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**EXHIBIT A**  
**Statement of Work**  
**Primary Mirror Segment Gravity Performance Verification**  
**TMT.OPT.CON.09.004.DRF01**

**Draft August 10, 2009**

**Exhibit A of RFP (TMT.BUS.MGT.09.313.REL01)**

**Tasks**

**Task 1: Contractor shall perform the design of a metrology system for measuring the zenith angle-dependent gravity-induced optical surface change of a TMT Prototype 2 (P2) Mounted Segment Assembly (MSA).**

1.1 The design shall be able to perform the measurements and meet the requirements specified in Exhibit B of this Request for Proposal:

**TMT.OPT.SPE.09.001.REL01**  
**M1 Segment Metrology Requirements**  
**For Prototype 2 Performance Verification**

1.2 The design shall incorporate testing in as many orientations as is required to discern the P2 MSA gravity response in three orthogonal directions. The design shall consider the minimum number of measurements required to extract model verification data and shall recommend the ideal number of test configurations, for example:

Referring to Figure 1, one possible set of orientations that would accomplish the objectives are:

- Zenith pointing, +Z direction up
- Nadir pointing, +Z direction down
- Inclined at a zenith angle of 90°, Y-axis vertical, +Y direction up
- Inclined at a zenith angle of 90°, Y-axis vertical, -Y direction up
- Inclined at a zenith angle of 90°, X-axis vertical, +X direction up
- Inclined at a zenith angle of 90°, X-axis vertical, -X direction up

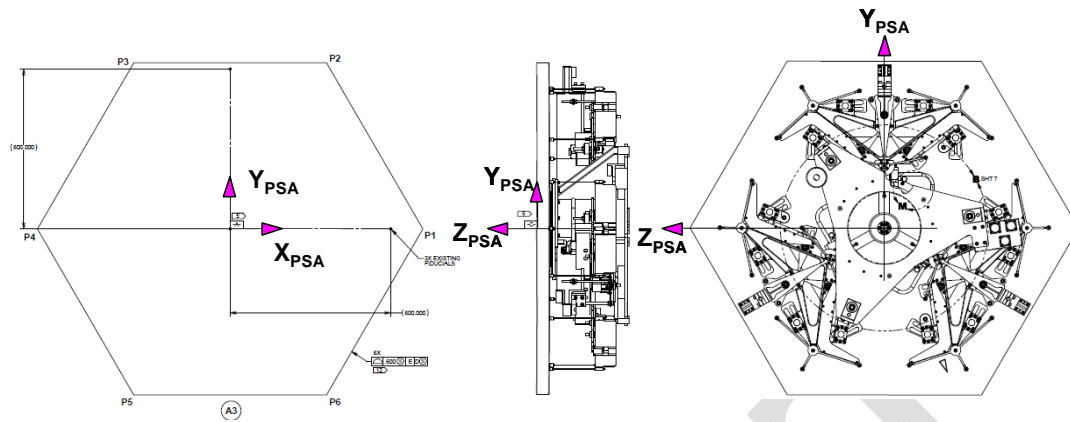


Figure 1. Primary Segment Assembly (PSA) Coordinate System

Another possible set of orientations that would accomplish the objectives are:

- Zenith pointing
- Nadir pointing
- Inclined at a zenith angle of 45-60° X-axis horizontal
- Inclined at a zenith angle of 90°, X-axis horizontal
- Inclined at a zenith angle of 45-60° Y-axis horizontal
- Inclined at a zenith angle of 90°, Y-axis horizontal

Fewer orientations are acceptable as long as the objectives of this effort and the accuracy and repeatability requirements presented in Exhibit B can be met.

1.3 The design shall develop the mechanical and optical layout of the Metrology System including all hardware and optics required to set-up and perform measurements of the P2 MSA.

1.4 The design shall include optical analysis and error budgeting to predict and optimize the performance of the Metrology System, and verify that the accuracy and repeatability requirements are met.

1.5 The design shall enable collection and processing of data to provide P2 MSA surface maps with the resolution and accuracy described in Exhibit A at each orientation determined in 1.2. The design shall enable subtraction of the Zenith-pointing surface measurements from the other orientations in order to calculate the gravity-induced surface changes.

## **Task 2.0: Contractor shall conduct an Implementation Review at the Contractor's facility**

2.1 The implementation review shall include but not be limited to:

- A layout or configuration drawing of the Metrology System, documenting its optical and mechanical configuration. Deviations from the approach described in the proposal shall be presented.
- A complete description of the planned test sequence of the P2 MSA.
- A summary of all calculations and analyses performed
- An error budget documenting the predicted performance of the Metrology System

- A compliance matrix documenting the performance of the Metrology System relative to the requirements
- A complete description of the calculations and analyses that will be performed on the data resulting from the full measurement test
- A summary of the handling operations planned for the P2 MSA, including the detailed design and structural analysis (as required) of the handling equipment and facility interface hardware.
- Vendor quotes for any procurements of greater than \$5,000.
- Descriptions of:
  - Metrology System assembly and test procedures
  - P2 MSA handling procedures
  - Segment measurement procedures
  - Data processing procedures
- An Implementation Report documenting the above shall be provided three days prior to the Implementation Review

2.2 As a result of the Implementation Review, TMT shall produce a list of Action Items. Contractor shall disposition these action items. (i.e. Contractor shall either accept or reject with justification each Action Item.)

### **Task 3.0: Implement Metrology System and Perform Measurements**

- 3.1 Contractor shall prepare an Addendum to the Implementation Report which will address any issues and Action Items identified by TMT. Any changes to the planned measurements, procedures, and data processing that were presented in the Implementation Report shall be described. The Contractor shall send the Addendum to the Implementation Report to TMT.
- 3.2 Subject to TMT's approval of the Addendum to the Implementation Report, Contractor shall gather, procure or fabricate all hardware, software, and facilities required to build the Metrology System.
- 3.3 Contractor shall assemble and commission the Metrology System.
- 3.4 Contractor shall perform Surface Measurements of the P2 MSA in the orientations determined in paragraph 1.2.
- 3.5 Contractor shall subtract the results of the Zenith-pointing Surface Measurements from the surface measurements at the orientations determined in 1.2 in order to calculate the Gravity Induced Surface Changes. The Gravity Induced Surface Changes shall be documented in surface maps that are separated into Zernike terms as described in Exhibit B.
- 3.6 Contractor shall assess the as-built accuracy and repeatability of the Metrology System. Where possible, Contractor shall subtract surface errors caused by the metrology system from the surface measurements of the P2 MSA in order to calculate the Gravity Induced Surface Changes of the P2 MSA.

3.7 Contractor shall document the results of the measurements in a Measurement Report. The Measurement Report shall contain, but is not limited to, the following:

- A description of the Metrology System
- A summary of the configuration, conditions, and results of all Surface Measurements including:
  - Copies of the procedures used during the collection of measurements
  - Copies of the procedures used during data processing
- The assessment of the repeatability and accuracy of the Metrology System
- A summary of the calculated Gravity Induced Surface Changes
- A summary of any testing issues or anomalies

#### **Task 4.0: Weekly Telecons**

In the performance of the above, the Contractor shall conduct weekly meetings with TMT in which technical, schedule and cost issues are discussed. These will usually be telecons. In the event of agreed-upon critical milestone events, such as set-up and performance of surface measurements, TMT representatives will visit the Contractor's facility and witness activities in lieu of the weekly telecon.

The purpose of the weekly telecons is to allow TMT visibility into progress and possible issues. In the absence of issues, the telecons are expected to last approximately one half hour.

#### **Task 5: Metrology System Storage**

After completion of Task 3, the Metrology System that has been developed to perform this effort may be needed for future measurements of segment assemblies. Contractor shall store the Metrology System for a period of up to 4 years, as specified by TMT, so that it can be reassembled to perform possible future contract measurements.

#### **Deliverables**

- Implementation Review and Report per task 2.1
- Addendum to the Implementation Report per task 3.1
- Raw data from the Surface Measurements described in task 3.5
- Calculated Gravity Induced Surface Change surface maps as described in task 3.6 and 3.7
- Measurement Report per task 3.8
- Weekly Meetings per task 4.0
- Metrology System storage per task 5.0