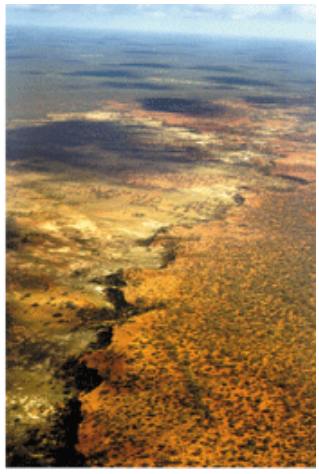
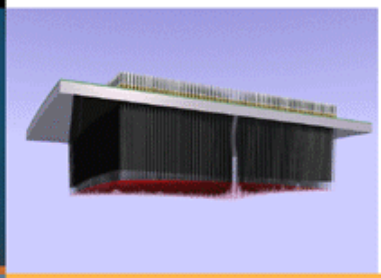
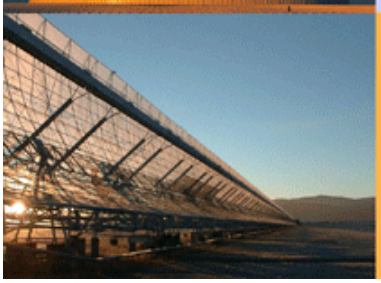


The Gemini and SKA MNRF: Australia's Astronomy Future





Annual report 2004-05

Executive summary

The Gemini and SKA Major National Research Facility (MNRF) aims to provide significant Australian participation in major new optical, infrared and radio facilities including the twin Gemini 8-metre telescopes and the Square Kilometre Array (SKA). During 2004/5, there have been several major achievements towards this goal, and several important discoveries as a result of Facility access by the community. The key achievements include:

- The discovery, using the superb seeing conditions of the Gemini telescopes, of a very faint, extended stellar disk around the nearby galaxy NGC 300. Also using Gemini, the first measurement of the size of the broad-line region, using the technique of gravitational microlensing, in a high-redshift quasar QSO 2237+0305.
- The completion of the rebuilding of the Near-infrared Integral Field Spectrograph (NIFS) for the Gemini-North telescope. The original unit was destroyed in the January 2003 Canberra fires. The replacement unit was constructed, in collaboration with ANU staff, by a Canberra-based aerospace company, Auspace Ltd.
- Successful completion, led by the Anglo-Australian Observatory, of a feasibility study for the Wide Field Multi-Object Spectrograph (WFMOS), an optical instrument which will revolutionize our understanding of the high-redshift Universe.
- The development by the Anglo-Australian Observatory in conjunction with Redfern Optical Components, of optical fibres able to suppress all hydroxyl (OH) lines in the wavelength range 1.50 to 1.57 μm, thereby dramatically lowering the night-sky background in the infrared.
- The completion of the design and layout of the first prototype printed circuit board for the 2 GHz digital filterbank for the Compact Array. The sensitivity and versatility of the Compact Array will be greatly enhanced on completion of the final filterbank.
- Deployment in January 2005 of the Radio Frequency Interference (RFI) measurement trailer at Mileura WA, the Australian candidate SKA site. This trailer will gather data for twelve months and form part of Australia's SKA site submission proposal.
- Completion of a real-time 'fringe-check' facility to validate Very Long Baseline Array (VLBI) data, significantly increasing the usefulness and robustness of radio astronomy data taken with Australian facilities.
- The release of disk-based VLBI systems and supercomputer-based software correlation to the Australian community, allowing a significant increase of sensitivity over existing VLBI observations.

Towards the end of 2004/5, a review was conducted by an external panel of distinguished astronomers who reported that the "MNRF program is significantly advancing astronomy in Australia by paving the way for the major projects of the future". The review is publicly available at the Gemini & SKA MNRF website. AABoM will use the recommendations of the review panel in the coming year to further strengthen the impact of the MNRF on Australian Astronomy.

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1. Progress with establishment, enhancement and operation

1.1. Governance

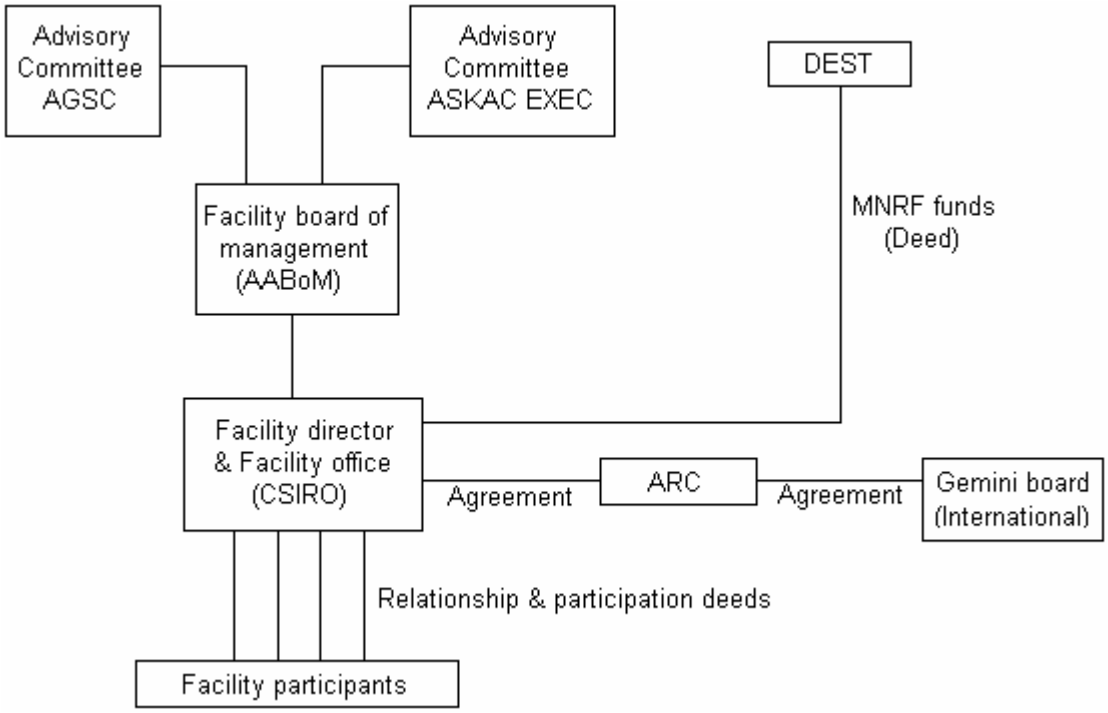


Figure 1: Relationships within the MNRF

This MNRF is managed by the MNRF Director, with assistance from the facility office. The Director reports to the Australian Astronomy Board of Management (AABoM).

The MNRF programme funds part of the Australian component of two international facilities, Gemini and the Square Kilometre Array (SKA). The steering committees of these facilities, the Australian Gemini Steering Committee (AGSC) and the Australian SKA Consortium Executive (ASKAC) advise AABoM, and AABoM provides the Department of Education, Science and Training (DEST) with an annual progress report. Upon acceptance of this annual report DEST provides the facility office with the MNRF grant for that year. The facility office then distributes these funds to the various projects contingent on receipt of satisfactory progress reports detailing performance against agreed milestones.

In addition, the Australian Research Council (ARC) manages the relationship with the international Gemini consortium. Payment for additional time is made by the facility office to the Gemini consortium.

1.2. Project summaries

1.2.1. Project Office

During 2004/05 the new MNRF Office team of Lister Staveley-Smith (Director) and Mark McAuley (Executive Officer) commenced their roles with the MNRF. This increased the quantity of resources and breadth of skills available to the MNRF Office, allowing a number of achievements during the year, in particular:

- Increased communication with MNRF project teams, including a quarterly report for project leaders and the creation of an extranet for project leaders.
- The MNRF budget has now been updated. During this process mistakes in the accounting of the MNRF finances by CSIRO were identified and corrected.
- A review of the MNRF was held at CSIRO's Radiophysics Laboratory in Marsfield. The review team consisted of: A. Beasley, G. Illingworth, P. Shaver, D. Wilson and J. Moore.

1.2.2. Gemini

1.2.2.1. Increased share of Gemini telescopes

The MNRF Gemini Project in 2004/05 supported Australian use of the Gemini telescopes in two main ways: by continuing to pay for the additional 1.43% share in the Gemini Partnership, and by agreeing with the UK's Particle Physics and Astronomy Research Council to purchase an additional eight nights per semester of time on Gemini South, for each of the semesters 2005B, 2006A and 2006B. Together, these arrangements will more than double the time available to the Australian community during the remainder of 2005 and 2006.

Despite the increase in Australian Gemini time available, demand has increased at an even faster rate, leading to record oversubscription. For semester 2005B, a record thirty-one proposals were received, oversubscribing the available time by a factor of 2.84. The Australian share of Gemini is now more oversubscribed than any other Australian telescope.

There has also been an increase over the last year in the number of Australian papers published using Gemini data. Two of the most exciting results include:

- The discovery by Bland-Hawthorn et al[1]. that the disks of spiral galaxies can extend much further than previously thought. They took advantage of the superb image quality and seeing available at Gemini to trace the stars around galaxy NGC 300 far further than had ever been done before for a spiral galaxy. The question posed by this result is: how can stars form in these extremely low surface density environments? A new mode of star formation may be required.
- The first measurement of the size of the broad emission-line emitting gas around a high redshift quasar, by Wayth et al[2]. using the novel technique of gravitational micro-lensing. The observations were only possible with Gemini, relying both upon its superb seeing and the unique capability of its integral-field unit spectrograph.

[1] Bland-Hawthorn et al. (2005, ApJ, 629, 239)
[2] Wayth et al. (2005, MNRAS, 359, 561)

1.2.2.2. RSAA Gemini instrumentation

Near-Infrared Spectrograph (NIFS)

The rebuilding of NIFS is now complete. Problems were encountered with the HAWAII-2 science detector and the decision was made to upgrade to a HAWAII-2RG detector. This has now been installed and NIFS is undergoing final alignment in preparation for acceptance tests and shipment in August 2005. However, problems remain in interfacing detector data to the VME-based control system, and these have led to critical delays in beginning tests of the full software system.

Gemini South Adaptive Optics Imager (GSAOI)

GSAOI construction is now complete. Problems were encountered during the first cooldown; a cryo-cooler failure was reported and mechanisms failed to operate. Both problems have since been rectified. The optics have been installed and GSAOI has undergone its second cooldown with optics and two engineering detectors. The optical performance has been confirmed to be reasonable, but tuning of the focus and installation of the four science detector is necessary before optical performance can be critically assessed. The On-Detector Guide Window implementation has been designed. Problems persist with inadequate infrastructure to operate the four 2048x2048 detectors simultaneously.

1.2.2.3. AAO instrumentation

Wide-field Multi-Object Spectrograph (WFMOS)

The Anglo-Australian Observatory led an international consortium in the WFMOS feasibility study. The study is complete, having established tolerances and modelled the effects of optical alignment, fabrication and assembly errors on the delivery of image quality. The AAO has also received good fabrication data and reassurance from glass vendors confirming the approach recommended for the corrector design.

Starbugs

Starbugs Phase A delivered a working prototype bug that has been demonstrated to position to within 10 μm under closed-loop control. This bug has been operated in a cryogenic environment down to a temperature of –100^{o}C. The AAO is working with its partners to develop anti-collision algorithms for the positioning of many Starbugs (10's to 1000's) on a field plate. Phase B will continue to develop the metrology and control aspects for multiple bugs.

Astrophotonics Optic Fibres

Astrophotonics Optic Fibres Phase 1 delivered a new broadband optical fibre that is being used for AAOmega, the next generation optical spectrograph for the Anglo-Australian Telescope, and which is being considered for WFMOS. A number of collaborative investigations have been set up to characterize and develop new fibre technologies for applications in astronomy. Phase 2 will pursue imaging fibre systems and optically reformatting fibres.

Astrophotonics OH suppression

The Astrophotonics OH suppression project is aimed at demonstrating the use of high-resolution Bragg gratings to remove narrow-band sky emission, thereby greatly darkening the near IR night sky and revolutionising future instruments for Gemini and other large telescopes. Over the past year the AAO has manufactured and tested a single-mode fibre which suppresses all OH lines in the spectral window 1.50 to 1.57

μm. These fibres are well-optimized for use on 30m telescopes with diffraction-limited performance. The project now plans to broaden the spectral window to suppress lines over the full H-band region. The project has also developed a prototype single-mode to multi-mode converter (SMF to MMF) that allows OH suppression in multi-mode fibre. This allows the technology to be used in seeing-limited applications, for example WFMOS. This work is protected by two patents pending.

1.2.3. SKA

1.2.3.1. AT Compact Array Broadband Backend (CABB)

Considerable progress has been made during the year in defining baseline conceptual designs for all components of the system. This has allowed work to proceed to the point where detailed prototype design is well defined and in some areas testing has begun.

IF Conversion System

The interface between the receiver frontend and the new broadband backend are two signals in the frequency range 4-12 GHz, representing the two polarisations of the active receiver. The IF conversion system has the function of selecting two independent 2 GHz bandwidth signals at two frequencies from each polarisation and converting them to the 2-4 GHz frequency range for input to the four samplers. Two concepts were investigated, one being a simple single conversion scheme, with a Local Oscillator (LO) in the 8-14 GHz range, and the other being an up-down conversion scheme with two LOs and an intermediate IF around 25 GHz. The former scheme relies on a switched filter arrangement to achieve the required image sideband rejection. It has the disadvantage that the LO of one frequency band may fall within the passband of the other frequency. The double conversion scheme avoids this problem, but at the expense of considerably increased complexity. The decision was made to proceed with the construction of a prototype of the single conversion design and to investigate methods to reduce the LO leakage to an acceptable level.

The two 8-14 GHz LO signals required for the two frequency bands will be distributed on optical fibre from the central control building to all antennas using equipment very similar to that developed for the distribution of the mm-wave receiver LO reference frequency in the range 11-15 GHz. Much of the existing designs can be taken over, with the major new effort being in the packaging of the antenna electronics and integrating the LO and conversion systems.

Sampler/Digitisers

In line with its aim to demonstrate what is currently perceived to be SKA relevant technology, a decision was made at an early stage of the project to push towards the use of multi-bit digitisation. The low sensitivity to RFI resulting from the high dynamic range associated with multi-bit systems was seen to be an important feature of any SKA backend design and therefore worthy of detailed investigation in a practical system such as CABB. For this reason data paths from the antennas in the CABB system have been defined to be at least 8-bit.

A 2 GHz bandwidth 8-bit digitiser, operating at 4 Gsamples per second, remains at this time just beyond the state-of-the-art. Although such a device has been advertised for imminent commercial release for the last year or more, it has not yet eventuated. A decision was made in September 2004 that the project could not afford to rely on this device becoming available and an alternative solution was sought. The design

that has been developed uses two commercial 2 G sample/s 10-bit A/D converters operating in an interleaved sampling mode. These devices have extra features specifically incorporated to allow optimisation in interleaved sampling schemes. The design includes special signal processing algorithms which provide the information required to adjust the sampling process to achieve maximum dynamic range. Following extensive tests on a first prototype, the design of a second prototype is now nearing completion. The latest design already includes much of the functionality required to interface to the data transmission system.

Data Transmission

One of the major decisions made over the past year was in the choice between analogue and digital data transmission from the antennas to the central control building. The analogue system was seen to be a relatively simple and cost effective solution. It avoided the potential for self-generated RFI at the antennas, inherent in the digital system, but had possibly serious drawbacks in the area of dynamic range. Experience gained in the design of wideband analogue fibre links for the wideband analogue correlator system at Narrabri and the Mopra spectrometer system had indicated that, with the use of special techniques to improve dynamic range, a suitable performance may have been possible. However, it was eventually realised that a dynamic range equivalent to an 8-bit digital data path was unlikely to be achievable with an analogue fibre link over the required 8 GHz of bandwidth. Since this decision, made in September 2004, a concept for a digital data transmission system has been developed and detailed design is now proceeding.

The data transmission system will use, wherever possible, commercial 10 Gbit/s fibre optic components, commonly used in wide area network links. The 128 Gbits/s data from each antenna will be sent on four fibres, using four colours on each fibre in a dense wavelength division multiplexing scheme.

Filter Bank/Correlator

Detailed design and layout of the prototype 2 GHz digital filterbank (DFB) printed circuit board (PCB) has proceeded during the entire year. The job is significantly more complex than originally expected and is now five months behind schedule. Part of the problem has been with the PCB design software, which has proved to be very inefficient in handling such a large and complex design. The design has 17 large 1150-pin field programmable gate arrays (FPGA) with over 136,000 track segments on a twenty layer PCB. Nevertheless, the layout has recently been completed and the goal is to have a prototype 2 GHz DFB operating in July. Means of expediting the design of further prototypes and the final PCB are being investigated. It is likely that PCB layout of future designs will be outsourced.

Following on from work in previous years on the FPGA firmware design for DFBs, significant effort has gone into consolidating design techniques in preparation for the initial 2 GHz design. New FFT firmware cores have been developed and successfully implemented in hardware.

Further work on the overall architecture of the filter bank/correlator unit has shown that the digital delay system for the ATCA can be incorporated into the main processing core, obviating the need for a separate delay system.

Installation

Some initial plans for installation at Narrabri have been considered. The initial goal is to install the new backend in parallel with the existing ATCA system, so that

simultaneous or near-simultaneous operations will be possible. This appears to be achievable, possibly with some degradation in some aspects of the performance of the new system. The advantages of being able to compare old and new during initial testing would appear to far outweigh any disadvantages associated with a less than optimal positioning of the new system. When initial tests are complete, the new system will be moved to replace the old in an operation that is expected to require a three to four week shutdown.

1.2.3.2. New Technology Demonstrator (NTD)

The revised project, from July 2004, has concentrated on the development of focal plane array (FPA) technology in association with parabolic reflectors for the antenna systems. This decision was taken after the development of Luneburg lenses for the SKA was found to be not practical, and after various other options such as the use of cylindrical antennas were also considered.

There were also significant changes to the management of the NTD project. Colin Jacka was appointed as project leader, Simon Johnston as project scientist, and Tony Sweetnam as project manager from July 2004. John Kot remained as project engineer.

A new project plan was created with the following technology objectives:

- 10x10 FPA operating over the frequency range 800-1700 MHz, with 1 to 3 parabolic reflector antennas (cost dependent, but probably two reflectors, each 15 m diameter).
- RFI and spectral line ripple cancellation using FPA (commercial applications are possible)
- RF and IF beam-forming to give extremely wide fields of view.
- Polarization purity
- Correlation of large number (at least 20) of independent beams
- Wide band operation with low RFI levels
- Proof of infrastructure in remote desert environment (power supply, on-site data transport)

The strategy for the revised project was to tackle the area of greatest uncertainty by first setting up an experimental test bed to determine the real difficulties with digital beamforming of signals from a focal plane array mounted in a parabolic dish.

Dr John O'Sullivan was employed to deal with the overall systems engineering stemming from the use of focal-plane-arrays. Dr Tim Cornwell's contribution will be to specify the requirements and the design for the post correlator software needed to create useful scientific output from the enormous quantities of data that a telescope using focal-plane-arrays will produce.

To conduct the initial experiments three key components are required: parabolic dish antennas, a digital beamformer and a focal-plane-array:

- A team from India claimed that they could produce a low cost parabolic dish using their Preloaded Parabolic Dish design. However, the NTD team's assessment was that more development work was required and the proposed construction methods were labour intensive. Therefore, arrangements were made with Sydney University to acquire two disused 13.7 m parabolic dishes, complete with mounts, from the old Fleurs observatory. The antennas were installed at Marsfield in July 2005.

- In October 2004 MIT Haystack indicated their desire to look at ways of collaborating and sharing development costs between the MIT Low Frequency Demonstrator (LFD) project and the NTD project. At a meeting in Melbourne in November 2004 John Bunton and the MIT digital processing engineers agreed it was possible to create a common design for the digital subsystems that would meet the needs of both instruments despite some significant differences. Further, it was agreed this group should continue to work together. A white paper outlining a common, modular, extensible, digital signal processing architectural design for filterbanks, beamformers and a correlator which would satisfy the needs of both the NTD and the MIT Haystack LFD was completed in January 2005. These designs could also be used for the SKAMP project. Since then, a team from the CICT Centre has taken that design and translated it to an existing set of hardware. When fully assembled this will provide a twenty-four analogue channel, 24 MHz wide, digital beamformer which will be used for the initial experiments. The design and prototype of the discrete receiver that will be reproduced for each array element has been completed and a theoretical design for an LNA in Microwave Office has been produced.
- Negotiations have been completed with the University of Massachusetts for access to their Vivaldi design software and for assistance with its use. Negotiations are also underway with ASTRON to purchase a modified Thea tile/array consisting of 8x8 Vivaldi feed elements which will allow us to start our initial experiments without having to develop and make our own FPA from scratch. John O'Sullivan and Tim Cornwell have produced a document summarising the initial experiments that need to be conducted to understand issues relating to digital beamforming of focal plane arrays.

1.2.3.3. Monolithic Microwave Integrated Circuit (MMIC)

Activity during the past year was in two areas. The first was in the development of InP HEMT MMICs, mainly for millimeter wave applications for the ATCA. The second was concerned with the design of RF-CMOS integrated receiver MMICs operating at around 1 GHz.

InP HEMT MMICs

After a pause in the early part of the period due to staff commitments to the delivery of the 3mm receivers to the ATCA, work continued on the testing of packaged MMICs fabricated in the 2003 InP HEMT run. This included tests at cryogenic temperatures of an 85-115 GHz coplanar waveguide LNA MMIC and a 30-50 GHz LNA MMIC. Both of these devices showed good performance. The former will be used in the 3mm receiver being built for Mopra, while the latter is likely to find application in the 7mm upgrade of the ATCA.

New MMIC designs were prepared for submission in the April 2005 fabrication run. These included a new 3-stage 30-50 GHz LNA, 1-3 GHz and 4-8 GHz LNAs and the implementation of large format transistors for use in low frequency LNA designs, for example, a LNA for the NTD project. Plans for the design of an InP LNA MMIC for the NTD were abandoned after a study showed that the technology was unlikely to deliver the specified performance. A discrete design, possibly using large InP transistors, was considered to be a better alternative.

The new designs, plus repeats of successful earlier designs, were submitted for fabrication in April 2005. The wafers are expected to be returned in September 2005.

RF-CMOS Integrated receiver MMICs

The revised goal had been to submit for fabrication in December 2004 a design containing test structures for an integrated receiver. This was deferred until February 2005 to allow a re-appraisal of project aims to bring them more into line with the developing requirements of the NTD project. Further delays resulted from problems encountered in the chip layout process, such that the designs were finally submitted in April 2005. The chips became available for testing in July 2005. The overall schedule for this component of the project has slipped accordingly, with the final product now likely to be available in early 2007. As a result, they are unlikely to find application in the NTD project, but remain a core technology development for the xNTD.

Reduced scope of project

It has become clear over the past year or more that the scope of the MMIC project needed to be reduced from that originally planned. This is largely due to the fact that the expected requirement for the use of specially developed MMICs in the various SKA demonstrators has not eventuated. In particular, the CABB project, which was expected to benefit greatly from the application of MMICs, particularly in the sampler and data transmission areas, has been able to satisfy requirements from commercial sources.

1.2.3.4. SKA Molonglo prototype (SKAMP)

Progress has been constrained by the small project team and the need to simultaneously maintain and operate the aging telescope. However, the hardware and software for Stage 1 are complete and the system is now being commissioned and debugged. Fringes followed by images from the complete Stage 1 system are expected shortly. Planning, design and some implementation for Stages 2 and 3 has now commenced. Design and planning for the fibre optic network necessary for distributing the local oscillator and collecting all the digital data for Stages 2 and 3 is complete and implementation has started.

SKAMP is also considering how it might make use of components and subsystems being developed for the NTD project. Filterbanks and the spectral line correlator are prime candidates for sharing NTD designs. The existing concept design for the spectral line correlator is compatible with the modular, extensible correlator architecture that was developed by John Bunton of CSIRO in collaboration with digital engineers form the MIT Haystack LFD team.

In order to allow development and testing of the new line feed and associated beamformers and receivers required for Stage 3, without having to dismantle part of the telescope and disturb its operation, it was decided to duplicate two bays of the existing telescope for use as a prototype testbed. Construction of this Rapid Prototyping Telescope (RPT) is well underway.

Work is continuing on the development of the broadband line feed both from a theoretical and a practical approach. A four square-like pair of broadband dipoles has been chosen as the line feed element. Martin Leung has been working on perfecting low loss matching from this line feed element to the LNA, essential to keeping the system noise temperature low. Argus Technologies is working on the design of a line feed module which will house eight elements and which will clip in to replace the existing feeds. These will all be tested on the RPT. Meanwhile Sergiy Vinogradov has

been modelling the effects of the imperfect parabolic surface on the beam width and side-lobes as the beam is scanned to one side.

1.2.3.5. SKA siting

The SKA siting report is proceeding well. The end of 2004 was spent assembling and integrating the RFI test trailer. Problems with the software and in a key item of equipment delayed the final deployment of this solar powered system to Mileura by one month. However, the RFI testing work is now in the process of routine collection of data following deployment of the trailer at the end of January 2005. The measurement equipment has worked well with only minor problems:

- A low noise amplifier was damaged by lightning
- The measurements were shut down for a couple of days due to lack of battery power following an unusual week of overcast weather
- A hard disk failure caused some anxious moments until the data was recovered.

Work toward the development of the detailed siting proposal follows the formal "Request for Proposals for Siting the SKA", received from the International SKA Project Office in September 2004. The Western Australian Government, through the Office of Science Innovation, is fully participating in working on the response to the Request for Proposals and a special SKA taskforce was recently created. Government of WA Departments have been the main source of detailed information about mining, towns, roads, and land ownership that has been fed into Connell Wagner's GIS database.

The first task was to identify the best position for the SKA core site at the Mileura station. This was done during a visit to Mileura in January 2005 in consultation with the managers of the pastoral lease and the local indigenous native title claimants.

The second task has been to develop an array layout based around the chosen core site which followed the log spiral formula specified by the SKA simulations working group and which also avoided a set of no-go areas such as populated areas, active mines and tenements and areas subject to cyclones. After several iterations the array layout will soon be partially frozen. This will allow us to concentrate on obtaining and assessing data which are not available for the whole of WA and Australia; data which is only possible to obtain for a specific latitude and longitude.

1.2.3.6. SKA supercomputer simulation & baseband processing (SKASS)

We have now developed a range of software applications that utilise the computing facilities developed during the first two years of the project, including:

- pulsar processing software for use on the cluster at the Parkes radio telescope;
- a software cross-correlator for the Swinburne supercomputer that correlates data collected from Australian and international VLBI arrays;
- auto-correlation spectroscopy software that uses the cluster at the ATCA for RFI monitoring and characterisation studies.

Some of these facilities are now available to the broad radio astronomy community as enhancements to the Australia Telescope National Facility. In particular, a highlight this year was the inclusion of the Swinburne supercomputing facilities as part of the regularly available VLBI National Facility. Users can now propose for disk-based recording experiments using Australian and overseas radio telescopes that are correlated in software on the Swinburne supercomputer.

Other highlights of the third year of the SKASS project are:

- Completion of a highly flexible software correlator using the Swinburne supercomputer (both XF and FX architectures);
- Completion, in close collaboration with CSIRO, of a "fringe-check" mode for the software correlator that allows real-time fringes to be formed before every regularly scheduled VLBI experiment and verification of the experimental setup. This has eliminated significant data loss from VLBI experiments, making the VLBI array more robust and efficient;
- Inclusion of the disk-based VLBI systems and supercomputer based software correlation as part of the Australian VLBI National Facility. These systems allow an improvement in sensitivity of up to four over the current Australian tape-based VLBI system, giving improved efficiency for VLBI observations;
- Production of the first VLBI images of astronomical radio sources using the new disk-based recording systems and software correlator, involving an international array of 9 telescopes, in 4 countries, probably the most complicated disk-based VLBI observation yet attempted;
- A new project, funded by Cray and the State of Western Australia, to achieve high performance software correlation using the Cray XD-1 machine.
- Development of VLBI capability in New Zealand and the very first attempts at Trans-Tasman VLBI observations;
- Development of software, in collaboration with the International SKA Project Office, to generate estimates for the build cost of the SKA, available at: http://astronomy.swin.edu.au/~shoriuch/SKAcostsim/.
- Development of an online interface to the MIT Array Performance Simulator (MAPS) that can be used by remote users for defining and running SKA simulations, available at: http://astronomy.swin.edu.au/ska/Simulator/.
- Development of software to perform automated RFI monitoring and characterisation observations at the Australia Telescope Compact Array, test observations, and initial data reduction;
- Organisation of the 3rd Australian SKA simulations workshop, held at Swinburne, attended by participants from Australia and three other countries;
- Participation in the international site selection process, in particular the production and distribution of the SKA array configuration guidelines for international proposers by Steven Tingay in the role of Chair of the SKA Simulations Working Group and the Configuration Simulations Task Force. This work was undertaken under the banner of the International SKA Project Office, for Prof. Richard Schilizzi.

1.3. Milestones

1.3.1. Project Office

Task	Project plan	Status	Comments
Project plans to be in place, and MNRF participation deeds (one each between CSIRO, on behalf of the MNRF office, and each participant) to be signed	December 2002	Completed: June 2004	
New board composition to be agreed	June 2003	Completed: May 2003	Board formed September 2003.
Annual report to be provided to DEST	September 2004	Completed: December 2004	Delays occurred due to completion of auditors' reports.
AABoM to meet at least:	Four times per year	Four meetings were held.	

1.3.2. Gemini

1.3.2.1. Increased share of Gemini telescopes

Task	Project plan	Status	Comments
The agreement with Gemini will be signed by ARC, (ratifying Australia's increased share of 1.43%).	November 2003	Achieved: October 2003	Brazil is the only partner who has not signed, but this has not delayed new shares coming into effect.
Australian astronomers will have access to an increased number of nights on Gemini	January 2003	Achieved: February 2003	Thirteen hours of extra time now available on each of the Gemini telescopes per observing semester.
A decision will be made on the strategic use of the balance of the MNRF Gemini funding	June 2004	Achieved: June 2004	The balance will primarily be used to purchase additional nights from the UK during 2005 and 2006

1.3.2.2. RSAA Gemini instrumentation

Task	Project plan	Status	Comments
1. Complete each of the remaining milestones for the completion of the	December 2004		NIFS completion. The NIFS science detector failed in late 2004. This

Near-infrared Integral-Field Spectrograph (NIFS)			has been replaced with a HAWAII-2RG detector with subsequent project delays. Acceptance tests are now scheduled to begin in July 2005.
2. Deliver NIFS to Gemini	February 2005	Revised: August 2005	
3. Successfully commission NIFS on Gemini North	June 2005	Revised: October 2005	Dependent on telescope availability
4. Award of a new instrument contract from Gemini	July 2004	Completed: November 2002	Instrument is Gemini South Adaptive Optics Imager (GSAOI)
5. Contingent on 4 above, complete each of the milestones associated with the design and construction of GSAOI (see a to e below)	September 2005	Revised: February 2006	Delayed due to failure of the NIFS detector and a GSAOI multiplexer.
5a. Approval of operational concept definition document and functional and performance requirements document by the US Association of Universities for Research in Astronomy (AURA)		Completed: May 2003	New milestone, added after project plan.
5b. Completion of ordering all optical elements		Completed: January 2004	New milestone, added after project plan.
5c. Completion of critical design review		Completed: October 2003	New milestone, added after project plan.
5d. Completion of cryostat and integration frame		Completed: March 2004	New milestone, added after project plan.
5e. Completion of first cool down with mechanisms.	August 2004	Completed: May 2005	New milestone, added after project plan.
6. Contingent on 4 above, deliver GSAOI	November 2005	Revised to: February 2006	
7. Contingent on 4 above, successfully commission	May 2006	On schedule	Commissioning date is dependent on telescope

GSAOI.			availability.

1.3.2.3. AAO instrumentation

Task	Project plan	Status	Comments
Provide back-office support for Gemini-related activities in Australia.	30 March and 30 September each year.	On schedule	Support provided at agreed level.
Pre-concept study for the Wide-Field Multi-Object Spectrograph (WFMOS).	June 2003	Completed: June 2003	
Complete Ukidna concept study for prototype of WFMOS.		Halted: December 2003	New milestone, added after project plan. Task halted as Gemini decided to seek WFMOS feasibility study. Results of Ukidna study documented.
Submit proposal for feasibility study for WFMOS.		Completed: March 2004	New milestone, added after project plan.
WFMOS feasibility study contract to be signed and study to begin.	July 2004	Completed: July 2004	New milestone, added after project plan.
WFMOS feasibility study submitted to Gemini.	February 2005	Completed: March 2005	New milestone, added after project plan.
Astrophotonics – Phase 2	June 2006	Awaiting start	New milestone, added after project plan.
Starbugs – Phase B	June 2006	Awaiting start	New milestone, added after project plan.

1.3.3. SKA

1.3.3.1. AT compact array broadband backend (CABB)

Task	Project plan	Status	Comments
Commencement of project	January 2002	Completed: January 2002	
Demonstration of DFB spectrometer	October 2003	Completed: January 2004	
Installation of 256MHz DFB at Mopra	July 2004	Completed: July 2004	
Completion of 2 GHz	March 2005	Revised:	

DFB (digital filterbank)		July 2005	
Testing of prototype photonic data transmission system	February 2004	Revised: October 2005	
Testing of prototype conversion system	October 2004	Revised: October 2005	
Commencement of final production	January 2006	Revised: March 2006	
Six antenna ATCA operational with new backend.	January 2006	Revised: June 2007	
Completion of integration of NTD into ATCA system.	July 2006	On hold.	NTD project now considering sites other than Narrabri.
Broadband ATCA tied array operational.	July 2007	Revised: September 2007	NASA 7mm tracking will use existing backend for initial operations.

1.3.3.2. New technology demonstrator (NTD)

Task	**Project plan**	**Status**	**Comments**
Establish cross-divisional collaboration (CTIP, CMIT, CMS, ATNF) to investigate possible low loss and density composite dielectric materials.	December 2001	Completed	
Develop analysis and design software for spherical lenses	June 2002	Completed	
Demonstrate low-loss dielectric with values suitable for spherical lens.	June 2003	Completed	
Complete design of prototype spherical lens and wideband feed.	June 2003	Completed: November 2003	
Test hybrid array / lens system using FARADAY phased array	June 2003	Completed: February 2003	
Develop signal transport model based on LOFAR and SKA specifications.	June 2003	Completed: July 2003	
Develop wideband beam-former concept using	June 2003	Completed: July 2003	"A Baseband Receiver Architecture for Medium-

direct digital sampling.			N SKA", Ferris, D., SKA2003, Geraldton, WA, 2003
Complete construction of prototype spherical lens and wideband feed.	June 2003	Completed: December 2003	
Complete EM testing on prototype lens. Evaluate test results.	June 2004	Completed	Hayman, D and Li, L., "Measurement of a Prototype CSIRO Luneburg Lens", CSIRO ICT Centre Publication Number 04/1819
Develop business plan for possible commercialization of dielectric / lens technology	June 2004	Revised: September 2004	Draft business plan being circulated. Commercial negotiations in progress.
Decision point on further development work on spherical lenses.	June 2004	Completed	
Demonstrate high-speed direct digital sampling and polyphase filter bank technology.	June 2004	Completed	
Decide choice of NTD concept (lens; lens + array; phased array)	June 2004	Completed	NTD will be a phased array-based system. Project plan being updated.
Develop complete EM analysis of lens plus integrated feed.	June 2004	Cancelled	The NTD project is now working to a new plan with revised milestones.
Stage 1: NTD design and development of proof-of-concept prototypes.	June 2005	Cancelled	
NTD PDR. Stage 2: NTD design & development.	June 2005	Cancelled	
NTD CDR. Stage 3: NTD development & construction.	June 2006	Cancelled	
Complete NTD construction.	June 2007	Cancelled	
Sufficient LNAs available	July 2005	Revised: September 2005	LNA design was completed at the end of 2004/05.

Final testing of RFCMOS chips	September 2005	Behind schedule.	
Control & Monitor software complete for testing @ Marsfield	September 2005		
FPA prototype testing & characterisation complete	November 2005	Revised: January 2006	
Critical Design review (CDR) – ie Detailed Design Complete	December 2005	Revised: March 2006	
NTD Project Completion and Demonstration	June 2007		

1.3.3.3. Monolithic Microwave Integrated Circuit (MMIC)

Task	**Project plan**	**Status**	**Comments**
Submit designs for first (InP) fabrication run.	March 2003	Completed March 2003	
Submit designs for second (sample and hold circuit) fabrication run.	April 2004	No longer required.	Commercial devices are now available that negate this sampler development.
Submit designs for integrated receiver prototypes	April 2004	Completed: April 2005	
Submit designs for integrated receiver assemblies	November 2004	Revised: January 2006	
Begin production fabrication of integrated receivers	January 2005	Revised: July 2006	
First devices (integrated receivers) available for integration into demonstrators	December 2004	Revised: March 2007	
Submit designs for third (stage 2 InP) fabrication run	January 2005	Completed: April 2005	
Final devices (samplers) available for integration into demonstrators.	December 2005	No longer required.	Commercial devices are now available that negate this sampler development.
Complete final integration of devices into demonstrators	December 2006	Cancelled	To be reported in relevant demonstrator project.

1.3.3.4. SKA Molonglo prototype (SKAMP)

Task	Project plan	Status	Comments
Test continuum correlator design	December 2003	Completed: May 2004	Delayed due to limitations with the PCB manufacturer.
Appoint RF Engineer	March 2004	Completed: June 2004	RF Engineer: Adrian Blake
Design concept for spectral line correlator	May 2004	Completed: December 2004	Top level logic design complete; final detailed design dependent on results from continuum correlator testing, causing delay.
Fringes from 96-station continuum correlator	June 2004	Revised to: July 2005	Fringes achieved with interim correlator and a selection of single baselines.
Update SKAMP scope of project document	June 2004	Completed: June 2004	
Complete design of spectral line correlator	September 2004	Delayed	New milestone added during 2004/05
Filters and correlator boards manufactured	May 2005		New milestone added during 2004/05
Optic fibre installation implemented	June 2005	Revised: July 2005	New milestone added during 2004/05

1.3.3.5. SKA siting

Task	Project plan	Status	Comments
Establish clear contact points between WA Office of Science and Innovation) and ATNF.	June 2003	Completed	
Produce CDROM characterising the Mileura Station site with detailed information on landform, vegetation, geology etc	June 2003	Completed	
Discuss with relevant bodies issues of native title, planning permission, EIA etc in relation to the Mileura site.	June 2003	Completed	
Produce Australian Initial Site Analysis Document	June 2003	Completed	

for submission to ISSC.			
Meet with key science groups in WA capable of supporting SKA.	June 2003	Completed	
Organise international SKA Meeting in Geraldton and ISSC visits to Mileura site.	July 2003	Completed	
Respond to ISSC on initial site analysis document.	June 2004	Completed: December 2003	
Establish a process for selecting the best SKA site within Australia.	December 2003	Revised: September 2004	Draft procedure and selection criteria already produced. Awaiting final RFP from ISSC.
Choose one “reference site” for further evaluation.	October 2003	Completed: October 2003	ASKACC chose Mileura Station, WA as the reference site.
Ensure an adequate international RFI testing procedure.	June 2004	Completed	
Stage 2: Initiate extended RFI tests to be conducted remotely over a full year, at the reference site.	June 2004	Completed: January 2005	
Choose whether Mileura site will be the Australian SKA site.	October 2004	Completed: December 2005	
Prepare final submissions for SKA siting if required	June 2005	Revised: December 2005	
Respond to ISSC on site submission if required	June 2005	Revised: March 2006	
Complete RFI tests to be conducted remotely over a full year, at the reference site.	June 2005	Revised: March 2006	Revised date agreed to by the International SKA Steering Committee.
Interact with ISSC to ensure that Australian site is selected as SKA site	June 2006	Revised: September 2006	
Evaluate siting project and identify improvements	June 2006	Revised: October 2006	

1.3.3.6. SKA supercomputer simulation & baseband processing (SKASS)

Task	Project plan	Status	Comments
SUT SKA workforce established.	June 2003	Completed	
SUT and Parkes supercomputer operational	June 2003	Completed	
Initial simulations of baseband data including RFI	June 2003	Completed	
Completion of a two-station software correlator running on the SUT supercomputer	June 2003	Completed	
Investigation of new ATNF digital filter bank	June 2003	Completed	
A meeting of Australian groups undertaking SKA simulations	June 2003	Completed	
Participation in global coordination of SKA simulation activities	June 2003	Completed	
Software correlator operational	June 2004	Completed	
Workstation cluster to Narrabri	June 2004	Revised: October 2004	
A baseband recording system that can be deployed at any Australian radio telescope	June 2004	Completed	
A meeting of international groups undertaking SKA simulations	June 2004	Completed: July 2003	
Establish the MIT/Haystack simulation software package as the standard SKA simulation package	June 2004	Revised: October 2004	
Complete development of the LOFAR package as the standard simulation package for SKA	June 2005	Cancelled	These three milestones have now been replaced by the five new milestones listed below. These

Software correlator integrated with array configuration studies	June 2005	Cancelled	modifications have been in response to several new opportunities within Australian SKA-related projects and within the international SKA project.
RFI mitigation studies at Parkes and the ATCA	June 2005	Cancelled	
Develop MIT/Haystack simulation package to be suitable for SKA studies.	June 2005	Completed	
Use clusters at Parkes and ATCA, in conjunction with the baseband recorders, to conduct RFI surveys at these two sites.	June 2005	Revised: September 2005	The only outstanding task is to make the archived baseband RFI survey data available via an online interface.
Use cluster at ATCA to process pulsar observations and measure suitability of the ATCA tied-array for pulsar observations.	June 2005	Revised: January 2006	
Use software correlator, baseband recorders and supercomputing facilities to prove the concept of e-VLBI using an array of Australian radio telescopes.	June 2005	Completed	
Develop software to calculate SKA cost based on parameters provided by all international SKA consortium members and guidelines set by the International Engineering Management Team.	June 2005	Completed	
Demonstrate RFI mitigation in simulated and real data	June 2006	On schedule	These two milestones have now been replaced by the six new milestones listed below.
Real and simulated spectral line observations with RFI mitigation	June 2007	On schedule	
Software correlation for eVLBI. as part of first eVLBI experiments.	June 2006		New milestone
Configuration studies for national and international	June 2006		New milestone

SKA site selection process, leading to the submission of the Australian site proposal in December 2005 and the evaluation of internationally proposed configurations as part of site proposals by June 2006.			
Development of RFI monitoring and characterisation hardware and software at the ATCA. Continuation of RFI observations and provision of data to ATCA users.	June 2006		New milestone
Support on-going eVLBI National Facility observations with software correlator.	June 2007		New milestone
Continue SKA simulations as part of international project.	June 2007		New milestone
Complete write-up and publication of results obtained throughout the course of the Swinburne MNRF program.	June 2007		New milestone

2. Research, access & collaboration

2.1. Facility's access regime

2.1.1. Gemini

All Australian astronomers are eligible to apply for time on the Gemini telescopes. Proposals are evaluated on the basis of scientific merit by the Australian Time Allocation Committee, which oversees time allocation on all optical/infrared national-access telescopes. There is no direct charge for access to the Gemini telescopes and the telescopes are not used for commercial purposes.

When new instruments, such as those being developed by the Research School for Astronomy and Astrophysics and the Anglo-Australian Observatory, are commissioned on the Gemini telescopes, they will be available to all Gemini consortium astronomers, including Australian astronomers.

2.1.2. SKA

As the SKA will not be operational for many years, there is currently no defined access regime. However, the Australian facilities that are being developed or enhanced as part of the SKA planning phase have the following access regimes:

- Australia Telescope Compact Array: Proposals for observing time are allocated by the Australia Telescope National Facility's time assignment committee on the basis of scientific merit.
- Molonglo prototype: Proposals for observing time will be allocated by the Australia Telescope National Facility's time assignment committee.
- The 30% of the Swinburne supercomputer (and all associated software) available for SKA-related work is fully open to all users and access can be arranged by contacting the SKASS project leader. In addition, the Swinburne software correlator and VLBI equipment are now included in the Australian VLBI National Facility. As such, users can propose to use the Swinburne facilities via the normal ATNF call for proposal and proposal peer review processes, as of June 2005. Users are not charged for access to the facility

2.2. Collaboration and linkages

2.2.1. Gemini

- NIFS: Auspace Ltd.
- WFMOS: Durham, Oxford, Johns Hopkins and Portsmouth Universities, US National Optical Astronomy Observatory and the Canadian Astronomy Data Centre
- Starbugs: The University of Technology Sydney, the Australian ARC Centre of Excellence for Autonomous Systems Collaboration, and the European Union's Optical Infrared Coordination Network for Astronomy (principally through the UK Astronomy Technology Centre).
- Astrophotonics Optic Fibres: Polymicro Technologies Inc, Optical Fibre Technology Centre, and Crystal Fibres in Denmark.

- Astrophotonics OH suppression: Redfern Optical Components for Fibre Bragg grating work, and the University of Bath for MMF to SMF conversion.

2.2.2. SKA

- CABB: Xilinx
- NTD: MIT Haystack observatory, South African SKA team and ASTRON (Netherlands Foundation for Research in Astronomy).
- MMIC: Northup Gruman Space Technologies, IRA Bologna, JBO, ASTRON, Macquarie University and IBM.
- Suzy Jackson attended the European Microwave Week in Amsterdam in October 2004. This resulted in useful interaction with EU colleagues with good feedback on her integrated receiver designs and their relevance to the SKA.
- SKASS: Cray computer Pty Ltd, Auckland University of Technology, National Radio Astronomy Observatory (USA), University of Western Sydney, Massachusetts Institute of Technology, Haystack Observatory, Communications Research Laboratory (Japan), Hartebeesthoek Radio Astronomy Observatory (South Africa), Japan Aerospace Exploration Agency and the Institute of Space and Astronautical Science.

2.3. Facility's contribution to research and training

2.3.1. Gemini

The Gemini telescopes are playing an important role in the training of Australian postgraduate students. In 2004-5, 66% of the proposals received had Australian PhD student involvement.

Papers to date published in refereed journals (Australian authors in bold):

- Kalirai, J.S., Richer, H.B., Reitzel, D., Hansen, B.M.S., Rich, R.M., Fahlman, G.G., **Gibson, B.K.**, von Hippel, T. (2005). "The Initial-Final Mass Relationship: Spectroscopy of White Dwarfs in NGC 2099 (M37)", *Astrophysical Journal (Letters)*,618, p. L123-L127.
- **Da Costa G.S.** (2004). "The Stellar Populations of dE Galaxies in Nearby Groups", *Publications of the Astronomical Society of Australia*, 21, p. 366-370.
- Smith J.K., Bunker A.J., Vogt N.P., Abraham R.G., Aragon-Salamanca A., Bower R.G., Parry I.R., **Sharp R.S.**, Swinbank A.M. (2004). "H-alpha Kinematics of a z~ 1 Disc Galaxy from Near-infrared Integral Field Spectroscopy", *Monthly Notices of the Royal Astronomical Society*, 354, p. L19-L23.
- de Grijs R., Smith L.J., Bunker A., **Sharp R.G.**, Gallagher J.S., Anders P., Lancon A., O'Connell R.W., Parry I.R. (2004). ``CIRPASS Near-infrared Integral-Field Spectroscopy of Massive Star Clusters in the Starburst Galaxy NGC 1140", *Monthly Notices of the Royal Astronomical Society*, 352, p. 263-276.
- **Croom, S.M**., Schade, D., **Boyle, B.J**., Shanks, T., Miller, L., Smith, R.J. 2004, ApJ, 606, 126. "Gemini Imaging of QSO Host Galaxies at z~2".
- Stanway, E.R., Glazebrook, K., Bunker, A.J., Abraham, R.G., Hook, I., Rhoads, J., McCarthy, P.J., **Boyle, B., Colless, M.**, Crampton, D., **Couch, W**., Jorgensen, I., Malhotra, S., Murowinski, R., Roth, K., Savaglio, S., Tsvetanov, Z. 2004, 604,

L13. “Three Lyα Emitters at z~6: Early GMOS/Gemini Data from the GLARE Project”.

- **Forbes, D**., Favio, R.F., Forte, J.C., Bridges, T., **Beasley, M.A**., Gebhardt, K., Hanes, D.A., Sharples, R., Zepf, S.E. 2004, Mon. Not, Royal, Astr. Soc., in press. “Gemini/GMOS Imaging of Globular Clusters in the Virgo Galaxy NGC4649 (M60)”.
- Sharp R.G., Parry I.R., **Ryder S.D.**, Knapen J.H., Mazzuca L.M. (2004). ``Age-dating a Star-Burst with GEMINI/CIRPASS Observations of the Core of M83", *Astronomische Nachrichten*, 325, p. 108-111.
- Smith V.V., Hinkle K.H., Cunha K., Plez B., Lambert D.L., Pilachowski C.A., Barbuy B., Melendez J., Balachandran S., **Bessell M.S.**, Geisler D.P., Hesser J.E., Winge C. (2002). ``Chemical Abundances in 12 Red Giants of the Large Magellanic Cloud from High-Resolution Infrared Spectroscopy", *Astronomical Journal*, 124, p. 3241-3254.
- Davidge T.J., **Da Costa G.S.**, Jorgensen I., Allington-Smith J.R. (2002). ``The M31 Dwarf Spheroidal Companion Andromeda V: g', r', and i' Imaging with the Gemini Multi-Object Spectrograph on Gemini North", *Astronomical Journal*, 124, p. 886-895.

Paper submitted for publication:

- **J. Bland-Hawthorn, M. Vlajic, K.C. Freeman,** B.T. Draine (2005). ``NGC 300: An Extremely Faint, Outer Stellar Disk Observed to 10 Scale Lengths", Astrophysical Journal, in press.
- **Randall B. Wayth**, **Matthew O'Dowd**, **Rachel L. Webster** (2005). ``A Microlensing Measurement of the Size of the Broad Emission Line Region in the Lensed QSO 2237+0305", *Monthly Notices of the Royal Astronomical Society*, in press.
- **Melatos, A**., et al. 2005, ApJ. “Rapid Variability of Subarcsecond Shock Structure in the Crab Nebula”.

In addition, Gemini instrument development has resulted in the following:

- McGregor, P. J., Hart, J., Stevanovic, D., Bloxham, G., Jones, D., van Harmelen, J., Griesbach, J., Dawson, M., Young, P., & Jarnyk, M. 2004, SPIE, 5492, 1003-1044: “Gemini South Adaptive Optics Imager”
- Stevanovic, D., & Hart, J. 2004, SPIE, 5495, 305-313: “Cryogenic Mechanical Design of the Gemini South Adaptive Optics Imager (GSAOI)”
- Bland-Hawthorn, J., Englund, M.A. & Edvell, G., New approach to atmospheric OH suppression using an aperiodic fibre Bragg grating, Optics Express 24:12 (2004)
- Leon-Saval, SG, Birks, TA, Bland-Hawthorn, J, Englund, M., Multimode fibres with single mode performance (2005), Optics Letters, submitted (April 2005)
- Haynes, R., and 4 colleagues, New age fibers: the children of the photonic revolution (2004), SPIE 5494, 586-597
- Bland-Hawthorn, J., and 4 colleagues, Honeycomb: a concept for a programmable integral field spectrograph (2004), SPIE 5492, 242-250

2.3.2. SKA

Russell Gough presented a paper titled “MMICs for the Australia Telescope mm-wave receiver system” at the GASS Symposium of the European Microwave Week in Amsterdam in October 2004. Vinogradov presented simulations of the new feed at the International Conference on Antenna Theory (ICATT05) in Kiev, Ukraine in May 2005. The paper will appear in the Conference Proceedings. A paper has also been accepted to the next URSI Conference to be held in October, 2005, in Delhi, India. Other papers include:

- Horiuchi, S. et al. 2005, in preparation. “The structure and evolution of the parsec-scale jet in J0006-0623 from global VLBI observations”;
- Takeuchi, H. 2005, in National Institute of Information and Communications technology (Japan), Technology Development Center News, #24, p 9. “Development of software baseband converter”
- Dodson, R. Tingay, S.J. et al. 2005, in National Institute of Information and Communications technology (Japan), Technology Development Center News, #24, p 18. “The Australian experience with the PC-EVN recorder”
- Dodson, R., Tingay, S.J. et al. 2005, in proceedings of the 7th EVN symposium (Eds Rafael Bachiller, Francisco Colomer, Jean-Francois Desmurs, and Pablo de-Vicente), p 253. “The Australian experience with the PC-EVN recorder”
- Koyama, Y. et al. 2005, in proceedings of 19th Asia Pacific Advanced Networks meeting (APAN) 2005. “e-VLBI with the high speed international research networks”
- Green, Kesteven, Campbell-Wilson, Adams, Bunton, Leung, Sadler & Hunstead: "The SKA Molonglo Prototype (SKAMP) Project - Progress Report" Oral and poster presentation made to SKA2004 conference in Penticton, Canada, July 2004.
- Leung, Vinogradov, "Progress towards a wide-band line feed for the Molonglo SKA Demonstrator", SKA2004, Penticton, Canada.
- Rondineau, Nosich, Daniel, Himdi, Vinogradov, "MAR Analysis of a spherical-circular printed Antenna with finite ground excited by an axially symmetric probe", IEEE Transactions on AP, 52, May 2004.
- Smith, Vinogradov, Vinogradova, "Rigorous analysis of extremely large spherical reflector Antennas, 2004 URSI International Symposium on Electromagnetic Theory", May 2004, Pisa, Italy.
- Vinogradova, Vinogradov, Smith, Rigorous analysis of extremely large spherical reflector Antennas: EM case, European conference for Mathematics for Industry (ECMI), June 2004, Eindhoven, Netherlands.
- Vinogradov, Green, Campbell-Wilson, Leuing, Vonogradova, Bunton, Kesteven, "Comparative Analysis of Cylindrical Reflectors of Ideal andApproximately Parabolic Shape", the International Conference on Antenna Theory (ICATT05), Kiev, Ukraine, May 2005.

2.4. Contribution to Australian industry

Please refer to the commercial Australian partners listed in 2.2 for a list of companies whose R & D has been stimulated by the new technology developments mentioned in this report.

3. Promotion of the facility

The Project Office hosted a Gemini and SKA MNRF symposium on 7th June 2005. The symposium was open to all members of the astronomical community, and was the main event during the financial year for promoting the MNRF.

3.1. Gemini

The major focus of the National Gemini Office's outreach efforts this year has been reaching out to the Australian astronomical community, to advertise the increased time available, increased completion rate of programs and wide range of new instruments that will be commissioned in 2005/06. The project scientist made a national tour, giving talks about Gemini to people from nine institutions in four states and territories.

GSAOI and Starbug technologies were presented at the 2004 meeting of the Society of Photo-optical and Instrumentation Engineers in Glasgow.

A number of presentations were given over the past 12 months that relate to the AAO MNRF program, these are as follows:

- New age fibers: the children of the photonic revolution (2004), SPIE 5494, 586-597, Haynes, R., and 4 colleagues
- Instrument science at the Anglo-Australian Observatory (2004), SPIE 5492, 1678-1688, Bland-Hawthorn, J.
- Honeycomb: a concept for a programmable integral field spectrograph (2004), SPIE 5492, 242-250, Bland-Hawthorn, J., and 4 colleagues
- All-silica fiber with low or medium OH-content for broadband applications in astronomy (2004), SPIE 5494, 598-609, Ferwana, S., and 6 colleagues
- Starbug: enabling the smart focal plane (2004), SPIE 5495, 600-610, McGrath, A. and A. Moore
- A survey of fiber-positioning technologies (2004), SPIE 5495, 348-359, Smith, G., and 5 colleagues
- The MOMFOS fiber positioner (2004), SPIE 5492, 1835-1845, Moore, A. M. and A. J. McGrath
- Ukidna: the RAVE machine (2004), SPIE 5492, 353-363, McGrath, A. J., W. Saunders, F. Watson, and S. Miziarski
- Prototyping results for a wide-field fibre positioner for the Giant Segmented Mirror Telescope (2004), SPIE 5382, 755-762, Moore, A. and A. McGrath
- Instrumentation at the Anglo-Australian Observatory (2004), SPIE 5492, 75-81, Barden, S. C.
- KAOS: kilo-aperture optical spectrograph (2004), SPIE 5492, 364-372, Barden, S. C., A. Dey, B. Boyle and K. Glazebrook
- Wide-field corrector with ADC compensator and image stabilizer for f/1.7 Gemini telescope prime focus (2004), SPIE 5492, 841-851, Liang, M., S. C. Barden and R. Robles
- Echidna: the engineering challenges (2004), SPIE 5492, 1228-1242, Bzreski, J. K., and 7 colleagues

- "Photonics in Astronomy," Univ. of Bath, June 2004
- "Photonics in Astronomy," Photonics Showcase, U. Sydney, Nov 2004
- "Astrophotonics," Univ. of Texas, Dec 2004
- "In search of the Dark Ages: New Technologies and New Ideas," UC Irvine, California, May 2005

In addition, several websites are maintained, including:

- http://www.ausgo.anu.edu.au/
- http://www.mso.anu.edu.au/~nifs/
- http://www.mso.anu.edu.au/~gsaoi/

3.2. SKA

The six projects within the Astronomy MNRF involved with SKA continue to work with international partners to position Australia at the forefront of SKA. For example:

- The CABB project engineer was invited to give a presentation at an EU Radionet workshop on digital backends held in Bonn, Germany in September 2004;
- The concept for the NTD was presented at the international 2004 SKA meeting by Professor Ron Ekers, and gained considerable international attention, as evidenced by the subsequent approaches by the South Africans and Canadians for collaboration, as discussed above;
- 3rd Australian SKA simulations workshop in September 2004;
- Dr Steven Tingay organised a summer school on radio astronomy and a radio astronomy workshop on Trans-Tasman VLBI in Auckland in March 2005.
- Dr Steven Tingay co-organised a VLBI operations and e-VLBI workshop for Australian collaborators in Hobart in February 2004;
- Mr Craig West gave research morning tea talk at NRAO, Socorro in July 2004, on software correlators for VLBI;
- Dr Steven Tingay gave ICT Faculty seminar on the Swinburne SKA project in December 2004;
- Tingay, Ogley, Horiuchi, various oral and poster presentations as part of SKA2004, International SKA Workshop, July 2004 (Penticton, Canada);
- Tingay SSWG presentation to the ISSC meeting in Penticton, July 2004;
- Tingay presentation to Auckland University of Technology SKA forum, December 2004;

There has also been extensive consultation and promotion of the Site Proposal and the proposed SKA telescope:

- July 18-22, 2004. Poster presented to SKA 2004 on Mileura Widefield Array.
- August 13, 2004. Federal Government Forum on Radio-quiet Zones.
- November 11-12, 2004. Presentation to MWA wokshop in Melbourne.
- January 10 -14, 2005 Week long show and tell trip with the WA Mid West Development Commission visiting the Murchison Shire Council, the Pia Wajarri Community, the Meekatharra Shire Council, the Cue Shire Council and the Combined Universities at Geraldton.
- January 31, 2005. Presentation to WA SKA Advisory Committee on SKA.

- February, 2005. Presentation to Wajarri Elders Working Group meeting at Yalgoo, WA.
- April 5, 2005. Presentation to Perth office of Yamaji Land and Sea Council.
- April 18, 2005 Address public meeting at the Murchison Shire Council.
- May 2, 2005. BJB presentation to media and parliamentarians at Scitech SKA meeting.
- May 2, 2005. Presentation to WASKAAC.
- May 4, 2005. Presentation to WA industry representatives at OSI on SKA.
- Regular presentations were made by Green to technical meetings held at the Radio Astronomy Laboratory, UC Berkeley, in the second half of 2004, as part of her sabbatical leave taken at Berkeley.
- Green, Kesteven and Bunton attended the SKA2004 Conference and presented posters and gave short oral presentations.
- Invited seminars were given by Green at University of California, Berkeley (Oct 2004) and VLA Operations Centre, NRAO, Socorro, New Mexico (Sept 2004). Opportunities to revive collaboration with the Electrical Engineering Department at the University of Sydney are actively being sought. This has also opened collaborative possibilities with researchers in the United Kingdom.

In addition to the professional activities listed above, some examples of public talks and press coverage include:

- Tingay lecture to Mornington Peninsula Astronomical Society in August 2004;
- Tingay lecture to Eaglehawk Senior Secondary College in Bendigo, August 2004;
- Tingay lecture to Bendigo District Astronomical Society in August 2004;
- Craig West lecture to Ballarat Astronomy Society and Ballarat Amateur Radio group, October 2004;
- Tingay lectures to Bendigo Senior Secondary College in April 2005;
- Tingay lecture to Bendigo District Astronomical Society in April 2005.
- Computerworld magazine: http://www.computerworld.com.au/index.php?id=1226084576, July 2004;
- Tingay interviewed on ABC Victorian regional radio, August 2004;
- Newspaper article in Bendigo Advertiser in August 2004;
- Tingay interviewed on ABC Victorian regional radio, April 2005;
- Two newspaper articles in Bendigo Advertiser in April 2005.

4. Commercialisation

The OH suppression developments that are flowing from the Anglo-Australian Observatory's instrumentation project have commercial potential. The new MMF to SMF converter allows a wide range of photonic actions to take place within a multimode fibre. This allows for the first time MMF coupling performance with SMF photonic capability, a function which is likely to have application across a wide industrial and science base. Beyond astronomy, the AAO have identified, and are investigating, four key areas for possible application:

- Local area networks
- Medical imaging
- Passive and active sensors
- New enabling technologies for space-based instruments

In addition, progress towards commercial applications of the Luneberg lens technology, developed at an earlier stage of the NTD project, is continuing.

5. Compliance with biological & radiation safeguards

Both the Gemini and SKA facilities are purely for astronomical research and associated technological developments. This work is not normally considered contentious in terms of science ethics, environmental risks, or danger to participants or others.

The Gemini Observatories have fulfilled all environmental requirements for their operation, as have the facilities of the Australia Telescope. Any expansion of Australia Telescope activities beyond the existing sites will be subject to an environmental impact study.

Site selection studies for the SKA in Western Australia are in collaboration with the Office of Science and Innovation and local leaders of the Aboriginal community.

6. Financial report

6.1. Financial summary

As indicated in the 2003/04 annual report, “the MNRF continued to significantly under-spend due to a number of projects running behind schedule. The board will be taking steps in 2004/05 to rectify these scheduling issues.” The board has now approved an updated budget covering all projects (see appendix A) and formal approval for this revised budget from DEST is pending.

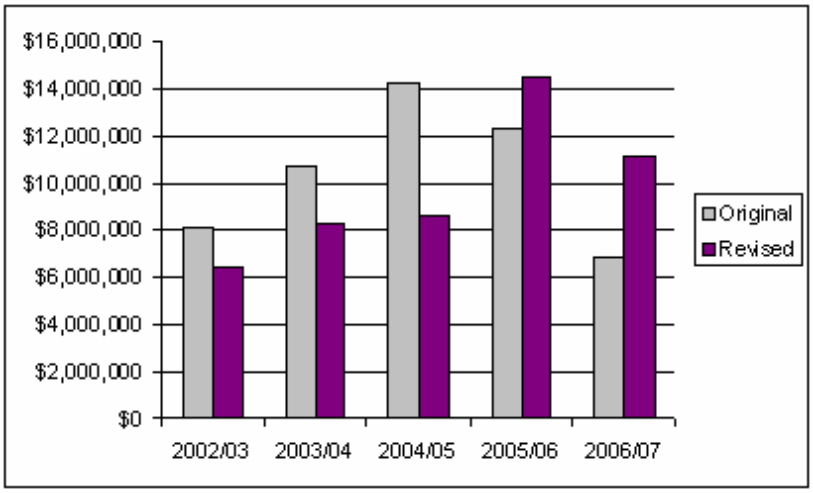


Figure 2: Revised expense budget .v. original expense budget

The updated budget was developed in the third quarter of 2004/05, and therefore was expected to provide an accurate forecast for the 2004/05 financial year. However, as normal, the MNRF accounts for the year were distributed across six organisations, increasing the complexity in conducting budget updates. Therefore, the variation of actual expenditure in 2004/05 against the revised budget of only 3.6%[3] is extremely reassuring, and indicates good communication between the Project Office and the MNRF participants.

The revised budget plans for a significant increase in expenditure 2005/06, addressing the commitment made in the 2003/04 annual report to have a plan to get the MNRF back on track for completion of its goals by the end of the MNRF in June 2007.

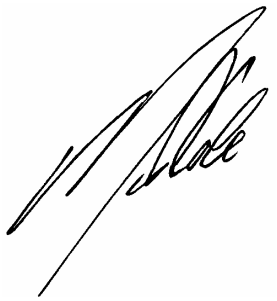
During the re-budgeting process, mistakes in the accounting of the MNRF revenue by CSIRO were discovered. These errors were brought to the attention of CSIRO’s corporate finance team, and the mistakes were corrected. From an MNRF perspective the primary problem was in the overstatement of the contributions made by CSIRO to the MNRF, with some of the original budget numbers being reported instead of actual contributions. The revenue aspect of the financial tables (section 6.2) for 2002/03 and 2003/04 has therefore been updated to reflect the actual contributions. However, it should be noted that this accounting error did not impact on the reporting of MNRF expenditure to-date, nor does it change the contributions that CSIRO will make to the MNRF over the life of the program. CSIRO will contribute to the MNRF during the remaining years of the MNRF to ensure it meets in full its matching obligations.

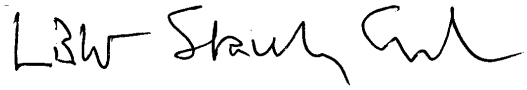
[3] Actual of $8,360,736 against a budget of $8,669,567

The major outstanding issue from a revenue perspective is a budgeted $1,500,000 contribution to the MNRF from the Sydney University Trust Fund. This amount was provided to the Trust Fund by the ARC to cover for currency fluctuations. At the end of 2004/05 discussions were underway to determine if this contribution will be made to the MRNF, or if it will continue to be held as a contingency to cover for future currency fluctuations. However, from an overall MNRF perspective, interest earned and increased contributions by some participants, means that the MNRF will still meet its committed matching contributions from participants even if this $1,500,000 is not made available.

An improvement this year in the area of financial management was the co-ordinated audit of the MNRF. The auditors, BDO, visited all active participants and produced a consolidated audit report for the MNRF (see section 6.3). This provides a much clearer picture of the MNRF finances compared to previous annual reports.

As confirmed by the auditor's report (section 6.3) all expenditure of the MNRF grant has been solely on the Facility in accordance with the Facility business plan.





Dr Martin Cole
Chairman
30th September 2005

Dr Lister Staveley-Smith
Director
30th September 2005

6.2. Financial tables

6.2.1. In-Kind Contributions from Participating Parties

Table 1

In-Kind Contributions from Participating Parties ($'000s)

Participating Party	Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	Agreement 2005/2006	Agreement 2006/2007	Cumulative Contributions (Total to Date - Actual)	Cumulative Contributions (Total to Date - Agreement)	Projected Grand Total 5 Years	Agreement 5 Years	Difference over 5 Years
CSIRO ATNF														
Salaries		760		830		830	-2,420	340	230	0	2,420	570	2,990	-2,420
Capital		0		0		0	0	0	0	0	0	0	0	0
Other	550	250	506	280	567	280	813	120	80	1,623	810	1,823	1,010	813
Total	550	1,010	506	1110	567	1110	-1,607	460	310	1,623	3,230	2,393	4,000	-1,607
CSIRO TIP														
Salaries	157	96	111	96	195	96	175	96	96	463	288	655	480	175
Capital		64		64		64	-192	64	64	0	192	128	320	-192
Other	422	0	111	0		0	533	0	0	533	0	533	0	533
Total	579	160	222	160	195	160	516	160	160	996	480	1,121	800	321
AAO														
Salaries	68	84	246	189		275	-234	541	675	314	548	1,590	1,764	-234
Capital		0		0		0	0	0	0	0	0	0	0	0
Other	68	28	167	63	325	137	332	271	337	560	228	1,168	836	332
Total	136	112	413	252	325	412	98	812	1012	874	776	2,698	2,600	98
SYDNEY UNI														
Salaries	67	128	70	131	147	135	-110	135	67	284	394	486	596	-110
Capital		0		0		0	0	0	0	0	0	0	0	0
Other	67	0	70	0		0	137	0	0	137	0	137	0	137
Total	134	128	140	131	147	135	27	135	67	421	394	623	596	27
ANU														
Salaries	420	173	216	173	246	173	363	172	172	882	519	1,226	863	363
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		0		0		0	0	0	0	0	0	0	0	0
Total	420	173	216	173	246	173	363	172	172	882	519	1,226	863	363
SWINBURNE														
Salaries	151	98	45	101	14	106	-95	29	0	210	305	239	334	-95
Capital	310	491	49	327		0	-459	0	0	359	818	359	818	-459
Other	2	0		0	105	0	107	0	0	107	0	107	0	107
Total	463	589	94	428	119	106	-447	29	0	676	1,123	705	1,152	-447
APT														
Salaries		15		15		15	-45	15	15	0	45	30	75	-45
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		5		5		5	-15	5	5	0	15	10	25	-15
Total	0	20	0	20	0	20	-60	20	20	0	60	40	100	-60
CEA														
Salaries		15		15		15	-45	15	15	0	45	30	75	-45
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		5		5		5	-15	5	5	0	15	10	25	-15
Total	0	20	0	20	0	20	-60	20	20	0	60	40	100	-60
WA Govt														
Salaries	73	100	71	100		100	-156	100	0	144	300	244	400	-156
Capital		75		75		75	-225	75	0	0	225	75	300	-225
Other	44	25		25		25	-31	25	0	44	75	69	100	-31
Total	117	200	71	200	0	200	-412	200	0	188	600	388	800	-412
UNSW														
Salaries		0		0		0	0	0	0	0	0	0	0	0
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		0		0		0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MELB UNI														
Salaries		0		0		0	0	0	0	0	0	0	0	0
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		0		0		0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELL														
Salaries		0		0		0	0	0	0	0	0	0	0	0
Capital		0		0		0	0	0	0	0	0	0	0	0
Other		0		0		0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total In-kind														
Salaries	936	1,469	759	1,650	602	1,745	-2,566	1,443	1,270	2,297	4,864	5,010	7,577	-2,566
Capital	310	630	49	466	0	139	-876	139	64	359	1,235	562	1,438	-876
Other	1,153	313	854	378	997	452	1,861	426	427	3,004	1,143	3,857	1,996	1,861
Total	2,399	2,412	1,662	2,494	1,599	2,336	-1,582	2,008	1,761	5,660	7,242	9,429	11,011	-1,582

6.2.2. Cash Contributions from Participating Parties

Table 2

Cash Contributions From Participating Parties ($'000s)

Participating Party	Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
CSIRO ATNF	444	832	230	1,032	1,616	1,532	-1,106	432	332	2,290	3,396	3,054	4,160	-1,106
CSIRO TIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AAO	0	0	0	0	486	0	486	0	0	486	0	486	0	486
SYDNEY UNI	65	155	65	155	244	155	-91	155	1,655	374	465	2,184	2,275	-91
ANU	245	315	245	315	245	315	-210	315	315	735	945	1,365	1,575	-210
SWINBURNE	10	10	10	10	63	10	53	10	10	83	30	103	50	53
APT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CEA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WA GOVT	0	0	264	0	852	0	1,116	0	0	1,116	0	1,116	0	1,116
UNSW	210	210	210	210	210	210	0	210	210	630	630	1,050	1,050	0
MELB UNI	52	52	52	52	52	52	0	52	52	156	156	260	260	0
DELL	0	85	85	0	0	0	0	0	0	85	85	85	85	0
insert additional Participants above this line														
Total	1,026	1,659	1,161	1,774	3,768	2,274	248	1,174	2,574	5,955	5,707	9,703	9,455	248

Other Sources	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
ARC	1,855	1,637	1,849	1,637	1,258	1,637	51	1,637	1,637	4,962	4,911	8,236	8,185	51
Victorian Govt	131	0	131	0	0	0	262	0	0	262	0	262	0	262
Sou. Qld Uni	5	0	5	0	0	0	10	0	0	10	0	10	0	10
Monash Uni	0	0	5	0	0	0	5	0	0	5	0	5	0	5
Tasmania Uni	0	0	2	0	0	0	2	0	0	2	0	2	0	2
insert additional Other Items above this line														
Total	1,991	1,637	1,992	1,637	1,258	1,637	330	1,637	1,637	5,241	4,911	8,515	8,185	330

	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
MNRF Grant	2,340	2,340	4,760	4,760	8,000	8,000	0	7,500	900	15,100	15,100	23,500	23,500	0

Grand Total of Cash Contributions	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
	5,357	5,636	7,913	8,171	13,026	11,911	578	10,311	5,111	26,296	25,718	41,718	41,140	578

6.2.3. Cash Heads of Expenditure

Table 3

Cash Heads of Expenditure ($'000s)

Total of Heads of Expenditure	Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
Salaries	821	483	942	155	1,676	155	2,646	155	155	3,439	793	3,749	1,103	2,646
Capital	358	560	107	1,760	793	1,760	-2,822	1,759	1,809	1,258	4,080	4,826	7,648	-2,822
Other	3,113	5,323	5,797	6,708	4,293	6,949	-5,777	7,157	6,248	13,203	18,980	26,608	32,385	-5,777
Totals	4,292	6,366	6,846	8,623	6,762	8,864	-5,953	9,071	8,212	17,900	23,853	35,183	41,136	-5,953

6.2.4. Summary of Resources Applied to Activities of MNRF

Table 4

Summary of Resources Applied to Activities of MNRF ($'000s)

	Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
Grand Ttl 5 Yrs Inkind from Tble 1	2,399	2,412	1,662	2,494	1,599	2,336	-1,582	2,008	1,761	5,660	7,242	9,429	11,011	-1,582
Grand Ttl 5 Yrs Cash from Tble 2	5,357	5,636	7,913	8,171	13,026	11,911	578	10311	5111	26,296	25,718	41,718	41,140	578
Ttl Resources Cash & Inkind Income	7,756	8,048	9,575	10,665	14,625	14,247	-1,004	12,319	6,872	31,956	32,960	51,147	52,151	-1,004

Allocation of Total Resources Applied to Activities of MNRF Between Heads of Expenditure ($)

	Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	Agreement 2005/2006	Agreement 2006/2007	Cumulative Total to Date - Actual	Cumulative Total to Date - Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
Total Salaries Cash & Inkind	1,757	1,952	1,701	1,805	2,279	1,900	80	1,598	1,425	5,737	5,657	8,760	8,680	80
Total Capital Cash & Inkind	668	1,190	156	2,226	793	1,899	-3,698	1,898	1,873	1,617	5,315	5,388	9,086	-3,698
Total Other Cash & Inkind	4,266	5,636	6,651	7,086	5,290	7,401	-3,917	7,583	6,675	16,207	20,123	30,465	34,381	-3,917
Grand Total (Cash & Inkind)	6,691	8,778	8,508	11,117	8,361	11,200	-7,535	11,079	9,973	23,560	31,095	44,612	52,147	-7,535

6.2.5. Summary of Planning/Construction/Upgrade/Operating Expenditure

Table 5

Summary of Planning/Construction/Upgrade/Operating Expenditure ($'000s)

		Actual 2001/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Variance from Deed (to end 2004/05)	2005/2006 Agreement	2006/2007 Agreement	Total to Date Actual	Total to Date Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
SKA Planning Phase	*CABB*	0	N/A	0	N/A	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
	NTD	1,621	N/A	1,208	N/A	649	N/A	N/A	N/A	N/A	3,478	N/A	N/A	N/A	N/A
	MMIC	300	N/A	0	N/A	0	N/A	N/A	N/A	N/A	300	N/A	N/A	N/A	N/A
	SKAMP	0	N/A	0	N/A	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
	Siting	117	N/A	0	N/A	0	N/A	N/A	N/A	N/A	117	N/A	N/A	N/A	N/A
	SKASS	688	N/A	0	N/A	0	N/A	N/A	N/A	N/A	688	N/A	N/A	N/A	N/A
	Total	2,726	3,640	1,208	2,582	649	1,517		523	0	4,583	7,739	5,106	8,262	-3,156
	insert additional items above this line														
SKA Construction/ Upgrade Phase	*CABB*	358	N/A	469	N/A	800	N/A	N/A	N/A	N/A	1,627	N/A	N/A	N/A	N/A
	NTD	0	N/A	0	N/A	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
	MMIC	0	N/A	145	N/A	301	N/A	N/A	N/A	N/A	446	N/A	N/A	N/A	N/A
	SKAMP	134	N/A	140	N/A	340	N/A	N/A	N/A	N/A	614	N/A	N/A	N/A	N/A
	Siting	0	N/A	0	N/A	1,242	N/A	N/A	N/A	N/A	1,242	N/A	N/A	N/A	N/A
	SKASS	0	N/A	374	N/A	421	N/A	N/A	N/A	N/A	795	N/A	N/A	N/A	N/A
	Total	492	0	1,128	2,199	3,104	2,946		3,212	3,338	4,724	5,145	11,274	11,695	-421
	insert additional items above this line														
Total Planning & Construction		3,218	3,640	2,336	4,781	3,753	4,463	0	3,735	3,338	9,307	12,884	16,380	19,957	-3,577
Operating Phase	Office salary	446	432	64	104	65	104		104	104	575	640	783	848	-65
	Office Other	0	50	58	50	89	50		50	50	147	150	247	250	-3
	SKA	0	0	0	0	0	0		0	0		0	0	0	
	Gemini Other	3,024	4,657	5,980	6,182	4,454	6,583		7,191	6,482	13,458	17,422	27,131	31,095	-3,964
Total Operating Phase		3,470	5,139	6,102	6,336	4,608	6,737		7,345	6,636	14,180	18,212	28,161	32,193	-4,032
Grand Total Expenditure		6,688	8,779	8,438	11,117	8,361	11,200	7,345	10,371	9,974	23,487	31,096	44,541	52,150	-7,609

6.2.6. Cash Cost (net of GST) of Purchased Capital Equipment

Table 6

Cash Cost (net of GST) of *Purchased* Capital Equipment ($'000s)

Fin Years	Description	Location	Quantity	Unit Value ($)	Total ($)
	List items separately > $50K				
	Supercomputer & IF, Parkes	Swinburne/ATNF	1	536	536
	Molonglo filterbank/correlator	Molonglo	1		0
2001/03	SKA demonstrator	ATNF	1		0
	Test equipment	ATNF	1		0
	Software	ATNF	1		0
	W'band correlator	ATNF	1	260	260
	Group items < $50K				
	In-kind capital items	ATNF	1	25	25
		CSIRO TIP			0
		W.A. DPC			0
Total					**821**
	List items separately > $50K				
	Supercomputer ATCA	Swinburne/ATNF	1	86	86
	Molonglo filterbank/b'former	Molonglo	1		0
	Semiconductor fabrication	ATNF	1		0
	SKA demonstrator	ATNF	1		0
2003/04	Test equipment	ATNF	1		0
	Software	ATNF	1		0
	W'band correlator	ATNF	1	62	62
	Group items < $50K				7
	In-kind capital items	CSIRO TIP			0
		W.A. DPC			0
Total					**155**
	List items separately > $50K				
	W'band correlator	ATNF	1	533	533
	Spectrun analyser	ATNF	1	88	88
2004/05	Fibre bragg grating OH	AAO	1	91	91
	Group items < $50K				
					81
Total					**793**
2005/06					0
Total					**0**
2006/07					0

6.3. Auditors report

BDO

Chartered Accountants
& Advisers

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GPO Box 2551 Sydney NSW 2001
Tel. +61 2 9286 5555 Fax +61 2 9286 5599
Email: bdosyd@bdosyd.com.au
www.bdo.com.au

AUDITORS REPORT TO THE DEPARTMENT OF EDUCATION, SCIENCE AND TRAINING REPRESENTING THE COMMONWEALTH IN RESPECT OF THE MAJOR NATIONAL RESEARCH FACILITIES PROGRAM

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2005

Scope

We have audited the Consolidated Income and Expenditure Statement of the Major National Research Facilities Program ('the Statement'), which is stamped for identification purposes, of the CSIRO Australia Telescope National Facility, Major National Research Facilities Program ('CSIRO ATNF MNRF') for the year ended 30 June 2005, as required by clause 13.3 of the Commonwealth Deed ("the Deed").

The Statement comprises audited financial information of the following participants:

- CSIRO ATNF
- CSIRO ICT
- Sydney University Trust
- Sydney University
- Swinburne University
- Australian National University
- AAO
- WA Government

CSIRO ATNF MNRF is responsible for the preparation and presentation of the financial information. We have conducted an independent audit of the financial information in order to express an opinion on it to the Commonwealth.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free from material misstatement. Our procedures include examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether in all material respects, the financial information is presented fairly in accordance with Australian Accounting Concepts and Standards and requirements of the Deed so as to present a view of the income and expenditure of CSIRO ATNF MNRF which is consistent with our understanding of its financial activities during the year.

Audit Opinion

In our opinion, the financial information presents fairly the income and expenditure in respect of the grant for the year ended 30 June 2005.

1. The Grant has been expended solely upon the establishment, enhancement and/or operation of MNRF in accordance with relevant Australian Accounting Concepts and applicable Australian Accounting Standards.

2. CSIRO ATNF MNRF's reporting of all allocations of the budgetary resources between Heads of Expenditure has a sound and reasonable basis.

3. Assets acquired by CSIRO ATNF MNRF from the Grant are vested as provided in the Commonwealth Deed (Clause 20).

4. The value of CSIRO ATNF MNRF's contributions (both cash and in-kind) towards the establishment and operation of the MNRF have a sound and reasonable basis.

BDO
Chartered Accountants

Melissa Alexander
Partner

Sydney, this 8th day of September 2005

CONSOLIDATED INCOME AND EXPENDITURE STATEMENT OF THE MAJOR NATIONAL RESEARCH FACILITIES PROGRAM FOR THE YEAR ENDED 30 JUNE 2005

	ACTUAL Year Ended 30 June 2005 $
INCOME:	
DEST Grant	8,000,000
Other	5,025,576
In-Kind contributions	1,598,916
TOTAL INCOME	**14,624,492**
EXPENDITURE:	
Salaries	1,627,512
Salary on-costs and overheads	48,888
Other expenses	2,439,327
In-Kind salaries	406,813
In-Kind salary on-costs and overheads	775,770
In-Kind other expenses	416,332
TOTAL EXPENDITURE	**5,714,642**
CAPITAL EXPENDITURE:	
Capital expenditure	792,711
TOTAL CAPITAL EXPENDITURE	**792,711**
TRANSFERS:	
Transfers to Non-Participants	1,853,383
TOTAL TRANSFERS	**1,853,383**
TOTAL EXPENDITURE FOR THE YEAR	**8,360,736**

Appendix A: Updated budget (June 2005)

Project Office Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	-$1,051,600	$336,381	$336,381
2003/04	-$876,600	$121,428	$121,428
2004/05	$1,957,400	$168,961	$168,961
2005/06	$2,360,700	$175,782	$175,782
2006/07	-$1,291,600	$178,478	$178,478
Total	$1,098,300	$981,029	$981,029

Gemini share Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$4,302,400	$4,505,521	$2,341,571
2003/04	$5,687,400	$5,889,838	$5,203,851
2004/05	$5,928,400	$5,561,018	$3,957,418
2005/06	$6,136,400	$6,007,162	$6,873,294
2006/07	$5,227,400	$5,098,162	$4,985,377
Total	$27,282,000	$27,061,701	$23,361,511

AAO Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$112,000	$134,900	$134,900
2003/04	$252,000	$413,000	$413,000
2004/05	$412,000	$891,100	$891,100
2005/06	$812,000	$700,000	$700,000
2006/07	$1,012,000	$700,000	$700,000
Total	$2,600,000	$2,839,000	$2,839,000

RSAA Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$242,600	$420,000	$420,000
2003/04	$242,600	$216,000	$216,000
2004/05	$242,600	$220,000	$220,000
2005/06	$242,600	$220,000	$220,000
2006/07	$242,600	$0	$0
Total	$1,213,000	$1,076,000	$1,076,000

CABB Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$1,150,000	$425,144	$425,144
2003/04	$1,475,000	$469,082	$469,082
2004/05	$1,800,000	$670,000	$670,000
2005/06	$450,000	$1,890,000	$1,890,000
2006/07	$400,000	$1,830,000	$1,830,000
Total	$5,275,000	$5,284,226	$5,284,226

NTD Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$895,000	$1,488,995	$1,488,995
2003/04	$1,710,000	$1,123,467	$1,123,467
2004/05	$2,360,000	$721,682	$721,682
2005/06	$1,010,000	$2,492,010	$2,492,010
2006/07	$610,000	$1,905,988	$1,905,988
Total	$6,585,000	$7,732,142	$7,732,142

MMIC Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$1,100,000	$310,541	$310,541
2003/04	$900,000	$158,661	$158,661
2004/05	$600,000	$310,330	$310,330
2005/06	$350,000	$550,420	$550,420
2006/07	$300,000	$525,400	$525,400
Total	$3,250,000	$1,855,352	$1,855,352

SKAMP Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$217,500	$134,000	$134,000
2003/04	$441,000	$312,000	$140,000
2004/05	$434,500	$647,000	$503,067
2005/06	$523,200	$523,200	$503,067
2006/07	$167,000	$167,000	$503,067
Total	$1,783,200	$1,783,200	$1,783,200

SKA Siting Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$200,000	$117,000	$117,000
2003/04	$200,000	$71,566	$71,566
2004/05	$200,000	$857,010	$857,010
2005/06	$200,000	$714,335	$714,335
2006/07	$0	$77,075	$77,075
Total	$800,000	$1,836,986	$1,836,986

SKASS Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$877,900	$593,050	$727,790
2003/04	$633,800	$722,936	$373,966
2004/05	$311,600	$355,200	$370,000
2005/06	$234,200	$355,200	$400,000
2006/07	$205,200	$355,200	$420,000
Total	$2,262,700	$2,381,586	$2,291,756

Interest Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$0	$114,534	$0
2003/04	$0	$27,695	$0
2004/05	$0	$207,346	$0
2005/06	$0	$442,673	$0
2006/07	$0	$190,463	$0
Total	$0	$982,710	$0

Total Year	Original budget receipts & payments	Updated budget receipts	Updated budget payments
2002/03	$8,045,800	$8,580,066	$6,436,322
2003/04	$10,665,200	$9,525,673	$8,291,021
2004/05	$14,246,500	$10,609,647	$8,669,567
2005/06	$12,319,100	$14,070,782	$14,518,908
2006/07	$6,872,600	$11,027,766	$11,125,385
Total	$52,149,200	$53,813,933	$49,041,202

Appendix B: Performance indicator survey

Note: There are two facilities covered by this MNRF: The Australian share of Gemini and the SKA. As the SKA will not be operational until at least the next decade, it is not possible to complete a performance indicator survey for the SKA. Therefore this performance indicator survey is only related to the Australian share of Gemini facility.

Name of Facility The Australian share of Gemini

NB: All questions refer to the current reporting period, unless otherwise specified.

1. Facility demand and usage

(a) Facility demand

230 %

>100% indicates Facility is oversubscribed

(b) Users accessing the Facility

User Type	National		International		Total
	Number	Percentage of total users	Number	Percentage of total users	Number
• Public-funded researchers (not university)	7	17%	0	0%	7
• Industry	0	0%	0	0%	0
• University	33	83%	0	0%	33
• Other (please specify)	0	0%	0	0%	0
• Total	40	100%	0	0%	40

(c) Competitive government grants used to access and conduct research at the Facility

Not applicable. Astronomers are not charged to use the Australian share of Gemini, rather time is allocated on scientific merit. The funding for the Australian share in Gemini is detailed in the financial tables elsewhere in the annual report.

(d) Opportunity cost to access similar overseas facilities

Not applicable. No eight metre class optical telescopes exist in Australia, and the Australian share of Gemini is already Australian access to an international facility.

(**e) Details of similar/same facilities emerging in Australia**

Not applicable. No eight metre class optical telescopes are planned for Australia.

2. Access arrangements

(a) User satisfaction with access arrangements

The Australian Gemini Office carried out a survey of Australian Gemini users. The results are discussed in the main text. In summary, users were very satisfied with the quality of data received and the support from both the national office and Gemini

observatory staff. There were, however, serious concerns about lack of data reduction software, and the very small proportion of even highly ranked telescope proposals that actually received complete data sets.

(b) To what extent have overseas users accessing the Facility provided increased leverage for Australian researchers to access overseas facilities?

In addition to the enhanced links Australia has developed with the other partner countries through its membership in Gemini, science programs being pursued by Australian researchers on the Gemini telescopes involve a high level of international collaboration. In 2004/05 over seventy percent of proposals involved international collaboration.

Collaborations involving astronomers in countries which belong to the Gemini partnership have the opportunity of obtaining multiple allocations of time for their project through being able to apply to the individual time assignment committees in each of the partner countries. Australian astronomers are effective users of this "joint proposal" mechanism; in 2004/05, fifty percent of the proposals received were in this category.

3. Facility promotion and enhancement to Australian SET

(a) Publications and activities which include data obtained from research performed at the Facility

Publication		Number	
		Local	Overseas
Academic	Peer reviewed journal and conference articles	1	7
	Books and chapters in books	0	0
Media	Newspaper, TV, radio	0	0
	Popular scientific press	0	0
Other (Websites)	(eg ABC Science Online)	0	0

(b) Prizes awarded for research conducted at the Facility

Award	Name of awardee	Reason

(c) Other communication and promotional activities

Activity	Number	
	Local	Overseas
Trade Displays	0	0
Seminars	15	10
Community-based fora eg talks to schools	3	0
Workshops	1	0

Conference poster presentations	3	5

(d) To what extent has the Facility contributed to enhancing the skills base and training opportunities for Australian researchers?

The Gemini telescopes are playing an important role in the training of Australian postgraduate students. In 2004/05 66% of the proposals received had Australian PhD student involvement, which in terms of numbers amounts to eight students who obtained Gemini data for their thesis. In addition there are ten postdoctoral researchers supported on Gemini-related ARC grants, located at the Australian National University's Research School for Astronomy and Astrophysics, Swinburne University of Technology, the University of Melbourne, the University of New South Wales and the University of Queensland.

4. Collaborative activities

Gemini is an international partnership managed by the Association of Universities for Research in Astronomy under a cooperative agreement with the USA National Science Foundation. The running of the Gemini telescopes is therefore beyond the scope of this report which is concerned solely with the approximately six percent of Gemini that comprises the Australian share of Gemini.

The international collaboration of the users of the Australian share of Gemini is covered in 2 (b) above.

5. Commercial activity and application of research results

(a) New Australian Enterprises

Activity	Number	Capitalisation ($'000)	Comment
Start-up companies and spin-offs	0	0	
Other (please specify)	0	0	

(b) What evidence is there that industry and research users are adopting sophisticated technologies and advanced designs and products developed by use of the Facility?

None.

(c) What evidence is there of new industry and/or research clusters, or expansion of existing clusters, that can be attributed to the existence and use of the Facility?

None.

6. Financial indicators

(a) Income from access arrangements

User Type	National ($'000)	International ($'000)	Total ($'000)
• Public-funded researchers (not university)	0	0	0
• Industry	0	0	0
• University	0	0	0
• Other (please specify)	0	0	0
• Total	0	0	0

(b) Additional investment (surplus to budget in Schedule 3)

Investor	National		International	
	Cash ($'000)	In-kind ($'000)	Cash ($'000)	In-kind ($'000)
• Public-funded researchers (not university)	0	0	0	0
• Industry	0	0	0	0
• University	0	0	0	0
• Federal Government	0	0	0	0
• State Government	0	0	0	0
• Local Government	0	0	0	0
• Non-Government Org	0	0	0	0
• Philanthropic contributions	0	0	0	0
• Other (please specify)	0	0	0	0
• Total	0	0	0	0

(c) Commercialisation of research results and knowledge diffusion

Activity	Number	Income ($'000)	Comment
• Licensing agreements	0	0	
• Contract services and consultancies undertaken by Facility for fee paying clients	0	0	
• Income to Facility from royalties and sales of products and services	0	0	
• Other (please specify)	0	0	
• Total	0	0	

(d) Total income received in the reporting year

Income type	National	International	Total
• Total Cash ($'000)	$1,764,992	$0	$1,764,992
• Total In-kind ($'000)	$0	$0	$0
• Total MNRF grant ($'000)	$1,476,836	[redacted]	$1,476,836
• Total	$3,241,828	$0	$3,241,828

(e) Self sufficiency in terms of operating costs

Percentage of total income that covers the Facility's operating costs excluding the MNRF grant.[4] 14 %

Declaration

I acknowledge that giving false or misleading information is a serious offence.

Signature of Facility project scientist: P. J. Francis.

Printed Name: Dr Paul Francis

Date: 8th September 2005

[4] During 2004/05 $1,200,259 of the MNRF grant was used towards the purchase of an additional share of Gemini for Australia, and $276,577 was contributed towards the operating costs of the Australian share of Gemini. The calculation of the self sufficiency of operating costs only considered the portion of the MNRF grant contributed towards the operating costs. In addition, a second payment of approximately $276,000 was due to be made at the end of 2004/05, however this payment was made late (ie early 2005/06) and has not been included as the MNRF is reported on a cash-accounting basis as requested by DEST.

Appendix C: AABoM members

- Dr Martin Cole (Chair), Cole Innovation & Design Pty Ltd
- Dr Brian Boyle, Commonwealth Scientific and Industrial Research Organisation
- Dr Matthew Colless, Anglo-Australian Observatory
- Dr Ron Ekers, Commonwealth Scientific and Industrial Research Organisation
- Mr Roger Franzen, Auspace Ltd
- Prof Penny Sackett, Australian National University
- Dr Lister Staveley-Smith, Commonwealth Scientific and Industrial Research Organisation
- Prof Erich Weigold, Australian Research Council

Appendix D: AABoM's advisory committees' members

Australian Gemini Steering Committee

- Prof. Warrick Couch (Chair), University of New South Wales
- A/Prof. Tim Bedding, University of Sydney
- Dr Brian Boyle, Commonwealth Scientific and Industrial Research Organisation
- Dr Matthew Colless, Anglo-Australian Observatory
- Prof. Gary Da Costa, Australian National University
- Dr Paul Francis, Australian National University
- Prof. Peter Hoj, Australian Research Council
- Prof. Penny Sackett, Australian National University
- Prof. Rachel Webster, University of Melbourne

Australian Square Kilometre Array Consortium Executive

- Dr Bob Frater (Chair), ResMed Ltd
- Dr Martin Cole (Deputy Chair), Cole Innovation & Design Pty Ltd
- Prof. Matthew Bailes, Swinburne University of Technology
- Dr Michael Barber, Commonwealth Scientific and Industrial Research Organisation
- Dr Brian Boyle, Commonwealth Scientific and Industrial Research Organisation
- Dr Ron Ekers, Commonwealth Scientific and Industrial Research Organisation
- Dr Anne Green, University of Sydney
- Prof. Sergei Gulyaev, Auckland University of Technology
- Prof. John de Laeter, Curtin University of Technology

Appendix E: Project leaders and project participants

Project Office – Mark McAuley

- Commonwealth Scientific and Industrial Research Organisation

Increased share of Gemini telescopes – Warrick Couch

- Australian National University
- Australian Research Council
- Commonwealth Scientific and Industrial Research Organisation
- Swinburne University of Technology
- University of Melbourne
- University of New South Wales
- University of Sydney

RSAA Gemini instrumentation – Peter McGregor

- Australian National University

AAO instrumentation – Sam Barden

- Anglo-Australian Observatory

AT compact array broadband backend (CABB) – Warwick Wilson

- Commonwealth Scientific and Industrial Research Organisation

New technology demonstrator (NTD) – Colin Jacka

- Commonwealth Scientific and Industrial Research Organisation

Monolithic Microwave Integrated Circuit (MMIC) – Warwick Wilson

- Commonwealth Scientific and Industrial Research Organisation

SKA Molonglo prototype (SKAMP) – Anne Green

- Commonwealth Scientific and Industrial Research Organisation
- University of Sydney

SKA siting – Tony Sweetnam

- Commonwealth Scientific and Industrial Research Organisation
- Government of Western Australia

SKA supercomputer simulation & baseband processing (SKASS) – Steven Tingay

- Dell Computer Pty Ltd
- Government of Victoria
- Swinburne University of Technology

Appendix F: Glossary

- AABoM Australian Astronomy Board of Management
- AAO Anglo-Australian Observatory
- ATNF Australia Telescope National Facility
- CABB Compact Array Broadband Backend
- CDR Critical Design Review
- CSIRO Commonwealth Scientific and Industrial Research Organisation
- DEST Department of Education, Science and Training
- DFB Digital Filter Bank
- FPA Focal Plane Array
- GSAOI Gemini South Adaptive Optics Imager
- MMIC Monolithic Microwave Integrated Circuit
- MNRF Major National Research Facility
- NIFS Near-infrared Integral Field Spectrograph
- NTD New Technology Demonstrator
- PCB Printed Circuit Board
- PDR Preliminary Design Review
- RFI Radio Frequency Interference
- RSAA Research School of Astronomy and Astrophysics
- SKA Square Kilometre Array
- SKAMP SKA Molonglo Prototype
- SKASS SKA Supercomputer Simulations
- VLBI Very Long Baseline Interferometry
- WFMOS Gemini Wide Field Multi-Object Spectrograph