RadWorks Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

ABSTRACT

The RadWorks project's overarching objective is the maturation and demonstration of affordable, enabling solutions to the radiation-related challenges presented to human exploration beyond Earth orbit.

ANTICIPATED BENEFITS

To NASA funded missions:

The technologies can protect crew health through compact, low mass, low power radiation monitoring/alert and mitigation using strategic arrangement of vehicle assets.

To NASA unfunded & planned missions:

The technologies can protect crew health through compact, low mass, low power radiation monitoring/alert and mitigation using strategic arrangement of vehicle assets.

To other government agencies:

Other government agences that work in radiation environments (e.g, Department of Energy, Department of Defense) may benefit through technologies that may help to protect humans.

To the commercial space industry:

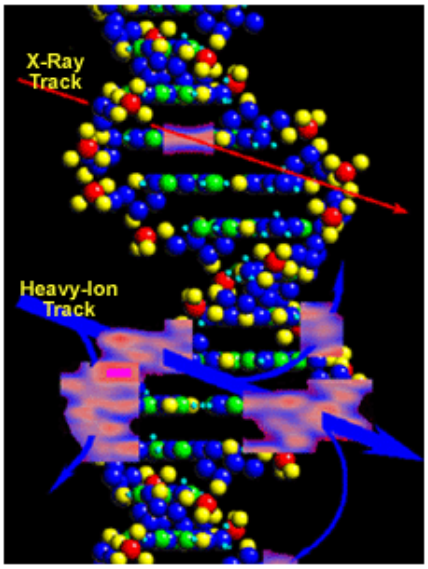
Industry and other agencies can use the technologies to support any missions involving protection of humans in radiation environments.

To the nation:

The project and help to enable human long-term space exploration. The technologies may also be used to protect humans in radiation environments (e.g., nuclear industry).

DETAILED DESCRIPTION

Since its inception if FY12, the RadWorks project has had as its overarching objective the maturation and demonstration of



RadWorks Project

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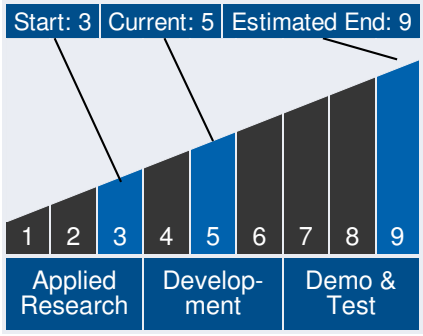
affordable, enabling solutions to the radiation-related challenges presented to human exploration. This has been done through the maturation and demonstration of system-level monitoring and design solutions. Since FY12, the project has continued to develop and deliver affordable, prototype element-integrated monitoring and alert/warning subsystems capable of enabling both ground-supported and autonomous architectural operations. In addition, the project has been doing comparative assessments of data collected utilizing radiation modeling programs, as well as producing advancements of modeling capability to enable protection and operational efficiencies for radiation shielding

For fiscal year (FY) 2016, the RadWorks project is continuing its maturation and prototyping of advanced, miniaturized radiation measurement technologies, along with their demonstrations. The RadWorks project successfully flew the Battery Operated Independent Radiation Detector (BIRD), a simplified, non-integrated version of Radiation Environment Monitor (REM) aboard the Multi-Purpose Crew Vehicle (MPCV) Exploration Flight Test-1 (EFT-1) to validate system operation in a space radiation environment and record charged particle data for post-flight analysis. In addition, there are five REM sensors flying as Detailed Test Objectives (DTO) on the International Space Station (ISS). These sensors are plugged into laptops and are measuring the ionizing radiation environment. Work is continuing to develop the Hybrid Electronic Radiation Assessor (HERA) which is slated to fly first as a Flight Test Objective (FTO) on the MPCV Experimental Module-1 (EM-1) flight, and secondly, as an integrated part of the Caution & Warning System (CWS) on the MPCV Experimental Module-2 (EM-2) flight. The RadWorks project also is developing an Advanced Neutron Spectrometer which will be flown as a DTO on the ISS.

Technology Maturity



Management Team

Program Director:
- Jason Crusan

Program Executive:
- Barry Epstein

Project Manager:
- Catherine Mcleod

Principal Investigator:
- Edward Semones

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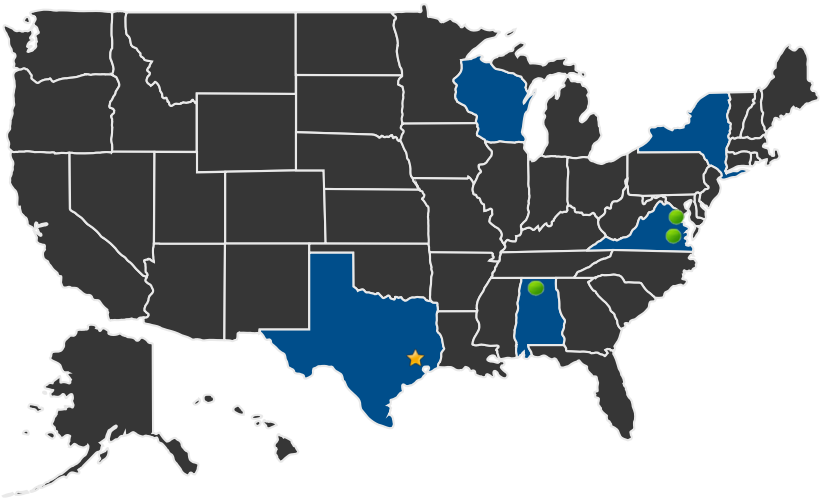
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Johnson Space Center

Supporting Centers:

- Langley Research Center
- Marshall Space Flight Center
- NASA Headquarters

Technology Areas

Primary Technology Area:
Human Exploration Destination Systems (TA 7)
- Cross-Cutting Systems (TA 7.6)
  - Construction and Assembly (TA 7.6.2)
    - Ballistic Fabric Barriers (TA 7.6.2.2)

Secondary Technology Area:
Human Health, Life Support, and Habitation Systems (TA 6)
- Radiation (TA 6.5)

Human Exploration Destination Systems (TA 7)

Continued on following page.

Other Organizations Performing Work:

- Analytic Mechanics Associates
- Brookhaven National Laboratory
- Futron
- Jacobs
- L-3 Communications
- MRI Technologies
- Space Technology Corporation
- University of Alabama - Huntsville
- University of Hawaii (Honolulu, HI)
- University of Houston
- University of Wisconsin
- USRA
- Wyle

LATEST SUCCESS STORY

EFT-1 RadWorks BIRD Success Story

In December 2014, the uncrewed EFT-1 flight took Orion to an altitude of approximately 3,600 miles above the Earth's surface, more than 15 times farther than the International Space Station's orbital position. During this journey, the spacecraft passed through trapped electron regions and encountered intense regions of the trapped proton belts located outside of the earth's atmosphere. Radiation measurements in these regions are key to understanding astronaut radiation exposure in the Orion MPCV during trapped proton belt transit and comparing the trapped proton belt models with measurements.

This flight offered the Advanced Exploration Systems (AES) RadWorks REM team the opportunity to design, build, integrate and fly a radiation detector in a vehicle designed as a precursor for human space flight. The team designed a detector that was low mass, power and volume. It successfully flew and recovered the Battery-operated Independent Radiation Detector (BIRD). The BIRD acquired radiation data throughout the mission. Its subsystems successfully triggered in response to launch

Technology Areas *(cont.)*

Science Instruments, Observatories, and Sensor Systems (TA 8)
- Remote Sensing Instruments and Sensors (TA 8.1)
  - Detectors and Focal Planes (TA 8.1.1)
    - Large Format Visible/Near Infrared Photon Counting Detector Array (TA 8.1.1.6)
  - Electronics (TA 8.1.2)
    - Onboard Radar Data Processing (TA 8.1.2.2)
  - Lasers (TA 8.1.5)
    - 3D Imaging Flash Light Detection and Ranging (LIDAR) (TA 8.1.5.4)
    - Pulsed Laser (TA 8.1.5.7)
    - Pulsed Tunable Near Infrared/Infrared Laser (Gas Detection) (TA 8.1.5.8)
- In-Situ Instruments and Sensors (TA 8.3)
  - Field and Particle Detectors (TA 8.3.1)
    - Energetic Particle Detector (> 30 keV – Several GeV) (TA 8.3.1.1)
    - Fast (Energetic) Neutron Detector (TA 8.3.1.5)

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accelerations, acquired and archived data through landing and completed the planned shutdown routine.

Source: NASA Technical Report: “BIRD Data Report from Exploration Flight Test 1” (DAA 33427)

PROJECT LIBRARY

NASA Technology Use

- EFT-1 RadWorks Bird Technology Infusion
  - (http://techport.nasa.gov:80/file/16819)

Success Stories

- EFT-1 RadWorks BIRD Success Story
  - (http://techport.nasa.gov:80/file/16814)

Technology Areas *(cont.)*

Entry, Descent, and Landing Systems (TA 9)
- Aeroassist and Atmospheric Entry (TA 9.1)
  - Thermal Protection Systems for Rigid Decelerators (TA 9.1.1)
    - Solar and Space Radiation Attenuating Materials (TA 9.1.1.6)

Nanotechnology (TA 10)
- Sensors, Electronics, and Devices (TA 10.4)
  - Sensors and Actuators (TA 10.4.1)
    - High Performance Radiation Sensors (TA 10.4.1.2)
  - Nanoelectronics (TA 10.4.2)
    - Flexible, Stretchable Electronics (TA 10.4.2.1)
    - Nanoelectronics Based Memory Devices (TA 10.4.2.3)

Continued on following page.

Technology Areas *(cont.)*

Materials, Structures, Mechanical Systems and Manufacturing (TA 12)
- Structures (TA 12.2)
  - Lightweight Concepts (TA 12.2.1)
    - Composite and Inflatable Habitat (TA 12.2.1.3)
    - Lander and Surface Habitat (TA 12.2.1.6)
  - Innovative, Multifunctional Concepts (TA 12.2.5)
    - Multifunctional Non-Pressurized Structure (TA 12.2.5.3)
- Manufacturing (TA 12.4)
  - Electronics and Optics Manufacturing Process (TA 12.4.3)
    - Special Electrical Process (TA 12.4.3.3)

DETAILS FOR TECHNOLOGY 1

Technology Title

RadWorks Project

Technology Description

This technology is categorized as a hardware system for other applications

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the project has been doing comparative assessments of data collected utilizing radiation modeling programs, as well as producing advancements of modeling capability to enable protection and operational efficiencies for radiation shielding

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Capabilities Provided

The technology provides radiation monitors, and design guidance to maximize the inherent radiation protection qualities of baseline spacecraft designs.

Potential Applications

The technologies being developed by RadWorks have many potential applications in helping to mitigate the risks associated with radiation exposure to human crews and critical vehicle systems by providing advanced compact, low mass, low power radiation monitoring and alert capabilities and provisions for advancing solar particle events (SPE) radiation storm-shelter capabilities that utilize multi-functional materials and existing launch mass.

Versions of the compact, low mass, low power radiation monitoring detectors are currently flying on ISS and a simplified, non-integrated version of the detector was successfully flown on the Exploration Flight Test-1 (EFT-1) in December 2014. Integrated versions of the detectors are planned for the future Exploration Mission-1 (EM-1) and EM-2 flights. In addition to flight opportunities, this miniaturized technology has potential usage in ground-based experimental detection systems and is currently being considered for usage in a NASA Space Technology Mission Directorate (STMD) - funded project called Thick Galactic Cosmic Rays (GCR) shielding. SPE Storm Shelter technologies could have applications in any future human missions beyond low Earth orbit (LEO), like the Asteroid Retrieval Mission and Mars. Development and advancement of

radiation transport analytical software is applicable to the vehicle architecture designers that are currently trying to determine optimal shielding thicknesses and placement of vehicle systems to minimize astronaut radiation exposure. Other potential organizations that could use improved transport codes inside and outside of NASA are the Human Spaceflight Architecture Team (HAT), the NASA Human Research Program (HRP), and the US Department of Energy nuclear physics labs.