SCIENCE VERIFICATION OBSERVATIONS ON VLT-UT1 COMPLETED

THE VLT-UT1 SCIENCE VERIFICATION TEAM

Science Verification (SV) observations on UT1 have taken place as planned from August 17 to September 1 (cf. The Messenger, 92, 5, for a presentation of the goals and the strategy of SV). Although the meteorological conditions on Paranal have been definitely below average, very valuable data have been gathered and are now being prepared for public release. The telescope has been working with spectacular efficiency and performance through the whole period. After having been disassembled to install the M3 Tower, the telescope was reassembled again putting back in place the M1 mirror cell (August 15). The Test Camera was re-installed at the Cassegrain focus on August 16, the telescope was realigned and tested, and finally released to the SV Team at midnight local time on August 17. The first SV observations were promptly initiated thereafter. The SV period ended on the morning of September 1, spanning a total of 142 hours, dusk to dawn. Of these, 44 hours have been lost due to bad meteorological conditions (clouds or wind exceeding 15 m/s), and 15 hours for minor technical problems, with an effective down time of $\sim 10\%$. For a total of 95 hours the telescope has been used to collect scientific data, including twilight flat-fielding and photometric standard star observations.

Table 1 gives the actual time invested on each of the SV programmes, along with their level of completion compared to the initial planning. This includes operational overheads, such as read-out times, target acquisition, etc. For those programmes that could not be completed care was taken to complete the necessary observations for at least one object.

All SV data will be released by September 30 to the ESO and Chilean communities. It will be possible to retrieve the data from the VLT archive, while a set of CDs will also be distributed to all Astronomical Research Institutes within ESO member states and Chile. Data on HDF-S will be public worldwide, and retrievable from the VLT archive. Updated information on data release can be found on the ESO web site at `http://www.eso.org/vltsv`.

The measured image quality on the Test Camera frames has been often better than the outside seeing as measured by the DIMM seeing monitor. At least part of this effect is due to the field stabilization operated by the secondary mirror, which worked in closed loop all through the SV period.

Also the M1 active control worked in closed loop through all the observations. In practice, the figure of the primary mirror is optimized several times per minute with no operational overhead. The seeing/image quality data are now being analyzed to gather a better understanding of the telescope performance and of the site seeing while extreme meteorological conditions were prevailing.

On the morning of September 1 the telescope was returned to the Commissioning Team, and commissioning resumed.

Table 1: Summary of Science Verification Observations

Programme	Hours	% of planned
HDF-S NICMOS and STIS Fields	37.1	98 %
Lensed QSOs	3.2	82 %
High-z Clusters	6.2	55 %
Host Galaxies of Gamma-Ray Bursters	2.1	56 %
Edge-on Galaxies	7.4	65 %
Globular cluster cores	6.7	57 %
QSO Hosts	4.4	--
SN1987A	0.0	0 %
TNOs	3.4	--
Pulsars	1.3	18 %
Flats and Standards	22.7	99 %

Figure 1 on the front page is a colour composite of the HDF-S NICMOS field that combines U, B, R, and I frames with image quality better than $0\farcs9$, as listed in Table 2.

Figure 2 shows the colour composite of the same field with the addition of the H-band HST/NICMOS (F160W) image from the ST-ECF public archive reduced at ST-ECF by W. Freudling. The HST image (Figure 3) was obtained with nearly the same total exposure time as the VLT (R-band) images, and their combination is meaningful since the VLT and NICMOS images reach similar depths. This is the result of several effects compensating each other, such as the K-correction, the better angular resolution of the HST image ($\sim 0\farcs2$), and the larger collecting area of the VLT.

All objects in the NICMOS image are also noticeable in Figure 1, with the exception of the very red object in the vicinity of the face-on spiral. The bright red object near the bottom of the image was noted by Treu et al. (astro-ph/9808282) as being undetected on optical images to the limit of $R = 25.9$. This object is clearly present in all the VLT Test Camera coadded images, with the exception of the U-band image.

Figure 4 shows the colour composite image of the optical Einstein ring 0047-2808 (Warren et al. 1996, MNRAS, 278, 139), a $z = 3.595$ star-forming galaxy which is lensed by a red elliptical at $z = 0.485$. Exposure times are 1 h in the narrow band filter NB559 (centered at the redshifted Lyα of the distant galaxy) and 900 s in B and V.

Table 2: VLT Test Camera Data on The HDF-S NICMOS Field

Filter	No. of exposures	total integration time (sec)	FWHM of the coadded image
U	16	17788	0''.71
B	15	10200	0''.71
V	16	14400	0''.78
R	8	7200	0''.49
I	12	10158	0''.59

Bruno Leibundgut and Roberto Gilmozzi of the SV Team conducted the observations on Paranal, with the local assistance of Martin Cullum of the SV Team and of Eline Tolstoy and Marc Ferrari (both ESO fellows). Jason Spyromilio, Anders Wallander, Marco Chiesa and Stephan Sandrock of the VLT Commissioning Team ensured smooth telescope operations throughout the whole period. The Paranal Engineering Department under Peter Gray provided all the maintenance and trouble shooting support that was needed.

The rest of the SV Team, including Guido De Marchi, Francesco Paresce, Benoit Pirenne, Peter Quinn, Alvio Renzini, and Piero Rosati guaranteed quick reductions and quality control of the data in Garching and prompt feedback to the Team on Paranal. Fabio Bresolin and Rodolfo Viezzer of the Office for Science extensively contributed to the reductions and calibrations. Robert Fosbury and Richard Hook of the ST-ECF combined the coadded frames to produce the colour images presented here.

Results, problems, and strategy were discussed in daily video-conferences Garching-Paranal, that were also attended by Massimo Tarenghi, the Director of the Paranal Observatory. The video-conferences took place at about noon Garching time (6am on Paranal), with the Paranal team reporting on the observing conditions and the observations completed during the night, and the Garching Team reporting on the progress in inspecting and reducing the data of the previous nights. Then, while the Paranal people were sleeping, data from the previous night were inspected and reduced in Garching, with feedback on what was best to do during the following night being emailed to Paranal several hours in advance of the beginning of the observations. The SV Team was really active 24 hours a day.

Figure Captions

Figure 1 (Front Page) – The colour composite constructed from the $U + B$, R and I VLT test camera images of the Hubble Deep Field South (HDF-S) NICMOS field. Exposure times are given in Table 2 of the editorial. The $U + B$, R and I images are displayed in the blue, green and red channels, respectively. The image is scaled from a low cut about 1-σ below the peak of the sky noise histogram to a high point which makes the star below the large spiral galaxy approximately white. The spiral galaxy itself has been masked and displayed with a different stretch to keep the internal structure visible.

Figure 2 – The colour composite of the HDF-S NICMOS field constructed by combining the VLT Test Camera images in $U + B$ and R with the near-IR HST NICMOS/camera 3 F160W ($\sim H$ band) 7040 s exposure. These images were used for the blue, green and red channels, respectively. The NICMOS image was smoothed to match the resolution of the R-band VLT image. The boundary of the NICMOS image is also shown.

Figure 3 – The original, un-degraded HDF-S NICMOS image of the same field shown in Figure 2.

Figure 4 – The colour composite image of the optical Einstein ring 0047-2808, produced by a red elliptical at $z = 0.485$ lensing a star-forming galaxy at $z = 3.595$. A 1 hour image through a narrow-band filter centered at the redshifted Lyα of the distant galaxy is coded green, while the 900 s B- and V-band images are coded blue and dark red, respectively, with the latter enhancing the lensing elliptical galaxy.

Astroclimate during Science Verification

When, at one of the best observatories worldwide, over two weeks and more, the sky is often cloudy, the seeing poor, the wind fairly strong and blowing from unusual directions, one is allowed to start talking of an astroclimatological anomaly. When this occurs during the science verification of the first 8m-class telescope mounting a monolithic mirror, the event deserves a more detailed analysis.

Cloudiness at Paranal is the conjunction of seasonal trends and El Nino events on top of some longer, as yet unexplained cycle (The Messenger 90, 6). As we are currently in the lows of the latter cycle and despite the end of the 1997-98 El Nino event, August 1998 was promising less than 70% photometric nights: the two nights lost for cloudiness during the two weeks of science verification were thus well within expectations.

The wind at Paranal is stronger in Winter (30% of the time more than 10m/s) than in Spring or Summer (15% only): one and a half nights lost because of wind in two weeks of observing is thus not anomalous.

As clouds have no reason to prefer windy nights, the two previous effects tend to cumulate and the total time lost was close to 30% of the total available observing time, nothing to be ashamed about!

Unfortunately, the seeing conditions were not at all inside the statistical margin as can be seen on the Figure: not only did we have an excess of very bad seeing (10% of the time worse than 2 arcsec) but also a deficit of good seeing periods (3 times less than normal).

This situation cannot be explained by a synoptic analysis: only a slight excess of temperature was reported over South-America during the first week, the jet stream behaviour was also quite normal during the whole period. Nevertheless the wind vane at Paranal more than usual kept pointing at North-East or South-East where the bad seeing comes from (valleys and nearby summits). In addition, a cold front causing a sudden drop of the air temperature turned the ground around the observatory into a highly efficient local seeing generator several degrees warmer than normal.

Whatever further improvements we make in the understanding of the generation mechanism of atmospheric turbulence, the operation strategy of ground-based astronomical facilities has nevertheless to be designed to confront from time to time a highly non-deterministic environment.

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