



A relocatable lander to explore Titan's prebiotic chemistry and habitability



Melissa Trainer, Dragonfly Deputy Principal Investigator on behalf of the Dragonfly Team  
NASA Goddard Space Flight Center

OPAG, 10 February 2021

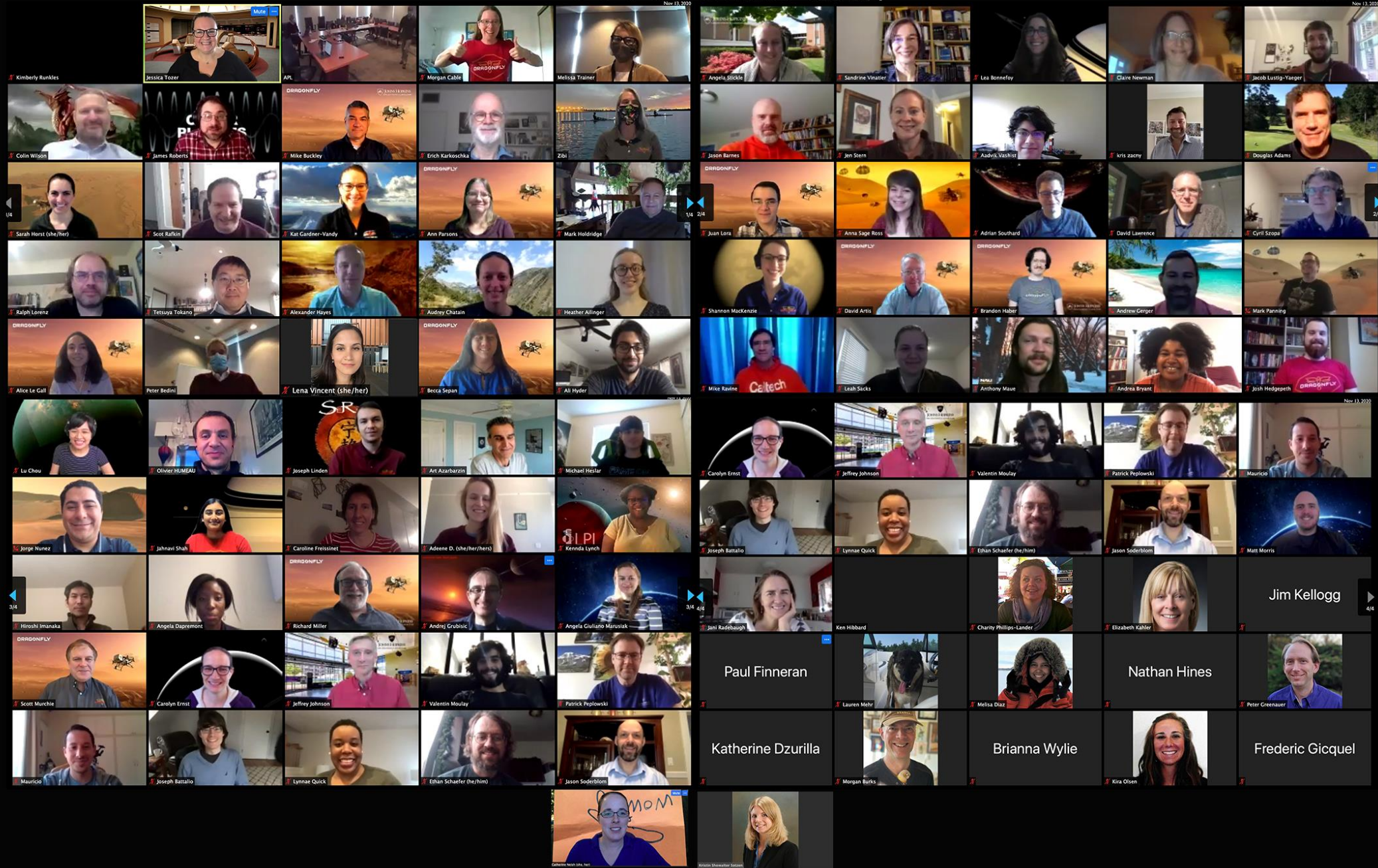
*Dragonfly's baselined use of an MMRTG remains in a pre-decisional state. The decision about launching a nuclear payload is officially made after the NEPA process has been completed with the signing of a Record of Decision (ROD) or Finding of No Significant Impact (FONSI).*

Dragonfly

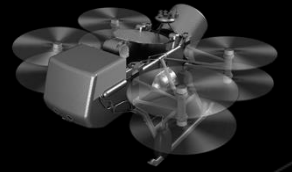


# DRAGONFLY TEAM PHOTO - ZOOM

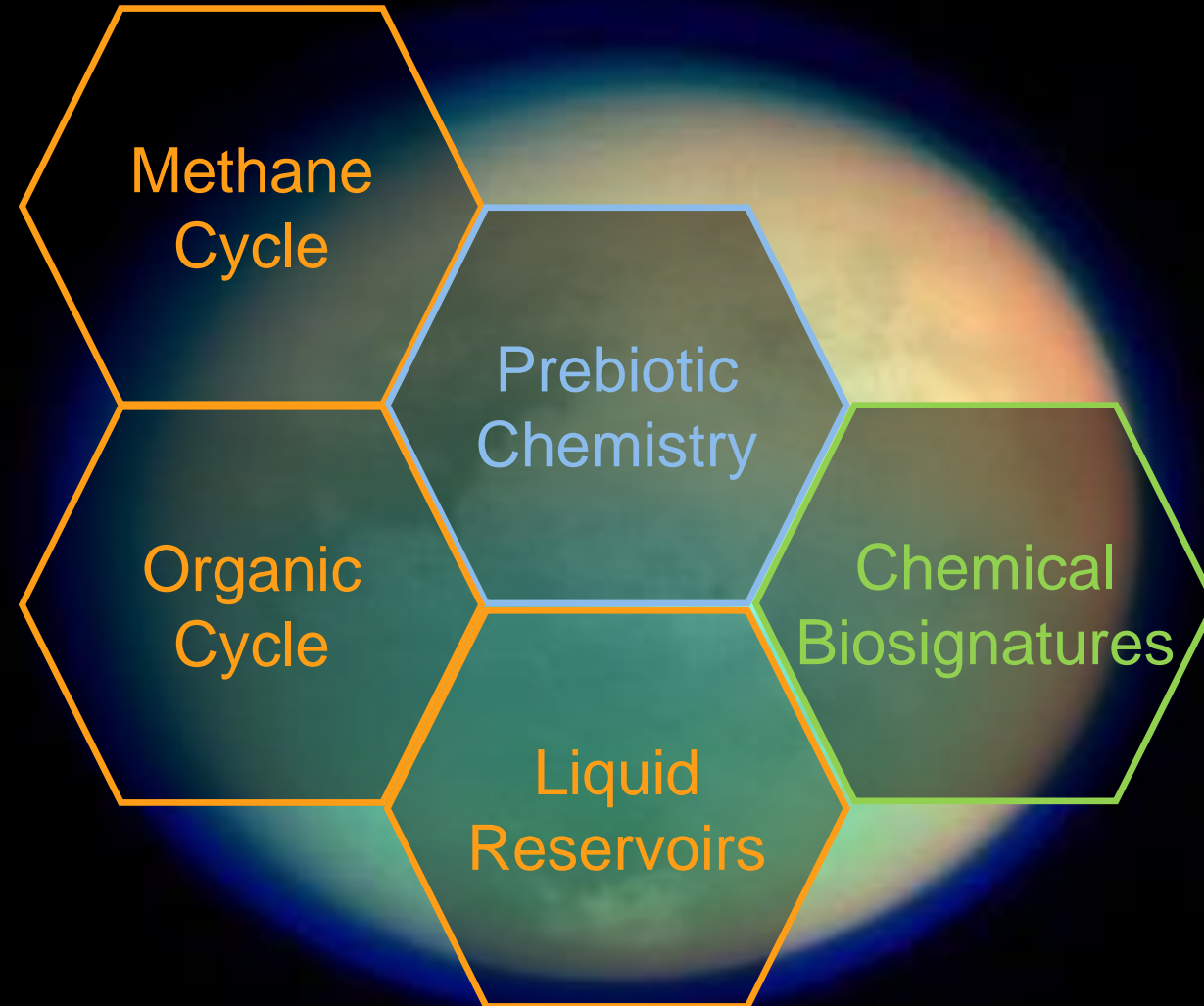
Nov 13, 2020



# Dragonfly mission science

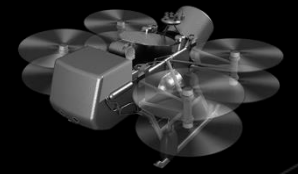


- Prebiotic chemistry
  - Analyze chemical components and processes at work that produce biologically relevant compounds
- Habitable environments
  - Measure atmospheric conditions, identify methane reservoirs, and determine transport rates
  - Constrain processes that mix organics with past surface liquid water reservoirs or subsurface ocean
- Search for biosignatures
  - Search for chemical evidence of water- or hydrocarbon-based life

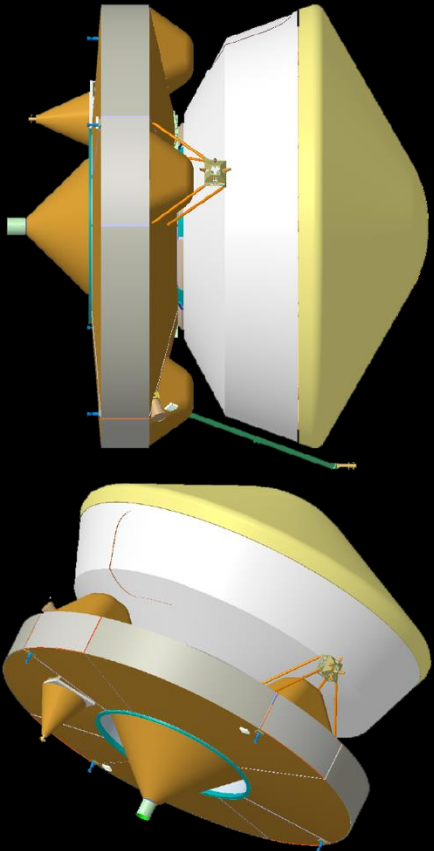




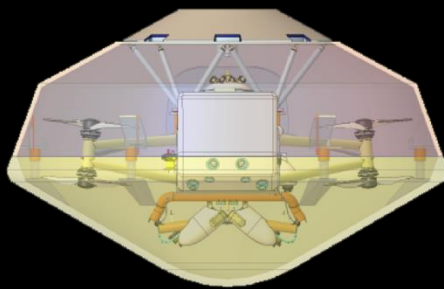
# Dragonfly mission elements



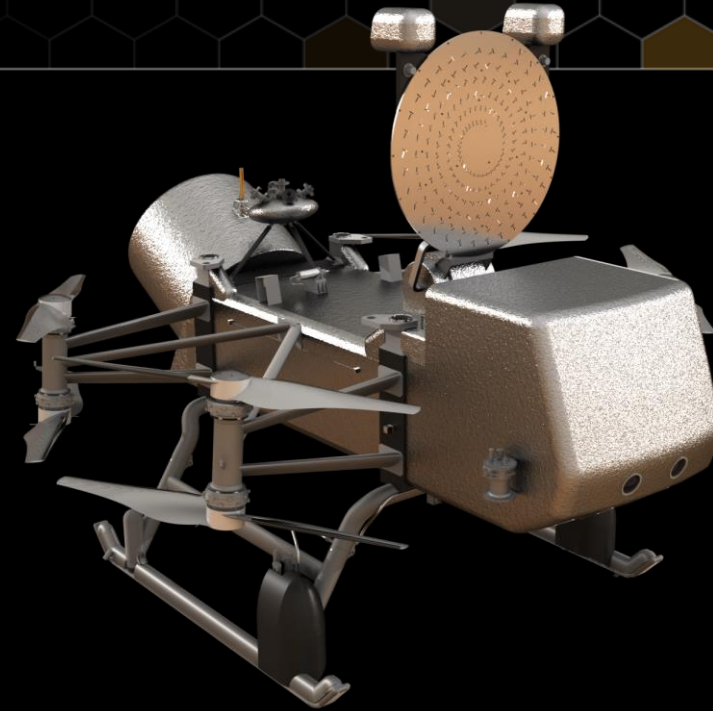
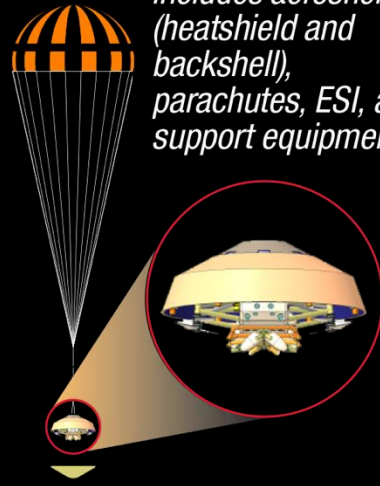
**Spacecraft =  
Cruise Stage + Entry Vehicle**



**Entry Vehicle =  
EDL Assembly + Lander**



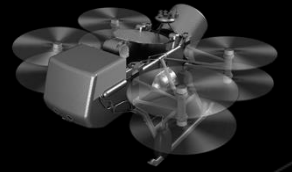
*EDL assembly includes aeroshell (heatshield and backshell), parachutes, ESI, and support equipment.*



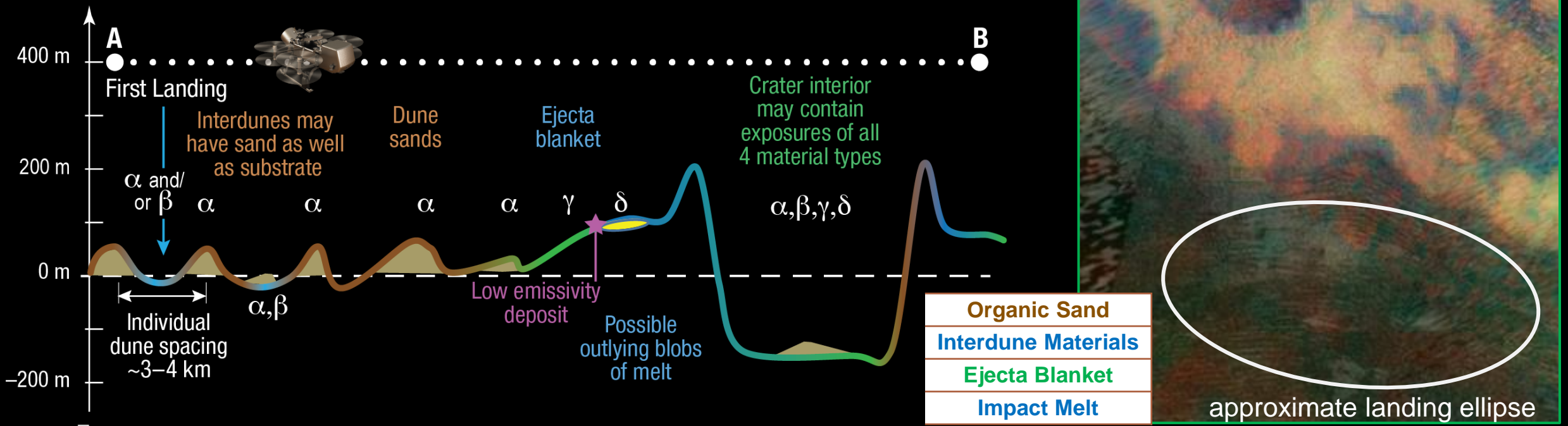
**Rotorcraft Lander**  
*Surface configuration  
with HGA deployed*

- **MMRTG**
  - Charges battery to power flight and science activities
  - Waste heat maintains nominal thermal environment in lander
- **Direct-to-Earth communication**
  - HGA articulation used to target cameras for panoramas of surrounding terrain
- **Measurements on surface and in flight**
  - Aerial imaging
  - Atmospheric profiles
  - Surface sampling and composition measurements

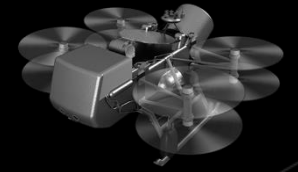
# Dragonfly mission timeline at Titan



- ~3.3 years of exploration
  - 16-day Titan sols
  - Nominal flight schedule is once per 2 Tsols (~1 flight / Earth month)
  - Traverse distance up to ~180 km
  - Exploration of ~25-30 unique sites

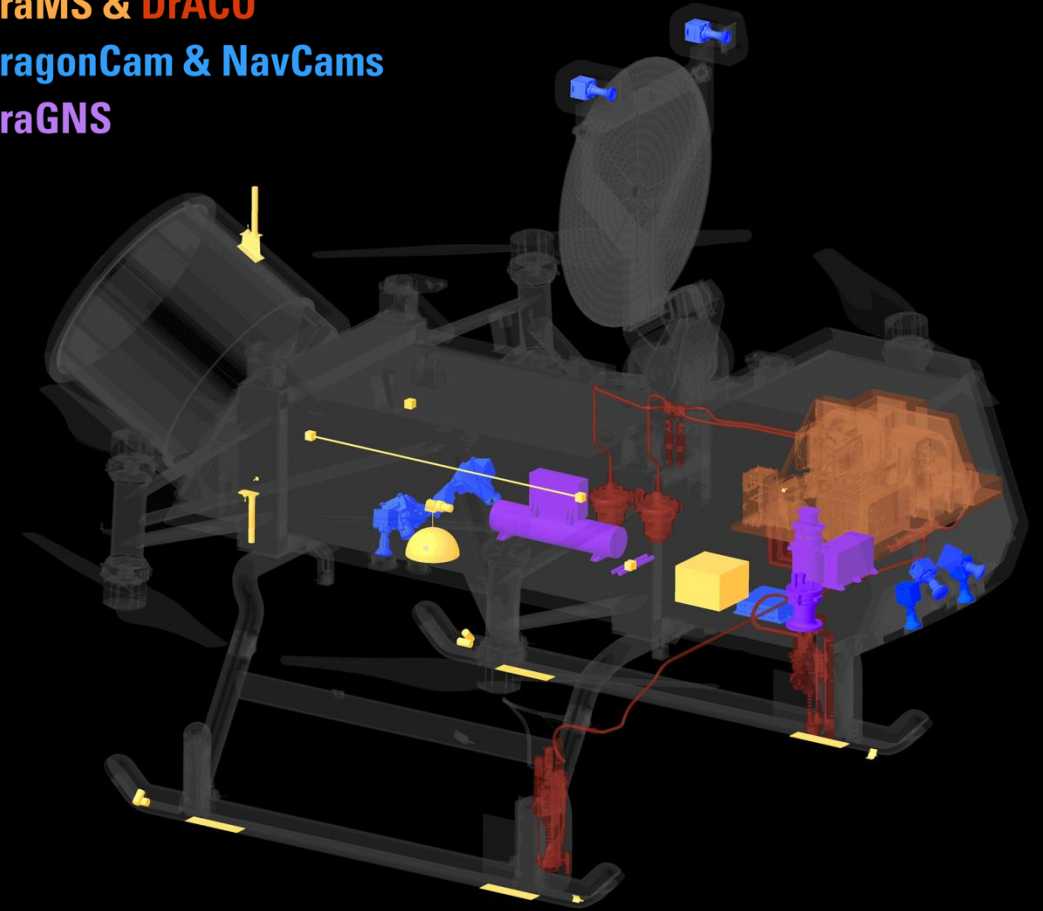


# Multidisciplinary science measurements

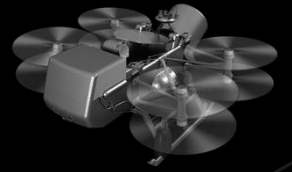


- DraGMet: Geophysics & Meteorology Package (APL, JAXA Lunar-A seismometer)
- DraMS: Mass Spectrometer (GSFC, CNES)
- DrACO: Drill for Acquisition of Complex Organics (Honeybee Robotics)
- DragonCam: Camera Suite (MSSS)
- DraGNS: Gamma-ray Neutron Spectrometer (APL, LLNL, GSFC, Schlumberger PNG)

- > DraGMet
- > DraMS & DrACO
- > DragonCam & NavCams
- > DraGNS



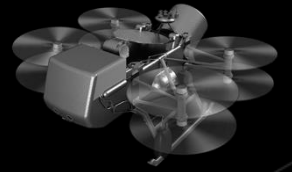
# Dragonfly mission updates



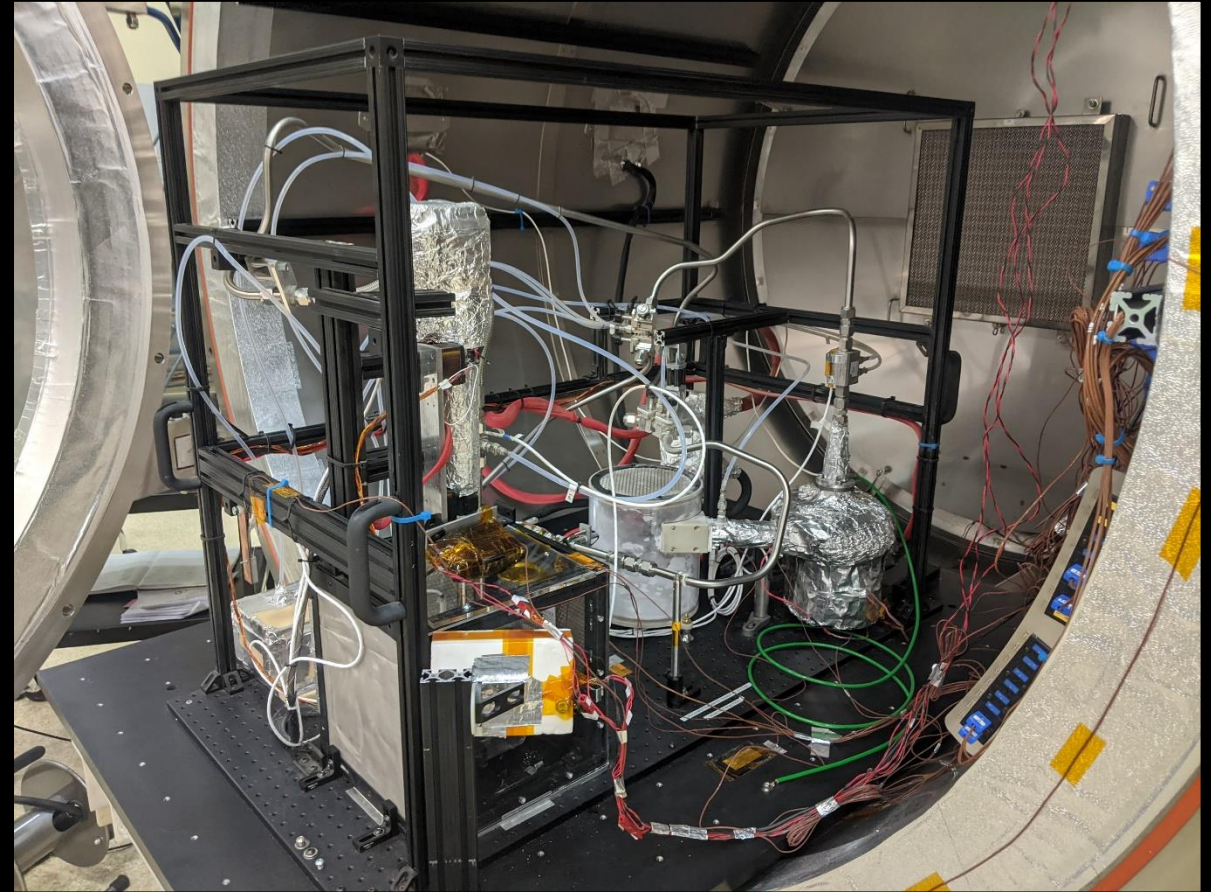
- Now working towards a 2027 LRD
  - Project team is in the midst of re-baselining cost and schedule for the 2027 LRD
- Level 1 Science Requirements are finalized
- Tremendous progress on technical development and testing in a challenging year
  - Team safety has been the priority as COVID-19 pandemic continues
  - Most work continuing remotely, with in-person activities (e.g., testing) being conducted as possible
- Virtual Team Meeting in November 2020
  - Welcomed Guest Observers, part of NASA trial program
- First cohort of the Dragonfly Student Guest Investigator Program selected (2020-22)



# DrACO Pneumatic Transfer System (PTS) TPEC Testing



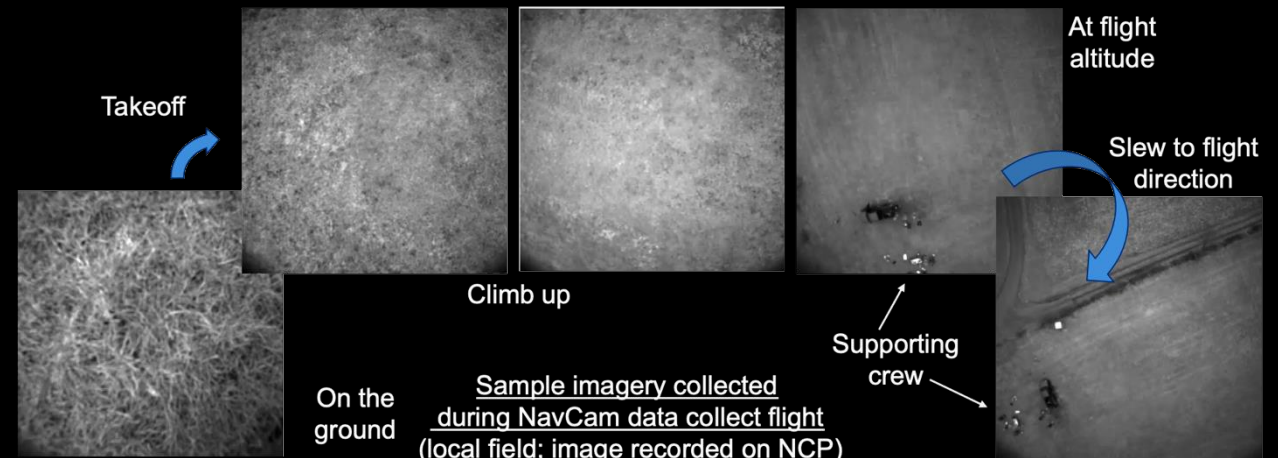
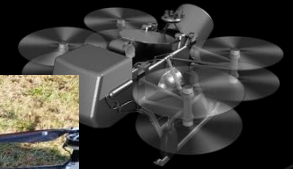
- DrACO transports drilled surface samples to the mass spectrometer interface using a Pneumatic Transfer System (PTS)
- A high-fidelity “Brassboard” of the DrACO PTS was tested inside Titan Pressure Environmental Chamber (TPEC) @ APL Nov 2020.
- Brassboard testing successfully demonstrated pneumatic sample transfer of various simulants in Titan conditions.
- Blower ingested ~12,000 cc, or twice the mission duration’s worth, of abrasive simulant (crushed walnuts) without any observable loss in performance.
- TRL6 test objectives satisfied through successful completion of pneumatic sample transfer and impeller life.



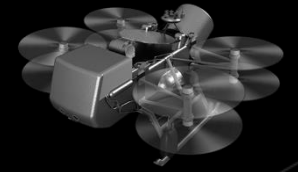


# “Configuration 1” Flight Test

- **Integrated Configuration 1 drone platform flight test**
  - Demonstrate flight-worthiness of the integrated drone platform under realistic flight profiles; Matching frames and rotor spin direction on actual drone
  - Control the integrated platform using both ground-piloted (manual) and autopilot (Pixhawk) controller sources
  - Collect IMU data in-flight for post-processing and performance assessment of the IMU-propagated navigation solution



# Dragonfly Student Guest Investigators – first cohort



Project	Dragonfly Team Mentors	Mentees
Seismic investigation of Titan's interior using full waveform modeling	Mark Panning, JPL	<b>Andrea Bryant</b> , University of Chicago, Physics
Spectral/compositional library for interpretation of DragonCam/DraGNS measurements	Shannon MacKenzie & Richard Miller, APL	<b>Karla Negrete</b> , University of Maryland Baltimore County (UMBC), Mech. Eng.
Development of the DragonCam microscopic imager multispectral LED arrays	Jorge Núñez, APL	<b>Brianna Wiley</b> , Florida Agricultural & Mechanical University (FAMU), Mech. Eng.

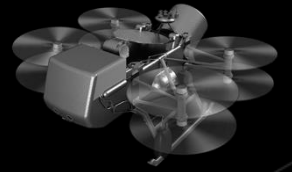


- **Goals of Program**

- Extend opportunities for graduate students to work with *Dragonfly* scientists and engineers
- Encourage broader participation by making it easier for students who **don't already** have connections to *Dragonfly* or NASA spacecraft missions, and/or who **don't** have a planetary science background
- Serve as an “on-ramp” to provide networking opportunities and to expand training of the next generation of mission team members and leaders



# Upcoming activities and engagement



- Following ISRR, continuing development activities; next milestone review is PDR in Aug 2022
- International Agreements (CNES, JAXA, DLR) are being worked
- Coordination of Planetary Protection and Communication Plans
- **New Dragonfly Student Guest Investigator Program Opportunities (2021-23)** expected to be posted at end of February
  - <https://dragonfly.jhuapl.edu/Student-Opportunities/>
- Community and public engagement highlights:
  - Presentations for the Student Guest Investigator Program at LPSC (upcoming), DPS, and NSBP:
    - **Quick, L. C.**, et al. 2020. *The Dragonfly Mission to Titan and the Student and Early Career Investigator Program: Broadening Participation on Planetary Mission Teams*. Abstract, **Annual Conference of the National Society of Black Physicists**, Virtual, November 2020.
  - PI Turtle TED talk featured on NPR “TED Radio Hour”



<http://dragonfly.jhuapl.edu>