Mobile Phased Array Weather Radars

Developments from the ARRC at the University of Oklahoma

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ARRC Technology Roadmap

Dish-Based Rotators

2000

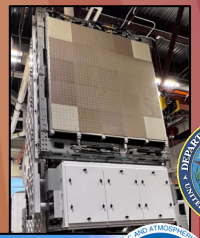
2005

First Phased Arrays

2010

2015

Digital Phased Arrays



2020

2025

Horus Phased Array Radar

S-Band, Fully Digital Polarimetric PAR Demonstrator

Now Operational

SPECIFICATIONS OF THE FULLY DIGITAL HORUS RADAR

Operating Frequency	2.7–3.1 GHz
Element Polarization	ATSR/STSR/RHCP/LHCP
Tx Waveform Type	AWG/LFM/NLFM
Tx Peak Power (single element)	10 W/polarization
Max Tx Pulse Width	100 μs @ 10% duty cycle
Max Tx Bandwidth	100 MHz
Element Spacing	0.5 λ @ 2.951 GHz
Max Number of Panels	25 (1600 dual-pol elements)
Max Electronic Scan Angle	$\pm$45° az, $\pm$45° el
Mechanical Positioner	360° az, -1–92° el
Aperture Size	2.03$\times$2.03 m^2
Tx/Rx Beamwidth Broadside	2.58° (no taper)
Total SNR Losses Tx/Rx	6.01/9.81 dB
Sensitivity (1 pulse)	4.3 dBZ @ 50 km

*Designed to be **scalable**, upgradable, maintainable and real-time operation*

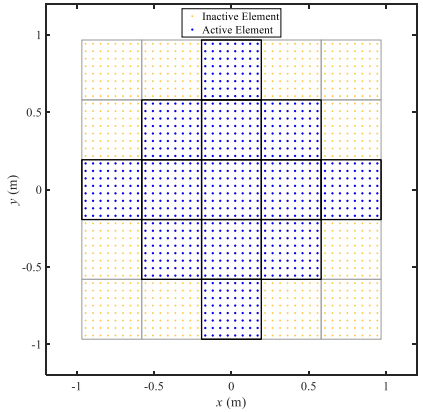
Palmer et al., *Horus – A Fully Digital Polarimetric Phased Array Radar for Next-Generation Weather Observations*, IEEE Transactions on Radar Systems, vol. 1, pp. 96-117, doi: 10.1109/TRS.2023.3280033, 2023.

Horus Weather Measurements

13-Panel Testing of Horus Scalability

8 August 2023

13-Panel Array (832 Channels)



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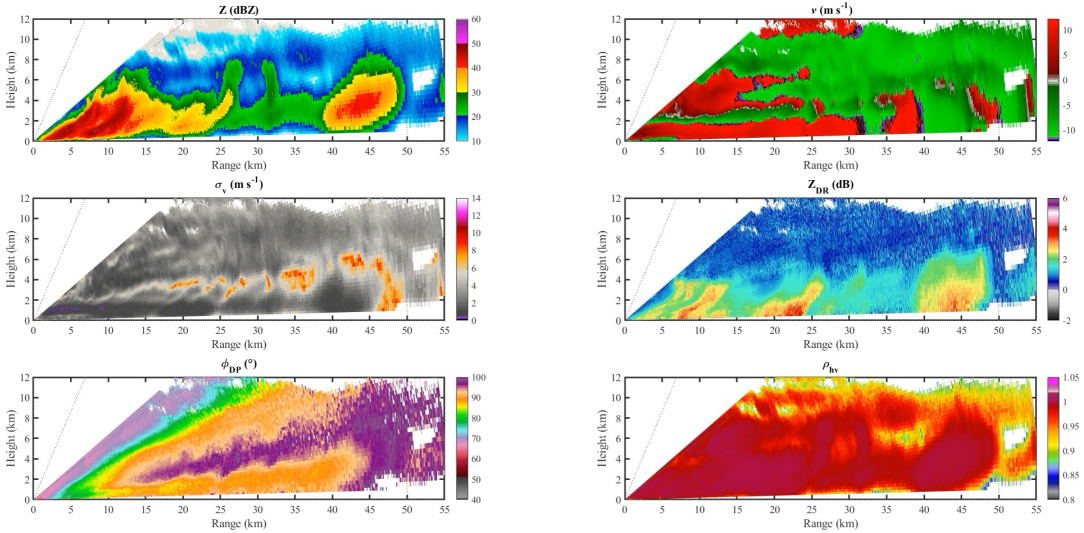
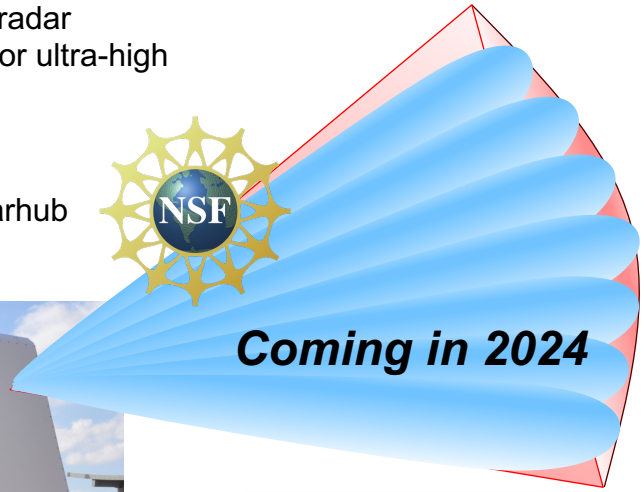


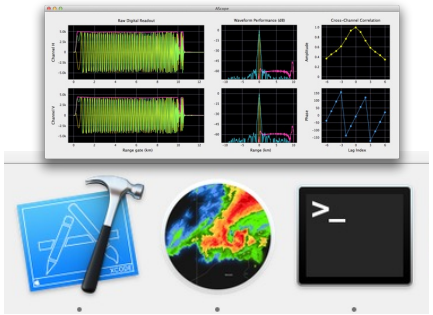
- RHI scans (0.5-32°, 0.5° steps) were collected from convective storms
- 30-μs LFM waveform (10 m range resolution/10-m range sampling)
- PRT of 1 ms, 128 pulses/beam, **8-sec/RHI**
- With 13 panels (832 dual-pol channels), sensitivity ~12 dBZ at 50 km

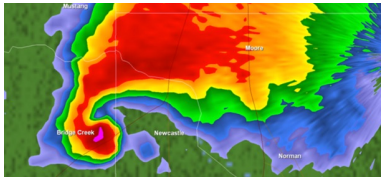
Polarimetric Atmospheric Imaging Radar (PAIR)

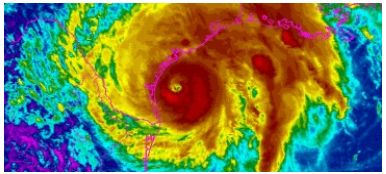
C-Band, Mobile, Polarimetric Imaging PAR

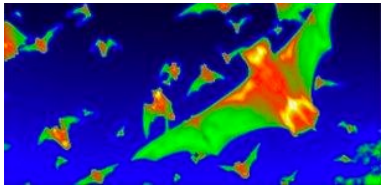
- Mobile, C-band, Polarimetric Imaging radar
- Digital beamforming and e-scan in el for ultra-high update time (360ºx20º in 6-10 s)
- E-scan pencil or spoiled beam in el
- High sensitivity (-2.9 dBZ @ 10 km)
- Data will be available via ARRC's radarhub











Take-Away Points

- Science dictates and the community has voiced the need for polarimetric **phased array technology**
- The all-digital **Horus** PAR (S-band) is **operational** - the ARRC continues to make promising measurements and add new modes on the fully digital Horus radar
- The **scalable** design of the **Horus** digital phased array radar allows the creation of the larger-aperture systems
- The imaging **PAIR** (C-band) will be operational in **2024**