ter/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.

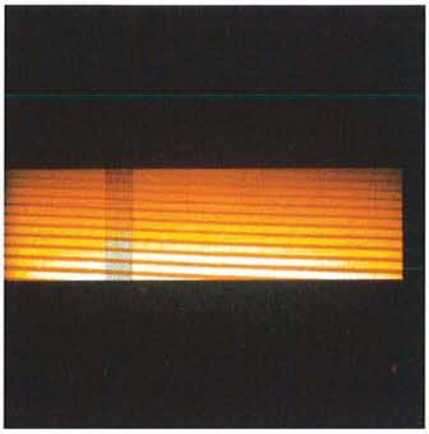

Figure 1: *A flat field image taken with the ESO MAMA detector. The spectral range runs from about λ3500 Å to λ4100 Å. The vertical dark stripes to the left of the image and the horizontal dark line that runs from the left to the centre of the image are due to defective anodes within the tube. Ultraviolet wavelengths are to the top.*

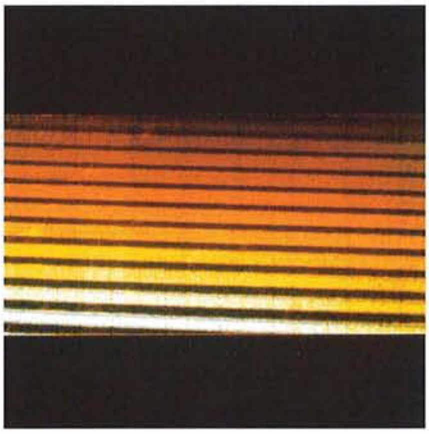

Figure 2: *An expanded view of Figure 1. The "chicken wire" structure seen in the flat field is due to small gain differences between the different amplifiers.*

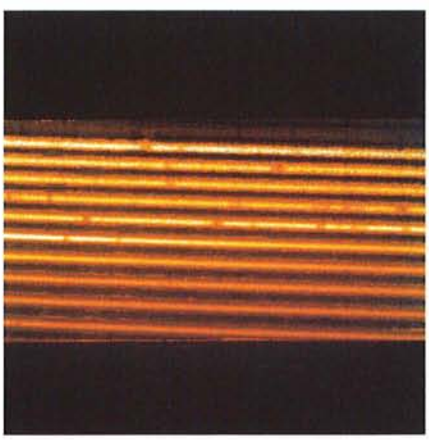

Figure 3: *A spectrum of the 16-mag quasar 1101-264. This spectrum has been divided by the flat field exposure shown in Figures 1–2. Note that the response is now very smooth.*

From a cosmetic point of view, the MAMA is comparable to CCD # 8. Evenly spaced across the detector format, a number of individual vertical columns showed about 20 % less response than their neighbours. However, typical differences between adjacent columns is ±5 %. Similar behaviour exists also for the rows. These characteristics, due to the discrete nature of the anodes, are largely cosmetic since they do not significantly influence the detective quantum efficiency. The only uncertainty is their stability; they will be hard to remove if they are unstable. During our runs they proved to be stable in a given run, but we do not yet have enough experience to prove that they are, in fact, stable over a long period of time. In any event, amplitude of the fixed-pattern modulation was greatly reduced after the detector had been re-optimized before the March 1990 observing run. It may be possible to reduce these offsets even further so that they may not be a problem in the future, although this would necessitate changing the anode encoding scheme and, hence, the current MAMA electronics. Figure 2 illustrates the fixed-pattern modulation and Figure 3 shows a 5.6-hour spectrum of the 16-magnitude quasar 1101-264 after division by the flat field. Note that the spectrum is somewhat wider at far ultraviolet wavelengths than it is in the blue. This is probably due to the effects of atmospheric refraction differentially moving the UV spectrum relative to the blue during the long integration. Blue light was used to centre the quasar.

With the Short Camera, the MAMA detector showed a rather larger point-spread function than it showed in the laboratory in Garching. However, because the resolution obtained with the Long Camera (for which a more suitable field lens was available) was significantly better (FWHM ≈ 1 pixel), it seems clear that the field lens used for these observations was limiting the MAMA resolution with the Short Camera[2]. Also, sharp absorption features show increased residual central intensity in the MAMA spectra when compared to the CCD spectra. Possible explanations for this effect include: the non-optimum field lens used, scattered light in the MAMA tube, or due to scattering of photoelectrons in the tube. Again, the use of the CASPEC Short Camera taxed the resolution capabilities of the MAMA detector. Figures 4–5 illustrate these points.

The MAMA has a number of advantages over the CCD. ESO astronomers will probably find that the chief advantage of the MAMA is that in the UV spectral interval the MAMA has a higher Detective Quantum Efficiency than any other panoramic detector that has been deployed on La Silla. Another advantage is that since the accumulated spectrum is displayed as the integration proceeds, the astronomer can continuously monitor the overall system performance.

[2] A purpose designed field lens is currently on order and will be installed in the near future.

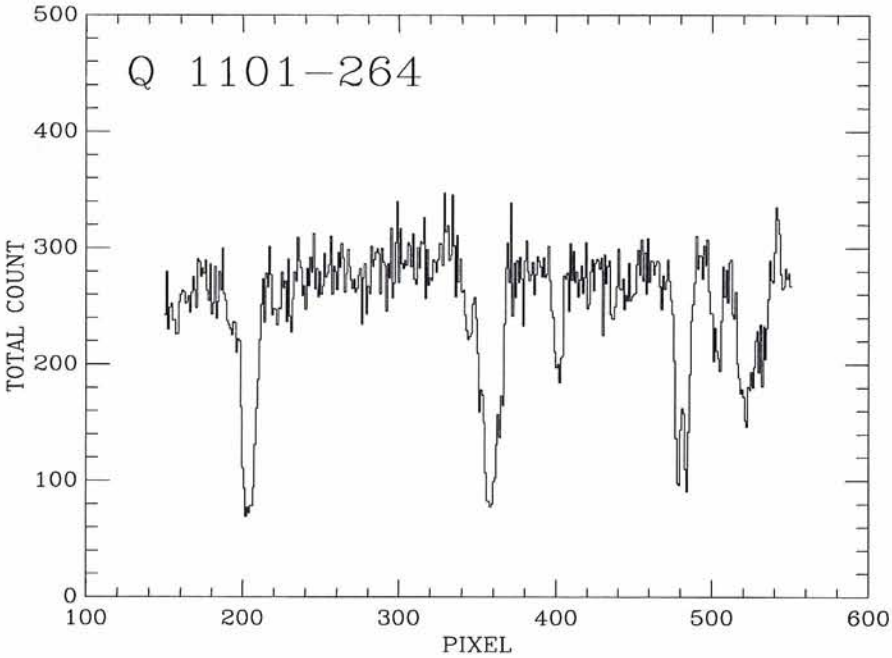

Figure 4: *A portion of the extracted spectrum of the quasar 1101-264. The scattered light background between the orders has been removed. This results in good scaling of the strong absorption lines.*

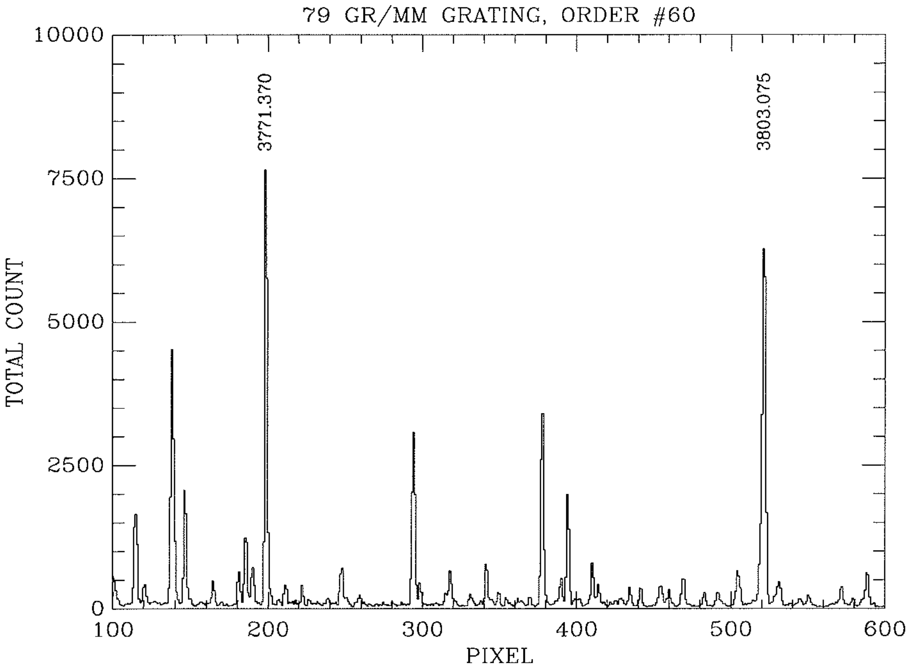

Figure 5: *The Thorium-Argon spectrum. It may be compared with that given in the ESO Atlas of the Thorium-Argon Spectrum (ESO Scientific Report No. 6 – July 1987).*

On-line monitoring of centring errors, clouds, etc. is possible when the ratemeter is attached to the detector. Because the astronomer can see the spectrum building up, the object identification is obtained early in the observation, and integration can be halted when it is judged that a sufficiently high signal/noise ratio has been obtained. It is therefore very well suited to those problems in which very long exposures of faint objects are needed. Because there is no readout noise, long exposures can be broken into short segments that are interspersed with calibration spectra. This is a significant advantage for instruments, such as CASPEC, that suffer from flexure problems. For spectra taken with very high spectral resolution, the rotation of the Earth smears long exposures. With the MAMA, long exposures of faint objects can be broken in order to obtain velocity calibrations. The MAMA has a very low dark background (about 0.1 event/pixel^{-1} hour^{-1} at 5C), and it also discriminates against the cosmic rays that plague long integrations with CCD detectors.

The ESO MAMA detector has a somewhat smaller ($\approx 1000 \times 250$ pixels) format than the CCDs and the loss of a number of pixels leaves one with only about 670×250 contiguous pixels. To achieve overlap of the spectral orders the short Camera must then be used. This results in a less than optimal mapping of a high resolution image onto the relatively coarse resolution detector. If, in the future, the full MAMA format becomes available, the CASPEC Long Camera could be used and the detector pixel size would be better matched to the spectrograph optical resolution.

The present data taking software used with the MAMA does not allow access to IHAP during integrations. The computer is therefore not then available to perform other tasks, such as the precise estimation of the signal/noise ratio of an exposure as the integration proceeds, arithmetic on previous exposures, computing the continually changing atmospheric dispersion parameters, etc. The atmospheric dispersion parameters are needed to accurately centre the UV image of an object in the slit since the ESO TV cameras detect only the visual image of the object. Because the differential atmospheric dispersion is so large in the UV, the ability to calculate the position angle and amplitude of the dispersion is particularly important for a UV sensitive detector such as MAMA. Future minor revisions to the data taking software will allow the MAMA detector to be used more efficiently.

In conclusion, the ESO MAMA is a working detector with particular advantages for UV observations. A few minor modifications presently being undertaken will make the detector even easier to use. It thus fills a needed capability in the instrument compliment of ESO.

If there is sufficient user interest in the MAMA detector, ESO could purchase additional tubes with improved characteristics. We suppose that this will depend to some extent in the future availability of improved CCD detectors that could become competitive with the MAMA for the UV applications, as well as the interest in applications where the fast temporal response time of the MAMA can be utilized.

Deconvolution of NTT Images of E/S0 Galaxies

F. ZAVATTI[1], O. BENDINELLI[1], G. PARMEGGIANI[2], G. G. C. PALUMBO[1,4] and G. F. BIGNAMI[3]

[1] *Dipartimento di Astronomia, Università di Bologna, Italy.*
[2] *Osservatorio Astronomico di Bologna, Italy.*
[3] *I. F. C. T. R./C. N. R., Milano, Italy.*
[4] *I. TE. S. RE./C. N. R., Bologna, Italy.*

Introduction

The New Technology Telescope (NTT) has recently become fully operational and subsequently made available by ESO to European astronomers in the standard scheduling procedure.

The first glimpses of the high quality images obtainable by virtue of the happy combination of advanced technology and excellent seeing conditions at La Silla have already been published (*The Messenger,* issues 56 and 58).

On the other hand, in recent years a considerable effort has been put into the development of highly sophisticated mathematical techniques to deconvolve images in one and two dimensions.

Although the effects of atmospheric