Measurements by ESPI of surface deformation of a heated mirror and comparison with multiphysics simulations

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The manufacture of mirrors for space application is expensive and the requirements on the optical performance increase over years. To achieve higher performance, larger mirrors are manufactured, but larger mirrors are more sensitive to temperature variations which induce degradation of optical performances. To avoid the use of an expensive thermal regulation, we need to develop tools able to predict how optics behaves with thermal constraints.

This paper presents the comparison between experimental surface mirror deformation and simulation results obtained in OOFELIE::Multiphysics by Open Engineering. The local displacements of the mirror surface have been measured by electronic speckle pattern interferometry (ESPI), and the wavefront error with a commercial interferometer.

Our experimental sample is a heated parabolic off axis monolithic aluminum mirror. The mirror is placed on a thermally insulating plate to prevent heat loss by conduction while heating from the back of the lateral side. ESPI is used in combination with temporal phase unwrapping to measure the mirror surface displacements. This technic requires a diffusing surface to create speckle: the object beam is sent to a diffuser before it illuminates the mirror. In order to discriminate the RBM from the mirror and the RBM due to the environment (e.g. optical table dilatation) the displacements of an invar reference plate are also recorded by ESPI by the same camera. Simultaneously a commercial interferometer is used to measure the experimental wavefront error and compare the results with the theoretical model. Finally, a comparison between the experimental measurement and the expectations of the multiphysics model is performed.