THE AUSTRALIA TELESCOPE NATIONAL FACILITY

AT Technical Data
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Transient Response of the Receiver System - Implications for Bandwidth Synthesis.

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INTRODUCTION

When making test observations using bandwidth synthesis, Mark Wieringa noticed that the wrong system temperature was being used to scale each integration cycle. On March 23, 1993, Mark investigated this problem by stepping an attenuator by 2 dB.

The data taken by Mark clearly showed the transient behaviour of the sampler statistics and measured system temperature which occurs when the output power of the receiver system changes. The variation in the measured system temperature, which is described in this note, may be a problem for bandwidth synthesis, especially if the observing frequency is switched rapidly.

THE TESTS

A small portion of the data collected when Mark carried out the tests on March 23, 1993, is shown in Fig. 1. The attenuator on CA04 was stepped from 6 dB to 8 dB during cycle #9, and then changed back during cycle #12. The integration cycle time was 10 seconds.

Fig. 1 also shows that when the attenuator on CA04 was changed
- the sampler statistics decreased to 11.7%, increased to 24.0% and then decreased towards their nominal value of 17.1%[1],
- the measured system temperature increased by 11% for cycle #9 and decreased by 5% for cycle #12, and
- the correlation between antennas CA04 and CA05, scaled using the measured system temperature but not corrected for variations in the sampler statistics, dropped by 15% and then increased by 13% before returning to its original level.

SYSTEM TEMPERATURE VARIATION

Fig. 2 shows the correlation between antennas CA04 and CA05. The correlation, scaled using the measured system temperature but not corrected for variations in the sampler statistics, is written to the RPFITS file. The correlation, scaled using the measured system temperature and corrected for variations in the sampler statistics is also plotted in Fig. 2. As expected, the large fulctuations in the uncorrected correlation have been removed, but the correlations for cycles #9 and #12 still reflect the variations in the measured system temperature. If we were to use a constant value for the system temperature, the correlations for cycles #9 and #12 are more typical of the rest of the data.

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[1] Since these tests were carried out, the target for the sampler statistics has been changed from 17.1% to 17.3%.

The measured system temperature[2] increased by 11% and decreased by 5% as a result of the 37% decrease in the output power of the receiver system which occured when the attenuation was increased by 2 dB[3]. Note that, as only the *attenuation* was changed, the *actual* system temperature did not change; only the *measured* system temperature changed.

The effect on the synch detector of changing the receiver output power is described in more detail by George Graves[1]. The effect is more pronounced when the noise source switching rate is low: at present the noise source is switched at 8 Hz.

It is also clear that the measured system temperature was one cycle ahead of the rest of the data, varying in the cycle in which the attenuator was changed - in effect anticipating the change of attenuation[4].

CONCLUSION

The system temperature variations noted here are, at best, a second order effect, and will not seriously affect data from routine Compact Array observations. The system temperature variations occured because changing the fine attenuator changed the output power of the receiver system. Similar system temperature variations may occur whenever the output power of the receiver system changes.

During bandwidth synthesis, changing the observing frequency may also change the output power of the receiver system. The system temperature variations will become a more serious problem if, for bandwidth synthesis, the observing frequency is switched every 2 or 4 cycles.

George Graves[1] has outlined changes which could be made: changes to the synch detector modules, and the use of a higher switching frequency for the noise source. As it looks increasingly unlikely that these changes will be made, it may be necessary to smooth the measured system temperature for bandwidth synthesis, or use a flux calibrator and ignore the measured system temperature.

REFERENCES

[1] George Graves, "Modifications to Analog Synch Detector (C52) Modules", AT/44.2/011

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[2] The measured system temperature is computed from the ratio of the gated total power to the synch detector output. The gated total power and the synch detector output are measured 2 seconds before the end of a cycle.

[3] The antenna control computer switches the attenuator 2 seconds before the end of a cycle.

[4] Since these tests were carried out, the software has been changed so that the system temperature measurements are applied to the correct integration cycle.

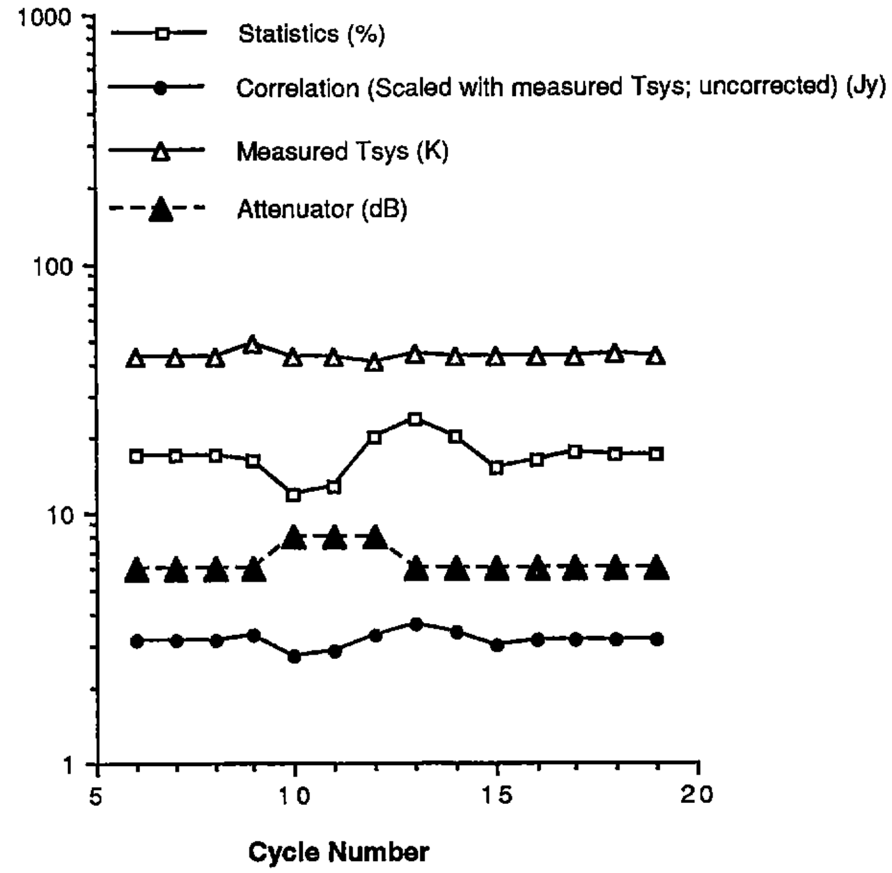

Fig. 1. A portion of the data collected on March 23, 1993, showing the variation in the sampler statistics and measured system temperature which occured when the attenuator on CA04 was stepped by 2 dB.

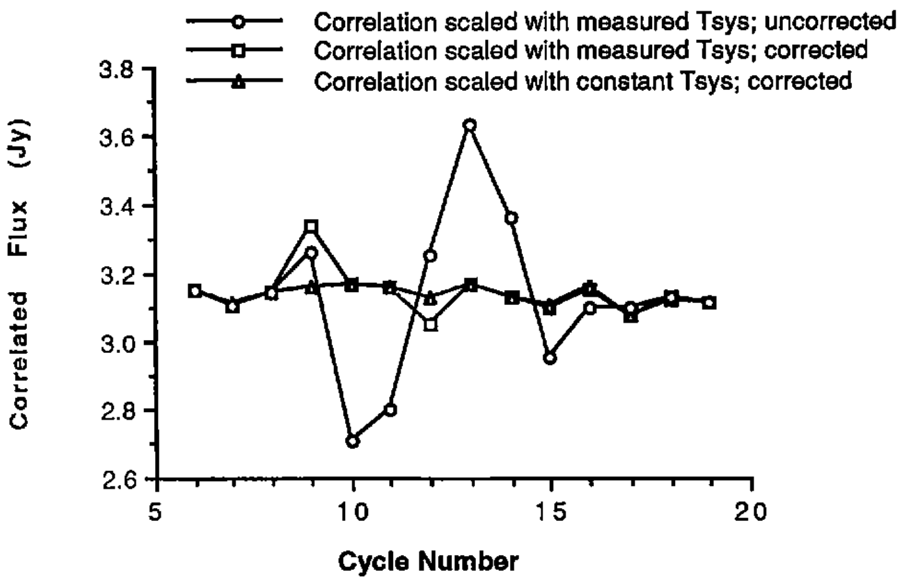

Fig. 2. The correlation, scaled using the measured (or a constant) system temperature and corrected (or not corrected) for variations in the sampler statistics.