AIDA-2020-SLIDE-2018-006

**AIDA-2020**

Advanced European Infrastructures for Detectors at Accelerators

**Presentation**

# DQM4HEP: A generic Data Quality Monitoring for High Energy Physics

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05 October 2017


The AIDA-2020 Advanced European Infrastructures for Detectors at Accelerators project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.

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

The electronic version of this AIDA-2020 Publication is available via the AIDA-2020 web site <http://aida2020.web.cern.ch> or on the CERN Document Server at the following URL: <http://cds.cern.ch/search?p=AIDA-2020-SLIDE-2018-006>

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# DQM4HEP
# Status and prospects.

## CHEF 2017 - Lyon

R. Ete, A. Pingault, T. Coates

**DESY**

**October 5, 2017**

HELMHOLTZ GEMEINSCHAFT

AIDA 2020

UNIVERSITY OF SUSSEX

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DESY

# Summary

- Introduction
- Framework presentation
- Experiments running with DQM4HEP
- EUDAQ / DQM4HEP interface
- Current status
- Ongoing and future work

# Introduction

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 $\leftrightarrow$ 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)

# DQM4HEP

## Quality test API

### 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 :

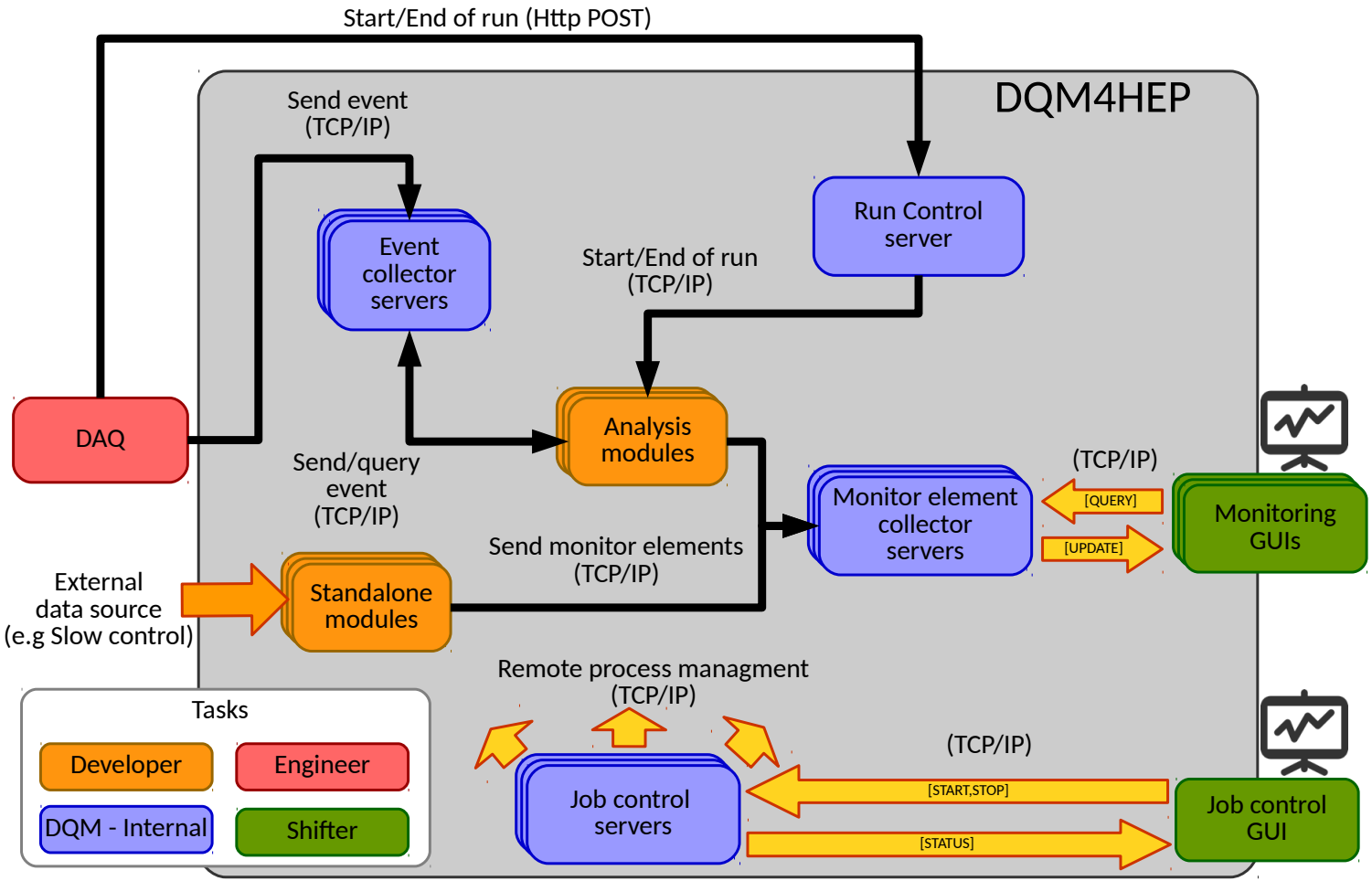
- Kolmogorov test using a reference histogram
- Mean of histogram within an expected value

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

- Test different histograms with the same gaussian distribution

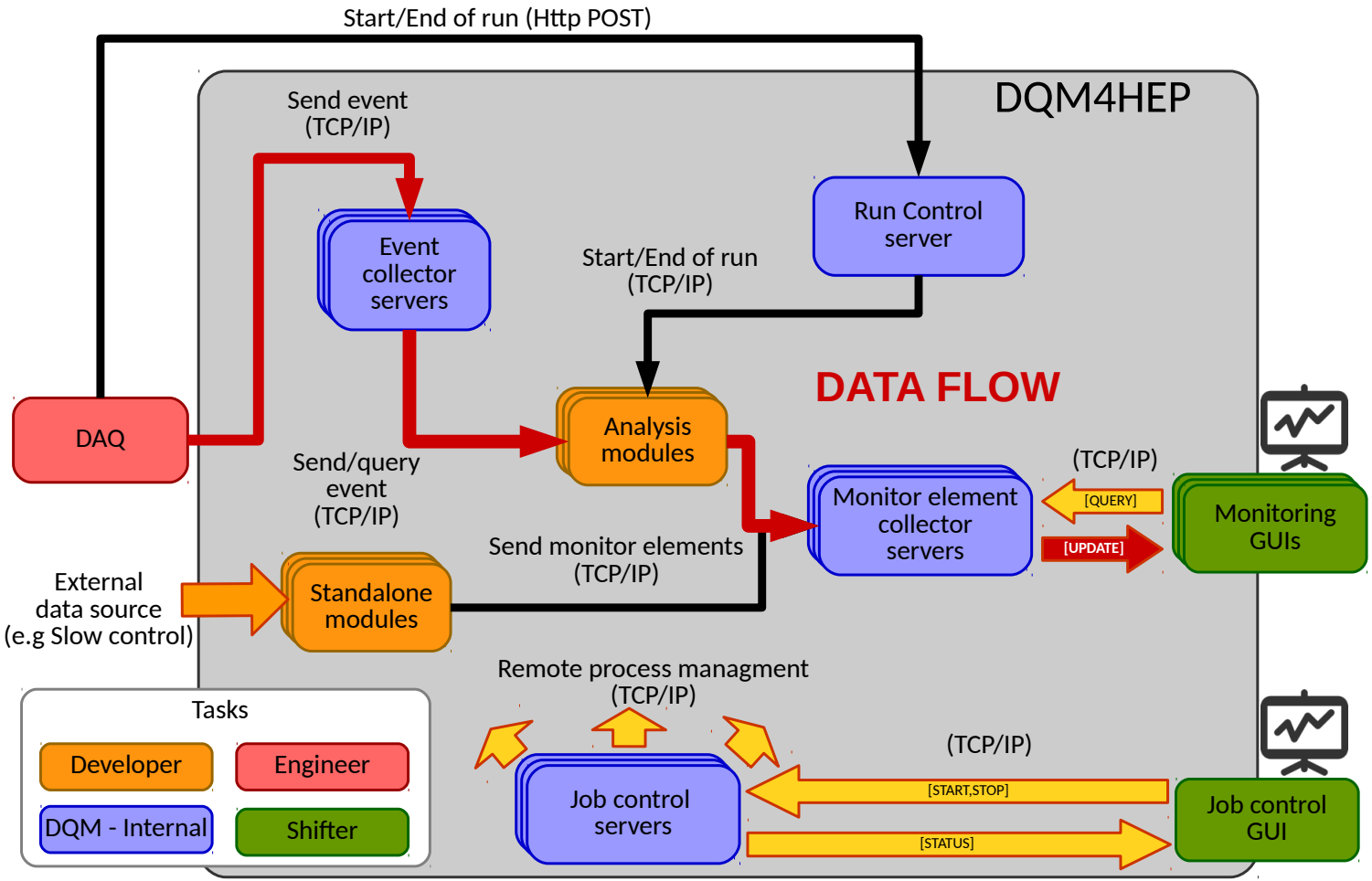
# DQM4HEP

## Online architecture



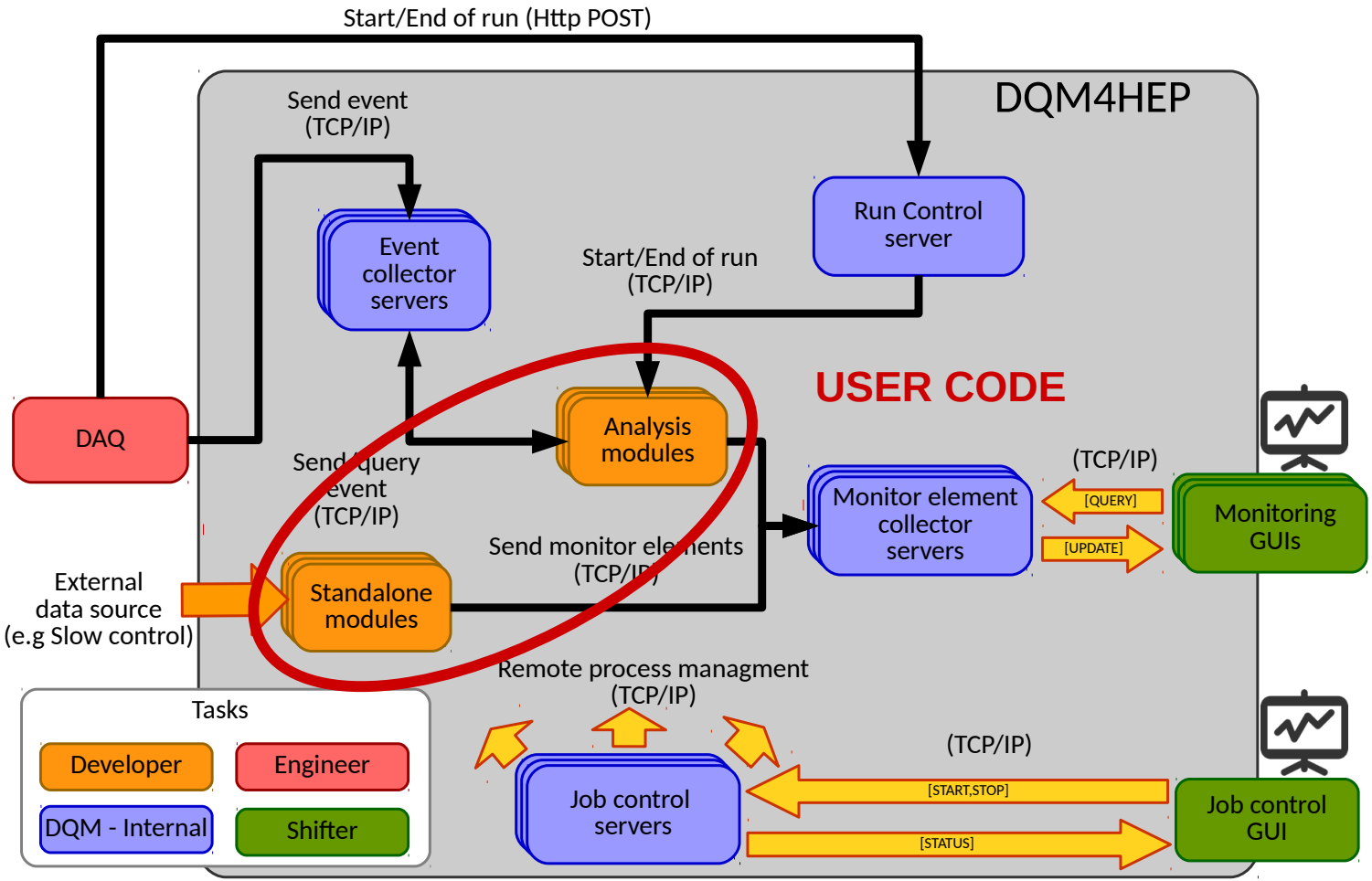
# DQM4HEP

## Online architecture



# DQM4HEP

## Online architecture



## Analysis module

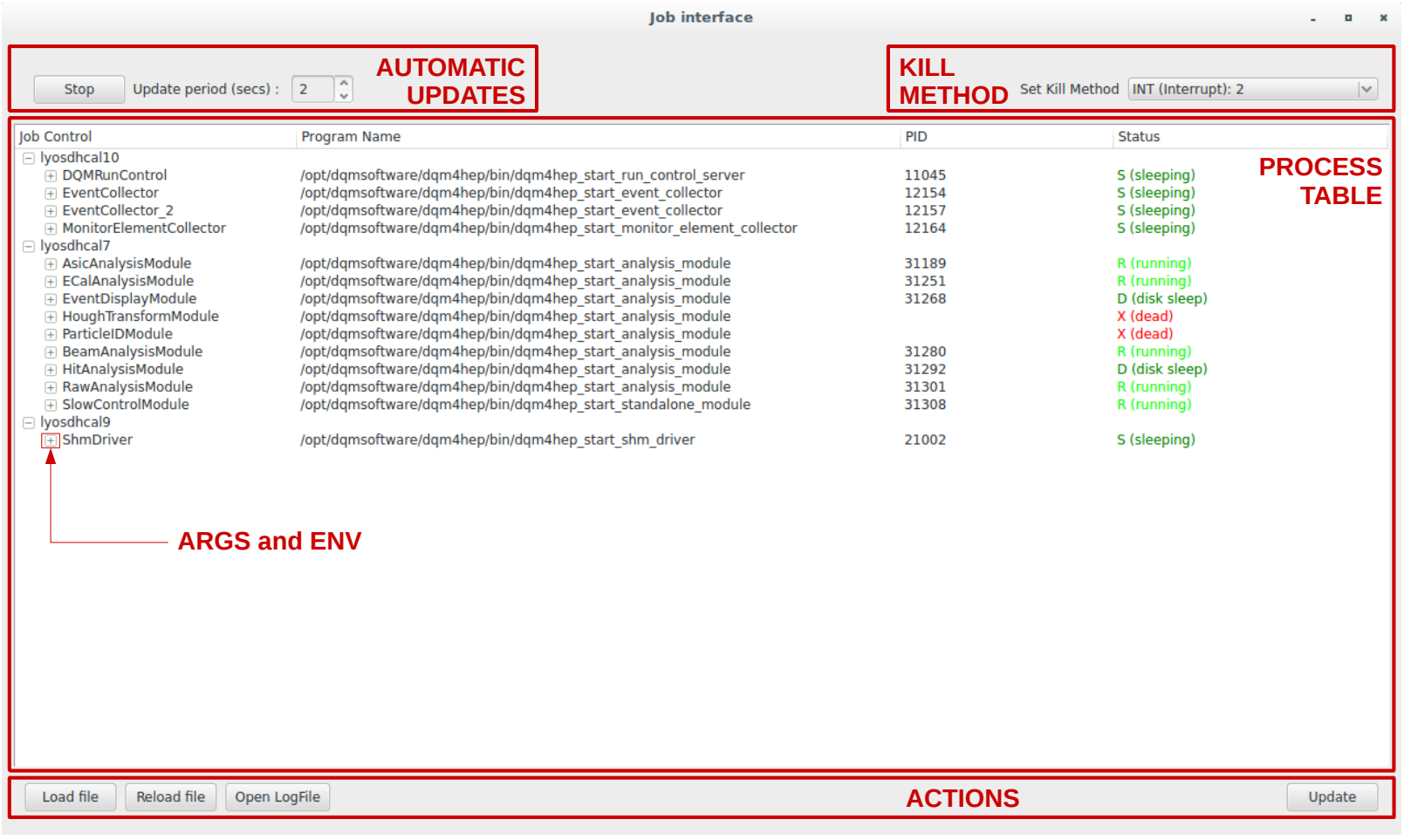
- **Receive and process event (e.g from DAQ)**
- Book and fill histograms
- Process quality tests
- Send histogram and QReports to collectors with cycle structure
  - Every N events/seconds
  - User can reset histogram if needed at end of cycle

## 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

# DQM4HEP

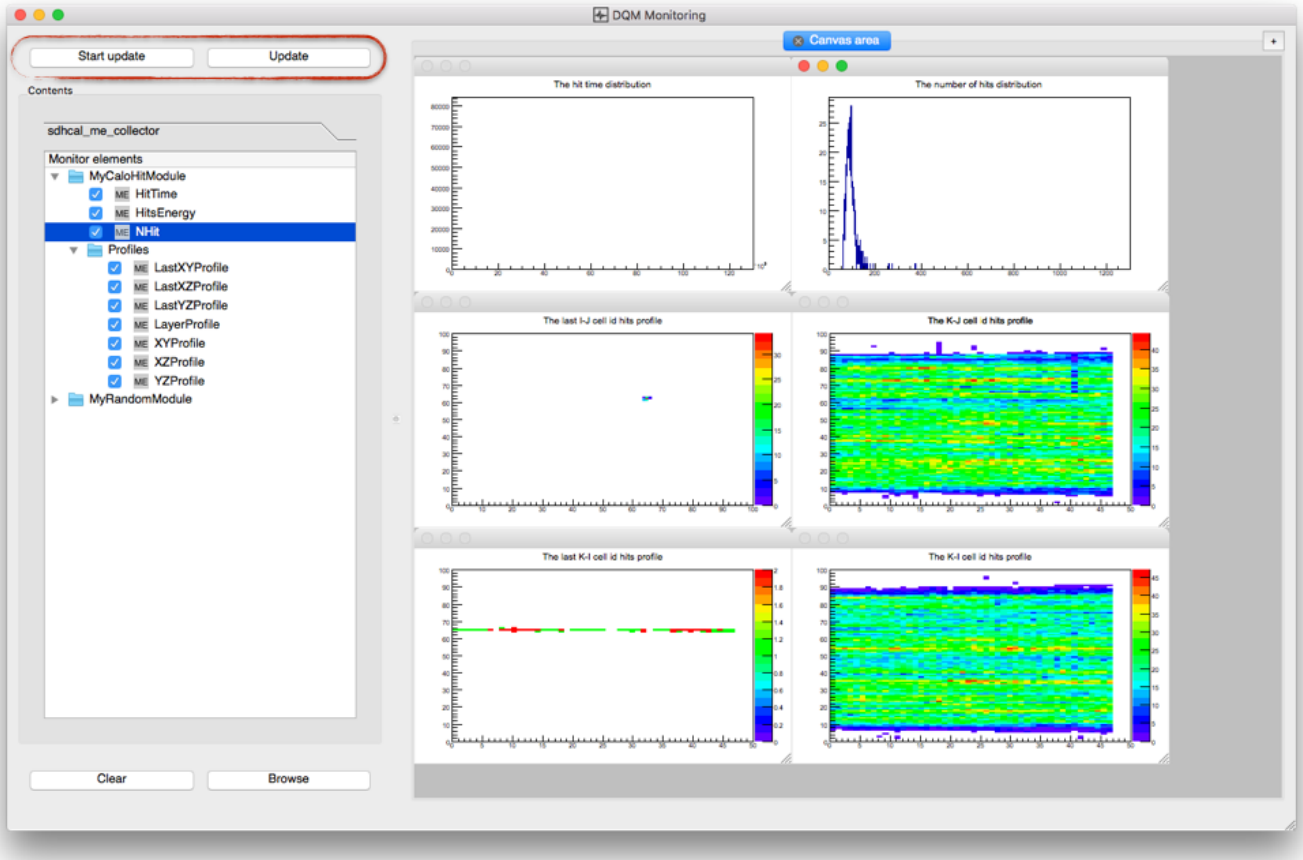
## Job control interface (Qt Gui)




Start/stop/manage many processes on many hosts

# DQM4HEP

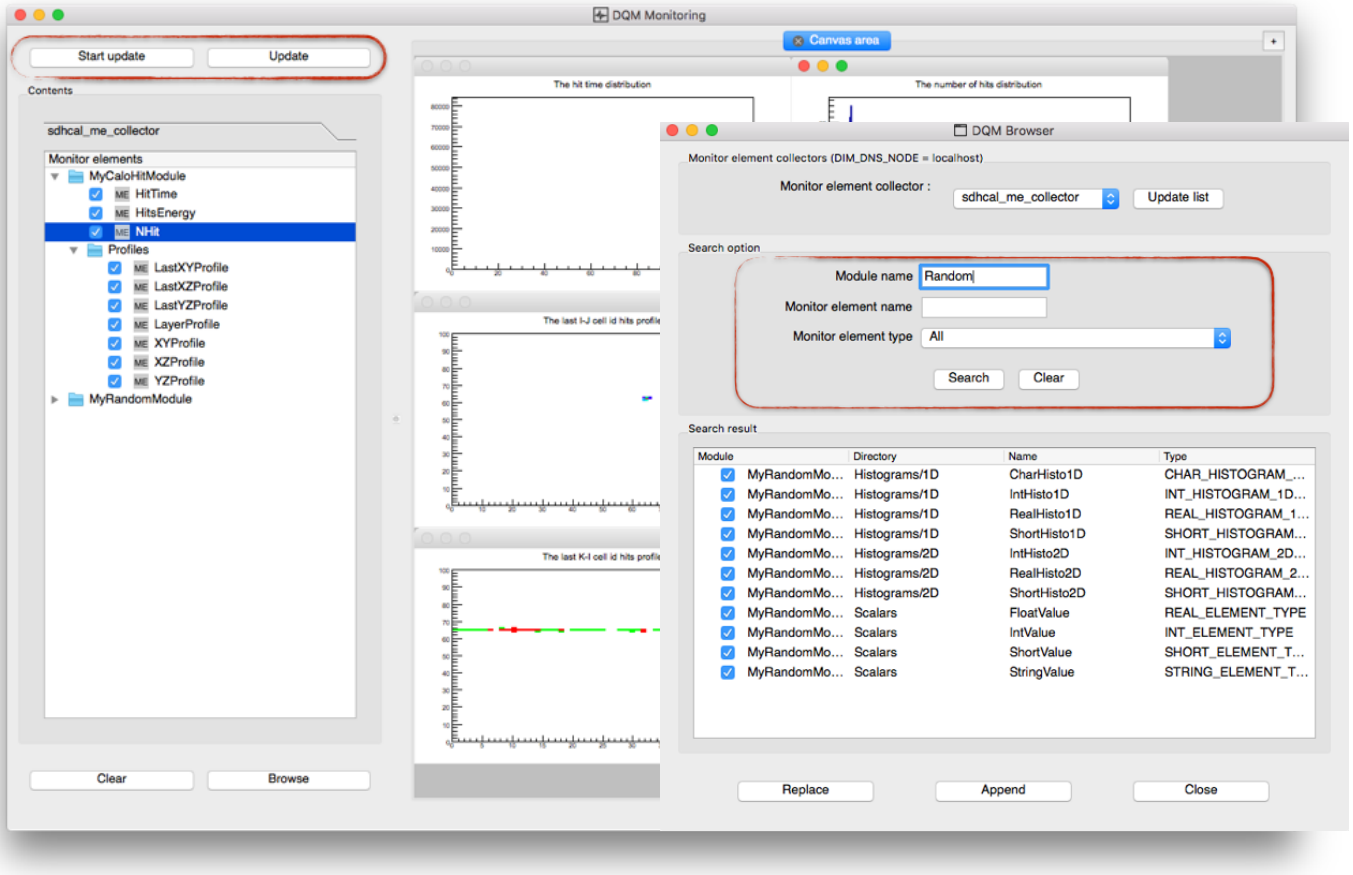
## Online monitoring interface (Qt Gui)




- Histograms organized in tree structure
- Plot many histograms at the same time
- Receive real time updates
- Browse histograms on collectors

# 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

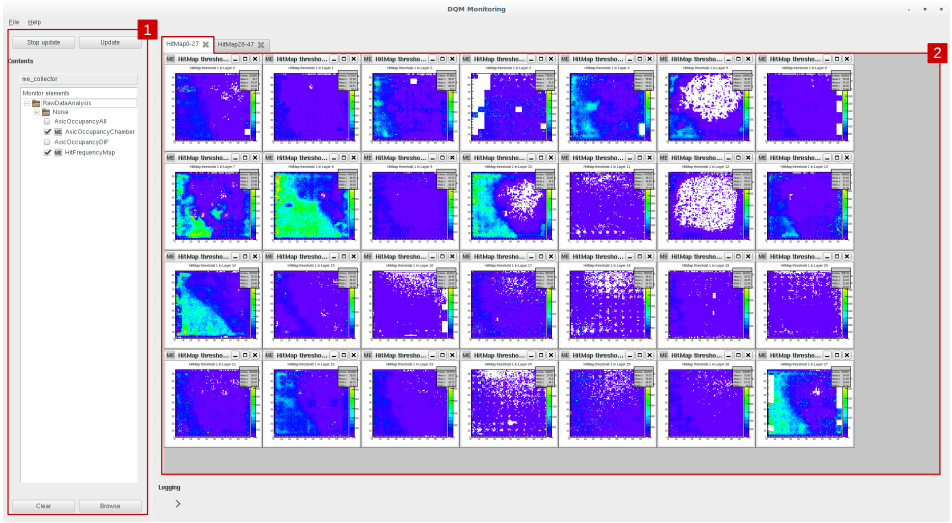
# DQM4HEP

## Detectors using DQM4HEP

DQM4HEP used by different detectors in the CALICE collaboration.

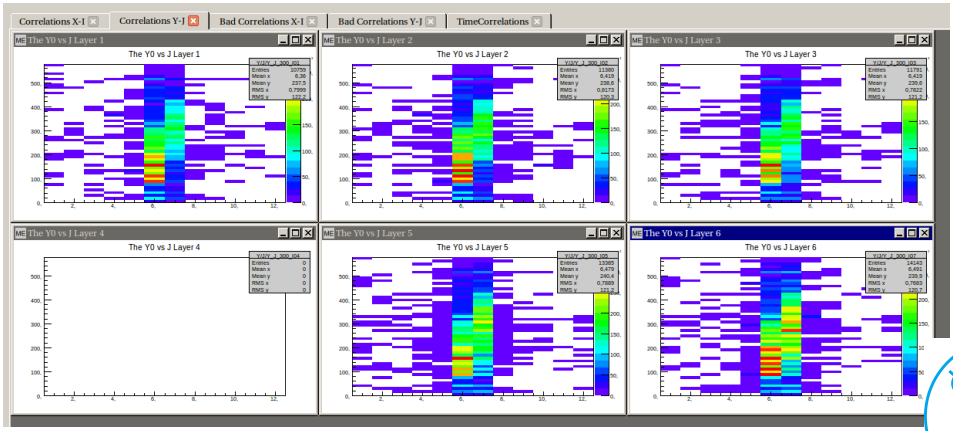
SDHCal online monitoring

- 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



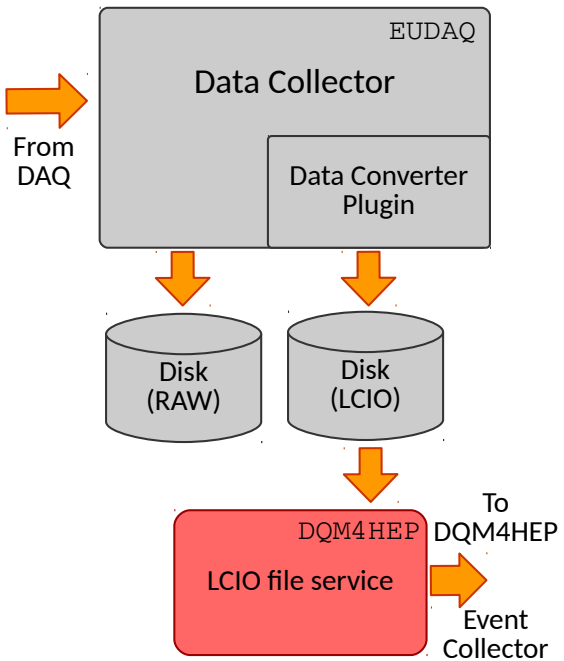
# DQM4HEP

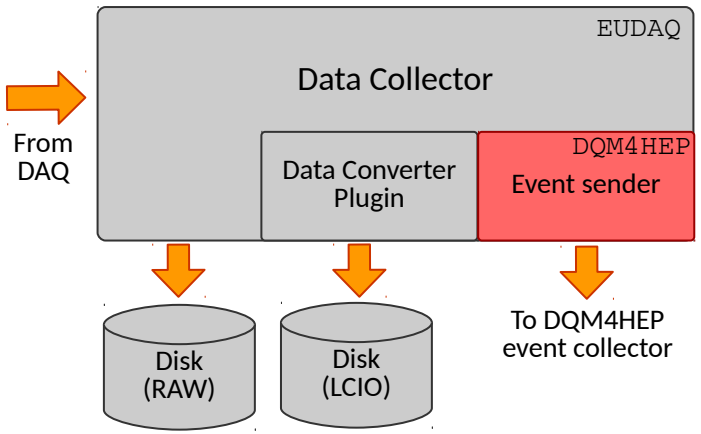
## AIDA2020 and EUDAQ binding

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.



# DQM4HEP

## Ongoing work on framework

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

**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)

# DQM4HEP

## Ongoing work on framework

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 withing 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

# DQM4HEP

## URLs and contact

GitHub collaboration

`https://github.com/dqm4hep`

Installation package (`v04-03-00`)

`https://github.com/dqm4hep/dqm4hep`

Slack channel (Announcements, issues, management)

`https://dqm4hep.slack.com`

Contact us !

- R. Ete (`remi.ete@desy.de`)
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- T. Coates (`tc297@sussex.ac.uk`)