Integration of MuSTAnG into the International Muon Spaceweather Telescope Network

Rainer Hippler
University of Greifswald (Germany)

Greifswald

located at the Baltic coast
200 km north of Berlin

Hansestadt Greifswald

Home town of Caspar David Friedrich

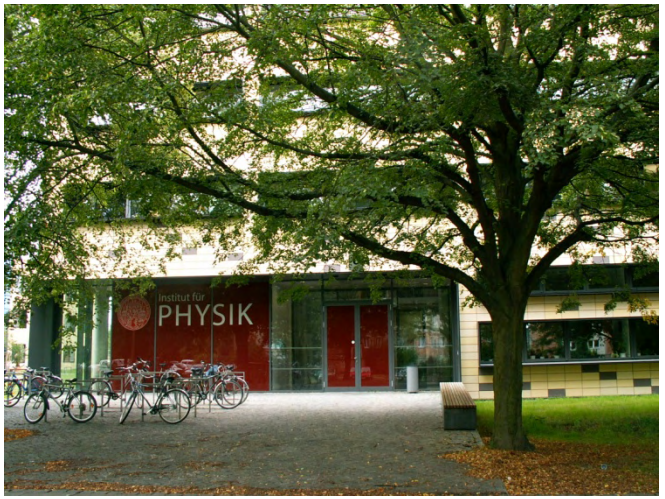
Marktplatz

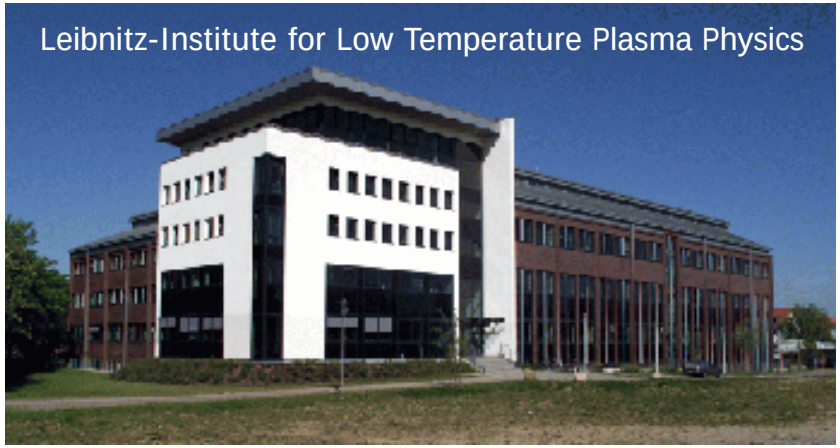
University of Greifswald

Founded
1456

Physics in Greifswald

2007





MuSTAnG

Muon Spaceweather Telescope for Anisotropies at Greifswald

University of Greifswald, Germany (R. Hippler)

1A Greifswald, Germany (F. Jansen)

HTS GmbH Coswig, Germany (W. Göhler)

University of Bern, Switzerland (E. Flückiger)

University of Applied Science Stralsund, Germany (B. Zehner)

IEP-SAS, Slovakia (K. Kudela)

Funded and supported by:

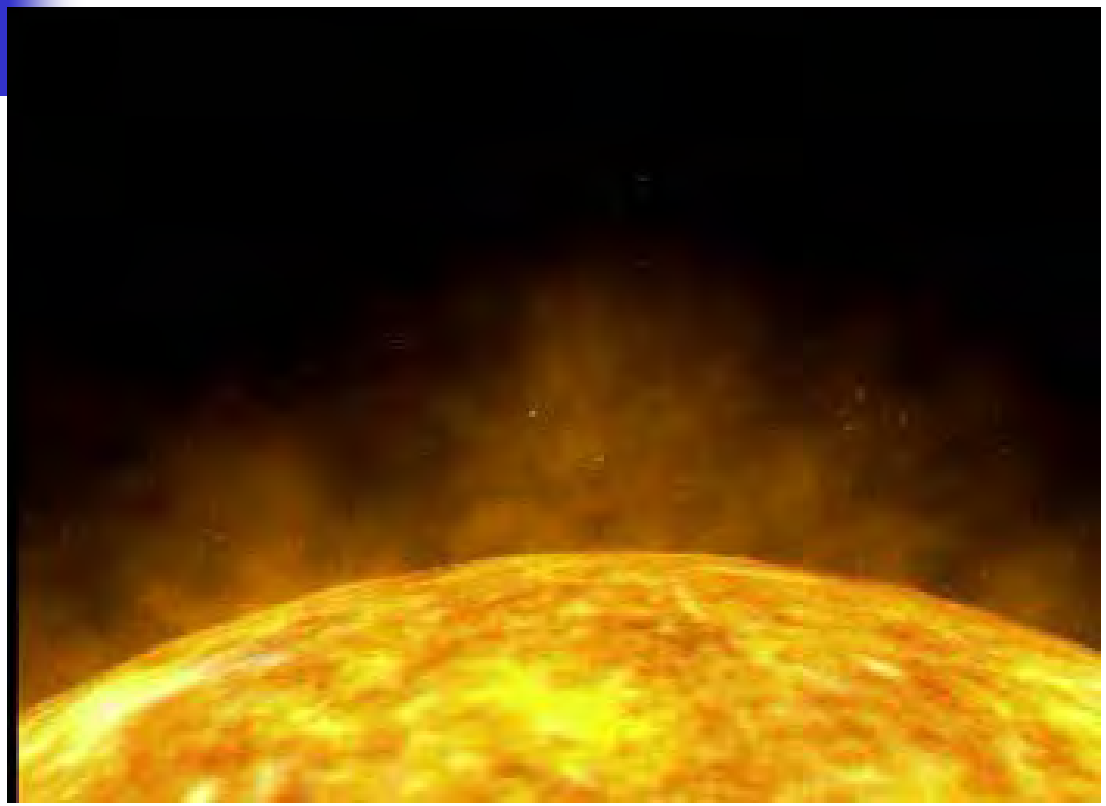
European Space Agency (ESA)

Deutsches Zentrum für Luft- und Raumfahrt (DLR)

Slovak Academy of Sciences

INTAS 8777 „Solar and Galactic Cosmic Rays

Spaceweather Storms



Coronal mass ejections (CMEs) provide hazards to the Earth environment, in particular to satellites, astronauts, aircraft crew and passengers, and to power lines on ground.

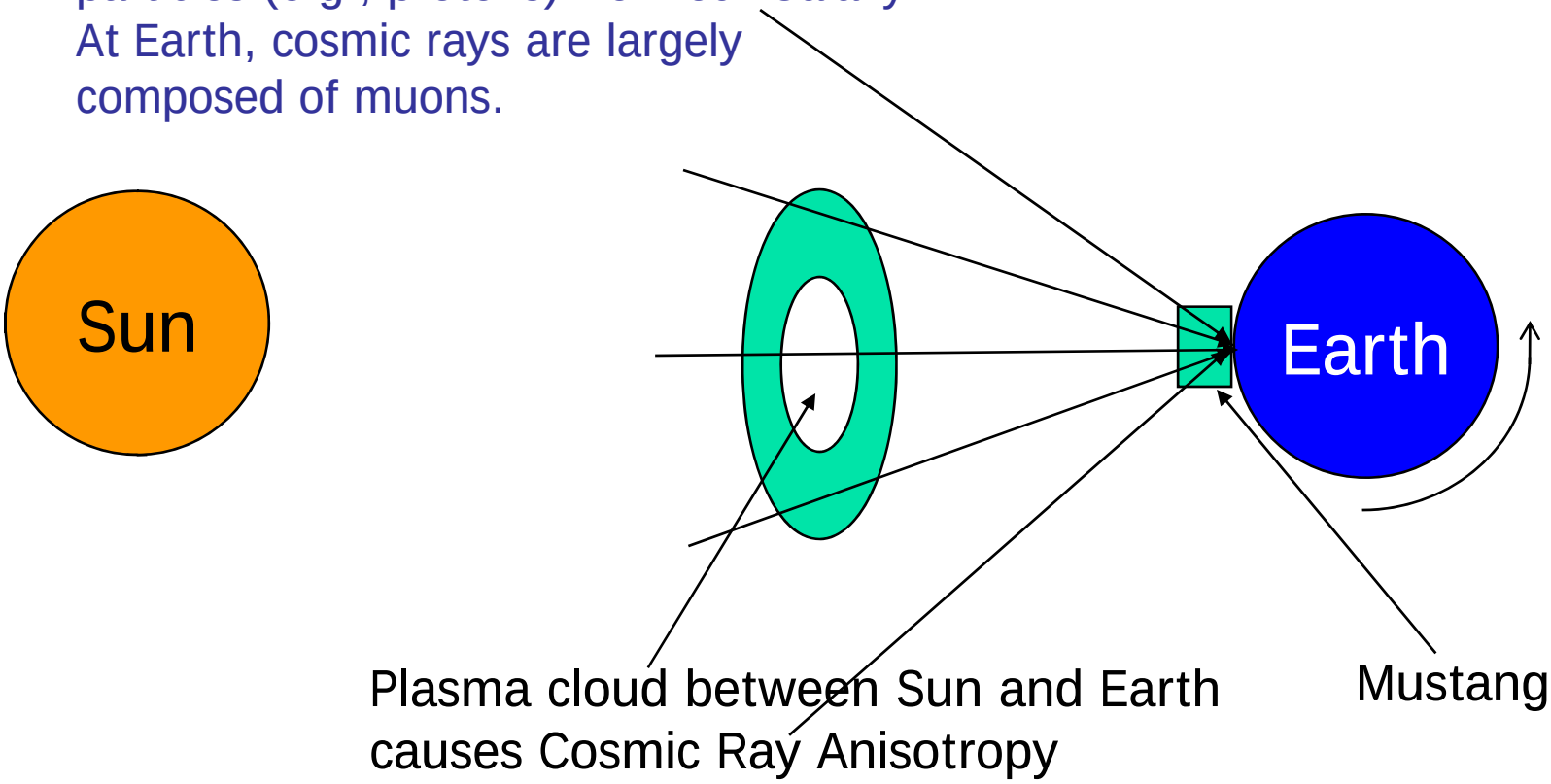
MuSTAnG aims to follow-up the propagation of CMEs between Sun and Earth.

Working Principle of MuSTAnG

- The Earth is surrounded by galactic cosmic rays originating from the Milky way.
- The cosmic ray intensity at Earth is nearly constant. However, whenever the galactic cosmic rays traverses a dense plasma cloud its intenstiy changes.
- MuSTAnG measures the intensity variations of galactic cosmic rays due to coronal mass ejections (CMEs) between Sun and Earth and is thus capable to predict the CME arrival at Earth.

Galactic Cosmic Ray Intensity Variations

Galactic cosmic rays are high-energy particles (e.g., protons) from our Galaxy. At Earth, cosmic rays are largely composed of muons.



Precursor Storm Signal

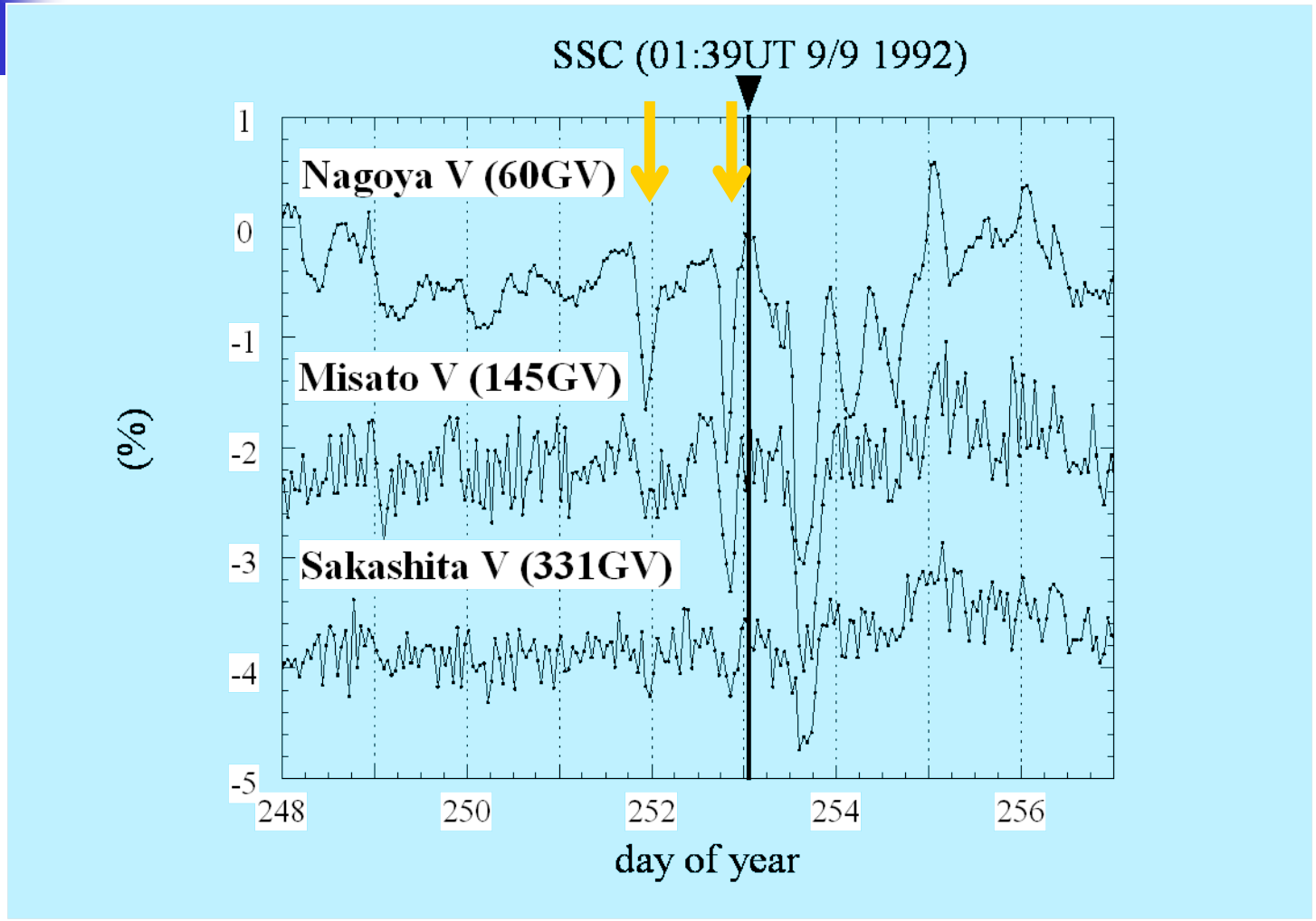
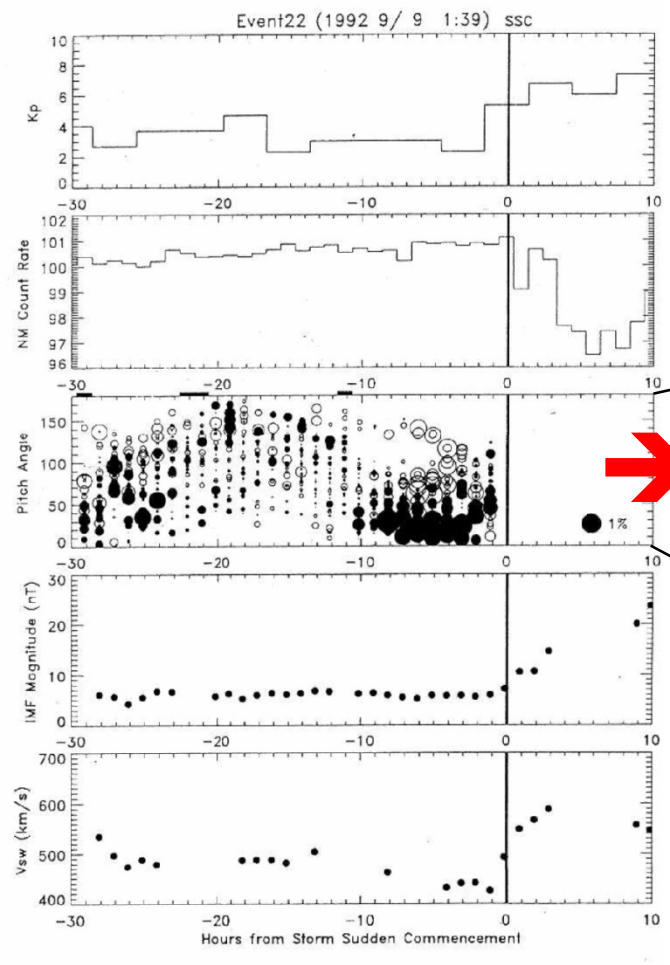
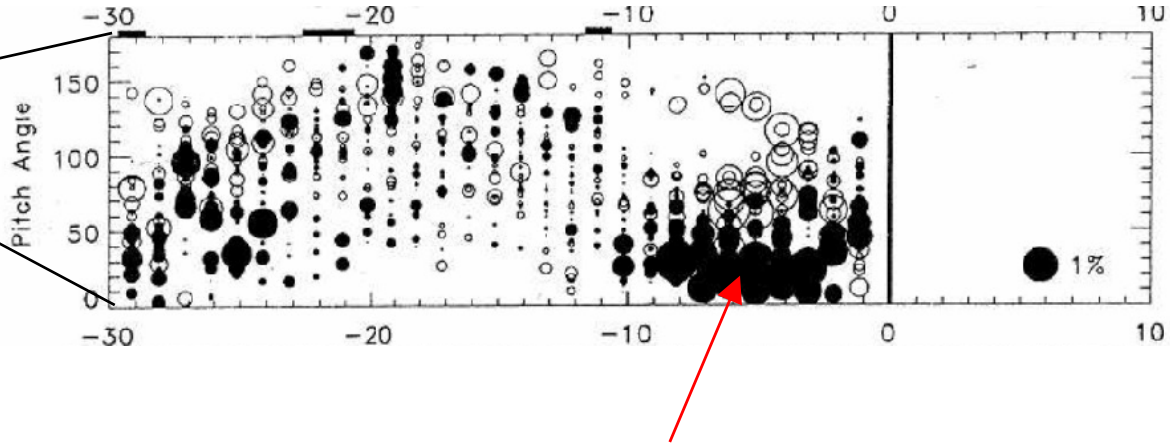


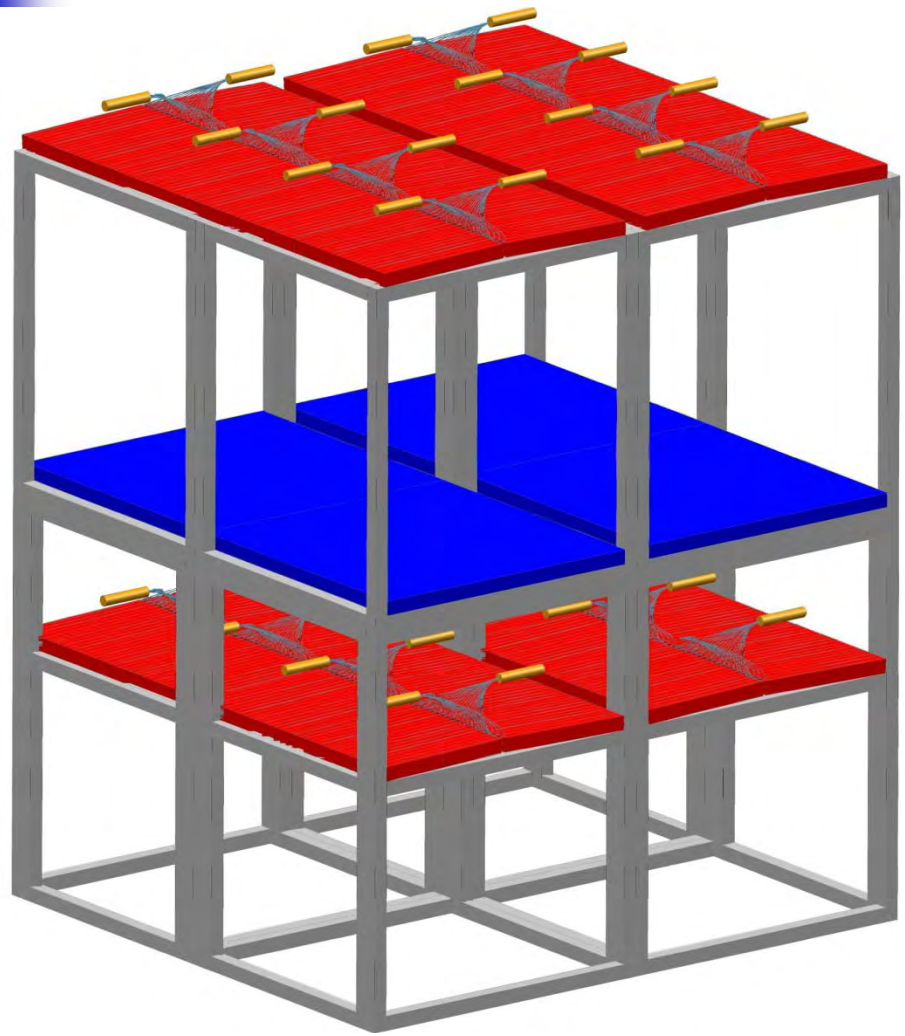
Figure 13: Ground-based observations for the period covering the geomagnetic storm on September 9, 1992 (from top to bottom): K_p geomagnetic index, McMurdo neutron monitor relative count rate, anisotropy derived from the muon telescopes (○ PAI, ● PAD), IMF magnitude and solar wind velocity (for details see Ref. [17]).



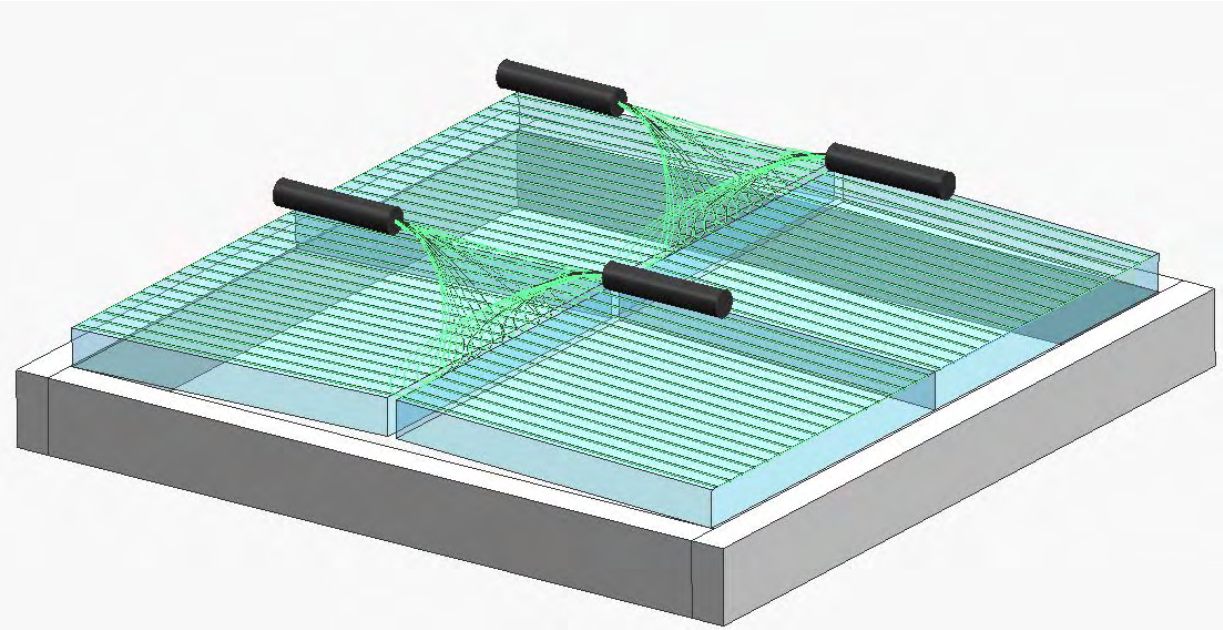


Anisotropy prior to SSC

MuSTAnG: phase 1 (4m^2)



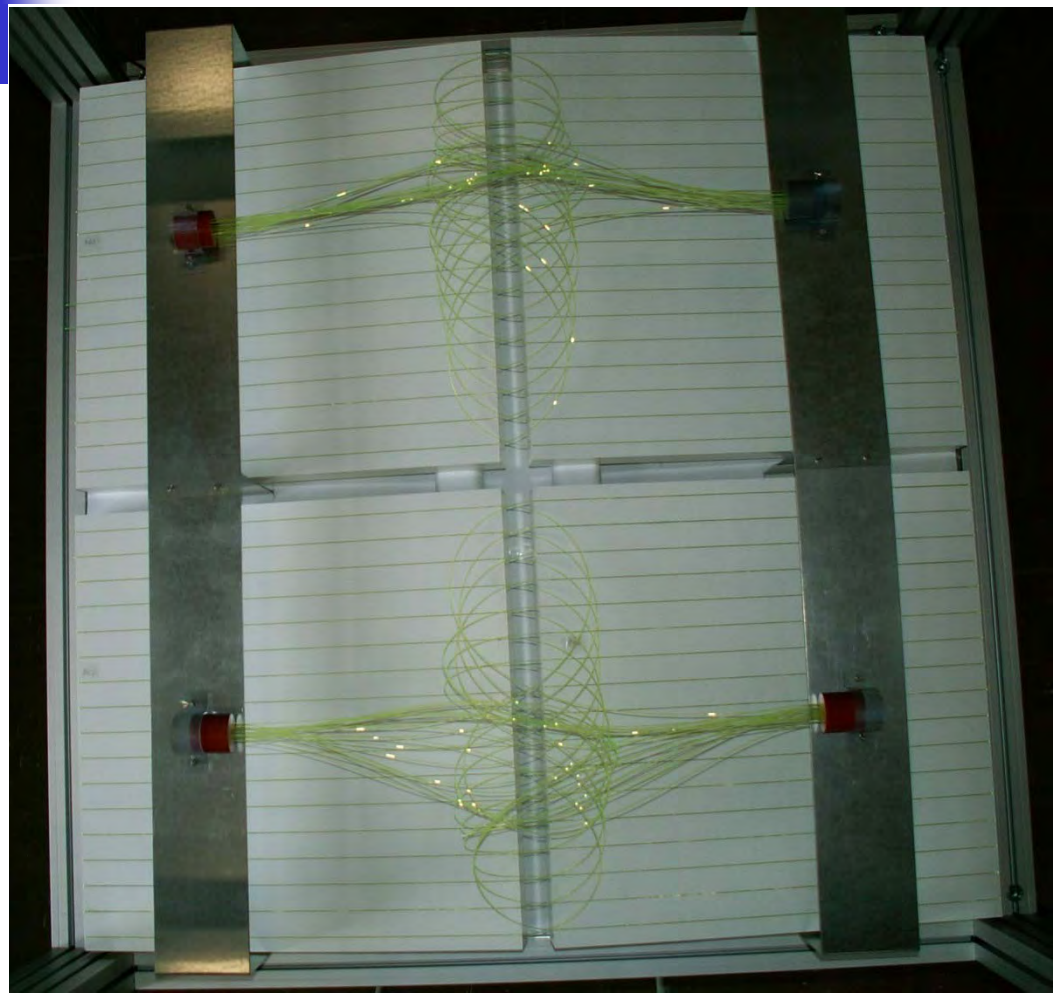
Detector element (4 × 0.25 = 1 m^2)



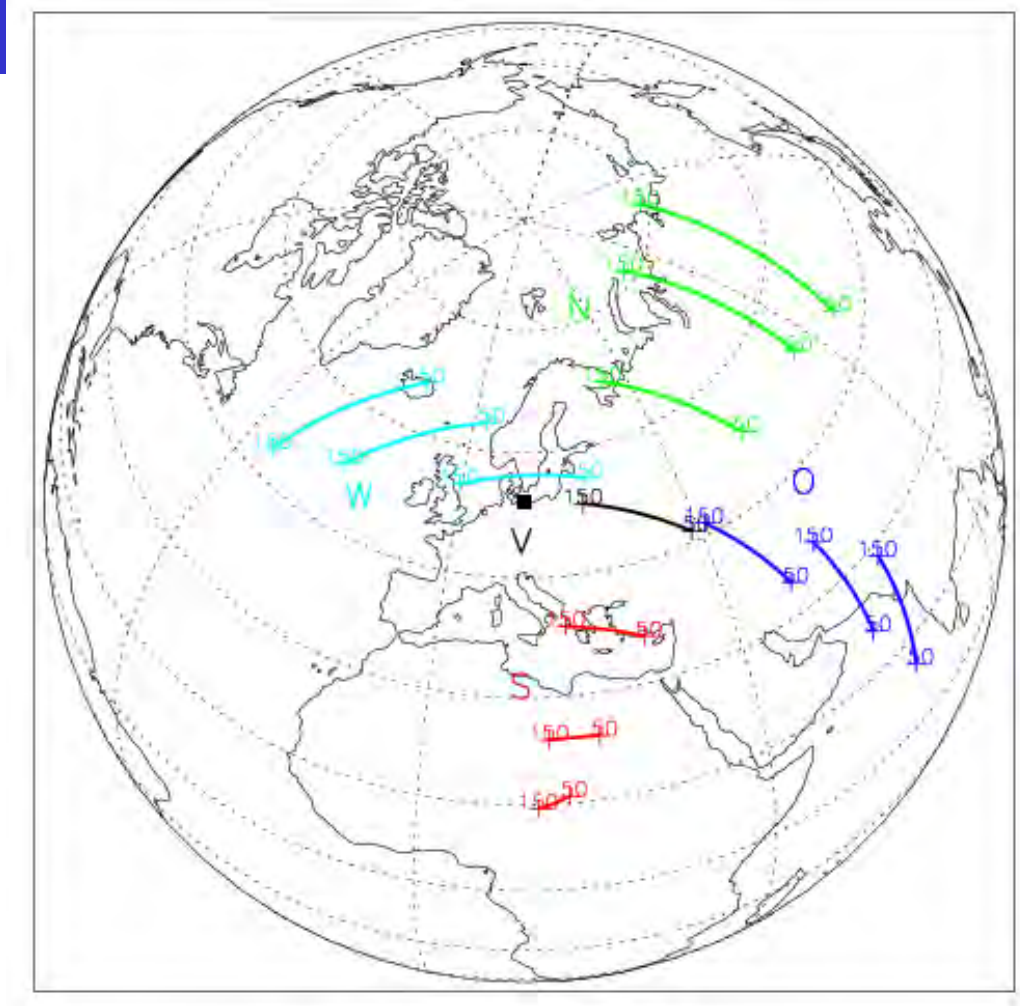
Detector box:

- 4 scintillator plates each with
- 17 wavelength-shifting fibres connected to
- P30A photomultiplier modules

Scintillator plates with wavelength-shifting fibres



Asymptotic viewing directions

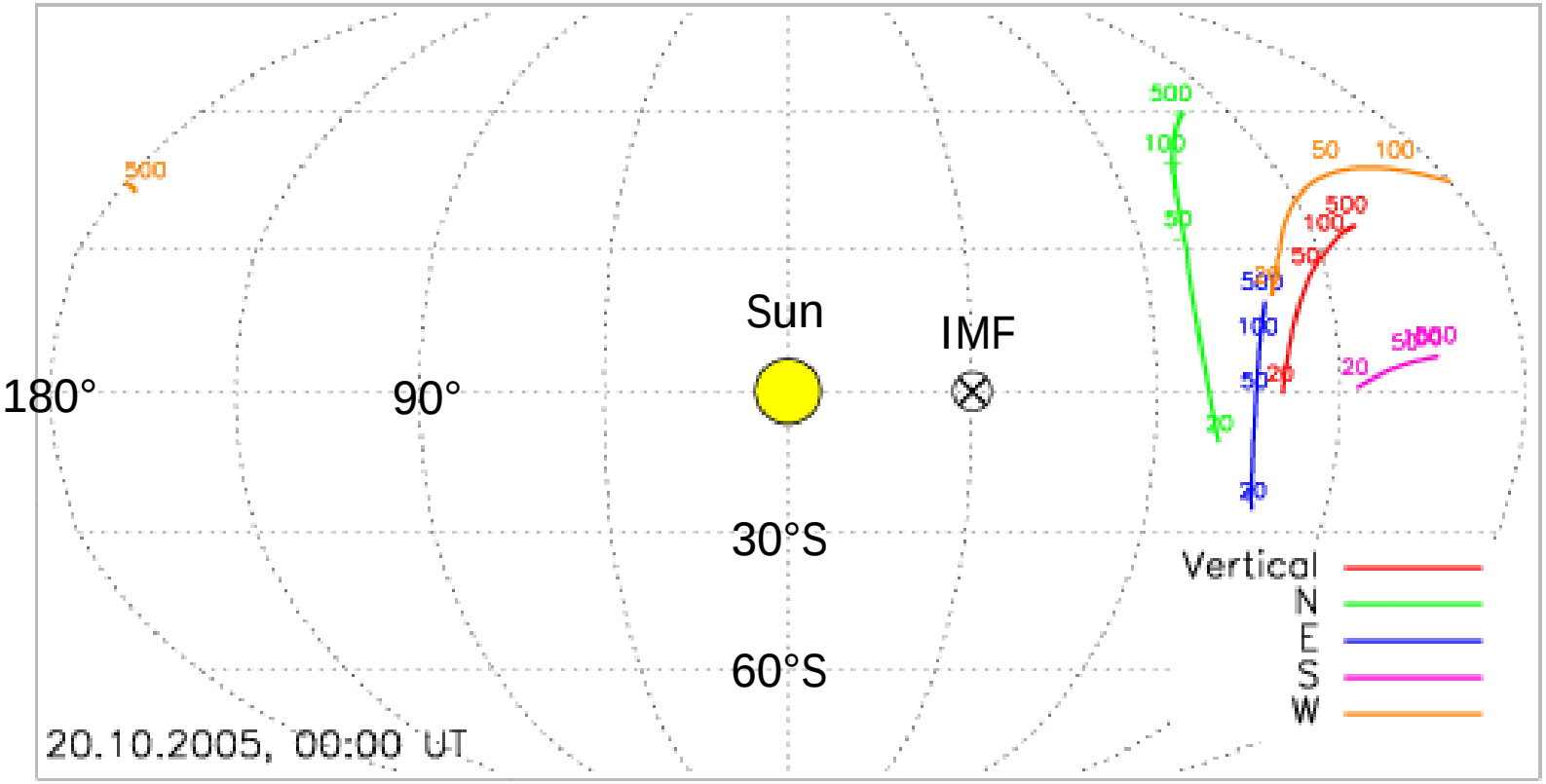


- Location: Greifswald
- 13 (of 49) Viewing directions:

  V, N, E, S, W
- Detector size: 0.25 m^2
- Rigidity spectrum: 50-150 GV

Directional Viewing

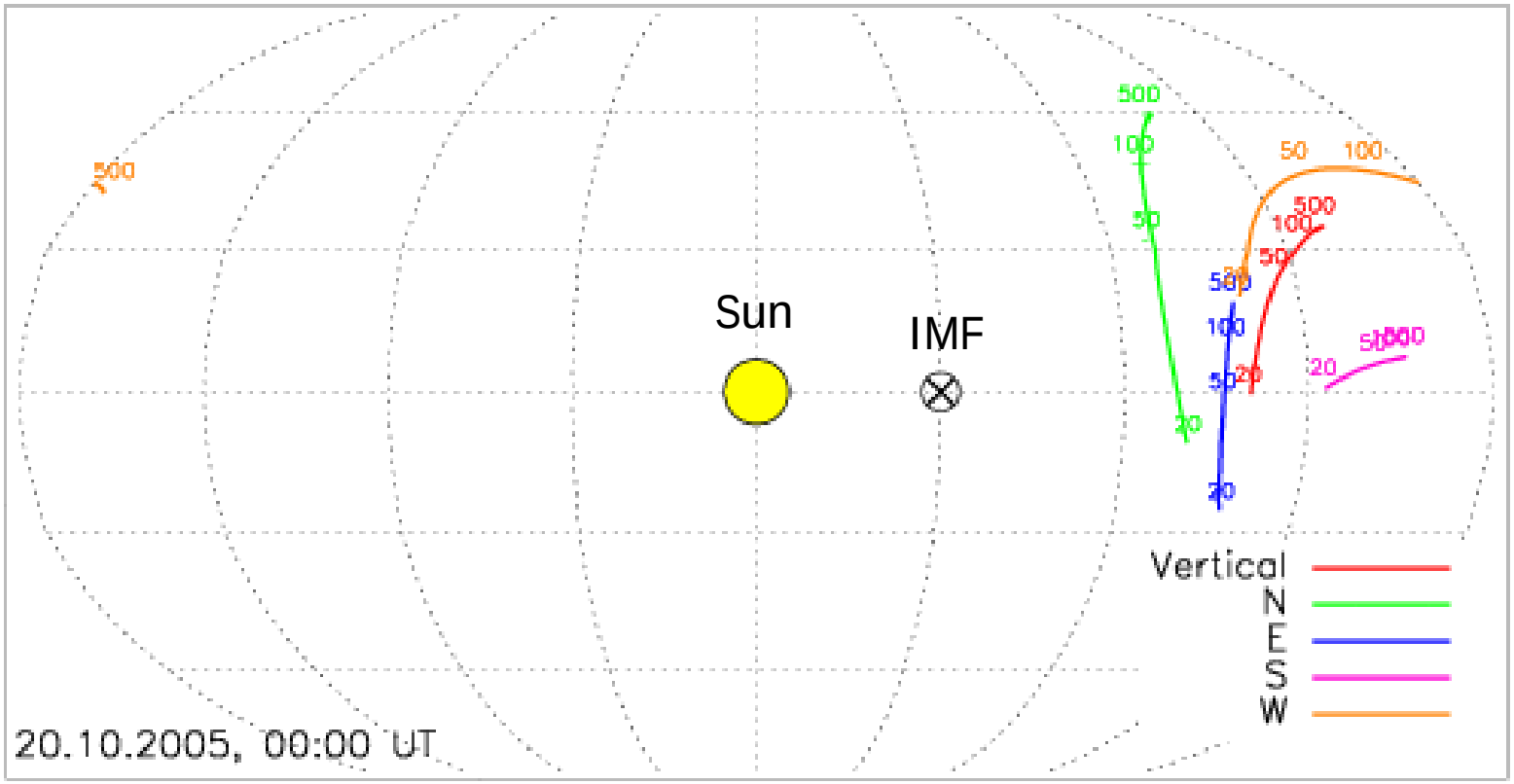
Flückiger (2007)



Example: Five selected viewing directions of the
MuSTAnG Muon Space Weather Telescope for Anisotropies at Greifswald
(~ 54°N, ~ 13°E)
(GSE coordinate system, Robinson projection)

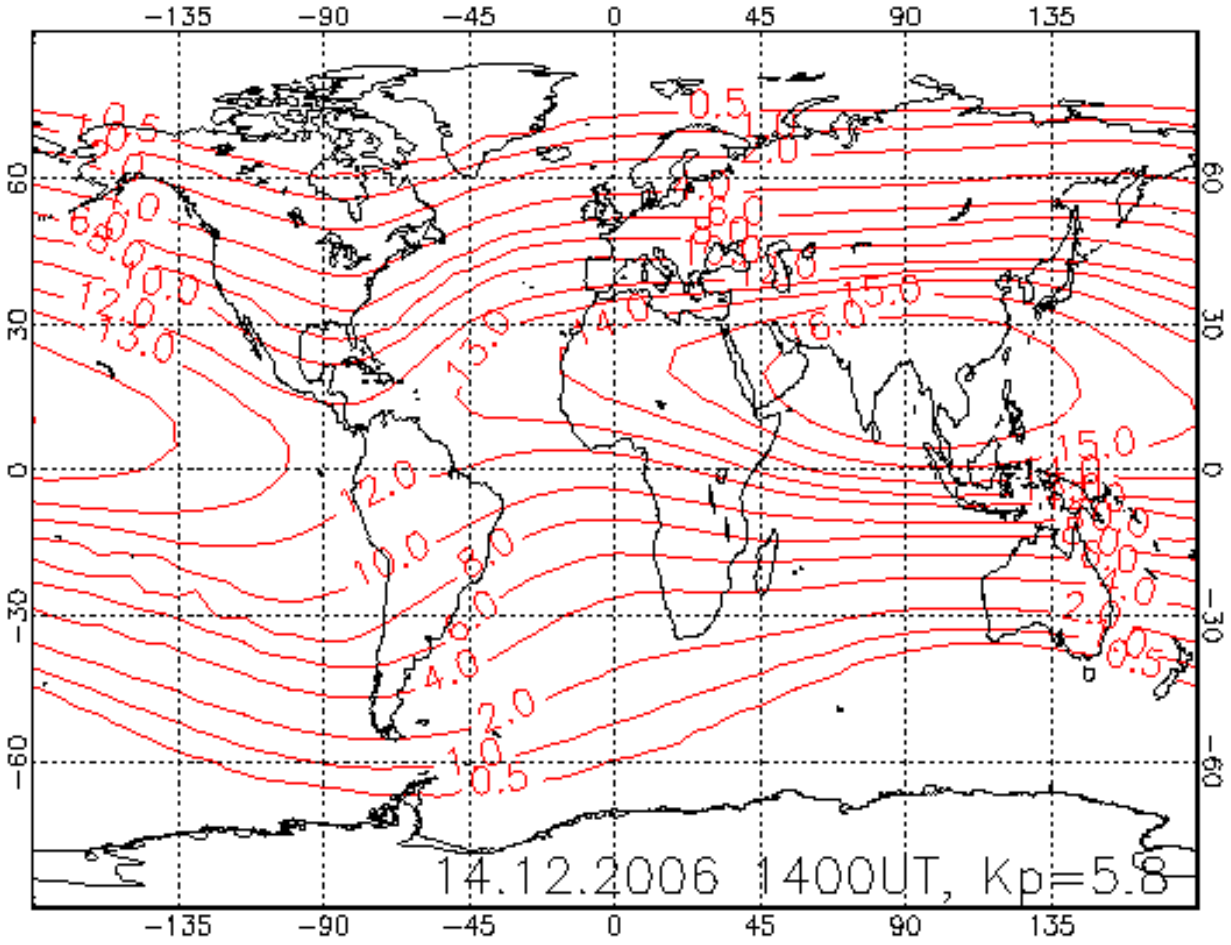
Directional Viewing

Flückiger (2007)



Example: 24-hour rotation of five selected viewing directions of the MuSTAnG Muon Space Weather Telescope for Anisotropies at Greifswald (GSE coordinate system, Robinson projection)

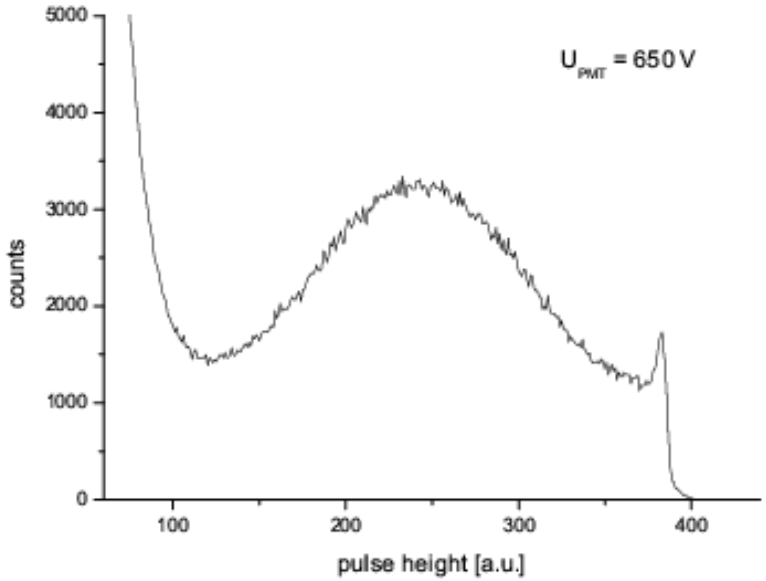
Cut-off rigidities



14 December 2006, 14.00 UT

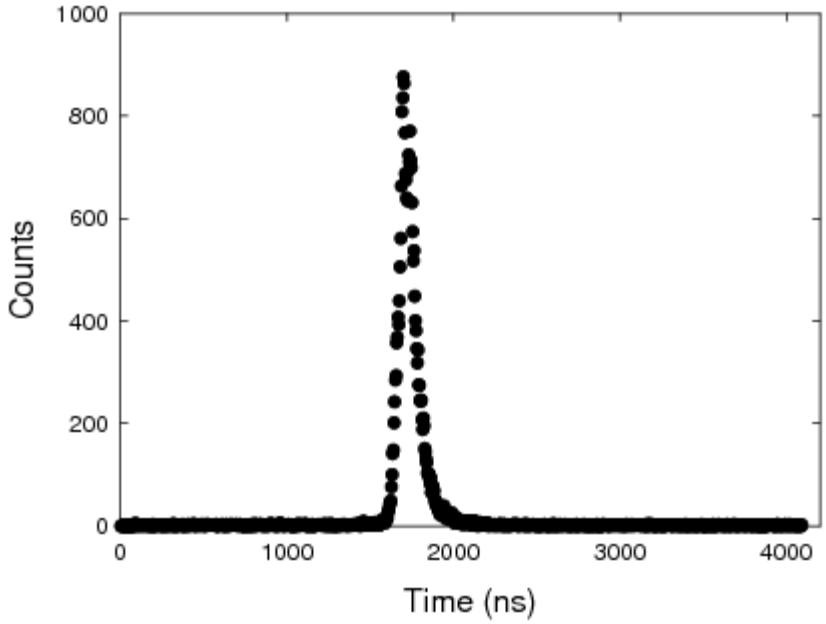
Planetocosmics (U Bern)

Scintillator tests

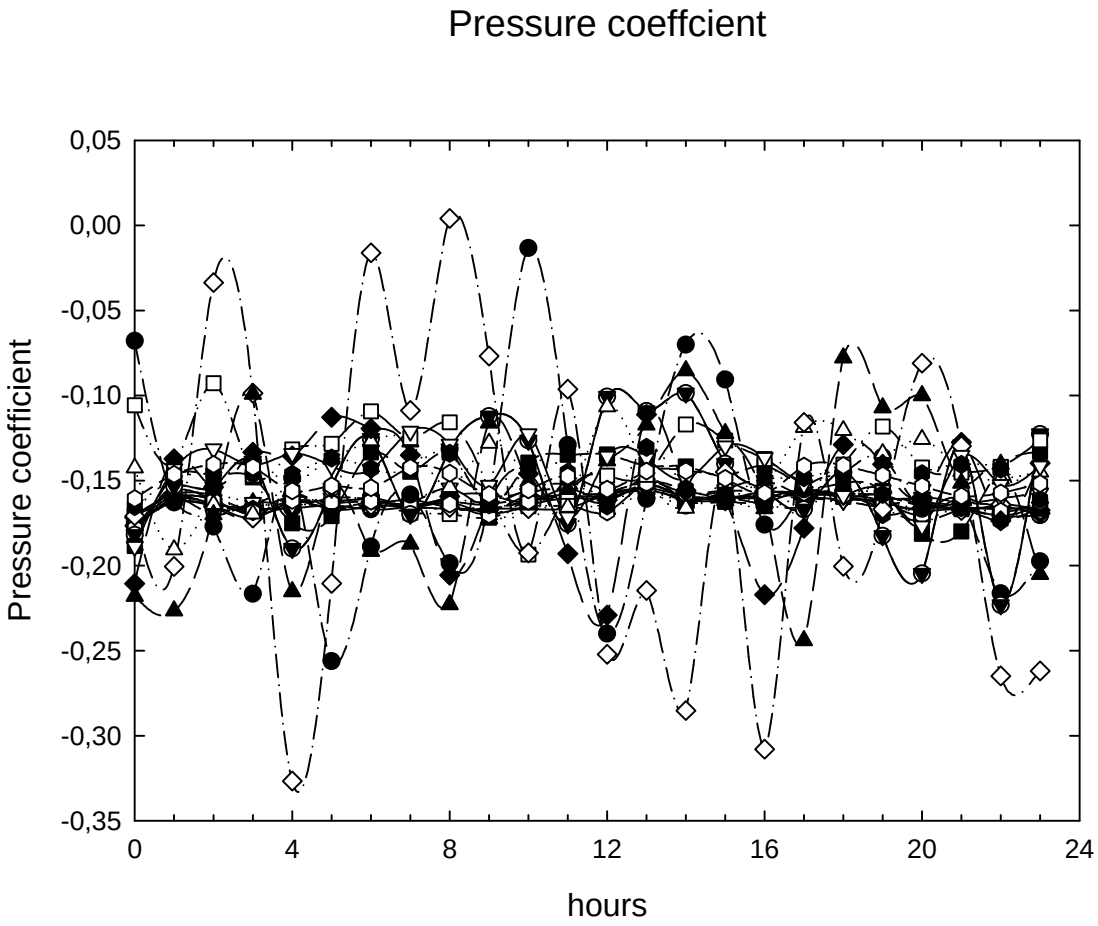


Scintillator response

Time correlation



Pressure coeffcient

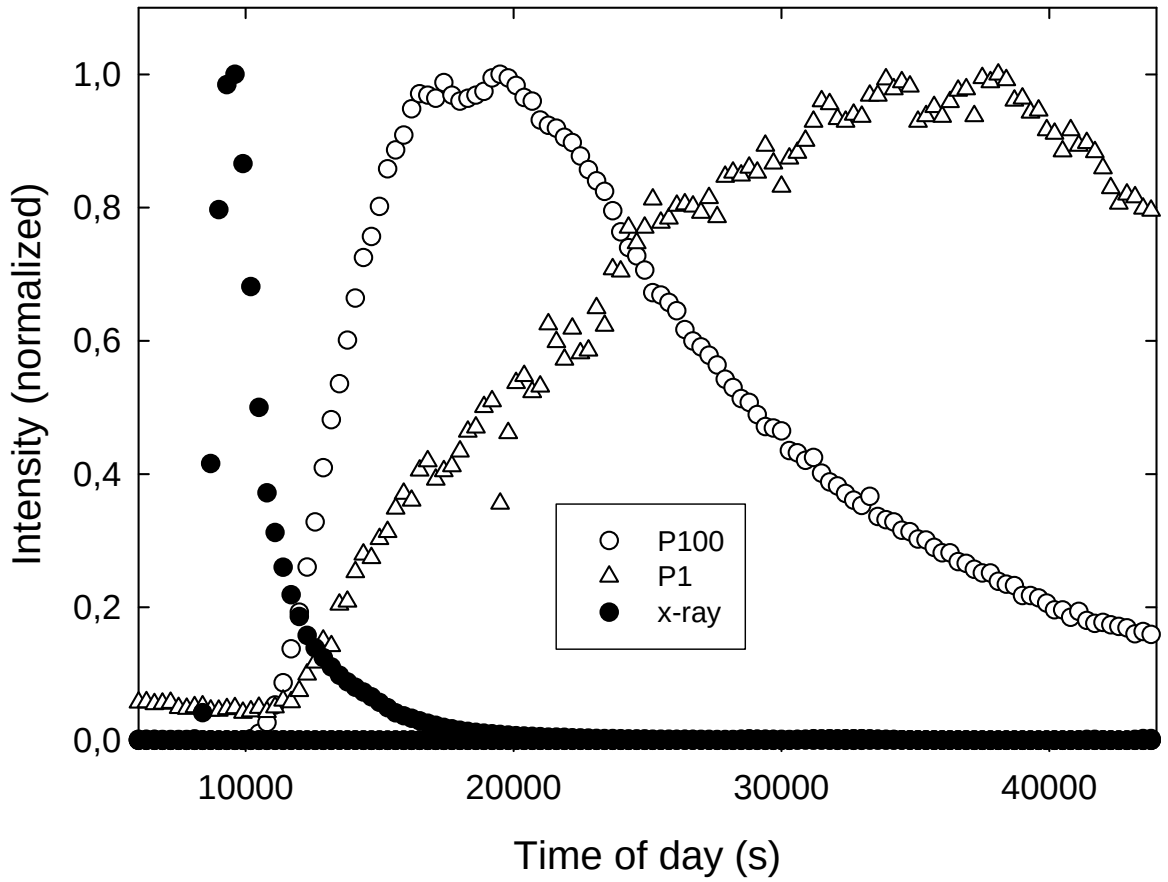


Integration of MuSTAnG into existing muon telescope network

MuSTAnG is part of an international muon spaceweather telescope network:

- Nagoya, Japan (K. Munakata)
- Hobart, Australia (M. Duldig)
- Sao Martinho, Brazil (N. Schuch)
- Kuwait (I. Sabbah)
- Bartol, USA (J. Bieber)

13 December 2006 (GOES 11)

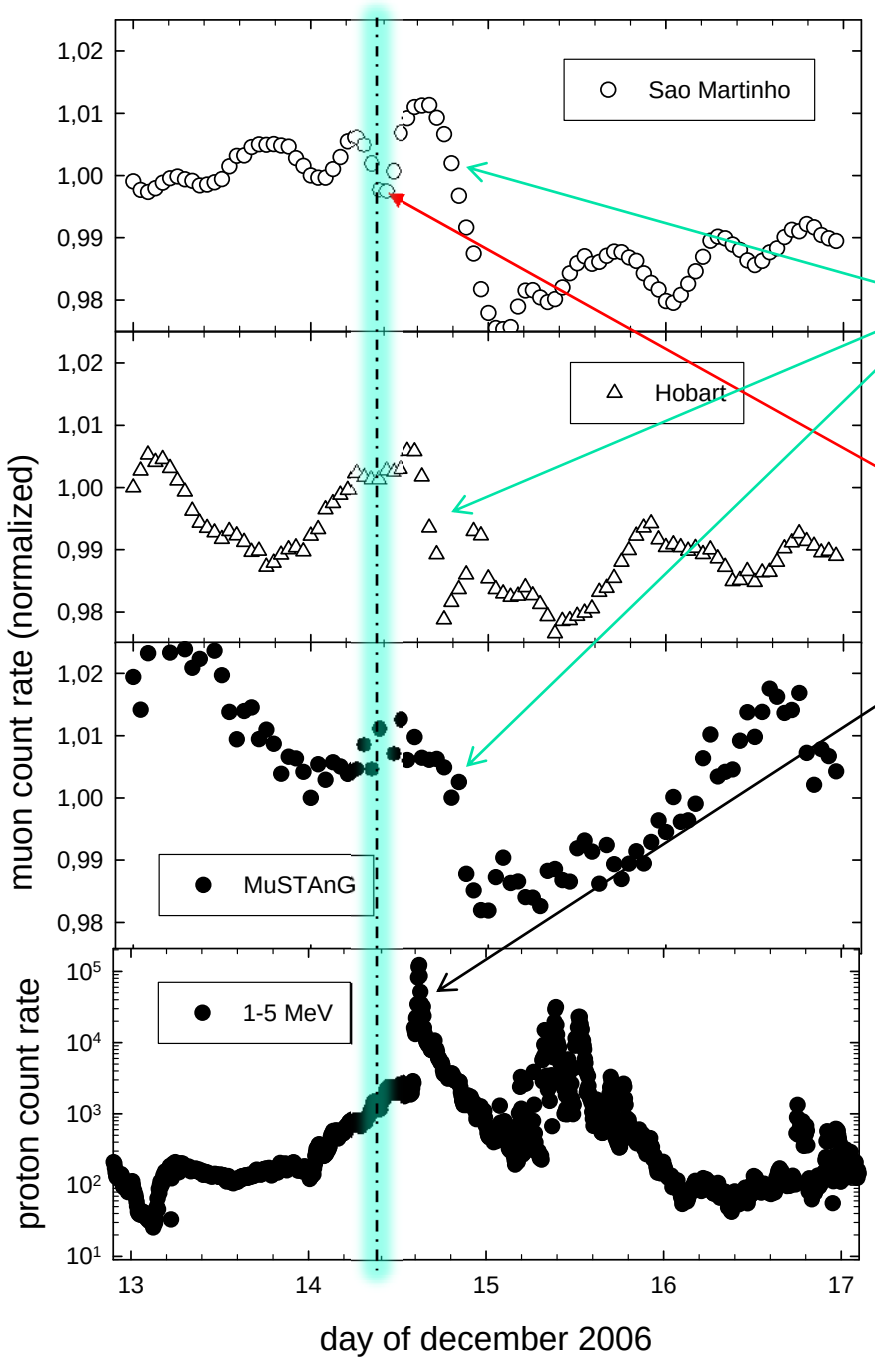


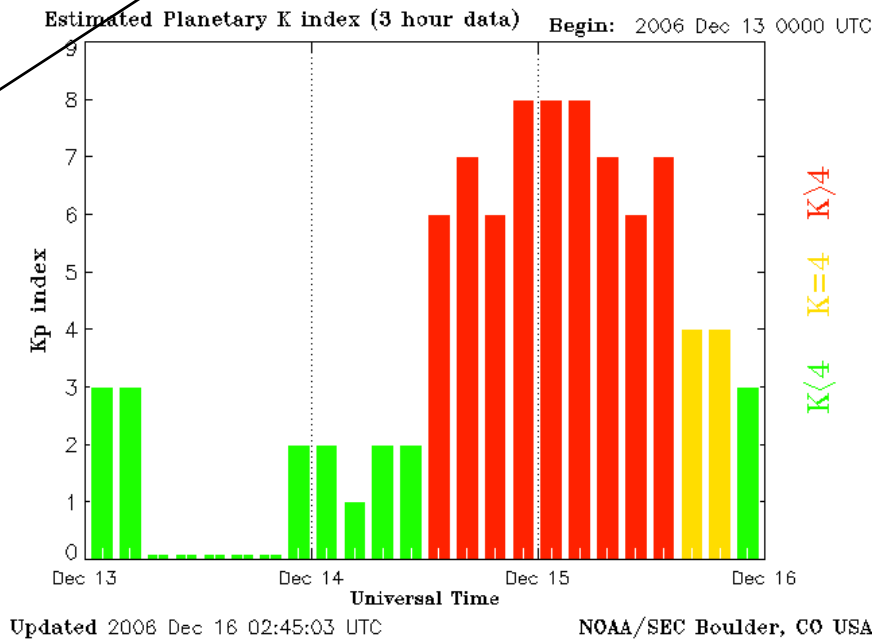
13 December 2006 space weather event

Muon telescope observations & GOES 11 Proton data

Precursor

Kp index






Thank
You

International Cooperation

Financial Support by ESA, DLR, UG, and IEPSAS.