

INTAS 8777



Solar and Galactic Cosmic Ray Acceleration and Modulation

University of Greifswald (Germany)
University of Bern (Switzerland)
University of Tel Aviv (Israel)
Yerevan Physics Institute (Armenia)

Greifswald

Home town of Caspar David Friedrich



Marktplatz

University



Physics in Greifswald



2007



Max-Planck-Institute for Plasma Physics

Leibniz-Institute for Low Temperature Plasma Physics



Rainer Hippler

INTAS 8777

Jungfraujoch

Jungfraujoeh-Sphinx 3573 m / 11723 ft



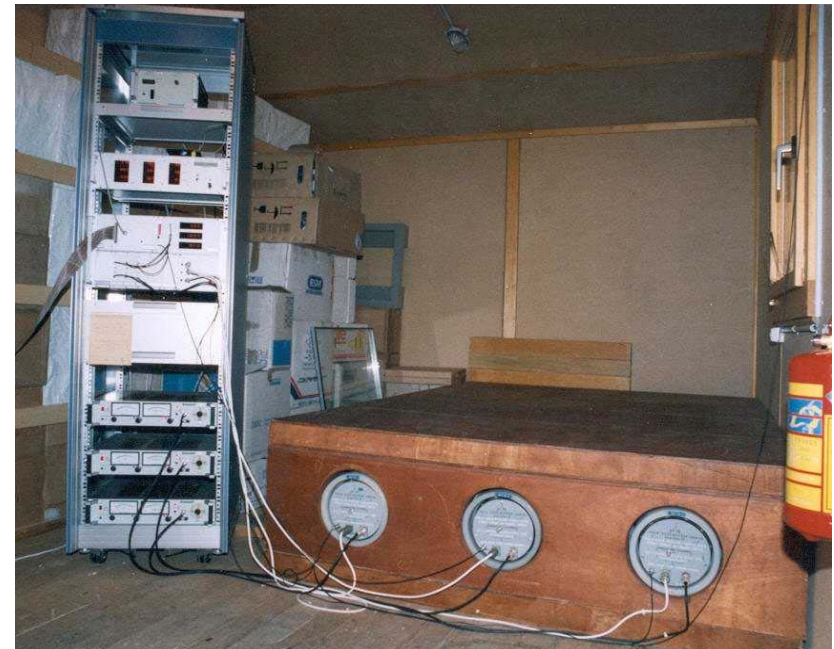
University of Bern



Neutron Monitors at Jungfrauoch <http://cosray.unibe.ch/>



18-IGY



3-NM-64

Tel Aviv University



Mt. Hermon

Muon Telescope Site



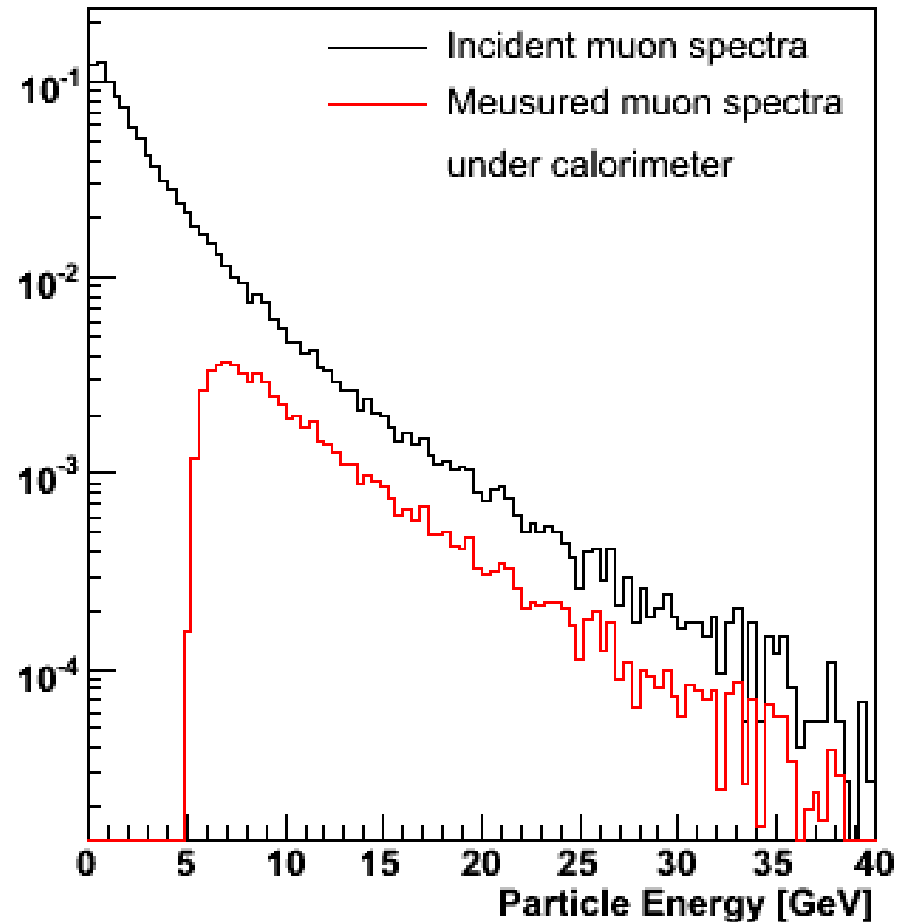
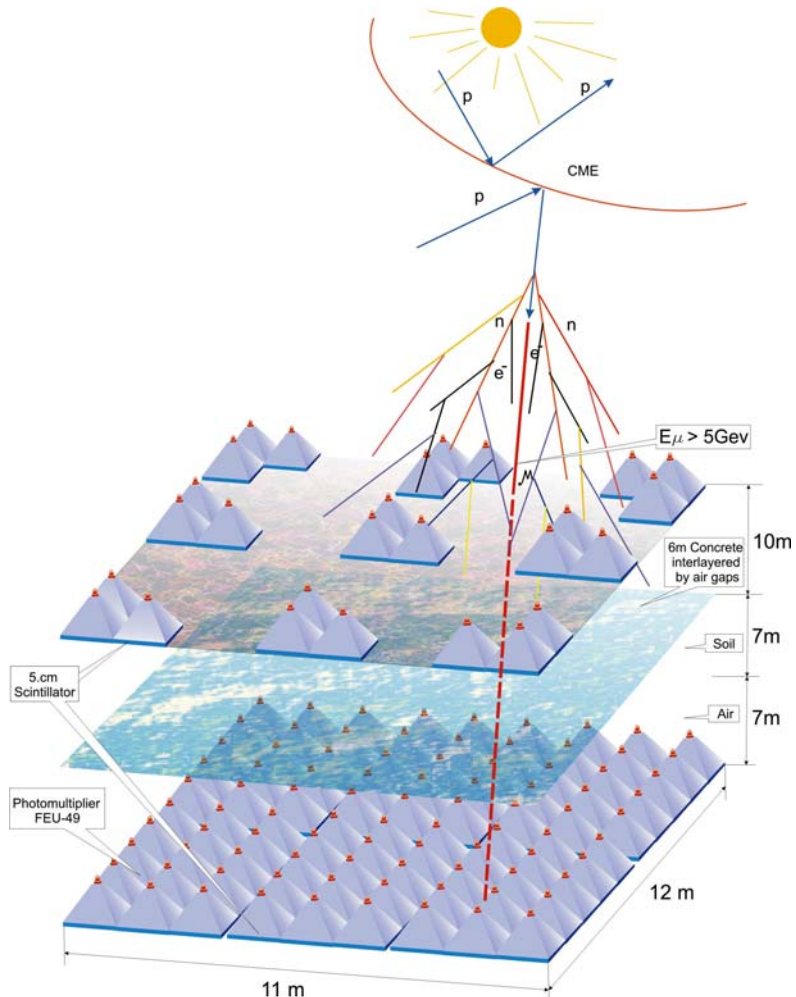
Armenia







Aragats Multidirectional Muon Monitor (AMMM)





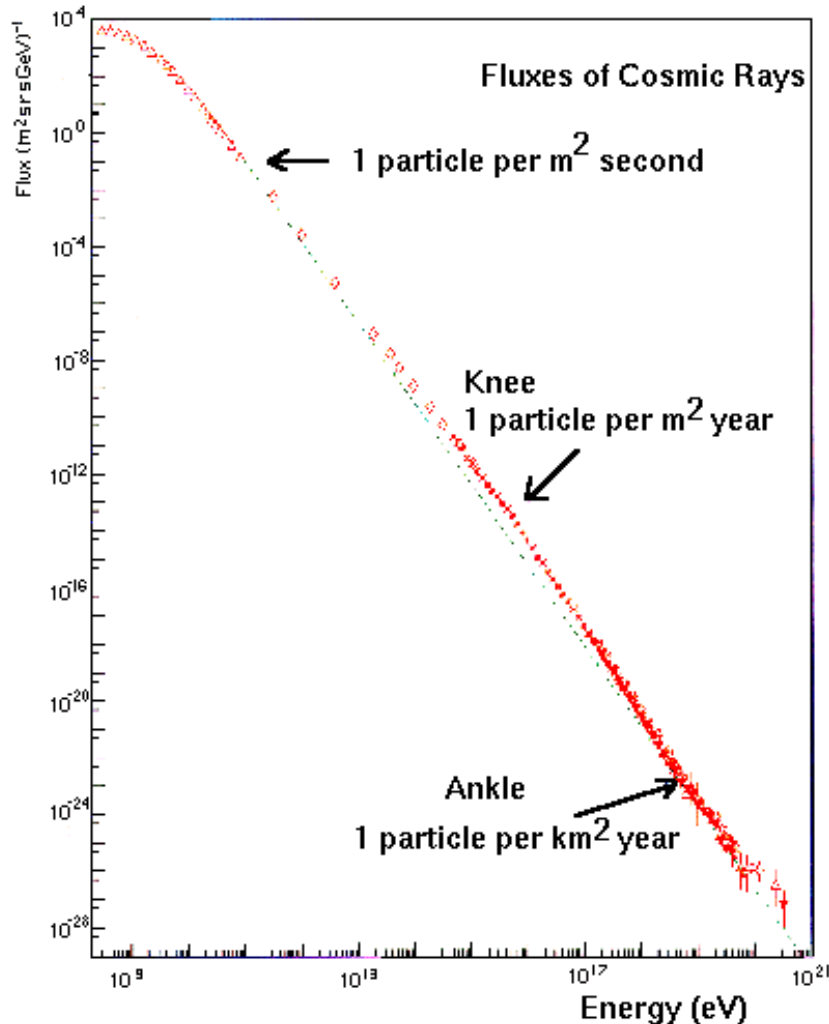
Cosmic Rays

There are different types of cosmic rays:

- **Galactic cosmic rays** are probably accelerated in the blast waves of supernova remnants in the Milky Way Galaxy.
- **Solar cosmic rays** are produced in high energy processes at or near the Sun after a violent eruption at the Sun.
- **Composition** of galactic cosmic rays:
 - Protons: 87 %
 - Helium nuclei: 12 %
 - Heavy atomic nuclei: 1 %



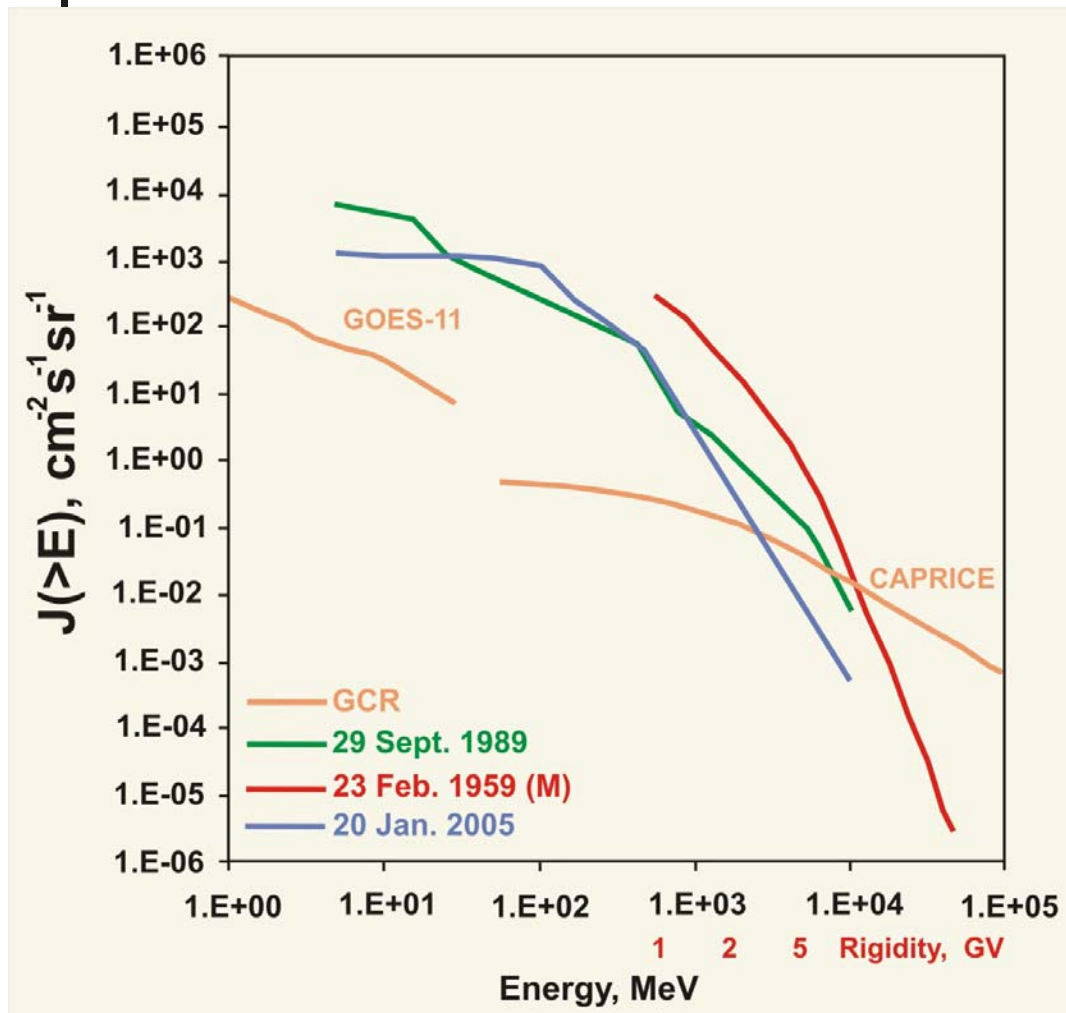
Galactic Cosmic Rays



Galactic cosmic rays (GCR) originating from the Galaxy are accelerated to the highest energies known.

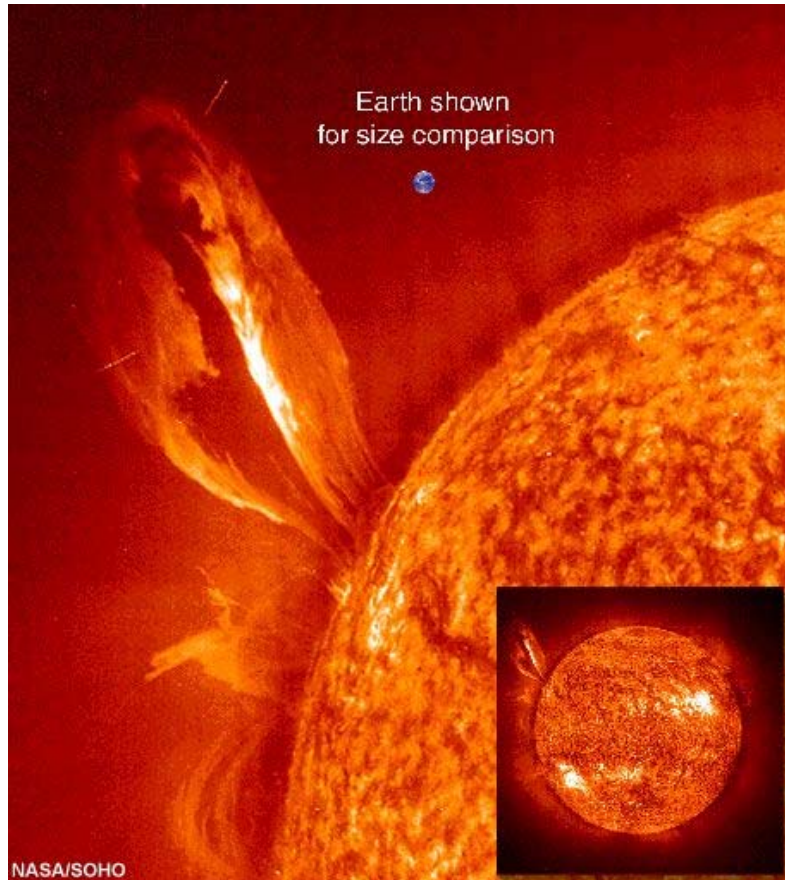


Solar cosmic rays



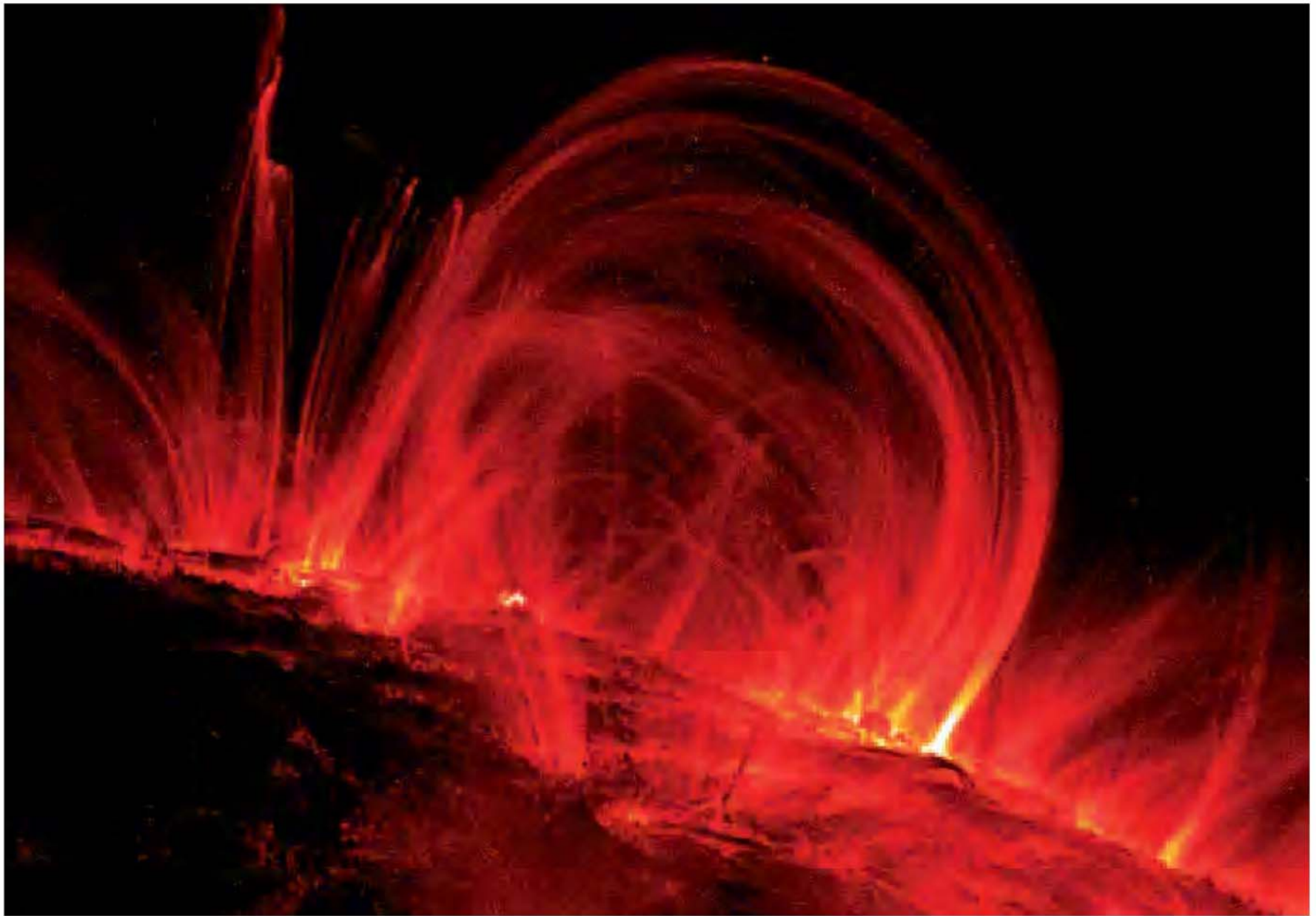
Solar cosmic rays (SCR) originate from energetic solar particle events (SEP). SCR have a steeper energy dependence and do not extend to as large energies as GCR.

Spaceweather Storms



SCR are ejected in the course of Coronal mass ejections (CME) providing hazards to the earth environment, in particular to satellites, aircraft and spacecraft crew and passengers, and to power lines on ground.





TRACE, NASA

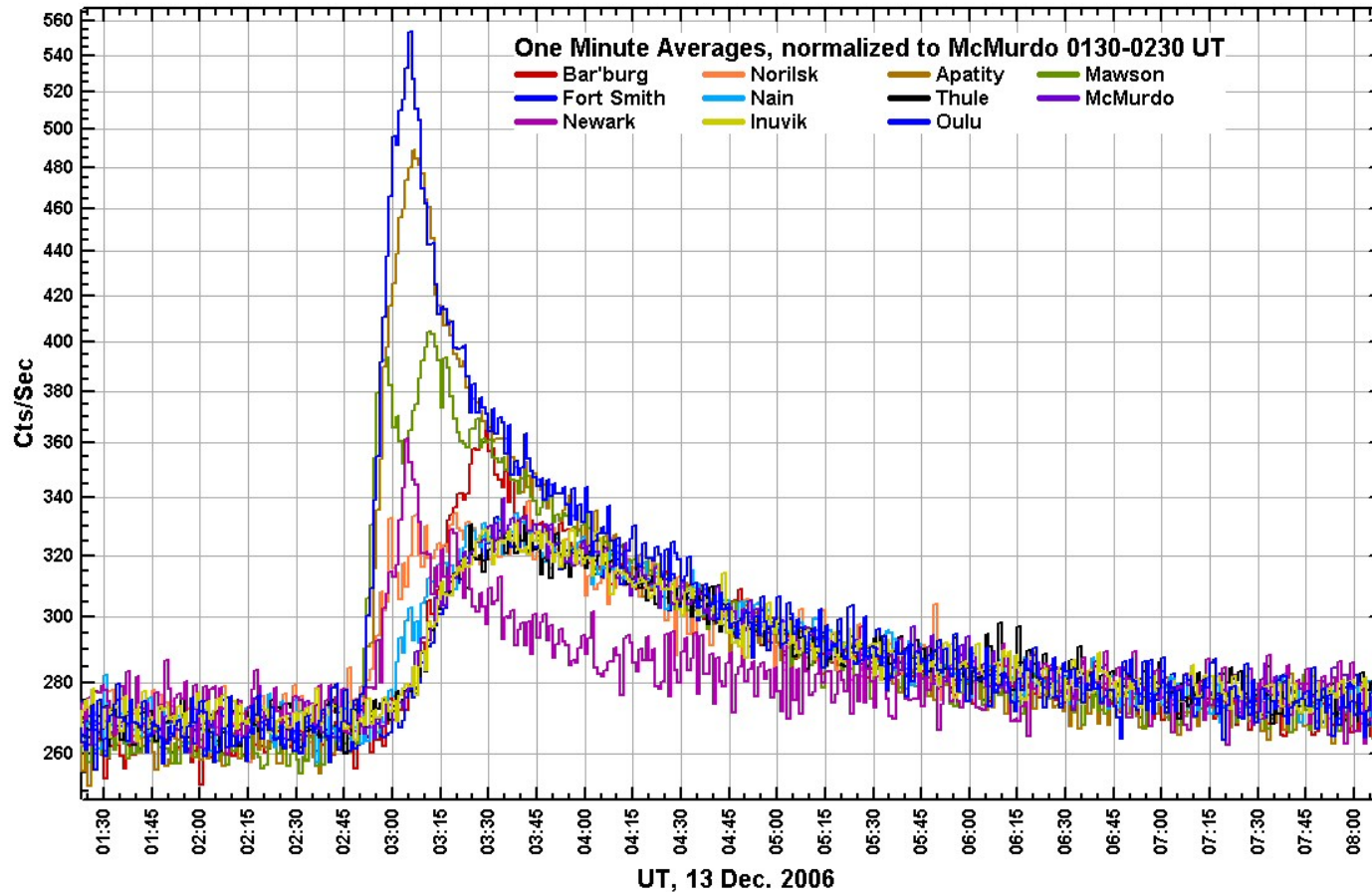
Rund 30-mal so groß wie der Erddurchmesser sind diese im extrem ultravioletten Spektralbereich (Wellenlänge: 17 nm) sichtbaren Bögen in der Sonnenkorona.



Neutron monitors



Spaceship Earth Observations of the Solar Minimum GLE Recorded December 13, 2006 by Neutron Monitors



CR Anisotropies for Space Weather Applications



Kp

NM Count Rate

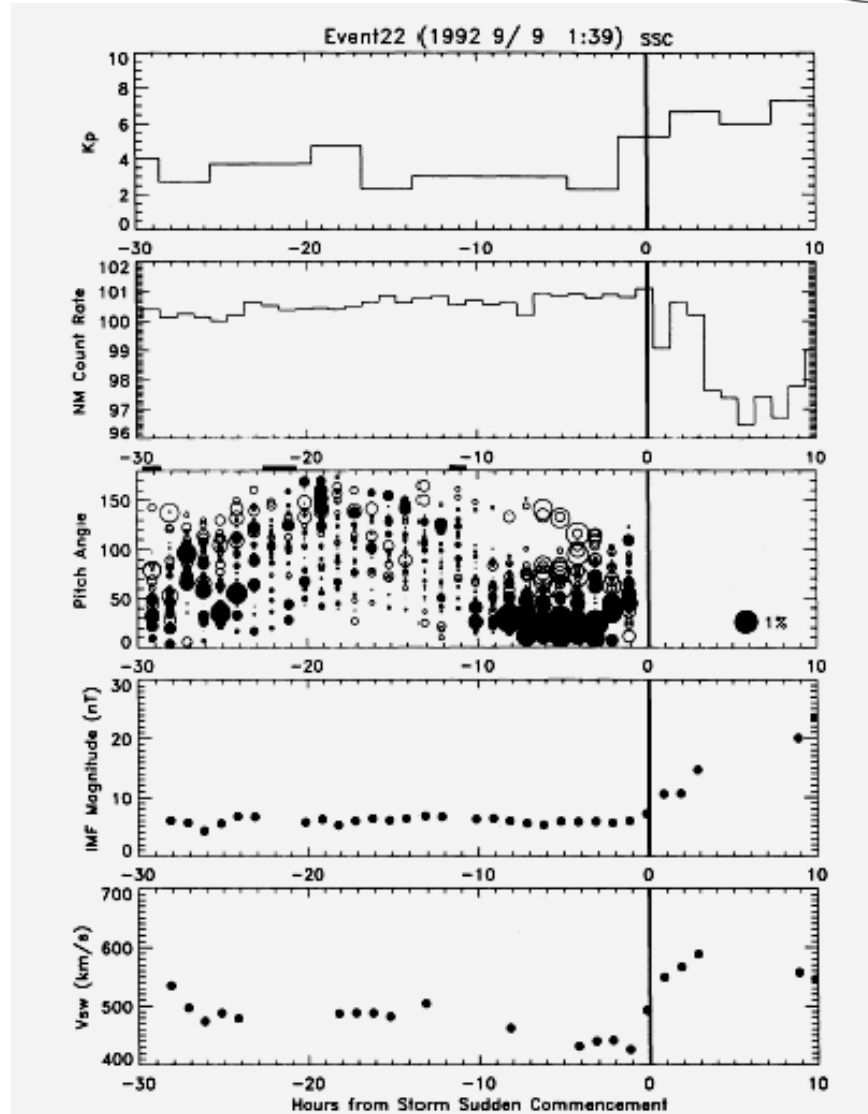
Muon telescope anisotropy

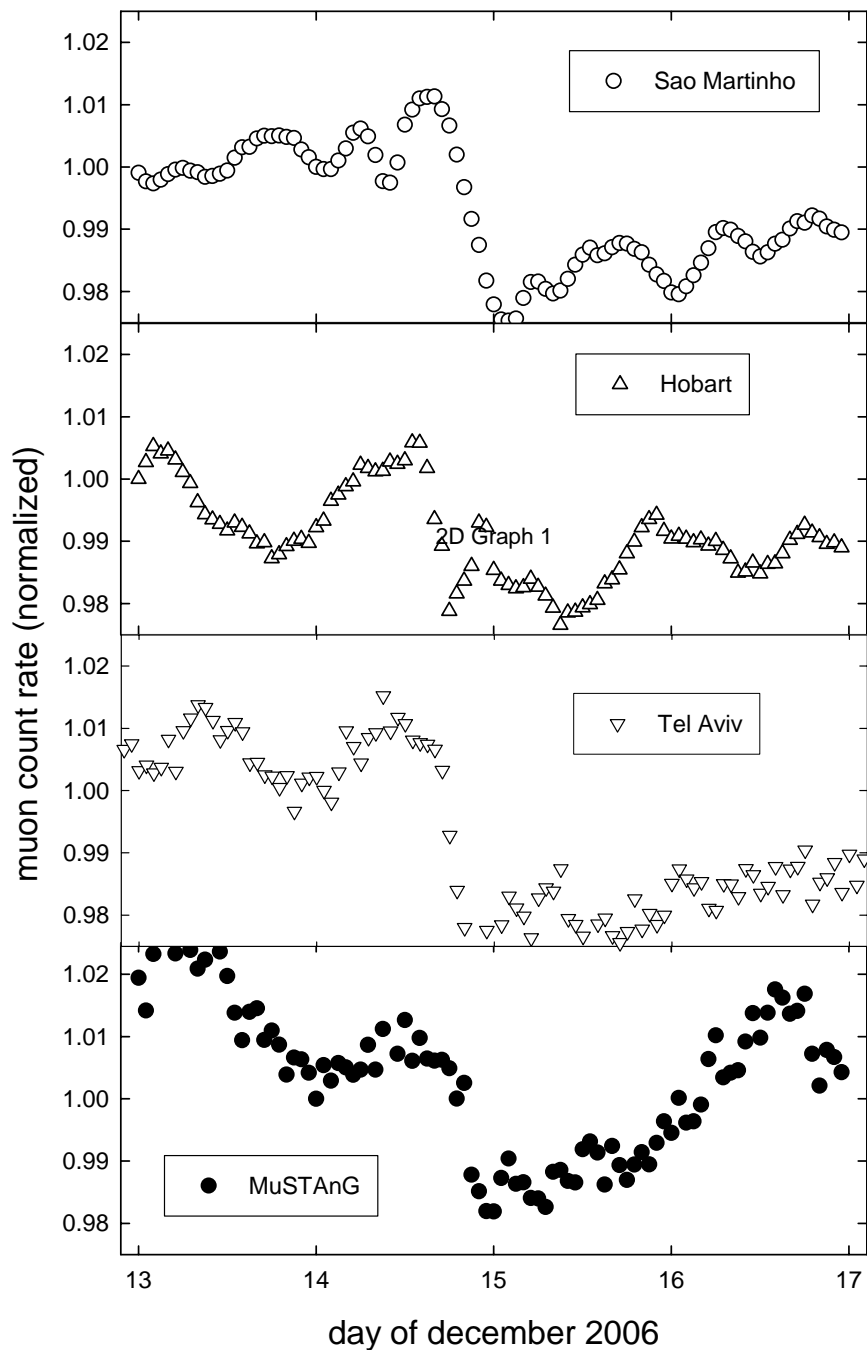
IMF Magnitude

Solar Wind Velocity

Munakata et al., 2000

Rainer Hippler





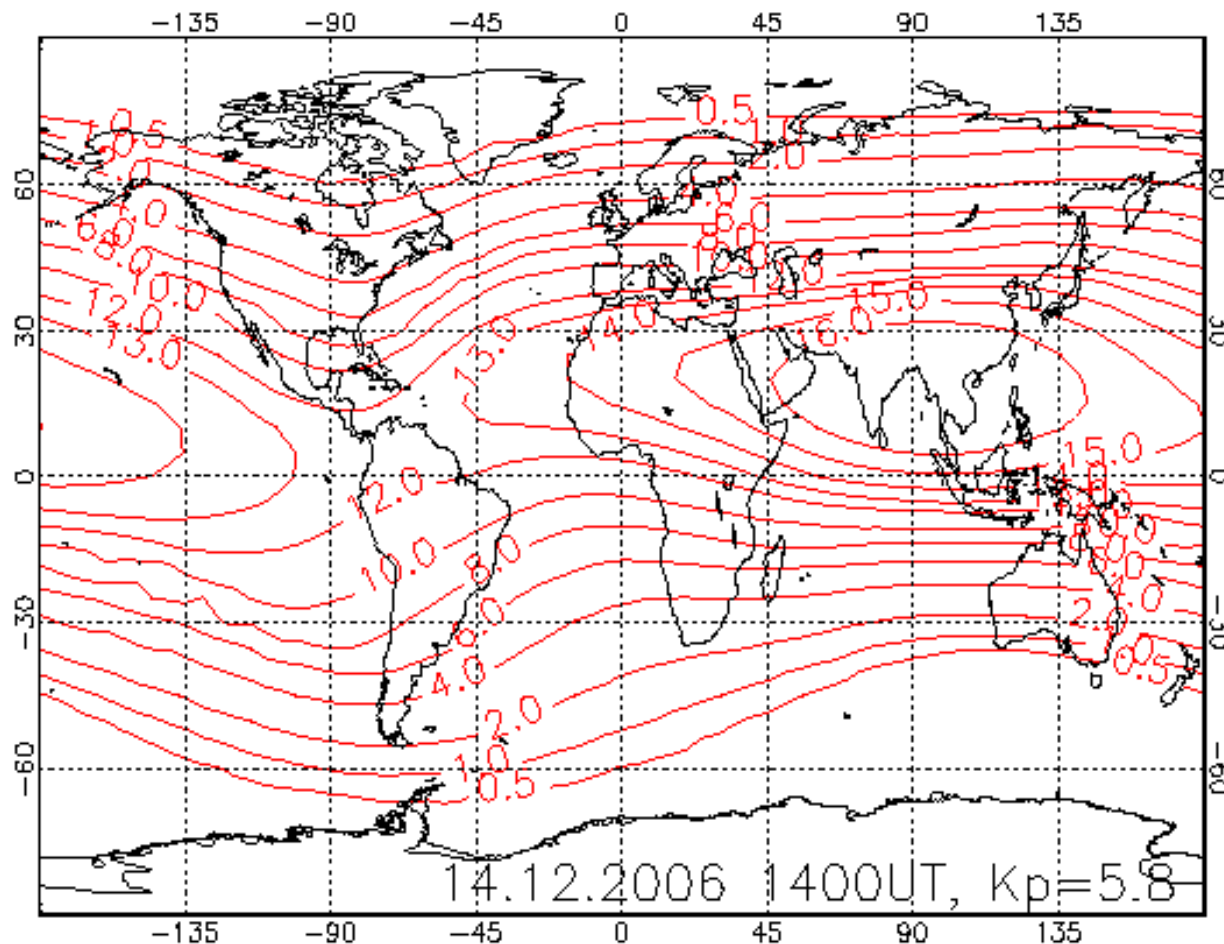
Muon telescope observations 13 December 2006 space weather event



Objectives (I)

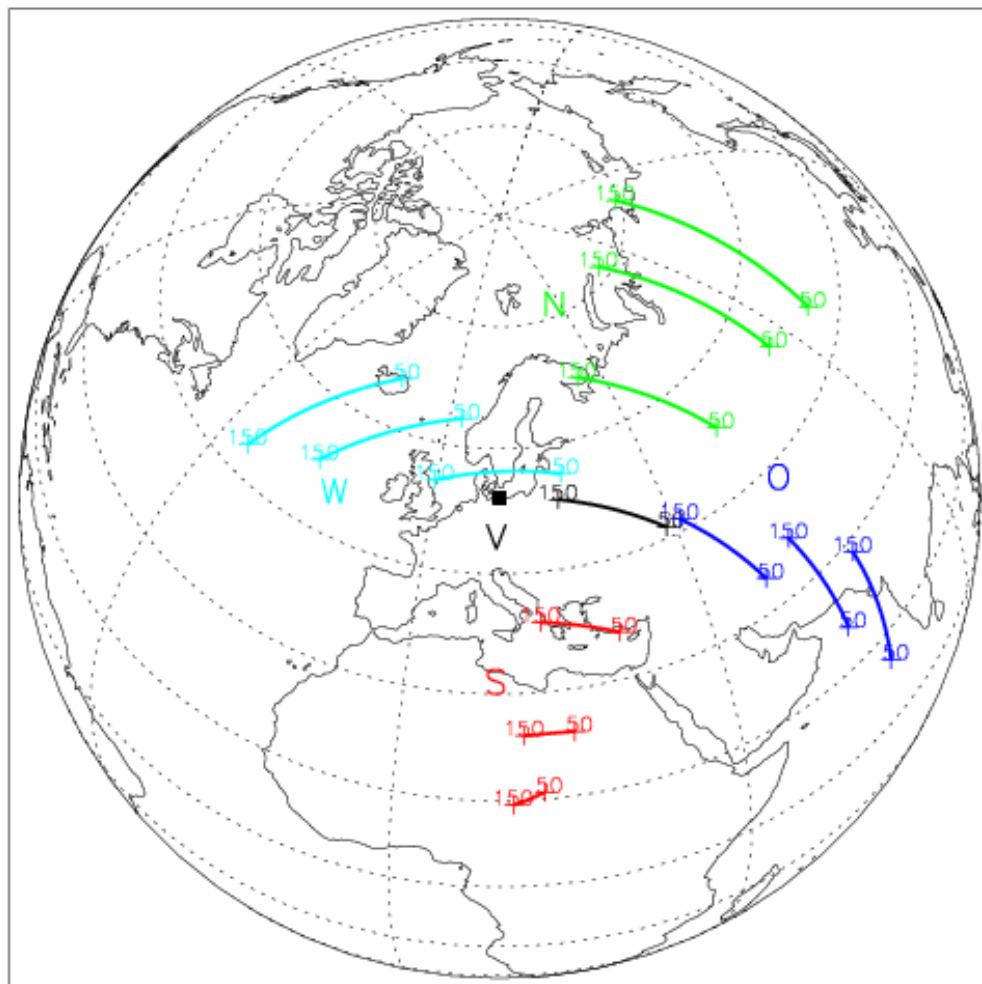
- **Calculation and simulation of particle trajectories and detector response functions:**
 - (i) Performing multiple simulations of the particle traversal through the atmosphere and detectors.
 - (ii) Preparing data bases for alternative input values of modeling algorithms, covering important energy ranges and particle types.
 - (iii) Estimation of the detector response for different species of primary flux for the cosmic ray detectors and telescopes.

Cut-off rigidities



Planetocosmics
(U Bern)

Asymptotic viewing directions



- Location:
MuSTAnG Greifswald
- 13 (of 49) Viewing directions:
V, N, E, S, W
- Detector size:
0.25 m²
- Rigidity spectrum:
50-150 GV



Objectives (II)

- **Detector hardware development:** Existing networks of particle telescopes are unable to measure the energy of Solar Cosmic Ray (SCR) in the range 5-20 GeV. Modernization and enlargement of existing CR telescopes is foreseen, in particular:
 - **Modernization and enlargement of Aragats Multidirectional Muon Monitor (AMMM):** We propose to enlarge the muon detector at Aragats station up to 120 m² and to equip it with modern electronics for precise measurements of the energy spectra of SCR up to 20-30 GeV and with improved angular resolution.
 - **Enlargement of MuSTAnG:** The University of Greifswald is presently setting up a Muon Telescope for Spaceweather Anisotropies at Greifswald (MuSTAnG). The telescope is financed by the European Space Agency (ESA). An enlargement to 24 m² is foreseen.



Objectives (III)

- **Advanced Data Processing:** Detector software development for data acquisition and advanced data processing. Establishing data bases attached to the Internet portal with fast access modes. Development of a fast-computing system for enhanced collaborative environments and enhanced data sharing.
- **Calculation of the energy spectra of Solar Energetic Particle events:** Calculation of Solar energetic particle events (SEP)
- **Eurasian Muon and Neutron Telescope Network (Aragat, Bern, Greifswald, Tel Aviv) for Radiation and Spaceweather Storm Warning.**

A person in a dark coat stands on a rocky peak, looking towards a bright star in a dark, starry sky. The scene is illuminated by a purple and blue glow, with a large, glowing rock formation on the right. The overall atmosphere is mysterious and awe-inspiring.

Thank

You