higgs recoil mass study @ 250GeV ILC

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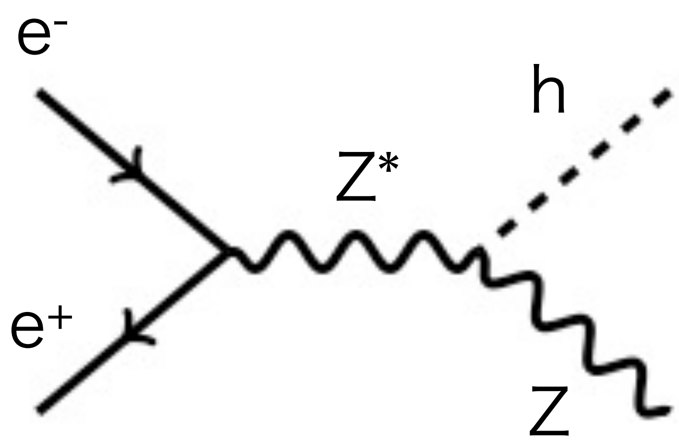
Outline

- What is “recoil mass” ?
- Why “qqH” ?
- background estimation, cut optimization
  - Method
  - Result
- Higgs recoil mass with “cut”
- Summary & Next step

What is recoil mass ?



The typical higgs production mode at ILC is “higgs-strahlung”.

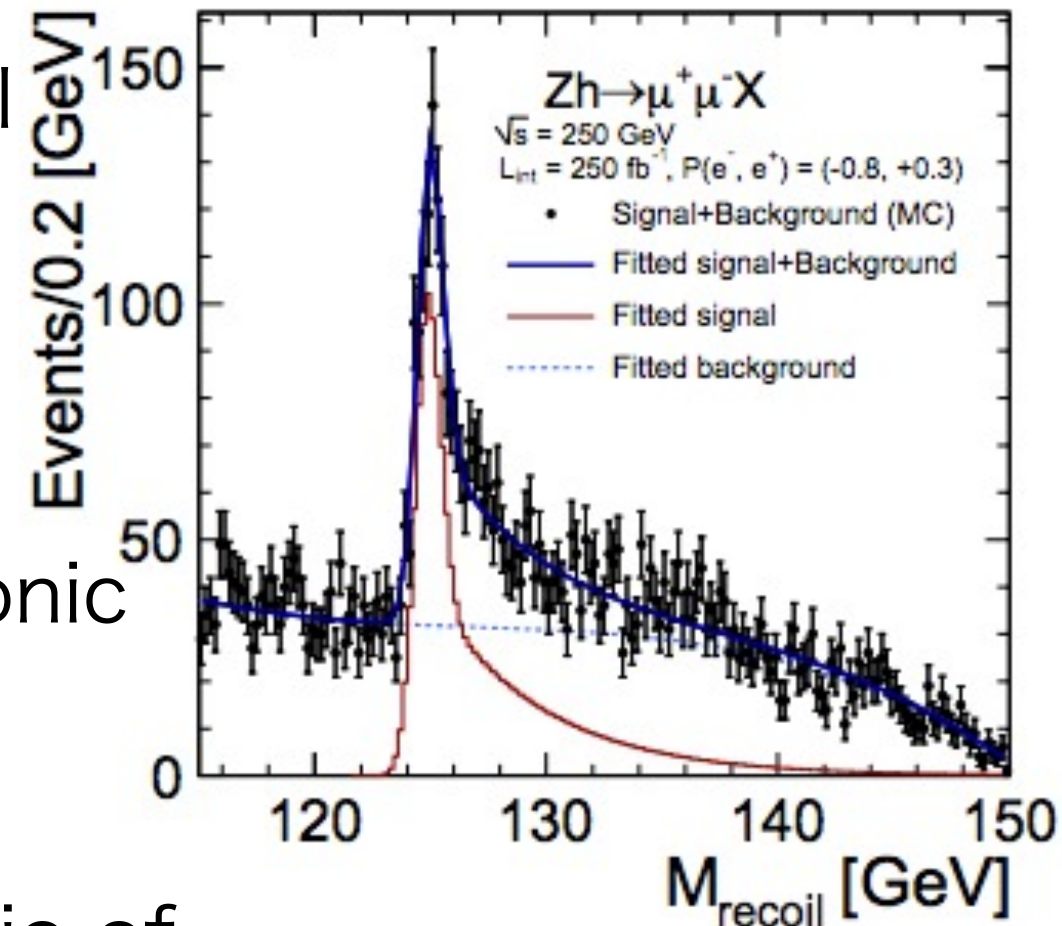
In this channel, we don’t have to look any higgs because we can use four momentum conservation.

$$m_{\mathrm{recoil}}^2 = (\sqrt{s} - E_Z)^2 - |\, \vec{p}_Z \,|^2$$

(Initial 4-momentum of e^+e^- collision is well determined.)

To use four momentum conservation,
we should reconstruct Z mass as well as possible.

Why qqH ?



In recoil mass study, leptonic channel such as Z -> e^+e^-, mu^+mu^- has very good signal/back-ground ratio.

BUT, the branching ratio of Z -> leptonic is ~3.5% for each generation.

On the other hand, the branching ratio of

Z -> hadronic is ~70%.

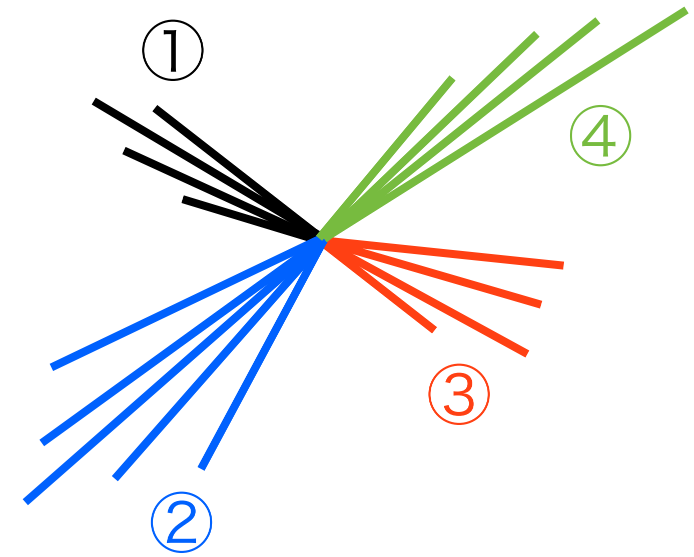
This is the big motivation for qqH study.
Fortunately, detector performance, JER ~3.5% with PFA, support this qqH study. (ex. ZZ,WW separation)

Event list

- The recoil higgs mass against Z->hadronic with DBD sample.
- Polarization both (-0.8,0.3) and (0.8,-0.3) are used.
- for background estimation,
  two kinds of background were considered.
  - ZZ -> qqqq.
  - WW -> qqqq.

DBD sample is created with mixed final states,
so we select from qqqq events with flavors consistent to ZZ/WW event
that two MC di-jet mass within 10 GeV from Z mass for ZZ events
and two MC di-jet mass within 10 GeV from W mass for WW events.

reconstruction for background rejection



1.Forced 4-jets clustering for each event.
2.Reconstruct every pair of jets.
(1-2,1-3,1-4,2-3,2-4,3-4)
3.Record the pair which is the nearest to Z mass as horizontal axis. (ex. 2-3)
4.Reconstruct the rest pair. (ex. 1-4)
5.Record the rest pair mass as vertical axis.
6.Repeat 2-5 for every event.

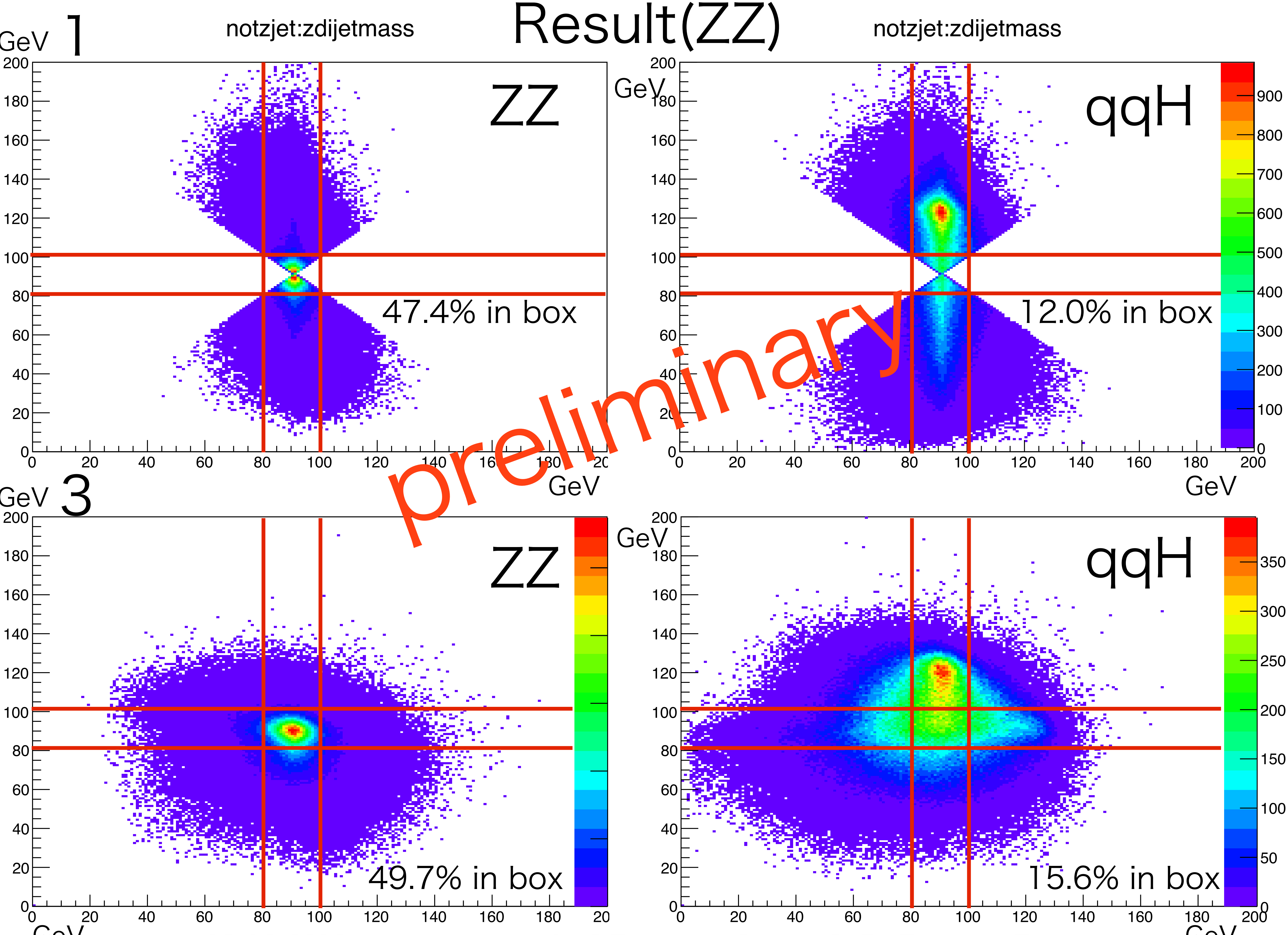
Comparison of jet pairings

- We checked three types of jet pairing,
  - 1. select minimum (Z/W mass - di-jet mass)^2 from every pair (same method as previous slide)
  - 2. select minimum (Z/W mass - di-jet mass)^2 from pairs (1-2,1-3,1-4)
  - 3. select minimum (Z/W mass - di-jet mass)^2 + (Z/W mass - restjetmass)^2 from every pair
  - Set the rejection box at (81-101,81-101) for ZZ and (70-90,70-90) for WW

	ZZ(WW)	qqH,Z(qqH,W)
1	47.4% (56.9%)	12.0% (9.2%)
2	49.8% (57.1%)	13.7% (10.6%)
3	49.7% (63.9%)	15.6% (11.7%)

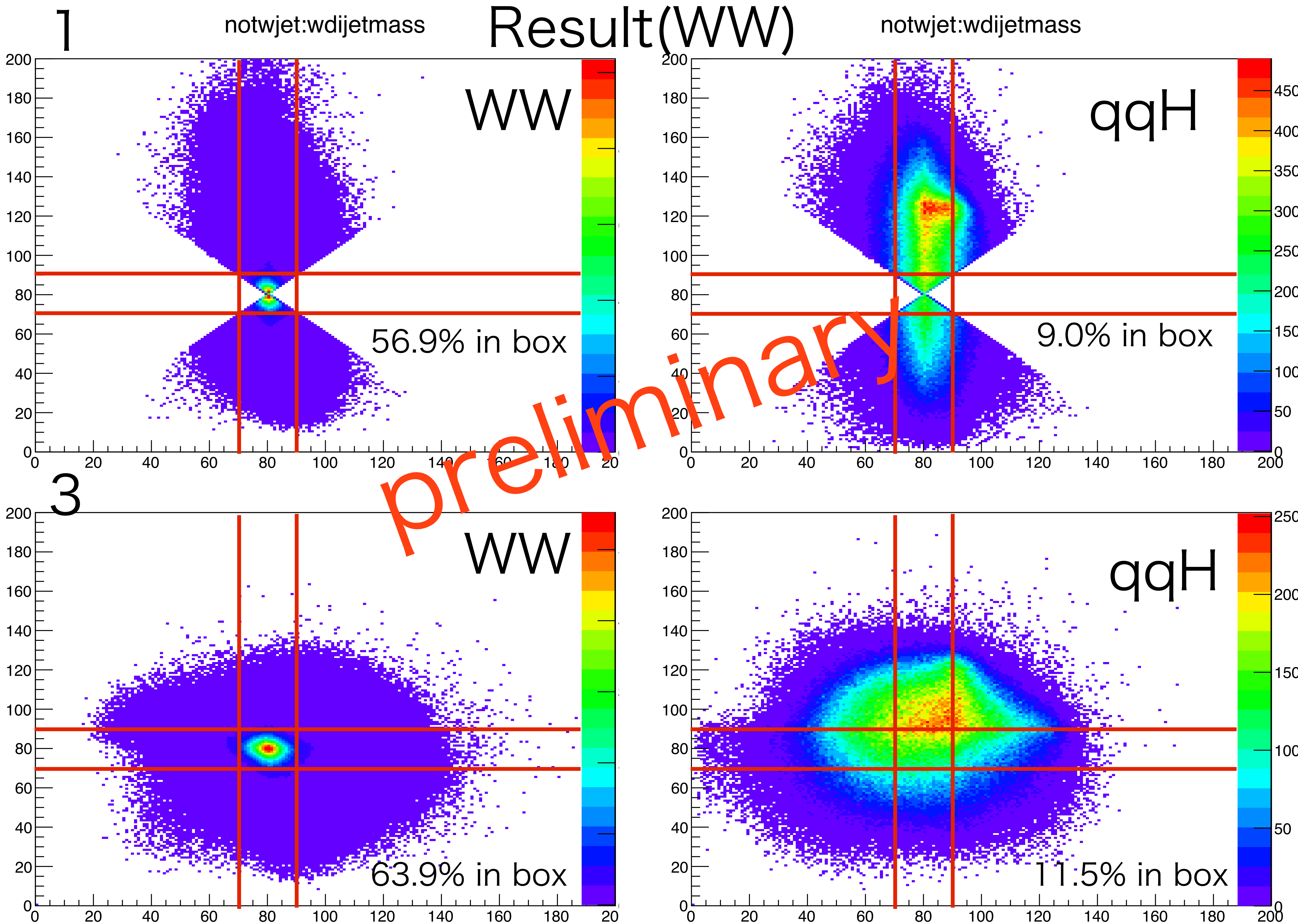
Adopt 1. for the following analysis

Result(ZZ)



1
notzjet:zdijetmass
ZZ
47.4% in box
notzjet:zdijetmass
qqH
12.0% in box
3
ZZ
49.7% in box
qqH
15.6% in box
GeV
preliminary

Result(WW)



1
notwjet:wdijetmass
WW
56.9% in box
notwjet:wdijetmass
qqH
9.0% in box
3
WW
63.9% in box
qqH
11.5% in box
preliminary

Signal efficiency with cut

decay mode	counts	ZZ cut	WW cut	both cut	(%)
qqH all eLpR	46,401	41,110	42,438	38,003	81.9%
qqH all eRpL	31,344	27,772	28,661	25,676	81.9%
H -> bb eLpR	25,734	22,830	23,761	21,271	82.7%
H -> bb eRpL	17,282	15,322	15,931	14,259	82.5%
H -> WW eLpR	10,656	9,292	9,584	8,468	79.5%
H -> WW eRpL	7,235	6,315	6,518	5,764	79.7%
H -> ZZ eLpR	1,379	1,211	1,268	1,129	81.9%
H -> ZZ eRpL	941	824	870	774	82.2%
H -> $\gamma\gamma$ eLpR	172	161	160	152	88.2%
H -> $\gamma\gamma$ eRpL	123	113	114	106	86.3%
ZZ eLpR	129,454	70,147	110,049	60,482	46.7%
ZZ eRpL	59,676	32,529	50,165	27,724	46.5%
WW eLpR	1,682,990	1,474,368	737,943	661,742	39.3%
WW eRpL	116,661	101,945	50,375	45,235	38.6%

preliminary

reconstruction for recoil mass

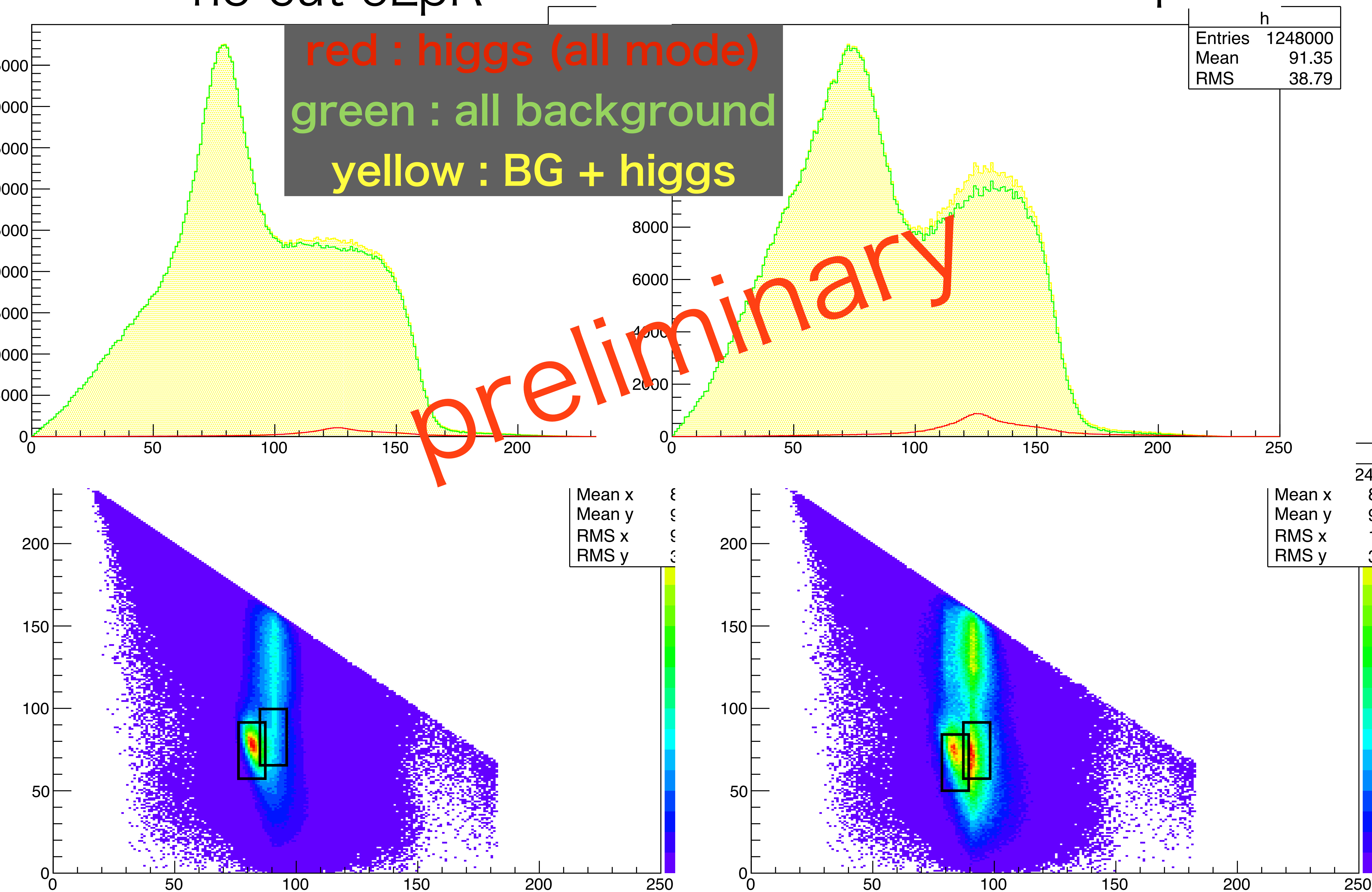
- Apply the rejection box to reduce WW/ZZ background (as shown in previous slide)
- We used "**y-value clustering**" to study higgs recoil mass.

$$y = \frac{2\min(E_i^2, E_j^2)(1 - \cos\theta_{ij})}{Q^2}$$

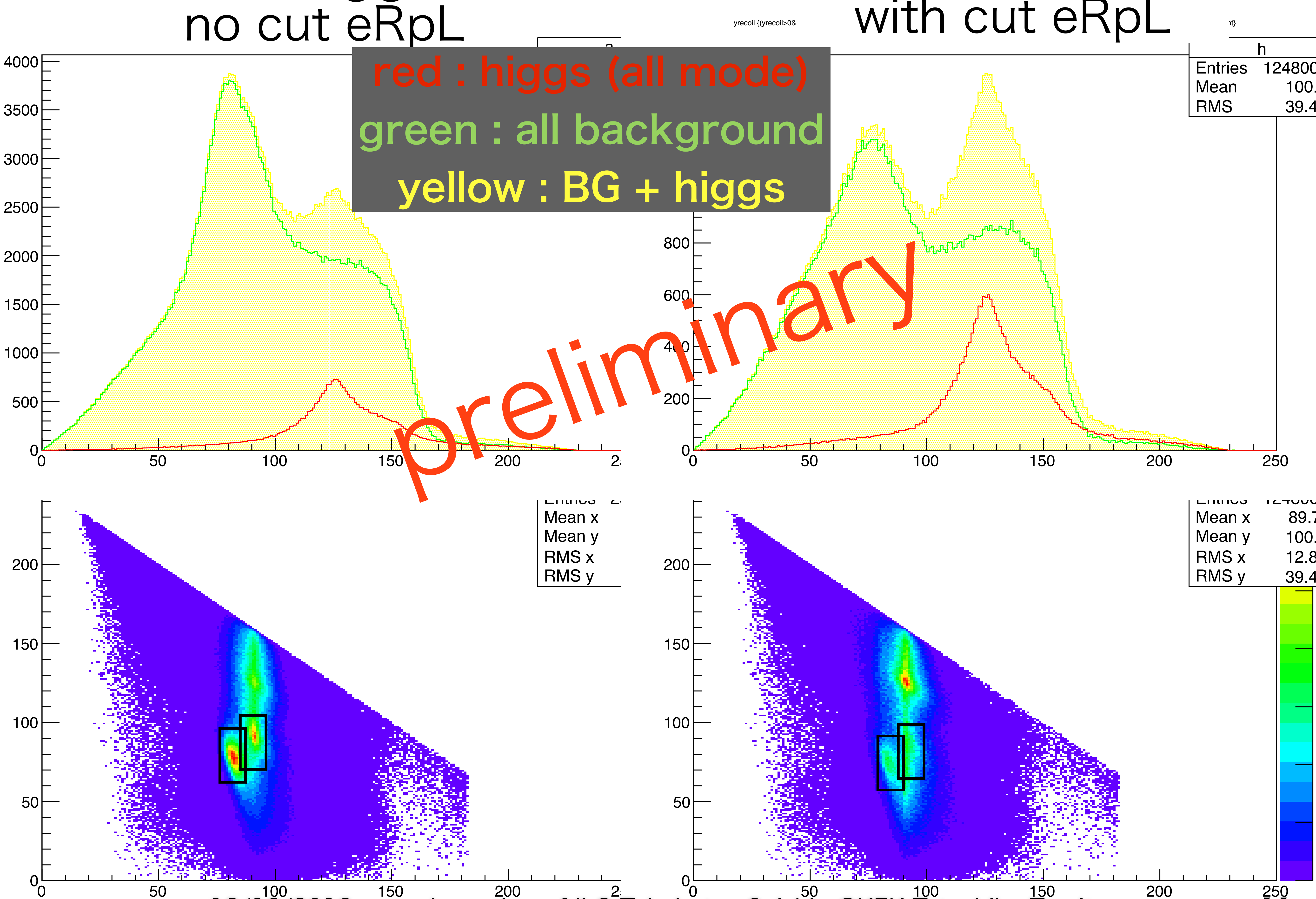
in this time, y-threshold fixed to 0.005

Higgs recoil mass with “cut”

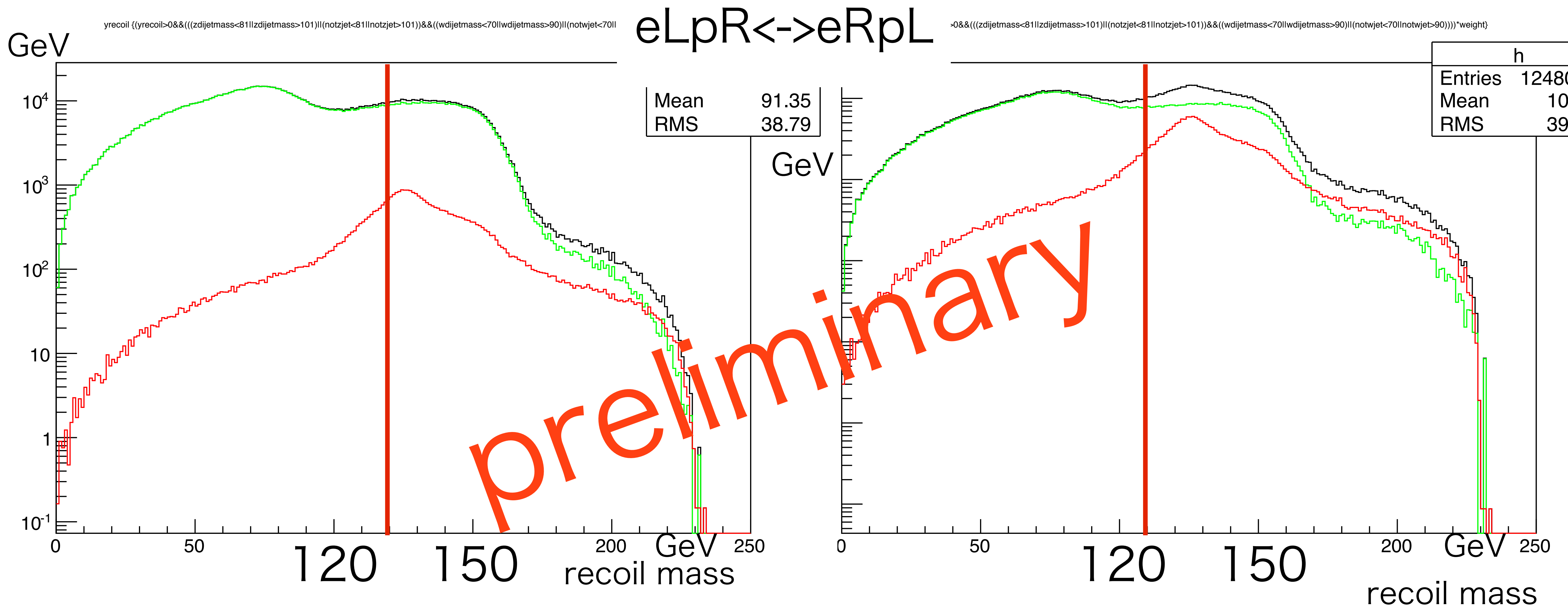
no cut eLpR | with cut eLpR



Higgs recoil mass with “cut”



Significance with cut



events with recoil mass > 120GeV(eLpR), >110GeV(eRpL)

	qqH	ZZ/WW	significance
eLpR	26,250	363,995	42.0 σ
eRpL	20,894	41,490	83.7 σ

Summary & Next step

- We started higgs recoil mass study
  using qqH channel at 250GeV ILC.
- BG study using forced 4-jets clustering.
  - ZZ reduced ~54%, WW reduced ~61%.
- Recoil mass study using y-value clustering.
  - signal efficiency with cut ~82%.
  - higgs recoil mass is clearly separated from BG.
  - The next step -> optimize cut.
    optimize jet pairing with y-value.
    consider other BG (qqlv etc...)
    applying other cuts (jet pT,angular cuts etc.)