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Australian Government
Department of Defence
Defence Science and Technology Organisation

The Defence Science and Technology Organisation (DSTO) is part of the Department of Defence and provides scientific advice and support to the Australian Defence Organisation. DSTO is headed by the Australian Chief Defence Scientist, Dr Roger Lough, and employs about 2100 staff, including some 1300 researchers and engineers. It is one of the two largest research and development organisations in Australia.

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Managing Editor: Jimmy Hafesjee
e-mail: jimmy.hafesjee@defence.gov.au

Editor: Tony Cox
Phone: 61 8 8259 6554 Fax: 61 8 8259 6191
e-mail: tony.cox@dsto.defence.gov.au

Design and illustration: Rebekah Meere
Phone: 61 3 9626 7141 Fax: 61 3 9626 7133
e-mail: rebekah.meere@dsto.defence.gov.au

Media enquiries: Darryl Johnston
Phone: 61 2 6265 7947
e-mail: darryl.johnston1@defence.gov.au

Mailing list enquiries: Angie Toutziarakis
Phone: 61 3 9626 7432
e-mail: angela.toutziarakis@dsto.defence.gov.au

More information is available about DSTO on its web site at: www.dsto.defence.gov.au

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Australian DEFENCESCIENCE

Enhancing cartography **with digital mapping**

Defence has long acknowledged the essential nature of geospatial information for its strategic planning and operational activities. DSTO is now exploring the latest in digital technologies to enhance the usability and utility of cartographic materials.

DSTO researcher Dr Bob Williams says the basic purpose of cartography is to create a model of the world and disseminate information to users.

"Geospatial intelligence is a spatial and temporal way of describing geographical features, infrastructure and environmental aspects. The description then involves the modelling, representation and location of these features to place them in a reference system."

This field of research is an analytical discipline embodying a number of applied sciences, disciplines and technologies. The sciences include geography, cartography and mapping, geodesy and surveying, geomatics, several earth sciences, and computer science. Disciplines include photogrammetry and remote sensing, spatial analysis and geographic information systems. Technologies include GPS and location-based technologies, geographic information systems (GIS) and information technology.

Geospatial intelligence as a Defence function primarily aims to understand the physical and cultural aspects of the global security environment.


Dr Bob Williams.

GEOSPATIAL INFORMATION INFRASTRUCTURE

The means of acquiring, processing and disseminating geospatial intelligence to the Defence community is known as the Geospatial Information Infrastructure (GII).

GII provides the supporting services needed to ensure information content meets user needs, is easily accessible, and can readily be applied to support operational information requirements. It also ensures the supporting infrastructure components of policy, doctrine, training and force structure are in place to optimise the use of the geographic information, products and services provided.

Defence Minister Robert Hill recently stressed the importance of GII to Defence in the following terms.

"The convergence of the fighting power of the three services is made possible by networking and by the support provided by greatly enhanced intelligence capabilities. The upgrades of our space-based surveillance capability and our geospatial information infrastructure will provide us with superior situational awareness."

EXCITING FUTURE FOR CARTOGRAPHY

Reflecting on recent developments in digital information technologies, Dr Williams sees the day when every imaginable form of location-based information will be represented in a form that mirrors the whole world, with this information made available for a plethora of applications immediately.

"Digital mapping is about to change our world by much more completely documenting aspects of reality, then integrating that information into our computers and phones, having major impacts on the way we do our business," he says.

"Spurred on by advances in space imagery, digital photography, global satellite positioning, mobile phones, location-based technologies, search engines and new ways of marking information for the World Wide Web, the practice of cartography is now undergoing rapid change."

Besides supporting various agencies and groups within the Australian Defence Force, DSTO also collaborates with academia (notably the University of Melbourne through the CRC on Spatial Information, and RMIT University) on research and development activities concerning geospatial information infrastructures and spatial data quality.

Autonomous UAV flight
a world first

A world-first in autonomous, Intelligent Agent-controlled flight was achieved recently by an unmanned aerial vehicle (UAV). The successful first flight, undertaken by DSTO and Agent Oriented Software, convincingly demonstrated both in-flight Intelligent Agent control of the aircraft and fully autonomous mission selection capabilities.

The flight test (involving an Avatar UAV made by Codarra Advanced Systems) was conducted in restricted airspace at the Australian Army's Graytown Range about 150 km north of Melbourne.

The Avatar was guided by a JACK™ intelligent software agent that directed the aircraft's autopilot during the course of the mission. The JACK™ Intelligent Agent software utilised was developed and marketed by Agent Oriented Software Pty Ltd.

The flight began with ground control flying the UAV up to 122 metres, at which point both the autopilot and the Intelligent Agent software were engaged. The pre-programmed mission was to hold a northerly course and altitude for about 1 km to waypoint 'Alpha', make a turn of 180 degrees and return to the launch area.

THE CHALLENGE SET FOR AUTONOMOUS OPERATION

The on-board Intelligent Agent was then given another objective to attain.

JACK™ received two optional waypoint goals, both about 500 m on either side of the original track, one to the east and the other west. It also received a GPS decision point along the track.

When the Avatar reached this decision point, the Intelligent Agent was able to reason, based on the real-time GPS and wind readings, which optional waypoint was the quickest to reach under the current conditions. The Intelligent Agent then directed the autopilot to turn onto the new course, fly to the selected waypoint goal, and then return to the launch area.

The on-board JACK™ agent chose the best route to fly after evaluating real-time flight and weather data accessed through a direct link to the autopilot and its GPS (Global Positioning System). The Agent was constantly updated with the Avatar's position, air speed, ground speed and drift so it could intelligently pick the best route to take.

While these first Avatar/JACK™ flights totalled no more than 40 minutes and involved only a simple choice for the Intelligent Agent, they demonstrated absolutely both in-flight intelligent agent control of the aircraft and fully autonomous operation.

According to Dr Andrew Lucas, Managing Director of Agent Oriented Software, "this ground breaking achievement is of great significance to UAV operators and manufacturers worldwide. It shows that UAVs can now autonomously re-plan and execute missions without ground operator intervention."

MORE INTELLIGENT UAV REDUCES DEMANDS ON OPERATORS

Furthermore, there are enormous savings in operational costs and manpower requirements on offer, explains Dr Lucas.

"The success of this flight, controlled by Intelligent Agent software, signifies a new age in unmanned vehicle operations. Instead of the current situation where ten personnel are required to support one medium UAV, we are looking forward with confidence to the day where a team of ten UAVs could be controlled by one operator."

Intelligent Agents can also handle in-flight incidents such as loss of radio communications, poor landing visibility or avoiding radar intercepts by using pre-programmed contingency plans. The Agents can arrive at responses to such events and direct the autopilot to act, which greatly alleviates the need for planners to develop and validate new contingency plans for each mission.

JACK Teams is an extension to JACK™ software to model military team characteristics explicitly including command and control structures, developed jointly by Agent Oriented Software and DSTO. The demonstration flight is the first step in developing a system that allows a single human operator assume responsibility for a cohesive team of UAVs contributing effectively to joint goals. The testing program will continue with flights planned in the new year for multi-UAV missions with tactical decision-making using JACK teams.

Missile countermeasures – from flares to lasers

Major breakthroughs in laser design have led to the DSTO-developed MUltiband Research Laser INfrared (MURLIN) unit performing beyond expectations in field trials. The MURLIN program aims to enhance the capability of existing directed infrared countermeasure systems (DIRCMs). DSTO is now looking to offer the technology to industry for commercialisation.

Research in this field is being driven by the increasing threat of widely available heat-seeking missiles which are targeting military and civilian aircraft around the world.

Military aircraft currently use flares as infrared missile decoys, but there are many disadvantages in doing so. Missile seeker guidance systems and counter-countermeasures are ever evolving to defeat this kind of countermeasure; the countermeasure supply is exhaustible; and it uses flammable material that poses a safety risk to the aircraft and anyone directly under its path during activation.

By comparison, directed infrared countermeasure systems (DIRCM) can operate continuously without pilot attention, require no consumables, and the emitted infrared laser light is intrinsically safe to other aircraft or anyone on the ground.

At the core of DSTO's DIRCM jamming system is the MURLIN laser which generates three different spectra of light simultaneously within the infrared range. A DIRCM locates an incoming infrared missile and overwhelms its sensors with laser radiation, causing the missile to veer harmlessly away out of control.

MURLIN'S ADVANTAGE

While there are several such multi-band laser systems in development worldwide, MURLIN has a number of aspects that place it at the forefront in terms of cost, size and effectiveness. DSTO researcher Dr David Lancaster explains.

"Current in-service DIRCM systems use either a lamp only or a lamp and laser. The drawback with the use of a low technology lamp is its lack of 'spectral brightness' and high divergence as well as its inherent inefficiency. In addition, it has to be built into the beam director turret, thereby requiring a relatively bulky piece of apparatus to house it."

"Since the turret has to be placed outside the aircraft with direct exposure to the airstream to avoid optical aberrations, size is important. The MURLIN system, being a multiband laser, does away with the requirement for a separate lamp. It is an all-laser solution, and only beam-directing optics are required in the beam director."

Another potential improvement that the MURLIN research program can contribute to DIRCM system performance is the ongoing development of a custom-made optical fibre, micro-engineered with tiny channels in fluoride glass. It is anticipated that this optical fibre can be used to connect all the components of the DIRCM in a more flexible, efficient and compact way, allowing for further miniaturisation of the laser turret.

The latest version of the MURLIN laser is also more compact and more powerful while actually using less power, which gives the DIRCM greater range with a greater spread of the laser beam, making it more potent overall.

A COOPERATIVE VENTURE

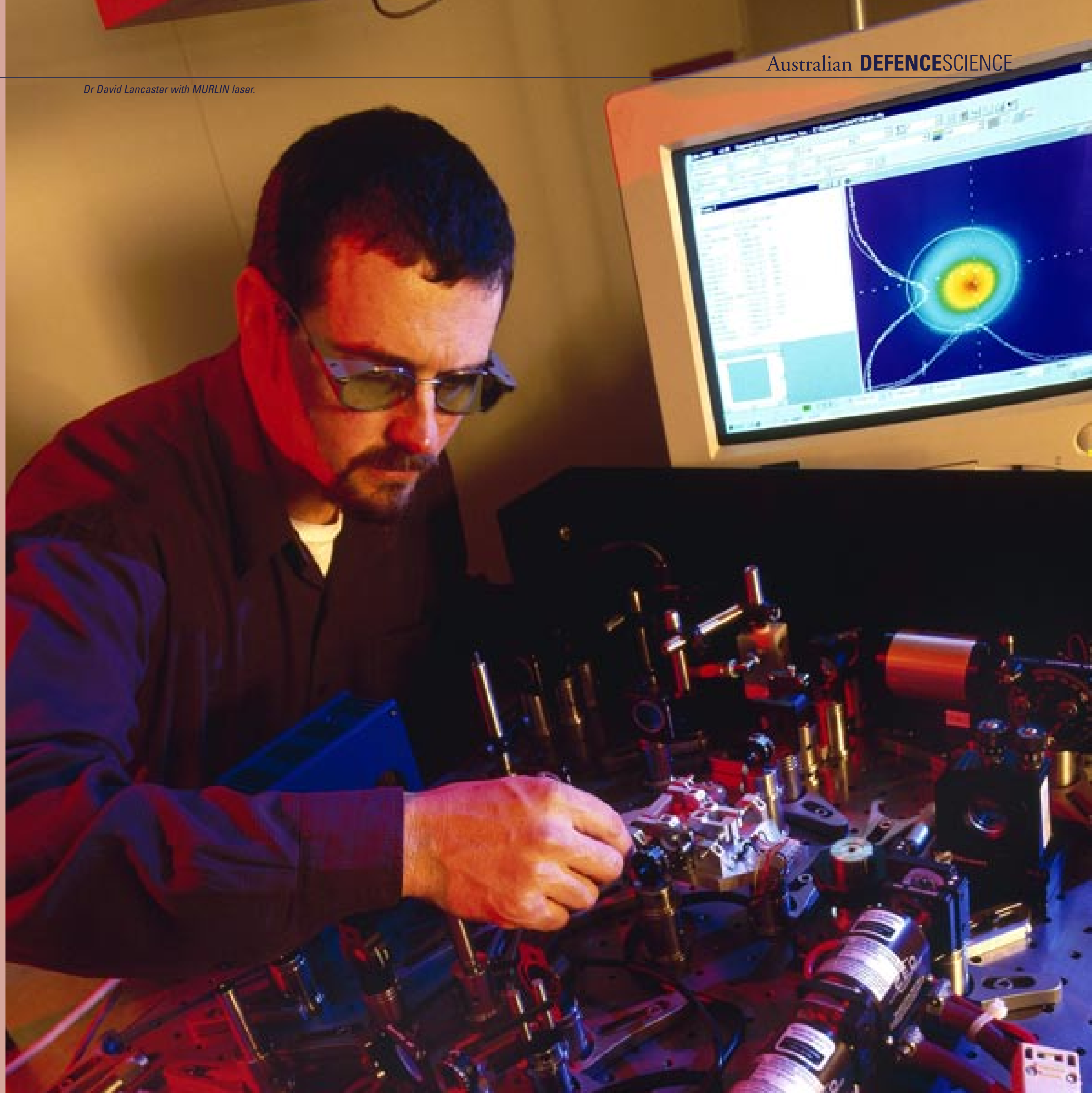
The development of the laser is one of several tasks being carried out under agreement PA 10 funded by the Australian Department of Defence and the US Army Communications and Electronics Development and Engineering Centre (CERDEC).

It has involved close collaboration between the laser developers, such as Dr Lancaster, and electro-optics countermeasure personnel, including specialist Dr Miro Dubovinsky. The work undertaken by the team involves optimising the jamming algorithms to defeat the infrared sensors on incoming missiles. The researchers have worked together to develop the required laser specifications, designing the laser from the ground up to optimise it for countermeasure applications, and carried out collaborative trials of these prototypes.

The MURLIN laser technology was developed at DSTO with the close involvement of Tenix personnel from the outset. The project began with the construction of laser and frequency conversion modules on large laboratory optical tables, after which a 'breadboard' system was developed. Tenix then built a prototype in order to evaluate the technology and aspects of the engineering process. A semi-ruggedised version is now being engineered for aircraft trials use.

The potential applications for this technology outside Defence include areas as diverse as research into the atmosphere, spectroscopy, remote sensing and communications.

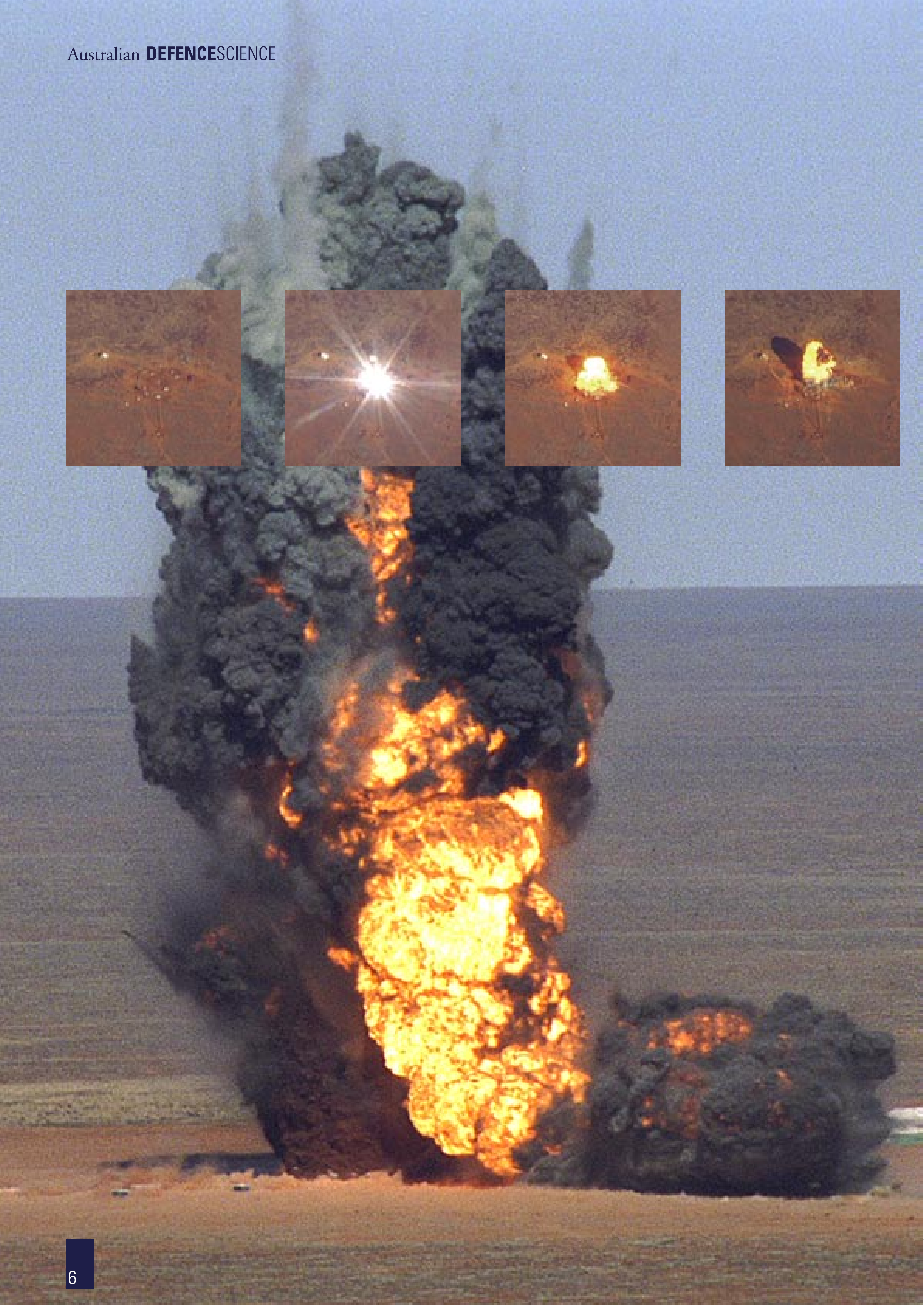
Australian **DEFENCE**SCIENCE



Dr David Lancaster with MURLIN laser.

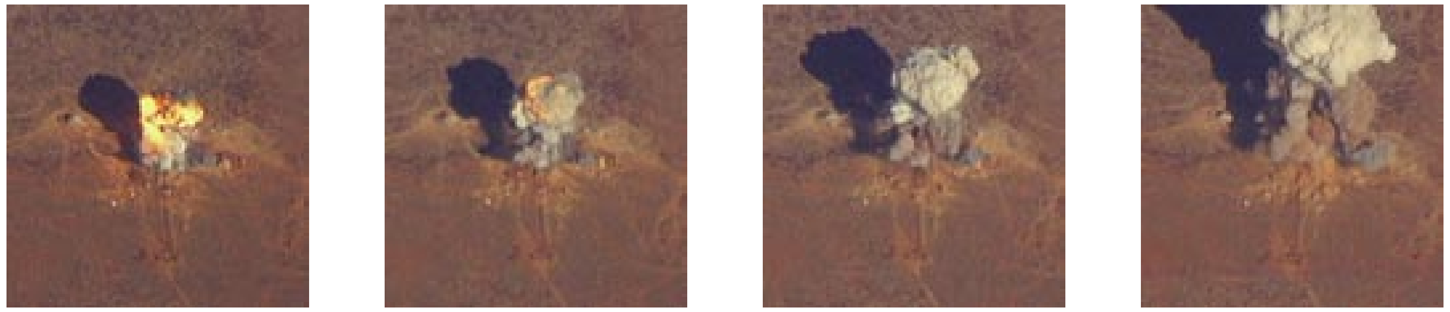
C-130 Hercules deploying flare IR countermeasures.

DSTO researchers William Isterling, Dr Miro Dubovinsky and Dr David Lancaster replacing commercially-developed laser in test bed with the new compact MURLIN laser.



Australian DEFENCESCIENCE

Explosives trial blasts out safety data



An explosives trial held at Woomera in South Australia in May this year is providing data that will inform international safety criteria for the safe storage of explosives. Following changes in ammunition design and storage practices over recent decades, many analysts worldwide have come to the view that correctly stored modern ammunition is safer than before, and so, current safety distances from magazines should be re-assessed.

The trial was carried out at a remote test site within the Woomera Prohibited Area 27 kilometres by road from the Woomera township – one of few sites globally capable of accommodating a trial at the level of complexity the exercise involved.

The detonation site and test items were extensively instrumented, with multiple sensors using ten kilometres of optic fibre cable to measure blast pressure and other parameters. The effects were visually monitored at ground level by cameras in protective housings.

A five tonne mass of high explosives was detonated above the ground to represent a bulk storage location, with the blast being exposed to various structures and test objects including residential and commercial buildings, military field structures and shipping containers holding glass of various thicknesses.

The split-second event was also recorded from overhead by DSTO's ISR Test Bed multi-mode radar, which collected continuous data throughout the detonation to produce a real-time radar image sequence. This imagery data is being analysed for bomb damage assessment and coherent change detection of the explosion site. Comparison with imagery taken before the explosion may bring out more detailed information about the blast shockwave and other features.

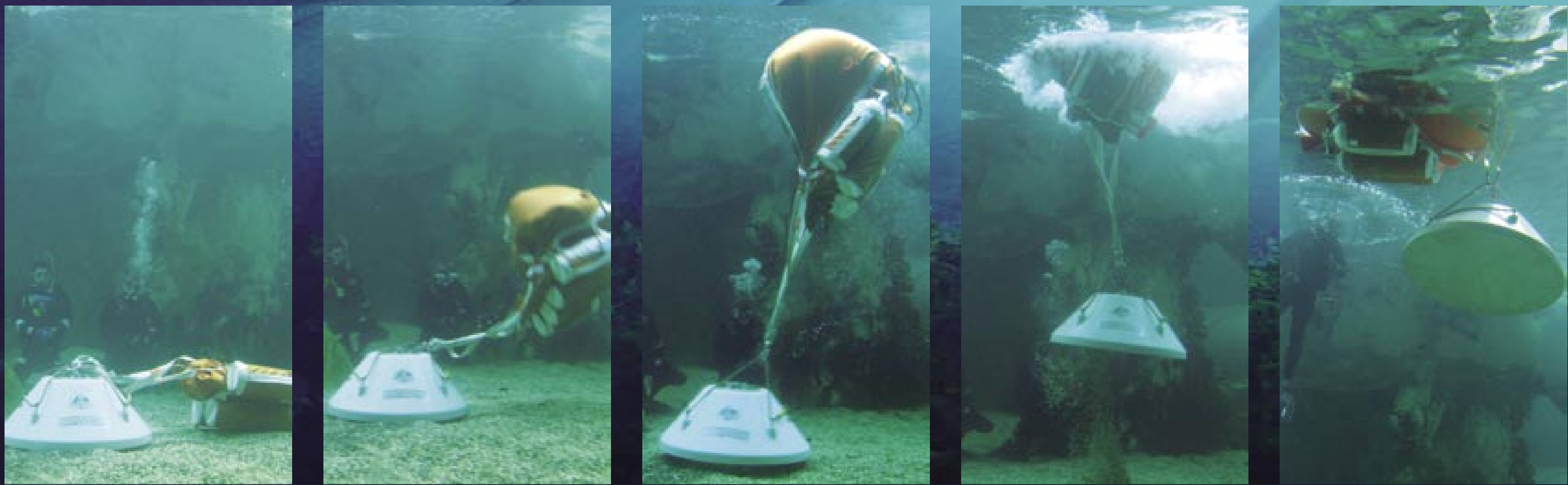
The trial was the most recent in a series of detonations carried out since the 1980s under a Memorandum of Understanding for Defence research between the United Kingdom Ministry of Defence and the Australian Department of Defence. Defence organisations from The Netherlands, Germany, USA, Canada, and Singapore also participated.

Australian **DEFENCE**SCIENCE

Safer mine clearance **with new lift bag**

Working in partnership with the Royal Australian Navy and Tasmanian companies Liferaft Systems Australia and Fiomarine Industries Pty Ltd, DSTO has developed a safer and more reliable means of removing underwater explosive mines. The Cormorant Lift Bag is an inflatable device capable of remotely raising underwater objects weighing up to 1000 kilograms from depths of 90 metres.

Demonstration of Cormorant Lift Bag in the Sydney Aquarium Seal Pool.



During a recent public trial of the technology at the Sydney Aquarium, Defence Minister Senator Hill described the nature of the problem the technology aims to counter.

"Sea mines are a significant hazard for navy operations and commercial shipping because they are cheap to make, easy to deploy and becoming increasingly sophisticated and hard to detect," he said. "The safe disposal of sea mines is a high priority for the Navy, and technologies such as the new lift bag will assist the diving team to carry out their clearance operations in safety."

Several years ago, Defence planners saw the need for an improved mine lift device that had greater performance capabilities and also required less maintenance than the existing types of explosive-activated devices. The Defence Materiel Organisation, DSTO and Navy then worked together to prepare the specifications for the development of a new model.

THE DEVELOPMENT PARTNERS

In 2003, a contract worth over $850,000 was awarded to Liferaft Systems Australia (LSA) for the design and construction of twelve ordnance recovery units for the Navy. LSA was chosen for the project because of its expertise in inflation systems.

Another Hobart-based company, Fiomarine, having developed a submersible marine marker buoy and retrieval system featuring an acoustic control capability, was subcontracted by LSA to develop the underwater acoustic communication system and the electronics for the gas management system.

DSTO and LSA developed a prototype mine lift bag that became known as the Cormorant Lift Bag, named with the retrieval capabilities of the web-footed diving bird in mind. Trials of the prototype were successfully completed in Jervis Bay and Hobart during the early part of 2004. Following the delivery of the training and maintenance packs, the Navy Clearance Divers are now using the prototype unit for user trials prior to full production of the remaining units.

Eventually, two units of the device will be deployed on each of Australia's six Huon Class Coastal Minehunter ships that detect undersea mines using active sonar.

CORMORANT TAKES A DIVE

When a mine is located, Navy Clearance Divers attach the Cormorant Lift Bag to the mine on the seafloor by hand. The lift bag can then be activated remotely by an acoustics communications command located up to a kilometre away. Gas cylinders in the lift bag assembly fill the bag with air, raising the mine to the surface in a controlled manner by venting air during the ascent. On retrieval, the mine is analysed and then disposed of by neutralisation or detonation in a safe area.

The Cormorant Lift Bag has several innovative features that make it the leader in its field.

It reaches depths and lifts weights beyond other lift bags; its metallic parts are made from aluminium and non-magnetic stainless steel, giving it an acceptably low magnetic signature; it facilitates acoustic communication up to a distance of one kilometre; it contains a time/date release that acts as a default in case of a breakdown in acoustic communication; it can automatically recharge its bladder on the surface to compensate for loss of pressure through wave buffeting while under tow; it is easier and safer to transport because it does not contain any explosive items; and it meets all health and safety requirements for pressure and shock.

Since it does not use an explosive activation system, the Cormorant lift bag is also more cost-effective to buy and operate.

Senator Hill said the collaboration was another fine example of Defence working with industry to develop a product that adds to Australia's mine warfare capability. As a result of the collaboration, Liferaft Systems has been able to expand its product range and enter new markets.

"This latest technology demonstrates how good we are at generating innovative ideas but also following through with the production of world-class product that has significant potential for exports," he said "We have developed a low-cost but superior Australian solution when no commercial product was available to meet the Navy's needs."

Making aircraft less visible **to infrared eyes**

DSTO researchers have been investigating the feasibility and cost-effectiveness of providing ADF aircraft with infrared (IR) signature suppression technologies to reduce the likelihood of successful engagement by IR guided missiles.

The study comprised a detailed requirements analysis, which included measuring the IR signatures of aircraft to identify the location and relative contribution of major IR radiation sources. The measurement data has also been used to develop aircraft IR signature models to determine which parts of the aircraft might benefit from IR signature suppression and to what degree.

The measurement activity involved measuring the aircraft on the ground at low altitudes, and at very close range. Measurements were taken of the emitted and reflected radiation around the aircraft from many different angles and in sufficient detail to determine the temperature distribution over the entire airframe. These airframe temperatures were then used as inputs to a DSTO-developed IR signature model which provided a means of evaluating the suppression requirement against various IR guided missile systems.

The model has also been used to evaluate alternative suppression concepts, especially the ability of each concept to achieve a minimum suppression requirement.

RATIONALE FOR SUPPRESSION MEASURES

Modern IR sensors are now sensitive enough to detect exhaust plume emissions as well as hot engine parts, and are capable of 'locking-on' at any orientation aspect to the aircraft at significantly longer distances than those of a few decades ago. The performance of today's Mach 2 missiles – which are smarter, more sensitive and more agile than before – means that aircraft crews have virtually only seconds to respond with evasive action or electronic warfare countermeasures.

While military aircraft are generally fitted with some form of reactive self-protection measures such as flare decoys and IR jammers, passive IR signature suppression has a vital role to play in lessening the likelihood of successful missile attack. It effectively reduces the lock-on range for IR guided missiles and therefore the effective launch envelope, and increases the jamming-to-signal ratio, with both effects enhancing the effectiveness of existing reactive measures.

DSTO researcher Dr Greg Bain says, "In some scenarios, passive IR signature suppression may avoid lock-on entirely, effectively keeping the missile in the launch tube."

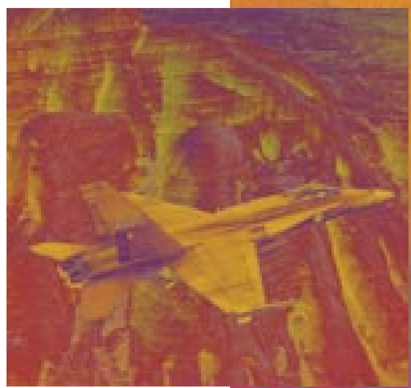
"Moreover, these measures are highly cost-effective since they are relatively simple to install and require no special maintenance or operational support requirements."

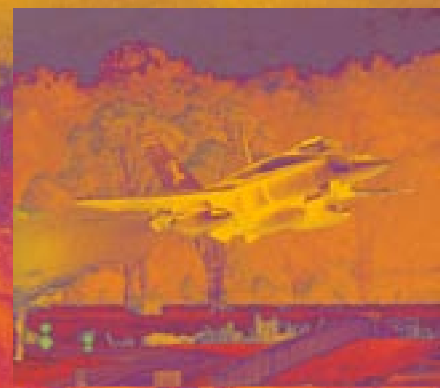
IR SIGNATURE SUPPRESSION MEASURES

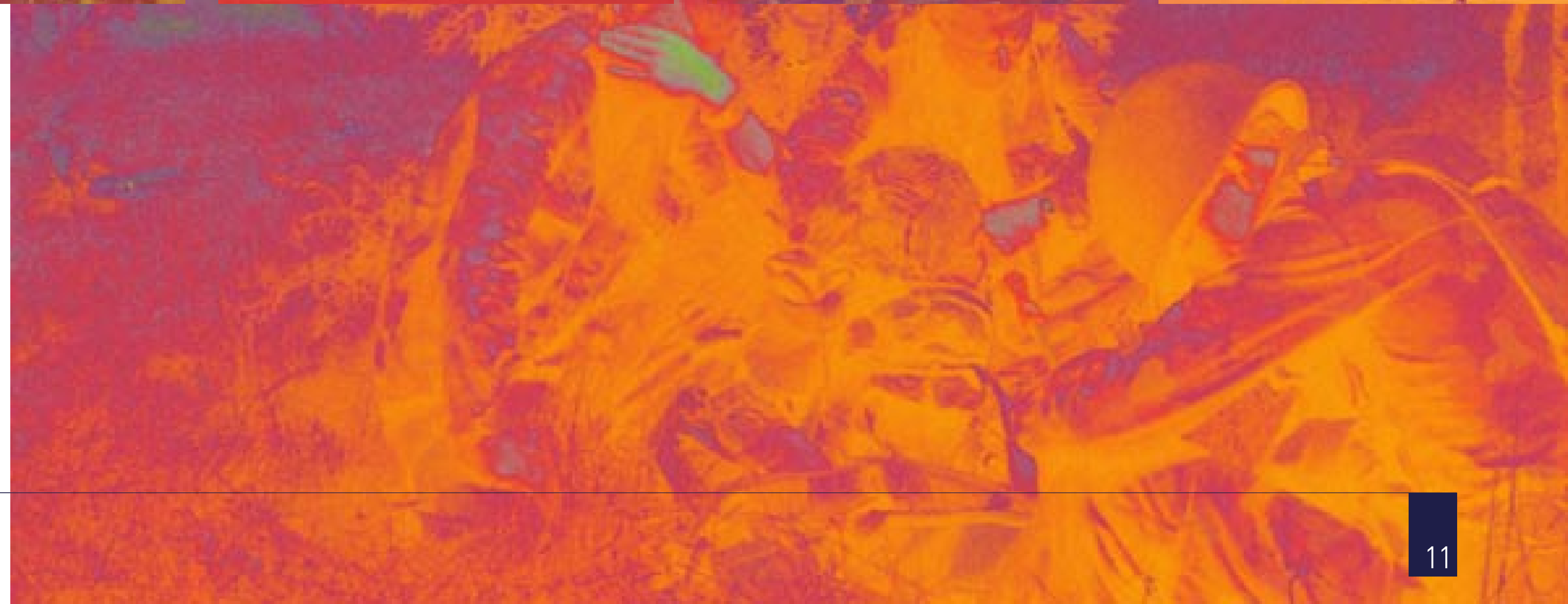
Since the engine and exhaust plume are often the main sources of IR radiation, signature suppression measures typically require engineering or configuration modifications to the aircraft near the engine.

One kind of modification involves the addition of exhaust mixing devices to blend the hot engine exhaust with the cooler outside air, leading to a dispersed and significantly cooler exhaust plume. Another kind is the implementation of shielding mechanisms that use the exhaust itself to pump the ambient air over engine hot surfaces.

Dr Bain, describing the gist of the work, elaborates, "The trick is to ensure that any modification does not become another strong source of radiation itself. Also, any proposed suppression solution must not significantly degrade the performance of the engine; it must not be too heavy, or difficult to maintain and should reduce the IR signature sufficiently to cost-effectively enhance the survivability and, hence, the capability of the aircraft."







This project has now entered the next phase, essentially moving from the computer to the real world with the development of an experimental test rig in which candidate suppression concepts will be further assessed at a scale approximately one fifth of full size.

This work will ultimately enable DSTO to assess existing commercial off the shelf (COTS) IR signature solutions, or alternatively, contribute to the development of an IR signature solution in collaboration with Australian industry and other partners.

Giselle
- antenna with a difference

A new kind of antenna has been developed by DSTO for direction-finding and geo-location purposes to solve a major problem researchers have been grappling with for decades. The significance of this technology is that it allows these activities to be undertaken using vehicle-mounted antennae in the field, rather than relying purely on large fixed strategic collection systems for high frequency (HF) signals.

Scientists have long known that the electric and magnetic fields from a radio wave run at right angles to the direction the wave is moving in. It is also known that HF skywave signals – long-range signals that return to earth after bouncing off the ionosphere – spin as they travel along.

Using this combined information, it is possible to plot the measurements of a signal to find a plane on which all these electric field points lie, and thus work out the direction the signal is propagating along.

With this theoretical understanding to direction finding (DF) well established, the approach in practice involved a three-loop antenna (north-south, east-west and waist loop) to measure the field and determine the direction of arrival – and therein lay some serious limitations on usability.

According to researcher Angus Massie, "the maths involved in getting results had proven to be very hard because the waist loop sees the world differently from the other two loops. Consequently, there weren't any effective DF systems around that used this approach."

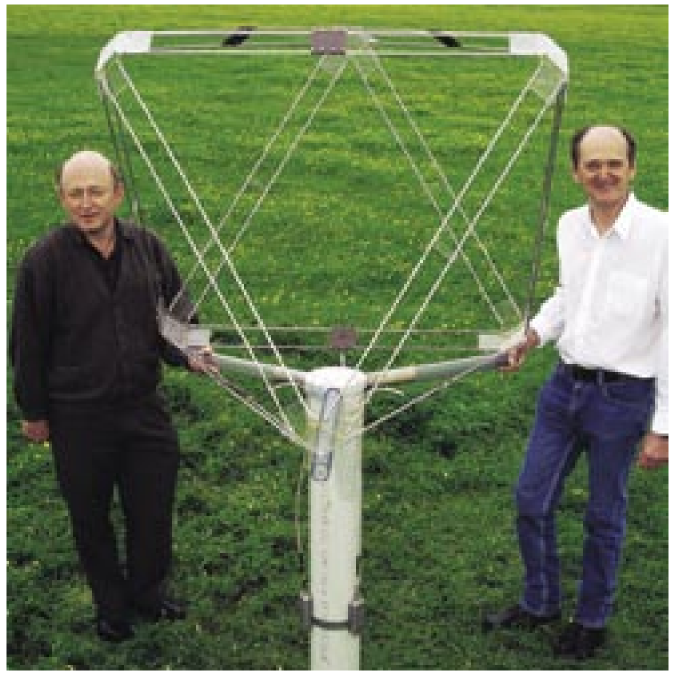
FRESH APPROACH

Because of recent problems experienced in listening to digital modems coupled with an interest in affordable digital HF receivers, the DSTO researchers decided to reconsider the ideas from scratch.

Massie explains, "We decided to start with the signal processing required and built an antenna that helped the maths rather than the traditional approach of treating the RF and the processing as separate problems. It gave us an odd looking antenna, but the total system is quite elegant."

Once this basic approach was visualised, Wayne Martinsen developed the actual aerial, known as 'Giselle', a colourful expansion of the acronym GSL being bandied about over many months.

Giselle is different from previous DF antenna in that the three loops are all 'ground symmetric', meaning that they all see the ground in the same way. Its unique configuration is attained by doubly rotating the traditional triad of loops so that all their tops and tails are the same distance from the ground.



Angus Massie and Wayne Martinsen with the DSTO-developed "Giselle".

NUMBER CRUNCHING FOR RESULTS

With this promising hardware in operation, the next issue facing the researchers was data analysis, undertaken by Dallas Taylor and Angus Massie.

"Once we knew we had a good antenna we collected some typical skywave signals to look at," says Massie. "At the moment, we are only using the phase information for the three loops, so instead of trying to get all the data onto a plane the theory says that we should end up with a circle of data when we are looking along the line of propagation. The great thing is that we find very clean circles popping out of the processing, which shows that the methodology has real promise."

While the initial results look very promising, more work is needed to fully verify the applicability of the approach.

BRIEFS

Turntable to study platform radar signatures

A turntable capable of holding and rotating aircraft of up to 60 tonnes will be built at RAAF Base Edinburgh, adjacent to DSTO's Edinburgh site, to assist DSTO with electronic warfare research.

The range of RAAF aircraft it will be able to handle includes C-130J Hercules, jet fighters, trainers, Blackhawk helicopters and other smaller platforms. A design brief calls for investigations into the ability of the turntable to handle the RAAF's new Wedgetail Airborne Early Warning and Control aircraft.

The turntable will enable DSTO scientists to analyse the radar 'signatures' of Australian military aircraft by turning the aircraft relative to DSTO's radar measurement equipment rather than moving the sensor equipment itself. The advantages of moving the aircraft are that it saves time, and avoids the ingress of serious errors that can arise if the radar's immediate environment is changed and its orientation is affected.

The turntable, to be built with funding from the Defence Materiel Organisation, is expected to be constructed within nine months at a cost of about $1million. No other precision turntable of such size exists in Australia.

The turntable will also enable radar signatures to be acquired from other military platforms such as the Australian Army's new Abrams tanks.

Virtual cockpit measures 'fit' and usability for aircrew

DSTO has been contributing to research on a $4.2 million RAAF Anthropometry Project.

The venture has three key components: an anthropometric survey of the current ADF aircrew population and the potential recruit population, the development of anthropometric cockpit accommodation guidelines for most of the ADF aircraft fleet, and the creation of CAD models for most aircraft in the fleet.

DSTO is developing an anthropometry/human modelling capability to support the analysis of cockpit human-machine interface issues, using a powerful software tool known as Jack. Widely applied overseas in the automotive and defence industries, Jack was used during the Comanche helicopter project to ensure 90% of the population could fly the aircraft.

DSTO has already received a number of requests for advice on anthropometric and human-machine interface issues from the ADF. Following a period of training and evaluation, the tool will be applied to these requests.

Australian DEFENCESCIENCE

Composite replacements ready to fly

DSTO, in collaboration with the Cooperative Research Centre for Advanced Composite Structures (CRC-ACS), is developing advanced fibre composite aircraft panels to replace the high-maintenance metallic variety. The technology used is known as Composite Replacement Panel Technology (CRPT).

Composite replacement panels, being resistant to corrosion and fatigue cracking, are significantly more durable than existing aluminium ones, and the panel configuration can also be designed to enhance impact resistance. The use of new low-temperature curing composite materials ensures that manufacturing costs are competitive with metallic panels. Certification costs are also low because the CRPT itself is certified. For any specific panel, only those aspects different from the approved set of design solutions would need to be tested.

A major focus of the research, which has received strong support and sponsorship from the RAAF Director General of Technical Airworthiness over the past eight years, has been to develop a validated capability to predict strain within a composite replacement panel and the aircraft sub-structure under the combined action of mechanical and thermal loads. This was successfully demonstrated recently with a full-scale test of a composite panel on an F-111 at RAAF Base Amberley.

Potential extension of the technology to produce light-weight composite panels with integrated ballistic protection is being explored to address a recently identified capability gap with rotary wing aircraft.

CALENDAR

25 - 29 Oct 2004	EURONAVAL 2004 Le Bourget, Paris, France Phone: 03 9848 1171 Email: newexhibition@bigpond.com
8 - 10 Nov 2004	Waveform Diversity & Design 2004 Edinburgh, Scotland Email: wdd2004@iee.org http://conferences.iee.org/waveform/
8 - 10 Nov 2004	Communication and Computer Networks (CCN) MIT, Cambridge, Massachusetts, USA Email: calgary@iasted.org
15 - 16 Nov 2004	Defence Human Factors Special Interest Group meeting (DHFSIG 2004) Bridport Resort and Convention Centre, Tasmania Contact: Chris Forbes-Ewan Phone: 03 6352 6607 Email: chris.forbes-ewan@defence.gov.au
28 Nov - 1 Dec 2004	Circuits, Signals and Systems Clearwater Beach, Florida, USA Email: calgary@iasted.org
7 - 8 Dec 2004	2nd Australasian Workshop on Structural Health Monitoring Melbourne Contact: Chris Galea Phone: 03 9626 7634 www.personal.monash.edu.au/~chiuw/workshop/workshop.html
14 - 16 Feb 2005	Artificial Intelligence and Applications Innsbruck, Austria Email: calgary@iasted.org
18 - 20 Apr 2005	Networks and Communication Systems Krahi, Thailand Email: calgary@iasted.org
28 Sep - Oct 2005	21st Conference on Optical Communications SECC, Glasgow, UK http://conferences.iee.org/ecoc05/index.html

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