Single detector stereo-SCIDAR at the 2.3 m Telescope at Siding Spring Observatory

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Abstract

Site characterisation for atmospheric turbulence analysis is crucial for the development and design of adaptive optics systems, especially for systems for extremely large telescopes. There are many seeing monitors and optical turbulence profilers. Seeing monitors such as the Differential Imaging Motion Monitor (DIMM) often have a simpler design and smaller telescope requirements than optical turbulence profilers at the expense of height resolution limitations and are only able to provide seeing measurements integrated over the entire atmosphere above the instrument, but cannot provide a detailed height resolved atmospheric turbulence profile. Other more complex instruments such as the Multi-Aperture Scintillation Sensor (MASS), Slope Detection and Ranging (SLODAR) or generalised Scintillation Detection and Ranging (SCIDAR) require larger telescope apertures and more complex setups, but can yield a more spatial and time resolved atmospheric turbulence profile. The generalised SCIDAR technique suffers from signal limitation due to its optically overlapping pupil images. This can be overcome with stereo-SCIDAR by separating the pupil images optically making the opto-electronic setup more complex and expensive as two scientific cameras are required to record the optically separated pupil images.
Furthermore, as site testing campaigns are expensive to run at large telescopes, there are few campaigns that have been conducted frequently for an extended period of time to reliably investigate detailed seasonal changes.
To overcome some of these challenges, the Advanced Instrumentation and Technology Centre of the Research School of Astronomy and Astrophysics at the Australian National University has designed, built and operated a single-detector generalised stereo-SCIDAR. The instrument was commissioned on the 2.3 m Telescope at Siding Spring Observatory in April 2022 and has been operated every month for a year. In this paper, we present the design of the single-detector generalised stereo-SCIDAR instrument as well as the preliminary results of data evaluation focussing around the system's capabilities and the seasonal changes of the atmospheric turbulence patterns at Siding Spring to showcase its potential for site characterisation at other astronomical sites in the world.

Keywords: Stereo, SCIDAR, site characterisation, site testing, atmospheric turbulence

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