Memorandum

To: John Webber ALMA Document: FEND-40.02.06.00-101-A-REP

From: John Effland
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Date: 2006-06-28

Revisions:

2006-06-28		Initial
2006-06-28	jee	Minor editorial changes
2006-06-29	jee	Minor editorial changes suggested by J. Webber

Subject: ALMA Front End Allan Variance Predictions *vs*. Antenna Cabin Temperature Stability

1. Summary

Current specifications for temperature stability in the ALMA antenna cabin include:

> "The maximum temperature gradients in the air shall not exceed 1ºC per hour."

It's possible that the as-built antennas might not meet this specification which will consequently degrade Front End gain stability outside current specifications. Moreover, the proposed Rev B Front End gain stability specifications are more stringent than current specifications, and the Front End won't meet the proposed gain stability specifications even with current temperature stability specifications. Further degradation of cabin temperature stability exacerbates the problem.

2. Discussion

This memo predicts Front End gain stability by using gain change with temperature specifications for the warm IF amplifiers and IF switch. LO changes with temperature are considered in other documents.

To simulate gain changes *vs.* temperature, the overall gain sensitivity was calculated as the sum of gain changes from the two dominant contributors residing in conditioned air outside the cryostat:

Warm IF amps:	0.034 dB/°C
IF Switch:	0.08 dB/°C (see datasheet in Figure 5).
Overall (Sum):	0.114 dB/°C

A linear gain drift was applied to both theoretical and measured amplitude data using this overall gain sensitivity and the resulting Allan Variance was calculated.

The straight line in Figure 1 is the Allan Variance of an ideal receiver with no gain variation and was obtained by assuming normally-distributed samples with an arbitrary 0.1 s sampling interval. The distribution has a standard deviation of 0.001 which results in Allan Variances falling close to measured results. The three curved lines show

how different rates of temperature change affect overall gain stability of the receiver. Figure 2 shows amplitude *vs*. time for the both ideal case and for the case when gain variation results from temperature changes of 4°C/Hr.

Both existing and proposed Rev B specifications for Allan Variance are also included in Figure 1. This ideal Front End would just meet proposed Rev B specifications at 300s assuming the cabin's existing temperature stability specification of 1°C/Hr.

Measured amplitude data for the Band 6 cartridge (including warm IF amps) was also modified to illustrate how cabin temperature changes affect receiver gain stability. The lower curve in Figure 3 is measured gain stability for the cartridge when the ambient temperature was nearly constant (*i.e.,* within about 0.1°C as measured on the Warm IF plate), as shown in Figure 4. Next, a temperature change of 4°C/Hr was assumed and a linear drift was applied to the amplitude measurements (with the sign adjusted to yield the greatest amplitude change). Allan Variance was computed for this case and is shown as the top curve in Figure 3.

The Band 6 cartridge doesn't meet the proposed Rev B specifications with existing temperature stability values. Further degradation of cabin temperature stability clearly exacerbates things.

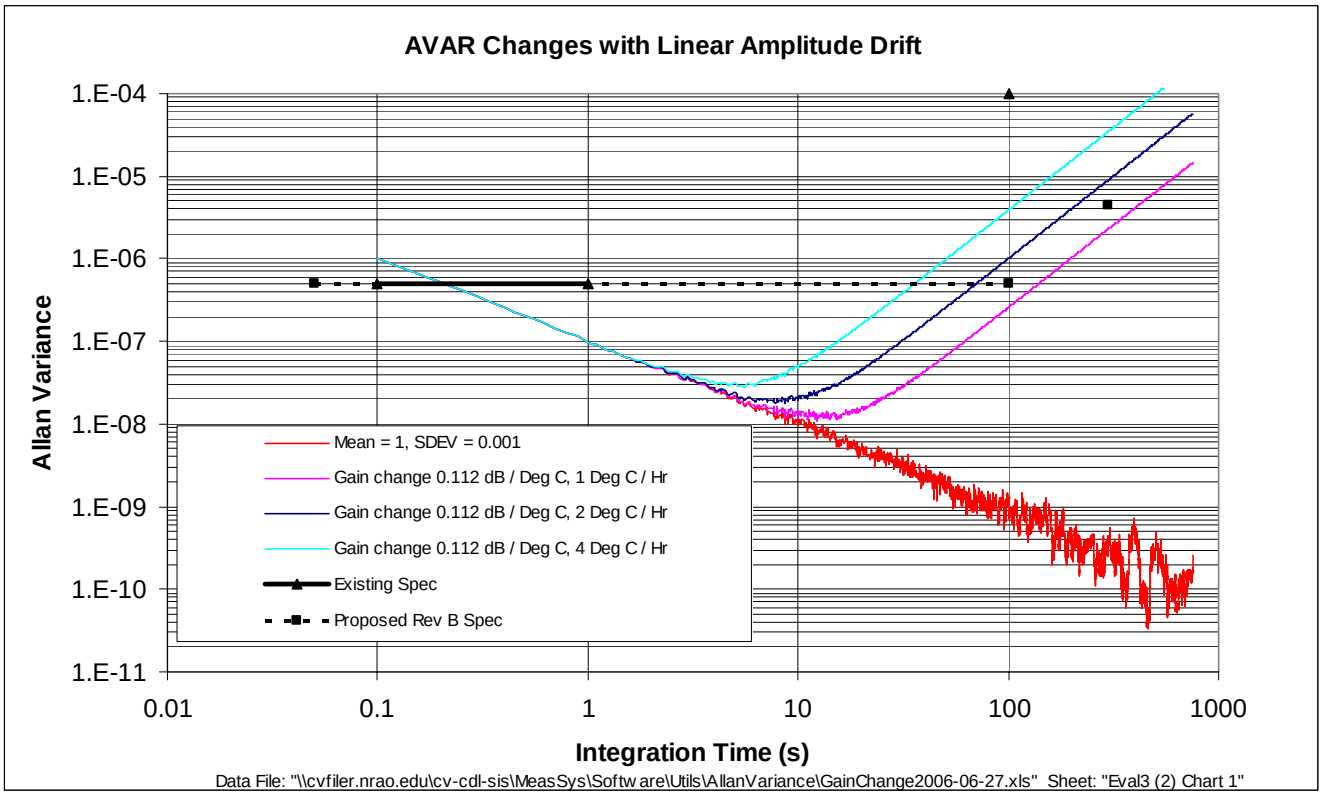

Figure 1: Simulation of Allan Variance using Perfect Amplitude Sequence with Linear Gain Change

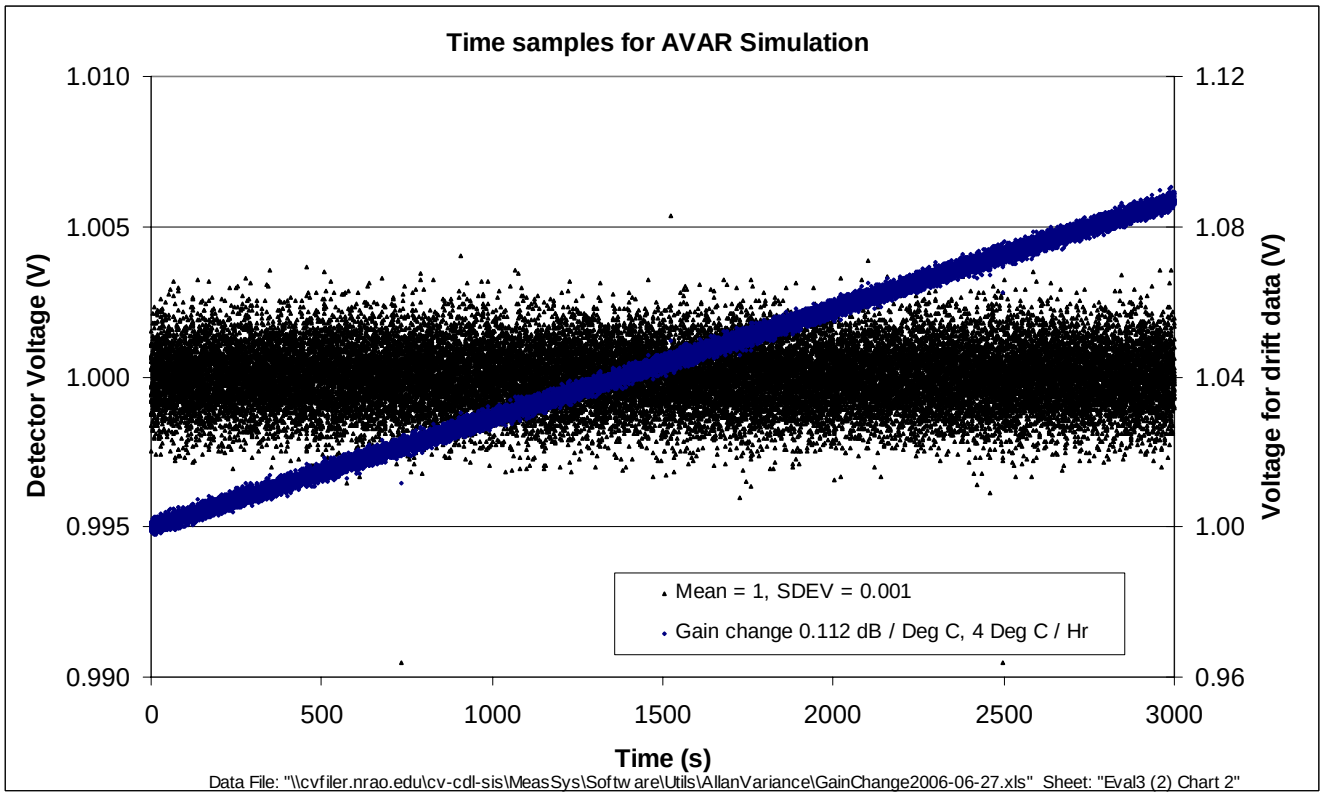

Figure 2: Time sequence for simulation shown in Figure 1

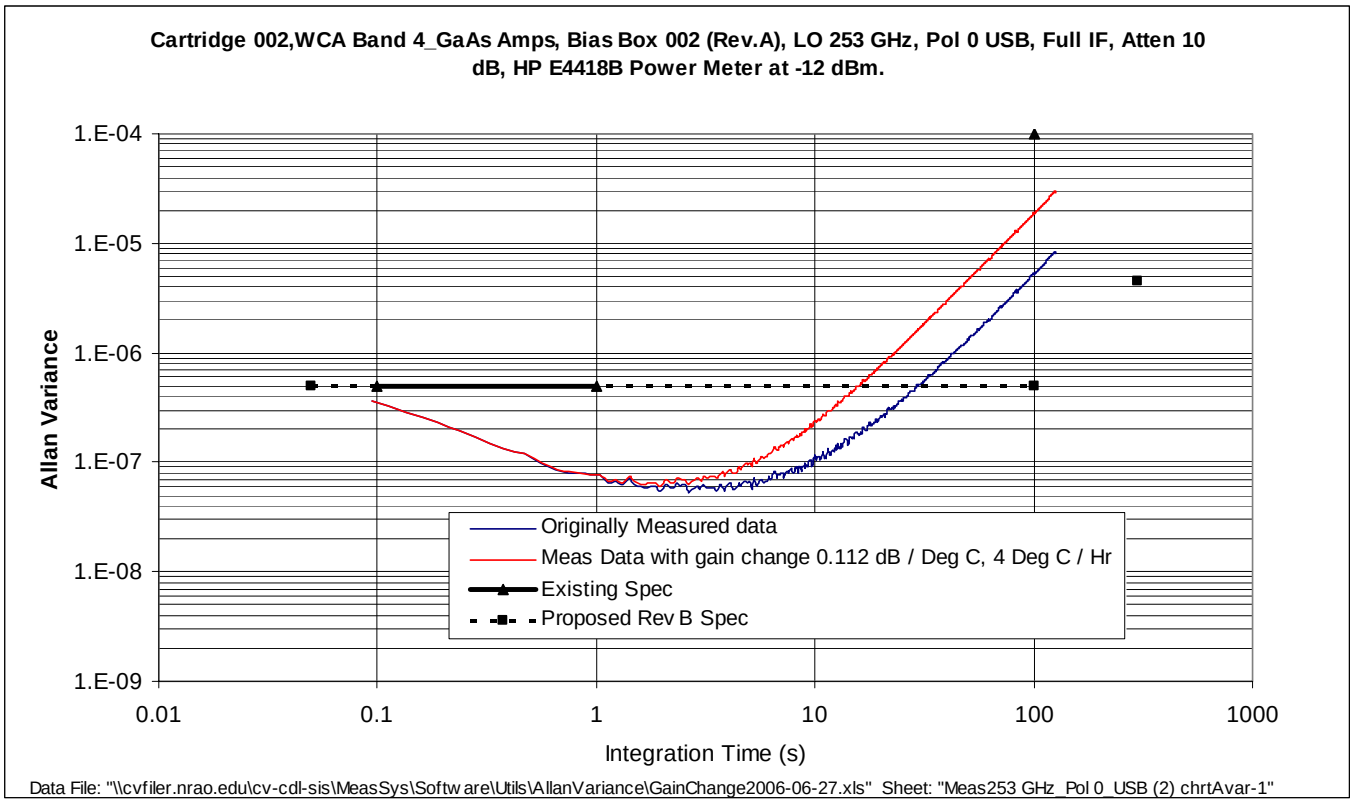

Figure 3: Measured Data and Simulated Linear Gain Change

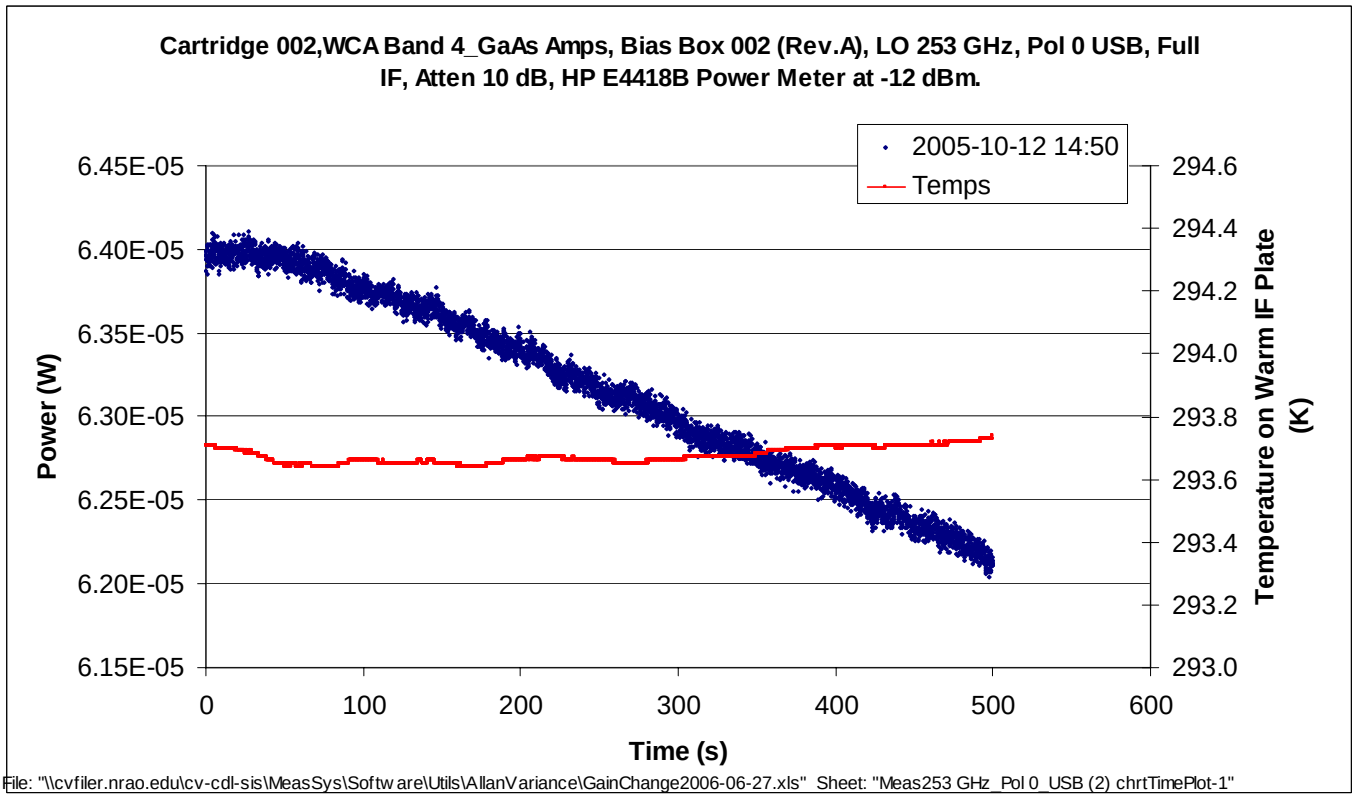

Figure 4: Time sequence and Temperatures for measured of Figure 3

NORDEN MILLIMETER

Model:N05-8009 SN: 1001 Paths Measured: 2 and 8

Spec	Spec Min	Spec Max	Units	Data (Min/Max)		Condition
Freq Range	4	12	GHz			
CH-CH Isolation	45		dB		60 81	Input - Output Input - Input
VSWR In		1.4 2.3			1.3 2.2	Channel ON Channel OFF
VSWR Out		1.3			1.28	
Gain	15	20	dB	17.6	19.8	0dB attenuation
Gain Flatness per 2 GHz		1	dB P-P		1.0	After 2.1dB Gain Slope Removed
Gain Flatness Entire Band		2	dB P-P		1.4	After 2.1dB Gain Slope Removed
Noise Figure		15	dB		14.9	
Attenuation Range	15		dB		14.0	
Attenuation Step		1	dB	0.7	1.2	
Accuracy of Attenuation		1	dB/+-		1.1	
Operating Current (Vcc,8v)		1000	mA		620	
Operating Current (Vee,-15v)		250	mA		190	
Gain Temp Coefficient		0.08	dB/Deg C	0.073		40 10 to ~~35~~ 70 DegC
Phase Temp Coefficient		1	Deg/Deg C	0.73°		At 12GHz
Size						
Length		5.51	In.			

Pre Seal Data

Tested By: _____ Date: 6-23-06

Q.A.: _____ Date: _____

(1)

Figure 5: Datasheet for Prototype IF Switch