

Dark matter search in higgs portal scenario

'10 10/15

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status

- Check the cross-section limit with following setup.

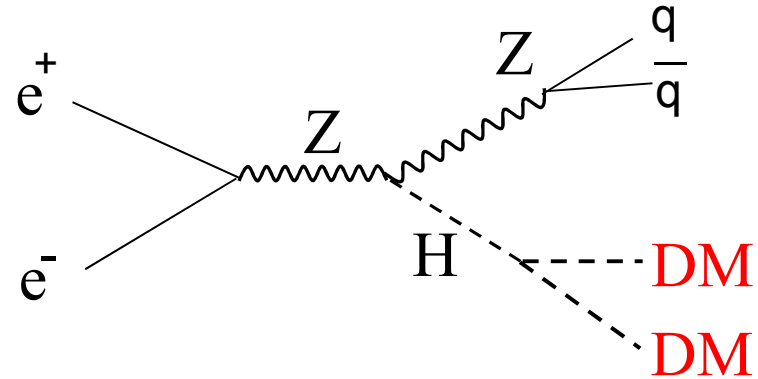
Setup

- Checked dark-matter mass : 61~ 100 GeV
- Background
 - ZZ, WW, Zvv, eeZ, evW
- Luminosity : 2 ab⁻¹
- Ecm : 300 GeV
- Beam polarization : electron +0.8, positron -0.3

Event under consideration

<signal (scalar)>

- $ee \rightarrow ZH^* \rightarrow qqDMDM$



<background>

- $ee \rightarrow WW : 2386 \text{fb}$ • $ee \rightarrow ZZ : 830 \text{fb}$ • $ee \rightarrow \nu\nu Z : 10.08 \text{fb}$
 – $WW \rightarrow qqln$ – $ZZ \rightarrow qqnn$
- $ee \rightarrow eeZ : 4803 \text{fb}$ • $ee \rightarrow e\nu W : 1088 \text{fb}$

analysis procedure

- Reconstruction of all events as 2 jets
- Event selection
 - Z-mass cut , Z-angular cut, Z-energy cut
- likelihood analysis
 - Parameter : Z-angular , Z-mass , Z-momentum

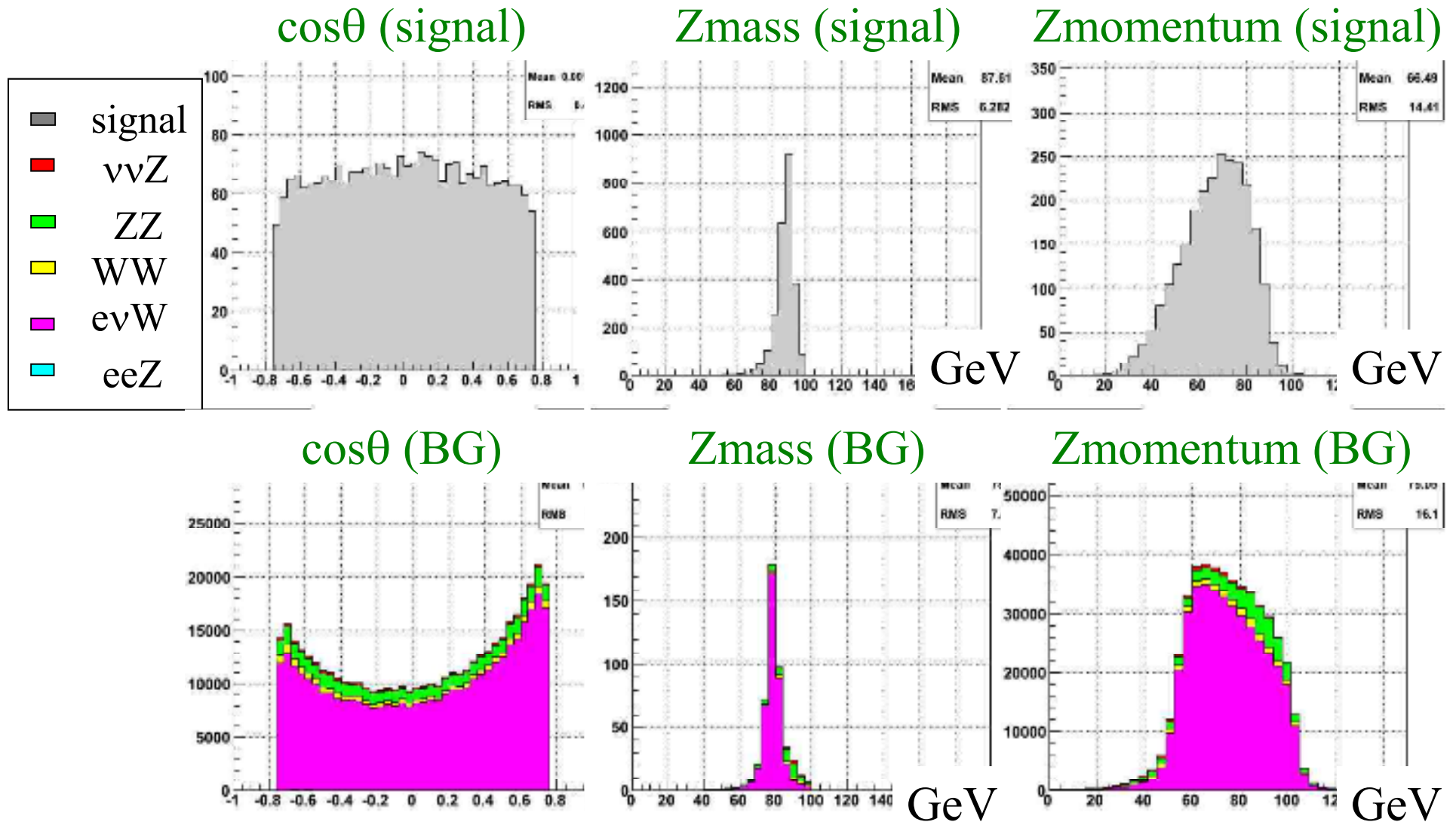
Analysis at 70GeV dark-matter

In this meeting, only the 70 GeV version is shown

- Put the signal cross-section 3fb at first.
- First, signal event was selected by cut base analysis.
 - Z mass cut : $Z_{\text{mass}} < 100 \text{ GeV}$
 - Z angular cut : $|\cos\theta| < 0.75$
 - Z energy cut : $95 < Z_{\text{energy}} < 130 \text{ GeV}$
- Next, likelihood analysis was performed.

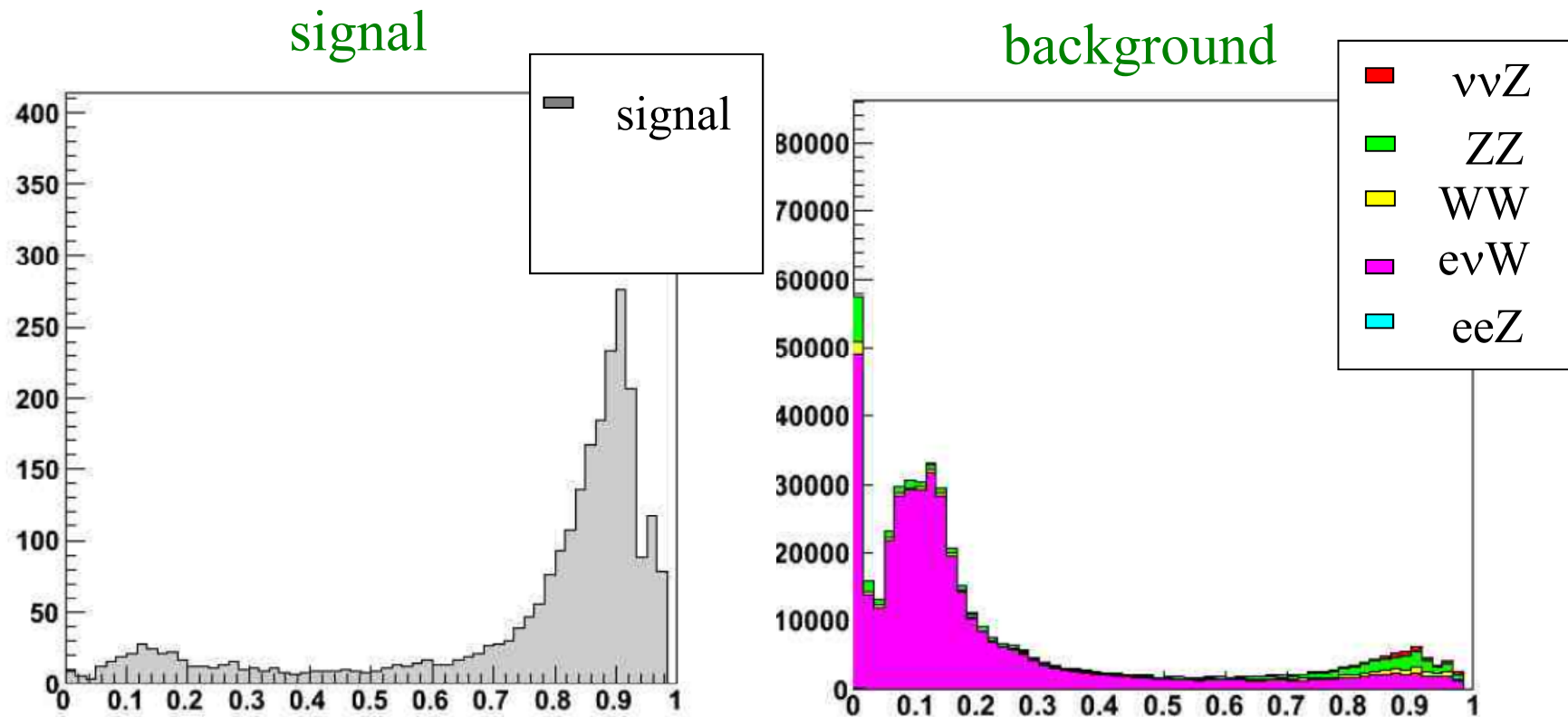
Likelihood parameters

The parameters of likelihood was checked



Likelihood analysis

The distribution of Likelihood function was checked



Signal and BG are separated

Reduction table

| | Non cut | zmass | Cos θ | Zenergy | Likelihood |
|--------|---------|---------|--------------|---------|------------|
| Signal | 3943 | 3853 | 3215 | 2594 | 1983 |
| vvZ | 20175 | 12946 | 8608 | 5327 | 3894 |
| ZZ | 1661878 | 406512 | 250877 | 55074 | 24418 |
| WW | 4773700 | 174097 | 68073 | 16135 | 6753 |
| evW | 2177000 | 1187710 | 724636 | 3205653 | 20431 |
| eeZ | 9607180 | 4132100 | 131474 | 576 | 168 |


Significance is 8.2 (signal cross-section = 3 fb)



3σ cross-section limit was calculated : 1.08 fb

Summary table

| | Fermion | | Scalar | | Vector | |
|------|--------------|---------------------|--------------|---------------------|--------------|---------------------|
| Mass | significance | Cross-section limit | significance | Cross-section limit | Significance | Cross-section limit |
| 61 | 7.3 | 1.216 | 7.9 | 1.12 | 7.4 | 1.204 |
| 70 | 8.2 | 1.08 | 8.5 | 1.044 | 7.9 | 1.128 |
| 80 | 9.2 | 0.964 | 9.1 | 0.968 | 8.9 | 0.996 |
| 90 | 11.2 | 0.776 | 11.2 | 0.784 | 11.0 | 0.796 |
| 100 | 9.7 | 0.892 | 13.9 | 0.612 | 13.4 | 0.636 |

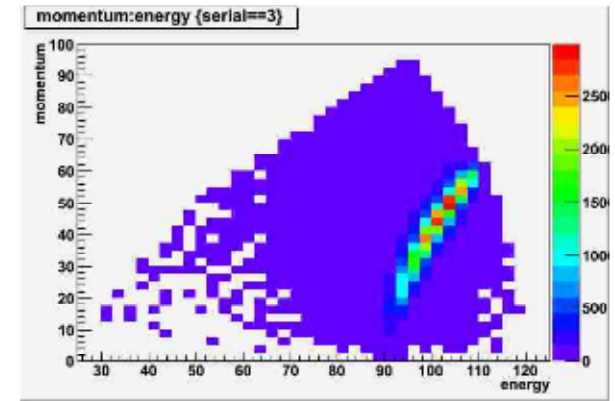
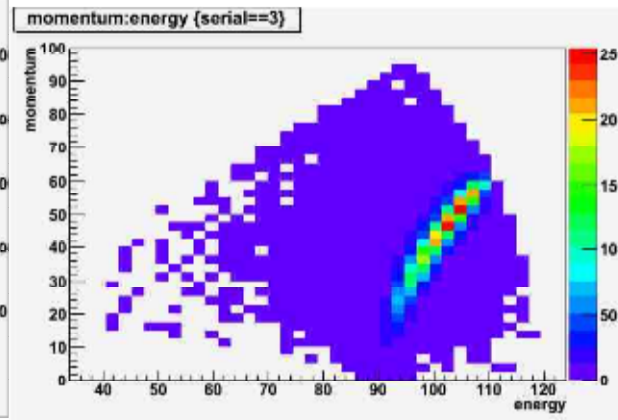
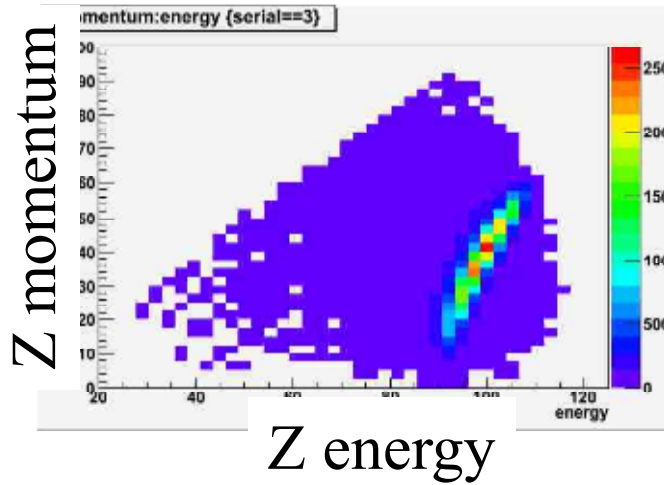
too small 

Mass : 90GeV

fermion

scalar

vector

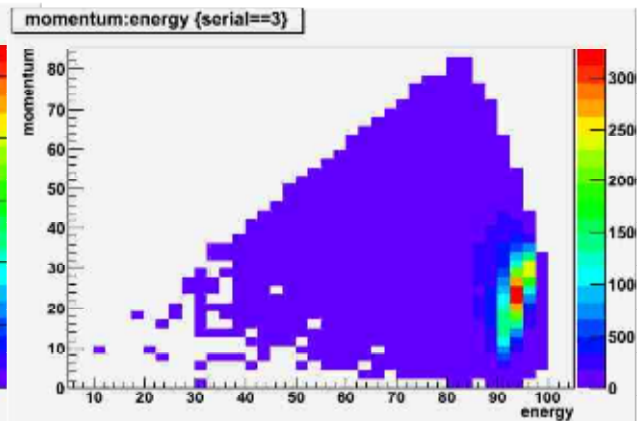
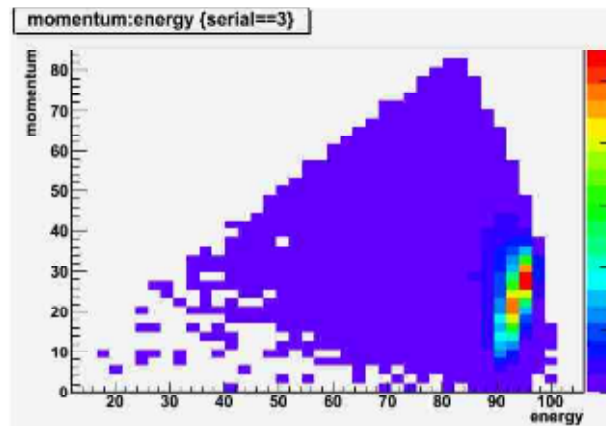
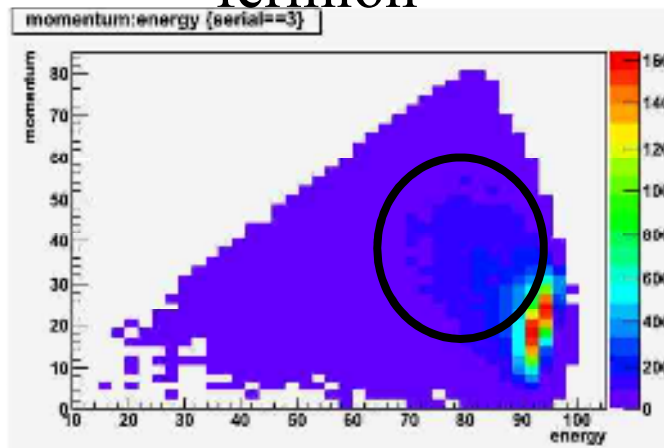


Mass : 100GeV

fermion

scalar

vector



Summary & plan

Summary

- The fermion dark-matter (**only** 100GeV mass) had the strange distribution at Z_{energy} vs Z_{momentum} 2D hist.

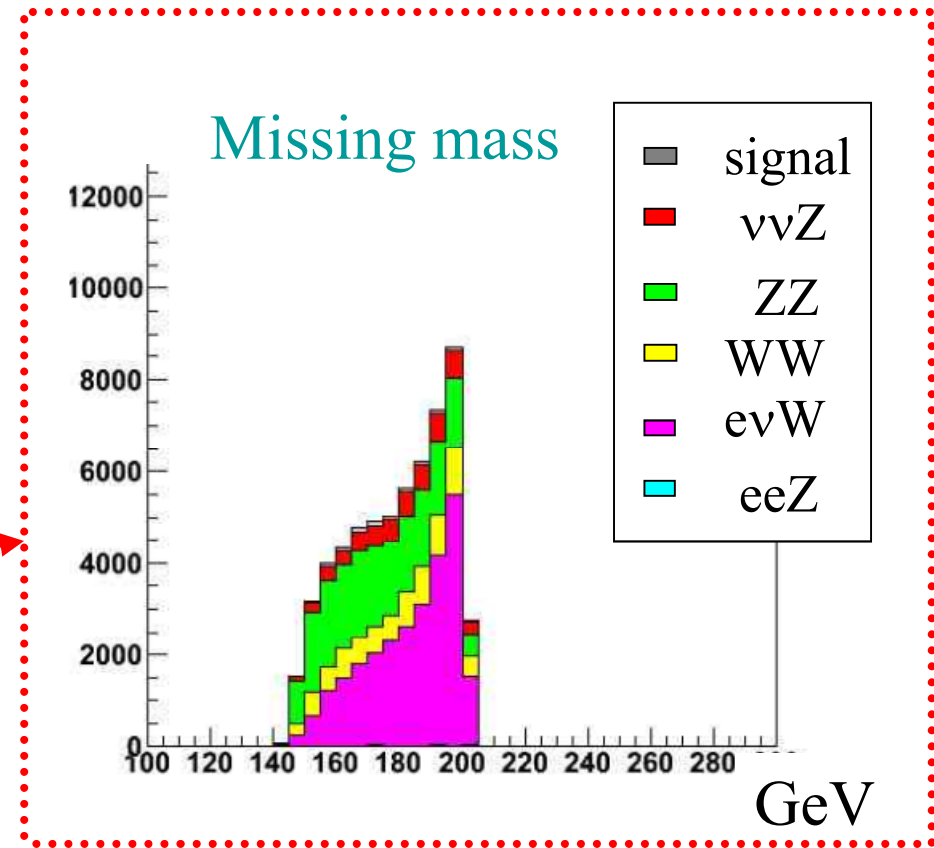
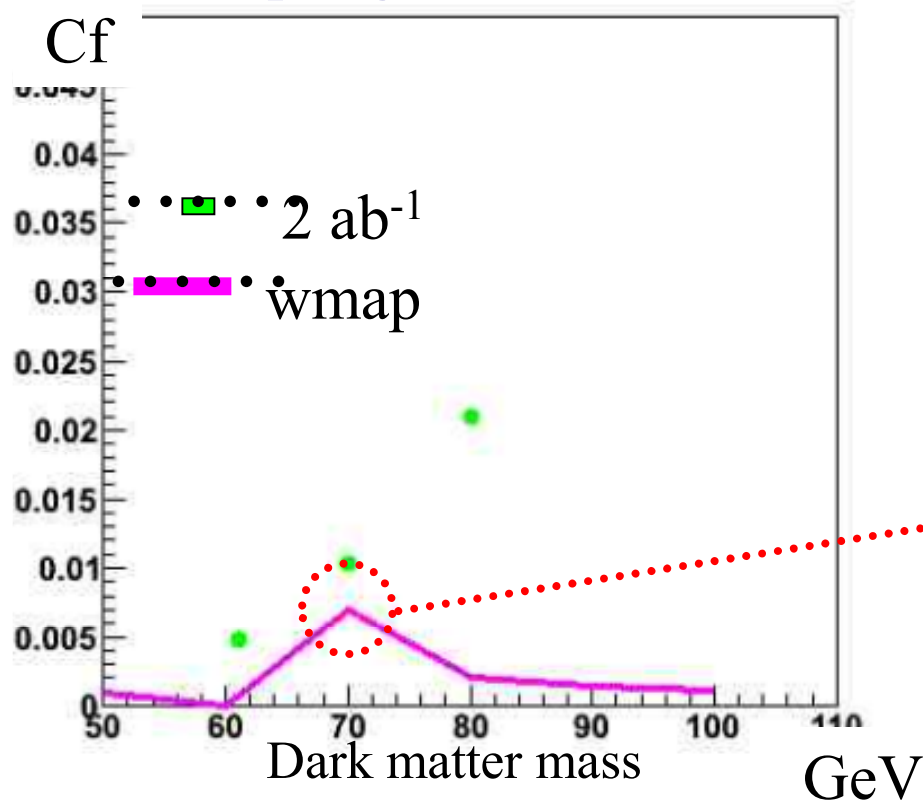
Plan

- Next setup the dark-matter mass **under** 60GeV and check the ILC sensitivity of higgs-dark matter coupling.
 - But, if dark matter mass is set **under** 60GeV, the cross-section become **wrong** value. So the current generator code can not calculate it in this case.

ILC sensitivity : Fermion

The cross-section (3σ) limit was checked by changing Dmass
And coupling constant is calculated from it.

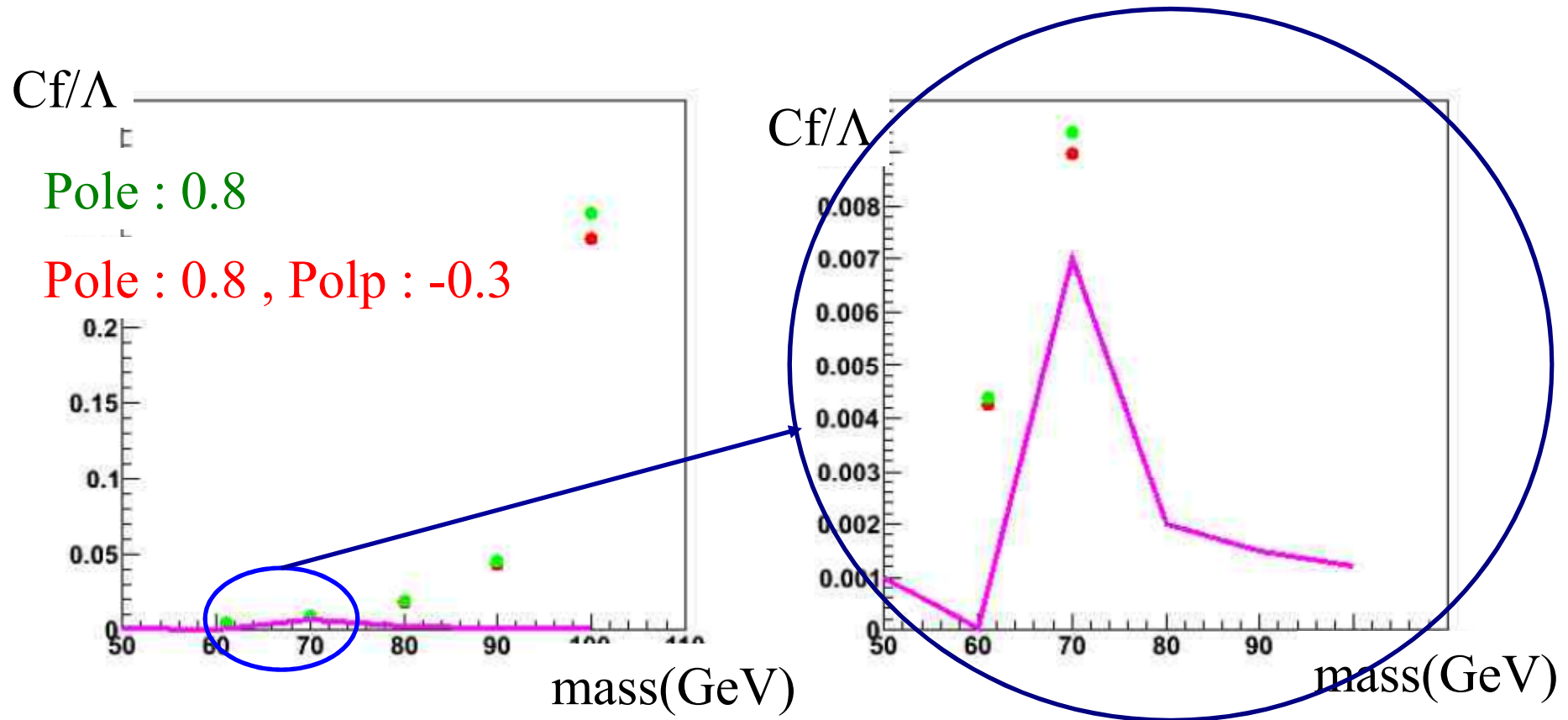
coupling constant limit



ILC sensitivity do not reach the wmap line

Coupling constant limit

The sensitive limit of higgs-fermion dark matter coupling constant

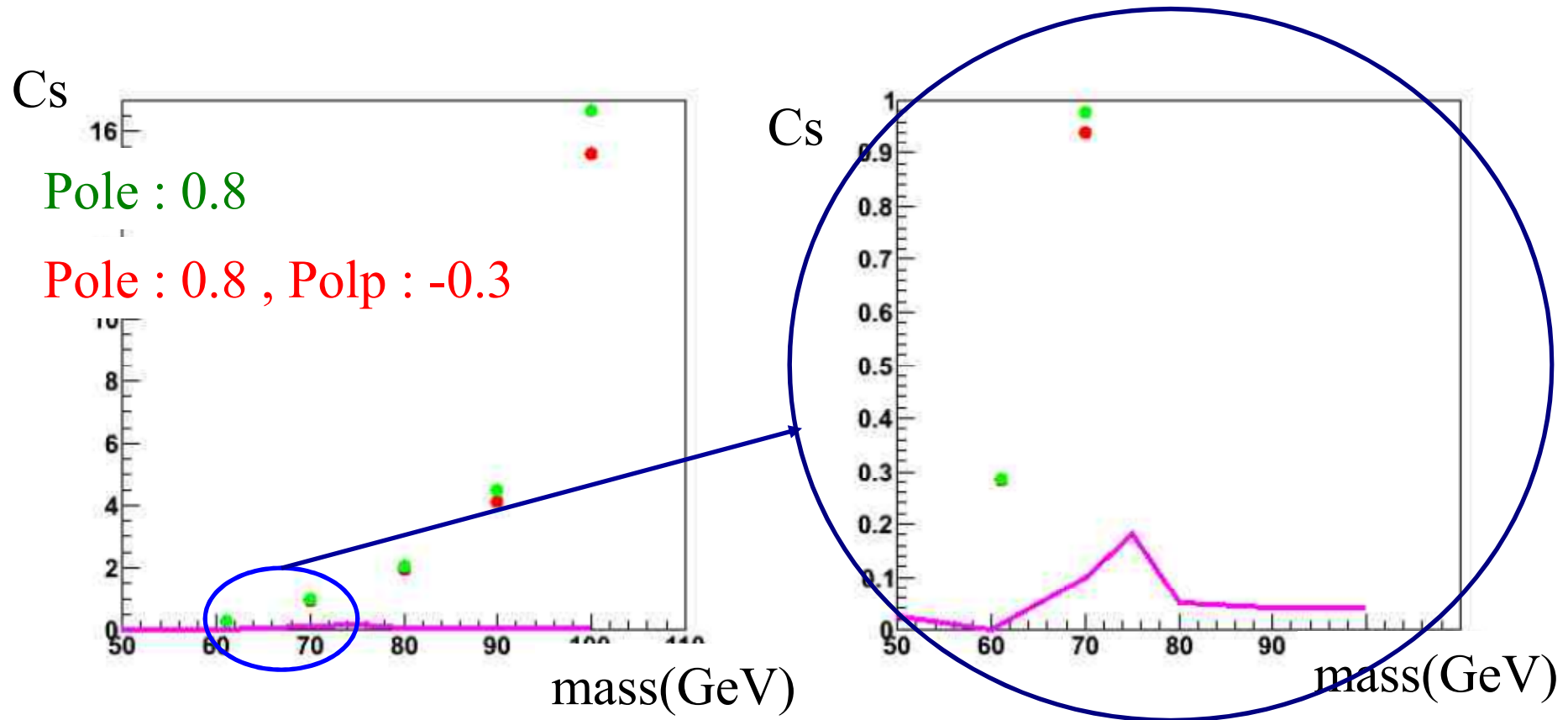


The positron beam pol was successful.

But the red dot also did not reach the W-map line.

Coupling constant limit

The sensitive limit of higgs-scalar dark matter coupling constant

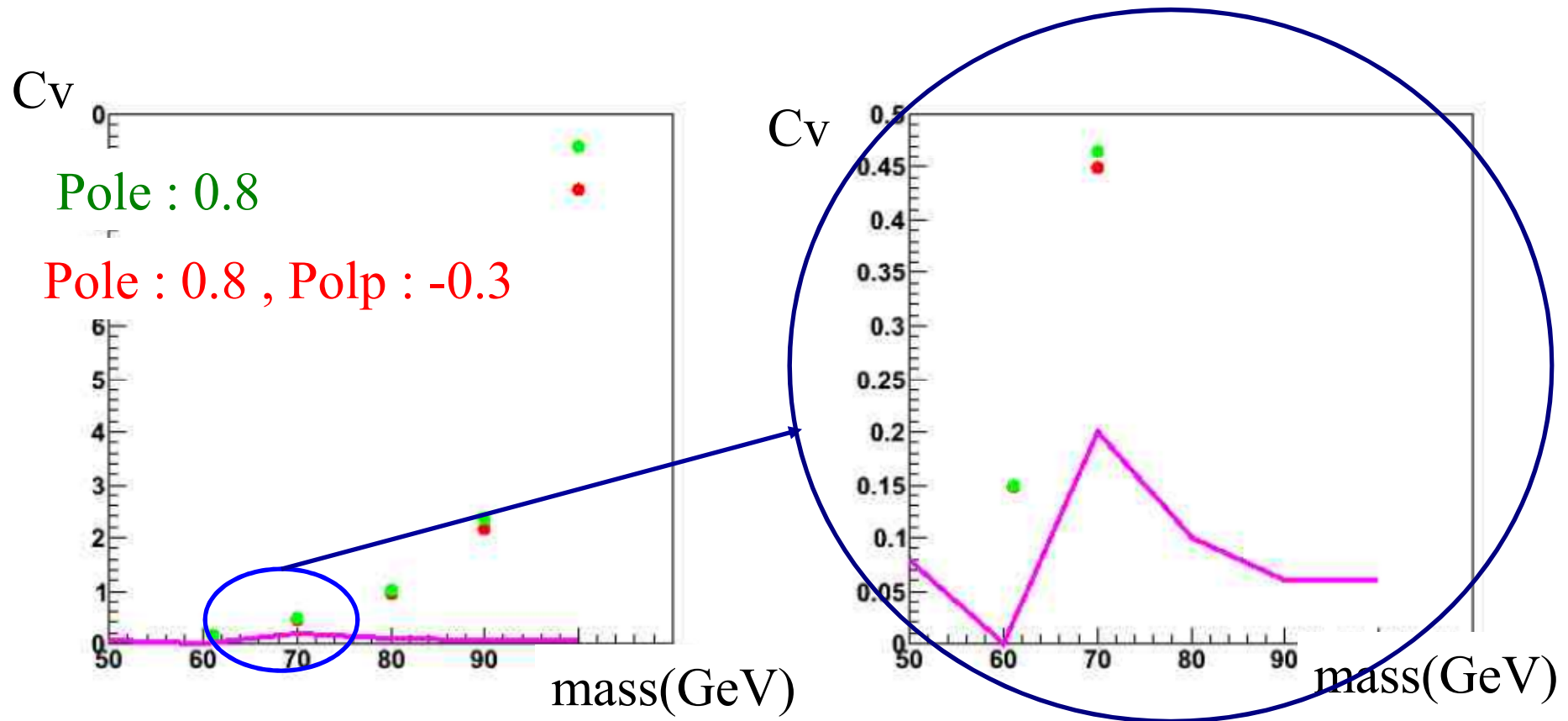


The positron beam pol was successful.

But the red dot also did not reach the W-map line.

Coupling constant limit

The sensitive limit of higgs-vector dark matter coupling constant



The positron beam pol was successful.

But the red dot also did not reach the W-map line.

fermion

Red plots

Green plots

| Mass(GeV) | Cross-section (fb) | Cf/ Λ | Cross-section (fb) | Cf/ Λ |
|-----------|--------------------|---------------|--------------------|---------------|
| 61 | 1.216 | 0.00426436 | 1.276 | 0.00436829 |
| 70 | 1.08 | 0.00897966 | 1.184 | 0.00940208 |
| 80 | 0.964 | 0.0181578 | 1.052 | 0.0189685 |
| 90 | 0.776 | 0.0434025 | 0.872 | 0.04600089 |
| 100 | 0.892 | 0.258912 | 1.008 | 0.275233 |

scalar

Red plots

Green plots

| Mass(GeV) | Cross-section (fb) | Coupling constant | Cross-section (fb) | Coupling constant |
|-----------|--------------------|-------------------|--------------------|-------------------|
| 61 | 1.12 | 0.283408 | 1.14 | 0.285927 |
| 70 | 1.044 | 0.94041 | 1.13 | 0.978377 |
| 80 | 0.968 | 1.9631 | 1.064 | 2.05814 |
| 90 | 0.768 | 4.12197 | 0.932 | 4.49422 |
| 100 | 0.612 | 15.2666 | 0.732 | 16.6964 |

vector

Red plots

Green plots

| Mass(GeV) | Cross-section (fb) | Coupling constant | Cross-section (fb) | Coupling constant |
|-----------|--------------------|-------------------|--------------------|-------------------|
| 61 | 1.204 | 0.147497 | 1.228 | 0.14896 |
| 70 | 1.128 | 0.449201 | 1.212 | 0.465626 |
| 80 | 0.996 | 0.968114 | 1.088 | 1.01184 |
| 90 | 0.796 | 2.17119 | 0.924 | 2.33926 |
| 100 | 0.636 | 8.57522 | 0.764 | 9.3986 |