Data Exploration of UAV Flights Recorded on Smartphones

Jonathan Tobin[1], Milton Garces[1], David Chichester[2], Jay Hix[2], Scott Watson[2]
[1]University of Hawaii at Manoa, [2]Idaho National Laboratory
Consortium for Enabling Technologies and Innovation (ETI)

Acoustic Data

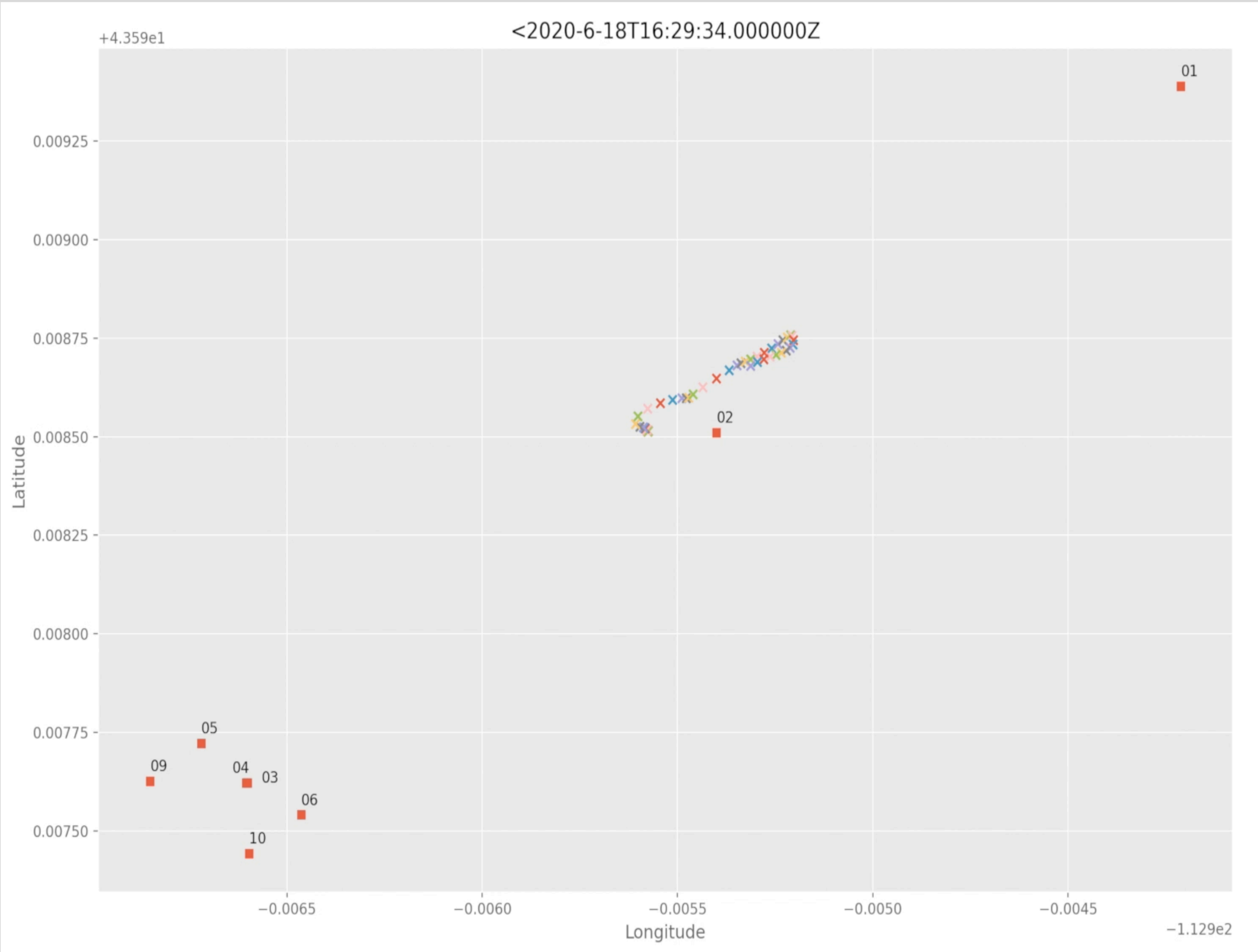

Figure 1. Four minute ten second section of UAV flight test 2. Orange squares are stationary smartphones, and the populating X's are the path of the UAV.

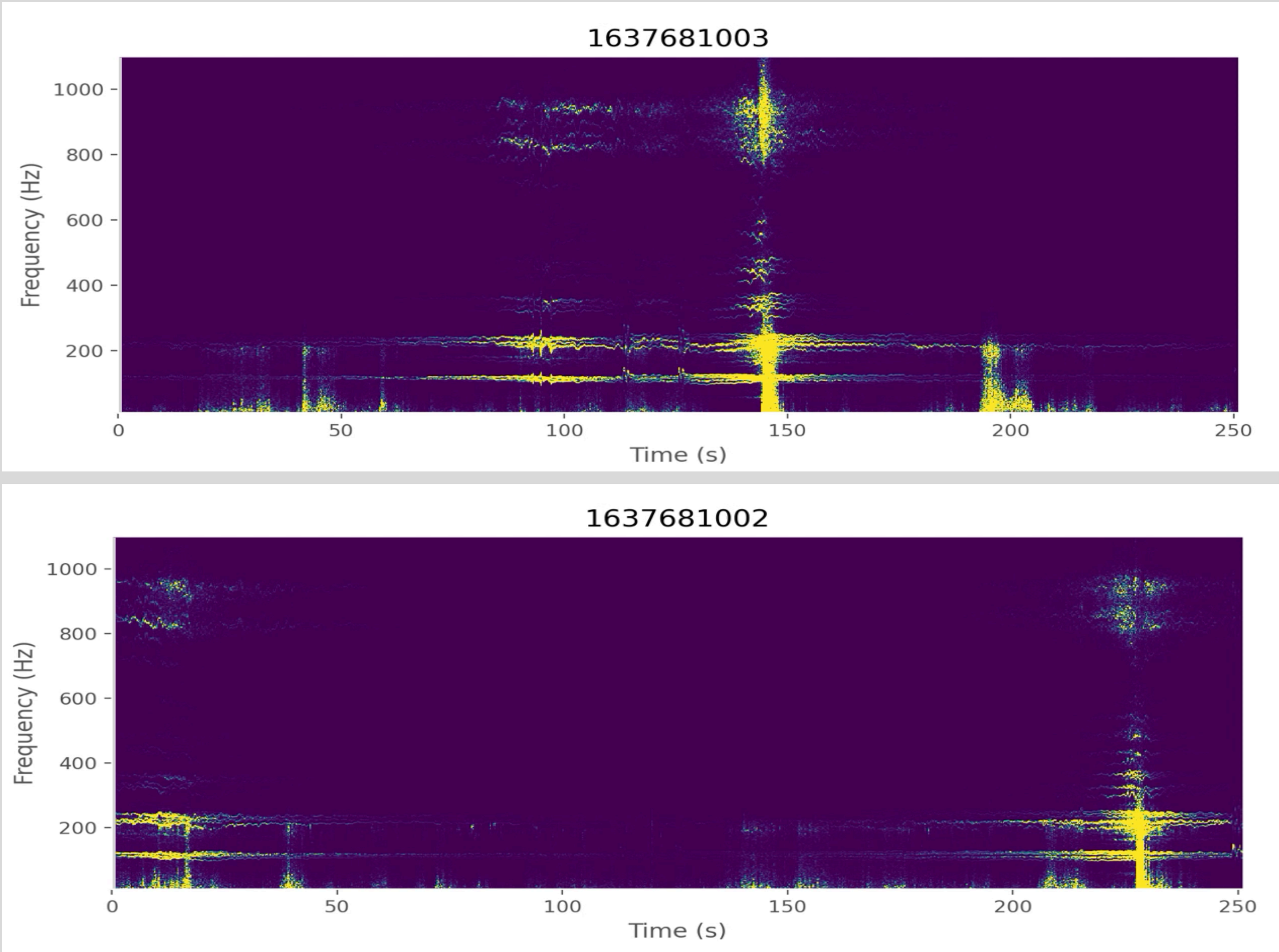

Figure 2. Spectrograms of phone 03 (top) and phone 02 (bottom) correlating with time segment in Figure 1. Clear power increases as UAV nears phone and dissipates UAV leaves phone. Specific harmonic patters evident.

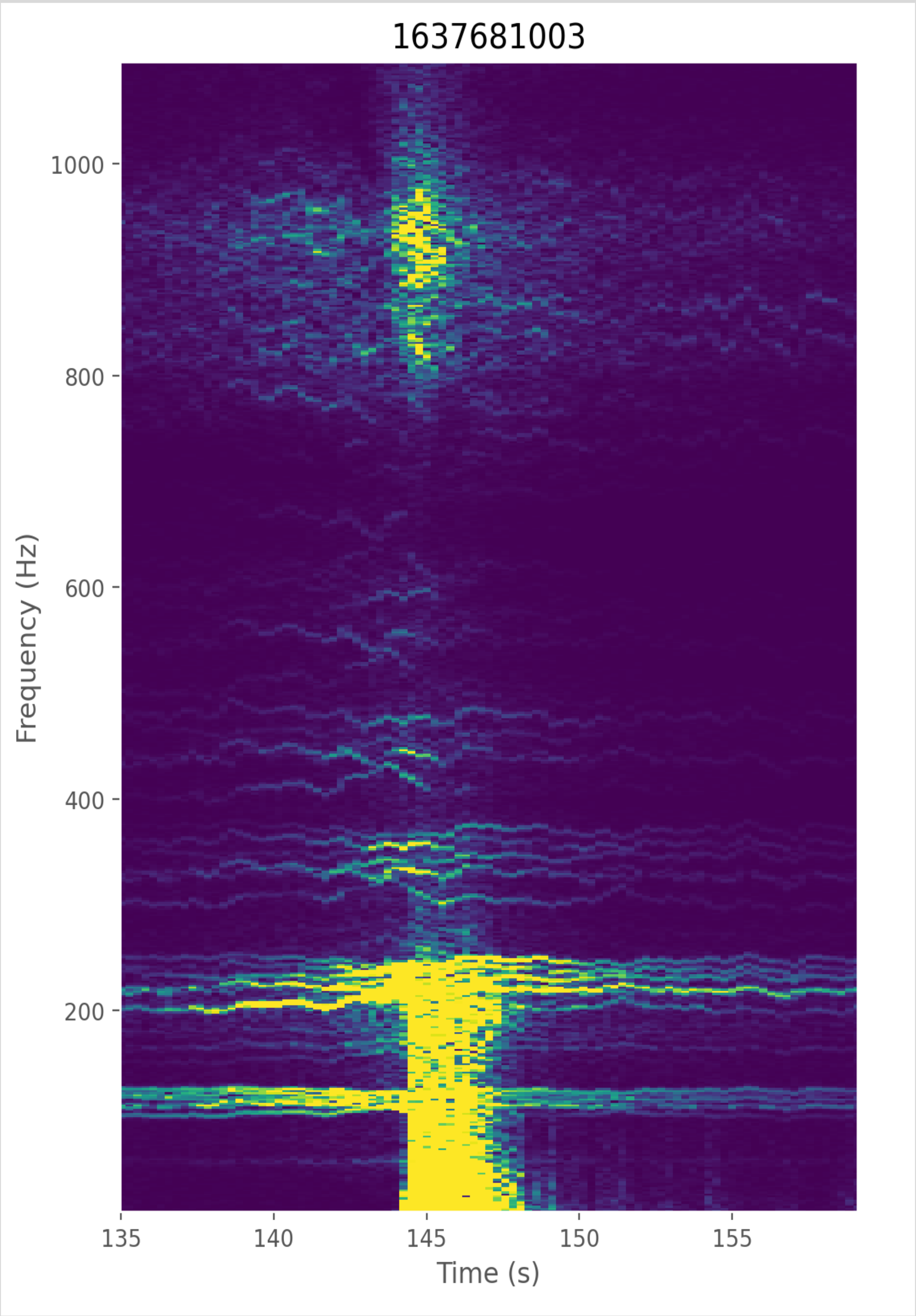

Figure 3. Spectrogram of phone 03 focusing on the moment the UAV passes over the phone. Spectral bands evident.

Motivation/Background

- Unmanned Aerial Vehicles (UAVs) pose concerns to nuclear non-proliferation efforts due to the increasing accessibility and advancement UAV technology which may be used nefariously
- Our goal is to leverage smartphones as sensors ultimately for detection and localization of UAVs
- Drone motors/propellers generate harmonic patterns, with a fundamental frequency described by,

$$f_0 = rpm * n_b/60$$

n_b = number of propeller blades
rpm = revolutions per minute

- Each set of motors/propellers operates at specific RPM depending on UAV movement

Experimental Setup

- Eight Samsung S8's with microphones recording at 8kHz, positioned on ground in vented protective casing with y-axis pointed north
- DJI Matrice 600 (M600 - hexacopter) with DJI 6010 motors and 2170R propellers
- Two flight tests with varying paths and one stationary test

Figure 3. M600 UAV during INL test. Smartphone protective casing is visible on bottom left.

Future Work

- Further analysis of moving acoustic sources with smartphone sensor network
- Design methods for event detection and classification
- Deep learning for classification and localization – beginning attempt as drone/no drone and drone within certain vicinity of sensor
- Localization using signal processing techniques
- Conduct further experiments using varying phone configurations, flight paths, and UAVs

ISLA

National Nuclear Security Administration