

**Trigger and readout at the
LHC experiments for Run 3
and beyond in Spain -
COMCHA**

Report of Contributions

Contribution ID : 1

Type : **not specified**

ATLAS

Monday, 20 March 2023 14:05 (30)

Which session do you think it fits best?

Presenter(s) : RIU, Imma (IFAE Barcelona)

Session Classification : Introduction

Trigger and read ... / Report of Contributions

CMS

Contribution ID : 2

Type : **not specified**

CMS

Monday, 20 March 2023 15:25 (30)

Which session do you think it fits best?

Presenter(s) : CEPEDA, Maria (CIEMAT)

Session Classification : Introduction

Contribution ID : 3

Type : **not specified**

LHCb

Monday, 20 March 2023 14:45 (30)

Which session do you think it fits best?

Presenter(s) : MARÍN BENITO, Carla (Universitat de Barcelona)

Session Classification : Introduction

Contribution ID : 4

Type : **not specified**

Impact of the high-level trigger for detecting long-lived particles at LHCb

Tuesday, 21 March 2023 17:00 (20)

Long-lived particles (LLPs) are very challenging to search for with current detectors and computing requirements, due to their very displaced vertices. This study evaluates the ability of the trigger algorithms used in the Large Hadron Collider beauty (LHCb) experiment to detect long-lived particles and attempts to adapt them to enhance the sensitivity of this experiment to undiscovered long-lived particles. One of the challenges in the track reconstruction is to deal with the large amount of combinatorics of hits. A dedicated algorithm has been developed to cope with the large data output. When fully implemented, this algorithm would greatly increase the available statistics for any long-lived particle search in the forward region, for the Standard Model of particle physics and beyond.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : ZHUO, Jiahui (IFIC)**Presenter(s)** : ZHUO, Jiahui (IFIC)**Session Classification** : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 5

Type : **not specified**

Downstream track reconstruction algorithms for GPU-based High level trigger at LHCb

Wednesday, 22 March 2023 09:30 (20)

The LHCb Upgrade in Run 3 has changed its trigger scheme for a full software selection in two steps. The first step, HLT1, is entirely implemented on GPUs and is running on real time a fast selection to reduce the collision rate from 30 MHz to 1 MHz.

In this talk we will discuss the design and implementation of several algorithms which are focused on the reconstructions of tracks downstream the magnet, using the new Scintillating-Fiber tracker (Scifi) and the silicon strip Upstream Tracker (UT) detectors. Those algorithms are crucial for detecting long-lived particles of SM and BSM.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : JASHAL, Brij Kishor (IFIC)

Presenter(s) : JASHAL, Brij Kishor (IFIC)

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 6

Type : **not specified**

Developments for the ATLAS Tile Hadronic Calorimeter for the Phase II Upgrade

Tuesday, 21 March 2023 09:30 (20)

TileCal is a hadron calorimeter located in the central region of the ATLAS experiment at the Large Hadron Collider. It is comprised of iron absorbers and scintillator tiles that produce light when charged particles cross the tiles, which is then collected by photomultiplier tubes. The signals from the photomultiplier tubes are digitized in sync with the LHC clock and transmitted to the Read-Out Drivers (RODs) at a rate of 100 kHz. The ROD is the core component of the back-end electronics, responsible for tasks such as energy and time reconstruction, trigger and data synchronization, and data compression. The IFIC-TileCal group was involved in the design, production, installation, and maintenance of the ROD system.

For the upcoming High-Luminosity Large Hadron Collider experiments, the ATLAS trigger and readout architecture has been altered. TileCal will read out signals for every bunch crossing before any trigger selection is applied, leading to a total bandwidth of 40 Tbps. These data will be processed by the PreProcessors (PPr), located in the off-detector electronics. The PPr modules will handle the interface with the Level 0 trigger and overall DAQ and detector control systems. The TilePPr is a modular ATCA system consisting of a custom ATCA Carrier board and several mezzanine cards. The IFIC-TileCal group is responsible for the hardware and firmware designs, production, installation, and maintenance of the PPr modules.

The presentation will give a comprehensive overview of the current and future systems for the HL-LHC, including a description of the hardware and firmware developments underway within the IFIC-TileCal group.

Which session do you think it fits best?

DAQ & Infrastructure for Phase-2 systems

Primary author(s) : CERVELLÓ DUATO, Antonio (Instituto de Fisica Corpuscular (ES))

Presenter(s) : CERVELLÓ DUATO, Antonio (Instituto de Fisica Corpuscular (ES))

Session Classification : High-speed electronics devices for trigger and DAQ

Contribution ID : 7

Type : **not specified**

Overlap muon track finder HLS implementation and firmware testbench for the Phase-2 upgrades

Tuesday, 21 March 2023 10:00 (20)

To handle the throughput required for the Phase-2 L1T, the detector electronics must be improved using cutting-edge technology such as high bandwidth optical data transfer. Additionally, new electronics with deeper buffering and faster processing are required to meet the increased standards for data gathering in terms of latency.

The overlap muon track finder (OMTF) allows to reconstruct muon trajectories in the transition region between CMS barrel and endcaps by measuring how good the detected hits match the average track of the muon with certain transverse momentum.

The OMTF algorithm implementation for the Phase-2 upgrade is being adapted to the new firmware in order to add new hit information to the transmitted data, and to improve the resource use and the overall latency inside the chip. This study proposes the use of High-Level Synthesis (HLS) as a method to factorize and optimize the original OMTF code and its following implementation in a custom-board FPGA.

Which session do you think it fits best?

High-speed electronic devices (FPGAs, GPUs, optics)

Primary author(s) : LEGUINA, Pelayo (University of Oviedo); VICO VILLALBA, Carlos (Universidad de Oviedo); FOLGUERAS, Santiago (Universidad de Oviedo)

Presenter(s) : LEGUINA, Pelayo (University of Oviedo)

Session Classification : High-speed electronics devices for trigger and DAQ

Contribution ID : 8

Type : **not specified**

Real time reconstruction and selection of long living particles in the LHCb trigger

Tuesday, 21 March 2023 16:30 (20)

From Run-3 onwards, LHCb has an adaptable fully-software based trigger. Work has been undertaken to enable reconstruction and selection of particles decaying up to 7.5 m from the interaction point, in real time, in LHCb's HLT2. This allows for exciting new physics measurements including electromagnetic dipole moment measurements and BSM LLP searches. This talk gives an overview of the challenges, efforts and prospects in this approach.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : SANDERSWOOD, Izaak (IFIC)

Presenter(s) : SANDERSWOOD, Izaak (IFIC)

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 9

Type : **not specified**

Performance of the trigger system for displaced muons in CMS

Monday, 20 March 2023 17:30 (20)

The performance of the HLT and OMTF for displaced muons is presented. In Run3, new HLT paths designed to trigger on displaced muons have been added. In addition to the displaced standalone muon paths that were present in Run2, these new paths are designed to trigger on displaced global muons. Several improvements have also been made in the L1 trigger system to identify displaced muons. A new algorithm is currently being developed for the OMTF, its preliminary performance is also presented.

Which session do you think it fits best?

Run-3 trigger performance

Primary author(s) : SOTO RODRIGUEZ, Alejandro (University of Oviedo)

Presenter(s) : SOTO RODRIGUEZ, Alejandro (University of Oviedo)

Session Classification : Run-3 trigger performance

Contribution ID : 10

Type : **not specified**

High-performance electronics for the phase-2 upgrade of the Drift Tubes CMS subdetector

Tuesday, 21 March 2023 10:30 (20)

The challenging conditions expected during HL-LHC require a series of upgrades to reach its ultimate luminosity. A large fraction of the detector's instrumentation, particularly, the trigger and readout electronics will need to be substituted to fully exploit the increased luminosity and cope with the increased occupancy and radiation in the detectors. Ultimate performance is expected to be achieved by the use of the latest technologies, such as the Trigger system which will be implemented using electronics based on the advanced telecommunications standard (ATCA), very high speed links (up to 25 Gbps) and the most advanced FPGAs on the market. On-detector electronics also needs to profit from high speed electronics but needs to operate under radiation. Microsemi Polarfire devices and custom CERN's ASICs for optical transceivers are being used. The use and implementation of these electronics for the CMS muon readout and trigger system upgrade will be presented

Which session do you think it fits best?

DAQ & Infrastructure for Phase-2 systems

Primary author(s) : NAVARRO TOBAR, Álvaro (CIEMAT)**Presenter(s)** : NAVARRO TOBAR, Álvaro (CIEMAT); FERNÁNDEZ BEDOYA, Cristina (CIEMAT)**Session Classification** : High-speed electronics devices for trigger and DAQ

Contribution ID : 11

Type : **not specified**

Early Run 3 Trigger Menu and Operations in ATLAS

Monday, 20 March 2023 17:00 (20)

The online event selection in ATLAS takes place in two stages. At the first level trigger (Level-1), hardware-based, custom electronics and information from the calorimeters and muon spectrometer are used to select events. At the second and final stage, the High Level Trigger (HLT), software-based, various object-specific algorithms as required by different analysis groups apply further selections to filter events. The HLT algorithms, represented as “trigger chains” are collectively known as the “trigger menu”. Therefore, the ATLAS trigger menu encapsulates the selections used by all ATLAS physics analyses and detector studies. This talk covers the trigger menu and its performance in the first year of Run 3 operations. During the second long shut down of the LHC (LS2, 2019-2021), various upgrades were made to the ATLAS trigger system, including new triggers to optimize the data collection. These upgrades have either been deployed in 2022 or have been tested to be implemented for data taking in 2023. The upgraded trigger system will be able to cope with the much higher levels of pileup expected in Run 3, which reached an average number of interactions per bunch crossing of 40.9 in 2022.

Which session do you think it fits best?

Run-3 trigger performance

Primary author(s) : SENTHILKUMAR, Varsha (IFIC (CSIC-UV))**Presenter(s)** : SENTHILKUMAR, Varsha (IFIC (CSIC-UV))**Session Classification** : Run-3 trigger performance

Contribution ID : 12

Type : **not specified**

The new DT Phase 2 Filter for the CMS experiment

Tuesday, 21 March 2023 15:00 (20)

The CMS Drift Tube (DT) trigger system reconstructs muon signals with great efficiency by correlating signals inside each DT chamber. A new layer of FPGA-based electronics, the so-called DT Phase 2 Filter, capable of simultaneously correlate information from several DTs, will be included in the CMS Muon system for the upcoming era of the High Luminosity LHC. A review of the different strategies for muon triggering in a possible DT Filter scenario is presented.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : VICO VILLALBA, Carlos (Universidad de Oviedo)**Presenter(s)** : VICO VILLALBA, Carlos (Universidad de Oviedo)**Session Classification** : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 13

Type : **not specified**

Measuring energy and position with LHCb Calorimeter for Run III conditions

Tuesday, 21 March 2023 17:30 (20)

Abstract:

Neutral pions and photons play a crucial role in the LHCb physics program since they are used in a variety of physics analyses. These particles are not electrically charged and therefore cannot be detected by the tracking system. Instead, their energy and position can only be measured by the electromagnetic calorimeter sub-detector (ECAL).

During Run I and Run II, energy and position measurements were taken by analyzing the energy deposits in a 3x3 cluster centered on the ECAL cell with the maximum energy deposition. However, ongoing studies are exploring the optimal cluster shape to use for the current Run III period. Considering that LHCb will be operating at 5 times more luminosity in Run III, there will be more occupancy in the detector, resulting in more frequent overlaps between 3x3 clusters and a higher pile-up effect from external particles hitting the detector cells. This will lead to a loss in resolution for both position and energy measurements.

To address this, using smaller cluster shapes, such as 2x2 or SwissCross, can reduce those effects resulting in better measurement resolution. It's worth noticing that reducing the cluster size is a valid solution since the Molière radius of electromagnetic showers in the ECAL is smaller than one cell size, so one cell can contain all the energy from a particle.

The upcoming presentation will cover resolution studies for different cluster shapes under Run III conditions, as well as energy and position corrections that can enhance the overall measurement resolution.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : Mrs. GARCIA MORENO, Paula (Universitat de Barcelona)

Co-author(s) : MARÍN BENITO, Carla (Universitat de Barcelona)

Presenter(s) : Mrs. GARCIA MORENO, Paula (Universitat de Barcelona)

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 15

Type : **not specified**

A muon tracking algorithm for the Level 1 trigger in the CMS barrel muon chambers during HL-LHC

Tuesday, 21 March 2023 14:30 (20)

This contribution studies the performance of the Analytical Method (AM) algorithm for trigger primitive (TP) generation in the CMS Drift Tube (DT) chambers under the conditions of High Luminosity LHC (HL-LHC). The algorithm has been developed and validated both in software with an emulation approach and through hardware implementation tests. The obtained performance on Phase II simulated data shows timing and position resolutions close to the ultimate performance of the DT chambers, with resilience to potential ageing situations. The firmware version has been implemented in state-of-the-art FPGAs and included in a prototype chain of the HL-LHC electronics operated with real DT chambers during cosmic and collision data taking. The agreement between the software emulation and the firmware implementation has been studied and verified.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : LEON HOLGADO, Jaime (CIEMAT)**Presenter(s)** : LEON HOLGADO, Jaime (CIEMAT)**Session Classification** : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 16

Type : **not specified**

Inclusive radiative lines for run 3 in LHCb

Monday, 20 March 2023 16:30 (20)

The LHCb detector has undergone a large update during Long Shutdown 2 involving both subdetectors and the Trigger and Data acquisition systems. This talk will briefly cover the most important upgrades in the Trigger system and present how the inclusive radiative lines have been modernized to run optimally in the new conditions.

Emphasis will be given to:

- Evolving to a 'hardware-less' trigger
 - Use of GPUs for the first stage of the trigger
 - Benefits of running an offline-quality reconstruction in the HLT2 stage
 - Real time calibration
 - Increased instantaneous luminosity
 - Selective persistence
- and particular to the radiative inclusive lines:
- Inclusive lines: particularities
 - Implementation and optimization
 - Performance

Which session do you think it fits best?

Run-3 trigger performance

Primary author(s) : LOBO SALVIA, Aniol (Universitat de Barcelona)

Presenter(s) : LOBO SALVIA, Aniol (Universitat de Barcelona)

Session Classification : Run-3 trigger performance

Contribution ID : 17

Type : **not specified**

Plans for the Overlap muon track finder for the Phase-2 L1T upgrade of the CMS experiment (TBC)

The plans for the Overlap muon track finder for the Phase-2 L1T upgrade of the CMS experiment. Potential algorithms, firmware development, prospective studies will be discussed.

Which session do you think it fits best?

High-speed electronic devices (FPGAs, GPUs, optics)

Primary author(s) : FOLGUERAS, Santiago (Universidad de Oviedo)

Presenter(s) : FOLGUERAS, Santiago (Universidad de Oviedo)

Session Classification : High-speed electronics devices for trigger and DAQ

Contribution ID : 18

Type : **not specified**

Lessons learned when approaching algorithms for Trigger

Wednesday, 22 March 2023 10:30 (20)

Reconstruction algorithms or more generally any algorithm bound to serve in the trigger needs to fulfil given efficiencies and accuracies to comply with the physics necessities, but also be compatible with a given time budget. Increasing data throughputs are often a challenge that classical algorithms and approaches cannot sustain. For this reason, new strategies are required. Some techniques may look very promising yet fail the implementation requirements. A tougher evaluation of the methods, complexity of the algorithm and adaptation to the hardware is then necessary to meet all specifications. This concept is illustrated through the approach of the reconstruction algorithm for the calorimeter of LHCb in the real time analysis framework.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : VILASIS-CARDONA, Xavier (DS4DS, La Salle - Universitat Ramon Llull)**Presenter(s) :** VILASIS-CARDONA, Xavier (DS4DS, La Salle - Universitat Ramon Llull)**Session Classification :** Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : **19**

Type : **not specified**

Welcome and goals

Monday, 20 March 2023 14:00 (5)

Which session do you think it fits best?

Presenter(s) : FOLGUERAS, Santiago (Universidad de Oviedo)

Session Classification : Introduction

Contribution ID : **20**

Type : **not specified**

General discussion

Monday, 20 March 2023 18:00 (30)

Which session do you think it fits best?

Session Classification : Run-3 trigger performance

Contribution ID : 21

Type : **not specified**

COMCHA

Wednesday, 22 March 2023 11:30 (20)

Which session do you think it fits best?

Presenter(s) : OYANGUREN, Arantza (IFIC- Valencia)

Session Classification : COMCHA & Computing infrastructures

Contribution ID : 22

Type : **not specified**

Introduction to Artemisa

Wednesday, 22 March 2023 12:00 (20)

Which session do you think it fits best?

Presenter(s) : GARCIA NAVARRO, Jose Enrique (IFIC (Instituto de Fisica Corpuscular))

Session Classification : COMCHA & Computing infrastructures

Contribution ID : 23

Type : **not specified**

Physics-motivated event selection using the Level-1 Topological Trigger at the ATLAS detector

Tuesday, 21 March 2023 15:30 (20)

As we push to increase the instantaneous luminosity of the ATLAS detector, strict requirements on events are needed in order to reduce the output rate to the desired 1-1.5kHz. We can be clever about how we select events; imposing topological requirements through kinematic and angular cuts on combinations of particles allows us to further reduce the event rate without having to tighten the individual trigger objects thresholds required. In Run 2, the ATLAS detector successfully operated the Level-1 Topological trigger as part of the Level-1 Trigger system, taking inputs from the calorimeter (L1Calo) and muon systems (L1Muon). In parallel, a bitwise simulation system ran within the High-Level trigger (HLT) that acted as an important tool not only during commissioning, but for monitoring and validation. Moving into Run 3 (Phase-1), a new L1Topo hardware system has been implemented, and has been in commissioning during 2022 alongside the commissioning of the new L1Calo hardware system. During this time, the L1Calo and L1Topo Run-2 systems have been running in parallel with the Phase-1 system, allowing continuity of performance. New topological algorithms for Run 3 have been completed, along with adaptations in the simulation framework for the new inputs from L1Muon and L1Calo as they became available. The motivation, implementation and commissioning results of the L1Topo system in Run 2, along with the status of the commissioning of the new L1Topo system in Run 3 will be shown.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : HARRISON, Jack (IFAE - Barcelona)**Presenter(s)** : HARRISON, Jack (IFAE - Barcelona)**Session Classification** : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Trigger and read ... / Report of Contributions

PIC

Contribution ID : 24

Type : **not specified**

PIC

Which session do you think it fits best?

Session Classification : COMCHA & Computing infrastructures

Contribution ID : 25

Type : **not specified**

Closing remarks

Wednesday, 22 March 2023 13:00 (10)

Which session do you think it fits best?

Presenter(s) : RUIZ MARTINEZ, Arantxa (IFIC (CSIC-UV))

Session Classification : COMCHA & Computing infrastructures

Contribution ID : 26

Type : **not specified**

Summary of the DRD7 meeting

Tuesday, 21 March 2023 11:30 (30)

Which session do you think it fits best?

Presenter(s) : REDONDO FERNANDEZ, Ignacio (CIEMAT)

Session Classification : High-speed electronics devices for trigger and DAQ

Contribution ID : 27

Type : **not specified**

Open discussion

Tuesday, 21 March 2023 12:10 (50)

Which session do you think it fits best?

Session Classification : High-speed electronics devices for trigger and DAQ

Contribution ID : 28

Type : **not specified**

An alternative muon tracking strategy in LHCb

Wednesday, 22 March 2023 10:00 (20)

Allen is the GPU implementation of the High Level Trigger of LHCb. It is able to run the full reconstruction at a 30 MHz and reduce the rate by a factor of 30/60.

A tracking algorithm using only the VERTex LOcator (VELO) and the MUON system, implemented in the Allen framework, is presented. The long distance between the VELO and the MUON systems - together with a precise parametric description of the LHCb magnetic field makes possible a 4-5% momentum resolution despite a spatial resolution of O(10cm) per hit in the MUON segment. These tracks are then used to produce dimuon candidates using the precise resolution of the VELO.

Which session do you think it fits best?

Trigger Algorithms, ML / AI applications

Primary author(s) : CASAIS VIDAL, Adrián (IGFAE (Universidade de Santiago de Compostela))

Presenter(s) : CASAIS VIDAL, Adrián (IGFAE (Universidade de Santiago de Compostela))

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 29

Type : **not specified**

General discussion on algorithms

Tuesday, 21 March 2023 18:00 (30)

Which session do you think it fits best?

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 30

Type : **not specified**

General discussion on algorithms

Which session do you think it fits best?

Session Classification : Trigger Algorithms, ML / AI applications running on both non-CPU HW and CPUs (HLT)

Contribution ID : 31

Type : **not specified**

Closing discussion

Wednesday, 22 March 2023 12:30 (30)

Which session do you think it fits best?

Session Classification : COMCHA & Computing infrastructures