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**Draft Request For Proposal  
Primary Mirror Segment Gravity Performance Verification  
TMT.BUS.MGT.09.313.REL01  
Draft August 19, 2009**

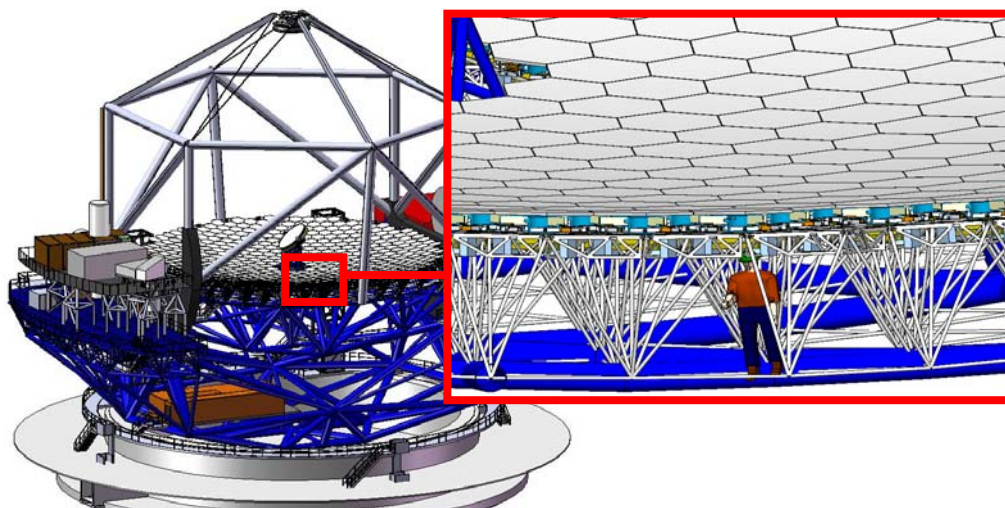
**THIS IS A DRAFT RFP. THE REQUIREMENTS, SPECIFICATIONS, TERMS  
AND CONDITIONS ARE NOT FINAL AND ARE SUBJECT TO CHANGE.**

## 1 Background

The TMT Observatory Corporation in collaboration with The California Institute of Technology (Caltech), the University of California (UC) and the Association of Canadian Universities for Research in Astronomy (ACURA) are managing the TMT Project (TMT). The objective of the Project is to design, construct and operate the world's largest optical-infrared telescope.

TMT is an international collaboration consortium which is generously funded by Caltech, UC, ACURA, the Gordon and Betty Moore Foundation, the Association of Universities for Research in Astronomy (AURA), the US National Science Foundation, the Canadian Foundation for Innovation (CFI), the Ontario Ministry of Research and Innovation (ORF), the National Research Council Canada (NRC), the British Columbia Knowledge and Development Fund (BCKDF) and the National Science and Engineering Research Council of Canada (NSERC).

TMT is soliciting proposals for measurement and analysis of gravity-induced deformation of the spherical optical surface of a representative prototype primary mirror segment.



*Figure 1. TMT Telescope Design*

The Primary Mirror of TMT is an array of 492 hexagonal segments. *Figure 1* shows a design concept for the telescope with an enlarged view of the primary mirror structure. Each mirror segment will be supported by a passive support system consisting of nearly-independent axial and lateral support systems. The axial support system is a 27-point whiffletree, and the lateral support employs a central diaphragm. The support system includes a 21 degree-of-freedom warping harness system that allows for correction of low-spatial-frequency surface errors. The support system, in conjunction with the M1 control system, will position the segments to form a unified primary mirror surface. In order to enable the required telescope performance, the optical surface errors of each segment must be low under all expected operating conditions.

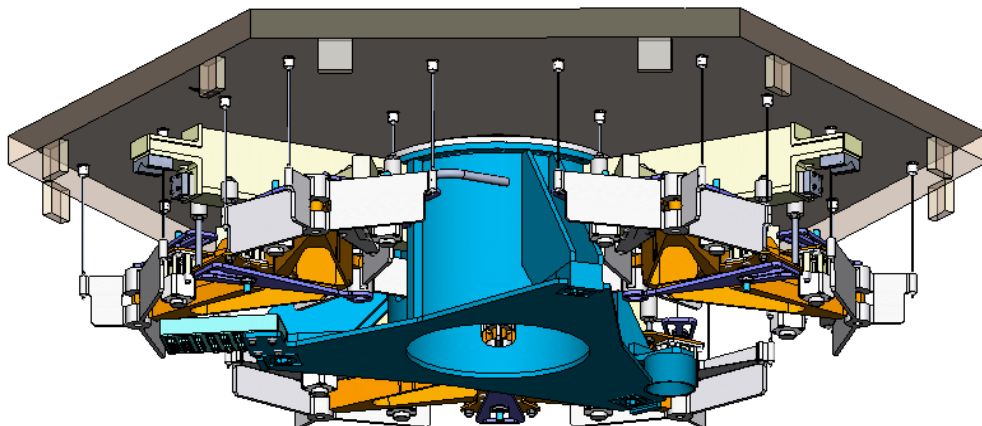
TMT is currently fabricating prototype segment assemblies which will be used to provide optically tested performance data to aid the design development of the telescope. The Prototype-2 (P2) will be the second prototype segment for the TMT primary mirror and will consist of a polished glass segment with its permanently-attached mount, the Segment Support Assembly (SSA).

P2 will be assembled as a Mounted Segment Assembly (P2 MSA) consisting of a representative optical segment mounted to a Segment Support Assembly, with warping harness actuators, edge sensors and cables attached. The MSA is the unit that would be removed from the TMT telescope primary mirror structure for re-coating and servicing. *Figure 2* shows an assembled MSA, excluding cables. The interface to the MSA is further described in the Polished Mirror Assembly (PMA) Drawing, which is attached to this RFP as Exhibit C. The PMA Drawing represents the P2 MSA prior to attachment of the sensors and cables. The P2 MSA will include sensors and cables.

The P2 MSA incorporates a prototype optic with the following properties:

- Material: low expansion glass ceramic
- Size: hexagonal, 1.44m across hexagon corners, ~45mm thick
- Optic front surface (S1): polished, concave, spherical, radius of curvature = 60.077m
- Optic back surface (S2): polished, convex, radius of curvature = 62.5m
- Coating: not applied
- Mass: ~210 kg

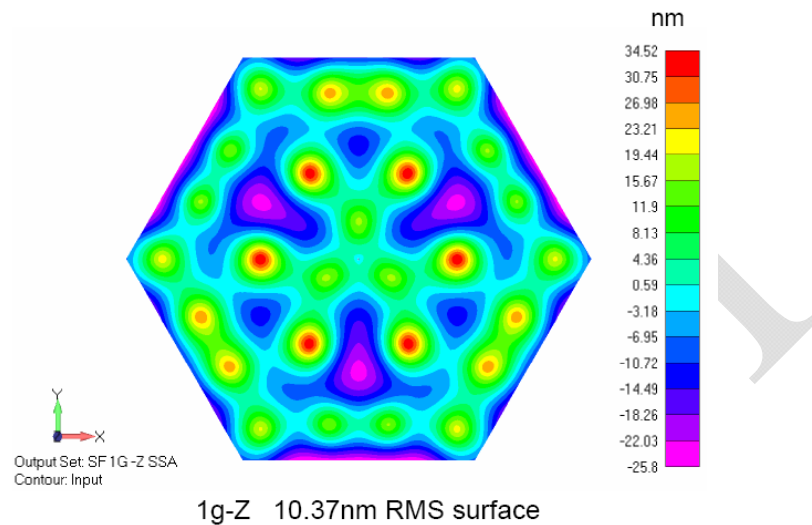
The as-manufactured P2 MSA will exhibit surface figure errors of TBD nm peak-to-



*Figure 2. Mounted Segment Assembly (MSA) - excluding cables*

valley when zenith-pointing.

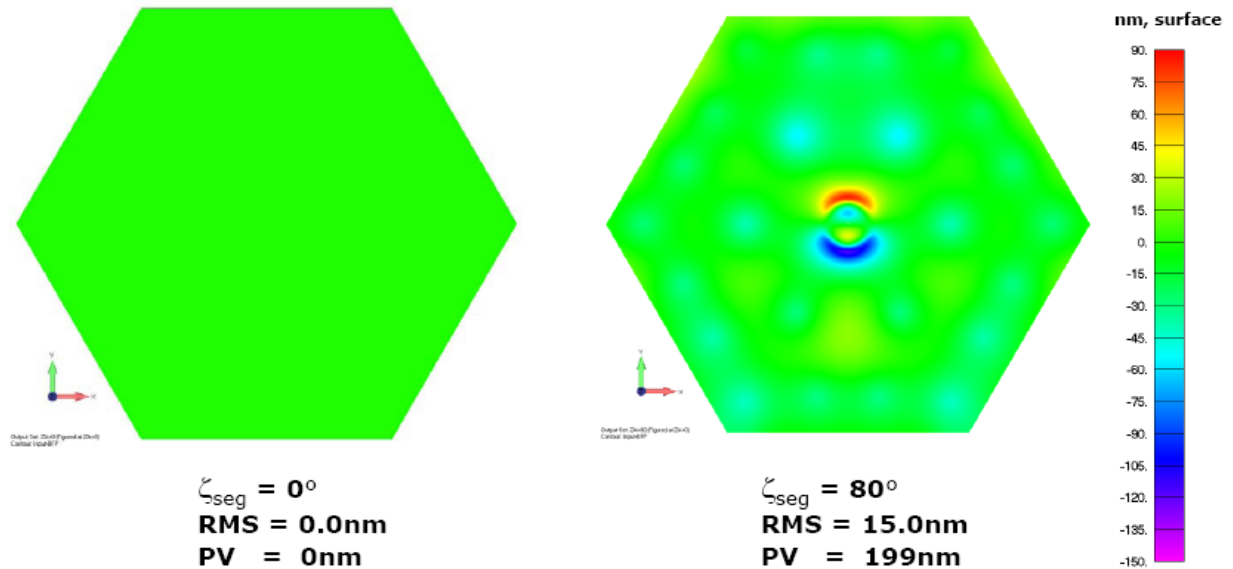
During the mass production of TMT segments, the as-mounted segments will exhibit a number of deterministic and random surface errors. A contributor to the deterministic errors will be the gravity distortion (print-through). A plot of expected zenith-pointing gravity distortion is shown below in *Figure 3*.



*Figure 3: Gravity distortion of a zenith-pointing, geometrically perfect segment*

During final fabrication of segments for TMT, each segment will be mounted to a SSA, and the optical surface of each segment will be measured with the segment in the zenith-pointing orientation at summit temperature. Surface errors present in this condition will then be removed using a deterministic final figuring technique. As a result, the zenith-pointing surface errors of each final MSA are expected to be low. However, the P2 MSA will not undergo this final-figuring process. As such, significant surface errors may be present in the P2 MSA, even at zenith pointing.

In addition, during telescope observations, segments will be inclined away from zenith-pointing by angles of up to  $80^\circ$ . As zenith angle increases, the surface figure of the segment that was polished-out in the zenith-pointing condition will degrade and gravity print-through artifacts will build. This is illustrated below in *Figure 4*



*Figure 4: Surface errors of a perfectly figured, perfectly mounted segment at zenith angles of  $0^\circ$  and  $80^\circ$*

Although extensive optimization has been performed to guide the design of the support system to minimize gravity-dependent surface figure errors, and eliminate low-spatial frequency surface figure errors, we anticipate that small manufacturing tolerances will result in random, low-spatial frequency, gravity dependent surface errors. It is the goal of this testing to validate the predicted performance, and to quantify the random errors that are present on the prototype.

## 2 Desired products

TMT wishes to verify the modeled performance of the Prototype 2 optical surface as it rotates from zenith pointing to an inclined angle. To this end, TMT is seeking a contractor to design and build, then use a metrology test set to measure the optical surface deformation of P2 in multiple orientations from zenith-pointing to inclined angles. Because each segment can be installed in any of 6 locations within the M1 array (locations 60 deg. apart), the lateral gravity vector may act upon the segments in any direction, therefore measurements shall be made to understand the surface deformation resulting from rotations around two orthogonal axes perpendicular to the P2 optical axis: X-axis rotation and Y-axis rotation.

The details of the desired tasks and deliverables are defined in Exhibit A of this RFP:

### Exhibit A.

#### Statement of Work

#### Primary Mirror Segment Gravity Performance Verification

**TMT.OPT.CON.09.004.DRF01**

**(Statement of Work)**

Measurement requirements are defined in Exhibit B of this RFP:

**Exhibit B.**

**Requirements**

**Primary Mirror Segment Gravity Performance Verification**

**TMT.OPT.SPE.09.001.DRF01**

**(Requirements)**

The resulting data shall be processed to describe measured zenith-angle-dependent, gravity-induced surface deformation. The measured data shall be transformed so that it can be compared to the predicted deformations from TMT's performance models.

**3 TMT Furnished Equipment**

TMT will provide the P2 MSA to be tested.

**4 Period of Performance**

The proposed work is anticipated to begin in November or December 2009.  
The P2 MSA is expected to be available for testing in March or April of 2010.  
The proposed work is expected to be completed by TBD months after contract award.

**5 Shipping and Delivery**

TMT will pay for shipping costs to deliver the P2 MSA to the Contractor and to return the P2 MSA to TMT.

Unless specified otherwise in writing, all other deliverables shall be shipped to TMT Observatory Corporation and the contract price must include the delivery cost under the shipping terms of Delivered Duty Paid to the TMT Observatory Corporation Office in Pasadena, CA.

**6 Storage or Delivery of Metrology Equipment**

Storage: Metrology equipment that will be developed with this funding shall reside at the contractor's facility in either active or stored configuration due to the possibility of future follow-on segment measurements described in Section 7 below.

Delivery: TMT may desire the ability to test mirror segments during production or during the lifetime of the observatory. Therefore, TMT would like to consider whether the metrology test set can be a deliverable system.

**7 Potential follow-on segment measurements:**

- A) Characterization of the influence functions (optical surface shape) for each of the 21 warping harness actuators in the P2 MSA will be required. It may be most efficient to use some of the metrology equipment developed for the current

contract for this task. The influence functions are expected to be represented by low and mid-spatial frequency wavefront differences from an un-perturbed state. This testing would be performed with the segment maintained in a single orientation.

- B) TMT may build a third generation prototype (P3) in the future and may want to test its performance in a similar manner. For purposes of this proposal, assume that the testing of the P3 segment is identical to the testing of the P2 prototype described herein.

## **8 Cost and Contract Type**

The expected contract type for this work is Fixed Price with a not-to-exceed price ceiling of \$400,000.

If the respondent feels that the effort required to perform this work cannot be accomplished with the expected contract type, please explain and suggest an alternative.

All proposed costs must include all applicable taxes, insurance and duties.

Model Contract terms and conditions are attached and incorporated into this RFP as Exhibit D.

## **9 Required Proposal Format**

The proposal shall have the following sections in the following order:

### **A. Qualification Section**

- a) Presentation of the background of the respondent including existing metrology systems and experience developing metrology systems of similar nature to TMT requirements
- b) Describe the personnel who will perform the proposed task(s) and their availability.
- c) Describe the facilities needed to conduct the proposed task(s) and indicate whether the required facilities are available either in the respondent's facilities or in a subcontractor's facilities.
- d) Describe the experience of the personnel involved with the management of the proposed task(s).
- e) Describe the technical expertise of the personnel available in the respondent's technical staff, or in the staff of subcontractors, in the key technical areas of the proposed task(s).

### **B. Technical Section**

- a) Describe the recommended metrology system option for this effort including a description of alternatives that were considered, the measurement test setup,

data collection method, data processing method, and an estimate of the accuracy and repeatability of the test.

- b) Discuss what maximum zenith-pointing surface figure error of P2 MSA can be tolerated and how the metrology system will accommodate as-received surface figure error on the P2 MSA
- c) Describe the calculations that will be performed to determine zenith angle dependent gravity-induced surface change
- d) List any exceptions to the tasks listed in the Statement of Work or to requirements in the Requirements Document; how these exceptions will impact the quality of data that TMT will receive; and how TMT can still achieve the required deliverables if these exceptions are accepted
- e) Describe how the metrology system may be required to change if TMT desires to use it for the future follow-on segment measurements described in Section 7 of this RFP.
- f) Describe whether the metrology system can be delivered to TMT in the future.

#### C. Cost and Schedule Section

- a) Include the line item price of each proposed task for the proposal, its basis, and time phasing. The price for management required to supervise the tasks must also be included. The Proposed Cost must include all applicable taxes and duties
- b) Describe a list of TBD(quantity) milestones that can be used to evaluate work progress.
- c) Provide a schedule indicating the initiation and completion of each proposed task and the date of all meetings, milestones and deliverables
- d) Describe the management effort that will be expended to ensure the effort will be within the final allocated funding level or lower. Describe schedule and cost contingencies that have been included to ensure that the funding allocation will not be exceeded to the best ability of the respondent.
- e) Describe the cost required to modify the metrology system developed for this contract to enable the work described in Section 7 of this RFP. Also, provide a cost estimate for the testing described in Section 7. These costs shall include cost basis and applicable taxes and duties, but shall not be included within the TMT budget allocation provided in Section 8.
- f) Describe the cost required to deliver the metrology system developed for this contract. These costs shall include cost basis and applicable taxes and duties, but shall not be included within the TMT budget allocation provided in Section 8.

#### D. Exceptions to the RFP

- a. State any exceptions to this RFP in your Proposal
- b. TMT is not obligated to accept any exceptions.

## 10 Submission Instructions

RFP Issued	TBD
Final Date for Request For Clarification	
Submissions	TBD
Proposal Submittal Date and Time	TBD
Contract Commencement Date	TBD

The required method of submission is in an electronic form. We will evaluate the proposal in its electronic form.

Respondents may submit their quotes to the TMT Senior Contracts Specialist at:

[pratheep@tmt.org](mailto:pratheep@tmt.org)

by the proposal submission date and time of \_\_\_\_\_ (“Proposal Submittal Date and Time”).

The respondent must provide a table of contents with page number references in its proposal. The table of contents should be in sufficient detail to facilitate easy reference to the sections of the proposal and all separate supplemental information. The font size of the proposal may not be less than 12 points.

Requests for Clarification regarding this RFP must be submitted by the date established in this Section 10 for such requests. TMT reserves the right to publicly post all submitted questions, requests and correspondence. All questions, requests and correspondence regarding all aspects of this RFP shall be directed (only) to:

Pratheep Eamranond  
TMT Observatory Corporation  
2632 E. Washington Blvd.  
Pasadena, CA 91107  
E-mail: [pratheep@tmt.org](mailto:pratheep@tmt.org)

A request for an extension of the Proposal Submittal Date and Time must be made in writing. Approval of requests for an extension shall be determined at TMT’s sole discretion. Postmarking by the Proposal Submittal Date and Time shall not substitute for actual proposal receipt. Emailed proposal submissions must be confirmed in writing to have been received by TMT prior to the Proposal Submittal Date and Time.

## 11 Basis for Award of Contract

Proposals will be reviewed by a Source Selection Board ("SSB") comprised of reviewers designated by TMT. The SSB will submit the result of their review to the Source

Selection Official. The Source Selection Official will render the final determination of an award, if any, for this RFP.

Each proposal will be evaluated separately using evaluation criteria separated into three sections: A) Qualification, B) Technical, and C) Cost and Schedule, as defined below. The evaluation criteria sections are of equal importance and they are listed in no particular order. The Source Selection Board's evaluation criteria will be the following:

A. Qualification Section:

- Demonstrated Relevant Technical Experience
- Demonstrated Relevant Management Experience
- Adequacy of Existing Facilities for the Proposed Task
- Ability to manage the cost and schedule to meet TMT's funding allocation

B. Technical Section:

- Design concept and performance prediction of metrology system
- Technical risk associated with the proposed metrology system
- Data handling ability
- Ability to produce the desired data products and required deliverables
- Ability to accommodate future segment measurements described in Section 7.

C. Cost and Schedule Section:

- Best Value to TMT for the Proposed Task
- Timely Completion Schedule for the Proposed Task

**12 Contract Award Condition:**

Issuance of this RFP does not require TMT to award a contract. TMT reserves the right to reject any or all proposals; to waive any technicalities, informalities, or irregularities in any proposal at its sole and absolute discretion. TMT reserves the right to request clarification or additional information at any time. TMT reserves the right to award multiple contracts, a single contract or no contracts. In addition, TMT reserves the right to re-solicit proposals or to temporarily or permanently abandon the procurement. If TMT awards a contract, it will award the contract to the respondent or respondents whose

proposal(s) is (are) the most advantageous to the Project as determined by TMT in the exercise of its sole and absolute discretion.

TMT also reserves the right to award a contract based (i) on proposals initially submitted, without discussion, clarification or modification, or (ii) on the basis of negotiation with none, any or all of the respondents. Therefore, each respondent should make sure that its proposal is compliant with this RFP.

Each respondent is hereby notified that a contract may be established by any collaborating organization of the TMT Project (ACURA, The University of Toronto, Caltech, UC, or the TMT Observatory Corporation). The Contract Award Conditions exercised by TMT in this Section shall also be exercised by any collaborating organization of the TMT Project.

### **13 Anticipated Award Date:**

This contract shall be evaluated and awarded approximately 4 weeks after the proposal submission deadline

### **14 Responsible Respondent**

TMT will only establish contracts with a responsible respondent. A responsible respondent is defined as an organization or institution that demonstrates the financial ability, resources, skills, capability, willingness, and business integrity necessary to perform on the potential contract resulting from this RFP. TMT's determination of whether a proposal is from a responsible respondent will be made at TMT's sole and absolute discretion.

### **15 Proprietary Information**

Respondent's proprietary information must be clearly marked in accordance with the terms contained in TMT's standard non-disclosure agreement. TMT's standard non-disclosure agreement is attached to this RFP as Exhibit E. Failure to execute a non-disclosure agreement will not obligate TMT to consider or protect respondent's data except as otherwise required by law or regulation. Any information subject to export controls must also be clearly identified.

### **16 For additional information contact:**

Pratheep Eamranond  
(626)-395-1607  
[pratheep@tmt.org](mailto:pratheep@tmt.org)