ON THE POSSIBILITIES OF LARGE-SCALE RADIO AND FIBER OPTICS DETECTORS IN COSMIC RAYS,

G.A.Gusev, M.A.Markov, I.M.Zheleznykh
Institute for Nuclear Research, the USSR Academy of Sciences, Moscow, USSR

ABSTRACT

Different variants of radio and fiber optics detectors for registration of super high energy cascades in the atmosphere and in dense media are discussed. Particularly the possibilities for investigation of quasi horisontal EAS and simulated muons from these EAS with the help of radio detectors and fiber optics detectors located on the ice surface are considered.

1. Introduction. The problems of super high energy physics and astrophysics not accessable by modern accelerators require creation of surface, under ground, and deep under water super large area and volume detectors. The particles with energy up to $E \simeq 10^{28}$ eV (particularly neutrino) could be created in the evolution of the stable (or long life-time) elementary black holes with Planck's masses and dimensions [1-3] which could have been formed in early Universe. Such absolutely cold black holes ($T \to 0$) could have external mass ($\sim 10^{28}$ eV) determined by the electric charge or the rotational moment.

2. Different Radio Detectors. In recent years several variants of super large radio detectors [3-7] were proposed based on the principle of the registration of the cascade coherent radio emission which was proposed as early as 1961 [8]. We note three possibilities.

The first possibility is founded on the reflection of EAS radio emission from the Earth and ionosphere producing the augmantation of the region where EAS radio emission may be received, up to 10^4-10^5 km^2. The second possibility is founded on some crust transparency for cascade radio emission created by the neutrino in the crust and spreading out in the atmosphere (RAMAND-A) [3,6,7]. The last possibility (RAMAND-I) [5,7] is founded on the use for example of antarctic ice in which radio emission absorption for frequencies up to 1 GHz is very small (for temperature -50°C in the frequency band 0,5-1 GHz the attenuation is about 10 dB/km).

Particularly a radio detector with volume 10^{11} m^3 could be used for determination of electron antineutrino fluxes in the energy region $6\cdot10^{15}$ eV with the help of the reaction $\tilde{\nu}_e + e^- \to W^- \to$ hadrons in the W-boson resonance region and for determination of Pγ-neutrino fluxes [7,9] with energy $\sim10^{19}$ eV (compare also optic registration of Pγ-neutrino cascades spreading out in the atmosphere [10]).

3. Large-scale radio detectors for quasi horisontal EAS and muons. Here we consider the possibility of complex radio installation for EAS muons registration by its cascade radio emission in the ice simultaneously with the EAS radio emission. We also discuss the utilization of fiber optics detectors for EAS registration.

It is known that EAS muon spectra (see for example [11] have high energy muon component. Its cascades in the volume 1 km according to [11] have statistics of the order of 10 events per year per steradian for cascade energies above $5\cdot10^{14}$eV. This allows to registrate simultaneously EAS with energy more than $3\cdot10^{18}$eV and muon cascade with energy more than

$5\cdot10^{14}$eV(for effective noise temperature $\sim1000^{\circ}$C) with probability of the order of 1.

Complex radio detector is shown in Fig.1. Such radio detector has two parts: EAS radio detector (domain 1) and EAS muon cascade radio detector in the ice (domain 2). These parts are placed so that for EAS axe in the domain 1 in the zenith angle region 60°-80° the radio spot from the muon cascade with deepness of 500m is projected on the domain 2. The radio detector has 50 antennas (separated from each other on a distance of 500m) with the amplifiers in the frequency band of 30-70MHz, so 7-10 channels receive a signal as much as 30-20dB above the atmosphere noise for EAS energy of 10^{19}eV [3]. Muon cascade radio detector has 50 antennas (placed on a distance 250m) with the amplifiers in the frequency band of 200-100MHz, so for cascade energy about $5\cdot10^{14}$ eV 10-20 channels receive the signal with signal noise ratio $\sim$ 10dB [5].

We consider the possibility of changing EAS radio detector by fiber optics detector. The idea of such detector consists in the registration of the optic Cherenkov radiation of the electrons crossing the light guide. The optic emission guided in the fiber can propagate with small absorption at large distances to the photomultiplier (with small photocathode). It is known that after passing the distance of 1 cm in dense matter an electron in the optic region lets 200 Cherenkov photons. For a fiber of the diameter 0,5 mm this will give 10 photons and for an aperture of 0,3 10% of photons will be guided exepting some EAS electrons coming from directions along and normaly to the fiber. So one electron produces one photon guided in the fiber. For a cable consisting of 10 fibers of diameter 0,5 mm the calculation gives 200 photons at the photocathode, if the EAS axe is at distance of 250 m from the cable (EAS energy being $\sim 10^{19}$ eV). If the photomultiplier effectiveness is roughly 10% then there will be registrated 20 one electron pulses during some units microseconds. At Fig.2 the complex detector with EAS fiber optics detector (threshold is about 10^{18} eV) is presented.

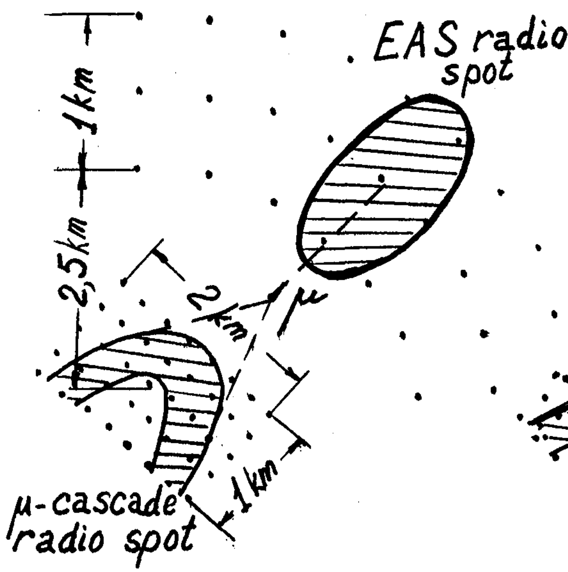

Fig.1. Complex Radio Detector for Quasi Horisontal EAS and Muons.

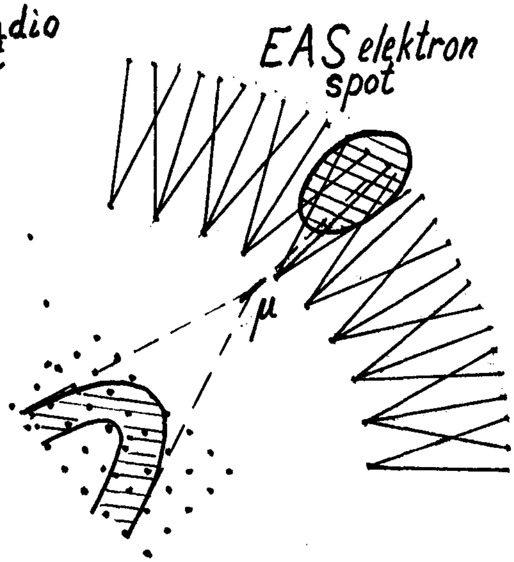

Fig.2. Complex Detector with EAS Fiber Optics Detector.

4. Conclusion. Complex detector placed on the ice surface may be important instrument for research of neutrino, primary composition of cosmic rays, promt muon creation at super high energies and etc.

5. Acknoledgements. We wish to thank A.E.Chudakov and L.G.Dedenko for an useful discussion.

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