ADC Performance in UV and IR

Introduction:

The original LRIS-ADC Phase-A Report did not include performance shortward of 0.4 microns, although this material was presented to the Review Committee at the actual review (http://www.ucolick.org/~phillips/adc/). We have been charged by the committee to provide performance (ie. residual correction) results over the wavelength range 0.31—1.1 microns, and using actual indices of refraction rather than the interpolation formula used for the Review.

One difficulty is that is that there are various ways to calculate the prism separation to produce optimal results. For example, the Nelson & Mast report simply minimized the rms radii of images – however, this may have the affect of providing very poor corrections at some wavelengths. In the following figures. the prism separation is calculated by averaging over the separation needed to superimpose the images at the sample wavelengths onto an image at 0.45 microns. This probably provides a better result for most science applications.

Since the results are given relative to a reference wavelength of 0.45 microns, the residual dispersion at this wavelength is always zero.

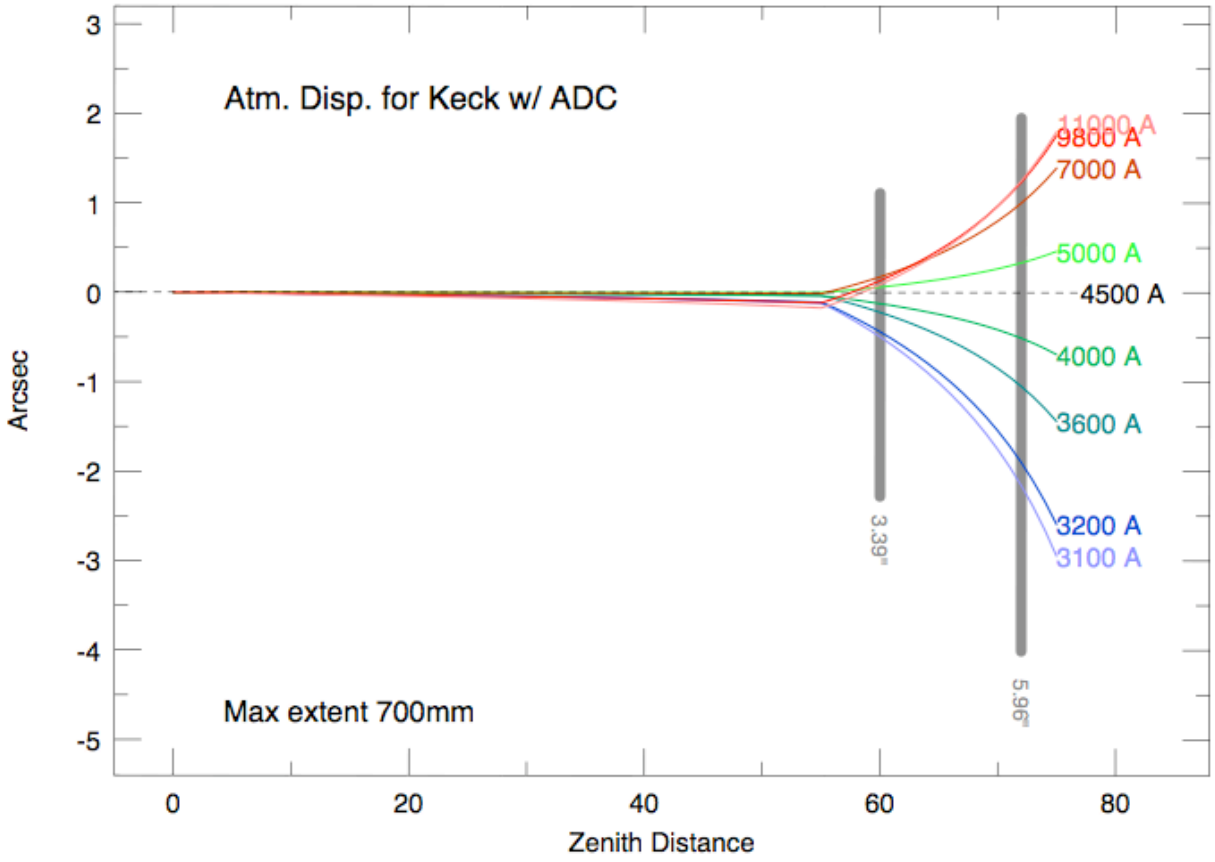
The ADC model used is for the original design: 5° prism angle, 700mm maximum separation, inner surfaces of the prisms perpendicular to the optical axis of the telescope. The sample wavelengths chosen were: 0.32 – 1.10 microns in equal log-intervals (0.32, 0.36, 0.40, 0.45, 0.50, 0.56, 0.63, 0.70, 0.79, 0.88, 0.98, 1.10 microns), and 0.31 microns. We note that the last value is likely to be of extremely low interest, as the Mauna Kea atmospheric extinction is 1.5 magnitudes per airmass at this wavelength, that is, a factor of 0.25 at Z=60 compared to the zenith. For this reason, observers interested in this wavelength are unlikely to observe far from the zenith, and thus need an ADC. (For comparison, at 0.32 microns the extinction is 0.8 mag/airmass).

[A note about indices of refraction used:

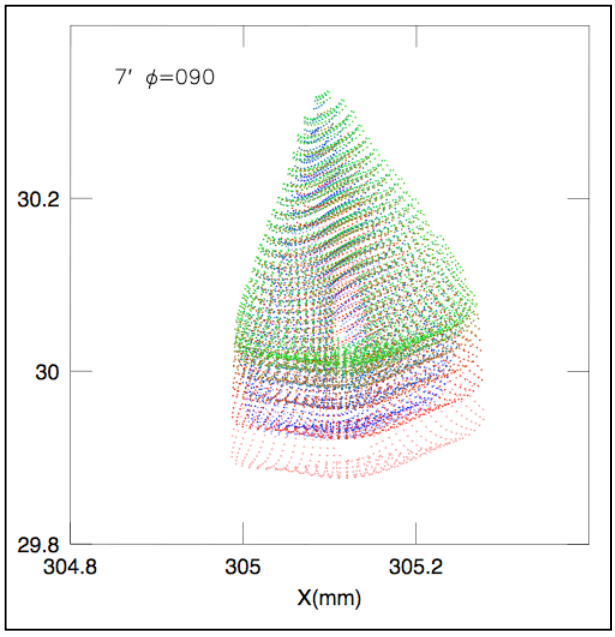
The indices at each wavelength were obtained from http://www/luxpop.com for UV-grade fused silica and for air, both at 2C. The fused silica values are referenced to I. H. Malitson, *J. Opt Soc. Am.* 55, no. 10, pp. 205—1209 (1965). Values from this source agree with those from Corning to within the stated accuracy (3×10^{-5}). They appear to be slightly below those adopted in the Nelson & Mast report by 5×10^{-5}.]

Performance Figures

The following figure shows the ADC performance over zenith distances of 0—75 degrees, with the design ADC of maximum 700mm prism separation (5 degree prisms). The maximum prism separation is reached at Z=54°. The two grey bars show the *non-corrected* dispersion at Z=60° and Z=72° for reference.

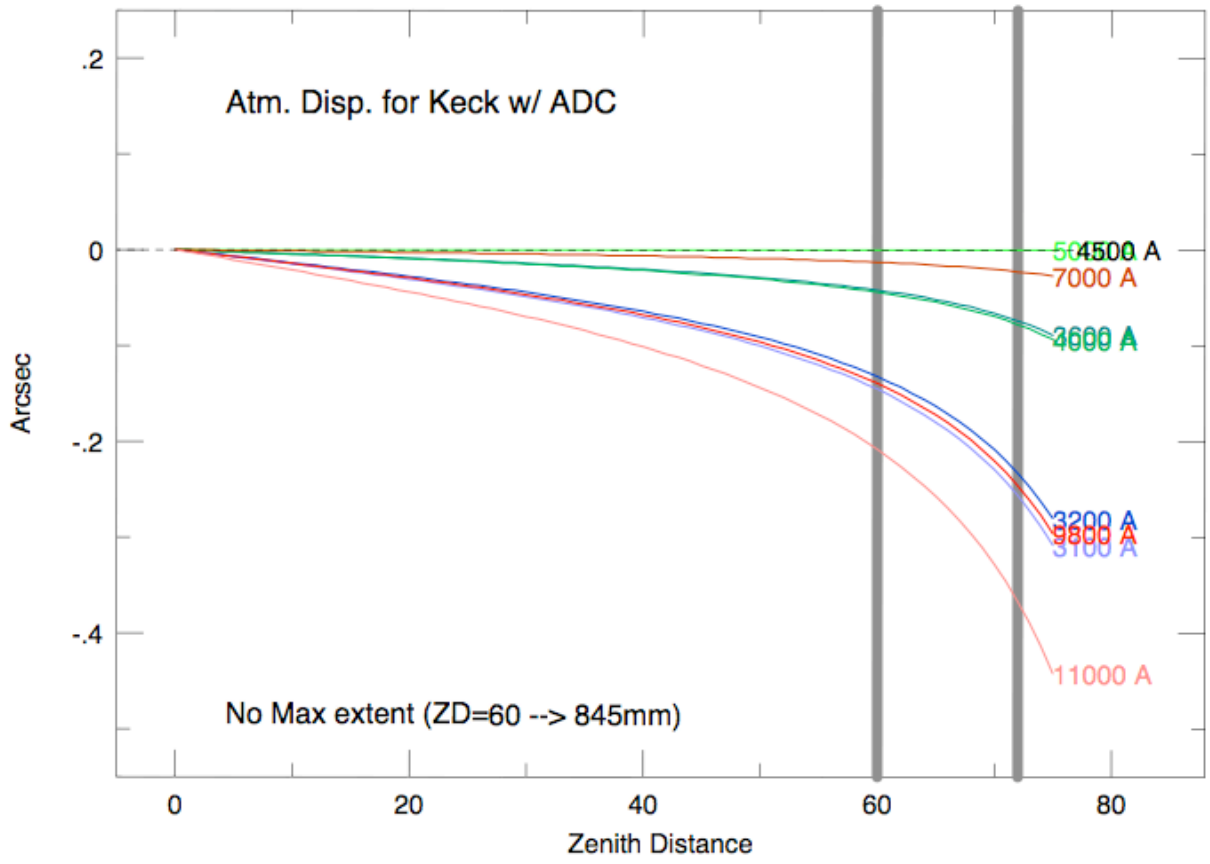


The figure to the right is a typical spot diagram showing ADC-corrected images at all the sample wavelengths. This is at Z=54° and 700mm separation.



To illustrate the corrections achievable, the following figure shows the ADC of the same design but without a maximum prism separation. Full correction is achieved at Z=60°

with a prism separation of 845mm. The scale has been magnified compared to the figure above. (Note that all curve lie at or below zero because 0.45 microns was chosen as the reference wavelength, as discussed above. Also, note that this figure is identical to that above for zenith distance up to 54°.)

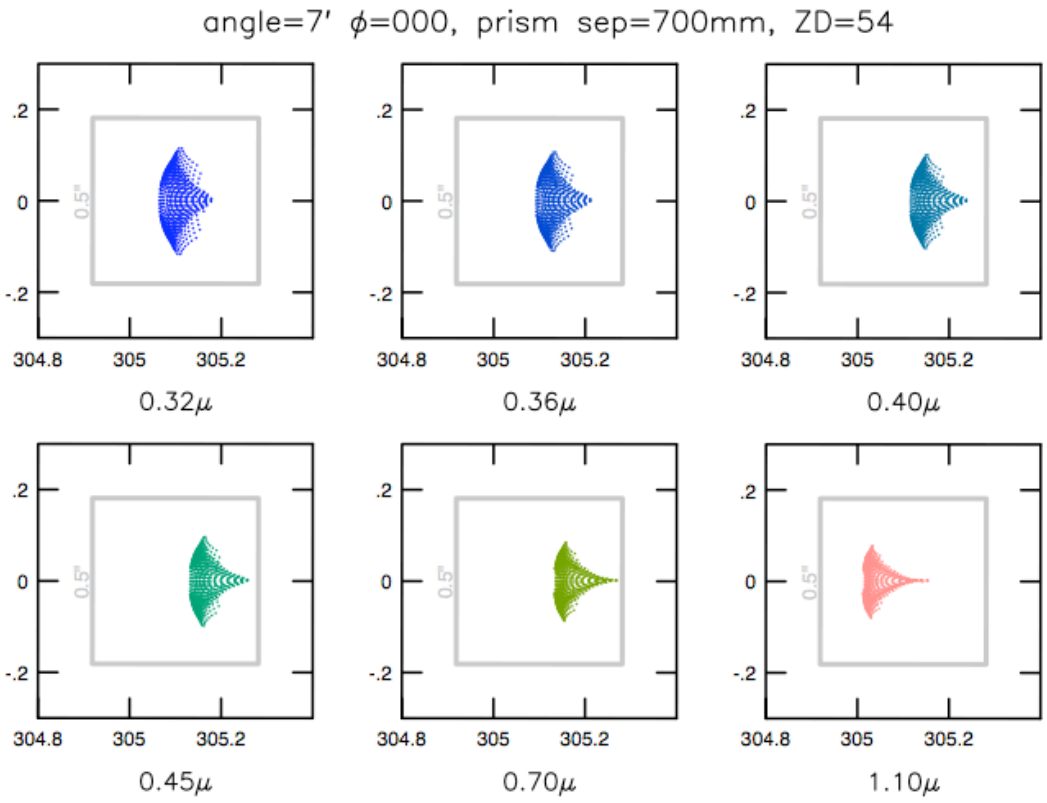


Residual dispersion values:

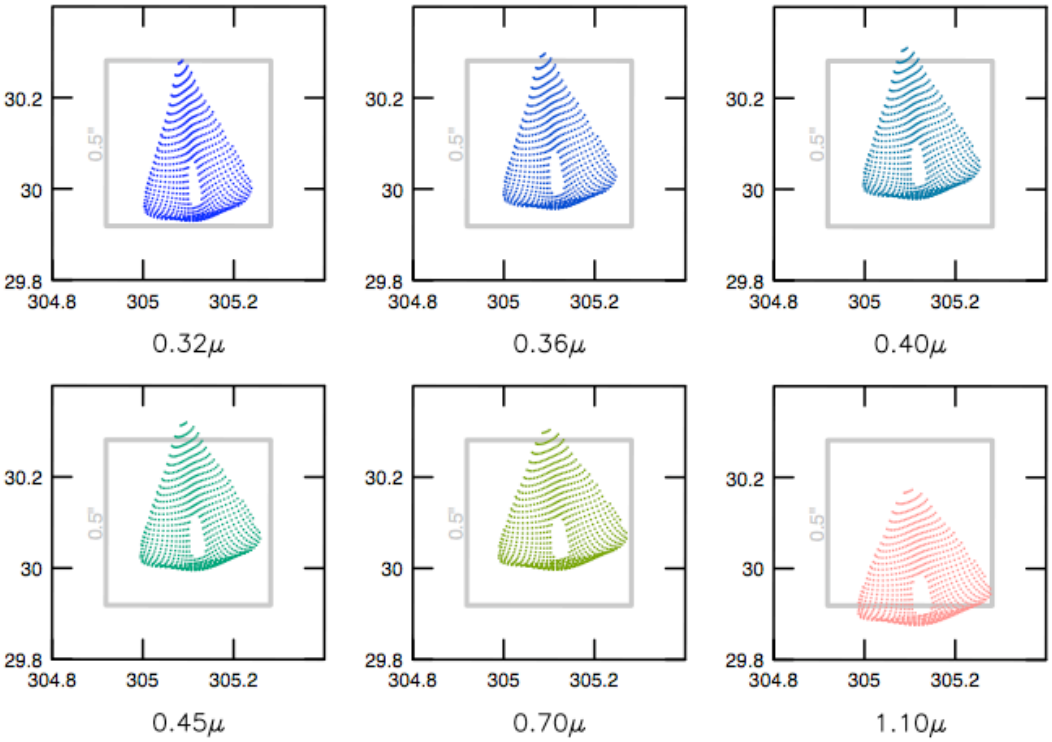
□(□m)	*Residual (Z=55)*	*Residual (Z=60)*	*Residual (Z=60,700mm)*
0.31	-0.068”	-0.083”	-0.495”
0.32	-0.057	-0.070	-0.419
0.36	0.017	0.020	-0.202
0.40	0.016	0.018	-0.1.5
0.45	0.052	0.062	0.019
0.50	0.052	0.062	0.080
0.56	0.052	0.062	0.132
0.63	0.059	0.071	0.182
0.70	0.041	0.049	0.194
0.79	0.031	0.036	0.211
0.88	-0.007	-0.009	0.193
0.98	-0.063	-0.077	0.152
1.10	-0.120	-0.146	0.108
rms	0.059”	0.071”	0.235”

PSF Quality

A question arose at the Review whether PSFs are significantly different at UV wavelengths than at 0.4 microns. Since the difference in refractive index is small over the entire wavelength range in comparison to the average index of fused silica relative to air, it was argued that aberrated images should not be very different in the UV. The following spot diagrams bear out this expectation. These are for a point 7 arcmin off-axis in the x-direction, and full 700mm prism separation. Each set shows six wavelengths. The three sets are for dispersion (and thus correction) at angles of 0, 90 and 180 degrees with respect to the x-axis.



angle=7′ ϕ=090, prism sep=700mm, ZD=54



angle=7′ ϕ=180, prism sep=700mm, ZD=54