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ALIGNMENT AND QUALIFICATION OF THE GAIA TELESCOPE USING A SHACK-HARTMANN SENSOR

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Since almost 20 years, Imagine Optic develops, manufactures and offers to its worldwide customers reliable and accurate wavefront sensors and adaptive optics solutions. Long term collaboration between Imagine Optic and Airbus Defence and Space has been initiated on the Herschel program. More recently, a similar technology has been used to align and qualify the GAIA telescope.

I. The GAIA telescope

Gaia is an ambitious ESA mission to chart a three-dimensional map of our Galaxy, the Milky Way, in the process revealing the composition, formation and evolution of the Galaxy. The payload design is characterized by a dual telescope concept (2 times 1.45 x 0.5m²), with a common structure and a common focal plane. Both telescopes are based on a three-mirror anastigmat (TMA) design. Both telescopes are aligned to have the exact same focal length (35m).

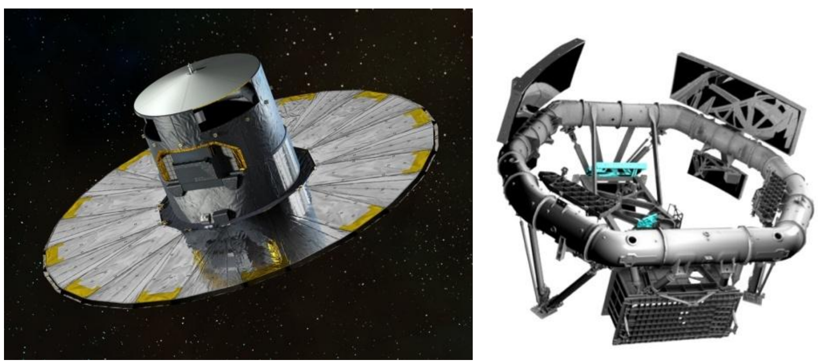

Fig. 1. The Gaia mission, the SIC structure and the two telescopes

II. The RFlex system

Based on a Shack-Hartmann sensor, the RFlex has been designed to allow easy characterization of telescopes. Such a system can be easily calibrated on site by the use of a small concave mirror. Once calibrated, an accuracy of $\lambda/200$ rms on the telescope is achievable thus limited by the flatness of the autocollimation mirror. The Rflex are small, light and not sensitive to vibrations or air turbulences.

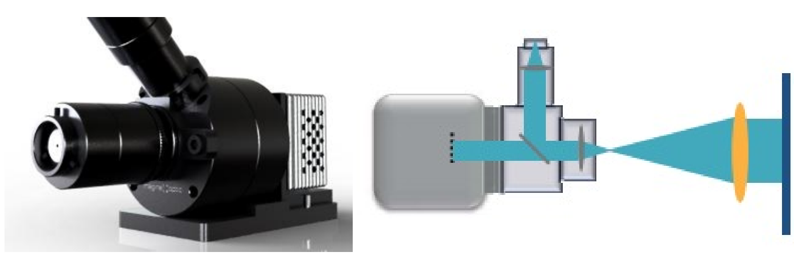

Fig. 2. The RFlex and its optical architecture

III. The alignment process and the telescope characterization

The RFlex has been used to measure the WFE alternatively on both telescopes on their single but very large field (1m). The exit pupils of the telescopes are imaged on the measurement plane of the wavefront sensor to avoid pupil distorsion. Alignment and characterization have been done at ambient temperature at 670nm and also at 870nm for the RVS (Radial Velocity Spectrometer). The same RFlex sensor can indeed be used at different wavelengths.

The 9 first Legendre coefficients are used to characterize each measured WFE map. The CodeV model is used to predict the influence of each actuator. By a minimization of a merit function taking into account several measurements in the field, the mirror can be aligned by controlling the actuators. The correlation between the measurement and the model are done up to Legendre 19 to include high order information.

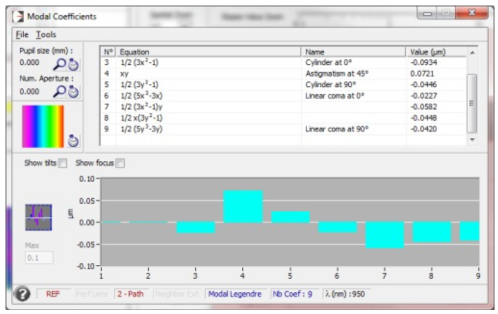

Fig. 3. 9 rectangular Legendre used as alignment criteria

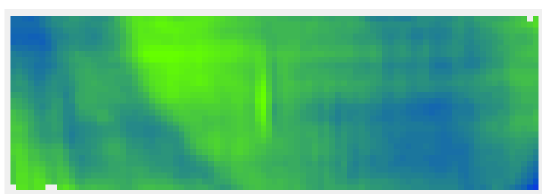

Fig. 4. Example of a measured wavefront after alignment

On ground alignement using RFlex has contributed to telescope flight predictions better than 50 nm rms at 120K cryogenic operational temperature.

ACKNOWLEDGMENTS

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