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Data Quality Monitoring system of the Baikal-GVD experiment

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Introduction

The main purpose of the Baikal-GVD Data Quality Monitoring (DQM) system is monitoring the status of the detector and performing the data validation. The DQM system is integrated with the Baikal-GVD's unified software framework "BARS" (see poster of B. Shaybonov) and operates in quasi-online manner. The characteristics of data records under monitoring form two groups of parameters related to the distributions described the Poissonian character of events flow, and also the signal charge measurements.

Estimation of the Poissonian character of events flow

Detection of events is Poissonian-like process and recorded telescope data obey the distributions – exponential, Poissonian, and uniform.

- The calibration systems (LED matrices or laser sources) should worsen the shape of distributions, and decreased the fit quality.
- Unstable environmental conditions of the telescope (see poster of R. Dvornicky) also lead to deterioration of distributions.

Exponential distribution test:

The time difference between two consecutive events is described by the exponential function.

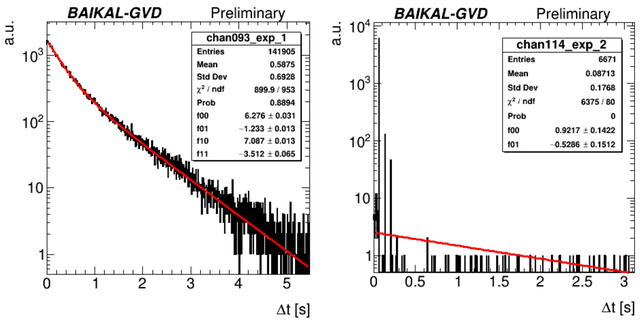


Figure 1. Exponential distributions for channels: standard run (left), calibration run with laser source (right).

Poissonian distribution test:

The expected number of the recorded events should follow the Poissonian distribution for any fixed time interval. The fixed time interval is chosen to have ~ 20 recorded events on average.

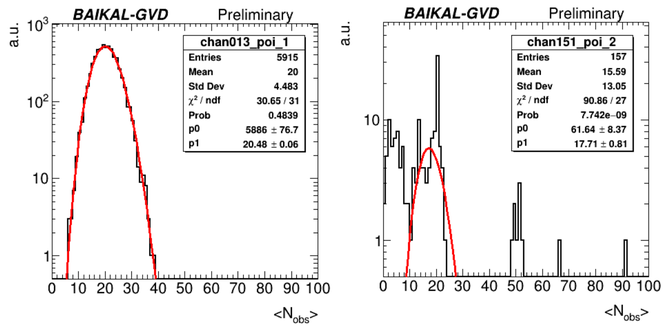


Figure 2. Poissonian distributions for channels: standard run (left), calibration run with laser source (right).

Uniform distribution test:

Uniform distribution is described the count rate of the recorded events

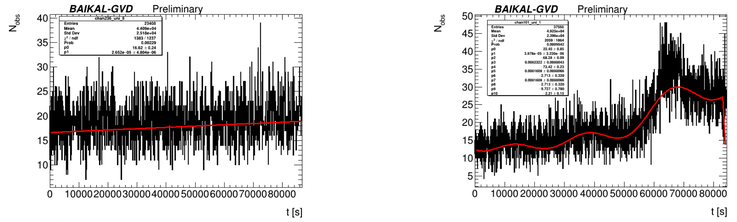
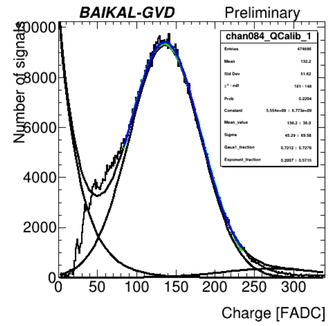


Figure 3. Uniform distributions for some selected channels: stable (left), and unstable (right) environmental condition

Charge distributions test

There is a possibility to analyze signals which generated trigger in the given event from other signals separately.

Non-trigger signals:



Using information from channels that did not fire the trigger for a given event we obtain the combined charge distribution of non-trigger signals, and 1 p.e. gaussian distribution dominates in combined one. The position of the 1 p.e. peak is extracted and used as calibration factor for recorded charge from FADC counts to p.e.

Figure 4. The charge distribution of non-trigger signals for a some selected channel.

Non-trigger signals also give the opportunity to estimate the noise count rate:

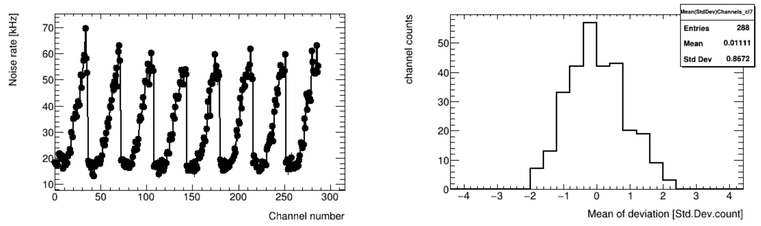


Figure 5. The noise rates for channels in some selected run (left). Channels noise deviation from the depth-averaged value during half of a season (right).

Trigger signals:

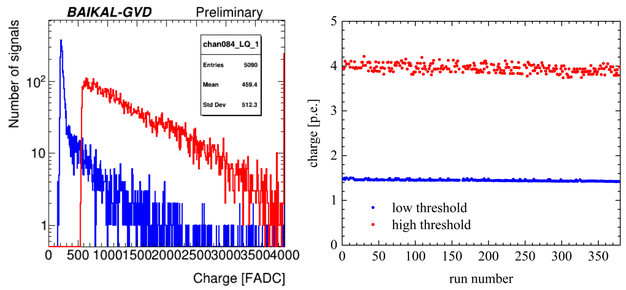


Figure 6. The signal charge values for some channel participating in the trigger (left). Low and high thresholds within over a half of year for some channel (right).

DQM system performs extraction and validation of the trigger charge thresholds. Low and high threshold values are set to be ~ 1.5 p.e. and ~ 4 p.e., respectively. The stability of these values is permanently monitored by the system for all channels during the run as well as the season

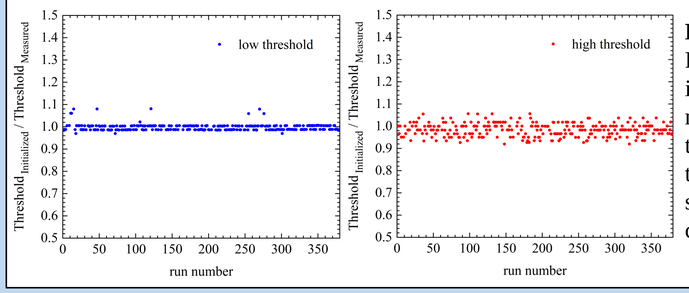


Figure 7. Ratios of the initialized to measured trigger thresholds for some selected channel

Graphical user interface

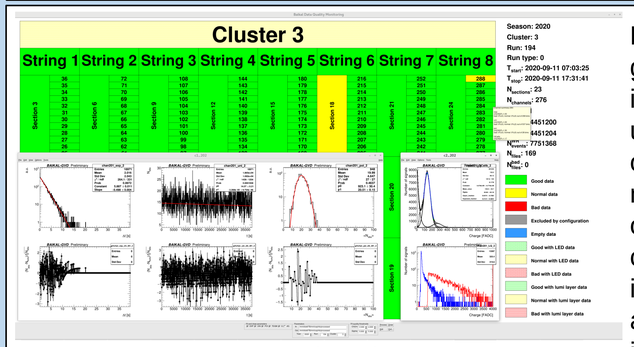


Figure 8. Graphical user interface of the DQM system.

DQM system's graphical user interface allows use the DQM outputs in off-line mode. Any level of the telescope can be seen independently and supporting info is presented

Quality estimation algorithm

The purpose of the quality estimation algorithm is to obtain the quality status of the recorded data for each telescope unit. We fit the distributions with expected functions by means of the minimum chi square method. Fit quality is estimated via χ^2 /NDF with threshold values for good (<2), normal (<4), and bad (>4) data. Fit quality estimations are summed up as logical *and*.

Summary

- Data quality monitoring system allows to monitor all crucial parameters of the detector and to estimate the quality of the obtained data
- System operates automatically within Baikal-GVD's unified software framework "BARS" and it's graphical user interface allows to analyze the data quality in an off-line mode
- Channel (optical module), section, and cluster levels are considered independently
- DQM system takes into account a possible quick change of the telescope's background environment