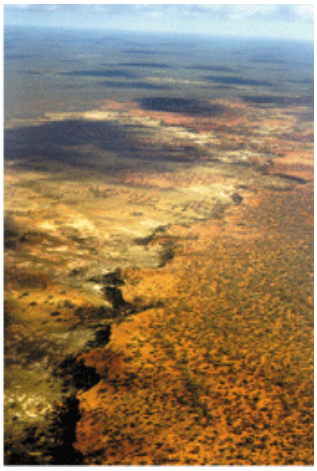
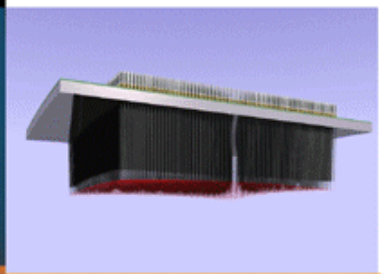
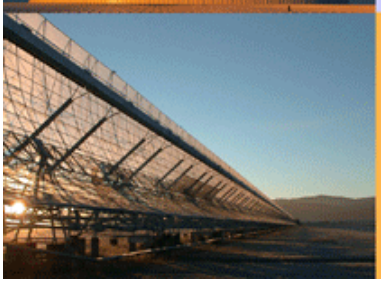


The Gemini and SKA MNRF: Australia's Astronomy Future





Annual report 2005-06

Executive summary

The Gemini and SKA Major National Research Facility (MNRF) was set up in 2002 with the aim of providing significant Australian participation in major new optical, infrared and radio facilities, including the twin Gemini 8-m telescopes and the Square Kilometre Array (SKA). With one year remaining (the MNRF concludes in June 2007), many objectives have been achieved and major new facilities are about to come on-line. The highlights of the past year have been:

- The acquisition of 16 extra nights on the Gemini South telescope in semesters 2005B and 2006A, with a further 8 nights to follow in 2006B. The extra time was made available following a purchase from the UK. Together with the extra 1.43% share, the Gemini time available to Australian astronomers has increased by 110% in 2005/6 (over that previously available) as a direct result of MNRF funding. Over the entire lifetime of the MNRF program, the hours available to the Australian community is projected to have been increased by 80%.
- Access to 30 nights on the Magellan telescopes has been purchased. Although these are 6.5-m telescopes, they are of high efficiency, are widely regarded as belonging to the '8-m class', and possess instrumentation which complements that of Gemini.
- First light of the Near-Infrared Spectrograph (NIFS) occurred on Gemini North in October 2005. This was followed by successful commissioning. NIFS will be fully available to the Gemini community from semester 2006B.
- Completion of the Gemini South Adaptive Optics Imager (GSAOI) and successful on-site acceptance tests, prior to planned installation on Gemini South in September 2006.
- The awarding of a contract for a Wide-Field Multi-Object Spectrograph (WFMOS) concept study to an AAO-led team, following the successful completion of the feasibility study in July 2005.
- Successful submission of the Australian bid to site the SKA and 12 months of successful monitoring of the levels of radio-frequency interference at the Australian SKA candidate site at Mileura Station, WA.
- Installation of an SKA technology demonstrator, the New Technology Demonstrator (NTD), consisting of two ex-Fleurs antennas, in December 2005 and the acquisition of a THEA tile from the ASTRON SKA group in the Netherlands. First fringes were obtained with the NTD in June 2006.
- Successful commissioning of the Compact Array Broadband Backend (CABB) prototype spectrometer on the 22-m Mopra telescope; this increases the available bandwidth to 8 GHz, substantially increasing the number of molecular lines that can be simultaneously observed.
- First successful Australian 'eVLBI' measurements and the availability, as a national facility, of the Swinburne supercomputer for software correlation of data recorded at Australian radio telescopes; seven user experiments have so far been processed with the new facility.

2005/06 has been a scientific and technological success for the Gemini and SKA MNRF. We look forward to more in the final year, when the remaining facilities, CABB and SKAMP, begin to come on-line.

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1. Establishment, enhancement and operation

1.1. Governance

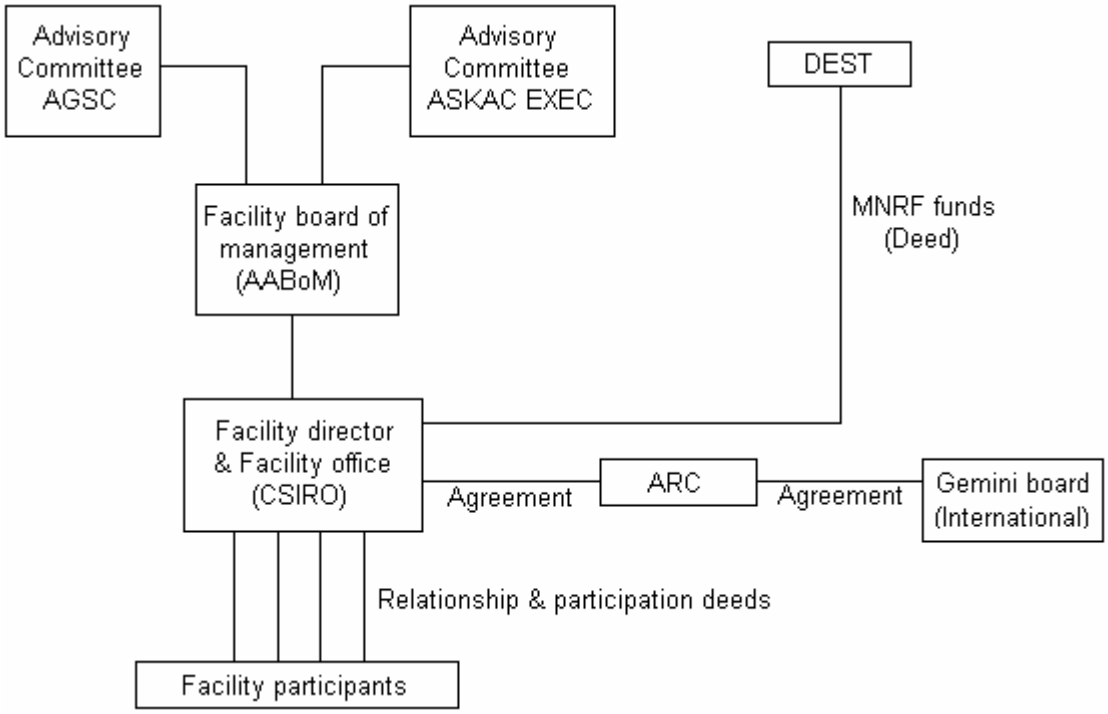


Figure 1: Relationships within the MNRF

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 board approval, following 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

The GSKA MNRF delivered its audited annual report to DEST by the 30th September 2005 as required. However, a large part of the DEST payment ($5.4m of the 2005/06 $8.4m grant) was delayed until June 2006. The delay in receiving funds significantly decreased the amount of interest that the MNRF had anticipated it would earn.

Given the number of changes to the GSKA MNRF during its first few years, the original contract with DEST was significantly out-of-date. A contract variation was therefore completed with DEST early in 2006 to reflect the expected financial commitments until the end of the MNRF. This contract variation also reflected the resource redirection following the 2005 review of the MNRF.

1.2.2. Gemini

1.2.2.1. Gemini Share

The Gemini Share project supports 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 purchasing an additional 8 nights per semester of time on Gemini South, for each of the semesters 2005B, 2006A and 2006B. Together, these arrangements increased the Gemini time available to the Australian community by 110% for the 2005/6 period. Over the entire lifetime of the MNRF program, the hours available to the Australian community of large telescopes will have increased by 80%.

For 2005B - 2006B, Australia's share of Gemini Time is roughly six nights per semester on Gemini North, and 14 per semester on Gemini South. Semester 2006A was the best on record in terms of amount of Australian projects completed.

The deadline for the 2006B semester was March 31st; oversubscription for the semester was similar to the 2006A semester - only around 1.35 for both Gemini North and South. This is low compared to the 2.6 oversubscription rate for 2005B.

There has also been progress in the “Aspen Process” to build the next generation of Gemini instruments, and the MNRF made Australia’s first of five scheduled payments to this programme.

As part of the MNRF’s plan to secure nights on the Magellan telescopes for Australian astronomers, two Magellan Fellowship positions were advertised to support the Magellan telescopes and their instruments at the Las Campanas Observatory; the shortlisted candidates will be interviewed in La Serena, Chile, in September 2006.

1.2.2.2. RSAA Gemini Instrumentation

Near-Infrared Spectrograph (NIFS)

On-site acceptance tests for NIFS were successfully completed at the Mitchell, ACT, offices of Auspace Ltd in August 2005. The instrument was shipped to the Gemini North 8-m diameter telescope in Hawaii in late-August 2005 and ANU and Auspace staff reassembled and tested the instrument through September. NIFS saw first light on the sky on 18 October 2005 and was commissioned successfully in two observing runs in October and November. The instrument was offered to the community for Science Verification observations in December 2005 and these observations occurred in January 2006. The first guaranteed time observations were completed in February 2006, with a second guaranteed time observing run occurring in July 2006. The instrument is now fully available to the Gemini community and has been offered for scientific observations in Gemini semester 2006B.

GSAOI

Assembly, integration, and testing of the Gemini GSAOI instrument was completed in 2005/06 at RSAA’s Mt. Stromlo Observatory. A major effort has been required to complete the detector subsystem. This mosaic of four HAWAII-2RG near-infrared

detectors records the science image and simultaneously performs rapid readout of four On-Detector Guide Windows that provide wave front data to Gemini's Multi-Conjugate Adaptive Optics system. The mosaic detector system is now operational and reading out the On-Detector Guide Windows at frame rates up to the required 800 Hz.

On-site acceptance tests for GSAOI were completed successfully in July 2006. Some minor modifications are now being undertaken before the instrument will be shipped to the Gemini South 8-m diameter telescope in Chile in September 2006.

1.2.2.3. AAO Instrumentation

Wide-field Multi-Object Spectrograph (WFMOS)

The WFMOS Feasibility Study was completed on time in July 2005, and the AAO submitted a proposal to AURA for the next-stage WFMOS Conceptual Design Study in October 2005.

In December 2005 the AAO-led consortium was named by the Gemini Board as one of the two teams to carry out concept studies. Gemini expanded the scope of the study and increased the funding from US$1.5M to US$1.725M; the completion date for the study was extended from November 2006 to March 2007 to allow Subaru to complete its component of the work.

At Gemini's behest, work started on the study immediately, even though contract negotiations were still in progress. AAO negotiated and signed Memoranda of Understanding with other institutions on the WFMOS study team (acting as subcontractors).

By May 2006 the concept study contract was ready to sign and the AAO-led team had carried out US$400k of work. At its May meeting, however, the Gemini Board decided, in response to a shortfall in funding for the whole Gemini 'Aspen' instrumentation program, to delay signing the study contracts. The AAO is currently awaiting a decision on the future of the WFMOS project from the Gemini Board in November 2006.

In the meantime, the AAO has secured alternative funding to continue its own components of the WFMOS concept study, and to explore alternative telescope platforms for WFMOS. This work will continue through June 2007, and is hoped to bridge the delay until the Gemini study is restarted. [Since the period covered by this report, the Gemini Board has found additional funding and resolved to re-start the WFMOS Concept Study; the AAO has re-opend contract negotiations with Gemini.]

The AAO is currently installing a new software system for project management and accounting (MS Dynamics SL), that, together with improved workflows, will facilitate the management of the WFMOS studies. The new system is planned to be in operation by the end of 2006.

Astrophotonics

Phase 1 of this project delivered a new broadband optical fibre that was first deployed in the new AAOmega spectrograph on the AAT in January 2006 and is being considered for WFMOS.

Phase 2 began in November 2005 and is exploring imaging fibre systems, infrared fibres and optically-reformatting fibres.

OH-suppression fibres

The third phase of the project has the goal of realizing a commercial prototype MMF grating for demonstration on the AAT. This is a 50 micron core fibre which suppresses 36 OH lines in the H band at a resolution of R=10,000. The design of this on-sky demonstrator system is complete; the system is expected to be tested on the AAT early in 2007. The next goal is to realize a test OH-suppression fibre bundle for the Gemini f/30 MCAO focus.

Starbugs

Phase B started in July 2005 and was completed in January 2006. It continued to develop the metrology and control aspects for the bugs. The project further developed and characterized the dynamic role of Starbugs operating in a cryogenic environment on large (8m/ELT) telescopes.

The AAO has established links with the University of Technology Sydney (UTS) and the Australian ARC Centre of Excellence for Autonomous Systems for developing anti-collision algorithms for the positioning of many (10's to 1000's) of Starbugs on a field plate. The AAO has also fostered links with European groups (such as UKATC, CSEM and LAM) that are interested in implementing Starbugs on an ELT.

Gemini support

The AAO has continued its role as the clearing-house for Australian Gemini proposals, hosting the server software which receives incoming proposals and arranging for printing and distribution of proposals received to members of the Australian Time Allocation Committee (ATAC). The processing of proposals at the AAO has been streamlined, and the layout and readability of proposals has been improved.

AAO staff have supported NIRI/Altair, bHROS, Phoenix and GNIRS for Australian Gemini users, and attended the National Gemini Offices meeting at NOAO Tucson in November 2005 for updates on Gemini instrumentation, and discussions on improving observer support across the Gemini partnership.

1.2.3. SKA

1.2.3.1. AT Compact Array Broadband Backend (CABB)

Graeme Carrad took over the role of Project Manager in November 2005. A major re-evaluation of the overall project was undertaken at this time. This resulted in the development of a modified implementation plan described by a new list of milestones. These indicate a significant overrun compared to the originally planned June 2007 finish date.

The new plan sees a "Stage 1" CABB system becoming available for testing in July 07. Stage 1 will be a single frequency system with the antenna equipment installed in such a way as to allow parallel operation of the existing backend and the new CABB backend. The existing backend system will be required to provide Ka-band tracking for NASA, due to begin in July 07. The period from July 07 until early 2008 will be used to thoroughly test the CABB system in parallel with, but not impinging on, normal ATCA operations. Testing will also be necessary to ensure that the CABB backend can provide the spacecraft tracking facility. Initial operational use, with one frequency only, will also be possible during this time. At the completion of this

period an extended shutdown will be required to remove the existing backend systems from the antennas and install the full CABB antenna equipment in its final position.

One of the major issues forcing these changes was uncertainty in the supply of the Xilinx FPGAs, which were fundamental components of the overall CABB system design. In particular, there was an apparent indefinite delay in the delivery of FPGAs for the sampler prototype, originally due for delivery in October 2005. At the time, there was significant doubt whether Xilinx would ever achieve the performance required for the CABB design with this family of FPGAs. This has subsequently proved to be well founded in that Xilinx have since downgraded the performance specifications for these devices. This forced a major re-think of the design of the sampler/data transmission systems, resulting in delays to the overall project schedule.

Re-design of the sampler/data transmission systems commenced in December 2005. In June 2006 a complete prototype sampler/data transmission path was operating in the laboratory, providing excellent performance at the nominal 10Gbits/sec transmission rate over a 4km test fibre link.

The detailed design of the final signal processing PCB commenced in February 2006. This built on experience gained with the production of the CABB prototype signal processing PCB, which has proved to be a great success in the Mopra 8GHz spectrometer, installed at Mopra in May 2006. The design of the new PCB was completed in June 2006 and sent for manufacture. It is expected that testing will commence in August/September.

Under the auspices of the CABB project, a new optical fibre cable has been installed at Narrabri linking the central control building to antenna 6. This replaces the original link to antenna 6 with a cable whose capability matches the upgraded single-mode fibre links to all other antennas. This will facilitate development of data transmission systems for CABB, allowing the use of a uniform system across the entire array.

1.2.3.2. New Technology Demonstrator (NTD)

The NTD project consists of the development of sub-systems (wide field-of-view antenna feeds, receivers, digital beamformers, data transmission, control and computing) together with the necessary systems engineering to integrate them into an operating instrument which would benefit the development path towards the SKA.

The NTD project is on schedule and is well on the way to achieving its initial goals and to providing an essential deliverable to the xNTD project. A revised schedule has been implemented with plans for the development of focal plane array technology having been revised away from the development of Vivaldi elements.

During the ground tests of the ThEA tile it became clear that severe intermodulation distortion was occurring in the amplifiers within the tile. The wide open front end meant that strong interferers at frequencies well away from the intended band of operation were causing intermodulation products that had the effect of raising the whole in-band noise floor 20 dB or more. Two major sources of interference were the SBS television transmission at about 530 MHz and new 3G mobile phone transmission at about 2.2 GHz.

The local Marsfield RFI environment had degraded further from when last measured at the end of 2004. The intermodulation would severely limit the test that we could perform with the ThEA tile unless we could reduce the level of interfering signals

Whilst unable to change the bandwidth of the ThEA tile into the first LNA, there was room to put a filter after this LNA and before the next stage of amplification. A prototype filter was made and it was found that inserting it into the circuit did significantly reduce in-band intermodulation products. It was decided to modify the whole ThEA inserting bandpass filters for each element.

This modification exercise effectively delayed the readiness of the tile for several months.

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 Indium Phosphide (InP) High Electron Mobility Transistor (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 1GHz.

InP HEMT MMICs

Wafers from the InP fabrication run were originally due for delivery in September 2005. This was significantly delayed due to an oversight by the manufacturer in preparing export documentation. Eventually, arrangements were made to deliver one of the wafers in January 2006.

On-wafer testing of this single stage 2 InP wafer was completed in March 2006. The performance of the ATNF circuits was good and the yield was high. The wafer was sent back to the manufacturer for dicing and was returned in May 2006. Subsequent cryogenic tests of the packaged 7mm low noise amplifier MMICs have confirmed excellent performance across the entire 30 to 50GHz band. The single wafer will provide sufficient circuits for outfitting the ATCA with the planned 7mm capability.

RF-CMOS Integrated receiver MMICs

The year began with the delivery of the first RF-CMOS integrated receiver test structure MMICs. Subsequent tests gave good results on all but one circuit, the low noise amplifier, which had good gain but high noise figure. The RF amplifier showed better than expected performance.

Based on experience gained with the first fabrication run, circuit designs for the second RF-CMOS wafer run were prepared. These were completed and the chip layout finished in time for the deadline for submission for the fabrication run scheduled for July 2006. The circuits on this chip include an improved low-noise amplifier design, RF bandpass filters, an RF amplifier, a Gilbert cell mixer with a divide-by-4 quadrature clock circuit, an anti-aliasing filter and amplifier for the IF and a pair of 6-bit sampler-digitisers. These circuits have been interconnected to form a complete integrated receiver. Input and/or output signals from some blocks have also been brought out to chip pins so that individual blocks can be tested. This also allows the use of off-chip filters for testing purposes.

1.2.3.4. SKA Molonglo prototype (SKAMP)

Progress on the SKA Molonglo Prototype has been slow but generally steady.

Spectral Line Correlator

With the small team working on this ambitious project, resource availability has been a key factor slowing progress. In particular the spectral line correlator required for SKAMP II needed a significant digital design expertise. The engagement of Domain-42 Pty. Ltd. in January 2006 gave a major boost to the design and development of this

spectral line correlator. Work on the architecture and the detailed design has continued with a series of workshops held to finalise critical aspects of the design.

The 415V switch board and power distribution wiring at the Molonglo Observatory have been replaced and rewired so that there is sufficient power available for the new correlator.

Line Feed and the Rapid Prototyping Telescope

Whilst the focus of effort on the SKAMP project has been on SKAMP II as this is seen as critical to the future work of the telescope, work on the line feed and the rapid prototyping telescope, RPT, has also continued at a steady pace. This work is required for SKAMP III. The RPT is a new stand alone bay, built largely from steelwork left over from the construction of the original telescope. It will allow thorough testing of techniques to remesh the telescope and of the linefeed prototypes without the need to tamper with the existing operating system. Martin Leug's prototype line feed has been completed and is ready for testing.

Fibre-optic cable

The new fibre optic network to carry dual polarised data back from each of the 176 half bays along the telescope to the correlator has been installed and terminated.

New wideband receiver design

Duncan Campbell and Adrian Blake have made good progress on design a new wideband receiver and digitiser required for SKAMP II.

1.2.3.5. SKA Siting

The formal proposal to site the SKA in Australia was submitted to the International SKA Planning Office (ISPO) on 16th December 2005. Preparing this comprehensive report with input from a large number of contributors (e.g. the Western Australian Government through the Office of Science and Innovation and the regional Mid-West Development Commission; DEST; IPS Radio and Space Services; Australian Communications and Media Authority (ACMA); engineering consultants Connell Wagner and Burns Roe Worley, and a number of ATNF scientists) was thus the major activity for the first half of the 2005-2006 year.

The detailed 150-page colour siting report (plus supporting CD) highlighted Australia’s natural advantages as a site for the SKA, namely excellent sky coverage, radio-quiet environment, ionospheric stability, benign troposphere, extremely low population density in key areas, as well as its scientific, economic and political strengths.

Throughout the period and up to the end of January 2006 monitoring of the radio frequency environment was carried out at the proposed core SKA site at Mileura. A comprehensive report was then compiled, edited and submitted on CD to the International SKA Planning Office in March 2006 as required.

Since March 2006 the team has been further engaged in report writing in answer to further questions and request for information submitted to proposers by the International SKA Planning Office.

1.2.3.6. SKA supercomputer simulation & baseband processing (SKASS)

The last year has seen several milestones brought to completion (all year 4 milestones have been brought to practical completion). The Swinburne project has also had several exciting highlights.

The report on the feasibility of a software autocorrelation spectrometer for the Tidbinbilla 70 m antenna has been completed, drawing upon the experience obtained over the last three years in software cross-correlation.

The outstanding work (from year 3) on developing a pulsar timing system for the ATCA has been completed. The hardware to record pulsar timing data has been installed and tested at the ATCA, and software to analyse the data has been installed and tested on the 16 node PC cluster at the ATCA.

A continuing series of test experiments, to demonstrate eVLBI using the software correlator at Swinburne and the recently installed fibre optic connections to the ATNF telescopes, was brought to practical completion with test observations in March and May. Refinements of the system will take place over the next few years in its operational phase, but these do not form a formal milestone for the MNRF. This ongoing eVLBI work will make heavy use of the software correlator, ported to the Cray XD-1 at the University of Western Australia. The XD-1 Cray software correlator is enabled to make use of FPGA libraries developed as a collaboration between Swinburne and Cray.

The software correlator developed at Swinburne is now an operational component of the Australian VLBI array and available for users. Thus far, seven user experiments have been supported using this system and demand for the hard-disk recording system and correlation in software has increased in the two semesters that this mode of operation has been available.

As Chair of the international SKA simulations working group, Steven Tingay has completed his work on array configuration studies of the 4 international site proposals. This brings an MNRF milestone to completion and culminated in a report to the ISPO on the properties of the four proposed sites, to be used by the international site advisory committee in the SKA site shortlisting process. Following the submission of this report, Tingay stepped down as SimWG and CSTF Chair, after 3 years in this position.

In terms of exciting highlights, in the last year Swinburne shipped the first PI-proposed VLBI experiment from its now fully operational software correlator. The experiment (v193a) was a 4 station, 256 Mbps observation aimed wide-field imaging of the Chandra deep field south, by Prof. Ray Norris and collaborators. This is a major highlight. A second experiment is to be shipped shortly, an OH spectrapolarimetric observation by Indra Bains et al (v195a).

Both these observations were observed in March, giving a turnaround time for correlation of ~2 months. VLBI observations were again scheduled in May. During this session, ~40 TB of disk-based VLBI data was obtained and is currently being processed by the Swinburne software correlator.

A contract is currently being drafted between Swinburne and the ATNF, for Swinburne to provide full correlation services for the Australian VLBI array for a period of two years, allowing users access to the much improved capabilities of the disk-based recording system and software correlator.

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 2005	Completed: September 2005	
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	8 nights per semester to be purchased from the UK on Gemini South in each of 2005B, 2006A and 2006B; Remainder is being spent on the purchase of nights on the Magellan telescope, and to support Australian involvement in the Aspen program.

1.3.2.2. RSAA Gemini instrumentation

Task	Project plan	Status	Comments
1. Complete each of the remaining milestones for the completion of the Near-infrared Integral-Field Spectrograph (NIFS)	December 2004	Completed: August 2005	Milestone completed with the completion of NIFS Acceptance Tests
2. Deliver NIFS to Gemini	February 2005	Completed: August 2005	Shipment of NIFS in August 2005
3. Successfully commission NIFS on Gemini North	June 2005	Completed	
4. Award of a new instrument contract from Gemini	July 2004	Completed: November 2002	Instrument is Gemini South Adaptive Optics Imager (GSAOI)
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: September 2006	
7. Contingent on 4 above, successfully commission GSAOI.	May 2006	Revised to: October 2006	

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.
WFMOS Conceptual Design Study awarded	Jan 2006	Complete	New milestone, added after project plan.
WFMOS Conceptual Design Study start	Jan 2006	Complete	New milestone, added after project plan.
WFMOS Conceptual Design Study contract signed	May 2006	Delayed [restarted Sep 2006]	New milestone, added after project plan. Study suspended by Gemini in May 2006 before contract signed.
WFMOS Conceptual Design Study complete	Oct 2006 (extended to Mar 2007)	Delayed [now expected to be Nov 2007]	New milestone, added after project plan. Study suspended by Gemini in May 2006 before contract signed.
WFMOS-A Design Study start	Jul 2006	Complete	New milestone, added after project plan. Australian WFMOS Design Study to bridge

			Gemini suspension
WFMOS-A Design Study complete	Jun 2007	In progress	New milestone, added after project plan. Australian WFMOS Design Study to bridge Gemini suspension
Astrophotonics – Phase 1	Jun 2005	Complete	New milestone, added after project plan.
Astrophotonics – Phase 2	Jul 2006	Complete	New milestone, added after project plan.
OH suppression - FBG prototype	Feb 2005	Complete	New milestone, added after project plan.
OH suppression – SMF to MMF prototype	Mar 2005	Complete	New milestone, added after project plan.
OH suppression – MMF prototype on AAT	Dec 2006	In progress	New milestone, added after project plan.
Starbugs – Phase A	Jun 2005	Complete	New milestone, added after project plan.
Starbugs – Phase B	Jun 2006	Complete Jan 2006	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 DFB (digital filterbank)	March 2005	Completed Oct 2005	
Testing of prototype photonic data transmission system	February 2004	Completed Jun 2006	
Testing of prototype conversion system	October 2004		Now part of amended plan - see below
Commencement of final production	January 2006		Now part of amended plan - see below
Six antenna ATCA	January 2006		Now part of amended plan

operational with new backend.			- see below
Completion of integration of NTD into ATCA system.	July 2006	On hold.	NTD unlikely to be situated at Narrabri.
Broadband ATCA tied array operational.	July 2007	Revised: May 2008	NASA 7mm tracking will use existing backend for initial operations.

Additional Milestones From revised (Nov 2005) project plan.

Commencement of amended plan.	Dec 2005		
Complete detailed design of modified concept sampler/data transmitter PCB	Feb 2006	Completed in March 2006	
Begin design of "final" DFB/Correlator PCB	Feb 2006	Completed	
Testing of prototype photonic data transmission system	May 2006	Completed in June 2006	
Testing of prototype conversion system	June 2006	Testing commenced in July 2006	
Complete design and submit "final" DFB/Correlator PCB for fabrication	June 2006	On schedule	
Assemble first DFB/Correlator PCB	Aug 2006		
Begin testing DFB/Correlator PCB	Sep 2006		
Begin integration and testing of complete data path. Requires final prototypes of all data path components.	Oct 2006		
Complete testing DFB/Correlator PCB and complete data path.	Nov 2006		
Begin fabrication of production quantities of DFB/Correlator PCB	Dec 2006		
Begin stage 1 installation of CABB racks in the antennas - off the turret	Jan 2007		
6 antennas outfitted with stage 1 CABB equipment	May 2007		
Complete, and begin testing of, DFB/Correlator PCBs	May 2007		
Install stage 1 DFB/Correlator and begin	July 2007		

full array tests; in-parallel operation with existing backend			
Complete Stage 1 testing	Sep 2007		
Commence extended shutdown to remove old backend in the antennas and replace with full CABB backend	Feb 2008		
Solution successfully tested after commissioning.	May 2008		

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 direct digital sampling.	June 2003	Completed: July 2003	"A Baseband Receiver Architecture for Medium-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	Completed	The Victorian Centre for Advanced Materials Manufacturing has funding to develop the dielectric material for use in commercial microwave antenna systems. Participants in the project include CSIRO, Swinburne University and Polyfoam Pty Ltd. CSIRO has been granted a non-exclusive licence for Radio Astronomy use only.
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	Cancelled	Replaced by new milestones below for the final year of the project
Final testing of RFCMOS chips	September 2005	Cancelled	Dealt with by MMIC project
Control & Monitor software complete for testing @ Marsfield	September 2005	Completed	
FPA prototype testing & characterisation complete	November 2005	Cancelled	Replaced by new milestones below for the final year of the project
Critical Design review (CDR) – ie Detailed Design Complete	December 2005	Cancelled	
NTD Project Completion and Demonstration	June 2007	Cancelled	
Preliminary electrical design and simulation completed.	August 2006		New milestone from 06/07 project plan.
Mechanical design completed.	November 2006		New milestone from 06/07 project plan.
Full electrical design and simulation completed.	November 2006		New milestone from 06/07 project plan.
ThEA tile and beamformer working mounted in Fleurs dishes	30 July 2006		New milestone from 06/07 project plan.
Prototype construction completed.	March 2007		New milestone from 06/07 project plan.
Prototype installed and being tested on the Fleurs dish	April 2007		New milestone from 06/07 project plan.
Test results and analysis available for formal review	June 2007		New milestone from 06/07 project plan.
Closure document submitted to PRB.	July 2007		New milestone from 06/07 project plan.

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)	April 2004	No longer required.	Commercial devices are now available that negate

fabrication run.			this sampler development.
Submit designs for integrated receiver prototypes	April 2004	Completed: April 2005	
Submit designs for integrated receiver assemblies	November 2004	Cancelled	Replaced by new milestones below.
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.
Submit designs for third integrated receiver fabrication run	February 2007		New milestone, added after project plan.
Complete testing of devices from third integrated receiver fabrication run	June 2007		New milestone, added after project plan.

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	Completed	
Update SKAMP scope of project document	June 2004	Completed: June 2004	
Complete design of spectral line correlator	September 2004	Completed	New milestone added during 2004/05
Filters and correlator boards manufactured	May 2005	Revised: October 2006	New milestone added during 2004/05
Optic fibre installation implemented	June 2005	Completed	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 for submission to ISSC.	June 2003	Completed	
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	Completed	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	Completed: November 2006	
Respond to ISSC on site submission if required	June 2005	Completed April 2006	
Complete RFI tests to be conducted remotely over a full year, at the reference site.	June 2005	Completed: March 2006	
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 modifications have been in response to several new opportunities within Australian SKA-related projects and within the international SKA project.
Software correlator integrated with array configuration studies	June 2005	Cancelled	
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	Completed	
Use cluster at ATCA to process pulsar	June 2005	Completed	

observations and measure suitability of the ATCA tied-array for pulsar observations.			
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	Cancelled	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	Cancelled	
Software correlation for eVLBI as part of first eVLBI experiments.	June 2006	Completed	New milestone
Configuration studies for national and international 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 06.	June 2006	Completed	New milestone
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	Completed	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 program.	June 2007		New milestone

2. Research, access & collaboration

2.1. Facility's Access regime

2.1.1. Gemini

This project provides Australian astronomers with access to the two Gemini 8m telescopes. All Australian astronomers are eligible to apply for time on these telescopes and, if successful, get this time free of charge. Proposals are evaluated by the Australian Time Assignment Committee (which oversees time allocation on all optical/infrared national-access telescopes) and awarded time on the basis of scientific merit and in accordance with ARC objectives. The Australian Gemini Steering Committee oversees Australian access to Gemini.

In 2005/06, a total of 46 proposals requesting time on the Gemini telescopes were received (up from 30 in 2003/04), involving 63 astronomers from 10 Australian institutions. A total of 522 hours of observing time was requested, oversubscribing the available time (science ranking band-1 and band-2) by a factor of 2.4. The Australian Time Assignment Committee provides detailed technical and scientific feedback to all applicants, be they successful or not.

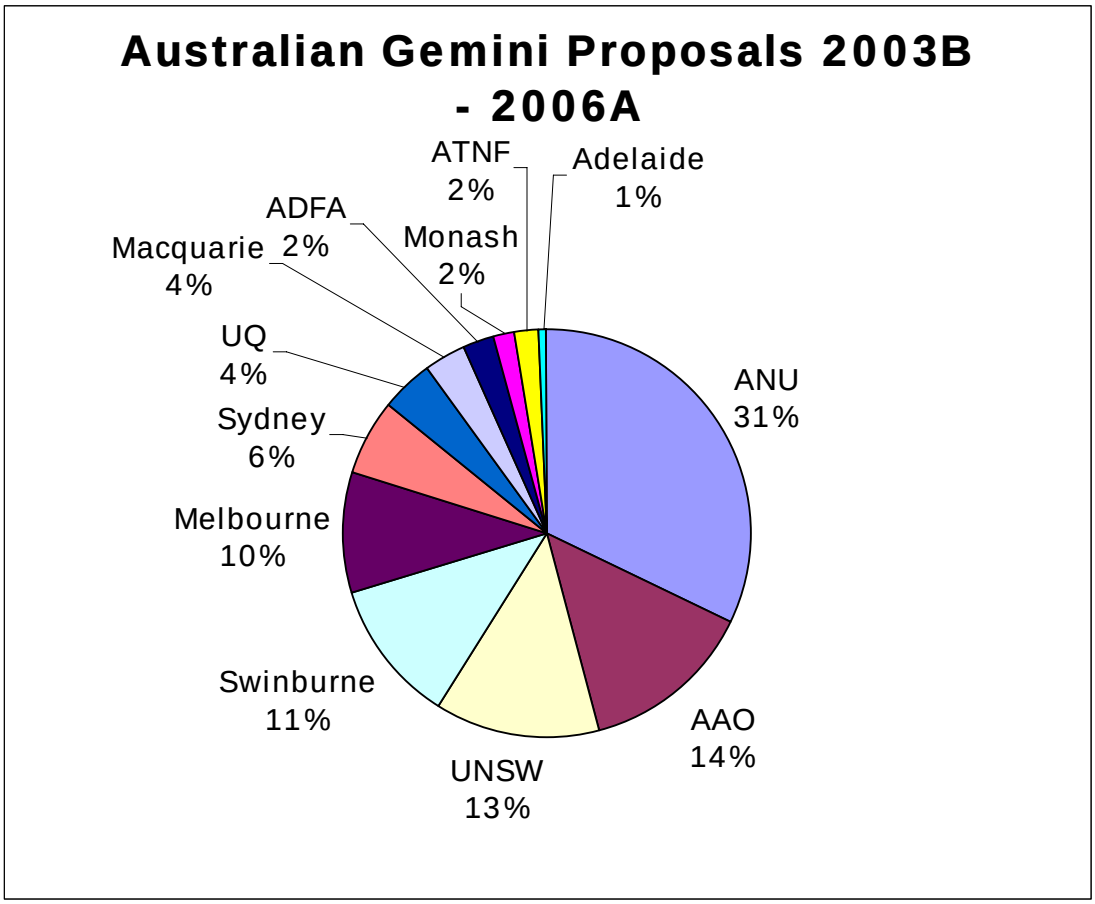


Figure 2: Australian Gemini applications

In early years, a very small fraction of the Gemini proposals that were awarded time by ATAC were actually fully executed. Last year we noted that this fraction seemed to be strongly rising, but that it would bear watching.

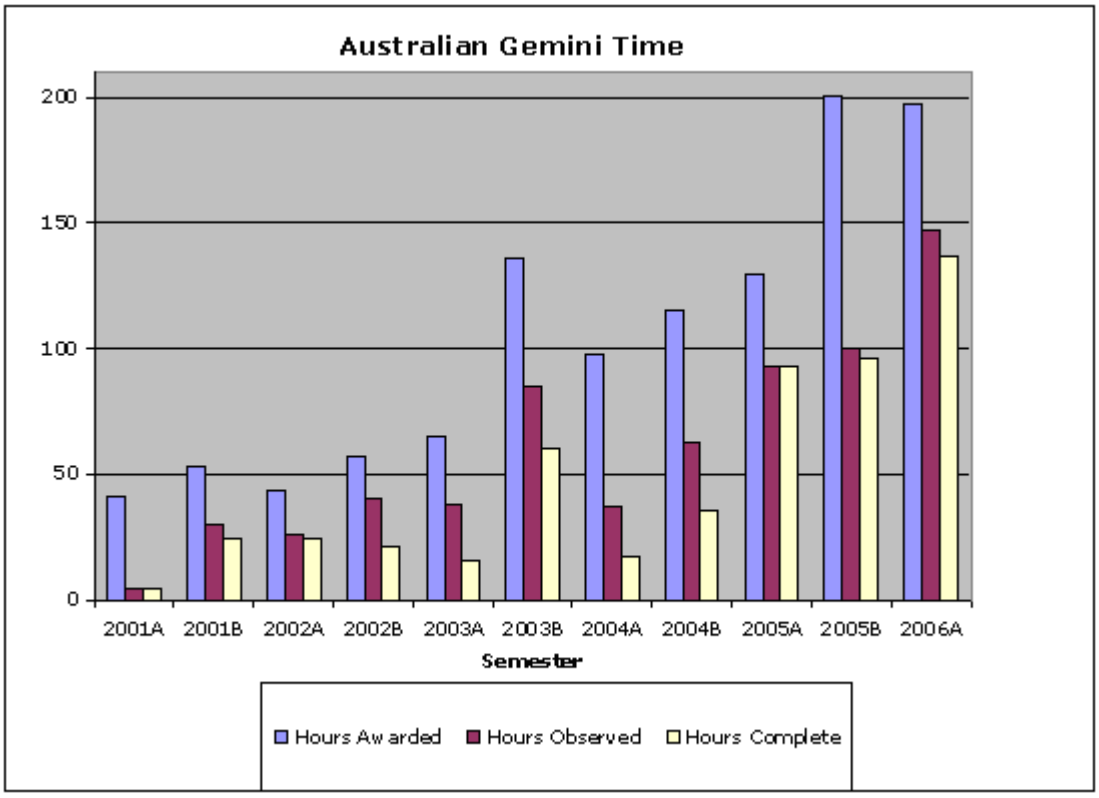


Figure 3: Gemini projects completed

As the graph shows, about 60% of the hours allocated by ATAC are actually observed, which is consistent with typical weather statistics at the Gemini telescopes. In recent years, Gemini's policy has changed, so they try and start fewer programs, but emphasise finishing whatever they've started. The completion rate in 2005B was bad for Australia (but good for other partners). This was primarily because of extremely poor weather in Chile, where we had the overwhelming majority of our time; semester 2006A was much better.

Gemini is now giving us access to time on the Subaru and Keck telescopes, via the swapping of nights. Australia has been a disproportionately heavy user of both swaps, accounting for over 40% of the swap time.

Applications for Magellan time

The time will be classical (i.e. not queued/service-observing), and the specific nights will be announced ahead of time (3-4 per semester per telescope). Proposers will need to request a minimum of two nights, and will need to go to the telescope in person. Horse trading between partners is allowed, should we need different dates or a different break-down of dark/bright time, etc. Proposals will be technically evaluated by the Gemini Project Scientist, at least until the new Magellan fellows are on the ground in Chile.

Once the proposals have been ranked by ATAC there will be a short time for horse-trading between partners, either by the Australian Gemini Project Scientist or by the chair of ATAC.

2.1.2. SKA

The 30% of the Swinburne supercomputer (and all associated software) available for SKA-related work is fully open to all users. Contact should be made with stingay@astro.swin.edu.au to arrange accounts on the cluster and arrangements for support.

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.

No charge is made for access to Swinburne MNRF facilities and full support is provided for users.

2.2. Collaboration and linkages

2.2.1. Gemini

Australia's usage of the Gemini telescopes continues to be highly collaborative. The most common pattern is for Australians at one institution to collaborate with overseas researchers. Collaborations between different Australian institutions, which do not involve international institutions, are relatively rare.

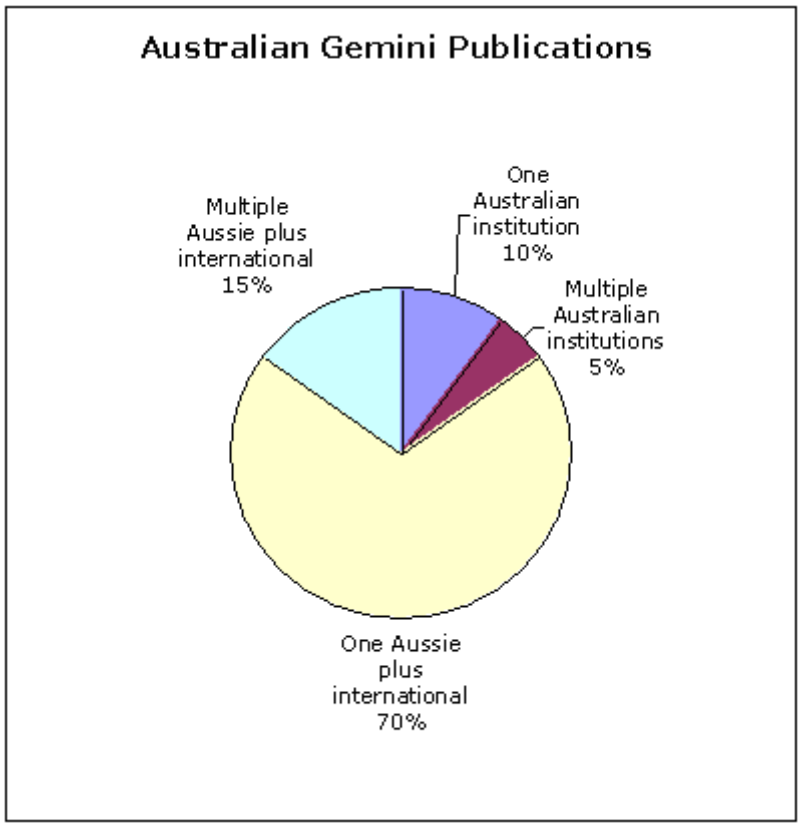


Figure 4: Gemini publications

2.2.1.1. AAO

WFMOS Studies

The WFMOS studies have been undertaken by the AAO as the leader of a consortium consisting of the following institutions: in the US, the National Optical Astronomy Observatories and Johns Hopkins University; in the UK, the Universities of Oxford, Durham and Portsmouth, and the Rutherford Appleton Laboratory.

All work undertaken during these studies was covered by MOUs drawn up between the AAO and these institutions for the purpose of setting costs and revenue distribution, and to protect IP.

Astrophotonics

Collaborative investigations have been set up with Polymicro Technologies Inc, Optical Fibre Technology Centre (OFTC), Crystal Fibres (Denmark), Macquarie University, University of Sydney, and the University of Durham (UK) to characterize and develop new fibre technologies for applications in astronomy.

OH-suppression fibres

The AAO continues to collaborate on this project with Redfern Optical Components for Fibre Bragg grating work, and with the University of Bath for MMF to SMF conversion. We have shared patents with these organisations and all commercialisation work is covered by MOUs. Additional collaborations have begun with the LAM in Marseilles and with the European Southern Observatory in Munich.

Starbugs

This work has been carried out in collaboration with the European OPTICON consortium, principally through the UK Astronomy Technology Centre in Edinburgh. IP for this work is covered by a joint MOU amongst consortium members.

2.2.2. SKA

2.2.2.1. CABB

There was collaboration with other SKA projects, such as NTD and SKAMP, in seeking to develop parallel approaches and cross-fertilisation, particularly in the signal processing area.

The CABB project engineer was invited onto the review panel for the EVLA correlator and also attended preliminary design review at Penticton, Canada in July 2005.

2.2.2.2. NTD

The NTD team is collaborating with MIT Haystack observatory, sharing our experiences and designs relating to all aspects the digital signal path including polyphase filter banks and correlation processing, to assist them with their LFD project. The team is also working with the South African SKA KAT team jointly developing telescope management and control software. Finally, the ThEA tile which is being used as the initial focal plane phased array feed was supplied by ASTRON (Netherlands Foundation for Research in Astronomy).

2.2.2.3. MMIC

The project manager attended the 2006 IEEE Mediterranean Electrotechnical Conference and a PHAROS (PHased Arrays for Reflector Observing Systems) meeting. This resulted in useful interaction with EU colleagues in the areas of phased array receivers and MMIC fabrication utilizing a state-of–the art process at a European foundry.

2.2.2.4. SKAMP

In January this year the SKAMP team contracted Domain-42 Pty. Ltd., two digital designers in Tasmania, to assist with the design of the spectral line correlator for SKAMP II. They have made rapid progress and are on target for producing a prototype system by October 2006. Work has also continued with Argus Technology, who have supported and funded, Martin Leung to develop the dual polarised line feed required for SKAMP III as a PhD project. The major part of work has been completed and Martin is writing up his PhD.

2.2.2.5. SKASS

External companies & research agencies involved in the Swinburne SKA project:

- Dell Computer Pty Ltd;
- Cray computer Pty Ltd;
- CSIRO;
- Australian National University;
- Geoscience Australia;
- Auckland University of Technology;
- National Radio Astronomy Observatory (USA);
- University of Western Australia;
- University of Western Sydney;
- Curtin University of Technology;
- Massachusetts Institute of Technology, Haystack Observatory;
- Communications Research Laboratory (Japan);
- Hartebeesthoek Radio Astronomy Observatory (South Africa);
- Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science;

Research activities (e.g. observing proposal or construction of a device or instrument) undertaken at the Project that involved 3 or more participants

- Utilisation of disk-based recorders and software correlators for VLBI, includes fringe-checking software, regular VLBI experiments, first attempts at Trans-Tasman VLBI, and eVLBI.
- Contributions to Australian SKA site selection process;
- Contributions to international SKA site selection process;

Research activities that involved international researchers

- Utilisation of disk-based recorders and software correlators for VLBI;
- Development of MIT/Haystack software package for SKA simulations;

- Generation of international SKA array configuration guidelines for proposers;
- Analysis and interpretation of correlated VLBI data.

Research activities undertaken at the Project involving at least one industry participant with a significant contribution to the project.

- All activities of the Swinburne project are supported by Dell Computer Pty Ltd, through technical support and advice on the required computing hardware;
- Development of new high performance software correlation in collaboration with Cray computer, using Cray XD-1 machine.

2.3. Contribution to research and training

2.3.1. Gemini

The applicants for Australian Gemini time continue to be fairly evenly split between faculty members, post-docs and students.

The dramatic rise in the number of publications coming from Australian Gemini use continues: the number of Australian papers using Gemini data grew from 9 to 27.

A major science highlight using Gemini was the identification of the companion star to a bizarre “chameleon” supernova that changed its appearance mid-blast. Stuart Ryder (AAO) led a team which used the superb seeing obtained with Gemini to pinpoint this faint companion star, and hence work out why the supernova changed type.

Another highlight was the discovery (by Swinburne PhD student Michael Pierce and his team) that the giant elliptical galaxy M105 does contain vast quantities of dark matter. An overseas group has claimed a couple of years ago that this galaxy did not contain dark matter, which if true would have toppled much of modern cosmology. Pierce et al. were able to show that the previous result was based on a biased tracer of the mass. Using globular clusters to trace the mass, they were able to show that this galaxy did indeed fit with orthodoxy.

Papers published during the 2005/06 financial year involving Australian astronomers are:

- Ryder S.D., Murrowood C.E., Stathakis R.A. (2006). ``A post-mortem investigation of the Type IIb supernova 2001ig", Monthly Notices of the Royal Astronomical Society: Letters, 369, p. L32-L36.
- Hinkle K.H., Fekel F.C., Joyce R.R., Wood, P.R., Smith V.V., Lebzelter T. (2006). ``Infrared Spectroscopy of Symbiotic Stars. IV. V2116 Ophiuchi/GX 1+4, The Neutron Star Symbiotic", Astrophysical Journal, 641, p. 479-487.
- Blondin S., Dessart L., Leibundgut B., Branch D., Hoeflich P., Tonry J.L., Matheson T., Foley R.J., Chornock R., Filippenko A.V., Sollerman J., Spyromilio J., Kirshner R.P., Wood-Vasey W.M., Clocchiatti A., Aguilera C., Barris B., Becker A.C., Challis P., Covarrubias R., Davis T.M., Garnavich P., Hicken M., Jha S., Krisciunas K., Li W., Miceli A., Miknaitis G., Pignata G., Prieto J.L., Rest A., Riess A.G., Salvo M.E., Schmidt B.P., Smith R.C., Stubbs C.W., Suntzeff N.B. (2006). ``Using Line Profiles to Test the Fraternity of Type Ia Supernovae at High and Low Redshifts", Astronomical Journal, 131, p. 1648-1666.

- Francis, P.J., McDonnell, S. (2006). ``Fluorescent Lyman-alpha Emission from Gas Near a QSO at Redshift 4.28", Monthly Notices of the Royal Astronomical Society, in press.
- Pierce M., Bridges T., Forbes D.A., Proctor R., Beasley M.A., Gebhardt K., Faifer F.R., Forte J.C., Zepf S.E., Sharples R., Hanes D.A. (2006). ``Gemini/GMOS Spectra of Globular Clusters in the Virgo Giant Elliptical NGC 4649", Monthly Notices of the Royal Astronomical Society, 368, p. 325-334.
- Soderberg A. M., Kulkarni S. R., Price P. A., Fox D. B., Berger E., Moon D.-S., Cenko S. B., Gal-Yam A., Frail D. A., Chevalier R. A., Cowie L., Da Costa G. S., MacFadyen A., McCarthy P. J., Noel N., Park H. S., Peterson B. A., Phillips M. M., Rauch M., Rest A., Rich J., Roth K., Roth M., Schmidt B. P., Smith R. C., Wood P. R. (2006). ``An HST Study of the Supernovae Accompanying GRB 040924 and GRB 041006", Astrophysical Journal, 636, p. 391-399.
- Whiting M.T., Webster R.L., Francis P.J. (2006). ``Multi-object spectroscopy of the field surrounding PKS 2126-158: discovery of a z= 0.66 galaxy group", Monthly Notices of the Royal Astronomical Society, 368, p. 341-350.
- Pierce M., Beasley M.A., Forbes D.A., Bridges T., Gebhardt K., Faifer F.R., Forte J.C., Zepf S.E., Sharples R., Hanes D.A., Proctor R. (2006). ``Gemini/GMOS Spectra of Globular Clusters in the Leo Group Elliptical NGC 3379", Monthly Notices of the Royal Astronomical Society, 366, p. 1253-1264.
- Fox D.B., Frail D.A., Price P.A., Kulkarni S.R., Berger E., Piran T., Soderberg A.M., Cenko S.B., Cameron P.B., Gal-Yam A., Kasliwal M.M., Moon D.-S., Harrison F.A., Nakar E., Schmidt B.P., Penprase B., Chevalier R.A., Kumar P., Roth K., Watson D., Lee B.L., Shectman S., Phillips M.M., Roth M., McCarthy P.J., Rauch M., Cowie L., Peterson B.A., Rich J., Kawai N., Aoki K., Kosugi G., Totani T., Park H.-S., MacFadyen A. and Hurley K.C. (2005). ``The Afterglow of GRB 050709 and the Nature of the Short-hard Gamma-ray Bursts", Nature, 437, p. 845-850.
- Proctor R. N., Forbes D. A., Forestell A., Gebhardt K. (2005). ``Spatially Resolved Stellar Populations in the Isolated Elliptical NGC 821", Monthly Notices of the Royal Astronomical Society, 362, p. 857-866.
- Smith V.V., Cunha K., Ivans I.I., Lattanzio J.C., Campbell S., Hinkle K.H. (2005). ``Fluorine Abundance Variations in Red Giants of the Globular Cluster M4 and Early-cluster Chemical Pollution", Astrophysical Journal,633, p. 392-397.
- Ciardi D.R., Telesco C.M., Packham C., Martin C.G., Radomski J.T., De Buizer J.M., Phillips C.J., Harker D.E. (2005). ``Crystalline Silicate Emission in the Protostellar Binary Serpens SVS 20", Astrophysical Journal,629, p. 897-902.
- Matheson T., Blondin S., Foley R.J., Chornock R., Filippenko A.V., Leibundgut B., Smith R.C., Sollerman J., Spyromilio J., Kirshner R.P., Clocchiatti A., Aguilera C., Barris B., Becker A.C., Challis P., Covarrubias R., Garnavich P., Hicken M., Jha S., Krisciunas K., Li W.D., Miceli A., Miknaitis G., Prieto J.L., Rest A., Riess A.G., Salvo M.E., Schmidt B.P., Stubbs C.W., Suntzeff N.B., Tonry J.L. (2005). ``Spectroscopy of High-Redshift Supernovae from the ESSENCE Project: The First 2 Years", Astronomical Journal,129, p. 2352-2375.
- Melatos A., Scheltus D., Whiting M.T., Eikenberry S.S., Romani R.W., Rigaut F., Spitovsky A., Arons J., Payne D.J.B. (2005). ``Near-Infrared, Kilosecond

Variability of the Wisps and Jet in the Crab Pulsar Wind Nebula", Astrophysical Journal,633, p. 931-940.

- Bland-Hawthorn J., Vlajic M., Freeman K.C., Draine B.T. (2005). ``NGC 300: An Extremely Faint, Outer Stellar Disk Observed to 10 Scale Lengths",
- Astrophysical Journal, 629, p. 239-249.
- Driver, S.P., Liske, J., Cross, N.J.G., De Propris, R., Allen, P.D. (2005). ``The Millennium Galaxy Catalogue: The Space Density and Surface-Brightness Distribution(s) of Galaxies", Monthly Notices of the Royal Astronomical Society,360, p. 81-103.
- Wayth R.B., O'Dowd M., Webster R.L. (2005). ``A Microlensing Measurement of the Size of the Broad Emission Line Region in the Lensed QSO 2237+0305",

Outcomes from AAO research are largely described in the following papers, published in the Proceedings of the SPIE meeting held in Orlando, Florida, in July 2006 on Astronomical Telescopes and Instrumentation:

- A new look for Gemini: rapid-cured composites for an exchangeable top-end, Miziarski S.M. et al., SPIE 6273, paper 121, in press.
- Advances in infrared and imaging fibres for astronomical instrumentation, Haynes R. et al., SPIE 6273, paper 148, in press.
- Applications of fibre tapers in astronomy, Marcel J., Haynes R. & Bland-Hawthorn J., SPIE 6273, paper 153, in press.
- Coupling light into optical fibres near the diffraction limit, Horton A.J. & Bland-Hawthorn J., SPIE 6269, paper 58, in press.
- Instruments without optics: an integrated photonic spectrograph, Bland-Hawthorn J. & Horton A.J., SPIE 6269, paper 23, in press.
- It’s Alive! Performance and control of prototype Starbug actuators, Haynes R. et al., SPIE 6273, paper 69, in press.
- Deployable payloads with Starbug, McGrath A.J. & Haynes R., SPIE 6273, paper 70, in press.

Other AAO related publications are:

- Smart-MOMSI Instrument Concept and technology Development, Cunningham C. et al., SPIE 6273, paper 68, in press.
- A Scaleable Pick-off Technology for Multi-Object Instruments, Hastings P.R. et al. SPIE 6273, paper 116, in press.
- Starbug – A Smart Focal Plane technology for ELR instruments, Haynes R. & McGrath A.J., Instrumentation for Extremely Large Telescopes, Ringberg Castle, August 2005. MPIA Heidelberg, Special Publication 0106, June 2006.
- Wide field Astronomy with Starbug, Haynes R. & McGrath A.J., Integral Field Spectroscopy: Techniques and data Production, Durham, 2005. New Astronomy Review, Vol. 50, Issues 4-5, pp 329-331, June 2006.
- Progress on smart focal plane technologies for extremely large telescopes, Cunningham, C. et al., SPIE Proceedings, Chromaticity effects in adaptive optics; wavelength dependence of amplitude compensation, Vol. 5904, pp. 281-292, October 2005.
- In search of First Light: New technologies and New Ideas, Bland-Hawthorn J., New Astronomy Reviews, 50, 75, 2006.

A graduate student from the University of Sydney, Jackie Marcel, completed her Masters thesis in 2006, based on research carried out as part of the Astrophotonics project at the AAO.

2.3.2. SKA

The CABB project has contributed to the development of technology for the SKA by investigating special signal processing techniques that are considered to be important inputs to the SKA design process.

Suzy Jackson's work on the RF-CMOS integrated receiver MMICs is being carried out in collaboration with Macquarie University, where she is enrolled for a PhD degree. She has published a paper titled "RF design of a wideband CMOS integrated receiver for phased array applications", in Experimental Astronomy (2004).

Martin Leung is a PhD student at the University of Sydney working on development of a new wideband feed element to replace the existing feed at the Molonglo telescope. Other undergraduate students at the University of Sydney are engaged in projects involving the telescope.

SKASS related papers:

- Lenc and Tingay, 2006, AJ, in press. "The sub-parsec scale radio properties of southern starburst galaxies. I. Supernova remnants, the supernova rate, and the ionised medium in the NGC 253 starburst"
- Horiuchi, S. et al. 2006, in preparation. "The structure and evolution of the parsec-scale jet in J0006-0623 from global VLBI observations";
- Deller, Tingay, and Bailes, 2006, in preparation. "A software correlator for very long baseline interferometry using multi-processor computing environments"

Training: Continuing PhD students Mr Adam Deller and Mr Emil Lenc. Continuing co-supervised PhD student at the Auckland University of Technology, Mr Tim Natusch.

2.4. Contribution to Australian industry

2.4.1. Gemini

2.4.1.1. NIFS

Auspace Ltd staff gained valuable professional experience through rebuilding, assembly, integrating, testing, and commissioning NIFS at a major international observatory. ANU technical staff have now taken positions in industry as a result of these projects completing.

2.4.1.2. AAO Instrumentation

The new technology activities are providing activity and focus for Redfern Optical Components and the Optical Fibre Technology Centre (OFTC).

2.4.2. SKA

2.4.2.1. SKA Siting

The Australian SKA Planning Office actively promotes involvement of Australian Industry in key areas of SKA research. A webpage is maintained at http://www.atnf.csiro.au/projects/ska/industry.html

2.4.2.2. SKASS

The team has research relationships primarily with Dell and Cray and source equipment from both companies.

3. Promotion of the Facility

3.1. Project Office

The MNRF symposium for the 2006 calendar year will be combined with the ASA meeting to be held in July 2006.

3.2. Gemini

The national Gemini office put out four press releases this year, and arranged a special “Gemini” issue of the Australian Sky and Space Magazine, including copies of the Gemini virtual tour CD. The project was promoted within the Australian community with a number of talks at different institutions, by distributing the “Gemini Focus” newsletter, and by a special session at the annual scientific meeting of the Astronomical Society of Australia. The Gemini Projects Office also maintains an informative website at http://www.ausgo.anu.edu.au with information for both astronomers and the general public.

The AAO promoted the work carried out under the MNRF program at the major SPIE meeting on astronomical instrumentation held in Orlando, Florida, in July 2006 and other workshops and conferences throughout the past year (see conference proceedings papers listed at 2.3 above).

A number of talks and presentations were given over the past 12 months that relate to the AAO MNRF program. In addition to the conference presentations and posters listed above, there were also presentations on Astrophotonics, Starbugs and OH-suppression fibres at the European Opticon Smart Focal Planes workshop in Edinburgh, November 2005.

3.3. SKA

The SKA projects were promoted by:

- The CABB Project Engineer invited to give a presentation at an EU Radionet Engineering Forum Workshop on next generation correlators held in Groningen, Netherlands in June 2006.
- NTD, SKAMP and SKA siting presentations at the SKA Meeting in Pune, India Oct 30th - Nov 3rd, 2005, the WARS2006 (Workshop on Applications of Radio Science) Leura, February 2006 and the SKA Public Meeting, ATNF Marsfield, 20th April 2006
- Molonglo Open Day: 40 years of Science at Molonglo. Sydney University November 17 and BBQ on site at Molonglo Friday November 18, 2005.
- SKAMP talk at The Grote Reber Memorial Conference "New Techniques and Results in Low Frequency Radio Astronomy" (Hobart, Australia) December 2005
- SKASS was promoted at five talks/seminars, nine workshops, and several times via various radio and local television outlets.

The broader SKA concept was promoted in several publications by Martin Cole:

- “Engineering the Square Kilometre Array” (Engineers Australia Jan 2003);
- “Engineering the Square Kilometre Array” (Engineers New Zealand Nov 2003);
- “Huge Radio Telescope moves to Next Phase” (Engineers Australia Apr 2005).

4. Commercialisation

4.1. Gemini

The OH suppression project may have wider commercial potential outside astronomical instrumentation. The 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 that may have application across a wide industrial and science base. Beyond astronomy we have identified four key areas for possible application:

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

The AAO is working with collaboration partners to explore applications in astronomy and other potential fields.

4.2. SKA

A licensing agreement covering the SKASS software correlator code is currently being developed in order that the code can be distributed to interested parties, potentially for profit. In addition, an agreement between ATNF and Swinburne for Swinburne to provide VLBI correlation services is currently being negotiated, worth $120,000 over two years.

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

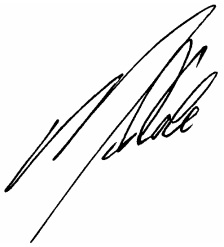
6.1. Financial summary

The MNRF is on track to spend the entire MNRF grant of $23,500,000 on the approved programmes defined in the original business plan and amended by the 2006 contract variation with DEST. As of 30th June 2006, $5,368,795 of the grant (including projected interest until the end of the MNRF) remained unspent, with the 2006/07 financial plan showing commitments for $5,290,361 of this grant:

Date	**Item**	**US$**	**AU$**
Aug-06	Swinburne SKASS		$217,200
Aug -06	2nd 2006 Gemini 1.43% Ops	$205,735	$278,020
Sep-06	Sydney SKAMP		$71,501
Sep-06	Swinburne ELT		$70,000
Oct-06	3rd UK nights	$500,000	$675,676
Jan-07	Magellan payment (1/4)	$172,500	$233,108
Jan-07	Magellan – AAO payment (1/4)		$234,414
Jan-07	Swinburne – ELT		$140,000
Feb-07	2nd Aspen	$928,500	$1,254,730
Mar-07	1st 2007 Gemini 1.43 Ops	$210,878	$284,970
Jun-07	2nd 2007 Gemini 1.43% Ops	$210,878	$284,970
Jun-07	Magellan payment (3/4)	$517,500	$699,324
Jun-07	Magellan – AAO payment (3/4)		$703,242
Jun-07	AAO PM software		$120,000
2006/07	**Total grant expenditure**		**$5,267,155**
	MNRF grant remaining		**$101,639**

The small surplus of $101,639 reflects a prudent decision by the Board to maintain a small buffer against exchange rate fluctuations against the US dollar. For example, the current overseas commitments mean that for every one cent change in the exchange rate, the buffer changes by $50,000. The above summary assumes an exchange rate of 0.74. The final commitment of $120,000 for AAO project management software is also contingent upon a favourable exchange rate.

The Board will decide during 2006/07 how to allocate any small remaining surplus.



Dr Martin Cole, Chairman
30th October 2006

Mr Mark McAuley, Executive Officer
30th October 2006

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 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	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		340	-2,760	230	0	2,760	230	2,990	-2,760
Capital		0		0		0		0	0	0	0	0	0	0	0
Other	550	250	506	280	567	280	1,043	120	1,736	80	2,666	930	2,746	1,010	1,736
Total	550	1,010	506	1,110	567	1,110	1,043	460	-1,024	310	2,666	3,690	2,976	4,000	-1,024
CSIRO TIP															
Salaries	157	96	111	96	195	96		96	79	96	463	384	559	480	79
Capital		64		64		64		64	-256	64	0	256	64	320	-256
Other	422	0	111	0		0	524	0	1,057	0	1,057	0	1,057	0	1,057
Total	579	160	222	160	195	160	524	160	880	160	1,520	640	1,680	800	880
AAO															
Salaries	68	84	246	189		275		541	-775	675	314	1,089	989	1,764	-775
Capital		0		0		0		0	0	0	0	0	0	0	0
Other	68	28	167	63	325	137	261	271	322	337	821	499	1,159	836	322
Total	136	112	413	252	325	412	261	812	-453	1,012	1,135	1,588	2,147	2,600	-453
SYDNEY UNI															
Salaries	67	128	70	131	147	135	173	135	-72	67	457	529	524	596	-72
Capital		0		0		0		0	0	0	0	0	0	0	0
Other	67	0	70	0		0		0	137	0	137	0	137	0	137
Total	134	128	140	131	147	135	173	135	65	67	594	529	661	596	65
ANU															
Salaries	420	173	216	173	246	173		172	191	172	882	691	1,054	863	191
Capital		0		0		0		0	0	0	0	0	0	0	0
Other		0		0		0	277	0	277	0	277	0	277	0	277
Total	420	173	216	173	246	173	277	172	468	172	1,159	691	1,331	863	468
SWINBURNE															
Salaries	151	98	45	101	14	106	102	29	-23	0	311	334	311	334	-23
Capital	310	491	49	327		0		0	-459	0	359	818	359	818	-459
Other	2	0		0	105	0	123	0	230	0	230	0	230	0	230
Total	463	589	94	428	119	106	225	29	-252	0	900	1,152	900	1,152	-252
APT															
Salaries		15		15		15		15	-60	15	0	60	15	75	-60
Capital		0		0		0		0	0	0	0	0	0	0	0
Other		5		5		5		5	-20	5	0	20	5	25	-20
Total	0	20	0	20	0	20	0	20	-80	20	0	80	20	100	-80
CEA															
Salaries		15		15		15		15	-60	15	0	60	15	75	-60
Capital		0		0		0		0	0	0	0	0	0	0	0
Other		5		5		5		5	-20	5	0	20	5	25	-20
Total	0	20	0	20	0	20	0	20	-80	20	0	80	20	100	-80
WA Govt															
Salaries	73	100	71	100		100		100	-256	0	144	400	144	400	-256
Capital		75		75		75		75	-300	0	0	300	0	300	-300
Other	44	25		25		25		25	-56	0	44	100	44	100	-56
Total	117	200	71	200	0	200	0	200	-612	0	188	800	188	800	-612
Grand Total In-kind															
Salaries	863	1,369	688	1,550	602	1,645	275	1,343	-3,479	1,270	2,428	5,907	3,698	7,177	-3,479
Capital	310	555	49	391	0	64	0	64	-715	64	359	1,074	423	1,138	-715
Other	1,109	288	854	353	997	427	2,228	401	3,719	427	5,188	1,469	5,615	1,896	3,719
Total	2,282	2,212	1,591	2,294	1,599	2,136	2,503	1,808	-475	1,761	7,975	8,450	9,736	10,211	-475

6.2.2. Cash Contributions from Participating Parties

Table 2

Cash Contributions From Participating Parties ($'000s)

Participating Party	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	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	1,533	432	-5	332	3,823	3,828	4,155	4,160	-5
CSIRO TIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AAO	0	0	0	0	486	0	331	0	817	0	817	0	817	0	817
SYDNEY UNI	65	155	65	155	244	155	118	155	-128	1,655	492	620	2,147	2,275	-128
ANU	245	315	245	315	245	315	213	315	-312	315	948	1,260	1,263	1,575	-312
SWINBURNE	10	10	10	10	63	10	79	10	121	10	161	40	171	50	121
APT	0	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	0
WA GOVT	0	0	264	0	852	0	510	0	1,626	0	1,626	0	1,626	0	1,626
UNSW	210	210	210	210	210	210	210	210	0	210	840	840	1,050	1,050	0
MELB UNI	52	52	52	52	52	52	52	52	0	52	208	208	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	3,045	1,174	2,119	2,574	9,000	6,881	11,574	9,455	2,119

Other Sources	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance	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	1,607	1,637	21	1,637	6,569	6,548	8,206	8,185	21
Victorian Govt	131	0	131	0	0	0		0	262	0	262	0	262	0	262
Sou. Qld Uni	5	0	5	0	0	0		0	10	0	10	0	10	0	10
Monash Uni	0	0	5	0	0	0		0	5	0	5	0	5	0	5
Tasmania Uni	0	0	2	0	0	0		0	2	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	1,607	1,637	300	1,637	6,848	6,548	8,485	8,185	300

	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance	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	8,400	7,500	900	900	23,500	22,600	24,400	23,500	900

Grand Total of Cash Contributions	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance	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	13,053	10,311	3,319	5,111	39,348	36,029	44,459	41,140	3,319

6.2.3. Cash Heads of Expenditure

Table 3

Cash Heads of Expenditure ($'000s)

Total of Heads of Expenditure	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	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	2,476	155	4,968	155	5,916	948	6,071	1,103	4,968
Capital	358	560	107	1,760	793	1,760	876	1,759	-3,705	1,809	2,134	5,839	3,943	7,648	-3,705
Other	3,113	5,323	5,797	6,708	4,293	6,949	8,806	7,157	-4,129	6,248	22,008	26,137	28,256	32,385	-4,129
Totals	4,292	6,366	6,846	8,623	6,762	8,864	12,158	9,071	-2,866	8,212	30,058	32,924	38,270	41,136	-2,866

6.2.4. Summary of Resources Applied to Activities of MNRF

Table 4

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

	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	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	2,282	2,212	1,591	2,294	1,599	2,136	2,503	1,808	-475	1,761	7,975	8,450	9,736	10,211	-475
Grand Ttl 5 Yrs Cash from Tble 2	5,357	5,636	7,913	8,171	13,026	11,911	13,053	10311	3319.405	5111	39,348	36,029	44,459	41,140	3,319
Ttl Resources Cash & Inkind Income	7,639	7,848	9,504	10,465	14,625	14,047	15,556	12,119	2,844	6,872	47,323	44,479	54,195	51,351	2,844

Allocation of Total Resources Applied to Activities of MNRF Between Heads of Expenditure ($'000s)

	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	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	1,684	1,852	1,630	1,705	2,279	1,800	2,751	1,498	1,489	1,425	8,344	6,855	9,768	8,280	1,489
Total Capital Cash & Inkind	668	1,115	156	2,151	793	1,824	876	1,823	-4,420	1,873	2,493	6,913	4,366	8,786	-4,420
Total Other Cash & Inkind	4,222	5,611	6,651	7,061	5,290	7,376	11,034	7,558	-410	6,675	27,196	27,606	33,871	34,281	-410
Grand Total (Cash & Inkind)	6,574	8,578	8,437	10,917	8,361	11,000	14,661	10,879	-3,342	9,973	38,032	41,374	48,005	51,347	-3,342

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

Table 5

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

		Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Variance from Deed (to end 2005/06)	Agreement 2006/2007	Total to Date Actual	Total to Date Agreement	Projected Grand Total 5 Years	Agreement 5 Years	Difference 5 Years
Planning Phase	*CABB*	0	N/A	0	N/A	0	N/A	0	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
	NTD	1621	N/A	1208	N/A	649	N/A	2393	N/A	N/A	N/A	5871	N/A	N/A	N/A	N/A
	MMC	300	N/A	0	N/A	0	N/A	0	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	0	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	0	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	0	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	2,393	523		0	6976	4,250	6,976	4,250	2,726
	insert additional items above this line															
Construction/ Upgrade Phase	*CABB*	358	N/A	469	N/A	800	N/A	1257	N/A	N/A	N/A	2884	N/A	N/A	N/A	N/A
	NTD	0	N/A	0	N/A	0	N/A	0	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
	MMC	0	N/A	145	N/A	301	N/A	207	N/A	N/A	N/A	653	N/A	N/A	N/A	N/A
	SKAMP	134	N/A	140	N/A	340	N/A	664	N/A	N/A	N/A	1278	N/A	N/A	N/A	N/A
	Siting	0	N/A	0	N/A	1242	N/A	1317	N/A	N/A	N/A	2559	N/A	N/A	N/A	N/A
	SKASS	0	N/A	374	N/A	421	N/A	526	N/A	N/A	N/A	1321	N/A	N/A	N/A	N/A
	Total	492	0	1,128	2,199	3,104	2,946	3,971	3,212		3,338					
	insert additional items above this line															
Total Planning & Construction		3218	3640	2336	4781	3753	4463	6364	3735	-948	3338	15671	16619	19009	19957	-948
Operating Phase	Office salary	446	432	64	104	65	104	31	104	-138	104	606	744	710	848	-138
	Office Other	0	50	58	50	89	50	71	50	18	50	218	200	268	250	18
	SKA	0	0	0	0	0	0	0	0		0					
	Gemini Other	3,024	4,657	5,980	6,182	4,454	6,583	8195	7,191	-2960	6,482	21653	24613	28135	31095	-2960
Total Operating Phase		3470	5139	6102	6336	4608	6737	8297	7345	-3080	6636	22477	25557	29113	32193	-3080
Grand Total Expenditure		6688	8779	8438	11117	8361	11200	14661	11080	-4028	9974	38148	42176	48122	52150	-4028

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 ($)	Total ($)
2002/03	List items separately > $50K				
	Supercomputer & IF, Parkes	Swinburne/ATNF	1	536	536
	Molonglo filterbank/correlator	Molonglo	1		0
	SKA demonstrator	ATNF	1		0
	Test equipment	ATNF	1		0
	Software	ATNF	1		0
	W'band correlator	ATNF	1	260	260
	Group items < $50K				0
	In-kind capital items	ATNF	1	25	25
		CSIRO TIP			0
		W.A. DPC			0
Total					**821**
2003/04	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
	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**
2004/05	List items separately > $50K				
	W'band correlator	ATNF	1	533	533
	Spectrun analyser	ATNF	1	88	88
	Fibre bragg grating OH	AAO	1	91	91
	Group items < $50K				
					81
Total					**793**
2005/06	List items separately > $50K				
	NIFS components	ANU	1	145	145
	W'band correlator	ATNF	1	303	303
	SKAMP correlator & filterbank	Syd Uni	1	254	254
					0
					0
	Group items < $50K				
					174
Total					**876**
2006/07	List items separately > $50K				
					0
					0
	Group items < $50K				
					0
Total					**0**
Grand Total					**2645**

6.3. Auditors report

BDO

Chartered Accountants & Advisers

Level 19, 2 Market St. Sydney NSW 2000
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 2006

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 Gemini and SKA Major National Research Facilities Program ('GSKA MNRF') for the year ended 30 June 2006, 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

GSKA 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 included 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 GSKA 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 2006.

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

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

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

BDO

BDO
Chartered Accountants

Melissa Alexander

Melissa Alexander
Partner

Sydney, this 18th day of October 2006

BDO

CONSOLIDATED INCOME AND EXPENDITURE STATEMENT OF THE MAJOR NATIONAL RESEARCH FACILITIES PROGRAM FOR THE YEAR ENDED 30 JUNE 2006

	ACTUAL Year Ended 30 June 2006 $
INCOME:	
DEST Grant	8,400,000
Other	2,783,499
In-Kind contributions	2,502,683
TOTAL INCOME	**13,686,182**
EXPENDITURE:	
Salaries	2,476,357
Salary on-costs and overheads	38,824
Other expenses	3,772,919
In-Kind salaries	274,670
In-Kind salary on-costs and overheads	2,206,761
In-Kind other expenses	21,252
TOTAL EXPENDITURE	**8,790,783**
CAPITAL EXPENDITURE:	
Capital expenditure	875,899
TOTAL CAPITAL EXPENDITURE	**875,899**
TRANSFERS:	
Transfers to Non-Participants	4,993,857
TOTAL TRANSFERS	**4,993,857**
TOTAL EXPENDITURE FOR THE YEAR	**14,660,539**

Note: As with previous years, the Sydney University Trust Fund has provided the GSKA MNRF with a statement of Gemini payments to the NSF, but has not allowed the GSKA MNRF auditors to audit the Trust Fund. Therefore, this audit report does not show the income to the MNRF in the form of ARC and University payments to the Trust Fund. However, the financial tables assume income to equal expenses for the component of the MNRF that passes through the Trust Fund. The income stated in the auditor's report does not include this income.

Appendix A: 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

321 %

>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)	3	6%	0	0%	3
• Industry	0	0%	0	0%	0
• University	46	94%	0	0%	46
• Other (please specify)	0	0%	0	0%	0
• Total	49	100%	0	0%	49

(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

In last year's report we discussed a user survey complaining about the very small fraction of complete data sets received. Gemini have dramatically improved their observing efficiency, and the fraction of complete data sets is now well above 80%.

(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 2005/6 72% 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, 51% 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	0	14
	Books and chapters in books	0	0
Media	Newspaper, TV, radio	20	5
	Popular scientific press	10	3
Other (Websites)	(eg ABC Science Online)	5	5

(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	10	20
Community-based fora eg talks to schools	2	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 2005/6 47% of the proposals received had Australian PhD student involvement, and 40% had post-docs on the proposal. 13 students and 14 post-doctoral researchers were awarded time on Gemini.

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

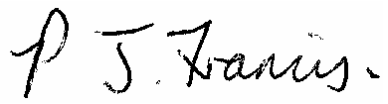
Activity	Number	Income ($'000)	Comment
• Licensing agreements	0	0	
• Contract services and consultancies undertaken by Facility for fee paying clients	0	0	
• Income to Facility from royalties and sales of products and services	0	0	
• Other (please specify)	0	0	
• Total	0	0	

(d) Total income received in the reporting year

Income type	National	International	Total
• Total Cash ($'000)	$1,869,330	$0	$1,869,330
• Total In-kind ($'000)	$0	$0	$0
• Total MNRF grant ($'000)	$4,668,134	[redacted]	$4,668,134[1]
• Total	$6,537,464	$0	$6,537,464

(e) Self sufficiency in terms of operating costs

Percentage of total income that covers the Facility's operating costs excluding the MNRF grant. 70%



Facility Project Scientist

5th September 2006

[1] Out of the $4,668,134, only $800,270 was for the operating cost of the 6.19% of Gemini. The rest of the money was for purchasing part of the 6.19% or purchases of nights from owners of the other 93.81% of Gemini. Therefore, in calculating the percentage of operating costs covered external to the MNRF, only the $800,270 was considered ($800,270 / ($1,869,330 + $800,270) = 0.3).

Appendix B: 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 C: 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 D: 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 E: 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