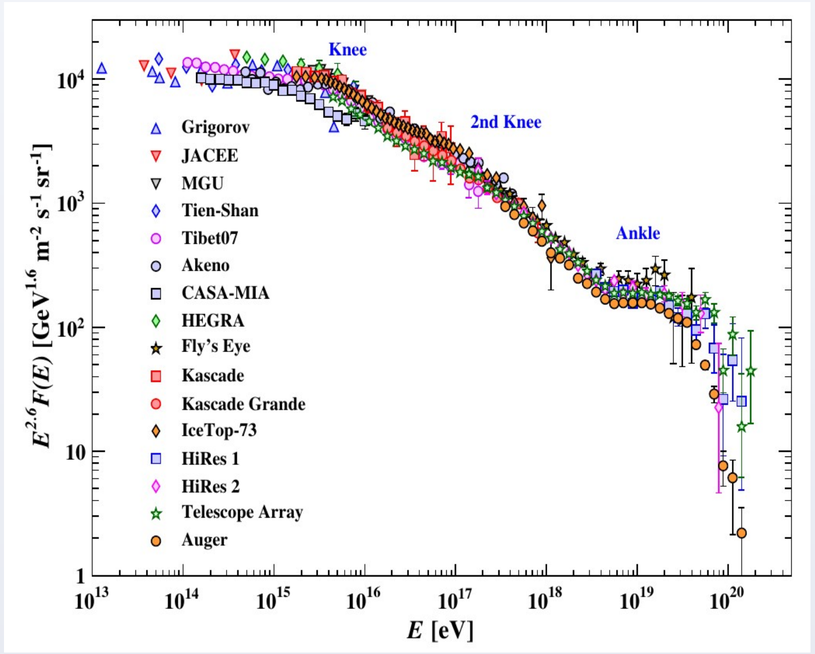
Trigger system of the NUCLEON space experiment

U.M. Nurtayeva[1,3], **V. M. Grebenyuk[1], D. M. Karmanov[4], A. Pan[1,3], D. M. Podorozhny[4], S. Yu. Porokhovoy[1], A. B. Sadovsky[1], A. V. Tkachenko[1] and L. G. Tkachev[1,2]**

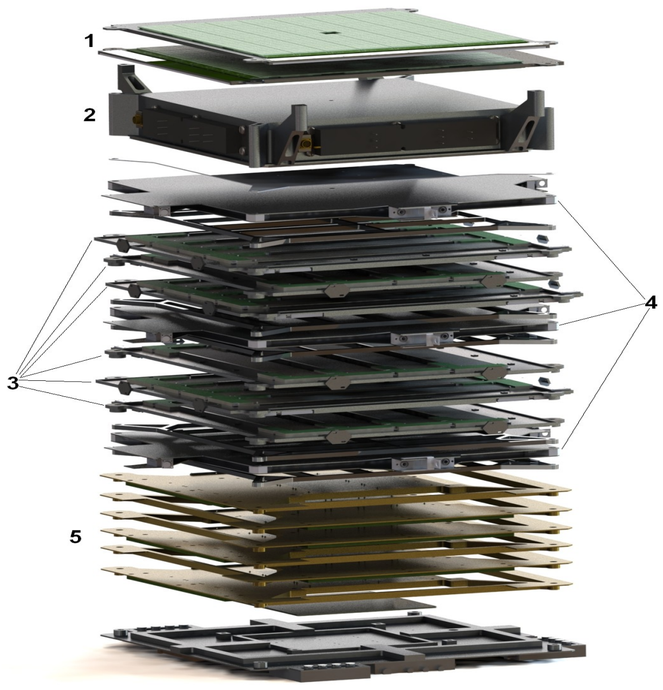
[1]Joint Institute for Nuclear Research, Dubna, 141980, Russia
[2]Dubna State University, Dubna, 141980, Russia
[3]The Institute of Nuclear Physics, Almaty, 050032 Kazakhstan
[4]Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, 119991, Russia

The NUCLEON satellite experiment is designed to investigate directly the energy spectra of galactic cosmic ray nuclei and its charge composition before the "knee": in the energy interval from 100 GeV to 100 TeV and the charge range Z = 1-30 respectively. The "knee" energy range of $10^{14} - 10^{16}$ eV is a crucial region for the understanding of the cosmic-ray acceleration and propagation in the interstellar medium. The NUCLEON detector has been data taken since December, 2014. The NUCLEON trigger system and cosmic ray (CR) events selection are described, including the beam tests at the SPS CERN, flight tests in orbit and the Monte-Carlo simulation. Measuring the energy spectrum, charge, mass of CR particles will provide the missing information about the sources of CR, about the mechanisms of their acceleration and propagation in the galaxy.



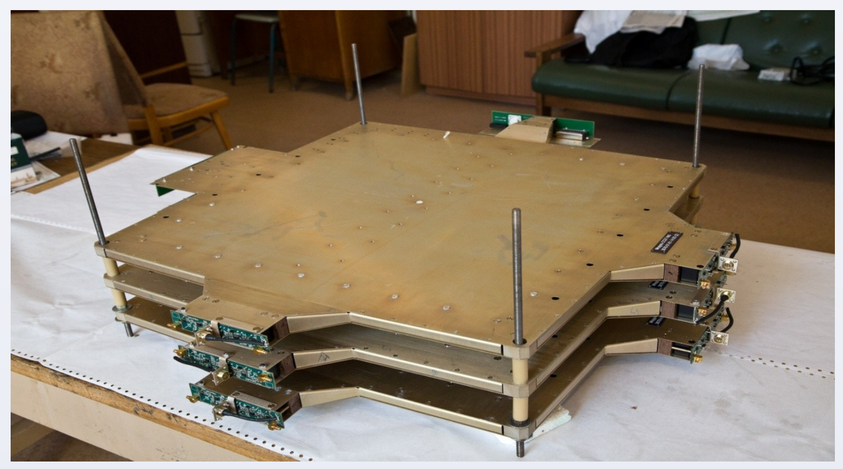
The «knee» region is a spectrum of CR at E ~ 10^{11} - 10^{16} eV. The NUCLEON experiment aim is to measure the spectrum and composition of CR in the pre-knee region to obtain the information about the sources of CR, the mechanisms of their acceleration and propagation in our galaxy. During the flight the data were obtained up to $5 \cdot 10^{14}$ eV.

THE NUCLEON DETECTOR



The schematic view of the NUCLEON device

THE SCINTILLATION TRIGGER SYSTEM

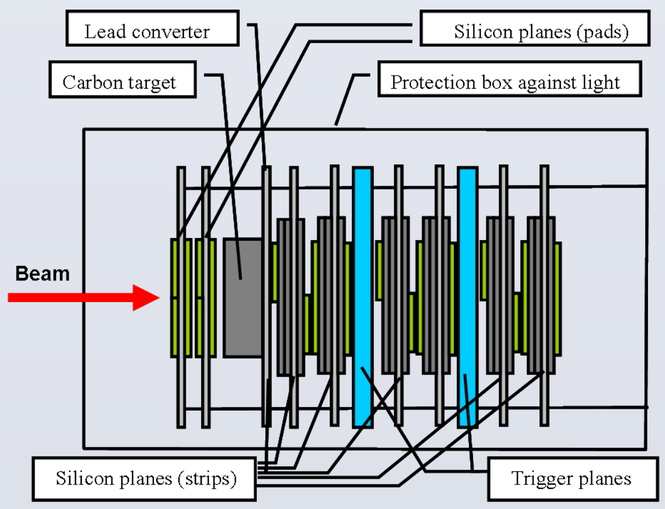


Three modules of the NUCLEON trigger system

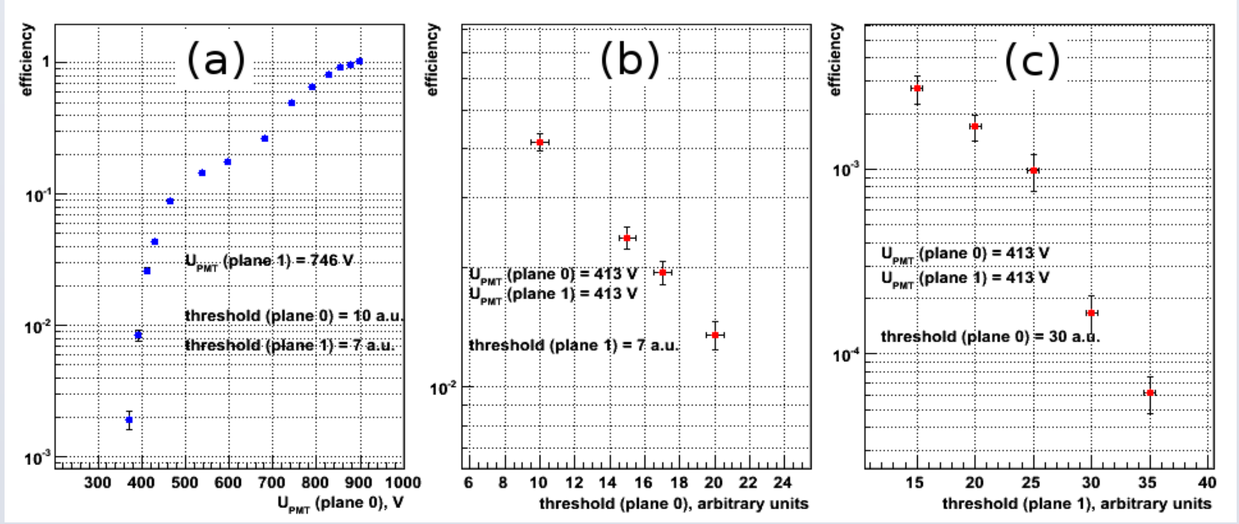
The detector consists of the following main systems:
(1) the charge measurement system (CMS) of the primary particles
(2) the graphite target
(3) the tracker for the energy measurement system (EMS) by the KLEM method.
(4) the fast scintillation trigger system (STS) to select useful and suppress background events;
(5) the tungsten-silicon ionization calorimeter
(6) the service electronics

CALIBRATION AND BEAM TESTS OF STS AT SPS CERN

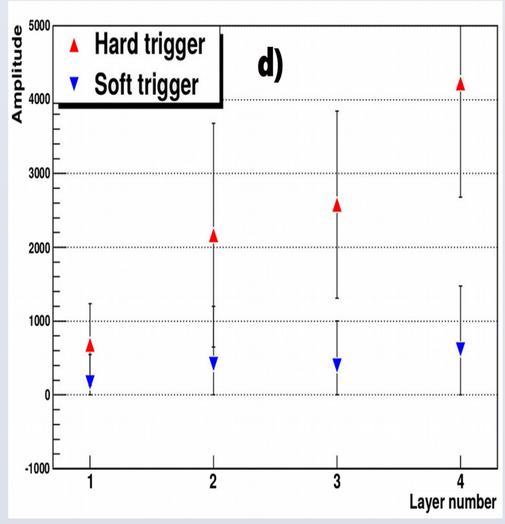
The NUCLEON scintillator and silicon detectors, readout and data taking electronics have been tested at SPS CERN. The beam spot is ~ 1.5 cm and intensity of 10^3-10^4 particles per second. The beam tests of the NUCLEON detector prototypes have been carried out with pions up to 350 GeV/c.



The scheme of beam test experiment on the SPS CERN

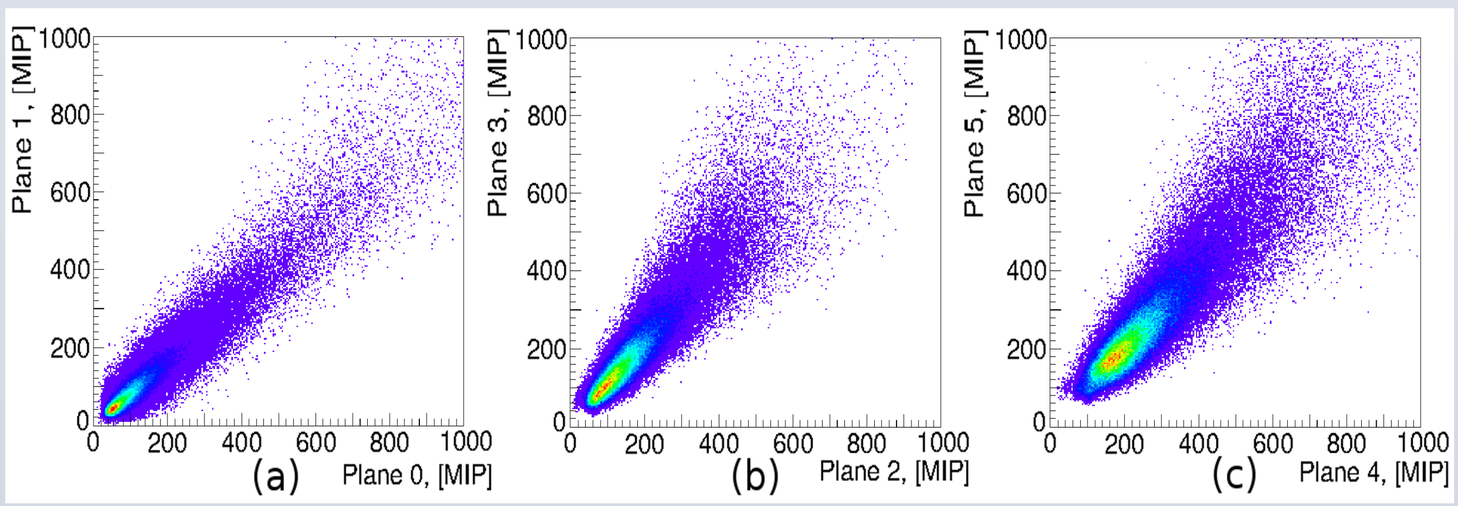


The suppressing efficiency of the beam particle at different threshold and HV values

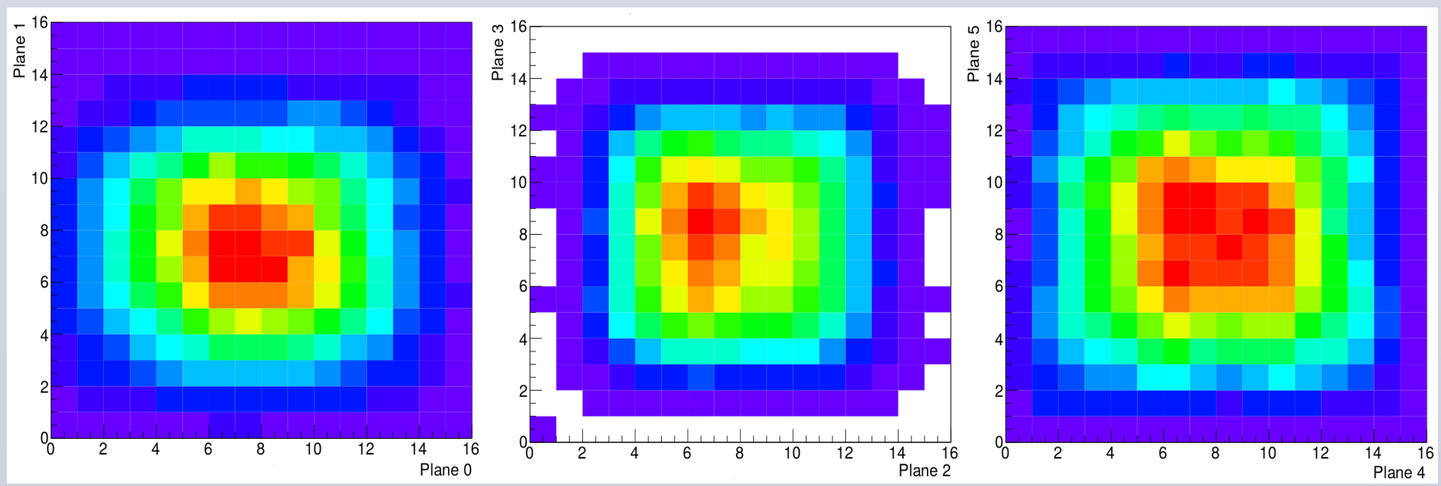


Value of the average total amplitude of the event with silicon microstrip planes at different trigger conditions

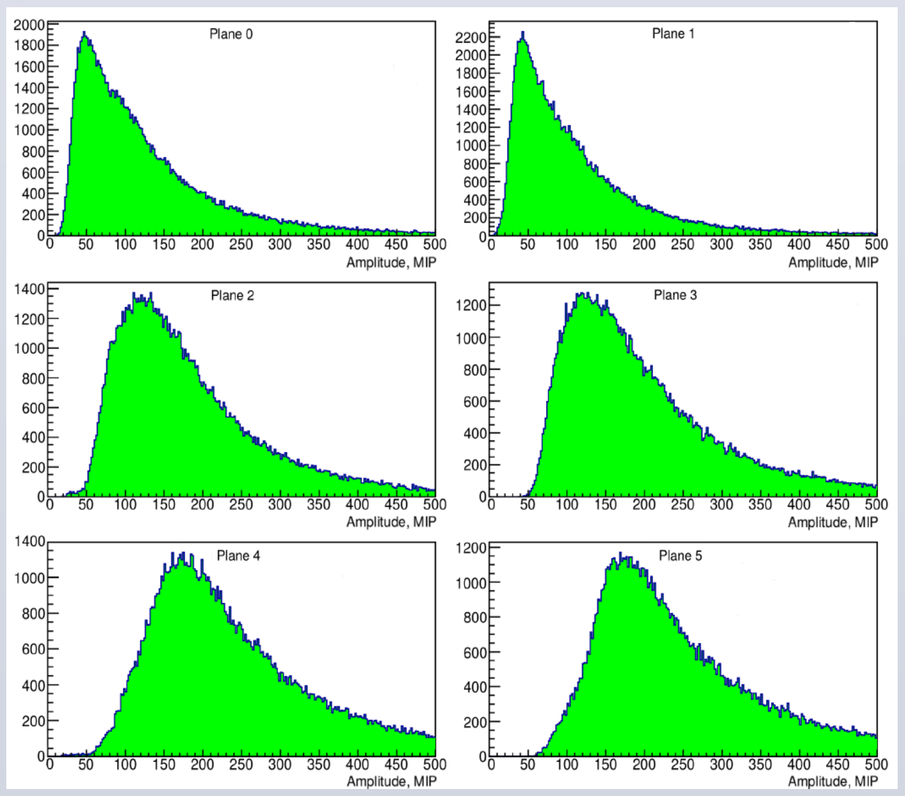
THE COMBINE FLIGHT TESTS OF STS



Correlation of amplitudes in adjacent planes of the STS module



Position of axes of the secondary shower in STS module



Distribution of the integral amplitudes in STS planes

Conclusion:

The NUCLEON detector for the study of CR in the 10^{11} - $5 \cdot 10^{14}$ eV was launched into orbit in December 2014.

The results obtained in flight tests in orbit show that all detectors and electronics of the STS operates reliable and stable in accordance with the beam test measurements at SPS CERN.

During the NUCLEON detector operation in orbit a number CR events were obtained and preliminary physical results are publishing.