
A NEW ELECTRONIC READOUT FOR THE ATLAS LIQUID ARGON CALORIMETER

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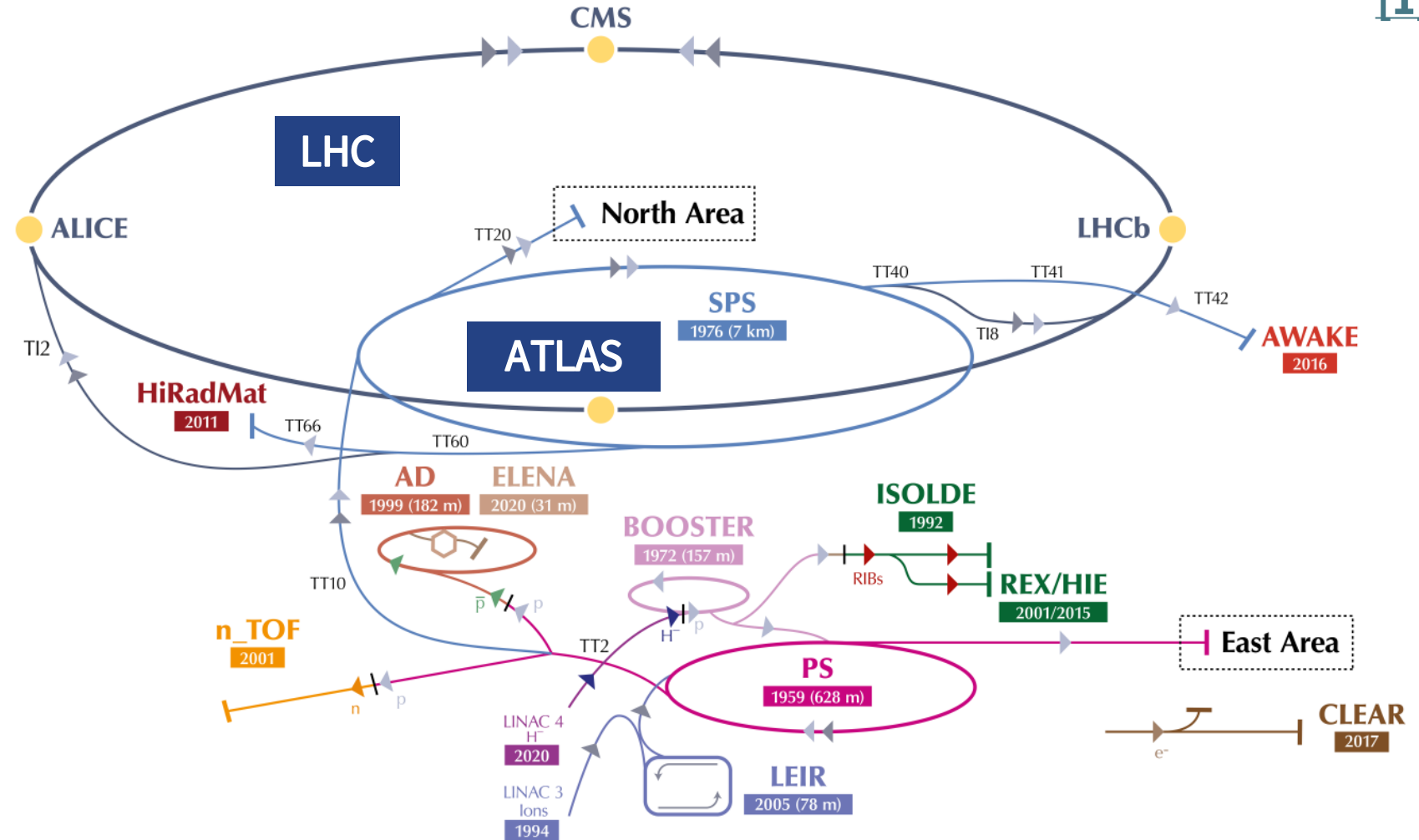
OUTLINE

- I. **Background information** about CERN
 - Large Hadron Collider (LHC)
 - ATLAS Detector
 - Liquid Argon (LAr) Calorimeter Readout
- II. **Purpose** of the analysis tool
- III. **Structure** of the analysis tool
- IV. **Outputs** from the analysis tool
- V. Summary

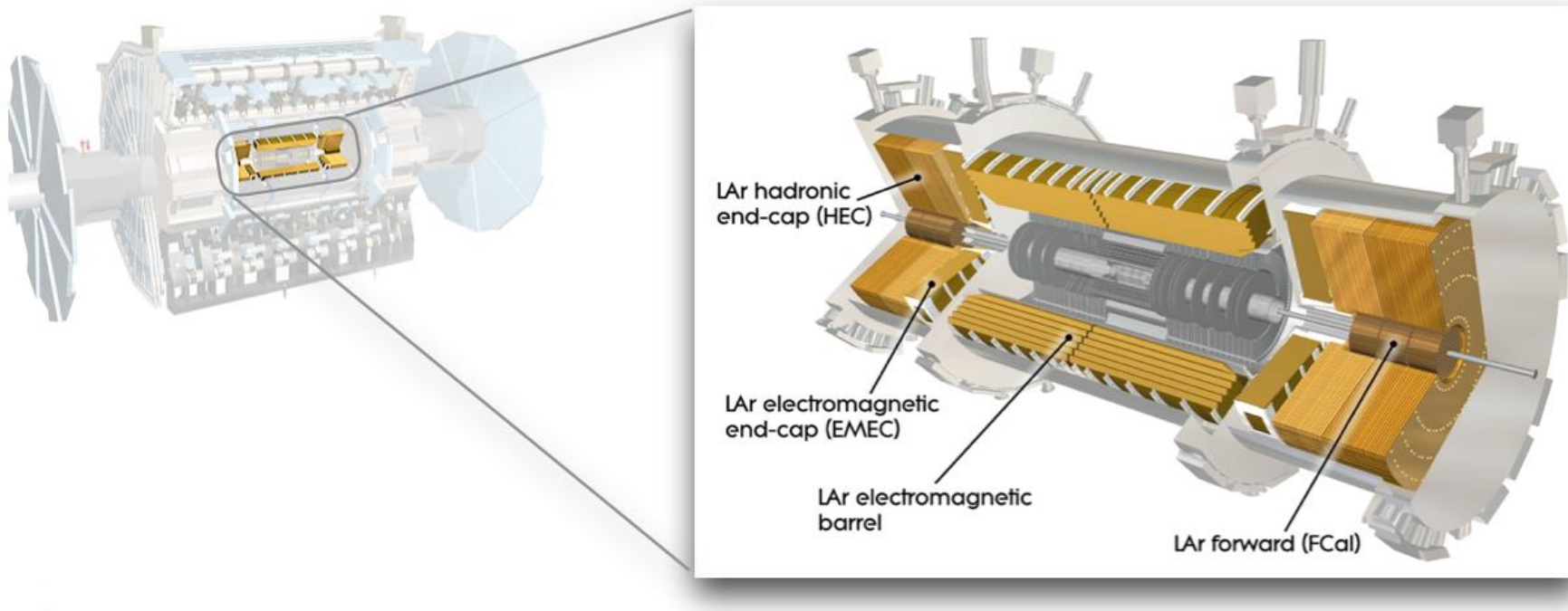
LARGE HADRON COLLIDER (LHC)

[1]

- **Purpose:** proton-proton collisions, chain of accelerators boosting particle energy in stages
- **ATLAS:** General-purpose detector, Higgs boson studies & beyond the standard model searches
- **High-Luminosity LHC:** Extends discovery potential by increasing the number of collisions per seconds



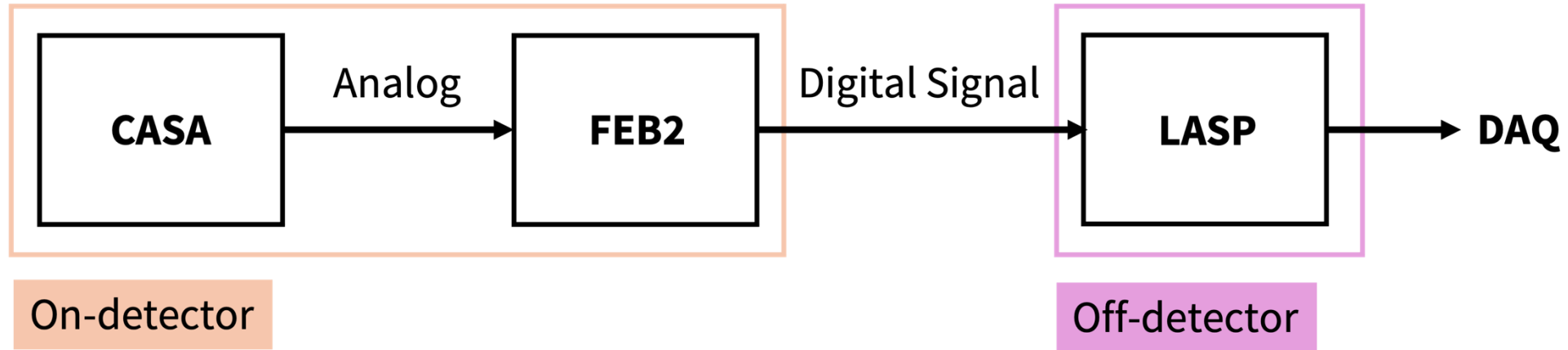
LIQUID ARGON (LAR) CALORIMETER



[2]

- Sampling calorimeter measuring the energy of **electrons, photons** and **hadrons**.
- Number of cell readout channels : 182,468
- **ATLAS Liquid Argon calorimeter Phase-II upgrade project:** New readout electronics system tolerating increased radiation and compatible with the trigger system.

LAR CALORIMETER READOUT ARCHITECTURE (SIMPLIFIED)



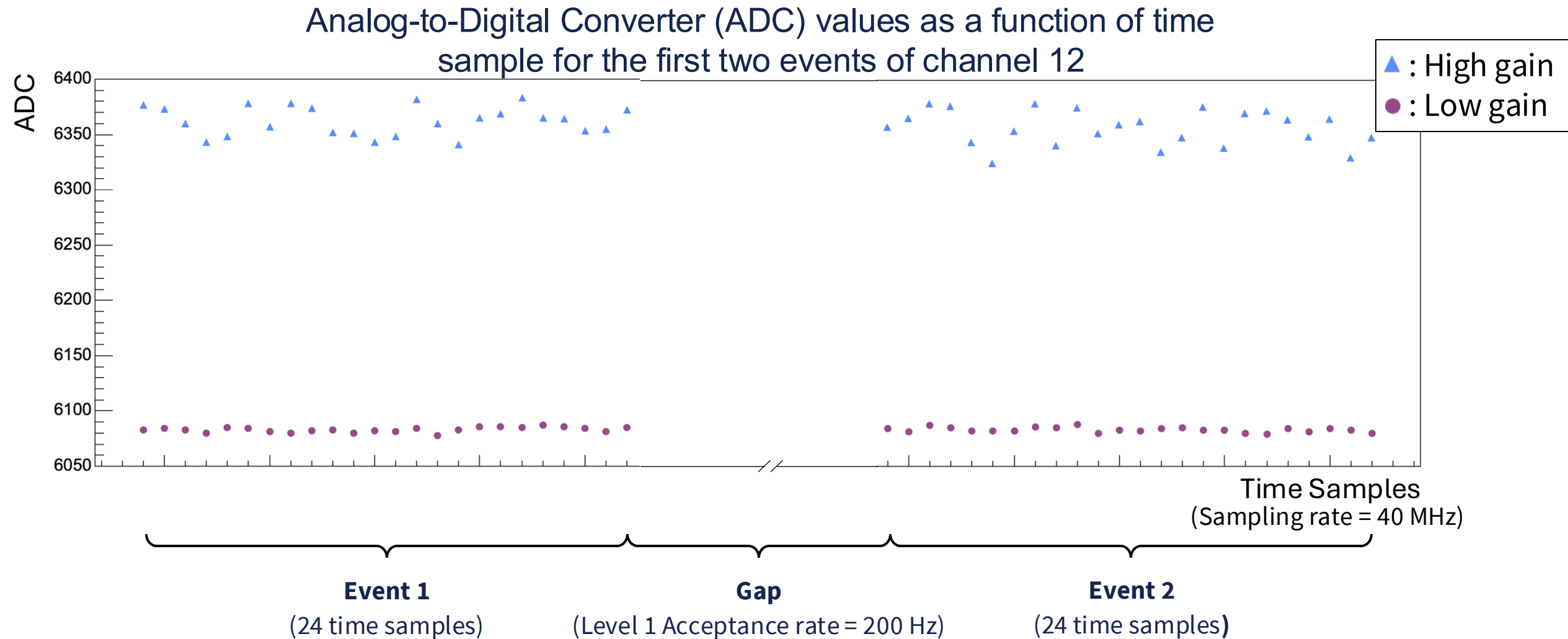
Front-end electronics

- Calibration board (CASA):
Injects detector-like signals
- Front-end boards (FEB2):
Amplify and shape analog pulses, apply dual gain, digitize and serialize the signals.

Off-detector electronics

- LAr Signal Processor Boards (LASP):
Perform signal processing, energy reconstruction and buffering.
- Data Acquisition (DAQ):
Results are sent to the data acquisition system.

STRUCTURE OF THE TEST DATA



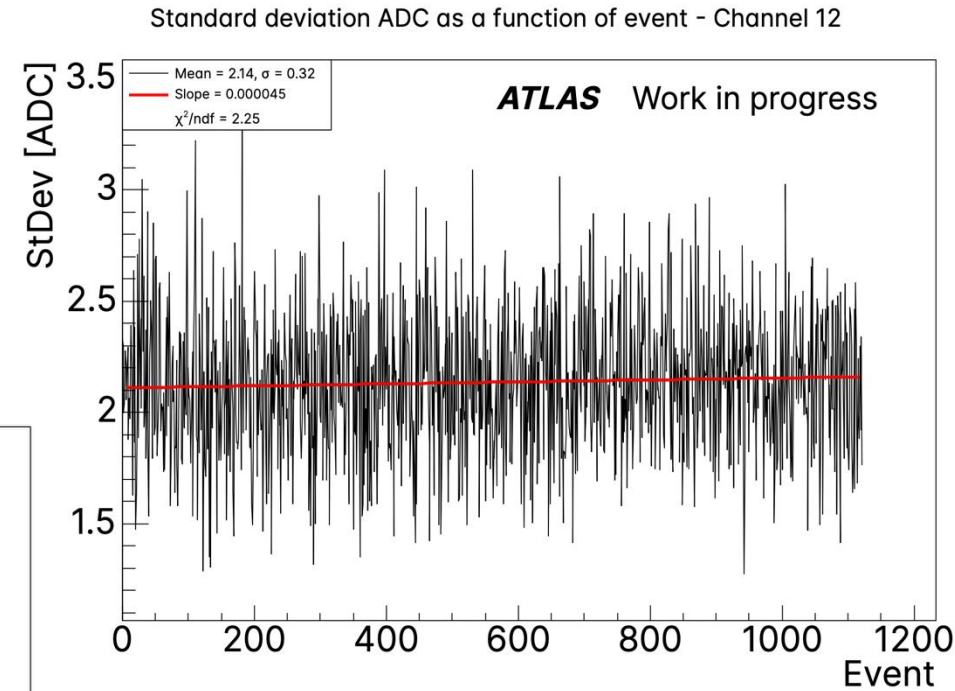
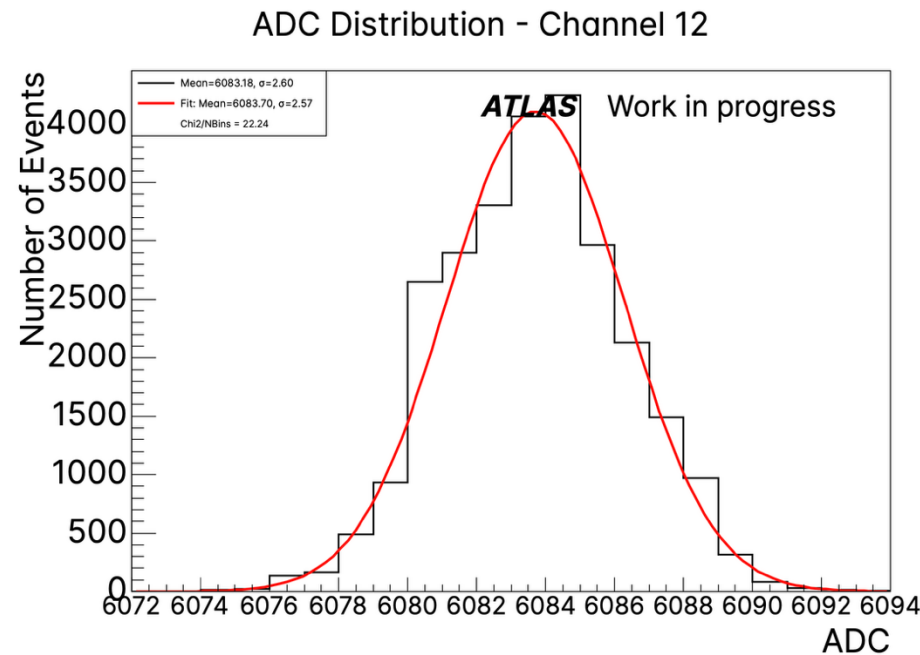
PURPOSE OF THE ANALYSIS TOOL

Analysis of the data coming from the new readout system:

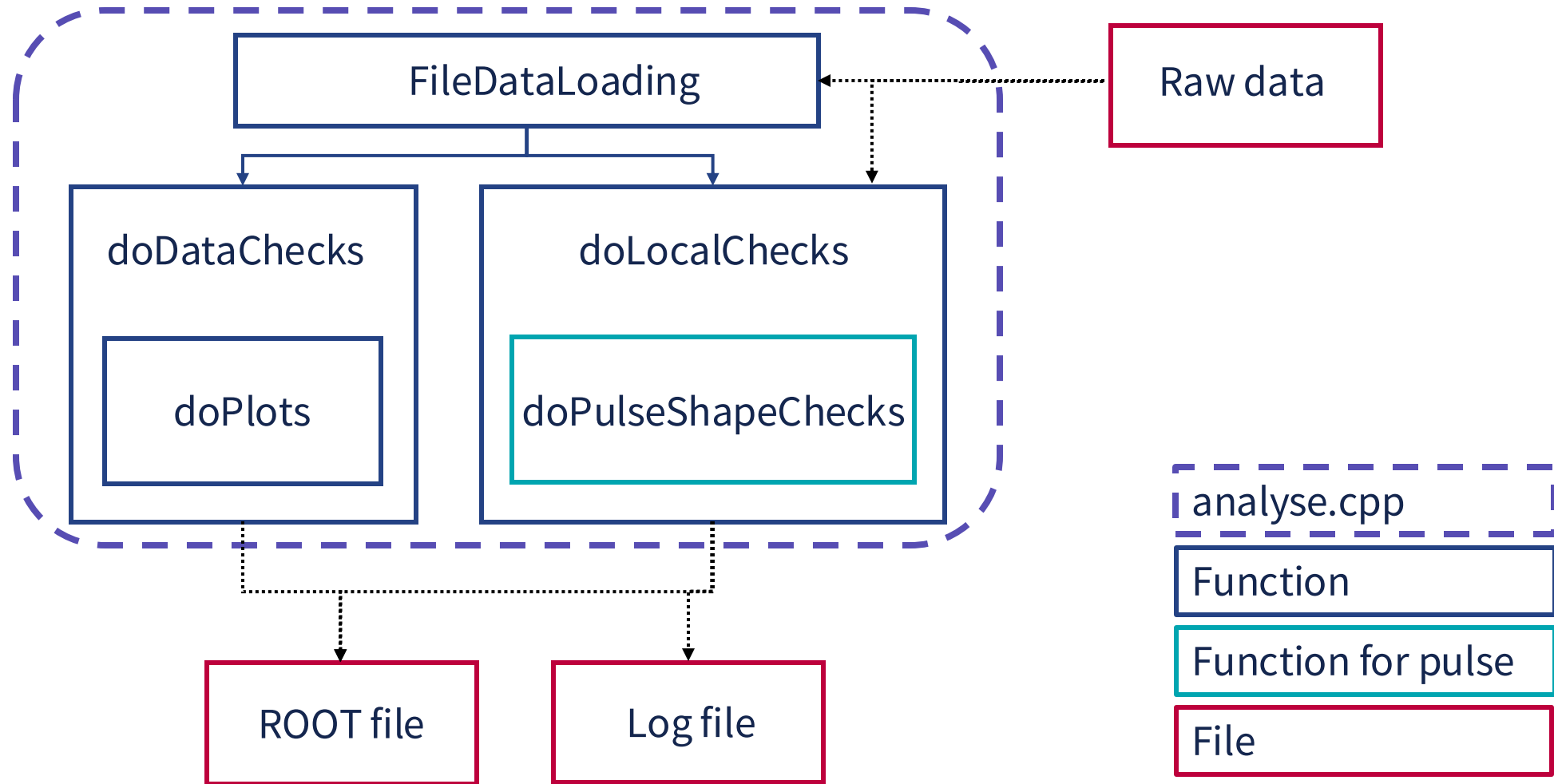
- **Pedestal runs:** no injected signals
- **RAMP and Delay runs:** injected calibrated pulses

Detection of **unexpected behaviours** by investigating:

- Mean
- Standard deviation
- Amplitude
- etc.

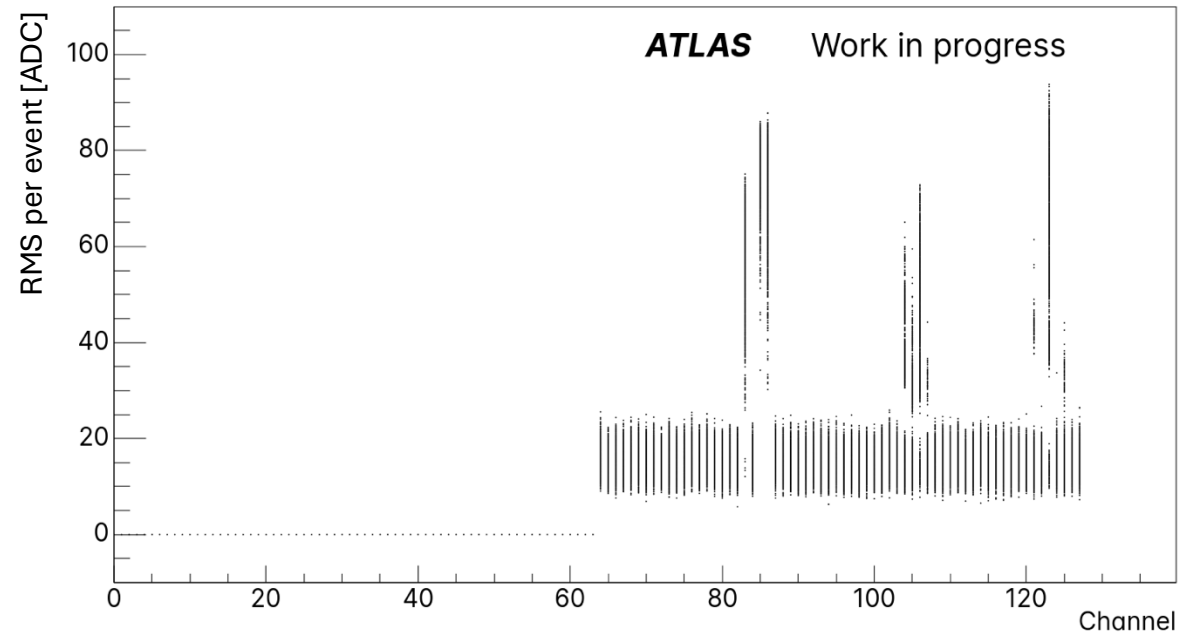


FUNCTIONAL STRUCTURE OF THE ANALYSIS TOOL

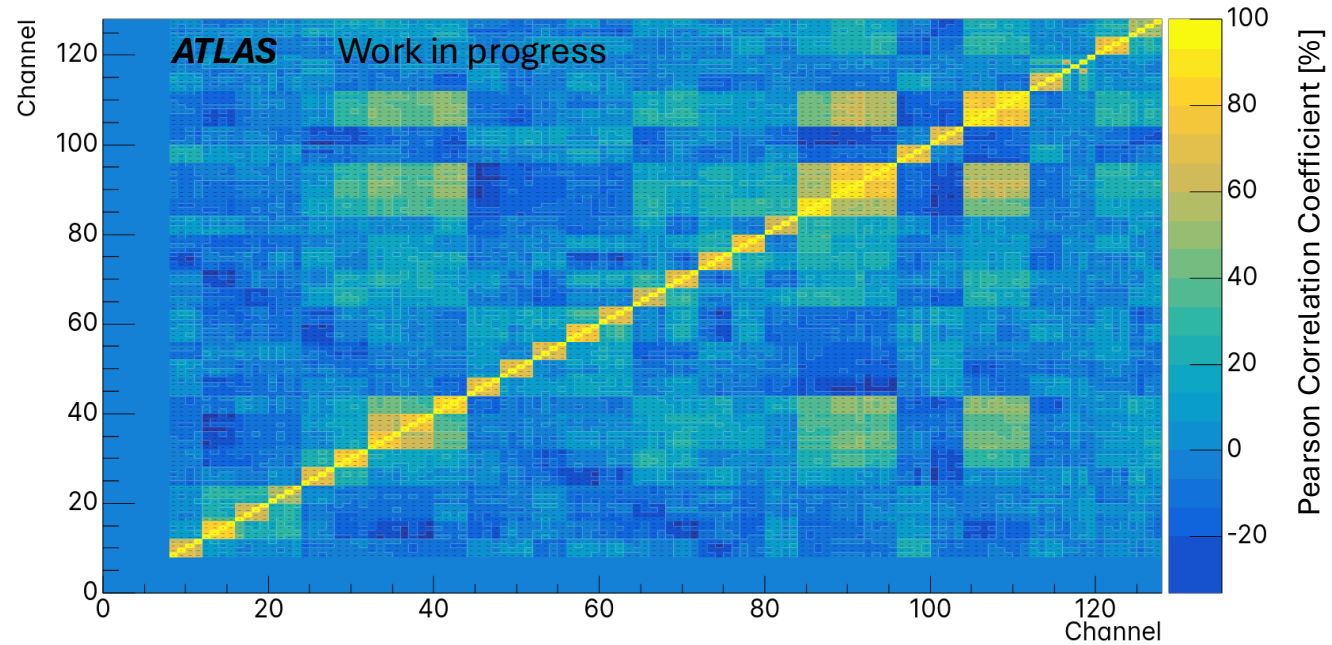


SUMMARY PLOTS

RMS per event as a function of channels



Pearson Correlation Coefficient of the mean ADC between channels

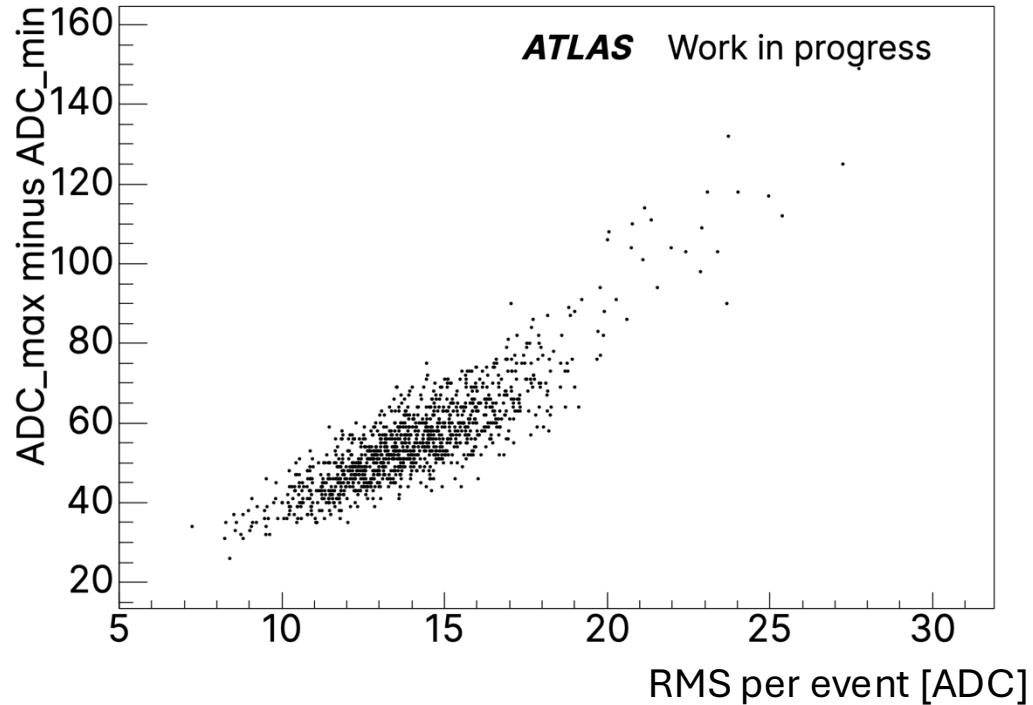


Representative plots offering a global overview of the data:

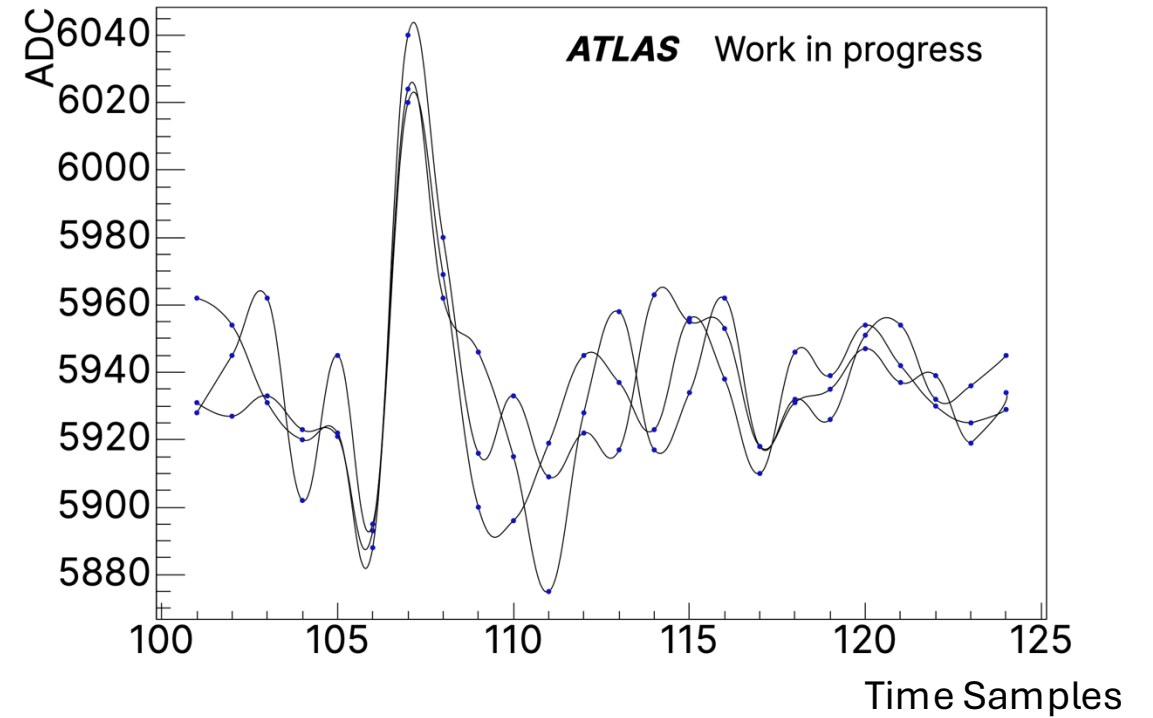
- RMS per Event vs. Channel: Highlights event-wise anomalies across channels.
- Pearson Correlation Coefficient of Mean ADC: Reveals linear correlation between channels that could be due to electronics cross-talk.

CHANNEL-SPECIFIC PLOTS

ADC Range as a function of RMS – Channel 121



ADC as a function of time samples – Channel 121



Illustrative plots generated for individual channels:

- Δ ADC vs. RMS: Shows how ADC range varies with RMS, revealing fluctuations and potential signal anomalies.
- ADC vs. time sample (Anomalous Events): Visualizes time-domain behavior for events exhibiting irregularities.

Summary

- Development of new electronics readout for the ATLAS Liquid Argon calorimeter in preparation for High-Luminosity LHC.
- Development of tools to facilitate the detection and visualization of anomalies in data recorded by a readout test system at CERN.

Outlook

- Development of a website to display results, and integration of automated analysis execution.



REFERENCES

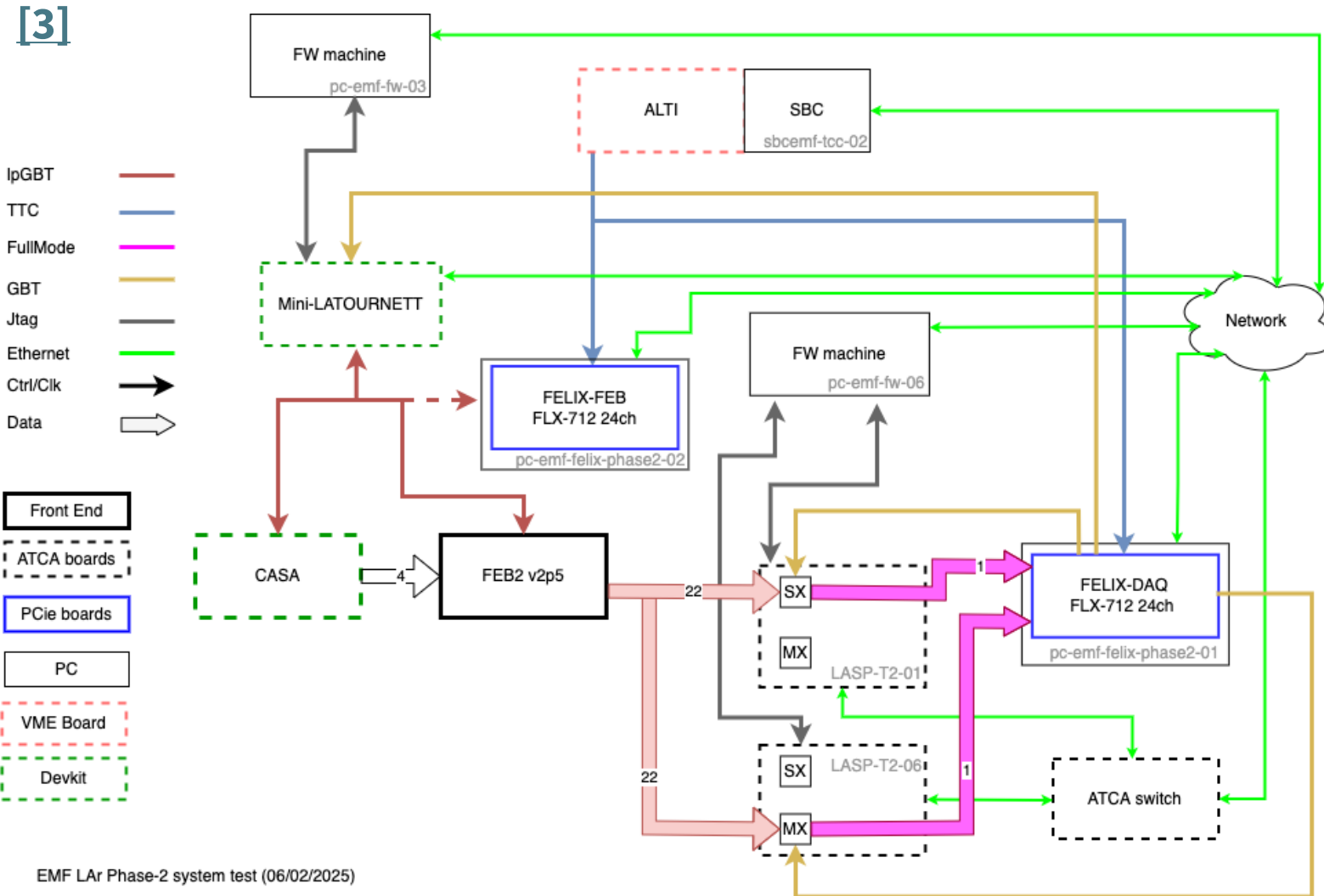
- [1] Mobs, E. (2019). *The CERN accelerator complex in 2019*. CERN. <https://cds.cern.ch/record/2684277>

- [2] Pequenaio, J. (2008). *Computer generated image of the ATLAS Liquid Argon*. CERN. <https://cds.cern.ch/record/1095928>

- [3] EMF. (2025). *LAr Phase-II system test setup and interconnections*. LAr HL-LHC integration & operation documentation. <https://atlas-lar-hl-lhc.docs.cern.ch/Doc-EMF-setup.html>

BACKUP SLIDES

LAR CALORIMETER READOUT ARCHITECTURE (PHASE-II UPGRADE)



Front-end electronics

- Front-end boards (FEB2):
Amplify and shape analog pulses, apply dual gain, digitize, and serialize the signals.
- CASA (calibration board):
Injects calibrated signals for both amplitude and timing.

Off-detector electronics

- LAr Signal Processor Boards (LASP):
Perform signal processing, buffering, synchronization, and BCID alignment before sending data to the DAQ.
- ALT1 (Atlas Local Trigger Interface):
Generate a common clock for the system
- Mini-LATOURNETT (Lar Timing System):
Configures the FEB2 and CASA boards.

WEBSITE ON DEVELOPMENT

Platform for visualizing analysis results:
<https://emf-data-analysis.web.cern.ch>

EMF Data Analysis

Welcome to the EMF Data Analysis platform! As new components for the LAr calorimeter readout system undergo testing, an analysis tool has been developed to interpret the data and identify any unexpected behavior. This website provides a visual interface to explore the results of these analyses.

For more information on the analysis tool, see the GitLab repository: [Data Readout for FELIX](#).

Analysed Files

Select a file

Analysis Results for the file: *output-test-LTI-multiphases-2-HG-hct22l-2025-06-24_histo.root*

Summary of the anomalies

Doing tests for FebId = 26, gain = 0 and measurement = 0

The number of events is: 1139

FebChannel 0: 100% iEvents with zero RMS

FebChannel 1: 100% iEvents with zero RMS

Select FEB ID: 26

Select Measurement: 0

Submit

Summary Plots

Mean ADC Stdev ADC Mean Range ADC PCC Mean PCC Stdev RMS per Events

Average over all events of the difference between the maximum and minimum ADC as a function of channel.

Low Gain:

High Gain:

Average ADC range as a function of channel

Average ADC range as a function of channel

Channel-Specific Plots

Channel (0-127): 12

Submit

ADC Distribution Mean ADC Stdev ADC ADC Range vs. RMS ADC Signal

Displayed below histograms illustrating the distribution of ADC values across recorded events.

Low Gain:

High Gain:

