IAF EARTH OBSERVATION SYMPOSIUM (B1)
Earth Observation Sensors and Technology (3)

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FREEFORM OPTICS DESIGNS FOR OHB'S NEW SPACE OPTICS INSTRUMENTS

Abstract

Freeform optics are widely acknowledged to be a game changer in future space missions and instruments: they allow a better performance with a reduced number of optical elements, in a smaller volume and with lower mass. Moreover, freeform optical designs bear a high potential to cut the time required for integration and alignment of the instrument. In short, time and cost from initial design to final space readiness will be considerably reduced by introducing freeform surfaces into optical space instruments.

Their fields of application are predominantly Earth observation, planetary and astronomy missions as well as laser communication terminals. Size can vary from CubeSat level instruments to large high-end space telescopes and cover all applications from TIR down to shorter wavelength systems in VIS and UV. Most benefical will freeform optics be for instrument types like hyperspectral, multi-spectral (e.g. for CO2 and/or CH4 monitoring) and thermal infrared high resolution ground imagers as well as instruments requiring a large field-of-view. The biggest challenges for operating freeform optics in orbit sustainably are low micro-vibration, optimal surface roughness and minimised wave-front errors at all operational times.

The existing limitations concerning freeform designs within the classical optical modelling and optimization tools like Zemax or Code V have recently been overcome by OHB System AG's advanced design tool chain. Essential part is OHB's proprietary, self-developed freeform optics design software named "DORIS" that is based on algorithms for generalized differential ray-tracing. This way, OHB has brought itself into a position to not only design freeform optics, but also correlate metrology results with the corresponding simulations and validate the specified optical performance parameters (alignment, wave-front, line-of-sight, straylight etc.) in a precise, consistent and unambiguous way.

The cutting edge optical design and engineering capabilities OHB today can offer allow to bring the freeform technology successfully into space: currently OHB is working on the design, machining, integration and characterization of an innovative freeform telescope for a high-res TIR application and of a second-generation hyperspectral instrument. The paper will give insight into OHB's in-house freeform optics design tool chain and present freeform instrument designs and performance verification results of running programs.