Characterization

Daily Temperature Differences within the LMT structure

![Graph showing temperature differences in various components of the LMT structure.](image)

- Large Structural Components
  - Sun El
  - Sun Radiation
  - BUS-Apex
  - BUS-ARS
  - BUS-BC
  - BC-ARS
  - Apex-ARS

- Antenna Backup Structure
  - Sun El
  - Sun Radiation
  - BUS: Inner-Outer
  - BUS: Top-Bottom
  - BUS: Right-Left
  - BUS: Front-Back

Temperature Difference vs. UT
Photogrammetry Maps

Best parabola removed

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<th>Dish</th>
<th>I-R</th>
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Vertical Astigmatism
Analysis of Maps

Major contribution from Vertical Astigmatism Term
Lessons Learned

• Temperature gradients within the BUS are worst problem.
• Largest deformation is the Vertical Astigmatism, followed by Defocus. *This is the one we need to worry about the most.*
• Most of the deformation is in low spatial order terms (below polynomial 15). *We only need to measure deformations at low spatial order.*
• Antenna Surface Alignment
  Measure surface with photogrammetry
  Changes in surface shape make it difficult to improve setting.

• Changes in Surface Shape during Observations
  Antenna gain can change significantly even under nighttime conditions
  Antenna pointing drifts with time

• Problems are worse under daylight conditions due to uneven solar heating.
  Best performance is at night
  Observing Time is lost
Mitigation
Strategy 1

Minimize structural temperature differences

• Follow recommendations of antenna designer...

• Thermal Cladding - Antenna is covered with insulating material
  
  No direct sunlight
  Slows structural response
  But isolates antenna BUS from ambient air, so hot air is retained.

• BUS Ventilation
  
  A feature of all large antennas
  Need to install system of fans to circulate air within the BUS.
  
  Project underway – now in design phase.
Mitigation Strategy 2

Real-time Correction

• Approach:
  • Measure (or infer) surface deformation.
  • Use LMT Active Surface to make corrections.

• Measurement Techniques
  • Infer deformations from structural temperatures.
  • Infer deformations from astronomical measurements
  • Measure deformations in real time

• LMT is pursuing all approaches.
Experience at other antennas suggests that we need measurements at ~200 positions on the structure to infer deformations accurately.

LMT program to install 256 temperature sensors is underway.
Real time measurements of Vertical Astigmatism at LMT

LMT makes regular measurements of this effect during observations.
Example of Daytime Observation

LMT is conducting daytime tests to characterize behavior.
Real-time Measurements

A concept for LMT

Length Error:
\[
\frac{\Delta L}{L} = 5 \times 10^{-7}
\]

LMT Concept

- Estimate Zernike Coefficients through polynomial 15
- Surface Reconstruction Error: 30 microns RMS
- Estimate 6 degrees of freedom
- Residual pointing error due to secondary misalignment: 0.25” RMS

Precision Distance Measurements within Structures

Testing at VLT

Etalon Absolute Multiline Technology
Summary

• Studies of LMT Thermal Deformations have characterized the problem.

• Strategies have been developed to mitigate problems and work is underway
  • Minimize Temperature Gradients
  • Measure Deformations and Correct

• Expected Improvements
  • Better surface alignment.
  • Better nighttime performance.
  • Useful scientific observing during daylight hours.