

National Aeronautics and Space Administration



Human Research Program Opportunities

**3rd ISS Research and Development Conference
Chicago, IL
18 June 2014**



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Human Research Program Goal



The goal of HRP is to provide human health and performance

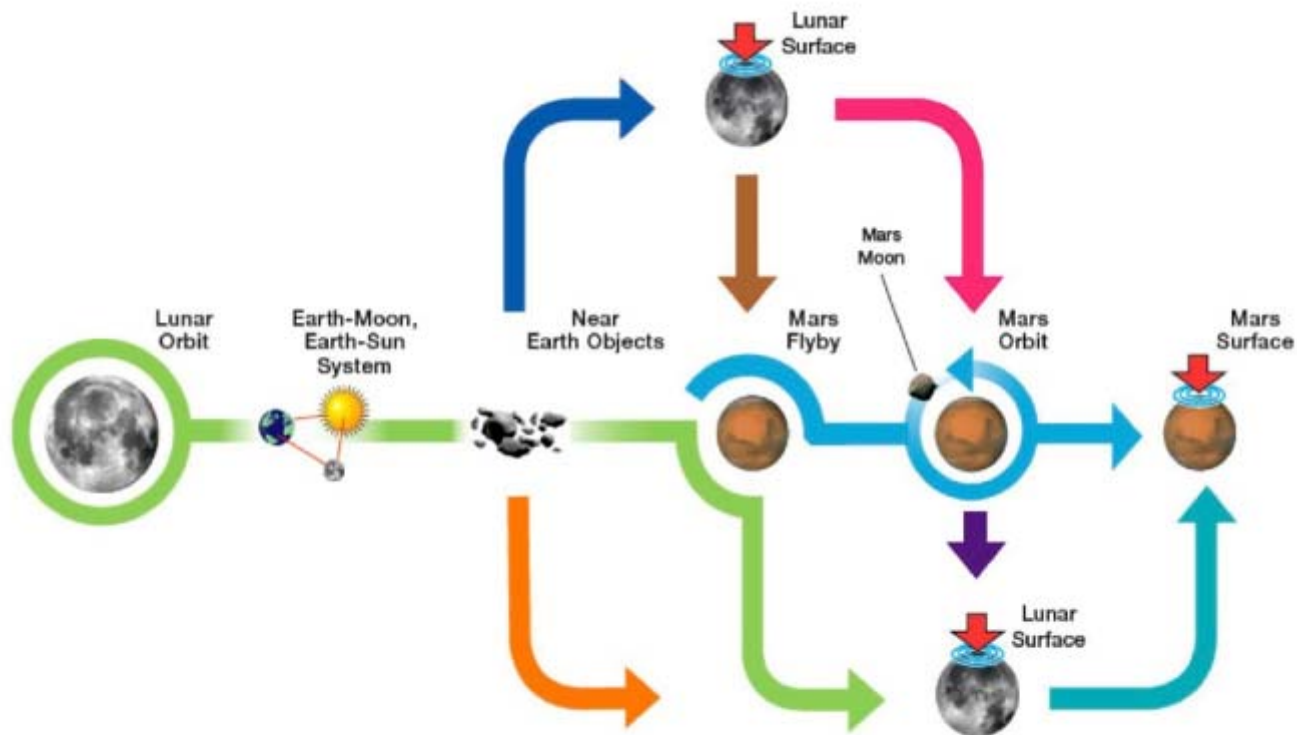
countermeasures,
knowledge,
technologies, and
tools

to enable safe, reliable, and productive human
space exploration.



18 June 2014

Future Missions: The Flexible Path



Schedules for the next destinations are unknown, but the goals are all beyond Low Earth Orbit (LEO)

Risks Requiring Human Research



CHP

1. Risk of Adverse Behavioral Conditions and Psychiatric Disorders
2. Risk of Performance Errors Due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness, and Work Overload
3. Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team
4. Risk of Performance Errors Due to Training Deficiencies
5. Risk Factor of Inadequate Nutrition
6. Risk of Bone Fracture
7. Risk of Cardiac Rhythm Problems
8. Risk of Clinically Relevant Unpredicted Effects of Medication
9. Risk of Crew Adverse Health Event Due to Altered Immune Response
10. Risk Of Early Onset Osteoporosis Due To Spaceflight
11. Risk of Impaired Performance Due to Reduced Muscle Mass, Strength and Endurance
12. Risk of Intervertebral Disk Damage
13. Risk of Orthostatic Intolerance During Re-Exposure to Gravity
14. Risk of Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity
15. Risk of Renal Stone Formation
16. Risk of Spaceflight-Induced Intracranial Hypertension/Vision Alterations
17. Risk of Adverse Health Effects Due to Alterations in Host-Microorganism Interactions

Behavioral, Physiological, Medical

ECLSS

HRMO+
AMO+?

Radiation

EDL

EVA

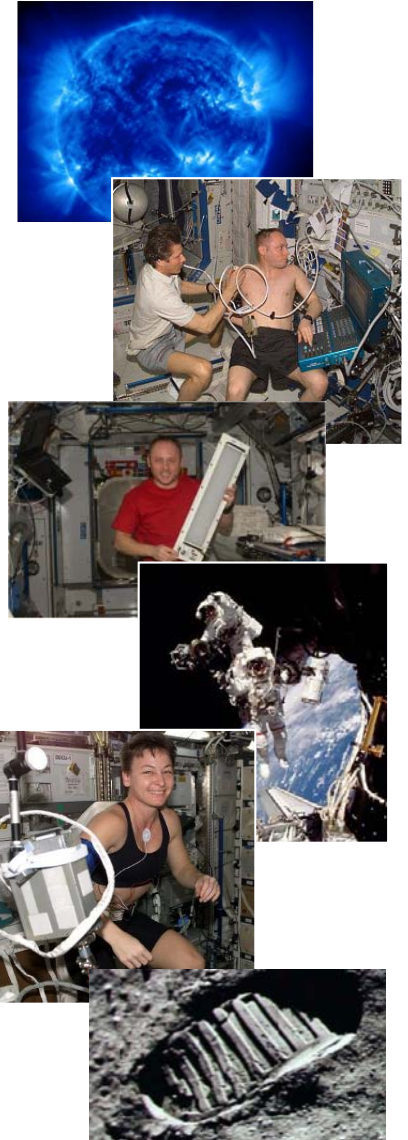
19. Risk of Injury from Dynamic Loads
20. Risk of Impaired Control of Spacecraft, Associated Systems and Immediate Vehicle Egress Due to Vestibular/Sensorimotor Alterations Associated with Space Flight
21. Risk of Compromised EVA Performance and Crew Health Due to Inadequate EVA Suit Systems
22. Risk of Decompression Sickness
23. Risk of Performance Decrement and Crew Illness Due to an Inadequate Food System
24. Risk of Adverse Health Effects of Exposure to Dust and Volatiles During Exploration of Celestial Bodies
25. Risk of Inadequate Design of Human and Automation/Robotic Integration
26. Risk of Inadequate Human-Computer Interaction
27. Risk of Inadequate Critical Task Design
28. Risk of an Incompatible Vehicle/Habitat Design
29. Risk of Radiation Carcinogenesis
30. Risk of Acute and Late Central Nervous System Effects from Radiation Exposure
31. Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs)
32. Risk Of Degenerative Tissue Or Other Health Effects From Radiation Exposure

Interfaces w/ Systems, Environment

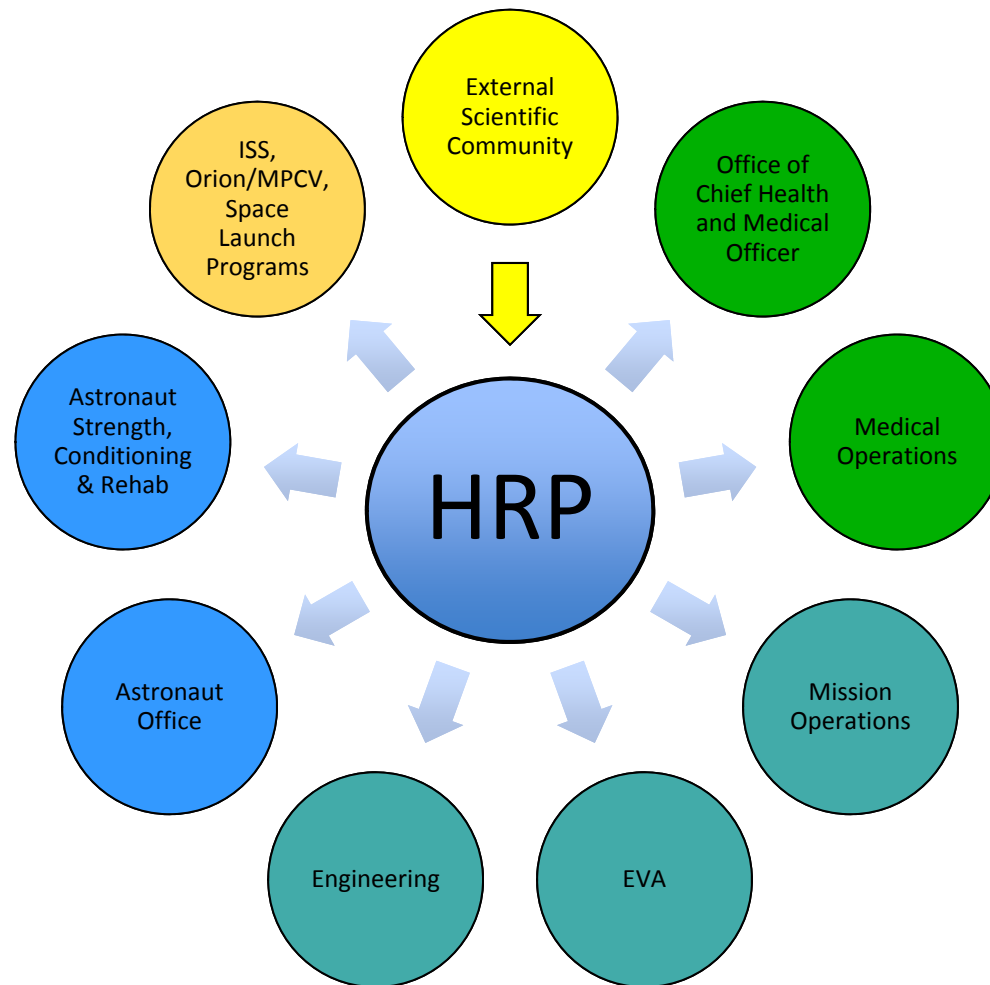
Overview: Components of HRP



- **Space Radiation**
 - ❖ Human health effects, limiting factors for vehicle environments and crew selection; computational shielding modeling; measurement, warning technologies
- **Exploration Medical Capability**
 - ❖ Medical care, crew health maintenance technologies (monitoring, diagnostic, treatment tools, techniques); medical data management; probabilistic risk assessment
- **Human Health Countermeasures**
 - ❖ Integrated physiological, pharmacological, nutritional countermeasures suite; Extra-Vehicular Activity (EVA) related physiology research to support new EVA suit development
- **Behavioral Health & Performance**
 - ❖ Behavioral health, performance monitoring tools, countermeasures (sleep/circadian; neurobehavioral; psychosocial), crew composition, selection, assessment, training capabilities; intervention, communication techniques to support exploration missions
- **Space Human Factors & Habitability**
 - ❖ Anthropometry, display/control, usability, cognition, habitability, lighting, ergonomics; advanced food development; lunar dust characterization, toxicological testing, characterization of microbiological hazards
- **ISS Medical Project**
 - ❖ ISS research integration and operations
- **National Space Biomedical Research Institute (NSBRI)**
 - ❖ Nationally competed, peer-reviewed research projects addressing HRP content utilizing investigators at more than 63 institutions in 23 states
- **Program/Science Management:**
 - ❖ Overall leadership of the program, support and integrate program science, policies and processes, and oversight of NSBRI Cooperative Agreement

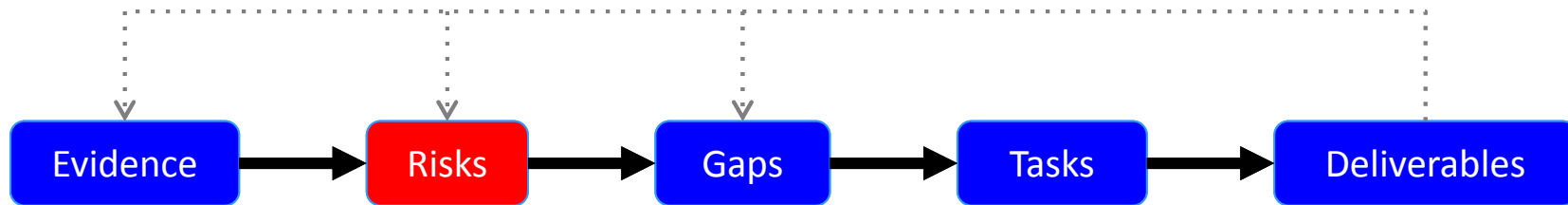


Integration With Other Organizations



10 Sept 2013

Program Architecture



Human Research Roadmap

A Risk Reduction Strategy for Human Space Exploration

Explore the Roadmap Search the Roadmap
HRP Architecture

32 Risks
279 Gaps
963 Tasks

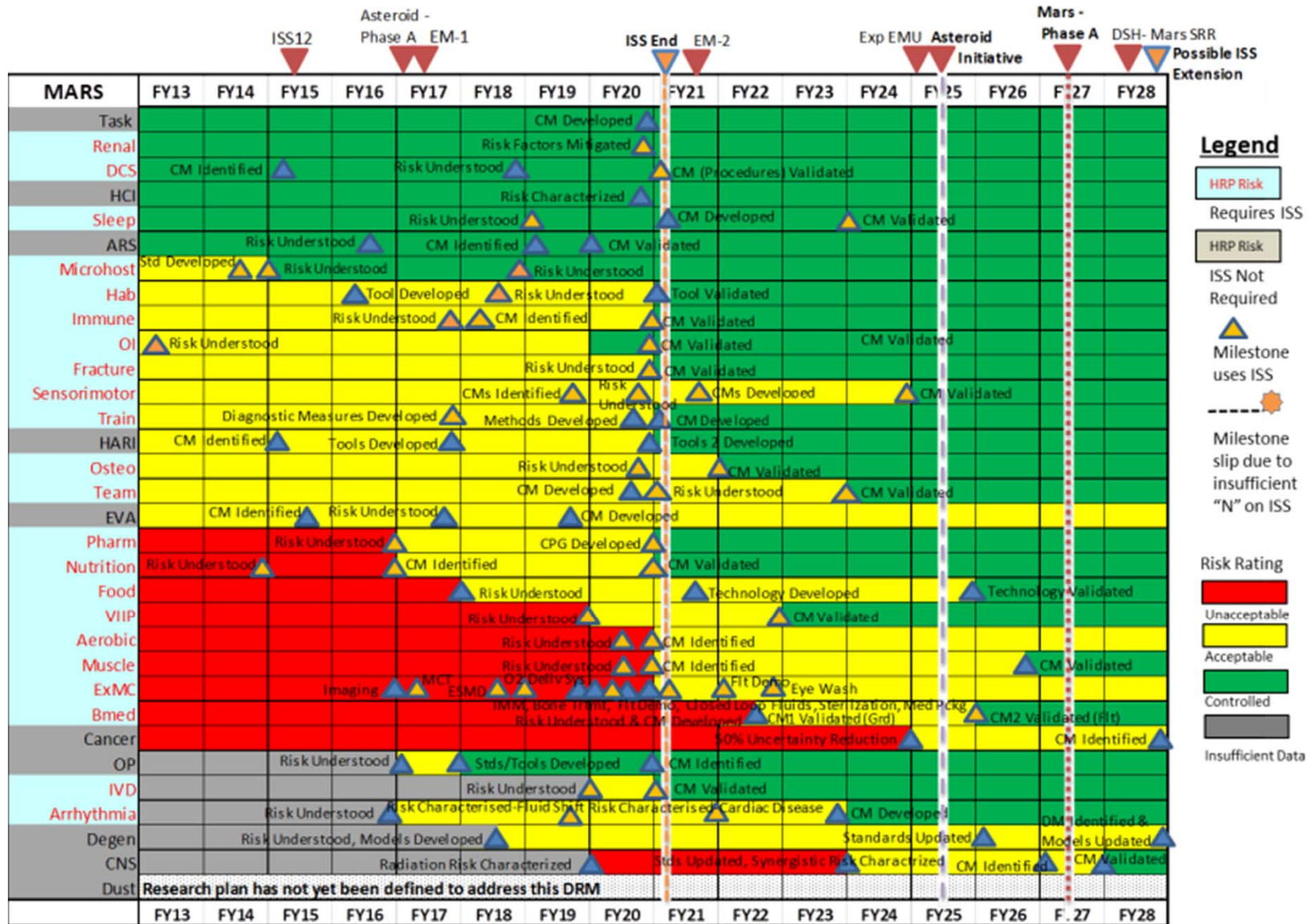
The complex block features a central graphic with a dark space background. It shows a space station in orbit, a bright orange sun, and a view of Mars with two astronauts on its surface. The text 'Human Research Roadmap' is at the top, followed by the subtitle 'A Risk Reduction Strategy for Human Space Exploration'. Below the graphic are two links: 'Explore the Roadmap' and 'Search the Roadmap', and the text 'HRP Architecture'. To the right of the graphic, a yellow-bordered box contains the statistics: '32 Risks', '279 Gaps', and '963 Tasks'.

<http://humanresearchroadmap.nasa.gov/>

HRP Path To Risk Reduction



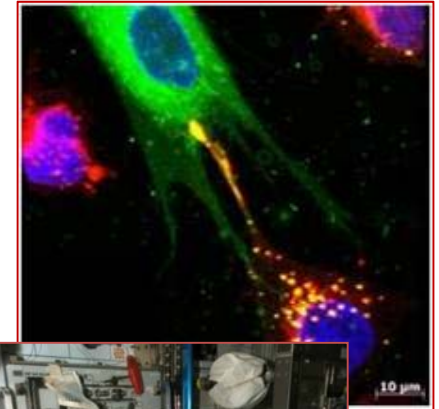
Under Revision



Overview: Human Research Program



- **Established in 2005 to focus NASA's research on highest risks to human health & performance during exploration missions**
 - ❖ Perform research necessary to understand and reduce spaceflight human health and performance risks in support of exploration
 - ❖ Develop technologies to reduce medical risks
 - ❖ Develop NASA spaceflight human system standards
- **Highest health risks associated with exploration missions have been identified, documented, reviewed, and are actively managed**
- **Research underpinnings have been established by National Academies**
- **Independent, external scientific review used extensively**
- **Collaborative research with Internationals, other U.S. Agencies**
- **Products include:**
 - ❖ Information to design exploration architectures, vehicles, and missions
 - ❖ Countermeasures
 - ❖ Research deliverables that define space medical, environmental and human factors standards (standards define acceptable human health risk)
 - ❖ Technologies and Tools



Solicitations



- **NASA Research Announcement (NRA)**
 - ❖ Human Exploration Research Opportunities (HERO)
 - ❖ Released annually, typically at the end of July
 - ❖ Solicits ground-based, bed rest definition and flight definition proposals
 - ❖ Issued jointly by NASA HRP and the National Space Biomedical Research Institute (NSBRI)
 - ❖ Topics are derived from HRP Integrated Research Plan, <http://humanresearchroadmap.nasa.gov>
 - ❖ “Flagship”- special emphasis topics currently under review
 - ❖ “Omnibus”- solicitation for investigations ≤ 1 year providing innovative approaches to any defined risk in the HRP Integrated Research Plan
 - ❖ International collaborators on U.S. proposals that demonstrate clear scientific benefits or cost savings are particularly encouraged
 - ❖ 2014 HERO will be available through NASA Research Opportunities homepage at <http://nspires.nasaprs.com>
 - NRA to be issued: July 30, 2014
 - Step-1 Proposals to be due: September 4, 2014
 - Step-2 Proposals to be due: December 3, 2014
 - Award notification: April 2015



Other Mechanisms

- **Other Solicitations**

- ❖ **Experimental Program to Stimulate Competitive Research (EPSCoR)**

- Directed at PIs in jurisdictions that have not in the past participated equably in competitive aerospace and aerospace-related research activities (e.g., Wyoming)
- EPSCoR solicitation typically released in first quarter of each year
- <http://www.nasa.gov/offices/education/programs/national/epscor/home/index.html>

- ❖ **Small Business Innovation Research (SBIR)**

- Targeted at PIs working at small businesses with 500 or fewer employees
- SBIR Program funds the research, development, and demonstration of innovative technologies that fulfill NASA needs and have significant potential for successful commercialization
- SBIR Program has three phases
- Solicitation is typically released in November of each year
- <http://sbir.gsfc.nasa.gov/>

- **Unsolicited proposals**

- ❖ NASA encourages the submission of unique and innovative unsolicited proposals which will further the Agency's mission
- ❖ May be sent by any PI at any time to:
 - Unsolicited Proposal Office
 - Mail Code BA
 - 2101 NASA Parkway
 - Houston, TX 77058-3696



Special Characteristics of HRP Research

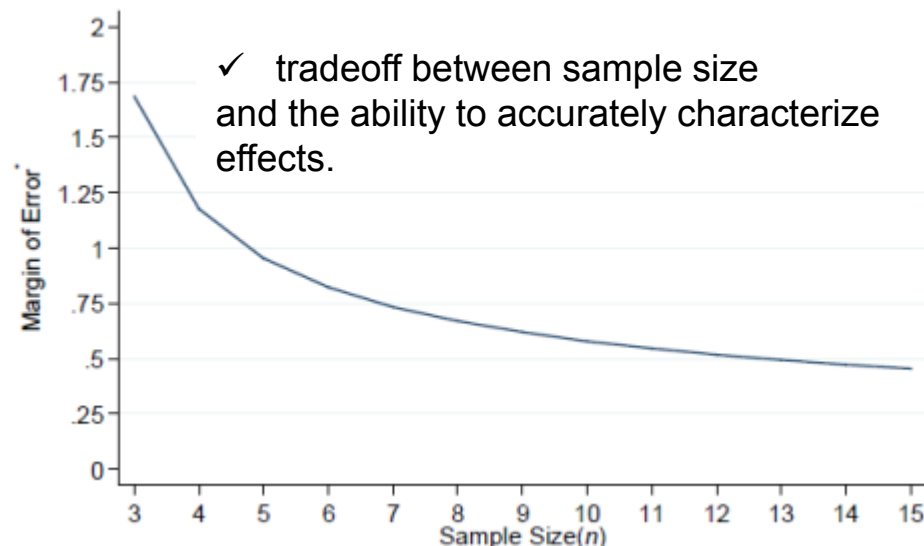
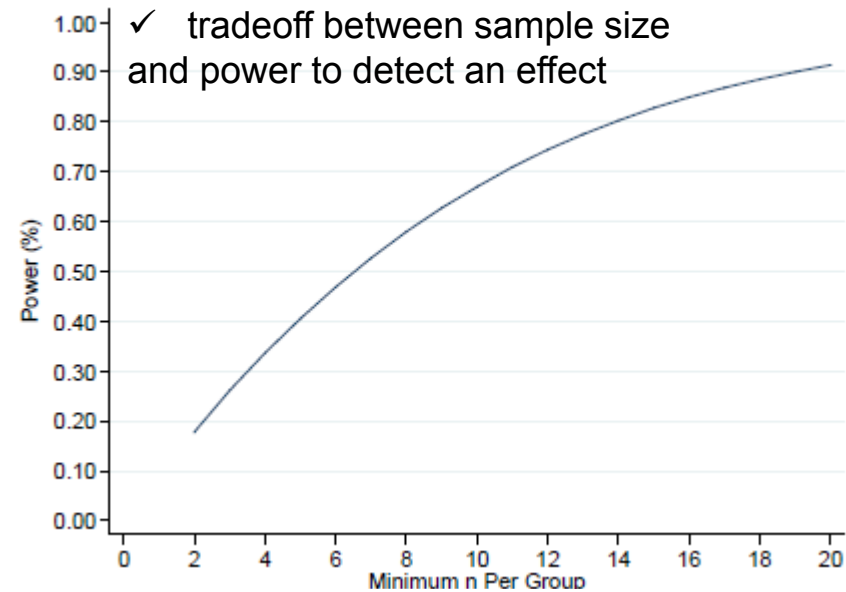
- **HRP conducts risk based research.**
- **Flexibility to replan or address new issues as needed.**
- **Limited time to get the “best” answer.**
- **Unique constraints.**
 - ❖ Small “n”
 - HRP considers ISS 1 year mission and ‘n’= 1 important
 - ❖ Constrained environments and often poorly controlled, less than ideal research conditions
- **HRP & NASA must make important decisions based on current information available.**
- **While awaiting a specific design reference mission HRP proactively defines critical mission attributes to guide research.**
 - ❖ Example: Duration (< 6 mo., > 6 mo.), communication delay
- **Obtain information and devices that have an immediate benefit to planned NASA exploration missions.**
- **Require access to exploration conditions, microgravity and space radiation.**
 - ❖ ISS and appropriate terrestrial analogs



How large does 'n' need to be?

- **Detecting meaningful changes/effects, for example, the ability of a novel intervention to reduce negative consequences of spaceflight on the human by XX %, relative to current standards.**
- **Flexibility for NASA to balance research resources across identified risks given low 'n' and constrained research conditions**

NASA → can be a leader in refining and promoting approaches to small 'n' research



ISS Research – Human Research Program

Critical to mitigating 19 of 31 health risks relevant to human exploration



On-Orbit Research Facilities



Human Research Rack-1



Exercise Facilities



Human Research Rack-2

Biomedical Research



Nutritional Requirements



Physiological Changes and Exercise Countermeasures



Immunological Changes



Crew Sleep and Performance Research

Biomedical Capabilities Development



Lightweight Trauma Module

18 June 2014



Integrated health care system



Portable Medical Imaging

IV Fluid Generation



International Research Collaborations



ESA Muscle Physiology Facility



CSA Cardiovascular Function Experiment



JAXA Bone Loss Countermeasure Experiment



Russian Fluid Shift Countermeasure Experiment



Conclusion



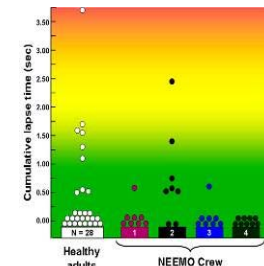
- **Human Research Program was designed to meet needs of human space exploration**
 - Understand and reduce the risk to crew health and performance in exploration missions
- **Strategy and Approach**
 - Evidence/Risk-based Program Architecture:
Evidence → Risks → Gaps → Tasks → Deliverables
 - Use a competitive solicitation process and peer review to fund Tasks that produce Deliverables to define or reduce risk
- **Deliverables**
 - Research deliverables that define space medical standards
 - Information to design exploration architectures, vehicles, and missions
 - Countermeasures
 - Research support for efficient medical operations
 - Space biomedical technologies and tools
- **Funding mechanisms**
 - NASA Research Announcement (HERO)
 - EPSCoR
 - SBIR
 - Unsolicited Proposals



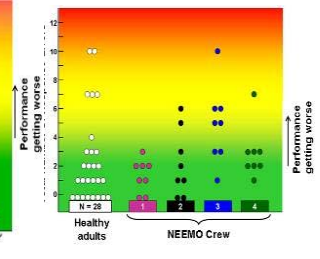
Clay Anderson performing CCISS during Inc 16



Exploration task test



N9 Errors of Omission (lapses)



N9 Errors of Commission (false starts)



Vibe bedrest study