JUL.16-18 LC2019 Changchun , CIOMP

Unification of system calibration and optical design

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In the field of software tools for the computation and simulation of optical systems, currently there exist two completely separate areas. On the one hand software tools for the design and simulation of optical systems and components - on the other hand software solutions for the calibration of measuring instruments and sensors. Both areas are indispensable. Without the simulation and optimization capabilities of modern optical design software, it would not be possible to design systems that meet the rising demands in respect to system performance. However, for real systems these high demands can only be reached if the fabrication of the optical elements can be carried out with the required precision. Since surfaces can only be fabricated with the accuracy they can be measured, metrology is one of the key enabling technologies for industries like the semiconductor production or precision engineering. Besides the extremely high accuracy also other parameters like flexibility in respect to surface shape or measurement time play an important role. In many cases these parameters can only be reached by a sophisticated calibration of the metrological system. By taking a closer look on optical design and system aberration calibration software we can see that there is a huge overlap in the functionality. For example both need the ability to trace rays through an optical system. Also the ability to optimize the system in respect to the design specification or - in case of a calibration - in respect to the calibration data plays an important role in both fields.

We present a novel software solution which represents a unification of the world of optical design and calibration. By combining the separate fields in one software package it is possible to achieve a wide range of benefits.

A first advantage is, that the whole development of a measurement device - from the first design sketch to the machine software used within the final product - can be realized using just a single tool and data format. Further through the high flexibility of the approach, it is easy to adapt the calibration to a wide range of measurement devices such as interferometers, deflectometric as well as fringe projection systems. This leads to large savings in time and money when developing such devices.

The main difficulty with the development is the high complexity of the project. We manage to deal with this challenge by lying a strong focus on a highly modular implementation as well as object oriented representation of the optical systems. The gain from this philosophy is a user friendly, intuitive handling of the software even with complex systems. This is especially an advantage with folded systems like EUV-lithography setups or off-axis telescopes, as well as multi-pass systems like interferometers. Furthermore, typical applications in the area of optical design such as scattering- and ghost analyses or the calculation and optimization of system tolerances can be carried out much more efficiently. We will present the main design concepts behind the software as well as first application examples that show the benefits of our novel approach.

SHORT BIO:

Dr. Goran Bastian Baer studied engineering at the university of Darmstadt and Stuttgart. After his diploma he worked as a research associate at the Institute of Applied Optics (ITO) at the University of Stuttgart in the field of interferometry. The focus of his work was the calibration of non-null interferometers for the measurement of aspheres and freeform surfaces, especially the Tilted-Wave-Interferometer. Since 2016 he is working as an independent engineering consultant. In 2017 he started to work on software based solutions that combine the design and calibration process of optical systems.

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