3. First Technical Run at the 3.6-m Telescope

The first test run of MEFOS at La Silla took place from January 30 to February 7, 1991. The final instrument structure was used but with nine positioning arms only. The goal of the observing run was to check the telescope interfaces and to practise all instrument mounting and adjustment procedures. The fibre output slit could be mounted either at the spectrograph collimator or at a photomultiplier to verify the accuracy of the fibre centring. The whole system (including the read-out of the photomultiplier) was controlled by the instrument PC in the Control Room.

The spectral calibrations and flat-fields were performed using the Optopus flange mounted, as usual, on the Cassegrain adapter. The lamps sent the beams directly to the prime focus through the central hole of the main mirror. They were controlled together with the spectrograph CCD by the OPTOPUS software package running on the HP 1000 telescope computer.

Apart from minor difficulties in the mechanical installation and in the control software, the main problems were encountered in the object acquisition: at the beginning the arms were not able to reach the correct positions. This was traced down to a slightly erroneous value of the scale we were using. After this correction, the final position of the arms was still not fully satisfactory because the programme did not yet include the field distortion. Nevertheless, once the objects were brought inside the image fibres and analysed with the acquisition programme, the arms could send the spectral fibres to the objects with relatively good accuracy: better than 0.4 arcsec. Two factors contributed to this uncertainty: the spherical aberration produced by the non-perfect alignment of the triplet corrector, and small drifts in the tracking of the telescope during the acquisition exposure time. In the laboratory the procedure of target acquisition and displacement of the arms to put the spectral fibre in front of the object yields an accuracy of better than 10 μm or 0.17″.

In the last three nights of the run, a number of scientific exposures were obtained. The most important exposure was on a field of galaxies with magnitudes between 17.5 and 18.6. This field had been observed before with OPTOPUS by C. Balkowsky and R. Kraan-Korteweg. The field acquisition exposure time of 5 min and the spectral exposure time of 1 hour proved to be sufficient for the purpose. The spectrum displayed in Figure 5 is from a galaxy of $m_B = 18.6$, $z = 0.06$ and reaches a signal-to-noise ratio of 50. An actual measurement of the relative efficiency of MEFOS and OPTOPUS is almost impossible because of the strong dependence on seeing. A computation which takes into account telescope, fibre and spectrograph effects indicates that MEFOS should be approximately 25% more efficient than OPTOPUS.

Acknowledgements

The design and construction of this instrument was done under the responsibility of André Collin and the mechanical workshop of the CNRS at Bellevue. We are grateful to Daniel Hofstadt for his continuous support of the project, to all colleagues who helped us during the test in Chile – in particular A. Gilliotte, M. Maugis and O. Lavin – and to P. Focardi for her help in the data reduction.

News on ESO Instrumentation

S. D'ODORICO, ESO

1. EMMI

EMMI, the ESO Multi-Mode Instrument, is in regular operation at the Nasmyth B focus of the NTT since November 1990 (see *The Messenger* **61**, p. 51). In March and April of 1991 part of the EMMI team (H. Dekker as project coordinator and optical engineer, J. L. Lizon for opto-mechanical integration and testing, A. Longinotti and G. Raffi for the control software, R. Reiss for the CCD and the author for the astronomical tests) was again on the mountain for a number of upgrades on the instrument. These are shortly summarized below.

1.1 Multi-Object Spectroscopy

The operation and the first results of the MOS mode of EMMI have been described in the *Messenger* No. **63**. Further work was needed to refine the object selection software, for slight modifications of the hardware and to prepare a user interface. The work is now completed and the mode is in operation. Figure 1 shows one MOS observing sequence. Table 1 lists the main parameters and compares them with the equivalent facility in EFOSC1 at the 3.6-m.

1.2 Medium-Dispersion Spectroscopy with the Dichroic

The DIMD mode is now also in operation. In this configuration the slit is fed by a wide-band mirror instead of the blue- or red-optimized mirrors and the blue and red beamsplitter prism below the slit is replaced by a dichroic prism. All types of coatings represent state-of-the-art coating technology. The absolute efficiencies as measured in the ESO optical laboratory are shown in Figure 2. The EMMI control software fully supports the DIMD mode and allows parallel exposures (but sequential read-out) of the two CCDs.

TABLE 1: *MOS in EMMI and (for comparison) EFOSC1*

	EMMI	EFOSC1
Wavelength range (A)	4200–10000	3600–10000
Field (arcmin)	10×10	3.6×5.8
Punch field (arcmin)	5×8	3.6×~4
Aperture shape	slit	circ. hole
Hole size (arcsec)	1.3×8.6 1.9×8.6*	2.1 3.6
No. objects per field (typical)	10–30	5–15
Punching machine	on line (on EMMI)	off line (control room)

* Available October 1991.

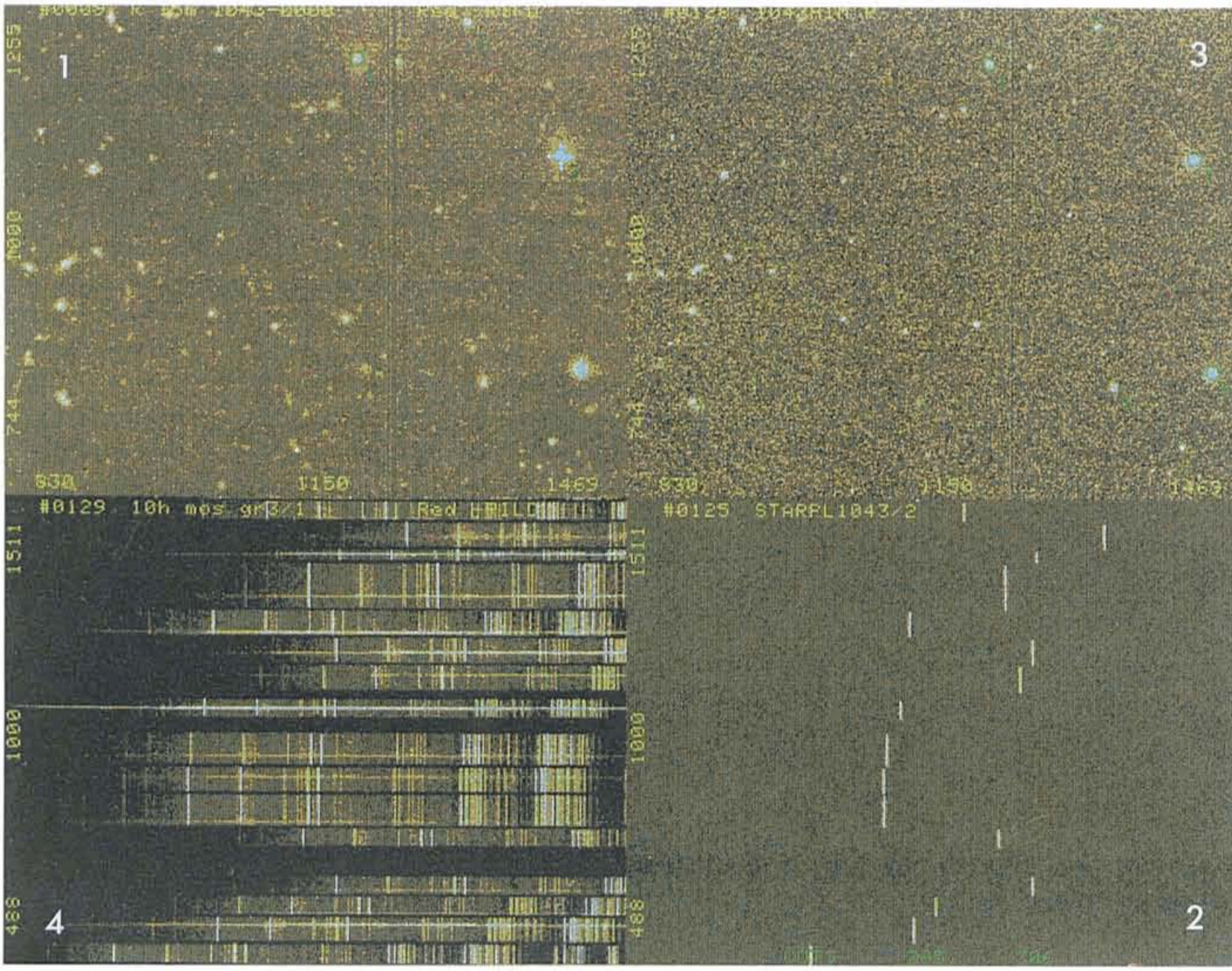


Figure 1: *These four images taken by H. Dekker, B. Peterson and the author in March 1991 illustrate the steps in obtaining a MOS exposure in the red arm of EMMI. Image 1 is a 15-minute R exposure of an empty field at high galactic latitude (see a deep image of the same field in the front page of the* Messenger *No.* ***64****). The brightest galaxies have visual magnitudes of 20–22. Object selection for later multi-slit spectroscopy is carried out with an interactive programme running at present in the IHAP environment. At the end a punching file is produced. This operation may take between 20 and 60 minutes depending on the number of objects and the complexity of the field. The aperture plates (up to 4) are mounted in a wheel in the instrument and punched there by a special device. A quick calibration exposure (image 2) is used to check the quality of the slits. The whole operation can take place in the afternoon preceding the spectroscopic observations. At the beginning of the night, a short image of the same field is obtained (image 3). The alignment correction is usually very small due to the high pointing accuracy of the telescope. The spectroscopic exposure is finally obtained: image 4 shows a 75-minute exposure on galaxies in the magnitude range 20.5-22.*

1.3 A Ford 2048^2 CCD Installed in the Red Arm

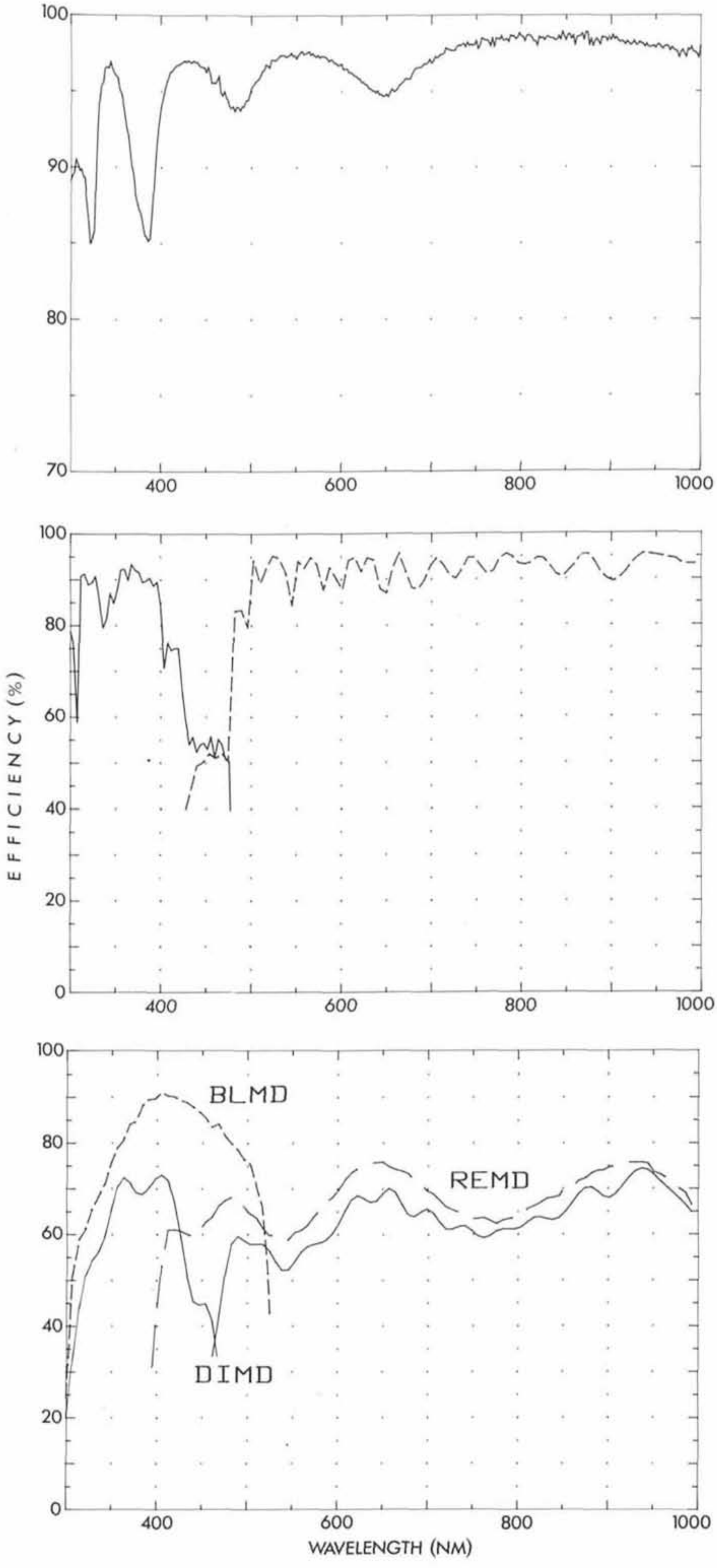
In the first six months of observations, the red arm of EMMI operated with a coated 1024^2 TH CCD as a detector. A number of complaints were received because of the compressed scale (0.44 arcsec/pixel), of the field limitation and of the heavy fringing at red wavelengths due to the coating. In April a 2048^2 Ford CCD was installed: this now gives the full field of the instrument (10×10 arcmin) with a better scale (0.35 arcsec/pix). The cosmetic is excellent and the CCD is uncoated. The efficiency is lower than for the coated Thomson CCD below 450 nm only, a region where the red arm is not really designed to operate. Still there are applications where the lower r.o.n. of the Thomson ($4e^-$ instead of 7 of the Ford) is an asset. While the discussion between the two detector options goes on, we plan to install a new CCD next year (see below).

TABLE 2.

THE SUSI PROJECT TEAM	
S. Balon	Procurement of mechanics. Integration and testing. Installation
J. Brynnel and W. Nees	Electronics
R. Buettinghaus	Integration and mechanical manufacturing
S. Deiries and T. Ducros	CCD preparation and testing
G. Hess	CAD design and drafting. Documentation
H. Kotzlowski	Instrument conceptual and mechanical design (Project Coordinator)
J.L. Lizon	Flexure testing
S. Longinotti	Control software
R. Reiss	CCD installation and optimization. CCD controller
G. Rupprecht	Procurement of optical components

1.4 Upgraded Version of the User Interface

EMMI is a complex instrument which offers on-line two large-size CCD detec-



tors and very different modes of observations, from echelle spectroscopy to multi-object spectroscopy. Given this background it is not surprising that the occasional user needs time to learn how to deal in the most efficient way with the instruments and its control software. It is the (perhaps biased) opinion of the author that instruments like EMMI should be ideally operated in a service mode to exploit in the most efficient way their capabilities, but it is very difficult, besides being expensive, to find and train the right operators for this type of work. In the meantime, we have to rely on the good will and the unlimited resources of the visiting astronomers. The excellent scientific results obtained at the NTT by many visitors prove that the learning process can be very fast and effective.

In these first 9 months of operation the control software, initially not bug-free, has been consolidated and a new, more friendly version of the user interface was installed in April. In November 1991, a further upgraded version will be installed, again with the goal to speed up some operations and to make the system simpler to use. Thanks to the work of the La Silla software group, a work-station has also been added to the system for data acquisition and to operate MIDAS at the telescope. This is of considerable help because the HP computer-based data-analysis system IHAP cannot handle large-size (2048^2) CCD images.

1.5 Planned Improvements of EMMI

Two detector changes are foreseen to further improve the performance of the instrument. In November of this year it is planned to install a thinned 1024^2 TK CCD in the blue arm to increase the efficiency and to increase the field. In the middle of 1992 it is – tentatively – planned to install a 2048^2 TK device in the red arm to increase the efficiency in the 400–500-nm range.

2. SUSI

With the installation of EMMI at the Nasmyth B focus of the NTT in November 1990, the possibilities of high angular resolution imaging at the NTT had become limited. With the installed optical cameras and CCD detectors, the EMMI pixel size is 0.29 arcsec in the

Figure 2: *Absolute efficiency of the EMMI wide-band coated mirror (top) of the dichroic (centre) and of the medium dispersion modes of EMMI (bottom). The blue MD channel (BLMD), the red MD channel (REMD) and the dichroic MD (DIMD) are identified.*

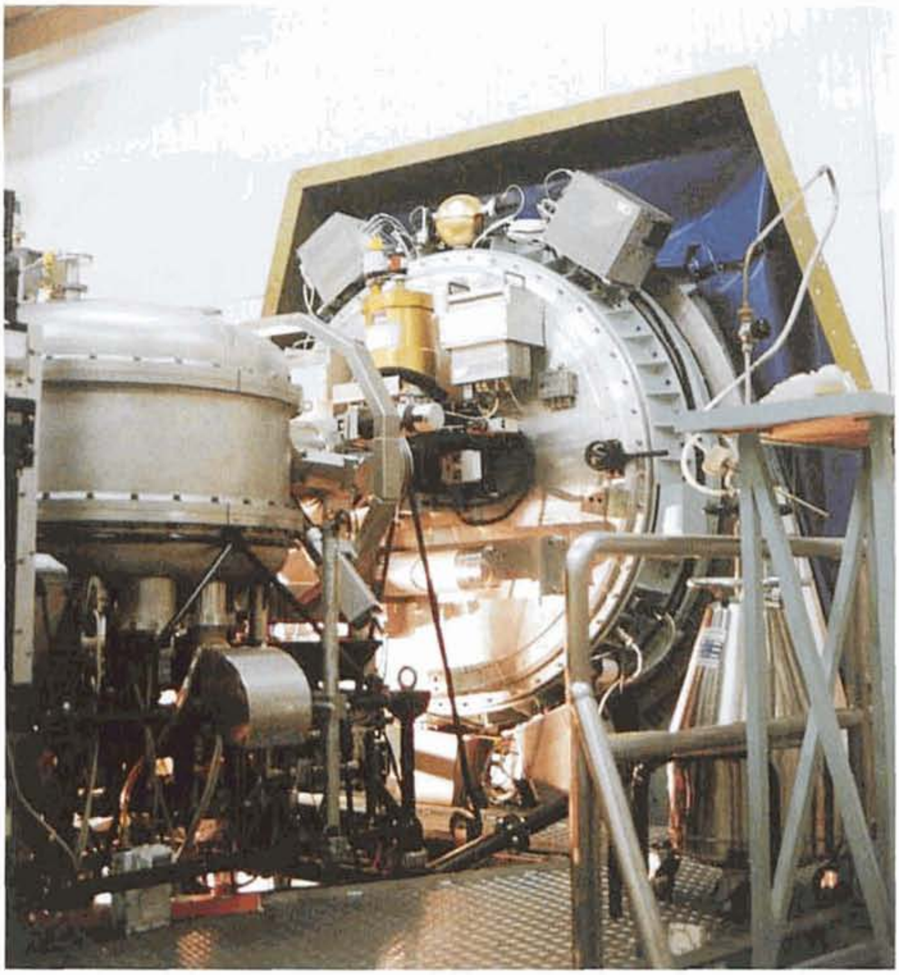


Figure 3: *SUSI installed at the Nasmyth A focus of the telescope. The CCD dewar and the control electronics are visible at the top of the adapter, the access platform and IRSPEC in the foreground.*

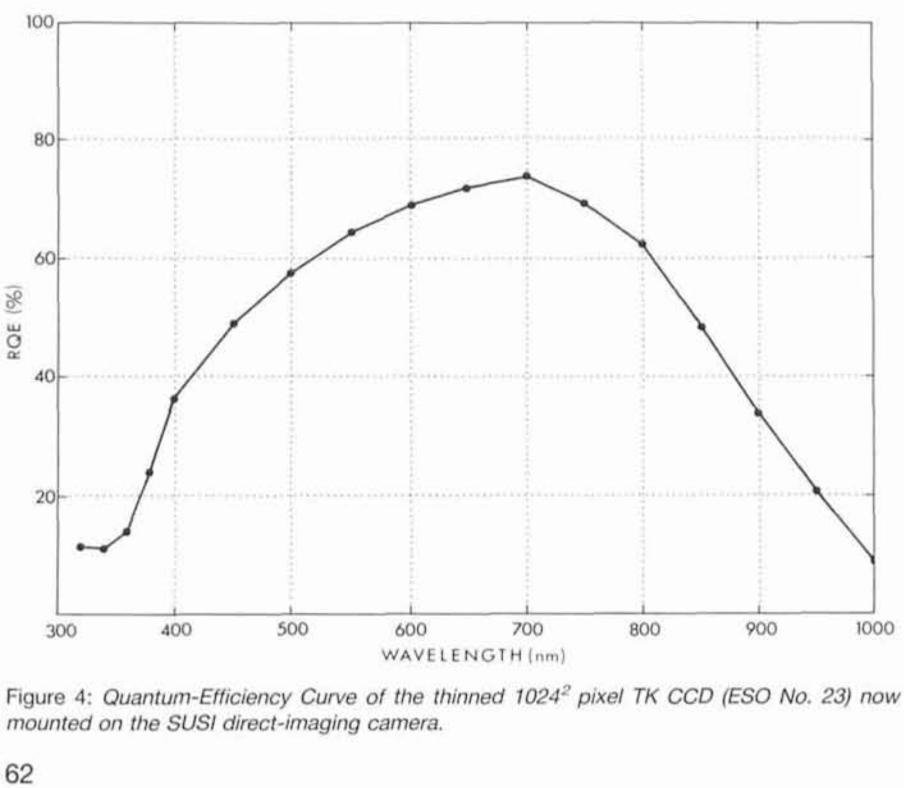


Figure 4: *Quantum-Efficiency Curve of the thinned 1024^2 pixel TK CCD (ESO No. 23) now mounted on the SUSI direct-imaging camera.*

blue arm with the 1024^2, 19-μm pixel Thomson CCD and 0.35 arcsec in the red arm with the 2048^2, 15-μm pixel Ford CCD. With these scales the CCDs cover the total corrected field of the instrument. It is an optimal compromise between the requirements of the different modes of observations of the instrument, but the stellar images are not sampled in an optimal way when the seeing is better than 0.7 arcsec approximately. The experience of the first year of operation of the NTT has shown that this happens for a relevant fraction of the observing time, and therefore unique opportunities for imaging at high angular resolution could be lost. To fill the gap, ESO developed in a 6-month crash programme a dedicated imaging facility named SUSI, the SUperb Seeing Imager to be mounted on the adapter at the Nasmyth A focus and to be used as a standby mode of EMMI for observations in unique seeing conditions (see also the article by J. Breysacher and M. Tarenghi on the introduction of flexible scheduling at the NTT in the *Messenger* No. **63**, p. 6).

In April 1991, SUSI was installed at the NTT and *immediately* offered to the visiting astronomers whose programmes call for high angular resolution. The user interface will be finalized in November 1991. The change from EMMI to SUSI (Nasmyth A to Nasmyth B) can take as little as 10 minutes. Figure 3 shows the instrument at the telescope. Because of the narrow space between the adapter/rotator and the derotator of the stationary IRSPEC, SUSI has a very simple and compact structure. At the centre of the field, a three-position mirror unit takes care of directing the light to an optical CCD or to a "visiting" detector (at this time a mechanical dummy is mounted) or to let it finally pass through to IRSPEC. The CCD dedicated mirror used at present is aluminized. In November, a wide-band, high-efficiency coated mirror with the efficiency shown in Figure 2 will be installed. A filter wheel with 8 positions is placed in front of the CCD shutter in the F/11 converging beam of the NTT. The internal diameter of the single filter cell to be fitted in the wheel is 60 mm. The CCD detector presently used is a thinned TK 1024^2, 24-μm CCD. This leads to a pixel size of 0.13 arcsec and a field of 2.2×2.2 arcminutes. The quantum-efficiency curve as measured by ESO is given in Figure 4. The design of the mirror unit and of several other parts profited from the experience on the EMMI functions. Still, to have the instrument designed, built by external firms, integrated and tested in Garching and later in Chile within little more than 6 months was a major achievement

Figure 5: *(a) A 2-minute R exposure on the irregular galaxy NGC 3109 at the red arm of EMMI. A windowed format of 1700×1000 pixels (10×5.8 arcmin) in the 2048² Ford CCD was used. The FWHM of the stellar images is 1.1 arcsec. (b) A 3-minute exposure of a section of the same galaxy taken with SUSI through a Gunn i filter. The FWHM of the stellar images is 0.55 arcsec. The two white crosses near the faint spiral galaxy at the centre of the image are separated by 2 arcsec. The brightest star is identified by the two white arrows in the corresponding EMMI image.*

Figure 6: *The centre of the Terzan 7 cluster from a 900-second B exposure with SUSI (courtesy of Roberto Buonanno, Osservatorio Astronomico di Roma). The FWHM of the stellar images is on average 0.46 arcsec.*

for which the SUSI project team (see Table 2) is to be congratulated. That the effort paid off can be seen from the two examples of astronomical observations (Figs. 5b and 6).

MIDAS Memo

ESO Image Processing Group

1. Application Developments

Besides on-going developments of new packages and improvements of existing ones, many small changes were made in the MIDAS system to remove bugs or to increase functionality and/or user friendliness. The most important ones are given below.

In the Echelle package two new methods for order definition and ripple correction have been added. Of course, the old methods are still available.

Two new commands have been implemented to correct bad rows and columns in CCD images. The method is based on a poster paper presented by G. Pojmanski at the 3rd ESO/ST-ECF Data Analysis Workshop.

The FILTER commands have been modified to take care of the frame boundaries in the filtering. In addition, the FILTER/MEDIAN command has been revised to increase its speed.

Several commands have been added to improve the usage of catalogues in