Study of a L1 topological trigger to select radiative Z decay in the ATLAS detector

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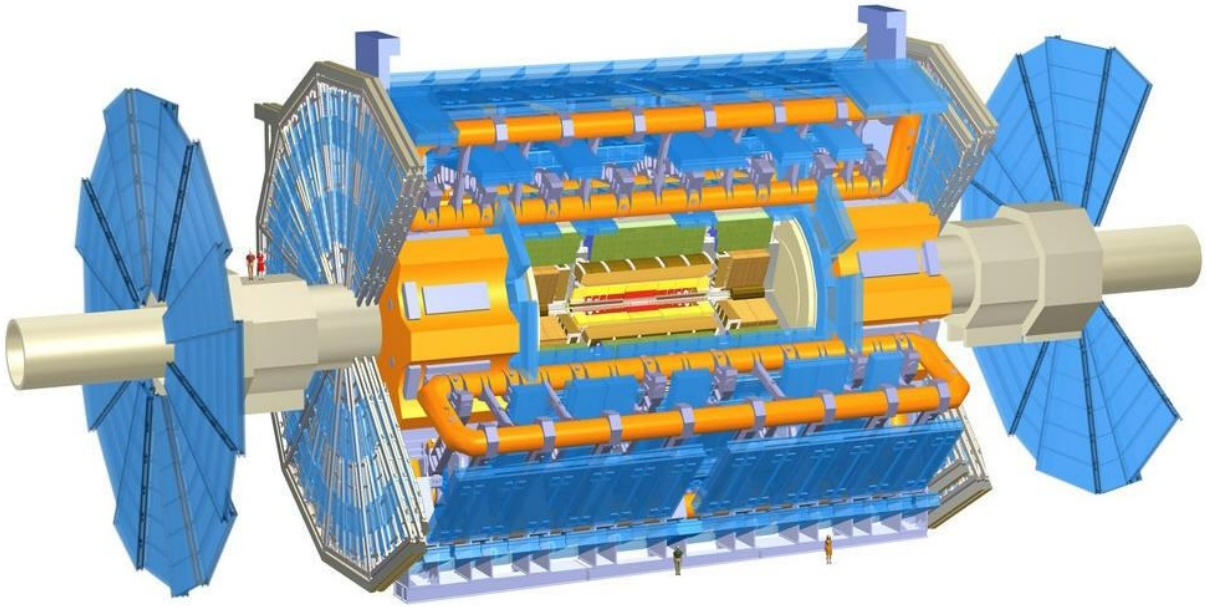


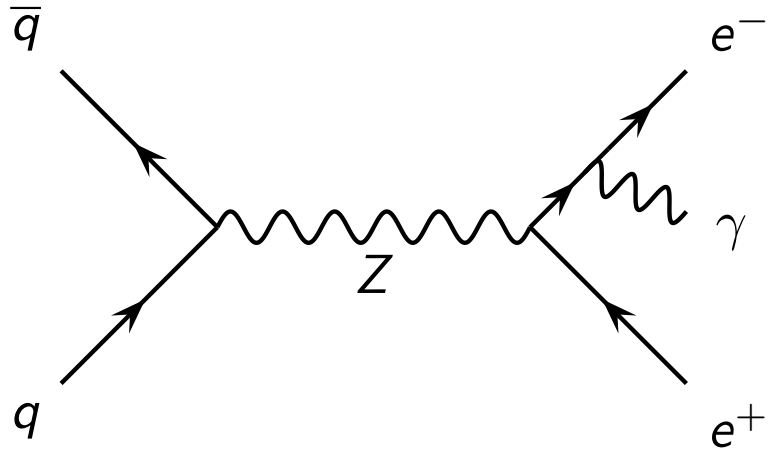
Introduction

LHC RUN 2

- Larger luminosity and higher energy (up to $2x10^{34}$ $cm^{-2}s^{-1}$, $\sqrt{s} = 14$ TeV)
- Increased pile-up (up to 50-60 interactions/bunch crossing)
- Immense QCD background
- Necessity to reduce the rate, especially at the hardware-based Level-1 trigger.

Idea

Include a selection in the L1 topological trigger to select radiative Z decays in the electron channel



Radiative Z decay are used to study photon trigger and identification efficiencies.

ATLAS detector and trigger system

ATLAS is a multi-purpose detector

Electrons and photons are reconstructed by combining information from the **electromagnetic calorimeter** and the inner tracking detectors.

The trigger system is composed of a hardware-based L1 and a software-based high-level trigger

In Run 2 it will be possible to require additional constraints at L1 (e.g. Invariant mass).

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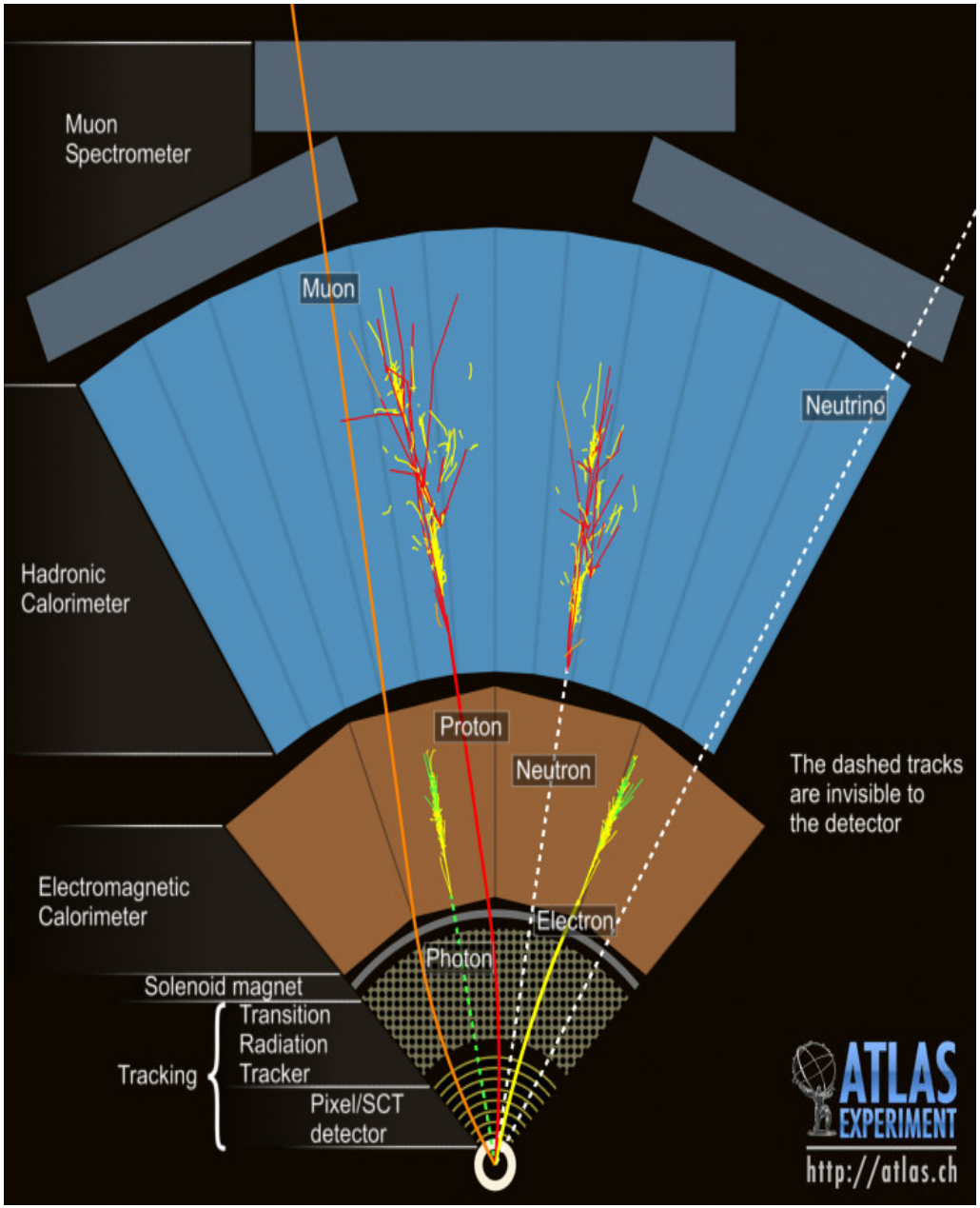
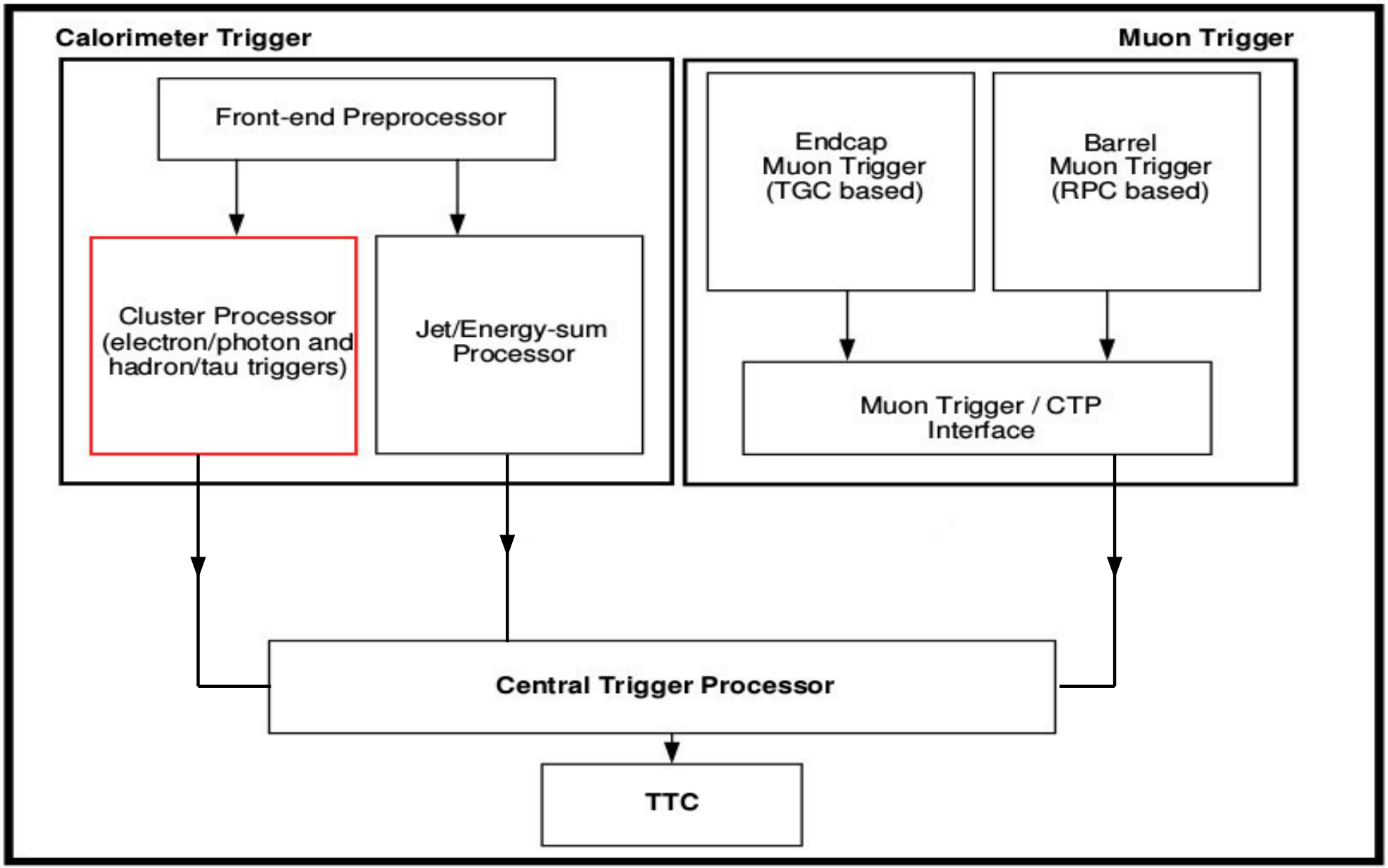
L1 Topological Trigger



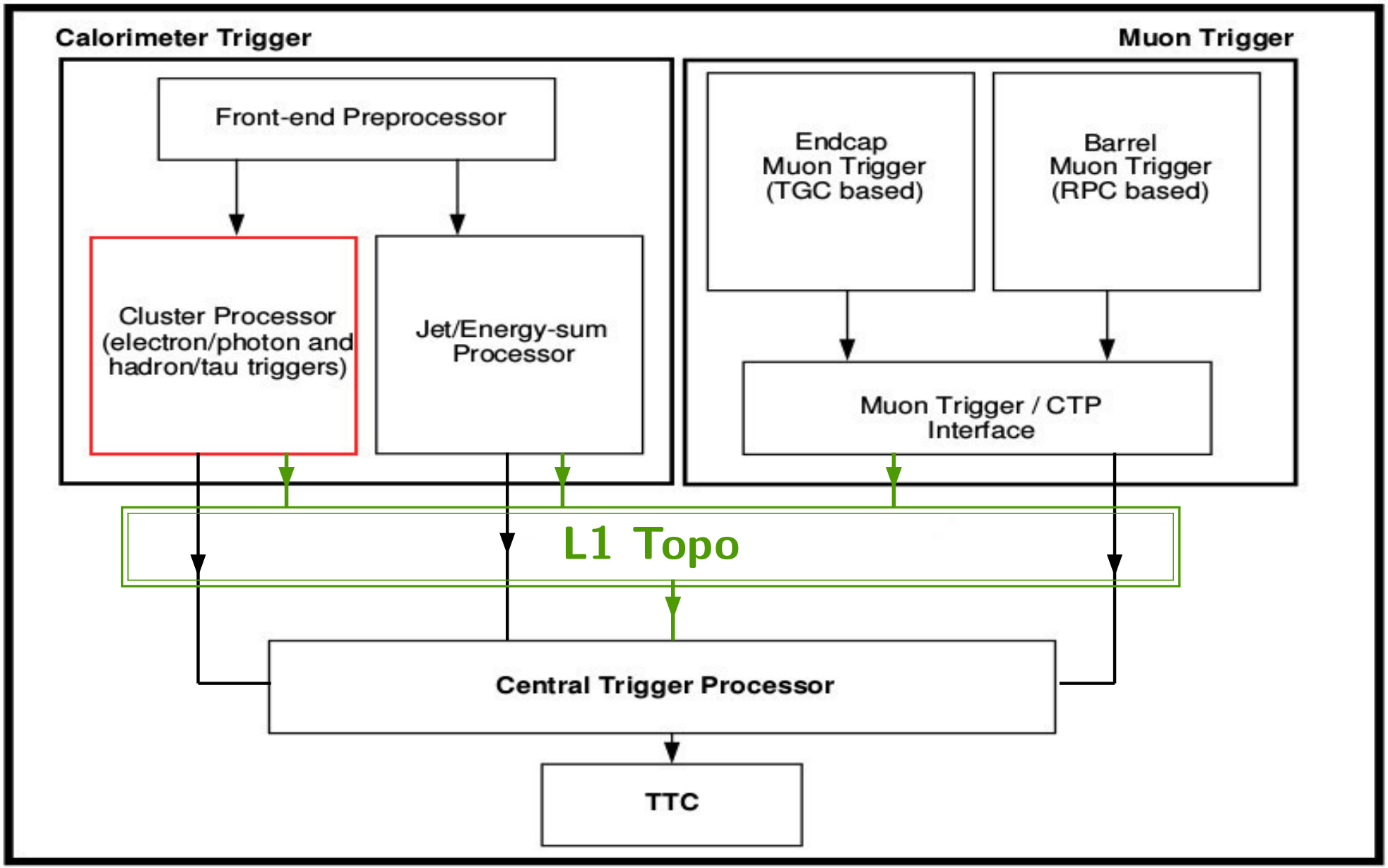
L1 Trigger

Run 1: 20 Mhz L1 input/65 kHz L1 output, 8 TeV, lumi 0.7×10^{34} cm^{-2}s^{-1}



L1 Trigger

Run 2: 40 Mhz L1 input/100 kHz L1 output, 14 TeV, lumi 2×10^{34} $cm^{-2}s^{-1}$

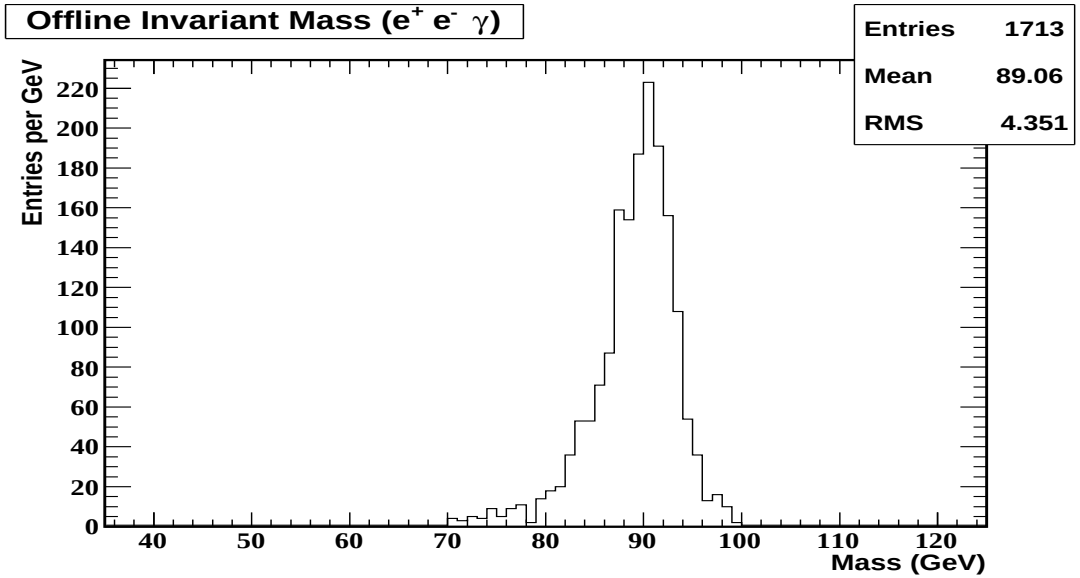


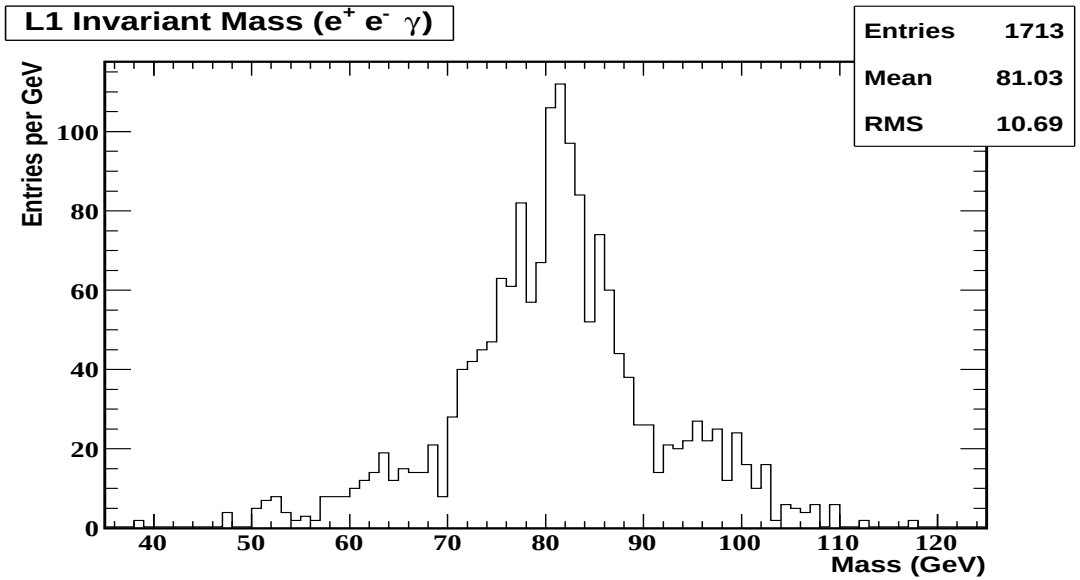
Z invariant mass: Offline and L1

- The samples used for the signal were MC $Z \rightarrow ee\gamma$.
- For the signal we selected offline e^-, e^+ and γ, that satisfied the standard quality criteria of the ATLAS collaboration.

  Only $Z \rightarrow ee\gamma$ events detected by the offline within a minimal mass window (70,100) GeV, where considered.
- The match between L1 clusters and the Offline objects was done finding the closest cluster (to each object) and considering $\Delta R < 0.15$, with:

$$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$

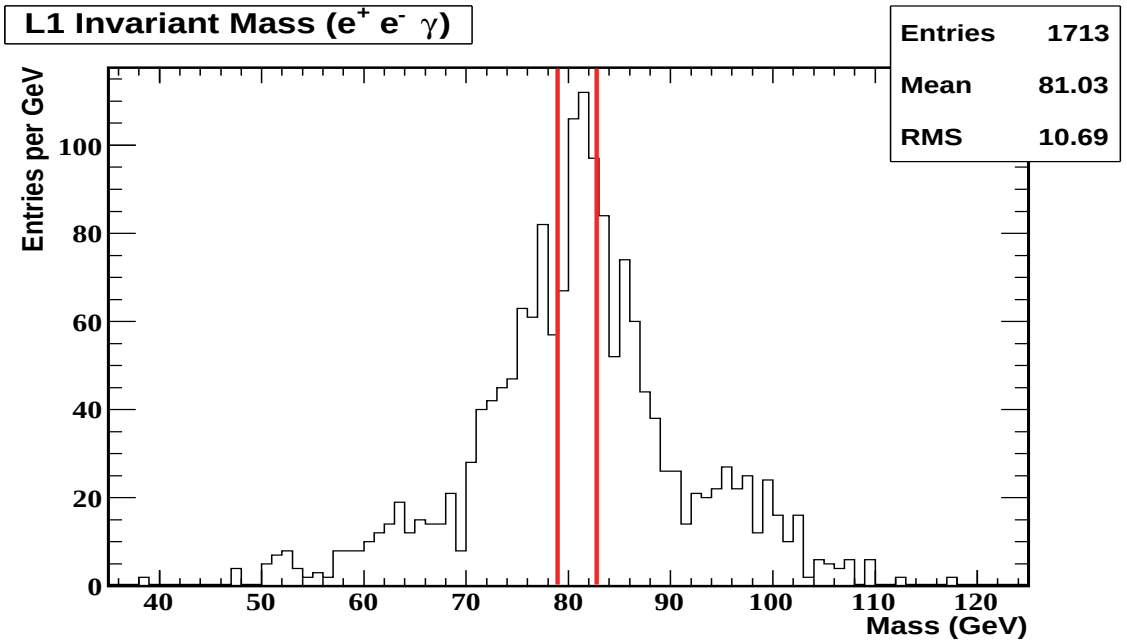




Z invariant mass: L1 cuts

- We perform different cuts on the invariant mass of the Z, calculated using the L1 Calo clusters.
- We open the window around the peak and save the number of entries as a function of the window size from ± 1 to ± 80 GeV.
- We calculate the efficiency as

$$Eff = \frac{\sharp \text{ of entries}^{after\ \ cut}}{\sharp \text{ of entries}^{total}}$$



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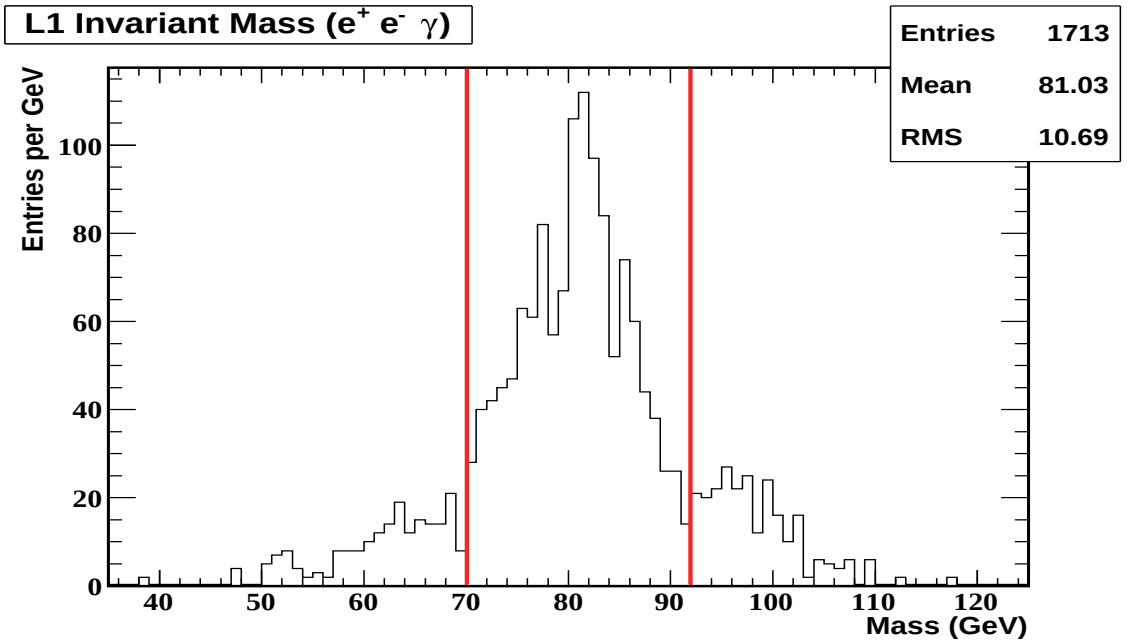

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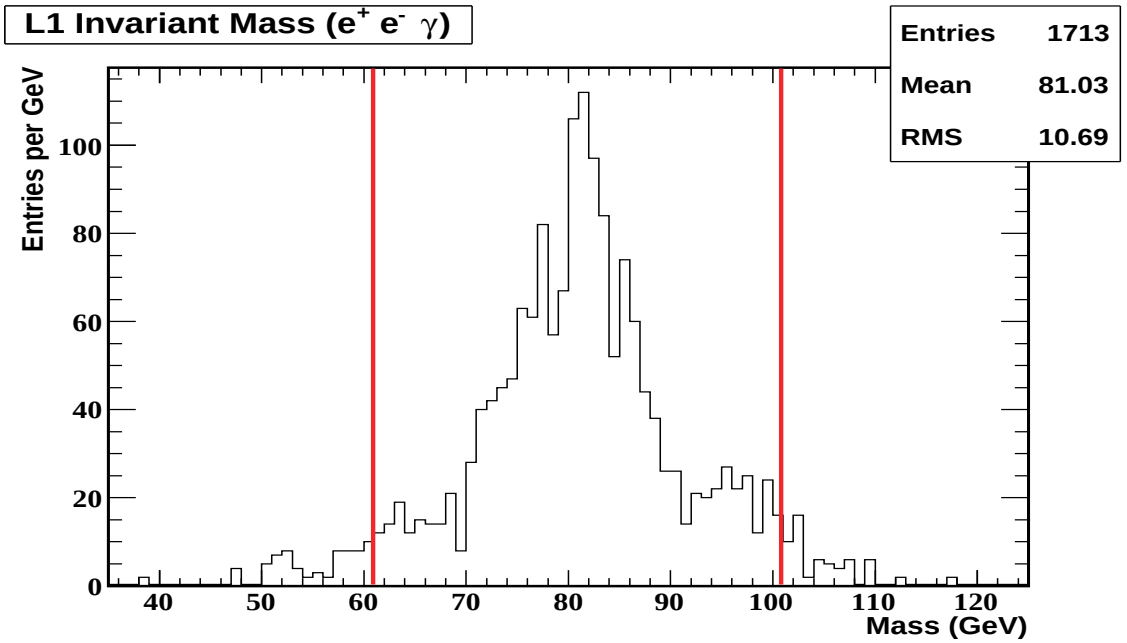

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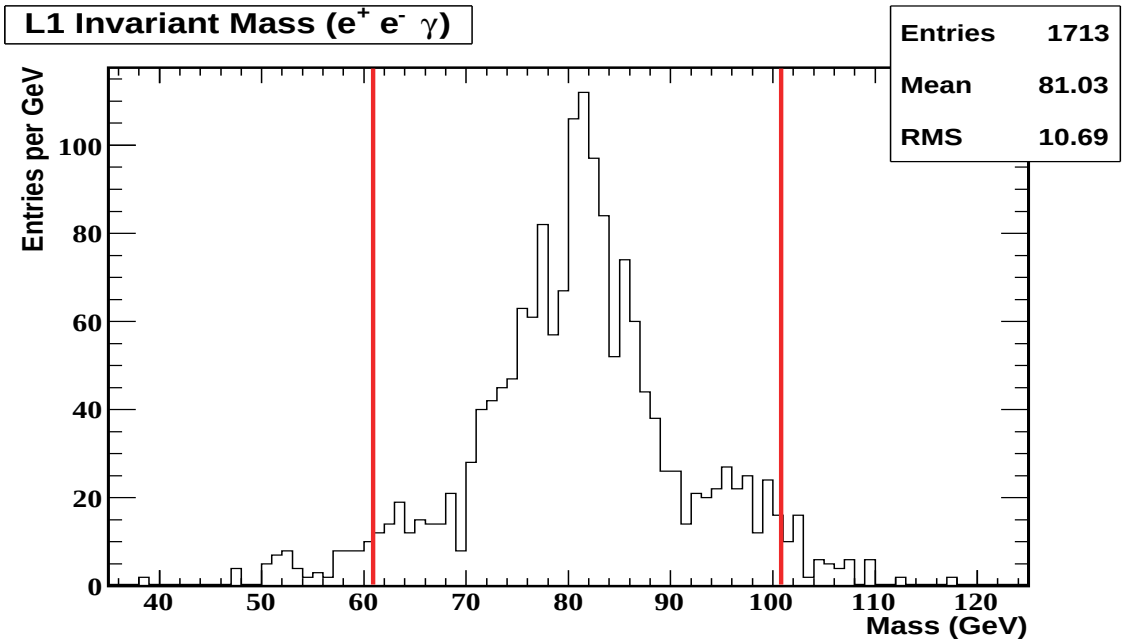
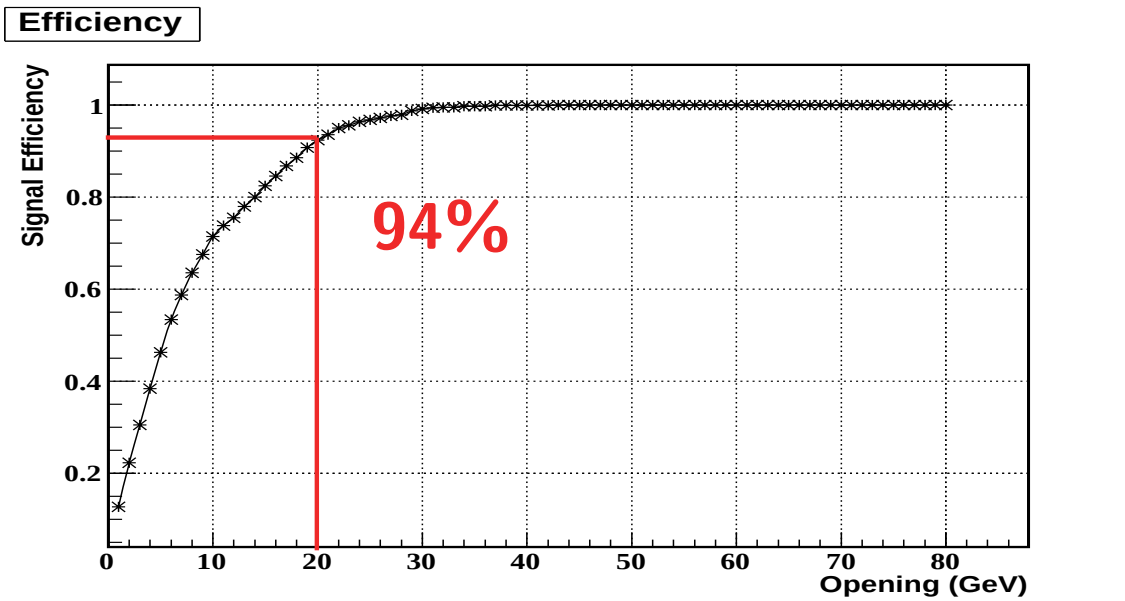
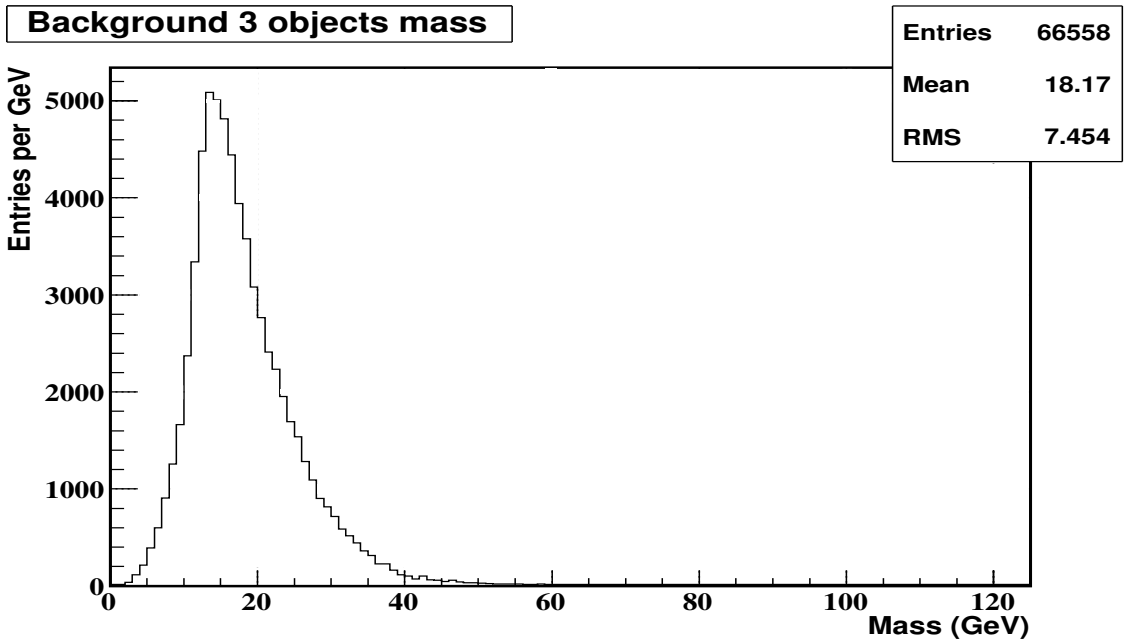
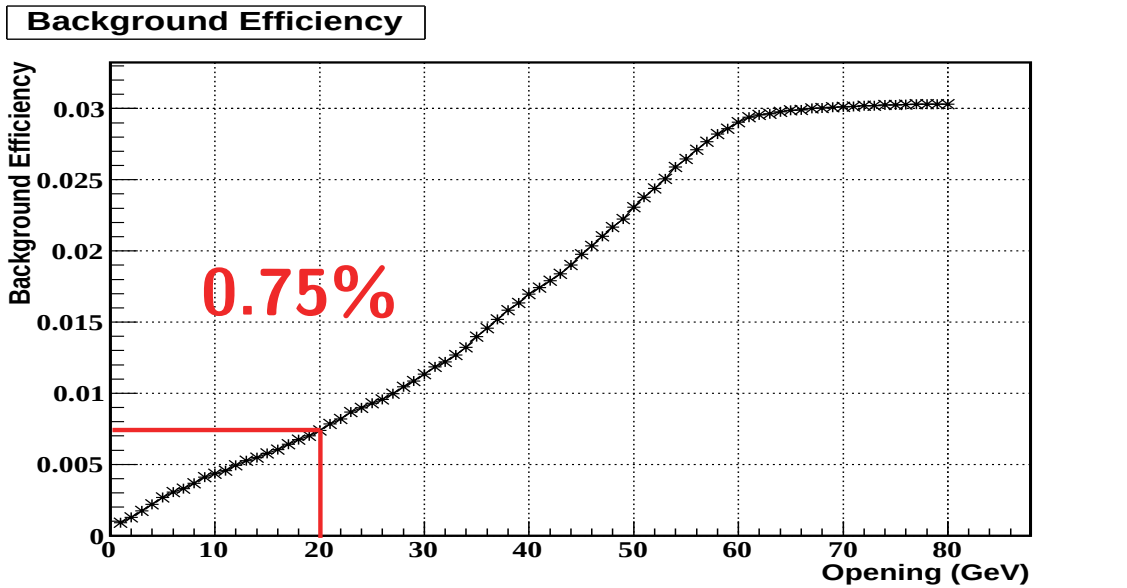




Background: MC Minimum Bias

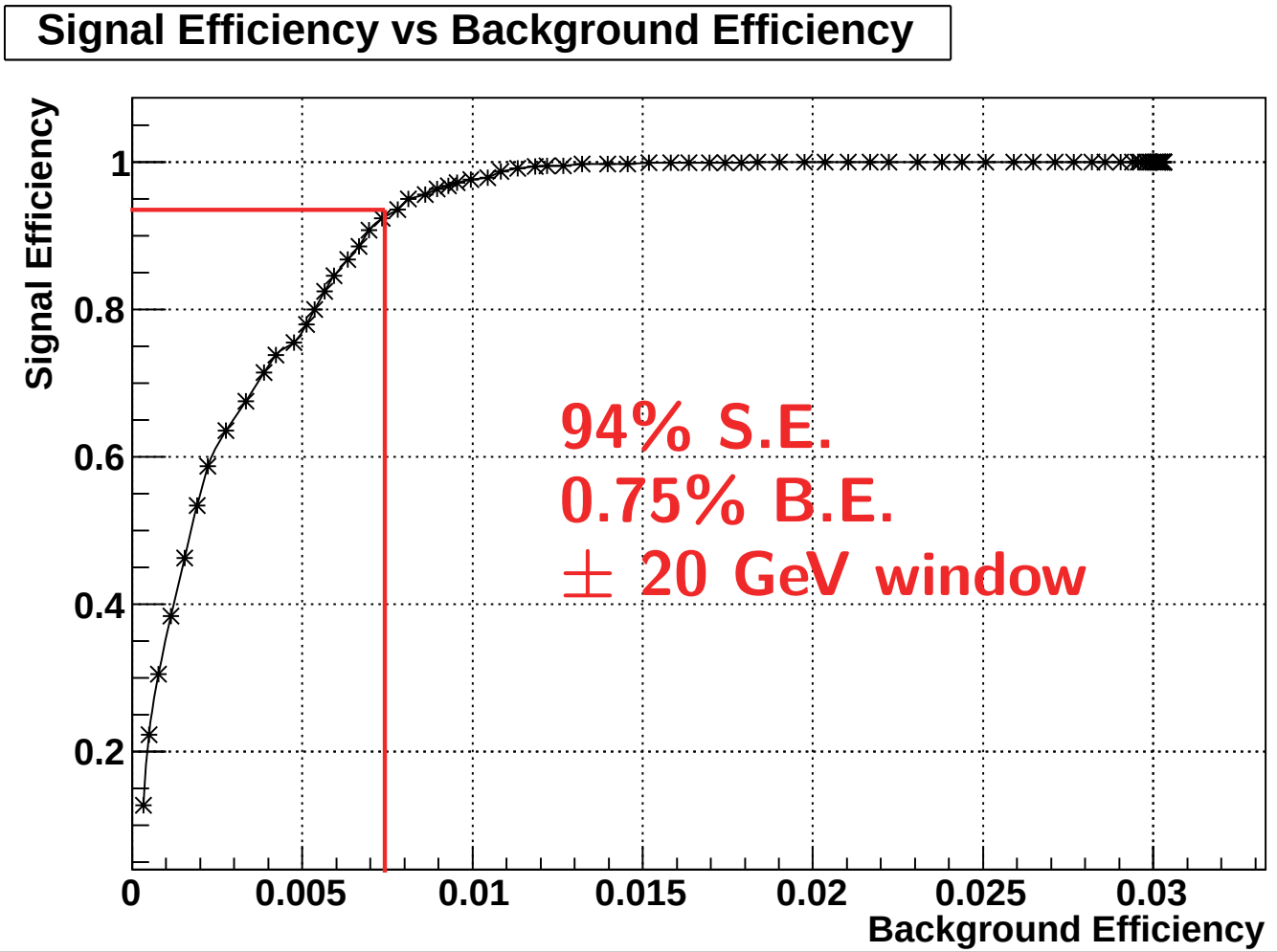
- Already the 3 object requirement with $p_T > 7$ GeV leads to a background reduction of 97%.
- We then perform the same Z mass window selection at L1 as described for the signal, to the background.
- The background efficiency as a function of the window size shows a significant further reduction.





Signal Efficiency vs Background Efficiency

- Comparison of the signal efficiency and the background efficiency.
- Aim to get a high signal and a low background efficiency.
- A possible choice leads to $\sim 94\%$ signal efficiency with a background efficiency of 0.75%.



Summary

We studied a possible L1 topological trigger selection for radiative Z decay in the electron channel

- Requiring 3 L1 calo objects with $p_{\mathrm{T}} > 7$ GeV leads to a background reduction of 97%.
- Applying an additional Z invariant mass selection of ± 20 GeV around the peak, we found a signal efficiency of $\sim 94\%$ with a background efficiency of 0.75%.

Next step:

- Estimate additional signal efficiency and trigger rate due to this new selection w.r.t. existing triggers.