Weekly Updates

Ryuta

12/19/2019

Status

- Z(->ee)H(Z->νν, Z*->qq)

  -- try to optimize the lepton selection

  -- run single/zh/2fbg/4fbg

- This slide, the contents are

  -- Lepton Isolation

  -- the running result from ee channel

About Lepton isolation I.

-- Selection for “isolated” lepton (in current setting)

1. PID - it’s PID should be either electron or muon

2. “Polynomial” isolation (next page)

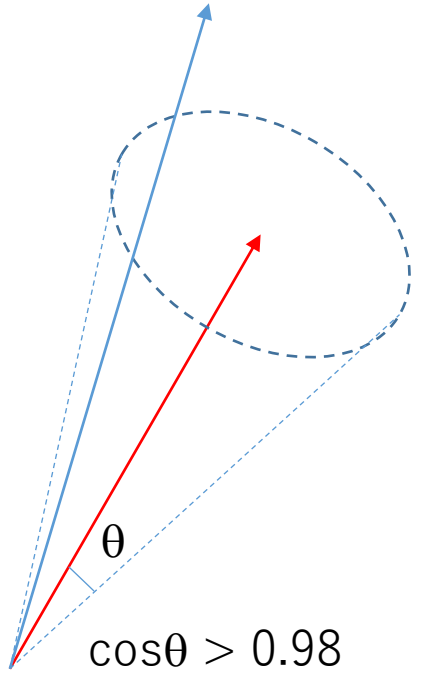
3. “Rectangular” isolation

$E_{min} < E(Lepton) < E_{max}$ with E_{min}=3 GeV, $E_{max} \sim \infty$

actually, only this condition

$ConeE_{min} < ConeE(Lepton) < ConeE_{max}$ with $ConeE_{min}$=0, $ConeE_{max} \sim \infty$

“Cone Energy”, summation of energy within a cone



$\cos\theta > 0.98$
$\sim 11.5°$ (current value)

About Lepton isolation II.

-- “Polynomial” isolation --

Can see brief explanation from below URL:
https://github.com/iLCSoft/MarlinReco/tree/master/Analysis/IsolatedLeptonFinder

Polynomial cuts on the 2D plane of track energy vs cone energy,
with the parameters of the cuts are defined as
- A (IsolationPolynomialCutA)
- B (IsolationPolynomialCutB, GeV)
- C (IsolationPolynomialCutB, GeV^2)

The parameters are used in the following formula:
- Econe^2 < A*Etrk^2 + B*Etrk + C

If the above equation holds true, the candidate passes the isolation requirement.

With the same notation as previous page, it is

$$\mathrm{ConeE(Lepton)} \times \mathrm{ConeE(Lepton)} < \mathrm{A*E(Lepton)*E(Lepton)+B*E(Lepton)+C}$$

About Lepton isolation III.

ConeE(Lepton) × ConeE(Lepton) < A*E(Lepton)*E(Lepton)+B*E(Lepton)+C

(1) Our current (muon channel) settings

A=0.01, B=C=0

→ ConeE(Lepton) × ConeE(Lepton) < 0.01*E(Lepton)*E(Lepton)

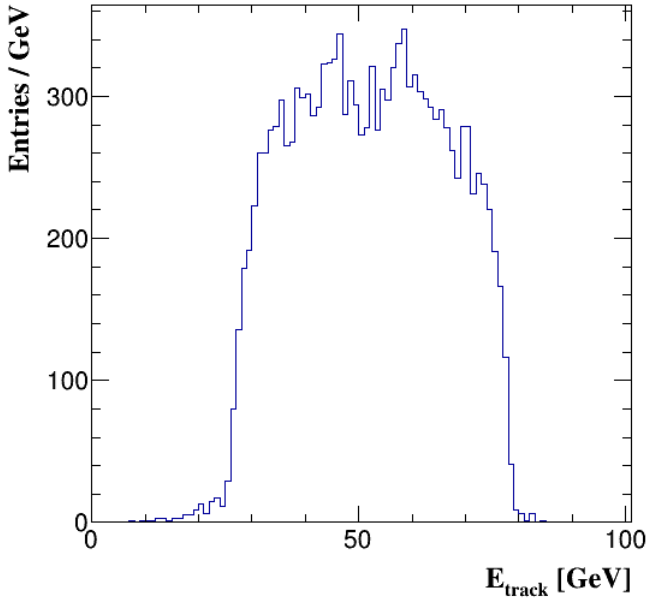
→ ConeE(Lepton)< 0.1*E(Lepton) ⇔ ConeE(Lepton)/E(Lepton)<0.1

(2) settings shown in example of
https://github.com/iLCSoft/MarlinReco/tree/master/Analysis/IsolatedLeptonFinder

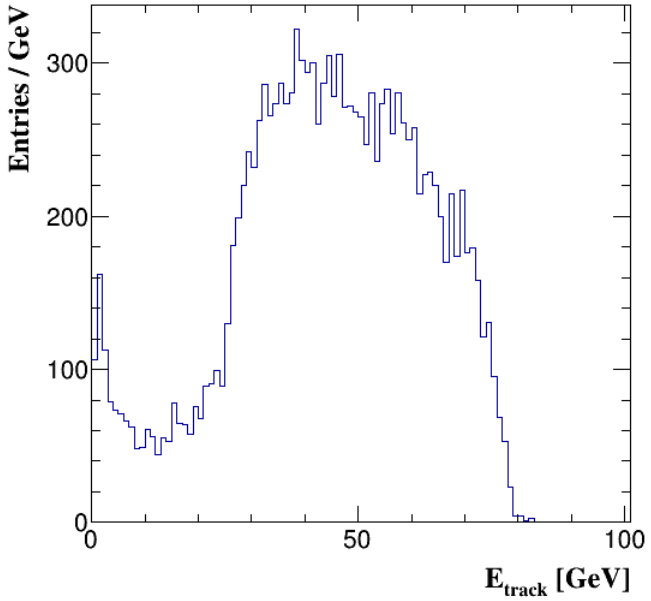
A=0, B=20, C=-300 → ConeE(Lepton)/E(Lepton) < ~0.4-0.5

Z(→ee)H(→invisible) ch.

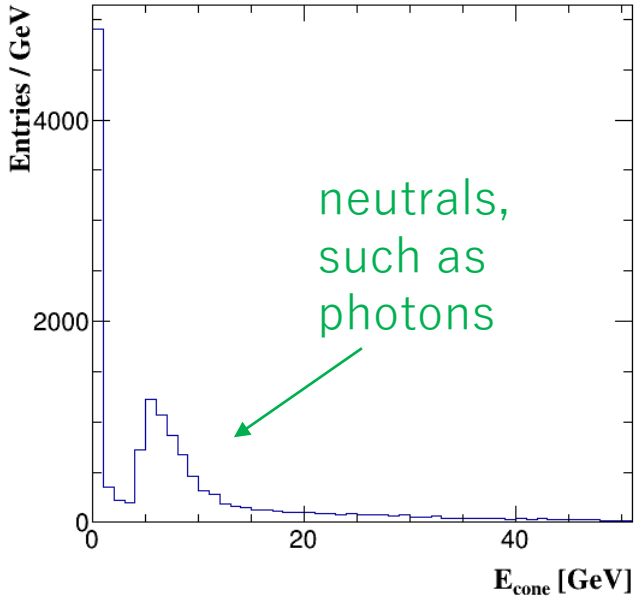
- Check the ConeE(lepton) and the ratio, defined as ConeE(Lepton)/E(Lepton)
- Using Z(→ff)H(→(ZZ*→)$\nu\nu\nu\nu$) MC samples. Select "Z→ee" , by MC truth.
  /cefs/data/DstData/CEPC240/CEPC_v4/higgs/smart_final_states/E240.Pffh_invi.e0.p0.whizard195/



E(track) of MC truth ee

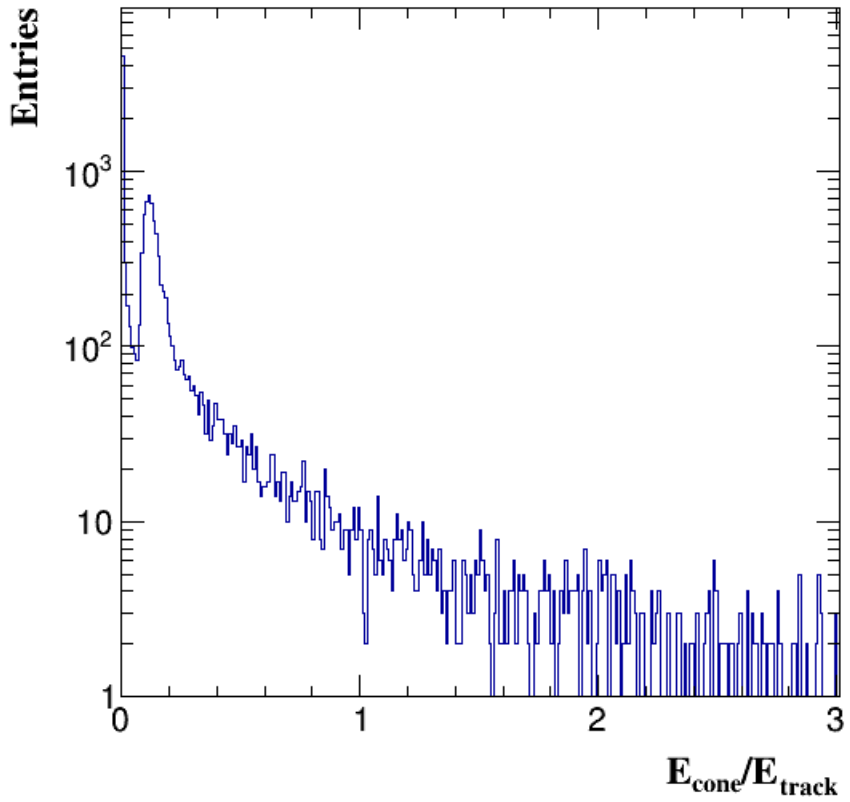


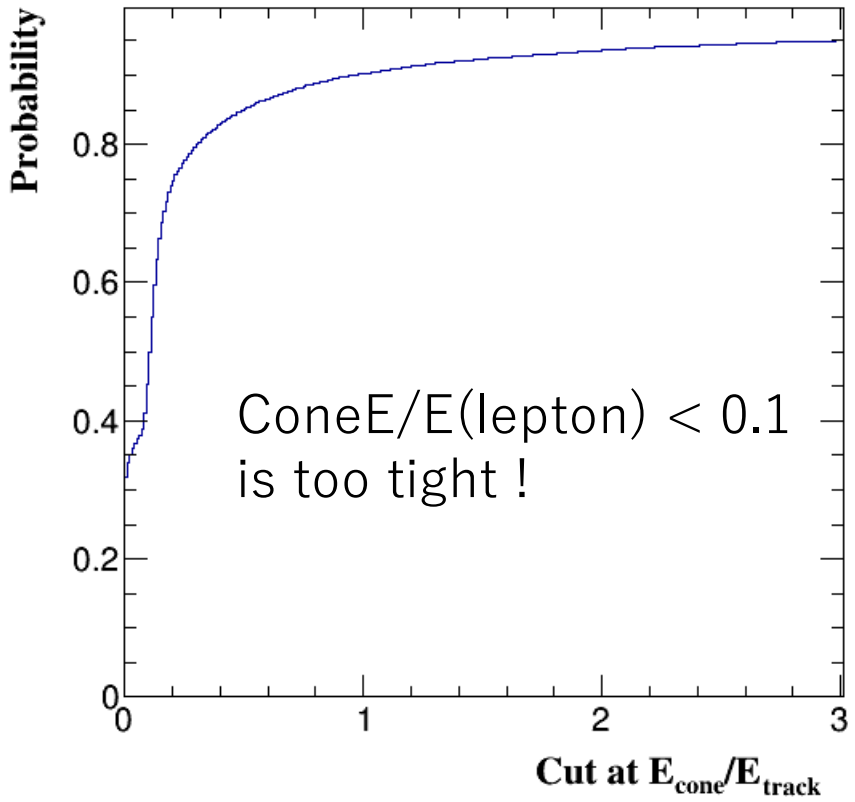
E(track) of Reco. ee



ConeE of Reco. ee

Z(→ee)H(→invisible) ch.

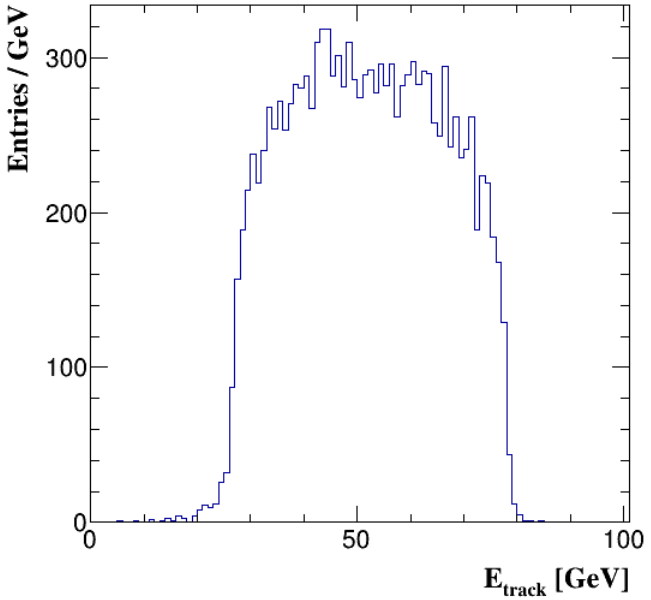




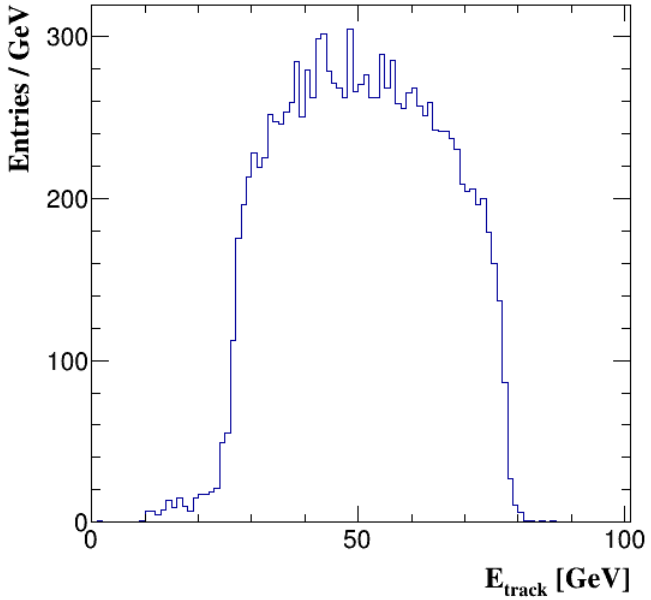
ConeE/E(lepton) < 0.1
is too tight !

Z(→μμ)H(→invisible) ch.

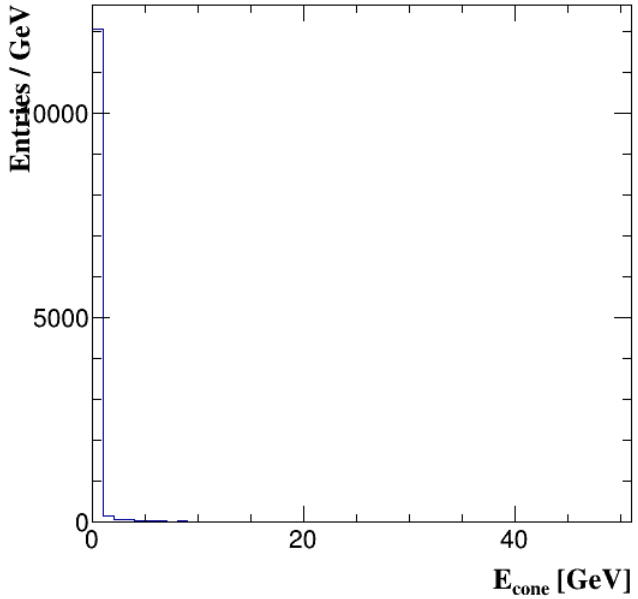
- Repeating the process for μμ to see the difference
- Using Z(→ff)H(→(ZZ*→)νννν) MC samples. Select "Z→μμ" , by MC truth.



E(track) of MC truth μμ

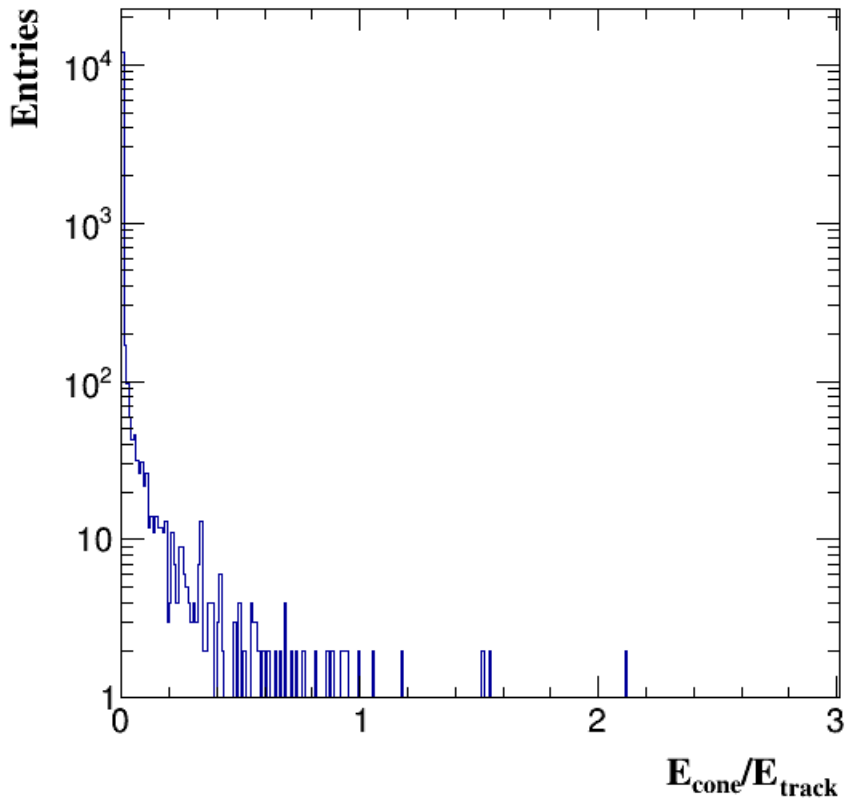


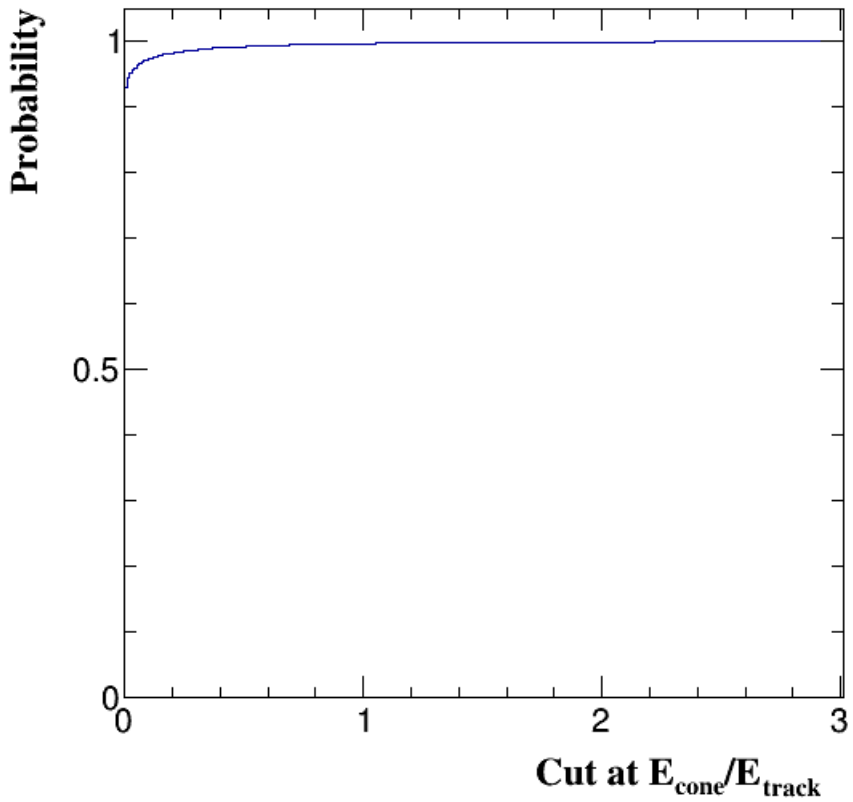
E(track) of Reco. μμ



ConeE of Reco. μμ

Z(→μμ)H(→invisible) ch.

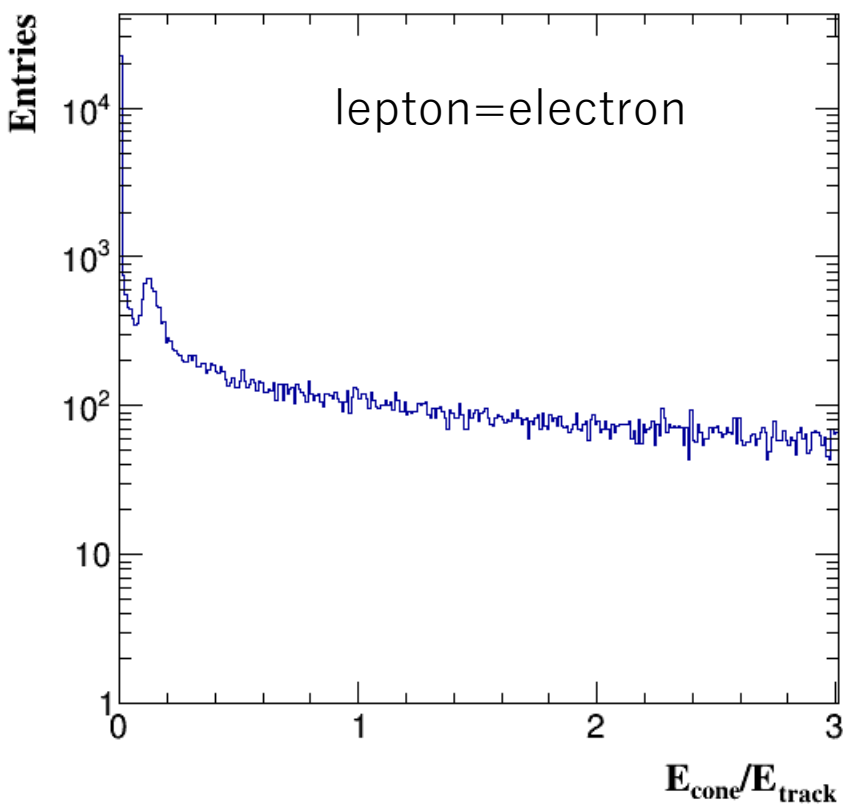


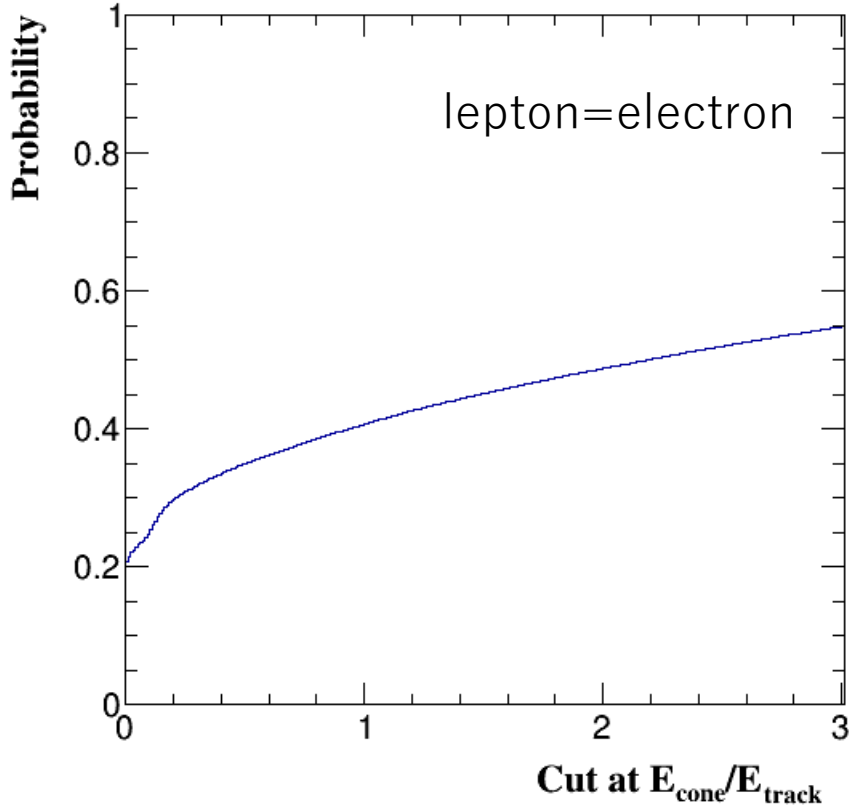


$Z(\rightarrow\nu\nu)H(\rightarrow WW)$ ch.

- Repeating the process on $Z(\rightarrow\nu\nu)H(\rightarrow WW)$ as an example for bg.

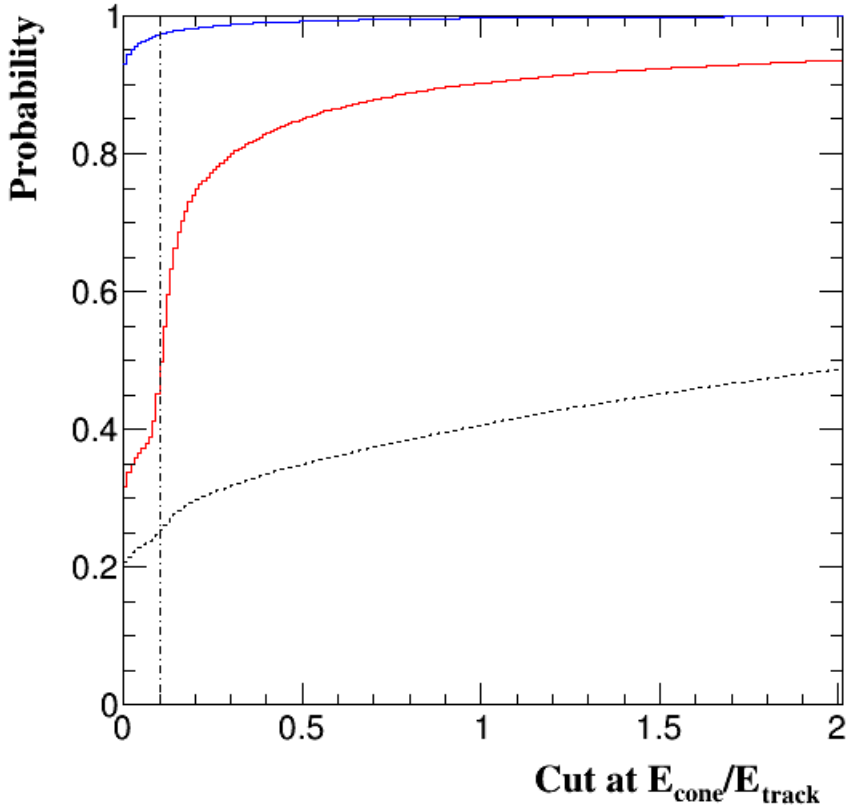
(electrons from WW are the candidate of bg.)



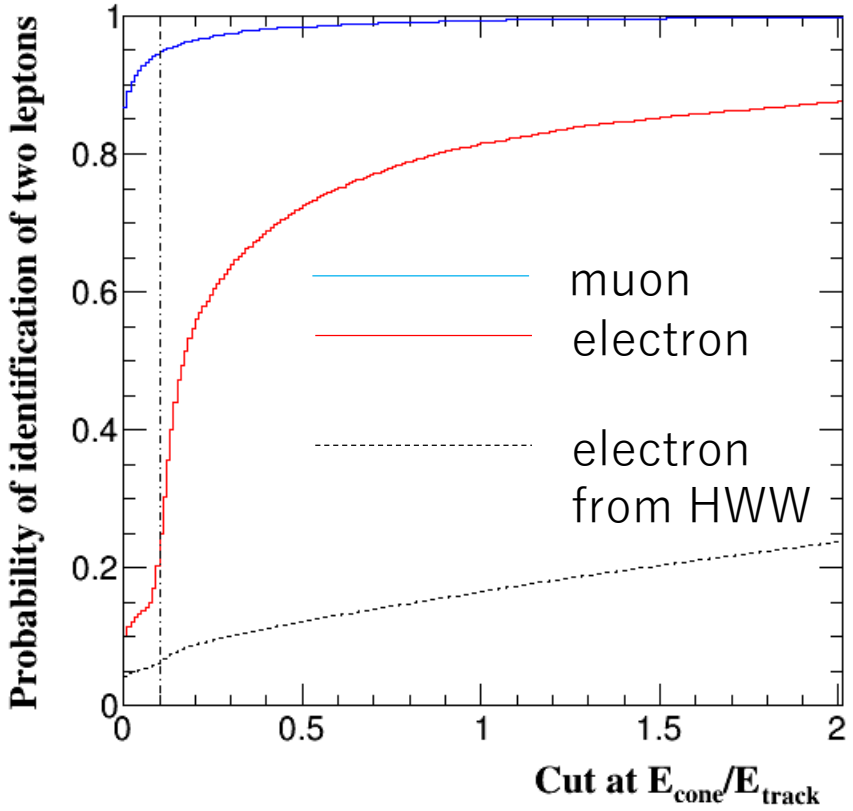


Comparison of the ratio

“ConeE/E(lepton) < 0.1 “ is good for muons



Prob. × Prob. , considering both l^+ l^- should be tagged as “isolated” leptons



Now, fix as “ConeE/E(lepton) < 0.7, with Emin(Leoton)>10 GeV

Z(->ee)H(Z->νν, Z*->qq)

2019-12-18

Pre-selection

IsolatedleptonFinder

- “Use lepton PID” ON
- “Rectangle-Isolation” ON
- “Polynomial-Isolation” ON
  - same as “muon”, but parameters are changed.

Higgs2zz

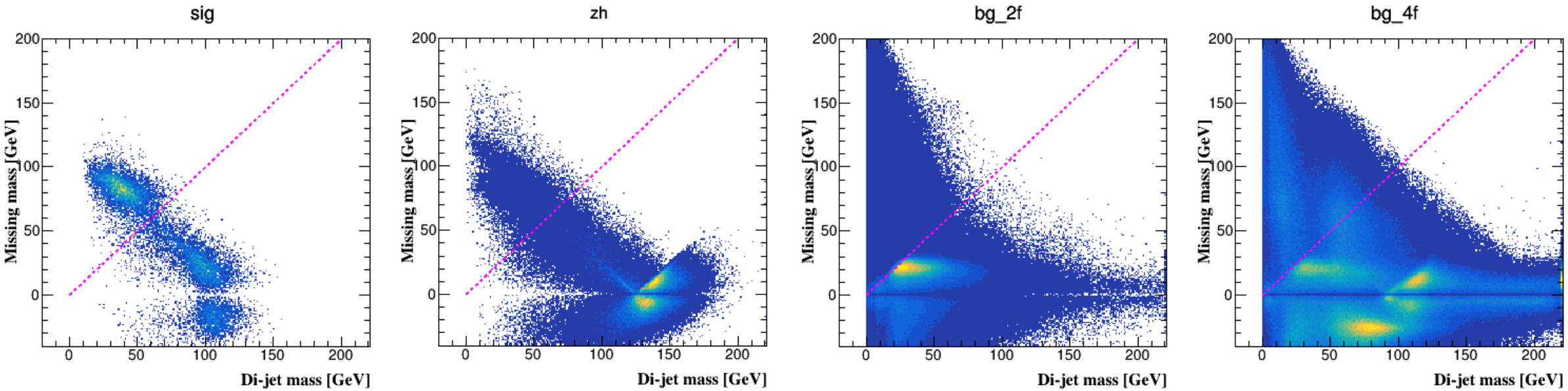
- N(e+)==1, N(e-)==1,
- N(lepton) == 2
- N(jets)==2
  - same as “muon”

```
-bash-4.1$ ./submit.sh 1.4.2
run mumuHzz
plot pictures and save results
Plot information...
scale for signal is 0.010008768
name                    scale                   final
ele1h_ww                0.08456                 17
nnh_zz                  0.06832                 33
e3e3                    6.65404613861           26
ww_sl0tauq              1.10899434445           133
sze_l0tau               1.10888554561           44
sw_sl0qq                1.10891173157           171


cut                     llhzz       zh          2f          4f
Raw events              1000        1140511     801811977   107203890
Pre-selection           501         22058       40351084    2873260
Signal or not           166         21885       40351084    2873260
missingM > M(dijet)     75          637         2333507     478833
M(dimuon)               71          525         339622      114862
RecM(dimuon)            68          481         170873      56389
N(pfo)                  68          210         30694       13149
Pt(total visible)       65          200         21614       11630
Min angle               46          155         427         1693
Missing Mass & M(dijets) 35         69          254         491
Single jet              33          62          26          384
RecM(dijet) not qqhzz   33          62          26          384
VisM not vvhzz          0           0           0           0
-bash-4.1$
```

Turned off

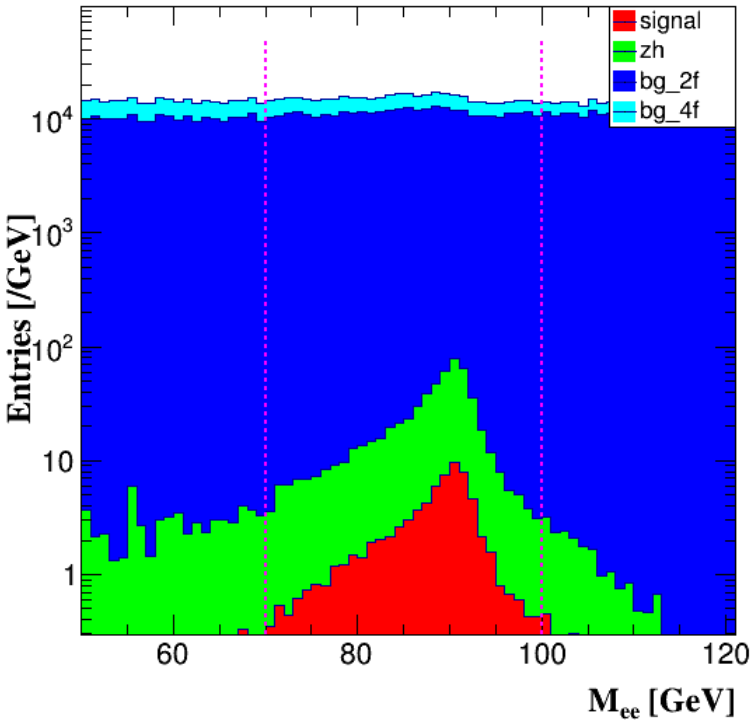
Event selection - I.



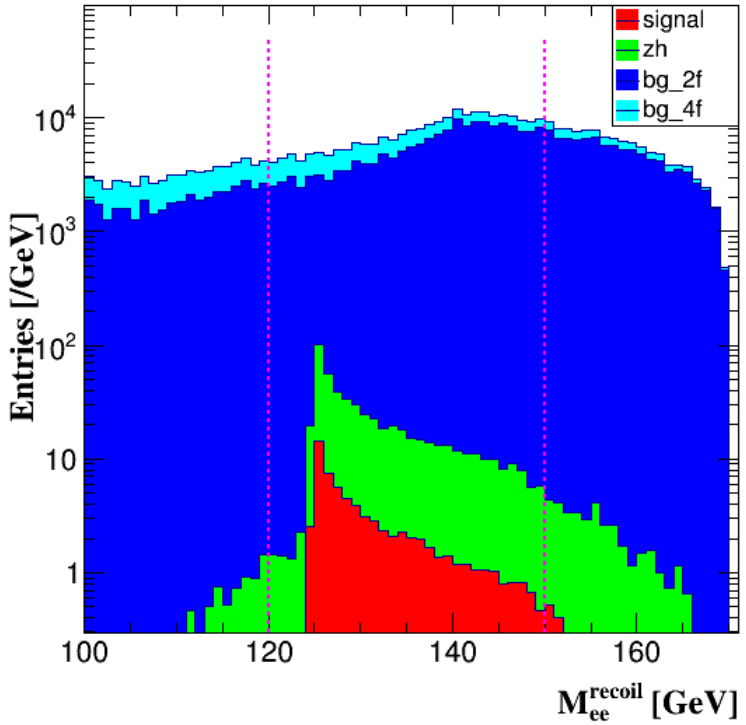
・ Distribution before cut, “Missing mass > Di-jet Mass” is applied

Because of reduction of background events (from 12/16), the some structures can be seen now.

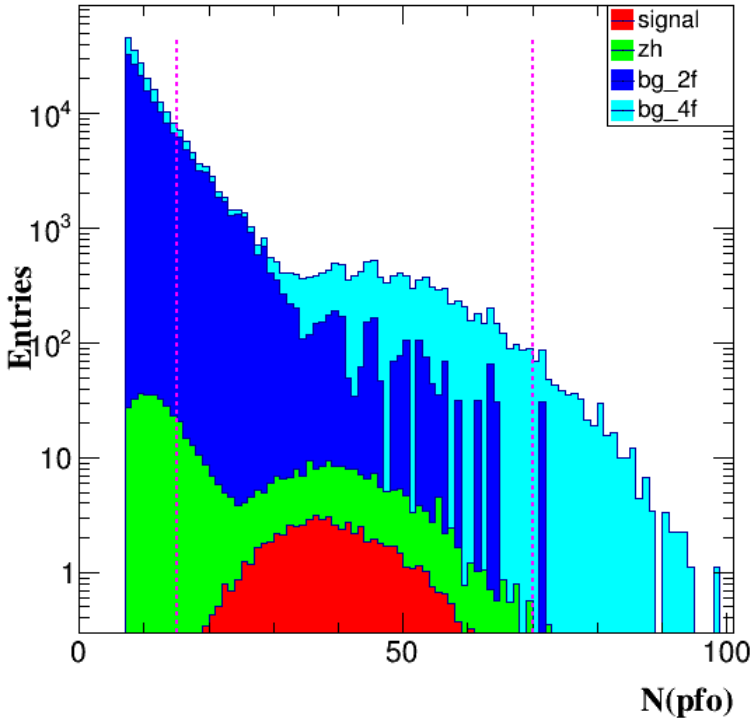
Event selection - II.



70 < M(ee) < 100

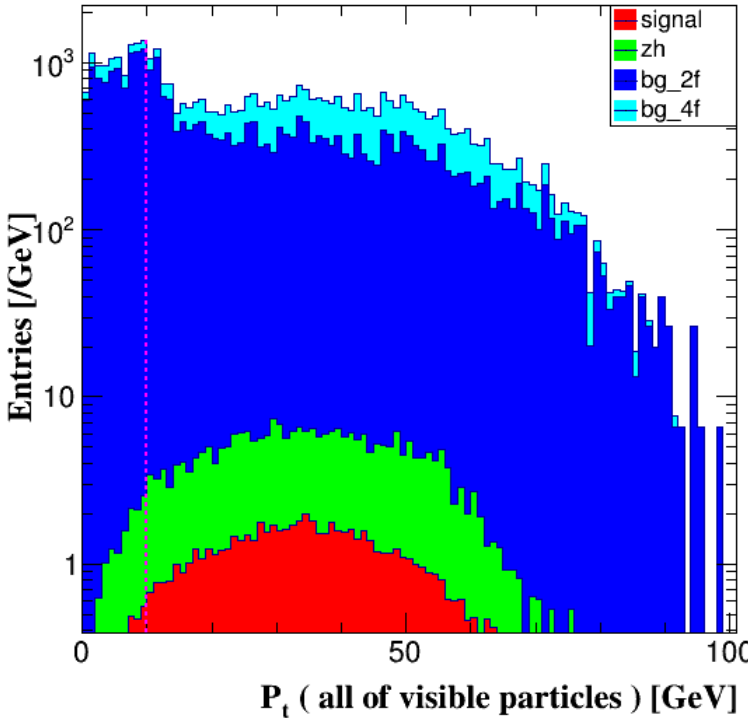


120 < Recoil M(ee) < 160

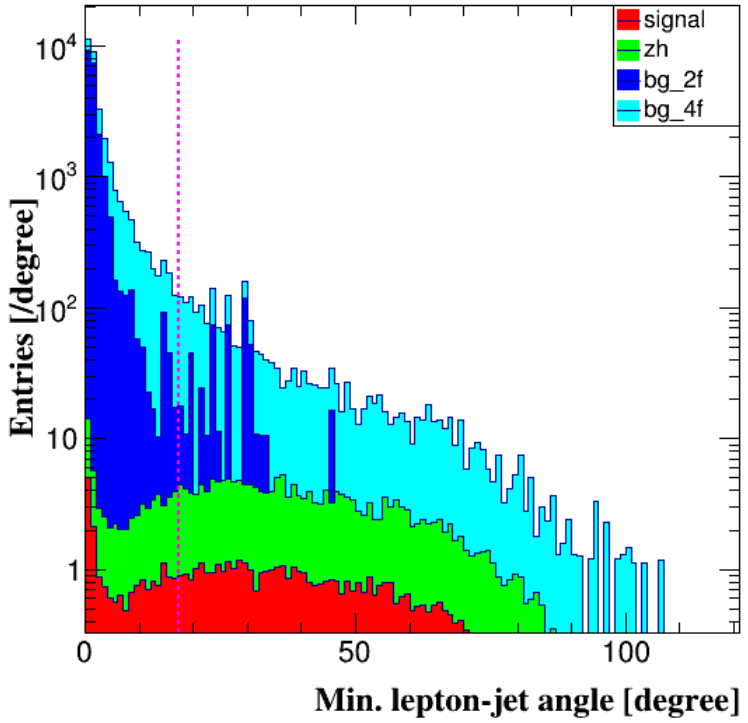


70> N(pfo) >15

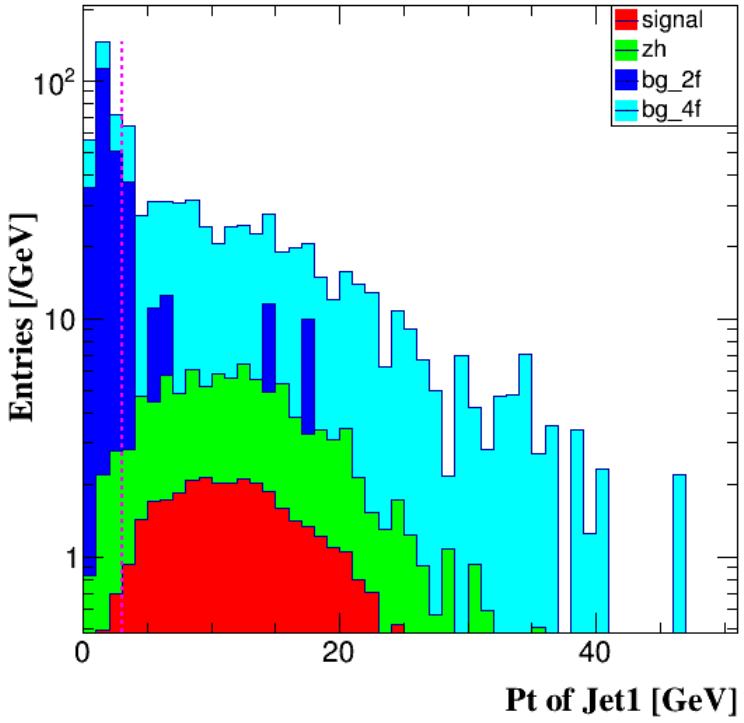
Event selection - III.



Pt(total visible) > 10



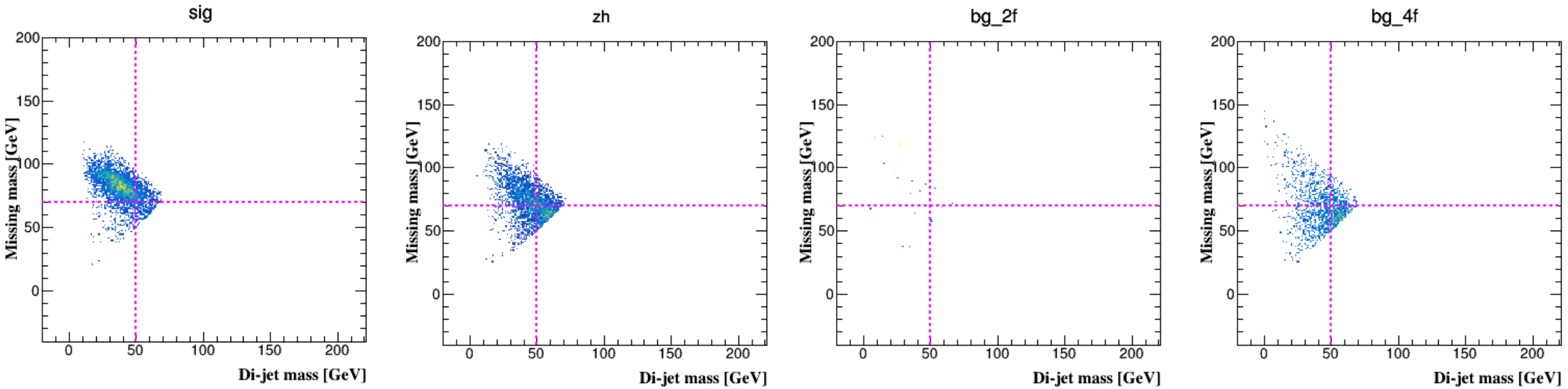
Min. angle > 17.2



Pt(jet1) > 3

Event selection - IV.

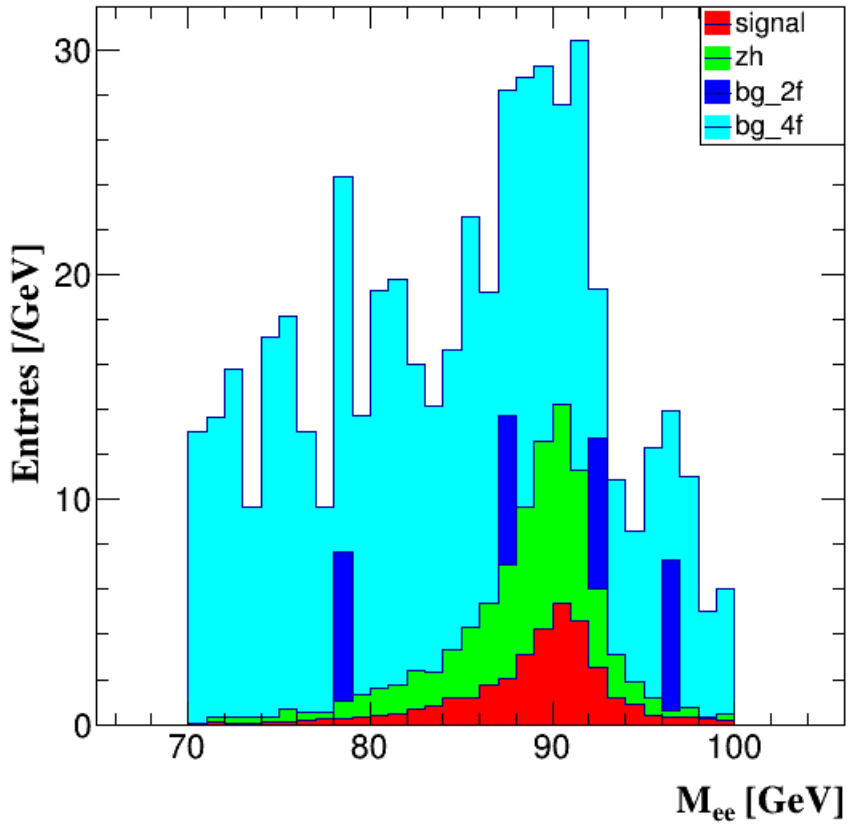
Signal & 4fermion bg has similar distribution

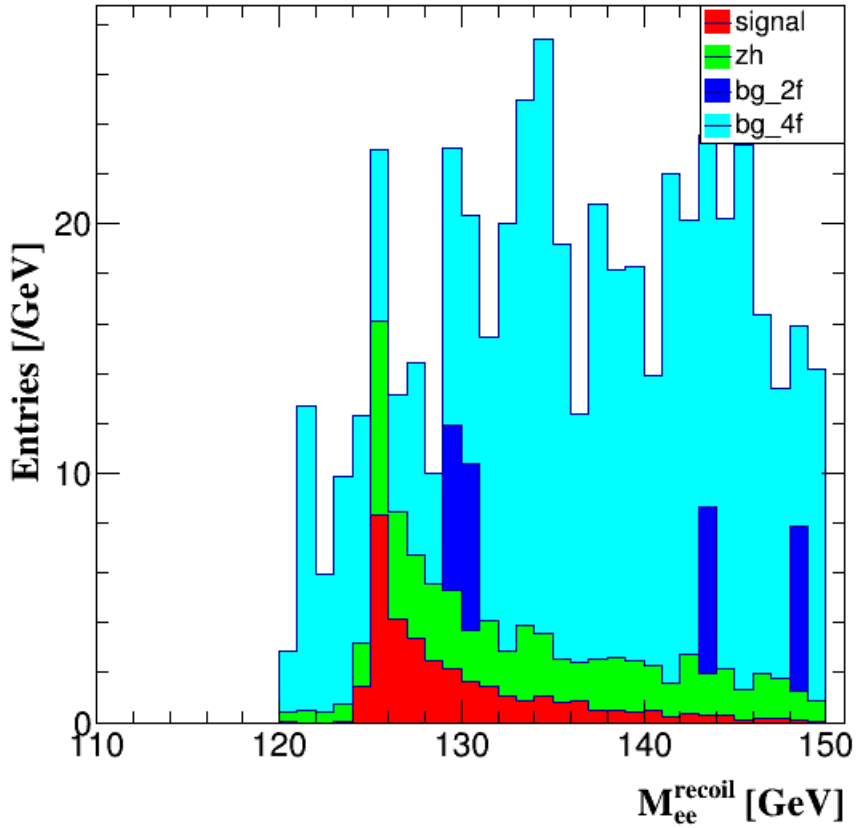


Missing Mass > 70 GeV & M(dijet) < 50 GeV

Original one (muon channel) is Missing Mass > 80 & M(dijet) < 35, but can reduce signal much

Final distributions



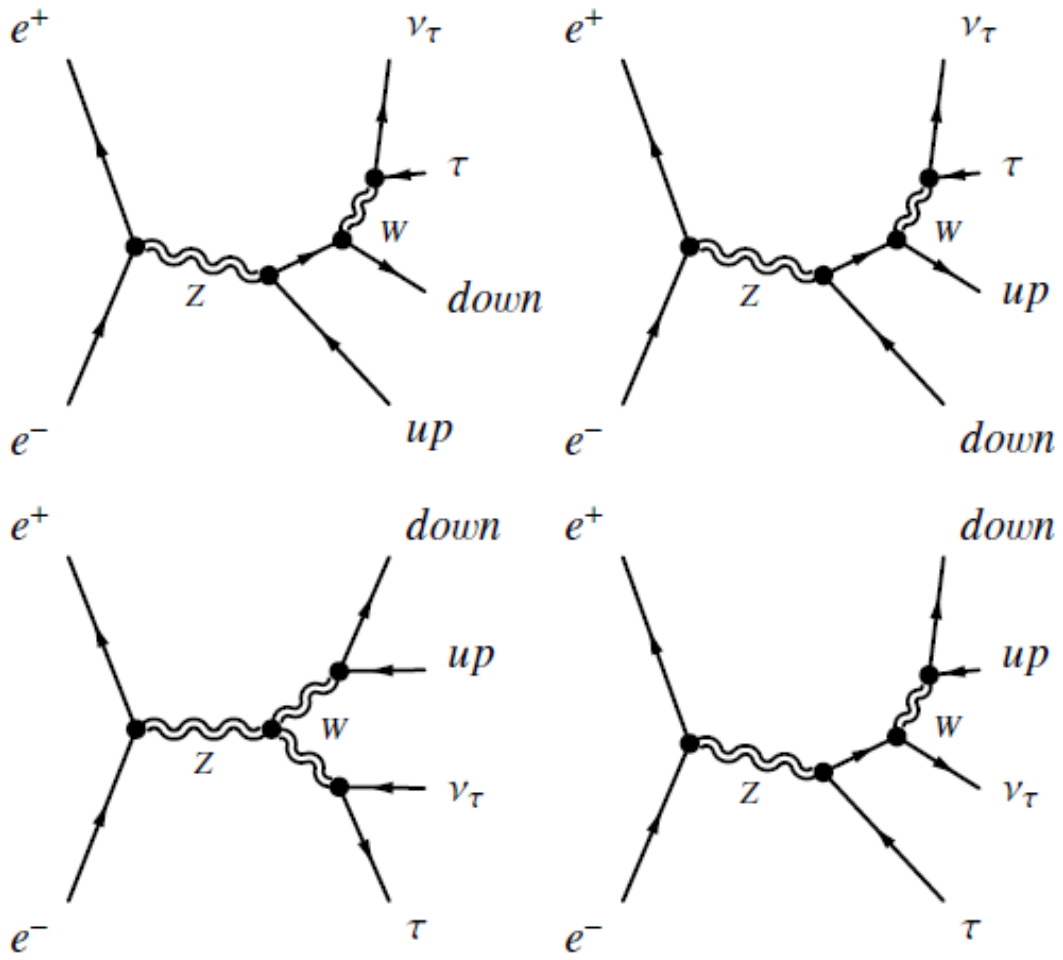


name	scale	final
e1e1h_ww	0.08456	17
nnh_zz	0.06832	33
e3e3	6.65404613861	26
ww_sl0tauq	1.10899434445	133
sze_l0tau	1.10888554561	44
sw_sl0qq	1.10891173157	171

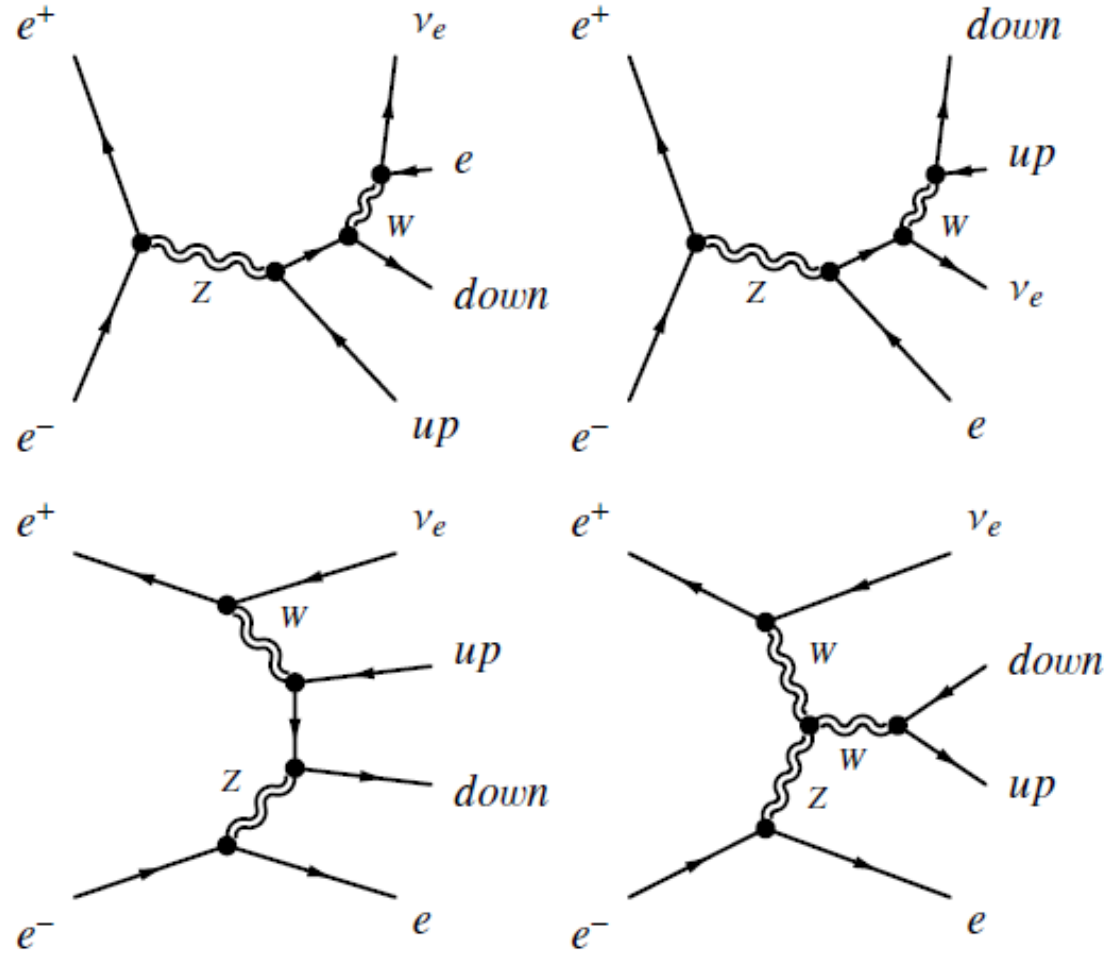
These “ww” related bg. are large. The others are similar to muon ch.

Ref: diagram of two background channels

6.22 ww_sl0tauq



6.39 sw_sl0qq



What’s next

- For this specific channel, how to suppress the two main background is matter.

- go first, the draft/cepc note with muon channels ? along with the ee channel study ?