Performance Test Plan for the SECCHI COR1 Engineering Test Unit

Drawing Number 2052611
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1 Introduction

The optical performance of the COR1 Engineering Test Unit (ETU) will be tested at the Vacuum Tunnel Facility operated by the High Altitude Observatory (HAO) at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. This is the same facility which was used for testing of both versions of the COR1 breadboard models.

The tests of the ETU at NCAR will be facilitated by having a number of features in common with the two earlier breadboard models. The ETU will be mounted on the same Newport Instruments X95 optical rail, so that it will be supported and steered in the same way as in the earlier tests. It will also use the same "privacy screen" setup, on which is mounted the photodiode monitor. The camera and photodiode monitor will also be the same, so that the same electrical and coolant interfaces will be used. The cross calibration between the camera and photodiode monitor was established in the previous two tests, and was consistent between the two tests, so it will not need to be repeated for this test.

An additional electrical feedthrough will be required for a polarizer control mechanism. This feedthrough will be mounted on the same bulkhead as the other feedthroughs.

Once the measurements and data analysis are complete, a report will be written describing the results, in the same way as was done for the two breadboard models.

2 Properties to be tested

The properties of the instrument that will be tested at the NCAR/HAO facility are as follows:

- The scattered light properties of the instrument.
- The polarization level of the scattered light.
- The resolution of the instrument.
- The degree of sensitivity of the instrument to obstructions outside the observed field of view.
- The effect of introducing a focal plane mask will be tested.
- The procedure for changing out the objective lens shall be tested.

In addition to the above tests, the ETU will also have a witness sample mounted next to the objective lens. However, this will not be addressed here.

Table 1: The order in which tests will be carried out. "X" marks cases where the vacuum system, polarizer, and/or focal plane mask will be used.

Test	Vacuum	Polarizer	Mask
Stray light	X		
Polarization	X	X	
Resolution			
Field of view	X		
Focal plane mask			X
Lens change out	X	X	
Diffuser			

Table 2: Relationship between requirements from verification matrix (document #2052610) and test descriptions in this document.

Requirement		Section
3.1-1	Signal To Noise Ratio	2.1
3.1-2	Maximum Stray Light	2.1
3.1-3	Spatial Resolution	2.3
3.1-4	Unobstructed Field Of View	2.4
3.1-5	ETU Optical Design	N/A
3.3-4	RMS Spot Size	2.3
3.3-5	Occulter Edge Diffraction	2.5
3.3-6	Residual Polarization	2.2
3.3-7	Light Tight	2.1
3.3-20	Objective Lens Mount	2.6
3.3-21	Optical Alignment Budget and Stability	2.3

Each of the above tests will be discussed in the following subsections. The test sequence is given in Table 1. Table 2 identifies how the test plan relates to the test requirements established in COR1 document #2052610.

2.1 Stray light

The stray light properties of the ETU will be characterized using the same procedure used for the two previous breadboard instruments. The ETU will be mounted in a vacuum chamber at the end of a 100 foot tunnel. At the far end of the tunnel, a heliostat is used to illuminate a diffuser window with sunlight. A lens focused on the diffuser sends the light down the tunnel, and an adjustable iris sits between the lens and the ETU. Thus, this iris defines the edge of an artificial solar disk. For that reason, the ETU should be designed for an object at a distance of approximately 100 feet, instead of infinity. The distance between the iris and the front aperture was determined in previous tests to be 1155 inches (96.25 feet), so this number should be used for the ETU alignment.

The Newport rail supporting the breadboard will be mounted in the center to a yolk on a ball joint and roller which allows motion in pitch and yaw. The back end of the rail will be attached to two crossed linear motion stages, to control the pitch and yaw motions. This allows the instrument to be aligned to the source.

The cold block on the detector will be cooled with a 50/50 mixture of glyconol and water. Additional cooling will be provided by a thermal-electric cooler (TEC) between the cold block and CCD.

The relationship between the source brightness, as determined by the photodiode monitor, and the data numbers measured by the CCD, was determined in the two previous breadboard measurements. Each of the two calibration exercises resulted in the same result, so it will not need to be repeated for the ETU. This is good, because the calibration exercise required removing the optics from the rail, to expose the detector directly to the source. However, the calibration will be checked by off-pointing the instrument so that the image of the source is completely off the occulter, and introducing a 4.0D neutral density filter in front of the camera.

2.2 Residual polarization

The polarization properties of the instrument will be explored by putting a commercial Oriel polarizer into the beam. The polarized signal will be measured at -60°, 0°, and +60°, in the same manner as in flight. An Oriel rotator will be used to control the polarization angle. The polarizer will be mounted at the same location in the ETU that will be used for the flight polarizer.

2.3 Resolution

To measure the resolution of the instrument, an optical target will be placed at the location of the iris, and the instrument will be offpointed so as to image the target. The heliostat will not be used for this test, to keep within the flux capabilities of the detector.

Because of the need to measure resolution, and to be most consistent with the configuration of the flight instruments, the camera will be at the nominal focus of the source, rather than at the occulter focus as in previous tests.

2.4 Unobstructed field of view

After some discussion, it was decided that the most critical spacecraft elements which may protrude into the field-of-view are the release pins. To test the effect of these pins, a spring will be placed at an appropriate location at the edge of the COR1 field of view. This spring will be attached to the outer privacy mask. No GSE is required.

Another plan involves collars of various length to be placed around the front aperture. This would simulate the addition of a thermal collar which has been suggested to raise the temperature of the objective lens. However, this requirement has been demoted to low priority.

2.5 Focal plane mask

To test the procedure for removing the bright rings which have been seen around the edge of the occulter, a simulation of the focal plane mask will be introduced into the optical path. This mask must be mounted onto a Newport LP-2 mount, so that it can be accurately aligned. It should be mounted at the location where the flight mask will be located—this may require that the ETU camera be moved further back from its nominal location.

2.6 Objective lens change-out

The procedure for changing out the objective lens will be tested, using an abbreviated version of the stray light test. This test will also address whether any of the features seen in the scattered light test can be attributed to the objective lens. If significant changes are seen with the alternate objective lens, then the polarization test will be repeated with the alternate lens. Also the original objective lens will be put back, to test repeatability.

2.7 Diffuser

A diffuser will be placed in front of the objective lens, to simulate the action of the diffuser that will be used during flight. The only GSE required for this test is a standard lab stand to hold the diffuser in front of the objective.

3 Equipment

The following test equipment will be used during the calibration of the ETU at the NCAR/HAO facility. The equipment is broken down into three catagories, based on who is supplying the equipment, and whether or not the equipment was used in the previous breadboard tests.

Table 3 shows equipment supplied by NCAR/HAO. All of this equipment was previously used for the breadboard tests, unless noted. In addition, HAO will provide the regular cleanroom supplies, i.e. garments, masks, gloves, wipes, notebooks, pens, cleaning materials, etc.

Tables 4 and 5 list equipment used in the previous breadboard tests. Unless otherwise noted, these items are packaged in the one of the two breadboard shipping boxes. Finally, Table 6 lists the new equipment supplied by GSFC which was not previously used in the breadboard testing.

4 Handling procedures

The ETU and associated equipment will always be handled while wearing cleanroom garments, masks, and gloves, while it is outside of its protective wrapping. Outside of the cleanroom, wrapped items will be handled with gloves on.

Table 3: Equipment supplied by NCAR/HAO.

Quantity	Item	Comment
1	Instrument cradle	With ball joint and roller
1	Interface between cradle and rail	
1	X-Y positioning mechanism	
1	Interface between X-Y mech. and rail	
1	GSE for X-Y positioner	
1	Glyconal refrigerator and pump	
1	Fixed coolant lines within chamber	
1	Large privacy screen	Mounted to table
1	Bulkhead interface with feedthroughs	New feedthrough for polarizer
-	Ultrahigh purity (UHP) nitrogen	
1	1/4 inch N2 feedthrough, with valve	New
1	1/4 inch OD Teflon tubing, 15 feet	New
1	Ultrasonic cleaner	

4.1 Unpacking

When the ETU arrives at the NCAR/HAO facility, the outer llumalloy wrapping will first be removed in the antechamber just outside the cleanroom. It will then be immediately carried into the cleanroom through the large double doors. The inner wrapping will be removed in the cleanroom.

All other equipment will be handled the same way, except that it will enter the cleanroom through the gowning room entrance. One person in the gowning room, wearing gloves, will first remove the outer wrappings, and then hand it to another person in the cleanroom, where the inner wrapping will be removed. Any equipment which is not wrapped will be cleaned as it is brought into the cleanroom, using either wipes or the cleanroom vacuum as appropriate. All the llumalloy bags will be stored to be reused for the return shipment.

Once the instrument is mounted inside the vacuum chamber, it will be connected for nitrogen purging as per COR1 document #2052629.

4.2 Packing

The ETU will be double wrapped in fresh llumalloy, with both an inner and outer wrapping. It will then be carried outside of the cleanroom through the large double doors, and packed in its shipping container.

All other equipment will be single wrapped inside of the cleanroom, reusing the bags that the equipment was unpacked from. They will then be passed through the gowning room entrance to another person wearing gloves, who will wrap them in a second outer bag, again reusing the bags that the equipment was originally unpacked from.

Table 4: Goddard equipment used in the previous breadboard tests, except electronics cables.

Quantity	Item	Comment
1	Keithley 617 Electrometer	
1	Marlow SE5020-01 TEC Controller	
1	Lunchbox Computer (w/ GPIB card)	
1	UniBlitz 325B Shutter Controller	
1	Photometer electronics (w/ doc.)	
1	Photometer detector & cable	
2	Andover bandpass filters	
1	AC/DC Supply	
1	PCI Interface	
1	Camera head assembly on Newport carrier	Shipped on rail
1	Main electronics box	
1	Low voltage power supply box	
1	CCD clock drivers box	
1	CCD preamp box	
2	UDT PIN13D photodiodes	One calibrated
1	Inner privacy screen	Mounted to rail
4	Screws to mount privacy screen	
4	Stand-offs to mount privacy screen	
2	Flexible Stainless Steel 1/4" line	
2	Feet to support Newport rail	
1	Set of Metric Allen wrenches	
1	Set of English Allen wrenches	
1	Sun Gun	
5	Power cables	
2	Anti-static straps	
1	Reel of copper braid	
Several	Spare Newport carriers (weights)	

Table 5: Goddard electronics cables used in the previous breadboard tests.

Quantity	Item	Comment
1	H100 Camera LVPS Cable	
1	H110 Camera LVPS Cable	
1	H120 Camera Clock Driver Cable	
1	H140 Camera Video Cable	
1	H150 Camera Bias Cable	
1	H160 Camera COM2 Cable Adapter	
1	H170 Camera DHA Cable Adapter	
1	H200 Vacuum TEC Harness	
1	H210 Vacuum TEC Cable Feedthru	
1	H220 Atmosphere TEC Adapter cable	
1	H230 Atmosphere TEC Harness	
1	H240 Electrometer Cable	
1	H250 TEC controller Harness	
1	H300 Vacuum Camera Harness	
1	H310 Vacuum Camera Cable Feedthru	
1	H320 Atmosphere Camera Adapter cable	
1	H330 Atmosphere Camera Harness	
1	H340 Serial Null Modem Cable	
1	PCI Cable	

Table 6: New equipment supplied by Goddard which was not used in the previous breadboard tests.

Quantity	Item	Comment
1	Oriel rotator mechanism	
1	Controller for Oriel rotator	
1	Interface to optical rail	
1	Polarizer	
1	GPIB cable	
1	Optical target for resolution test	
2	Focal plane mask, in LP2 carrier	
1	Spare objective lens, premounted	
1	4.0D neutral density filter	Packed with electronics
1	Opal diffuser	
1	Stand for opal diffuser	
-	Llumalloy for wrapping ETU	
-	Fresh llumalloy bags for shipping	
-	Extra llumalloy bags for return	

4.3 Nitrogen purge

The procedure for bringing the vacuum chamber back up to atmosphere will include simultaneously backfilling the instrument with ultrahigh purity dry nitrogen. The procedure will start with the nitrogen valve to the vacuum chamber being slowly opened until the correct flow rate is achieved. The chamber fill valve will then be opened. As the pressure in the vacuum tank rises, the nitrogen flow will be adjusted to keep the flow rate constant. The nitrogen purge will continue all the time that the tank is at 1 atmosphere pressure.

References

2052610 SECCHI Inner Coronagraph (COR1) Engineering Test Unit (ETU) Definition and Test Program Requirements

2052612 COR1 ETU Removal and Replacement of the Objective Lens Mount

2052629 COR1 ETU Venting and Purging Procedure