Ongoing MonteCarlo analysis of the qqh signal with the SDHCAL reconstruction. – Overlay impact –

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Setup

- The latest MC production *sv02-02-01*, set 250 GeV, reconstructed with the SDHCAL *rv02-02-01*.mILD_l5_o2_v02 has now included the overlay events.
- Number of available events 50k in the DST-Merged files analyzed.
- Polarization eLpR (analysis of other polarizations is planned in the future).
- Beam crossing angle correction applied.

The objective of this preliminary analysis is to understand the effect of the newly included overlay into the signal events.

Z identification (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 quality variables are defined:

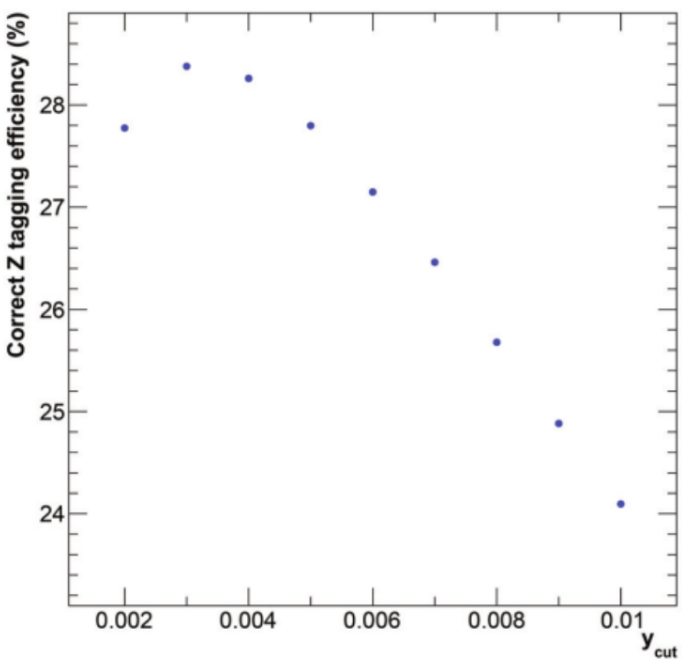
$$Z_{Tag} = \frac{E_Z^{j_1,j_2}}{E_Z^{Total}} \quad Z_{Purity} = \frac{E_Z^{j_1,j_2}}{E^{j_1,j_2}}$$

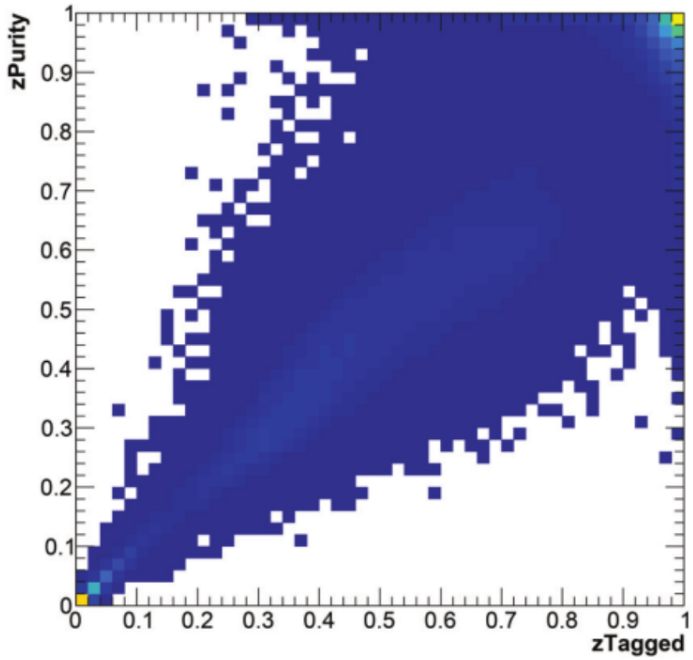
where $E_Z^{j_1,j_2}$: MC-truth di-jet energy from the Z, E_Z^{Total}: MC-truth Z energy and E^{j_1,j_2}: MC-truth total di-jet energy.

- The $E_Z^{j_1,j_2}$ is computed through a loop over all the PFOs. The associated MC particle energy is weighted using the RecoMCTrughLink excluding the particle with a Higgs as a parent (pdgId $= 25$).

Z identification (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 reconstruction selection efficiency. A di-jet is considered efficient if $Z_{Tag} > 0.9$ and $Z_{Purity} > 0.9$.

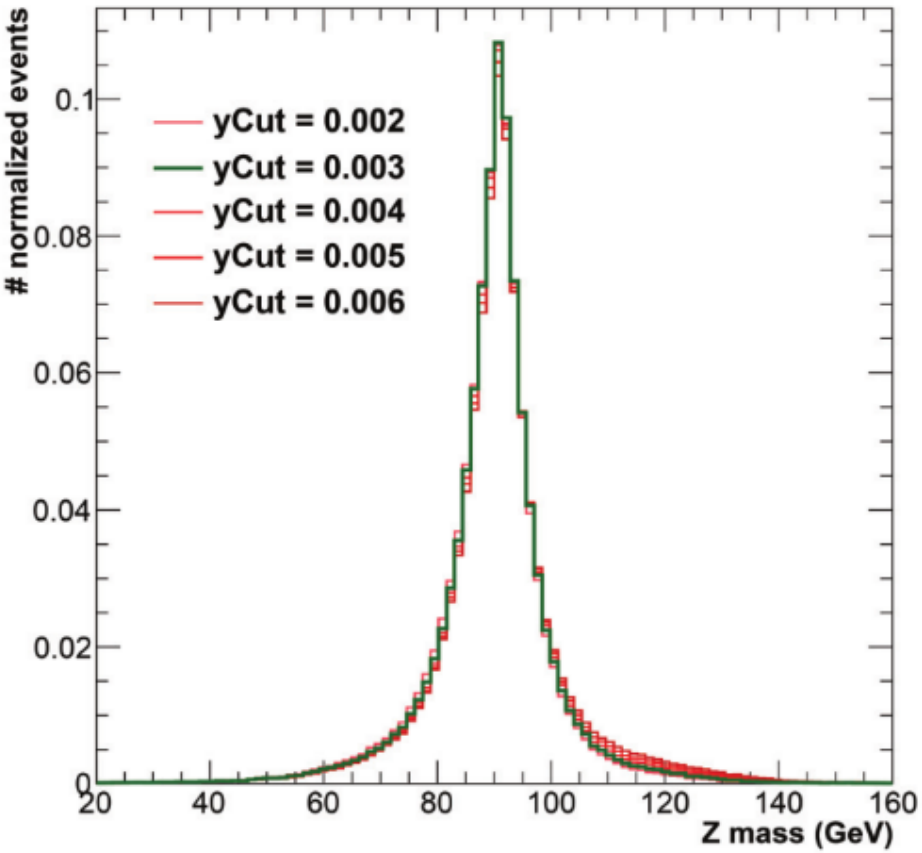


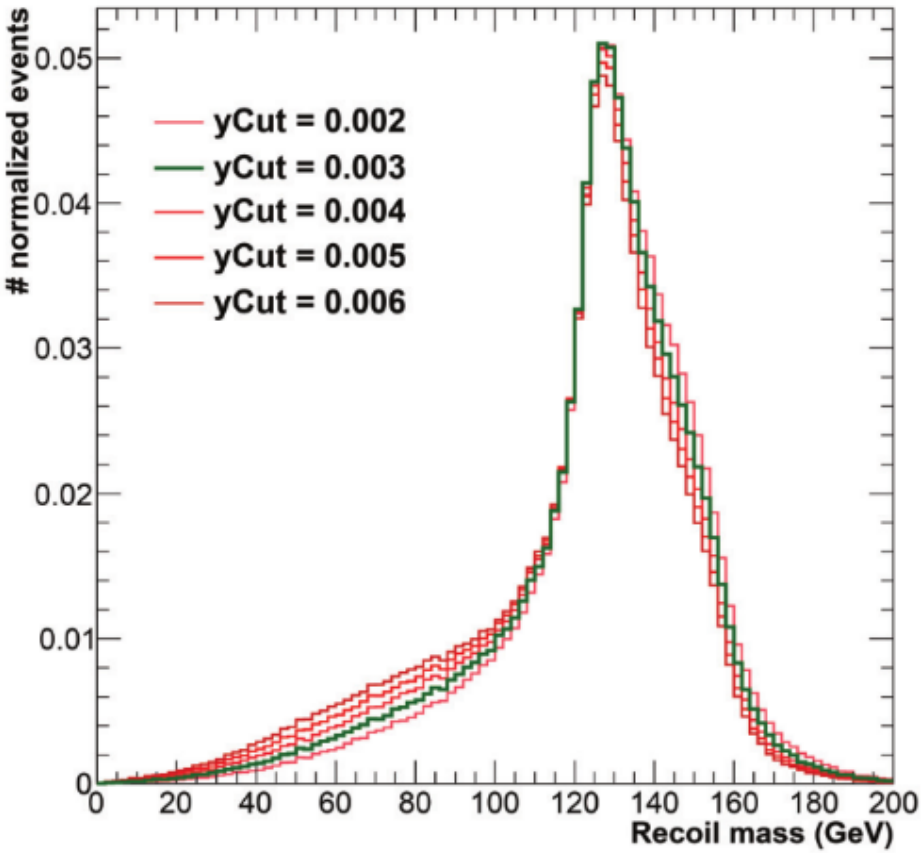


The optimal value in this previous study was $y_{cut} = 0.003$.

M_Z and M_{Recoil} (previous results)

$$M^2_{Recoil} = [\sqrt{s} - E_Z]^2 - \vec{pz}^2$$





FastJet algorithms

We want to find the set of parameters from the jet clustering algorithms from which the impact of the overlay is minimal. The two algorithms studied are:

- *Generalized k_t algorithm for e^+e^- collisions (ee_genkt) in the YCut exclusive mode.*

$$d_{ij} = min(E_i^{2p}, E_j^{2p}) \frac{1 - cos(\theta_{ij})}{(1 - cos(R))} \quad ; \quad d_{iB} = E_i^{2p}$$

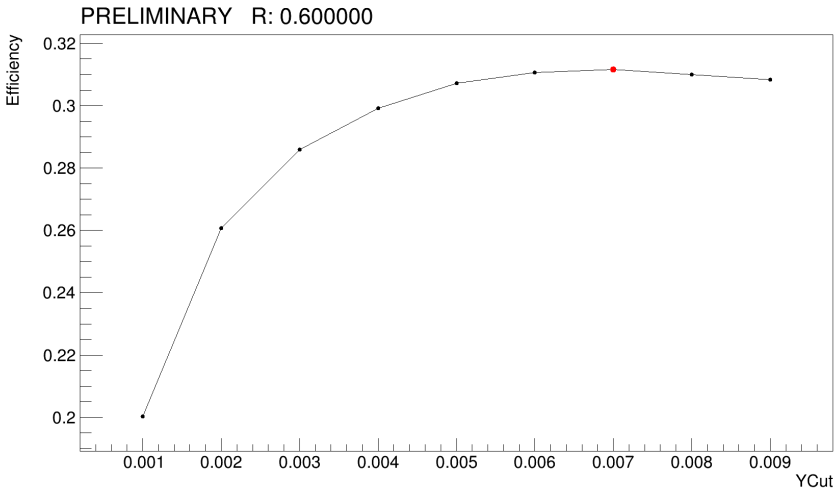
- *k_t algorithm for e^+e^- collisions (ee_kt) in the YCut exclusive mode.*

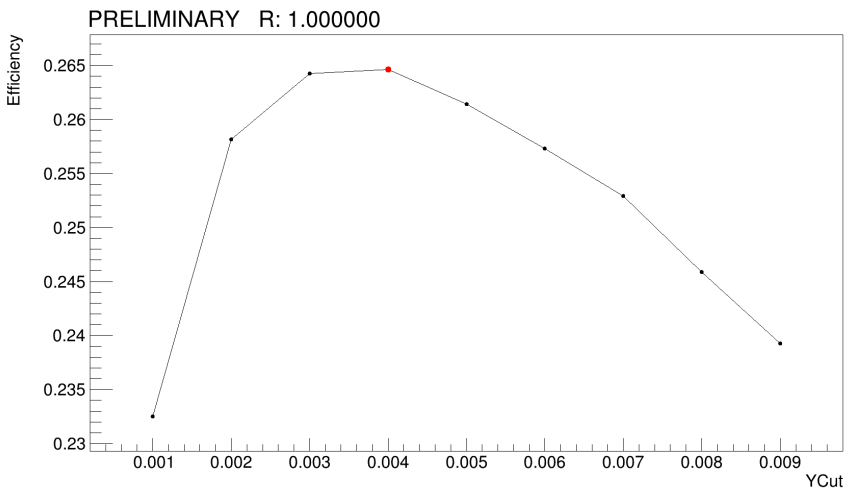
$$d_{ij} = 2min(E_i^2, E_j^2)(1 - cos(\theta_{ij}))$$

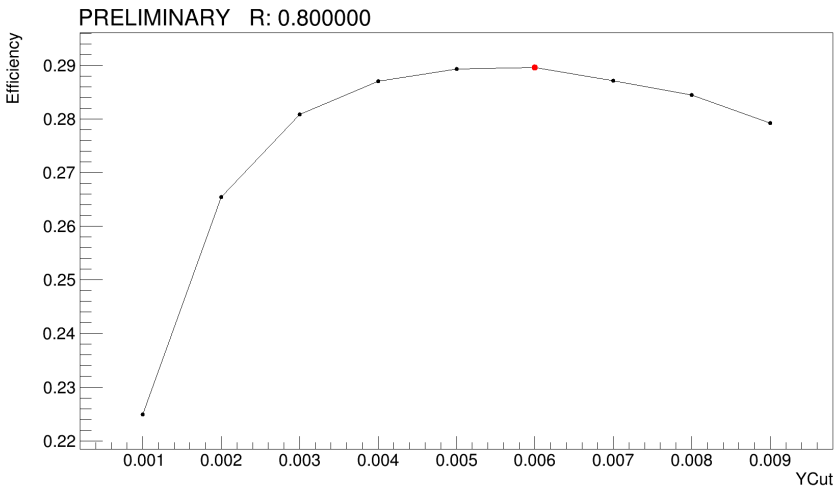
Parameters: ee_genkt -> **YCut**, **R** and **P** ; ee_kt -> **YCut**

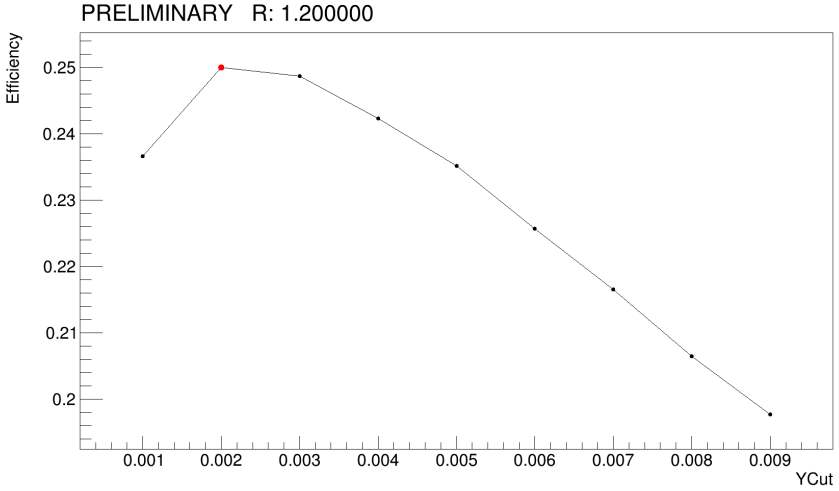
YCut scans ee_genkt

YCut scans like the ones in Slide 4 are performed for different values of **R** and **P** for the ee_genkt algorithm and another one for the ee_kt algorithm.









YCut scans ee_kt

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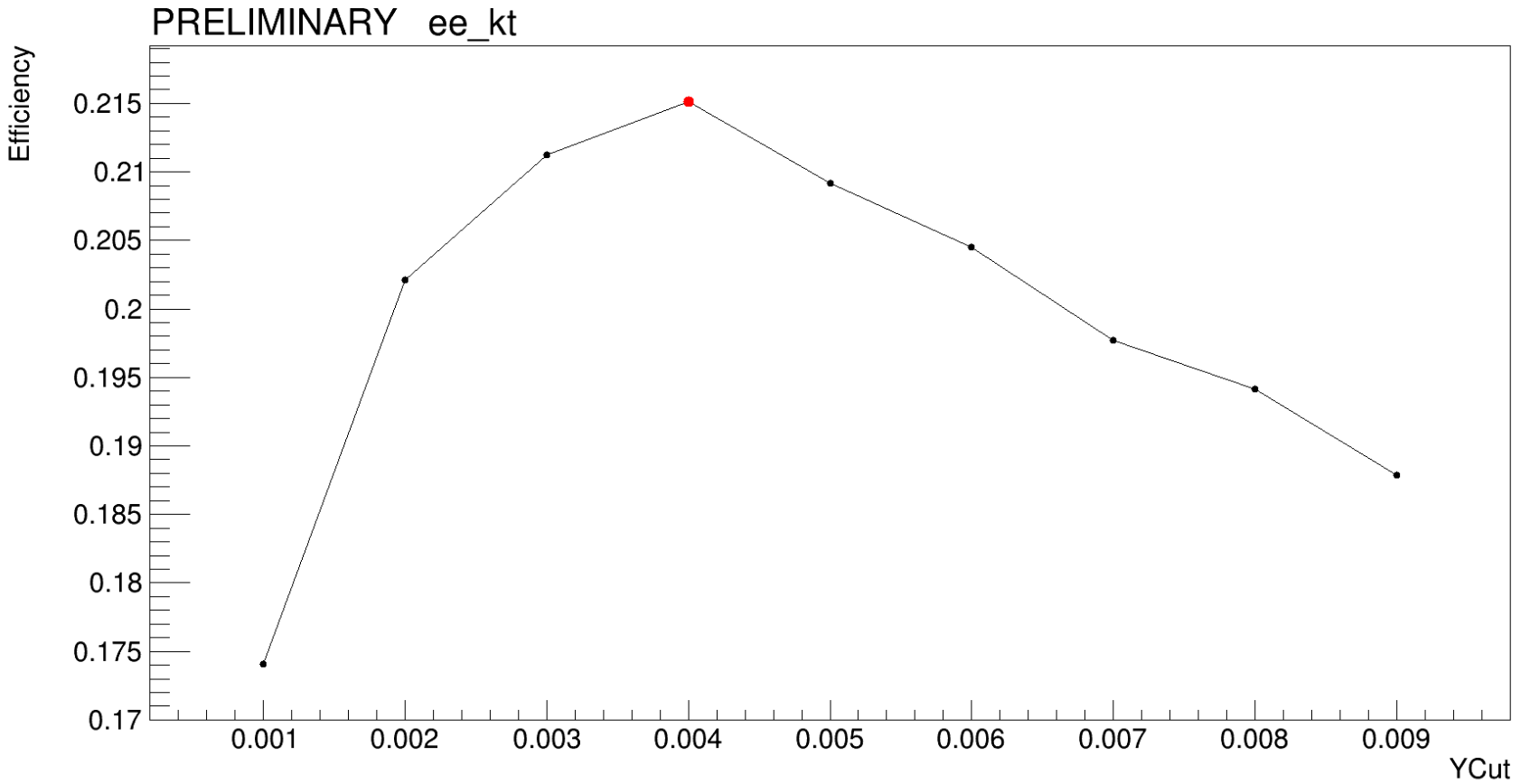
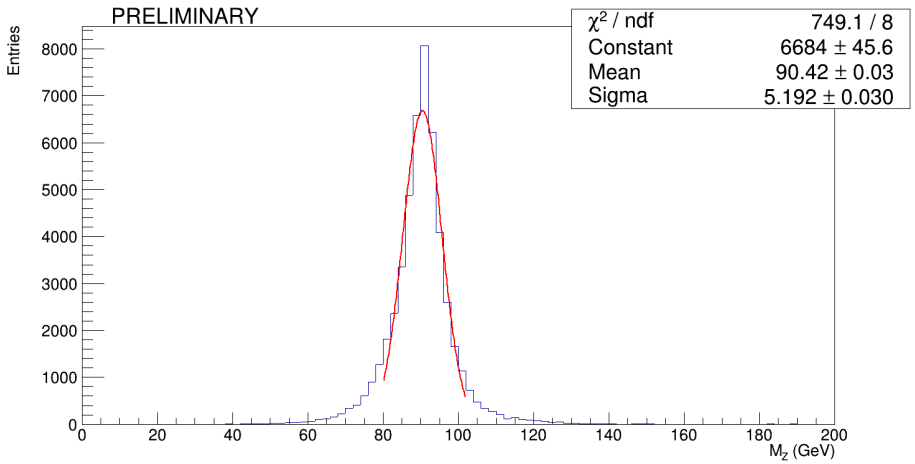


Quality variables

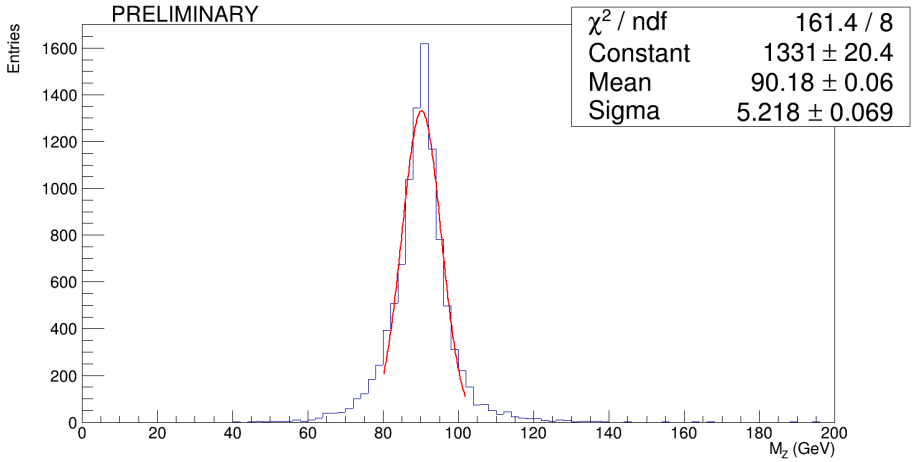
From the studied parameters R = 0.6 gives the highest efficiency. However this does not mean that gives the best jet reconstruction. The quality variables computed are:

- Z_{Mass} differences (%). The Z mass is reconstructed, following the previous procedure, with and without overlay. This distribution is fitted to a gaus function and then two differences are computed:
  $ZDiff = |M_Z - M_Z^{NoOverlay}|/M_Z$
  $OverlayDiff = |M_Z^{Overlay} - M_Z^{NoOverlay}|/M_Z^{NoOverlay}$

R = 0.6



R = 0.6 No Overlay



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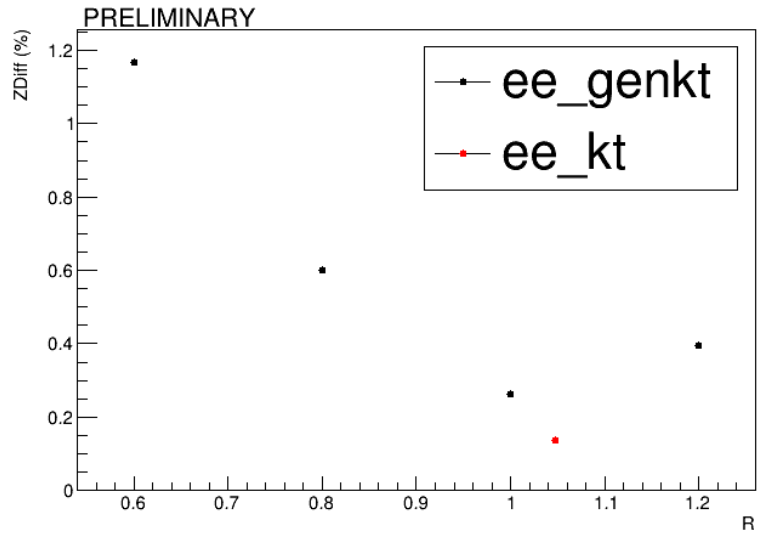
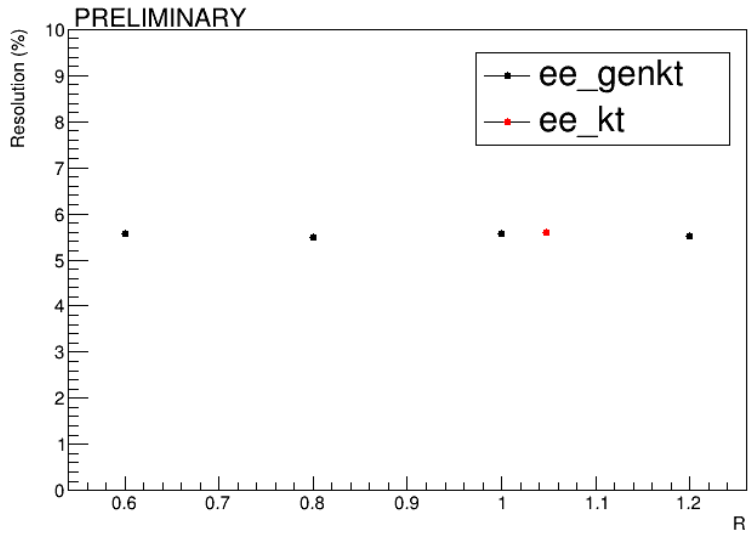
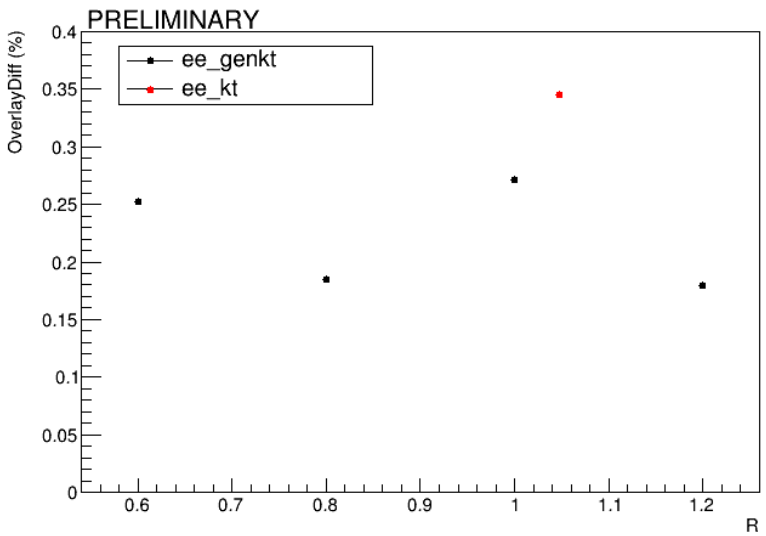
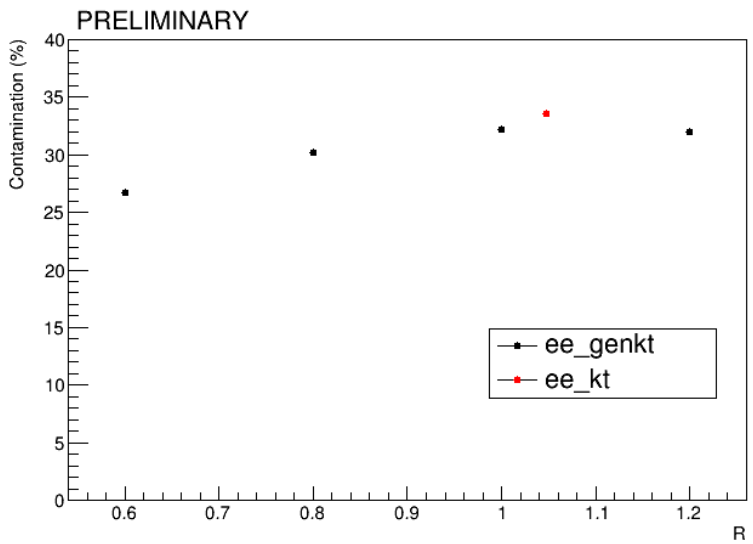
- Z_{Mass} "resolution". (σ/M_Z) from the previous fit.
- Jet Contamination (%). The mean percentage of jets that have some overlay contribution.

Quality variables



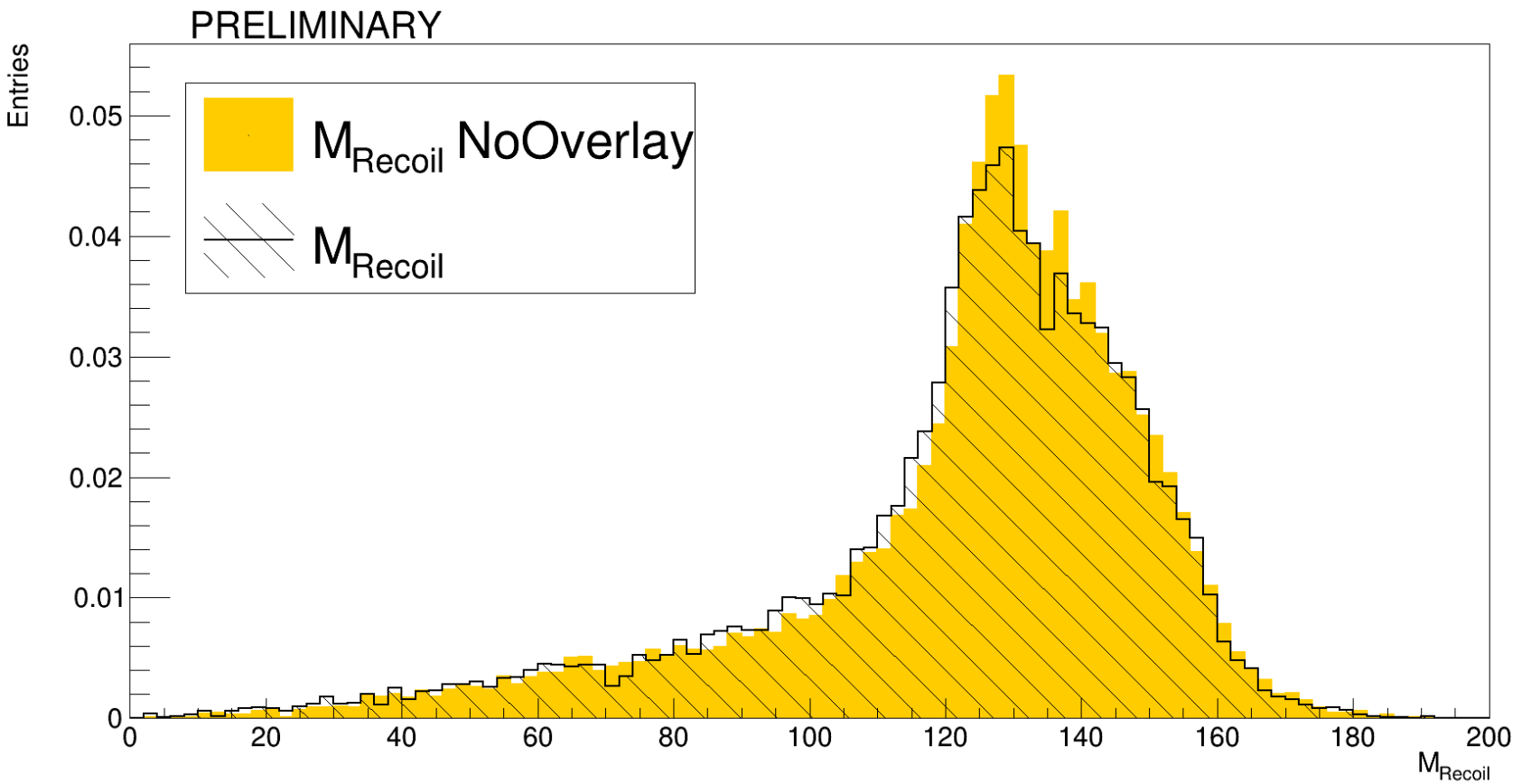






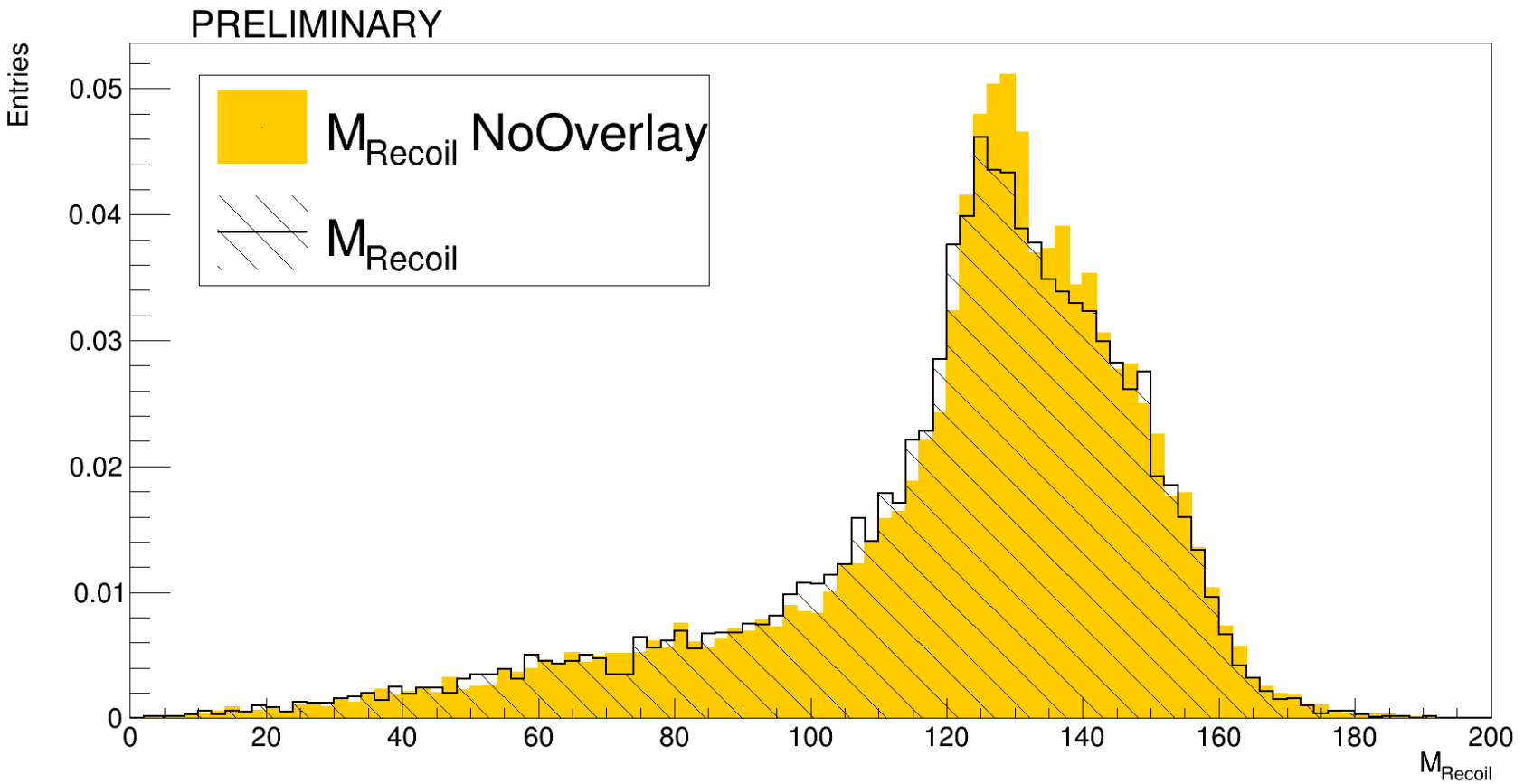
Recoil mass ee_genkt

With this algorithm the optimal parameters have been found to be R = 1.0 and YCut = 0.004 and an impact of less than 0.3 % from overlay in the Z reconstruction.



Recoil mass ee_kt

With this algorithm the optimal parameter is YCut = 0.004 and an impact of 0.35 % from overlay in the Z reconstruction.



Conclusion

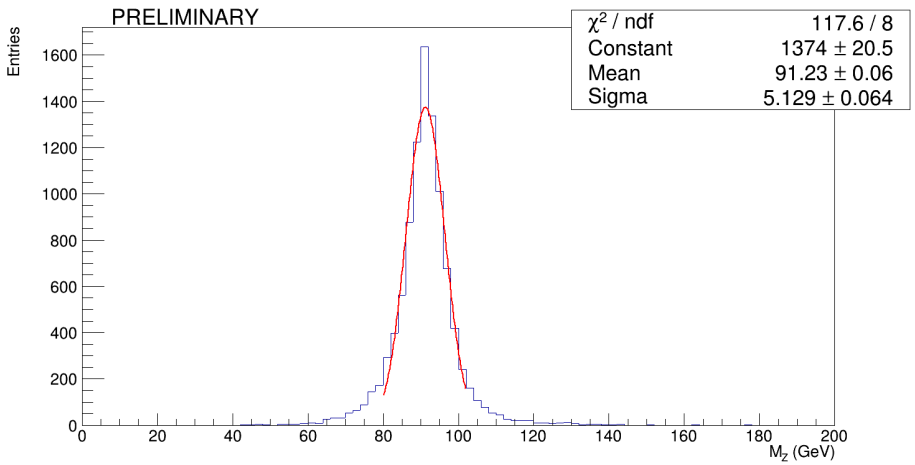
It have been shown the set of parameters that minimizes the overlay effect while efficiently reconstructing the Z mass and showing healthy recoil mass distributions.

A slightly better shape in the recoil mass is obtained from the ee_kt method that indicates that it is the algorithm that should be used.

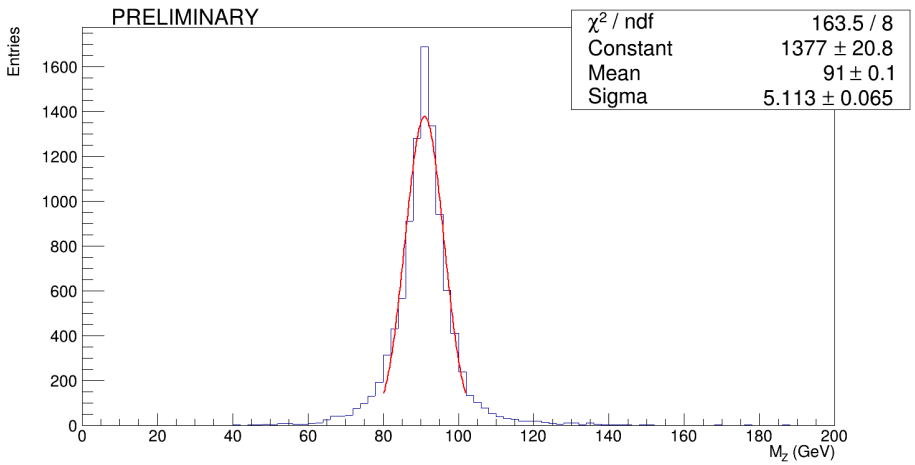
BACKUP

M_Z R = 1.0

Overlay

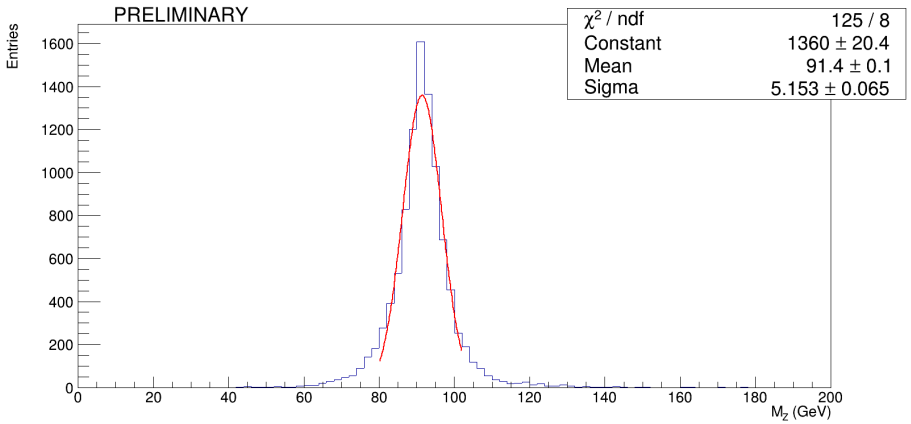


No Overlay



M_Z ee_kt

Overlay



No Overlay