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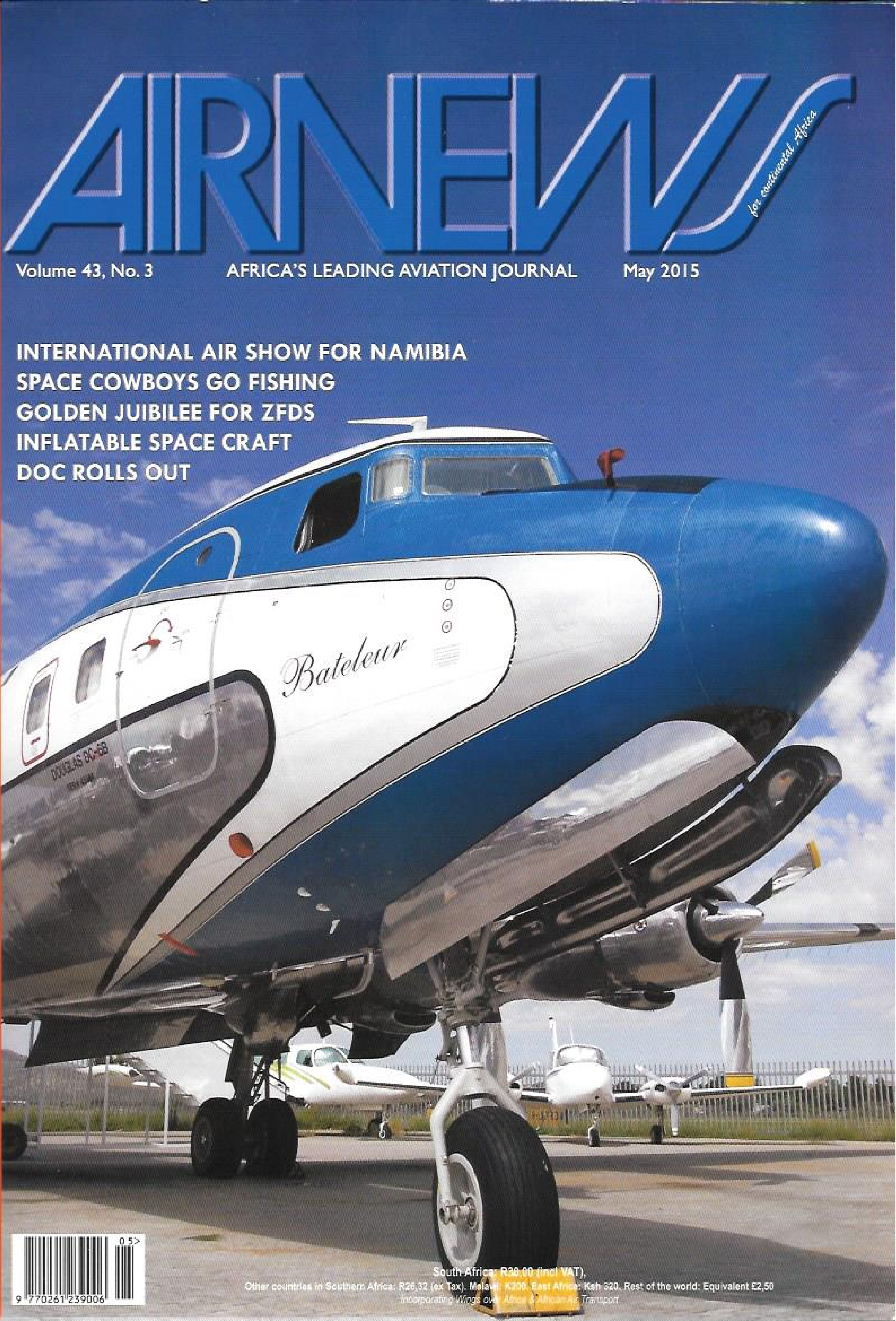

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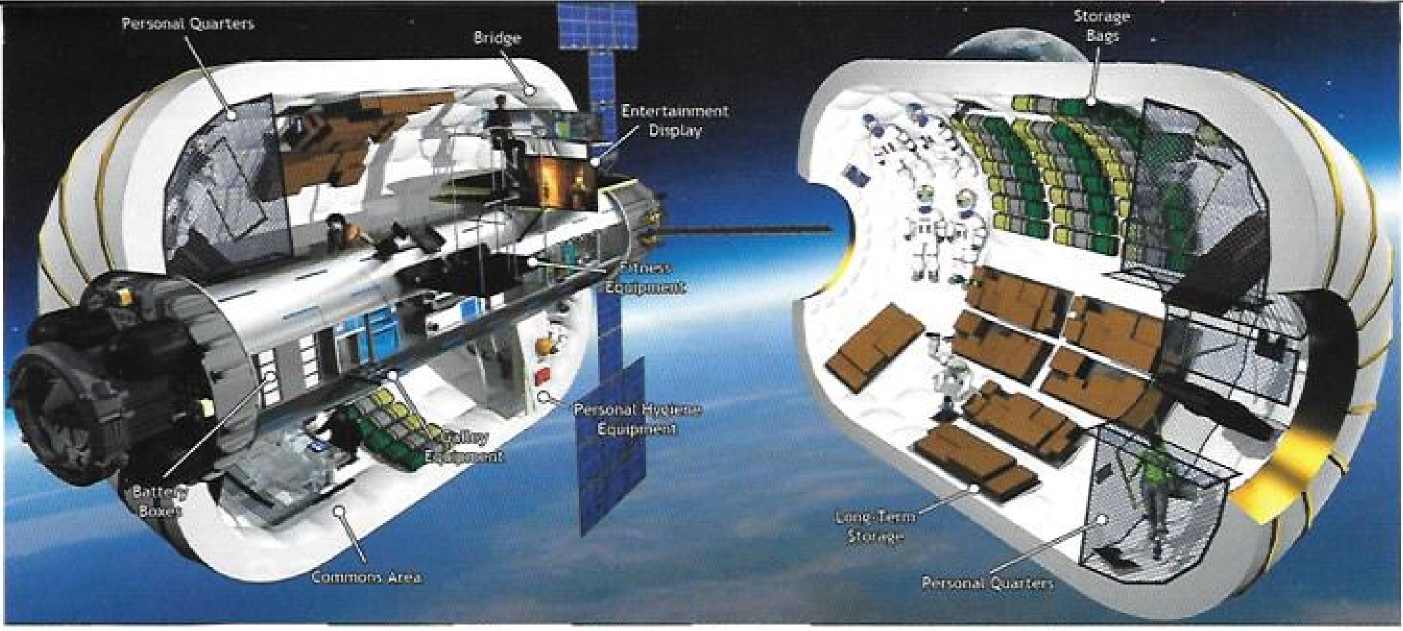


Coming soon – BLOW-UP SPACE STATIONS

By Henry M. Holden

NASA ENGINEERS began investigating the concept of expandable spacecraft in 1958, and tyre manufacturer, Goodyear, built several prototypes, which initially looked much like giant rubber inner tubes.

The idea was developed up until the late 1990s, when development of an inflatable living quarters unit for the nascent International Space Station (ISS), called TransHab, was scrapped due to budget limitations. NASA resurrected the idea and took another look at expandable module technology in early 2010.

In 2012, NASA signed a $17,8-million contract with Bigelow Aerospace, of Las Vegas, Nevada, to build an inflatable crew habitat called Bigelow Expandable Activity Module (BEAM) for the International Space Station (ISS).

With the Space Shuttles gone, the weight of material that must be boosted to orbit is the major contributor to a space mission's cost. Folded fabric packages that inflate, concertina style, to full size once in orbit offer more spacecraft volume for a given launch mass than a traditional metal-based unit.

Radiation and X-rays are also a never-ending problem. High-energy particles called cosmic rays constantly fly through space, and when they strike metal shielding, they can emit secondary radiation in the form of X-rays. This does not happen with Kevlar-based fabric shields and so expandable habitats could be more desirable and safer for astronauts

Top: *BEAM can house four to six people in an approximate 6,7-metre long habitat. It will have a usable volume of 330 m^3. The pressurised usable volume of a 20 ton B330 is 330 m^3, compared with the 106 m^3 of the 15-ton ISS Destiny module, offering 210% more habitable space with an increase of only 33% in mass.* **Above:** *The Bigelow Expandable Activity Module (BEAM) is seen during a media briefing where NASA and Bigelow Aerospace announced that BEAM would join the International Space Station to test expandable space habitat technology.* (Images: Bigelow Aerospace) heading deeper into space.

Bigelow has made progress developing shielding that resists punctures from space debris and micrometeorites. BEAM's skin, for instance, is made from layers of material like Kevlar to protect occupants from high-speed impacts.

"The craft's skin has been tested in the lab alongside shielding used on the ISS," said Bigelow director, Mike Gold. "Our envelope will not only equal, but be superior, to what is flying on the ISS today. We have a strong and absolute focus on safety," he added.

When fully expanded, the module's hull thickness will be approximately 0,46 of a metre (18 inches) and will offer superior ballistic protection. The hull will also feature at least four large UV protection-coated windows that will offer unparalleled and safer earth viewing from orbit.

TWO YEAR TEST PERIOD

BEAM will fly uninflated inside a SpaceX Dragon capsule during a two-year test period.

In its packed configuration aboard the Dragon spacecraft launched on a Falcon 9 rocket, the module will measure approximately eight feet (2,44 m) in diameter.

Once attached to the space station's Tranquillity Node and after undergoing a series of hardware validations, the module will be deployed, resulting in an additional 565 cubic feet of volume — about the size of a large family camping tent — accessible by astronauts aboard the orbiting laboratory.

The BEAM will launch aboard SpaceX CRS-8, also known as SpX-8, a spaceflight cargo resupply mission to the ISS scheduled for later this year.

Once BEAM is attached to the Tranquillity Node, the space station crew will perform initial systems checks before deploying the habitat.

During the BEAM's minimum two-year test and technology demonstration period, crews will routinely enter to take measurements and monitor its performance to help inform designs for future habitat systems.

Learning how an expandable habitat performs in the thermal environment of space, and how it reacts to radiation, micrometeoroids, and orbital debris will provide information to address key concerns about living in the harsh environment of space.

All this data is essential to understanding the technology for future astronaut habitats for use in long-duration space travel.

Following the test period, the module will be jettisoned from the station, burning up on re-entry.

Bigelow hopes the tests done in orbit will prove that inflatable capsules are safe and reliable for space tourists and commercial research, an idea almost as old as NASA itself.

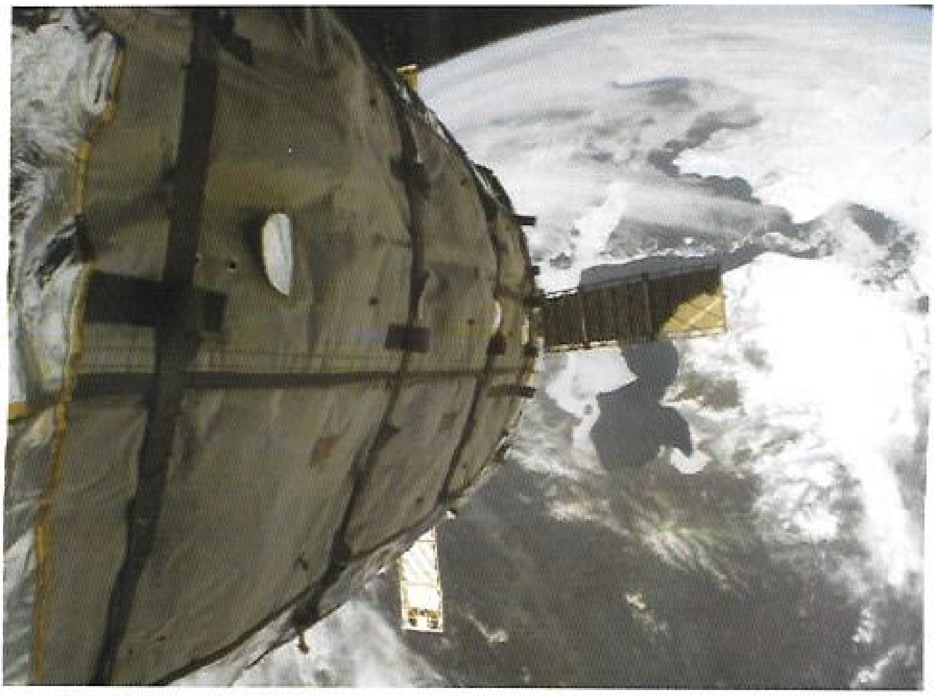
This is not the first venture into expandable spacecraft technology for Bigelow Aerospace. Genesis I and Genesis II became Bigelow's first operational space crafts and were a great success when they launched in 2006, and 2007. Like its predecessor, Genesis II is still in orbit testing and validating the technologies necessary to construct and deploy a full-scale, crewed, commercial orbital space complex. The Genesis craft are one-third the size of BEAM.

BEAM, also known as the B330 (previously known as the Nautilus space complex module) was evolved from NASA's TransHab habitat concept. B330 will have 330 cubic metres (12 000 cu ft.) of internal space, hence its numeric designation. The pressurised usable volume of a 20 ton B330 is 330 m^3, compared with the 106 m^3 of the 15-ton ISS Destiny module; offering 210% more habitable space with an increase of only 33% in mass.

The craft will support zero-gravity research including scientific missions and manufacturing processes. Beyond its industrial and scientific purposes, however, it has potential as a destination for space tourism and a craft for missions destined for the Moon, Mars and beyond.

Expandable habitats could dramatically increase the amount of volume available to astronauts while also enhancing protection against radiation and physical debris.

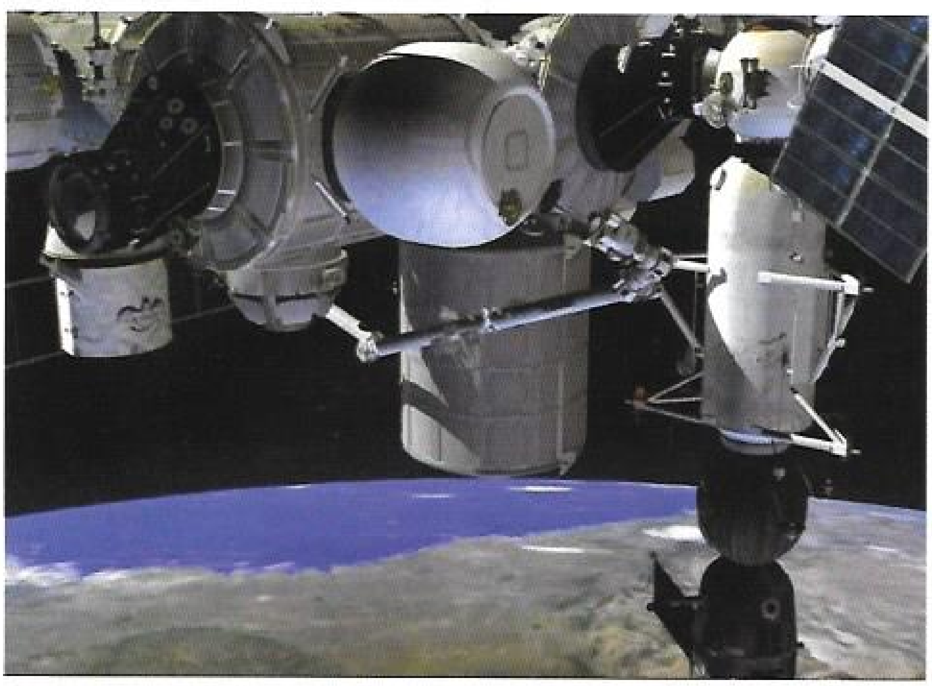
Innovative advances in efficiency



ABOVE: *Genesis II was Bigelow Aerospace's second prototype expandable. It lacks the smooth structure of the current iteration of an expandable habitat.* (Image: Bigelow Aerospace)..

BELOW: *An artist's rendition of the BEAM module (balloon structure at top centre) berthed to the Tranquility node of ISS. Astronauts enter the module a few times a year to gather performance data and inspect the structure. Following the test period, the module will be jettisoned from the station, burning up on re-entry.* (Image: NASA).

BELOW RIGHT: *William Gerstenmaier, NASA's associate administrator for human exploration and operations, and Jason Crusan, director of the agency's advanced exploration systems division, view the packed version of the Bigelow Expandable Activity Module at Bigelow's facility in Las Vegas, Nevada, recently.* (Image: Stephanie Schierholz).



provided by expandable habitats may provide new options for extending human presence further into the solar system, both in transit and on the surface of other planets, while also supporting the development of innovative platforms for commercial use in low-Earth orbit.

Expandable habitats, also described as inflatable habitats, greatly decrease the amount of transport volume for future space missions. These "expandables" weigh less, and take up less room on a rocket while allowing additional space for living and working. They also provide protection from solar and cosmic radiation, space junk, and other pollutants.

Crews travelling to the moon, Mars, asteroids, or other destinations could use them as semi-permanent habitable structures to the extent providing safe shelter of a stranded crew until a rescue mission reaches them.

They will also enable astronauts to fly in the next generation reusable spacecraft such as the SpaceX Dragon and the NASA Orion which, unlike the retired space shuttles, flew astronauts and cargo simultaneously.

EARTH APPLICATIONS

There are also dozens of possible uses for *these expandable habitats on Earth.* Durable, reliable and safe expandable structures have a wide variety of applications on Earth, from infrastructure improvements and repairs, to protection of human health and safety.

Expandables can be used as pop-up habitats in disaster areas or remote locations; storm surge protection devices; pipeline or subway system plugs to prevent flooding, fluid storage containers, hyperbaric chambers for pressurised oxygen delivery, and many other applications.

In the next decade, NASA plans to extend human spaceflight from low-Earth orbit operations to "proving ground" operations in cis-lunar space orbiting the moon. In this proving ground, NASA will validate vital hardware, including deep space habitats, as well as operations and capabilities necessary to send humans on long-duration missions to Mars or other deep-space destinations in which they must operate independently from Earth.

"We're fortunate to have the space station to demonstrate potential habitation capabilities like BEAM," said Jason Crusan, director of Advanced Exploration Systems at NASA headquarters, in Washington.

"The station provides us with a long-duration microgravity platform with constant crew access to evaluate systems and technologies we are considering for future missions farther into deep space."→