Design and challenges for the HARMONI laser guide star sensors

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Abstract

HARMONI is the first light visible and near-IR integral field spectrograph for the ELT. It covers a large spectral range from 450nm to 2450nm with resolving powers from 3500 to 18000 and spatial sampling from 60mas to 4mas. It can operate in two Adaptive Optics modes - SCAO (including a High Contrast capability) and LTAO - or with NOAO. The project is preparing for Final Design Reviews. The laser Tomographic AO (LTAO) system provides AO correction with very high sky-coverage and it is supported by two systems: the Laser Guide Star Sensors (LGSS) and the Natural Guide Star Sensors (NGSS). The LGSS analyse the wavefront coming from 6 laser guide stars (LGS) created by the ELT; light that is picked up at the at the very entrance of the instrument with a dichroic mirror. LTAO is complemented with NGSS that probe the wavefront on natural guide star for tip, tilt, focus determination. The LGSS is made of 6 independent wavefront sensor (WFS) modules mounted on a rotator of 1100 mm diameter to stabilise the pupil onto the microlens array in front of the detector and with an accuracy of 90". Each LGS WFS is designed to compensate variations of the LGS mean layer centroid from 75 km to 92 km altitude at zenith angles from 0◦ to 60◦ with a dedicated mechanism in each module. We present the optical and mechanical design of the LGSS proposed for FDR. The optical design is based on the use of freeform lenses to minimize the numbers of optical components, to accommodate for the diversity of sodium layer configurations and to ensure a small amount of aberrations in each LGS path. The WFS itself is based on a CMOS detector from SONY: it provides a large number of pixels to accept elongated spots up to 16 arcsec without truncation and to sample the pupil with 68 sub-apertures with a pixel size of 1.15". The trade-off of the mechanical design is also presented to illustrate how materials (carbon benches) have been carefully selected to ensure resistance to earthquake with a reduced mass to obtain a complete system smaller than 3 tons and with a first mode larger than 12Hz. The current challenge of the design relies on the choice of the microlens array technology to minimize the transmission loss.

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