



Memorandum

To: File

From: J. Effland
G. Morris
T. Marshall

Date: 2004-09-09

Subject: Measured Parallelism and Concentricity of Band 6 Cartridge SN001

Summary

The parallelism of the 4K stage with respect to the 300K baseplate is about 26 μm . This means that the 4K plate is tilted 0.15 milliradian or only 3% of the 5 milliradian beam centering specification.

The worst-case concentricity of the 100K, 20K, and 4K plates with respect to the 300K baseplate is about 300 μm , which is less than RAL's measured value of 456 μm .

Consequently, flipping and rotating the G10 sections doesn't degrade the parallelism or the concentricity of the first Band 6 cartridge.

Introduction

Parallelism of the 4K plate relative to the 300K baseplate and concentricity of all cold stages relative to the 300K baseplate are important mechanical requirements for the Band 6 cartridge:

1. to maintain stringent 5 milliradian beam pointing accuracy specifications, because the optical components are mounted on the 4K stage, and
2. to prevent damage to Dewar cold finger assemblies when inserting and removing the cartridge from either the cartridge test Dewar or the receiver.

The G10 spacer sections for all stages in the Band 6 cartridge were flipped and rotated to align access holes with interior components located between each stage. Those changes could alter the:

1. planarity of the 4-K stage with respect to the 300K baseplate (which we define as parallelism), and the
2. concentricity of all cold stages with respect to the 300K baseplate.

This memo documents the mechanical measurements obtained after cartridge construction to confirm no significant changes occurred in either parallelism or concentricity.

RAL Mechanical Measurements

Figure 1 is mechanical data measured by RAL for their first Band 6 cartridge. Detailed descriptions of the procedures used to measure these data were requested but not yet received.

Measurement Locations

Figure 2 shows the locations on the 4K stage for the NRAO’s planarity measurements. The planarity was measured relative to the 300K baseplate, and the measurement locations on the 300K baseplate were directly below the 4K locations but outside the G10 spacer.

1.1 Planarity

Planarity was obtained by measuring the height of the four sets of test locations shown in Figure 2 using a Starrett 708B dial gauge held to a granite table with a Starrett 254 Master Height Vernier. Heights relative to location “B” were measured on the 4K plate. The planarity measurement was repeated on the 300K plate at locations almost directly below the 4K locations, but just outside the G10 spacer. We define parallelism as the planarity of the 4-K stage with respect to the vacuum side of the 300K baseplate, which means that the 4K planarity data was normalized by the corresponding measurements on the 300K baseplate and is shown in the last line in Table 1. The worst-case parallelism is 26 μm compared with RAL’s measured worse-case value of 17 μm as shown in Figure 1.

Table 1: Planarity and Parallelism Measurements				
Heights (inches) Relative to Location B:				
Plate	Location			
	A	B	C	D
300K	-0.00035	0	0	-0.0004
4K	0.0007	0	-0.0002	-0.0005
Difference between 4K and 300K plates (parallelism):				
inches	0.00105	0	-0.0002	-0.0001
mm	0.026	0	-0.005	-0.002

1.2 Concentricity

Concentricity was measured with an Ono Sokki EG225 digital dial gauge mounted on a rugged stand made in China but constructed similar to the Starrett 254 and clamped to the granite table. The dial indicator measured the distance along a longitudinal cut from the outer wall of the 300K baseplate to the outer walls of the 110K, 20K and 4K plates. The bottom edge of the outer wall of the baseplate was selected as a reference because RAL measured a circularity of only 9 μm and a concentricity of only 3 μm for that wall. To account for differences in plate diameters as a function of the longitudinal distance on the cartridge, the outer walls were measured near their bottom and top (just below the bevel) edges and both sets of data were recorded.

Figure 3 serves as a consistency check by showing the difference in diameter of the top edge of the 300K baseplate with respect to the bottom. Figure 3 also shows the repeatability of the reference position obtained after measuring the top and bottom edges of the 100K, 20K, and 4K plates.

The measured concentricity results are shown in Figure 4 along with the results for an ideal cartridge. The taper starting with the 100K stage and continuing through the 4K stage is evident in the measured data. If concentricity is defined as the maximum discrepancy in distance between the ideal and measured positions, then the maximum concentricity is about 300 μm in the direction of “A”. This is less than the 456 μm measured by RAL and shown in Figure 1.

Conclusions

The parallelism of the 4K stage with respect to the 300K baseplate is about 26 μm . This means that the 4K plate is tilted 26 μm over the 170 mm diameter of the 4K plate, so the tilt angle is

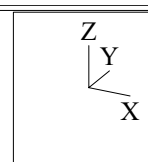
$$\theta_{Tilt} = \tan^{-1}\left(\frac{0.026}{170}\right) = 0.15 \text{ mrad}$$



or only 3% of the 5 mrad beam centering specification.

The worst-case concentricity of the 100K, 20K, and 4K plates with respect to the 300K baseplate is about 300 μm , which is less than RAL's measured value of 456 μm .

Consequently, flipping and rotating the G10 sections doesn't degrade the parallelism or the concentricity of the first Band 6 cartridge.



4*Lo-tol | 3*Lo-tol | 2*Lo-tol | Lo-tol | 50%Lo-tol | Nominal | Nominal | 50%Hi-tol | Hi-tol | 2*Hi-tol | 3*Hi-tol | 4*Hi-tol

PLANE-4K	Actual
Flatness	0.017
Parallelism	0.017
Z-axis	279.509

CIRCLE-4K	Actual
Circularity	0.015
Concentricity	0.456

PLANE-12K	Actual
Flatness	0.003
Parallelism	0.024
Z-axis	199.631

CIRCLE-12K	Actual
Circularity	0.009
Concentricity	0.306

PLANE-90K	Actual
Flatness	0.007
Parallelism	0.014
Z-axis	119.770

CIRCLE-90K	Actual
Circularity	0.034
Concentricity	0.281

PLANE-A-300K	Actual
Flatness	0.036

CIRCLE-300K	Actual
Circularity	0.009
Concentricity	0.003

DOWEL LINE	Actual
Angle to TOP LINE	15.098

Figure 1: RAL Measured Mechanical Data for Band 6 Cartridge SN001
 File \\Cvfiler\cv-cdi-sis\Cartridge\Documentation\Cartridge01\Mechanical\RAL001.pdf

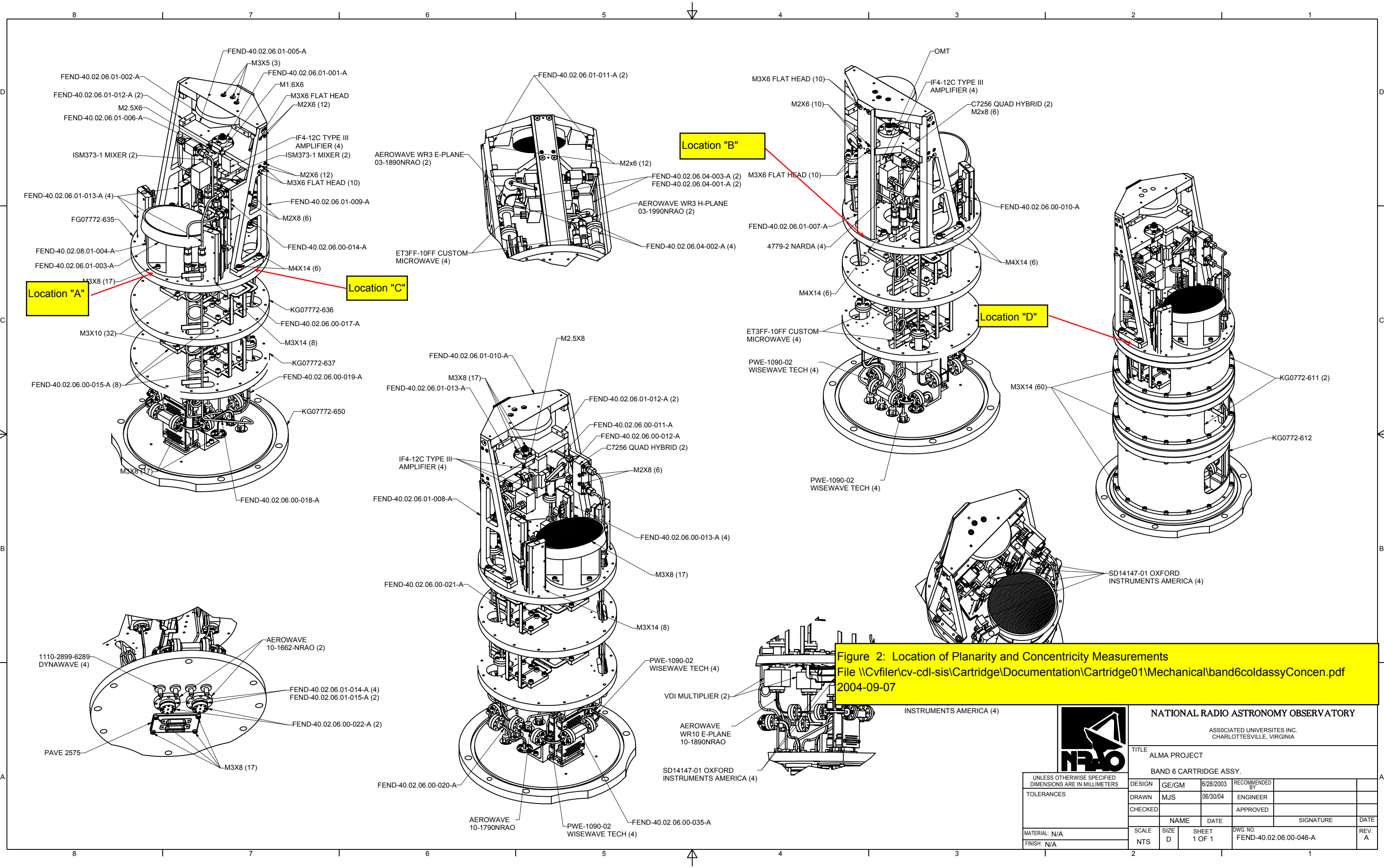


Figure 2: Location of Planarity and Concentricity Measurements
 File \\Cvfiler\cv-cdl-sis\Cartridge\Documentation\Cartridge01\Mechanical\band6coldassyConcen.pdf
 2004-09-07

		NATIONAL RADIO ASTRONOMY OBSERVATORY ASSOCIATED UNIVERSITIES INC. CHARLOTTESVILLE, VIRGINIA			
		TITLE ALMA PROJECT BAND 6 CARTRIDGE ASSY.			
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS	DESIGN	GE/GM	6/28/2003	RECOMMENDED BY	
TOLERANCES	DRAWN	MJS	06/30/04	ENGINEER	
	CHECKED			APPROVED	
		NAME	DATE	SIGNATURE	DATE
MATERIAL: N/A	SCALE	SIZE	SHEET	DWG. NO.	
FINISH: N/A	NTS	D	1 OF 1	FEND-40.02.06.00-046-A	REV. A

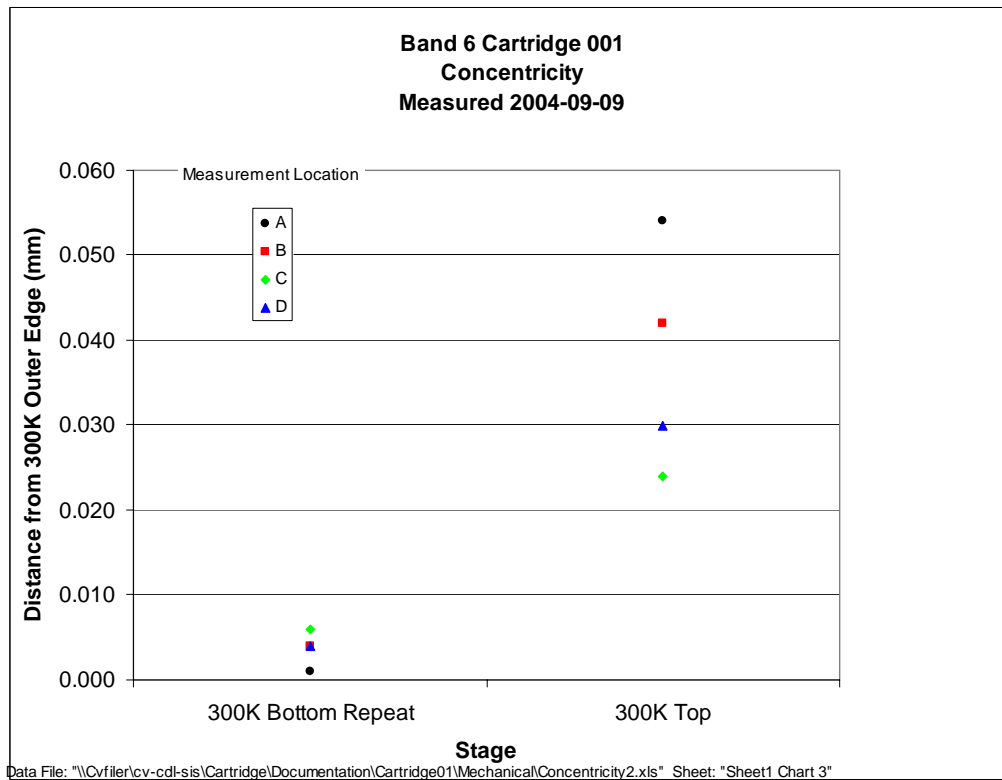


Figure 3: Consistency checks

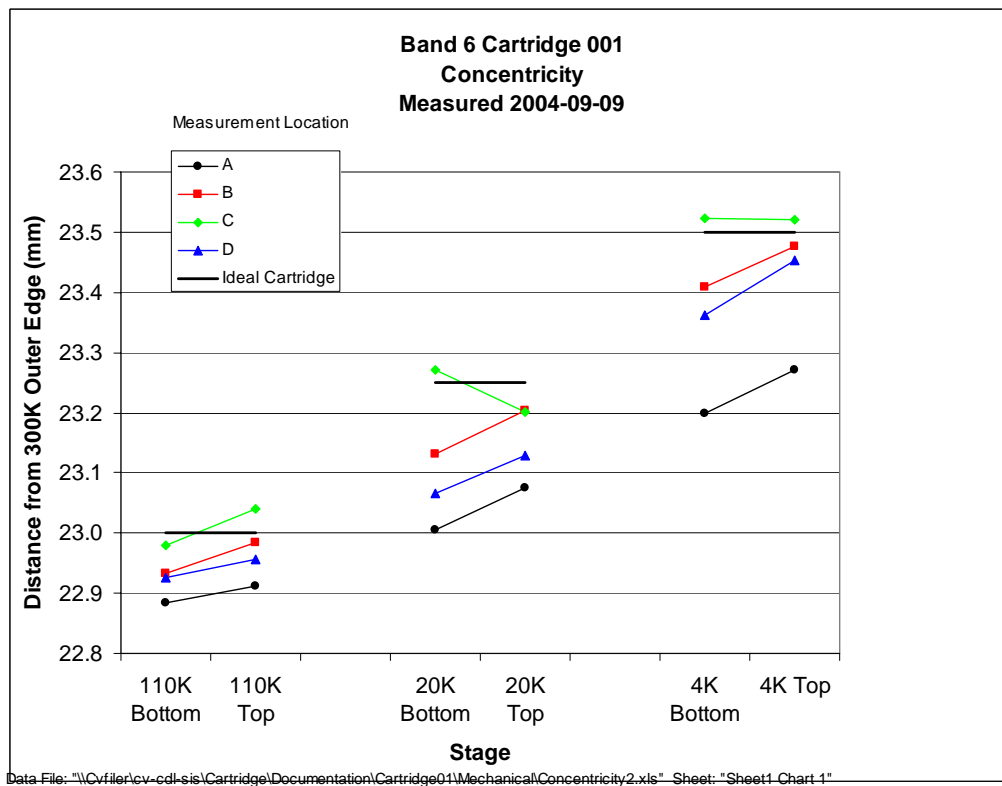


Figure 4: Concentricity Data