ANNEXURE - E

For

Dynamic Multi Star Field Simulator

(DMSS)

1. Introduction

This annexure provides the technical specifications for procuring a **D**ynamic **M**ulti **S**tar Field **S**imulator (DMSS) for testing the star sensors under dynamic sky conditions. ISRO-IISU is looking for a simulator to evaluate the star tracker based Inertial Reference unit aiding with various performance parameters under dynamic sky conditions. The enclosed document provides necessary specifications and requirements to be met by the suppliers for the delivery of the simulator. It also provides the details of deliverables and schedules.

The delivered items shall be in conformity with the requirements/specifications laid down in this document. In case the supplier is unable to meet any particular specification requirement, he should point out highlighting the deviations.

ISRO-IISU reserves the right to witness the system test results, review the progress of work at various milestones of the program. The supplier shall suggest the review scheme along with the proposal. If any test is to be carried out at a place other than the supplier's place, the supplier shall make appropriate arrangements for the participation of ISRO-IISU nominee(s).

Although the specifications given in the document here are firm, ISRO reserves the right to accept, modify or waive any of the technical specifications as per their requirement.

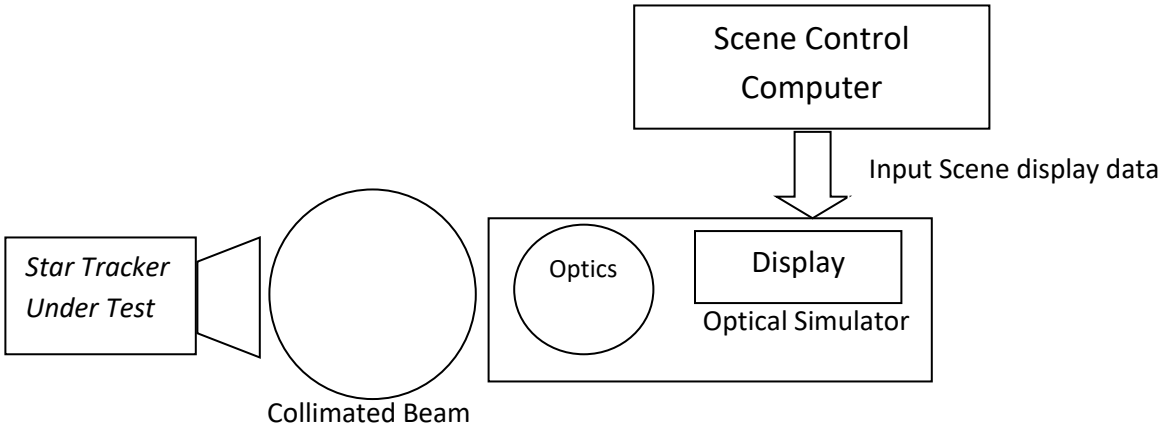
2. General Description

The DMSS produces required number of stars at infinity within the designed field of view. Typically, the simulator is expected to simulate upto 50 stars simultaneously in the given field of view up to a visual magnitude of 6. The attitude software would simulate motion of the stars at various rates and accelerations to test the star sensor under dynamic conditions.

The DMSS should dynamically simulate stellar images and display them in the field of view of a star sensor thus allowing all its nominal operating modes to be tested including its autonomous ability to recognize current attitude. In addition to stars, many disturbances like the moon blooming, planets, satellites crossing the field of view, background and stray light, or even effect of proton impacts on the image are to be simulated.

DMSS typically consists of an Optical Simulator driven by a Computer with appropriate software. The Optical Simulator is a single unit typically consisting of a display with suitable collimating optics housed in a mechanical housing. The display is driven by a computer hereafter referred to as Server (Scene control computer) which houses the application software which drives the simulator to various user defined dynamic conditions. This server, with its application software is capable of driving the display to simulate stars, project multiple stars of different magnitudes and simulate stars with rate and acceleration. The server can drive multiple units of Optical Simulators with necessary synchronization. The Server (Scene control computer) is typically mounted in a 19-inch rack mount chassis and loaded with the appropriate control software. A Typical block diagram of the Star Simulator is shown in Fig: 1

Fig 1: Block diagram of Dynamic Star Field Simulator



As input, the control computer software application receives current star tracker attitude in an earth centric inertial reference frame. Input also includes rate and acceleration as seen by the star tracker. With this input, computations are done to determine the visible stars in the current field of view of the star tracker. In addition to the starry sky image, the selected disturbances are added which could be additional stars that are not in the current catalogue, planets, extended objects (simulated like a uniform disk masking stars behind it), additional moving stars (to simulate debris or satellite crossing the field of view), background and straylight (like dynamical model or predefined background static or dynamic images), protons effect (simulated like dots and streaks with random positions and very short life duration) and a specific moon model that simulates blooming on detector pixels. The scene information is then sent to the star simulator to display as a collimated beam in the field of view of the star tracker. The output rays from the simulator enter Star tracker input pupil and make images as if the light were coming from the real sky. The system works like a dynamic planetarium.

This simulator is of small form factor and is typically mounted on the star tracker using an equivalent mechanical interface. This simulator shall be reliable, high performance, simple in operation and should conform to all safety regulations applicable.

3. Technical Specification of Dynamic Multi Star-field Scene Simulator for Star trackers

3.1 Technical Specifications

Sl.No	Item Description	Specification
1.	Test Simulator type	Test system for Star Trackers simulating the Real Sky Scenery consisting of Electro optical simulator and control computer.
2.	Usage Methods	Single Head, Multi Head
3.	Operating modes	Open loop, Closed loop
4.	Simulator Mounting	Mounted to Star Tracker using equivalent Mechanical

		Interface.
5.	Dynamic Specifications	• Simulate Scenes with angular rate variable from 0^0/s upto 10^0/s or better • No constraints on acceleration.
6.	Field of view	≥ 25^0, circular
7.	Number of stars in FOV	50 stars as per note below (a). This parameter represents the total number of stars to be displayed on simulator's display. (b). If total number of stars in FOV in any specified direction/orientation is < 50, then all the stars in the FOV shall be displayed on simulator's display. (c). If total number of stars in FOV any specified direction/orientation is >= 50, then brightest 50 stars in the FOV shall be displayed on simulator's display.
8.	Star diameter	≤ 0.02^0 (at 90%)within FOV for faintest star Mi>5.6
9.	Star Position Accuracy	≤ 0.01^0
10.	Angular Resolution	≤ 0.012^0 @90% in 25^0 FOV
11.	Beam Diameter	Compatible beam diameter to cover 50mm Star Tracker aperture and 25^0 FOV
12.	Update /Refresh rate of stars	Minimum 100Hz
13.	Distance from star Tracker optics	10-40mm from star tracker optics.
14.	Weight	Preferable less than 2Kg.
15.	Simulated objects	• Stars from star catalogue in range 1.5mi to 6mi ± 0.2mi • Star dynamic magnitude range of at least 4.5 • Solar system objects (Moon, Earth and Sun Planets) • Protons (>5000 impacts per image, punctual or streak) • Extended objects (via data input or file)
16.	Star catalogue	• Built in Star Catalogue • Provision to load customized star catalogues according to simple file format
17.	Background	• Dynamical stray light (via image files or simulated by model) • Extended objects (to mask part of the FOV)
18.	Dynamic simulation operation Mode	• Orbit propagator including maneuver profile editor • File and Data input for real time customized orbits and attitude profiles
19.	Synchronization requirements	• Time Synchronization for multiple DMSS to be provided

20.	Data logging for analysis	• Logging of time tagged simulated attitude • Logging of time tagged simulated star image location with magnitude, pixel location, no. of stars, catalog numbers. • Separate files for each requirement as stated above.
21.	Server Type	• PC in 19-inch rack mount chassis/Standard PC with compatible software.
22.	Server Features	• Provide Scene simulation for single head or Multiple heads with synchronization • Use star tracker current position to generate input scenes including planets sun, moon, earth at various rates and accelerations. • Cater to drive each simulator independently at any location.
23.	Server interface	• Facility to control the Scene Control Computer (server) remotely through another PC. USB, LAN facilities to be available.
24.	Demonstration by vendor	• Sl. No. 8, 18, 19 & 20 to be demonstrated by vendor

3.2 Operational Requirements

S l. No	Item Description	Specification
1.	Environment conditions	Standard Ambient Lab condition
2.	Continuous Operation	Minimum 24 hours continuous operation
3.	Simulator Life duration	Minimum 5 years
4.	Isolation	Electrical and Thermal Isolation from Star tracker to be provided
5.	Harness Compatibility	Minimum 5m for ambient conditions

4. Software

Necessary software to control the position and magnitude of a star in X-Y coordinate within the field of view shall be provided. The distortion model for simulator if any shall be bundled with the same. Software CD's with all necessary drivers to be supplied for installation into a different PC.

5. Mechanical system

The mechanical system shall consist of mount for mounting the simulator to Purchaser equipment (Star tracker). The mechanical interface of the Simulator to be provided in form of CAD model and/or mechanical drawings.

6. Electrical Interface

All electrical interfaces between simulator and test PC to be specified including connector details, signal specifications and live voltage levels. Electrical interface for synchronization with Purchaser Equipment (star tracker) to be provided. The electrical interface shall be compatible with Indian Standards.

7. Test Procedures

Acceptance test (Meeting at supplier premises) shall be performed prior to shipment and shall be repeated after the installation at ISRO-IISU to establish satisfactory performance of the simulator. The ISRO-IISU representative shall participate in the acceptance tests and upon successful completion of them the equipment shall be shipped. The supplier representative shall install and commission the equipment at ISRO-IISU premises and provide necessary training for its usage. The test plan and methods to demonstrate the specification compliance for specifications given in table 3.1 and table 3.2 are to be provided.

8. ACCEPTANCE, INSTALLATION AND TRAINING:

Test Results as per the specifications mutually agreed by both the parties shall be provided & clearance shall be obtained from ISRO-IISU before shipment of the simulator.

The supplier shall demonstrate the capabilities of the system, after the installation at ISRO-IISU. The supplier shall bring additional test equipment needed for conducting test and evaluation during the time of installations on returnable basis. The procedures shall also include the tests for optical spare parts, if applicable.

The purchaser has the option to waive the acceptance tests participation and provide clearance to ship by mail. However, installation and demonstration of the performance of the system at purchaser's premises is a must. A test and acceptance plan shall be submitted by supplier for both.

The contractor shall demonstrate the capabilities of the system for test and evaluation prior to shipment and after the installation at Purchaser's premises. The contractor shall inform at the time of order acceptance, the additional test equipment needed for conducting test and evaluation at purchase's premises. Also, supplier shall bring any specialized equipment required for testing and installation in India on returnable basis.

9. Warranty

Twenty-Four months warranty should be provided for the full system and their accessories including software from the date of installation, supported by performance warranty.

10. Delivery Schedule

All items shall be supplied **within T0+6 months (T0 = From the date of receipt of purchase order).** The details of various components of the system like Optics, LCD display, simulator controller,

Network interface, Mechanical drawings with dimensions and test procedures shall be supplied well in advance.

Installation and training shall be done within 30days of communication from ISRO-IISU after receipt of items.

11. Deliverables

1. Simulator with all required accessories of Optical simulator for collimated beam, Mechanical mounts, Control computer with driver card and necessary software, cables, power adapters.
2. Rack for holding the server in the requested configuration.
3. Opto-mechanical devices for calibration of simulator if any.
4. All necessary manual containing a complete description of the functioning of the item, instructions necessary for operation and maintenance of the system and interface definitions.
5. Test reports for tests performed in accordance with accepted test plans.
6. All Software documentation including software CD.
7. Operational manual
8. Service manuals
9. Warranty certificate.
10. Harness Cables 10m length - 2 Nos

All items to be packed properly to ensure safe transportation to ISRO-IISU premises.