IEEE AESS Radar Challenge 2025

High-Resolution FMCW Radar for Non-Destructive Testing of RAAC Structures

Phaser Pharaohs team

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Project Overview

Objective:

Modify the Analog Devices CN0566 Phaser radar platform and use it for the non-destructive Testing (NDT) of Reinforced Autoclaved Aerated Concrete (RAAC) panels.

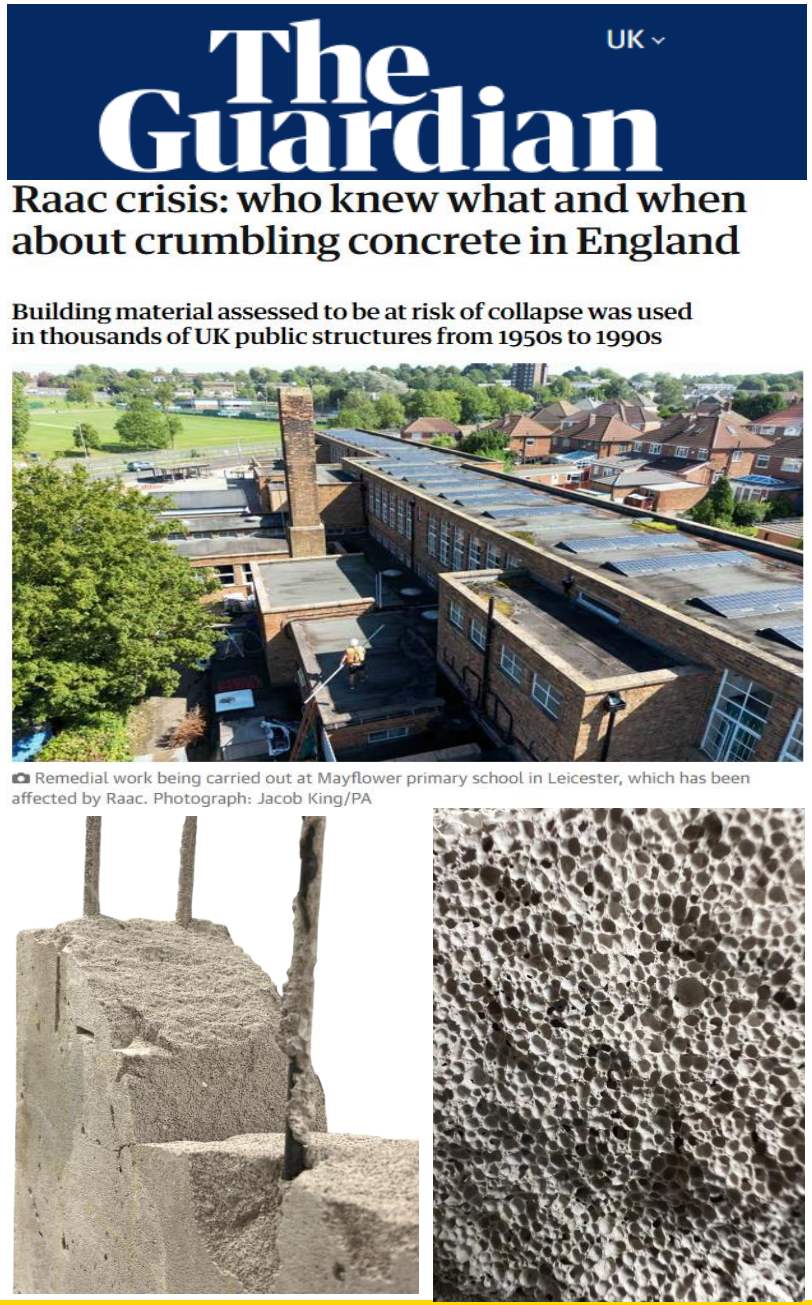
Motivation:

- RAAC is porous, absorbs moisture, and leads to **steel rebar corrosion**.
- Its **short lifespan (~30 years)** and hidden failure modes pose safety risks.
- Current inspection methods are limited or destructive.

Project Goal:

Leverage **beamforming + bandwidth expansion** to:

- Achieve **5 cm range resolution** and **fine angular resolution**
- Build a prototype system for **RAAC imaging at short range (<1 m)**


The Guardian

UK

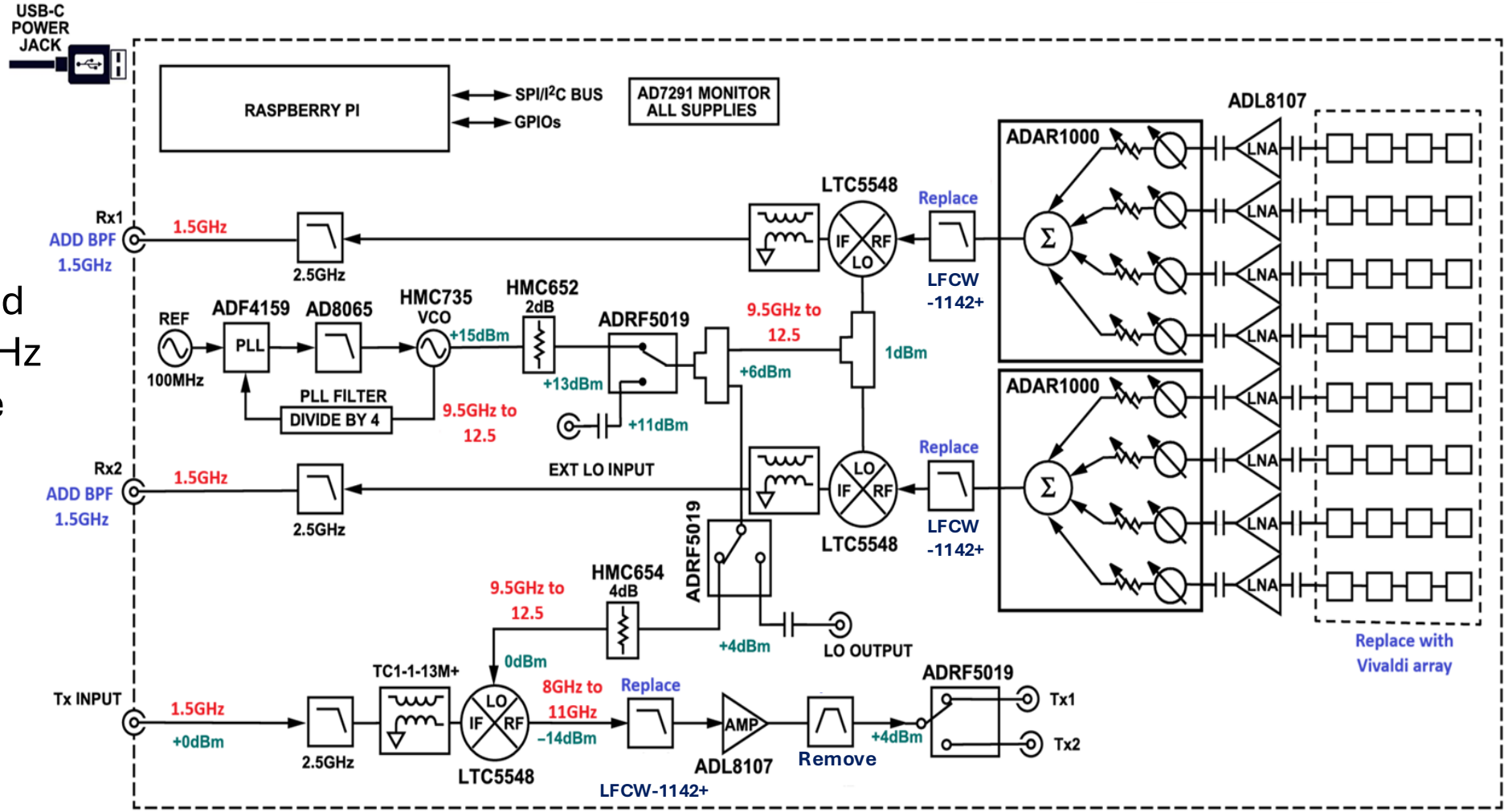
Raac crisis: who knew what and when about crumbling concrete in England

Building material assessed to be at risk of collapse was used in thousands of UK public structures from 1950s to 1990s

Remedial work being carried out at Mayflower primary school in Leicester, which has been affected by Raac. Photograph: Jacob King/PA

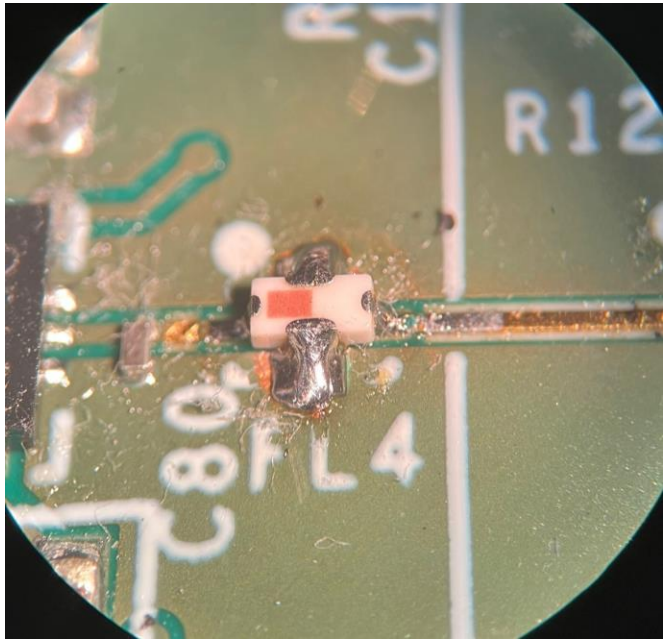
Proposed Modifications

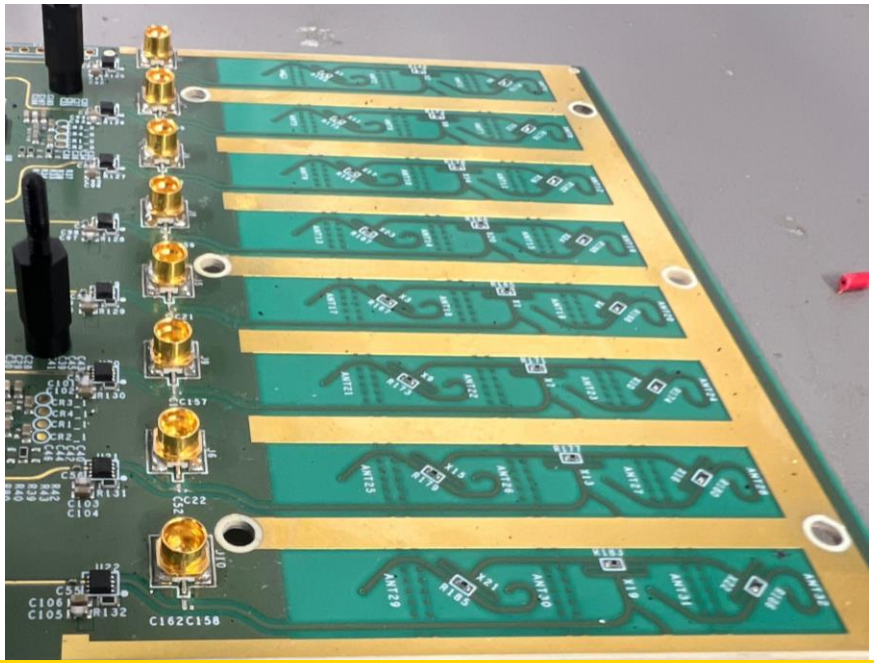
Proposed Hardware modifications to expand usable BW from 500 MHz to 3 GHz → ~5 cm range resolution.

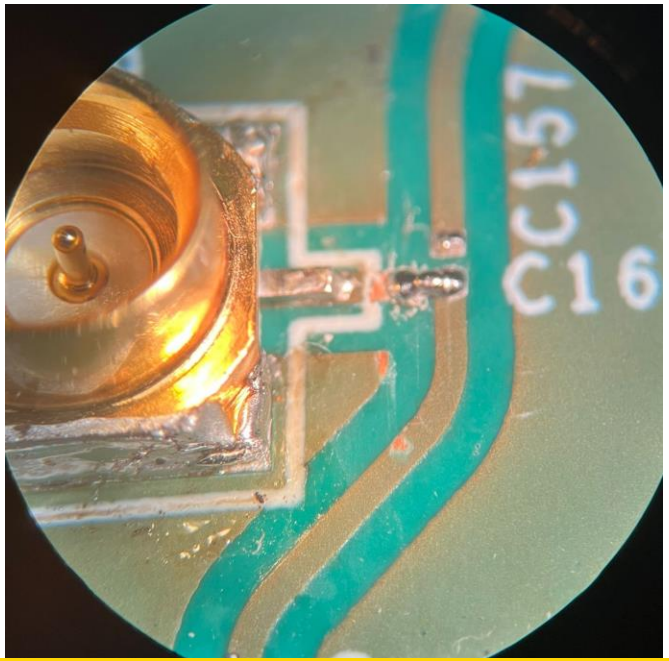


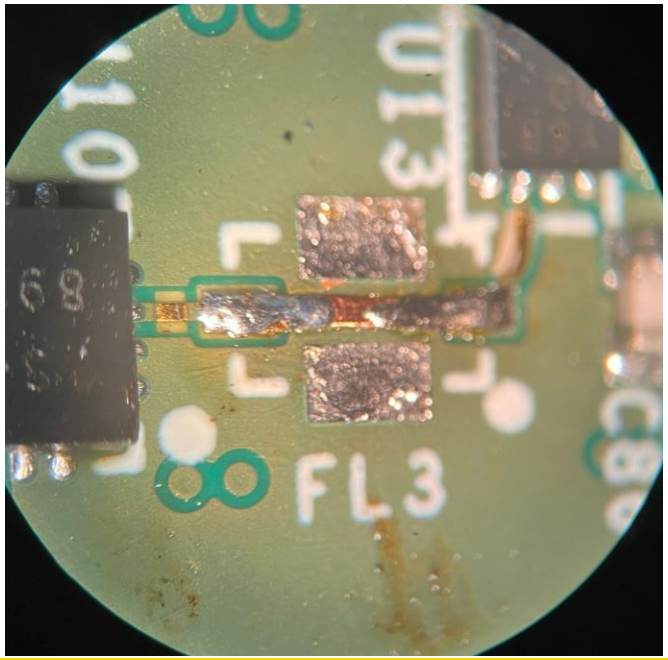
Hardware Modifications

1. Change filters to match the new operating frequency band (8-11GHz).
2. Change the RF route to the onboard connectors.
3. Attach the RF connectors for the external antenna array.





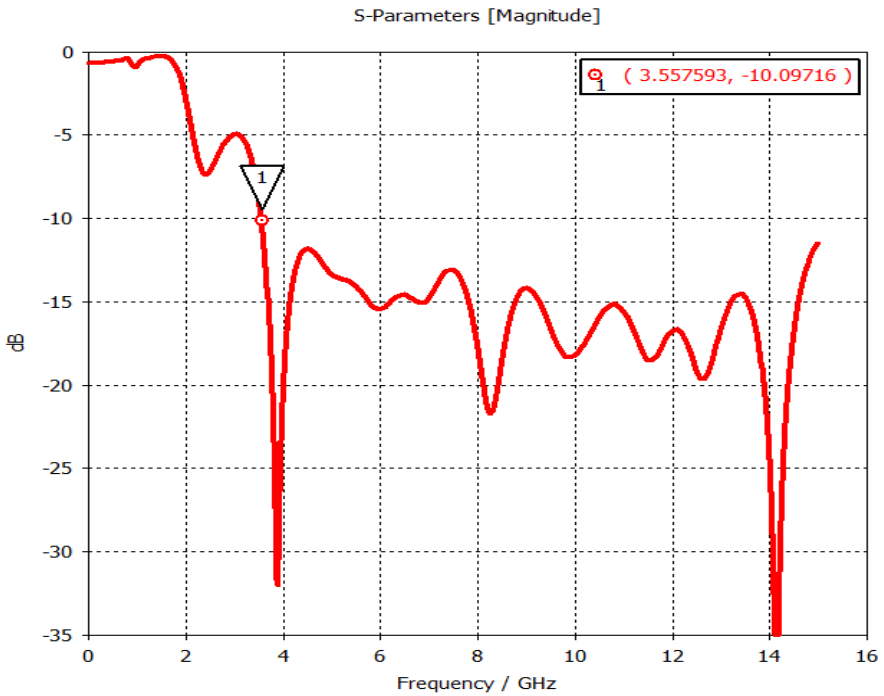


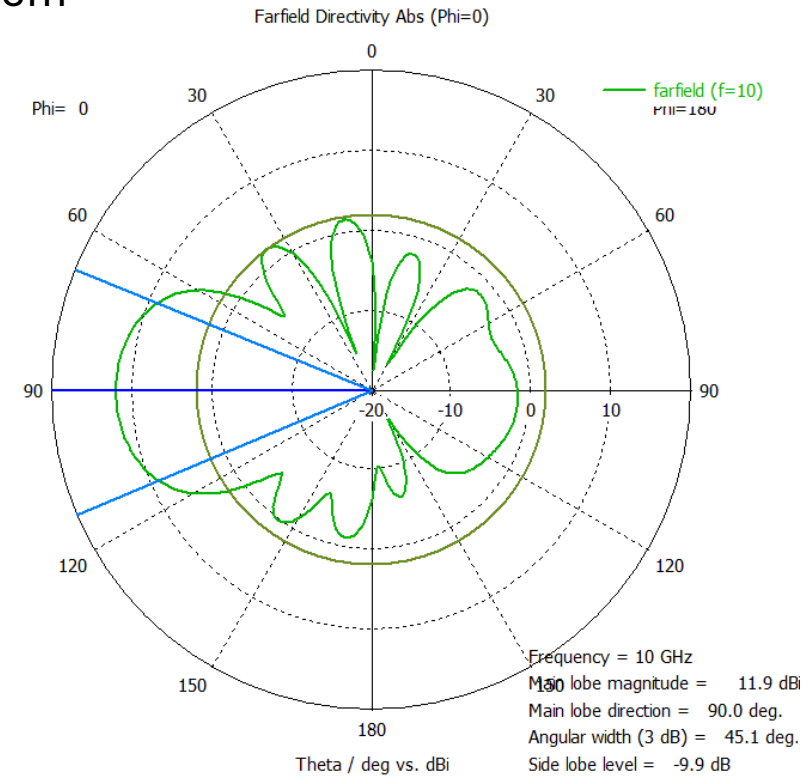


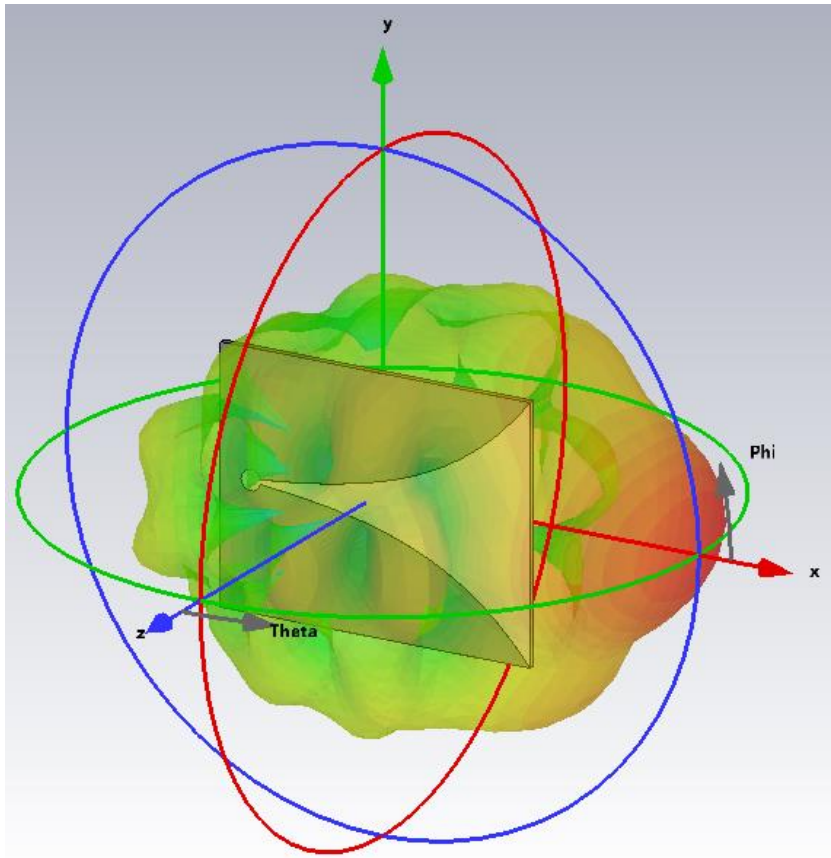
Receiving Antenna Array

Vivaldi antenna element:

- Operating between 3.5GHz to 15Ghz
- Gain : 12dBi @10GHz
- Antenna dimensions: 6.2×7.8 cm
- Main side lope level: -10dB



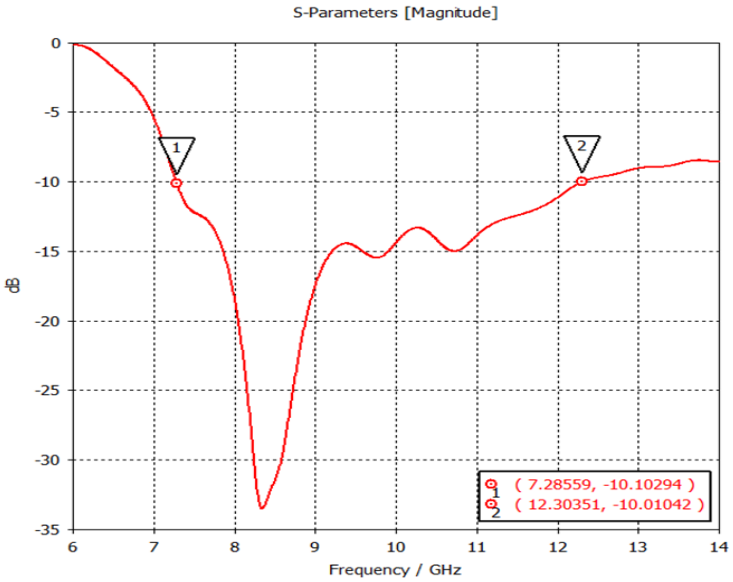


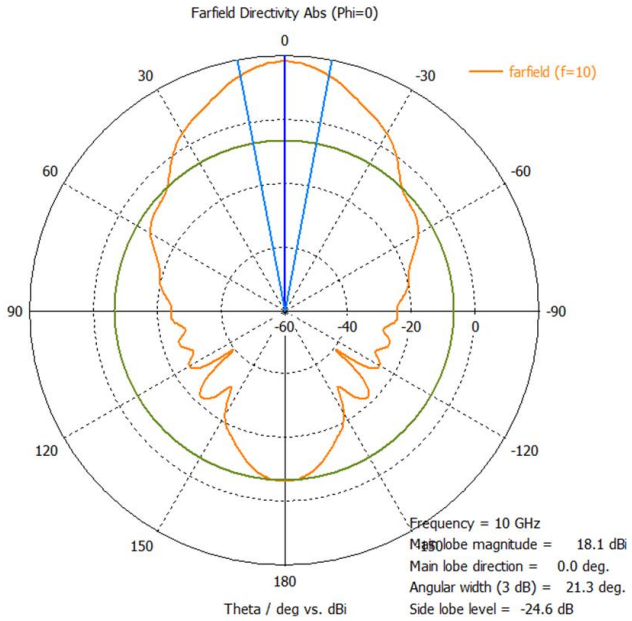


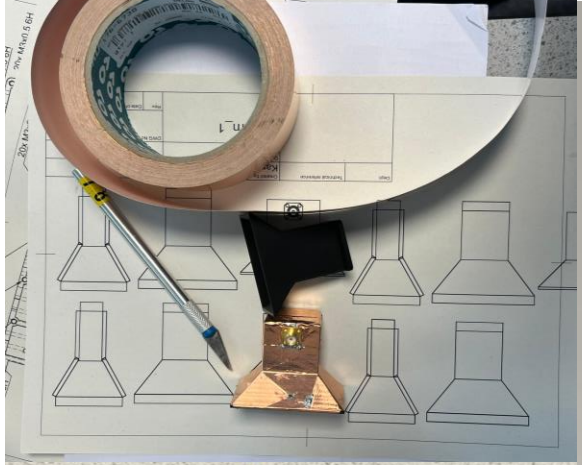
Transmitting Horn Antenna

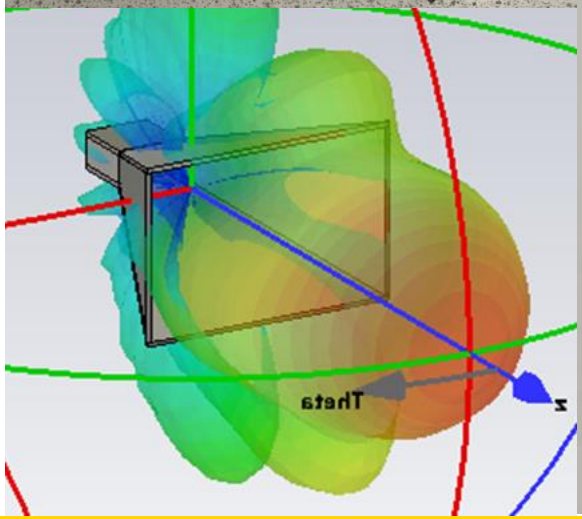
We design and fabricate two Horn antennas (Gain 18 &12 @ 10GHz)
For this application, we will use the high-gain Horn

- Operating between 7.3 – 12.3 GHz
- Gain: 18 dBi @10GHz
- Main to side lope level: -24.6 dB @10GHz
- Antenna dimensions: 7.5×11×12 cm



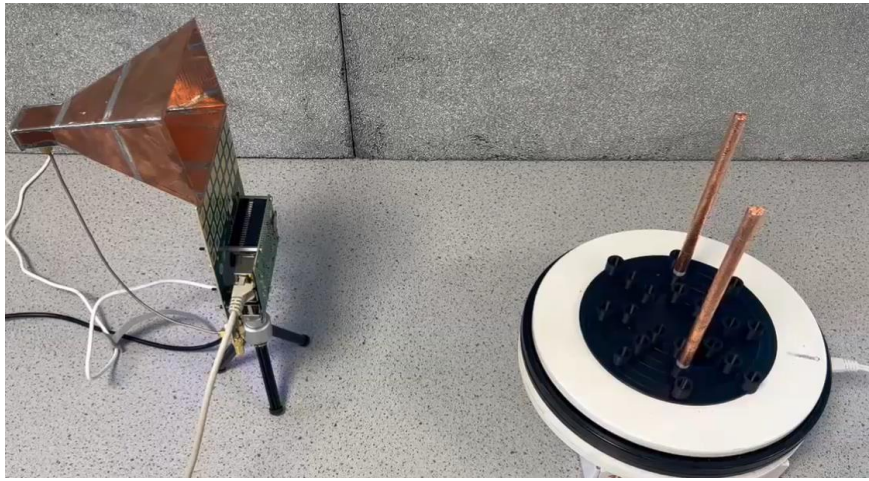






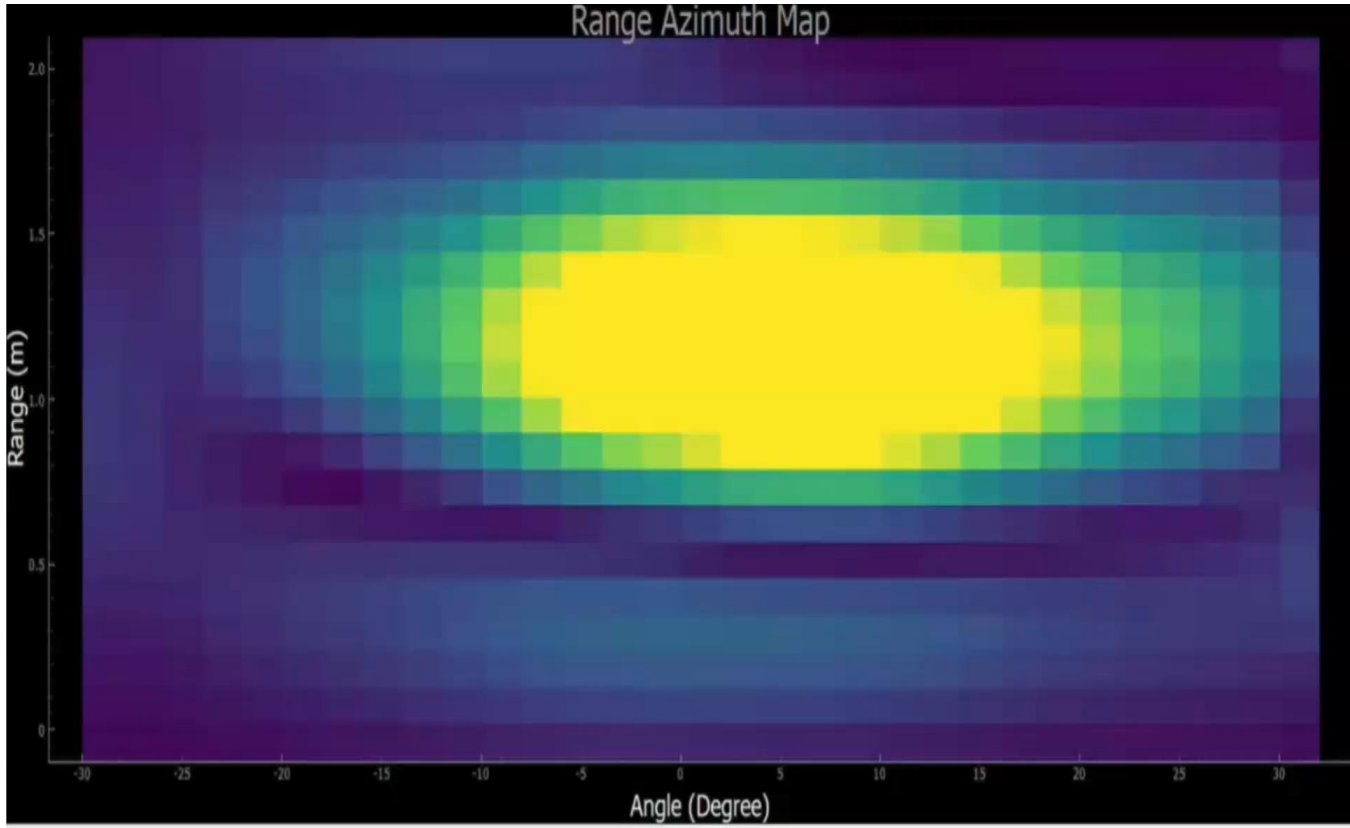
Standard Configuration

Tapered beam steering / BW 500 MHz



Radar:
TX: single 18 dBi Horn antenna
RX: Standard patch array
BW: 500 MHz
Fc: 10.25 GHz

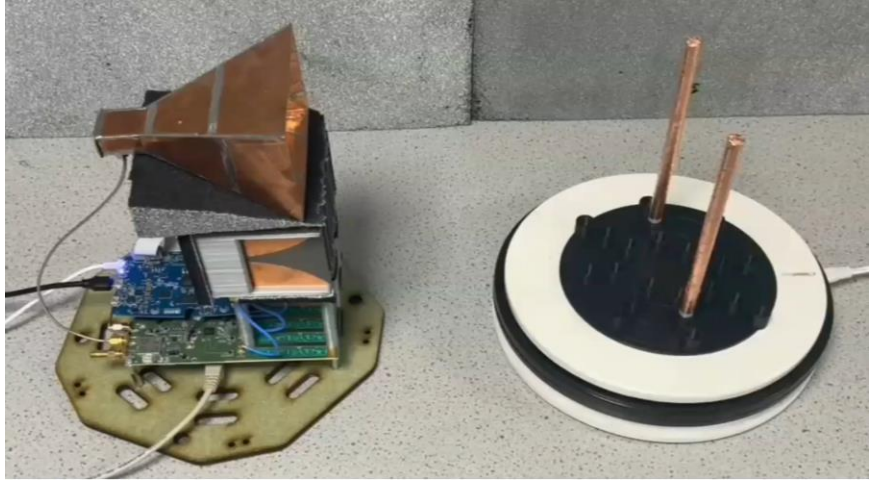
Target:
Range ~30 cm
Separation = ~10 cm



MANCHESTER 1824

High Range Resolution Configuration

Tapered beam steering / BW 3000 MHz



Radar:

TX: single 18 dBi Horn antenna

RX: 8-element 12dBi Vivaldi array

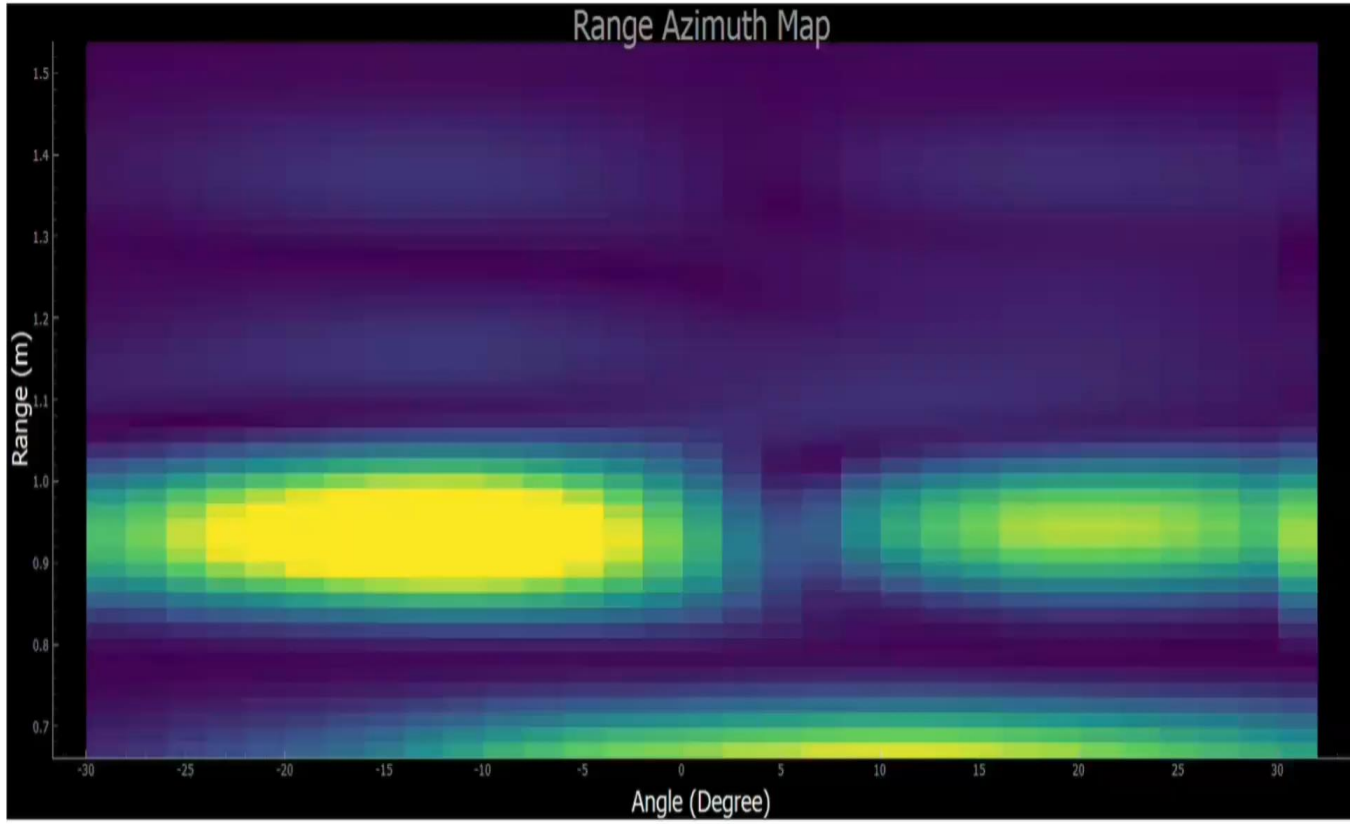
BW: 3000 MHz

Fc: 9.5 GHz

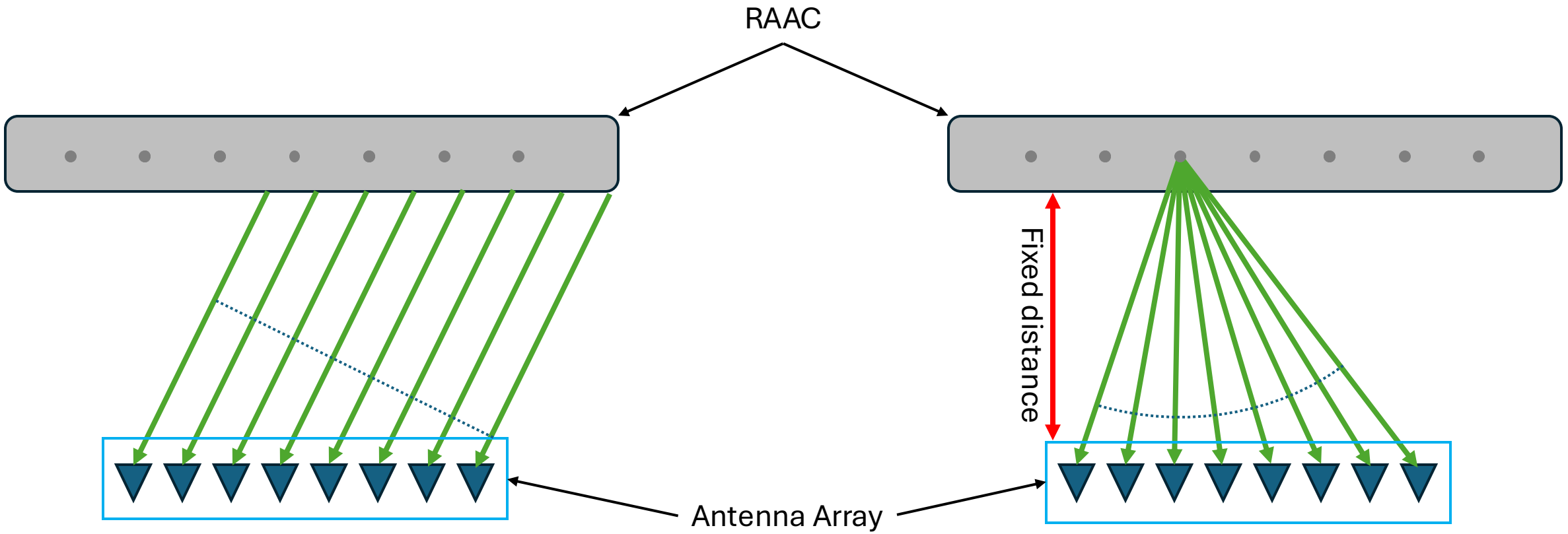
Target:

Range ~30 cm

Separation = ~ 10 cm

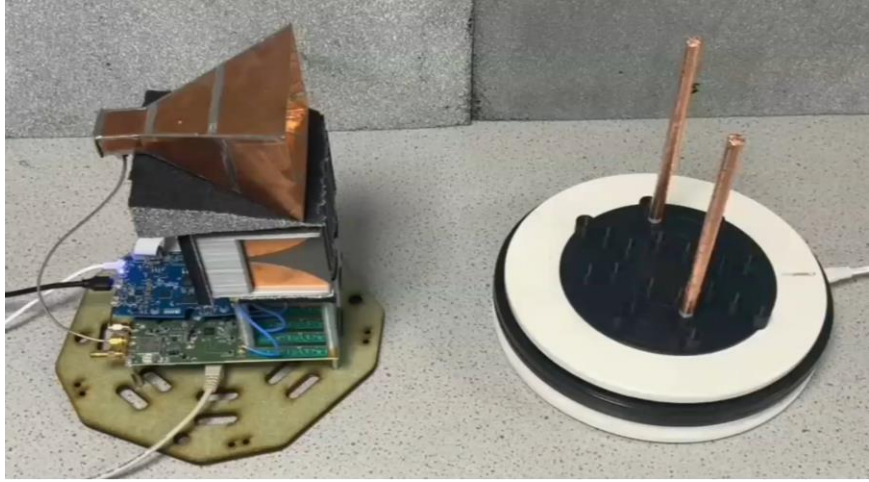


Plane-wave beam steering vs Focused beam steering



High Range Resolution Configuration

Focused beam steering / BW 3000 MHz



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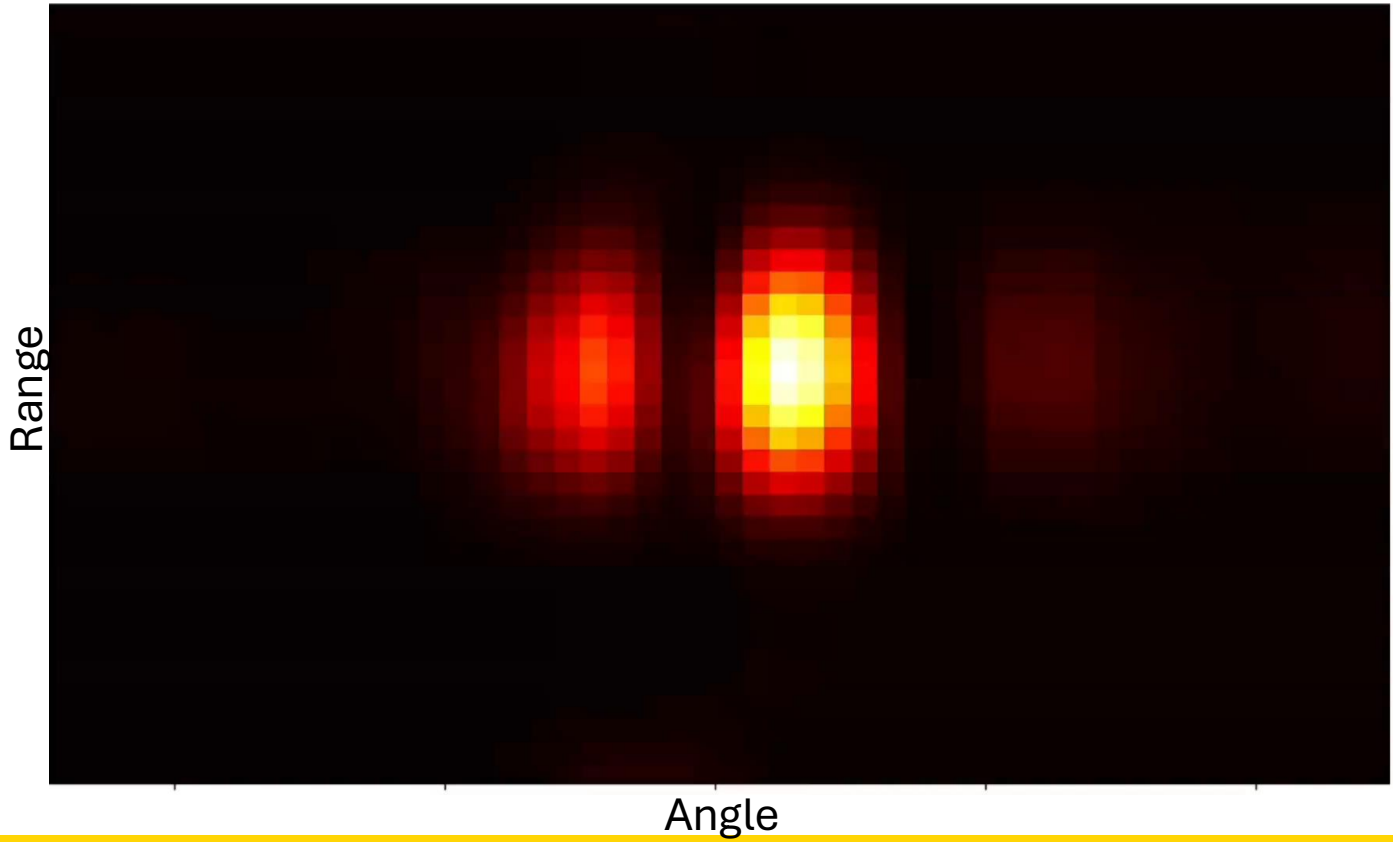
Target:

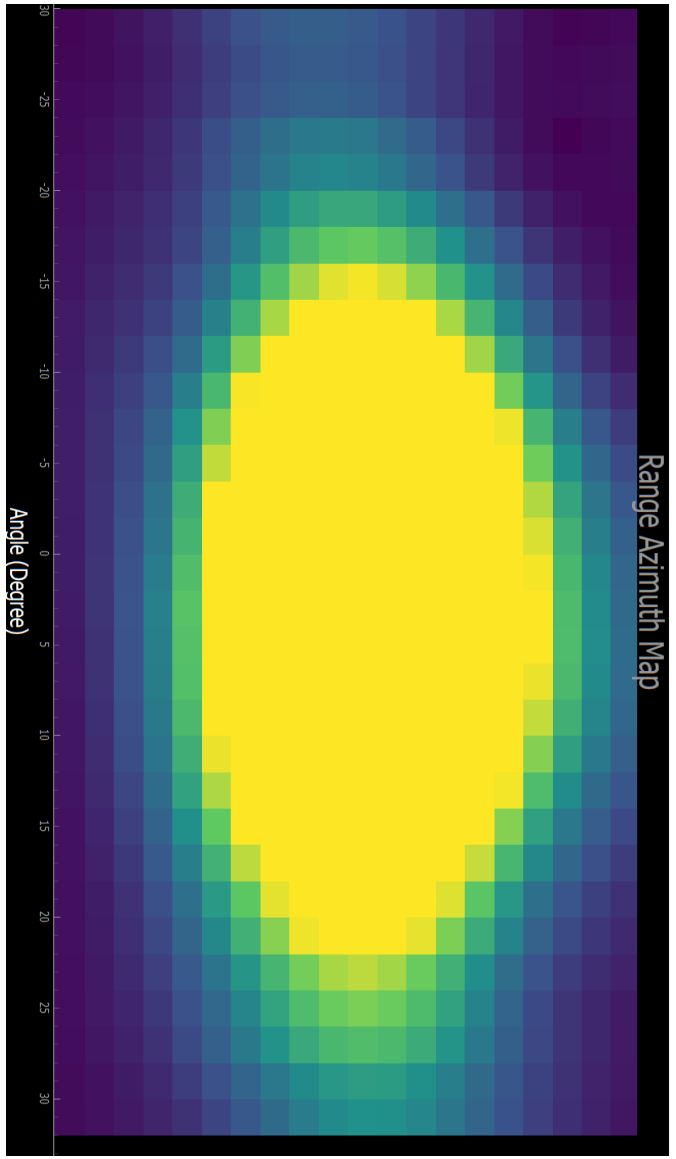
Range ~30 cm

Separation = ~ 10 cm



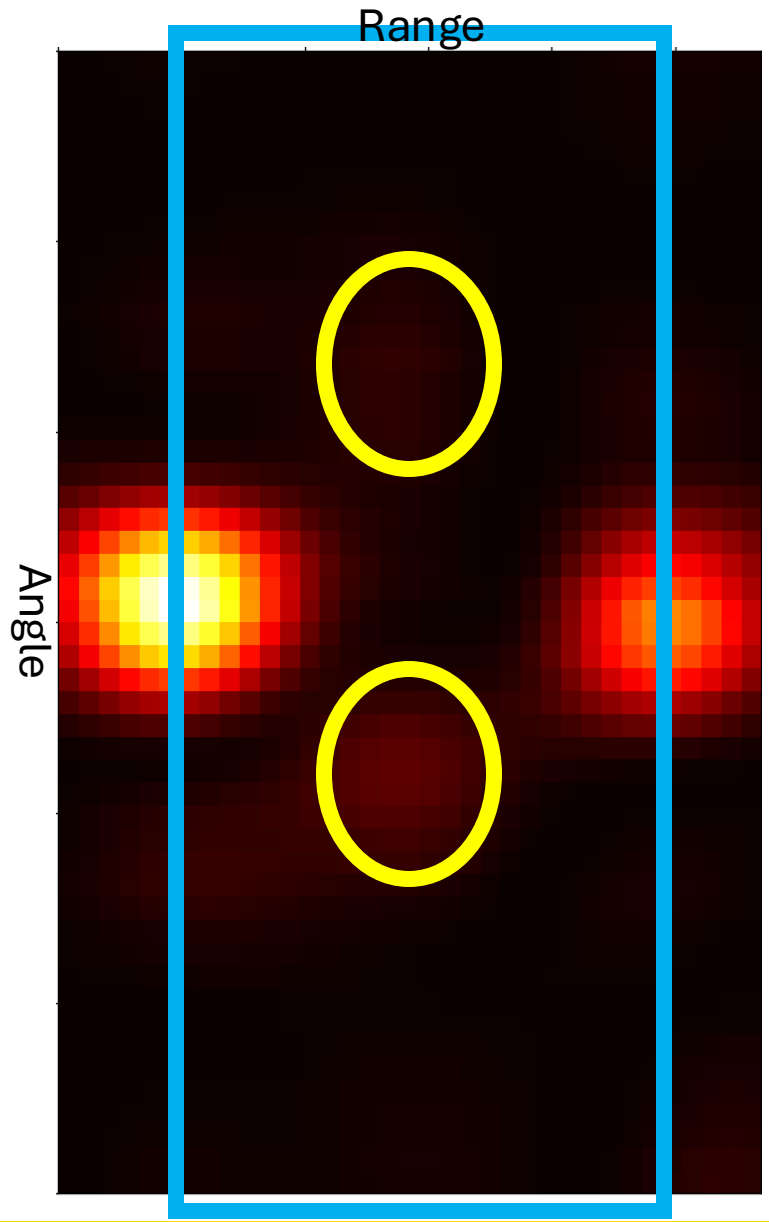
Inspecting a Sandbox with Two Metal Rods

Tapered beam steering / BW 500 MHz



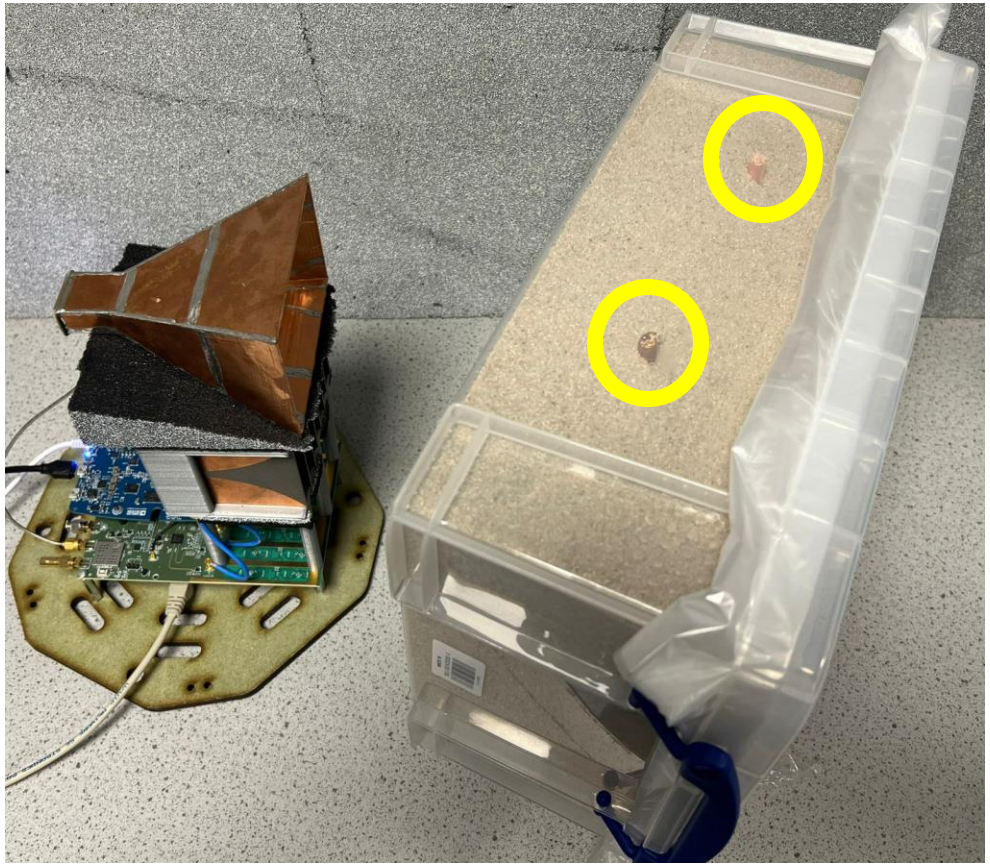
Inspecting a Sandbox with Two Metal Rods

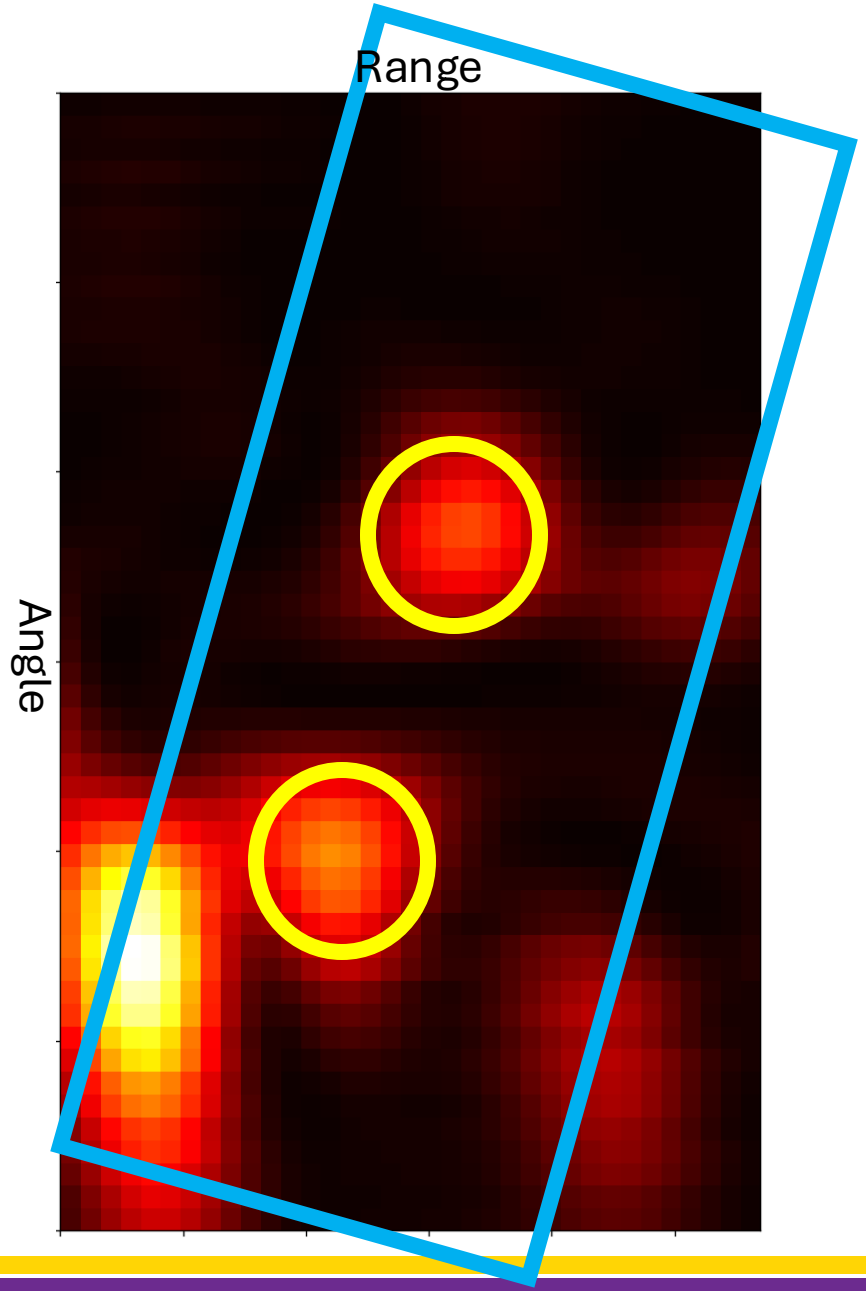
Focused beam steering / BW 3000 MHz



Inspecting a Sandbox with Two Metal Rods

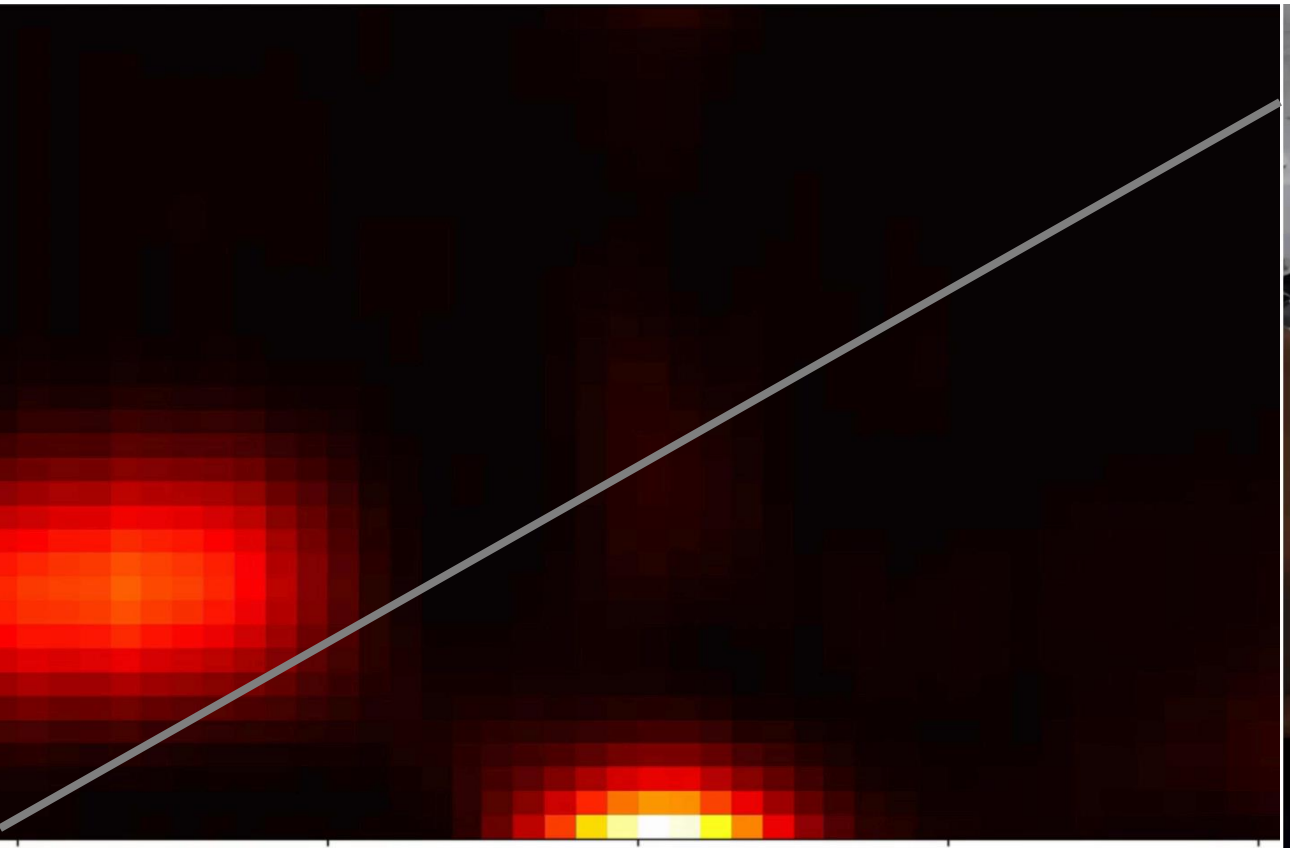
Focused beam steering / BW 3000 MHz

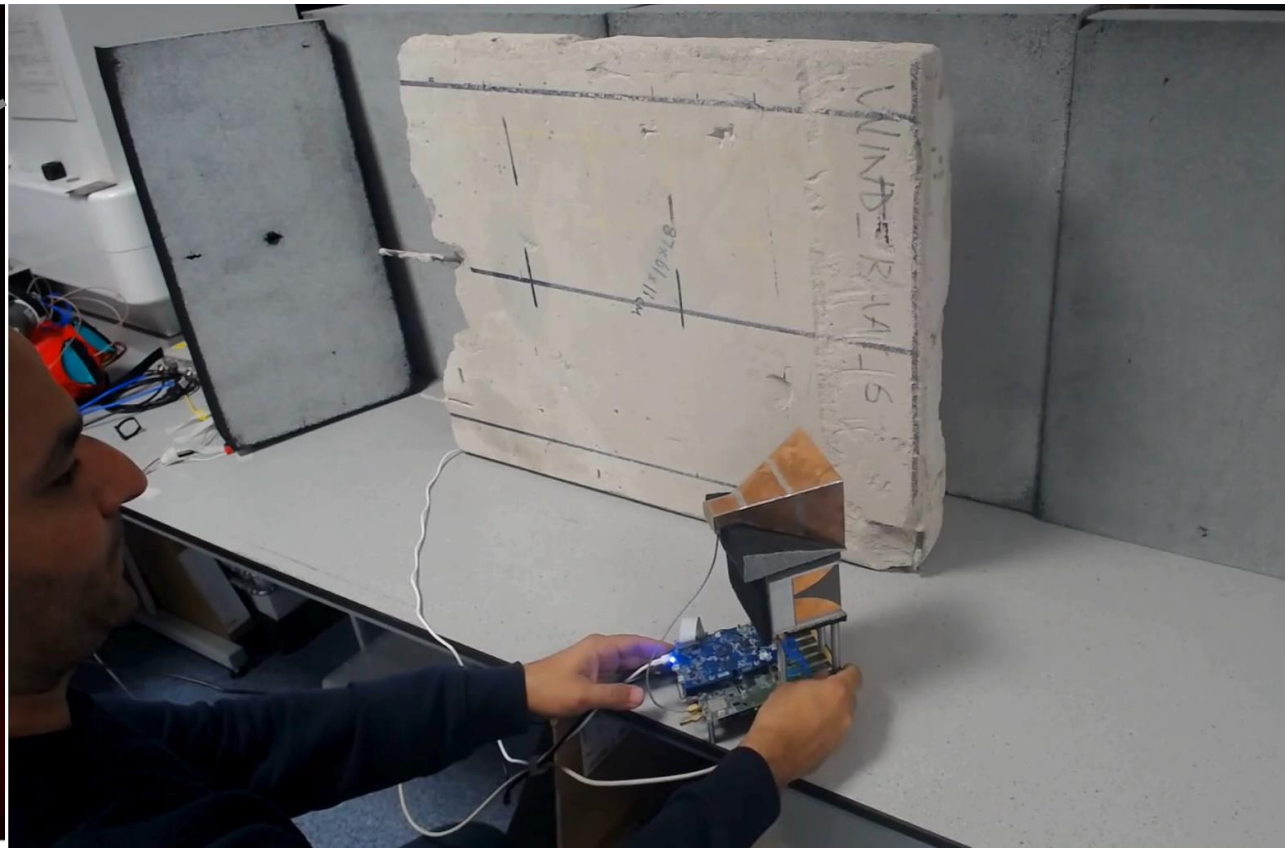




Inspecting Steel Reinforcement of a RAAC Sample

Focused beam steering / BW 3000 MHz





Conclusion and Future work

You could add something on combining the array with SAR
conclusion that the Phasor platform could be ideal for a host of new, very short-range radar applications in NDT