DQM4HEP : a generic data quality monitoring framework for HEP

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DQM4HEP
A data quality monitoring framework.

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DESY
January 17, 2018
Summary

- Introduction
- Framework presentation
- Experiments running with DQM4HEP
- Current status
- Ongoing and future work
DQM systems in a nutshell

DQM systems in HEP domain:

- Automated data quality assessment
- Alert users when anomalies are observed
- Provide for online/offline analysis
  - Automatic data quality tests, possibly with reference histograms
  - Distributed system for online analysis (data collectors)
  - Dedicated visualization interfaces for shifters
- Must be scalable: from prototypes to collider-like detectors

General goal of using a DQM framework in testbeams:

- Having a better understanding of your DUT
- Understand your setup and run settings
- Avoid starting bad runs
- Discard bad/unexpected data
DQM systems for testbeams

Typical use cases:

• Environmental/slow control monitoring
  - Gas flow
  - Current/HV
  - Temperature
  - Pressure
  - B field
  → Avoid to start bad runs, discard bad runs

• Hit maps (e.g calorimeters or trackers)
  - Detect inefficient areas
  → Discard bad data, understand your DUT

• Beam structure analysis
  - Check particle properties: type, momentum/energy ...
  → Avoid starting bad runs

• Combine telescope + DUT
  - Run tracking algorithm, quickly detect mis-alignment
  → Understand your setup, discard unexpected data

Problem:

- One experiment = one EDM = one framework !
- Detector algorithm (DA) not re-usable by other experiments
- Leads to duplicated software and efforts
- EDM dependency: custom prototype EDM make use of these framework complicated
  → Each new prototype comes with its ad-hoc solution

Need for a more generic framework
DQM systems for testbeams

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Need for a more generic framework
Philosophy:

- Encapsulate changes in (abstract) interfaces
  - No EDM, just a handler for your data
  - Data streaming: how should we read/write your data

- Make user code *plugable*
  - Plugins in shared library: plug and play
  - Make the framework easily extensible

Features:

- Core:
  - Streaming tools for reading/writing event
  - Quality test tools: interface + many templates

- Online:
  - Online analysis plugin (API)
  - Distributed system (TCP/IP)
  - Data collectors: event and histogram collector servers
  - Remote process management
Monitor element

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

Quality test

- Implement the logic for monitor element testing
- Output a quality report (quality flag, success, etc)
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Concrete example:

- π⁺ beam in a calorimeter
- Plot the total energy distribution.
- Assess quality:
  - Fit distribution with gaussian function
  - Extract $\chi^2$ and mean value
  - Check for any deviation

![Reconstructed energy](Normal run)

![Reconstructed energy](Beam conversion)
DQM4HEP
Online architecture
User DQM Standalone Module

DQM Module API

Query operation
Perform operation
Return request result
Notify user module
User defined input data

Alert system
Monitor Element sender

Send alert
Send monitor elements

Return request result
Archiver
Quality tests
Monitor elements

DQM Standalone Module Application
DQM4HEP
Online monitoring interface (Qt Gui)
DQM4HEP used by different detectors in the CALICE collaboration.

SDHCal online monitoring

- Hit map
- Electronics rate
- Slow control : I, HV, LW, T, P
- GRPC efficiency, multiplicity

AHCal online monitoring

- Hit map
- Correlation with Telescope hits
- Electronics rate
DQM4HEP developed within AIDA2020 WP5 (see MS67):

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

EUDAQ also developed within AIDA2020 WP5 as the DAQ solution (see MS46).

Plan an integration in the EUDAQ event builder

- Replace current EUDAQ monitoring
- Send event to DQM4HEP event collector before writing to disk

Once this is achieved, the two frameworks will provide a rather complete and robust suite for test beam data taking.

DESY slow control monitoring developed within AIDA2020 WP15.

Plan also to develop a DQM4HEP generic slow control module for the DESY test beam area, based on the SC software (see next talk by M. Wu).
Current available version is v01-04-04:

- Fully working version, used as proof of principle
- EUDAQ-DQM4HEP interface not feasible (run control)
- Module configuration (xml files) messy in case of a multiple host deployment
- No clear separation between online and offline tools
- No documentation available for users ...
DQM4HEP
Status - Ongoing work

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• Refactoring on-going:
  ▪ ✓ Separation of the framework into Core / Net / Online / Vis packages
  ▪ ✓ Make the classes more C++11 like and re-usable
  ▪ Necessary refactoring to allow for EUDAQ binding
    ▪ ✓ Run control re-implemented
  ▪ ✓ Core and Net packages have been fully re-implemented
  ▪ + Online package in development
  ▪ ✗ Vis package not yet re-implemented
Framework functionalities:

- ✓ Custom interface to any DAQ run control (SOR/EOR/Status)
- Quality assessment in offline mode:
  - ✓ Configure your quality tests in an xml file
  - ✓ Run them on a ROOT file and output results (✓ file ✓ console × db)
  - + Strong effort to develop built-in qtests for users (extensible)
- ✓ Database config: XML parser allows to fetch parameters from MySQL db
- + Javascript interface: visualization and steering through web pages
- Documentation
  - + User documentation (manual) written in parallel of ongoing development
  - ✓ Technical documentation (doxygen) generated/pushed online when a PR is merged
- ✓ Travis CI added for all packages
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More projects:

- Development of DESY slow control monitoring with DQM4HEP
  - Can run continuously and provide information to users at any time
- DESY beam line uses EUDAQ → DQM4HEP will comes for free on DESY beam line
- Looking for integration in other experiments ...
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Timescale for the new version: ~ June 2018!
GitHub collaboration (contributing, issues)
   💻 https://github.com/dqm4hep

Installation package (v01-04-04)
   💻 https://github.com/DQM4HEP/dqm4hep/releases/tag/v01-04-04

Slack channel (Announcements, forum, management)
   🟢 https://dqm4hep.slack.com

Documentation (ongoing, be patient !)
   📖 Read the docs: http://dqm4hep.readthedocs.io
   Doxygen: https://dqm4hep.github.io/dqm4hep-doxygen/

Contact us!
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