Advantages of a Solid-state based Radar System over a Magnetron-based Marine Radar System:

Solid state radars represent the state-of-the art in bird detection radar sensors with the following advantages:

Parameter	*Solid State*	*Magnetron*
Maintenance	LOW – no “lifed” items	HIGH – annual parts replacement
Remote administration	Fully digital and remote controllable	Requires additional digital interface for full remote control
MTBF (Mean Time Between Failure)	50,000 hours	3,000 hours
Built-in-test (BIT) facilities.	Extensive and fully remote accessible	Limited
Antenna speed (24 & 46 rpm)	8 to 46 rpm electronically selectable standard; high speed scanning provides improved track quality	Standard is 24 rpm; requires motor and gear changeout for high speed scanning
Antenna tilt-up	YES	NO
Emitted power density	Low power mode for short range use and operations near hot ordinance or in telemetry restricted environments	HIGH
Variable frequency	YES – electronic built-in; allows operation of multiple sensors proximate without in-band interference	NO – requires custom built up or downshifted magnetrons to manage in-band interference issues
Start-up	Instantaneous operation - no warm up period required	No instant start – requires warm-up period
Spares	LOW	HIGH (replacement magnetrons)
Frequency diversity upgrade option (improved detection over water)	YES	NO
Doppler processing upgrade option	YES	NO

Each of the above advantages helps to offset the higher initial of procuring a solid state system cost (approx. 2.5 times cost of the magnetron equivalent) with cost, operational and performance benefits realized over the lifetime of the system. The magnetron-based radar represents a legacy system whereas a solid state radar is the state-of-the-art and the future of marine radar world wide. Typically a marine radar requires replacement of a magnetron every 3000 hours or approximately every 6 months. A solid state radar system transmitter has a MTBF of 50,000 hours or greater than 11 years of operation. This translates to reduced maintenance hours and spare part costs over the lifetime of the system. The solid state radar also provides significantly improved detection ranges for standard targets at lower peak power than conventional magnetron based radar as illustrated below.

Comparable Detection ranges for IEC 60936-1/62388 and Solid State Radars

Height (m)	Radar Cross Section (sq m)	IEC 60936-1 (nm)	IEC 62388 (nm)	Solid State (nm)
60	50,000	20	20	24.2
6	5000	7	8	12.7
3	2500	-	6	10.4
10	50,000	7	11	15.6
5	1,800	-	8	11.6
4	7.5	-	5	7.8
3.5	10	2	4.9	7.6
3.5	5	-	4.6	7.2
2	2.5	-	3.4	5.8
1	1	-	2	4.1

The summary below contains a performance assessment for DeTect's solid state radars against the IALA Advanced/Extended recommendations.

- Calculations are carried out using CARPET V2.13
- PFA is $10^{-}6$ noting that VTS PFA is generally higher therefore these ranges will be improved if 10^{-4} is used for calculations.
- Performance figures are Probability of Detection at 80%

Solid State Performance Assessment

Antenna Elevation	Target Type	Modeled as fluctuating point target		Detection and tracking ranges for standard atmosphere and rain/sea as indicated	
		RCS	Height	Clear	10mm/h Rain
50m ASL	1	1m²	1m ASL	10nm 8.25nm Sea State 4	-
	2	3m²	2m ASL	12nm 11.23nm Sea State 5	9nm 10.64nm Sea State 5
	3	10m²	3m ASL	14nm 13.3nm Sea State 6	12nm 12.71nm Sea State 6
	4	100m²	5m ASL	17nm 16.29nm Sea State 7	15nm 15.83nm Sea State 7
	5	1000m²	8m ASL	20nm 19.2nm Sea State 8	18nm 18.71nm Sea State 8

1 Nm = 1.852 km

RCS is a measure of radar reflectivity. The Radar Cross Section is expressed in terms of the physical size of a hypothetical uniformly scattering sphere that would give rise to the same level of reflection as that observed from the sample target. In reality, sharp corners and edges provide good reflectors and even a small target can have a relatively large RCS

Specifications:
MERLIN Aircraft Birdstrike Avoidance Radar System
S-band Solid State Radar Sensor

The solid state radar sub-system technology as of the 2009 MERLIN Avian Radar System is a "range unambiguous" radar utilizing a coherent receiver, pulse compression and Doppler processing techniques to provide sub-clutter visibility of targets. The radar has been designed to exceed the IALA recommendations for a VTS radar sensor. The NT version of the radar is designed for operation in either X or S frequency bands or both; detection of small targets in all weather conditions; and, high reliability and availability.

Four (4) sensor versions are available: Surveillance Radar Dual Band (5.5m & 3.9m), Surveillance Radar X-Band (5.5m), Surveillance Radar X-Band (3.7m), and Surveillance Radar S Band (3.9m). An extended range (ER) version will be offered in late 2012. For aircraft-bird strike risk management, DeTect provides the all S-band version MERLIN system that delivers the highest available level of performance for bird detection of any system on the market and includes reliable detection and tracking of birds in all weather conditions. Birds fly in weather, particularly when they are migrating and the obsolete magnetron-based, X-band systems are completely blinded by heavy fog and light rain which is the most high risk period for aircraft birdstrikes as the pilots can't see the birds and the birds can't see the aircraft. The new generation all solid state S-band MERLIN system meet the all weather bird detection requirement and represent the current state-of-the-art in bird radar technology.

Specification and Performance Parameters:

- Electronically variable antenna rotation rates from low speed 8 RPM to high speed 48 RPM scanning for improved track quality
- Solid state transmitter for high reliability with MTBF >50,000 hours
- "Simultaneous" short, medium and long pulse transmission for simultaneous maximum range detection for bird detection and airspace security
- Digital Pulse Compression to 15m range cell size out to maximum range (subject to export control license)
- Pulse Doppler processing for rain and sea clutter rejection providing (available in early 2010) for sub-clutter visibility improvement factor of 25dB
- Dynamic range of 126 dB (inc. STC and Pulse Compression gain) ensures simultaneous detection of large and small targets
- Pulse Repetition Frequency Discrimination
- Frequency Diversity option for enhanced detection in weather and over water bird detection.

The S and X band antenna systems have the following characteristics at 3GHz & 9.41GHz respectively as follows:

	X Band		S Band
	LPA-A37	LPA-A55	LPA-A3
Overall Length	3.7m	5.5m	3.9m
Turning Circle Diameter	3.8m	5.6m	4m
Frequency Band	9.22 to 9.44 GHz		2.92 to 3.08GHz
Gain	32.7dB	34.5dB	27.5dB
Horizontal Beamwidth @ -3dB	< 0.7°	< 0.45°	2° max.
Vertical Beamwidth @ -3dB	25°		26.5°
Horizontal Sidelobes within ±10° of main beam	< -26dB		At least -28dB down on main beam
Horizontal Sidelobes outside ±10° of main beam	< -33dB		At least -35dB down on main beam

FREQUENCIES:

Variable frequency in X- and S-bands:

- X-Band : 9210MHz – 9490 MHz (14 available bands)
- S-Band : 2920MHz – 3080 MHz (8 available bands)

Operation will be within one of the pre-selected frequency bands, each band being 20MHz wide. Transmission bands will be capable of being configured during commissioning to prevent mutual interference between co-located radars

The new generation MERLIN systems with solid state radar technology radar radically departs from conventional magnetron-based systems low power RF pulses for hot ordnance and telemetry restricted environments such as airports and space launch complexes. The transceiver has a nominal peak output power of 170W into the antenna system operating with duty ratios of up to 13%. This high duty ratio, possible due to transmitter design and pulse compression techniques in the receiver results in an equivalent transmitted peak power of 170kW assuming a maximum pulse compression ratio of 1000:1.

DeTect
APPLIED RADAR TECHNOLOGIES

ANTENNAS

A gear driven antenna pedestal powered by a synchronous AC motor rotates the antenna at 24 or 48 RPM in a clockwise direction (viewed from above). Antenna speed selection is effected at the controlling display. One or two antennas can be co-mounted allowing for expanded airspace detection with both antennas horizontally polarized and utilize the latest polyrod end fed slotted array technology. The use of Doppler and pulse integration techniques negate the need for “lossy” circular polarization. The arrays are enclosed in separate white polycarbonate plastic cases:

	Length (m)	**Horizontal Beamwidth °**
X Band	2.8, 3.7 or 5.5m	< 0.7 or < 0.45
S Band	3.9m	< 2.0

MAINTENANCE

Routine maintenance is not required for normal operation of the unit other than general housekeeping tasks i.e. external cleaning of the unit.

PERFORMANCE

Solid state transistors obviate the need for a warm-up time. The radar will be powered at all times by the mains supply. On detection of a master display, the unit will “wake up” and be ready for transmission within 5 seconds.

DIAGNOSTICS

Solid state transistor amplifiers will output a nominal peak power of 170W at a maximum duty cycle of 13% into the rotating joint. BIT monitoring outputs a “Low RF Power” warning message when the RF power output falls below 100W. The transistors are “fail-soft” thereby providing graceful degradation in the event of a single or multiple failure.