Human Health and Performance Risk Management

NSBRI External Advisory Committee
April 12, 2016

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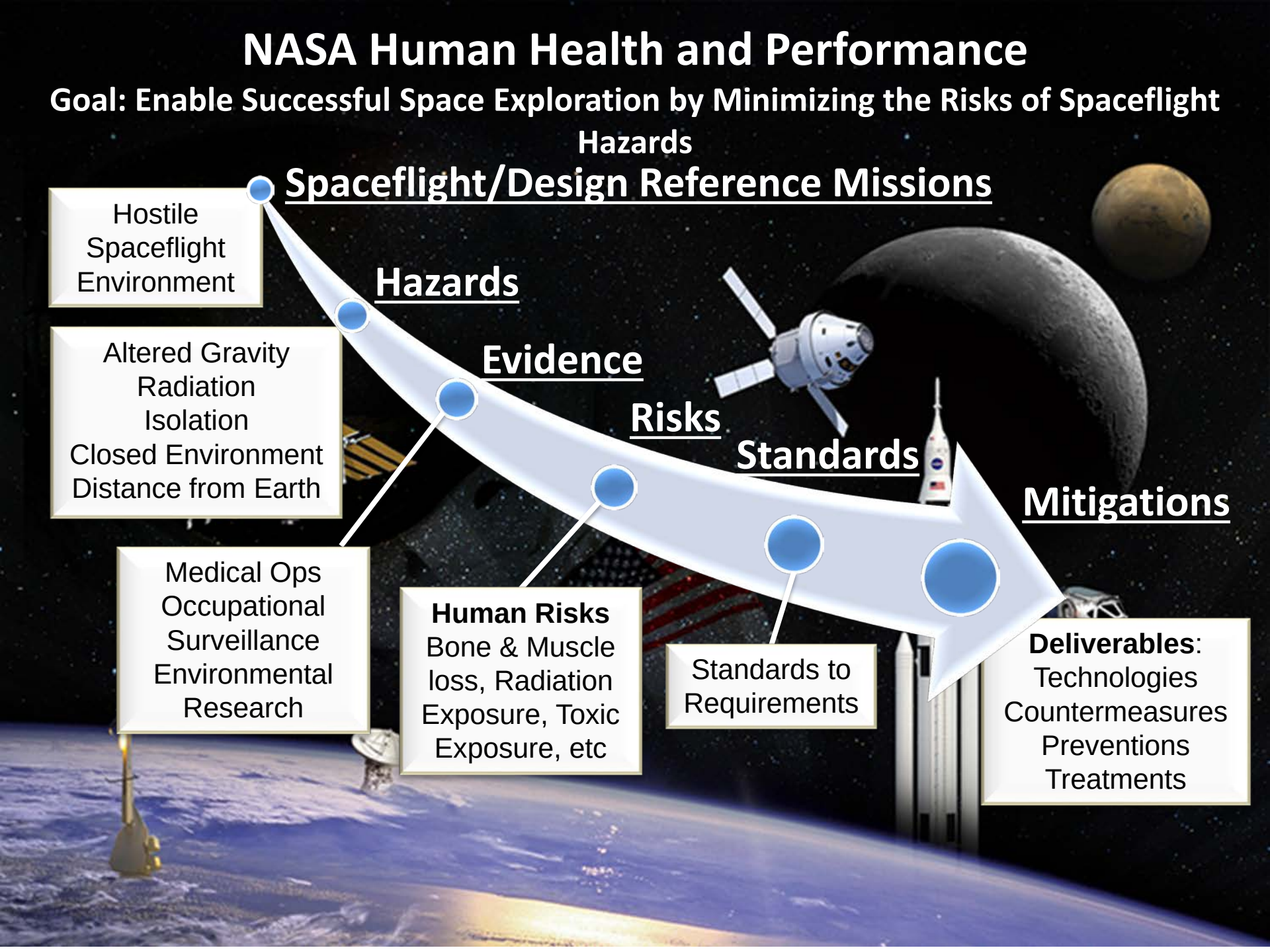
NASA Human Health and Performance

Goal: Enable Successful Space Exploration by Minimizing the Risks of Spaceflight Hazards

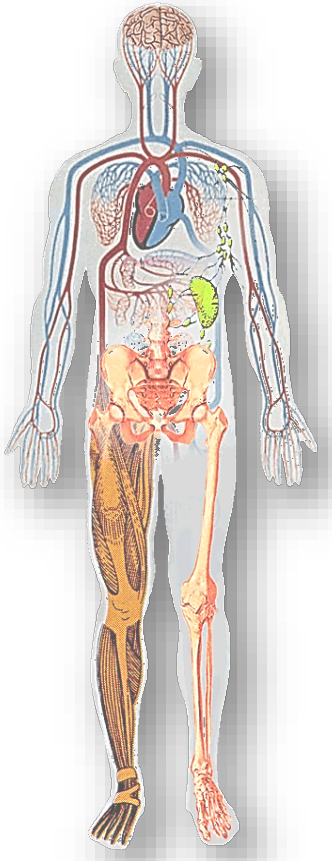


Hazards of Spaceflight

Hazards Drive Human Spaceflight Risks

Altered Gravity - Physiological Changes

Balance Disorders
Fluid Shifts
Cardiovascular Deconditioning
Muscle Atrophy
Bone Loss



Distance from earth

Drives the need for additional "autonomous" medical care capacity – cannot come home for treatment

Space Radiation

Acute In-flight effects
Long term cancer risk

Hostile/ Closed Environment

Vehicle Design
Environmental – CO_2 Levels, Toxic Exposures, Water, Food
Decreased Immune Function

Isolation & Confinement

Behavioral aspect of isolation
Sleep disorders

All of the Human Risks are evaluated against the following categories:

DRM Categories	Mission Duration	Gravity Environment	Radiation Environment	Earth Return
Low Earth Orbit	6 months	Microgravity	LEO - Van Allen	1 day or less
	1 year	Microgravity	LEO - Van Allen	1 day or less
Deep Space Sortie	1 month	Microgravity	Deep Space	< 5 days
Lunar Visit/Habitation	1 year	1/6g	Lunar	5 Days
Deep Space Journey/ Habitation	1 year	Microgravity	Deep Space	Weeks to Months
Planetary Visit/Habitation	3 years	Fractional	Planetary*	Months

*Planet has no magnetic poles, limited atmosphere

Examples of Missions that would fall into the DRM Categories:

Low Earth Orbit – ISS6, ISS12, Commercial Suborbital, Commercial Visits to ISS, future commercial platforms in LEO
Deep Space Sortie: MPCV test flights, moon fly around or landing, visits to L1/L2, deep space excursion
Lunar Habitation: Staying on the surface more than 30 Days (less than 30 days would be similar)
Deep Space Habitation: L1/L2 Habitation, Asteroid visit, journey to planets
Planetary Habitation: Living on a planetary surface, MARS

Evidence is gathered from in-flight medical and research operations, spaceflight analogs, terrestrial analogs, and/or animal data. Data must be correlated from NASA medical (LSAH), research (LSDA), environmental & terrestrial data bases.

NASA/HMTA Human Risks Evidence Base

Medical Data (mandatory)

Medical data generally does not require informed consent and may only be used for:

- ❑ Medical care by clinician
- ❑ Occupational Surveillance

Environmental & Operational Data

Data gathered to understand the occupational environment, such as:

- CO_2 levels, acoustic, landing loads, radiations levels, mission operations

Research Data (voluntary)

- Research data requires informed consent by the subject & the data.
- Ground analogs
- Includes animal research

Terrestrial Data

Related terrestrial incidence, treatment and research

¾ of Risk Evidence from Operational Medical/Environmental/ Occupational Surveillance Programs

+

¼ of Risk Evidence from Research Programs (Focus on Human System Risks understanding and countermeasure development)

Correlation of data by subject matter experts & physicians.

Generation of Metrics to assess Human System Risks

Summary of Human Risks of Spaceflight
Grouped by Hazards – 30 Human Risks

Altered Gravity Field
1. Spaceflight-Induced Intracranial Hypertension/Vision Alterations
2. Renal Stone Formation
3. Impaired Control of Spacecraft/Associated Systems and Decreased Mobility Due to Vestibular/Sensorimotor Alterations Associated with Space Flight
4. Bone Fracture due to spaceflight Induced changes to bone
5. Impaired Performance Due to Reduced Muscle Mass, Strength & Endurance
6. Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity
7. Adverse Health Effects Due to Host-Microorganism Interactions
8. Urinary Retention
9. Orthostatic Intolerance During Re-Exposure to Gravity
10. Cardiac Rhythm Problems
11. Space Adaptation Back Pain

Concerns
1. Clinically Relevant Unpredicted Effects of Meds
2. Intervertebral Disc Damage upon & immediately after re-exposure to Gravity

Radiation
1. Space Radiation Exposure on Human Health (cancer, cardio and CNS)

Distance from Earth
1. Adverse Health Outcomes & Decrements in Performance due to inflight Medical Conditions
2. Ineffective or Toxic Medications due to Long Term Storage

Isolation
1. Adverse Cognitive or Behavioral Conditions & Psychiatric Disorders
2. Performance & Behavioral health Decrements Due to Inadequate Cooperation, Coordination, Communication, & Psychosocial Adaptation within a Team

Hostile/Closed Environment-Spacecraft Design
1. Acute and Chronic Carbon Dioxide Exposure
2. Performance decrement and crew illness due to inadequate food and nutrition
3. Reduced Crew Performance and of Injury Due to Inadequate Human-System Interaction Design (HSID)
4. Injury from Dynamic Loads
5. Injury and Compromised Performance due to EVA Operations
6. Adverse Health & Performance Effects of Celestial Dust Exposure
7. Adverse Health Event Due to Altered Immune Response
8. Reduced Crew Health and Performance Due to Hypobaric Hypoxia
9. Performance Decrements & Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, & Work Overload
10. Decompression Sickness
11. Toxic Exposure
12. Hearing Loss Related to Spaceflight
13. Injury from Sunlight Exposure
14. Crew Health Due to Electrical Shock

ISS Crew: Scott Kelly, Mikhail Kornienko Sign On For One-Year Mission

Posted: 11/26/2012 9:29 am EST Updated: 11/26/2012 9:40 am EST

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FOLLOW: Video, Scott Kelly, International Space Station, Iss Crew, Iss Mission, Mikhail Kornienko, International Space Station, Science News

By: Tariq Malik
Published: 11/26/2012 08:12 AM EST on SPACE.com

A veteran NASA space commander and Russian cosmonaut have signed on for the ultimate space voyage: a yearlong trip on the International Space Station.

American astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko will launch on the one-year space station flight in spring 2015 and return to Earth in spring 2016, NASA officials announced today (Nov. 26). They will begin their mission training in early 2013.

The mission will help NASA understand how the human body adapts to extremely long space missions, such as voyages around the moon, to an asteroid and ultimately to Mars, NASA officials said.

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Astronaut Scott Kelly Preparing for Unprecedented One Year in Space; Mission to Experiment on His Bone Mass, Vision, Immune System

By Latin Times Staff Writer, Dec 07, 2012 08:00 PM EST

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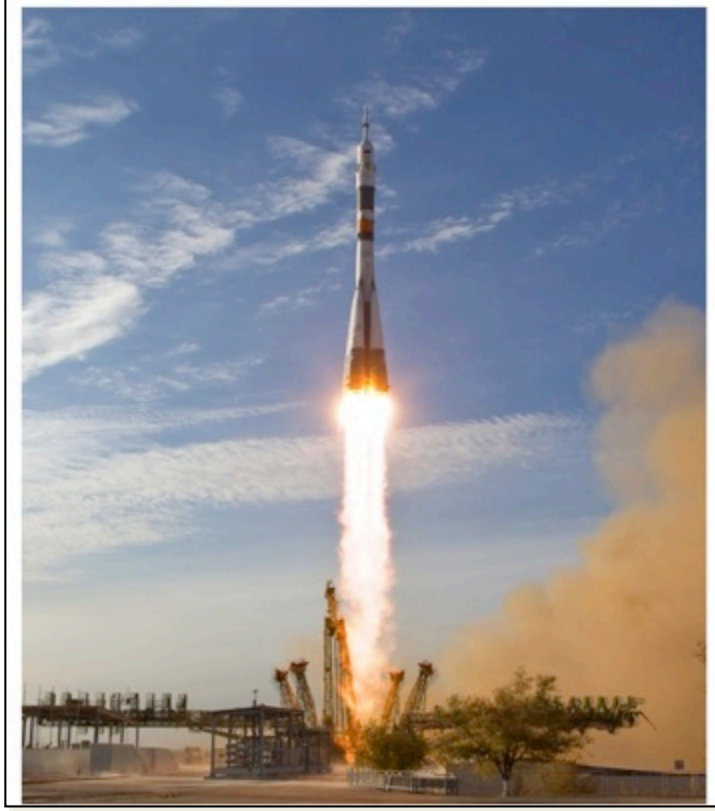
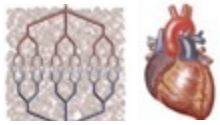
Tags: NASA, Space

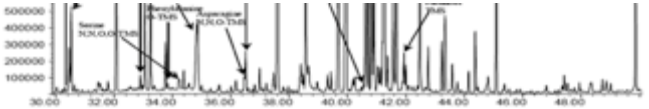




Vasculature
Lee

Cognition
Basner

Microbiome
Turek



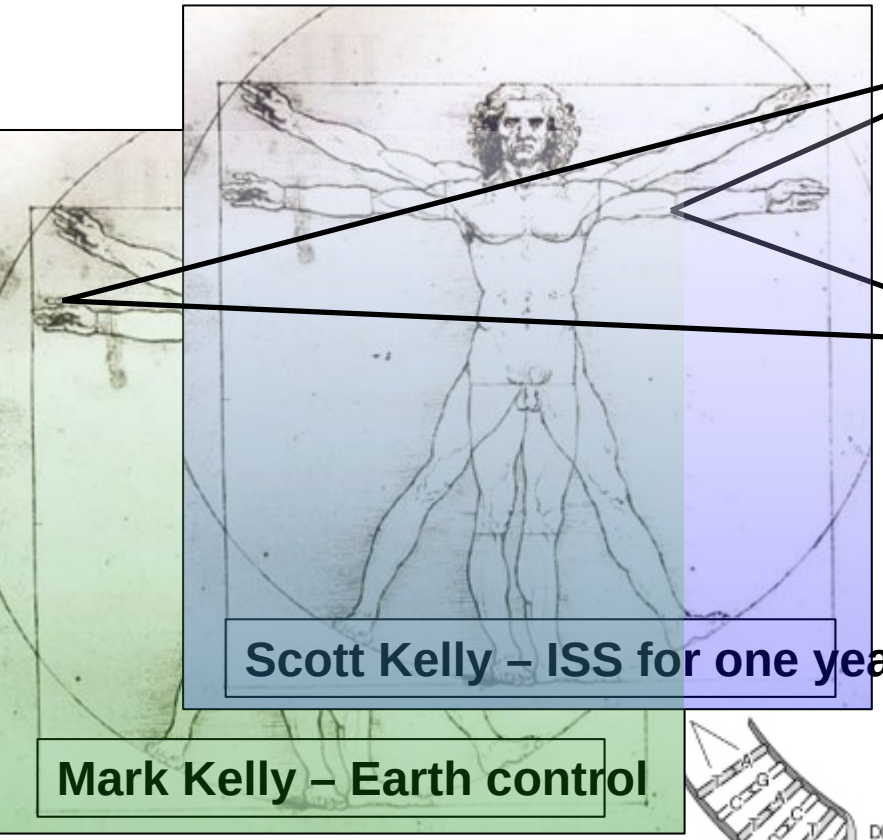
Targeted and Global Metabolomics
Lee/Rana, Mignot/Snyder & Smith

Cytokines
Mignot

Telomere Length
Bailey

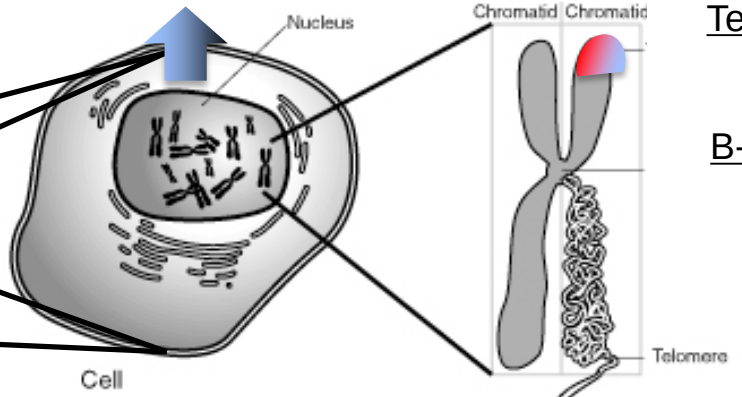
B-cells / T-cells
Mignot

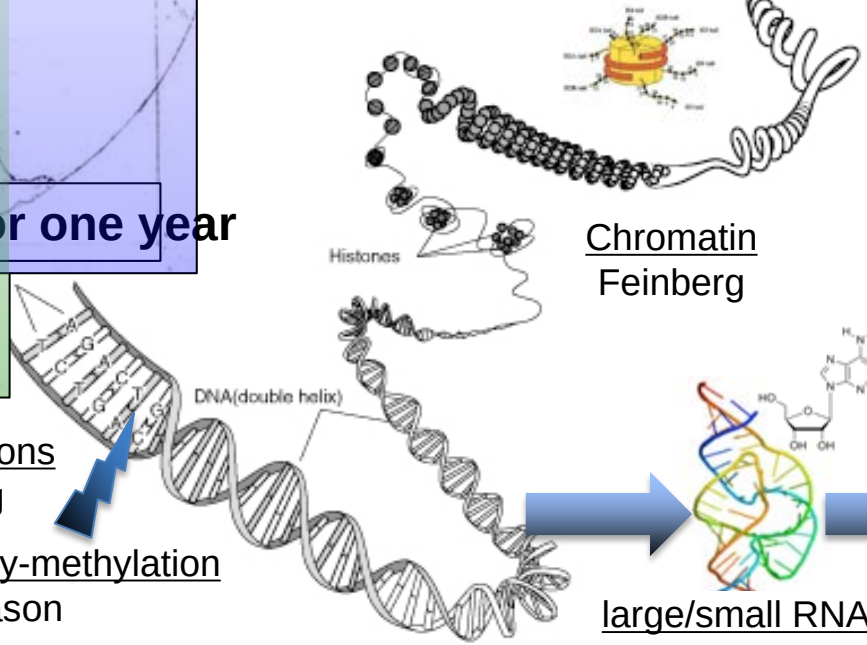
Antibodies
Mignot/Snyder



Scott Kelly – ISS for one year

Mark Kelly – Earth control

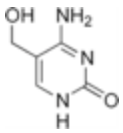


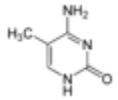


Chromatin
Feinberg

DNA Mutations
Feinberg

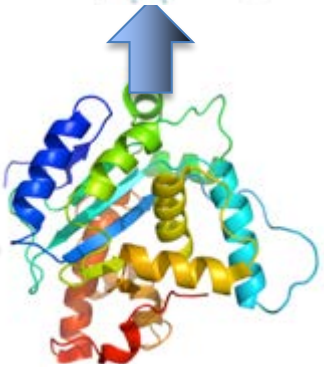
DNA Hydroxy-methylation
Mason





DNA Methylation
Feinberg & Mason

large/small RNA
& RNA Methylation
Mason



Proteomics
Lee/Rana

The Power of Crowd Based Challenges

NASA's Practical Toolkit for Open Innovation

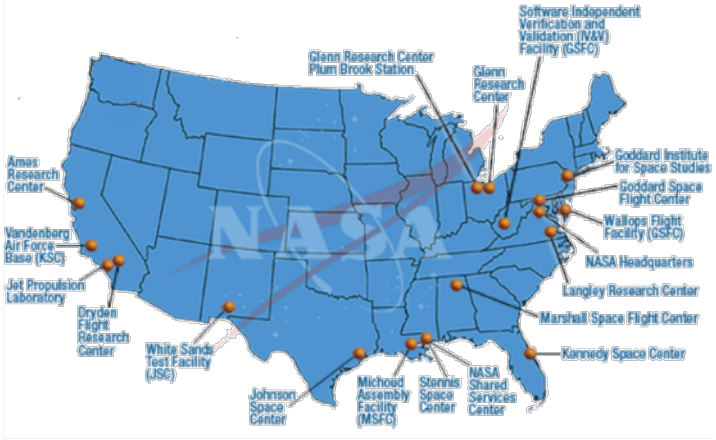
NASA's Center of Excellence for Collaborative Innovation (CoECI)

NASA@WORK

Over 18,000 Registered Members

(30% of NASA's 60,000 CS & Contractor Workforce)

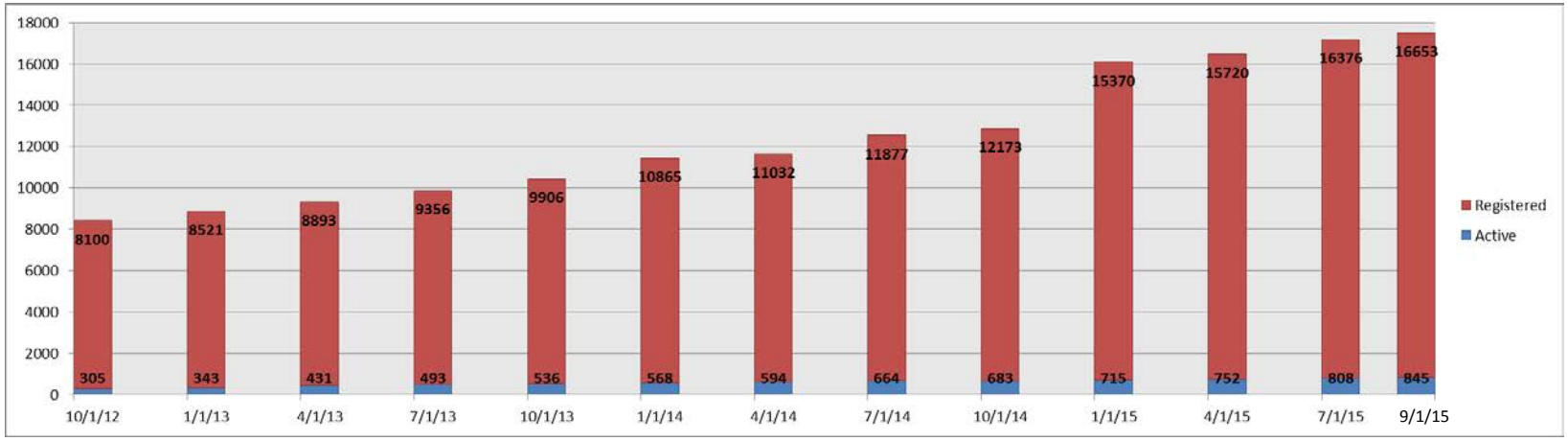
People that work at NASA want to make a difference!



15-20 Challenges per Year

2-4 Active challenges posted at any one time

New challenge posts every ~2-3 weeks



Growth of the NASA@work Community since October 2012

CoECI's Crowdsourcing Experience

12 Theoretical

7 Ideation*

1 Reduction to Practice

1 Video

*3 USAID

14 Algorithms*

17 Software** ***

5 Ideation

4 Graphics

*USPTO, USAID, 2 EPA
**2 CMS, OPM, DOE
***

2 Videos

3 Eng. Design*

*2 VA

NASA@WORK

87 Challenges

10 Tech Surveys*

*1 EPA

2 Ideation

15 CAD Modeling

5 Graphics

NON-INVASIVE MEAUREMENT OF INTRA-CRANIAL PRESSURE

Challenge - Non-invasive method or technology to measure the absolute intracranial pressure (i.e., the pressure of the interior of a human's head).

Total Cost to NASA$35,000

Challenge Award $15,000

Resulted in Partnerships

NASA Tournament Lab

Center of Excellence for Collaborative Innovation

Results

- UCLA's ICP Algorithm was selected as winning solution; Also identified via a Tech Scouting effort
- Being considered as addition to active flight study pending accuracy validation