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The future of australian neutron monitoring

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Abstract. Responsibility for the Australian neutron monitor network is being transferred from the University of Tasmania to the Australian Antarctic Division. The transfer has already involved the closure of the Darwin and Brisbane stations and the creation of a new 18-NM-64 monitor at Kingston, near Hobart. In 2002 the existing Hobart (sea-level) and Mt Wellington stations will be closed and their equipment used to increase the size of the Mawson monitor to 18 BF_3 tubes.

1 Introduction.

The Australian neutron-monitoring program commenced in 1956 with the establishment by the University of Tasmania (UT) of a 12-counter IGY type monitor (Simpson, 1957) part-way up Mt. Wellington, close to Hobart (McCracken, 2000). The BF_3 proportional counters detectors were of the then standard type approximately 1 m long and 5 cm diameter. The site, at an altitude of 725 m and known locally as *The Springs*, was at the then upper limit of the electrical supply on the mountain. Some early references to this monitor named it "Hobart", causing potential confusion with later near sea-level instruments.

In March 1957 a similar 12-counter monitor was installed at Mawson, Antarctica, as an extension of the muon-monitoring program that had been underway there since 1955 in collaboration with the Australian Antarctic Division (AAD). In the same year the university installed a 6-counter monitor at Lae, in New Guinea while the University of Sydney, as its contribution to the IGY, installed a 12-counter monitor in the Sydney area. After the IGY the latter instrument was transferred to the University of Tasmania and was relocated to Brisbane. In 1962 a second Antarctic monitor was installed at the Wilkes base.

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Monitoring continued during and beyond the IQSY in 1965, the first significant interruption to the program being the destruction of the Mt Wellington monitor in the major southern Tasmania bush fire on 7 February 1967. Also by that time poor environmental conditions had severely reduced the reliability of the Lae monitor. It was closed and its tubes were returned to Hobart in 1970. The Wilkes monitor was moved to the new nearby Casey station when Wilkes closed early in1969. Funding restrictions forced the closure of the Casey instrument two years later.

Replacement of the Mt Wellington monitor was delayed by funding problems and the new 6-counter NM-64 type monitor (Carmichael, 1968) using BP28 counters did not start operations until June 1970. The new monitor's count rate was about eight times that of its predecessor.

The Mawson monitor was moved in 1972 to a new nearby building but was not otherwise upgraded while the other IGY monitors continued in operation. About 1973 the University of Texas at Dallas offered the University of Tasmania the 18-counter NM64 monitor then at Fort Churchill in northern Canada. Nine counters went to a new installation at Darwin and the remaining nine were used to replace the previous IGY monitor at Brisbane. Both the new monitors were installed at the airports of the respective cities, close to Bureau of Meteorology (BoM) facilities. They were largely automated, requiring only occasional attention, plus weekly removal of recording tapes by BoM staff. About the same time a 9-counter NM-64 monitor was installed on the Hobart campus of the university. The final addition to the original NM-64 network occurred in 1986, when a 6-counter NM64 monitor replaced the original IGY instrument at Mawson. The network then remained stable until 2000, with 9-counter monitors at Darwin, Brisbane and Hobart and 6-counter ones at Mawson and Mt Wellington. The only change in this period was a move of the Brisbane instrument to a new BoM site when their old site was relocated to follow airport changes.

2 The situation in 2001

The review of the Department of Physics at the University of Tasmania in 1997 recommended that its research effort should be concentrated into radio-astronomy and theoretical physics. The cosmic ray program should be wound down in an orderly manner. The university later agreed to donate its neutron monitors to the AAD.

By the late 1990s it was known that redevelopment plans at Brisbane and Darwin airports would require the relocation of BoM facilities at both places during 2000. The concomitant need to move the neutron monitors was not funded. Although from a cosmic ray viewpoint it would be highly desirable to continue observations at those latitudes, the AAD has no brief or ability to mount long-term monitoring operations on the Australian mainland. Consequently the Brisbane monitor was returned to Tasmania in February 2000, followed by the Darwin monitor in October the same year.

The international standard size for NM-64 monitors is 18 counters. The AAD has therefore decided to reorganise its available detector tubes into two 18-counter monitors for the foreseeable future. The first, using equipment from the Brisbane and Darwin monitors, is located at the Division's headquarters at Kingston, Tasmania, a few kilometres south of Hobart. The first half of this instrument commenced operation in April 2000 using the ex Brisbane equipment. The second half, using the equipment returned from Darwin, commenced operation in December 2000.

Table 1. Details of the new Kingston monitor

Station:	Kingston, Tasmania	
Latitude:	-42.99°	
Longitude:	147.29°	
Altitude:	65 m	
Cutoff:	1.88 GV	
Opening:	First 9 counters:	20 April 2000
	Second 9 counters:	December 2000

BF_3 counters produce pulses of millivolt size. A critical aspect of long-term neutron monitor operation is therefore reliability of the pulse amplifiers and associated discriminators. Those latterly in use in the UT network were designed and built in the late 1980s. By the late 1990s some were suffering stability and noise problems. The transfer of the equipment to the AAD was a good opportunity to upgrade the amplifiers, and all other aspects of the recording systems, to current standards. The new amplifiers, designed at the Bartol Research Institute, University of Delaware, enable on-line pulse-height-analysis of each counter in essentially real-time, thus for the first time permitting us to easily distinguish between detector and electronic problems. The operating voltage is adjustable for each individual counter and the recording system will operate at one-minute accumulations with timing controlled from a GPS receiver. The second half of the Kingston monitor was equipped with the new systems from the outset. The first half, still running in May 2001 using the good amplifiers from the old system, will be upgraded later in 2001. Fig 1 shows the April 2001 Ground Level Enhancements (GLEs) recorded by the first half of the monitor.

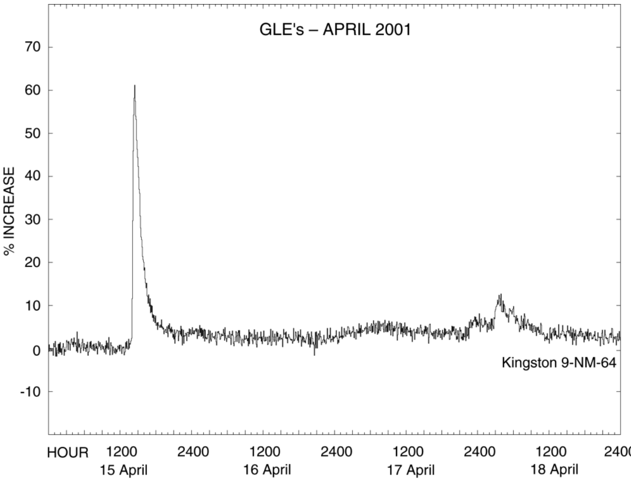

Fig 1. The April 2001 GLE's seen by the first half of the new neutron monitor at Kingston.

4 Planned changes at Mawson

The second part of the transfer from UT to AAD will involve upgrading the Mawson monitor from its present six counters to the 18-counter standard. The electronics will be upgraded at the same time. The additional detectors will come from the Mt Wellington and Hobart campus monitors. The upgrade is planned for the Antarctic summer 2002/2003. The existing Mt Wellington and Hobart monitors will be closed approximately six months before the transfer takes place. Once upgraded, Mawson will become a full member of the *Space Ship Earth* consortium (Moraal et al., 2000; Duldig, 2001), which will utilise data from a carefully chosen worldwide set of neutron monitors in order to continuously monitor interplanetary conditions in real time. Mawson's directions of viewing (Fig 2) fill a major gap between those of Nain, Canada and Apatity, Russia.

Details of the current status and some history of the Australian neutron monitors are currently located at www.phys.utas.edu.au/physics/cosray/observatories.htm. This page will probably eventually transfer to the Antarctic Division's cosmic ray site. More extensive historical descriptions appear in several papers in ANARE Research Notes 102 (2000).

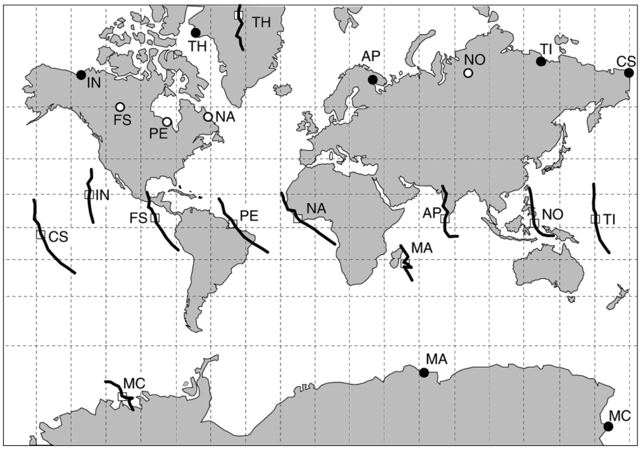

Fig 2. Approximate directions of viewing" of Space Ship Earth Neutron Monitors. Each line represents the variation with rigidity of primary particle arrival direction at the magnetopause. Highest rigidities are closest to the physical location of the detector. Open squares indicate the mean direction of viewing of each station.

AP	Apatity, Russia	MC	McMurdo, Antarctica
CS	Cape Schmidt, Russia	NA	Nain, Canada
FS	Fort Smith, Canada	NO	Novosibirsk, Russia
IN	Inuvik, Canada	TH	Thule, Greenland
MA	Mawson, Antarctica	TI	Tixie Bay, Russia

4 Latitude Survey

An ongoing program, jointly operated by the University of Tasmania, the Antarctic Division and the University of Delaware, runs a transportable neutron monitor each southern summer on a ship-borne round trip between Seattle and McMurdo, as part of a long-term project to obtain a better understanding of the atmospheric absorption processes as the primary spectrum changes during the solar cycle. The first results have been published (Clem et al., 1997, Bieber et al., 2001). It is hoped that the surveys will continue through at least the forthcoming solar minimum. A second transportable monitor is planned.

5 Ground Level Enhancements

A database of GLE records has been held at the US Air Force Geophysics Directorate in Boston since 1986. The AAD is accepting responsibility for its continued operation and the handover is currently under way. The AAD database will be web based, with future mirror sites planned for Europe and the USA (Duldig and Watts, 2001).

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