



# RHN study

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S O K E N D A I

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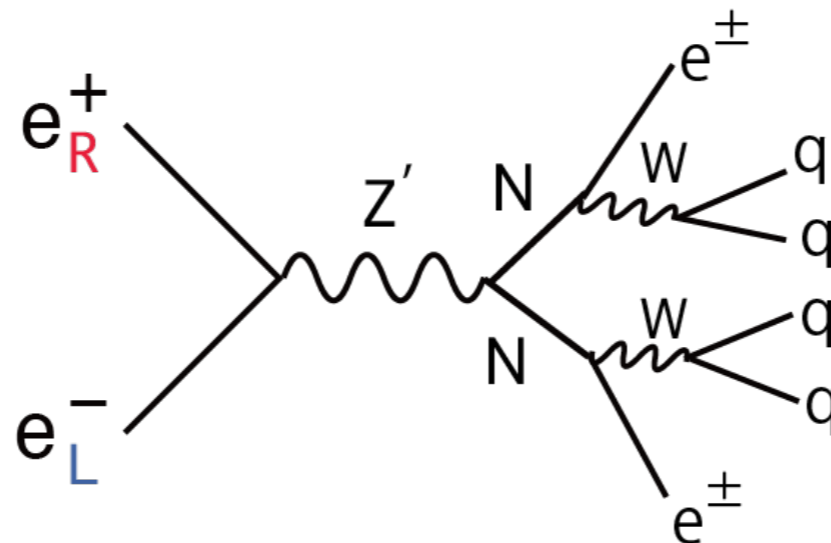
# Motivation

Why do we find the right handed neutrino(RHN)?

- ▶ key to matter > anti-matter
- ▶ “why is neutrino mass small?”
- ▶ Unification of quark and lepton ...etc

Right handed neutrino is **Majorana** particle. ( $\nu = \bar{\nu}$ )

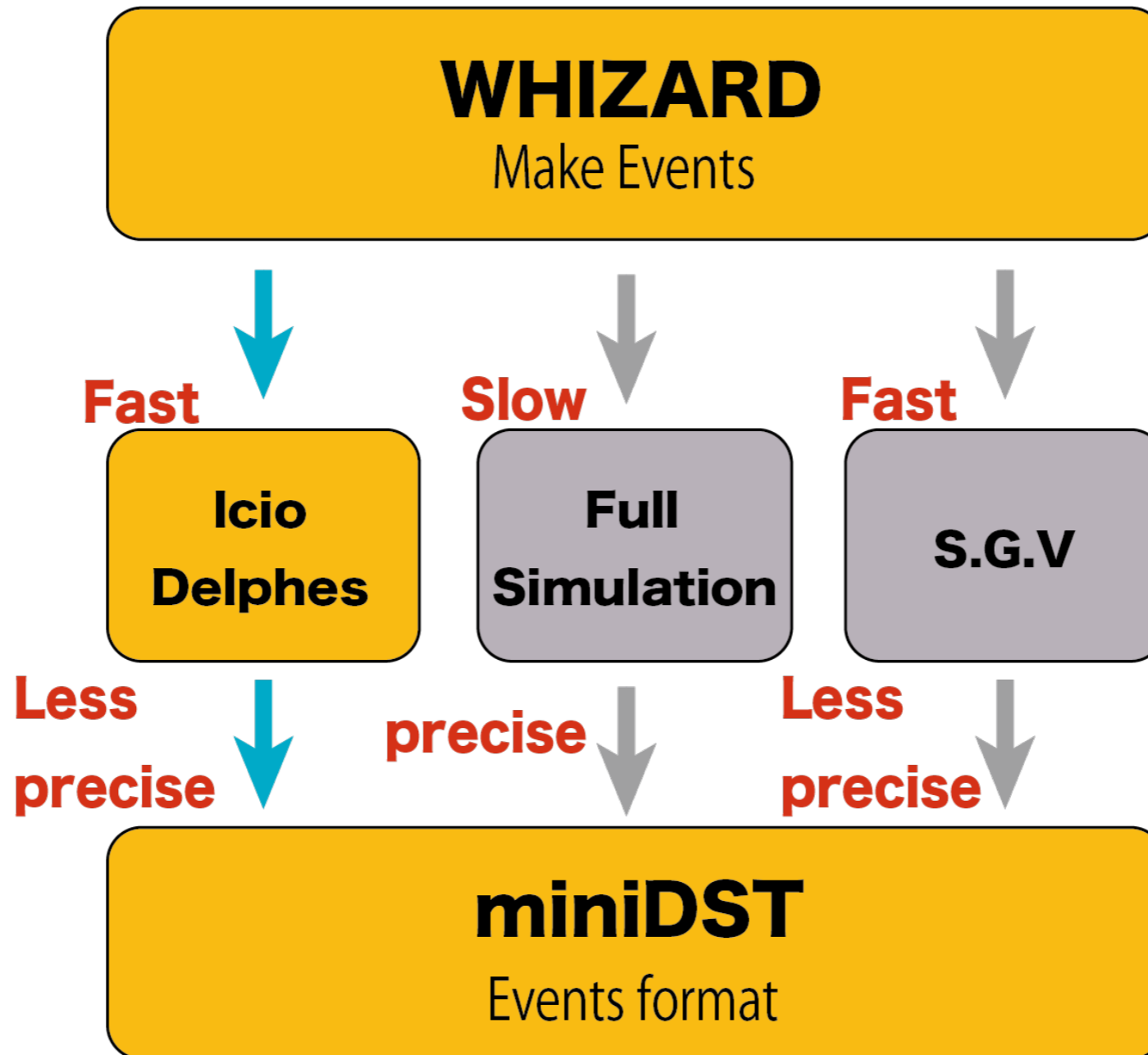
➔ RHN **pair** production <sup>OK!</sup>



Lepton # violation!

No SM BG!

# Analysis tool



## Fast simulation

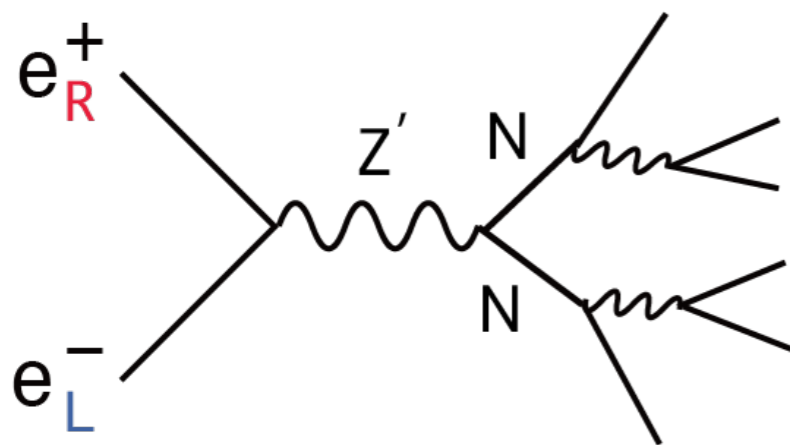
- ▶ All detector parameter is adjusted by “ILC cards”
- ▶ Using smear function

# Event conditions

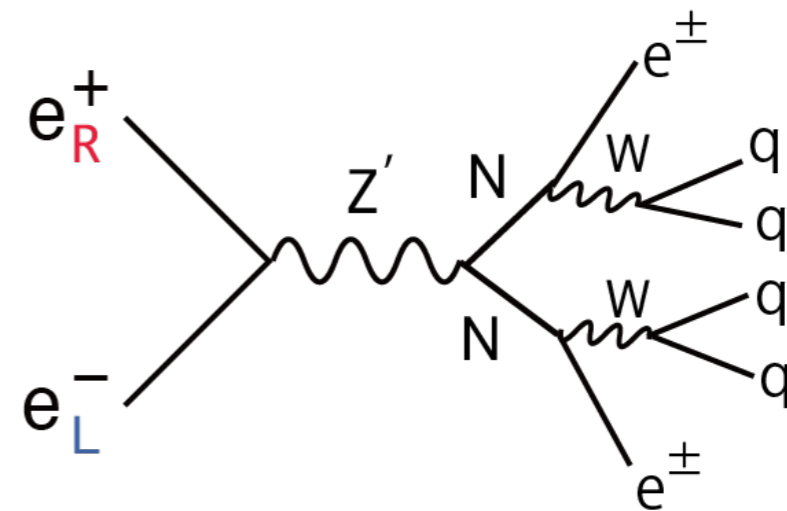
- ▶  $\sqrt{s} = 500$  [GeV]
- ▶ Generated event # = 5000
- ▶  $g_{1p}$  : coupling constant between  $Z'$  and RHN
- ▶  $|V_{eN}|^2$  : the “light-heavy” neutrino mixing matrix

$M_N$ [GeV]	$M_{Zp}$ [TeV]	$g_{1p}$	$ V_{eN} ^2$	$\Gamma_N$ [GeV]
100	7	1	0.001	1E-04
200	7	1	0.005	2E-02
100	3	0.05	0.001	1E-04
200	3	0.05	0.005	2E-02

RHN can decay with all possible processes

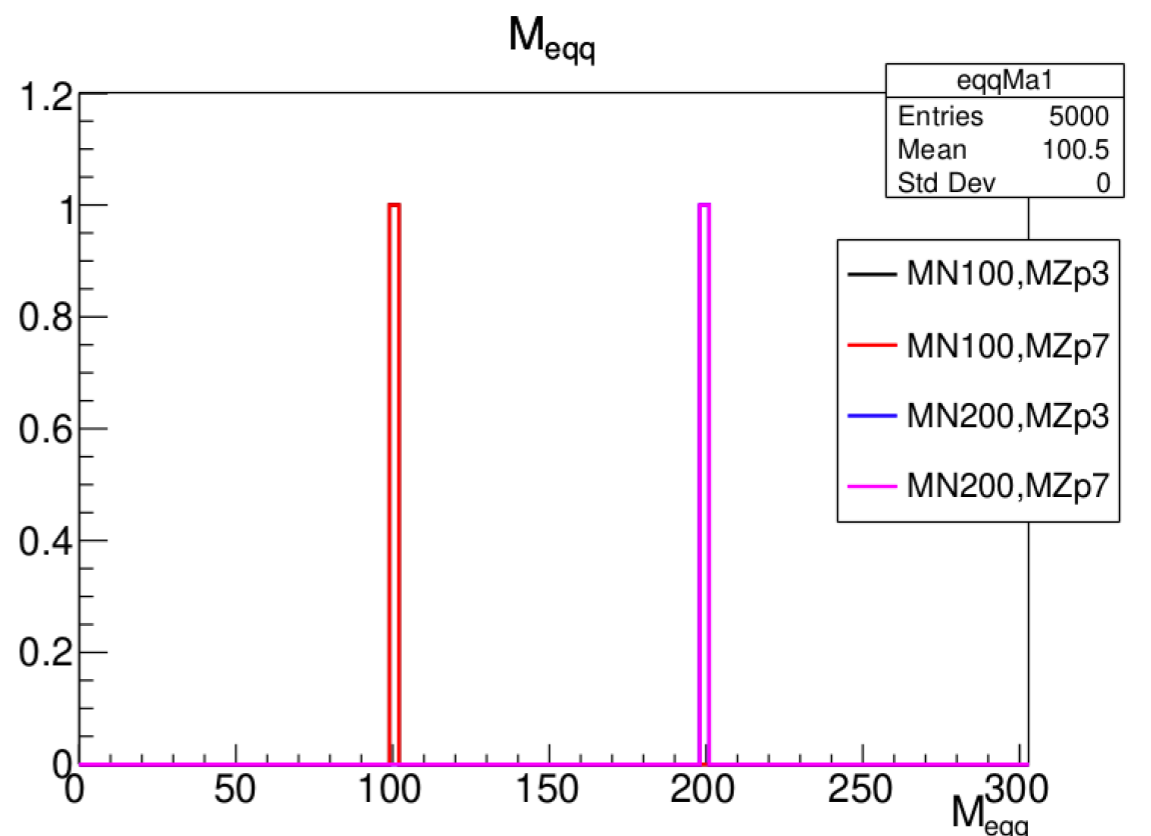
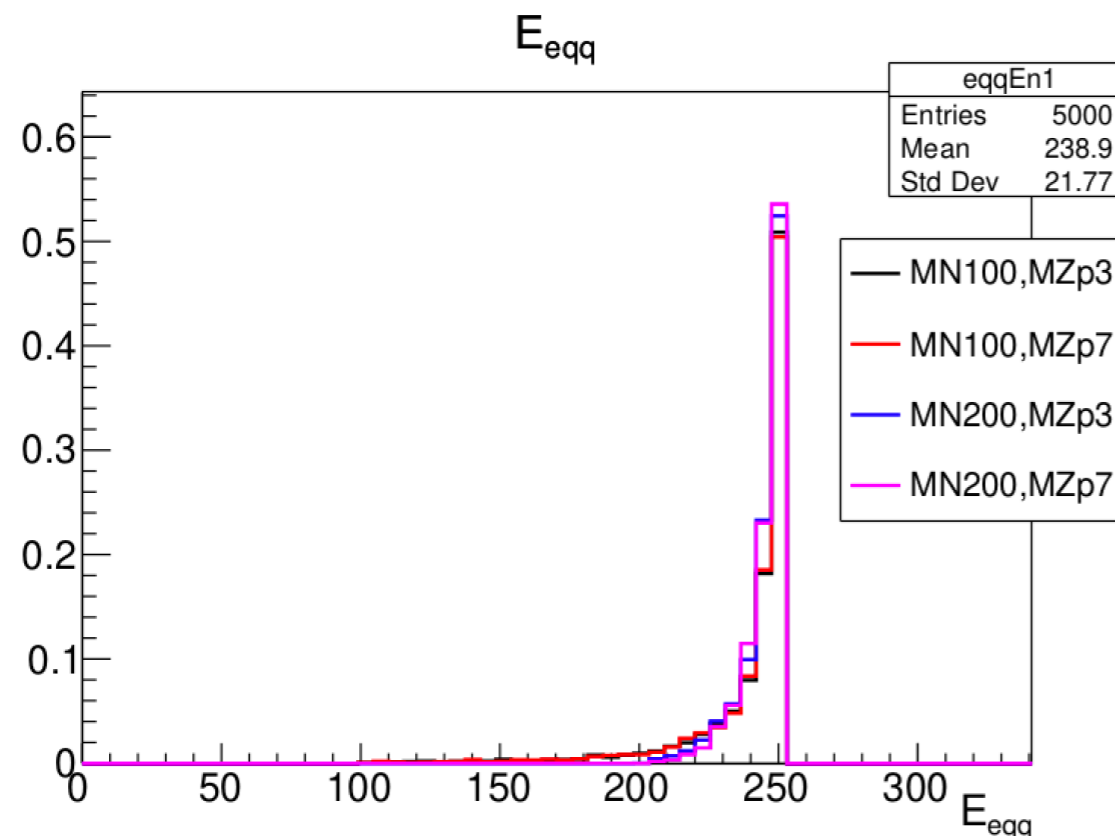
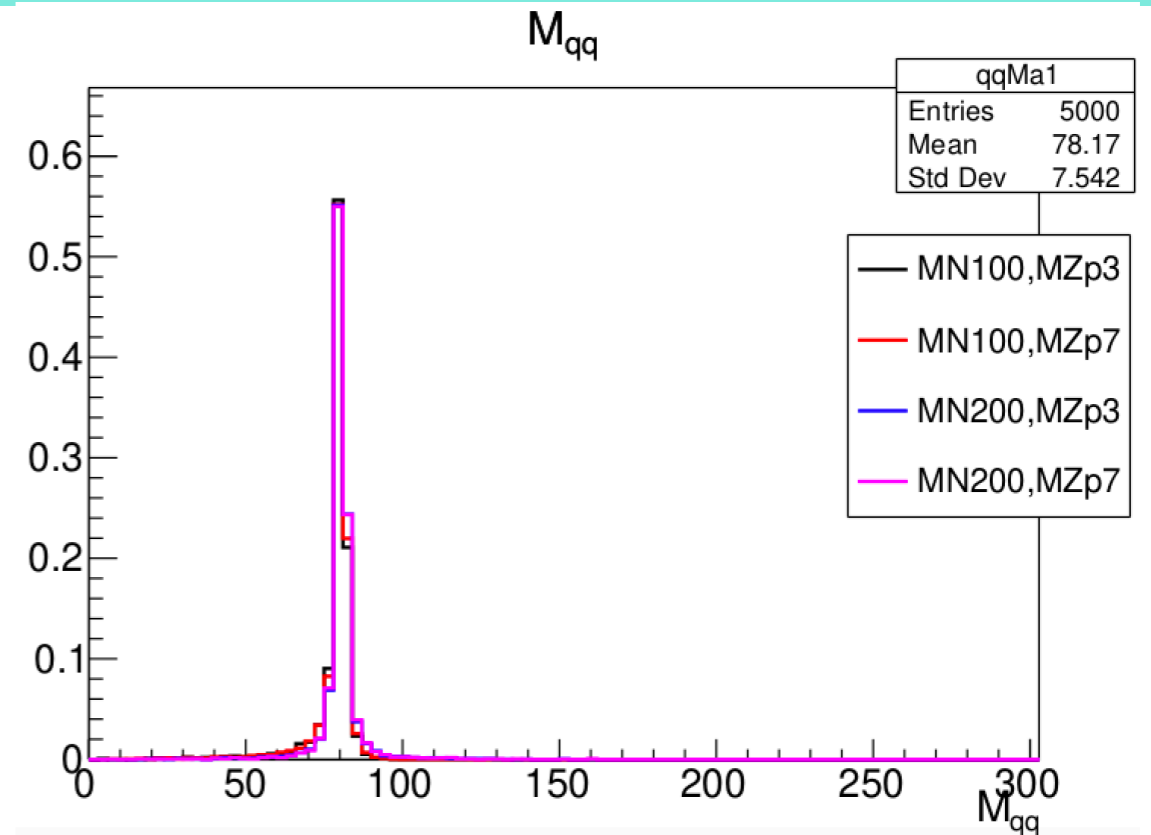
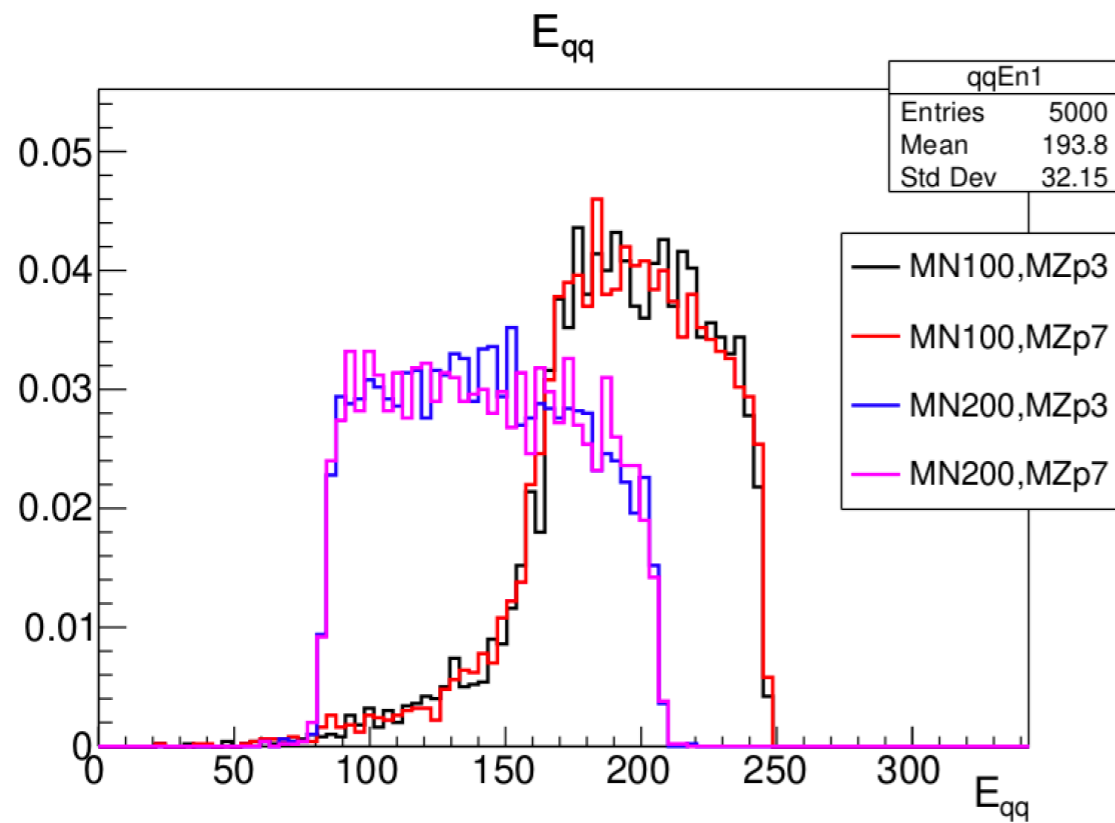


➔  
We focus on

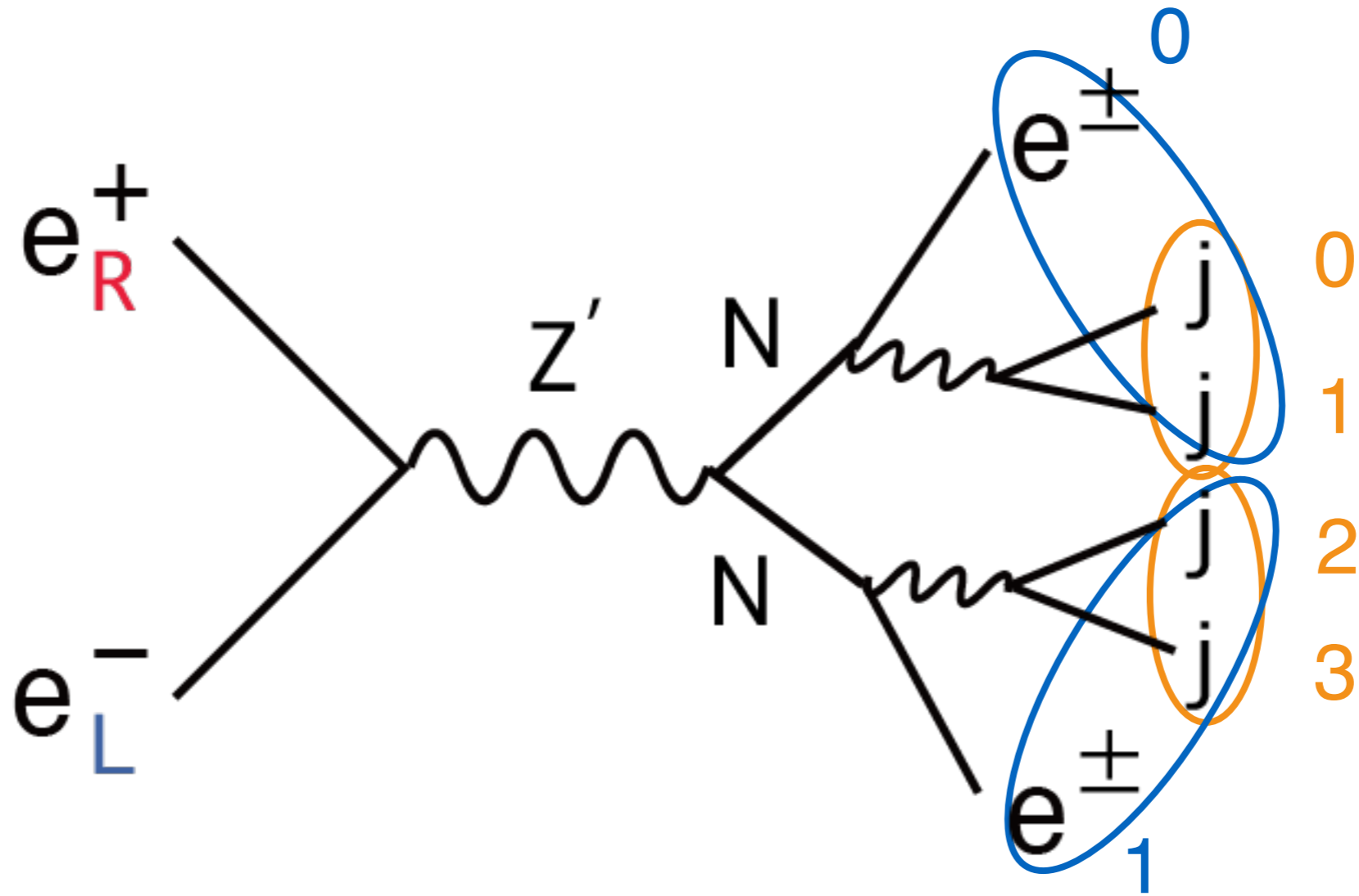


**Dominant decay mode** (BR  $\sim 36\%$ )

# MC particles - Energy, Mass



# Reconstructed particles



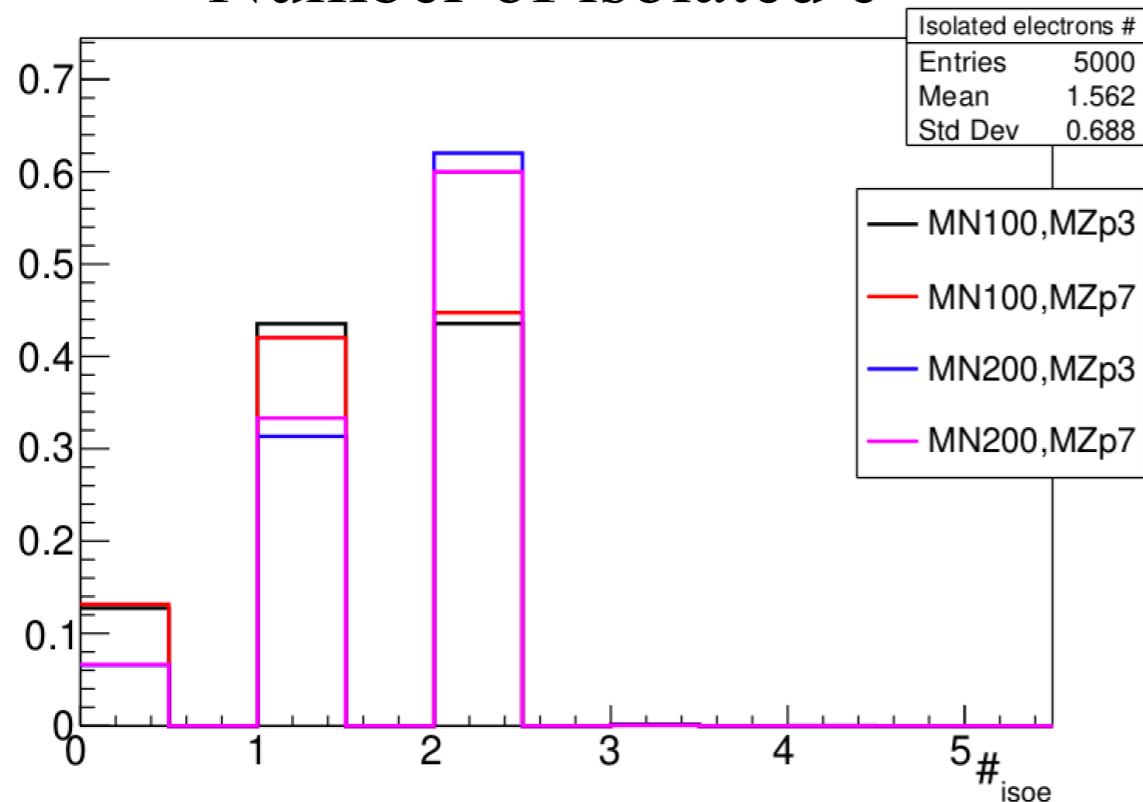
Label  $j$  as 0,1,2,3 and  $e$  as 0,1



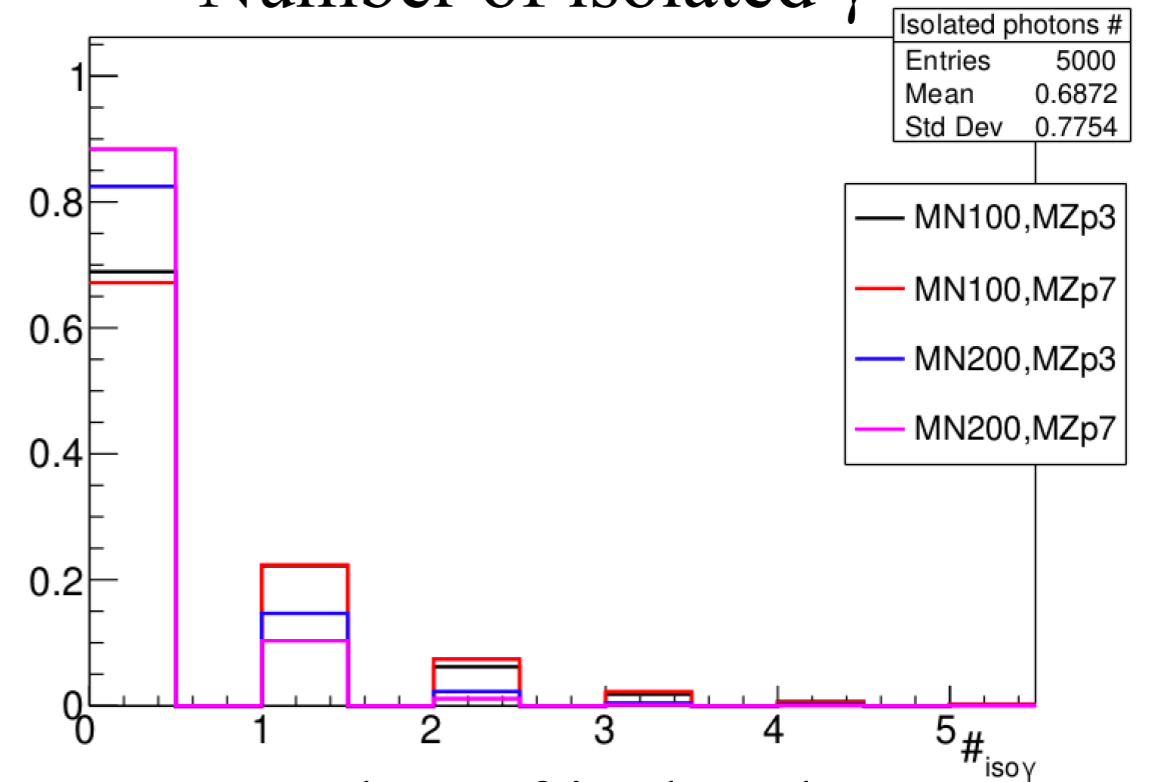
Search for the correct combination of  $jj$  and  $jje$

# Reconstructed particles - Isolated e, $\gamma$ , $\mu$

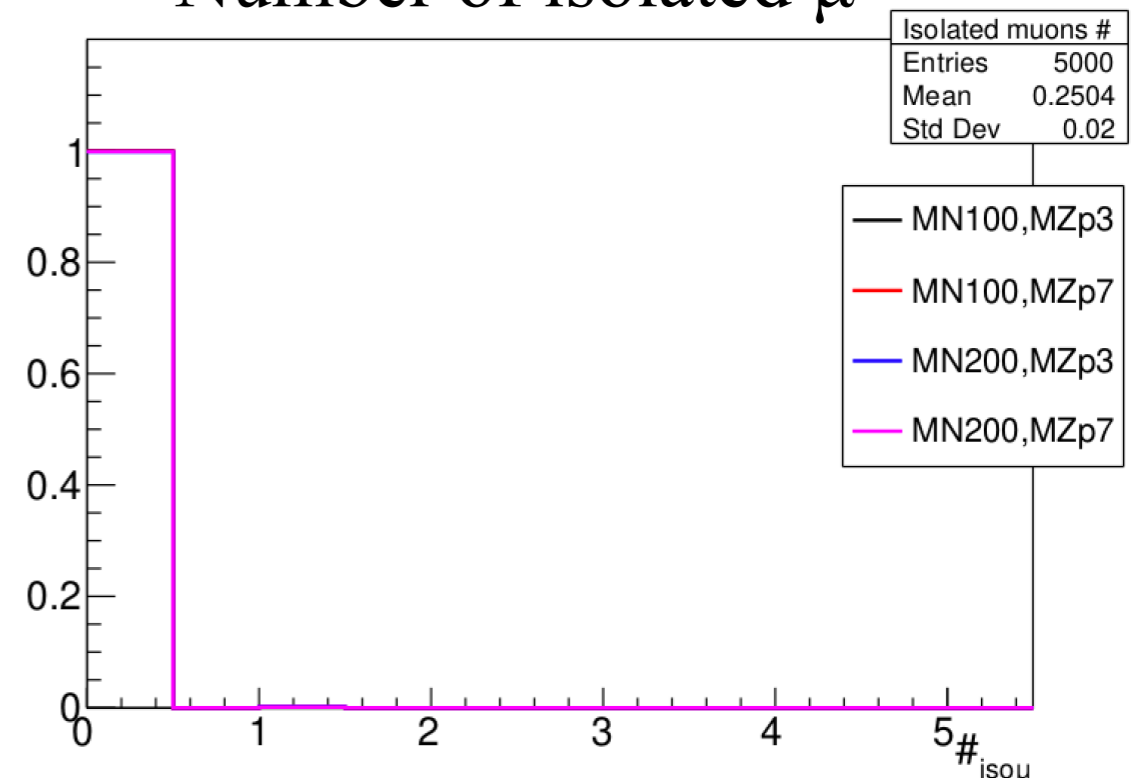
## Number of isolated e



## Number of isolated $\gamma$

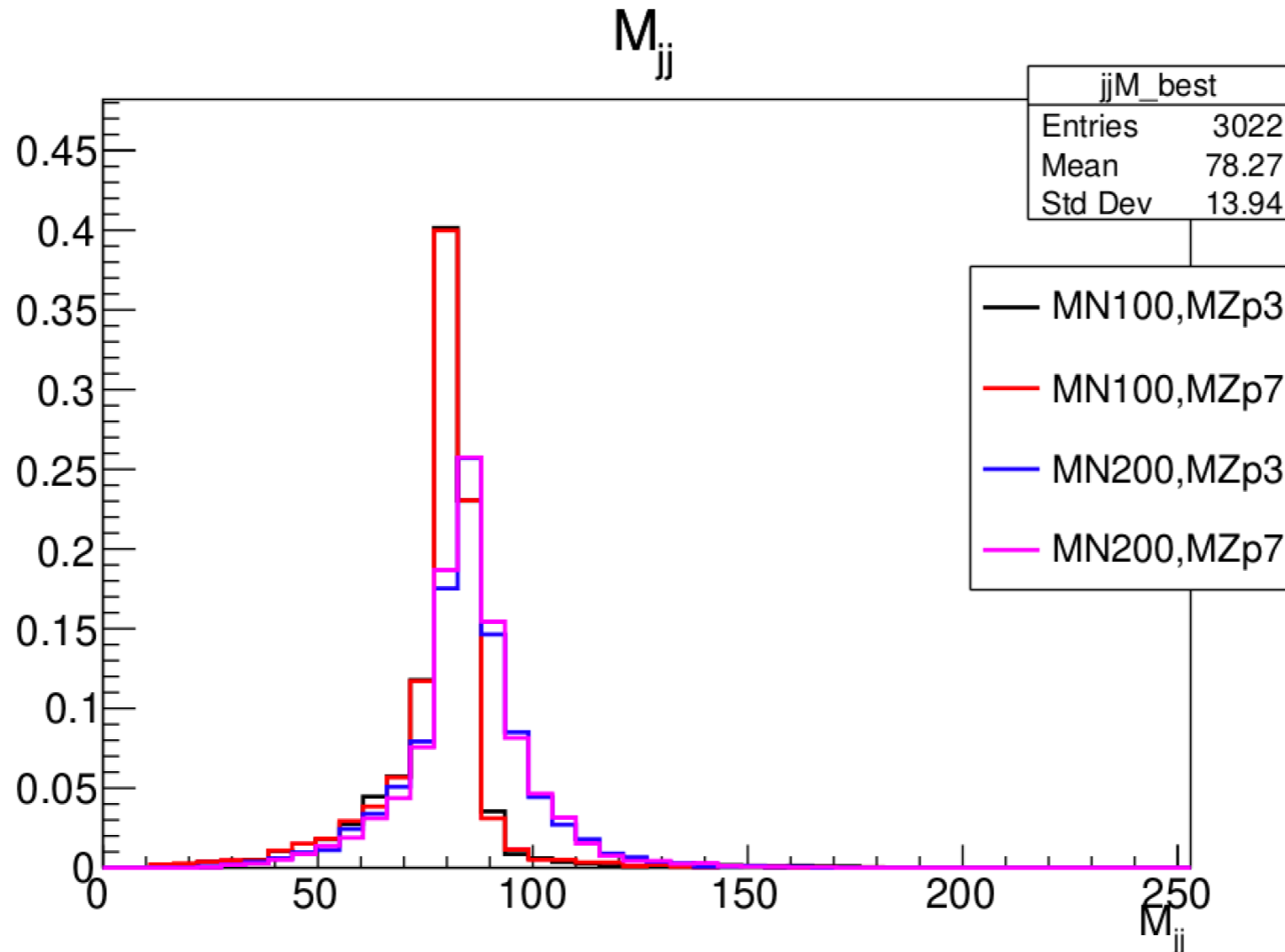


## Number of isolated $\mu$



Isolated electron # = 2  
Isolated photon # = 0

# Reconstructed particles - Jets



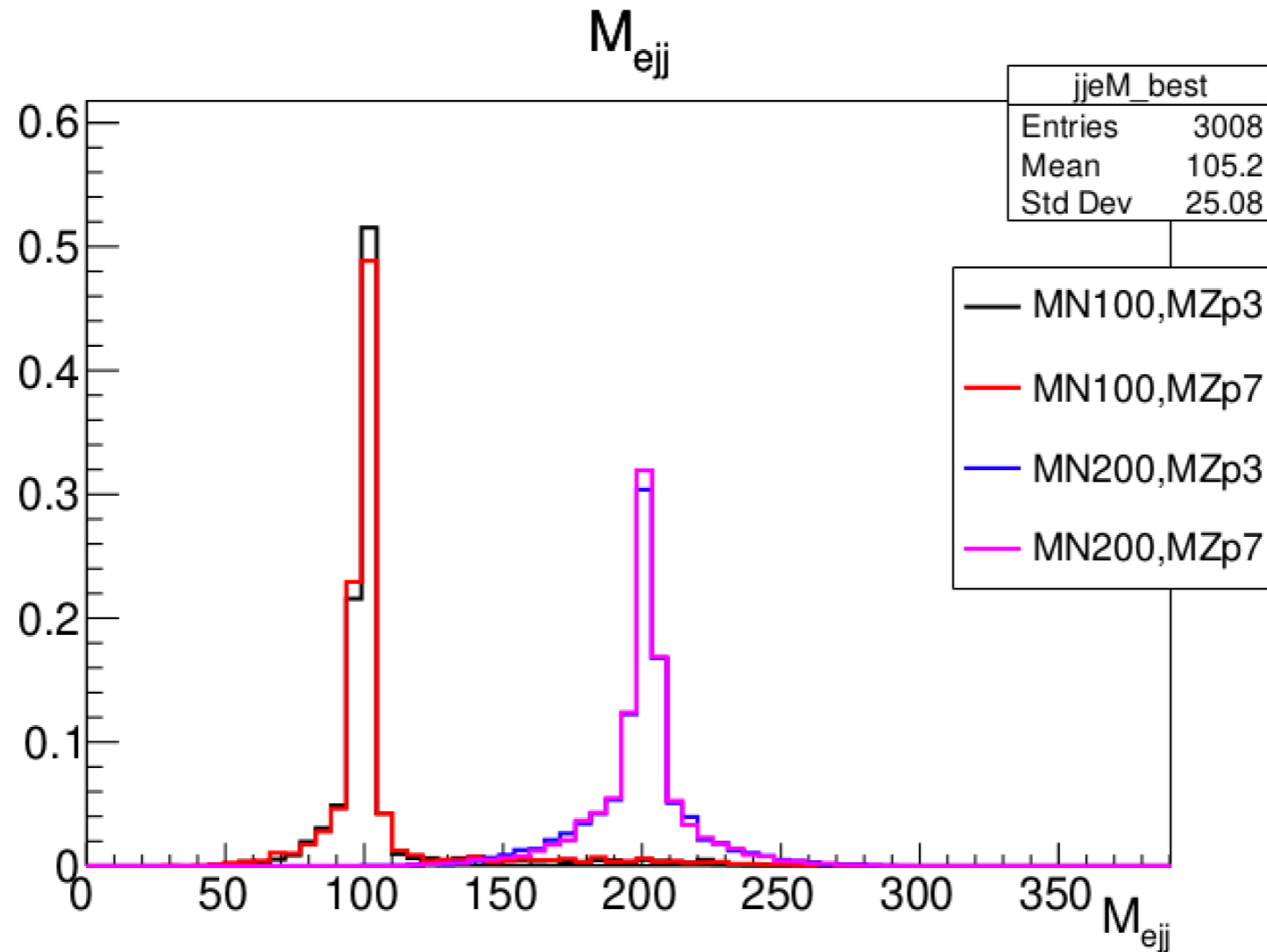
- Isolated electron # = 2, Isolated photon # = 0
- Jet pair 1  $\rightarrow$   $m_{jj1}$ , Jet pair 2  $\rightarrow$   $m_{jj2}$

$$F = \text{abs}(m_{jj1} - m_w) + \text{abs}(m_{jj2} - m_w)$$

$\rightarrow$  Choose combination with minimum F



# Reconstructed particles - Jets



- Isolated electron # = 2, Isolated photon # = 0
- Best Jet pair 1 + iso e  $\rightarrow$  mjje1, Best Jet pair 2 + iso e  $\rightarrow$  mjje2

We expect for “ $M_{jje1} = M_{jje2}$ ”

$$F = (M_{jje1} - M_{jje2})^2$$



Choose combination with minimum F

# Next steps

- ▶ Analysis 6f and 4f background processes
- ▶ More understanding the property of jets combinations



Back up

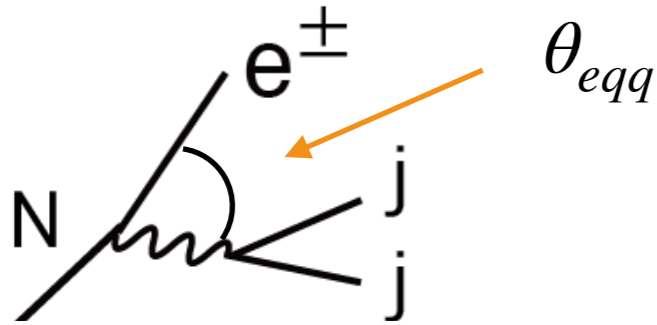
# # events at ILC

Cross section[fb]

$M_N$ [GeV]	$M_{Zp}$ [TeV]	$g_{lp}$	$ V_{eN} ^2$	$\Gamma_N$ [GeV]	$\sigma(ee \rightarrow N N)$	#	$\sigma(ee \rightarrow \nu N)$	#
100	7	1	0.001	1E-04	7.03E-02	100	1.70E+02	270000
100	7	1	0.005	5E-04	5.57E-01	900	8.51E+02	1360000
200	7	1	0.005	2E-02	2.76E-01	430	7.12E+02	1120000
100	3	0.05	0.001	1E-04	3.30E-02	50	1.70E+02	270000
200	3	0.05	0.005	2E-02	3.24E-01	500	7.12E+02	1120000

# : events number expected at ILC

# MC particles - angle distribution



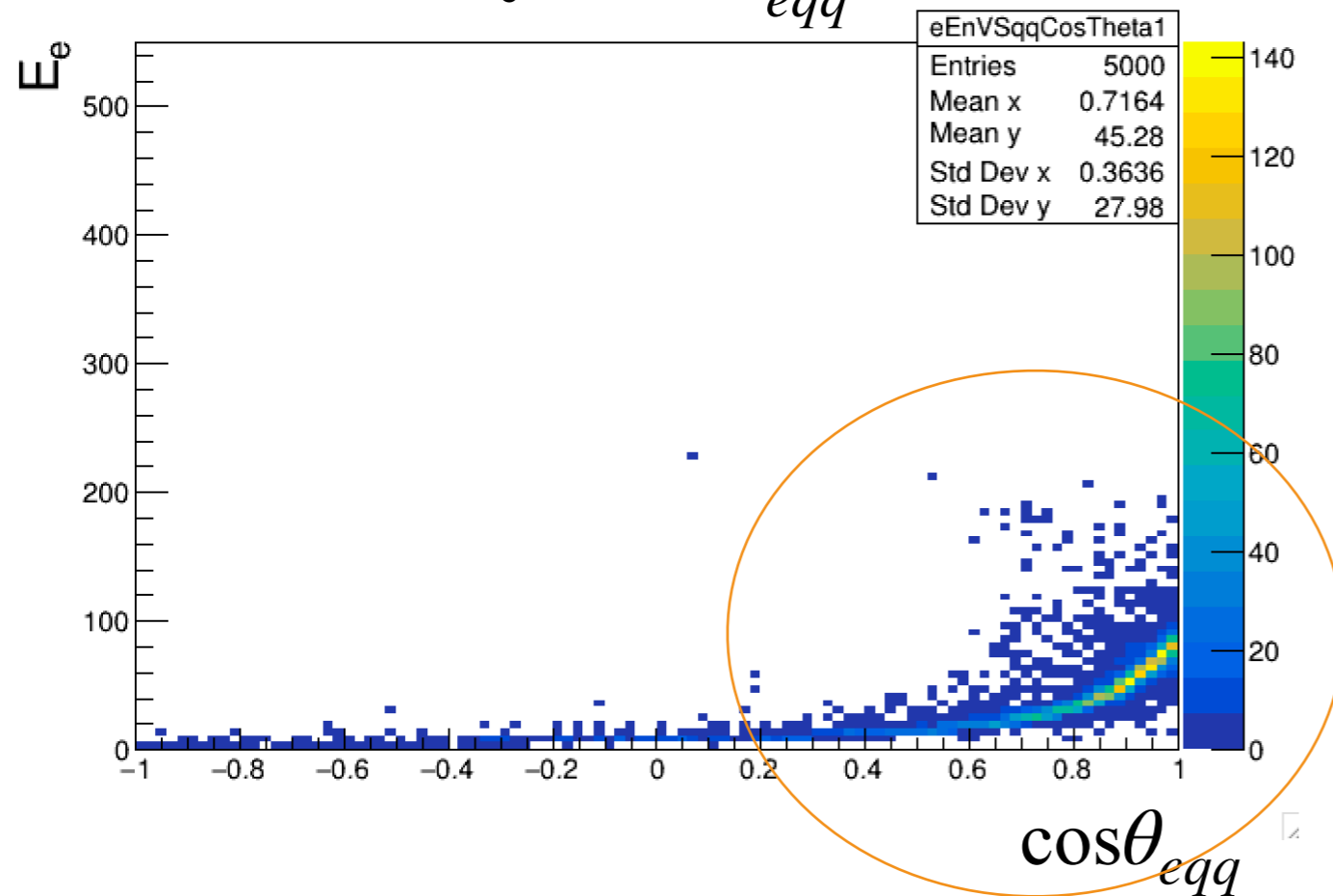
$M_{\text{RHN}} = 100 \text{ GeV}$

$M_{\text{Zp}} = 7 \text{ TeV}$

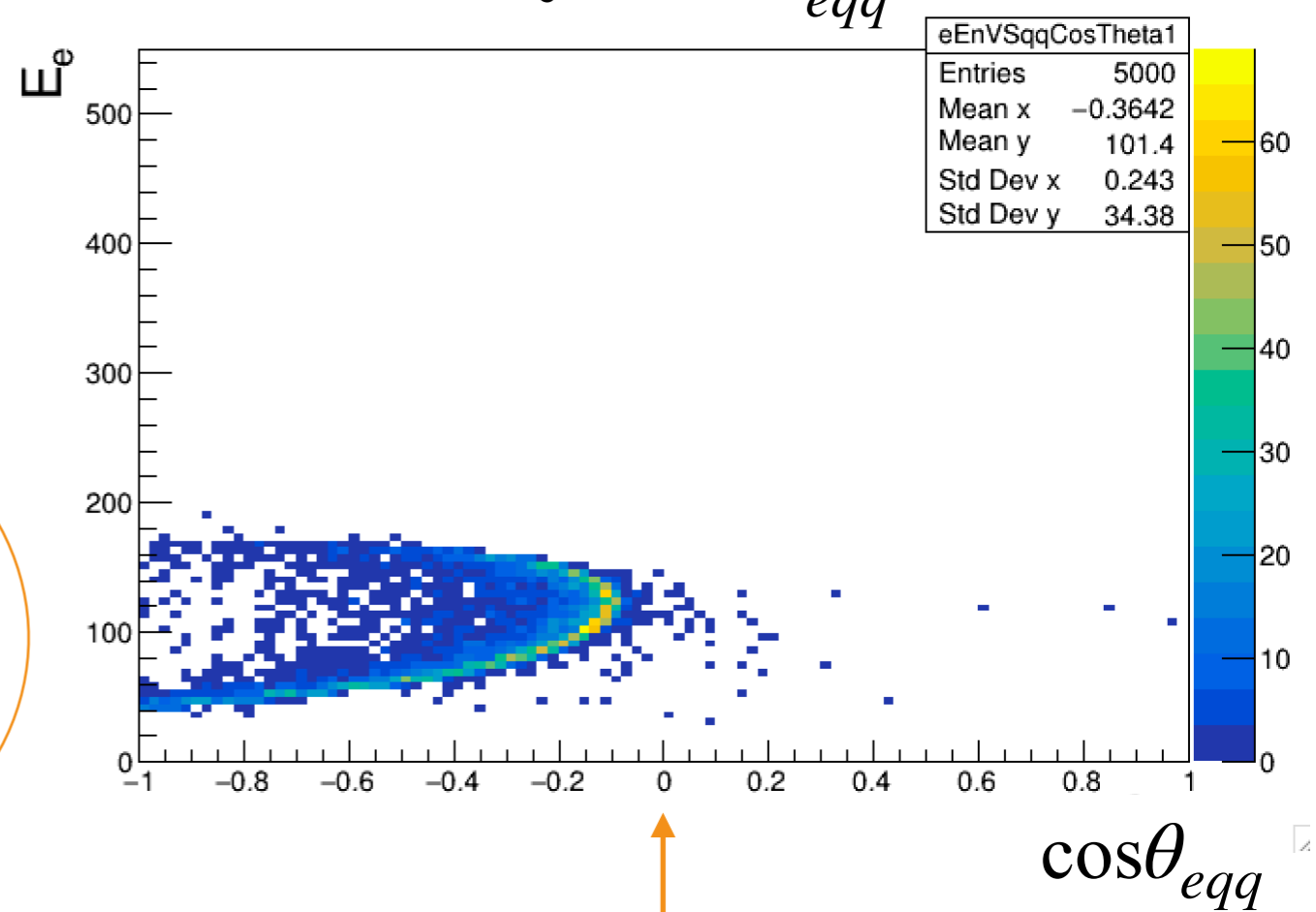
$M_{\text{RHN}} = 200 \text{ GeV}$

$E_e \text{ vs } \cos\theta_{eqq}$

$E_e \text{ vs } \cos\theta_{eqq}$



Same direction



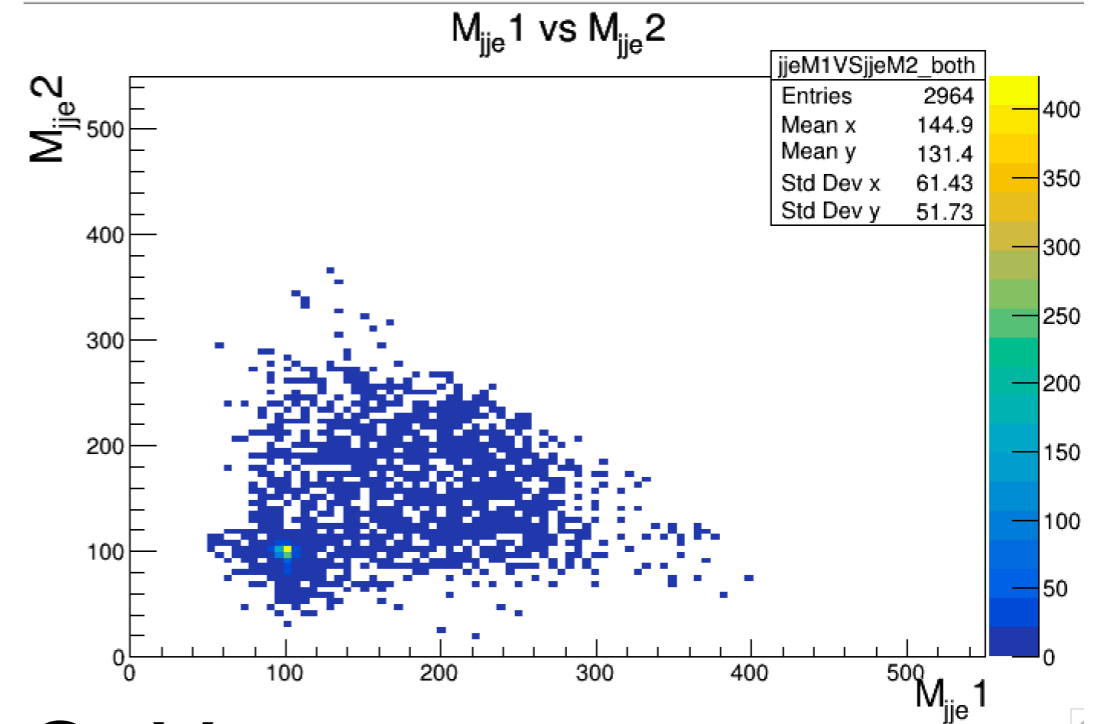
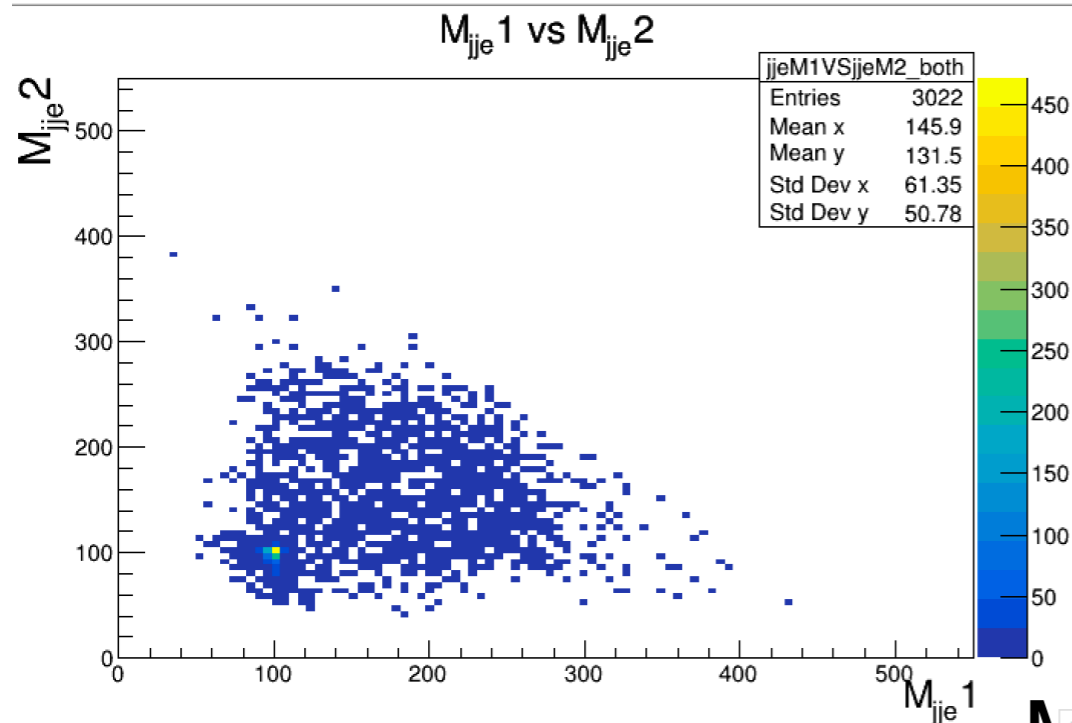
$90^\circ$

# Mjje1 VS Mjje2

MZp = 3TeV

$M_{\text{RHN}} = 100 \text{ GeV}$

MZp = 7TeV



$M_{\text{RHN}} = 200 \text{ GeV}$

