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

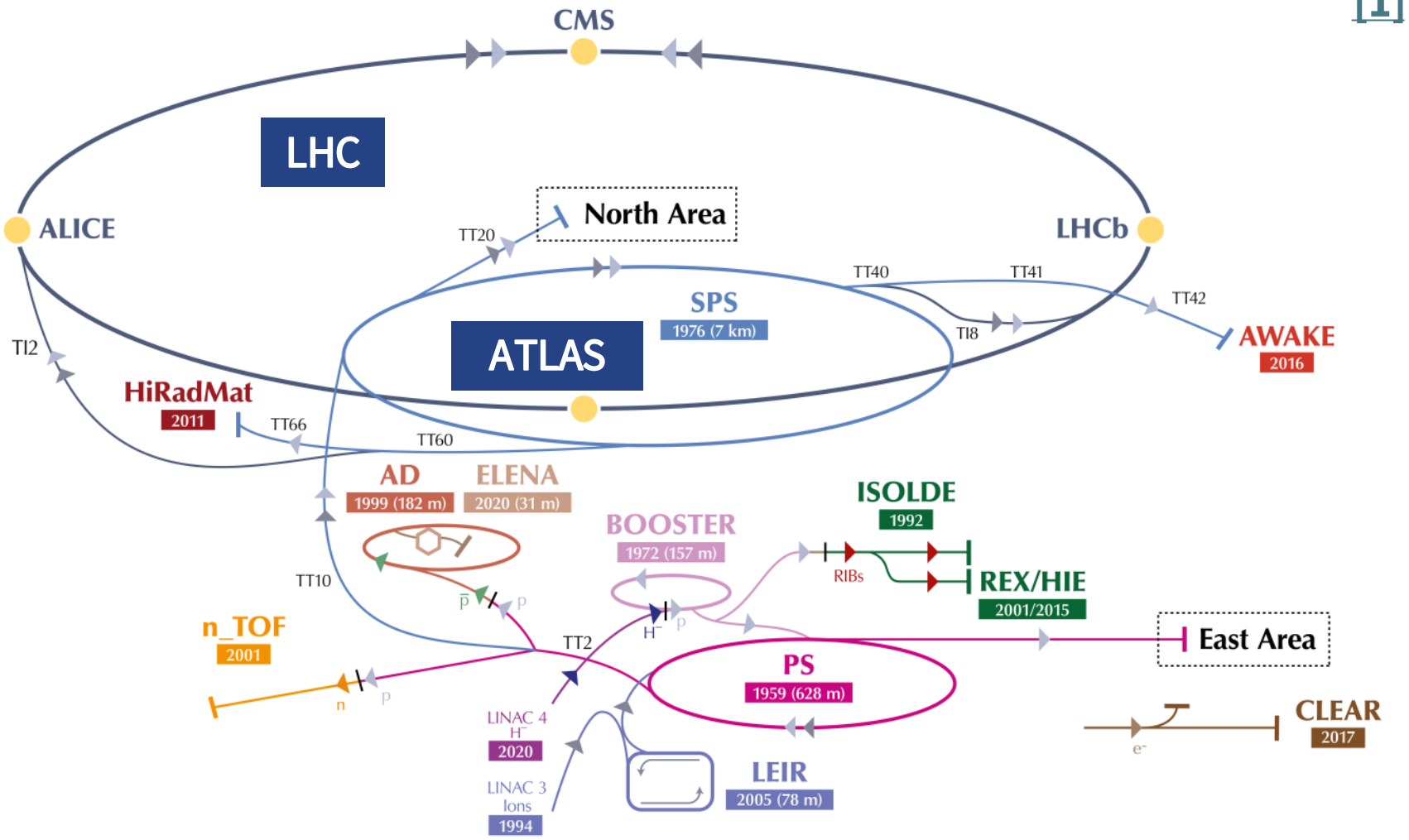
LARGE HADRON COLLIDER (LHC)

- **Purpose:** proton-proton collisions, chain of accelerators boosting particle energy in stages

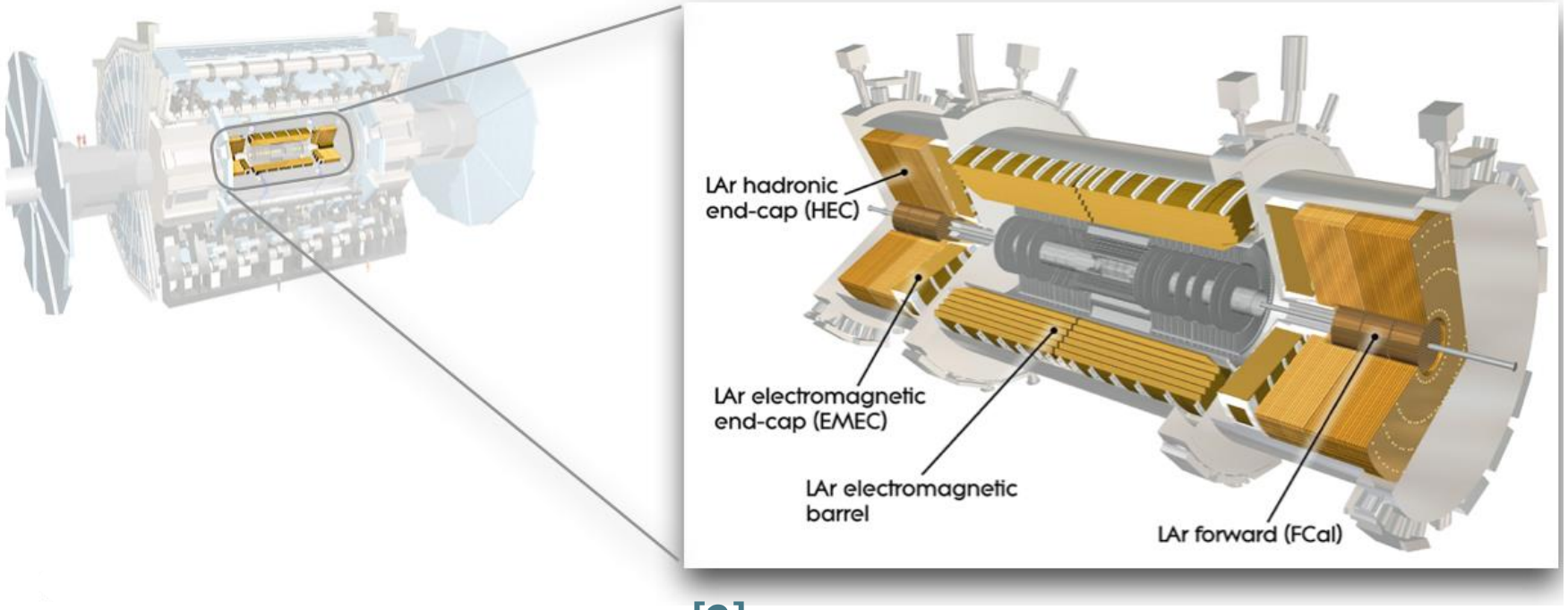
- **ATLAS**: General-purpose detector, Higgs boson studies & beyond the standard model searches

- **High-Luminosity LHC**: Extends discovery potential by increasing the number of collisions per seconds

[1]



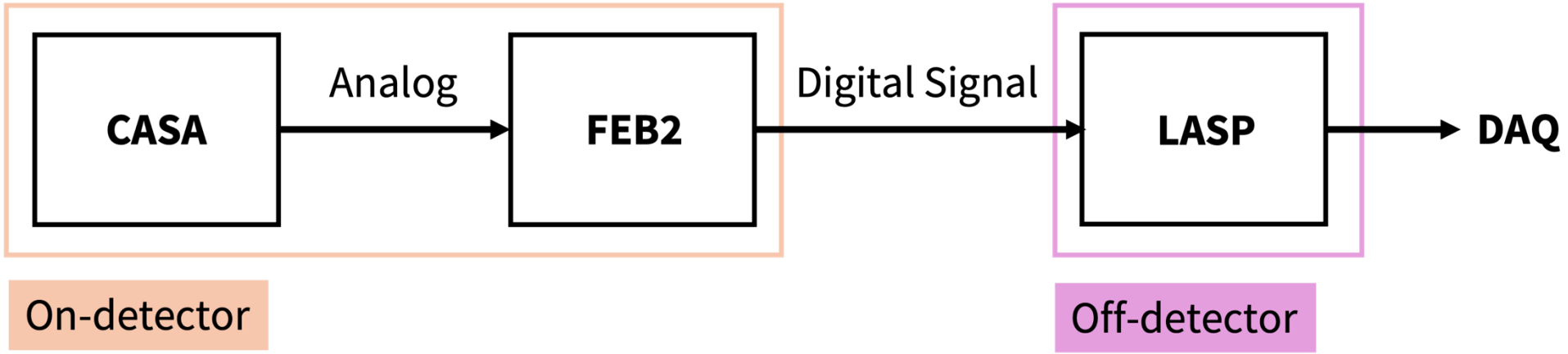
LIQUID ARGON (LAR) CALORIMETER



[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)



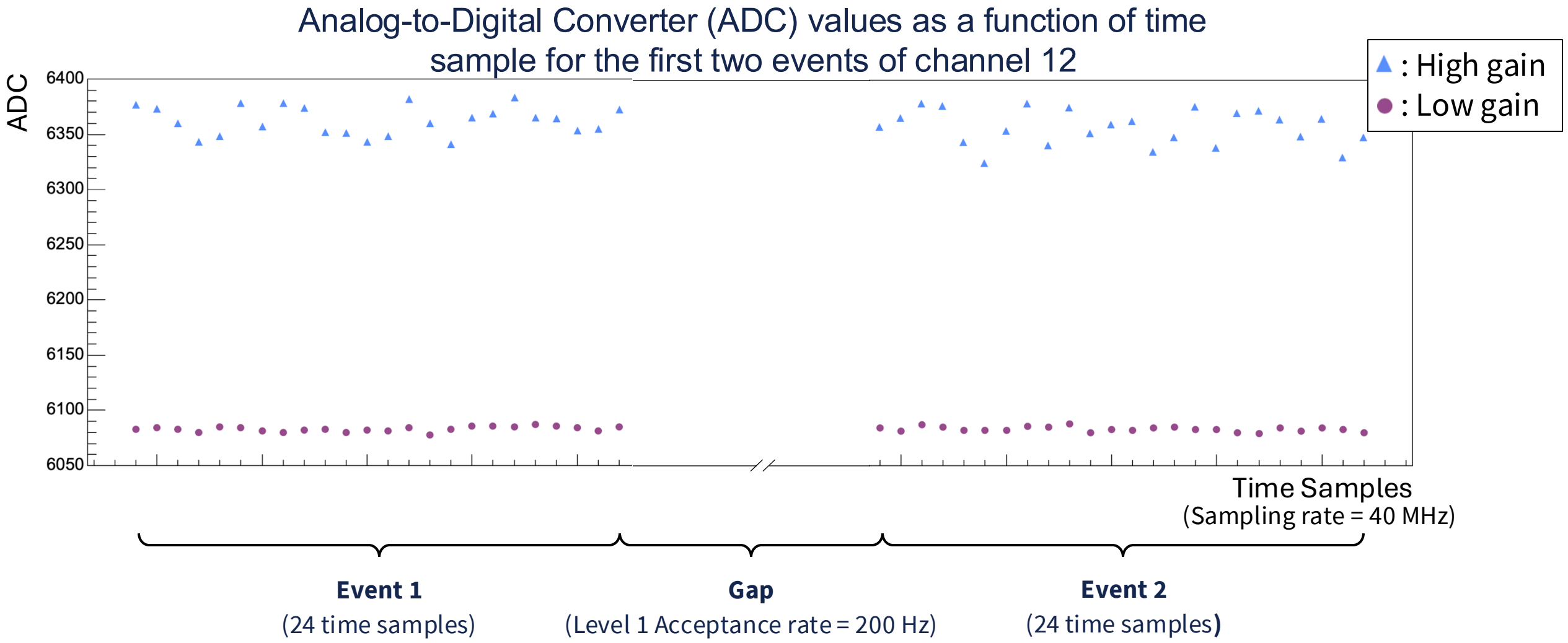
Front-end electronics

- 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



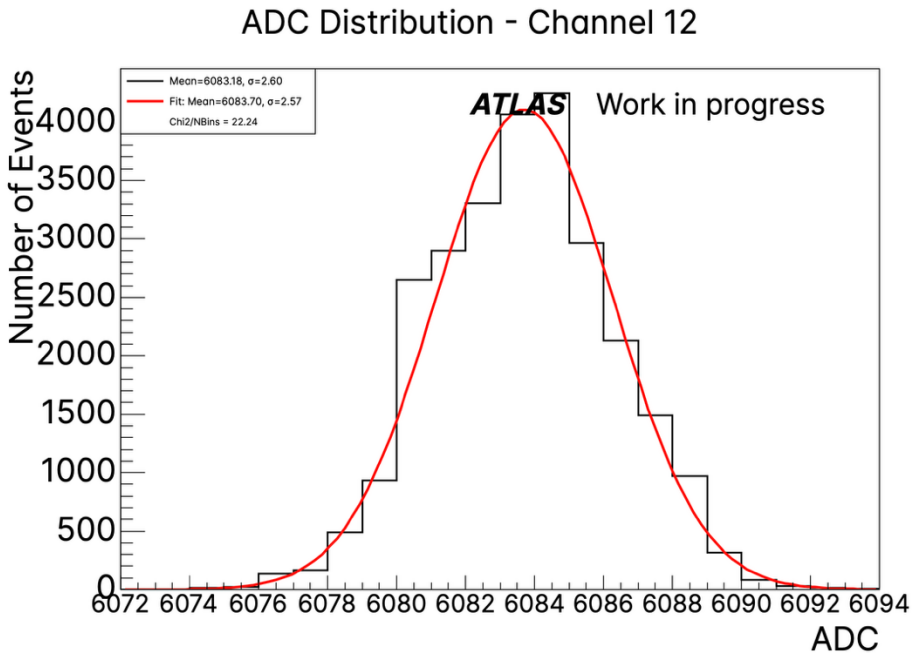
PURPOSE OF THE ANALYSIS TOOL

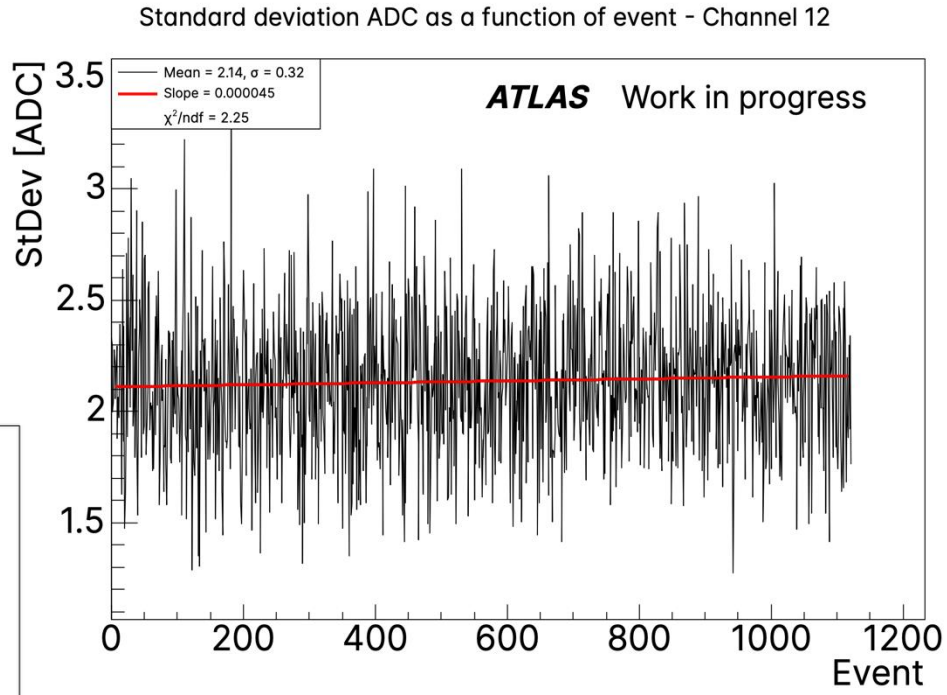
Analysis of the data coming from the new readout system:

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

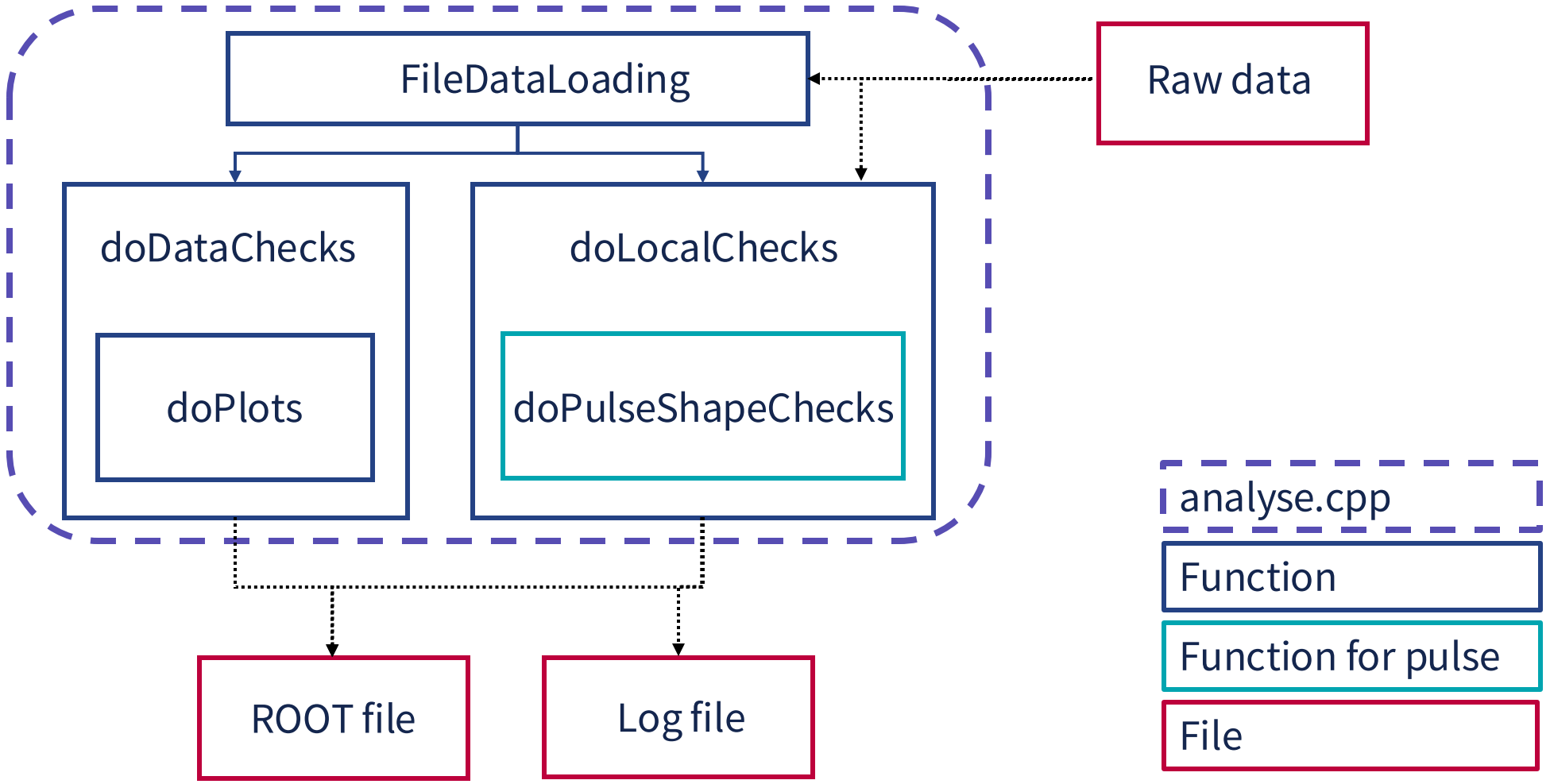
Detection of **unexpected behaviours** by investigating:

- Mean
- Standard deviation
- Amplitude
- etc.



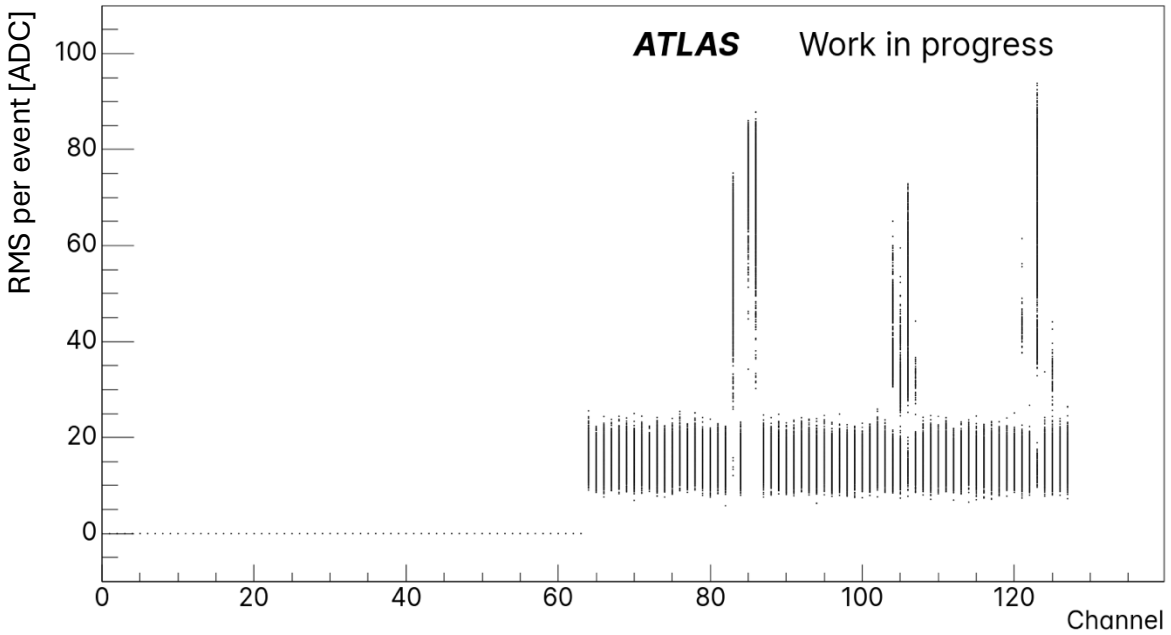


FUNCTIONAL STRUCTURE OF THE ANALYSIS TOOL

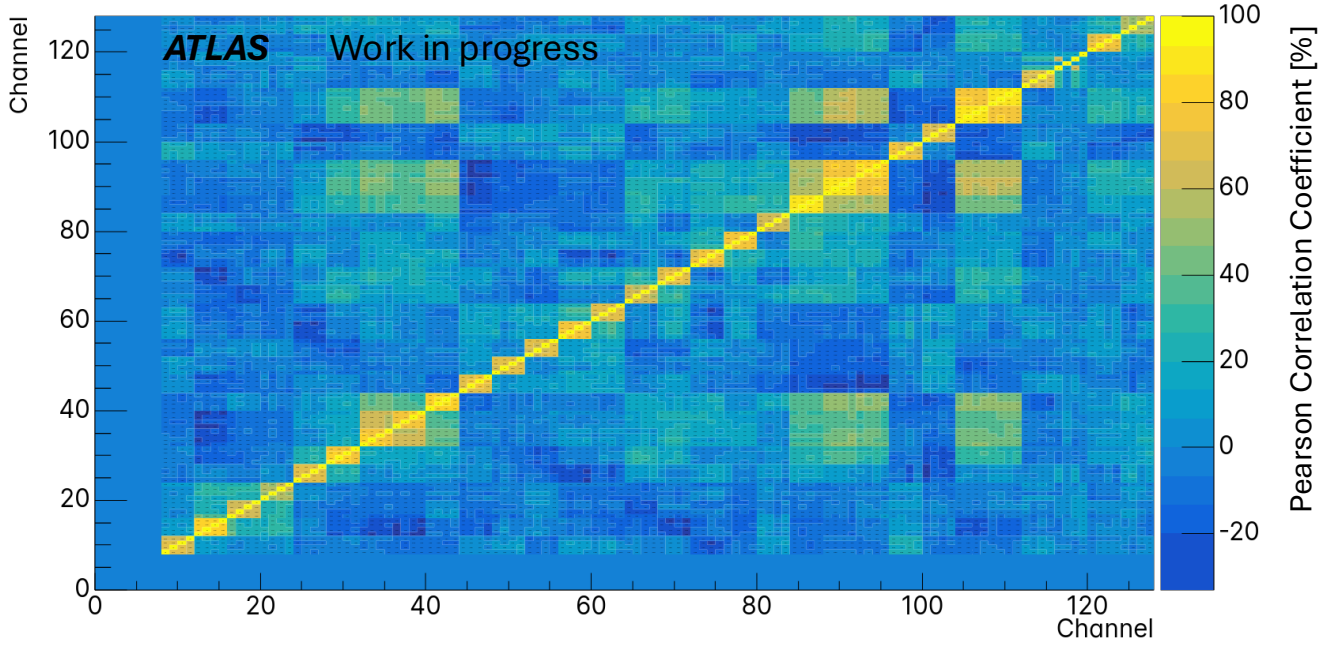


SUMMARY PLOTS

RMS per event as a function of channels



Pearson Correlation Coefficient of the mean ADC between channels

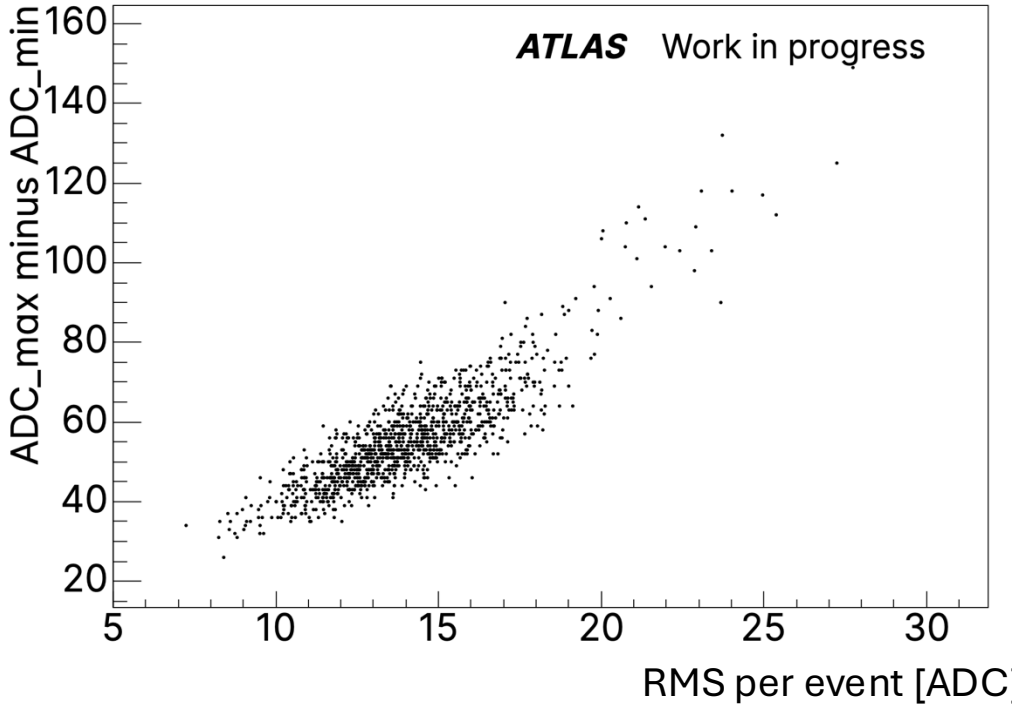


Representative plots offering a global overview of the data:

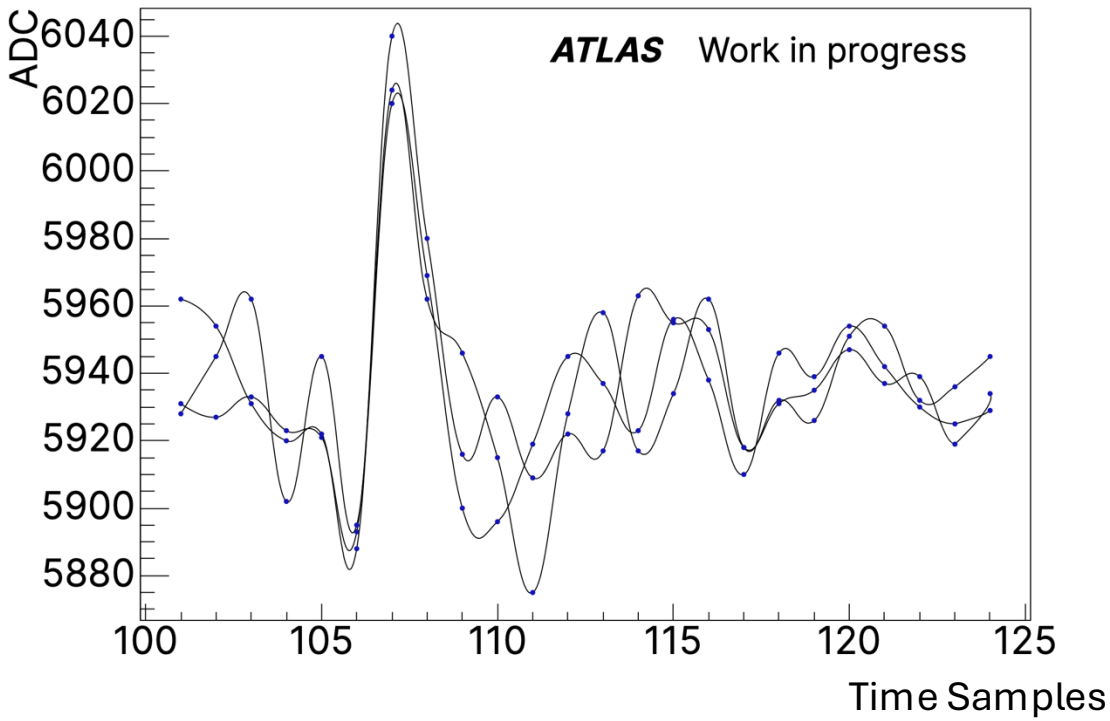
- RMS per Event vs. Channel: Highlights event-wise anomalies across channels.
- Pearson Correlation Coefficient of Mean ADC: Reveals linear correlation between channels that could be due to electronics cross-talk.

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:

- ΔADC 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

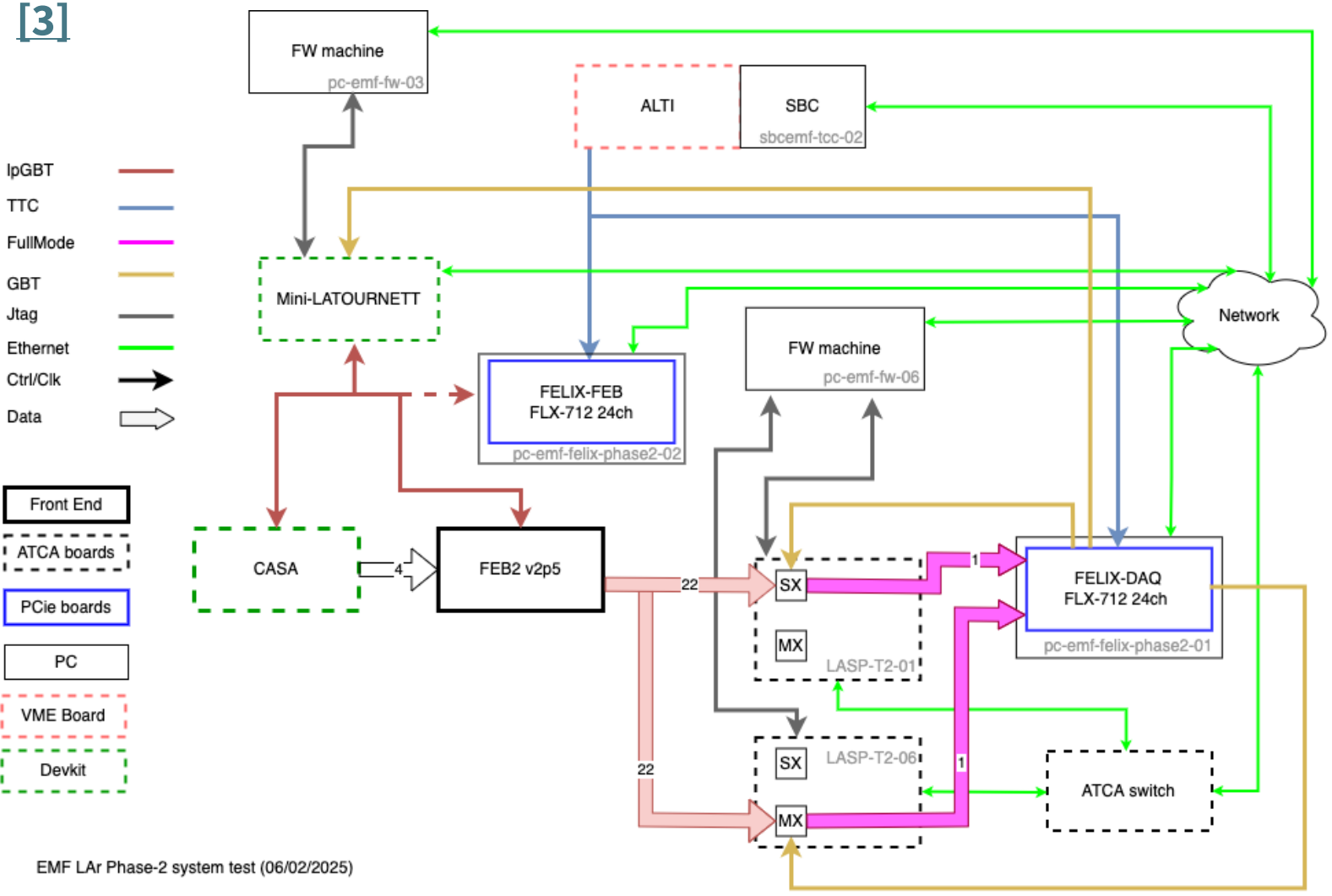
[2] Pequenao, J. (2008). *Computer generated image of the ATLAS Liquid Argon*. CERN. https://cds.cern.ch/record/1095928

[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)

[3]



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.
- ALTI (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