HESSI SPACECRAFT
TMS TEST

HSI_MIT_038A

2000-NOV-17

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DRAFT

As Run on: ______________________________ (Date/Time)

By ______________________________ (Test Conductor)

DOCUMENT REVISION RECORD

Rev.	Date	Description of Change
A	2000-10-17	Initial Release

Western Range/NASA Safety:____________________________ ____________
Date

Project Manager: ____________________________ ____________
Peter Harvey Date

System Engineer: ____________________________ ____________
David Curtis Date

QA: ____________________________ ____________
Ron Jackson Date

Imager Lead: ____________________________ ____________
Alex Zehnder Date

PAUL SCHERRER INSTITUT PSI	**HESSI**	Document Identification **HESSI-AZ15-002**
Laboratory for Astrophysics	**Twist Monitoring System TMS**	PKS-Code: =6 TGA 30
DocTyp: ☐ Management ☐ Product	**HSI_MIT_038A**	Issue: 11/15/2000 Update:

Scope of the document

The documents describes the TMS system, the requirements and its operation.

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Distribution:

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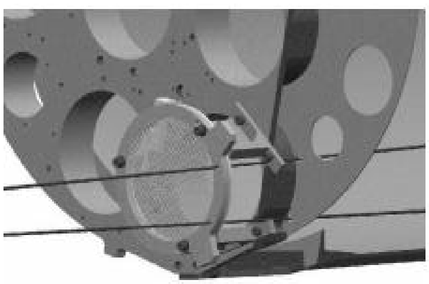
Depository: ☐ A. Zehnder ODRA/120 Remarks: ☐	**Foreign ID:**

1. PURPOSE OF TWIST MONITORING SYSTEM (TMS)

The HESSI (High Energy Solar Spectroscopic Imager) mission uses as imaging techniques 9 co-rotating collimators pairs. They produce an intensity modulation of the X-ray depending on the angle of incidence. The modulation efficiency is close to 100% for perfect aligned-, and decreases steeply for misaligned collimator pairs. The alignment tolerance for finest grid is 20 arcsec corresponding to less than a 1mil at the periphery of the trays. Therefore maintaining the angular alignment is essential for the success of the mission. The twist monitoring system allows with high precision to monitor the any deviation from the initial alignment made in Switzerland using mechanical and optical coordinate measuring machines (CMM). The TMS is used after transportation of HESSI and before and after every environmental test.
To verify and monitor the angular alignment of the grids and trays with respect to each other an interferometric system has been designed. Rear grids and the rear tray have pinholes illuminated one after the other by lasers. Through these pinholes light falls on annuli in the front grids and the front tray. The light is diffracted by the annuli into rings, which are detected by a CCD camera. Possible twist can be detected with redundancy. Grids 1 to 8 and the tray bear TMS features. The resolution of the TMS is in the order of a few arc seconds.



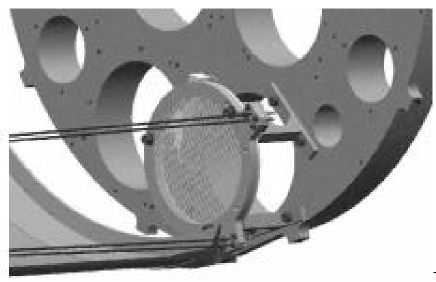


Fig .1. Principle of the TMS for one device (grids or tray): Rear tray/grid with 4 laser diodes attached to 30? m pinholes illuminate 2 annuli on the front tray. The 4 converting rays are intersected on a CCD camera, producing four interference patterns. Any angular rotation (twist) between front and rear system can be monitored by analyzing these patterns.

2. HARDWARE DESCRIPTION

The TMS consist of two main components.

- An imager based system with lasers/pinholes and annuli.
- A standoff structure for the CCD camera, which is placed 1300mm in front of the front grids.
- Control system
- Rolling ladder at least 10 feet high with rails (to be supplied by VAFB)

2.1 Imager based system:

There are in total 10 independent TMS, namely two redundant for the tray-to-tray twist and one for each grid number 1 to 8. Grid 9 has no TMS. Each of the TMS consists of four 3mW 635nm laser assembly on the rear tray or rear grids and of 2 annuli on the front tray or front grids, respectively. The each laser is mounted behind a 30μm pinhole; therefore the laser power outside the imager is reduced to less than a μW. The harness of the 44 lasers is mounted on the rear tray and routed to a 50 pin Canon male connector located at the –x side of the rear tray. In the non-operation mode a service plug shorts the lasers. The plug must be removed before launch (**Red tag item)**. For the alignment of the standoff structure two low-power lasers must be mounted on special brackets on the upper imager endring. They must be removed after ever TMS. TMS can only be made with a special TMS front scaffold. Its purpose is to shield the stray light of the lasers on the grids. This scaffold must be replaced with the flight scaffold after the last TMS.

2.2 TMS CCD Camera standoff structure

The CCD camera (Sony 1/2" CCD chip) is mounted on an x-y translation stage 1300mm above the front grids (sunny side). The front grids are about 2300mm above the floor; therefore the total height of the system is about 4000mm (160'). The floor space needed is about 2 by 2 m^2 on the –y side of the spacecraft. Fig. 2 shows the system after assembly at JPL. Fig. 3 shows the system in operation mode near the spacecraft.

2.3 Control System

The control system consists of four items:

- A controller box for the x-y drive, the camera rotation and for the setting of the CCD sensitivity.
- A black and white TV monitor for the online monitoring of the camera position
- A laptop computer for the storage of the interference pattern for further processing
- A laser power controller, connected via RS 232 cable with the laptop computer

The system is AC powered via 110V to 230V transformer, which is connected to a Swiss connector type distribution box. No controller runs on 110V AC.
The space required for the controllers is about 1 by 1.5 m^2. Fig 4 shows the control system. It must be located not further than 15m from the spacecraft.

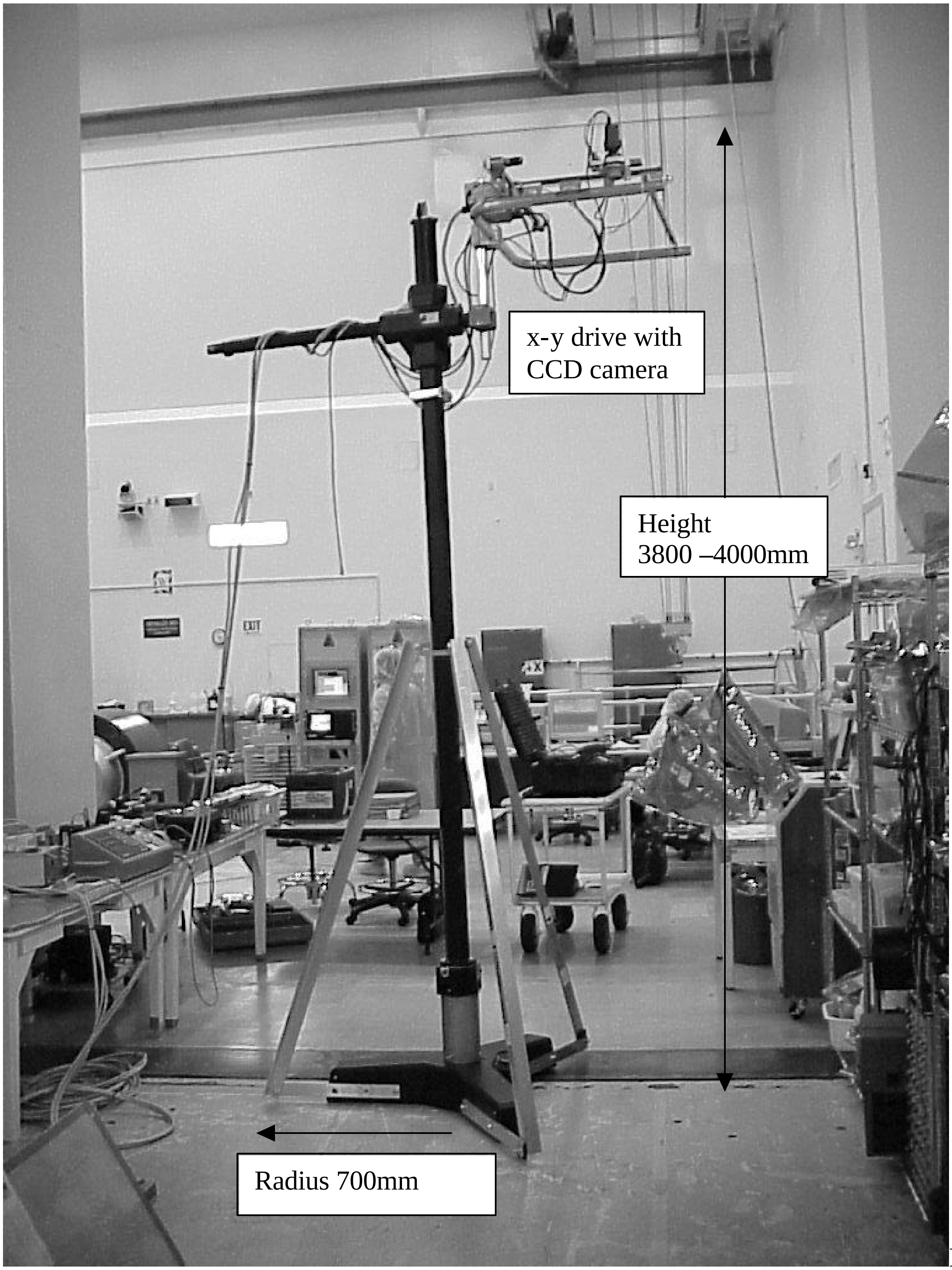


Fig. 2 CCD Camera standoff structure

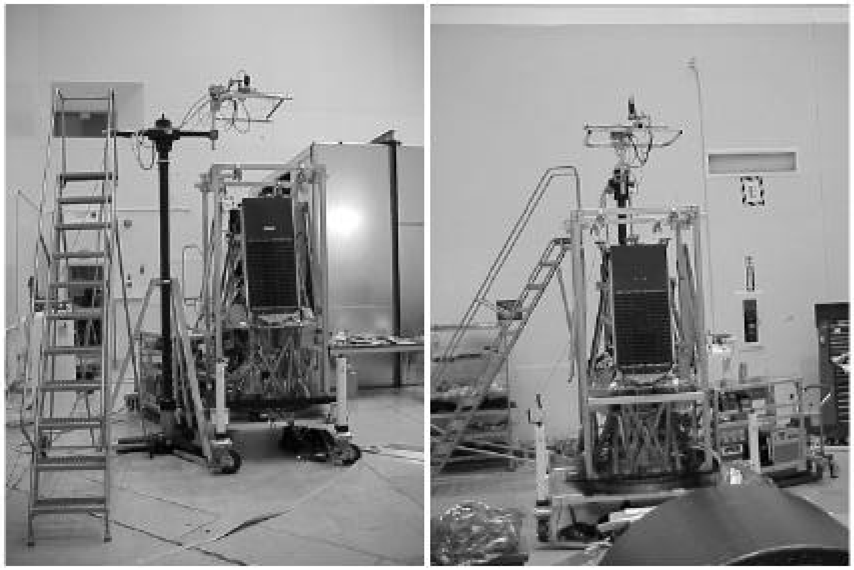


Fig. 3. TMS with S/C left view from +x side, right view from +y side

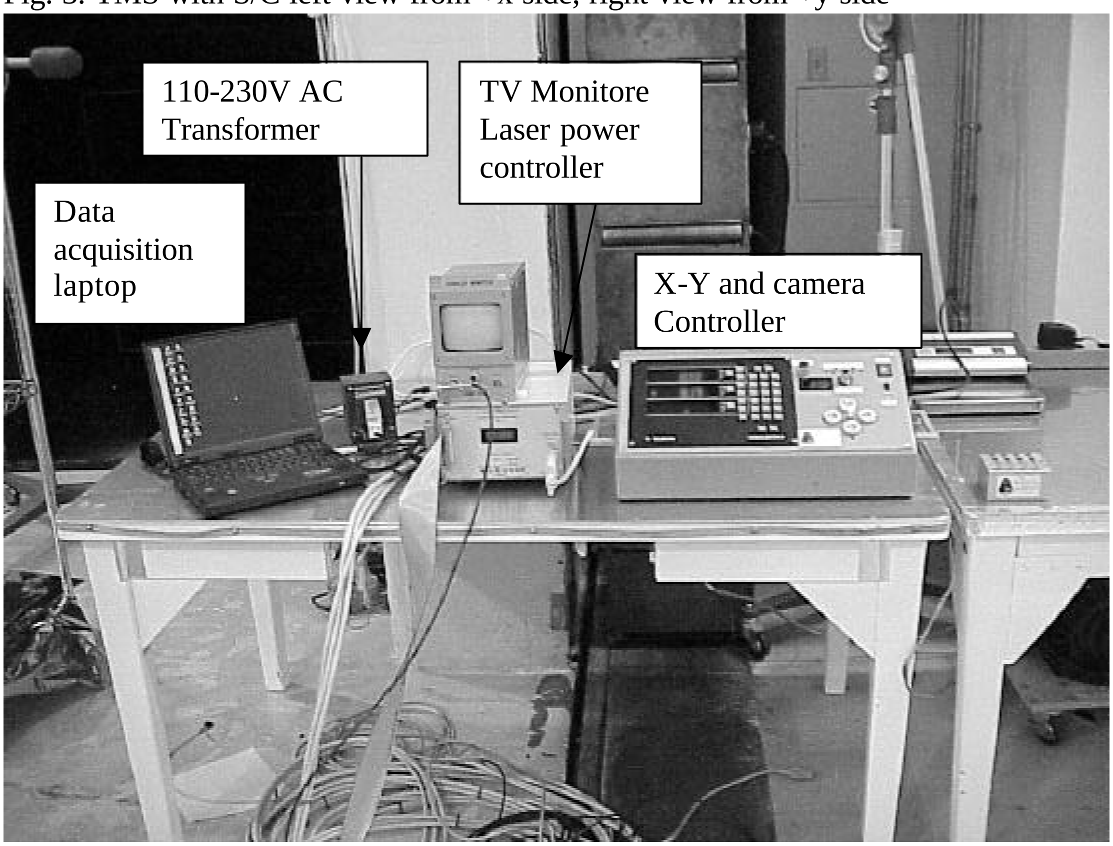


Fig. 4. TMS Controllers

3. ASSEMBLY AND SET-UP

3.1 Assembly

The TMS system is shipped in 3 boxes each about 50kg in weight. Prior to operation the standoff structure has to be assembled including the x-y drive. Two people can assemble the system in about 3 hours. Assembly must be made in a save distance (>10m) from the spacecraft. All movements (+ - x and y and camera rotation have to be checked including the proper operation of the end-switches.

3.2 Grounding scheme

The lasers are grounded to the S/C structure, but the laser power supply (-4.5V) is floating. A 9V battery powers the curent monitor of the laser power supply. The standoff structure is not grounded; all chassis of the controllers are grounded to the AC ground via the 110V to 120V transformer.

3.3 Setup with the S/C

The following requirements must be meet:

- Assembled and tested standoff structure.
- Table with controller system
- S/C on solid floor,
- Additional equipment needed
  - Ladder (VAFB supplied)
  - Flash light
  - Metric tool box (PSI)
- Check that the integration and test facility can be made dark

The following operations have to be performed:

1. Adjust the S/C cart upper surface between 125 and 380mm above the floor surface. Be careful that the aft antennas housings do not touch the floor or objects on the floor (cables etc.)
2. Level the S/C using a spirit level
3. Mount the 2 alignment lasers on the upper endring and connect it to the power supply box. Check the polarity, red on red, blue on blue
4. Remove the TMS laser shorting plugs, and wear personal grounding straps. Connect 50pin the flat band cable between S/C and laser power controller.
5. Preadjust the standoff structure height to 2080mm above S/C support platform.
6. Roll standoff structure as close as possible to the -y side of the S/C, the vacuum pump stand must be placed on the –x side.
7. Roll ladder to standoff structure and attach camera BNC cable, remove camera dust cover.
8. Adjust standoff structure in x and y to HESSI coordinate system, release structure roll mechanism.
9. Switch on external alignment laser and calibrate x-y scan.
10. Switch of room light,
11. Verify the calibration with tray TMS 0
12. Adjust focus.
13. Start data taking

Time needed: 1-1.5 hours

3.4 Data acquisition and analysis

Requirements:

- Dark I&T facility
- No strong airflow
- Quiet environment.

The best time for TMS is at evening after working hours
Time needed for test and quick analysis is about 1.5 to 2 hours

3.5 Disassembly

If quick test showed consistent results then

- Remove standoff structure from S/C
- Disconnect laser power cable
- Disassembly standoff structure and store it in the 2 wooden shipping boxes #3 and 4
- Pack controllers, PC and xy- drive in Alu box #2
- Pack tools in box # 5 and 6
- Ship boxes #2,3,4,5,6 by air freight to

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