



SPACE DOSIMETRY

Hungarian Innovations

Balazs Zabori

Centre for Energy Research, Lead Aerospace Engineer
REMRED Space Technologies Ltd., Chief Technical Officer
HUNOR Research and Outreach Program Manager
Advisor of Hungarian ESA Delegation
Member of ESA Moon Strategy Team



→ SPACE RISKS

Radiation

Travelling to the Moon and Mars
x700



International Space Station
x250



Airplane
x40



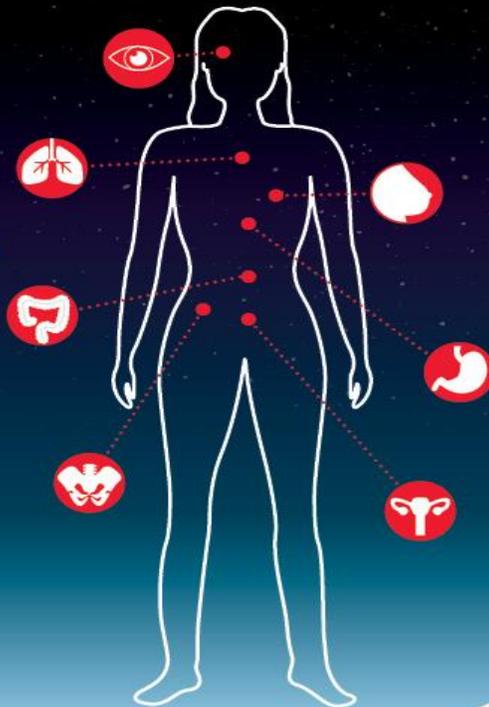
Mountains
x2

Ground
x1



Earth's atmosphere and geomagnetic field **protect us from space radiation**

Areas of the body **most at risk**



One day in space is equivalent to the radiation received on **Earth for a whole year.**



#Space19plus #ScienceAtESA



Space19

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SPACE DOSIMETRY

Cosmic radiation risks to human spaceflight

Sustainable long-term human space presence requires monitoring and protection solutions

Hungary has one of the longest heritage and knowledge in the domain...





The Beginning – PILLE, more than a success story...



PILLE: the Hungarian word for “butterfly”



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Space dosimetry developments
from 1970's

System is composed from
Reader Unit + Dosimeters

First time flown onboard Salyut-6
in 1980-1983



PILLE: more than a success story...

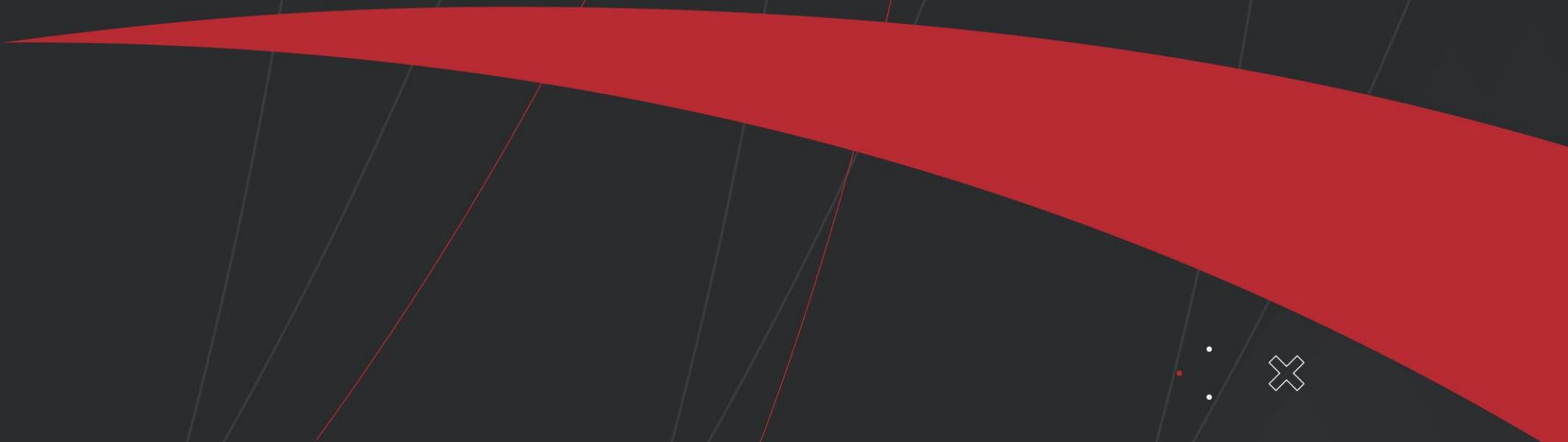


- The 2nd-gen PILLE was flown on **Salyut-7** and transferred to **Mir** to be used until the deorbit of Mir in 2001
- From 2001 the 3rd-gen PILLE is used on **ISS** and **space vehicles** (space shuttle)
- Nowadays the 3rd-gen & 4th-gen PILLE is used on **ISS** together (Zvezda) as part of the service system
- During its more than 20 years of service lifetime, the PILLE system **never malfunctioned**
- Note that until now PILLE is the only instrument used for routinely EVA dosimetry
- *Making this system one of the longest used piece of spaceflight hardware in the history of human spaceflight...*





Nowadays – TRITEL, the story continues...



TRITEL: acronym for a “triaxial telescope”



System developments
from 2000's

System is composed from
Central Unit + Detector Unit

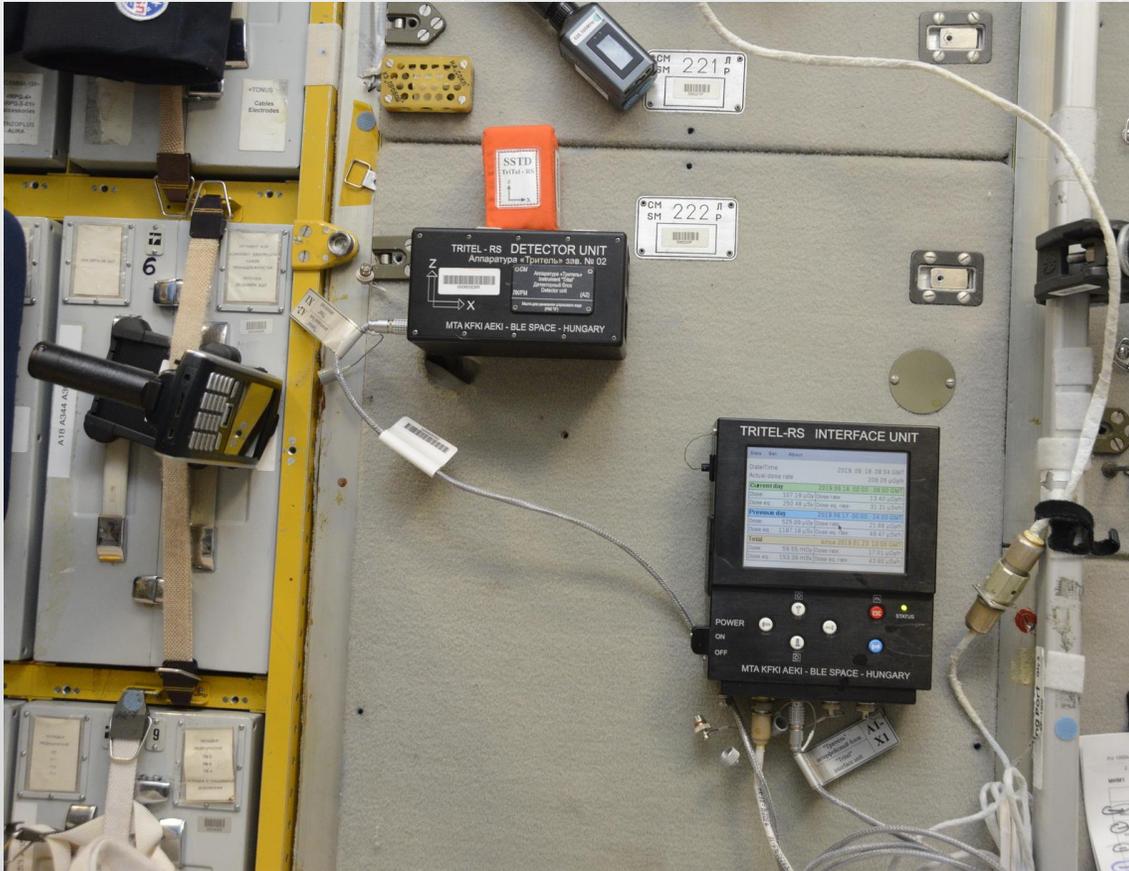
First time flown on ISS Columbus
in 2012-2013



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TRITEL: the story continues...

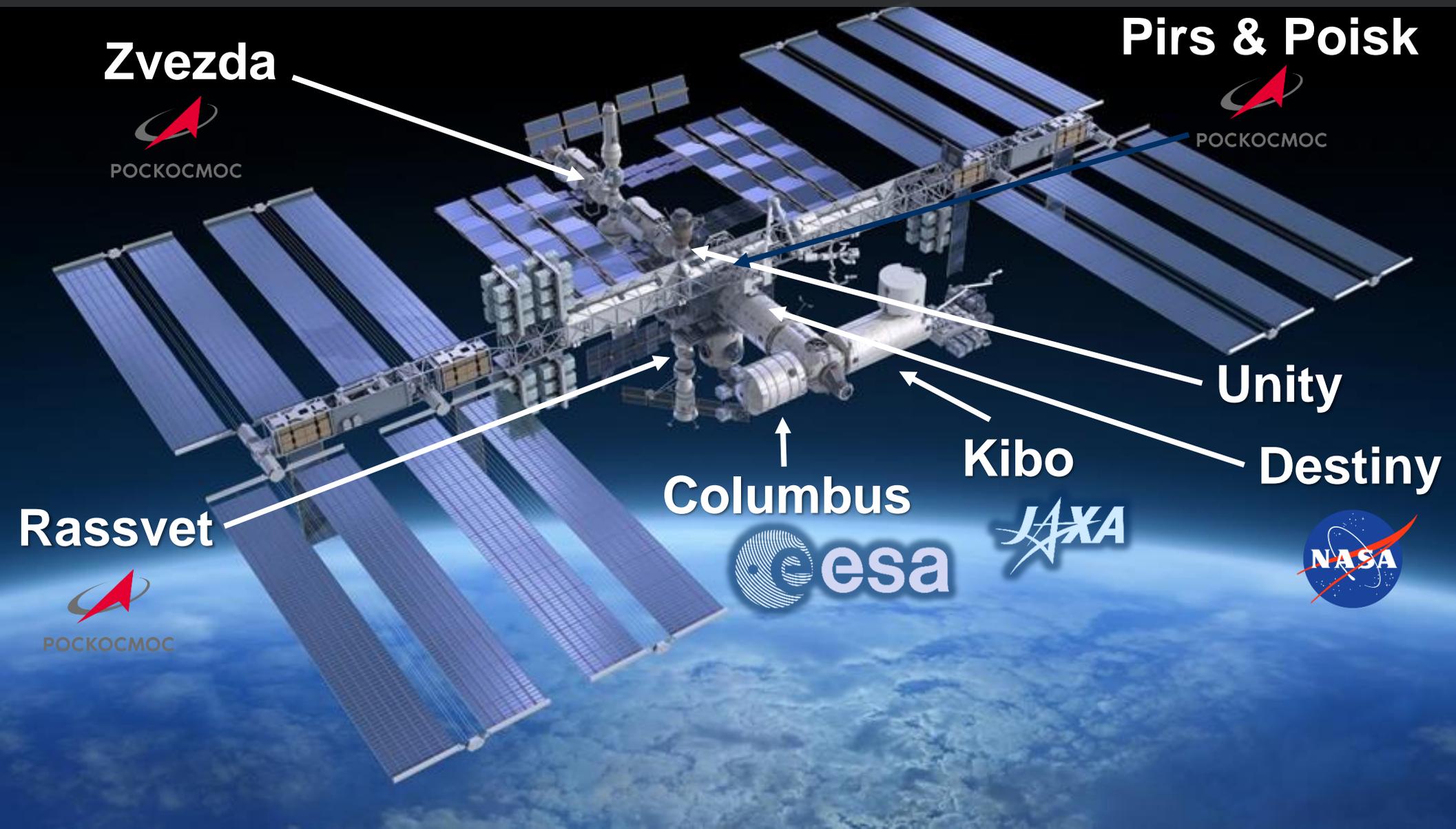


- The full 1st-gen TRITEL system was flown on ISS Zvezda from 2017 until nowadays
- A 1st-gen TRITEL Detector Unit is operated on the ESEO SmallSat launched in 2020
- The system is using passive control detector packages
- The system is integrating the long-term heritage and experiences of PILLE
- *Making this system appropriate for future Moon and Mars missions...*





Hungarian Service Dosimeters on ISS





Future strategy – Beyond LEO to Moon and Mars...





STEP III.
Future Mars mission
Martian Orbit & Landing

Mars mission service operation

STEP II-b.
Earth Return Orbiter mission
Earth-Mars Travel
Martian Orbit

*Critical science data collection
for Mars mission preparations*

STEP II-a.
Lunar Gateway & Artemis
Moon Orbit & Landing

*Service operation demonstration
in Moon missions*

STEP I.
International Space Station
Low Earth Orbit

New technology demonstrations



STEP I. – NEW TECHNOLOGY DEMONSTRATIONS



- New technology developments are planned to be demonstrated **on ISS as part of HUNOR program in 2024**

NEW DEVELOPMENTS

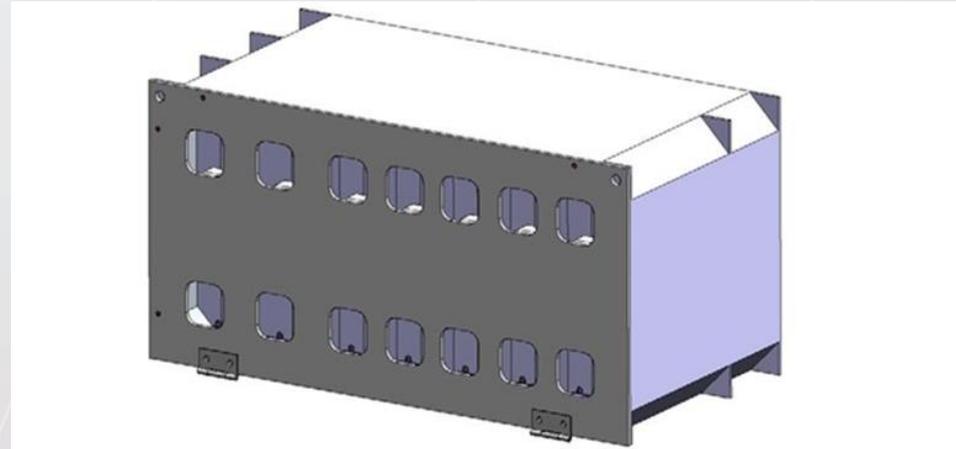
- **2nd-gen TRITEL Detector Unit**
- **TRIPIL Complex Space Dosimetry System**
- **PSDS Personal Space Dosimetry System**





STEP II-a. – SERVICE OPERATION DEMONSTRATIONS IN MOON MISSIONS

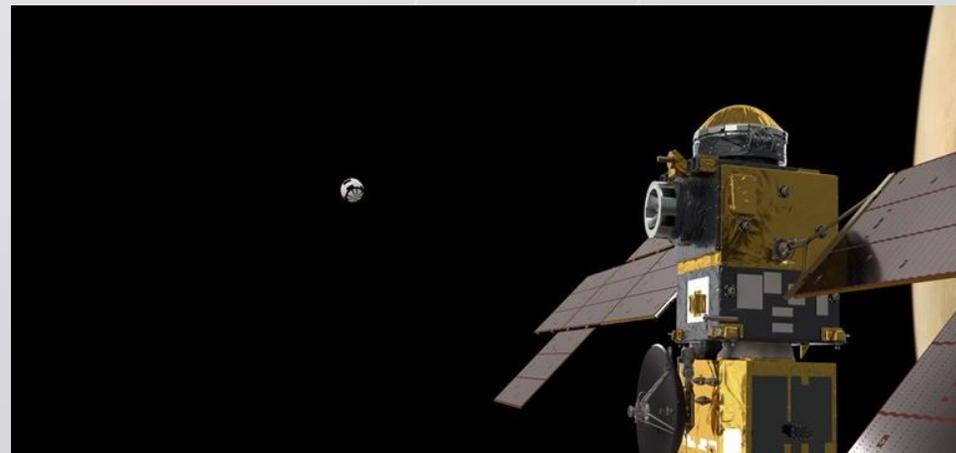
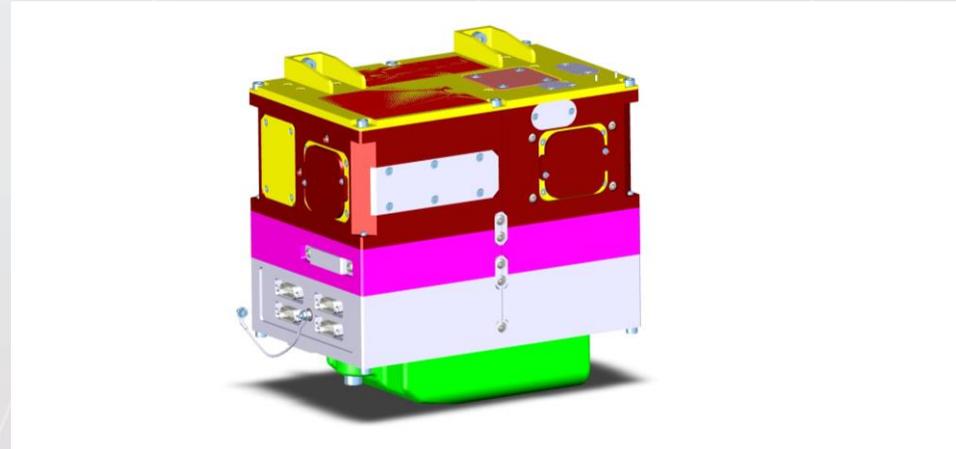
- IDA (Internal Dosimeter Array) Payload Development to be hosted in **Lunar Gateway US HALO module** during early utilization phase (launched in 2024) in Moon orbit
- Passive detector packages for **ORION EM-1** demonstration mission
- *Discussions for dosimetry monitoring provision in Artemis landing missions...*



STEP II-b. – CRITICAL SCIENCE DATA COLLECTION FOR MARS MISSION PREPARATIONS



- SDT (Space Dosimetry Telescope) Payload Development to be hosted on **Earth Return Orbiter** (launched in 2026) during the travel between Earth and Mars and in Moon orbit
- *Discussions to support the dosimetric preparations of future human Mars mission based on the science output of SDT payload...*



In 2026...

2nd TRITEL #2 & #3

Gateway in Moon orbit

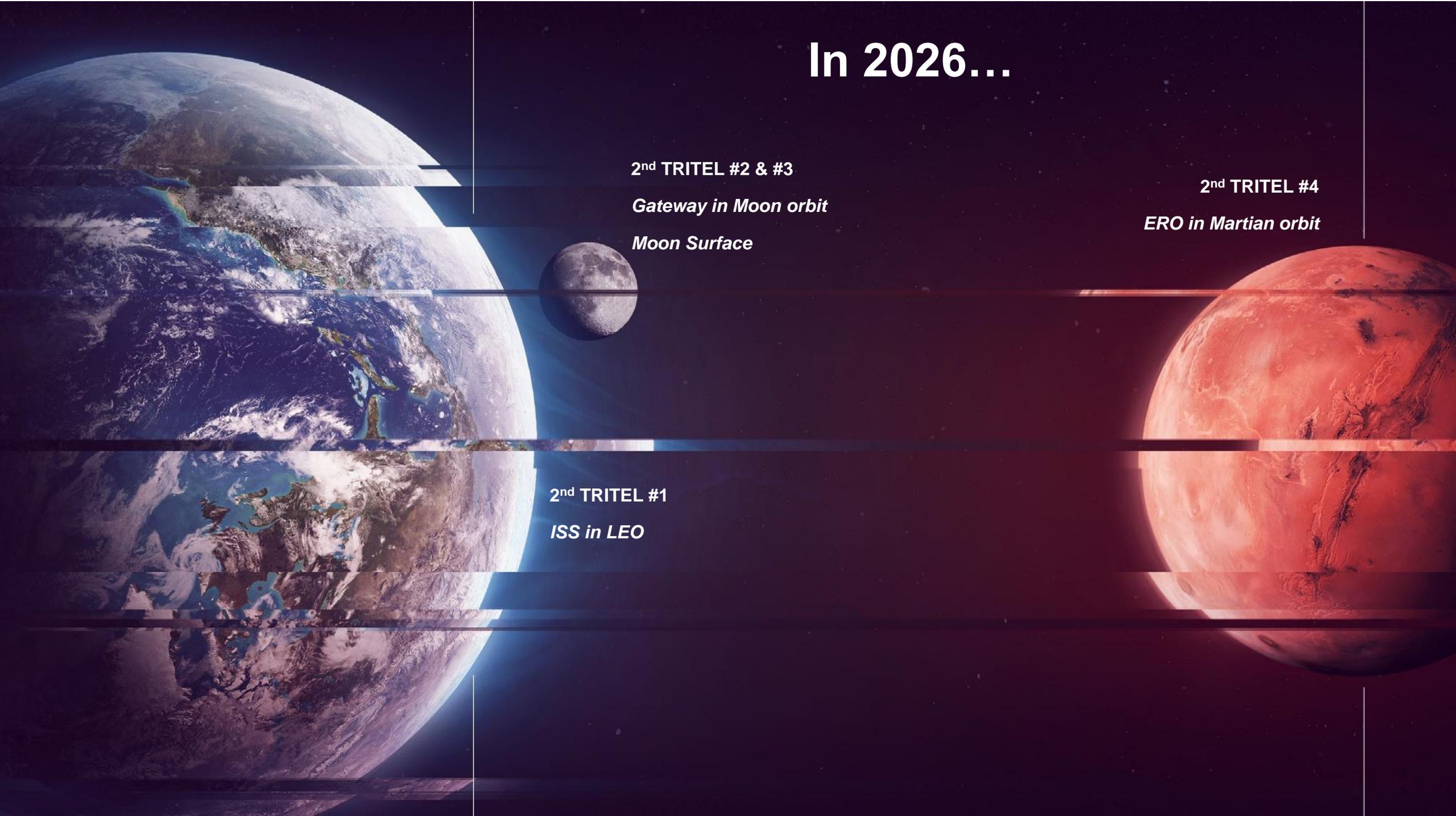
Moon Surface

2nd TRITEL #4

ERO in Martian orbit

2nd TRITEL #1

ISS in LEO



STEP III. – TO SUPPORT HUMAN MARS MISSION

- **Proven space dosimetry systems**

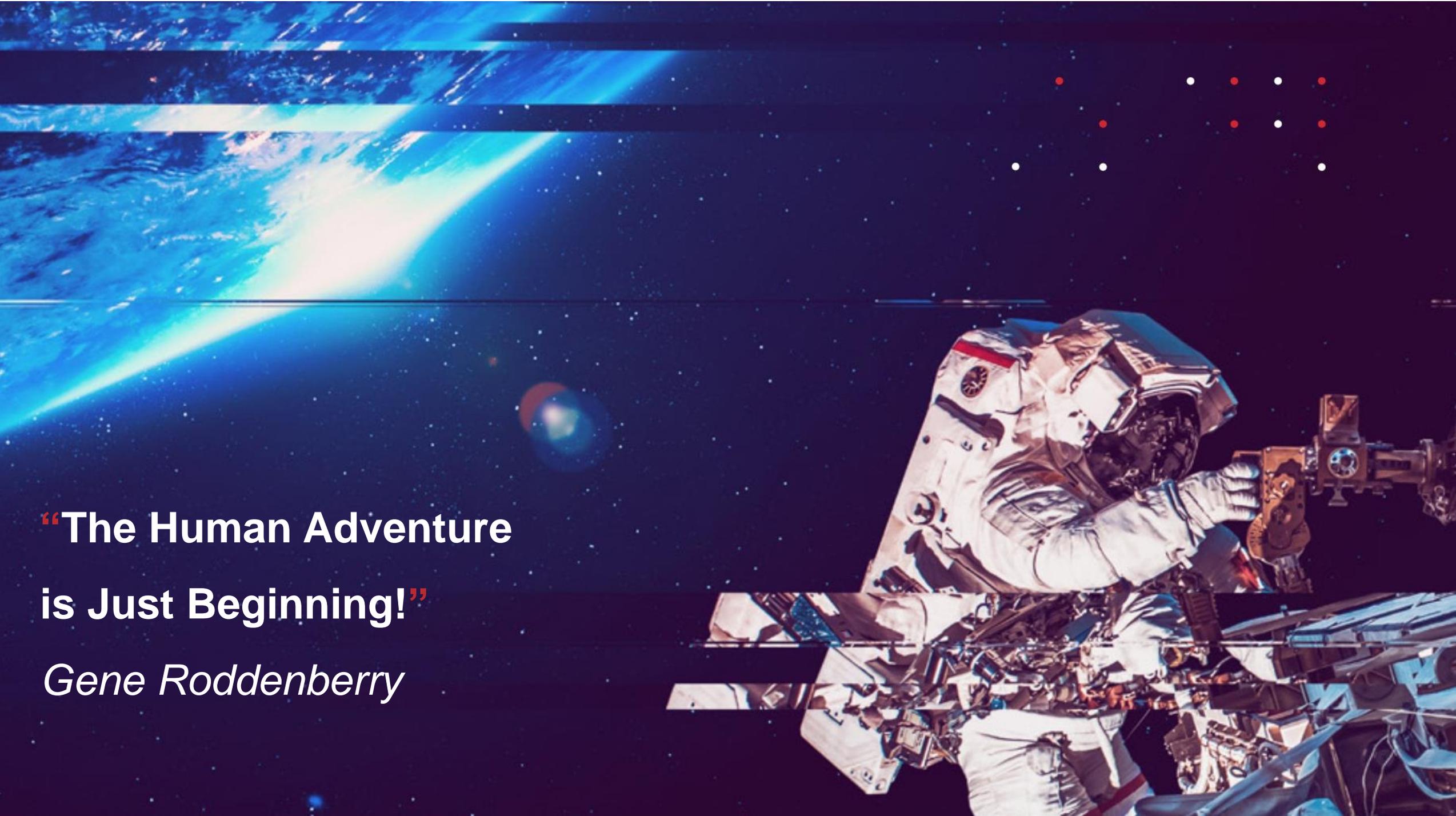
- PILLE
- TRITEL
- TRIPIL
- PSDS

- **Complex space dosimetry service**

- Environmental dosimetry
- Personal dosimetry
- EVA dosimetry

- ***To become one of the world leader in the field of space dosimetry...***



A composite image showing two astronauts in white space suits working on the exterior of a space station. The station's complex structure, including solar panels and various instruments, is visible. In the background, the Earth's blue and white atmosphere curves across the top left, and the deep black of space is filled with numerous stars. A grid of red and white dots is visible in the upper right corner.

**“The Human Adventure
is Just Beginning!”**

Gene Roddenberry



Centre for Energy Research

REMRED Space Technologies Ltd.

1121 Bp, Konkoly-Thege Miklós Str. 29-33.

+36 (20) 222 0139

ek-cer.hu

remred.space

