TITAN AERIAL DAUGHTERCRAFT

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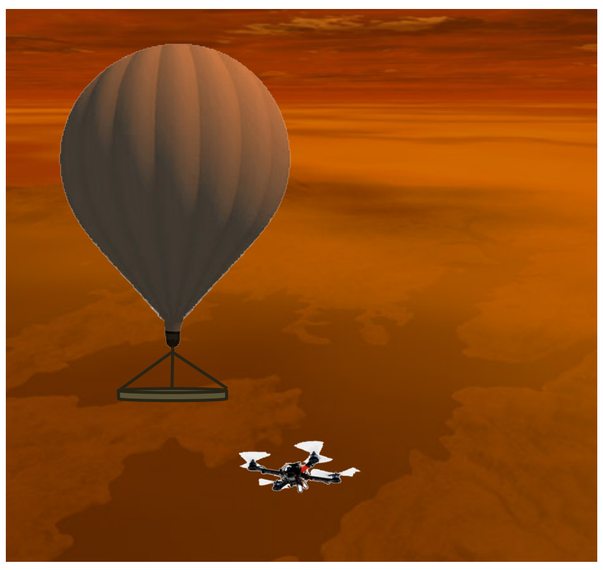
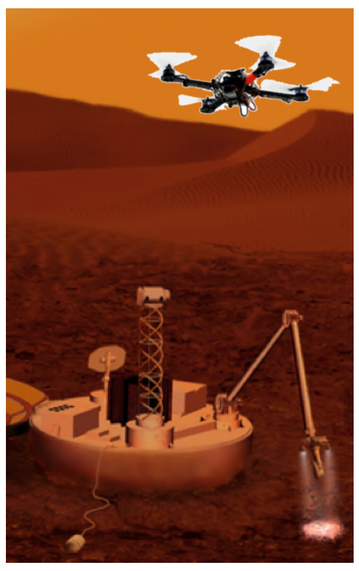
SYSTEM AND MISSION CONCEPT

- Small (< 10 kg) VTOL rotorcraft that could deploy from a balloon or lander to acquire close-up, high resolution imagery and mapping data, land at multiple locations to acquire microscopic imagery, sample surfaces and atmosphere, return the samples to the mothership for analysis, and recharge from a RPS on the mothership to enable multiple sorties.
- Plausible feasibility based on prior studies of heavier-than-air flight for Titan, preliminary designs at JPL of smartphone-like avionics for a small Mars rotorcraft concept, likelihood that similar avionics can be used for Titan with more thermal insulation, and mid-TRL maturity of the necessary autonomous navigation functions.

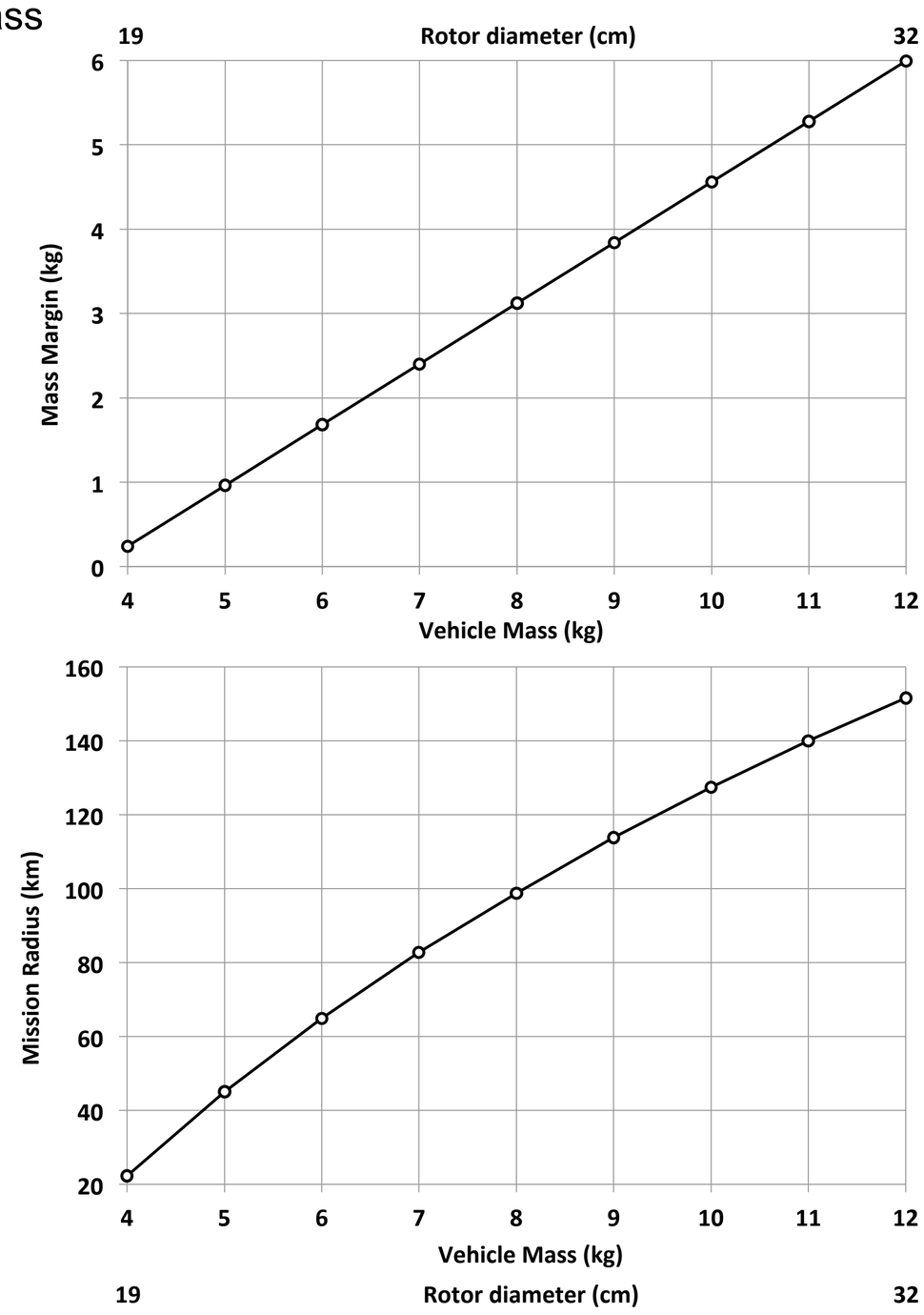




MASS MARGIN (or RANGE) vs. ROTORCRAFT SIZE

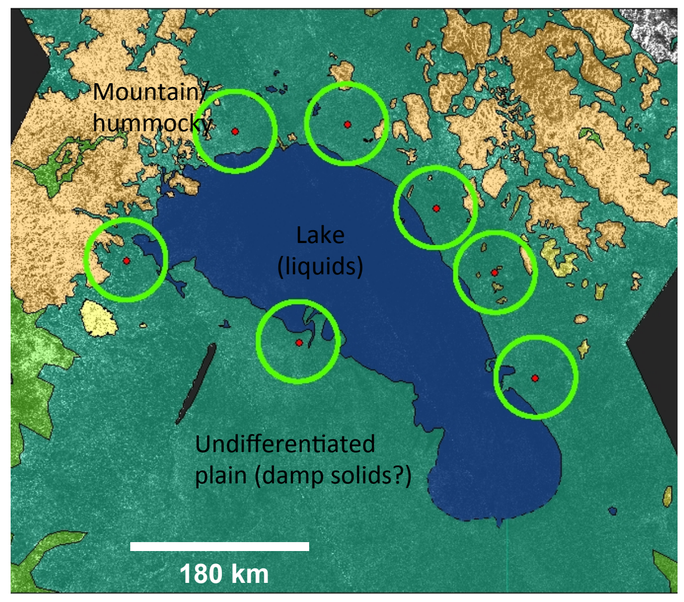
Quadrotor configuration selected for current study for mechanical and control simplicity:

- Fix avionics mass and power at 0.5 kg, 20 W and payload mass and energy at 2 kg, 1.7 Wh, based on prior work
- For a given total mass, estimate required rotor size and structural mass, and allocate all remaining mass to battery
- For balloon scenario, estimate mass margin vs. total mass with balloon at 10 km altitude drifting at 1 m/s, 10 min at surface
- For lander scenario, estimate mission radius vs. total mass

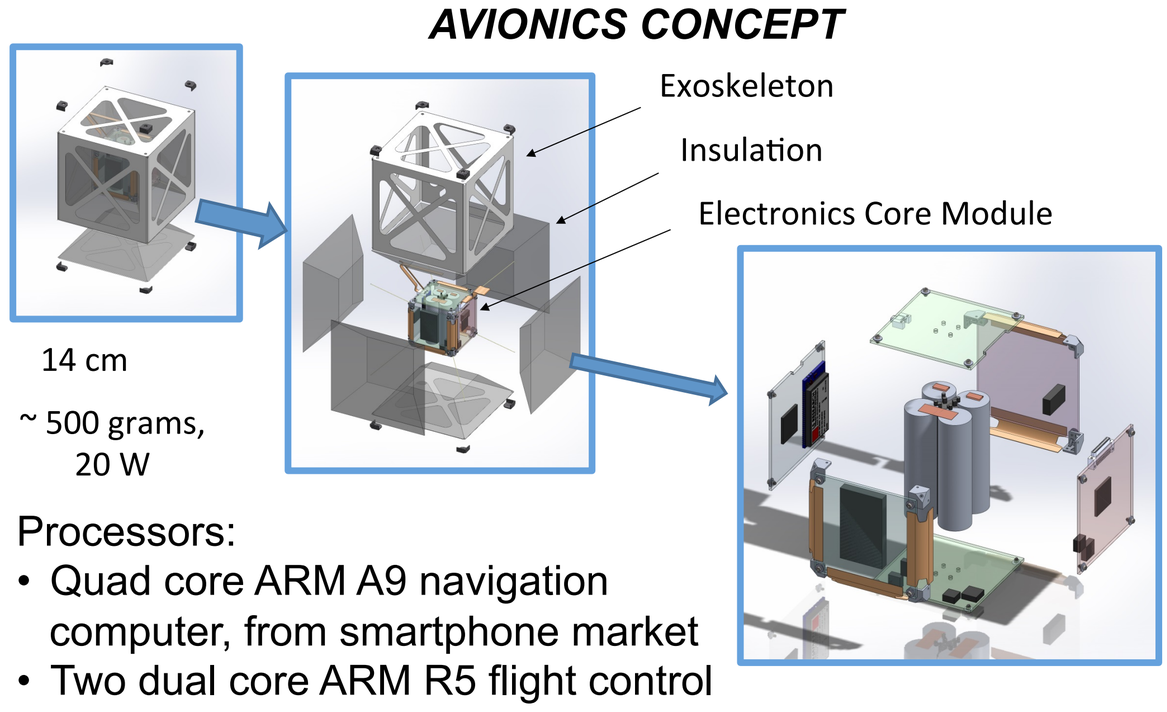


NOTIONAL LANDER MISSION

- Precision landing near Ontario Lacus using steerable parachute and terrain-relative navigation by onboard matching of visible imagery to prior radar maps.
- Acquire liquid and solid samples to return to a mass spectrometer on lander.



AVIONICS CONCEPT

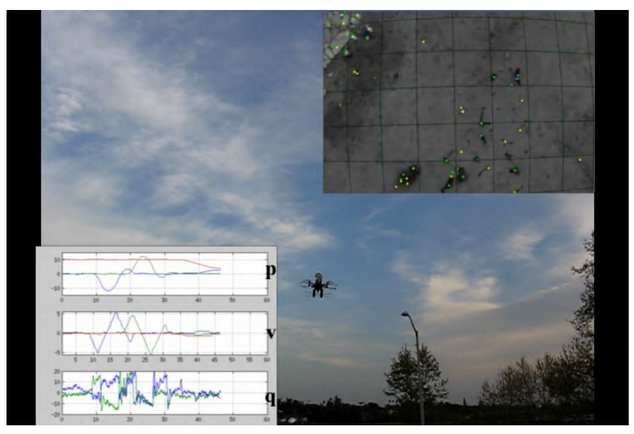


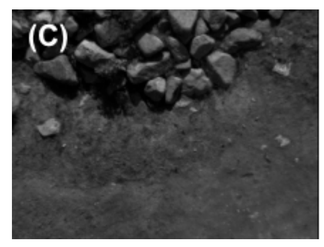
Processors:

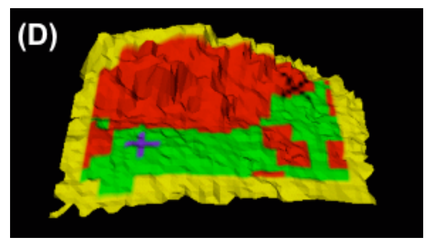
- Quad core ARM A9 navigation computer, from smartphone market
- Two dual core ARM R5 flight control computers, from safety critical systems market

NAVIGATION (MID-TRL IN TERRESTRIAL TESTBEDS)

- Inertial sensors, altimeter, plus onboard visual feature tracking and matching to radar maps for position/heading estimation
- Onboard terrain mapping with camera, radar, or lidar for safe landing for sampling
- Docking with lander aided by RF bearing and range sensor and visual target on lander

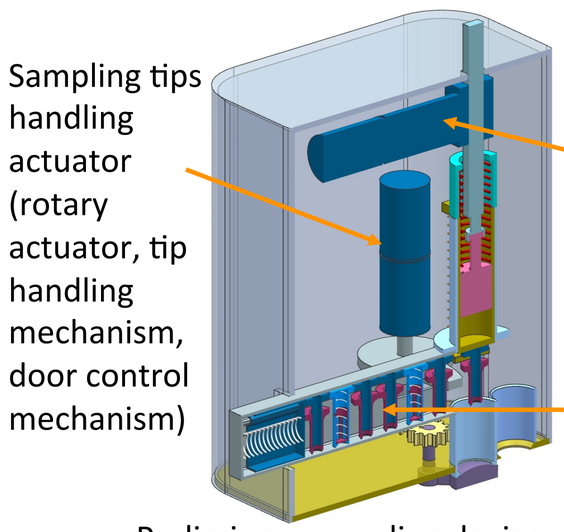






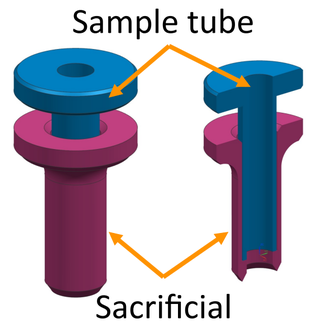
SAMPLER CONCEPT

- Two actuators can control the sampling tip loading and delivery and the sampling event
- Docks with the mother craft in a predefined location for sample delivery and recharging

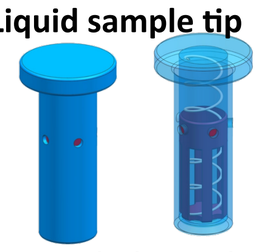


Preliminary sampling device concept;
est. 1.8 kg and 14x13x7 cm

Solid sample tip



Liquid sample tip



Venting holes with spring-loaded sliding sleeve valve