Analysis status of ZH recoil mass

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Introduction

- Goal :
  - Determination of precise Higgs mass and ZH cross-section.
- **Analysis of ZH recoil-mass is important for detector optimization.**
- Signal :
  - ee → ZH → ee/μ μ X (7.5fb)
    - Luminosity : 670 fb^{-1} (5k events)
- B.G.
  - ee → ZZ → ee/μ μ qq (79fb)
    - Luminosity : 252 fb^{-1} (20k events)
  - ee → WW → ee/μμ + 2neutrinos (182fb)
    - Luminosity : 264 fb^{-1} (48k events)

The number of events are scaled to 250 fb^{-1}.

Analysis outline

- Setup
  - Detector simulation : Jupiter
  - Reconstruction : Marlin (ilcsoft v01-04)
  - E_{CM} = 250GeV
  - Detector : gldapr08_14m, gldprim_v04, j4ldc_v04
    - J4ldc : like LDC (in Jupiter)

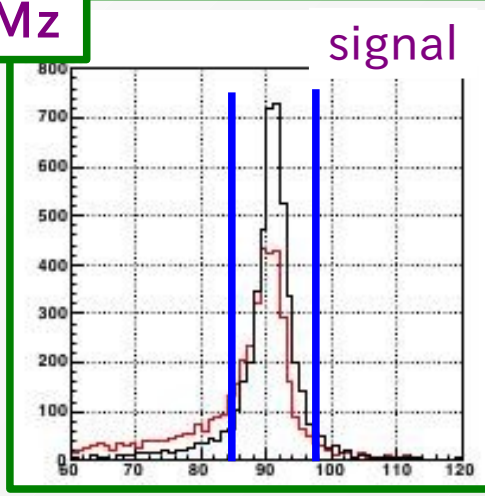
- Analysis outline

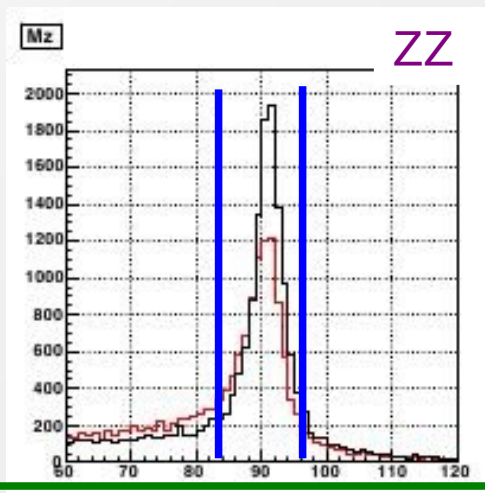
1. Selection of 2 lepton tracks from Z.
   - The tracks have the least χ^2 values for M_Z.
   - Two leptons have opposite charge each other.
2. Selection of well-reconstructed events.
3. Reconstruction of Higgs recoil mass.

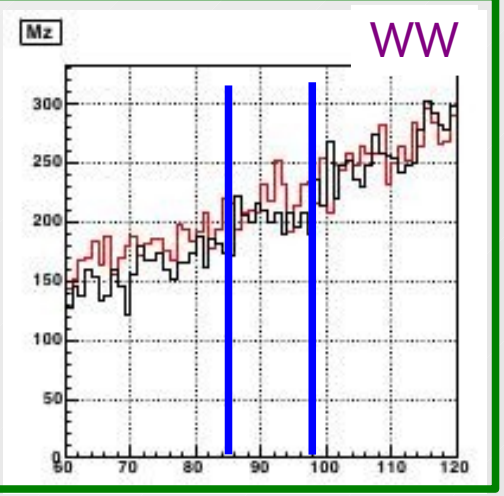
Cuts for selection

Electron channel
Muon channel

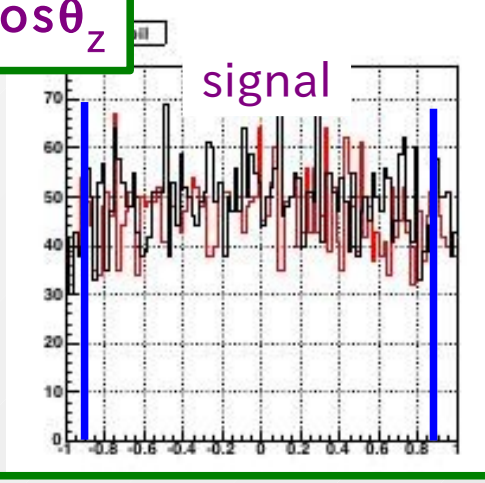
Mz

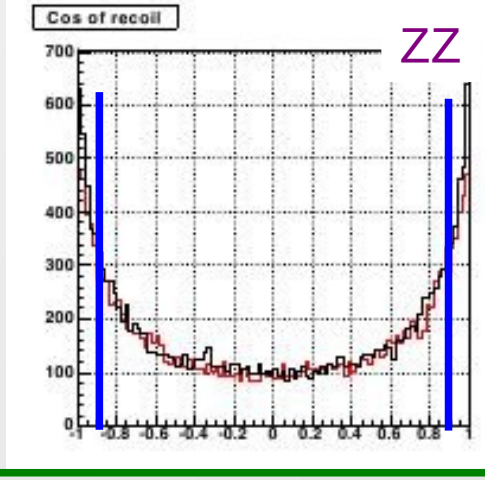


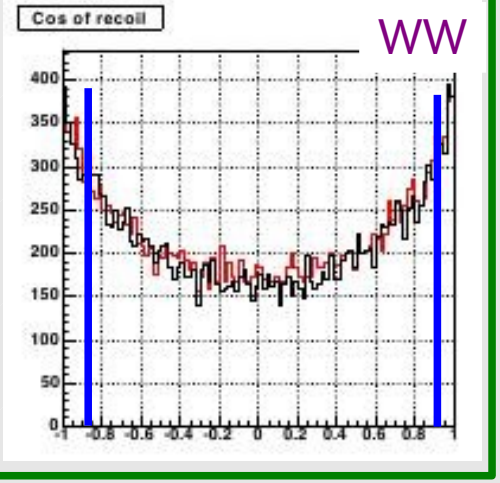




$\cos\theta_z$





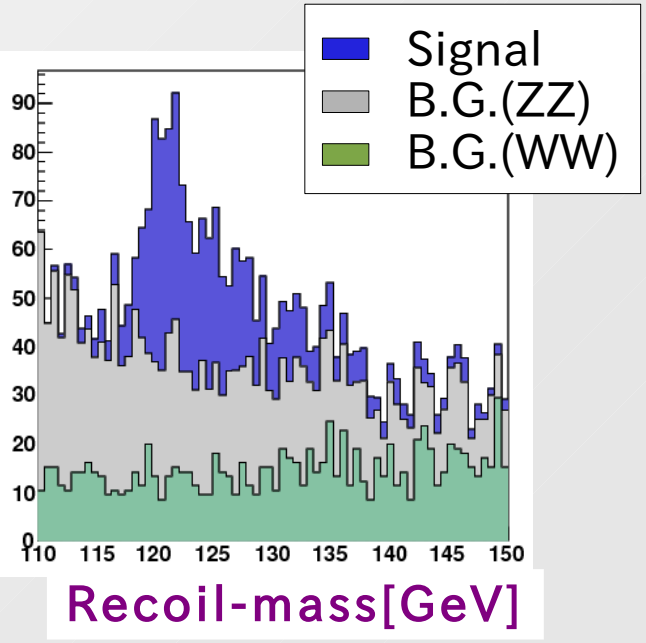


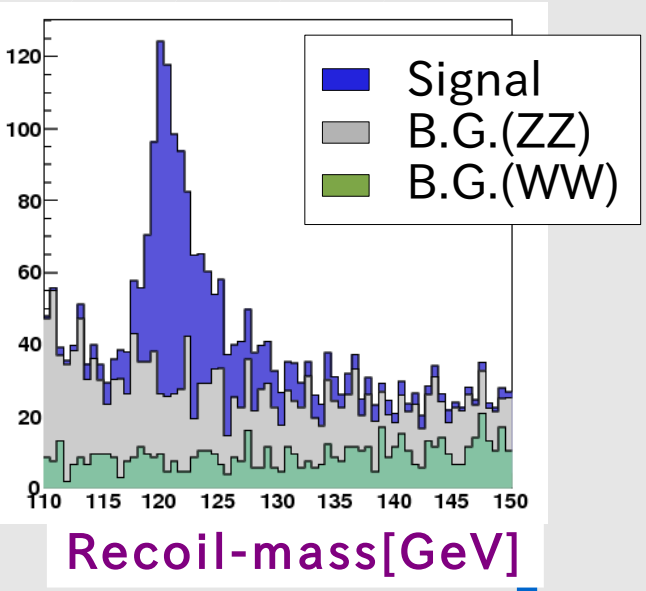
- Events with M_z of 85-97GeV and $|\cos\theta_z| < 0.9$ are selected.
- The angular cut is applied to two lepton tracks for selection of well reconstructed tracks.
  - $|\cos\theta_{lepton}| < 0.95$ (TPC coverage : 0.98)

Reduction rate (gldprim v04)

e channel	ZH	ZZ	WW
No cut	5000	20000	48000
2 tracks	4612(92.2%)	16855(84.3%)	22252(46.4%)
$85<M_Z<97$	2877(57.5%)	8376(41.9%)	2608(5.43%)
$\lvert\cos\theta_{lep}\rvert < 0.95$	2616(52.3%)	7612(38.1%)	2259(4.71%)
$\lvert\cos\theta_Z\rvert < 0.9$	2378(47.6%)	5959(29.8%)	1908(3.98%)

μ channel	ZH	ZZ	WW
No cut	5000	20000	48000
2 tracks	4932(98.6%)	18059(90.3%)	21563(44.9%)
$85<M_Z<97$	4017(80.3%)	11084(55.4%)	2437(5.08%)
$\lvert\cos\theta_{lep}\rvert < 0.95$	3598(72.0%)	9931(49.7%)	2067(4.31%)
$\lvert\cos\theta_Z\rvert < 0.9$	3301(66.0%)	7760(38.8%)	1783(3.71%)



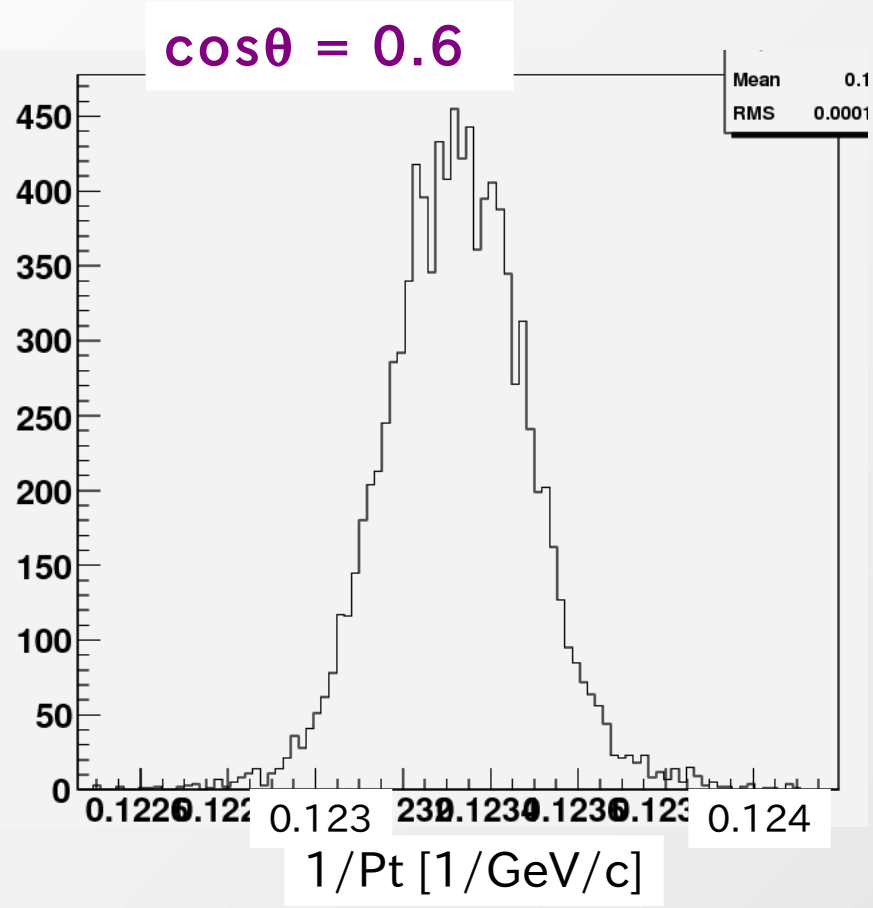


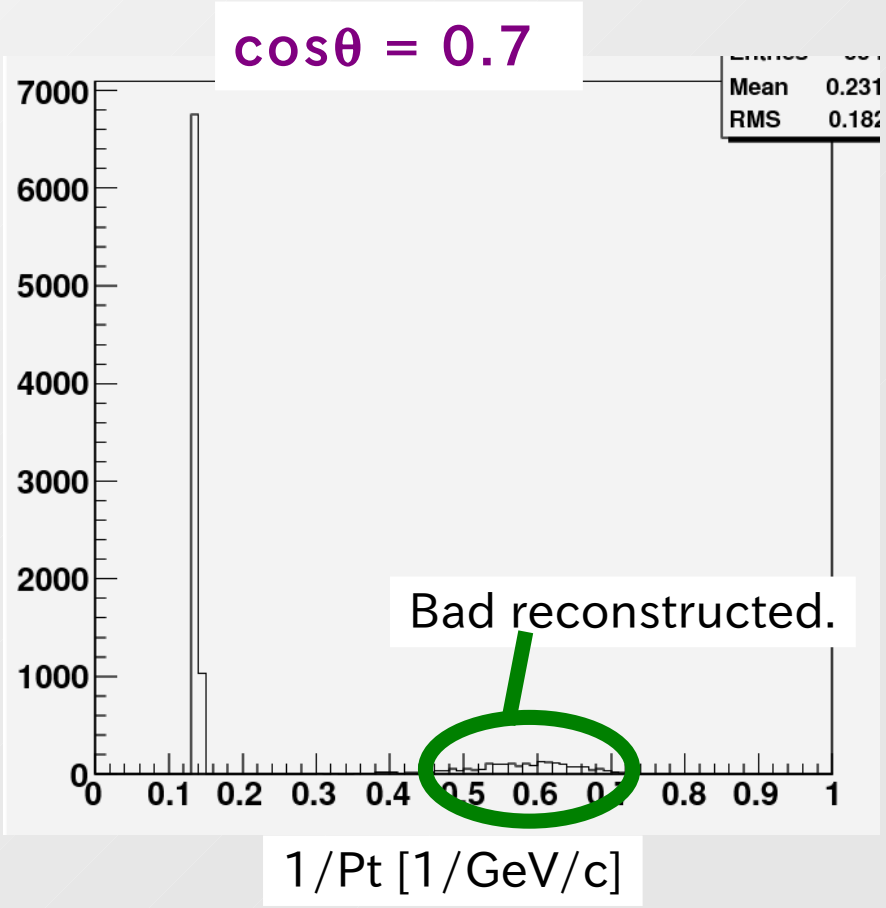
- M_Z and $\cos\theta_Z$ cuts reduce the backgrounds.
- Acceptance
  - e-channel : 47.6%(signal), 29.8%(ZZ), 3.98%(WW)
  - μ-channel : 66.0%(signal), 38.8%(ZZ), 3.71%(WW)

Muon channel

$(ee \rightarrow ZH \rightarrow \mu\mu X)$

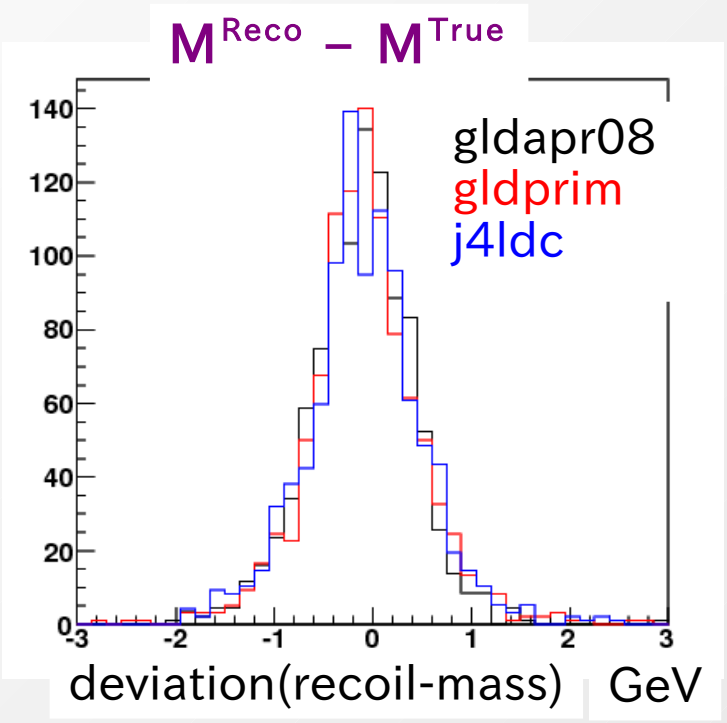
Momentum resolution (single muon)

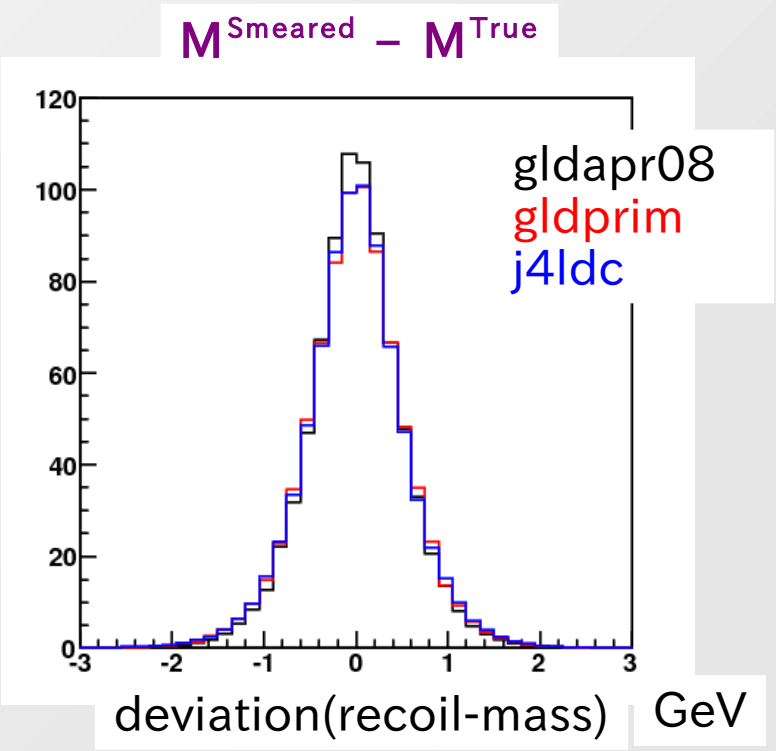




- The momentum resolution of single muon were checked.
- For cosθ = 0.7, some tracks were not reconstructed.
  - To be checked.
- Comparison between three geometries were done using |cosθ|<0.6 tracks.

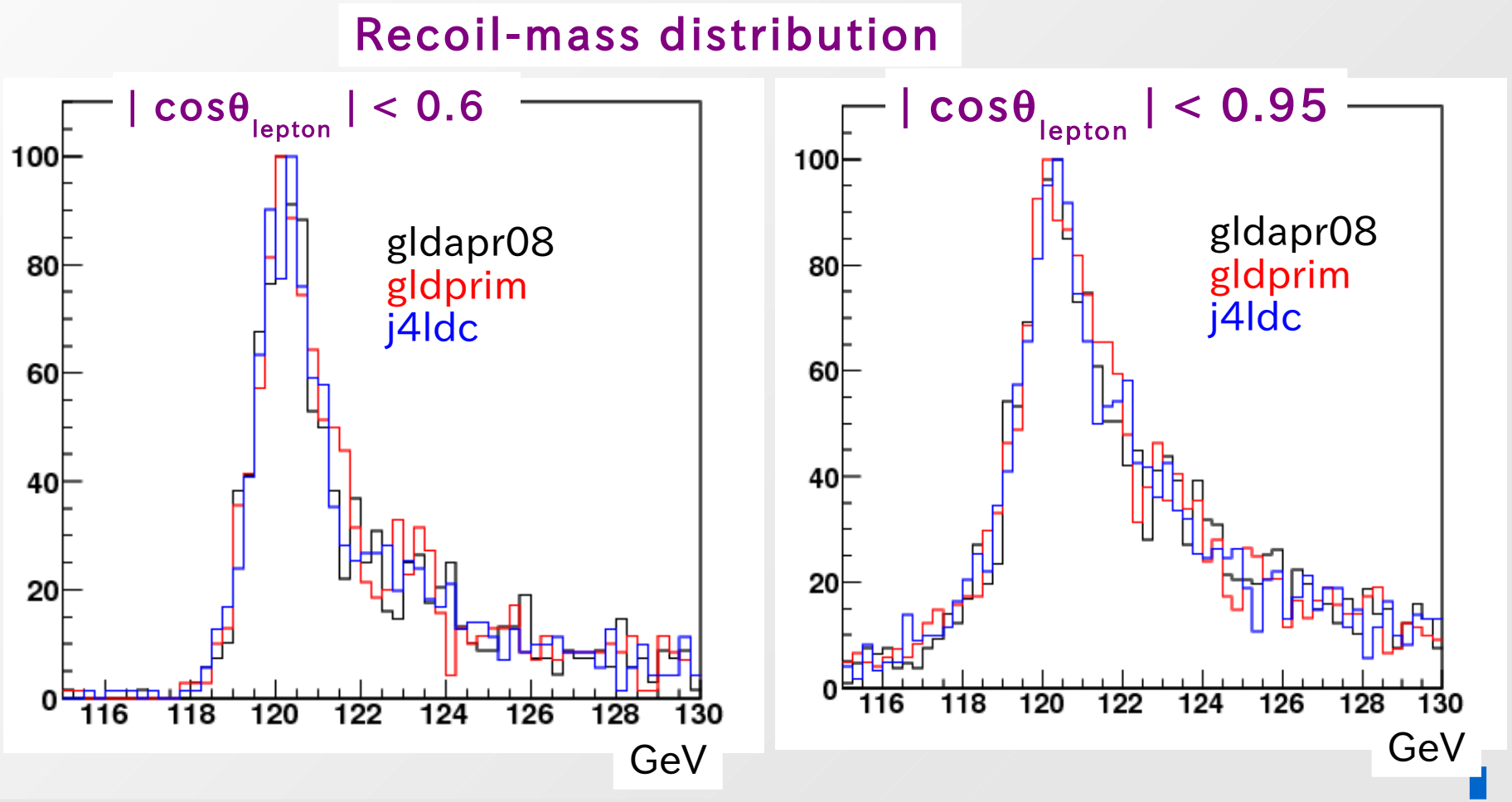
Deviation of recoil mass





- To compare detector performance, the value of
  "recoil mass $^{\text{reconstructed/smeared}}$ – recoil mass $^{\text{true}}$"
  were checked.
  - $M^{smeared}$: reconstructed recoil-mass using smeared μ tracks by momentum resolution.
  - There is no difference between three detectors.
- $M^{smeared} - M^{True}$ is the same as $M^{Reco} - M^{True}$.
- **The resolution of recoil mass is determined by the tracker performance.**

Recoil-mass distribution



- The recoil-mass distribution seems to be same between three geometries.
- Although the measurement accuracy of Higgs mass and ZH cross-section have to be estimated by fitting, the fitting has not be done yet.

Electron channel

$(ee \rightarrow ZH \rightarrow ee\,X)$

Hengne's fitting function

Hengne@LAL (11th Sep.)

New Formula Invited:

Move the linking point to the right side of Higgs Peak.

Pure Gaussian

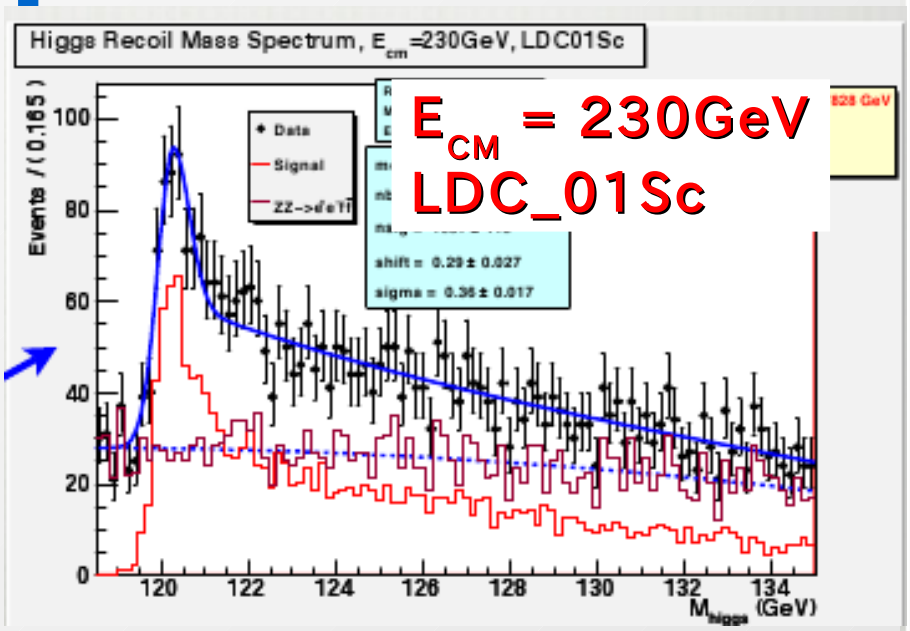
$$f(x) = N \begin{cases} e^{-\frac{(x-x_0)^2}{2\sigma^2}} & : \quad \frac{x-x_0}{\sigma} \leq k \\ \beta e^{-\frac{(x-x_0)^2}{2\sigma^2}} + (1-\beta) e^{-(x-x_0)\frac{k}{\sigma}} e^{\frac{k^2}{2}} & : \quad \frac{x-x_0}{\sigma} > k \end{cases}$$

Gaussian fraction

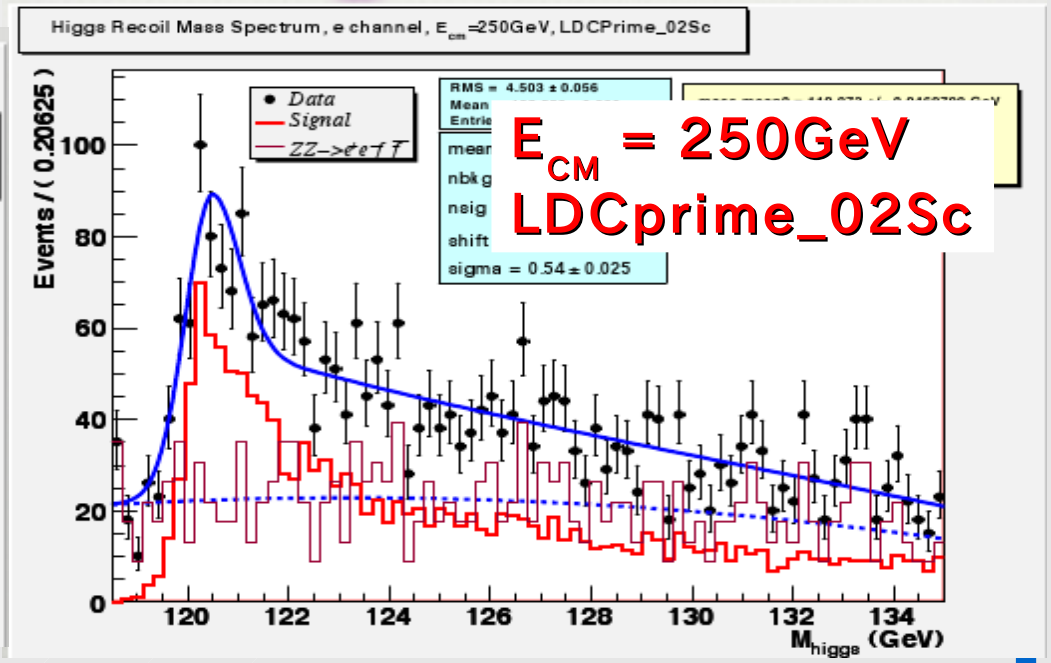
Gaussian Part

Modified exponential

a factor for continuity



E_{CM} = 230GeV
LDC_01Sc

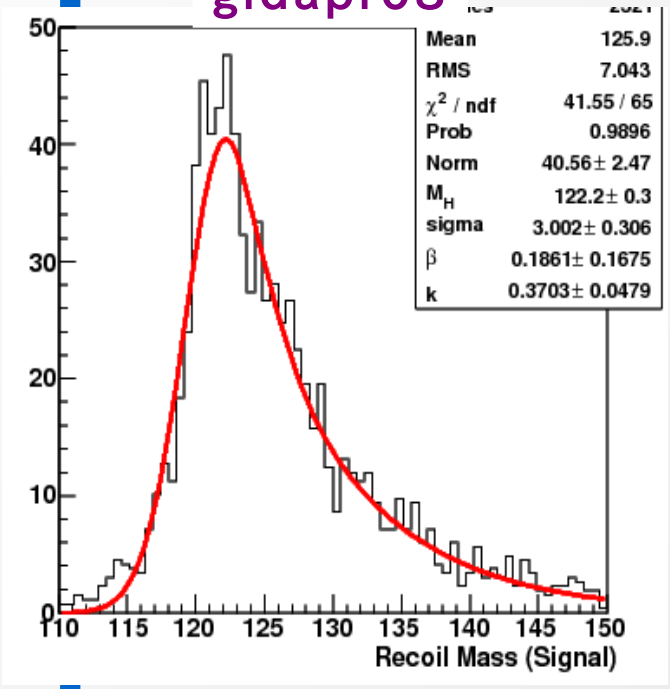


E_{CM} = 250GeV
LDCprime_02Sc

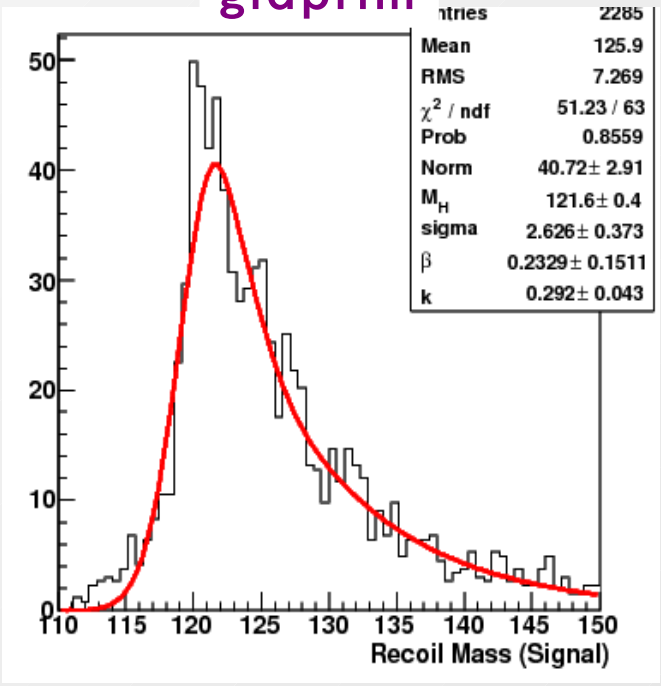
Fit with this function was tried for my analysis.

Fit with Hengne's function

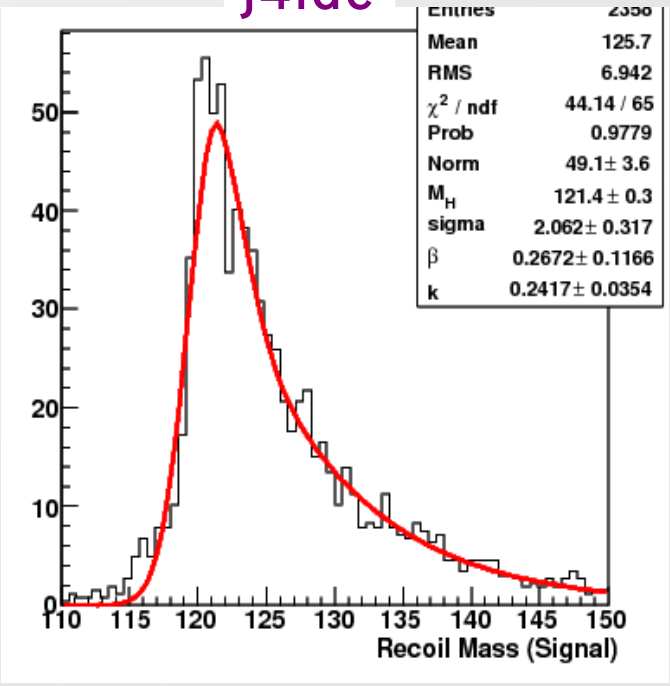
gldapr08



gldprim



j4ldc



- Fitting with Hengne's function was tried.
  - Only (electron channel) signal.
- Fitting seems to be bad at the peak.
  - More studies are needed.

Summary

- The analysis of ZH recoil mass is important for detector optimization (E_{CM} = 250GeV).

μ-channel

- The deviation of recoil-mass and recoil-mass distribution are comparable between three geometries.
- (For ZH recoil mass analysis)
  to optimize the detector parameter, the tracker performance is important.
- ΔM_H and $\Delta\sigma(ZH)$ have to be estimated by fitting (next step).

e-channel

- Fit using Hengne's function was tried
  - It seems to be bad.
  - It have to be improved (next step).

Backup slides

Detector parameters

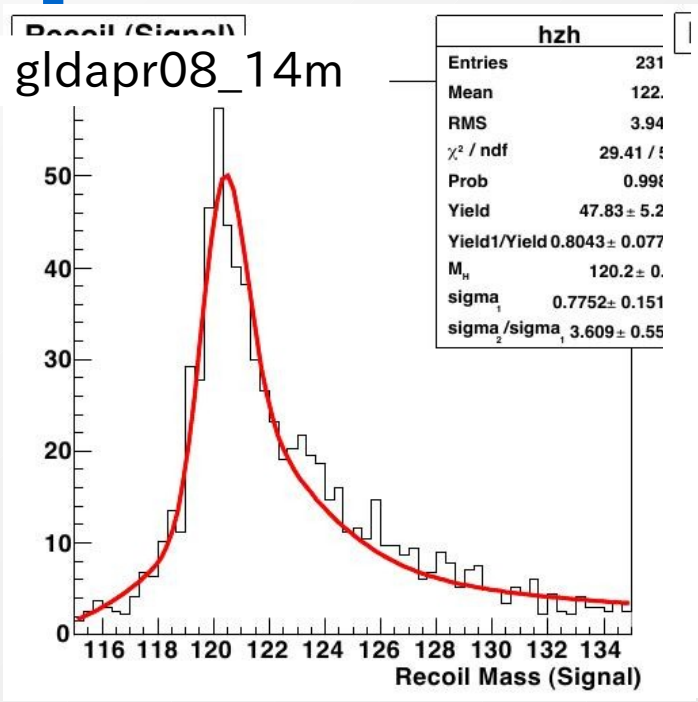
		gldapr08_14m	gldprim_v04	j4ldc_v04
beam pipe	radius	15	14	13
VTX	radius 1st layer	17.5	16	15
	radius 2nd layer	19.5	18	17
	radius 3rd layer	38	37	36.5
	radius 4th layer	40	39	38.5
	radius 5th layer	58	58	58
	radius 6th layer	60	60	60
TPC	drift length	2500	2250	2060
	rMin	437.15	435	340
	rMax	1971.6	1740	1520
SOL	B-field	3	3.5	4
Ecal barrel	rMin	2100	1850	1600
	rMax	2700	2350	2100
Ecal endcap	rMin	400	400	300
	rMax	3494	3114	2760
	zMin	2800	2450	2200
Hcal barrel	rMin	2998	2648	2398
	zMax	2700	2350	2100
Hcal endcap	rMin	400	400	300
	rMax	3494	3114	2760
	zMin	2998	2648	2398

Fitting status (muon channel, signal)

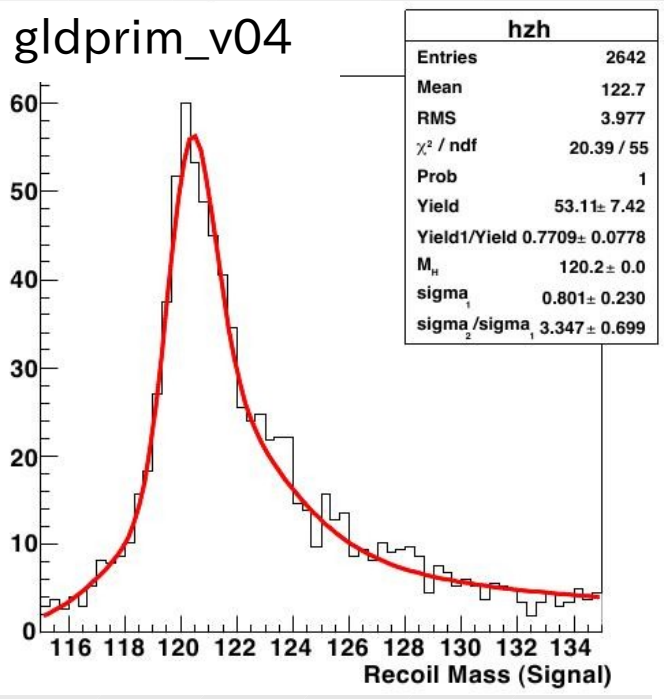
$$F_H(m) = \left(\frac{m - M_H}{\sqrt{s} - M_H} \right)^{\beta - 1} \quad + \quad \text{Double gaussian}$$

(convolution)

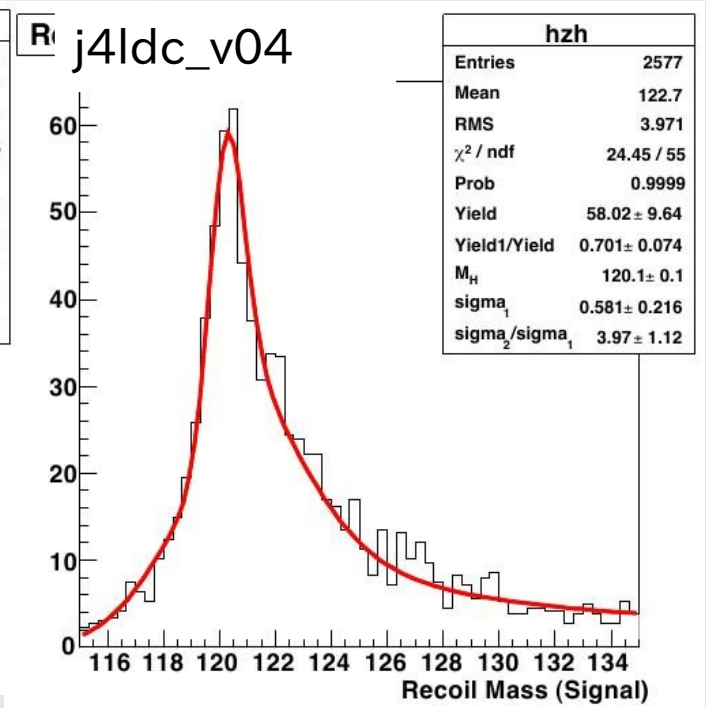
gldapr08_14m



gldprim_v04



j4ldc_v04



The shape of fitted function seems to be different.