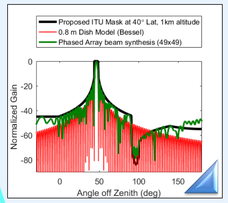
CLAS-ACT

Conformal Lightweight Antenna Structures for Aeronautical Communication Technologies

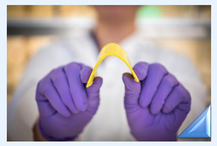
National Aeronautics and Space Administration

Overview/Description

This project developed an antenna to enable beyond line of sight (BLOS) command and control for small UAVs. We took advantage of a newly assigned provisional Ku-band spectrum for UAVs and used unique antenna design to avoid interference with ground systems. This required the design of an antenna with high isotropic effective radiated power (EIRP) and ultra-low sidelobes. The antenna was made with polymer aerogel as a substrate to both reduce weight and improve performance, as demonstrated in an Aero Seedling. In addition, designing the antennas to be conformal to the aircraft fuselage will reduce drag.



Challenge: Use phase array antenna beamforming to help mitigate ground station interference for ITU compliance

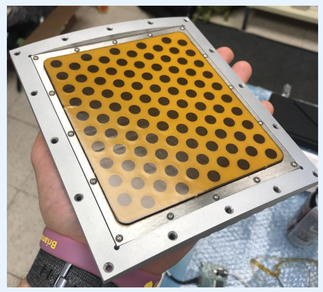


Challenge: Fabricate a tightly integrated antenna system using an ultra-lightweight flexible substrate

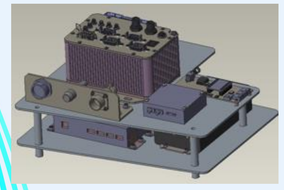
Goal: Advance antenna technology using aerogel substrate to reduce SWaP (size weight and power) for UAV SatComm

Feasibility Assessment / Benefit if Feasible

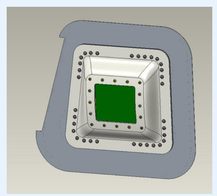
- Antenna performance and flight requirements/feasibility defined
- Demonstration of conformable aerogel (1 m bend radius in 1 cm thick substrate/no need to mold to net shape
- Demonstration of high directivity antenna array and beam steering capabilities in lab environment/25-30 dB reduction exceeding acceptable level of interference in controlled environment
- Demonstration of 20 dB sidelobe reduction from standard parabolic dish antenna in flight test/meets requirements for reducing interference with fixed service ground stations



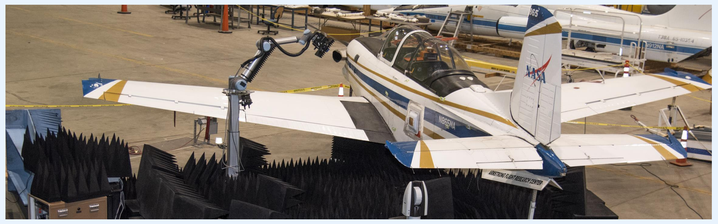
Conformal phased array antenna



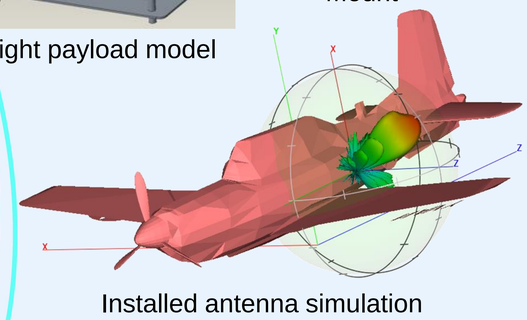
Flight payload model



Flight Antenna Mount



Ground based antenna characterization



Installed antenna simulation

In flight antenna characterization

Partners

- LMN/GRC: (Aerogel synthesis and characterization) Mary Ann Meador (PI), Stephanie Vivod, Rocco Viggiano, Baochau Nguyen, Linda McCorkle, Jessica Cashman; Haiquan Guo
- LCA/GRC: (ITU guru) Robert Kerczewski
- LCF/GRC: (Antenna design, fabrication and testing) James Downey (co-PI), Bushara Dosa
- LCN/GRC: Bryan Schoenholz, Marie Piasecki, Peter Slater
- LaRC: (Design and trade-off studies on aero-dynamics, structural, mass saving, robustness) Scott Kenner, Anne Mackenzie, Mark Cagle, Ray Rhew, Jeremy Smith
- AFRC: (Integration, ground test and flight test of concept design on the Ikhana UAS) Andy Gutierrez, Patricia Martinez, Ricardo Arteaga, Kelly Snapp, Kelly Snap, Thomas Matthews, Mirela Isic, Debra Randall, Scott Howe, Marc Nicholson, Greg Strombo, Ben Pearsen, Dale Hogg
- ARC: (Flight test simulations) Richard Alena, Aaron Cohen, Sasha Weston, Needa Lin

Status

- Flexible polyimide aerogels successfully integrated in antenna
- Interference mitigation techniques successfully demonstrated in antenna test facilities
- Portable Laser Guided Robotic Metrology System successfully deployed for in-situ antenna measurements at both GRC and AFRC
- Antenna and support payload successfully integrated onto an AFRC T34-C aircraft
- Successful in flight antenna characterization completed at AFRC in June 2019
- Positive feedback given by Independent Review Panel following Step 1 Feasibility Assessment

Next steps

- Step 2 Feasibility Assessment to CAS management on11/7/19
- Final closeout report due 12/30/19
- Transition to follow-on project ADaPT (Antenna Deployment and oPtimization Technologies)

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