



The Hungarian CoCoRAD Stratospheric Cosmic Radiation Experiment in the BEXUS Program of the ESA

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REXUS/BEXUS

Rocket and Balloon Experiments for University Students

- **The main goals**

- » to experience a full lifecycle of a real space project
- » to learn about rockets and balloons for carrying out experiments

- **The organisers**

- » European Space Agency Educational Office
- » Swedish National Space Board (SNSB)
- » Swedish Space Corporation (SSC)
- » German Aerospace Center (DLR)

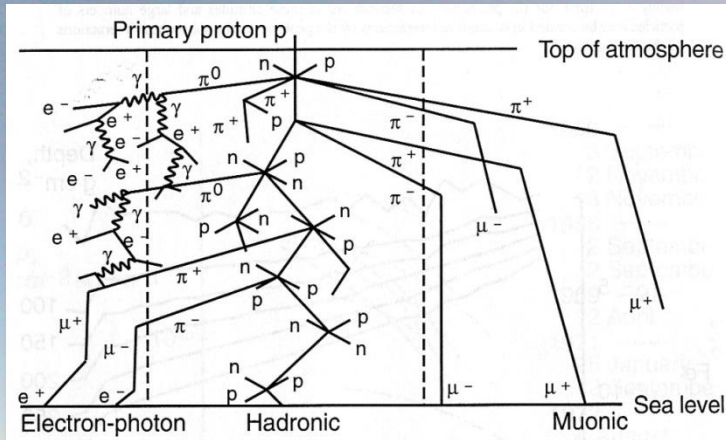


The first Hungarian student team participating the REXUS/BEXUS programme



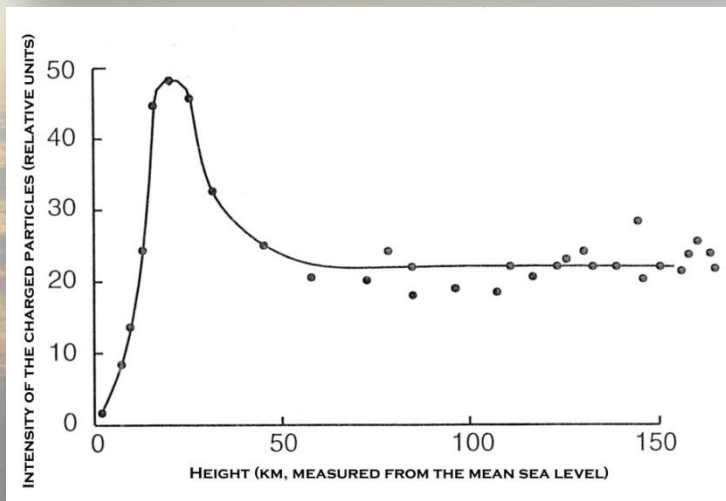
cocorad.kfki.hu

The cosmic radiation environment in the atmosphere



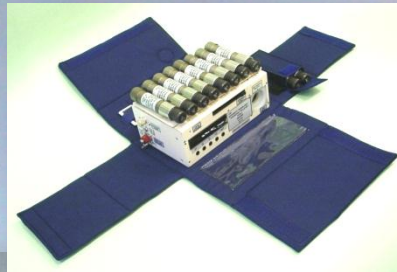
Schematic representation of the particle production in the atmosphere.

The complex radiation environment in the atmosphere not well studied!



Intensity of charged particles as a function of altitude.

The Pille thermoluminescent space dosimeter

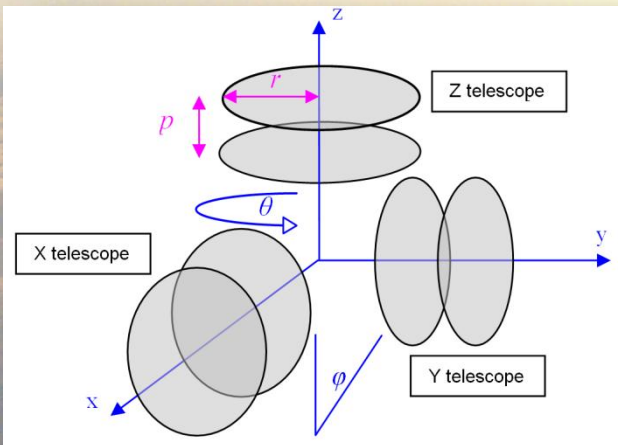


- **The development has begun in 1970's**
 - » First flight: 1980, Bertalan Farkas, first Hungarian astronaut (cosmonaut)
 - » Since that the Pille was onboard all space stations
- **Thermoluminescent (TL) dosimeter system**
 - » a light-weight reader device and several dosimeters
 - » $\text{CaSO}_4:\text{Dy}$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

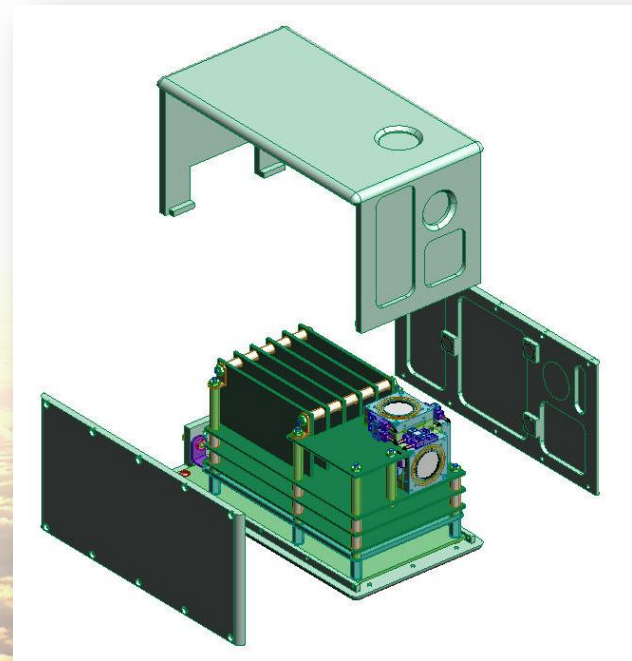
The TriTel 3-dimensional space dosimetric telescope

- *The development has began several years ago*

- » in the Hungarian Academy of Sciences Centre of Energy Research by the Space Dosimetry Research Group
- » to study the cosmic radiation and its dose contribution
 - ▶ the average quality factor of the cosmic radiation
 - ▶ LET spectra in three direction
 - ▶ absorbed dose, equivalent dose

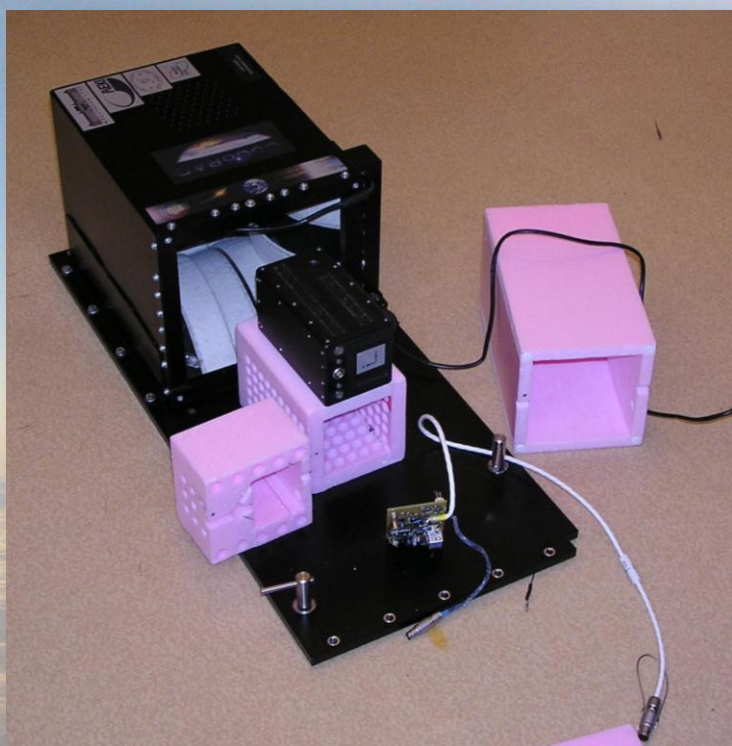


3D telescope geometry.

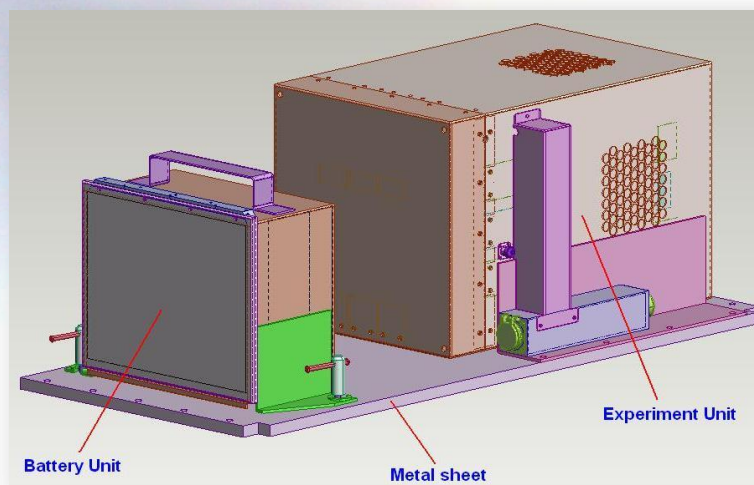


The exploded view of the TriTel.

The CoCoRAD experiment setup



The experiment setup.





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 Pfozfer maximum based on the measured data.	Tertiary

27 September 2011 – The launch of the BEXUS-12



The location of Kiruna.

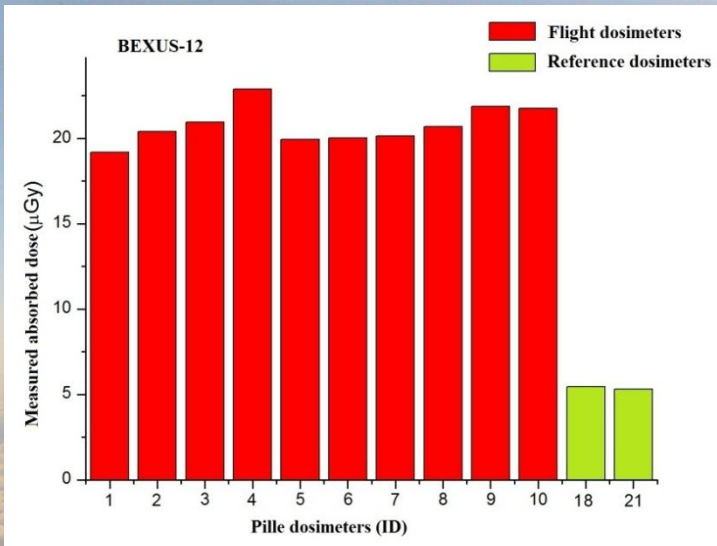


The BEXUS-12 gondola.

The launch of the BEXUS-12.



Results from the flight of the CoCoRAD - Pille



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

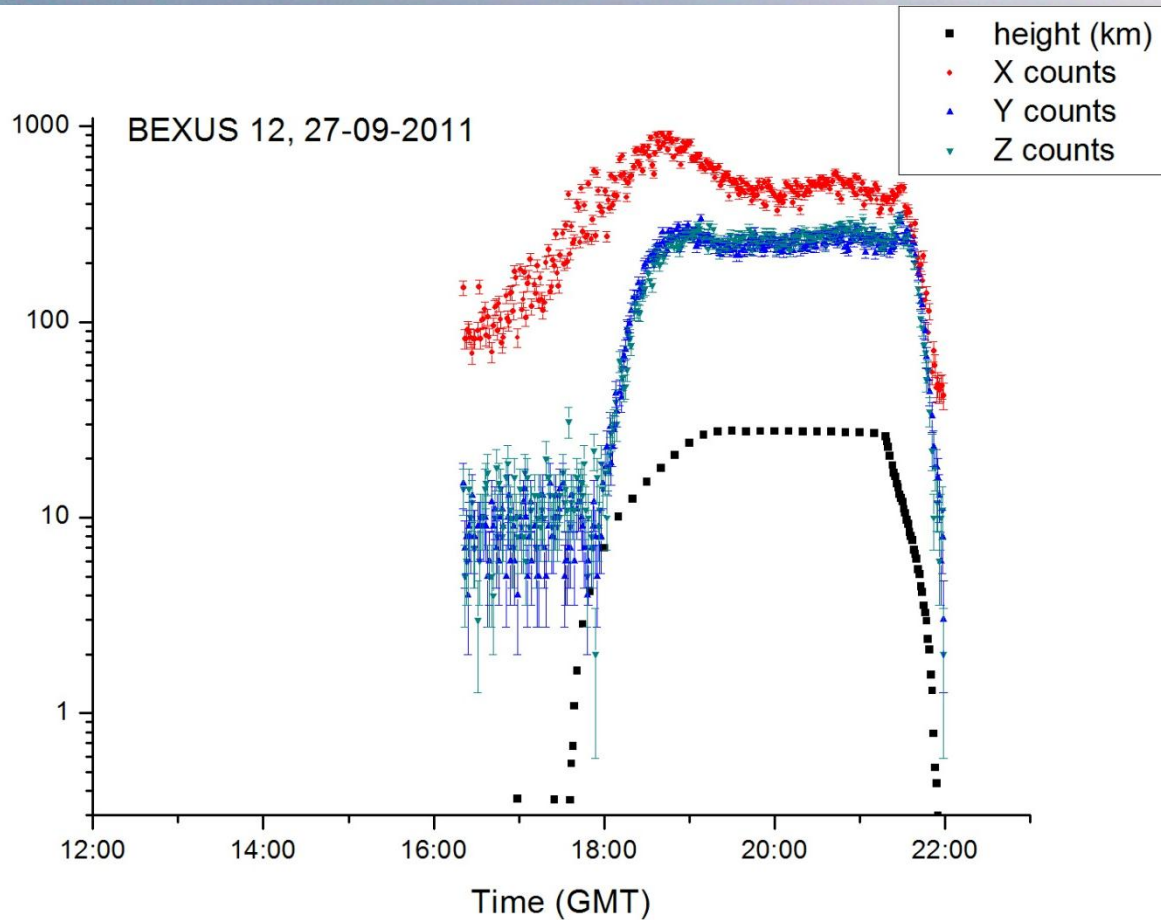
The excess absorbed dose of the BEXUS-12 flight $15.6 \pm 1.1 \mu\text{Gy}$

The average dose rate in Kolari $\sim 100 \text{ nGy/h}$

Corrected excess absorbed dose of the BEXUS-12 flight $13.1 \pm 1.5 \mu\text{Gy}$

The estimated error of the measurements $\sim 7\text{-}10 \%$

Results from the flight of the CoCoRAD - TriTel



Results from the flight of the CoCoRAD - TriTel and Pille comparison

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

Conclusions

- **The CoCoRAD experiment has been flown onboard the BEXUS-12 balloon**
 - » the first mission of the TriTel without major failures
Zábori et. al., The Hungarian CoCoRAD experiment in the BEXUS programme of the ESA, IAC paper
 - » the usability of the Pille in stratospheric flights verified
Zábori et. al., Environmental Dosimetry with the Pille TL Space Dosimetry System During the BEXUS-12 Stratospheric Balloon Flight, IRPA paper
 - » we have shown the possibility of using a correction for Pille
Zábori et. al., The CoCoRAD balloon-borne cosmic radiation and dosimetry measurements in the frame of the BEXUS programme, IAC paper
 - » first Hungarian student participation in the REXUS/BEXUS programme

Future plans: **TECHDOSE experiment onboard BEXUS-14 this year!**

techdose.energia.mta.hu

Acknowledgements

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Thank you for your attention!

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