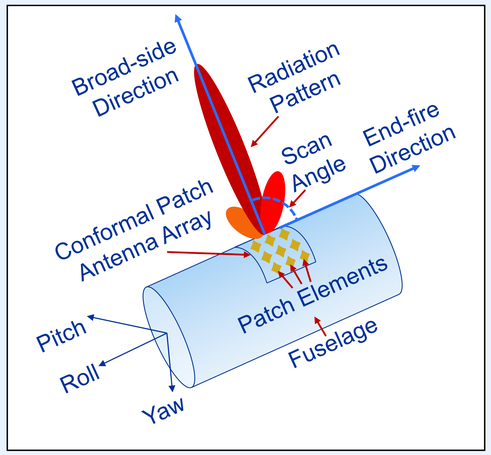
CLAS-ACT

Conformal Lightweight Antenna Structures for Aeronautical Communication Technologies

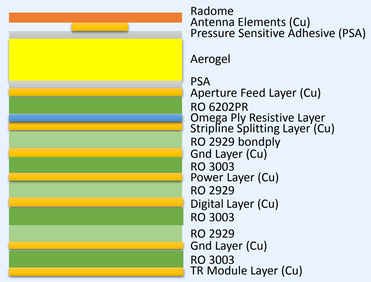
National Aeronautics and Space Administration

Overview/Description

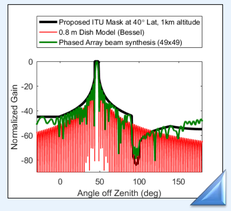
This project is to develop antennas which enable beyond line of sight (BLOS) command and control for UAVs. We will take advantage of newly assigned provisional Ku-band spectrum for UAVs and use unique antenna designs to avoid interference with ground systems. This will involve designing antennas with high isotropic effective radiated power (EIRP) and ultra-low sidelobes. The antennas will be 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.



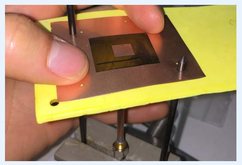
Notional conformal microwave antenna with high EIRP



Notional antenna design (not to scale)

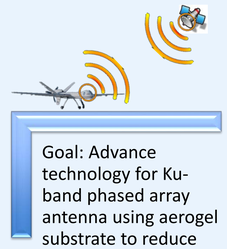


Challenge: Use phase array antenna beamforming to help mitigate ground station interference for ITU compliance

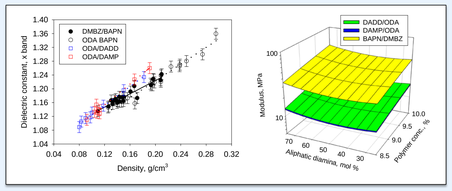


Single element antenna

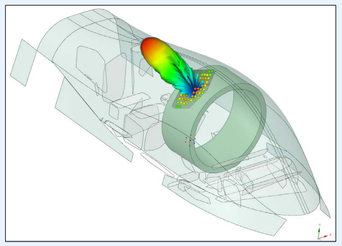
Challenge: Fabricate a tightly integrated antenna system using an ultra-lightweight flexible substrate



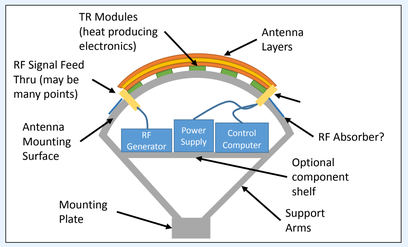
Goal: Advance technology for Ku-band phased array antenna using aerogel substrate to reduce SWaP (size weight and power) for UAV SatComm



Optimization of aerogel properties



Possible configurations for flight test of partial antenna array



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

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), Bryan Schoenholz, Marie Piasecki, Bushara Dosa, 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, Bill Fredericks
- AFRC: (Integration, ground test and flight test of concept design on the Ikhana UAS) Andy Gutierrez, Patricia Martinez, Ricardo Arteaga, Kelly Snapp,
- ARC: (Flight test simulations) Richard Alena, Aaron Cohen,

Status

- Polyimide aerogels with higher bendability at 2-3 mm thickness demonstrated
- Antenna Element/Subarray designed and simulated
- Fabricated single element antenna with aerogel and conventional substrate
- Performed beam steering in antenna range with T/R modules and conventional substrate
- Far/near field scanner designed for hangar test of antennas on Ikhana
- Models built to simulate performance of full size array on curved surface
- Flight simulation of aircraft to ground interference

Next steps

- Multilayer sandwich fabrication of full subarray prototype antenna
- Design and fabrication of antenna support structure and control systems to enable flight test
- Fabrication and testing of antennas with high EIRP and ultra-low sidelobes in lab environment
- Flight test to demonstrate 20 dB reduction in antenna sidelobes

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