Architecture Overview and System Performance of the Airborne Phased Array Radar (APAR) for Atmospheric Research

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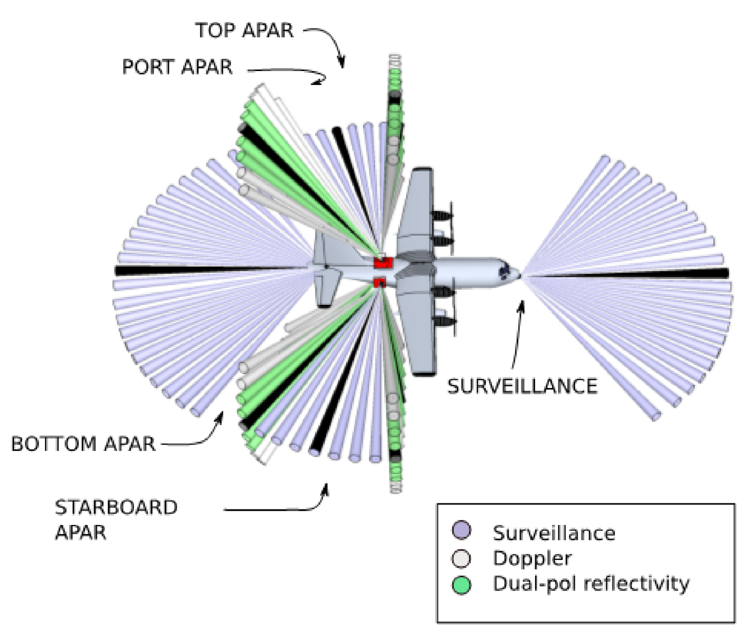
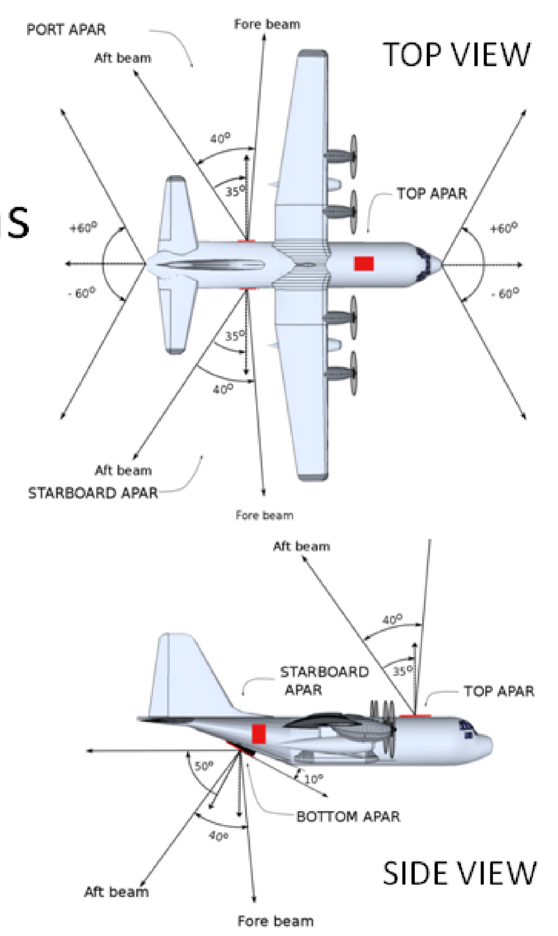
Background

The National Center for Atmospheric Research (NCAR) is investigating potential configurations for the next generation of airborne radar which is capable of retrieving dynamic and microphysical characteristics of clouds and precipitation, Loew et al. (2007), Moore et al. (2007). This radar is intended to replace the aging ELDORA, which is currently without an operational platform as of January 2013, Hildebrand et. al. (1996). A modular, dual-polarization, C-band phased array is currently under consideration. The airborne platform provides unique challenges for the radar design engineer. Mechanical stress, weight restriction, thermal management, prime power conservation, limited power aperture, lifetime and cost are factors, which must be managed effectively and taken in account for defining the APAR architecture. The proposed APAR system consists of four C-band active electronically scanned array (AESA) antennas strategically mounted on the fuselage of the NSF/NCAR C-130 aircraft. The "composite" scanning of all four AESAs yields a full 360° dual Doppler coverage, as in the current ELDORA. An important advantage of the AESAs over ELDORA is the ability to scan in azimuth as well. This feature, used in conjunction with data from the C-130 weather avoidance radar, will be exploited to produce a composite PPI "surveillance." Another important advantage is that dual polarization measurements can now be obtained.

APAR 4 Face Concept on NSF/NCAR C-130

Composite & Surveillance Scans

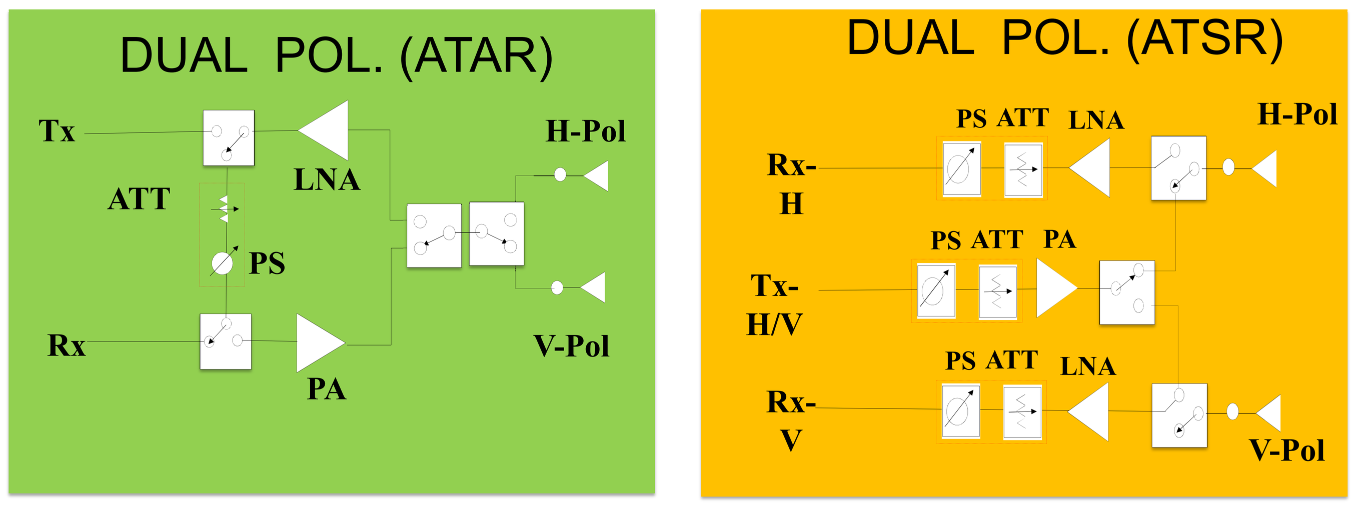




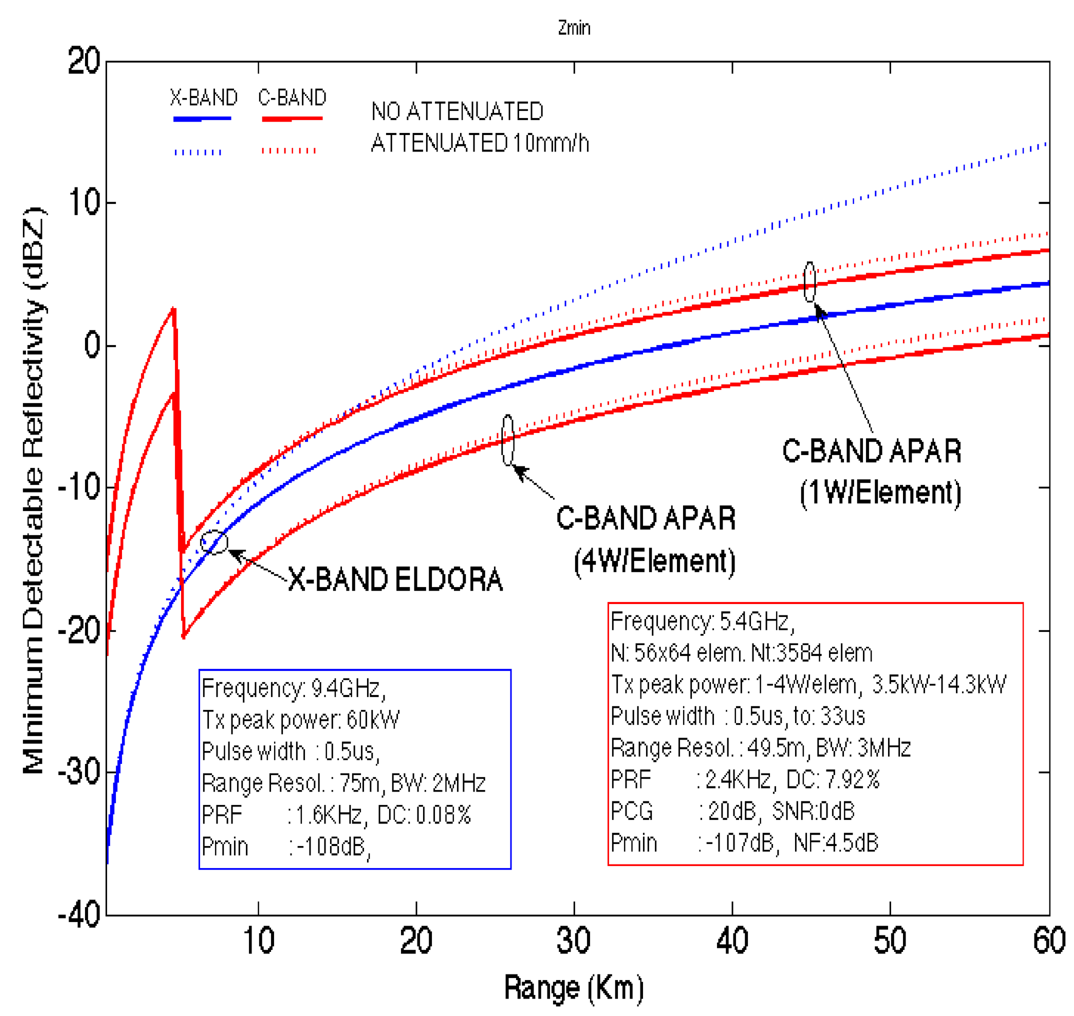
Physical Constraints	
Size	1.9 m x 1.5 m
Weight	270 kg/Face
Prime Power	< 5.5 KVA/Face; < 1.5W/element

TR Module Architectures

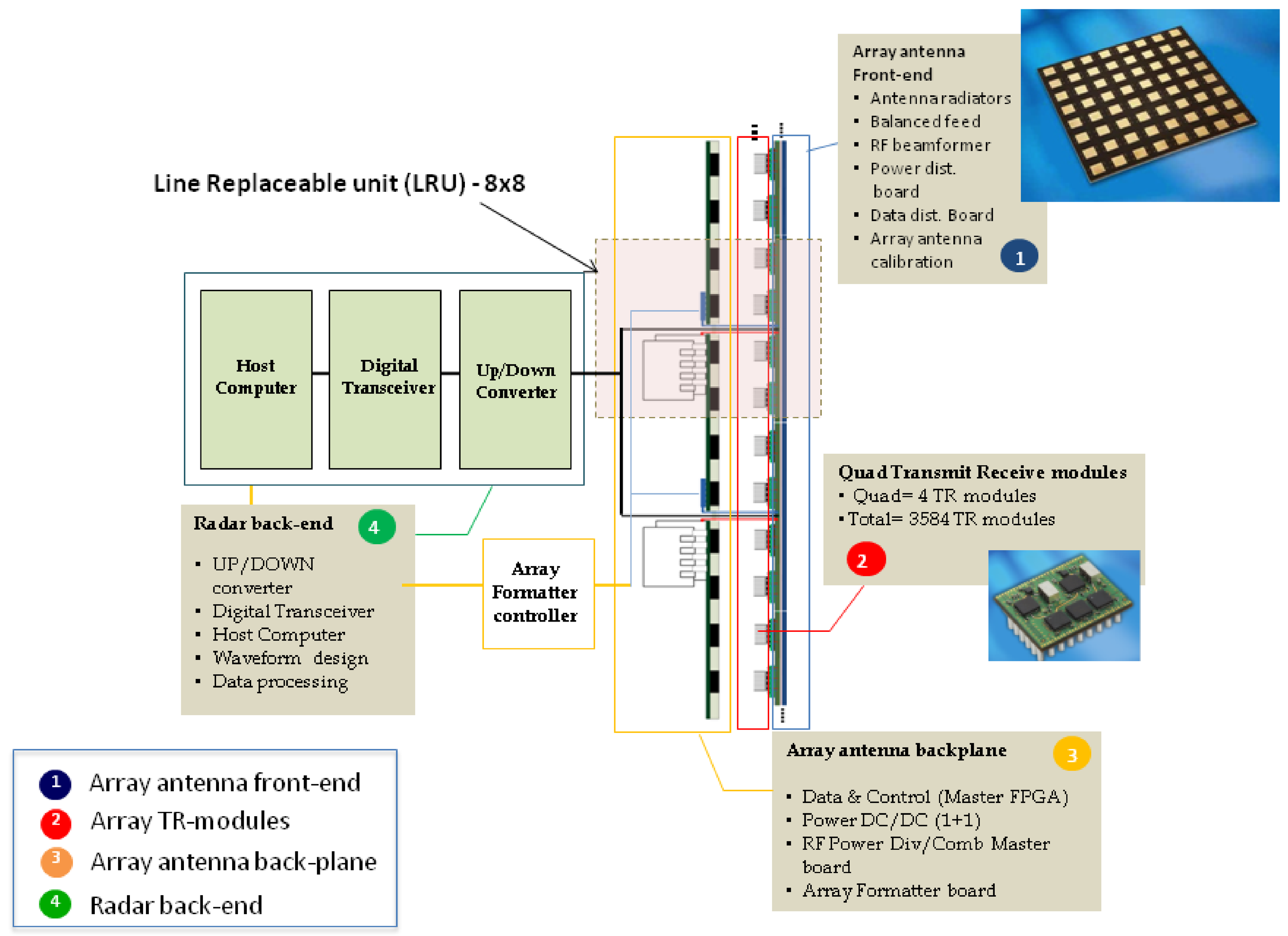
Alternate transmit, alternate receive (ATAR) by virtue of fewer components, consumes less power and costs significantly less than alternate transmit, simultaneous receive. However, cross-pol measurements take twice as long to make.



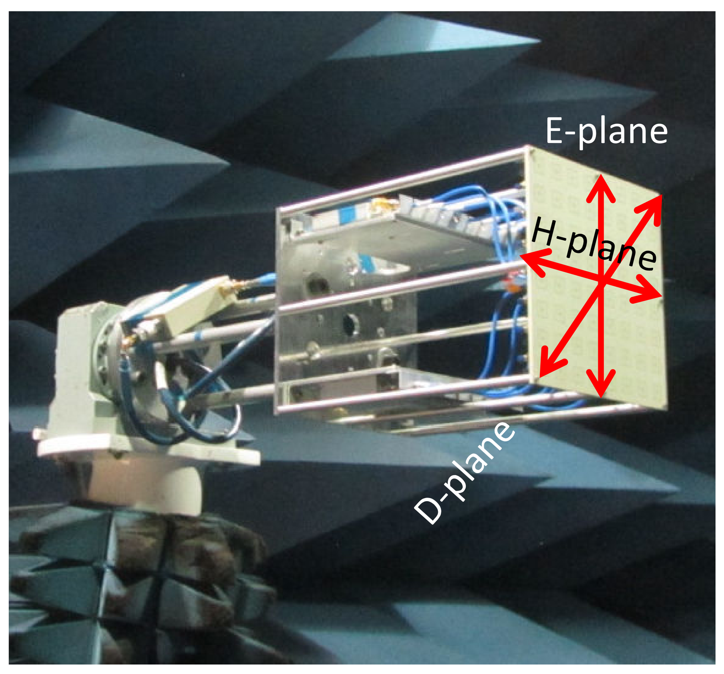
Sensitivity APAR vs. ELDORA



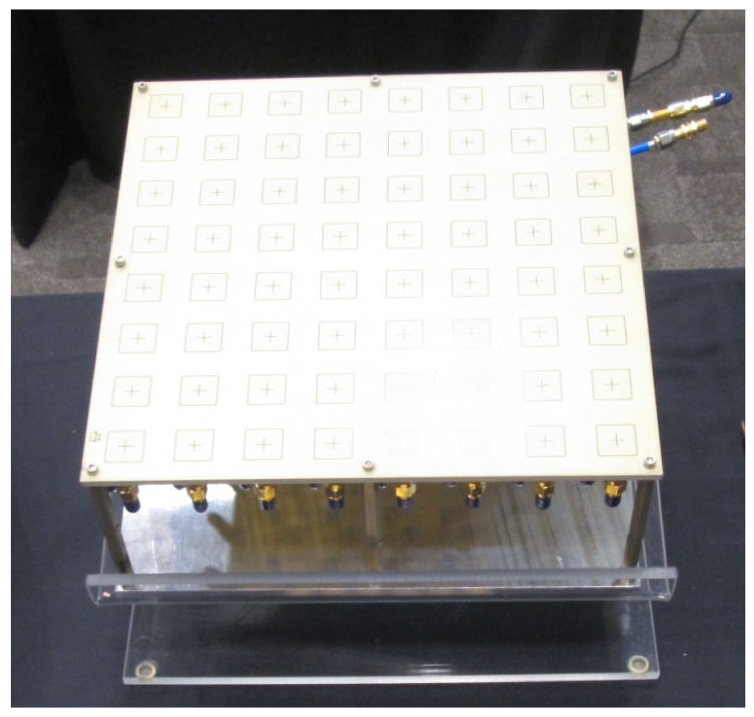
APAR Architecture



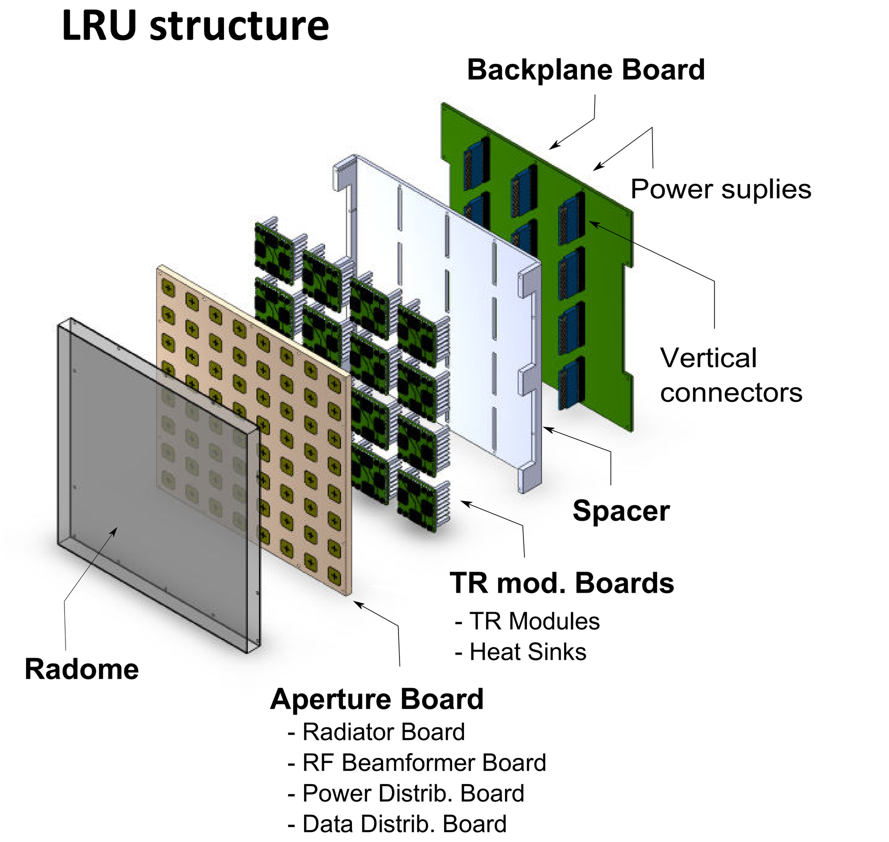
Line Replaceable Unit (LRU) Development

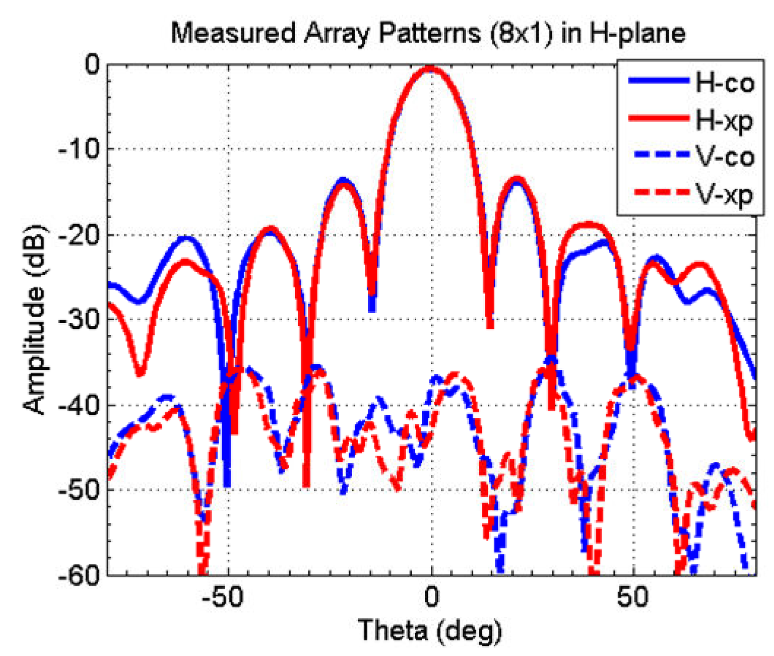


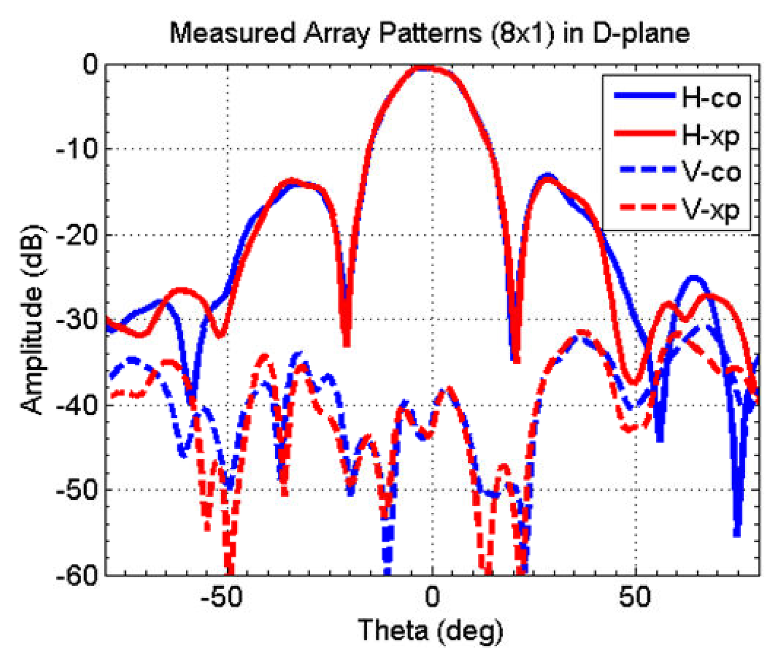
Antenna aperture testing in anechoic chamber

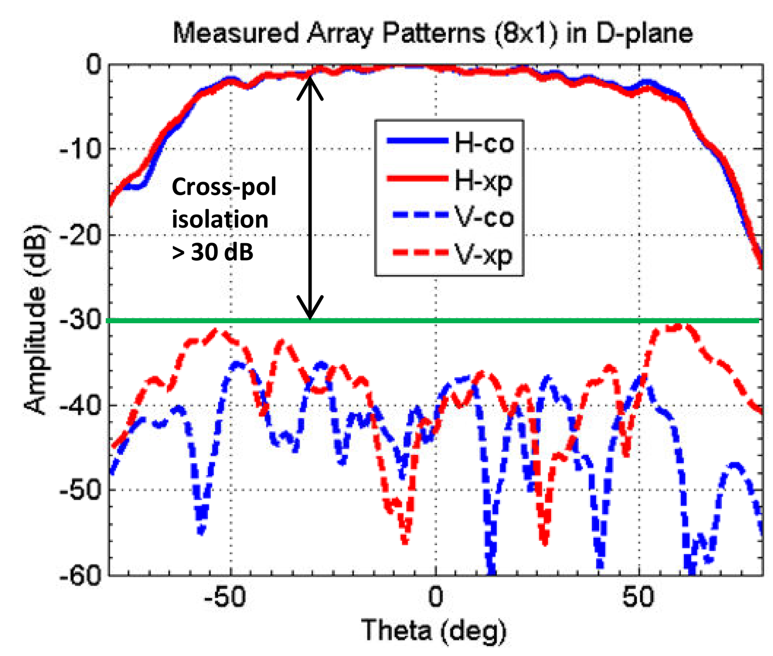


Antenna aperture









Comparison of expected APAR characteristics with current ELDORA radar

Parameter	Units	Eldora (X-band)	APAR(C-band)
Frequency	GHz	9.3- 9.8	5.35-5.45
Wavelength	cm	3.22-3.06	5.5
# Elements (El/Az)	-	-	64/56
# Total elements per panel	-	-	3,584
Beamwidth (El/Az)	deg	1.8/2.0	1.6/1.8
Antenna gain	dB	39	41
Min. detect. signal at 10 Km	dBZ	-10	-15
Sildelobe level	dB	-20 to -24	-25
Pulse repletion frequency	Hz	2000	2000
Peak transmit power	Kw	40	14.3
Spatial resolution at 10km	m	314	314
Along-track resolution	m	300	120
Pulse width	us	1.0-4.0	0.5-50
Polarization	-	Horizontal	Dual Linear
Beam overlapping	%	25	25
Unambiguous range	km	75	75
Unambiguous velocity	m/s	32	55
Transmitted waveform	-	Stepped Chirp	Pulse compression (PC)

Future Work

Over the next year, the plan is to integrate the quad TR modules into a fully functional LRU whose performance will then be characterized.

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