HIGH-MOUNTAIN BURST DETECTOR FOR STUDYING THE CORES OF EXTENSIVE AIR SHOWERS

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1 The construction of burst detector prototype

The ionization chambers (IC) are made of copper waveguides of rectangular cross-section 5.5x11.0 cm^2 with a wall thickness of 2.5 mm, the chamber length is 3 m. The collecting electrode is a brass tube 3 mm in diameter. The chambers are filled with ultra pure argon at 4.5 atm (Figure 1).The IC are operated in ionization mode at 600 V (without gas amplification)

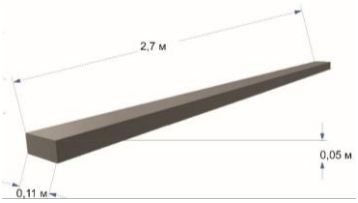

Figure 1. The ionization chambers of the burst detectors.

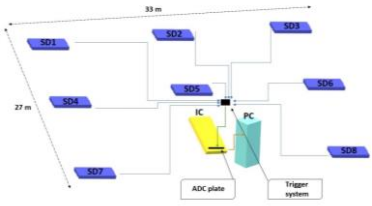

Figure 2. General layout of the BD prototype, yellow part indicates the BD and the blue parts the scintillators (ADC).

The BD prototype is assembled from eight ICs parallel to each other and is located in the center of the "Chronotron" installation, which consists of eight scintillation detectors arranged in the layout shown in Figure 2. A trigger from the existing 8-channel Chronotron installation is generated for the BD using the coincidence circuit shown in the Figure 3. The microcircuit is a logical 8 AND-NOT element and produces a trigger signal at the output if signals from all eight scintillation detectors arrive at the same time.

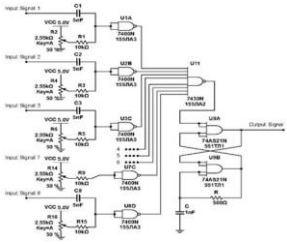

Figure 3. An eight-channel coincidence circuit.

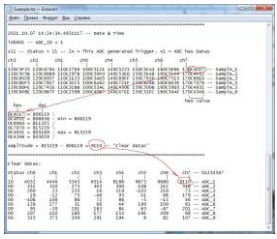

Figure 4. ADC data format.

2 Readout

The dynamic range of the electronics for the ICs is 10^4, i.e., the BD must register signals in the range from 10 to 10^5 particles per IC.

To implement this condition, an 8-channel, 24-bit AD7768 ADC (Analog Devices) [14] and an AD8065 amplifier were used. The main contribution to the noise comes from the amplifier. The magnitude of these noises is approximately equal to the signal from several particles.

The readout board has one eight-channel ADC and eight analog channels. An AD8065 (Analog Devices) was used as an amplifier for both charge-sensitive stage and discriminator.

The preprocessing program on the computer takes the data in binary form and writes it to a file in hexadecimal format. In addition to the data itself, it contains various service information:
– date and time;
– board ID;
– board status: the trigger is generated on the board, the presence of stored data in the FIFO, and others;
– eight values per line: ADC channel state, channel number, measured value;
– line - one ADC count;
– six lines - six consecutive readings corresponding to one event (one Trigger);
– nine blocks of six lines each are data from nine measuring boards (Figure 4).

When processing data on a computer, the first samples are taken as the zero level. The signal 153 pulse amplitude is obtained by subtracting this value (Figure 5).

As an example, an algorithm for processing data on a computer is shown:
– the value of one ADC channel is taken;
– converted to decimal values;
– the minimum value of the first three is taken;
– the maximum value of the following is taken, their difference is calculated and the result is written as "pulse amplitude" in the data file.

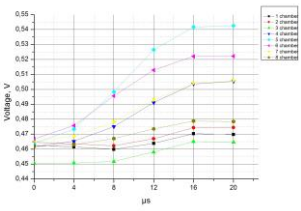

Figure 6. Typical 6-count pulse front shape obtained from 8 ionization chambers.

Reference
1) O.A. Kalikulov, N.O. Saduyev et.al Study of the spatiotemporal structure of extensive air showers at high energies. 2022 JINST 17 C04014