Small Unmanned Aerial Vehicle System for Wildlife Radio Collar Tracking

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Problem Statement

- Conventional Method VHF:
  - Cost +
  - Size (collars) +
  - Time -
  - Weight –
  - Data -

Problem Details:

- Radio Collars:
  - 48-152 MHz, 163-165 MHz, 216- 220 MHz
  - 10 kHz freq. difference
  - Pulse transmission:
    - 30 to 120 times per minute
    - As short as 18 milliseconds

Proposed Solution:

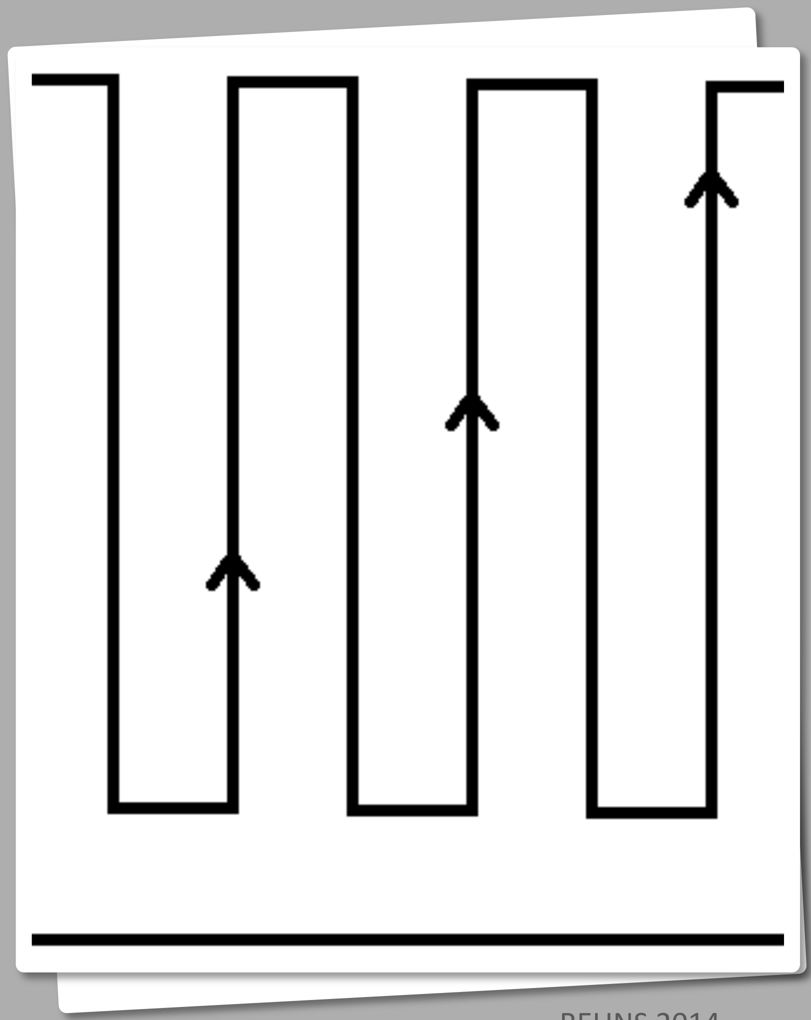
- Utilize legacy radio collars
- Automated aerial vehicle.
- Benefits:
  - Larger search area
  - Multiple collars
  - Cost
  - Ease of Use
  - Flexibility

Enabling Technology:

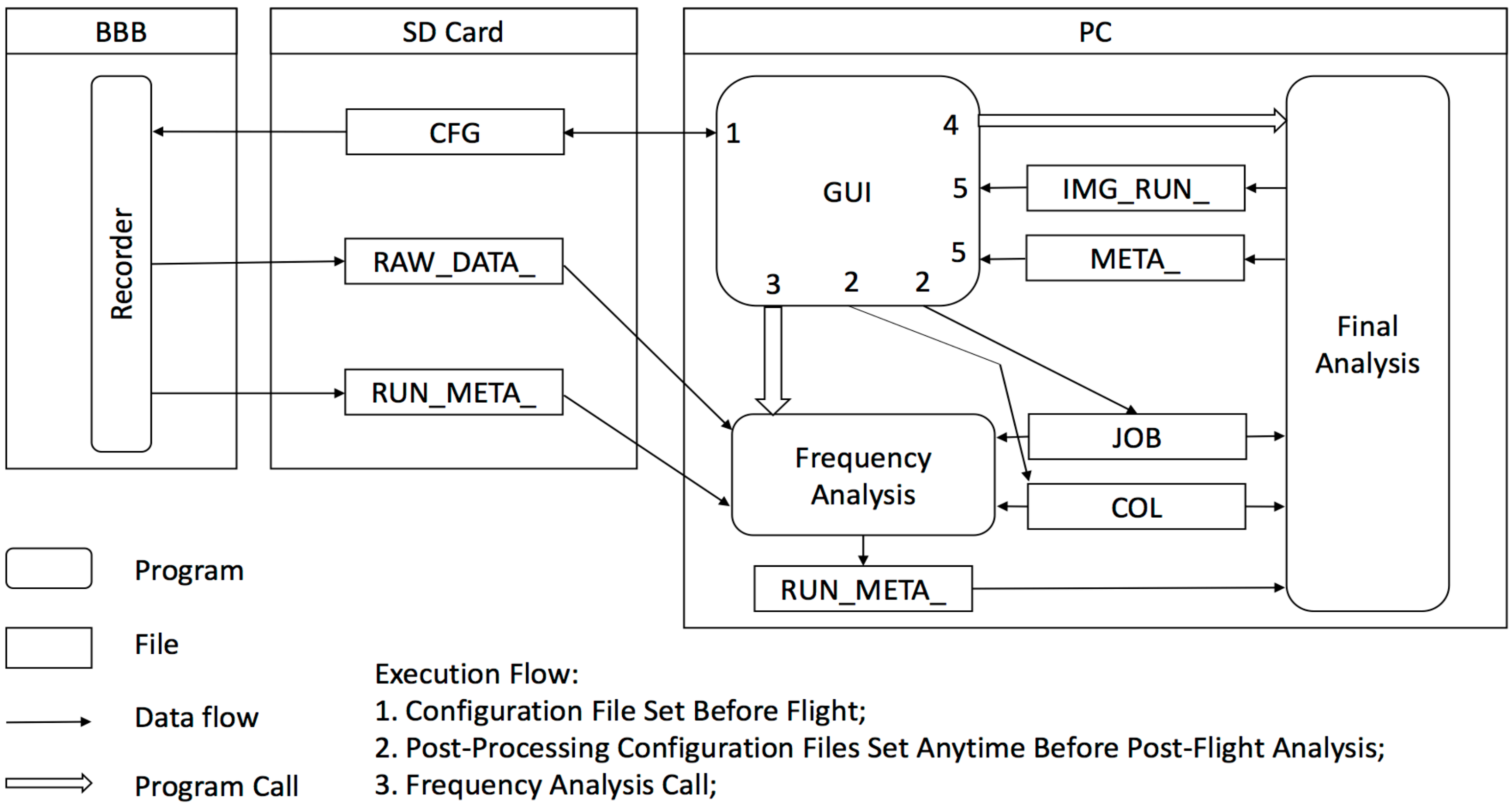
- Digital television receivers
  - Software Defined Radio
  - Low Noise Amplifier
  - ADC
  - Cost
- Microcontrollers
  - BeagleBoneBlack
- Low-Cost UAVs

System Model:

- Small UAV
  - Microcontroller
  - GPS Module
  - Software Defined Radio
  - Omnidirectional Antenna
- Lawnmower
- Post-Processed Data



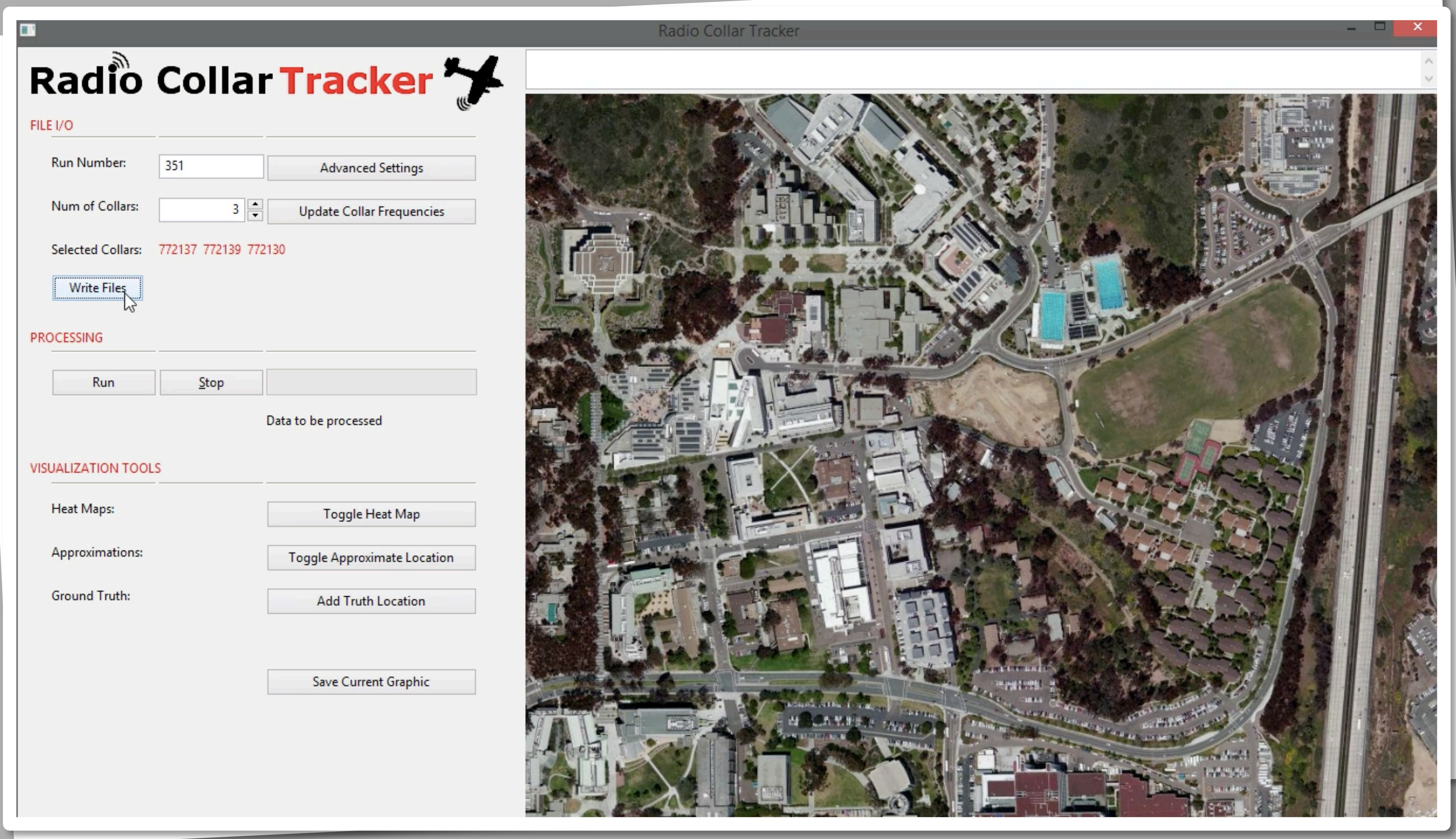
System Model:



Execution Flow:

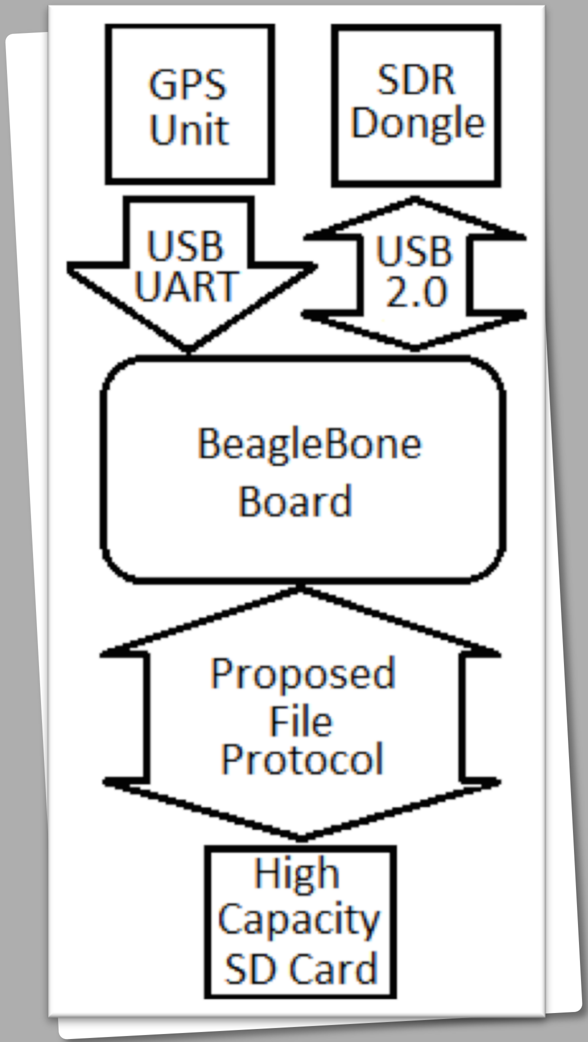
1. Configuration File Set Before Flight;
2. Post-Processing Configuration Files Set Anytime Before Post-Flight Analysis;
3. Frequency Analysis Call;
4. Final Analysis Call;
5. Result Files Loaded for User Displaying.

Graphical User Interface:



Hardware:

- BeagleBoneBlack (linux OS)
- 3D Robotics GPS Module
- 64GB SD Card
- Rafael Micro R820T tuner
    - 24 MHz to 1766 MHz
    - 8-bits ADC (up 2.4 MHz)



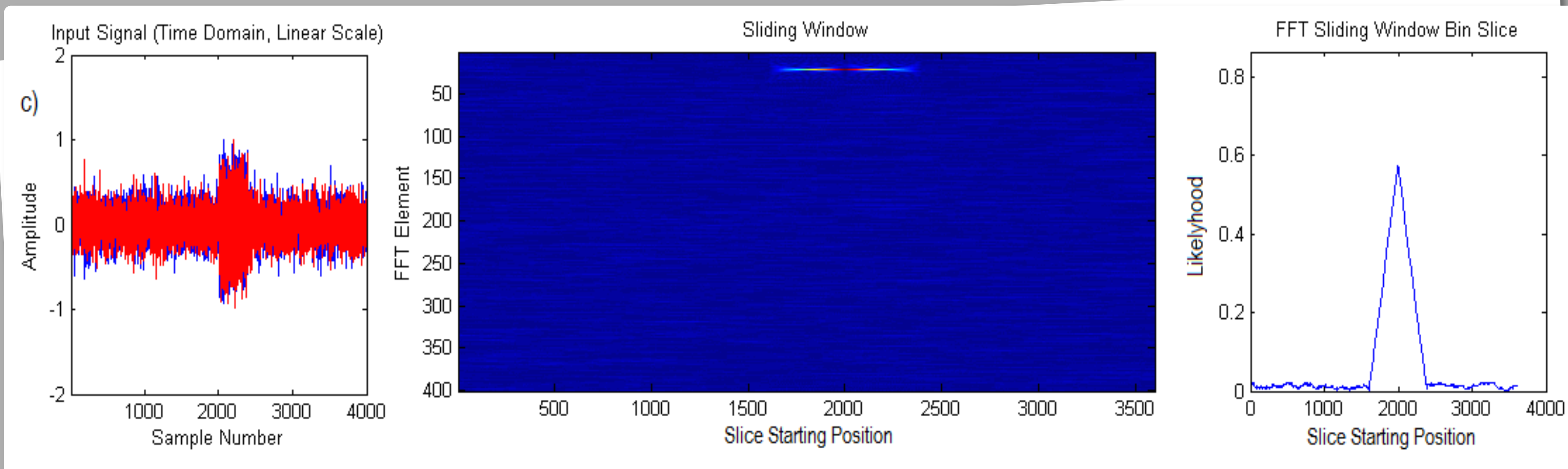
Software and File Protocol:

- RTL-SDR Library
- C Program for control logic on BBB
  - GPS, Signal, Gain
- Frame (1.5 s), 2 MHz Sample Rate, 8-bit quantization, => 6 MB/frame, 24 MB/6 sec
- 4 Hr. data per SD card

2xSampling Frequency bytes	1 byte	12 bytes
Demodulated signal frame 1	Current Analog Gain	GPS pos.
Demodulated signal frame 2	Current Analog Gain	GPS pos.
Demodulated signal frame 3	Current Analog Gain	GPS pos.
	...	
Demodulated signal frame n	Current Analog Gain	GPS pos.

Data-Processing:

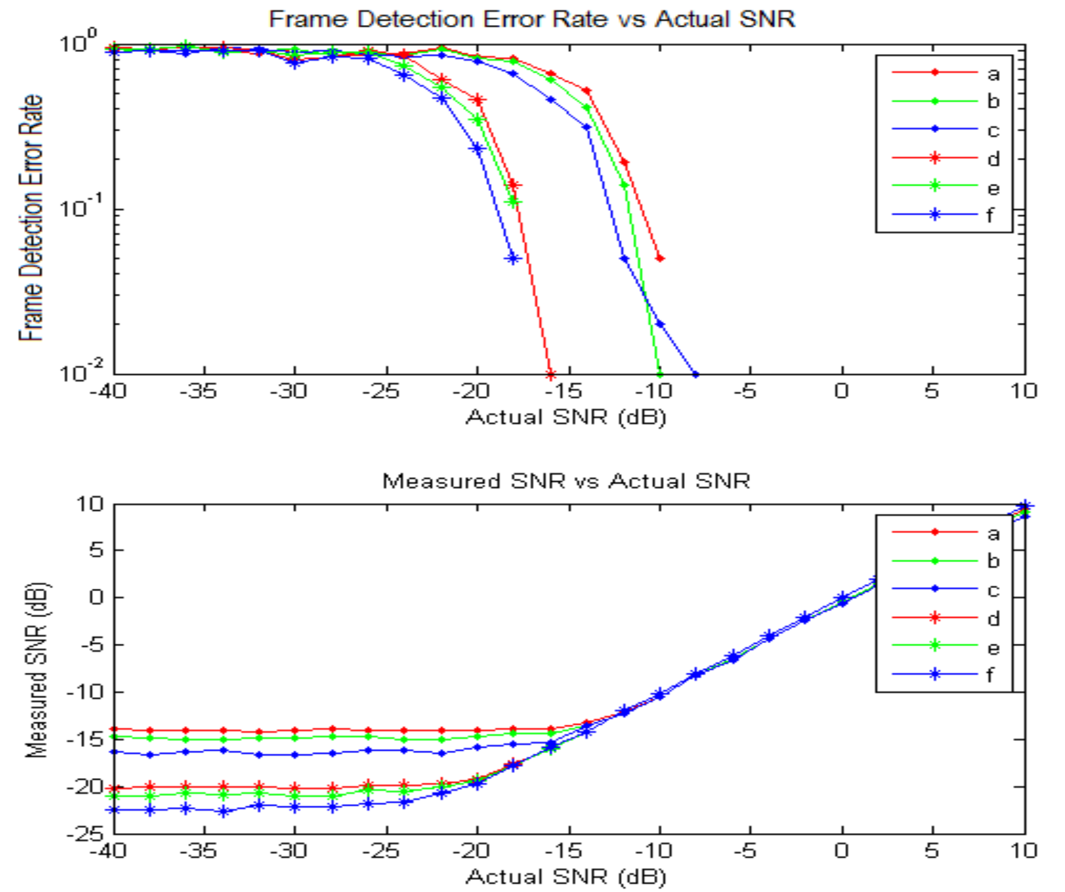
- Center frequency, sample rate, pulse duration, periodicity
- Bin selection of pulse
  - Sliding Fast Fourier Transform
  - SNR = $P_{\text{signal bin}} / P_{\text{remainder}}$, associated with GPS position



Simulated Results:

TABLE I. EXECUTED SIMULATIONS

Simulation Run	*Frequency Error Margin (Hz)*	*Sampling Frequency (kHz)*
a	*1500.0*	*10.240*
b	*500.0*	*10.240*
c	*150.0*	*10.240*
d	*1500.0*	*40.960*
e	*500.0*	*40.960*
f	*150.0*	*40.960*



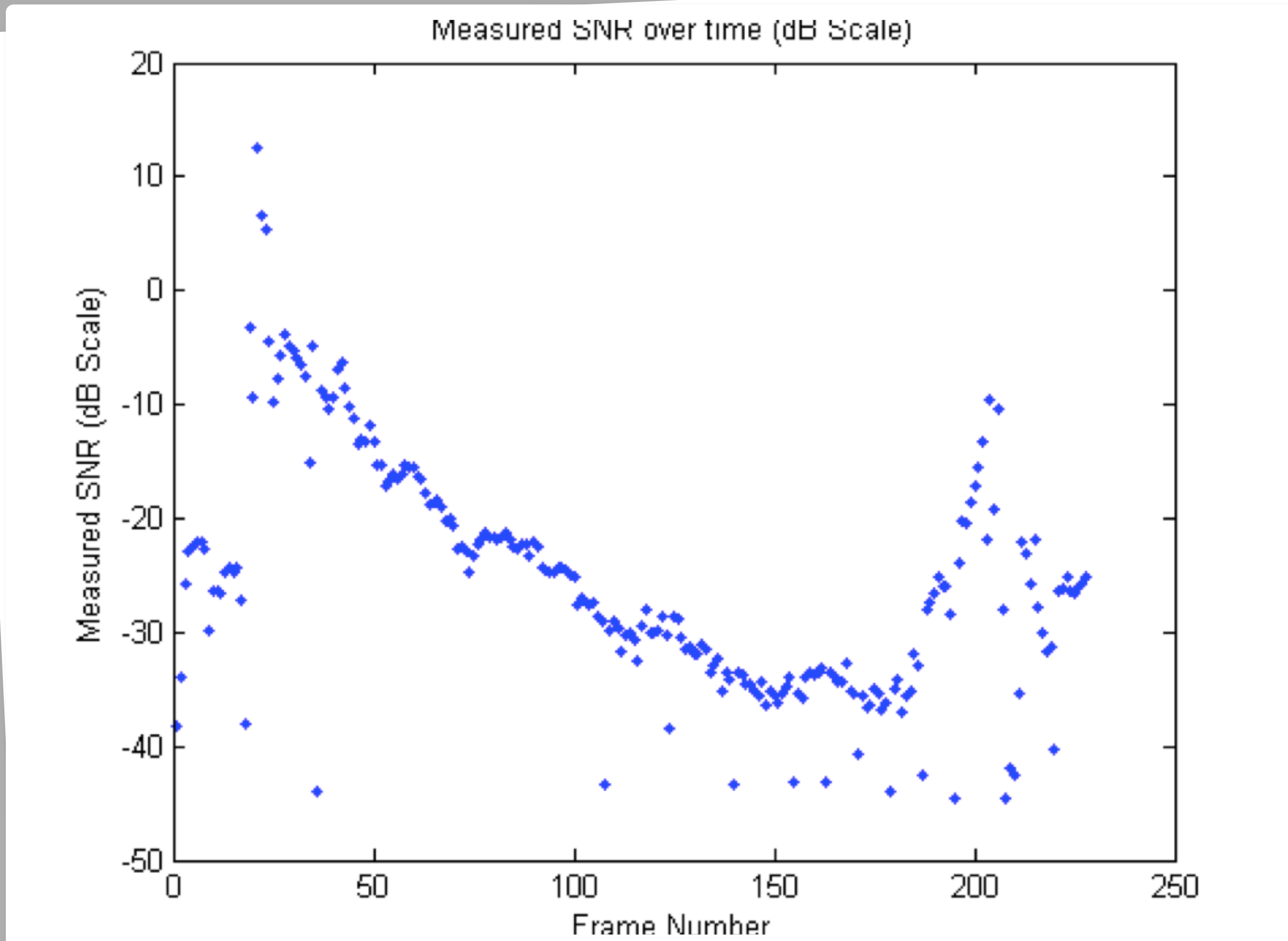
Field Test (vertical):

F_s: 2.048 MHz

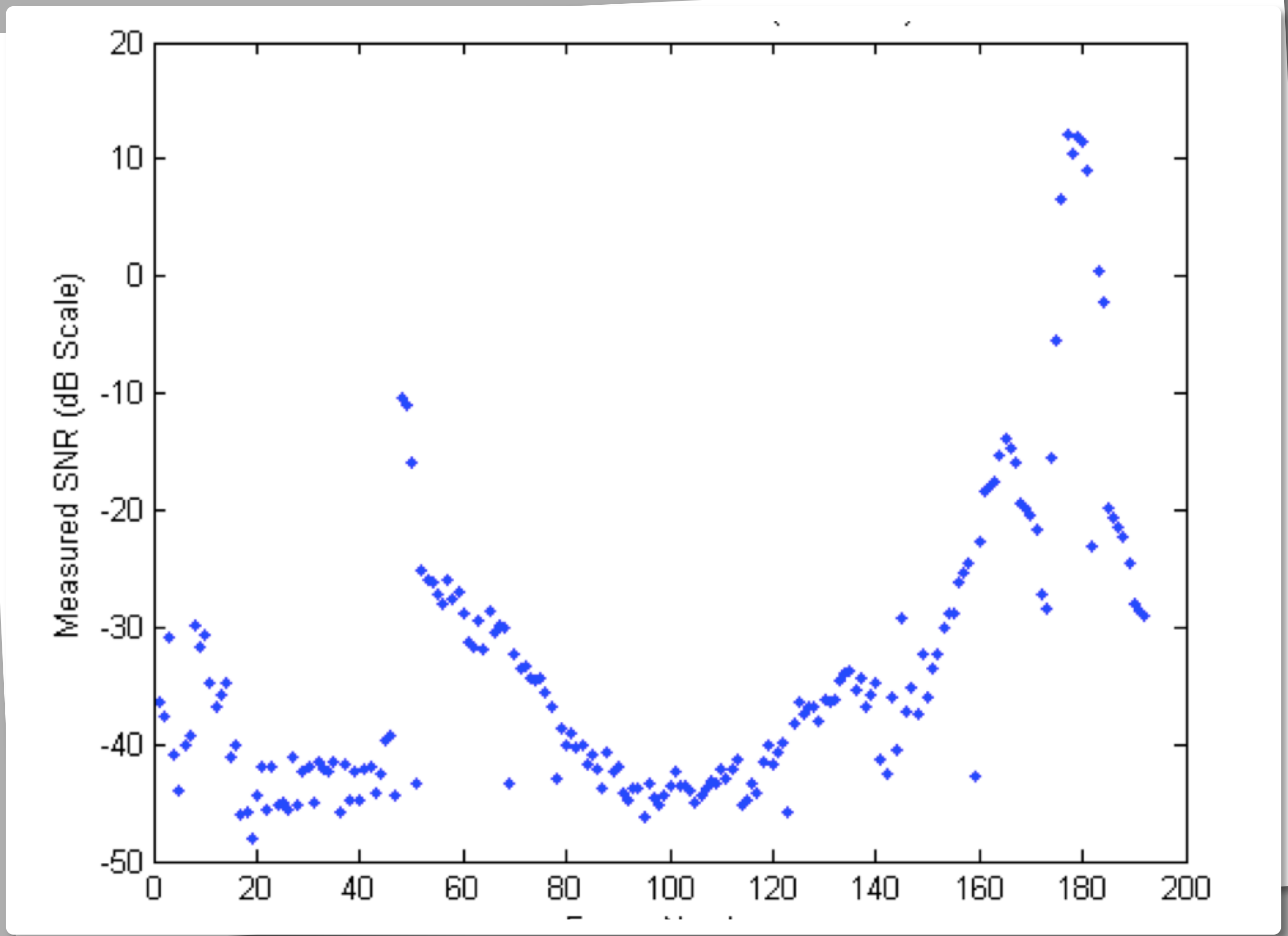
Collar F: 172.742 MHz

Frame: 1.5 seconds

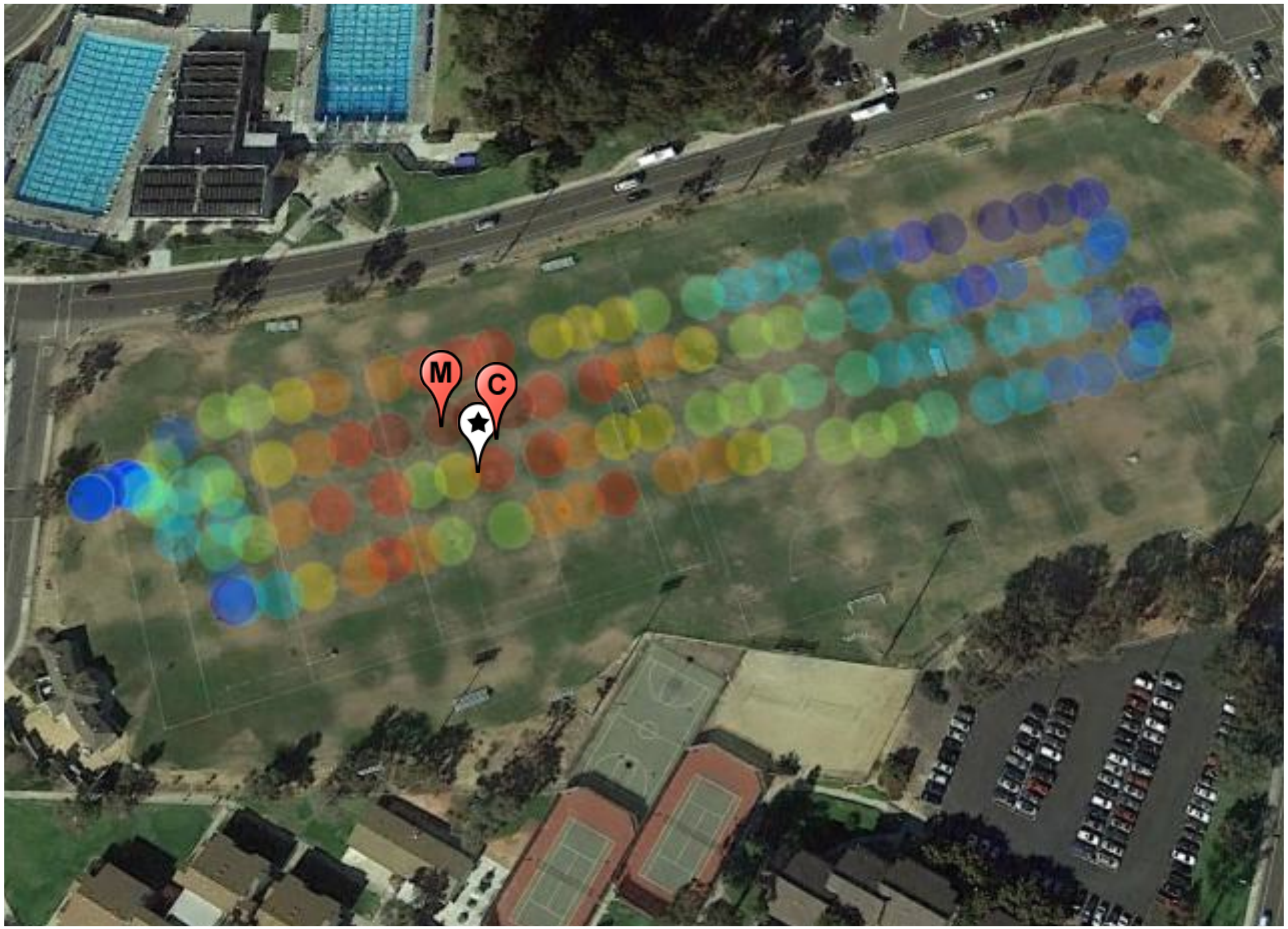
Pulse duration: 20 ms



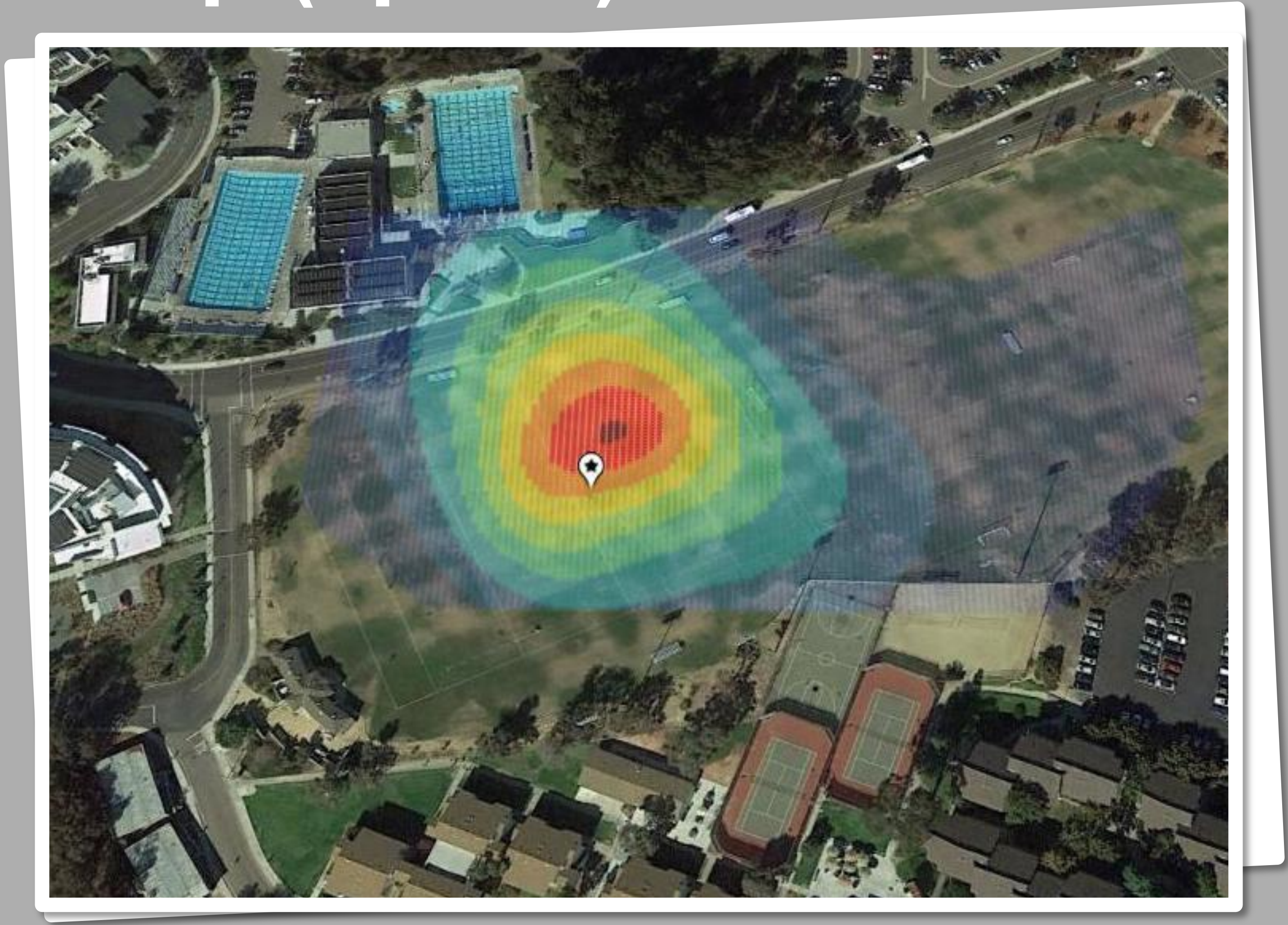
Field Test (horizontal):



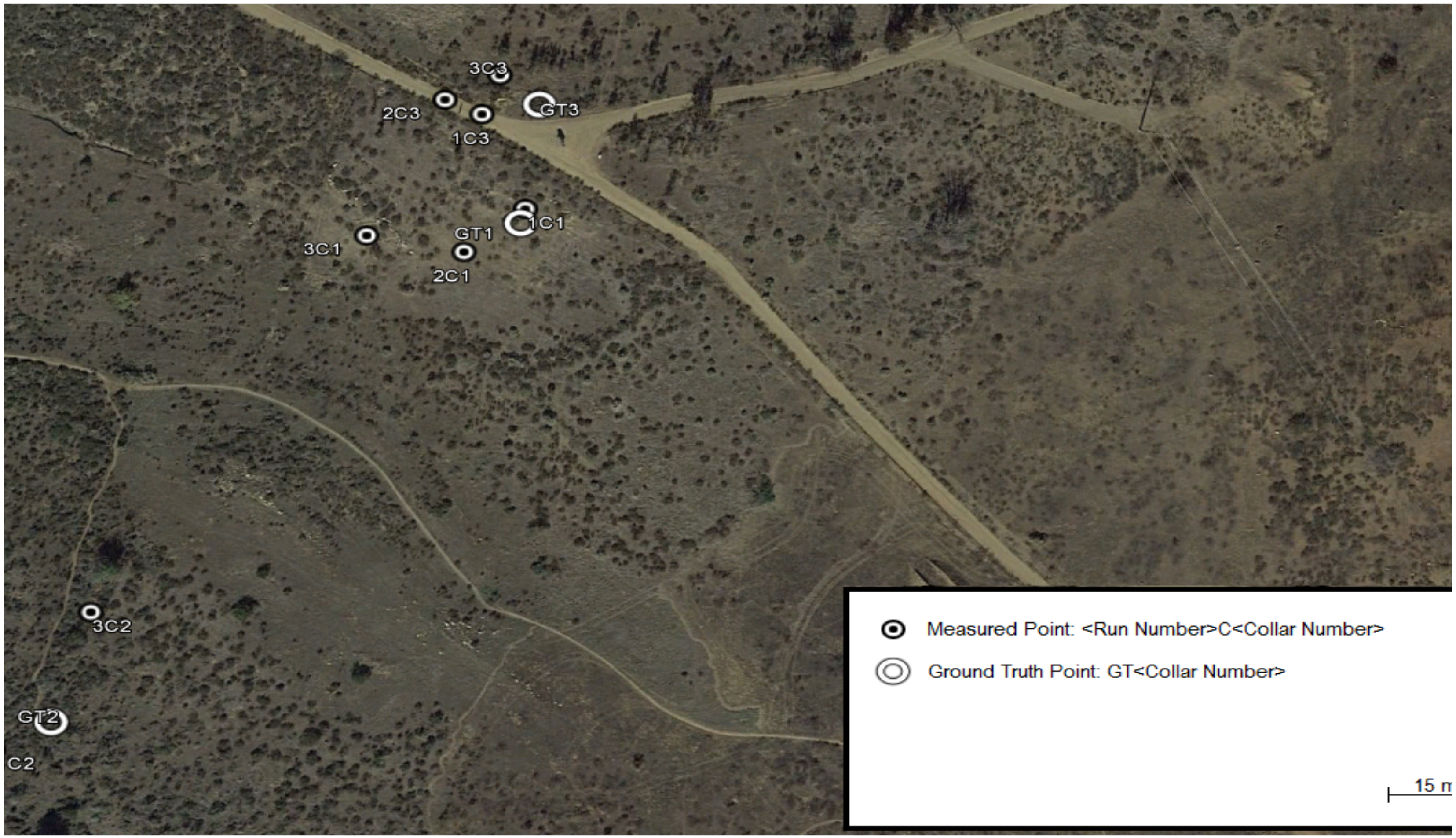
Heat Map:



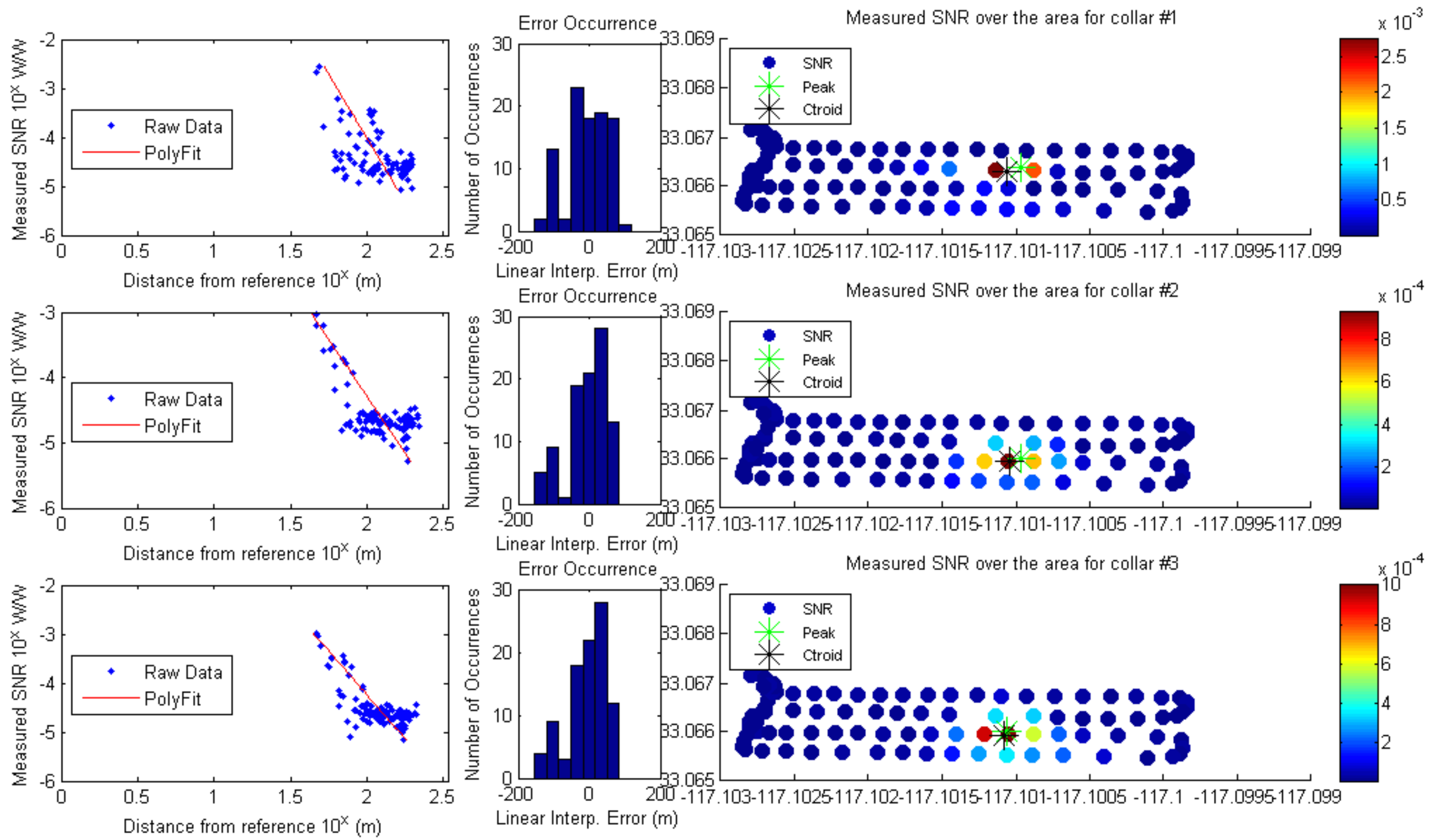
Heat Map (spline):



Advanced Field Test:



Advanced Field Test:



Acknowledgements

RESEARCH

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THANK YOU

Questions?