

Online Identification of key-parameters for synthetic-based calibration with Pyramid WFS

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The AO instruments of the future ESO-Extremely Large Telescope (ELT) will all include Pyramid Wave-Front Sensor (PWFS) in their design as these WFS provide a gain in sensitivity with respect to the more common Shack Hartmann WFS (SH-WFS). This gain in performance comes with a cost in terms of operational complexity. The PWFS appears indeed to be highly non-linear with a response that depends on the level of AO correction itself, the so-called optical gains of the PWFS. Coupled to this very first technical challenge, the ESO-ELT will provide a challenging environment for the AO calibration with a large number of degrees of freedom, that will have to be calibrated without any external calibration source and unprecedented distances between Deformable Mirror (DM) and AO instruments. Regular evolution of the DM-WFS registration (Rotation, shifts or other anamorphosis of the DM actuators grid with respect to the WFS subapertures) are thus to be expected during the operations. These mis-registrations have to be monitored and compensated as they will highly affect the AO performance or lead to loop instability. To tackle these operational challenges, we propose to consider a pseudo-synthetic approach where calibration data are generated from a synthetic model which parameters are identified from experimental inputs using a mis-registration identification algorithm. We investigated two different strategies to retrieve the signals required by the algorithm: an invasive approach, where specific signals are applied over the DM commands during the operations and a non-invasive approach, where a noisy interaction matrix is estimated from closed-loop data and used to retrieve the mis-registration parameters. In this study, we analyze the accuracy and limitations of both methods, taking in consideration the specificities of the PWFS.

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