

The Optical and Mechanical Design for The Extreme AO System MagAO -X

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MagAO-X Optical and Mechanical Design

K-mirror (Hedglen et f/11 input beam from Magellan al. this meeting) aligns pupil in rotation Pupil alignment loop mirror Woofer DM: ADC: (0.55· ALPAO 97 1.85 μm)

All optics in MagAO-X use custom locking kinematic optical mounts: where the front clamp locks down the spring loaded mirror cell. Better than **2μrad/C thermal stability.** Provisional Patent #62/632,544 See Kautz et al. this meeting for details.







actuators. removes large PV wavefront errors (See Van Gorkom et al. for details)

corrected Tweeter DM: BMC 2KDM. 2040 actuators, 1700 modes, 3.7 kHz, 3.5µm stroke (see Males et al.) Science Cameras: 6x6" FOV, 6 mas/pix. Both EMCCDs used

Low Order EMCCD WFS (measures NCP errors post coronagraph)

> Floating (closed loop) optical table (air removes all external vibrations >10 Hz)



Pyramid

Pyramid WFS – OCAM2 120x120 3.7kHz, <1enoise (Measures the wavefront slopes of >2000 modes with low aliasing, high sensitivity). The PWFS also keeps the pupils aligned via a slow loop.

The Current view of the MagAO -X Instrument in the Clean **Room** Steward Observatory's High-Contrast Lab (PI Jared Males).



The f/69 focal plane **PSF**. This is the same PSF that exactly hits the tip the Pyramid WFS. This image suggests the initial alignment is

The 4 Pupil Image formed by the pyramid and camera lens on the **OCAM PWFS**. This is the expected shape from an unmodulated PWFS with no wavefront error. See Schatz et al. for more detail.

f/69 focus

Lyot Stop wheel (pupil plane) used with **PIAACMC** coronagraph

Coronagraphic Focal Plane Mask wheel

PWFS modulator PI331 TT mirror

Beamsplitter (PWFS path is reflected green rays; Science path red rays). Optical design optimized to minimize NCP errors

vAPP coronagraph wheel (Pupil plane) removes diffracted light from star via interference (Miller et. al. this meeting)

Pyramid WFS

reasonable.

SUMMARY

MagAO-X has passed its PDR last year and has moved past the design phase and procurement phase to the integration and testing phase (See Males et al. for more details). Today all the long lead time optics, DMs, and fabricated parts have been fabricated and delivered (or will be so within weeks). Initial optical alignment and testing of our off-axis parabolas is excellent (see images above), and all our super polished optics look within spec. (P-V< $\lambda/40$; surface roughness < 0.1 nm rms). We are planning for the first commissioning run in 2019A at the Magellan Clay telescope.

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