Specifications of ShARCS: the Shane Adaptive optics infraRed Camera-Spectrograph for the Lick Observatory Shane 3-m telescope

Updated 2015/01/04 2:35pm

This document and the ShARCS manual detail the specifications of ShARCS. For more information, including filter curves and operations details, please see the ShARCS manual online at
http://mthamilton.ucolick.org/techdocs/instruments/sharcs/summary/.

Table 1. ShARCS Observing Modes and Details

Observing Mode	Filters	Details
Imaging:	J, H, Ks, K continuum bands, various narrow-band filters	2, 3, 4, 4 pixels per lambda/D sampling, respectively. Occulting finger diameter = 0.8″
Spectroscopy:[1]	H and K grisms	R∼500, Dispersion=600km s^{-1}, slit 0.15″×6.9″
Polarimetry:[2]	Wollaston prism	Half Field aperture = 31.4″×8.4″, for use with the externally mounted wave plate

[1] Spectroscopy mode is available, but not yet fully commissioned.
[2] Polarimetry mode is in progress and not yet available.

Detector Characteristics

Image plate scale:	0.033 arcsec/pixel
Unvignetted Square Field of View:	20″×20″
Illuminated Circular Field:	a circular region with diameter 840 pixels or 27.7″
Detector:	Teledyne HAWAII-2RG
Pixel size:	18 μm
Quantum efficiency:	85% over wavelength range 1.0 –2.5μm
Read noise:	21 e$^-$ with CDS
	6 e$^-$ with 16 Fowler reads
	5 e$^-$ with 32 Fowler reads
Gain:	2.35 e$^-$/DN
Operational area:	1976 × 1453 pixels (69.0%)
Minimum full frame readout time:	1.45 seconds
Windowing mode readout time:	0.11 seconds with a 100×100 square pixel region
Linearity:	∼30,000 DN, or ∼70,500 e$^-$

Aperture and Filter Wheels

| Aperture Masks in ApertureWheel	Filters in FilterWheel#1	Filters in FilterWheel#2
Pinhole 0.15″diam	K grism with R∼500, Dispersion=4.3μm=600km s^{-1}	H grism with R∼500, Dispersion=3.3μm=600km s^{-1}
Vertical slit for spectroscopy, 0.15″×6.9″	Pupil Viewer	Dark position
Half-field for polarimetry	BrGamma 2.167μm narrow	Open
Open for imaging	H$_2$ 1-0 S(1) 2.125μm narrow	J CH$_4$ 1.183μm narrow
Horizontal slit, 6.9″×0.15″	Ks continuum	K CH$_4$ 2.356μm medium
Occulting Finger, 0.8″ wide	H continuum	K continuum
	J continuum	Wollaston Prism for polarimetry
	Open	[Fe II] 1.644μm narrow
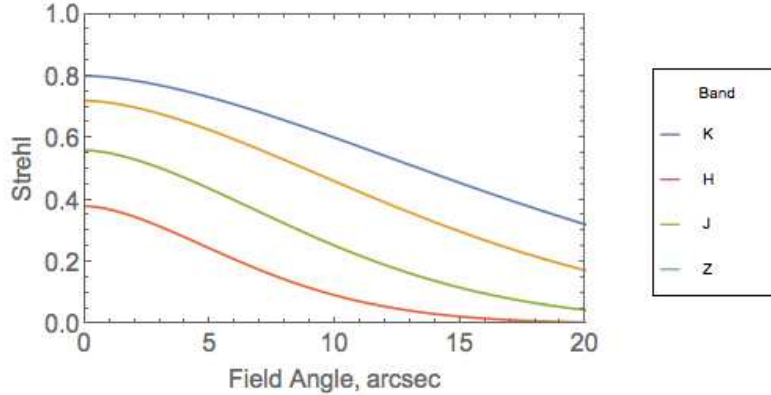
Figure 1. Expected degradation of the Strehl with field angle (distance from the center of the field, in arcseconds). The baseline Strehls at the center ($0''$) are from the ShaneAO nominal performance budget for the Laser Guide Star mode with 16 subaperatures on the WFS and seeing $r_0 = 10$ cm.

ShaneAO Guide Star Requirements - note that remote operations in LGS mode are possible.

Operation Mode	Maximum Distance from Target	Faintest Guide Star R magnitude
Natural Guide Star	$24''$	12
Laser Tip-Tilt Star	$120''$	19

Measured Zero Point and Predicted Limiting Magnitudes

Filter	Zero Point (mag)[3] Measured	Predicted Limiting Magnitudes for LGS[4]	
		8x WFS mode with Strehl=0.6	16x WFS mode with Strehl=0.8
J	22.3	21.3	22.28
H	24.3	20.5	21.0
K	23.5	18.7	19.0

[3] $ZP = 2.5 \log_{10}$(N photons/second <u>measured</u> from a 0th magnitude star)

[4] **Predicted** point source limiting magnitudes (8 or 16 subapertures LGS) for 300s 16-Fowler-read exposure, with S/N=5 and modeled sky backgrounds. The calibrated background measurements (and measured limiting magnitude) are coming soon.*
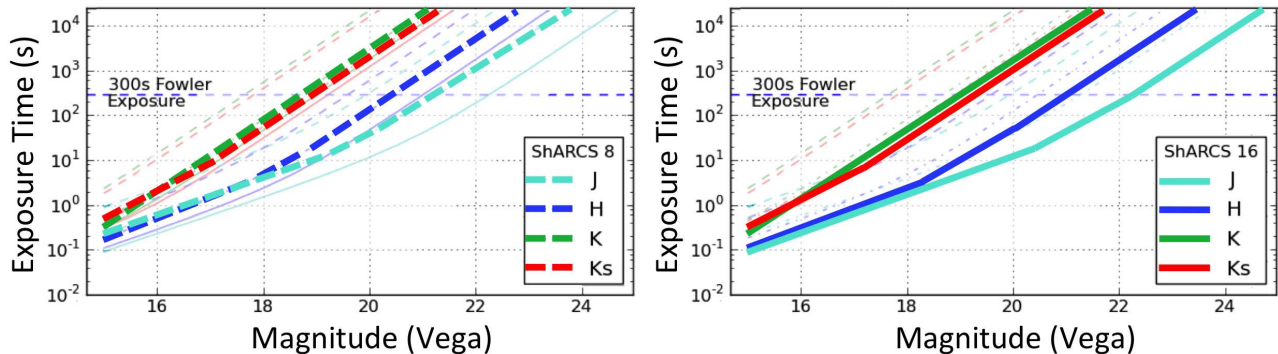

Figure 2. **Predicted** ShARCS exposure time (seconds) required to reach a Signal-to-Noise Ratio of 5 plotted versus point source magnitude for one exposure for ShaneAO LGS using WFS Modes 8x (**left** bold dashed lines) and 16x (**right** bold solid lines). The various filters are shown by different color lines: J in light blue, H in dark blue, K in red, and Kshort (Ks) in green. ShARCS is predicted to be approximately 6 times faster than IRCAL. For more detailed comparisons with IRCAL and the modeled sky backgrounds, please see the website in the footnote.*

*More sensitivity calculations are available at `http://www.ucolick.org/~srikar/ShARCS/index.html`