

CEPC HZZ Project

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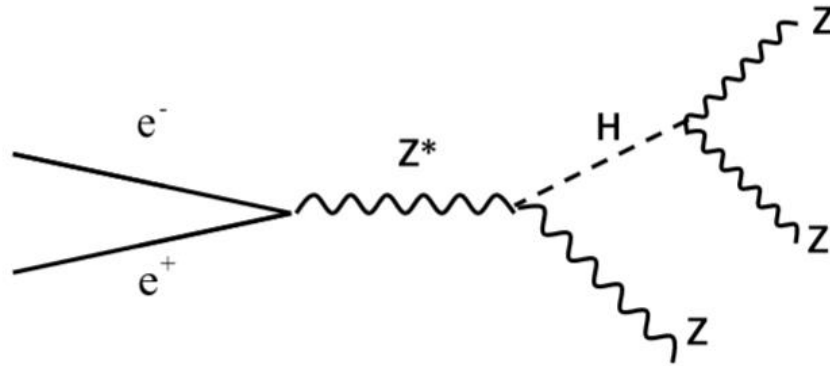
July 10th, 2019

Introduction

CEPC

- e^+e^- collider, \sqrt{s} can be precisely controlled
- Great for measurement of Higgs properties

HZZ Analysis



- $H \rightarrow ZZ^*$ Branch Ratio $\approx 2.64\%$
- One of the key factors to deduce the Higgs boson width and precision

$$\Gamma_H = \frac{\Gamma(H \rightarrow ZZ^*)}{BR(H \rightarrow ZZ^*)}$$

Target

Two Channels

- $Z(\mu^+\mu^-)H(Z \rightarrow \nu\nu, Z^* \rightarrow jj)$
 $Z(\mu^+\mu^-)H(Z \rightarrow jj, Z^* \rightarrow \nu\nu)$ (**Lingteng, Ryuta**)
- $Z(\nu\nu)H(Z \rightarrow \mu^+\mu^-, Z^* \rightarrow jj)$
 $Z(\nu\nu)H(Z \rightarrow jj, Z^* \rightarrow \mu^+\mu^-)$ (**Alex**)

What to do

- Learn how to use Ryuta's framework and reproduce Lingteng's results
- Implement Alex's results using Ryuta's framework
- Optimize cut-based analysis using Alex's object selections
- Optimize cut-based analysis using Ryuta's object selections
- Compare cut-based to BDT based on Alex's object selection

Current Status and Results

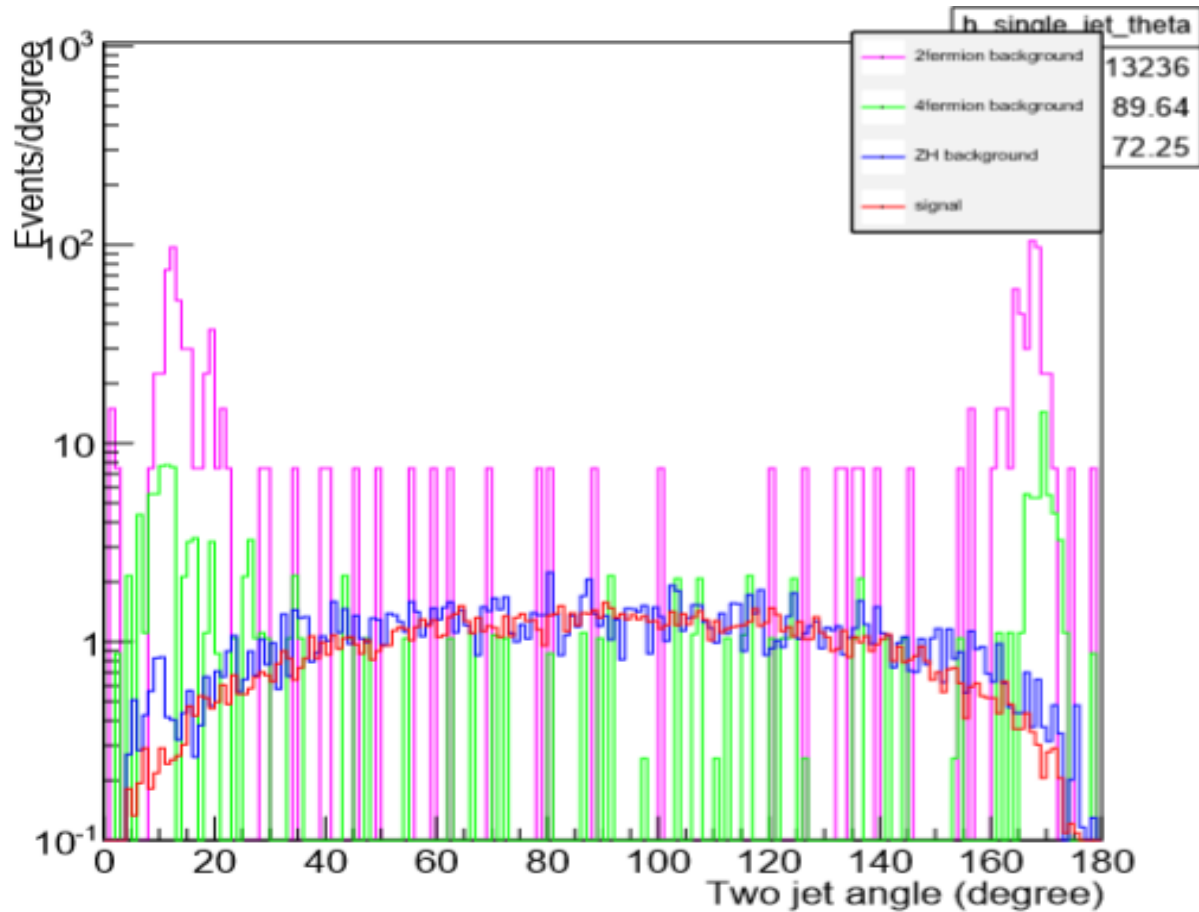
Process

- Running through Lingteng/Ryuta's framework
- Reproducing plots and tables
- Confirming the results with Lingteng's results

Current Status

- $Z(\mu^+\mu^-)H(Z \rightarrow \nu\nu, Z^* \rightarrow jj)$: **Finished**
- $Z(\mu^+\mu^-)H(Z \rightarrow jj, Z^* \rightarrow \nu\nu)$: **Finished**

Results(vvjj) & Question



Two jet angle

?(why not used)

Results(vvjj)

Cutflow

cut	signal	zh background	2f background	4f background
Raw events	1212	12557950	8828594187	1180400980
<i>Pre – selection</i>	817	31794	4170834	735206
<i>Signal or not</i>	270	31571	4170834	735206
$M_{miss} > M_{dijets}$	138	2132	1945599	240838
$80GeV < M_{\mu^+\mu^-} < 100GeV$	127	1254	1338593	48117
$120GeV < M_{Recoil} < 150GeV$	126	1227	152297	15384
$15 < N_{pfo}$	125	506	5953	760
$10GeV < Pt_{visible}$	118	462	783	321
<i>Min angle</i> > 17.2°	109	429	582	194
$M_{miss} > 80GeV, M_{dijets} < 35GeV$	79	90	553	78
$Pt_{jet1,2} > 3GeV, E_{jet1,2} > 5GeV$	68	72	0	8

Lingteng's

Reproduced

cut	llhzz	zh	2f	4f
Raw events	1212	12557950	8828594187	1180400980
Pre-selection	817	31794	4170834	735213
Signal or not	270	31571	4170834	735213
missing mass > dijet	138	2132	1945599	240844
M(dimuon)	127	1254	1338593	48117
RecM(dimuon)	126	1227	152297	15385
N(pfo)	125	506	5953	760
Pt(total visible)	118	462	783	321
Min angle	109	429	582	195
Missing Mass & M(dijets)	79	90	553	78
Single jet	68	72	0	8
N(lepton)	68	72	0	8

Reason: Jet energy cut has changed

Results(jjvv)

Cutflow

cut	signal	zh background	2f background	4f background
Raw events	1266	12557950	8828594187	1180400980
<i>Pre – selection</i>	854	31794	4170834	735206
<i>Signal or not</i>	282	31571	4170834	735206
$M_{miss} > M_{dijets}$	138	29438	2225234	494368
$80\text{GeV} < M_{\mu^+\mu^-} < 100\text{GeV}$	126	24273	1543274	250618
$120\text{GeV} < M_{Recoil} < 150\text{GeV}$	125	24159	93570	22035
$30 < N_{pfo} < 100$	122	18136	321	18956
$10\text{GeV} < P_{t\text{visible}} < 50\text{GeV}$	100	4612	59	1636
$17.2^\circ < \text{Min angle} < 90^\circ$	94	4352	59	1422
$M_{miss}M_{dijets}$	59	850	0	308
<i>Single jet</i>	52	706	0	283

Lingteng's

Reproduced

cut	llhzz	zh	2f	4f
Raw events	1266	12557950	8828594187	1180400980
Pre-selection	854	31794	4170834	735214
Signal or not	282	31571	4170834	735214
missing mass > dijet	138	29438	2225234	494370
M(dimuon)	126	24273	1543274	250618
RecM(dimuon)	125	24159	93570	22036
N(pfo)	122	18136	321	18957
Pt(total visible)	100	4612	59	1636
Min angle	94	4352	59	1422
Missing Mass & M(dijets)	59	850	0	308
Single jet	52	706	0	283

Reason: Jet energy cut has changed(?)

Next to do

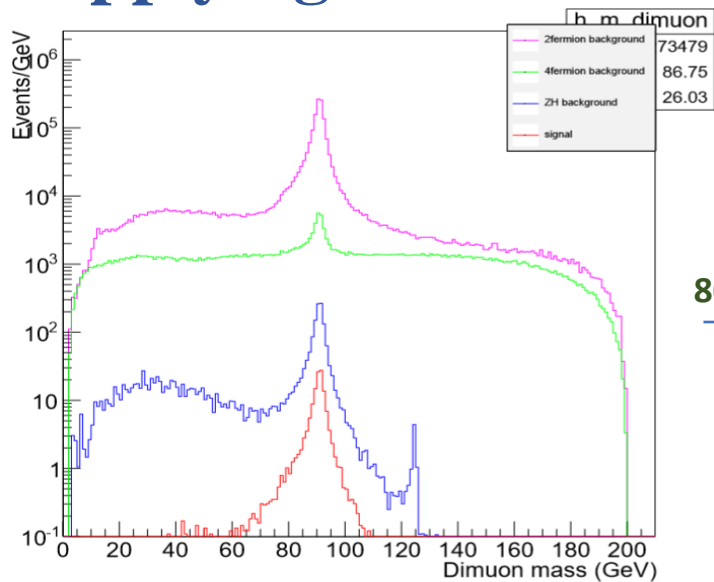
Main

- **Implement Alex's selection into Ryuta's framework**
`/cefs/higgs/guyx/hig2zzjjvv/python/sel_events.py`
- **Compare this result to Alex's result**

Minor

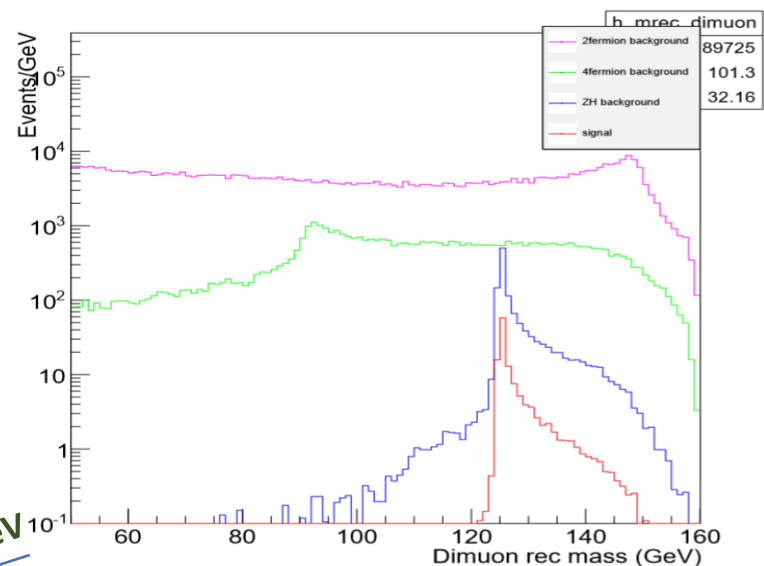
- **Implement plotting programs**

Applying different cuts(vvjj)



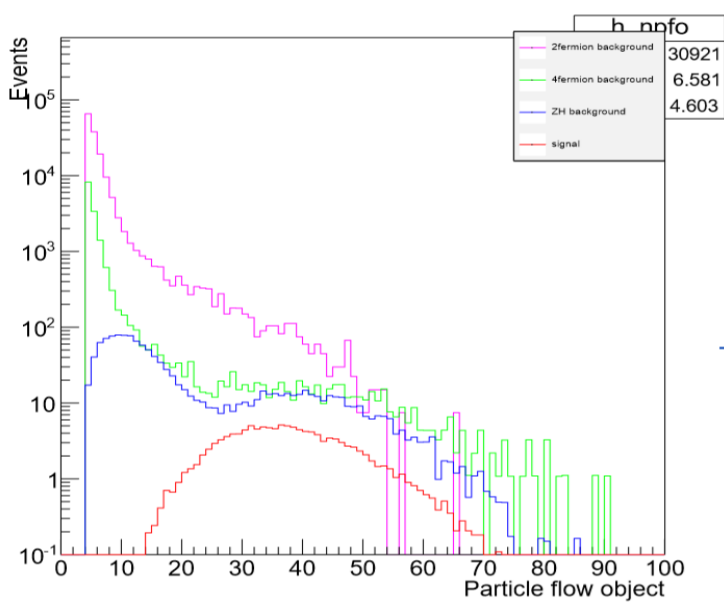
Original dimuon Inv mass

$80\text{GeV} < \text{inv_mass} < 100\text{GeV}$



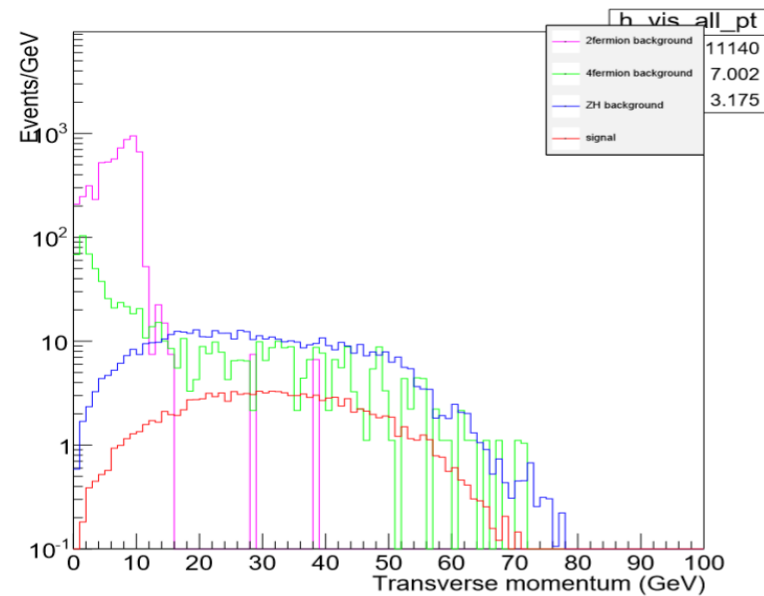
Dimuon Rec mass

$120\text{GeV} < \text{rec_mass} < 150\text{GeV}$



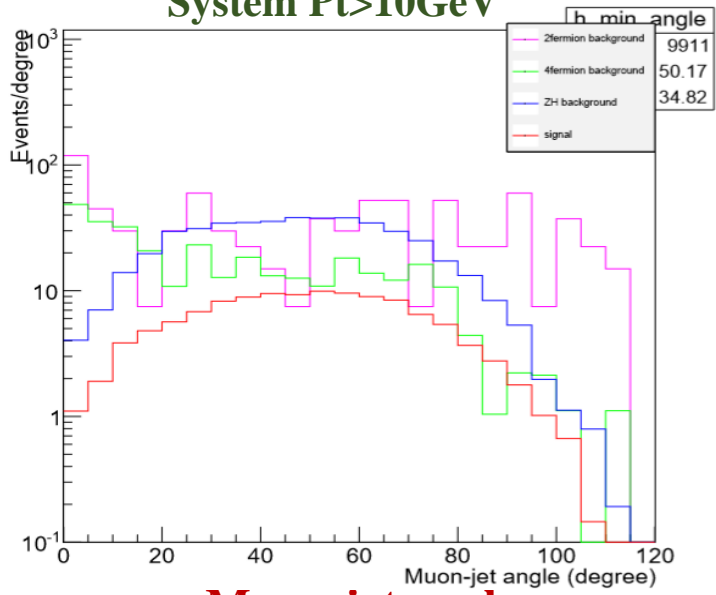
Particle flow number

Particle number > 15



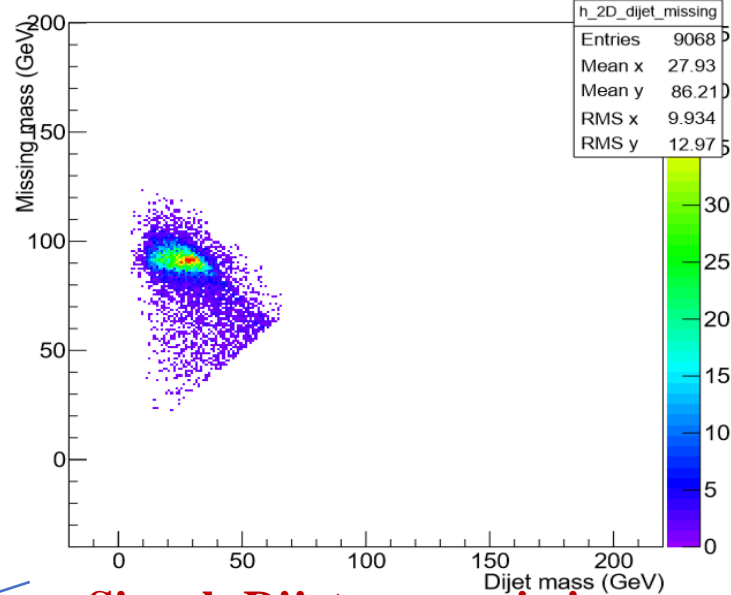
System Pt

System Pt>10GeV



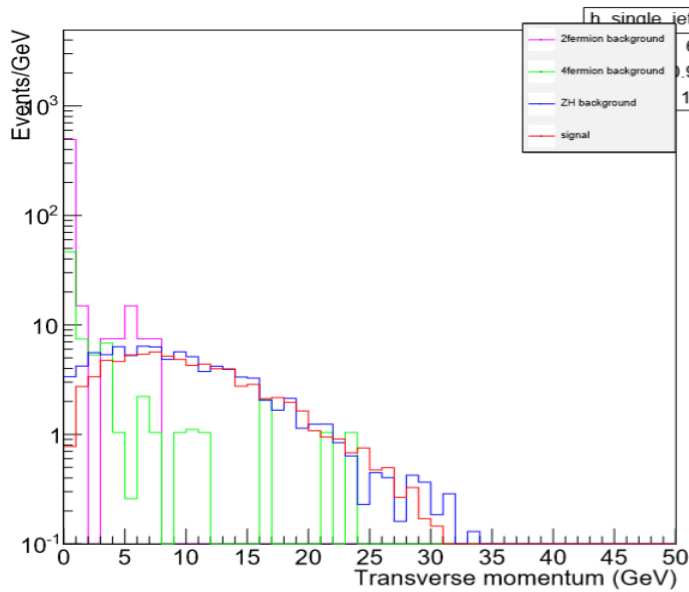
Muon-jet angle

muon-jet angle > 17.2



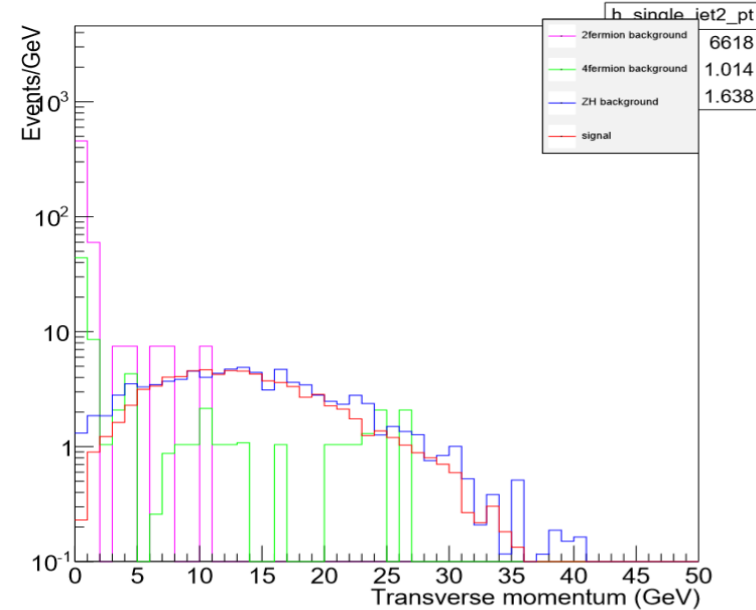
Signal: Dijet_m vs missing_m

dijet_mass < 35 GeV
missing_mass > 80 GeV



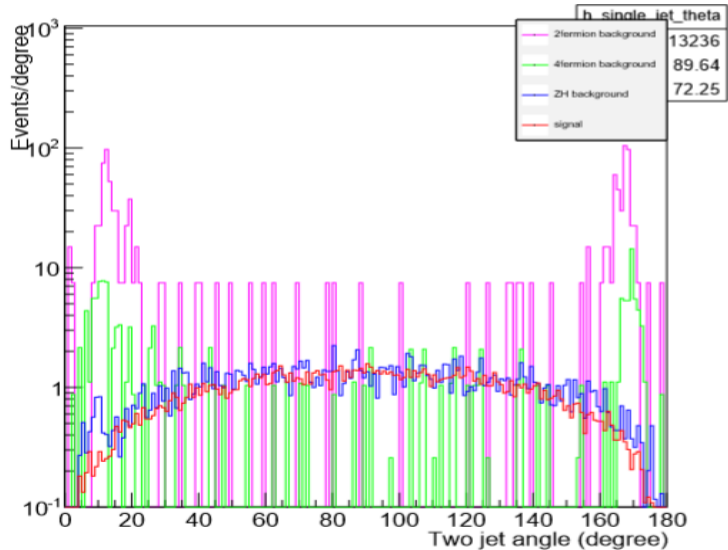
Jet 1 Pt

Jet 1 Pt > 3 GeV



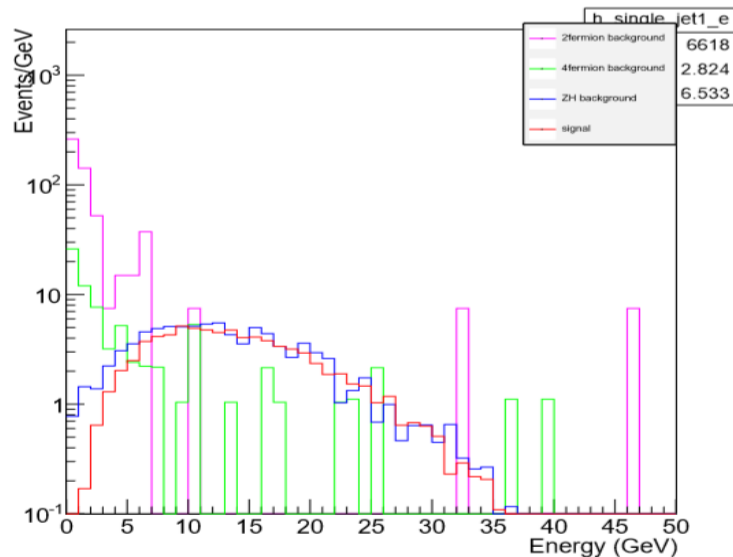
Jet 2 Pt

Jet 2 Pt>3GeV



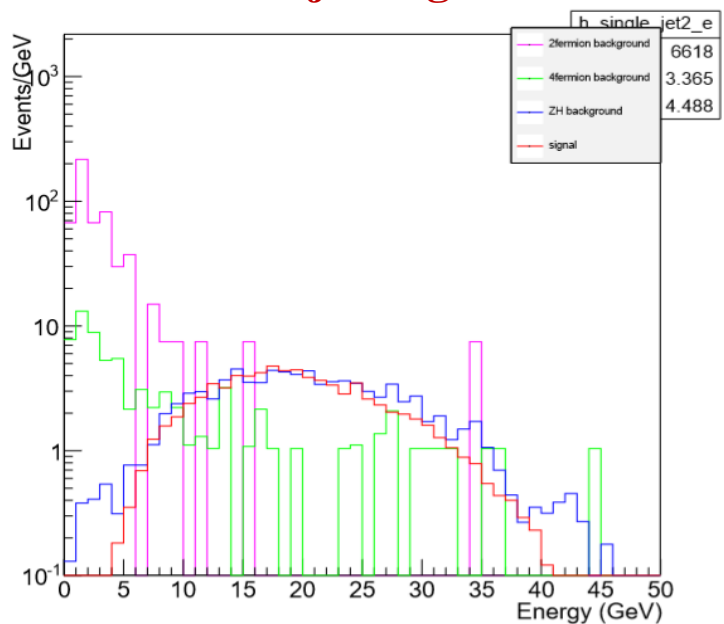
Two jet angle

?(why not used)



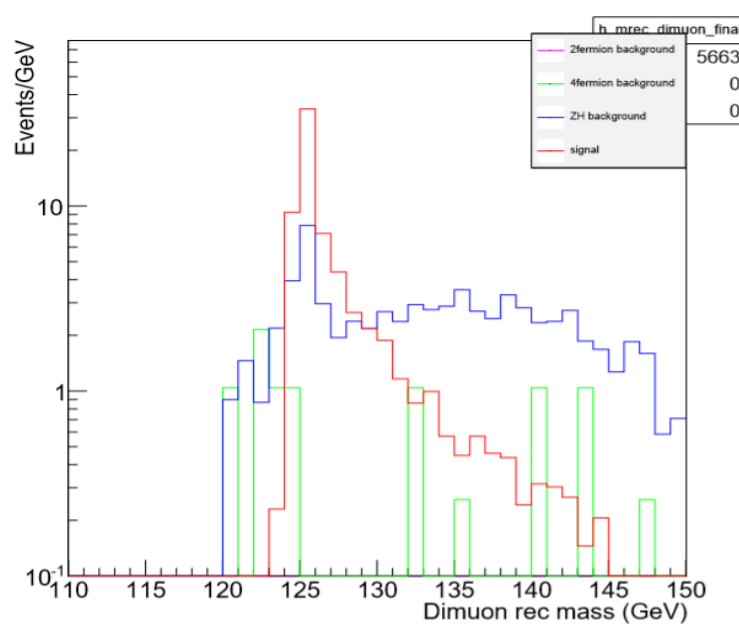
Jet 1 Energy

Jet 1 energy > 5 GeV



Jet 2 Energy

Jet 2 energy > 5 GeV



Dimuon reco_mass final