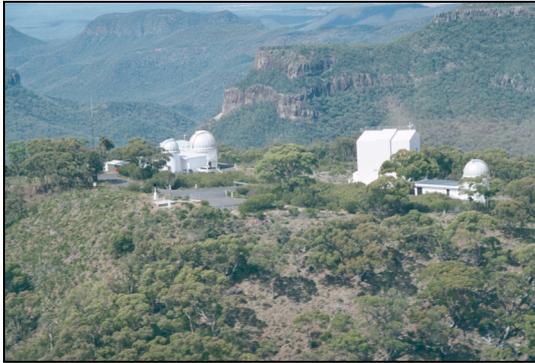


# Siding Spring Observatory:

## A Tradition in National Collaborative Research Infrastructure

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Siding Spring Observatory (SSO) is the premier facility on the Australian mainland for optical and infrared astrophysics research. Located in the Warrumbungles near Coonabarabran in northern New South Wales, the site is home to telescopes owned and operated by the Australian National University (ANU), telescopes operated by the Anglo-Australian Observatory (AAO), and several other national and international facilities. For years SSO has satisfied all of the principles for NCRIS funding.

Two telescopes (the ANU 40-inch and ANU 2.3metre) and the SSO site itself, are owned, operated, and funded by the ANU.<sup>1</sup> Nevertheless, for many years, the Research School of Astronomy & Astrophysics (RSAA) at the ANU has run its own telescopes as an open-access national facility, giving its Telescope Time Allocation Committee (which includes non-RSAA astronomers) the brief: "*To optimise the scientific return for Australian astronomy of the ANU telescopes on the basis of the scientific merit of proposals.*" For more information on its open, merit-based access policy, see <http://www.mso.anu.edu.au/observing/>

### Demand and Productivity of the Facility

The Decadal Plan for Australian Astronomy notes the importance of Siding Spring Observatory to Australian astronomy, particularly emphasizing the role of the shared site, the ANU 2.3m telescope, and the new ANU SkyMapper telescope.

The true national character of the observatory is demonstrated by the origins of the users of ANU telescopes at Siding Spring. As Table 1 indicates, the share of time used by non-ANU Australian astronomers has been increasing steadily so that **non-ANU Australian use of ANU telescopes is now comparable to ANU use.**

**Table 1: Origin of Chief Investigators using ANU Telescopes at SSO 2002-2005**

CI Institution	% Nights in 2002	% Nights in 2003	% Nights in 2004	% Nights in 2005
ANU	58	53	48	41
Non-ANU Australian	16	22	37	39
Foreign	26	25	15	20

The quantity and impact of the research done on ANU telescopes is high. According to the recent Australian Decadal Plan, *New Horizons*, ten percent of all citations to Australian

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<sup>1</sup> Siding Spring Observatory is the facility and site operated by the ANU. Several other observatories use the site on Siding Spring Mountain, through agreements with ANU intended to recover costs from tenants for operation of the site. No leasing fee has been charged.

astronomy are based on work undertaken with ANU telescopes. According to the Decadal Plan, **Australian publication and citation rates associated with ANU telescopes are 65-75% of those of the Anglo-Australian Telescope (AAT), a remarkable achievement for the ANU facilities, which operate on a substantially smaller budget.**

Efficiency is also high. Based on statistics from the 40% of users that complete observing reports, downtime on ANU telescopes at SSO is currently 3% for the 2.3-m and 4% for the 40-inch. Downtime due to weather is about 40%.

Another productivity indicator is the use of ANU telescopes at SSO to generate PhD theses. As shown in Table 2, ANU telescopes are widely used by higher degree research (HDR) students, with a considerably higher proportion of these students coming from non-ANU Australian universities than from the ANU itself.

**Table 2: HDR Students awarded time on ANU Telescopes at SSO in 2002-2005**

Institution	Total Number	% of Total
ANU	20	26
Non-ANU Australian	31	40
Foreign	27	35

Averaged over 2002-05, the numbers in Table 2 mean that ANU telescopes at SSO support the production of about 11 PhD theses per year, 7 of which are Australian. Based on data over a similar time frame, the Anglo-Australian Observatory has estimated that 9 PhD theses per year use data from the AAT, about 4 of which are Australian.

PhD Student Home Institution	Table 3: Distribution of HDR Use of ANU/SSO telescopes in 2002-2005			
	ANU 2.3m		ANU 40"	
	# Distinct Students	Nights Scheduled	# Distinct Students	Nights Scheduled
ANU	16	440	10	166
UNSW	7	100	3	95
Macquarie	5	46	2	28
U Sydney	6	41	3	61
Swinburne	3	23	1	6
U Melbourne	3	16	1	6
ADFA	2	8	0	0
Murdoch	1	7	0	0
JCU	1	7	0	0
Monash	1	2	0	0
U Queensland	0	0	1	6
Australian Total	44	690	21	368

Furthermore, as Table 3 shows, the young researchers using ANU telescopes are distributed across Australia. The ANU facility at SSO provides the only open-access, multi-instrumented research telescopes that can be actually operated - in an independent, hands-on way – by Australian PhD students.

**Thus, in terms of scientific productivity and support of Australian research training, ANU facilities at Siding Spring compare favourably with those of the Anglo-Australian Observatory.**

## The Need for National Funding for National Access

Over many years, the ANU has provided the telescopes and their maintenance, maintained the observing site on which they and other telescopes sit, provided documentation and first-night assistance to observers, regardless of their institution, operated a Lodge for visiting observers and a Visitor's Centre for the visiting public, and provided technical support for observers and on-going instrumentation upgrades. A capital investment in the order of \$A50M has already been made in ANU SSO infrastructure, most of it by the ANU. Recently a grant of \$A5.6M was awarded by DEST for new instrumentation and improved access infrastructure.

Site costs can be recovered from current national and international tenants via site agreements with ANU (new site agreements will be negotiated) that accurately reflect true cost recovery and provide clarity to tenants.

The costs associated with national use of ANU telescopes, however, are not recompensed to the ANU in any way. While the ANU is proud to be able to provide leadership through open, merit-based access to its own research facilities, bearing the full cost of national use is no longer sustainable. LIEF has been ruled out as a mechanism for recovering operational costs. **Thus, without the influx of appropriate NCRIS funds beginning in 2007, national access to ANU telescopes at SSO will need to be funded directly from individual institutions themselves, or discontinued.**

## SSO Infrastructure over the NCRIS Lifetime

Given the large national use of ANU telescopes at Siding Spring, and the possibility of NCRIS funding, options are presented below for how non-ANU use of ANU telescopes might be supported in a manner consistent with NCRIS guidelines and Decadal Plan priorities.

In the Decadal Plan, *New Horizons*, SSO elements identified as most crucial were:

- (a) *The ANU-owned site itself.* It is proposed to resource site needs by direct and full cost-recovery from all tenants.
- (b) *The new ANU SkyMapper telescope.* The ANU is dedicated to its intention to make all data associated with the SkyMapper Southern Sky Survey available electronically to all astronomers worldwide in a timely fashion.
- (c) *The ANU 2.3-metre telescope.* The telescope will have unique capabilities for Australian astronomers once its DEST and ANU-funded Wide Field Spectrograph (WiFeS) becomes available in 2007. An extension to allow excellent blue performance for WiFeS may be possible through a multi-institutional LIEF bid that has just been submitted. **The ability to do quantitative spectrophotometry over a wide spectral range and spatial field makes WiFeS on the 2.3m unique in the world amongst the class of integral field spectrographs.**

The primary element that NCRIS needs to address, therefore, is national use of the 2.3m, including its associated share of site costs. Due to its high use, options for funding national access to the 40-inch telescope are also provided. In the options that follow, costs are derived from expenditure averaged over the past five years. Depreciation is not included.

SkyMapper survey data will be made available to all Australian astronomers regardless of which option is chosen. Options become effective 1 May 2007 for the 40-inch (when SkyMapper comes on-line) and 1 Nov 2007 for the 2.3m (when WiFeS should be available). The 50% sharing ratio is based on the current use of ANU/SSO telescopes.

**National Use of SSO Telescopes****\$1000 AUD****Effective beginning: 1 May (40") & 1 Nov (2.3m) 2007**

<b>Option 1: NCRIS shares usage costs with ANU NCRIS funds 50% of 2.3m and 40" Operations</b>	Annual Cost	<b>NCRIS Tot</b>
2.3m Operations (50%)	370	1356
2.3m Site Costs (50%)	57	208
40" Operations (50%)	185	770
40" Site Costs (50%)	28	118
<b>TOTAL NCRIS</b>	<b>640</b>	<b>2452</b>
<b>MATCHING COMPONENT FROM ANU</b>		<b>2452</b>
<ol style="list-style-type: none"> <li>1. Time awarded on merit to all national users</li> <li>2. 50-50 Split to be reviewed in 3 years</li> </ol>		

<b>Option 2: NCRIS shares usage costs with ANU NCRIS funds 50% of 2.3m Operations</b>	Annual Cost	<b>NCRIS Tot</b>
2.3m Operations (50%)	370	1356
2.3m Site Costs (50%)	57	208
<b>TOTAL NCRIS</b>	<b>427</b>	<b>1564</b>
<b>MATCHING COMPONENT FROM ANU</b>		<b>1564</b>
<ol style="list-style-type: none"> <li>1. 2.3m time awarded on merit to all national users</li> <li>2. 50-50 Split to be reviewed in 3 years</li> <li>3. 40" unavailable for non-ANU use (except via institutional cost sharing, see Opt 3)</li> </ol>		

<b>Option 3: Institutional Consortia share costs with ANU</b>	<b>Share Cost/yr</b>
Cost of 25% minimum share of 2.3m	<b>213</b>
Cost of 25% minimum share of 40"	<b>107</b>
<ol style="list-style-type: none"> <li>1. Up to 50% of time reserved for purchase</li> <li>2. Site costs included</li> <li><b>3. Option unavailable unless telescope fully subscribed.</b></li> <li>4. No observers/night assistance provided; only experienced observers allowed.</li> </ol>	

<b>Option 4: No sharing of costs or usage</b>	<b>Yearly Cost</b>
<b>Effective beginning: 1 May (40") &amp; 1 Nov (2.3m) 2007</b>	
1. No non-ANU use of ANU Telescopes at SSO	<b>0</b>

The levels of funding indicated in Options 1 and 2 would provide maintenance, site costs, and technical support through the NCRIS period. **NCRIS funding would need to flow at the annual rate beginning 1 May 2007 (for the 40-inch) and 1 November 2007 (for the 2.3m).** Certainty of funding would be required by 1 November 2006.

Based on subscription rates, the ANU has closed its 24-inch telescope (37% subscription

over last five years) to merit-based, open access. The same will be true of the ANU 40-inch (83% subscription), once SkyMapper is operational, if national funding is not available. The subscription factor for the ANU 2.3m (currently 1.03) is expected grow greatly in 2007+.

**Given past history, we would expect about 37 (55) PhD theses and at least 105 (145) publications** in refereed journals to be generated **from the ANU 2.3m (2.3m + 40-inch)** during the NCRIS period. However, these numbers may be considerably underestimated since the **WiFeS spectrograph, the remote observing** made possible by the DEST Systemic Infrastructure Initiative grant, **and the need for spectroscopic follow-up of SkyMapper survey targets will increase demand for the 2.3m beginning in 2007 with the availability of WiFeS.**

### Primary Risks and Their Mitigation

- Tenants are not able to meet site costs, so site costs blow out. Mitigation: Fund AAO, the primary tenant, appropriately. Ensure that international tenants pay their fair share.
- The blue arm of WiFeS is not funded by ARC LIEF grant. Mitigation: Immediately fund the blue arm from 2006/07 NCRIS monies, curtailing NCRIS spending elsewhere.

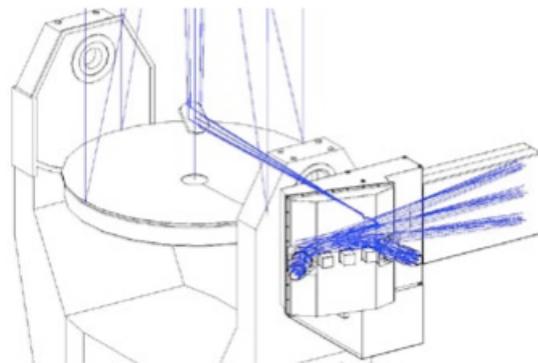
### Compatibility with NCRIS Principles

(a) *Australia's investment in research infrastructure should be planned and developed with the aim of maximizing the contributions of the research and development system to economic development and social wellbeing;*

- The training opportunities provided by the ANU 2.3m for independent, hands-on operation of a major research telescope are not matched elsewhere in Australia.

(b) *Infrastructure resources should be focussed in areas where Australia is, or has the potential to be, world-class (in both discovery and application driven research) and provide international leadership;*

- **WiFeS on the ANU 2.3m will be an exceedingly powerful device, with spectral coverage** from the ultraviolet atmospheric cut-off up to nearly one micron in the infra-red, **excellent wavelength resolution, field of view, and high overall efficiency. It will operate up to 30 times faster than existing spectrographs in a host of science applications.** In single-star mode, the limiting magnitude will be  $\sim V = 22$  mag. **WiFeS will be unique among optical integral field spectrographs worldwide.**



Optical paths of WiFeS on the Nasmyth A port of the ANU 2.3m at SSO.

(c) *Major infrastructure should be developed on a collaborative, national, non-exclusive basis. Infrastructure funded through NCRIS should serve the research and innovation system broadly, not just the host/funded institutions. NCRIS funding should encourage collaboration and co-investment among universities, government, independent and private sector research organizations. It should not be the function of NCRIS to support institutional level (or small-scale collaborative) infrastructure;*

- NCRIS funding will be used to ensure that the ANU 2.3m is accessible to all Australian astronomers on the **basis of merit**. All time allocated on the telescope, including that funded through ANU matching, would be awarded on the basis of a redefined **Time Allocation Committee with increased national representation**.
- (d) *Access is a critical issue in the drive to optimise Australia's research infrastructure. In terms of NCRIS funding there should be as few barriers as possible to accessing major infrastructure for those undertaking meritorious research;*
- With appropriate levels of NCRIS support, access to the ANU 2.3m would be completely open to the Australian astronomical community. **Logistical access is made particularly easy** for on-site users due to the presence of an Observer's Lodge (separately funded on a cost recovery basis by ANU). The implementation of TAROS (Telescope Automated and Remote Operation System) in 2007 will enable Australian users to observe from their home institutions without travel to SSO.
- (e) *Due regard should be given to the whole-of-life costs of major infrastructure, with funding available under NCRIS for operational costs where appropriate;*
- The funding requested from NCRIS, together with equal matching from ANU, would provide the operational costs for infrastructure for which the major investment has already been made. The most productive **lifetime of the WFeS instrument** of five years beyond commissioning is **well matched to the NCRIS timescale**.
- (f) *The Strategy should seek to enable the fuller participation of Australian researchers in the international research system.*
- Users of the 2.3m telescope often combine data from it with data taken with other telescopes of the national and international research infrastructure system. This **complementarity** is particularly strong with the Anglo-Australian Telescope, the Gemini 8m telescopes, the Subaru 8m telescope, and the 8m telescopes of the European Southern Observatory, and via optical follow-up of radio observations.

#### **NCRIS Criteria for Investment:**

- (1) Must result in excellent research infrastructure that addresses the national requirements of the relevant capability area described in the NCRIS Roadmap.
  - See comments under (b) above.
- (2) Must result in research infrastructure that is accessible by researchers on the basis of merit at reasonable prices, and that encourages collaboration in research.
  - See comments under (d) and (f) above. **The cost per night of 2.3m is about 2.6K\$, even assuming a 10% loss to mechanical or aluminising downtime. This is about a factor of 1.5 to 2 less than other telescopes of its class around the world.**
- (3) Must include a facility ownership and management structure that will result in the efficient and effective operation of the infrastructure.
  - Ownership will stay with the ANU, which already runs the facility efficiently. The effectiveness of the operations could be judged by a national **SSO User's Committee to be set up as an NCRIS advisory body**.
- (4) Must include an implementation strategy and business case that will result in the efficient implementation and effective ongoing financial management of the infrastructure.
  - See (3) above.