The NUCLEON instrument technological sample testing by pion beams

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Abstract. **The NUCLEON experiment is being prepared for cosmic ray research at energy range 10^{12}-10^{15} eV. A new method has recently been proposed for measuring the spectra of primary CR particles by recording the spatial density of secondary charged particles produced by interactions of primary particles inside the setup. The photons are converted into charged electronpositron pairs by a tungsten converter. This method can be used to construct lightweight spectrometers of large geometrical factor for satellite experiments. The functional protoype of experimental device was tested by charge particles beams on SPS accelerator (CERN). The test results have demonstrated the feasibility of performing an orbital experiment with the proposed equipment.**

***Keywords*: NUCLEON beam test**

I. Introduction

The NUCLEON satellite experiment is aimed to investigate high energy (10^{12}-10^{15} eV) cosmic rays. The new method of energy measurements is used. This method is based on event by event measuring the spatial density of flux of secondary charged and neutral particles produced in a vertex point of nuclear interaction in the carbon target and passing through a thin tungsten gamma-converter [1,2]. This technique allows to construct large aperture lightweight device. The beam tests were performed to investigate energy and charge parameters of the new device. In this paper we present some results of beam tests in comparison with the Monte-Carlo simulation data. In autumn 2008 the technological prototype was tested. The pion (π+) beams of energies 200, 250, 300, 350 GeV were used. The main aims of this beam test were:
- Microstrip detectors channels calibration;
- Events selection criteria elaboration;
- Analysis of energy determination accuracy, comparison with simulation results.

Fig. 1: Side view of the NUCLEON device design.

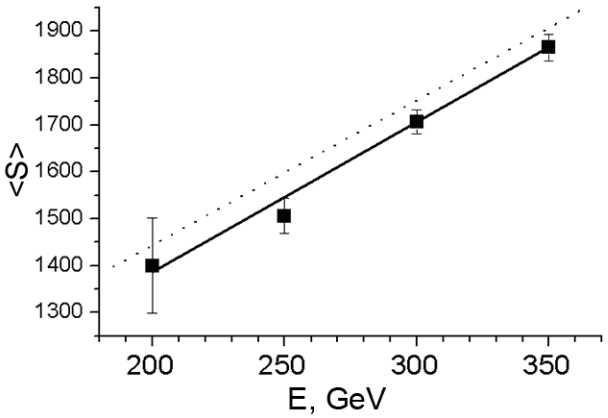


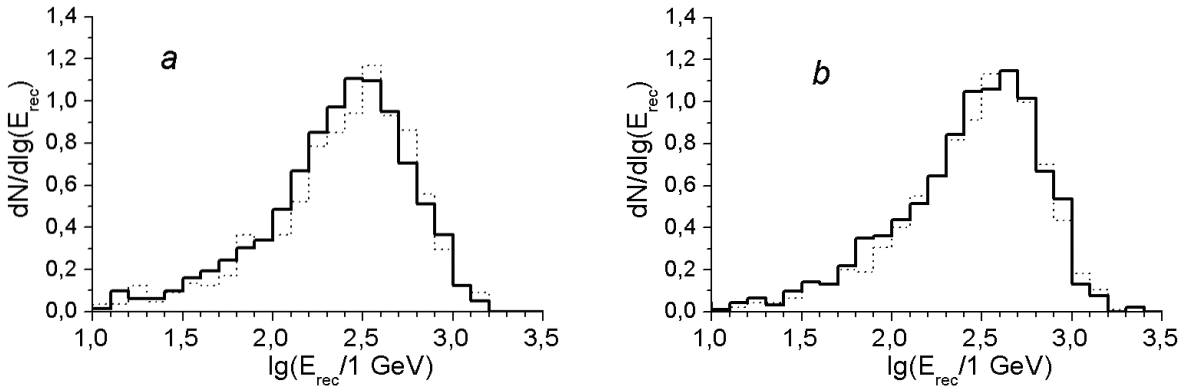
Fig. 2: Calibration curves S(E).

II. Device concept

The structure of NUCLEON prototype is close to the structure of the orbital device. The view of the NUCLEON device design is shown in Fig. 1. It includes the charge measuring system (4 pad silicon detector layers), carbon target (68 mm), the tracker and the energy measuring system (6 microstrip silicon detector

TABLE I: Parameters of Energy Measurements by Beam Test.

	Experiment					Simulation		
E, GeV	$< S >$	$< E_{rec} >$, GeV	$\sigma, \%$	N_{tot}	N_{trig}	$< S >$	$< E_{rec} >$, GeV	$\sigma, \%$
200	1400	204±32	87	3405	30	1454	219	98
250	1506	238±12	90	2695	350	1594	265	88
300	1706	300±8	80	4719	858	1731	308	82
350	1865	350±9	77	5857	963	1923	367	77



(a) E=300 GeV (b) E=350 GeV

Fig. 3: Reconstructed energy distributions.

layers mounted on lead plates), the trigger system, control electronics. Every detector layer included 4 silicon detectors. The Monte-Carlo simulation was performed by GEANT 3.21 program.

III. Energy reconstruction in accelerator tests

The experiments in CERN were performed to test the functional prototype. The NUCLEON device was exposed with the pion beams of energy 200, 250, 300, 350 GeV in 2008. Simulations of beam tests were performed for all values of energy. Detector responses are reproduced well enough by Monte-Carlo simulations with GEANT3.21 tool [3]. The results of this analysis confirmed our suggestion about the opportunity of the NUCLEON device to measure energy of particle by the proposed method. Calibration dependencies S(E) are presented in fig.2 for experiment (solid) and simulation (dashed). Examples of reconstructed energy distributions are shown in fig.3 for experimental and simulated events for pions with energies 300 and 350 GeV. The mean values of reconstructed energies and RMS are presented in table 1. Thus our experimental and simulation data are in an agreement.

IV. Conclusions

Performed simulation has shown an opportunity of cosmic ray energy spectra reconstruction by the NUCLEON satellite experiment. The simple trigger criteria permit to reject the main part of background events. Charge detector resolution allows to separate different nuclei. Large experimental material obtained by beam tests confirms simulation data about charge and energy characteristics of the NUCLEON device.

V. Acknowledgements

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References

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