Preliminary studies on Higgsstrahlung with hadronic final topologies

ILD software & analysis meeting
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Overview, preliminary results

- Inspired in previous analysis done by our group detailed in Guillaume Garrillot's thesis.[1]
- 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 check if the jet incident angle correction to the SDHCAL energy reconstruction improves the physics performance.
- We have got promising results from the CERN 2015 SDHCAL test-beam (a note is being written).
- Higgsstrahlung signal events with $Z \rightarrow$ hadronic identification and recoil-mass performance are for the moment our test variables.

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[1] https://www.theses.fr/2019LYSE1013

Signal samples

- We have started from scratch with the latest MC-2020 MonteCarlo production. $\sqrt{s} = 250\,GeV$, ILCSoft:v02-02.
- For the moment only **o1** samples are available.[1] (see backup slides)
- Our detector Model would be ILD-l5-o2 with the SDHCALs
- **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_l5_o1_v02/v02-02/rv02-02.sv02-02.mILD_l5_
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.

$$Z_{tag} = \frac{E_Z^{j_1,j_2}}{E_Z^{total}} \qquad Z_{purity} = \frac{E_Z^{j_1,j_2}}{E^{j_1,j_2}}$$

$E_Z^{j_1,j_2}$: MC-truth di-jet energy from the Z, E_Z^{total}: MC-truth Z energy, E^{j_1,j_2}: MC-truth total di-jet energy.

- The $E_Z^{j_1,j_2}$ 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).
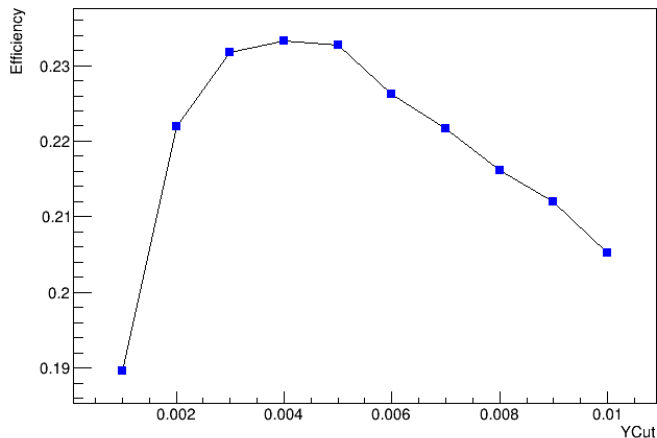
Z identification (with SDHCAL, previous results)

The algorithm used in this study was *ee_kt_algorithm* within fast-jet with ExclusiveYCut strategy. An optimization of y_{cut} has to be done in order to maximize the di-jet reconstructionselection efficiency. A dijet is considered efficient if $Z_{tag} > 0.9$ and $Z_{purity} > 0.9$
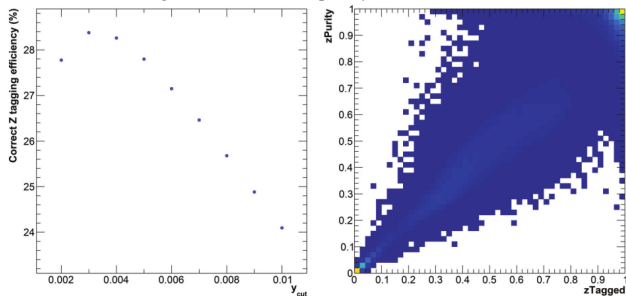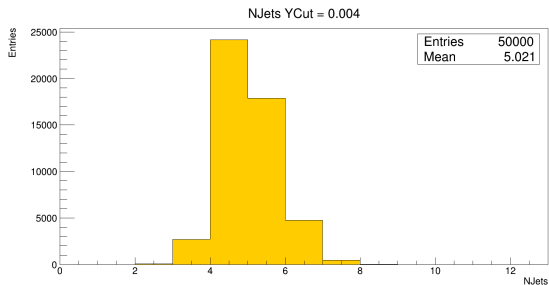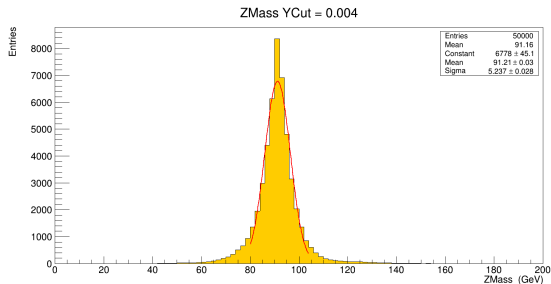

The optimal value in the previous study was $y_{cut} = 0.003$.

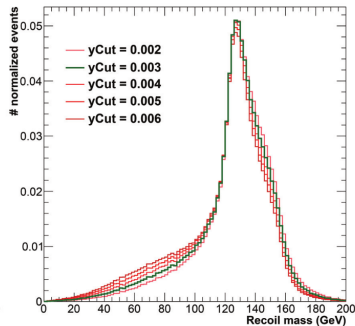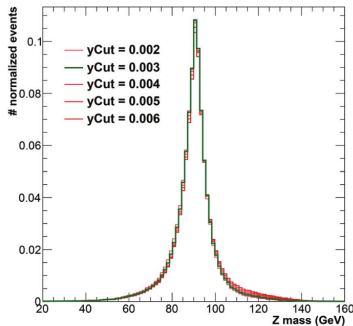# Z identification with o1(AHCAL) MC-2020 results

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

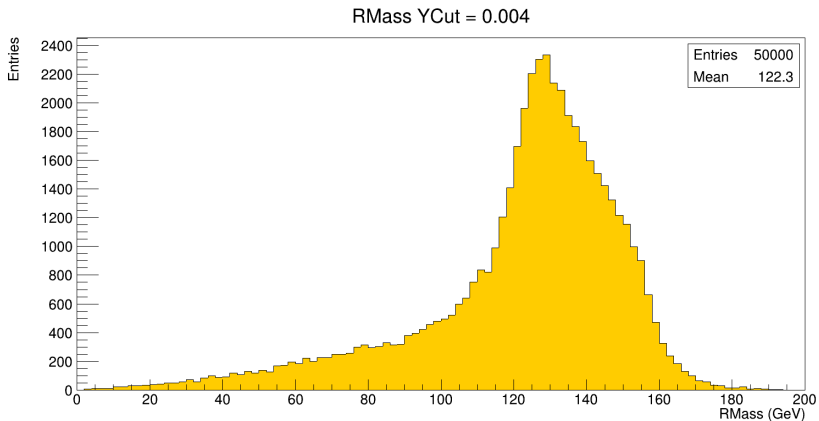# Z identification with o1(AHCAL) MC-2020 results

Recoil Mass (with SDHCAL, previous results)

$$m_{rec}^2 = \left[\sqrt{s} - E_Z\right]^2 - \vec{p_Z}^2 \tag{1}$$

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 we will consider in these studies.

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
[ MESSAGZMxpvInfiniteVector 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 occured - (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"] ============================================
```