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

Alignments between the Two Telescopes and with Spacecraft

UVIT-CDR-00-09

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Critical Design Review
Ultra Violet Imaging Telescope

Tests and Calibration of Optics

Alignments between the Two Telescopes and with S/C

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Abbreviations

CREST	Centre For Research & Education in Science & Technology
UVIT	Ultra Violet Imaging Telescope
TIR	Telescope Invar Ring
TT3	Telescope Tube 3
SC	Satellite Cube
SA	Satellite Adaptor
AC	Alignment Cube
IIA	Indian Institute of Astrophysics
NUV	Near Ultra Violet
PMA	Primary mirror assembly
PM	Primary Mirror
SMA	Secondary mirror assembly
VIS	Visible
DB	Detector Bracket

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1.0. Scope of the Document

This document briefs about the alignment requirement between FUV and NUV/VIS telescopes, test method and accuracies achieved with the proposed method of measurement. It also describes the alignment requirement on telescope axis to satellite cube and measurement method and accuracies. Various alignment activities and test procedures on UVIT payload is documented and shall be referred for details.

2.0. Introduction

Axis of the UVIT pay load needs to be known to an accuracy of 1 arc min ?? wrt the roll axis of satellite axis, when it is integrated on satellite central cylinder as shown in Figure1. As the optical axis of the unit telescope can not be accessed in satellite level after the integration of payload on to the satellite, it is necessary to transfer the optical axis to a location which can be accessed at satellite level for finding the orientation the payload wrt the satellite. A 19mm alignment cube, called Satellite cube (SC), is mounted on the satellite-adaptor (which couples the payload to S/C) to which the optical axis of unit telescope is transferred, during the integration of the payload in the laboratory, with an accuracy of 30arc sec. After the environmental test, the alignment between the telescope axis and the SC will be checked in laboratory, before integration of the payload to satellite. Before transferring the unit telescope axis to the SC, Parallelism between the telescope is found during integration of two telescopes on Satellite adaptor at CREST. The accuracy of parallelism required is < 60 arc sec and it is measured with an accuracy of 20arc Sec.

3.0 Alignment Requirements/Accuracy on FM Payload

Description		Requirement	Can be achieved	Accuracy
Alignment between axes of the two telescopes:		1 arc min	30 arc sec	20 arc sec
Alignment between Axes of the reference Tel. NUV: and Transfer Cube on the Cone	***Along Roll Axis***	3 arc min	1 arc min	20 arc sec
	Along Pitch Axis	10 arc min	3 arc min	1 arc min

4.0. Alignment between FUV and NUV/VIS telescope

Alignment between two telescopes is the measure of parallelism between the axis of the Unit telescopes of integrated Payload on satellite adaptor. The information of optical axis of unit telescope, defined as axis of the primary mirror, is available from three locations, Primary mirror rear surface, Secondary mirror rear surface and alignment cube on Detector bracket. During the integration of unit telescope, the optical axis is transferred to these three locations with an accuracy of 10-arc second. The parallelism between the unit telescopes will be measured by measuring the angle between either Primary mirror back surfaces or secondary mirror back surfaces or the alignment cubes of individual telescopes.

The Accuracy of the measurement of parallelism is better than 20arc second.

Alignment of two telescopes axis on the satellite adaptor cab be achieved better than 30" . If parallelism is found beyond 1arc min, then correction will made by shimming at TIR/TT3 flange interface of one of the telescope(FUV).

Measurement and alignment of two telescopes for parallelism is carried out as follows:

1. Finding Optical Axis from NUV/VIS telescope (Figure 2)
2. Transfer of Optical axis to Primary mirror back surface and Alignment cube (Figure 2)
3. Integrate NUV /VIS telescope on Satellite adaptor
4. Transfer of Optical Axis to secondary mirror back surface (Figure 3)
5. Finding optical axis from FUV telescope
6. Transfer of Optical axis to Primary mirror back surface and Alignment cube
7. Integrate FUV telescope (with out secondary) on Satellite adaptor (Figure 4)
8. Find the parallelism between the FUV telescope Axis (From Primary Mirror front face) and NUV/VIS telescope axis (secondary mirror back surface) with the help of Theodolite (1arc second) – Figure 4.
9. If the parallelism is found beyond 1 arc min, then appropriate shimming will be done at interface of TIR/Telescope Tube -3 flange interface.
10. 25micron shimming at flange of 400mm diameter gives a tilt correction of 13 arc sec.
11. After bringing down the tilt between the two telescope below 1arc min, unmount FUV telescope from Satellite adaptor and proceed for secondary mirror integration
12. Transfer of Optical Axis to secondary mirror back surface (FUV telescope)
13. Integrate FUV telescope on Satellite adaptor
14. Find the parallelism between the FUV telescope Axis (secondary mirror back surface) and NUV/VIS telescope axis (secondary mirror back surface) with the help of Theodolite (Figure 6)

5.0. Alignment of Optical axis to Satellite cube (SC)

As the alignments cubes on Unit telescopes, primary and secondary mirror surfaces are not accessible at the stage of UVIT payload on Satellite, it is necessary to transfer the optical axis to a location which can be accessed at satellite level for alignment of UVIT payload. Hence a location is identified on satellite adaptor of UVIT payload where a alignment cube is mounted. This alignment cube is called satellite cube (SC).

1. Mount Satellite cube (with mount) on Satellite adaptor
2. Align the theodolite to the Pitch axis on Satellite adaptor (pitch axis is defined by holes in the two flanges and marking is also made on the face of Satellite adaptor – Accuracy 1 arc min)
3. Sight SC cube side face (parallel to Yaw axis) and adjust the cube orientation to align to Pitch axis – accuracy 20 arc sec (Figure6)
4. Transfer the optical axis from NUV/VIS secondary mirror to satellite cube front face (face normal to optical axis) with the help of theodolite – accuracy 30 arc sec (Figure 5)

6.0. Post Environmental Test

1. Parallelism between the unit telescope on Satellite adaptor will checked after vibration and Termovacuum test at ISITE as shown in Figure 6.

2. Alignment between Satellite cube and the optical axis will be repeated after vibration and Termovacuum test at ISITE as shown in Figure 6

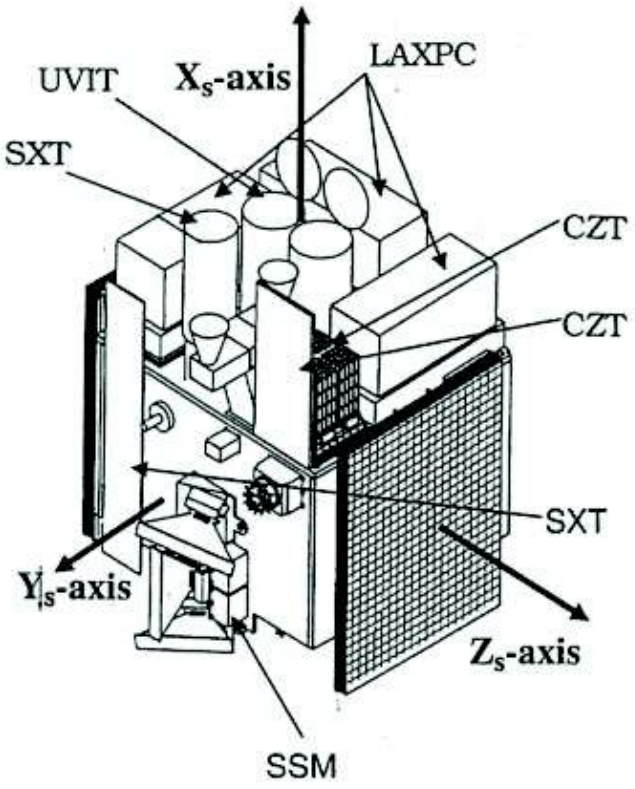

Figure 1: Configuration of the payloads in Astrosat and UVIT payload is integrated at the central cylinder of the satellite

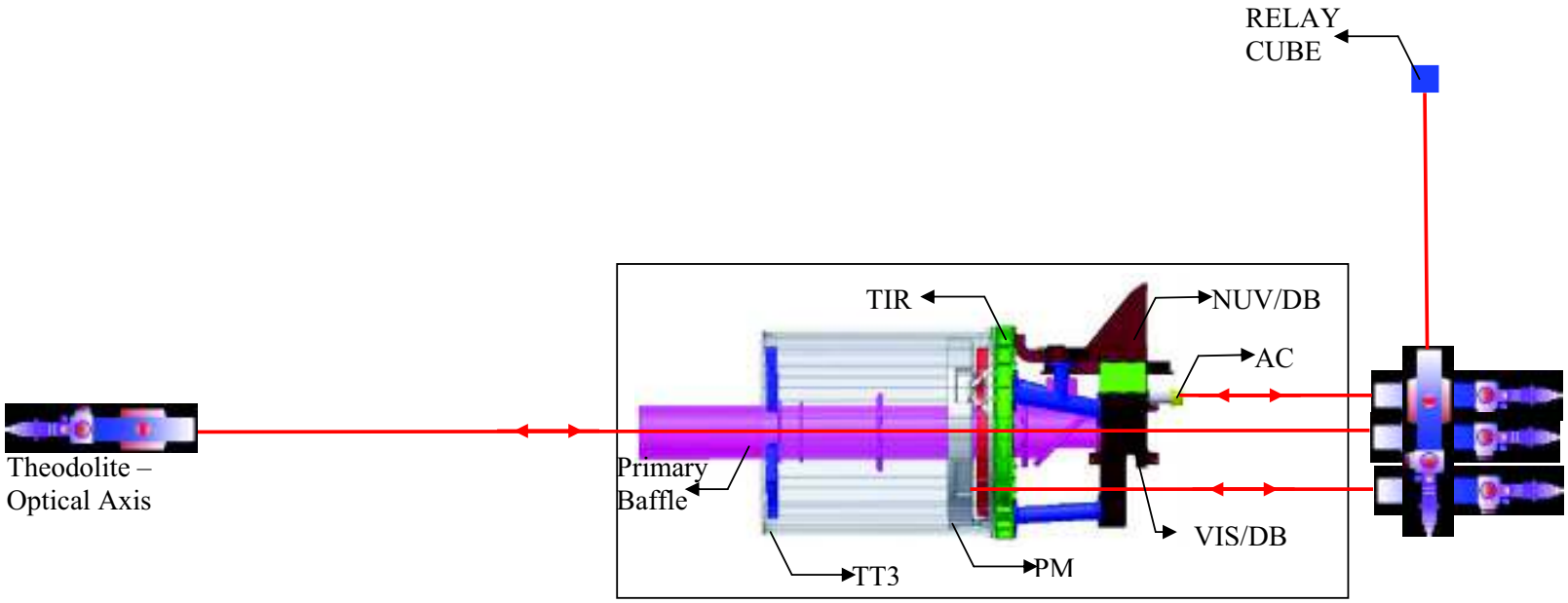

Figure 2 :Layout shows finding Optical Axis from the front face of the primary mirror, transfer of optical axis to Alignment cube and Primary mirror back surface (Accuracy of finding optical Axis 10arc sec)

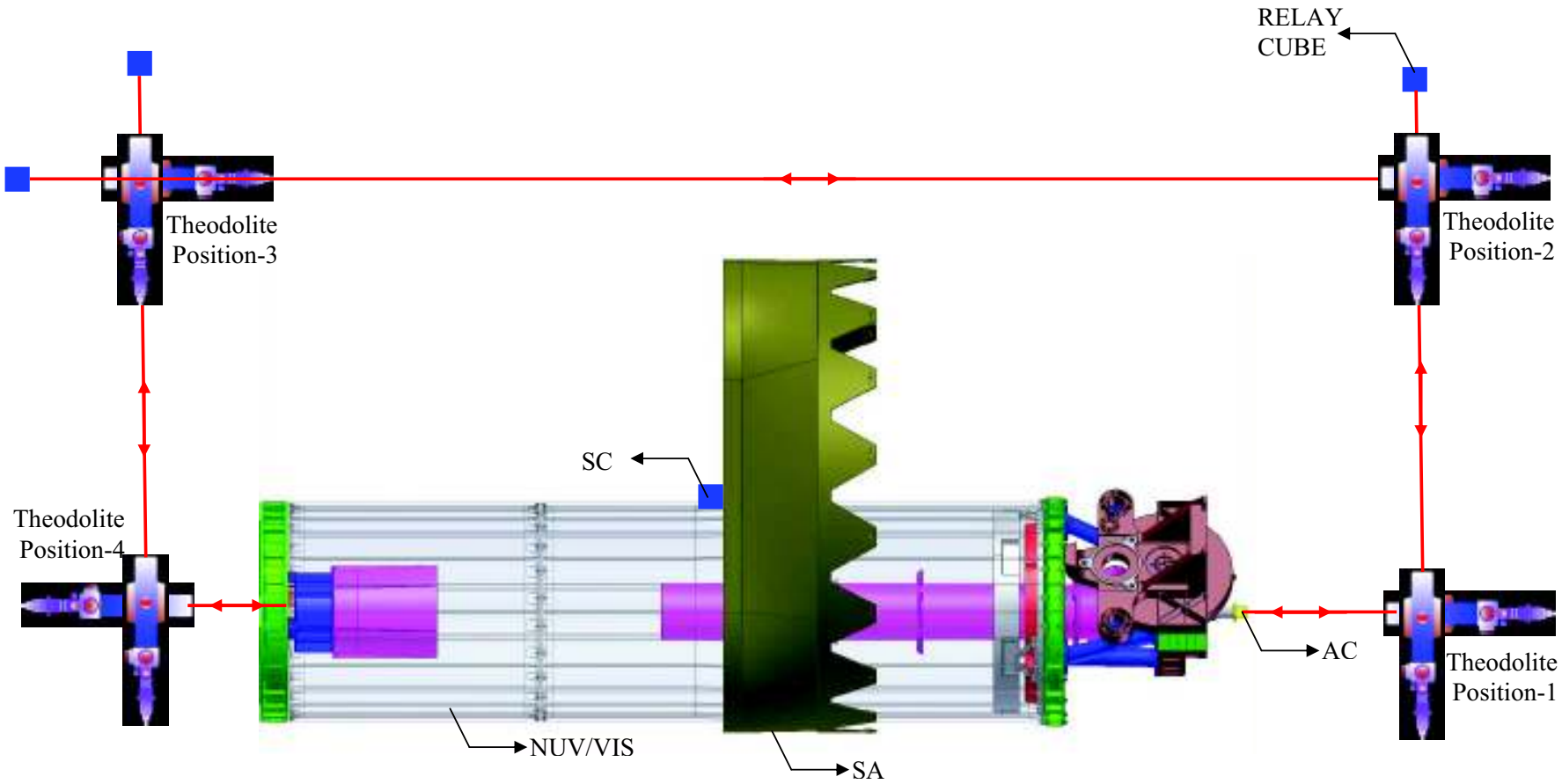

Figure 3 :Layout shows transfer of optical axis from Alignment cube and Primary mirror back surface to secondary mirror back surface (Accuracy of transfer better than 20arc sec)

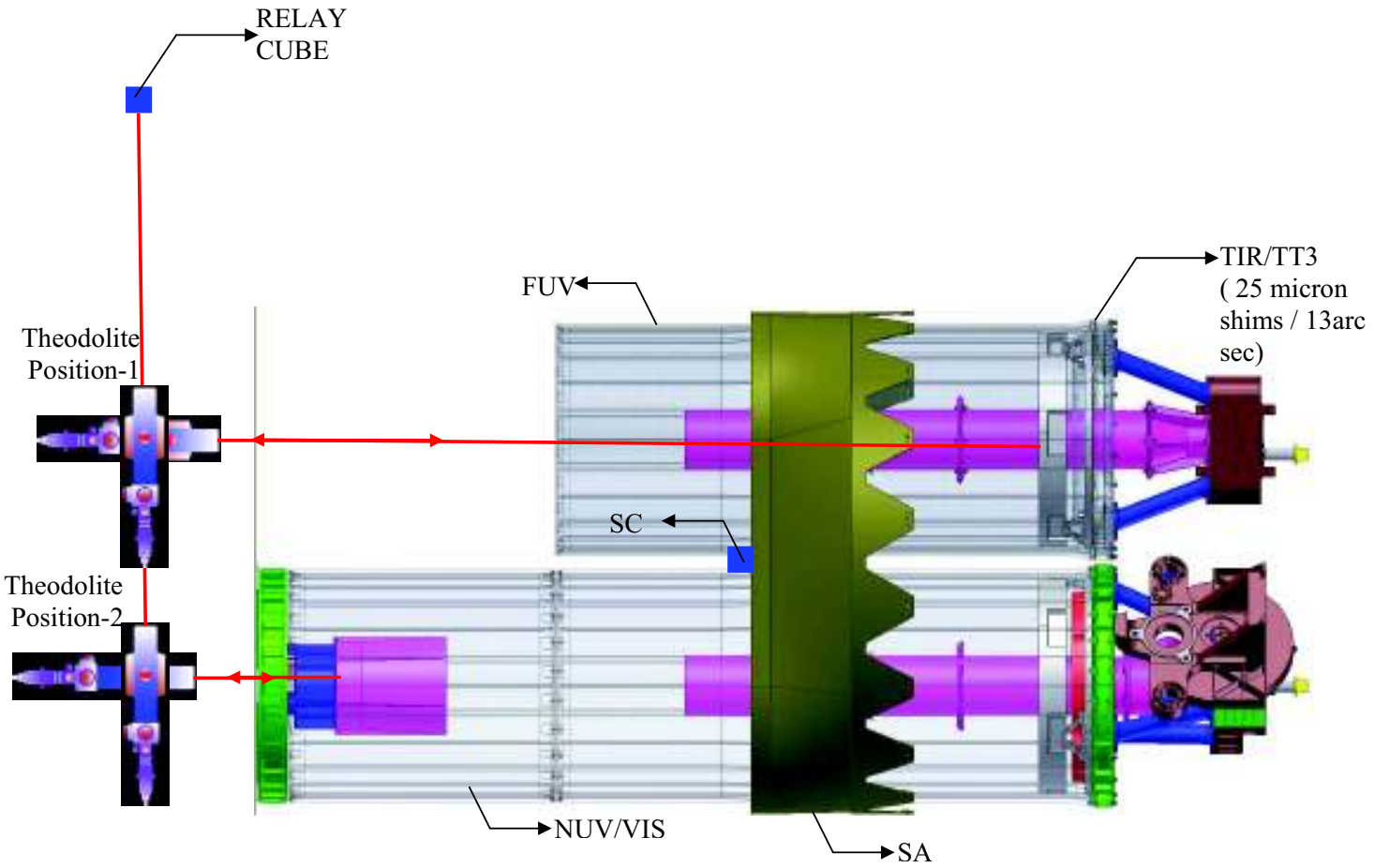

Figure 4: Layout of finding& correcting parallelism between FUV & NUV telescopes(Accuracy better than 20arc sec)

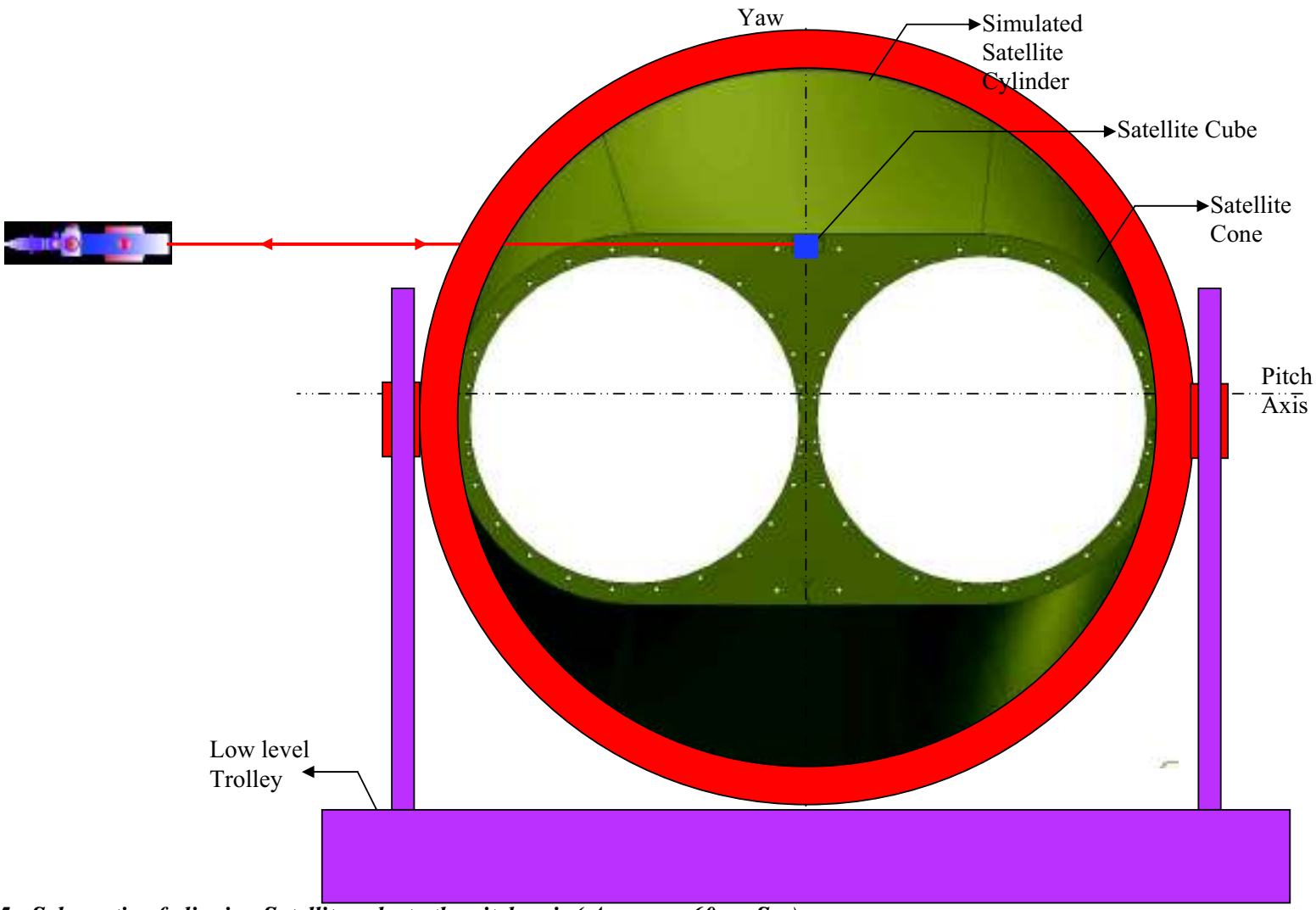

Figure 5:. Schematic of aligning Satellite cube to the pitch axis (Accuracy 60arc Sec)

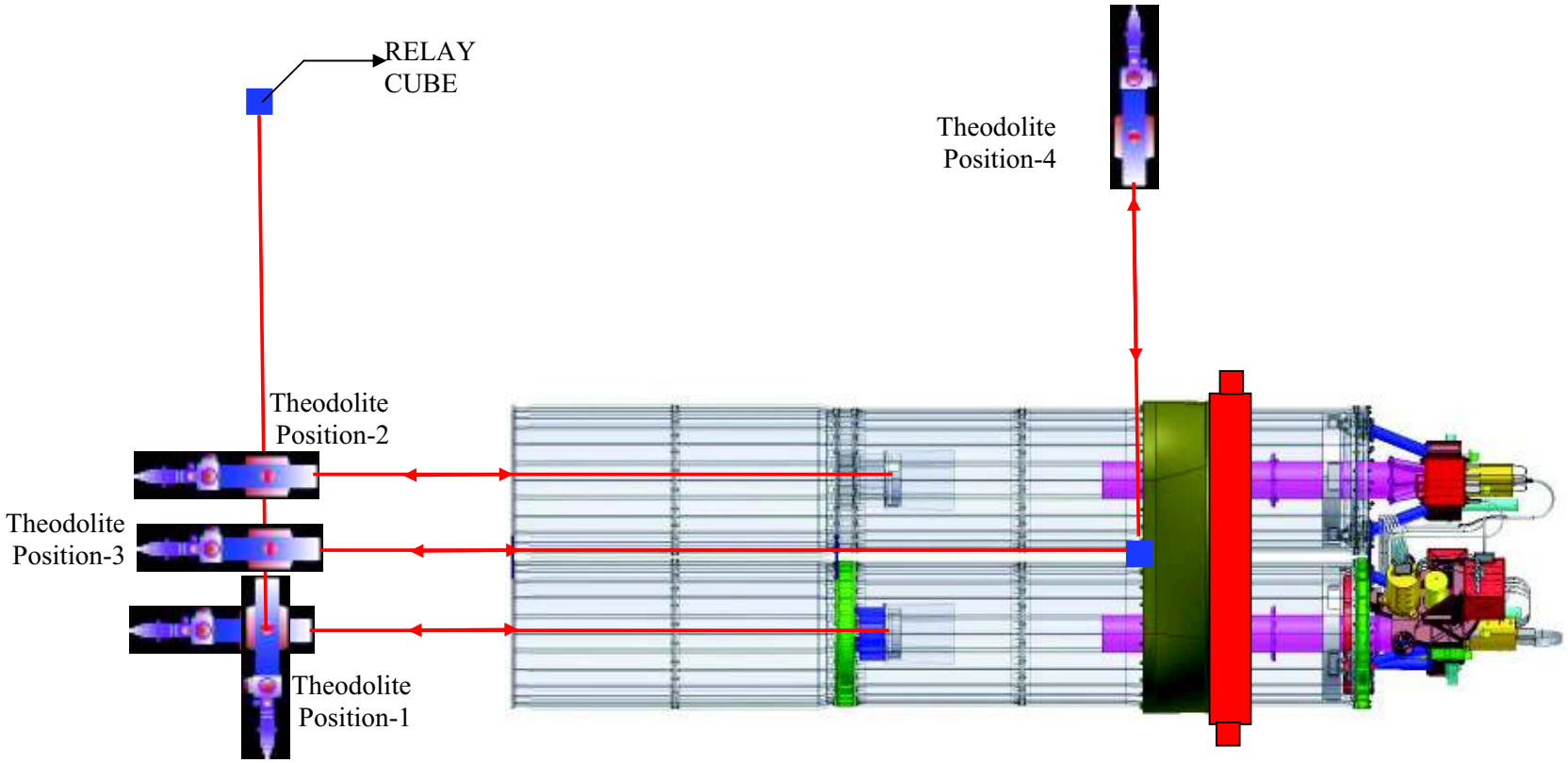

Figure 6:. Layout shows transfer of Optical Axis to the Satellite Cube on Satellite adaptor. (Accuracy better than 30 arc sec)