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FINE ALIGNMENT OF AEROSPACE TELESCOPES FOR THE EARTH OBSERVATION SATELLITE MISSION ENMAP

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SUMMARY

Three-mirror anastigmat telescopes are not only known for their outstanding optical performance for wide field-of-view observation but as well for the complexity of their alignment. In the frame of the Environmental Mapping and Analysis Program (EnMAP), a hyperspectral instrument for Earth Observation, a three-mirror anastigmat telescope is aligned to design performance (28 nm RMS) by use of optical wavefront measurement, computation and implementation of relative position corrections with accuracies down to 1 μm .

I. INTRODUCTION

The EnMAP telescope is an off-axis telescope made of three aspherical mirrors and a folding mirror mounted on bipods. Following a highly precise mechanical placement process [1], final alignment is performed by position correction of a single compensator element. The mirror position change by shimming is demonstrated to be reproducible within 1 μm .

II. TEST PRINCIPLES

Input data for the alignment is generated in a double-pass wave front measurement of the assembled telescope. The measurement setup using a large flat mirror, a combined illumination and detection equipment (TAID) and theodolites in ISO-5 clean room environment is presented. The telescope is illuminated using a monochromatic light source at several field points and the corresponding wave front error is measured with up to 1 nm RMS accuracy using lateral shearing interferometry.

III. ANALYSIS

Measurements are then processed using a proprietary custom-developed software (SOFA). This tool uses the Zernike decomposition of the measured wave front and calculates relative compensator movements based on the known properties of the optical design. In a second step, the software uses the Stewart-platform theory to compute the thickness of 6 shims that are integrated to correct the mirror position.

IV. RESULTS

Our process was successfully applied to the demonstrator model (Risk Mitigation Telescope, RMT) and to the flight model of the EnMAP telescope reducing the initial wave front error of $\sim\lambda/5$ RMS to $\sim\lambda/15$ RMS in a single iteration. In a second iteration improvement up to design performance of $\sim\lambda/25$ RMS was predicted and demonstrated on flight hardware (PFM) incorporating a compensation movement in 10 degrees of freedom implemented on two mirrors.

V. CONCLUSIONS

Besides the validation of the measurement and process chain, the performance results show that the required corrections for the telescope alignment could be realized as predicted by the integration of shims manufactured with thickness accuracy of 1 μm .

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REFERENCES

- [1] Kolmeder et al.: "Optical Integration Process for the Earth-Observing Satellite Mission EnMAP", unpublished Proc. of SPIE Vol. 10562 105624S-2