Development of front-end electronics of TAIGA-IACT

K.G. Kompaniets, for the TAIGA collaboration
National Research Nuclear University «MEPhI»
E-mail: KGKompaniets@mephi.ru

Currently, the Observatory TAIGA (Turka Advanced Instrument for cosmic rays and Gamma Astronomy) is being deployed in the Turka valley (Buryatia). A special feature of the complex is a hybrid method of gamma-ray shower detection by a wide-angle HSCCORE Cherenkov detector and a system of atmospheric Cherenkov telescopes TAIGA-IACT [1]. The basis of the registration system of each IACT is a matrix camera, which consists of 547 pixels based on the PMTs, with a field of view of 8 x 8 degrees and an angular pixel size of 0.36 degrees.

The data acquisition system (DAQ) of the atmospheric Cherenkov telescope camera is modular and consists of 23-identical Cluster board serving the PMT units and the Central unit of the system – the Central Controller. Central Controller provides control of operation of Cluster boards, development of a common trigger, synchronization, data collection from Cluster boards and data storage in the intermediate buffer, data exchange with the Central computer.

The performance analysis for the first season resulted in the development of ~ 100 ns Local Timer between the Central Controller of a DAQ system of the telescope and Cluster Board Preamplifier. Triggers in a coincidence window 12нс signals exceeding a predetermined in_ADC threshold code. The range of linearity of measurements when using two MAROC 3 channels for each PMT is 1000 - from 50 to 50 pC.

Check list of all main Board characteristics.

1. Voltage at the test points
2. The presence of connection interfaces, correctness of loading / reading the configuration data
3. The correct operation in the measurement mode rate account
4. Correct operation in the mode of measuring the currents of the PMT: several control points for each channel
5. Correct operation in the mode of measuring the pedestals characteristics of the spectra symmetry, continuity, Sigma, spread between channels, crosstalk between channels, external and internal ADC
6. The correct operation in the measurement mode of the signal amplitudes: the characteristics of the spectra of the symmetry, continuity, Sigma, dispersion between channels, crosstalk between channels, the transfer coefficients, the linearity, the next mode of the regulators and automatic transmission, external and internal ADC
7. The correctness of the set values of the DAC (HV): multiple output points for each channel
8. Characteristics trigger system : the trigger efficiency for different thresholds and multiplicities, the width of the gate is a match, the HOLD time of development, interaction with Central Controller, stability under intense random flow of input signals.

Conclusion

• The camera of the telescope has a wide, two-level mode of trigger event and registration.
• The system configuration remote update mode is implemented.
• The mode of simultaneous registration of triggered events and measurement of the counting rate and PMT currents is implemented.
• Currently, the camera is being assembled and adjusted with upgraded PMT Cluster boards for the second telescope.

References

Matching on the single PMT anode output with MAROC

To expand the dynamic range, two channels of ASIC MAROC3 process signals from the same PMT. Signals from each PMT are transferred to the scheme of current monitoring.

The range of linearity of measurements when using two MAROC 3 channels for each PMT is 1000 - from 50 to 50 pC.

Time specification.
- The integration time 35 ms
- Gate of coincidence 12 ns
- MAROC triggers delay 25 ns
- External ADC conversion time 51.2 µs
- Maximum internal ADC conversion time 120 µs
- Trigger data transfer time 1.4 µs
- Event data transfer time 20.0 µs
- PMT current measurement time 60 µs
- MAROC board load time ~ 0.22 ms

Trigger conditions
Triggers in a coincidence window 120ns signals exceeding a predetermined threshold from a presized amount of PMT.

The dependence of the input charge at 50 % of the trigger efficiency of 32 channels on the DAC threshold code.

The two-level mode algorithm to determine the global trigger allows you to register the amplitude of each triggered PMT.

The local HOLD is generated on any trigger of PMT at the time of the signal maximum of the shaper. The duration of the signal is about 100 ns. The local trigger is generated on coincidence of local PMT triggers and transmits to the Central Board information about the PMT triggers.

The global HOLD is formed on the Central Board on any trigger and passed on all MAROC Boards.

The global trigger is generated on coincidence of all PMT triggers. If a global trigger is formed, MAROC Boards, which was a local HOLD, starts the ADC. If a global trigger is not formed, the global HOLD reset.

The system configuration remote update mode

Functional Diagram of Cyclone III Device Family Remote System Upgrade

The capacity of the configuration ROM is increased by 16 times, which allows you to store up to 16 different configurations.

Each application configuration can be remote overwritten by duty program.