

Australian Optical/IR NCRIS Process

THE CASE FOR ADDITIONAL 8M ACCESS

Warrick Couch (UNSW)

1. Background

The last decade has seen the emergence of the 8m-class¹ of optical/infrared telescopes as the largest and most powerful research facilities operating at these wavelengths. More than a dozen such telescopes have been successfully constructed and are now in routine operation as common-user facilities. By virtue of their unrivalled light-gathering power and their excellent imaging performance, they have opened up a myriad of new scientific opportunities across all the key areas of astrophysical study.

Australia has had direct access to 8m telescopes for more than 6 years, through its membership of Gemini. This provides Australian astronomers with access to twin 8.1m telescopes at two of the best mid-latitude sites in the world – Mauna Kea in Hawaii and Cerro Pachon in Chile. Initially, Australia was a 4.76% share partner in Gemini when it joined in 1997, but an additional 1.43% share was purchased in 2002 using MNRF funding, taking its share to 6.19%. This now gives Australian astronomers access to up to 17.5 nights per year on each of the two Gemini telescopes (or effectively 35 nights or a 12.4% share of a single 8m telescope). Additionally, it has returned more than A\$10M to Australia in instrumentation work, with Gemini contracting RSAA/ANU to build NIFS and GSAOI, and the AAO to undertake feasibility and concept studies for WFMOS.

The MNRF funding has also been used to increase Australia's 8m access through the purchase of nights. A total of 24 nights (8 in each of the 2005B, 2006A & 2006B semesters) on Gemini-South were purchased from the UK at a cost of USD62.5K per night. In addition, the purchase of 30 nights on the Magellan telescopes (15 in each of the years 2007 & 2008) has just been negotiated, at a cost of USD46K per night, half of which will be provided in-kind, through the appointment of two Australian Magellan Fellows who will provide scientific and technical support at the telescopes.

In looking to the future, in particular the next 5-10 years covered by the NCRIS program and Australian Astronomy's Decadal Plan², 8m optical/infrared telescopes will undoubtedly be the front-rank research facilities world-wide, and will have a central role in tackling most of the scientific 'big questions' confronting astronomers over this period, and in particular those identified in the Decadal Plan³. Underpinning this will be the availability of a new generation of innovative instruments that will open up unexplored regions of 'discovery space'. Key examples in this context include more advanced applications of the now maturing adaptive optics (AO) technologies (such as extreme- and ground layer-AO), and construction of the WFMOS instrument, which will provide a wide-field (degree-sized) highly-multiplexed optical spectroscopy capability on an 8m for the first time.

¹ We include in this class, telescopes with an effective primary mirror diameter in the range 6.5 – 10 meters.

² *New Horizons, A Decadal Plan for Australian Astronomy 2006 – 2015*

³ See Table 4.1 in the Decadal Plan.

For Australia to remain at the forefront of observational astronomy at these wavelengths, it is essential that it have access to such facilities and, in order to undertake *scientific programs of major scope and impact*, for that access to be at a significant level. This was firmly articulated in the Decadal Plan, with access to 20% of an 8m telescope being set as one of the community’s highest priority goals for the coming decade. More specifically, this was to be achieved through continued membership of Gemini as well as increasing and diversifying our 8m access:

“The astronomical community considers it essential that Australia maintain its 2006/07 level of 8m access (i.e. equivalent to 20% of an 8m telescope) throughout the decade. This will enable Australia to exploit the new science opportunities made possible by instrumentation being built by the Gemini partnership. It will also increase the community’s access to a broader suite of instruments on a variety of 8m telescopes in addition to those of the Gemini partnership.”

2. Infrastructure provided

The top level requirement is for Australia to acquire additional 8m access, over and above its current 6.19% share of Gemini, so that its total access meets the Decadal Plan goal of 20% equivalent of an 8m telescope. With the Gemini share being equivalent to 12.4% of an 8m, additional access amounting to **7.6% equivalent of an 8m** is required to meet this target. This could be on any front-ranked 8m telescope facility (including Gemini), subject to availability and careful scrutiny that such access is in the best interests of the Australian astronomical community, scientifically, strategically, and financially.

This additional access can be acquired in one or more of three possible ways; these plus the strengths and weaknesses of each can be summarized as follows:

Additional share Acquired via:	Strengths	Weaknesses
Purchase of additional share	<ul style="list-style-type: none"> • Buys influence and equity in facility • Time is ‘in perpetuity’ provided funding can be maintained 	<ul style="list-style-type: none"> • Funding post-NCRIS might be problematical • More expensive since includes capital component • Opportunities to buy share scarce
Purchase of nights	<ul style="list-style-type: none"> • More flexibility in phasing & matching community needs • No financial commitment required beyond NCRIS 	<ul style="list-style-type: none"> • No influence in facility • Less pressure on funding agency to continue support
Instrument construction in exchange for share/nights	<ul style="list-style-type: none"> • Money spent in Australia • Community likely to be first to exploit instrument scientific-ally 	<ul style="list-style-type: none"> • Australian institutions must carry financial risk

Which of these options will be available to the Australian community over the NCRIS funding period, and on what telescopes, cannot be definitively specified at the present time. However, the following three possibilities are very likely:

- *Purchase of further nights on Gemini* – The UK have indicated they will most likely be willing to continue selling Australia nights on Gemini-South “on similar terms” to the present arrangement.
- *Purchase of further nights on Magellan* – There are strong indications that Australia will be able to extend and perhaps develop further its current arrangement for purchasing time on the Magellan telescopes, when it comes to an end in two years time.
- *Purchase of additional Gemini share* – It is possible that Argentina might relinquish its 2.5% share in Gemini, in which case it would be available for the other partners to take up. However, the chances of Australia being able to acquire more than 6.19% of this share (equivalent to an additional 0.16% share) are small⁴.

3. Cost of the infrastructure

The cost of additional 8m access can be estimated using what Australia pays annually for its 6.19% share of Gemini, both in operations costs and in providing the local support infrastructure (Australian Gemini Office, Gemini Scientist, Deputy Gemini Scientists, technical support staff) as a benchmark. These costs, plus the annual fixed payment Australia will make to Gemini over the next 5 years (2006-2010) for its share of the Aspen instrumentation program can be summarized as follows:

Annual costs for Australia’s 6.19% share of Gemini (in 2006 dollars, exchange rate = 0.75)		
	US\$M	AU\$M
• Observatory Operations	1.782	2.376
• Aspen instrumentation program	0.929	1.239
• Local support infrastructure (AusGO)	-	0.282

Obtaining forward projections of these costs over the entire NCRIS period (2006-2011) is straight forward. The “Observatory Operations” cost in each of the years 2006-2010 has already been agreed to and set by the Gemini partners, being subject to an annual 2.5% increase over this period. It is assumed this 2.5% ramp continues into 2011. Local support costs are calculated assuming an indexation of 4%, consistent with the annual rise in these costs seen over the lifetime of the ARC LIEF funding.

Presented in the table below are the estimated costs of 8m access over the 2006-2011 NCRIS time-frame. These not only include the amounts that are anticipated to be required from NCRIS (shaded cells), but also those associated with existing arrangements funded through the LIEF and MNRF schemes, which are important to identify for matching and phasing purposes (noting that both will provide funding through until the end of 2007). From the second column of the table it can be seen that through these

⁴ The Gemini Agreement stipulates that each partner has first option on purchasing their ‘share fraction’ of any such relinquished share. Hence, for Australia to acquire significantly more than its 6.19% entitlement of this relinquished share, it would require one or more of the major partners (US, UK, Ca) to forego theirs and for there to be partner-wide agreement to Australia purchasing it instead.

current arrangements (Gemini share, Gemini nights, Magellan), our total access is equivalent to ~20% of an 8m⁵.

Costings for current and future 8m access (in A\$M)

	% 8m (tot %)	Source of funds	06	07	08	09	10	11*	Total
Gemini share: 6.19% share+Aspen+AusGO	12.4	LIEF + MNRF	3.89	3.97	-	-	-	-	7.86
		NCRIS	-	-	4.03	4.11	4.19	2.17	14.50
Gemini nights: purchased from UK	5.7	MNRF	1.33	-	-	-	-	-	1.33
Magellan: 30 nights over 2007 & 2008	2.9	MNRF	0.92	0.92	-	-	-	-	1.84
Additional 8m access	7.6 (20)	NCRIS	-	-	1.72	1.77	1.82	0.94	6.25
	5.1 (17.5)	NCRIS	-	-	1.16	1.19	1.22	0.63	4.20
	2.6 (15)	NCRIS	-	-	0.59	0.61	0.62	0.32	2.14

* NCRIS funding ends mid-2011

In terms of the call on NCRIS funding for 8m access, there are two components whose bottom line requirements are as follows:

- (1) **Gemini (6.19% share):** Assuming that *all* costs associated with Gemini membership (including our contribution to the Aspen instrumentation program) will be paid from NCRIS from 2008 onwards, **the total funding required over the lifetime of NCRIS = A\$14.5M.**
- (2) **Additional 8m access:** By a simple scaling of what Australia pays for its 6.19% share of Gemini (equivalent to 12.4% of an 8m)^{6,7}, three options for purchasing additional 8m share have been costed. Their details and total cost are as follows:
 - (i) **Decadal Plan target – 20% total equivalent access:** via purchase of an additional 7.6% of an 8m - **TOTAL COST = A\$6.25M**
 - (ii) **De-scope Option 1 – 17.5% total equivalent access:** via purchase of an additional 5.1% of an 8m – **TOTAL COST = A\$4.20M**
 - (iii) **De-scope Option 2 – 15% total equivalent access:** via purchase of an additional 2.6% of an 8m – **TOTAL COST = A\$2.14M**

There was a strong consensus at the town hall meeting held at the University of Sydney on 21 April that component (1) should be funded from NCRIS, and so no further discussion of it is required. Rather the community needs to give careful consideration to component (2) and to weigh up the first option – of achieving the 20% Decadal Plan

⁵ Allowing for the $(6.5/8)^2$ factor that takes into account the difference in aperture size between the Magellan and Gemini telescopes.

⁶ Only “operations” and “local support” costs (but not the “Aspen” cost) are included here.

⁷ This provides estimates that are fully consistent with the general costs of access across the various 8m class telescopes.

target – against the other options for spending the “optical/ir” component of the NCRIS funding that have been put before it. The two “de-scope” options above have been provided to assist this process.

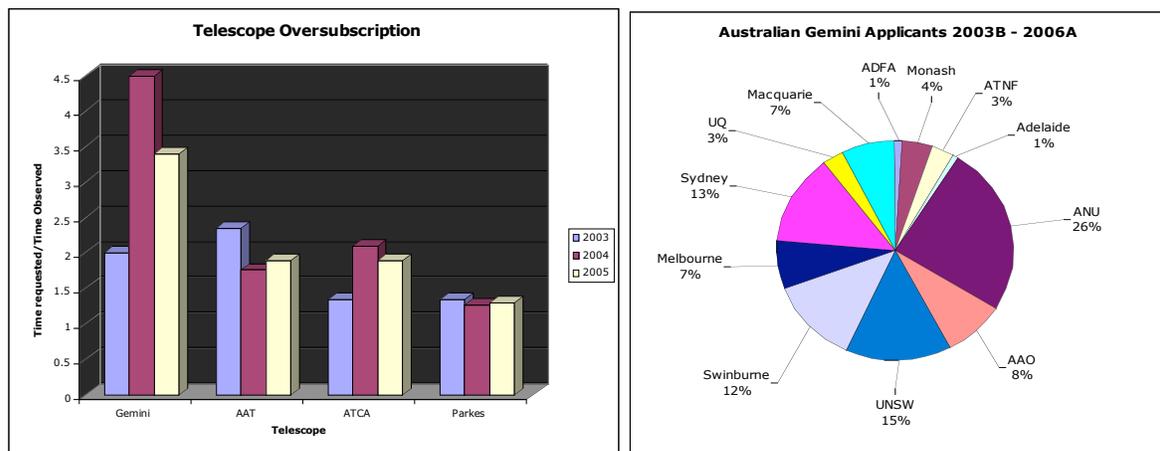
4. Access and allocation of additional 8m time

All Australian astronomical researchers will have access to the additional 8m time. The allocation of this observing time will be made by the Australian Time Assignment Committee (ATAC) on the basis of scientific merit. This peer review committee is highly experienced in allocating time on our national 4m (AAT) and 8m (Gemini) optical/infrared telescope facilities. Moreover, it also has considerable experience in the allocation of additional 8m time – viz the extra nights on Gemini-South purchased from the UK and nights on ESO’s VLT obtained through the AAO’s OzPos contract – and it will be responsible for allocating the forthcoming time that Australia has purchased on the Magellan telescopes.

5. Demand for 8m time

ATAC has been awarding time on the Gemini telescopes to Australian astronomers for more than 5 years now, and this provides a reasonably firm picture as to what the ‘steady-state’ demand for 8m time is currently, how widely spread the demand is across our institutions, and hence what it is likely to be in the future.

The figure below left compares the oversubscription rates between Gemini, the AAT, the ATCA and the Parkes telescopes over the three years 2003-2005, and while it is certainly true that the demand for time on the Gemini telescopes has shown some large semester to semester fluctuations, it can be seen that, overall, Gemini has the greatest demand of all these facilities. The pie chart on the right shows that this demand comes from across almost all of our Australian astronomical institutions, indicating the strong ‘national facility’ role that the Gemini telescopes play. Moreover, Gemini access fosters strong international and national collaboration within our community, with 90% of all Australian research publications based on Gemini data involving collaborations of this type.



6. Scientific outcomes

6.1 Publications

Australia has an excellent track record of converting its time on national astronomical facilities into high impact refereed journal publications, as manifested by the figures included in the AAO's submission to the recent AAO DEST Review. While this is yet to be demonstrated with Gemini – the telescopes have only just recently become fully operational, and hence observational programs and their ensuing publications have not been completed for a sufficient length of time to reliably measure their impact – the initial indications, based on the raw numbers of publications, are promising. The total number of refereed Gemini papers published across the partnership has just passed the 200 mark, of which 21 were either Australian-led or co-authored.

6.2 Research training

The Gemini telescopes have already proven to be an important research tool in the training of Australian postgraduate students. Over the last 3 years, 32% of the proposers requesting Australian Gemini time have been postgraduate students. Furthermore, these students have been broadly spread over most of the astronomy institutions within Australia, indicating that such demand is strong nationally. Translated into actual numbers of students, 16 PhD students have obtained Gemini data for their theses over the last 3 years, 2 have completed their theses, and another 4 are expected to finish within the next six months. We are thus starting to see the emergence of a new generation of young astronomers with 8m observational experience, involving the use of state-of-the-art astronomical instrumentation. Continued and increased 8m access is essential to attracting the students into astronomy and sustaining and growing this type of postgraduate training where they can work at the scientific forefront using the very best optical/infrared telescopes and instrumentation.

7. Major risks

- There is not sufficient demand within the Australian community to maximize the scientific exploitation of the additional 8m access.
- Australia is only able to purchase additional nights and not additional share in 8m facilities, and hence our NCRIS investment does not lead to any extra influence over the governance, operation and scientific agenda of the facilities in question.

The first of these risks can be mitigated against to some extent by ensuring that a reasonable fraction (>30%) of the “additional 8m access” NCRIS funding is designated for the purchase of additional nights, thereby providing flexibility in responding to variations in demand, both for 8m time and access to certain instrument capabilities. This has been a successful strategy in the use of the “increased 8m access” component of the MNRF funding. It also provides flexibility in responding to variations in exchange rates.

Additionally, a survey of our Gemini user community has indicated that there is a common perception that our share of Gemini, and hence the amount of time available is so small, that it is futile applying for significant amounts of time and thus contemplating undertaking major projects. By increasing our overall 8m access up to the ~20% level, this can hopefully be largely overcome, and demand will actually increase over present levels.