



ISSRDC



EXPLORATION MEDICAL INTEGRATED PRODUCT TEAM

ISS Technology Demonstrations for Future Spaceflight Medical Systems

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Human Research Program

STEPS TO MARS



EARTH:

Simulated spaceflight hazards
in Ground Analogs | :envihab |
Antarctic Stations | NEK | HERA |
Space Radiation Lab

LOW EARTH ORBIT:

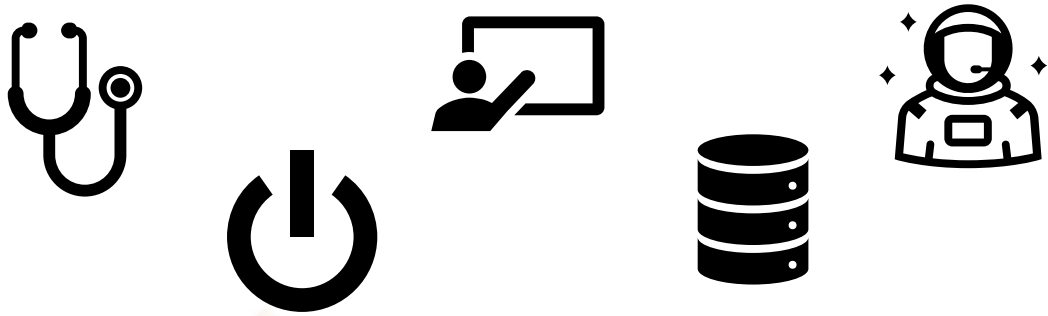
International Space Station –
A unique testbed to study micro-
gravity and environment hazards,
with varying mission durations

LUNAR MISSIONS:

Decreasing Earth-dependence
around and on the lunar surface.
Provides insight into deep space
radiation; behavioral health, and
gravity transitions



What does the need for medical capabilities beyond low earth orbit look like?



Different methodologies can be considered when assembling an **exploration spaceflight medical system**.

Multiple separate medical devices are currently used on the International Space Station (ISS).

Devices can **integrate capabilities**, potentially providing efficiencies over multiple separate devices however this also introduces **single point of failure** risk.

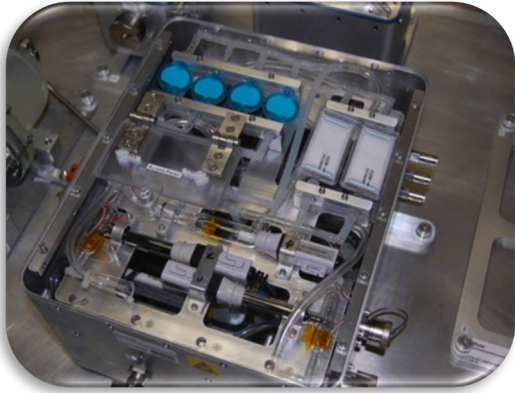
Capabilities documented in:
[Long Duration Lunar Orbit and Lunar Surface \(LDLOLS\)](#)

medical system foundation capabilities created by NASA's Exploration Medical Capability (ExMC) element.

[Mars Medical System Capabilities Prioritization List](#)

created by NASA's Exploration Medical Integrated Product Team (XMIPT).

Technology Demonstrations: Timeline on ISS



2010

2016-2018

2020

2021

2022

2022

IVGen

MCT

AMOS

HemoCue

rHEALTH One

AMOS

2024 Technical Sessions

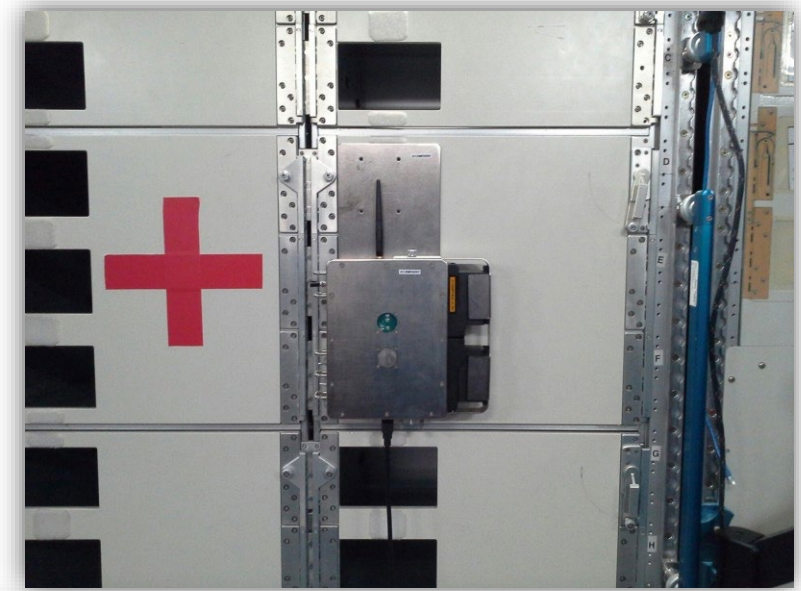
In-situ Laboratory Analysis

- An **in-situ medical capability for blood analysis** could provide an important tool for meeting the medical diagnosis needs of crew members during long-duration missions beyond LEO.
- **HemoCue®** WBC DIFF analyzer (HemoCue, Brea, CA) – marked the first time that white blood cell measurements were successfully performed real-time in microgravity.
- reusable Handheld Electrolytes and Lab Technology for Humans (**rHEALTH**) ONE (rHEALTH, Bedford, MA) – flow cytometry and sheath-based hydrodynamic focusing methodologies successfully demonstrated in microgravity.



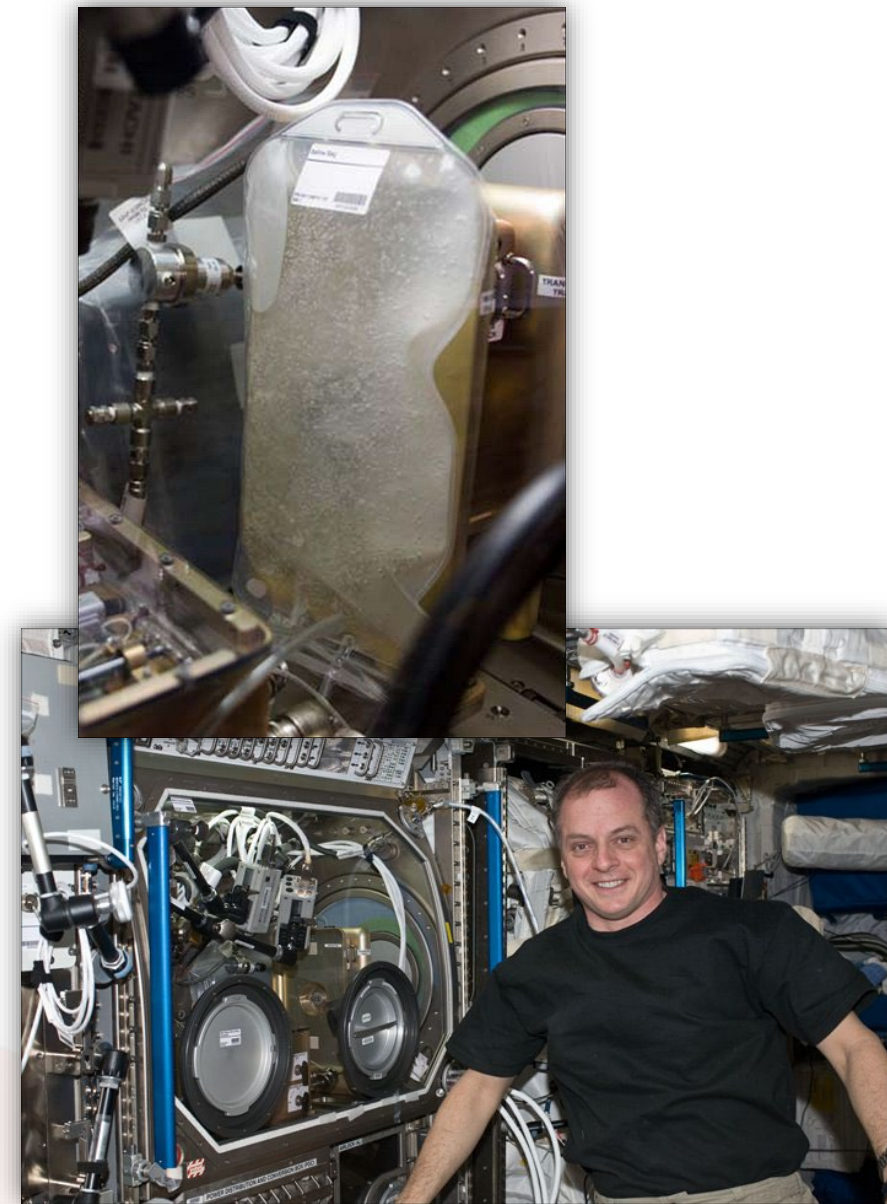
Medical inventory

- NASA currently relies on **crew self-reporting** to manage and maintain medical inventory on ISS.
- The ability to maintain an **accurate inventory** becomes more critical during long duration missions since the crew will need to be increasingly autonomous in **finding and utilizing** medical items, including those scenarios when alternative treatments need to be considered due to limited or no resupply.
- HRP's Medical Consumables Tracking (MCT) project was developed by ZIN Technologies, Inc.
- Demonstrated **real-time tracking of medical supplies** aboard the ISS utilizing Radio Frequency Identification Device (**RFID**) technology to perform automated inventory and was installed in the Crew Health Care System (CHeCS) Resupply Stowage Rack (RSR).
- Battery powered system that performed an **automated inventory** cycle every 30 days and had a **manual** initiation option. Results of locker contents **transmitted wirelessly** to ground.



Intravenous Fluid

- The challenge of **limited shelf life**, exacerbated by lack of resupply opportunities beyond low earth orbit, affects a plethora of medical system components including IV fluid.
- HRP's intravenous fluid generation (IVGEN) project was developed by ZIN Technologies, Inc.
- IV fluids were successfully generated with IVGEN using the **potable water** supply on ISS and XMIPT is in the process of developing a **miniaturized version** of the original IVGEN hardware for a future Tech Demo aboard the ISS.
- ISS demo produced **2 bags of saline solution**, and **4 bags of purified water**. The saline solution was returned to ground and evaluated per the USP standard.
- USP testing resulted in passing results for **endotoxin** and **sterility** tests, but some **saline concentration** inconsistencies were observed.



Medical Training

- The Autonomous Medical Officer Support (AMOS) project is developing an autonomous training and guidance tool to augment crew members' medical capabilities when out of direct contact with Earth.
- Software is menu-driven, human-centered and modular in design.
- Enhances telemedicine capabilities, reduces preflight training load, streamlines skill management process, and enables autonomous procedure performance.
- Current modules focus on kidney and urinary bladder ultrasound guidance.
- AMOS tech demos highly successful, with acceptable to excellent bladder and kidney images obtained by untrained users.



ULTRASOUND IMAGING KIDNEY

MENU ← | Help | Exit

OBJECTIVE FOUNDATION SETUP EXAM PROCEDURE QUIZ SURVEY REFERENCE

OBJECTIVE PROCEDURE OUTLINE RIGHT KIDNEY LEFT KIDNEY ENDING THE EXAMINATION

Right Kidney: Finding the Kidney and the Starting View

STEP 3 OF 11
OPTIMIZE THE RIGHT KIDNEY STARTING VIEW:

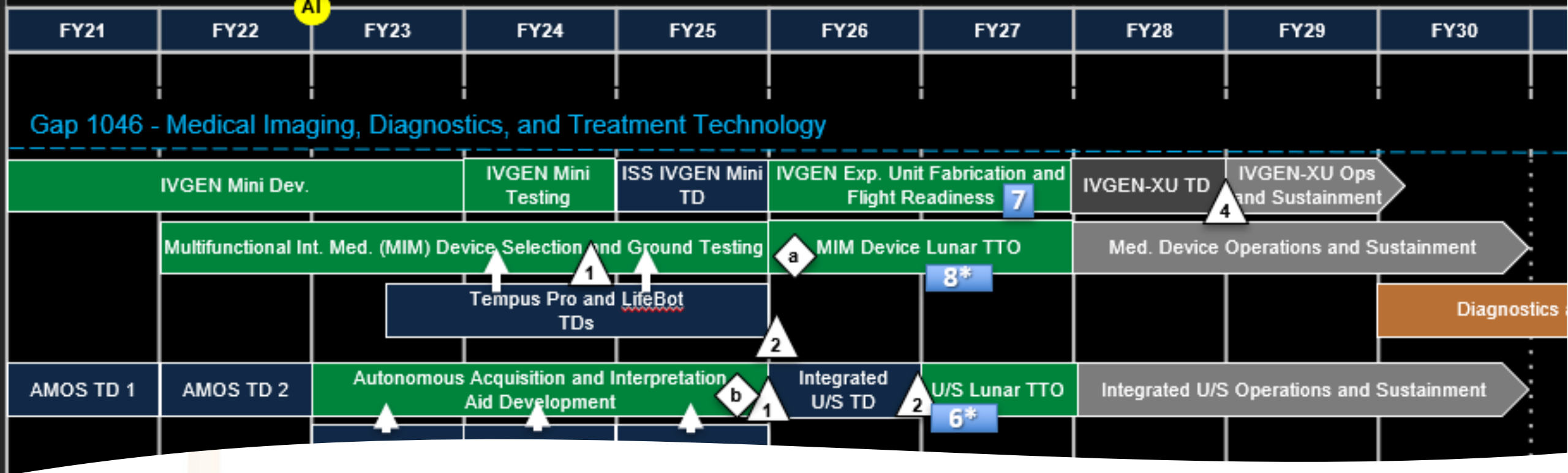
- A. Apply **probe** at zone purple 2 (grid in Figure to right) with probe marker towards the subject's head. ([Review probe handling in Foundation section](#))
- B. Look for the **kidney** (Note that kidneys move with respiration).
- C. If not found at once, use rapid meandering up, down, and towards the side of the body. Once the kidney is found, reduce speed and range of probe movement.
- D. Apply more **gel**, reapply probe to same location, and adjust the **gain** as needed.
- E. Slowly move the probe to hover over the kidney, i.e., bring the kidney to the middle of the image with small adjustments.
- F. Tune probe position for longest image (left-to-right dimension on the screen) to include upper pole (left on image) and lower pole (right on image) ([Review in Foundation section](#)).
- G. Translate probe away from spine while keeping the kidney in longest view, optimizing for the widest image (up-down dimension on the screen).
- H. Practice tilt-sweeping throughout the volume of the kidney. Longest and widest view is the Starting View ([Review in Foundation section](#)).

Right Kidney Starting View

Procedure Milestone: You have arrived at the Starting View for right kidney imaging- ready to begin right kidney imaging and data collection.

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59



Roadmap and Future Work

- HRP and MCO are setting priorities for tech demos and supporting annual tech demos using a combination of mCOTS and in-house developed technologies, computational models, and software tools.
- It may be beneficial to customize or modify devices for spaceflight medical systems that only contain required capabilities.
- Some commercially available devices currently do not interface easily with an integrated data architecture and more data interface development will be needed.

Acknowledgements

Thank you to NASA's Human Research Program and Mars Campaign Office for supporting medical device tech demos.

Thank you to all my co-authors for their tremendous expertise, dogged tenacity, and passion!

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"Space is for everybody. It's not just for a few people in science or math, or for a select group of astronauts. That's our new frontier out there, and it's everybody's business to know about space."

– Christa McAuliffe [US Teacher & Astronaut]

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