Search for transient events of small scale observed by Tupi telescopes in association with spacraft detectors

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August, 2012 La Paz Bolivia

Topics

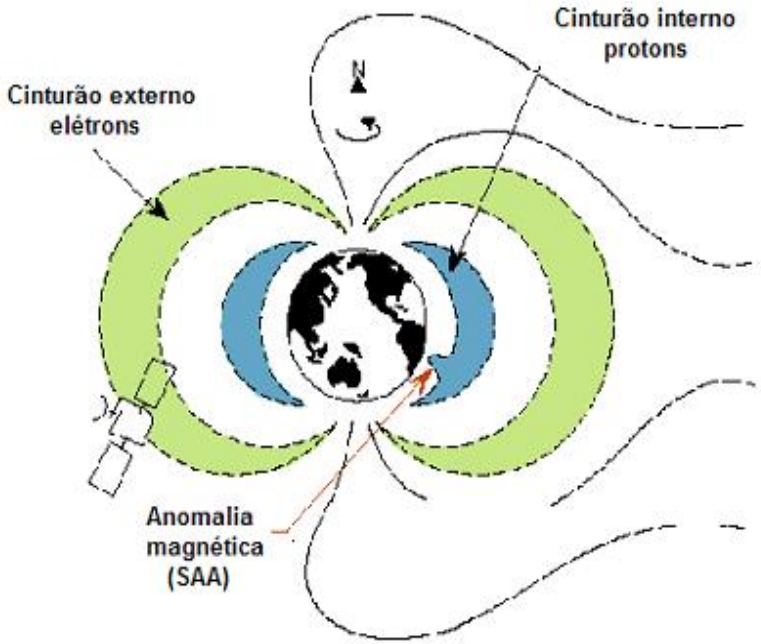
Primary a secondary cosmic rays

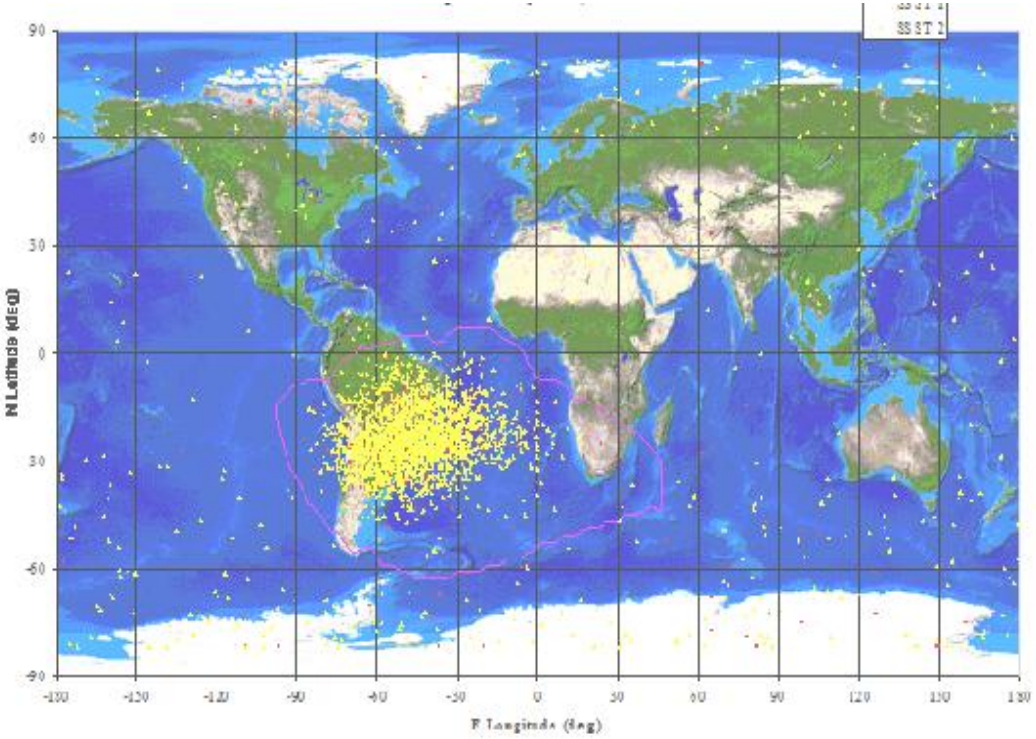
- Muons
- The Tupi muon telescopes
- Solar transient events
- Solar flares
- Coronal mass ejection
- Interplanetary shocks
- Association with satellite events
- Solar physics and climate
- Conclusions

Tupi experiment **Nitroi** **Rio de Janeiro** **Brasil**

The Tupi telescopes

South Atlantic Anomaly

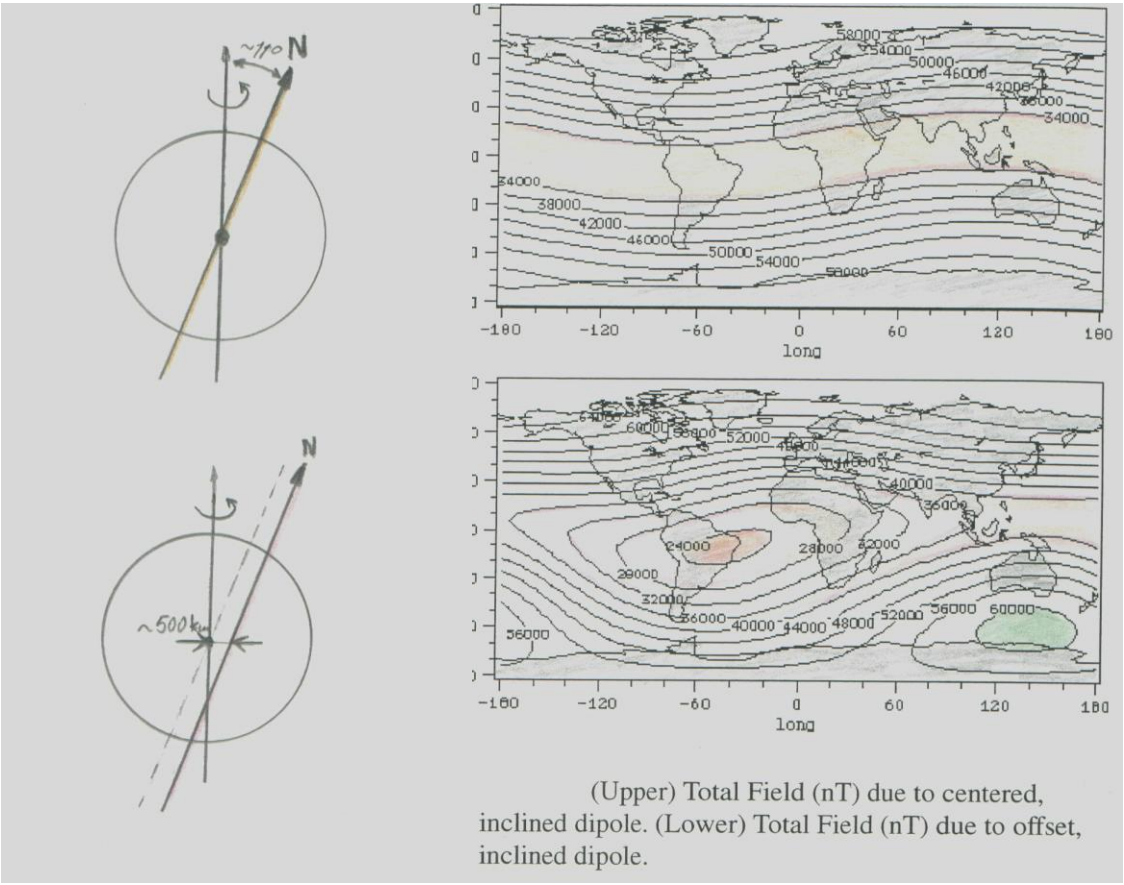




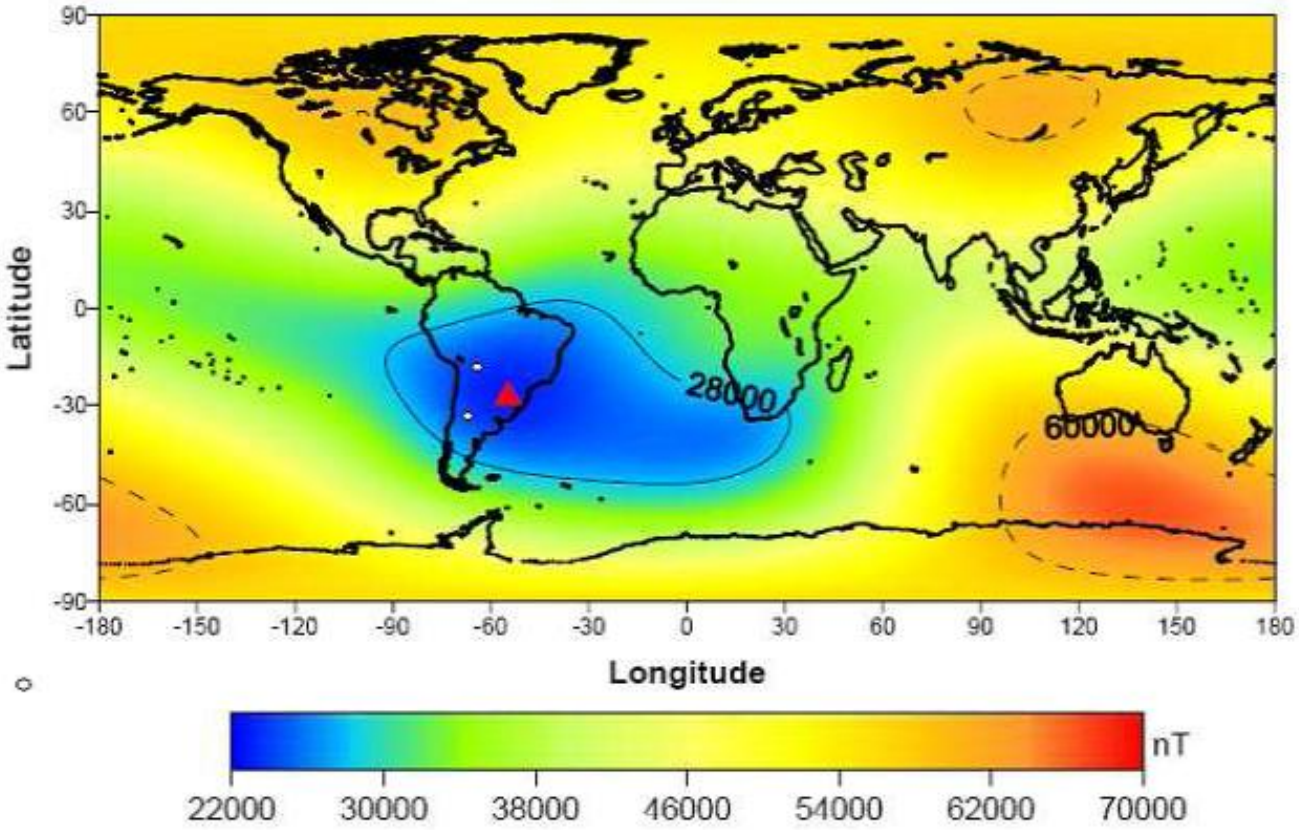
SAA is frequently said is due to the

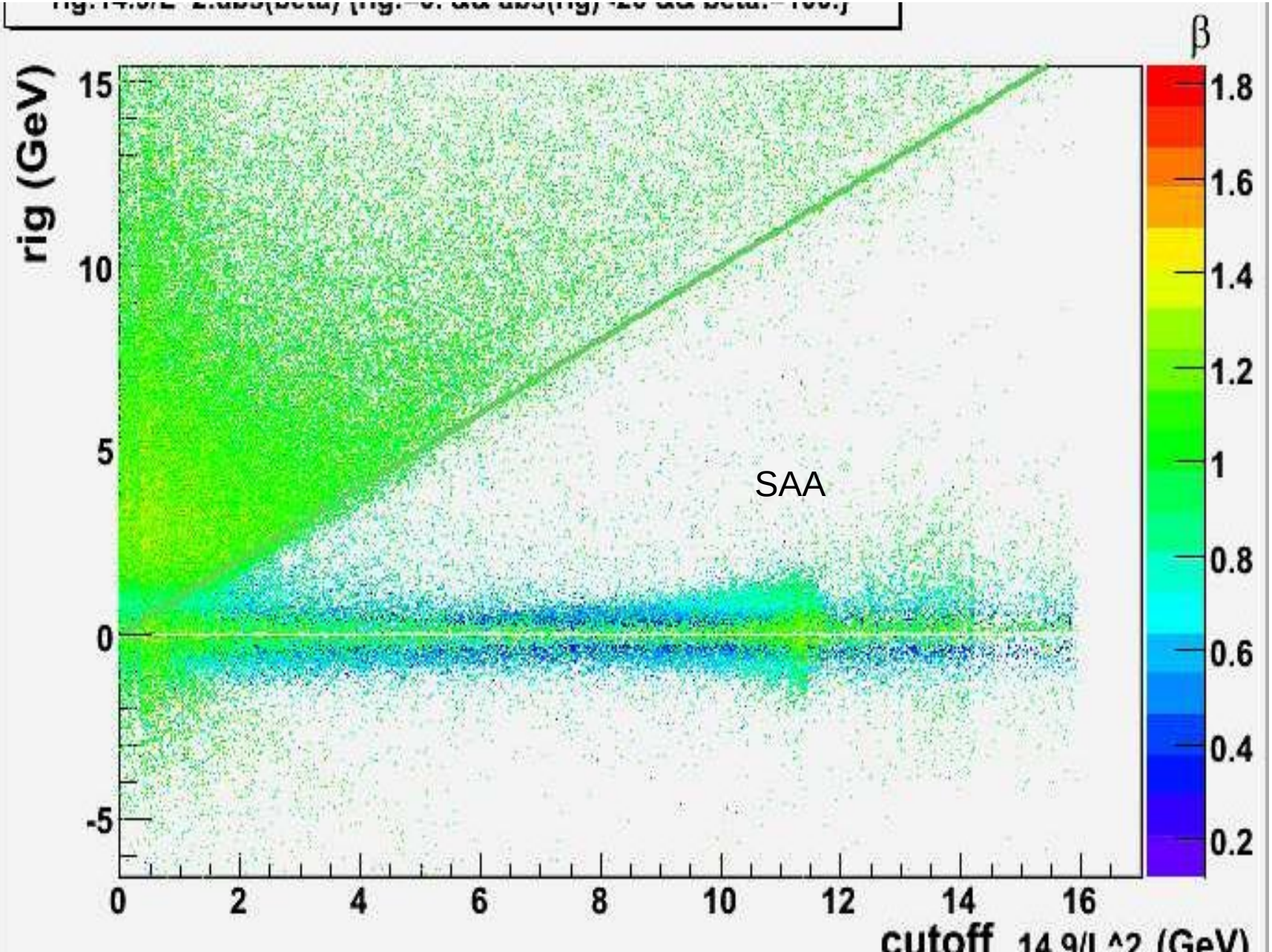
The tilt of the dipole axis with respect to the rotational axis

And due to the displacement of the geomagnetic axis from the center of the Earth

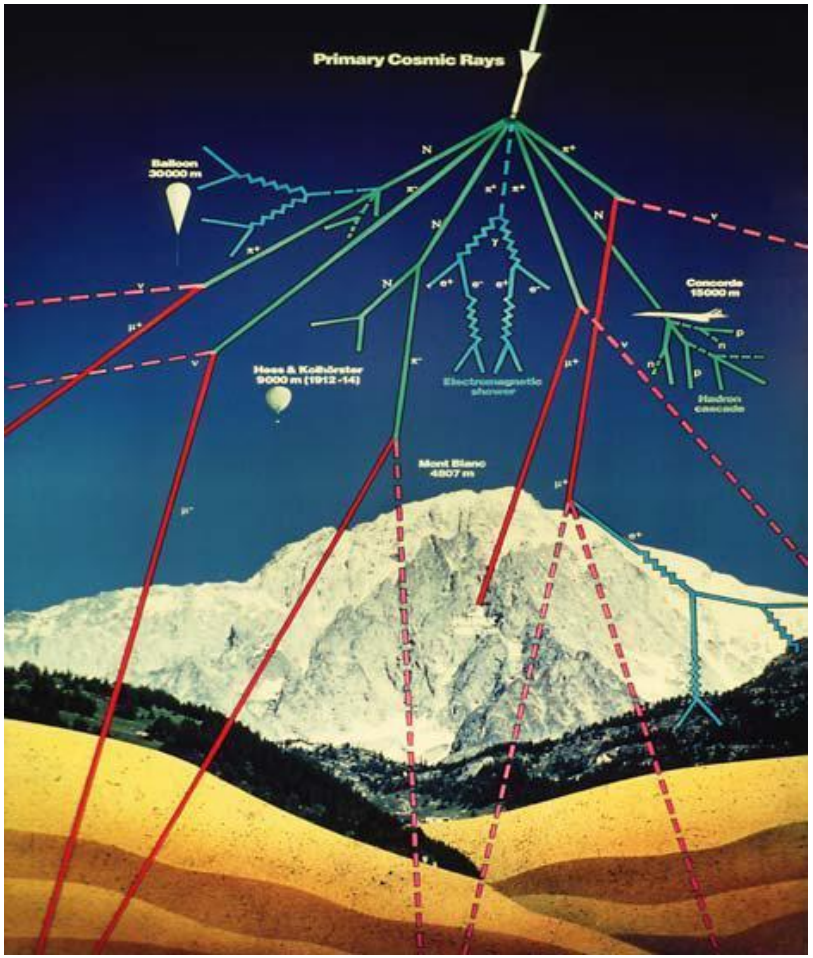


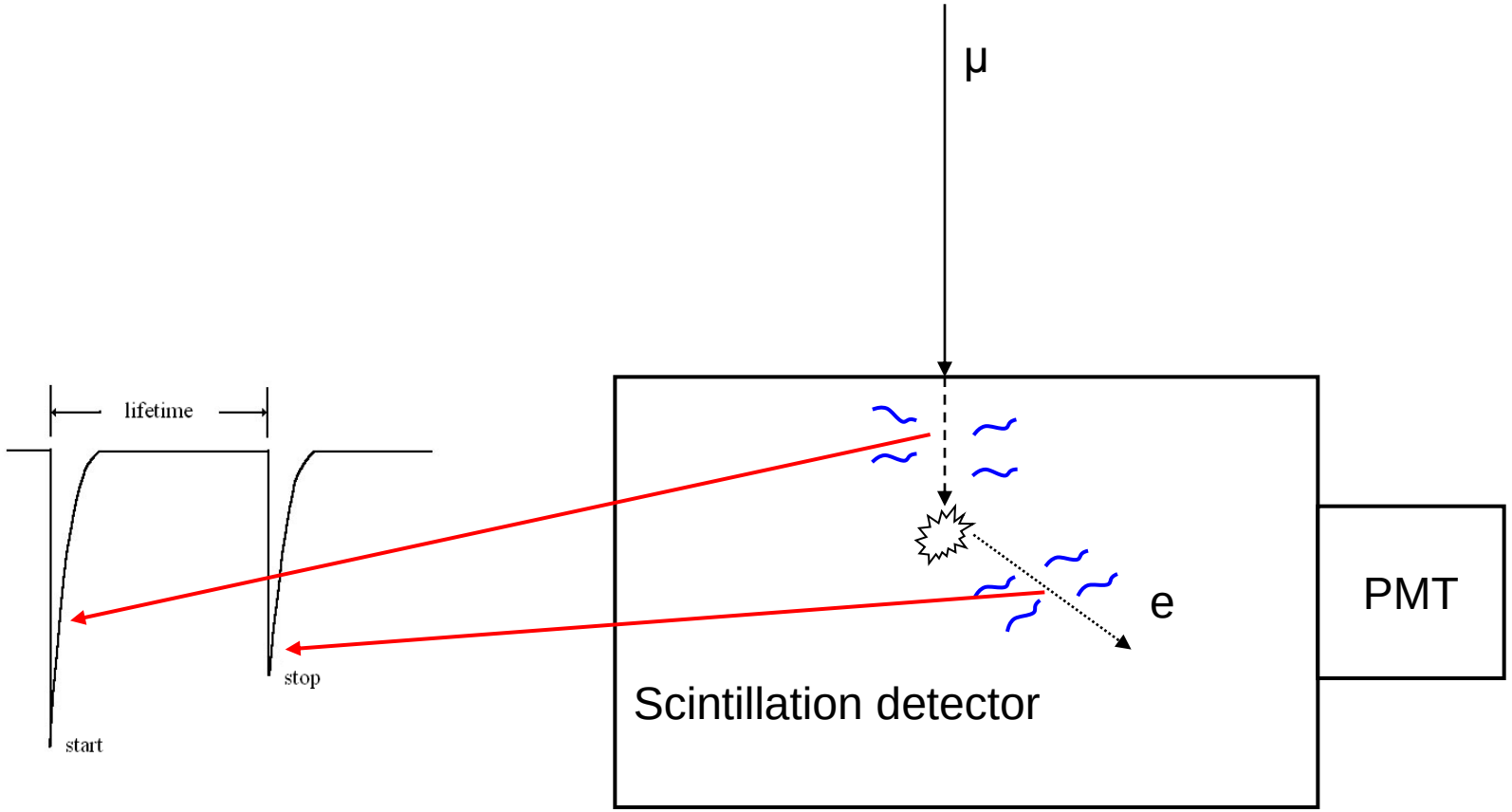
(Upper) Total Field (nT) due to centered, inclined dipole. (Lower) Total Field (nT) due to offset, inclined dipole.


90
60
30
0
-30
-60
-90
Latitude
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180
Longitude
28000
60000
nT
22000
30000
38000
46000
54000
62000
70000

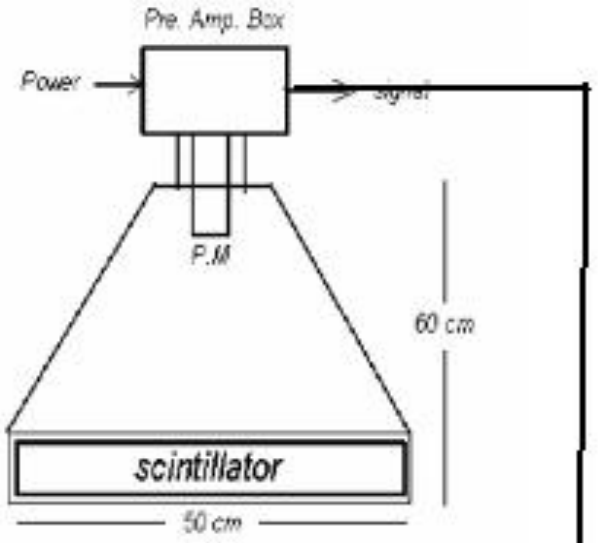

rig (GeV)
15
10
5
0
-5
0
2
4
6
8
10
12
14
16
cutoff 14.9/L^2 (GeV)
β
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
SAA

Cosmic rays


Primary Cosmic Rays
Balloon
30000 m
Hess & Kolhörster
9000 m (1912-14)
Concorde
15000 m
Mont Blanc
4807 m


μ
lifetime
start
stop
e
PMT
Scintillation detector

TUPI Muon decay System

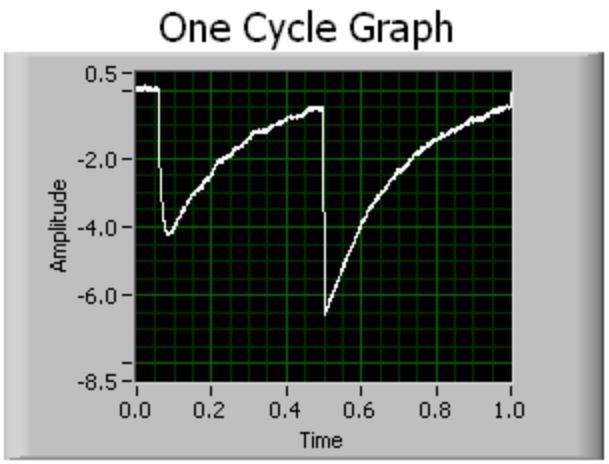


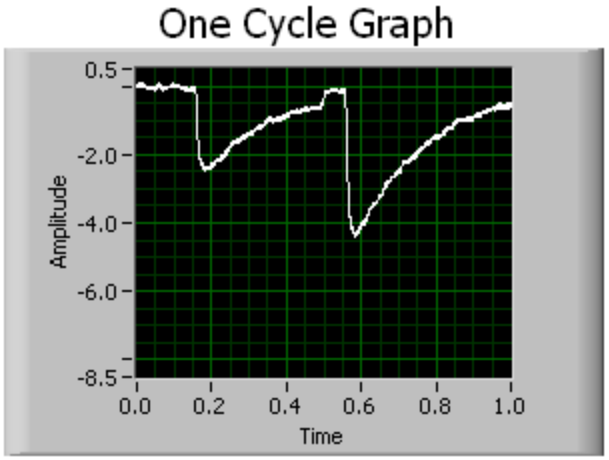
2 GHz

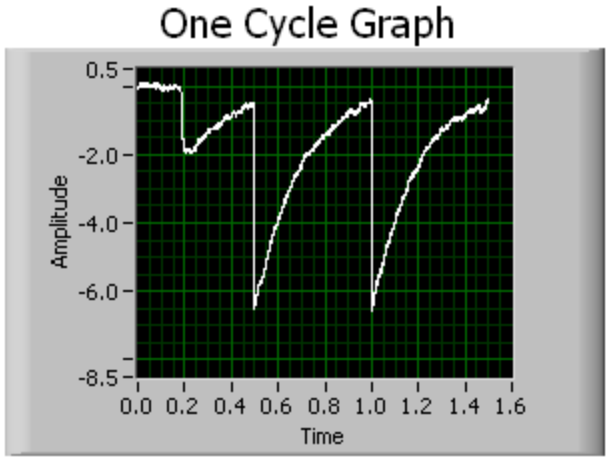
USB

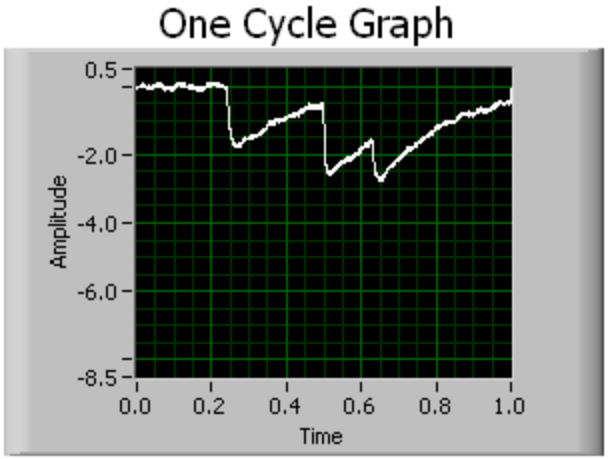
DUAL CORE
LabVIEW

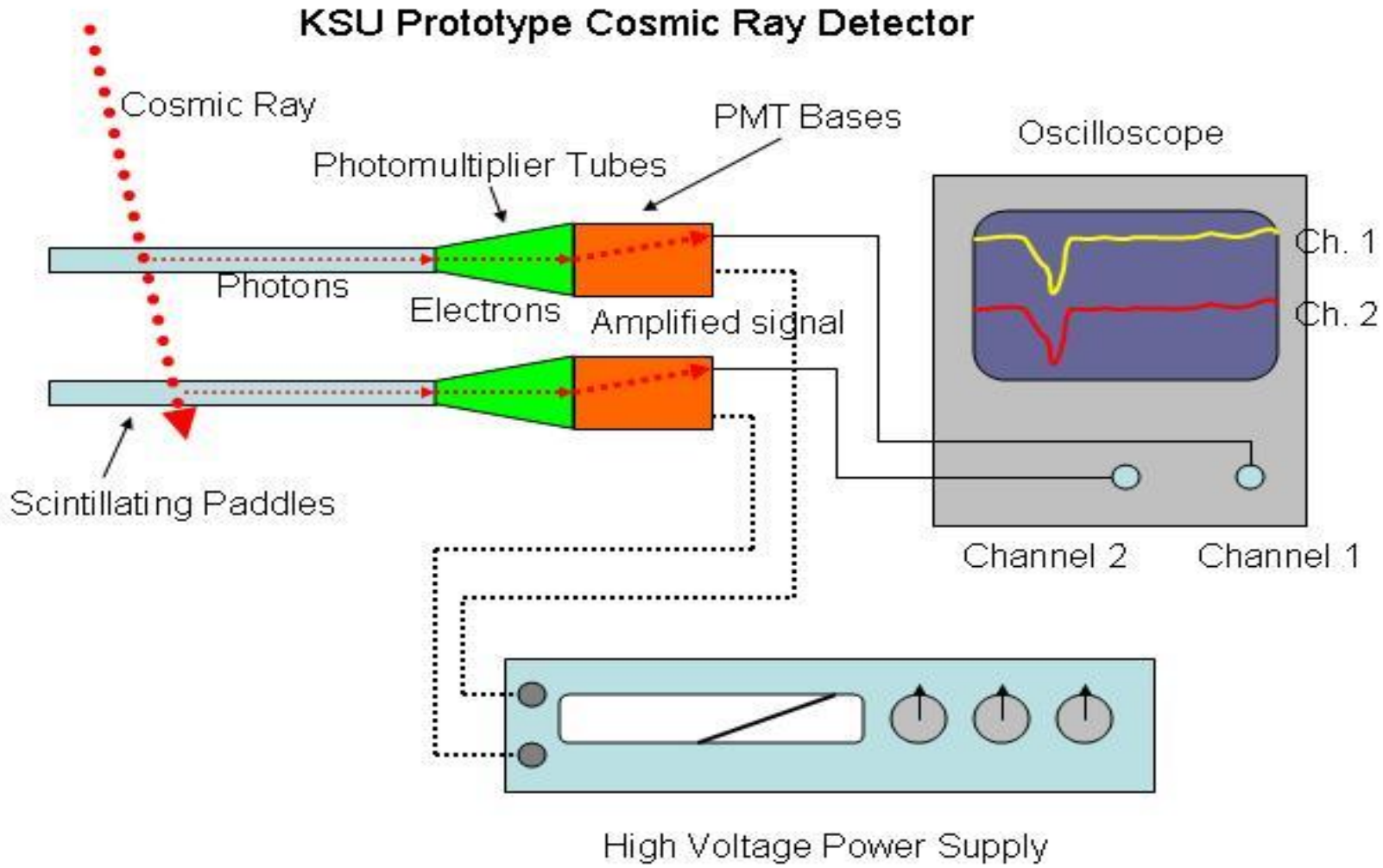
Tupi Results

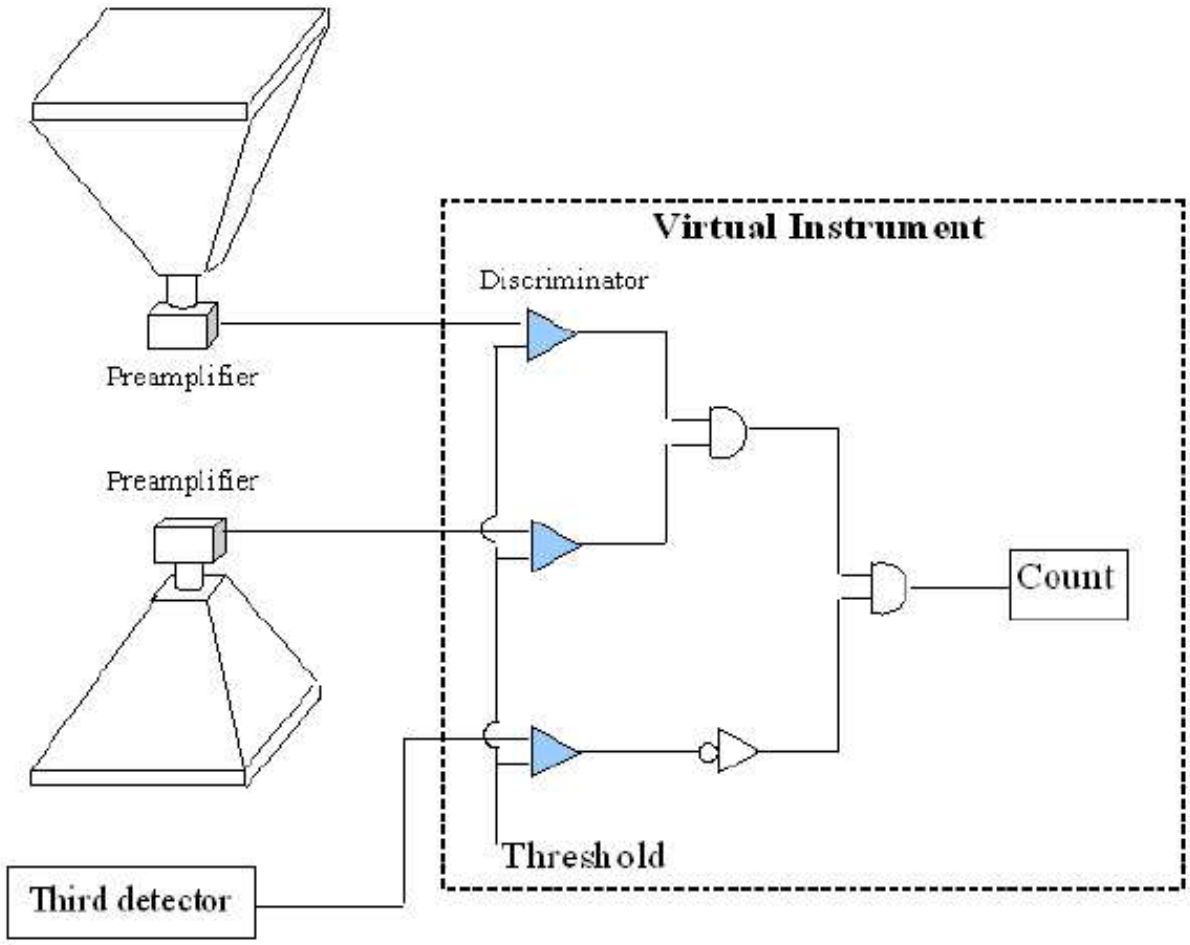






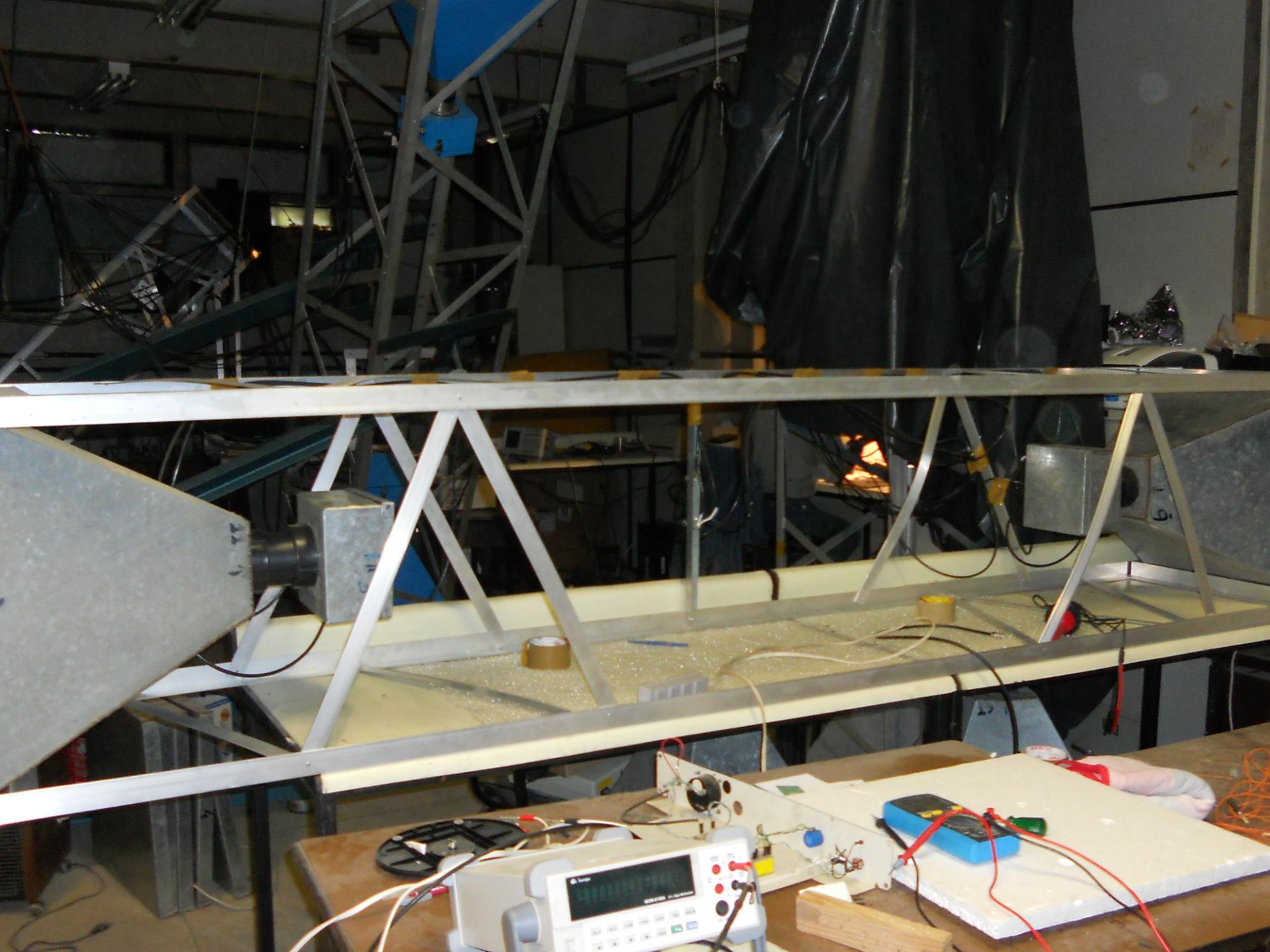


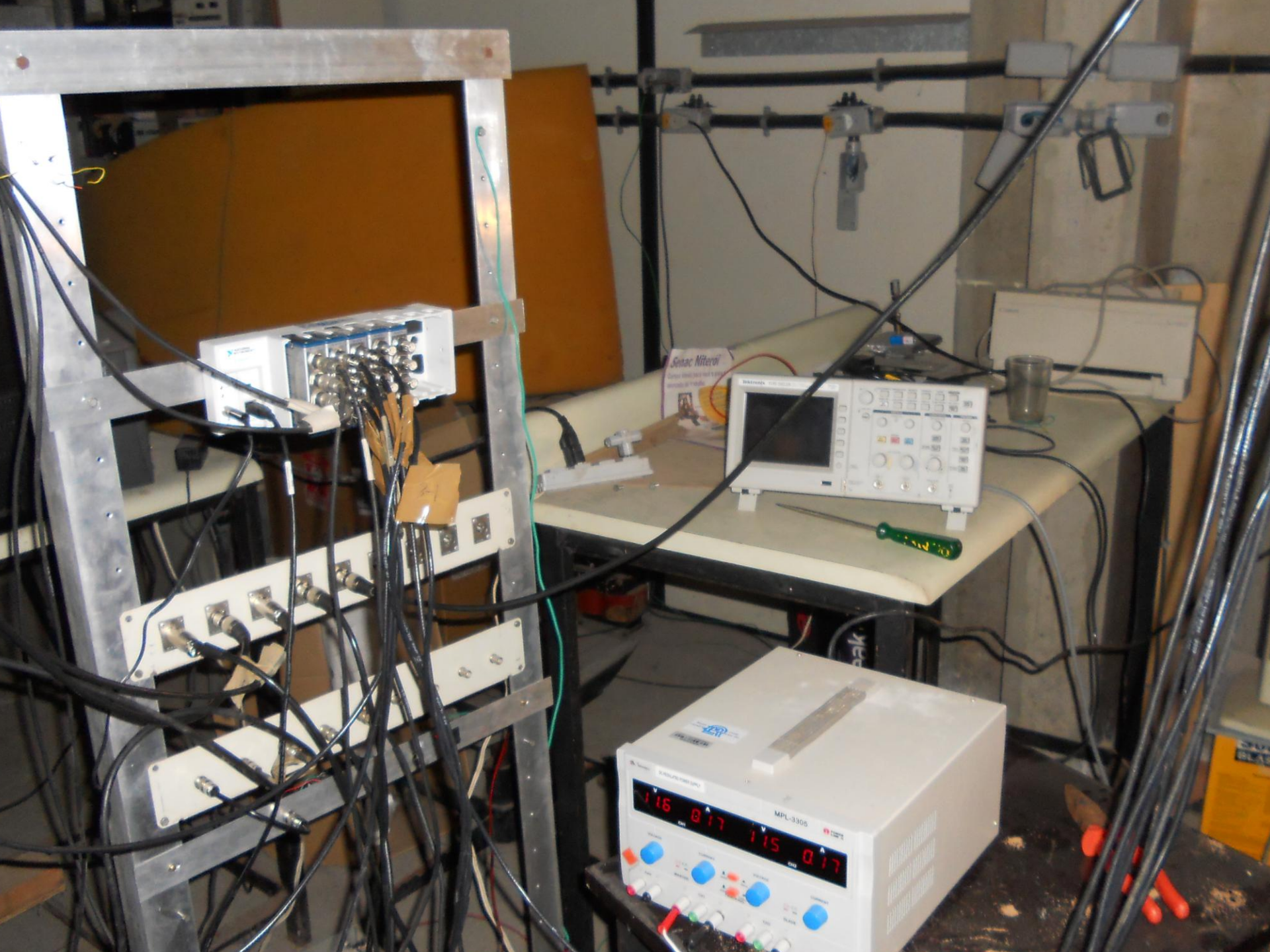

KSU Prototype Cosmic Ray Detector
Cosmic Ray
PMT Bases
Oscilloscope
Photomultiplier Tubes
Ch. 1
Ch. 2
Photons
Electrons
Amplified signal
Scintillating Paddles
Channel 2
Channel 1
High Voltage Power Supply


Virtual Instrument
Discriminator
Preamplifier
Preamplifier
Count
Threshold
Third detector

TELESCÓPIO TUPI


SAMSUNG

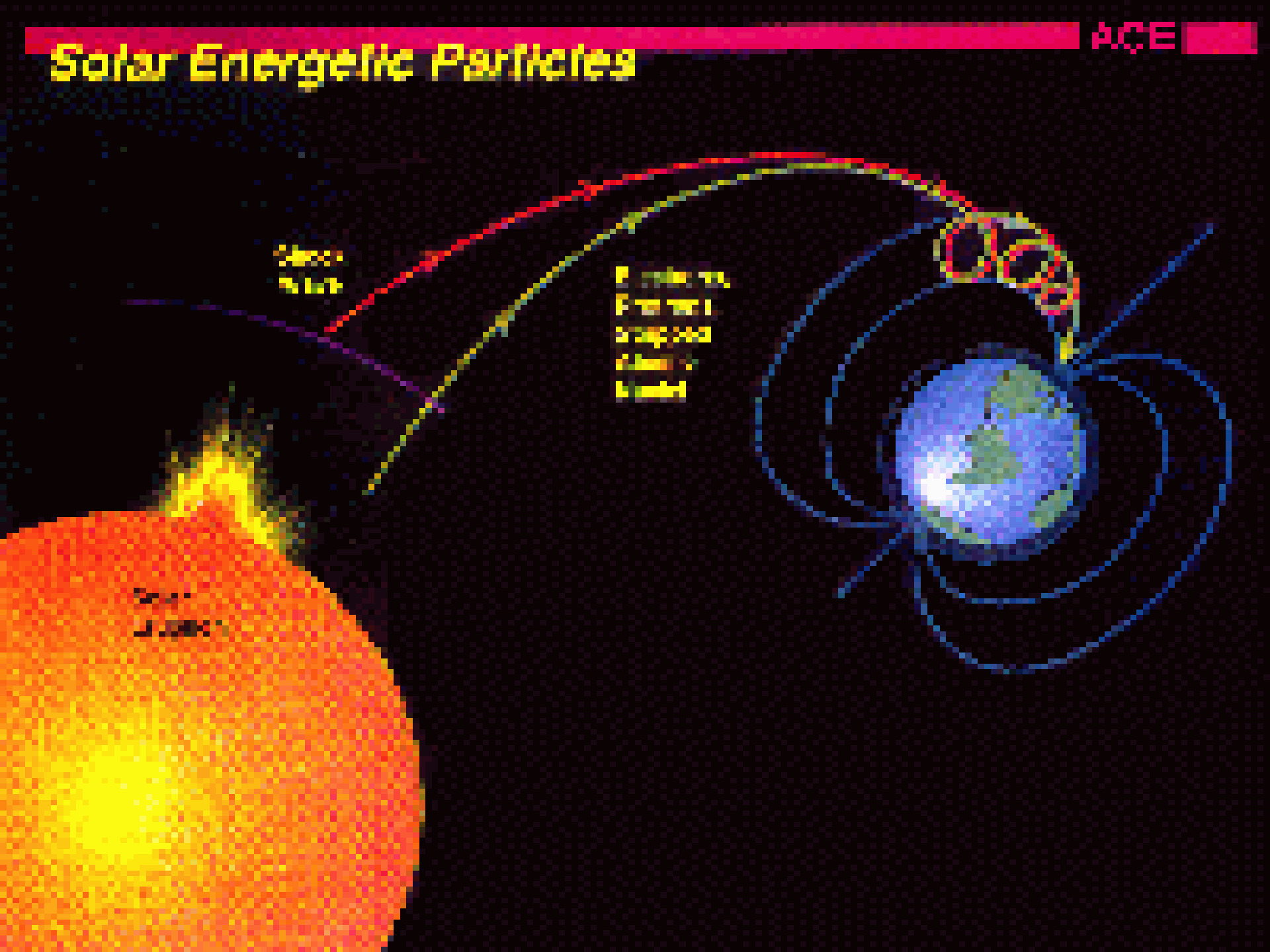



Senac Niterói
MPL-3305

SOLAR PHYSICS

Solar Energetic Particles

ACE



PHYSICAL REVIEW D 86, 022001 (2012)

Search for a simultaneous signal from small transient events in the Pierre Auger Observatory and the Tupi muon telescopes

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(Received 12 January 2012; published 2 July 2012)

We present results of a search for a possible signal from small scale solar transient events (such as flares and interplanetary shocks) as well as possible counterparts to gamma-ray burst (GRB) observed simultaneously by the Tupi muon telescope (Niteroi, Brazil, 22.9° S, 43.2° W, 3 m above sea level) and the Pierre Auger Observatory surface detectors (Malargue, Argentina, 69.3° S, 35.3° W, altitude 1400 m). Both cosmic ray experiments are located inside the South Atlantic Anomaly region. Our analysis of several examples shows similarities in the behavior of the counting rate of low energy (above 100 MeV) particles in association with the solar activity (solar flares and interplanetary shocks). We also report an observation by the Tupi experiment of the enhancement of muons at ground level with a significance 8σ in the 1-sec binning counting rate (raw data) in close time coincidence (T-184 sec) with the Swift-BAT GRB110928B (trigger = 504307), according to the GRB Coordinate Network report. At the same time this event was not included in the Swift-XRT products for GRBs. The GRB 110928B coordinates are in the field of view of the vertical Tupi telescope, and the burst was close to the MAXI source J1836-194. The 5-min muon counting rate in the vertical Tupi telescope as well as publicly available data from Auger (15 min averages of the scaler rates) show small peaks above the background fluctuations at the time following the Swift-BAT GRB 110928B trigger. In accordance with the long duration trigger, this signal can possibly suggest a long GRB, with a precursor narrow peak at T-184 sec, or a transient Galactic source.

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Exp Astron (2011) 31:177–197
DOI 10.1007/s10686-011-9242-5

ORIGINAL PAPER

Connection among spacecrafts and ground level observations of small solar transient events

An overview of small solar transient events observed at ground

Carlos Roberto A. Augusto · Anderson C. Fauth · Carlos E. Navia · Hisatake Shigeouka · Kin H. Tsui

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Abstract An overview of the results of the search for small solar transient events, in association with muon enhancements (deficits) registered at ground-level by the Tupi muon telescopes, is presented. Among the events, there are

SOLAR PHYSICS AND CLIMATE

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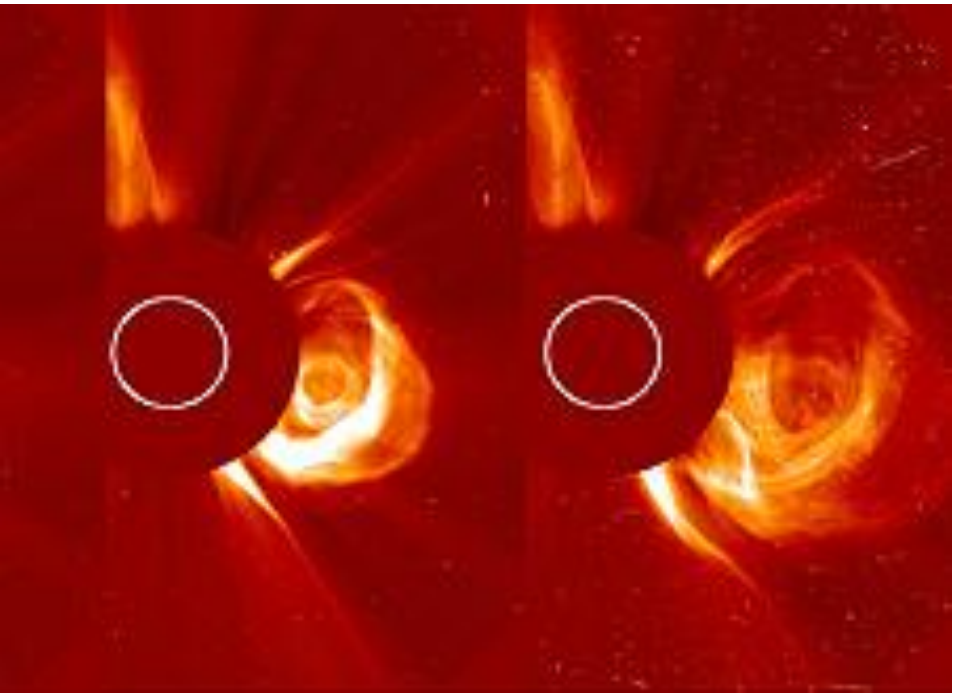
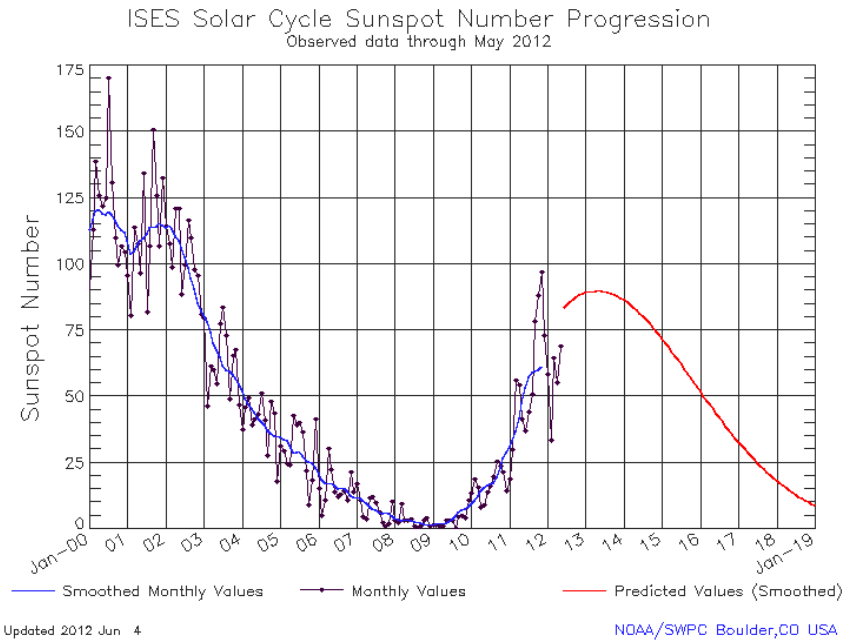
Universidad Mayor de San Andres (La Paz -Bolivia)

Solar Physics

CME (SOHO)

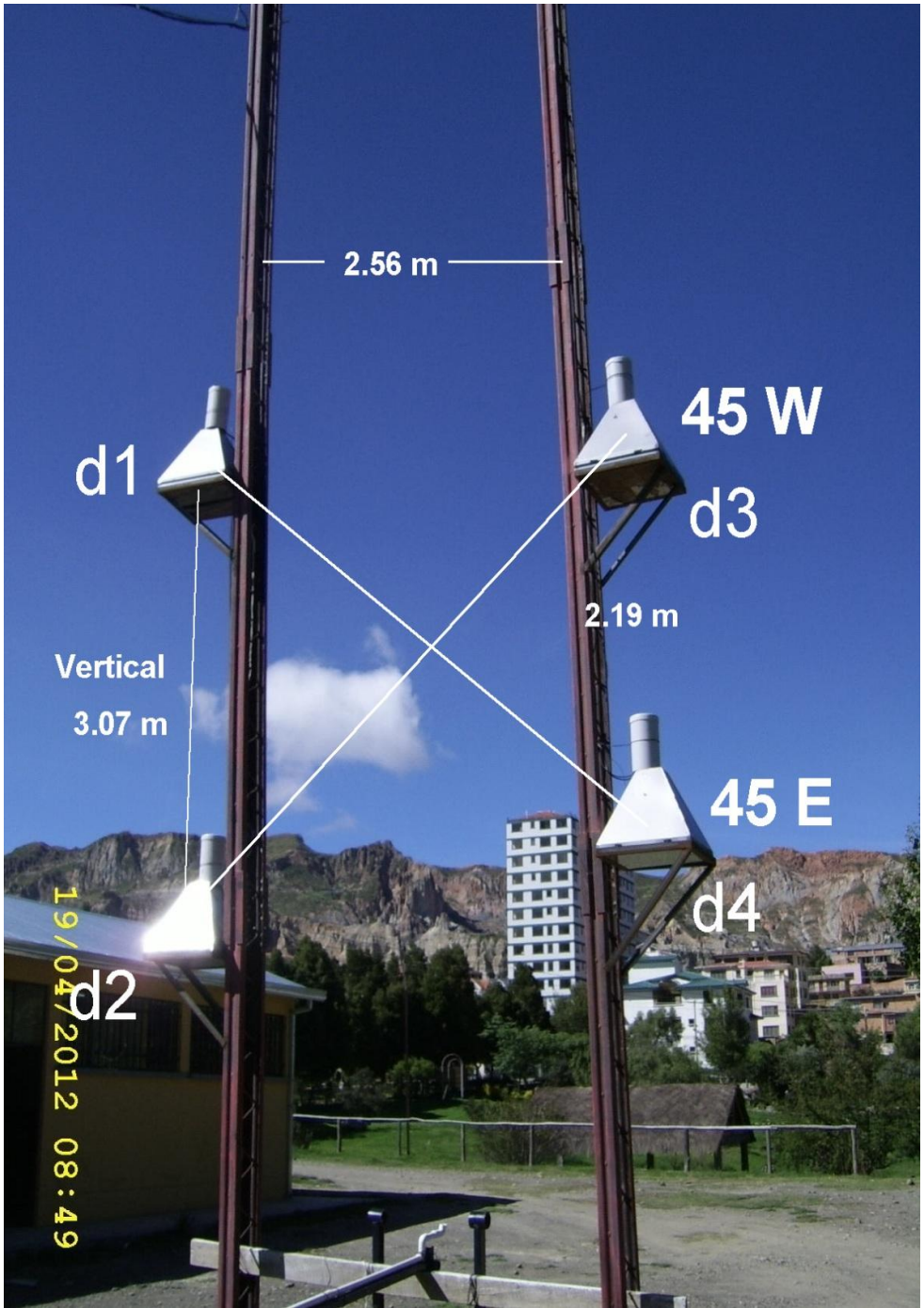


Solar cycle (11 years)



Cota Cota Telescope

La Paz Bolivia


2.56 m
45 W
d1
d3
2.19 m
Vertical
3.07 m
45 E
d4
d2
19/04/2012 08:49

Angulo sólido de los telescopios

- Vertical: 0.10 strd.
- 45 W: 0.07 strd.
- 45 E: 0.07 strd.
- Vertical adicional: 0.19 strd.

Sistema de detección

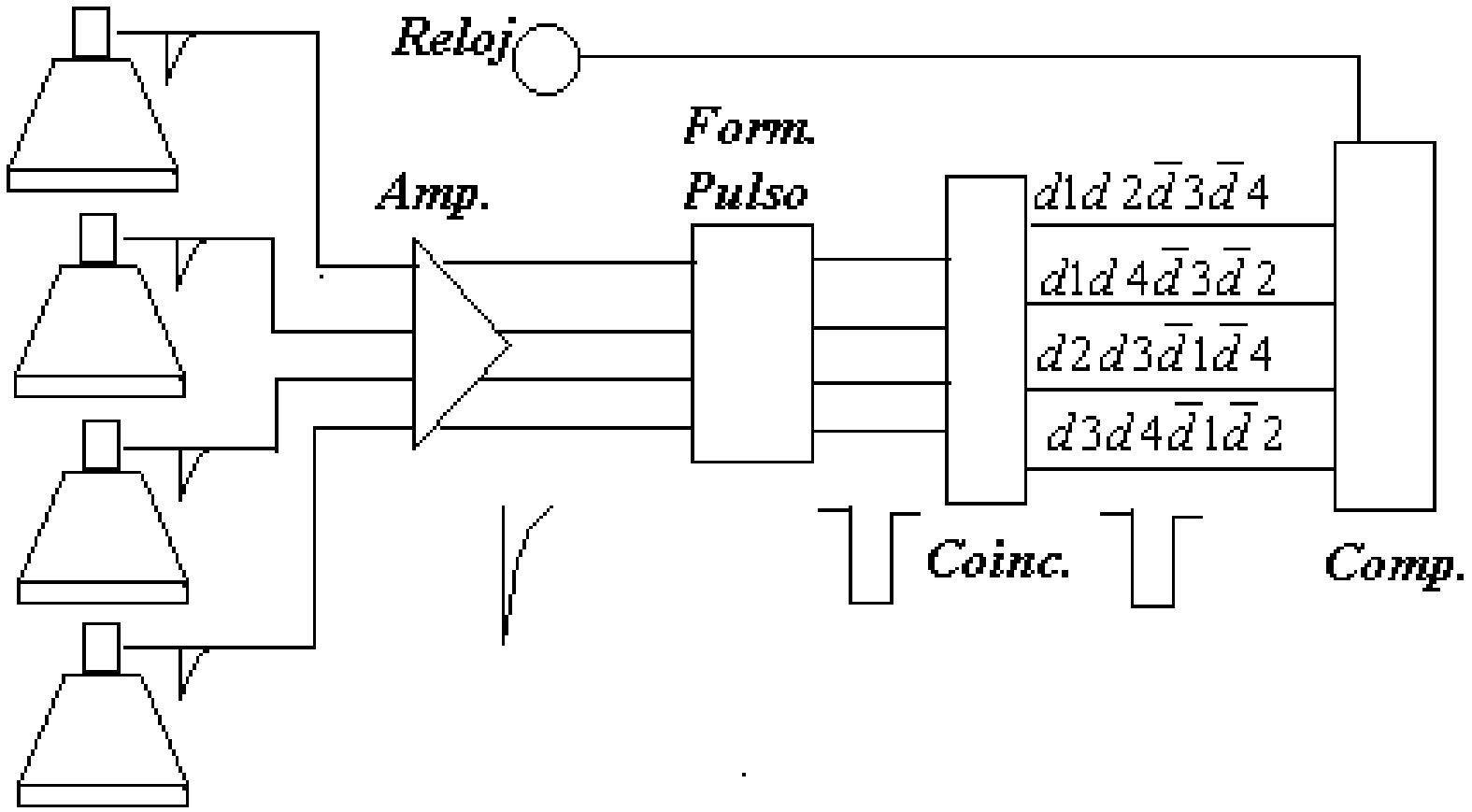
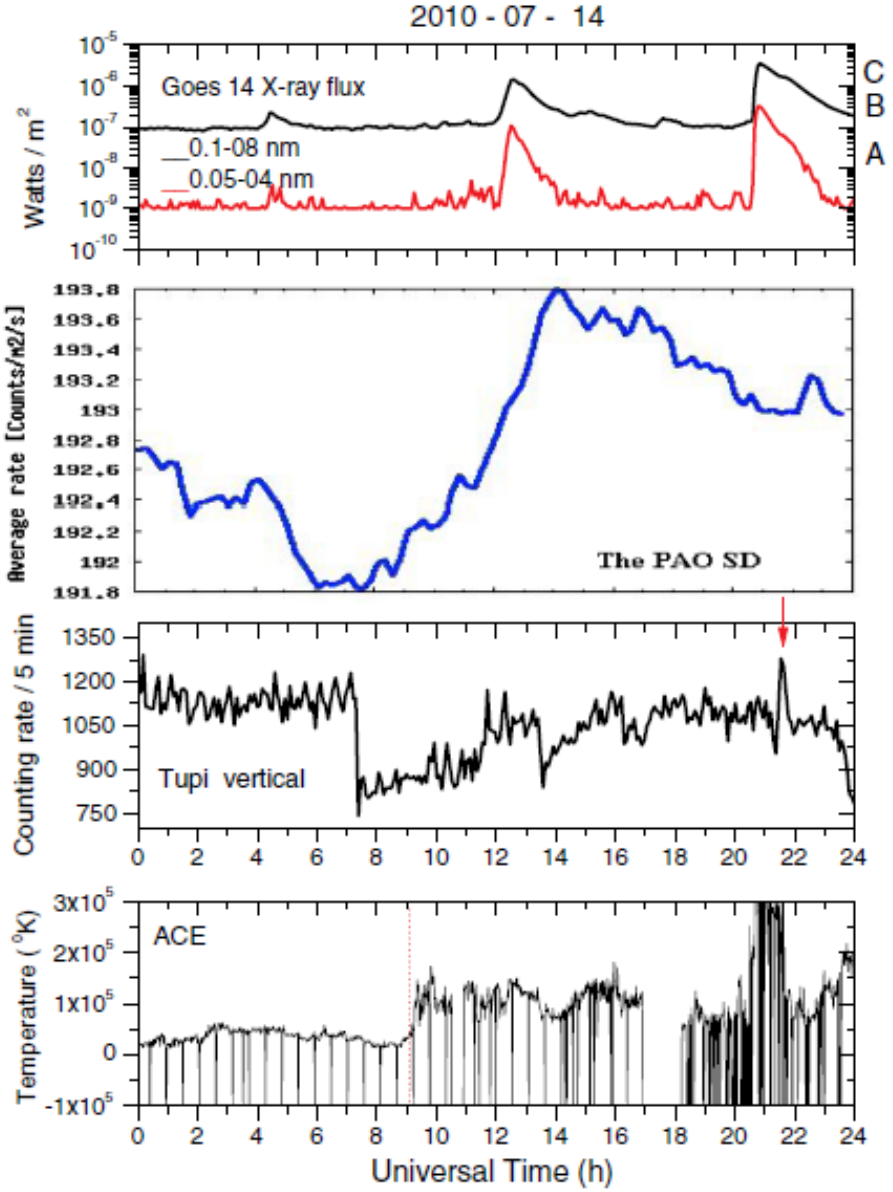


FIG. 3 (color online). View of a unit of the Pierre Auger water-Cherenkov detector (left) and the vertical Tupi telescope (right).

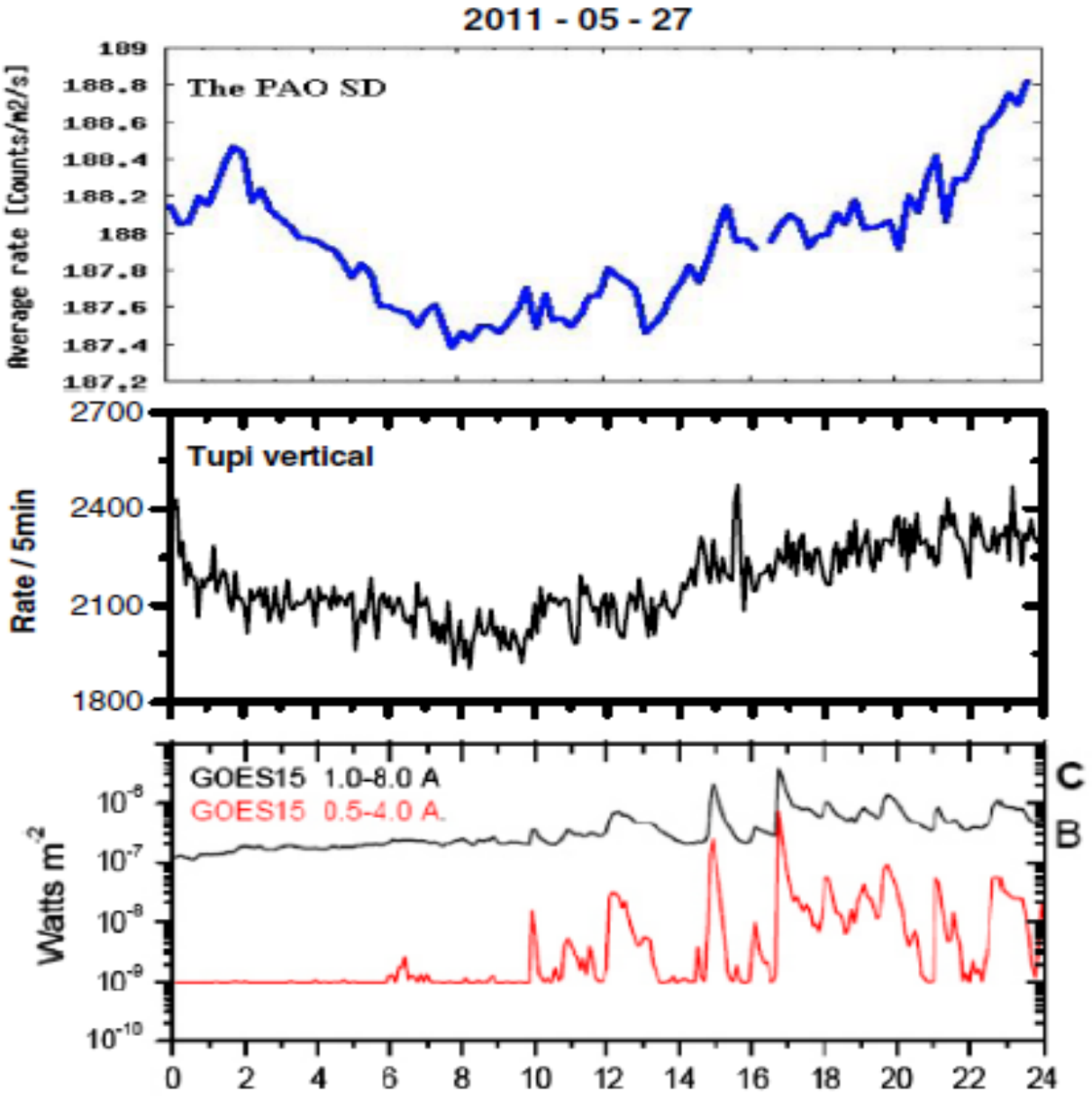
The effective solid angle of each detector (the PAO SD and Tupi) can be roughly obtained from the following relation:

$$\Omega = 2\pi(1 - \cos\theta_z), \quad (1)$$

where θ_z is the maximum zenith angle. For a water-Cherenkov tank detector (the elementary unit of the PAO SD) the effective θ_z is 60°, that gives $\Omega_{\text{eff}} = 3.14$ sr. The effective field of view of the Tupi telescopes is estimated as $\Omega_{\text{eff}} \sim 0.37$sr, around 8 times smaller than the water-Cherenkov tank detector. This narrow solid angle [20] of the Tupi telescopes is the main difference in comparison with the Cherenkov tank detector solid angle. A photograph of both detectors is shown Fig. 3.


2010 - 07 - 14
Goes 14 X-ray flux
0.1-08 nm
0.05-04 nm
Watts / m2
C
B
A
Average rate [Counts/m2/s]
The PAO SD
Counting rate / 5 min
Tupi vertical
Temperature (°K)
ACE
Universal Time (h)

SEARCH FOR A SIMULTANEOUS SIGNAL FROM SMALL .



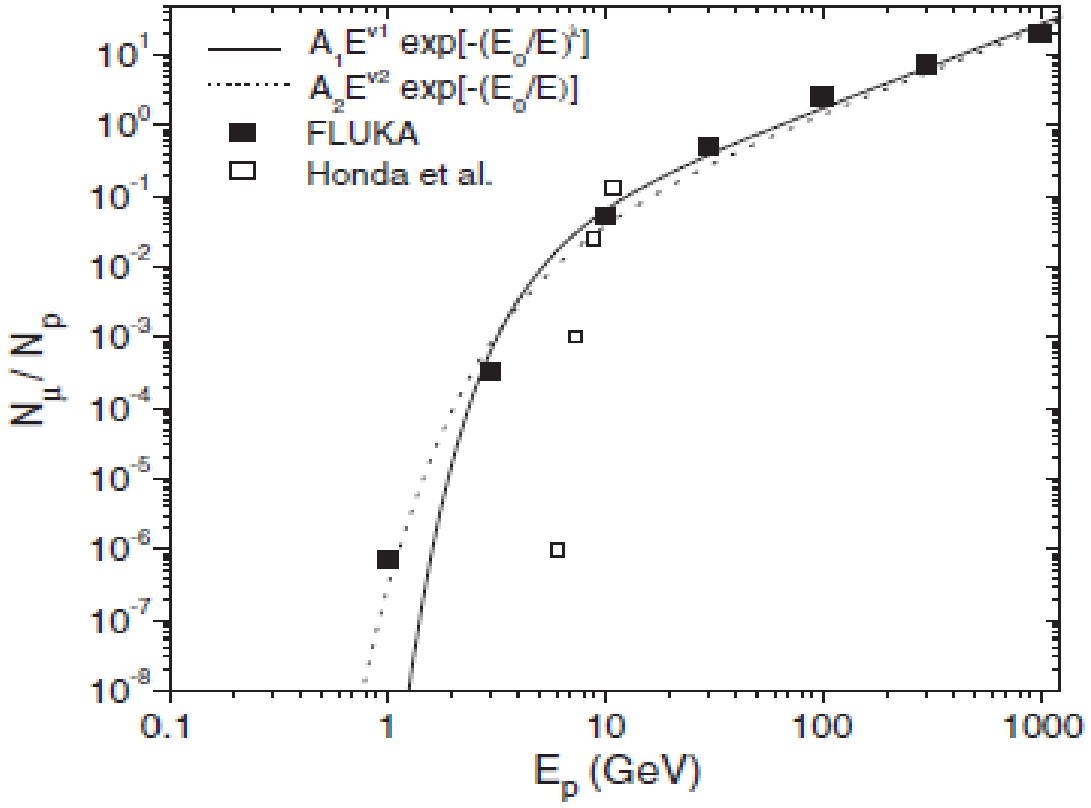


FIG. 6. Yield function, as the number of secondaries at sea level per proton focusing vertically at the top of the atmosphere, as a function of proton energy. The black squares represent the FLUKA Monte Carlo results [25], the open squares are results from [26] for proton energies above 7 GeV, and the lines are two parametrizations used in the present work.

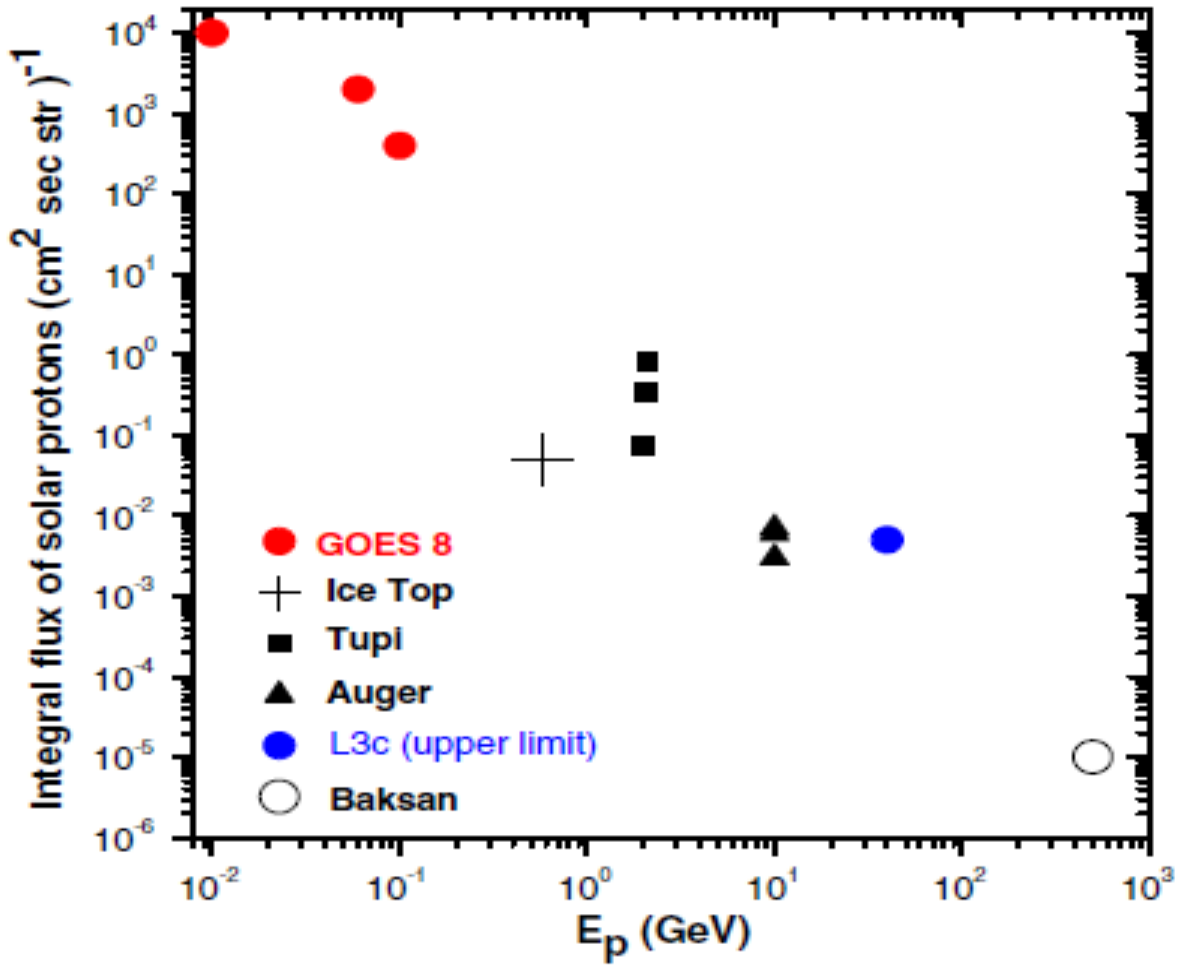
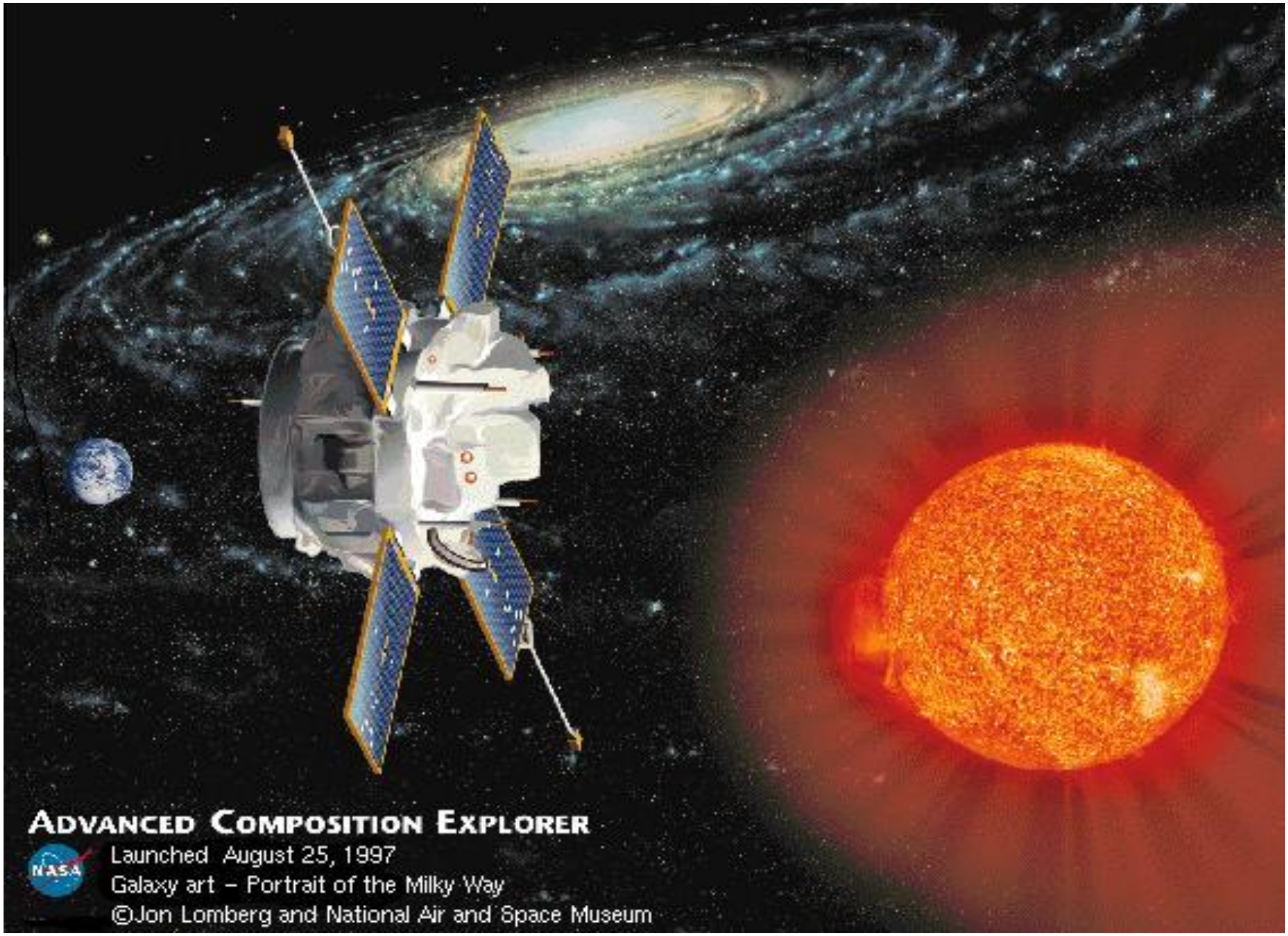


FIG. 7 (color online). The solar flare induced proton flux (integral energy spectrum) obtained by this work for the 27 May 2011 C-class solar flare compared with other measurements [27,29]. See text for details.

INTERPLANETARY SHOCKS

CME

CIR


ADVANCED COMPOSITION EXPLORER
Launched August 25, 1997
Galaxy art – Portrait of the Milky Way
©Jon Lomberg and National Air and Space Museum

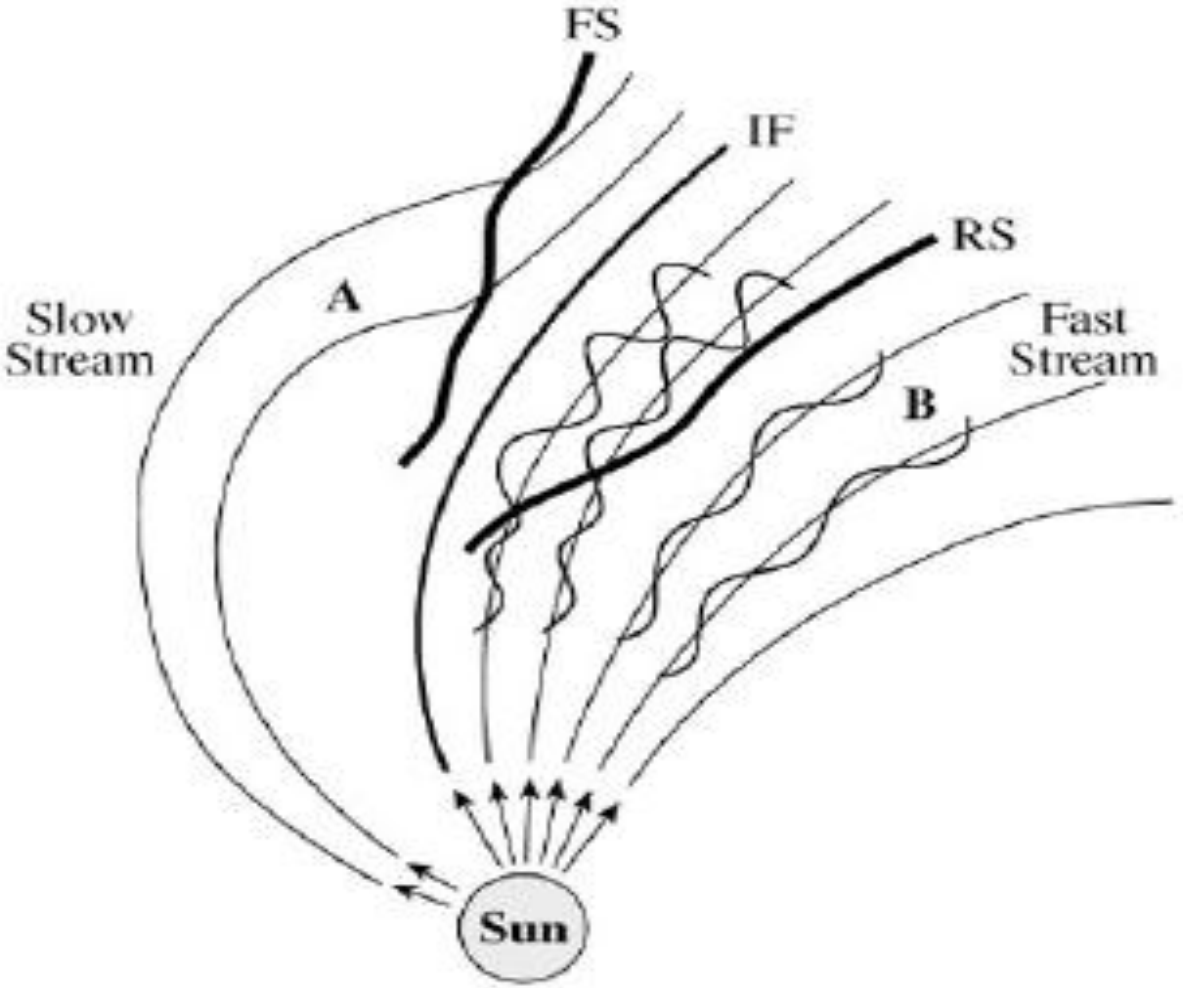
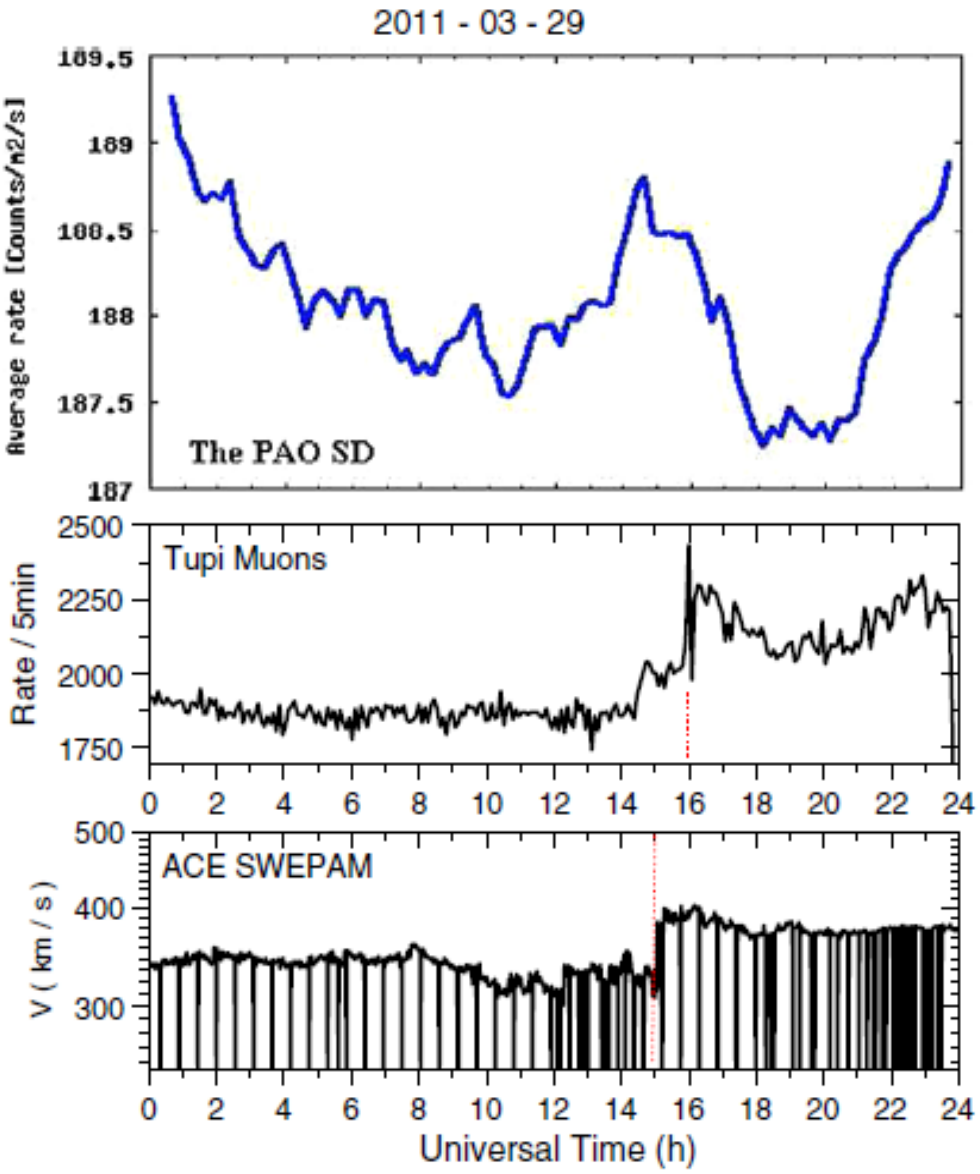
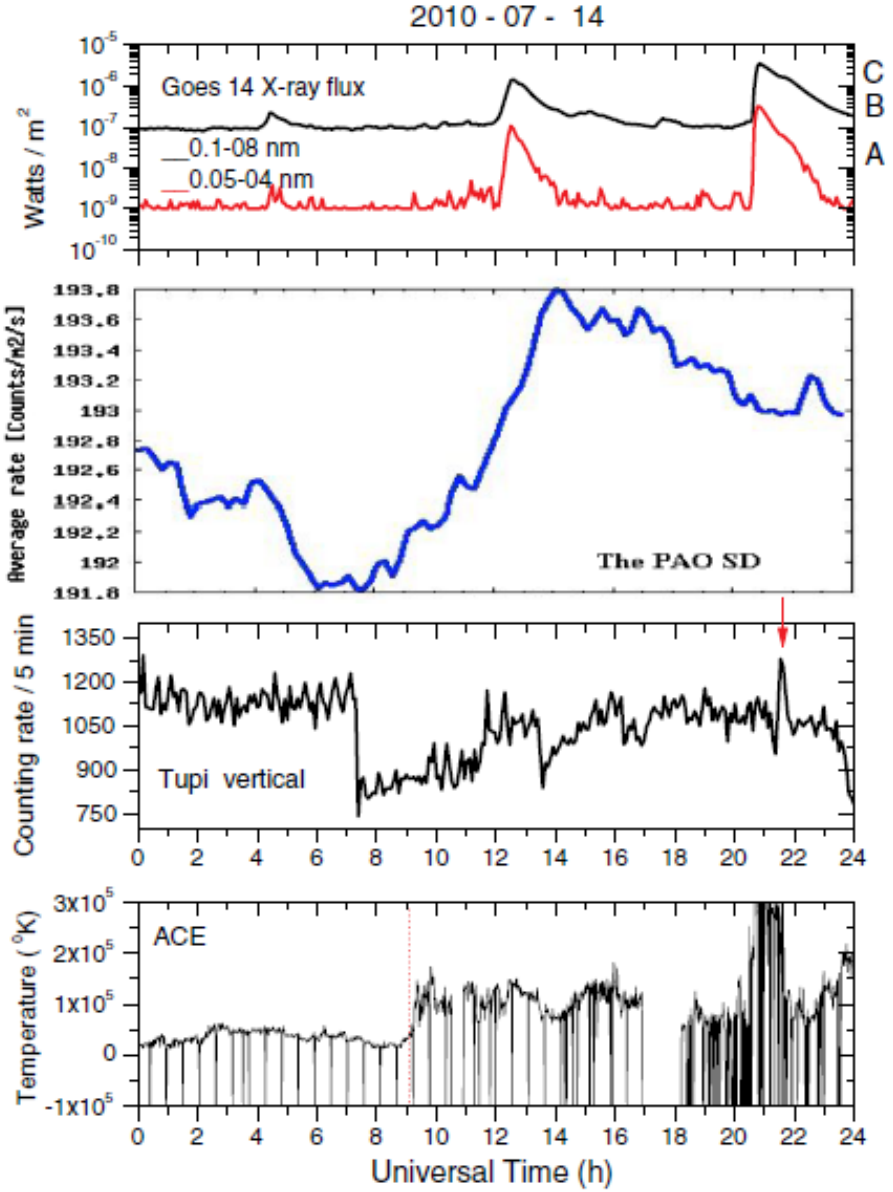


Fig. 5. Mechanism of the formation of a CIR. The high-speed solar wind, originating in coronal holes interact with the preceding slow solar wind, forming forward (FS) and reverse (RS) shocks.


2011 - 03 - 29
Average rate [Counts/m2/s]
189.5
189
188.5
188
187.5
187
The PAO SD
Rate / 5min
2500
2250
2000
1750
Tupi Muons
V (km / s)
500
400
300
ACE SWEPAM
0 2 4 6 8 10 12 14 16 18 20 22 24
Universal Time (h)


2010 - 07 - 14
Goes 14 X-ray flux
0.1-08 nm
0.05-04 nm
Watts / m2
C
B
A
Average rate [Counts/h2/s]
The PAO SD
Counting rate / 5 min
Tupi vertical
Temperature (°K)
ACE
Universal Time (h)

Is there gamma ray signal at sea level?

Is there muon signal (excess)?

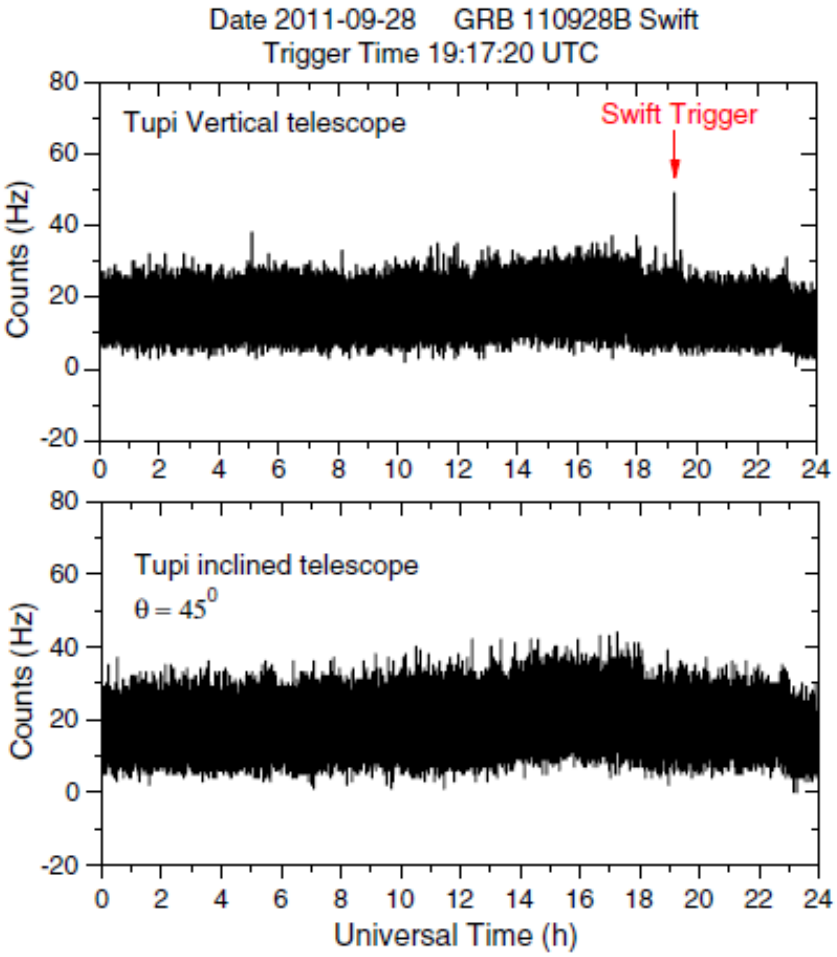
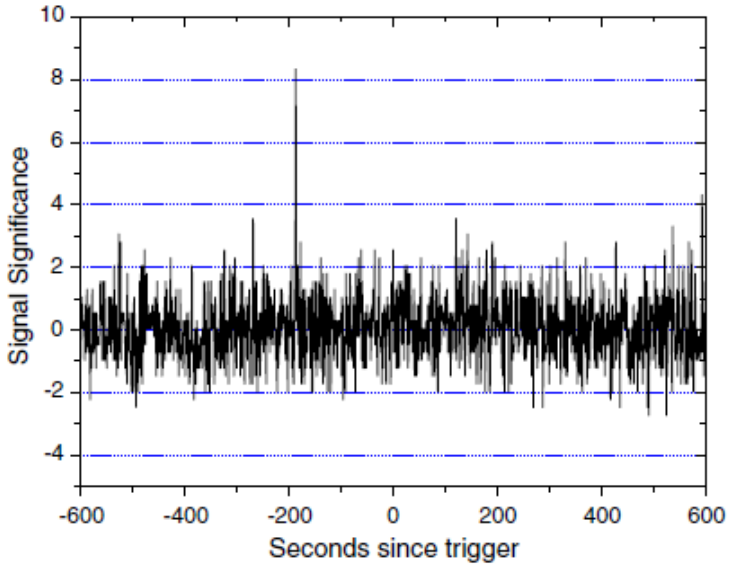


FIG. 10 (color online). Time profile of the 1-sec binning counting rate (raw data) observed by the vertical (top panel) and inclined (bottom panel) Tupi telescopes on 28 September 2011. The vertical arrow indicates the Swift-BAT GRB 110928B trigger.

analysis



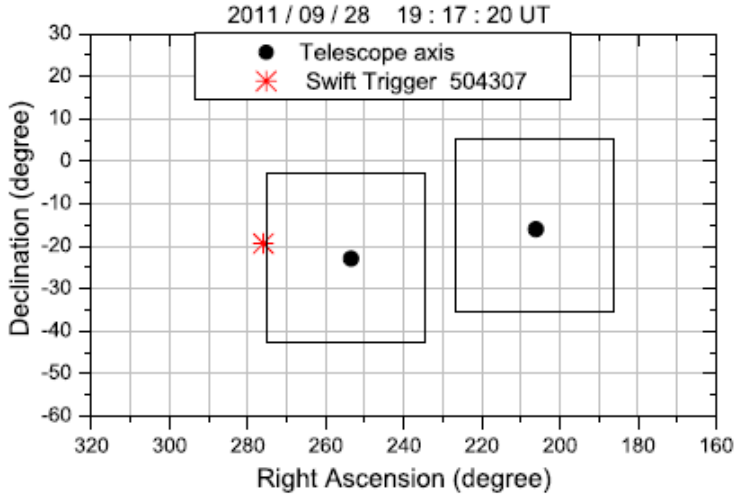
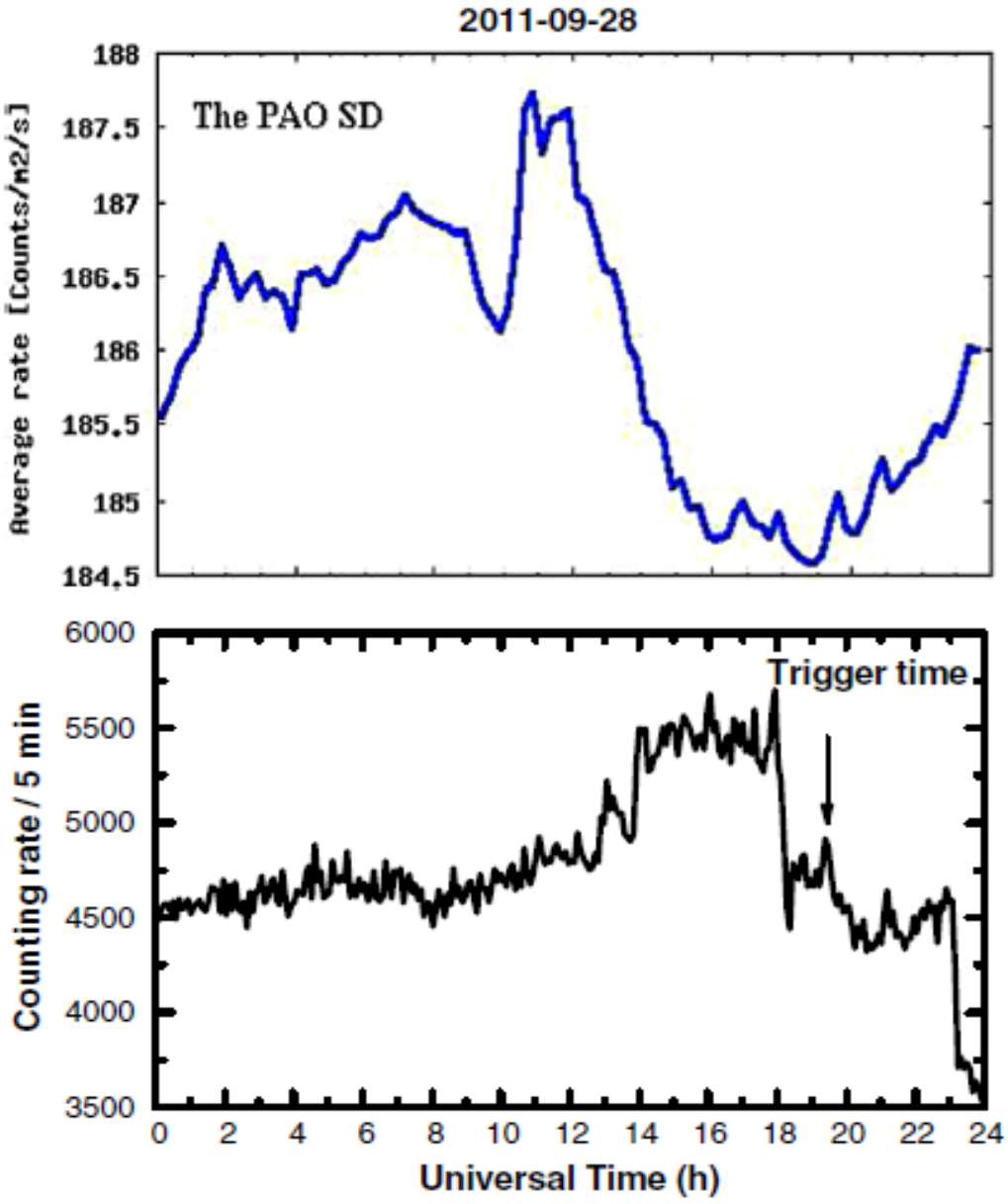


FIG. 11 (color online). The equatorial coordinates of the Tupi telescope's (vertical, on the left, and inclined, on the right) axes (black circles). Squares represent the field of view of the telescopes and the asterisk is the position (coordinates) of the Swift-BAT GRB110928 (trigger = 504307).


2011-09-28
The PAO SD
Average rate [Counts/m2/s]
188
187.5
187
186.5
186
185.5
185
184.5
Trigger time
Counting rate / 5 min
6000
5500
5000
4500
4000
3500
0
2
4
6
8
10
12
14
16
18
20
22
24
Universal Time (h)

Conclusions

- Solar Physics and climate project is in progress.
- The Tupi telescopes already have colected around 54 transient solar events in association with spacecraft, during the ascension phase, of the 24 solar cycle.
- Correlations with global climate parameters is in progress.
- Data from Campinas, Niteroi and La Paz together it had covered the maximum and decline of the solar cycle 24.