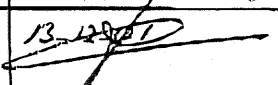
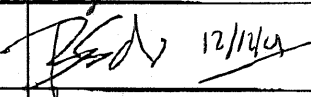


ENGINEERING SERVICES SECTION  
METROLOGY

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Optical measurements on the  
INTEGRAL JEM-X FM01 detector

Document No. : TOS-MTE/T/MET/0336  
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Issue No. 03	Date:		
01	29-10-2001	A11 2 and ANNEX A	1] Direction of cube mirror elevations. 2] Annex A: Sketch A detector Z axis correction 1] -Z mirror +Y face wrt. Y axis central collimator line. 2] Elevation of -Z mirror -Z face and the +z face of the +Z mirror. 3] Elevation about the Y and Z axis of top surface from the $\varnothing 258$ mm. collimator ring.
02	12-11-2001		
03	11-12-2001		
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1] General.

The Esa Estec Metrology laboratory was requested by the Danish Space Research Institute (DSRI) "Mr. Niels Lund", to perform alignment measurements on INTEGRAL JEM-X-FM01 detector. Requested was to measure the angles between collimator lines and the two mounted cube mirror axis. See attached DSRI FAX COVER from 28-09-2001 in ANNEX B.

2] Used alignment equipment.

The measurements were performed with a Leica T3000 digital theodolite. The theodolite was mounted on a two axis translation table which was on its turn mounted onto a granite surface table of 1x6x0.5 meter. A WILD GAP1 Autocollimation prism was used as external reference to transfer the detector Y axis as defined by the collimator lines to the cube mirrors.

3] Measuring set up.

The JEM-X-FM01 Detector was placed with its aluminium transport plate on the granite surface plate, in front of the theodolite. The granite surface plate was levelled within 2 arc. seconds. The theodolite was mounted on the two axis translation table. The Autocollimation prism was placed between the detector and the theodolite.

4] Performed measurements:

4.1] The optical axis of the theodolite was adjusted parallel with the collimator Y axis as defined by the central collimator line. The theodolite Azimuth reading was set to 0.000 °. The Autocollimation prism was levelled and adjusted with its normal parallel to the collimator Y axis as measured by the theodolite. In addition the elevation of the mirror +Y face was measured.

4.2] The theodolite was translated along the detector Z axis to the -Z cube mirror. By autocollimation on the prism, the optical axis of the theodolite was adjusted parallel to the detector Y axis. The theodolite Azimuth reading was set to 0.000 °. In the theodolite autocollimation mode, the angle between the detector Y axis and the normal of the mirror was measured.

4.3] The same measurements were performed on the +Z cube mirror.

5] Additional measurements.

On request of the project, the following additional measurements were performed:

- 5.1] The angle between the collimator Z axis, "as defined by the central collimator line over the Z axis" and the +Y face of the -Z mirror.
- 5.2] The elevation of the -Z face of the -Z mirror and the +Z face of the +Z mirror.
- 5.3] The elevation about the Y and Z axis, of the top surface from the  $\varnothing$  258 mm. collimator ring.

6] Measuring set up for the additional measurements:

- 6.1] The optical axis of a theodolite was adjusted parallel with the collimator Z axis as defined by the central collimator line.  
The theodolite Az. reading was set to  $0.000^\circ$ .  
By mutual collimation with the theodolite on the -Z mirror, the angle between the collimator Z axis and the +Y face of the -Z mirror was measured.
- 6.2] The elevation of the -Z face of the -Z mirror and the +Z face of the +Z mirror were measured with an additional theodolite.
- 6.3] The elevation of the collimator ring was measured with an dial gauge. Measured was the distance from the top of the collimator ring to the collimator mounting surface on four points. (-Z/+Z/-Y and +Y).  
The angle about the Z and Y axis was calculated.

7] Measuring results:

- 7.1] The actual Azimuth angle of the +Z cube mirror wrt. the detector Y axis is  $0.413^\circ$   
The measured Elevation angle is  $89.659^\circ$  (Theodolite reading).  
Actually, the normal of the cube mirror is downwards by an angle of:  
 $90.000^\circ - 89.659^\circ = 0.341^\circ$
- 7.2] The actual Azimuth angle of the -Z mirror wrt. the detector Y axis is  $0.405^\circ$   
The measured Elevation angle is  $89.541^\circ$  (Theodolite reading).  
Actually, the normal of the cube mirror is downwards by an angle of:  
 $90.000^\circ - 89.541^\circ = 0.459^\circ$ .
- 7.3] The angle between the collimator Z axis and the +Y face of the -Z mirror is  $89.505^\circ$ .
- 7.4] The measured Elevation angle of the -Z face of the -Z mirror is  $89.962^\circ$  (Theodolite reading)  
Actually the normal of the mirror face is downwards by an angle of  $0.038^\circ$
- 7.5] The measured Elevation angle of the +Z face of the +Z mirror is  $90.104^\circ$  (Theodolite reading)  
Actually the normal of the mirror face is upwards by an angle of  $0.104^\circ$

7.6] The angle of rotation of the top surface from the collimator ring about the Z and Y axis was calculated as following:

7.6.1] Angle about the Y axis:

Distance point -Z to collimator mounting plane 184.71 mm.

Distance point +Z to collimator mounting plane 184.74 mm.

Distance point -Z to +Z = 254 mm.

Calculated angle about the Y axis =  $0.007^\circ$

7.6.2] Angle about the Z axis:

Distance point -Y to collimator mounting plane 184.59 mm.

Distance point +Y to collimator mounting plane 184.79 mm.

Distance point -Y to +Y = 254 mm.

Calculated angle about Z axis  $0.045^\circ$

Note: For the actual measure angles and direction see sketch A/B and C in ANNEX A.

REMARK

- 1] Since the measurements were performed with the detector supported on the aluminium transport plate, the measured Elevation angles can be slightly different from the Elevation angles as measured when the detector was supported direct on its mounting surface.
  - 2] It should be noticed the the collimator lines in the direction of the Z axis are interrupted lines and the lines in the direction of the Y axis are continuous lines.
- 8] Straightness of collimator lines.

In addition the straightness of the central Y line and the lines on the left (-Z) and right (+Z) side of the central line and the central Z line were measured.

Results:

Straightness of the central Y line: 0.06 mm.

on the -Z side : 0.07 mm.

on the +Z side : 0.08 mm.

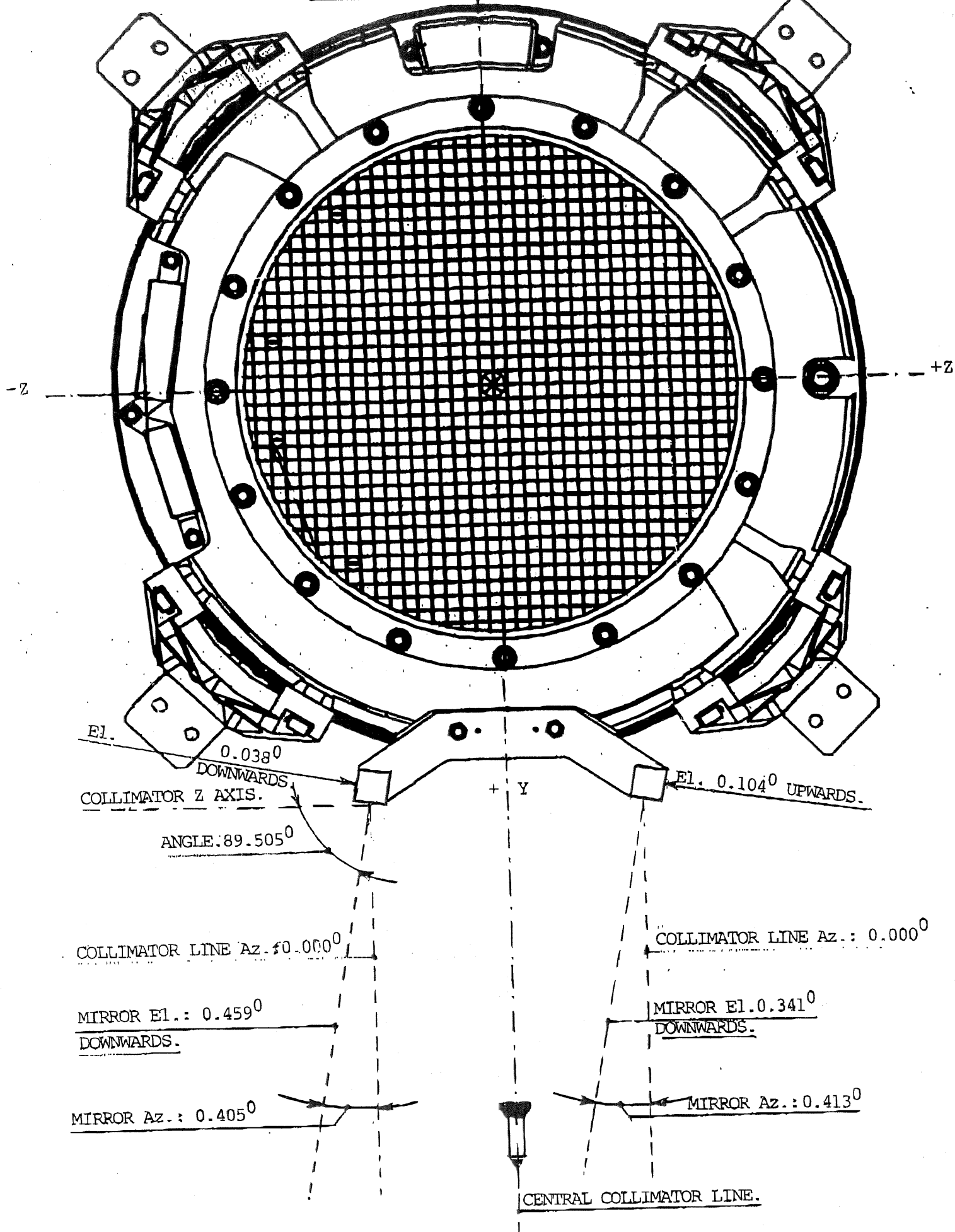
Straightness of the central Z line: 0.10 mm.

9] Determination of measuring accuracy:

For the optical measurements  $\pm 0.001^\circ$

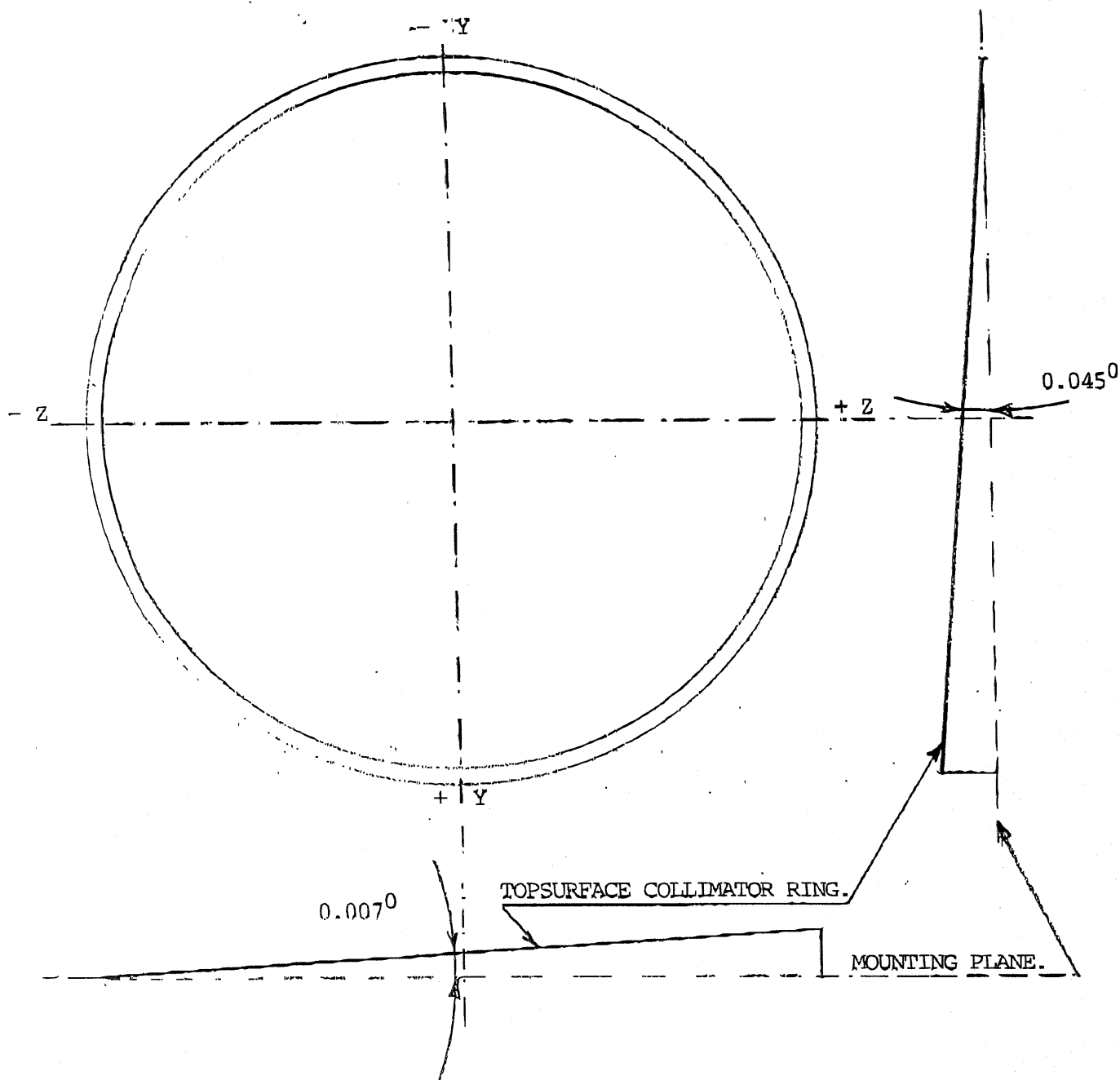
For the straightness measurements  $\pm 0.02$  mm.

## ANNEX A.



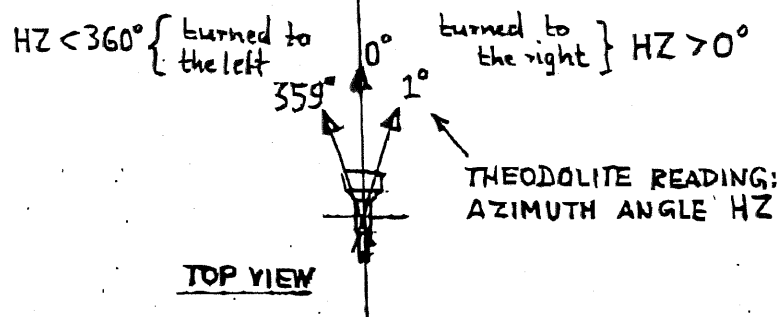
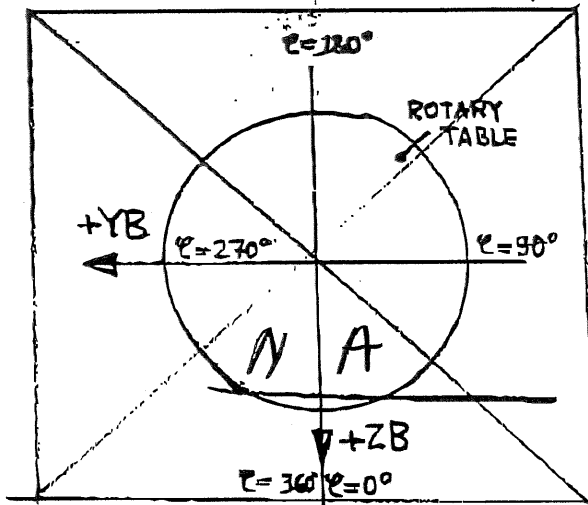


INTEGRAL JEM X FM 01 DETECTOR

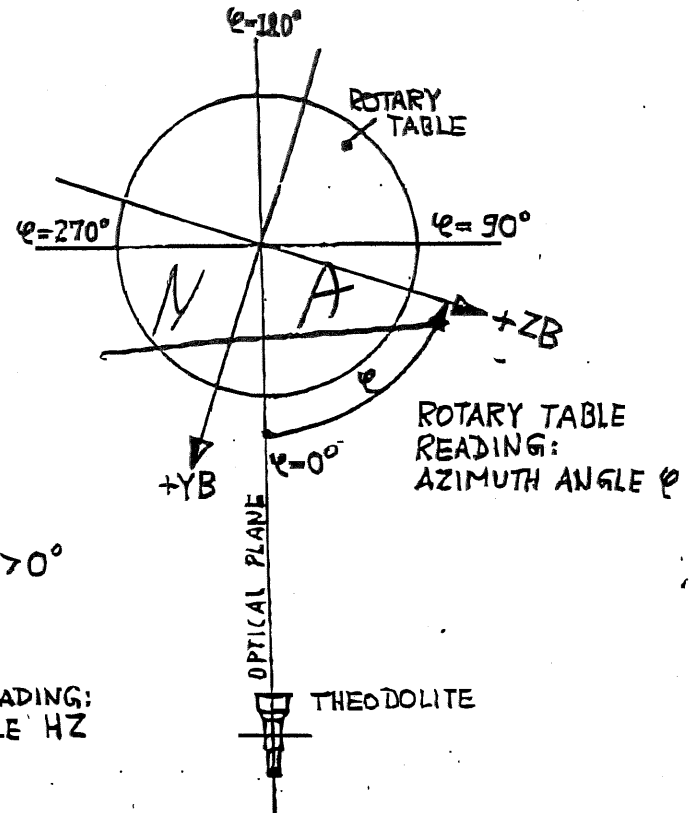


ROTATION OF COLLIMATOR RING TOP SURFACCE ABOUT THE Z and Y AXIS,  
WITH THE DETECTOR MOUNTING PLANE AS REFERENCE.

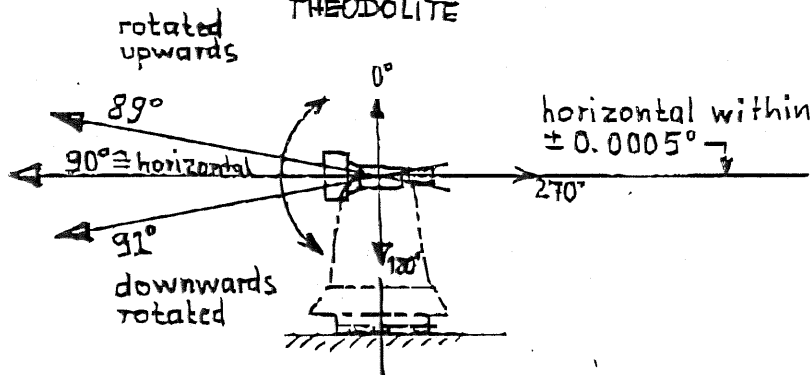
TOP VIEW



TOP VIEW



SIDE VIEW  
THEODOLITE



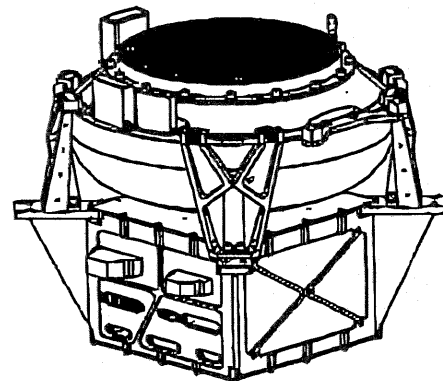
THEODOLITE READING: ELEVATION ANGLE V

AUTOCOLLIMATING  
THEODOLITE, MODEL:  
LEICA T3000 A

THEODOLITE AZIMUTH AND ELEVATION SCALE. ~~ROTARY TABLE SCALE~~

Technical drawing of a square plate with dimensions and labels:

- Y Spotfaced Areas  $\phi 12.3$  for M6 Washers**: Label at the top left.
- Dimensions**:
  - 247**: Overall width of the plate.
  - 49.9**: Distance from the top edge to the center of the spotfaced areas.
  - 10.9**: Distance from the center of the spotfaced areas to the edge of the plate.
  - 240.0**: Distance from the center of the spotfaced areas to the center of the plate.
- Labels**:
  - R255.2**, **R221.0**, **R190.0**: Labels on the right side, likely indicating radii or distances.
  - Z**: Label on the left side, indicating a vertical axis or direction.



Grounding stud

72

185

9

55.9

142.4

163.5

168

J01

J02

J03

J04

J05

J06

J07

159.8

169

213.7

222.6

234.2

108.4

142.4

198

All bolts and nuts will be tightened according to ESA PSS-03-206 Issue 1, page 18-19 (friction coefficient = 0.1), strength grade 8.8 or strength class 70.

CoG in coordinates (72,158,173)  
 MoI: X-axis = 4.02E05 kg=mm<sup>2</sup>  
 Y-axis = 5.17E05 kg=mm<sup>2</sup>  
 Z-axis = 5.17E05 kg=mm<sup>2</sup>

POWER:  
Detector = 5.5W  
D.FEE = 22.5W

**Thermal surfaces:** The DFE surface are painted with Chemglaze Z306 (emission coefficient = 0.85). The Detector dome has emission coefficient = 0.93.

The radiative areas between the Detector dome and the DFE top-plate has emission coefficient = 0.80.

Thermistor position are shown on drawings: JEMX-EMTH/B/S1, Hydrac N543, see following pages,

Top view

8 psc. Ø6.4±0.1/0 for M6.0 (Ø0.0)

Alignment Cubes (2 psc.)

4 psc. of collimator sources pointing in -X direction

Grounding stud M4

Dimensions (inches): 14.9, 36.4, 346.8, 331.9, 173.4, -116, 14.9, 17.2, 32.1, 317, 331.9, 349.1, 367.4, 14.9, 102.5, 244.5, 14.9

Drawing No.	
Rev.	
Date	
By	

Alignment Cubes  
(2 psc.)

4 sec. of calibration  
sources pointing in  
-X direction

Project Number	17000000	Project Name	17000000	Project Status	17000000
Project Manager	PC	Project Sponsor	JP	Project Approval	17000000
Project Start Date	17000000	Project End Date	17000000	Project Duration	17000000
Project Budget	17000000	Project Cost	17000000	Project Revenue	17000000
Project Risk	17000000	Project Impact	17000000	Project Benefit	17000000