Memorandum

To: File

From: J. Effland
N. Horner

Date: 2005-07-27

Revisions:

-	2005-07-26	jee	Initial
A	2005-07-27	nh	Reviewed by Neil Horner
B	2005-07-27	jee	Grammatical updates in several sections.

Subject: Measured Parallelism of Band 6 Cartridge SN000 (Prototype Cartridge)

Summary

The 4K stage misalignment in parallelism for the Band 6 prototype cartridge, measured with respect to the 300K stage, will cause about 0.8 milliradian of beam pointing error, which is just 16% of the specified maximum value of 5 milliradians. Parallelism is defined here as the difference in the direction of normal vectors from two planes:

1. formed by the 300K stage surface nearest the vacuum, and
2. by the 4K stage.

Mirror misalignment, which can also cause beam pointing errors, was not measured here because we lack the equipment to do so. It is also important to note that this prototype Band 6 cartridge doesn't include pins in the mirror mounting arms. At the urging of the Band 6 PDR committee, these pins have been installed on all production cartridges to better locate the mirrors. However, beam patterns measured with this prototype cartridge don't show significant scan errors, at least when measured using our early and admittedly crude system, so we think mirror misalignment is modest.

Introduction

IRAM intends to validate the Band 6 optics design by measuring the Band 6 prototype cartridge (SN000) beam patterns with their near-field scanner. They will use just the top of RAL's cryostat for initial measurements, but later measurements may include installation of the cartridge in a complete cryostat.

Parallelism of the 4K plate relative to the 300K baseplate is an important mechanical requirement for the Band 6 cartridge to maintain the stringent 5 milliradian beam pointing accuracy specifications, because the optical components are mounted on the 4K stage.

The prototype cold cartridge body, built by RAL, was used by the Band 6 group to confirm mechanical design concepts and is reported to lack the mechanical accuracy necessary for production use. However, measurements documented in this memo suggest that the mechanical accuracy of the prototype is sufficient for optics design validation.

Measurements

Figure 1 shows the measurement locations on the 300K baseplate and 4K stage. Parallelism was measured relative to the vacuum side of the 300K baseplate, and the measurement locations on the 300K baseplate were directly below the 4K locations but outside the G10 spacer.

Parallelism was obtained by measuring the height of the four test locations shown in Figure 1 using a Starrett 254 Master Height Vernier. Heights for the 4 locations were measured on each plate relative to the base of a granite block. The Starrett measures in units of inches and the raw measured data are shown in Table 1. Table 2 is the same data as Table 1 with everything converted to mm.

Table 3 provides data for the tilt angle calculations. First, the distance between the 300K and 4K stages were calculated for each of the four measurement locations. Then those distances were again normalized to location "B" on the 4K plate.

As seen in Table 3, the worst-case difference between the 300K and 4K plates, normalized to location "B," is -0.14 mm at location "D". That value is used to estimate the pointing error attributable to the parallelism between the 4K and 300K plates by assuming 170 mm for the 4K plate diameter and using:

$$\theta_{Tilt} = \tan^{-1}\left(\frac{-0.140}{170}\right) = -0.82\ mrad\ .$$

Table 1: Raw Measured Data

Cartridge 00 (Prototype) Mechanical Measurements				
All Measurements in Inches				
Significant Figures +/-	0.001	inches		
	Location on Plate			
Plate	**A**	**B**	**C**	**D**
300K	0.432	0.431	0.432	0.432
(Repeat)	0.432	0.430		
4K	11.375	11.375	11.381	11.371
File: \\Cvfiler.cv.nrao.edu\cv-cdl-sis\Cartridge\ Documentation\Cartridge00\Mechanical\Parallelism.xls				

Table 2: Measured Data Converted to mm (From Table 1)					
Cartridge 00 (Prototype) Mechanical Measurements					
Measurements in inches but converted to mm				25.4	mm/inch
Significant Figures:	0.025	mm			
	Location on Plate				
Plate	**A**	**B**	**C**	**D**	
300K	10.97	10.95	10.97	10.97	
(Repeat)	10.97	10.92			
4K	288.93	288.93	289.08	288.82	
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Table 3: Tilt Angle Calculations					
Difference (mm) between 4K and 300K plates (not normalized to B)					
4K	277.95	277.99	278.10	277.85	
Difference (mm) between 4K and 300K plates (normalized to B)					
4K	-0.04	0.00	0.11	-0.14	
Diameter of 4K plate:		170	mm		
Tilt angle on 4K plate:		-0.822	mrad		
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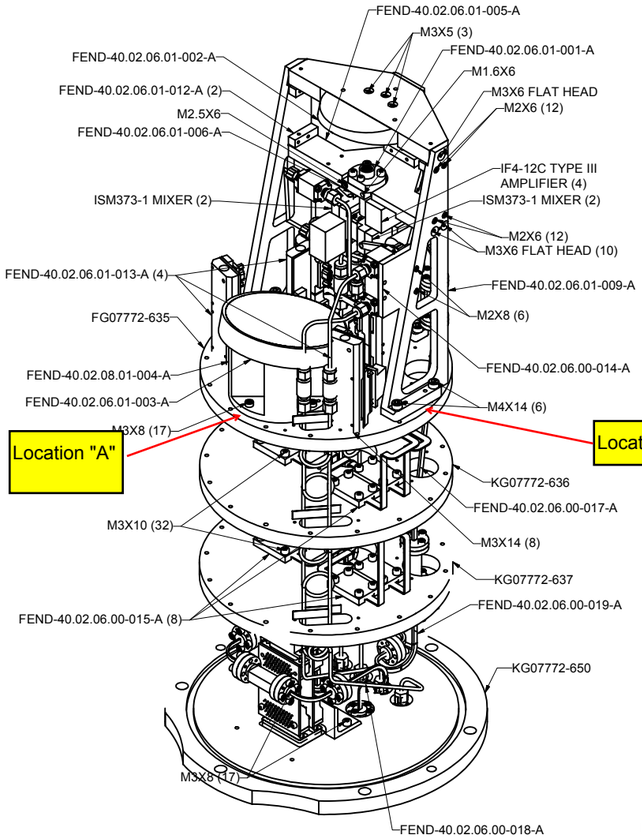

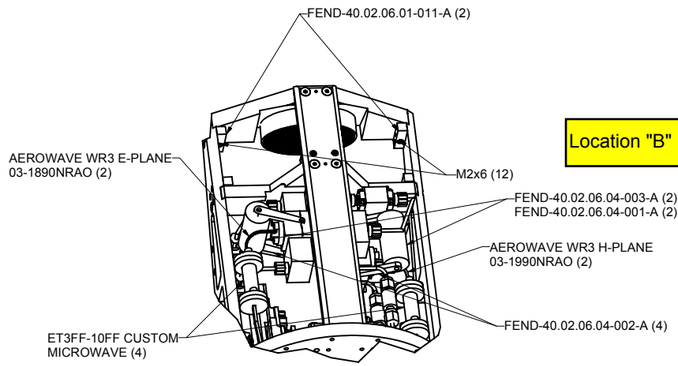

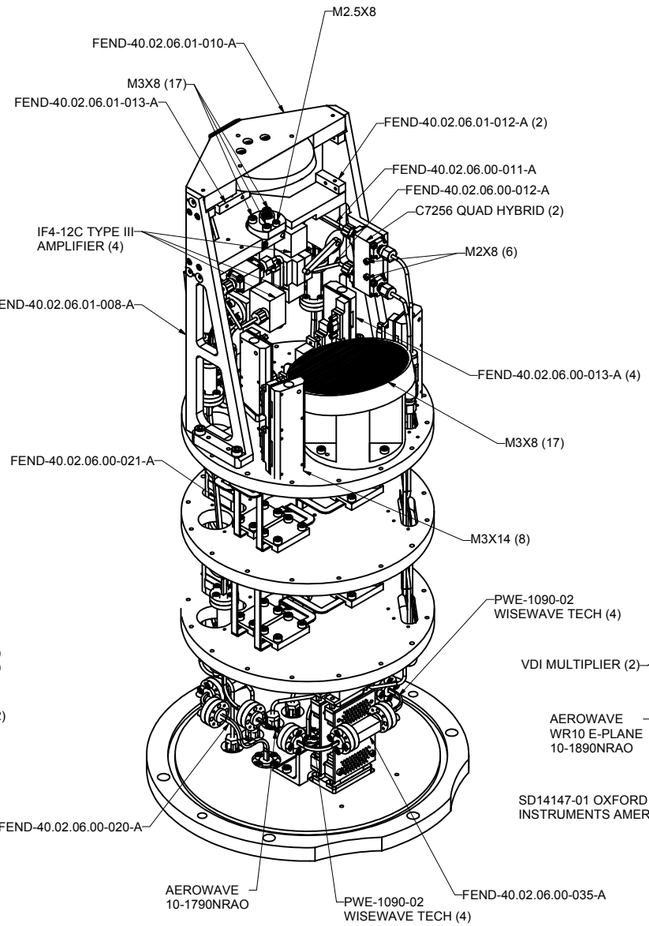

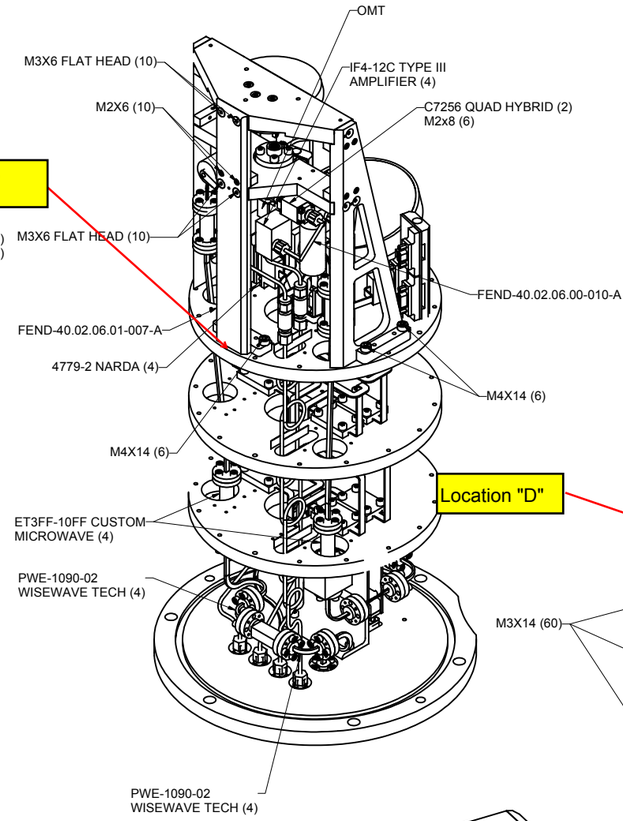

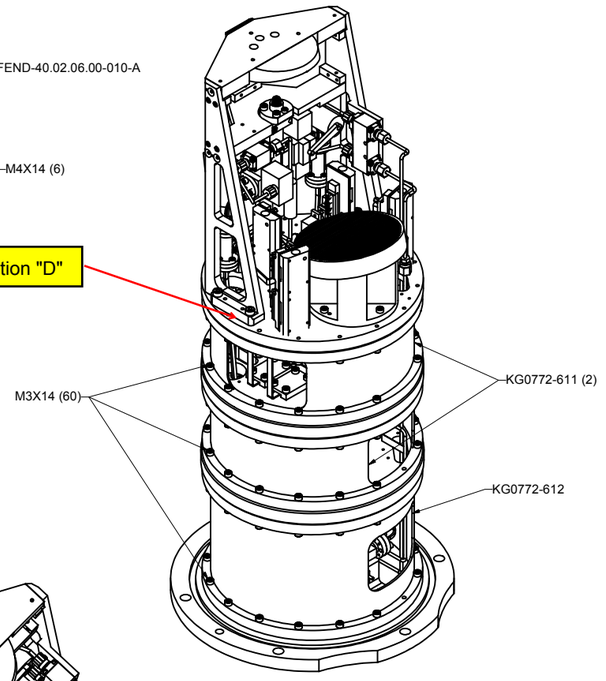

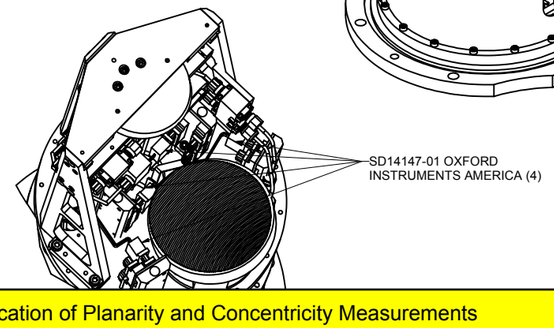

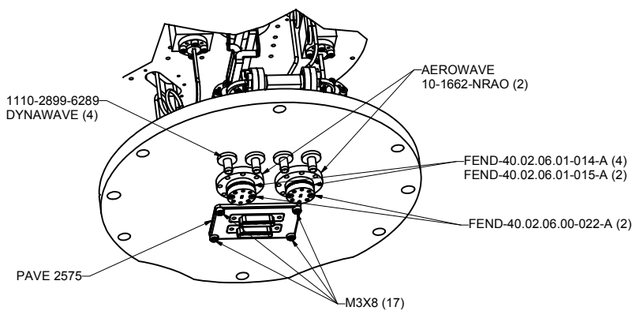

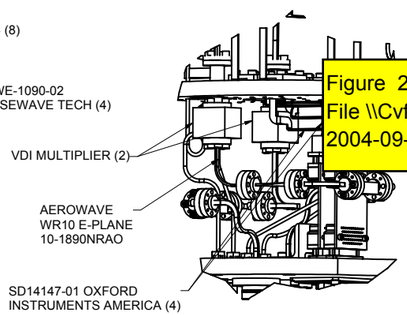

Figure 2: Location of Planarity and Concentricity Measurements
File \\Cvfiler\cv-cdl-sis\Cartridge\Documentation\Cartridge01\Mechanical\band6coldassyConcen.pdf
2004-09-07

NATIONAL RADIO ASTRONOMY OBSERVATORY

ASSOCIATED UNIVERSITES INC.
CHARLOTTESVILLE, VIRGINIA

TITLE
ALMA PROJECT

BAND 6 CARTRIDGE ASSY.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS

TOLERANCES

MATERIAL: N/A

FINISH: N/A

DESIGN	GE/GM	6/28/2003	RECOMMENDED BY		
DRAWN	MJS	06/30/04	ENGINEER		
CHECKED			APPROVED		
	NAME	DATE		SIGNATURE	DATE

SCALE	SIZE	SHEET	DWG. NO.	REV.
NTS	D	1 OF 1	FEND-40.02.06.00-046-A	A