

Department of Electrical, Computer,
Software and Systems Engineering



Development of a Wireless Avionics Intra-Aircraft Communication Testbed for Electromagnetic Radiation Measurements

Eduardo Rojas-Nastrucci, Daniel Sommer, and Sarath Irigireddy.

Embry-Riddle Aeronautical University, Daytona Beach, FL, 32114. E-mail:

rojase1@erau.edu

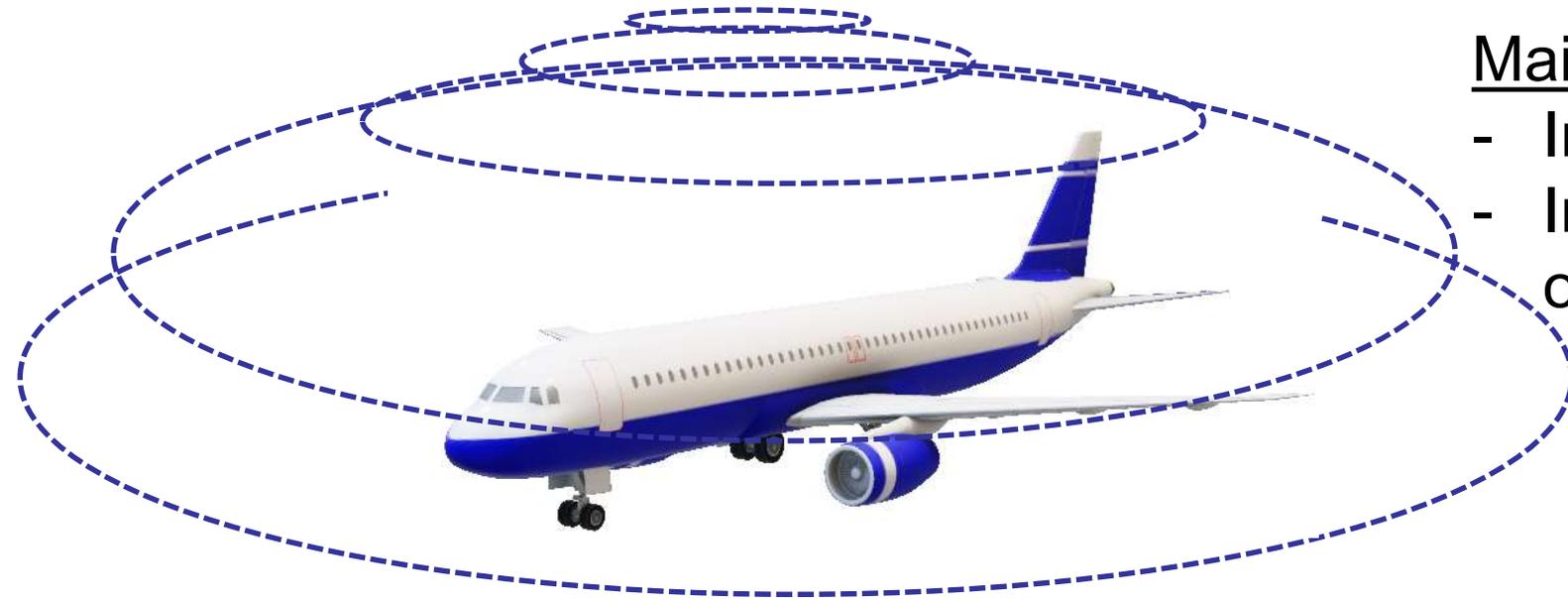
Wireless Devices and Electromagnetics Laboratory

www.wide.lab.com

Motivation and Prior Art

Update from RTCA SC-236 – PWST 2018

Wireless Avionics Intra-Communications (4.2 – 4.4 GHz)



Main challenges WAIC:

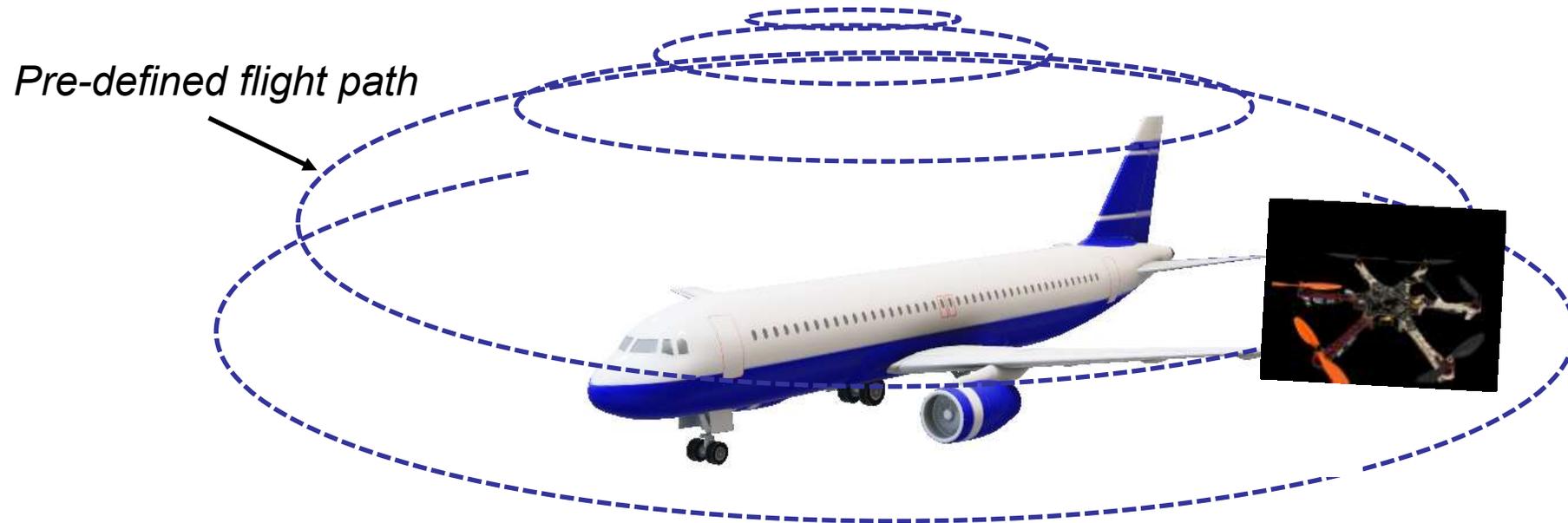
- Interference with Radio Altimeter.
- Interference with other aircraft while on the ground.
 - Coexistence with the radio altimeter.

RTCA community: power measurement over a hemisphere around the

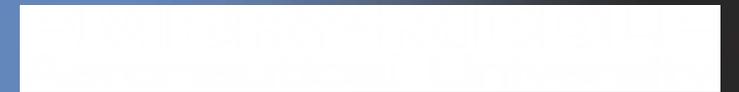


Motivation and Prior Art

Proposed Solutions: UAV- and SDR-Based Electromagnetic Radiation Measurement



To measure the WAIC system radiation characteristic using an unmanned aerial vehicle (UAV) that performs a predefined flight path while capturing the radiated fields from the WAIC device.



Prior Art

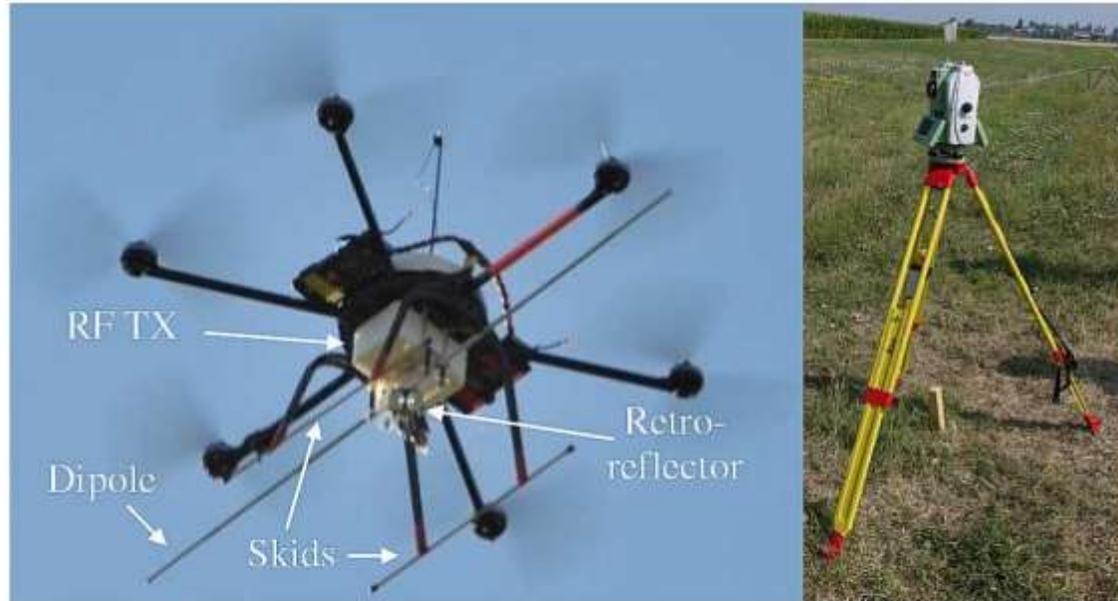


Fig. 1. (left) Flying hexacopter equipped with RF transmitter, telescopic dipole, and optical retroreflector; the overall size is about 72 cm. (right) Motorized total station on the tripod.

G. Virone et al., "Antenna Pattern Verification System Based on a Micro Unmanned Aerial Vehicle (UAV)," in IEEE Antennas and Wireless Propagation Letters, vol. 13, pp. 169-172, 2014.

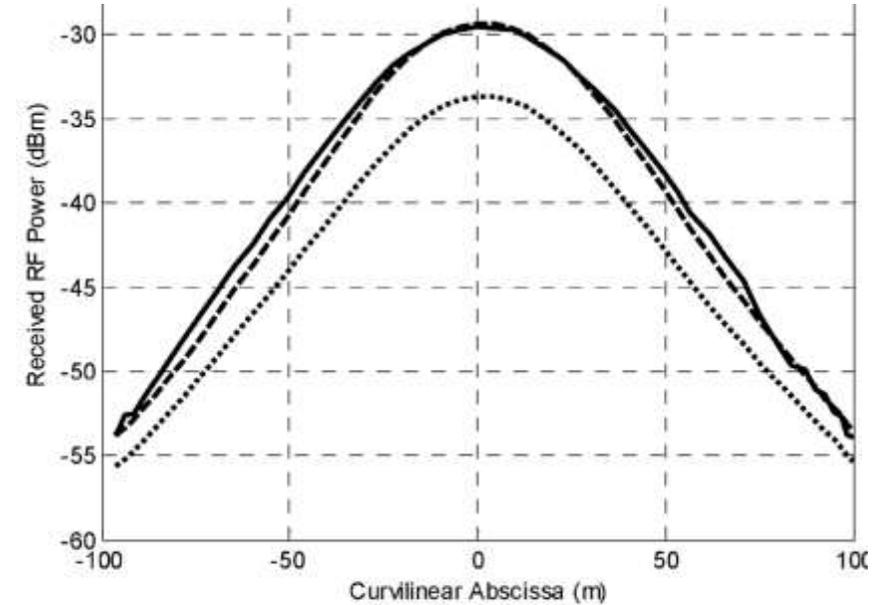


Fig. 5. Received power pattern for quasi- E -plane scan of the biconical antenna at 150 MHz: measurement (solid); simulation with soil (dashed); simulation without soil (dotted).



Fig. 2. (left) Biconical antenna PMM BC-01 and (right) log-periodic antenna PMM LP-02 on the measurement field.

Prior Art

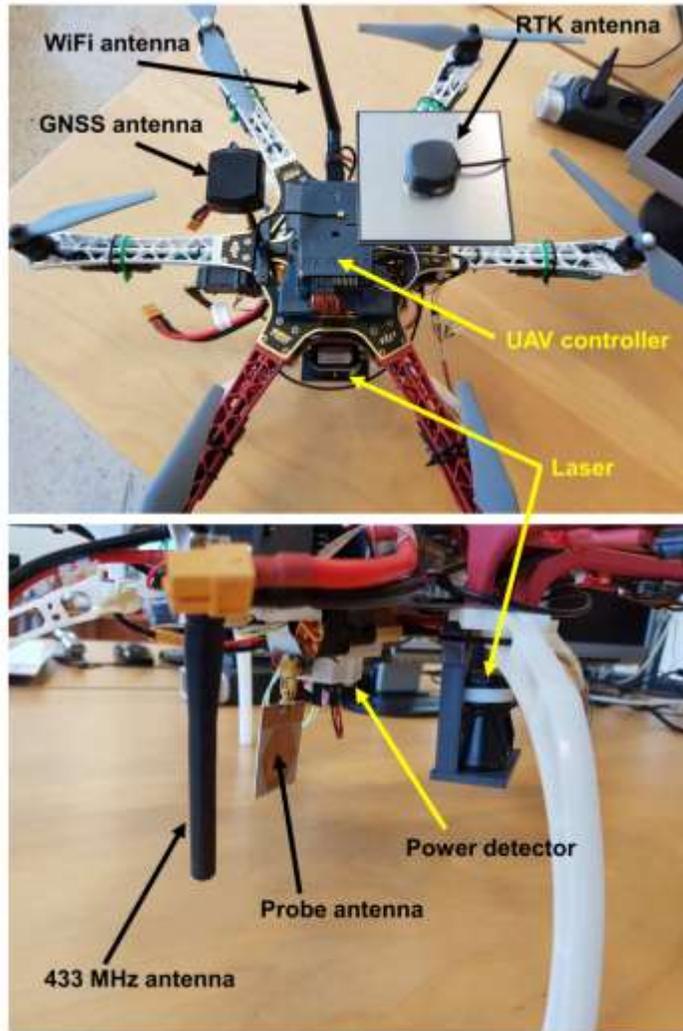


FIGURE 2. UAV with the RTK and the probe printed monopole antenna onboard.

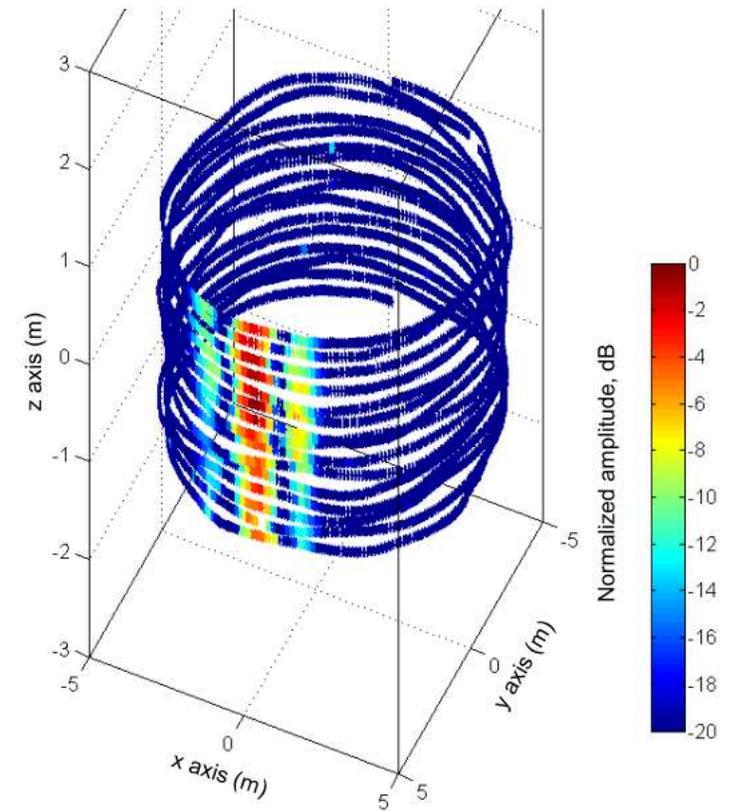


FIGURE 13. Measured amplitude of the NF radiated by the AUT at the UAV flight path positions. Targeted flight path: cylindrical domain of radius $R = 4.5$ m. $f = 2950$ MHz. Axes centered at the AUT position.

M. García-Fernández et al., "Antenna Diagnostics and Characterization Using Unmanned Aerial Vehicles," in IEEE Access, vol. 5, pp. 23563-23575, 2017.

Capabilities for WAIC

Testing

Gulfstream GIII and Learjet airplanes available for research. Devices can be installed for research purposes and they have radio altimeters installed.

Gulfstream GIII



Learjet



Rockwell Collins
Radio Altimeters



UAV platform main features:

- RF receiver in the 4.2-4.4 GHz frequency range.
- Autopilot for flying pre-defined path.
- Flight computer with accelerometers, gyroscopes, magnetometer, barometer, and LiDAR sensor.
- GNSS with 1 cm + 1 ppm accuracy with real-time kinematic compensation.
- 5 lb payload capacity, with 20+ min. of flight time.
- Radio altimeter receiver antenna attached to a gimbal for changing antenna direction.
- Telemetry data transmission up to 40 km.
- Measurement data transmission up to 15.5 km.

Sub-Systems:



UAV Platform: Frame, flight control, power.

Gimbal

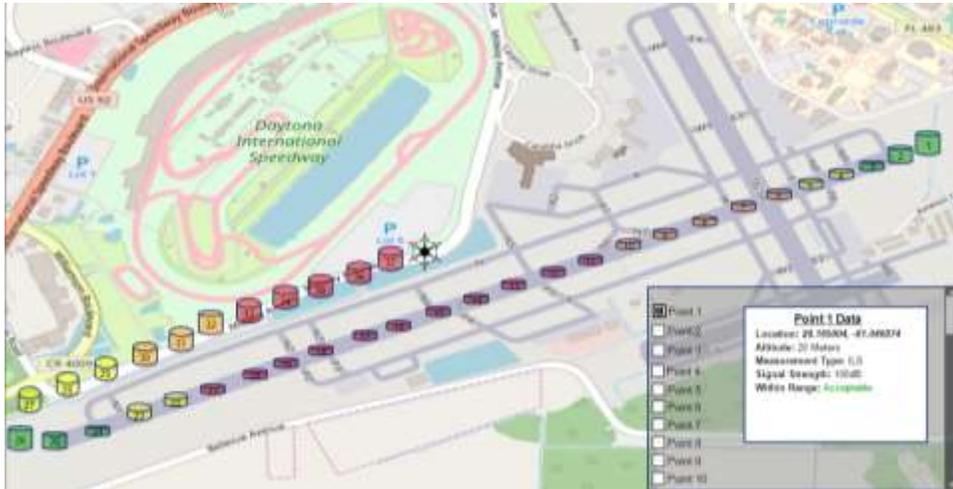
Data Processing and Communications

Software Define Radio (SDR) and Antenna

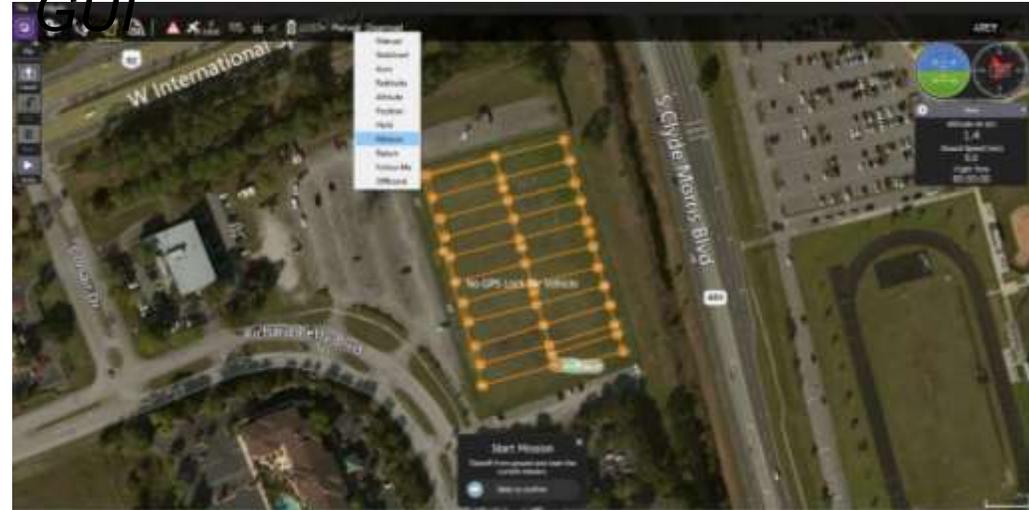
Sub-Systems:

Software:

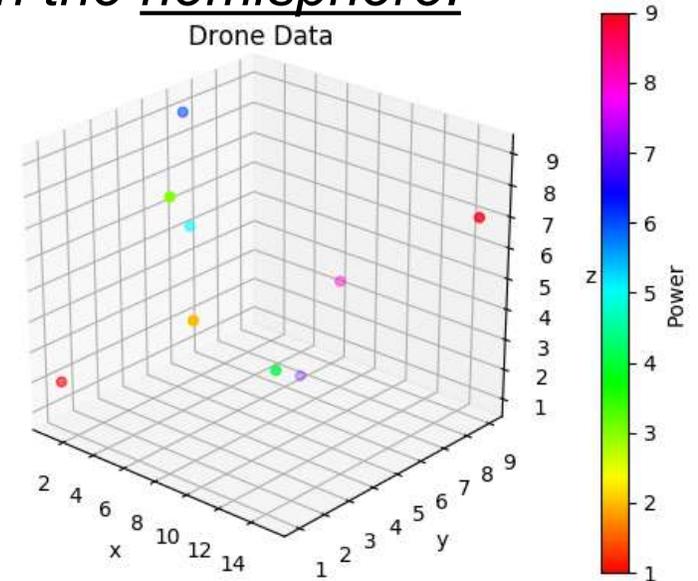
GUI for Measured data overlay



Flight path and control GUI

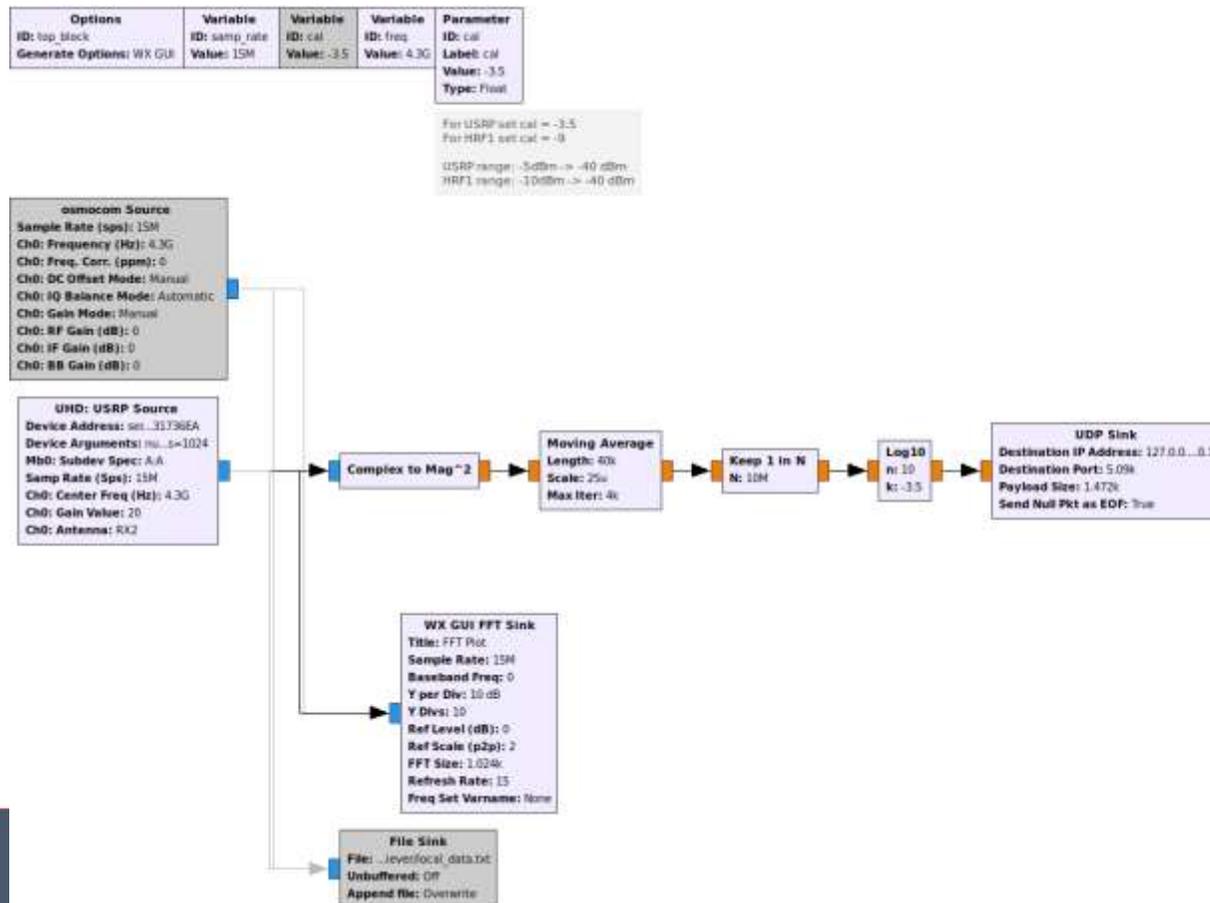


Power levels on the hemisphere:



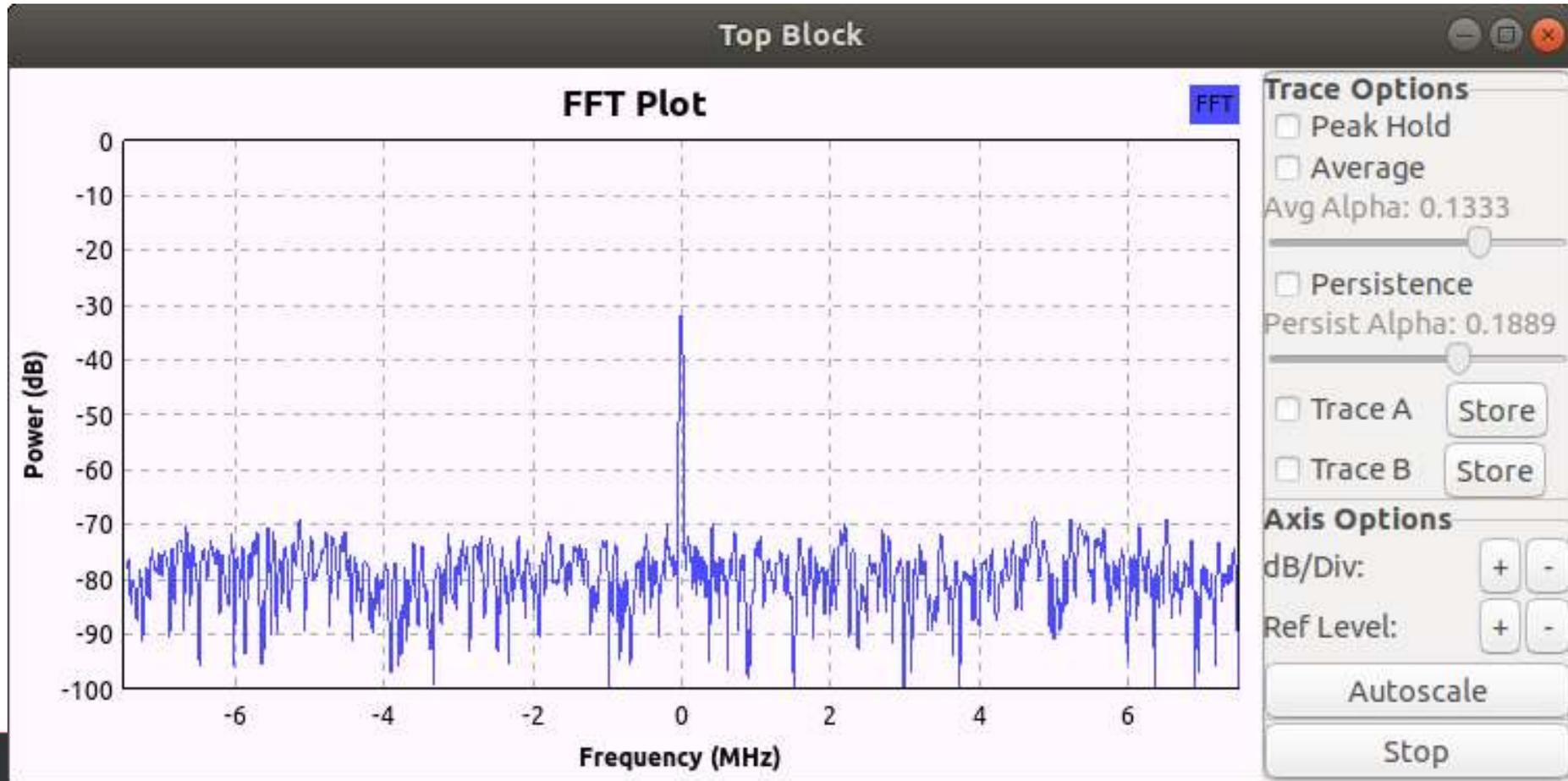
Software Define Radio:

- GNU radio script used to receive and save data collected from an SDR.
- Power measurements are calibrated with a spectrum analyzer and a RF source.



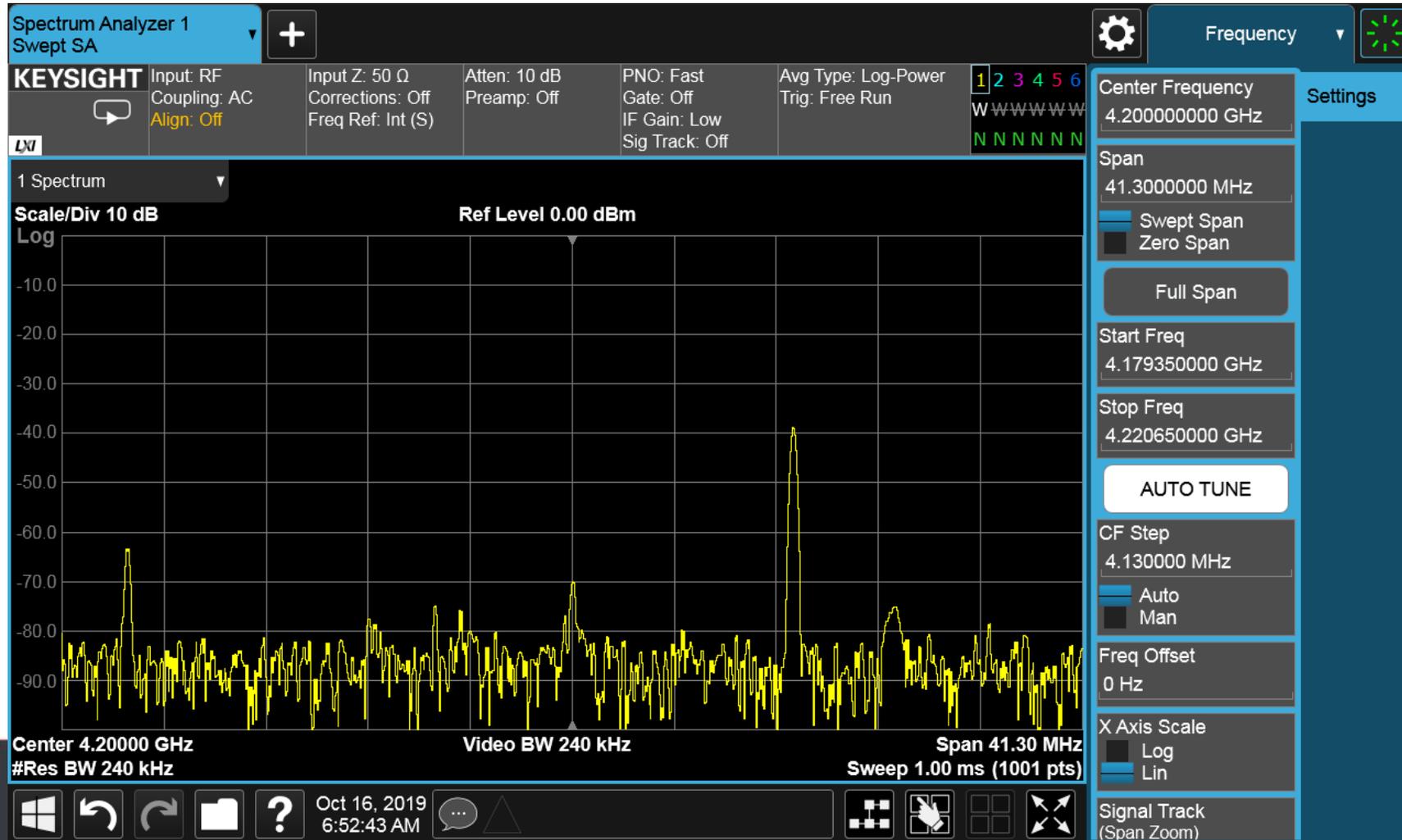
Software Define Radio:

- The systems measures the signal spectrum, tagged with GPS coordinates.



SDR: Creating a “Radio Altimeter”

- Frequency Modulated Continuous Wave (FMCW) radar signal using a SDR.



Gimbal and Radio Altimeter Antennas:



Differential GPS:



Flight Test:



*Capabilities – WAIC
Device Fabrication
and Testing*



Keysight PNA (67 GHz)



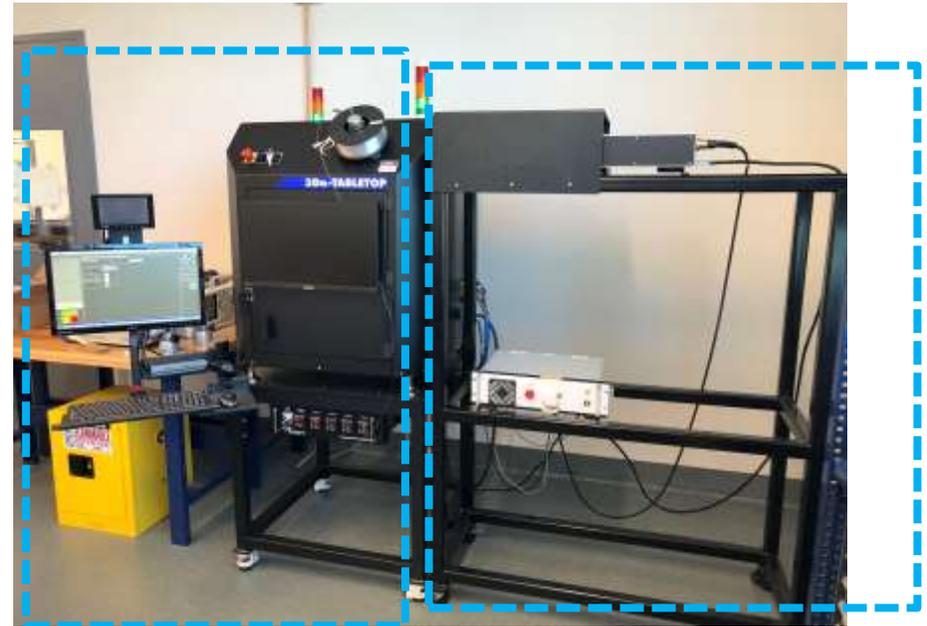
ETS AMS-8500 Anechoic Chamber
(12 ft x 12 ft x 24 ft)



LPKF Laser PCB Mi



RF Probing

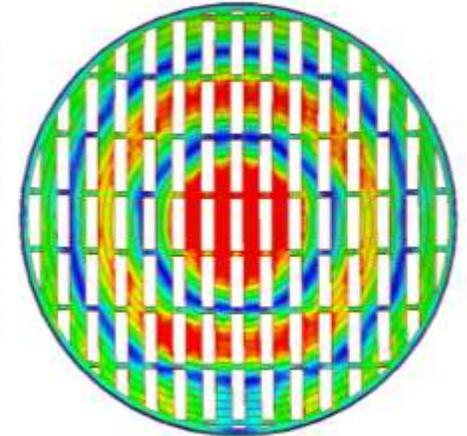
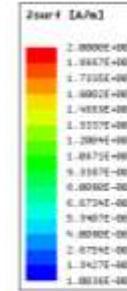
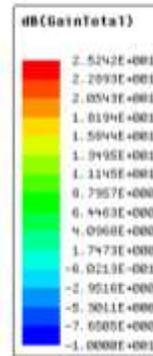


nScript DPAM system Femtosecond Laser (10 W)

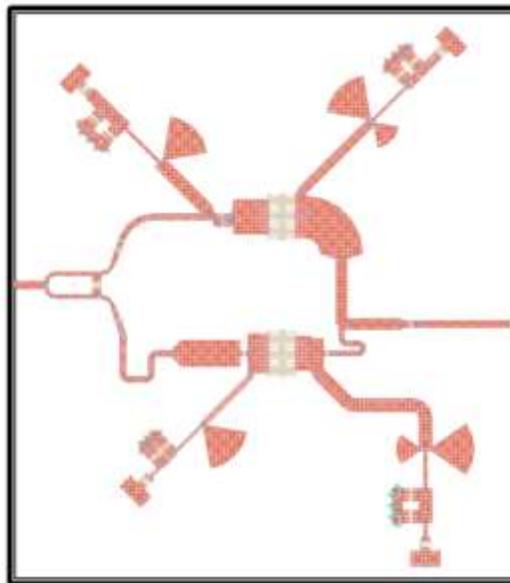


Capabilities – Software tools for WAIC device design

Anslys HFSS (Electronics Desktop)



Keysight ADS



$\Delta y = 110.45 \text{ mm}$

$\Delta x = 102.74 \text{ mm}$

Thank you

