Teaming for Future Space Exploration

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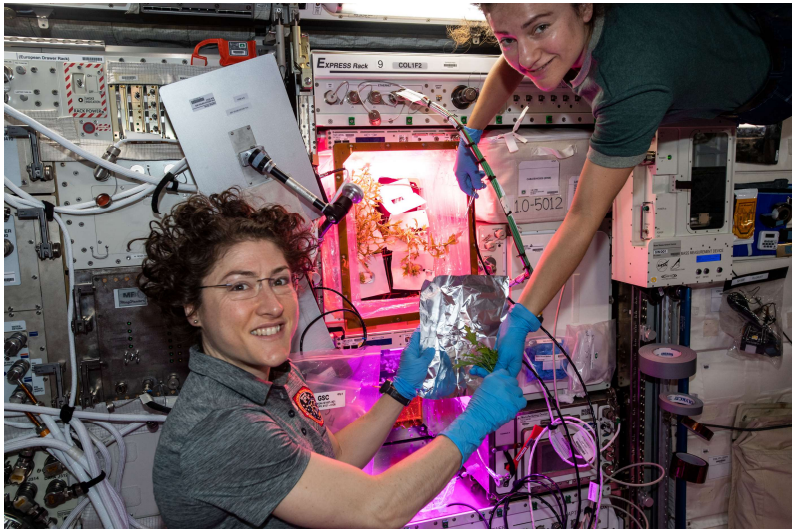
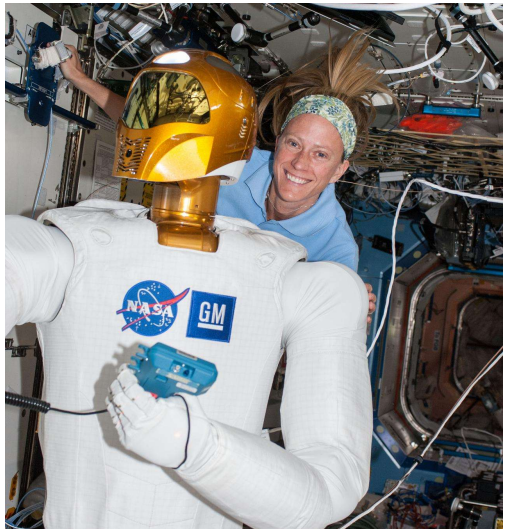
Spacework is Teamwork



Christina Koch and
Jessica Meir
harvesting greens

Astronauts Stephanie Wilson and
Mark Vande Hei supporting
spacewalk from Mission Control

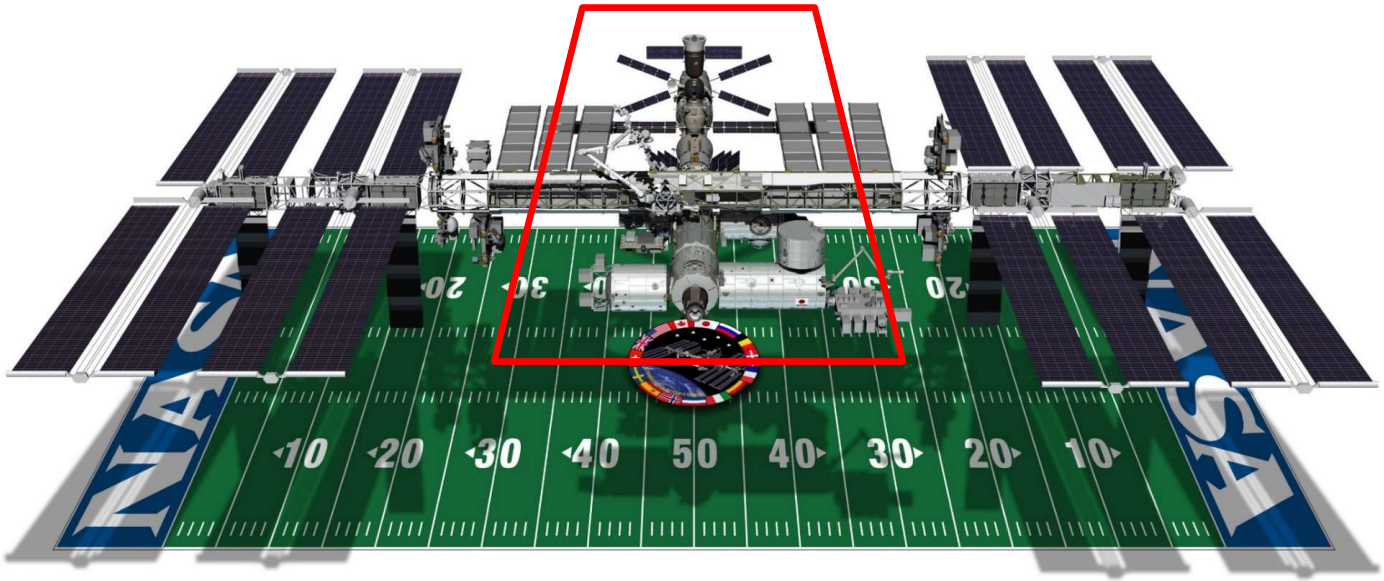


Astronaut Karen
Nyberg with
Robonaut 2

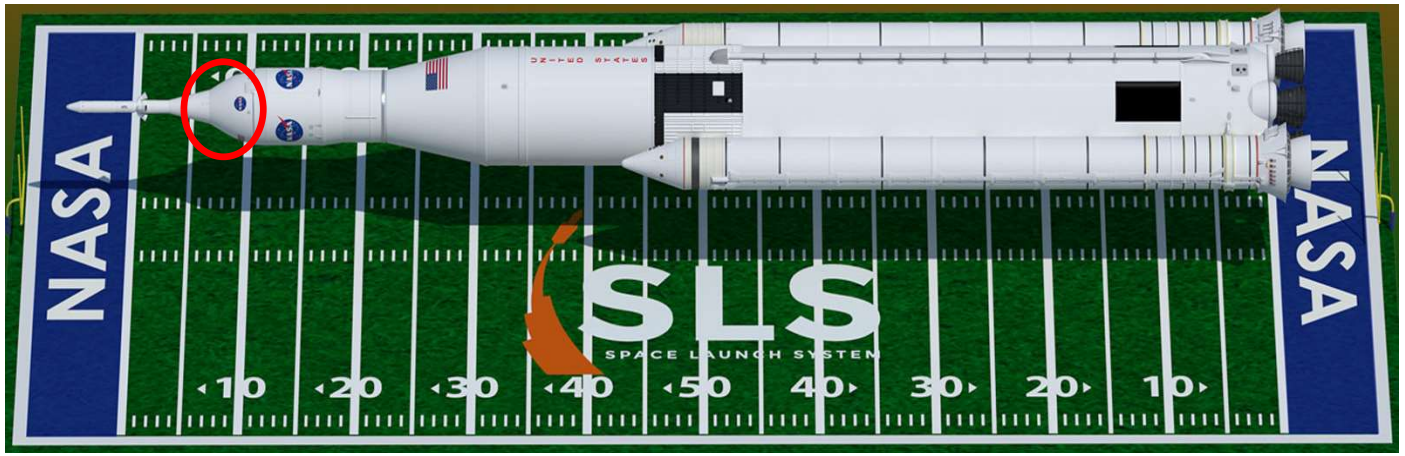
Current vs Future Missions

Current ISS Operations	Future Exploration Challenges
Low Earth Orbit • Real-time communication with ground operations, family • Provision of crew care packages • Discretionary events • Evacuation options • Cupola and Photography • Exercise 2 hours/day • High tempo workload **Astronauts thrive on the ISS** Large Volume Private Crew Quarters 6 – 12mth Duration	**Deep Space** • Up to 2.5 year duration • Communication delay/loss • More autonomous operations • No re-supply, crew rotation, evacuation • Smaller confined vehicle • Radiation, and Earth out of view! **Major Challenges** • Selection & crew composition for resilience • Team cohesion & coordination • Fatigue, workload management • Motivation, family connectedness Mars

ISS



SLS &
Orion

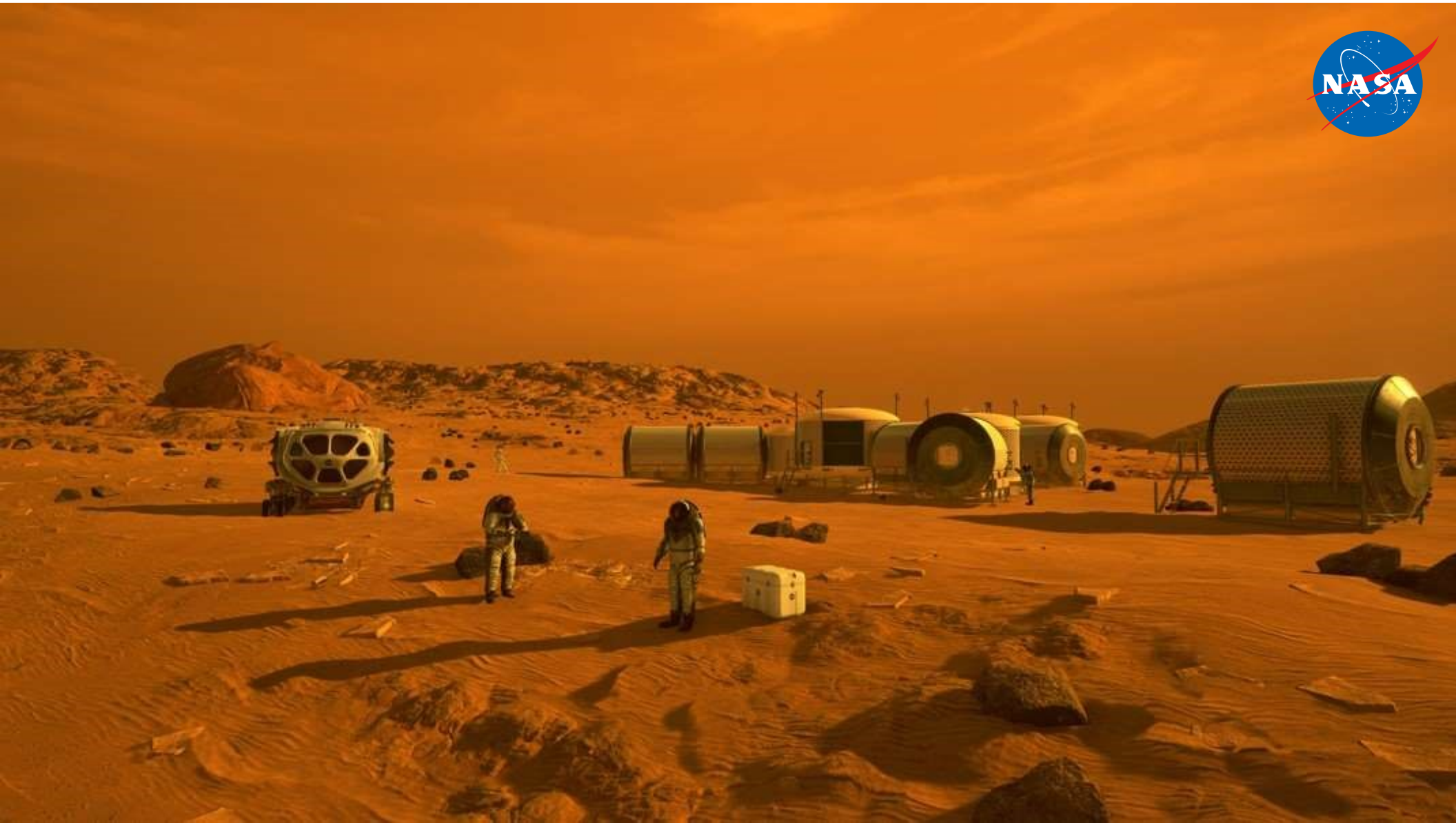


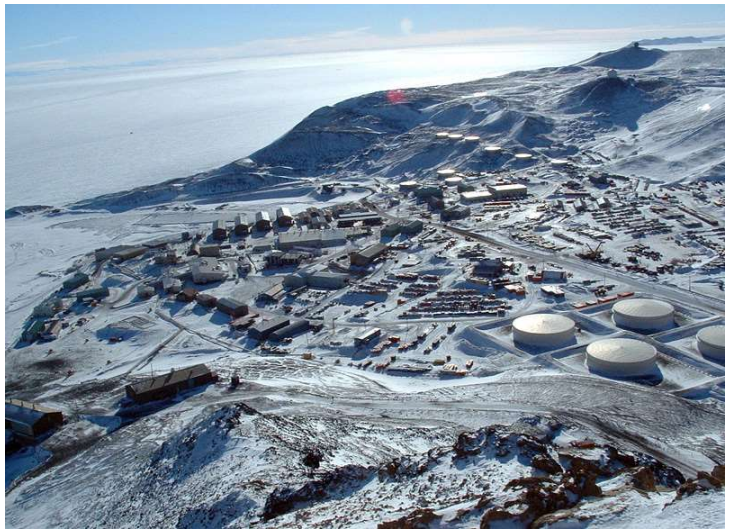
Teaming for Artemis Missions

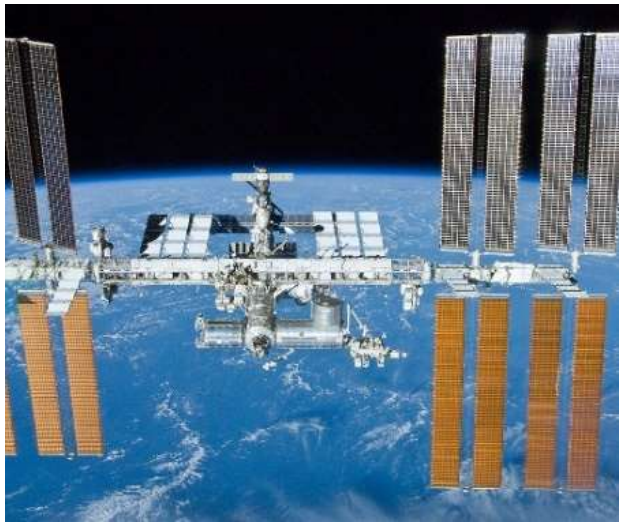
Living and working in small spaces

High workload with repeated EVAs

Still have close support from MCC possible


NASA

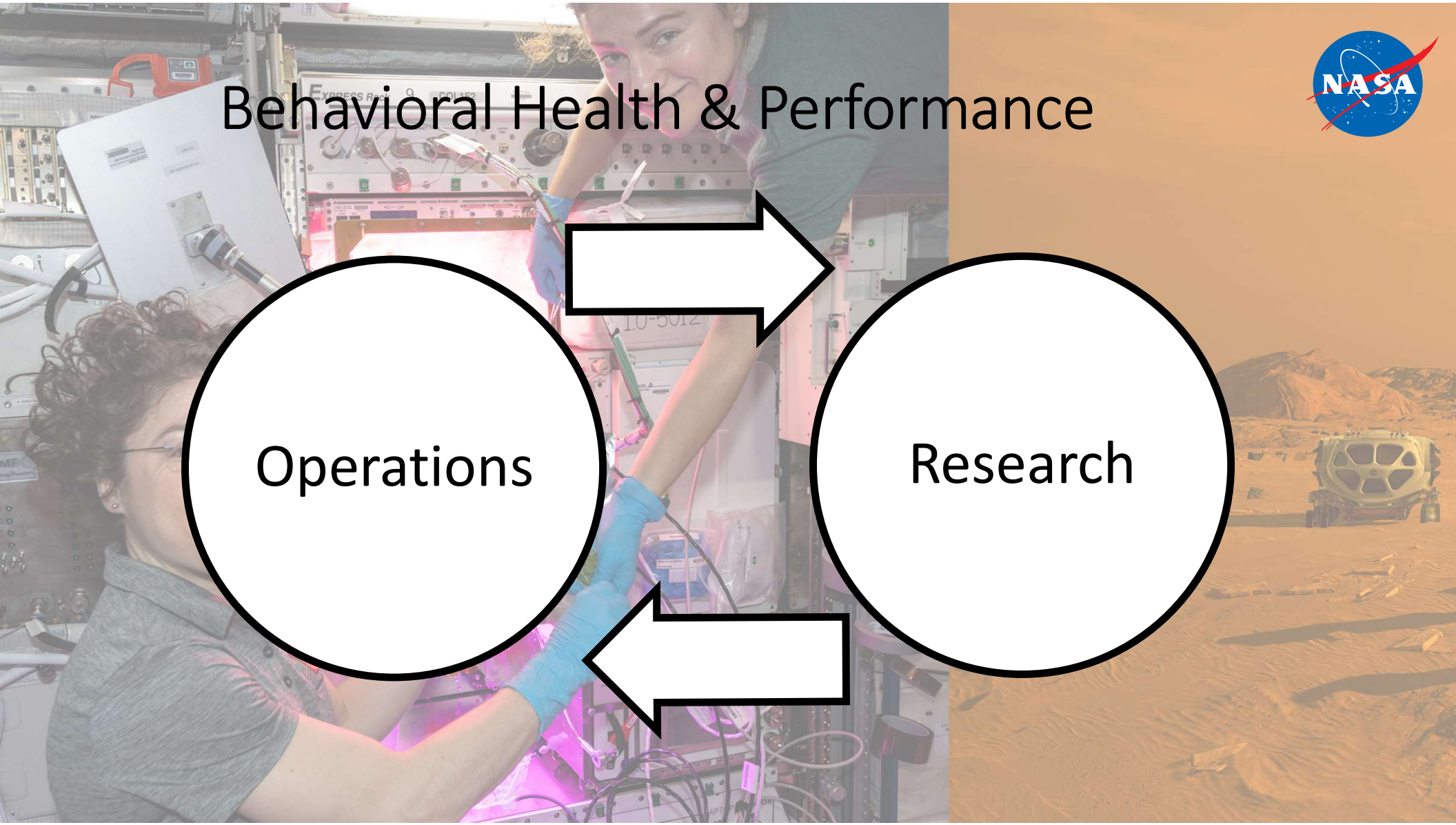




Research in Space and Space Analog Environments

Photo credits: NASA, National Science Foundation /Cody Johnson

Behavioral Health & Performance



Select → Train → Compose → Train → Self-Correct

Monitor

Counter-measures

Astronaut Selection for Team-Oriented Missions

	Mission Type: Mars	*M*
1	Self-Care	95.14
2	Technical	94.21
3	Small Group Living	94.07
4	Judgment	92.57
5	Motivation	92.00
6	Teamwork	91.50
7	Adaptability	91.00
8	Autonomous Worker	89.59
9	Communication	88.86
10	Leadership	87.64
11	Emo Independence	86.00
12	Sociability	85.79
13	Ops Orientation	84.14
14	Emotion Mgmt	83.71
15	Followership	83.29
16	Learner/Teacher	81.93
17	Confidence	81.00
18	Family	75.86

- Astronaut job analysis 2015 update (Barrett et al., 2015)
  - Astronaut SME panels, interviews, survey -> 18 competencies
  - Ranked by importance ratings, on a 0-100 importance rating
- 10 competencies “needed at hire” vs. “enhance with training”
  - Understanding that training will improve upon existing, high level of competency
- Avoid personality extremes; be team-oriented

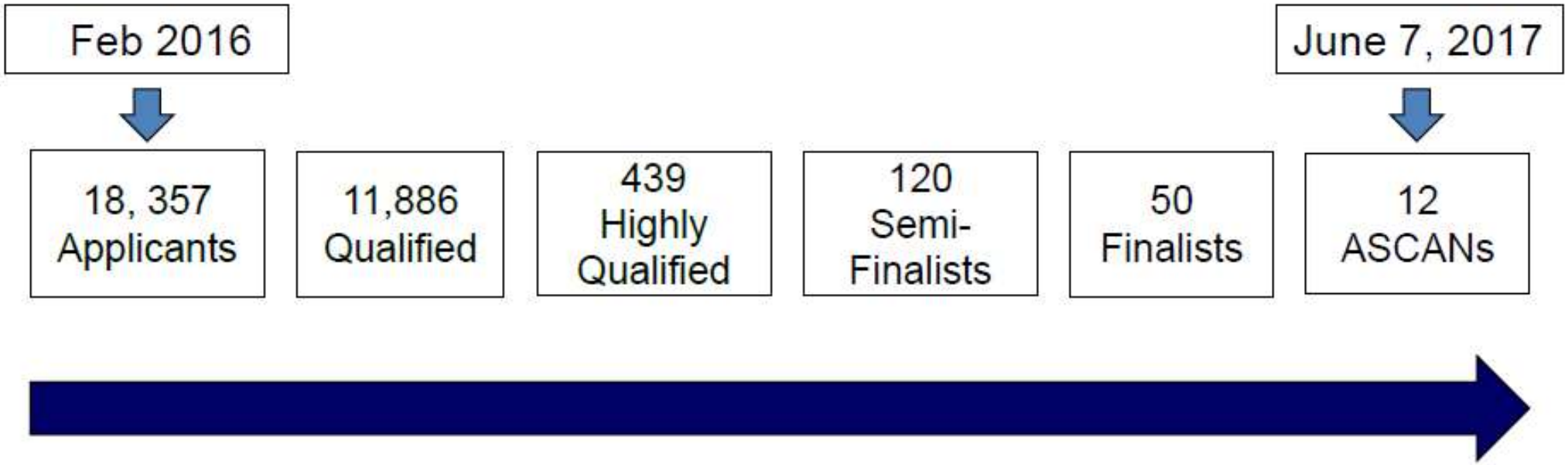
Astronaut Selection: Recent ASCAN classes

2017 – the “Turtles”

2021 – the “Flies”

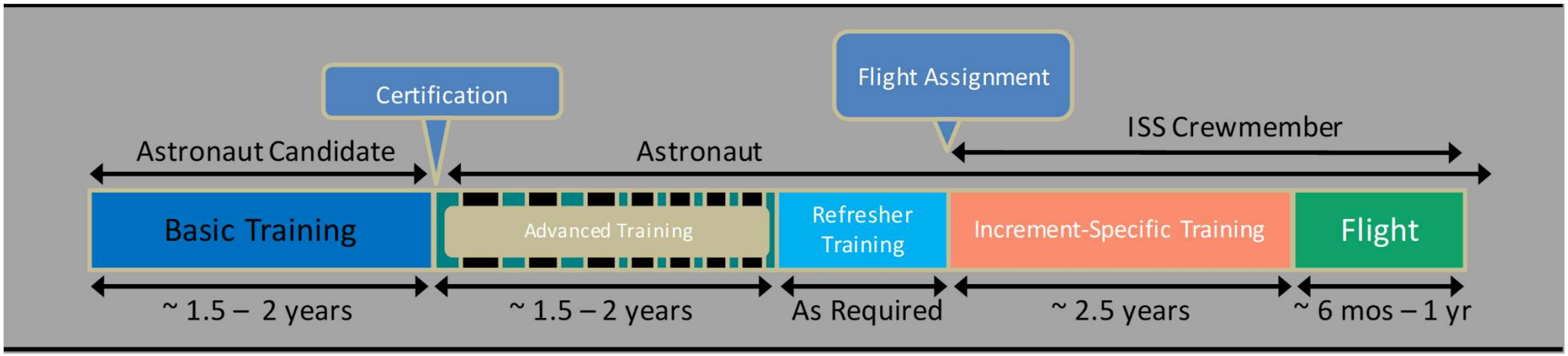
with UAE partners

Astronaut Candidate Selection



(Beven et al., 2018, AsMA)

Astronaut Training Flow



(Slack, 2016, SIOP)

Astronaut Candidate Training

Jessica Watkins preparing for underwater training

National Outdoor Leadership School

Astronaut Training Expeditionary Skills

5 Key Skills

- Self-Care/Self-Management
- Leadership/Followership
- Communication
- Team Care
- Teamwork and Group Living

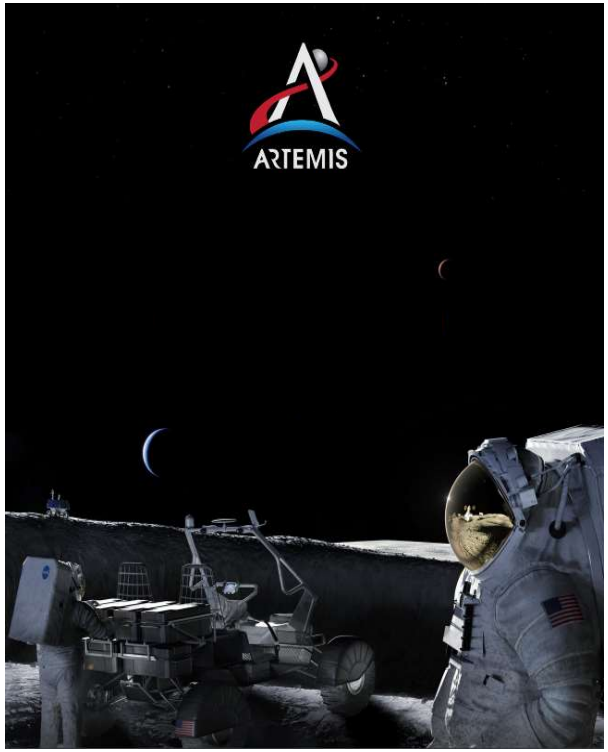
(Landon & Paoletti, 2021)

Additional BHP-Related Astronaut Training

- Expectations of Spaceflight
- Field Geology (integrated)
- T-38 jet training (integrated)
- Stress Management
- Conflict Management
- Cross-Cultural Training

(Sipes et al., 2021; Hughlett et al., 2021)

Future: more training with intact assigned team; additional interpersonal relationships training; immersive; in-mission refreshers



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Team Composition

- Some combinations of people work better together than others
- Deep- vs. Surface-level Factors
  - Deep: values, needs, interests, norms, personalities
  - Surface: gender, ethnicity, nationality, language
- Evidence: Avoid extremes, tokenism, faultlines

NASA/TM-2015-218568

Critical Team Composition Issues for Long-Distance and Long-Duration Space Exploration

A Literature Review, an Operational Assessment, and Recommendations for Practice and Research

Suzanne T. Bell
Shanique G. Brown
Neal B. Outland
Daniel R. Abben

5 Major Factors for LDEM

- Culture and gender differences
- Personality
- Abilities, expertise, background
- Team size
- Network factors –multi-team system

(Bell, 2007; Bell et al., 2015; Contractor et al., 2017; Fiore et al., 2015; Schmidt, 2015)

Data Collection in HERA

Teams complete 45 day missions

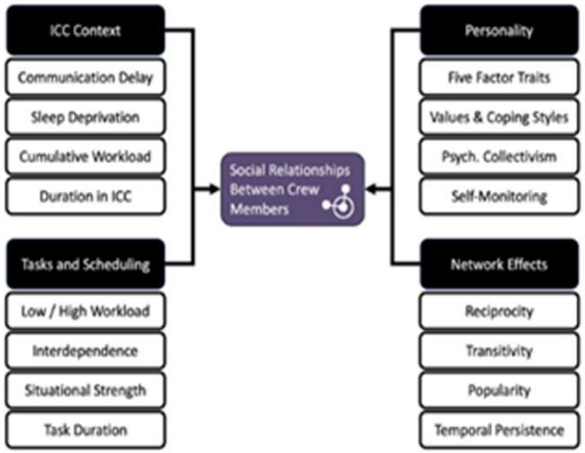
Isolation
Sleep Deprivation
Communication delay

Heavily scheduled days
Slam shifts
Emergency simulations

Team Composition and Dynamics

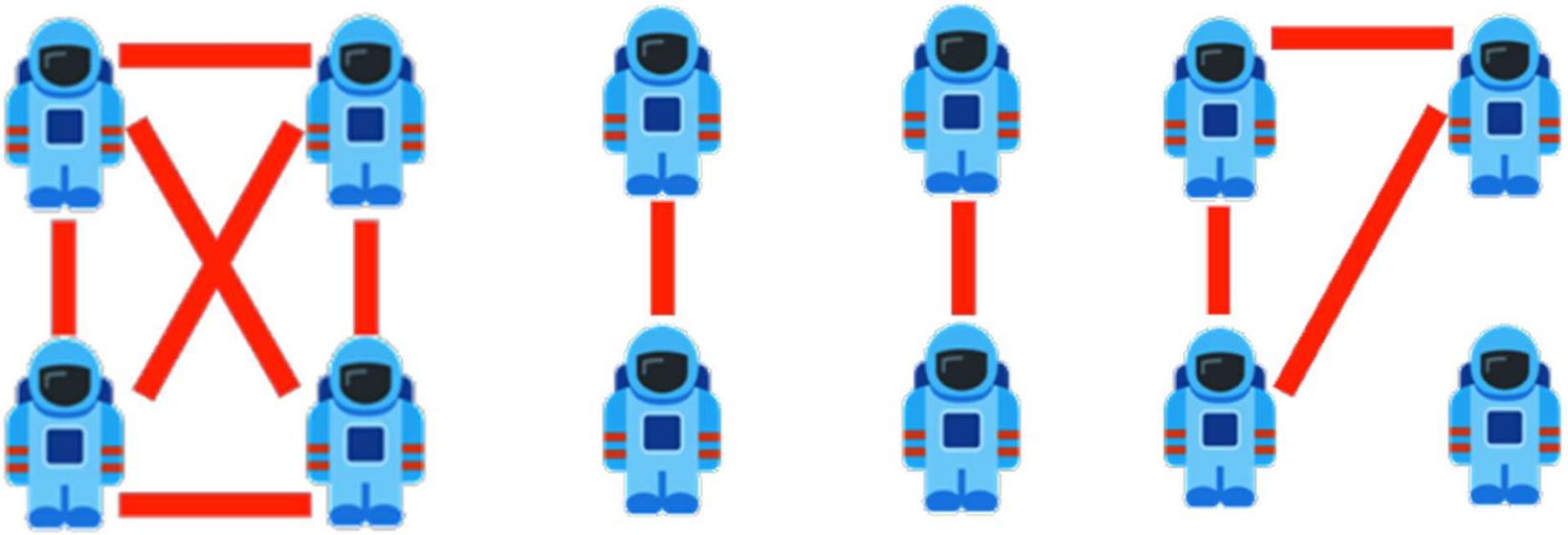
Data-driven, dynamic team composition can support interpersonal relationships

- HERA C3/C4 data used to build crew pairing prototype
- HERA C5 tested prototype
  - **Finding:** 'Best' pairings increased constructive, decreased destructive effects to relationships



(Antone et al., Contractor, 2021, IAC proceedings)

Team Dynamics in Long-Term Isolation

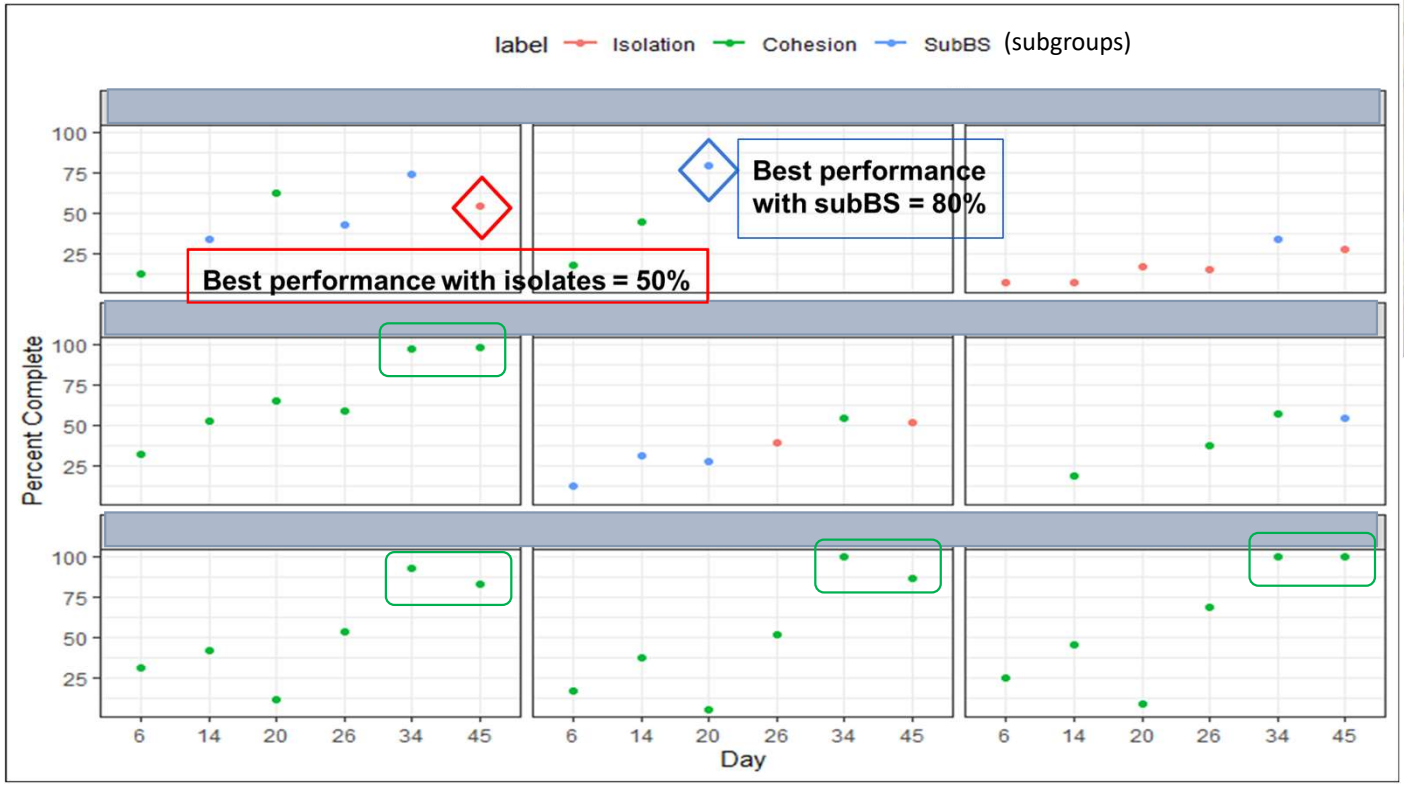


Integrated **Subgrouping** **Isolate**

(Bell, Nyberg, et al., 2021, IWS)

Interpersonal Relationships & Cohesion → Performance

Cohesion predicts objective performance



9, 5-person crews in isolation for up to 45 days

HERA Multi-Mission Space Exploration Vehicle (MMSEV) task

(Bell, Nyberg, et al., 2021, IWS)

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Questions?