$1.6*10^3$ DAYS OF DATA FOR THE DLR RAMIS MEASUREMENTS IN LEO AND FURTHER UPDATES ON THE DLR M-42 DETECTOR FAMILY

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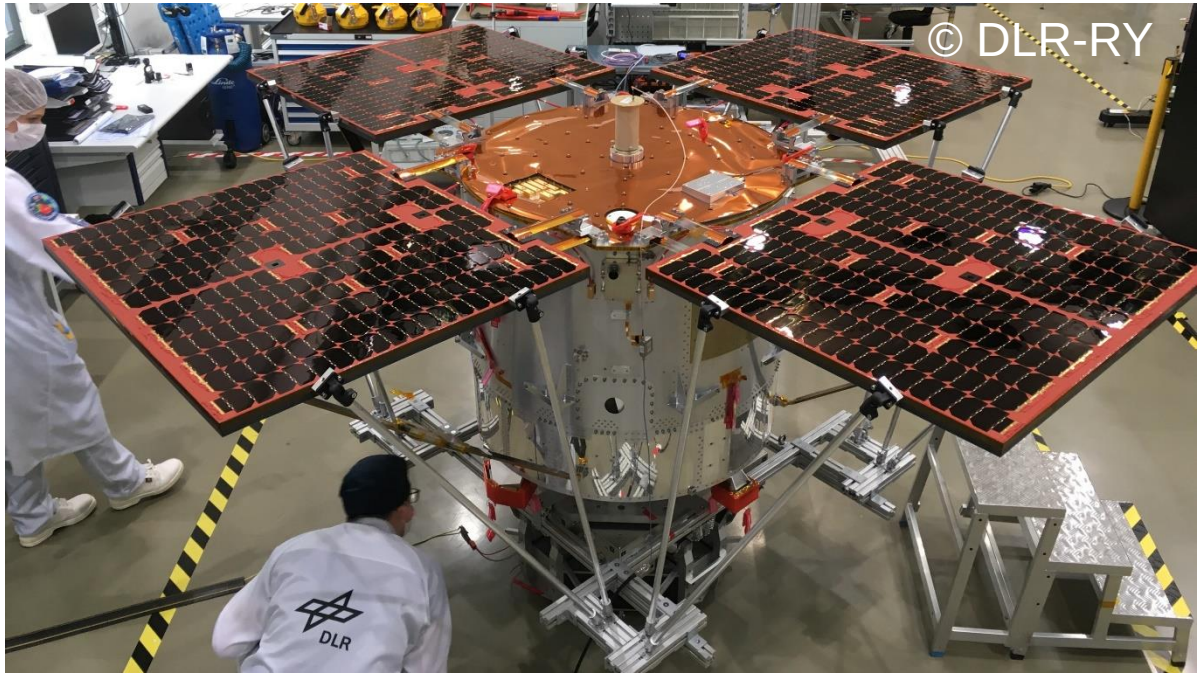
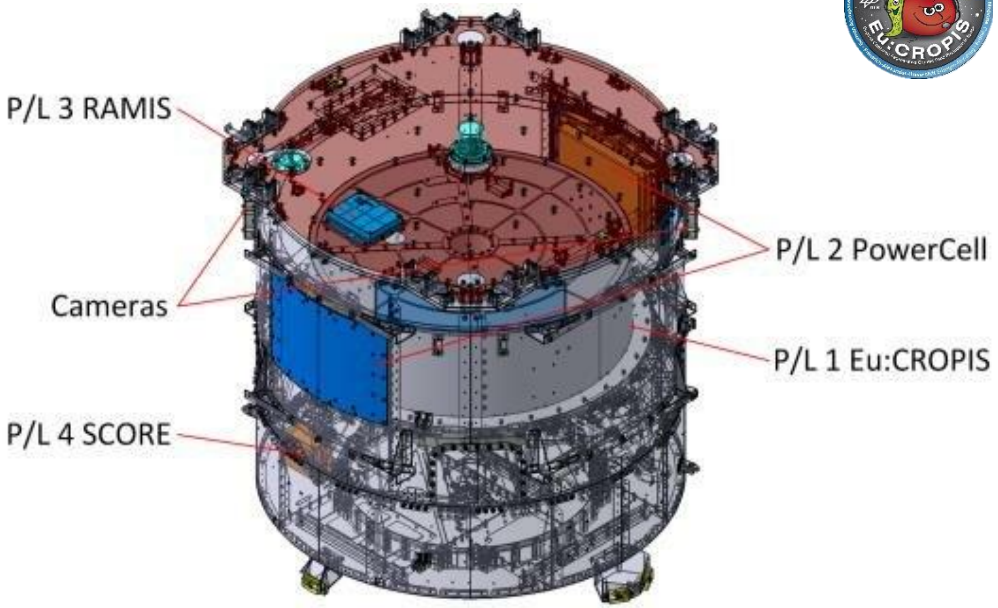
DLR

Eu:CROPIS: New Compact Satellite Class by DLR





https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-11082/
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Eu:CROPIS: **Mission Goal**

Microgravity-Science and Technology
https://doi.org/10.1007/s12217-018-9654-1

ORIGINAL ARTICLE

Eu:CROPIS – "*Euglena gracilis*: Combined Regenerative Organic-food Production in Space" - A Space Experiment Testing Biological Life Support Systems Under Lunar And Martian Gravity

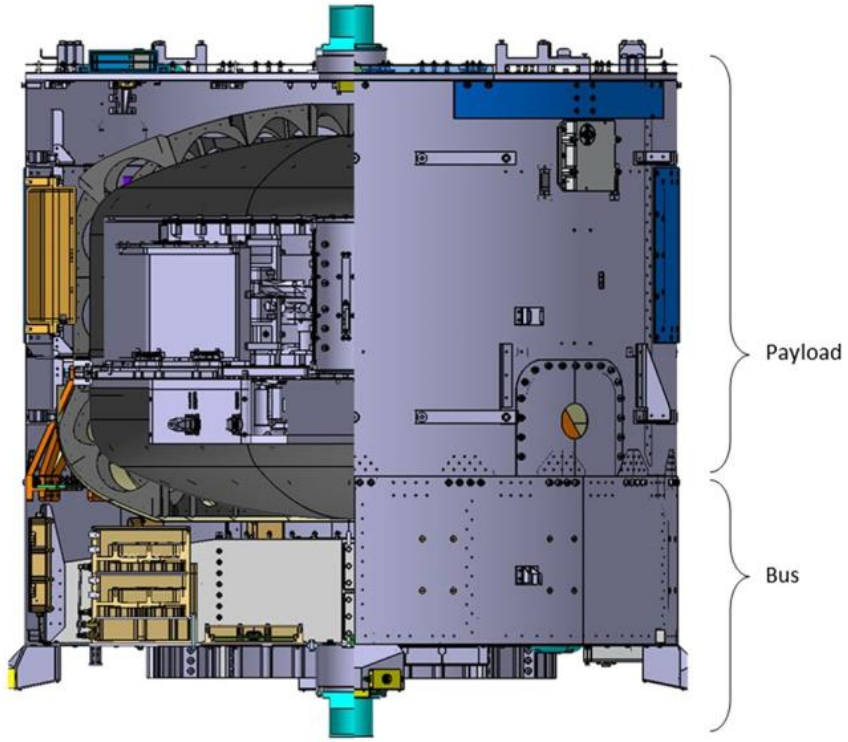
Jens Hauslage[1] · Sebastian M. Strauch[2] · Olaf Eßmann[3] · Ferdinand W. M. Haag[2] · Peter Richter[3] · Julia Krüger[2] · Julia Stoltze[2] · Ina Becker[2] · Adeel Nasir[2] · Gerhild Bornemann[1] · Hartmut Müller[3] · Toni Delovski[3] · Thomas Berger[1] · Aleksandra Rutczynska[1] · Karel Marsalek[1] · Michael Lebert[2]

Received: 7 August 2018 / Accepted: 7 September 2018

Abstract

Human space exploration needs stable life support systems for the supply of oxygen, water and food for each human explorer due to long term missions. The most promising approach for building stable life support systems is a combination of physico-chemical and biological systems. These hybrid systems combine the reliability of physico-chemical and the sustainability of biological life support systems. Also the disadvantages, which are the finite resources of physico-chemical and the imperfect reliability of biological systems, are mutually balanced. To improve the reliability of biological life support systems, a combination of different biological systems may stabilize the whole approach during long term operations. The satellite mission Eu:CROPIS (*Euglena gracilis*: Combined Regenerative Organic-food Production In Space) is a testbed for investigating the behavior of combined biological life support systems under the influence of altered gravity, here, Lunar and Martian gravity. The core systems are a biological trickle filter for processing urine into a fertilizer solution via nitrification and *Euglena gracilis*, a photosynthetic protist which is able to produce oxygen and biomass while protecting the whole system against high ammonia concentrations.

Keywords Compact satellite · Life support system · Moon · Mars · Reduced gravity · Nitrification



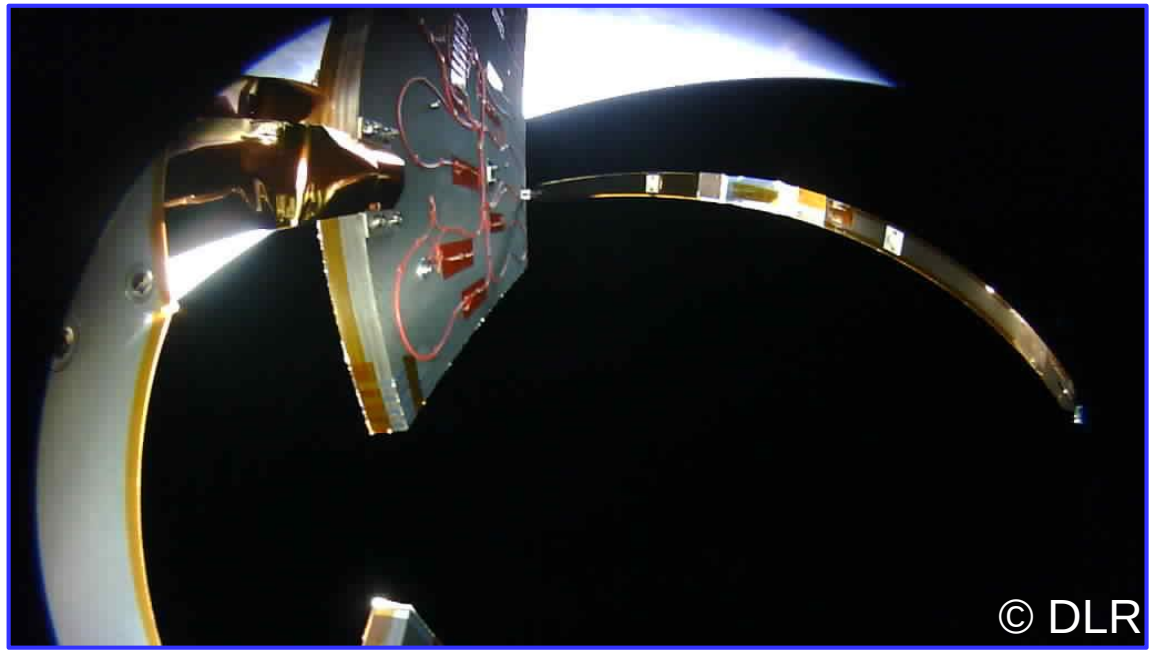
https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-11082/
https://www.dlr.de/irs/en/desktopdefault.aspx/tabid-11288/#gallery/29952

Eu:CROPIS: Launch

Eu:CROPIS	NORAD ID 2018-099BB	
	Dec. 2018	Aug. 2023
Perigee	578.3 km	570.0 km
Apogee	598.2 km	574.7 km
Inclination	97.7°	97.6°
Period	96.3 min	96.0 min i.e. 15.0 / day ☹
Semi major axis	6959 km	6943 km
Mission duration	2 years TBC	Until the end.

https://www.n2yo.com/satellite/?s=43807

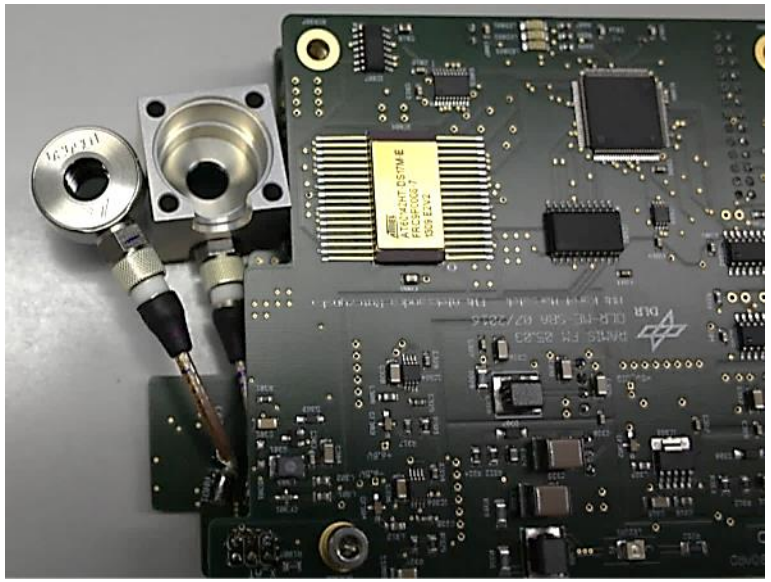
Eu:CROPIS: **Solar panel deployed**

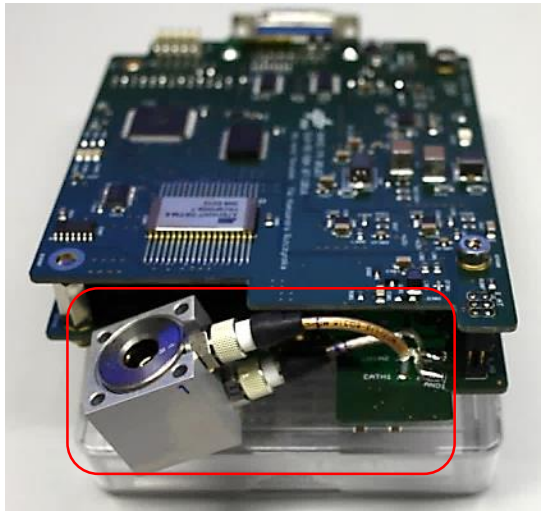


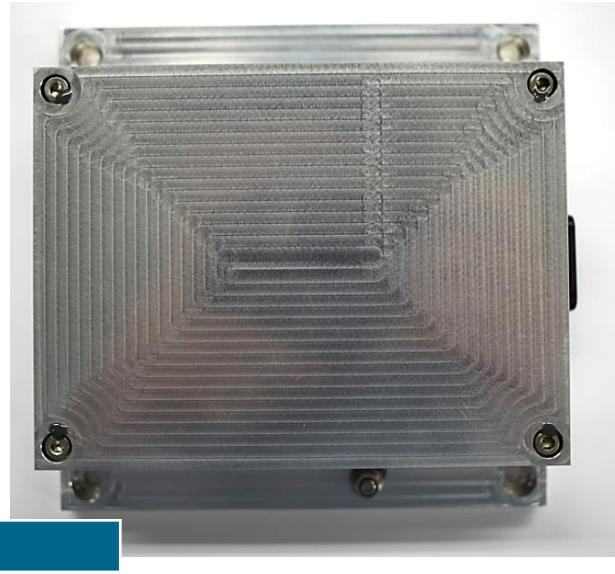
Eu:CROPIS	NORAD ID 2018-099BB
Perigee	578.3 km
Apogee	598.2 km
Inclination	97.7°
Period	96.3 min
Semi major axis	6959 km
Mission duration	2 years

https://www.n2yo.com/satellite/?s=43807

Eu:CROPIS: **RAMIS** (**RA**diation **M**easurements **I**n **S**pace)



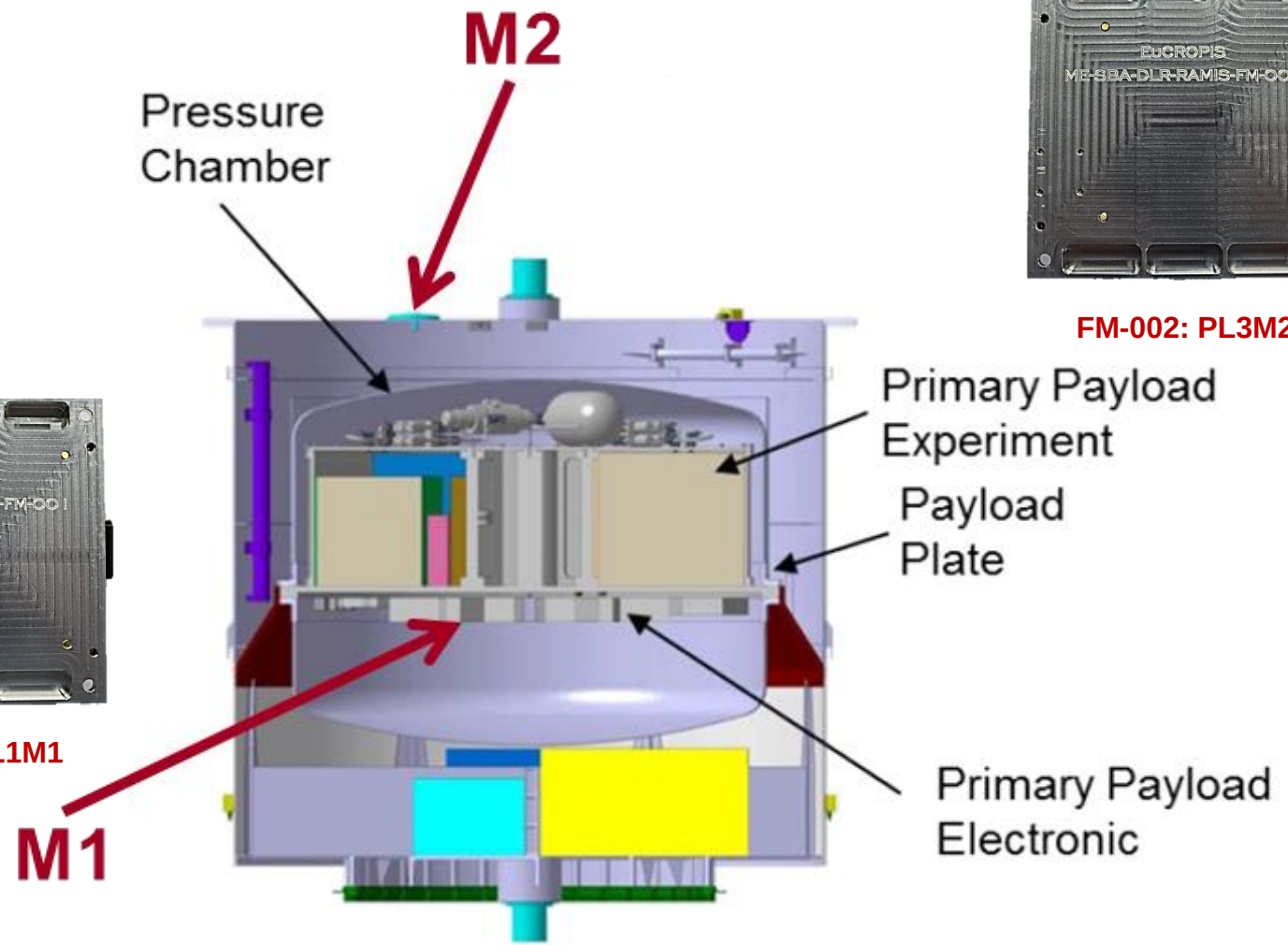




RAMIS	FM	Position
PL1M1	ME-SBA-DLR-RAMIS-FM-001	Inside Eu:CROPIS as sensor for PL1
PL3M2	ME-SBA-DLR-RAMIS-FM-002	Outside Eu:CROPIS

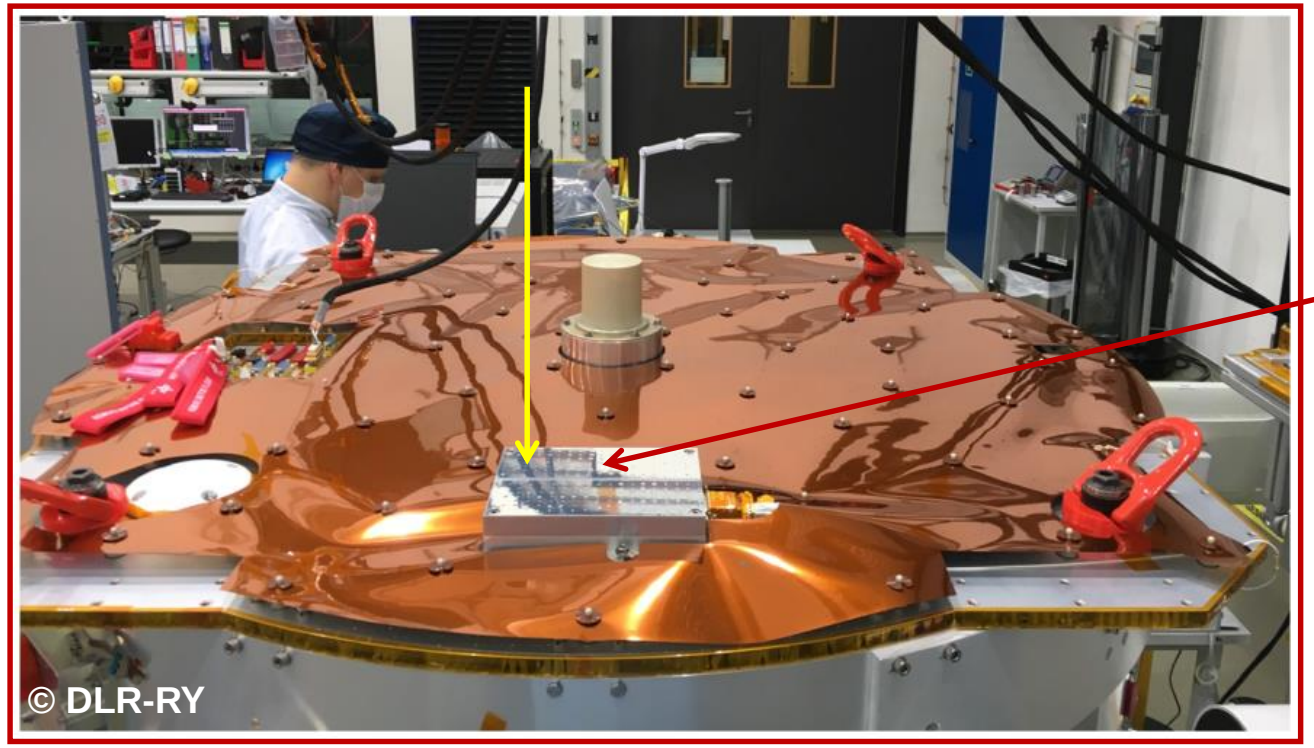
Eu:CROPIS: **RAMIS** Mounting Locations

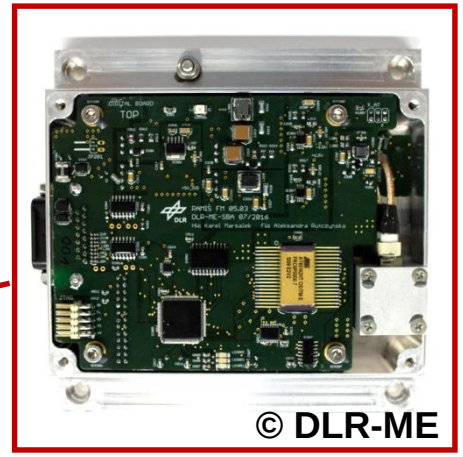
FM-001: PL1M1



FM-002: PL3M2

Eu:CROPIS: **RAMIS** Fact Sheet I





RAMIS	FM	
Dimensions	140 x 140 x 35	mm^3
Mass	608	g
Supply voltage	28	V
Power consumption	1.82	W

PL3M2	D1 (upper diode)	D2 (lower diode)
Electron Energy [MeV]	1.38	1.48
Proton Energy [MeV]	24.3	25.6

Eu:CROPIS: **RAMIS** Fact Sheet II

Single Detector Data		
Radius	0,51	cm
Thickness	300	µm
Area	0,817	cm^2
Mass	57,11	mg
GF	5,133	$sr*cm^2$

Telescope Data		
Distance between the diodes	0,73	cm
Opening angle	109	°
GF	1,423	$sr*cm^2$
Mean path length	335,85	µm

Ranges		
Energy range (in Si)	0.09 – 145	MeV
LET Range (in H2O)	0.15 – 228	keV/µm

Eu:CROPIS: **RAMIS** Data Product

RAMIS Data

H/K

Extended H/K

Spectrum

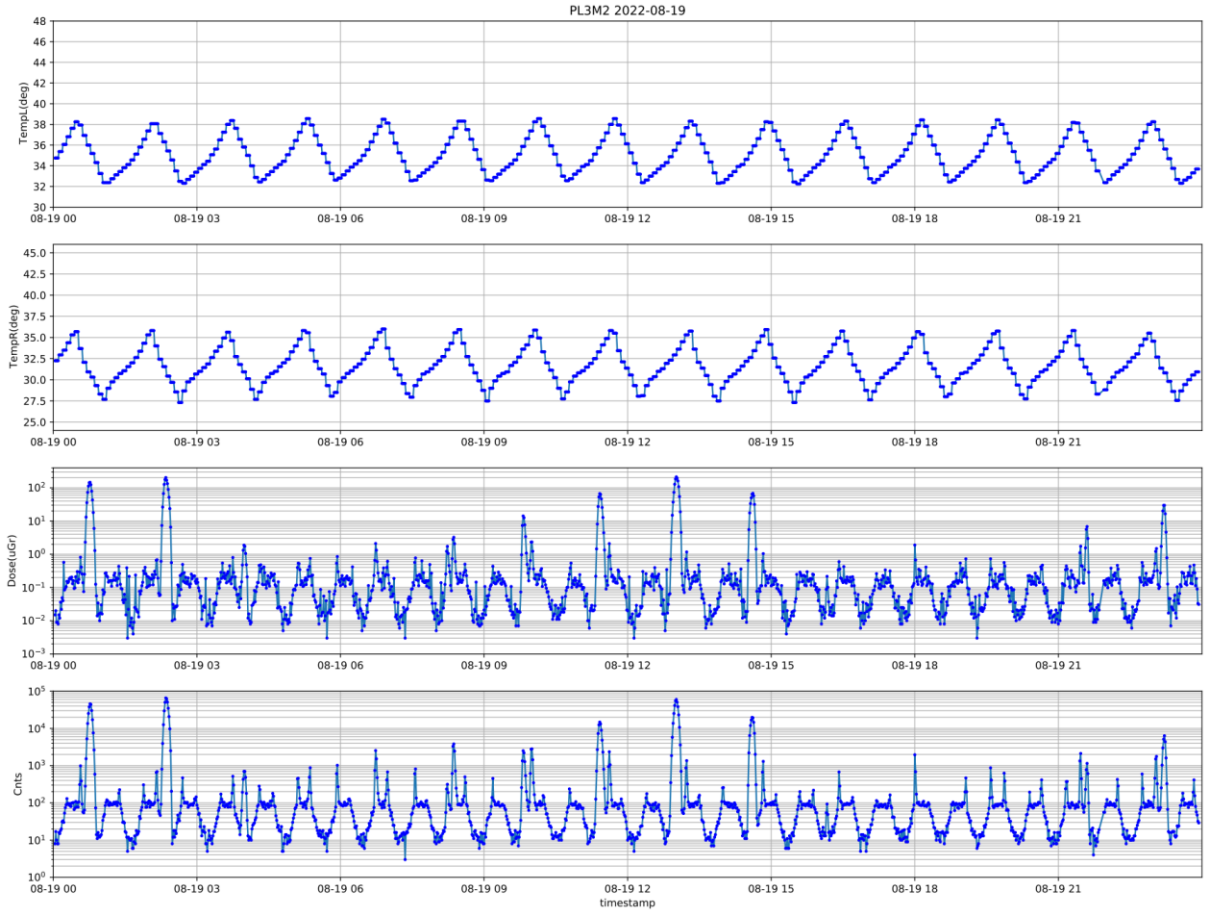
```
Parser Version 1.0.0

Inputfile:
- Name          : 20181205_183849_1280_0.1280
- Dir           : ..\Data\PL3M2\2018\12\05
- Size          : 16467

Outputfile:
- Name          : 20181205_183849_1280_0.1280.txt
- Generated     : Mon Feb 11 23:31:46 CET 2019

**** CCSDS
APID = 1280
Packet length = 16460
Service Type = 160
Service Subtype = 1
obt = 2018-12-05 18:38:49.464 +0000 UTC

**** Housekeeping
VoltD3P3    =    3.312 V
VoltD5      =    5.034 V
VoltA6P5    =    6.636 V
VoltA6M5    =   -6.522 V
VoltBias    =   82.676 V
LocalTemp   =    24.25 deg
RemoteTemp  =   22.562 deg
Status Byte = 0x0

**** Extended Housekeeping
Timestamp (BCD)      = 2018.12.05 18:37:00
Threshold Diode 1    = 77.674 mV
Threshold Diode 2    = 83.144 mV
ParamTable Version   = 3.2
Firmware Version     = 3.0
Dose incr. [5 mins] = 1.026 uGy
Dose incr. [0]       = 0.042 uGy
Dose incr. [1]       = 0.271 uGy
Dose incr. [2]       = 0.547 uGy
Dose incr. [3]       =  0.77 uGy
Dose incr. [4]       = 1.026 uGy
Countrate  [0]       =   33.0
Countrate  [1]       =  145.0
Countrate  [2]       =  283.0
Countrate  [3]       =  418.0
Countrate  [4]       =  552.0

**** Spectrum
  Ch; HG1 n; LG1 n; HG2 n; LG2 n; HG1 c; LG1 c; HG2 c; LG2 c;
   0;     3;   308;     0;   335;     0;     0;     0;     0;
   1;    91;   221;     0;   196;     0;    45;     0;    40;
   2;   160;   113;   257;    97;     0;    27;     0;    34;
   3;    20;    51;    54;    45;     0;    12;     0;    18;
   4;     5;    22;     8;    29;     0;    10;     0;     6;
   5;     2;    12;     5;    14;     0;     6;     0;     5;
   6;     6;    12;     1;    10;     0;     5;     0;     4;
   7;     1;     6;     1;    10;     0;     4;     0;     2;
   8;     3;     6;     2;     8;     0;     2;     0;     0;
   9;     7;     2;     2;     9;     0;     1;     0;     3;
  10;    10;     1;     7;     8;     0;     1;     0;     4;
```

Eu:CROPIS: **RAMIS** Data Set for PL3M2 + PL1M1

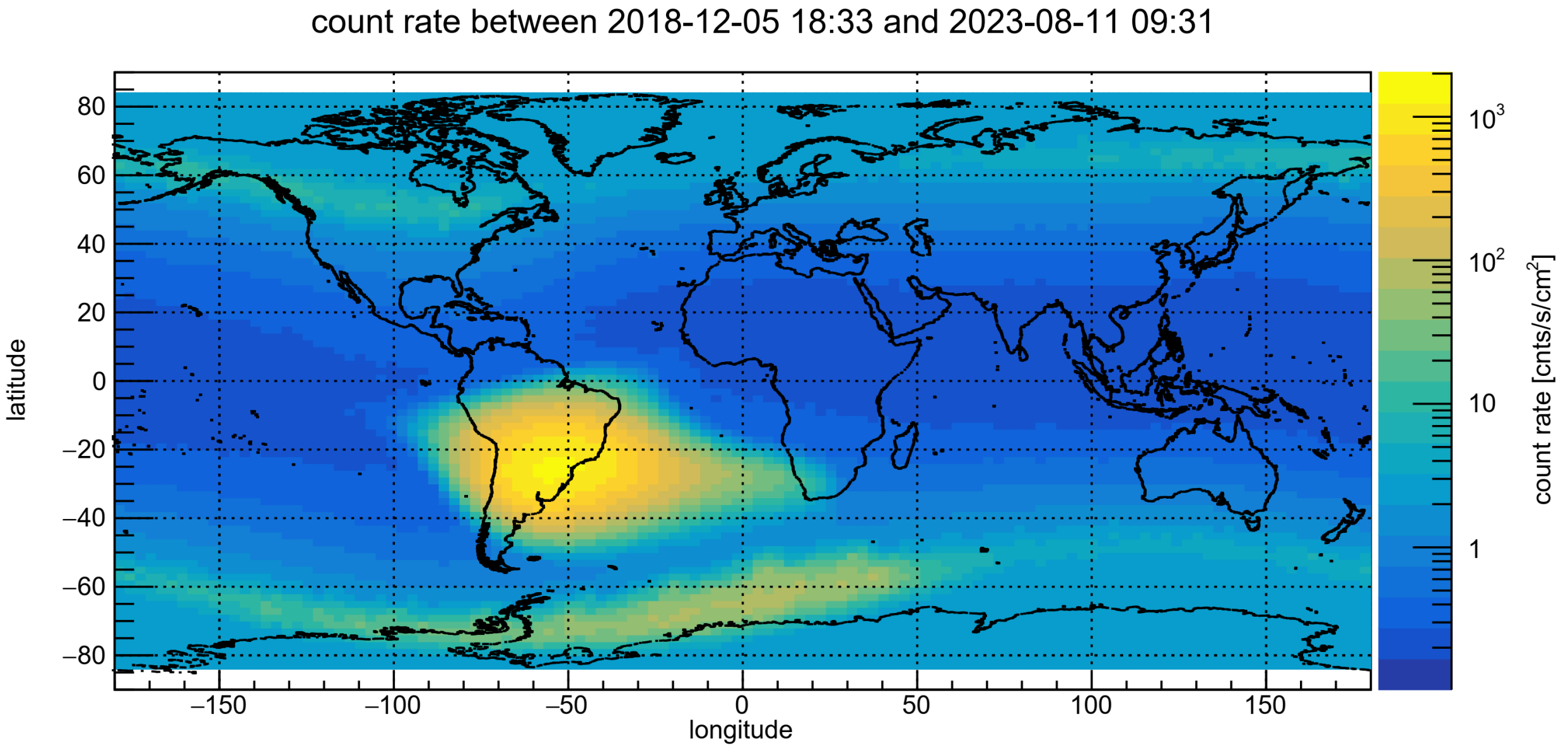
RAMIS	Data	Time resolution
D1	Count and dose rate	1 minute
D1 + D2	Count and dose rate	5 minute
	Energy deposition spectra	5 minute
	LET spectra	5 minute

Eu:CROPIS: **RAMIS** Statistics

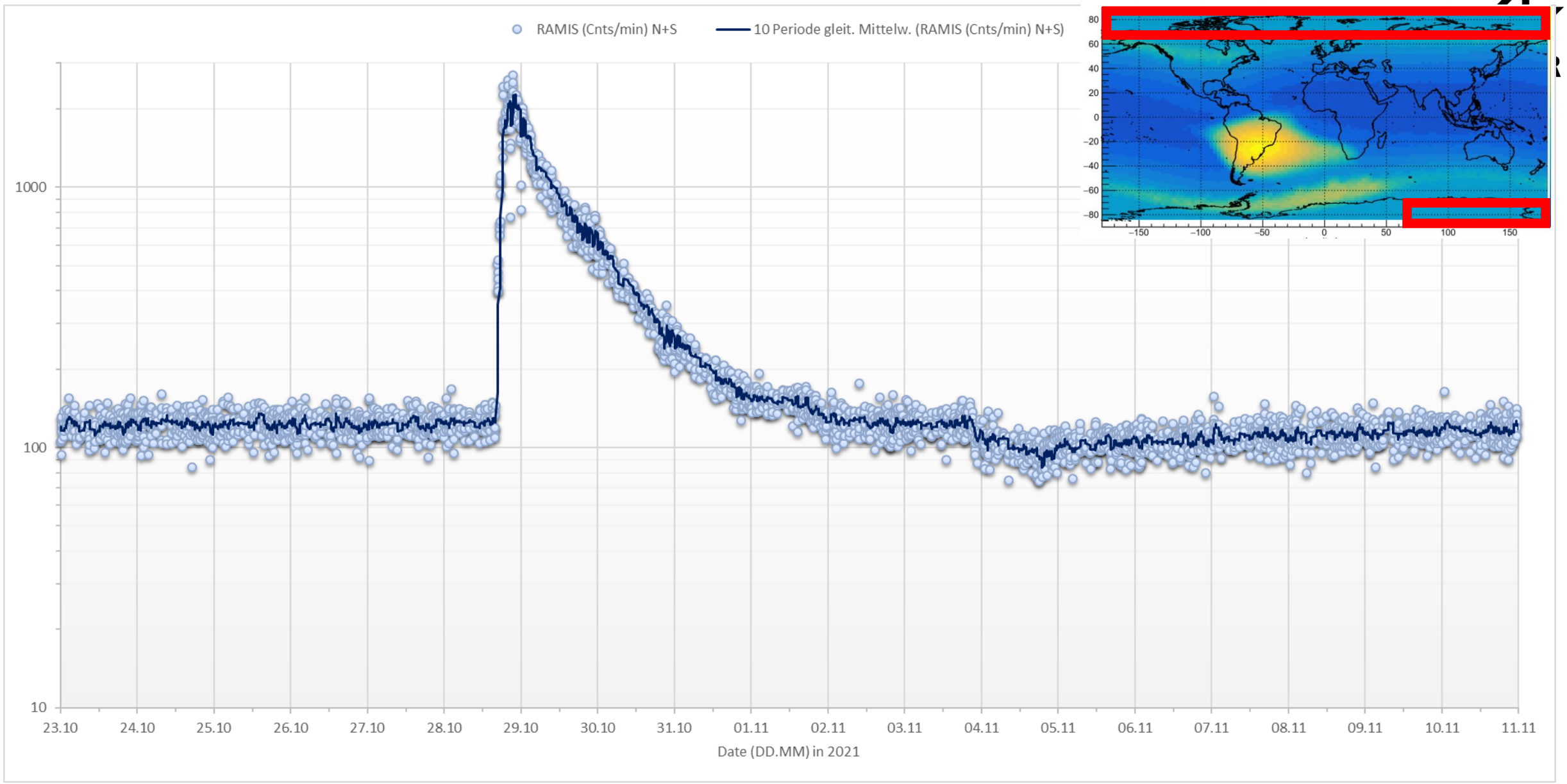
Date	Day of Mission [DoM]	PL3M2 Data [min]	PL3M2 data [hour]	PL3M2 data [days]	Mission coverage [%]
24. August 2023	1724	2316709,0	38611,8	1608,8	**93,32**



PL3M2 count rate [cnts/cm^2/s] - **FULL**



1 | 28 October 2021



Geophysical Research Letters

RESEARCH LETTER
10.1029/2023GL103069

The First Ground Level Enhancement Seen on Three Planetary Surfaces: Earth, Moon, and Mars

Jingnan Guo[1,2], Xiaolei Li[1], Jian Zhang[1], Mikhail I. Dobynde[1], Yuming Wang[1,2], Zigong Xu[3], Thomas Berger[4], Jordanka Semkova[5], Robert F. Wimmer-Schweingruber[3], Donald M. Hassler[6], Cary Zeitlin[7], Bent Ehresmann[6], Daniel Matthiä[4], and Bin Zhuang[8]

[1]Deep Space Exploration Laboratory, School of Earth and Space Sciences, University of Science and Technology of China, Hefei, PR China, [2]CAS Center for Excellence in Comparative Planetology, USTC, Hefei, PR China, [3]Institute of Experimental and Applied Physics, Christian-Albrechts-University, Kiel, Germany, [4]German Aerospace Center (DLR), Institute of Aerospace Medicine, Cologne, Germany, [5]Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria, [6]Solar System Science and Exploration Division, Southwest Research Institute, Boulder, CO, USA, [7]Leidos Corporation, Houston, TX, USA, [8]Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, NH, USA

Key Points:

- This is the first ground level enhancement event simultaneously measured on Earth, Moon, and Mars
- We analyze the radiation measurements at 3 locations and compare with our model predictions based on detected solar energetic particle (SEP) flux
- We show that extreme SEP events can induce much higher (~100 times) radiation doses on the Moon than on Mars

Review of Scientific Instruments ARTICLE scitation.org/journal/rsi

The German Aerospace Center M-42 radiation detector—A new development for applications in mixed radiation fields

Cite as: Rev. Sci. Instrum. 90, 125115 (2019); doi: 10.1063/1.5122301
Submitted: 30 July 2019 • Accepted: 2 December 2019 •
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T. Berger,[a] K. Marsalek, J. Aeckerlein, J. Hauslage, D. Matthiä, B. Przybyla, M. Rohde, and M. Wirtz

AFFILIATIONS

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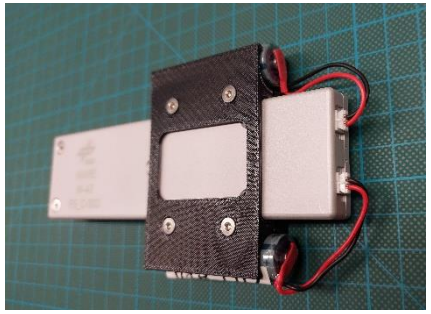
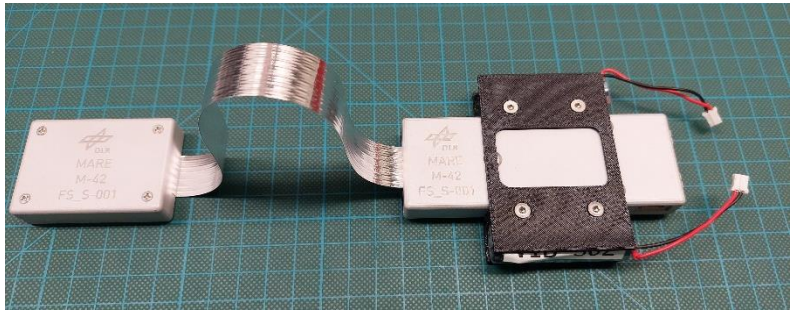
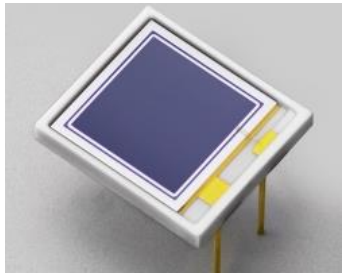
Note: This paper is part of the Special Collection: Materials and Life Science Experiments for the Sounding Rocket MAPHEUS.
[a]**Author to whom correspondence should be addressed:** thomas.berger@dlr.de

DLR M-42: Detector family, technical data

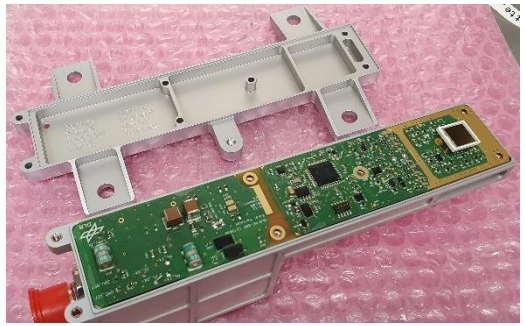






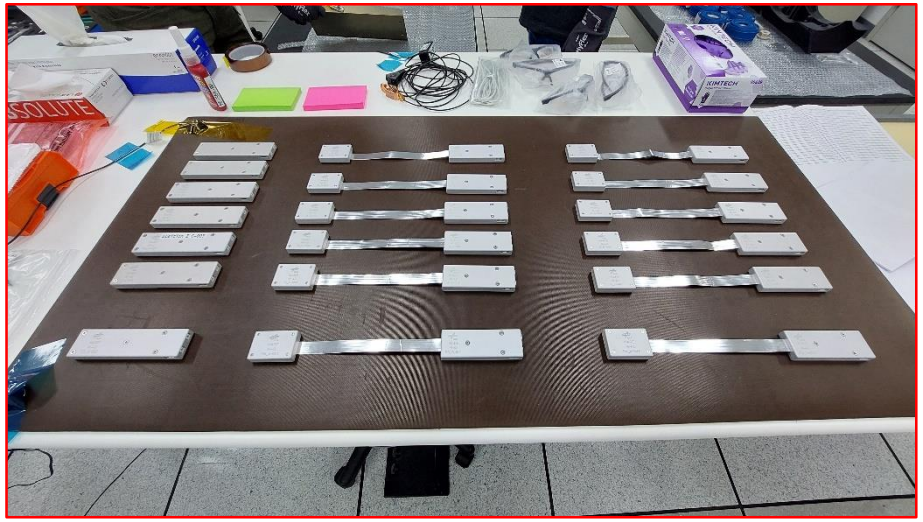
Si 11 x 11.1 mm^2

300 µm

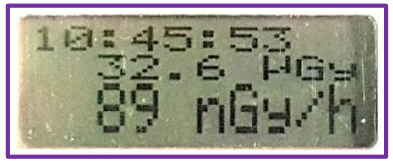


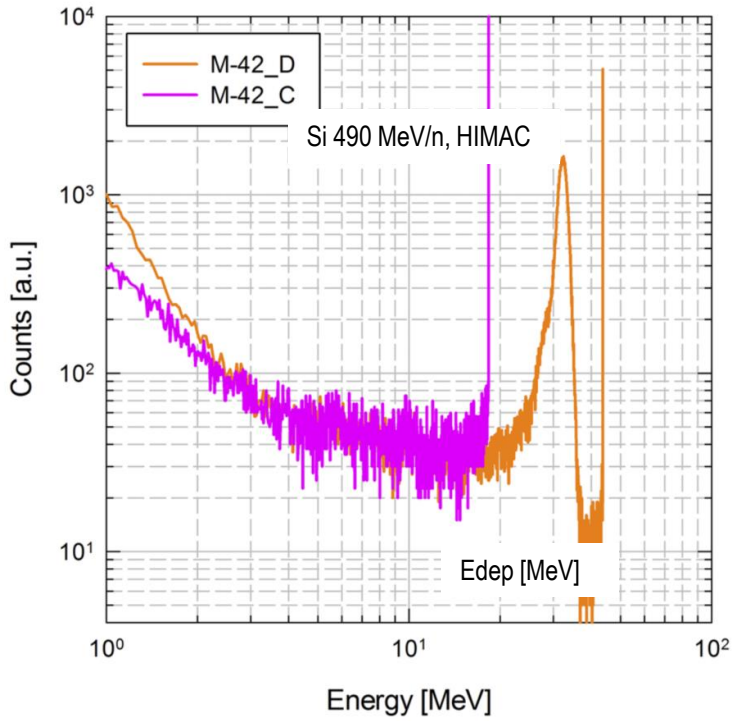
M-42	Compact	Split	EXT	Displ	Lunar	
Dimensions	142 x 38 x 13	54 × 38 × 13 106 × 38 × 13	142 x 38 x 13	182 × 44 × 22	203 x 94 x 60	mm^3
Mass with batt.	144	156	144	237	216 no battery	g
Supply voltage	3.6	3.6	3.6	3.6	28	V
Power consumption	<= 3	<=3	<= 3		12	mA
Battery runtime	70	70	70	20	-	days
Sensors	Accel, temp	Accel, temp	Accel, temp	Accel, temp, **pressure**	Accel, temp	
Emin/max (Si)	0.06-18	0.06-18	0.06-**135**	0.06-**43**	0.06-18	MeV

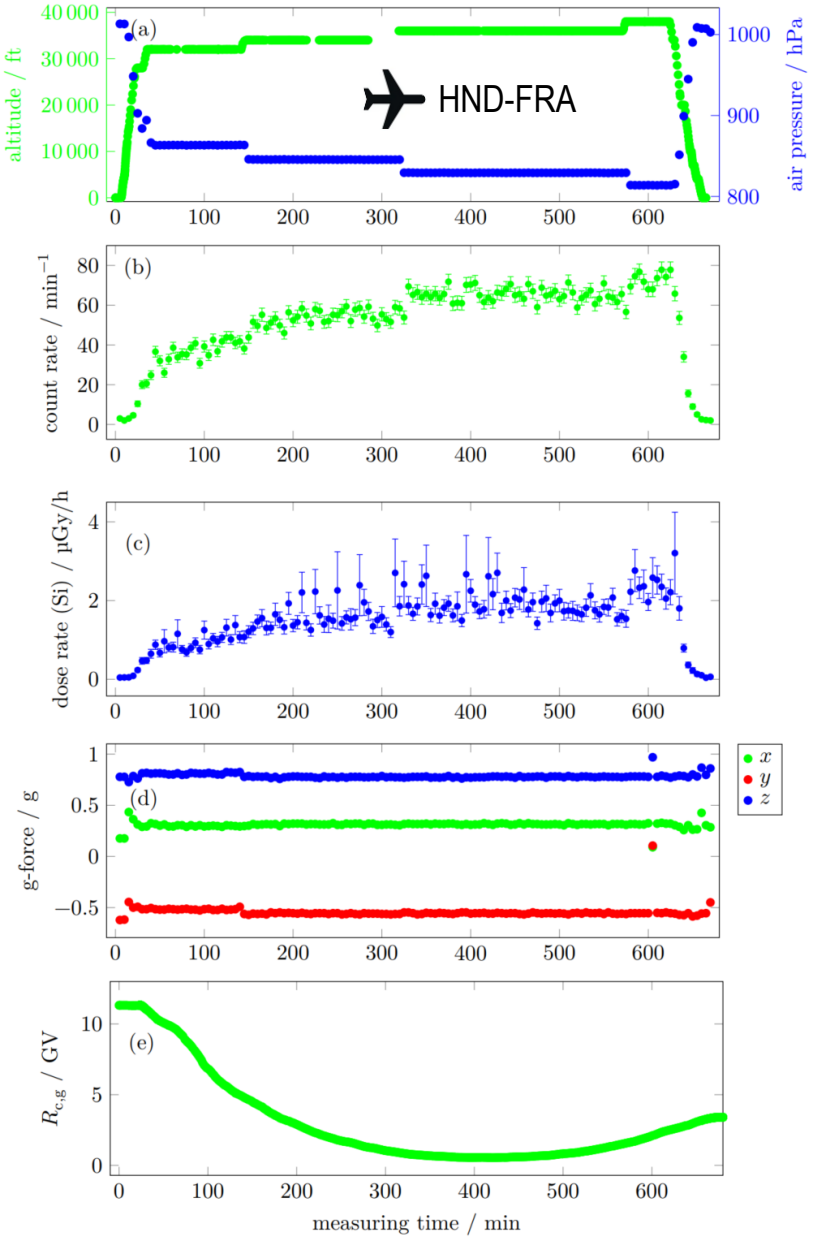
DLR M-42: M-42_C and M-42_S for MARE



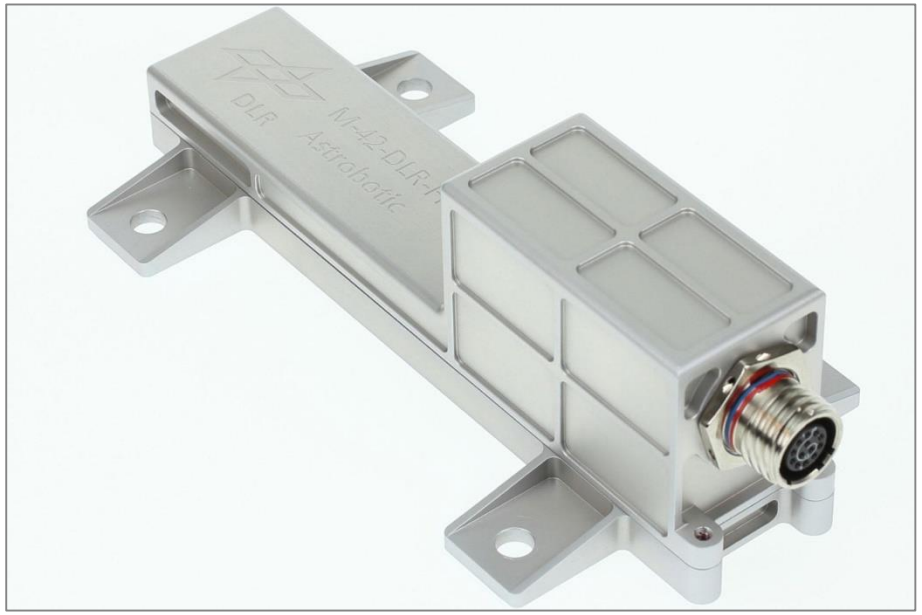
DLR M-42: DISPLAY

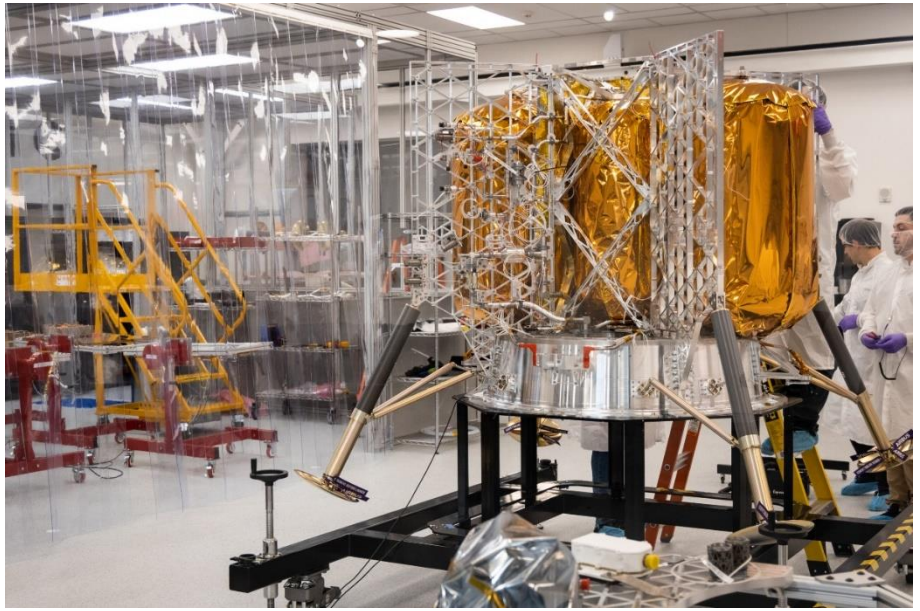






DLR M-42: ASTROBOTIC PEREGRINE LANDER → Moon





- Launch NET Q4 2023
- 28 V, RS422

ASTROBOTIC

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- DLR-ME-BIO: Jens Hauslage, Ruth Hemmersbach
- DLR-MUSC: Stephan Sous, Hans-Herbert Fischer
- DLR-RY: Hartmut Müller, Falk Nohka, Olaf Eßmann, Toni Delovski, Claudia Philpot, Catherin Düvel, Fabian Greif
- DLR-RB: Gary Morfill, Lukas Grillmayer, Daniel Schulze, Stephan Borek
- University of Erlangen: Michael Lebert, Ferdinand Haag

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  Long Live the HIMAC!!!!

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