Lick APF

2.4 Meter Telescope

Technical Report

Lick APF Primary Mirror Test Results

TR-13108-1

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TABLE OF CONTENTS

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1 INTRODUCTION

This document describes the primary mirror test results. Acceptance testing was conducted on February 27, 2008. Mount liftoff tests were performed on February 28-29, 2008.

1.1 SCOPE

The information in this document describes acceptance testing of the primary mirror, as well as repeatability of the primary mirror mount.

1.2 CONFIGURATION

This document has been configured as **TR-13108-1** and is a designated controlled document under the EOST Quality System.

1.3 REFERENCES

The following source documents may be used as reference materials for this document:

[1] Lick 2.4-m Primary Mirror Final Test Report, Rayleigh Optical Corporation, 9/7/07

[2] Additional Testing of the 2.4-m Lick Primary Mirror, Rayleigh Optical Corporation,11/20/07

1.4 DEFINITIONS AND ACRONYMS

- PV – Peak-to-Valley
- ROC – Rayleigh Optical Corporation
- WFE – Wavefront Error (twice the surface figure error)

2 ACCEPTANCE TESTING

2.1 SUMMARY OF RAYLEIGH'S TEST REPORT

The report from ROC detailed the performance of the mirror. The initial report estimated the errors on the test optics by averaging measurements of the primary taken at four different rotations: 0°, 90°, 180°, and 270°. As this approach would be insensitive to quadrafoil ($\cos 4n\Phi$) type errors, an additional measurement was taken at 315° to estimate those errors. ROC's estimate of the WFE prior to inclusion of the quadrafoil errors was 49.4 nm. Adding the quadrafoil gives a WFE of 50.5 nm.

2.2 INSPECTION

The test setup was visually inspected. The largest surface defects were well marked and corresponded to those mapped in ROC's test report. The positions of the fiducials were consistent with a clear aperture of 2350 mm.

Fringe patterns were examined for consistency with the measured WFE. Both horizontal and vertical fringes were reasonably straight and had a PV of approximately 0.5 waves. Measurements taken the previous day had a PV of 0.6 waves, close to what was observed in the fringe pattern.

2.3 WFE MEASUREMENT

With the mirror at the 90° position, ROC took a WFE measurement. This consisted of 40 individual measurements, half with positive tilt and half with negative tilt to average out errors generated by the null lens when measuring away from the null. These measurements took approximately 3 hours.

The resulting WFE was 62.4 rms, 375 nm PV. This is consistent with the measurement taken the previous day as well as the measurements in ROC's test report, prior to subtraction of their estimate of test optic errors.

2.4 WFE REPEATABILITY

To check repeatability of the measurements, the WFE result was subtracted from a measurement taken the previous day. The RMS of the difference was 31.4 nm. There was clearly high frequency noise in the measurement. Removing the highest frequencies (looking at the residual with 36 Zernikes subtracted), this gives 25.6 nm.

Taking this as an additional error source and adding it in quadrature to the final mirror WFE gives 56.6 nm as a worst case estimate of the mirror WFE. Since the final mirror figure was obtained by averaging four rotations of the mirror, the repeatability will be improved by averaging. If the repeatability were cut in half, the estimate of WFE drops to 52.1 nm.

EOST's error budget allocated 82 nm for the mirror figure and support while zenith pointing. The final result is comfortably within the budget, assuming no additional errors from the support (see next section).

3 MOUNT REPEATABILITY

The mirror was released from the support, including rotational flexures, and lifted completely off the support points. Then it was replaced and reconnected to the support.

A measurement taken of the mirror, using 40 individual measurements as before, gave a WFE of 60.4 nm rms, 356 nm PV. This measurement was subtracted from the measurement taken the previous day, prior to liftoff of the mirror. The difference was 28.2 nm, comparable to the repeatability observed for the WFE.

A second liftoff test was conducted the next day. The difference from the first liftoff result was 26.4 nm, again within the repeatability of the measurements.

4 CONCLUSION

The mirror was accepted after witnessing tests at ROC. Including repeatability as a test uncertainty pushes the WFE to 52-56 nm, comfortably within the error budgeted to the primary mirror and support.

Liftoff tests had no observable change due to the mount, with the differences within the repeatability of the measurements.