
NASA
EMMANUEL URQUIETA

Medical risks during the journey to Mars and its benefits on Earth

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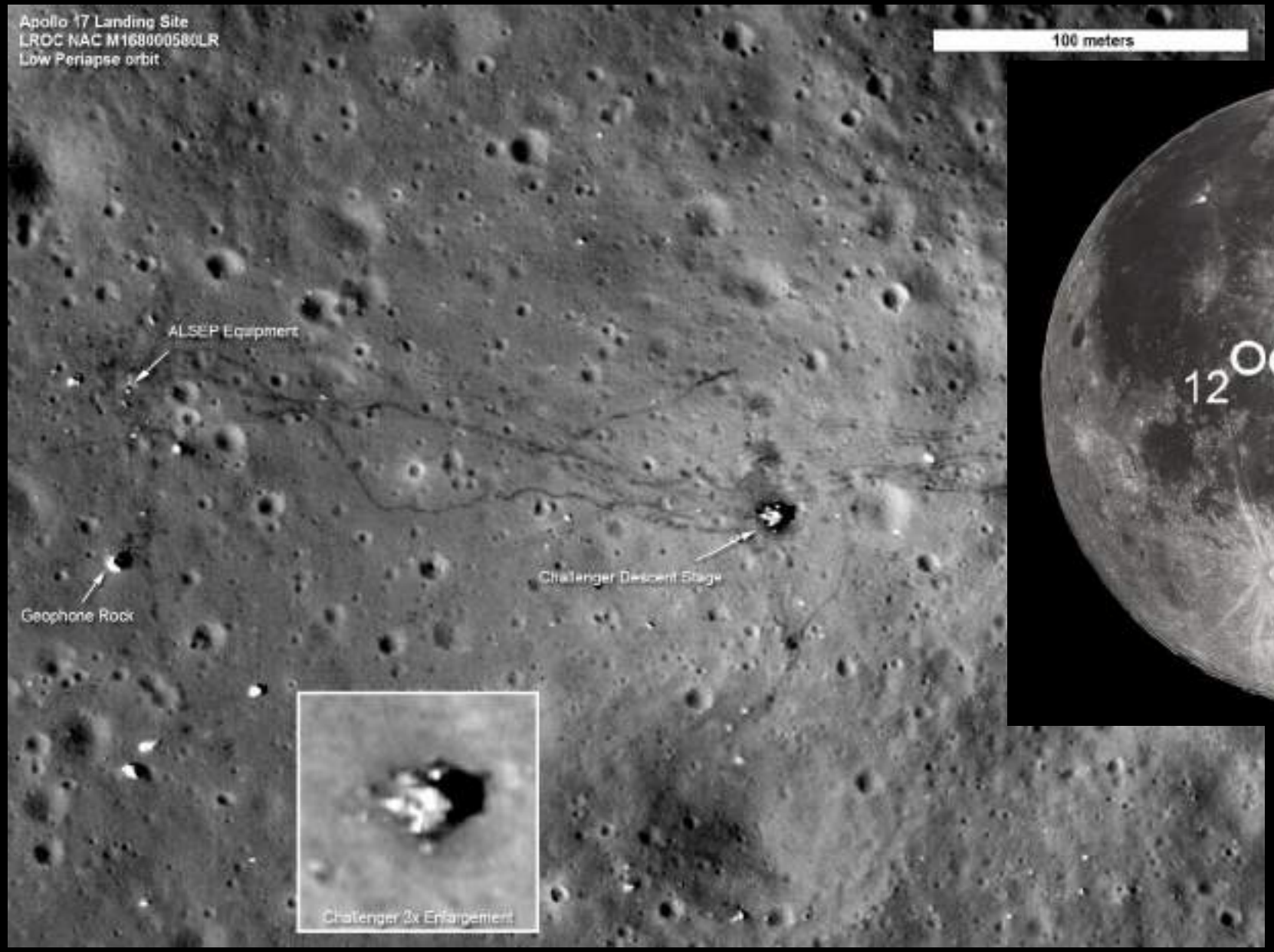
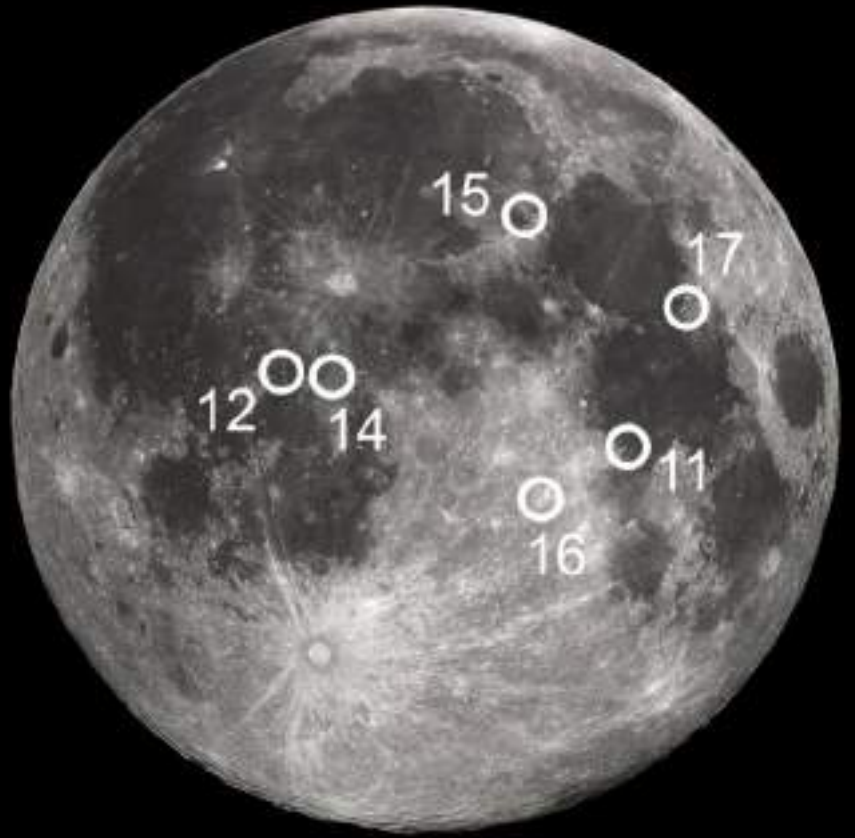
NASA funded Translational Research Institute for Space Health

TRANSLATIONAL RESEARCH INSTITUTE FOR SPACE HEALTH

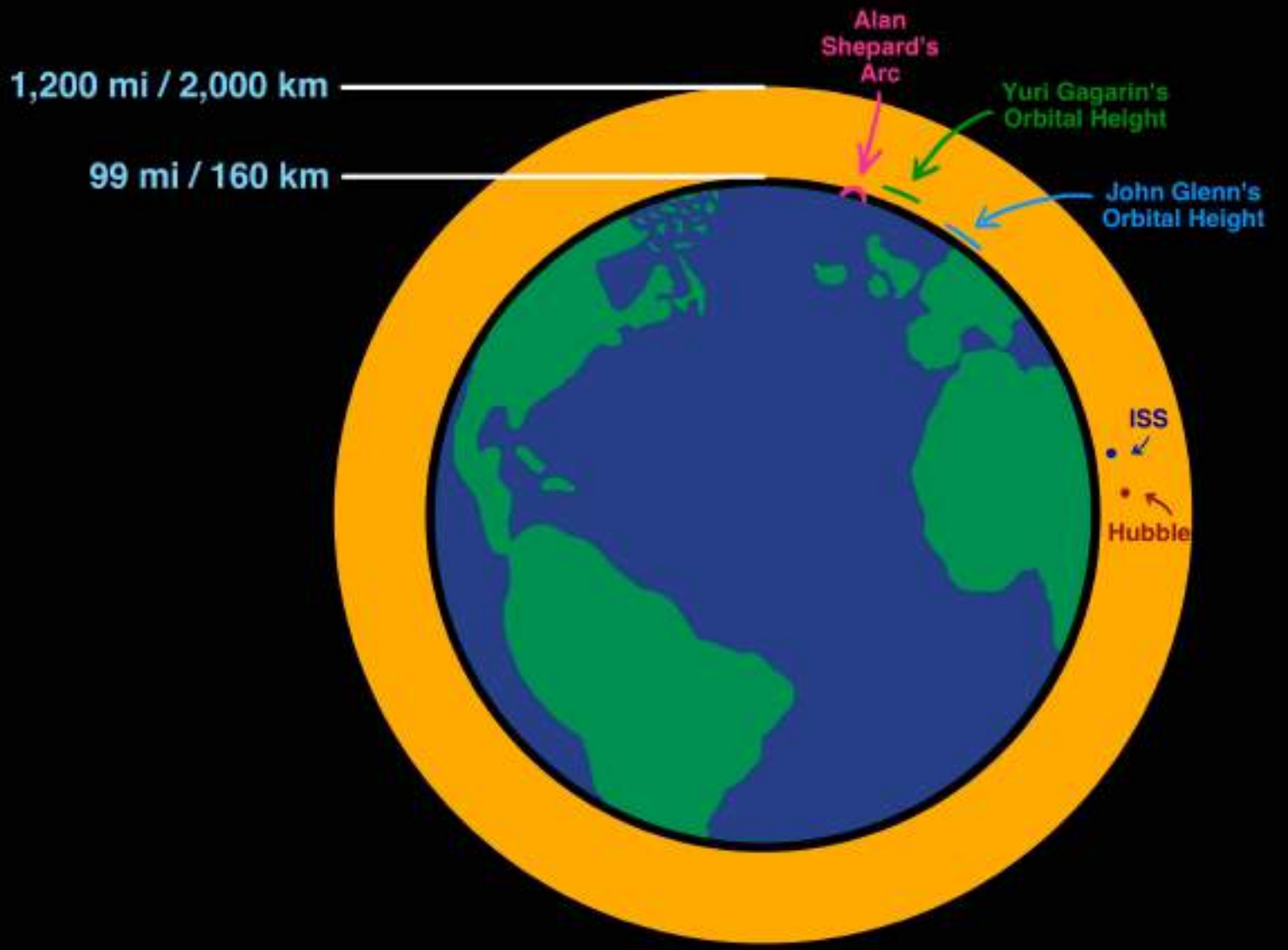




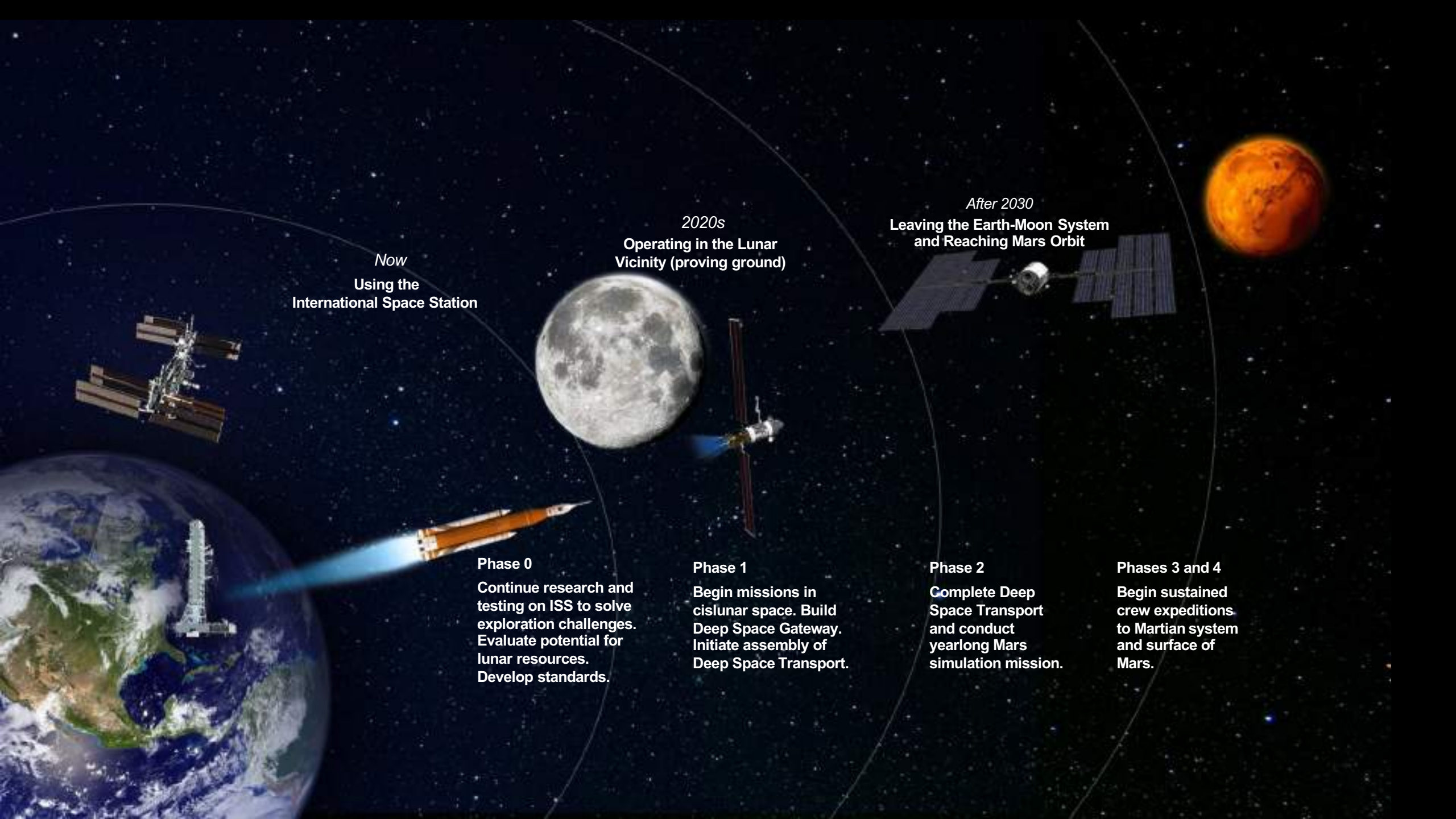
Apollo 17
Last Moon landing
(December 1972)

Low Earth Orbit (LEO)

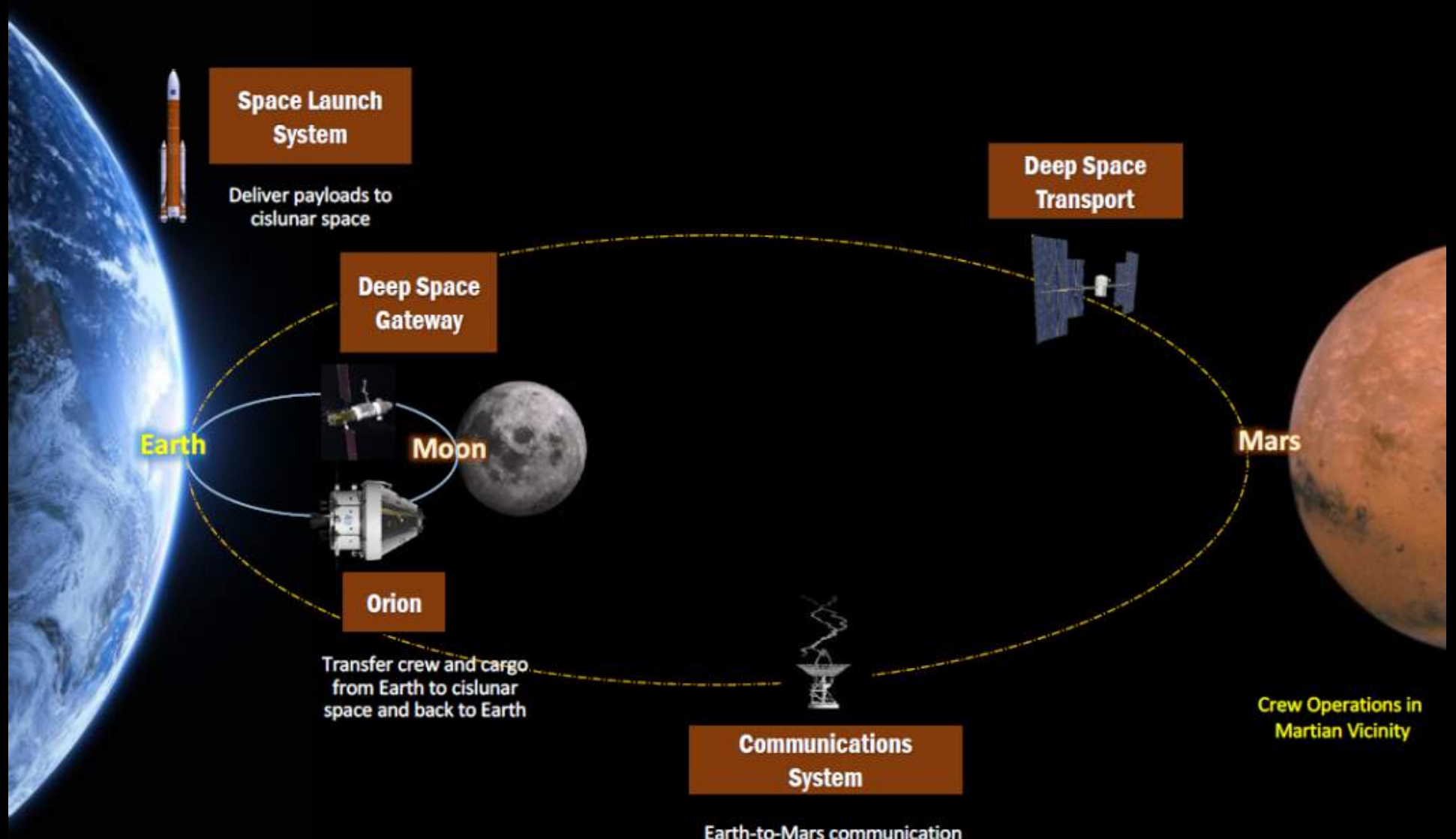
All sizes to scale



waitbutwhy.com

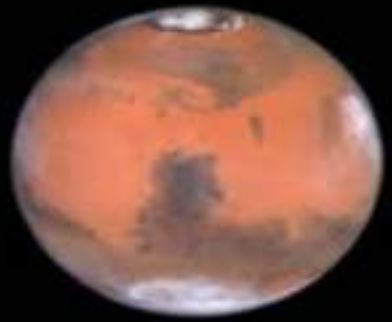

Now
Using the International Space Station
2020s
Operating in the Lunar Vicinity (proving ground)
After 2030
Leaving the Earth-Moon System and Reaching Mars Orbit
Phase 0
Continue research and testing on ISS to solve exploration challenges. Evaluate potential for lunar resources. Develop standards.
Phase 1
Begin missions in cislunar space. Build Deep Space Gateway. Initiate assembly of Deep Space Transport.
Phase 2
Complete Deep Space Transport and conduct yearlong Mars simulation mission.
Phases 3 and 4
Begin sustained crew expeditions to Martian system and surface of Mars.

Example Phase 3 Mission Elements



Compare Going to Mars to Where We Are Today with ISS

228,000,000 kilometers



~1 - 3 years transit time

Communications (up to 42 minutes)

~ 2 days transit time

Communications (near real-time)

Crew exchanges

Crew supplies and logistics

Crew and atmosphere samples

Modified hardware

Emergency Crew Return

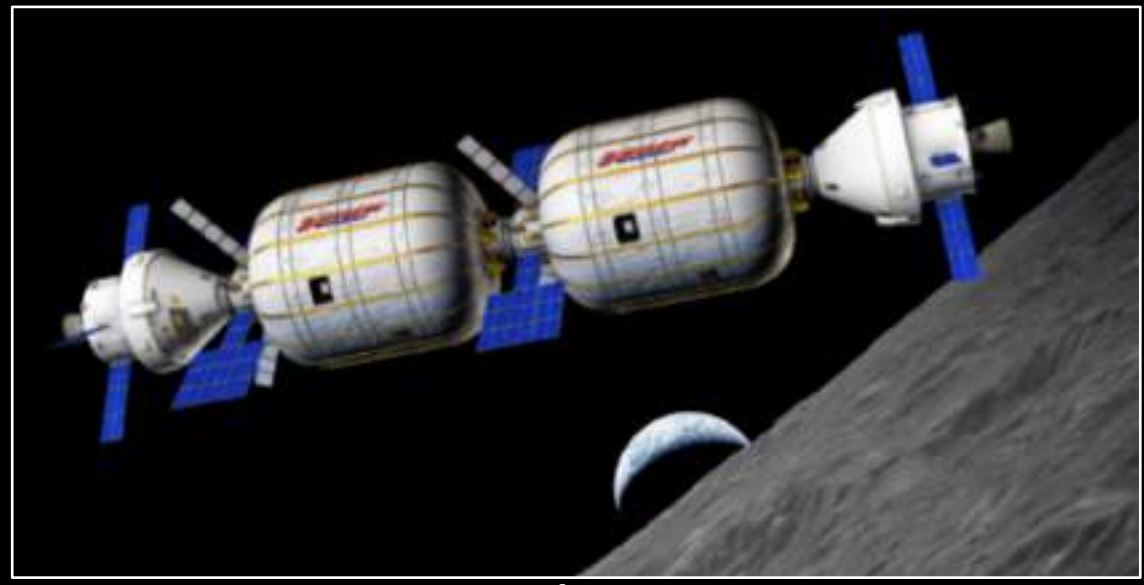
Trash

" recreate living on Earth capability "

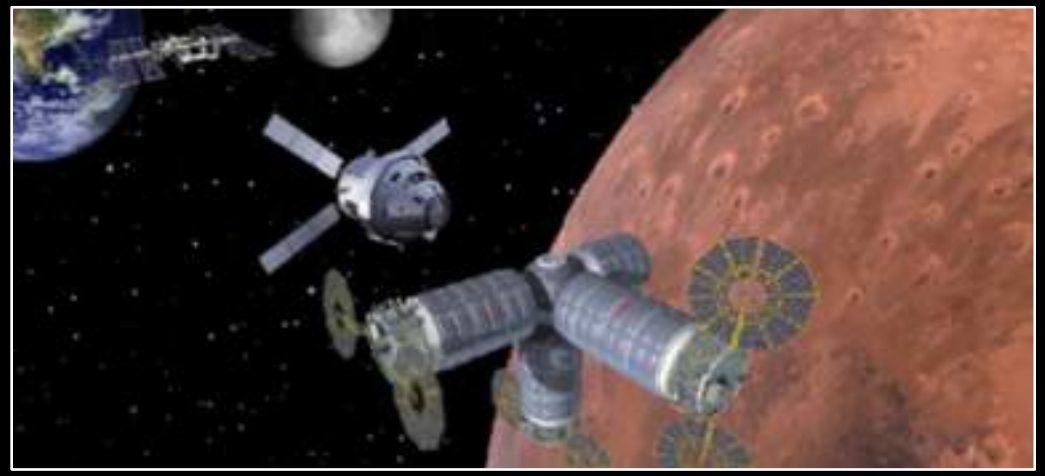
390 kilometers

" extreme car camping in space "

Lockheed Martin | Denver, CO



Bigelow Aerospace LLC | Las Vegas, NV

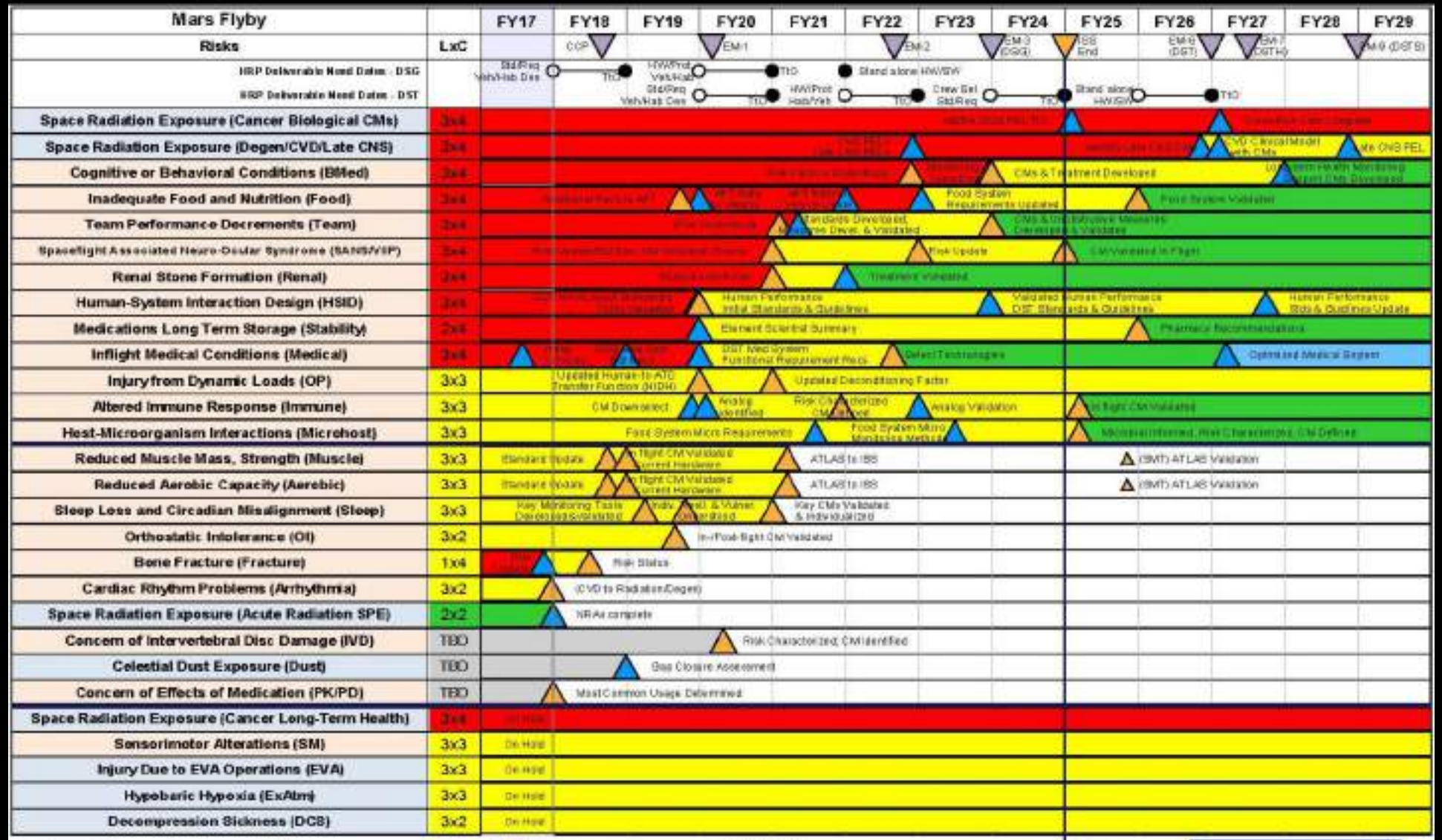


Orbital ATK | Dulles, VA

Boeing |Houston, TX

HRP Integrated Path to Risk Reduction

PPBE19 Baseline



Autonomous Clinical Care

Crew Health Care Facility

- non-invasive diagnostic capabilities for medical/surgical care
  - "smart" systems
  - non-invasive imaging systems
- definitive surgical therapy including robotic surgical assist devices and surgical simulators
- blood replacement therapy
- laboratory support

Telemedicine

- preventive health care
- diagnostic/therapeutic capabilities from ground-based consultants

Mars Surface Stay Requirements

Autonomous facilities

Crew health care

- Radiation Protection
- Medical Surgical care
- Nutrition - Food Supply
- Psychological support
  - meaningful work
    - surface science
      - planetary
      - biomedical
    - simulations of Mars launch, trans-Earth injection, and contingencies
    - progressive debriefs, sample processing, etc.
    - housekeeping
  - communications capability

Habitat

- Maintenance/housekeeping
  - workshop with HRET capabilities
- Exercise supplemental to Mars surface activities
- Recreation
- Privacy

HRET: human-robotic exploration team

Rodent Research Contributes to Osteoporosis Treatments

Ames Research Center

Amgen Inc.
Thousand Oaks, California

NASA Technology

- NASA needs to learn how to protect bone density and muscle strength in astronauts while in space
- The Commercial Biomedical Testing Module (CBMT) developed at Ames houses mice for experimentation in microgravity to study the problem

Technology Transfer

- Amgen, through BioServe Space Technologies, arranged to test three treatments for maintaining bone health and density on mice aboard space shuttles
- Experiments traveled aboard missions in 2001, 2007, and 2011, yielding promising results

Benefits

- One of the three treatments is now available as Prolia, an osteoporosis treatment, and a second is in clinical trials
- Prolia is shown to increase bone density and significantly reduce risk of bone fractures

Pressure Garments Save New Mothers' Lives

Ames Research Center

Safe Motherhood
San Francisco, California

NASA Technology

- G-suits are worn by aviators and astronauts to prevent pooling of blood in lower body during extreme acceleration and reentry from orbit
- NASA discovered that similar compression garments can be used to treat women who experience severe bleeding after giving birth

Technology Transfer

- In the 1990s, the company ZOEX utilized NASA's research to develop the Non-Inflatable Anti-Shock Garment
- Later, an obstetrics professor designed a similar garment, the Non-Pneumatic Anti-Shock Garment (NASG), to stabilize women suffering from post-natal bleeding until they can receive medical care

Benefits

- The NASG is backed by the World Health Organization and used in 20 countries.
- Mortality rate among women suffering obstetric hemorrhaging reduced by 50 percent in studies conducted in Egypt, Nigeria
- Garment can be used at least 70 times, which comes out to less than a dollar per application.

Tool Kit Simplifies Development of High-Affinity Molecules

Johnson Space Center

AM Biotechnologies LLC
Houston, Texas

NASA Technology

- NASA will need new diagnostic capabilities to monitor astronauts' health as they travel to Mars
- Antibodies, commonly used to detect biomarkers, degrade when exposed to radiation and are only viable for a few months

Technology Transfer

- Short strands of DNA and RNA can fold themselves into three-dimensional structures called aptamers, which can be used for diagnostics, are impervious to radiation, and don't degrade
- After securing an SBIR contract, AM Biotechnologies developed a new method to rapidly create precise diagnostic aptamers using micro-beads that aptamers stick to

Benefits

- X-Aptamer Selection Kit, already being used by universities and industry, takes days, not weeks, to create the desired aptamers
- X-Aptamers could be used to target drug treatments for cancer, other diseases
- One aptamer, Pegaptanib, approved by the FDA as a treatment for macular degeneration

Space-Ready Spectrometer Offers Terrestrial Advantages

Jet Propulsion Laboratory

Brimrose Corporation
Sparks, Maryland

NASA Technology

- In the 1990s, NASA was looking for a rugged spectrometer for a lander to be carried by the European Space Agency's Rosetta comet orbiter
- Chemical composition analysis was to be conducted by spectroscopy in the near-infrared and visible light spectra

Partnership

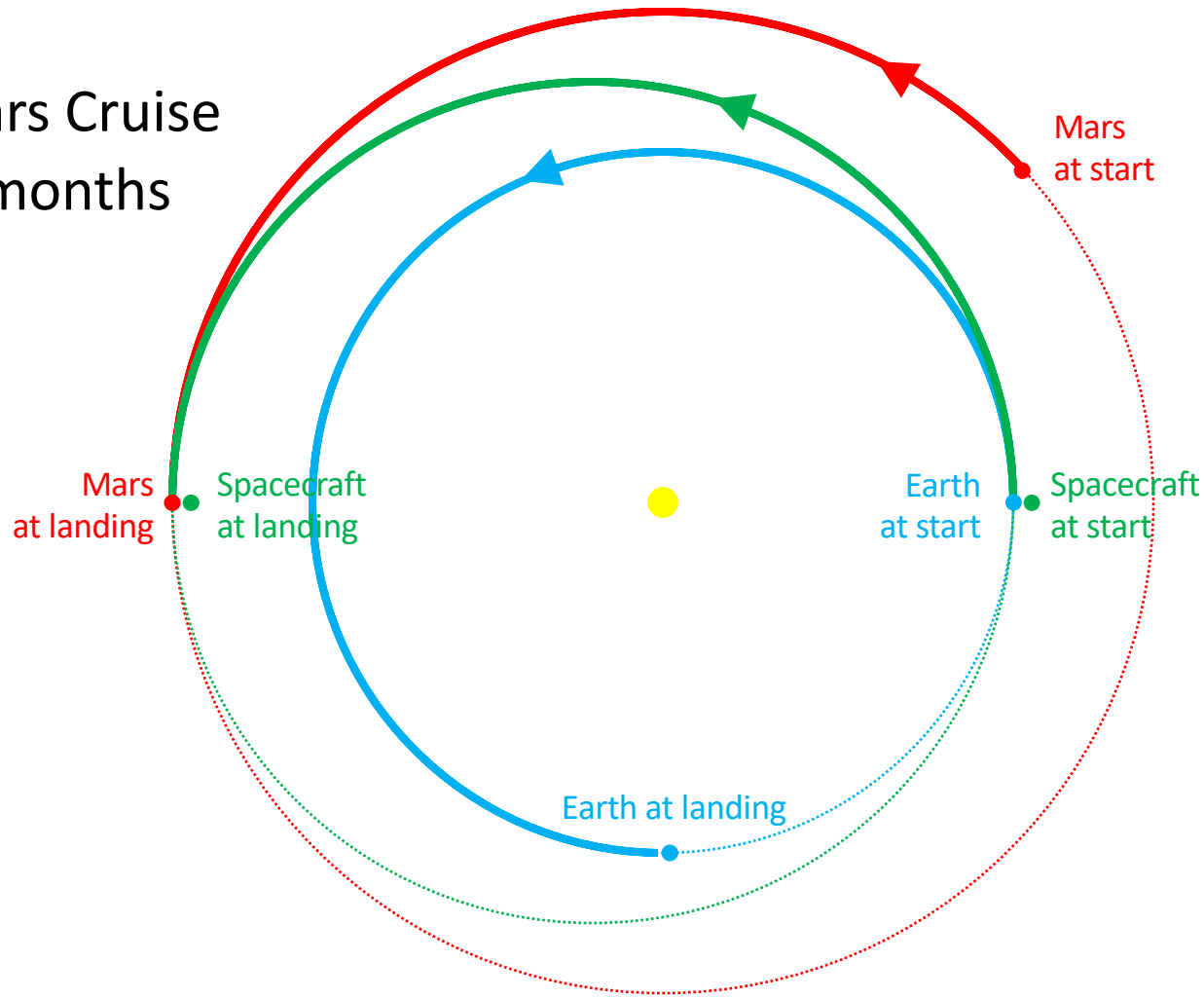
- Brimrose secured two SBIR contracts to make a space-ready acousto-optic tunable filter (AOTF) spectrometer, but NASA pulled out of the lander project
- Spectrometer made to be lightweight, energy-efficient, and able to withstand extreme temperatures and radiation exposure

Benefits

- Brimorse's Luminar AOTF analyzers now widely used by pharmaceutical industry, agriculture, healthcare, material science, oil companies
- New versions include touchscreens, longer battery life, and Linux compatibility
- Company uses AOTF in other applications, including acousto-optic modulator flown on ISS

Access to the Deep Space Network for the vehicle may be as limited as 1 hour in a 24 hour period.

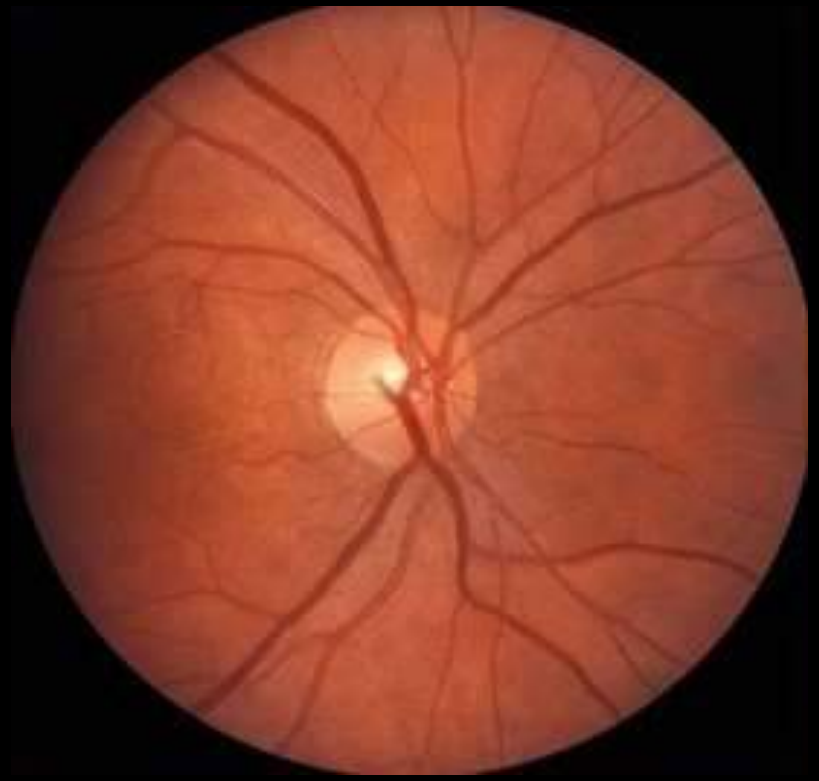
Trans-Mars Cruise
About 9 months



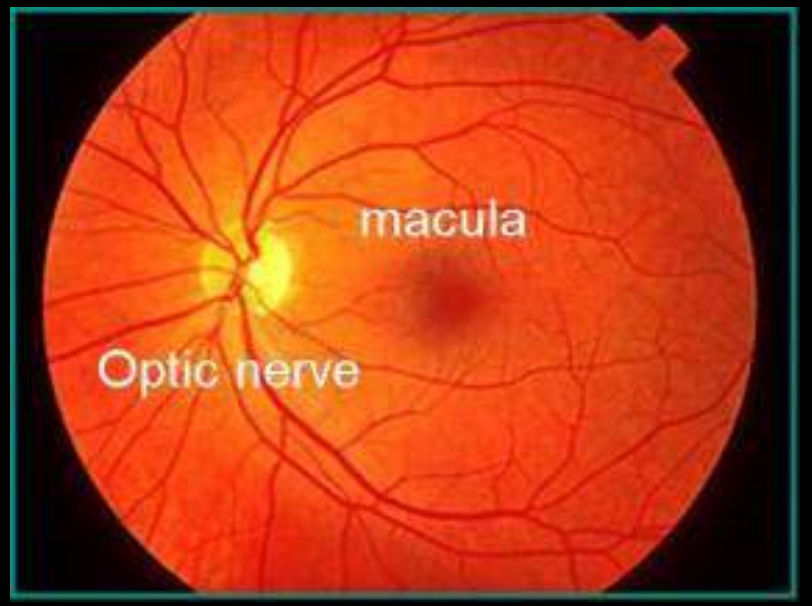
A Mars mission cannot use the current operational medical approach because that approach is totally dependent on real-time communication with the ground.

Spaceflight Associated Neuro Ocular Syndrome (SANS)

- SANS case definition:
  - Diagnosis: Papilledema Frisen grade 1 o more through fundoscopy.



Self-Imaging, Wide Angle, High Resolution Retinal Imaging System



Bob Main, ABOM
SeeCare Technologies LLC


Intelligent Ultrasound

Lymphatic Imaging Device

Eva Sevick, Ph.D.
U.T. Health Sciences

What it does

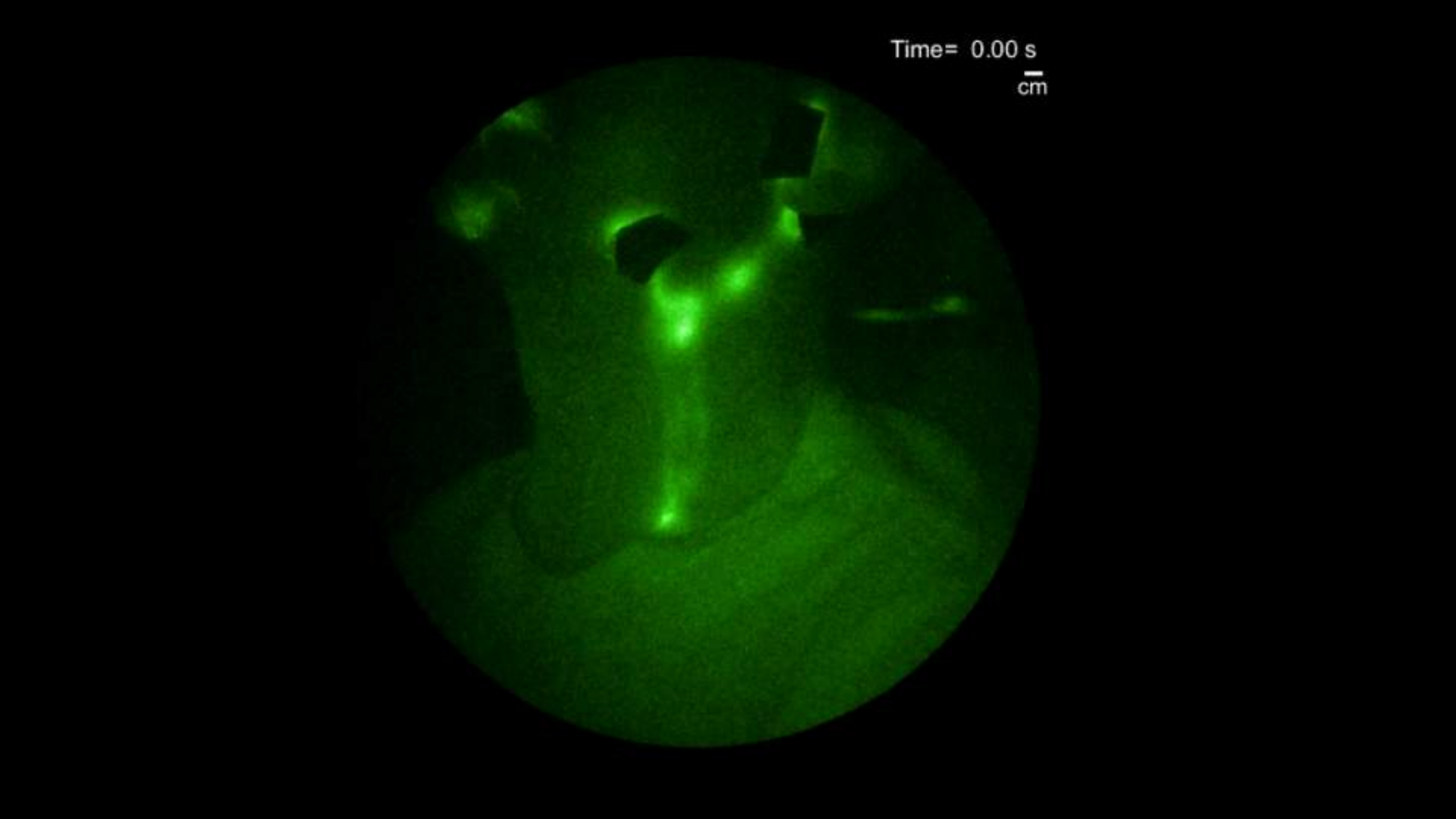
- Helps to obtain lymphatic flow images
- Software will be able to estimate flow

Why it's cutting edge

- New technology using a NIRF (infrared) camera
- Uses minimal amounts of injected dye
- FDA approved

How it can be used

- Could help to explain what causes SANS (Spaceflight Associated Neuro-Ocular Syndrome)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