

## Background

Beamforming is a signal processing technique that uses the interaction of multiple sensing elements to improve the overall characteristics of the sensor. Beamforming techniques generally used in radio frequency applications such as phased-array radar can also be employed in acoustic applications with comparable success. Beamforming can be used with Photo-acoustic sensing (PAS), the process of using controlled light pulses to elicit an acoustic response from a substance.

### Functionality:

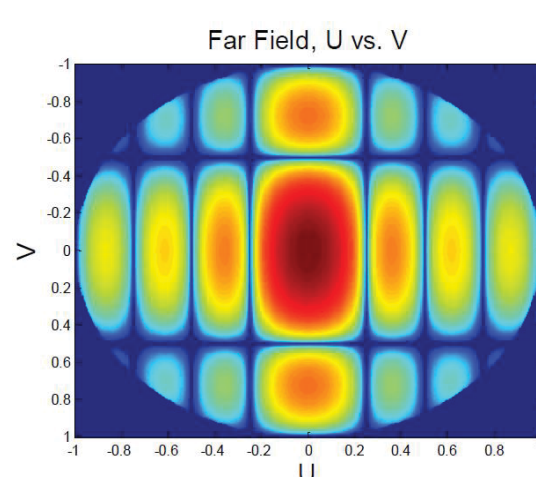
- Form beam at a desired frequency.
- Electronically steer to the desired target.

### Applications:

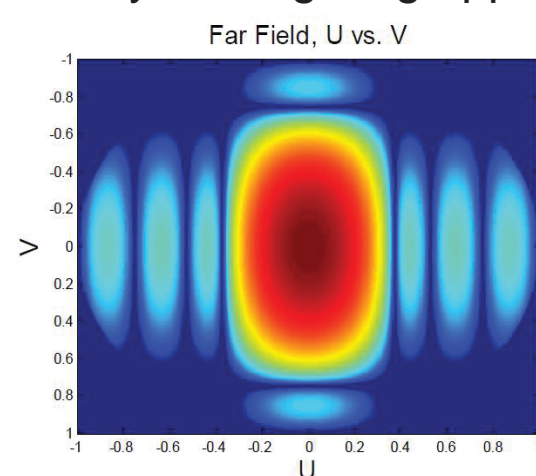
- Use by military to detect explosives from a safe distance.
- Audio surveillance in various areas; ability to single out a voice or signal in noisy environments.

## Beam Forming Plot

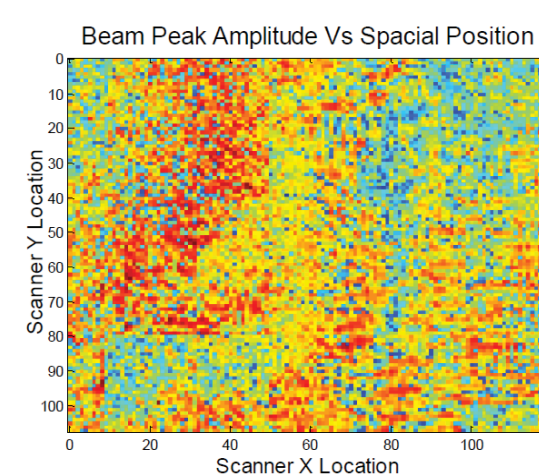
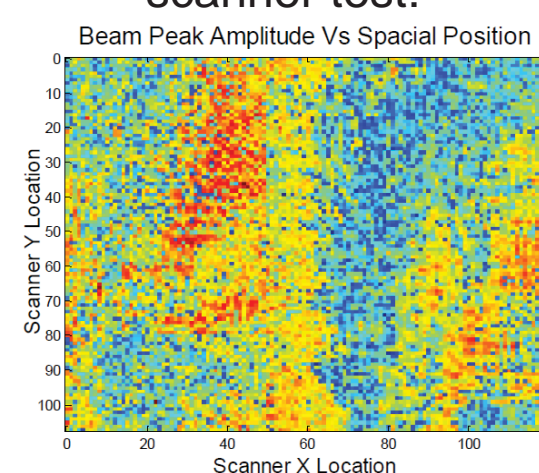
Simulation:



Taylor weighting applied:



Actual beam form from scanner test:

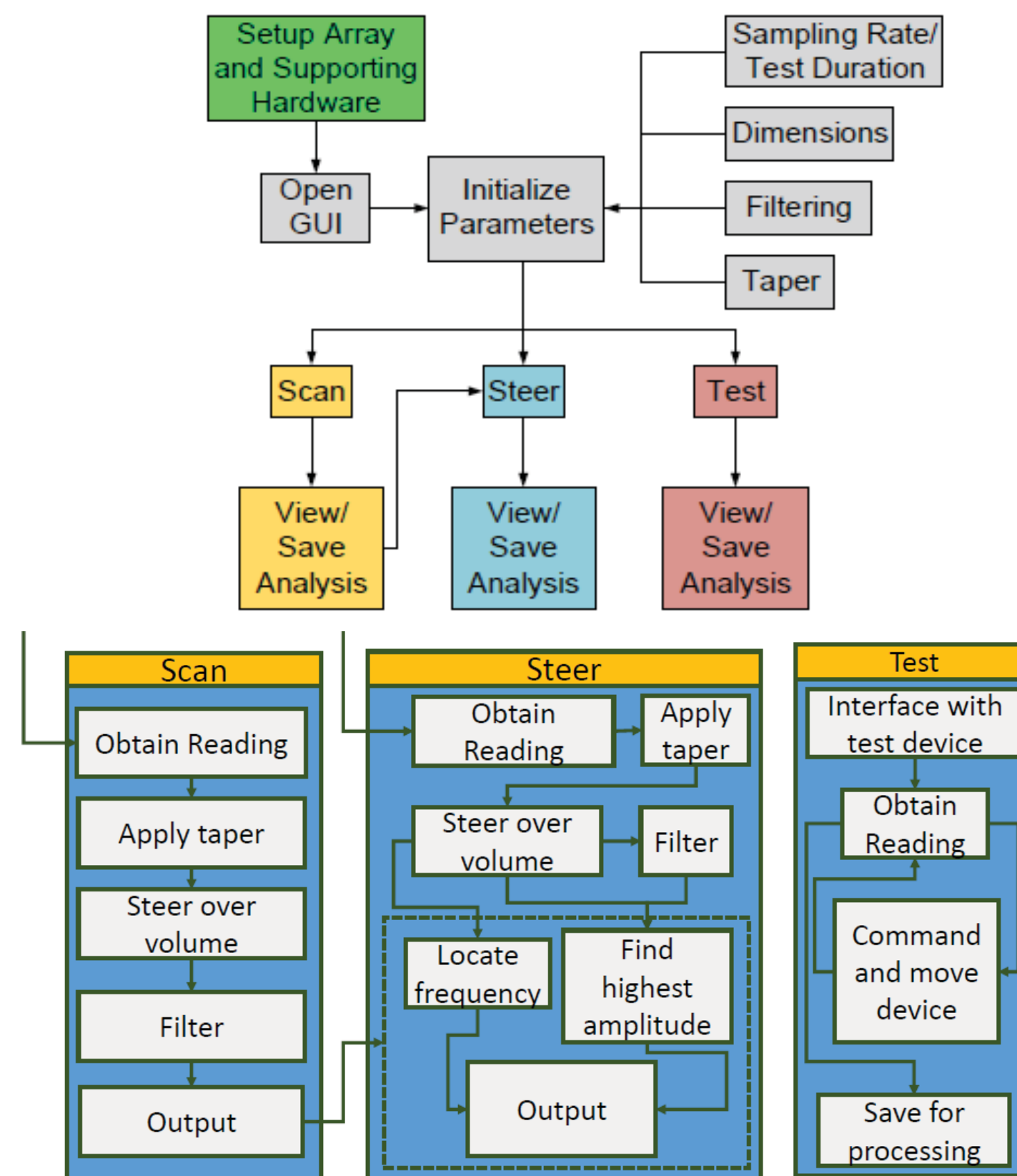


The results show unintended steering error and amplitude variations that must be resolved.

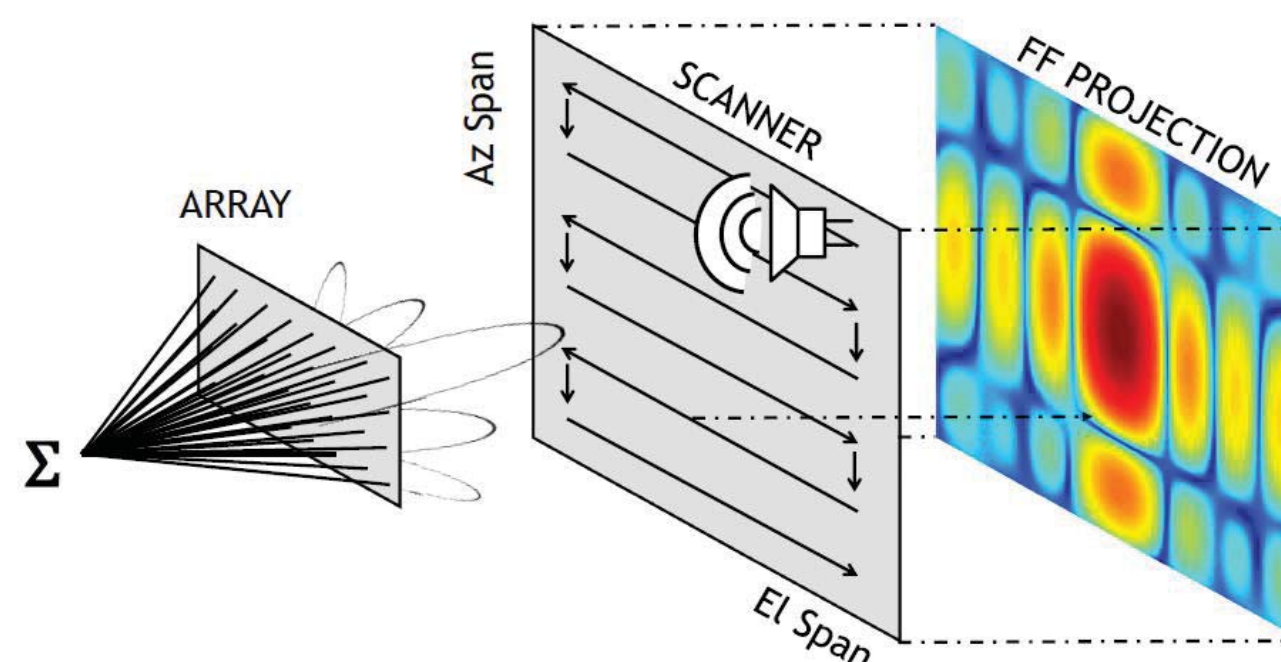
## Future Plan

This project can be continued to improve functionality, reduce the total cost, and optimize the design.

## Functional Flow



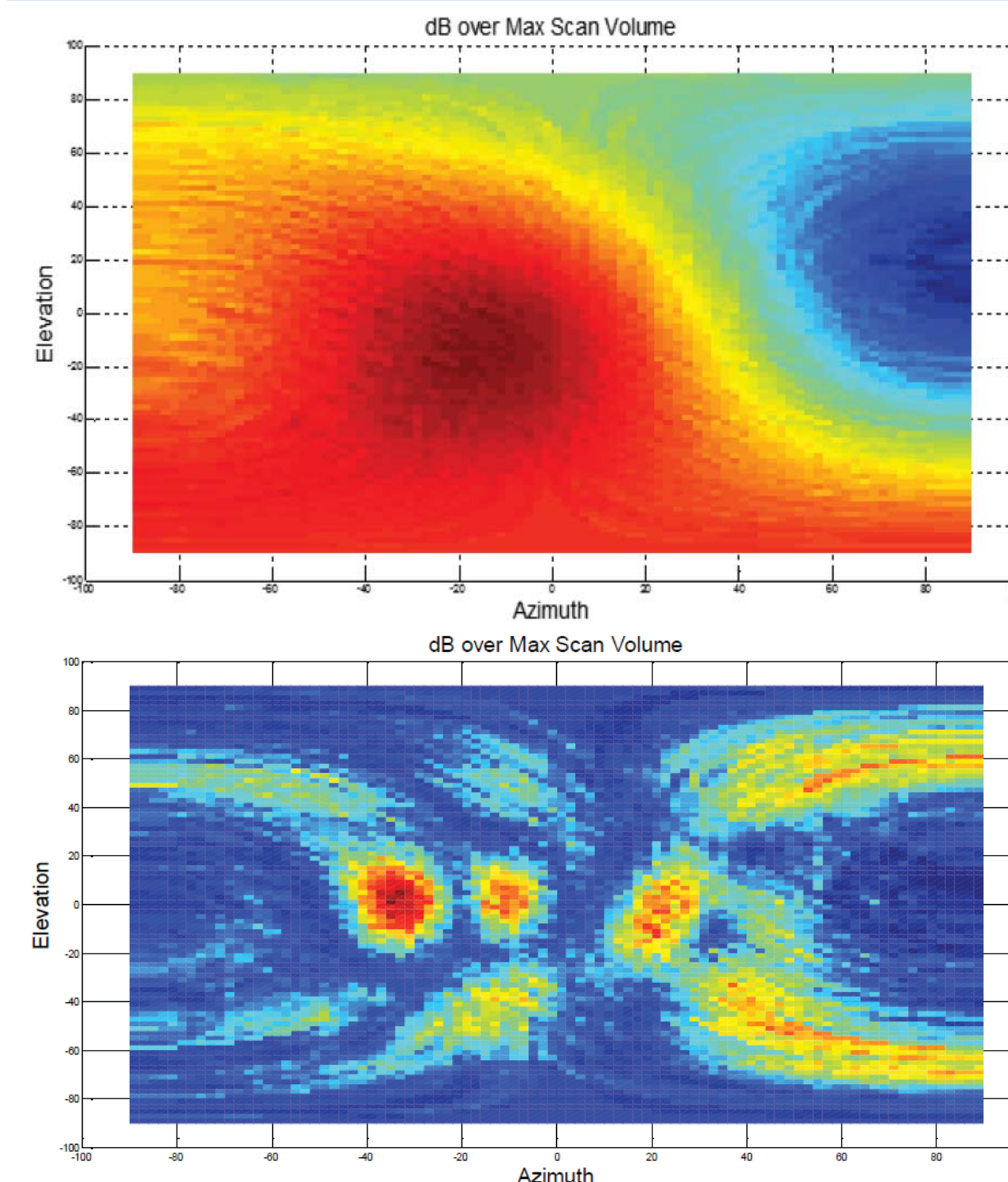
## Testing Procedure



## Hardware and Software Components

- 32 microphones mounted in a grid pattern to make up an array with 1.3" spacing in azimuth and elevation.
- National Instruments analog to digital converter.
- Matlab and Python used for data collection and signal processing.
- Electronic steering using Matlab.

## Electronic Scan Beam Plot



These plots show more steering error as well as false amplitude detections. More investigation is needed.

## Acknowledgements

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*Special Thanks:*

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