Memorandum

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Revisions:			
	10 Apr 2008	jee	Initial
	14 Apr 2008	jee	Updated to include 2nd order corrections

Subject: Allan Deviation of Phase Jumps

Jumps or pops in phase existed in about 30% of the CTS phase stability measurements for Cartridge B6-002. Although those phase jumps have been eliminated by rerouting cables, analysis of how they affect phase is useful. This note shows Allan deviation of phase:

1. after removal of phase jumps,
2. comparing results using CTS and my software, and
3. after removal of both phase jumps and 2nd order phase drift.

Allan deviation of phase was calculated using both my software[1] and the CTS software, which originated from Jason Castro in Greenbank and employs a slightly different algorithm[2].

Figure 1 shows phase with a jump for LO = 221 GHz, Pol 1, LSB. Figure 2 is phase after the jump is removed by adding a 7° offset during the interval of the jump. Figure 3 is phase after removing the 2nd order drift from the jump-corrected phase in Figure 2. Allan deviation for these cases is graphed in Figure 4 using both the current CTS software and my software. Note how removing the 2nd order drift component improves by a factor of 3 or 4 Allan deviation for long averaging times.

Figure 5 and Figure 6 show uncorrected and fixed phase jump data for LO = 221 GHz, Pol 0 USB and Figure 7 shows a significant improvement in Allan deviation.

Figure 8 and Figure 9 are graphs of phase for a case where the variance in the Allan deviation is small. Also note that for this case, the discrepancy is small between the different software versions.

The results show that eliminating phase jumps and 2nd order drift is important for reducing Allan deviation. Subsequent measurements prove that minimizing temperature swings in the existing test apparatus is essential to meet stability specifications. A test system less sensitive to temperature changes is under construction, but long lead times will delay using that system for several months.

[1] Effland and Schmitt, "Gain Stability Measurements of Band 6 Cartridge SN002", NRAO memo dated 2005-12-08, (ALMA number FEND-40.02.06.00-168-A-REP), Appendix I, Page 11, available here.
[2] Using a LabVIEW Virtual Instrument writing using the "Tao=Input (Interlaced)" method.

Figure 1: Original Phase and Temperature Data

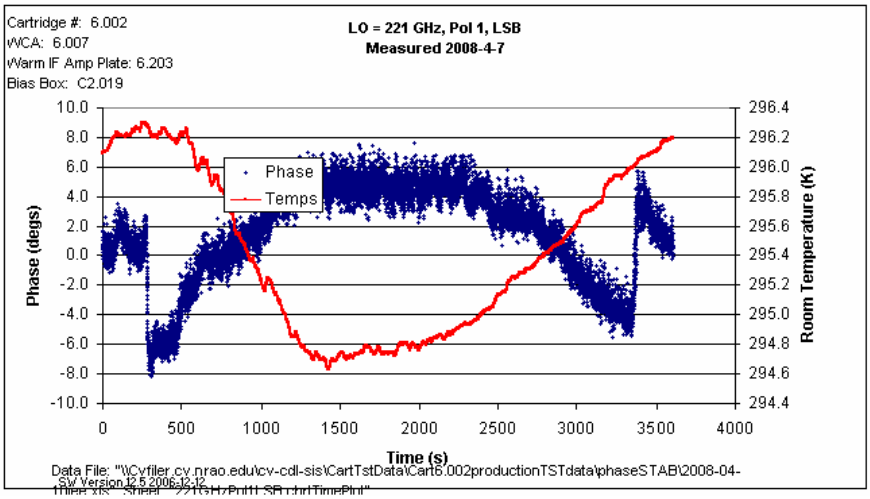

Figure 2: Phase and Temperature Data of Figure 1 with phase jumps fixed

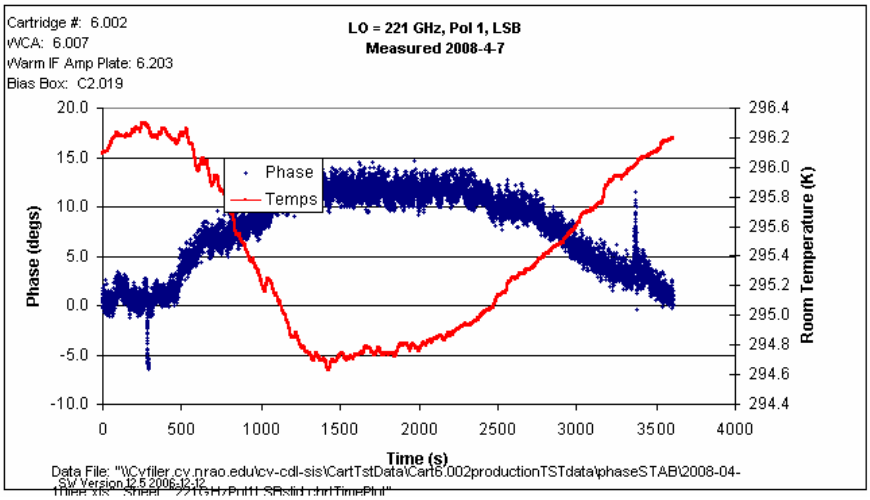

Figure 3: Phase of Figure 2 with 2nd order phase correction to eliminate parabolic component (light blue)

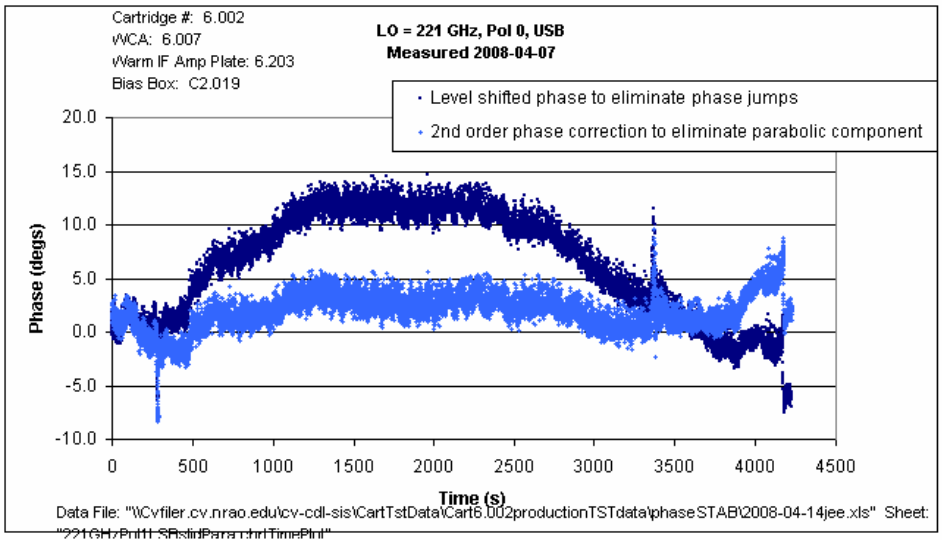

Figure 4: Allan Deviation for original, shifted, and 2nd order corrected phase (Figure 1, Figure 2, and Figure 3)

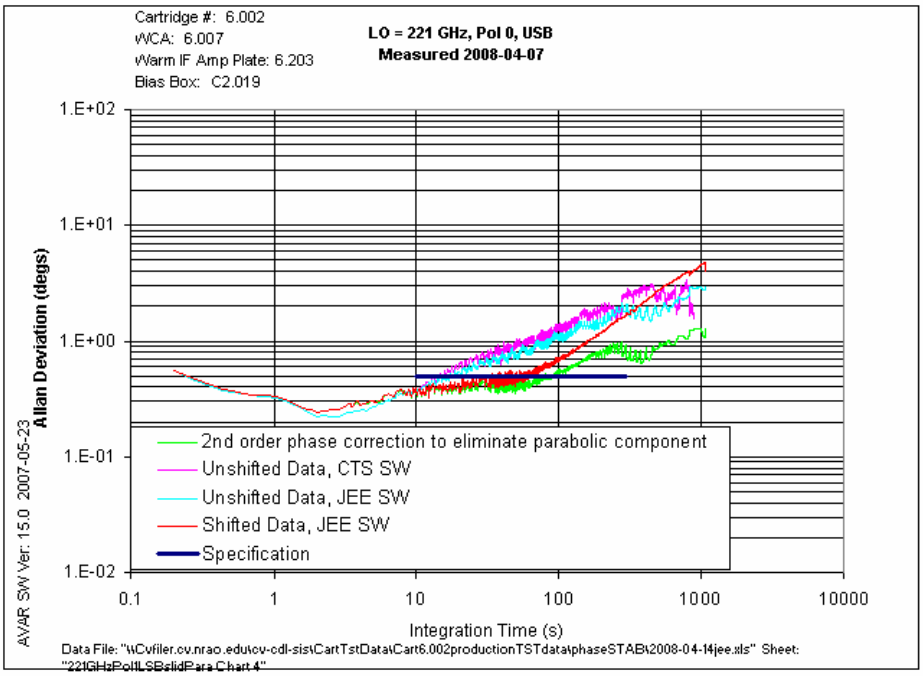

Figure 5: Original Phase and Temperature Data, LO = 221 GHz, Pol 0 USB

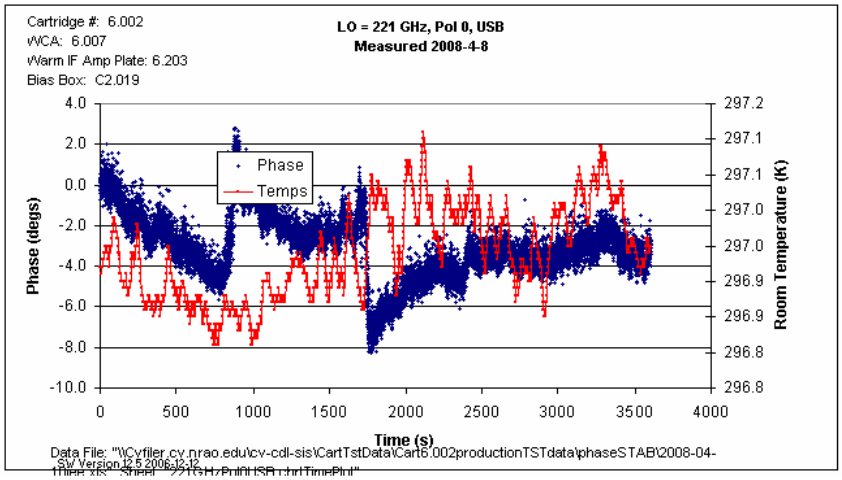

Figure 6: Phase and Temperature Data of Figure 5 with phase jumps fixed

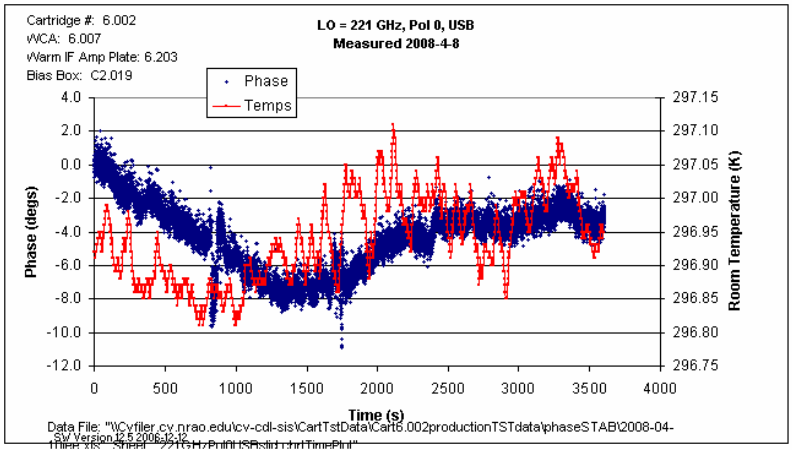

Figure 7: Allan Deviation for phase of Figure 5 and Figure 6

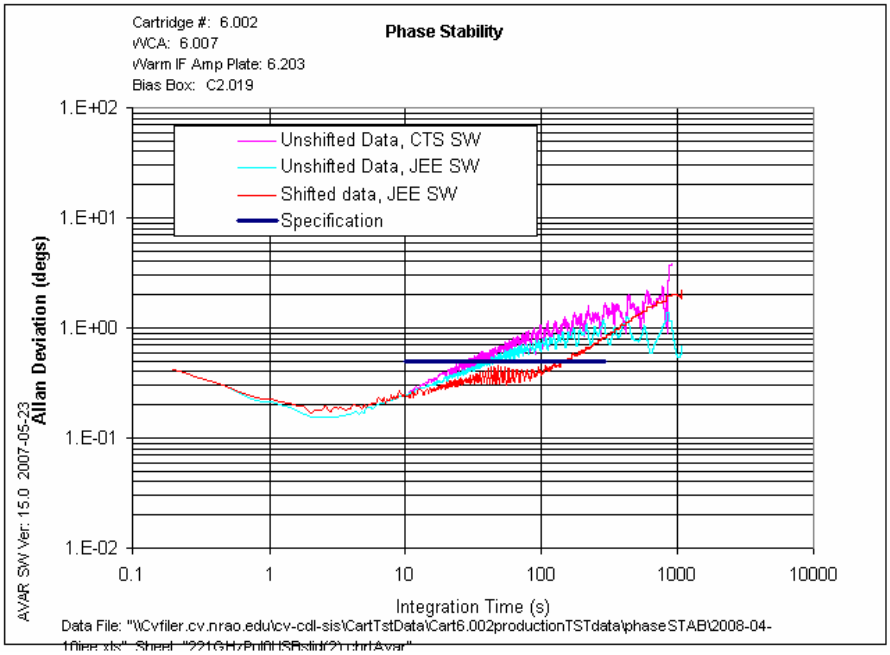

Figure 8: Phase and Temperature, 245 GHz, Pol 1, USB

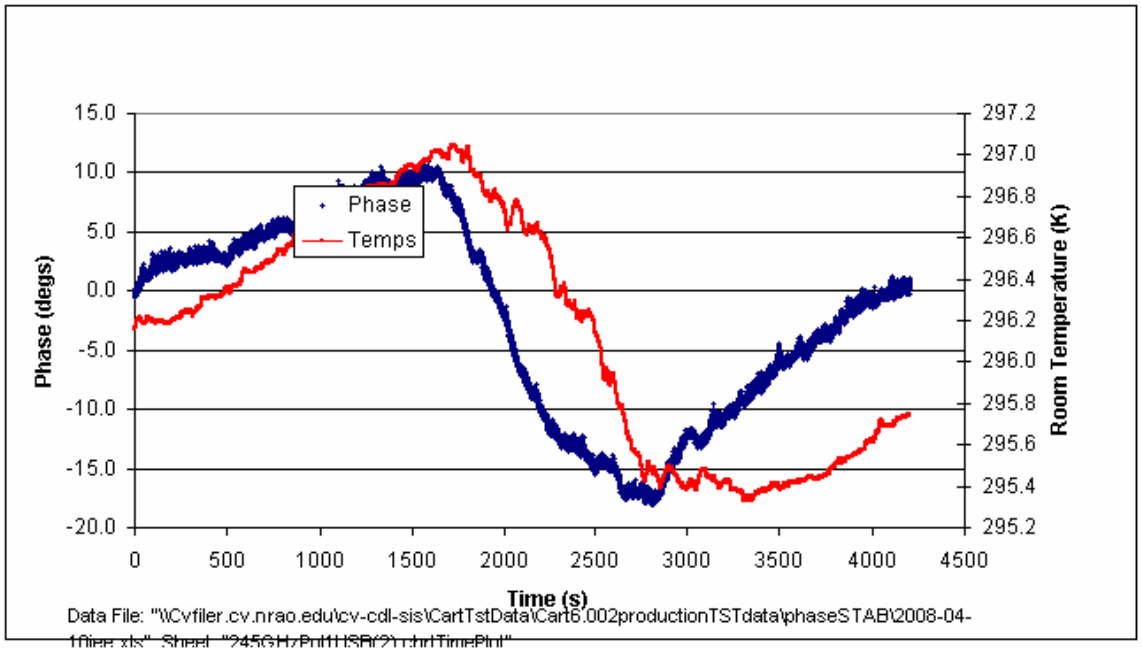

Figure 9: Allan Deviation of Figure 8