Laser Tracker Measurement of SAO Primary Mirror

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Abstract: This report describes the analysis results of the Laser Tracker measurement taken of the SAO primary mirror.

The SAO primary mirror has been generated and ground to the best fit sphere, which has a neutral zone located at the 75% point of the mirror diameter. The surface has been ground using 12 micron loose abrasives with a large tile tool. Some open bubbles exposed to the front surface were found and treated by grinding using a small ball. The ground surface has been inspected under high intensity light and no major issues were found.

Before aspherizing the surface, a Laser Tracker surface measurement was made to check the surface quality (symmetry and irregularity) and the Radius of Curvature.

1. Specification of SAO Mirror

According to the document "SAO 1.2-m Primary Mirror Technical Specifications and Requirement: UASO 30125-TS-1," the Inner CA is 6 mm larger and Outer CA is 6 mm smaller than the aperture we used for our surface measurement and analysis. This small change will not make any difference.

a. Clear Aperture:

Inner CA = 350 mm

Outer CA = 1200 mm

b. Radius of Curvature

ROC = 4590.87 mm (nominal)

c. Conic Constant

K = -1.040231

With the nominal specification, the expected aspheric departure is calculated to be ~ 40µm pv, as shown in the illustrations provided in Fig. 1.

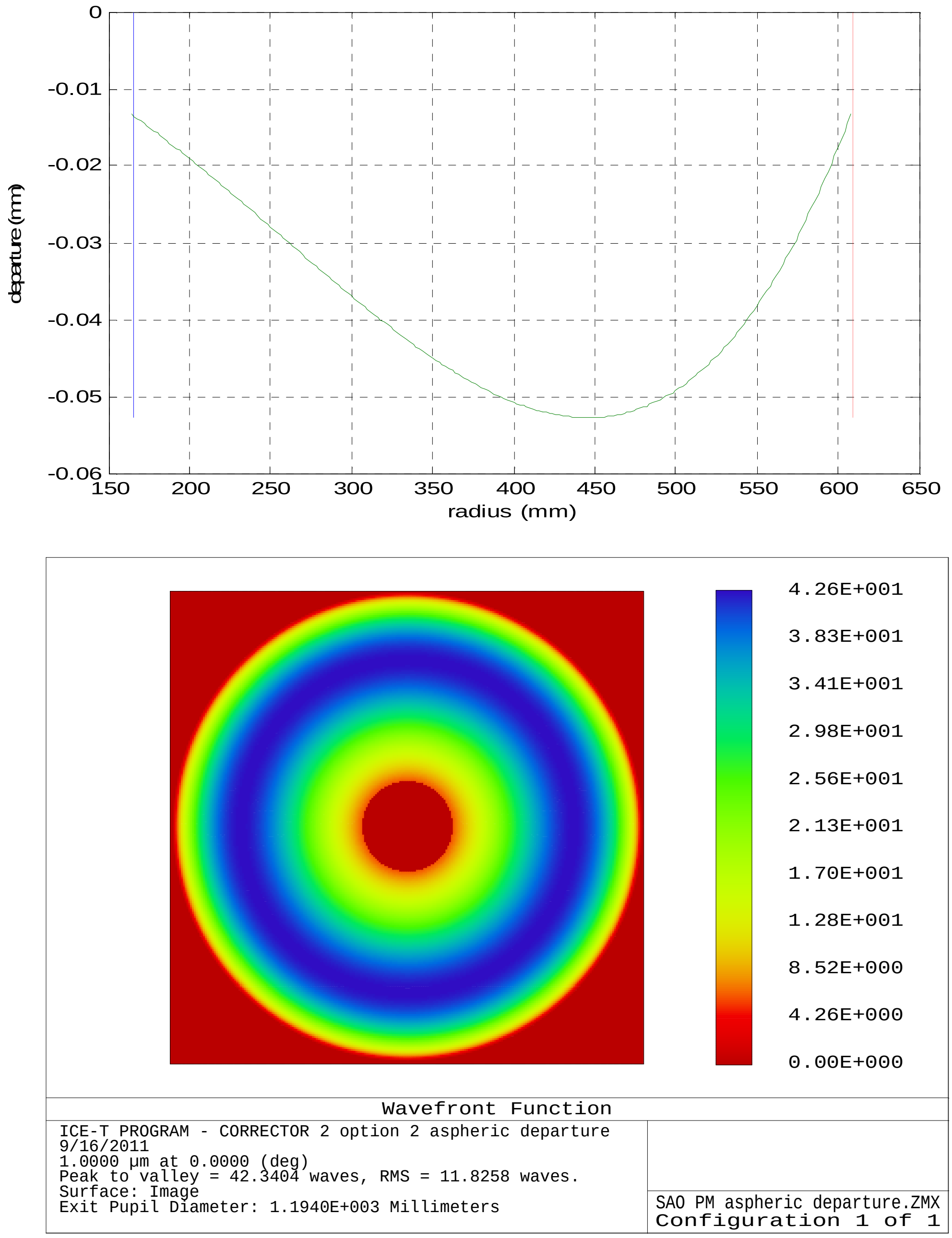

Fig. 1 Expected Aspheric Departure

2. Test Set-up

A FARO Laser Tracker with ¾" SMR in Interferometric mode is used to take surface scan data. The Laser Tracker was mounted approximately 2-m above the SAO mirror, and an optician scanned the surface using a ¾" SMR. (We didn't take a picture of overall set-up when the actual measurement was made but Fig. 2 is a very similar testing set-up that was applied to another 1-m class aspheric mirror.)

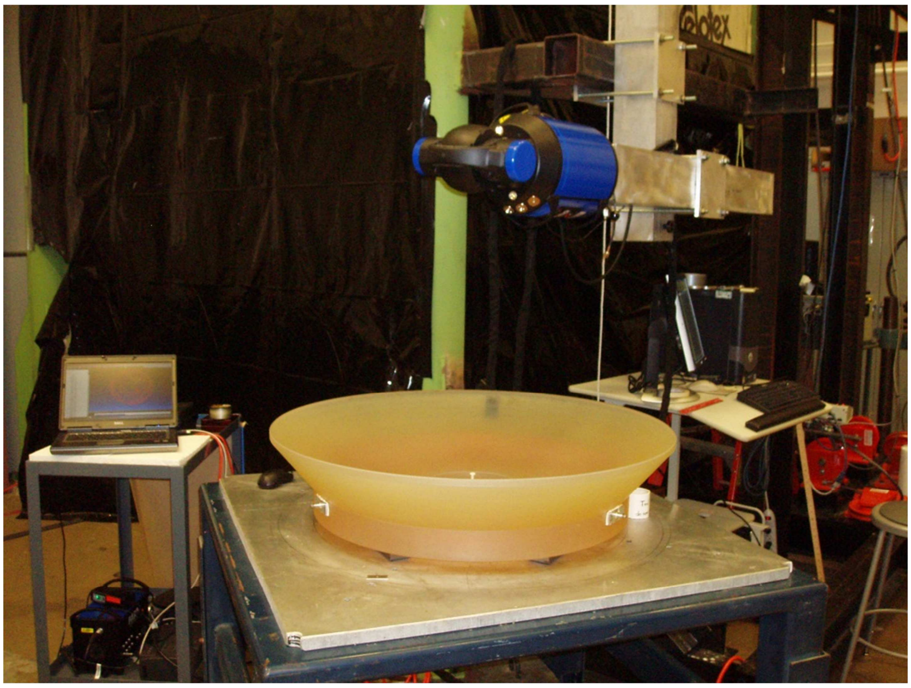

Fig. 2 Example of Laser Tracker Measurement Set-up (this figure shows an *f*/0.3 asphere ready for measurement)

3. Data Analysis

Fig. 3 shows the paths of the data scans taken for the SAO primary mirror. The total number of data points used for analysis was 50232. (Data was taken on 8/29/20110)

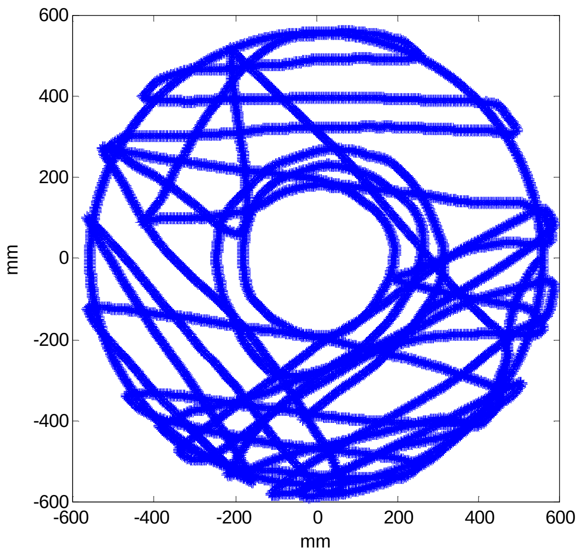

Fig. 3 Data scan paths in CA

3.1 Fitting to the ideal aspheric surface

Fig. 4 shows the fitting result to the ideal aspheric surface of nominal Radius of Curvature and Conic constant. As expected the result shows aspheric departure and should be close to the expected aspheric departure in Fig. 1.

Fig. 5 shows average radial profile from the map in Fig. 4 and also should be close to the expected aspheric departure in Fig. 1.

Fig. 6 shows fitting residual and the residual error is 1.8 micron RMS. there are some outliers but didn't impact to the overall result.

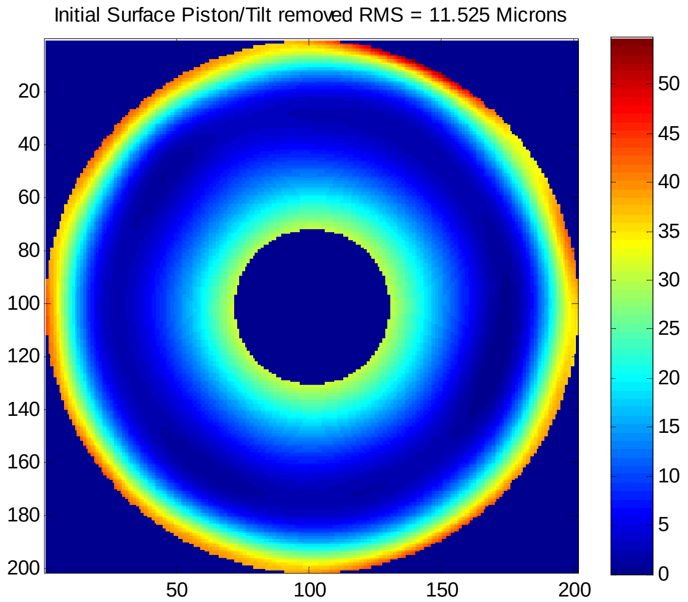

Fig. 4 Difference from ideal surface (Should be close to the aspheric departure)

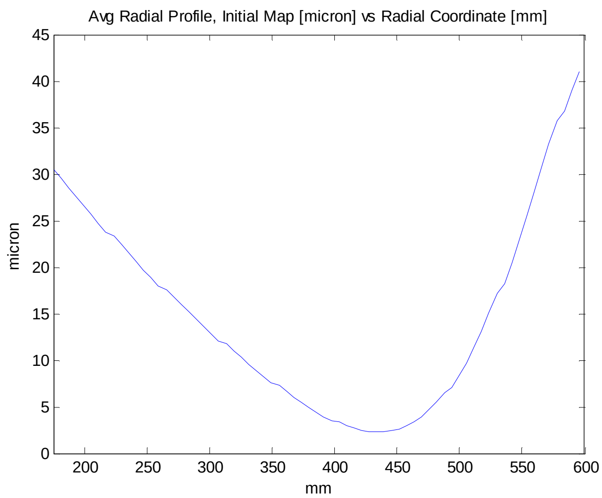

Fig. 5 Average Radial Profile (Should be close to the aspheric departure)

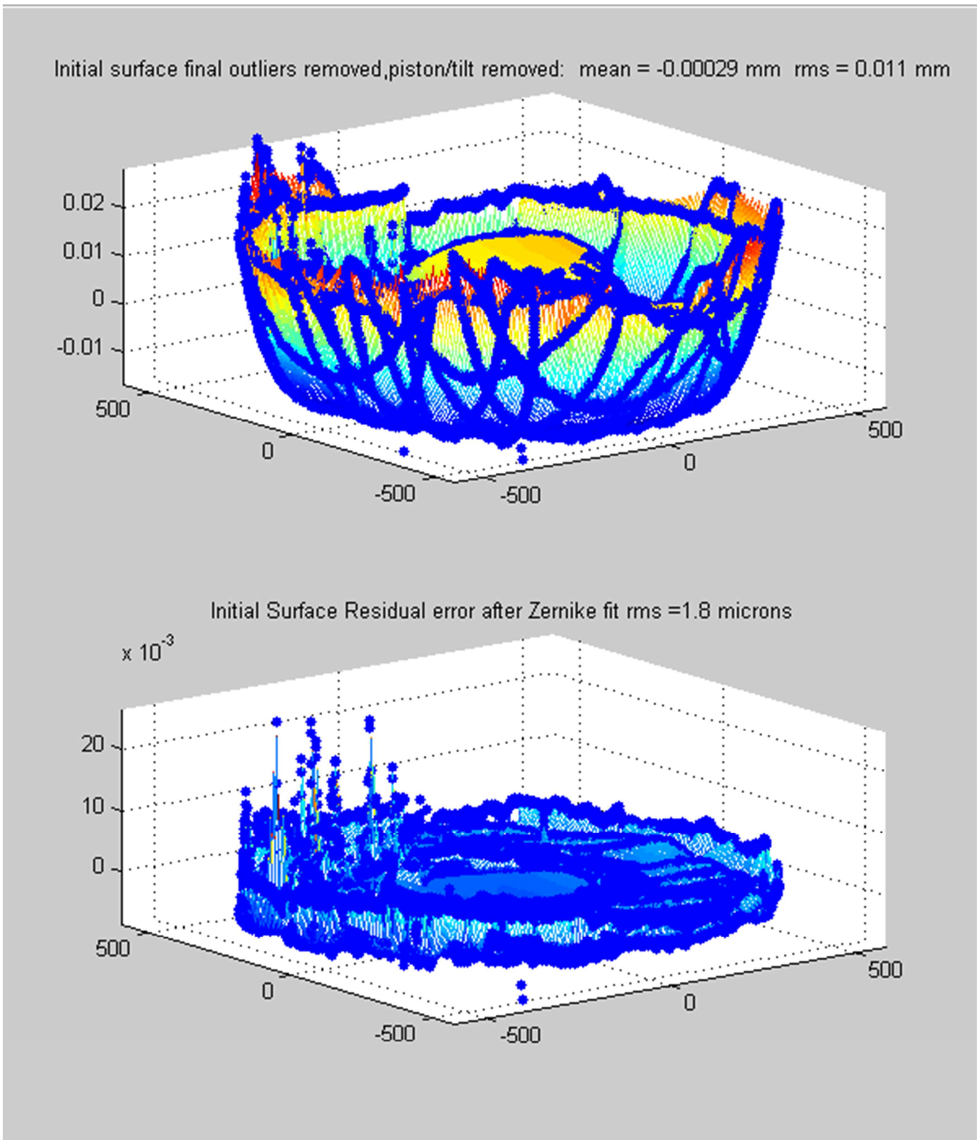

Fig.6 Fitting Residual from ideal surface

3.2 Fitting to best-fit sphere

Fig. 7 shows the fitting result to best-fit sphere. As expected the result is expected to be flat and the surface quality is about 1.5 micron RMS sphere.

Fig. 8 shows average radial profile from the map in Fig. 7 and also should be close to a flat.

Fig. 9 shows fitting residual and the residual error is 1.8 micron RMS. there are some outliers but didn't impact to the overall result.

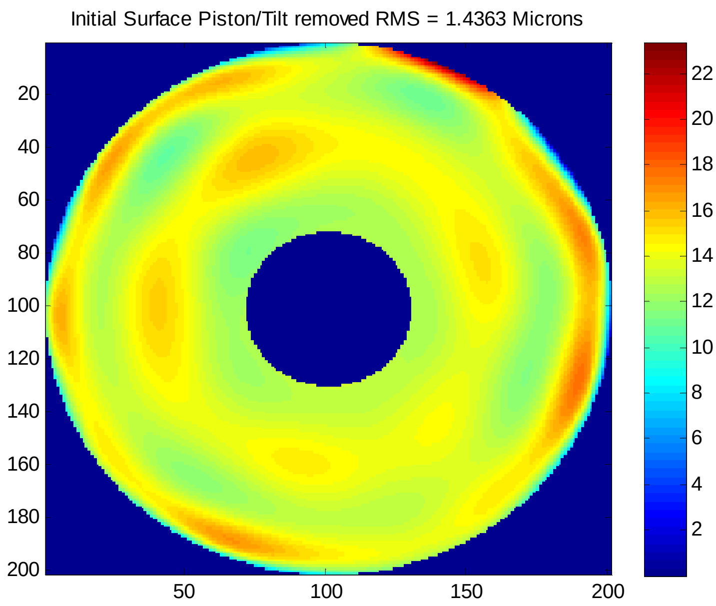

Fig. 7 Departure from Sphere

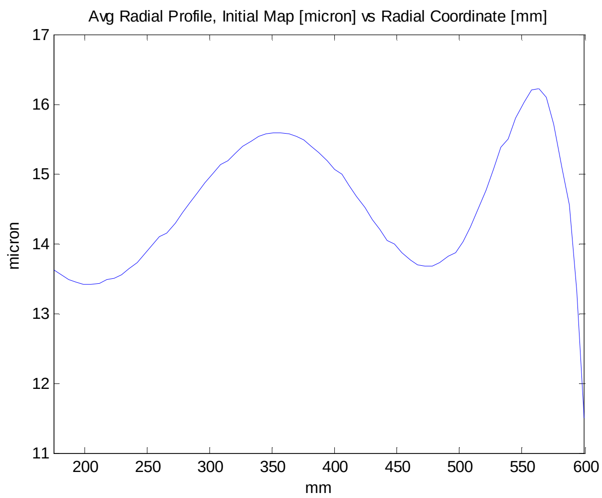

Fig. 8 Average radial profile

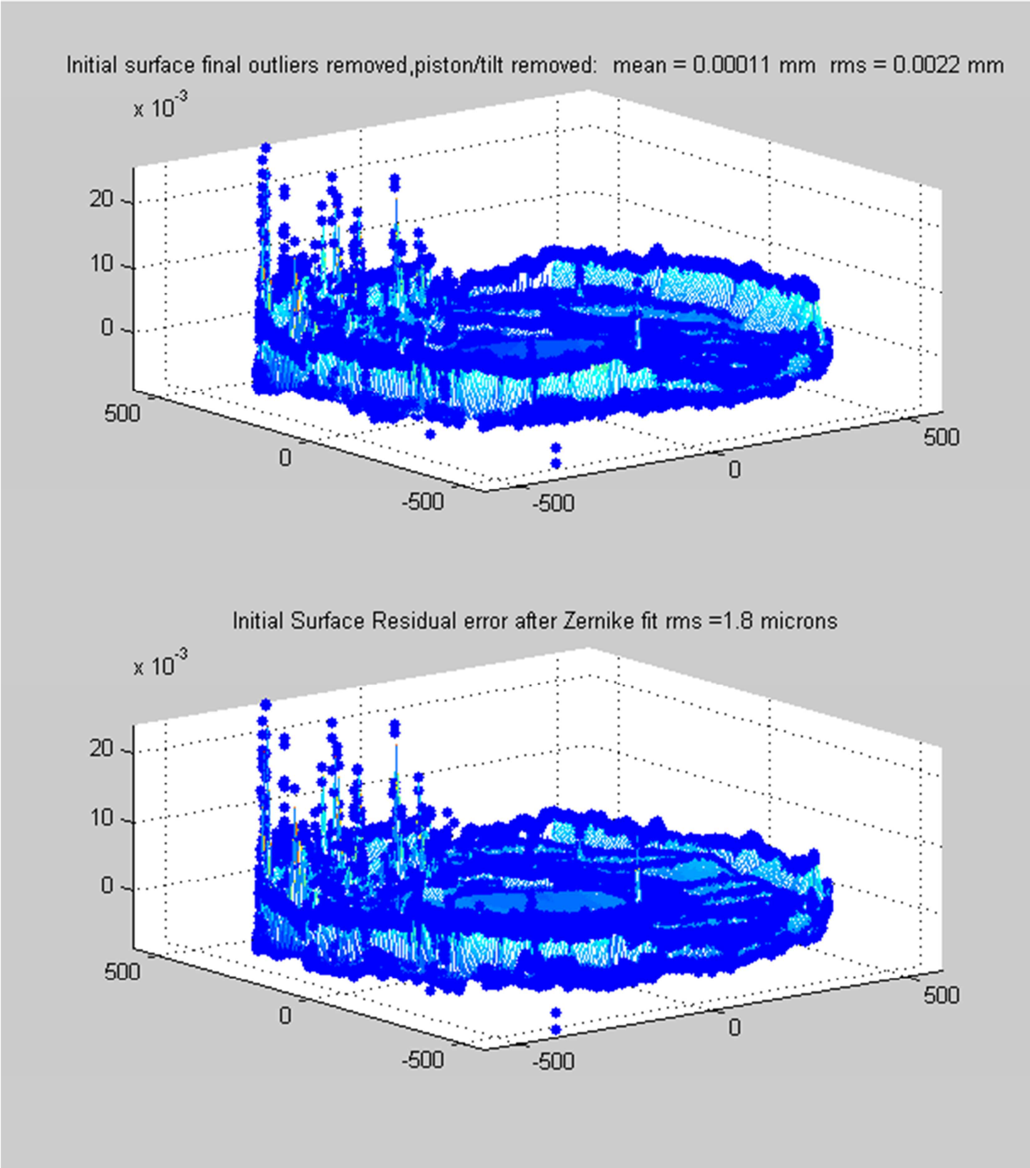

Fig. 9 Fitting Residual from sphere

4. Summary

The SAO primary mirror is in the fine grinding stage and is ready for aspherizing and polishing. According to our Laser Tracker measurement, both the surface quality (symmetry and irregularity) and the Radius of Curvature are very close to the best-fit sphere that we intended.