Laboratory Demonstration of Real Time Frame Selection with Magellan AO

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The Magellan AO system combines a pyramid wavefront sensor (WFS) and high-order adaptive secondary mirror (ASM), and will see first light on the Magellan Clay telescope in November 2012. With a 23 cm projected actuator pitch, this powerful system will enable good correction in the optical (0.5 to 1 μm). Realistic laboratory testing has yielded Strehl ratios greater than 40% in (0.765 μm) on bright simulated stars. On fainter stars our visible AO camera, VisAO, will work in the partially corrected regime with only short moments of good correction. We have developed a form of lucky imaging, called real-time frame selection (RTFS), which uses a fast shutter to block moments of bad correction, and quickly opens the shutter when the correction is good, enabling long integrations on a conventional CCD while maximizing Strehl ratio (SR) and resolution. The decision to open or shut is currently based on reconstructed WFS telemetry. Here we report on our implementation and testing of this technique in the Arcetri test tower in Florence, Italy, where we showed that long exposure f SR could be improved from 16% to 26% when the selection threshold was set to the best 10% of instantaneous SR.

Follow MagAO at: http://visao.as.arizona.edu

Unpacked: Magellan AO is integrated at LCO, waiting to go on-sky

Our 585 element adaptive secondary mirror (ASM) in the cleanroom at LCO.

The W-Unit contains the pyramid wavefront sensor (WFS) and the VisAO science and acquisition camera.

Following nearly a year of testing and a successful pre-ship review in Arcetri, Italy, the Magellan AO system has been shipped to Las Campanas Observatory (LCO), Chile. The system has been fully re-integrated and tested at LCO and is ready to go on-sky in November, 2012.

Real Time Frame Selection

The slope-vector is reconstructed on a GPU, which results in a 90% improvement in speed. MagAO comes with modal control, so calculating spatial mode 10’s Strehl requires averaging the reconstructed mode amplitudes in quadrature. The modes are weighted with selection criteria.

Laboratory Closed Loop Results

These images show the resultant PSF for various selection thresholds, at SOSSF. RTFS improved Strehl from 16% to 26%, and FWHM improved from 30.9 mas to 27.3 mas.

The perfect 24.3 mas Airy pattern is shown below for comparison.