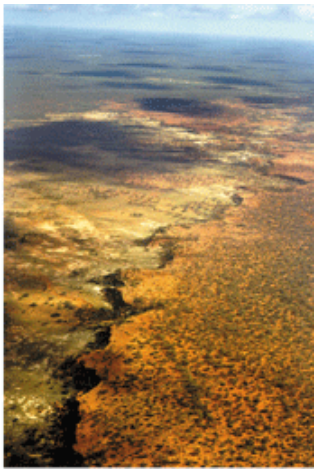
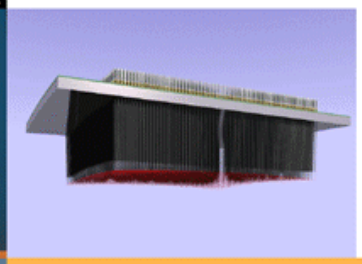
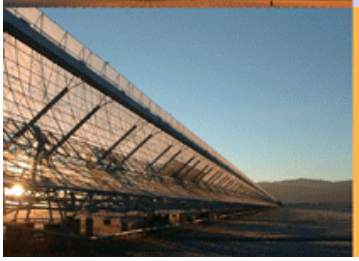


The Gemini and SKA MNRF: Australia's Astronomy Future





Annual Report 2006-07

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). The MNRF concluded in June 2007: the objectives of the original proposal have been achieved with major new facilities now available to the Australian astronomy community. The highlights of the past year have been:

- The Near-Infrared Spectrograph (NIFS) was made fully available to the Gemini community from semester 2006B.
- The Gemini South Adaptive Optics Imager (GSAOI) has been delivered to Gemini and has passed all acceptance testing. It cannot, however, be used until Gemini completes the laser adaptive optics system which feeds it. This has been delayed and first-light is not now expected until autumn 2008.
- Selection of the Australian SKA site as one of 2 acceptable sites for the SKA (the other being Southern Africa) in September 2006. On-site monitoring of the levels of radio-frequency interference at the Australian SKA candidate site in WA continue, with progress on infrastructure, land and heritage to lead to a site permit for ASKAP.
- Good progress with the development of Focal Plane Array receivers as part of SKA technology demonstrator, the New Technology Demonstrator (NTD). THEA tile from the ASTRON SKA group in the Netherlands & chequerboard array.
- A further additional 8 nights were allocated on the Gemini South telescope in semester 2006B. The extra time was made available following a purchase from the UK allocation. Taken together with the additional 1.43% share of Gemini time, over the entire lifetime of the MNRF program, observing time on 8-m class telescopes available to the Australian community has increased by 80+%, directly as a result of the MNRF funding.
- 8 nights of time were purchased on the Magellan 6.5m telescopes in semester 2007A, further increasing the availability of time on large optical/IR telescopes to the Australian community, and offering different capabilities from Gemini (particularly a wide-field capability with the IMACS camera, and high dispersion spectroscopy with the MIKE spectrograph). A further 7 nights have been allocated in 2007B.

As evidenced by the above list, the Australian Astronomy Gemini and SKA programmes have had significant scientific and technological success in 2006-07, following the standard set in each of the previous four years.

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1. Establishment, enhancement and operation

1.1. Governance

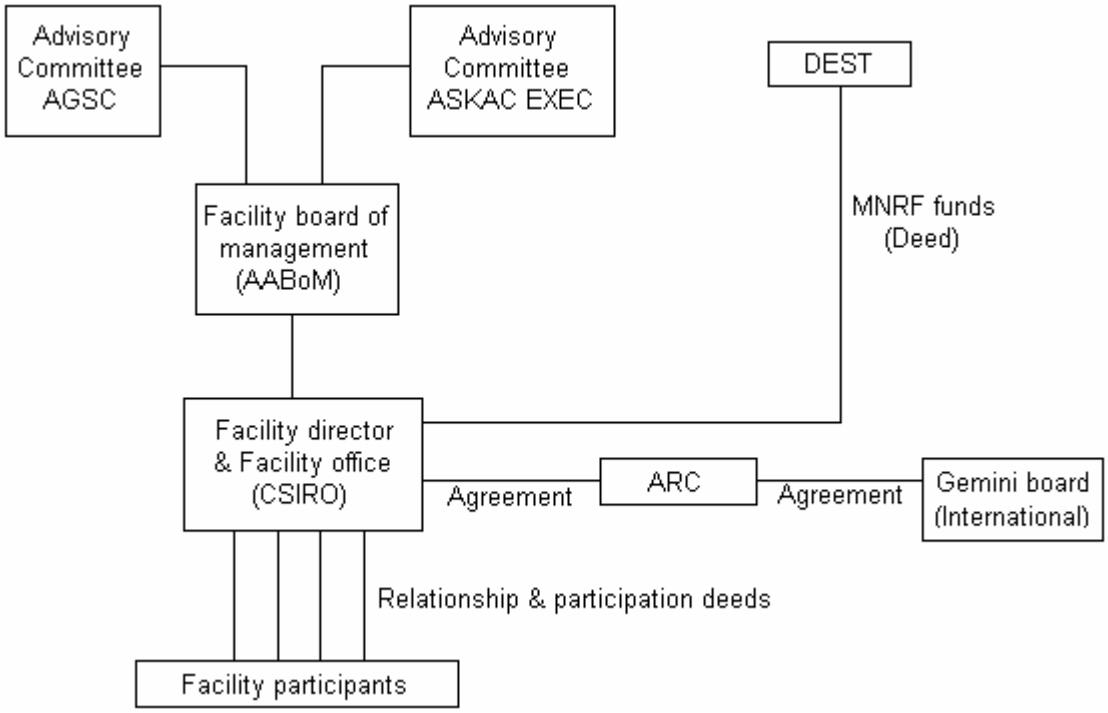


Figure 1: Relationships within the MNRF

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 2006 as required. The final DEST payment ($5.4m of the 2005/06 $8.4m grant) was received in June 2006 and a full final year budget was agreed as part of the 2005-06 annual reporting process.

No changes to the MNRF contract, or the budget were necessary during 2006-07 and the project has run smoothly.

The increasing value of the Australian dollar against the US dollar provided a small surplus of funds in the MNRF accounts. It was agreed with DEST that this could be transferred to Astronomy Australia Ltd, a company set up to administer the Astronomy NCRIS funds. This transfer has been completed, and the AAL contract with DEST reflects this additional income. Details are given in the full Financial report at the end of this document.

1.2.2. Gemini

1.2.2.1. Gemini Share

The Gemini Share project supports Australian use of the large telescopes in two main ways: by continuing to pay for the additional 1.43% share in the Gemini Partnership, by purchasing an additional 8 nights per semester of time on Gemini South, for each of the semesters 2005B, 2006A and 2006B, and by purchasing 15 nights per year of time on the Magellan Telescopes in 2007 and 2008. Together, these arrangements increased the large optical telescope time available to the Australian community by 120% for the 2006/7 period.

The "Aspen Process" to build the next generation of Gemini instruments has been in some disarray, due to uncertainties in the amount and timing of funds to be contributed by the USA, Canada and the UK over the next three years. Nonetheless, the Gemini Planet Imager is under construction, the Planetary Radial velocity Spectrograph detailed design study is underway, and negotiations are underway to restart the WFMOS studies, as discussed below.

The purchase of time on the Magellan telescopes has commenced. This time has proven popular, being oversubscribed by a factor of 3. The first observers have now been to Magellan, and have apparently secured excellent data. The two Australian-funded Magellan fellows (David Floyd and Riccardo Covarrubias) have both now started work at Magellan.

1.2.2.2. RSAA Gemini Instrumentation

Near-Infrared Spectrograph (NIFS)

NIFS was available to the astronomical community in queue mode for 129 nights in the 2006/07 reporting period. It will be available in queue mode for a further 72 nights in semester 2007B, some of which using the Laser Guide Star facility. The instrument was used for Guaranteed Time observations by the ANU instrument team in July and December 2006.

GSAOI

On-site acceptance tests for the GSAOI instrument were completed in July 2006. The instrument was shipped to the Gemini South telescope in Chile in August 2006. Laboratory commissioning occurred in October 2006. The instrument will now wait until Gemini's Multi-Conjugate Adaptive Optics (MCAO) system is completed in early 2008 before on-sky commissioning of GSAOI can occur and the Guaranteed Time science program can commence. The Australian astronomical community has

been invited to participate in the Guaranteed Time program. Six programs were suggested with participants from ANU, Swinburne University of Technology, UNSW, and Macquarie University. A final decision will be made later in 2007 once the performance of MCAO is better determined.

1.2.2.3. AAO Instrumentation

WFMOS design studies

The Gemini Board agreed to re-start the WFMOS concept studies at its November 2006 meeting. However the re-start was delayed, first by the negotiation with Gemini and NSF over the reimbursement of expenses for the original, aborted study, and then by the inability of the other team to identify an institution willing to act as prime contractor. Payment for the original study was received in March 2007, and an alteration in the terms and conditions of the study, agreed by the Gemini Board at its May 2007 meeting, allowed the other issue to be resolved. The AAO submitted a letter of intent that it would respond to a revised call for proposals in May 2007, and will submit the new proposal at the end of July, with the aim on re-starting the 12-month study in September 2007.

The additional funding the AAO secured to continue its own components of the WFMOS concept study, and to explore alternative telescope platforms for WFMOS, is now halfway complete, and is expected to be finished in early 2008.

The AAO is now in the final stages of installing and testing 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 was planned to be in operation by the end of 2006, but some difficulties with the software and the supplier have delayed the go-live date to July 2007. The software should be bedded in before the new WFMOS concept study starts in September.

Astrophotonics

Phase 1 of this project was completed in June 2005, and delivered a new broadband optical fibre that was first deployed in the new AAOmega spectrograph on the AAT in January 2006 and which is being considered for WFMOS.

Phase 2 began in November 2005 and completed in July 2006. It explored imaging fibre systems, infrared fibres and optically-reformatting fibres.

OH-suppression fibres

The first phase of this project was the construction of a Fibre Bragg Grating (FBG) prototype that was able to suppress the strong OH lines that dominate the near-infrared sky background. This goal was achieved in February 2005. The second phase was to construct a prototype system for feeding multi-mode fibre (MMF) into single-mode fibres (SMF) imprinted with FBGs. This was completed in March 2005. Both these phases represent significant technological breakthroughs.

The third phase of the project has the goal of realizing a commercial prototype MMF grating for on-sky demonstration using the AAT. This is a 50 micron core fibre which suppresses 36 OH lines in the near-infrared H band at a resolution of R=10,000. The manufacture of the prototype is complete, but additional work at the telescope is needed to allow the system to be tested on-sky. This has been delayed

by reprioritisation of other aspects of this program. The on-sky tests are now expected to occur in the latter part of 2007.

Starbugs

Phase A was completed in June 2005 and delivered a working prototype Starbug that has been demonstrated to position to within 10 μm under closed-loop control. This bug has been operated in a cryogenic environment down to a temperature of –100C.

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 meetings 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)

Significant progress has been made during the year, although there have been delays in a number of areas. As a result, and with a view to minimising any delay in the final completion date, plans for the Stage 1 installation at Narrabri have been significantly reduced in scope.

The original plan for Stage 1 was to have all six antennas being outfitted with an interim single frequency CABB facility. This would have allowed in-parallel tests with the existing backend, with the possibility of some early observations over a six to eight month period prior to the final installation. In light of the delays being experienced, the extra resources required to implement this 6-antenna interim system were considered to be excessive. The modified Stage 1 plan sees only three antennas outfitted. This will allow significant resource savings while having little impact on our ability to test all aspects of CABB. The ability to do useful

astronomical observations with the full array prior to the final installation is lost. Current projections see the final installation date being delayed by around 2 months.

In the early part of the year progress was good in most areas. In particular, the complex signal processing board, in many ways the heart of the CABB system, passed through the fabrication and early testing phases close to schedule. Delays began to occur with the fine-tuning of the signal processing board, and in the design of the signal processing firmware that runs in it. These complex tasks proved to be significantly more time consuming than had been expected. As a result, the full data path tests, which had originally been planned for November 2006, were not completed until April 2007.

The successful completion of these tests was an important milestone for the project, as it demonstrated that all of the major components, viz., the conversion system, the multi-bit digitisers, the wideband data transmission system, and the signal processing hardware and firmware, as designed, would be capable of meeting the specifications. It also meant that final fabrication of these components could proceed.

The first production runs of digitiser PCBs and central processor interface PCBs have now been completed. The main signal processor PCBs will be delivered at the end of July and an initial fabrication run will commence.

Other components, required for the reduced Stage 1 installation, such as the conversion and local oscillator modules are proceeding on schedule. The racks, which will accommodate the CABB equipment in the antennas, were installed in their interim locations during an extended shutdown in April. Since then, the staff at Narrabri has been preparing connections to the racks. The central site CABB racks have also been installed in the screened room. Installation of components in the antennas, and in the central site will commence in late July and proceed into August when good access to the required antennas is available during an extended period of split array operation.

A pulsar digital filter bank containing a number of CABB hardware components, including a digitiser and the first CABB signal processor PCB, has been operating at Parkes since March. Although some problems have been encountered with intermittent data errors, this unit is the first 1GHz bandwidth pulsar processor, providing pulsar timing of unprecedented accuracy. It is also providing invaluable experience of the CABB components in an operating environment. Control and data acquisition software, and pulsar processing firmware developed for this system have direct application to CABB.

1.2.3.2. New Technology Demonstrator (NTD)

This final year of the NTD project has been very successful. Following the detailed investigation of the ThEA tile phased array, the project has developed a new "chequerboard" design for phased array feeds that is promising to provide both wide field of view and wideband operation with system noise temperatures comparable with conventional horn feeds.

The NTD project started this year with the main objective being to get a good understanding of the behaviour of Vivaldi feeds from a careful analysis of published

works, coupled with measurements of the ThEA tile on the NTD interferometer at Marsfield. For this, the ThEA tile was mounted on the East antenna of the NTD. The front-end receivers had been modified to reduce the effect from local interference, and it was connected to the full receiver chain and digital beamformer. Fully functioning NTD observing software was implemented, so that beamformed responses from this fully-digital system were possible.

The first ThEA tile interferometer measurements were done with Optus B3 satellite and then with the bright radio galaxy Fornax A. Work then commenced on more quantitative measurements of element beam patterns, covariance, etc.

Both the experimental tests and theoretical models (derived in collaboration with the University of Massachusetts) of the ThEA array indicated that there were fundamental issues with the assumption that Vivaldi elements were the best choice for a phased array feed: At this point the project decided to focus its reserach on simpler array elements than Vivaldi feeds.

A prototype 5 x 1 element focal plane array, based on simple linear dipoles, was modelled and simulated, then fabricated with measurements taken in spherical antenna range. Testing of this 5 x 1 phased array feed was particularly successful in that it showed good agreement between theoretical models and experimental measurements. Following some further work, a significant theoretical breakthrough in the design of elements for the phased array feed was made and a whole new 5 x 5 experimental module was made using a “chequerboard” (fat dipole) design. The project team has derived a method to improve the modelling software and handle larger array sizes.

This project has achieved its objectives in developing focal plane array technology and was closed on the 30 June 2007. The infrastructure and the IP from the NTD project will continue and be used and further developed as part of the ASKAP (previously known as the xNTD) project.

1.2.3.3. Monolithic Microwave Integrated Circuit (MMIC)

The major activities were in two MMIC technology areas, Indium Phosphide (InP) and Complimentary Metal Oxide Silicon (CMOS).

InP HEMT MMICs

In the InP area, effort was directed at wrapping up the second of the two InP fabrication runs carried out in collaboration with the EU FP 5 Faraday project. Chips from the first wafer delivered from this run were used in the new 7mm receivers for the ATCA. The receivers were installed on the telescope in April 2007 and have met all relevant specifications. The remaining wafers from this run were finally delivered in September 2006. Wafer testing was completed in March 2007. The activity was completed with the delivery of final diced chips to our EU partners.

RF-CMOS Integrated receiver MMICs

In the CMOS area, work continued on the design of integrated receiver MMICs of the type required for the SKA and its pathfinders. Chips from the second fabrication run were delivered in September 2006. Testing was completed in

January 2007. This confirmed that all of the sub-circuits functioned as expected. Also successfully demonstrated was the first complete System on Chip receiver, incorporating frequency down conversion of an RF signal, followed by filtering and digitising of the resulting IF signal. Of note is the performance of the 6-bit quadrature analogue to digital converter (ADC), which exhibits spurious free dynamic range (SFDR) of at least 35 dB and is capable of operating at clock rates in excess of the design goal, 256 Ms/s. The chip functions well when all subsystems are used simultaneously and maintains the 35dB SFDR of the ADC.

The new LNA design on this chip is a qualified success, showing an input return loss of better than 15dB, and useable gain from 200MHz to 2GHz. The noise temperature of 180K is somewhat higher than anticipated but does verify the noise cancelling principle. A similar circuit, without noise cancelling, exhibits noise temperatures in excess of 240K.

A third CMOS fabrication run was undertaken in April 2007. The new MMIC design builds on the success of the last chip while more closely addressing the specific requirements of the ASKAP project. Notably, the IF bandwidth of the chip was increased from 200 MHz to 300 MHz and the quadrature LO circuitry was modified to suit ASKAP system requirements. Chips are due for delivery in July 2007, by which time this activity will have transferred to the ASKAP project.

A new activity was undertaken to investigate a new type of MMIC process. Circuits were designed for inclusion on the OMMIC (EU) advanced 70nm metamorphic high electron mobility transistor (MHEMT) wafer fabrication run being organised by the EU FP 6 PHAROS project. The performance of MHEMT technology has the potential to rival that of Indium Phosphide technology, and having circuits fabricated outside of the US will avoid the difficulties recently experienced in getting Export License approval from the US State Department. Three circuits were designed, a 30-50 GHz low noise amplifier (LNA), a 4-8 GHz LNA and a 1-10 GHz differential LNA. They were submitted for fabrication in September 2006. Ten off of each circuit design were fabricated and delivered in April 2007 and a sample of these was tested. The measured performance of the 30-50 GHz LNAs was almost as good as that of comparable InP circuits and the measured performance of the 4-8 GHz LNAs was slightly better than that of comparable InP circuits

1.2.3.4. SKA Molonglo prototype (SKAMP)

The development of subsystems to upgrade the Molonglo telescope to a spectral line capability, SKAMP 2, has proceeded steadily. CSIRO, through Dr John Bunton, has been responsible for the architectural design of the spectral line correlator and the detailed design work, schematics and layout of the FPGA PCBs, was subcontracted to Domain 42 Pty Ltd, an SME based in Hobart. This work is well behind schedule. There are three reasons for this. First the scope and complexity of work was underestimated, second there have been some significant changes in the architecture and hence the scope of the project, and third a key resource at Domain 42, Chris Weimann, has not been available. The architectural changes were made to ensure that the system will meet all specifications and be useful not only for SKAMP but also for the MWA (Mileura Widefield Array) which is now contributing to the funding of the design. In order to limit further delays some PCB routing has now been subcontracted to a team in India.

The fibre optic cable network at the Molonglo observatory required for SKAMP2 and SKAMP3 has been fully installed and tested.

A digital communications prototype for sending digital data from the receivers to the control room has been undergoing long-term testing. A number of test issues remain. At present data is being transferred on a long term basis at 1.8 Gbits per second with no errors.

The local oscillator generator and distribution system has been designed, prototyped and tested and ninety-six local oscillator fibre optic transmission modules are in production. Ninety-six high speed transmission modules are in also production ready for installation.

The change over of the telescope control computer has begun with the removal of redundant systems and the rewiring of some control systems.

The design of the linefeed required for SKAMP 3 is complete and one module is currently undergoing extensive field testing and analysis.

The construction of the Rapid Prototyping Telescope (RPT), a new stand alone duplicate of one bay of the main telescope, is complete and the second half is currently having its mesh surface installed. The RPT is a test bed for testing out the whole of the SKAMP3 system including the re-meshing techniques, before extensive modification of the 88 bays of the main telescope.

Prototypes of the new wideband receivers are being tested. At this stage their design is scheduled to be ready for production at the beginning of November 2007.

It should be noted that SKAMP has received funding from other sources over the period 2006-07, amounting to approximately $150,000 cash and $250,000 in-kind.

Unfortunately the deployment of Telstra's new wideband CDMA network known as NEXT G has caused significant interference to the telescope from handsets operating within the band. Staff have been working with Telstra and the ACMA to produce a technical fix and they have developed a prototype tunable inter-digital filter which may be an extra subsystem required before SKAMP 3 begins operations.

1.2.3.5. SKA Siting

Since submitting the Australian SKA Site bid and report on the 12-month RFI testing at the site in 2005/2006 the SKA Siting team has continued to promote the excellence of the Australian candidate SKA site – in national and international meetings, newsletters and via webpages.

1.2.3.6. SKA supercomputer simulation & baseband processing (SKASS)

The final year of the MNRF program at Swinburne has brought to completion the final milestones for SKASS, as listed in the table below. The Swinburne MNRF program has delivered on its promise of providing cutting edge upgrades for existing facilities, for the good of the current user community, while demonstrating baseband technologies for the SKA and contributing to SKA simulation efforts.

In terms of the final milestones for year 5 of the project, ongoing eVLBI National Facility observations have been supported using the Swinburne software correlator. Following successful tests in year 4, eVLBI was first offered as part of the VLBI National Facility at the December 2006 proposal deadline. The first National Facility eVLBI observations were undertaken in March 2007, part of a ToO proposal for Circinus X-1, a galactic X-ray binary (Figure 1). The eVLBI array is centred around the ATNF telescopes at Parkes, ATCA, and Mopra, the University of Tasmania telescope near Hobart, the 1 Gbps fibre-based network between the ATNF telescopes, and the Swinburne software correlator, installed and operated on the CPSR2 pulsar cluster computer at the Parkes Observatory.

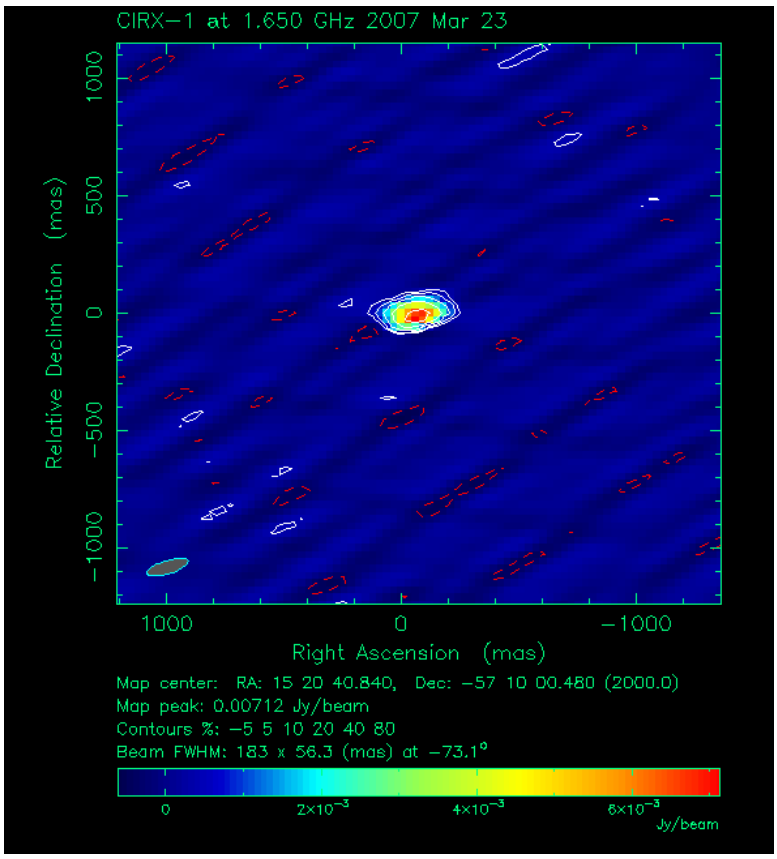


Figure 1: Image of Circinus X-1 at 1.650 GHz from the first National Facility eVLBI observations in March 2007. The image and data are published in Phillips et al. (2007)

At the June 2007 proposal deadline, several eVLBI proposals were submitted to make use of these new facilities. During the June 2007 VLBI session, further refinement of the eVLBI system allowed successful tests using a sustained 256 Mbps data rate from the three ATNF telescopes and 128 Mbps from the Hobart telescope, correlated in real-time at Parkes. First results from the eVLBI array have been published by Phillips et al. (2007).

In addition to eVLBI developments based on the software correlator, the software correlator now supports all Australian VLBI observations, allowing the decommissioning of the ATNF S2 correlator early in 2007. A contract between Swinburne and the ATNF is in place to govern and manage this work. A

comprehensive paper on the software correlator has been published by Deller et al. (2007).

In support of the development of the software correlator at Swinburne for National Facility support, Swinburne has recently upgraded the supercomputer to now consist of 145 dual processor (quad core per processor) machines. In addition, Tingay was PI on a Swinburne infrastructure proposal that secured $600k of cash, $130k of which was for the purchase of disks for VLBI. Matching this $130k, ATNF contributed $150k of cash and the University of Tasmania contributed $20k. The combined $300k purchased enough disks to support all National Facility VLBI observations at high data rates (256 Mbps – 1 Gbps).

Further, a licensing agreement was generated at Swinburne, governing the terms under which external institutions can use the Swinburne software correlator. Currently, the software has been taken up by several major institutions under these terms. The NRAO are using the software correlator as the basis for the upgrade of the VLBA. The MPIfR is using the software correlator as the basis for the upgrade of the astronomy/geodesy VLBI correlator in Bonn. Several minor institutes have taken up the software correlator, for local developments. Swinburne and the NCRA are currently engaged and funded (through a DEST Australia/India bilateral funding scheme) to install and operate the Swinburne software correlator on the GMRT.

Growing from the software correlator work, Swinburne is now a participant in the NCRIS 5.13 capability (The Structure and Evolution of the Australian Continent) and will be providing the software correlation facility for a new array of four geodetic VLBI antennas in Australia and New Zealand.

As well as VLBI, the hardware deployed at the Australian telescopes and at Swinburne as part of this project have been used for a range of other experiments in 2006/07. Briefly, the hardware has been used for observations of giant pulses from the Crab pulsar (Bhat and Tingay, 2007) and in the search for ns radio Cherenkov pulses from the moon, in an effort to detect extremely high energy neutrinos (in collaboration with Professor Ron Ekers).

The Swinburne team have continued SKA simulations work as part of the international SKA project, via SKADS. This work has now been brought to completion. Swinburne hosted a visit by Dr Andrei Lobanov in September 2006, to work on SKADS simulations.

A number of results based on the Swinburne MNRF project have been written up and published, or are in press or preparation (see section 5).

In recognition of the Swinburne team bringing the SKA MNRF project to completion in 2006/07, and achieving research excellence over a 5 year period, the team (Tingay, Bhat, Horiuchi, Deller, and Lenc) was awarded the 2006 Vice-Chancellor's Research Award at Swinburne University.

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	Complete: June 2004	
New board composition to be agreed	June 2003	Complete: May 2003	Board formed September 2003.
Annual report to be provided to DEST	September 2005	Complete: September 2006	
AABoM to meet at least:	Four times per year	Complete: final close out meeting held on 12 June 07 with AABOM's agreement	

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	NIFS commissioned in Oct/Nov 2005
4. Award of a new instrument contract from Gemini	July 2004	Completed: November 2002	Instrument is Gemini South Adaptive Optics Imager (GSAOI)
5. GSAOI Design & construction		Completed July 2006	GSAOI Acceptance tests complete
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	Completed August 2006	GSAOI delivered to Gemini South Telescope
7. Contingent on 4 above,	May 2006	Completed	GSAOI Laboratory

successfully commission GSAOI.		October 2006	commissioning Oct 06, however instrument awaits Gemini's MCAO system before true first-light.

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	Restarting	New milestone, added after project plan. Suspended by Gemini in May 2006; project re-started Nov 2006; call for proposals May 2007
WFMOS Conceptual Design Study complete	Oct 2006 (revised to Sept 2008)	In progress	New milestone, added after project plan. Delays to study imposed

			by Gemini
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	Jan 2006 to Dec 2006 (revised to Dec 2007)	In progress	New milestone, added after project plan. This milestone delayed due to external reprioritisation of other aspects of the program
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 operational with new backend.	January 2006		Now part of amended plan - 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	Completed in Jul 2006	
Assemble first DFB/Correlator PCB	Aug 2006	Completed in Aug 2006	
Begin testing DFB/Correlator PCB	Sep 2006	Started in Sep 2006	
Begin integration and testing of complete data path. Requires final prototypes of all data path components.	Oct 2006	Started in Nov 2006	
Complete testing DFB/Correlator PCB and complete data path.	Nov 2006	Completed in Apr 2007	
Begin fabrication of production quantities of	Jan 2006	Started in May 2007	

DFB/Correlator PCB			
Begin stage 1 installation of CABB racks in the antennas - off the turret	May 2007	Completed in Apr 2007	Only 3 antennas outfitted as per modified stage 1.
6 antennas outfitted with stage 1 CABB equipment	July 2007	Aiming for 2 antennas outfitted by Aug 2007	Third antenna will follow by Oct 2007
Complete, and begin testing of, DFB/Correlator PCBs	May 2007	Delayed	Expected in Aug 2007
Install stage 1 DFB/Correlator and begin full array tests; in-parallel operation with existing backend	July 2007	Delayed	Initial 2-antenna tests expected in Aug 2007
Complete Stage 1 testing	Sep 2007	Delayed	Testing will continue into early 2008
Commence extended shutdown to remove old backend in the antennas and replace with full CABB backend	Feb 2008	Delayed	Now planned for Apr 2008
Solution successfully tested after commissioning.	May 2008	Delayed	Now planned for Jun 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 2006/07
Critical Design review (CDR) – ie Detailed Design Complete	December 2005	Cancelled	Replaced by new milestones below for 2006/07
NTD Project Completion and Demonstration	June 2007	Cancelled	Replaced by new milestones below for 2006/07

Preliminary electrical design and simulation completed.	August 2006	Over the course of the year 2006/7 there were substantial revisions to the project plan and to the milestones. The major change in direction was a result of the revelation that Vivaldi elements were not the way to proceed. This impacted on the simple linear project plan shown opposite. All the milestones listed with the
Mechanical design completed.	November 2006	
Full electrical design and simulation completed.	November 2006	
ThEA tile and beamformer working mounted in Fleurs dishes	30 July 2006	

Prototype construction completed.	March 2007	exception of installing the 5x4 prototype array on the NTD interferometer have been achieved. The ThEA tile reamains installed on the NTD and continues to be used for the development of beamformer and calibration understanding and algorithms
Prototype installed and being tested on the Fleurs dish	April 2007	
Test results and analysis available for formal review	June 2007	
Closure document submitted to PRB.	July 2007	

Detailed Milestones for the NTD project for 2006/07 are as follows:

Milestone	Planned date	Status
Preliminary Design Review	Completed August 2005	
Assembly of the test bed system consisting of the two Fleurs dishes	Completed March 2006	
THEA tile received	Completed (array at ATNF) December 2005	
Assembly of the test bed system consisting of the two Fleurs dishes	Dec-06	Completed Dec-05
First Dish Commissioned	Complete May 2006	
Second Dish Commissioned	Complete June 2006	
Simple two-element interferometer operational	Complete July 2006	
Investigation of THEA tile FPA on single antenna complete	First phased complete Sept 2006, measurements ongoing	
Alternative FPA design (linear array) complete	July 06	Being done in stages. A 5 x 1 element array has been built, tested, measured in antenna range
Development of the 5 x4 focal plane array.	Prototype complete May 2007	All the bits for the 5 x 4 array have been obtained.
Beamformer experiments	Ongoing as at April 2007	

NTD Final Project Report	Complete 30 June 2007	

1.3.3.3. Monolithic Microwave Integrated Circuit (MMIC)

Task	Project plan	Status	Comments
Submit designs for first (InP) fabrication run.	March 2003	Completed March 2003	
Submit designs for second (sample and hold circuit) fabrication run.	April 2004	No longer required.	Commercial devices are now available that negate this sampler development.
Submit designs for integrated receiver prototypes	April 2004	Completed: April 2005	
Submit designs for integrated receiver assemblies	November 2004	Cancelled	Replaced by new milestones below.
Begin production fabrication of integrated receivers	January 2005	Cancelled	Production no longer Considered to be part of this project
First devices (integrated receivers) available for integration into demonstrators	December 2004	Revised: March 2007	See final milestone of this project
Submit designs for third (stage 2 InP) fabrication run	January 2005	Completed: April 2005	
Receive wafers from foundry – second InP run	September 2005	Completed September 2006	New milestone
Final devices (samplers) available for integration into demonstrators.	December 2005	No longer required.	Commercial devices are now available that negate this sampler development.
Submit designs for third integrated receiver fabrication run	April 2006	Completed June 2006	New milestone
Complete testing second InP run	August 2006	Completed March 2007	New milestone
Complete testing of devices from second integrated receiver fabrication run	October 2006	Complete December 2006	New milestone
Complete final integration	December	Cancelled	To be reported in relevant

of devices into demonstrators	2006		demonstrator project.
Submit designs for third integrated receiver fabrication run	February 2007	Complete April 2007	New milestone, added after project plan.
Complete testing of devices from third integrated receiver fabrication run	June 2007	Devices due at ATNF in July 2007	New milestone, added after project plan. Testing and further development will form part of the ASKAP project.

1.3.3.4. SKA Molonglo prototype (SKAMP)

Task	Project plan	Status	Comments
Test continuum correlator design	December 2003	Completed: May 2004	Delayed due to limitations with the PCB manufacturer.
Appoint RF Engineer	March 2004	Completed: June 2004	RF Engineer: Adrian Blake
Design concept for spectral line correlator	May 2004	Completed: December 2004	Top level logic design complete; final detailed design dependent on results from continuum correlator testing, causing delay.
Fringes from 96-station continuum correlator	June 2004	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: December 2007	Expected end of 2007
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	June 2003	Completed	

points between WA Office of Science and Innovation) and ATNF.			
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	Australia short-listed as one of two acceptable SKA sites in Sept 2006
Evaluate siting project and identify improvements	June 2006	Revised: October 2006	Location of core moved within the Section 19 area to ensure no conflict with mining activities. RFI assessment of revised site choice conducted in January 2007.
Respond to ISSAC report on site submission	February 2007	Complete February 2007	New milestone As a result of a meeting in November 2006 Premier Carpenter announced in February 2007 that the Government of WA supported the conclusions of the meeting that the site core should be within Boolardy Station in WA.
Continue to promote Australian site	June 2007	Continuing	New milestone Site investigations are part of EU FP7 PrepSKA proposal and should provide continuing forum for site input.

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	June 2003	Completed	

RFI			
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	Complete 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	June 2005	Completed	

ATCA, in conjunction with the baseband recorders, to conduct RFI surveys at these two sites.			
Use cluster at ATCA to process pulsar observations and measure suitability of the ATCA tied-array for pulsar observations.	June 2005	Completed	
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	June 2006	Completed	New milestone

characterisation hardware and software at the ATCA. Continuation of RFI observations and provision of data to ATCA users.			
Support on-going eVLBI National Facility observations with software correlator.	June 2007	Completed	New milestone
Continue SKA simulations as part of international project.	June 2007	Completed	New milestone
Complete write-up and publication of results obtained throughout the course of the program.	June 2007	Completed	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, and the two Magellan 6.5m 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 both Gemini and Magellan, and the proposal process is run by the Australian Gemini Office, currently based at the ANU.

In 2006/07, a total of 78 proposals requesting time on the Gemini or Magellan telescopes were received (up from 46 in 2005/06), involving 74 astronomers from 12 Australian institutions. A total of 564 hours of Gemini observing time was requested, oversubscribing the available time (223 hours) by a factor of 2.53. Note that this understates the real oversubscription, as a Gemini proposal has to be ranked in science-band 1 or 2 to have a decent chance of being executed, and the number of hours available in these bands was only 122 hours, leading to an oversubscription factor of 4.62.

A total of 450 hours of Magellan time were requested, oversubscribing the available time (150 hours) by a factor of 3.0. The Australian Time Assignment Committee provides detailed technical and scientific feedback to all applicants, be they successful or not.

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.

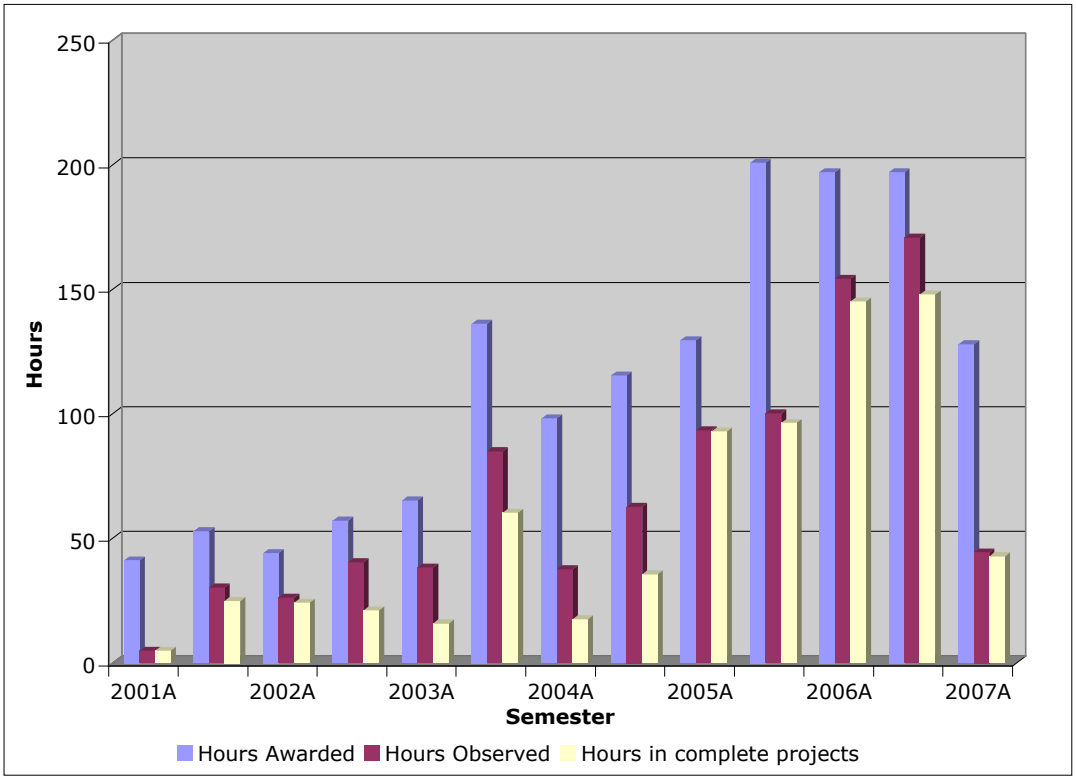


Figure 3: Gemini projects completed

As the graph shows, semesters 06A and 06B were the best yet for Australia. The combination of the extra MNRF funded nights and a very high completion rate led to record amounts of complete data being delivered to Australian astronomers. This was despite an earthquake at Gemini North which shut down the telescope for about a month. Semester 07A, by contrast, is not looking good. The semester had officially just finished at the time of writing, but semester boundaries are blurry at Gemini, and our completion rate may yet rise significantly. This will bear watching over the next few months.

The first five Australian groups awarded time on Magellan have now returned from the telescopes. One night was lost to instrument failures, and the affected group have been allocated a compensating night in semester 07B. All other groups reported excellent weather and smoothly running telescopes, and received excellent data, which are currently being analysed.

2.1.2. ANU RSAA Instrumentation

NIFS

NIFS has been available to the astronomical community throughout the 2006/07 reporting period. Australian time is awarded through the Australian Time Allocation Committee on a merit basic as assessed based on a scientific justification. NIFS has been available on the telescope in queue mode for a total of 129 nights in the reporting period. NIFS has been used for some fraction of this queue-scheduled time.

GSAOI

GSAOI is not yet available to the community because this must await completion of the Gemini MCAO system. When this occurs, the instrument will be available to the community on the same basis as NIFS.

2.1.3. SKA

2.1.3.1 AT Compact Array Broadband Backend

Access to the ATCA's new CABB system will be through the National Facility's standard time allocation procedure.

2.1.3.2 SKASS

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

The Swinburne software correlator and VLBI/eVLBI 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.

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. As the pie-chart shows, the overwhelming majority of applications are collaborations between Australian and international researchers.

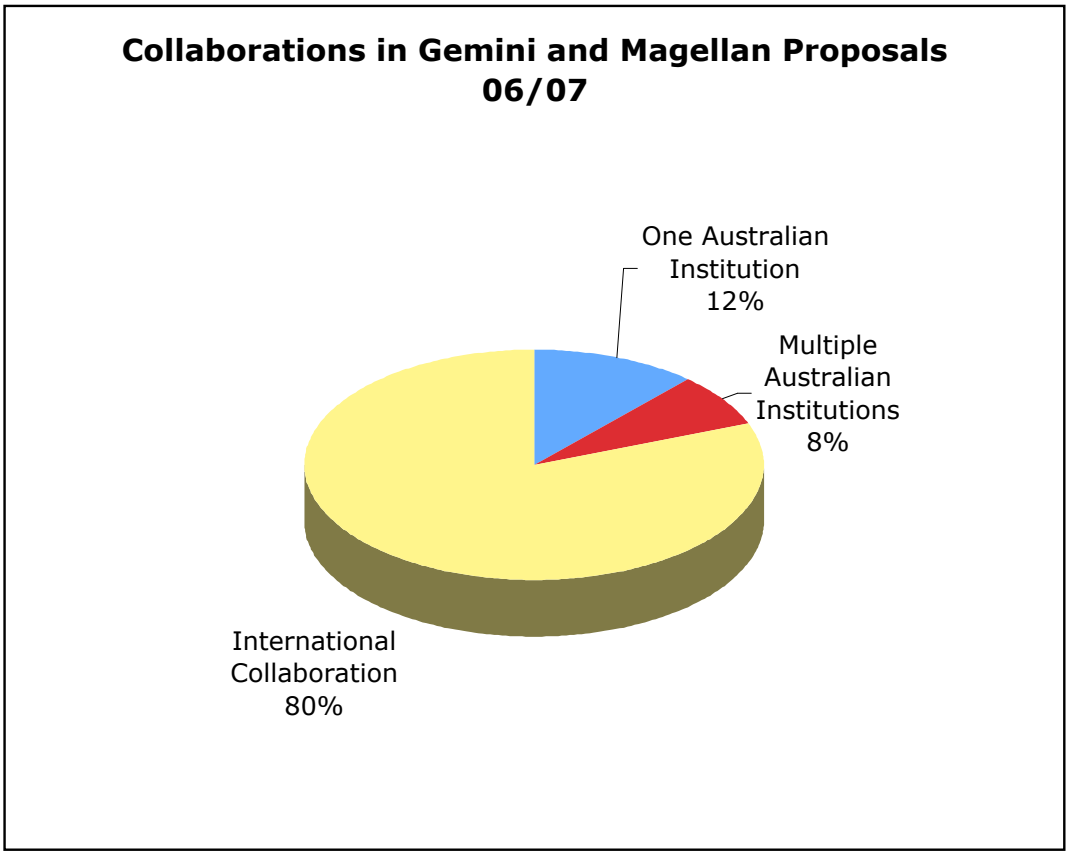


Figure 4: Collaboration Status of Applications for Australian Gemini and Magellan time.

2.2.1.1. AAO Instrumentation

WFMOS Studies

The WFMOS studies have been undertaken by the AAO as the leader of a consortium comprising 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 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.

2.2.1.2. RSAA Gemini Instrumentation

NIFS

The NIFS Guaranteed Time observations are being analysed by astronomers at ANU working in collaboration with Prof Thaisa Storchi-Bergmann in Brazil and her student, Dr Tracy Beck at the Gemini Observatory in Hawaii, and Dr Michihiro Takami and Dr Tae-Soo Pyo from the Japanese Subaru Observatory. NIFS was allocated 32.5 hr in Band 1 (highest priority), 124.2 hr in Band 2, and 17.5 hr in Band 3 in semester 2007A. This was distributed amongst 16 programs involving astronomers from Australia, Canada, USA, UK, Brazil, and Japan.

GSAOI

Plans for use of GSAOI Guaranteed Time are centred on six programs involving astronomers from ANU, Swinburne University of Technology, UNSW, and Macquarie University.

2.2.2. SKA

2.2.2.1. CABB

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

A CABB project engineer was invited onto the review panel for the EVLA correlator and the Long Wavelength Array Technical Advisory Committee.

2.2.2.2. NTD

The NTD team is collaborating with MIT Haystack observatory, sharing expertise and system designs relating to all aspects the digital signal path towards the LFD (MWA) project. The team is also working with the South African SKA KAT team jointly developing telescope management and control software, under a project termed the Convergent Radio Astronomy Demonstrator ‘CONRAD’. The ThEA tile which was used as the initial focal plane phased array feed was supplied by ASTRON (Netherlands Foundation for Research in Astronomy), and results have been shared with the ASTRON team.

2.2.2.3. MMIC

The InP activity was carried out in collaboration with European colleagues as part of the EU FP 5 and 6 Faraday and Pharos projects. EU engineers visited ATNF to undertake testing of their MMIC designs, and ATNF personnel attended a number of EU project meetings. In particular, the project manager attended an EU

sponsored SKA Design Study (SKADS) DS4-T1 meeting. SKA Design Study #4 (DS4) studies the technical foundations and enabling technologies for the SKA, and DS4-T1 is concerned with the advancement in the semiconductor work of relevance to the SKA. This resulted in useful interaction with EU colleagues in the area of low noise amplifier design, and especially the application of novel MMIC technologies to the realization of low noise amplifiers for SKA pathfinders.

The CMOS design work contributed to a PhD project, with joint supervisors from Macquarie University and ATNF.

2.2.2.4. SKAMP

Given the development path for the digital signal processing systems (DSPs) for SKAMP, ASKAP and MWA, Australian SKAMP engineers are collaborating with the MWA (MIT-led) project and have been involved in a number of engineering and project planning discussions: in Melbourne (Dec 06 and June 07) and Berkeley (Mar 07). In addition, Dr John Bunton, SKAMP and ASKAP DSP systems engineer attended a meeting at the Medicina Radio Telescope Observatory in Italy to discuss collaboration on Cylindrical Reflectors including DSP system design.

The SKAMP team has contracted Domain-42 Pty. Ltd., a digital design house based in Tasmania, to assist with the design of the spectral line correlator for SKAMP II. They have produced a prototype system by October 2006. The development of SKAMP systems has also involved collaboration with CSIRO ICT Centre. Research discussions were also held with A/Prof Godfrey Lucas of the School of Electrical Engineering at the University of Sydney, Dr Tom Landecker, Dr Tony Willis and Dr Bruce Veidt (all from the DRAO, Canada) and Prof Andrew Parfitt of the University of Adelaide. Many of the discussions were to assist PhD student, Mr Martin Leung.

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 are:

- Dell Computer Pty Ltd;
- Cray computer Pty Ltd;
- IBM;
- 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;
- Max Plank institute for Radioastronomy;
- Metsahovi Radio 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 by this Project in collaboration with industry include:

  - 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;
  - Exploration of software correlation algorithms on the Cell BE computing platform.

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 (41%), post-docs (33%) and students (26%).

Across the whole Gemini partnership, the publication rate has continued to rise strongly, and is very comparable to the rates achieved by other large optical/IR telescopes. Australia continues to participate fully in this, with 10 refereed papers published in the 2006/7 financial year.

Refereed papers published during the 2006/07 financial year involving Australian astronomers are:

GRB 060505: A Possible Short-Duration Gamma-Ray Burst in a Star-forming Region at a Redshift of 0.09. Ofek, E. O.; Cenko, S. B.; Gal-Yam, A.; Fox, D. B.; Nakar, E.; Rau, A.; Frail, D. A.; Kulkarni, S. R.; Price, P. A.; Schmidt, B. P.; Soderberg, A. M.; Peterson, B.; Berger, E.; Sharon, K.; Shemmer, O.; Penprase, B. E.; Chevalier, R. A.; Brown, P. J.; Burrows, D. N.; Gehrels, N.; Harrison, F.; Holland, S. T.; Mangano, V.; McCarthy, P. J.; Moon, D.-S.; Nousek, J. A.; Persson, S. E.; Piran, T.; Sari, R.; . The Astrophysical Journal, Volume 662:1129-1135, June 20.

Very Large Excesses of 18O in Hydrogen-deficient Carbon and R Coronae Borealis Stars: Evidence for White Dwarf Mergers. Clayton, Geoffrey C.; Geballe, T. R.; Herwig, Falk; Fryer, Christopher; Asplund, Martin; . The Astrophysical Journal, Volume 662:1220-1230, June 20.

Born-Again Protoplanetary Disk around Mira B. Ireland, M. J.; Monnier, J. D.; Tuthill, P. G.; Cohen, R. W.; De Buizer, J. M.; Packham, C.; Ciardi, D.; Hayward, T.; Lloyd, J. P.; . The Astrophysical Journal, Volume 662:651-657, June 10.

The GLARE Survey - II. Faint z ~ 6 Lyα line emitters in the HUDF. Stanway, Elizabeth R.; Bunker, Andrew J.; Glazebrook, Karl; Abraham, Roberto G.; Rhoads, James; Malhotra, Sangeeta; Crampton, David; Colless, Matthew; Chiu, Kuenley. Monthly Notices of the Royal Astronomical Society, Volume 376:727-738, April 1.

The globular cluster kinematics and galaxy dark matter content of NGC 4649 (M60). Bridges, Terry; Gebhardt, Karl; Sharples, Ray; Faifer, Favio Raul; Forte, Juan C.; Beasley, Michael A.; Zepf, Stephen E.; Forbes, Duncan A.; Hanes, David A.; Pierce, Michael. Monthly Notices of the Royal Astronomical Society, Volume 373:157-166, November 1.

The Afterglow, Energetics, and Host Galaxy of the Short-Hard Gamma-Ray Burst 051221a. Soderberg, A. M.; Berger, E.; Kasliwal, M.; Frail, D. A.; Price, P. A.; Schmidt, B. P.; Kulkarni, S. R.; Fox, D. B.; Cenko, S. B.; Gal-Yam, A.; Nakar, E.; Roth, K. C.. The Astrophysical Journal, Volume 650:261-271, October 10.

The link between submillimetre galaxies and luminous ellipticals: near-infrared IFU spectroscopy of submillimetre galaxies. Swinbank, A. M.; Chapman, S. C.; Smail, Ian; Lindner, C.; Borys, C.; Blain, A. W.; Ivison, R. J.; Lewis, G. F.. Monthly Notices of the Royal Astronomical Society, Volume 371:465-476, September 1.

Fluorescent Lyman alpha emission from gas near a QSO at redshift 4.28. Francis, Paul J.; McDonnell, Sunsanee. Monthly Notices of the Royal Astronomical Society, Volume 370:1372-1378, August 1.

Multiband study of NGC7424 and its two newly discovered ultraluminous X-ray sources. Soria, R.; Kuncic, Z.; Broderick, J. W.; Ryder, S. D.. Monthly Notices of the Royal Astronomical Society, Volume 370:1666-1676, August 1.

Mid-infrared source multiplicity within hot molecular cores traced by methanol masers. Longmore, S. N.; Burton, M. G.; Minier, V.; Walsh, A. J.. Monthly Notices of the Royal Astronomical Society, Volume 369:1196-1200, July 1.

2.3.2. AAO Instrumentation

The outcomes of the research carried out under this program at AAO are largely described in the following papers:

OH-suppression fibres:

Optimisation Algorithm for Ultrabroadband Multi-channel Aperiodic FBG Filters (2007), J. Opt. Soc. Amer. A, in press, Bland-Hawthorn, J., Buryak, A. & Kolossovski, K.

Coupling Light into Few-Mode Optical Fibres. I: The Diffraction Limit (2007), Optics Express, 15, 1444-1453, Horton, A.J. and Bland-Hawthorn, J.

Multimode Fibres with Single-Mode Performance: A Low Loss 7-mode Converter (2007), Optics Express, in press, Bland-Hawthorn, J., Leon-Saval, S.G., Witkowska, A.W. and Birks, T.A.

On the Performance of ELT instrumentation (2006), SPIE, 6269, 60, Cuby, J.-G., Prieto, E., Ferrari, M., Hugot, E., Bland-Hawthorn, J, and Blais-Ouellette, S.

Coupling Light into Optical Fibres near the Diffraction Limit (2006), SPIE, 6269, 52, Horton, A.J. and Bland-Hawthorn, J.

Instruments without Optics: an Integrated Photonic Spectrograph (2006), SPIE, 6269, 21, Bland-Hawthorn, J. and Horton, A.J.

New Instrument Concepts for Observational Cosmology (2006), New Astronomy Reviews, 50, 237, Bland-Hawthorn, J.

Application of Fiber Tapers in Astronomy (2006), SPIE, 6273, 122, Marcel, J., Haynes, R. and Bland-Hawthorn, J.

Advances in infrared and imaging fibres for Astronomical Instrumentation (2006), SPIE, 6273, 119, Haynes, R., McNamara, P., Marcel, J. and Jovanovic, N.

Starbugs*:*

Deployable payloads with Starbugs (2006), SPIE, 6273, 57, McGrath, A.J. and Haynes, R.

It's Alive! Performance and Control of Prototype Starbug Actuators (2006), SPIE, 6273, 56, Haynes, R., McGrath, A.J., et al

Wide-field Astronomy with Starbugs (2006), New Astronomy Reviews, 50, 329, Haynes, R. and McGrath, A.J.

***WFMOS**:*

Moving Stellar Groups in the Galaxy: Ancient Relics of a Bygone Era (2007), Science, submitted (Mar 07), De Silva, G., Freeman, K.C., Bland-Hawthorn, J. and Asplund, M.A.

Chemical Homogeneity in Collinder 261 and Implications for Chemical Tagging (2007), AJ, 133, 1161, De Silva, G.M, Freeman, K.C., Asplund, M.A., Bland-Hawthorn, J., Bessell, M.S., Collet, R.

Chemically Tagging the HR 1614 Moving Group (2007), AJ, 133, 694, De Silva, G.M., Freeman, K.C., Bland-Hawthorn, J., Asplund, M.A., Bessell, M.S.

Stellar Populations: the Next Ten Years (2007), ASPC, in press (astro-ph/0701883), Bland-Hawthorn, J.

Galactic History: Formation & Evolution (2007), Mem. Soc. Astron. Ital. 77, 1095-1102, Bland-Hawthorn, J. & Freeman, K.C.

Near Field Cosmology (2006), Science, 313, 311, Bland-Hawthorn, J. and Peebles, P.J.E.

The RAVE Survey: Constraining the Local Escape Speed (2007), MNRAS, in press, Smith, M.C., .., Bland-Hawthorn, J., et al

Galactic Kinematics with the RAVE Data: the Distribution of Stars towards the Galactic Poles (2007), MNRAS, in press, Veltz, L., Bienaymé, O., Freeman, K.C., Binney, J., Bland-Hawthorn, J. et al.

The Radial Velocity Experiment (RAVE): First Data Release (2006), AJ, 132, 1645, Steinmetz, M, .., Bland-Hawthorn, J. et al

Performance of AAOmega: the AAT Multi-Purpose Fibre-Fed Spectrograph (2006), SPIE, 6269, 14, Sharp, R., …, Haynes, R. …, Mayfield, D. et al

A New Look For Gemini: Rapid-Cured Composites for an Exchangeable Top End (2006), SPIE, 6273, 95, Miziarski, S., McGrath, A.J., Milby, N., Brosius, D.E. and von Bertouch, M.J.

Making it Real – Computer Graphics and Astronomical Instrumentation (2006), SPIE, 6271, 42, McGrath, A.J.

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.

2.3.2.1. RSAA Gemini Instrumentation

To date, one paper based on NIFS observations has been submitted for publication:

Gemini Observations of Disks and Jets in Young Stellar Objects and Active Galaxies, McGregor, P, Dopita, M., Sutherland, R, Beck, T, & Storchi-Bergmann, T 2007, in press astro-ph/07060074

Two papers based on NIFS observations are in preparation:

Gemini-NIFS Observations of H_2 2.122 μm Emission Towards HL Tau: A Micro Molecular Bipolar Outflow Takami, M., Beck, T. L., Pyo, T.-S., McGregor, P. J., Aspin, C., Davis, C., & Nishikawa, T. 2007

Gemini NIFS Integral Field Spectroscopy of YSO Environments: Spatially Extended Molecular Hydrogen Emission in the Inner 200 AU
Beck, T. L., McGregor, P. J., & Takami, M. 2007

The skills base and training level of Australian technologists has been enhanced by the involvement in these projects of approximately twenty mechanical, optical, electronics, and software engineers and technicians at AU and at our industry partner, Auspace Ltd, who assisted in the rebuild and commissioning of the NIFS instrument. Since this work completed, approximately half of these people have accepted work in other Australian technology companies.

2.3.3. SKA

2.3.2.1 CABB

The 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.

2.3.1.2 MMIC

The CMOS design work forms a large part of Suzy Jackson's PhD thesis. The work was published in the following presentation:

> *A Single-Chip RF-CMOS Receiver for SKA Pathfinders*
> S. Jackson, P.Hall, J, Harrison. Poster presented at SKA Paris meeting, September 2006.

2.3.1.3 NTD

The NTD project and related SKA work has resulted in a number of papers;

> *Focal plane array development for MIRANdA (Australian SKA Pathfinder)*
> S.G. Hay, J.D. O'Sullivan, J.S. Kot, C. Granet, A. Grancea, A.R. Forsyth, D.B. Hayman
>
> *Experimental Verification of Array Modelling*
> Hayman, D. Tenth Australian Symposium on Antennas, Sydney Feb. 14-15, 2007
>
> *NTD prime-focus horns* Granet, C.; Davis, I.M.; Cantrall, C.; Grancea, A.; Hayman, D.B. & Forsyth, A.R. CSIRO ICT Centre, 2006 technical report
>
> *Radiation Pattern and Scattering Matrix Measurement of the NTD Five by One Linear Connected Array* Hayman, D. CSIRO ICT Centre, 2006 technical report
>
> *Area Scaling for the SKA?* Bunton, J.D., SKA memo79, June 2006, www.skatelescope.org
>
> *SKA Survey Optimization* Wright,M., Bregman, J., Braun, R., Bunton, J., Cornwell, T, Ekers, R., Gaensler, B., Hall, P., Lonsdale, C., O'Sullivan, J., Rendong, N., Schilizzi, R., Taylor, R., SKA Memo 81, 05 June 2006, www.skatelescope.org
>
> *Dish Cost Frequency Scaling* Bunton, J.D., SKA Memo 90, Jan. 2007 http://www.skatelescope.org/PDF/memos/memo_90.pdf
>
> *Wideband focal plane array development for Australia's New Technology Demonstrator* Hay, S.G., O'Sullivan, J., Kot., J.S. and Granet, C.J., Proceedings of EuCAP 2006, Nice, France, 6-10 November 2006.
>
> *Scan impedance behaviour of some connected arrays with transmission-line feeds* Hay, S.G., O'Sullivan, J., Kot. J.S. and Granet, C.J. Proceedings of International URSI Commission B Electromagnetic Theory Symposium, Ottawa, Canada, 26-28 July, 2007.

Modelling investigations of wideband focal-plane arrays for xNTD Hay, S.G., O'Sullivan, J., Kot, J.S. and Granet, C.J. 10th Australian Symposium on Antennas, Sydney, Australia, 14-15 February, 2007.

Wide Field of View Imaging with Parabolic Cylindrical Reflectors
Bunton, J.D., '' IEEE Trans. Antennas and Propagation, Vol 34, No 7, July 2006, pp 2131-2136

A Radioastronomy Correlator Optimised for the Virtex-4 SX FPGA
Bunton, J.D., Campbell-Wilson, D., Cappallo, R., Kincaid, B. IEEE 17th International Conference on Field Programmable Logic and Applications, Amsterdam, Netherland, Aug 27-29, 2007

The NTD beamformer: an adaptable hardware platform
Bunton, J.D., FPGAs in Radio Astronomy workshop 2007, Feb 5-8, Sandy Bay, Tasmania

The SKAMP Project
Bunton, J.D., FPGAs in Radio Astronomy workshop 2007, Feb 5-8, Sandy Bay, Tasmania

Calibration and simulation strategy for multi-feed interferometers
M.A.Voronkov, T.J. Cornwell, "", a talk at the wide-field imaging workshop, Cape Town, South Africa, December 2006.

2.3.1.4 SKA Siting

CSIRO ATNF education programs conducted in WA remote schools to raise awareness of astronomy and provide education to regional areas to assist in providing trained future workforce for radio astronomy.

2.3.1.5 SKAMP

Attendance at the following meetings by team members resulted in presentations and one peer reviewed publication (to IEEE). The contributions were as follows:

(a) "Next Generation correlators for Radio Astronomy", in Groningen, Netherlands, 27-29 June 2006. Two papers presented:

Bunton: "Common correlator design for xNTD, SKAMP and LFD"

De Souza: "SKAMP2 correlator"

(b) IAU Joint Discussion 12 on "Long wavelength Astrophysics", in Prague, Czech Republic, August, 2006. One paper presented by Green : "MOST – new Galactic ISM results and progress towards low frequency spectroscopy"

(c) IEEE Antennas and Propagation Symposium, in Honolulu, Hawaii, 10-15 June, 2007. One peer reviewed paper:

Leung, Kot, Jones: "Wideband dual polarized line feed for a cylindrical reflector radio telescope"

(e) ATNF Student symposium in May, 2007. Talk given by PhD student Martin Leung, titled “Wideband dual polarized line feed for the Molonglo Telescope”.

2.3.1.6 SKASS

Continuing PhD students at Swinburne working on SKASS related issues are Mr Emil Lenc and Mr Adam Deller. There is a continuing external PhD student at Auckland University of Technology, Mr Tim Natusch and new students to commence at Swinburne in the second half 2007 are Mr Aquib Moin, Ms Yulia Sokolova.

Papers in preparation, accepted, in press, and published in 2006/07.

Jones, L. et al. 2006, MNRAS, 369, 1995

Deller, A.T, Tingay, S.J., Bailes, M., and West, C. 2007, PASP, 190, 308

Norris, R.P., Tingay, S., Phillips, C., Middelberg, E., Deller, A., Appleton, P.N. 2007, MNRAS, in press

Phillips, C.J. et al. 2007, MNRAS, in press

Horiuchi, S. et al. 2007, AJ, accepted

Bhat, R., and Tingay, S.J. 2007, in preparation

Lenc, E. et al. 2007, in preparation

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 provided activity and focus for Redfern Optical Components and the Optical Fibre Technology Centre (OFTC).

2.4.1.3. RSAA Gemini Instrumentation

ANU collaborated with an industry partner, Auspace Ltd, in the rebuild and commissioning of the NIFS instrument. ANU and Auspace staff gained valuable professional experience through rebuilding, assembling, integrating, testing, and commissioning NIFS at a major international observatory.

Several ANU technical staff who worked on NIFS and GSAOI have now taken positions at Electro Optics Systems Ltd, a local opto-electronics company in Canberra. EOS has a specific interest in adaptive optics that is an area developed at ANU through close association with the Gemini Observatory in the construction of these adaptive optics instruments. EOS is a leading international manufacturer of medium-size professional telescopes.

2.4.2. SKA

2.4.2.1. NTD

Since late 2005, the Australian SKA Industry Cluster Consortium comprising Boeing, Cisco Systems, BAe Systems, RFS, Raytheon, Tenix, RLM, CSIRO, AEEMA, RF Technologies and Global Innovation Centre have been working collaboratively to provide a strong industry foundation for the 'mega-science' Square Kilometre Array (SKA) initiative. The consortium has since been increased with a number of new members that have expressed a keen interest in the challenges and opportunities inherent in the complex task of realising the world's next-generation radio-telescope and its potential to foster new technologies for adjacent markets (telecoms, defence and ICT).

The formation of the Consortium, with its associated industry-led Cluster activities, recognized the necessity for early and ongoing Australian industry engagement with NTD and its successor projects, all aligned to R&D development for the SKA. Current objectives, supported by the above organisations and a grant from AusIndustry's Industry Cooperative Innovation Program (ICIP), include the identification of projects/prototypes suitable for SKA Cluster development as well as the identification of Australian capability and the formulation of a SKA technology roadmap.

In order to meet these objective, during 2006/07 the project team conducted a series of 8 National briefings across Australia, including Perth, Geraldton, Melbourne, Canberra, Sydney and Adelaide.

The events discussed the NTD work and its promise, and have led to the identification of many companies with SKA-related capabilities and to a number of collaborations between CSIRO and interested companies wishing to engage with early-phase R&D, particularly with ASKAP which follows on from NTD.

The Australian SKA industry cluster initiative is endorsed by the Australian Government's Electronics Industry Action Agenda led by the Australian Electrical and Electronic Manufacturers Association (AEEMA).

2.4.2.2. SKA Siting

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

2.4.2.3. SKAMP

Postgraduate student, Martin Leung, continued collaboration with engineers at Argus Technologies Limited throughout 2006-07. He used their specialised equipment and software to model, prototype and test the SKAMP3 line feed design. Mr Leung also contributed to other antenna design and development work at Argus Technologies.

2.4.2.4. SKASS

The team has relationships primarily with Dell, Cray, and Apple and source equipment from these companies. The team is developing a research collaboration with IBM Australia, with a view to submitting an ARC Linkages proposal in November 2007.

3. Promotion of the Facility

3.1. Project Office

3.2. Gemini

3.2.1 AAO Gemini Instrumentation

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.

3.2.2 RSAA Gemini Instrumentation

Two papers based on NIFS observations were delivered at the Fifth Stromlo Symposium held in Canberra in December 2006.

A major media focus was the opening of ANU's Advanced Instrumentation and Technology Centre at Mt Stromlo in October 2006. The building was opened by the DEST Minister, Julie Bishop MP. A feature of the building is the instrumentation that had by then been delivered to the Gemini Observatory, and the potential to extend this to the construction of the 25-m diameter Giant Magellan Telescope. ANU is a founding member of the Giant Magellan Telescope consortium to build one of the world's largest optical/infrared telescopes.

3.3. SKA

3.3.1 NTD

NTD progress has been promoted via the ASPO newsletters, the ATNF website and a number of activities, including the SKA industry cluster initiative described elsewhere in this report. NTD-related research has also been strongly promoted via participation at a number of conferences during 2006-07, these include the International SKA Engineering and Joint Working Group Meeting, 4-8 September, IAP Paris. At this meeting, a number of Australian engineers acted as panel members for many of the Engineering discussions and also are members of a number of the Engineering working groups

NTD FPA development work was the focus of the "Technical Challenges of SKA FPA Pathfinders Workshop" held at CSIRO ATNF, 12-14 March 2007. This workshop was very successful, and incorporated the Third International Focal Plane Array Workshop, building on the two previous workshops hosted by ASTRON in past years. The workshop attracted 96 participants, representing a wide interest group of astronomers, engineers and industry representatives from Australia, Europe, Canada, USA, South Africa and New Zealand. Participants included 17 industry representatives, including 9 from Australian SKA core sponsors of the industry cluster (BAE Systems Australia, Raytheon, Cisco, Tenix and Radio Frequency Systems) as well as other companies (EMSS, IBM, MotionTech and MawTech). Two participants hailed from Australia's Defence Science Technology Organisation (DSTO). Representing the radio astronomical FPA development

projects world-wide, there were 9 participants from NL, 12 from Canada, 6 from UK, 1 from NZ, 3 from South Africa's SKA project, 3 from USA and 1 from ISPO.

In compiling the workshop program, the SOC ensured that the 3-day workshop covered all relevant aspects to realizing astronomical FPAs in depth. Contributions from each of the major FPA initiatives (NTD/ASKAP (Aus), Apertif (NL), PHAD (CA) and EU SKADS and PHAROS projects) were well received, and all raised important discussions. It is clear that many collaborative and complementary aspects exist between all of these projects.

The workshop was particularly notable in that it attracted two of the world's most eminent EM theorists: Professor Raj Mittra, the Director of the Electromagnetic Communication Lab at Pennsylvania State University and Professor Jin-Fa Lee, from the ElectroScience Lab, Ohio State University. Both gave excellent presentations on their respective modeling methods for large FPA structures and both have expressed keen interest to work on the FPA design challenges with the ASKAP project.

The workshop was co-sponsored by the International SKA Project Office, CSIRO Australia Telescope National Facility (ATNF) and CSIRO's Information and Communications Technologies (ICT) Centre.

3.3.2 SKA Siting

Representatives of the Australian SKA Siting team attended the IAU Conference in Prague in August 2006 and a subsequent meeting of SKA Working Groups in Paris in September 2006. Information was also disseminated to the wider Australian astronomy community through meetings of an SKA Reference Group held in July 2006 and March 2007. Regular ASPO Newsletters were also produced throughout the year. An international SKA workshop and science meeting was held in Sydney in March 2007. The SKA website hosted by CSIRO ATNF was regularly updated.

3.3.3 SKAMP

Work on the SKAMP project has been included in the Australian SKA Planning Office newsletters and presented at a student symposium. Information is also available on the University of Sydney and CSIRO ATNF webpages. Material support for the SKAMP project has been provided by the ARC, Argus Technologies, Altium and Xilinx. The last two companies have donated electronic hardware and logic chips.

3.3.4 SKASS

SKASS was promoted at four invited talks/seminars, ten workshops, and several times via various radio and local television outlets, in both Australia and New Zealand, as well as internationally.

4. Commercialisation

4.1. Gemini

4.1.1 AAO Gemini Instrumentation

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

We are working with our collaboration partners to explore applications in astronomy and other potential fields.

4.2. SKA

4.2.1 CABB

A direct spin-off of the CABB development is the Mopra Ultra-Wideband Spectrometer, MOPS. This 8GHz bandwidth instrument, together with the new broadband MMIC-based 75 to 117GHz receiver, has revolutionised the use of Mopra for millimeter-wave spectroscopy. Mopra is now seen as a world-leading instrument in the field. The signal processing hardware used in MOPS is the CABB prototype signal processor board, with firmware that is a direct prototype for the digital filter banks required for CABB.

The new 1GHz bandwidth Pulsar Digital Filterbank (PDFB) installed at Parkes is already providing unprecedented accuracy in pulsar timing measurements. It has excited considerable interest from overseas observatories, which has led to orders of five from ATNF, with potentially more orders to come. The major hardware components in the PDFB were developed for CABB. A major part of the software and firmware developed for the PDFB have direct application in CABB.

The signal processing technologies developed for CABB have placed ATNF at the forefront, worldwide, in wideband multi-bit processing for radio astronomy, with direct applications to the development of the SKA.

4.2.2 SKASS

A licensing agreement covering the SKASS software correlator code, in order that the code can be distributed to interested parties, potentially for profit, has been finalised and is in place. In 2006/07, 3 institutions took up the code and signed agreements. Additionly, an agreement between ATNF and Swinburne for Swinburne to provide VLBI correlation services has been negotiated and has been in force since October 2006, worth $120,000 over two years.

SKASS undertakes contract work to the Auckland University of Technology, at $15,000 per year.

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

MNRF has fully allocated the total 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. Over the financial year 06/07, this was disbursed as follows:

Date	Item	US$	AU$
Aug-06	Swinburne SKASS		$217,200
Aug -06	2nd 2006 Gemini 1.43% Ops	$205,735	$273,858
Sep-06	Sydney SKAMP		$71,501
Sep-06	Swinburne ELT		$70,000
Oct-06	3rd UK nights	$500,000	$660,328
Jan-07	Magellan payment (1/4)	$172,500	$221,169
Jan-07	Magellan – AAO payment (1/4)		$234,414
Jan-07	Swinburne – ELT		$140,000
Feb-07	2nd Aspen instrumentation*	$928,500	$273,077
Mar-07	1st 2007 Gemini 1.43 Ops	$210,878	$261,668
Jun-07	2nd 2007 Gemini 1.43% Ops	$210,878	$257,482
Jun-07	Magellan payment (3/4)	$517,500	$629,562
Jun-07	Magellan – AAO payment (3/4)		$703,242
Jun-07	AAO PM software		$120,000
Jun-07	Gemini ops shortfall payment#	$342	$416
2006/07	**Total grant expenditure**		**$4,133,916**
	MNRF grant remaining		**$1,234,879**

Notes to the above Table:

Shortfall catch-up payment to balance previous year's payments to US Gemini operations: Cause believed to be due to US bank charges.

* Following advice from the Australian Gemini Steering Committee, it was agreed to only part-pay Australia's 2007 share of the Gemini 2nd Aspen instrumentation program, amounting to USD 231,023. It should be noted that sufficient funds were set aside to cover Australia's full 6.19% share of the US$75M cost of the Aspen program in its first two years – 2006 and 2007. This amounts to two annual payments of US$928,500, the first of which was paid on schedule during 2006. However the 2007 payment could not be made in full due to uncertainties in the

financial commitments the other Gemini partner countries could make to this program. The payment of USD 231,023 was the amount required for Australia to meet its share of the "Intermediate" Aspen program (with total cost of US$45M), which represents the current level of financial commitment to Aspen across all the partner countries. Its payment ensures that Australia remains in good standing in being up to date with its Aspen payments.

At 30 June 2007 the MNRF balance comprises:

- ASPEN instrumentation 2007 instalment, remaining part-payment AUD 820,561 (equivalent to USD 679,477 at 85c/AUD).
- 'surplus' generated during 2006/07 by the increasing value of the AUD of AUD 414,733.

Following advice from DEST, these funds were transferred to Astronomy Australia Ltd (AAL), the manager of the Radio and Optical Astronomy NCRIS grant. The (future) allocation of these funds is fully described in the DEST-AAL Funding Agreement.

Financial tables

6.1.1. 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	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Difference 5 Years
CSIRO ATNF													
Salaries	0	760	0	830	0	830	0	340	492	230	492	2,990	-2498
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	550	250	506	280	567	280	1,043	120	1,333	80	3,999	1,010	2989
Total	550	1,010	506	1,110	567	1,110	1,043	460	1,825	310	4,491	4,000	491
CSIRO TIP												0	
Salaries	157	96	111	96	195	96		96	0	96	463	480	-17
Capital		64		64		64		64	0	64	0	320	-320
Other	422	0	111	0		0	524	0	586	0	1,643	0	1643
Total	579	160	222	160	195	160	524	160	586	160	2,106	800	1,306
AAO												0	
Salaries	68	84	246	189		275		541	396	675	710	1,764	-1054
Capital		0		0		0		0	0	0	0	0	0
Other	68	28	167	63	325	137	261	271	762	337	1,583	836	747
Total	136	112	413	252	325	412	261	812	1,158	1,012	2,293	2,600	-307
SYDNEY UNI												0	
Salaries	67	128	70	131	147	135	173	135	185	67	642	596	46
Capital		0		0		0		0	0	0	0	0	0
Other	67	0	70	0		0		0	0	0	137	0	137
Total	134	128	140	131	147	135	173	135	185	67	779	596	183
ANU												0	
Salaries	420	173	216	173	246	173		172	79	172	961	863	98
Capital		0		0		0		0	0	0	0	0	0
Other		0		0		0	277	0	0	0	277	0	277
Total	420	173	216	173	246	173	277	172	79	172	1238	863	375
SWINBURNE												0	
Salaries	151	98	45	101	14	106	102	29	0	0	311	334	-23
Capital	310	491	49	327		0		0	631	0	990	818	172
Other	2	0		0	105	0	123	0	0	0	230	0	230
Total	463	589	94	428	119	106	225	29	631	0	1531	1,152	379
APT												0	
Salaries		15		15		15		15	0	15	0	75	-75
Capital		0		0		0		0	0	0	0	0	0
Other		5		5		5		5	0	5	0	25	-25
Total	0	20	0	20	0	20	0	20	0	20	0	100	-100
CEA												0	
Salaries		15		15		15		15	0	15	0	75	-75
Capital		0		0		0		0	0	0	0	0	0
Other		5		5		5		5	0	5	0	25	-25
Total	0	20	0	20	0	20	0	20	0	20	0	100	-100
WA Govt												0	
Salaries	73	100	71	100		100		100	0	0	144	400	-256
Capital		75		75		75		75	0	0	0	300	-300
Other	44	25		25		25		25	0	0	44	100	-56
Total	117	200	71	200	0	200	0	200	0	0	188	800	-612
Grand Total In-kind											0	0	
Salaries	863	1,369	686	1,550	602	1,645	275	1,343	1,152	1,270	3,580	7,177	-3,853
Capital	310	555	49	391	0	64	0	64	631	64	990	1,136	-448
Other	1,109	288	854	353	997	427	2,228	401	2,681	427	7,869	1,896	5,917
Total	2,282	2,212	1,591	2,294	1,599	2,136	2,503	1,808	4,464	1,761	12,439	10,211	1,616

6.1.2. 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	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Difference 5 Years
CSIRO ATNF	444	832	230	1,032	1,616	1,532	1,533	432	1,323	332	5,146	4,160	986
CSIRO TIP	0	0	0	0	0	0	0	0	0	0	0	0	0
AAO	0	0	0	0	486	0	331	0	3	0	820	0	820
SYDNEY UNI	65	155	65	155	244	155	118	155	130	1,655	622	2,275	-1,653
ANU	245	315	245	315	245	315	213	315	416	315	1,364	1,575	-211
SWINBURNE	10	10	10	10	63	10	79	10	110	10	271	50	221
APT	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
WA GOVT	0	0	264	0	852	0	510	0	0	0	1,626	0	1,626
UNSW	210	210	210	210	210	210	210	210	125	210	965	1,050	-85
MELB UNI	52	52	52	52	52	52	52	52	65	52	273	260	13
DELL	0	85	85	0	0	0		0	0	0	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	2,172	2,574	11,172	9,455	1,717

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	Actual 2006/2007	Agreement 2006/2007	Actual 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	1,521	1,637	8,090	8,185	-95
Victorian Govt	131	0	131	0	0	0		0	15	0	277	0	277
Sou. Qld Uni	5	0	5	0	0	0		0	5	0	15	0	15
Monash Uni	0	0	5	0	0	0		0	5	0	10	0	10
Tasmania Uni	0	0	2	0	0	0		0	0	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	1,546	1,637	8,394	8,185	209

	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Actual 2006/2007	Agreement 2006/2007	Actual 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	0	900	23,500	23,500	0

Grand Total of Cash Contributions	Actual 2002/2003	Agreement 2002/2003	Actual 2003/2004	Agreement 2003/2004	Actual 2004/2005	Agreement 2004/2005	Actual 2005/2006	Agreement 2005/2006	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Difference 5 Years
	5,357	5,636	7,913	8,171	13,026	11,911	13,053	10,311	3,718	5,111	43,066	41,140	1,926

6.1.3. 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	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Difference 5 Years
Salaries	821	483	942	155	1,676	155	2,476	155	1,019	155	6,935	1,103	5,832
Capital	358	560	107	1,760	793	1,760	876	1,759	2,885	1,809	5,019	7,648	-2,629
Other	3,113	5,323	5,797	6,708	4,293	6,949	8,806	7,157	4,686	6,248	26,695	32,385	-5,690
Totals	4,292	6,366	6,846	8,623	6,762	8,864	12,158	9,071	8,590	8,212	38,648	41,136	-2,488

6.1.4. 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	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Variance from Deed
Grand Ttl 5 Yrs Inkind from Tble 1	2,282	2,212	1,591	2,294	1,599	2,136	2,503	1,808	4,464	1,761	12,439	10,211	1,616
Grand Ttl 5 Yrs Cash from Tble 2	5,357	5,636	7,913	8,171	13,026	11,911	13,053	10,311	3,718	5,111	43,066	41,140	1,926
Ttl Resources Cash & Inkind Income	7,639	7,848	9,504	10,465	14,625	14,047	15,556	12,119	8,182	6,872	55,505	51,351	3,542

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	Actual 2006/2007	Agreement 2006/2007	Actual 5 Years	Agreement 5 Years	Variance from Deed
Total Salaries Cash & Inkind	1,684	1,852	1,630	1,705	2,279	1,800	2,751	1,498	2,171	1,425	10,514	8,280	1,979
Total Capital Cash & Inkind	668	1,115	156	2,151	793	1,824	876	1,823	3,516	1,873	6,009	8,786	-3,077
Total Other Cash & Inkind	4,222	5,611	6,651	7,061	5,290	7,376	11,034	7,558	7,367	6,675	34,564	34,281	226
Grand Total (Cash & Inkind)	6,574	8,578	8,437	10,917	8,361	11,000	14,661	10,879	13,054	9,973	51,087	51,347	-872

6.1.5. 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	Actual 2006/2007	Agreement 2006/2007	Actual 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
	NTD	1,621	N/A	1,208	N/A	649	N/A	2,393	N/A	N/A	N/A	5,871	N/A	N/A
	MMIC	300	N/A	0	N/A	0	N/A	0	N/A	N/A	N/A	300	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
	Siting	117	N/A	0	N/A	0	N/A	0	N/A	N/A	N/A	117	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
	Total	2,726	3,640	1,208	2,582	649	1,517	2,393	523	0	0	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	3,356	N/A	6,240	N/A	N/A
	NTD	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	N/A
	MMIC	0	N/A	145	N/A	301	N/A	207	N/A	374	N/A	1,027	N/A	N/A
	SKAMP	134	N/A	140	N/A	340	N/A	664	N/A	386	N/A	1,664	N/A	N/A
	Siting	0	N/A	0	N/A	1,242	N/A	1317	N/A	1,099	N/A	3,658	N/A	N/A
	SKASS	0	N/A	374	N/A	421	N/A	526	N/A	865	N/A	2,186	N/A	N/A
	Total	492	0	1,128	2,199	3,104	2,946	3,971	3,212	6,080	3,338	14,775	0	14,775
	insert additional items above this line													
Total Planning & Construction		3,218	3,640	2,336	4,781	3,753	4,463	6,364	3,735	6,080	3,338	21,751	19,957	1,794
Operating Phase	Office salary	446	432	64	104	65	104	31	104	9	104	615	848	-233
	Office Other	0	50	56	50	69	50	71	50	36	50	256	250	6
	SKA	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gemini Other	3,024	4,657	5,980	6,182	4,454	6,583	6,195	7,191	4,741	6,482	26,394	31,095	-4,701
Total Operating Phase		3,470	5,139	6,102	6,336	4,608	6,737	6,297	7,345	4,786	6,636	27,265	32,193	-4,928
Grand Total Expenditure		6,688	8,779	8,438	11,117	8,361	11,200	14,661	11,080	10,868	9,974	49,016	52,150	-3,134

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

Table 6

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

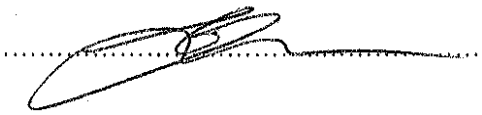
Fin Years	Description	Location	Quantity	Unit Value ($)	Total ($)
2002/03	List items separately > $50K				
	Supercomputer & IF, Parkes	Swinburne/ATNF	1	536	536
	Molonglo filterbank/correlator	Molonglo	1		0
	SKA demonstrator	ATNF	1		0
	Test equipment	ATNF	1		0
	Software	ATNF	1		0
	Wband correlator	ATNF	1	260	260
	Group items < $50K				0
	In-kind capital items	ATNF	1	25	25
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
	Wband correlator	ATNF	1	62	62
	Group items < $50K				7
Total					155
2004/05	List items separately > $50K				
	Wband correlator	ATNF	1	533	533
	Spectrum 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
	Wband correlator	ATNF	1	303	303
	SKAMP correlator & filterbanks	Syd Uni	1	254	254
	Group items < $50K				
					174
Total					876
2006/07	List items separately > $50K				
	Supercomputer	Swinburne/ATNF	1	335	335
	VLBI disks	Swinburne/ATNF	1	296	296
	Wband correlator	ATNF	1	2,018	2,018
	Fibre upgrade	Sydney Uni	1	102	102
	Group items < $50K				134
Total					2,885
Grand Total					5,530

The Gemini and SKA MNRF
Australia's Astronomy Future

2006-07 Annual Report

Presented to DEST by Dr Martin Cole, Chair, AABOM and Dr Carole Jackson, GASKA MNRF Director:

..... **Dr Martin Cole**



..... **Dr Carole Jackson**

30 September 2007

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

285 %

>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	5%	0	0%	3
• Industry	0	0%	0	0%	0
• University	47	95%	0	0%	47
• Other (please specify)	0	0%	0	0%	0
• Total	50	100%	0	0%	50

(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

An informal survey of 10 users was conducted by e-mail early in 2007. It revealed general satisfaction with Australia's access to Gemini and Magellan.

(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 and Magellan, science programs being pursued by Australian researchers on the Gemini and Magellan telescopes involve a high level of international collaboration. In 2006/7 80% of proposals involved international collaboration, up from 72% in the previous year

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 2006/07, 56% 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	10
	Books and chapters in books	0	0
Media	Newspaper, TV, radio	3	1
	Popular scientific press	3	1
Other (Websites)	(eg ABC Science Online)	3	1

(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	5	0
Workshops	4	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 and post-doctroal researchers.. In 2006/7 26% of Australians proposaing for Gemini and/or Magellan time were PhD students, 33% were post-docs and 41% faculty.

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

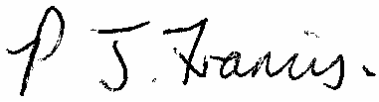
Activity	Number	Income ($'000)	Comment
• Licensing agreements	0	0	
• Contract services and consultancies undertaken by Facility for fee paying clients	0	0	
• Income to Facility from royalties and sales of products and services	0	0	
• Other (please specify)	0	0	
• Total	0	0	

(d) Total income received in the reporting year

Income type	National	International	Total
• Total Cash ($'000)	$2,612,200	$0	$2,612,000
• Total In-kind ($'000)	$0	$0	$0
• Total MNRF grant ($'000)	$4,741,000		$4,741,000[1]
• Total	$7,353,200	$0	$7,353,200

(e) Self sufficiency in terms of operating costs

Percentage of total income that covers the Facility's operating costs excluding the MNRF grant. 78%



Facility Project Scientist

27th August 2007

[1] Out of the $4,741 only $519,566 was used towards 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 $519,566 was considered ($519,566 / ($1,790,454 + $519,566) = 0.22).

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 Carole Jackson, 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 (Co-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 – Dr Carole Jackson

- Commonwealth Scientific and Industrial Research Organisation

Increased share of Gemini telescopes – Prof 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 – Prof Peter McGregor

- Australian National University

AAO instrumentation – Dr Sam Barden

- Anglo-Australian Observatory

AT compact array broadband backend (CABB) – Dr Warwick Wilson

- Commonwealth Scientific and Industrial Research Organisation

New technology demonstrator (NTD) – Dr Colin Jacka

- Commonwealth Scientific and Industrial Research Organisation

Monolithic Microwave Integrated Circuit (MMIC) – Dr Warwick Wilson

- Commonwealth Scientific and Industrial Research Organisation

SKA Molonglo prototype (SKAMP) – Prof 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) – A/Prof 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
- ASKAP Australian SKA Pathfinder
- 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