Orion Artemis II Optical Communications (O2O)

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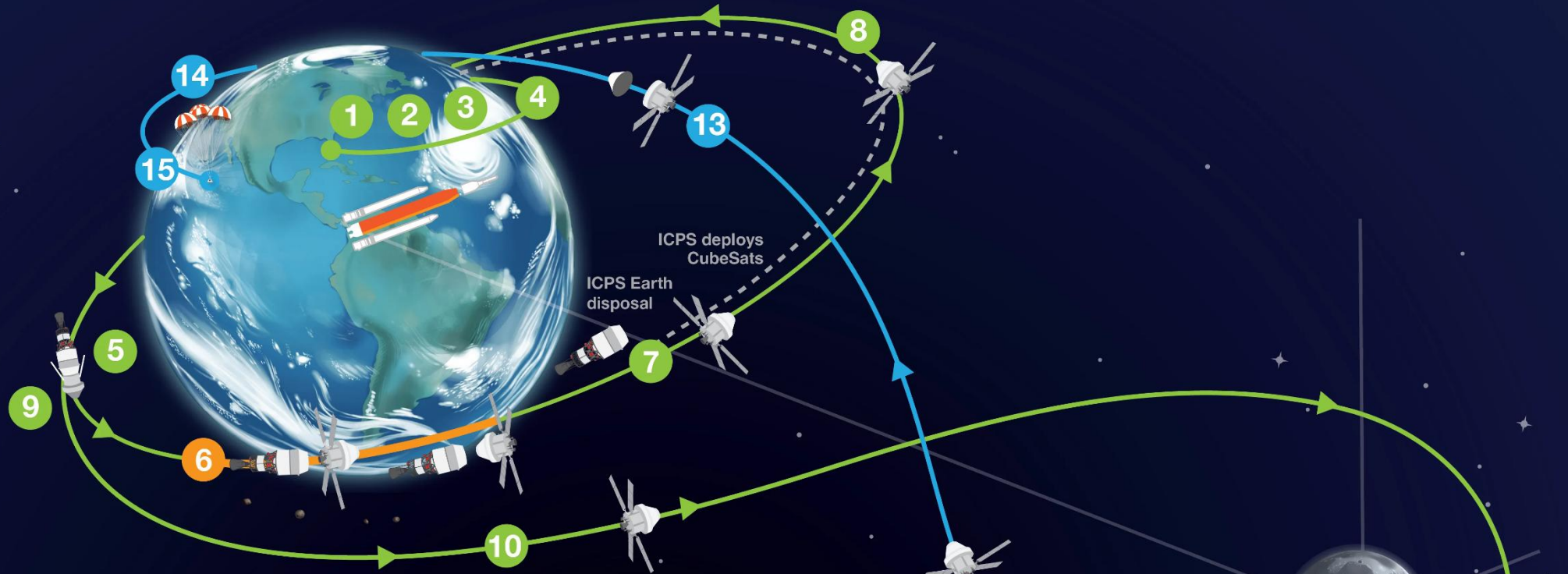
The Artemis Campaign

National Aeronautics and Space Administration

Source: https://www.nasa.gov/wp-content/uploads/2025/02/iparch05-m2mpo-updates.pdf?emrc=d93da2



ARTEMIS II

First Crewed Test Flight to the Moon Since Apollo

1 LAUNCH
Astronauts lift off from Launch Pad 39B at Kennedy Space Center.

2 JETTISON SOLID ROCKET BOOSTERS, FAIRINGS, AND LAUNCH ABORT SYSTEM

3 CORE STAGE MAIN ENGINE CUT OFF
With separation.

4 PERIGEE RAISE MANEUVER

5 APOGEE RAISE BURN TO HIGH EARTH ORBIT
Begin 23.5-hour checkout of spacecraft.

6 ORION SEPARATION FROM INTERIM CRYOGENIC PROPULSION STAGE (ICPS) FOLLOWED BY PROX OPS DEMO
Plus manual handling qualities assessment for up to 2 hours.

7 ORION UPPER STAGE SEPARATION (USS) BURN
Begins high Earth orbit checkout. Life support, exercise, and habitation equipment evaluations.

8 PERIGEE RAISE BURN

9 TRANS-LUNAR INJECTION (TLI) BY ORION'S MAIN ENGINE
Lunar free return trajectory initiated with European service module.

10 OUTBOUND TRANSIT TO MOON
Outbound trajectory correction (OTC) burns as necessary for lunar free return trajectory; travel time approximately 4 days.

11 LUNAR FLYBY
4,047 mi/6,513 km (mean) lunar far side flyby altitude.

12 TRANS-EARTH RETURN
Return trajectory correction (RTC) burns as necessary to aim for Earth's atmosphere; travel time approximately 4 days.

13 CREW MODULE SEPARATION FROM SERVICE MODULE

14 ENTRY INTERFACE (EI)
Enter Earth's atmosphere.

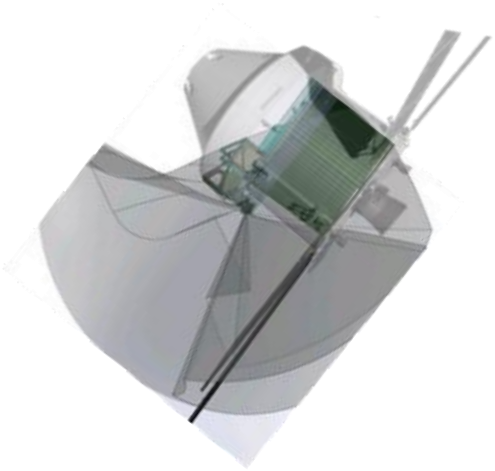
15 SPLASHDOWN
Ship recovers astronauts and capsule.

PROXIMITY OPERATIONS DEMONSTRATION SEQUENCE	
1	10
2	11
3	12
4	13
5	14
6	15
7	16
8	17
9	

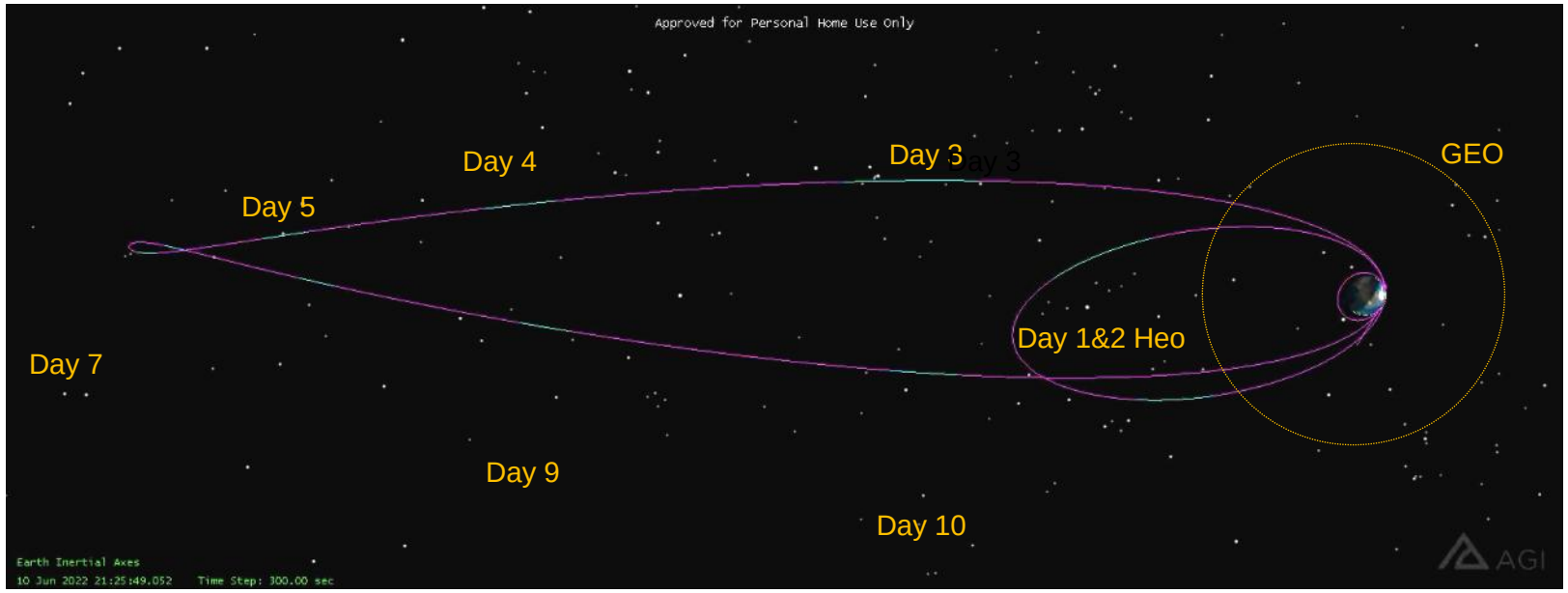
Image Source: https://www.nasa.gov/missions/artemis/artemis-ii-map/

AIIMM–08.20.25

Artemis II Mission Trajectory (Example)



Orion Orientation (Tail to Sun)



NASA Artemis/Orion

- NASA Artemis missions to return humans to moon in 2020's
  - 2022 Artemis-1 uncrewed lunar flyby
  - 2026 Artemis-2 crewed lunar flyby
  - 2027 Artemis-3+ lunar landing
- Moon provides staging ground for eventual missions to Mars
- Orion comm capability
  - S-band phased array transmitters
  - Up to ~2 Mb/s from lunar ranges to NASA Deep Space Network
- Orion Artemis-II Optical comm (O2O) to provide
  - Up to 250 Mbps return
  - 20 Mbps forward

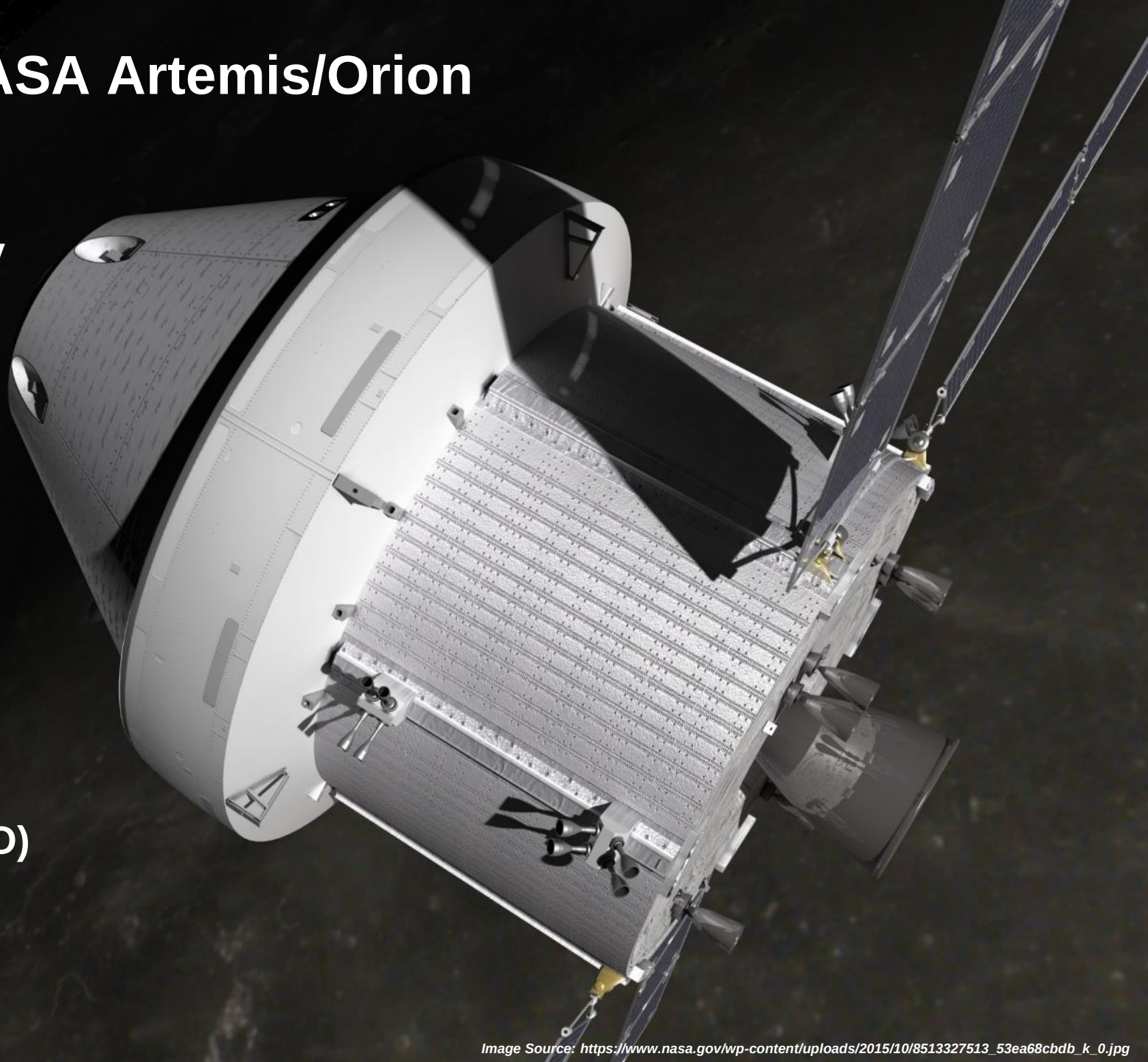
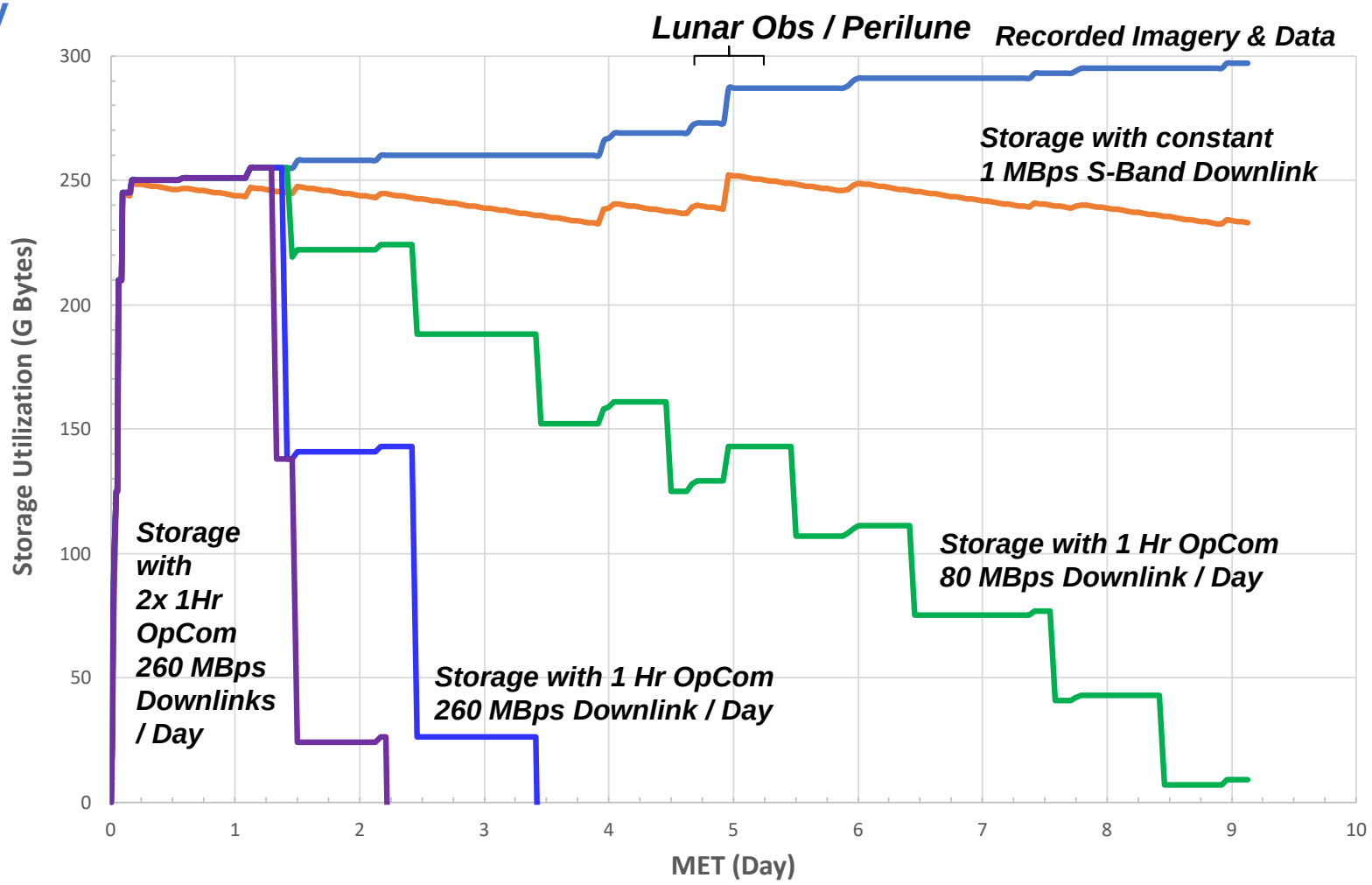


Image Source: https://www.nasa.gov/wp-content/uploads/2015/10/8513327513_53ea68cbdb_k_0.jpg

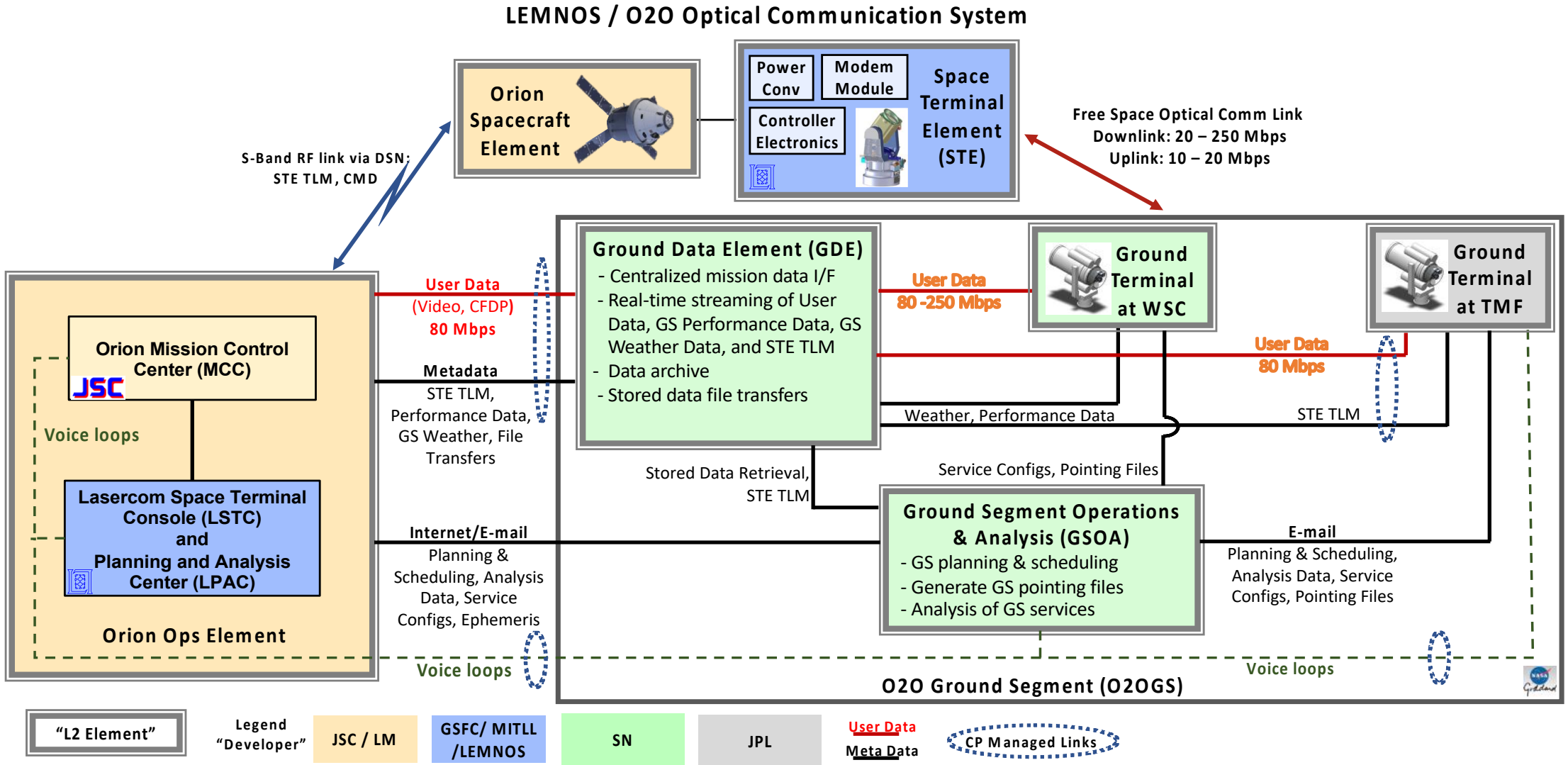
Orion Storage and Data Rates

- Orion subsystems expected to generate ~250 GB of data in first day of mission and ~300GB by end of mission
- Using S-Band continuously,
  - Downlink limited to ~ 7GB of data per day
  - 230 GB remains onboard at landing
- With planned 1 hour/day of 80Mbps optical comm,
  - Downlink 36GB of data per day
  - 6x increase per day!
- With 1 hour/day of 260 Mbps optical comm,
  - Downlink 117GB per day almost
  - All data downlinked after 4 days
- With 2 hour/day of 260Mbps optical comm
  - Downlink 234GB/day
  - All data downlinked after 2 days

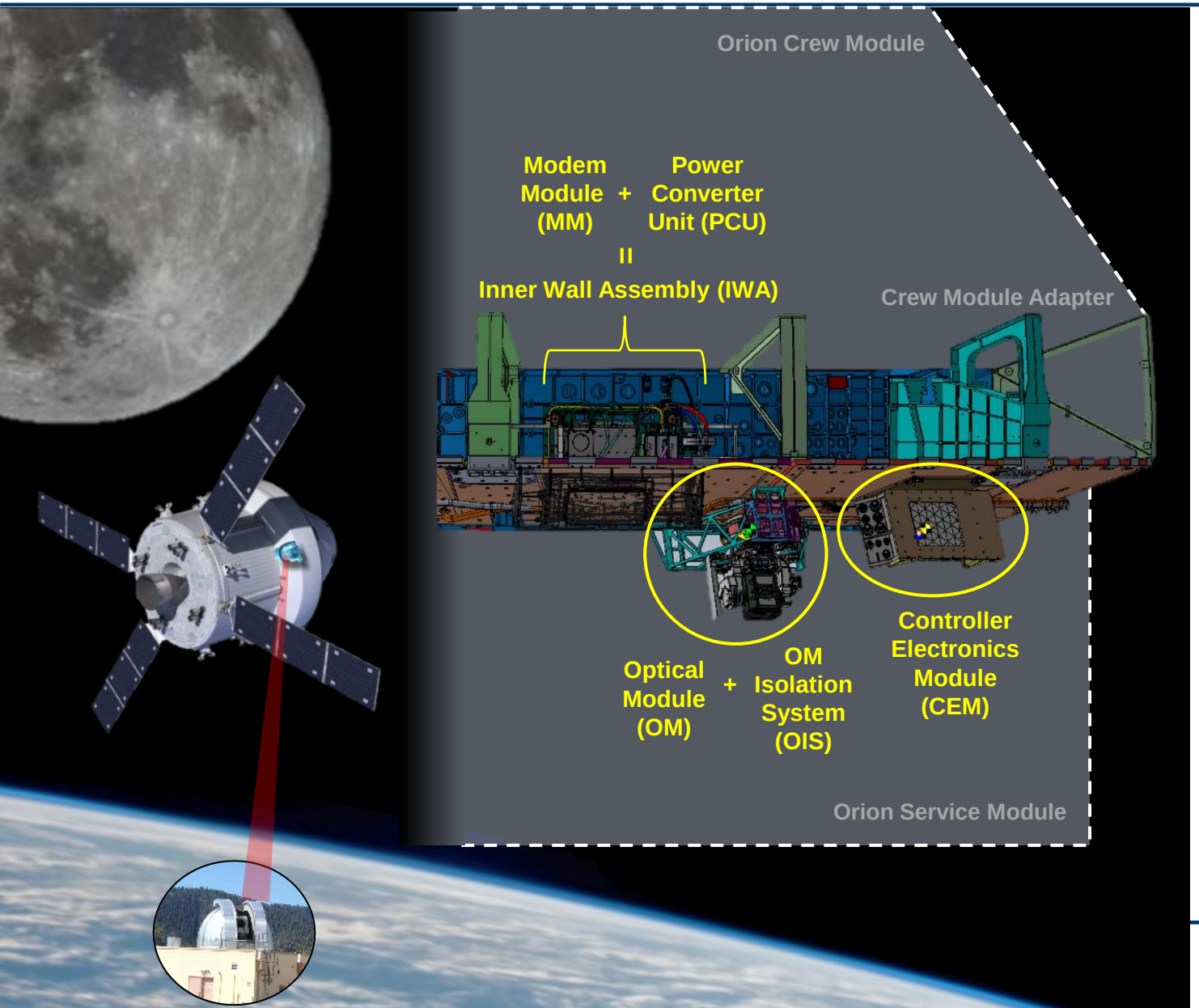
Orion Recorder Utilization



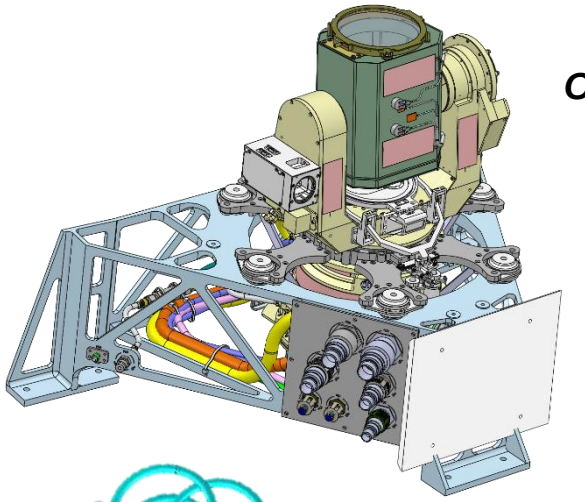
O2O Mission Level Architecture Diagram



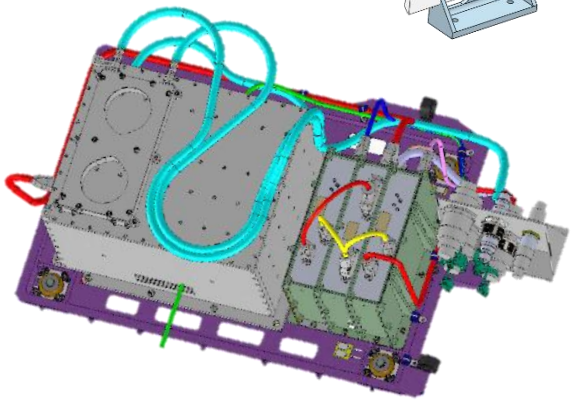
O2O Space Terminal Element



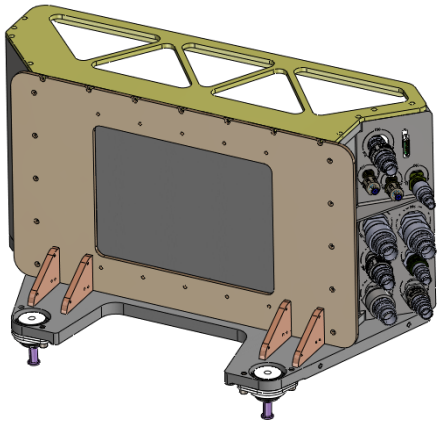
Three Space Payload "Islands"



Optical Module



Inner Wall Assembly

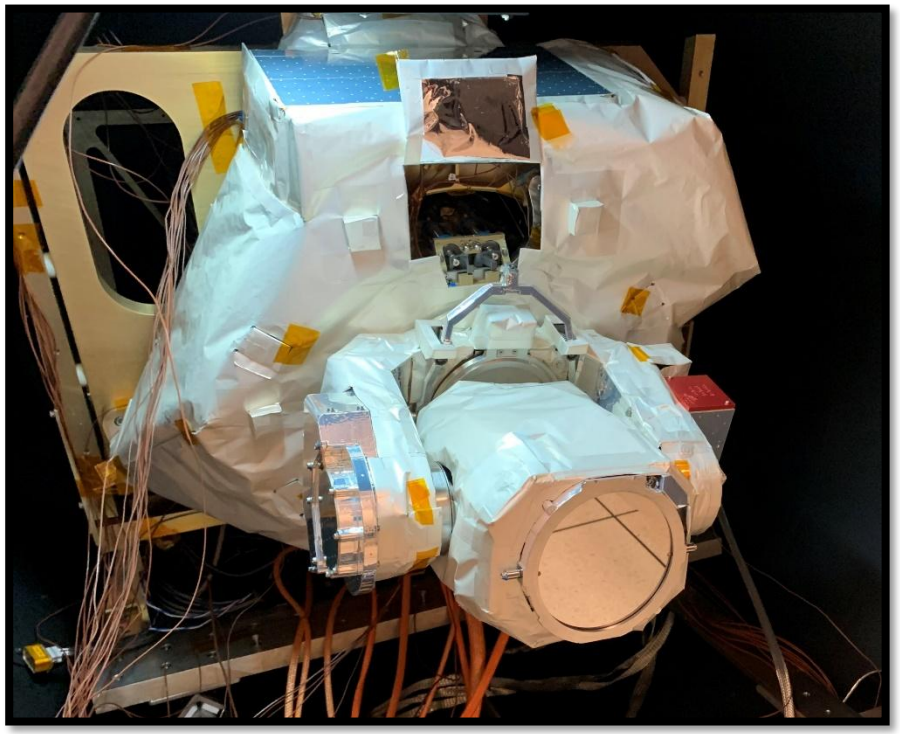


Controller Electronics

Mass: 76 kg (incl. mounting & thermal control structure)
Power: 165W (incl. power conversion & thermal control)

Optical Module Island

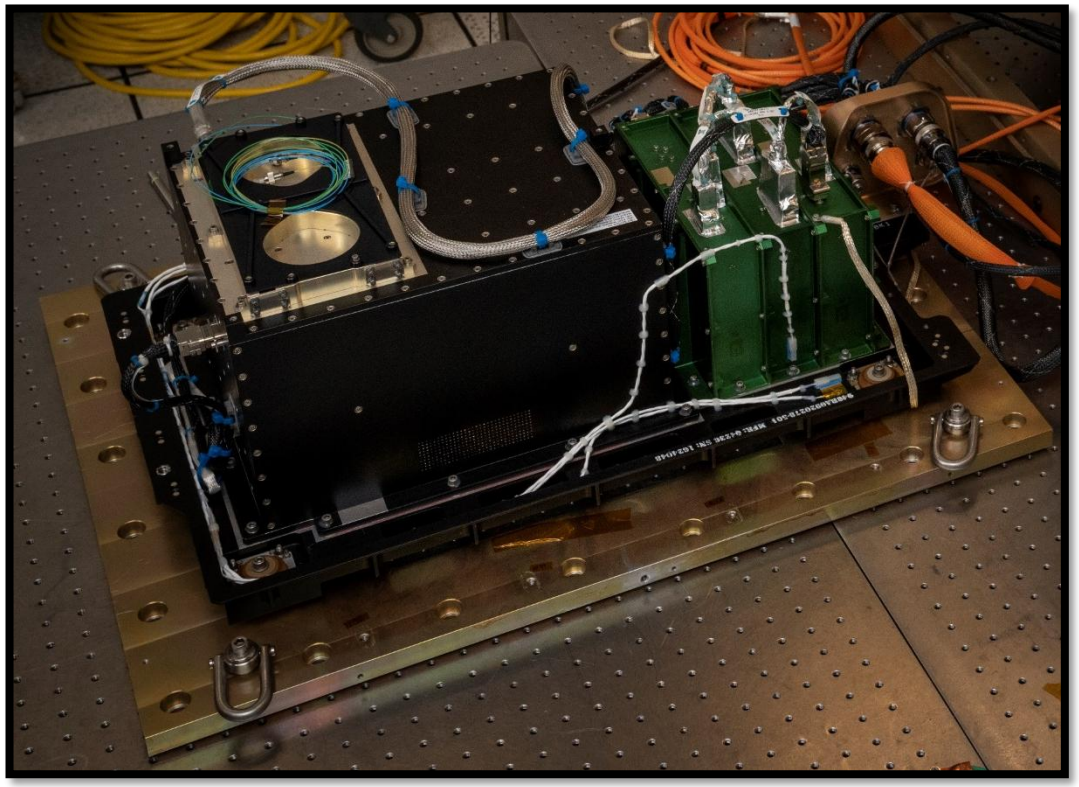
- **Industry and MITLL-built optical module**
  - **10-cm off-axis telescope**
  - **Hemispherical field of regard**
  - **Coudé-path to small optics bench**
  - **Star tracker for attitude knowledge**
  - **Multiple fine-steering optics for simplifying alignment process and maintaining alignment during mission**
- **Island structure allows mounting to Orion exterior panels**
  - **Includes isolation system for mitigation of launch loads**
  - **Includes self-contained thermal control system**
    - **Radiator for small optics**
    - **Controller Electronics controls multiple operational heater zones**



Assembled Optical Module Island Installed in Thermal Vacuum Tank

Inner Wall Assembly

- **Industry-developed modem provides**
  - **Data interfaces to spacecraft**
  - **Data encoding and modulation onto transmit laser**
    - **Pulse position modulation (CCSDS standard)**
    - **Downlink data rates of 20-260 Mbps**
  - **High power transmit signal amplifier (1W)**
  - **Low-noise optically-preamplified receiver**
    - **Pulse position modulation (CCSDS standard)**
    - **Uplink data rates of 10, 20 Mbps**
  - **Fiber interfaces to optical module**
- **Avionics mounted on isolated plate inside Crew Module Adapter**



Inner Wall Assembly

Image Source: https://images.nasa.gov/details/KSC-20230602-PH-GEB01-0023

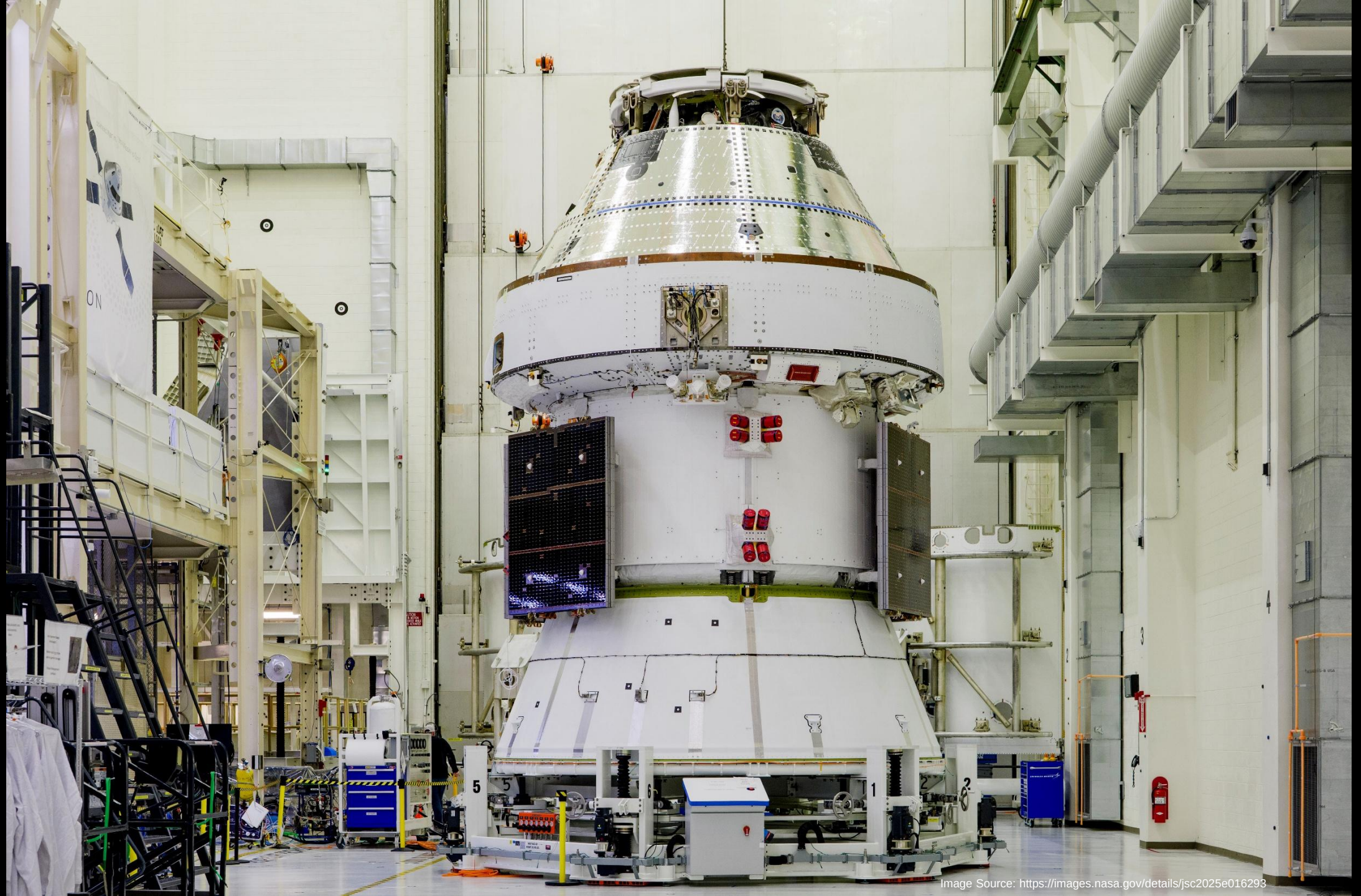


Image Source: https://images.nasa.gov/details/jsc2025e016293

Image Source:https://www.nasa.gov/general/nasa-progresses-toward-crewed-moon-mission-with-spacecraft-rocket-milestones/