NASA SBIR/STTR Technologies

S3.02-9845 - I-Sail: 2500-Square-Meter Solar Sail Prototype Demonstrator

PI: David Carroll

CU Aerospace, LLC - Champaign, IL

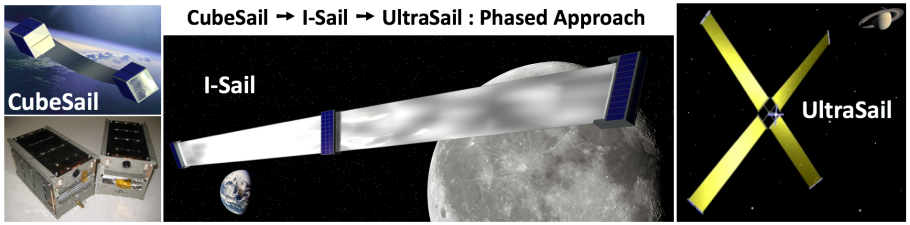
Identification and Significance of Innovation

A team of CU Aerospace, the University of Illinois at Urbana-Champaign, and NeXolve propose the Phase I design and development of a 25 kg spacecraft for initial flight test of a 2,500 m^2 UltraSail demonstrator, called I-Sail. This technology represents a next-generation high-risk, high-payoff solar sail system for the launch, deployment, stabilization and control of very large (km^2 class) solar sails, enabling very high payload mass fractions for interplanetary and deep space spacecraft. UltraSail is an innovative, non-traditional approach to propulsion technology achieved by combining propulsion and control systems developed for formation-flying microsatellites with an innovative solar sail architecture to achieve controllable sail areas approaching 1 km^2, sail subsystem areal densities less than 5 g/m^2, and thrust levels many times those of ion thrusters used for comparable deep space missions. I-Sail represents the next stage of risk reduction for the UltraSail technology prior to full scale interplanetary development in the next decade.

CUAerospace

ILLINOIS NeXolve

CubeSail → I-Sail → UltraSail : Phased Approach



(20 m²) Fabricated and Manifested for Launch 11/2017

(2,500 m²) Proposed I-Sail Demonstrator for UltraSail Risk Reduction

(100,000 m²) Theoretical Viability to Interplanetary Destination Established (2003 – 2006)

Estimated TRL at beginning and end of contract: (Begin: 4 End: 5)

Technical Objectives and Work Plan

The primary technical objective of Phase I is the design of the next generation I-Sail spacecraft demonstrator for fabrication in Phase II (a two-order of magnitude scale up in sail area from the prior subscale 20 m**2** CubeSail hardware) with a goal of sail areal density of ~10 g/m**2**. Additionally, Phase I objectives will include systems engineering of the spacecraft, risk reduction, and selection of potential missions with requirements.

Phase I tasks include:
1. Design of I-Sail prototype demonstrator
2. Establish method to deploy sail from reel
3. Solar sail material selection
4. Attitude control system analyses
5. Mission requirements and life
6. Systems engineering: power, thermal, risk
7. Reporting and meetings

With a successful Phase III in-space demonstration of I-Sail, the UltraSail technology will have reached TRL 8 and a full-scale deep space UltraSail mission will be the next step.

NASA Applications

The NASA Technology Roadmap calls for an in-space demonstration of a 2500 m^2 sail to Earth escape in the 2019-2022 timeframe; the proposed I-Sail can meet this goal. Solar sails are potentially useful for a range of robotic NASA missions of relevance to NASA's science and exploration goals ranging from Near-Earth to Sun-Earth Lagrange point L1 to Mars to the Kuiper Belt, an interstellar probe, and a multiple NEO rendezvous mission. The UltraSail concept has very high payload mass fraction potential of ~60% resulting in economical missions.

Non-NASA Applications

A number of mission concepts have been identified that make solar sail propulsion the go-to technology for high C3 missions. I-Sail and UltraSail have military applications for earth-observing missions at high orbit where stationary observing is useful, e.g. pole-sitting missions. NOAA and NSF have strong interests in the science that can be returned from non-Keplerian orbits and Lagrange points.

Firm Contacts

David Carroll
CU Aerospace, LLC
301 North Neil Street, Suite 502
Champaign, IL, 61820-3169
PHONE: (217) 239-1703
FAX: (217) 239-0630

NON-PROPRIETARY DATA