Benchmark Analysis for e^+e^- -> gamma Z process

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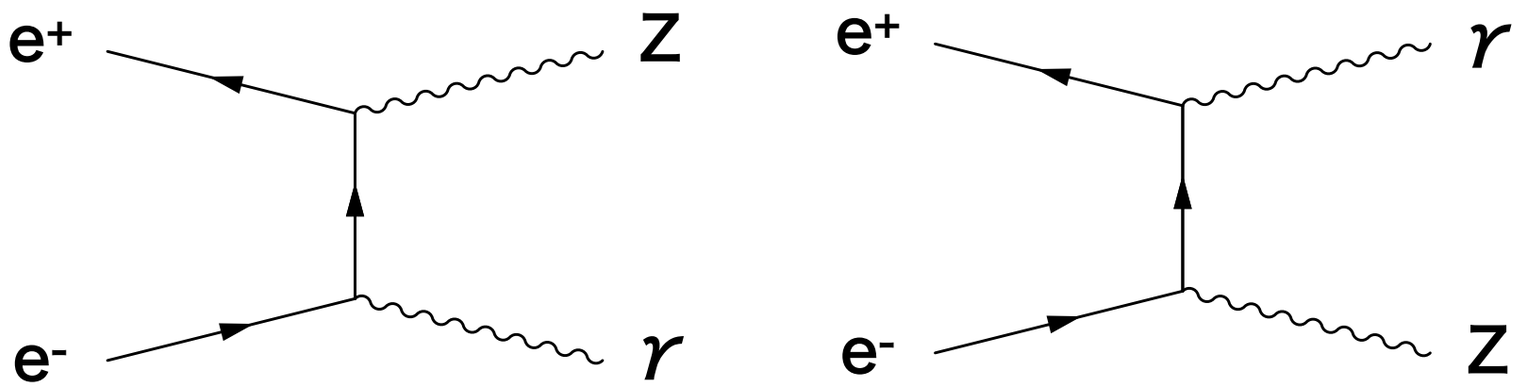
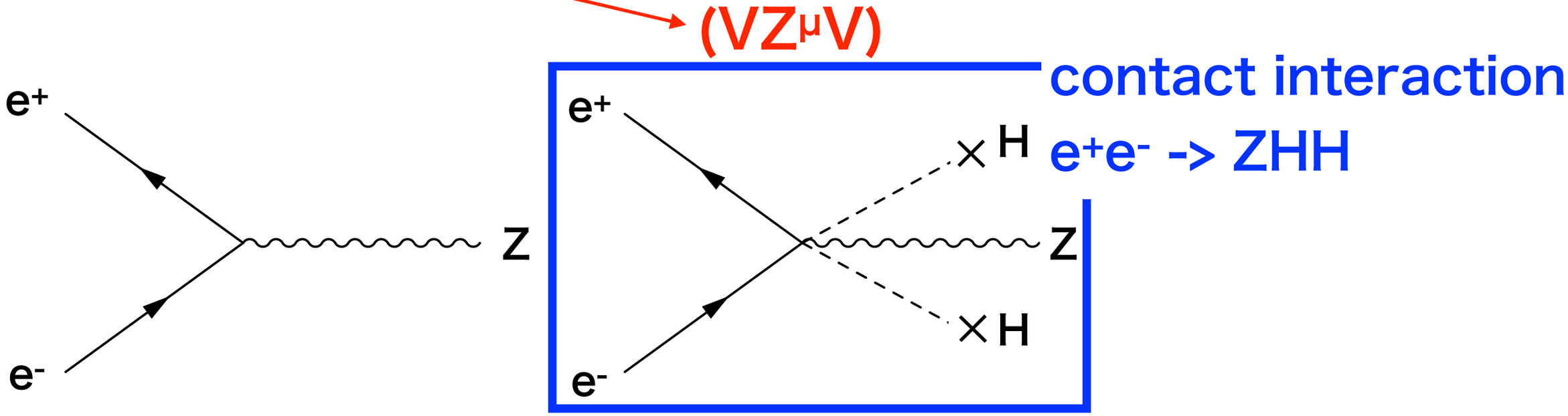
Introduction



- Physics motivation of the analysis : EFT analysis for e^+e^- -> $\gamma Z/\gamma\gamma/ZZ$
- Asymmetry in left- and right-handed eeZ coupling is very powerful

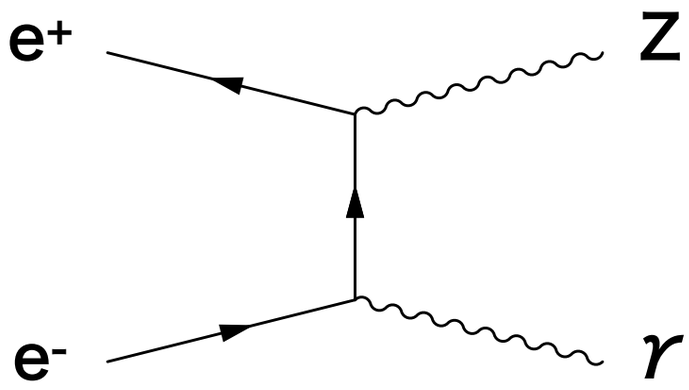
to improve the constraints on following Dimension-6 EFT operators

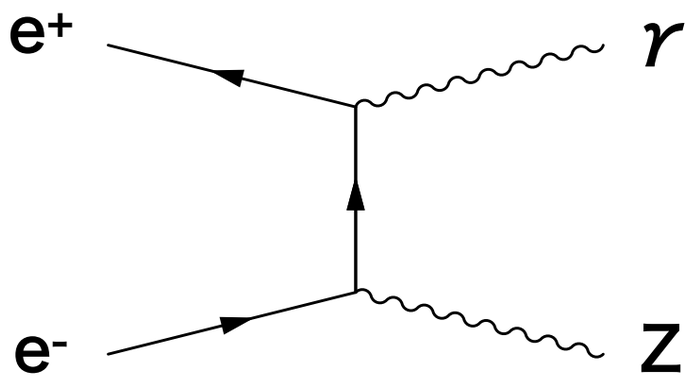
$$\Delta\mathcal{L} = i\frac{C_{HL}}{v^2}(\Phi^\dagger D^\mu \Phi)(\overline{L}\gamma_\mu L)$$



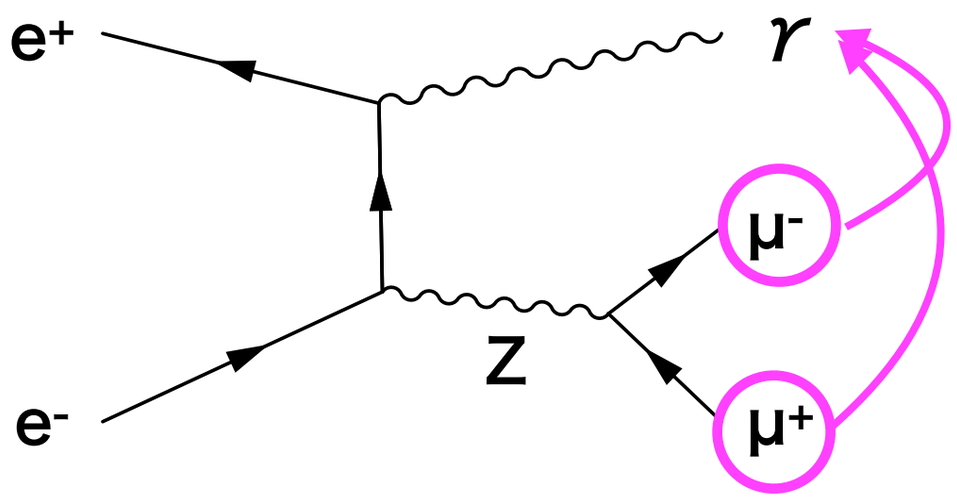
Introduction

Detector benchmark motivation of this analysis





Energy Scale Calibration



Mass of Z: precisely known

$$E_Z{}^2 - E_\gamma{}^2 = M_Z{}^2$$

$$E_Z + E_\gamma = E_{CM}$$

500 GeV

Photon Energy Calibration, Jet Energy Scale Calibration

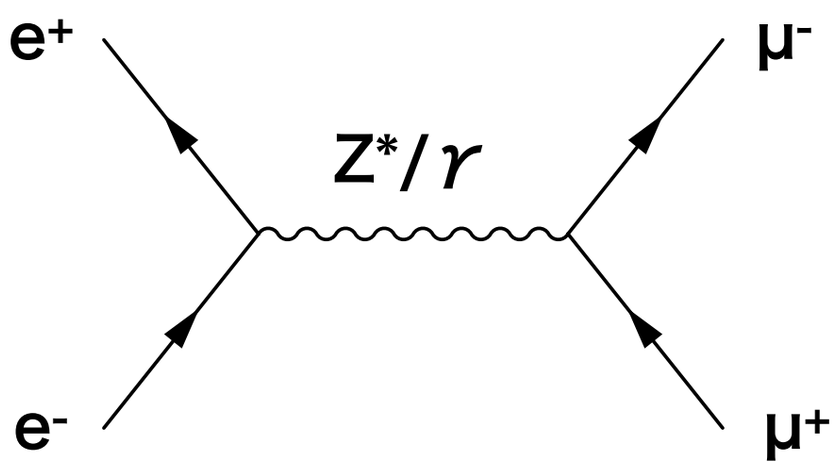
Analysis Setup

- Signal Channels **e^+e^- -> γZ Z -> ll/qq (E_{CM}=500 GeV)**
- In this time, ll = **$\mu^+\mu^-$**
- I used one of the DBD samples “P2f_z_l.eL.pR”
- <u>Event Selection</u>

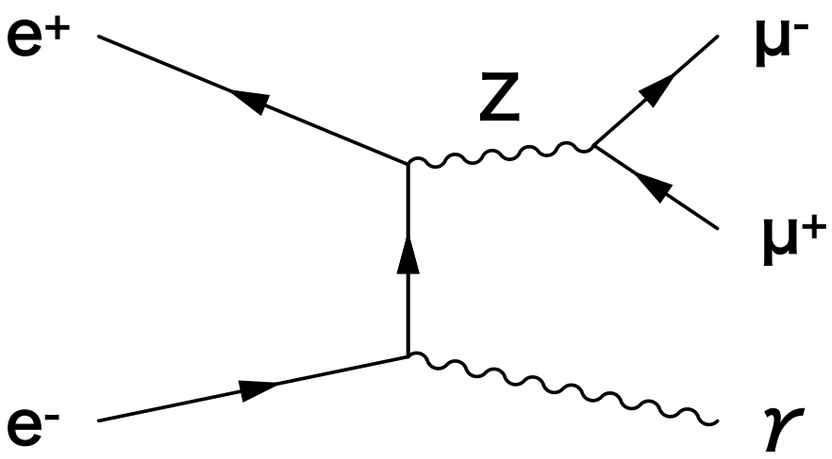
  Step1: select events with two isolated leptons

  (using IsolatedLeptonTagging processor)

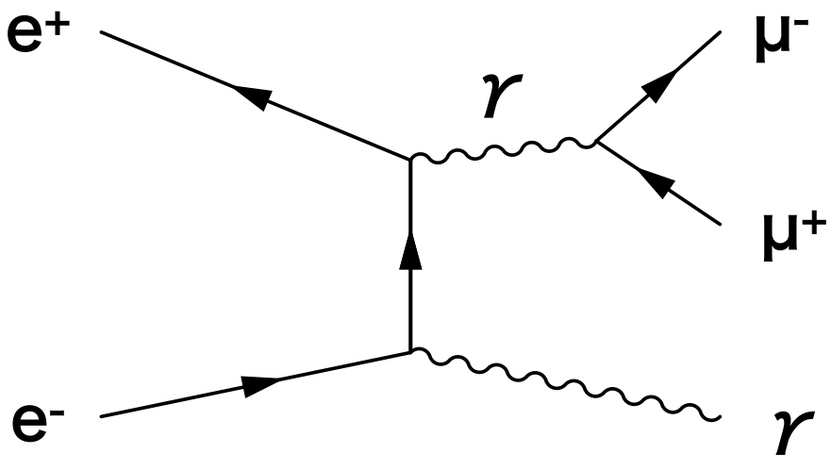
  -> 3 diagrams are included in the sample



$M(\mu^+\mu^-)$ = 500 GeV



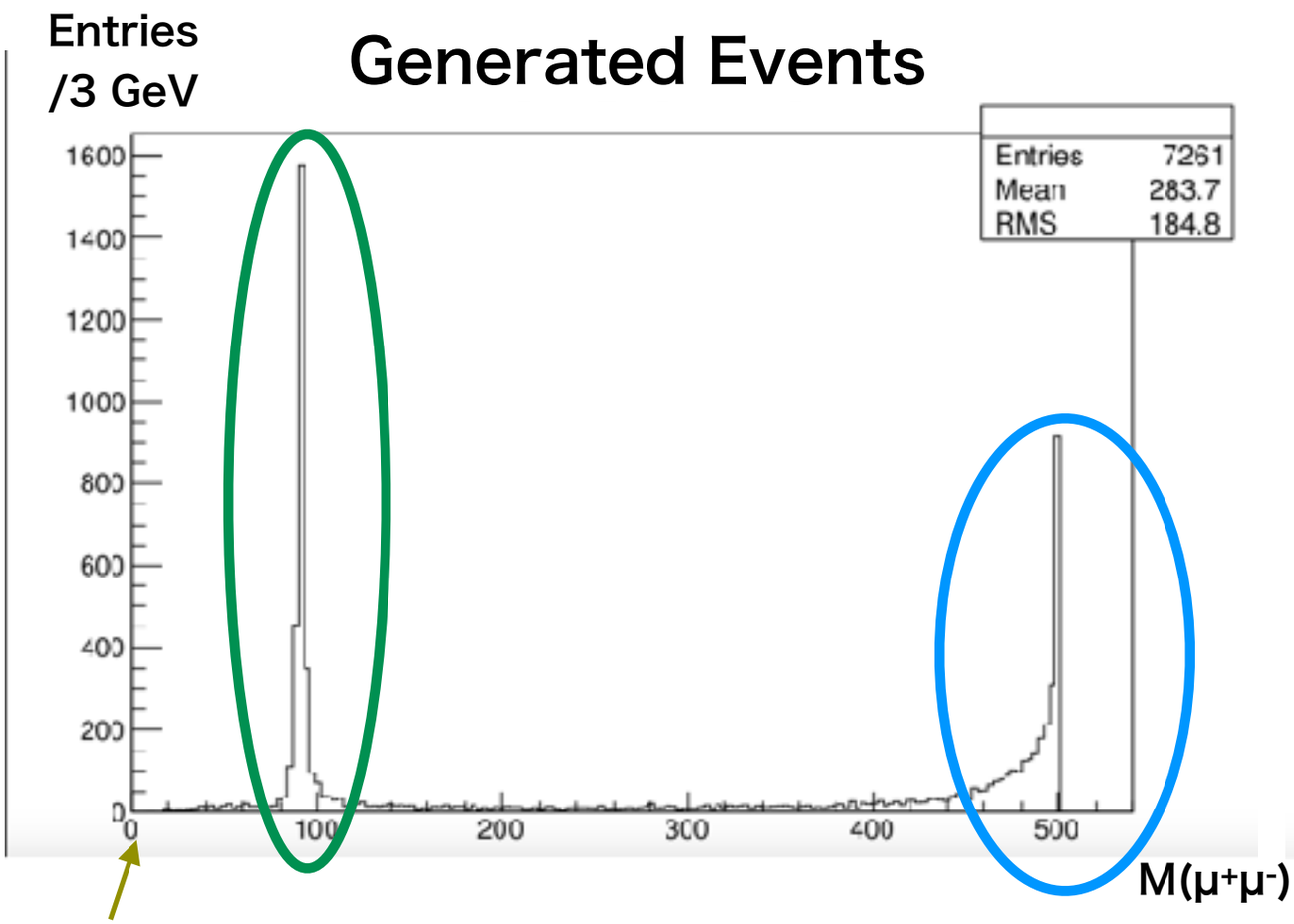
$M(\mu^+\mu^-) = 91.2$ GeV

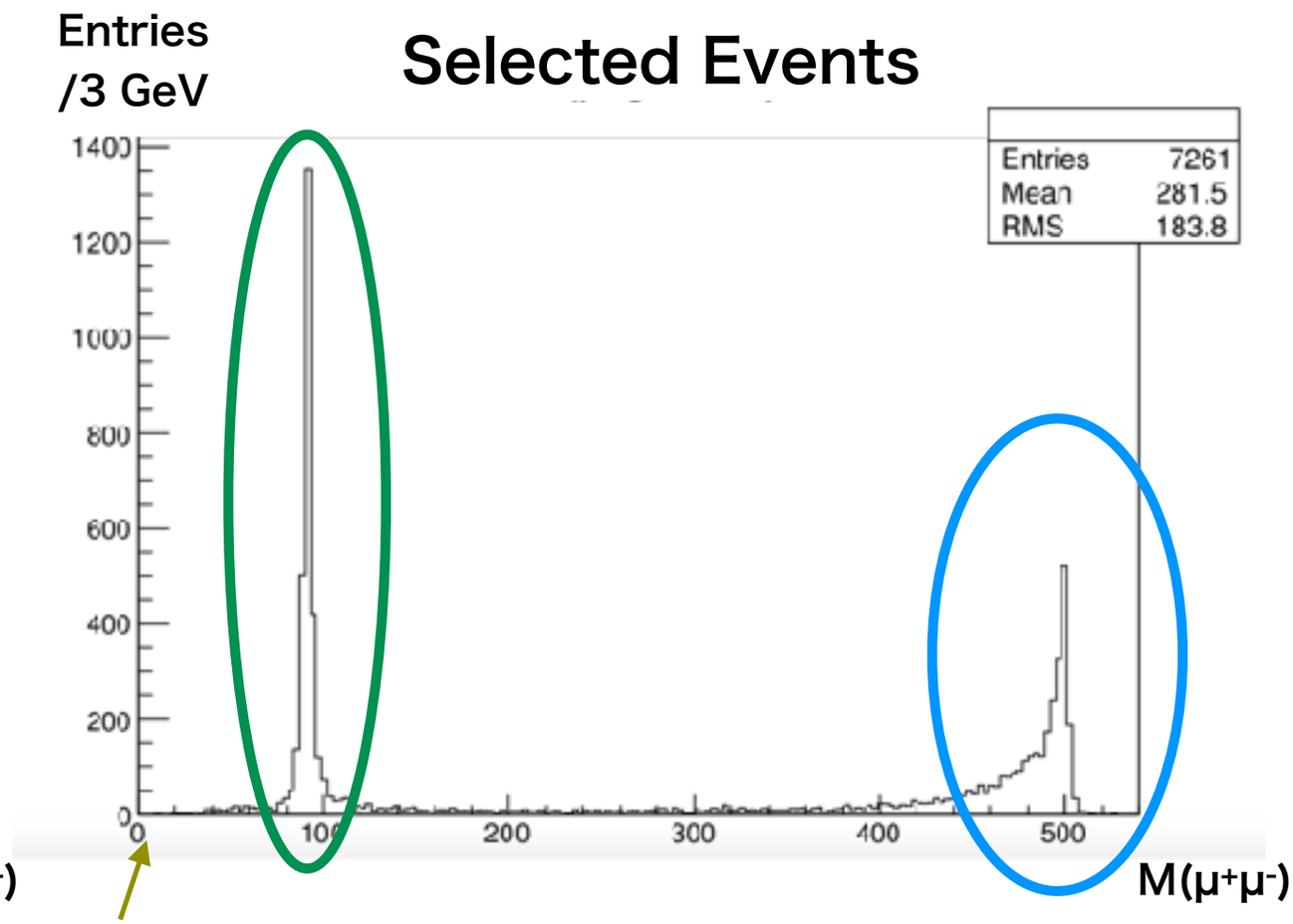


$M(\mu^+\mu^-) \sim 0$ GeV

Step2: select events with one isolated photon
(This step is not done yet)

M(μ+μ-) distribution



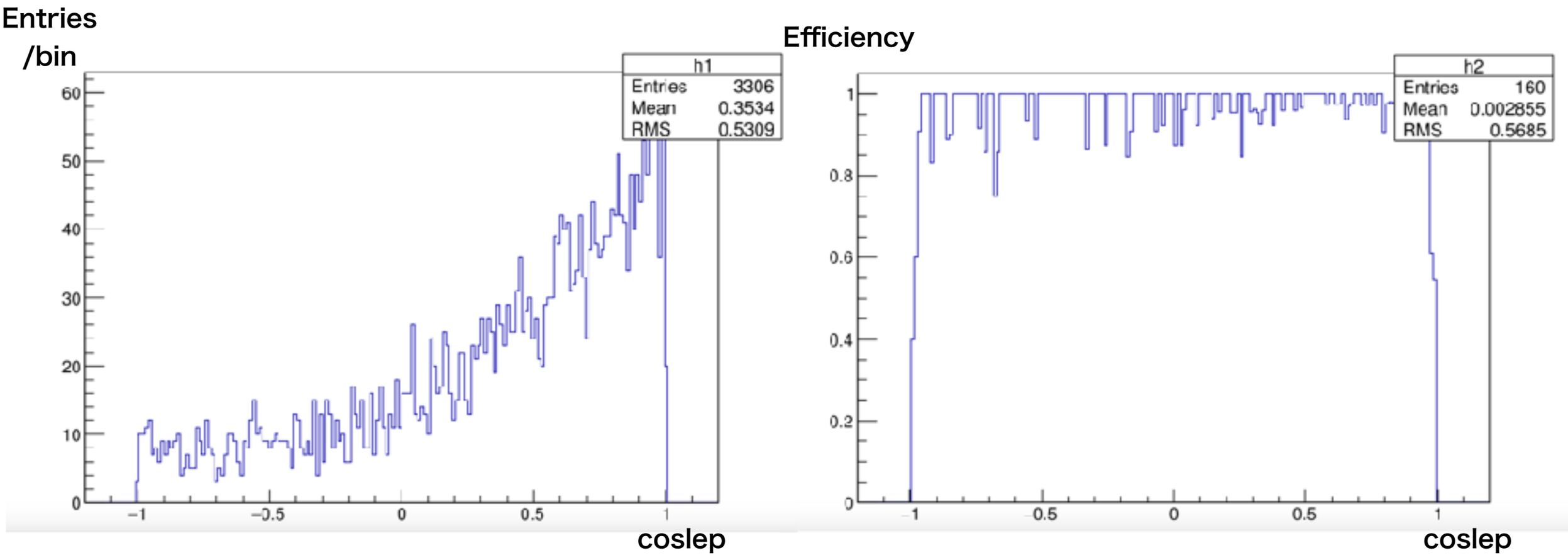


- For each process, distribution of efficiency

$$eff = \frac{N_{(selected)}}{N_{(generated)}}$$

as function of angle

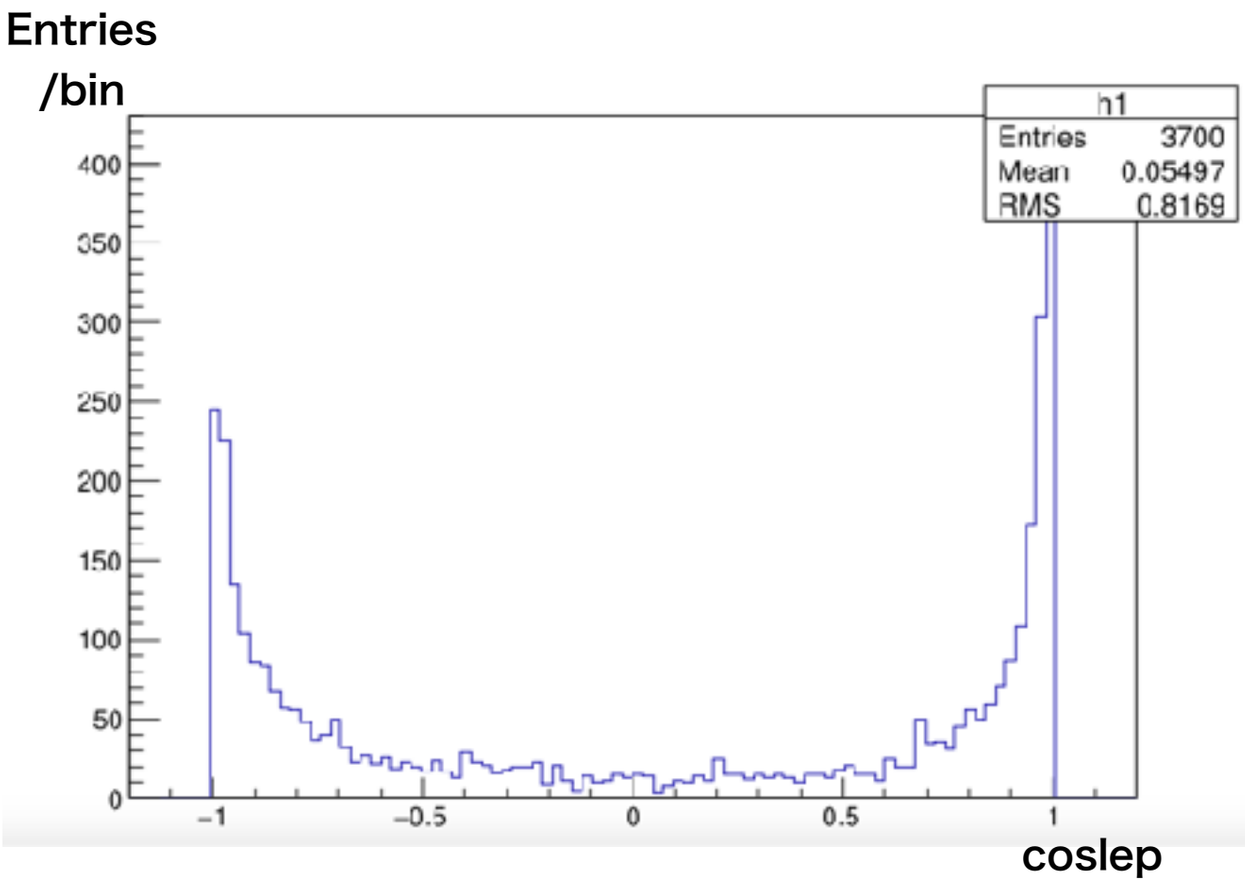
$M(\mu^+\mu^-) > 400$ GeV

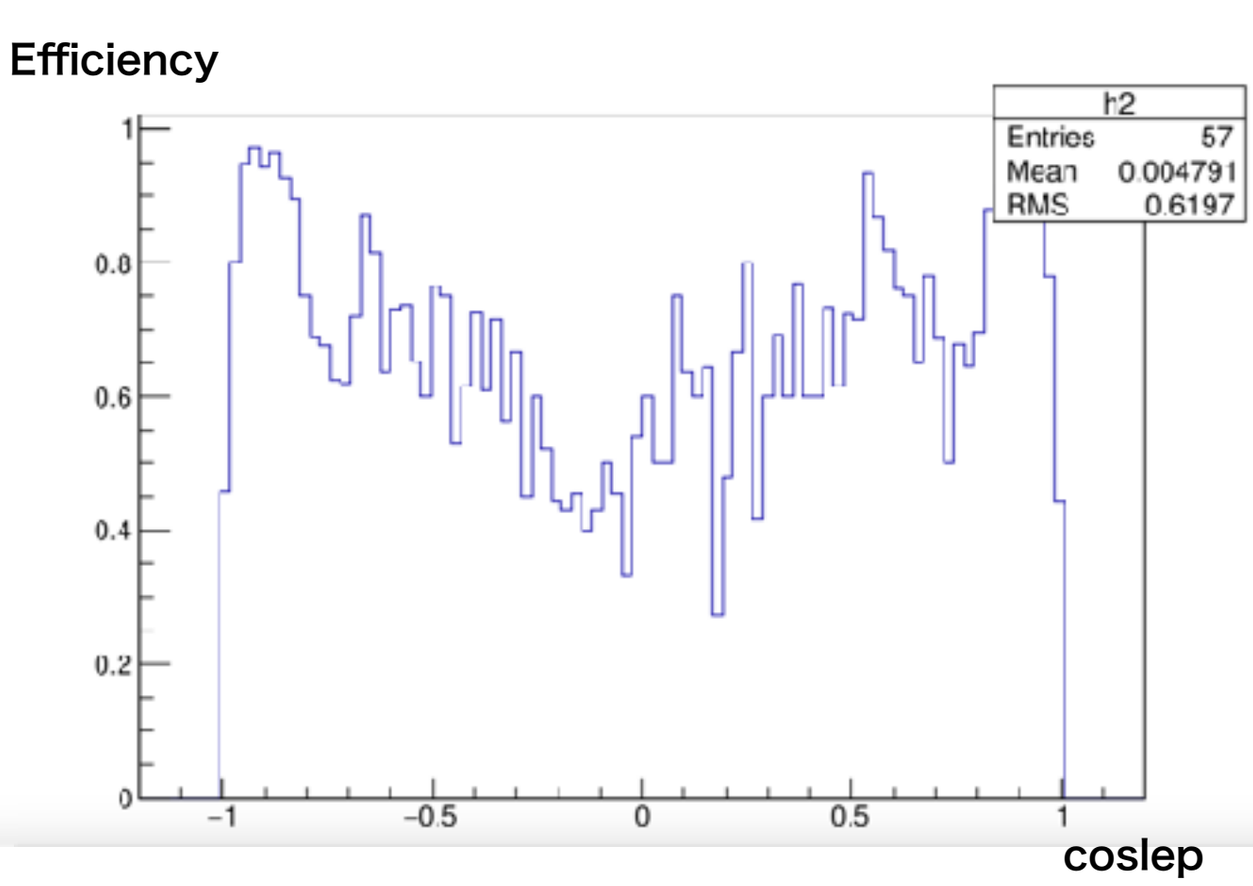


coslep = the angle μ^- is emitted

- The efficiency is closed to 100% at any angle.

|M(μ⁺μ⁻)-91.2| < 10 GeV



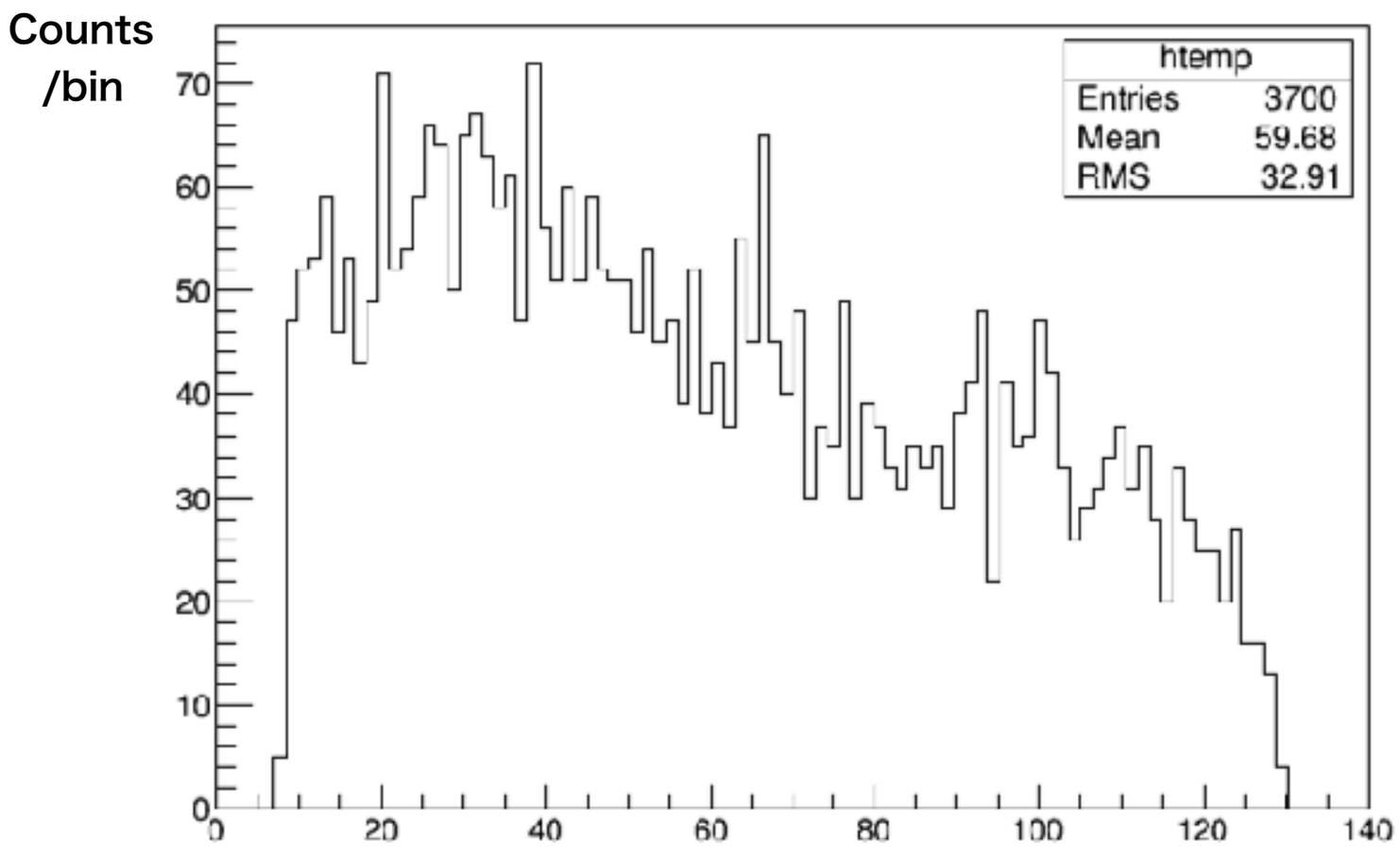


coslep = the angle μ⁻ is emitted

- The efficiency around coslep ~ 0 is very low (~ 0.5).
  <- low energy muons are cut (momentum cut)?
  <- two muons go in the almost same direction
  (cut by isolation criteria)?

$|M(\mu^+\mu^-)-91.2| < 10$ GeV muon energy

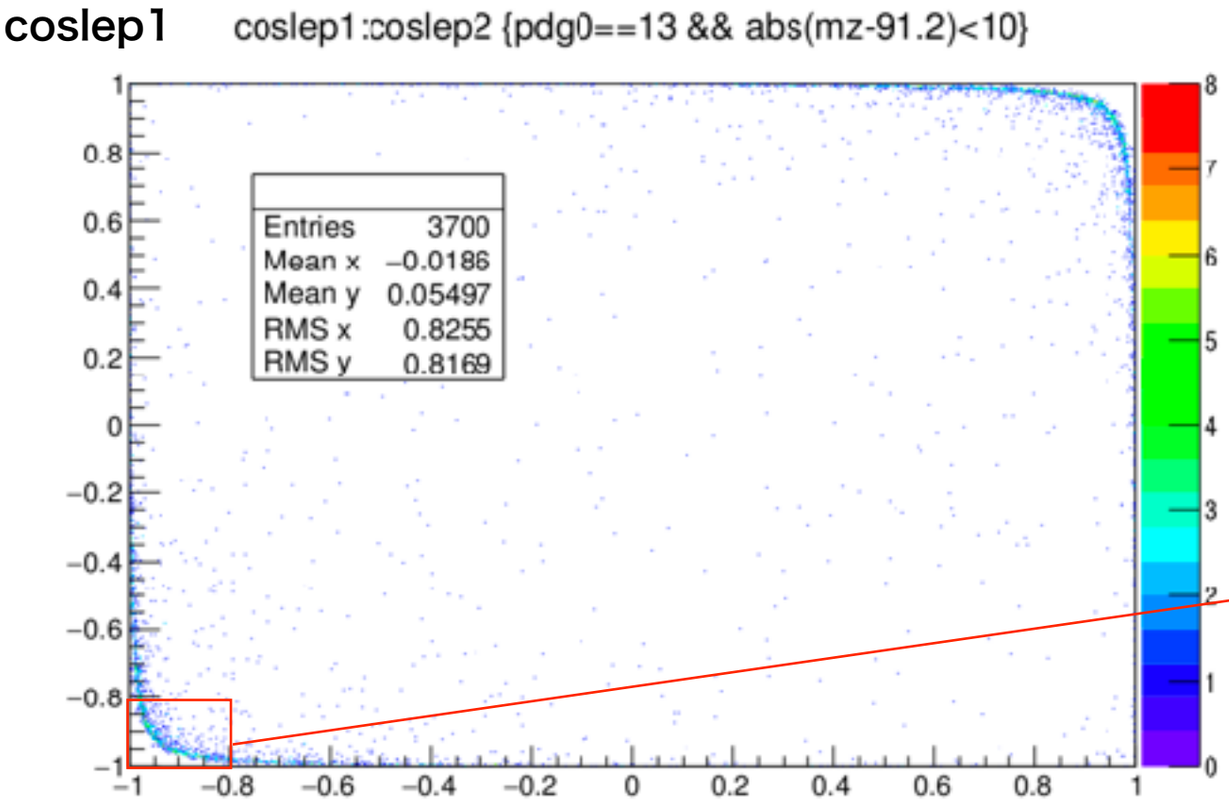
- In the isolated lepton selection process,
  low energy muons are cut
  so as to cut muons from jet which have low energy.
  -> need to check muon energy

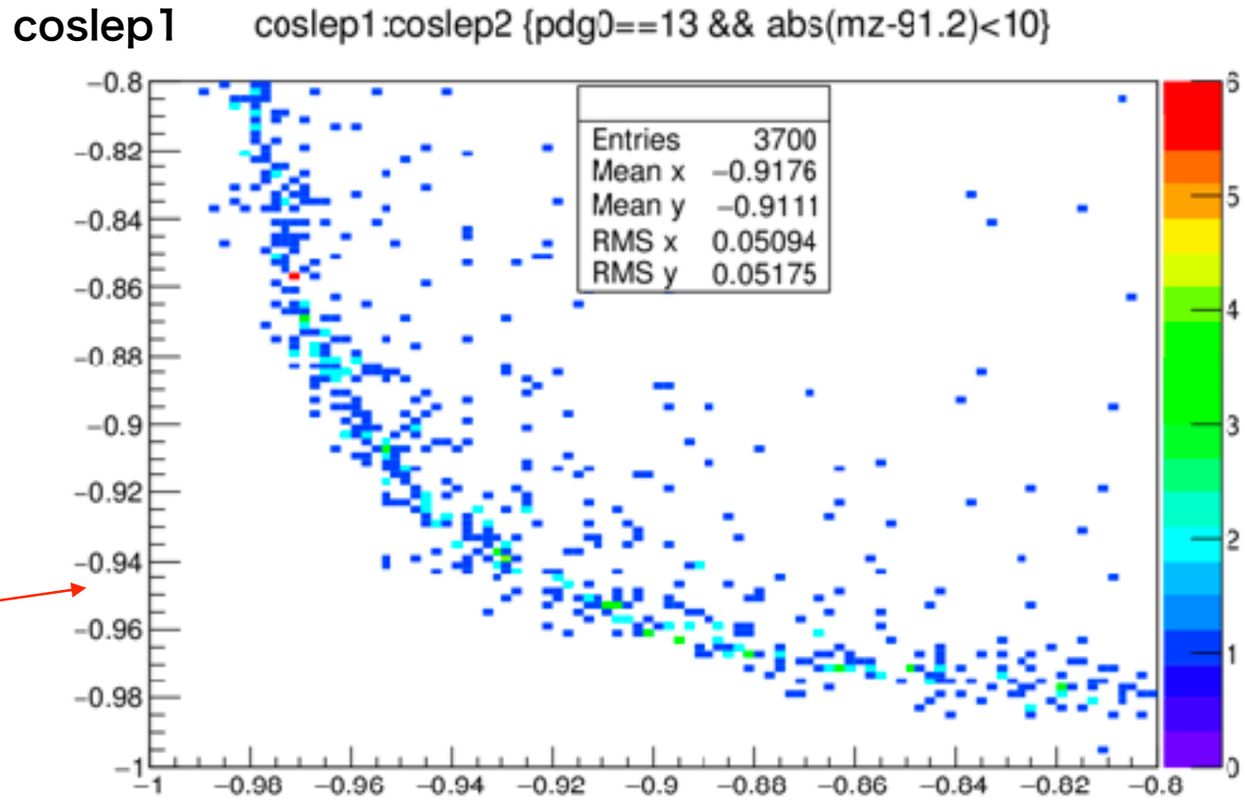


The number of low energy events is not so many.

Coslep1 (μ^- angle) vs. Coslep2 (μ^+ angle)

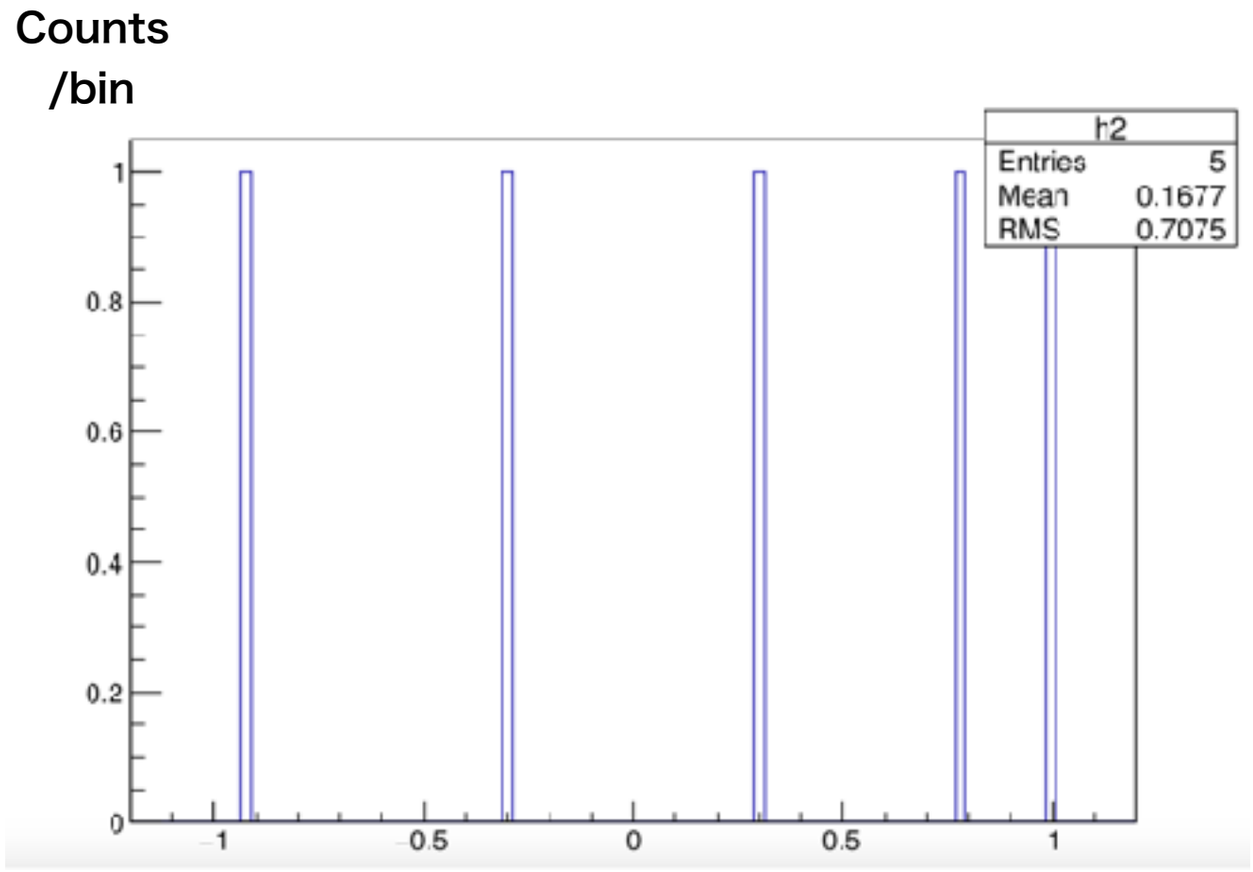
- Two muons are cut
  if they travel in the almost same direction
  -> Their angles are checked.

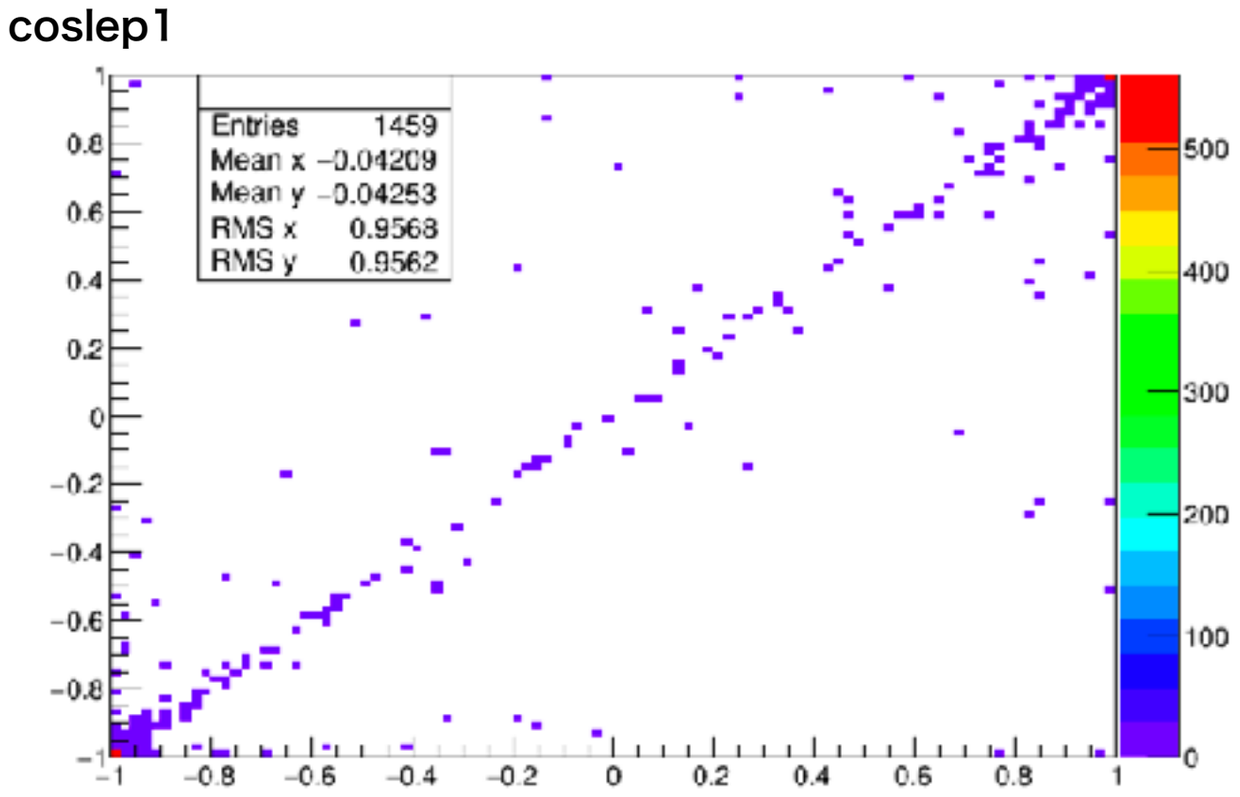




- When one lepton is at the barrel region, the other one goes into beam direction which is hence not reconstructed.

M(μ⁺μ⁻) < 20 GeV





coslep1=μ⁻ angle, Coslep2=μ⁺ angle

- They are rejected as they go in the same direction (cone cut).

Conclusion

- Benchmark analysis for e^+e^- -> gamma Z is started.
- Efficiency is studied for 3 kinds of processes (diagrams).
- In the $M(\mu^+\mu^-) > 400$ GeV case, efficiency is close to 100% at any angle.
- In the $|M(\mu^+\mu^-) - 91.2| < 10$ GeV case, efficiency is low (~0.5) at coslep ~0. This is because one of the other muon tends to go in the beam pipe direction.
- In the $M(\mu^+\mu^-) < 20$ GeV case, efficiency is very low because two muons are collimated and hence are rejected by isolation requirement.

Future Plan

- Estimate the energy resolution for muons

- Implement isolated photon selection
  and study photon section efficiency
  and photon energy resolution

- Look at the new samples for large and small ILD model

- Do full analysis including background

- Study electron channel, and jet channel