Name of research institute or organization:

Physikalisches Institut, Universität Bern

Title of project:

SONTEL - Solar Neutron Telescope for the identification and the study of high-energy neutrons produced in energetic eruptions at the Sun

Project leader and team:

Dr. Rolf Bütikofer

Project description:

The solar neutron telescope (SONTEL) at Gornergrat, Switzerland, has been in continuous operation since 1998 as the European cornerstone of a worldwide network for the study of high-energy neutrons produced in energetic processes at the Sun (Flückiger et al., 1998). The network consists of seven solar neutron telescopes that are located at high altitudes and at low to mid latitudes (short path through atmosphere) as well as at different longitudes (24 hour readiness to observe): Mt. Norikura (Japan), Yanbajing (Tibet), Mt. Aragats (Armenia), Gornergrat (Switzerland), Mt. Chacaltaya (Bolivia), Sierra Negra (Mexico) and Mauna Kea (USA). The network was established during the nineties of the last century, i.e. it was almost completed at the beginning of solar activity cycle 23 that started in 1996.

SONTEL Gornergrat was in continuous operation during 2011, with only some short data gaps caused by electrical power outages. The Sun was not very active in 2011 and no solar cosmic ray event in the relativistic energy range was observed by ground based cosmic ray detectors. In 2011 the radioactivity measurement with a GammaTracer device inside the detector housing of SONTEL was continued.

In order to interpret the ground-based cosmic ray measurements, it is necessary to know the relationship between the counting rate of the detectors and the primary particle flux penetrating the Earth's atmosphere. This relationship is usually simulated with Monte Carlo methods as it can hardly be determined experimentally or analytically. In 2002 Michael Moser developed a Monte Carlo software based on the GEANT3 codes to simulate the detector properties (Moser, 2002; Moser et al., 2003). In 2011 our Japanese colleagues began simulating the different solar neutron telescopes of the network with software based on GEANT4. Nagai, University of Nagoya, Japan, determines the detector properties by also including the material of the detector housing. Moser did not consider the detector housing in his investigations. The preliminary results of the computations for SONTEL Gornergrat by Nagai are shown in Figure 1. The plot shows the 10-minute count rates of the different SONTEL channels caused by the different secondary cosmic ray particles incoming into the detector. The simulated and measured total counting rates (sum of all particles) are also shown for each SONTEL channel. In a next step the results of the computations by Moser and by Nagai will be compared.

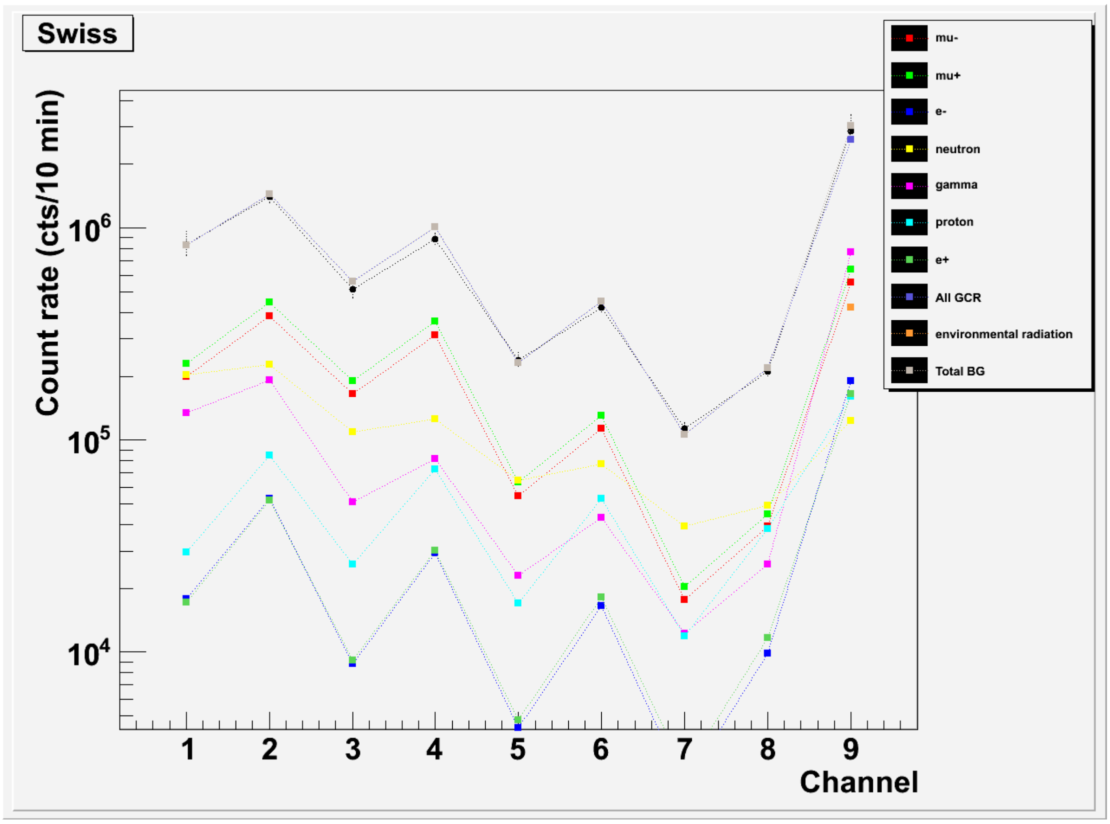

Figure 1. *Simulated counting rates of different SONTEL channels caused by μ^- (red), μ^+ (green), e^- (blue), neutrons (yellow), γ (magenta), protons (light blue), e^+ (light green), simulated total counting rate of channel (gray), measured total counting rate of channel (black). Channels are as follow: 1: >32.2 MeV with anti, 2: >32.2 MeV without anti, 3: >64.4 MeV with anti, 4: >64.4 MeV without anti, 5: >96.6 MeV with anti, 6: >96.6 MeV without anti, 7: >128.8 MeV with anti, 8: >128.8 MeV without anti, 9: total counting rate of proportional counters (anti). Graph by Yuya Nagai, University of Nagoya, Japan, private communication.*

<u>References</u>

Flückiger, E. O., R. Bütikofer, Y. Muraki, Y. Matsubara, T. Koi, H. Tsuchiya, T. Hoshida, T. Sako and T. Sakai, A new solar neutron telescope at Gornergrat, Proc. 16th European Cosmic Ray Symposium, rayos cósmicos 98, 219, Universidad de Alcalá, Spain, 1998.

Moser M.R., Solar Neutron Telescope Gornergrat Monte Carlo Simulation of Detector Properties, Diploma Thesis, 2002.

Moser M.R., E.O. Flückiger, R. Bütikofer, L. Desorgher, Y. Muraki, Y. Matsubara, T. Sako, H. Tsuchiya, T. Sakai, GEANT applications for the interpretation of ground-based solar neutron observations, Prc. 28Th International Cosmic Ray Conference, 3215-3218, 2003.

Key words:
Astrophysics, cosmic rays, solar neutrons

Internet data bases:
http://cosray.unibe.ch
http://binary.stelab.nagoya-u.ac.jp/Neutron/index.html

Collaborating partners/networks:
Prof. Y. Matsubara, Dr. T. Sako, Dr. S. Masuda, Y. Nagai, Solar Terrestrial Environment Laboratory, Nagoya University, Nagoya 464-8601, Japan
Prof. Y Muraki, Konan University, Nada-ku, Kobe 657-0000, Japan

Address:
Physikalisches Institut
Universität Bern
Sidlerstrasse 5
CH-3012 Bern

Contacts:
Rolf Bütikofer
Tel.: +41 31 631 4058
Fax: +41 31 631 4405
e-mail: rolf.buetikofer@space.unibe.ch
URL: http://cosray.unibe.ch/nm