H recoil mass in ZH (z->qq) using SDHCAL

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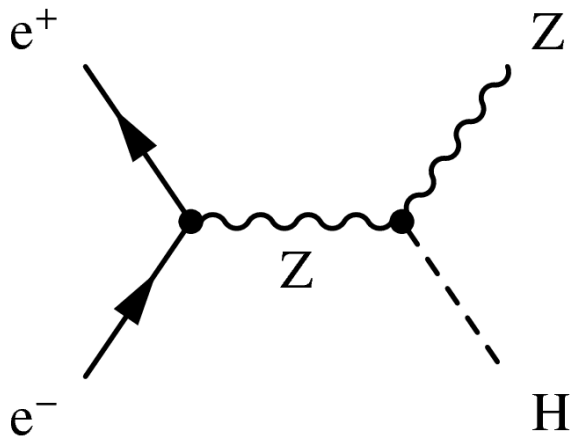
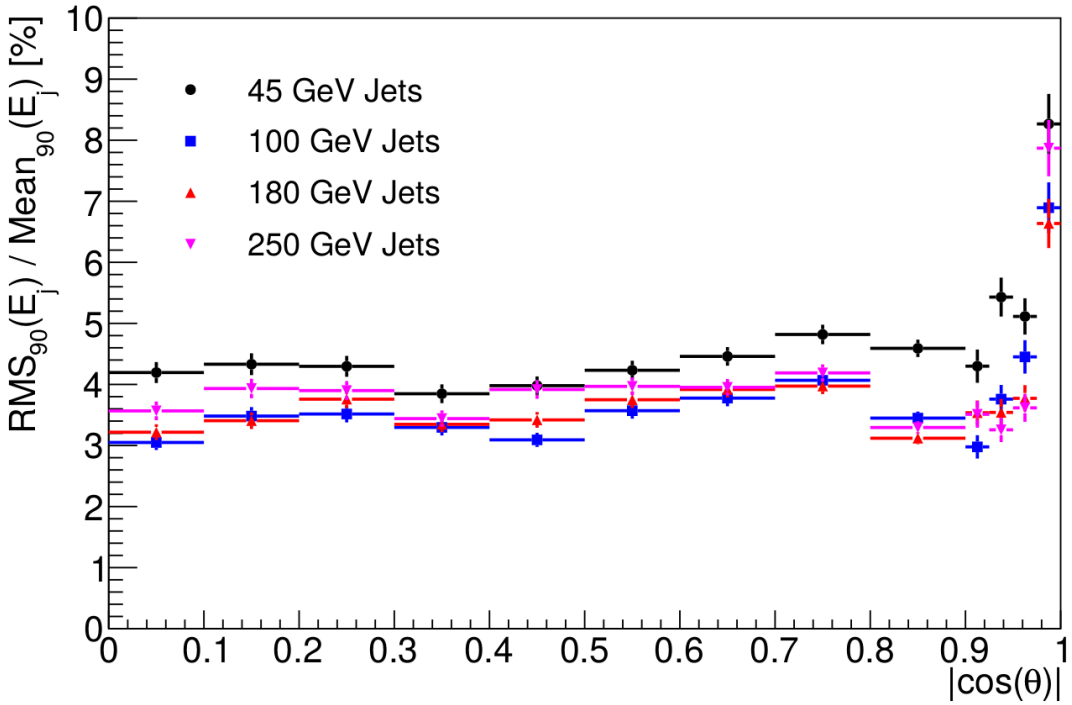
- At $\sqrt{s}$ = 250 GeV , the higgsstrahlung process is the dominant higgs production channel
- It is usually considered for $Z \rightarrow \mu\mu$ and Z->ee decays as it provides clear event topology
- It is however limited by the small branching ratio of $Z \rightarrow ll$ (~3 % for each lepton)
- On the opposite, the $Z \rightarrow qq$ provides a lot more statistics (br ~ 70%), but the event topology is not as clean as for Z leptonic decays



- Event sample :
  - DBD samples
  - ILCSoft : v01-17-09
  - ILD Model : ILD_o2_v05 (SDHCAL option – Videau geometry)
  - Signal only :(



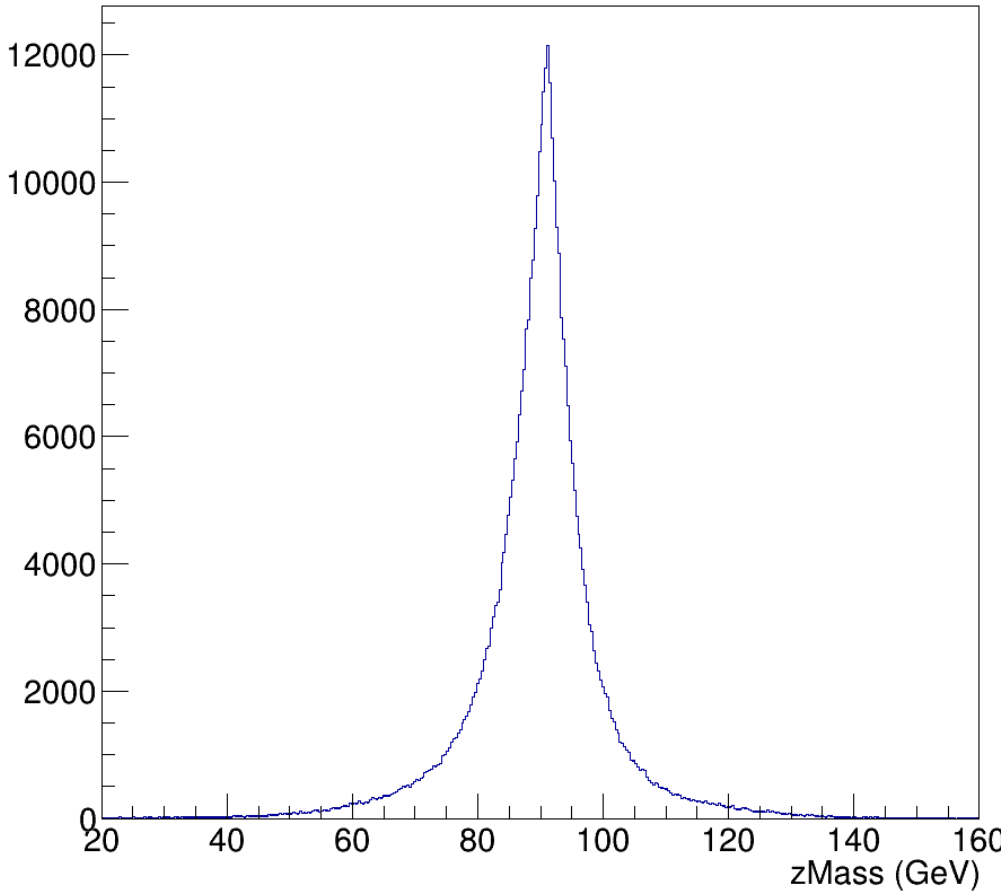
- Depending on the higgs decay channel, the events can have different topologies :
  - For example H->$b\bar{b}$ will give a 4-jet final state , H->WW->$q\bar{q}\tau\nu$ 5-jet final state, H->WW->$q\bar{q}q\bar{q}$ and H->ZZ->$q\bar{q}q\bar{q}$ 6-jet final state
- Jet clustering is performed using Durham algorithm with a fixed y_{cut} in order to not constrain the number of jets

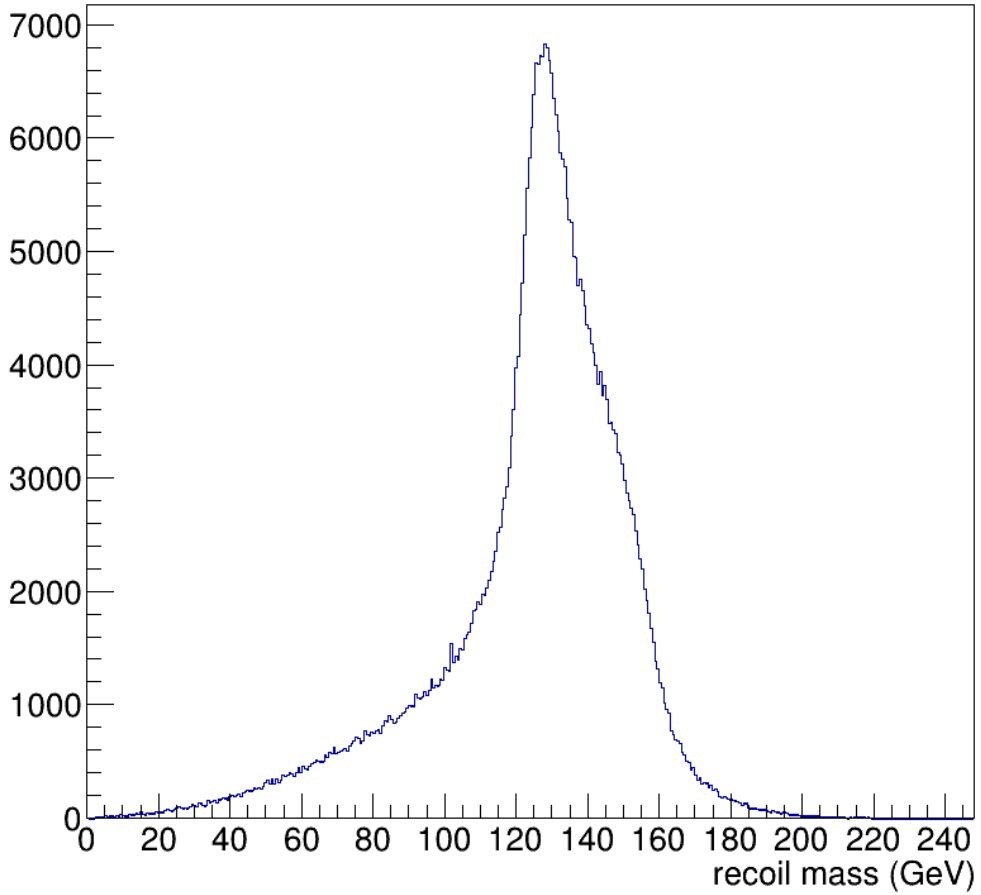
$$y_{ij} = \frac{2\min\{E_i^2, E_j^2\}}{E_{vis}^2}(1 - cos\theta_{ij})$$

- The jet pair with invariant mass closest to m_Z is identified as the Z
- The recoil mass is calculated using the Z jet pair :

$$m_{rec}^2 = (\sqrt{s} - E_{Dijet})^2 - p_{Dijet}^2$$

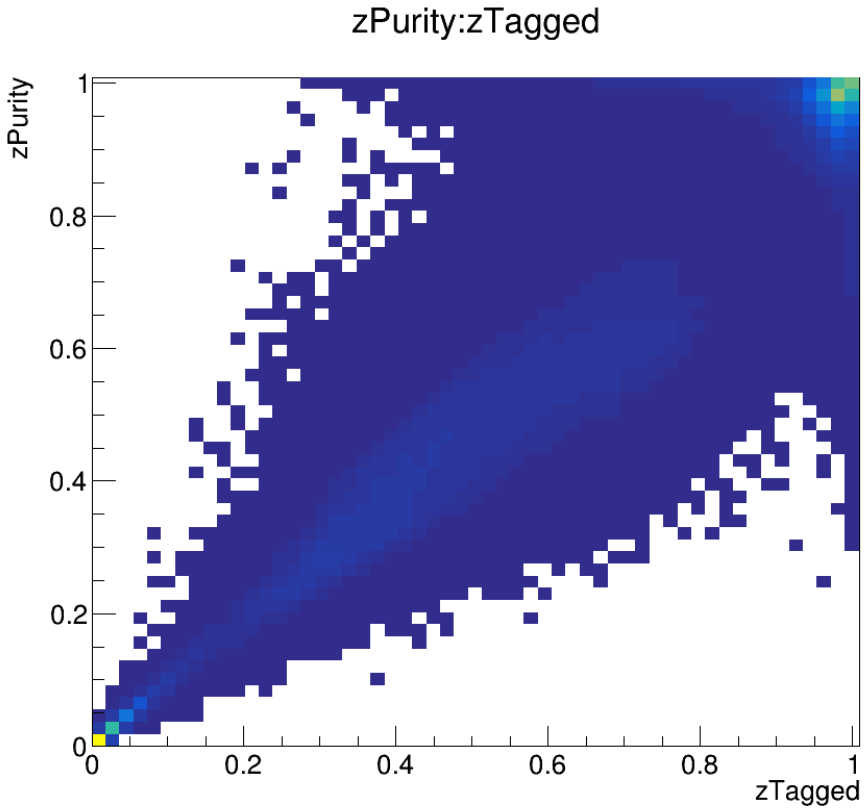
- Full reconstruction :
  - Recoil mass far from optimal
  - Mainly due to jet overlap and bad recombination

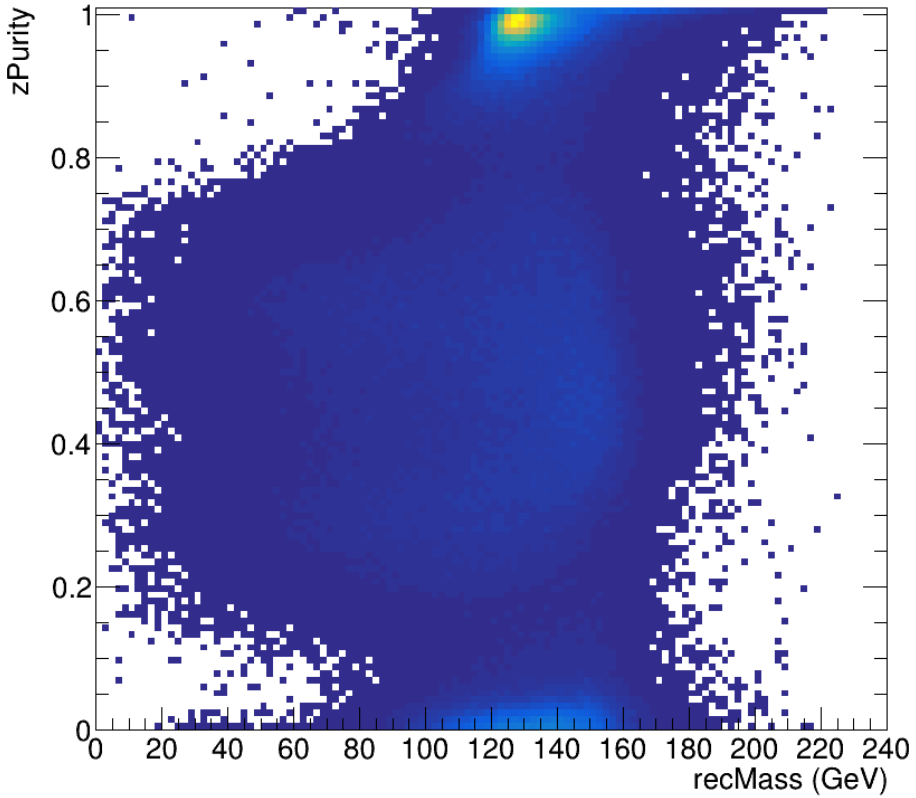




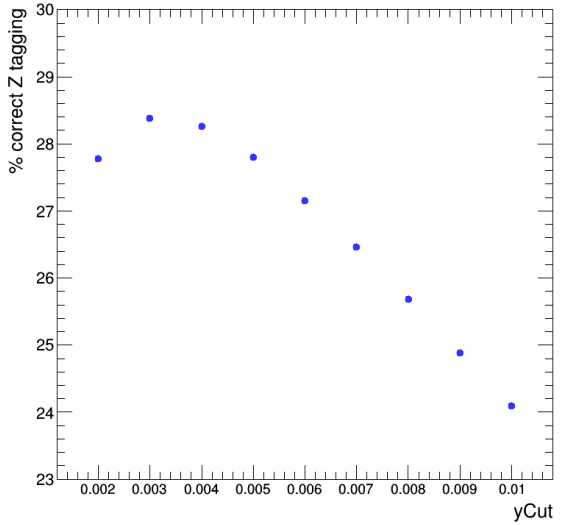
ycut = 0.003

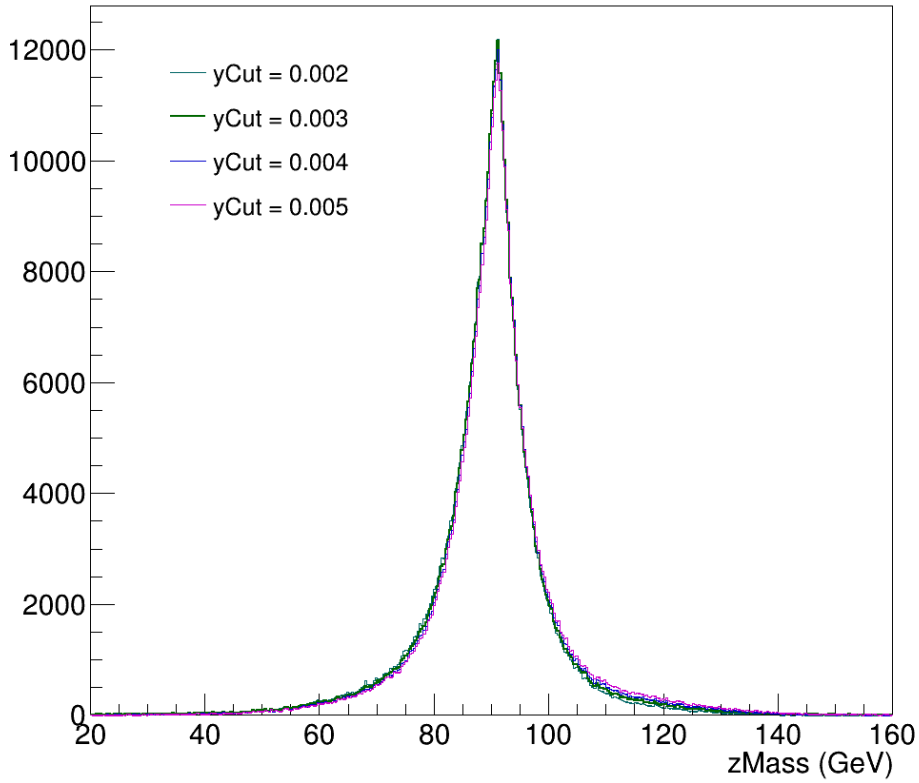
- Using MC information, it appears that the Z is actually badly reconstructed
- I define 2 variables to quantify the efficiency of the Z reconstruction :
  - zPurity ≡ %of energy that comes from the Z in the chosen Z di-jet
  - ztagging ≡ %of total event Z energy that goes into the chosen Z di-jet

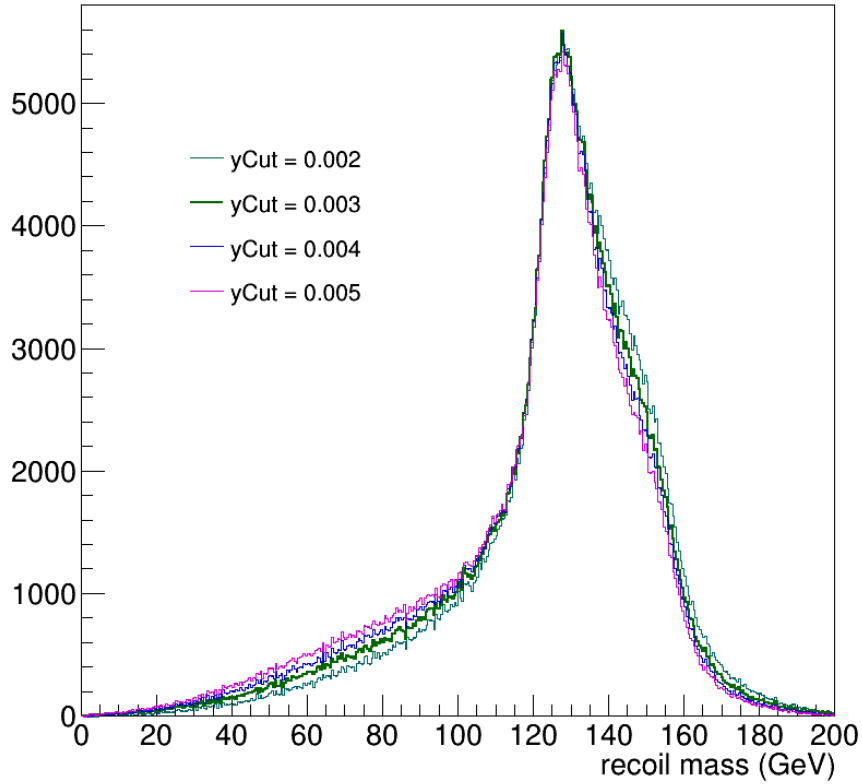




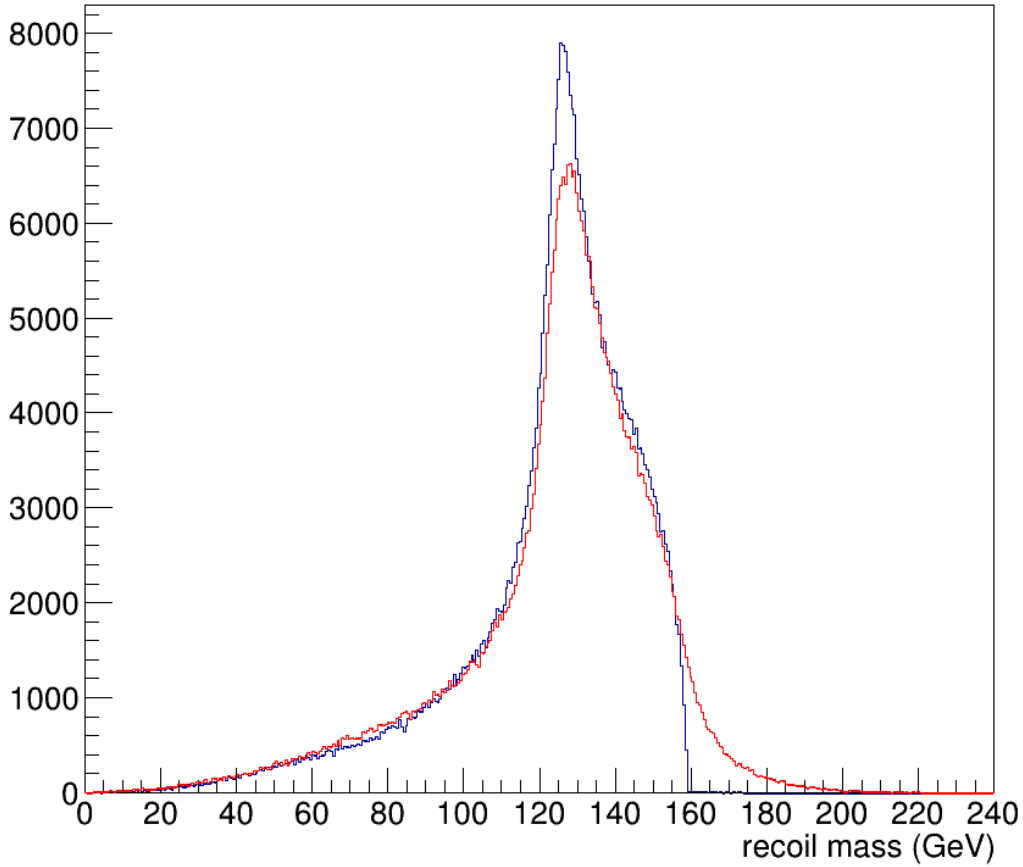
- The y_{cut} is chosen to 'maximize' the efficiency of Z reconstruction
- If the zPurity and zTagging variables are both > 90 % for an event, it is considered correctly tagged
- Z reconstruction is best for y_{cut} = 0.003, with a reconstruction efficiency of ~28.4 % (which is still pretty low...)



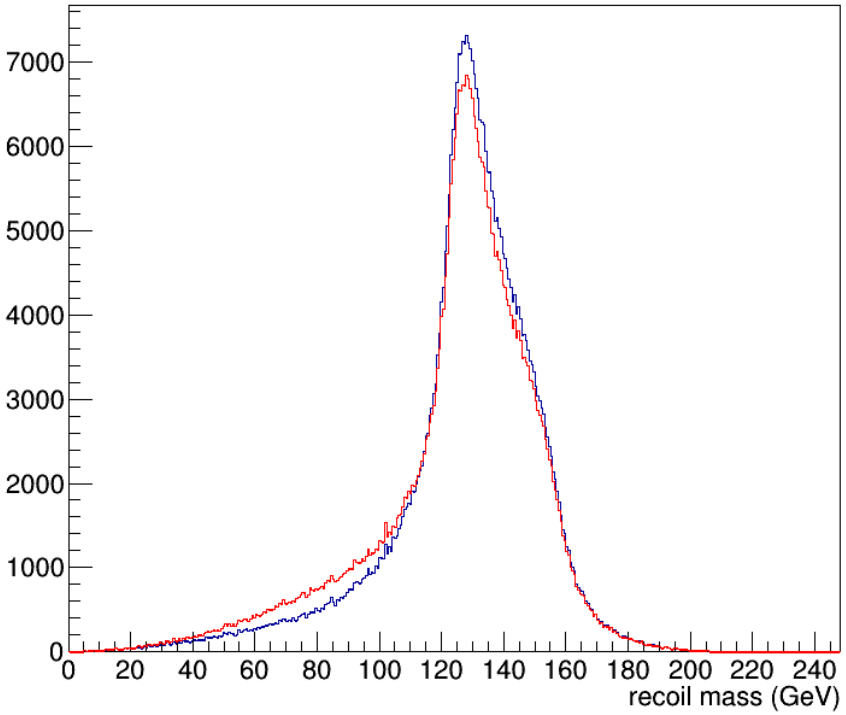


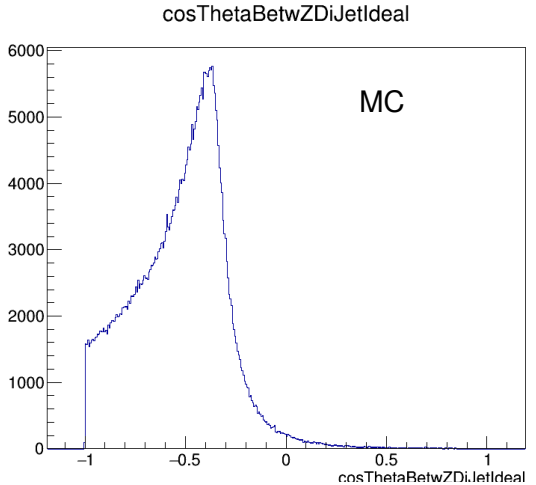


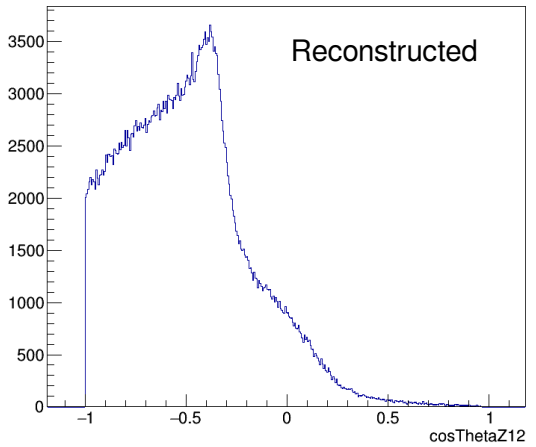
- The recoil mass distribution can be improved by constraining the chosen Z di-jet to have its mass equal to the true m_Z



- The Z di-jet selection is based only on its invariant mass
- At √s = 250 GeV, the Z has low boost, and therefore the di-jet should have a big opening angle
  - By applying a penalty to di-jets that have a small opening angle, it is possible to improve the efficiency of the Z reconstruction







$$\chi^2 = (m_{Dijet} - m_Z)^2 + \alpha(cos\theta_{Dijet} - \beta)^2 \quad if \quad cos\theta_{Dijet} > \beta$$

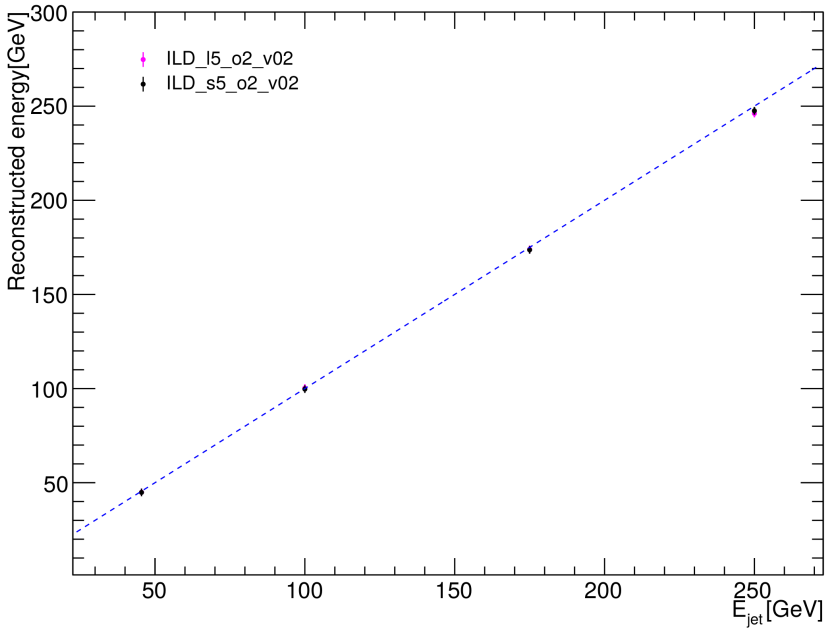
$$\chi^2 = (m_{Dijet} - m_Z)^2 \quad \text{otherwise}$$

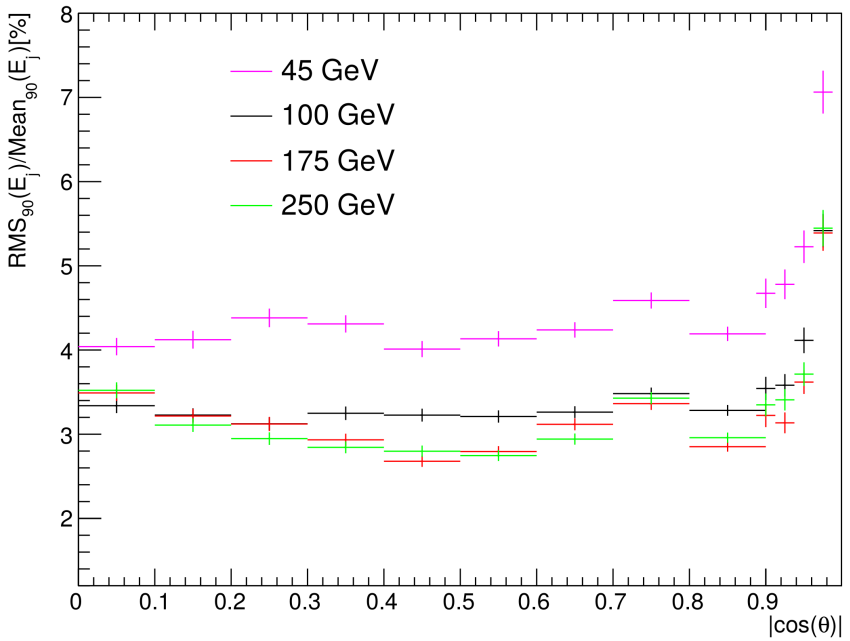
α = 800

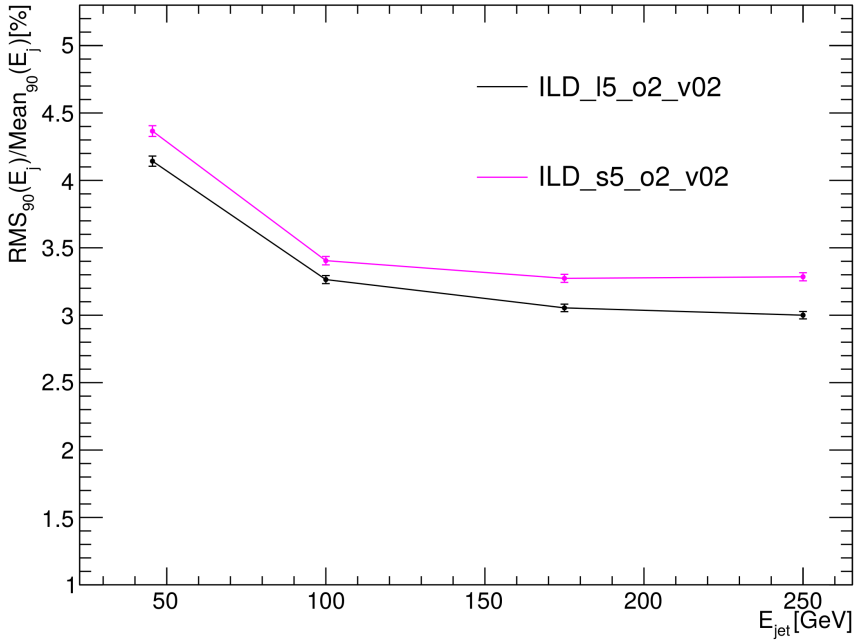
β = -0.3

- Applying this kind of chi2 improves a bit the efficiency of Z reconstruction : 28.4% -> 30.7%

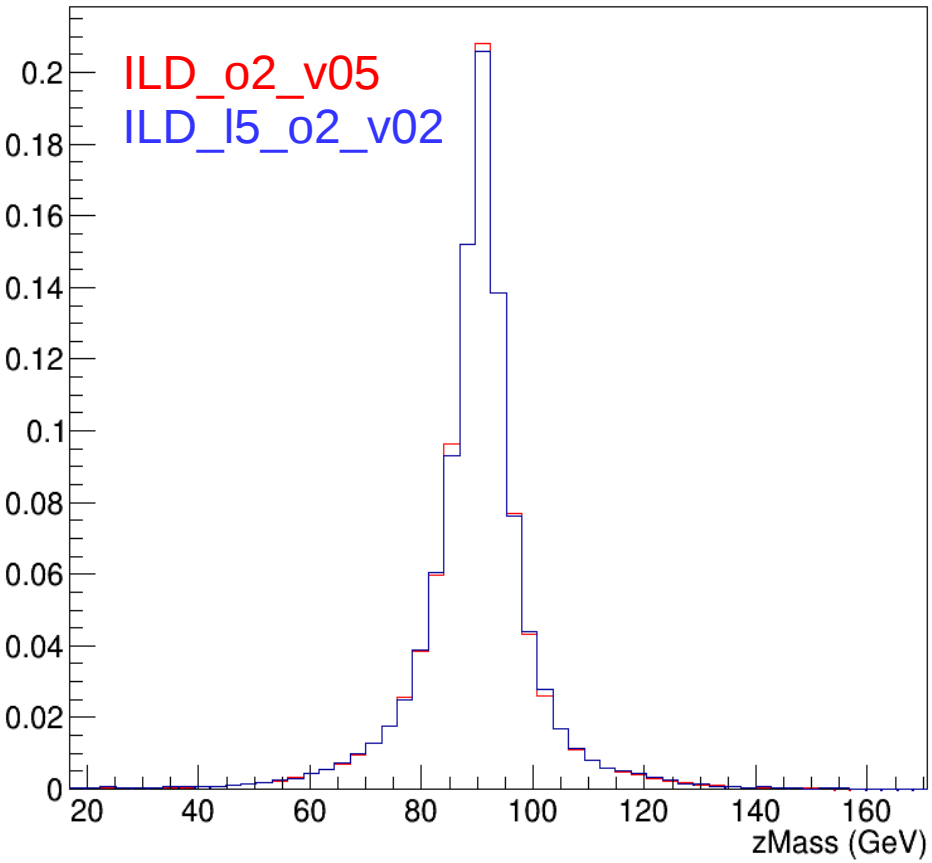
- New event sample
  - Same DBD samples
  - ILCSoft **v01-19-06**
  - ILD Model : **ILD_l5_o2_v02**

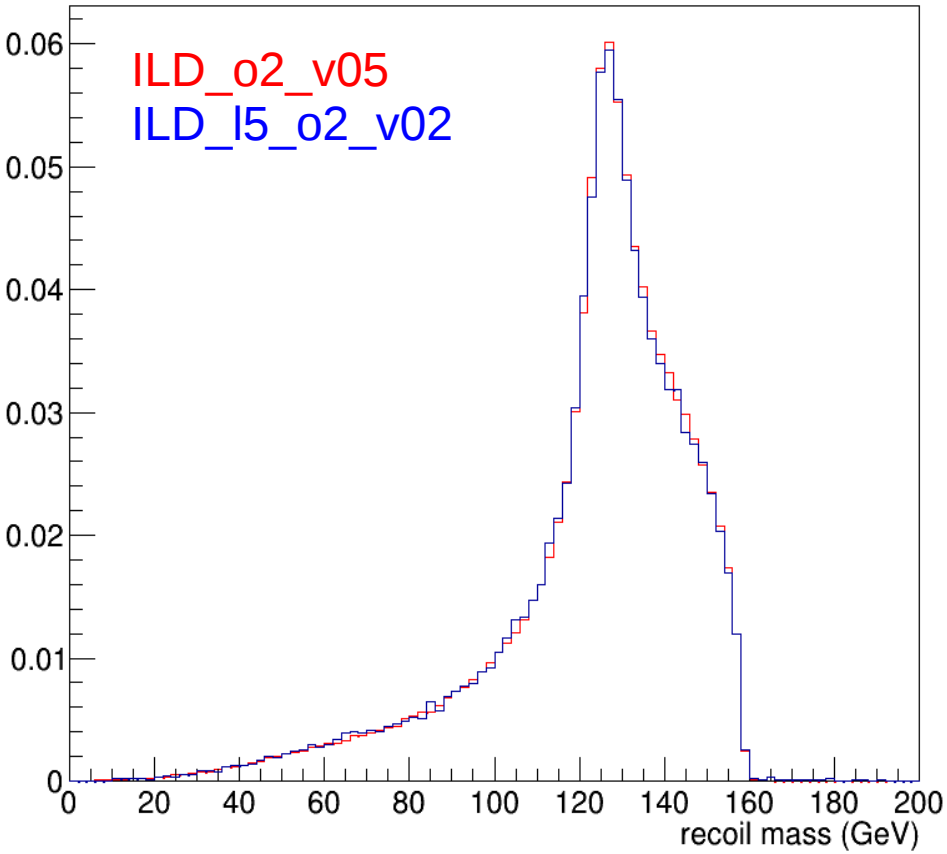




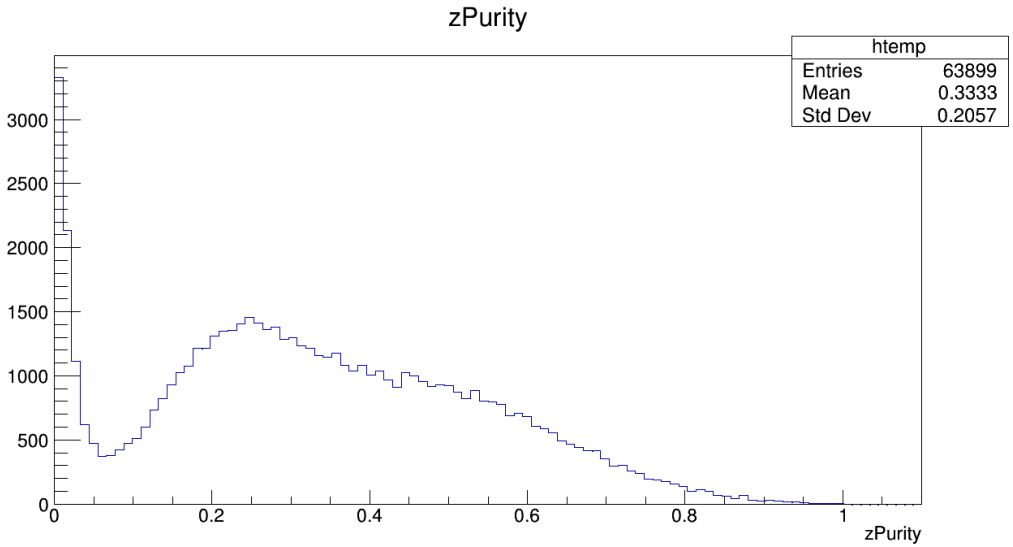


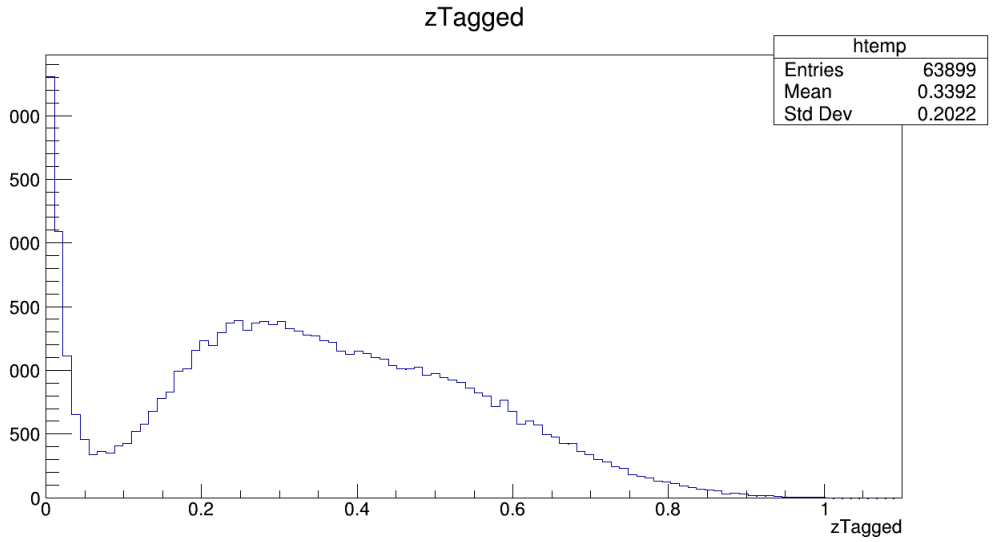
- Results with new samples are consistent with old samples
  - ILD_l5_o2_v02 reconstruction seems OK





- ...but link between reconstructed particles and MC particles seems to have problems





- A look at the RecoMCTruthLink

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collection name : RecoMCTruthLink
parameters:

-------------- print out of LCRelation collection ------

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parameter FromType [string]: ReconstructedParticle,
parameter ToType [string]: MCParticle,
fromType : ReconstructedParticle
toType : MCParticle

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| [00000926] | [00000246] | 1.00e+00|
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Before

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-------------- print out of LCRelation collection ------

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parameter ToType [string]: MCParticle,
fromType : ReconstructedParticle
toType : MCParticle

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```

Now
Is this expected behavior ?

- Plans :
  - Reconstruct with ILD_l5_o2_v02 model for $\sqrt{s}$ = 250 GeV :
    - qqH events
    - All background :
    - $q\bar{q}$
    - WW->qqqq
    - WW->qqlv
    - ZZ->qqqq
    - ZZ->qqll
  - And do a complete study of ZH cross section measurement
  - Analyse the upcoming test ZH events at $\sqrt{s}$ = 500 GeV