

# A Europa CubeSat Concept Study for Measuring Europa's Atmosphere

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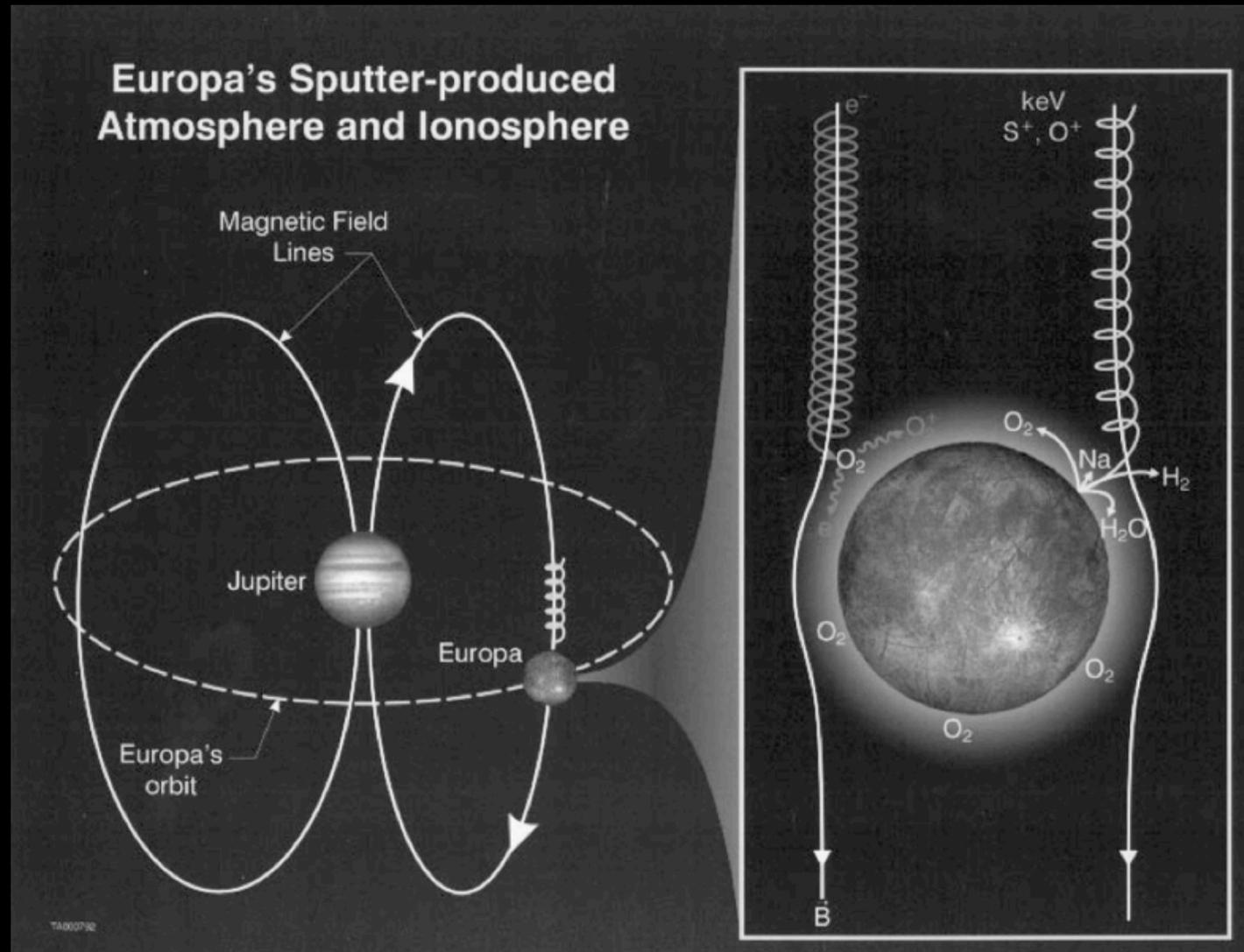
# Task

- JPL is flying Europa Multiple Flyby Mission (Europa Clipper) – Launches mid 2020s
- Interested in what could be done with a 3U CubeSat deployed from the clipper
- Resulted in DARCSIDE
  - Deployable Atmospheric Reconnaissance CubeSat with Sputtering Ion Detector at Europa

# Europa Atmosphere

- Decided to study Europa's atmosphere
- Two Experiments
  - Drag measurement – Heritage to Mars aerobraking
  - High energy particle detector – Heritage to Voyager particle detectors
- Want to improve understanding of icy satellites (moons)
- Implications for understanding Europa's surface

# Formation of Europa's Atmosphere

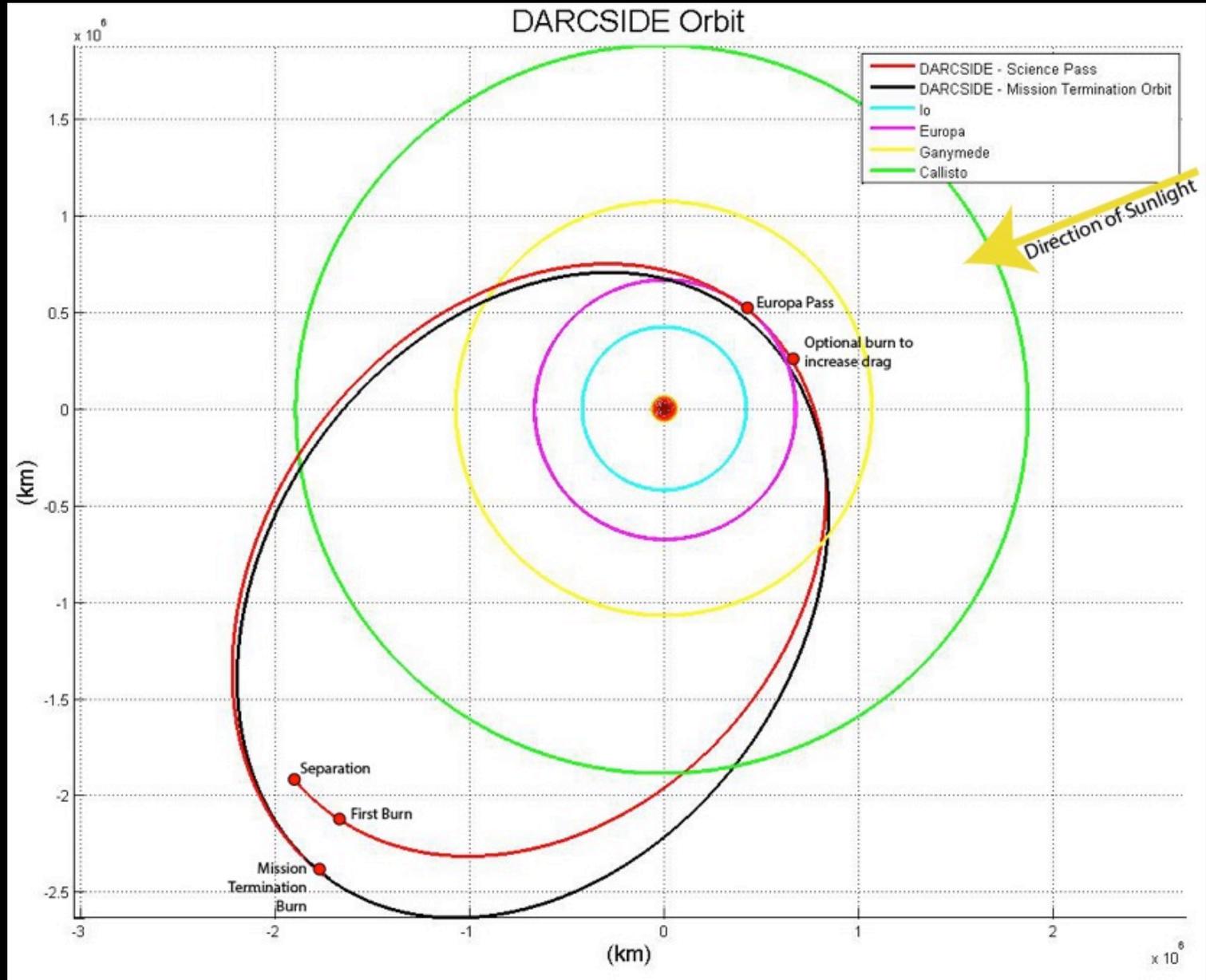


McGrath et al. (2009)

# Planetary Protection

- Planetary Protection Category III Mission
  - Can never touch the surface of Europa
  - Has significant implications for mission termination sequence

# Mission Design



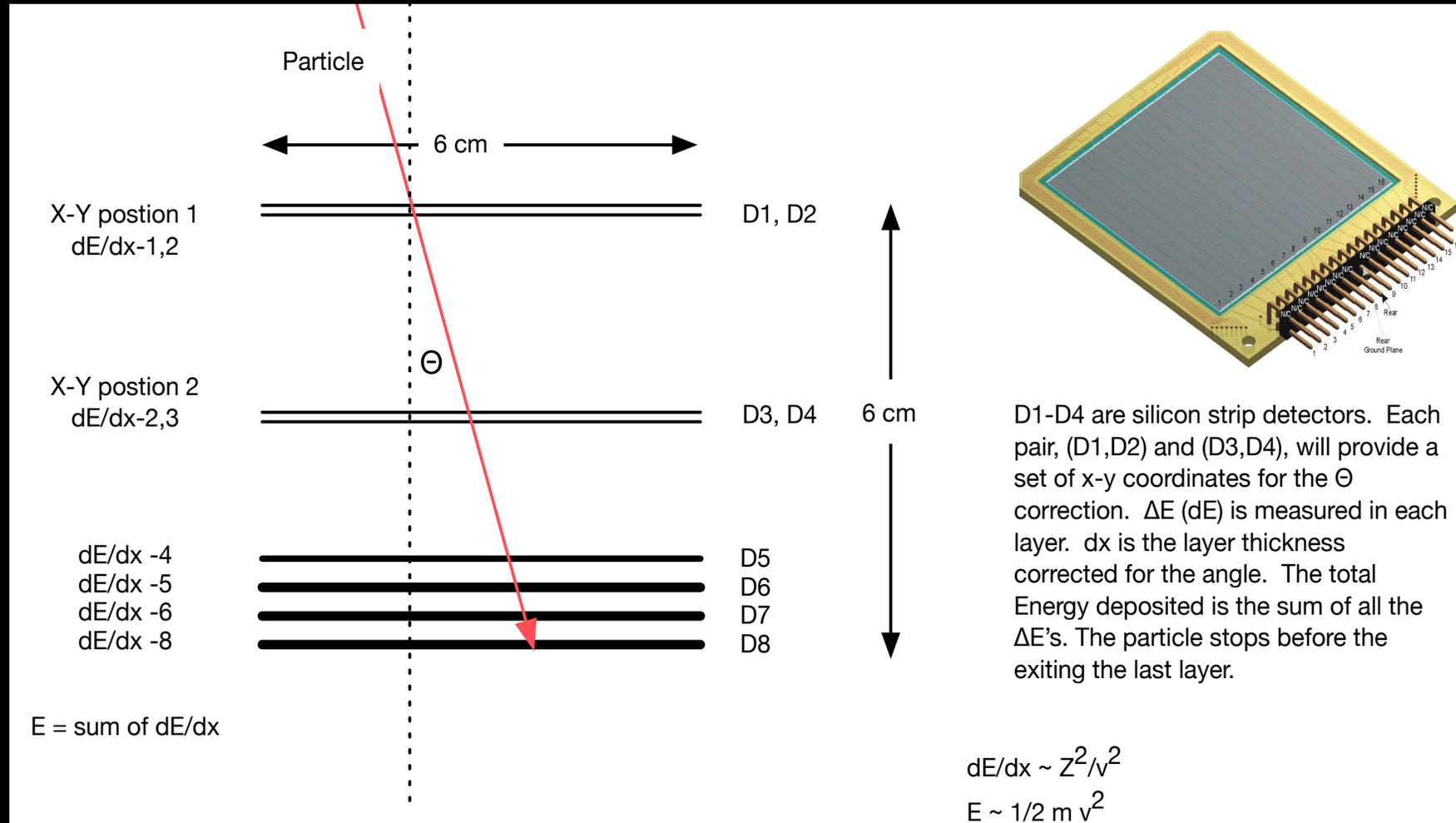
# Orbital Trajectory

- Release shortly before apogee
- Cruise 175.66h (7 days)
- Burn right before Europa increases drag & sets up bi-elliptic transfer
- Targeting a pass over Europa at 1km – 10km
- Mission Termination generates an inclined orbit with a lower perijove than Europa.

Maneuver	$\Delta V$ (m/s)
First Burn	3.1
Optional burn to increase drag	200
Mission Termination	100
ADACS & TCM	30
Total	333.1

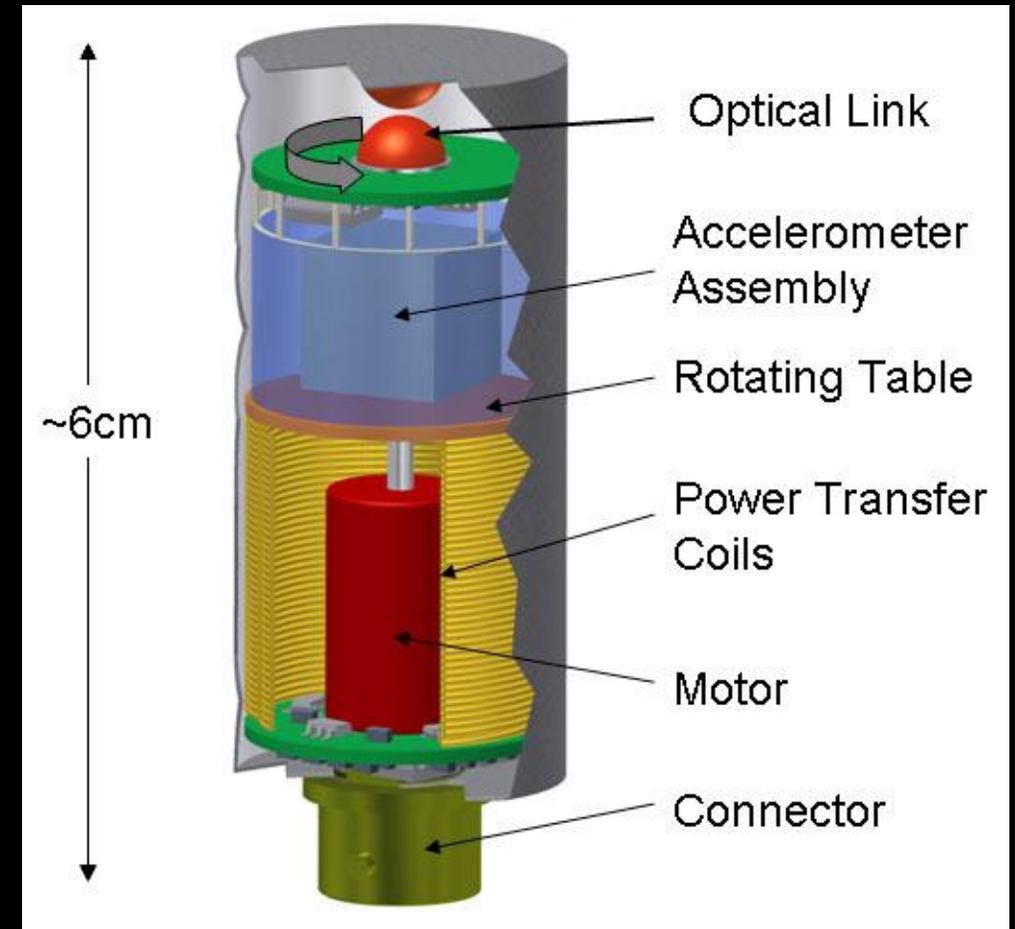
# Particle Detector

- Voyager Heritage

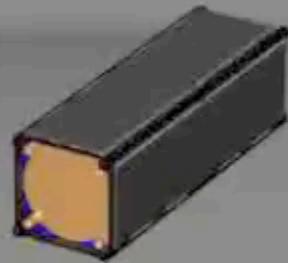


# MEMS Nano-G Accelerometer

- Under development by AFRL
- Detection limit of 10 nano-g ( $9.8 * 10^{-8} m/s$ )
- Capable of measuring predicted drag on DARCSIDE



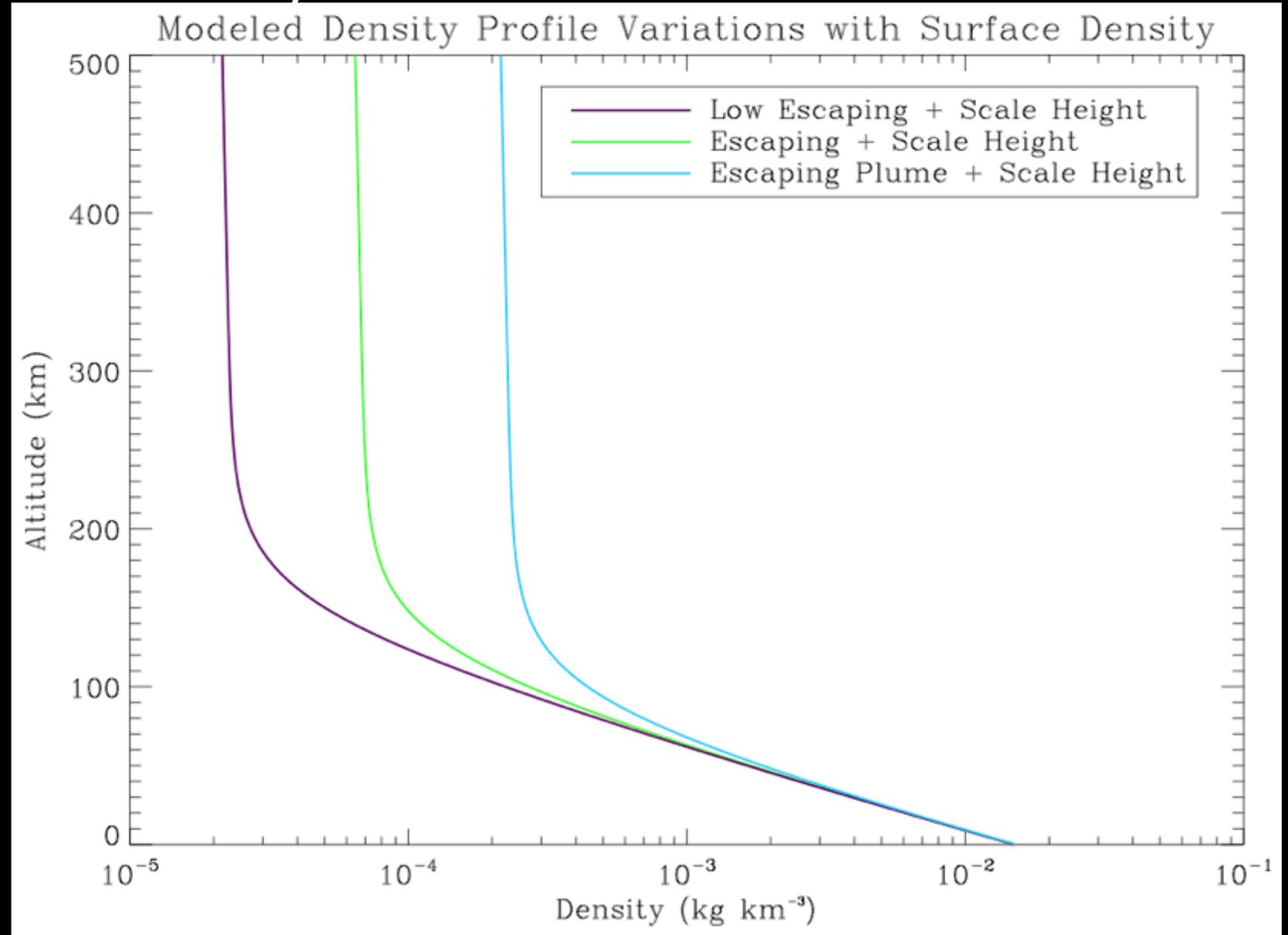
# Deployables



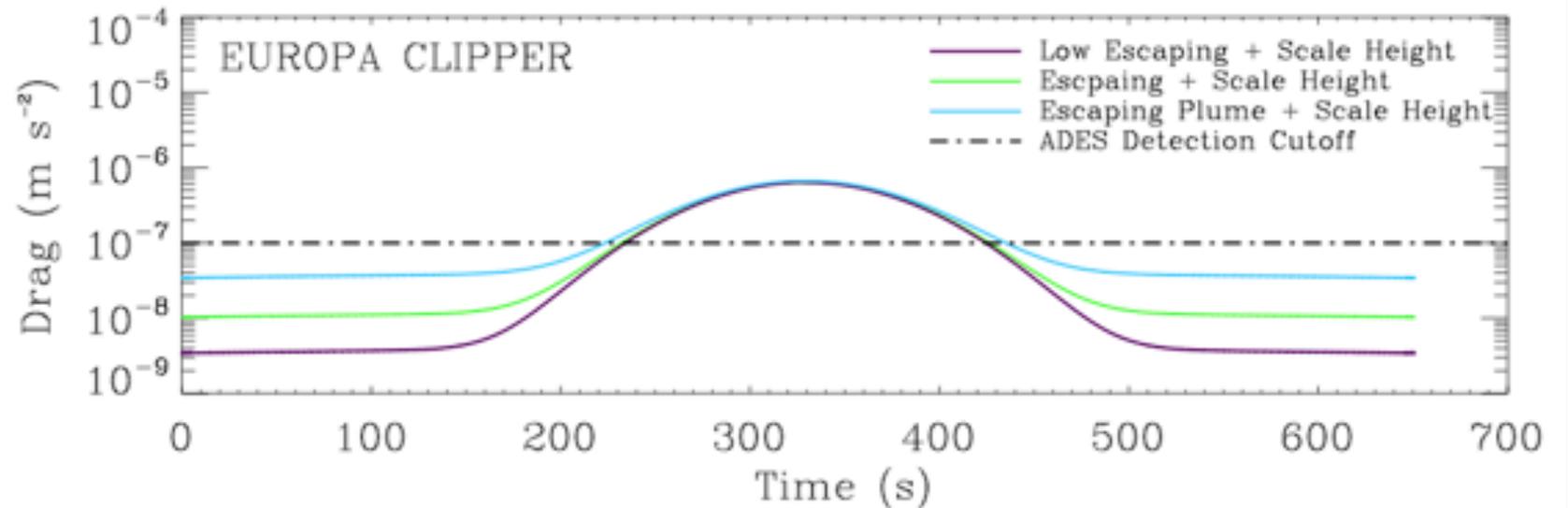
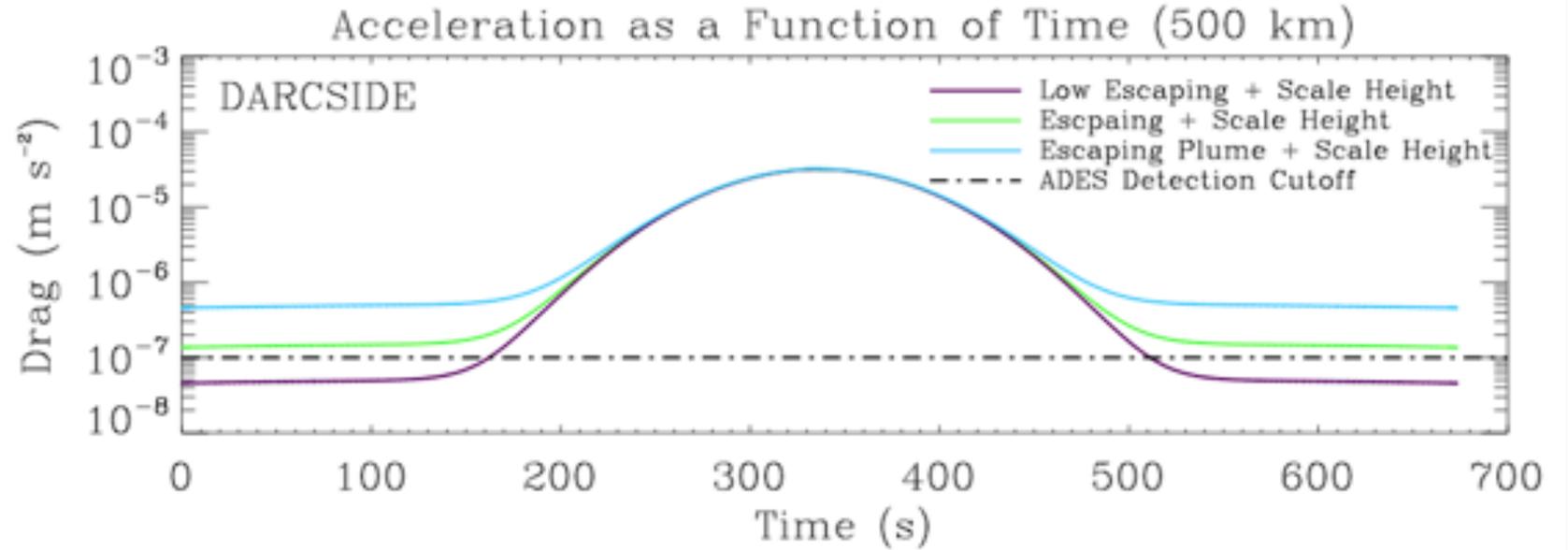
# Europa Atmosphere models

- Used published models to initialize Europa's neutral atom torus
- Assumed atmospheric models based on two particle populations:
  - Bound (but exponentially decreasing w/altitude)
  - Escaping
- Computed family of atmospheric density profiles with range of surface gas densities

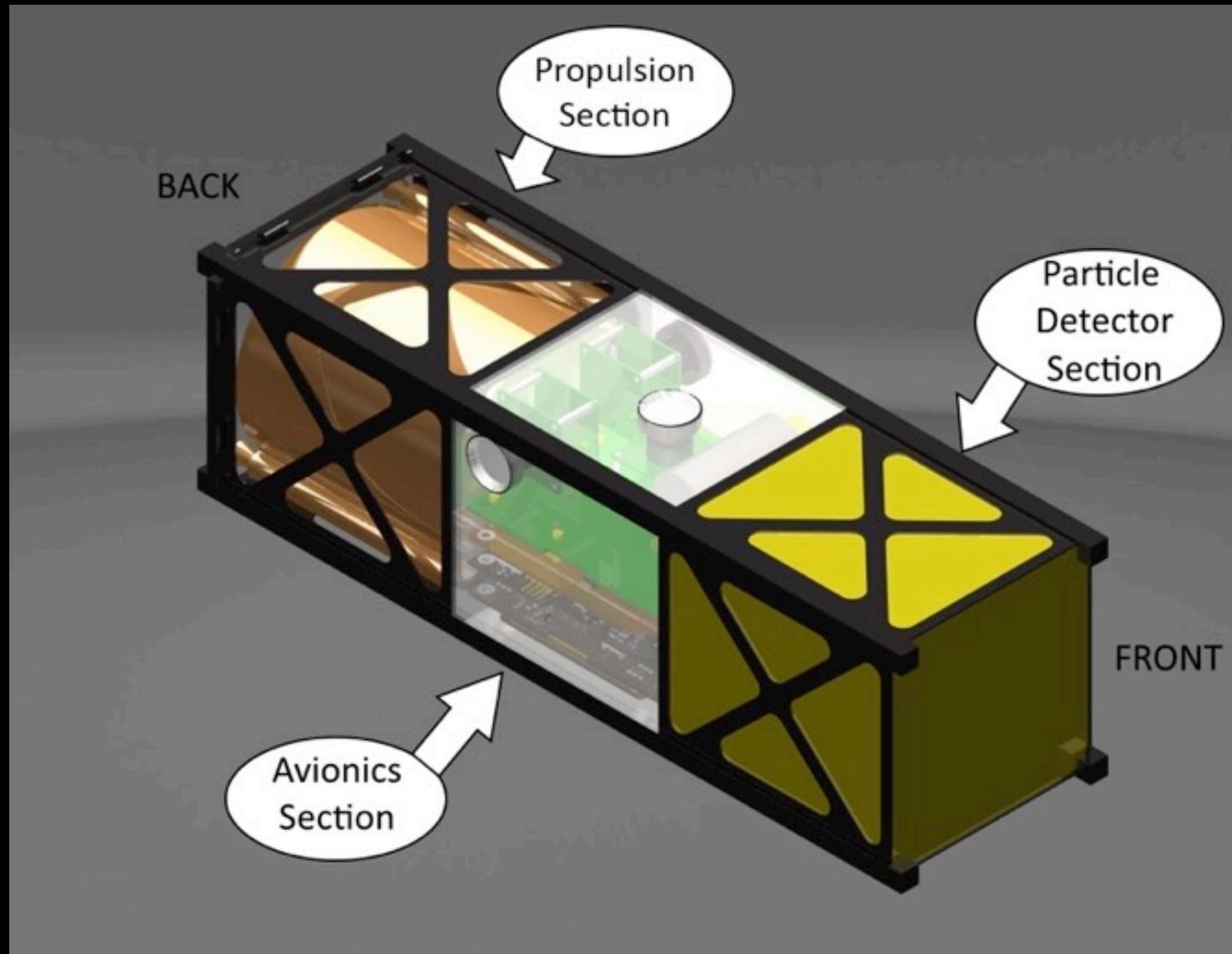
# Atmosphere Density



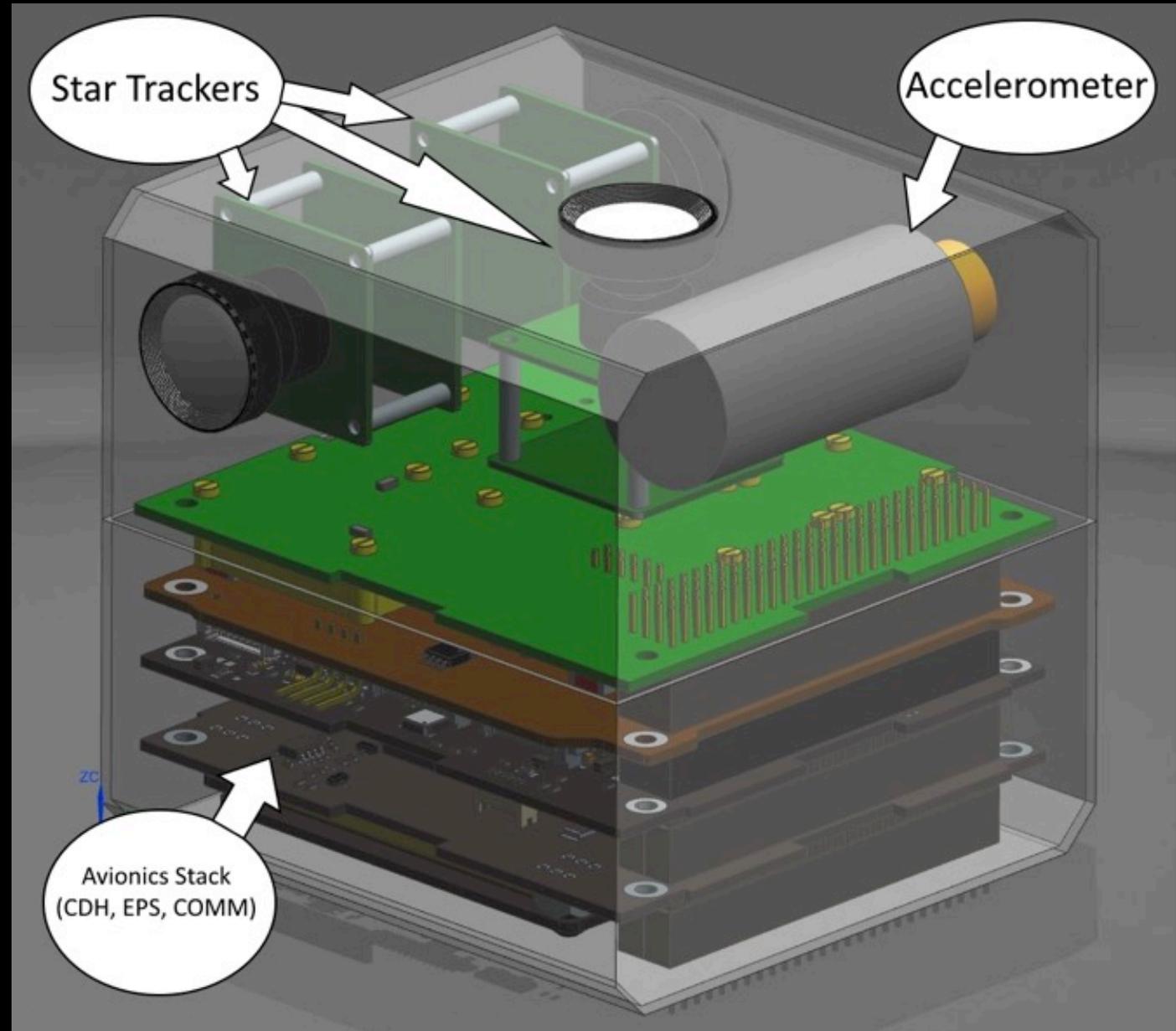
# Drag Estimates

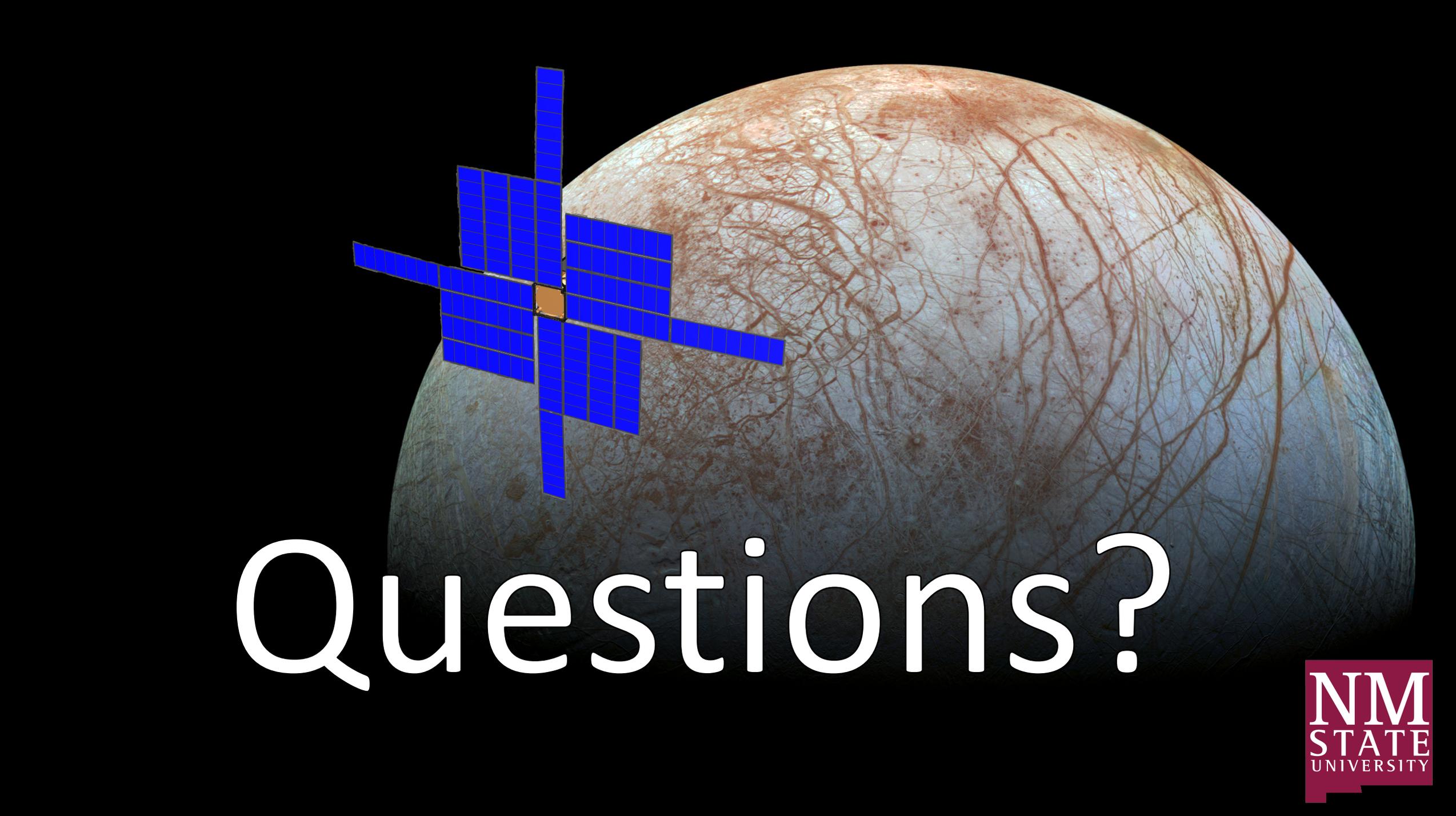


# DARCSIDE Spacecraft Bus



# DARCSIDE Avionics



A satellite with four blue solar panel arrays is shown in orbit around a planet. The planet has a reddish-orange upper hemisphere and a blue and white lower hemisphere, with a network of reddish-brown lines crisscrossing its surface. The background is black.

Questions?