limitation on the effective sky coverage. To maximise our chances of finding a suitable star even more, the existing wavefront sensor will be upgraded with a Low-Light-Level CCD that has virtually zero read noise and would give us an extra magnitude in faintest detectable star. As can be seen in the adjacent figure (courtesy Remko Stuik, Leiden) the *conservatively estimated* sky coverage will be extremely good, even at the galactic pole.

The laser light scattered into the atmosphere of course has to be blocked from entering the science instruments, both at the WHT as at other telescopes at the observatory. Within NAOMI a dichroic mirror will block the laser light from going into the science beam. But the situation with other telescopes is more complicated and requires a coordination of laser operation and the pointing of all telescopes that might be affected in order to avoid that some telescope will inadvertedly cross the laser beam. Much experience with this problem has been obtained at Mauna Kea observatory where such a laser traffic control system has been put into operation. A similar system will be put into operation at La Palma. The system will collect pointing information and inform all telescopes whether or not there is a risk of crossing the laser beam. If necessary the laser beam will automatically be intercepted.

Performance Expectations

In preparation for this project, various performance predictions were carried out by Richard Wilson at Durham University. As the main scientific niche for AO at the WHT rests with the visible light OASIS integral-field spectrograph the focus is on achieving moderate but significant improvements of image quality down to 0.6 nm. It is unrealistic with current technology to aim for high Strehl ratios at these wavelengths. But as the calculations below show, image FWHM will improve very significantly at short wavelengths and performance in the near IR is even better.

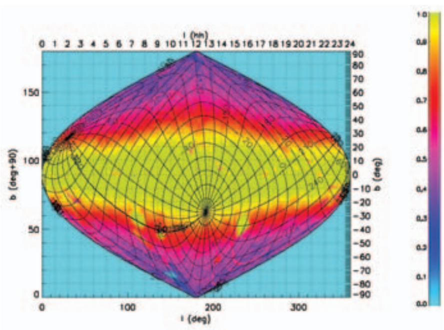

Figure 3. Representation of the sky coverage for finding a star brighter than R=18 within a search diameter of 1.5 arcminutes (courtesy Dr Remko Stuik, Leiden University).

The model calculations were designed to deliver realistic figures for the expected improvement of image quality as a function of seeing, wavelength, natural guide star brightness, and distance of the natural guide star to the science object. A typical profile of atmospheric turbulence strength with height was assumed. The following table shows a few of the model results. The model calculations indicate very attractive improvements in image quality when NAOMI will be used with a laser beacon. But of course above all, the laser enhancement will provide such performance for nearly any point in the sky, thus opening up the exploitation of AO to surveys of large number of targets.

	R-band FWHM (")	H-band FWHM (")
Faint tip-tilt star on-axis		
Typical seeing (0.74")	0.28	0.14
Good seeing (0.54")	0.17	0.12
Faint tip-tilt star at 60 arcsec		
Typical seeing (0.74")	0.32	0.17
Good seeing (0.54")	0.21	0.15

Scientific Invitation

The GLAS project will open up a new exciting area of astronomical exploitation for the William Herschel Telescope. There is much work ahead, and much to learn on how to optimally use the future new facility. Moreover, an added attraction of the laser system is that it can serve as a testbed for concepts of future laser systems at much larger telescopes.

Progress on this project will be reported in future articles in this Newsletter. If you are excited about the prospects as we are, and interested in working with us to define detailed scientific plans, don't hesitate to contact us. ¤

René Rutten (rgmr@ing.iac.es)

Cute-SCIDAR: An Automatically Controlled SCIDAR Instrument for the Jacobus Kapteyn Telescope

J. J. Fuensalida[1], B. García-Lorenzo[1], J. M. Delgado[1], C. Hoegemann[1], M. Verde[1], M. Reyes[1] and J. Vernin[2]

1: Instituto de Astrofísica de Canarias; 2: Laboratoire Universitaire d'Astrophysique de Nice

In February 2004 the Cute-SCIDAR instrument was installed at the 1m Jacobus Kapteyn telescope (JKT) for a systematic monitoring of the atmospheric turbulence at the Observatorio del Roque de los Muchachos (ORM). The proper knowledge of the atmospheric turbulence structure is crucial for optimising the efficiency of adaptive optics systems. SCIDAR has proved to be the most contrasted and efficient technique from ground level to obtain the optical vertical structure of the atmospheric turbulence. The classical (Vernin & Roddier, 1973; Rocca, Roddier & Vernin, 1974) and generalised SCIDAR (see e.g. Klueckers et al., 1998; Ávila, Vernin & Masciadri, 1997; Fuchs, Tallon & Vernin, 1994) techniques analyse the scintillation patterns produced at the telescope pupil by the light coming from the two stars of a binary system. Turbulence profiles as a function of height, C_N^2 (h), are derived through the inversion of the autocorrelation of scintillation patterns. Wind vertical profiles, V(h), are derived from the cross-correlation of a series of scintillation patterns relative to a reference pattern. Figure 1 sketches the SCIDAR technique.

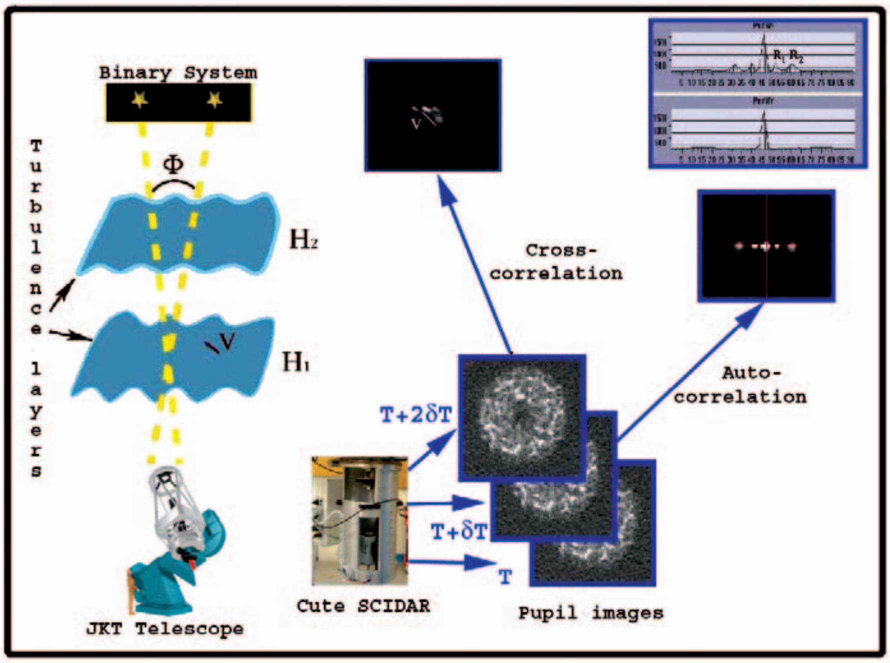

Figure 1. SCIDAR technique layout. From the observation of binary stars, we get a stack of consecutive images of scintillation. The average auto-correlation function of them gives information of the C_N^2 profiles, and average cross-correlation functions give the wind of the layers.

The main drawback of SCIDAR observational campaigns is the tedious setting up of the instrumentation and the computational effort needed to infer the nightly turbulence and wind profiles. Therefore, systematic recording of turbulence and wind structure requires a huge number of highly qualified human resources. Consequently, the development of a fully automated SCIDAR device is of increasing importance to characterise the atmospheric turbulence and fix the input requirements and limits of the future multi-conjugate adaptive optic systems to be installed at the ORM. The Instituto de Astrofísica de Canarias (IAC) has developed a SCIDAR instrument providing high performance in automatic control and data reduction, the Cute-SCIDAR. It has been designed for the 1m JKT, with the goal of monitoring the vertical turbulence with a high temporal coverage. This device is not only restricted to the JKT but can also be used on other telescopes.

Technical Description

Figure 2 presents the optical scheme of the SCIDAR instrument. From the observational point of view, the SCIDAR technique requires that the detector is able to move along the optical axis to allow selection of the different conjugated planes. Moreover, the rotation around the optical axis is most than desirable for a SCIDAR instrument: because the star beams should be properly orientated on the detector (with its rows) in order to simplify the data reduction.

The Cute-SCIDAR allows the automatic control of any of the SCIDAR instrument components. The detector is lodged in two devices permitting the motion in the XY plane (perpendicular to the optical axis) to correct the small flexure displacements in the observational plane. The maximum range in the XY plane is 25 mm. A long electronically controlled rail to place the detector in the adequate conjugated plane provides the movement along the optical axis, Z direction. This motion also facilitates the instrument focusing procedure, since it permits to easily verify (using a single star) the state of collimation of the beam. The maximum displacement in the Z direction is 300 mm. The current detector is a commercial sensitive CCD camera of PCO. The instrument can rotate up to 270° with respect to the telescope through a crown wheel. Another complementary mechanism is a diaphragm, placed in the focal plane of the telescope (see the scheme of Figure 2), and also electronically controlled. The diaphragm mechanism permits the proper alignment of the observing binary star with the instrument optical axis. After a short successful commissioning at the Carlos Sánchez telescope at the Observatorio del Teide in Tenerife, the Cute-SCIDAR was installed at the JKT in February 2004. Figure 3 (left) shows the Cute-SCIDAR already installed at the JKT. Figure 3 (right) shows the essential instrument components. In this figure, we can see the diaphragm and collimator (1) within the instrument cover. The detector can be seen at the bottom opened door (2) and the crown wheel is the golden ring (3) connecting

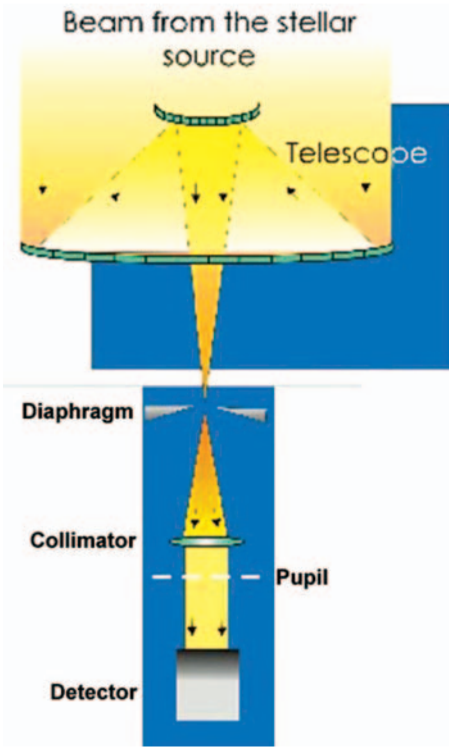

Figure 2. SCIDAR instrument optical scheme.

the instrument and the telescope. The label (4) indicates the electronic box controlling the mechanical elements of Cute-SCIDAR.

Control Software

A specific software package for the control of the different mechanical components and a pre-processing on-line data evaluator has been developed. A user-friendly interface based on MS-WINDOWS XP allows handling the different instrument components from the telescope control room. Figure 4 shows an example of the quick-look data interface: the left upper image corresponds to the pupil image of a binary star (the data recorded at the detector), and the right upper plot is the 2D normalised auto-correlation of this image; the bottom plots are cross-correlations of the left upper image and a reference image. The bottom right plot is a X-cut along the 2D autocorrelation function showing the presence of at least two turbulence layers (the two peaks to the left and right of the central brightest peak).

Observational Campaigns at the JKT

After a successful commissioning of the Cute-SCIDAR at the JKT last February 2004, we have started a monitoring program of the atmospheric turbulence. We are carrying out monthly one-week observing SCIDAR campaigns and we already have data corresponding to 30 nights of observations. On each night we can record more than 1500 different atmospheric turbulence vertical profiles above the Observatorio del Roque de los Muchachos. Preliminary results obtained from these data have been recently presented to the astronomical community (Fuensalida et al., 2004; Hoegemann et al., 2004; Fuensalida et al., 2003). Figure 5 shows the temporal evolution of the atmospheric turbulence profiles along an observing night at the JKT. In this figure, the X-axis corresponds to the time (in UT) along the night referred to midnight.

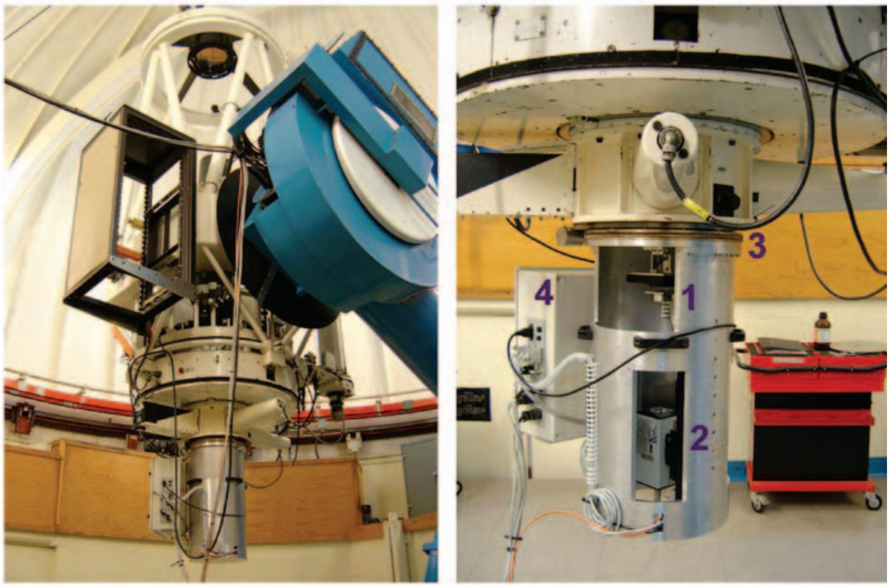

Figure 3. Views of the Cute-SCIDAR instrument installed at the Jacobus Kapteyn Telescope.

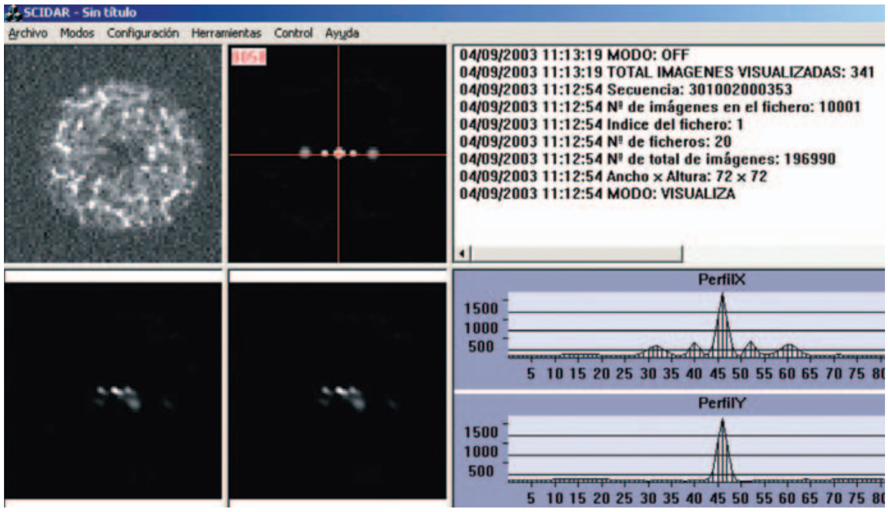

Figure 4. User interface window showing an example of the on-line data evaluator.

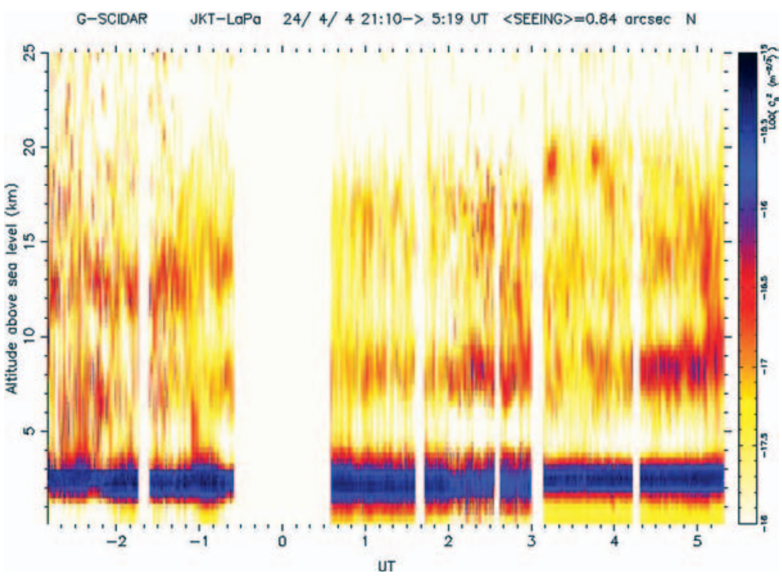

Figure 5. Evolution of turbulence vertical profiles at the Observatorio del Roque de los Muchachos during the night of 23-24 April 2004. The mean seeing derived from these profiles was 0.84 arcsec being in good agreement with the DIMM measurements.

The Y-axis is the altitude above sea level, and the colour bar on the right side indicates the values of $C_N^2(h)$. The dome seeing contribution has been rejected.

In semester 2004B we will continue the monitoring of the turbulence structure at the JKT after the extension of the agreement with the Isaac Newton Group of Telescopes. The Cute-SCIDAR team thanks the staff of the Isaac Newton Group of Telescopes for their usual high standard of service. ¤

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Begoña García (begona.garcia@iac.es)

SuperWASP: The Trials and Tribulations of a Remote Inauguration Ceremony

Don Pollacco (Queen's University Belfast), Ian Skillen (ING), Javier Méndez (ING) and the WASP Consortium

It is ironic that in this technical age we live in there are few professional facilities in operation that are designed to monitor the sky at optical wavelengths. Historically, this work has been left to dedicated amateur astronomers often using observatory grade equipment. Part of the reason for the absence of professional projects is the lack of reliable equipment and the huge data rates involved. The SuperWASP facility is an attempt by professionals to join in the exploitation of the time domain. It is the rapid development of robotic technology and affordable, but powerful, computing that has made this project feasible.

The main science aims of SuperWASP include the detection of extra-solar planets (the so-called *hot-Jupiters*), optical counterparts to Gamma-Ray Bursters and rapidly moving near-Earth asteroids. While the UK Particle Physics and Astronomy Research Council (PPARC) provided some seed funding for SuperWASP, the bulk of the funding came from the Queen's University Belfast (QUB). Other contributions came from the Open University, the Royal Society, Andor Technology and St. Andrews University. The QUB funding became available in March 2002.

Those of you who have been out to La Palma over the last year may have noticed the appearance of the SuperWASP enclosure on the Roque. In fact avid viewers of the CONCAM all-sky images noticed that the building was erected during the day of the 6th July 2003. Shaped like a garage sized shoe box but with a peculiar stepped-roof, it is sited on the hillside below the JKT towards the Swedish Solar Telescope. The enclosure is composed of two rooms with the instrument itself located at the southern end of the building and the control computers at the other end.

Figure 1. SuperWASP at dusk on the 27th November 2003 — first light. The WHT dome is in the background (photo courtesy Jens Moser).