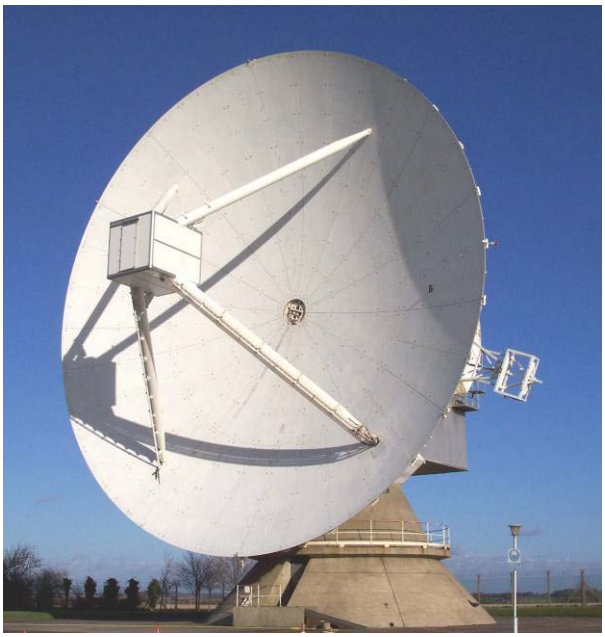
CAMRa radar



The Chilbolton Advanced Meteorological Radar (CAMRa) is an S-band dual-polarisation Doppler radar based on a fully-steerable 25 m diameter dish antenna, a magnetron transmitter, a dual-channel superheterodyne receiver, and a hybrid analogue-digital signal processor. The radar uses a digital signal processing scheme to achieve coherent-on-receive operation. The radar transmits alternately horizontally and vertically polarised pulses and receives both co-polar and cross-polar returns. This approach permits real-time measurement and display of Z, Z_{DR}, LDR, v, w, ϕ_{DP}, K_{DP} and ρ_{HV}. For more detailed studies, full time-series measurements of I and Q are also possible over a large number of range-gates and transmitted pulses.

Typical research areas for which CAMRa is used include rainfall rate estimation, hydrometeor characterization (with aircraft verification), effects of precipitation on terrestrial and earth-space radio propagation, multi-wavelength studies of cloud and precipitation, clear-air and boundary-layer investigations and satellite sensor ground-truth verification. It is operated on a case-study basis.

The specification of the radar is as follows:

Parameter	Value and comments
Radar type	Dual-polarisation pulsed Doppler
Operating frequency	3076.5 MHz
Transmit polarisation	Horizontal and vertical, pulse-to-pulse switching
Receive polarisation	Simultaneous co-polar and cross-polar
System noise figure	5.5 dB including duplexer / miscellaneous losses
Transmit power	600 kW peak pulse
Range resolution	75 m
Maximum number of range-gates per ray	1200
Number of pulses averaged per ray	64 per polarisation, 128 total
Maximum unambiguous range	246 km
Maximum unambiguous velocity	14.9 m / s

Antenna type	Prime-focus fed parabolic dish
Diameter	25 m
Gain	53.5 dBi
Beamwidth	0.28° (FWHM; -3 dB, 1-way)
First sidelobe level	-20 dB (1-way)
Scan rate	Typically 1° / second in azimuth and elevation
Far-field distance	12.5 km

Receiver type	Dual-channel super-heterodyne, 30 MHz IF
Noise figure	3.5 dB excluding duplexing / miscellaneous losses
IF type	Dual-channel, logarithmic detector and limiting amplifier with I/Q detector
IF bandwidth	4 MHz
Video bandwidth	2 MHz
Dynamic range	96 dB

Transmitter type	Cavity magnetron
Peak power	600 kW
Pulse-width	0.5 μs
Pulse repetition frequency	610 Hz nominal
Pulse-coding	Un-coded, rectangular pulse

Data acquisition / processing system	Pentium PC plus custom ADC / timing cards
Number of channels	8 (of which 7 are in use)
Number of bits per channel	12
Sampling rate	2 MHz
System timing / clock frequency generation	Derived from crystal-controlled reference
Algorithms used	Pulse-pair processing at 0, 1 and 2-lag
Real-time control / display system	Multi-screen colour monitors
Archive data format	Net-CDF

Measurements and their typical accuracies	Z, Z_{DR}, LDR, v, w, ϕ_{DP}, K_{DP}, ρ_{HV} and I / Q time-series data
Co-polar reflectivity, Z	1.0 dB (figures assume rain of w = 2 m / s)
Differential reflectivity, Z_{DR}	0.2 dB
Linear depolarisation ratio, LDR	1.5 dB
Doppler mean velocity, v	0.15 m / s
Spectral width, w	0.15 m / s

A detailed description of the radar sub-system hardware and of the signal processing scheme, together with examples of typical measured data, is given in 'The Chilbolton Advanced Meteorological Radar: a tool for multidisciplinary atmospheric research' by J. W. F. Goddard, J. D. Eastment and M. Thurai. IEE Electronics and Communications Engineering Journal, April 1994. Vol. 6, No. 2. pp 77 – 86.

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