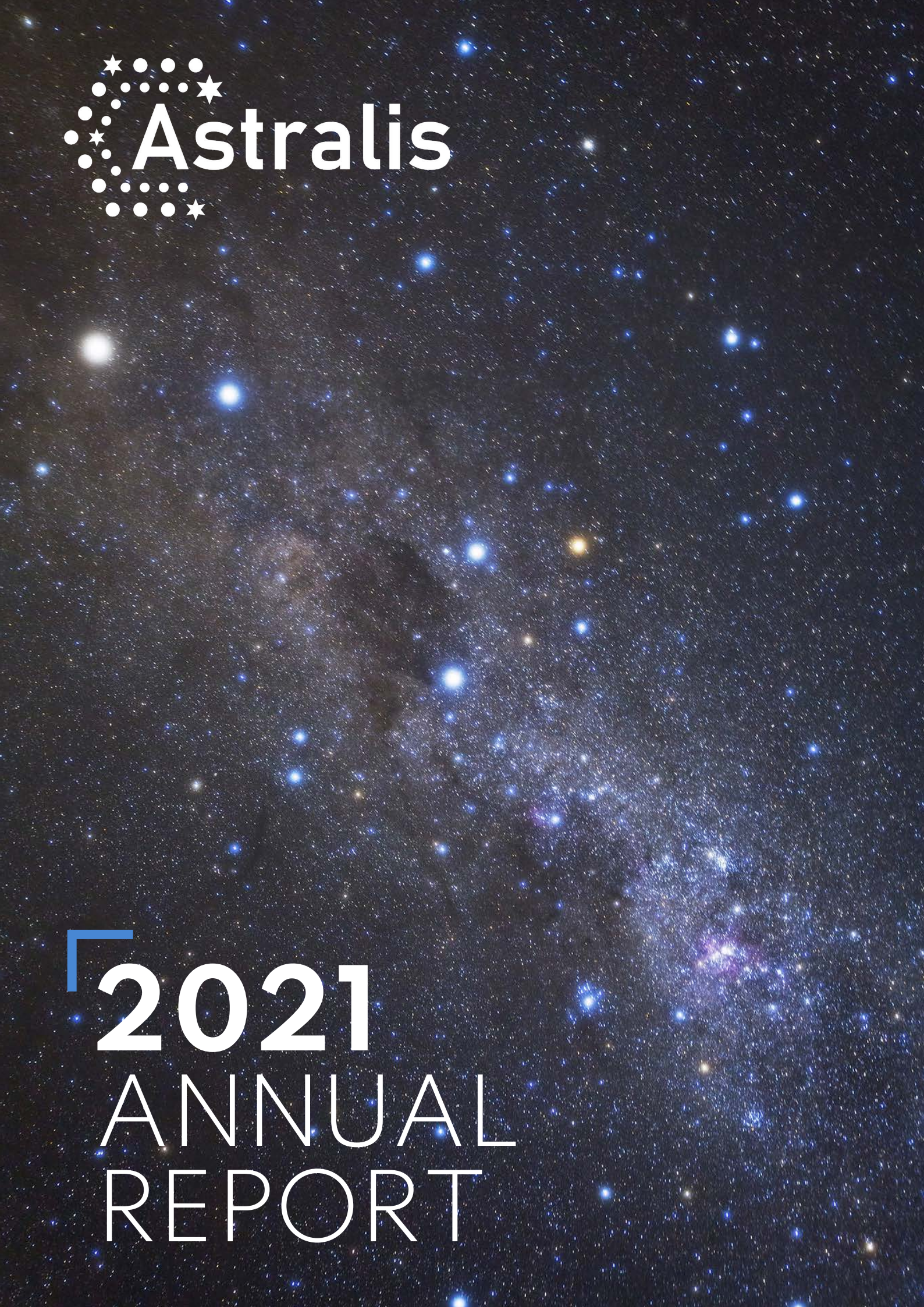

2021 ANNUAL REPORT

The Astralis Instrumentation Consortium provides Australia's national capability for optical astronomy instrumentation by combining expertise and resources from Macquarie University, the University of Sydney and the Australian National University.

MACQUARIE University

THE UNIVERSITY OF SYDNEY

Australian National University

Astronomy Australia Ltd.

astralis.org.au
info@astralis.org.au

Cover image: The Southern Cross and the Pointers. Credit: Ángel R. López-Sánchez & Álvaro Iranzo Gutiérrez.

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2 GLOSSARY

4MOST	4-meter Multi-Object Spectroscopic Telescope
AAL	Astronomy Australia Limited
AAO	Australian Astronomical Optics
AAOC	Australian Astronomical Optics Consortium
AAO-DIIS	Australian Astronomical Observatory operated by Department of Industry, Innovation and Science
AAT	Anglo-Australian Telescope
AB	Astralis Board
AESOP	Australian-European Southern Observatory Positioner
AIP	Leibniz Institute for Astrophysics Potsdam
AITC	Advanced Instrumentation Technology Centre
ANU	Australian National University
ARC	Australian Research Council
ARC FT	Future Fellowships grant scheme provided by ARC
ASIC	Australian Securities and Investments Commission
AST3	Antarctic Survey Telescopes
Astralis-AAO	Astralis Instrumentation Consortium AAO node
Astralis-AITC	Astralis Instrumentation Consortium AITC node
Astralis-USyd	Astralis Instrumentation Consortium University of Sydney node
Astralis MC	Astralis Management Committee
ASTRO-3D	ARC CoE for All Sky Astrophysics in 3 Dimensions
ATLAS	Advanced Technologies for Laser Adaptive optics Systems
AURA	Association of Universities for Research in Astronomy
CGA NIG	National Institutes Grant
CoE	ARC Centre of Excellence
COO	Chief Operating Officer
CUBES	Cassegrain U-Band Efficient Spectrograph for VLT
DAG	Eastern Anatolian Observatory [Turkish: Dogu Anadolu Gozlemevi]
DIIS	Department of Industry, Innovation and Science (now DISER)
DIISR	Department of Innovation, Industry, Science and Research (now DISER)
DIRAC	Diffraction-limited Infra-Red Adaptive-optics Camera
DISER	Department of Industry, Science, Energy and Resources
DREAMS	Dynamic REd All-sky Monitoring Survey
ELT	Extremely Large Telescope – ESO
ESO	European Southern Observatory
FLAMES	Fibre Large Array Multi Element Spectrograph
FOBOS	Fibre Optics Broadband Optical Spectrograph
FTE	Full-time equivalent
GHOST	Gemini High-Resolution Optical SpecTrograph
GLAO	Ground-layer Adaptive Optics
GLINT	Guided Light Interferometric Nulling Technologies
GMT	Giant Magellan Telescope
GMTIFS	GMT Integral-Field Spectrograph
GMTO	Giant Magellan Telescope Organisation
GNOSIS	Near-infrared OH Suppression Experiment
HRMOS	High Resolution Multi-Object Spectrograph
IAA-Granada	Instituto Astrofísica Andalucía – Granada
ICRAR	International Centre for Radio Astronomy Research
IFU	Integral Field Unit
INAF	Istituto Nazionale di Astrofisica – Italy
IR	Infrared
JPL	Jet Propulsion Laboratory
LIEF	Linkage Infrastructure, Equipment and Facilities
LVM	Local Volume Mapper
MAAT	Mirror-slicer Array for Astronomical Transients
MANIFEST	The Many Instrument Fibre System
MAORY	Multi-conjugate Adaptive Optics RelaY
MAVIS	MCAO Assisted Visible Imager and Spectrograph
MCAO	Multi-Conjugate Adaptive Optics
MEC	Major Equipment Committee
MECG	Major Equipment Committee Grants
MQ	Macquarie University
MSE	MaunaKea Spectroscopic Explorer
MSEPO	Maunakea Spectroscopic Explorer Project Office use: MSE Project Office in the table
NASA	National Aeronautics and Space Administration
NatCap	National Optical Astronomy Instrumentation Capability
NCRIS	National Collaborative Research Infrastructure Strategy
NIG	National Institutes Grant
NSF	National Science Foundation
OHB	Otto Hydraulic Bremen
R&D	Research and Development
RSAA	Research School Of Astronomy & Astrophysics
SAIL	Sydney Astrophotonic Instrumentation Laboratory
SDSS	Sloan Digital Sky Survey
SME	Small and Medium-sized Enterprise
SPIE	International Society for Optics and Photonics
SSO	Siding Spring Observatory
SUT	Swinburne University of Technology
TAC	Time Allocation Committee
TAIPAN	Transforming Astronomical Imaging surveys through Polychromatic Analysis of Nebulae
TOLIMAN	Telescope for Orbital Locus Interferometric Monitoring of our Astronomical Neighbourhood
UKST	United Kingdom Schmidt Telescope
USyd	The University of Sydney
UWA	University of Western Australia
VAMPIRES	Visible Aperture Masking Polarimetric Interferometer for Resolving Exoplanetary Signatures
VISTA	Visible and Infrared Survey Telescope for Astronomy
VLT	Very Large Telescope – ESO

3 INTRODUCING ASTRALIS

The Astralis Instrumentation Consortium (Astralis), formerly known as the Australian Astronomical Optics (AAO) Consortium, is an unincorporated collaborative joint venture comprising four partners, created to establish a National Optical Astronomy Instrumentation Capability (NatCap) in response to the Commonwealth Call in 2017. The Astralis Consortium was formed to enhance Australia's international capability and competitiveness in astronomy-related optical and infrared instrumentation programs. The Australian Government, through the National Collaborative Research Infrastructure Strategy (NCRIS), is providing up to $50 million over ten years to support the NatCap development. The Consortium was officially established on 1 July 2018 and was rebranded as Astralis in April 2021.

The Consortium comprises the following parties:

- **Macquarie University**, in the form of a new department – Australian Astronomical Optics-Macquarie (Astralis-AAO) – within the Faculty of Science and Engineering. Astralis-AAO consists of staff and facilities from the North Ryde site of the former Australian Astronomical Observatory.
- **The Australian National University** (ANU), through its Advanced Instrumentation Technology Centre (AITC) within the Research School of Astronomy and Astrophysics. AITC has adopted the name Astralis-AITC for Consortium business.
- **The University of Sydney** (USyd), through elements of the Sydney Astrophotonic Instrumentation Laboratory (SAIL) within the School of Physics. The astronomical instrumentation section of this group is called Astralis-USyd for Consortium business.
- **Astronomy Australia Limited** (AAL), supported by the National Collaborative Research Infrastructure Strategy (NCRIS) – an Australian Government program to deliver world class research facilities.

Vision: Astralis will be a leading international astronomical instrument designer and builder, serving Australian astronomy by proposing and delivering innovative and effective solutions to the most significant observational challenges in optical and near-infrared astronomy.

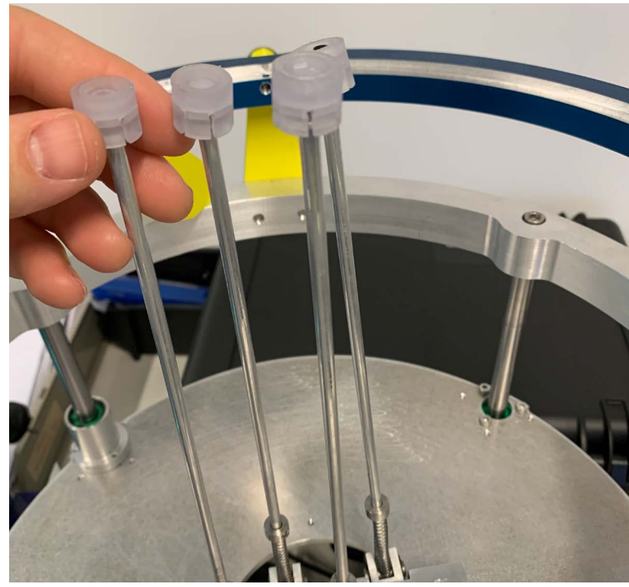
Mission: Astralis seeks to establish Australia in the top tier of global astronomical instrumentation builders through a national partnership known for innovation, quality, integrity, and service.

Core Values: Collaboration, Trust, Mentorship, Innovation, Integrity, Equity.

These principles guide us through our objectives and collaborations.

Astralis is governed by the Consortium Board, consisting of one voting member appointed by each partner (from AAL, Macquarie, ANU, and USyd) and at least one independent voting member, but no more than one less than the total number of Consortium partners.

Operations of the Astralis Consortium are overseen by a Management Committee that reports to the Consortium Board. The Management Committee includes at least one representative from AAL and members from other partners with technical expertise in the field of astronomy, astronomical instrumentation, optical or mechanical engineering, or another related field.



LEFT: Astro-selfie infinity shot captured on the 1.8m EOS telescope at Mount Stromlo Observatory. Credit: Celine d'Orgeville, Australian National University.
ABOVE: Astralis-AAO engineers integrating prototypes of MANIFEST subcomponents. Credit: MANIFEST Team.

4 FOREWORDS

4.1 BOARD CHAIR'S REPORT

The Board of the Astralis Instrumentation Consortium is the overarching governance body for Australia's leading partnership in optical/IR astronomy instrumentation, as established under the Australian Astronomical Optics (AAO) Consortium Agreement of 30 June 2018. Comprising a senior member from each of the four Consortium partners, along with three independent members (one of whom operates as Chair), the Board meets three to four times a year along with the Directors of the three Consortium nodes, now known as Astralis-AAO, Astralis-AITC and Astralis-USyd.

The Consortium is required to serve the Australian astronomy community via design and construction of ground-based optical and infrared instrumentation of national significance. It pursues this aim by designing, building and transferring instrumentation for major international telescope operators including ESO and the GMTO. The Australian astronomy community, in return, receives observing time on some of the large, premier telescopes hosted by these facilities.

A key task for the Board in 2021 was to approve the annual business plan and set the forward budget, while also fulfilling an advisory role to the four partners on Consortium strategy as well as oversight of its astronomy instrumentation projects. The Consortium is financially underpinned by a $5M per annum (indexed) NCRIS grant, administered by AAL.

During the year, the Board also took the important step of rebranding the Instrumentation Consortium from AAO to Astralis. This change allows the Consortium to build on the excellent reputation internationally of the former AAO, while also projecting to customers the specific technical instrumentation capabilities of each of the three nodes.

In 2021, Astralis approached the conclusion of its legacy domestic projects including HECTOR and TAIPAN, and is therefore well placed for the future to optimise engineering and technical effort on ESO and GMT instrumentation – which should support the national astronomy sector's aim of Australia achieving full membership of ESO from 2027. Good progress is being made on our flagship project MAVIS for ESO, and GMTIFS / MANIFEST for GMT, while Astralis continues to be engaged by ESO commercially for a significant amount of work on software pipelines.

The Board is equally keen to ensure that business development and industry engagement progresses. Only through successful pursuit of commercial instrumentation or services to bring in additional external funds can the node partners invest in and progress R&D projects. This will help guarantee Consortium longevity and allow the nodes to remain competitive in the international market of state-of-the-art astronomy instrumentation projects.

During the 2021 year, the Board established terms of reference for a performance review of Astralis operations in order to receive recommendations for funding and operations during the ensuing six years of NCRIS funding (from mid-2022). This international Review Committee, chaired by Professor Rachel Webster FAA, is expected to report to the Board by the end of April 2022. The outcome and actions taken will be communicated to key stakeholders in due course.

On behalf of the Board, I should like to thank two directors who departed during 2021. Dr Sarah Pearce FTSE (representing AAL) and Mr David Luchetti (the observer from DISER), both made major contributions during their time on the Board. We also wish to thank two senior staffers who served as Astralis Chief Operating Officer during the year, namely Dr Katrina Sealey and Dr Caroline Foster, who directly and ably assisted the Board in its role while also chairing the Astralis Management Committee. The Board wishes all four well as they move on to other roles beyond the Consortium in 2022.

In conclusion, I commend this Annual Report to you in the hope that those with a vested interest in Australian optical/IR astronomy may be informed of the Consortium's achievements pursued on behalf of the national astronomy sector.

Dr Rosalind Dubs FTSE FAICD
Board Chair
Astralis Instrumentation Consortium

4.2 A MESSAGE FROM OUR NODE DIRECTORS

The Astralis Consortium has had a most successful year. This is attributed to the dedicated staff who, despite COVID lockdowns and delays, have met many critical deadlines. We are proud of delivering on several significant instruments in 2021, including AESOP, Hector, and a key ESO pipeline. MAVIS and MANIFEST also met major milestones. This year saw the rebranding of the Consortium from AAO to Astralis – a fresh face uniting the Consortium members under a new cohesive banner – while the three nodes continued to improve their collaboration and the sharing of work and resources. There was also a strong push towards industrial and academic engagement in non-astronomy areas such as space and defence. We expect this involvement to grow over coming years leading to a substantial stream of new income.

An independent review of the Consortium was begun in 2021, and we look forward to the external advice coming from a strong international review panel, guiding our strategic direction going forward. We would like to thank the Astralis Board members for their time, valuable advice and guidance.

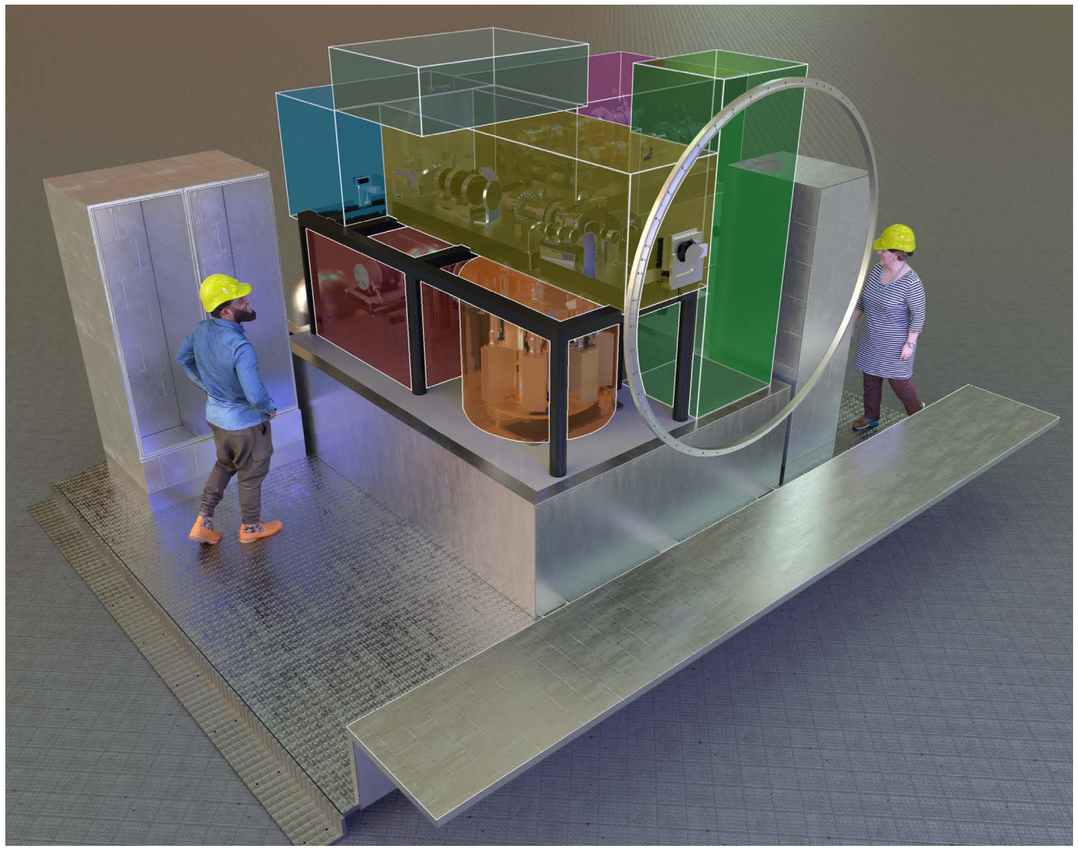
Julia Bryant (Astralis-USyd Node Director),
Francois Rigaut (Astralis-AITC Node Director)
Mark Casali (Astralis-AAO Node Director)

Associate Professor Julia Bryant. Credit: University of Sydney.

Professor Mark Casali. Credit: Mark Casali.

Professor Francois Rigaut. Credit: Stuart Hay ANU.

5 THE YEAR IN HIGHLIGHTS



A rendering of MAVIS on ESO's VLT/UT4 Nasmyth platform (placed on the side of the telescope) highlighting the main modules: yellow – adaptive optics module; orange – laser guide star wavefront sensor; red – natural guide star wavefront sensor; blue (behind) – imager; fuchsia – spectrograph; green – calibration unit. Credit: ESO/MAVIS Consortium/L. Calçada.

5.1 MAVIS CONSTRUCTION APPROVED BY ESO

In June 2021, ESO and the international MAVIS Consortium signed an agreement for the design and construction of the MCAO Assisted Visible Imager and Spectrograph (MAVIS). MAVIS is a flagship project of the Astralis Consortium built for the ESO's VLT AOF (Adaptive Optics Facility) to be installed at the fourth Unit Telescope (UT4) called Yepun (this translates to 'Venus' in the Mapuche (Mapudungun) language of indigenous Chileans).

MAVIS will be the first facility-class visible MCAO system in the world, using up to 8 laser guide stars to deliver the highest possible angular resolution on an optical telescope over a 30" field-of-view, as well as integral field spectroscopy between a 3" to 6" field-of-view.

By probing the frontier of angular resolution and sensitivity across a large portion of the observable sky, MAVIS will enable progress on an array of scientific investigations, from the planets in our own solar system to those around other stars, and from the physics of star formation in the Milky Way to the first star clusters in the Universe.

Find out more in the **ESO Messenger (p.7-11)**[1].

1 https://www.eso.org/sci/publications/messenger/archive/no.185-dec21/messenger-no185.pdf

5.2 AESOP DELIVERED FOR INTEGRATION WITH 4MOST SYSTEMS

In mid-2021, Astralis completed and shipped AESOP, a next generation fibre positioner unit for the 4MOST instrument, currently being assembled for ESO's 4-metre VISTA telescope in Chile. The design for AESOP is an evolution of Astralis' tilting spine technology, first designed and implemented on the FMOS-Echidna instrument for the Subaru telescope. AESOP deploys 2,400 optical fibres to precise positions on the curved focal surface of the telescope. This technology allows for a substantial improvement in multiplexing over the previous generation of fibre positioners. Importantly, each fibre can be rapidly deployed anywhere within a fixed patrol area, enabling a complete reconfiguration within minutes.

Astralis engineers with the fully assembled AESOP instrument in the integration room prior to final system testing. Credit: Astralis-AAO.

LEFT: AIP staff with the recently arrived Astralis-built AESOP component, ready for assembly into 4MOST.
RIGHT: AESOP components ready for installation, proudly showing a distinctly Australian emblem. Credit: AIP.

The AESOP project commenced in 2012 and was successfully assembled at Astralis-AAO's integration room in May 2021. It was subsequently disassembled and packed for its journey to Germany for integration with other 4MOST subsystems, safely arriving at AIP Potsdam in October 2021. AESOP was the first major subsystem of the 4MOST project to be delivered.

The AESOP and AIP Potsdam 4MOST teams will continue working together on the assembly of the instrument for commissioning in 2022.

5 THE YEAR IN HIGHLIGHTS

5.3 HECTOR SPECTROGRAPH INSTALLED AT THE AAT

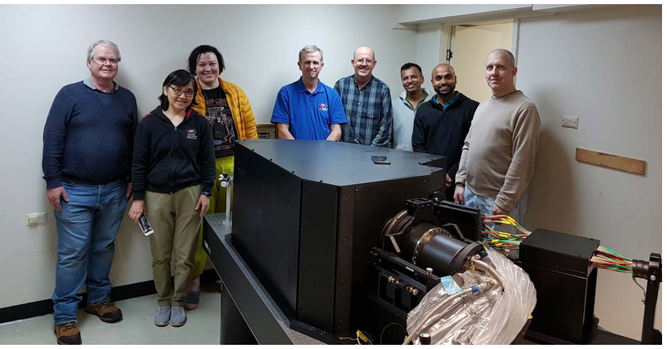
In November 2021, Hector was successfully installed on the AAT by observatory staff and Astralis instrument and science teams, completing 5 years of development and construction. The Astralis team then commenced commissioning of the instrument in December 2021.

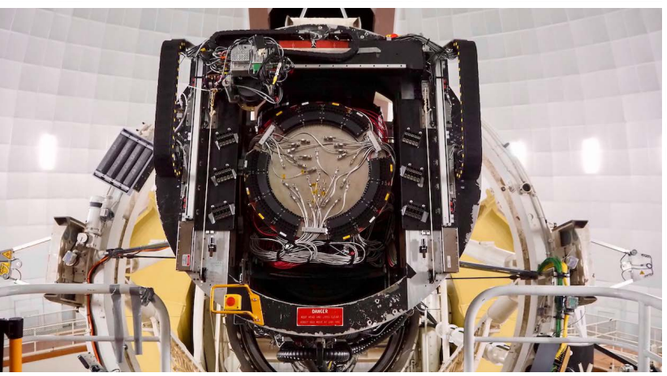
As its next main dark time instrument, Hector signals a big step forward for the AAT. The instrument will survey up to 15,000 nearby galaxies with its multi integral-field-unit spectrograph – with approximately 70% of galaxies imaged out to 2 effective radii. The Hector survey will allow researchers to study how galaxies build up mass and angular momentum, and how star formation and nuclear activity is affected by the interstellar environment.

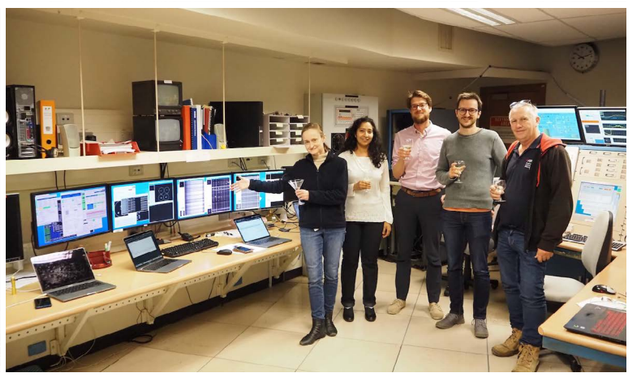
Hector's novel positioner places new optical imaging devices, called 'hexabundles', across the AAT's 2-degree field plane. However, for the first time, these are positioned in 3D – hovering at different angles above the field plane in order to correct for telecentricity of the telescope and recoup up to 20% extra light. Galaxies were simultaneously imaged in all 21 hexabundles in the first run, with accurate calibration of this positioning the biggest challenge during commissioning, with the second and third runs to take place over January-March 2022.

The new second spectrograph for Hector, called Spector, is currently achieving a higher throughput and spectral resolution, fulfilling the unique requirements of the Hector instrument.

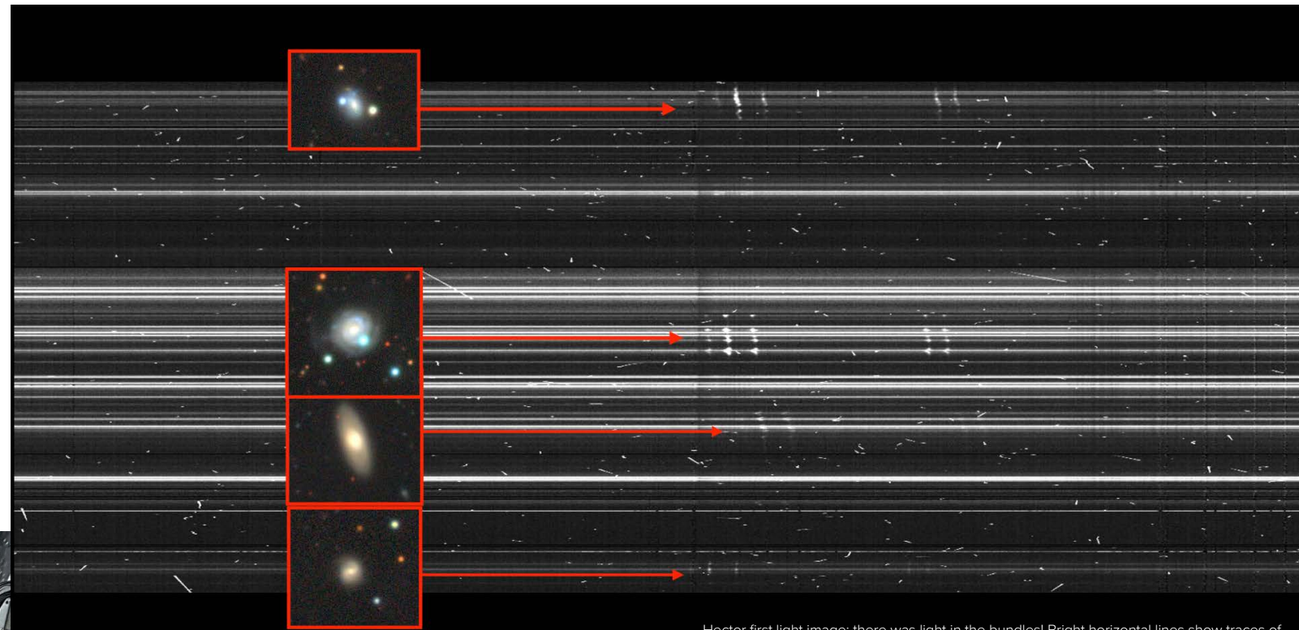
Astralis wishes to thank everyone within the instrument and science teams, without whom this tremendous success would not have been possible. We also wish to thank the incredible AAT site staff for their excellent efforts during the installation.







TOP- LEFT: The Astralis-AAO Hector team behind the new Spector spectrograph at AAT during Hector Commissioning in November 2021. From left to right: David Robertson, Jessica Zheng, Ellen Houston, Lew Waller, Tony Farrell, Naveen Pai, Mahesh Mohanan and Ross Zhelem. Credit: David Robertson (Macquarie University). TOP-RIGHT: Tony Farrell (Astralis-AAO) with the Hector top-end plate and hexabundles. Credit: David Robertson BOTTOM-LEFT: The Hector instrument on the AAT's top end. The futuristic-looking silver hexabundles plugged on the circular magnetic plate can be seen in the centre of this image. Credit: Dr Jesse van de Sande (University of Sydney). BOTTOM-RIGHT: Hector Science commissioning team celebrating first light in style in the AAT control room (left to right: Astralis-USyd Director A. Prof. Julia Bryant, and University of Sydney staff Dr Madusha Gunawhardana, Dr Jesse van de Sande, Dr Sam Vaughan, and AAT telescope operator Steve Chapman (ANU)). Credit: Dr Jesse van de Sande (University of Sydney).



Hector first light image: there was light in the bundles! Bright horizontal lines show traces of light from the superposed galaxies. Each horizontal line represents a fibre. Vertical/diagonally aligned dots show emission lines and the more inclined the pattern, the higher the rotation of the stars across the face of the galaxy. A fantastic outcome for a first commissioning run. Credit: Dr Madusha Gunawhardana (University of Sydney) and the Hector Team.

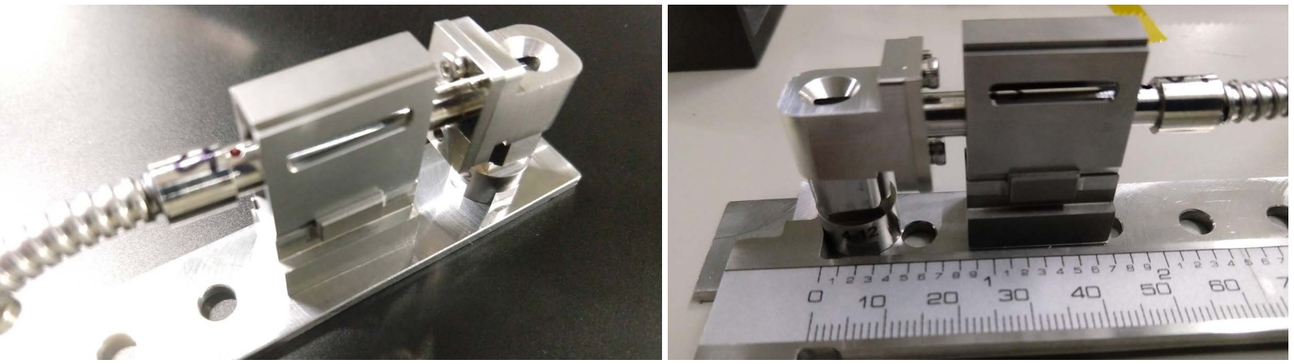
5.4 MANIFEST ENTERS THE NEXT PHASE OF INSTRUMENT DESIGN

In November 2021, GMTO carried out a review of the first phase of MANIFEST's Conceptual Design. The review reports captured GMTO's delight at the technical progress demonstrated by the team thus far, with Astralis continuing to collaborate closely with the MANIFEST Project Manager and Chief Scientist at GMTO to finalise the design in the coming years.

MANIFEST is a facility multi-object fibre system for the Giant Magellan Telescope (GMT). An important GMT capability, it will consist of hundreds of Starbug robots independently patrolling the focal plane and feeding light to a chosen spectrograph. MANIFEST will have multiple fibre configurations, ranging from single fibres to single and multiple integral-field units.

LEFT: Rendering of the MANIFEST concept. See cartoon person near the bottom for scale. Credit: MANIFEST Team.

5 THE YEAR IN HIGHLIGHTS



High precision hexabundle ferule, magnet casings and coupling components manufactured to align optical fibre bundles accurately to galaxies on the Hector field plate. Machining by Nicholas Hacko Watchmakers/NHmicro. Credit: Prof Julia Bryant, Astralis-USyd.

5.5 INDUSTRY ENGAGEMENT – COLLABORATION WITH NICHOLAS HACKO WATCHMAKERS

The Astralis Consortium is interested in developing partnerships with local manufacturers and industry to help translate innovative research technologies into outcomes that benefit all Australians. These efforts can also prompt small and medium-sized enterprises (SMEs) to upskill their manufacturing capabilities, opening new doors and expanding their customer base, in Australia and overseas.

The latest example of such a partnership is a collaboration that developed between the Hector team and Nicholas Hacko Watchmakers, a business specialising in the very high precision machining of miniature parts for exclusive watches. The Hector project required machining of small parts at a level of precision that was not achievable by any of Astralis' conventional machining suppliers. The resulting partnership provided Hacko with specialist training in the Astralis laboratories, leading to an upskilling of their staff and a broadening of their capabilities – to create parts for other astronomical instruments, and expand into other areas of science and medicine. Overall, Hacko manufactured parts worth tens of thousands of dollars for Hector, and has since received work orders from other groups, including biomedical companies, starting up a new side business called NHmicro. Developing collaborations with local suppliers also had clear benefits for the Hector project, allowing for flexibility, efficiency, and a much higher level of precision considered possible in the early design stages for the instrument.

5.6 ESO PIPELINES CONTRACT EXTENDED BY 2 YEARS

The ESO Pipelines project brings together decades of Astralis expertise from Astralis-AAO and Astralis-AITC in the field of innovative algorithms, data, and software engineering. In this project, Astralis is collaborating with ESO on the maintenance and development of pipeline data reduction software for a number of their VLT instruments.

The project started in 2019 and was funded to run for an initial period of three years. The team currently maintains and develops 21 data reduction packages for FORS, GIRAFFE, HAWK-I, KMOS, MOLECFIT, MUSE, OMEGACAM, SPHERE, UVES, VIRCAM, VIMOS, VISIR, X-SHOOTER, DETMON, TELLURICCORR, AMBER, CRIRES, ISAAC, MIDI, NACO, and SINFONI.

Python bindings for the CPL pipeline library are also being developed, which will bring this powerful and standard ESO library to Python users. A beta version of this software was released at the end of 2021.

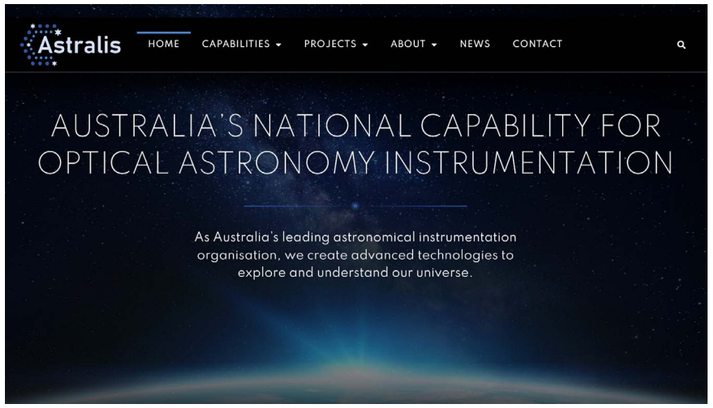
A highlight for 2021 was ESO's decision to extend the project to the end of 2023, giving Astralis the opportunity to continue this fruitful collaboration with ESO and become involved in additional interesting upgrades to the pipelines. For example, significant work will be carried out in 2022 to bring the previously stand-alone observatory Quality Control software into the instrument pipelines, as well as preparing them for their annual release to the Observatory and the community.

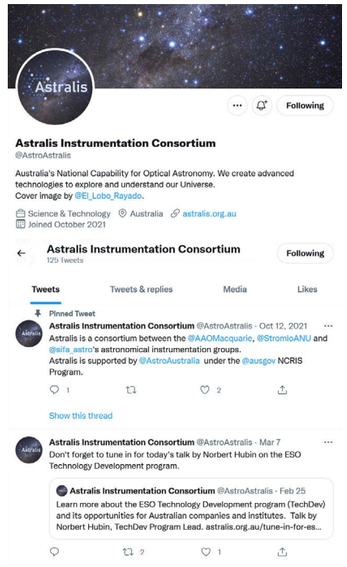
5.7 SUCCESSFUL REBRANDING OF THE CONSORTIUM

In April 2021 the Astralis Board approved the initiative from the Astralis Management Committee to change the name of the Consortium from "Australian Astronomical Optics Consortium" to the "Astralis Instrumentation Consortium" (Astralis). This change reflects the successful growth of the Consortium into a partnership that continues to advance, maximising the benefits of the collaboration by sharing work and resources.

The rebranding activity was accomplished via the strategy outlined in the Consortium Communications Plan, with the design of visual elements including a new logo and website (astralis.org.au), launched in April 2021. Since then, 10 news updates have been posted on the Astralis website.

The rebrand of the Consortium was communicated to internal and external stakeholders, followed by an effective online launch via social media (with the creation of a **Twitter** account (@AstroAstralis) and **LinkedIn** page). These accounts have been operating since October 2021 and have so far accrued over 140 followers, comprising astronomy and space professionals, as well as technology enthusiasts.





ABOVE: Snapshot of the astralis.org.au homepage. The new Astralis-branded website was launched in May 2021. RIGHT: @AstroAstralis Twitter account snapshot as at 7 March 2022. The account has aggregated >90 followers since its first tweet on 12 October 2021.

5.8 EDUCATION AND TRAINING – HRMOS WORKSHOP

The High-Resolution Multi-Object Spectrograph (HRMOS) Science team held an international hybrid meeting, led by Gayandi de Silva (Astralis-AAO), Eline Tolstoy (University of Groningen) and Maria Sofia Randich (INAF) over 18 – 22 October 2021. The program included invited and contributed talks highlighting the variety of scientific areas that will be advanced by HRMOS on the VLT in the coming decade.

The meeting attracted over 150 registered participants from 23 countries (including several members of Astralis staff remotely participating from Australia).

The final day of the meeting was dedicated to those new and innovative technical designs, currently in development, created to meet the ever-present challenges posed by the science. The meeting organisers were congratulated by participants, receiving excellent feedback from those who had an opportunity share their excitement and support for HRMOS science. The meeting highlighted that a niche instrument like HRMOS will actually be able to cater to a large community as a workhorse instrument for the VLT in the ELT era.

6 ASTRALIS AWARDS AND STAFF ACHIEVEMENTS

2021 ANU VC's Award for Excellence in Research celebration held at Mount Stromlo. Some members of the Astralis-AITC team are missing (many still working from home). Dr Roger Haynes and Prof. Céline d'Orgeville hold the Award certificate, which will be framed and displayed in the new year. Credit: Astralis-AITC.

6.1 GROUP AWARDS

- **Astralis-AITC, led by Prof Céline d'Orgeville**, won the 2021 ANU's Vice-Chancellor's Award for Research Excellence.
- **Astralis-AAO GMT/MANIFEST** team won the 2021 Macquarie University's Faculty of Science and Engineering award for Project Excellence.
- **A. Prof Richard McDermid** (Astralis-AAO) and the MAVIS team secured $1,749,940 in ARC LIEF grant funding for MAVIS.
- **Prof Peter Tuthill** (Astralis-USyd) and the Heimdallr team secured $770,000 in ARC LIEF grant funding for Heimdallr.

6.2 INDIVIDUAL AWARDS

- **Prof Joss Bland-Hawthorn** (Astralis-USyd) was awarded the Australian Institute of Physics' Walter Boas Medal.
- **Prof. Celine d'Orgeville** (Astralis-AITC) received the 2021 SPIE Diversity Outreach Award for her work in the Inclusion Diversity Equity and Access (IDEA) space in Australia and internationally.
- **A. Prof Simon Ellis** (Astralis-AAO), **Prof Michael Ireland** (Astralis-AITC) and **Prof Joss Bland-Hawthorn** (Astralis-USyd) featured among the nine Editors of the Astrophotonics, the feature issue published jointly by the Journal of the Optical Society of America and Applied Optics with more than 20 state-of-the-art papers in diverse topics of astrophotonics.
- **Dr Caroline Foster** (Astralis) was awarded an Australian Research Council Future Fellowship with the University of New South Wales.
- **Dr Ángel López-Sánchez** (Astralis-AAO) was awarded the presidency of the Spanish Researchers in Australia-Pacific along with a 2021 Pillar Award for his fundamental contribution to science dissemination.
- **Dr Noelia Martinez Rey** (Astralis-AITC) received the 2021 ANU College of Science IDEA Award for her work as chair of the ANU RSAA IDEA committee over the past 2 years.
- **Dr Rob Sharp** (Astralis-AITC) and colleagues were awarded $238,000 in ARC Linkage funding for Adaptive Optics developments with GMT.

Walter Boas Medal. Credit: aip.org.au

Ángel López-Sánchez (centre) being elected as president of the SRAP at the 2021 annual general assembly in November. Credit: Dr Ángel López-Sánchez.

7 ASTRALIS MANAGEMENT COMMITTEE ACTIONS

The role of the Astralis Management Committee is to oversee operations of the Consortium, prepare reports, business and strategic plans, as well as carrying out the annual implementation plan. The Committee holds regular fortnightly meetings, quarterly project report review meetings and delivers monthly updates to the Astralis Risk Register and Projects & Opportunities Registers. The Committee delivered the new 2022 Business and Implementation Plans, approved by the Astralis Board at its November 2021 meeting.

7.1 STRATEGIC ACTIVITIES

- **Research & Development (R&D) Strategy**: The successful future of the Consortium is dependent on the organisation of its R&D structure and processes to maintain a competitive edge and relevance for the astronomical community. The Committee commissioned a team of astronomers and instrument builders/designers to draft the R&D Roadmap, which will be reviewed by the Board at its April 2022 meeting. Astralis staff have been actively involved in the preparation of the R&D Roadmap by participating in two workshops organised by the Consortium. The purpose of the first workshop was to identify the key science questions and directions of the next decade(s). The second workshop was dedicated to identification of key technologies required to achieve those science goals.
- **Unification of Project Management Approach**: The Project Management Team held a workshop and multiple meetings during 2021 to identify areas where a Consortium-wide approach may be beneficial. The team has begun working on a draft of the Astralis Project Management methodology, to be completed in 2022.
- **Process of Rebranding**: After the renaming proposal was accepted by the Board in April 2021, the Committee prepared a schedule of actions and developed plan to communicate the Consortium name change to key stakeholders. After 'Astralis' was registered with ASIC and the redesigned website was launched, the COO of Astralis led the design of new marketing material, document templates and brand guidelines, while also implementing a strong social media campaign. A Slack workspace for Astralis was developed and regular news updates were sent out (via all-staff mailing) to facilitate better cross-node communications.
- The Management Committee developed and agreed to implement uniform procedures for progressing Consortium projects.
- Uniform financial reporting was also implemented among Consortium nodes and a working version of the NCRIS NatCap Funding distribution was agreed to by all parties.

7.2 OPERATIONAL IMPROVEMENTS

- In 2021, all three nodes signed the Astralis Master Service Agreement (MSA). The first Schedule under the new MSA was signed by Astralis-AITC and Astralis-AAO for the ESO Pipelines project.

7.3 IMPACT OF COVID-19 PANDEMIC LOCKDOWNS

All Astralis offices and laboratories suffered pandemic restrictions and lockdowns in 2021. This inevitably caused delays to some projects due to staff shortages, as well as supply chain and manufacture issues. Staff were reassigned to tasks that could be done from home, and in some instances, work was transferred to other nodes where possible.

This approach allowed all projects to progress regardless of the pandemic and helped mitigate the impact of COVID-19 on Consortium activities. Despite the ongoing impact of COVID19 lockdowns and restrictions, the Consortium continues to achieve key project milestones.

7.4 INDEPENDENT CONSORTIUM REVIEW

As required by Section 7.13 of the Consortium Agreement, the Astralis Board commissioned an external review to examine the performance of Astralis after the first three years of Consortium operation. The Terms of Reference for the review drafted by the Management Committee were approved by the Board.

The review process officially commenced in August 2021 with the appointment of a review panel. The interviews began with key external and internal stakeholders, including Astralis management, associate researchers, instrument scientists, project teams, customers, suppliers, and government representatives. A final report and recommendations from the review will be presented to the Board at its April 2022 meeting.

8 2021 PROJECT PORTFOLIO

Projects that formed part of the Astralis portfolio during 2021 are listed in Tables below. The projects are selected based on the “New Projects and Opportunities” section of the Astralis Instrumentation Consortium Collaboration Guidelines.

Astralis projects are prioritised as follows.

- **Priority 1 projects** with reporting are of national and/or international significance and directly address the Astronomy Decadal Plan, the National priorities or are generating profitable commercial revenue. They may or may not be supported by NCRIS funding (Table 1).
- **Priority 2 projects** with reporting do not meet the criteria of Priority 1, though they benefit the Australian astronomical community and are supported by NCRIS funding (Table 2).
- **Non-reportable Consortium Projects** are typically single node optical/IR ground-based astronomy projects that do not meeting Priority 1 or 2 criteria and are not supported by NCRIS funding (Table 3).

Priority 1 and 2 projects supported by the AAL NCRIS allocation are required to submit biannual progress reports in accordance with NCRIS guidelines. Non-reportable Consortium projects are included as in-kind contributions to demonstrate the extent of the Consortium capabilities. Projects with a value greater than $300K require Board approval and projects less than $300K are provided to the Board for information only.

8.1 CURRENT PROJECTS CATEGORIES OVERVIEW

Categorisation of Astralis projects is based on three criteria:

1) Driving Reasons: Decadal plan (DP) / International growth (IG) / Australian Community (AC) / Profit (P) / Strategic Technology (ST);

2) Business Areas: Core Astronomy (CA) / Non-Core Astronomy (NCA);

3) Nature: International (I) / National (N).

The asterisk * in Table 4 highlights projects that are driven by multiple reasons.

8.2 PRIORITY 1 PROJECTS

Projects	Lead	Timeline	Supported by	Nodes	Returns to Stakeholders
MAVIS	Astralis-AITC	2019-2026 (Phase A and Phase B – E)	ESO – Hardware costs, NCRIS – Labour costs	Astralis-AITC & Astralis-AAO	Astronomers: telescope time, open new fields of research First project awarded by ESO to a Consortium led by Australia
MANIFEST	Astralis-AAO	2011-2030	Contract – GMTO, NCRIS	Astralis-AAO	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain Additional credit in GMTO for Australia
4MOST	Astralis-AAO	2012-2023 (main Astralis-AAO component delivered in 2021)	4MOST Consortium, UWA, ICRAR, ARC LIEF, AAL, DISER, NCRIS, ESO	Astralis-AAO	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain
ESO Software Pipelines	Astralis-AAO	2019-2023	ESO	Astralis-AAO, Astralis-AITC	Astralis: enhanced reputation Astronomers: Familiarity with ESO systems
GMTIFS	Astralis-AITC	Q4/2019-Q1/2022	NCRIS funding as Australian GMT in-kind contribution	Astralis-AITC	Industry: Catalyst for engineering and instrument innovations with potential use in a number of applications in and beyond astronomy Astronomers: Only ELT program in which the Australian community participates
Hector	Astralis-USyd	Hector-I on-sky December 2021.	NCRIS, ARC LIEF, ARC FT, USyd, AAO-DISER	Astralis-USyd , Astralis-AAO	Astronomers: The next main dark time instrument for the AAT; it fulfils the science needs of a large Australian team Support of ASTRO-3D CoE and other ARC-funded science projects SSO Observatory, AAT users: Keeps AAT competitive internationally
DIRAC	Astralis-AAO	2019-2022	ATASAM (Ataturk University, Turkey)	Astralis-AAO, Astralis-USyd, Astralis-AITC	Astralis: Reputational gains, Surplus for priority Consortium activities
Blue MUSE	Astralis-AAO	2020-2028	NCRIS, ESO	Astralis-AAO, Astralis-USyd (TBC), Astralis-AITC (TBC)	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain
MAORY-IFU	Astralis-AAO	2020-2030	NCRIS, ESO	Astralis-AAO	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain
HRMOS	Astralis-AAO	2020-2030	NCRIS, ESO	Astralis-AAO, Astralis-USyd (TBC), Astralis-AITC (TBC)	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain
Eupraxia	Astralis-AAO	2020-2023	NCRIS, ESO	Astralis-AAO, Astralis-USyd	Astronomers: Unique instrument parameter space Astralis: Reputational gain, New instrument contracts
Heimdallr	Astralis-USyd	2020-2022	NCRIS, International collaborator’s grants, ESO, ARC LIEF	Astralis-AITC, Astralis-USyd	Astronomers: Unique instrument parameter space Astralis: Reputational gain, New instrument contracts
CUBES	Astralis-AAO	2020-2027	NCRIS, ESO	Astralis-AAO	Astronomers: telescope time and access to data, unique instrument parameter space Astralis: reputational gain

Table 1. Priority 1 projects summary.

8 2021 PROJECT PORTFOLIO

8.3 PRIORITY 2 PROJECTS

Projects	Lead	Timeline	Supported by	Nodes	Returns to Stakeholders
Subaru GLAO/ ATLAS	Astralis-AITC	2020-2022	ARC Linkage, ANU, Subaru telescope, Tohoku & Arete Associates	Astralis-AITC	International engagement: engineering nights on Subaru and international support of Laser and Adaptive Optics capabilities; Astronomers: telescope time
Subaru Nasmyth Beam Switcher	Astralis-AAO	2018-2022	Subaru Telescope	Astralis-AAO	Astralis: reputational gain
Subaru GLINT and VAMPIRES	Astralis-USyd	07/2018-12/2022	NCRIS, ARC DP Grants (PI Peter Tuthill) Future funding: NCRIS, Future ARC grants.	Astralis-USyd, Astralis-AAO	Astronomers: Significant science advances for Australian observers; International engagement: Prove Australian-led technologies to enable Australia to win a large instrument contract for an ELT

Table 2. Priority 2 projects summary.

8.4 NON-REPORTABLE CONSORTIUM PROJECTS

The same project management practices apply to all Astralis projects, however the following projects are not reported on to the Consortium and are managed by the individual node project management offices.

Projects	Lead	Timeline	Supported by	Nodes	Returns to Stakeholders
AST3	Astralis-AAO	2014-2023	ARC LIEF, SUT, AAO-DIIS	Astralis-AAO	• Telescope time for astronomers; • Unique instrument parameter space; • Access to data; • Enhanced reputation.
GHOST	Astralis-AAO	2013-2022	AURA Inc, on behalf of Gemini Observatory	Astralis-AAO, Astralis-AITC	• Telescope time for astronomers; • Access to data; • Enhanced reputation.
SSO support	Astralis-AAO	2018-2022	ANU	Astralis-AAO	• Reliable telescope services.
Local Volume Mapper (LVM)	Astralis-AAO	2019-2022	SDSS, ARC (TBD)	Astralis-AAO	• Telescope time for astronomers; • Unique instrument parameter space; • Access to data; • Enhanced reputation.
FOBOS for Keck	Astralis-AAO	2019-2028	Keck Foundation, NSF, ARC	Astralis-AAO	• Telescope time for astronomers; • Unique instrument parameter space; • Access to data; • Enhanced reputation.
MSE	Astralis-AAO	2018-2028	MSEPO, ARC	Astralis-AAO	• Telescope time for astronomers; • Unique instrument parameter space; • Access to data; • Enhanced reputation.
Data Central	Astralis-AAO	2018-	NCRIS, AAL	Astralis-AAO, Astralis-AITC	• Access to data; • Enhanced reputation.
Veloce Azzurro / Verde	Astralis-AITC	2019-2021	ARC-LIEF funding	Astralis-AITC	• Enhance capability of an existing AAT facility; • Instrument access via the SSO TAC; • Enhanced international reputation.
2.3m AUTO	Astralis-AITC	Q1-2020 to Q4 2022	CGA NIG grant ($500k), RSAA, MEC grant (to be submitted)	Astralis-AITC, external partners, as specified on the LIEF bid	• Efficient scheduling and observation for astronomers. • Rapid spectroscopic follow-up. • Enable time-domain observations.
DREAMS	Astralis-AITC	Q4 2020 to Q1 2022	Currently ANU Translational fellowship – Anna Moore. LIEF funding also requested and Linkage application is being written.	Astralis-AITC	• Data access for astronomers; • Unique instrument parameter space.
PYXIS	Astralis-AITC	2020 to 2022	ARC discovery project lead by Michael Ireland (lead CI) and Tony Travouillon	Astralis-AITC	• Development of CubeSat-compatible technologies; • Advancement of interferometry.
TOLIMAN	Astralis-USyd	Q3 2020 to Q4 2023	Breakthrough grant and other non-NCRIS funds (USyd, NASA-AMES, NASA-JPL, Japanese Space Agency, Italian Space Agency, European aerospace conglomerate OHB)	Astralis-USyd	• Unique instrument parameter space for astronomers; • Builds Australia's skills in the space sector.
MAAT	Astralis-AAO	2020-2022	Consortium of institutes led by IAA-Granada.	Astralis-AAO	• Access to data; • Enhanced reputation.

Table 3. Non-reportable projects summary.

8 2021 PROJECT PORTFOLIO

CURRENT PROJECTS CATEGORIES OVERVIEW

	International		National
	Core Astro	**None-Core Astro**	**Core Astro**
Decadal plan driven (DP)	**Priority 1** MAVIS MANIFEST 4MOST GMTIFS Blue MUSE MAORY-IFU HRMOS Eupraxia* Heimdallr* CUBES		**Priority 1** TAIPAN* Hector* **Non-reportable** SSO* Data Central
International growth driven (IG)	**Priority 2** Subaru GLAO/ATLAS Subaru Nasmyth Beam Switcher Subaru GLINT&VAMPIRES* **Non-reportable** AST3 GHOST Local Volume Mapper FOBOS for Keck MSE MAAT		
Australian community driven (AC)		**Non-reportable** TOLIMAN*	**Priority 1** Hector* **Non-reportable** DREAMS Veloce Azzurro/Verde 2.3m AUTO
Profit driven (P)	**Priority 1** DIRAC	**Priority 1** ESO Software Pipeline	**Non-reportable** SSO*
Strategic Technology (ST)	**Priority 1** Eupraxia* Heimdallr* **Priority 2** Subaru GLINT&VAMPIRES*	**Non-reportable** TOLIMAN*	**Priority 1** TAIPAN* Hector* **Non-reportable** PYXIS

Table 4. Current Projects Categories Overview. (Priority 1 Projects; Priority 2 Projects; Non-reporting Consortium Projects)

9 2021 FINANCIAL POSITION

The Astralis Consortium generated close to $13M combined net revenue in 2021, of which $8M relates to ground based optical instrumentation projects within the scope of the Consortium.

NatCap funding from the NCRIS grant provides $5M (indexed) of support to Astralis per year, provided to the partner nodes via AAL with a distribution profile formulated in the Consortium agreement. In 2021, 86% of NatCap funding directly supported international and national instrumentation projects that benefited the Australian astronomy community. The residual 14% supported the transition of the former AAO to Macquarie University, with the contribution to premises costs occurring prior to relocation to Macquarie University's main campus.

In 2021, close to 80% of Astralis expenditure was related to international projects, which included approximately 60% of spending on instrumentation for ESO and GMT. Accordingly, Astralis income was principally (85%) derived from ESO and GMT related projects. The apparent operating deficit (~$2.7m) for the calendar year 2021 (Table 5) is a consequence of a number of domestic legacy projects in final stages of conclusion and closure, as well as projects for international clients with long-term delivery timescales and milestone-based payments. Consequently, the large effort and expenditure of 2021 has not yet reached the delivery milestones, where the revenue involved will subsequently be recognised.

Consortium Instrument project category	**Expenditure (A$'000)**	**Revenue (A$'000)**
Domestic / national projects	2,067	773
ESO and GMT projects	6,529	6,775
Other Consortium projects for international clients	1,876	194
Consortium project administration	260	278
Total	**10,733**	**8,020**

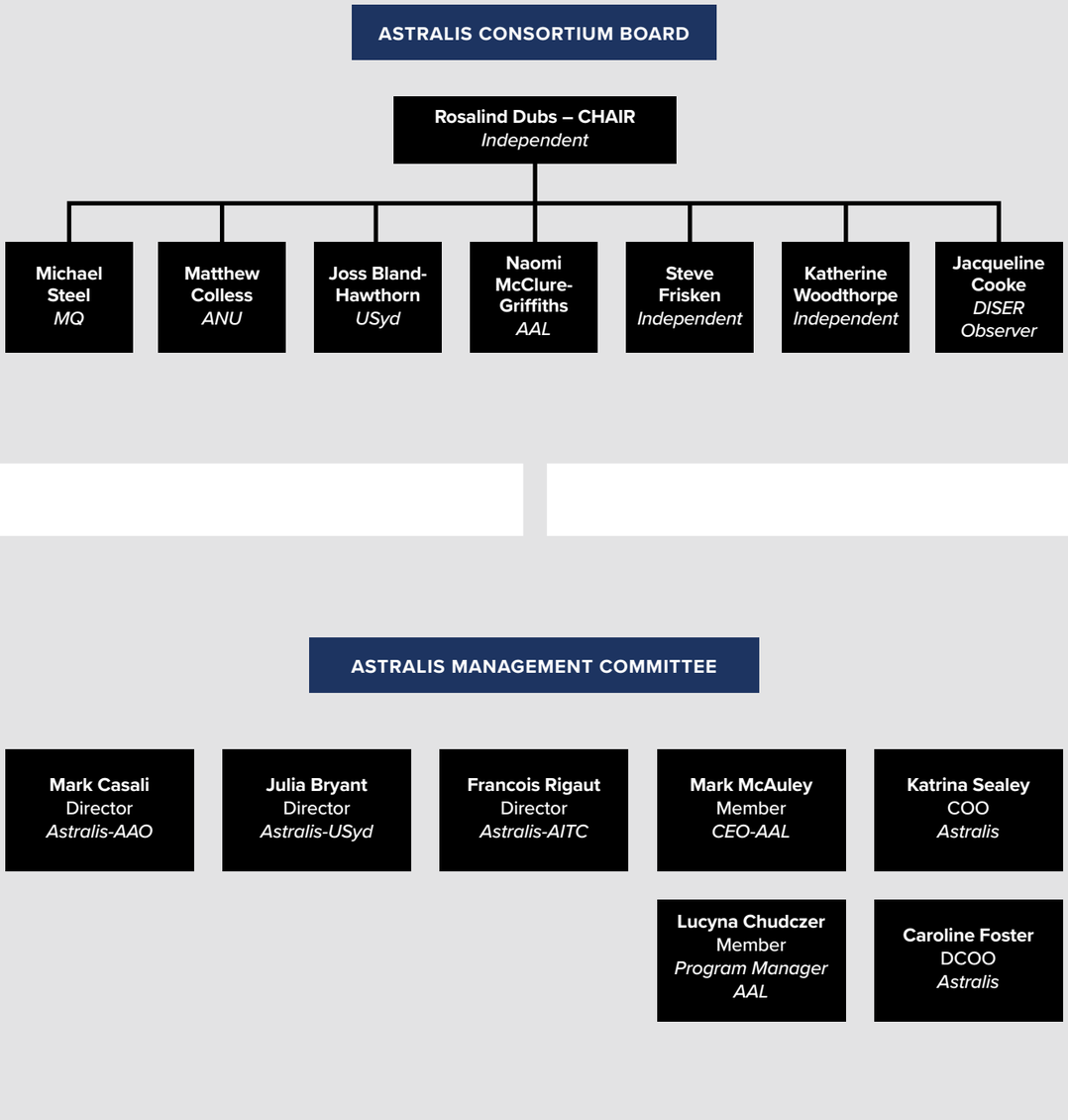
Table 5: A high-level summary of expenditure and revenue for CY 2021.

In 2021 Astralis Consortium operated with 111 staff across 9 categories listed in Table 6.

Unit	**Staffing Level**
Director & Admin	14
Project management and systems engineering	8
Mechanical Engineering	23
Optical Engineering	6.5
Electrical Engineering	5
Software/IT	17.5
Instrument Science/Academics	32
Detectors & system control	4
HDR Students	3
Total	**113**

Table 6: Staff allocations.

10 GOVERNANCE STRUCTURE



Governance Structure of Astralis Instrumentation Consortium.

10.1 GOVERNANCE

The current governance structure of Astralis is illustrated in the Organisational Chart (Figure 15). Members of each node report to the Director of that node. The Directors report to the Astralis Board via the Astralis Management Committee as specified in the Consortium Agreement. The Astralis Board may appoint advisory committees to assist it with the performance of its responsibilities. As envisaged in the Consortium Agreement, the Astralis Board appointed an advisory panel of experts in 2021 to undertake a review of the Consortium for the Initial Period and suggest the options for future operations for the Subsequent Period.

10.2 ASTRALIS BOARD MEMBERS

The Board advises Astralis on its strategic direction and also has the responsibility to review and approve the business and strategic plans, the annual budget and other reports. The Board can appoint the technical review committee and industry advisory cluster when required.

The Astralis Board includes nominees from the four Consortium partners and three independent members. An observer from the Department of Industry, Science, Energy and Resources (DISER) also attends Board meetings in a non-voting capacity.

Astralis Board members in 2021

Dr. Rosalind Dubs – Chair, Independent

FTSE[1], FAICD[2]

Dr. Ros Dubs has had a diverse international business career, holding senior executive and board roles in publicly listed, private and government companies. She is a Non-Executive Director of ASC Pty Ltd, Astronomy Australia Ltd, ANU Enterprise Pty Ltd, and the SmartSat CRC Ltd. She is a former non-executive Director of Aristocrat Leisure Limited and the Australian Academy of Technology & Engineering. Dr. Dubs specialised in the management of large engineering organisations, including with Thales SA in Paris and Stuttgart in aviation, transport and defence. She also served as Deputy Vice-Chancellor (External Relations) of the University of Technology Sydney, where she fostered engagement between academia and business, and chaired the Australian Space Industry Innovation Council from 2010 to 2012.

[1] FTSE: Fellow of the Australian Academy of Technological Sciences and Engineering

[2] FAICD: Fellow of the Australian Institute of Company Directors

10 GOVERNANCE STRUCTURE

Prof. Matthew Colless – ANU Nominee

FAA[1], FRAS[2], FAAAS[3]

Prof. Matthew Colless is Director of the Research School of Astronomy and Astrophysics at the Australian National University. He was previously the Director of the Australian Astronomical Observatory. He obtained his BSc at Sydney, his PhD at Cambridge, and has held positions at Durham, Kitt Peak and Cambridge. His research uses large redshift and peculiar velocity surveys of galaxies to understand their evolution and the large-scale structures they form, and to measure cosmological parameters. He is currently focusing on two upcoming galaxy surveys: the Hector integral field spectroscopy survey studying galaxy evolution and the 4MOST Hemisphere Survey studying the peculiar velocities of galaxies in the local Universe. He led the OzPoz fibre positioner project for the Fibre Large Array Multi Element Spectrograph (FLAMES) instrument for the Very Large Telescope (VLT) array and is leading the design of the Many-instrument Fibre system (MANIFEST) for the Giant Magellan Telescope (GMT). Prof. Colless is a Fellow of the Australian Academy of Science, an Honorary Fellow of the Royal Astronomical Society, a Fellow of the American Association for the Advancement of Science, an ISI Citation Laureate, a member of the European Southern Observatory (ESO) Council, the ANU Founders' representative for the GMT project, and a former Vice-President of the International Astronomical Union.

Prof. Jonathan Bland-Hawthorn – USyd Nominee

FAA, FOSA[4], FAIP[5]

Prof. Joss Bland-Hawthorn is an Australian Research Council (ARC) Laureate Fellow Professor of Physics and Director of the Sydney Institute for Astronomy (SIFA), School of Physics, University of Sydney. In 1993, he joined the Australian Astronomical Observatory. In 2007, Joss was awarded the prestigious Federation Fellowship with a tenured professorship in SIFA. In 2009, he co-founded the Institute of Photonics and Optical Science (IPOS). In 2012, he was elected a Fellow of the Australian Academy of Science and the Optical Society of America. In 2014, Joss was awarded the Australian Laureate Fellowship. He has won numerous awards and serves on several boards including Section H (IAU) and the Annual Reviews of Astronomy and Astrophysics (USA).

[1] FAA: Fellow of the Australian Academy of Science

[2] FRAS: Honorary Fellow of the Royal Astronomical Society

[3] FAAAS: Fellow of the American Association for the Advancement of Science

[4] FOSA: Fellow of the Optical Society

[5] FAIP: Fellow of the Australian Institute of Physics

Prof. Michael Steel – MQ Nominee

Prof. Michael Steel is the Head of the Department of Physics and Astronomy at Macquarie University in Sydney. He is an optical physicist with interests in nonlinear optics, quantum optics and integrated photonics who joined Macquarie in 2007 after seven years in the photonic design software industry. His current research is focused on opto-acoustic interactions in nonlinear waveguides with applications in sensing, microwave communications in one-way optical systems. He is a council member of the Australian and New Zealand Optical Society. In 2017 Mike led Macquarie's role in the Consortium bid and served as the interim Director of Astralis-AAO from its establishment in July 2018 until the appointment of the permanent Director Prof. Mark Casali in April 2019. In 2018-2019 he led the Department of Physics and Astronomy in securing a major upgrade of the Macquarie University Astronomical Observatory which is now one of the finest on-campus observatories in the country.

Dr. Naomi McClure-Griffiths – AAL Nominee (from Nov. 2021)

Prof. Naomi McClure-Griffiths is a Professor at the Research School of Astronomy and Astrophysics (RSAA) at The Australian National University. Prior to this, Naomi spent 13 years at CSIRO holding various roles, including OCE Science Leader and Head of National Facility Science for the Australia Telescope National Facility. Naomi's area of research is in the structure and evolution of gas and magnetic fields in our own Milky Way and the nearby Magellanic System. Her research group uses radio telescopes, including the Australia Telescope Compact Array, Parkes Radio telescope and Green Bank telescope. Naomi co-leads the Galactic ASKAP survey, GASKAP, and the Polarisation survey, POSSUM and has roles in SKA science planning, including membership on two SKA Science working groups (HI and The Galaxy), the SKA Science and Engineering Advisory Committee, Australia New Zealand SKA Coordination Committee (ANZSCC) and ANZSCC's Science Advisory Committee. Naomi is a Fellow of the Astronomical Society of Australia and a Member of the International Astronomical Union. Naomi completed her PhD in Astrophysics at the University of Minnesota in Minneapolis, MN USA. She received the 2006 Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year and the 2015 Pawsey Medal from the Australian Academy of Science.

In her capacity as AAL Board Chair, Naomi is a member of the National Committee for Astronomy (NCA) and a member of the Australia-ESO Coordinating Group. Naomi Joined the AB in November 2021.

10 GOVERNANCE STRUCTURE

Dr. Steve Frisken – Independent

FTSE, FOSA

Steve is an inventor and entrepreneur with a thirty-year career in photonic innovations and start-ups. He founded Photonic Technologies (acquired by Nortel), Engana (acquired by Finisar) and then Cylite in 2013. He is currently the CEO of Cylite, recipient of the 2020 Sir William Hudson Engineering Excellence prize for the development of Ophthalmic 3D Imaging employing Hyperparallel Optical Coherence Tomography. His other research interests include Hyperspectral microscopy, Holoscopy. He is a prolific inventor, with 43 granted US patents in Optics including the invention of the Dynamic Wavelength Processor, a telecom networking product which enabled flexible wavelength reconfiguration of the global optical internet and has generated more than $1 Billion in revenue. Steve was awarded the ATSE Clunies Ross Medal in 2013 in recognition of his success in the development and commercialisation of novel optical technologies. Steve Frisken has a PhD in theoretical physics and is also the recipient of the OSA Richardson Medal and the 2018 Australian Prime Minister's Innovation Prize.

Dr. Katherine Woodthorpe – Independent

AO, FAICD, FTSE

Dr Katherine Woodthorpe AO is an experienced Chair and Non-Executive Director serving for 20 years on the boards of a variety of organisations including listed entities, government boards and for-purpose organisations. She has a strong track record in a broad range of innovation-dependent industries including healthcare, renewable energy and environmental and climate science. She has been cited in various media as one of Australia's most influential people in innovation. Katherine has a BSc (1st Class Hons) from Manchester University and PhD in Chemistry, is a Fellow of the Australian Institute of Company Directors (and President of their NSW Council), and was awarded an honorary doctorate from the University of Technology Sydney. She was cited in the Australian Financial Review as one of the 2013 "100 Women of Influence" and is a Fellow of the Academy of Technology and Engineering. In 2017 she was appointed an Officer in the Order of Australia.

Dr. Woodthorpe joined the AB on 1 October 2020.

Ms Jacqueline Cooke – DISER Observer

Mrs Jacqueline Cooke joined the then Department of Industry, Innovation, Science and Research when it was formed in 2008, working on the National Collaborative Research Infrastructure Strategy program, with a focus on e-research infrastructure and data repositories. Prior to this Jacqueline worked in Broadcasting Policy roles in the Department of Communications, Information Technology and the Arts. In recent years Ms Cooke has worked across the department in a range of sectoral areas primarily relating to the Square Kilometre Array (SKA), Industry Innovation Precincts, Cooperative Research Centre policy, Entrepreneurs' Program policy, commercialisation and collaboration policy, and incubator and start-up policy. Jacqueline has recently returned to work on the SKA and also has responsibility for the Department's engagement and programs in optical astronomy.

Previous Board members who served in 2021:

Dr Sarah Pearce (AAL Nominee), Term: Apr 2020-Nov 2021
Mr David Luchetti (DISER Observer), Term: Jul 2018-Apr 2021

10.3 ASTRALIS MANAGEMENT COMMITTEE

The Astralis Management Committee includes the node directors (or representative/s) from the four Consortium partners, the Chief Operating Officer (COO) and the Deputy Chief Operating Officer (DCOO) as shown on page 18.

The Management Committee is responsible for the day-to-day operations of the Consortium. Core responsibilities include the preparation of annual reports, business and strategic plans, as well as carrying out the annual implementation plan. In 2021, the COO and DCOO have shared the responsibility of chairing the Astralis Management Committee.

The members of the Astralis Management Committee at the end of 2021 were:

Name	Entity	Position
Prof. Mark Casali	Astralis-AAO	Director of Astralis-AAO
Prof. Francois Rigaut	Astralis-AITC	Director of Astralis-AITC
A/Prof. Julia Bryant	Astralis-USyd	Director of Astralis-USyd
Mr. Mark McAuley	AAL	AAL Chief Executive Officer
Dr. Katrina Sealey		Astralis Chief Operating Officer
Dr. Caroline Foster		Astralis Deputy Chief Operating Officer

Additional 2021 Astralis MC attendee:
Dr Lucyna Chudczer, Program Manager, AAL

Previous Astralis MC Member who served in 2021:
Dr Mita Brierley, Chief Business Officer, AAL (until Nov. 2021)

The Milky Way. Credit: Angel R. López-Sánchez.

In June 2021, ESO and the international MAVIS Consortium signed an agreement for the design and construction of the MAVIS, a flagship project of the Astralis Consortium built for the ESO's VLT Adaptive Optics Facility to be installed at the fourth Unit Telescope, called Yepun – pictured here. Credit: ESO/B. Tafreshi.

In November 2021, Hector was successfully installed on the AAT. Credit: Ángel R. López-Sánchez.

Astralis

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ASTRALIS-USYD

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