Critical Design Review (CDR)
Of
ULTRA VIOLET IMAGING TELESCOPE (UVIT)
(June 17th -18th 2011, ISAC, Bengaluru)

Post Vibration/ TVac Optical Alignment Tests on Flight Model

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Critical Design Review
Ultra Violet Imaging Telescope

Tests and Calibration of Optics

Post Vibration/TV Optical and Alignment Tests on FM Telescopes

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Abbreviations

CREST	Centre For Research & Education in Science & Technology
UVIT	Ultra Violet Imaging Telescope
FM	Flight Model
FOV	Field of View
SC	Satellite Cube
IIA	Indian Institute of Astrophysics
NUV	Near Ultra Violet
PM	Primary Mirror
VIS	Visible

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1.0. Scope of the Document

This document briefs about the test plan on UVIT FM telescopes to check that all the optical functions and alignments are in good health, after environmental tests.

2.0. Introduction

FM telescope integrated on Satellite adaptor undergoes Vibration and .then TV test at ISITE. We do not have resources to carry out detailed optical tests after assembly of the full payload. Therefore, a list of limited key tests is made to ensure that the optical function and alignments are in good health. These tests are done before the environmental tests as well as after the environmental tests. A comparision of the results obtained before and after the environmental tests is made to assess any damages during the tests. Field of view (FOV) test measures the misalignment of center of field with respect the optical axis by sighting aperture of the detector with a theodolite, focussed to infinity, and kept behind the secondary mirror. Another test planned to be carried out is field illumination test of detectors. In this test the detectors are illuminated by a monochromator, kept near door of the telescope, to check the sensitivity of the detectors, and integrity of the filters. Any defects in any of the optical component in the path of the beam would give non uniformity in the image made by the detector. In addition to the above tests, parallelism between the telescopes and the alignment of telescopes with satellite cube also will be done after vibration and TV test and the test results will be compared with Pre environmental test data.

3.0. Post/Pre environmental tests on FUV and NUV/VIS telescopes

- Field of view Test
- Field Illumination test:

- Parallelism Between telescope
- Telescope Axis to SA cube

3.1 Field Illumination test

This test is done to check sensitivity of the detectors, and integrity of the filters in NUV and VIS telescopes. The illumination is given, by a pin-hole mounted on output of a monochromator, at a selected wavelength. The pinhole is kept on the silica window in the door. This test is first done at CREST, IIA. The detector is expected to give a near flat image over its area, unless there is some defect in the filter or some other optical element. The images obtained at CREST are compared with the images obtained after the tests/assembly at ISAC.

3.1.1 Test setup & procedure

Monochromator with UV source is mounted infront of silica window on the door of NUV/VIS telescope integrated on satellite adaptor as shown in Figure1.. Exit pinhole of the Monochromator is illuminated by selected wavelength (center wavelength of NUV/VIS). Beam exits pinhole falls on primary mirror, secondary mirror and finally illuminates detector thru filter. the detector is exposed in integration mode and the image will be anlysed for uniformity. Any defects in any of the optical component in the path of the beam would give non uniformity in the image.

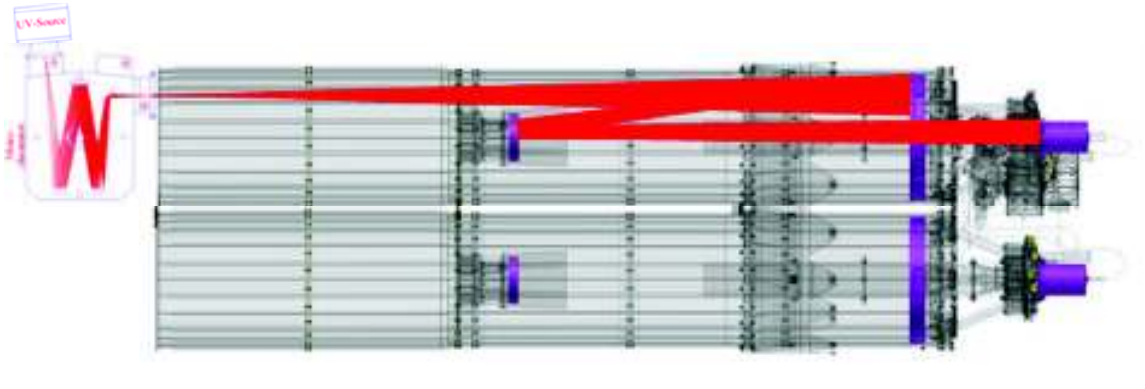

Figure 1. Schematic of testing sensitivity of detectors, and integrity of the filters in NUV/ VIS and FUV telescopes.

This test is conducted on FUV telescope by illuminating the Silica window on FUV telescope door. The air gap between Monochromator and the silica window is purged with UHP N2 along with purging of FUV telescope. The detector will be exposed at 180nm and the uniformity of the image would be checked for any defects in the optical elements of FUV telescope.

3.2 Field Of View Test

- The effective field of view of the payload is given by the overlap between the fields of the 3 channels. Thus, in order to maximize this overlap, axes of the two telescopes are checked to be aligned to <30". This is obtained through checks at various levels of assembly. A final check is made by sighting apertures of the FUV and NUV detectors by a theodolite from behind the secondary mirrors – this check is repeated after the vibration and TV tests.
- The field of view is estimated by focal length of the telescopes and parameters of the detectors. It is also checked directly for FUV and VIS channels by sighting aperture of the detectors by a theodolite placed behind the secondary mirror. (The NUV detector cannot be seen as the beam splitter only reflects in NUV). In orbit, observations of astrometric fields give an exact estimate of the field and the plate scale.
- In addition, it is checked that centers of the NUV and VIS fields are aligned to < 1'

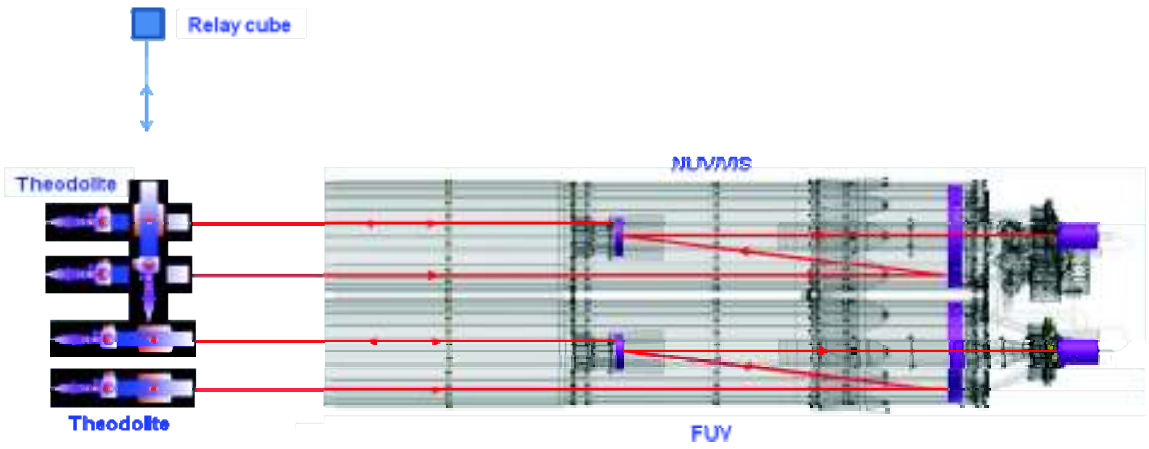

Figure 2. Schematic shows testing of alignment of FOV wrt the optical axis of the individual telescopes.

3.2.1 Test setup & procedure

1. Mount Theodolite on the XY Stage over the optical bench and place it behind the FUV secondary mirror of integrated telescopes on satellite adaptor as shown in Figure 2.
2. Sight the secondary mirror center and make the Theodolite autocolimation with Secondary mirror back surface
3. Make the azimuth angle 0deg, 0min, 0sec and note down the elevation angle (vd, vm, vs)
4. Rotate the Theodolite to 90deg, 0min, 0sec in the azimuth direction
5. Place an relay cube (reference mirror)and adjust it to autocollimation to the Theodolite
6. Move the Theodolite XY stage away from secondary mirror (laterally) with the guidance of straight edge and the reference mirror and make sure that the Theodolite is still autocollimation with reference mirror for the privous azimuth& elevation angle as in Step 5
7. Rotate the teodolite to readings in step 3 and sight the Primary mirror surface
8. Shine the primary mirror with Bright light so that light reaches to FUV detector window

9. Sight left edge of the detector window and note down the Azimuth & Elevation angle
10. Similary Sight right edge of the detector window and note down the Azimuth & Elevation angle
11. Bring back the theodolite to the reading in Step 8
12. Sight top edge of the detector window and note down the Azimuth & elevation angle
13. Similary Sight bottom edge of the detector window and note down the Azimuth & elevation angle
14. Calculation: Find the difference in aximuth and elevation angles between the steps3 & 9 and3 & 10
15. Calculation: Find the difference in aximuth and elevation angles between the steps 11 & 12 and 11& 13
16. The calculated readings in steps 14 & 15 can be checked after vibration test.
17. Repeat the test on both VIS and NUV detectors of VIS/NUV telescope and record the readings in the **Table.1**

Table 1. ***Table for telescope FOV test data***

Measurement location	***FUV detector***		***NUV detector***		***VIS detector***	
	VSR	***HSR***	***VSR***	***HSR***	***VSR***	***HSR***
On axis						
Top edge(-yaw)						
Bottom edge(+yaw)						
Left edge (-pitch)						
Right edge (+pitch)						

3.3 Parallelism b/w telescope and Alignment between telescope and Satellite cube:

This test will be carried out at CREST to get the data on parallelism between two telescopes integrated on satellite adaptor and the alignment between the satellite cube and telescope axis. These data will be checked after Vibration and TV test for any deviation.

Post vibration and TV check will be carried out at ISITE. The details of the test method ans schematics are given in the report: ***Document No.*** *: UVIT-CDR-00-09-* ***Version 1.0***