AT. 39.3/028

ATCA Bandpass Variability

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25 March 1993

This memo reports on an observation on 8 January which were intended to examine instrumental polarisation of the ATCA. The observation was approximately 6 hours of 1934-638 at 4.8 GHz with the 128 MHz/33 channel system. A special correlator configuration was used so that the XY phase bandpass could be measured.

The weather during the observation was hot (40°), and atmospheric phase stability was poor.

In the calibration process, solutions were found for antenna gains, bandpass functions and polarisation leakage parameters. The antenna gains were solved for every 15 s intergration. The bandpass function was either held constant over the observation or solved for every 15 sec. The polarisation parameters were held constant. The XY phase of the reference antenna was held constant, although there was evidence that this varied by about a degree over the observation. The XY phase bandpass on the reference antenna was held constant. Given that 1934-638 is unpolarised, variation in XY phase of 1 degree will induce errors of order 10^{-4} of the Stokes-I flux.

The rms measured T_{sys} was 60.0K, which implies a theoretical rms noise of approximately 35 mJy in each channel for a Stokes parameter (I, Q, U or V).

The data showed that there was no evidence for variation with time of the polarisation leakage parameters, and the data obeyed the polarisation leakage model very well. The flux in the XY and YX correlations remains constant with time when gain corrections, but not leakage corrections, have been applied. When leakage corrections were applied, the residual flux in the XY and YX channels were consistent with the thermal noise limit. The polarisation leakage terms were unusually large during the observation, being 3–4% (normally they are 2%).

The XX and YY correlations did not calibrate quite as well. Investigation seems to suggest that this is a result of bandpass variations. Figure 1 shows the rms scatter in the Stokes I and V correlations after calibration, as a function of channel number. The calibration assumed either a constant or a variable bandpass. The scatter due to thermal noise should be 35 mJy. This is achieved for Stokes V (both for constant and variable bandpass). This suggests that the polarisation effects or polarisation calibration procedure is not the culprit. The theoretical limit is met (or marginally surpassed!) for channels 7 to 27 for Stokes-I when a variable bandpass is solved for. The fact that we can surpass the theoretical limit warns us that we are overfitting the data. When constraining the bandpass to be constant, the scatter in the Stokes-I points becomes appreciably worse than theoretical, particularly at the band edges.

Figure 2 shows the fractional difference between two sets of bandpass functions as a function of channel number (or actually frequency in the plot). These two sets of bandpasses were each derived from 7 minutes of data taken 70 minutes apart. They show differences of order 1-2% at the band edges. Closer examination of the bandpass functions show that the differences are mainly phase differences. This is partially apparent in Figure 2, where Antenna 3 is appreciable better than the others. This is an artifact of using Antenna 3 as the reference antenna in the calibration process (as absolute phase is neither measurable nor important the bandpass phase of the X feed of the reference antenna is fixed at 0).

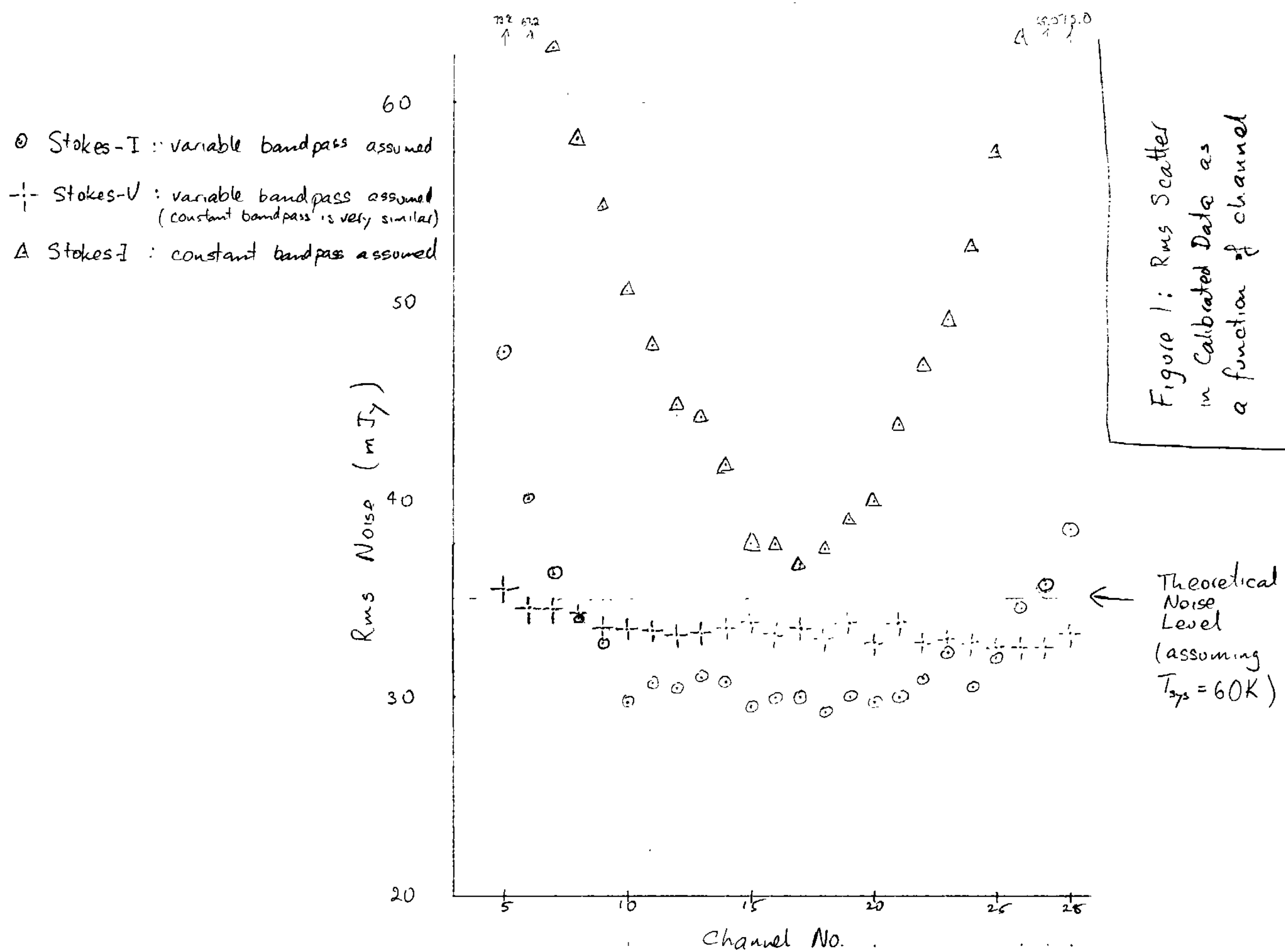
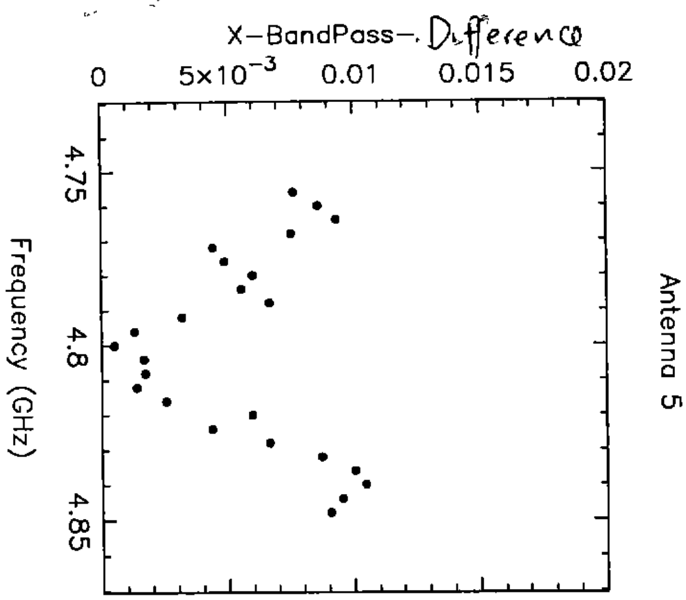
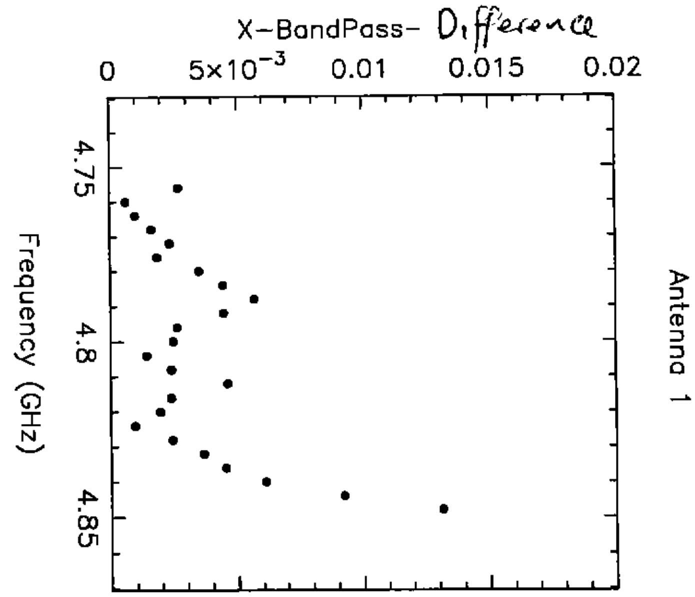
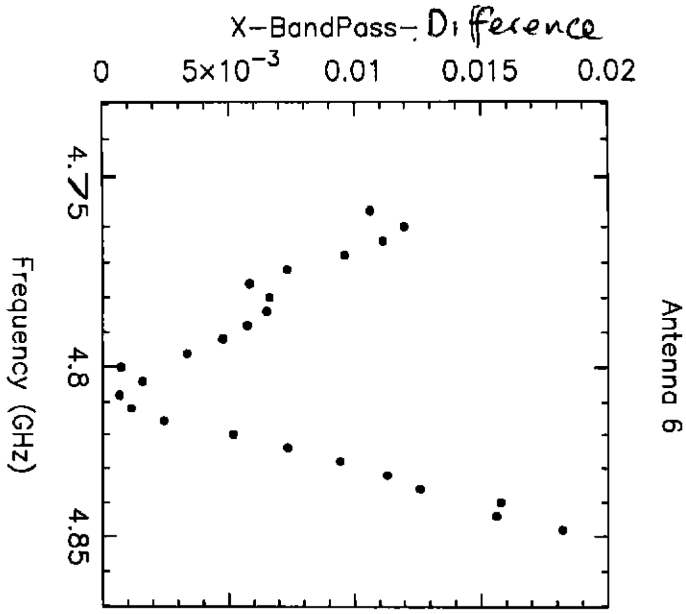
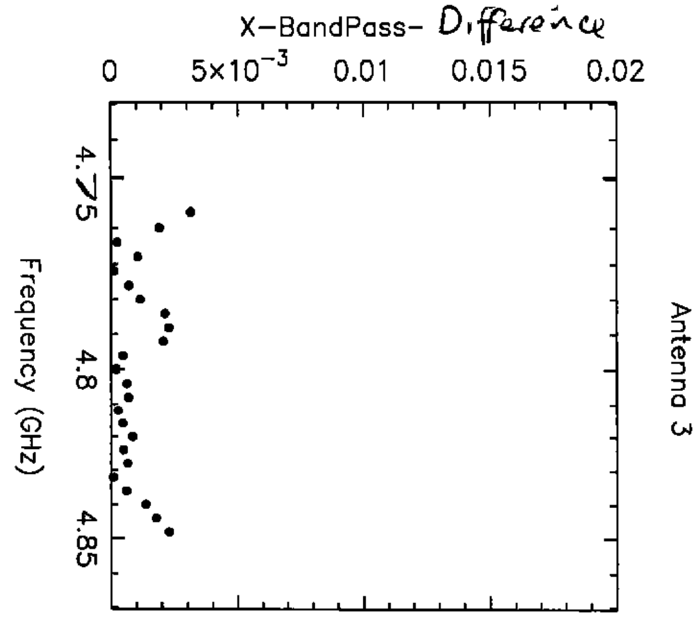


Figure 1: Rms Scatter in Calibrated Data as a function of channel









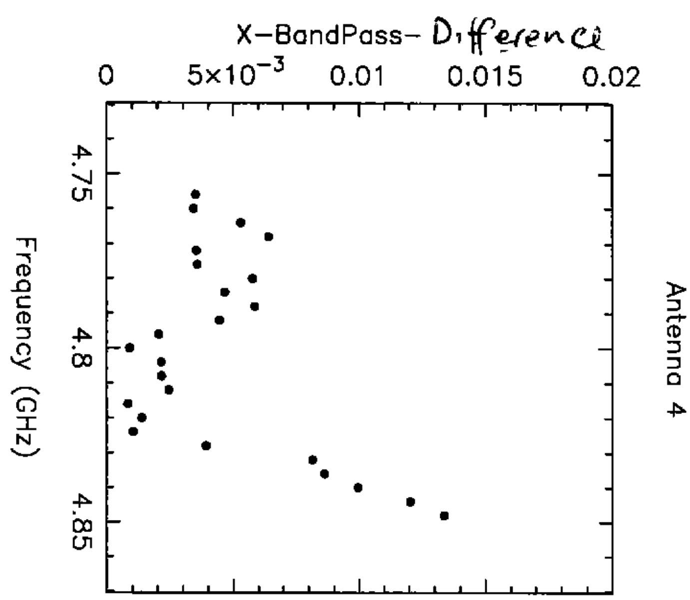


Figure 2:
Magnitude of Difference Between Bandpasses taken 1 hour apart.

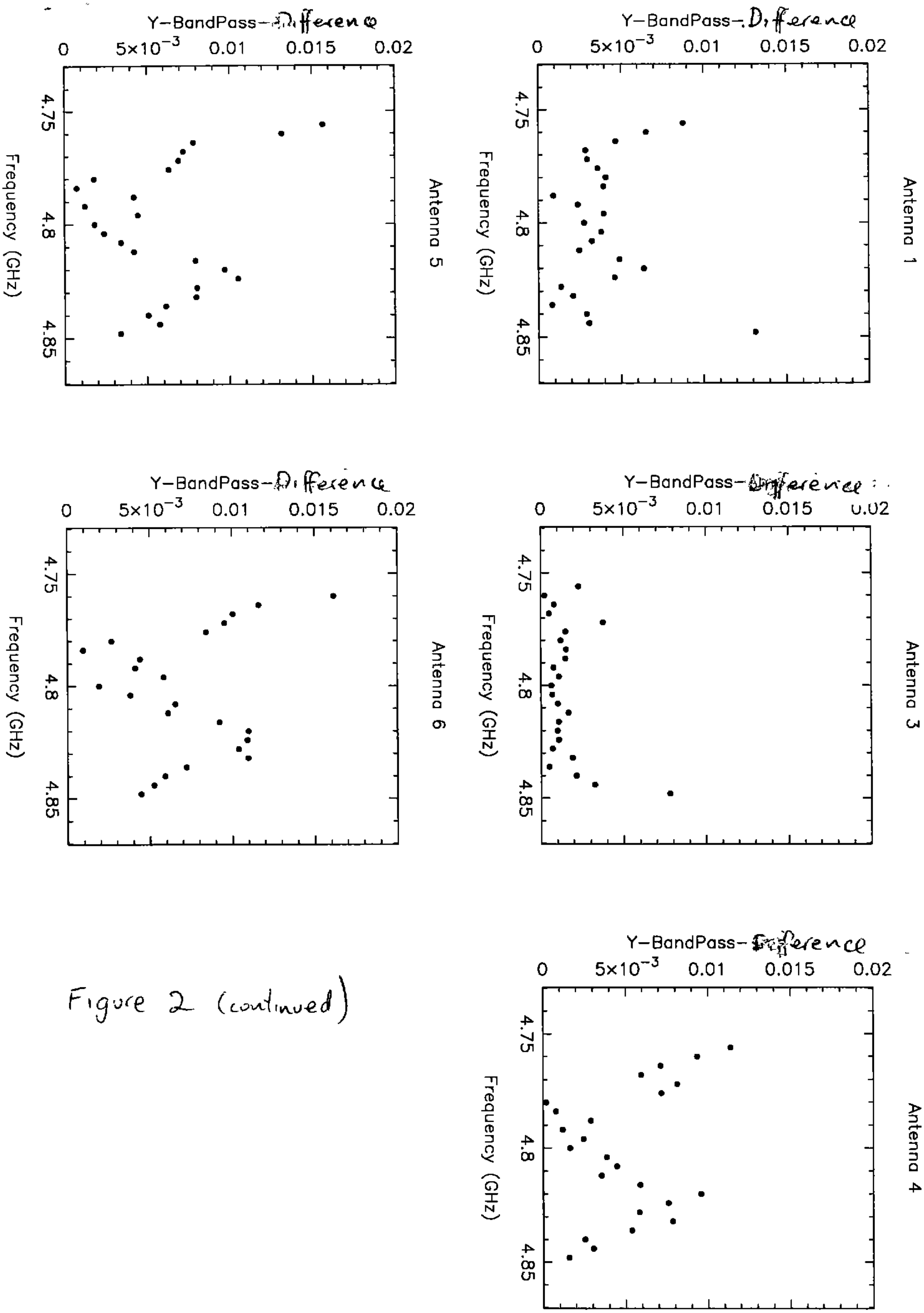


Figure 2 (continued)