



Astronomy
Australia
Ltd.

Industry Engagement **Why & how?**

Wednesday 8 November 2022

Dr James Murray
AAL Director of Programs



QuasarSat's digital phased array technology can potentially link to hundreds of satellites at once.
Credit: QuasarSat.



Industry Engagement in the **Decadal Plan**

The Decadal Plan called for the establishment of “a *central body to promote and facilitate industry engagement with the next generation of global facilities.*”

The Decadal Plan Mid-Term review marked this as:
NOT ACHIEVED.





Industry Engagement **focus**

Additional reasons for IE:

- **Building the business case for ESO & economic benefit.** The Government wants to see evidence of commercial translation of university research.
- **Because opportunities are there.** Astronomy research can go far here, but communication between academics and industry remains the biggest hurdle for many researchers to get started.



Andrew Jameson (ADACS)
with the new Keck RTC.
Credit: Karl Glazebrook.



Regardless of the motivation for doing industry engagement, the first step is the same.

Understand and document what we have.

Industry Engagement: **How do we start?**





- A commercialisation audit
- Key technologies / facilities and skills
- Industry partners (~5 per node)

Industry Engagement: **How do we start?**





Industry Engagement case study: **Keck Real-Time Controller**

Swinburne's **Professor Karl Glazebrook** and his team have helped to develop a new **Real Time Controller (RTC)** for the W. M. Keck Observatory's AO system.

The team (with help from ADACS) collaborated with University of Paris, ANU and Italian company **Microgate (project leaders)**, to develop a new RTC – with 100 times more computational throughput than conventional AO computations.



AAL Support: None.
SELF-FUNDED /
MOTIVATED.

Left: Professor Glazebrook at the Keck Observatory. Credit: Karl Glazebrook. Right: Project leaders Microgate are experts in fast precision timing for astronomy and sports science. Credit: Microgate.



Industry Engagement capability: **ADACS**

Astronomy Data and Computing Services (ADACS)

is a joint venture between AAL, Swinburne and Curtin. Their specific capabilities include:

- System analysis & design
- Scientific computing
- HPC
- Machine learning
- Full-stack web development
- Large-scale database optimisation
- Cloud computing
- Scientific visualisation.



AAL Support: Established and supported via NCRIS.

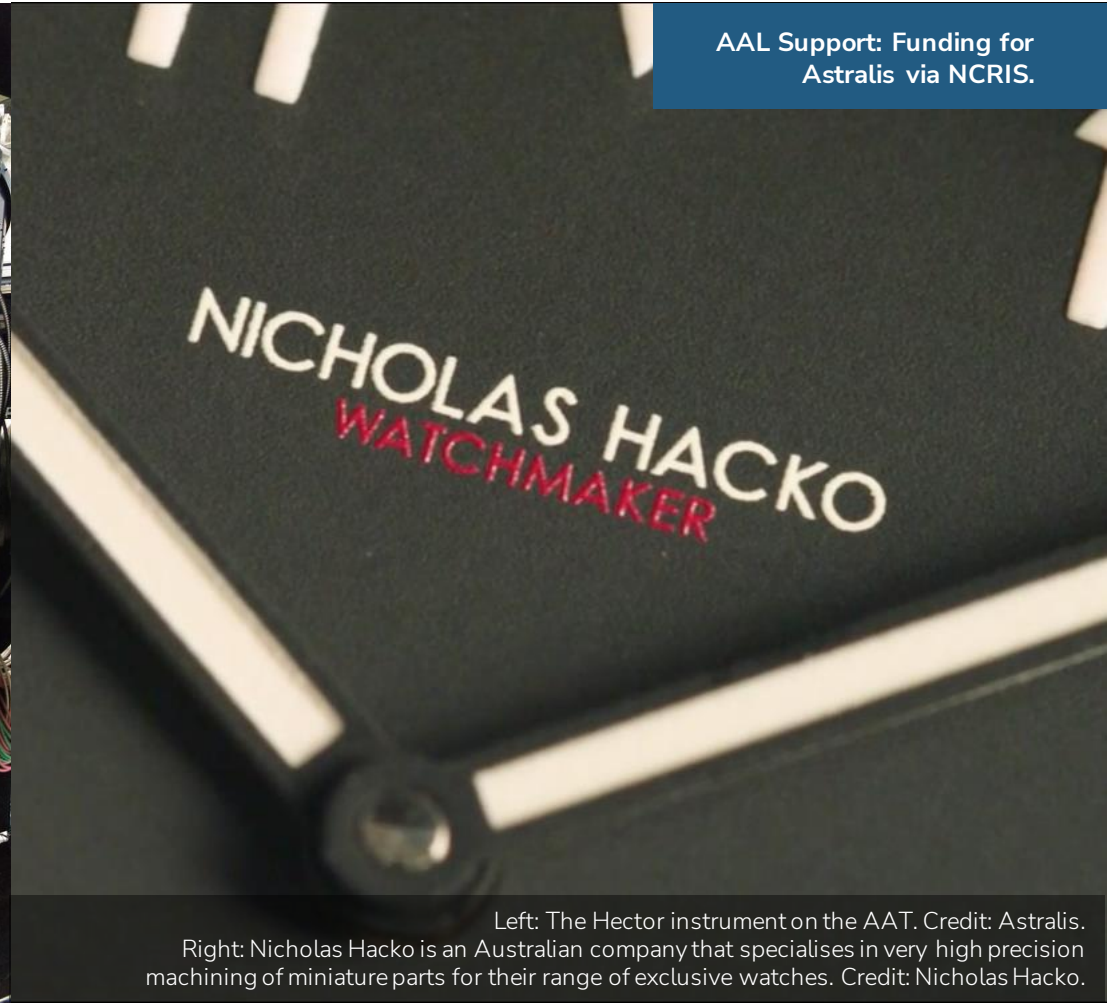
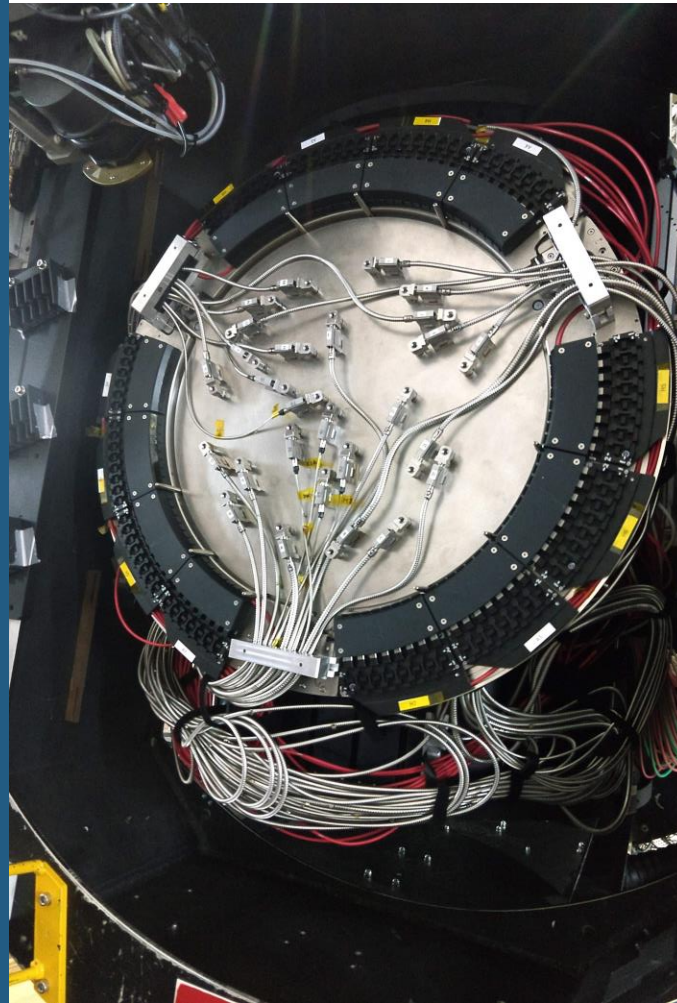
ADACS have been key partners in some recent examples of successful industry engagement. Left: The Keck Real-Time Controller (with Swinburne University). Credit: WMKO. Right: Stawell gold mine – mDetect project. Credit: Carl Knox, Swinburne University of Technology.



Industry Engagement case study: **Hacko and Hector**

A major new instrumentation project for the **AAT** has led to a partnership with one of the most specialised Australian watchmakers, **Nicholas Hacko**.

Specialising in very high precision machining of miniature parts, Hacko visited the project laboratory several times and worked through different prototypes, eventually manufacturing ~\$40k of parts for the new Hector instrument.



Left: The Hector instrument on the AAT. Credit: Astralis.
Right: Nicholas Hacko is an Australian company that specialises in very high precision machining of miniature parts for their range of exclusive watches. Credit: Nicholas Hacko.



Industry Engagement case study: **QuasarSat**

CSIRO commercialisation specialist, **Dr Ilana Feain**, is a founding Director of **QuasarSat** (Quasar Satellite Technologies).

A new Australian start-up, QuasarSat is based on CSIRO phased array technology. It will potentially link to hundreds of satellites at once, dramatically increasing the efficiency and speed of real-time digital communications.



AAL Support: Some seed funding.
MOSTLY SELF-FUNDED / MOTIVATED.

Left: CSIRO commercialisation specialist Dr Ilana Feain is a founding Director of Quasar. Right: CSIRO's phased array technology was developed to give radio telescopes a wide angle view of the sky. Both images – credit: CSIRO.



Industry Engagement case study: **MyLM**

CSIRO project engineer Matt Shields is the founder of MyLM.

From his work on a parts tracking system for ASKAP, Matt saw how this could be applied to the biomedical devices supply chain.

He then founded MyLM – a company that catalogues and tracks medical devices – allowing hospitals and medical institutions to better manage their inventory.



AAL Support: Connections.
MOSTLY SELF-FUNDED / MOTIVATED.

Left: Matt Shields from CSIRO created MyLM. Credit: Matt Shields.
Right: MyLM was based on Matt's work to build an ASKAP parts tracking system. Credit: CSIRO.



Industry Engagement case study: **Water Tanks to Peru**

**Dr Jose Bellido Caceres
from University of Adelaide**

approached AAL with an opportunity – to help SA business Aquamate supply water tanks to a gamma-ray observatory in Peru.

AAL worked with DISER and the university to fund prototypes for field testing. If successful, Aquamate could win a ~\$40M contract to supply 6,500 water tanks to the Southern Widefield Gamma-ray Observatory.



Left: Dr Jose Bellido Caceres, University of Adelaide. Credit: LPTHE Cosmic 2016. Right: Dr Caceres in front of a water tank at Aquamate's facility. Credit: University of Adelaide/Jose Bellido Caceres.



Call to Action

AAL wants to showcase more case studies and capabilities statements on our new industry engagement website.

Please get in touch with James Murray at AAL to discuss your industry engagement project.

AAL Industry Engagement Call to Action

Professor Karl Glazebrook – Keck Observatory RTC

Professor Karl Glazebrook, Swinburne University of Technology – Keck Observatory Real Time Controller

Swinburne University of Technology Professor, Karl Glazebrook, and his team have helped to design a new Real Time Controller (RTC) for the two 10 m Keck Observatory telescopes, located on Maunakea, Hawaii.

The RTC is the heart of the Adaptive Optics (AO) system for the two Keck Telescopes – a technology that allows ground based telescopes to measure and counteract the turbulence present in the Earth's atmosphere, allowing up to an image to match the resolution possible from orbital telescopes. The new AO system is essential for obtaining observation results from between 70 to 100 nights per year, with the two Keck Telescopes serving a broad international community of astronomers from the likes of the University of California and Caltech, to NASA and other space organisations.

While AO systems have been used on the Keck for several decades, it was determined that a new RTC was required, one with much greater computational throughput. The collaboration involving Professor Glazebrook and his team contacted other Real Time AO at the Keck Observatory visited Swinburne to discuss their proven expertise in computational science and supercomputing. After Professor Glazebrook was recruited to another group at the University of Paris, who had been developing GPU based AO algorithms, a collaboration was formed between these two institutions – along with Australian National University (ANU) and an Italian company called Montage (who created the timing systems for the Keck RTC) and led the project overall – submitting a design for a new RTC in response to Keck's call for proposals.

A new RTC would have to be as flexible as possible in order to perform regular system updates. Something that the existing AO system was unable to manage efficiently. Hence the computational speed, software expertise and timing precision offered by their collaboration was sufficient to make the team successful bidders. Creating the Computational Engine of the RTC, led by Swinburne (based on their expertise in this area) and project leader Montage managed the hardware/vendor interfaces.

For their part of the project, Swinburne was greatly assisted by the experts from ANU, who provided a depth of software engineering expertise that was vital for the success of the project, with a specialist programmer assigned specifically to work on the project.

“ If it had not been for Swinburne to deliver this, that instrument at Keck and get the first light image. This has been a major software engineering project and research that has been done across the depth of expertise built up from the Supercomputing Army (SARA) and Astronomy Data and Computing Strategy (ADCS). Swinburne has been project management of Andrew James and the programming skills of Neil Cassin. An amount of time has been and the extended collaboration has been established.”

— Professor Karl Glazebrook / Head of Swinburne's collaboration to design the advanced RTC for the Keck Observatory

The new RTC, designed and developed by this collaboration, has 100 times more computational throughput than conventional AO computers. This means that each frame returned can have more complex algorithms applied to it, and the rate of each frame will be two to four times faster than the current AO system.

This dramatic increase is all down to the new Graphics Processing Units (GPUs). It is the first time flexible GPUs have been used for this purpose on a large telescope, enabling software modes that can be changed and reprogrammed quickly, as opposed to current AO hardware based systems in use that are not nearly as flexible. Considering the speed in which the completion times must rise in order to keep up with the rate of changing atmospheric turbulence, the speed and flexibility of the new RTC computer developed by the team is a game-changer for the future of AO system technology.

From project commencement in July 2018, the collaboration designed and developed three RTCs – one for use on each Keck telescope and another kept as a backup. While the program was designed partly due to COVID-19, engineering teams have been able to the project recently reached a major milestone – achieving ‘on sky’ status in May 2021 for the first time in one month. Once ‘on sky’ status is achieved in both modes, the project will give the green light to replace the current RTC on the two Keck telescopes. A completion date for the new Real Time AO system is expected in the first half of 2023. With a typical capacity of operating in 11 modes, future flexible applications include installation into other ground-based telescopes around the world, as well as real time scientific imaging opportunities and adapting the world's first RTC technology to process a greater resolution for earth satellite imagery.

Dr Ilana Feain – QuasarSat

Dr Ilana Feain, CSIRO – Quasar Satellite Technologies

CSIRO commercialisation specialist, Dr Ilana Feain, is a founding Director of Quasar Satellite Technologies. A new Australian start-up, Quasar is based on CSIRO phased array technology designed originally for use in radio astronomy to study weaknesses coming from objects like pulsars and supermassive black holes. Dr Feain sees the opportunity to bring together state of the art technology, private investment and industry expertise to change the way that global users collect data from satellites in space.

Currently, ground stations used for satellite communication can usually only link to one satellite at a time, creating a bottleneck of who to get back down to the ground. Quasar's, digital phased array technology, however, can potentially link to hundreds of satellites at once, dramatically increasing the efficiency and speed of real-time digital communications.

“ CSIRO played an early technology development role in assessing the viability of ASOP to an enormous portion of the sky at one time – about 20 times the area that conventional telescopes could see. We used the expertise of one of our most successful in this technology enterprise satellite businesses and that demonstrates industry.”

— Dr Ilana Feain / CSIRO Commercialisation Specialist and Founding Director of Quasar

For more on Dr Feain and her Quasar project, please see AAL's Quasar project page on the Quasar Satellite Technologies website.

Dr Jose Bellido Caceres – Water Tanks to Peru

Dr Jose Bellido Caceres, University of Adelaide – Water Tanks to Peru

AAL recently supported a South Australian business and astronomer from the University of Adelaide to secure a \$40 million contract to design and build water tanks to defend governments at an observatory located in South Africa.

In early 2020, AAL was approached by Dr Jose Bellido Caceres, an astronomer at the University of Adelaide, with an opportunity to support an Australian business to supply equipment under their own, with minimal government funding for a gamma-ray observatory planned for construction in South Africa.

AAL worked with the Entrepreneur's Programs, sponsored by the Department of Industry, Science, Energy and Resources (ISER) to support the business (Aquasafe) and the University to fund a series of prototypes to be used for field testing in Mexico and Peru. Aquasafe is based about 1000 km south of Adelaide (CSIRO in South Australia, with over 20 years' experience in designing and building water storage tanks for the domestic and international market. Several field testing of the prototype water tanks has occurred, equipment built with a contract worth approximately \$40 million to supply 6,500 water tanks to the Southern Waterfall Gamma-ray Observatory (SWGO).

Gamma rays cannot be directly detected from observatories on the ground, but radiation that known as secondary particles produced by gamma rays interacting with the atmosphere can be detected in water. Once inside a water tank, it is possible to detect the light emitted by the

“ The Large High Altitude Air Shower Observatory (LHAASO) – a new large ground based gamma-ray observatory located in China – has been built to observe the 200+ number of billions of very energetic gamma rays, opening a new window in astronomy. After field testing, the Southern Waterfall Gamma-ray Observatory will be one of the Southern sites, including the particle tanks, leading to PVF sources and transient gamma-ray emission ranging from hundreds km up to the PVF sources.”

— Dr Jose Bellido Caceres / University of Adelaide

The partnership with Aquasafe clearly comes with enormous benefits for the SWGO Collaboration, and it seems other international observatories teams are also expressing interest in Aquasafe's innovative large size image to light, which will be made the water tanks made for the SWGO project. These gamma-ray tanks can also be used without the water tanks, following into large tanks of water. Observations at the West Pacific Institute in Germany are currently looking at creating a new generation detector at a rural site in Peru, using these gamma-ray tanks, covered over an area of at least ten times larger than the LHAASO. The Gamma-ray tanks have recently returned Australia, made gamma-ray tanks from Aquasafe for testing at the West Pacific Institute in Germany in three months in Germany.

For more information on the water tanks, Aquasafe and the SWGO project, see the University of Adelaide's news story.

AAL's industry engagement activities aim to support the maximisation of the economic advantage to Australia from astronomy research.

An example of the case studies currently on AAL's IE website.

Left: The Keck Observatory RTC
Middle: Quasar Satellite Technologies.
Right: Water Tanks to Peru