Plan of Advanced technology research of cosmic radiation dose measurement based on altitude conditions

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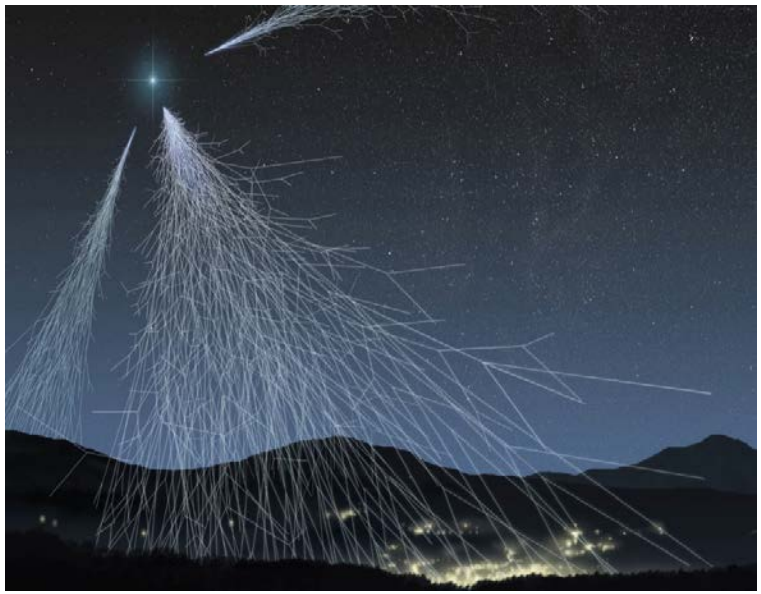
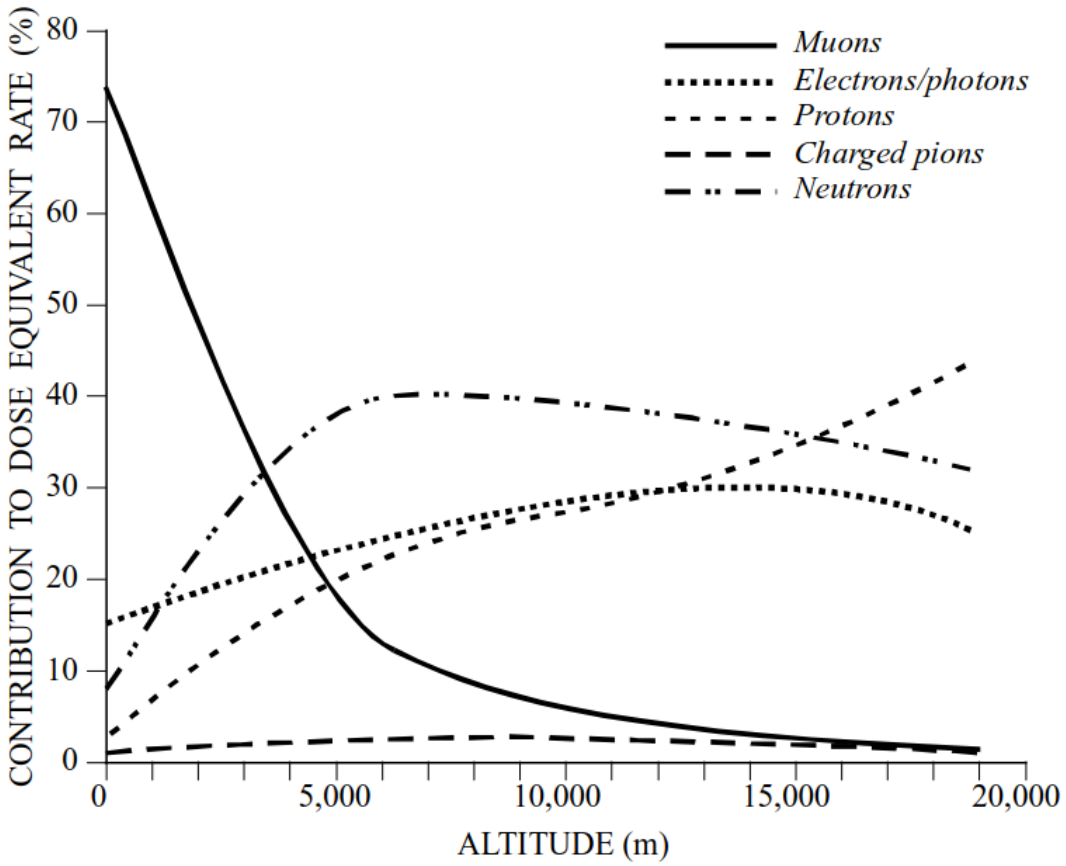
Background introduction

Cosmic rays are important parts of natural radiation sources, and their exposure increased with altitude.



At the altitude of 3000m, the effective dose rate of cosmic rays to the human body is about 3 times that of the sea level, while that of 4500m is 6 times, and that of 5000m is about 8 times.

Background introduction



The components of the dose rate from the cosmic ray in the atmosphere

At a height of about 5000 meters above sea level, the difference in the composition of cosmic rays which can make an important contribution to the dose is not very large compared with the altitude of the flight.

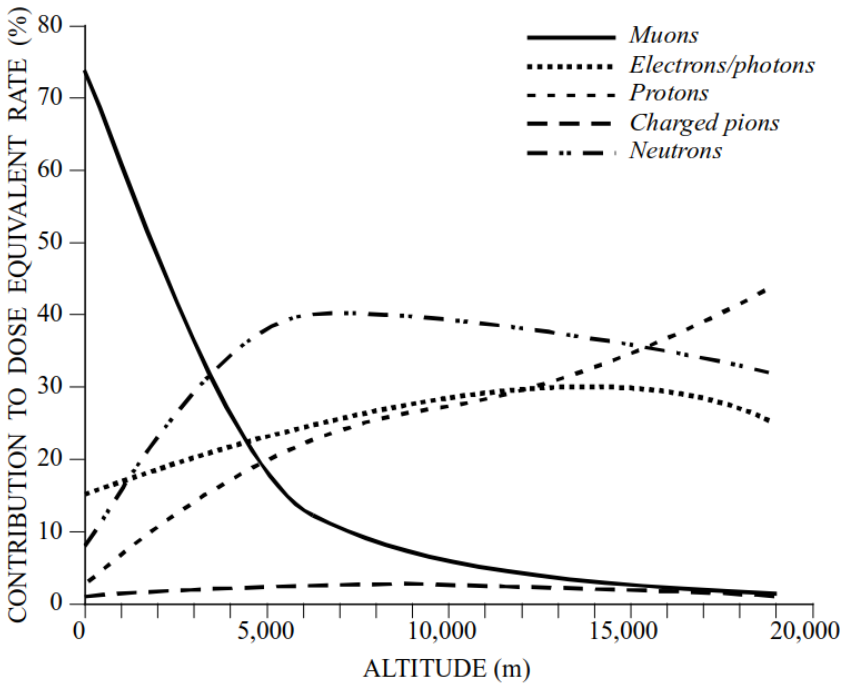
The cosmic rays' dose measure technologies established on the high altitude area's ground may also be used for dose measurement in aircraft. Supplemented by heavy nuclear dose monitoring technology, they can also be extended to the field of dose measurement in spacecrafts.

Background introduction

The study of cosmic ray dose monitoring using plateau conditions has its special advantages:

① Compared with plain area, the cosmic ray radiation in plateau area is stronger. About every 1800m increase, the dose rate caused by cosmic rays is doubled.

② Compared with plain areas, the composition of cosmic rays in plateau area is more similar to that of cosmic rays at the altitude of aircraft.



Background introduction

③ Do not limited by the conditions of the volume and weight of the equipment, the time of the experiment and the number of participants in the field. The cost is lower also.

④ The consideration of the safety factors is often much.

Research status and development trend in China and Other Countries

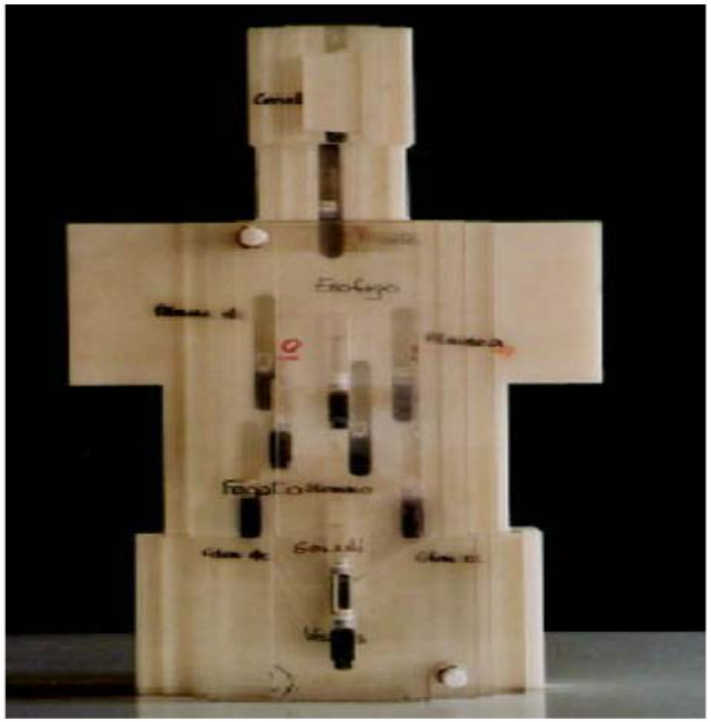
In 2003, the Chacaltaya Observatory in Bolivia and the Testa Grigia research station in Italy jointly carried out the dose assessment of the human body by cosmic ray irradiation at high altitude.

The work is divided into two parts:

1. The spectrum measuring of neutrons caused by cosmic rays in Chacaltaya and Testa Grigia regions
2. Dose distribution measuring by the dosimetry human models and dosimetry devices .

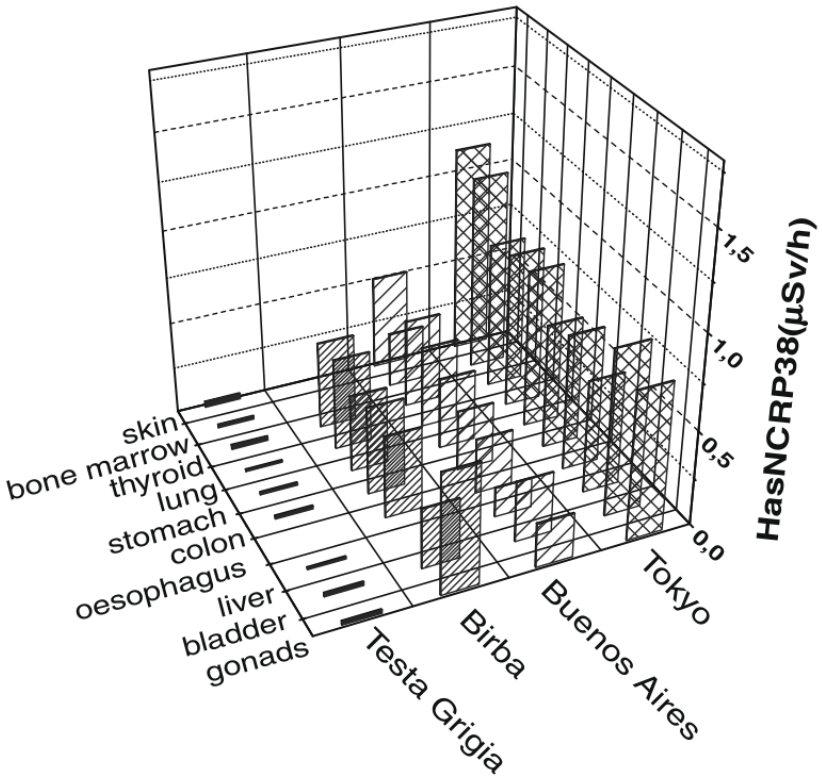
At present, the technology established in this work has been applied to site dosimetry on a long distance traveling plane crossing the two poles and and the dose evaluation of aircraft crew.

Research status and development trend in China and Other Countries



Phantom(Jimmy phantom) used by Chacaltaya Observatory and Testa Grigia research station

Research status and development trend in China and Other Countries



Neutron doses in various organs measured at different altitudes by using Jimmy phantom

Locations and heights:

Plateau, Testa Grigia:3.48km;

BIRBA balloons: 38km;

route I: Buenos Aires-Malpensa:

about 10.83km;

Route II: Tokyo - Rome:

about 10.56km)

Research status and development trend in Other Countries

Matthias M. Meier and others(in Germany) measured and calculated the cosmic ray dose at high altitude by using the tissue equivalent proportional counter, various semiconductor detectors and the bubble neutron dosimeters.

In 2001, Spurny and others(in Czech) analyzed the cosmic ray dose at high altitude, subsonic and supersonic aircraft flying height and space flight height by theoretical calculation and experiment, and used a variety of detectors to the phantom.

Ilya G. Usoskin in Finland and the Gennady A. Kovaltsov(in Russian) set up a model based on FLUKA to calculate the cosmic ray ionization in the atmosphere, and have been applied in practice.

In 2013 Steven A. Walkera, the American scientist, calculated the dose distribution of heavy ions in various organs of astronauts in 1977.

Li Tiehui(in China) measured the neutron spectrum and dose of the cosmic rays at the top of Tibet's Gan Bala mountain by using various detectors.

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It can be seen that the combination of cosmic ray dosimetry and related technologies at high altitude, aeronautical and spaceflight is an active research field in recent years. It is one of the important research directions in the future of radiation dosimetry. And the advanced technology developed in the study of high altitude cosmic ray dose measurement may also be applied to the field of radiation dose measurement in Aeronautics and Astronautics

Research Contents

Dose distribution of cosmic rays in phantom

The detectors used include traditional detectors and some newly developed detectors

The phantoms used are an improved CDP phantom for astronaut dose research in China and a Jimmy phantom used in Italy.

The preliminary application test in space flight will be carried out by using the aircraft equipped with detectors in phantom

Research Contents

CDP phantom

The probes and their functions are:

TLD :absorption dose

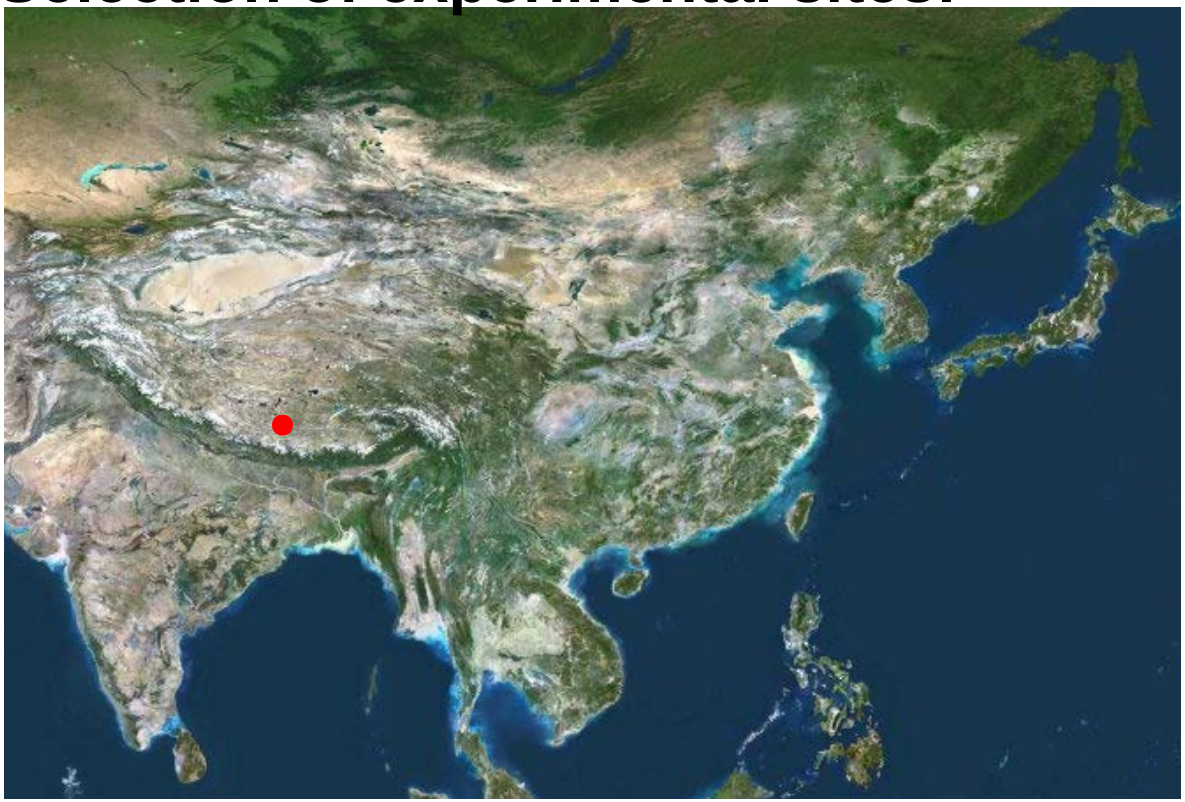
CR-39 :particle fluence and LET

CZT :absorption dose

Plastic scintillation fiber detectors :particle’s LET and the absorption dose.

Research Contents

Selection of experimental sites:

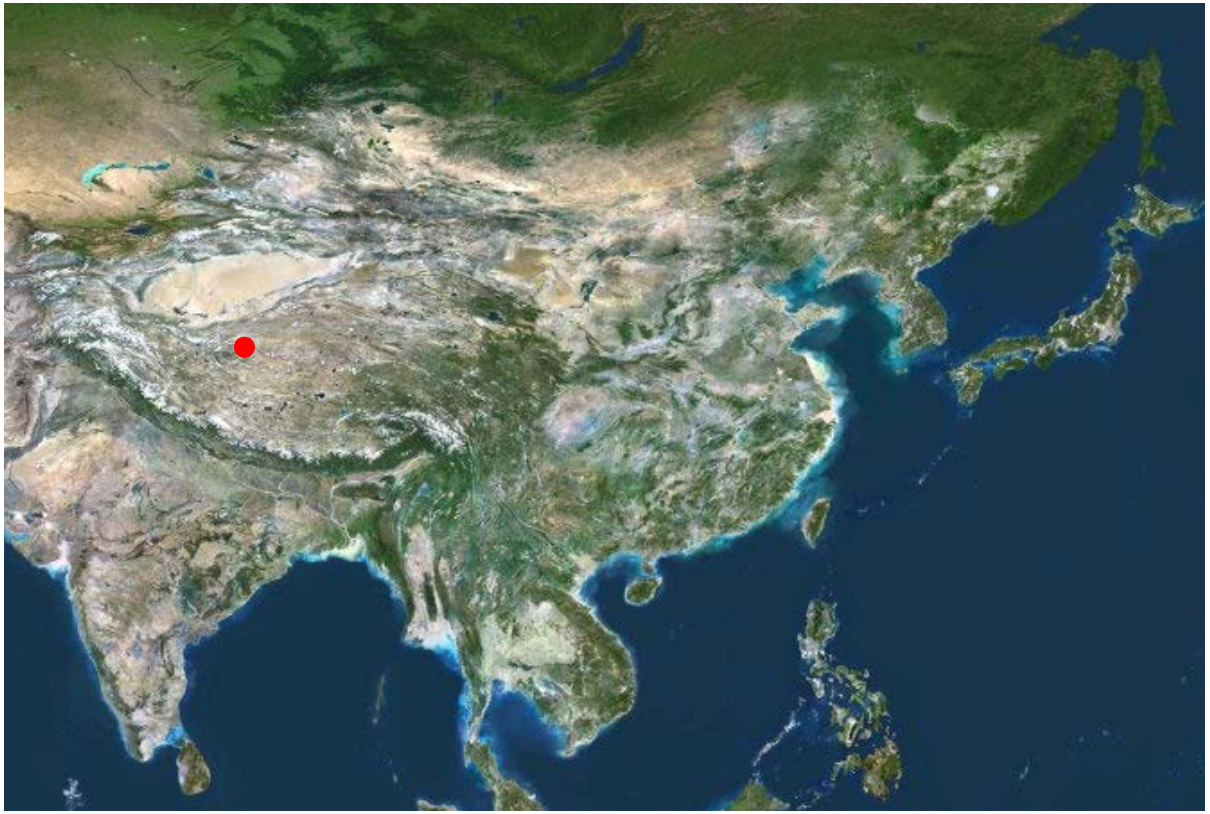


The Tibet Yangbajing cosmic rays observation station

(about 4300m a.s.l.)

Research Contents

Selection of experimental sites:



NaQu District (about 5200m a.s.l.)

Research Contents

Calculation of composition and magnitude of cosmic rays at experimental sites

The SPENVIS program

GEANT4

Calibration of Detectors

The probe will be irradiated by X/ gamma ray, neutron, proton and heavy ion with known energy and dose to determine the relationship between the output and the input amount.

Research Contents

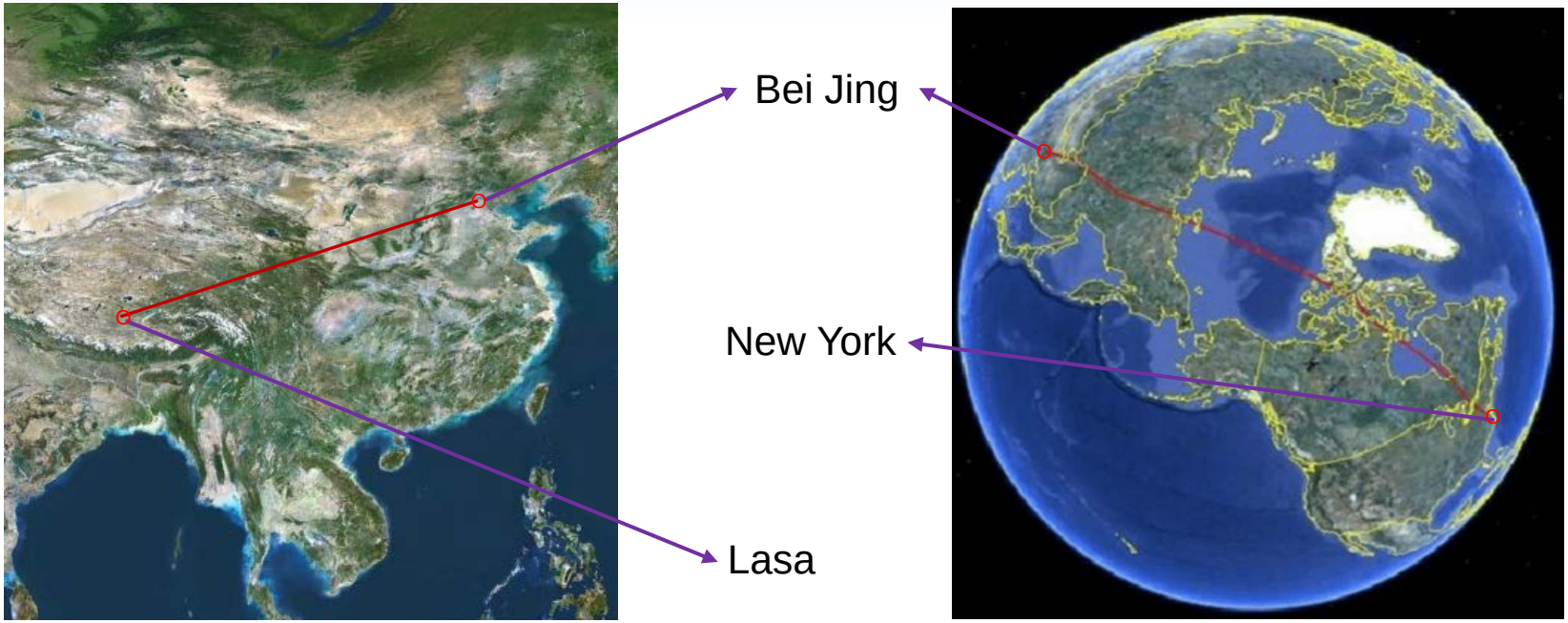
Dose measurement in different organs of Jimmy phantom

Add the bubble dosimeters to measure neutron dose in different parts.

Analysis of the dose data of the phantom

The absorbed dose, equivalent dose and effective dose of organs and tissues in CDP phantom and Jimmy phantom will be analyzed according to the measurement results

Research Contents



Application of terrestrial cosmic ray dosimetry in aviation dose measurement

The phantom and detectors are assembled (only passive detectors are assembled) and transported by aircraft. The Lhasa - Beijing flight is selected for a short round-trip transport, and a trip to the Beijing - New York flight over the North Pole is selected for a long air line. Data will be read and analyzed after the transport.

Research goals

Develop a dose distribution measurement and analysis technique in human models for cosmic rays under high altitude conditions and a preliminary application of the technology.

Key problems to be solved

1. Plateau adaptability of detector and detection equipment

2. The improvement of the sensitivity of the active measuring equipment

3. Establishment of Monte Carlo model for the dose distribution of cosmic rays in the human body at high altitude.

4. Establishment of dose analysis technique for plateau cosmic rays in human models.

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LOGO

Thank You !