

Egress Fitness
HRP IWS 2026

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Science Background

- Both physiological adaptation to microgravity and re-entry into a gravity environment result in reduced functional capacity
- Quantification of astronauts' post-landing functional performance is necessary to:
  - Design concepts of operation for exploration missions
  - Establish evidence-based fitness for duty standards
- There are two high-risk tasks that may have to be performed soon after gravity transitions:
  - Unassisted capsule egress task after return to Earth
  - Planetary EVA soon after landing on Mars (or the Moon)

Objectives

- CIPHER Egress Fitness
  - To quantify postflight (after a mission on the ISS) time course changes in unassisted capsule egress and planetary EVA task performance
  - To characterize the recovery to acceptable planetary EVA task performance as a function of EVA task type, time in space, time post-landing, and other potential determinants of performance (e.g., sleep, nutrition, exercise, sensorimotor performance)
    - Requires data sharing with other CIPHER studies and MedB testing

- Fram 2 Mission Objectives
  - Perform actual egress from the lander capsule – demonstrate feasibility of performing this task for research
  - Compare results of both actual capsule egress and mockup capsule egress

Experiment Design Review

Preflight Data Collection | Crew Launch | Crew Landing | Travel to Rally Airport | Travel to Ellington | Sleep | Postflight Data Collection @ JSC











Pilot Egress Fitness

EVA Suit Fit Check
Partial Planetary EVA & FAM
Capsule Egress & FAM
L-180-90

Actual Capsule Egress (Fram2)

Mockup Capsule Egress (R+1-4h)

Partial Planetary EVA R+18-36h

Egress Fitness

EVA Suit Fit Check
Planetary EVA & FAM
L-180

Mockup
Capsule Egress & Fam
Planetary EVA
L-60

Mockup
Capsule Egress
R+1-4h

Partial Planetary EVA R+18-36h

Planetary EVA R+4, R+8

Unassisted Mock-up Capsule Egress

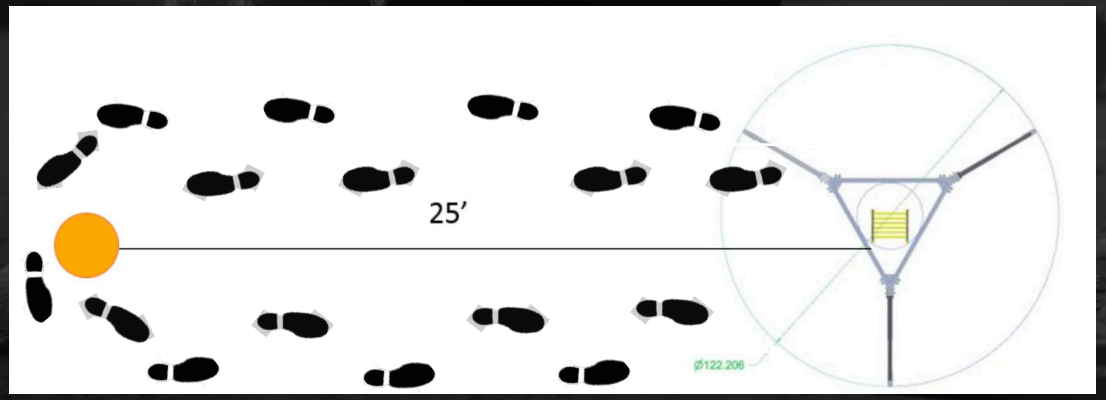
Capsule egress test is performed pre- and post-flight (R+0 at rally airport) using a capsule simulator (before doffing the LEA suit**):

1. Egress from “recumbent seat” (lying on your back)
2. Deploy and secure ladder
3. Ascend the ladder with survival pack
4. Hand survival pack out of the top of the hatch to operator
5. Descend ladder
6. Retrieve survival pack and walk to a safe waypoint (medical tent or around cone ~50ft)

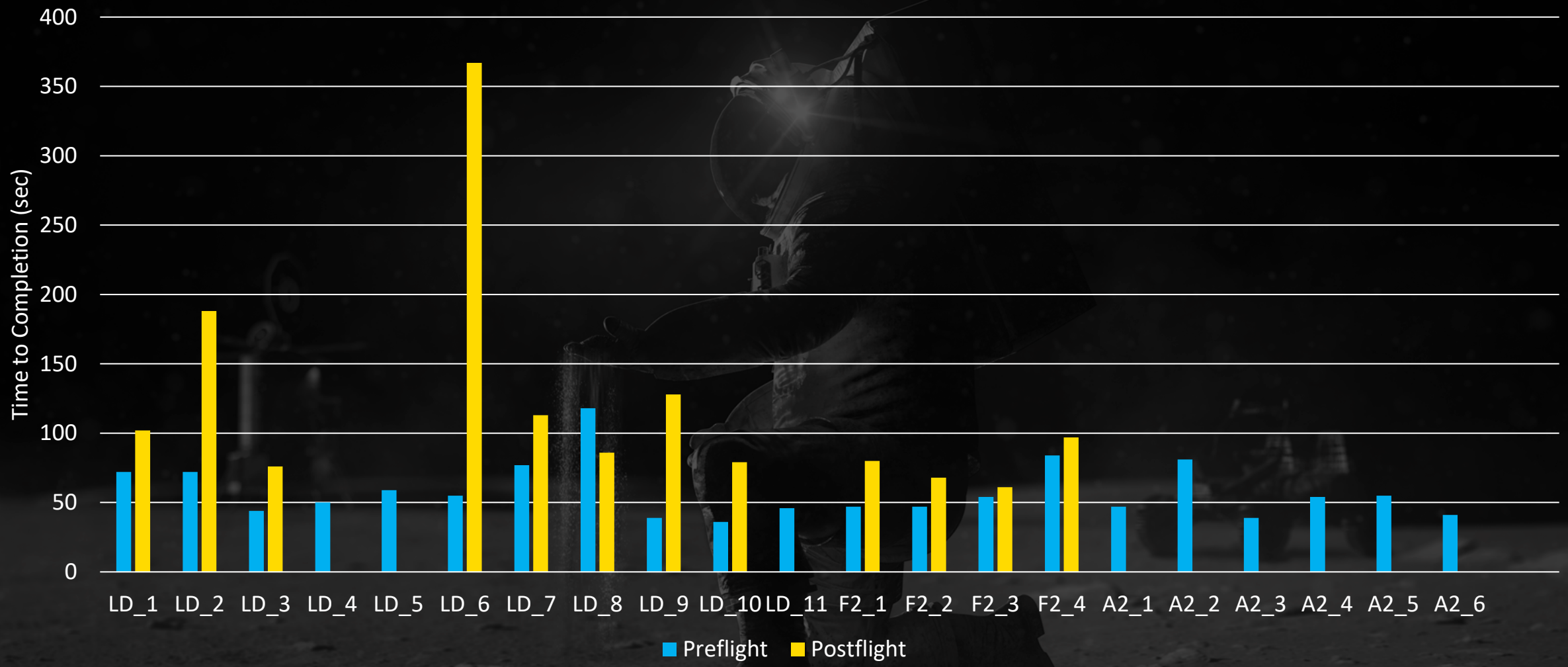




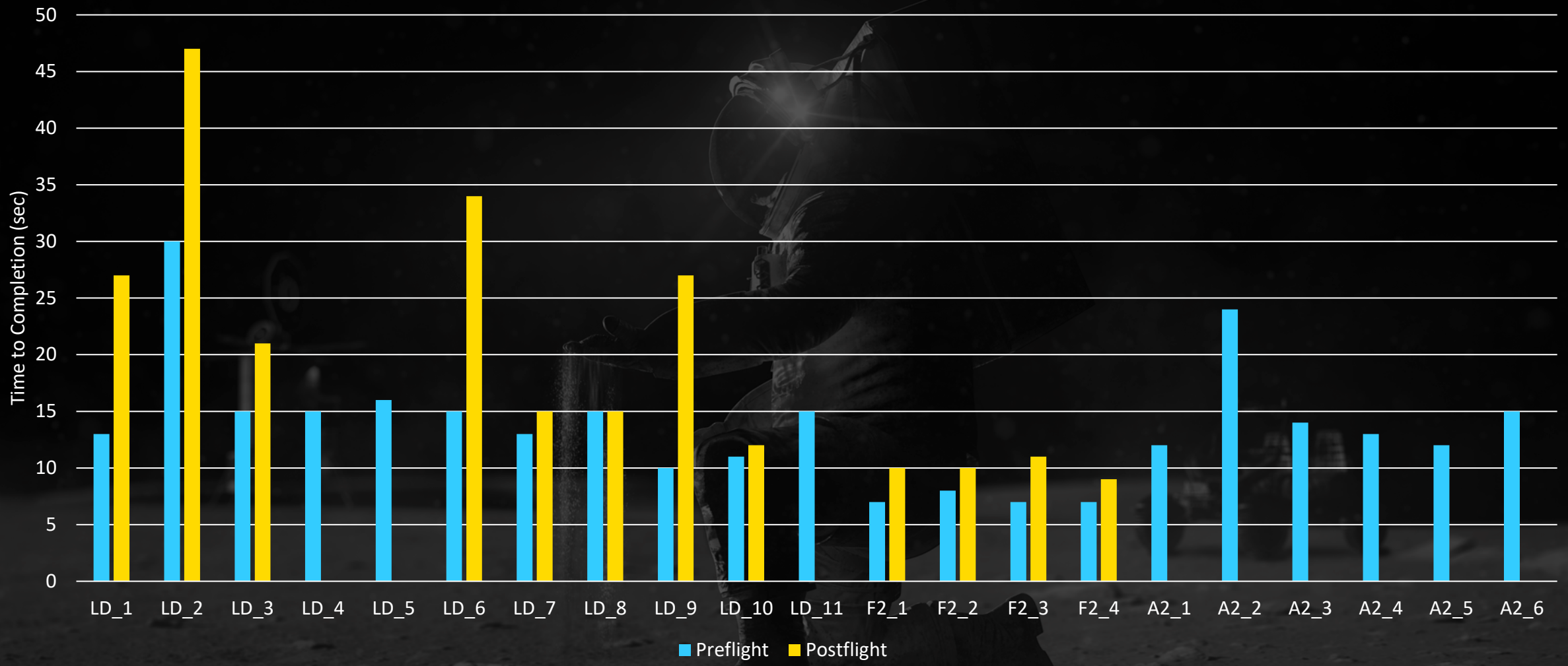
Doffing of IVA suit happens prior to mock-up capsule egress



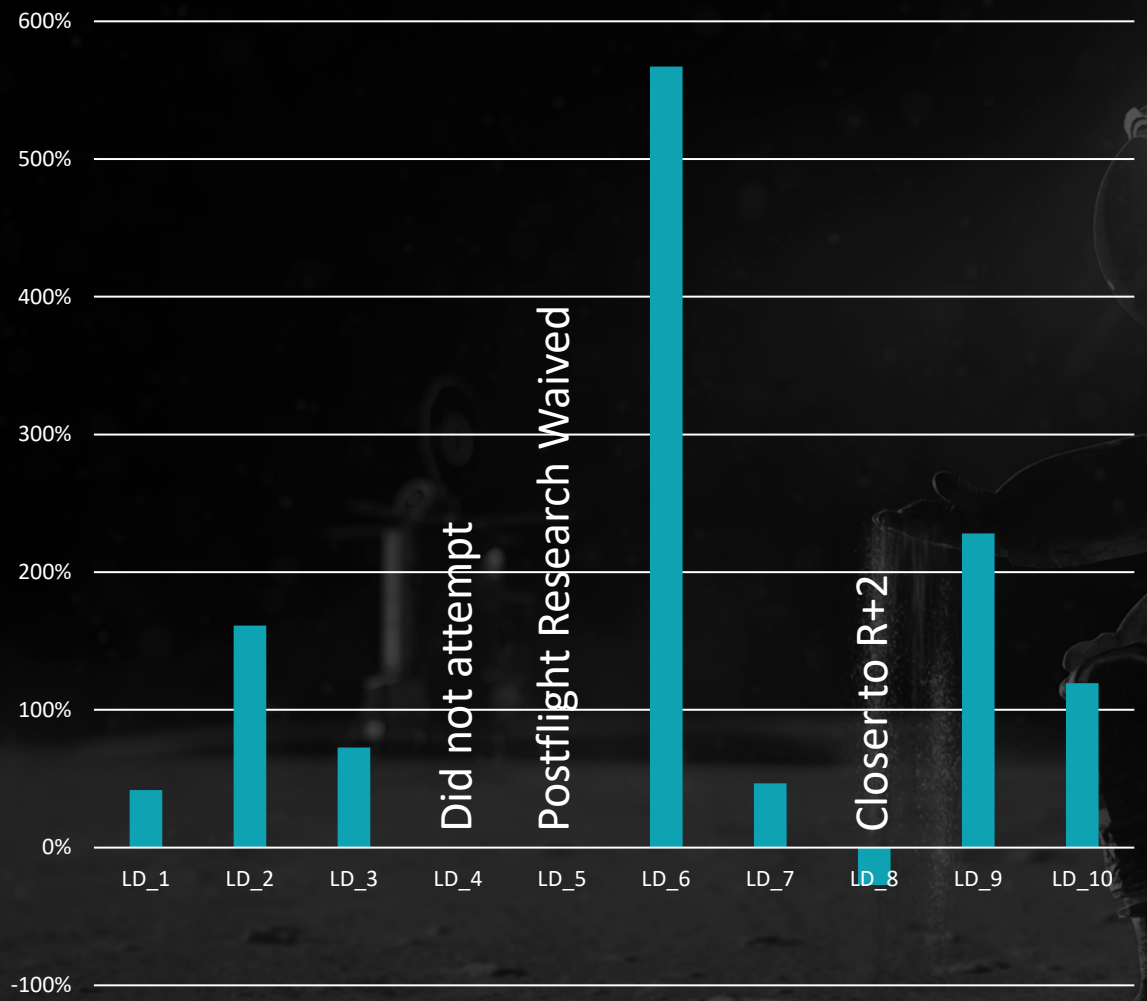
Capsule Egress Mockup – Egress Durations



Capsule Egress Mockup – Walking Durations



Percent Increase from Preflight – Capsule Egress



- Huge diversity in results
- 1/10 was unable to attempt
- 1/10 had research waived
- 1/10 postflight testing very delayed
- Least impacted long duration flyers had times less than double pre-flight
- Others had times 2x, 4x or even 6x longer than preflight baseline
- Data sharing between CIPHER studies and MedBs may help explain some of the heterogeneity
- Limitations
  - Not really an emergency – just a simulation
  - Teamwork could help or cause congestion/traffic

Actual Capsule Egress







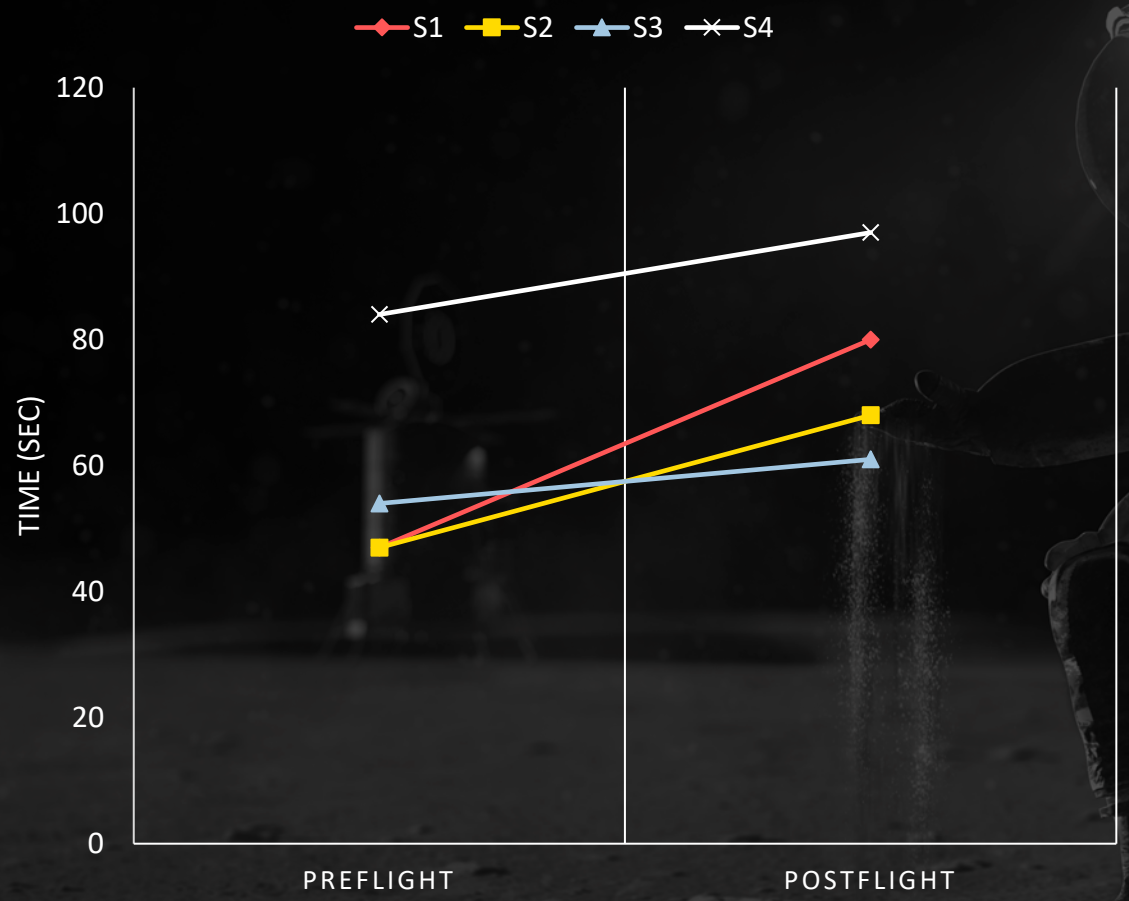




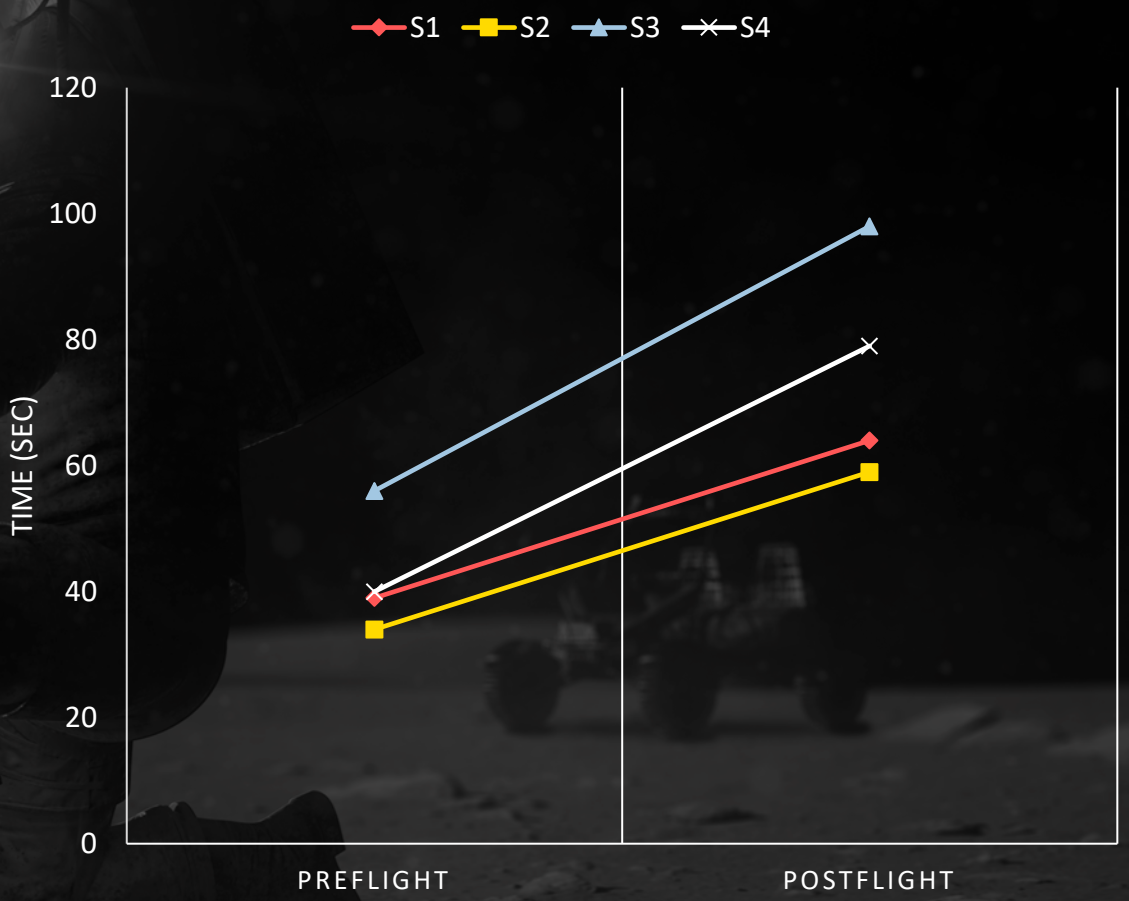
- Differences from Mockup Capsule Egress
  - Confined space
  - Multiple people in the cabin
  - Seat order – one person goes at a time in a specific order
  - Task performed while wearing IVA suit
  - Survival packs are different masses
- Crew Comments
  - Mockup was more complicated & harder
  - Actual capsule is enclosed – you're more aware of surroundings and causing damage

Fram 2 – Capsule Egress Results

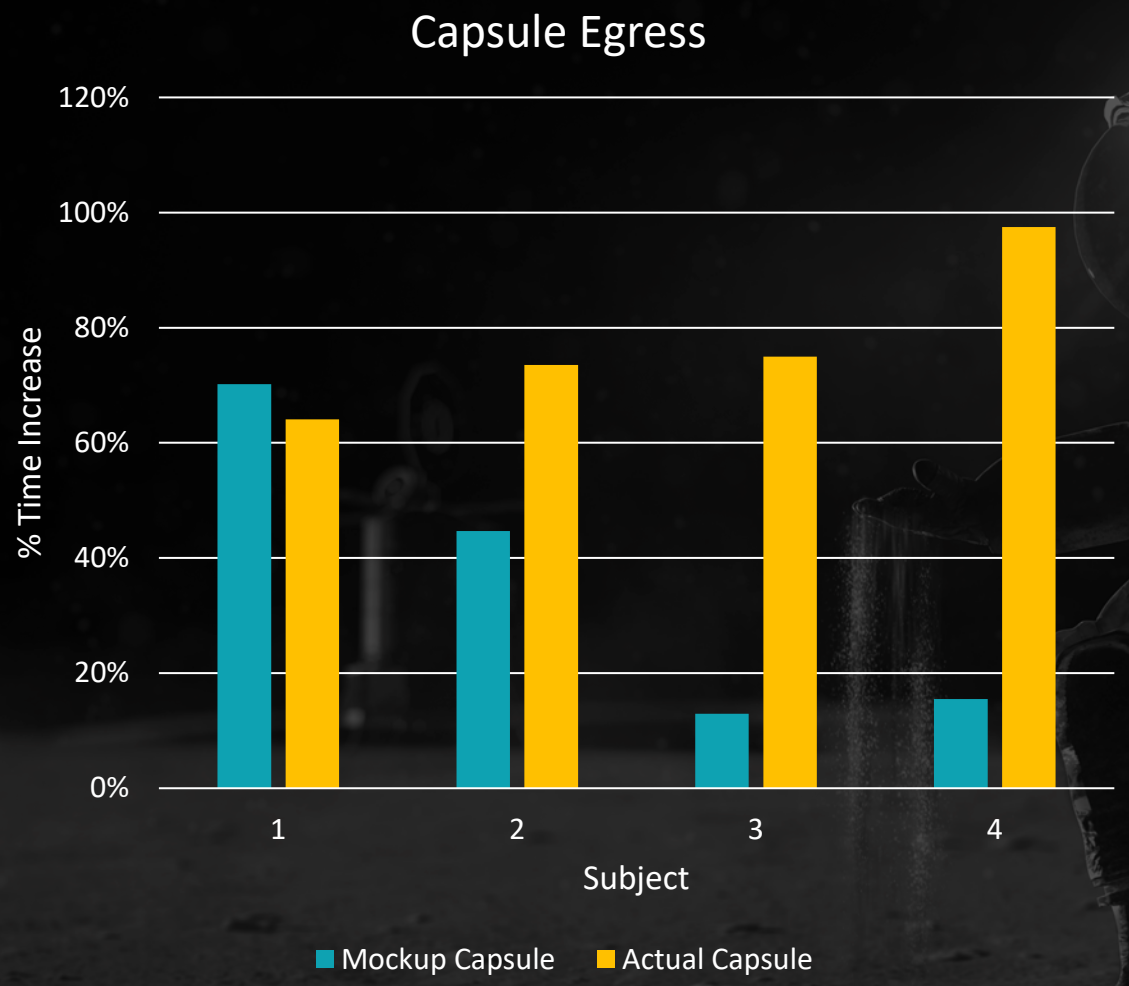
MOCKUP CAPSULE EGRESS



ACTUAL CAPSULE EGRESS



Fram 2 Results – Actual vs Mockup



- Performance decrements were noted across all 4 crewmembers doing the actual capsule egress
- Within 3 hours, some short duration flyers were performing the task near baseline
- Crew comments
  - S1 – Mockup more complicated & harder
  - S3 - Mockup not provoking; more adapted by time of doing mockup
  - S4 – Was a little dizzy doing mockup; mockup harder to climb; easier to manage weight

Partial Planetary Simulated EVA

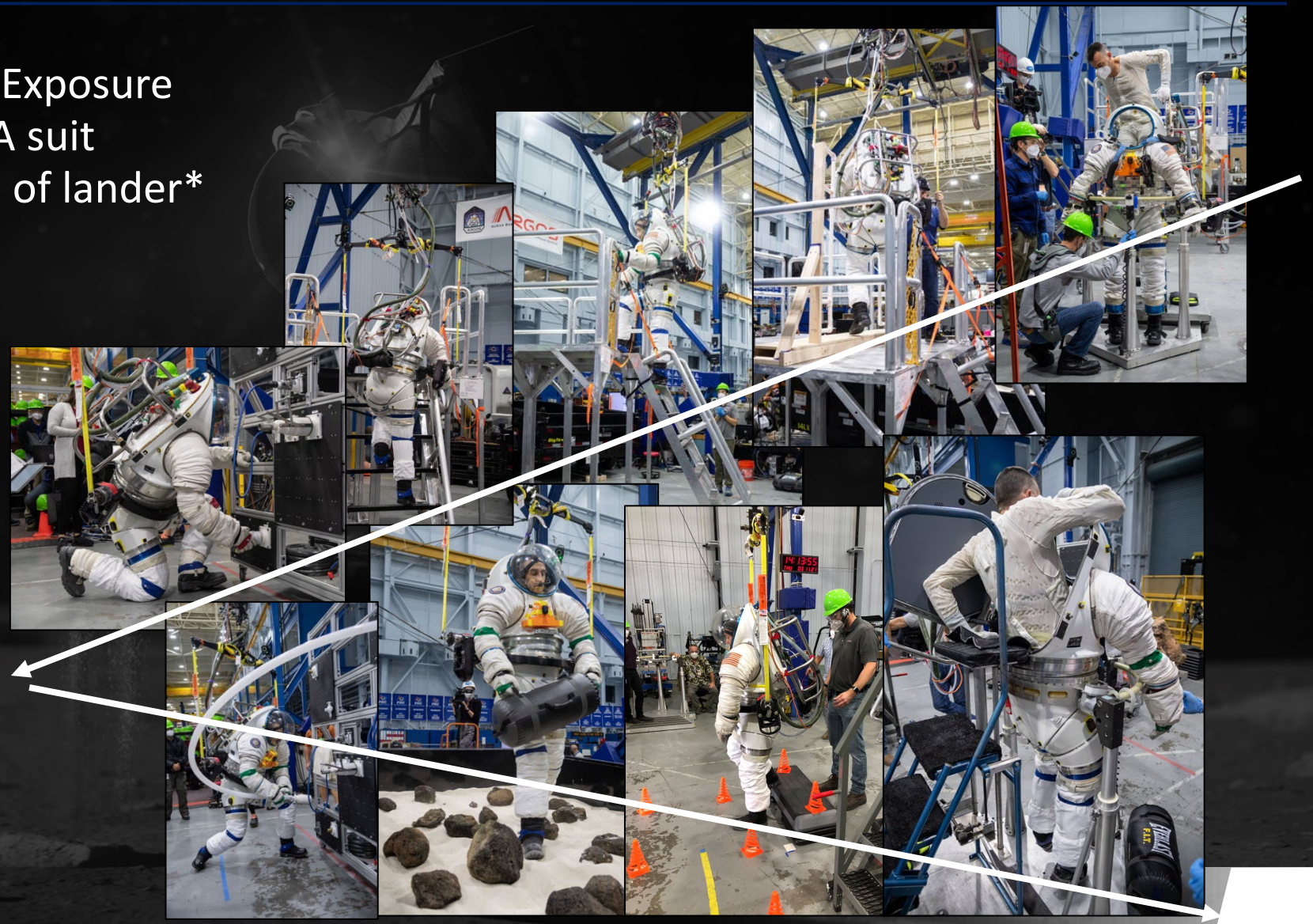
Pre-flight: Anytime pre-flight (with fam) after Mark III or xEMU Suit Fit Check
Post-flight: R+1 at JSC



- Planetary EVA circuit consists of functional tasks that represent a realistic post-landing EVA scenario
- Tested at JSC in the Active Response Gravity Offload System (ARGOS) offloaded to Martian gravity - 3/8 G
- Performed in MKIII or xEMU suit @ 4.3 psid
- Task evaluation includes:
  - Ability to complete the task
  - Time to completion
  - Metabolic energy expenditure
  - Heart rate
  - Video

Partial Planetary EVA Tasks – R + 1

1. Pre-test brief, LCG Don, EIS/Suit Exposure
2. “Self” ingress and pressurize EVA suit
3. ARGOS calibration & float to top of lander*
4. Translate through a hatch
5. Descend a ladder
6. Supply umbilicals task board
7. Perform object relocation
8. Align with rear entry port sim
9. “Self” egress EVA suit



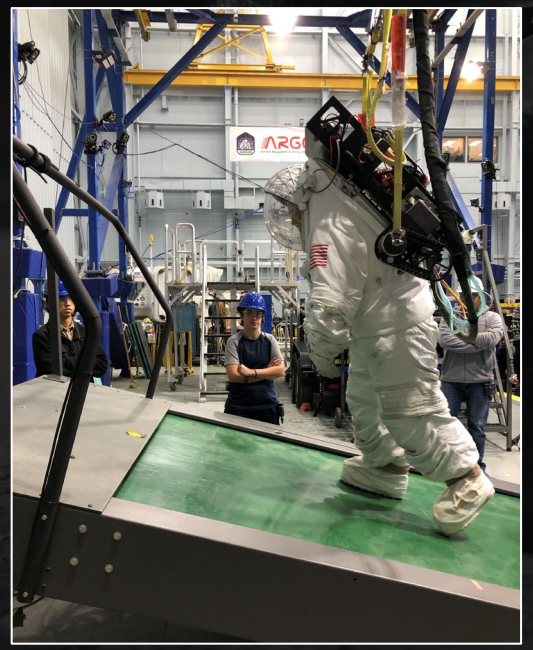
All 10 long duration subjects were able to complete this partial planetary EVA on R+1

Data analysis pending

Unique CIPHER R+4 & R+8 Egress Fitness Tasks: Geology & Ambulation

- Mock X-ray Fluorescence (XRF) sample (1 min kneeling static hold)
- Kneeling rock chip sample on the same rock using the hammer & chisel
- Standing trenching sample using scoop/shovel with an extender handle
- Incline/decline treadmill ambulation
  - Self selected speed

Treadmill Grade	Distance (m)
0	50
-5	100
0	50
5	100
0	50
-10	100
0	50
10	100
0	50
20	100









Thank you!

The presented efforts were primarily funded by the following organization(s):

- Human Research Program (HRP)
- Extravehicular Activity and Human Surface Mobility Program (EHP)