



ROI Spaceflight Implementation: Top Tips and Recommendations

Human Research Program
Research Operations & Integration
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Outline

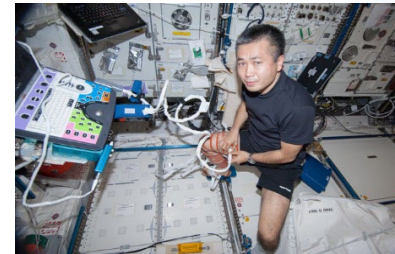
- Overview of the spaceflight environment
 - ISS
 - The changing environment
 - New and upcoming capabilities
- Challenges in conducting spaceflight research
- ROI
- Tips for new PIs



The International Space Station (ISS) and Human Research



- The ISS is our best available platform for studying the unique effects of spaceflight stressors on the human to prepare for future missions beyond low Earth orbit (LEO)
- Astronauts on the ISS participate in human research studies across a wide range of topics as we study individual and integrated human systems
- Complexity of human research on the ISS has increased over time
- There are many research tools available to investigators who wish to conduct human physiological research on ISS and specialized tools may be flown for specific studies
- Implementation of human life sciences research during space flight is limited by various resource constraints



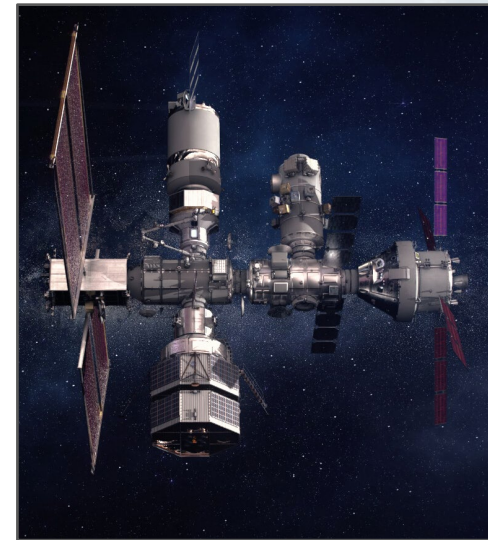
The Changing Spaceflight Environment

- Increasing commercial presence in spaceflight
- Multiple options for launches and landings
- Mix of government, professional, and private astronauts
- Upcoming ISS decommissioning
- Return to lunar missions
- Use of lunar missions and LEO to prepare for Mars



New and Upcoming Capabilities

- The return of US-based launches and landings with new vehicles
- Commercial free-flyer missions
- Commercial missions to the ISS
- Commercial Low Earth Orbit Destinations (CLD)
 - Commercial space stations
- Artemis
- Gateway



Challenges in Conducting Spaceflight Research



- Crew time: preflight, inflight and postflight
- Conflicts and constraints with competing research
- Sample storage and stability
- Experiment complexity
- Power requirements
- Data and communications availability
- Hardware access/failures
- Restricted flight ops
- Weight and volume
- Astronauts may be presented with over 30 human research experiments
 - and select, on average ~15 in which to participate
- **These challenges will vary by vehicle, mission, and/or platform**



Research Operations and Integration (ROI)



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- Work with HRP, Elements, and PIs to understand research goals and develop ways to capture data during spaceflight
 - Crew-time –before, during and after flight are limited
 - Spaceflight environment –microgravity, radiation and confinement
 - Up/down mass constraints
 - Technology constraints



Research Operations and Integration (ROI)



- Work with groups inside and outside of NASA to enable the science:
 - NASA Medical Operations
 - NASA Flight Operations Directorate
 - International Partners
 - Commercial Vehicle Providers



Research Operations and Integration (ROI)



■ Science Data Collection Support:

- Astronaut testing support
- Informed Consent Briefings
- Communication of testing details/requirements
- Provide real-time guidance for operations
- Coordinate and negotiate with internal/external groups



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Tips for New PIs Conducting Spaceflight Research



- Know your requirements and communicate early
 - Planning for spaceflight missions typically starts more than a year in advance
 - Properly defining your research requirements and getting them documented is critical to successful integration and implementation
 - Requirements that are not documented, or are documented poorly are unlikely to be implemented
- Be flexible and build that flexibility into your requirements
 - For all resources, you will be one among many requests and requirements that need to be balanced
 - Balance flexibility with experimental control in developing constraints (“Goldilocks” approach), flex but not so much your science breaks
 - New missions, vehicles, and studies mean a higher chance for things to go wrong, be prepared for ‘good enough’ but not perfect science
- Plan to share
 - Don’t design your study assuming you’ll be researching alone, many experiments have overlapping requirements: blood draws, behavioral surveys, heart rate measurement, etc.
 - Where possible, these measures are combined to reduce redundancy and save crew time; investigators can access these data via data sharing agreements



Tips for New PIs Conducting Spaceflight Research



- Be kind to your human research subjects
 - Crewmembers participating in flight research are limited by crew time, resources, competing science
 - Avoid subject burn out, eliminate as much redundant testing as possible, minimize crew time needs
 - Consider the unique challenges of spaceflight, collecting biological samples and many other measures is more difficult in spaceflight than on the ground
- Understand your responsibilities as the researcher
 - Keep to the schedule and deliverable milestones, this will give your study a much better chance of being implemented
 - IRB – You are responsible for managing your study with the IRB of record (often the NASA IRB) and other relevant IRBs (e.g., JAXA, ESA, HRMRB), and ensuring privacy and confidentiality of subject data and health information
 - If funded by NASA you have unique responsibilities – submitting data to NLSP/LSDA and final reports to NASA
- Stay aware of the environment and mission your study is in
 - When designing and modifying your study consider key environmental factors and potential confounds: sleep/wake schedule, diet, exercise, lighting environment, other bio sampling, medications, other surveys
 - Validate and test your protocol, procedures, hardware, and software on the ground before attempting to fly them



Tips for New PIs Conducting Spaceflight Research



- Play well with others
 - Your study is unique, your measures (and crew time requirements) may not be
 - Willingness to data share and combine measures is to the benefit of your subjects, NASA, and ultimately you
 - Communication is essential, each investigator brings specialized talents and skill to meet the mission objectives
- Research is not plug and play
 - Single point failures are not an option – plan for redundancy and backup plans in all aspects of your study design
 - Plan hardware, software, and procedures to allow remote troubleshooting; test everything in the lab
 - Depending on complexity and operations/hardware, the safety process can take weeks to months, plan ahead
- Plan ahead to get it right the first time - Second chances for data collection may be limited, if even possible
 - Ensure that supplies are delivered well before needed, support facilities are scheduled and available, including flexibility for weekend and evening support, coordinate shipments well in advance of delivery
 - If traveling to support a study arrive early and leave late, don't plan to arrive or leave the day of testing, plan for dry/wet runs
- You won't know data is missing until it's gone
 - Check your data as early and as frequently as possible, once a mission ends and a new mission starts fixing missing data issues lies somewhere between difficult and impossible





Thank you for your time and attention!

