

**Microbial Monitoring from the frontlines to space: A successful validation of a Department of Defense (DoD) funded small business innovation research (SBIR) technology on board the International Space Station (ISS).**

Authors:

Cherie Oubre (KBRWyle, JSC)

Christina Khodadad (KSC)

Victoria Castro (KBRWyle, JSC)

Mark Ott (JSC)

Lawrence Pollack (Defense Threat Reduction Agency, DTRA)

Monsi Roman (MSFC)

The RAZOR EX, a quantitative PCR instrument, is a portable, ruggedized unit that was designed for the Department of Defense (DoD) with its beginnings traceable to a Small Business Innovation Research (SBIR) contract beginning in 2000. The PCR instrument's primary function post 9/11 was for frontline troops and first responders to detect biological threat agents and bioterrorism activities in remote locations to include field environments. With its success for DoD, the instrument has also been employed by other US Departments to include Homeland Security. The RAZOR EX underwent stringent testing by the vendor as well as the DoD and was certified in 2005.

The identification and quantitation of microbial pathogens is necessary both on the ground as well as during spaceflight to maintain the health of astronauts and to prevent biofouling of equipment. Currently, culture-based monitoring technology has been adequate for short-term spaceflight missions but may not provide the robustness required for long duration missions. A NASA sponsored workshop in 2011 determined that the more traditional culture-based method should be replaced or supplemented with more robust technologies. NASA scientists began researching innovative molecular technologies for future space exploration and as a result, Polymerase Chain Reaction (PCR) was recommended. Shortly after, in 2012, NASA sponsored a project to identify and review current, commercial, cutting edge PCR technologies for potential applicability to spaceflight operations. Scientists identified and extensively evaluated three down-selected candidate technologies with the potential to function in microgravity. After a thorough Voice of the Customer (VOC) trade study and extensive functional and safety evaluations, the RAZOR EX PCR instrument (BioFire Defense, Salt Lake City, UT) was selected as the most promising current technology for spaceflight monitoring applications.

In 2015, the RAZOR EX hardware was chosen as one of the commercial-off-the-shelf (COTS) instruments incorporated into the Water Monitoring Suite of technologies for rapid development and flight demonstration. The RAZOR EX launched on SpaceX-9 in July 2016 and flight testing initiated the validation, hardware functionality, and established consistency with ground controls.

The DoD funded SBIR project successfully led to the RAZOR EX development and produced a beneficial product to address multiple customer requirements. The instrumentation has shown it can be used in many environmental scenarios, both land-based as well as space-based. NASA's inflight testing of the technology validated its functionality and sensitivity in microgravity. The instrument's small footprint,

portability, and direct 'sample-to-answer' results provide autonomy to crew members and also provides a potential viable system for future, long duration spaceflight missions.

**Short Word Abstract.**

The RAZOR EX<sup>®</sup> PCR unit was initially developed by the DoD as part of an SBIR project to detect and identify biothreats during field deployment. The system was evaluated by NASA as a commercial technology for future microbial monitoring requirements and has been successfully demonstrated in microgravity on-board the International Space Station.