AN OVERVIEW OF THE ACTIVE OPTICS CONTROL STRATEGY FOR THE THIRTY METER TELESCOPE

Mark Sirota et al
TMT Observatory Corporation
Pasadena, CA, 91105 U.S.A.

The Thirty Meter Telescope (TMT) is a collaborative project between the California Institute of Technology, the University of California, the Association of Asian Universities for Research in Astronomy, the National Astronomical Observatory of Japan, the Department of Science and Technology of India, and the National Astronomical Observatory of China.

TMT will be sited at Mauna Kea, Hawaii. Construction on-site is to begin in 2014. First light with 492 segments in 2021.

Four Principle Local Control Systems

1. Mount Control System (MCS)
   - Azimuth and Elevation Drives
2. Primary Mirror Control System (M1CS)
   - Three actuators per segment (1476 total)
   - Twenty one shape actuators (warping harnesses) per segment (10,332 total)
3. Secondary Mirror Control System (M2CS)
   - Five degrees of freedom
   - Hexapod, (θ, δ, θ, δ, θ, δ)
4. Tertiary Control System (M3CS)
   - Two degrees of freedom
   - Rotation and Tilt

Active Optics Simplified Block Diagram

Real Time Feedback via On-Sky Measurements

Real time corrections based on on-sky optical measurements can come from one of three sources.

1. Alignment and Phasing System (APS)
   - Used on-sky after segment exchanges to:
     • measure and correct the global and segment shapes of M1.
     • align M2 to M1
     • calibrate the M1 edge sensors
2. AGWFS + Acquisition, Guider and Wavefront Sensor
   - Used with the TMT AO system NFIRAOS in conjunction with the near infrared instrument suite.
   - Provide position corrections to the M2
   - Provide low spatial frequency shape corrections to the M1

Alignment and Phasing System

1. Based on the design developed for the successful Keck telescopes.
2. MICS maintains the overall shape of the primary mirror by attenuating the response due to gravity, temperature, wind, and vibration disturbances.
3. The MICS is aligned and phased using the Alignment and Phasing System (APS) every 4 weeks or after a segment exchange (2 weeks). Look up tables are used in between calibration runs.
4. MICS controls the global shape of the M1 using segment-mounted edge sensors and actuators.
5. Real time on-sky measurements by the AGWFS or AO system offloads are used to complement the static look up tables built using APS data.

Characteristics of the Principle and Outer Control Loops

Wind Driven Segment Motion

Phasing Concept

Prototype Actuator
Prototype Sensor
Integrated Single Segment Test Bed

M1CS Components and Integrated Testing

M1CS

1. Based on the design developed for the successful Keck telescopes.
2. M1CS maintains the overall shape of the primary mirror by attenuating the response due to gravity, temperature, wind, and vibration disturbances.
3. The M1CS is aligned and phased using the Alignment and Phasing System (APS) every 4 weeks or after a segment exchange (2 weeks). Look up tables are used in between calibration runs.
4. M1CS controls the global shape of the M1 using segment-mounted edge sensors and actuators.
5. Real time on-site measurements by the AGWFS or AO system offloads are used to complement the static look up tables built using APS data.

Alignment and Phasing System

1. Based on the design developed for the successful Keck telescopes.
2. Shack-Hartmann wave-front sensor to measure and correct the shapes of individual segments and overall image quality.
3. Phasing camera to phase segments (minimize height discontinuities between adjacent segments).
4. Measurement of shapes is parallelized and corrections via 21 actuator warping harness are automated.