

# Preliminary studies on Higgstralum with hadronic final topologies

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# Overview, preliminary results

- Inspired in previous analysis done by our group<sup>1</sup>
- Wanting to apply the knowledge we have got from the test-beams data analysis.
- We have started to work in the possible improvements of the ILCSoft reconstruction algorithms.
- Our goal is to asses the energy reconstruction if we include the incident angle of the jet on the detector surface as an input variable.
- We have got promissing results from the CERN 2015 SDHCAL test-beam (a note is being written).
- Higgstralum signal events with  $Z \rightarrow$  hadronic identification and recoil-mass performance are for the moment our test variables.

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<sup>1</sup><https://www.theses.fr/2019LYSE1013>

# Signal samples

- We have started with the latest MC-2020 MonteCarlo production.  
 $\sqrt{s} = 250$ , ILCSoft:v02-02.
- For the moment only **o1** samples are available.[1] (see backup slides)
- Our detector Model would be ILD-15-o2 with the SDHCAL
- o2 signal samples have been requested
- In order to make progress we have started to check our workflows with the o1 simulation.

```
[1]/ilc/prod/ilc/mc-2020/ild/dst-merged/250-SetA/higgs/ILD_15_o1_v02/v02-02/rv02-02.sv02-02.mILD_15_o1_v02.E250-SetA.I402011.Pqqh.eL.pR.n000.d_dstm_15095_*.slcio.
```

# Z identification (with SDHCAL, previous results)

- We run over all possible jet combinatorial possibilities.
- Then we choose the pair that give us the closest mass to the Z known mass.
- Two variables are defined in order to identify correctly the jets associated to a Z boson.

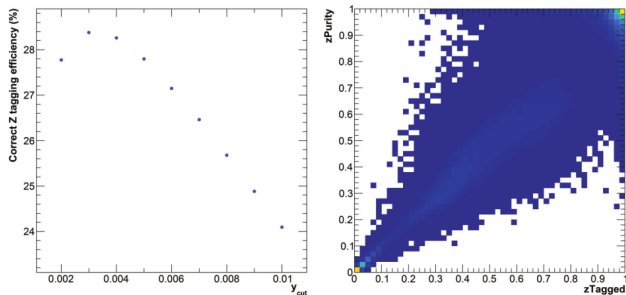
$$Z_{tag} = \frac{E_Z^{j1,j2}}{E_Z^{total}} \quad Z_{purity} = \frac{E_Z^{j1,j2}}{E^{j1,j2}}$$

$E_Z^{j1,j2}$ : MC-truth di-jet energy from the Z,  $E_Z^{total}$ : MC-truth Z energy,  
 $E^{j1,j2}$ : MC-truth total di-jet energy.

- The  $E_Z^{j1,j2}$  is computed through a loop over all the PFOs. The associated MC particle is weighted using the RecoMCTruthLink excluding the particles with a higgs parent(pdgId=25).

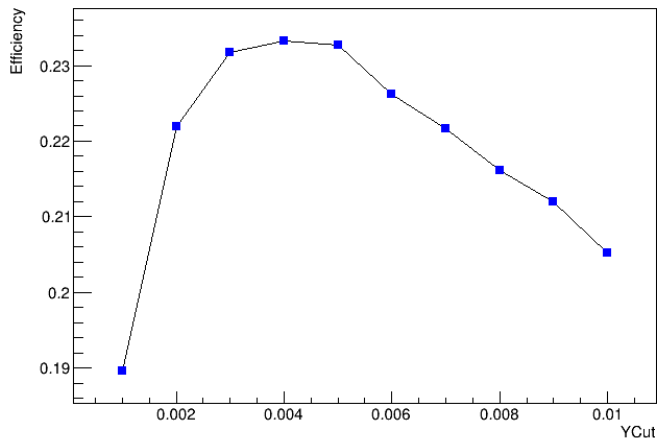
# Z identification (with SDHCAL, previous results)

The algorithm used in this study was *fast-jet* and a parameter optimization,  $y_{cut}$ , has to be done in order to maximize the Z tag efficiency. An dijet selection is considered efficient if  $Z_{tag} > 0.9$  and  $Z_{purity} > 0.9$



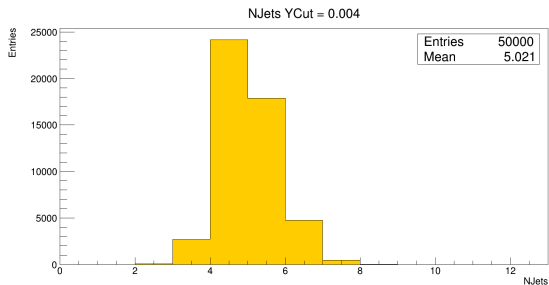
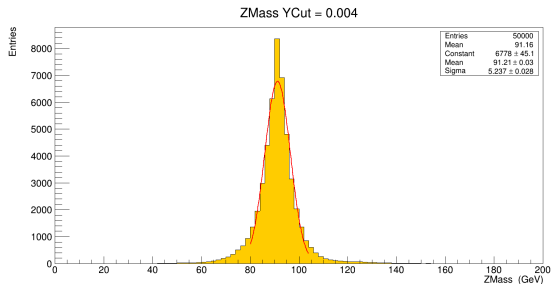
The optimal value in the previous study was  $y_{cut} = 0.003$ .

# Z identification with o1(AHCAL) MC-2020 results



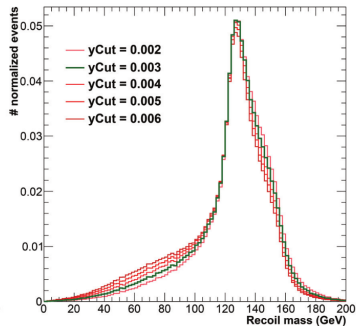
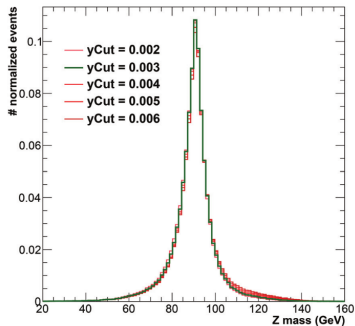
The new  $y_{cut}$ , with the AHCAL simulation, shows a similar shape. But different maximum  $y_{cut} = 0.004$ .

# Z identification with o1(AHCAL) MC-2020 results

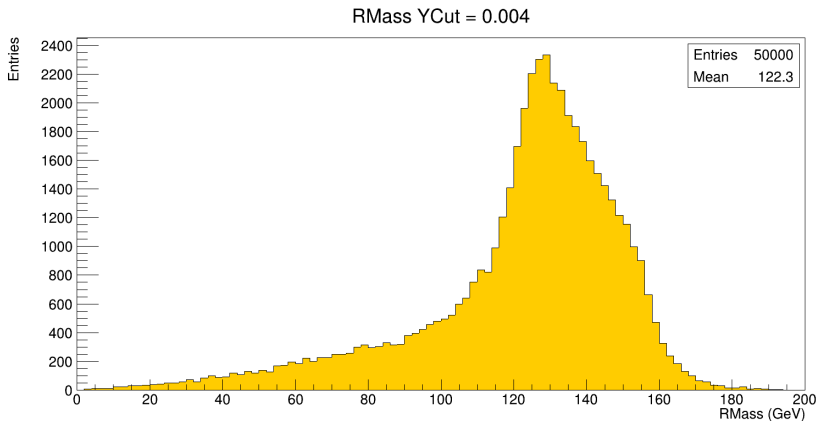


# Recoil Mass

$$m_{rec}^2 = [\sqrt{s} - E_Z]^2 - \vec{p}_Z^2 \quad (1)$$



# Recoil mass o1 MC-2020 results



# Conclusions

- Our goal is to take this analysis to the very end. Background simulation and cross section measurements with its correspondent uncertainties.
- Timing is also a variable that we would like to consider.

# Backup

## Backup



# o2 crash reproduced

```

/ILD_l5_v02/v02-02/00015322/000/sv02-02.mILD_l5_v02.E250-SetA.I270002.PBeamstr-seeablepairs.e0.p0.n001_105.d_sim_00015322_5.slcio
[ MESSAGE ZMxpvInfiniteVector thrown:
ZMxpvInfiniteVector: Attempt to do vector /= 0 -- division by zero would produce infinite or NAN components
at line 313 in file /cvmfs/ilc.desy.de/sw/x86_64_gcc82_sl6/CLHEP/2.3.4.3/CLHEP/Vector/src/ThreeVector.cc
*****
A runtime error occurred - (uncaught exception):
ZMxpvInfiniteVector: Attempt to do vector /= 0 -- division by zero would produce infinite or NAN components
Marlin will have to be terminated, sorry.
*****

E "PairBgOverlay"] *** Opening file for overlay : number of available events: 600
[ MESSAGE "PairBgOverlay"] Overlay::modifyEvent: total number of available events to overlay: 600
[ MESSAGE "MyStatusmonitor"] ===== Run :      1 Event:      0
[ WARNING "MergeCollectionsEcalBarrelHits"] MergeCollections::processEvent : incompatible parameter vector sizes : InputCollections: 2 <->
InputCollectionIDs 0
[ WARNING "MergeCollectionsEcalBarrelHits"] MergeCollections::processEvent : standard numbering (0,1,2,...) used.
[ WARNING "MergeCollectionsEcalEndcapHits"] MergeCollections::processEvent : incompatible parameter vector sizes : InputCollections: 2 <->
InputCollectionIDs 0
[ WARNING "MergeCollectionsEcalEndcapHits"] MergeCollections::processEvent : standard numbering (0,1,2,...) used.
[ MESSAGE "MySimDigital"] have processed 1 events
[ VERBOSE "MyDDMarlinPandora"] ===== WARNING =====
[ VERBOSE "MyDDMarlinPandora"] static method CellIDDecoder::setDefaultEncoding
[ VERBOSE "MyDDMarlinPandora"] does nothing anymore. Use the constructor to
[ VERBOSE "MyDDMarlinPandora"] specify your encoding string !!
[ VERBOSE "MyDDMarlinPandora"] =====

```