A F/5.2 Camera with a Thinned 2048^2 CCD at the EMMI Red Arm

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Characteristics of the New Camera

The red arm of the EMMI spectrograph/imager at the Nasmyth focus of the NTT (D'Odorico, 1990, *The Messenger,* 61, 51) was designed and built to operate with a F/5.2 and a thinned 2048^2, 27-μm CCD. When the instrument was under construction, the development of large-size, thinned CCDs was delayed, forcing ESO to build a faster camera to feed a smaller-size CCD. The instrument started to operate in 1990 in this configuration. After the delivery of a thinned SITe (former TEK) 2048^2, 24-μm CCD of relatively good quality, the F/5.2 camera was in February 1994 installed at EMMI. Figure 1 shows the camera and the CCD cryostat mounted on the side of the red arm of EMMI. In the imaging and spectroscopic mode, the new set-up provides a better sampling with a scale of 0.27 arcsec/pixel and an unvignetted field of view of 9.1 × 8.6 arcminutes. The image quality is better than two pixels over the entire field, even with the current curved CCD (see below). Figure 2 shows the FWHMs for stellar images distributed over the CCDs from an image obtained during the test time.

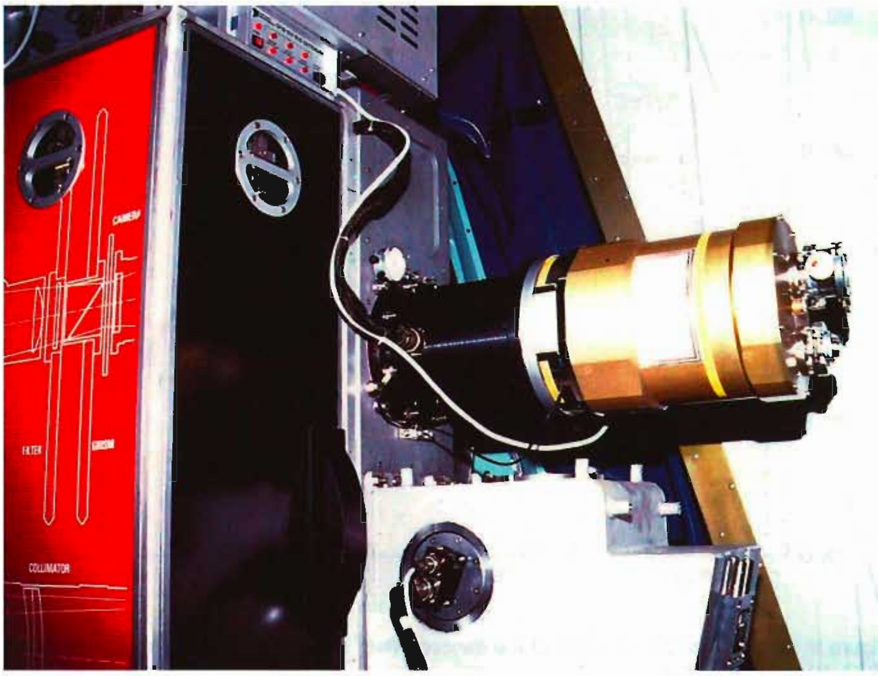

Figure 1: *The new camera and the CCD cryostat are shown on the red side of EMMI mounted on the Nasmyth adaptor of the NTT.*

The New CCD at the Red Arm of EMMI (ESO #36)

The new CCD with its dedicated ESO VME controller was fully characterized and optimized in its performance in the ESO Laboratory. The quantum efficiency curve is shown in Figure 3. With respect to the coated Loral chip which was installed until February 1994, the new CCD and the new camera bring an efficiency gain of 4.2 at 4500 Å, 2.2 at 5500 Å, 1.9 at 6500 Å and 1.8 at 8000 Å.

This gain has been confirmed by the determination of the efficiency curves of the instrument obtained from standard star observations. Other key parameters of the chip are summarized in Table 1. They have been confirmed by measurements at the telescope and will be regularly monitored.

It is important to notice two limitations of this CCD. The active surface is convex with a peak at its centre in the direction of the camera, an artifact of the manufacturing process which was not known in advance. The curvature can be well approximated by a paraboloid. The difference between the centre and the corners of the CCD is approximately 200 μm. If the instrument is focused on an intermediate plane, the image blur due to this effect will be one pixel or less, with the exception of the extreme corners of the image. A new field lens which matches this curvature has now been ordered. The second limitation is the relatively long reading time of the large chip: a little less than six minutes are needed from the closure of the shutter to the display of a slow read-out frame. This is reduced to about 4 minutes for the fast readout mode.

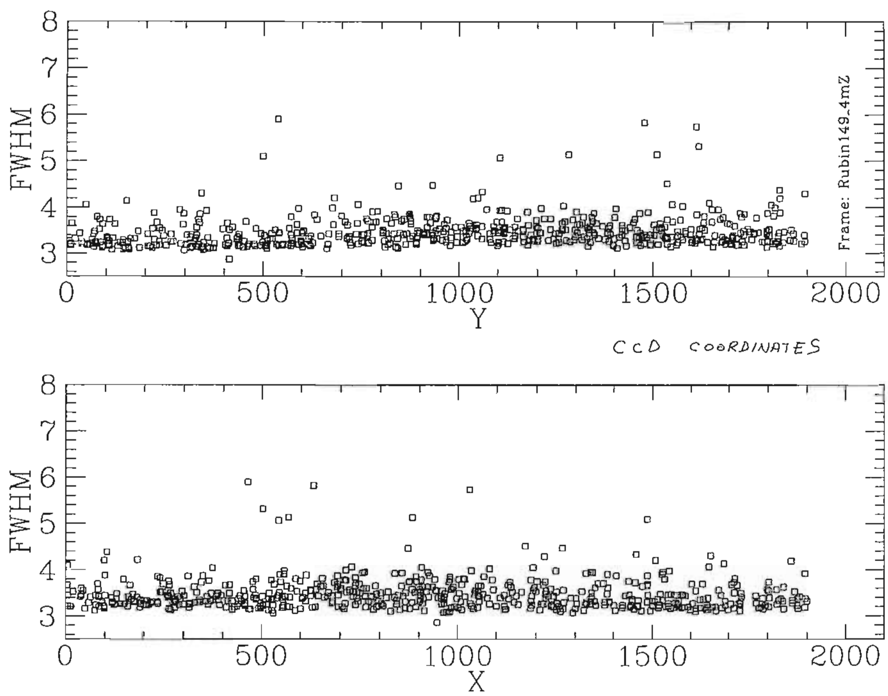

Figure 2: *FWHMs in pixels of stellar images in the x and y directions measured by J. Storm at various positions of one 4-min CCD frame in the Z colour.*

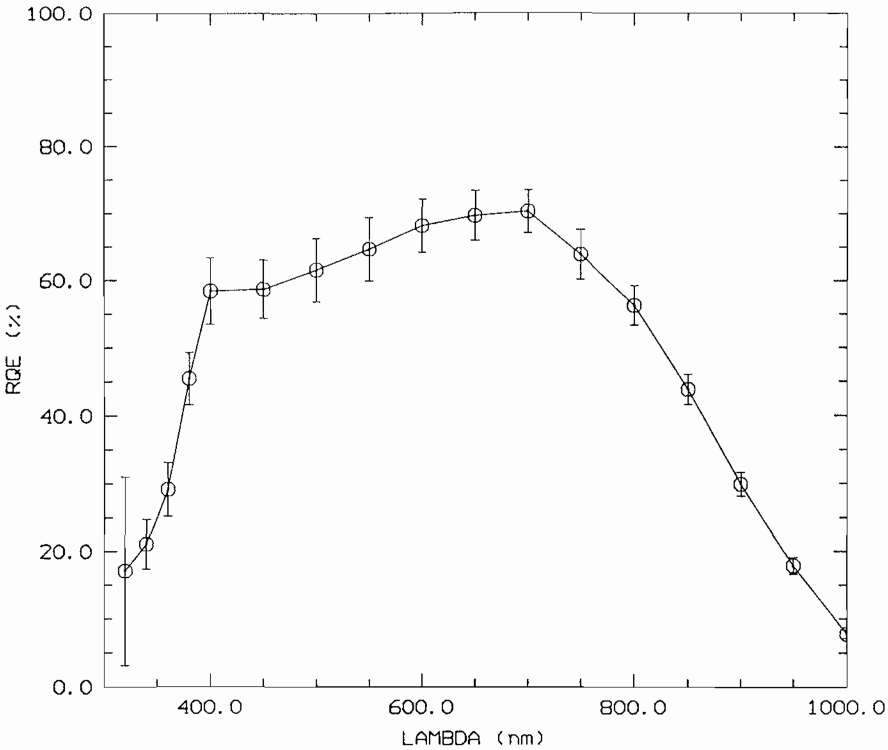

Figure 3: *Quantum efficiency curve of the thinned 2048^2 CCD (ESO #36) as measured in the ESO detector laboratory.*

This long reading time is due to the large number of pixels through a single output of the CCD but also to the limitation of the present ESO acquisition system based on the A900 computer. It is envisaged to replace it with a more efficient system based on VLT standards at the end of 1995. At present an option available to the user is the read-out through two outputs of similar characteristics (but not identical, thus requiring separate calibrations). The gain in slow mode is then 80 seconds. A quick-look mode (2 outputs, fast read-out, binning 2×2) requires about 1 minute.

Table 1: Main properties of the ESO CCD #36

Usable pixel number and size	2086×2046, 24 μm
QE	See Figure 3
Read-out noise (slow)	4.8 e/pixel
Read-out noise (fast)	8 e/pixel
Linearity	Better than 1 % from 30 to 200,000 e/pixel
Cosmetics	~10 partially hot columns (Amplifier D)
Dark current	≤5 e/pixel/hr at 151 K
Cosmic ray event rate	4 events/min/cm^2

An Updated EMMI Operating Manual

As of April 1st, 1994, the NTT has entered a new operation scheme which also foresees a major upgrading of the control hardware and software with the goal to fully exploit the unique capabilities of this telescope (see Baade et al. in *The Messenger,* 75, 1). As part of this effort, version 2 of the EMMI and SUSI Operating Manual is being prepared by E. Giraud and it will be released in June 1994. More detailed information on performance and data format of the instrument with the new camera and CCD will be included there.

Acknowledgements

The successful installation of the new camera and CCD is the result of the effort of several persons. H. Dekker planned and coordinated the activities in Garching and La Silla. O. Iwert, S. Deiries and R. Reiss put into operation and tuned the CCD in the laboratory. Again O. Iwert, R. Reiss together with P. Moore and P. Sinclaire installed the CCD and its controller at the telescope and optimized the performance there. T. Abbott has collected CCD test data at the telescope and verified the operating characteristics.

J.L. Lizon, H. Dekker and S. Moreau tested the optical camera in the laboratory. The first two later installed it at the telescope. They also conducted with Ph. Gitton a general check up of many EMMI functions. Astronomical test observations and/or their analysis were carried out by S. D'Odorico, J. Storm, and R. Mignani of the Dipartimento di Fisica of the University of Milano.

Test of an R4 Echelle Mosaic

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Why an R4 Echelle Grating?

The term "R4" describes one of the most important characteristics of an echelle grating, namely the tangent of the blaze angle. An R4 grating has a nominal blaze of 76 degrees, whereas the classical R2 has 63.5 degrees. Multiplied by the beam diameter, the tangent of the blaze angle yields the optical depth of the grating which determines the resolution that can be attained. The R4 echelle mosaic described here has a size of 450×130 mm, it is a downscaled prototype version of the UVES[1] echelle which will have a size of 840×214 mm. To manufacture it, a novel technique has been developed in

[1] UV-Visual Echelle Spectrograph. See *The Messenger* **70**, p. 13 for a full description of this dual-beam, cross-dispersed VLT instrument.