The Advanced Radar Research Center at the University of Oklahoma

Applications of UAS Related to Radar

Robert D. Palmer

Executive Director, Advanced Radar Research Center
Associate Vice President for Research
Tommy C. Craighead Chair & Professor, School of Meteorology
Adjunct Professor, School of Electrical and Computer Engineering
Scientific Fellow, National Severe Storms Laboratory, NOAA

GeoFence Surveillance Radar Development

Mark E. Weber[1], Mark Yeary[2,3], Phil Chilson[2,4,5], Robert Palmer[2,4]

[1]NOAA OAR National Severe Storms Laboratory (NSSL)
Cooperative Institute for Meteorological Studies (CIMMS), University of Oklahoma
[2]Advanced Radar Research Center (ARRC), University of Oklahoma
[3]School of Electrical & Computer Engineering (ECE), University of Oklahoma
[4]School of Meteorology (SoM), University of Oklahoma
[5]Center for Autonomous Sensing and Sampling (CASS), University of Oklahoma

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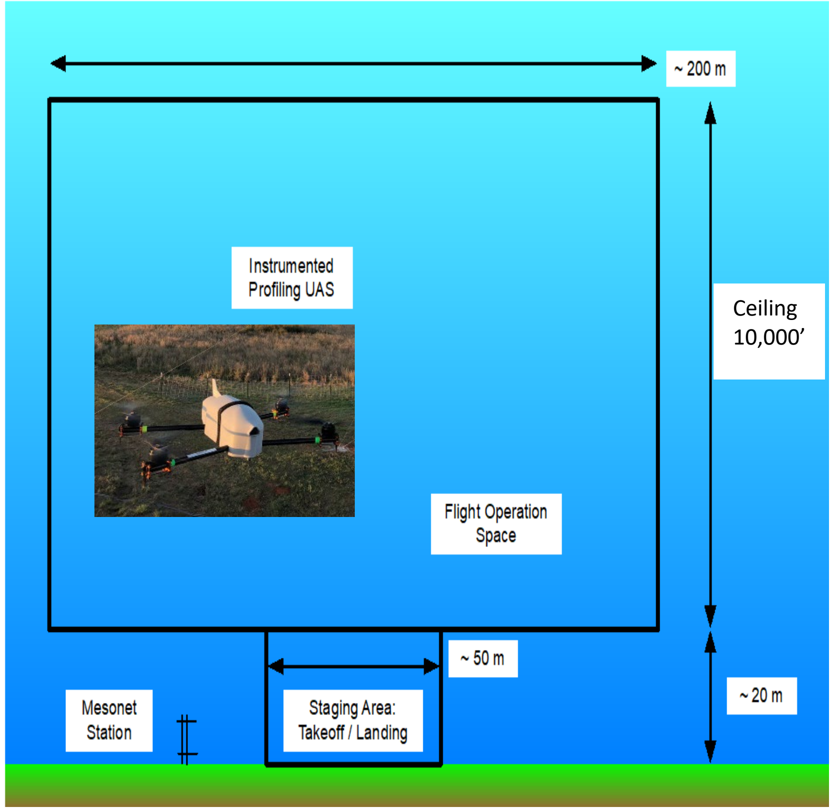
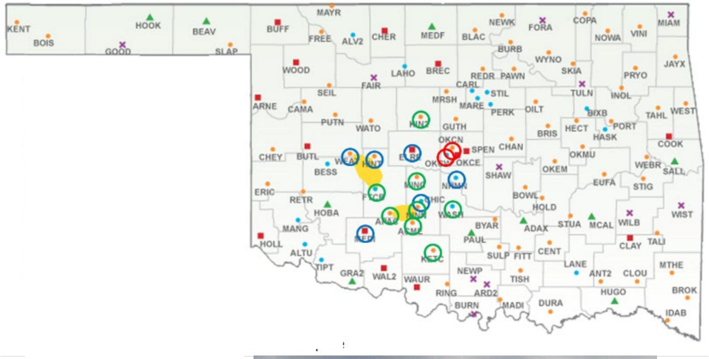
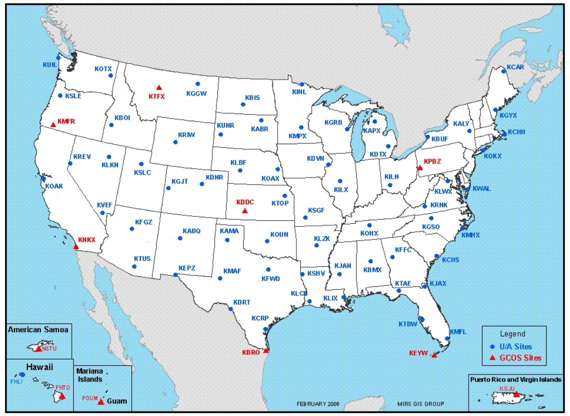
Crawl, Walk, Run Strategy





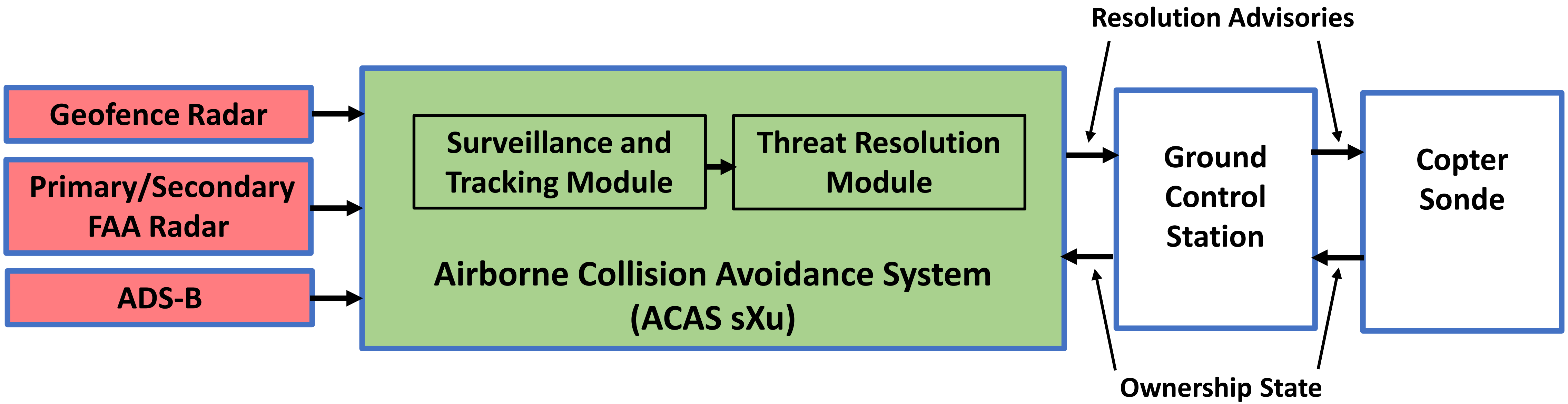


1) "CopterSonde" soundings to 10,000' at Kessler Atmospheric and Ecological Field Site, piloted from OU's National Weather Center

2) Oklahoma 3D-Mesonet (120 stations)

3) Complement to National Rawindsonde Network

Detect and Avoid (DAA) System Architecture

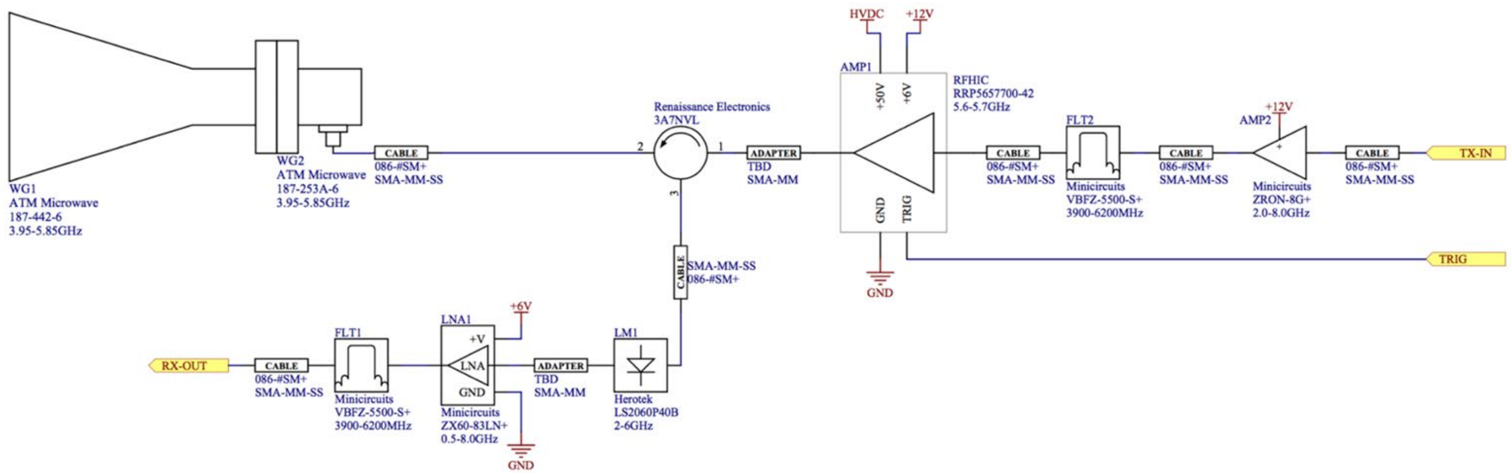


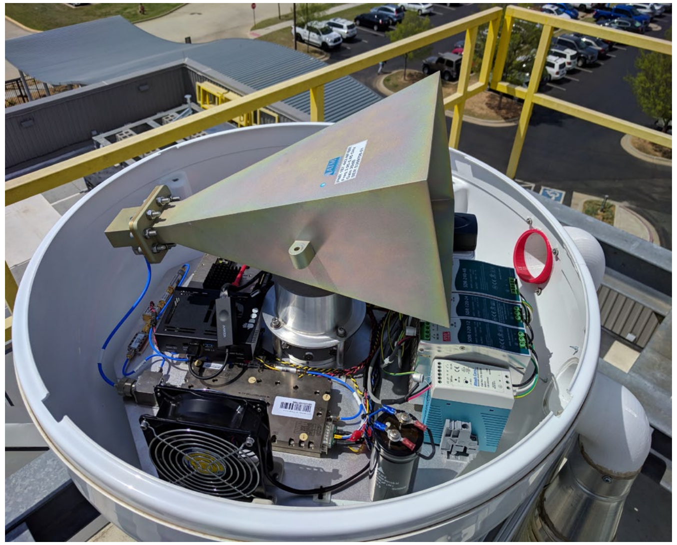
Surveillance

Maneuver Algorithms (MIT/LL)

sUAS-Sounder Control

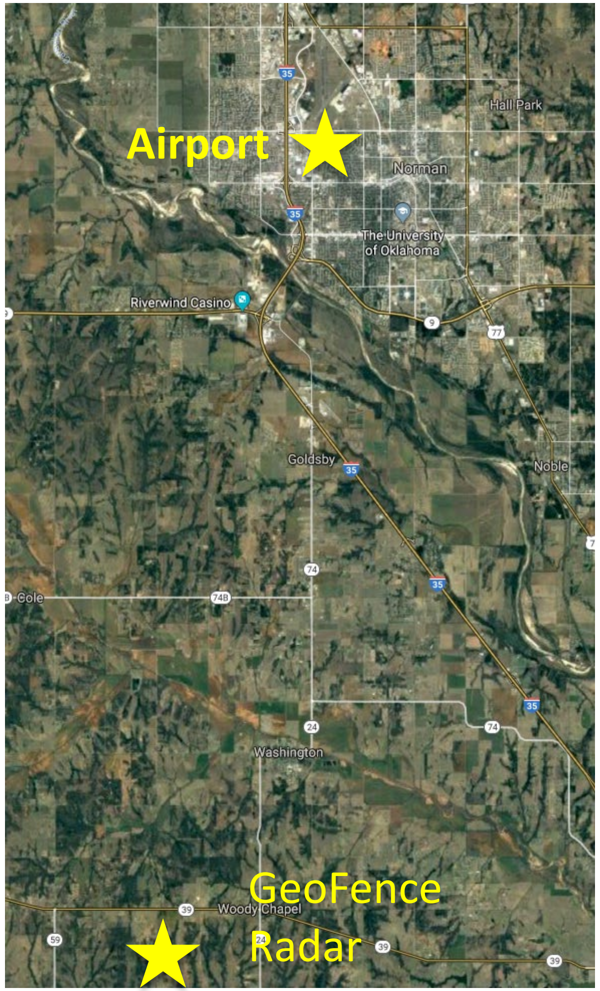
Geofence Radar: Rev 1.0

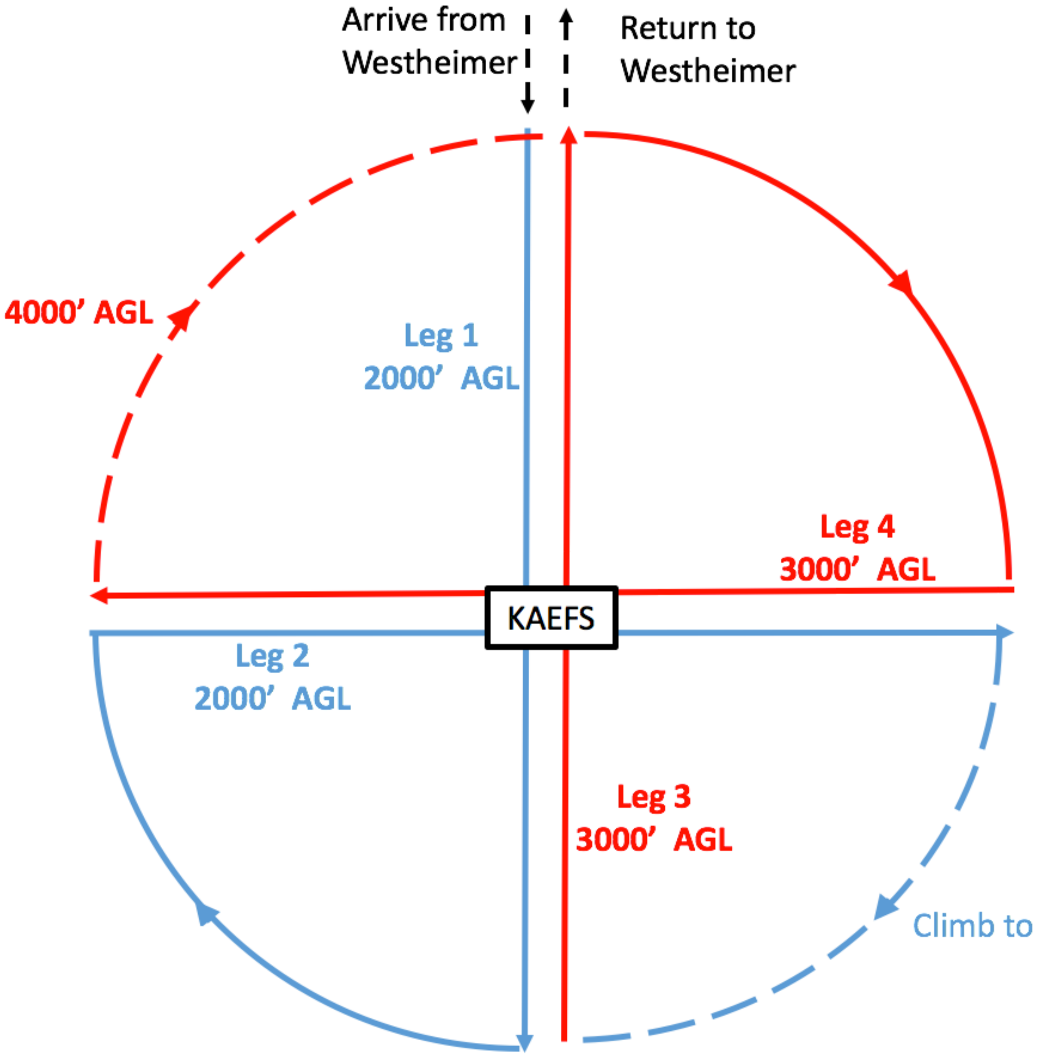




- Low-cost
- Leverage existing ARRC transceiver/software
- C-band provided low-cost transmitter
- Detection w/comms to ground station

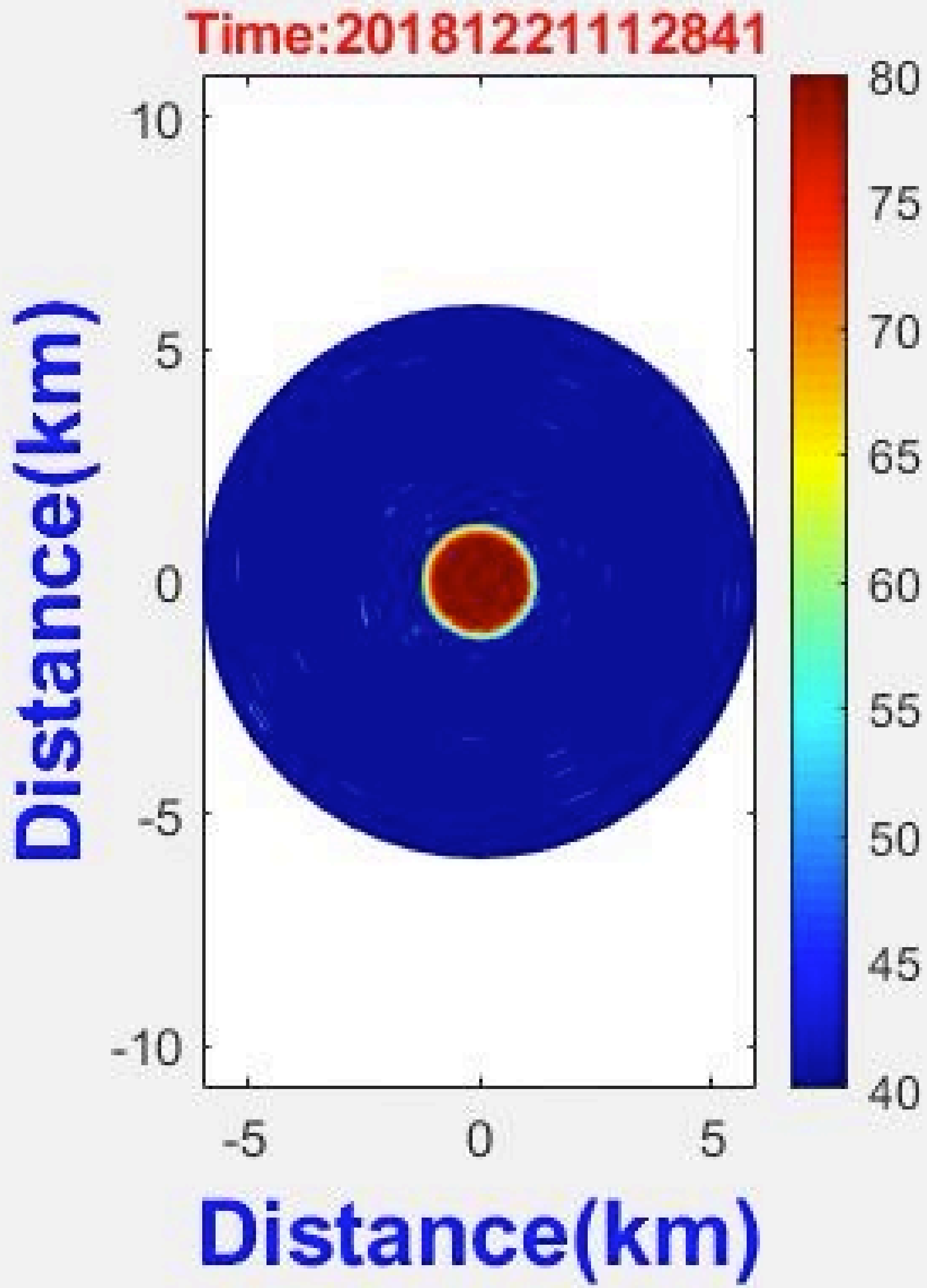
Rev 1.0 – Flight Pattern, Fall 2018





- Working with OU's Department of Aviation
- OU's Kessler Atmospheric and Ecological Field Station (KAEFS) provided the ideal venue to deploy the GeoFence radar
- KAEFS is ~20 km south of OU's main campus

Results, Fall 2018

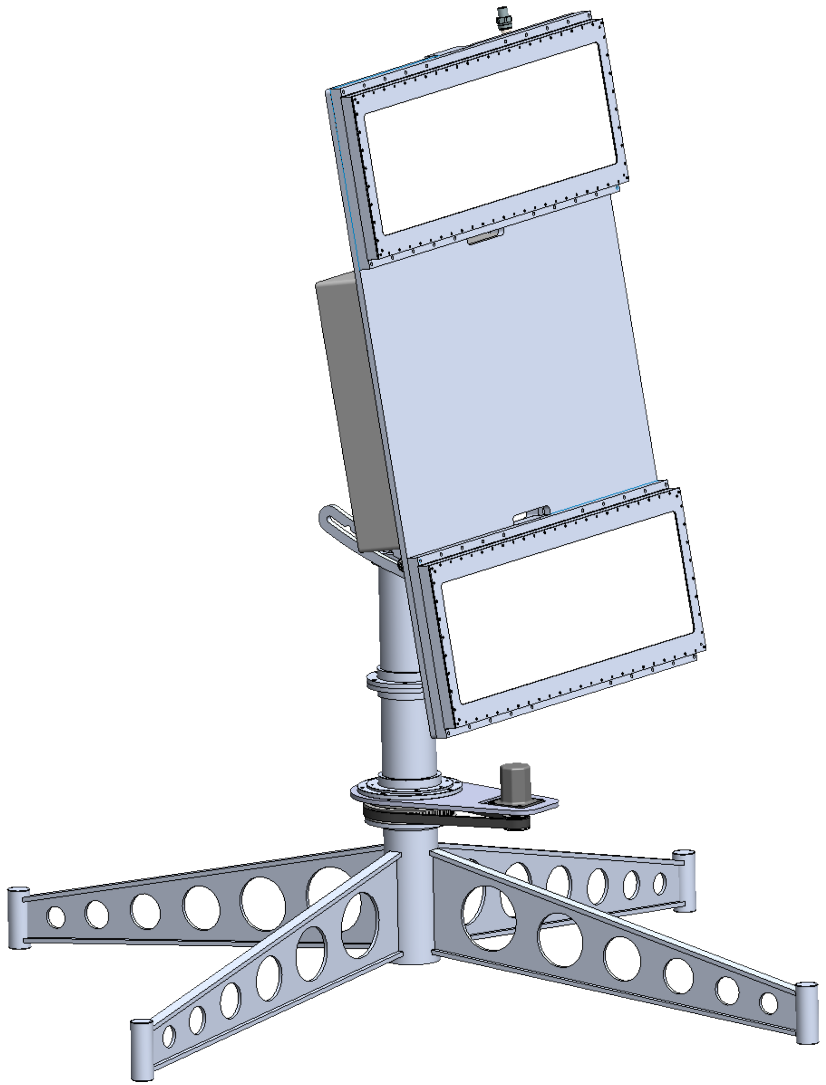


Rev 2.0: X-Band GeoFence

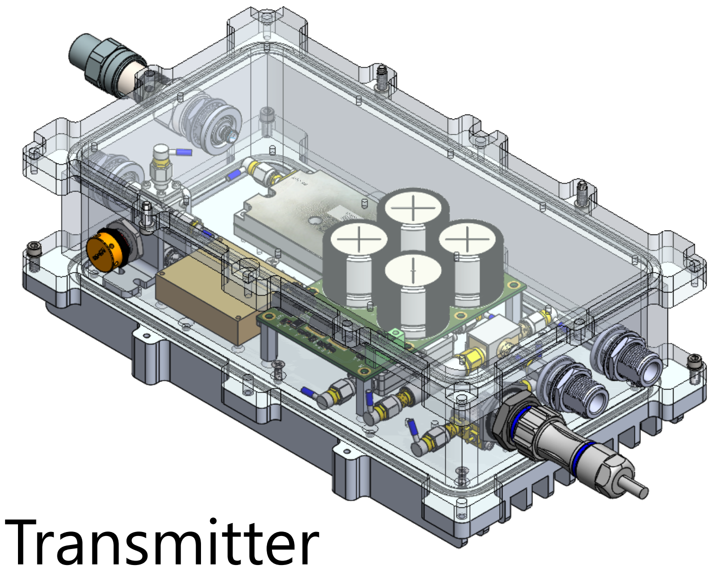
- To tighten the beamwidth, while keeping a reasonable antenna size, the operating frequency was changed to X-band.

- Rev 2.0's improvements include: bifurcated antenna solves blind-zone, better slip ring was incorporated, bulky radome eliminated, etc.

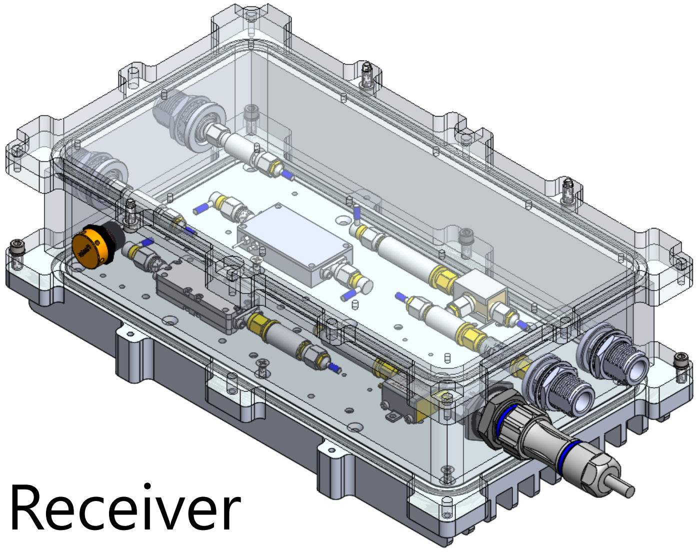
- Detailed design was completed in the spring of 2019. Build and test will be completed in the fall of 2019.



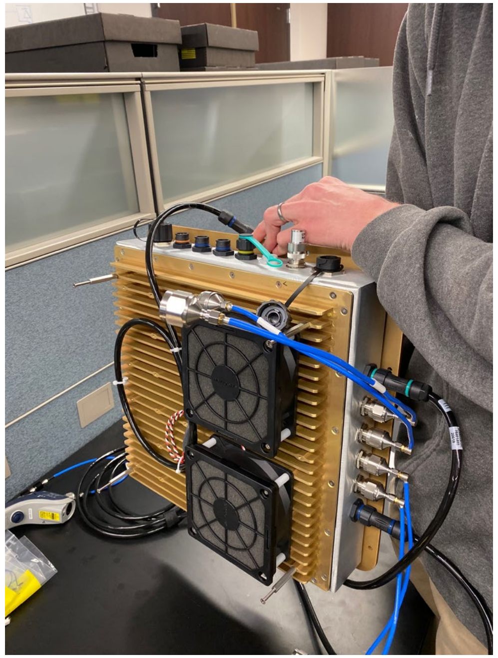
Completed X-band Electronics

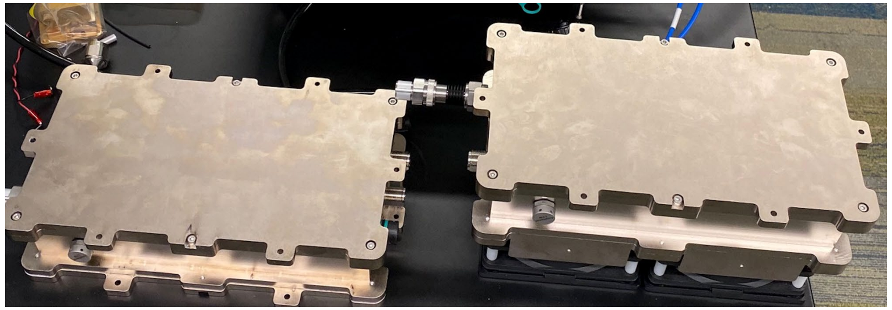


Transmitter



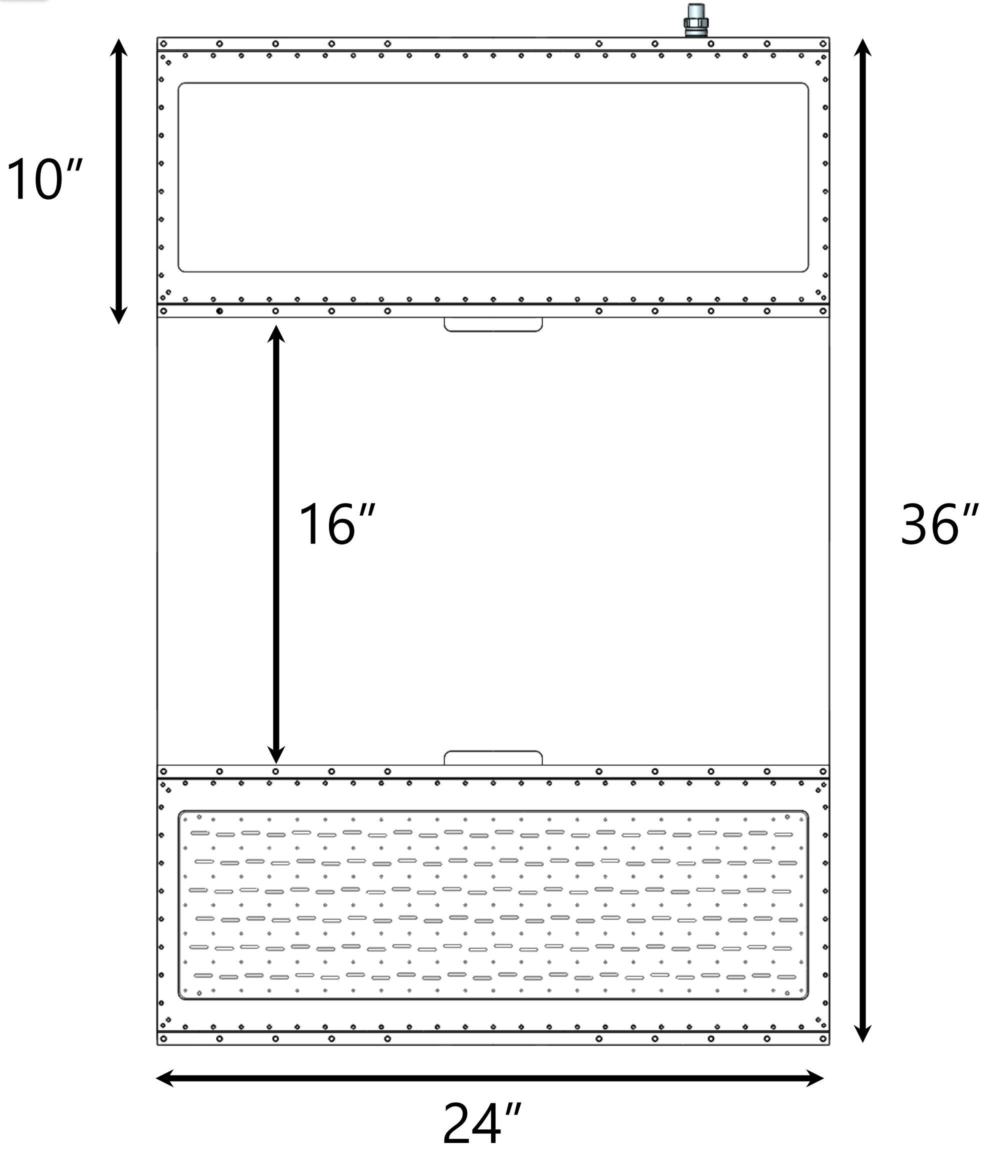
Receiver

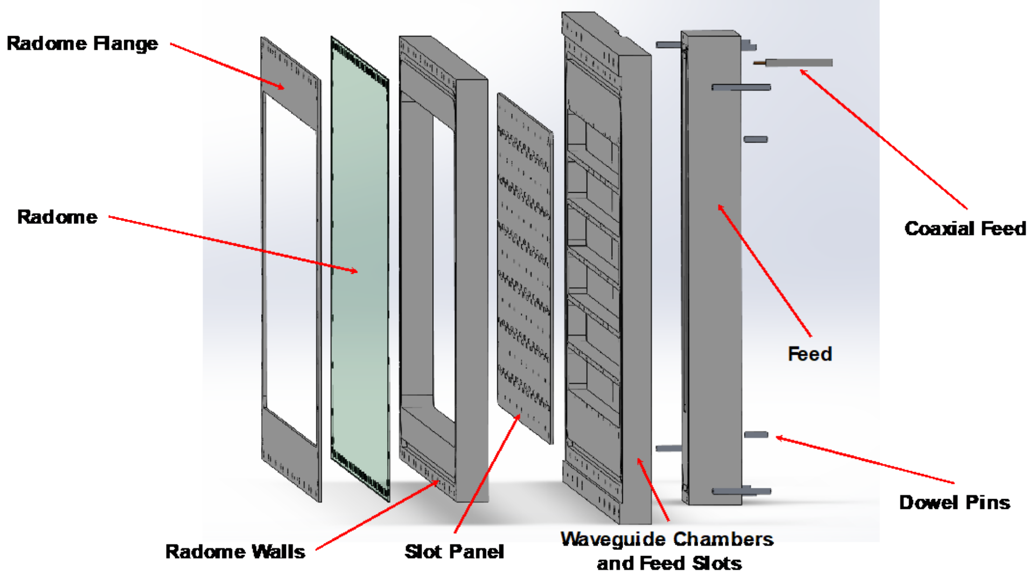




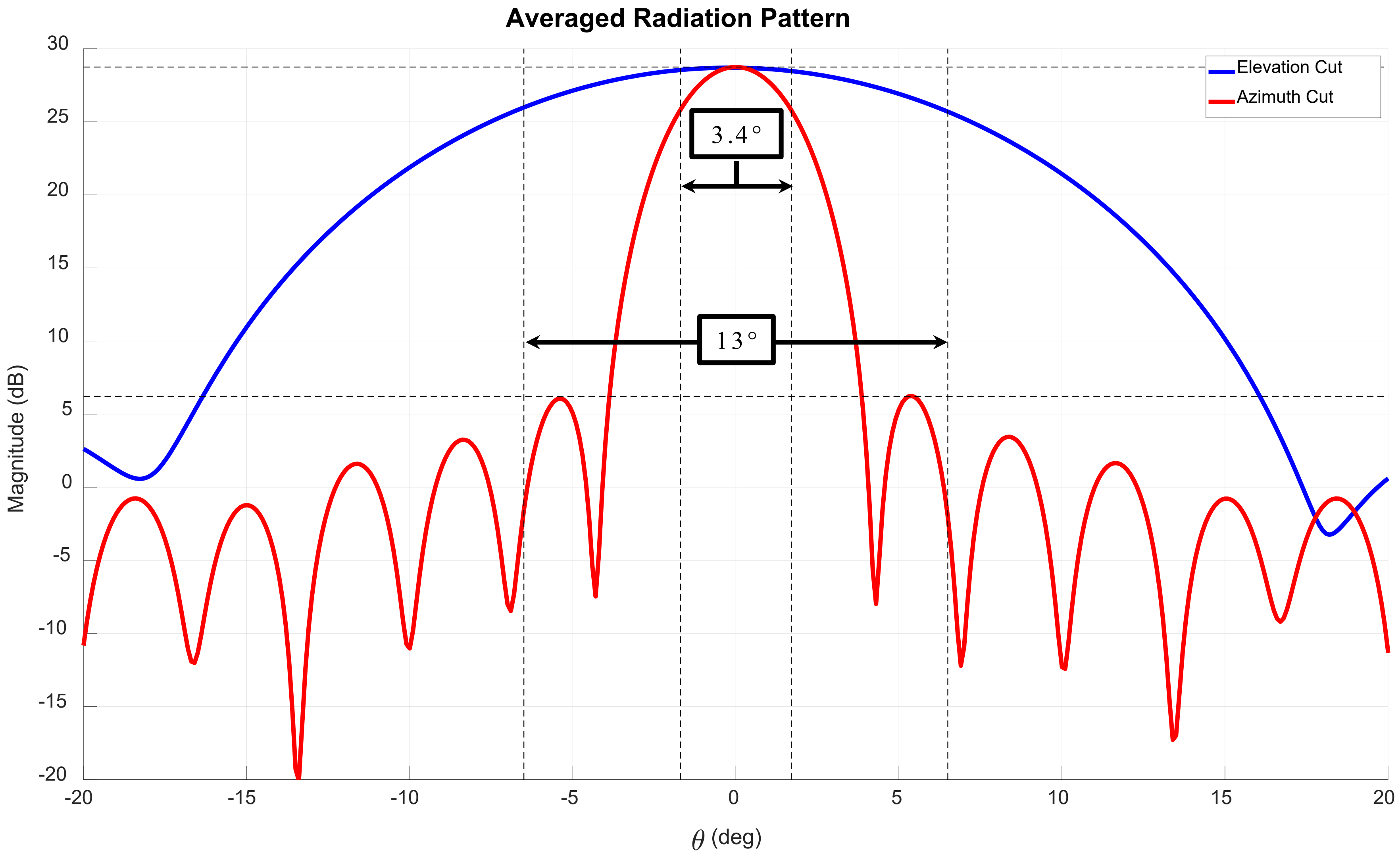
Completed and Tested

Tapered Slotted Waveguide Antenna

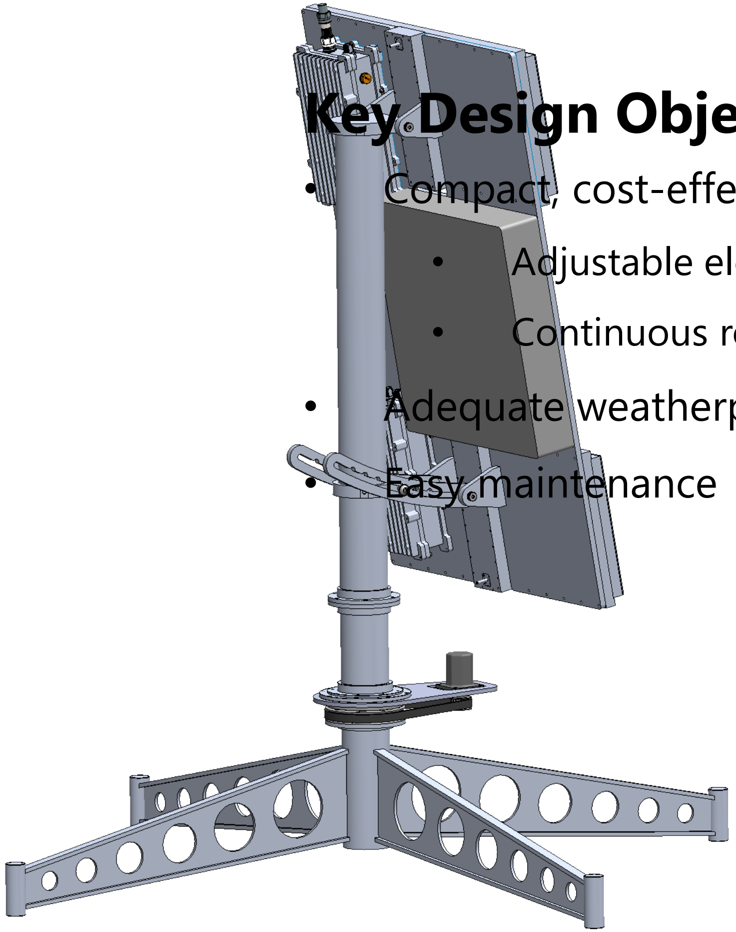




Expected Antenna Performance

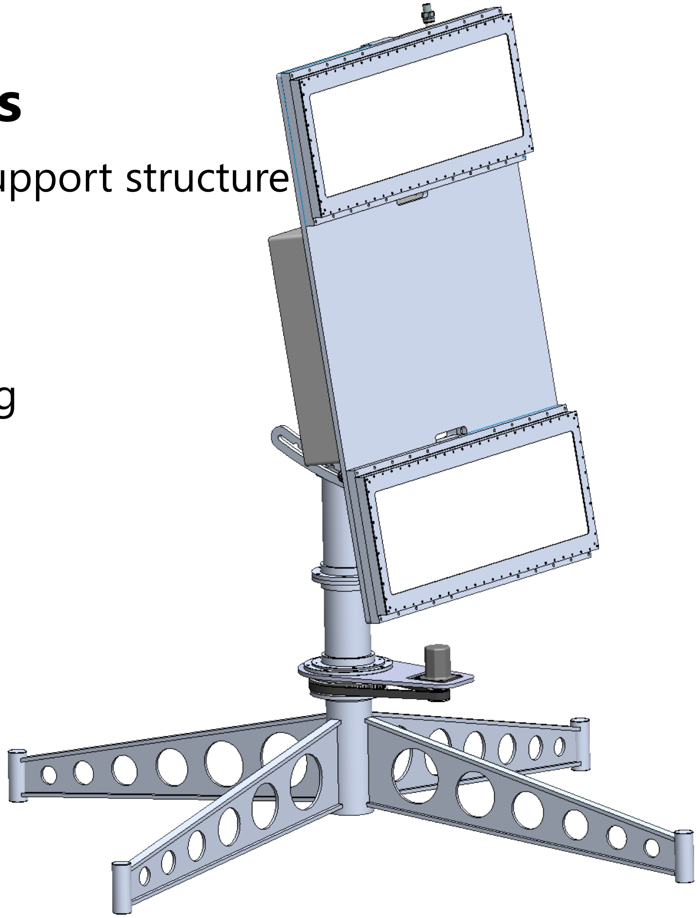


Geofence X-Band Mechanical

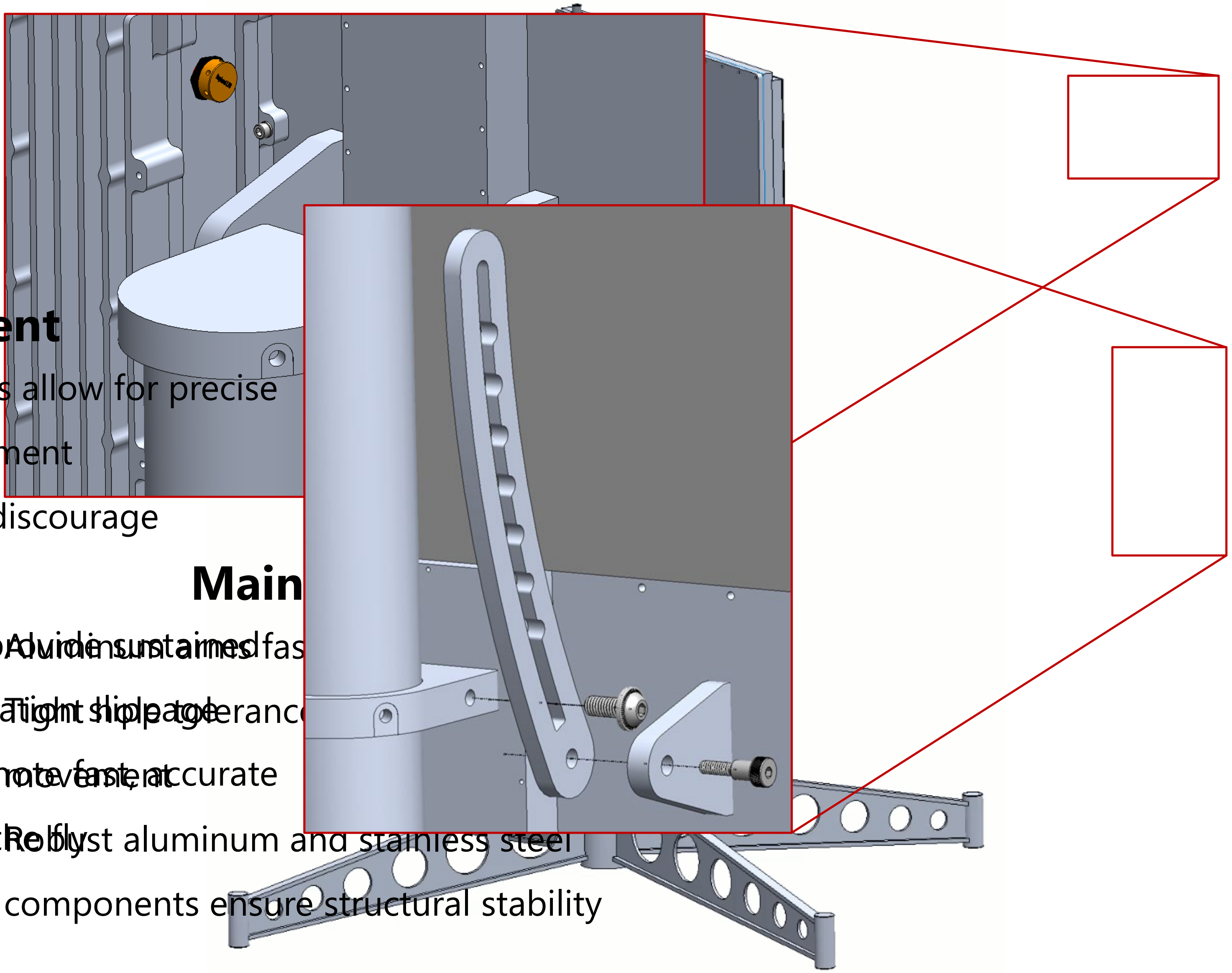


Key Design Objectives

- Compact, cost-effective support structure
  - Adjustable elevation
  - Continuous rotation
- Adequate weatherproofing
- Easy maintenance



Geofence X-Band Support Structure



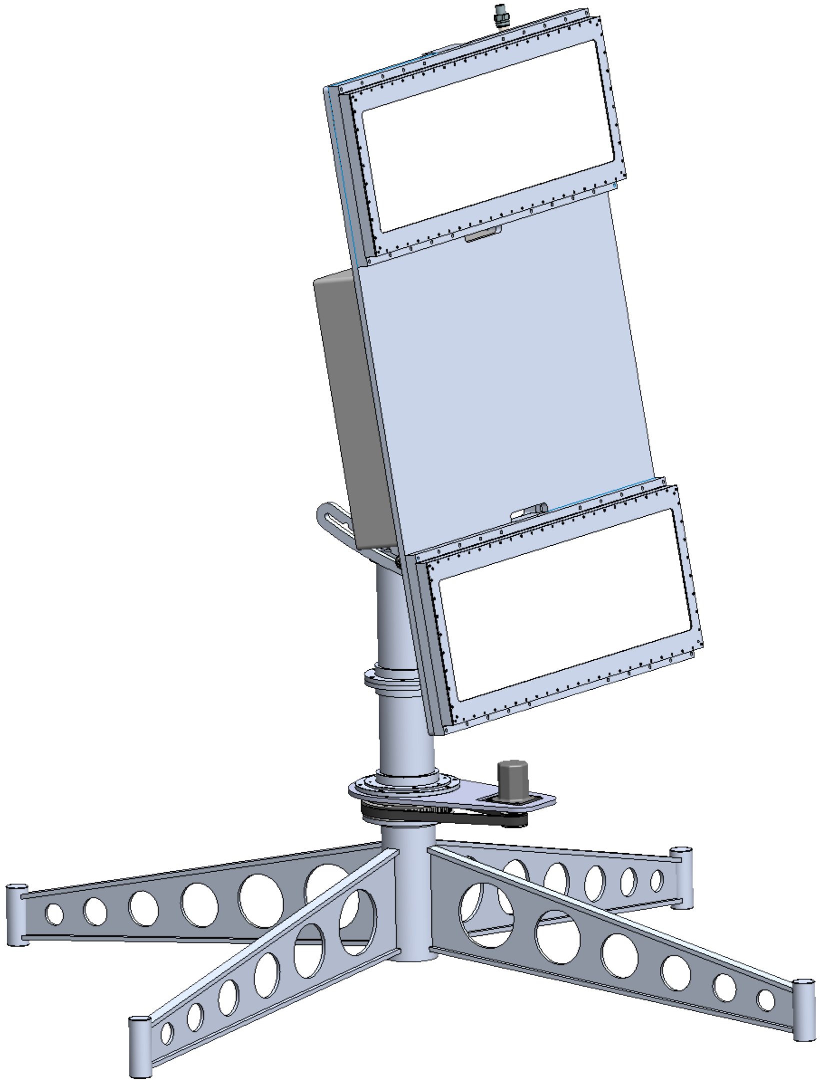
Elevation Adjustment

- Sturdy aluminum slides allow for precise elevation angle adjustment
- Tight hole tolerances discourage unwanted movement
- Wedge-lock washers provide sustained clamping to resist elevation slippage
- Optional notches promote fast, accurate elevation changes on the fly

Main

- Aluminum arms fas
- Tight hole toleranc movement
- Robust aluminum and stainless steel components ensure structural stability

Expected Project Outcomes



- Demonstrate **prototype DAA system** and provide design documentation and test data
- **Extend KAEFS sUAS Certificate of Operations** (COA) to allow remote operations from National Weather Center and increase sounding ceiling to 3 km AGL
- Design data, performance analysis provides foundation for FAA authorization for **future regional or national UAS profiling networks**

UAV-Based Radar Test and Calibration

Jorge L. Salazar-Cerreno, Arturo Umeyama, Brent Wolf, Anthony Segales, Caleb Fulton

Advanced Radar Research Center (ARRC), University of Oklahoma
School of Electrical & Computer Engineering (ECE), University of Oklahoma
Center for Autonomous Sensing and Sampling (CASS), University of Oklahoma

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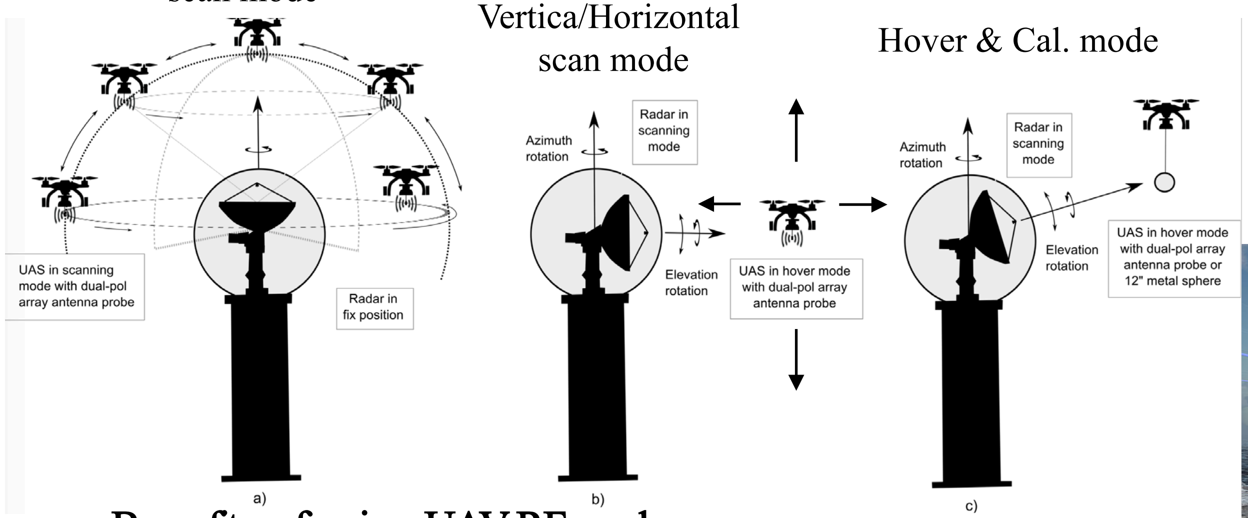
UAV Probe for Radar Test and Calibration

Enable in-situ test and characterization of a large radar platform including environmental factors such as, radome, neighbor radars, towers, lightning protection, ground reflections diffractions, and temperature.

Spherical/Cylindrical scan mode

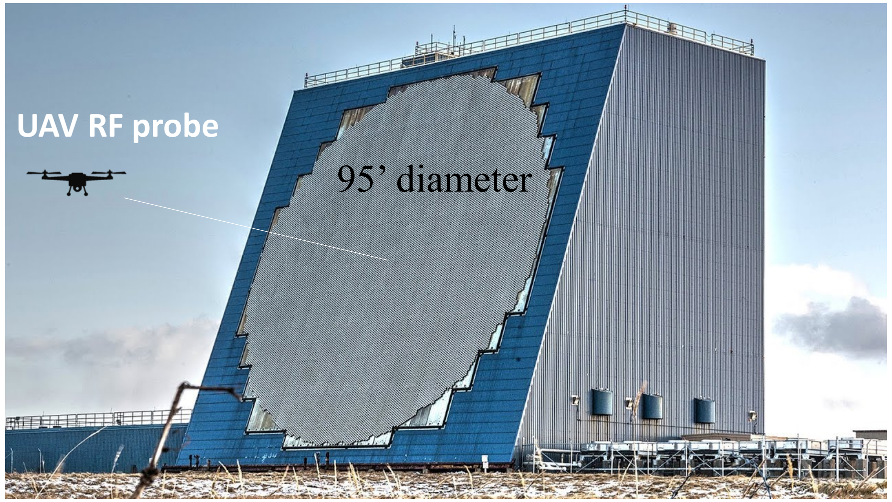
Vertica/Horizontal scan mode

Hover & Cal. mode



Benefits of using UAV RF probe

- Easy to deploy
- Low O&M cost
- Enable different test modes (Radar cal. pattern test, and radome inspection, etc.)

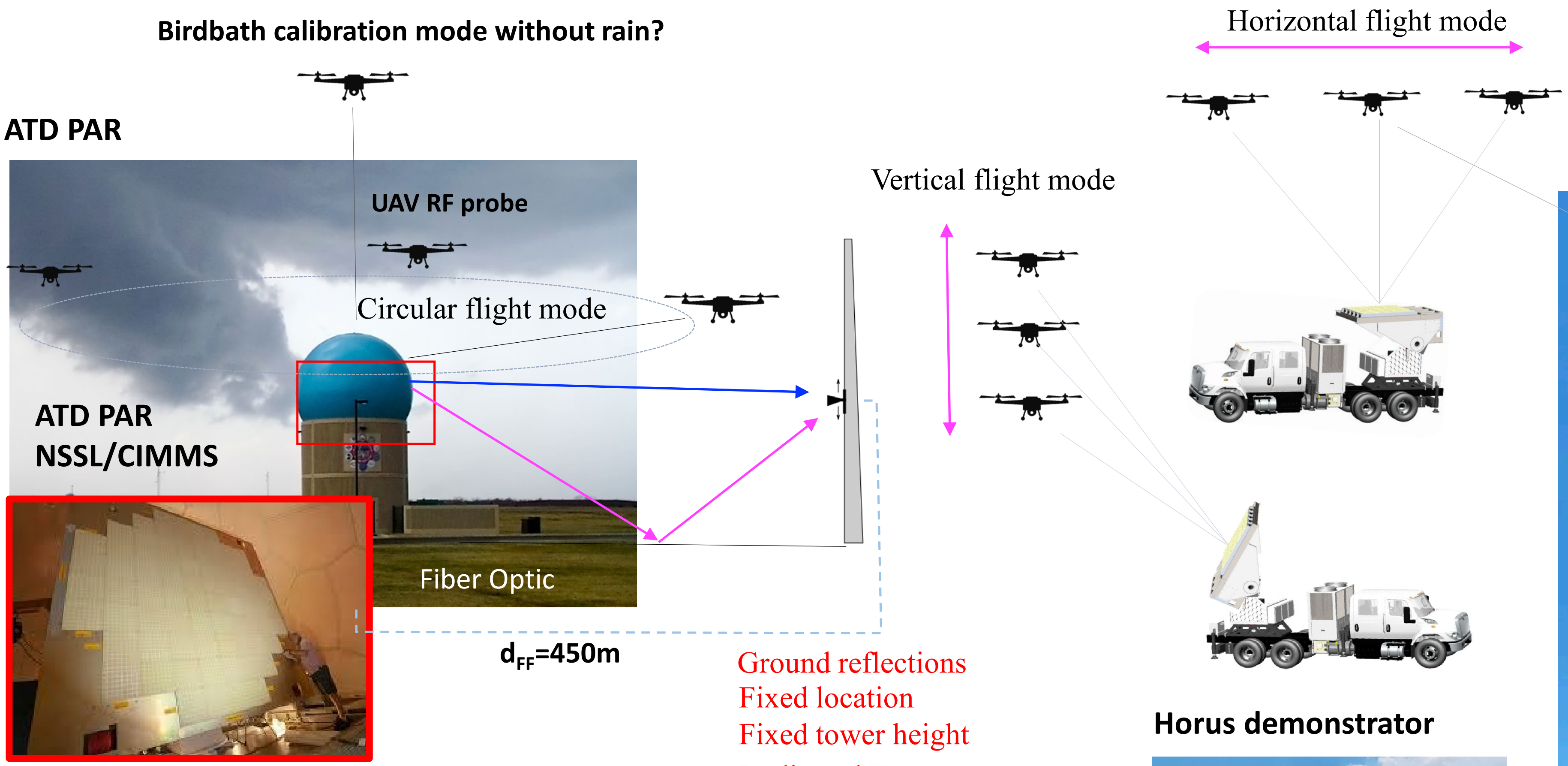


The COBRA DANE an L-band PAR located at Shemya, Alaska

USS Navy Carrier

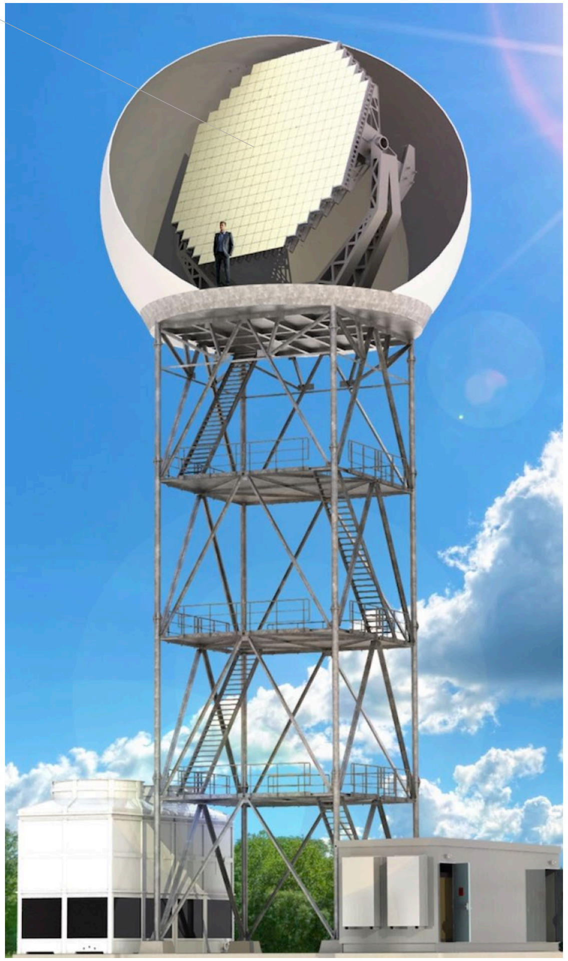
Raytheon AN/TPY-2 X-Band radars

ARRC UAV RF Probe for PAR Radars



Horus demonstrator

FF Pattern Test/Calibration



Benefits of using UAV RF probe

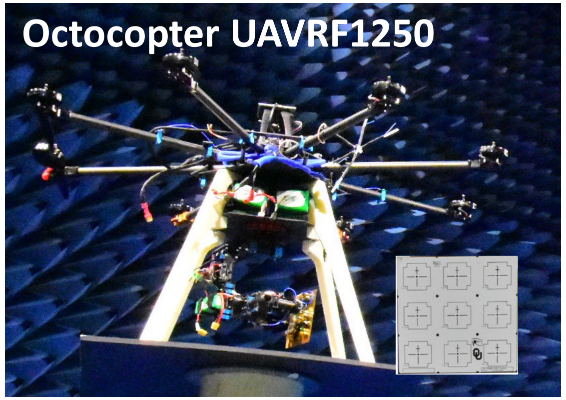
- Easy to deploy (any time and any place)
- No tower is require, low O&M cost
- Enable different test modes (Radar cal. Pattern test, and radome inspection

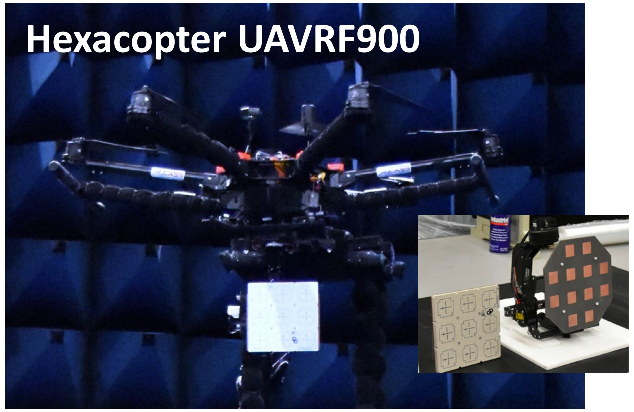
ARRC UAV Development Timeline

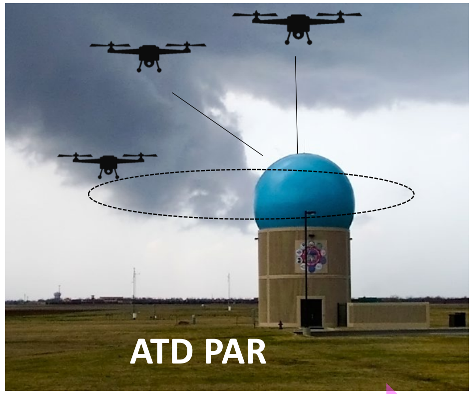
DJI Phantom 3

RD100

- Limited platforms
- Simple antenna

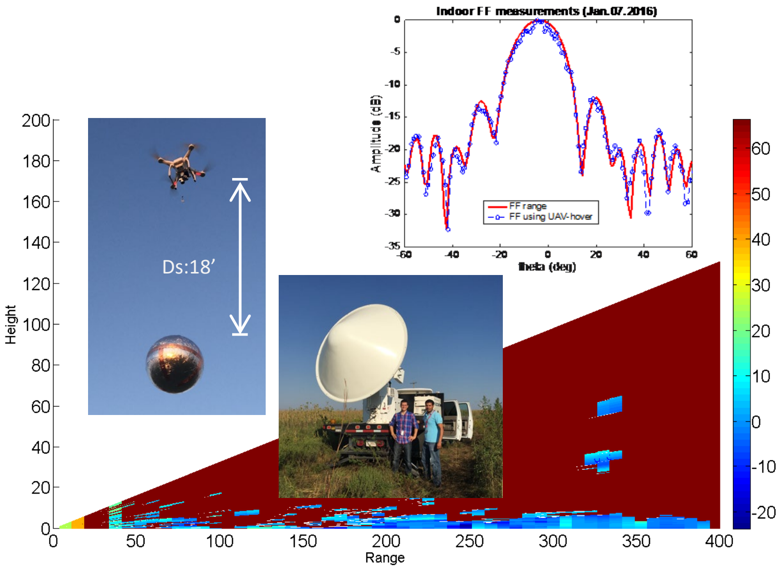






2016 | 2017 | 2018 | 2019 | 2019 -2020

PROOF OF CONCEPT USING COMMERCIAL PLATFORMS	PROOF OF CONCEPT USING CUSTOMIZED UAV	DEVELOPMENT OF HIGH-PERFORMANCE UAV PLATFORM	FIELD TEST & VALIDATION



- Octocopter UAVRF1250
- Flight time ~30 min
- Size: 1.25
- Propeller size: 18”x5.2”
- Position accuracy <7cm
- D-GPS, PPK
- Landing gear: Fix (no retractable)
- Antenna: 3x3 array with separate corporate feed
- X-Pol: : -30 dB (broads), -20 dB (20 deg)

- Hexacopter UAVRF900
- Flight time ~18-20 min
- Size: 0.89m
- Propeller size: 15”x5.2”
- Position accuracy <4 cm
- D-GPS, PPK/RTK
- Landing gear: Fix (no retractable)
- Antenna: 4x4 array with separate corporate feed
- X-Pol: : -40 dB (broads), -30 dB (20 deg)

- RF test at the indoor chambers (NF &FF)
- Single Polarization antenna pattern test
- Dual-pol CPPAR patterns test
- Dual-pol ATD patterns test
- PX1000 radar calibration
- Horus & PAIR patterns and radar characterization

Thank You

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