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Hardware and first results of TUNKA-HiSCORE

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ABSTRACT

As a non-imaging wide-angle Cherenkov air shower detector array with an area of up to 100 km^2, the HiSCORE (Hundred*i Square km Cosmic ORigin Explorer) detector concept allows measurements of gamma rays and cosmic rays in an energy range of 10 TeV up to 1 EeV. In the framework of the Tunka-HiSCORE project we have started measurements with a small prototype array, and planned to build an engineering array (1 km^2) on the site of the Tunka experiment in Siberia. The first results and the most important hardware components are presented here.

1. Tunka-HiSCORE

The Tunka-HiSCORE detector array is a ground-based extensive air shower Cherenkov detector array that samples the air shower light front using the non-imaging technique. With a spacing of about 100–300 m between stations, it is possible to cover a large area with a small number of detectors. For the physics goals, see Ref. [1], for a description of the expected reconstruction performance see Ref. [2]. We are currently working towards an engineering array [5] of 1 km^2 on the site of the Tunka experiment [3,4].

2. Detector station concept

2.1. Planned station setup

A single detector station consists of four Photomultiplier Tubes (PMTs) of a diameter of 8 in. (20 cm) with six dynodes that yield a nominal gain of 10^4 at a supply voltage of 1.4 kV.

Each PMT is equipped with a light collector (Winston cone) made up of ALANOD 4300 UP material with a reflectivity of 80%. In the standard configuration, the Winston cones have a half opening angle of 30° and point to the zenith. For a better view of the galactic plane, it is possible to tilt the viewing axis of the stations. The cones increase the light collection area by a factor of four in comparison to pure PMT area, resulting in a total light collection area of 0.5 m^2 per station. Each cone is composed of ten segments of reflective material, mounted along the optical axis and fixed with plates at the top and bottom of the cone [2].

To acquire the shower data, the high-gain anode channel signals of the PMTs are split and amplified by a custom fast preamplifier. One set of signals is processed by a clipped sum trigger. In this trigger system, each signal is first clipped at an adjustible clipping threshold, then the clipped signals are summed up. If there was an event, the amplitude of the signal is four times the amplitude of a single clipped signal. The threshold for the following trigger should be slightly below this level so that it only sets off if all four channels had a signal that was high enough to be clipped. This behavior greatly reduces noise, especially the noise produced by afterpulses of the PMTs.

The other set of the PMT signals is summed up and sampled via a custom DRS4 chip based board. For the same purpose we also

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