

Profilometry and Polishing of primary mirror for the PLANETS telescope

*Masato Kagitani¹, Kazuya Nagata¹, Yasumasa Hirahara², Keisuke Takahashi³, Mikio Kurita^{4,3}, Yusuke Morimoto^{4,3}, Yusuke Hanamura², Takeshi Sakanoi¹, Yasumasa Kasaba¹

1. Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 2. Graduate School of Environmental Studies, Nagoya University, 3. LogistLab Inc., 4. Graduate School of Science, Kyoto University

A low-scattered light telescope PLANETS (Polarized Light from Atmospheres of Nearby Extra-Terrestrial Systems) would be a 1.8m off-axis telescope on Mt. Haleakala, Hawaii. The primary mirror is an off-axis parabola made of CLEARCERAM with 1.85 m in diameter and 100 mm thick on edge. Grinding and pre-polish of the mirror blank were completed by ITT/Exelis. Then we have started the final phase work of polishing and figuring in collaboration with LogistLab Inc. in Japan. A unique profilometry technique “dragging three-probe method” (Kurita et al., 2016, Kurita et al., 2022) was employed to measure surface figure error. By dragging three equally spaced laser ranging probes along a straight line, change in local curvature corresponding to the second derivative of the figure is measured, and the figure is derived by second-order integration of the curvature. Measurement along a single path does not determine the secondary order of the figure though, by combining measurements of multiple mutually intersecting straight paths and closed circular paths, high-precision measurement of 20 nm RMS or less will be achieved. The measurement system is robust against environmental vibration and temperature variation. Combining with an industrial robotic arm system, we can quickly switch profilometry probes into a polishing tool enabling to shorten cycle of metrology and polish.

The off-axis parabolic primary mirror of PLANETS is supported from the back with 36-point active support structure (Kagitani+2020). To confirm operation of the active support structure and verifying the measurement accuracy of the dragging three-point method, we made 2 micro-m P-V deformation with the active support structure, and compared the deformation expected from the FEM model calculation and the measurement results. The results agree with each other with 17 nm RMS, confirming that the FEM model of the active support structure reproduces the actual deformation well. As of February 2023, after 18 measurement and polishing cycles and a total of 1500 hours of polishing processes, the figure error of the primary mirror, excluding the Zernike term 6 or less, has decreased from 760 nm to 120 nm RMS. In the presentation, we will introduce the latest polishing result.