Distortions from the LRIS ADC

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We have studied sub-aperture design of the ADC to look for differential distortion as the prisms separate. Some distortions are introduced by the ADC, but these are found to be less than or equal to ±0.1 arcsec in magnitude in each axis.

One requirement for an ADC to operate across a range of zenith distances is that differential distortions cannot be too large. For LRIS, errors less than 0.1 arcsec are generally deemed tolerable.

For this study, we have chosen nine points across the LRIS field: the center (7 arcmin off the telescope axis in x) and eight additional points forming a grid with 108mm spacing in x and 160mm spacing in y. The latter 8 points lie very near the corners and the centers of the edges in the LRIS field. We then modeled the spot locations with the sub-aperture ADC (5° prisms) at zero and 850mm prism separation (that is, null position and full correction at Z=60°), with the latter position modeled with the prism dispersion at 0°, 90°, and 180° with respect to the x-axis. Furthermore, these positions were sampled both with no telescope re-pointing (so the images were displaced with respect to the no-ADC positions), and with telescope re-pointing to place the central spot at a constant location (305.3mm, 0). The fully extended positions (at each prism orientation) were then compared to the null-position spot locations, allowing for a translation and rotation determined via a least-squares fit. Since the re-pointed case is the one used in practice, we present these numbers below:

Prism orientation	X range ″	X (rms) ″	Y range ″	Y (rms) ″	Rotation °
0°	-0.068 to 0.068	0.050	-0.055 to 0.055	0.044	0
90°	-0.016 to 0.021	0.011	-0.053 to 0.073	0.039	0.001
180°	-0.097 to 0.095	0.072	-0.025 to 0.025	0.018	0

Curiously, the residuals (ie, differential distortions) were less in the case of no re-pointing (not tabulated here) than in the re-pointed case. This can be understood in the following sense: the distortions introduced by the ADC itself are quite small. However, as the prisms are separated, the focal surface is displaced and the telescope must be re-pointed to maintain images in the same locations. When re-pointed, however, the field lies at a different radius from the telescope axis, and thus is subject to different distortions due to the RC-design. It is actually the changing location in the telescope focal surface that produces the dominant differential distortions. Fortunately, these appear to be just barely tolerable.

One further item to notice: when the prisms are not oriented at 0 or 180°, the best solution requires the field to be slightly rotated (by amounts ≈0.001°). Applying the rotation will be important for maintaining the best image quality, particularly if the offset guider is being used since it is far from the field center. Note that differential atmospheric refraction will probably also introduce an effective rotation of the field, which will also require modeling and correction for best results.