HERA-B ECAL MONITORING SYSTEM AND CALIBRATION PROCEDURES OVERVIEW

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A brief description of ECAL Monitoring system and some basic ideas of the calibration procedure are given in this draft.

1 Introduction.

Electromagnetic Calorimeter(ECAL) in HERA-B experiment is intended to provide electron identification and to form pretrigger for selection electron candidates. [1] Main parameters of the calorimeter are summarized in Table 1.

HERA-B ECAL consists of 56 by 42 modules employing the same "shashlik" technology.The calorimeter is subdivided into three sections with different granularity. For each calorimeter cell readout is performed by photomultiplier(PM) connected with single ADC input of front-end driver(FED). FED electronics provide fast readout and digitization of analog signals and ensure calorimeter pretrigger [2]. Each PM has own high voltage(HV) power supply/divider(on a base of Cocroft-Walton scheme) with built-in 10-bits DAC, which permits to vary high voltage. Every calorimeter cell is equipped with LED. LED control electronics allow to choose the pattern of LEDs to be fired and vary amplitude of the light pulse.

2 Three levels of HERA-B ECAL monitoring system.

Monitoring or slow control system of HERA-B ECAL has three levels. The first level monitors functionality of the HV system. The monitoring of the second level is based on the analysis of LED signals and roughly controls channels stability. The last level analyzes the 'minimum bias' events and is responsible for monitoring of the shape and position of the channel pedestals as well as the shapes of the channel spectra.

2.1 High voltage protection status control

In High Voltage Control Electronics a built-in protection mechanism is foreseen, which disconnects groups of channels from high voltage power supply in case of overcurrent. By request of the control software each HV electronics crate returns 256 bit pattern which contains the status of the HV protection

Table 1. HERA-B ECAL properties.

	Inner section	Middle section	Outer section
Number of channels	2100	2128	1728
Number of FED boards	84	80	62
Number of HV power cables	84	196	172

for channels powered by this crate. Alarm is starting each time any change is occurred as compared with stored 'ideal' configuration.

2.2 LED signals analysis and ECAL channels stability control

HERA proton accelerator cycle consists of 220 bunches marked in increasing order. Each new cycle rectangular pulse 'First BX' is delivered at all HERA-B components. ECAL test pulse system reproduces several individually delayed and prescaled replicas of 'First BX' [3]. One of this replicas is to provide LED fire signal to flash LED at the time of chosen bunch crossing. Second one informs experiment Fast Control System that this event should be extracted from FEDs pipeline. The normally LEDs are fired during one of so-called 'empty' bunches, which is not filled by protons. This way the stability of channels is monitored continuously during data taking. If for the given channel LED is switched off pedestal value and its width could be found the same way.

2.3 Monitoring based on data acquired

To extract output calorimeter data the global shared memory area [4] is used. Buffer corresponding to single readout board is subdivided into unique header and raw data itself for each FED channel.
There are 2 kinds of output data monitoring. First is a fast monitoring that analyzes and checks ECAL FED headers and collects lists of FEDs with correct header, FED's with wrong data and FED's duplicated. Any change with respect to the stored FEDs configuration is also tracking down. The second type of monitoring, more slow, is in charge for individual channels ADC spectra analyzing. After fixed statistics collection final histogramms classification is performed comparing them with 'ideal' spectrum shape: gaussian pedestal + smoothly dropping tail(Fig. 1).

For channels with spectra shapes acceptable for further analysis pedestal values and widths are extracted from the left part of distribution.

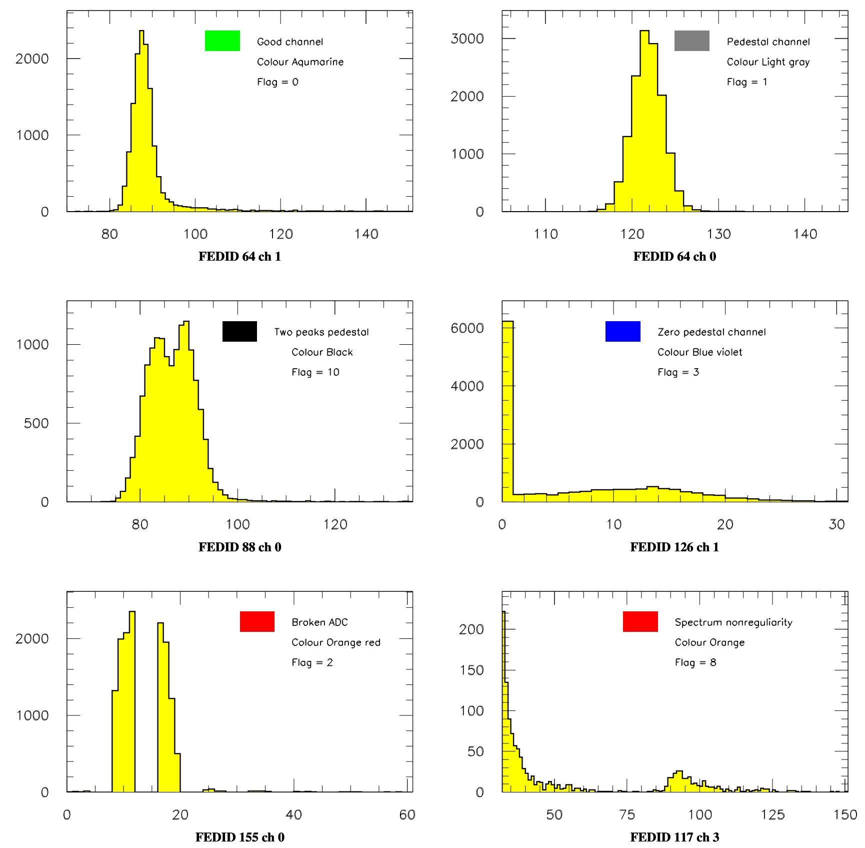

Figure 1. Channels spectra examples

3 HERA-*B* ECAL monitoring tools.

ECAL monitoring software is running on different machines with UNIX-like operation systems. Communications between different applications are implemented partly through pseudo terminals and partly through the standard HERA-*B* common messages system [5]. Control software flowchart includes(Fig. 2):

- three monitors,corresponding to 3 levels of monitoring;

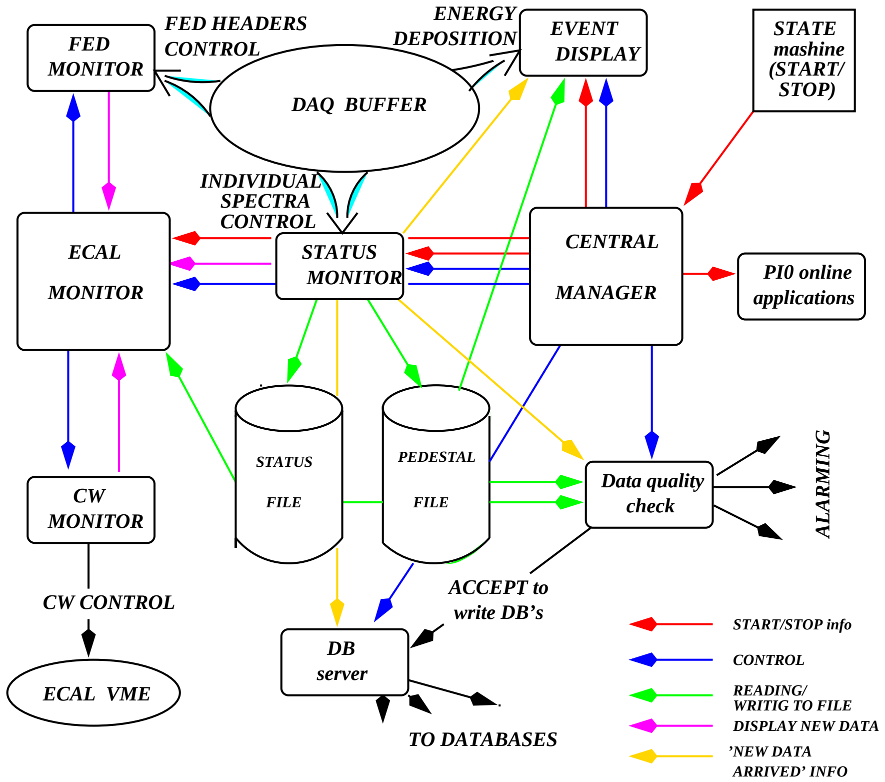

Figure 2. HERA-*B* ECAL monitoring tools

- ECAL monitor(ECALMON),that displays status of these subsystems [6];
- EVENT display, that shows energy deposition in ECAL cells.
- Data quality check tool,that tracks down pedestals drift and calculates number of bad channels to start alarm if controlled values are out of allowed limits.
- Central manager program,that provides control over several applications and delivers info about START / STOP [7] of the data taking.

4 Calibration.

The specific of the initial calibration of the ECAL is in the fact that it is based solely on the data from ECAL itself and does not require information from other detectors.

4.1 Equalization of channels occupancies to mean values

Though all PMs were precalibrated in laboratory within 10% accuracy it was not possible to identify π^0 peak in two body effective mass distribution. Basing on temporary magnetic field absence it was proposed to use coaxial simmetry of 2 dimensional distribution for ECAL channels occupancies. Dividing channels by groups forming coaxial rings on ECAL surface and supposing all channels are precalibrated one could assume that mean value of occupancies within rings should be close to the true value. Then rather small statistics(about 200.000 event) is sufficient to equalize responses of channels to corresponding mean values and then obtain gain correction factor for each channel.

4.2 π^0 calibration

After one stage of calibration π^0 peak was observed. It was used for absolute calibration of ECAL channels. If for the particular channel only those 2-cluster combinations are considered when this cell is the central cell of one of clusters, one can assume that π^0 peak position is determined by the calibration of this cell. Thus one can obtain the correct gain of the cell. Procedure usually converges in several iterations. In case of small statistics one can consider all cells at the same radius as a whole. To check quality of π^0 calibration η signal is used. With limited statistics available it is not possible to check individual channels calibration, only overall ECAL ajustment.

5 Conclusions.

During last year of data taking monitoring software tools were developed and tested in working conditions. Now they are on a stage of futher optimization. Inner and Middle parts of ECAL were calibrated by different methods and miscalibration is less than 5 percents. π^0 and η peaks are clearly seen(see Fig. 3).

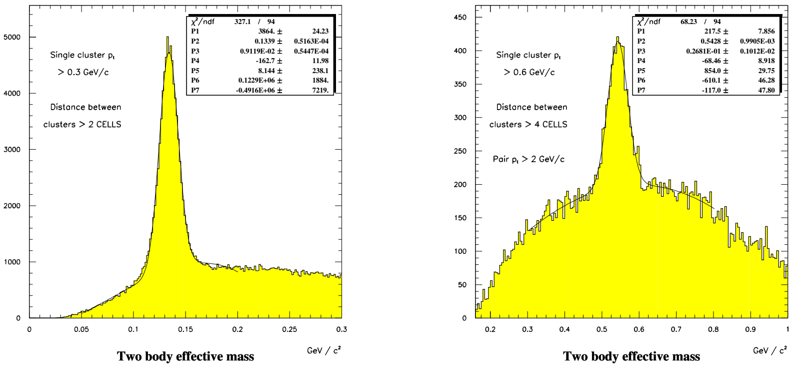

Figure 3. π^0 and η signals: individual cells calibration

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