ENERGETIC PARTICLE EXPERIMENT ERNE

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Abstract. The Energetic and Relativistic Nuclei and Electron (ERNE) experiment will investigate the solar atmosphere and the heliosphere by detecting particles produced in various kinds of energy release processes. ERNE is at the upper end in energy among the SOHO particle instruments. The instrument will measure the energy spectra of elements in the range Z=1-30. The energy coverage varies dependent on the particle species from a few MeV/n up to a few hundred MeV/n and electrons from 2 to 50 MeV. At high energies, ERNE records also the direction of the incident particles for accurate measurements of the pitch angle distribution of the ambient flux within the viewing cone. Especially the isotope identification capability has been one of the instrument design goals, thus providing new data regarding various fundamental questions in solar physics.

Key words: solar physics – cosmic rays – solar flares – coronal mass ejections

1. Introduction

ERNE measures energetic particles: electrons, protons and isotopes of heavier elements. It measures the energies, identifies the particles and records the directional distribution of the flux of solar particles. The research program of ERNE and the SOHO satellite is to understand the structure and behavior of the Sun, and to investigate the open questions related to the cosmic ray modulations in the solar system.

The two-year measurement period starting at the end of 1995 coincides with solar activity minimum, when the low noise level of the interplanetary magnetic field (IMF) allows observation even of minor events.

Among the most important problems still lacking a sufficient answer are the mechanisms of energy release and transport, the chemical and isotopic composition in different parts of the solar atmosphere, the processes of particle acceleration, magnetic field reconnection on various spatial and temporal scales, the generation and properties of different types of shocks, relations between various phenomena occurring in active regions (e.g., flares, coronal mass ejections, erupting filaments, shocks), and the propagation of energetic particles in the IMF and the extent of interplanetary acceleration. Key contributions towards solving these problems can be obtained from suprathermal and energetic particle observations by using these particles as diagnostic

tools for remote probing of solar processes. Most of these processes have a distinctive signature in the timing, composition, and energy spectra of the accelerated particles.

Being outside the Earth's magnetosphere, the particle instruments on board SOHO have a direct view of the charged particle flux coming along the interplanetary magnetic field line.

Measurement of energy spectra of various ions as well as isotopic abundance ratios gives information on the acceleration of solar energetic particles. By adding measurement of the anisotropy of the particle flux at the spacecraft location, it is possible also to study the propagation of these particles in the IMF.

The measurements will cover particle flux at quiet time, solar particle events, flux enhancement due to particle acceleration by interplanetary shocks and solar modulation of galactic cosmic rays.

This experiment supported by the other particle and solar wind experiments on board SOHO will give a detailed picture consisting of various particle types and energy ranges. Together with observations of other instruments of the SOHO mission this will form a database for research of solar phenomena in detail - particle observations can be related to observed characteristics of the region where particles are accelerated. Because no local magnetic field measurements are carried out on board SOHO, collaborative work with other spacecrafts producing magnetic field data is needed.

At an early phase of SOHO project, ERNE and COSTEP (Comprehensive Suprathermal and Energetic Particle Analyzer) (Müller-Mellin et al., 1995) formed a collaboration called CEPAC (COSTEP-ERNE Particle Analyser Collaboration). Although ERNE and COSTEP are separate investigations, their instruments have been adjusted to each other so that a wide range of particle energies and species from the energetic heavy nuclei to suprathermal electrons is covered.

CEPAC consists of three sensor units, which have common interfaces to the spacecraft data handling system through the Common Data Processing Unit (CDPU) and to the spacecraft power bus through the Low Voltage Power Converter (LVPC).

Design and production of the ERNE Sensor Unit (ESU), LVPC and CEPAC common ground support equipment were responsibilities of the ERNE part of CEPAC.

2. Scientific Objectives

2.1. Solar particle production

Impulsive solar particle events originate in compact regions low in the corona. These events are characterized by a large number of electrons compared to protons. Impulsive events with enriched $^3\text{He}$ and heavy element popu-