AT. 39.3/023

Australia Telescope National Facility

Also Compact Array Analysis
AT 31.6.3/005.

Interference Within the Antenna Conversion System.

Introduction

Previous tests (Ref 1) by Mark Wieringa and Ravi Subrahmanyan have shown that there is considerable interference within the 20 cm (1.25 - 1.78 GHz, L-band) and 13 cm (2.2 - 2.5 GHz, S-band). Using two antennas, pointing in different directions, with no fringe rotation, amplitudes of about 100, and in some cases 1000 Jansky, were observed. Much of this is from satellites (GLONASS, GPS and GMS) and there is little that can be done to reduce this problem. However, some of the interference is generated within the antennas. With suitable shielding or filtering, it should be possible to reduce this.

Interference paths.

There are several paths by which interference could enter the system. Some are:-

(i) Spurious signals within the Local Oscillator system could be conducted into the conversion system with the LO signals.

(ii) Interference from equipment within the vertex room could radiate and leak into the horns, producing coherent outputs for a pair of antennas.

(iii) Locally generated sources of interference (Central control building, IPS, microwave ovens in quarters, receiver lab, etc.) could leak into pairs (or more) of antennas, producing coherent outputs.

(iv) Internally generated signals within the Sampler system could leak into the IF path and produce coherent signals from the correlator.

Some tests were performed to give an indication of levels of interference within the conversion system, (and the associated samplers.)

Interference within Conversion System.

I would be surprised if there was a problem here as care was taken with this part of the system design. The maximum permissible levels of spurious signals on the local oscillator signals were theoretically derived (Ref 2), and the units produced have very low levels of spurious. High order conversion products by leakage of one LO into a following mixing stage have been addressed by careful attention to the filtering.

From previous tests, interference appeared to be all entering the system by the horn. It was decided to do an observation to test this hypothesis.

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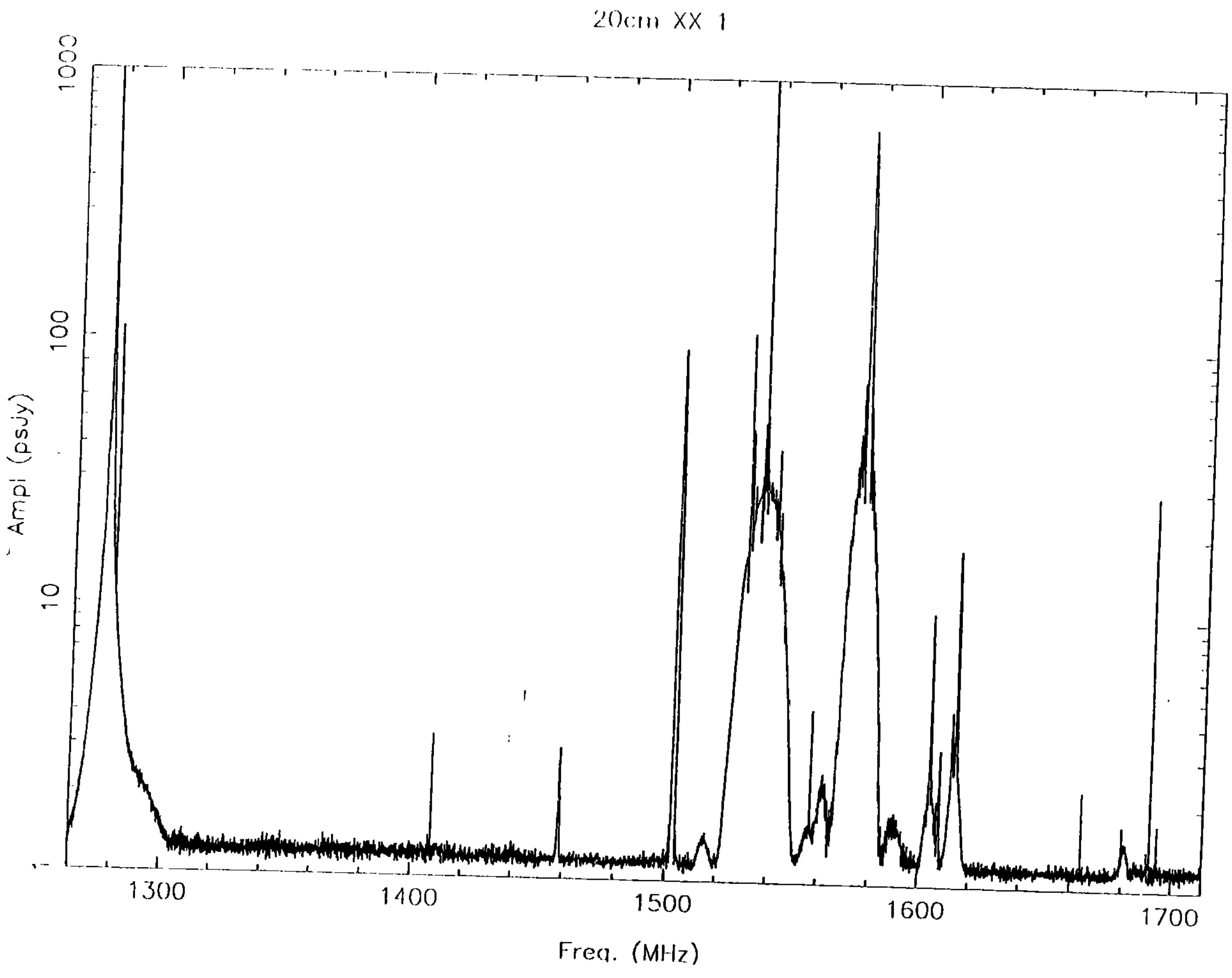
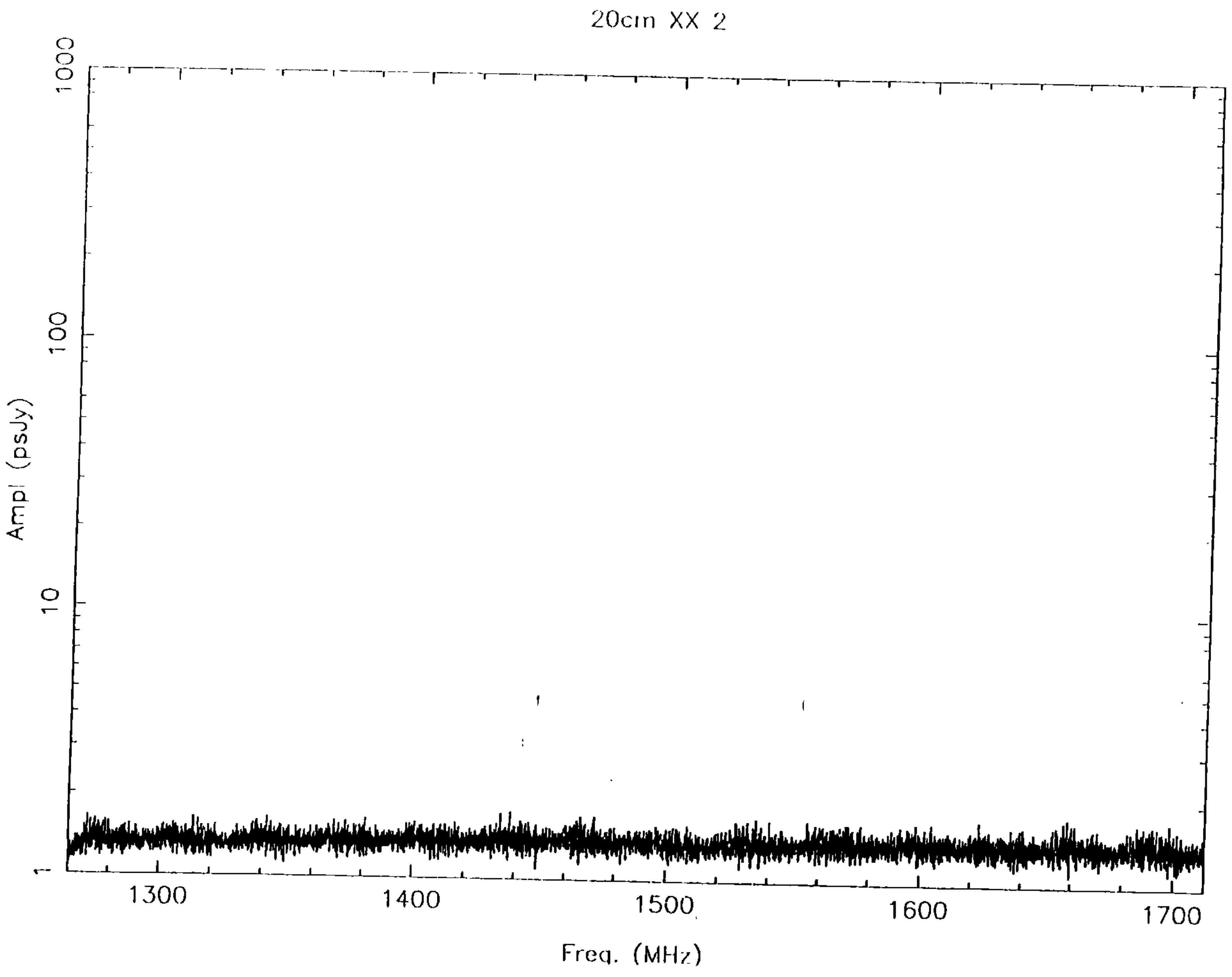

20cm XX 1
1000
100
10
Ampl (psJy)
1300
1400
1500
1600
1700
Freq. (MHz)

The outputs from the Low Noise Amplifiers (LNAs) were then disconnected, and a noise source connected directly to the polarisation A input of the RF module for each antenna. Also, a termination was put on the B polarisation input of the RF module. After a minor change in setting of the phase-invariant IF attenuator, polarisation A had the required level of IF power.

The cross correlation for A polarisations for the pair of antennas should be zero, as they had independent noise sources producing the system noise. (Of course, a power spectrum would be greater than zero. If there was no correlation, it would have random phase.)

Following is a graph showing the spectrum for the pair of antennas for this unusual system setup.



20cm XX 2
1000
100
10
1
Ampl (psJy)
1300
1400
1500
1600
1700
Freq. (MHz)

The Tsys measurement scheme could not be used as the associated noise source is connected to the waveguide section after the horn. That whole section had been disconnected from the conversion system. It is possible that there is a factor of two between the first and second plots, as Tsys may have been enabled for one and disabled for the other.

However, a factor of two is rather irrelevant when there is interference greater than 100 or 1000 Jansky.

Conclusion.

For the fairly short integration time, there was no indication of any interference within the conversion (or sampler) system, for the 20 cm band (L-band).

All of the interference appears to be entering the system by the horn (or the LNAs or their associated bias lines). A longer integration time, using a narrow bandwidth, would be required, to ensure that there the level of interference is below the limits required for observations. However, the vast majority (or all) of interference is *not* within the conversion system.

Observations for the 13 cm band would be required to show that the interference there is also being produced by signals entering the horn. However, if there is no observable interference within the conversion system for the 20 cm band, I think it would be extremely unlikely to be a problem for the 13 cm band.

Implications:

The path by which RFI enters the system obviously affects the procedures we use to reduce it. Screening the vertex room, and other procedures, should reduce the interference generated from within the vertex room. (See Ref 3 for a discussion of this).

If the interference is entering the horn, 180 degree phase switching will be useless to reduce it. However, phase switching would reduce the DC term in the correlation due to sample level sensitivity, and due to any random biassed bit errors in the IF data transfer system. (The demodulation can be done before the correlator, in the screened room).

If phase switching is required only for these reasons, a phase switch in the RF path just after the LNA would be a poor choice of positions. It is difficult to make broadband phase shifters with accurate phase shift, and small change of amplitude for this phase shift, for the present AT bands. To build such devices for the proposed higher frequency bands would be extremely difficult.

A much better place for a 180 degree phase switch would be in one of the local oscillator paths. Small changes in loss when switching would not affect the conversion system gain so much. (A change of say 1dB in LO power has a small effect on the conversion loss of the mixers used.) The phase switch would produce a uniform change in phase across the full band.

The phase switches could be put in the UHF LO signal path. However, when 256 MHz bandwidths are implemented, the UHF LO will not be used. Extra phase switches would be required for these IF's.

A better place would be in the 2 GHz LO path. All RF bands (present and those proposed, including unconverted VHF and UHF bands) pass through this conversion. If they were placed here, nothing would need to be added or changed when higher frequency bands are added to the instrument.

Acknowledgments.

The observations were a combined effort of Russell Gough, Shaun Amy and myself (George Graves). (Evan Davis also assisted with the correlator set up). Mark Wieringa reduced the data on the modified AIPS package at Narrabri. The program changes had previously been done by Mark and Ravi Subrahmanyan. Thanks also to Mal Sinclair and Henry Kanoniuk for useful comments about this note.

George Graves, Russell Gough, Shaun Amy & Mark Wieringa.
1 September 1992.

References:

1. "A Survey of the interference in the 13 and 20 cm bands at the ATCA", M.H.Wieringa and R. Subrahmanyan. May 18, 1992.

2. AT. 22.1.1/029 "Spurious Signals, Comb Lines and Local Oscillators."

3. AT. 31.6.2/025 "Radiated Interference from the Vertex Room."