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SUBMISSION 13

The University of Sydney

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Faculty of Science
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NSW 2006 AUSTRALIA

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Memorandum

To: Parliamentary Standing Committee on Public Works
Ref: Provision of Facilities for Headquarters Joint Operations Command, NSW
From: A/Prof. Anne Green, Director, Molonglo Radio Observatory
on behalf of the University of Sydney

Impact of HQJOC Project on the Molonglo Radio Observatory

Committee Submission
28 May 2004

Background

The Molonglo Radio Observatory, 30km east of Canberra, is the site of the largest radio telescope in the Southern Hemisphere, the Molonglo Observatory Synthesis Telescope (MOST). The telescope makes very deep images of the sky at radio wavelengths and has produced a host of important research results over the past 40 years as well as training a generation of radio astronomers, many of whom now occupy top positions at overseas and local institutions. It continues to be a world-leading facility, operated by the School of Physics within the University of Sydney, with funding from the University and the Australian Research Council. It is currently completing a major research project to map the entire southern sky, to study the evolution and structure of our Universe and to discover key elements of star birth and death. This is the Sydney University Molonglo Sky Survey (SUMSS), which is expected to be completed by 2006.

The telescope currently operates by receiving radio emission from the sky in a narrow band of 843 ± 1.5 MHz, for which we have footnote protection with the Australian Communications Authority. The main users of this band are mobile phone companies. The SUMSS project is vulnerable to Radio Frequency Interference (RFI) from man-made transmissions because the site is in a radio-quiet area remote from habitation and our observing and analysis strategies have not needed to be sophisticated in mitigating RFI. This means our images are easily corrupted by the artefacts caused by man-made signals. Future projects will have extensive

RFI mitigation strategies embedded from the beginning.

Our second major focus is a project funded by the Federal Government under the Major National Research Facilites II Program to provide Australia with a new low-frequency facility (built on the mechanical superstructure of MOST) which will probe emission from the early Universe. This is the SKA Molonglo Prototype (SKAMP) project, which will also prototype new technologies in high-speed digital signal processing that will be part of Australia's bid to host the next generation radio telescope, the Square Kilometre Array (SKA). The SKA is a AU$2 billion project proposed to start a decade from now. The SKAMP project is Australia's principal technology demonstrator for the SKA and is jointly undertaken with CSIRO and industry partners, with funding from DEST and the Australian Research Council. This new facility will receive radiation from 300 – 1400 MHz; over most of this range there is no formal spectrum protection. RFI mitigation is therefore a major part of the research plan for this project.

The Headquarters Joint Operations Command, NSW (HQJOC) and the Molonglo Radio Observatory, University of Sydney are both projects in the national interest. The critical issue for this Submission is :

> **What is the probable impact of the Defence facility HQJOC on the operation of the Molonglo Radio Observatory, and how is the impact to be managed to minimise adverse economic and scientific outcomes for both projects, while preserving the national interest?**

Radio Frequency Interference

The susceptibility of the Molonglo Radio Observatory to RFI from a complex and diverse Command Centre sited 5 km away is poorly determined, even though there has been a limited series of tests made and simulations performed as part of the Environmental Impact Assessment. Likewise, the accurate radio emission profile of HQJOC, including military and non-military electromagnetic emissions, is unknown for both the construction and operational phases. The Department of Defence has funded the initial experiments to evaluate the effect of a single transmitter placed on the selected Woodlands site. It should be noted that the best of several possible sites in this area, from the Observatory perspective, was selected and we are very appreciative of the cooperation received from the Defence project team with this study.

The testing involved the generation of a broadband noise signal of known power at the HQJOC site, which was then received and imaged by the telescope. It is clear that we can detect quite faint signals and that they will ruin our images. The level at which the research results are compromised beyond use is the subject of ongoing study. However, simulations and a single transmitter simply do not represent an accurate picture of a facility housing more than 1000 staff with computers, diverse electronic equipment, vehicle traffic and supporting systems. There is also the construction phase with its heavy machinery to consider.

The construction and normal operations of HQJOC have the potential to compromise the scientific objectives of the Molonglo Radio Observatory. In the worst possible scenario, if the emissions from HQJOC result in the Molonglo Radio Observatory being rendered non-

viable, then provision needs to be made to relocate and re-establish an internationally competitive observatory at another location. We regard this option as a last resort, since it is not in the national interest either to render the present observatory unviable or incur the considerable cost and delay in re-establishment at another site.

Action Plan

To assess and manage the mutual impact of MOST and HQJOC a Steering Committee and active Working Group were set up between us and the Department of Defence. The process has been very productive and cordial and we appreciate the efforts by Defence personnel.

The full impact of RFI generated by the HQJOC project cannot be accurately estimated at present. The new SKAMP telescope is not complete. RFI varies with telescope position and is clearly worse when the telescope is tilted towards the north (and the HQJOC site). Since the final performance of the new telescope is not yet known our full sensitivity to RFI is also unknown.

As a result of the HQJOC project we have accelerated our research into RFI mitigation. Apart from the Environmental Impact Study, this has been self-funded. We are hopeful of restarting negotiations with Defence for a joint research team funded by DSTO/Defence to investigate mutual issues to do with RFI, including the detection and blocking of signals. This research will have strong implications for the much more sensitive future telescope, the SKA.

When calculating the impact of HQJOC, we applied Australian standards and formulated a quantifiable moderate approach. For example, we estimates the transmissions that would raise our detected background noise level and degrade our signal by 10%. Much more than this would render our observations useless. For the SUMSS project (more vulnerable) this could be as low as 50μW total emitted power from the site, integrated over half a hemisphere. For SKAMP, we are better prepared to deal with RFI and recognise that spectrum protection is not feasible. Here we would be able to tolerate a total signal power up to 1mW. We give these rough estimates to the Committee to emphasise how sensitive our telescope is. We are measuring signal power of 10^{-28}W/Hz/steradian and could detect signals one thousand times weaker than the emission from a single mobile phone transmitting from the moon.

The transmission from HQJOC will be subject to path loss and diminished by shielding and many other factors. We are cautiously optimistic that the measures planned will enable us to continue our front-line research during both the construction and operational phases of HQJOC.

Particular strategies that will improve the situation:

1. Plant substantial vegetation on the intervening ridge line.
2. Shield all buildings, including meshing windows. Peripheral buildings (outside the central core) may need screening if there is computer controlled machinery, photocopiers, etc there.
3. Restriction to be imposed on radios used by perimeter security guards. Careful choice of alarm systems.

4. Low-powered mobile phones to be used, maybe requiring a micro-cell transmitter tower on the HQJOC site.
5. Australian standards for shielding to be enforced. Additional shielding for service buildings if required.
6. Direction be given to the contractors during the building phase to adhere to agreed RFI minimisation strategies. Guidelines also to be in place for the operational phase for the same purpose.

Memorandum of Understanding

It is envisaged that a Memorandum of Understanding (MOU) between the Department of Defence and the University of Sydney be completed and signed. There is currently a draft document being discussed. This is the wish of the stakeholders with interests in the Molonglo Observatory operations. The stakeholders include the Australian SKA Consortium Committee, the National Committee for Astronomy, the Australian Research Council, the Australia Telescope National Facility and the University of Sydney. This MOU is to manage the RFI impact of HQJOC, including the provision of technical assistance and agreed compensation if ongoing research proves impossible.

Comments on the Document of Statement of Evidence

The Statement of Evidence presented to this committee does not include a mention of the need to undertake minimisation of RFI on the environment. It is the intent of the HQJOC project to exist in harmony with the surrounding environment and the electromagnetic spectrum is an integral part of this environment.

No specific mention is made of metal cladding or meshing for either the core or the ancillary buildings although this has been discussed.

No specific mention is made of any factors from the Environmental Impact Assessment.

Concluding Summary

The Molonglo Observatory has a long and distinguished record in astronomical research world-wide and the present and planned (and funded) research projects continue to have a leading position. The proposal to build a new Defence Facility for the Headquarters of the Joint Operations Command, NSW, so close to our Observatory is unwelcome, but we have been appreciative of the cooperation and efforts of the Defence personnel who have carriage of this project, to accommodate our concerns. We are cautiously optimistic that we can determine strategies to minimise the impact and enable us to work collaboratively with Defence to preserve the integrity of the work of both sites.

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