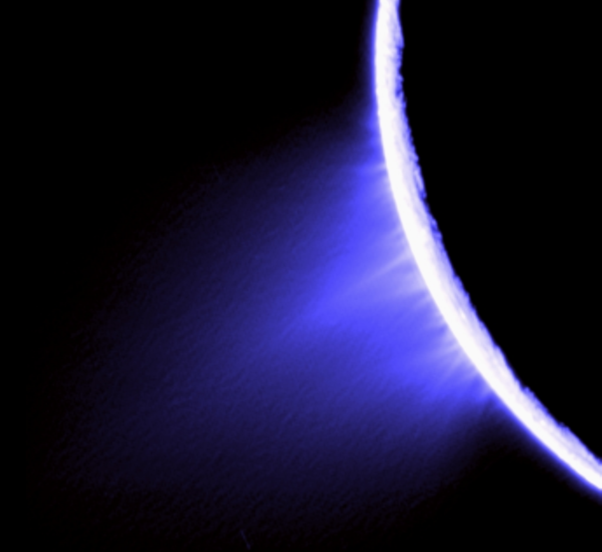
I nvestigating
the
C omposition
of
E nceladus

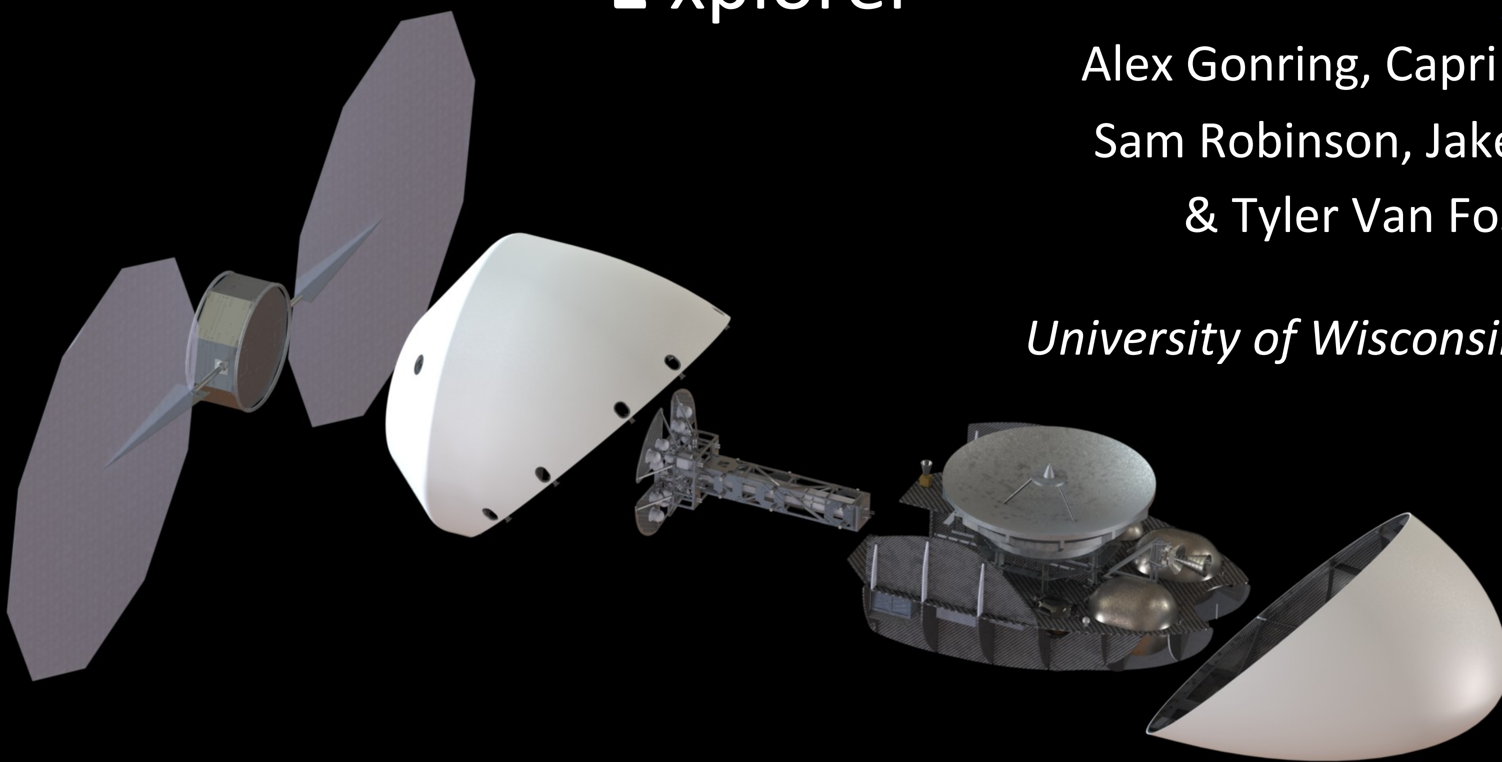
via

P rimary
L ander
and
U nderwater
M icroorganism
E xplorer

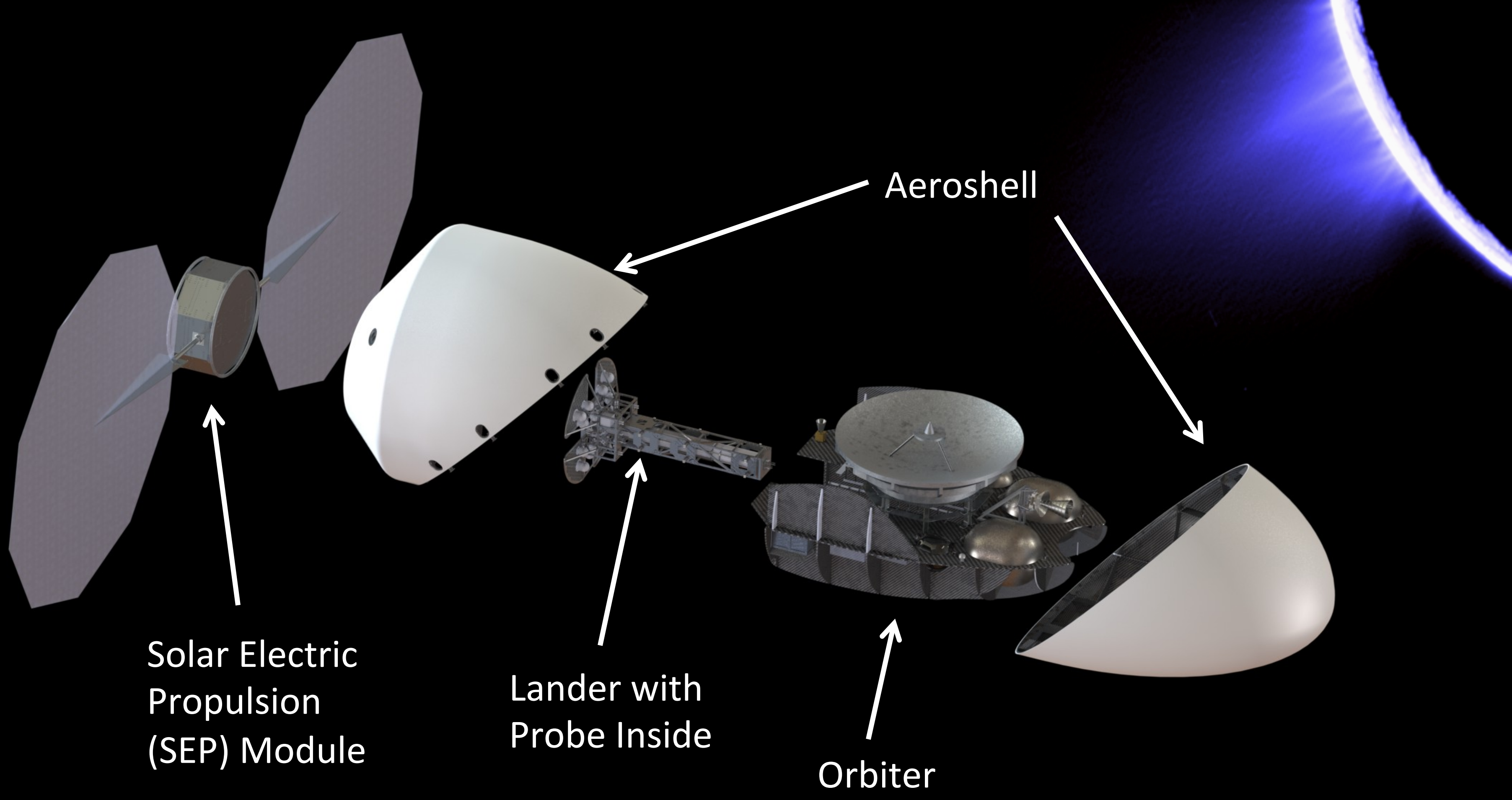


Alex Gonring, Capri Pearson,
Sam Robinson, Jake Rohrig,
& Tyler Van Fossen

University of Wisconsin - Madison

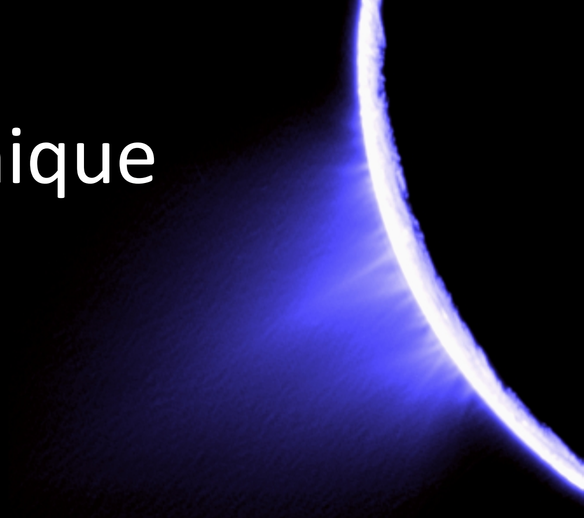


ICEPLUME Mission Overview

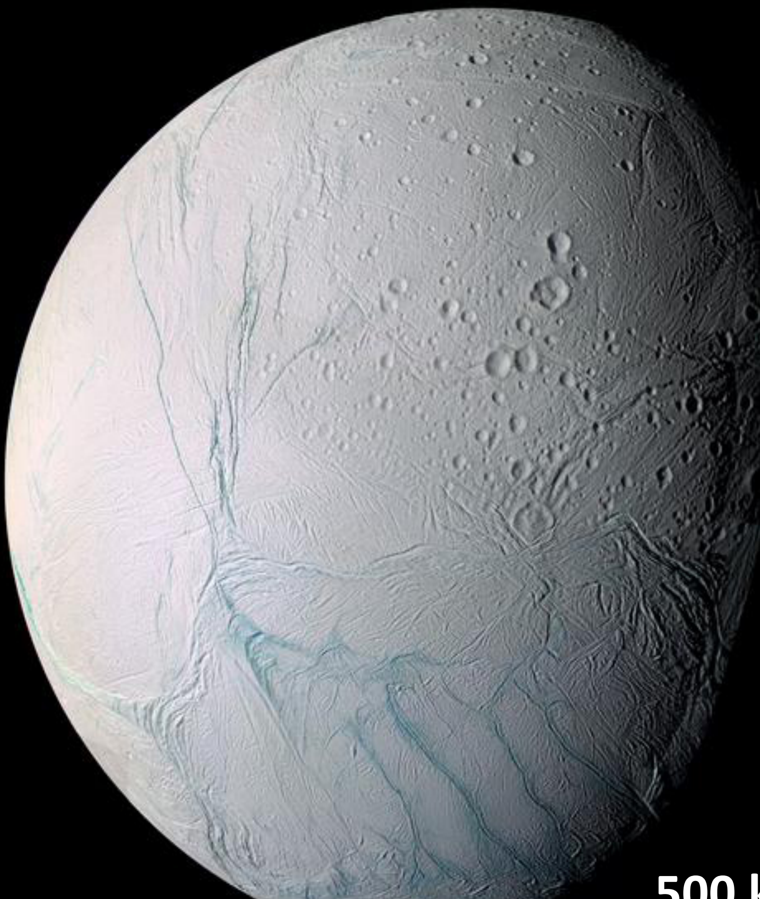


1. Launch
2. SEP Separation from Aeroshell
3. Titan Aero-Gravity Assist and Aeroshell Ejection
4. Lander Deployment to Enceladus' Surface
5. Probe Deployment from Lander

Saturn's moon Enceladus shows unique characteristics.

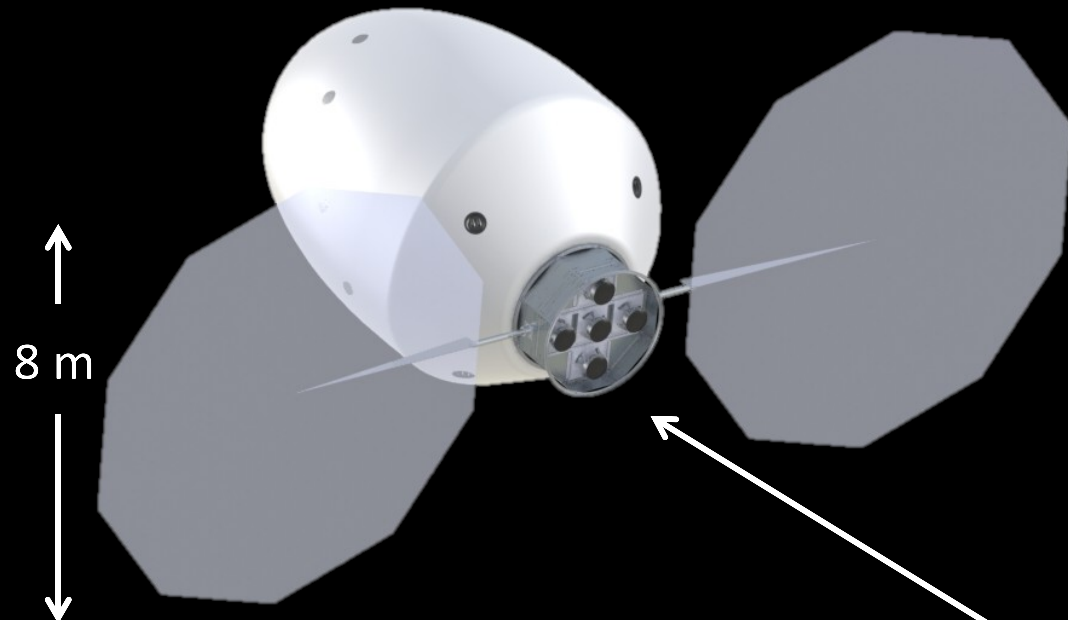


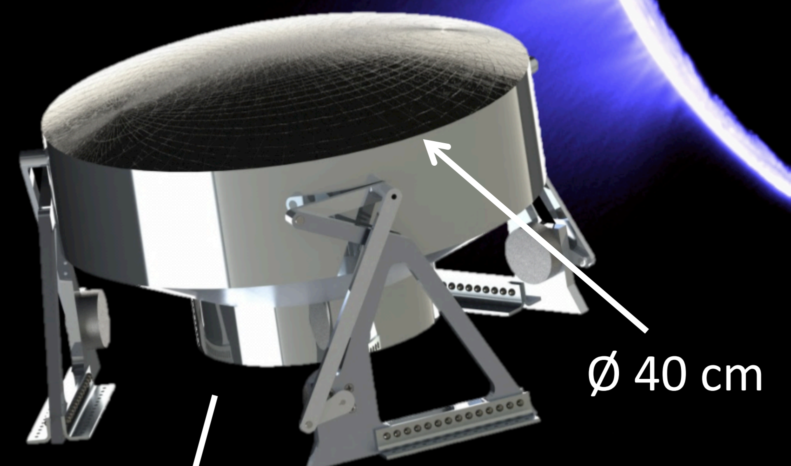
- Recent geological activity
- Warm South Pole
- Plume contributes to E-Ring
- "Tiger Stripes" supply fresh ice
- Fundamental needs for life
    - Water (Cassini measured 90%)
    - C H N O basic elements
    - Energy source
- Astrobiology may exist on Enceladus

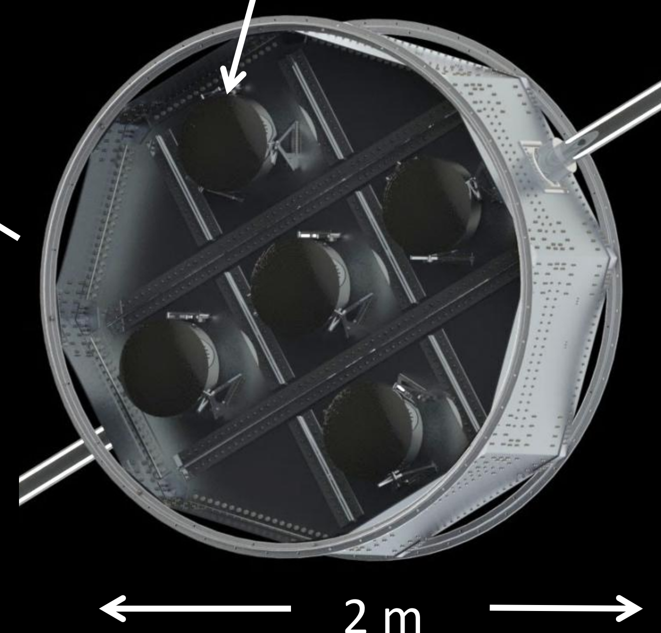


500 km

Solar Electric Propulsion and Gravity Assists will provide the initial ΔV to Saturn.

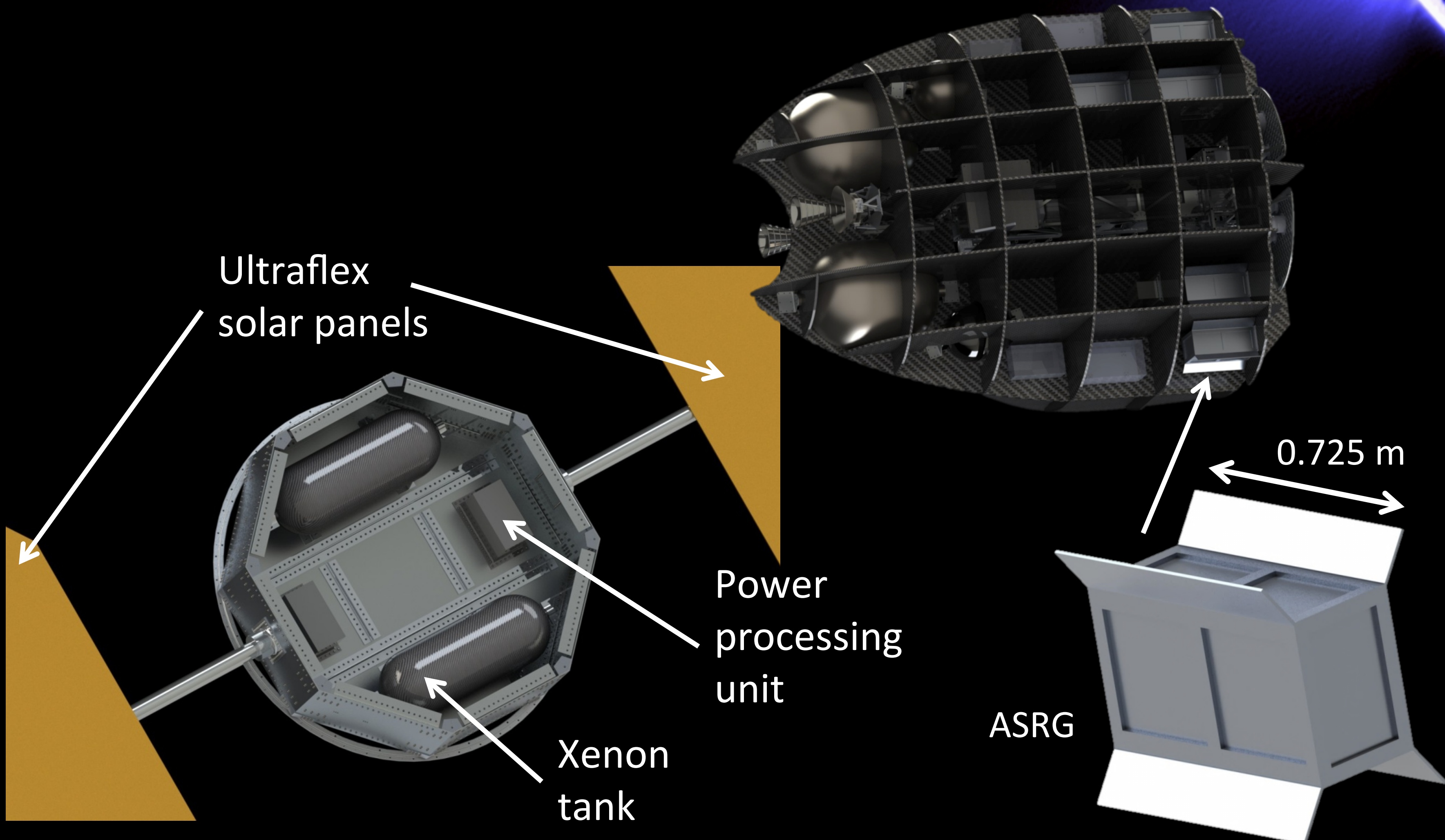






The 61.2 m^2 solar arrays provide 27.6 kW to power the 5 NEXT thrusters.

The Ultraflex solar panels provide power and xenon fuels the ion thrusters. Advanced Stirling Radioisotope Generators operate the instruments on the orbiter.



An aeroshell is required for atmospheric entry during aero-gravity assist.

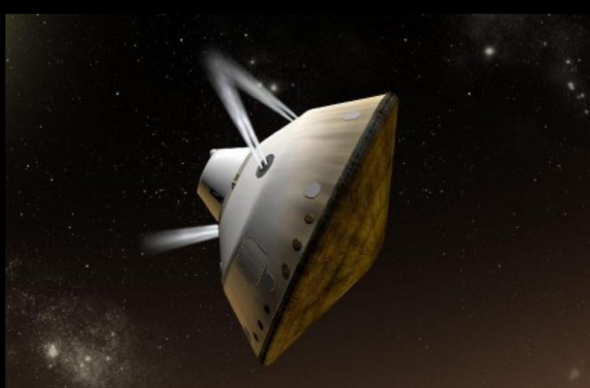
- Solar Electric Propulsion with aerocapture provides ~ 2.4x more mass delivered to final destination (~ 500 kg)

- Added complexities:

1) RCS thrusters for trajectory alignment

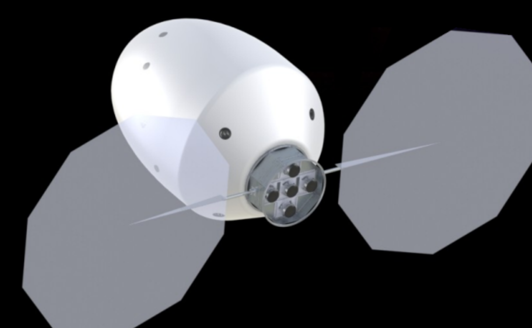
2) Heat shield for thermal protection (~1500° C, 99% KE)

3) Payload configuration within volumetric constraint



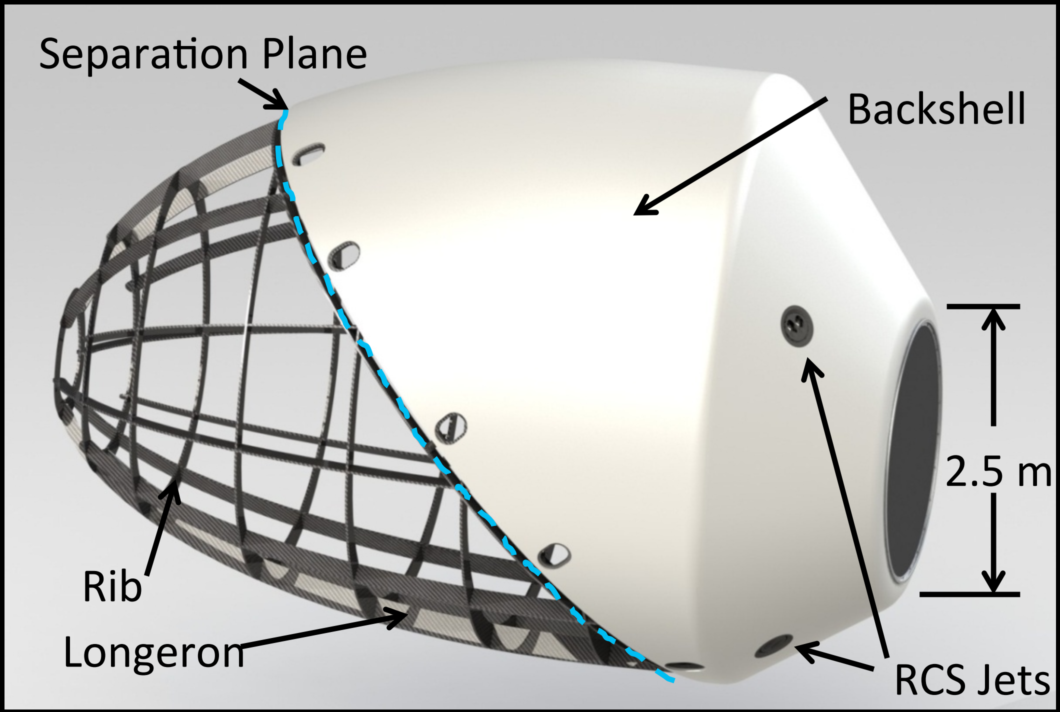
MSL (Ø 4.5m)

Orion heat shield (Ø 5m)



ICEPLUME (Ø 5.0 m)

Low-density materials are required to minimize aeroshell mass.



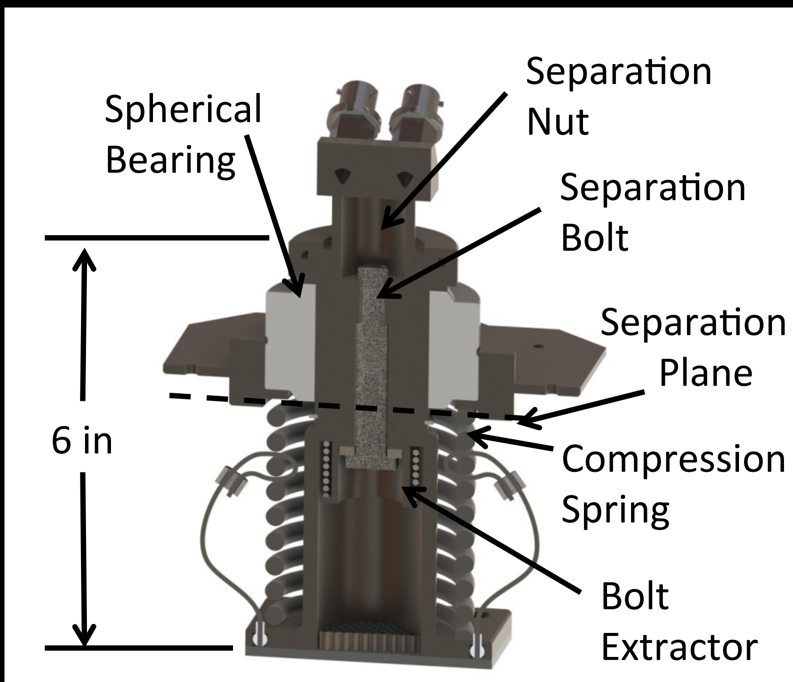
<u>Structural Material</u>:
graphite polycyanate composite

- Aeroshell: 2.6 cm molded honeycomb
- Framework: 1.6 cm isogrid
- Face Sheets: 2 mm thick sheet

<u>Thermal Protection Materials:</u> ** 14-31% improvement on heritage aerial densities

- PhenCarb-20 (500 W/cm^2)
- SRAM-20 (260 W/cm^2)
- SRAM-17 (210 W/cm^2)
- SRAM-14 (150 W/cm^2)
- Acusil II (100 W/cm^2)

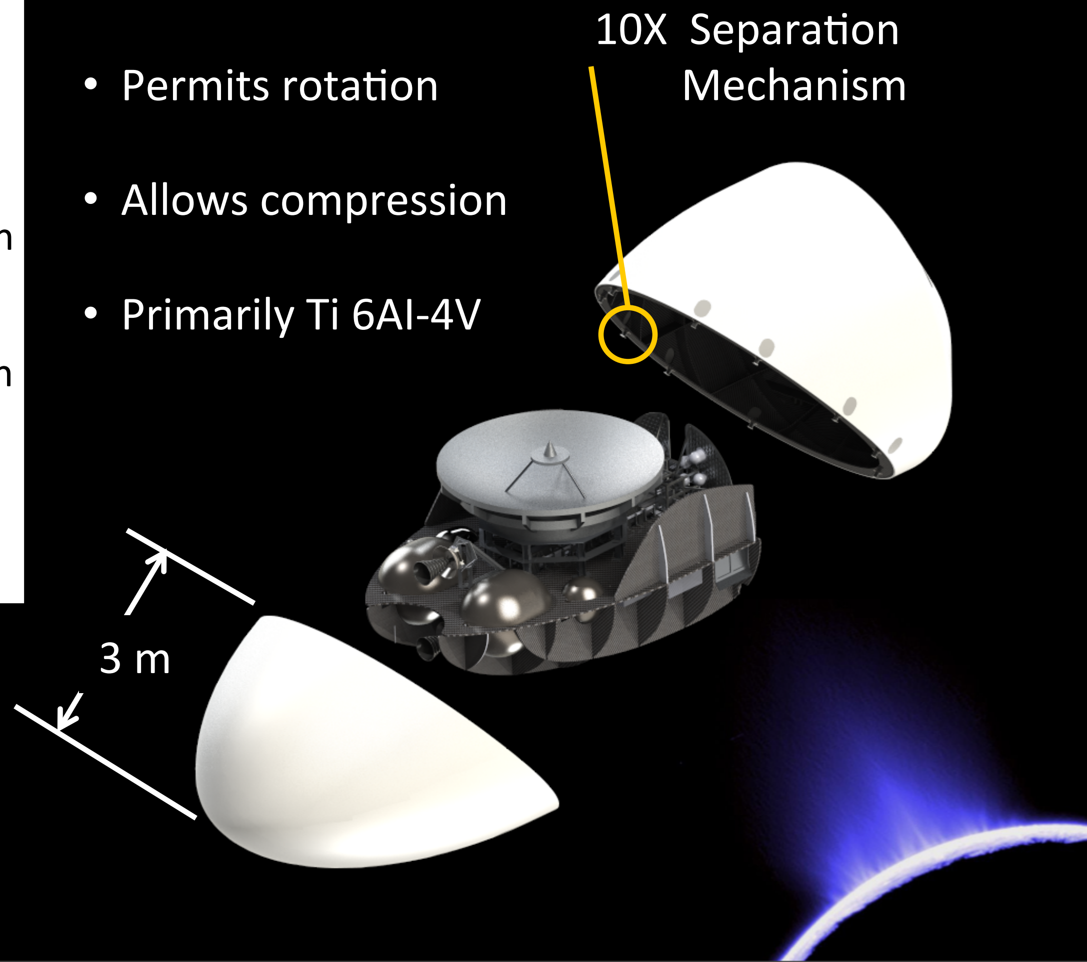
Ten separation mechanisms split the aeroshell and deploy the orbiter after aero-assist.



** Based on the Mars Science Laboratory (MSL) design

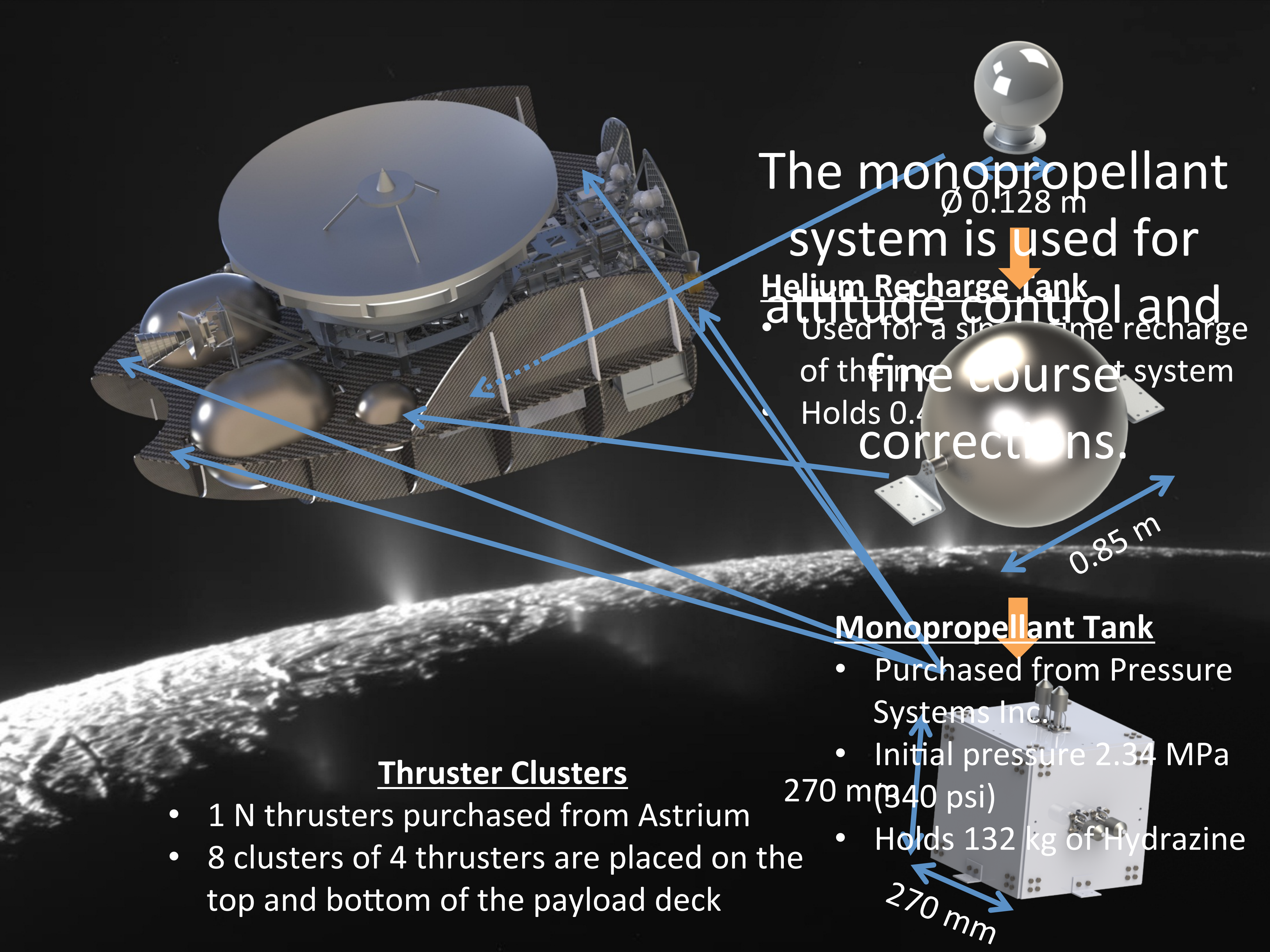
<u>Requirements:</u>

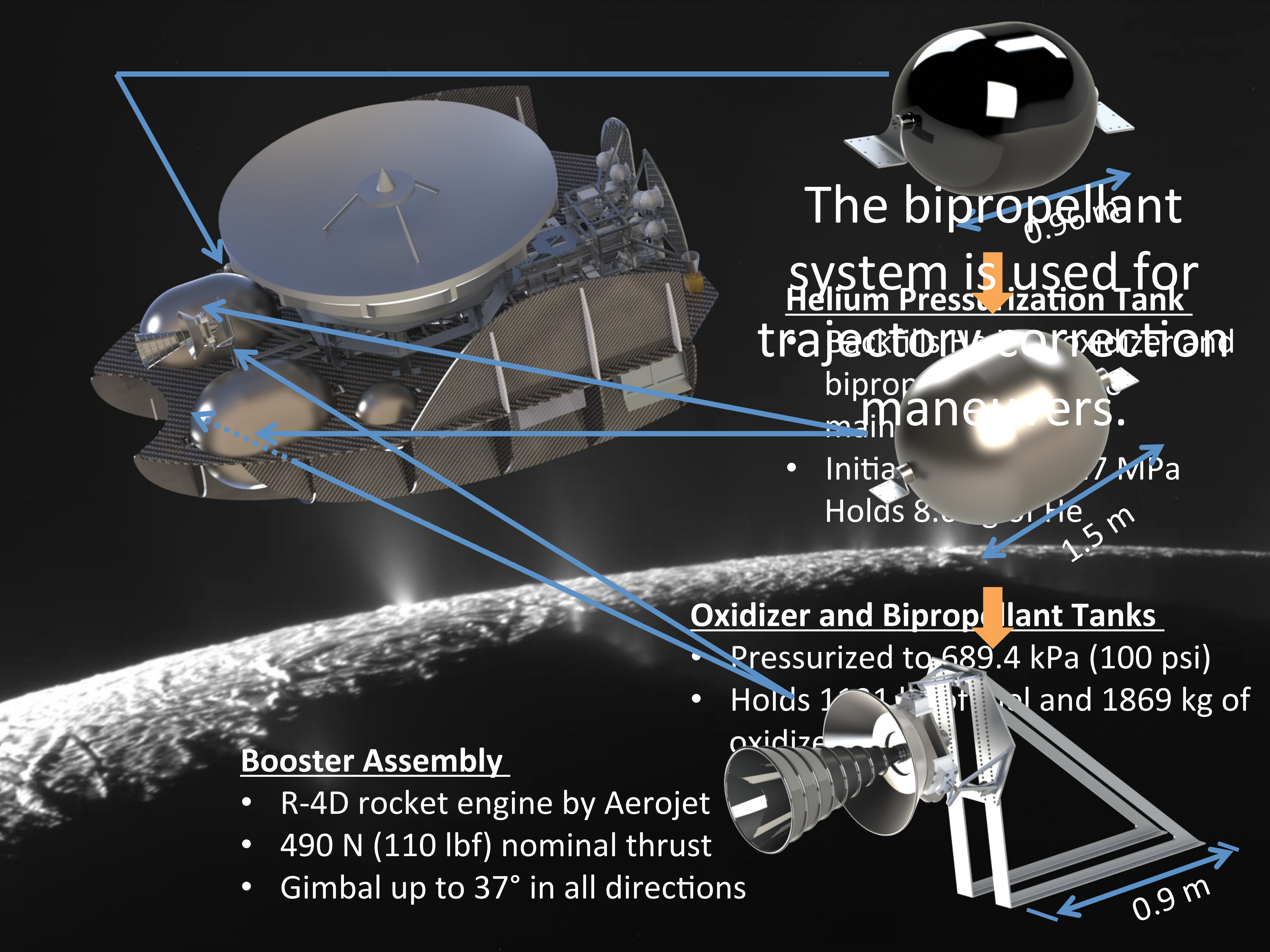
- Permits rotation
- Allows compression
- Primarily Ti 6AI-4V



Multiple propulsion systems are needed to accomplish our mission.

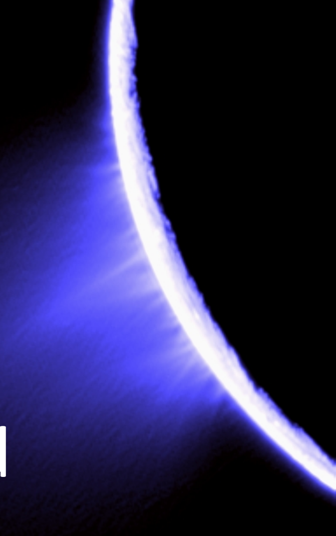
- System uses separate monopropellant and bipropellant propulsion modules
- Monopropellant module will use 132 kg of hydrazine (N_2H_4) and 0.9 N thrusters for attitude control in conjunction with reaction wheels
- Bipropellant module will use 3000 kg of monomethylhydrazine (MMH) for fuel and nitrogen tetroxide (NTO) for oxidizer


The monopropellant system is used for attitude control and fine course corrections.
Ø 0.128 m
Helium Recharge Tank
• Used for a single time recharge
of the … system
• Holds 0.4
0.85 m
Monopropellant Tank
• Purchased from Pressure Systems Inc.
• Initial pressure 2.34 MPa (340 psi)
• Holds 132 kg of Hydrazine
270 mm
270 mm
Thruster Clusters
• 1 N thrusters purchased from Astrium
• 8 clusters of 4 thrusters are placed on the top and bottom of the payload deck


The bipropellant system is used for trajectory correction maneuvers.
Oxidizer and Bipropellant Tanks
Pressurized to 689.4 kPa (100 psi)
1.5 m
Booster Assembly
R-4D rocket engine by Aerojet
490 N (110 lbf) nominal thrust
Gimbal up to 37° in all directions
0.9 m

Science instruments similar to the Cassini mission will explore mission goals.

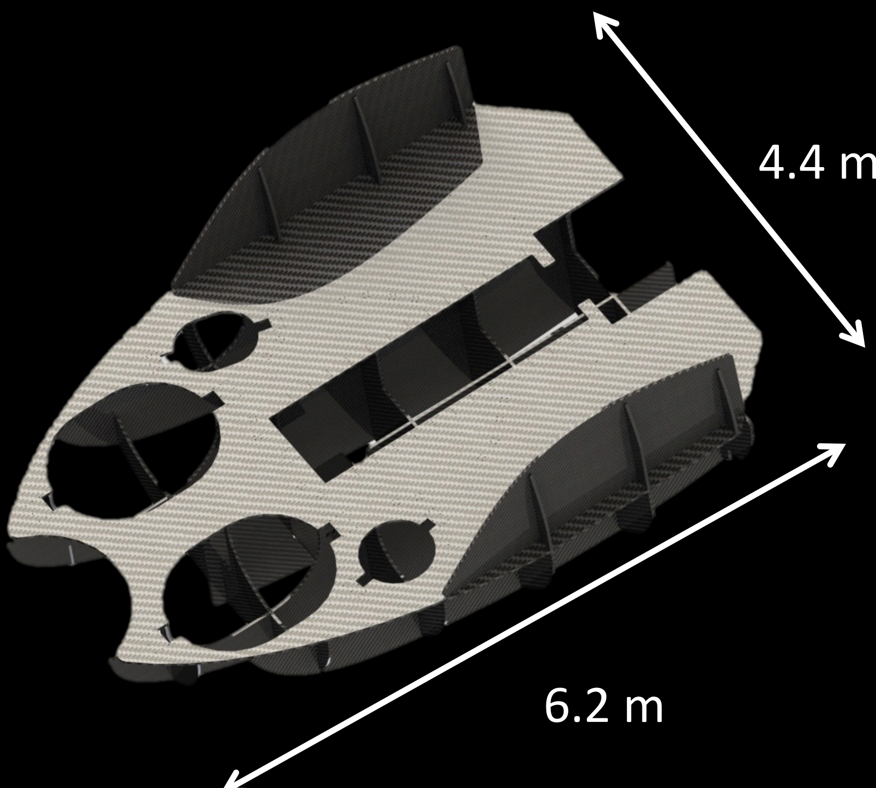
Instrument	Mass Allowance (kg)	Power Allowance (W)	Similar to
High resolution camera	60	60	Cassini
UV-IR imaging spectrometer	18	12	Cassini
Gas chromatograph mass spectrometer	10	28	Cassini
Radar or laser altimeter	42	109	Cassini

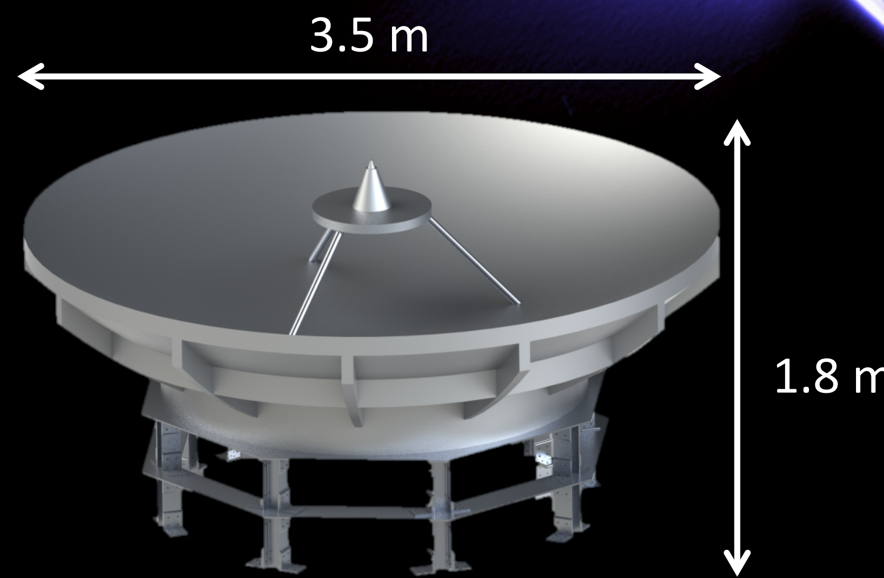


The orbiter contains multiple communication systems.

- Radio frequency subsystem with antennas provide communication for the orbiter to and from Earth.
  - High-gain Antenna (HGA)
    - Support communication with Earth while in orbit about Enceladus
    - S-band Probe/Lander communication
  - Two Low-gain Antennas (LGA)
    - Support communication with Earth during transit

The orbiter's structure is constructed primarily of a composite payload deck.





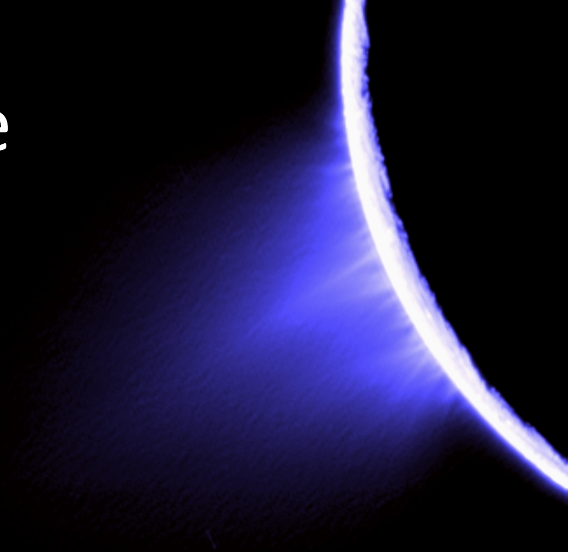
Payload Deck Structural Material:
graphite polycyanate composite

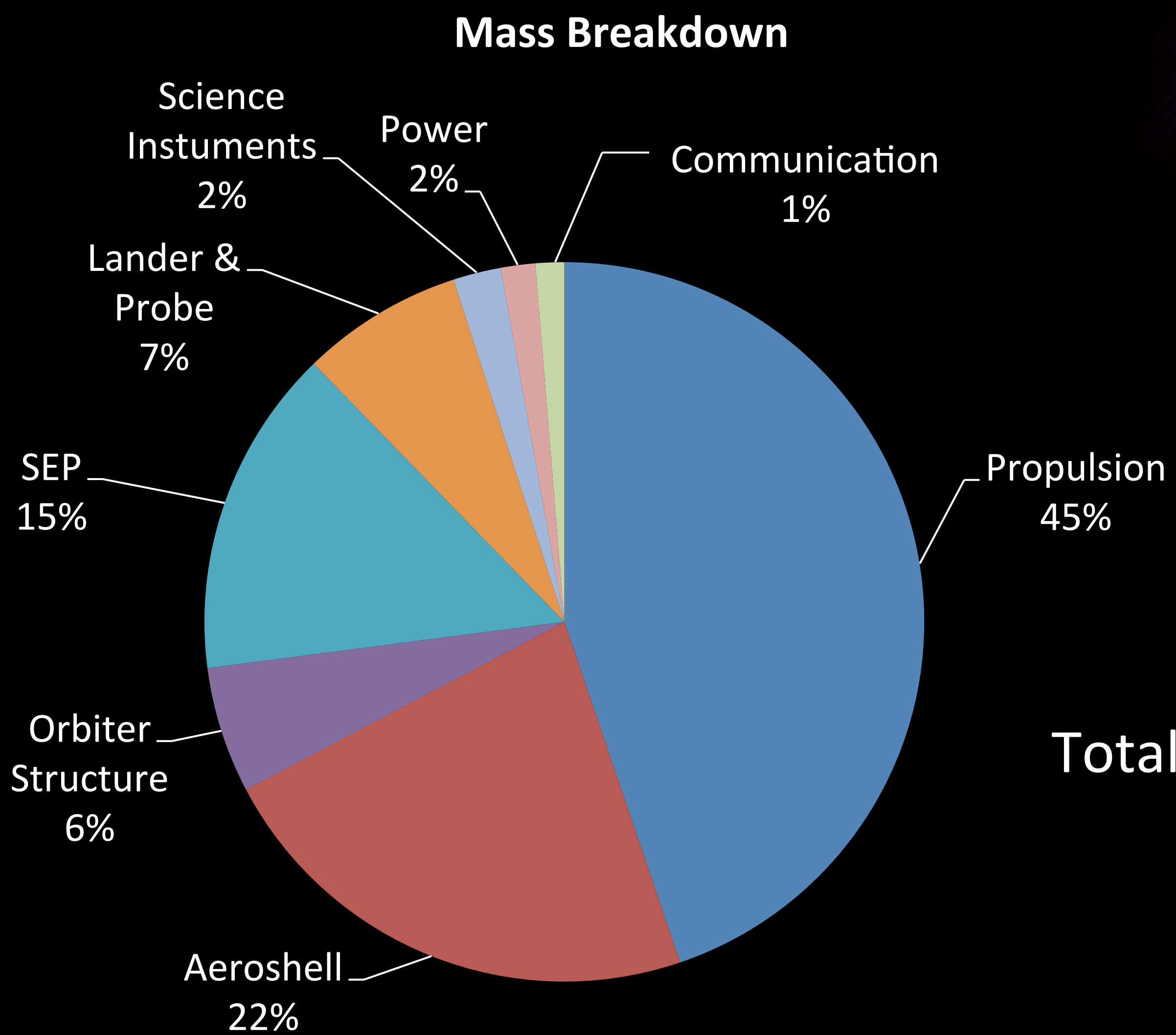
- Deck Panels: 2 cm isogrid
- Face Sheets: 1.6 mm thick sheet

HGA Structural Material:

- 6061-T6 aluminum I beams
- 6061-T6 angle brackets
- 7075-T73 aluminum sheet

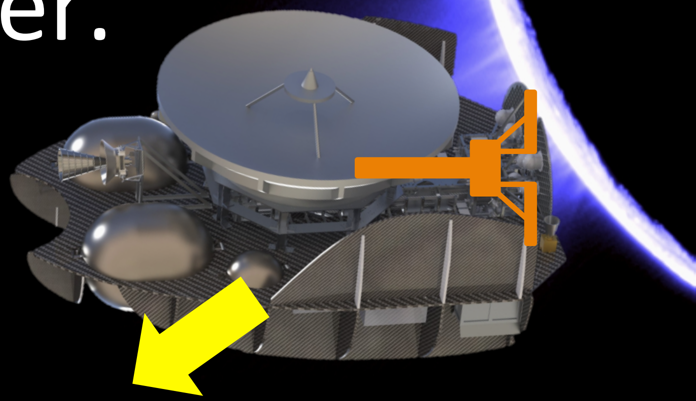
A majority of the total mass will be allotted towards payload delivery.



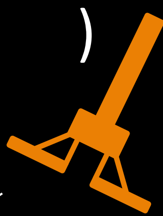


Total Mass from LEO:
7559 kg

The lander will be deployed from the back of the orbiter.

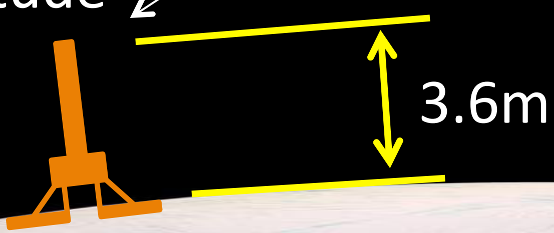


- No aeroshell required
- Heat flux value of (compared with)

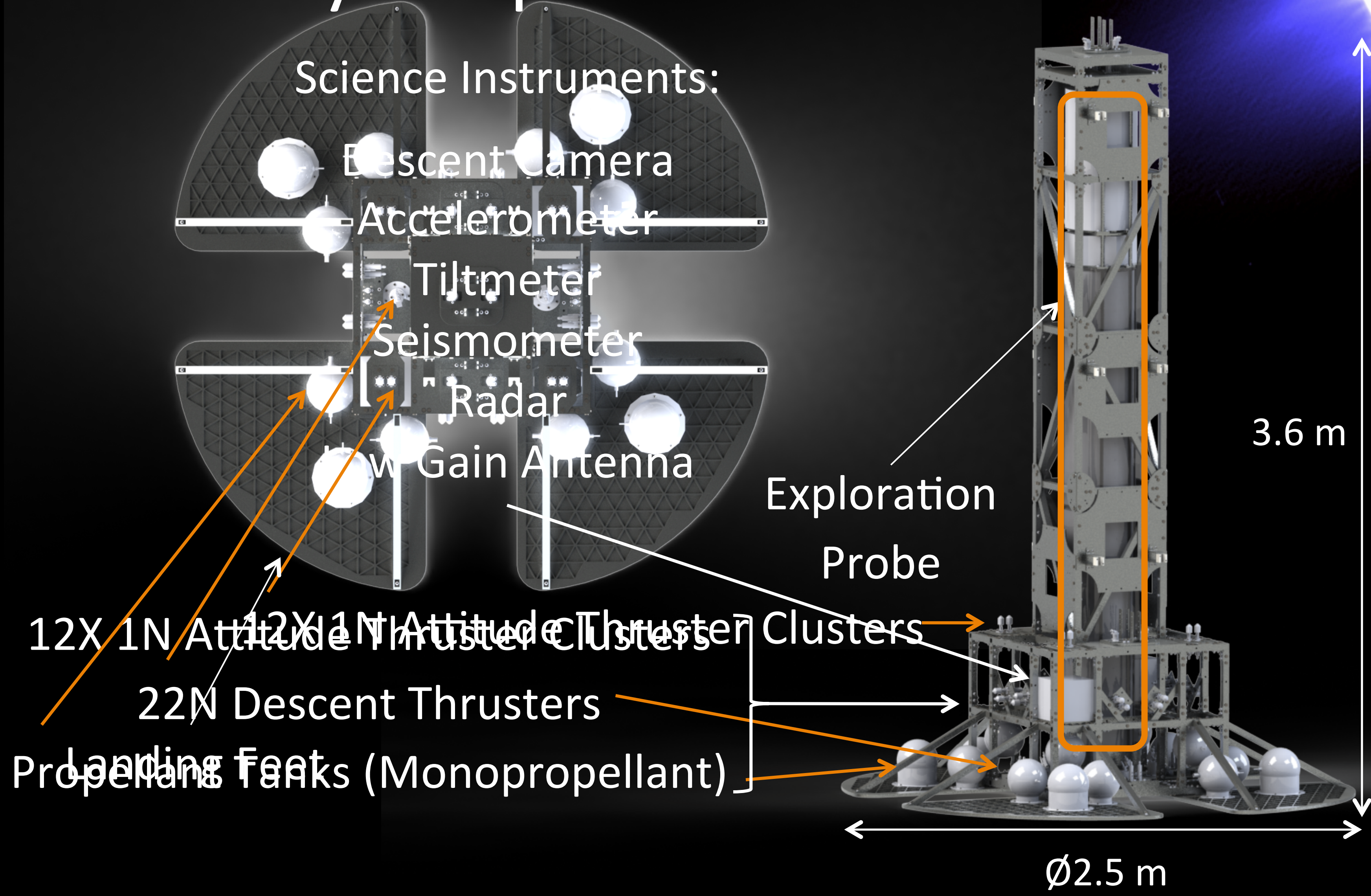


- Lander held to orbiter with pyronuts
- Deployed by expanding spring
- Guided out on rails

- 4X 22N descent thrusters
- 16X 1N attitude thruster clusters
- Radar



The main objective of the lander is to carry the probe to the surface.



Thank you!   Questions??

ICE PLUME

GONRING • PEARSON
ROBINSON • ROHRIG • VAN FOSSEN

<u>IPPW-9 Staff & Student Organizing Committee</u>

<u>University of Wisconsin Faculty and Staff</u>

Dr. Elder   **Prof. Hershkowitz**

Dr. Sandrik