WRMISS 2026: Conference Program

final-draft: 18 August 2026

29th WRMISS Conference Program: Tuesday 1st September 2026

08:30 – 09:00	Registration
09:00 – 09:30	Welcome, organizational Issues
09:30 - 10:30	Scientific Session 1
10.30 – 11:15	Coffee/Tea Break
11.15 – 12:15	Scientific Session 2
12:15 – 13:45	Lunch
13:45 – 15:15	Scientific Session 3
15:15 – 16:15	Coffee/Tea Break
16:15 – 17:45	Scientific Session 4

Guenther Reitz, Ondrej Ploc, Peter Svihra	Welcome, organizational Issues

Scientific Session 1

Premkumar Saganti	Long-Duration Radiation Biology Studies in Space and in simulated Microgravity: From ISS to Moon and Mars
Luca Lunati/ Virgina Boretti	Bringing Space to Earth: Optimization and Biological Modelling of The GCR simulator at GSI_FAIR

Scientific Session 2

Martin Kakona	Asymmetry in SPACEDOS Measurements During SAA Transits
Carlos Granja	Detection sensitivity and specific tracking response to charged particles and neutrons by Timepix detectors with Si, SiC, GaAs and CdTe sensors

Scientific Session 3

Stefan Gohl	Space Weather Monitoring with SATRAM
Maximilian Radenhäuser	Over 2800 days in space – the RAMIS radiation detector on the DLR Eu:CROPIS mission
Marcin Patecki	Long-Term in Flight validation of a compact radiation Monitor Inside the ISS Columbus Module

Scientific Session 4

Maximilian Brüdern	DOSIS and DOSIS 3D – data from the DOSTEL instruments focusing on 2024 – 2026 with special emphasis on SPEs and electrons measured inside the ISS
Robert Filgas	Results from radiation spectrometer HardPix onboard the ISS and ION satellites
Luca Di Fino	East-West Anisotrophy of GCR Measured inside Columbus by Lidal detector

29th WRMISS Conference Program: Wednesday 2nd September 2026

09:00 - 10:30	Scientific Session 5
10.30 - 11.15	Coffee/Tea Break
11.15 – 12:15	Scientific Session 6
12.15 - 13:45	Lunch
13:45 – 15:15	Scientific Session 7
15:15 – 16:15	Coffee/Tea Break
16:15 – 17:45	Scientific session 8
19.00 TBD	Conference Dinner

Scientific Session 5

Virgina Boretti	LIDAL: Decoding Cosmic Radiation One Particle at a Time
Luca Lunati	Beyond dosimetry in the ISS, a new analysis approach for the LIDAL Experiment
Martin Losekamm	Analysis of Flux Profiles in the SAA with the RadMap Telescope

Scientific Session 6

Masayuki Naito	Comparative study on space radiation dosimetry in the International Space station and Artemis-1 Orion with two different Quality Factors
Thomas Camp-bell-Ricketts	HERA, there, and everywhere

Scientific Session 7

Thomas Berger	Update on the MARE-Evaluation on Artemis I and preliminary results from Artemis II
Patrik Pinczes	Analysis of the Radiation Environment in Lunar Orbit for the RADTEL and Tritel Telescopes
Don Hassler	Recent Results from the Surface of Mars with RAD

Scientific Session 8

Salman Khaksari	Multipoint Observations of the 9 October 2024 CME-driven Shock:Implications for Solar energetic particle Forecasting at Mars
Jan Leo Loewe	Constraints on Relativistic Runaway Electron Avalanches on Mars from Long-Term in situ Electron Measurements during Dust events
Piers Jiggens	Final Report of ESA's Future Exploration Radiation Facility Definition Team

29h WRMISS Conference Program: Thursday 3rd September 2026

09:00 - 10:30	Scientific Session 9
10.30 - 11.15	Coffee/Tea Break
11.15 – 12:15	Scientific Session 10
12.15 - 13:45	Lunch
13:45 – 15.15	Scientific Session 11
15:15 – 16.15	Coffee/Tea Break
16:15 – 17.45	Scientific Session 12
17:45 - !8:15	Wrap up, adjurn

Scientific Session 9

Eric Benton	Progress on Tissue Equivalent Dosimeters being developed at Oklahoma State University
Bent Ehresmann	Update on the development of the Miniaturized Fast Neutron Detector (Mini-FND)
Martin B. Smith	Development of the Canadian Active Neutron Spectrometer CANS)

Scientific Session 10

Radek Novotny	Spacepix3: A Radiation-Hardened Pixel Detector for Orbital Dosimetry
Milan Malich	Hardpix: A Modular Timepix3 Based Radiation Monitor for Advanced Radiation Environment Characterization

Scientific Session 11

Moritz Kasemann	Update on the DLR M-42 instrument family and future missions
Ondrej Ploc	Overview of the CZPAD Experiment
Jakub Slegl	Monte Carlo Simulations for the CZPAD Dosimetry experiment

Scientific Session 12

Michal Marcisovsky	Albedo Neutron Monitoring in Polar Eath Orbit Using a Compact Dual-Mode Radiation detector on REXIS Spacecraft
Mathis Mewes	Small Instrument, High Energies: The Desin an simulation of the GalacticRay high-energy Telescope, GRETEL
Jaroslav Sochan	Proxima:a collobarative platform for operational European space weather data products
	Final Discussion and Adjurn

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WRMISS 2025: Abstracts

Progress on Tissue Equivalent Dosimeters being developed at Oklahoma State University

Eric Benton, Conner Heffernan, Garrett Thornton and Buddy Gersey

Physics Dept., Oklahoma State University, Stillwater, Oklahoma USA

The OSU Atmospheric Ionizing Radiation Tissue Equivalent Dosimeter (AirTED) is a low cost, compact ionizing radiation detector which consists of a tissue equivalent proportional counter (TEPC) to measure high LET radiation including secondary neutrons, primary and secondary protons and heavy ions, and a Si PIN photodiode to measure low LET radiation including x-/gamma-rays, electrons and positrons. The Atmospheric ionizing Radiation Silicon Dosimeter (AirSiD) is a light-weight, battery-powered radiation spectrometer using only a Si PIN photodiode. Software has been developed to automatically analyze data from the two detectors in order to yield LET spectra, total absorbed dose and dose equivalent. This software is being applied to the one year of measurements obtained by our SpaceTED detector aboard the ISS in 2024. Both AirTED and AirSiD were calibrated at the HIMAC heavy ion accelerator in Japan. In September 2025, SpaceTED flew aboard a Blue Origin, New Shepard flight over southwestern Texas and yielded the expected 11 minutes of data. AirTED was flown aboard a USAF Compass flight over the southwest US and us scheduled for upcoming flights over Alaska. We are also continuing with solar balloon flights over central Oklahoma.

Update on the MARE Evaluation on Artemis I and pre-liminary results from Artemis II

Thomas Berger for the Artemis Mare I and the Artemis DLR Team

German Aerospace Center (DLR), Institute of Aerospace Medicine (ME), Cologne, Germany

Human space and human lunar exploration are becoming a reality within the NASA Artemis program. The Artemis I mission in 2022 enabled the first flight of the Orion spacecraft, powered by the European Service Module (ESM) to distances away from Earth never reached by a human-rated spacecraft so far. The MARE experiment on Artemis I flew two female anthropomorphic phantoms (Helga and Zohar) equipped with thousands of passive and 34 active (DLR, NASA) radiation detectors to determine the radiation load on female astronauts during this mission. In addition, Zohar was equipped with a radiation protection vest (AstroRad). The first part of the presentation will provide an update on the current work performed by the MARE team in terms of data evaluation and simulations for the Artemis I mission. In April 2026 the Artemis II enabled, for the first time after Apollo, the flight of four astronauts to the Moon and back. DLR provided four M-42 EXT radiation detectors within this mission mounted at distinct positions in Orion. The second part of the presentation will therefore provide first preliminary data measured during Artemis II and a comparison with data measured during the Artemis I mission.

LIDAL: Decoding Cosmic Radiation One Particle at a Time

Virginia Boretti, Luca Lunati, Luca Di Fino, Giuseppina Nigro, Giorgio Baiocco, Alice Mentana, and Livio Narici

Accurate assessment of radiation exposure in space requires a detailed characterization of the radiation environment encountered by astronauts. Reliable radiation risk models depend on knowledge of the kinetic energy spectra of all particle species present in the field. To our knowledge no detectors have performed yet particle-by-particle measurements and reconstructed energy spectra, within the spatial constraints of a habitat. LIDAL (Light Ion Detector for ALTEA), installed in the Columbus module of the International Space Station (ISS), is currently the only instrument capable of performing such detailed measurements in a space habitat. LIDAL consists of three Silicon Detector Units (SDUs), each comprising six silicon planes positioned between two LIDAL Detector Units (LDUs). Each LDU contains a plane of eight plastic scintillator bars (80 × 20 × 4 mm3) equipped with fast electronics that form the first Time-of-Flight (ToF) system deployed inside a crewed spacecraft. By combining measurements of the energy deposited in the silicon detectors with ToF information from the scintillators, LIDAL simultaneously characterizes multiple properties of particles traversing the detector. This unique measurement capability is now fully exploited to enable nuclear identification of individual particles crossing the detector. The method relies on a newly developed nuclear identification algorithm, within the HyperIon framework, which compares the energy deposited on each silicon plane—and, when available, the particle time of flight—with the results of detailed FLUKA-based Monte Carlo simulations of the detector. This approach enables the reconstruction of particle tracks and interaction histories, including both particles that traverse the entire detector and those that stop within it. In this presentation, we describe in detail the HyperIon framework and present the first measured kinetic energy spectra obtained inside a space habitat for particles ranging from Hydrogen up to Iron (Z=1,26) , together with comparisons to simulation results. We also report the first Z^2/β^2 spectrum, a key parameter in modern radiation risk models. These measurements can provide direct input to radiation risk models to improve risk assessment and can serve as benchmarks for validating radiation transport simulations

DOSIS and DOSIS 3D – data from the DOSTEL instruments focusing on 2024 – 2026 with special emphasis on SPEs and Electrons measured inside the ISS

Maximilian Brüdern[1], Thomas Berger[2], Bernd Heber[1], Daniel Matthiä[2], Bartos Przyblya[2]

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As part of the DOSIS and DOSIS 3D experiment two identically manufactured DOSimetry TELescopes (DOSTELs) monitor the radiation environment within the Columbus laboratory on board the International Space Station (ISS). Both DOSTEL instruments provide the count- and dose rates with a high time resolution, i.e., 20 or 100 seconds, as well as Linear Energy Transfer (LET) spectra that are usually integrated over a half orbit, i.e., 45 minutes. The analysis of the current DOSTEL data shows that we are leaving the recent solar maximum behind and are beginning to transition into a new solar minimum phase. Yet, on November 11th we observed one of the largest Solar Energetic Particle (SEP) events of recent years. This event will be analyzed in more detail, followed by a summary of the dose contribution of all recent SEP events and also showing additional contributions from outer belt electrons over the years 2024 to 2026.

As an outlook into the near future, we present our work on a newly build DOSTEL 3D instrument that consists of three perpendicular dosimetry telescopes. The biggest improvement, besides an increase in energy- and time resolution, is the integration of a sophisticated onboard computer that allows us to obtain and analyze DOSTEL 3D in real-time.

HERA, there, and everywhere

Thomas Campbell-Ricketts, NASA SRAG

In April 2026, humans flew further from Earth than ever before, and with them, so flew several HERA radiation detectors. Preliminary radiation measurement results from this adventure around the Moon will be reported. One year earlier, in April 2025, a privately funded mission, Fram2, flew with another HERA instrument on board. Fram2 was the first ever crewed vehicle to enter a polar orbit. HERA data collected during this flight will also be presented. Currently, the Space Radiation Analysis Group at NASA is working on delivering an unprecedented number of HERA-like instruments for ISS, several lunar landings, and lunar orbit. I will give an overview of these exciting prospects.

EAST-WEST ANISOTROPY OF GCR MEASURED INSIDE COLUMBUS BY LIDAL DETECTOR

Luca di Fino, ASI Italy

LIDAL is a particle telescope developed to characterize the radiation environment inside the ISS, to evaluate the radiation risk for the astronauts, as well as to provide continuous validation for radiation and transport models. LIDAL has been launched to the ISS in November 2019, and it started measuring in January 2020. Since then, it has been measuring the radiation environment in the Columbus module almost without interruptions. Thanks to its fast scintillators the LIDAL detector system is the first one to measure the time of flight of ions inside a space habitat.

This together with the silicon telescope, part of the system allows for the first evaluation of charge and kinetic energy of each incoming ion in the ISS. The LIDAL system is a 49 cm long, 20 planes (18 silicon, 2 scintillators) telescope. Each plane is 8 x 16c m^2. The 18 silicon planes are striped in alternate orthogonal directions, to track each particle. Each of the 2 fast scintillators planes (0.4 cm thick), sandwiching the silicon planes, is made of 8 2-cm wide scintillators bars, to help tracking. The two scintillator planes system can measure the time of flight of the ions with an accuracy (sigma) between 70 and 100 ps. Due to its narrow field of view, the LIDAL telescope has been rotated to measure in all three main ISS directions providing a further demonstration of the high anisotropy of the radiation field in the Columbus module.

Exploiting LIDAL’s capability to reconstruct the incidence direction of incoming particles, we performed a detailed analysis of the East–West anisotropy of the GCR flux inside the Columbus module. By comparing measurements acquired during ascending and descend in orbital segments—when the ISS is oriented approximately in opposite directions with respect to the geomagnetic field—we were able to separate the intrinsic East–West asymmetry of the GCR flux from the modulation induced by the station’s local shielding. This approach provides the first quantitative assessment of this effect within a space habitat and offers new insight into how the ISS structure shapes the radiation environment experienced by astronauts.

Update on the development of the Miniaturized Fast Neutron Detector (Mini-FND)

Bent Ehresmann (SwRI), Don Hassler (SwRI), Michael Vincent (SwRI)

The Mini-FND (Miniaturized Fast Neutron Detector) instrument is based on the highly successful ISS/RAD FND instrument that has been operating onboard the ISS since 2016. We reduced volume, mass, and power draw by replacing the original Photo Multiplier Tube (PMT) read-out detector with an array of small-sized, low-voltage Silicon Photo Multipliers (SiPMs). Mini-FND will fly as part of the LEIA (Lunar Explorer Instrument for space biology Applications) instrument suite on NASA's CLPS-22 lunar lander mission. Here, we provide an update on recent progress in the development of the Mini-FND instrument, including environmental testing and preliminary calibration efforts, as well as an outlook on the future work and timeline for integration and delivery before launch in October 2027.

Results from radiation spectrometer HardPix onboard the ISS and ION satellites

Robert Filgas, Czech Technical University in Prague, Institute of Experimental and Applied Physics

HardPix is a miniature Timepix3-based radiation spectrometer developed by the Institute of Experimental and Applied Physics, Czech Technical University in Prague. HardPix builds on the success of our SATRAM detector, which is monitoring radiation environment in space onboard Proba-V since 2013, but adds a multilayer design and onboard processing capability. Particle identification is performed using a combination of track morphology and stopping-power information, enabling effective separation of electrons, protons, and heavier ions, measuring their deposited energy and in some cases even determining the incident energy. HardPix detectors were launched to LEO in 2023 and 2025 onboard D-Orbit ION satellites as part of the UK Space Weather Instrumentation, Measurement, Modelling and Risk (SWIMMR) project. Two more HardPix units were successfully operating on the outer shell of the ISS in 2025 and 2026 as part of the New Zealand mission Heki. Details of the HardPix instrument will be presented together with processed space weather data measured in orbit. Additionally, Neutron HardPix will be introduced - a modification to HardPix using conversion layers for capability to measure fluxes of thermal, epithermal and fast neutrons. This semiconductor neutron spectrometer is planned for lunar rover mission MAGPIE to map lunar subsurface water deposits and for NASA mission to study the biological risks of the lunar neutron environment

Space Weather Monitoring With SATRAM

Stefan Gohl, Institute of Experimental and Applied Physics, CTU in Prague

The Space Application of Timepix Radiation Monitor (SATRAM) was launched aboard ESA's Proba-V satellite in May 2013 into a low Earth, Sun-synchronous orbit (820 km) and has operated continuously since then. The SATRAM module incorporates a Timepix chip with a 300 um-thick silicon sensor segmented into a 256 x 256 pixel matrix with a 55 um pitch. Although originally conceived as a technology demonstrator, its long operational lifetime has enabled comprehensive scientific data analysis. Detector stability and resilience to the space environment have been evaluated; while some degradation has been observed, data quality remains largely unaffected. In addition to dosimetric measurements, the single-layer Timepix detector enables particle species identification, flux determination, and proton spectrum reconstruction. Two particle-identification methods are presented. The first employs a decision tree to classify electrons, protons, and heavier ions using track morphology and stopping power. The second uses a neural network based on characteristic features extracted from pixelated particle tracks. Particle fluxes were determined through simulations of detector response and geometry. Electron fluxes measured by SATRAM were compared with those from the Energetic Particle Telescope onboard the same satellite, showing good agreement. Additionally, a Bayesian deconvolution method was used to derive a proton spectrum from SATRAM data. Finally, the composition of Galactic Cosmic Rays was measured. These results demonstrate that a single-layer Timepix detector can provide competitive measurements of mixed radiation fields compared with more complex multilayer detectors, while delivering science-grade data with a large field of view at low mass and power consumption. The impact of lessons learned from SATRAM data analysis on the development of state-of-the-art Timepix-based radiation environment monitors is also briefly discussed.

Detection sensitivity and specific tracking response to charged particles and neutrons by Timepix detectors with Si, SiC, GaAs and CdTe sensors

Speaker/co-author: C. Granja (VSB-TU Ostrava) / J. Janecek (IEAP CTU Prague)

Radiation environments exhibit different and complex radiation fields of varying composition, large gradients (intensity, direction) and different spectral distribution. This is the case with secondary cosmic rays in Earth's atmosphere, particle therapy environments and especially outer space. Determining the makeup composition in terms of radiation components and spectral distribution is often a challenge especially when discrimination is required. This task is suitably targeted by the semiconductor pixel detectors Timepix which provide noiseless counting imaging capability and spectral-tracking response of single particles. This is made possible by the hybrid architecture of the ASIC chip bump-bonded to the semiconductor sensor assembly and the integrated per-pixel signal electronics providing independent energy- and counting-response. However, the particular semiconductor sensor used significantly determines the specific radiation response. In this work I present experimental data acquired with Timepix detectors equipped with Si, SiC, GaAs and CdTe sensors. Physics calibrations are performed at particle accelerator beams and at well-defined reference fields including monoenergetic neutrons in wide range (thermal, slow, fast). Derived look-up tables are applied to data acquired in complex and mixed-field environments. Distinct particle-sensor detection channels are proposed for different radiations which is in particular valuable for neutrons in broad range. Specific chip-sensor configurations are suitable for different radiation fields and particular applications. The methodology and results obtained with different sensor materials are shown for charged particles (electrons, protons, light ions) and mono-energetic fast neutrons at various energy ranges as well as environmental mixed-radiation fields in particle radiotherapy and in Earth's atmosphere at mountain altitudes.

Recent Results from the Surface of Mars with RAD

Don Hassler (SwRI), Bent Ehresmann (SwRI), Cary Zeitlin (NASA), Bob Wimmer-Schweingruber (CAU)

The Radiation Assessment Detector (RAD) on the Mars Rover Curiosity has been effectively serving as a space weather monitor on the surface of Mars since Curiosity landed on the red planet in 2012. RAD has measured the impact of more than a dozen solar storms, with the frequency of events increasing as the Sun approaches solar maximum. We will present results and analysis of recent measurements from RAD. We will discuss these events and their implications for space weather predictions, as well as the need for heliosphere-wide space weather monitoring to support future human exploration to Mars and beyond.

Final Report of ESA's Future Exploration Radiation Facility Definition Team

Piers Jiggens, ESA

In 2025, ESA commissioned a Facility Definition Team (FDT) to define requirements for radiation instrumentation for future exploration missions and to investigate measurement techniques and instrument concepts that could meet them. The FDT's work focusses on the main destinations (Earth orbit, Moon, and Mars) covered by ESA's Directorate of Human and Robotic Exploration (HRE).

Within HRE, Exploration Science covers two categories of scientific questioning: exploration-focussed science, needed to enable the exploration programme, and exploration-enabled science, exploiting the programme's missions to answer scientific questions. The FDT's requirements cover radiobiological protection, spacecraft design and operations, resource prospecting, heliophysics, and fundamental physics, with space weather being a prominent aspect linking these fields.

The team derived a catalogue of instruments and required resources (e.g., volume, mass, power, and data volume), summarising the physical and logical principles utilised by the catalogued instruments. The requirements were assigned priorities and candidate instruments to inform resource allocation for future exploration missions.

The FDT identified concepts, detector elements, and instruments warranting further development to meet the requirements primarily in support of exploration-focussed science but optionally covering exploration-enabled science. This is intended to inform the scope of future ESA technology development contracts in this domain.

This presentation discusses the work of the FDT and the rationale for each of the judgments made. It presents a vision of what a network of radiation observatories supporting exploration missions and helping to safeguard future generations of ESA astronauts and robotic explorers might look like. The final report of the FDT, which is summarised in this presentation, will be made available for community feedback.

Asymmetry in SPACEDOS Measurements During SAA Transits

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We report on an asymmetry observed in data measured by the SPACEDOS02 detector during transits through the South Atlantic Anomaly (SAA). Significant spatial differences in the measured flux of ionizing radiation are observed both between repeated transits in the same direction and between transits along the southwest-to-northeast and northwest-to-southeast trajectories. Preliminary results indicate that these differences are difficult to explain by detector shielding asymmetry alone. Although the exact cause of the observed discrepancies remains unknown, we wish to highlight this phenomenon so that it may become the subject of broader investigation.

Update on the DLR M-42 instrument family and future missions

Moritz Kasemann, Karel Marsalek, Bartos Przybyla, Daniel Matthiä, Joachim Aeckerlein, Maximilian Radenhäuser, Aleksandra Rutczynska, Markus Rohde, Thomas Berger

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The space radiation environment is the most complex natural radiation environment one can encounter. It not only poses a threat to spacecraft and their electronics, but can also harm humans who venture into deep space. A flight to the Moon or to Mars would first have to pass the Earth's radiation belts (Van Allen Belts) with the inner (proton and electron) and the outer (electron) belt and then in free space the relevant spacecraft (and possible humans inside) is exposed to the galactic cosmic radiation (GCR) environment. Measuring the radiation load in space provides valuable data to protect astronauts. The data can further be applied to benchmark radiation transport codes and used to design new shielding materials.

Within the last decade the Biophysics working group of the Radiation Biology Department has developed, built, tested and flown a set of active radiation detector systems in various missions. These consist of the *M-42* detector family (M-42 compact, M-42 split, M-42 display, M-42 EXT, M-42 BIG, M-42 PSD) - successfully applied on several airplane flights, NASA balloon flights over Antarctica, MAPHEUS (sounding rocket) flights, within the RadMap experiment on-board the International Space Station (ISS), the NASA Artemis I and II mission and the Astrobotic Peregrine I flight.

To better characterize the complex space radiation environment, the M-42 detector family undergoes continuous development and refinement. This iterative effort has led to three new detector configurations:

- **M-42 BIG:** Features a significantly increased dynamic energy range while providing higher count rate capabilities.
- **M-42 Pocket:** Integrates the flight-proven analog signal-processing architecture of the M-42 EXT (deployed on Artemis II) alongside an integrated display within a compact, portable form factor.
- **M-42 CUBE:** Employs Position Sensitive Diodes (PSDs) arranged in a telescope configuration, enabling precise determinations of incident angle and Linear Energy Transfer (LET).

This talk provides an overview of the M-42 detector family and presents an in-depth look at its newest configurations.

Multi-Point Observations of the 9 October 2024 CME-Driven Shock: Implications for Solar Energetic Particle Forecasting at Mars

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On 9 October 2024, a major Solar Energetic Particle (SEP) event was detected simultaneously across a wide range of heliolongitudes and heliocentric distances. Signatures were observed by Solar Orbiter, Parker Solar Probe (PSP), STEREO-A, near-Earth spacecraft (SOHO, GOES, ACE), and surface instruments on Mars (MSL/RAD). The event originated from an X1.8 solar flare in Active Region (AR) 3848, which produced a fast, Earth-directed full-halo coronal mass ejection (CME). This study aims to characterize the acceleration and heliospheric distribution of SEPs during this event and to evaluate its implications for space weather forecasting and radiation risks for future human exploration of Mars. We investigated SEP events observed during the cruise phase to Mars and on the Martian surface by the Radiation Assessment Detector (RAD). We also used the Realtime Electron Alert System for Exploration (ReLEASE), originally developed to forecast SEP arrivals at Earth, as the basis for a Mars forecasting approach. For each event, we compared the magnetic footpoints of Earth and Mars to assess whether Mars was magnetically connected to the same solar source region as Earth. If a favorable magnetic connection existed, an SEP event forecasted by ReLEASE at Earth was considered likely to impact Mars as well. To evaluate this approach, we combined remote-sensing observations of flares and CMEs with in situ particle measurements from multiple spacecraft located at different heliolongitudes and heliocentric distances. Analyses of SEP onset times, fluxes, and energy spectra enabled us to investigate particle acceleration and transport processes and to assess the reliability of extending Earth-based SEP forecasts to the Martian environment. During the cruise phase of the Mars Science Laboratory (MSL) mission to Mars, the spacecraft followed a Hohmann transfer orbit, an elliptical path that requires the lowest amount of fuel from Earth to Mars (1–1.52 AU), producing distinct Parker spiral magnetic footpoints for Earth, the spacecraft, and Mars. For 70 days after departure, it remained well connected to the near-Earth heliosphere, enabling SEP observations at Earth to correspond closely with in situ measurements, after which connectivity gradually shifted toward Mars. As expected during the cruise phase to Mars, the 5 SEP events detected by RAD showed favorable magnetic connectivity between Earth and Mars. However, among the more than 15 SEP events observed by RAD on Mars over 13 years, only one showed favorable magnetic connectivity among Earth, Mars, and STEREO-A. This SEP event was associated with an X1.8 flare (01:25–02:43 UTC) and a full-halo CME (02:12 UTC; 1,500–2,100 km/s) that reached Earth on 10 October at 14:45 UTC, producing S2-level proton enhancements and widespread SEP detections at Earth and Mars.

Constraints on Relativistic Runaway Electron Avalanches on Mars from Long-Term in situ Electron Measurements during Dust events

Jan Leo Loewe, University of Kiel

Chide et al. (2025) provided the first in situ evidence that Martian dust activity can generate electric fields approaching the atmospheric breakdown threshold (~20 kV/m) through triboelectric charging. The spatial scale of such fields, however, remains unknown. Models suggest that large-scale coherent electric fields may develop over the full vertical extent of dust devils, reaching heights of 5–10 km. These fields could accelerate ambient atmospheric electrons to “runaway” energies of several tens of MeV, potentially triggering relativistic runaway electron avalanches (RREAs) that propagate toward the Martian surface.

Here, we present a joint analysis of observations from the Mars Science Laboratory (MSL) instruments Radiation Assessment Detector (RAD), Navigation Camera (Navcam), and Rover Environmental Monitoring Station (REMS), aimed at identifying potential RREA signatures associated with Martian dust devils. We further provide model estimates of the expected RREA fluxes and associated dose rates.

Over seven years and six months of observations since July 2018, including more than 287 dust devil passages over the “Curiosity” rover, no evidence for RREA signatures was found. These results suggest that RREAs in the thin Martian atmosphere either do not occur or are extremely rare. The limiting factor is not expected to be the electric field strength within dust devils themselves, but rather their vertical spatial extent, homogeneity, and/or temporal persistence. Although our calculations predict very large electron fluxes in the case of RREA occurrence on Mars, the resulting radiation exposure is unlikely to pose a significant hazard to instruments or astronauts.

Analysis of Flux Profiles in the SAA with the RadMap Telescope

Martin Losekamm, ESA

Unlike many other radiation monitors, the tracking calorimeter at the heart of the RadMap Telescope can reconstruct particle trajectories with nearly omnidirectional sensitivity – i.e., across almost the entire solid angle – with a resolution of 2° ~ 5°. We present an update on the ongoing analysis of data from the International Space Station recorded inside the South Atlantic Anomaly that shows how this capability can be used to reconstruct flux profiles of protons in the radiation belts. We also discuss how we used simulation and beam-test data to validate track reconstruction and to determine response functions and uncertainty matrixes.

Bringing Space to Earth: Design, Optimization and Biological Modeling of the GCR simulator at GSI-FAIR

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Space Radiation remains one of the major show stoppers for the human exploration of the Solar System. Accurate characterization of both biological and non-biological risks from radiation exposure is therefore essential. While ground-based experiments provide valuable insights, reproducing the full complexity of the space radiation environment on Earth remains a significant challenge. Traditional accelerator-based studies typically rely on sequential, mono-energetic, single-ion irradiations, which fail to capture the effects of simultaneous spatially and temporally correlated mixed radiation fields encountered in space.
To overcome these limitations, we completed the development and commissioning of the GCR simulator and successfully validated it at GSI (Darmstadt, Germany) in May 2025.
The GSI GCR simulator employs a hybrid active-passive approach: the energy of a primary ^{56}Fe beam is actively varied from 1 GeV/u down to 0.35 GeV/u and combined with passive custom-designed complex and slab modulators. Six optimized hardware configurations reproduce distinct regions of the GCR kinetic energy spectra. By properly weighting these configurations, the system can replicate GCR-like spectra that closely mimic both kinetic energy and LET (Linear Energy Transfer) distributions at 1 astronomical unit (AU) under solar minimum conditions,behind 10 g/cm^2 aluminium shielding, representative of a lightly shielded space habitat. Changes in heliospheric conditions can be simulated entirely through software, while shielding effects can be investigated by physically adding materials of varying composition and thickness along thebeamline.
In this presentation, we will discuss the design, optimization, and future challenges of the GCR simulator at GSI. In addition to the physical characterization of the simulated GCR field, its biological effectiveness is evaluated using the Local EFect Model (LEM IV), which provides monoenergetic RBE estimates from photon linear-quadratic (LQ) parameters (α, β). These estimates are combined using an extended version of MiRaCal, a toolkit developed at GSI, which now accounts for the temporal structure of the irradiation and the time required to complete a full GCR simulation. This combined approach links the physical characteristics of the simulated field to its expected biological response, providing an essential complement to the spectral validation of the simulator.
Finally, we will also present the next-generation simulator at the upcoming FAIR facility, where the setup will be upgraded through a new design and optimization procedure to energies up to 10 GeV/u, a world first in heavy-ion irradiation and in reproducing the full GCR kinetic energy spectrum relevant to both biological and non-biological experiments.
Established through a collaboration between GSI and the European Space Agency (ESA), the GCR simulator is now operational as the only facility of its kind in Europe. The next-generation GCR simulator at FAIR will overcome current energy limitations introducing new experimental capabilities and defining a new frontier in space radiation research.
As humanity prepares to return to the Moon and venture further into deep space, this infrastructure represents a critical advancement in our ability to assess and mitigate radiation risks, ultimately enabling safer and more sustainable human exploration of the Solar System.

Beyond dosimetry in the ISS, a new analysis approach for the LIDAL telescope

Luca Lunati, Virginia Boretti, Luca Di Fino, Giuseppina Nigro, Giorgio Baiocco, Alice Mentana, andLivio Narici

The characterization of the radiation environment inside crewed space habitats is a key requirement of current international roadmaps for human exploration beyond Low Earth Orbit (LEO). The renewed commitment of space agencies and private stakeholders to sustained lunar presence and future missions to Mars places increasing emphasis on the reliable assessment of astronaut radiation exposure risk. In this context, the International Space Station (ISS), operating in LEO, represents a unique laboratory for investigations of the complex radiation environment under realistic and heterogeneous shielding conditions.

The Light Ion Detector for ALtea (LIDAL), deployed onboard the ISS Columbus module since January 2020, is specifically designed to perform particle-by-particle radiation measurements relevant to human spaceflight risk assessment.

LIDAL is a 46 cm long active-particletelescope composed of 18 silicon strip detector planes, providing accurate measurements of energy deposition, coupled with segmented plastic scintillators that deliver Time of Flight (ToF)information with a resolution better than 100 ps. This unique configuration enables the simultaneous determination of particle charge, kinetic energy, and dosimetric quantities for eachdetected ion, a capability currently unmatched among radiation detectors operating inside spacehabitats. To fully exploit the combined energy deposition and ToF information, a dedicated analysis algorithm, HyperIon, has been developed. This approach allows event-by-event nuclear identification and reconstruction of the kinetic energy of particles impinging on the detector.

In this presentation, LIDAL single-particle data collected between 2020 and 2026 are used to derive Linear Energy Transfer (LET) and absorbed dose spectra. Furthermore, the simultaneous determination of particle charge and velocity allows the direct application of NASA radiation quality factors, providing for the first time an experimental evaluation of the dose equivalent based on particle-resolved measurements inside a crewed space habitat. Owing to its telescope geometry and directional sensitivity, the detector also enables the investigation of local shielding effects through measurements performed at different orientations along the three principal ISS axes. Overall, the presented results highlight the importance of advanced particle-by-particle measurements in improving the characterization of the radiation environment inside spacehabitats and provide valuable input for radiation risk assessment in support of future human spaceflight.

HardPix: A Modular Timepix3-Based Radiation Monitor for Advanced Radiation Environment Characterization

Milan Malich, Institute of Experimental and Applied Physics
Czech Technical University in Prague

Accurate characterization of ionizing radiation environments requires compact, reliable, and energy-efficient instrumentation capable of long-term operation under demanding conditions. HardPix is a modular, low-power radiation monitor based on one or two Timepix3 pixel detectors, designed to provide detailed measurements of particle radiation while meeting strict resource constraints. The instrument employs a robust architecture based predominantly on commercial off-the-shelf (COTS) components, combined with radiation-mitigation features including latch-up protection and ECC-protected memory. Its flexible detector configuration allows the integration of particle stopping or conversion layers, enabling mission-specific optimization and enhanced sensitivity to selected particle species.

To address limited telemetry bandwidth, HardPix incorporates on-board data-processing concepts derived from machine-learning-based particle identification and energy-estimation methods, enabling significant data reduction while preserving scientifically relevant information. The platform has undergone extensive environmental qualification, including vibration, shock, thermal-vacuum, and electromagnetic compatibility testing, supported by an in-house rapid-development verification framework. Hardware performance and operational stability have been successfully demonstrated in representative radiation-monitoring applications and technology-demonstration missions.

The demonstrated reliability, modularity, and adaptability of the HardPix platform make it a promising instrument for future radiation-monitoring studies. Its capability to provide detailed particle measurements with low power consumption and increasing on-board autonomy supports efforts to improve radiation environment characterization and to expand the scientific use of pixel-detector-based dosimetry systems in challenging operational environments.

Keywords: HardPix, Timepix3, radiation monitoring, dosimetry, radiation environment, onboard processing, COTS, particle detection

Albedo Neutron Monitoring in Polar Low Earth Orbit Using a Compact Dual-Mode Radiation detector on REXIS spacecraft

Michal Marcisovsky, Stellar nuclear s.r.o.

Earth albedo neutrons constitute an important component of the radiation environment in polar low Earth orbit, but their spatial, spectral, and temporal variability remains insufficiently characterised. Improved measurements are needed for spacecraft dosimetry, interpretation of mixed radiation fields, and validation of atmospheric radiation-transport models.

REXIS is a proposed small-satellite mission whose primary objective is the passive inspection of legacy nuclear-powered spacecraft and ejected reactor cores in long-lived Earth orbits. Its radiation payload includes a compact dual-mode detector consisting of a neutron- and gamma-sensitive scintillator located at the centre of a moderating Bonner sphere. This “scintillator-in-sphere” configuration is intended to detect neutron emission associated with radioisotope power sources and gamma-ray signatures of reactor fission products, particularly the 661.7 keV line associated with Cs-137 decay.

During cruise and target-approach phases, the same instrument can perform systematic measurements of the ambient albedo neutron and gamma-ray fields along a high-inclination or polar orbit. The resulting dataset would support validation of atmospheric-albedo models, interpretation of stand-off measurements near nuclear-powered targets, and spacecraft dosimetry in polar low Earth orbit.

Small Instrument, High Energies: The Design and Simulation of the GalacticRay high-Energy TELescope, GRETEL

Mathis Mewes, Stephan I. Böttcher, Robert F. Wimmer-Schweingruber

The measurement of high-Z particles in low Earth orbit is a crucial part of space weather and space safety. With the Galactic Ray high-Energy Telescope (GRETEL), we present a new particle instrumentfor the detection of relativistic protons and heavy ions. GRETEL is designed to comply with the tight constraints imposed by CubeSat missions. The detectorst hemselves are very similar to the High Energy Telescope (HET) on board Solar Orbiter, namely a bismuth germanium oxide scintillator accompanied by two stacks of double-layer silicon detectors. Great changes have been made to the front-end electronics in both hard- and software. GRETEL uses a new design with a smaller form factor, a more efficient electronics layout, and redesigned readout logic, saving space and reducing power consumption and costs. In a low polar orbit, Earths magnetic field can be used as a giant magnetic spectrometer, making use of the fact that the spacecraft probes have different geomagnetic cutoff rigidities along its trajectory, enabling the measurement of ionic charge states. We plan to fly GRETEL on the CubeSat mission HANS (Hamburg Autonomous Northern lights Survey), developed by the Orbital Research team of the Hamburg University of Technology (TUHH).

Comparative study on space radiation dosimetry in the International Space Station and Artemis-1 Orion with two different quality factors

Masayuki Naito, National Institutes for Quantum Science and Technology (QST)

Space radiation dosimetry is a critical issue for future crewed exploration of Moon, Mars and deep space as crews will be exposed to higher radiation doses during prolonged spaceflight. Current dose assessment methods for space radiation, such as galactic cosmic rays (GCRs) and solar energetic particles, rely on the quality factor recommended by the ICRP, Q_{ICRP}. This quality factor depends solely on linear energy transfer (LET), enabling straightforward application to LET measurements using nuclear track detectors such as CR-39. Meanwhile, alternative quality factors, such as Q_{NASA}, which incorporate both LET and particle charge, have been developed to account for particle track structure effects. Although Q_{NASA} provides more detailed risk estimates, its application to the practical measurements has been challenging. To address this limitation, we previously proposed an approach to apply Q_{NASA} to CR-39 LET measurement, termed Q*, which incorporates charge weighting contributions from GCR particles in each LET region.

A potential issue with the Q* approach is the variations in charged particle composition due to environmental factors such as geomagnetic fields, solar modulation, and shielding by spacecraft structures. In the present study, the Q* approach was validated through comparison with Q_{ICRP} using optical stimulated luminescence dosimeter and CR-39 measurements from two space missions conducted in the ISS Columbus module and aboard the Artemis-I Orion spacecraft, both under similar solar activity conditions. The comparison showed that the differences in proton contributions resulted in negligible differences in dose equivalents between Q_{ICRP} and Q*, attributing to the similar quality factor weighting for proton in both approaches.

SpacePix-3: A Radiation-Hardened Pixel Detector for Orbital Dosimetry

Radek Novotny, Czech Technical University

SpacePix-3 is the latest generation of the SpacePix silicon-on-insulator monolithic active pixel sensor family developed for compact space-radiation monitoring. It features a 64 × 64 active pixel matrix with column-parallel digitization. It builds on SpacePix-2 by introducing backside-pulse digitization, corrections of previously identified bugs, and improvements in readout, control, and operational reliability. Radiation-hardening measures are incorporated into the ASIC architecture to improve tolerance to single-event effects during long-term operation in orbit.

The ASIC records deposited energy together with two-dimensional ionization patterns. This enables identification and characterization of electrons, protons and heavier ions in mixed orbital radiation fields, and supports measurements of particle flux, energy-deposition spectra, event morphology, and linear-energy-transfer distributions.

The SpacePix family has acquired flight heritage through the SpacePix-2-based SpacePix Radiation Monitor (SXRM) flown aboard the VZLUSAT-2 spacecraft. This contribution presents the SpacePix-3 design improvements and initial characterization, together with orbital measurements obtained by SXRM and preceding detection chip generation. The results demonstrate the applicability of monolithic pixel detectors to low-mass, low-power active dosimetry and space-environment monitoring.

Long-Term In-Flight Validation of a Compact Radiation Monitor Inside the ISS Columbus Module

Marcin Patecki, SigmaLabs sp. z o.o.

Continuous radiation monitoring inside crewed spacecraft is essential for characterizing the environment in which astronauts live and work and for complementing established dosimetry systems. The Scalable Radiation Monitor (SRM), developed by SigmaLabs around CERN's SpaceRadMon-NG sensing subsystem, was installed inside the Columbus module of theInternational Space Station in July 2025 as part of the RadMon-on-ISS experiment during the GNIS/Axiom Mission 4. SRM combines a floating-gate dosimeter for total ionizing dose (TID) with two SRAM-based channels sensitive to radiation-induced single-event upsets, together with temperature and voltage monitoring.We present in-flight results acquired during long-term operation onboard the ISS. The instrument operated continuously and stably, with no instrument-level malfunction affecting the analysed dataset. Both TID channels showed consistent monotonic dose accumulation. For the period with concurrent measurements, SRM reproduced the dose evolution recorded by the DOSTEL instrument with very good agreement. The observed dose was also consistent with radiation-environment model predictions for shielding conditions representative of the ISS interior. Both SRAM detectors registered persistent single-event activity, including the expected geographical enhancement associated with the South Atlantic Anomaly. Differences between the two channels were consistent with the distinct response characteristics of the memory technologies.

The results demonstrate reliable long-term operation of a compact, low-resource radiation monitorin a crewed orbital habitat. SRM provides environmental and electronics-response observables that can complement established ISS dosimetry and support radiation awareness on future crewed spacecraft.

ANALYSIS OF THE RADIATION ENVIRONMENT IN LUNAR ORBIT FOR THE RADTELAND TRITEL TELESCOPES

Patrik Pinczes, HUN-REN Centre for Energy Research, Space Research Department

The TriTel and RADTEL charged particle detectors developed by HUN-REN Centre for Energy Research are going to fly in space in the near future. The locations and missions are: 6500km above Earth’s poles with the Aurora-D and highly eccentric lunar orbit 100-1000 km above the surface. TriTel is athree-axis radiation dosimeter measuring linear energy transfer (LET) spectra to derive absorbed doseand dose equivalent, while RADTEL is used for particle type and spectral characterization.The instruments measure ionizing radiation with energy ranges for protons between 3 – few hundreds of MeV, and electrons between 300 keV – 6 MeV. As technology demonstration for the upcoming missions, RADTEL was on Low-Earth Orbit between 2022-2024 onboard the RADCUBE-RADTEL 3U Cubesat, and successfully measured cosmic radiation, including 2 Solar Proton Event (SPE) sequences. TriTel was successfully measuring on the ISS from 2013. Their data will allow us to improve fore-andnowcasting of ionizing radiation during SPE events caused by coronal mass ejections and solar flares. The current modelling of SPE is confined to specific sections of the Solar System due to complex electromagnetic field structures and differing SPE origins. The Lunar environment, which iscurrently specified in European Space Agency (ESA) documents, like the European Cooperation for Space Standardization (ECSS) as interplanetary environment. There is no consideration for albedo or scattered particles, local magnetic anomalies or the cover of the Moon’s shadow. The Earth’s magnetotail also has special effect on Lunar environment.This work focuses on the expected radiation environment for Lunar orbits with consideration of the above effects and how current cosmicradiation models like CREME96, ESP and others could be applied to said environment.

Overview of the CZPAD Experiment

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CZPAD is a personal radiation dosimetry experiment developed for the planned Czech astronaut mission to the ISS in 2027. It includes the wearable SPACEDOS04 active dosimeter, with particular emphasis on neutron detection. We present the experiment concept and selected results from detector development, comparisons, and testing, including recent measurements in the well-characterised neutron field of the LR-0 research reactor.

The presented results were obtained using the CICRR infrastructure, which is financially supported by the Ministry of Education, Youth and Sports – project LM202304

Over 2800 days in space – the RAMIS radiation detector on the DLR Eu:CROPIS mission

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RAMIS (size: 140x140x35mm^3, mass: 608 gram, power consumption 1.8 Watt) is a radiation detector developed for the DLR Eu:CROPIS satellite mission. *RAMIS* uses an arrangement of two silicon detectors in telescope geometry and maps the radiation environment in the course of the mission. For this *RAMIS* stores count- and dose rate data with a 1-minute and energy deposition spectra with a 5-minute cadence. Eu:CROPIS was launched on December 03rd 2018 into a polar orbit circling around Earth at an average altitude of ~600 km. *RAMIS* is located on the outside of the satellite and was activated on December 05th 2018 and has continuously provided data during the course of the mission. Due to the polar orbit of the satellite *RAMIS* measures a) the variation of galactic cosmic radiation (GCR) in dependence on the orbit, b) the contributions of protons in the inner Earth radiation (Van Allen), c) variations of the trapped electron intensity during crossings of the outer radiation belt and finally (d) the changes in the radiation environment due to the changes in the solar cycle as seen in a high number of detected Solar Particle Events (SPE).

Using a machine learning algorithm, the complex radiation environment could be classified into GCR, radiation belts and SPEs. Using these data, the long-term changes of the low Earth orbit (LEO) radiation environment in the course of the solar cycle will be presented, and we will also show comparisons to the data from NASA's Cosmic Ray Telescope for the Effects of Radiation (CRaTER), ESA's Standard Radiation Environment Monitor (SREM) on Proba-I and the LEO-DOS instrument on the NextSat-2 satellite.

LONG-DURATION RADIATION BIOLOGY STUDIES IN SPACE AND IN SIMULATED MICROGRAVITY: From ISS to Moon and Mars

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Long-duration human space exploration requires a comprehensive understanding of the combined effects of chronic space radiation and altered gravity on biological systems. A landmark collaborative study conducted aboard the International Space Station by the Japan Aerospace Exploration Agency (JAXA) and the National Aeronautics and Space Administration (NASA) investigated the effects of prolonged space environmental exposure on embryonic stem (ES) cells. Frozen ES cells were launched in March 2013 and stored in the Minus Eighty-Degree Laboratory Freezer for ISS within the Kibo module. Samples were returned to Earth after 443, 711, 1167, and 1584 days of exposure. Radiation dose accumulation was quantified using the Passive Dosimeter for Life-science Experiments in Space – PADLES (CR-39 and thermoluminescent detectors). Following return, cells were thawed, cultured, and subjected to comprehensive transcriptomic analyses to evaluate early molecular responses to chronic space radiation under microgravity conditions.

Monte Carlo Simulations for the CZPAD Personal Dosimetry Experiment

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Monte Carlo simulations play a role in the development of the CZPAD detector, guiding both hardware design optimization and experimental data interpretation. In this work, we present calculations for optimizing conversion layer thickness, evaluating shielding efficiency, and benchmarking simulations against experimental results obtained at the CERF-EU facility and the LR-0 research reactor. Furthermore, we discuss predictive calculations for an onboard International Space Station (ISS) mission, focusing on the orbital radiation environment and the expected detector response. All transport simulations were performed using the PHITS code system, incorporating an integrated cosmic ray source with a DLR-based Low Earth Orbit (LEO) radiation model and AP-8 trapped proton spectra.

Development of the Canadian Active Neutron Spectrometer (CANS)

Martin B. Smith[1] for the CANS collaboration

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The Canadian Active Neutron Spectrometer (CANS) is being developed to monitor neutron radiation on the International Space Station (ISS). The CANS will collect scientific data that will be used for refining radiation risk assessment models, for validating radiation transport codes, and for studying the effects of space radiation on shielding materials, electronics, and biological systems. The instrument will measure neutrons in the energy range 0.5 MeV to 100 MeV and will discriminate neutron signals from those produced by charged particles, gamma rays, and X-rays.

During Phase B of the project, a Demonstration Model (DM) of the CANS has been designed and fabricated. In Phase C, a high-fidelity Engineering Model (EM) will be produced. The DM and EM will undergo performance characterization using high-energy neutrons, protons, and mixed fields produced at international accelerator facilities. In this presentation, the status of the CANS instrument and early results from the DM characterization will be reported.

This project is undertaken with the financial support of the Canadian Space Agency

Proxima: a collaboratve platorm for operatonal European space weather data products

Jaroslav Sochan, Global Singularity s.r.o.

Turning scientfc space weather models into operatonal, reusable, and interoperable data products is stll a major challenge for the European space weather community. Proxima is a platform built to solve this problem. It offers a shared environment where scientsts, model developers, and end users work with the same set of tools: data pipelines, AI/ML model hosting, interactive dashboards, and federated web pages that can be embedded directly into the ESA SWESNET portal.

In the first stage, Proxima will host three Slovak data products that will be added to ESA SWESNET. ASPIS provides ionospheric scintillation nowcasts and 1-hourforecasts. SCSS-Net is a deep-learning model that detects solar active regions and coronal holes in solar images. ESADOS is a long-term archive of the heliocentric modulaton potental, used for cosmic-ray and aircrew dosimetry studies. All three products run on the same platorm components, which shows how very diferent scientfic outputs can be delivered through one common framework without losing their scientfic value.

Proxima is built through a collaboraton model that is becoming more important for ESA. Global Singularity provides the technical platorm, the Slovak Academy of Sciences ensures the scientfic quality of the data processing, and the Technical University of Košice develops the AI/ML models. The work is supported by the ESA ITT Space Weather Sofware Toolkit.

In this contributon we present the plattorm, the integraton of the first three products, and our plan to open Proxima to data providers across Europe, making it easier to add new contributons to SWESNET.