

# ADAPTIVE OPTICS AT LBT WITH PISCES

## NEAR-IR IMAGING CAMERA PISCES

- Near-IR (1-2.5  $\mu$ ) camera, HAWAII-1 array (QE>60%, RON=20e-, gain=4.4 e-/ADU; linear range < 90 ke-)
- 1024x1024 pixels, 0.021"/pixel, circular FOV  $\sim$ 21"
- Nyquist sampling ( $\lambda/D = 0.031''$  in J, 0.039" in H, 0.054" in K)
- Readout modes:
  - Minimum readout 0.8 sec, double-correlated & Fowler sampling, frame co-adding available
  - Rapid readout (2-30 Hz) of smaller region of interest (subarray mode)
- Filters, 10 slots available:
  - currently installed: 2.140  $\mu$ m, 2.086  $\mu$ m, Fe II (1.64  $\mu$ m), 1.083  $\mu$ m, J, H, Ks, Jcontinuum, open, & dark
  - Can install : Br- $\gamma$  2.16  $\mu$ m, H $\alpha$  2.12 and 2.25  $\mu$ m, CO overtone bandhead 2.29  $\mu$ m, Pa- $\gamma$  1.099  $\mu$ m, 2.09  $\mu$ m, 2.26  $\mu$ m)
- Predicted sensitivities (10-sigma, 1 hour, Vega mag) for point sources, assuming a good AO correction (see below):
  - J-band: 24.6 mag
  - H-band: 24.2 mag
  - K-band: 23.4 mag
- Achieved Strehl Ratio: J-band: 0.47; H-band: 0.85; K-band: 0.92

## LBT FIRST LIGHT AO SYSTEM

LBT has the most advanced AO system currently available at the telescopes, see Riccardi et al., 2010, SPIE, 7736-82, and Esposito et al., 2010, SPIE, 7736-12. Observations require a bright ( $R < 17$ , see below) reference star near the scientific target.

- PSF shape: max contrast of  $\sim 10^4$  at 0.4". This is achieved on the reference stars, with magnitude brighter than  $R \sim 12$  (see fig. below).

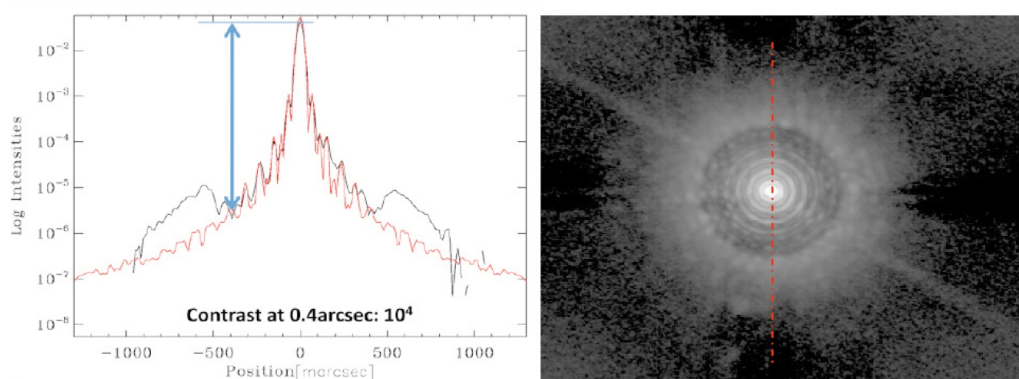
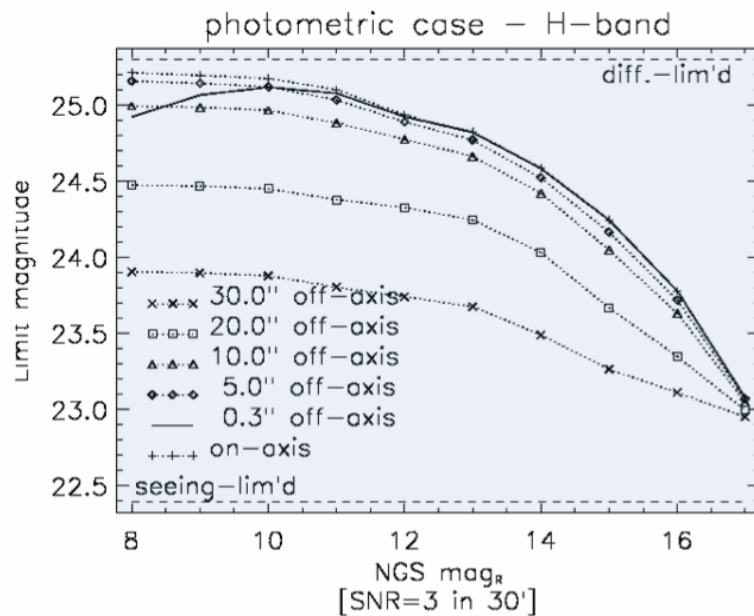


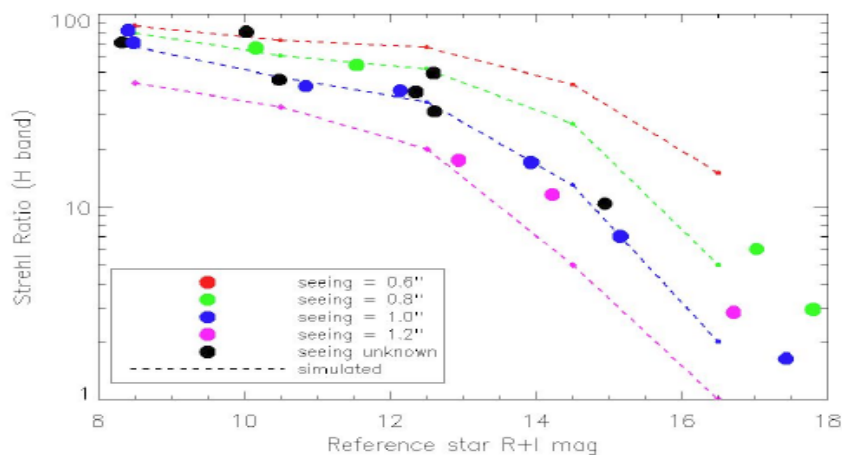
Figure 17. Comparison between diffraction limited PSF profile (red line) and AO corrected PSF (black line). reported profile section is highlighted in the figure on the right. See text for more informations.

- Degradation:** PSF degrades with reducing the luminosity of the reference star and its distance from the scientific target. The wavefront sensor for the AO correction is sensitive to a broad wavelength band encompassing R and I, therefore the luminosity of the reference star in this band drives the AO correction and the final PSF. Figure below shows the limiting magnitude as a function of guide star magnitude for several distances from the guide star.

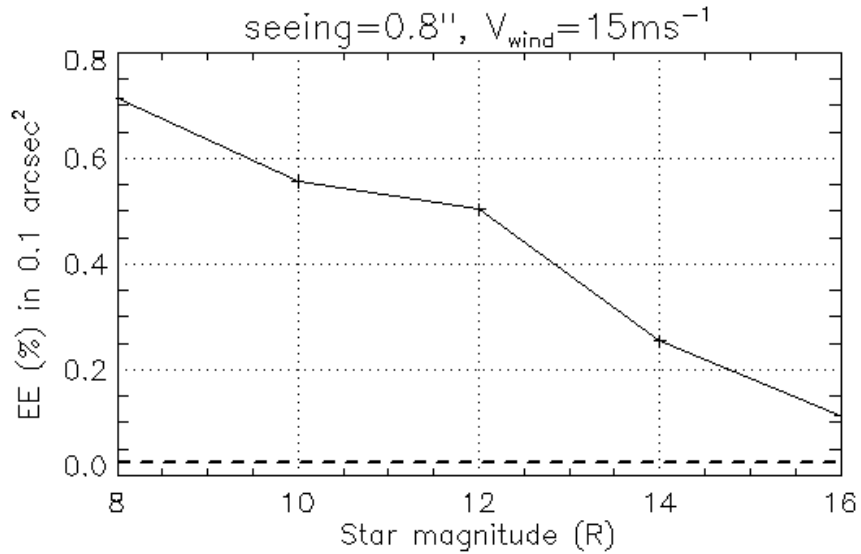


*Limit magnitude as a function of guide star magnitude at several distances from the guide star*

- Performances:** Strehl ratio and encircled energy as a function of the “R+I” magnitude of the reference stars are shown in the two figures below



**Caption:** Performance of LBT AO secondary: Strehl Ratio (H-band) vs. guide star magnitude and atmospheric seeing. [SPIE meeting 2010]



*Encircled energy in 0.1 square arcsec as a function of guide star magnitude*

- Timing: typical time to close the AO loop: 1 minute; Maximum duration of integration: no real limit, the AO holds lock for hours if needed.

## **PISCES + AO @ LBT**

- Targets and reference stars must have dec  $> +5^\circ$  in order to be observable for a significant fraction of the night and with low air mass.
- Typical expectation overhead to change AO field is  $\sim 10$  minutes.