

# Rejection of cosmics with real data

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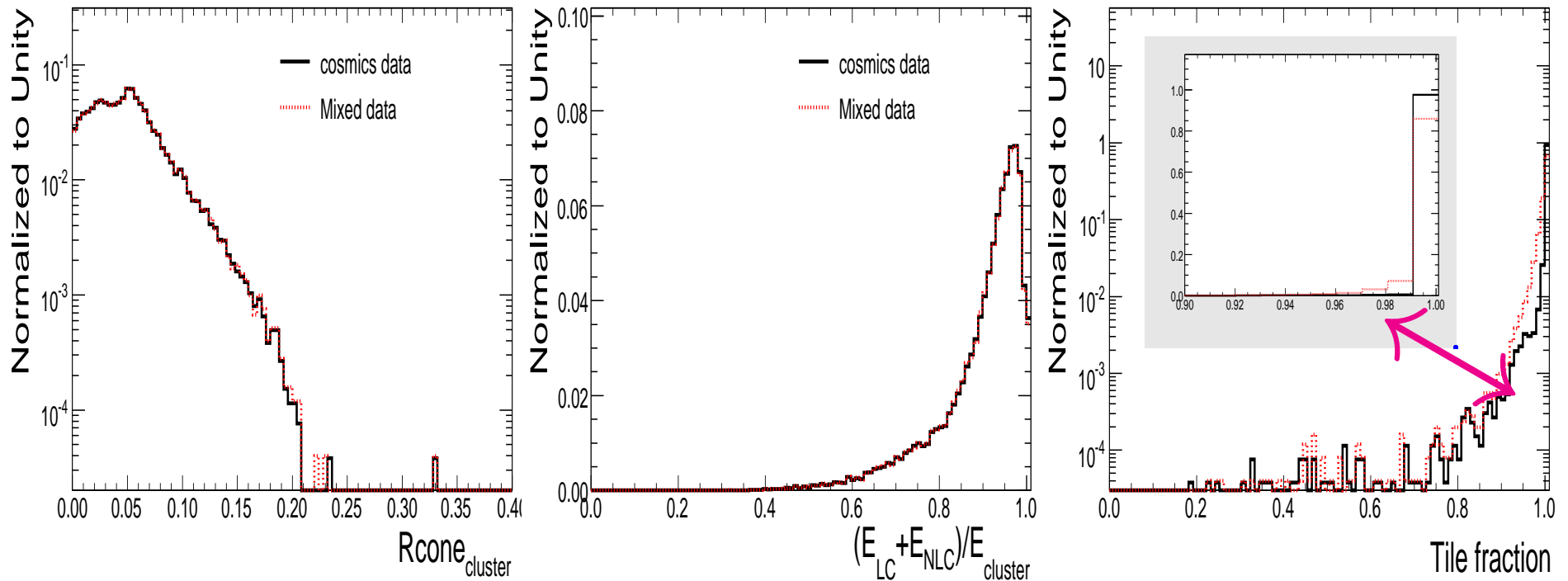
Thanks to all LAr and TileCal community

# Introduction

- *Large missing  $E_t$  can originate from high energy cosmic muons.*
- *Analysed cosmics data recorded with ATLAS detector and observed some cosmic muon clusters with larger energy deposition ( $E_{cluster} > 50\text{GeV}$ ) in TileCal.*
- *Motivation: After applying  $Time_{cluster}$  cut, the LLR obtained with shower shapes ( $R_{cone_{cluster}}$ ,  $(E_{LC} + E_{NLC})/E_{cluster}$  and Tile fraction) is provided to further separate such muon clusters from jets.*
- *In order to consider the impact of mini-bias events, mixing L1Calo cosmic events with mini-bias MC is done.*
- *Used samples:*
  - Cosmics : L1Calo cosmic run 92160 and 92226; Athena v14.2.25
  - Mixed data: Mixed the above cosmics with mini-bias MC;  
**event-by-event overlay**; Athena v14.2.25
  - J5 MC: Athena v14.2.25

**NOTE:**  $E_{cluster} = E_{Tile}$  in the study

# Shower shapes in *cosmic alone* and *mixed events* for clusters with energy greater than 50 GeV



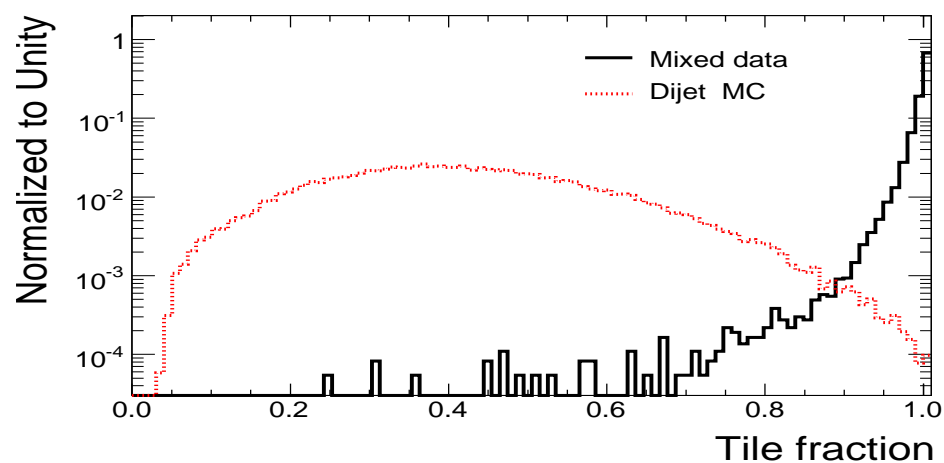
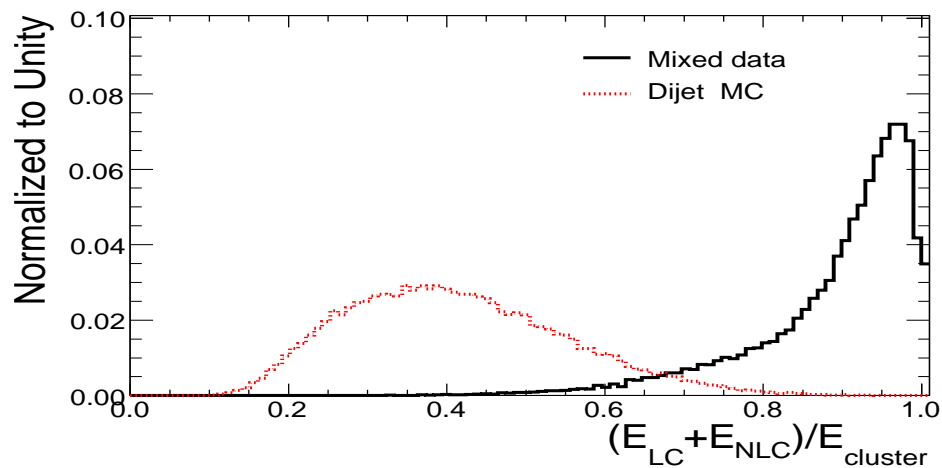
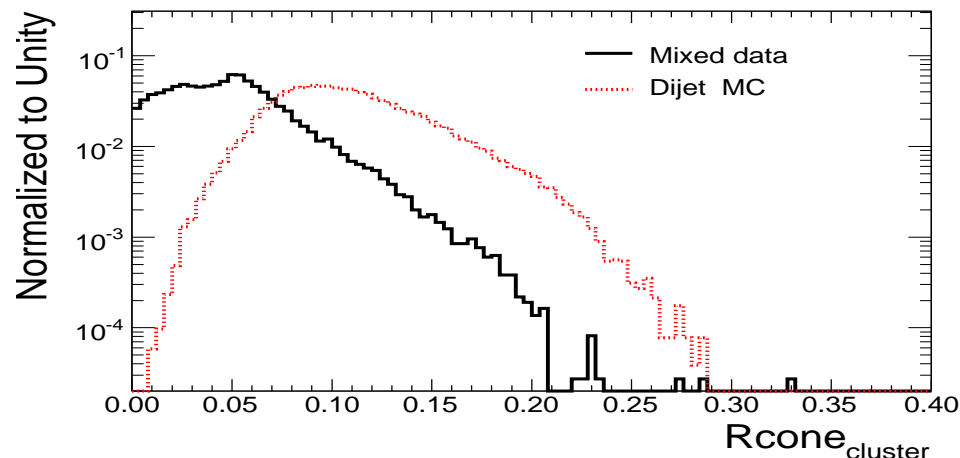
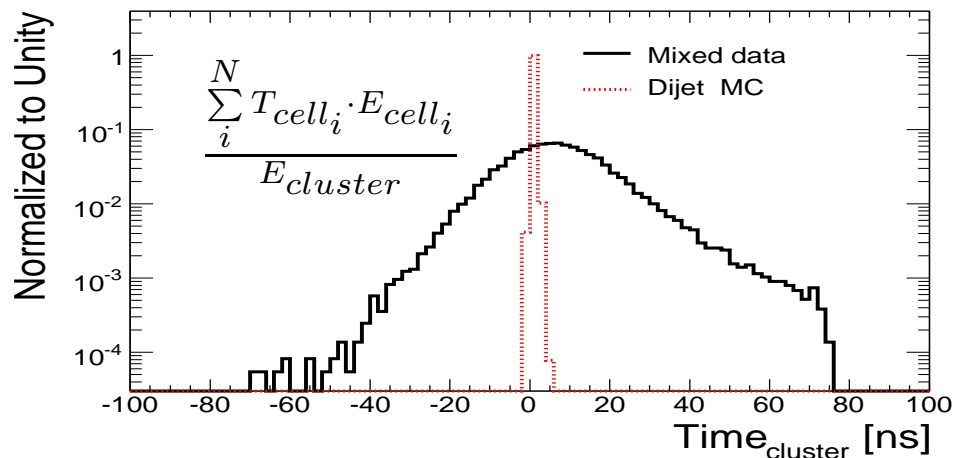
Left:  $R_{cone} = \sum_{i=1}^N \sqrt{(\eta_i - \eta_{cluster})^2 + (\phi_i - \phi_{cluster})^2} \cdot E_{cell_i} / E_{cluster}$

Middle: Energy of the 2 leading cells divided by the cluster energy

Right:  $E_{Tile} / (E_{LAR} + E_{Tile})$

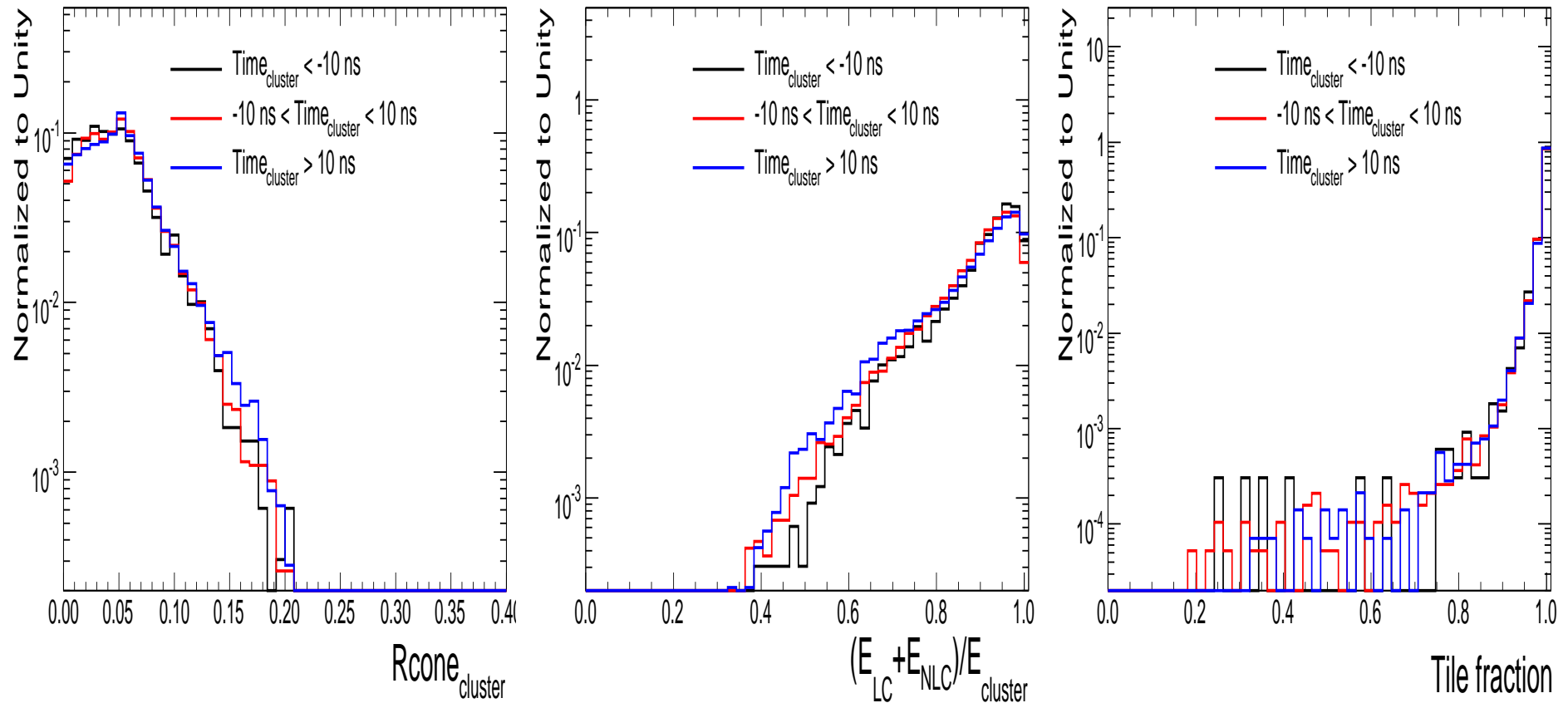
- No obvious difference between cosmic alone and the mixed events for  $R_{cone}$  and  $(E_{LC} + E_{NLC})/E_{cluster}$ .
- The Tile fraction is sensitive and the distribution is wider after mixing cosmic with mini-bias MC.

# Comparisons between *mixed events* and *J5 MC* for clusters with energy greater than 50 GeV



- Significant difference between muon clusters and jets
- $Time_{cluster}$  is a powerful cut to reject cosmic muons
- $R_{cone}$ ,  $(E_{LC} + E_{NLC})/E_{cluster}$  and Tile fraction are used to build PDF and LLR

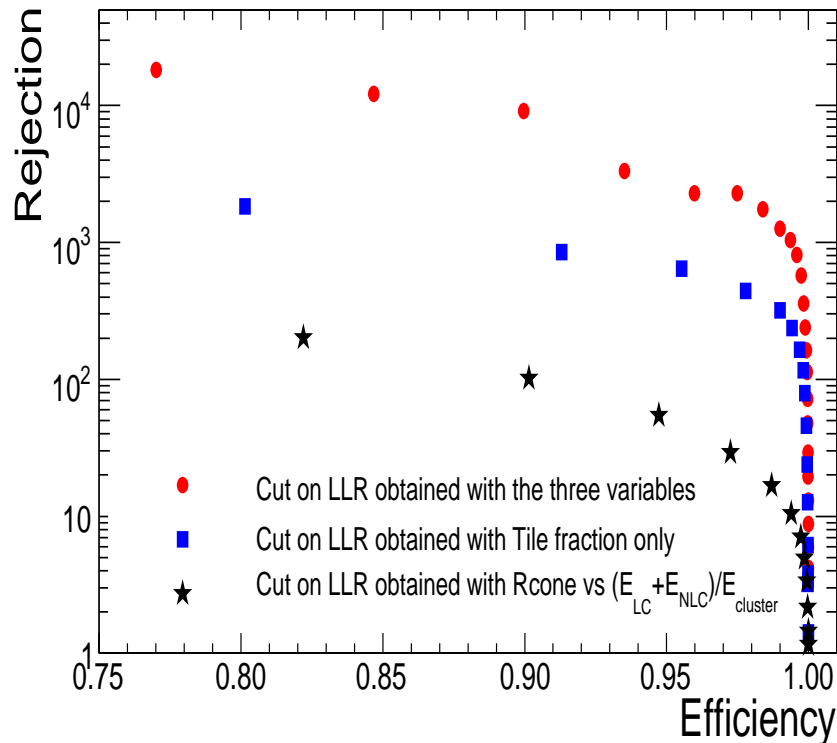
# Correlation between shower shapes and $Time_{cluster}$



Shower shapes in different bins of  $Time_{cluster}$

$Time_{cluster}$  is independent of the shower shapes,  $R_{cone}$ ,  $(E_{LC} + E_{NLC})/E_{cluster}$  and Tile fraction.

# Cosmics rejection as a function of jet efficiency



- Using  $R_{cone}$ ,  $(E_{LC} + E_{NLC})/E_{cluster}$  and Tile fraction to construct LLR
- One can choose a cut of  $LLR$  on cosmic muon/jet candidate to separate cosmic muon and jet.
- For example: jet efficiency 99.9%  
cosmic muon rejection 239

## Summary

- $Time_{cluster}$  is powerful to reject cosmics. It is independent of shower shapes.
- Provided LLR obtained with shower shapes.

Plan: To add LAr information on all shower shapes and comply with the conventions accepted in JetEtmiss group