Atmospheric dispersion

For off-zenith astronomical observations with ground-based optical telescopes, the atmospheric dispersion elongates star images to spectra with the blue end point toward the Zenith. This effect of the atmospheric dispersion on images size relative to the diffraction limit (Airy disk) increases with telescope diameter. Finding a suitable atmospheric dispersion corrector (ADC) for extremely large telescopes (ELTs) is a real challenge.

Linear ADC and its limitation

One possible solution for atmospheric dispersion correction is to use a linear ADC (LADC) [1] (see Fig. 2).

Despite the simplicity of LADCs, their intrinsic aberrations could make it difficult to achieve diffraction-limited imaging. The monochromatic aberrations are usually compensated by adaptive optics (AO) system [1-3]. In ELTs the intrinsic chromatic aberrations are not significant in slow beams (e.g. f/15), however their correction becomes critical in fast beams (faster than f/5). In ELTs, sometimes there is an intermediate fast focus, F1, which helps to reduce the linear size of an ADC. The drawback of using a fast focus is that the chromatic aberrations of the ADC are magnified at the final slow focus. The chromatic aberrations in the final focus could prevent ELT from achieving its diffraction-limited image quality (Fig. 3).

Achromatic RADC

To avoid chromatic effects of LADCs, an achromatic ADC design was considered. Figure 5 and 6 present an optical layout and the spots of the new achromatic design of the RADC. The ADC consists of three lenses and it is located near the intermediate focus F1. The first two lenses, L1 and L2, are the counter rotating elements, which tune the intrinsic dispersion of the ADC for different Zenith angles. The third lens L3 preserves the geometry of the beam at F1. Therefore, L3 makes the ADC an afocal system and it also corrects for the residual aberrations of L1 and L2.

References