THE NEWEST HUNGARIAN COSMIC RADIATION MEASUREMENT RESULTS IN THE STRATOSPHERE USING STRATOSPHERIC BALLOONS AND SOUNDING ROCKETS

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Cosmic ray research in Hungary, in the Centre for Energy Research
Historical background of cosmic ray research in Hungary

- **Hungarian measurement systems**
  - Pille
  - TRITEL
  - Track detectors

- **Measurements on board**
  - Salyut-6, -7
  - Mir Space Station
  - Space Shuttle (NASA)
  - ISS Columbus (ESA)
  - ISS Russian Segment
  - Satellite missions

B. Farkas Hungarian astronaut with the Pille

Sally Ride NASA astronaut with the Pille

The International Space Station

The Mir Space Station

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Recent cosmic ray research missions

2016- Planned Satellite Experiments
- ~ 600 km, polar orbit
- advanced silicon detector

2012-2013 ISS Experiments
- ~ 350-400 km
- TRITEL silicon detector
- Columbus module
- Russian Segment

2015 Sounding Rocket Experiment
- 88 km apogee
- Geiger-Müller (GM) counters

2011-2012 Stratospheric Balloon Experiments
- ~30 km floating altitude
- TRITEL silicon detector
- GM counters
- Passive detectors

Source: http://www.nasa.gov
Space weather research in the stratosphere

Source: http://www.nasa.gov
Space weather research is a key issue nowadays

- solar-terrestrial environmental conditions influencing the Solar System
- the main source is the Sun with an overall 11-year cycling behaviour
- several interconnecting physical mechanism:
  - solar activity and solar cosmic radiation, magnetosphere, atmosphere, galactic cosmic radiation
- the main indicators of the space weather are the cosmic radiation and the magnetospheric conditions
- the cosmic radiation environment influencing the human spaceflight future plans and capabilities (such as human Mars expedition)

Space weather influences on Earth

- space weather can influence our daily life mainly through our technology dependence
- space weather and Earth climate connections are not fully understood:
  - space weather climate influencing capability can be significant since the main energy source of every climate process on Earth is the Sun
Cosmic ray research in the stratosphere

- the space age and the technology based civilisation opened the gateway to the new frontiers
- direct space weather effect to our daily life: technology and climate
- dynamic radiation environment (influenced by the magnetosphere, atmosphere, solar activity)
- needs to better understand for reliable future forecast possibilities

Secondary particle production in the stratosphere (McAulay et al., 1996)
Recent years cosmic ray research results in the stratosphere – connections with the space weather

Source: http://www.nasa.gov
Stratospheric balloon flights

BEXUS launch at ESRANGE Space Center

<table>
<thead>
<tr>
<th>Floating altitude range</th>
<th>25-30 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission time</td>
<td>4 – 8 hours</td>
</tr>
<tr>
<td>Nominal vertical velocity</td>
<td>5 m/s</td>
</tr>
<tr>
<td>Maximum load weight</td>
<td>~ 200 kg</td>
</tr>
</tbody>
</table>
Experiment instrumentation on balloons

**TRITEL 3-dimensional silicon detector telescope system**

**Pille TL crystal bulb**

**Solid State Nuclear Track Detector**

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Experiment design on balloons

Experiment 3D design model

Experiment in reality

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Highlighted key scientific results from the balloon flights

Measured absorbed dose rates in water by TRITEL as a function of the altitude.

- The dose rate caused by the cosmic radiation at around 25 km is almost the same what can be expected at the ISS.

- The dose rate caused by the cosmic radiation at the altitude range of the aircrafts is thirty times higher than on the ground.

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Highlighted key scientific results from the balloon flights

Measured radiation profiles using ZP1210 type GM-tubes.

21.5 ± 0.3 km

22.4 ± 0.3 km

BEXUS-14 balloon flight
24-09-2012
68°N
Sounding rocket flight

Improved Orion rocket (REXUS system configuration)

Source: SSC

REXUS-17 sounding rocket before the launch

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Experiment instrumentation on the rocket

<table>
<thead>
<tr>
<th>GM-tube type</th>
<th>ZP1200</th>
<th>ZP1210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier</td>
<td>Centronic</td>
<td>Centronic</td>
</tr>
<tr>
<td>Number of GM-tubes</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Sensitive cross-area (cm²)</td>
<td>~ 6</td>
<td>32</td>
</tr>
<tr>
<td>Gamma dose rate (mGy/h)</td>
<td>$10^{-3} – 10^2$</td>
<td>$3 \times 10^{-4} – 10^1$</td>
</tr>
<tr>
<td>Operating voltage (V)</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Photon sensitivity ratio (ZP1200/ZP1210)</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>
Experiment design on rocket

Experiment design and location on-board the rocket

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Experiment design on rocket

Experiment design and the launch

Source: SSC

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Highlighted key scientific results from the rocket flight

~ 60 s\(^{-1}\)

~ 43 s\(^{-1}\)

23.6 ± 1.0 km

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Highlighted key scientific results from the rocket flight

- Vertically oriented ZP1210 GM tubes
- Horizontally oriented ZP1210 GM tubes
- Vertically oriented ZP1200 GM tube
- Horizontally oriented ZP1200 GM tube

- ~ 23 km
- ~ 25 km
- ~ 45-50 km

REXUS-17 rocket flight
17-03-2015
N°68

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Space weather research in the Near-Earth region

» space weather significantly can influence our daily life

» we have to understand the effects of the space weather in the Near-Earth Region to provide reliable forecast in case of any kind of solar events

» the cosmic radiation environment and the magnetic field of the Earth has to be measured in more detail from the ground up to the lower orbiting spacecraft’s altitudes or even more

» our recent experiments in the stratosphere have been shown that the behaviour of the radiation field is not well studied and need to be understand in more detail

» we are developing in the next few years an advanced, silicon detector based cosmic radiation and magnetic field measurement experiment for future missions to study the effects of the space weather
Thank you for your attention!

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