Altitude profile of atmospheric radiation in the Arctic region obtained during a scientific balloon flight with MDU-1 Liulin

Alexandar Mishev[a] [b], Alexandros Binios[a], Esa Turunen[a], Ari-Pekka Leppänen[c], Nicholas Larsen[a], Eija Tanskanen[a], Ilya Usoskin[a] [b], Jouni Envall[a], Toivo Iinatti[a], Pasi Lakkala[a]

[a] *Sodankylä Geophysical Observatory, University of Oulu, Finland*
[b] *Space Physics and Astronomy Research Unit, University of Oulu, Finland*
[c] *Radiation and Nuclear Safety Authority – STUK, Rovaniemi, Finland*

1: Background

- Cosmic rays constantly bombard the Earth and provide a source of radiation at higher altitudes. This increase in radiation at higher altitudes can have a negative impact on humans and instruments. It is therefore imperative that the link between altitude and radiation dose is understood well, particularly in the polar regions where the protection from cosmic rays provided by the Earth's magnetic field is greatly diminished.
- Different data sets for background radiation using different devices under various conditions are needed to create a reliable basis for improving atmospheric radiation models.
- The small portable silicon semiconductor based mobile dosimetry unit, (MDU)-1 Liulin, provides a convenient way to obtain such radiation data.
- In this work a Liulin device is used to obtain radiation data in the arctic region whilst attached to a HEMERA-2 zero-pressure balloon flight to obtain an altitude profile of atmospheric radiation.

2: Theory

- Liulin device was sealed inside a thermally insulated aluminium box and attached to the HEMERA-2 zero-pressure balloon.
- Balloon's flight started from the Swedish Space Corporation's Esrange site in Kiruna, Sweden, and proceeded over Rovaniemi, Finland, before returning to the surface.
- Device reached a ceiling altitude of 33km, remaining at this altitude for 3 h 25m.
- Dose rate data is collected for the entire duration of the flight with a time resolution of 1 minute.
- Collected data was compared to a dose model developed at Oulu. [1]

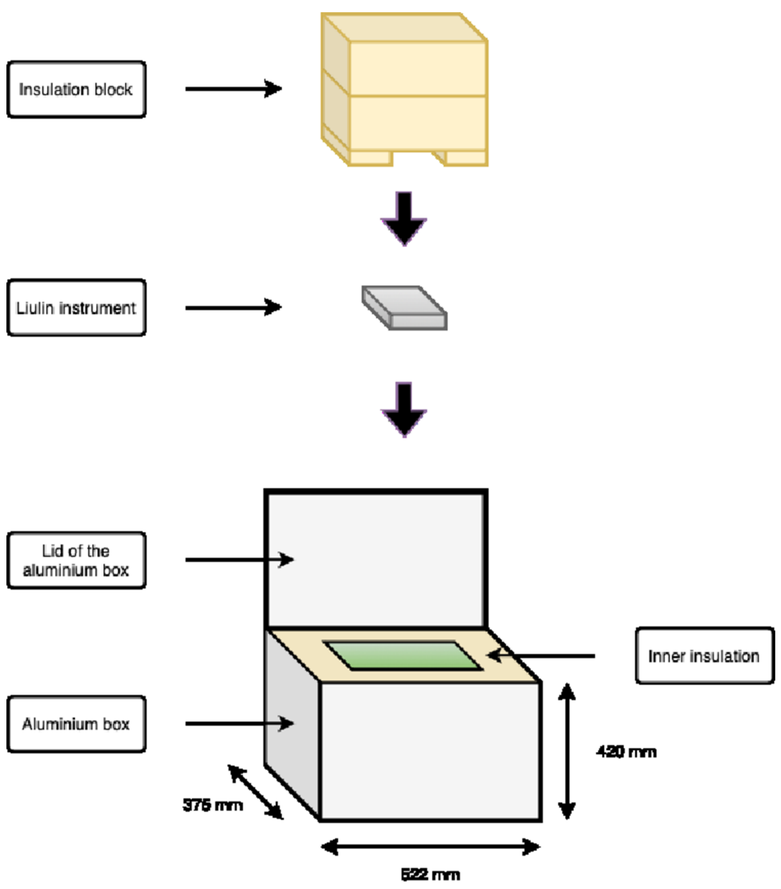

Figure 1: Sketch of the Liulin payload for the HEMERA balloon flight [2]

3: Results

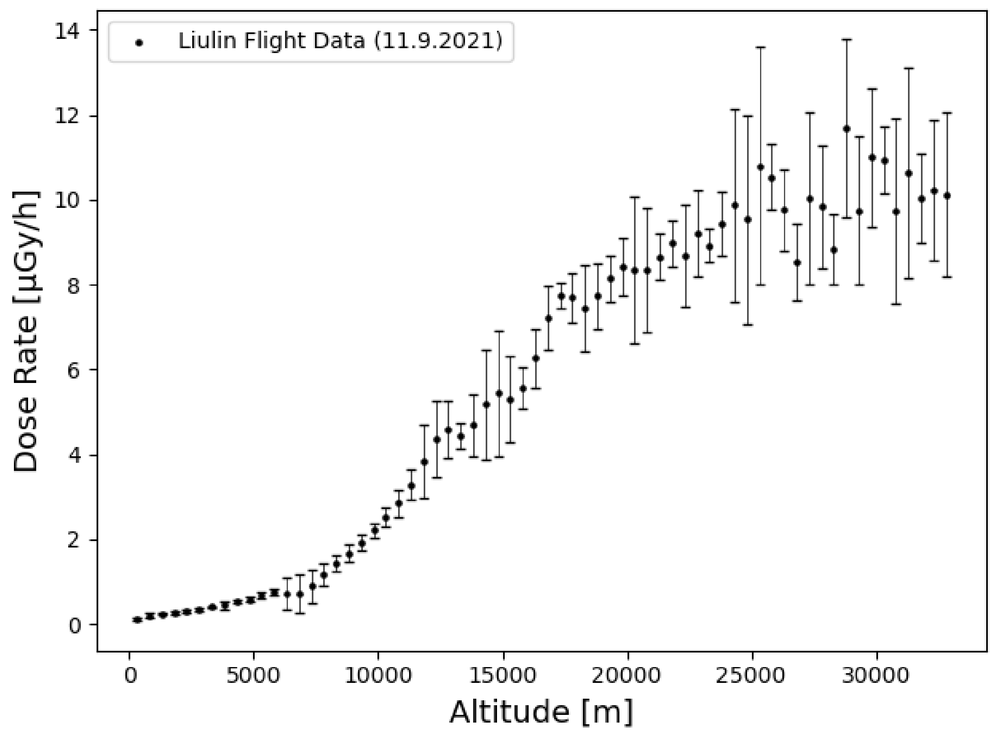

Figure 2: Dose rate plotted against the altitude of the Liulin device during the HEMERA-2 balloon flight on 11 September 2021.

- Regener-Pfotzer maximum is barely seen, similar to previous results [3] & [4]
- This could be caused by many factors, such as the location of the study or the nature of the balloon's flight

	Dose Rate [µGy/h]	
Alt. [km]	Liulin	Model
3	0.37 ± 0.9	0.22 ± 0.08
10.7	2.8 ± 0.7	6.4 ± 2.0
15.2	5.2 ± 1.3	7.7 ± 2.1

Table 1: Data for dose rate measured at various altitudes using the Liulin device and computed using the Oulu dosimetric model.

- Difference in absorbed dose is attributed to natural background radiation at low altitudes (3km) and the limited sensitivity of the Liulin device to secondary hadrons at higher altitudes.

4: Conclusion

- MDU-1 Liulin device was successfully used to collect new data for atmospheric background radiation, proving that this device can be a useful reusable tool to collect future data sets in a similar manner around the globe, particularity in polar regions were there is a lack of systematic studies.
- It was found that at high-latitude regions with low cut-off rigidity values the Regener-Pfotzer maximum is less pronounced, potentially due to the region's higher flux of lower energy GCRs. (Further studies are needed)
- A disagreement between the Oulu radiation dose model and Liulin measurements was found and believed to be a by-product of background radiation and the Liulin device's limited sensitivity to hadrons.

References

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