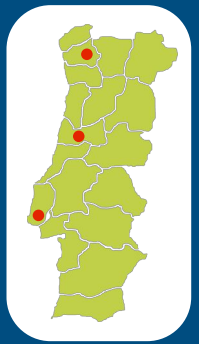
ATLAS EXPERIMENT Group Report



LIP

Universidade do Minho
Escola de Ciências

Ciências ULisboa

TÉCNICO LISBOA

UNIVERSIDADE D COIMBRA

TileCal Operations Activities

We are a strong group with many leading contributions in different TileCal activity areas

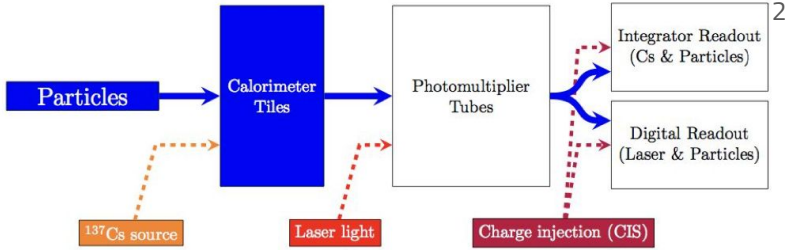
Leadership positions

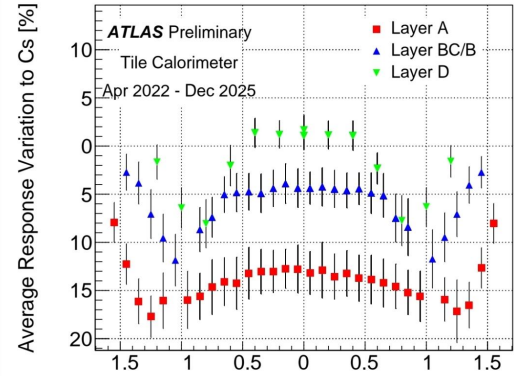
- Full responsibility on the DCS system (F. Martins)
- Leading Data Preparation group (H. Santos)
- Phase II Performance Studies (R. Pedro)
- Run Coordinator (M. Kholodenko, Nov 24-April 25)

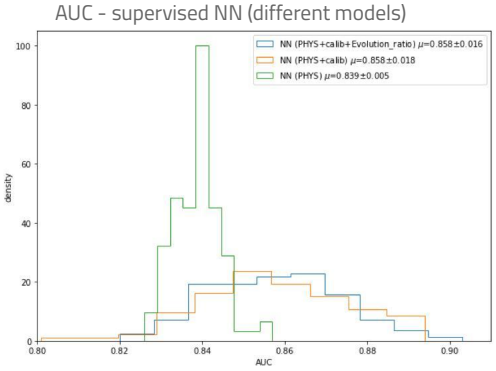
Contribution to

- Cs calibration (production & analysis of calibrations)
  - Leading contribution
- Ageing studies of optical components:
  - Run 2 publication JINST 20 (2025) 06, P06006
  - Analysed Run 3 data
- Exploring anomaly detection for bad channels identification

[More information]







ATLAS Trigger

Operations:

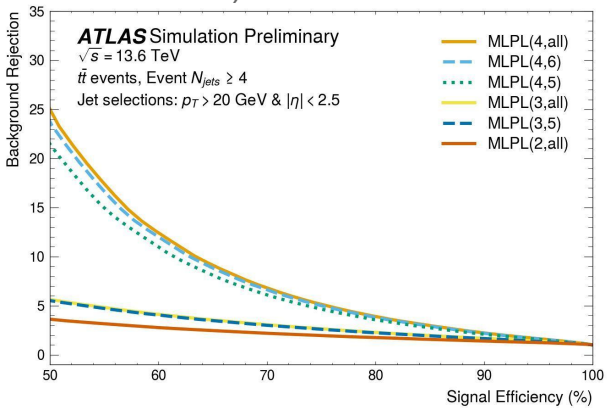
Coordination roles:

- HLT Jet Signature group (Patricia Conde, 2025-26)
- HLT Calo group (Nuno Fernandes, 2024-March 26)

DIPZ fast pile-up rejection algorithm

Published performance plots

PubNote on final stages of approval (I. Ochoa contact editor)



Upgrade:

HLTCalo GPU demonstrator

Fully developed and implemented by the LIP team

- Includes all reconstruction steps, plus calibration, plus generic GPU-friendly Event Data Model

Done in 2025:

- Performance studies for the ATLAS decision on the HLT farm
- Ported data preparation step
- Working on publication &thesis

March 2026: ATLAS decided on a mixed solution (GPUs+CPUs) for the HL-LHC Trigger farm

- Big opportunity for us

AD@L0 trigger

Starting studies of anomaly detection at L0Global

Forward Detectors & Computing

Forward Detectors

ALFA:
- DCS maintenance
- Last station to be removed in LS3

AFP DCS:
- Co-coordination (L. Seabra)
- Support during data taking
- General updates of the movement and cooling controls
- Identified and replaced voltage regulation boards damaged by radiation

AFP and what remains from ALFA will be dismantled in LS3. Our contribution to FWD ends then

Distributed Computing

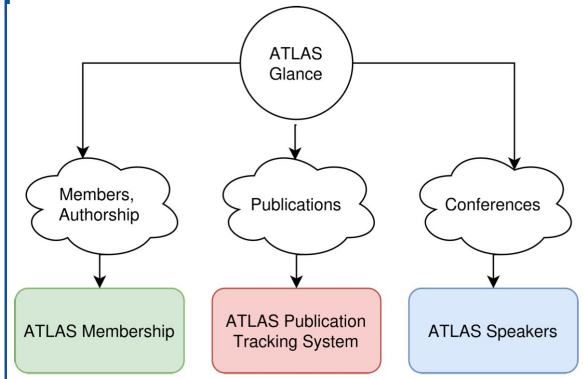
H. Wolters

ES-Cloud coordination
- 4-5% of all ADC resources
- Efficiency above 90%.

LIP's Tier-2 NCG-INGRID-PT running stable fulfilling pledges
- 4% increase in comparison with 2023.
- Key grid middleware services upgraded
- New 100Gbps network connection
- New authentication & authorization systems

ATLAS Computing Run Coordination and Monitoring of Sites and Central Services
- Focus on automatization of services and monitoring

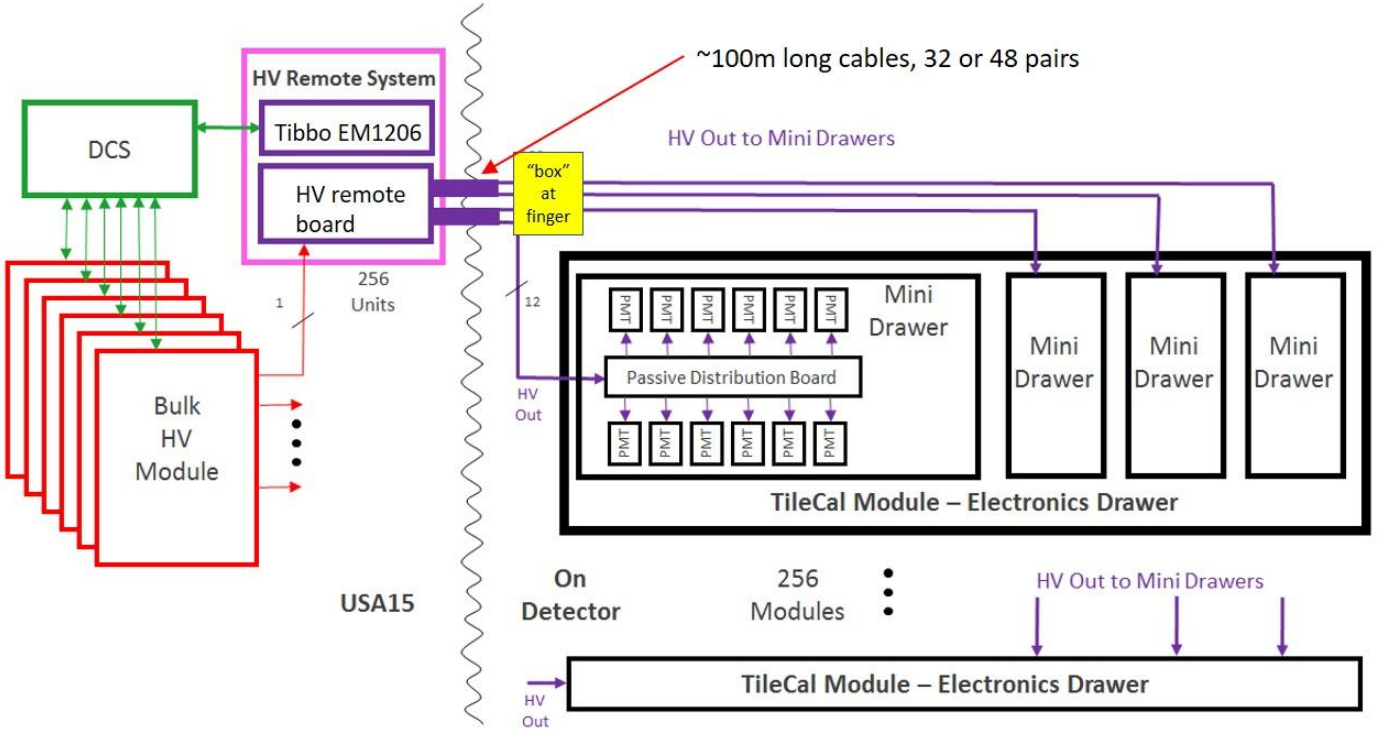
Glance



Product Management of the development team (G. Pinhão)
- Constant functionality improvements in all the systems
- Software migration

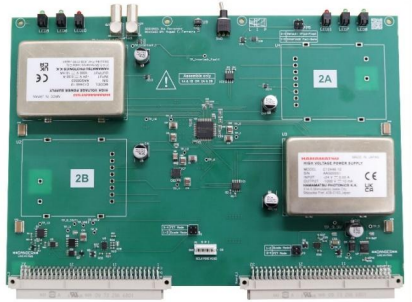
Activities finished in August 25
- G. Pinhao finished her contract

Upgrade of the TileCal High Voltage Distribution System



In collaboration with the Electronics Lab, Detectors Lab and Mechanical Workshop

TileCal High Voltage Upgrade



In production this year!

HVsupply, HVremote boards:

- Design ready, last protypes produced and tested
- Prepared test bench for quality control and calibration
  - Additional test benches to be produced this year
- Setup for burn-in tests of the HVbus boards ready

HVbus boards:

- Preproduction done

Cables:

- Problems with the fire resistance of the selected cable

For 2026:

- Produce and test cables with different outermost material
  - New: positive results with different production method suggest that change of material may not be needed
- Production of the HVsupply, HVremote and cables
- Test the OPC UA for crate and respective SCADA component for control and monitoring

In collaboration with the Electronics Lab, Detectors Lab and Mechanical Workshop

High Granularity Timing Detector

In production this year!

Electronics:

- Ongoing pre-production of HV patch panels/filters
- Quality control device commissioned

Interlock & DCS:

- TM communications board designed & produced for HGTD & ITK
  - Quality control done. Commissioning ongoing.
- Implemented HV monitoring
  - Ongoing tests
  - Simpler version for the demonstrator module ongoing
- Monitoring of CO2 temperature carrier boards designed and produced

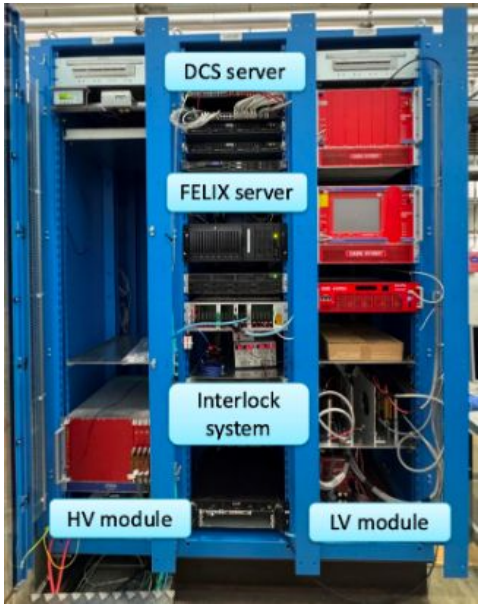
Infrastructure:

- Production of HV cables and pigtails prototypes done

Entering final production this year

More details in backup

Demonstrador rack in Bldg. 180
LIP: Interlock & DCS



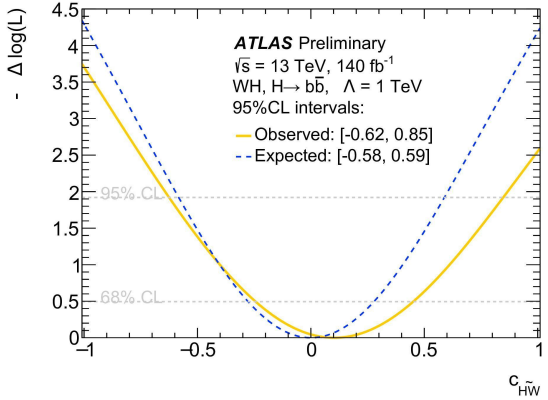
Physics

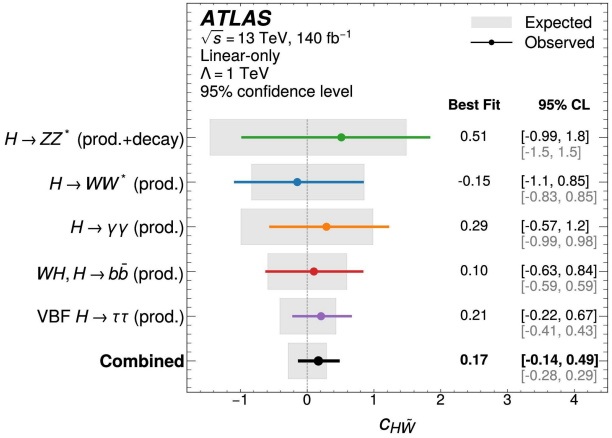
Higgs Boson Measurements

Search for CP-violating HWW couplings in WH(bb) with Run 2 data
- Limits among the best world-wide

WHbb provided crucial input to the Higgs CP combination
- Submitted to PRL
- I. Ochoa (editor of the note)

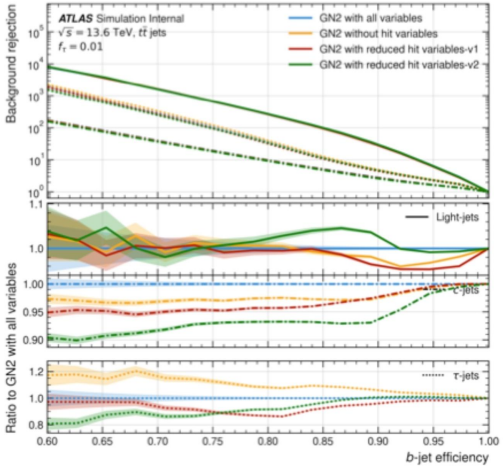
Working on Partial Run 3 data analysis
- Expect publication by the end of the year





Heavy Ion Physics

Used hit-related variables to improve b-jet selection in pp collisions (first step towards better taggers in HI)

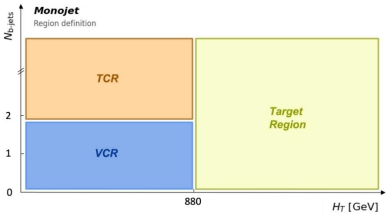


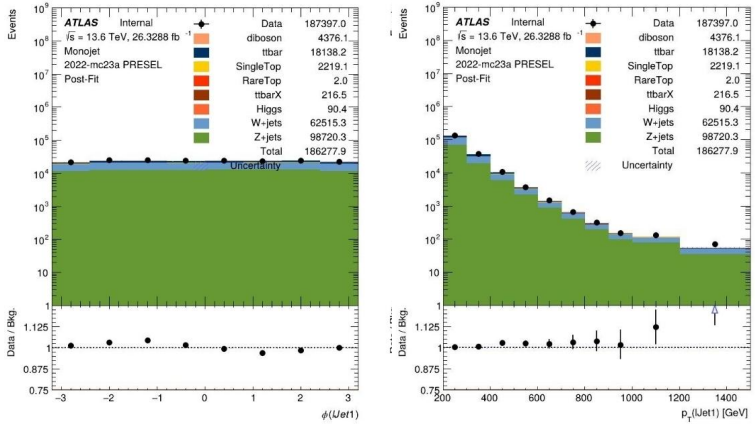
Physics

Anomaly Detection

Fully hadronic topologies
Full development of analysis framework
2026:

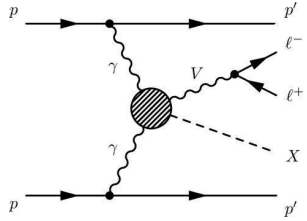
Study different AD models and test them for different physics processes

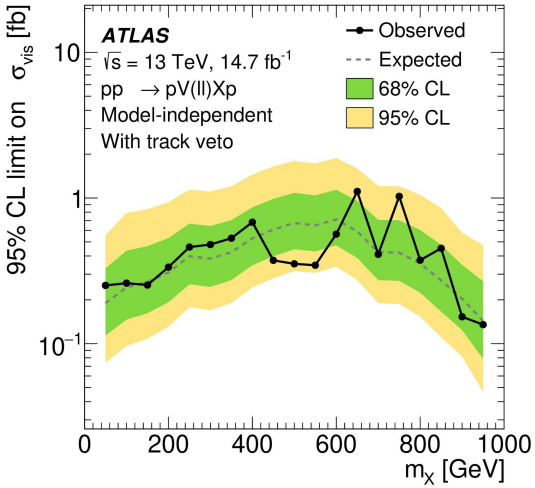




Missing mass analysis

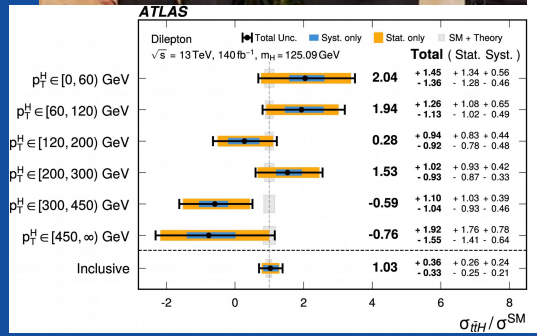
Submitted to JHEP

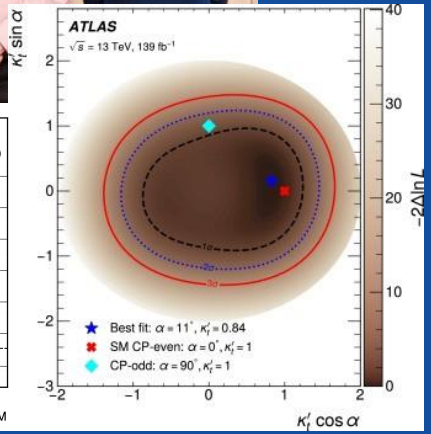




Prizes

Ana Luísa Carvalho, ATLAS PhD Prize, Feb 2025



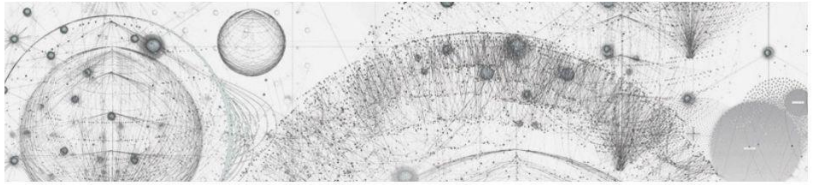


Breackthrough Prize

FUNDAMENTAL PHYSICS BREAKTHROUGH PRIZE

MISSION BOARD TROPHY EVENTS NOMINATIONS NEWS CONTACTS MANIFESTO
COMMITTEE PRIZES LAUREATES RULES

Search



FUNDAMENTAL PHYSICS

Insights from fundamental physics have overturned our assumptions about the world around us. Last century, general relativity reshaped our picture of space and time, and quantum mechanics replaced the march of cause and effect with a dance of probabilities. Just in the last few decades, we have detected the Higgs boson and gravitational waves, and discovered that the expansion of the Universe is accelerating.

This century is likely to produce more surprises. From the subatomic to the cosmic scale, physicists are opening windows into the deep structure of reality.

The Breakthrough Prize in Fundamental Physics was founded in 2012 by Yuri Milner to recognize those individuals who have made profound contributions to human knowledge. It is open to all physicists – theoretical, mathematical, experimental – working on the deepest mysteries of the Universe.

LIP Group responsibility positions

- F. Martins, TileCal DCS coordinator.
- I. Ochoa, contact editor for PUB note on WH(bb) CP measurement
- I. Ochoa, contact editor for paper on combination of analyses probing the CP nature of HVV couplings
- I. Ochoa, first reader for ATLAS PUB note “Explaining the ATLAS GN2 Flavour Tagging Algorithm with Integrated Gradients”.
- I. Ochoa, convener of Reconstruction and SW Triggers working group, HEP Software Foundation
- I. Ochoa, vice-leader of WG3 of COST Action EPIGRAPHY (CA24153)
- I. Ochoa, contact editor of the DIPZ publication.
- H. Santos, HGTD Interlock coordinator.
- H. Santos, TileCal Data Preparation and Performance coordinator
- H. Santos, chair of the ATLAS Authorship Committee (until March 2025)
- H. Wolters, coordinator of the Iberian Cloud.
- H. Wolters, responsible for the Portuguese Federated Tier2 in the Iberian Cloud Squad.
- H. Wolters, member of the ATLAS International Computing Board
- L. Coelho, analysis contact for the ttHH search paper.
- L. Seabra, AFP DCS co-coordinator, ALFA DCS responsible.
- M. Teixeira, analysis contact for the dilepton with AFP analysis
- N. Santos, HLT Calo co-cordinator.
- N. Castro, member of the ATLAS Physics Office and coordinator of the gitlab continuous integration team for the ATLAS
- publications.
- R. Gonçalo, HGTD Patch Panels coordinator
- R. Gonçalo, contact editor for the ttH(bb) CP paper
- R. Gonçalo, HGTD Speakers Committee
- R. Gonçalo, member of the CB Chair Advisory Board
- R. Pedro, TileCal HL-LHC Software and Performance Co-coordinator (until Nov 2025)
- R. Pedro, analysis contact for the jet+MET anomaly detection analysis
- P. Conde Muíño, Jet Trigger Coordinator (since September 2025)

Remarks

Strong team with many young members (PhD/Master students)

- Important contributions to all fields of activity
- Collaboration with other LIP groups and national research centres
- Connection to many Universities in Portugal

Weaknesses:

- Reduced number of postdocs

Opportunities:

Exploit collaboration with industry and
Run 3 data and Upgrade activities provide a wide range of topics to attract Master & PhD students

Threats:

- Critical situation of the Fundo CERN: funding ended in December 2025
- Loosing outstanding students after Master due to lack of funding or adequate PhD funding programmes
- Delicate human power situation (technicians, postdocs)

ADAPT: Anomaly Detection Across the Pipeline: From Detector Control to Trigger and Physics analysis

PI: H. Santos

Research project submitted to "all scientific domains" funding call (PTDC)

- 250 k€ for 3 years
- Complementary innovative research topic
- Subtasks:
  - AD for the DCS data
  - AD for the data quality monitoring
  - Edge ML for real time AD at trigger level (L0 Global, non-QCD jet identification)
  - Searches for BSM physics in monojet topologies (AD)
  - Application to industry: Brisa (monitoring of road infrastructure operational technology and intelligent transportation system)

Good experience:

- Many companies interested in AD for control systems
- Opens new possibilities for the future

Thanks!

REPÚBLICA
PORTUGUESA

fct

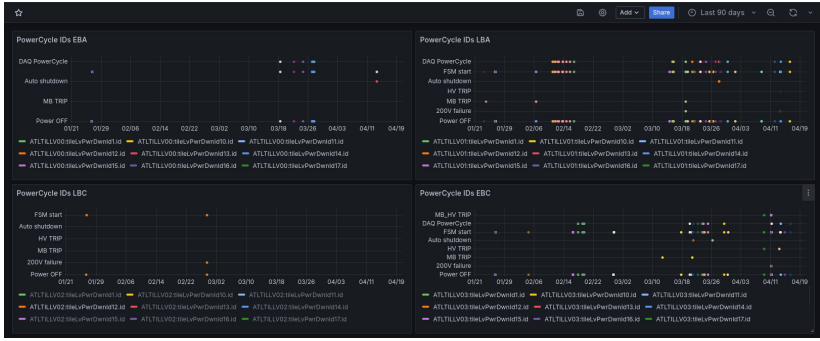
Fundação
para a Ciência
e a Tecnologia

Operations

Tile Calorimeter DCS

Activities for 2026 data taking:

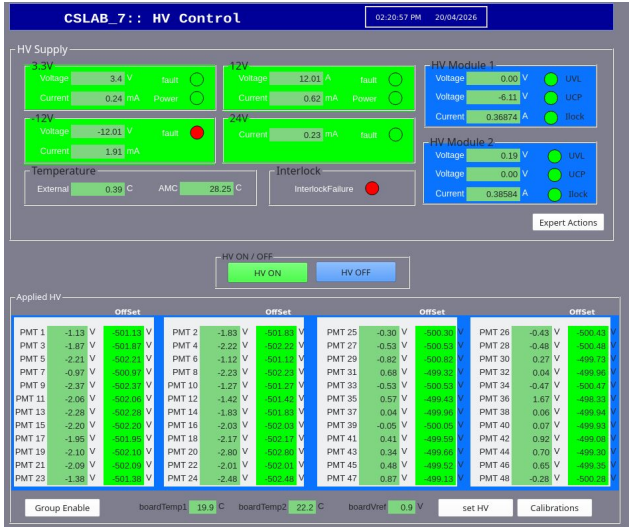
- Maintenance of actual control system
- Provide training for the DCS on-call shifters and take on-call shifts
- Added online monitoring for power-cycles of the on-detector’s electronics
- Replace hardware in counting room, due to failure or preventive replacement



Grafana dashboard for module power cycle

DCS for High Lumi-LHC

- Finalize the control software (OPC UA and WinCC OA component), for:
  - 200 V AC/DC power supply
  - High Voltage (HV) Remote crate control
  - Laser system used for calibration of TileCal
- Made a proposal to ATLAS DCS for OPC UA bridge between DCS and DAQ system
- Complete the development of QA system for DC-DC low voltage power supplies
- Assist in the preparation of vertical test system for Tile electronics ; powering and data acquisition system
- Integration of the various control components in the DCS Finite State Machine



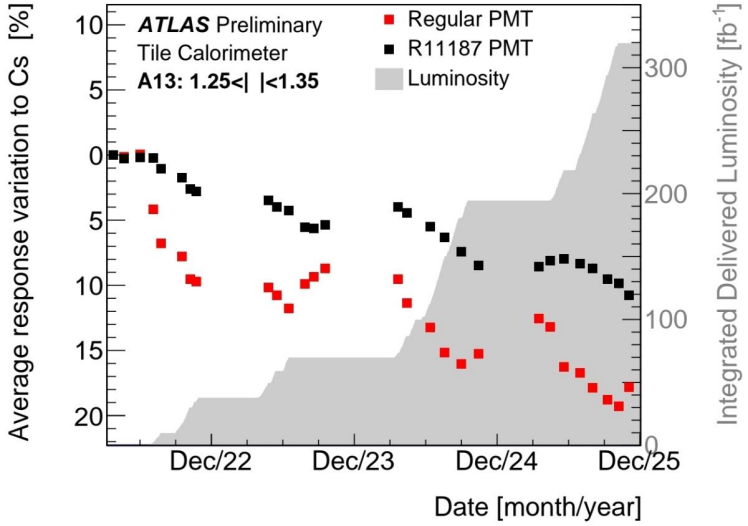
User interface to control and monitoring of HV for Phase II

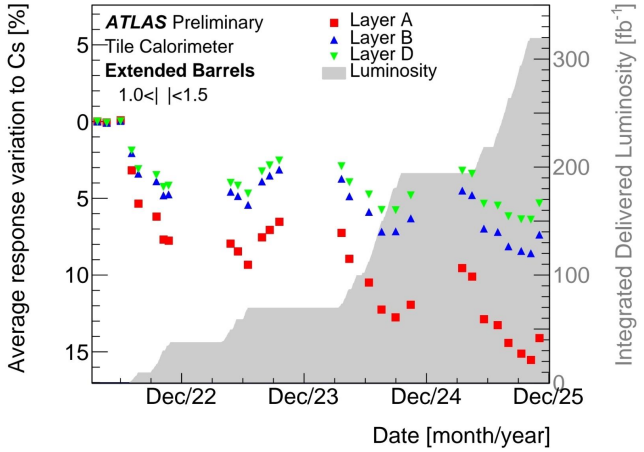
TileCal Laser and Caesium Calibration

M. Kholodenko, B. Pereira, R. Pedro

- Caesium calibration
  - Responsible by the acquisition scans and calibration calculation

- Laser calibration
  - PMT calibration and monitoring during 2024 data taking
  - Laser calibration of 2022+23 TileCal luminosity measurement
  - Study of new PMT model for Phase II upgrade

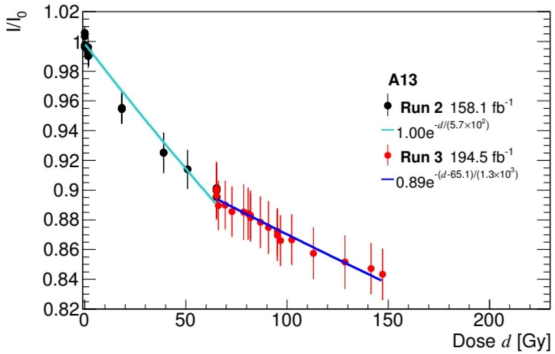


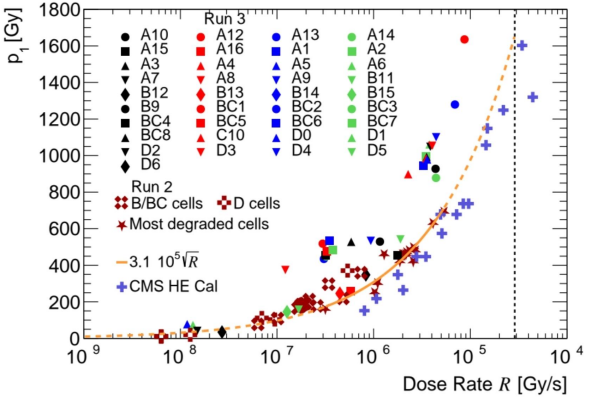


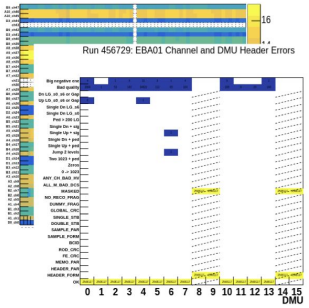
TileCal Radiation Hardness and DQ automation

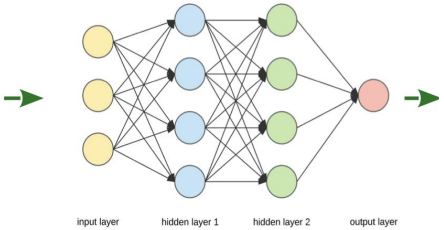
A. Berti, B. Pereira,
I.Moreira. R. Pedro

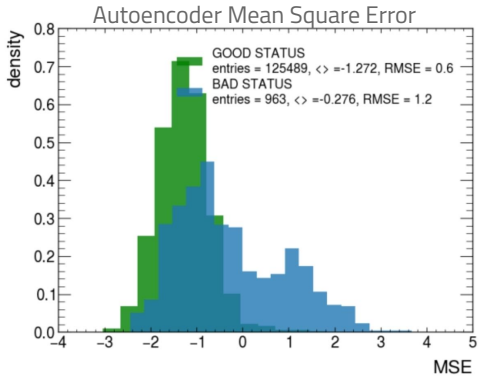
- Run 3 Radiation hardness study
  - Different tendency of the dose-rate effects
  - Requires more complicated models for accurate predictions
- Exploring Machine learning for the automation of DQ monitoring
  - NN for classification
  - AutoEncoder to learn good behaviour and identify anomalous channels (Anomaly Detection)



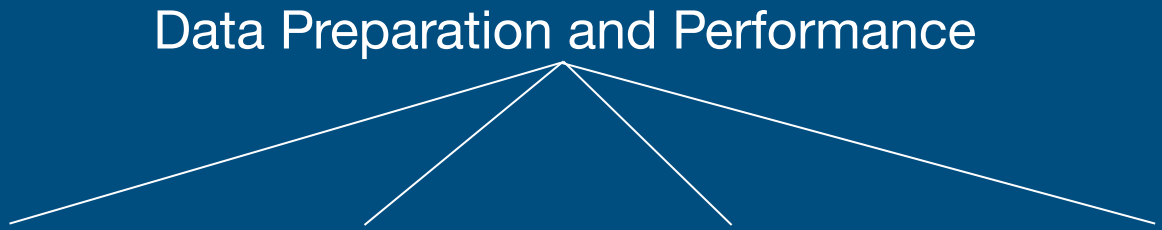








Data Preparation Coordination of TileCal - LIP responsibility



Calibrations

Cesium, Minimum Bias, Laser, and Charge Injection Systems

Databases

COOL and CONDBR2 to manage calibration constants, conditions data, and Data Quality flags

Performance

Electromagnetic scale uniformity and validation;
Signal reconstruction;
E/p analysis

Data Quality

Daily monitoring of the full calorimeter to identify and address issues affecting data integrity immediately

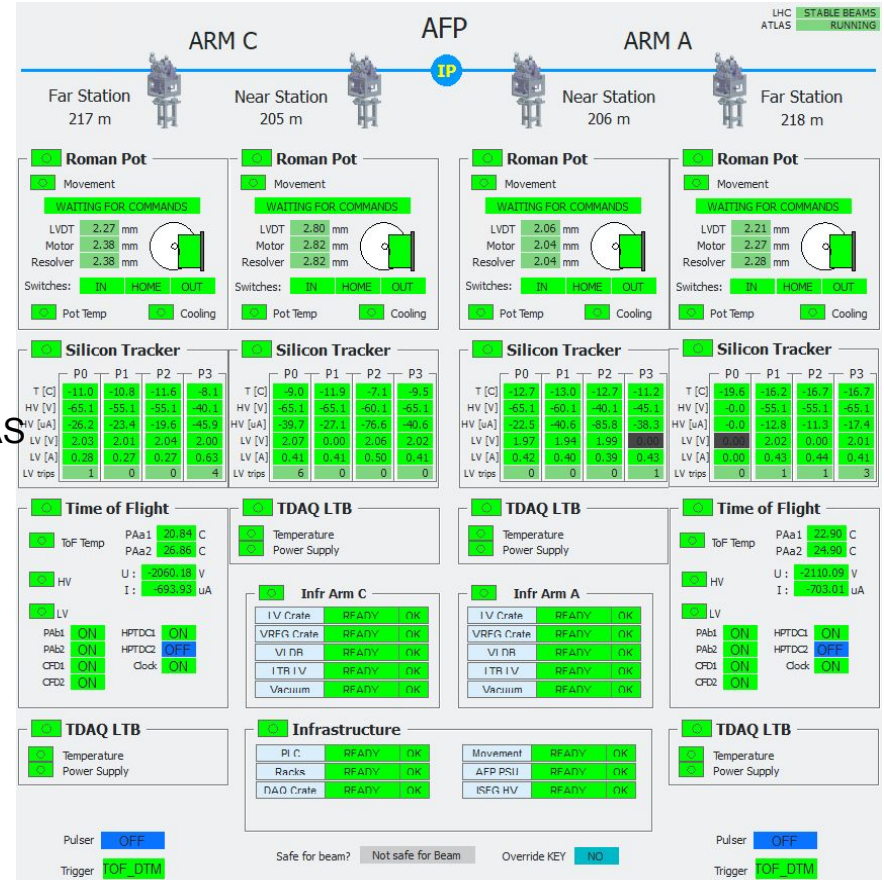
FWD DCS

AFP DCS:

- Mitigation of high radiation effects in the hardware
  - Vreg boards tests and repairs
  - Decreasing CAN bus speed
  - New automation procedures in the DCS
- Provide support during data taking as on-call expert or participate in special runs
- Follow general maintenance/updates requested by ATLAS DCS

ALFA DCS:

- Integrated in the AFP DCS
- Only one arm without detectors installed
- Monitoring of vacuum and ventilation

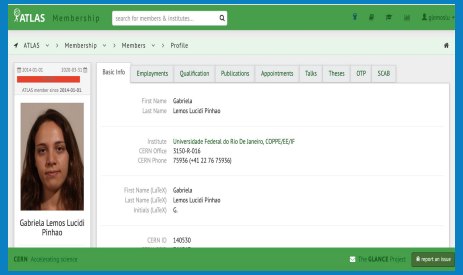


ATLAS Distributed Computing

- ES-Cloud:
  Tier-1 in Barcelona and Tier-2s in Valencia, Barcelona, Madrid, Lisbon, São Paulo and Santiago de Chile
  - ES-Cloud TIER-1 and TIER-2s offer 4% of all ADC resources and strive to reach 5% in 2025.
  - The efficiency for all sites except one is above 90%.
- LIP's Tier-2 NCG-INGRID-PT running stable fulfilling pledges
  - 4% increase in comparison with 2023.
  - several key grid middleware services were upgraded.
  - now connected to the LHC Open Network Environment (LHCONE) via a dedicated 100Gbps network connection and full IPv6 connectivity
  - The new token based authentication and authorization system was deployed.
- ATLAS Computing Run Coordination and Monitoring of Sites and Central Services
  - Lack of manpower for ADC requires continuous efforts for automatization of services and monitoring
  - Ongoing transition to a new issue tracking system, documentation and helpdesk
  - LIP is contributing by organizing the Computing Run Coordination Shifts and developing

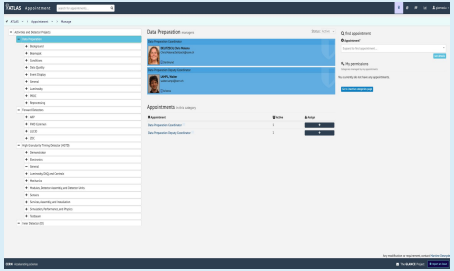
Membership

ATLAS members, institutes, employments, qualifications and author lists



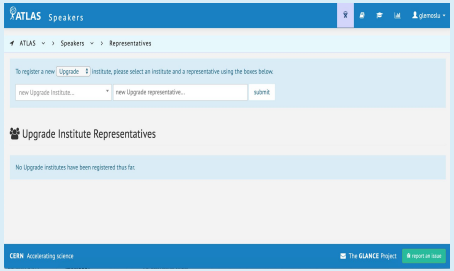
Appointments

ATLAS appointments and categories



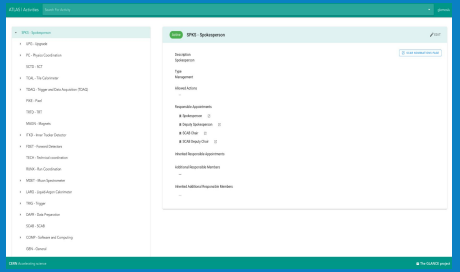
Speakers

ATLAS Conferences, talks and speakers



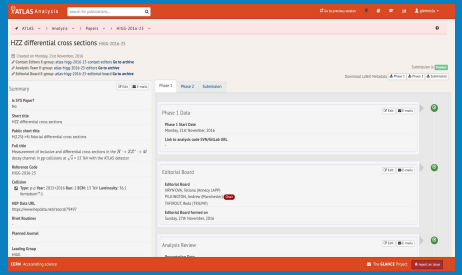
Nominations/Activities

ATLAS nominations for speaker selection done by activity groups



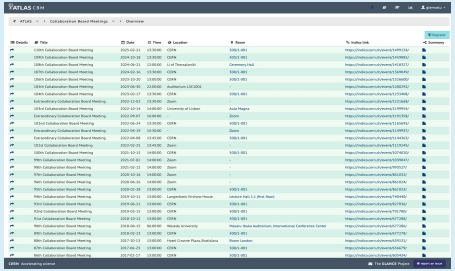
ATLAS Publication Tracking

Analyses, Papers, CONF notes, PUB notes and PLOTs

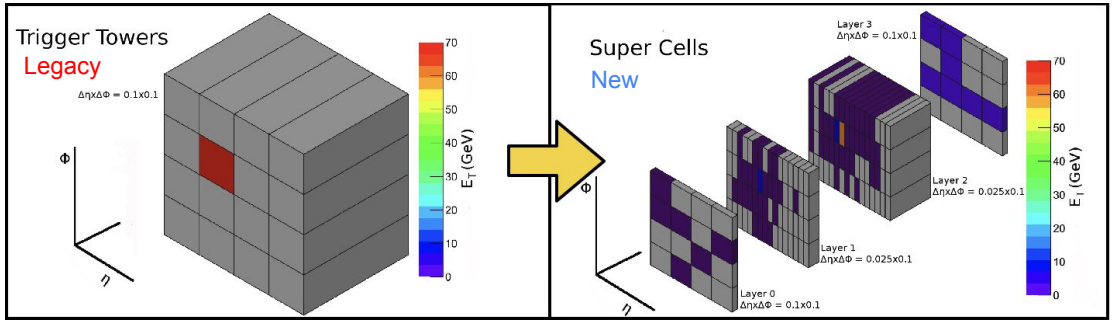


CBM

Collaboration Board meetings and its attendees



Trigger Operations



LAr Super Cells as trigger objects + New Feature extractors to process information

- **Coordination roles:**
  - HLT Jet Signature group (P. Conde Muíño, 2025-2026)
  - HLT Calo group (Nuno Fernandes, 2024-2026)
- **Expected in 2025:**
  - HLT Large-R jet triggers will use dedicated L1 inputs, more robust across different substructure metrics.
  - On-going at LIP: R&D for new pile-up robust algorithms for multi-jet triggers.

Upgrades

HGTD - LIP responsibilities

Work done in close collaboration with Detector Lab, Machine Workshop and Electronics Lab

Data Acquisition (DAQ) and Control

- ALTIROC total integrated dose (TID) measurements and functional testing
- Development of Embedded Local Monitor Board (ELMB) carrier boards for CO_2 cooling monitoring

Interlock System

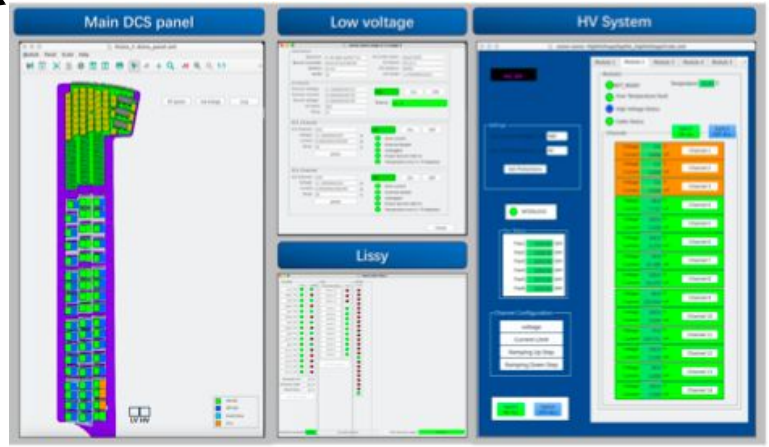
- Responsibility for the complete interlock system

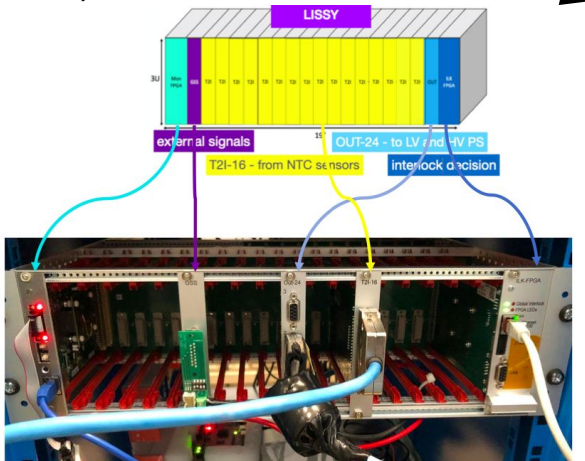
Detector Control System (DCS)

- Control of High Voltage power supplies

High Voltage System

- Patch panel filters
- HV, LV and sensor cable and in-detector pigtails

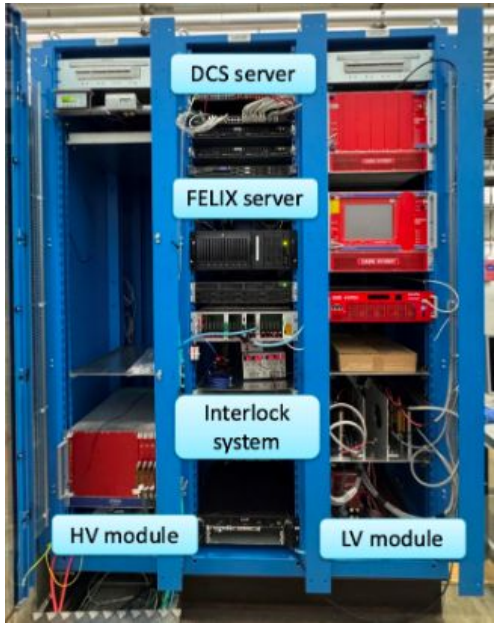




LISSY crate (interlock) protecting the Demonstrator @b180 CERN

HGTD Interlock and TM board

Demonstrador reack in Bldg. 180
LIP: Interlock & DCS



LIP responsible for entire HGTD Interlock system

TM (Transfer Module) communications board designed and produced at LIP

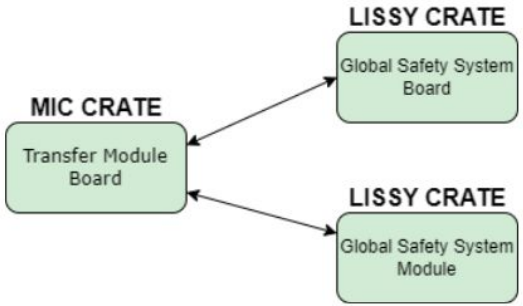
Prototypes produced to check functionality and compatibility with the other MIC and LISSY components

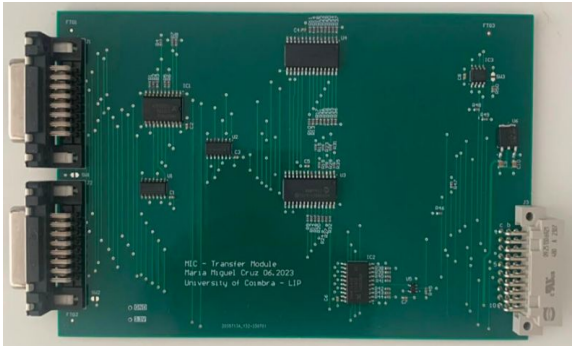
Production: 48 boards (ITk and HGTD)

Quality control of full board production done – based on dedicated testing board

MSc student assigned to commission the TM Testing Board and conduct tests on the 48 boards.

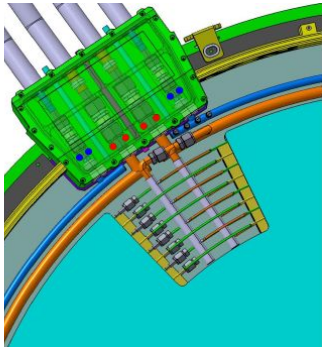
Just waiting for feedback from ITk on last tests

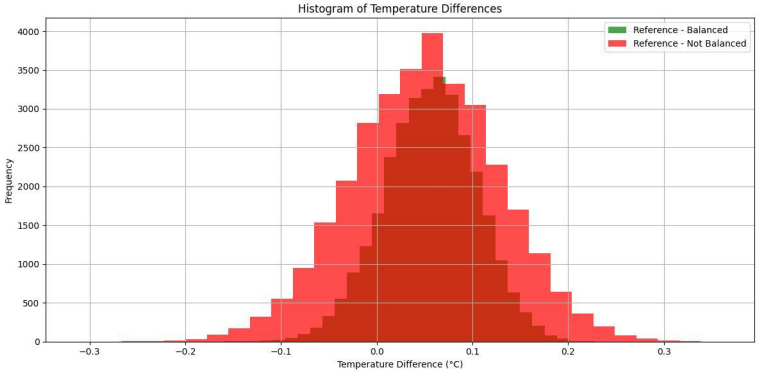


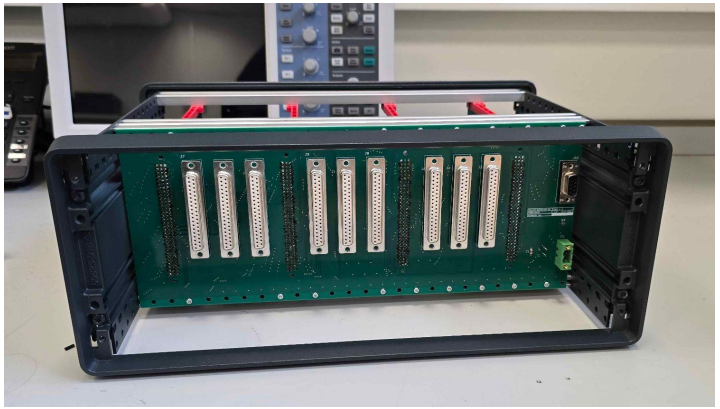


DCS: CO2 temperature

- CO_2 cooling temperature measurement with 0.2 ºC accuracy in [-80 ºC, +60 ºC]
- Use Pt10k sensors and ELMB2 transducer boards
- Carrier boards and crate backplanes designed amd produced by LIP
- Final PCBs currently being produced

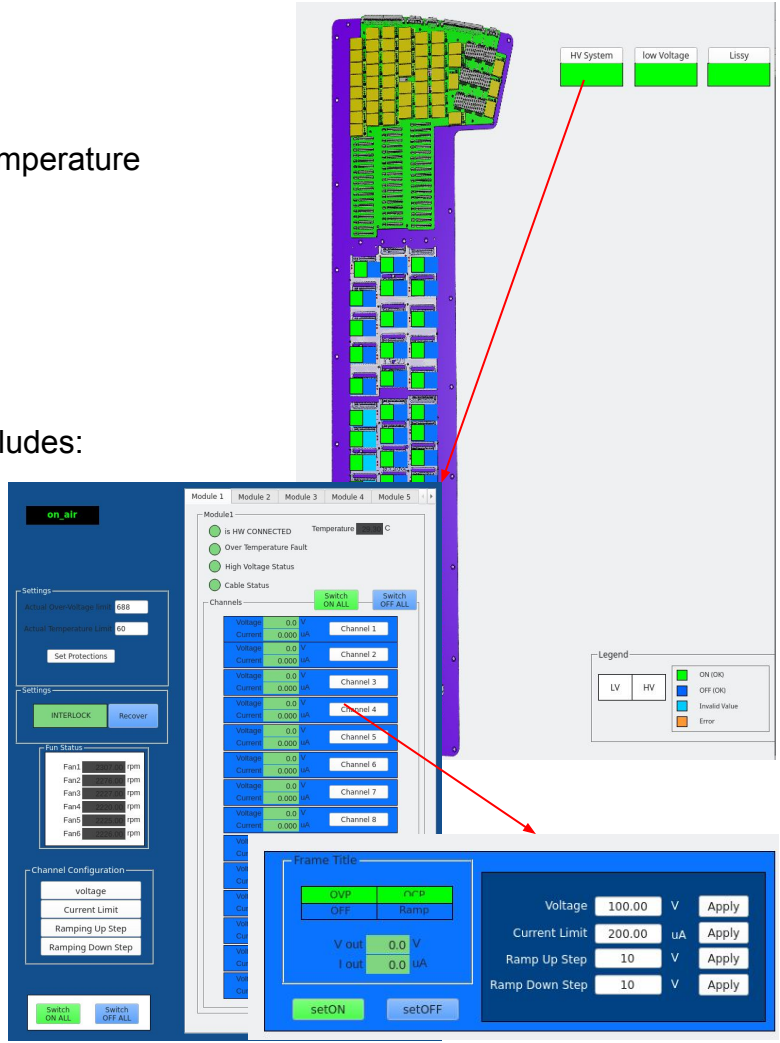




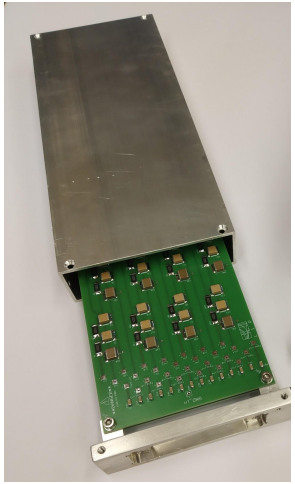


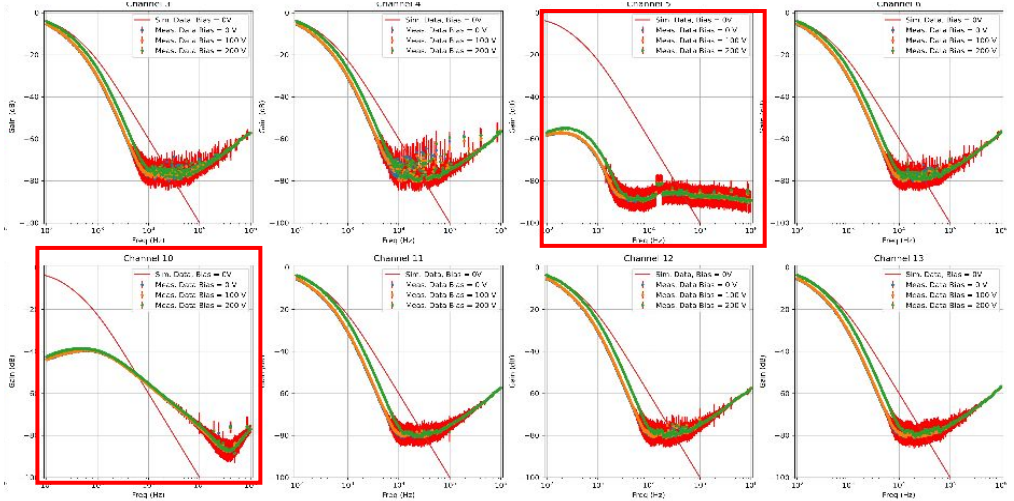
HGTD
DCS

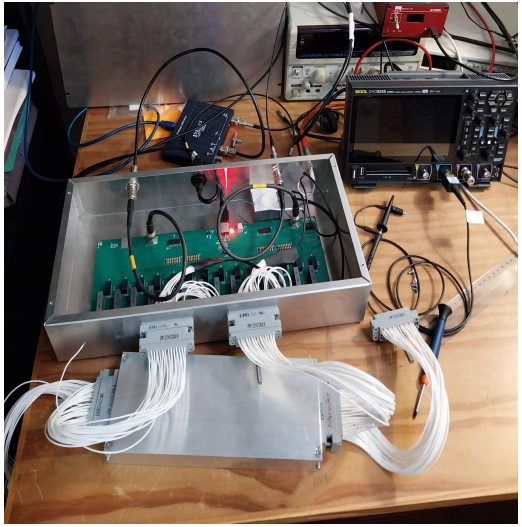
- Ongoing development of monitoring crate back-plane to monitor the temperature probes installed in the HGTD cooling system
  - System based on the CERN's Embedded Local Monitoring Board
- Ongoing tests with the final version of the High Voltage crate
  - SCADA system was updated
  - Added new features in the user-interface and alarms
- Preparation of simple user interface for HGTD demonstrator, which includes:
  - Low Voltage
  - High voltage
  - Interlock system
- Provide expert assistance/guidance in other parts of the HGTD DCS



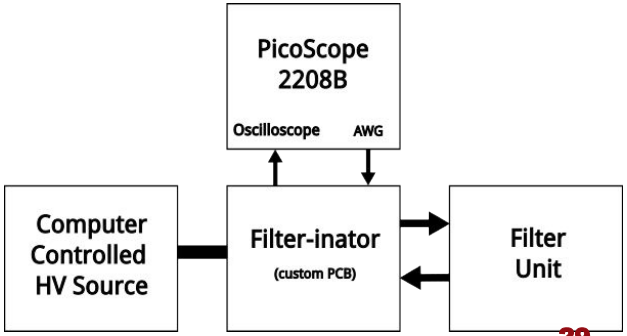
HV Filters and Quality Control







- HV filter units for HGTD – modular design with 28 filters / box for 8032 HV channels
- Quality Control device commissioned - Uses filter response as QC metric
  - Combination of: LIP-made HV source; PicoScope 2208B (oscilloscope + Arbitrary Wave Generator); “Filter-inator” test device. PC-controlled
  - Example above shows 2 bad channels – traced to broken wire soldering



HV Filter Pre-Production and Next Steps

- Pre-production (60 filters) filters being assembled for demonstrator:

- Aluminium cases ready
- Detector side connectors at LIP for pre-production
- Waiting for ITT-Cannon connectors to finish pre-production: June
- Components acquired
- PCBs in production, to be leaded by local company
    - 2 productions failed and needed to change PCB supplier

Next Steps:

- Finish design and produce new version of “Filter-inator” to ease tests
- Produce 2 filters + cables for demonstrator
- Pre-production: 60 filters
- Exercise QC on pre-production filters before shipping to CERN
- Prepare PRR using demonstrator results

Cable Production

Producing several cables for HV, LV, temp. sensors, both inside and out of vessel

First 5 cable drums now at LIP-Coimbra

HV pigtails	330
LV pigtails	165
NTC pigtails	66
12V LV cables for Mod0 and istallation	14
HV cables for Mod0 and assembly	28
HV cables for flex chain S05	148
Long HV cables from USA15	188
Long HV cables from USA15	132
proximity HV cables from vessel to filter boxes	320
proximity LV cables between vessel and Bric1 PS	160
300V cables	40
12V interlock cables	40
12V control cables	10
NTC cables	64
Pt10k	18

Calorimeter Reconstruction on GPUs

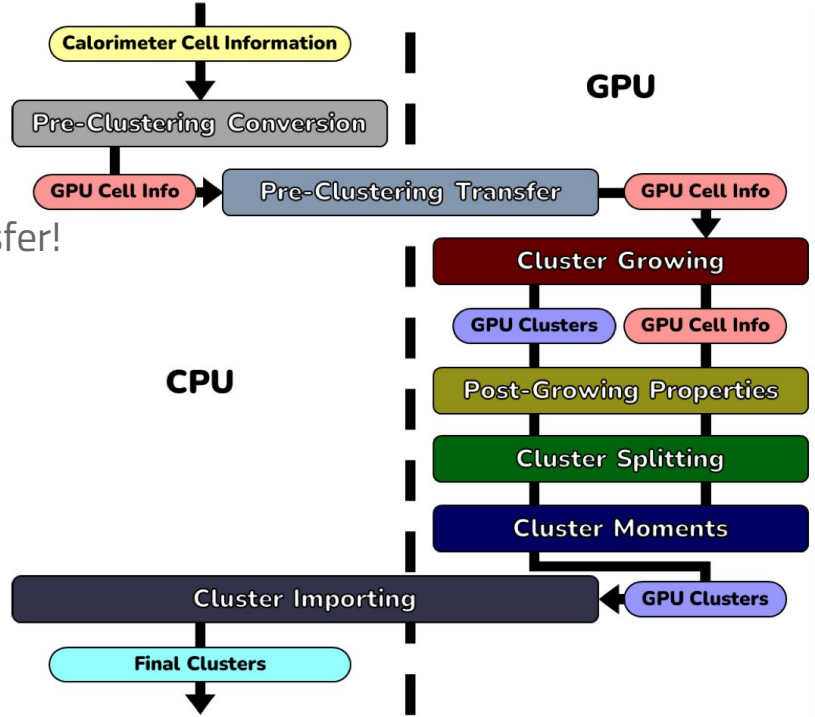
Full responsibility of the LIP team

- All the cluster reconstruction ported to GPUs
  - 100% agreement in cluster reconstruction
  - Factor 6-10 improvement in execution time
  - 80% of the time spent in data conversion&transfer!
- Data preparation step ported in 2025

Marionette:

- New generic Event Data Model GPU-friendly
  - Avoids data transformation step
  - Fully developed but not implemented in the TopoAutomatonClustering

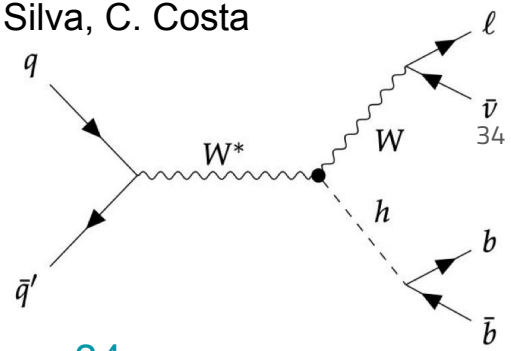
Plans for 2026:



Physics

R. Barrué, P. Conde, M. Kholodenko, I. Ochoa,
B. Rosalino, M. Silva, C. Costa

CP-violation in the HWW couplings



Beyong SM physics may modify the HWW interaction

Possible CP-even:

CP-odd couplings:

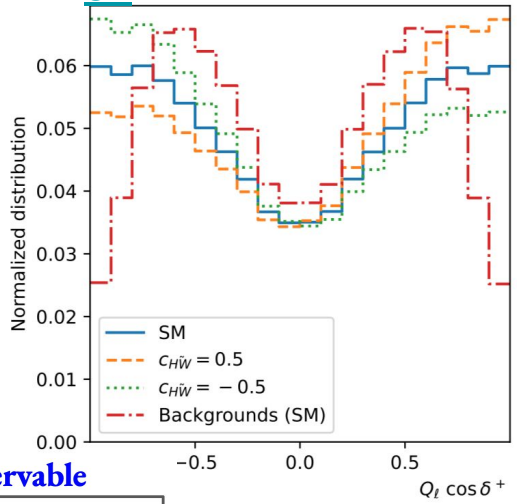
Up to now: focus on the CP-odd component

SMEFT formalism

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_{d>4} \sum_{i} \frac{c_i O_i^{(d)}}{\Lambda^{(d-4)}}$$

$$|\mathcal{M}|^2 = |\mathcal{M}_{SM}|^2 + \frac{c_{H\widetilde{W}}}{\Lambda^2} 2\Re\left(\mathcal{M}^*_{O_{H\widetilde{W}}} \mathcal{M}_{SM}\right) + \frac{c^2_{H\widetilde{W}}}{\Lambda^4} |\mathcal{M}_{O_{H\widetilde{W}}}|^2$$

34



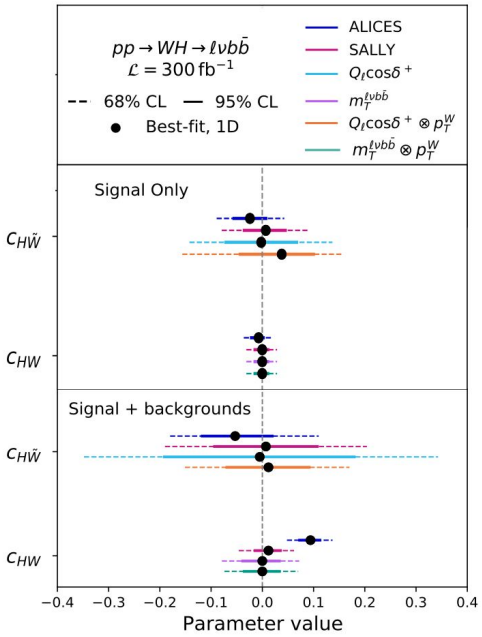
Angular observable

$$\cos\delta^+ = \frac{\mathbf{p}_\ell^{(W)} \cdot (\mathbf{p}_H \times \mathbf{p}_W)}{|\mathbf{p}_\ell^{(W)}| \cdot |\mathbf{p}_H \times \mathbf{p}_W|}$$

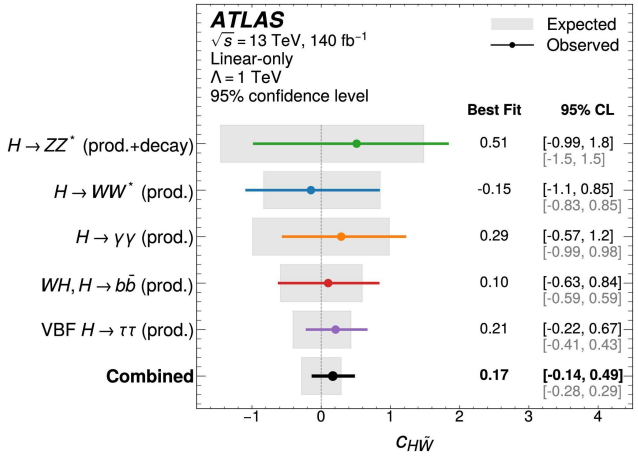
M. Kholodenko's PhD thesis (ongoing)
R. Barrué PhD thesis (finised)
B. Rosalino's Master thesis (done)

CP-violation in the HWW couplings

Using ML-based inference methods
- SALLY
  - R. Barrué's thesis
  - JHEP04(2024)014
- ALICES (M. Silva's Master thesis)



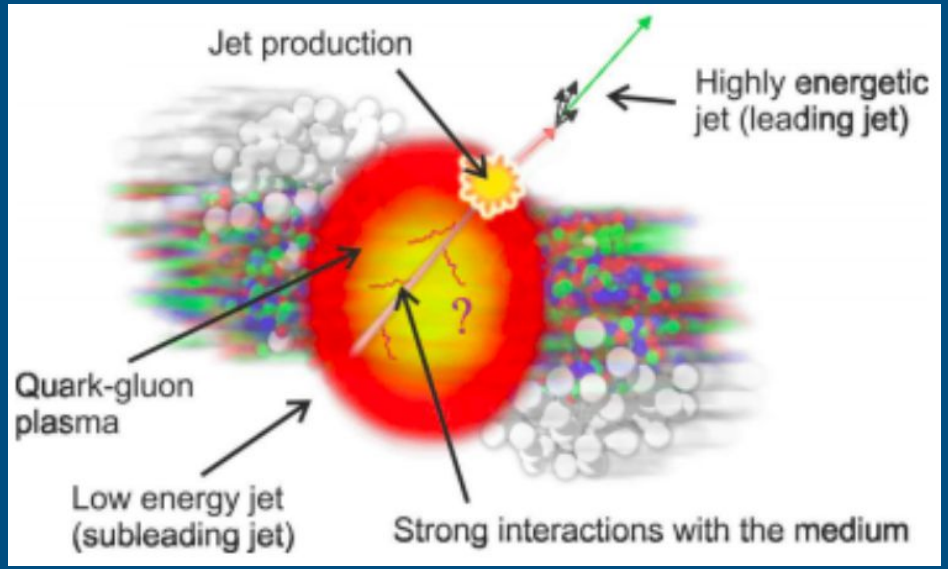
STSX WH(bb) measurement: arXiv:2410.19611
Constraints on CP-odd HWW couplings:

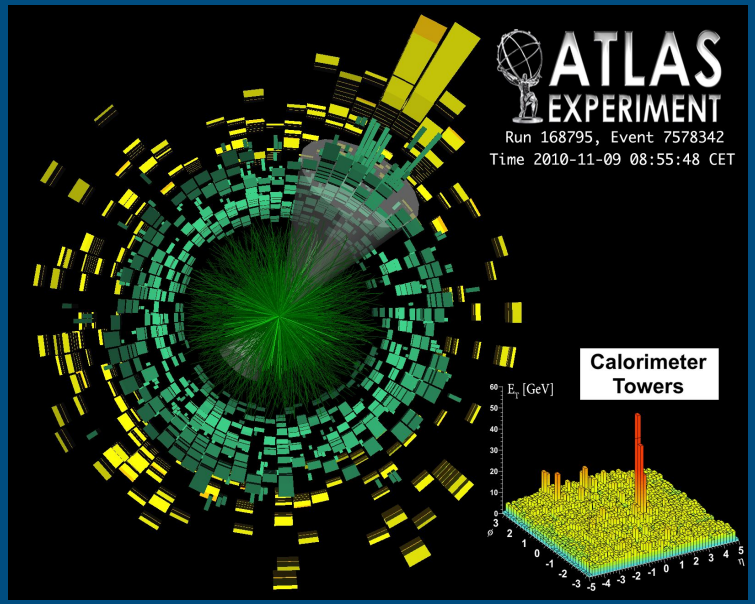


Preparing now Run 3 Analysis!

b-jets in Heavy Ions

In Pb+Pb collisions a new state of matter is created - The Quark-Gluon Plasma, the state of matter in the first micro-seconds of the universe



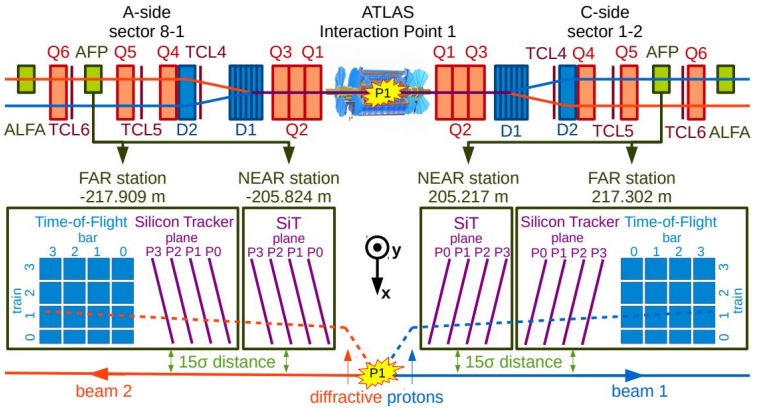


Jets are suppressed and those surviving are modified when crossing the QGP

We can infer the properties of the QGP by studying this modification - In particular the jets that originate in the bottom quark (b-jets) are very interesting probes

Missing Mass Search in Proton-Tagged Dilepton Events with AFP

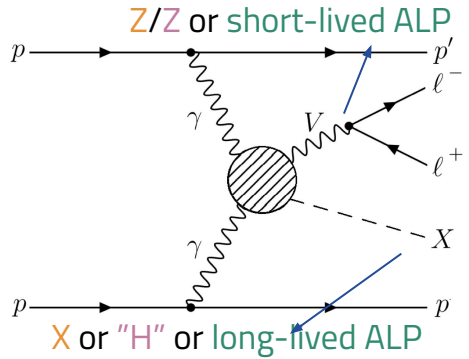
M. Barros, N. Castro

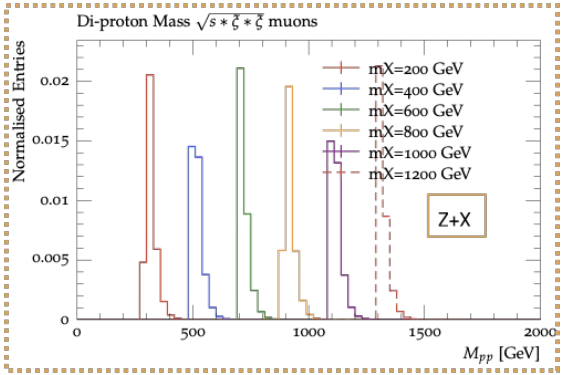


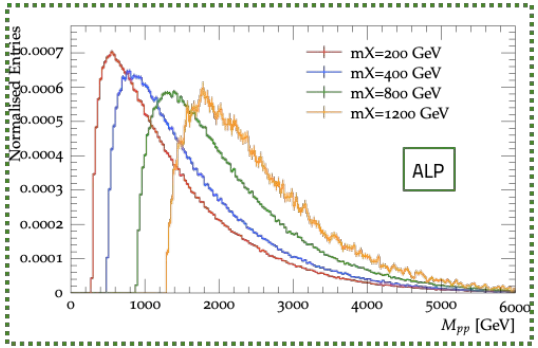
$$m_X^2 = (E_{\gamma\gamma} - E_{ll})^2 - (\overrightarrow{p_{\gamma\gamma}} - \overrightarrow{p_{ll}})^2$$

AFP

Central Detecto







- Limits for the three different signals with both channels combined