MATTER AND TECHNOLOGIES

Contribution ID: **118** Type: **Poster**

WOMBAT: A modular software for wavefront sensing and optimization at PHELIX

Many experiments at large-scale laser systems require the highest on-target intensities. This is achieved only for beams with minimal aberration, which becomes more and more difficult to realize for large-aperture laser systems where the beam dimension nowadays exceeds 10 cm. Therefore, wavefront sensing and correction is crucial to suit the needs of current applications [1]. Commercial solutions in software and hardware have been available for the last two decades. However, these solutions often are specialized for a certain setup that might not fit the particular needs of the facility. Adaptions of existing systems are possible, but rather cost-intensive and do often require third-party-maintenance over the lifetime of the system.
Therefore, a more flexible software for wavefront sensing and correction is currently being developed at the PHELIX facility at GSI, Darmstadt. The "Wavefront Optics Measurement and Beam Analysis Tool"(WOMBAT) is a modular LabVIEW-software that offers great flexibility while working with custom and commercial hardware. The software contains a camera-module that acquires images from arbitrary camera model, including commercial Shack-Hartmann sensors (SHS). Further modules are available to perform and analysis of its data, wavefront reconstruction as well as a modal analysis in terms of the Zernike-polynomials. The measurement quality is comparable to commercial solutions and even supersedes them in some fields. Wavefront correction can be conducted with different adaptive optics systems, including motorized mirrors, movable lenses and deformable mirrors. For this purpose, modules for response recording and wavefront control are implemented, using a driver interface that can easily be adapted for new hardware.
The performance of the current state of WOMBAT has been quantitatively verified and proven in various experiments, compensating static aberrations and enabling manual optimization of the focus. Further functionality is being investigated, including continuous recording and compensation of on-shot-aberrations and an algorithm to retrieve the wavefront from far-field-images.

References

[1] SW Bahk, P Rousseau, TA Planchon, V Chvykov, G Kalintchenko, A Maksimchuk, GA Mourou and V Yanovsky. Generation and characterization of the highest laser intensities (1022 W/cm2). Optical Letters, 29(24):2837-2839, 2004.

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Track Classification: DMA