DQM4HEP : a generic data quality monitoring framework for HEP

Ete, R. (DESY) *et al*

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This work is part of AIDA-2020 Work Package **5: Data acquisition system for beam tests**.

DQM4HEP
A data quality monitoring framework.

BTTB6 2018 - Zurich

R. Ete, A. Pingault, T. Coates

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 assessement
- 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

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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

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Need for a more generic framework

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Data Quality Monitoring for High Energy Physics

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

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Quality test API

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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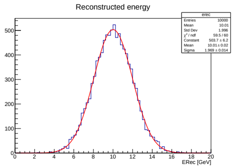
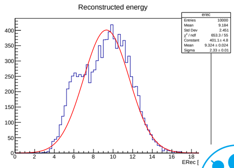
Concrete example:

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



Normal run



Beam conversion ?

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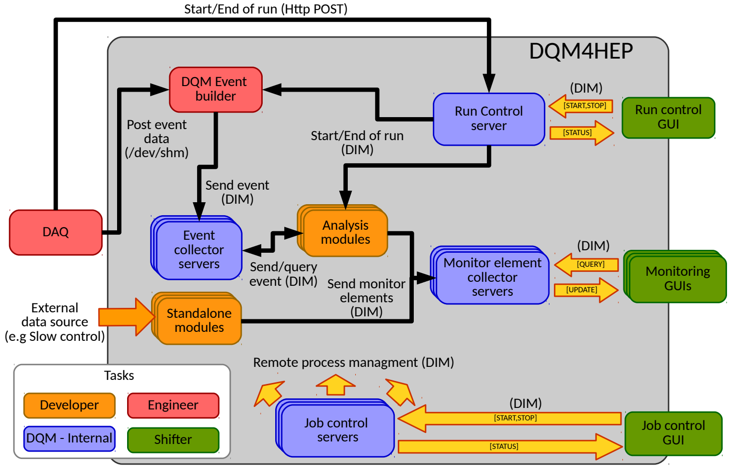
Online architecture



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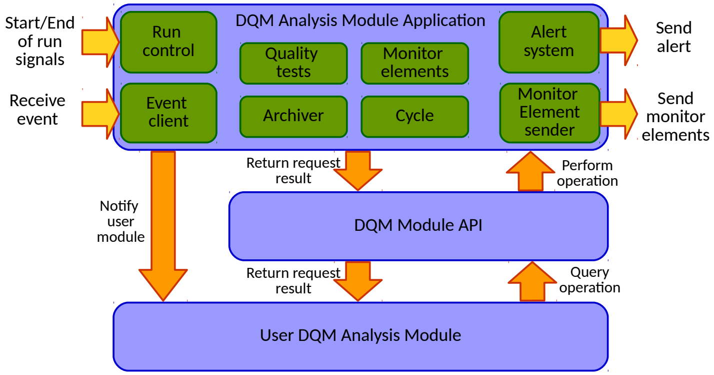
Data analysis module



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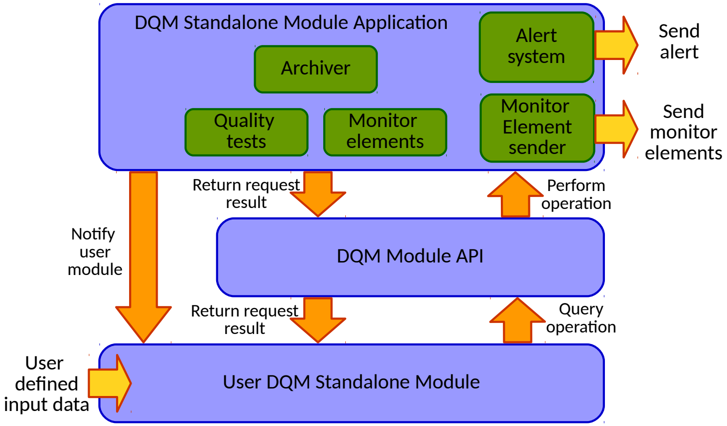
Slow control module



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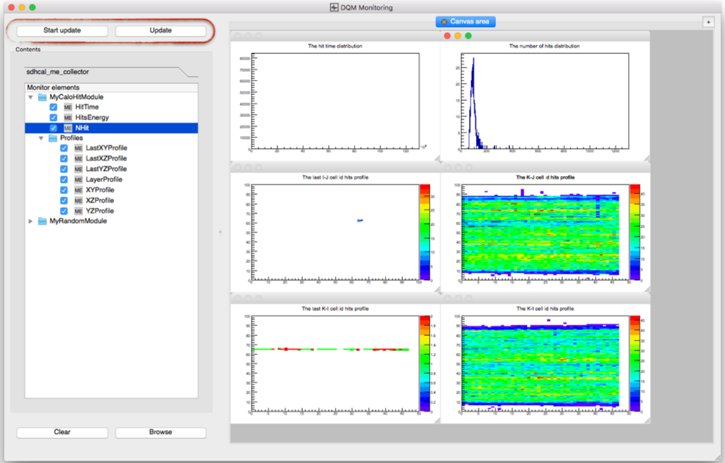
Online monitoring interface (Qt Gui)



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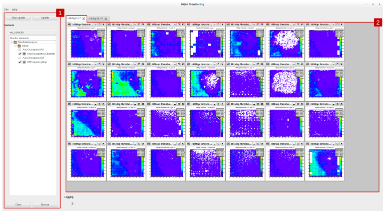
Detectors using DQM4HEP

DQM4HEP used by different detectors in the CALICE collaboration.

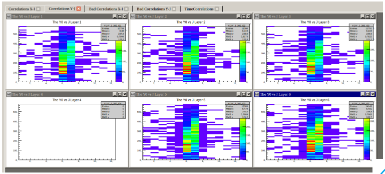
SDHCal online monitoring

- 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



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AIDA2020 WP5 / WP15

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 developped 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).

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Status - Ongoing work

- Current available version is `v01-04-04`:
  - Fully working version, used as proof of principle
  - EUDAQ-DQM4HEP interface not feasable (run control)
  - Module configuration (xml files) messy in case of a multiple host deployment
  - No clear seperation between online and offline tools
  - No documentation available for users ...

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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

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Ongoing work - More functionalities and projects

<u>Framework functionalities:</u>

- ✓ Custom interface to any DAQ run control (SOR/EOR/Status)
- Quality assessement 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
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More projects:

- Development of DESY slow control monitoring with DQM4HEP
  - Can run continuousely 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 !

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URLs and contact

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!

- R. Ete (`remi.ete@desy.de`)
- A. Pingault (`antoine.pingault@ugent.be`)
- T. Coates (`tc297@sussex.ac.uk`)