Brief information about the project

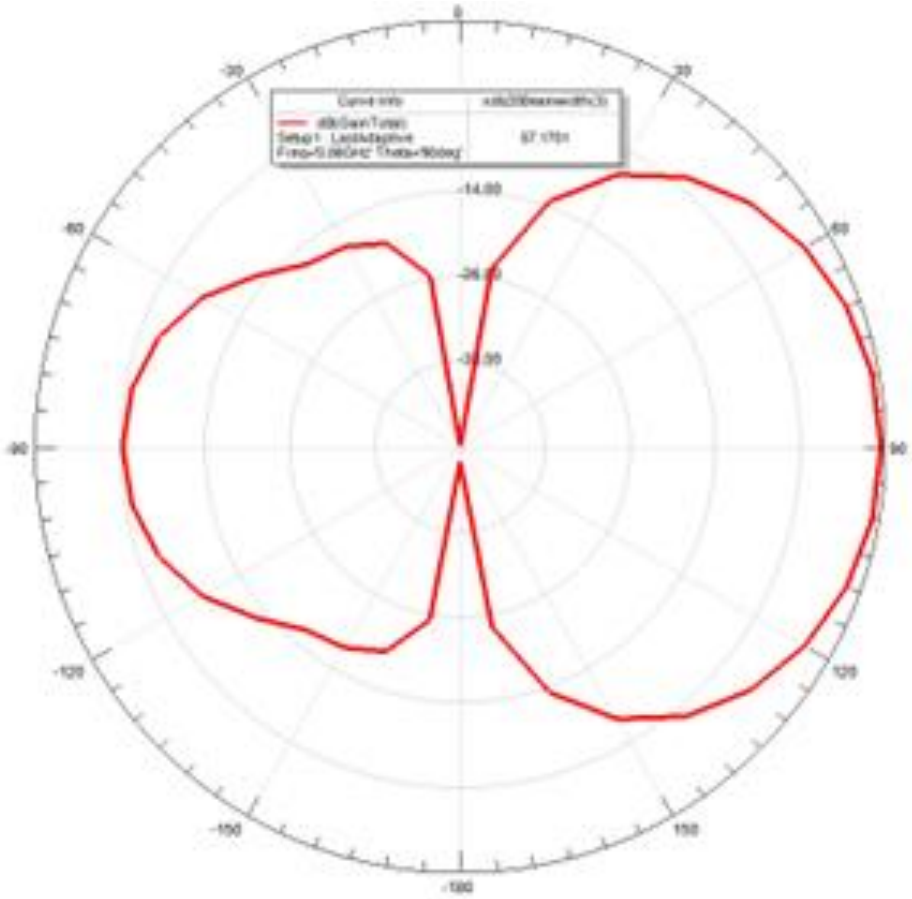
Name of the project	AP14971466 «Spatial structure of extensive air showers at cosmic ray energies above 10^{15} eV».
Relevance	An analysis of the experimental situation leads to the conclusion that changes in the characteristics of the EAS are due to astrophysical reasons associated with the appearance of a new CR component in the knee area. A number of data indicate that this component may be of non-nuclear origin. The most convincing indications of this are obtained from the existence of many frontal globes and an excess of muons in globes with gamma families. It is not possible to obtain such characteristics in nuclear models. In the project, it is proposed to develop a very high-frequency (VHF) antenna of the Uda-Yagi type for the 50-65 MHz range to register the radio frequency component of the EAS. It is proposed to install these antennas at the Tien Shan High-Mountain Scientific Station (TSHMSS).
Purpose	In this study, it is proposed to develop a bipolar antenna for recording ultrahigh energy emissions, assemble and set up a prototype of a bipolar antenna in the laboratory and test this antenna in a high-altitude area.
Objectives	1. To develop a bipolar, directional, very high frequency 4-element Uda-Yagi antenna for detecting the EAS component; The task is to create an antenna of the Uda-Yagi type with four elements, providing bipolar orientation and operating at very high frequencies to detect the component of Extensive Air Showers (EAS). The process includes analysis of requirements and specifications, antenna design taking into account frequency characteristics, directivity and polarization, modeling to optimize parameters, production of a physical prototype, testing for compliance with requirements, development of technical documentation and integration of the antenna into the EAS detection system. To complete this task of developing a bipolar, directional, very high-frequency 4-element Uda-Yagi antenna for detecting the component of Extensive Air Showers (EAS), we will use the HFFS Ansoft software for modeling and optimizing the antenna, as well as AutoCAD for creating drawings and designing. The tasks of the work can be described in the following paragraphs: 1. Study of antenna requirements, including frequency range, directivity and polarization, on the basis of which design parameters will be determined. 2. Creating a conceptual antenna design using the AutoCAD program, including determining the size of the elements and their location.

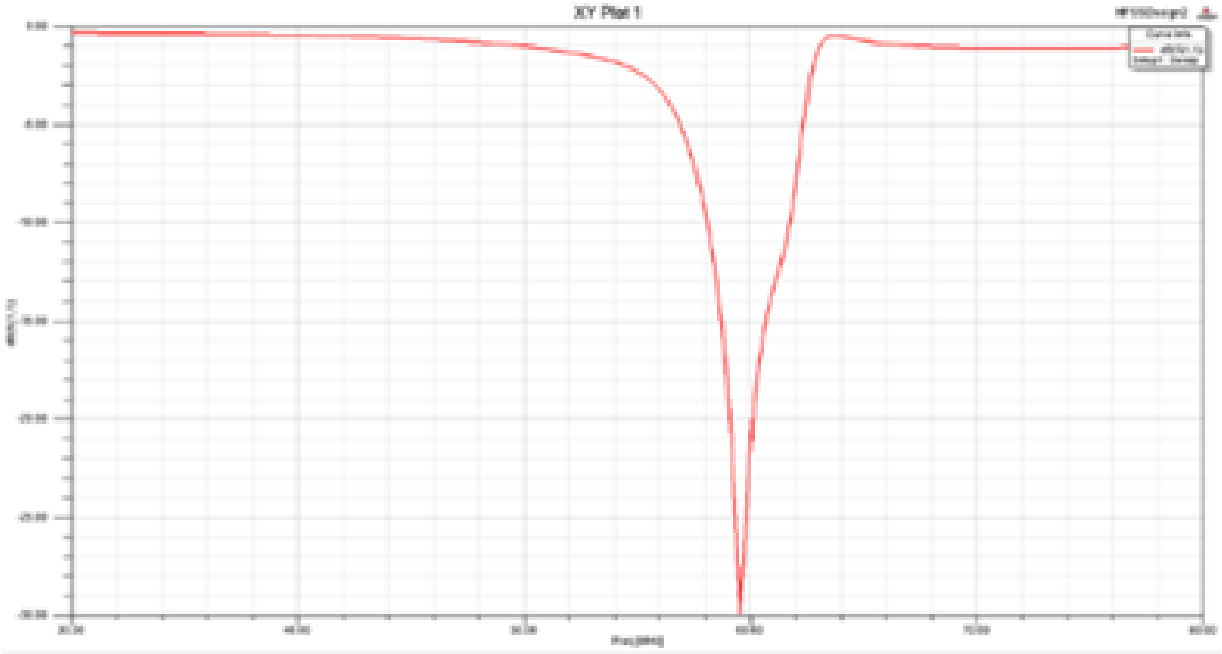
	3. Modeling an antenna using HFFS Ansoft to evaluate its electromagnetic characteristics such as gain and directivity. 4. Optimization of antenna parameters based on simulation results to achieve the required characteristics. 5. Create antenna drawings in AutoCAD, including directional lobes to visualize their shape and orientation. 6. Production of a physical prototype of the antenna based on the developed specifications. 7. Conducting prototype testing to verify its performance and compliance with requirements. 2. Assembly and commissioning of a prototype bipolar antenna for recording ultrahigh energy emissions in laboratory conditions The task is to assemble and set up a prototype bipolar antenna in order to register Extensive Air Showers (EAS) of ultrahigh energies in laboratory conditions. Ions. EAS are cosmic particles interacting with the Earth's atmosphere and creating electromagnetic flares that can be detected using specialized antennas. The key steps in completing this task include: 1. Preparation of materials and components: Obtaining all necessary components and materials to assemble the antenna in accordance with its specifications. 2. Antenna assembly: Assembly of all antenna elements in accordance with the design documentation, including installation of elements, wires, connectors and fasteners. 3. Setup and calibration: Adjust the antenna to certain frequencies and polarization, as well as calibrate its parameters for optimal performance. 4. Testing: Conducting tests to verify the operability of the antenna and its ability to register EAS signals in the laboratory. 5. Sensitivity and Gain adjustment: Optimize antenna parameters such as sensitivity and gain to improve its signal detection capability. 6. Troubleshooting: In case of malfunctions or malfunctions, carry out the necessary repairs or adjustments to ensure the normal operation of the antenna. 7. Documentation and reporting: Preparation of technical documentation on the assembly and commissioning of the antenna, as well as a report on the tests performed and their results. 3. Simulation of ultrahigh energy EAS using the CORSIKA package. Modeling of Extensive Air Showers (EAS) of ultrahigh energies with the help of the CORSIKA package represents an important stage in the research of cosmic particles. CORSIKA is a software specialized in simulating the interaction of cosmic particles with the Earth's atmosphere. Using CORSIKA, it is possible to

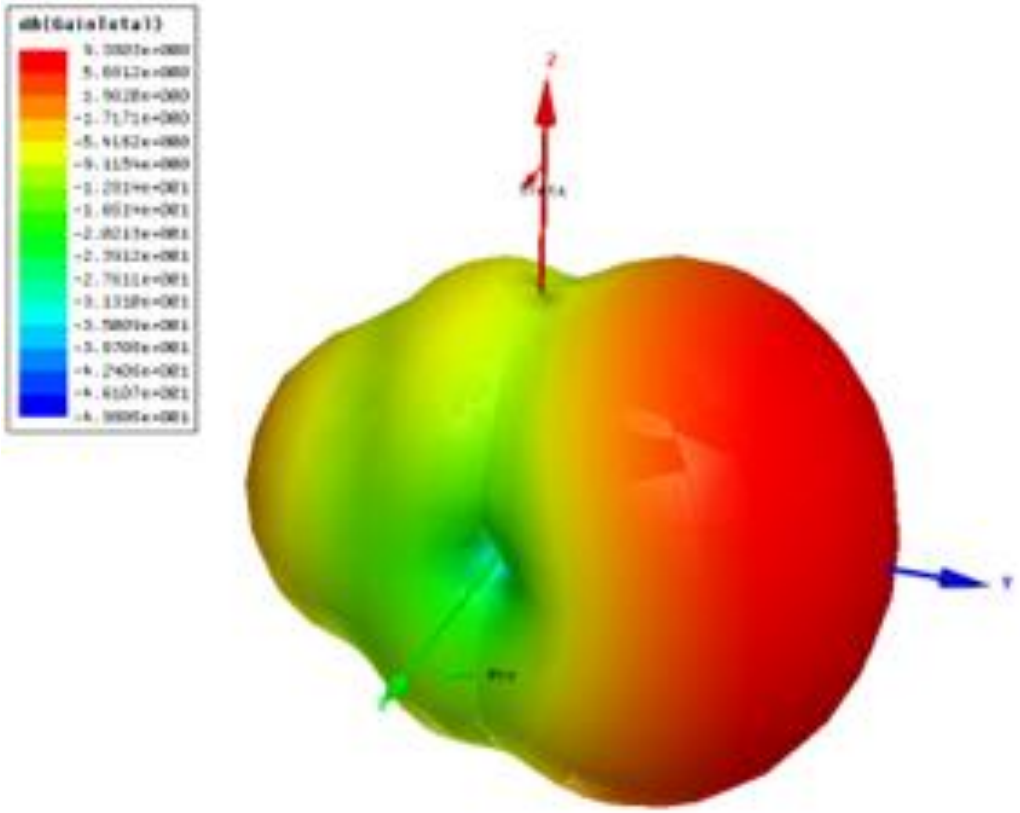
	simulate various types of cosmic particles, their trajectories, energies and effects in the atmosphere. This allows scientists to predict and analyze the characteristics of EAS, including their distribution, intensity, and spectral characteristics. Such modeling plays a key role in understanding the origin and nature of cosmic showers, as well as in developing methods and technologies for their detection and study. Thanks to the capabilities of CORSIKA, researchers can obtain valuable data for further scientific research in the field of space astrophysics and fundamental physics. 4. Installation of a bipolar antenna at a high-altitude scientific station (TSHMNS) The installation of a bipolar antenna at a high-altitude scientific station (TSHMNS) represents a key stage in the creation of infrastructure for observing Extensive Air Showers (EAS). Such stations provide optimal conditions for the registration of cosmic showers due to the absence of atmospheric sources of interference and a low level of electromagnetic noise. The installation of an antenna at a high-altitude station allows for the highest possible sensitivity and accuracy of recording the signals of the EAS. In addition, the advantage of high-altitude stations lies in their remoteness from urban and industrial sources of interference, which contributes to more accurate and reliable data measurement. 5. Launching a bipolar antenna in test mode to register ultrahigh energy waves and receive primary data. The launch of a bipolar antenna in test mode for recording Extensive Air Showers (EAS) of ultrahigh energies is an important stage in the research process. During antenna testing, the operability of all system components is checked, and its main characteristics, including sensitivity and accuracy of signal registration, are evaluated. Obtaining primary data during tests allows you to conduct a preliminary analysis of the antenna operation and determine the need for further adjustments or improvements. In addition, the test launch of the antenna provides an opportunity to evaluate its effectiveness in real-world operation and identify possible problems or malfunctions.
Expected and achieved results	It is expected that the implementation of this project will make it possible to make a significant step forward in the study of ultrahigh-energy cosmic rays and make an important contribution to the development of high-energy physics and astrophysics. In addition, the project has the potential for practical applications in the field of radar, radio astronomy and other fields of science and technology. 1. It is planned to create an antenna of the "wave channel" type (Yagi-Uda) to register radio emission from the EAS in the frequency range of 55-65 MHz. First, a computer

	model of the antenna was designed. A bipolar antenna circuit has been developed to register ultrahigh energy emissions. The bipolar antenna model was created in the HFSS Ansoft environment using the finite element method. For a detailed study, a 3D circuit was modeled in the AutoCAD 2021 software environment. The active vibrator has a half-wave length (0.5 λ), and it is 2.38 m, the reflector length, slightly larger than 0.5 λ, is 2.45 m, the directors have 2.26 m and 2.24 m, respectively. 2. A prototype bipolar antenna was assembled and set up for recording ultrahigh energy emissions in laboratory conditions. The geometric and physical parameters of the computer model and its physical prototype are fully consistent. An experiment was conducted to determine the characteristics of the antennas. For this purpose, a high-frequency signal generator G4-158, an Agilent N 9340B spectral analyzer were used, and measuring instruments were connected to the antennas via coaxial cables (50 ohms) with a length of 5m with "N male to SMA male" connectors. To study the bandwidth, the signal generator radiated in the range of 40-65 MHz in increments of 1 MHz. The distance between identical antenna samples was 20 m. As a result, the dependence of the received power on the frequency was constructed, which showed that the antenna in question can receive useful signals in the frequency range from 45 MHz to 63 MHz. The bottom was also built in a horizontal plane. 3. The ultrahigh energy EAS was modeled using the CORSIKA package. Ultrahigh energy EAS modeling using the CORSIKA package is a method for computer modeling the interaction of high-energy particles, such as cosmic rays, with the Earth's atmosphere. The CORSIKA (Cosmic Ray SImulations for KAscade) package is designed to simulate various aspects of particle interaction with the atmosphere and the Earth's surface. During the simulation, CORSIKA collected data on the processes occurring during the interaction of particles with the atmosphere. This data may include information about the creation of secondary particles, radio emission, and other characteristics of the EAS. The data obtained were analyzed to understand the characteristics of the EAS, such as particle distribution, energy, and radio emission spectra. The data will be used for comparison with experimental results and verification of theoretical models. The measurement results showed that the antenna is narrowly directed and, in addition to the main lobe, has a relatively small rear lobe. The simulation results are in good agreement with the results of field experiments. 4. A bipolar antenna will be installed at the high-altitude scientific station (TSHMNS)

	5.A bipolar antenna will be launched in test mode to register ultrahigh energy emissions and primary data will be received
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Shinbulatov Saken, young researcher, PhD, H-index – 1, 0000-0002-5296-2530, Scopus author ID: 57200407833. 2. :Zholdybayev Timur, Candidate of physical and mathematical sciences, Associate Professor, H-index – 9; ORCID: 0000-0003-3534-1000, Scopus Author ID: 8433851200.
List of publications with links to them	
Patents	-




XY Plot 1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