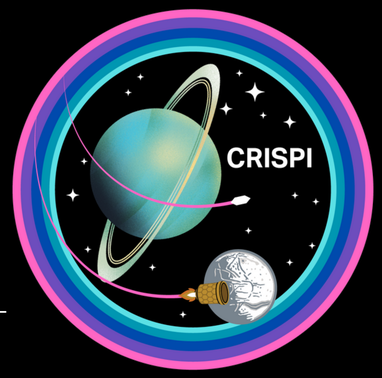
CRISPI

Compositional Regolith and Icy Surface analysis via Particle Impact

ZACH ULIBARRI, SAIMA JAMAL, LUCAS ARZOUMANIAN, ASHIN ALEX, RAMCHANDER RAO BHASKARA, ARTHUR CHADWICK, SNEHA GAYEN, KYUNGMIN KIM, MARK LOHATEPANONT, PREETI NAIR, KENIA NOVA, CARLOS OLIVEIRA, ADAM PARKS, RACHEL PRIDE, SURAJ SINGH, ABDUL SESSAY, JOSHUA UMANSKY-CASTRO, LUCIEN VOLK, ERIC YABLONSKI, MARTIN ZHOU, ELAINE PETRO, MASON PECK, DMITRY SAVRANSKY, FABIEN ROYER, AND ANDREW VAN PARIDON



SMDS

The 2025 Cornell SmallSat Mission Design School Project

SCIENCE MISSION

Study Ariel, the moon of Uranus and a potential icy ocean world with a unique single-flyby smallsat in-situ mass spectrometer dataset.

-Assess its habitability
-Characterize its surface chemistry
-Search for signs of past or extant life
-Break ambiguities in remote sensing datasets

OBJECTIVES AND OVERVIEW

The Compositional Regolith and Icy Surface analysis via Particle Impact (CRISPI) is a ride-along mission to provide synergistic science to the Uranus Orbiter and Probe (UOP) mission. It will study Ariel, a potential icy ocean world that is specifically called out in the Decadal Survey as a high priority astrobiology target.

CRISPI will provide unique in-situ mass spectrometer data to determine the moon Ariel's surface composition, assess its habitability, search for complex organics and biosignatures, and break ambiguities in the UOP optical spectrometer data to address some of the highest priority Origins, Worlds, and Life NASA Decadal Survey science questions, most importantly 10.2b, 10.5a, and 10.4.

CRISPI will determine the organic, ice, rock, and salt compositions and measure the ice-to-rock and salt-to-water ratios of lofted dust grains from Ariel's surface. These dust grains can be individually mapped to ovals of probability of surface origin. It will determine the composition of fresh surface material, identified by the presence of the volatile ammonia known to be present from Voyager spectrometer data. Working in synergy with the UOP's magnetometer, imagers, and optical spectrometers, it will assess habitability and search for organic signs of past or extant life on this far away moon.

While the Uranus Dust Experiment (UDEX) instrument would provide such measurements (and more) at Ariel and the other moons, CRISPI is a standalone ride-along smallsat that would require minimal alteration to existing UOP tours.

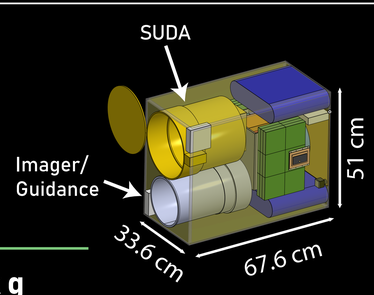
SCIENCE INSTRUMENT PAYLOAD

1x Impact Ionization Mass Spectrometer
Based on the SUDA instrument on the Europa Clipper

Payload Mass	14.6 kg
Payload Size (mm)	210 (h) x 70 (w) x 150 (l)
Uranus Cruise Energy	250 kWhr (from UOP RTG)
Science Phase Power	18.6 W (CRISPI battery)
Optimal Flyby Velocity	4-7 km/s
Dust Spectra	~5200 (25 km flyby)

Data per detection event = 31kB
Total data for 25km flyby = ~162 MB

Payload Processor: Xilinx Virtex-5QV + 32 bit Xlinix MicroBlaze Processor



SPACECRAFT AND ELECTRONICS

Launch Mass	~ 90 kg
Launch Volume	51 x 33.4 x 67.6 cm

Power Bank: 34x BA06 High Energy Density Battery Array for 2856 kWhr capacity (Indiv. battery capacity: 84Whr)

Propulsion: 21 kg Green Monoprop

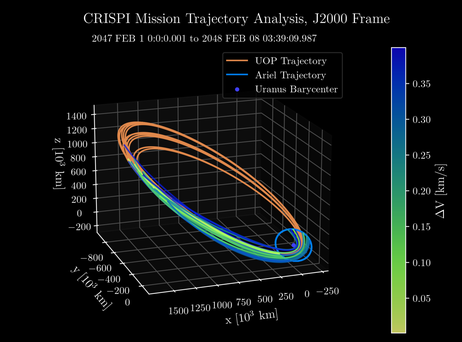
ADCS: COTS Star Tracker, IMU, Cold Gas Thruster Unit

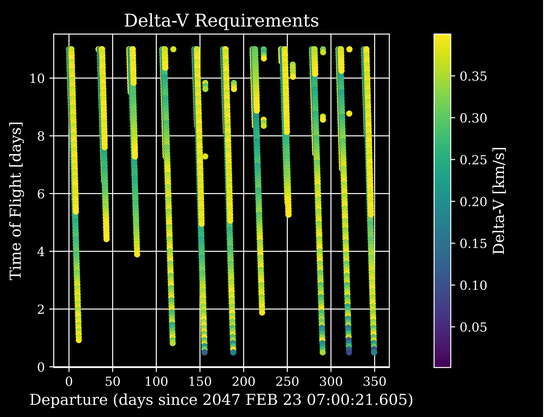
Communications:
EnduroSat S Band Transmitter & RX-2000 S Band Receiver w/ S-Band Patch Antenna for ~5 MBPS back to UOP for Earth uplink

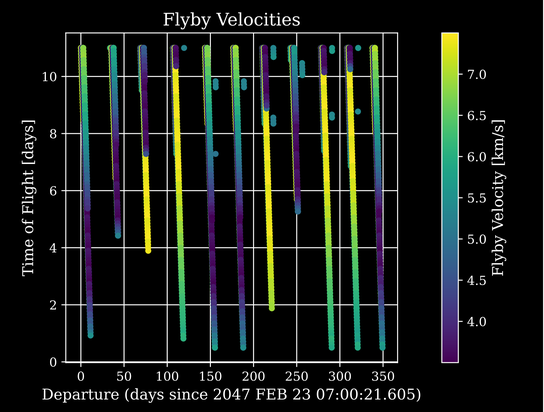
Thermal Insulation: MLI, heaters

Onboard Compute: Sirius LEON3FT | OS: RTEMS

EXAMPLE LAUNCH OPPORTUNITIES



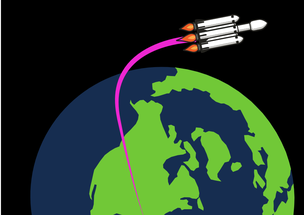




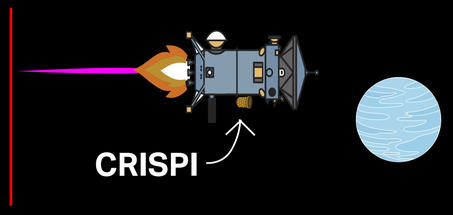
ALTERNATIVE RING SAMPLING MISSION

The Uranian rings are also high priority science targets. In principle, CRISPI may study each ring on its way into decommission crash into Uranus, but in reality it will be difficult to find such thin targets. As an alternative mission profile, CRISPI may launch before UOI to study a single ring with a single high-velocity, high-inclination ring flythrough.

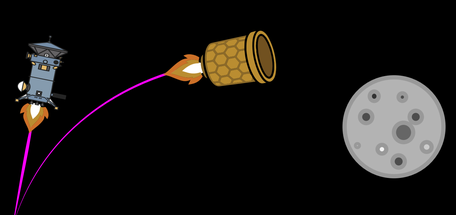
FALCON HEAVY LAUNCH WITH UOP



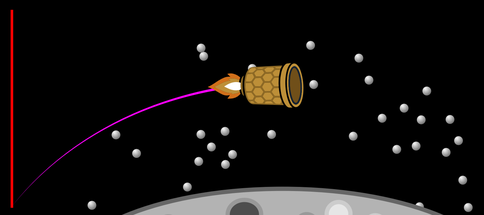
15 YEAR CRUISE AND 1 YEAR ORBIT INSERTION WITH UOP



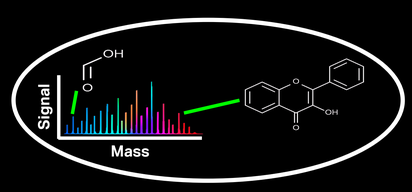
SEPARATION AND <5 DAY CRUISE TO ARIEL FLYBY



CRISPI COLLECTS SURFACE DUST, MAPS EACH GRAIN ORIGIN,



AND ANALYZES COMPOSITION OF EACH DUST GRAIN



CRASH DECOMMISSION INTO URANUS