The Wide Field Imager for the 2.2-m MPG/ESO Telescope: a Preview

D. BAADE[1], K. MEISENHEIMER[2], O. IWERT[1], J. ALONSO[3], P. AMICO[1], TH. AUGUSTEIJN[3], J. BELETIC[1], H. BELLEMANN[2], W. BENESCH[2], H. BÖHM[2], H. BÖHNHARDT[3], S. DEIRIES[1], B. DELABRE[1], R. DONALDSON[1], CH. DUPUY[1], O. FRANKE[2], R. GERDES[1], R. GILMOZZI[1], B. GRIMM[2], N. HADDAD[3], G. HESS[1], H. KLEIN[2], R. LENZEN[2], J.-L. LIZON[1], D. MANCINI[4], N. MÜNCH[2], G. RAHMER[1], J. REYES[1], E. ROBLEDO[3], A. SILBER[1]

[1]ESO, Garching
[2]Max-Planck-Institut für Astronomie, Heidelberg
[3]ESO, La Silla
[4]Osservatorio Astronomico di Capodimonte, Naples

History

In November 1995, the *La Silla 2000* working group of the Scientific Technical Committee (STC) as well as the Observing Programmes Committee (OPC) identified a very strong demand by the ESO community for wide-field imaging (0.5–2 degrees) capabilities (cf. Andersen, J. 1996: *The Messenger,* No. 83, p. 48). In all major areas of research, the primary driver was the identification and preselection of candidate targets for more in-depth studies with the VLT (see also: Renzini, A. 1998: *The Messenger,* No. 91, p. 54). The OPC report remarked: *In any case, an array of CCDs of 8000 × 8000 will have to be constructed: This is feasible but will not be a small undertaking.*

The strong encouragement given to ESO to investigate possibilities of implementing such a facility could nevertheless not eliminate the fact that in ESO's mid-term planning hardly any resources were left that on the desirable short timescale could have been assigned to a new project. It was, therefore, timely that simultaneously the Max-Planck-Institut für Astronomie in Heidelberg (MPI-A) proposed to build a wide-angle camera for the MPG/ESO 2.2-m telescope. After some iterations on the general scope of the project, it was agreed that MPI-A would be responsible for mechanics, optics, and filters whereas ESO would provide the optical design, the complete detector system, and all of the control software. Later, the Osservatorio Astronomico di Capodimonte (Naples) joined the project as the third partner and fortunately was able to absorb the lion's share of the cost of the CCD detectors.

This article intends to give a concise preview of the result of these efforts. The commissioning of the new camera will

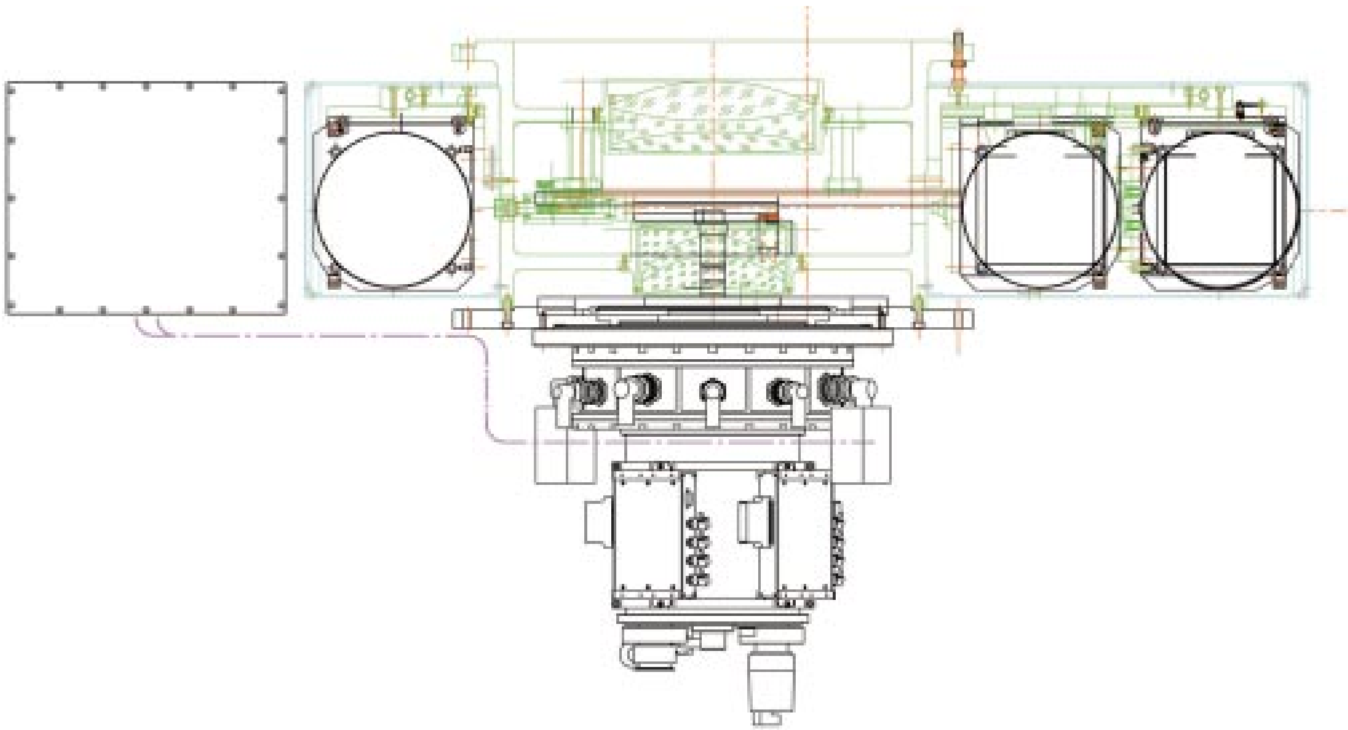

Figure 1: A schematic overview of the WFI. The left and the outer right circle are the apertures of filter holders mounted on the filter storage ring. The second circle on the right-hand side shows a filter after it has been moved out of the ring. It can then be rotated through 90 degrees out of the image plane, shifted to the left, and between the two triplets (shaded in green) inserted into the beam. The shutter is located right below the lower triplet. Next follows the cryostat head seen from outside with a number of vacuum connectors. The cylinder at the bottom (with a variety of attachments) is the liquid nitrogen tank. The large rectangle to the left is the FIERA control electronics box which also serves as a counterweight to balance the torque of the asymmetrically (with respect to the optical axis) located filter storage ring.

Figure 2: A view of the WFI filter exchange mechanism from the bottom and as assembled for first tests in spring 1998. The rectangle near the centre is a mount for interference filters (a dummy is visible) rotated into a plane perpendicular to the optical axis but outside the telescope beam; the recess for the filter intersecting the light towards the tracker CCD is on the left. The grooves at the top of the picture are located on the filter storage ring; there are fifty of them in total, and each can accommodate one filter. The rectangle in the upper right corner is a holder for the larger circular glass filters (with a dummy inserted) in its storage position. The filter ring can be rotated by means of the cogwheel in the upper left corner and the attached motor.

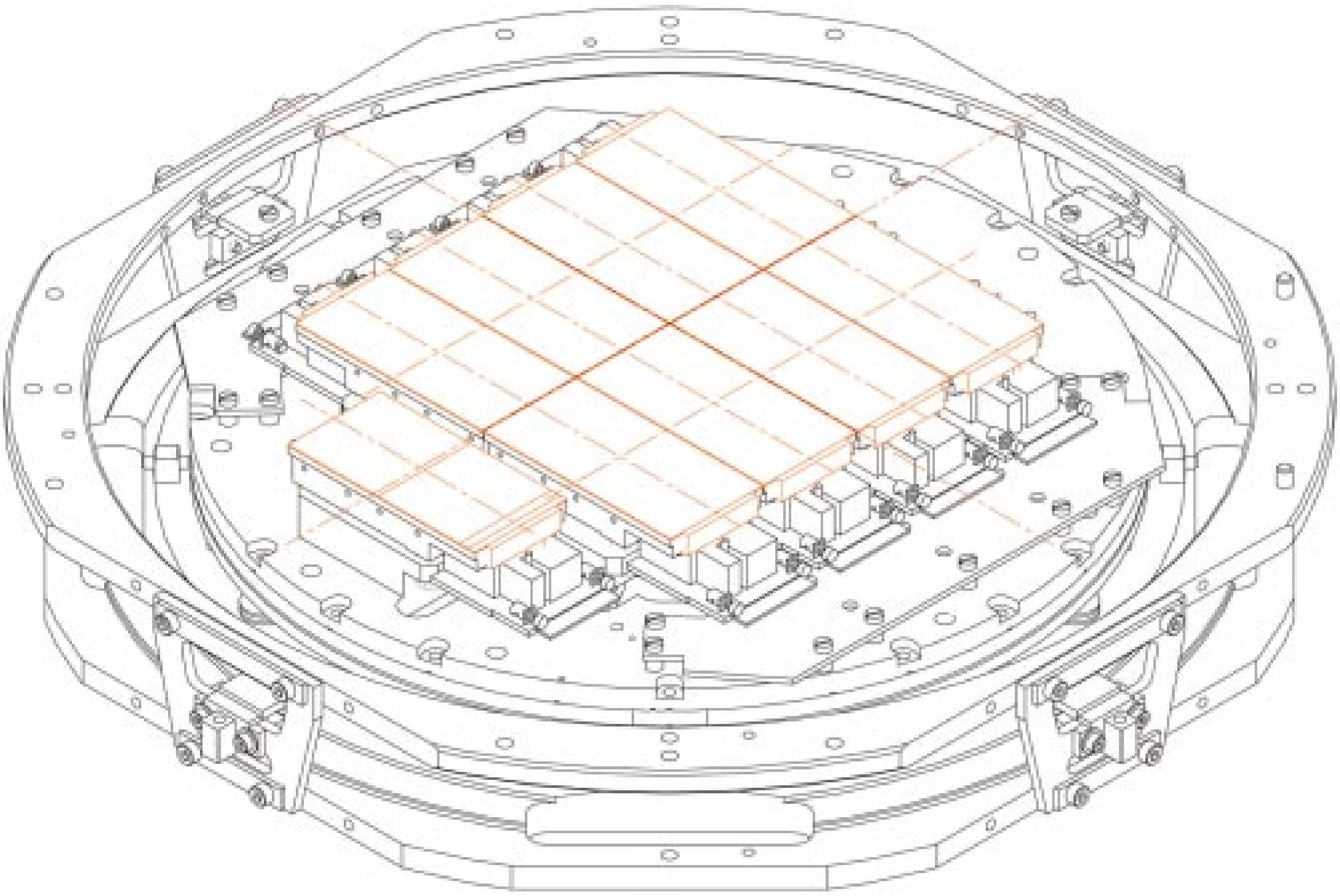

Figure 3: Partial drawing of the cryostat head of the WFI with the plate and sockets on which the CCD's are mounted. Two rows of four chips each form the science mosaic which measures about 12.5 × 12.5 cm². The extra CCD on the left front side is used for autoguiding.

take place in November and December 1998 (unfortunately, at the time of writing we were informed that a mishap during the manufacturing of one of the two triplets will probably produce this delay with respect to the original schedule), and first results will be reported in the March 1999 issue of *The Messenger.* The Wide Field Imager (WFI) will be the only instrument offered on the newly refurbished and upgraded 2.2-m telescope (cf. the report by the 2.2-m Telescope Team in this issue of *The Messenger).*

Optics

The optical design is essentially the one of a focal reducer with two triplets (a crude cross section can be seen in Fig. 1). It yields a scale of 0.24 arcsec per 15-µ pixel which over the field of view of 0.5 × 0.5 degrees varies by less than 0.1% (at 500 nm). From 350 nm to 1 µ 80% of the encircled energy falls onto a single pixel (except for the extreme field corners at long wavelengths). The throughput curve rises from 45% at 350 nm to 80% at 400 nm and thereafter remains flat through 1 µm.

Mechanics

Apart from providing the necessary support structure for the optics and protection against light and dust, the mechanics features two motorised functions (focusing is accomplished by moving the secondary mirror of the telescope). The first one is a large, roughly semi-disk-shaped shutter. It is designed to reach a precision of order 1 msec even for short exposures. The second one is the filter exchange mechanism. Up to 50 filters can be permanently mounted in a large rotating ring surrounding the camera (Fig. 1) where they are stored in a vertical position. An electromagnetic grabber can move a filter out of the ring, rotate it through 90 degrees, and slide it into the beam (Figs. 1 and 2).

Detector System

The focal plane is covered with a mosaic of eight 2k × 4k CCD44 devices from EEV. The pixel size of 15 µm matches the optical design. Figure 3 provides a 3-D view of parts of the cryostat head within which the chips are mounted. The gaps between the individual detectors (about 1.5 mm along the major and 0.8 mm along the minor axes) can be covered by multiple exposures with small telescope offsets. This procedure simultaneously allows cosmetic imperfections of the chips to be corrected for. Area-wise, the cosmetic defects are much less relevant than the inter-chip gaps. From 350 nm to 400 nm, the sensitivity rises from about 50% to 80% or above and only beyond 700 nm slowly decreases to slightly less than 30% at 900 nm; detectors and optics are not useful at wavelengths longer than 1 µm. The readout noise will be around 6 e^- per pixel, and the dead time for readout and file transfer to the instrument control workstation between consecutive exposures amounts to half a minute. Attached to the detector head is a liquid nitrogen-filled tank of the same type that is also used for many VLT instruments. All CCD functions are provided by ESO's standard FIERA controller and associated software.

Autoguiding

Besides the 2-by-4 science mosaic of CCD's, Figure 3 shows a ninth CCD on the western side (in right ascension). This so-called tracker CCD is of the same type as the other eight but has slightly lower cosmetic quality. It shares the shutter with the main detector array and is employed for autoguiding. Only the central 50% along the minor axis are unvignetted by the camera and the filter mount. But a sufficiently bright guide star can be placed anywhere on the chip. This CCD is controlled by the same FIERA system but completely independently so. A small window can be defined around the image of the star. After an integration, the duration of which is adjustable down to a fraction of a second, this window is shifted at a rate of about 40,000 rows per second to the readout register and then read at normal speed. The FIERA software automatically detects the star in this window, fits a Gaussian to it, and sends the results to the Telescope Control System which uses this information to let the telescope track properly.

Filters

In addition to glass filters, which in combination with the CCD sensitivity curve closely resemble the $B\ V\ R_C\ I_C\ Z+$ system (the U-band is broader than usual to achieve higher throughput), numerous intermediate- and narrow-band filters are foreseen. The complement of the latter will initially be incomplete but eventually cover the range from 370 nm to 930 nm in a quasi-continuous fashion suitable for the identification of high-redshift objects. A sub-set especially designed for this purpose is similar to the one described by Thommes et al. (1997, in R. Schielicke (ed.), Reviews in Modern Astronomy, Vol. 10, p. 297). A list of the filters available in Period 62 is provided on the WWW page referenced below. Glass filters are circular and also cover the tracker CCD. Medium- and narrow-band filters are square and do not extend into the guide star beam. Instead, a small separate glass filter is mounted in a corresponding recess in the holder so that the throughput is sufficient for autoguiding. In order to reduce differential atmospheric effects, the central wavelength approximates the one of the science filter.

Future Options

For Period 63, it is foreseen to test a set of linear polarisers. If the tests are successful, the polarimetry option will be offered in Period 64. Possibilities for slitless low-resolution spectroscopy are also being investigated.

The DAISY+ instrument and telescope control software environment and the control electronics of the 2.2-m telescope do not support low-level compatibility with the corresponding VLT systems. Therefore, a complete copy of the VLT Data Flow System (Silva, D., and Quinn, P. 1997: *The Messenger,* No. 90, p. 12) cannot be installed. However, in preparation for the VLT Survey Telescope (VST; *The Messenger*, this issue) to be erected on Paranal in the year 2001, which will have twice the field of view as the WFI, efforts are being undertaken for a partial implementation. The first step will be the development of a Phase 2 Proposal Preparation (P2PP) system. This will also enable suitable observing programmes to be carried out in service mode.

Updated information on the WFI will be made accessible via the WWW home page of the 2.2-m Telescope Team on La Silla (URL: http://www.ls.eso.org/lasilla/Telescopes/2p2T/E2p2M/WFI/news/WFI_P63.html).

D. Baade
dbaade.@eso.org