Health in Space: Daring to Explore
A Self-Guided Exhibition Tour

Introduction to this Guide

Health in Space is located on the Museum's Mezzanine level, in a gallery that opens onto the main upstairs corridor. It can be approached from the left if coming from the Museum's front elevator, or from the right if you take the stairs located in the Canada in Space exhibition. There are no doors into the gallery. Instead, an introductory wall shaped like half of a hexagon protrudes into the corridor. You can enter the exhibition from either side.

Once inside the exhibition, you will find a series of stations that include text panels, artifacts, video units, and interactive experiences. Some stations are freestanding, while others line the gallery walls. They are grouped into thematic areas: Introduction, Spotlight on David Saint-Jacques, Isolation, Gravity, Radiation, and The Future of Space Exploration. Visitors can circulate freely between these areas, but this guide sets forth a directed path for ease of navigation.

Videos, located throughout the exhibition, are typically located on the left-hand side of rail panels. Visuals within the videos are not essential for understanding or enjoyment. The buttons and earphone are labelled in Braille, and there are audio instructions to help visitors operate each unit.

This guide includes all of the exhibition's texts, from the main panels to the artifact details. It also includes descriptions of artifacts, and of significant images within the exhibition.

We hope that you enjoy your visit.

Section 1: Introduction

Directions

Begin your visit at the wall structure shaped like half of a hexagon that protrudes from the gallery. The wall on the left features the main introduction text. The centre wall is covered in monitors that present a silent montage of words and graphics that emphasize the exhibition's main themes. The wall on the right includes further content, including an introductory video.

Exhibition Content

(left wall)

Panel text:

Space is a dangerous place. Gravity, radiation, and isolation all pose unique health risks. Astronauts' health is a top priority from the time they're selected until well after their final mission. Doctors, scientists, technicians, engineers—and even the astronauts themselves—work together to support the health of those working in space. Cooperation is critical for the success of both current missions and future deep space expeditions. What they learn can also help solve medical challenges on Earth.

(right wall)

Panel texts:

Health and Medicine: Priorities of Stellar Proportion
Canada takes pride in advancing space-related health sciences, paving the way for tomorrow's space medicine. Canada is a leader in studying the impacts of space on the human body. With missions to Mars in their sights, experts are striving to overcome the risks of long-duration space expeditions. Imagine what new innovations this could bring.

Back on Earth: What's in it for Us?
Canada's space program specializes in health sciences. What we learn in space has the potential to improve medical treatments on Earth.

Image with caption:

David Saint-Jacques (CSA) is seated, testing out neuroArm, a robotic brain-surgery system. Based on Canadarm technology, neuroArm was developed at the University of Calgary. 2016

Section 2: Spotlight on David Saint-Jacques

Directions

If you enter the exhibition to the right of introductory wall structure, and turn left, you will encounter the content on the inside of the half hexagon. These three walls present information about David Saint-Jacques.

Exhibition Content

(left wall)

Panel texts:

A Canadian All-Star
David Saint-Jacques has worn many hats: engineer, astrophysicist, and family doctor—all before becoming an astronaut. David has been a member of Canada's astronaut corps since 2009. He was chosen, along with Jeremy Hansen, from 5,350 possible candidates. David is certified to pilot the Soyuz spacecraft, control Canadarm2 and perform spacewalks. He is also a crew medical officer, and is trained to operate specialized equipment to conduct science experiments in space.

Astro Stats
Born: Quebec City, Quebec
Birthdate: January 6, 1970
Education: B.Eng. (engineering physics), Ph.D. (astrophysics), Doctor of Medicine
Career Background: engineer, astrophysicist, family doctor
Languages: French, English, Russian, Spanish, and Japanese

Large-scale image with caption: David Saint-Jacques, wearing a flight suit, stands in front with a Northrop T-38 Talon supersonic training jet. December 2017

Additional images: Sepia-toned image of David Saint-Jacques as a curly-haired child, sitting at a school desk at École primaire des Saints-Anges in Saint-Lambert, Quebec. 1977

David and his brother take part in a costume contest at ski school—dressed as astronauts. Mount Saint-Bruno, Quebec. 1976

Video Unit: Getting to know David Saint-Jacques

(centre wall)

Artifact with caption:
Astronauts wear their iconic blue flight suits during training, and for public engagements. David wore this suit until late 2017, when he loaned it to the Canada Aviation and Space Museum for this exhibition.

Flight Suit
Gibson & Barnes
El Cajon, California
2017
Loan: Canadian Space Agency

(right wall)

Panel text:

Astronaut Training: Years of Commitment
David joined Canada's astronaut corps in 2009, and spent nearly a decade preparing for the journey of a lifetime. David completed basic training from 2009 to 2011. He studied everything from the fundamentals of space flight to the Russian language. David kept his skills sharp supporting space missions from the ground at NASA's Johnson Space Center until he was selected for his mission in May 2016. David then travelled in Canada, the United States, Germany, Russia, and Japan, completing mission-specific training on the Soyuz, the Station, and much more.

Artifacts with caption:

(Vacuum-sealed pouches filled with preserved food)

What's for Dinner, David?
Before his mission, David sampled and selected the foods he would eat during his stay on the Space Station. There are many restrictions—foods cannot be refrigerated or frozen, and they can't be too crumbly. David's chosen meals were specially packaged for safe storage and preparation on the Station.

Food Prepared for David Saint-Jacques' Mission
various makers
ca 2018
Loan: Canadian Space Agency

Directions

If you are facing the half hexagon, there are three free free-standing walls behind you. While spaced apart, they form another larger half hexagon. On each of these walls you will find further information about David Saint-Jacques. Begin with the wall on the right.

Exhibition Content

(right wall)

Panel texts:

On Assignment in Space
The International Space Station is a science laboratory. In this unique environment, astronauts conduct a wide variety of experiments. They study the human body, plants and other living organisms, and the properties of materials. They also test new technologies.

David's Involvement in Canadian Experiments

At Home in Space: Canada's first psychosocial experiment on the Space Station examines how astronauts from around the world make the Station feel like home.

Bio-Monitor: David was the first to test the Bio-Monitor in space. This wearable technology is designed to continuously monitor and record astronauts' vital signs, keeping an eye on their health and providing valuable data for researchers.

TBone: Astronauts' bones are weakened by exposure to microgravity. TBone uses 3D images, as well as blood and urine samples, to study changes in astronauts' bone health.

MARROW: The effects of microgravity on bone marrow are not fully known. MARROW is trying to determine if microgravity causes fat cells to accumulate in the bone marrow, impacting the production, function and destruction of red and white blood cells.

Vascular Echo: Vascular Echo uses blood tests and ultrasounds to study how microgravity impacts astronauts' hearts and blood vessels.

Wayfinding: For astronauts living on the Space Station, there is no real up or down. By examining their brains while they perform spatial-orientation tasks before and after their missions, Wayfinding aims to learn how astronauts find their way around in microgravity.

Vection: Using a virtual reality system, Vection examines how microgravity affects astronauts' abilities to judge distances and perceive their own motion.

Radi-N2: Astronauts are exposed to elevated levels of neutron radiation while they are in space. Radi-N2 measures those levels on the Space Station, and monitors how much astronauts absorb.

David's New Perspective

David chose to name his mission *Perspective* to honour the unique experience of seeing Earth from space. From the ground, it can be difficult to appreciate the complexities of our planet. Astronauts have the rare privilege of observing Earth from a distance—gaining a better perspective on both its beauty and its fragility. The design of David's mission patch is also symbolic, representing the power of dreams. By igniting human creativity and genius, dreams lead to the progress of humanity.

Decoding David's Mission Patch
David Saint-Jacques' mission patch represents the power of dreams. Each element in its design carries special meaning, as shown on this labelled diagram:

North Star: The North Star, symbolizing dreams, resembles a compass rose—a symbol of reason. Just as explorers follow the North Star or a compass, people are guided and inspired by dreams.

Star Trail: The colours of the star trail highlight the human ability to innovate and push limits. The red band symbolizes energy and passion, orange denotes creativity, and white represents science. The blue crescent that completes the star trail resembles a reflection in a lens. It symbolizes international collaboration—past, present and future—which is at the heart of the space program.

Four Stars: The four stars represent the people who work behind the scenes to ensure mission success. In a similar way, they signify the members of David's family.

Earth: The Earth as seen from space highlights a new and unique perspective, which inspires environmental responsibility and dreams of peace.

(centre wall)

Photo Op:

This wall features a life-sized graphic of David Saint-Jacques looking through a cut-away circular hatch, as if into the International Space Station. From behind the wall, visitors can place themselves within the same opening, giving the illusion from the front that they are looking through the hatch with David.

(left wall)

Panel text:

Dr. Saint-Jacques, Ready for Service
Before joining Canada's astronaut corps, David had a career as a family doctor. David and his wife, Véronique Morin, have both worked as doctors in Canada's North. David practised at Inuulitsivik Health Centre in Puvirnituq—an Inuit community in Nunavik, Quebec. A specialist in first-line care, he worked with limited resources and relied on technology to connect with medical resources available in urban centres. This experience is helpful when it comes to working on the Space Station—the ultimate remote location.

Back on Earth: Serving Northern Communities
There are many regions on Earth where isolation can make it difficult to deliver healthcare. In Canada's North, for instance, hospitals are often hours away by air. Space technologies for diagnostics and

communication, if adapted for life on Earth, will have the potential to improve healthcare across Canada and around the world.

Images with caption: Telehealth technologies increase remote communities' access to medical specialists. Here, a doctor at the University of Saskatchewan communicates with a patient at the Nain Community Clinic in Labrador in 2013. One image shows a doctor using computer technology to see and communicate with a patient. A second image shows the patient and two medical professionals looking at a screen, where they can see and communicate with the doctor.

Video Unit: Health Care and Canada's North

Section 3: Isolation

Directions

On the other side of the left wall you will encounter the Isolation section of the exhibition. This is the first of three sections presenting key factors that challenge astronauts' health in space. While the other side of the wall itself includes isolation-related content, proceed first to the nearby console unit that lines the gallery's back wall.

Exhibition Content

(console unit)

Panel text:

Isolation
Caring for people's physical and mental health is complicated. Working 400 kilometres above Earth's surface doesn't make it any easier. With the support of flight surgeons on Earth, astronauts play a hands-on role in their own medical care. Specialized training and technologies allow them to handle many medical situations in space. Astronauts receive support to alleviate the mental stresses of isolation, and enjoy activities that connect them to their lives back on Earth.

Is There a Doctor in the House?
Every crew on the Space Station has a Medical Officer. They receive special training, but don't always have a medical background. All astronauts complete about 40 hours of medical training. They learn the basic skills they need to care for their crewmates, from tying sutures to performing physical exams and basic dentistry. Astronauts communicate with doctors on Earth, but self-reliance is important. If a medical issue could not be solved in space, the astronaut would be evacuated to Earth.

Flight Surgeons: Always on Call
Every astronaut has a dedicated Flight Surgeon on Earth. This doctor follows the astronaut throughout their mission—from pre-launch training, to care after their return. Astronauts on the Space Station have private videoconferences with their Flight Surgeons every week.

Video Unit: The Flight Surgeon's Role

Panel text:

Maintaining Mental Focus
Working in space is the adventure of a lifetime, but the demands can be exhaustive. On a mission aboard the Space Station, astronauts typically spend six months with the same five people, within a loud artificial environment. It can be difficult to sleep, and there is little time for relaxation. Far from family and friends, astronauts worry about loved ones back home. Space agencies select astronauts carefully, train them to handle these mental pressures, and take steps to help preserve crew morale.

Video Unit: Health and Isolation (multiple videos)

Panel text:

Fostering Mental Well-being
Space agencies support astronauts in many ways during a mission.

- Extensive simulations and training exercises prepare astronauts for the stresses they will face.
- Astronauts have weekly video chats with their families.
- Astronauts receive crew care packages that include small gifts from loved ones.
- In their limited free time, astronauts enjoy hobbies such as photography and music.
- Celebrations on the Space Station mark important dates and holidays.
- Space agencies strive to ease astronauts' worries by providing support for their families.

Digital Interactive:
What would an astronaut do?
(This multiple-choice quiz, aimed at younger audiences, does not include audio. As visitors answer questions they accumulate points—more points for answers that are more correct—which in turn determine the final result that they read at the end of the quiz. The following includes the quiz introduction, the questions followed by their respective point values, and the final result screen texts.)

Astronauts have amazing careers, but their work comes with many challenges.
Do you know how they handle the pressures of astronaut life?

Question 1: When astronauts are in training they travel the world. Ideally, how would an astronaut feel about travel?

A. They would be willing to travel if they had to.
B. They would rather stay home.
C. They would be excited about everything they get to see and do.

Question 2: When astronauts "float" in microgravity it can be hard for them to tell which way is up. They sometimes feel space sick for the first few days of their mission. Based on this, who would make a better astronaut?

A. Someone who loves rollercoasters.
B. Someone who likes train rides.
C. Someone who often gets car sick.

Question 3: An astronaut disagrees with her crewmate about how to fix a vital piece of lab equipment. What would she do?

A. Talk things out—two heads are better than one!
B. Fix it her own way.
C. Let her crewmate fix it by himself.

Question 4: There is very little privacy on the Station. Others can hear when you video chat. What would an astronaut do if he heard his crewmate having a video chat?

A. Listen in!
B. Listen to some music so as not to be disturbed.
C. Respect their privacy and work somewhere else.

Question 5: Astronauts look forward to getting care packages filled with gifts from loved ones. What gift would an astronaut want to receive in space?

A. Clothing—they need the coolest golf shirt!
B. Letters, drawings from their children—small things that remind them of home.
C. A bicycle.

Question 6: Astronauts are very busy. Their time is scheduled down to the minute as they conduct experiments and maintain the Space Station. What helps them handle the pressure?

A. Snapping at the Ground Control crew.
B. Snacking!
C. Taking short breaks for hobbies like music and photography.

Question 7: Life continues back on Earth. Astronauts miss their families and friends. What technology would an astronaut use to make this easier to handle?

A. Teleporters—beam me down Scotty!
B. Daily phone calls and weekly videoconferences.
C. A computer to access to magazine and news articles.

Question 8: Astronauts sleep in small pods. It’s noisy, and there’s always light. How would an astronaut behave if he didn’t get enough sleep?

A. He’d keep it together—he’s trained for this.
B. He’d be impatient with his crewmates.
C. He’d be a groggy grumpy mess.

Question 9: It’s chore time on the Space Station. What job would an astronaut choose?

A. Whatever job seems easiest.
B. Whatever job doesn’t involve cleaning.
C. Whatever job helps keep the crew safe and healthy.

Question 10: What part of their work would an astronaut find most interesting?

A. Getting to “float” in space.
B. Doing science in space—an extreme laboratory!
C. Unclogging the Orbital Outhouse.

Scoring:
For each answer below, the first letter shown is worth 2 points, the second is worth 1 point, and the third is worth 0 points.

1. C, A, B
2. A, B, C
3. A, B, C
4. C, B, A
5. B, A, C
6. C, B, A
7. B, C, A
8. A, B, C
9. C, B, A
10. B, A, C

Possible Results:

(0 to 6 points)
That’s not how an astronaut would behave. Astronauts are team players. They work hard to stay calm and alert in the most stressful situations because they have great respect for the rest of the crew. They understand that for the mission to succeed, everyone must work well together.

(7 to 14 points)
You’re starting to get how an astronaut would behave. Astronauts put their team’s success ahead of their own needs—everyone is committed to the space mission. Taking a break for hobbies, talking to family, and receiving small gifts from home help astronauts keep a positive attitude in extreme situations.

(15 to 20 points)
You know your astronauts! No matter how much stress they face, astronauts respect their fellow crewmembers. They look forward to talking with family and friends, and receiving care packages, because staying connected to loved ones back on Earth helps prevent loneliness. This better enables them to focus on their space mission.

Directions

There is further content presented in display cases to the immediate right of this console unit.

Exhibition Content

Artifacts with captions:
(A light blue, short-sleeved golf shirt with a small NASA logo on the chest.)

This is the official shirt Dave Williams (CSA) and his fellow crewmembers wore aboard Space Shuttle *Endeavour*, during Mission STS-118 in 2007.

Dave Williams' Crew Shirt
2007
Loan: Dr. Dave Williams

(A small fabric patch)
The Canadian Space Agency's Operational Space Medicine group is responsible for the health and safety of Canadian astronauts. This patch belongs to astronaut Dave Williams (CSA), who managed this group in the 1990s.

ca 1993
Loan: Dr. Dave Williams

(A picture frame that encases a CD, a photo collage from Mission STS-118, and a signed authenticity certificate.)
Dave Williams (CSA) enjoyed listening to CDs in space—even though the MP3 format had superseded CDs by his second mission in 2007. He listened to *World Container* aboard Space Shuttle *Endeavour*. NASA framed this CD after his return to Earth.

Tragically Hip Album, framed for display
NASA
Houston, Texas
ca 2007
Loan: Dr. Dave Williams

Directions

Return to the free-standing wall.

Exhibition Content

Panel text:

Advancing Technology, Increasing Autonomy
Doctors on Earth use a full range of tools to diagnose and treat their patients. On the Space Station, options are limited. Astronauts have access to a select amount of medical equipment. While some is bought off the shelf, certain technologies are specially-designed for space missions. Canada has developed a number of notable medical technologies, and continues to innovate in this area. As space agencies prepare for longer missions, new tools are being developed to increase crew autonomy.

Artifact with caption:
(A small metallic grey box, roughly the size of a toaster. The front has many dials and buttons.)

Microflow Cytometer

Flow cytometers have been used to test medical samples since the 1960s. Microflow, developed for the CSA, is a miniaturized, simplified cytometer. Astronauts can operate the unit, and read the results themselves in space. Microflow was tested on board the Space Station in 2012–2013.

Microflow Cytometer (reproduction)
Institut national d'optique
Quebec City, Quebec
ca 2012
Loan: Institut national d'optique

Images with captions:

Tom Marshburn (NASA) performs an ultrasound scan on Chris Hadfield (CSA) aboard the Space Station. Hadfield is in a lying position as Marshburn holds the ultrasound unit's end against his neck. March 2013

Microflow is a Canadian technology used to analyze blood and other biological samples on the Space Station. Chris Hadfield (CSA) activated the unit for the first time in March 2013. In this image, Hadfield is pointing at the Microflow unit, which is floating in microgravity.

Artifact with caption:

(A black sleeveless shirt and a black headband on a mannequin.)

Bio-Monitor Shirt and Headband

It takes a lot of equipment to monitor astronauts' vital signs in space. Bio-Monitor, a Canadian wearable technology, aims to change this. Astronauts can wear the smart shirt and headband during physical experiments, at rest, and even while sleeping. A small battery device tucked inside the shirt continuously records data, which can be easily transmitted back to Earth.

Bio-Monitor Shirt and Headband
Carré Technologies

Montreal, Quebec
ca 2018

Image with caption: During his training, David Saint-Jacques (CSA) wears the Bio-Monitor, a system that includes a smart shirt linked to a mobile application. In this image, he wears the shirt and headband as he runs on a sunny day.

Section 4: Gravity

Directions

Back along the back wall, to the right of the Isolation console and artifact cases, you will find the Gravity section's main console. You can begin to explore the Gravity section here.

Exhibition Content

(console unit)

Panel texts:

Gravity
From take-off to touchdown, gravity tests the limits of astronauts' bodies. Astronauts endure extreme G-force during launch and when returning to Earth, but spend most of a mission "floating" in microgravity. This only sounds safe—microgravity decreases bone density, weakens the heart, and causes muscle loss. Astronauts can also experience vision problems and disorientation. Many of these effects are temporary, but some can persist after a mission is over, so astronauts take special precautions to minimize the risks.

Side Effect: Blurred Vision
Astronauts rely on their eyesight to read screens and operate control panels. Blurred vision could put a mission in jeopardy. In microgravity, fluids build up in astronauts' upper bodies. This can put pressure on the eyeballs and optic nerves, altering their shape and causing vision issues like blurring. This is a common problem—about 50% of astronauts report vision issues after a six-month mission. Ongoing research aims to better understand the phenomenon in preparation for future long-duration missions.

Interactive experience: Visitors can look through two large openings in a raised box, comparing two images of a scene on board the Space Station. One of the scenes is covered by a lens that mimics the visual effect of optic nerve swelling. The following text accompanies the experience: Optic nerve swelling can cause many vision problems. Blurring in the focal area, or in random spots, is common. This is dangerous for astronauts who rely on their vision to read and perform high-precision technical tasks.

Diagram: The central panel in this area features cross-section diagrams of two human eyeballs. The first shows a normal eyeball, while the second shows how a swollen optic nerve can compress and flatten the back of the eyeball.

Video Unit: Vision Issues

Panel text:

Side Effect: Bone Loss
On Earth, our bones stay strong carrying our body weight—but in space if you don't use it, you lose it. Healthy people's bones regenerate on Earth—the body absorbs bone tissue, but creates new bone just as quickly. This isn't the case in space. Living in microgravity, astronauts typically lose 1–2% of their bone density every month. That isn't a problem while they're "floating" on the Space Station, but brittleness increases their risk of fracture when they return to Earth—or land on Mars.

Interactive Experience: Touch and compare two three-dimensional bone scans. These are enlarged cross-sections of an astronaut's tibia scanned before and after a mission. The scans were taken by the University of Calgary as part of TBone, a Canadian experiment that studies changes in astronauts' bone health caused by the time they spend in space. Feel the area that is less dense. This is what happens when an astronaut experiences bone loss.

Panel text:

Back on Earth: Fighting Osteoporosis
Roughly 1.5 million Canadians suffer from osteoporosis. Over the age of 50, 1 in 4 women and 1 in 8 men will develop the disease, which causes bones to lose density and weaken. Studying astronauts' bone loss could lead to a better understanding of this medical condition.

Directions

To the immediate right of the Gravity console, you will find a display case featuring an artifact.

Exhibition Content

Artifact with caption:

(An open four-sided metal tray containing a series of colourful interconnected syringes and tubes.)

Flight Tray for Canadian Osteoporosis Experiment

This tray is a fully automated miniature laboratory. It flew in space aboard a Russian satellite in September 2007, as part of the Enhanced Osteoporosis Experiments in Orbit (eOSTEO) project. Inside the temperature-controlled tray, a system of valves and syringes provided nutrients and fluids for bone-cell cultures.

eOSTEO Flight Tray
Systems Technologies
Kingston, Ontario
2007
Loan: Canadian Space Agency

Directions

Directly behind you, on an angle, you will find a large display case. To its right is a free-standing wall housing an interactive experience. This material relates to the topic of disorientation in space.

Exhibition Content

(display case)

Artifact and caption:

(A metal frame, roughly a metre long, which sits low to the ground with a small seat and what looks like a small polka-dot umbrella.)

This intriguing Canadian device flew aboard Space Shuttle *Discovery*. It was used for a space sickness experiment that Roberta Bondar (CSA), Canada's first female astronaut, took part in. An astronaut would sit in the sled and, as the "polka-dot umbrella" spun, their balance would be analyzed.

Space Physiology Experiment Sled
CAE Electronics and McGill University Aerospace Medical Research Unit
Montreal, Quebec
1991
Artifact no. 1992.0029

Image with caption:

Roberta Bondar (CSA) sits in the Space Physiology Experiment Sled, her face obscured by the "polka-dot umbrella," as she and Norm Thagard (NASA) train for their mission at the Marshall Space Flight Center. Huntsville, Alabama. August 1991

(on adjacent wall)

Interactive Experience:

Disorientation Station
Visitors stand in a fixed spot, place their face inside a rotating polka-dotted sphere, and discover the degree to which they are personally impacted by visual disorientation. Explanatory text reads: Do you feel dizzy? Any nausea? In space, astronauts have no sense of up or down. The brain receives conflicting messages from the eyes and inner ears. This can cause nausea.

Directions

Circle around to the other side of the large display case. To you immediate left you will find more in-depth information about disorientation.

Exhibition Content

Panel texts:

Side Effect: Disorientation
Astronauts need to know which way is up—even when there's no real up or down. It can be hard for astronauts to orient themselves without the familiar pull of Earth's gravity. Disorientation causes some astronauts to feel like they are upside down, and some even become nauseated, or "space sick." Motion in their peripheral vision can also make them feel like they are moving. Research helps medical experts understand how disorientation affects astronauts' health and performance.

Back on Earth: Preventing Falls
Disorientation can be a problem for those at greater risk of experiencing falls. This includes seniors and people with neurological disorders such as Parkinson's disease. Studying astronauts' disorientation has the potential to help us better understand the condition.

Images with captions:
Dave Williams (CSA) "takes a spin" in a body rotating device. James Pawelczyk (NASA) monitors this disorientation experiment aboard Space Shuttle *Columbia*. April 1998

Dave Williams (CSA) takes part in one of the 26 Neurolab experiments on Space Shuttle *Columbia*. Neurolab studied the effects of microgravity on the nervous system. In this image he is shirtless, with cumbersome scientific instruments attached to his face and body. Another astronaut is assisting him. April 1998

Video Unit: Disorientation

Section 5: Radiation

Directions

From the disorientation content wall, head to your left, back towards the exhibition's back wall. Here you will find a third console unit that introduces the radiation section of the exhibition.

Exhibition Content

(console unit)

Panel texts:

Radiation
Radiation puts astronauts at risk when they are working outside Earth's protective atmosphere. The farther astronauts travel from Earth, the more radiation they are exposed to. Over time, exposure to certain types of radiation can raise an astronaut's risk of developing various diseases and conditions such as cataracts and cancer. Astronauts take special precautions to limit their exposure. They also participate in research to improve protective measures for future deep-space missions.

Worrisome Wavelengths, Perilous Particles
Radiation is energy moving through space. Low-energy radiation, such as radio signals and visible light, travels in long waves. Some types of high-energy radiation, such as X-rays and gamma rays, travel in short waves, while others, such as cosmic rays, are made up of fast-moving subatomic particles.

Exposure to low-energy radiation is generally considered safe, but high-energy radiation can significantly damage human cells.

Artifacts with captions:

(A small, blue metallic box with white knobs sits open. Black fabric cases are fastened to the inside top of lid.)

This little blue box holds a lot of science! Extravehicular Activity Radiation Monitoring (EVARM) was a Canadian experiment that measured astronauts' exposure during spacewalks, from 2001 to 2003. The reader captured data from dosimeters which were worn near different parts of the body inside a spacesuit.

EVARM Radiation Monitor and Dosimeters
Thomson & Nielsen
Ottawa, Ontario
ca 2001
Artifact no. 2014.0363

(Cylindrical vials filled with transparent resin. Tiny bubbles are visible within the resin.)

Bubble detectors are filled with tiny droplets of liquid suspended in an elastic polymer. When a neutron strikes one of the droplets, it creates a small gas bubble in the polymer. You can literally count the number of neutrons that strike the detector.

Bubble Detectors
Bubble Technology Industries
Chalk River, Ontario
ca 2018
Loan: Bubble Technology Industries

(A small rectangular item, similar in size to a D battery)

In partnership with Russia's Institute of Biomedical Problems, the CSA placed these dosimeters in cosmonaut sleeping areas aboard the Mir space station between November 1993 and February 1994. Readings from these devices were captured once the cosmonauts returned to Earth.

Dosimeter
Thomson Nielsen
Ottawa, Ontario
ca 1993
Artifact no. 1995.0966

Panel texts:

Sources of Space Radiation

From exploding stars to storms on the Sun, astronauts in low Earth orbit are exposed to radiation from many sources. Supernovae, or exploding stars, release cosmic radiation. Solar winds carry radiation from the Sun. Earth's magnetic field shelters us from most of this radiation, but some still gets through. These particles become trapped and circulate in Earth's magnetic field—particularly in the Van Allen belts. The farther astronauts travel from Earth, the greater their exposure to high-energy radiation.

Neutron Radiation: Bubbles of Trouble
When cosmic rays collide with physical matter, such as the walls of the International Space Station, they can release subatomic particles called neutrons. Neutrons can penetrate deep into human tissue—potentially damaging DNA and bone marrow, and increasing the risk of cataracts and cancer. Canada developed the Radi-N2 experiment to monitor neutron radiation on the Station.

Image with caption:
Chris Hadfield (CSA) holds bubble detectors for the CSA's Radi-N2 experiment while aboard the ISS. Radi-N2 measures neutron radiation levels aboard the Space Station. January 2013

Labelled Diagram:

Space Radiation by Altitude
This diagram illustrates how levels of space radiation increase the farther you travel from Earth's surface. Key points include:

Sea Level: 0 m

International Air Travel: 10.7 km
Space radiation is 10 times greater than at sea level.

Karman Line: 100 km
Boundary between the atmosphere and outer space

International Space Station: 400 km
Space radiation is 100 times greater than at sea level.

Labelled Diagram:

Sources of Space Radiation
This diagram illustrates how radiation emanating from the Sun travel though space towards Earth. Cosmic radiation originating even further away also travels towards Earth. The Earth's magnetic field acts as a shield, diverting radiation. Any radiation that penetrates circulates within the magnetic field, focussing primarily around the Van Allen Belts and Earth's northern and southern poles.

Panel text:
Measuring Radiation in Space

It is important to monitor astronauts' exposure to radiation. Dosimeters record the amount, or dose, of radiation to which astronauts are exposed. Canada has played an active role in developing technologies to measure radiation in space.

Video Unit: Health and Radiation

Directions

From the right-hand end of the radiation console, move back and to your left. You will find a free-standing wall with additional radiation content.

Exhibition Content

(free-standing wall and rail)

Panel texts:

Reducing the Risk
Careful equipment design and mission planning minimize astronauts' exposure to radiation. The International Space Station, and the suits worn on spacewalks, are made of lightweight materials including Kevlar® and polyethylene plastic, which provide protection against certain kinds of particles. Mission operations are timed to reduce astronauts' exposure—there are no spacewalks during solar storms, for example, when radiation levels are highest. If needed, astronauts can retreat to more shielded locations on the Space Station, such as the Kibo laboratory module, where water-storage tanks further insulate them from radiation.

Back on Earth: Protecting Workers
Space research sparks advances to better protect those who work with high-energy radiation, such as medical technicians and staff at nuclear power plants. The Canadian Space Agency's EVARM experiment, for example, tested small radiation detectors worn by astronauts during spacewalks. This experiment helped improve a radiation detector that is now used in more than 1,000 cancer clinics worldwide.

Digital Experience:
How would you block radiation in space?
(This multiple-choice quiz does not include audio. The following text includes the quiz introduction along with the questions and correct answers.)

The farther we travel from Earth and its protective magnetic field, the more space radiation we encounter. To keep astronauts safe on a mission to Mars, spacecraft will need shields made from materials that can block radiation while standing up to conditions in space. Do you know which materials would work best?

Should we build radiation shields out of iron?
No. Iron is very strong, but it's too heavy to ship into space. Iron can only block certain types of radiation.

Should we build radiation shields out of paper?
No. Paper is light, but it isn't very strong. It can only block a little bit of radiation, such as low-energy particles.

Should we build radiation shields out of Kevlar?
Yes. Kevlar is a synthetic fibre that is light, and five times stronger than steel! Kevlar can block radiation, and also protect against micrometeoroid strikes.

Should we build radiation shields out of lead?
No. Lead provides some protection from radiation, but it's dense and heavy, and can be toxic to humans.

Should we build radiation shields out of aluminum?
No. Aluminum is light and strong, but it only provides some protection from space radiation. It's a good choice for building the spacecraft itself, but not the shields.

Should we build radiation shields out of water?
Yes. Water is high in hydrogen, which makes it good at absorbing or deflecting particles of similar size, such as neutrons. The spaceship's shields can be filled with stored drinking water. They already use water as a radiation shield in the International Space Station's Kibo module.

Should we build radiation shields out of concrete?
No. Concrete is an excellent radiation shield, but it is very heavy. It is often used for nuclear shielding on Earth, but it can't be transported to space, or mixed and poured in microgravity.

Should we build radiation shields out of polyethylene plastic?
Yes. Polyethylene is light and versatile. It contains a lot of hydrogen, so it is good at blocking protons and neutrons (which are similar in size to hydrogen atoms). Polyethylene can be made into fabric, and multiple layers can be moulded together to form strong structures.

Section 6: The Future of Space Exploration

Directions

From the free-standing radiation wall, proceed backwards and towards the mezzanine hallway. Along the gallery's side wall you will find the exhibition's concluding content panel and rail.

Exhibition Content

Text panel:

The Future of Space Exploration
Astronauts on long-duration missions, such as a journey to Mars, will need to be more self-reliant than ever before. It will take months to reach Mars. All missions would be well over a year in length. Astronauts won't be able to communicate in real time with Mission Control, nor return to Earth in an emergency. Radiation, isolation, and reduced gravity will pose even greater medical challenges the farther humans travel from Earth. Canada's ongoing research and innovation will be vital for the success of future space missions.

Video Console: Health and Future Exploration

Directions

This concludes your visit to Health in Space: Daring to Explore. To exit the exhibition gallery, turn to your right. You are steps away from the open mezzanine corridor that boarders this gallery.

Enjoy the rest of your visit!