Protection and self-protection of the Murchison Radio-astronomy Observatory from radio frequency interference

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Abstract

The development and operation of a radioastronomy observatory site requires control of radio frequency interference, from external activities such as local industry and human settlement as well as from activities arising from the operation of the observatory itself. This paper reports on measures being taken in Australia to protect the Murchison Radio-astronomy Observatory, which is a candidate site for the Square Kilometre Array. Public standards for interference levels have been established, based on internationally approved ITU-R standards. Potential interference from industry will be managed by the ACMA and State Government measures, within the framework of a principle of co-existence. Technical advisory guidelines will describe the acceptable limits on the use of typical radio systems and electrical equipment. Interference from activities on the site, such as power generation, computing, and support functions, are being managed during the design process.

1. Introduction

Australia has proposed a site in Western Australia, the Murchison Radio-astronomy Observatory (MRO), as the site for the next generation Square Kilometre Array (SKA) radio telescope. The CSIRO Australian SKA Pathfinder (ASKAP) telescope is currently being constructed on the MRO site, and the Murchison Widefield Array (MWA), a wide-field, low-frequency dipole array telescope, is already in operation.

A major component of developing such a site is to monitor and control the level of radiofrequency interference (RFI) at the site from manmade sources. This includes broadband noise from electrical equipment (including vehicles, motors, powerlines, electric tools) as well as narrowband interference from intentional radio transmitters. As a first step, a remote site provides some level of protection due to distance from human settlements or industrial activity. However, even a remote site may have low levels of industry or sparse populations, and interference from more distant sources must also be controlled. Furthermore, the requirements of a modern radiotelescope such as the SKA, including power, active electronics, computing facilities and data transport, involve systems which are sources of radiofrequency interference in their own right. Therefore, the control of interference from the activities on the observatory site must also be managed.

The Mid West Radio-quiet Zone has been established by the Australian Communications and Media Authority (AMCA), Australia's national radiocommunications regulator. This paper describes specific technical measures being developed to protect the Mid West Radio-quiet Zone.

2. Standards for Interference Assessment

Recommendation ITU-R RA.769-2 describes levels of radiofrequency interference which are harmful to radioastronomy observations. It is an internationally accepted standard that defines the maximum level of interference which is consistent with typical astronomical applications. Based on that Recommendation, the ACMA has developed a Radiocommunications Assignment and Licensing Instruction (RALI) MS 32 which defines threshold values of interference to the MRO as a function of frequency. The values in RALI MS 32, as shown in Table 1, are the basis for agreements to control interference at the MRO.

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RALI MS 32 also provides for a restricted zone within 100 km of the MRO core (150 km for the lowest frequency band) where new radio licences will only be considered on a case-by-case basis. Outside the restricted zone but within a coordination zone, a consultation process is defined to evaluate new radio systems based on the thresholds in Table 1.

Table 1
Limits of harmful interference at the MRO

Frequency Range (MHz)	Restricted Zone Radius (km)	Coordination Zone Radius (km)	Threshold (dBm/Hz)
100-230	150	260	-214
230-240	100	180	-222
400-520	100	165	-224
520-820	100	190	-224
820-1000	100	145	-228
1,000-2,300	100	140	-230
2,300-6,000	100	120	-232
6,000-10,000	100	Not required	-232
10,000-25,250	100	Not required	-236

3. Co-existence Agreement

Within the zones defined in Table 1 above, there is some level of pastoral and industrial activity which must be considered. To promote a collaborative approach between the MRO and other industry uses, a co-existence agreement is being explored between the Australian Commonwealth Government and the Western Australian State Government, together with technical advisory guidelines (described in the following section.)

The ACMA has recently proposed the introduction of a Band Plan whereby industry would be required, if their activity has the potential to cause harmful interference on the MRO, to consult with the MRO entity to develop technical solutions that minimise the radio-frequency impact of their operation on the radio astronomy operations. In return, the MRO entity would be required to facilitate practical solutions that maximise opportunity for shared use of spectrum within acceptable limits.

4. Technical Advisory Guidelines

Technical advisory guidelines are being developed to describe the operation of certain classes of equipment within the Mid West Radio-quiet Zone. The guidelines will cover commonly used equipment such as vehicles, industrial electrical equipment and class-licensed communication systems such as satellite phones or WiFi. Based on typical technical parameters, including frequency, power levels, antenna characteristics and usage pattern, the level of expected interference to radioastronomy observations can then be assessed. This will allow more specific advice on the operation of each type of equipment within the Mid West Radio-quiet Zone, such as acceptable separation distances from the radiotelescope or techniques to reduce the interference. The development of these guidelines for the majority of equipment is expected to streamline the analysis of particular co-existence consultations.

5. Management of Self-interference

In the development of the ASKAP and MWA telescopes, issues of interference from the radioastronomy facility itself have been carefully considered. The ASKAP correlator building has been designed with high levels of RFI shielding (> 80 dB for the main building plus > 80 dB for the correlator room itself). RFI “airlocks” are used at each door to prevent leakage, and air, water and cabling penetrations have been assessed for RFI compliance. More importantly, ASKAP is designed as an unmanned facility that will be remotely operated. Apart from maintenance periods, there will not be any staff on the MRO site, thereby reducing the use of electrical equipment and vehicles.

In addition, the ASKAP power station is an RFI-compliant hybrid solar-diesel facility and will also be remotely operated.

The design of the ASKAP receivers and antennas is also based on strict RFI standards derived from Recommendation ITU-R RA.769-2. Testing of all electrical equipment used on the telescope site is required before deployment.

6. Conclusion

A range of measures have been described to assess, reduce and control the radiofrequency interference at the Murchison Radio-astronomy Observatory. These include regulation through legislation, consultation and collaboration with other spectrum users in the region, and control of interference from the observatory itself.