Using PASSATA for the numerical simulations of the CaNaPy LGS-AO monostatic, pre-compensated system

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Abstract

CaNaPy is a demonstrator of LGS-AO technologies for visible wavelengths. The primary objective of CaNaPy is to advance the maturity of novel LGS-AO concepts by showcasing their feasibility and performance, thereby laying the groundwork for future LGS-AO instruments in the large and extremely large telescopes.
CaNaPy offers a platform for verifying several breakthroughs, including complete uplink beam correction aimed at reducing the LGS's size from the 1m OGS ESA telescope, pyramid wavefront sensor utilizing the pre-compensated LGS, and high-power 589nm guidestar laser pulsed operation.

In the past, preliminary results regarding the expected performance of CaNaPy have been reported. However, it was lacking a full modelling of the system; a complete simulation of CaNaPy has now been established in PASSATA, an IDL-based object-oriented simulation software for end-to-end numerical simulations of adaptive optics systems. This modelling includes geometrical and physical optics propagation of the upward-propagated guide star laser, extended vertical sodium profile, and Karhunen-Loeve modal gain optimization within the control loop.

The LGS-AO system in CaNaPy employs a pulsed 63W CW guidestar laser that propagates through the entire 1-m aperture of the OGS telescope at Teide Observatory using double axicon optics to prevent losses caused by the central obstruction. We will present the expected performance of this monostatic approach, in which the same pupil is utilized for both transmitting and receiving the laser beam.
The primary objective of CaNaPy is to verify the effectiveness of its technologies in preparation for their possible implementation in large and extremely large telescopes. To achieve

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this goal, we have expanded our numerical modelling efforts to explore the feasibility of scaling CaNaPy's system to larger apertures. This work aims to identify the optimum trade-off between complexity and performance gain.

Keywords: CaNaPy, uplink precompensation, monostatic launch, modal gain optimisation