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Title: Global performance of SAXO, the XAO system of SPHERE

Abstract:

The SPHERE instrument (Spectro-Polarimetry High-contrast Exoplanet Research) is a second generation ESO instrument dedicated to high contrast imaging, and exoplanet direct detection and characterisation. The strategy of Wave-front Sensing [WFS] in SPHERE relies on two faces. Firstly, extreme adaptive optics (XAO) is required for both turbulence and quasi-static pattern compensation. Particularly, the high frame rate and large subaperture numbers of the Shack-Hartmann WFS allows SAXO to optimally measure and compensate for atmospheric turbulence. Moreover, the spatial filtering allows one to deepen the contrast curve, and is automatically adjusted on turbulence level to provide the best performance. Finally, a dedicated calibration procedure based on focal-plane wave-front sensing is optimized for NCPA compensation on the coronagraphic device, ensuring the best compensation of quasi-static speckle.

Secondly, a high robustness to faint magnitude guide star allows SAXO to address a large panel of targets for exoplanet detection and characterization. This is only made possible by the joint use of a dedicated Wave-Front Sensing for turbulence, EMCCD detector capability, and adaptation of the system to the star magnitude. The noise propagation has been carefully monitored and optimized. The weighted center of gravity gives an optimal trade-off between performance with respect to noise, and complexity of implementation. The use of an EMCCD detector allows a powerful noise reduction on the wave-front sensor detector. And finally, 5 SAXO observing modes are defined in order to cover all star magnitudes up to 16, with systematic optimal performance.

During the whole assembly integrations and test period, choices have been done to optimise the trade-off between performance, robustness, and simplicity of use. The self-adaptation and auto-calibration of the instrument has been a strong investment, as well as developing a great simplicity of use. We describe here the actions taken to reach this level of operation for SPHERE. Finally, perspectives are withdrawn for improving the strategy of WFS in the framework of future XAO instrumentations in E-ELT.