





I'C

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## A equipa ATLAS Portuguesa

National group: LIP (Lisbon, Coimbra, Minho) FCUL, FCTUC, U. Minho, CEFITEC/UNL, INESC-ID, BIOISI AdI engineers training program

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## Olhando para o inicio do Universo



## Identificação das partículas no detector





## Futuro do LHC e de ATLAS



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## LHC Upgrade Challenges



- Interesting processes have small cross-sections
- Need to process & select interesting events in real time
  - 40 MHz event rate

Very large number of interactions/event 10<sup>8</sup> electronic channels

Run 2	Run 3	Run 4
13TeV	14 TeV	14 TeV
1.2×10 <sup>34</sup>	2×10 <sup>34</sup>	5×10 <sup>34</sup>
23	55-80	140- 200
40 MHz	40 MHz	40 MHz
1000 Hz	1000 Hz	1000 Hz
25 ns	25 ns	25 ns
	Run 2      13TeV      1.2×10³4      23      40 MHz      1000 Hz      25 ns	Run 2    Run 3      13TeV    14 TeV      1.2×10 <sup>34</sup> 2×10 <sup>34</sup> 23    55-80      40 MHz    40 MHz      1000 Hz    1000 Hz      25 ns    25 ns

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## ATLAS TDAQ Architecture



## Using GPUs at trigger level

- > Thousands of cores with limited processing speed/core
- Different programming paradigm:
  Single-instruction-multiple-data
- Great potential to improve events processed/(s×CHF)
- Demonstrator prototype under implementation:

LIP group responsible for the calorimeter reconstruction

Cluster reconstruction

3D particle energy depositions







> TopoCluster reconstruction on CPU (~8% of total time)

Group cells according to their signal/noise ratio





> TAC: Topo-Automaton Clustering

Use a cellular automaton for the GPU (maximize parallelism)

Propagate flag on a grid of elements (cell pair)

Cells get the largest flag on each iteration











Phase I Demonstrator prototype results



- Energy difference <5% for most clusters</p>
- Preliminary time reduction factor obtained

Sample	Pile-up	Reduction factor
tt-bar	138	5
tt-bar	46	5
di-jets	40	1.3

Work developed in collaboration with Minho University and Computing groups at LIP

#### For Upgrade Phase II

New challenges and other interesting algorithms to parallelize! Jet substructure  $\rightarrow$  essential for new physics searches

## Phase

## Phase I TileCal hadronic calorimeter Upgrade



#### Phase I

- Gap scintillator/fibres replacement due to radiation damage
- R&D on radiation hard scintillators Irradiations at CTN
  - Tests at the LOMAC lab
- Fibres preparation and quality control

# LOMAC: Laboratório de Ótica e Materiais Cintilantes





#### Optical fibre preparation

Measurement of WLS optical fibres properties

Tile calorimeter readout





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## Phase II TileCal Upgrade



- > Detector electronics replacement
  - HV distribution boards
    - New boards designed @ LIP/FFCUL/INESC-ID
    - First prototype under implementation
    - To be tested with beams of particles at CERN (2017)
      - 1- Placa TIBBO EM1206-EV
      - 2- Expansor MCP23S17
      - 3- Controlo feito com o painel







More information on our web page

http://www.lip.pt/atlas/

You can always contact us at:





## Backup

TileCal Upgrade: scintillators and fibres

#### Tilecal scintillators and WLS fibers do not need replacement.

Exception: long scintillators in the gap/crack region that suffer significative radiation damage causing light loss





### GPU Calorimeter Clustering Performance



- Energy difference <5% for most clusters</p>
  - Cluster growing time reduction factor:

Sample	Pile-up	Reduction factor
tt-bar	138	2
tt-bar	46	2
di-jets	40	1.3

#### Potential larger gain with parallelization of next clustering steps (splitting)





## Some of the Portuguese contributions to ATLAS

### Hadronic calorimeter TileCal, Trigger, forward detectors

master

master

Tile



#### **Optical fibers**



PMT quality control



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#### Luminosity detector



**Detector** control



Performance, calibration, M & O

**Physics**  $\succ$ 

Events / 10 GeV

80

40



ATLAS Preliminary

100 120 140 160 180 200

100 √s = 7 TeV, Ldt = 4.7 fb

 $H \rightarrow WW^{(1)} \rightarrow IvIv + 0$  jets

Higgs (WW, bb and ttH)

WZ/ZZ/Wy

Single Top

H [125 GeV]

220 240

W+jets

- Top quark properties
- ≻ Heavy Ion Physics
- **Exotics Physics** Searches

