National Aeronautics and Space Administration

Briefing to the Mid-term Review Committee

Dr. Gale J. Allen

8 February 2017

NASA Organization

Office of the Chief Technologist

Office of the Chief Scientist

Office of the Administrator

10 NASA Centers

Aeronautics Research Mission Directorate

ARMD

Science Mission Directorate

SMD

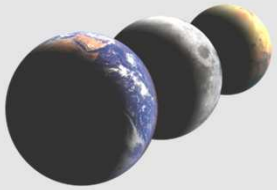
Space Technology Mission Directorate

STMD

Human Exploration and Operations

HEO

Space Operations Mission Directorate



Exploration Systems Mission Directorate

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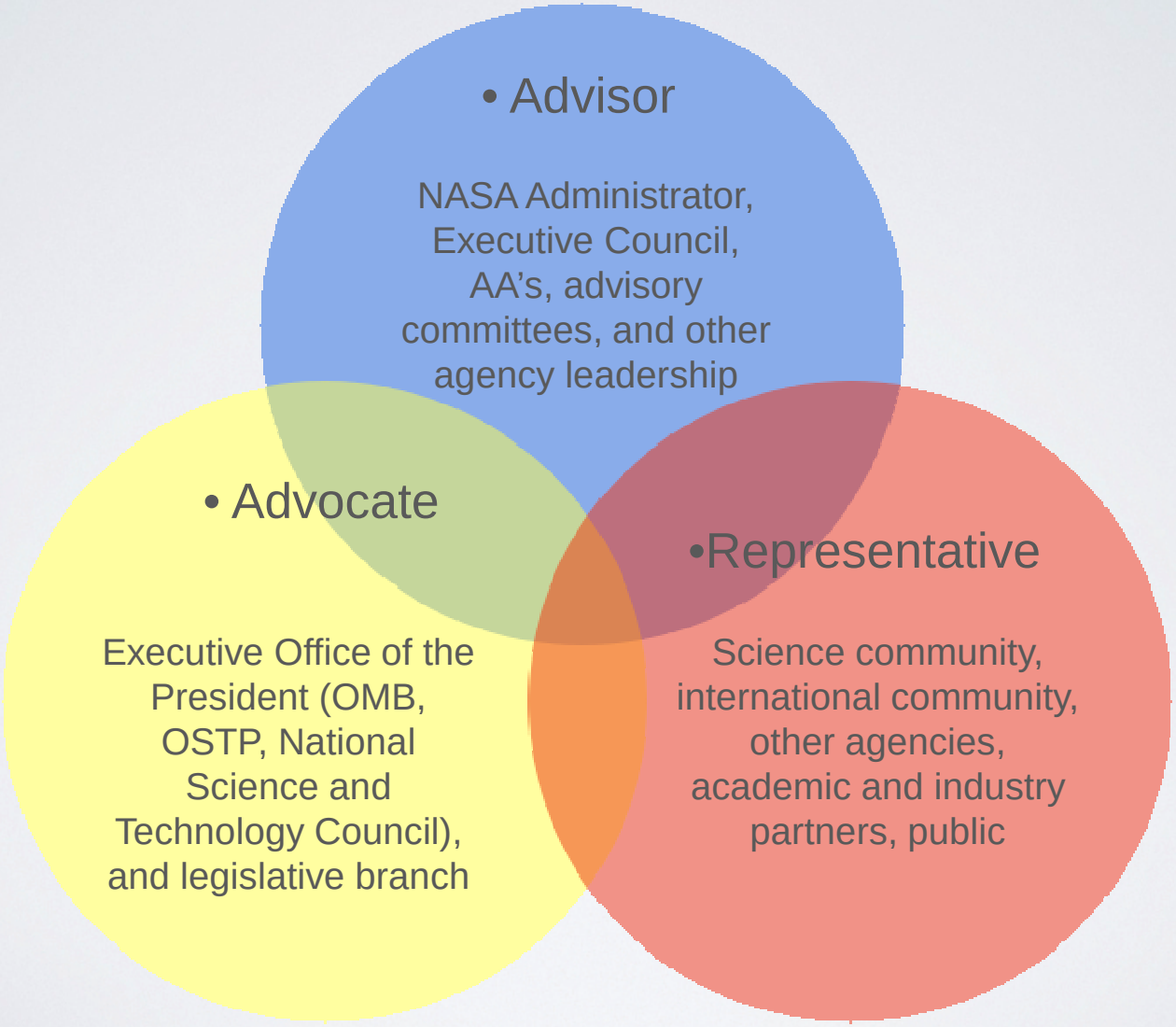
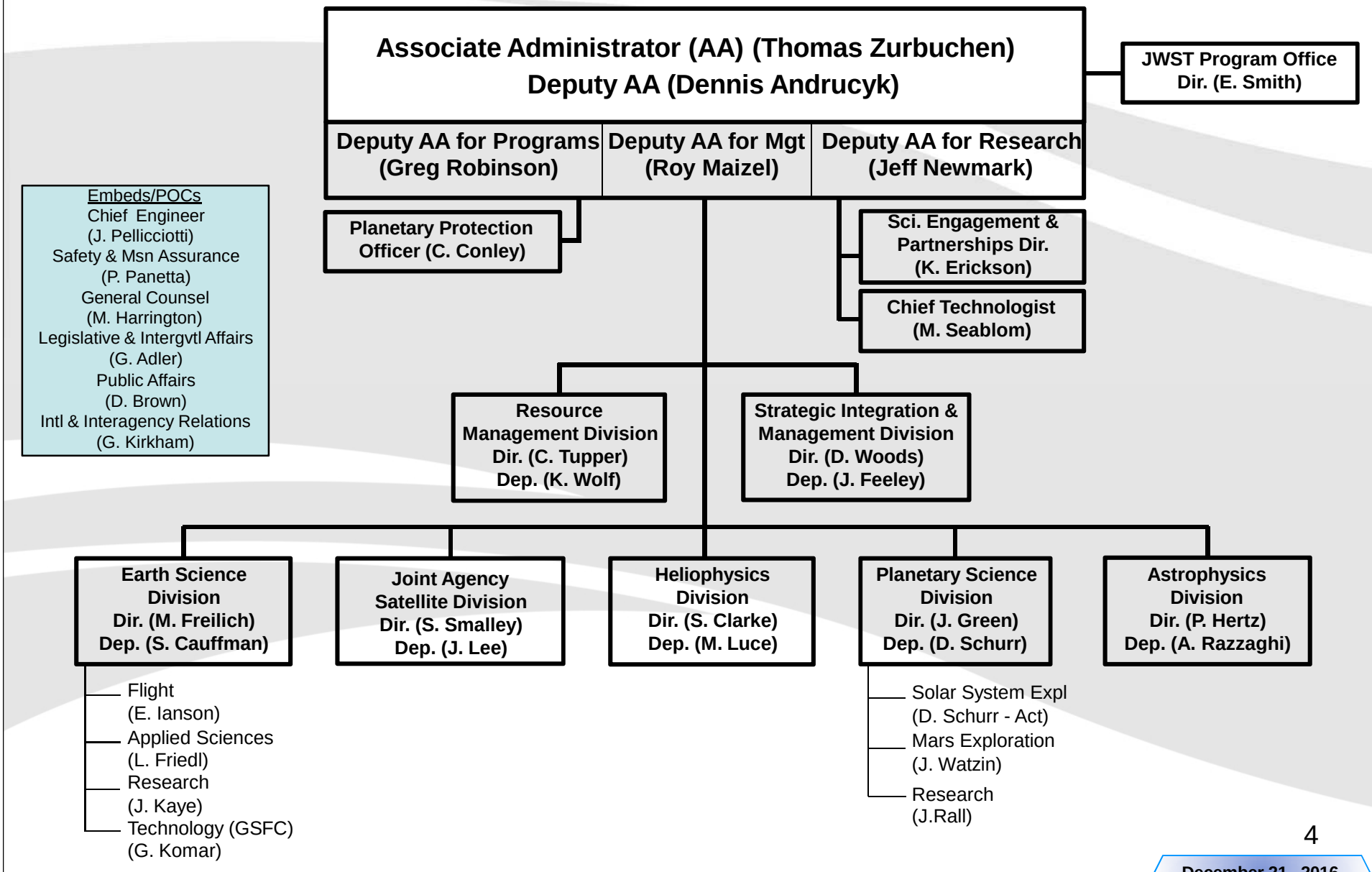
Role of the Chief Scientist



Science Mission Directorate Organization



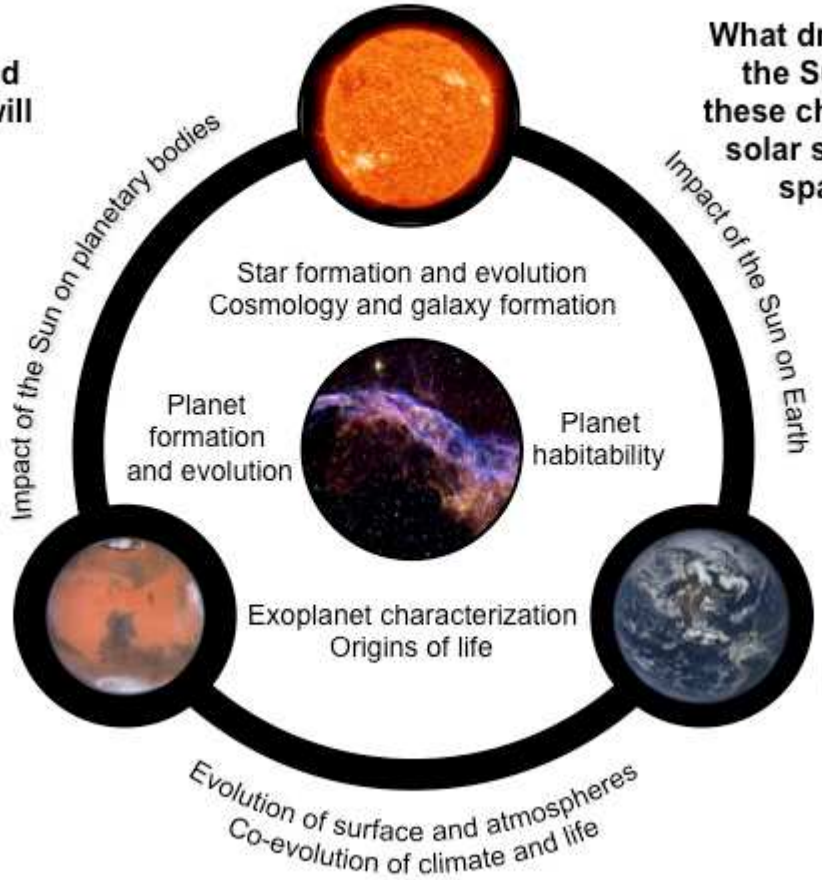
NASA Science Mission Directorate

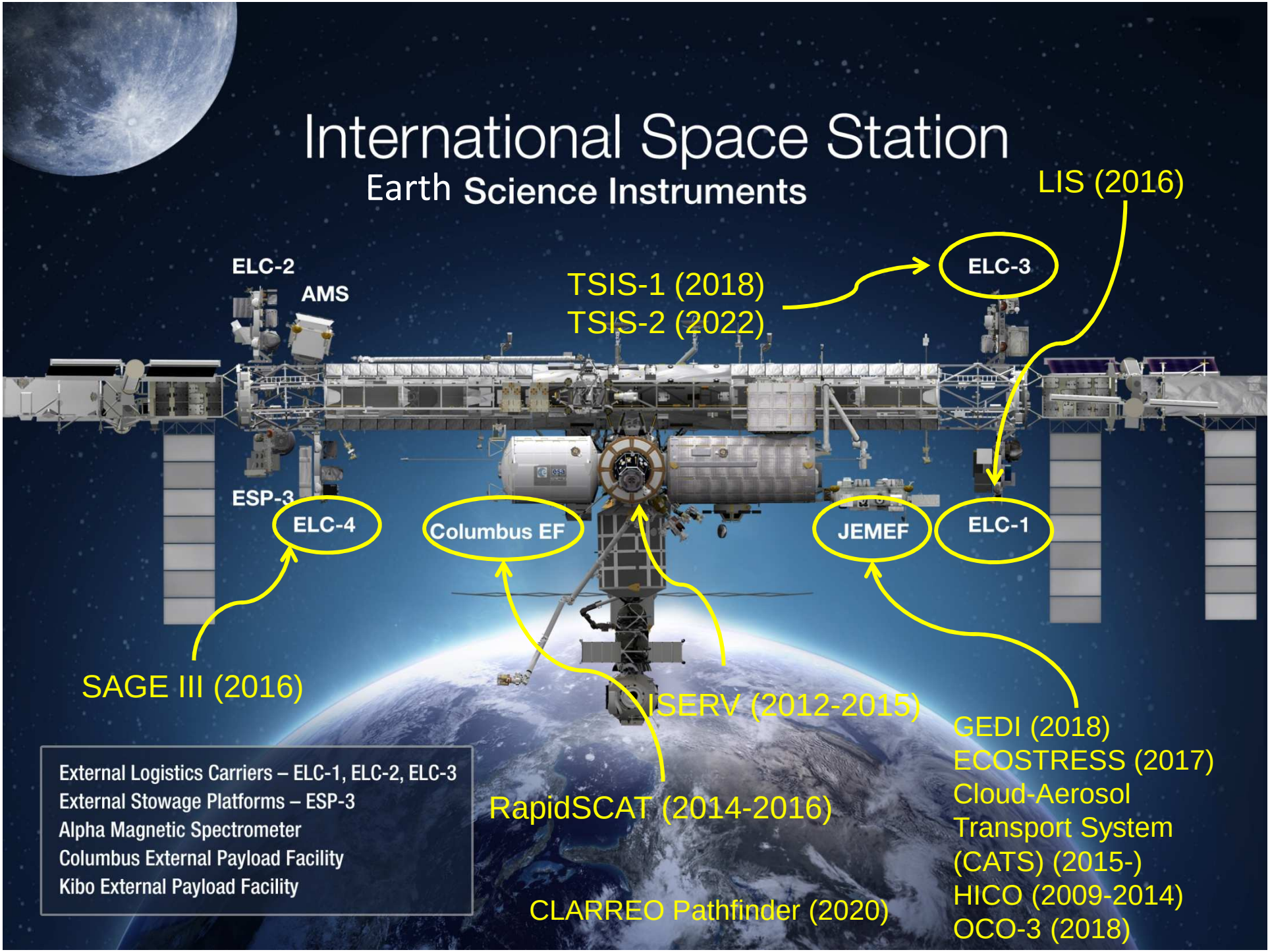
Science is interconnected; no important question stands alone. The Science Mission Directorate (SMD) is an organization where discoveries in one scientific discipline have a direct route to other areas of study. This flow is something extremely valuable and is rare in the scientific world.

- How and why are Earth's climate and the environment changing?
- How and why does the Sun vary and affect Earth and the rest of the solar system?
- How do planets and life originate?
- How does the universe work, and what are its origin and destiny?
- Are we alone?

- Science Mission Directorate is focused on missions
- Missions/instruments driven by decadals
- Research focus more or less consistent and budget stable over the decade
- Strong science community
- Earth Science and Astrophysics utilize ISS platform, external sites

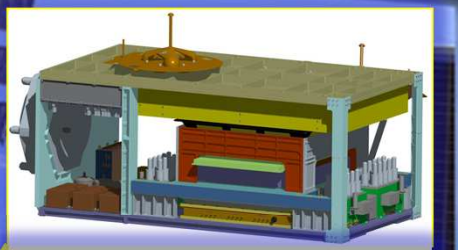
NASA Science Is Interconnected



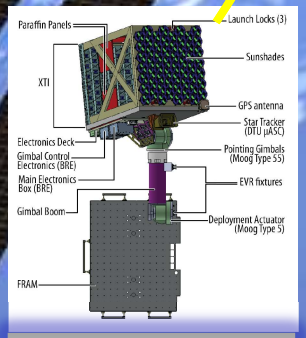

International Space Station
Earth Science Instruments
LIS (2016)
ELC-2
AMS
TSIS-1 (2018)
TSIS-2 (2022)
ELC-3
ESP-3
ELC-4
Columbus EF
JEMEF
ELC-1
SAGE III (2016)
ISERV (2012-2015)
GEDI (2018)
ECOSTRESS (2017)
Cloud-Aerosol Transport System (CATS) (2015-)
HICO (2009-2014)
OCO-3 (2018)
RapidSCAT (2014-2016)
CLARREO Pathfinder (2020)
External Logistics Carriers – ELC-1, ELC-2, ELC-3
External Stowage Platforms – ESP-3
Alpha Magnetic Spectrometer
Columbus External Payload Facility
Kibo External Payload Facility

Astrophysics on the ISS

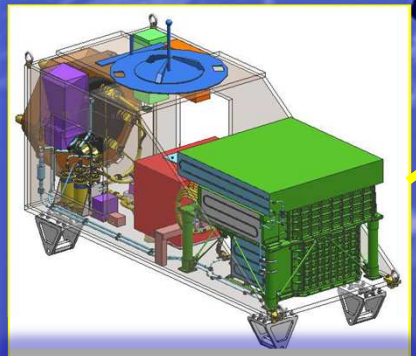
AMS Launch
May 16, 2011



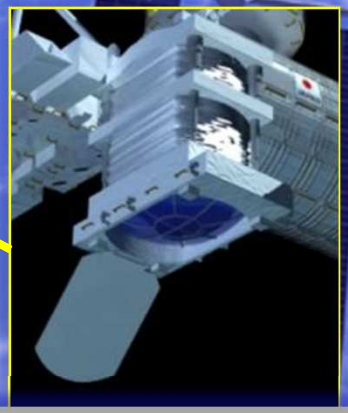
ISS-CREAM
June 2017



NICER
April 2017

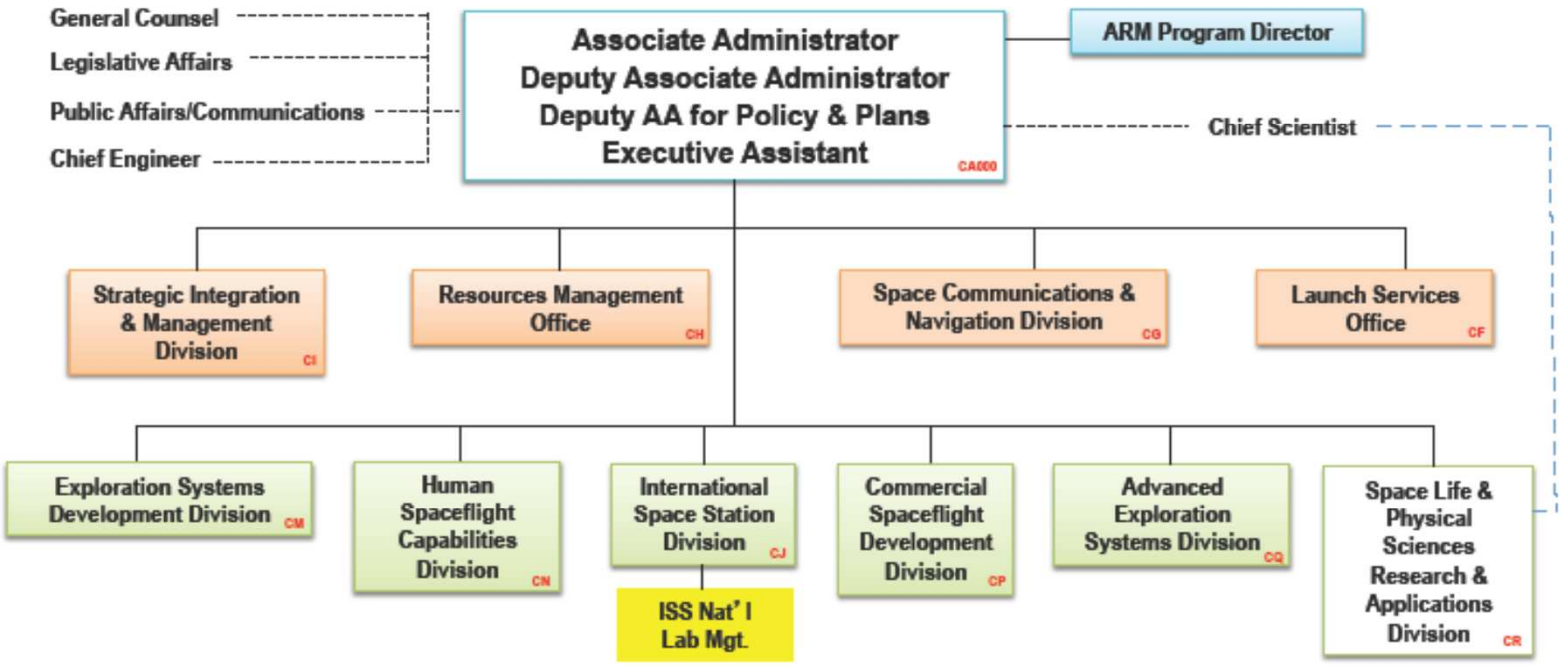


CALET on JEM
HTV Launch 2014



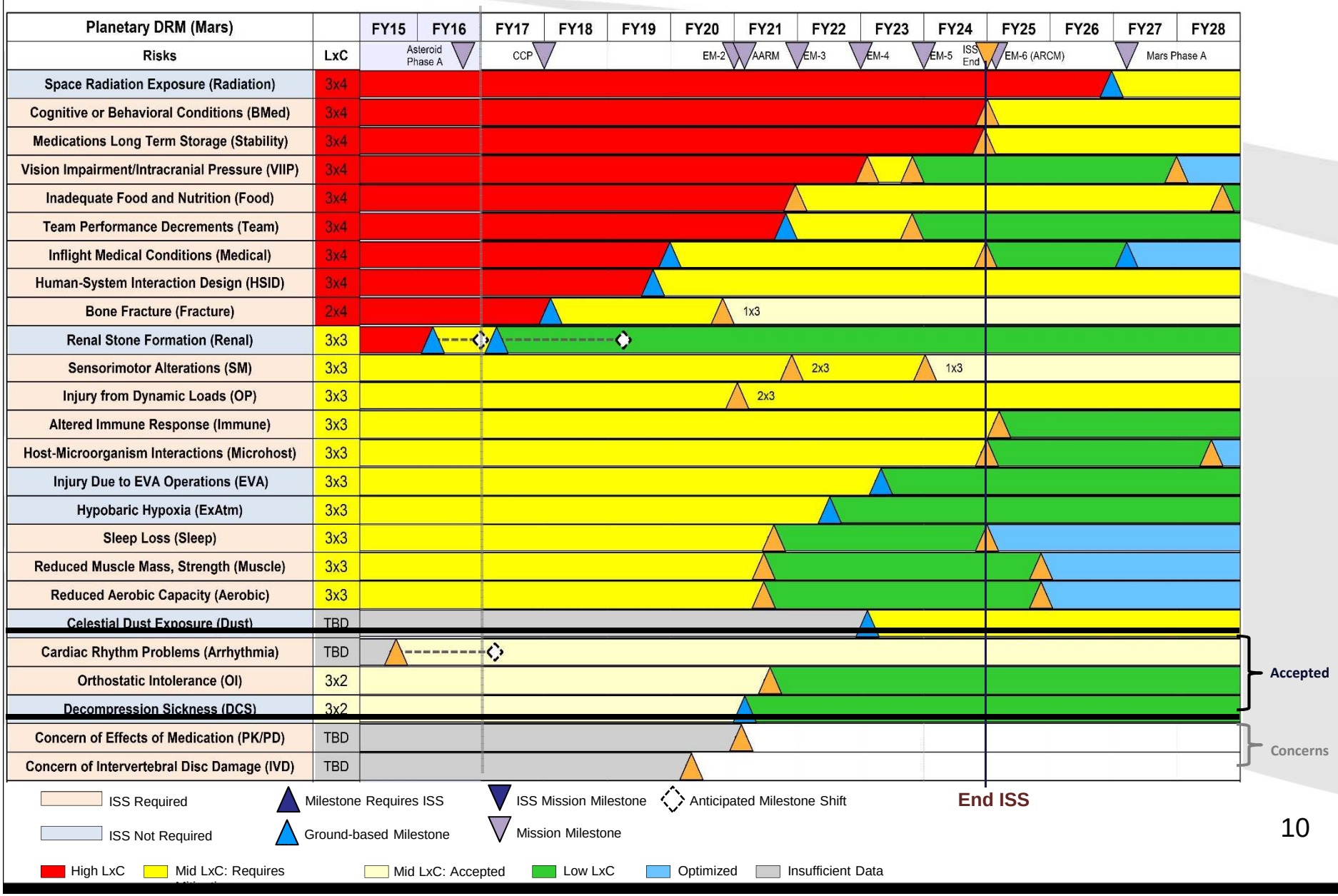
JEM-EUSO
Launch Tentatively planned for 2017

Human Exploration and Operations Mission Directorate Organizational Structure

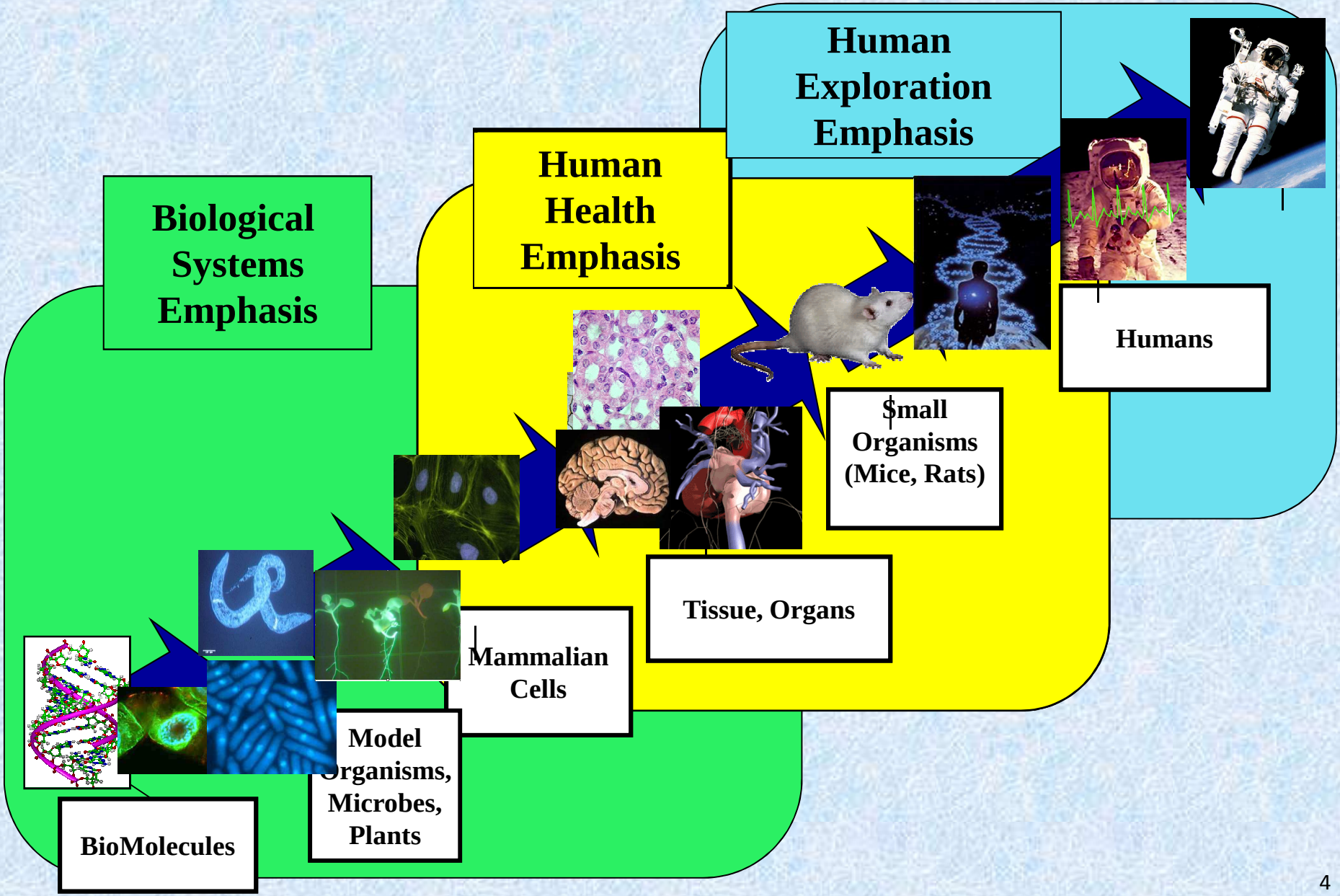


HEOMD ORG –CS –160418

HRP Integrated Path to Risk Reduction (Mars)

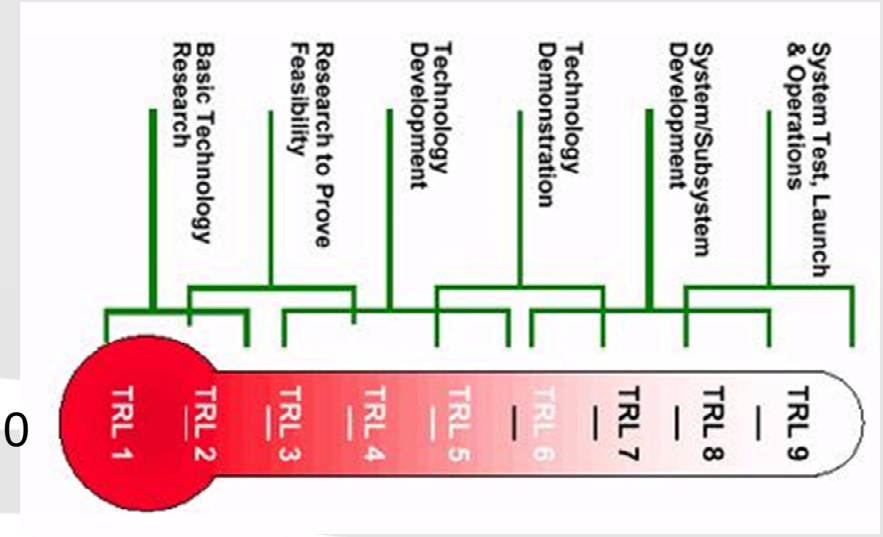


NASA Biology Continuum



NASA Technology Roadmaps

NASA Technology Continuum



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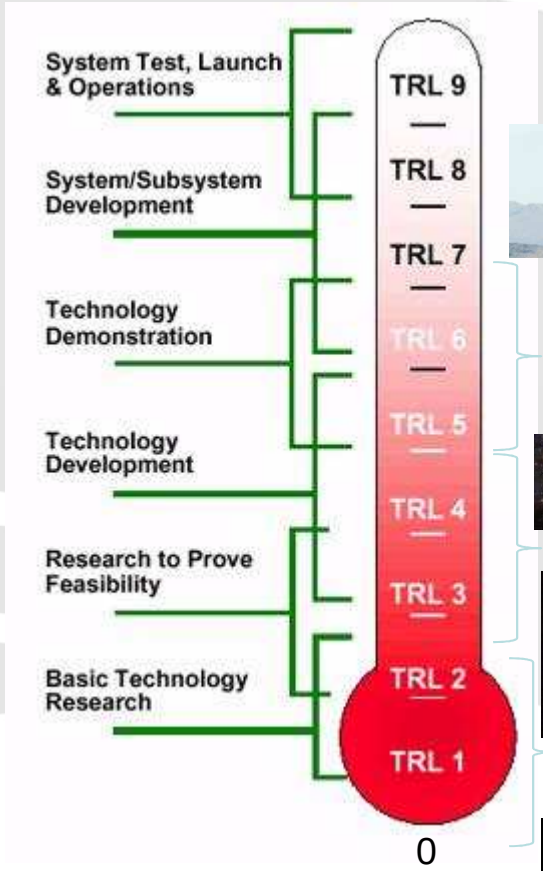
Physical Sciences Game Changing Technology Development
Foundational Engineering Sciences

← BASIC APPLIED DEVELOPMENT FLIGHT
(pipeline)

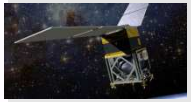
NASA Technology Continuum



LDSD
Low Density Supersonic Decelerator

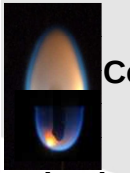
Morpheus

Technology Development



Green Propellant

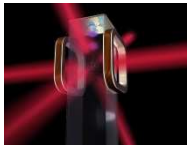
Game Changing



Combustion

Physical Scienc **Fluids**

Foundational Engineering Sciences



CAL Lab

Foundational Engineering Sciences

Develop the strategy for a program to provide foundational engineering knowledge and tools across the agency;

Coordinate the Agency's entire basic engineering science portfolio with strong linkages to NASA's science, technology, and engineering activities

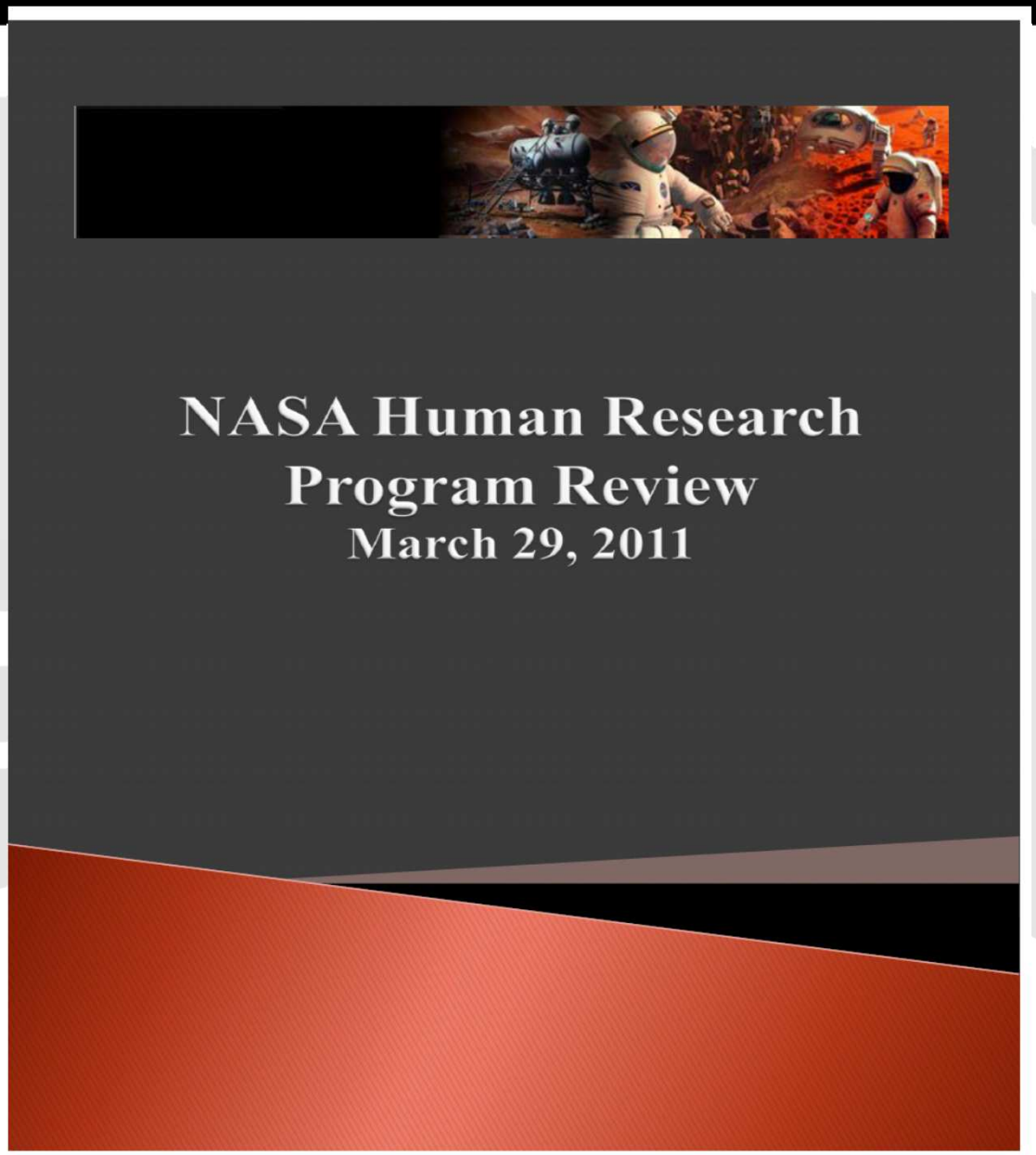
Sponsor a cohesive portfolio of basic engineering science activities at NASA centers, academia, and other organizations as appropriate.

Seek to infuse the new engineering tools, techniques and standards into standard NASA practice.

Seek to identify 'on-ramps' into technology development for the knowledge gained in the basic engineering science studies

Seek to leverage, coordinate and integrate NASA basic engineering science activities with relevant activities in other agencies, as well as the industrial and academic sectors.

Seek to ensure that SME knowledge and capabilities remain at the cutting edge, which has repeatedly proven necessary to solve NASA's practical problems


NASA Human Research
Program Review
March 29, 2011

Summary of Proceedings:

FAST-TRACK ACTION COMMITTEE ON THE UTILIZATION OF THE INTERNATIONAL SPACE STATION (ISS) AS A NATIONAL LABORATORY

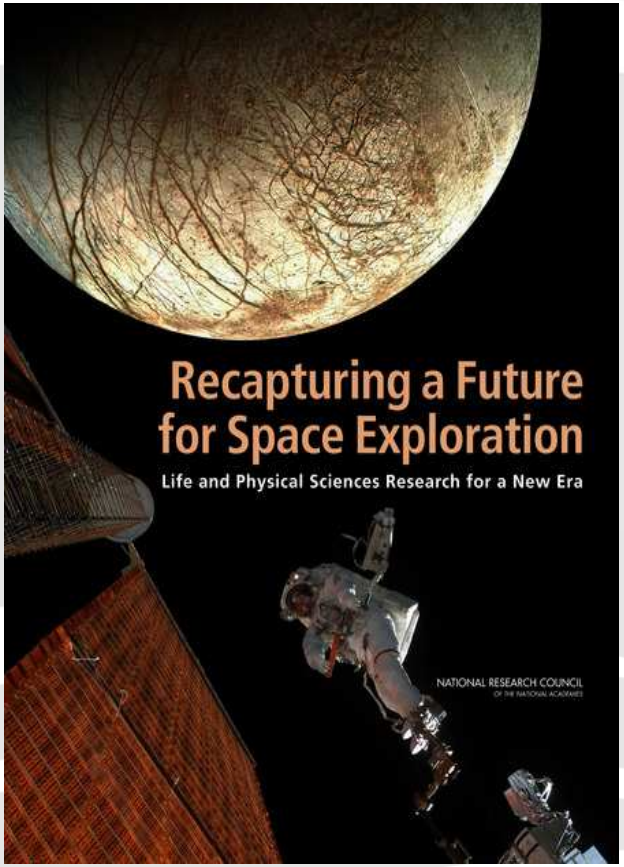
AUGUST 2013

PRODUCT OF THE

Committee on Science

OF THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

Recapturing a Future for Space Exploration



Then

- Constellation to the moon
- Open-ended; no budget or schedule constraints
- Combination of space biology, physical sciences, human research, technology
- Two bounding policies: Enabling and Enabled by
- Some overlap between the two
- Clearly outlined what is needed with priorities

Now

- SLS/Orion Mars/moon?
- Constrained budget
- Tighter schedule; LEO commercialization; ISS to 2024; cis-lunar habitat
- Technology and Human Research loosely coupled
- Pull versus Push – need to identify knowledge gaps in human research and technology and focus on filling those gaps
- Emphasis on public-private partnerships-
- What role do Other Government Agencies (OGAs) play? NSF, NIH, etc

Bounding Policy - Enabling

BOX 13.3
Sample Bounding Policy Option One

Goal: Send Humans to Mars

Prioritization Criteria 1 and 2 will be the most important functions in prioritizing research to support the goal of sending humans to Mars, and a way must be found to support the recommendations associated with these priorities in an integrated program with clear translational end points. Prioritization Criteria 3 and 5 will also have to be taken into consideration to achieve the science necessary to achieve this policy goal.

Criterion 1. The extent to which the results of the research will reduce uncertainty about both the benefits and the risks of space exploration (*Positive Impact on Exploration Efforts, Improved Access to Data or to Samples, Risk Reduction*)

→ **Relevant research recommendations**

Life sciences: P2, P3, B1, B2, B3, B4, AH1, AH2, AH3, AH5, AH6, AH7, AH8, AH9, AH10, AH11
Life sciences translational: CCH2, CCH4, CCH7
Physical sciences: AP1, AP4, AP6, AP8
Physical sciences translational: TSES1, TSES2, TSES3, TSES14

The efficacy of bisphosphonates should be tested in an adequate population of astronauts on the ISS during a 6-month mission.

Criterion 2. The extent to which the results of the research will reduce the costs of space exploration (*Potential to Enhance Mission Options or to Reduce Mission Costs*)

→ **Relevant research recommendations**

Research should be conducted in support of zero-boiloff propellant storage and cryogenic fluid management. Physical sciences research includes studies of advanced insulation materials, active cooling, multiphase flows, and capillary effectiveness (T2), as well as active and passive storage, fluid transfer, gauging, pressurization, pressure control, leak detection, and mixing destratification (T3).

Criterion 3. The extent to which the results of the research may lead to entirely new options for exploration missions (*Positive Impact on Exploration Efforts, Improved Access to Data or to Samples*)

→ **Relevant research recommendations**

Criterion 5. The extent to which the results of research are uniquely needed by NASA, as opposed to any other agencies (*Needs Unique to NASA Exploration Programs*)

→ **Relevant research recommendations**

What Has Happened Since Decadal was Commissioned?

- 2010 Constellation/moon destination cancelled
- 2010 Call for Asteroid/Mars Missions
- 2011 Recapturing a Future for Space Exploration Published
- 2011 CASIS selected as NGO for ISS Utilization- 50% utilization of United States Operating Segment (USOS) capabilities including crew time
- 2011 Space Life and Physical Sciences Research and Analysis Division formed in Human Exploration and Operations Mission Directorate (HEOMD)
- 2011 OCS/OCT Review of Human Research Program (OSTP request)
- 2012 OCS led NASA steering committee on response to decadal
- 2013 OSTP Life Sciences Subcommittee Assessment of ISS Utilization for Other Government Agencies
- 2013 NASA Advisory Council HEO subcommittee on Research established
- 2014 NAS Committee on Biology and Physical Sciences in Space established
- 2014 ISS extension to at least 2024
- 2015 NASA Low Earth Orbit Commercialization discussions
- 2016 Initiation of Mid-term Decadal Review
- 2017 Kick off of NASA (OCS/HEO led) Long Range R&D Plans for LEO and Beyond

Asking for a look forward since so much has changed!

Additional Information

Astrophysics on ISS

Astrophysics

AMS-02 (Alpha Magnetic Spectrometer - 02)
CALET (CALorimetric Electron Telescope)
CREAM (Cosmic Ray Energetics and Mass)
ExHAM-Interstellar Carbonaceous Solids (Quest for the Compositional identification and Chemical evolutional understanding of the Interstellar Dust)
MAXI (Monitor of All-sky X-ray Image)
NICER (Neutron Star Interior Composition Explorer)
NanoRacks-NanoRocks (NanoRacks-NanoRocks: Collisional Evolution of Particles and Aggregates in Microgravity)
Platan-Cosmic Rays (Search for Low Energy Heavy Particles of Solar and Galactic Origin)

Earth Science on ISS

Earth Remote Sensing

HREP-HICO (HICO and RAIDS Experiment Payload - Hyperspectral Imager for the Coastal Ocean)
SAGE III-ISS (Stratospheric Aerosol and Gas Experiment III-ISS)
Uragan-GC (Hurricane-GC) (Hurricane: Experimental Development of Groundbased System of Monitoring and Predicting the Progression of a Naturally Occurring Technogenic Catastrophe)
Volny-PK-1 (Waves-PK-1) (Waves: Observation in near Infrared Spectral Band Undulatory Disturbance in the Middle Atmosphere Layers of the Earth of Technogenic and Naturally Occurring Origin)
ISS-RapidScat monitors ocean winds for climate research, weather predictions and hurricane monitoring from the space station.

Cloud-Aerosol Transport System (CATS), a laser instrument measures clouds and the location and distribution of airborne particles such as pollution, mineral dust, smoke, and other particulates in the atmosphere