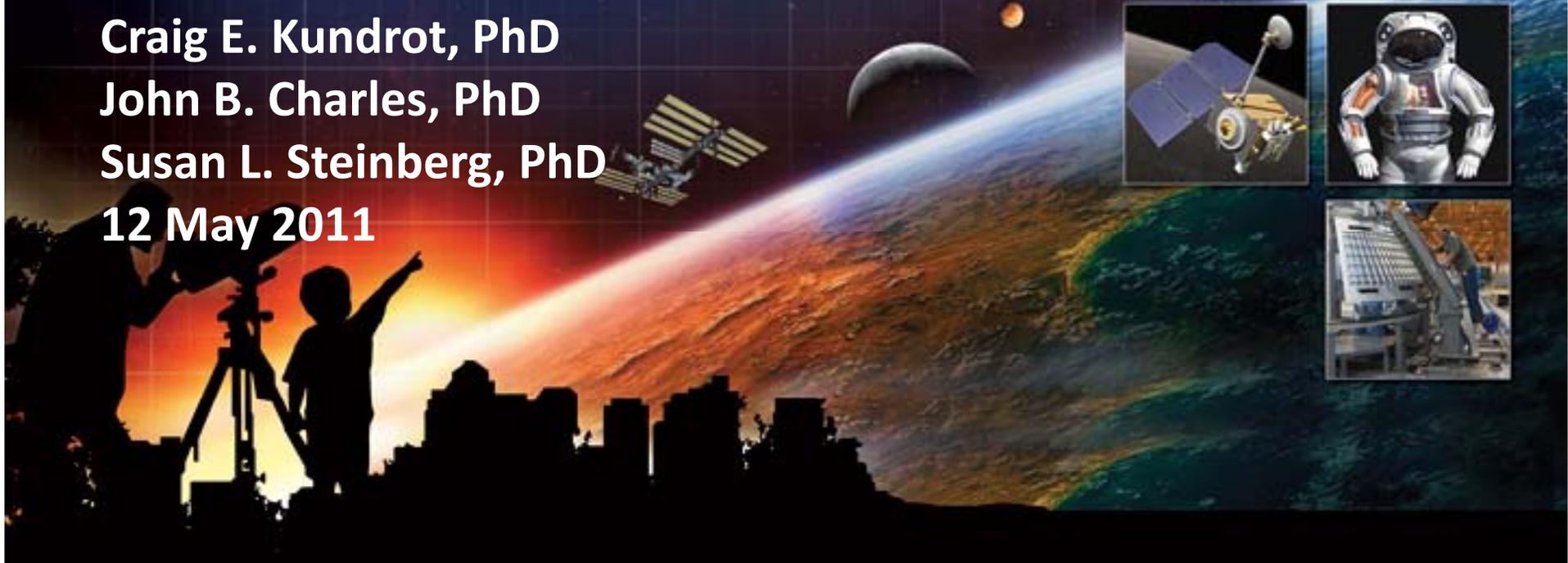
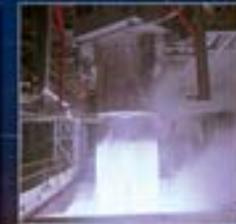




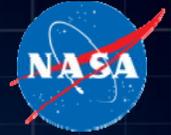
# Human Health and Performance Considerations for Exploration of Near Earth Asteroids (NEA)

*82<sup>nd</sup> Annual Scientific Meeting  
Aerospace Medical Association*

**Craig E. Kundrot, PhD**  
**John B. Charles, PhD**  
**Susan L. Steinberg, PhD**  
**12 May 2011**



**Disclosure Information- 82<sup>nd</sup> Annual Scientific Meeting**  
***Craig E. Kundrot***



I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use  
in my presentation

# Presidential Remarks on Space Exploration



## John F. Kennedy Space Center April 15, 2010



Early in the next decade,

a set of crewed flights will test and prove the systems required for exploration beyond low Earth orbit.

And by 2025,

we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the Moon into deep space.

So we'll start -- **we'll start by sending astronauts to an asteroid for the first time in history.**

By the mid-2030s,

I believe we can send humans to orbit Mars and return them safely to Earth.

And a landing on Mars will follow.

And I expect to be around to see it.

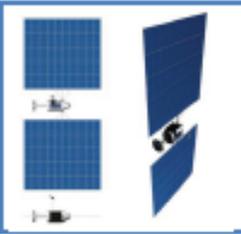
[http://www.nasa.gov/news/media/trans/obama\\_ksc\\_trans.html](http://www.nasa.gov/news/media/trans/obama_ksc_trans.html)

# NASA Human Exploration Framework Team



## Notional Architecture Elements



					
Space Launch System (SLS)-HLLV	Multi-purpose Crew Vehicle (MPCV)	Cryogenic Propulsion Stage (CPS)	Solar Electric Propulsion (SEP)	Lander	Mars Elements

Graphics are Notional Only – Design and Analysis On-going

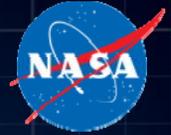
					
EVA Suit	Multi-Mission Space Exploration Vehicle (MMSEV)	Deep Space Habitat (DSH)	Robotics & EVA Module (REM)	Kick Stage	NEA Science Package

For Public Release

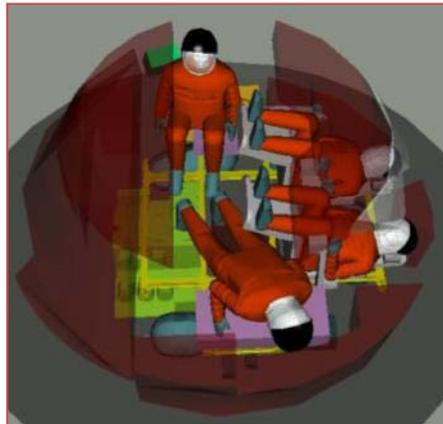
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www.nasa.gov/pdf/509820main\_Human\_Space\_Exploration\_Framework\_Summary-2010-01-11.pdf

# Human Research Program



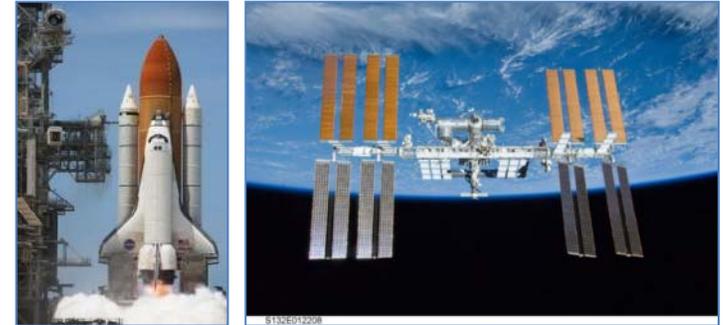
- The Human Research Program (HRP) in the Exploration Systems Mission Directorate was created in October 2005
- Program goals
  - ❖ Perform research necessary to **understand** and **reduce** spaceflight human **health** and **performance** risks in support of exploration
  - ❖ Enable development of human spaceflight medical and human performance standards
  - ❖ Develop and validate technologies that serve to characterize and reduce medical risks associated with human spaceflight



# Human Subsystem Risks



- The Office of the Chief Health and Medical Officer tracks about 60 risks for human space flight



- The Human Research Program has been working on 28 risks for missions to the Moon and Mars

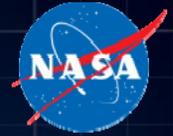
[humanresearchroadmap.nasa.gov](http://humanresearchroadmap.nasa.gov)



- These 28 risks provide the basis for asteroid mission risks

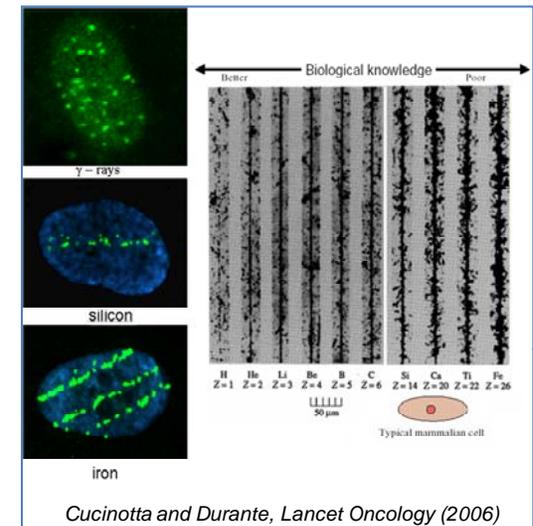
Human Exploration Framework Team (HEFT) Charter 

- **Mission:** The HEFT team is responsible for creating an evolvable decision framework for our Human Space Exploration Enterprise that drives out the knowledge, capabilities and infrastructure NASA needs to send people to explore multiple destinations in the Solar System in an efficient, sustainable way.
- **Objectives**
  - The initial HEFT activity will focus on standing up the organizational structure, getting it functioning, and conducting a first full iteration of the process
  - Near-term outcome of the process will be a suite of investment strategies and recommendations for human spaceflight capabilities and missions for 5, 10, and 15 year horizons, keeping Mars as the ultimate destination in mind
  - Impact the FY2012 Budget planning and budgeting process
    - Proposal must (and will) fit within NASA's space flight budget profile
    - Potential to influence the FY2011 budget priorities

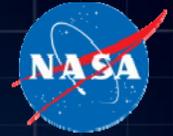


# Risk of radiation induced carcinogenesis

- NASA's radiation exposure standards permit a 3% risk of radiation exposure induced death (REID)
- Cancer is the primary driver of REID
- The REID standard limits mission durations in deep space to approximately
  - solar minimum
    - 5 months for males
    - 3 months for females
  - solar maximum
    - 7 months for males
    - 6 months for females
- These mission durations could increase by two months if “never smokers” are used as the reference population



# Risk of inadequate food system and nutrition



## ➤ One crew member for one year

- 670 kg
- 1.7 m<sup>3</sup>



## ➤ Stability and acceptability

- 12 month mission
- + time prepositioned
- + time loaded
- + time prepared



## ➤ Related issues

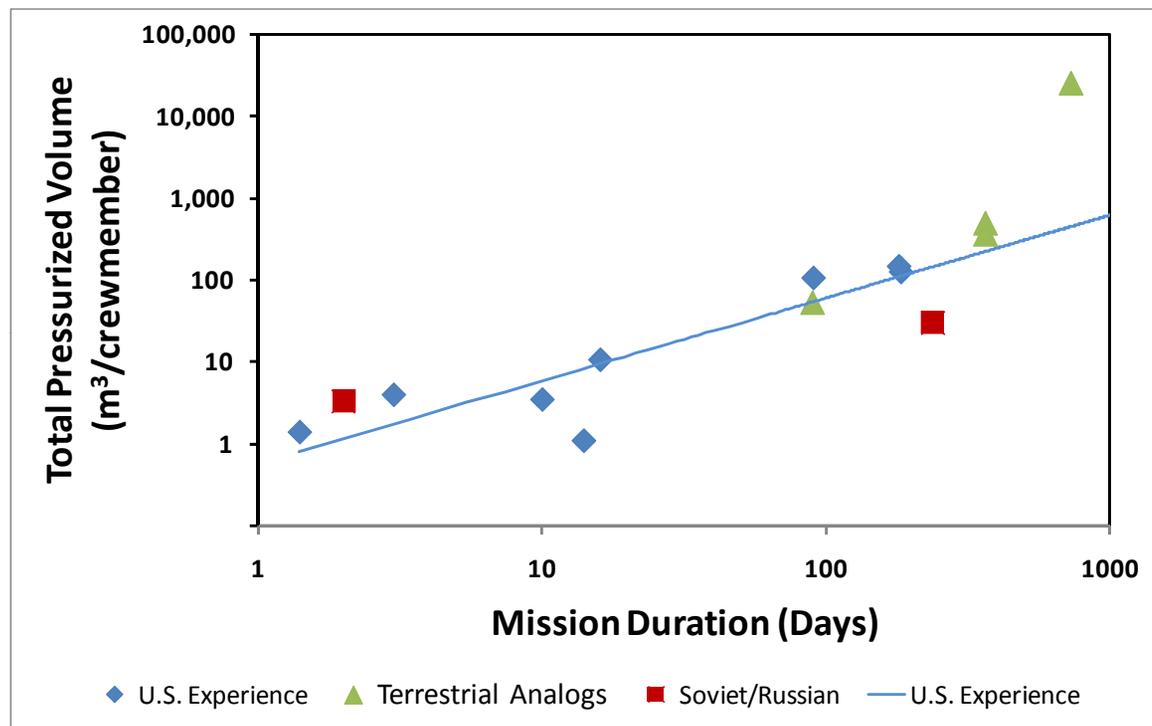
- Trash handling
- Water recycling



# Risk of behavioral health issues



- Confinement
- Isolation
- Communication delays
- Small crew size
- 1 month abort

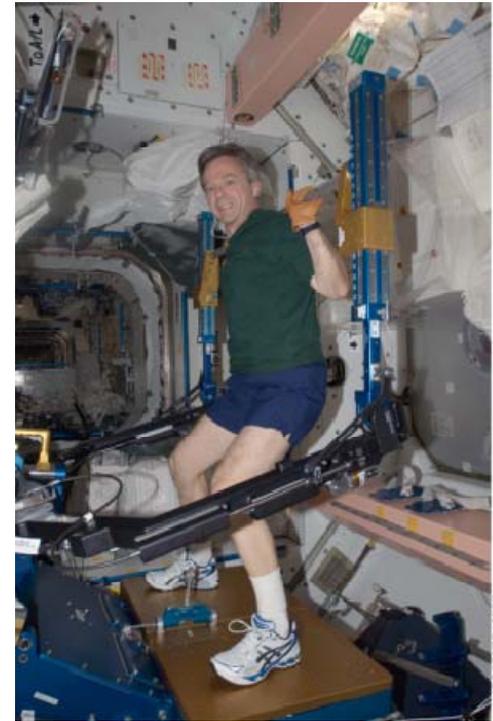


Earth as seen from 0.05 AU → •

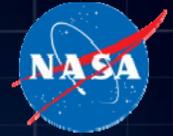
# Risk of muscle atrophy, cardiovascular atrophy, bone loss



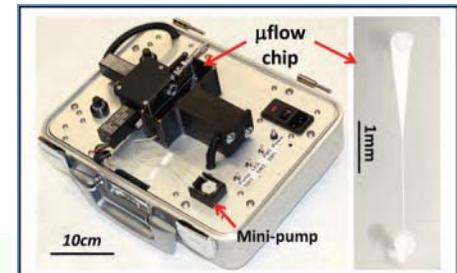
- What exercise equipment will be available?



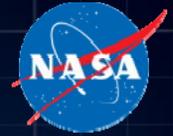
# Other risks



- Exposure to dust and volatiles  
EVA suitport or airlock?
- Lack of treatment for ill or injured  
crewmember  
one month abort?
- Decompression sickness  
EVA glove or end effector?



# Conclusion



- NASA is examining plans for a mission to an asteroid
- HRP is examining human health and performance risks for exploration missions beyond low Earth orbit
- Major risks for an asteroid mission
  1. Radiation exposure
  2. Inadequate food and nutrition
  3. Challenges to behavioral health
  4. Muscle, cardiovascular, bone atrophy
  5. Dust and volatiles
  6. Remote medical care
  7. Decompression sickness

