Novel radiation monitor set to offer 'vital' protection to spacecraft

A new radiation monitor is set to provide "urgently needed" warnings to protect spacecraft from one of the most significant hazards in space.

The Umbrella Radiation Monitor (URM), a novel instrument being developed by Umbrella Space Science Ltd (USSL), measures near-Earth space radiation environment in real time.

Plugging a gap in space weather data, URM will help to protect missions and spacecraft systems, which are at risk of malfunctioning if they are exposed to high levels of radiation.

Providing unprecedented orbit coverage, URM will deliver much-needed data for improving space weather forecasts and provide prompt data to warn spacecraft operators of extreme space weather events and changes to the status of radiation belts.

The dangers of the complex space environment

The space radiation environment is dynamic, complex and challenging, consisting of a variety of radiation types from high energy particles arriving from galactic sources outside the solar system, to sporadic particles emitted from the Sun. The Earth's magnetic field both protects the Earth from this radiation, and traps charged particles, providing regions of high intensity radiation.

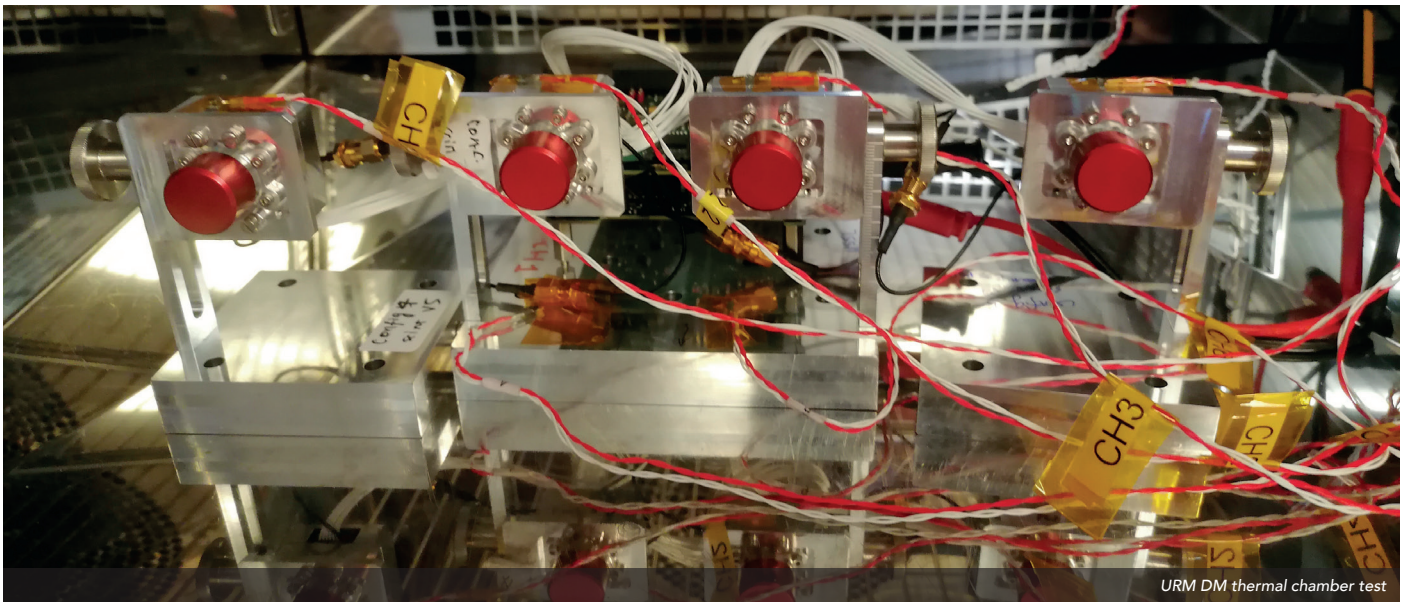
Unlike on Earth, where the magnetic field and atmosphere provides a strong natural shielding from radiation, spacecraft operate in an environment with minimal inherent protection. Depending on where you are in space, the Earth's magnetic field provides some protection, but mostly, satellites are directly exposed to space radiation.

These high energy particles pose a significant danger to satellites and their electronic components. Even relatively low levels of radiation can gradually degrade components, shortening a satellite's operational life. In more extreme cases, sustained exposure or a sudden spike in radiation can cause onboard instruments or systems to fail entirely.

Satellites are extremely vulnerable to space conditions and one of the biggest challenges in developing and testing instruments is the difference in how the electronics fare on the ground compared to how well they operate in space.

As part of the UK's National Space Strategy, the Space Domain Awareness programme was established to track, detect, and identify objects and activities in space. Its scope includes understanding and mitigating the hazards of space weather on space-based assets.

Space weather isn't just a threat to satellites; it can also affect life on Earth. High-energy radiation and geomagnetic storms can disrupt communications, GPS signals and electrical power grids as they interact with Earth's upper atmosphere and induce currents in transmission lines which overload transformers. Access to accurate, up-to-date space weather data is essential for protecting critical infrastructure, ensuring aviation safety, and safeguarding the satellite operations that modern society relies on.



URM DM thermal chamber test

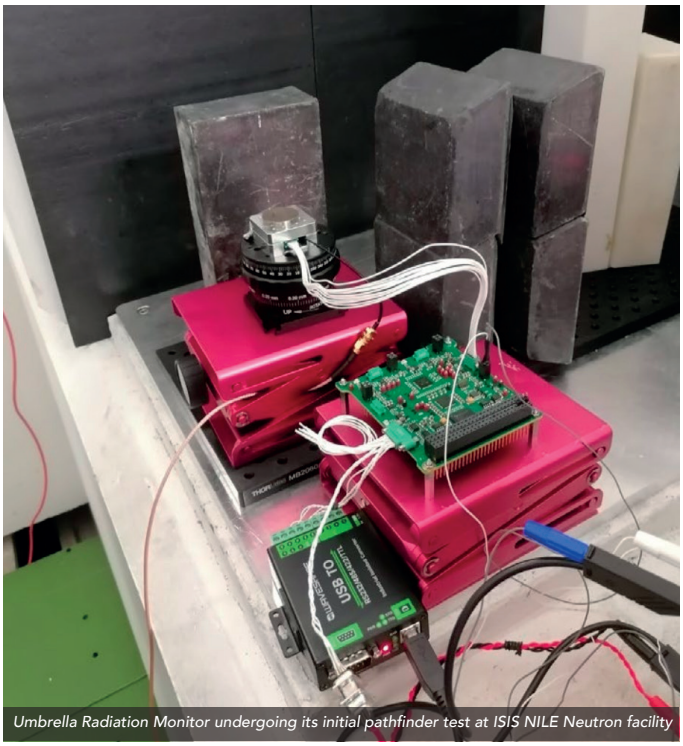
Enter URM

The URM system comprises up to four detector modules. Designed to be low cost, low mass and easily manufacturable – a strategy in line with the New Space approach – the team applied its experience and knowledge of design criteria and processes for ESA missions, to ensure the design and delivery of a highly reliable instrument.

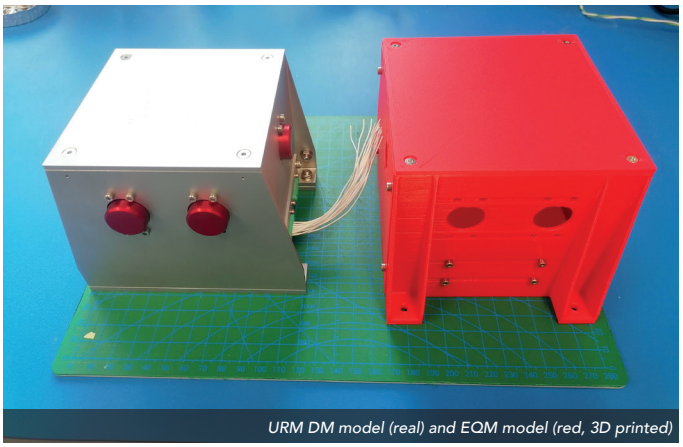
Providing in-situ radiation measurements, URM has three main objectives:

1. The provision of real time data warns spacecraft operators when they are about to enter a radiation belt – an intensive area of radiation – allowing all unnecessary functions to be shut down to avoid risk of damage.
2. Space weather warnings – space weather is caused by the Sun but takes some time to arrive and impact Earth. However, certain elements of space weather cause radiation levels to rise. The URM can detect these rises, providing crucial data to satellite mission or electrical grid operators so that operation plans can be altered accordingly, or precautions can be taken.
3. Accumulated radiation monitoring data – this indicates how much total ionised dose (TID) a spacecraft has experienced. Following the same principle as a car's mileage gauge, this data provides spacecraft operators with an indication of a satellite's life span, helping to inform decision-making around when to retire a satellite or when to take measures to expand its life.

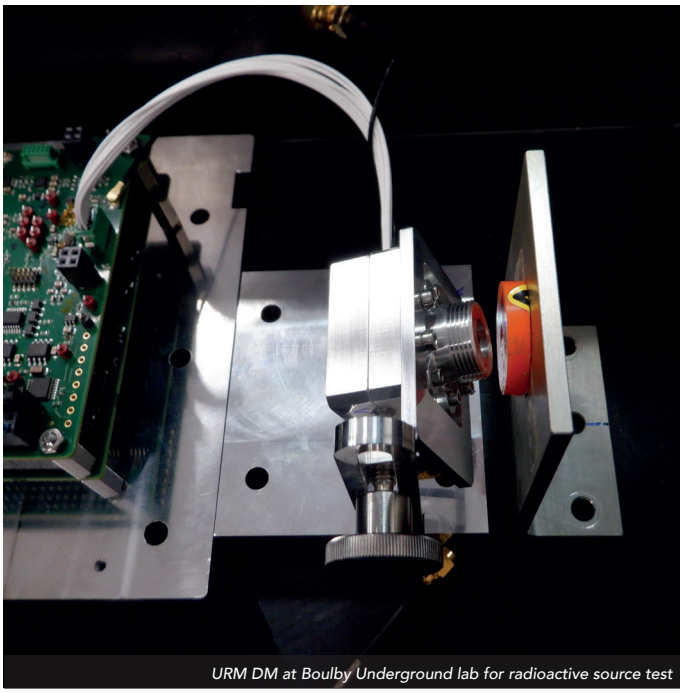
Outside of the space industry, URM has the potential to be utilised by those working in nuclear science or other fields where there is a risk of exposure to radiation. It can provide an instant warning if radiation rises to dangerous levels, along with longer term monitoring of dose exposure.



Umbrella Radiation Monitor undergoing its initial pathfinder test at ISIS NILE Neutron facility



URM DM model (real) and EQM model (red, 3D printed)



URM DM at Boulby Underground lab for radioactive source test

Current status of the project

The Centre of Earth Observation Instrumentation (CEOI) provided funding for the development of a Demonstration Model system and its field testing with multiple sources (radioisotope and a MC40 cyclotron proton source) to demonstrate sensors, system and firmware performance. From there, the team moved to developing an Engineering Qualification Model, subjecting the instrument to a range of rigorous environmental tests including shock and vibration testing and electromagnetic compatibility testing. The aim is to complete this phase of the project in the first three months of 2026.

Next steps

The final phase of the project will be the development of a Flight Model and achieving technology readiness level 8, when URM is fully verified, approved and ready to launch.

The team from USSL has been accepted to the OHB-LuxSpace's In Orbit Demonstration Initiative. Under this initiative, the Luxembourg Space Agency has mandated OHB LuxSpace to establish a Public-Private Partnership, enabling European entities to In-Orbit Demonstrate (IOD) their cutting-edge spaceborne technologies.

The targeted launch date for this initiative is the first half of 2027 and if the USSL is successful, it will allow for commercial applications of the technology.

In the words of Dr Hubert Hu

Founder of Umbrella Space Science Ltd

"URM is very well aligned with current space development. The space industry now is dominated by New Space, which is changing our lives. The constellations for different purposes – such as Earth imaging, communication and remote sensing – are rapidly expanding and there is more and more activity, but all these developments face a common problem – space weather.

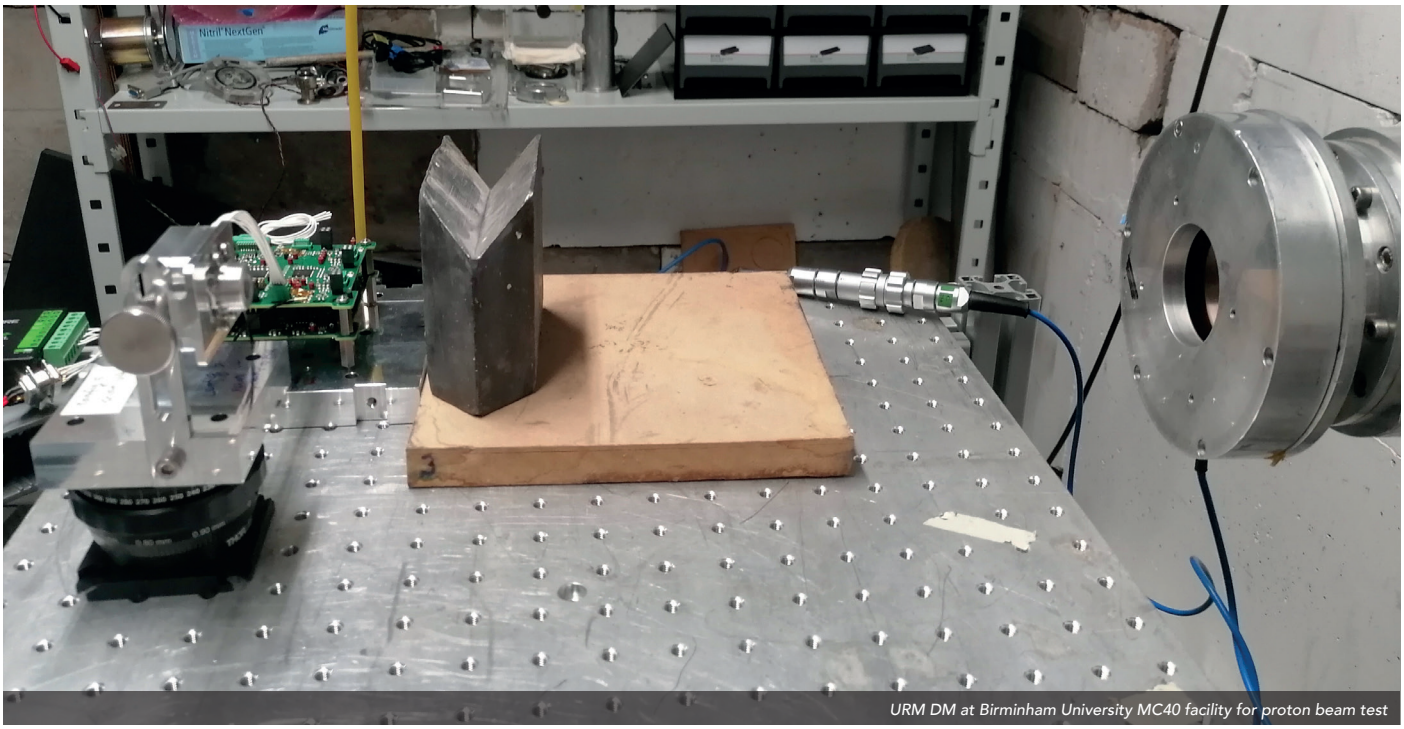
In the same way that we check the weather before making plans, in the future it will be the norm to check the space weather forecast for mission operations and planning. The goal is to minimise the risk arising from extreme space weather.

Our company's ambition is not limited to providing a single instrument. URM is our first product, but we plan to expand our offer to provide more coverage for space environment monitoring.

The space environment is complex – there are different species of particles and different energy ranges. Low, medium and high energy ranges all require different types of instruments, so we are aiming to move into low energy and also expand into monitoring the magnetic field strength, because they are all interlinked.

We need full spectrum data to help scientists build and improve space weather forecasting models. The combination of observations and forecasts provide the best way to make accurate predictions.

This is a young market, but it has a big future and we can see its potential."



URM DM at Birminham University MC40 facility for proton beam test

At a glance

- In-situ radiation measurements for: Spacecraft operators, space weather warnings and accumulated radiation monitoring data
- Comprises: Up to four detector modules, a controller board and a power board
- Total project cost: **£400,000**
- Funding from CEOI: **£300,000**

URM DM at Manchester Space Conference at ESA BIC booth