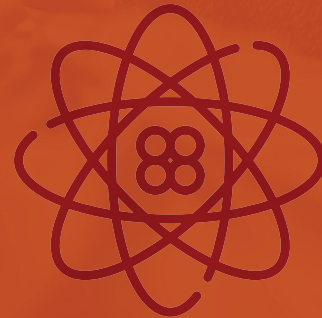
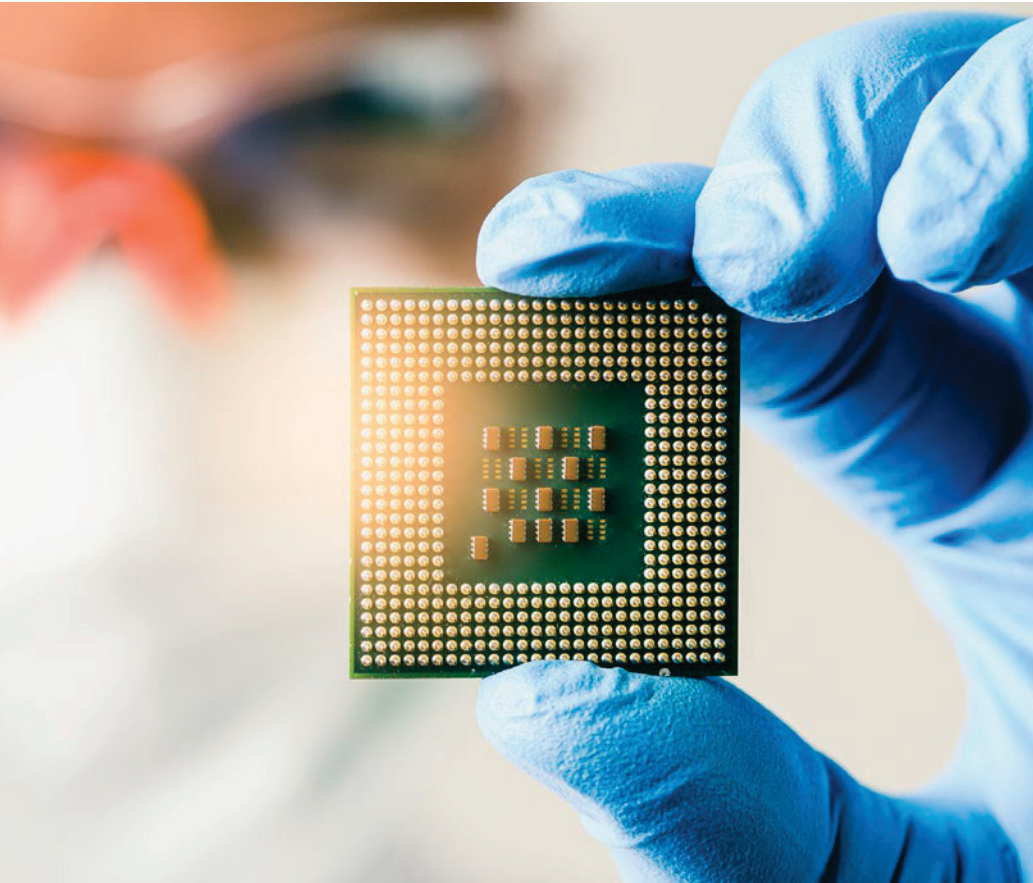




# Quantum Technologies





# DEFENCE RESEARCH CAPABILITY CATEGORY: **QUANTUM TECHNOLOGIES**

## **UWA Competitive Advantage**

- Precision patented technology based on hybrid photon-spin polaritons, which could in principle be used for highly sensitive measurements of the magnetic field, or wideband agile low-noise oscillators for radar and datacomms.
- Expertise in low-noise precision and quantum measurements, low temperature physics and hybrid quantum systems.
- Advanced mathematical methods and numerical techniques to model the dynamics of quantum systems and investigate quantum algorithms providing new possibilities for communication and data processing.
- New smaller sensors based on quantum and magnetic technologies with faster and more energy efficient electronics for communications, data processing/storage and for field-, substance-, gas- and bio-sensing.
- Miniaturized gravity gradiometer with improved performance and capable of being deployed from unmanned fast-moving platforms like UAVs, both airborne and submersibles.
- Interferometric Electromagnetic Gradiometer is ultra-sensitive and measures electromagnetic signatures created by submarines when they are silent and no acoustic tracking is possible. The system can be easily fit into fast moving unmanned submarine hunters such as drones, UAVs & AUVs.
- Microwave sensors that are ultra-sensitive and can localise radio frequency magnetic fields into a tiny volume with a range of applications.
- Precision oscillators and clocks including the world's best microwave oscillator which has been used in the most precise and sensitive defence radar systems, developed by Raytheon.

**Development of new quantum sensor and quantum communications technologies that deliver unprecedented sensor performance and communications security. UWA are world leaders in low-noise precision measurement involving frequency, time and quantum systems.**



### Outcomes and Impact

- Developed the lowest noise microwave measurement and oscillator technology (including sapphire oscillators at room temperature and cryogenic temperature) in the world, necessary for application in the best precision frequency systems, such as atomic clocks and atomic qubits, resulting in systems operating at the quantum projection noise limit. These inventions were responsible for the products sold by Poseidon Scientific Instruments Pty Ltd (now owned by Raytheon) and are at the heart of all their defence radar.
- Developed technology to transfer stable frequencies over free-space, useful for timing, GPS navigation and datacomms applications. Variations of this technology have also been used in advanced radar systems, and to build ultra-sensitive sensors to detect magnetic, electric and gravitational observables.
- Patented novel hybrid opto-mechanical technology to miniaturise a device to measure gravity gradients, useful for the detection of tunnels.
- Patented a new type of quantum hybrid sensing element for an intrinsic gravity gradiometer (IGG) for use in sensing variation in a gravity field at a location.
- An ultra-stable and accurate atomic optical lattice clock was built, and the signal derived from its cryogenic sapphire oscillators (the ground clocks) will be compared with satellite clocks as part of the European Space Agency's mission Atomic Clock Ensemble in Space (ACES).

This pioneering development will allow orders-of-magnitude better timing and synchronisation of clocks around the globe.

### Capabilities and facilities

Research Groups involved in this work include:

- [The Astrophotonics Group at ICRAR](#)
- [Quantum Clock flagship program](#)
- [The Quantum Information, Simulation and Algorithms \(QUISA\) Research Centre](#)

Facilities include:

- [The Quantum technologies and Dark Matter Lab \(QDM Lab\)](#)
- [ARC Centre of Excellence for Engineered Quantum Systems \(EQUS\)](#) and [QUANTX Labs](#)
- UWA Magnetic Characterisation Facility
- UWA Centre for Microscopy, Characterisation and Analysis
- The local node of the Australian National Fabrication Facility

### Contact Details

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