Generalized SCIDAR measurements at Mt. Graham

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ABSTRACT
We present the results of Generalized SCIDAR (GS) measurements of the vertical distribution of the optical turbulence above Mt. Graham in south-eastern Arizona. First results of an on-going site-characterization campaign covering 16 nights, distributed over 3.5 years are presented. The measured Cn2 profiles show that most of the turbulence above Mt. Graham is concentrated near the ground and that Mt. Graham is excellently suited for astronomical observations in terms of seeing, isoplanatic angle and coherence time. A fine sampling of the complete atmospheric turbulence can be achieved by combining the data from GS in convoluted fashion with a vertical resolution of ~1 km and those obtained with a newly developed method, based on GS, with a vertical resolution of ~25 m in the first 1500 m above the ground. Moreover, the impact of the retrieved turbulence profiles on Adaptive Optics systems, in particular the optimal conjugated heights of the Deferrable Mirrors, optimized for narrow as well as large FOVs, is estimated.

INTRODUCTION
The LBT (Large Binocular Telescope) is currently being commissioned at Mt. Graham and will make use of a sophisticated AO and MCAO system. In order to optimize the design of the AO system and to achieve the best possible performance, it is essential to know the turbulence characteristics above the telescope. For these reasons, a dedicated site-characterization campaign with a SCIDAR instrument mounted at the VATT to measure the atmospheric turbulence above Mt. Graham is currently being performed.

CN2 PROFILES
Using all the Cn2 profiles, the median profiles for each night (Fig. 2) and for all the data (Fig. 1) have been calculated. The seeing in single layers as retrieved with the high-vertical resolution method for one night. The wavefront coherence length τC as determined from the cross-correlation images is ~0.15 m. The total amount of turbulence below ~168 m above the ground is ~200 m and the isoplanatic angle ~0.67 arcsec. The Strehl ratio on-axis is ~0.71.

ASTRO-CLIMATIC PARAMETERS
So far we have measured ~14 000 Cn2 profiles, distributed over 16 nights in 2004 and 2005. From the measured cross-correlation images, we further determined the wind-speed profiles and the dome-seeing as described in Avila et al. Using these data, the astro-climatic parameters have been calculated (Table 1), which turn out to be very similar to the values measured with SCIDAR instruments at other good astronomical sites.

CONCLUSION
We present the results of 16 nights observations with a SCIDAR at the VATT on Mt. Graham. The retrieved atmospheric parameters are comparable to other good astronomical sites: the optimal conjugated height for the high-layer DM can be readily adjusted. To calculate the optimal conjugated heights of the DMs we used a semi-analytic model allowing to filter a Cn2 profile after correction of the AO system. From this residual Cn2 profile, the Fried parameter and thus the Strehl-ratio on-axis and the isoplanatic angle can be calculated. The optimal height of the DMs is then given by the altitude for which the Strehl/isoplanatic angle is maximal.

OPTIMAL CONJUGATE HEIGHTS FOR DMs IN MCAO
LINCNIRVANA is a Fourier interferometer currently being developed for the LBT. It will use a MCAO system with two deformable mirrors (DMs), where the conjugation height of the high-layer DM can be freely adjusted. To calculate the optimal conjugated heights of the DMs we used a semi-analytic model allowing to filter a Cn2 profile after correction of the AO system. From this residual Cn2 profile, the Fried parameter and thus the Strehl-ratio on-axis and the isoplanatic angle can be calculated. The optimal height of the DMs is then given by the altitude for which the Strehl/isoplanatic angle is maximal.

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Table 1: ASTRO-CLIMATIC PARAMETERS

<table>
<thead>
<tr>
<th>Site</th>
<th>Duration (nights)</th>
<th>Seeing (arcsec)</th>
<th>Isoplanatic Angle (arcsec)</th>
<th>Coherence Time (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Pedro</td>
<td>24 nights</td>
<td>~0.7</td>
<td>~0.8</td>
<td>~1.5</td>
</tr>
<tr>
<td>La Paloma</td>
<td>16 nights</td>
<td>~0.8</td>
<td>~1.0</td>
<td>~2.0</td>
</tr>
<tr>
<td>Mt. Graham</td>
<td>16 nights</td>
<td>~0.67</td>
<td>~1.3</td>
<td>~1.1</td>
</tr>
</tbody>
</table>

In this case the seeing, a measure of the total amount of turbulence below a given altitude, and the coherence length are calculated using all the Cn2 profiles.