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Nuclear Instruments and Methods in Physics Research A 461 (2001) 275–277

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

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NINA: a silicon detector for cosmic-ray astrophysics

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For the WiZard-NINA Collaboration[1]

Abstract

The NINA apparatus, on board the satellite Resurs-01 n.4, has been orbiting the Earth since July 10th, 1998, in polar revolution at 1 AU. Its scientific goal is the study of the galactic, solar and anomalous components of the cosmic rays in the range 10–200 MeV/n. After a description of the instrument, results of GCR fluxes measurements and of particle identification in orbit are presented.

PACS: 95.70.Sa; 95.55.−n

Keywords: Cosmic rays; Space vehicles; Silicon technology

1. The instrument NINA

The instrument NINA, developed by INFN (Italy) and MEPhI (Russia), is optimised for the detection of cosmic-ray nuclei of galactic, solar or anomalous origin at 1 AU, between 10 and 200 MeV/n. The apparatus is carried on board the Russian satellite Resurs-01 n.4, launched on a polar sun-synchronous orbit at 840 km altitude on July 10th, 1998.

NINA consists of the following four subsystems: the detector *(box D1)*, the on-board computer *(box D2)*, the interface computer *(box E)* and the power supply *(box P)*. The detector $D1$ is organised in 16 planes, each one composed of two n-type silicon detectors, $6\times 6\,cm^2$, segmented in 16 strips mounted back-to-back and orthogonal so as to measure the X and Y coordinates of the particle. The thickness of the first pair is 150 μm; all the others, however, are 380 μm thick. The interplanar distance is 1.4 cm

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0168-9002/01/$ - see front matter
PII: S0168-9002(00)01224-9

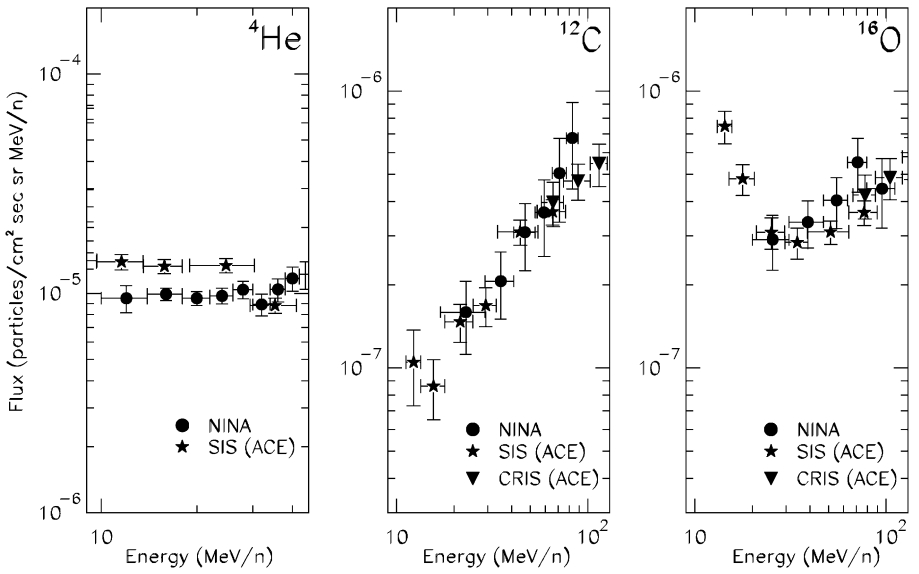

Fig. 1. Differential energy spectra for ^{4}He (left), ^{12}C (centre), and ^{16}O (right) in the solar quiet period December 1998–March 1999 as measured by NINA, together with data from SIS and CRIS on board ACE.

except for the first and second planes, maximum angular aperture of the detector is about 32°. The whole silicon tower is housed in a cylindrical aluminium vessel, 300 μm thick, filled up with nitrogen at 1.2 atm.

The analog signals produced by the particles in the silicon strips are digitised by means of a 12-bit ADC, with a full scale of 250 MeV; the resolution per channel is thus about 0.07 MeV/ch. The energy threshold for the single signal is 0.25 MeV.

NINA detector is mounted at the top corner of Resurs-01, in such a way as to point always to the zenith, whilst the interfaces and service boxes are located inside the body of the satellite. NINA can be remotely controlled from the ground by 24 means of telecommands; the average volume of data transferred from the satellite to the ground is 2 MB/day, corresponding to more than 20 000 events. NINA has a total of 16 MB mass memory available in the onboard memory storage of the spacecraft.

2. GCR fluxes measurements and isotope identification

The fluxes hereby presented refer to Galactic Cosmic Rays (GCR) registered by NINA in the

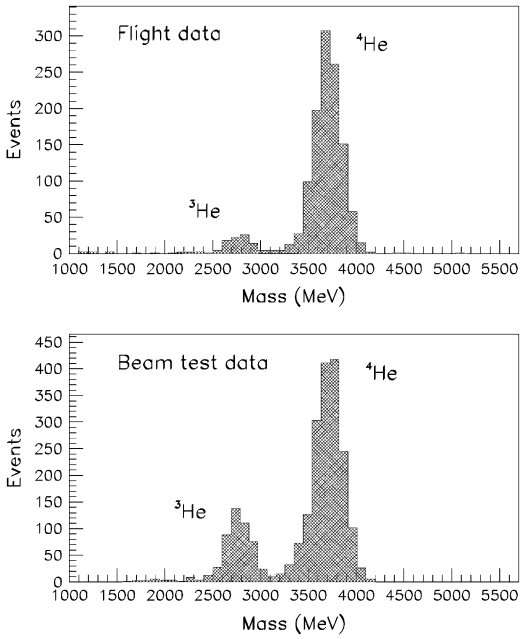

Fig. 2. Mass distribution of helium in orbit and during a beam test session, as reconstructed by NINA.

solar quiet period December 1998–March 1999, detected at a value of L-shell>6.

In Fig. 1, NINA flux of ^{4}He (left) is plotted together with data from SIS on ACE, and NINA fluxes of ^{12}C (centre) and ^{16}O (right) are compared to the results from SIS and CRIS on ACE; all ACE data are referred to the period 6 February–4 March 1999. The measurements from the three instruments are in very good agreement.

In Fig. 2, the reconstructed masses for helium isotopes detected by NINA in orbit are compared to those obtained during a beam test session; the mass resolution of NINA in flight is equal to about 0.16 amu for both helium isotopes, in agreement with expectations.