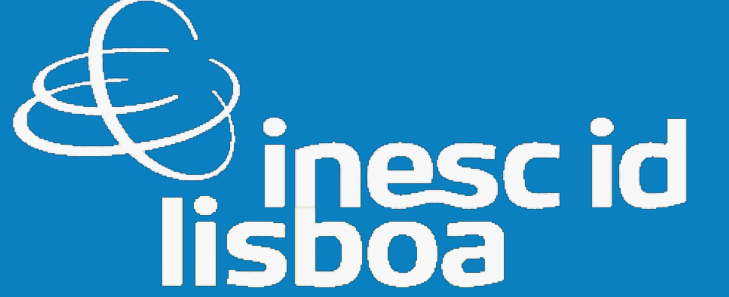
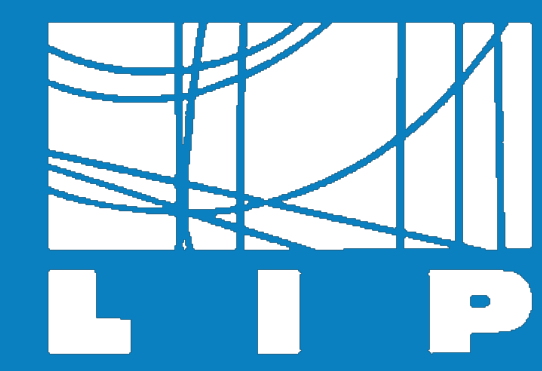


# Development of an FPGA-accelerated Clustering for the ATLAS Trigger System

José Cordeiro<sup>1</sup>, Pedro Tomás<sup>2</sup>, Nuno Roma<sup>2</sup>, Patrícia Conde Muíño<sup>3</sup>

<sup>1</sup>LIP, INESC-ID, IST, Univ. Lisboa, <sup>2</sup>INESC-ID, IST, Univ. Lisboa, <sup>3</sup>LIP, ATLAS, IST



## 1. Introduction

- ATLAS is one of the four experiments located at the Large Hadron Collider (LHC), at CERN, the biggest proton-proton collider ever built.

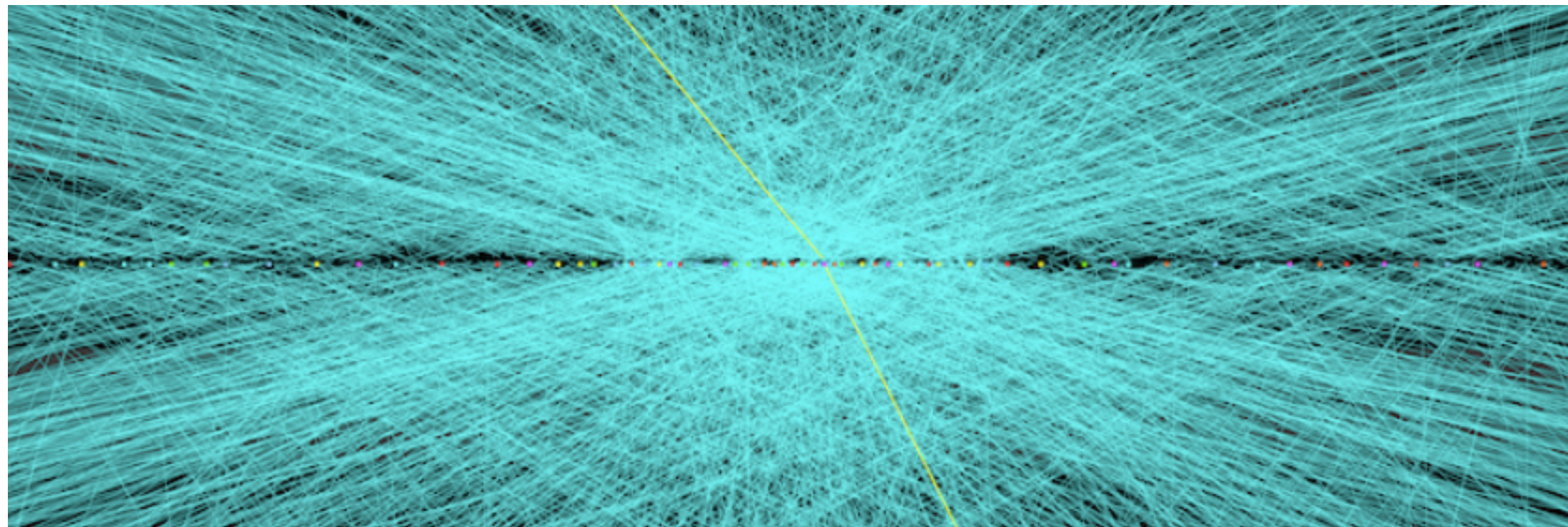


Figure 1: Collision simulation for the fourth LHC run

- The different number of interactions per event and maximum Luminosity expected for the LHC are the following:

	Run 2	Run 3	Run 4
Energy (√s)	13TeV	14 TeV	14 TeV
Max. Luminosity (cm <sup>-2</sup> s <sup>-1</sup> )	1-2×10 <sup>34</sup>	2-3×10 <sup>34</sup>	5-7×10 <sup>34</sup>
Interactions/event	40	55-80	140-200
Bunch crossing rate	40 MHz	40 MHz	40 MHz
Offline storage rate	1000 Hz	1500 Hz	10 kHz
Bunch spacing	25 ns	25 ns	25 ns

Figure 2: Collision simulation for the different LHC runs

## 2. Calorimeter

- The TileCal at ATLAS is an hadronic calorimeter that detects the energy of each calorimeter (cell) per event.

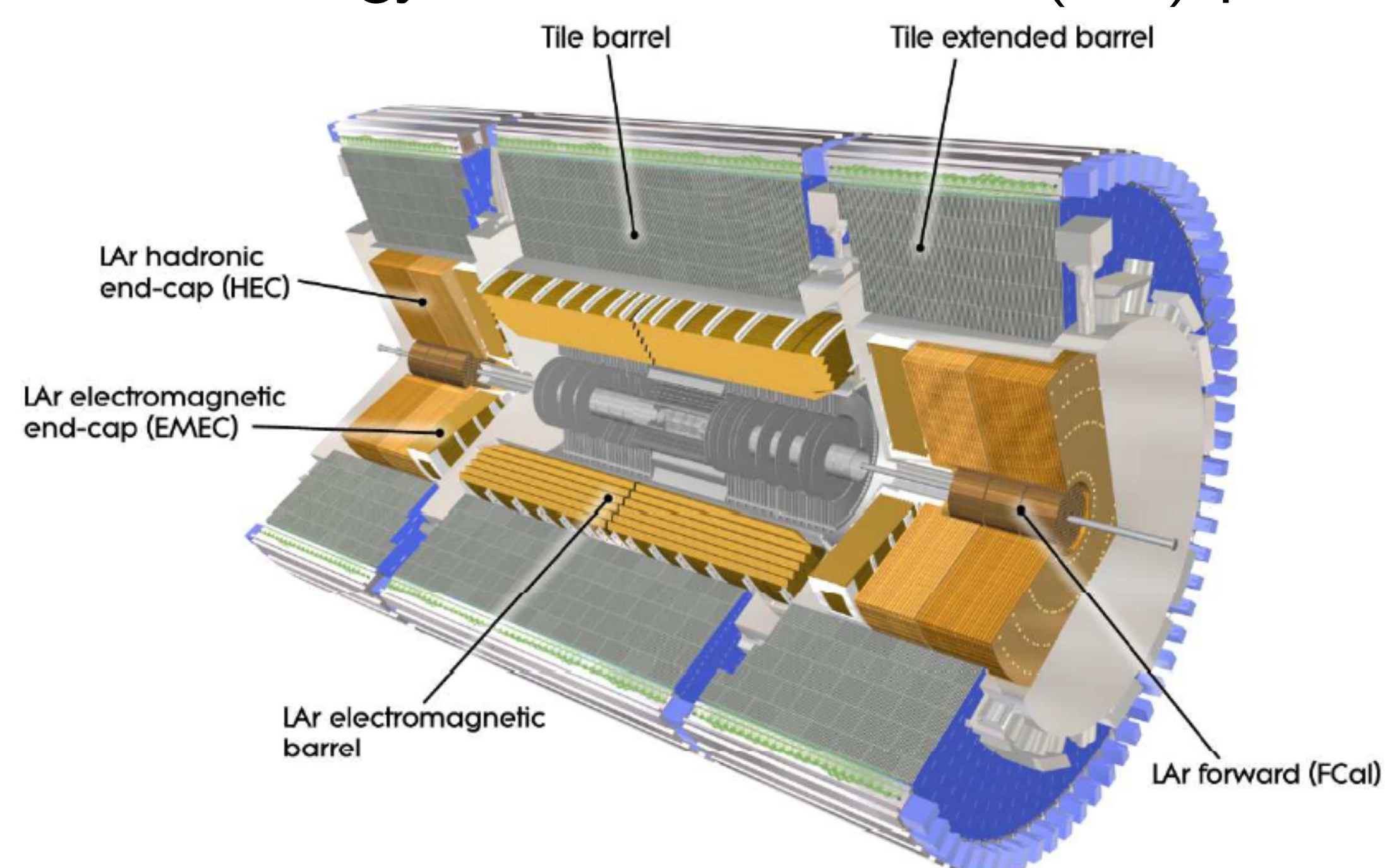


Figure 3: Cutaway view on the ATLAS calorimeter system. [1]

- One event is characterized by a distribution of different energy values on the calorimeter cells.

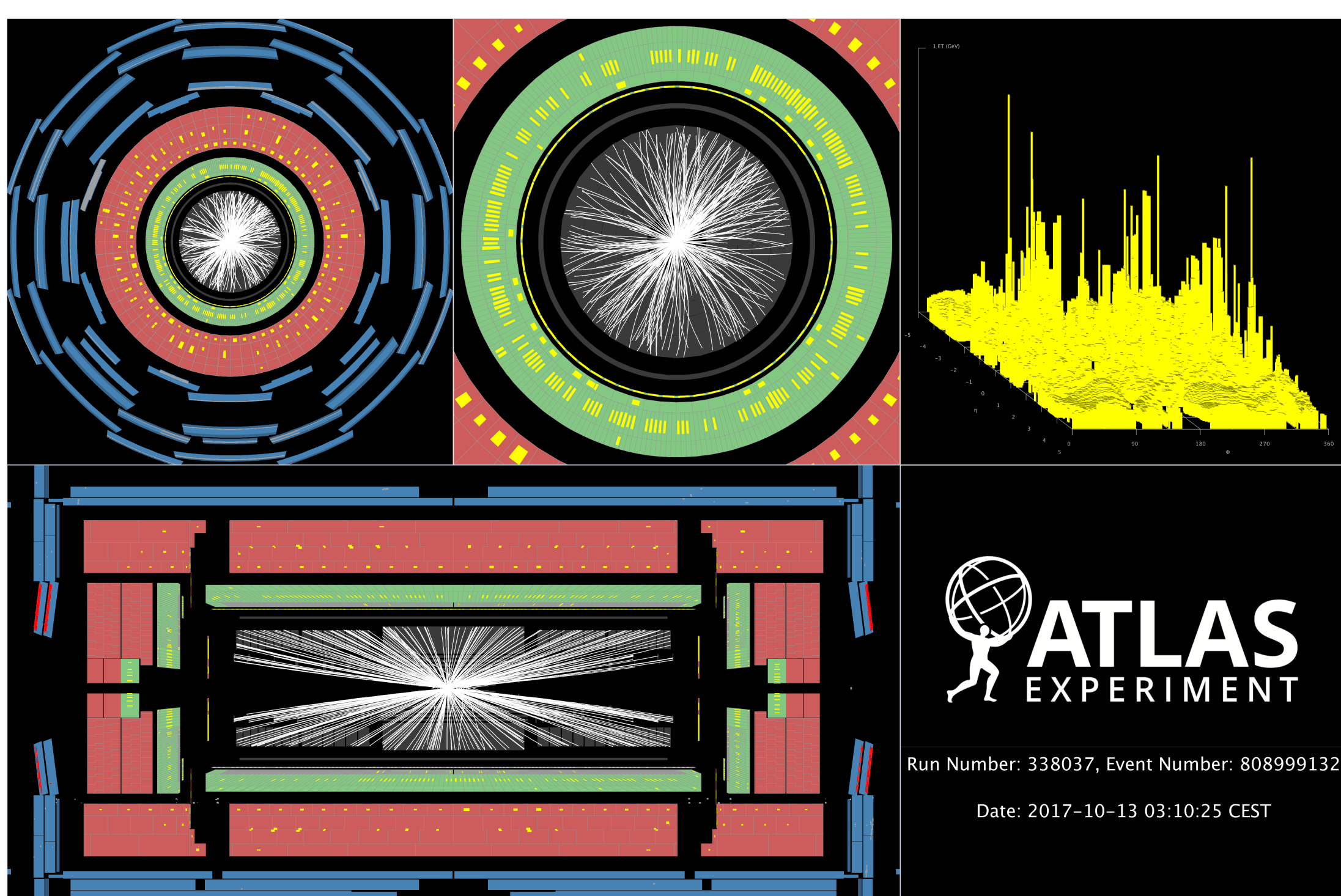


Figure 4: Event cells' clustering representation.

## 3. TopoCluster Algorithm

- TopoCluster is a three-dimensional topological calorimeter cluster reconstruction algorithm.
- Each cell is classified according to the signed ratio (S/N) between its energy and its predefined noise, currently with the following reference values: *Seeds*: S/N > 4, *Growing*: S/N > 2 and *Terminal*: S/N > 0.

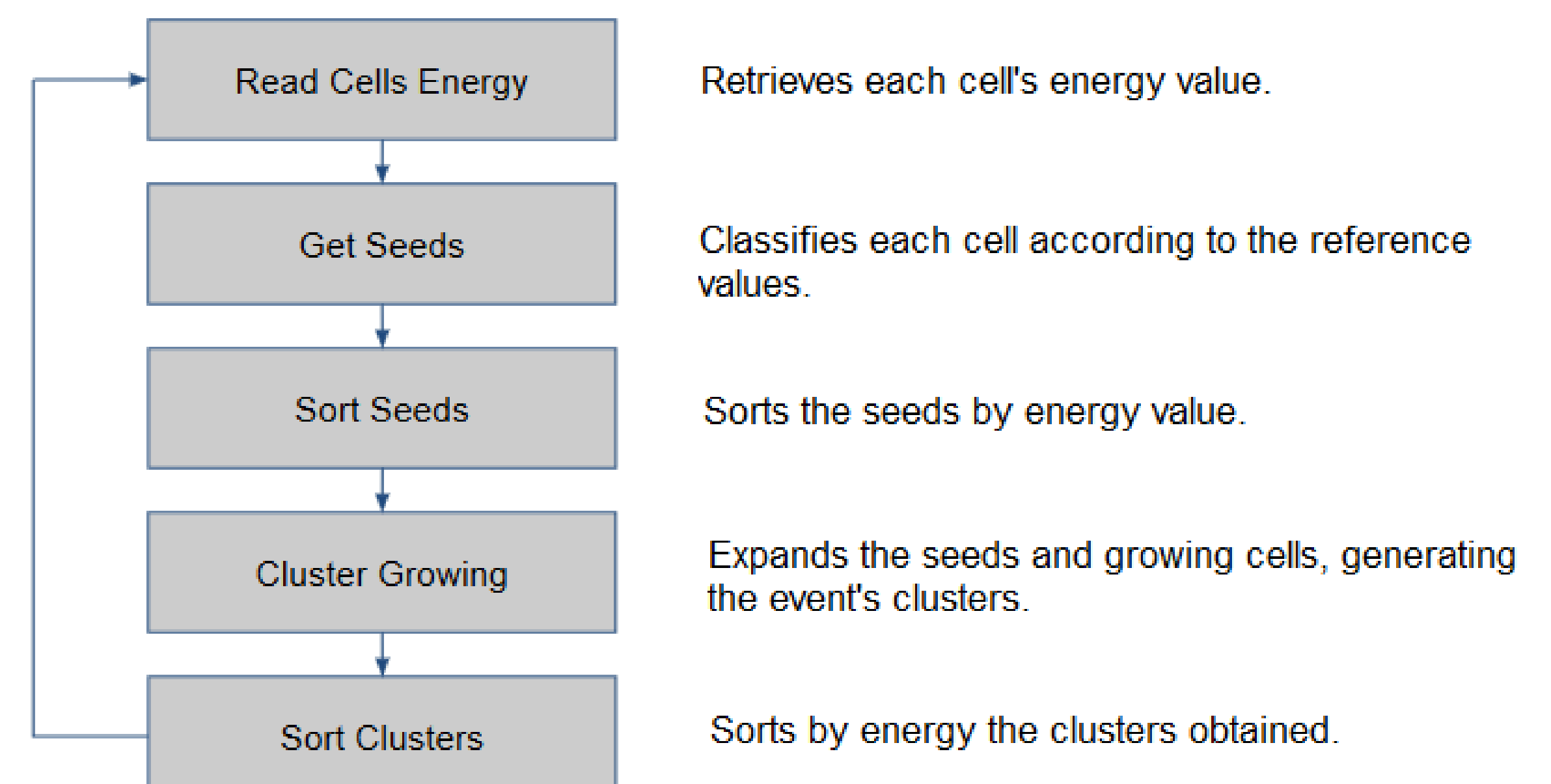


Figure 5: TopoCluster algorithm representation.

## 4. Goals of the Project

- The main goal of this projects is to design and implement an FPGA architecture of the TopoCluster algorithm to outperform in time the current CPU based implementation.

## 5. Algorithm pre-analysis

- By measuring the algorithm's time performance of 100 jet and 100 ttbar simulated events (repeating each event 5 times), it was possible to identify that the *Get Seeds* and *Cluster Growing* were the most time consuming parts, which will be the main focus of this project.

Time stamp of each opoCluster's partition

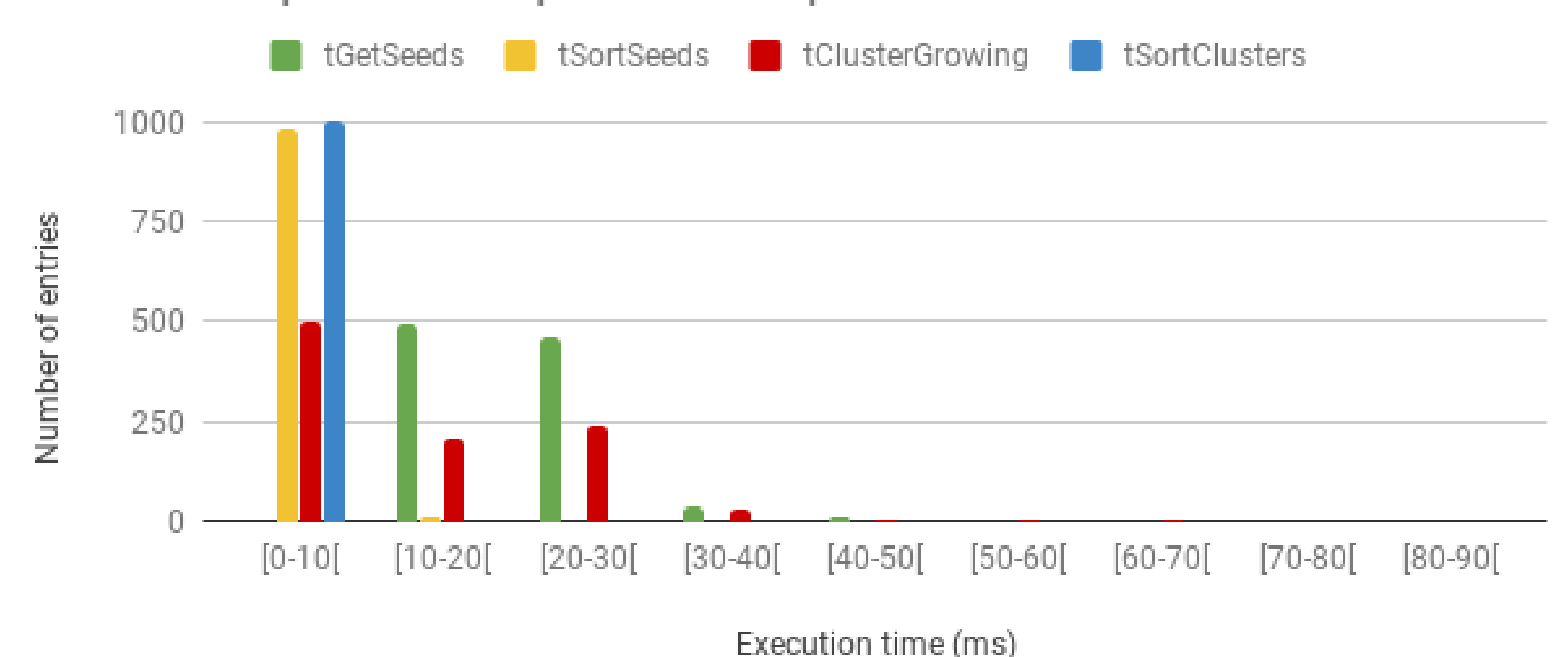


Figure 6: Duration of each part of the algorithm.

## 6. References

- [1] The ATLAS Collaboration, Topological cell clustering in the ATLAS calorimeters and its performance in LHC Run 1, 2017, DOI: 10.1140/epjc/s10052-017-5004-5.