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# Analytical tolerancing of high-contrast imaging performance under AO on the ELT

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## Abstract

High-contrast imaging (HCI) from the ground will provide complementary data to space-based missions looking for habitable exoplanets. While third-generation instruments like PCS on the ELT will be optimized for the search for temperate Earth analogues, several first-generation instruments will already be equipped with coronagraphs for HCI observations, like HARMONI, METIS and MICADO. Supported by AO, these instruments will perform high-contrast observations at unprecedented angular resolution, enabled by the 39-meter aperture of the ELT. These observations, however, are very sensitive to wavefront errors (WFE). In particular the 798 segments of the primary mirror need to be well-phased to limit the contrast degradation in the image. Recent studies on WFE stability for space-based, segmented telescopes have used an analytical approach to quantify the segment-based WFE tolerances imposed by the HCI system. We present a similar analysis on a ground-based telescope, the ELT, and adapt it to account for the dominating aberration factors on the ground. The major focus of our analytical study is the HCI performance under segmentation errors when working with AO-corrected images. Apart from segment-induced phase aberrations, we also investigate segment-based amplitude aberrations with an analytical tolerancing model, which can be induced by combinations of missing segments or their varying reflectivity.

**Keywords:** high, contrast imaging, segment phasing, coronagraphy, analytical model

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