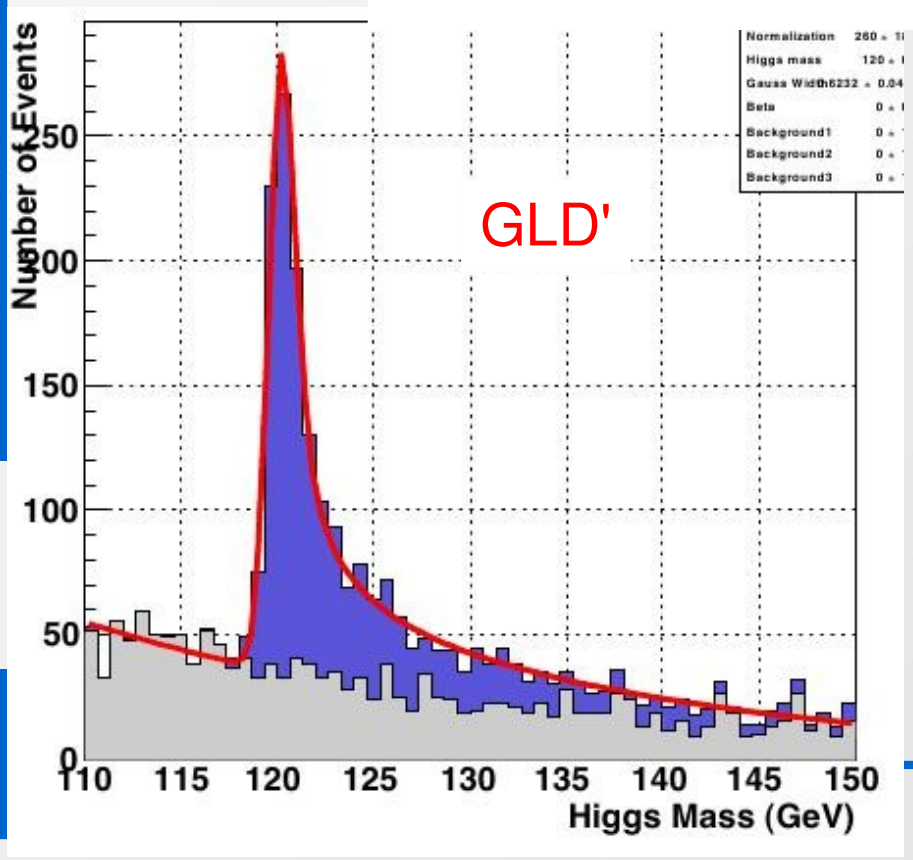
- The distribution of the recoil mass is fitted by a function:

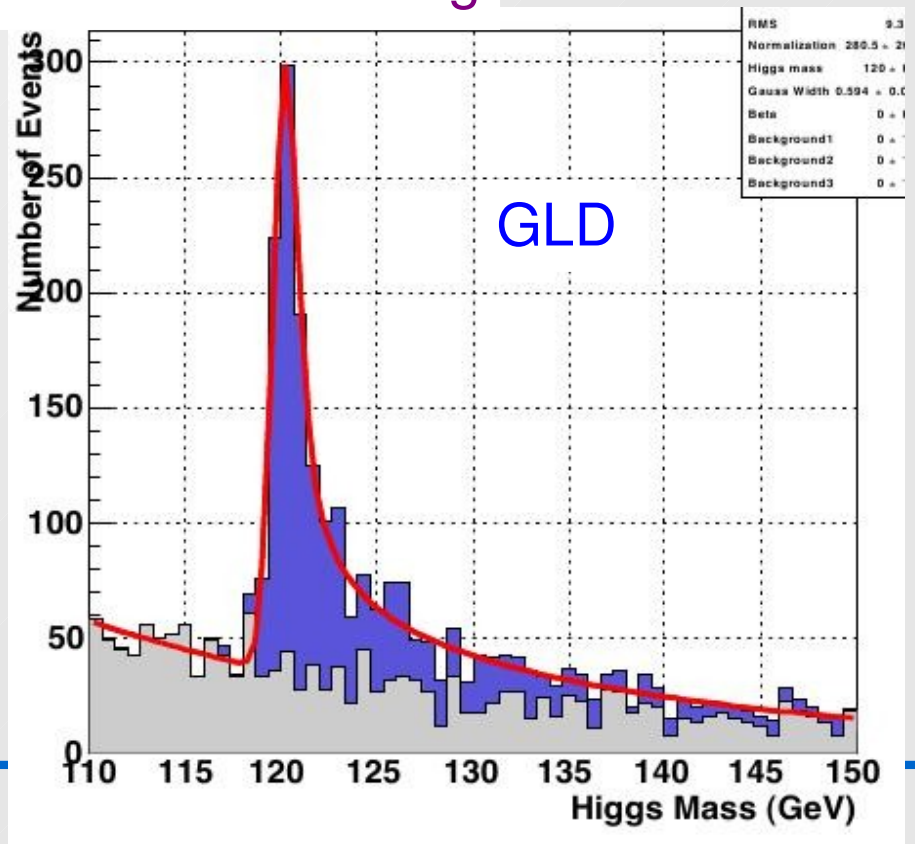
$$F(m) = N_H \int F_H(m,t) e^{\frac{-t^2}{2\sigma^2}} dt + F_Z(m)$$

$$F_H(m,t) = \left(\frac{m+t-M_h}{\sqrt{s}-M_h} \right)^{\beta}$$

$$\beta = \frac{2\alpha}{2\pi \log \sqrt{s}/m_e - 1}$$

Recoil mass distributions after the fitting





Estimation of measurement accuracy

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

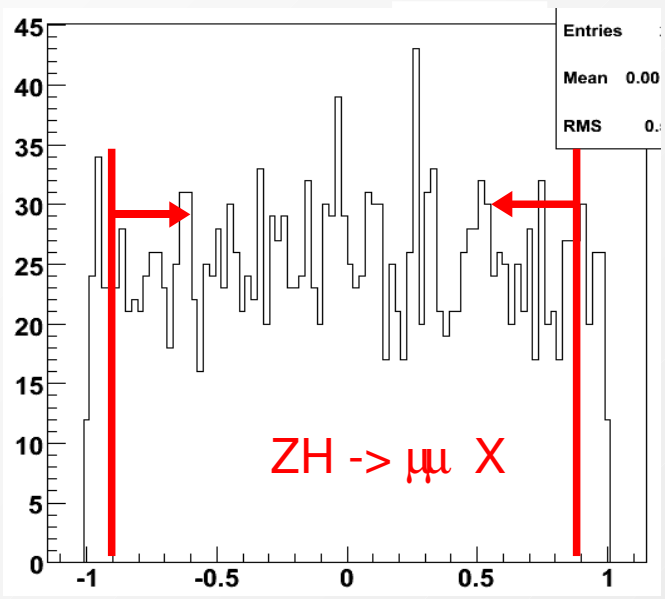
- **Measurement accuracy for $335fb^{-1}$**
  - ZH cross-section : 3.1% (for GLD')
    3.0% (for GLD)
  - Higgs mass : 40.8MeV (for GLD')
    37.9MeV (for GLD)

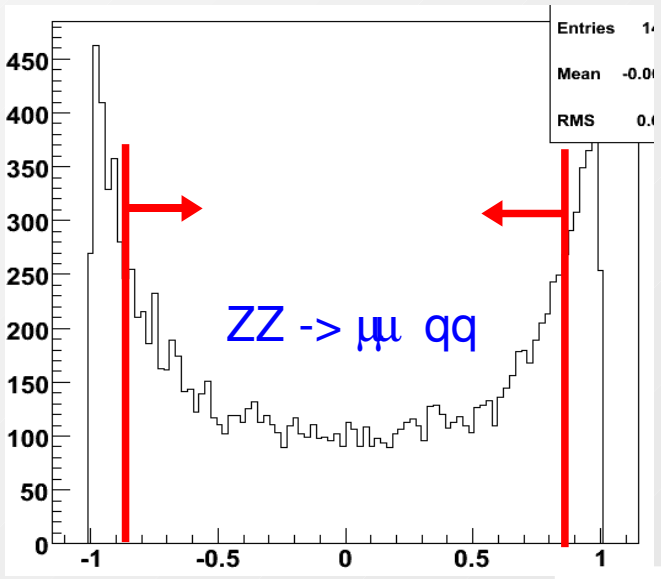
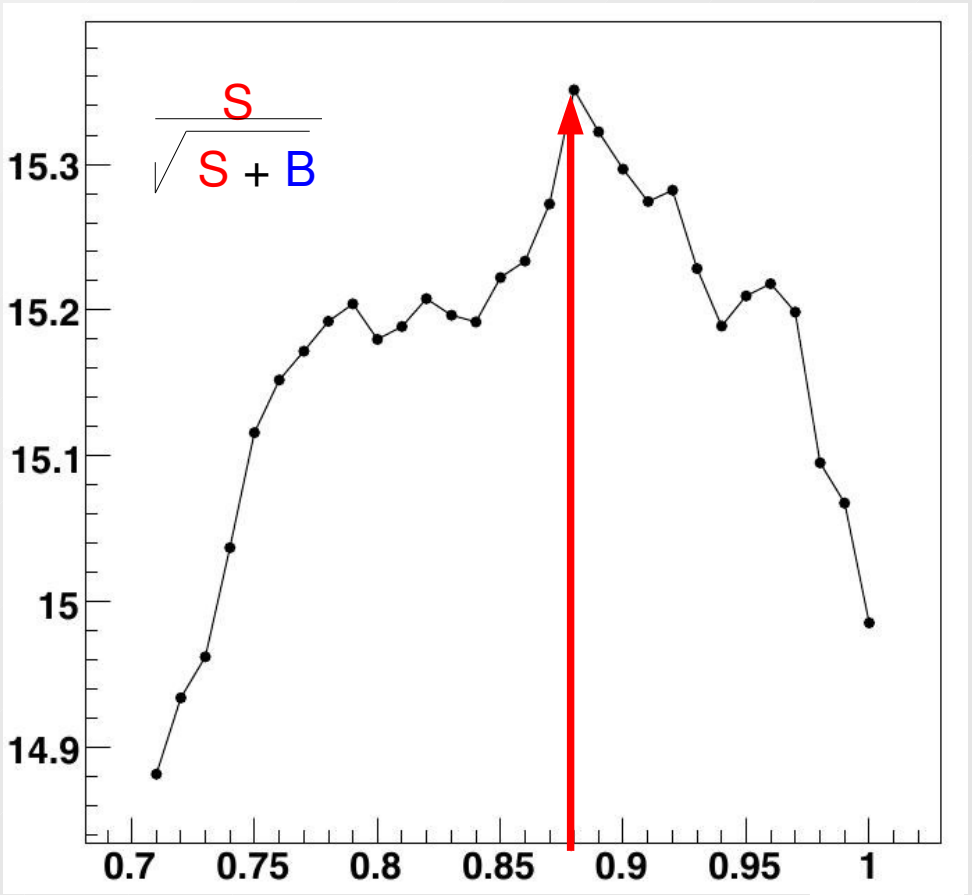
The resolution of Higgs mass deteriorates for GLD', because tracking accuracy of GLD' is worse than GLD.
To be checked!

Summary

- **Study of ZH recoil mass is ongoing for GLD' and GLD.**
- **The recoil mass distribution is reconstructed after the selection cuts.**
  - Mz, track angle, total energy and production angle
- **The measurement accuracy of ZH cross-section and Higgs mass is estimated for 335fb-1.**
  - Cross-section : 3.1%(GLD'), 3.0%(GLD)
  - Higgs mass : 40.8MeV(GLD'), 37.9%(GLD)
- **The reason of worse cross-section and Higgs mass resolution for GLD' should be checked.**

Decision of production angle cut





$\cos\theta_Z$