A Pseudo-Synthetic Calibration of an Adaptive Optics System

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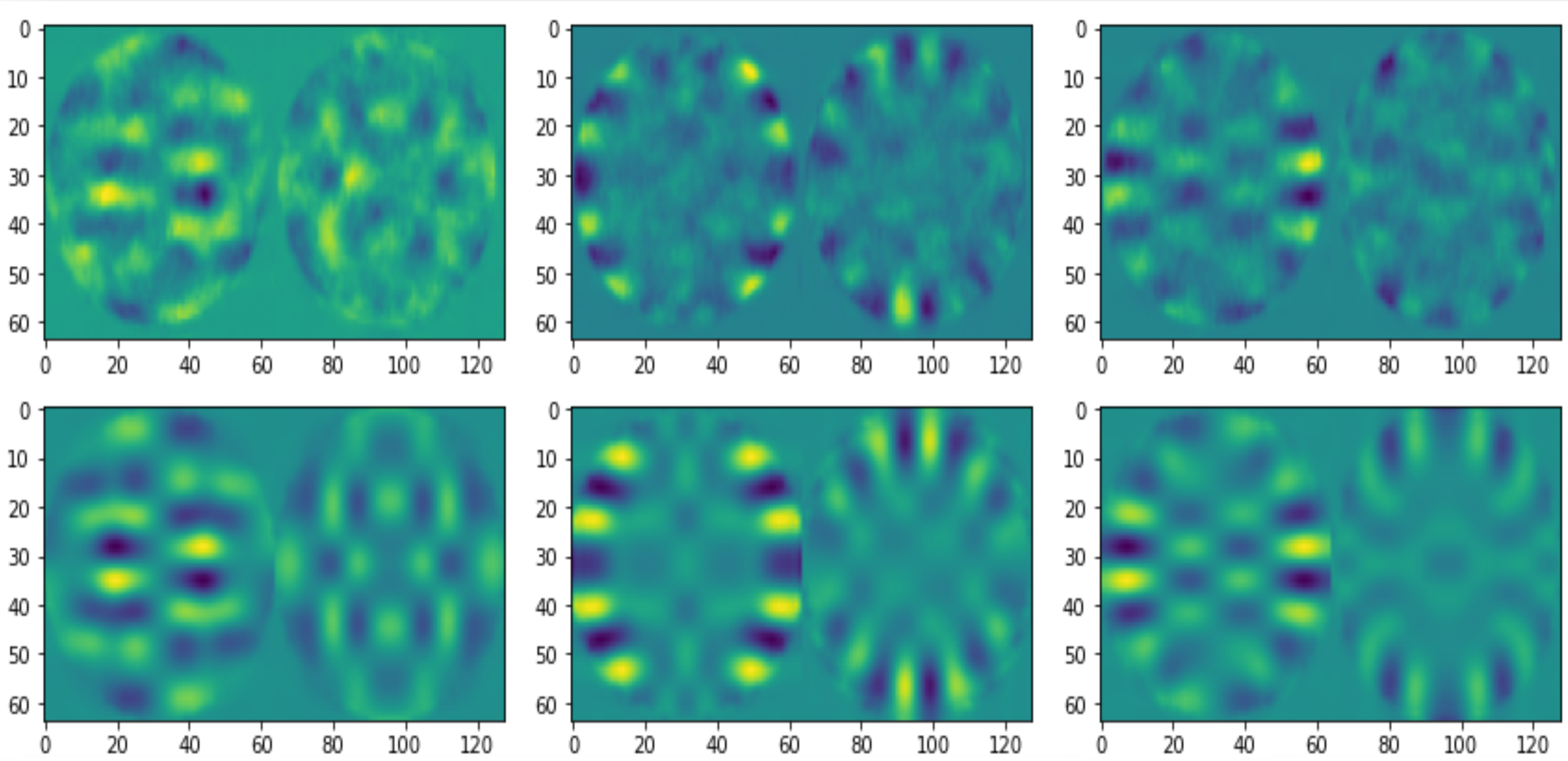
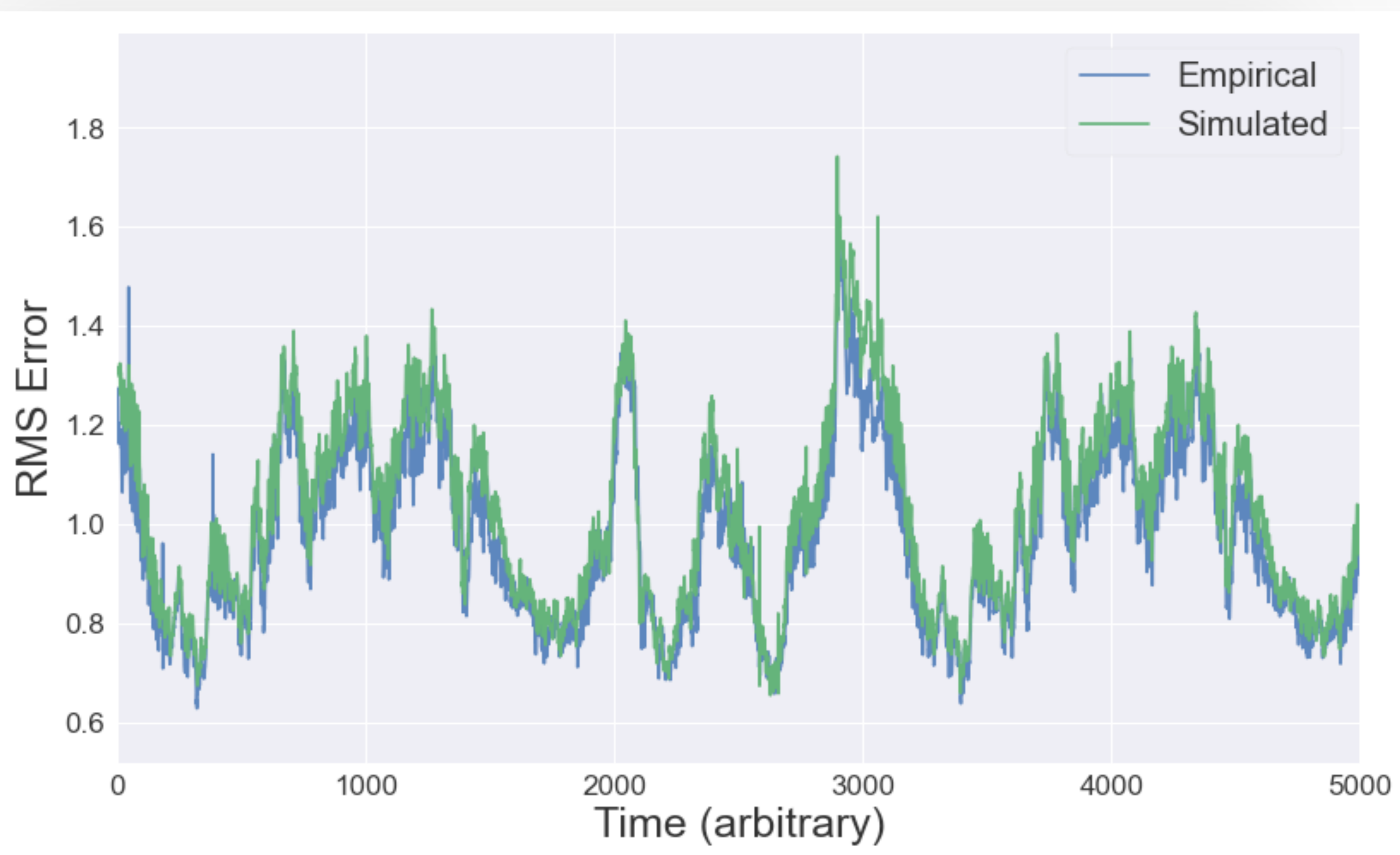
We use a novel method to calibrate AO systems on telescopes that use convex deformable secondary mirrors, which many existing and future large telescopes aim to include thanks to their significantly improved throughput. However, calibrating these AO systems is challenging because an artificial light source cannot be used for this purpose and the calibration must be done on sky. Under these constraints, we use the OOPAO simulation tool in python to model a physical system and to obtain an ideal calibration. Current empirical methods in measuring this interaction between deformable mirror and wavefront sensor are littered with background. Empirical calibrations together with the SPRINT technique, which seeks to extract the misregistrations present in the physical system, will serve to properly register the simulated system as close to the physical one as possible, thereby producing a noiseless result. This pseudo-synthetic calibration scheme has been validated on an optical bench AO system as well as preliminary on-sky results from the MAPS project on MMT.



Extracting Parameters: The empirical calibration contains all the information about the physical system. We identify these misregistrations by using the SPRINT algorithm (1). The best-fit parameters are applied to the simulation to create a ***pseudo-synthetic*** calibration of the physical system.



Closing the Loop: The first validation of the SPRINT algorithm on the optical bench. The total residual wavefront error for the pseudo-synthetic calibration is remaining stable over time when tested on synthetic atmospheric conditions.

Assessing Performance: We decompose the error in the correction by the contribution from each mode. The baseline for the error is set by the open loop wavefront error and the performance of the calibration is determined by how well each mode can reduce its contribution to the residual slope.

Citations:
[1] SPRINT, system parameters recurrent invasive tracking: a fast and least-cost online calibration strategy for adaptive optics — CT. Heritier (2021)

[2]

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