used with a 2048^2 CCD from Tektronix, which has not yet materialized on the market. A faster camera was then built to match smaller CCDs without too severe losses of the spectroscopic capabilities, but paying a price in terms of sampling frequency of the images in the detector plane. Two actions are underway to improve the situation by the beginning of 1991: ESO will install a CCD of smaller pixel size (0.35 arcsec/pixel) on the red channel and is building a CCD camera to be permanently mounted at the other nasmyth focus (pixel size about 0.1 arcsec) to exploit the windows of exceptional seeing (hopefully down to about 0.3 arcsec FWHM).

Examples of Astronomical Observations

The commissioning period in June–July was centred on the full moon and plagued by the first heavy rain of the year. It was however still possible to collect a number of astronomical observations. Many of them were obtained with a specific goal in mind (e.g. stability tests during long integration, measurements of the absolute efficiencies in the various observing modes, testing of the photometric accuracy and of the image quality, testing of polarization effects by mirror 3, etc.). The analysis of the data will further verify these aspects of the performance of the instrument at the telescope and will serve as input to the operating manual. We also obtained astronomical observations for illustrative or scientific purposes and four examples are shown in Figures 4 through 6.

The analysis of the first EMMI observations has just started but the preliminary reductions confirm that EMMI is up to or better than the target specifications (see e.g. the limiting magnitudes in Table 4 of the 1986 paper quoted above). The combination NTT-EMMI is likely to become a powerful tool for a wide range of astronomical programmes. Good luck to the future observers!

Acknowledgements

The successful maiden voyage of EMMI is the result of the efforts of several persons at ESO. Some contributed to a very specific task only, others have spent a large fraction of their working time in the last four years on the project.

The table at page 55 is an attempt to identify the EMMI project team and their tasks using a few words only: as such it is hardly exhaustive and it might be unfair to a few.

If someone discovers himself forgotten, would he please blame the stress of 20 days and nights of commissioning and forgive me. All have to be praised for their skill, patience and care: they managed very well indeed. A special, personal thank-you goes to Hans Dekker for overseeing the project with an optimism which fortunately is superior even to mine and to Jean-Louis Lizon for the infinite numbers of hours that he has spent in Garching and at La Silla carefully dealing with EMMI's 29 functions, one by one and together.

New 2D IR Array Detectors for Imaging and Spectroscopy at ESO

A. MOORWOOD, ESO

The lack of recent news in the *Messenger* may have created the impression among some infrared observers that perhaps not much has been going on in Garching to upgrade the performance of the infrared instrumentation on La Silla since IRAC was offered in April 1989. In fact, this has been a period of particularly intense activity aimed at expanding our infrared capabilities on La Silla in several areas considered to be both of immediate scientific interest and important preparatory steps on the road to implementing the VLT instrumentation plan. Our overall aim is to provide La Silla with first class imaging plus some low resolution spectroscopic capabilities throughout the infrared from 1 μm to ~17 μm plus an upgraded IRSPEC for 1–5 μm medium resolution long slit spectroscopy before we reach the period of peak effort required on the VLT instrumentation. This is an ambitious goal, at the limit of our resources, and a key element is of course the procurement of high performance array detectors which, given the rapid evolution in this field, their high cost and the need to obtain import/export approval, is not a trivial exercise by any means. In addition to our ongoing negotiations with Philips Components for a replacement 64 × 64 Hg : Cd : Te array for IRAC, therefore, we have also been in contact since early in 1989 with several other major detector manufacturers with the aim of procuring 2 D IR array detectors for the upgrade of IRSPEC at the NTT and to equip the new IRAC 2 cameras being developed to accommodate 256 × 256 format arrays. During the same period we have also been developing a new VME based acquisition system capable of handling the various different readout schemes and formats anticipated, expanding our laboratory test facilities, designing and tendering for the IRAC 2 cameras, preparing for the transfer of IRSPEC to the NTT and finalizing the technical specification of a 10-μm camera/spectrometer to be built in collaboration with the Service d'Astrophysique, CEN, Saclay.

Following a number of events within the space of a few weeks around the end of June and early July it is now possible to report here some positive results of these efforts. The most concrete is the delivery of an engineering and the first of two 58 × 62 InSb science grade arrays from the Santa Barbara Research Center whose procurement started with our request for quotation in January 1989 and is illustrative of the leadtime involved in obtaining such devices. Exhibiting dedication beyond the call of duty, Gert Finger braved 50 °C heat during one of the worst forest fires in Californian history to collect the latter at the beginning of July. Only a few days later, during a visit to Garching by Dr. K. Vural, head of the Imaging Devices Division of the Rockwell Science Center, we were able to draw up the technical specifications for a 256 × 256 Hg : Cd : Te array whose procurement had been approved by the STC and Finance Committee in May. Towards the end of July, in fact about a month after the effective kick off following the preliminary design review, the contract for the 10-μm camera was signed at Saclay. One disappointment has been the fact that we have been unable so far to replace the 64 × 64 Hg : Cd : Te array in IRAC both to offer improved performance to visitors and to avoid conflict with our other projects which are competing for the same limited manpower resources. Although the formal contractual delivery date (end July) had not expired at the time of writing, Philips Components had initially hoped to deliver earlier and we have thus been in a state of readiness to test and install the array on La Silla for several months.

Although several uncertainties in our overall programme still remain therefore, the prospects for substantially improved infrared spectroscopic and imaging capabilities on La Silla are currently looking good and this is an appropriate time to review their anticipated availability in order to give the community time to prepare for them.

TABLE 1: *IRSPEC Characteristics*

Wavelength range	1–5 (μm)
Pixel size	2 (arcsec.)
Slit length	2 (arcmin.)
Gratings	No. 1 300 l/mm, No. 2 600 l/mm
Resolving power	1300–3000 (2 pixels)
Detector	
Quantum efficiency	0.89 (2.85 μm)
Operable pixels	99.6 %
Read noise	350 e
Dark current (35 K)	100 e/s
Well capacity	1 E6 e
Overall point source sensitivity	5–10 gain below 3 μm (TBD)

IRSPEC Upgrade

At the time of its installation at the 3.6-m telescope towards the end of 1985, IRSPEC was the first instrument of its type to be equipped with a self-scanned monolithic array detector. During Period 46 (October 1990–April 1991) it is now planned to both transfer IRSPEC to the NTT and to upgrade it by replacing its present linear array with a 2 D InSb array. At the NTT the instrument will be permanently attached to the telescope structure at one of the Nasmyth foci and will therefore not be subject to flexure effects. An optical derotator installed between the slit and the telescope adapter will be used to compensate for field rotation, TV slit viewing will be retained and an integrating sphere equipped with a black body plus continuum and spectral line lamps located in the adapter will be available for internal calibration.

Replacement of the present 1 D array with a 2 D array will provide a new long slit capability, higher resolving power, better sampling, improved sensitivity and should substantially reduce the problems of object centring and sub-spectrum curvature (the so-called "vignetting") experienced at the 3.6-m telescope. The scientific performance and versatility of the instrument should therefore be considerably enhanced.

Both the SBRC 58 × 62 and the more recently developed Cincinnati Electronics 64 × 64 element InSb 1–5.6-μm arrays have been considered for the upgrade. A prototype array on loan from Cincinnati Electronics has already been tested in Garching and is the first device to be operated with our newly developed acquisition system. The actual array tested could be excellent for the thermal part of the IRSPEC range but, as known in advance, exhibits a large drop in quantum efficiency at the shorter wavelengths and requires cooling to ~10 K to avoid dark current limitations. At present, therefore, it is planned to install either the SBRC array already in-house or the second to be delivered in September. Table 1 summarizes the main instrument characteristics expected with this array, which has 76-μm pixels compared with 200-μm in the present linear array, together with the array performance data supplied by SBRC but which we have yet to confirm by our own tests.

IRAC

For more than 18 months now we have been faced with the problem of replacing the 64 × 64 Hg : Cd : Te array from Philips Components which was unfortunately damaged accidentally at La Silla before it could be offered to visitors. First test images with this array had been promising despite a rather large number (~10 %) of "hot" pixels, and its large well capacity was particularly attractive for imaging in the thermal infrared longward of 3 μm (Moorwood, Finger and Moneti, *The Messenger*, **54,** 56 (1988)). In fact, this was an experimental device still on loan from Philips who kindly agreed to write off its loss at their expense and to accept an improved and more formal specification for its replacement. This nevertheless took time and, subsequently, technical problems appear to have arisen in some of the development work undertaken to achieve our new specification. It has consequently not proved possible to obtain this array as quickly as appeared possible initially although it is still expected at any time and will be installed on La Silla as soon as possible. In the meantime the camera is still available with its 2.3 μm cutoff 32 × 32 array which had been supplied by Philips initially only for dark current tests and was not intended for operational use due to its smaller format and low filling factor which limits both its overall sensitivity and photometric accuracy. Nevertheless, even if not with the planned performance, this new capability on La Silla has produced new scientific results and provided valuable observational experience.

IRAC 2

The IRAC 2 camera under development in Garching is similar in concept to IRAC at the 2.2-m but provides a larger field (~3 arcmin.) and is designed to accommodate arrays of 256 × 256 pixels which have just recently become available. It will be equipped with standard broad-band filters, narrow-band filters, a K-band scanning Fabry Perot etalon for imaging spectroscopy at R ~ 1000 and typically 5 selectable image scales in the range ~0.1–2 arcsec/pixel depending on the array installed and the telescope (2.2- or 3.6-m). Actually, two cameras are being built with the idea originally of keeping one in Garching to provide the flexibility of upgrading the array as and when possible and then exchanging with the one of La Silla. As noted above, negotiations are now proceeding with Rockwell for the supply of a 256 × 256 Hg : Cd : Te array which, on the basis of our discussions so far could probably be delivered at the earliest by the middle of next year providing the necessary export approval can be obtained. This array will have a long wavelength cutoff at 2.5 μm and its outstanding features are its large format plus extremely low read noise and dark current (values of 20 e and <1 e/s respectively have been achieved with already existing arrays) which are more than sufficient to ensure background limited performance in all the modes foreseen for IRAC 2. In addition to making the array available to the community as soon as possible, however, we have an additional interest in evaluating it for the "short" wavelength channel of the VLT Medium Resolution IR Spectrometer/Imager to be built by ESO (Moorwood and Delabre, 1990, ESO Technical Preprint No. 13 – to appear in Proceedings of SPIE Conference 1235). Both InSb and Hg : Cd : Te arrays of this size and sensitive out to 5 μm are also under development and of obvious interest for the second IRAC 2 and for the long-wavelength channel of the VLT Spectrometer/Imager. In the meantime it is still planned to restore the L (3.8 μm) capability of IRAC as soon as possible and, depending if and when we actually receive the Rockwell array, to consider equipping one of the IRAC2 cameras with the second of our 58 × 62-element SBRC arrays.

10-μm Camera/Spectrometer (TIMMI)

This is a new instrument for the 2.2-/3.6-m telescopes to be developed, as mentioned above, in collaboration with the Service d'Astrophysique, Saclay, with an additional contribution from the Observatoire de Lyon. Again, in addition to providing a new observational capability on La Silla, this instrument is intended to provide technical feedback and observational experience in preparation for the VLT. In particular it is of interest to evaluate the 64 × 64 Ga : Si detector array to be supplied by LETI/LIR in Grenoble for this camera and which is a larger format version of the array developed for the Infrared Space Observatory but with a larger well capacity to handle the higher background levels experienced in groundbased use. TIMMI will provide for broad- and narrow-band imaging in the 10-μm window and probably out to the short-wavelength end of the 20-μm window and for grism spectroscopy at resolving powers of several hundred. First tests on La Silla are foreseen for April 1992 and a more detailed description of this instrument together with the meaning of its acronym will appear in a future issue of the *Messenger* when the project is more advanced.

The ESO MAMA Detector

M. CULLUM and E. J. WAMPLER, ESO

Introduction

For some time ESO has been interested both in improving the performance of the ESO detectors in the Ultraviolet spectral region, and in developing a working pulse counting detector, similar to the IPCS. A working MAMA pulse counting detector equipped with a low dark current, UV sensitive, bi-alkali photocathode is now available to the La Silla user community. It offers good UV sensitivity, freedom from readout noise and cosmic ray events, real time monitoring of the accumulating signal and excellent linearity for faint sources. For observations of faint sources with high resolution spectrographs in the spectral interval λλ3000 Å – 4000 Å, the MAMA detector is more than competitive with the present ESO CCDs and is therefore the detector of choice for ultraviolet CASPEC or the CES observations.

In common with other pulse counting detectors, the device saturates with bright sources. This translates into a requirement for long integration times for the flat field exposures needed to remove the pixel-to-pixel variations in detective efficiency. But, unlike the CCD detectors, long dark exposures are not needed to define the background.

The < 1 μsecond temporal resolution of the MAMA also provides a capability for future activities involving high time resolution observations (speckle, interferometry, adaptive optics, etc.) for which ESO has no other suitable detector available.

In late February, 1989, the MAMA detector was mounted on CASPEC where its performance was directly compared to that of ESO's #8 RCA CCD. At the beginning of the run the detector suffered damage to the anode array which reduced the available size of the detector format. After the observing session the detector was returned to Munich and then to the manufacturers, Ball Aerospace Systems Group, for inspection and evaluation. A second run with the same detector took place in early March, 1990. Because it has not yet proved possible to repair the damaged anode array, the tube in use on La Silla still suffers from a number of defective anodes that reduced the size of the detector field of view available. Here we describe our experience with the MAMA attached to CASPEC on the 3.6-metre telescope.

CASPEC Observations with MAMA

The MAMA detector was shipped to Chile in February 1989 and attached to CASPEC at the end of the month for a 6-night engineering run. On the afternoon of the first day, while the tube high voltage was slewing, the anode array suffered an electrical failure that physically broke the connection to one of the anodes and destroyed about 40 transistors in the associated pre-amplifiers. It took two days to replace these transistors. During this time CCD # 8, the standard CCD for CASPEC, was mounted and observations of SN 1987 A together with several quasars were made. After the MAMA was repaired, it replaced the CCD and the observations of the Supernova and the quasars were repeated. Thus, it was possible to make a direct performance comparison between this RCA CCD and the MAMA.

Despite the fact that CCD # 8 has rather good sensitivity in the near ultraviolet, there is no question that the MAMA gave a better signal/noise ratio than did the CCD for faint objects at wavelengths less than λ4200 Å. Because the MAMA count rate limitation translates to very long calibration exposures, and because we do not yet have very much information about the stability of the MAMA detector, it is not possible to compare the performance of the two detectors for high signal/noise ratio spectra[1], or for objects that have a high flux rate. The brightest magnitude that can be observed with the MAMA/CASPEC configuration without attenuation is about $m_U = 8$. Because of the encoded nature of the MAMA readout, the defective anode spoiled a band of columns 64 pixels wide situated towards one end of the detector field (see Fig. 1). Because we did not want to bridge the defective pixels in the data reduction process, we used the MAMA with the Short Camera and 79 gr/mm echelle so that a complete order could be recorded in the undamaged area. This resulted in a somewhat undersampled spectrum since the MAMA has 25 μm pixels as compared to the 15 μm pixels of the CCD. If the MAMA detector had the full format available, it would have been possible to use the CASPEC Long Camera to have obtained better matching of the MAMA format to the optical format of CASPEC. This option would have reduced the spectral coverage of the spectroscopic system.

[1] It should be remembered that photon-counting detectors are normally not optimum for high SNR applications.