



Development of A Shared C-band Mobile Polarimetric Atmospheric Imaging Radar (PAIR)

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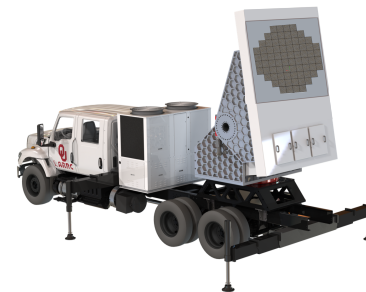
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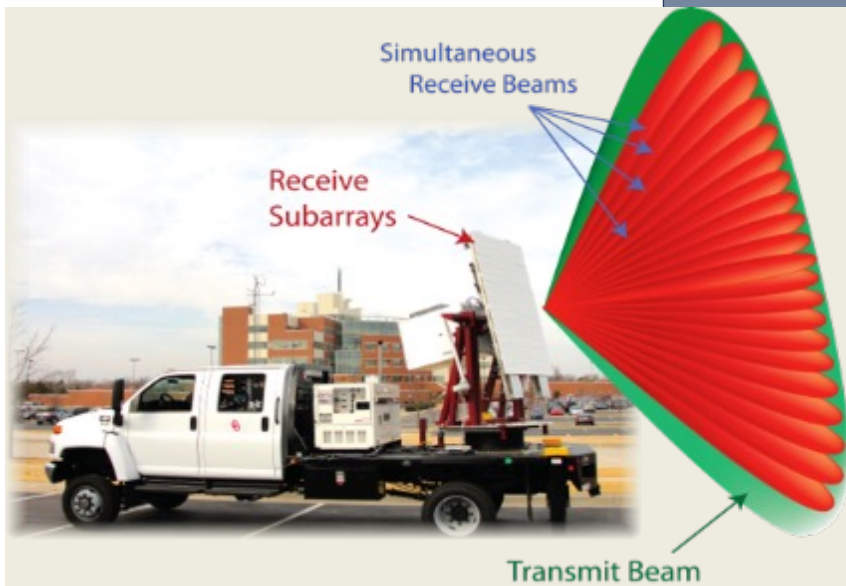


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What is an Imaging Radar ?



Imaging Radar:

Digital beamforming allows *simultaneous* measurements within the field of view (FOV) of the radar with an infinite number of beams: *ultra-high temporal resolution*



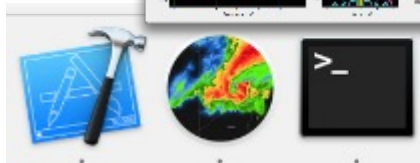
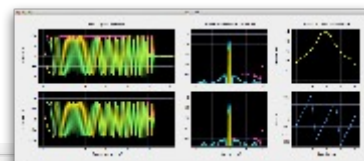
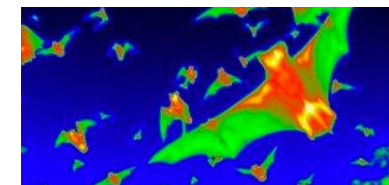
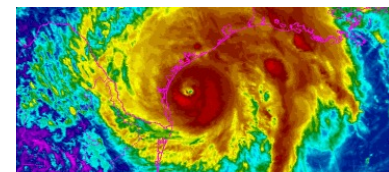
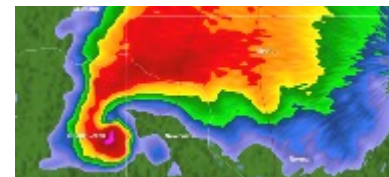
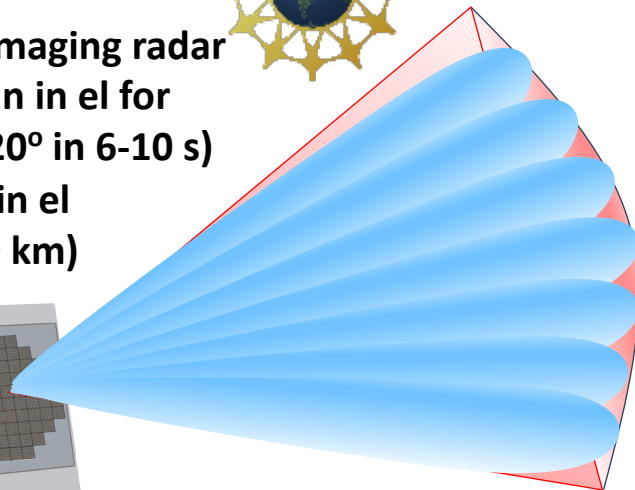
Polarimetric Atmospheric Imaging Radar (PAIR)



NSF-MRI Grant for development



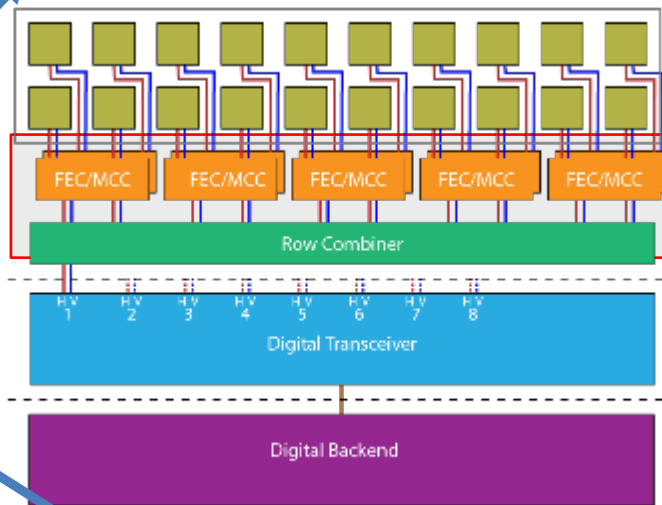
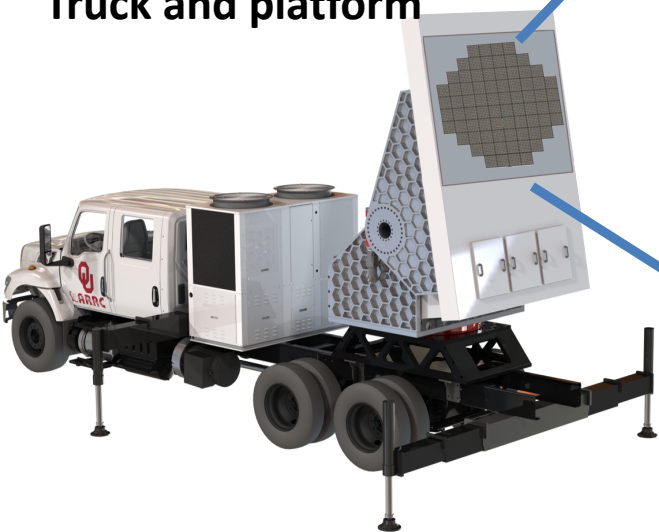
- Mobile, C-band, Polarimetric Imaging radar
- Digital beamforming and e-scan in el for ultra-high update time ($360^\circ \times 20^\circ$ in 6-10 s)
- E-scan pencil or spoiled beam in el
- High sensitivity (-2.9 dBZ @ 10 km)





PAIR subsystems

Truck and platform



Antenna

A full antenna panel is
8 x 8 elements

RF Front End

Consists of row combiner,
core chip and GaN front end

Digital Transceiver

Converts from C-band to digital I &
Q baseband signals

Backend

Stores all raw I & Q for post
processing and generates a limited
number of real time products

RF front end is developed In
collaboration with Rfcore, Korea





PAIR Array



Truncated Array Corners

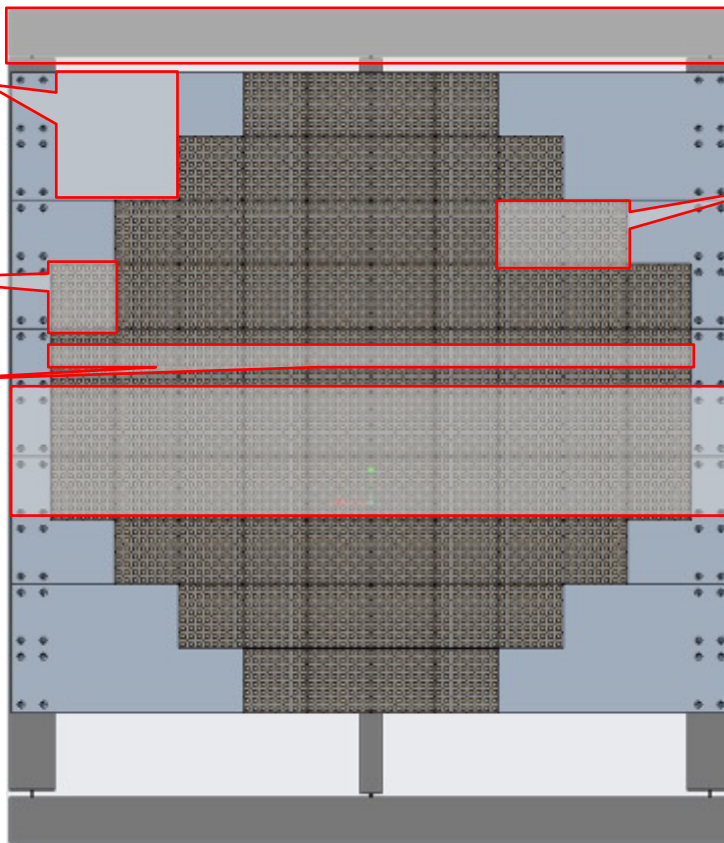
Corner elements are less critical for array performance and can be removed for cost and power reasons

Radiator Panel

Antenna Radiator Panel is 8 x 8 array of dual-pol elements

Analog Subarray

One subarray of 160 elements (80 x 2) with an analog beamformer. Each analog subarray is digitized individually



Structural Frame

Rigid steel structure supports array and forms the core of the array enclosure.

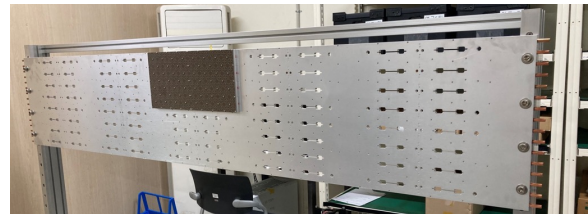
Electronics Subarray

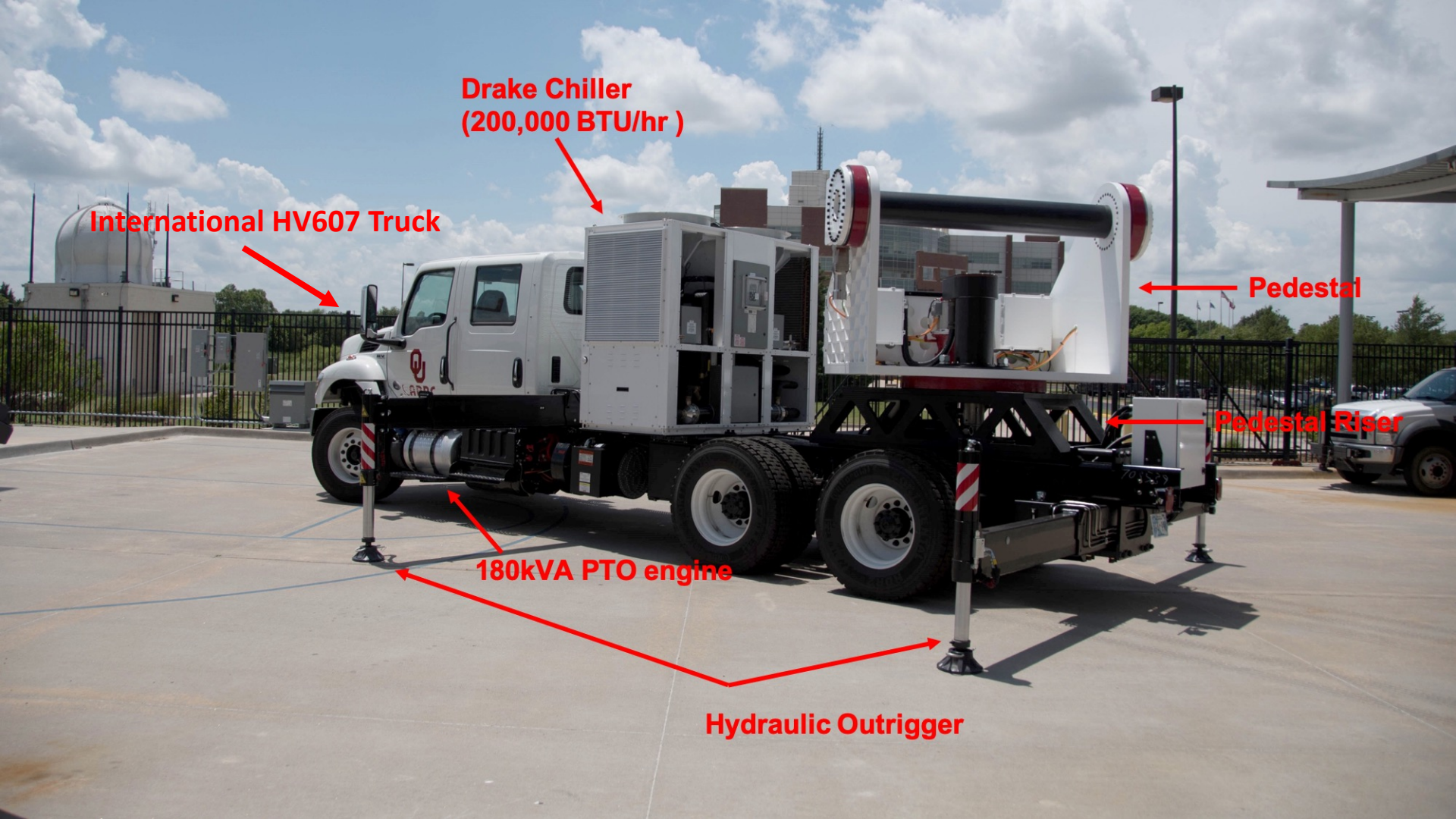
2x antenna tiles, 8x TRMs, and a subarray beamformer make up a single subarray



Cold Plate

Spans entire array. Gets mounted to the frame and never removed. Electronics Subarrays mount to the cold plate and are removable.





**Drake Chiller
(200,000 BTU/hr)**

International HV607 Truck

Pedestal

Pedestal Riser

180kVA PTO engine

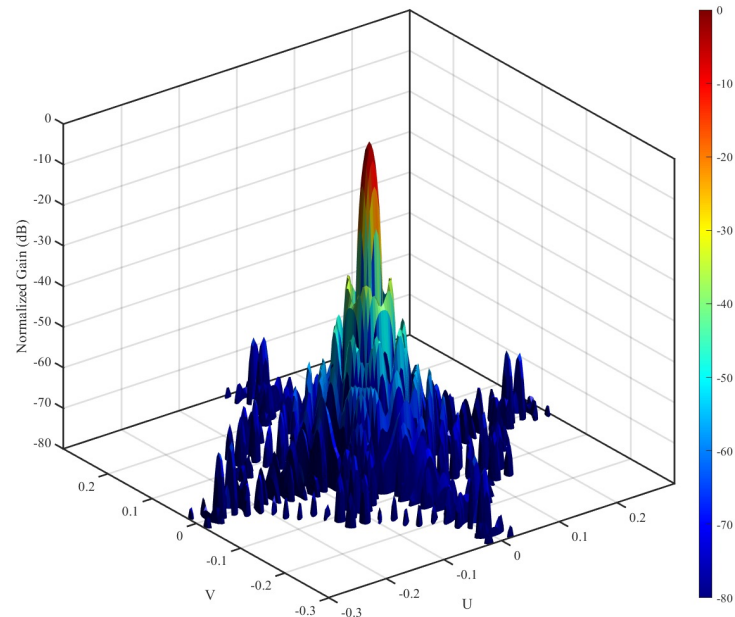
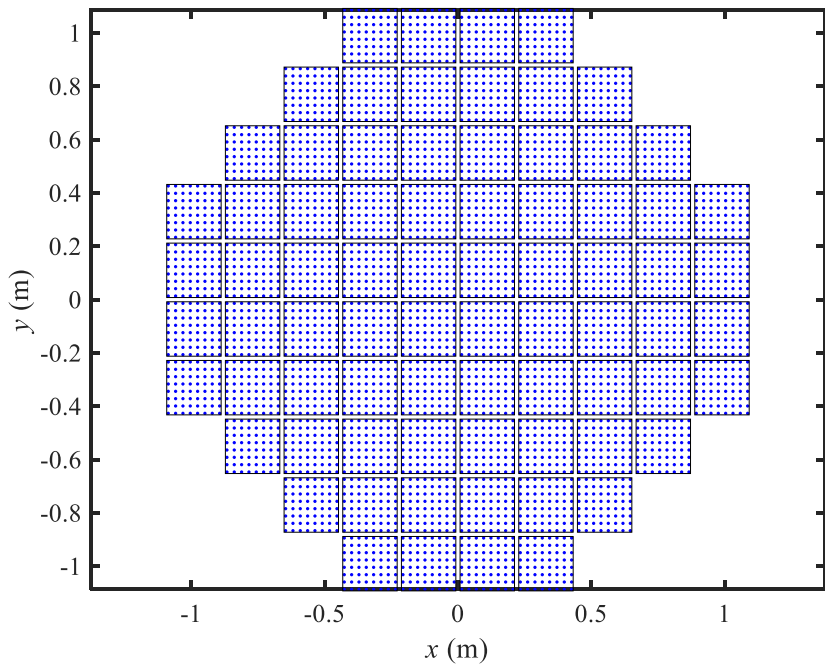
Hydraulic Outrigger



PAIR Pencil Beam (HPBW=1.5°)



PAIR Antenna



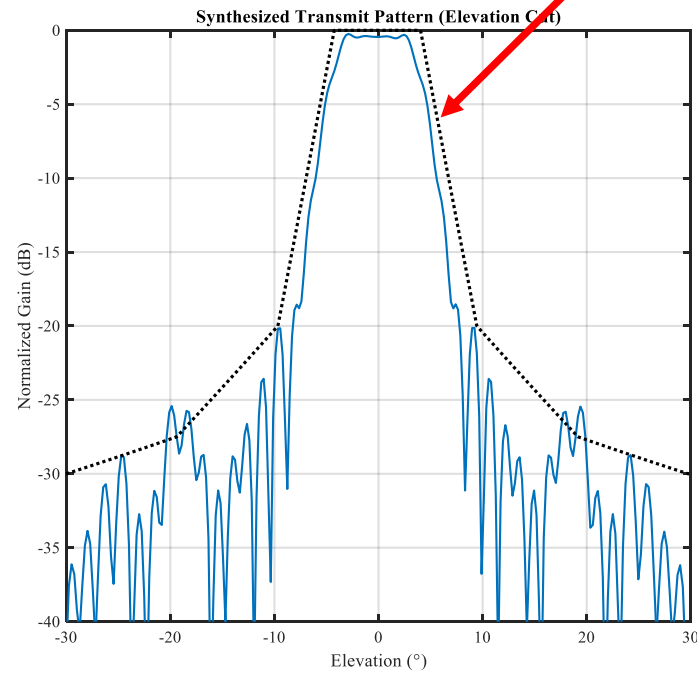
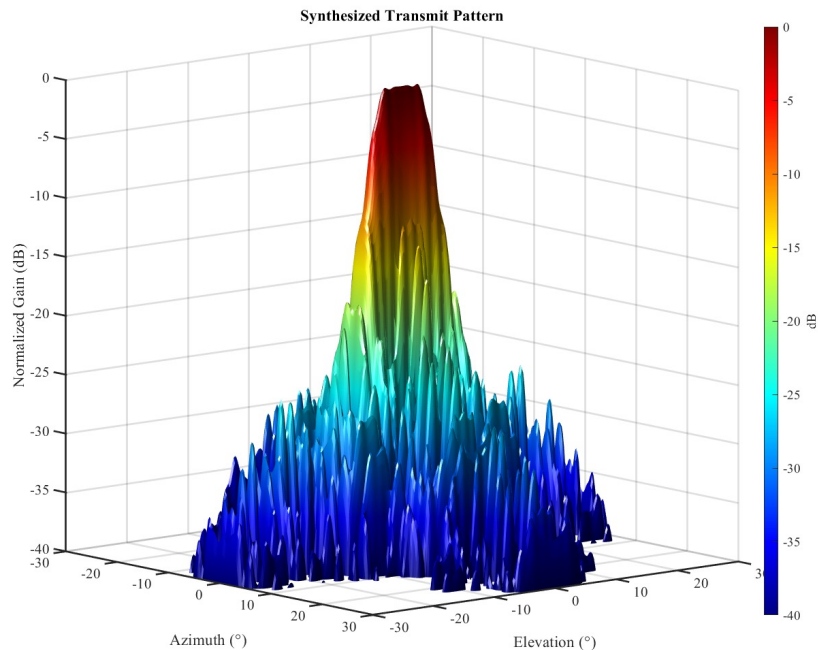


PAIR Spoiled Beam



Symmetric Pattern (HPBW: 8 deg)

Design mask



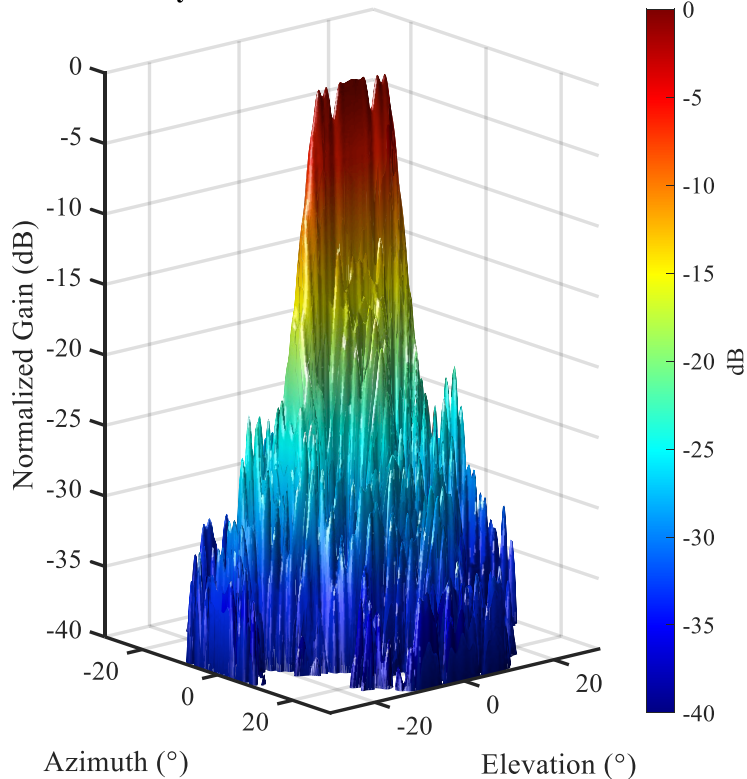


PAIR Spoiled Beam

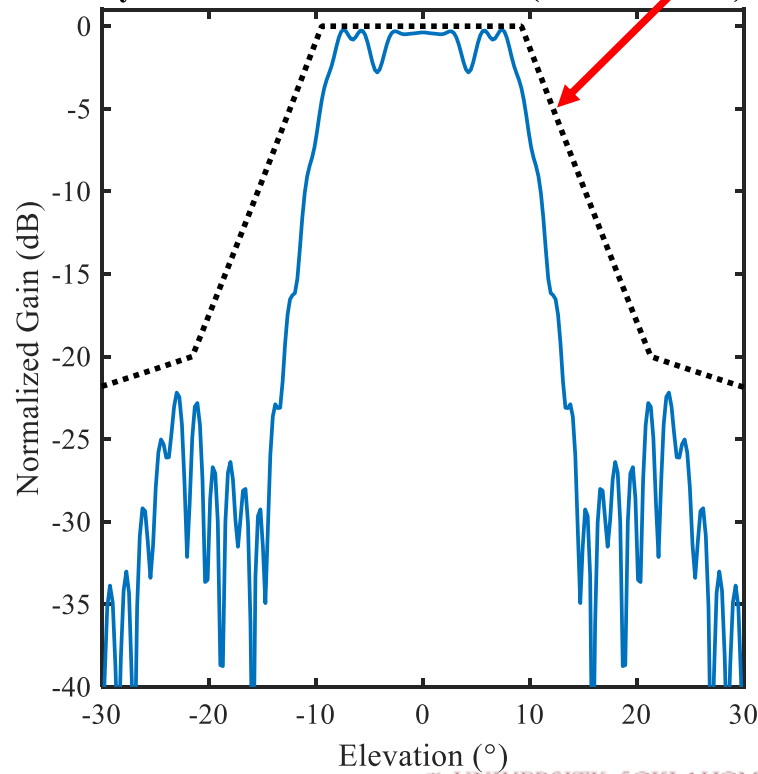


Symmetric Pattern (HPBW: 18.5 deg)

Synthesized Transmit Pattern



Synthesized Transmit Pattern (Elevation Cut)

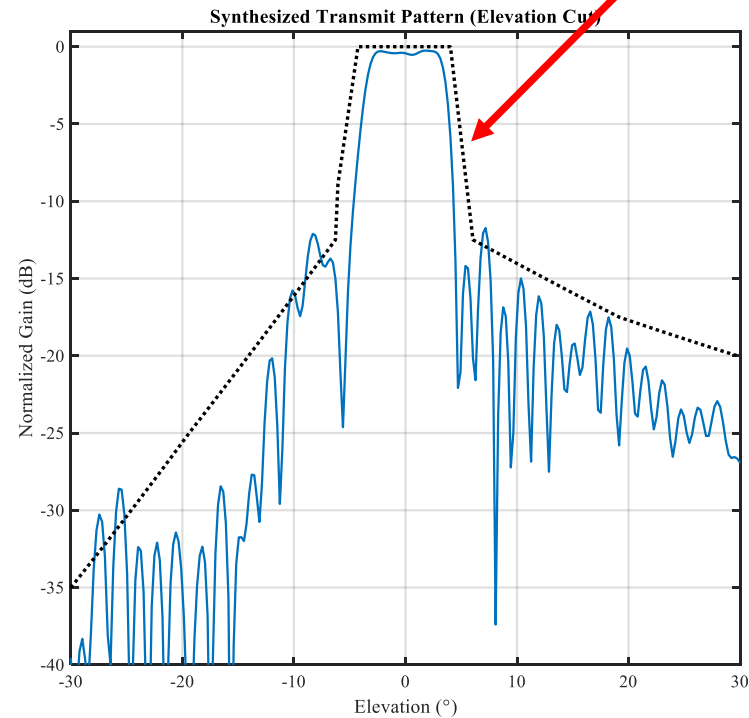
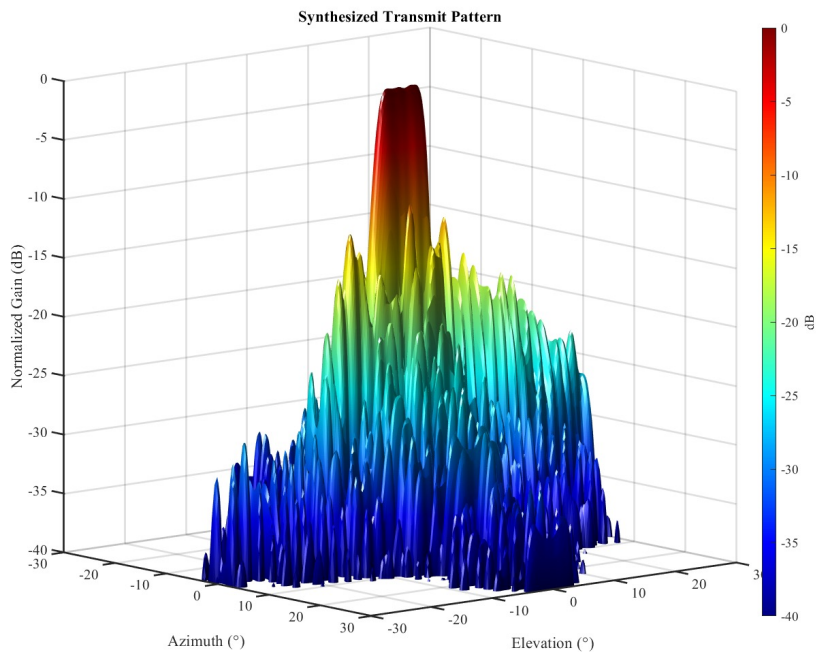




PAIR Spoiled Beam

Asymmetric Pattern (HPBW: 8 deg)

Design mask





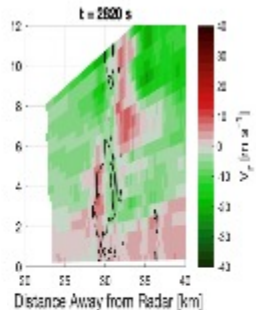
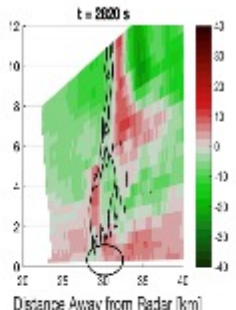
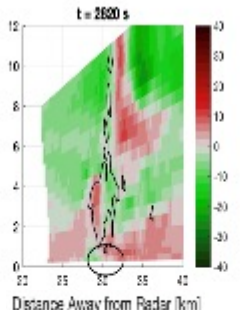
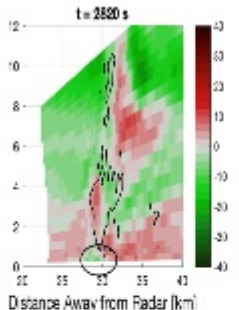
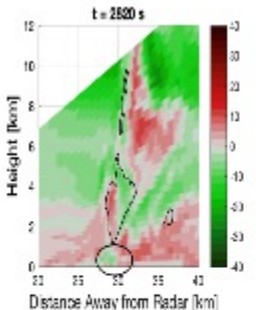
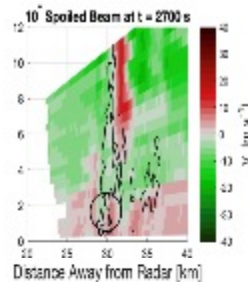
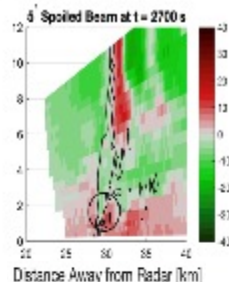
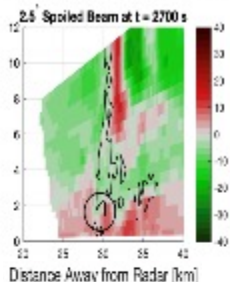
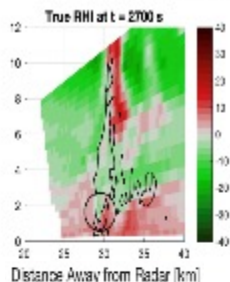
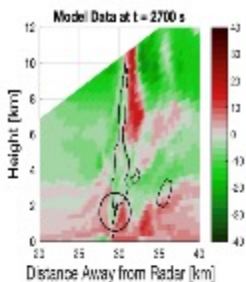
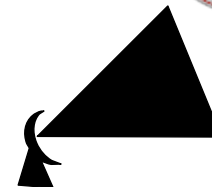
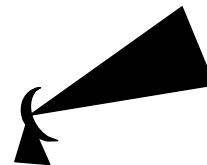
An example of different spoiling beams

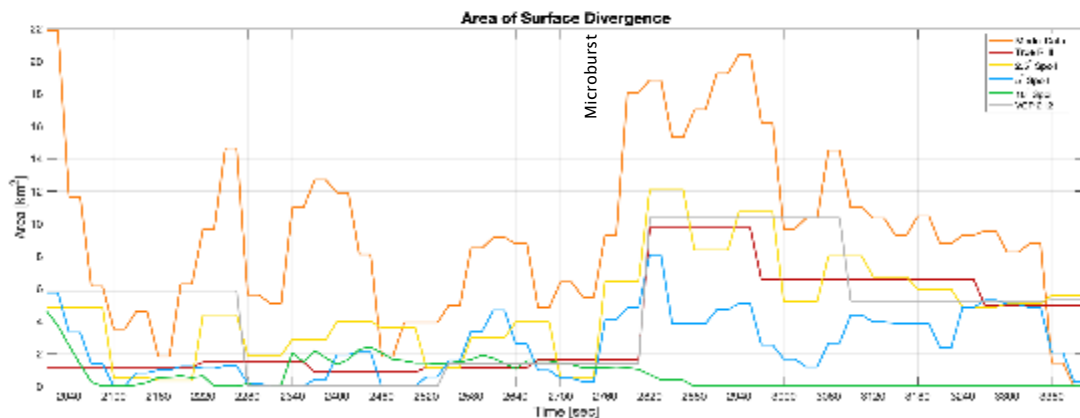
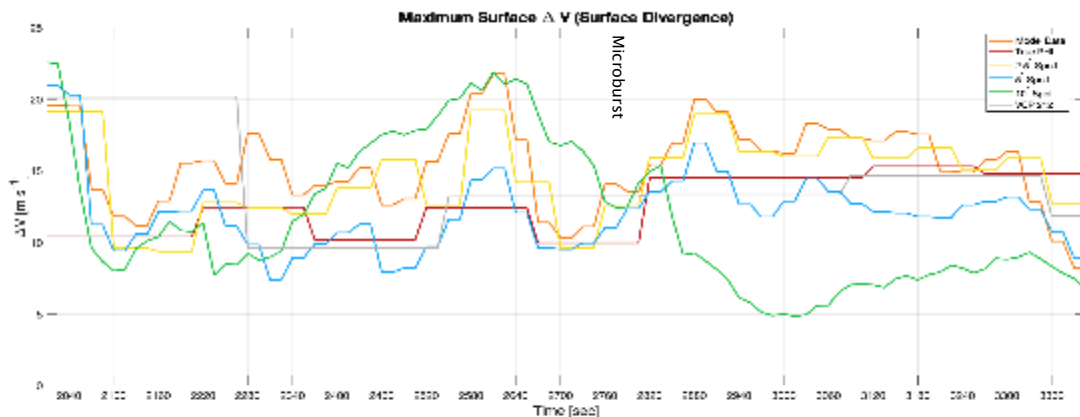


Pencil

Imaging at Varied Beamwidths

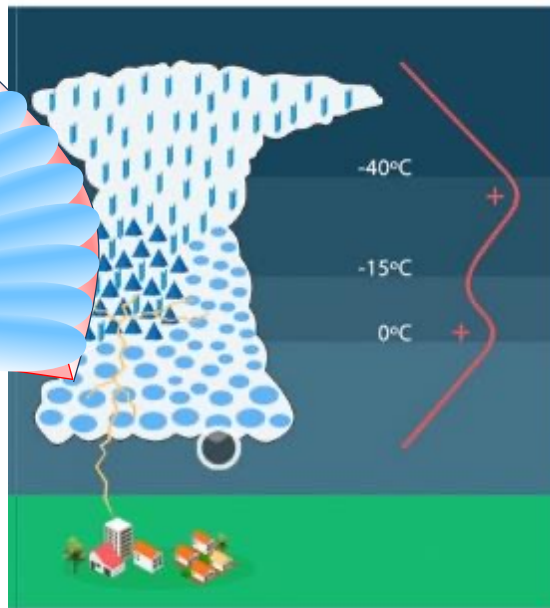
Beam







PAIR for Cloud Electrification Observations



From Mattos et al. (2016)

- Provide ultra-high temporal resolution via **imaging**
- Applying **spectral polarimetry** to further distinguish ice crystals and graupels.
- Investigation of different polarization modes (**STSR, ATSR, and circular**) @ C-band

Team:

OU: D. Schwartzman, V. Chmielewski, D. Bodine, M. Stock, and T. Yu

Texas Tech: E. Bruning



Summary



- An NSF-MRI sponsored mobile C-band polarimetric phased array radar (PAIR) is being developed at the ARRC.
- PAIR can provide simultaneous RHI scans and rapid update of volume coverage ($20^\circ \times 360^\circ$) in 6-10 sec.
- PAIR is capable of flexible polarization operations (i.e., STSR, ATSR, circular).
- The integration of PAIR is expected to be completed in Fall 2022.
- PAIR (and data) will be available for the communities.