# Welcome to Team 301 SDR SAR Review Session!

Marius Urdareanu - Hardware/Power Analyst
Grant Steans - Software Engineer
Tyree Lewis - Simulation Analyst and Data Collection
Nathaniel Henry - Front-to-Back End Integration

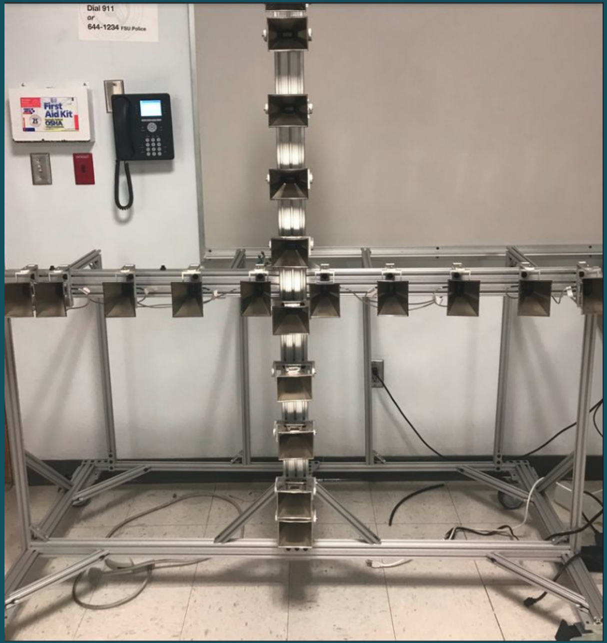
# Background

Speaker: Grant Steans

# What is the SDR-SAR?

The SDR-SAR is an ongoing project sponsored by Northrop Grumman. It is a device used to detect metal objects at a distance. There are horns lined across the SAR which either transmit or receive an LFM pulse.

# What is the SDR-SAR?




Speaker: Grant Steans

# Identifying the Problem

During the first iteration of the project, the SAR was able to successfully detect metal objects, however, there was noise leakage occurring between the horns which made acquiring data more difficult.


Speaker: Tyree Lewis

FAMU-FSU Engineering

# Implementing a Solution

To resolve the problem, the team purchased a USRP B200 radio. This radio will be used to filter the noise between horns, thus removing the leakage that occurs between horns.


Speaker: Tyree Lewis

FAMU-FSU Engineering

# Project Scope

Our goals for the project include:

- Refine the existing SAR to use SDRs to resolve the problems that occured in the previous iteration of the project.
- Ensure that metal object can be identified from at least 40ft.

# Ending of Phase I

The following are the goals met in our Phase I outline:

- Install Universal Hardware Drive (UHD) and GNU Radio on Linux
- Verification of GNU radio transmitting a simple sine wave to USRP B200
- Verification of receive signal on GNU Radio
- Verification of radar functionality
- Determining parameters for radar, to see supported frequencies
- Obtain all components needed for Phase II

# Entering Phase II

Speaker: Marius Urdareanu

FAMU-FSU Engineering

# Outline of the Phase II Test Plan

1. Create a multiple pulse waveform in Simulink for the GRC source file.
2. Finish VHDL code that generates PPS reference.
3. Add existing VHDL for switching between TR paths.
4. Get the VCO source board from TI programmed with the needed frequency.
5. Mechanize the RF components in the system box.

# Initial Progress

At the start of this semester, we obtained all the components we needed to begin progress on working with the SAR. These consisted of:

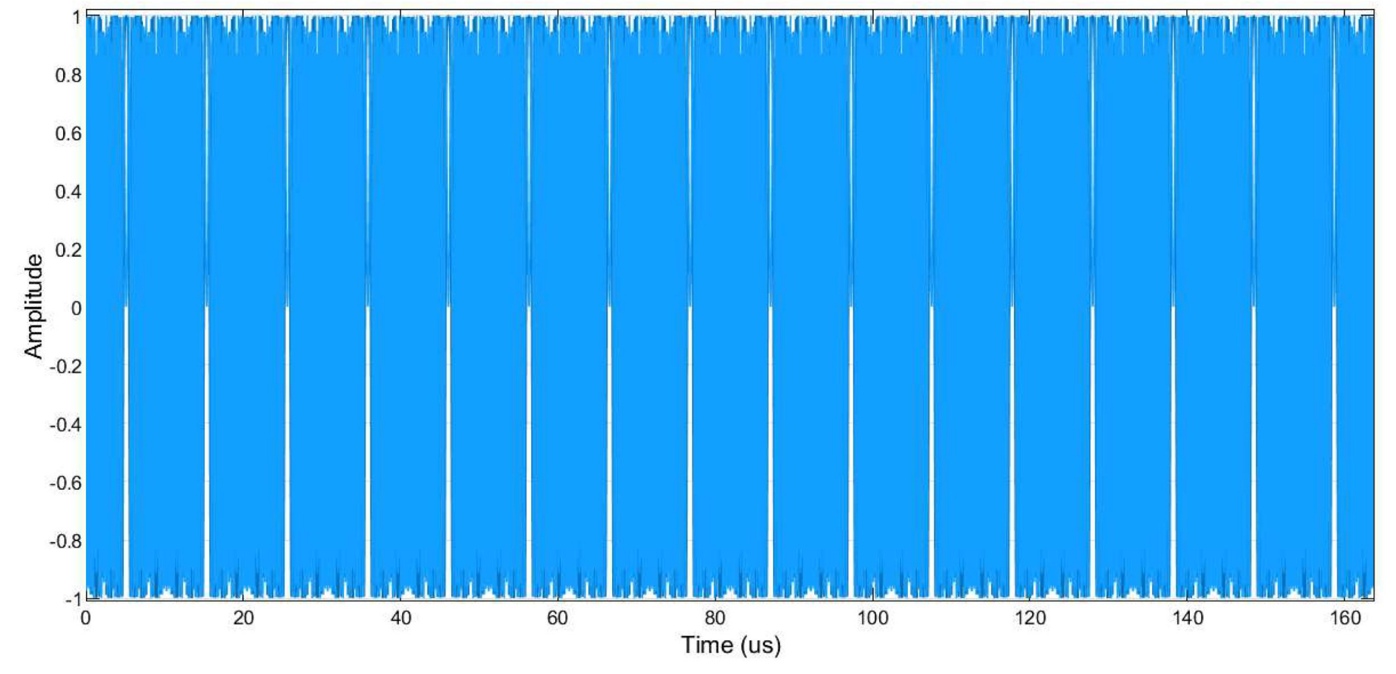
- VCO
- Splitters
- Mixer
- Amplifiers

# Multiple Pulse Waveform

A multiple pulse waveform has been generated using Simulink to be used as the GRC source file.

- This waveform consists of sixteen LFM pulses at 44.8MHz each.
- 512 samples per pulse.
- Sixteen pulses needed for the sixteen transmit horns on the aperture.

# Multiple Pulse Waveform



# Multiple Pulse Waveform

Results from the generated file through the instantaneous and delayed lines have also been gathered from the SDR. These results are generated through a MATLAB script which does most of the processing of the data gathered through the radio.

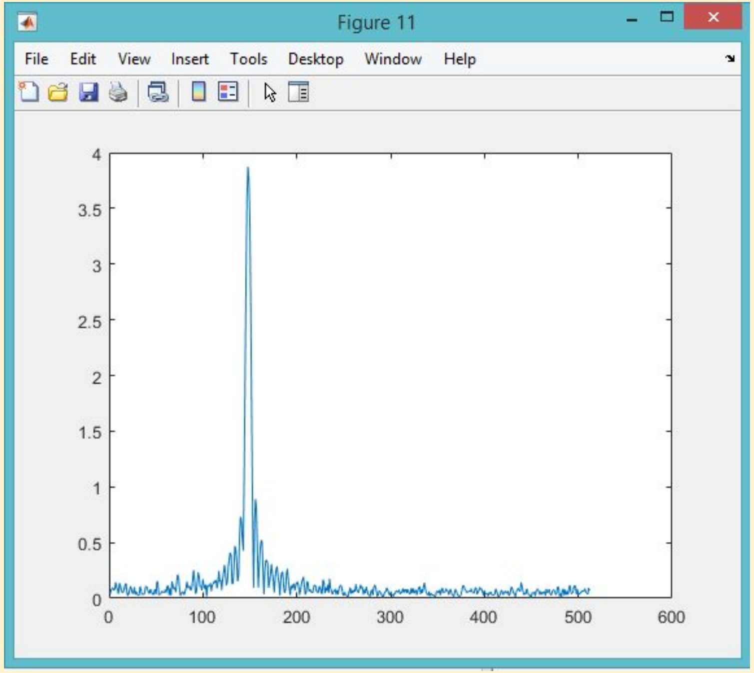
# Multiple Pulse Waveform

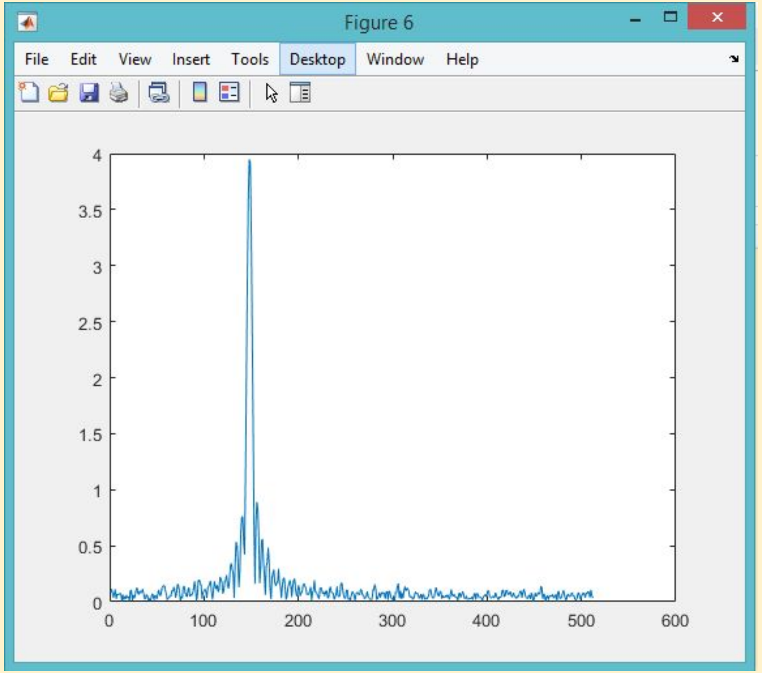
```
% Pulling the .bin file from GRC, converting to complex.
fid = fopen('long22_1.bin','rb');
grcoutput  = fread(fid,'float32');
N = length(grcoutput);
fclose(fid);
grcoutput_complex = grcoutput(1:2:N-1) + 1i*grcoutput(2:2:N);

% Reshaping the result to 16 individual pulses, and then taking
%  abs(fft()) of those pulses. After, max magnitude and location
%  of max magnitude is saved to mag and bin, respectively.
%  Location of matching complex number is then found using the bin
%  variable and a for loop.
grcoutput_complexA = reshape(grcoutput_complex,[],N/1024);
pulsed_fft = fft(grcoutput_complexA, 512);
pulsed_fft_mag = abs(fft(grcoutput_complexA, 512));
[mag,bin] = max(pulsed_fft_mag);
real_imag_maxmag = [];
for c1 = 1:length(mag)
    real_imag_maxmag(c1) = pulsed_fft(bin(c1),c1);
end
% Caluclating phase angle of the maxmimum magnitude values.
phase1 = angle(real_imag_maxmag);
```

# Multiple Pulse Waveform

We read in the response to the sixteen pulses sent through the radio, and then split the results into sixteen chunks, one for each pulse. A simple 512-point FTT is then applied to each chunk, and the magnitude of the FFT is then calculated.

# Multiple Pulse Waveform

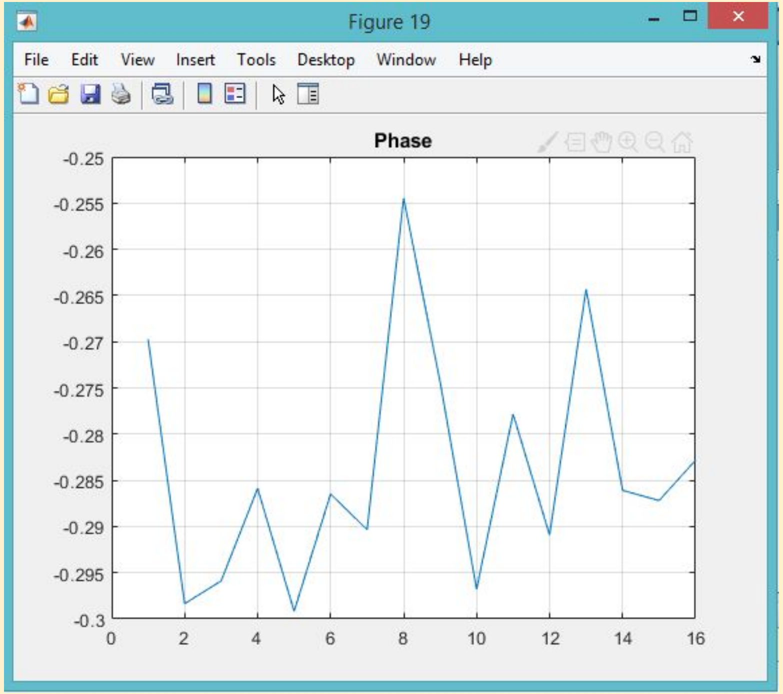


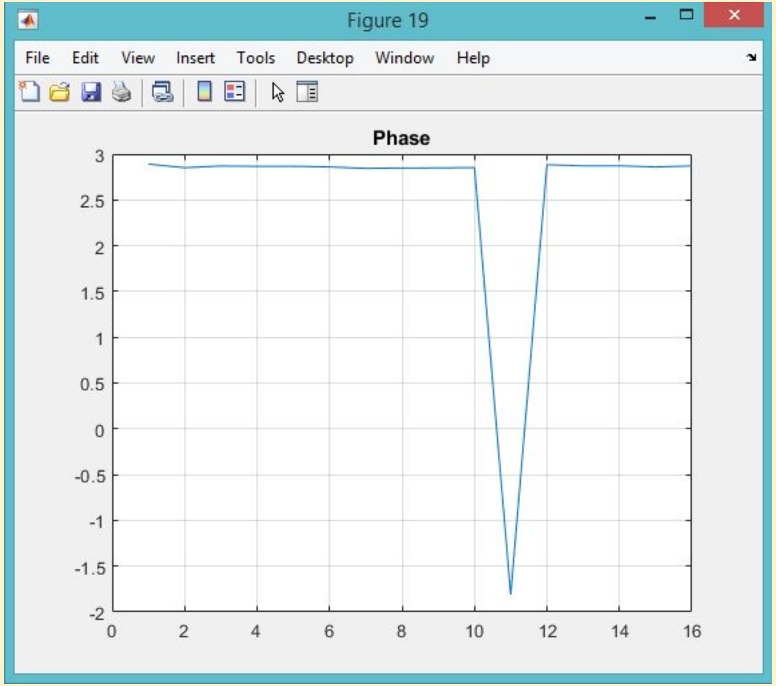



# Multiple Pulse Waveform

We then found the location (sample) of the highest magnitude response and captured the real and imaginary parts of the complex number at that location for all 16 pulses. The phase was then calculated using the MATLAB script and plotted for all 16 cases.

# Multiple Pulse Waveform

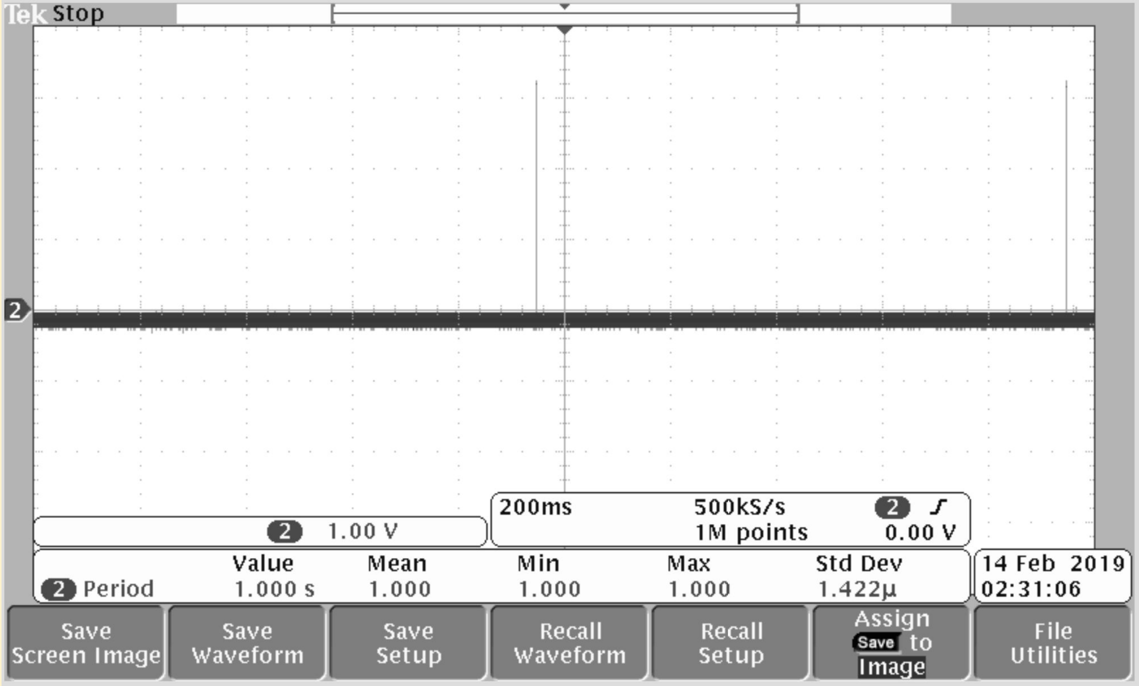


# PPS Timing Code

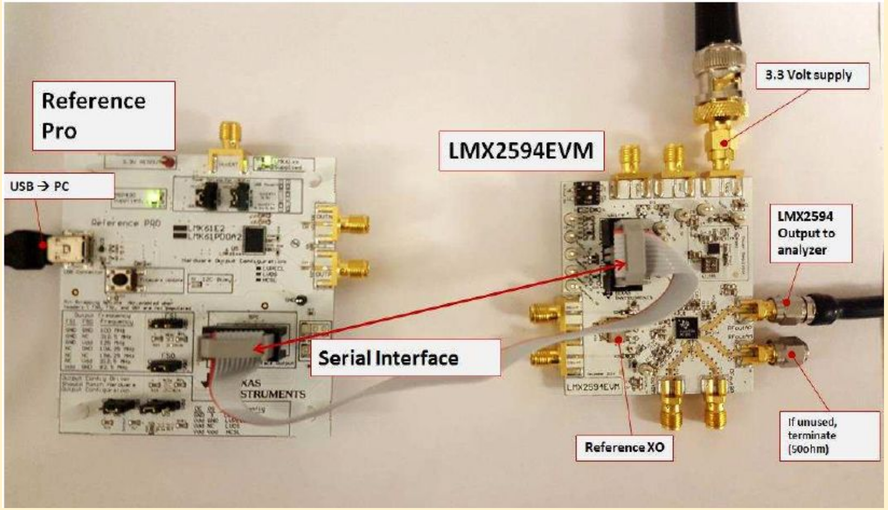
VHDL code has been completed for the Pulse per Second (PPS) reference used to sync the SDR and the Transmit/Receive horns on the aperture.

# PPS Timing Code



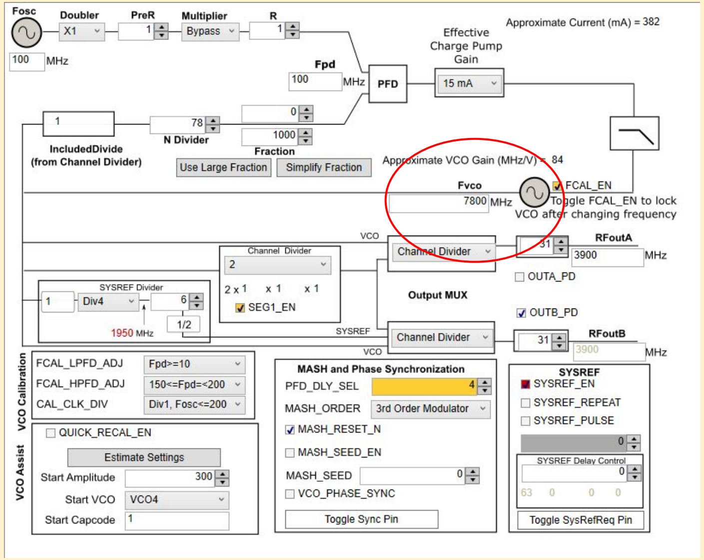
# Testing and Verification of the VCO

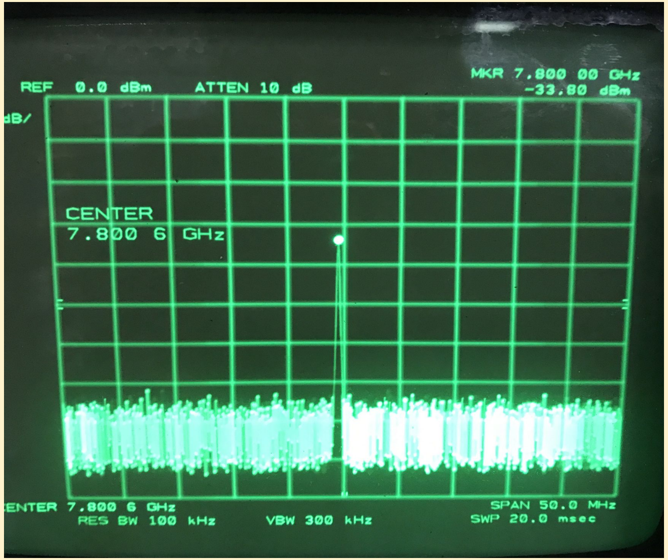
A voltage controlled oscillator (VCO) is a device that generates an output signal which is controlled by an input DC voltage. To verify the functionality of the VCO, it was tested using a spectrum analyzer to obtain a 7.8GHz center frequency. The setup for the VCO consists of an LMX2584EVM board and Reference Pro.



# Testing and Verification of the VCO

A software called TICS Pro is used for communicating with the vco, in order to obtain the results we need. The results displayed on the spectrum analyzer show that we can acquire the center frequency set on TICS Pro.



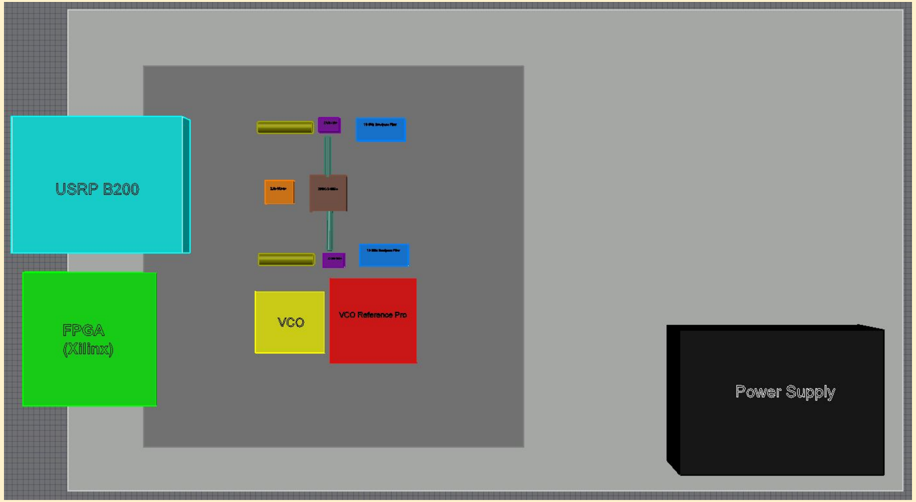

Speaker: Tyree Lewis

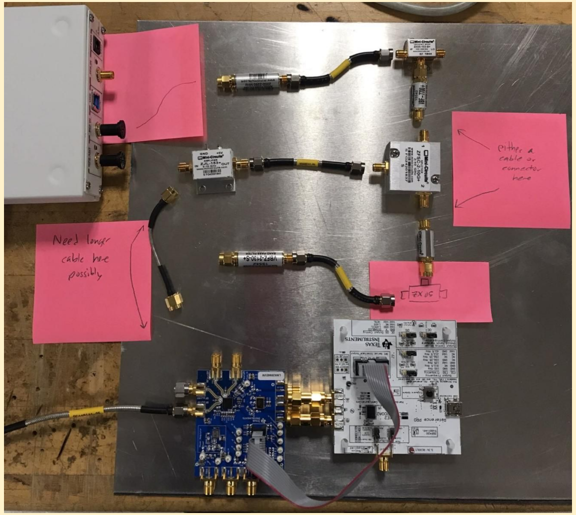
# Mechanizing the RF Components in System Box

In order to implement our software-based design for the SAR, the systems box needs to be modified for the new components the team received. Mechanizing these components will allow them to be easily accessible between the USRP B200 radio and the computer during operation of the SAR.

# Mechanizing the RF Components in System Box

Before integrating the components into the systems box, a CAD model was developed for the possible arrangement of the components. The goal is for the components to be placed on a metal sheet. This metal sheet will then be used as a mount for the components and fitted inside the systems box.



# Current Pacing

**2/15/19 - 2/21/19:** RF front end and back end setup with sponsor

**2/22/19 - 2/28/19:** RF front end and back end testing and verification

**3/1/19 - 3/7/19:** Develop algorithm for SAR to filter noise leakage

**3/8/19 - 3/14/19:** Testing the SAR with USRP B200

**3/15/19 - 3/28/19:** Error checking and refinement of data

**3/29/19 - 4/1/19:** Setup final presentation

# Conclusion

The team will be meeting with our sponsor this Friday to conclude the steps in Phase II and begin progress on the next tasks.

# Any Questions?