

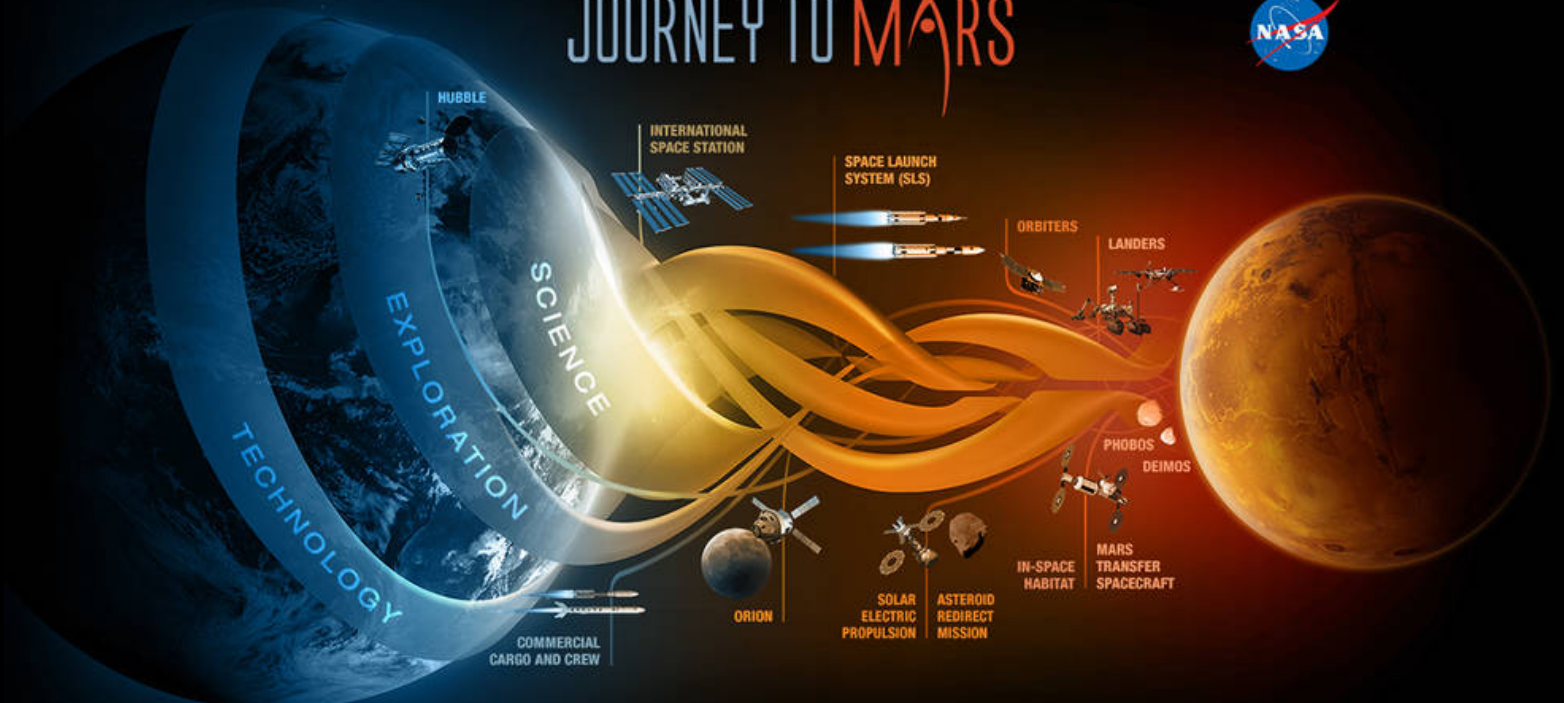


HEOMD VIEW OF SPACE WEATHER AND SPACE WEATHER NEEDS

John R. Allen

HEOMD/Crew Health and Safety

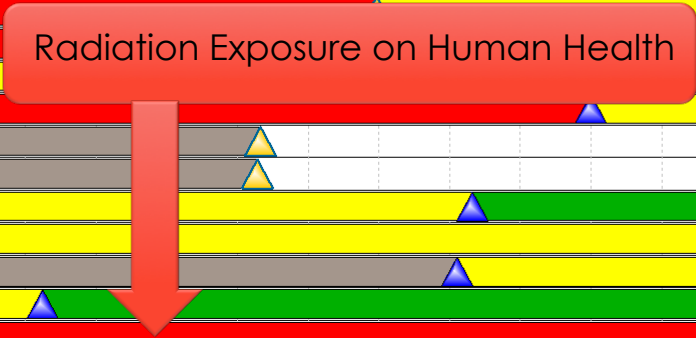
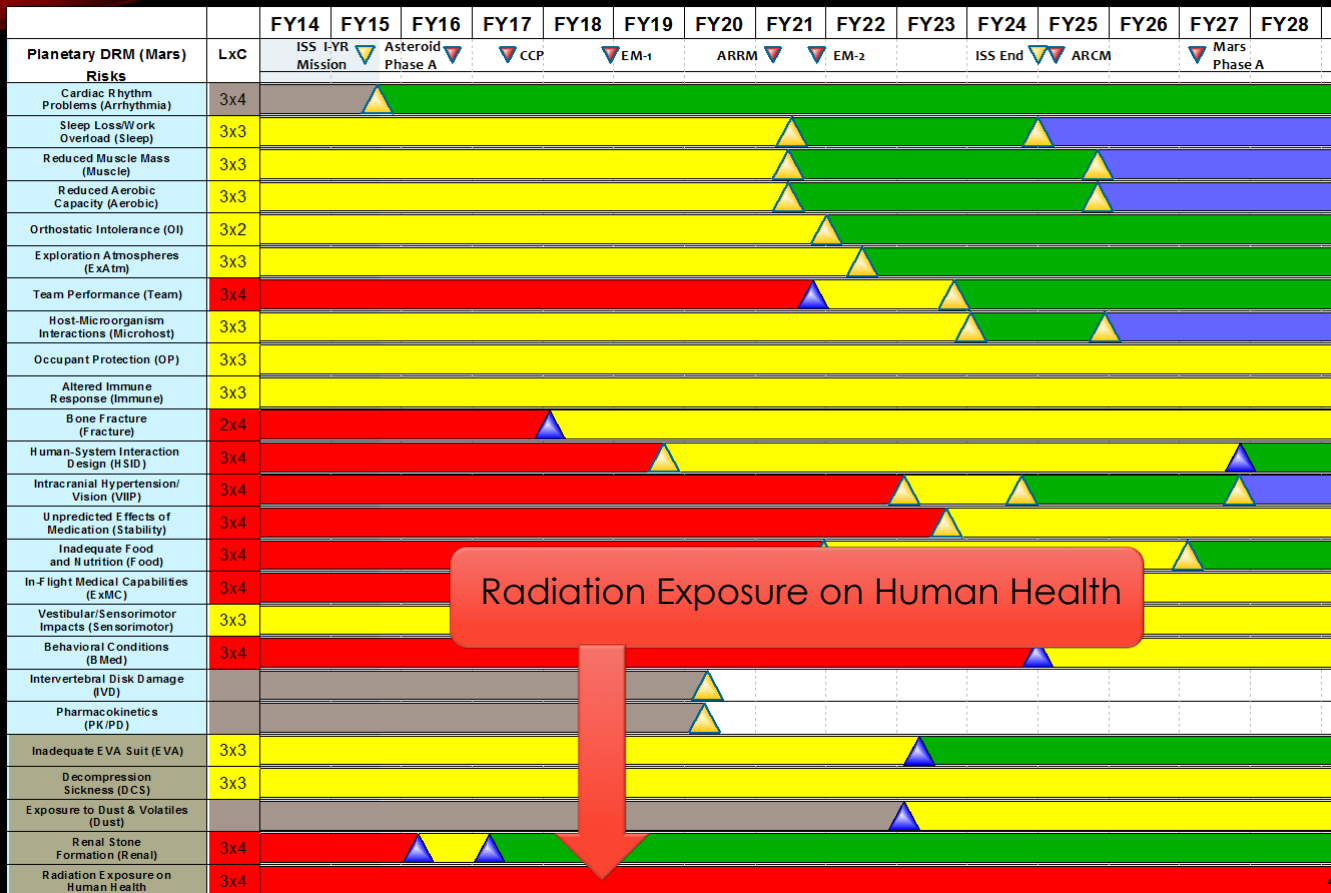
JOURNEY TO MARS



EXPLORATION CHALLENGES TO HUMAN HEALTH



HUMAN RESEARCH PROGRAM: PATH TO RISK REDUCTION



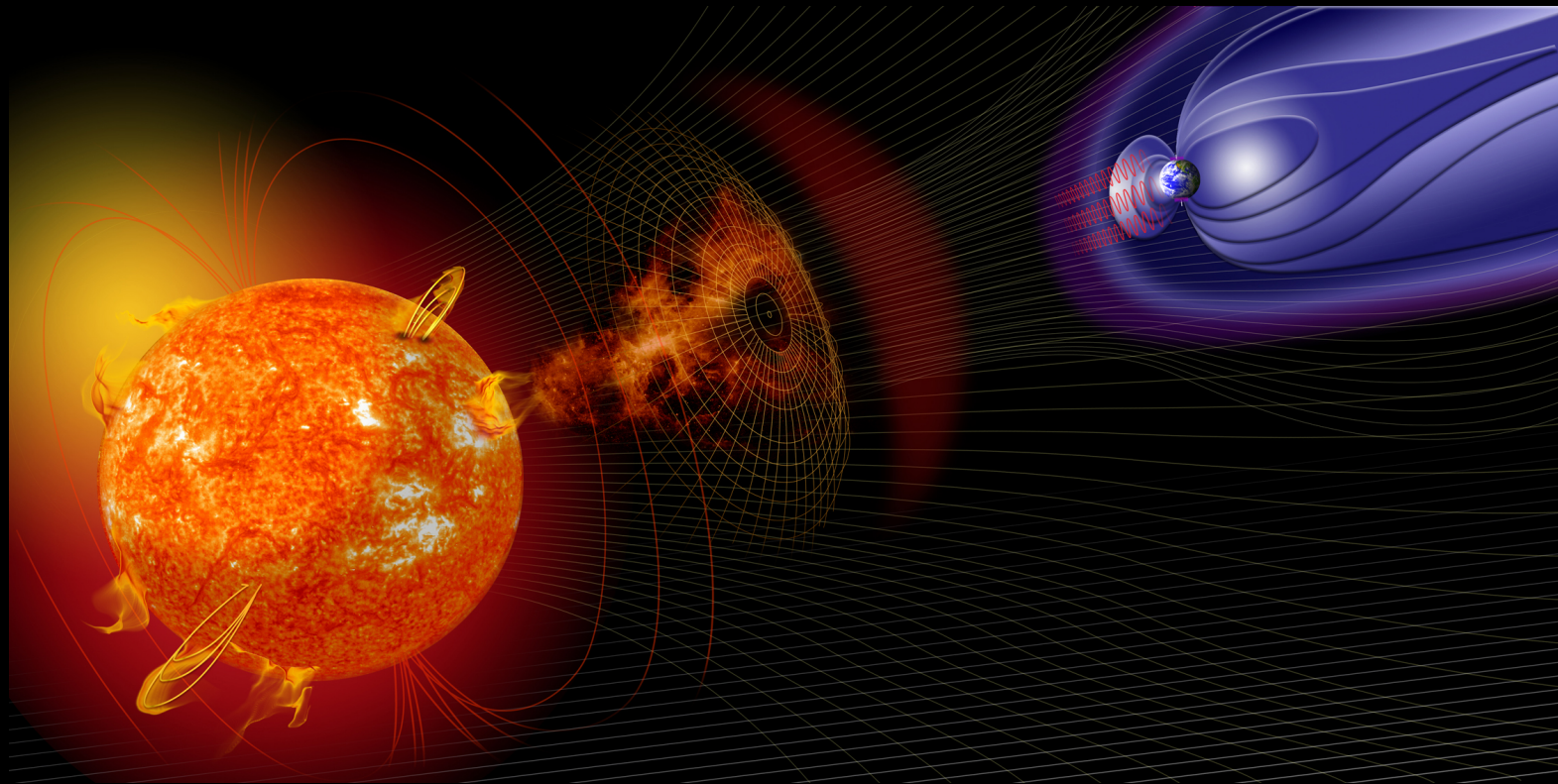
COUNTERMEASURES

- <http://www.nasa.gov/topics/journeytomars/index.html>

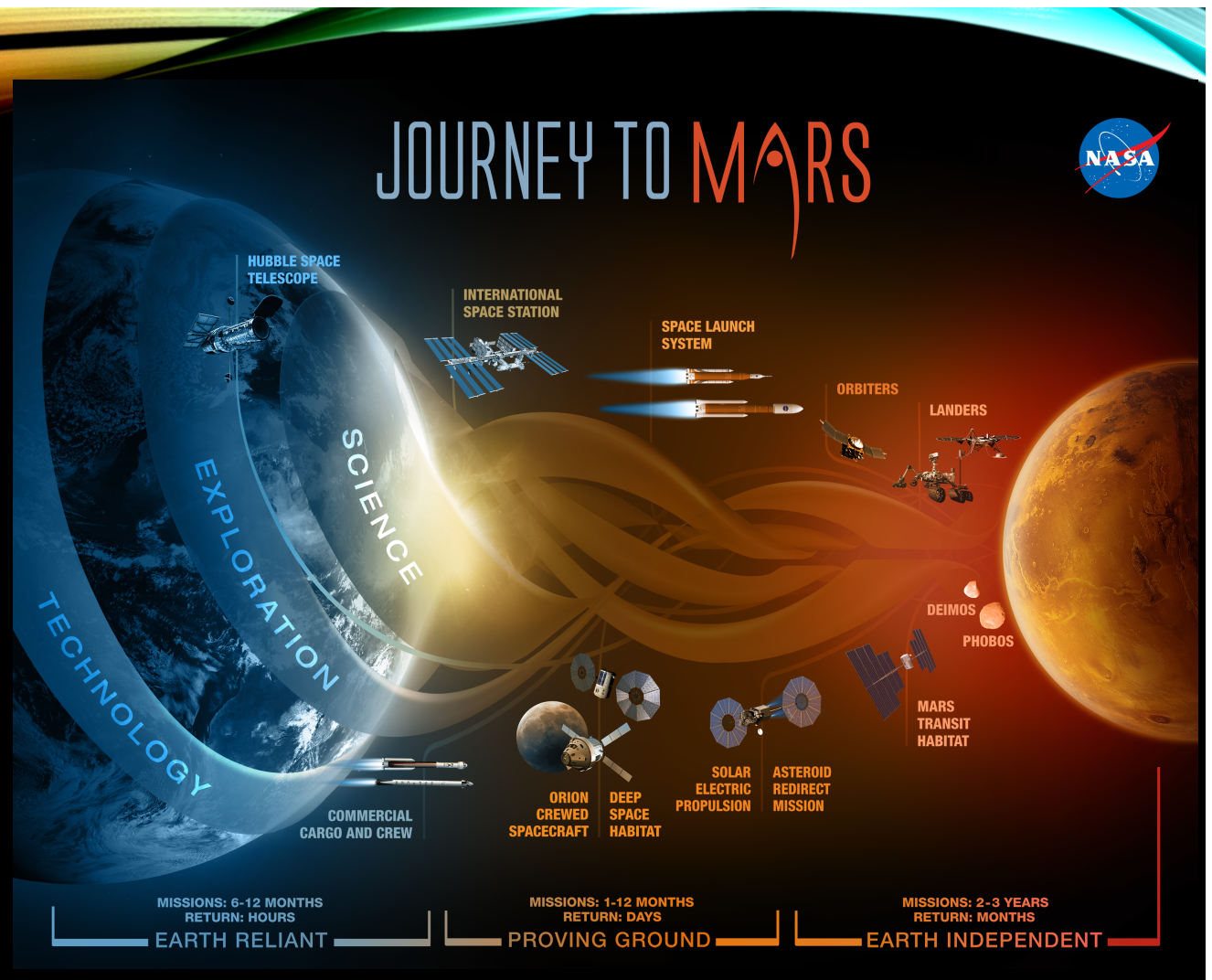


(Starwars.wikia.com)

EXPLORATION CHALLENGES TO SYSTEMS



- Single Event Upsets
- Electrical Charging
- Spacecraft Drag



ISS TECHNOLOGY DEMONSTRATION PLAN

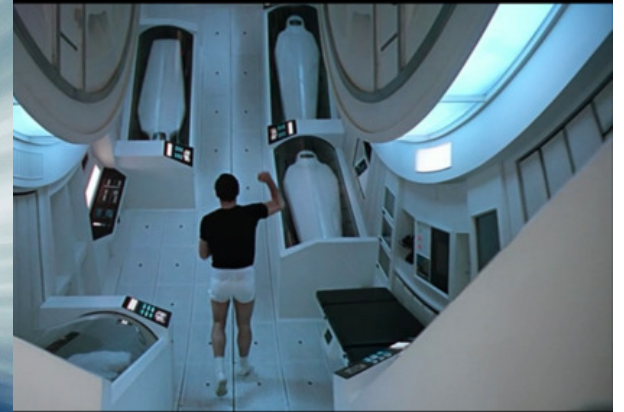
Capability Gap	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28
ECLSS															
Reliable CO2 Removal + ppCO2 < 2 mmHg	▲ CDRA-5	▲ LOST					▲ CDRA upgrades		▲ next gen system						
Smaller, simpler O2 Gen									▲ OGA upgrades						
High pressure O2 (3000 psi) for EVA & medical use															
Reliable urine processing = 85% recovery			▲ MIT III		▲ PCPA upgrade				▲ next gen UPA						
Reliable water processing w/ reduced expendables				▲ MF bed mod					▲ cat reactor mod						
Common biocide with on orbit replenishment															
Compact waste & trash mgmt, stable, 90% water recov							▲ UWMS		▲ HMC						
Additional O2 recovery from CO2 > 75%															
> 90% recovery of water from urine brine								▲ demo candidates							
Condensing HX robust anti-microbial coating															
10:1 volume reduction logistical & clothing		▲ adv. chg		▲ RPID				▲ Logistics Awareness						▲ laundry/sanitation	
Environmental Monitoring															
Trace Gas (on orbit, no grab sample return)	▲ AQM								▲ SAM						
Targeted Gases (fire products, NH3, hydrazine)				▲ MGM											
Water (individual compounds)															
Microbial (ID & qty species)															
Major Constituents (small, no maintenance)															
Particulates															
Acoustic (automated, alerting, no crew time)															
EVA															
Exploration PLSS/Microgravity Suit															▲ Deploy on ISS
Fire Safety and Response															
Emergency Mask (single cartridge)	▲ dual														
Contingency Air Monitor (overlap with targeted gas)															
Smoke Eater															
Water Mist PFE															
Large fire behavior in ug															
Crew Health & Performance Technologies															
Exercise Equipment															
Medical Equipment															
Food System															
Thermal (including Cryo)															
Zero Boil Off Cryo															
Phase Change Material															
Variable Heat Rejection radiators, single loop															
Power & Energy Storage															
Solar arrays															
Energy Storage															
Comm & Navigation															
High speed comm/internetworking															
Position, navigation, and timing															
Structures & Materials															
Materials/in-space manufacturing															
Structures & Health Monitoring															
Radiation Monitoring & Shielding															
ISRU (trash processing, resource prospecting, in-situ manufacturing) Plans under construction.															
Autonomous Operations															
Automated Rendezvous & Docking															
Robotics															
Robotic refueling															
Free flyer robots (IVA & EVA)															
Human assist robots															
Telerobotics															
Entry, Descent, Landing															

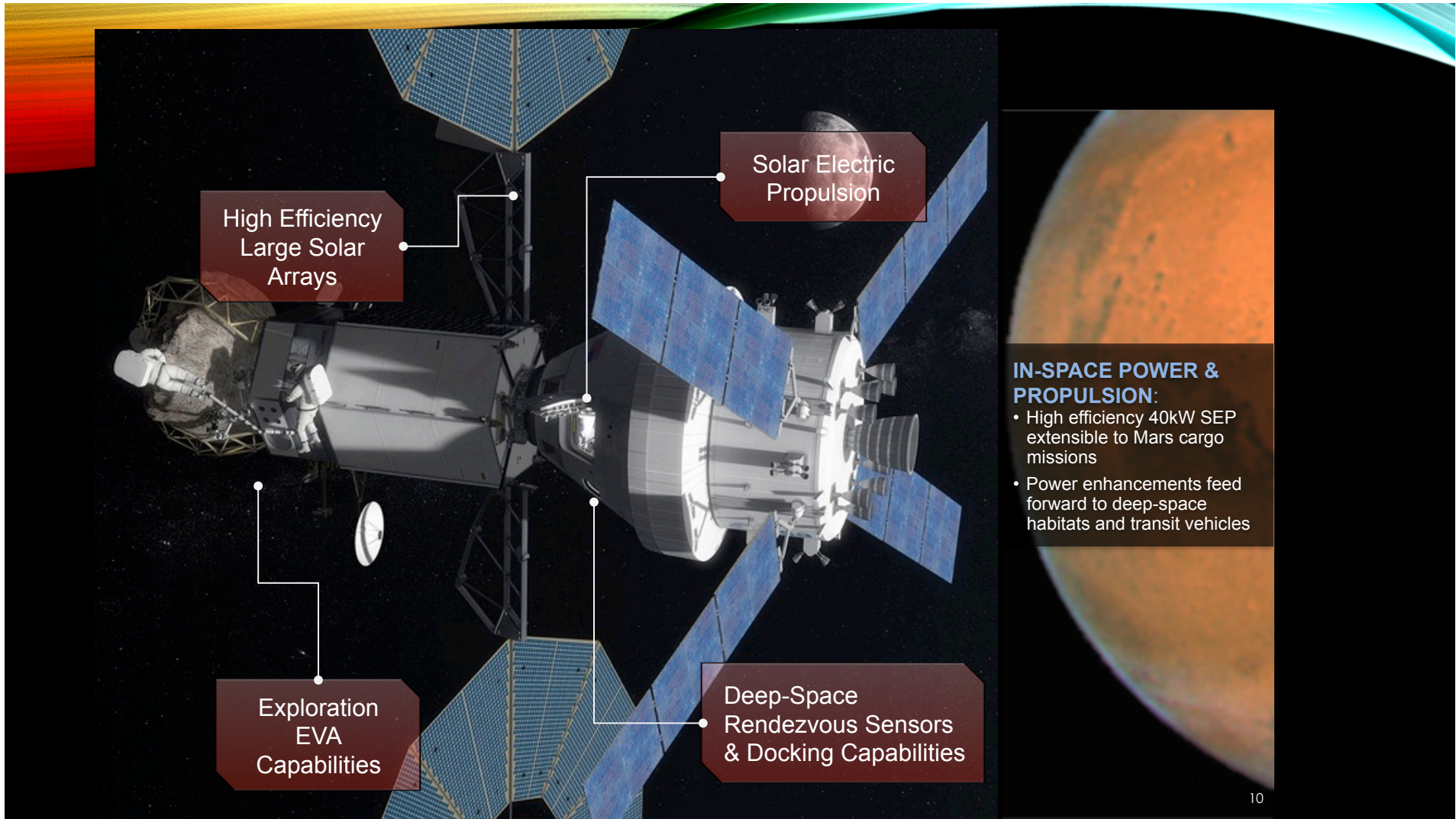
Radiation Monitoring and Shielding

■ no committed funding
■ some \$, but insufficient funding for ISS demo
■ sufficient funding to ISS demo
▲ Funded ISS demo
▲ Proposed ISS demo (not yet funded)

COUNTERMEASURES

- Warp Drive
- Teleportation
- Muscle
 - Exercise
- Bone
 - Exercise
 - Pharmaceuticals?
- Behavioral Health
 - Virtual/autonomous systems
- Radiation
 - Shielding?
 - Pharmaceuticals?





High Efficiency
Large Solar
Arrays

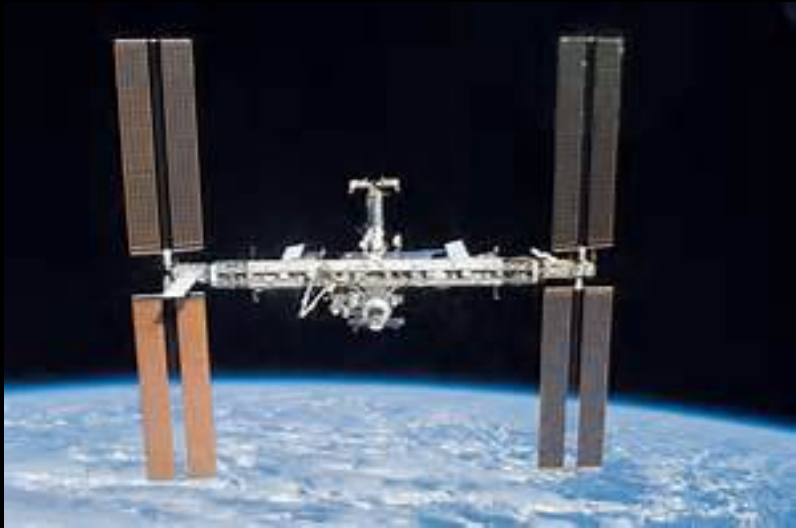
Solar Electric
Propulsion

Exploration
EVA
Capabilities

Deep-Space
Rendezvous Sensors
& Docking Capabilities

IN-SPACE POWER & PROPULSION:

- High efficiency 40kW SEP extensible to Mars cargo missions
- Power enhancements feed forward to deep-space habitats and transit vehicles



NEEDS

We want to have our cake and eat it too.





NEEDS

- WE WANT IT ALL, AND WE WANT IT NOW...
- We want space weather to be predictable...
- We want all of the good and none of the bad...
- We want to know
 - When we can safely launch
 - When we can safely operate
 - When will an event happen
 - How big will it be
 - How long will it last
 - Will it adversely impact humans
 - Will it adversely impact space-based and/or ground-based systems



WHAT CAN BE DONE?

- Continued research and development
- Improved propulsion may reduce human and systems exposure
- Improved shielding may improve our protection for humans and systems
- More and improved space weather models and forecasting will benefit both humans and systems
- ***Space Weather Operations Research and Mitigation Strategic Plan and Action Plan*** point to the importance of R2O and O2R
 - Close collaborations across directorates, centers, agencies, nations

QUESTIONS?

