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Summary

- Introduction
- Framework presentation
- Experiments running with DQM4HEP
- EUDAQ / DQM4HEP interface
- Current status
- Ongoing and future work
DQM systems in HEP domain:

- Evaluate data quality and alert users of anomalies
  - Are the distribution what we expect?
  - Comparison between runs or old/new software version
  - Quick feedback from hundred of plots is challenging

- Provide online and offline analysis
  - Automated data quality tests, possibly with reference histograms
  - Distributed system for online analysis (data collectors)
  - Dedicated visualization interface (Qt, Web)

- Already developed for most of HEP experiments (i.e AMORE or CMSSW)

But ... Based on experiment specific event format

- Not re-usable by other experiments
- Duplicated software
- Ad-hoc solution for test-beam setup monitoring

Development of a generic DQM software for any HEP experiment: **DQM4HEP**
DQM4HEP
Software overview

Key points :

• Standalone plugin system
  ▪ Plugin = C++ class in a shared library
  ▪ Load shared library at runtime and hook plugin class

• **Generic event data model/format.** User needs to define :
  ▪ Event model
  ▪ Conversion Model ↔ Binary

More general features :

• Online analysis (API)
• Distributed system (TCP/IP)
• Data collectors : event and histogram collector servers
• Quality test tools : interface + quality test templates
• Visualization interface (histograms and quality tests)
Monitor element

- Wrap a ROOT TObject
- Optionally hold a ROOT TObject as reference

Quality test

- Implement the logic to test a monitor element
- Output a quality report (quality flag, success, etc)

One monitor element can be tested with many QTests, e.g:

- Kolmogorov test using a reference histogram
- Mean of histogram within an expected value

One QTest can be attached to many monitor elements, e.g:

- Test different histograms with the same gaussian distribution
DQM4HEP
Online architecture
Analysis module

- **Receive and process event (e.g from DAQ)**
- Book and fill histograms
- Process quality tests
- Send histogram and QReports to collectors with cycle structure
  - Every N events/seconds
  - User can reset histogram if needed at end of cycle

Standalone module

- **Receive and process data from external source (e.g slow control)**
- Book and fill histograms
- Process quality tests
- Send histogram and QReports to collectors every N seconds
Start/stop/manage many processes on many hosts
DQM4HEP
Online monitoring interface (Qt Gui)

- Histograms organized in tree structure
- Plot many histograms at the same time
- Receive real time updates
- Browse histograms on collectors
- Histograms organized in tree structure
- Plot many histograms at the same time
- Receive real time updates
- Browse histograms on collectors
DQM4HEP used by different detectors in the CALICE collaboration.

SDHCAL online monitoring
- Hit maps
- Electronics rate
- Slow control: I, HV, LW, T, P
- GRPC efficiency, multiplicity

AHCAL online monitoring
- Hit maps
- Correlation with Telescope hits
- Electronics rate
DQM4HEP adopted as monitoring framework by AIDA2020 WP5:

**Task 5.4 Development of data quality and slow control monitoring**

Binding between the EUDAQ framework and DQM4HEP is ongoing.
ILD collaboration entering in a new MC production process.

Need for automatic data quality checks for simulated/reconstructed quantities.

Ongoing work to separate the main package (DQMCore) into two different software packages:

**dqm4hep-core**
- MonitorElement (ROOT)
- Quality test
- Event interface
- Streaming (xdrstream)
- Plugin management
- DB tools (MySQL)
- Logging (spdlog)

**dqm4hep-online**
- Modules (User classes, Online API)
- Event collector (server and client)
- Monitor element collector (server and client)
- Run control (server, client and external interface)
Current effort to provide an important set of quality test templates in core library

Users can also implement their own quality test(s)

- **Kolmogorov test (hist + ref)**
  - Mean within range
  - Mean 90 within range
  - No data after limit
  - No data before limit

- **Fit function and check $\chi^2$**
  - Likelihood fit
  - Fraction of data after limit exceed
  - Fraction of data before limit exceed
  - RMS lower than
  - RMS 90 lower than

- **RMS greater than**
  - RMS 90 greater than
  - Mean lower than
  - Mean 90 lower than
  - Mean greater than
  - Mean 90 greater than
  - RMS within range
  - RMS 90 within range

- **Fit function and check parameters within range**
  - Distance between two values

Incoming work: possibility to test any object in ROOT files using these quality tests
Conclusion

• Development of a new generic framework for data quality monitoring
• Used during test-beam by different detectors and combination of sub-detectors
• Current implementation works for online setup

Perspectives

• Refactoring of the framework to make it working for offline data quality monitoring
• Development of a EUDAQ binding for online data taking
• Development of quality test templates
GitHub collaboration

GitHub repository

- [https://github.com/dqm4hep](https://github.com/dqm4hep)

Installation package (v04-03-00)

- [https://github.com/dqm4hep/dqm4hep](https://github.com/dqm4hep/dqm4hep)

Slack channel (Announcements, issues, management)

- [https://dqm4hep.slack.com](https://dqm4hep.slack.com)

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