



Australian Government

Defence

Defence Innovation, Science and Technology Priorities

COMPANION TO:

**ACCELERATING ASYMMETRIC ADVANTAGE
DELIVERING MORE, TOGETHER**

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24**

Defence acknowledges the Traditional Custodians of Country throughout Australia. Defence recognises their continuing connection to traditional lands and waters and would like to pay respect to their Elders both past and present.

Defence would also like to pay respect to the Aboriginal and Torres Strait Islander people who have contributed to the defence of Australia in times of peace and war.



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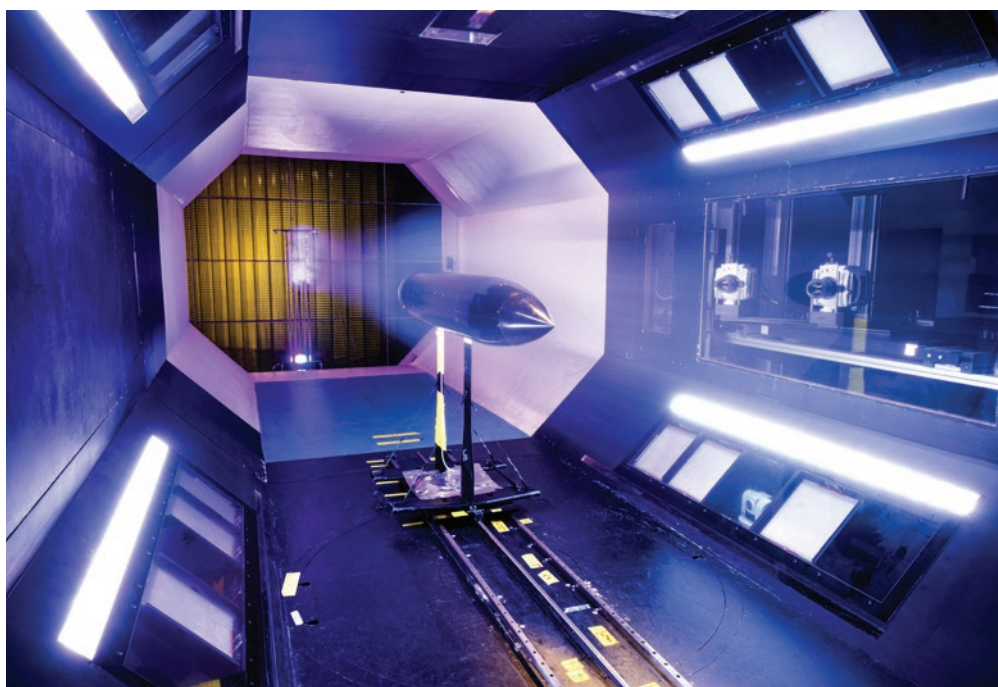
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Defence Innovation, Science and Technology Priorities

In the current geostrategic environment, we are seeing intense competition between major powers in relation to technology and gaining technological advantage. Defence's Innovation, Science and Technology (IS&T) ecosystem is essential to creating asymmetric advantage for the Australian Defence Force and accelerating innovation into capability.

Our IS&T ecosystem must be calibrated to this changed strategic environment. In response, our focus must be on rapidly pulling through emerging and disruptive technologies and accelerating delivery of minimum viable capability. Our research and development must focus on the challenges of today and tomorrow, and be driven by clear priority setting and demand signals from Defence.

The 2024 National Defence Strategy and 2024 Integrated Investment Program highlight the centrality of IS&T to Defence's ability to meet its mission objectives. The National Defence Strategy has also adopted the concept of minimum viable capability, to accelerate the acquisition of new capabilities into service faster, underpinned by the lowest acceptable mission performance in the required time.



Focused strategic research links deep scientific expertise with military application to explore new technological concepts, build critical mass, and undertake sensitive research needing to be done by Defence, particularly for the Future Integrated Force. These strategic investments develop the understanding of how technology can be integrated and used within a Defence context, its limitations and how it can be countered.

The 2024 National Defence Strategy and 2024 Integrated Investment Program articulated six priorities where IS&T will have the biggest impact for Defence through delivering accelerated asymmetric capabilities. The Defence IS&T strategy, "Accelerating Asymmetric Advantage - Delivering More, Together" responds to the National Defence Strategy requirements for a more integrated, focused, responsive and secure Defence IS&T ecosystem. It also supports technologies that enhance Defence's ability to understand audiences and key decision makers, building Australia's influence and ability to deter and de-escalate in crisis. The following provides the broad strategic research focus for the six IS&T priorities.





1. Hypersonics

Hypersonic systems travel faster than five times the speed of sound and offer critical capability advantage that can hold adversaries at risk further away from Australian shores. These systems are highly survivable and difficult to counter because of their manoeuvrability and short time of flight; hence, they can provide an extended range of protection for our military forces and impose a deterrence effect.

Hypersonic flight is extremely complex and challenging because of the strong interaction between aerodynamics, thermal dynamics and non-linear fluid flow physics. Consequently, new technologies and design approaches are needed as part of a complete system integration. The objective is to achieve practical, reliable and sustained hypersonic flight, which requires solutions to a number of challenges including thermal management within an extreme heat environment, structural integrity of the flight vehicle, stable flight control, high speed propulsion, as well as precise guidance and navigation.

Defence will accelerate the development and transition of hypersonic and counter hypersonic technologies to military capability, with specific focus on leveraging the AUKUS partnership agreement, under AUKUS Pillar II – Advanced Capabilities. Key research areas include hypersonic vehicle design, high temperature materials, thermal protection systems, high speed propulsion, guidance, navigation and control, novel sensors, as well as technologies for counter-hypersonic systems.

The United States and Australia are also collaborating on development and flight test of prototype hypersonic cruise missiles by the mid-2020s through the Southern Cross Integrated Flight Research Experiment (SCIFiRE) partnership.

Australia has a deep pedigree and long history in hypersonic research. In order to stay ahead of the curve, the IS&T ecosystem must come together to innovate across multiple disciplines in campaigns of iterative learning comprising wargaming, constructive simulation, and live and virtual experimentation.



2. Directed Energy

Directed energy weapons and protective capabilities provide a range of multi-domain capabilities from deterrence and target degradation to defeat of military threats, as well as hardening and protecting ADF platforms and personnel respectively. They operate on the principle of emission of concentrated electromagnetic energy from electrically charged systems/devices. These systems deliver military capability through the use of high-energy beams such as lasers and microwaves.

Directed energy systems achieve game changing capability at the speed of light and can provide scalable effects to match the level of threat. The system provides the warfighter with an operational and tactical advantage due to the near unlimited magazine capacity, which ensures sustained and continuous engagement. This supports safe operations for the warfighter as it minimises troop exposure during munitions transport in difficult terrain and enables platforms to stay in theatre for longer. Directed energy systems are efficient and have capacity to deliver military capability with precision. They have relatively few components and can provide short and long-range capabilities as long as they are provided with electrical power.

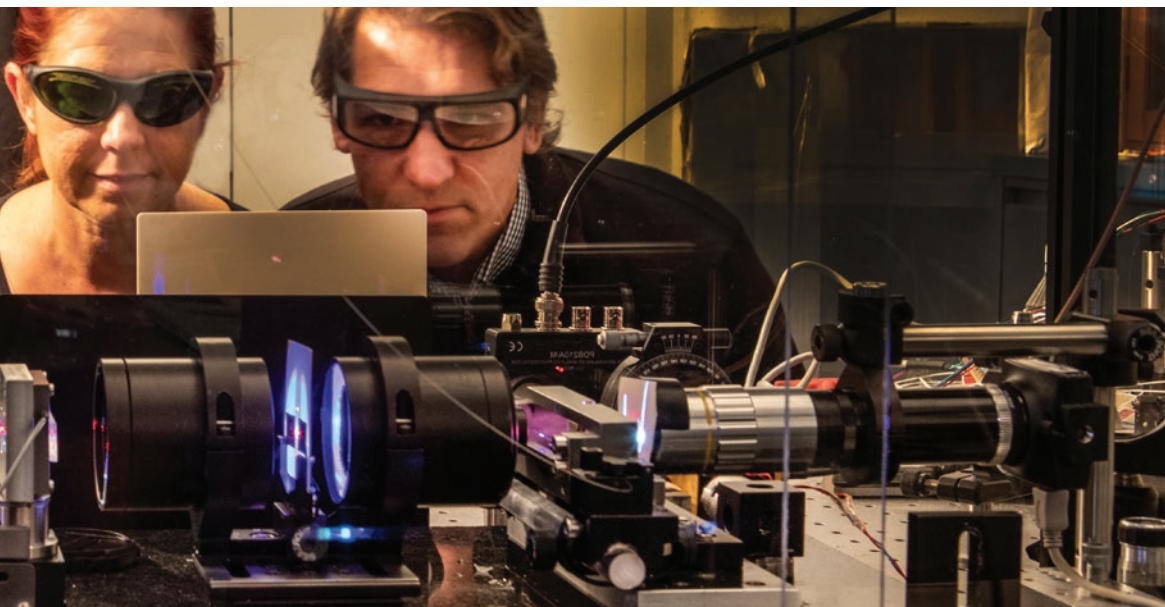
Defence will mobilise the Defence IS&T ecosystem to collaborate and translate technologies that enhance the performance of directed energy weapons and protective capabilities. Some of the important IS&T research areas include power and energy, power scaling of effectors, targeting and tracking and understanding and enhancing atmospheric transmission.





Australian Defence is seeking multidisciplinary partnerships and collaborations to boost innovation that can provide size, weight and power reduction of directed energy systems to enable broad platform integration. Manoeuvrability and capacity for integration into multi role, multi-platform operations on the battlefield will be a key focus of the IS&T ecosystem. Development and testing of cost effective prototypes, which can quickly undergo field-testing and deployment, will be prioritised to achieve capability for the ADF. To enhance the effectiveness of these systems, Defence will support and promote partnerships to enhance laser and RF system output powers and efficient beam combination of laser systems. To uplift tracking and targeting accuracy and precision in contested environment, artificial intelligence and machine learning models will be integrated into directed energy technology systems. Finally, Defence will explore and integrate technologies that leverage atmospheric models and adaptive optics to achieve key war fighting objectives.

Defence has supported the development of a laser based directed energy Counter Unmanned Aerial Systems (c-UAS) as well as funding the power scaling of high energy laser sources. Future lower 'technology readiness level' activities will be supported through the Advanced Strategic Capabilities Accelerator (ASCA) and partner initiatives such as the Defence Trailblazer at the University of Adelaide.



3. Trusted Autonomous Systems

Trusted autonomous systems enhance Defence capability by augmenting and safeguarding the critical human workforce across all five warfighting domains: maritime, land, air, space and cyber. They combine the capacity to track and intercept targets with the ability for rapid, supervised decision-making. Trusted autonomous systems are enabled by artificial intelligence and machine learning models to improve the accuracy and speed of interaction between entities. This interaction can be across the machine-machine interface or the machine-human interface. The increasing complexity of this interaction has led to growing demand for sophisticated and trusted systems that can operate in contested and denied environments. To provide a capability advantage, autonomous systems should be able to operate reliably and accurately, at the speed of relevance, with minimal human supervision.

The key areas of focus for the Defence IS&T strategy for trusted autonomous systems are; resilience, robustness, reliability, ability to learn and explain courses of action, verification and validation models, and interoperability across platforms and domains with allies.

To capture the war fighting advantages of trusted autonomous systems, Defence will engage with the IS&T ecosystem to develop systems that can operate within degraded and denied communication environments. A program of continuous development, integration and experimentation of resilient and reliable prototype systems will be implemented. Defence will prioritise those systems that can operate in contested environments, are cost effective to develop, and require a minimal logistics footprint to operate.

The Defence IS&T ecosystem will focus on dual use systems that can efficiently process and transmit large data sets to facilitate key war fighting objectives. Technologies will be pursued that maintain dependability in machine-to-machine interaction in the context of conflicting objectives.

The IS&T ecosystem will effectively adapt trusted autonomous systems to the battlefield, and ensure consistent system behaviour under variable conditions. Research into efficient and reliable communication between autonomous systems will be undertaken to enhance the decision-making capabilities of autonomous software and technologies. Defence will adopt concepts to optimise teaming behaviour for human-machine, machine-machine and teams-of-teams of varying configuration. Quick translation of IS&T into capability for the warfighter will be achieved through field-testing and experimentation of prototype systems with the ADF.



The IS&T ecosystem will promote the certification of artificial intelligence tool chains and software. Machine learning and artificial intelligence models will be verified and validated for controllers and autonomous devices. This will assure the safety and reliability of autonomous devices and enhance Defence capability. Finally, the IS&T ecosystem will create innovative concepts and ideas to support, adapt and coordinate between autonomous systems for task execution.

Defence's work in trusted autonomy is exemplified by our support to Project SEA1200 Maritime Uncrewed Warfare, in particular supporting the development of the Ghost Shark extra-large autonomous underwater vehicle and the Speartooth large uncrewed underwater vehicle, including collaboration with US and UK partners on key enablers for interoperability including underwater acoustic communications and command and control.





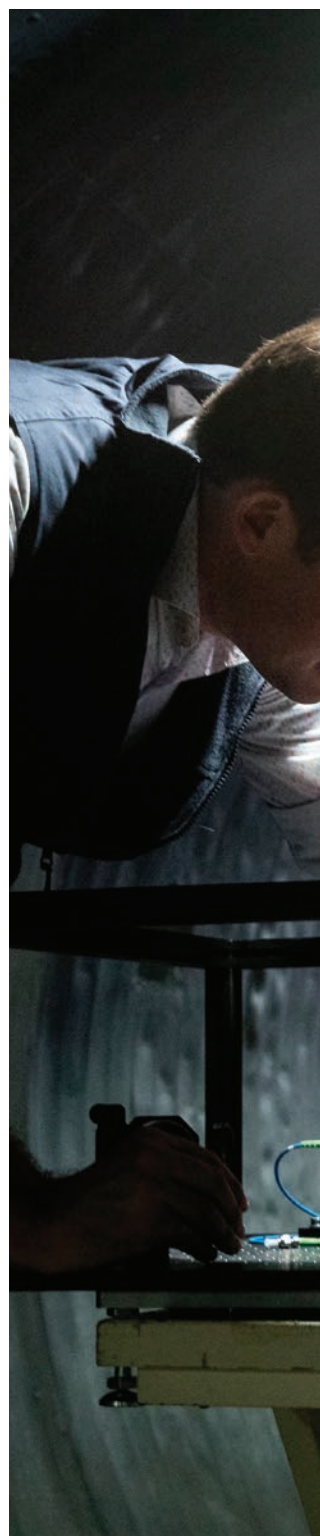
4. Quantum Technologies

Quantum technologies are an emerging area of science and technology that have significant potential to affect Defence capability through enhancing; secured communication, timing and synchronisation, machine learning, cryptography and networking.

Significant uplift of quantum IS&T capabilities within the innovation ecosystem will provide independent, reliable and accurate timing services in locations where space based timing services are absent or unreliable. This will enable the ADF to deploy military capabilities by denying an adversary access to space based time services in contested environment. Furthermore, Defence will adopt quantum technologies for precise navigation assurance to augment or replace inertial navigation systems. This will provide game changing capabilities to the Australian war fighter in locations with no access to the geographic positioning system (GPS).

The strategic priority in quantum technologies will uplift and adopt innovations that enhances the ADF's capabilities in surveillance, and reconnaissance operations in complex and difficult terrain. Australian Defence will collaborate to develop materials with high sensitivity and performance for reconnaissance operations. The capacity to engage in covert surveillance operations will provide the Australian soldier with a more complete picture of the battlefield. This will enable an efficient and accurate deployment of Defence capability to deter conflict and win wars.

Through the Defence IS&T Strategy, Defence will embrace technologies for secure communication across quantum networks. This will guarantee secure information sharing and transfer across devices. Novel algorithms that integrate quantum optimisation and machine learning will be tested for Defence applications. IS&T knowledge with potential Defence applications from these tests will be rapidly translated to enhance Defence capability.





5. Information Warfare

Information warfare applies IS&T capabilities in understanding, manipulating and leveraging information and information systems to gain a warfighting advantage. Information warfare relies on timely access, effects, intelligence, and coordination within and through cyberspace and the electromagnetic spectrum to deter, deny, degrade or deceive an adversary.

The effects generated through information warfare contributes to force protection, force projection and force multiplication, providing asymmetric advantages for Defence operations. Conversely, information warfare can be weaponised against Australia's population, institutions, infrastructure, and National Defence capabilities, potentially posing a disruptive and asymmetric threat.

Key focus areas for the Defence IS&T ecosystem include: cyber warfare, electromagnetic warfare (EW), cognitive warfare, intelligence collection and analysis, integrated command and control, adaptive multi-domain manoeuvre, and resilient operations in contested environments. Complexity, scale and pace are fundamental challenges intrinsic to all aspects of information warfare IS&T.

Research into technologies to achieve a step-change enhancement to the security and resilience of its networks and systems (cyber terrain), and the ability to detect and respond to constantly evolving cyber threats,



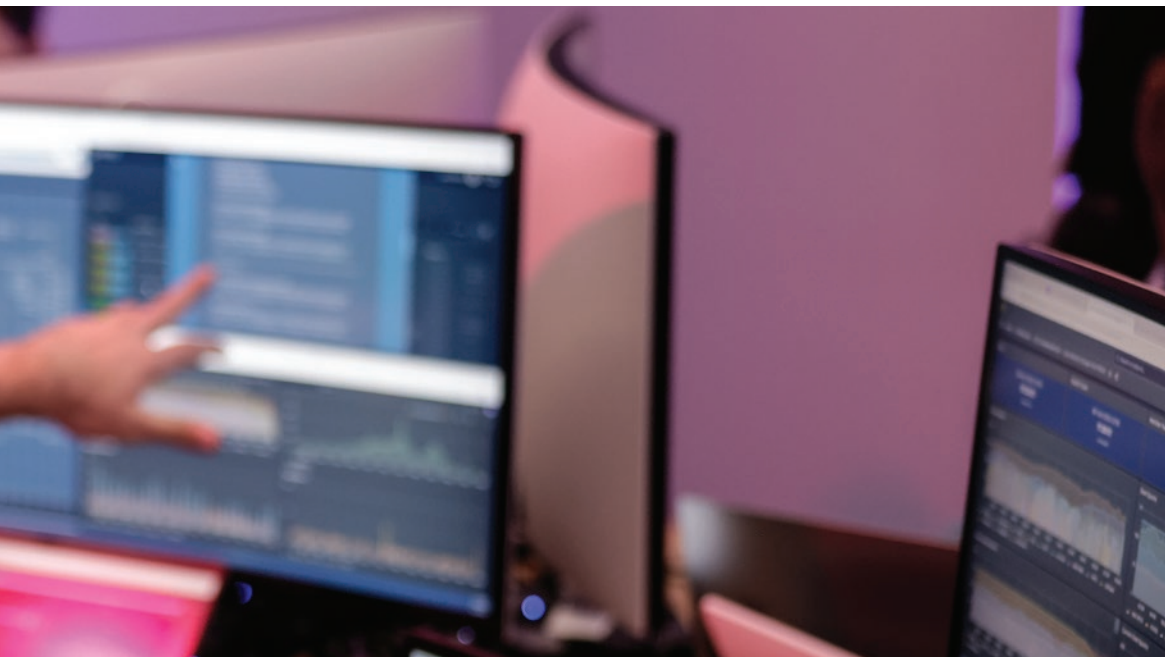


will drive down risk to mission. Automation, autonomy, and new approaches to cyber situational awareness and decision-making will be necessary to create impact at the speed of relevance.

Defence will invest in EW technologies to conduct distributed joint electromagnetic spectrum operations, generate defensive and offensive countermeasures against the latest adaptive threats, and to increase the resilience of spectrum dependent capabilities. In doing so, Defence seeks to enhance its ability to manoeuvre within the electromagnetic spectrum, creating electromagnetic spectrum superiority and asymmetric advantage in windows of time, frequency and space of our choosing. Defence's participation in AUKUS Pillar II EW Working Group and the AUKUS EW Innovation Challenge are key thrusts.

Defence will explore innovative solution for detecting, evaluating and countering the spread and impact of malign influence, and disinformation campaigns at home and abroad.

Investment in automated tools for rapidly and accurately identifying, fixing and tracking targets across multiple information sources will enhance battlespace threat and opportunity assessment. This will be complemented by the adoption and integration of technologies to optimise and scale all-domain operational command and control.



6. Long-range Fires

Long-range fires are missile systems with the capability to use rockets, sub systems and technologies to deliver military capability over long distances. Long-range weapons are multi-domain and therefore can be used on air, land and maritime platforms.

Long-range missiles provide effective deterrence and enable Australian Defence to project power far away from Australian shores. The missile systems will enhance the capacity of Australian Defence to respond in multi-domain contests from longer and safer distances.

Defence will capture advances in long-range fires that will uplift the capacity to deliver missiles over longer distances, in a shorter amount of time and with higher accuracy. Defence will coordinate the elements of the IS&T ecosystem to enhance innovation in the following areas: propulsion and energetics, collaborative weapons, material sciences, modelling and simulation and non-kinetic effects.

Elements of the IS&T ecosystem will be deployed to capture advances in technologies that enhance the performance of smaller, and powerful weapon systems over longer ranges and higher speeds. With allies and industry, ongoing research partnerships on solid rocket motor,



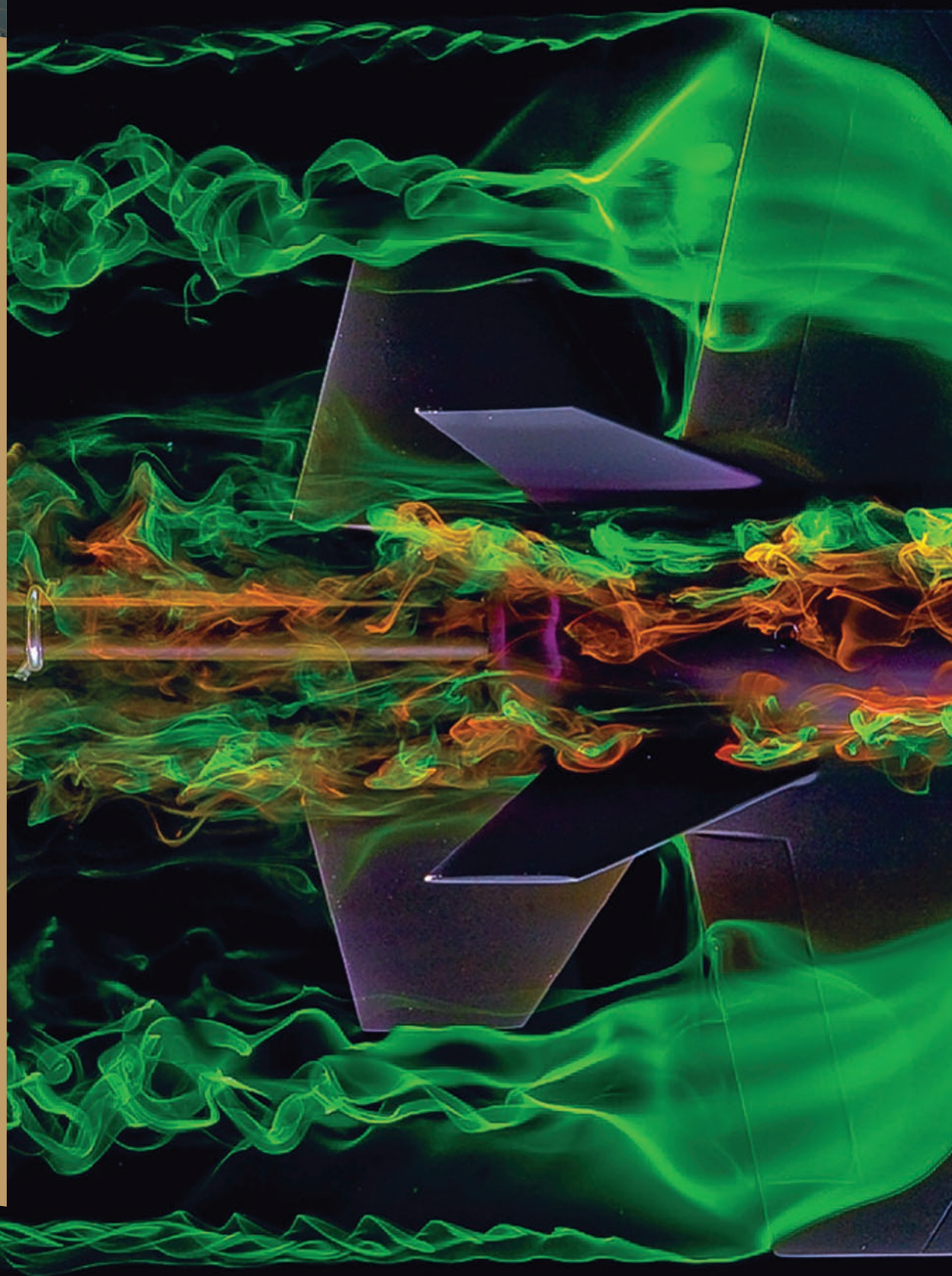


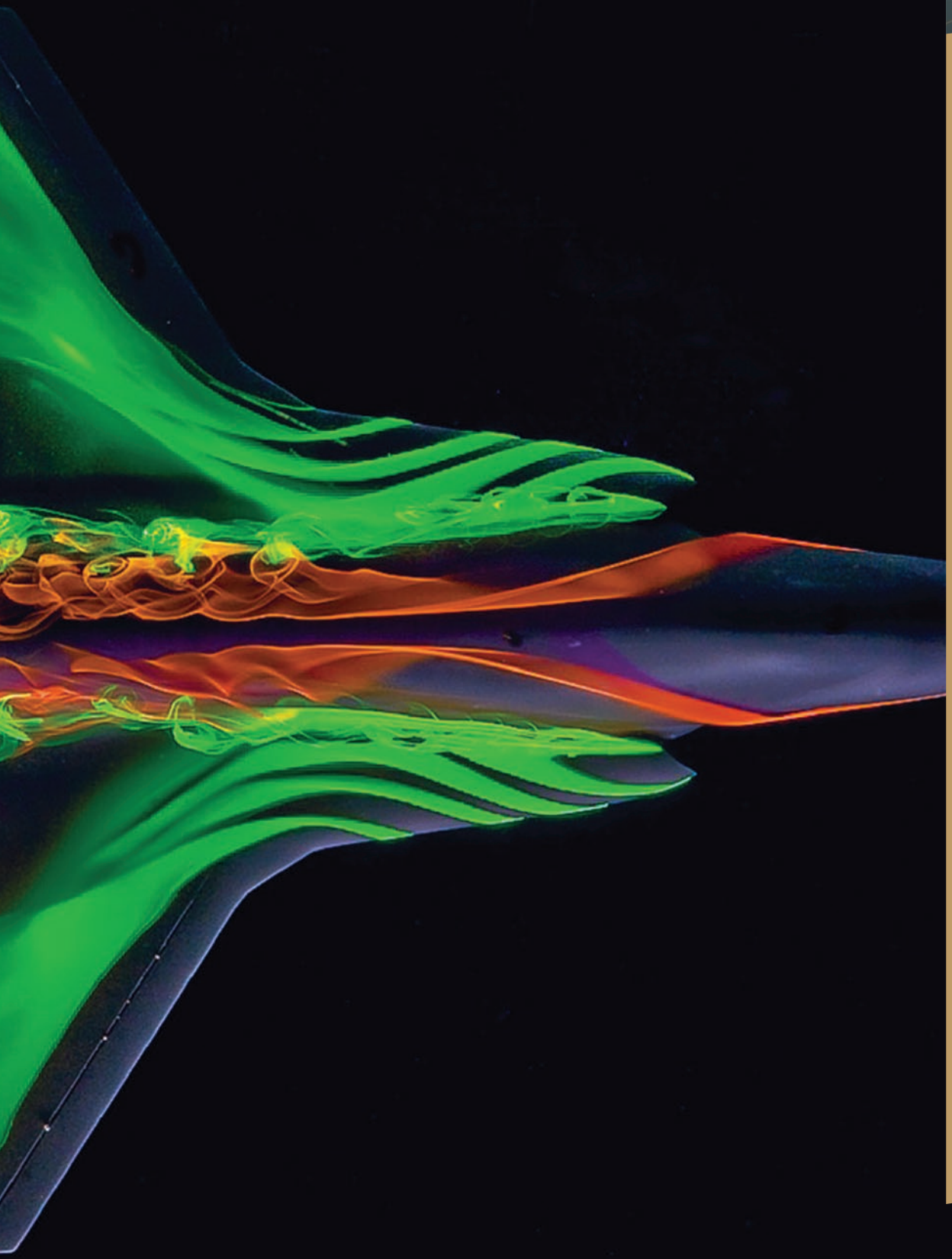
air breathing and propulsion technologies will continue to be integrated. This will include collaborations and partnerships on solid and liquid fuel ramjet technologies to enable significantly longer ranges.

The Defence IS&T ecosystem will enhance capabilities using artificial intelligence and machine learning. With allies and Defence industry, the ADF will integrate networked data communications, and collaborate to develop, fix, track and target capabilities. The ADF will use innovative concepts to develop precise targeting technologies that are scalable, and can be adapted to different platforms and sensor systems. The IS&T ecosystem will pursue advanced IS&T capabilities that enable the integration of small low cost weapons. This will provide operational flexibility and an effective and reliable alternative for capability delivery.

Defence will continue to explore innovation and expertise in non-kinetic effects to provide military advantage for the warfighter. These non-kinetic effects include advances in cyber, electronic warfare and other space based tools.









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