Analysis Practice

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Process

Final Goal: To be able to perform HtoSS analysis on myself.

After finding the lepton pair, the remaining particles are reconstituted in two jets (2 leptons + 2 jets).

① Find lepton pairs using IsolatedLeptonTaggingProcessors (signal event)

② Except for the lepton pair I found. Then jetclustering it

③ Jetclustering data to root

④ Calculate invariant mass from each quaternionic momentum

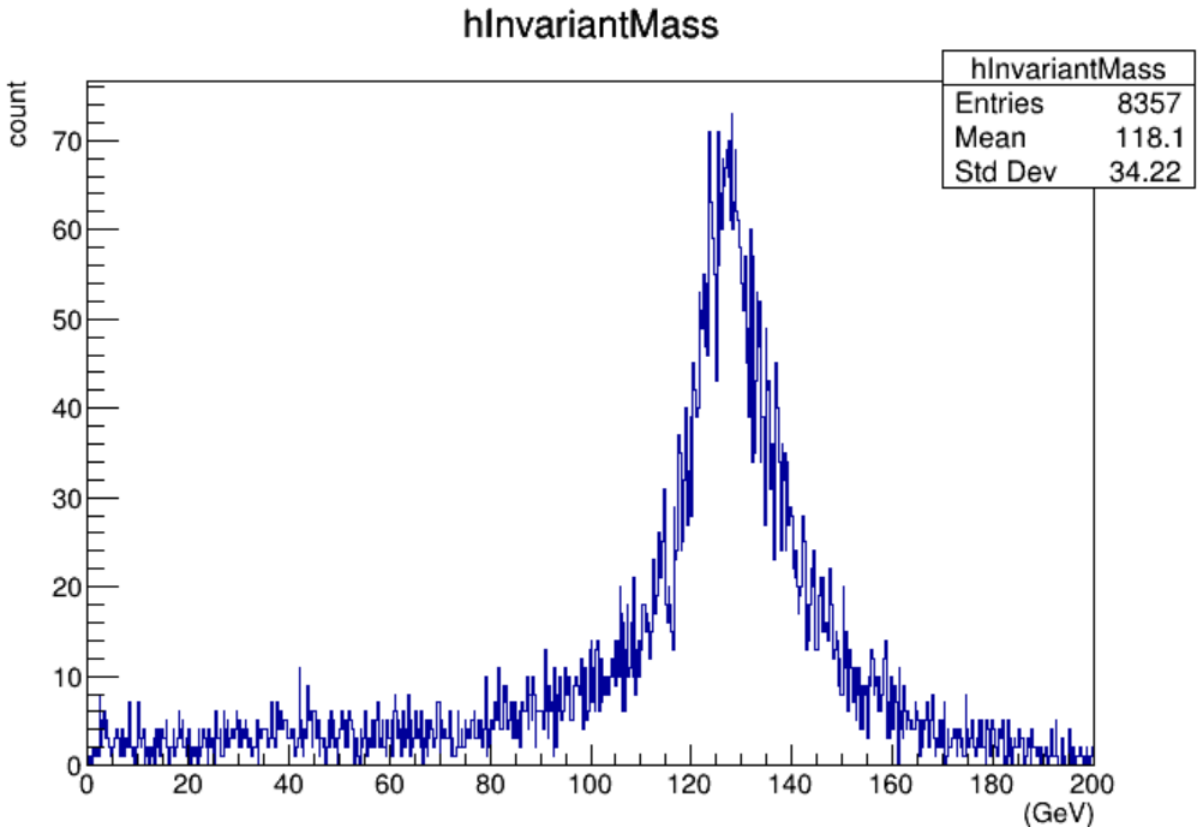
⑤ Use MakeClass to apply cuts

⑥ Perform steps ① ~ ⑤ again, adding BackGround as well.

Jet clustering (PandoraPFOs)

The data was reconstructed with two jets forced, except for the two identified leptons. (signal event)

Used data：rv02-02.sv02-02.mILD_l5_o1_v02.E250-SetA.I402004.Pe2e2h.eR.pL.n000.d_dstm_15089_0.slcio



The graph peaks at about 120 GeV
→ represents the mass of the reconstructed Higgs boson

The graph is widening because no cuts have been applied yet.

About the Cut

CM energy (GeV)		250		
Cut names	e/μ	condition	Sig.	Bkg.
Generated	e		3137	4512520
	μ		2917	4512520
# of e/μ track ID	e	$N_e >= 2$	2717	204403
	μ	$N_\mu >= 2$	2668	28175
Di-lepton mass (GeV)	e	$70 < M_{\ell\ell} < 110$	2208	34162
	μ	$80 < M_{\ell\ell} < 110$	2287	12901
Z direction	e	$\lvert\cos\theta\rvert < 0.8$	1797	21600
	μ	$\lvert\cos\theta\rvert < 0.8$	1889	8036
Di-jet mass (GeV)	e	$100 < M_{jj} < 140$	1394	2721
	μ	$115 < M_{jj} < 140$	1445	1955
Recoil mass (GeV)	e	$70 < M_{rec} < 140$	1184	1607
	μ	$70 < M_{rec} < 140$	1365	983
Significance (Efficiency)	e	$S/\sqrt{S+B}$	22.4 (37.8%)	
	μ		28.2 (46.8%)	

- Muon identification by calorimeter information
- Cutting of lepton masses to match Z masses
- Cutting in the Z direction for BGremoval of bosons
- Cutting jets to match Higgs mass
- Cut recoil masses to lepton pairs

These cuts were made for muon events

reference document: H.Ono「Evaluation of measurement accuracies of the Higgs boson branching fractions in the International Linear Collider」

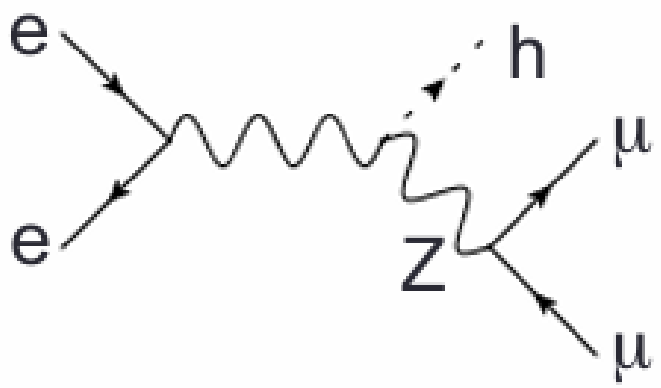
Signal Event Result

Results were normalized using cross section and luminosity.

$$Normalized\ Events = Events \times \frac{CrossSection}{Generated} \times Luminosity$$

Change in the number of events when cuts are made to signal events

cut name	reference	Signal events (my data)
Generated	2917	2717.275
track ID	2668	2286.45181
Di-lepton mass (GeV)	2287	2109.24529
Z direction	1889	1726.54424
Di-jet mass (GeV)	1445	1066.81576
Recoil mass (GeV)	1365	953.338555
	crossSection: 10.8691 fb	



The signal events did not differ greatly from the reference, but differences were observed in the Di-Jet Mass and Recoil Mass.

About the Background

The main background for lepton events is Z boson or W boson-derived events.
The following four events were used in the analysis.

- ZZ_semileptonic
- ZZ_leptonic
- WW_semileptonic
- WW_leptonic

semilptonic : Events contain one lepton pair
leptonic : Events contain two lepton pairs

BackGround Events Result

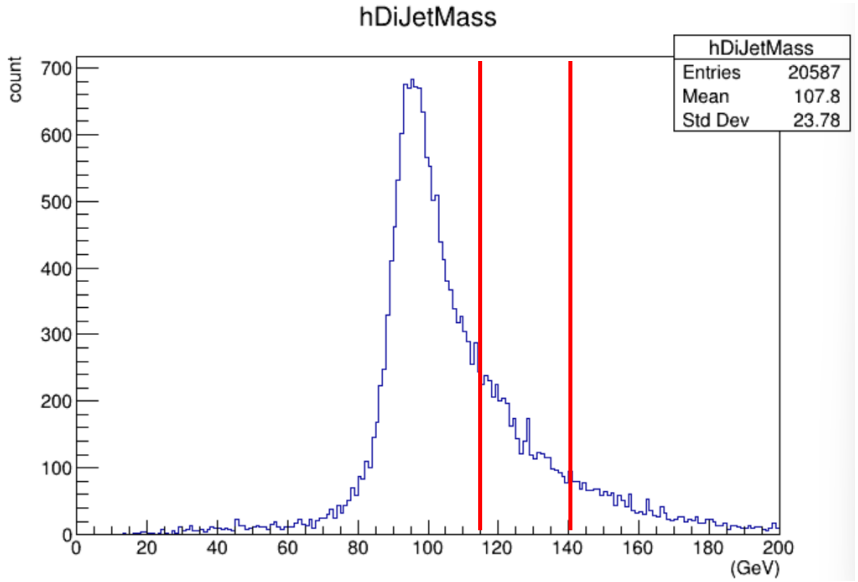
$$Normalized\ Events = Events \times \frac{CrossSection}{Generated} \times Luminosity$$

This one does not deviate greatly from the reference as well.
However, Di-Jet Mass and Recoil Mass differ slightly from the reference.

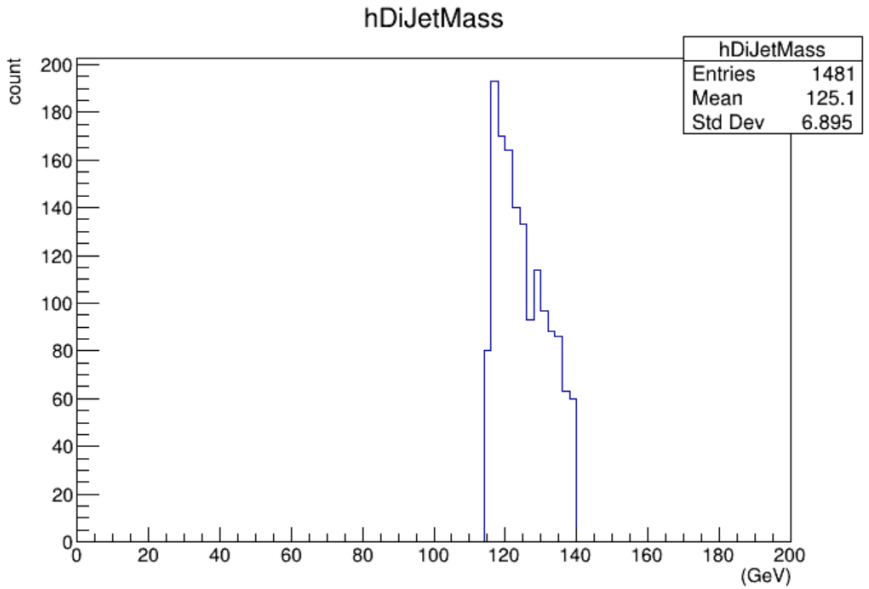
Normalized						
cut name	reference	ZZsemi	WWsemi	ZZlepton	WWlepton	Total
Generated	45122520	209519.75	4694775	22239.35	390855	5317389
track ID	28175	19749.92259	443.3954167	1861.110998	4693.896117	26748.33
Di-lepton mass (GeV)	12901	12277.62711	104.3283333	1323.114416	1564.632039	15269.7
Z direction	8036	7620.993104	78.24625	509.86896	1074.30721	9283.416
Di-jet mass (GeV)	1955	1420.781821	0	17.63557261	0	1438.417
Recoil mass (GeV)	983	1321.969851	0	12.50116539	0	1334.471
cross section		838.079 fb	18779.1 fb	88.9574 fb	1563.42 fb	

Consideration (Di-Jet Mass)

This is the Di-Jet Mass distribution of ZZ_semiLeptonic, the largest proportion of background events



115<M<140
Cut

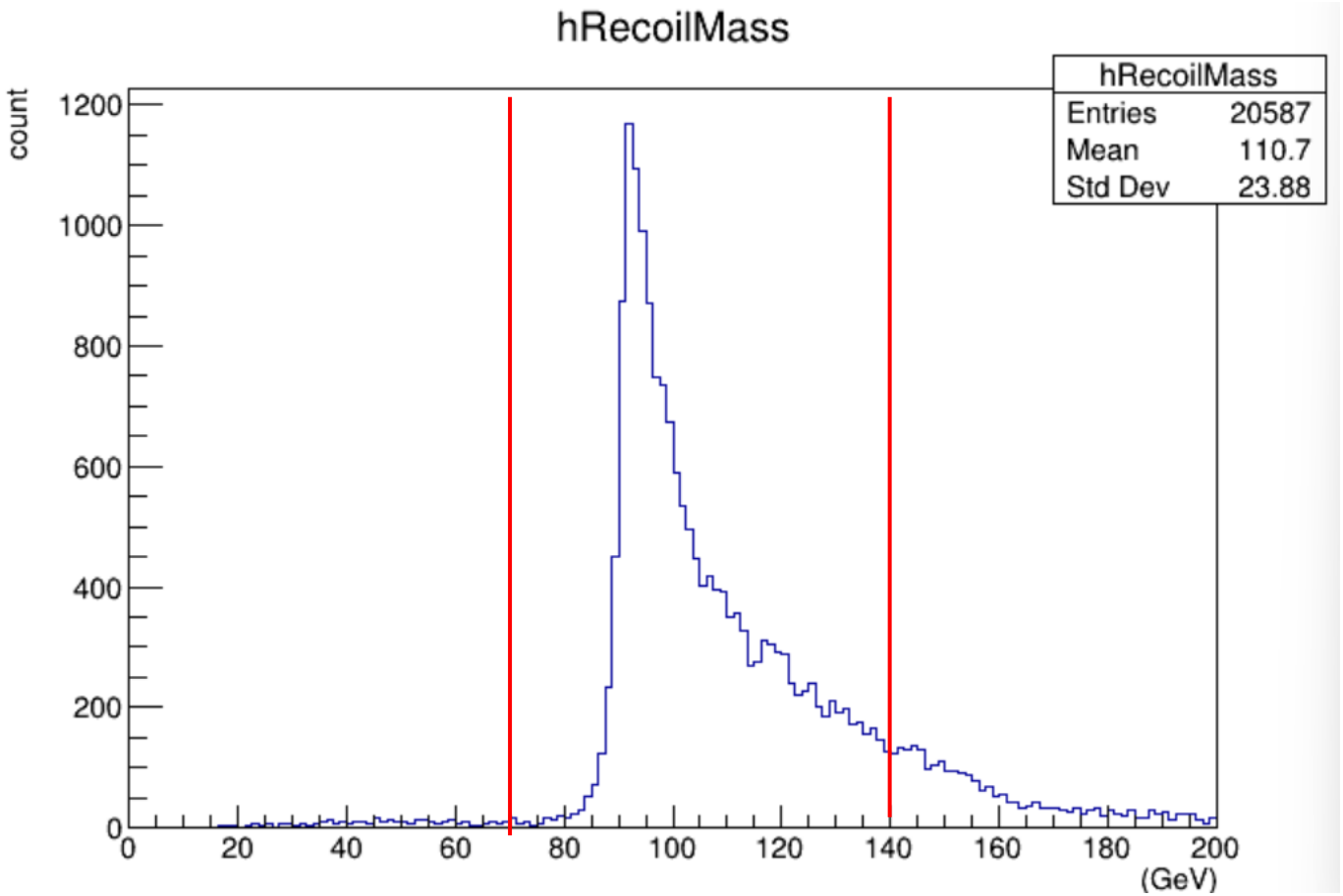


In Di-Jet Mass, the cut is made at 115<M<140

The graph with the cut shows a small peak at 125 GeV.
The invariant mass of the jet is included in one case.

Consideration (RecoilMass)

This is the RecoilMass distribution of ZZ_semiLeptonic



In Recoil Mass, the cut is made at 70<M<140.

However, the graph shows that most of the events are included in that range, so the range may need to be narrowed.

Maybe 80<M<140 would be okay?