



Balloon-borne dosimetry measurements in the frame of the BEXUS student programme – the CoCoRAD experiment

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Outline

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- The cosmic radiation environment in the atmosphere
- CoCoRad
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 - » Pille system
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REXUS/BEXUS

Rocket and Balloon Experiments for University Students

- **The main goals**
 - » to increase the interest in space sciences and technology
 - » to increase the awareness of the benefits of rockets and balloons for carrying out experiments
- **The organisers**
 - » European Space Agency Educational Office (ESA)
 - » Swedish National Space Board (SNSB)
 - » Swedish Space Corporation (SSC)
 - » German Aerospace Center (DLR)





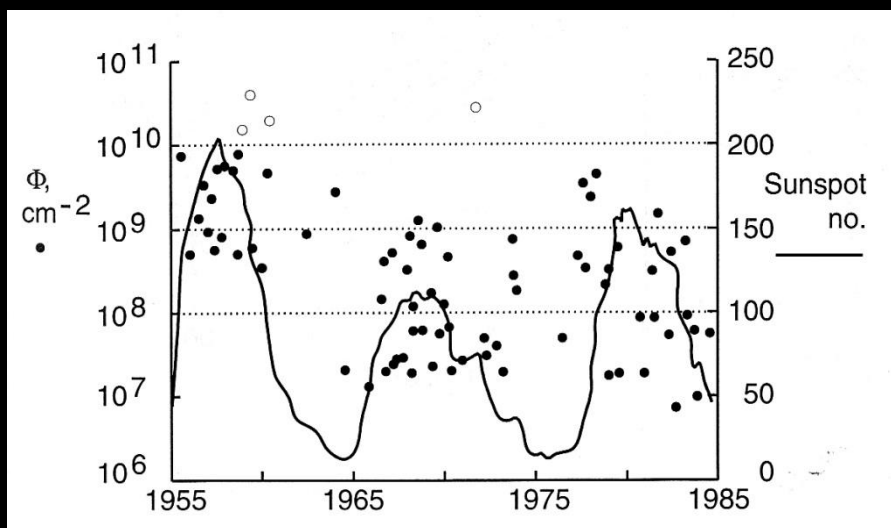
The first Hungarian student team participating the REXUS/BEXUS programme



cocorad.kfki.hu

The cosmic radiation environment in the atmosphere

- **The main sources of the high energy, charged particles (mostly trapped):**
 - » the galactic cosmic radiation (stars, supernova explosions,...)
 - » the solar wind (charged particles and magnetic field)
 - » the secondary particles



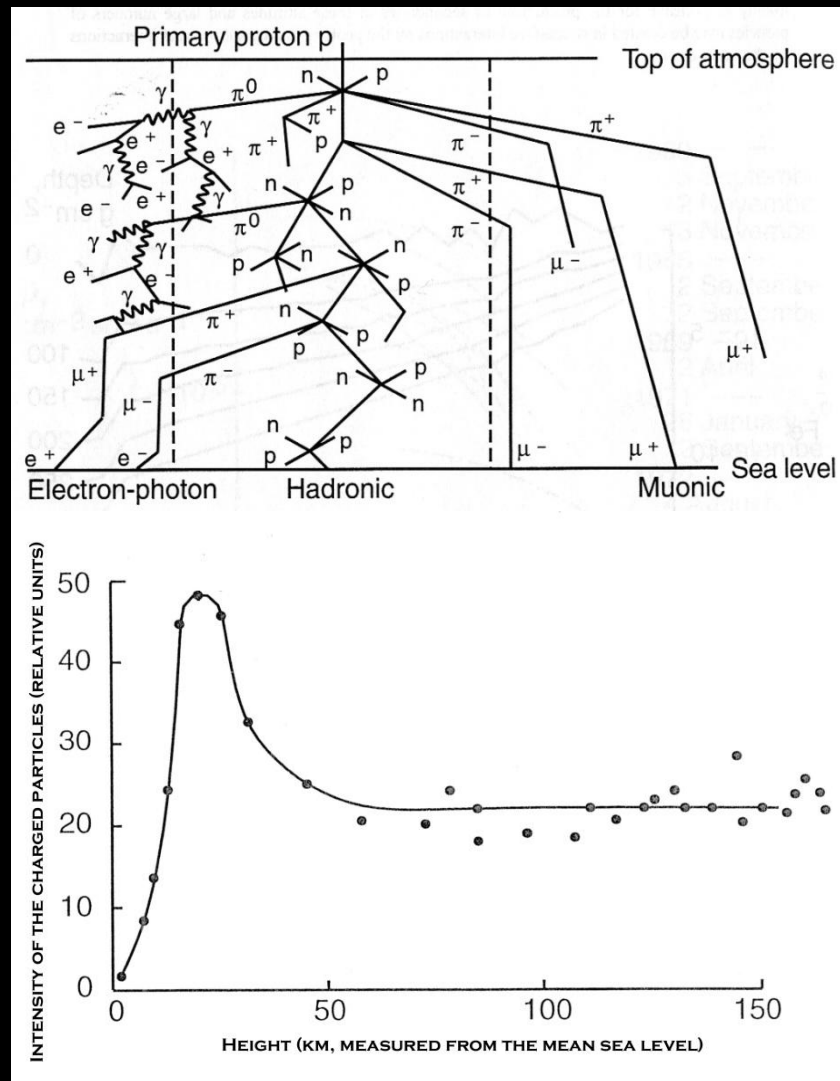
Proton fluences for solar flares in solar cycles 19, 20, 21 •.

The solid line shows the mean sunspot number.

The anomalous flares are indicated by ○.

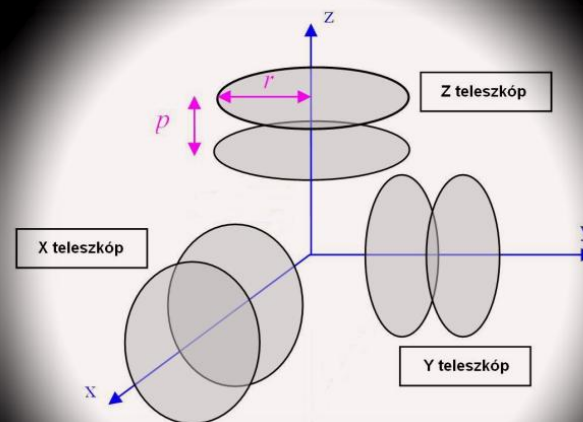
The cosmic radiation environment in the atmosphere

- Secondary particle production
- Pfozter maximum ~25 km
 - » the region where the secondary particle intensity builds up
 - » above: atmosphere density is too low to generate many secondary particles
 - » below: atmosphere shielding



The TriTel 3-dimensional space dosimetric telescope

- The development has began several years ago
 - » in the Hungarian Academy of Sciences Centre of Energy Research
Space Dosimetry Research Group
- Three silicone telescopes in three perpendicular axes
 - » measuring particles from all directions
 - » with nearly the same efficiency
 - » provides directional information
 - » LET spectra in three direction
 - » absorbed dose, equivalent dose
 - » the average quality factor of the cosmic radiation



The Pille thermoluminescent space dosimeter

- The development has begun in 1970's
 - » First flight: 1980, Bertalan Farkas, first Hungarian astronaut (cosmonaut)
 - » Since that the Pille was onboard all space stations
- Thermoluminescent (TL) dosimeter system
 - » a light-weight reader device and several dosimeters
 - » $\text{CaSO}_4:\text{Dy}$ TL material
 - » low efficiency above 10 keV/ μm
- The latest version is onboard ISS
 - » as a service dosimeter system of the Russian Zvezda module
 - » more than 30 000 measurements since 2003





Combined TriTel/Pille Cosmic Radiation and Dosimetric Measurements (CoCoRAD)

ID

Description of the objective

Priority

O1

To perform dosimetry measurements with the TriTel 3D silicon detector telescope at altitudes up to maximum 35 km.

Primary

O2

To measure the excess absorbed dose of the BEXUS balloon mission with the Pille thermoluminescent dosimeters.

Primary

O3

To intercompare the results of the measurements.

Primary

O4

To use TriTel data for improving the Pille results (correction).

Primary

O5

To measure the altitude dependence of the dose rates and LET spectra with TriTel.

Secondary

O6

To monitor first time the working of the TriTel detector in real mission conditions.

Secondary

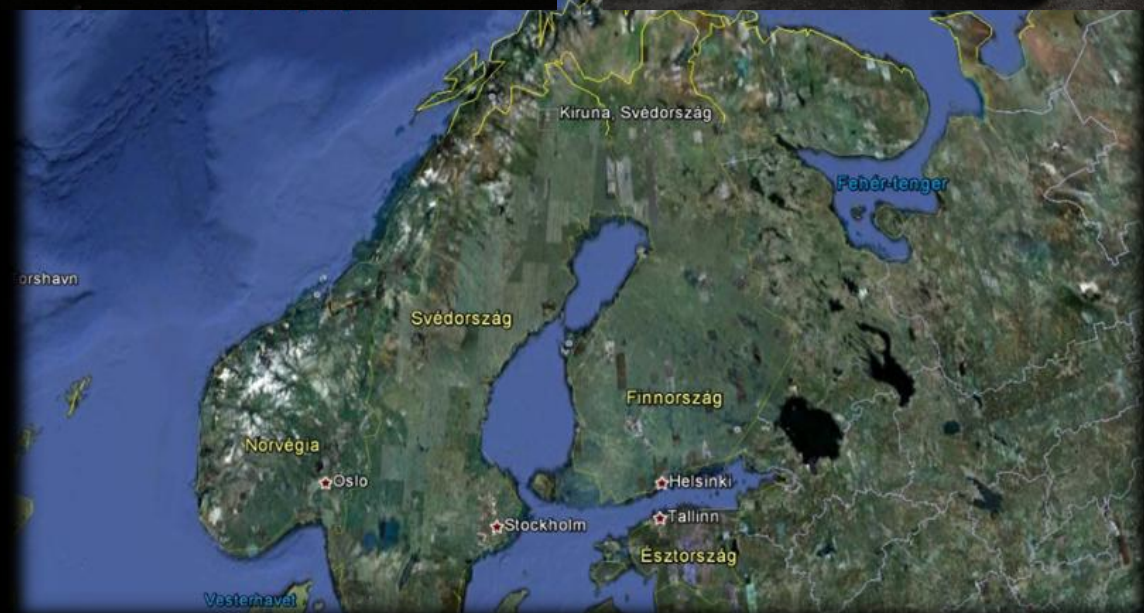
O7

To estimate the possible altitude of the Pfotzer maximum based on the measured data.

Tertiary

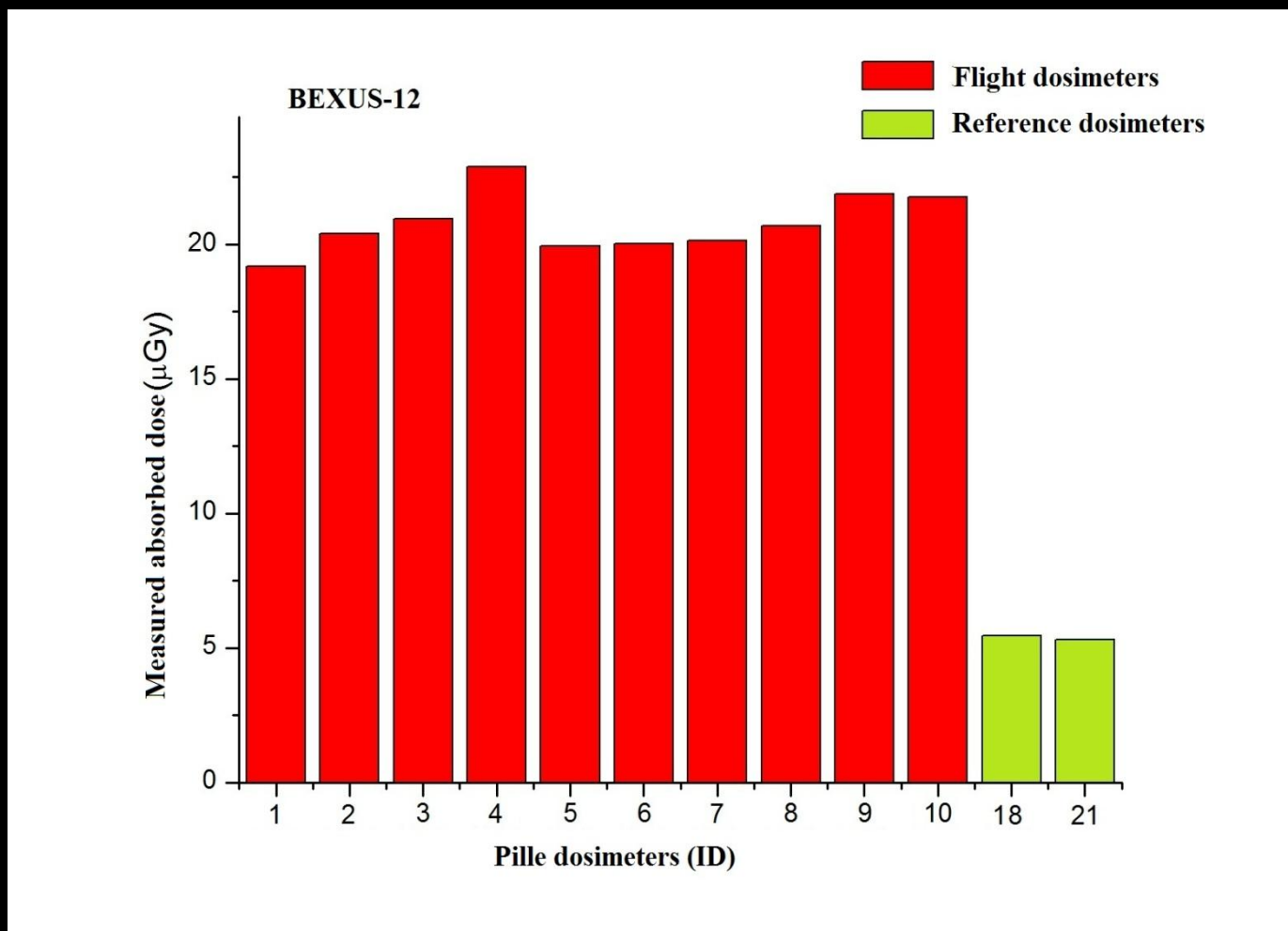


2011 September 27. – The launch of the BEXUS-12



4/25/2012

RAD2012, Nis



Preliminary results from the flight of the CoCoRAD

The average noise level of the chosen bulbs

$1.4 \pm 0.5 \mu\text{Gy}$

The mission time

$4.3 \pm 0.1 \text{ h}$

The time between the read-outs

$70 \pm 0.5 \text{ h}$

The measured average absorbed dose
(flight bulbs)

$20.8 \pm 1.1 \mu\text{Gy}$

The measured average absorbed dose
(reference bulbs)

$5.4 \pm 0.1 \mu\text{Gy}$

The measured average dose rate at the surface

$77.7 \pm 1.5 \text{ nGy/h}$

The excess absorbed dose of the BEXUS-12 flight

$15.6 \pm 1.1 \mu\text{Gy}$

The measured average dose rate by TriTel

$\sim 100 \text{ nGy/h}$

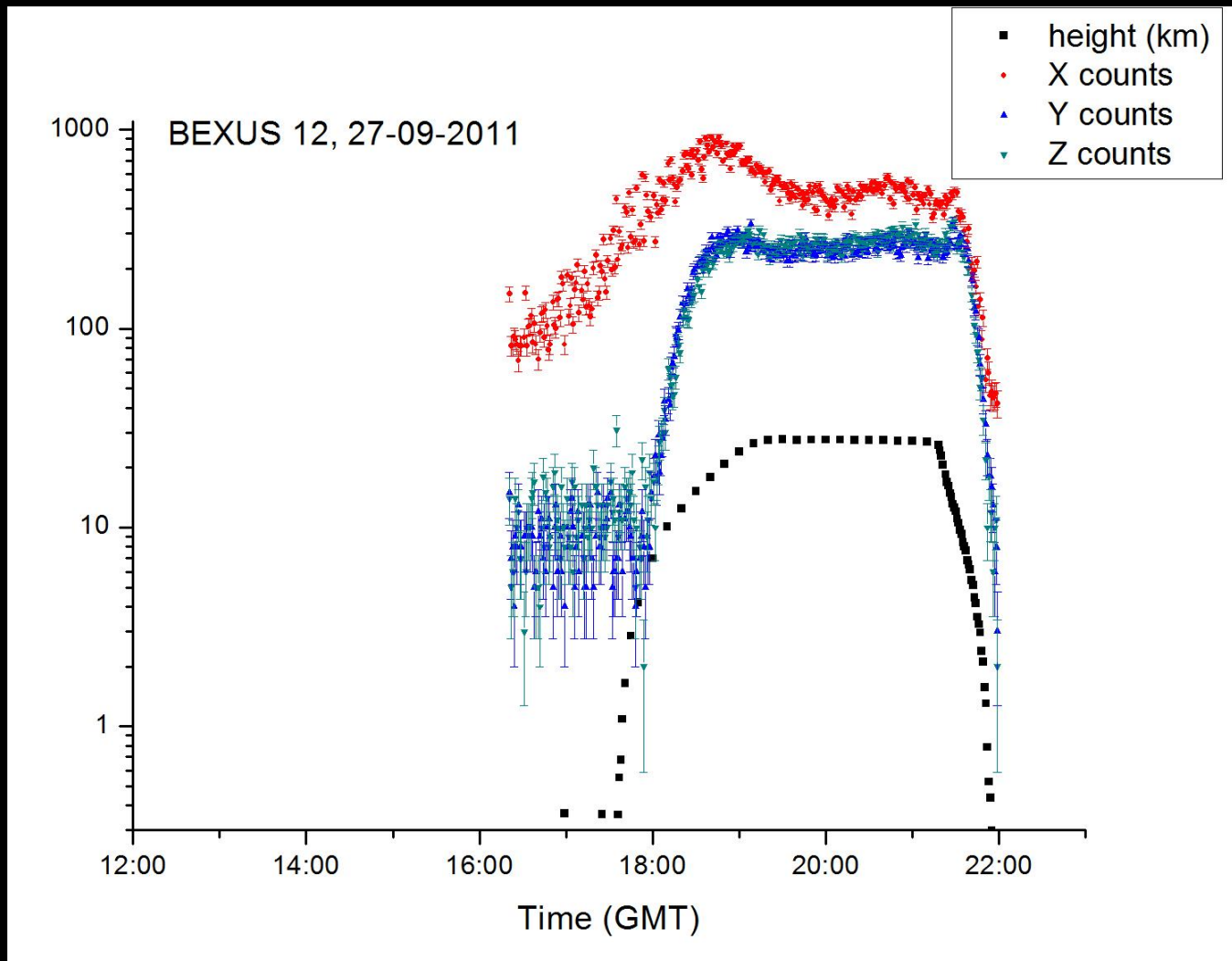
Corrected excess absorbed dose of the BEXUS-12 flight

$13.1 \pm 1.5 \mu\text{Gy}$

The estimated error of the measurements

$\sim 7-10 \%$

Preliminary results from the flight of the CoCoRAD



Preliminary results from the flight of the CoCoRAD

The measured absorbed doses in μGy

	TriTel X	TriTel Y	TriTel Z	Pille
Ascent phase	14.8 ± 0.8	5.4 ± 0.3	5.5 ± 0.2	-
Float phase (27.6 km)	16.3 ± 2.0	11.5 ± 1.0	11.9 ± 0.3	-
Descent phase	7.4 ± 0.4	2.7 ± 0.1	2.8 ± 0.1	-
Together	38.5 ± 1.8	19.6 ± 1.2	20.1 ± 0.8	13.1 ± 1.5

The Pille has low sensitivity to particles with LET higher than $10 \text{ keV}/\mu\text{m}$!



The correction factor for the Pille results:

1.5 ± 0.2

Summary

The CoCoRAD experiment has been flown on-board the BEXUS-12 balloon.

- **TriTel**

- » first time operated during a mission without major failures
- » measured time and energy spectras (primary and coincidence too)

- **Pille**

- » the measured absorbed doses were above the minimal sensitivity of the Pilles
- » the measured excess absorbed dose during the 4 hours long BEXUS-12 flight was about **13 μ Gy**

- **TriTel and Pille comparison**

- » correction factor calculated from the TriTel results for the Pilles: **1.5**



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BME Space Research Group

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German Aerospace Center

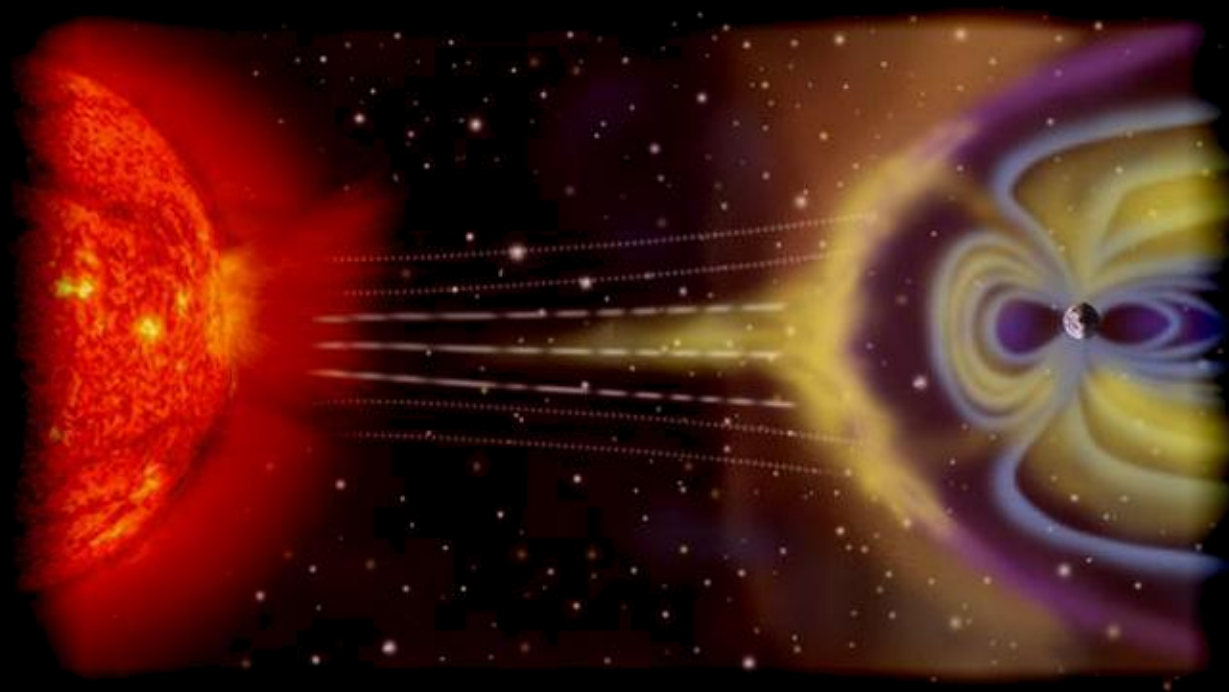
Swedish Space Corporation

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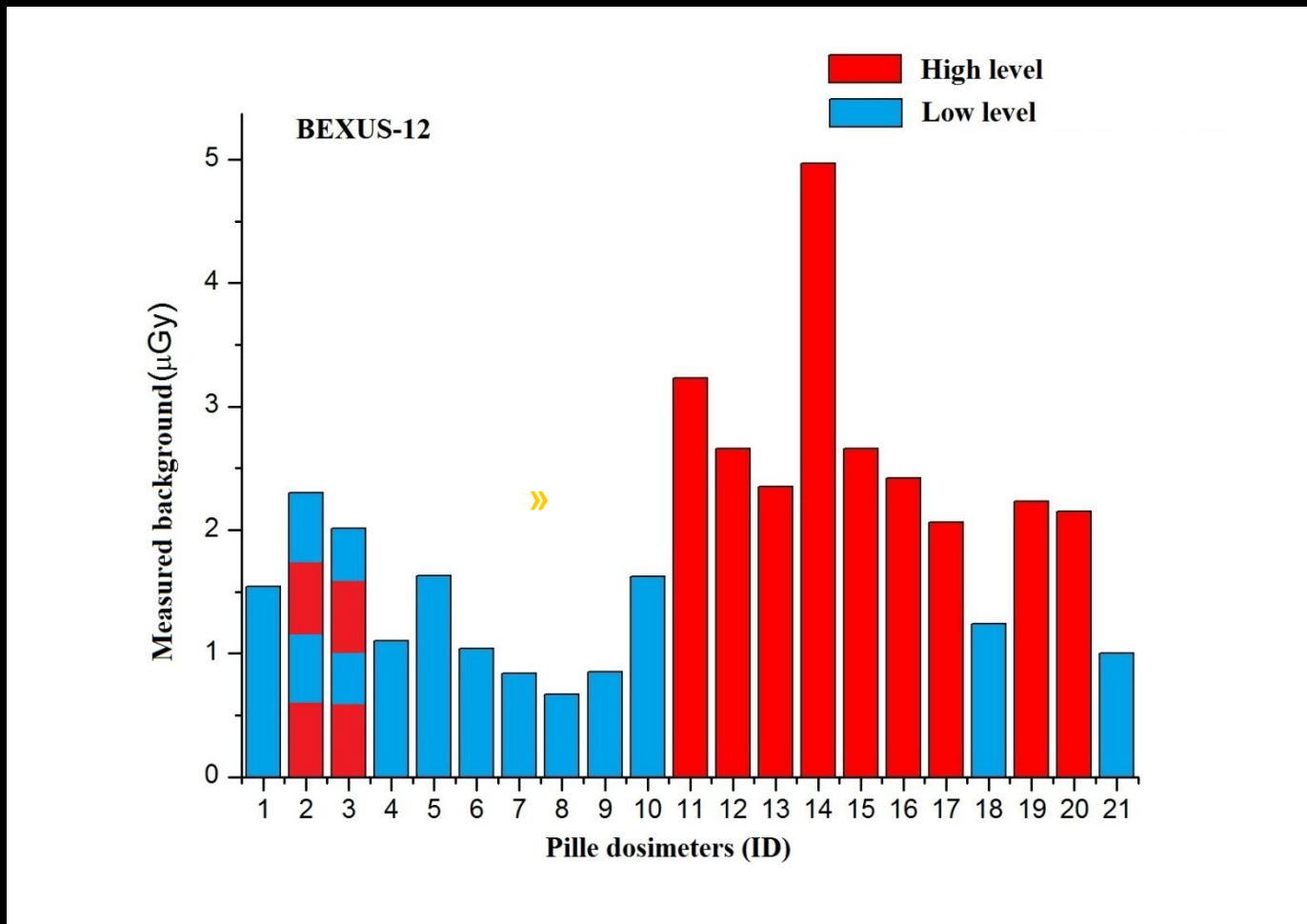
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The interaction of the solar wind and the magnetosphere of the Earth (NASA)

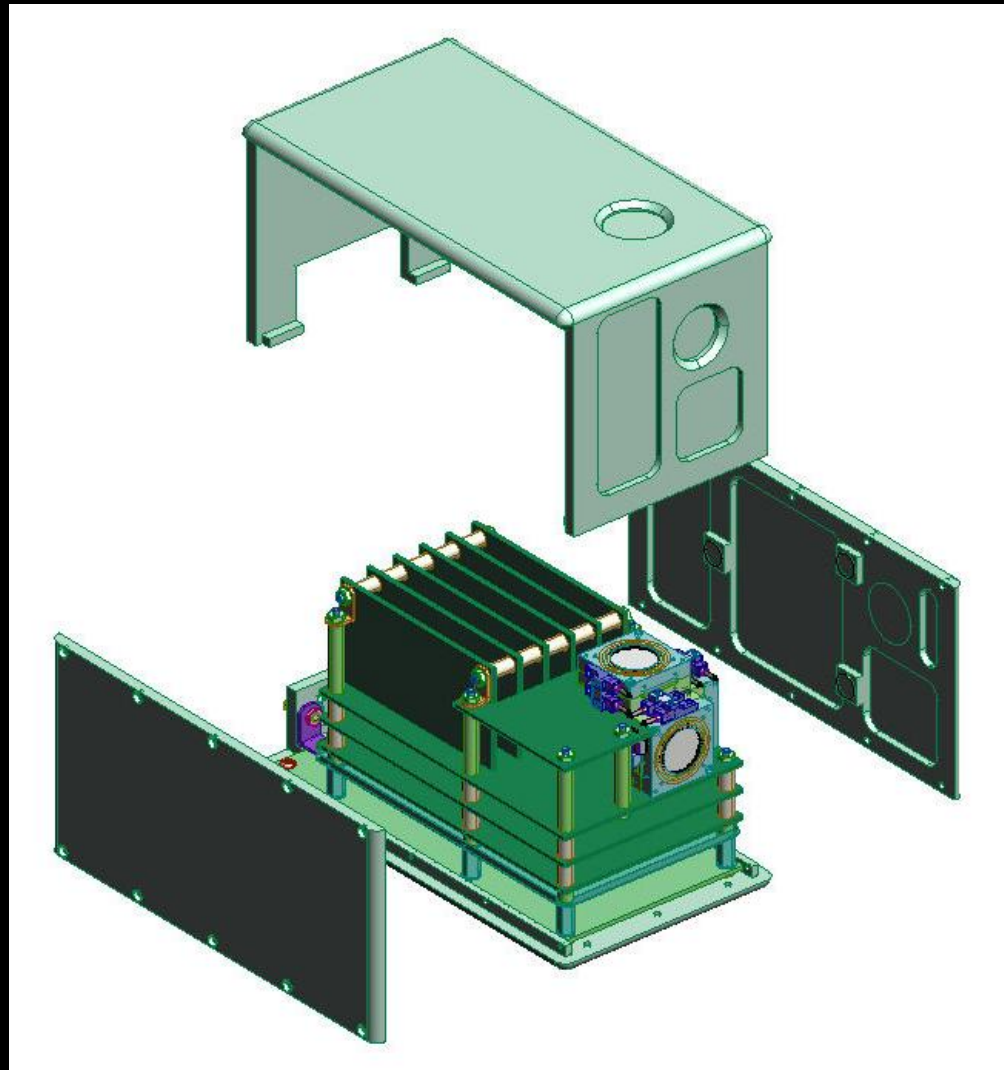


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