2020 ANNUAL REPORT

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Australian Astronomical Optics (AAO)
AAO-MQ (Macquarie University)
AAO-Stromlo (Australian National University)
AAO-USydney (University of Sydney)
AAL (Astronomy Australia Limited)

AAOMC April 2020

Cover image: The Milky Way. Credit: Sami Anas.
This spread: A deep infrared view of the Orion Nebula from HAWK-I, using ESO's VLT. Credit: ESO/H. Drass et al.

2 GLOSSARY

AAL	Astronomy Australia Limited
AAO	Australian Astronomical Optics
AAO-DIIS	Australian Astronomical Observatory operated by DIIS (now known as DISER)
AAOMC	Australian Astronomical Optics Management Committee
AAO-MQ	Australian Astronomical Optics-Macquarie
AAO-Stromlo	Australian Astronomical Optics-Stromlo
AAO-USyd	Australian Astronomical Optics-USydney
AAT	Anglo-Australian Telescope
AESOP	AAO ESO Positioner for 4MOST on the VISTA telescope
AITC	Advanced Instrumentation Technology Centre, ANU
ANU	Australian National University
ARC	Australian Research Council
ARC FT	Future Fellowships grant scheme provided by ARC
AST3	Antarctic Survey Telescopes
ATLAS	Advanced Technologies for Laser Adaptive optics Systems
CUBES	Cassegrain U-Band Efficient Spectrograph for VLT
DAG	Eastern Anatolian Observatory (Turkish: Dogu Anadolu Gozlemevi)
DIRAC	Diffraction-limited Infra-Red Adaptive-optics Camera for DAG
DISER	Department of Industry, Science, Energy and Resources, formally known as DIIS, DIISR
DREAMS	Dynamic REd All-sky Monitoring Survey proposed instrument for SSO
ELT	Extremely Large Telescope
ESO	European Southern Observatory
FLAMES	Fibre Large Array Multi Element Spectrograph for VLT
FOBOS	Fan Observatory Bench Optical Spectrograph for Keck
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
HRMOS	High Resolution Multi-Object Spectrograph for VLT
IFU	Integral Field Unit
LIEF	Linkage Infrastructure, Equipment and Facilities grant scheme provided by ARC
LVM	Local Volume Mapper
MANIFEST	Many-instrument Fibre system for GMT
MAVIS	MCAO Assisted Visible Imager and Spectrograph for the ESO's VLT AOF (Adaptive Optics Facility, UT4 Yepun)
MOSAIC	Multi-Object Spectrograph for ELT
MQ	Macquarie University
MSE	Maunakea Spectroscopic Explorer
NatCap	National Optical Astronomy Instrumentation Capability
NCRIS	National Collaborative Research Infrastructure Strategy
NGC	New General common Controller
NIG	National Institutes Grant
NRC-Herzberg	The National Research Council - Herzberg Institute of Astrophysics (Canada)
NSF	National Science Foundation (USA)
SAIL	Sydney Astrophotonic Instrumentation Laboratory, USyd
SDSS	Sloan Digital Sky Survey
SIFA	Sydney Institute for Astronomy
SUT	Swinburne University of Technology
TAC	Time Allocation Committee
TAIPAN	Transforming Astronomical Imaging surveys through Polychromatic Analysis of Nebulae, a Multi-object spectroscopic facility built for the UKST
TOLIMAN	Telescope for Orbital Locus Interferometric Monitoring of our 1 Astronomical Neighbourhood
UKST	United Kingdom Schmidt Telescope
UNSW	University of New South Wales
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
4MOST	4-meter Multi-Object Spectroscopic Telescope

3 INTRODUCTION

3.1 BACKGROUND

The Australian Astronomical Optics (AAO) Consortium has been established by four partners in answer to the Commonwealth's call in 2017 for the establishment of a National Optical Astronomy Instrumentation Capability (NatCap). The Australian Government, through the National Collaborative Research Infrastructure Strategy (NCRIS), is providing $50 million over ten years to support the establishment of the NatCap. The Consortium formally commenced on 1 July 2018. The Consortium comprises the following parties:

- **Macquarie University**, through *Australian Astronomical Optics-Macquarie (AAO-MQ)* within the Faculty of Science and Engineering, consisting of staff and facilities from the North Ryde site formerly known as the 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 use of *Australian Astronomical Optics-Stromlo (AAO-Stromlo)*.
- **The University of Sydney** (USyd), through elements of the Sydney Astrophotonic Instrumentation Laboratory (SAIL) within the School of Physics. The astronomical instrumentation activities of this group have been rebranded as *Australian Astronomical Optics-USydney (AAO-USyd)*.
- **Astronomy Australia Limited** (AAL), supported by NCRIS, which is an Australian Government program to deliver world-class research facilities.

3.2 AAO VISION, MISSION AND VALUES

The AAO Consortium pursues the following vision, mission and values.

The AAO Vision: Australian Astronomical Optics 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.

Led by the AAO Mission: we seek to establish Australia in the top tier of global astronomical instrumentation builders through a national partnership known for innovation, quality, integrity and service.

Our AAO Core Values are: collaboration, trust, mentorship, innovation, integrity, equity.

These guide us through our objectives and collaborations.

Images: (Left) Mike Petkovic and AAO-Stromlo staff, (Below) Bart Fordham. Credit: AITC/Australian National University.

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3.3 THE AAO GOVERNANCE

The governance structure of the AAO is illustrated in Figure 1 as specified in the Consortium Agreement. Members of each node report to the Director of that node. The Directors report to the Board via the Management Committee as specified in the Consortium Agreement. Each node has its own internal structure by which the Director and leadership team prioritise, assign and deliver work. The AAO Consortium Board may appoint advisory committees to assist it with the performance of its responsibilities as determined by the AAO Consortium Board.

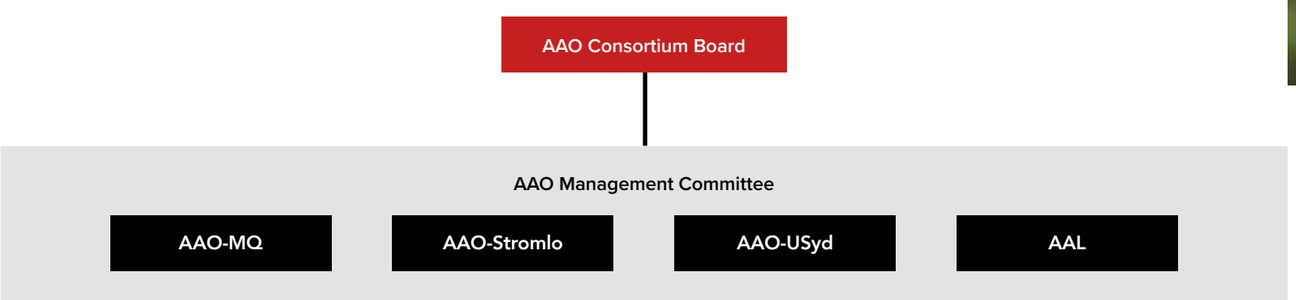


Figure 1. Governance Model for AAO Consortium.

3.4 AAO CONSORTIUM BOARD MEMBERS

The structure and roles of the AAO Board is outlined in Appendix 1 and comprises nominees of the four Consortium parties and three independent members. An observer from the Department of Industry, Science, Energy and Resources (DISER) also attends Board meetings. The 2020 AAO Consortium Board members include

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

Prof. Matthew Colless – ANU

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 leading the Taipan survey, which is using Starbug fibre positioner technology to measure the Hubble constant with 1% precision and test theories of gravity. 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

3 INTRODUCTION

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 AAO Consortium bid and served as the interim Director of AAO-MQ 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. Sarah Pearce – AAL Nominee

FTSE

As the Deputy Director of CSIRO Astronomy and Space Science, Dr. Pearce leads engagement in the international Square Kilometre Array (SKA) project and was part of the negotiating team for the SKA Treaty. Sarah also leads CSIRO's space research, including operating a share of the NovaSAR-1 satellite facility. Prior to joining CSIRO, Sarah was project manager of the UK's computing for particle physics program and a science advisor in the UK Parliament. She holds a PhD from the University of Leicester and an undergraduate degree in Physics from the University of Oxford.

Dr. Sarah Pearce joined the AAOCB in April 2020.

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 Ministers Innovation Prize.

Dr Frisken joined the AAOCB on 1 October 2020.

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 AAOCB on 1 October 2020.

Mr. David Luchetti – DISER Observer

Mr. David Luchetti joined the then Department of Industry, Science and Resources in 1990 and worked in a range of sectoral areas on issues relating to trade and industry policy. In 1997, David moved to AusIndustry (the program management division of the Department) and managed a number of multi-million dollar programs including the R&D Tax Concession Program and the Venture Capital Programs. In October 2004, David took responsibility for the Joint Strike Fighter and Defence Industry Policy Section within the Department. In April 2009, David was promoted to the position of General Manager, Science Policy and Programs within the Department. In 2015, David became the Project Director of the Australian Square Kilometre Array (SKA) Office and more recently he has taken on the additional responsibility of the Department's engagement in optical astronomy.

Previous Board members who served in 2020:

Prof. Robyn Owens (Independent), Term: 26 Sep 2018 – 30 Sep 2020
Prof. Markus Kissler-Patig (Independent), Term: 26 Sep 2018 – 30 Sep 2020
Prof. Rachel Webster (AAL Nominee), Term: Sep 2018 – Apr 2020

3 INTRODUCTION

3.5 AAO MANAGEMENT COMMITTEE IN 2020

The AAO Management Committee (AAOMC) includes the Node Directors (or representative/s) from the four Consortium parties and the Chief Operating Officer (COO), see Appendix 1 for AAOMC structure.

COO and Node Directors

Name	Entity	Position
Prof. Mark Casali	AAO-MQ	Director of AAO-MQ
Prof. Anna Moore	AAO-Stromlo	Director of AAO-Stromlo
A/Prof. Julia Bryant	AAO-USyd	Director of AAO-USyd
Dr. Mita Brierley	AAL	AAL Chief Business Officer
Dr. Katrina Sealey		AAO Chief Operating Officer

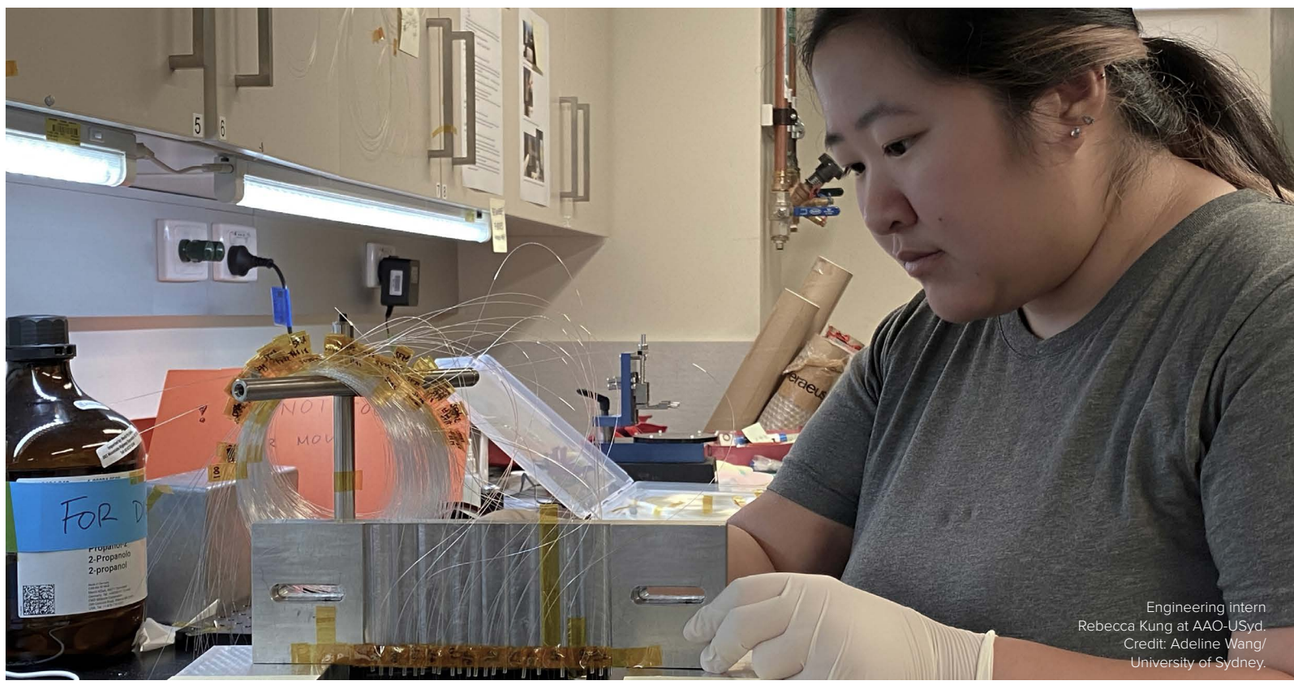
Additional 2020 AAOMC attendees

Name	Entity	Position
Prof. Jon Lawrence	AAO-MQ	AAO-MQ Head of Instrumentation
Dr. Roger Haynes*	AAO-Stromlo	AAO-Stromlo Technical Manager
Dr. Lucyna Chudczer	AAL	AAL Program Manager

** Representing AAO-Stromlo operations.*

Ellen Houston (left), Rebecca Brown (right).
Credit: Morris McLennan/Macquarie University.

4 2020 AAO MANAGEMENT COMMITTEE REPORT



Engineering intern Rebecca Kung at AAO-USyd.
Credit: Adeline Wang/ University of Sydney.

The year started strongly with the AAO Management Committee (AAOMC) holding fortnightly meetings to progress the 2020 Business Plan activities. However, by March 2020 we had refocused to develop a COVID-19 impact plan to support staff, mitigate impacts, ensure project continuity and plan for an uncertain future. What 2020 showed us was how well the Consortium works together and supports each other in uncertain times. Actions were put in place to support staff and projects across the Consortium.

COVID-19 resulted in each of the parties being confronted with a range of challenges. The Consortium found a variety of ways to work together throughout 2020 and successfully deliver projects and meet project milestones as outlined in **Sections 5** and **7**.

AAOMC 2020 Activity Highlights

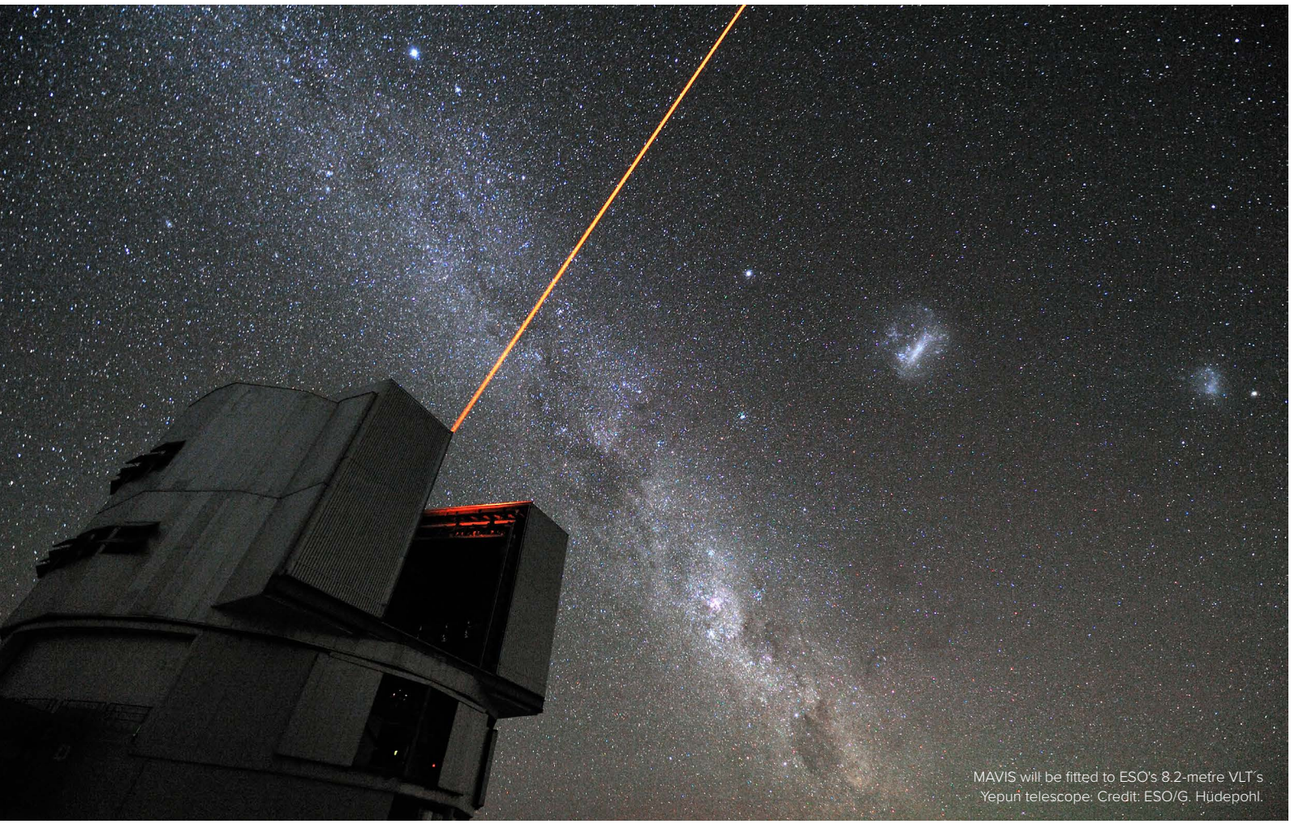
The AAOMC continued to progress the 2020 Business Plan activities including:

- the development of the AAOC Partner Engagement Framework
- producing an all of Consortium financial model
- signing a Consortium Master Service Agreement to enable easier collaboration on projects and resource sharing
- the development of a Staffing and Capabilities Plan to assist with future project and growth planning
- developing a new customer focused website featuring AAOC capabilities and projects
- producing a Consortium Working Manual, to provide easy access to all the master copies of key AAOC documentation.

In addition, the AAOMC delivered the 2019 Annual Report, 2021 Business Plan and Implementation Plan.

The following sections present key Consortium highlights (**Section 5**, **Section 6**), a brief update on projects (**Section 7**), and a summary of the 2020 calendar year finances (**Section 8**).

5 THE YEAR IN HIGHLIGHTS



MAVIS will be fitted to ESO's 8.2-metre VLT's Yepun telescope. Credit: ESO/G. Hüdepohl.

Some of the key 2020 AAO Consortium highlights are featured below.

MAVIS approved by ESO Council

MAVIS, the Multi-Conjugate Assisted Visible Imager and Spectrograph, got to a very promising start in 2020. Despite COVID, the Conceptual Design was passed on time and on budget, and the team received praise from the ESO review committee. Communication within the consortium, including the Australian, Italian, and French teams- worked very effectively, leading to a healthy, efficient instrument design. MAVIS has raised a lot of interest and support in the scientific community. Its science case is very diverse and has been released publicly in late 2020. Following a positive recommendation by the ESO Science and Technical Committee (10/2020), and the green light from the ESO Finance Committee (11/2020), MAVIS was approved by ESO Council early December 2020.

AESOP for 4MOST fully assembled and the LAR successfully held

AESOP is the fibre positioner unit for the 4MOST instrument for the VISTA telescope in Chile operated by ESO. It deploys 2448 optical fibres to positions on the curved focal surface of the telescope to extremely high precision. The AESOP project commenced in 2012. In October 2020, the AAO team completed a major milestone by successfully holding the Local Acceptance Review (LAR) that was attended remotely by the 4MOST Project Office. The module will be shipped to Germany in 2021 for system integration. In the overall 4MOST project, AESOP will be the first major subsystem to be delivered.

MANIFEST pre-conceptual design phase successfully completed

MANIFEST is the Starbug fibre positioning facility for the Giant Magellan Telescope. The AAO commenced the Pre-Conceptual Design Study for MANIFEST in 2018, after completing the Prototyping Design Study (in 2013), the R&D Phase (in 2012), and the Feasibility Study (in 2011). A final review of the pre-conceptual design phase was held remotely in April 2020. In Oct 2020 the GMT Organisation (GMTO) issued a report stating the phase was successfully completed and recommending that the team proceed with the development of the MANIFEST conceptual design phase.

Hector project major milestones achieved.

Hector is a new integral-field spectrograph instrument for the AAT. 2020 saw the Hector project progress from design to final parts. The new robotic position system demonstrated 10 micron positioning accuracy, the spectrograph large optics arrived and began assembly, the new-format optical fibre imaging devices (hexabundles) development was completed and final device manufacture begun, and the unique sky fibre system went from design to manufacture. Successful demonstration of the new innovation that underpins Hector in the robotic positioning system and the optical fibre system was a highlight for the Hector team.

ESO BlueMuse and CUBES Consortia joined

BlueMUSE is a proposed blue-optimised, medium spectral resolution, integral field spectrograph for ESO's VLT. BlueMUSE is currently in the pre-Phase A stage, with a kick-off of work expected in early 2021. The AAO contribution to the project will likely have a focus on the instrument opto-mechanical structure.

CUBES is a high-efficiency, medium-resolution ground based ultraviolet-optimized spectrograph, to be installed on ESO's VLT. The project is currently in the Conceptual Design study phase. The AAOC has been asked to analyse and provide a concept design for a fibre link between the planned CUBES instrument and another VLT spectrograph.

DIRAC final design review held

The DIRAC project involves the design, construction, and delivery of a near-infrared camera for diffraction-limited operation on the Turkish 4 metre DAG telescope, currently under construction. The preliminary design milestone for DIRAC was successfully completed in May 2020. Over the last quarter of 2020, the camera design continued and reached final design maturity. By the end of 2020, the final design review was conducted and review items received.

AVM conceptual demonstration to be delivered in partnership with GMTO.

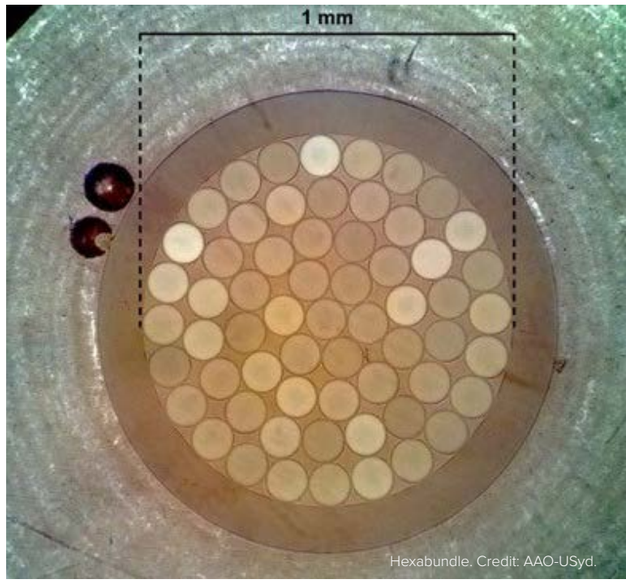
Modern astronomical instrumentation often requires cryogenic cooling to achieve optimal sensitivity. While a wide range of cooling technologies are available, many of the most efficient and convenient options, are prone to generating vibrations that can shake instruments and have the undesirable side-effects of blurring images. AAO-Stromlo partnered with the GMTO to deliver the first stage of a conceptual demonstration for an anti-vibration mount (AVM) to mitigate this important problem for GMT.

Heimdallr project work began at AAO-USyd

Major funding from the European Research Council for the partner project Bifrost has been secured, allowing key components (of order $1M) for Heimdallr to be purchased. The design phase is progressing, with clearer constraints now defined based on the Gravity+ progress and the Bifrost funding.

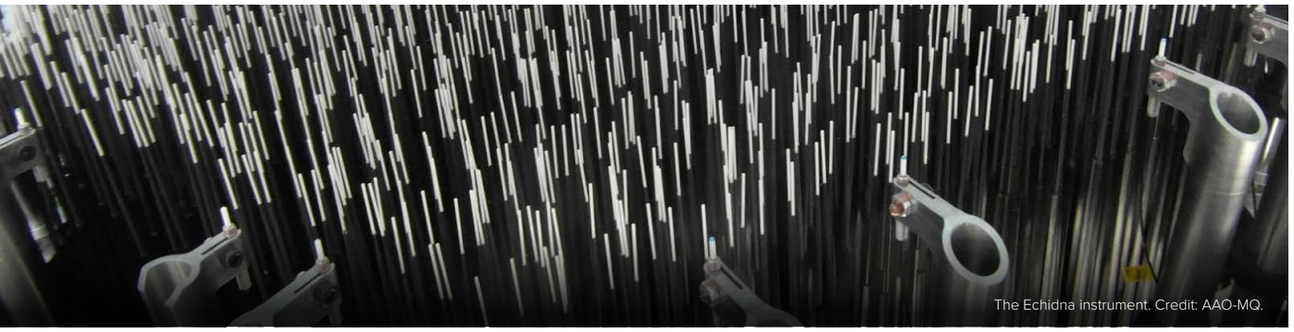
ESO Pipeline software project progress

The ESO Software Pipeline project is the development of pipeline data reduction software for ESO's VLT. Pipelines allow astronomers from around the world to access high quality calibrated data. In June 2020 the first release of these pipelines was overseen by the AAO software team. The first and second biannual reviews of the project for 2020 were successfully held.



Hexabundle. Credit: AAO-USyd.

6 2020 KEY AAO AWARDS AND STAFF ACHIEVEMENTS



The Echidna instrument. Credit: AAO-MQ.

- **The AESOP Team** was recognised with the Macquarie University Faculty of Science and Engineering – Project Excellence Award.
- **Dr. Katrina Sealey** and **Ms. Rebecca Brown** were recognised in the Macquarie University Faculty of Science and Engineering – Leadership in Inclusion (Equity and Diversity) Awards.
- **Prof. Céline d'Orgeville** won the 2021 SPIE Diversity Outreach Award in December 2020, in recognition of her leadership in diversity, inclusion, and equity activities in Australia and elsewhere in the world.
- **Prof. Joss Bland-Hawthorn** was awarded the 2020 Research Leader in the field of Astronomy and Astrophysics by The Australian.
- **A/Prof. Francis Bennet** won the Defence Connect Australian Defence Industry Awards-Innovator of the Year in December 2020.
- **Dr. James Gilbert** was named one of Australia's most innovative engineers by Engineers Australia in July 2020.
- **Yinuo Han**, PhD student at USyd, supervised by **Peter Tuthill**, received a prestigious PhD scholarship at the University of Cambridge.
- **A/Prof. Sergio Leon-Saval** was awarded the Officer's Cross (OfYC) (Cruz de Oficial) of the Order of Isabella the Catholic, awarded by Felipe VI, King of Spain.
- **A/Prof. Sergio Leon-Saval** was also awarded a Vice Chancellor's Award for his contribution as part of the Physics Undergraduate Lab Team.
- **Dr. Barnaby Norris** was awarded a Discovery Early Career Researcher Award (DECRA) in 2020 commencing in 2021.

Left: Katrina Sealey received an award for Leadership in Inclusion. Credit: MQ.
Right: Céline d'Orgeville won the 2021 SPIE Diversity Outreach Award. Credit: Céline d'Orgeville.

Sergio Leon-Saval was awarded the Officer's Cross (OfYC) (Cruz de Oficial) of the Order of Isabella the Catholic. Credit: Sergio Leon-Saval.

7 2020 PROJECT PORTFOLIO

A Consortium project is defined as any project involving more than one AAO node. The projects are selected based on the "New Projects and Opportunities" section of the AAO Consortium Collaboration Guidelines.

The projects are prioritised as described below.

Current Projects Portfolio (Section 7.1)

- **Priority 1 projects with reporting**: projects of national and/or international significance or high-profile revenue generating (they may or may not have NCRIS funding; Section 7.1.1).
- **Priority 2 projects with reporting**: projects that do not meet the criteria of Priority 1 and have NCRIS funding (Section 7.1.2).
- **Non-reportable Consortium Projects**: for information only. No Board or AAOMC reporting. Generally single node optical/IR ground-based astronomy projects not meeting the criteria above and without NCRIS funding (Section 7.1.3).

All projects listed in priority 1 and 2 are required to be included for NCRIS reporting purposes. Non- reportable Consortium projects are to be included as in-kind to show the strengths and capabilities of the Consortium.

AAO projects are categorised 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) / Industry (I)
3. **Nature**: International (I) / National (N).

Table 1 in Section 7.1 and Table 2 in Section 7.2 show the categories for the Current Project Portfolio, and Opportunities Register, respectively. The asterisk * in these tables highlights projects that are driven by multiple reasons.

7.1 CURRENT PROJECTS PORTFOLIO

Table 1: Current Projects Categories Overview

(This table covers: Priority 1 Projects; Priority 2 Projects; Non-reporting Consortium Projects)

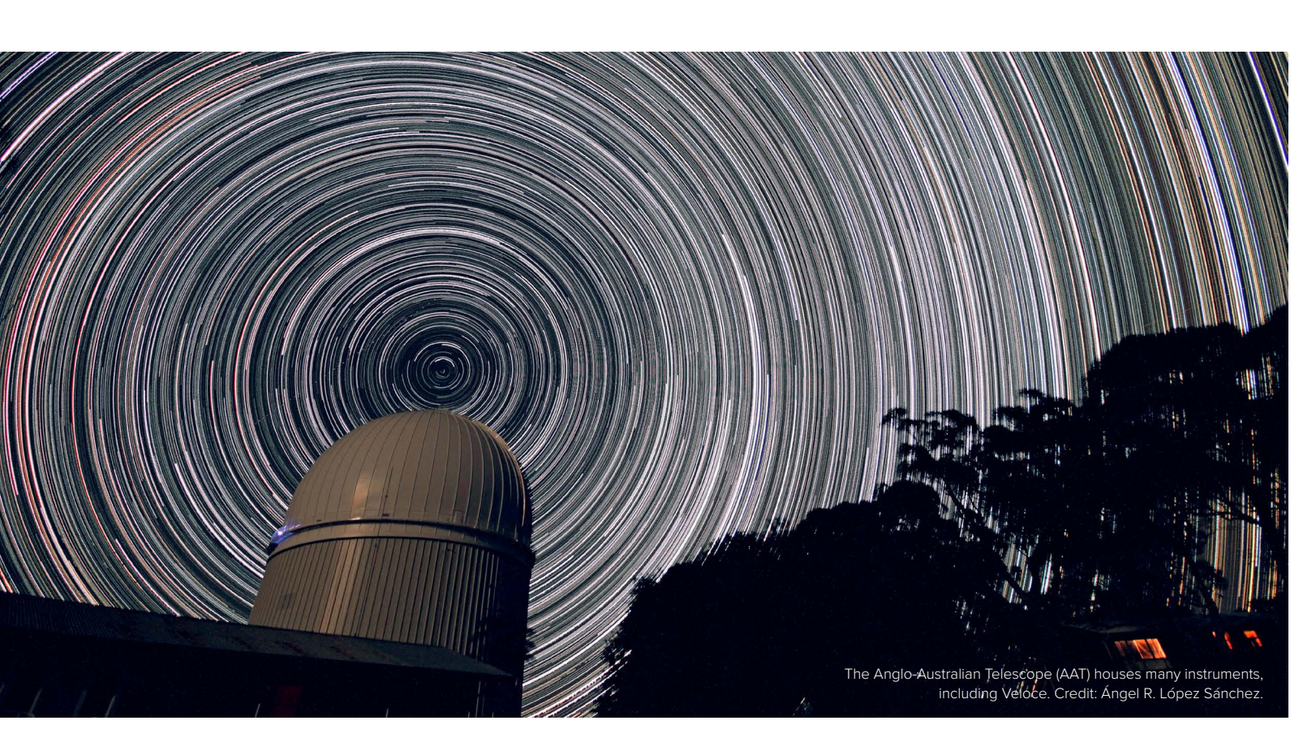
	International		National	
	Core Astro	None-Core Astro	Core Astro	None-Core Astro
Decadal plan driven (DP)	**Priority 1** MAVIS MANIFEST 4MOST GMTIFS Blue MUSE MAORY-IFU HRMOS Eupraxia* Heimdallr* CUBES		**Priority 1** TAIPAN* Hector* **Non-reportable** SSO* Data Central	
International growth driven (IG)	**Priority 2** Subaru GLAO/ATLAS Subaru Beamswitcher Subaru GLINT&VAMPIRES* **Non-reportable** AST3 GHOST Local Volume Mapper FOBOS for Keck MSE MAAT			

7 2020 PROJECT PORTFOLIO

Table 1: Current Projects Categories Overview – continued

(This table covers: Priority 1 Projects; Priority 2 Projects; Non-reporting Consortium Projects)

	International		National	
	Core Astro	None-Core Astro	Core Astro	None-Core Astro
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 Consortium Projects** SSO*	
Strategic Technology driven (ST)	**Priority 1** Eupraxia* Heimdallr* **Priority 2** Subaru GLINT&VAMPIRES*	**Non-reportable** TOLIMAN*	**Priority 1** TAIPAN* Hector* **Non-reportable** PYXAS	



The Anglo-Australian Telescope (AAT) houses many instruments, including Veloce. Credit: Ángel R. López Sánchez.

7.2 PRIORITY 1 PROJECTS

Projects	Lead	Timeline	Supported by	Nodes	Returns to Community
MAVIS	AAO-Stromlo	2019-2026 (Phase A and Phase B - E)	ESO – Hardware costs, NCRIS – Labour costs	AAO-Stromlo & AAO-MQ	• Telescope time for astronomers • Open new fields of research for astronomers • First project awarded by ESO to a consortium led by Australia
MANIFEST	AAO-MQ	2011-2030	Contract – GMTO, NCRIS	AAO-MQ	• Telescope time and access to data for astronomers • Unique instrument parameter space • Enhanced reputation • Additional credit in GMTO for AAL
4MOST	AAO-MQ	2012-2023 *(main AAO-MQ deliverable in late 2020)*	4MOST consortium, UWA, ICRAR, ARC LIEF, AAL, DISER, NCRIS, ESO	AAO-MQ	• Telescope time for astronomers • Unique instrument parameter space • Access to data • Enhanced reputation
ESO Software Pipelines	AAO-MQ	2019-2021 *(with option to extend to 2023)*	ESO	AAO-MQ, AAO-Stromlo	• Enhanced reputation • Familiarity with ESO systems
GMTIFS	AAO-Stromlo	Q4/2019-Q3/2020	NCRIS funding as Australian GMT in-kind contribution	AAO-Stromlo	• Catalyst for engineering and instrument innovations with potential use in a number of applications in and beyond astronomy • Only ELT program in which the Australian community participates
Hector	AAO-USyd	Hector-I on-sky by 2021A.	NCRIS, ARC LIEF, ARC FT, USyd, AAO-DISER	AAO-USyd, AAO-MQ	• The next main dark time instrument for the AAT • Keeps AAT competitive internationally • Fulfils the science needs of a large Australian team • Support of ASTRO-3D CoE and other ARC-funded science projects
TAIPAN	AAO-MQ	2014-2021	EIF, ARC, DISER, NCRIS, AAL, GMTO	AAO-MQ, AAO-Stromlo	• Unique instrument parameter space • Access to data for astronomers • Enhanced reputation
DIRAC	AAO-MQ	2019-2022	ATASAM (Ataturk University, Turkey)	AAO-MQ, AAO-USyd, AAO-Stromlo	• Enhanced reputation • Surplus for priority Consortium activities
Blue MUSE	AAO-MQ	2020-2028	NCRIS, ESO	AAO-MQ, AAO-USyd (TBC), AAO-Stromlo (TBC)	• Telescope time and access to data for astronomers • Unique instrument parameter space • Enhanced reputation

7 2020 PROJECT PORTFOLIO

7.3 PRIORITY 2 PROJECTS

Projects	Lead	Timeline	Supported by	Nodes	Returns to Community
Subaru GLAO/ATLAS	AAO-Stromlo	01-2020 to 12-2022	ARC Linkage, ANU, Subaru telescope, Tohoku & Arete Associates	AAO-Stromlo	• Engineering nights on Subaru • International support of Laser and AO capabilities • Telescope time for astronomers
Subaru Beamswitcher	AAO-MQ	2018-2021	Subaru Telescope	AAO-MQ	• Enhanced reputation
Subaru GLINT and VAMPIRES	AAO-USyd	07/2018-12/2022	NCRIS, Tuthill grants Future funding: NCRIS, Future ARC grants.	AAO-USyd, AAO-MQ	• Significant science advances for Australian observers • Prove Australian-led technologies to enable Australia to win a large instrument contract for an ELT

7.4 NON-REPORTABLE CONSORTIUM PROJECTS

The same project management practises apply to all AAO projects. The only difference is the following projects are not reported on to the Consortium and are managed by the individual nodes project management offices.

Projects	Lead	Timeline	Supported by	Nodes	Returns to Community
AST3	AAO-MQ	2014-2021	ARC LIEF, SUT, AAO-DIIS	AAO-MQ	• Telescope time for astronomers • Unique instrument parameter space • Access to data • Enhanced reputation
GHOST	AAO-MQ	2013-2021	AURA Inc, on behalf of Gemini Observatory	AAO-MQ, AAO-Stromlo	• Telescope time for astronomers • Access to data • Enhanced reputation
SSO support	AAO-MQ	2018-2021	ANU	AAO-MQ	• Reliable telescope services
Local Volume Mapper (LVM)	AAO-MQ	2019-2022	SDSS, ARC (TBD)	AAO-MQ	• Telescope time for astronomers • Unique instrument parameter space • Access to data • Enhanced reputation
FOBOS for Keck	AAO-MQ	2019-2028	Keck Foundation, NSF, ARC	AAO-MQ	• Telescope time for astronomers • Unique instrument parameter space • Access to data • Enhanced reputation
MSE	AAO-MQ	2018-2028	MSEPO, ARC	AAO-MQ	• Telescope time for astronomers • Unique instrument parameter space • Access to data • Enhanced reputation
Data Central[1]	AAO-MQ	2018-	NCRIS, AAL	AAO-MQ, ANU	• Access to data • Enhanced reputation
Veloce Azzurro/ Verde	AAO-Stromlo	2019-2021	ARC-LIEF funding	AAO-Stromlo	• Enhance capability of an existing AAT facility • Instrument access via the SSO TAC • Enhanced international reputation
2.3m AUTO	AAO-Stromlo	Q1 2020 to Q4 2021	CGA NIG grant ($500k), LIEF 2020 bid (pending), MEC grant (to be submitted).	AAO-Stromlo, external partners, as specified on the LIEF bid	• Efficient scheduling and observation for astronomers
DREAMS	AAO-Stromlo	Q4 2020 to Q1 2022	Currently ANU Translational fellowship – Anna Moore. LIEF funding also requested and Linkage application is being written.	AAO-Stromlo	• Data access for astronomers • Unique instrument parameter space
PYXAS	AAO-Stromlo	2020 to 2022	ARC discovery project lead by Michael Ireland (lead CI) and Tony Travouillon.	AAO-Stromlo	• Development of CubeSat-compatible technologies • Advancement of interferometry
TOLIMAN	AAO-USyd	Q3 2020 to Q4 2023	Breakthrough grant and other non-NCRIS funds.	AAO-USyd	• Unique instrument parameter space for astronomers • Builds Australia's skills in the space sector
MAAT	AAO-MQ	2020-2022	Various institutes	AAO-MQ	• Access to data • Enhanced reputation

[1] Data Central is now Optical Data Centre incorporating SkyMapper.

8 2020 FINANCIAL SUMMARY

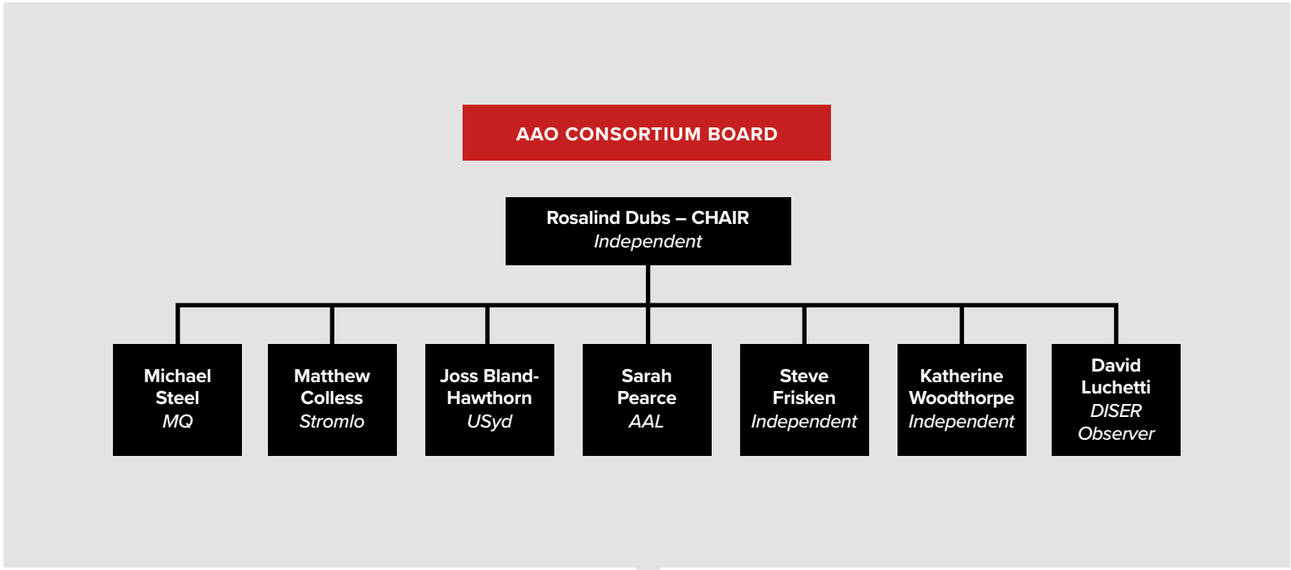
Overall, the Consortium is a collaborative endeavour between partners of ~$20m net revenue, ~$12.5m of which relates to ground based optical Instrumentation activities within the scope of the consortium. The NatCap fund supports the AAOC at the level of ~$5M through NCRIS/AAL. In 2020, the majority (~80%) of the NatCap fund was used to support international and national instrumentation projects benefiting the Australian astronomy community. The residual ~20% supported the transition of the former AAO to AAO-MQ and covers primarily the premises costs of AAO-MQ until moving onto Macquarie University's main campus. Overall ~60% of all AAOC activity related specifically to ESO/GMT projects and ~80% to all international projects. A high-level summary is shown in the table below.

Consortium Instrument project category	Expenditure ($1000AUD)	Revenue ($1000AUD)
Domestic	2,228	1,821
ESO/GMT	5,984	7,075
Other consortium projects for international clients	2,452	2,318
Consortium project administration	295	247
Total	**10,959**	**11,462**

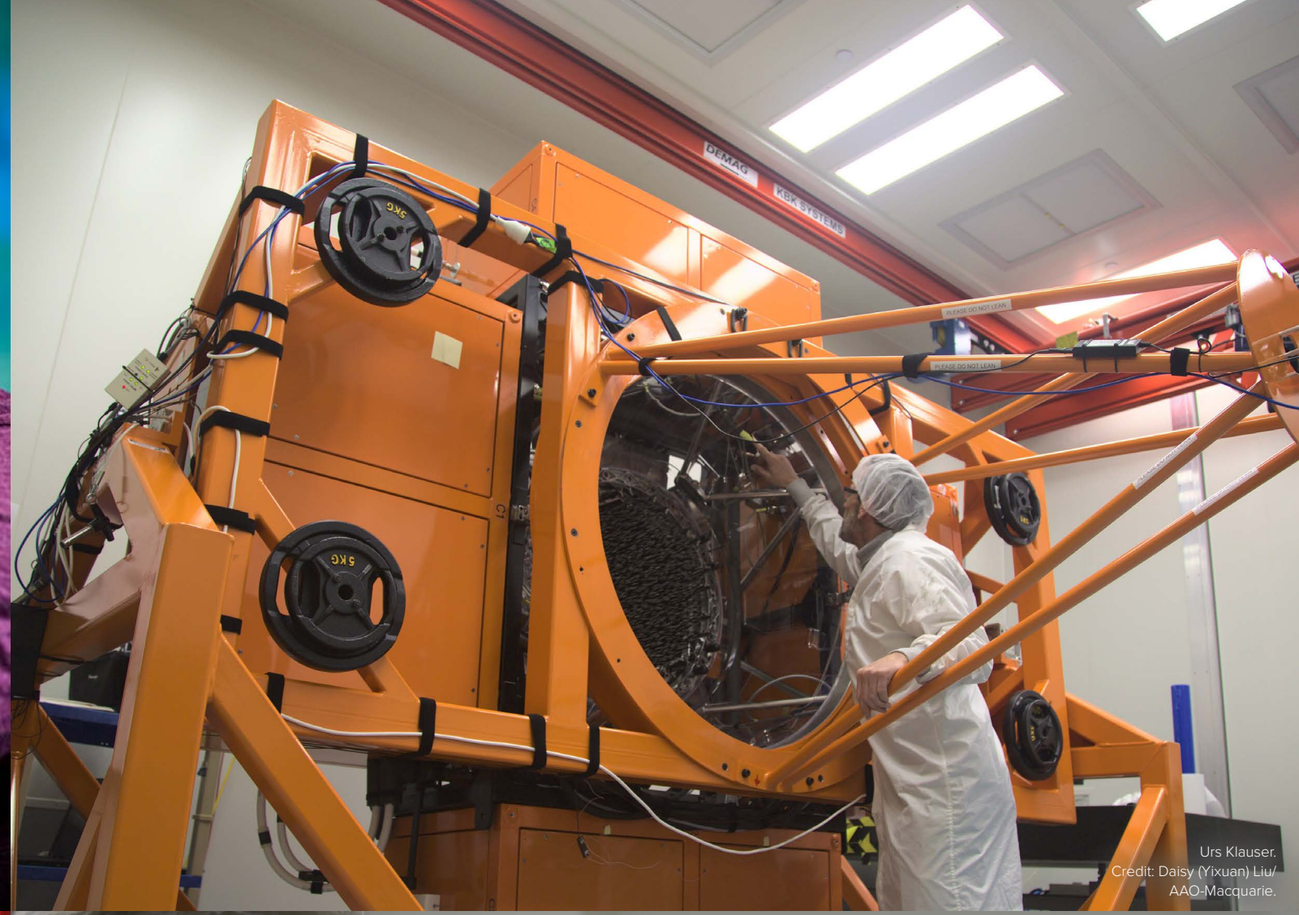
In 2020, the AAOC staffing included 111 staff across 9 units as shown in the table below.

Unit	Staffing Level
Director & Admin	14
Project management and systems engineering	8
Mechanical Engineering	22
Optical Engineering	6
Electrical Engineering	5
Software/IT	17
Instrument Science	17
Academics	17
Detectors & system control	5
Total	**111**

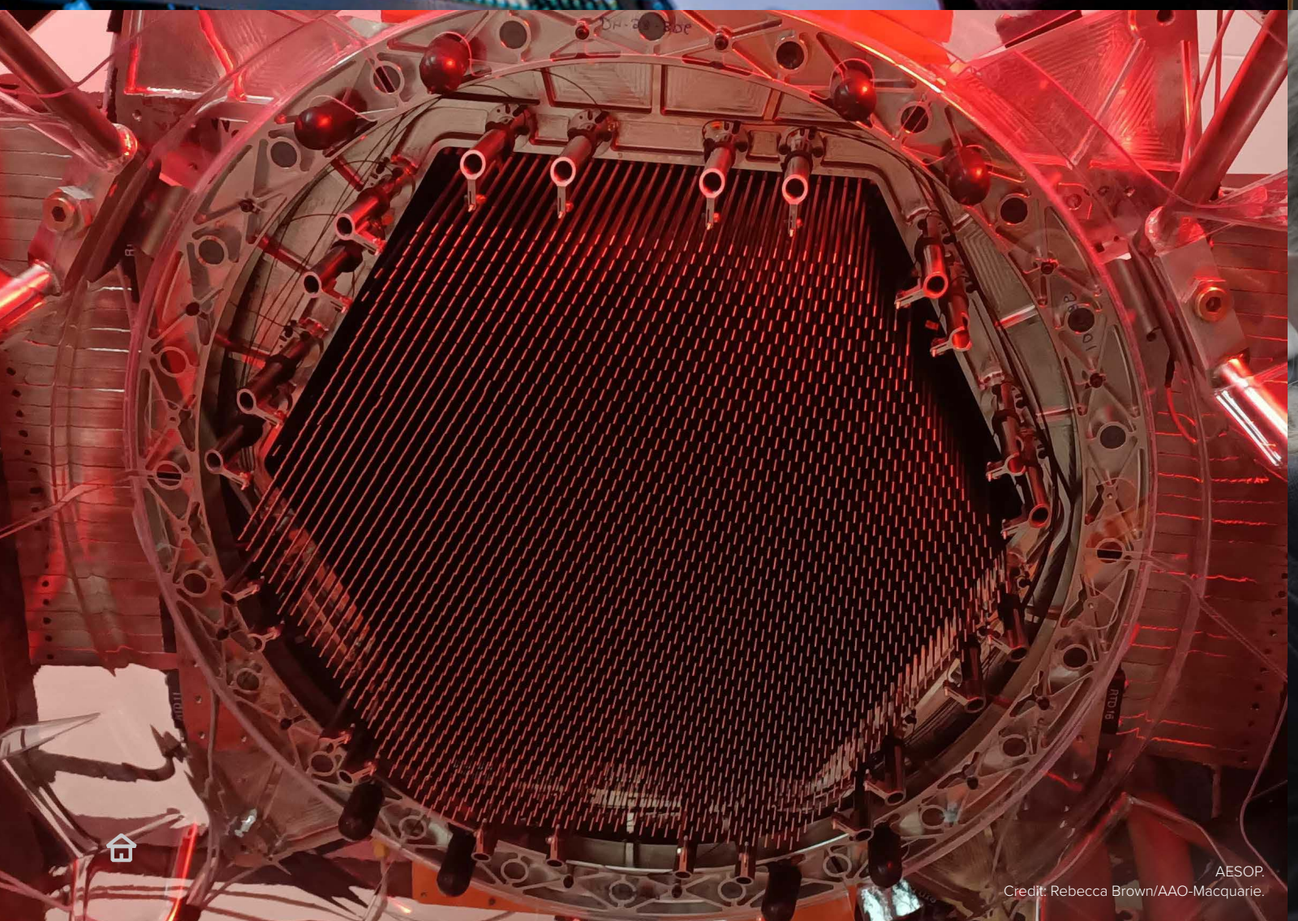
9 APPENDIX 1 – GOVERNANCE STRUCTURE (AS AT DEC 2020)



Sufyan Baker.
Credit: Morris McLennan/
Macquarie University.



Urs Klauser.
Credit: Daisy (Yixuan) Liu/
AAO-Macquarie.



AESOP.
Credit: Rebecca Brown/AAO-Macquarie.

Julia Bryant. Credit: Adeline Wang/University of Sydney.

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