

LUNAR SAMPLE RETURN

SMALL SPACECRAFT MISSION CONCEPT TO SUPPORT GATEWAY AND LUNAR SCIENCE



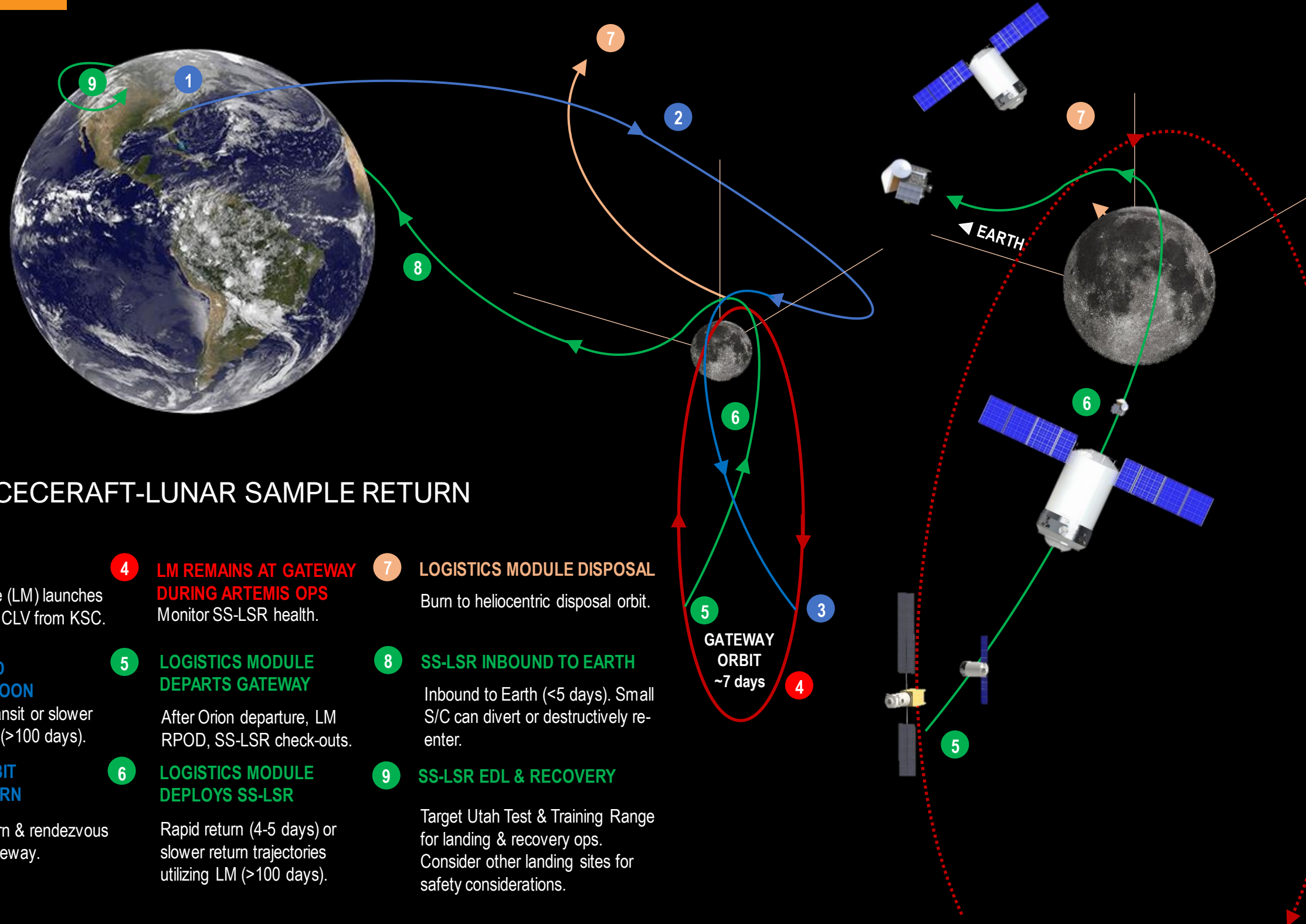
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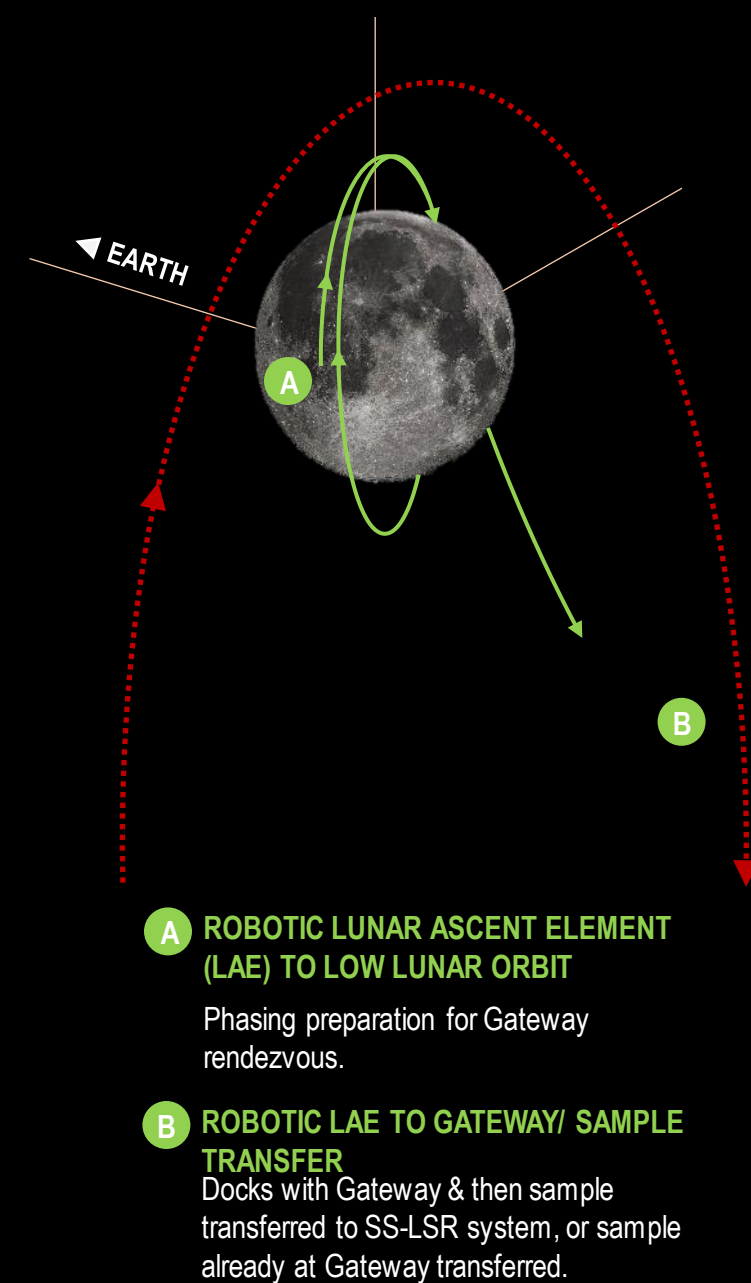
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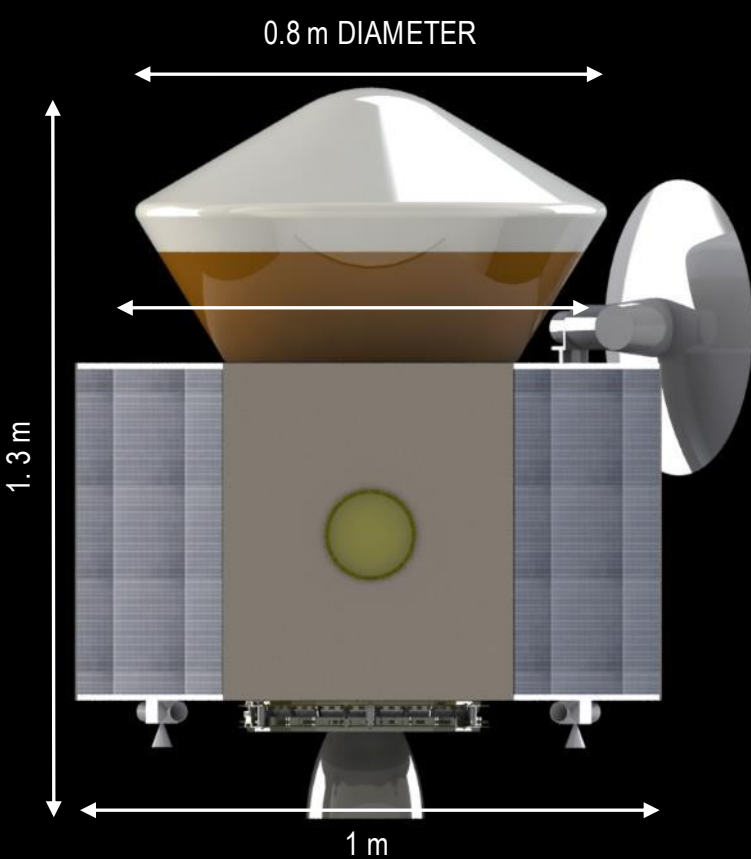
INTEGRATED WITH ROBOTIC LUNAR SURFACE OPERATIONS



SMALL SPACECRAFT-LUNAR SAMPLE RETURN

- 1 LAUNCH**
Logistics Module (LM) launches with SS-LSR on CLV from KSC.
- 2 LM OUTBOUND TRANSIT TO MOON**
4-5 day rapid transit or slower ballistic transfer (>100 days).
- 3 GATEWAY ORBIT INSERTION BURN**
LM performs burn & rendezvous to dock with Gateway.
- 4 LM REMAINS AT GATEWAY DURING ARTEMIS OPS**
Monitor SS-LSR health.
- 5 LOGISTICS MODULE DEPARTS GATEWAY**
After Orion departure, LM RPOD, SS-LSR check-outs.
- 6 LOGISTICS MODULE DEPLOYS SS-LSR**
Rapid return (4-5 days) or slower return trajectories utilizing LM (>100 days).
- 7 LOGISTICS MODULE DISPOSAL**
Burn to heliocentric disposal orbit.
- 8 SS-LSR INBOUND TO EARTH**
Inbound to Earth (<5 days), Small S/C can divert or destructively re-enter.
- 9 SS-LSR EDL & RECOVERY**
Target Utah Test & Training Range for landing & recovery ops. Consider other landing sites for safety considerations.

MISSION ELEMENTS



SAMPLE RETURN CAPSULE

- PAYLOAD-Sensor suite to monitor environments during mission. Thermocouples, IMU, etc
- RECOVERY SYSTEM-drogue chute and main.
- THERMAL PROTECTION SYSTEM-heat shield materials (PICA or HEEET), backshell can be various materials.

SPACECRAFT BUS

- BODY MOUNTED SOLAR PANELS
- S OR X-BAND COMM SYSTEM
- PROPULSION SYSTEM- ΔV ~ 500 m/s
- MOTORIZED LIGHTBAND x 2
- 3-AXIS CONTROL

PREPARATION FOR BASE CAMP



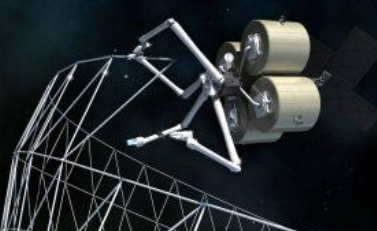
ROBOTIC EXPLORATION



LONG TERM EXPOSURE



IN-SPACE MANUFACTURING



HUMAN RESEARCH- Develop best methods and technologies to support safe, productive human space travel using Gateway as a Mars Transit analogue.



BIOLOGICAL SCIENCE- crew health monitoring, detailed investigations of cosmic conditions on astronauts and other organisms. Detailed 'OMICS' research to develop therapies and mitigations to long-term human exploration of deep space.

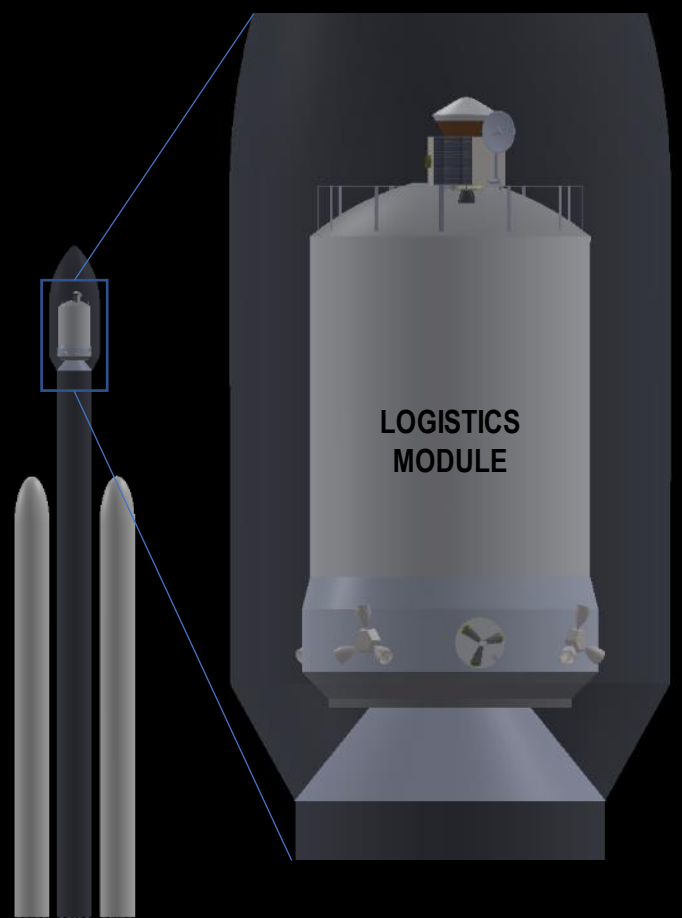


SMALL SPACECRAFT RETURN SYSTEM

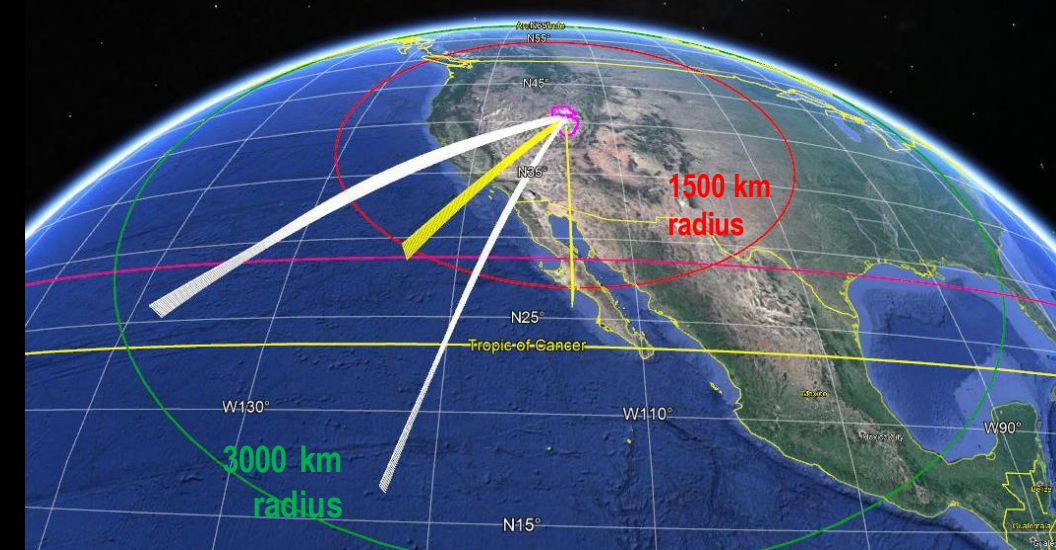
- Mounted as external unpressurized cargo
- Electrical & Physical interfaces per XORI standards.
- Dimensions: ~ 1 x 1 x 1 m
- Mass: ~250 kg

FALCON HEAVY LAUNCH VEHICLE

- Will launch Logistics Module
- Ability to tailor Logistics Module to meet Gateway development needs.

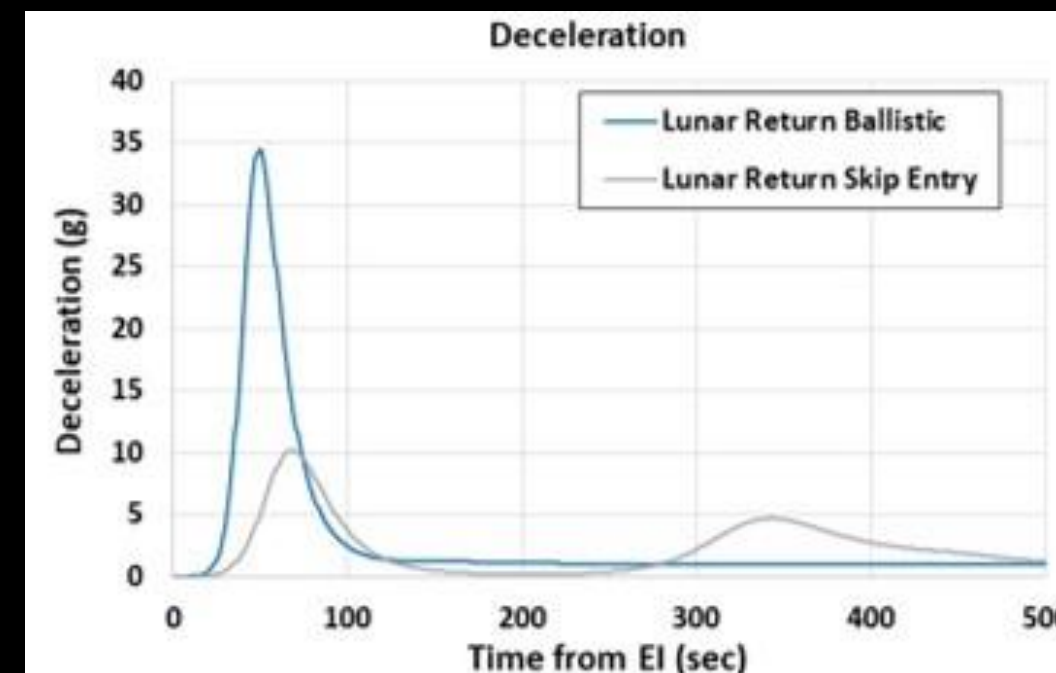


EDL & RECOVERY



BALLISTIC ENTRY TRAJECTORIES- increased deceleration loads
Stardust geometry @ - 6 deg EFPA, ~1500 km max down range

GUIDED ENTRY TRAJECTORIES- capability to manage deceleration loads
Lifting vehicle configurations provide increased down & cross range & greater operational flexibility



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<https://digitalcommons.usu.edu/smallsat/2022/all2022/153/>

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