



TNG: THE OIG USER MANUAL

June 2000

R. Cosentino, D. Fantinel, A. Ghedina, E. Giro, S. Benetti, A. Magazzù

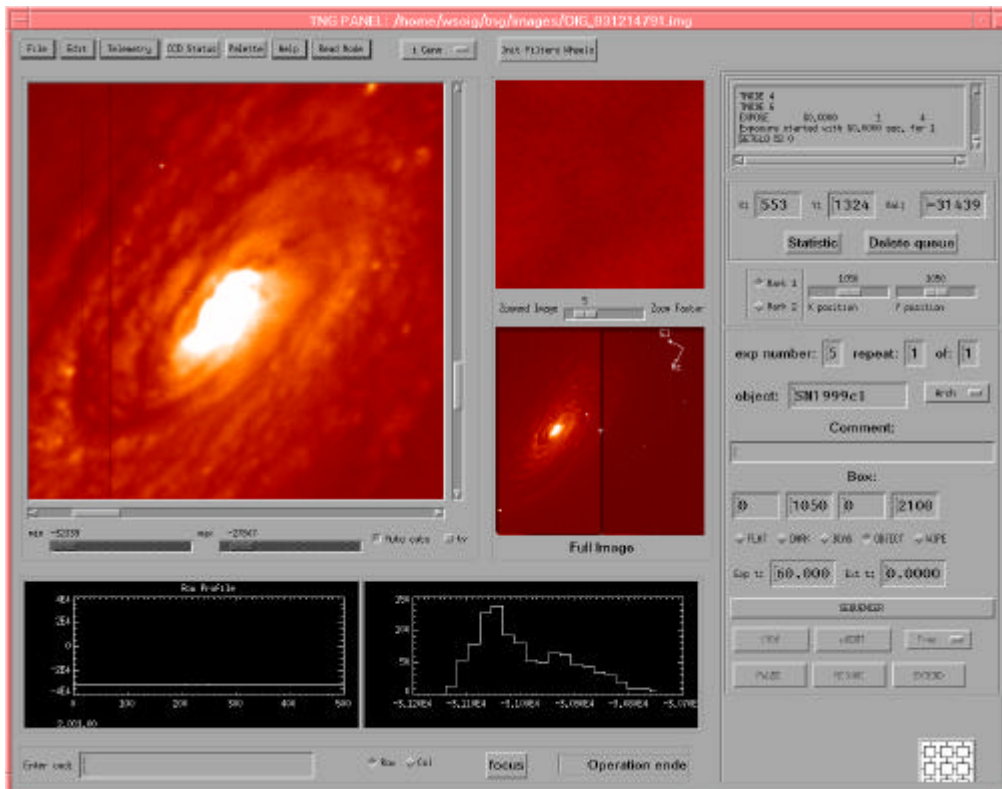
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Document available at: <http://www.tng.iac.es>





1 INTRODUCTION

The scope of following document is to give a detailed operational description of the Galileo Optical Imager (OIG).

Targeted persons for the use of this document are: the telescope operator, the instrument astronomer, the guest observer and every maintenance technician.

Due to the large standardisation of parts present in the TNG telescope it should be noticed that the description hereinafter is valid both for the handling of the scientific CCD cameras and for the service CCD cameras (trackers, Shack-Hartmann).

2 THE HARDWARE

2.1 THE NASMYTH A USER INTERFACE

The Nasmyth Instrument Interface A (NIA in the following) is the interface between the Telescope and the scientific instruments on the telescope arm A.

It is mounted on Derotator A and thus rotates with it. The NIA is composed of 4 main pieces (ranging in weight between roughly 200 and 950 kg each) and several other minor elements. When mounted it is like a parallelepiped measuring nearly 0.5×2×4 meters. You can see a picture of NIA in Fig. 2-1.

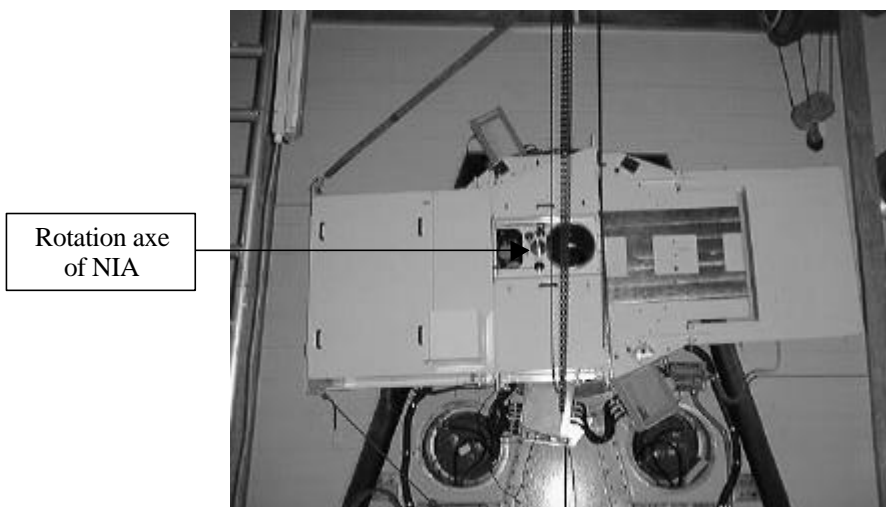


Fig. 2-1: The Nasmyth Interface mounted on The Derotator A without instruments.

In the centre of NIA you can find the OIG cryostat (see Fig. 2-2). It is mounted on the rotation axe of the NIA also containing the filter wheel system (see Section 2.3) and the sliding-carriage with the mirrors to direct the light to the IR camera, to the AdOpt module, or just to allow it passing through for the OIG.

Between the NIA and the cryostat there is the OIG shutter (Section 2.4). Electronics racks with the OIG controller, filter-wheel controller and shutter controller are placed on the external side of NIA and well accessible for technical operations (see Section 2.5).



All the instrumentation and NIA itself are powered by a remote controlled line starting from the telescope-derotator main cabinet (power-plant floor). All instruments have their own multiple plug and can be remotely switched on and off independently from the others.

2.2 THE OIG CRYOSTAT

The OIG cryostat is a custom modification of the standard INFRARED-LAB cryostat model ND-25. See Fig. 2-3.

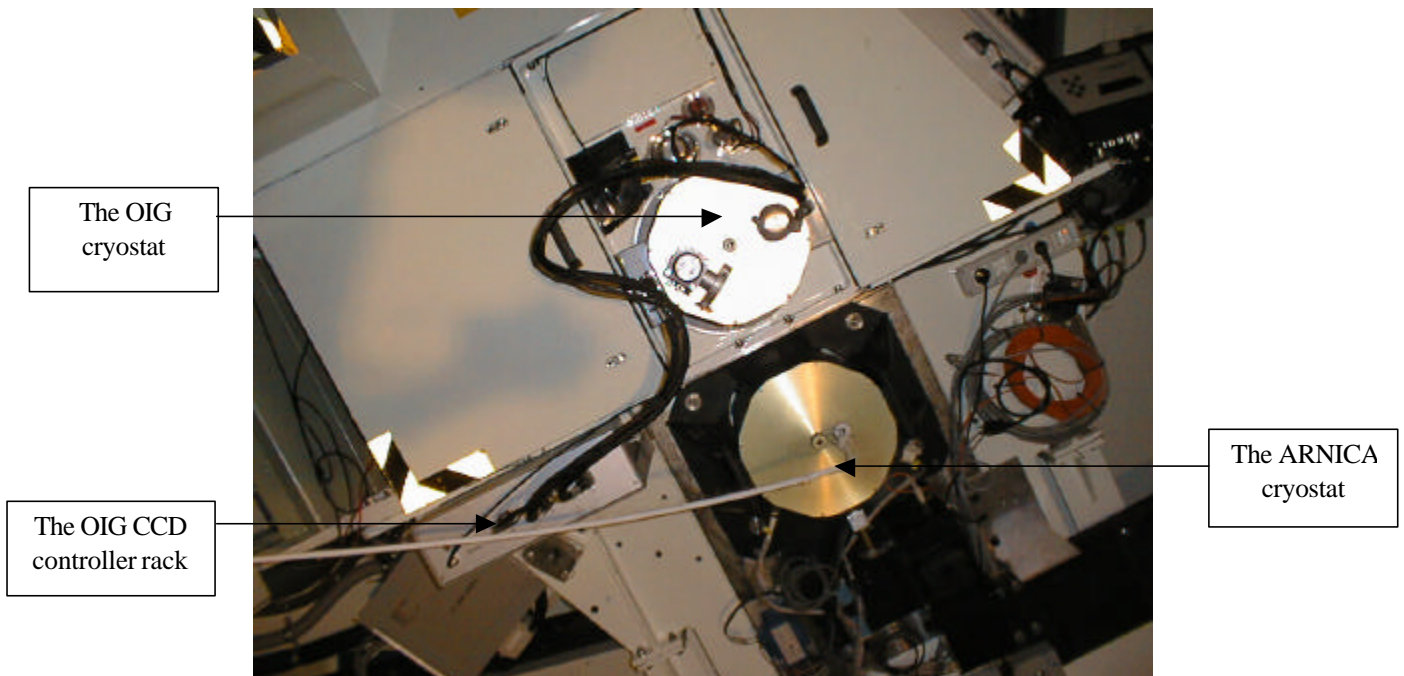


Fig. 2-2 The OIG and ARNICA cryostats mounted on NIA.

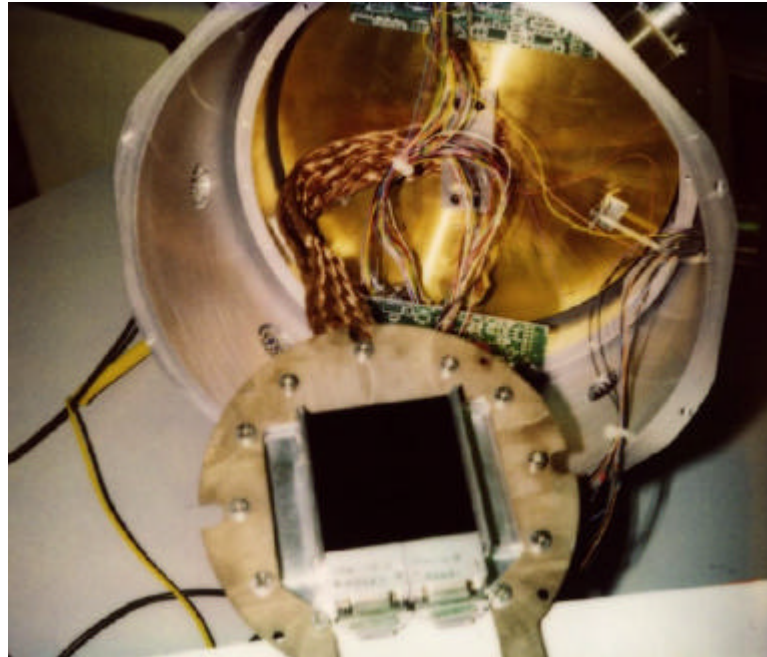


Fig. 2-3: Internal view of the cold plate with the CCD mosaic.

2.3 THE OIG FILTER WHEEL SYSTEM

There are 2 wheels mounted inside the NIA to select which filter has to be used for the OIG camera. Each wheel has 10 holes to provide space for 8 filters, 1 Atmospheric Dispersion Corrector (ADC) and a clear position. ADCs will be treated as filters in the following so that 18 filter positions will be available. Obviously when one is using the filter of one wheel, the other wheel will be on the clear or ADC position (actually there is no plan to mount any ADC and thus only the first option is implemented). Each filter holder has a writable/readable EPROM and for each wheel there is a Baluff sensor to write/read the EPROMs: there are then 18 positions for the wheels (each one corresponding to a pre-mounted filter) when using the Baluff sensor.

A picture of the filter wheel system can be seen in Fig. 2-4: obviously the shutter can't be seen when OIG is mounted. There is also a cover to protect the filters which in Fig. 2-4 has been removed. The whole system for one wheel (except for the wheel's brake) is drawn in Fig. 2-5.

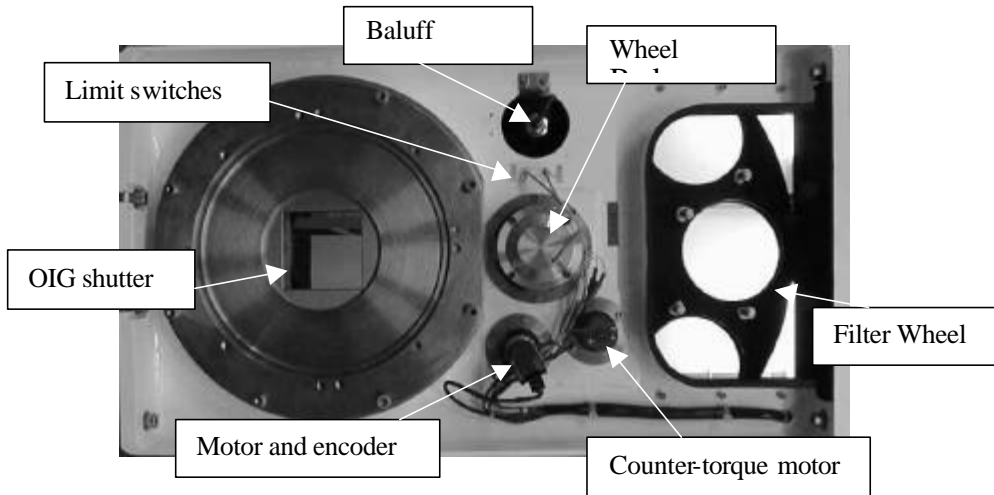


Fig. 2-4: The filter wheel system as seen from the outside of the NIA.

The program which allows operating the filter wheels is written in C and works under the PDOS operating system. The executable program, TASK19.c, is physically on the hard disk partition number 12 of VMEOIG. All VME systems can work in user or super mode; if in super mode (test and debugging phase) proceed as follows: to get there one has to connect a terminal (or sort of) to the VMEOIG, then to go to the hard disk partition 12 (if not already there) with the command:

```
>cd 12
```

and from there to start the GATE environment with:

```
>gate super.
```

All necessary tasks are spawned and a GATE prompt appears. From now on it is possible to send the commands, listed in Tab. 2.1, to the filter wheels.

The command to exit from GATE is `exit`.

CONNST		To check the connection status
INITFILT		To initialise the filters wheels
CLEAR		To select no filters
FILTER	<i>n</i>	To select filter number <i>n</i>
BALUFF	<i>n</i>	To move filter number <i>n</i> under the Baluff sensor
ROTABS	<i>w val</i>	To move the wheel <i>w</i> to the absolute position <i>val</i>
ROTREL	<i>w val</i>	To move the wheel <i>w</i> of <i>val</i> counts
ENBRAKE	<i>w</i>	To close brakes on wheel <i>w</i>
DISBRAKE	<i>w</i>	To open brakes on wheel <i>w</i>

Tab. 2.1: List of commands to TASK19.



CONNST - It is necessary to check the status of the connection between the VMEOIG and the NIA filter wheel before sending any command. This check is performed by the command CONNST.

If there is exchange of information between the two systems a message appears:

```
"The OIG Filter Controller is connected"
```

If on the other hand the connection is not present one sees:

```
"ATTENTION: The OIG Filter Controller is NOT connected"
```

This is probably due to the fact that the power of the rack is switched off or the serial cable is not connected. Check these two possibilities before proceeding.

INITFILT - This is a fundamental command if someone wants to drive the filter wheels in fixed positions, such as the clear position and a filter or an EPROM specified by their number. It is anyway **safer to use it always**, soon after the CONNST command.

If the connection is up, the filter wheels start to rotate and search for their respective edges, then set to zero their encoder's counts and move away from this position (they rotate roughly to the clear position). The whole procedure can take a few minutes and in the meanwhile messages appear to inform the user about the correct (or wrong) proceeding of the initialisation. Then the system is ready to receive safely any of the following commands.

It can often happen that, when the filter wheel is initialised being far from the edges' position, the system goes in Time Out. For safety reasons, Time Out happens roughly 20 seconds after the beginning of the initialisation while it takes much more time to the filter wheels to complete one whole turn during this phase. Anyway after 2 or 3 INITFILT commands the procedure should be completed.

CLEAR - This is the command to let the light go directly to the OIG, with no filter absorption. After the initialisation the filter wheels move next to this position but the command CLEAR should be sent anyway to be sure that the position is reached.

FILTER n - Actually there are only 8 filters mounted on the #1 filter wheel. It is then logical to give to **n** only values between 1 and 8. Greater values correspond to a CLEAR position, but with the inside of the filter holders not black anodised. When the filter is in its position you can see a message like:

```
+++++ Filter 3 is There. Brakes On. +++++
```

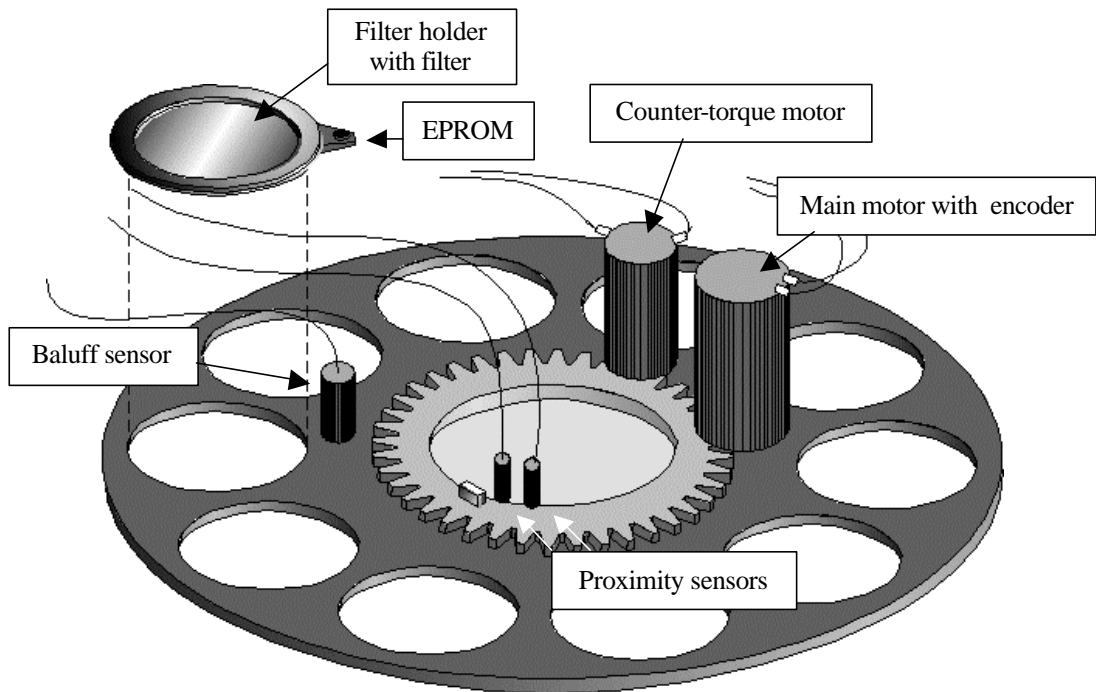


Fig. 2-5: Schematic drawing of the filter wheel system. The other wheel has the same component arrangement.

BALUFF n - Each of the filter holders has its own Baluff EPROM. When you give this command you choose to move one of the filter EPROM under the Baluff sensor in order to read what is memorised there. After the movement of the filter wheel you receive a printed message like the following one:

This filter is Johnson U:peak=368nm,pkTR=84%,FWHM= 93nm

ENBRAKE w - This command can be sent without initialising the system. It activates the brakes on one of the two filter wheels. You don't need to give this command when using commands like the previous ones because opening and closing the brakes is automatic in those procedures.

DISBRAKE w - This command can be sent without initialising the system. It opens the brakes on one of the two filter wheels. You don't need to give this command when using commands like the previous ones because opening and closing the brakes is automatic in those procedures.

ROTABS w val - This command could be sent without initialising the system. It moves one of the filter wheels to the absolute position **val**. **Never use this command if the system is not initialised OR if you don't know exactly what could be the consequences.** When the system is not initialised usually the encoder's counts start from the actual position and can be both positives and negatives, with values ranging roughly from -1670000 to 1670000. If the wheels move very fast, and is sent to an encoder value position which is further than the proximity sensors, it is possible that the proximity sensors don't recognise the edge and thus are not able to stop the rotation in time. If this happens one can get the filter wheel to be locked between the proximity edge and the mechanical edge.



ROTREL w val - This command could be sent without initialising the system. It moves one of the filter wheels to the relative position **val**. What is written for the previous command is still true here. **Never use this command if the system is not initialised OR if you don't know exactly what could be the consequences.**

When working under VME it may be necessary to read the values of the global variables that are used by this task.

Should this occur one has to write from the GATE prompt:

```
>glob 400
```

The list of Tab. 2.2 appears, only with the number and value of the global variables, and the time of last modification. To exit from the list the command is:

```
>Q (uppercase).
```

Name	#	Description	Before Init.	After Init.	Range values
INIT	400	Initialisation status	0	1	0,1
BIUZ	401	Bit 0 status wheel 1	0	0	0,1
BIUU	402	Bit 1 status wheel 1	0	1	0,1
BIUD	403	Bit 2 status wheel 1	0	0	0,1
BIUS	404	Bit 7 status wheel 1	0	0	0,1
BIDZ	405	Bit 0 status wheel 2	0	0	0,1
BIDU	406	Bit 1 status wheel 2	0	1	0,1
BIDD	407	Bit 2 status wheel 2	0	0	0,1
BIDS	408	Bit 7 status wheel 2	0	0	0,1
FILT	409	Filter number	0	0	0,18
BRA1	410	Brakes status of wheel 1	0	1	0,1
BRA2	411	Brakes status of wheel 2	0	1	0,1
POSU	412	Position of wheel 1	0	25000	0,1670000
POSD	413	Position of wheel 2	0	-33000	0,-1670000
ERP1	414	Error position of wheel 1	0	< 5	± 1670000
ERP2	415	Error position of wheel 2	0	< 5	± 1670000
CONX	416	Connection status	1	1	0,1
BALU	417	Baluff EPROM number	0	0	0,18

Tab. 2.2: List of global variables used in TASK19.

Moving the filter wheel when working under the user interface environment is much easier.

There is only one button to press in order to check both the connection status and to initialise the filter wheel.

From a pop-down menu it is then possible to choose which filter to set for the observation. The same commands given under VME can be sent from the command line in the user interface.

Solving Problems

If after 2 or 3 initialisations the filter wheel seems to be not responding correctly it is possible that it got stuck between the mechanical edge and the proximity sensor. It is necessary to set it free with GATE commands, from the VME or from the user interface (depending on which one you are using). It is a very simple procedure and it consists only in giving relative movements to the wheel that got stuck with the command **ROTREL w val** (see above).

Just remember to give always **positive values for wheel #1** and **negative for wheel #2**.



2.4 THE OIG DOUBLE-BLADE SHUTTER

The OIG double-blade shutter is designed to cover the whole field of the optical imager. The working area is 80 X 80 mm and the dimension is 220 X 150 X 35 mm. Thanks to a peculiar double blade mechanics and a two step motor driving system, the shutter assures a uniformity of exposure time of ± 0.8 ms over the whole field when exposed for 1 sec, while minimum exposure time is 10 ms.

The present OIG user-interface allows the operator to insert a minimum exposure time of 0.1 Sec, we found this minimum exposure time doesn't introduce any appreciable error on the taken frames.

The control electronics is located in the filter control rack and provides a simple interface to the CCD controller.

Fig. 2-6 shows the shutter block diagram and Fig. 2-7 shows the operating modes of the shutter. A schematic drawing of the curtains inside the shutter is shown in Fig. 2-5.

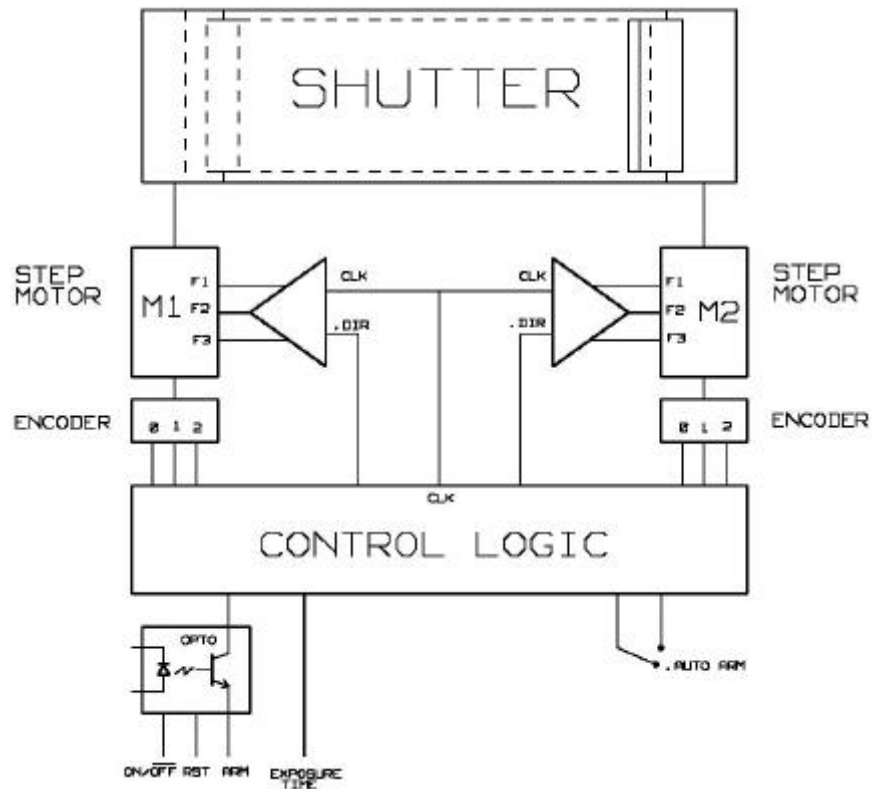
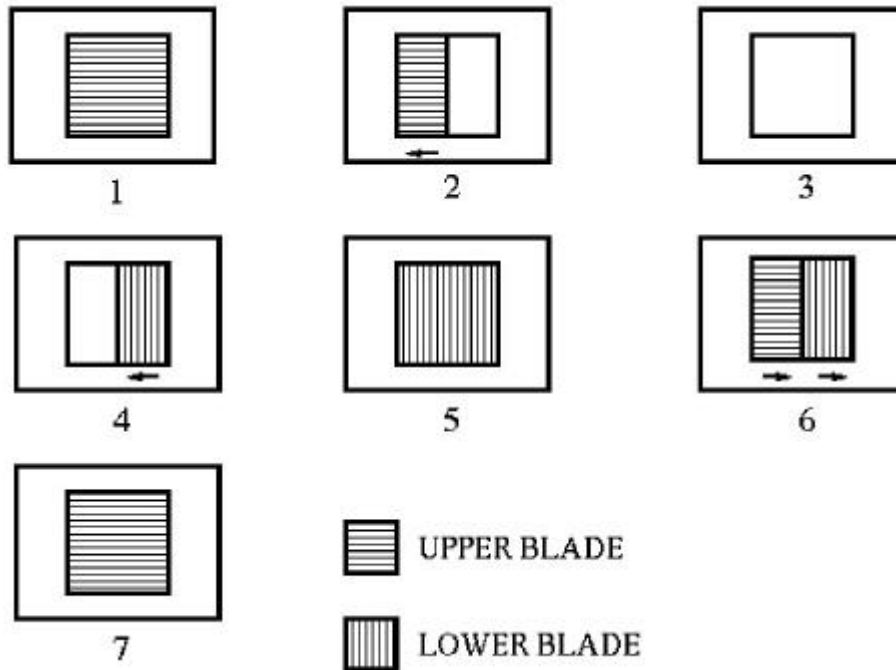


Fig. 2-6: Shutter block diagram.



1. THE SHUTTER IS READY TO BE OPEN (both blades are loaded)
2. THE SHUTTER IS OPENING (upper blade is moving while lower blade is loaded)
3. THE SHUTTER IS OPEN (upper blade is open while lower blade is loaded)
4. THE SHUTTER IS CLOSING (upper blade is open and lower blade is moving)
5. THE SHUTTER IS CLOSE (both blades are open)
6. THE SHUTTER IS CLOSE (both blade are loaded)
7. THE SHUTTER IS READY TO OPEN (both blades are loaded)

Fig. 2-7: Schematic view of the double-blade shutter operations.

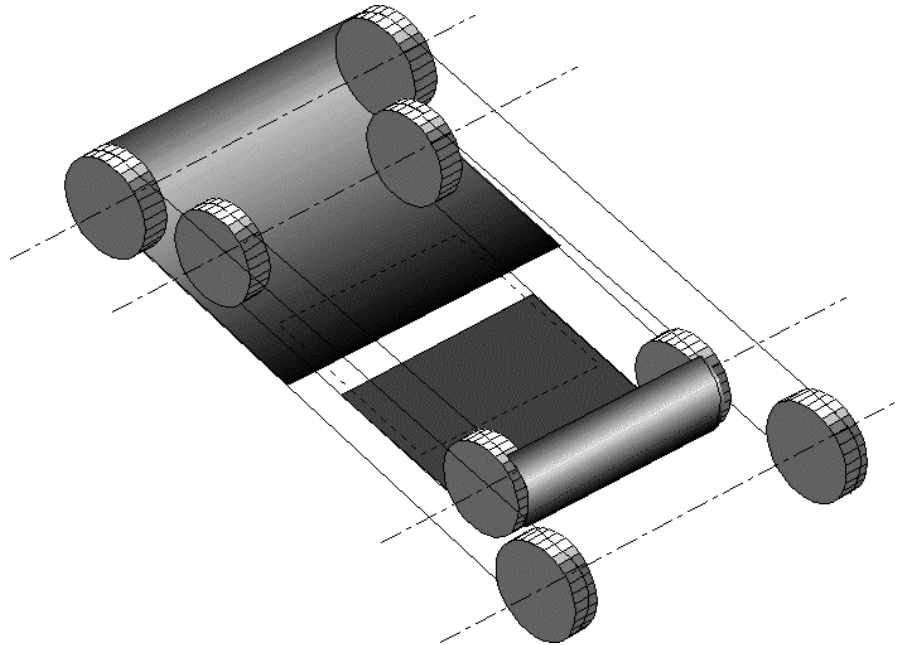


Fig. 2-8: Schematic drawing of the curtains inside the shutter.

2.5 THE OIG CCD-CONTROLLER (CCDC)

The architecture of the CCD's readout system is shown in Fig. 2-9. The first block is the CCD controller, which is located close to the cryostat. Into the CCD controller there is a bus (called "CCD controller bus"), in which are plugged-in a sequencer board and at least one analog board.

The sequencer board generates the clock sequences. Each analog board produces 8 programmable "bias voltages", 16 clock drivers with independently programmable up and low levels. Each board is able to read and process four channels independently.

This controller allows different readout modes:

- Full frame
- Frame transfer
- Binning on chip
- Windows

The controller is connected by optical fibers to a VME crate. This one contains:

- a shared memory for image storing;
- a transputer for commands dispatching to the controller;
- an Ethernet connection to the TNG workstation system.

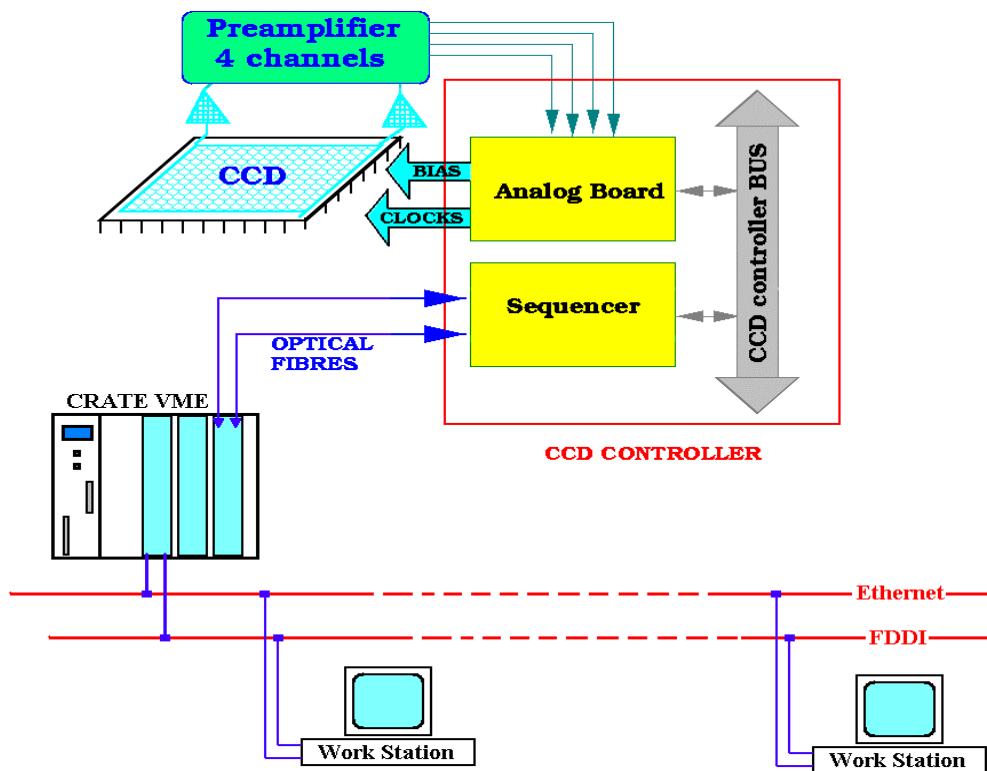


Fig. 2-9: CCDs readout system.

A complete CCD controller system is made by three parts:

1. The CCD Controller (CCDC) main rack;
2. The camera cryostat with the detector, amplifiers and bias buffers;
3. The host-computer (a PC, a VME connected inside a computer net).

The CCDC 19" main rack is shown in Fig. 2-10 (front and rear panel); it is mounted near the OIG cryostat on the Nasmyth-A instrument adapter (see Fig. 2-2).

The front panel provides the four main connectors to the cryo-head:

1. J1, the clock connector;
2. J2, the bias connector;
3. J3, the temperature connector;
4. The shutter connector



The rear panel shows the following parts:

1. The ON/OFF power switch;
2. The main plugs;
3. The 4 plugs for the fiber-link;
4. The DSP and the TRANSPUTER control LEDS (Green and Red respectively);
5. The switch for the LED inhibition.

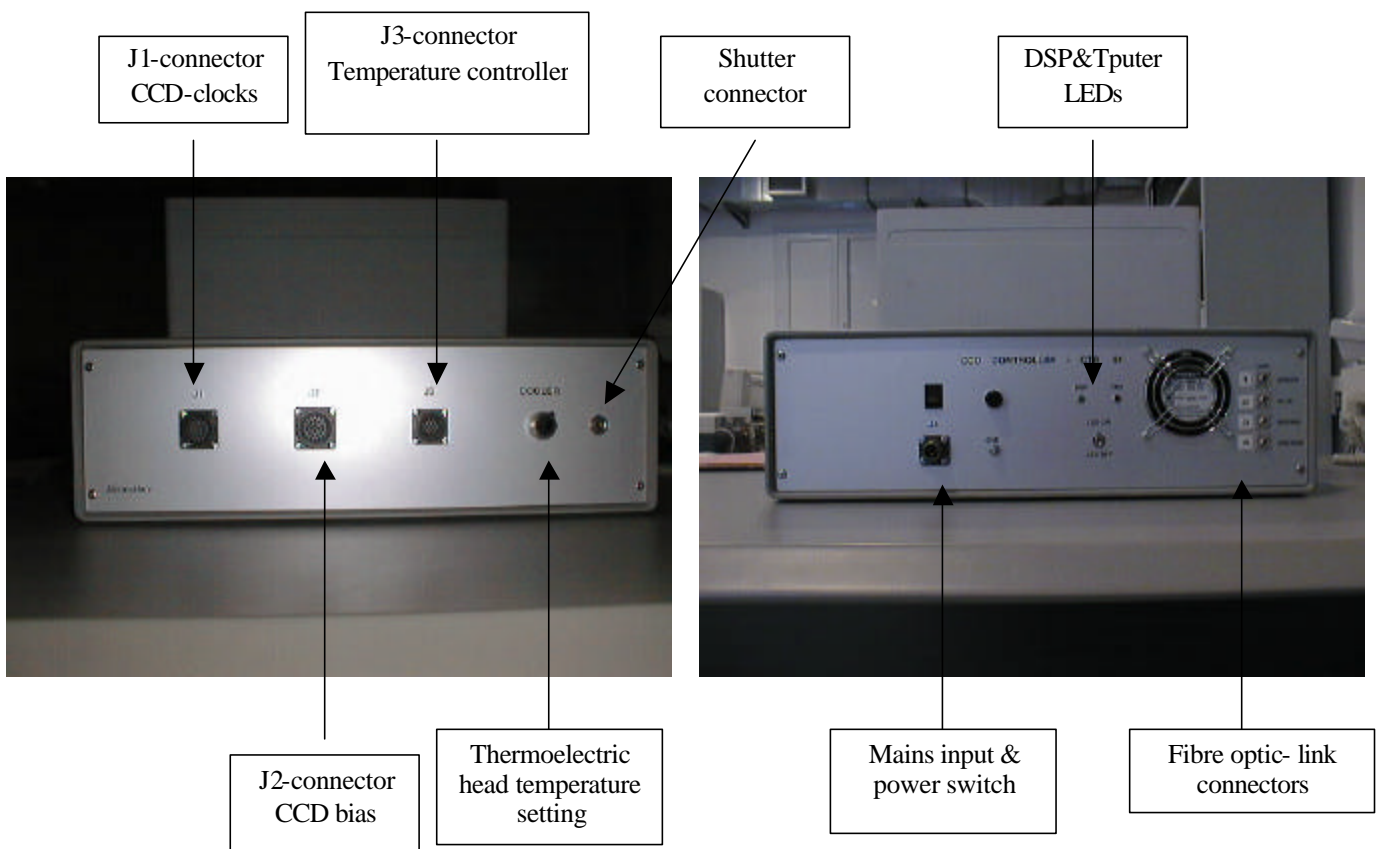


Fig. 2-10: CCDCTRL front and rear sides of the main box.

In Fig. 2-11 one can see a block diagram of the main parts of the CCD controller system and in Fig. 2-12 the VME/OIG rack is shown.

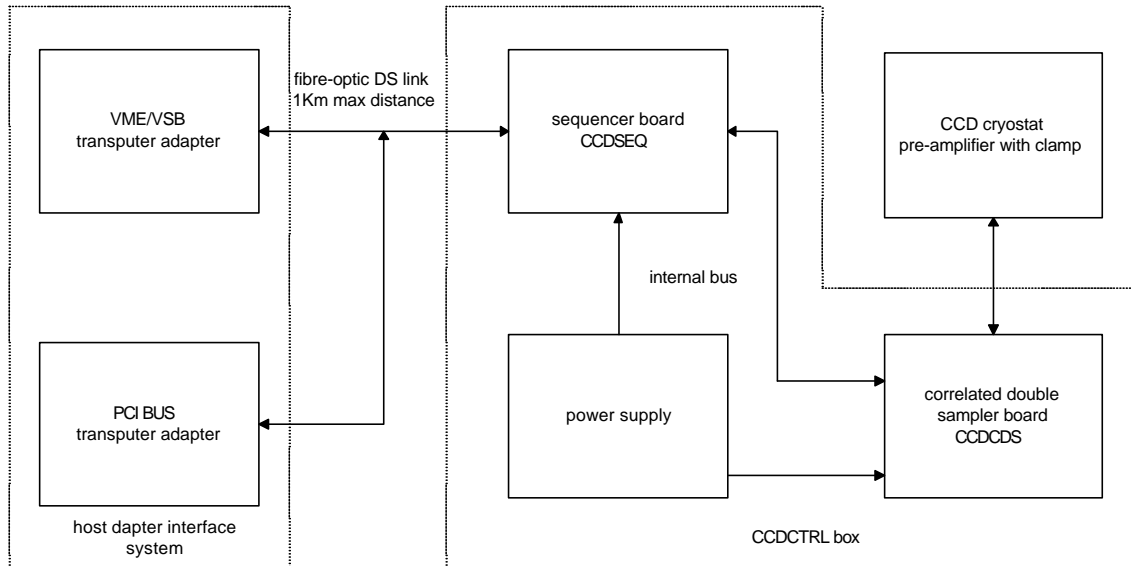


Fig. 2-11: Main parts of the CCD controller system.

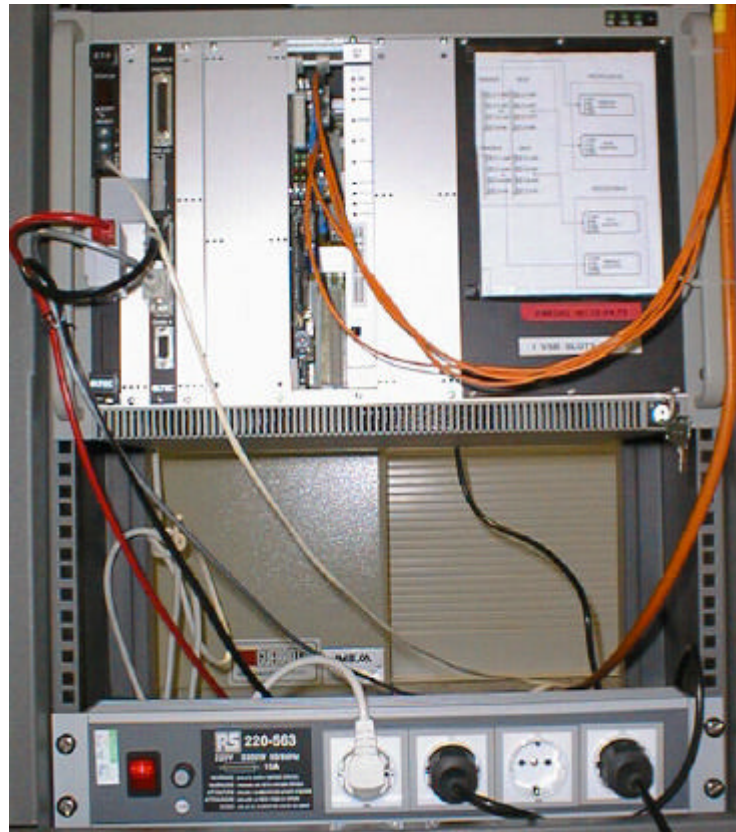


Fig. 2-12: VMEOIG rack.

2.6 THE SYSTEM POWER SUPPLY

The power distribution for the OIG camera is based on the same architecture used for all the instruments mounted at the Nasmyth A interface.

A schematic diagram is shown in Fig. 2-13; the main power switch to the derotator systems is handled directly by the VME-SERVICES (TNG control room) witch can switch power to the derotator-A main distribution power-box.

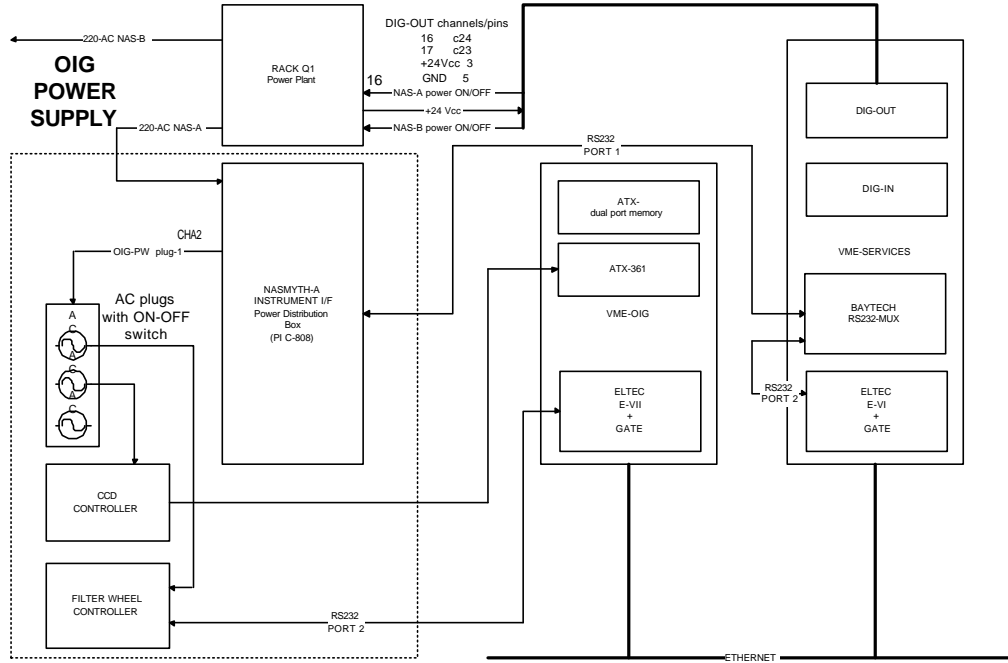


Fig. 2-13: OIG power distribution.

Once the main distribution power-box is powered, again the VME-SERVICES, can, through a serial connection switch power to the services in Tab. 2.3 via the control panel of Fig. 2-14:

220 Vacc plugs	service
1	OIG
2	ARNICA-NICS
3	ADOPT
4	SH-CAM
5	TRK-CAM
6	DEROTATOR

Tab. 2.3: Powered systems.



Telescope auxiliary services [1]

Telescope Control Services

M3 ATTENTION Move ONLY on zenith ! NOT Zenith	M3 Control ON OFF	M3 Switch ON OFF	M3 Piezo ON OFF	M3 Initialization M3 Initialization M3 Nas A Init M3 Nas B Init
VMEAOPT 1 ON OFF	M1/M2/M3 AOPT 2 ON OFF	M2 Ctrl & Brakes 3 ON OFF		
M4 Setup Connection ON Initialization ON	M4 Position = 1 OIG Arnica ADOPT -1 = Problems 1 = OIG 0 = Default 2 = NIR 3 = AdOpt	Power Nas. A Pw ON ON Pw OFF	Power Nas. B Pw ON Pw OFF OFF	
Power Derotator Nas. A Power ON Power OFF OFF Connection ON				
ARNICA On OFF Off OFF	OIG On ON Off OFF	ADOPT On OFF Off OFF	CCD SH On OFF Off OFF	CCD Trk On OFF Off OFF
Power Derotator Nas. B Power ON Power OFF Connection				
XXX On Off	XXX On Off	XXX On Off	XXX On Off	XXX On Off

Close Defaults

Fig. 2-14: Control panel for Telescope services.

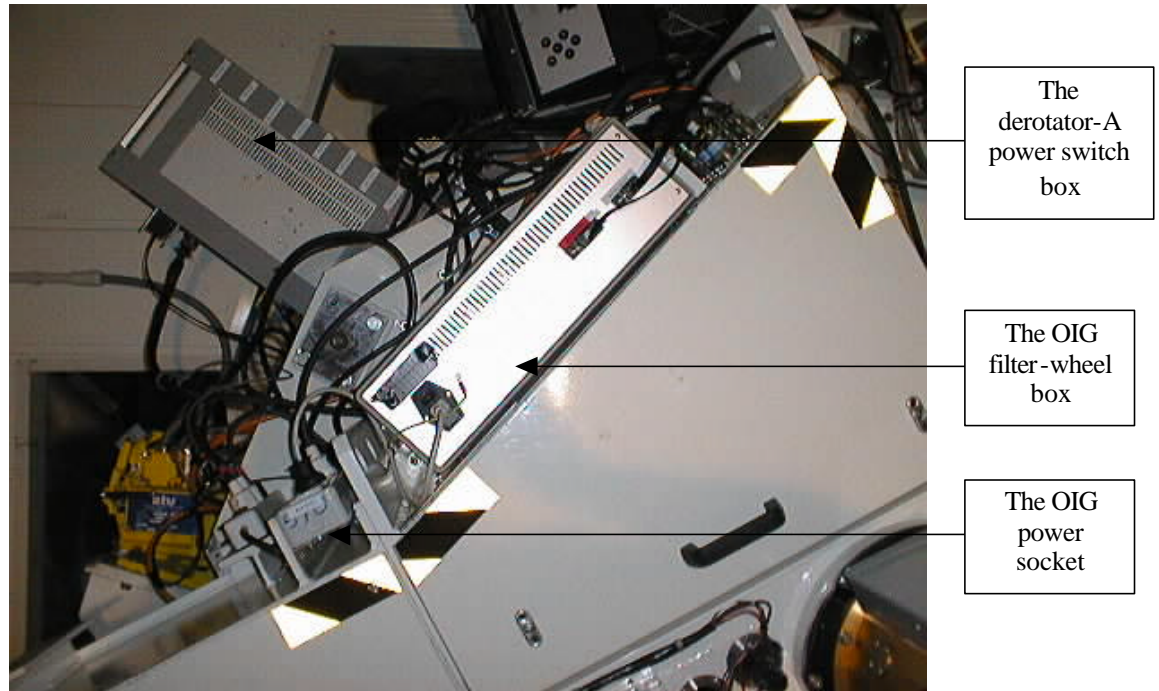


Fig. 2-15: The OIG filter-wheel box and the OIG power distribution socket.

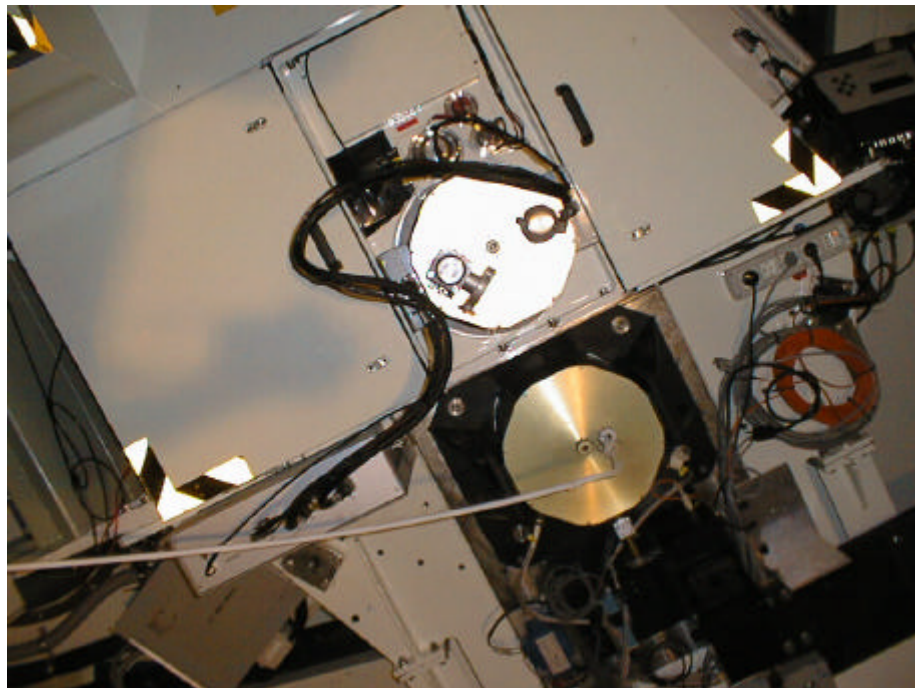
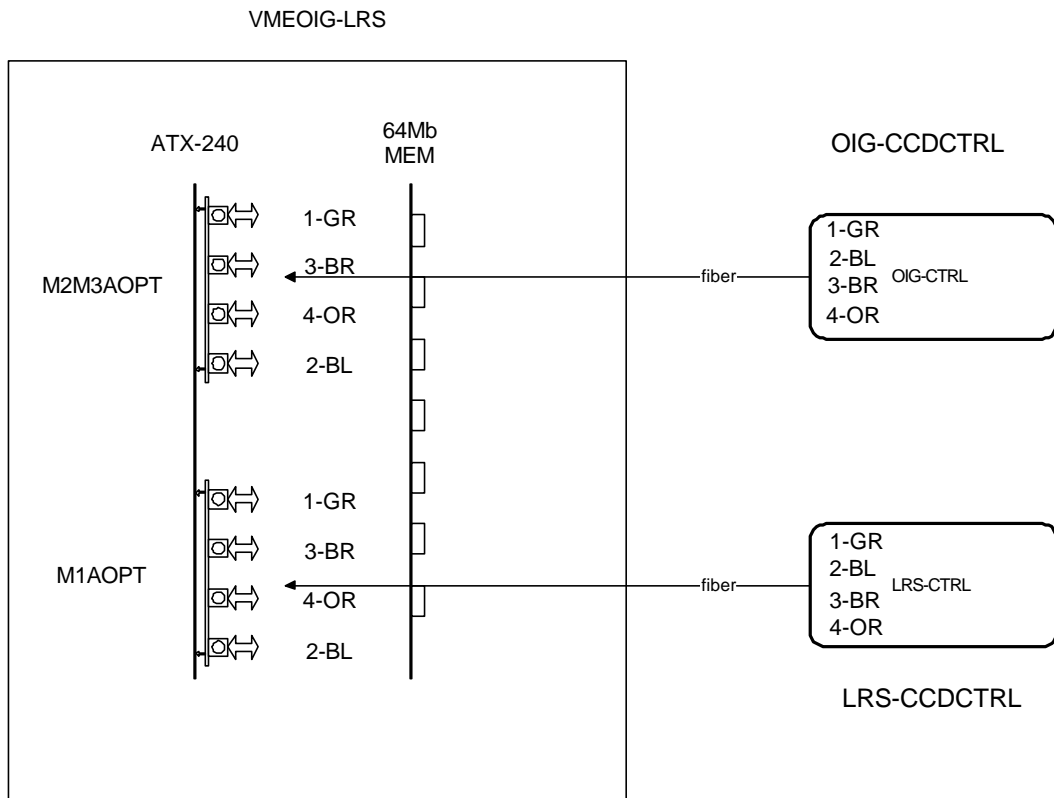
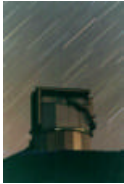


Fig. 2-16: The OIG cryostat and the OIG controller box.





3 THE SOFTWARE

3.1 THE CCD SOFTWARE

The CCD control software is written in OCCAM language; see the CCD CONTROLLER SYSTEM manual for more info. In Tab. 3.1 there is a list of available commands.

INDEX	OCCAM OPCODE	DESTINATION	OPERAND NUMBER	ACTION MODE	OPERAND CLASS	GATE ACRONYM
0	OPCD.SETSA	DSP560.PE	1	NOWAIT	NUM	setsa
1	OPCD.SETSB	DSP560.PE	1	NOWAIT	NUM	setsb
2	OPCD.SETLC	DSP560.PE	2	NOWAIT	NUM	setlc
3	OPCD.XMDUMP	DSP560.PE	1	WAIT	NUM	xmdump
4	OPCD.YMDUMP	DSP560.PE	1	WAIT	NUM	ymdump
5	OPCD.GETID	DSP560.PE	0	WAIT	NUM	getid
6	OPCD.SETLED	DSP560.PE	1	NOWAIT	NUM	setled
7	OPCD.SETGLED1	DSP560.PE	1	NOWAIT	NUM	setgled1
8	OPCD.LOADTAB	DSP560.PE	1	NOWAIT	STRING	loadtab
9	OPCD.DOSCAN	DSP560.PE	2	NOWAIT	NUM	doscan
10	OPCD.WIPE	BROAD	1	WAIT	NUM	wipe
11	OPCD.TONOFF	DSP560.PE	1	NOWAIT	NUM	tonoff
12	OPCD.BSHUTCR	DSP560.PE	1	NOWAIT	NUM	bhutcr
13	OPCD.RDBSTIME	DSP560.PE	0	WAIT	NUM	rdbstime
14	OPCD.CLCOUNT	DSP560.PE	0	NOWAIT	NUM	clcount
15	OPCD.ISHUT	DSP560.PE	1	NOWAIT	NUM	ishut
16	OPCD.SCCDTEMP	DSP560.PE	1	NOWAIT	NUM	sccdtemp
17	OPCD.RDTEMP	DSP560.PE	1	WAIT	NUM	rdtemp
18	OPCD.SETSTS1	DSP560.PE	1	NOWAIT	NUM	setsts1
19	OPCD.SETAREA	BROAD	2	WAIT	NUM	setarea
20	OPCD.SETBOX	BROAD	4	WAIT	NUM	setbox
21	OPCD.SETRMODE	BROAD	1	WAIT	NUM	setrmode
22	OPCD.BINNING	BROAD	2	WAIT	NUM	binning
23	OPCD.NCCD	BROAD	1	WAIT	NUM	nccd
24	OPCD.SETRLED1	LES1.PE	1	NOWAIT	NUM	setrled1
25	OPCD.CKHIGH1	LES1.PE	2	NOWAIT	NUM	ckhigh1
26	OPCD.CKLOW1	LES1.PE	2	NOWAIT	NUM	cklow1
27	OPCD.VOFS1	LES1.PE	2	NOWAIT	NUM	vofs1
28	OPCD.WLESREG1	LES1.PE	2	NOWAIT	NUM	wlesreg1
29	OPCD.SETBIAS	LES1.PE	2	NOWAIT	NUM	setbias
30	OPCD.TLMSTART	ATX260.PE	1	NOWAIT	NUM	tlmstart
31	OPCD.TLMSTOP	ATX260.PE	0	NOWAIT	NUM	tlmstop
32	OPCD.EXPOSE	ATX260.PE	3	NOWAIT	NUM	expose
33	OPCD.STOP	ATX260.PE	0	NOWAIT	NUM	stop
34	OPCD.ABORT	ATX260.PE	0	NOWAIT	NUM	abort
35	OPCD.PAUSE	ATX260.PE	0	NOWAIT	NUM	pause
36	OPCD.RESUME	ATX260.PE	0	NOWAIT	NUM	resume
37	OPCD.EXTEND	ATX260.PE	1	NOWAIT	NUM	extend
38	OPCD.BOOTDSP	ATX260.PE	0	NOWAIT	NUM	bootdsp
39	OPCD.TNODE	NODE.PE	1	WAIT	NUM	tnode



40	OPCD.FSHOT	DSP560.PE	1	NOWAIT	NUM	fshot
41	OPCD.SETVDD	ATX260.PE	2	NOWAIT	NUM	setvdd

Tab. 3.1: List of CCD commands.

3.2 THE VME SOFTWARE

The OCCAM code handling CCD cameras is the same for ALL cameras mounted at the TNG telescope; that is commands and telemetry responses are the same for all systems.

Each camera is controlled by a dedicated VME crate mounting GATE software. VMEs involved in camera handling are:

- VMEOIG (vmeoig.tng.iac.es) for OIG instrument;
- VMEAOPT (vmeaopt.tng.iac.es) for Active Optic system and Tracking and Shack-Hartmann cameras;
- VMELRS (vmelrs.tng.iac.es) for DOLORES instrument.

VME software (GATE) has some tasks to manage the system that are common to all VME crates; they are listed in Tab. 3.2. Applicative tasks are system-dependent and are listed in Tab. 3.3, in Tab. 3.4 and in Tab. 3.5.

TASK-ID	FUNCTION	RUN-TIME MODE
GATE	Task Handler	user/super
TASK1	Micro-commands from WS	User
TASK2	Micro-commands dispatching	User
TASK3	Alarms Handling	user/super
TASK4	Telemetry to WS	User
TASK5	Images to WS or to disk	user/super
TASK6	Global access Handling	user/super
TASK10	Heart beat	User

Tab. 3.2: GATE common tasks.

TASK12	OIG telemetry	user/super
TASK13	OIG controller commands	user/super
TASK15	OIG boot command	user/super
TASK19	OIG filter wheel Handling	user/super

Tab. 3.3: OIG tasks.

TASK11	AOPT commands	user/super
TASK12	AOPT telemetry	user/super
TASK13	Tracking and SH cameras	user/super
TASK15	Miscellaneous commands	user/super

Tab. 3.4: AOPT and Tracking tasks.



TASK12	LRS telemetry	user/super
TASK13	LRS controller commands	user/super
TASK15	LRS boot command	user/super

Tab. 3.5: DOLORES tasks.

Each task is stored inside a subdirectory of the working disc partition (*/taskxx*) holding the source code (*TASKxx.c*) and the compilation script (*DOTASKxx*), while the executable code (*taskxx*) is stored in the */bin* directory. Working partitions for all systems are summarized in Tab. 3.6.

SYSTEM	DISK LU
OIG	12:/
Tracking, Shack-Hartmann	13:/
DOLORES	12:/

Tab. 3.6: Camera software working directories.

The camera software foresees the subdirectories:

- */ccdtables* to hold the boot table directories for CCDs; they are:

/eev1 /eev2 /eev3 /loral1 /loral2 /loral3

according to the chip mounted on the system; the table to load is selected by the first parameter (OIG and DOLORES) or second parameter (Tracking and Shack-Hartmann) of the *loadboot* command according to the following scheme:

- 1 *eev1*
- 2 *eev2*
- 3 *eev3*
- 4 *loral1*
- 5 *loral2*
- 6 *loral3*

it also stores the CCD controller compatibility file to check the correspondence between the selected code (controller) and the allowed range for the chip. For more detailed information see the TNG CONTROLLER SYSTEM manual.

- */boot* to hold the OCCAM executable code for the CCD controllers; they are:

oig.btl sha.btl shb.btl tra.btl trb.btl lrs.btl

according to destination system; for technical cameras the bootable file to load is selected by the first parameter of the *loadboot* command according to the following scheme:

- 2 *tra.btl board1 2000*
- 3 *sha.btl board2 3000*
- 4 *trb.btl board1 2000*
- 5 *shb.btl board2 3000*



3.3 THE WORKSTATION SOFTWARE

Communications between VME software and OIG user interface are permitted by WSS. Its main duty consists in updating commands and telemetry queues between OIG Workstation (WSOIG) and OIG VME (VOIG). From WSS it is possible to start OIG User Interface simply clicking the relative button on the Nasmyth A panel.

3.4 THE MAIN USER INTERFACE SOFTWARE

When user interface is started the panel of Fig. 3-1 will appear to the user. This panel is divided into two main parts. On the left a quick look is present, while the right part permits the user to control the instrument. At least on the top of the window the user can access to a pull down menu for other functionalities (see below). Referring to Fig. 3-1 the typical user operations will be described.

Quick look facility appears divided into five parts. On the left a main window displays full resolution image. Under this window there are two slides to manually set cuts and two buttons devoted to set automatic cuts and to perform a simple TV scaling of the image. The graphic window is active, in the sense that the user can use it interactively with the mouse buttons:

- Right button: a square cursor will appear to the user to select a sample. The central part of the sample (the inner square) will be considered the star signal, while the outer area will be considered sky. To change sample dimensions click on one corner of the box with central button and drag it. A maximum of 400x400 pixels area is permitted. To change box position draw it with the left button. At this point there are two possibilities to confirm the choice.
 - right button. At this point a Statistics window (see fig.***) will appear. In the top of this window a tabular representation of the most important statistical quantities is reported:
 1. FWHM x: the FWHM (") along rows if gaussfit converges;
 2. FWHM y: the FWHM (") along columns if gaussfit converges;
 3. X position in pixels;
 4. Y position in pixels;
 5. Minimum value in the box;
 6. Maximum value in the box;
 7. Mean value in the box;
 8. Sky level;
 9. RMS (adu) in the box;
 10. Total signal in the box;
 11. Offset in R.A. (arcsec) to put the selected object the in position of the desired marker;
 12. Offset in DEC (arcsec) to put the selected object the in position of the desired marker;
 13. Angle of major axis of the elliptical gaussfit
 14. Selection of the desired marker on which to calculate the offset;
 15. Button to calculate the telescope offset.

In the bottom of the window is present a 3-D representation of the sampled box. Using the controls under this plot it is possible to change the point of view of the representation. It is possible to switch to a 2-D representation cut along rows.

- Double click right button: Now the same cursor enables the user to choose the coordinates of a box on the two chips. These coordinates are reported in the sequencer table in the box fields (see later).

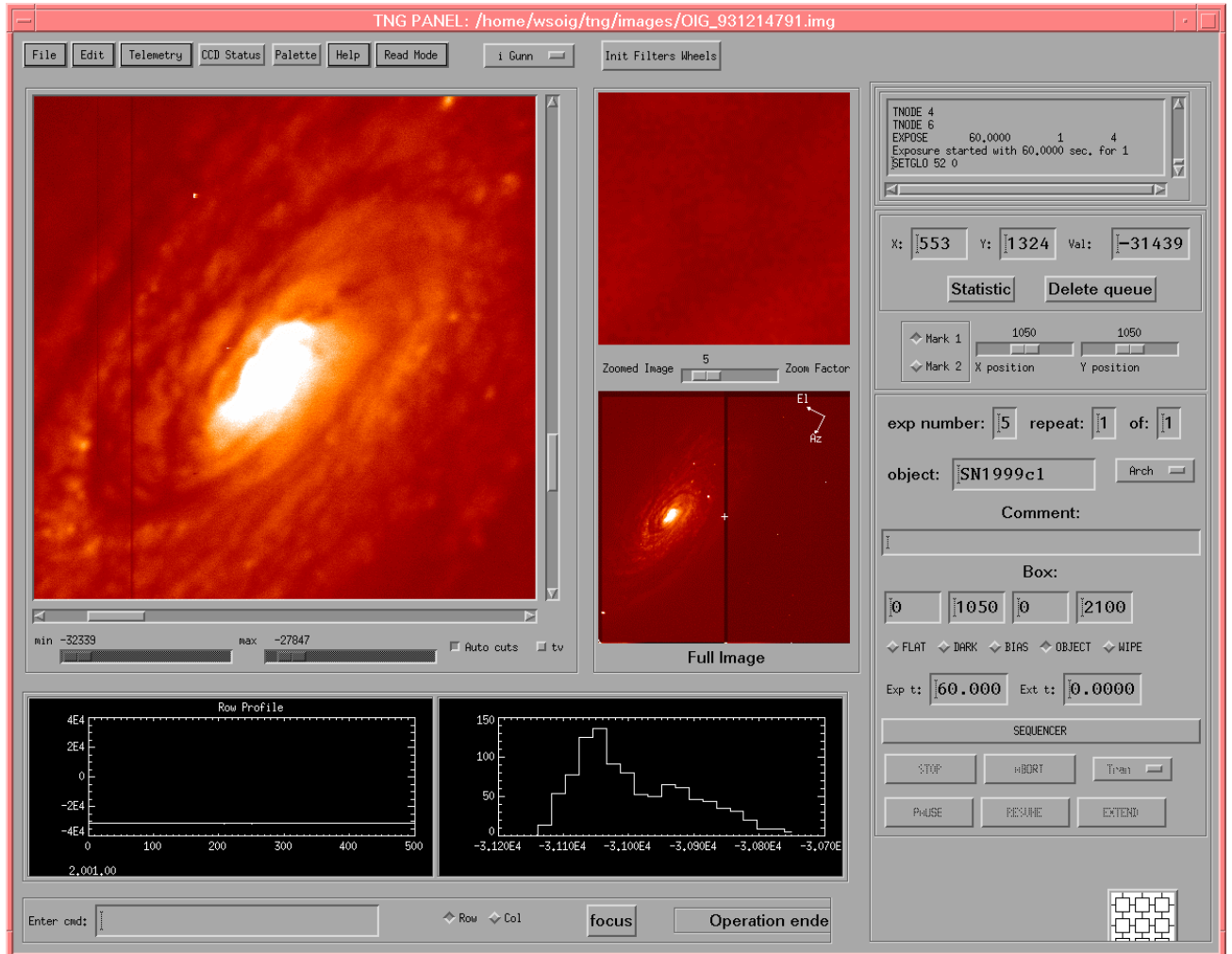


Fig. 3-1: The OIG main user interface.

The other windows in the left part show:

- a zoomed part of the image, moving mouse on the main display window the centre of zoomed region consequently changes, zooming factor is set using the slider under this window.
- A full frame image to show the selected positions of the markers. Clicking on elsewhere position puts this position in the centre of the main display window.

The right part of the main interface is dedicated to display actual camera settings and statistics. In particular there are:

- A log box for the messages between interface and low level CCD software;
- A box of quick access statistic (x y and pixel value at the position of cursor);
- A facility to set the positions of the markers;
- The order number of exposition (see sequencer interface section);
- Object's name;
- Archive flag;



- Eventual comment;
- CCD box;
- exposure's type;
- button to activate sequencer;
- button to control CCD (stop, abort, transmit, pause, resume, extend commands). To extend exposition put the number of seconds with sign to add in the left field *ext t*.

During an exposition a timer slider appears at the bottom of the window.

In the bottom part of the window two plots are displayed:

- profiles in row and column activated with left click of mouse;
- statistic of counts over a box of 40x40 pixels.

At the end other four controls are present:

- a command input to send single commands to the low level;
- an option between row and column for profiles plot;
- a button to activate automatic focus procedure;
- a status bar.

In the right bottom part a button permits to open boot interface.

3.4.1 The Boot Interface

The boot interface permits to boot the transputer network with different boot tables. The window on the left shows a schematic view of the transputer net. In the left five buttons permit to perform several action:

- Boot: boot the net with selectable tables (it is a pull down menu);
- Test net: test the functionality of the transputer network. When boot is loaded the system waits until VME sends acknowledgement to the interface. In the bottom part the commands sent to CCD are displayed.
- View: (?)
- Ispy: load ispy;
- Done: quit from boot interface.

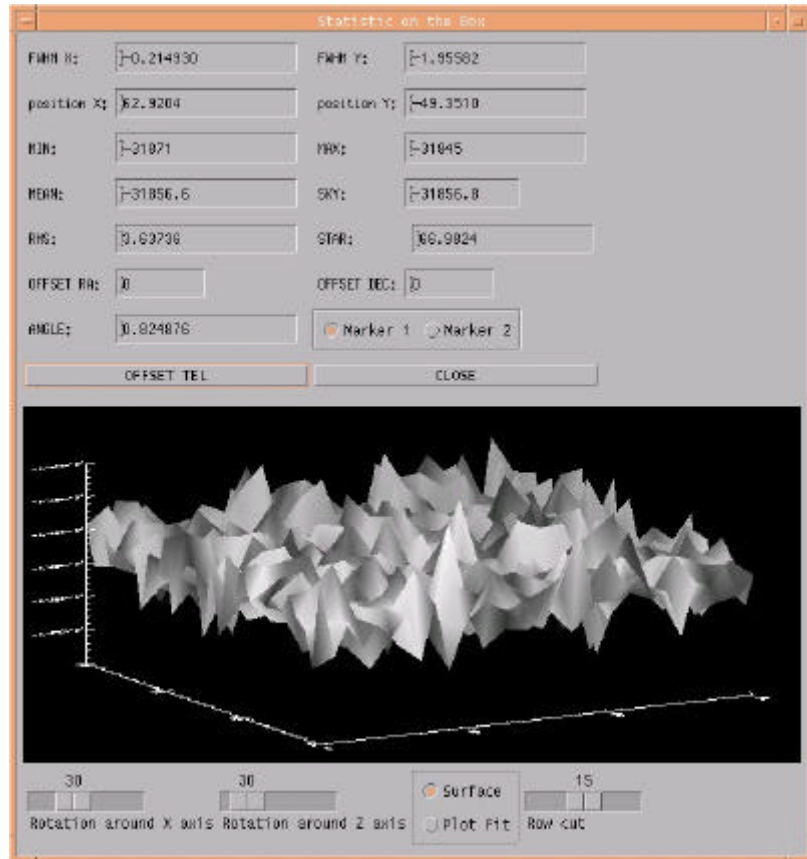


Fig. 3-2: The Statistics window.

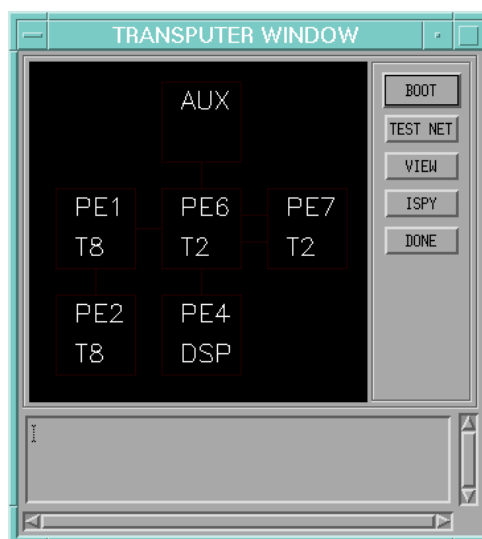


Fig. 3-3: The boot interface



3.4.2 The Sequencer Interface



Fig. 3-4: The sequencer interface

This window permits to activate a sequence of exposures. It is activated using the sequencer button in the main window interface. Its layout is shown in Fig. 3-4: it is a table of 10 exposure definitions in which the user can choose different set-up. Typically each line is composed by 11 fields:

- An activation button. If the button is activated the line is posed in the sequence.
- An exposure type list. The user can choose between [Flat, Dark, Bias, Object, Wipe].
- A repeat field. The selected exposure can be repeated until 9 times;
- An identifier field. This string will be put on the IDENTIFIER filed of fits header;
- An exposure field. The exposure time;
- A filter list. The user can choose between 18 positions on the two filter wheels;
- 4 fields for the CCD boxing: left and right columns, down and up rows. The default is the full frame CCD area;
- A save button. If set the image will be archived.

On the bottom of the window 5 buttons and a text field are present. Their functionalities are the following:



- Serrourier Temperature: this field permits the user to define, using serrourier temperature, the starting point of M2 position for automatic focus sequence;
- START: start exposure sequence;
- LOAD: load a predefined exposure sequence on the window table;
- SAVE: save a defined exposure sequence;
- RESET: rewrite the default values of sequence;
- QUIT: exit and destroy sequencer window.

3.4.3 Menu Functionality

Here is briefly described the top menu with its hierarchy.

- *File*
 - *Load*: Load a binary image from disk;
 - *Save*: Save an image in binary format;
 - *Print*: Print an hardcopy of the image;
 - *Exit*: Exit from user interface.
- *Edit*
 - *Open*: Open an image in FITS format;
 - *Save*: Save an image in FITS format;
- *Telemetry*
 - *One Shot*: Instantaneous telemetry from CCD;
 - *Start Telemetry*: Start a loop of telemetry (the refresh time is set by the user);
 - *Stop Telemetry*: Stop a telemetry loop;
 - *Image Telemetry*: Display telemetry from image binary header.
- *CCD Status*: Some important CCD settings. Among them CCD area (x pixels, y pixels), Box dimension and position (x pixels, y pixels), binning, and number of chip.
- *Palette*: a color editor utility to better display the image;
- *Help*:
 - *Commands*: A simple command help;
- *Read Mode*: This command **MUST BE USED VERY CAREFULLY**
 - *2 output left*: CCD is read form two left outputs;
 - *2 output right*: CCD is read form two right outputs;
 - *4 output*: CCD is read from four outputs. In this setting CCD boxing is not allowed.



3.4.4 The Telemetry Interface

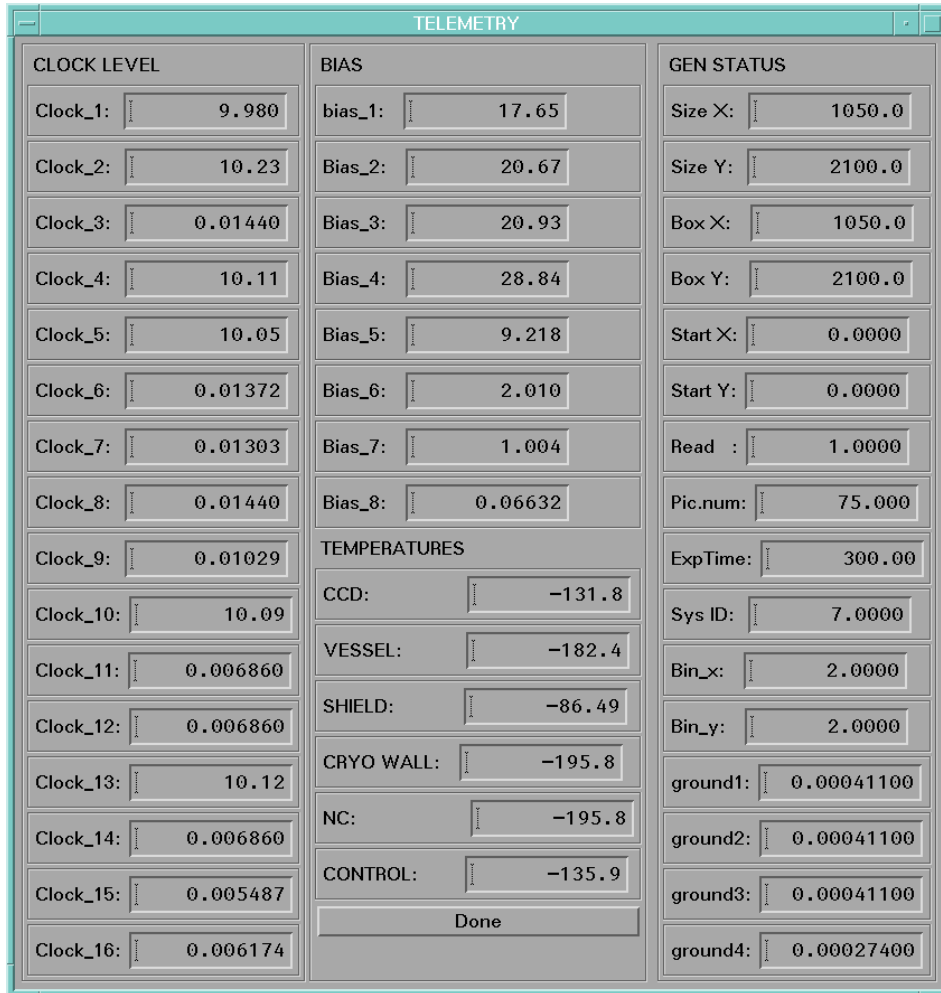


Fig. 3-5: The telemetry interface

From the top menu it is possible to open the window shown in Fig. 3-5. The quantities reported in this window are the same written in the binary header of each image. The window is divided into four parts:

- Clocks: there are 16 fields corresponding to the 16 levels of clocks;
- Bias: 8 fields for the 8 bias levels;
- Temperatures: the 5 temperature (°K) sensors placed on CCD, vessel, shield, cryostat wall and electronic control. A sixth sensor is not connected (NC)
- General Status: in this part all the other telemetry values are placed. In particular about CCD setting we have: chip area dimensions (in x and y pixel), box dimensions (in x and y pixel), position of the left down corner of the box in the chip, read-out mode, exposure time of the last exposure, system identifier (ID), binning and the four ground levels.



Telemetry window can be activated with various settings, to display instantaneous telemetry, looped or image telemetry. These possibilities are choose from the top menu.

3.4.5 Auto Focus

In the OIG user interface it is also implemented an auto focus procedure. It consists essentially in a sequence of images with different M2 positions. The different FWHM are calculated and a 2nd order polynomial fit is obtained. The parabola minimum is the best focus position.

To use this facility perform the following instructions:

- Take a full frame image;
- Open the sequencer and load the file *focus.exp*;
- Select a box with one star in the left chip;
- Edit the repeat field in the sequencer. You can choose between 3 and 9 exposure. A good choice may be 6;
- Fill the temperature field in the bottom left;
- Start exposures;
- At the and of the sequence click *focus* button on the bottom of the main window;
- A window like Fig. 3-6: will be displayed;
- Eventually deselect some wrong measurements;
- Press *calculate*. Two parabolas, x and y fit, and the calculated focus positions will be displayed.

Fig. 3-6: The focus window



4 ASTRONOMY

4.1 THE FILTER SYSTEM

The presently available filters and their main characteristics are listed in Tab. 4.1::

Filter	Peak WL. nm	Centr. WL. nm	Peak Tr. %	FWHM nm
U	367	361	67	60
B	445	436	67	103
V	523	533	84	93
R	592	625	82	128
g	493	518	82	103
r	638	659	86	81
i	828	825	85	192
z	870	~900	90	~140

Tab. 4.1: Filters characteristics

They are identified on the CCD user interface directly with the corresponding name. The 10 filter positions still free (basically all in the wheel #2) can be filled with user-provided filters.

In this case the filters should have a diameter of 106.0 +/- 0.2 mm and a thickness of less than 10.0 mm.

In the following Fig. 4-1, you can find the transmittance curves for the OIG filters, as given by the manufacturer.

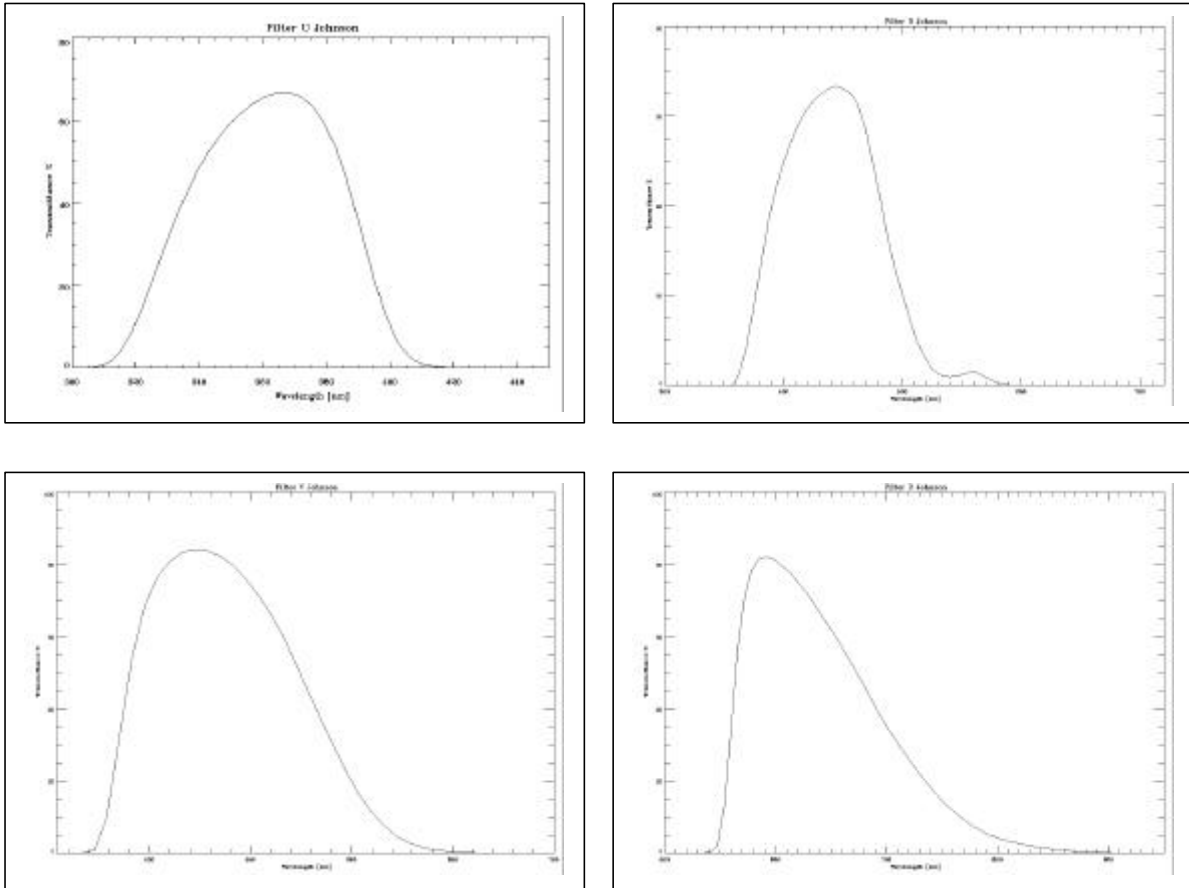


Fig. 4-1: Transmittance curves for the OIG filters.



Gunn Filters

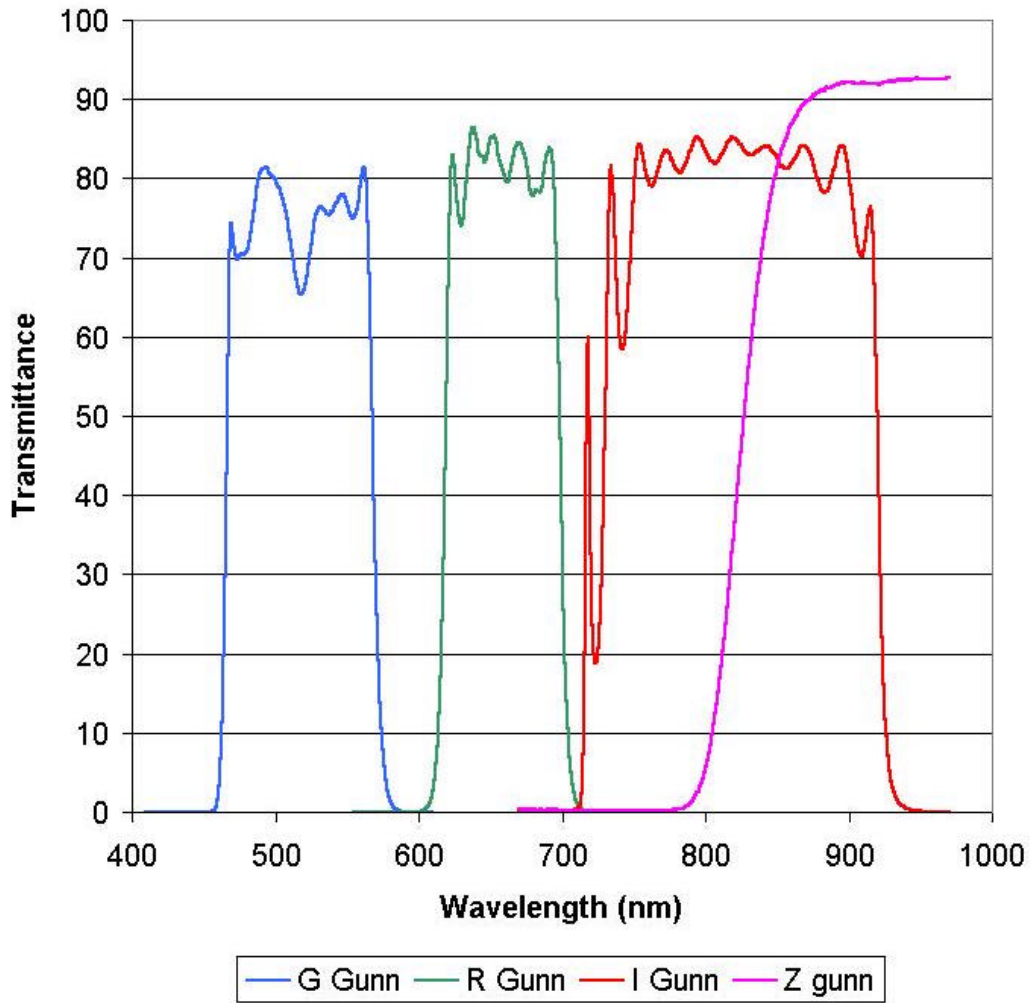


Fig. 4-2: Gunn filters.

4.1.1 Filter Mechanics

The two OIG filter wheels can allocate 9 filters each (two holes are permanently empty) for a total of 18 filters continuously available.

Custom filters can be inserted temporarily on the system provided they can fit with the dimensions of the filter cage shown in Fig. 4-3.

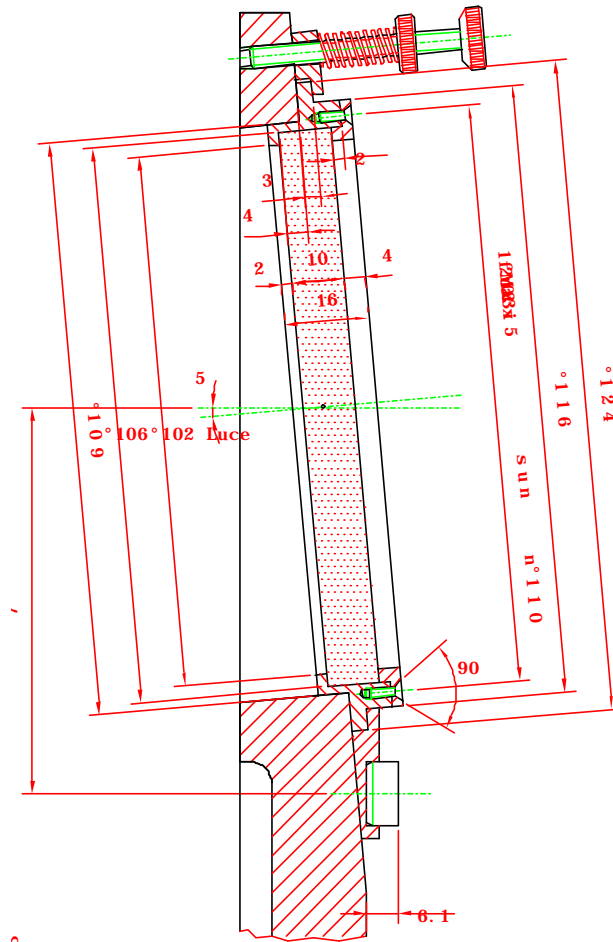


Fig. 4-3: The filter cage on the OIG filter wheel.

4.2 OIG DETECTOR MAIN CHARACTERISTICS

The CCDs used in TNG instrumentation are EEV 4280 (2048x4096) and Loral (2048x2048). Their characteristics are summarized in the following Tab. 4.2.



Manufacturer	LORAL	EEV4280
Chip Type	Thinned Back illuminated	Thinned Back illuminated
Pixel size	15 μm	13.5 μm
Area	2048 × 2048	2048 × 4096
Readout noise	12 e	10 e
MPP	Yes	No
Working temp.	-110 C	-130 C
UV treatment	Chemiosorption (Cu layer)	Ion implantation
AR Coating	Yes	Yes
Grade	2 (both)	2 & 3

Tab. 4.2: CCD's characteristics

4.2.1 Uniformity

The homogeneity of the CCD is measured using a standard method of illuminating it at different wavelengths with a uniform source of radiation and calculating the RMS all over the sensitive area.

The deviation from homogeneity is given by the following expression:

$$\text{Deviation form Homogeneity} = \sigma (\text{whole area}) / \text{mean (whole area)} \%$$

λ (nm)	LORAL	EEV4280
400	3.2 %	3.9 %
550	3.4 %	3.4 %
700	3.3 %	5.7 %
900	3.7 %	5.2 %

Tab. 4.3: Deviation from uniformity



4.2.2 Quantum Efficiency

The CCD quantum efficiency (QE) was measured in the wavelength interval 2000 10500 Å in incremental 100 Å. The CCD was illuminated using monochromatic light obtained through a Xenon lamp, a series of filters and a monochromator. The signal integrated on the CCD is then compared to the response of a calibrated photodiode.

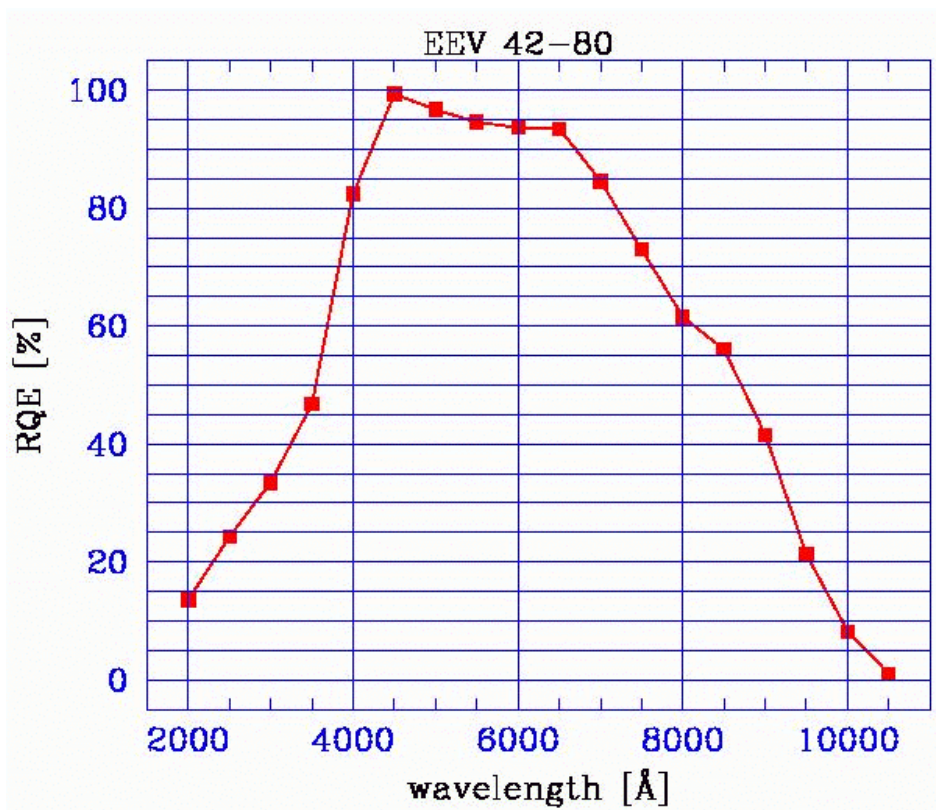


Fig. 4-4: QE of the EEV 4280

4.2.3 Dark Current

The dark current is measured taking a short dark exposure and a long dark exposure. The signal level in the two exposures is then compared. The frame is divided in 10¹⁰ pixel sub-frames and the dark current is computed for each of them. The results of this procedure are shown in figure **** as a histogram in the case of the CCD EEV42-80. The average value of the dark current turns out to be 6 electrons/pixel/hour.



4.2.4 Charge Transfer Efficiency

The charge transfer efficiency (CTE) is measured using the X-ray stimulation method. In particular, the parallel CTE is obtained exposing the CCD to the Fe55 source for a given amount of time. After integration, the columns are stacked together and the signal is plotted versus the number of pixel transfers. The CTE is then given by $CTE = 1 - (\text{Charge loss}) / 1620 e/N$

$$CTE = 1 - (s(0) - s(4095)) / (s(0) * 4096)$$

The LORAL CTE turned out to be 0.999982 while the EEV exhibits a CTE of 0.99999.

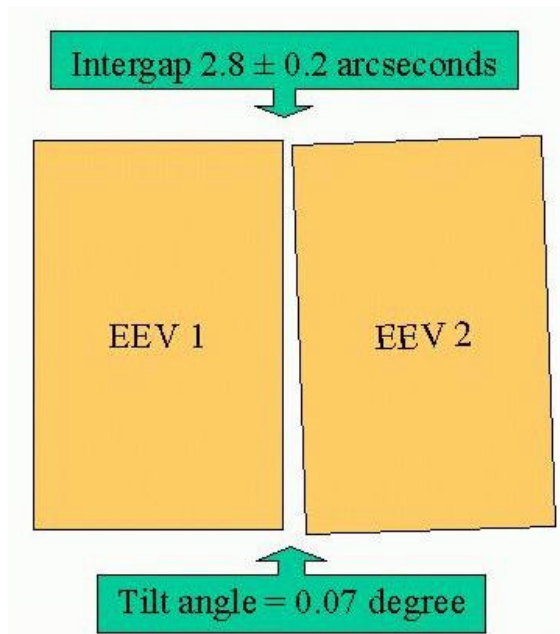


Fig. 4-5: Misalignment of OIG's mosaic



Manufacturer	LORAL-OIG	EEV4280
Linearity	<0.15%	<0.5
Uniformity	3.4	4.8
CTE	0.99998	0.99999
Quantum Efficiency at:		
400 nm	92%	82%
600 nm	80%	94%
900 nm	30%	41%
Read-out Noise	12e	4e
Conversion factor chip SX		1 e/ADU
Conversion factor chip DX		1 e/ADU
Readout time:		
Binning X 1		
Binning X 2		
Binning X 3		

Tab. 4.4: ****

4.3 CCD IMAGE

The structure of the CCD EEV4280 is showed in Fig. 4-6.

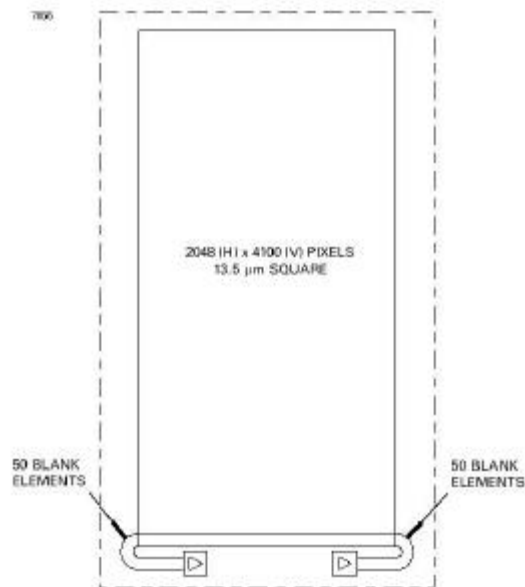


Fig. 4-6: EEV4280 structure.



The image area of the CCD is 2048 X 4100 pixel, while the length of the output register is 2148 pixel. The dimension of the image produced by the acquisition system is 2148 X 4200 pixels (without binning). This means that the prescan and overscan zones depends by the readout mode and by the binning utilised. The User Interface allows different acquisition modes and different binning on chip. In Tab. 4.5 and in Tab. 4.6 the overscan and prescan zones for the different kind of acquisition are showed.

Readout Mode	Binning	Image Size	X prescan	X image	X Overscan	Y overscan
Left	1 X 1	2148 X 4200	0 - 49	50-2097	2098 - 2147	4100-4199
Right	1 X 1	2148 X 4200	2098 - 2147	50-2097	0 - 49	4100-4199
Two outs	1 X 1	2148 X 4200	0 - 49 2098 - 2147	50-2097	NO	4100-4199
Left	2 X 2	1074 X 2100	0-24	25-1048	1049-1073	2050-2099
Right	2 X 2	1074 X 2100	1049-1073	25-1048	0-24	2050-2099
Two outs	2 X 2	1074 X 2100	0-24 1049-1073	25-1048	NO	2050-2099
Left	3 X 3	716 X 1400	0-15	16* - 698	699* - 715	1367-1399
Right	3 X 3	716 X 1400	699* - 715	16* - 698	0-15	1367-1399
Two outs	3 X 3	716 X 1400	0-15 699* - 715	16* - 698	NO	1367-1399

Tab. 4.5: EEV #1



Readout Mode	Binning	Image Size	X prescan	X image	X Overscan	Y overscan
Left	1 X 1	2148 X 4200	2148-2197	2198-4245	4246-4295	4100-4199
Right	1 X 1	2148 X 4200	4246-4295	2198-4245	2148-2197	4100-4199
Two outs	1 X 1	2148 X 4200	2148-2197 4246-4295	2198-4245	NO	4100-4199
Left	2 X 2	1074 X 2100	1074-1098	1099-2122	2123-2147	2050-2099
Right	2 X 2	1074 X 2100	2123-2147	1099-2122	1074-1098	2050-2099
Two outs	2 X 2	1074 X 2100	1074-1098 2123-2147	1099-2122	NO	2050-2099
Left	3 X 3	716 X 1400	716-731	732* - 1414	1415* - 1431	1367-1399
Right	3 X 3	716 X 1400	1415* - 1431	732* - 1414	716-731	1367-1399
Two outs	3 X 3	716 X 1400	716-731 1415* - 1431	732* - 1414	NO	1367-1399

Tab. 4.6: EEV #2

*) The value of this pixel is a mean of overscan and image area.

4.4 FLAT-FIELDING OIG

In the following examples of U, B, V, R, *i* normalised sky flat fields are given in Fig. 4-7 to Fig. 4-11. The images cut are 0.95, 1.05. The *i* flat field does not show any fringing because the twilight light has a continuum spectrum. An example of scientific *i* image with the typical fringing pattern is given in the following figures.

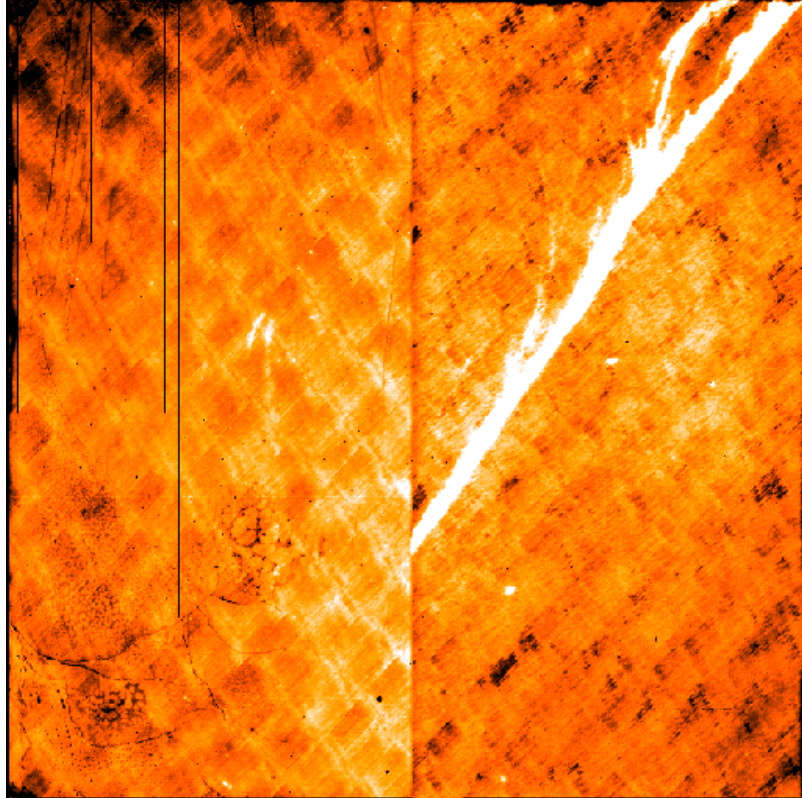


Fig. 4-7: U Bessel

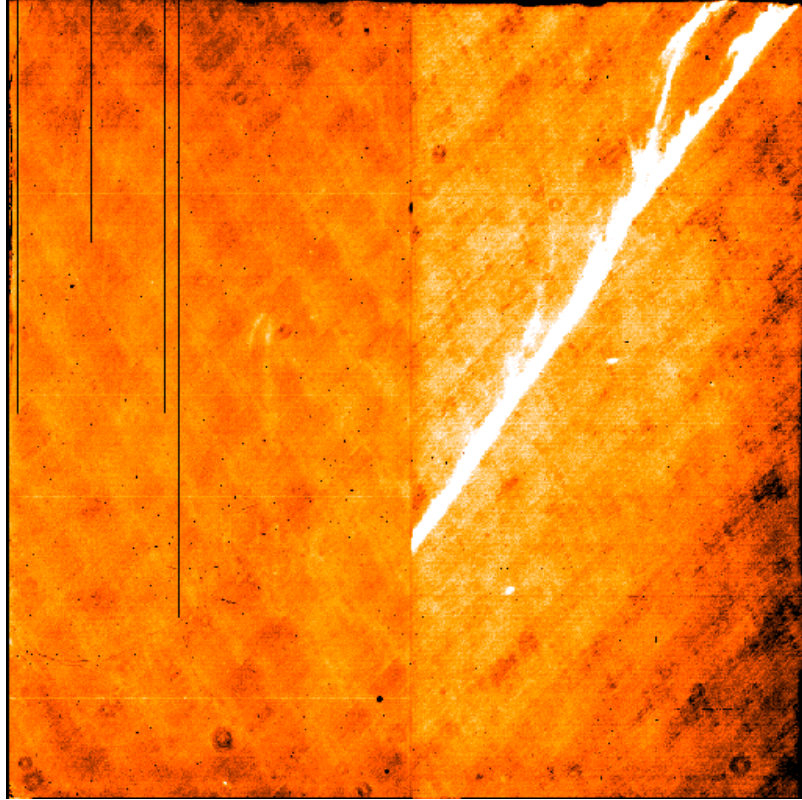


Fig. 4-8: B Bessel

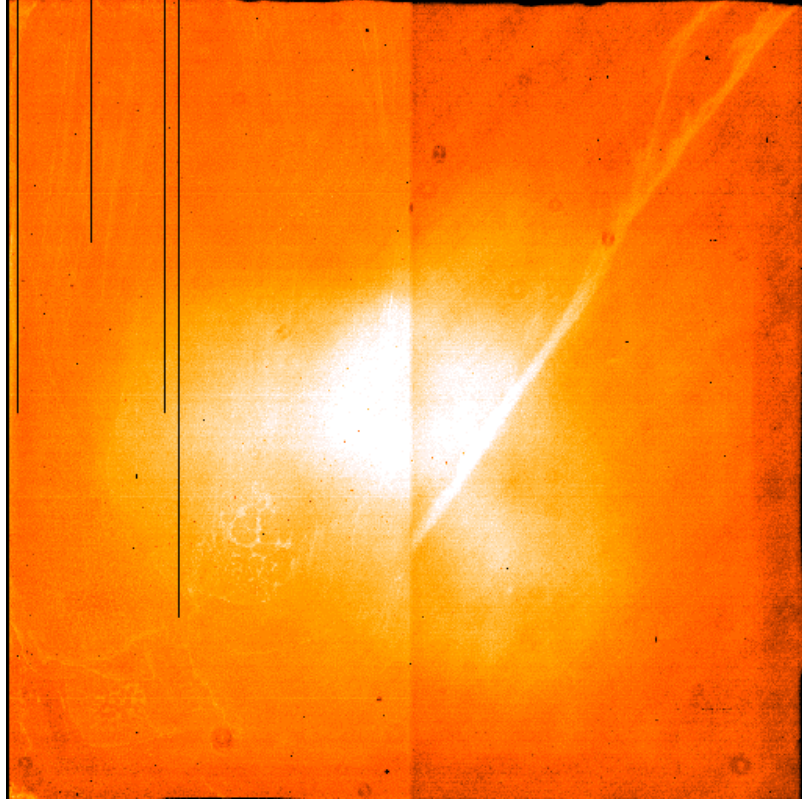


Fig. 4-9: V Bessel

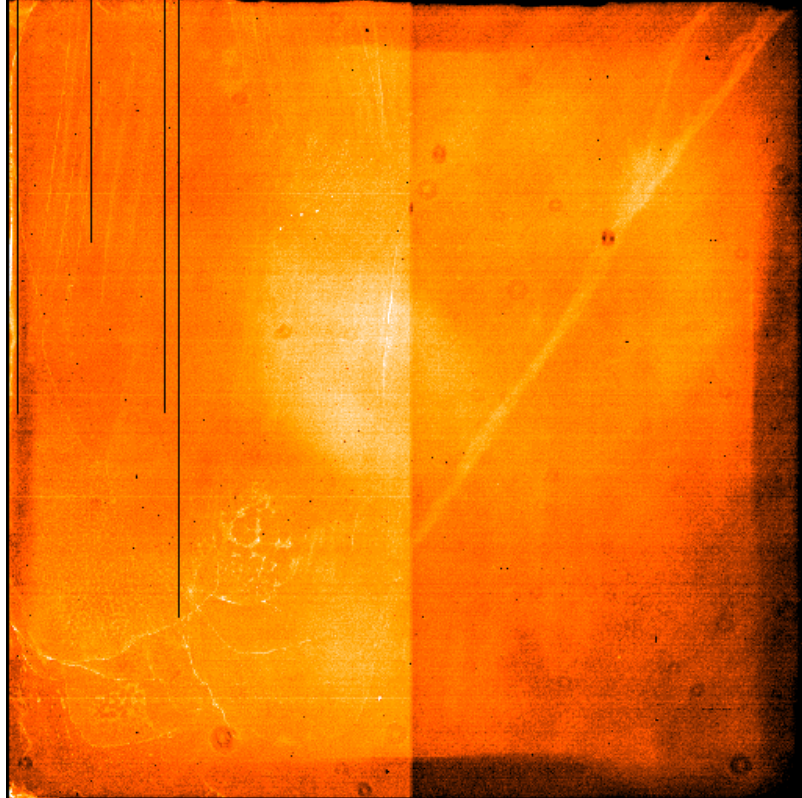


Fig. 4-10: R Cousins

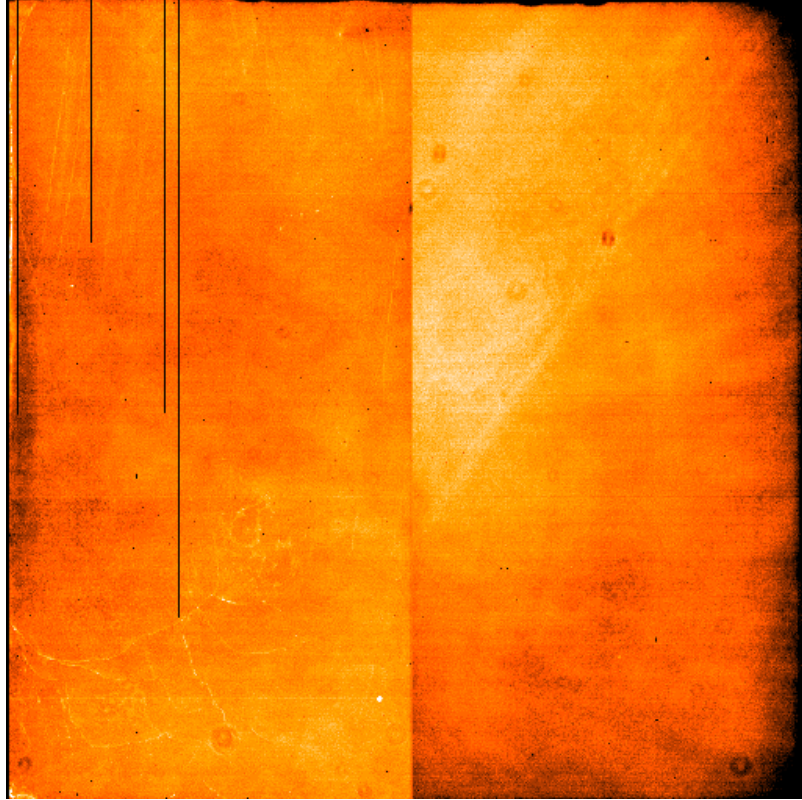


Fig. 4-11: i Gunn

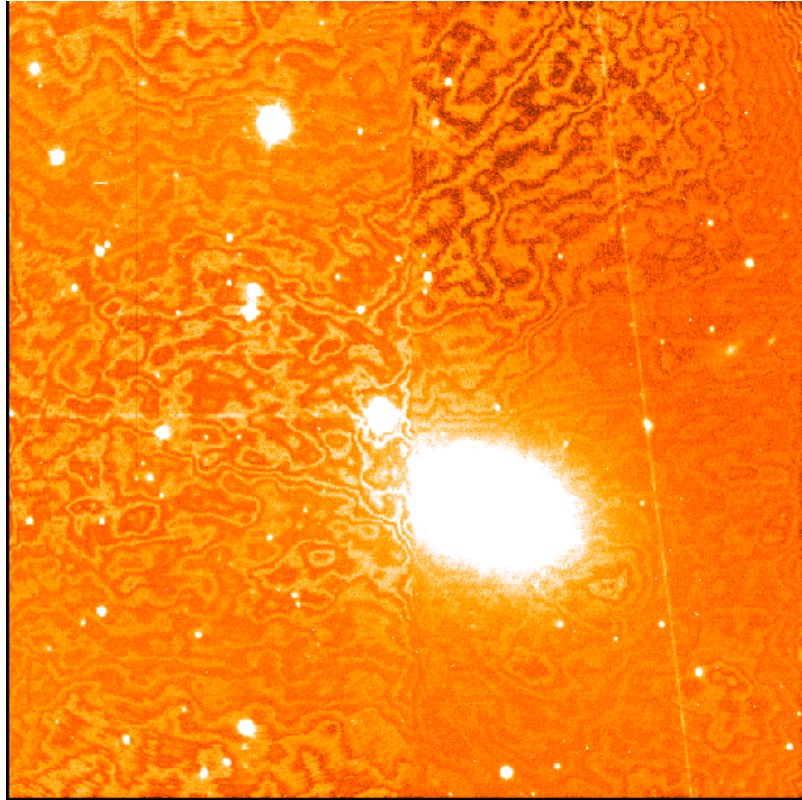


Fig. 4-12: i Gunn: Band Fringing 10%

4.5 FOCUS OPTIMIZATION

TBW

5 USING OIG

TBW

5.1 OIG START-UP

TBW

5.2 OIG SHUT-DOWN

TBW

5.3 OIG COOLING

TBW



5.4 OIG TROUBLESHOOTING

TBW

6 ACRONYMS

A/D - Analog to Digital Converter
BTAB - Bias Table
CCDC - CCD Controller
CCDSQ - CCD Sequencer
CDS - Correlated Double Sampler
CPU - Central Processing Unit
CTAB - Conversion Table
D/A - Digital to Analog Converter
DRO - Direct readout
DSP - Digital Signal Processor
EPROM - Erasable Programmable Read Only Memory
FPA - Focal Plane Array
HW - Hardware
ICF - Instrument Command File
IR - Infra Red
NIA - Nasmyth Instrument Interface A
NIB - Nasmyth Instrument Interface B
RMR - Readout Micro Routine
OICC - Optical Imager Control Computer
OIG - Optical Imager Galileo
OS - Operating System
RAM - Random Access Memory
ROM - Read Only Memory
SEDIT - Status Editor
SQT - Sequencer Tick
SW - Software
TBD - To Be Decided
TRAM - Transputer Module
VME - Versa Module Europe
VMEIF - VME Interface
WFTAB - Waveform Table
WS - Work Station
WT - Working Table
TR - Tristate
O.C. - Open Collector
Std TTL Standard TTL

7 REFERENCES

Ref. 1: CCDWG - Functions and requirements for the Galileo CCD cameras

Ref. 2: CCDWG - Architecture of Galileo CCD cameras



TNG: THE OIG USER MANUAL

June 2000

S. Benetti, C. Bonoli, R. Cosentino, D. Fantinel, A. Ghedina, E. Giro, A. Magazzù

Ref. 3: PERIMOS - DTM560 DSP-TRAM User Manual

Ref. 4: PERIMOS - DTM560 TOOLBOX User Manual

Ref. 5: Bortoletto, et al., SPIE *{\it proc.* 2654, 248, (1996)

Ref. 6: Smith, proceedings of Tucson conference: "CCDs IN ASTRONOMY", 153, (1989)

Ref. 7: Carter, et al., SPIE 1235, 644, (1990)

Ref. 8: Bortoletto, et al., Transputer Appl. and Systems '94, 161, (1994)

Ref. 9: Reiss, SPIE 2198, 895, (1994)

Ref. 10: Leach, proceedings of Tucson conference: "CCDs IN ASTRONOMY", 171, (1989)

Ref. 11: Bortoletto, D'Alessandro, Rev. Sci. Instr. 57, 253, (1986)

Ref. 12: Comoretto, et al., Arcetri technical report: "NICS: camera infrarossa TNG", 4, (1995)

Ref. 13: Gai, et al., SPIE *{\it proc.* 2198, 962, (1994)

Ref. 14: SUNDANCE - SMT227 Fibre-Optic TRAM manual

Ref. 15: INMOS - D7405 TOOLSET development SW

Ref. 16: INMOS - The TRANSPUTER databook

Ref. 17: MOTOROLA - DSP56001,"Digital Signal Processor User Manual".



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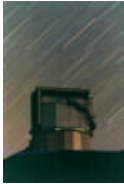
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