Search for Higgs portal Dark matter

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11/30

Upper limits

- **I included the following background and estimated an upper limit of signal cross section when the signal cross section is 0 [fb] .**
  - **i. ZH → Z(ZZ*) → qq(4ν)**
  - **ii. ZH → Z(ZZ*) → νν(qqνν)**
  - **iii. ZH → Z(ZZ*) → νν(ννqq)** ***higgs mass = 125GeV**

- **These figure are distribution for recoil mass after isolated lepton cut, forward electron veto and zmass cut.**

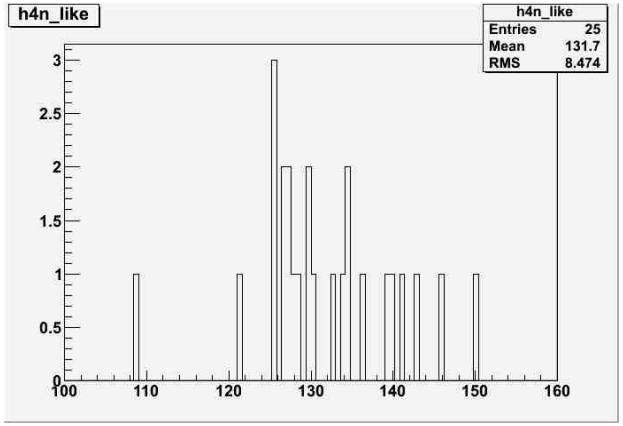

Fig1 . **ZH → Z(ZZ*) → qq(4ν)**

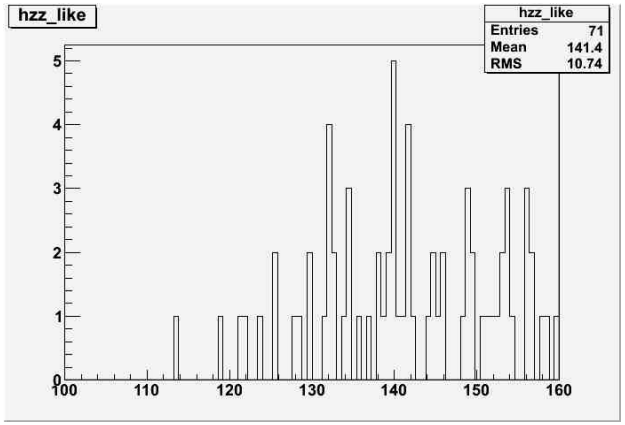

Fig2 . **ZH → Z(ZZ*) → νν(qqνν)**

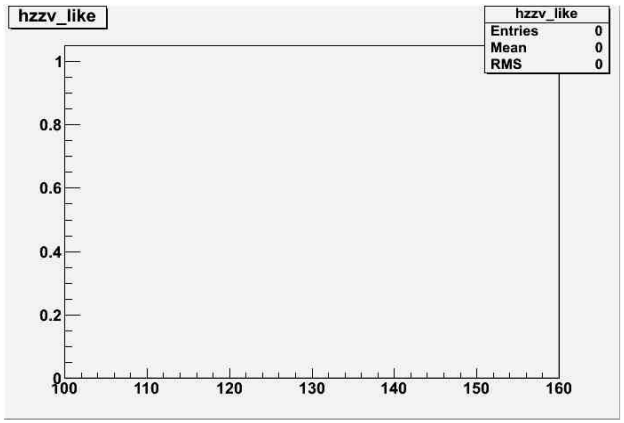

Fig3 . **ZH → Z(ZZ*) → νν(ννqq)**

Result

- I estimated upper limits when signal cross section is 0[fb]
- Optimization of the likelihood t ratio to minimize the upper limit.

→Best likelihood ratio cut is 0.4.

- I estimated the upper limit of Branting ratio H → DM,DM

$$BR(H \to DM, DM) = \frac{\sigma_{DD}^{C.L.95\%}}{\sigma(e^+e^- \to ZH)} \cong 0.3\%$$

Table 1.Previous result (BG: ZZ,ννZ,WW,eνW,eeZ)

likelihood ratio	N_{sig}(C.L 95%)	efficiency	upper limit
0	435	0.48345	0.900
0.1	415	0.4834	0.859
0.2	395	0.47976	0.823
0.3	395	0.46211	0.855
0.4	335	0.41466	0.808
0.5	285	0.32702	0.872
0.6	155	0.16984	0.913

Table 2.New result(BG: ZZ,ννZ,WW,eνW,eeZ, **ZH → Z(ZZ*) → qq(4ν), ZH → Z(ZZ*) → νν(qqνν), . ZH → Z(ZZ*) → νν(ννqq)**)

likelihood ratio	N_{sig}(C.L 95%)	efficiency	upper limit
0	435	0.48345	0.900
0.1	425	0.4834	0.879
0.2	415	0.47978	0.865
0.3	405	0.46211	0.876
0.4	355	0.41465	0.856
0.5	285	0.32704	0.871
0.6	155	0.16981	0.913

Summary and Plan

■Summary

- I estimated an upper limits when signal cross section is 0[fb].
- Optimization of the likelihood ratio cut to minimize the upper limit. →Best likelihood ratio cut is 0.4.
- I estimated $BR(H \to DM,DM)_{\text{upper limit}}$.

$$\longrightarrow \quad BR(H \to DM, DM) = \frac{\sigma_{DD}^{C.L.95\%}}{\sigma(e^+e^- \to ZH)} \cong 0.3\%$$

■Plan

I will change the DM mass and estimate an upper limit.

Signal and Background

■Signal event

e^+e^- → ZH → qq DM DM .

→2 Jets and 2 missing particles

Recoil mass against Z boson reconstructed from di-jet should be Higgs mass.

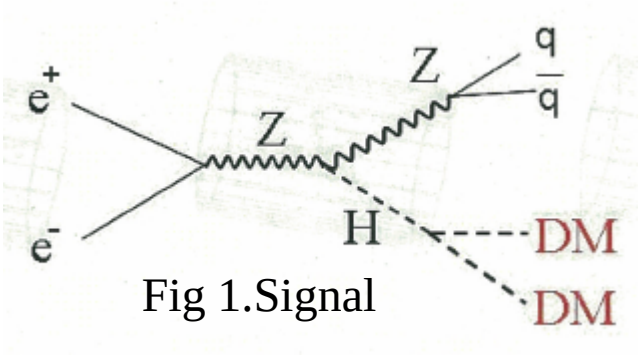

Fig 1.Signal

■background events

ZZ

ννZ → ννqq

WW

eνW→eνqq

eeZ →eeqq

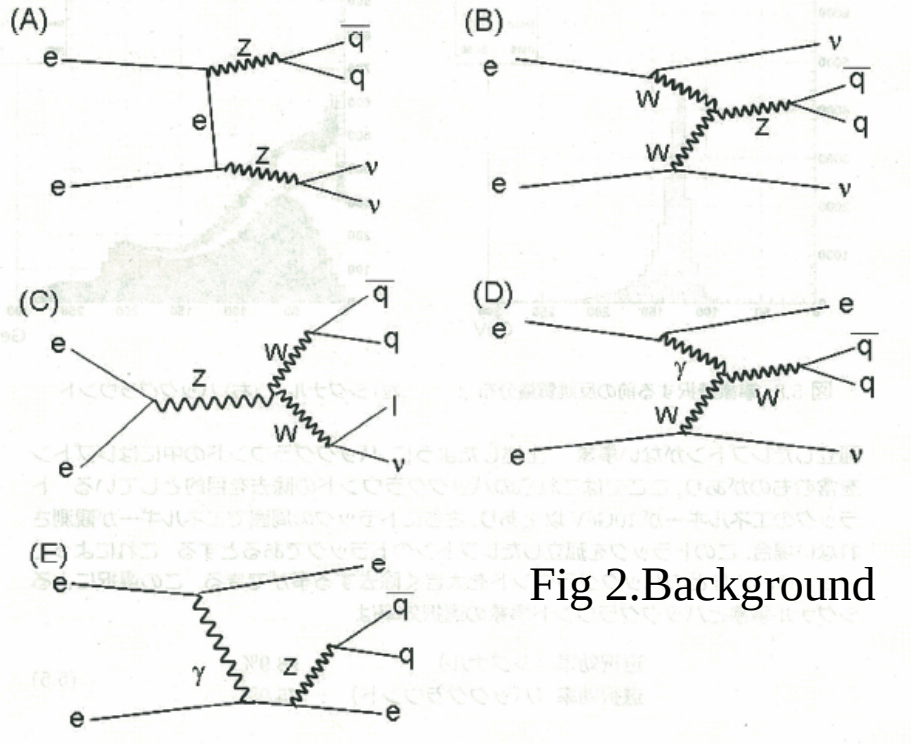

Fig 2.Background

Analysis

■ Machin Parameters

*Ecm=250GeV

DM is produced in the ee→ZH, Z→qq, H→DD process

*luminosity : 1[ab^{-1}]

*electron polarization :0.8

*positron polarization :-0.3

■ Model Parameters

*Spin of DM : 1/2

*DM mass : 50GeV

*Cf : 6.86

*Λ : 1000

■ Event Generation

* Background events of luminosity 1 [ab^{-1}] are generated .

* signal cross section is assumed 15fb.

(We will use the cross section calculated by thoerists)

Table 1. Cross section of background

Event Selection	eeZ	eνW	ννZ	WW	ZZ
Cross Section [fb]	3992	684	5	2783	982

Upper limits

- **I included the H → ZZ* → 4ν background and estimated an upper limit of signal cross section when the signal cross section is 0 [fb] .**

1.Generating the background distributions for recoil mass by ToyMC.

→ Difinition of ToyMC : $\mathbf{X_{h\to 4\nu} \times P_{sig} + X_{bg} \times P_{bg}}$ **: (1)**

($X_{h\to 4\nu}$: number of h→4ν back ground events X_{bg} : number of background events ,

P_{bg} : pdf for background recoil mass , P_{sig} : pdf for signla recoil mass)

2.Fitting the toymc distribution by fit function, and getting parameter N_{sig} of fit function.

→ Difinition of fit function : $\mathbf{P = N_{sig} \times P_{sig} + N_{bg} \times P_{bg}}$ **: (2)**

(N_{sig} : number of signal events , $N_{h\to 4\nu}$: number of h→4ν background events , N_{bg} :number of background events)

3. When 1000 experiments is performed , I can get a distribution of parameter N_{sig}(Fig 1).

4. When confidence lever is 95 % , I can get an upper limit of N_{sig} or upper limit of signal cross section .

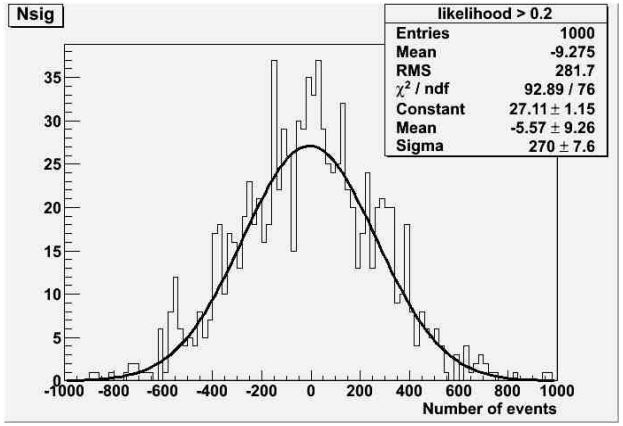

Fig1 . Distribution of parameter N_{sig}

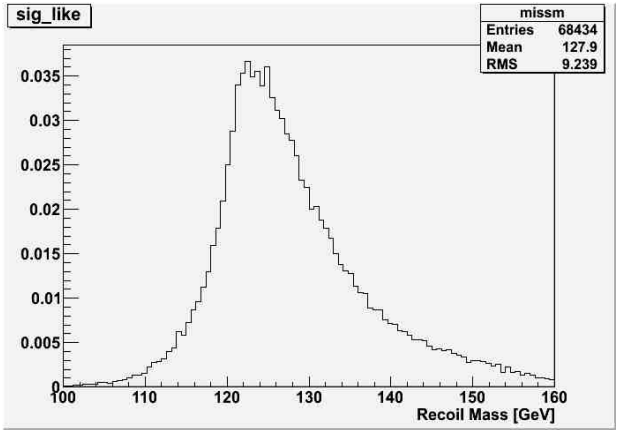

Fig2 . Pdf of signal for recoil mass

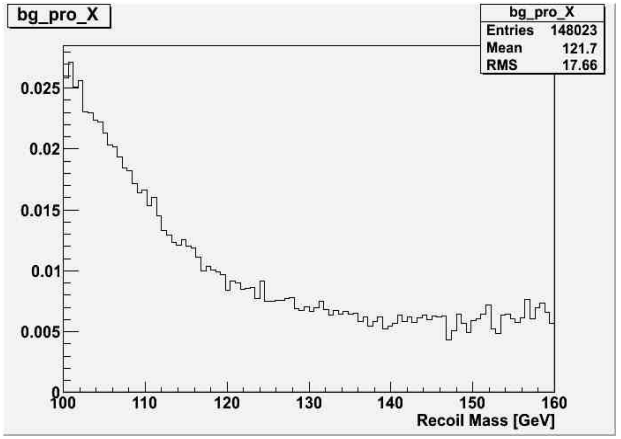

Fig3 . Pdf of background for recoil mass

Cross Section

- **I estimated the cross section of e+ e- to Z*H to qq 4ν background.**

  → The cross section is 0.13 [fb]

- **I generated 130 background events because luminosity is $1ab^{-1}$.**

- **$\sigma = \sigma(e^+ + e^- \rightarrow Z^* \rightarrow ZH) \times BR(H \rightarrow Z^*Z) \times BR(Z \rightarrow qq) \times BR(Z^* \rightarrow \nu\nu) \times BR(Z \rightarrow \nu\nu)$**

  = 0.13[fb]

- $\sigma(e^+ + e^- \rightarrow Z \rightarrow ZH) = 234.739 \pm 0.254$fb]
- BR(H→ZZ) = 0.02
- BR(Z→νν) = 0.2
- cross section = 0.19[fb]
- BR(Z→qq) = 69.91%