

## CORONAS-F.

The “CORONAS-F” satellite, the second one of CORONAS satellite series, launched on July 31, 2001 in Russia into a circular orbit with the altitude  $507\pm 21$  km and 82.5 degree inclination, provided scientific data during the whole period 2002 - 2003. The satellite is oriented towards the Sun. A complex of instruments measuring predominantly corpuscular energetic emissions from the Sun (SKL, coordinated by Skobeltsyn Institute of Nuclear Physics, Moscow, Russia) is a part of experimental devices. Institute of Experimental Physics, SAS, Košice, Slovakia participated at a device SONG measuring energetic neutrons, gammas and protons. Several tens of events with gamma ray increases due to the solar emissions were identified during the two years period.

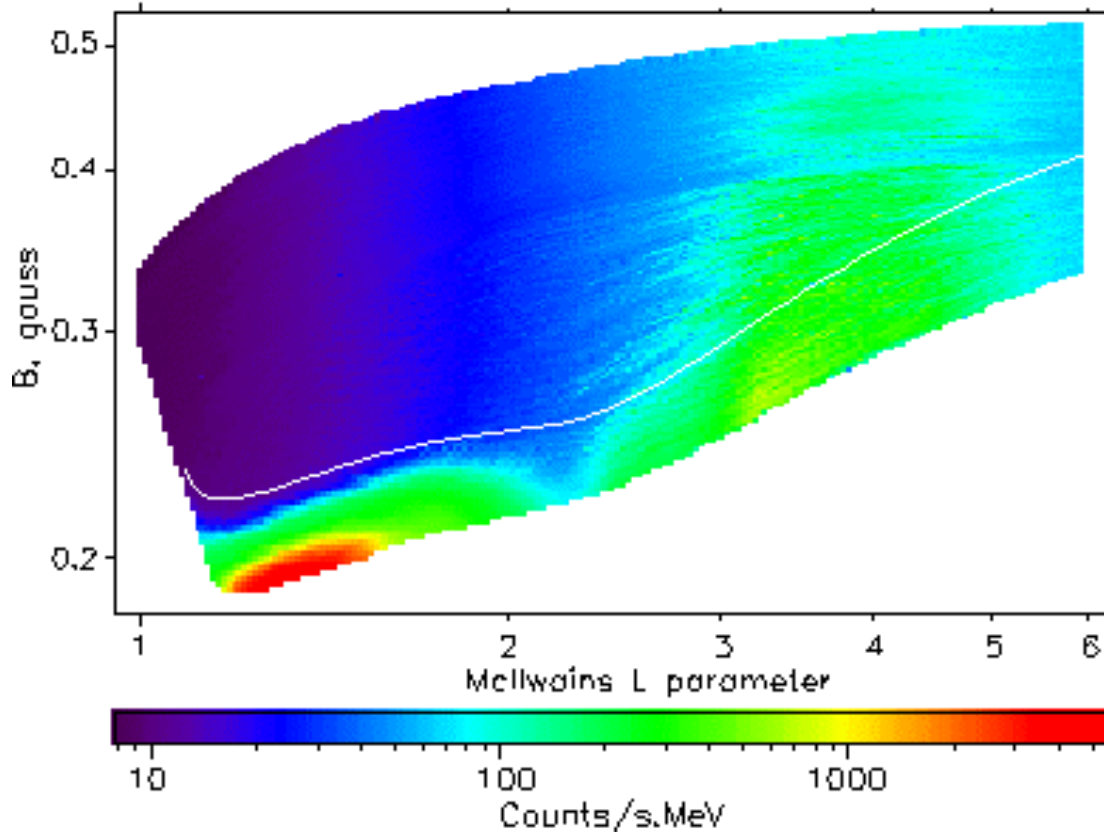
The dynamics of cosmic particles with the energies well below those of cosmic rays and well above those of solar wind (from few tens of keV up to several MeV) have been studied by the *Institute of Experimental Physics, SAS, Košice* (its Department of Space Physics) in the co-operation with the laboratories in abroad and with P.J. Šafárik University as well as Technical University Košice. In addition, the measurements of secondary cosmic rays observed by ground based methods have been analyzed. The analysis of the data obtained both from the low altitude and high apogee satellites, as well as development and construction of new instruments for the future studies continued in the period of years 2002 and 2003.

Both case and statistical type of studies were done with using the large amount of data by energetic particle instruments DOK-2 on Interball-1,-2, and DOK S on Magion 4 and 5, developed at the Department with cooperation of laboratories in abroad. Comparison with data of US satellite POLAR provided a possibility to study a unique case of ion acceleration at the bow shock to unusual high energies during a space weather event on May 4, 1998, when magnetosphere was strongly compressed. It was suggested that ions are accelerated at the quasi-parallel bow shock to energies as high as 1 MeV and subsequently transported into the magnetosheath during that event. More than 200 cases of energetic ion beams with narrow lines in energy spectrum were observed by DOK-2 on Interball-1 in 1995-1998. These events named as AMI (Almost Monoenergetic Ions) cannot be explained by current models of particle acceleration or escape from the magnetosphere. One hypothesis of the

explanation is suggested as the solar wind ions acceleration in a strong electrostatic field burst within a small region. Multispacecraft studies using also DOK-2 data on Interball-1 were used to describe the motion of the magnetopause due to the variations of interplanetary magnetic field. Statistical study of large amount of upstream ion events by DOK-2 has shown that for the diffusive upstream events observed near the bow shock there is much higher probability of observing high flux of protons for quasi-parallel connections to the model bow shock than for the cases with quasi-perpendicular geometry. This is in accordance with the Fermi acceleration at the shock. While such dependence is clear at low energies ( $\sim 20\text{-}30$  keV), it becomes less pronounced with the increasing energy. On the other hand the dependence on geomagnetic activity is increasing with energy. The relative importance of the two possible sources of the seed particles, namely those of solar wind ions and particles leaking from magnetosphere was described up to 300 keV on the large data set. The detailed energy spectra by DOK-2 instruments on Interball-1 and 2 showed many cases of dispersive velocity events. They can be used for remote timing and identification of the place of particle injection during geomagnetic disturbances. The dependence of the dispersive events occurrence on altitude, L and magnetic local time was obtained. A case study by DOK-2 during a small substorm when Interball-1 was near the reconnection point in the central magnetotail region, has shown the strong changes of ion flux anisotropy and fast change of energy spectra when the satellite crossed the neutral sheet. Papers and presentations using the measurements by DOK-2 and DOK-S for physical analysis are in [1,3,13,15,17,25,28,29,30,31,38,39,40,41,42,44,45].

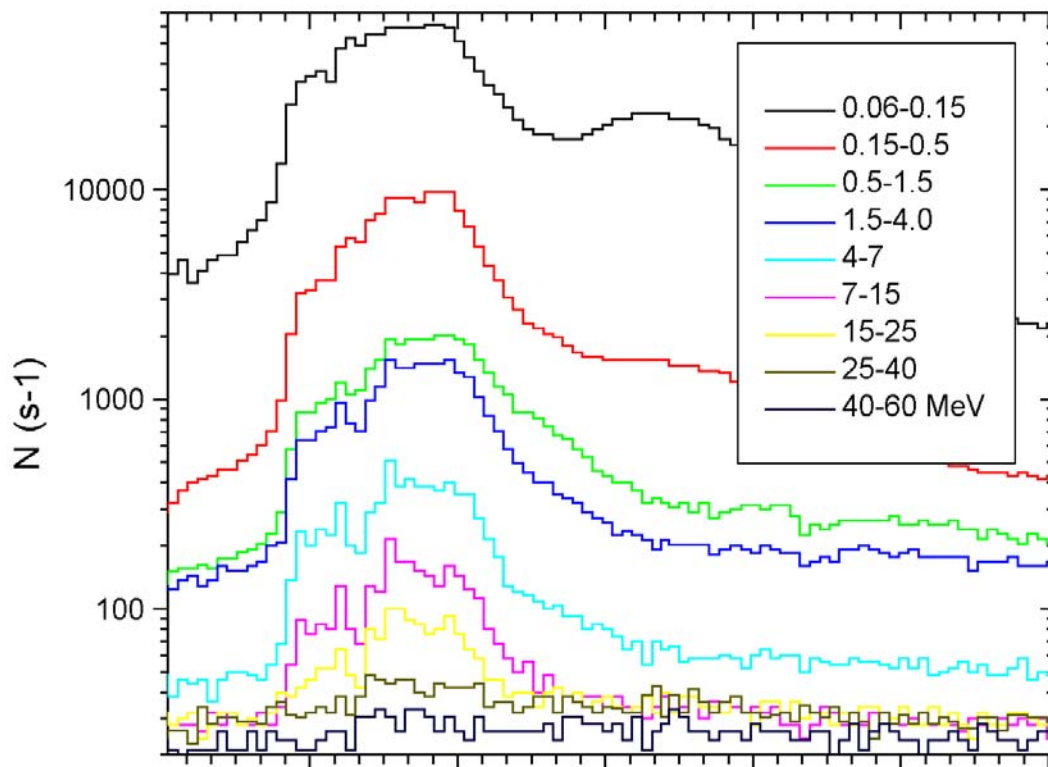
The detailed geographic and geomagnetic (L,B) maps of distribution of gamma ray flux at 500 km were obtained by analysis of SONG device measurement on CORONAS I. Comparison with data from US satellite SAMPEX showed similarities with energetic electron fluxes. Thus the measurements of gamma rays can be one of remote sensing observations of the energetic electron flux in radiation belts within the drift loss cone. Comparison of SONG gamma ray measurements with electron fluxes from AE-8 model was done in.

Data analysis of energetic particle measurements on satellite Active and on MIR orbital station yielded in the distribution of proton spikes near geomagnetic equator at different altitudes, various local times and for various levels of geomagnetic activity. Results using measurements by CORONAS I satellite are in papers or presentations [8,9,10,33].



*Fig. 1. Gamma ray (3 – 8.3 MeV) flux in LB coordinates obtained from measurements on CORONAS I satellite (altitude ~500 km).*

The instrument SONG M measuring the energetic gamma rays and neutrons (its electronic part was designed, constructed and tested in the Department) is working continuously on low altitude polar orbiting satellite CORONAS-F from July 2001 until now. About 40 high energy solar gamma ray emissions were identified from the data in years 2002 and 2003. Results using data from SONG on CORONAS F are in [7,34,35].

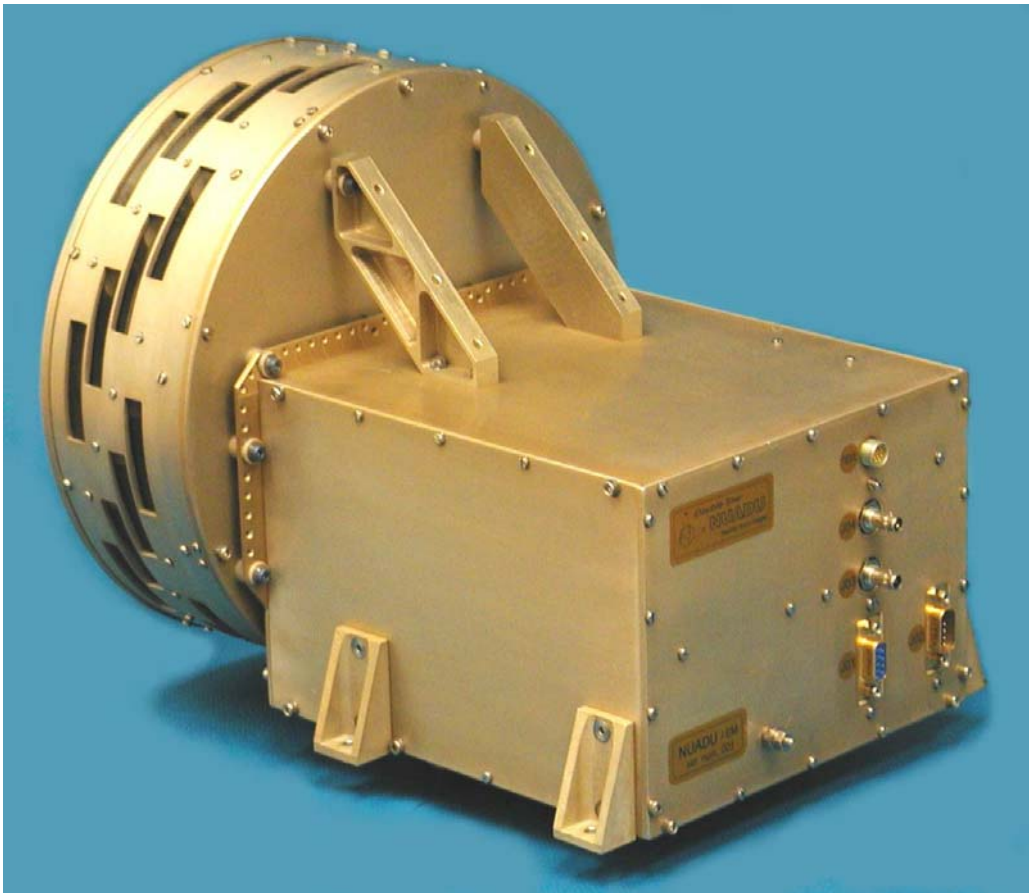


1630-1636 UT on August 25, 2001

*Fig. 2. Example of data obtained from measurements by SONG instrument on CORONAS F satellite. The count rates in different channels are displayed. A strong increase of high energy gamma rays (up to at least 20 MeV) was observed from a solar flare on August 25, 2001. SONG experiment observed also increase due to solar neutrons from that flare.*

The institute is continuing the works on design, development and testing of new instruments for the satellite measurements. A photostimulation method was suggested and developed for study of pile-up and dead time effects important for measurements of particle fluxes and energy spectra by solid state detectors in space [2]. The dependence of the registered spectral distortion and the dead time loss on the incident count rate can be observed and recorded clearly with the method. In cooperation with U. of Maynooth, Ireland and STIL Ireland the Electrical Supporting System for the mission ESA-ROSETTA was constructed with the contribution of the Department. In the same cooperation the Department is currently contributing to the design, testing and construction of the Ireland's national instrument NUADU (NeUtral Atom Detector Unit) for

China's Double Star Polar Mission (Principal Investigator Susan McKenna-Lawlor) for the polar mission of the project (joint project of ESA and Chinese Acad. Sci.). The objectives are oriented to processes controlling the ring current characteristics and monitoring of space weather effects in the magnetosphere. The energetic neutral atoms created by charge exchange of energetic ions with the neutrals of exosphere will be observed by a set of 16 solid state detectors regularly spaced over elevation of  $180^\circ$  remotely from the orbit of the satellite.



*Fig. 3. Ireland's national instrument NUADU (NeUtral Atom Detector Unit) for China's Double Star Polar Mission (Principal Investigator Susan McKenna-Lawlor). Launch is scheduled for July 2004. IEP SAS participated in the development and construction of this experiment.*

Data from cosmic ray continuous measurements by neutron monitor at Lomnický Štít with 1 min resolution are now available in real time at <http://neutronmonitor.ta3.sk>. The modulation of cosmic rays in the heliosphere and sensitivity of neutron monitor to galactic cosmic rays was studied. Connections between cosmic rays, solar variability and space weather effects, as well as temporal evolution of quasiperiodicities in cosmic ray records were examined in the series of papers [11,14,18,19,20,22,23,24,27,31,37,40,41,42,43]. The geomagnetic effects on cosmic rays have been checked by methods of trajectory computations in model geomagnetic field [4,5,16,26].

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