

CEPC HZZ Project

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Differences in object selection

	Ryuta	Alex
$\frac{E(\text{cone})}{E(\text{track})}$	0.4	0.1
<i>Lepton Emin /Gev</i>	10	3
<i>Lepton Emax /Gev</i>	100	<i>none</i>
<i>Isolation Minimum Track Energy/Gev</i>	10	3
<i>Use PID</i>	<i>false</i>	<i>true</i>
<i>Minimum Jet Energy/Gev</i>	<i>none</i>	1
<i>Total Npfo of two jets</i>	<i>none</i>	5

With/without visible mass (Higgs mass) in BDT/Cut

➤ Previous Results

- **BDT:** Used all visible mass (Higgs mass) as one of the BDT training's input features
- **Cut-based:** Applied strict cut ($120 < \text{visible mass} < 130$)

➤ Test

- Remove all visible mass from BDT input feature
- Remove strict cut (to $115 < \text{visible mass} < 130$) in cut-based analysis

BDT Results

➤ BDT results comparison (with/without visible mass as training input)

	signal	zh	2f background	4f background
Pre-selection	238	30 494	480 828	515 425
Is signal	226	30 268	480 828	515 425
nPFO ≥ 10				
115 < Visible Mass < 130	179	464	12 308	7 549
$ \text{Cos theta} < 0.9$	128	325	258	564
BDT score > 0	87	38	0	18

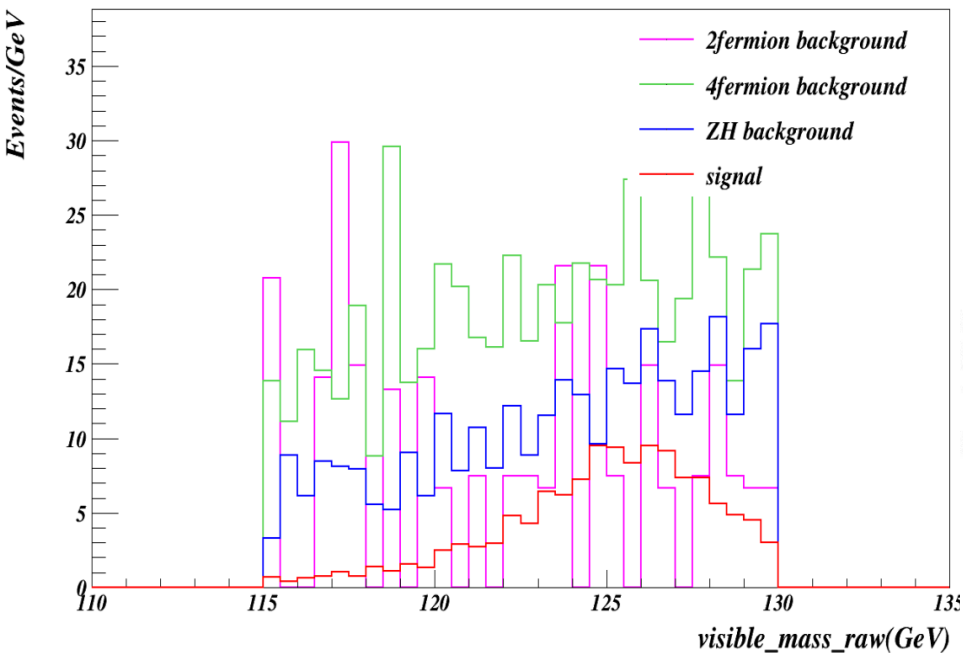
	signal	zh	2f background	4f background
Pre-selection	238	30 494	480 828	515 425
Is signal	226	30 268	480 828	515 425
20 \leq nPFO \leq 73				
120 < Visible Mass < 130	179	464	12 308	7 549
$ \text{Cos theta} < 0.9$	128	325	258	564
BDT score > 0	86	33	0	19

BDT Results

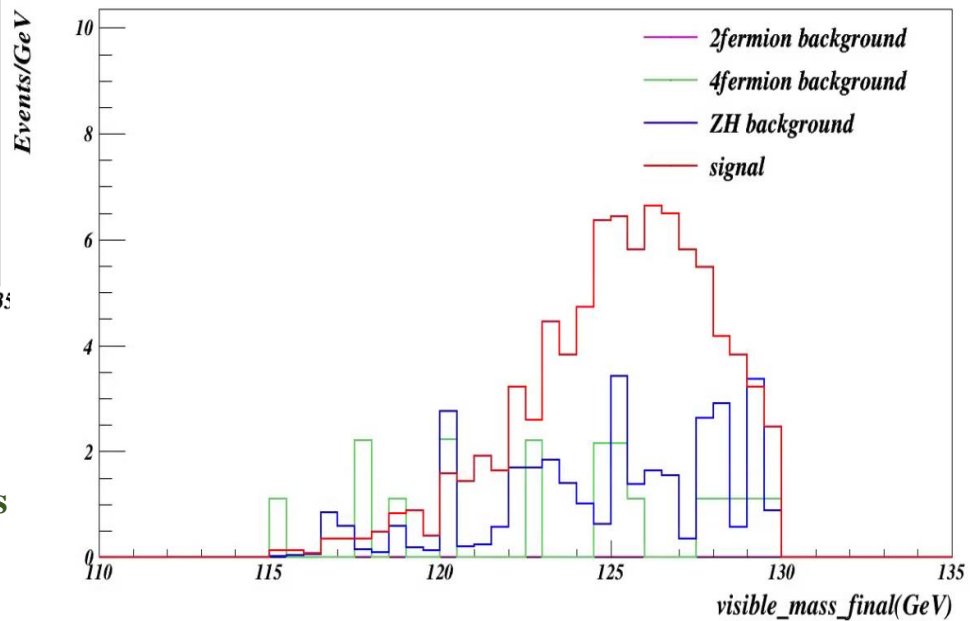
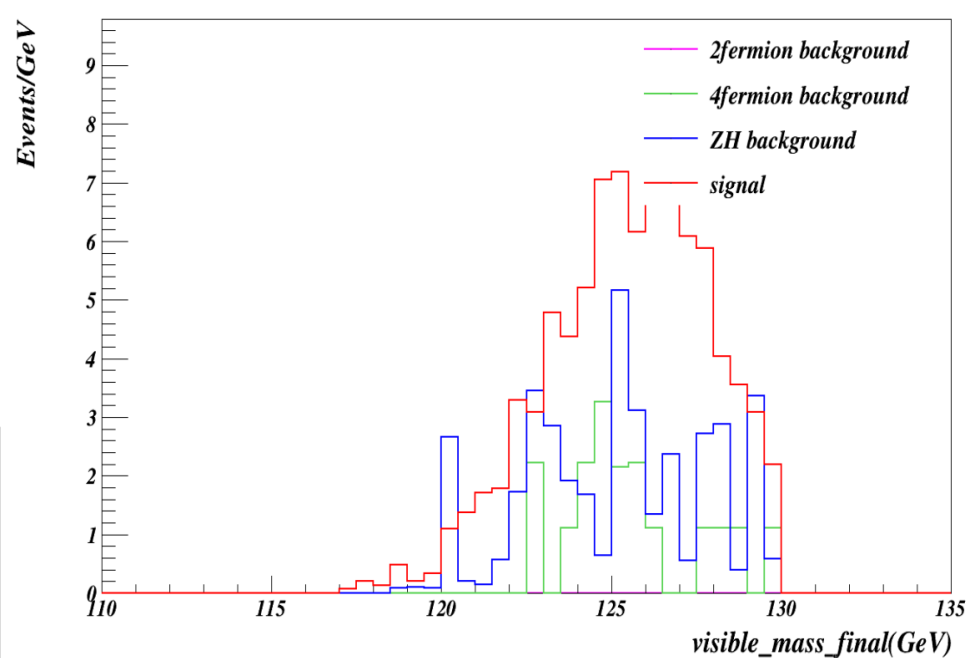
➤ Visible Mass

After BDT
(with visible mass in training)

Before BDT



After BDT
(without visible mass in training)



Cut-based Results

➤ Cut flow with strict visible mass cut

Cut info	Cut flow			
	nnhzz	zh	2f background	4f background
Raw	6844	1140511	801811977	107203890
Pre-selection	238	30494	480828	515425
2mu+2j	226	30268	480828	525425
20<Npfo<73	198	10580	61902	268709
120<Vis_all_mass<130	145	228	4620	3279
cos <0.9	104	168	36	216
104<dimuon_rec_m<214	103	147	36	185
40<Vis_all_p<70	91	78	0	56
14<dijet_m<99	90	76	0	50
14<Lead_jet_e<69	85	63	0	28
3<Sub_jet_e<49	83	61	0	24
20<Mj_angle<142	79	54	0	18
12<dimuon_m<96	78	54	0	16
vis_all_cos <0.9	78	54	0	16
69<vis_all_rec_m<101	77	52	0	14

Cut-based Results

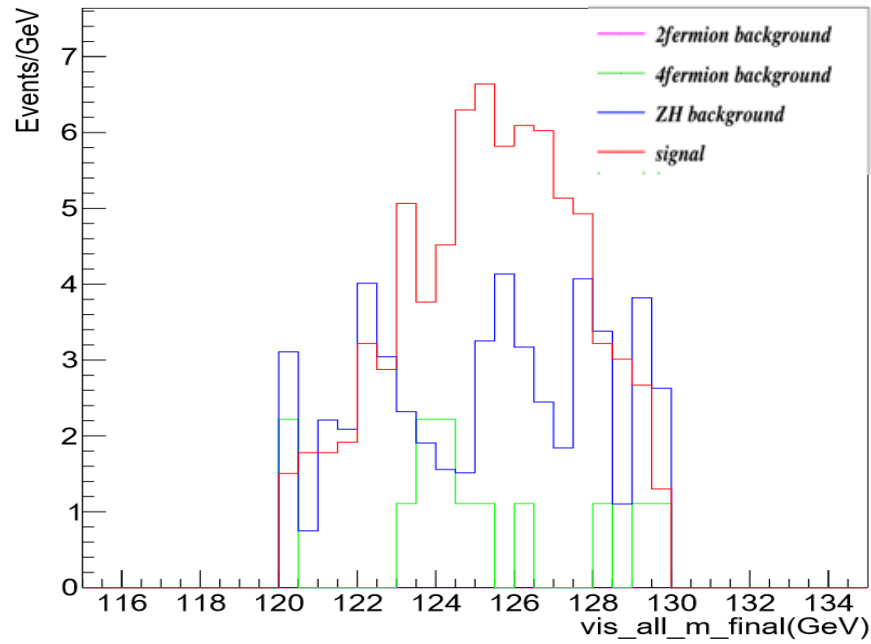
➤ Cut flow without strict visible mass cut

Cut info	Cut flow			
	nnhzz	zh	2f background	4f background
Raw	6844	1140511	801811977	107203890
Pre-selection	238	30494	480828	515425
2mu+2j	226	30268	480828	525425
20<Npfo<73	198	10580	61902	268709
115<Vis_all_mass<135	189	450	9694	6533
cos <0.9	136	328	132	414
104<dimuon_rec_m<214	133	285	125	366
40<Vis_all_p<70	115	157	6	105
14<dijet_m<99	111	150	6	100
14<Lead_jet_e<69	104	122	0	54
3<Sub_jet_e<49	101	116	0	46
20<Mj_angle<142	96	103	0	34
12<dimuon_m<96	96	100	0	33
vis_all_cos <0.9	96	100	0	33
69<vis_all_rec_m<101	88	89	0	30

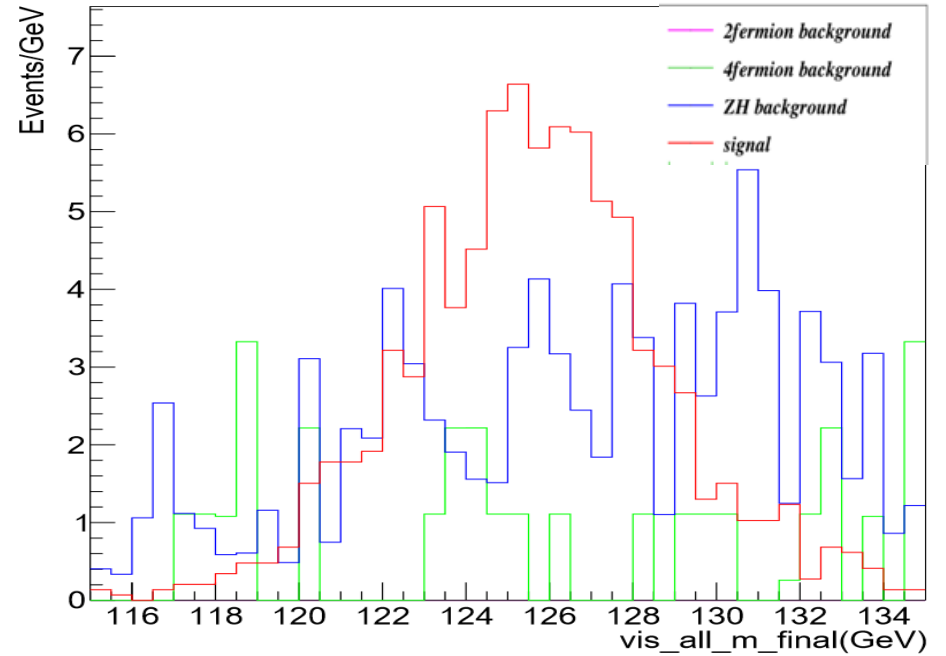
Cut Based Results

➤ Visible Mass

120 < Visible Mass < 130



115 < Visible Mass < 130



Using Alex's object selection for Ryuta's Channel

➤ **Information**

- **We only have ntuples with enough variables using Alex's object selection**
- **Using the ntuples and Lingteng's code to run the analysis, but with the normalization problem fixed**

Results

➤ Using Alex's object selection to do Ryuta's channel ($Z(\mu\mu)H(Z \rightarrow \nu\nu, Z^* \rightarrow jj)$)

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
$10GeV < P_{tvisible}$	118	462	783	321
<i>Min angle</i> $> 17.2^\circ$	109	429	582	194
$M_{miss} > 80GeV, M_{dijets} < 35GeV$	79	90	553	78
$P_{tjet1,2} > 3GeV, E_{jet1,2} > 5GeV$	68	72	0	8

Table in
Lingteng's thesis

cut	llhzz	zh	2f	4f
Raw events	1000	12557950	8828594187	1180400980
Pre-selection	616	30524	481301	515955
Signal or not	211	30307	481301	515955
missing mass > dijet	107	1605	115175	28838
M(dimuon)	95	726	73813	6836
RecM(dimuon)	95	707	7894	1360
N(pfo)	94	336	3271	574
Pt(total visible)	89	312	342	168
Min angle	85	298	283	139
Missing Mass & M(dijets)	62	80	254	46
Single jet	54	67	0	9
N(lepton)	54	67	0	9

Table using Alex's
object selection

Results

➤ Using Alex's object selection to do Ryuta's channel ($Z(\mu\mu)H(Z \rightarrow jj, Z^* \rightarrow \nu\nu)$)

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
$80GeV < M_{\mu^+\mu^-} < 100GeV$	126	24273	1543274	250618
$120GeV < M_{Recoil} < 150GeV$	125	24159	93570	22035
$30 < N_{pfo} < 100$	122	18136	321	18956
$10GeV < Pt_{visible} < 50GeV$	100	4612	59	1636
$17.2^\circ < Min\ angle < 90^\circ$	94	4352	59	1422
$M_{miss}M_{dijets}$	59	850	0	308
<i>Single jet</i>	52	706	0	283

Table in
Lingteng's thesis

cut	llhzz	zh	2f	4f
Raw events	1000	12557950	8828594187	1180400980
Pre-selection	616	30524	481301	515955
Signal or not	211	30307	481301	515955
missing mass > dijet	103	28701	366125	487117
M(dimuon)	92	22495	215657	239256
RecM(dimuon)	92	22401	17380	20630
N(pfo)	89	16776	321	16319
Pt(total visible)	74	4345	59	1273
Min angle	71	4186	59	1216
Missing Mass & M(dijets)	47	866	0	276
Single jet	42	716	0	260
N(lepton)	42	716	0	260

Table using Alex's
object selection

Z(jj) H(vvmm) Channel

➤ **Information**

- **Ntuple with enough variables using Alex's object selection**
- **Cut-based results**

Cut-based Results (first look)

➤ Cut flow table

Cut info	Cut flow			
	qqhzz	zh	2f	4f
Raw	20254	1140511	801811977	107203890
Pre-selection	826	30494	480828	515425
2mu+2j	203	30271	480828	515425
10<Npfo<200	203	29740	127867	428932
103<Vis_all_mass<224	201	10794	78612	108032
cos <1	201	10794	78612	108032
110<dimuon_rec_m<220	198	10583	10462	68771
10<Vis_all_p<50	163	7937	4765	34473
80 <dijet_m < 105	143	3916	484	19267
50<Lead_jet_e<80	134	3303	298	13443
25<Sub_jet_e<55	131	3228	291	12205
90<Mj_angle<175	129	3049	194	11310
Dimuon_m [10, 40]&&[80,100]	110	2394	126	9288
vis_all_cos <1	110	2394	126	9288
vis_all_rec_m [15,40]&&[75,105]	87	1255	14	2573

Cut-based Results (New cuts, running)

➤ Cut flow table

Cut info	Cut flow			
	qqhzz	zh	2f background	4f background
Raw				
Pre-selection				
2mu+2j				
38<Npfo<90				
Vis_all_mass [115,155]&[180,220]				
cos <0.9				
110<dimuon_rec_m<220 not [124,127]				
10<Vis_all_p<50				
80 <dijet_m < 105				
50<Lead_jet_e<80				
25<Sub_jet_e<55				
90<Mj_angle<175				
Dimuon_m [10, 40]&&[80,100]				
vis_all_cos <0.85				
vis_all_rec_m [15,40]&&[75,105]				