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Hemisphäre

New Testbench

Software User's Manual

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Name Date Signature Prepared: C. Cavadore 07/06/2002 F. Christen S. Darbon Name Date Signature Approved: /11/1999 Name Date Signature Released: /11/1999

VLT PROGRAMME * TELEPHONE: (089) 3 20 06-0 * FAX: (089) 3 20 06 514

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1 Abreviation and acronyms

LG Low Gain	
HG High Gain	
LN Liquid Nitrogen	
GUI Graphic User Interface	
CCS Central Control Software	
FIERA Fast Imager Electronic Readout Assembly	у
WS Workstation	
VLT Very Large Telescope	
RTAP Real Time Application Platform (Hewlett	-Packard)
GPIB General Purpose Interface Bus	
SW Software	

2 How does it work?

2.1 Hardware implementation

First of all, have a look to the physical set up (Figure 1 & Figure 2):



Figure 1 Hardware set up of the Testbench



Figure 2 Testbench hardware implementation

The system is mounted on a Newport 300 cm x 90 cm optical table top, which provide static rigidity and flatness, in addition to the standard configuration of sealed mounting holes. All hardware components are GPIB driven and controlled through a GPIB controller, by National Instruments, which holds up to 14 GPIB devices and is attached to a SPARC board with embedded FIERA controller through SCSI connection. A PULPO monitoring unit [7] for environmental variable control (temperature, humidity, etc.) will also be part of the system.

2.1.1 Lamp housing and lamp:

Two light sources are disposable on the testbench:

An halogen lamp with horizontally elongated filament (power up to 250W, typically OSRAM Xenophot HLX64640 or Philips 7148,150W or equivalent), hold in a standard convention cooled housing (ORIEL), equipped with a F/1 condenser, which produce a ~3 cm diameter collimated beam. This beam is then focused on the monochromator input slit by means of a secondary f/4 plano-convex lens, which matches the acceptance pyramid of the monochromator. The light system maximizes the total power into the monochromator and provides a smooth continuum within the desired wavelength range. This system is driven by a Power Supply and a Light Intensity Controller also produced by Oriel. The light intensity controller is directly connected to the lamp housing through a light sensing head, which monitors light variations, and interfaced to the power supply. It allows maintenance of constant light levels, for the duration of an exposure (exposure lengths vary from few seconds to about ten minutes) regardless of lamp aging, line voltage variations or changes in the ambient temperature.



Figure 3 Halogen lamp housing



Figure 4 Halogen lamp power supply (down) and light intensity controller (up)

A 150W Xenon arc lamp in a Universal Lamp Housing (ORIEL) with its power supply (ORIEL 68806)



Figure 5 Xenon lamp housing



Figure 6 Xenon lamp power supply

2.1.2 Monochromator:

An Oriel Multispec 257 Double Monochromator in subtractive dispersion configuration. In the current setup, the output from the first unit is dispersed in the reverse direction by the second unit, thus homogenizing the light across the output slit. The net dispersion remains as that produced by the first monochromator, but the amount of stray light is greatly reduced, quoted by Oriel to be of the order of 10-7 of the unblocked signal. That is, almost three orders of magnitude smaller that the measured stray light for a single monochromator of the same kind. The two devices can be controlled via GPIB in either an independent way or together (using the first one as master). Both are equipped with microstepping motor driven slits and 600 l/mm ruled gratings, whose peak efficiency is at 400 nm (Figure 10). The usable wavelength region (that is, where the grating efficiency is more than 20%), goes from 250 to 1300nm (well beyond our requirements). With this configuration, a minimum bandpass of ~0.1 nm can be reached. Two motorized filter wheels, that hold up to five filters each, are attached at the input of the first monochromator. They control respectively the order sorting filters from Schott (2 filters, with cut-off wavelength respectively at 450 and 665 nm) and neutral density filters from Melles Griot (see Table 2).

Schott	<u>GG475</u>	Schott	RG665	
Wavelength (nm)	Transmittance	Wavelength (nm)	Transmittance	
200 to 450	< 10 ⁻⁵	200 to 620	< 10 ⁻⁵	
460	9 10 ⁻⁵	630	< 6 10 ⁻⁴	
470	0.17	640	0.01	
480	0.66	650	0.10	
490	0.85	660	0.33	
500	0.89	670	0.59	
510	0.90	680	0.75	
520	0.90	690	0.83	
530 to 1200	0.91	700	0.88	
		710	0.90	
		720	0.90	
		730 to 1200	0.91	

Table 1 Separating order filters available on the monochromators

Reference	Diameter (mm)	Transmission	Material	Optical density (@ 550nm)
03FNQ045	25	50.12%	Fused Silica	0.3 ± 0.02
03FNQ047	25	25.12%	Fused Silica	0.6 ± 0.03
03FNQ057	25	10%	Fused Silica	$1.0.\pm05$
03FNQ065	25	0.3162%	Fused Silica	2.5 ± 0.125

Table 2 Neutral density available on the monochromators

The first unit is also equipped with an integrated shutter, which can be controlled both via external TTL signals and through GPIB commands. The minimum exposure time setting is 20msec, the transition time ~2ms. Positioning the shutter before the light is inputted into the integrating sphere, instead that putting it at the exit port, has the advantage of eliminating the shutter pattern problem.



Figure 7 The two monochromators MS257





Figure 9 RG665 filter



Figure 10 Grating mounted on the monochromators



Figure 14 03FNQ067 neutral density

2.1.3 Integrating Sphere:

A 50 cm diameter "custom made" Labsphere (Figure 16). Its 8 inches exit port provides a uniform illumination, over an area bigger than the size of $8k \times 8k$ CCD or Mosaic (a typical $8k \times 8k$ with 15 um pixel has a diagonal of about 17 cm; we will refer to this example throughout the paper). The primary output port is at 180 degrees with respect to the input port. A secondary output port (about 1.3cm), which hosts a photodiode, is drilled close to the primary output port. A baffle situated inside the sphere prevents that the output port "sees" directly the light source. The internal coating of the sphere is made in Spectraflect, a material that ensures a reflectance better than 98% in the range 400 - 1100 nm and better than 96% in the UV range (320-400 nm) (Figure 15). The best degree of uniformity across the illuminated field is achieved when mounting the CCD in close contact with the exit port. Otherwise, the degree of uniformity, defined as the ratio of the illuminance at the edge of the field to the illuminance on the axis through the center, is a function of the distance of the target form the source [8]. The second option has been chosen in order to have enough space between the sphere exit port and the detector to perform experiments (for instance, to put a lens and a target image to be projected onto the CCDs). The detector will be put at a distance of 50 to 75 cm from the sphere output port, so that, for a 8 inches light beam and a 8k X 8k 15 µm pixel CCD, the degree of uniformity of illumination is always in the range 95% - 98%. A better than 1% uniformity is of course obtained for smaller detectors.







Figure 16 The integrating sphere

2.1.4 Picommeters and diodes:

The testbench will be equipped with two photodiodes, one permanently mounted at the secondary output port of the integrating sphere and the other, needed for absolute flux calibration of the system, put at the detector's position. A permanent solution, with the latter diode fixed as close as possible to the detector and sharing with it the same focal plane, is also planned for the future. Separate ammeters are attached to diodes through low-noise triax cables. A Keithley 486 is connected to the sphere's diode: a 5½-digit autoranging picoammeter designed for low current applications where fast-reading rates must be performed. The measurement range is between 2nA and 2mA, with a resolution of 10fA (@2nA range). The diode is a Hamamatsu 1cm² Silicon Photodiode for precision photometry (NEP ~10-15) with good UV QE. The second diode is also a 1 cm² silicon Hamamatsu photodiode, which has been absolute calibrated by reference to PTL (National Physical Laboratory, England) and to PTB (Physikalisch-Technische Bundesantalt) standards. At present it is interfaced to a Keithley 6514 Electrometer/Multimeter, the same measuring range is between 20pA and 20mA. Both ammeters are controlled via GPIB by means of the GPIB controller.



Figure 17 The two ammeters: ke486 (down) and ke6514 (up)

2.1.5 Flanges system and light tight zone:

The integrating sphere is attached to a flange, fixed onto the table top, through a flexible light shield, which allows a length span of ~25cm. A second flange, which will hold a custom made plate for each detector head (at least three different systems are foreseen for the VLT detectors systems), is positioned at a distance of 50 cm from the first flange. The dewar itself will be hanging from the outer wall of the flange. A wooden light-tight box, with lateral access door, will close the space in between the two flanges. The flanges, the box, and some other minor elements are being designed by ESO's mechanical design office (Figure 2).

2.1.6 Motion controller



Figure 18 Motion controller MM4000



Figure 19 Motors assembly hosting a laser

A motion controller from <u>Newport</u> is also available that can drive up to 4 motors. An assembly (Figure 19), containing 3 motors and allowing movements in the 3 axis respectively to the CCD surface (Figure 73). The main use of this assembly is to drive a laser beam on to the CCD surface.

2.2 Software implementation

The software underlying this set up is described Figure 20:



Figure 20 Software setup of the Testbench

The blue names inside the boxes are the servers names to be launched before any access to the hardware.

FIERA in a standalone way can be used, provided that the fcdNoVltSrv server is running.

3 From the workstation side

3.1 Prerequisite:

The "fcdrun" account has to be used to control locally the testbench. The {root} directory is "/export/home/fcdrun".

On the UNIX workstation called odta5 near the testbench, after a reboot, you need to start all hardware devices.

First, you have:

- To launch the RTAP message manager (command: vccStartEnv -e \$RTAPENV), here, if one echoes \$RTAPENV you should get wodta5a.
- To Check that the variable CCDNAME is properly defined, echo \$CCDNAME, the setenv command could be added into the odta5.cshrc.local file located in the {root} /config/.

Next, you have to launch all the servers written in blue in the previous figure. To manage with that, a UNIX shell script "tbenchmgr.sh" will help you. By typing "tbenchmgr" at a shell prompt on odta5, you enter the main menu as shown by Figure 21:

-	_	odta5		
	Γ	Testbench management script Do not forget to put offline the CCDs via the fcdSlcuCon interface if nee	ded	1!
		WARNING! 2 server processe(s) is/are running! Check if any test procedure is running!		
l		WARNING! 1 interface processe(s) is/are running! Check if any test procedure is running!		
	F /	Disk capacity Filesystem kbytes used avail capacity Mounted on /dev/dsk/c0t3d0s7 6097755 1497456 4539322 25% /export/home		
	ŀ	Main menu		
	1 2 1) Start testbench's processes 3) Show testbench's running processe: 2) Kill testbench's processes 4) Exit tbenchmgr What do you want to do?> 3		

Figure 21 Testbench management script main menu

It is highly recommended to use this script to start up the testbench software and not to use shortcuts.

This script gives you information on the testbench environment and access to a simple menu that allows you to start, to stop and to trace one or a group of processes. A version of this script can be found <u>here</u>, 16/06/2002 version. This script is located in "{root}/tbenchSoft/script/tbenchmgr.sh". A symbolic link "tbenchmgr" has been created in the {root} directory the following line has been added at the end of the ".bashrc" file:

alias tbenchmgr ~/tbenchmgr

Before accessing the main menu, the script warns the user if server or interface processes are running. This is to prevent several sessions of the same server to run at the same time and to avoid that several users access the testbench at the same time. In case of a warning, you can get information on the nature of the running servers and/or interfaces by entering the "Show running testbench's processes" (item nr. 3). You should obtain the following sub menu (Figure 22):

-	odta5	-	j
	Testbench management script Show testbench's running processes menu		
	1) fcdNoVltSrv 7) logMonitor 2) fcdtserver 8) All server processes 3) rtdServer 9) All interface processes 4) fcdpServer 10) All processes 5) fcdSlcuCon 11) Return to main menu 6) Panel		
	Which server or interface running processes do you want to see?> 8		

Figure 22 Testbench management script: running Testbench processes menu

By choosing the item nr. 8 (All server processes), a typical output should be (Figure 23):



Figure 23 Testbench management script: see all servers processes

You know which processes are running. Now you should get informed on the purpose of the presence of these processes: a true session of measurements is running, these are remaining processes from a previous session ... If these processes can be removed, you should go back to the main menu and enter the "Kill testbench's processes" menu (item nr. 2).



Figure 24 Testbench management script: kill testbench processes menu

You can use the appropriate item to kill a specific process or a group of processes. For example, we can choose the item nr. 1 (Figure 24). All previous server processes will be removed (Figure 25).



Figure 25 Testbench management script: kill all servers processes

The script also gives information about the free space available on the disk that hosts the log file (Figure 21). If the disk usage is above 90% of its capacity (it should not happened!), contact the system manager.

3.2 How to set up the GPIB:

On August 2001, a new GPIB PCI board was installed on the new SPARC. To set up GPIB device, the following software should be used: ibconf (Figure 26).



Figure 26 The ibconf utility



Figure 28 The ibconf utility: configuration for 2nd ammeter

 Vecks
 National Instruments
 Device characteristics
 NI-488.2 Sol2
 2.2

 Device: monoi
 Access: gpib0
 Invalid character for option ring

 Primary GP18 address
 0 0H to 1EH

 Secondary GP18 address
 0 0H to 1EH

 Timeout setting
 T30s

 EOS byte
 0 0H to 1EH

 Set EOI with EOS on EES
 Note

 Value J or K key to change fields)
 'Y: reset value
 'O: return to map

Figure 27 The ibconf utility: configuration for the 1st monochromator



Figure 29 The ibconf utility: configuration for MM4000





Figure 30 The ibconf utility: configuration for the 2nd monochromator

Figure 31 The ibconf utility: configuration for the 1st ammeter

Move to a given device by using the "k" character on the keyboard. Hereafter, the panels showing the configuration data for each device:

3.3 Start the Testbench software

First, from main menu, we enter the "Start testbench processes " menu (item nr. 1). You should obtain the following menu (Figure 32):



Figure 32 Testbench management script: start logMonitor

3.3.1 The logMonitor

As all servers provide output messages in the log file, it is recommended, before any initialisation of the testbench servers, to launch the log monitor interface (item n. 8). You will be able to check each step of the initialisation of each server. You should obtain this interface (Figure 33):

-				VLT Log Monite	pr – @odta5 – Release 3.51.1.1	
<u>File</u> Scree	in Field Select	tion Sto	ore Logs	Filters		Help
💠 STOP		💠 IN	SPECT A	ALL 💠 INSPECT last	500 lines	Normal Logs
Date	Time	Environ	Module	Process	Log Text	
2002-05-08	08:44:10.2739	wodta5a	fcdNoV1	UNKNOWN	<pre>fcdNoVltSrvCOMM::fcdNoVltSrvCOMM -> Initialization of server ended sy</pre>	accessfully! 🛛
2002-05-08	08:44:10,2748	wodta5a	fcdNoV1	UNKNOWN	<pre>fcdNoVltSrv::main -> fcdNoVltSrvCOMM is now waiting for cownections!</pre>	
2002-05-08	08:44:10,2755	wodta5a	fcdNoV1	UNKNOWN	<pre>fcdNoVltSrvCOMM::manageConnection -> Beginning!</pre>	
2002-05-08	08:44:10,2769	wodta5a	fcdNoV1	UNKNOWN	fcdNoVltSrvCOMM::manageConnection -> Wait for new connection or new #	essage!
2002-05-08	08:45:01	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	08:50:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	08:55:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:00:01	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:05:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:10:01	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:15:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:20:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:25:01	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:30:02	none	UNIX	logBackupUtil	Clean Logs	
2002-05-08	09:35:01	none	UNIX	logBackupUtil	Clean Logs	
<u>a</u>						1
Clear Sc	reen Show	WError S	tack	🔟 Help On Error 📁 /	Automatic Scrolling 🔄 Filter	
Filter Seler	ction :					
📕 Env. 🗠	+			+ FrociD ==	📕 Proc. Name 🗠 📕	

Figure 33 logMonitor interface

See the Central Control Software (CCS) User Manual of the VLT Software to have more details about the possibilities of the logMonitor.

3.3.2 The fcdNoVItSrv server

Next, you have to launch the tcp-ip interface manager (command: fcdNoVltSrv; item n. 2 in the "Start testbench's process" menu). You can find a version of the binary <u>there</u> (build June 6^{th}) and the source code <u>here</u> (build June 6^{th} version). On the WS, the binary could be found there:

"{root}/tbenchSoft/fcdnvsrv/bin/fcdNoVltSrv" build June 6th, 2002 and the source code here: "{root}/tbenchSoft/fcdnvsrv/src/" (June 6th, 2002 version) and can be compiled by using make clean all. The purpose of this server is to allow any NON-VLT software client to communicate with VLT-SW drivers. This service uses the 2331 port. To enable fcdNoVltSrv to communicate, edit the /etc/services and add in this file: wodt 2331/tcp, put this command between vccMAKE::begin and vccMAKE::end. There is no need to restart anything but fcdNoVltSrv. The code source is located here. To launch this server, just select the item nr. 2 as shown in the following menu (Figure 34):



Figure 34 Testbench management script: starts fcdNoVltSrv server

Then, you are invited to choose a verbosity level in the range [0,4], 0 provides the lowest amount of messages and 4 the maximum (Figure 35).



Figure 35 Testbench management server: chooses the verbosity level for fcdNoVltSrv

Meaning of the verbosity levels:

- 0: this the default; only message coming from the main program are provided
- 1: previous messages + error messages from the "client communication object"
- 2: previous messages + information messages from the "client communication object"
- 3: previous messages + error messages from the "driver object"
- ◆ 4: previous messages + information messages from the "driver object"



Figure 36 Software architecture of fcdNoVltSrv

Finally, a typical output provided by this server at start up, with verbosity level = 4, in the logMonitor (Figure 37):

-	VLT Log Monitor – @odta5 – Release 3.51.1.1	· 🗆
<u>F</u> ile <u>S</u> cre	een Field Selection Store Logs Filters	<u>H</u> elp
💠 STOP	◆ MONITOR ◇ INSPECT ALL ◇ INSPECT last 500 lines	Normal Logs
Date	Time Environ Module Process Log Text	
2002-06-05	13:35:02 none UNIX logBackupUtil Clean Logs	
2002-06-05	13:35:23,7680 woldsta roomovi Unkinown roomovilsvyjaan -/ server is running in vertose wolder 4 13:35:23,7680 woldsta roomovi Unkinown fodbollsvyj000115vyj000M -> Totisizization of server begins (use function fodSDC	K.InitServer)
2002-06-05	13:35:23.7743 wodta5a fcdNoVl UNKNOWN fcdNoVltSrvCOMM::fcdNoVltSrvCOMM -> Initialization of server ended successfully	
2002-06-05	13:35:23.7752 wodta5a fcdNoV1 UNKNOWN fcdNoV1tSrv::wain -> fcdNoV1tSrvCOMM is now waiting for comnections!	
2002-06-05	13:35:23.7758 wodta5a fcdNoV1 UNKNUMN fcdNoV1SrvOUMM::wanageConnection -> wanageConnection begins!	
		, I
<u> </u>		
Clear St	Show Error Stack 🔲 Help On Error 📕 Automatic Scrolling 📑 Filter	
Filter Sele	ection :	
📕 Env. ~	+ Module ~ HereiD == Proc. Name ~ Hereine +	

Figure 37 Messages in logMonitor at fcdNoVltSrv startup

3.3.3 The Fiera software

The Fiera software (command: fcdSlcuCon+STARTUP+ONLINE; item n. 6 in the "Start testbench processes" menu; Figure 38), this one should be ONLINE, by usual means or user own request. The pulpo server (fcdpserver) is launched automatically by Fiera SW.

Before invoking the STARTUP command and setting the CCDs on line, you must verify that the \$CCDNAME environment variable is properly defined and that the definition of the voltages applied to the CCD in the configuration file "volttable.def" in the directory \$INS_ROT/SYSTEM/COMMON/CONFIGFILES/\$CCDNAME are correct.

Wrong voltages can cause irreversible damage to the CCD.

- odta5]
Testbench management script Start testbench's process menu		
1) All the servers 4) rtdServer 7) Panel 2) fcdNoVltSrv 5) All the interfaces 8) logMonitor 3) fcdtserver 6) fcdSlcuCon 9) Return to main menu Which process or interface do you want to start?>6		

Figure 38 Testbench management script: starts fcdSlcuCon

fcdCon – @	∂wodta5a	· 🗆
File		Help
CCD Name	DMarc	Reset Panel Values
Time (s) Repetition 1.0 forever Period: Image: Constraint of the state of t	Enabled Ena	ences
START WIPE PAUSE STOP WIPE CONTINUE CHANGE TIME STOP WAIT ABORT Start RTD	Exposure No: 1 Id: 18621 Status: Integrating Shutter Closed Read % 100% Transfer % Int time: 739.6 Read time: IP Min: 0 IP Max: IP Avg: 0 IP RMS: System State: Online Rdt	0% 44.1 0 0.00 IDLE
STARTUP STANDBY ONLINE	SHUTDOWN	INEERING INTERFACE

Figure 39 fcdSlcuCon interface

By invoking STARTUP (Figure 39), several processes, that send messages both to a terminal window and to the log file, are launched. Typical outputs are (Figure 40):

				VLT Log Monitor – @odta5 – Release 3.51.1.1	
<u>F</u> ile <u>S</u> cre	en Field Selec	tion Store Logs	s Filters		Help
💠 STOP		INSPECT A	ALL 💠 INSPECT last	500 lines Norma	l Logs
Date	Time	Environ Module	Process	Log Text	
2002-05-16	15:53:13.8546	wodta5a fod	logUserData	fcdSlcuStartupCamera:: Executing on host odta5	Δ
2002-05-16	15:53:13.9338	wodta5a fod	logUserData	fodSlcuStartupCamera:: INTROOT , RTAPENV wodta5a	
2002-05-16	15:53:14.0178	wodta5a fed	logUserData	fodSlcuStartupCamera:: INS_ROOT /disk1/INS_ROOT DEBUG_LEVEL	
2002-05-16	15:53:14.0920	wodta5a fcd	logUserData	fodSicuStartupCamera:: CCINAME DMarc, INS_USER SYSTEM,	
2002-05-16	15:53:14.1701	wodta5a fcd	logUserData	FodSLouStartupCamera:: INS_HOST odta5, UP_MODE 2	
2002-05-16	15:53:14.2492	wootaba fod	logUserData	fodSlouStartupLawera; Checking environment	
2002-05-16	15:55:14.4195	wootaba roo	Logioce/Data	FordSucureckerw: Southas	
2002-05-16	15+53+14 6653	wordt a5a ford	Logiser Data	EddSinGtathuCastars++ BURD Server starting in acts 2	
2002-05-16	15:53:14.8172	wodta5a RTAP	asgSend	csReplace.c.8 892 1 WirtE NOLDC: process not active REASON > process fodcon IMarc in environment wolta5a not existin	ne
2002-05-16	15:53:14.8191	wodta5a wsg	nsgSend	msgSetFilter.c 11 8992 2 W ccsERR_PROC_INFO : Cannot get information on process	- I
2002-05-16	15:53:14.9774	wodta5a fod	logUserData	fcdSlcuCleanCawera:: Cleaning up for IMarc	
2002-05-16	15:53:14.9874	wodta5a fodp	FodpServer	PULPO unit 1 on TTY "/dev/ttyb" initialized by server.	
2002-05-16	15:53:14.9913	wodta5a fodp	fodpServer	<pre> Server> Downloading initial values.</pre>	
2002-05-16	15:53:15.0284	wodta5a fcd	logUserData	fcdSlcuCleanCamera:: Removing old processes	
2002-05-16	15:53:15.7220	wodta5a fcd	logUserData	FodSLouStartupCawera:: loading database for DMarc	
2002-05-16	15:53:15.8283	wodtaba fod	logUserlata	FodSLouSetupLamera;: Building list of camera names	
2002-05-16	10:00:10.90/9	wootaba Foo	LoguserData	foosicusetupionera;; built list of comera names unarc	
2002-05-16	15:55:15.9944	wootaba roo	LogiserData	TodSloubetupCamera;: Loading data base for unanc	
2002-05-16	15+53+17 2734	wodta5a fod	Logiser Data	EndSin SetupCaret a	
2002-05-16	15:53:17.7467	wodta5a fod	LogilserData	EdSIGNStartupCamerat: Starting tis for IManc Logging to /tap/tis.log.16218	
2002-05-16	15:53:19.0509	wodta5a fcd	logUserData	fcdSlcuStartupCamera:: Starting fcdc40srv_sparc_link for DMarc logging to /tmp/fcdc40srv_sparc_link.log.16218	
2002-05-16	15:53:19.3286	wodta5a fod	logUserData	fcdSlcuStartupCawera:: Trying to PING the DSP code fcddspb.app	
2002-05-16	15:53:24.6583	wodta5a fod	logUserData	fcdSlcuStartupCamera:: DSP interface initialised	
2002-05-16	15:53:24.7589	wodta5a fod	logUserData	fodSlouStartupCamera:: Starting Fodexp for DMarc logging to /tmp/fodexp.log.16218	
2002-05-16	15:53:25.1138	wodta5a fed	fodexp	PROCESS STARTING fodexp 2.70.	
2002-05-16	15:53:25.3345	wodta5a fcd	logUserData	FodSLouStartupCamera:: Starting Fodcon for DMarc logging to /tmp/fodcon.log.16218	
2002-05-16	15:53:26.0102	wodtaba fod	ficdcon_UMarc	PRODESS STRETING Federon_IMane 2,70.	
2002-05-16	10:00:20.2404	wootaba foo	LoguserData	FoodblockstartupLaweraf; Starting Foolnt for Unarc logging to /tmp/foolnt.log.ib218	
2002-05-16	15:53:20.4001	wordt affan ford	Fodeyo	Enditional failed to man IIM device	
ETTS LOG	15:53:27		-	(NEURSEEN: No TIM andula present. India51	
FITS LOG	15:53:27		-	/RECOVERY: Time will be taken from local SLCU clock Eddta53	
2002-05-16	15:53:27.1980	wodta5a fcd	fodexp	Read FIERA configuration.	
2002-05-16	15:53:27.2160	wodta5a fod	logUserData	fcdSlcuStartupCamera:: Starting fcdtm for DMarc logging to /tmp/fcdtm.log.16218	
2002-05-16	15:53:28,1016	wodta5a fodp	fodpServer	<pre><server> Downloading initial values complete.</server></pre>	
2002-05-16	15:53:28.0998	wodta5a fcd	fcdit_DMarc	PROCESS STARTING fodit_DManc 2.70.	
2002-05-16	15:53:28,1055	wootaba fod	Fodit_DMarc	todit :: bound to port 5355.	
2002-05-16	15:55:28.0041	wootaba fed	rcainc_unarc	reuless Startuperentit Startup Endedt fan TMana langing ta /tan/Endedt lag 1999	
2002-05-16	15:55:20,4148	woodcaba roo	Fodevo	Pead FTPD configuration complete	
2002-05-16	15:53:28.6073	wodta5a_fcd	fodta IMarc	PROFESS STORTING Fortha IManc 2.70.	
2002-05-16	15:53:28,6385	wodta5a fcd	logUserData	fodSlouStartueCamera:: Waiting for SLCU S/W	
2002-05-16	15:53:28,8395	wodta5a fod	fodrdt	PROCESS STARTING found: 2.70.	
2002-05-16	15:53:29,9314	wodta5a fcd	logUserData	fcdSlcuStartupCamera:: LCU Processes Loaded	
2002-05-16	15:53:30.0137	wodta5a fod	logUserData	fcdSlcuStartupCamera:: complete	_
51					
Clear S	sreen Sho	w Error Stack	🗆 Help On Error 🛛 💻	Automatic Scralling TI Filter	
Eiltor Solo	ction :	- LITON ORDER			
	+	Module ~	+ ProcID ==	Proc. Name ~	

Figure 40 Messages in the logMonitor when STARTUP is invoked

Next, the ONLINE command (Figure 39) applies the voltages previously defined. Typical output is (Figure 41):

-				VLT Log Monitor – @odta5 – Release 3.51.1.1	· 🗆
<u>File</u> Scree	en Field Selection	Store Log	s Filters		<u>H</u> elp
STOP	💠 MONITOR 🗠	INSPECT	ALL 💠 INSPECT Ia	st 500 lines	Normal Logs
Date	Time Envi:	ron Module	Process	Log Text	
2002-05-16	15:56:16.2186 wodt	a5a fod	fodexp	Init.	Δ
2002-05-16	15:56:16.2202 wodt	a5a fod	fodexp	Initialise C40 interface.	
2002-05-16	15:56:16,2230 work	a5a fod	fodexp	Read and Download FIERA config.	
2002-05-16	15:56:16.4564 work	a5a fod	fodexp	Download H/W configuration.	
2002-05-16	15:56:16.8564 worth	a5a fod	fodexp	Download voltage tables.	
2002-05-16	15:56:18,9165 wodt	a5a fod	fodexp	Initialise detector head.	
2002-05-16	15:56:23,2966 wodt	a5a fod	fodexp	Perform H/W selftest.	
2002-05-16	15:56:31.9067 wodt	a5a fod	fodexp	DownLoad sequences,	
2002-05-16	15:56:37.0267 wodt	a5a Fod	fodexp	Sequence download complete.	
2002-05-16	15:56:37.0284 wodt.	aba rod	todexp	Sending command INI to fount_UMarc.	
2002-05-16	15:56:37.7749 Wolds	aba tod	fcdint_DMarc	TIM readily (a failed to open lift device,	
2002-05-16	15:55:57.7775 would	aba rou	Continet DMana	Triticiping BUDO available.	
ETTS 1.00	15:56:37.7809 0000	-	-	THE LEAST STOLE CONTRACTOR AND A CONTRACT STOLE STOL	
FTTS LOG	15:56:38 -	2	2	DET SHOT THE - SILE / Gype of shudee to docads	
2002-05-16	15:56:38 0883 world.	a5a fod	Fedint IMare	Initializing PILPD skitter controlor	
2002-05-16	15:56:41 4185 world.	a5a fod	Fodevo	Sending compand INIT to fodit IMarc	
2002-05-16	15:56:42.1937 work	a5a fod	fodit DMarc	forthis Dent failed to open IM device.	
2002-05-16	15:56:42.1963 work	a5a fod	fodit DMarc	TIM module is NOT available.	
2002-05-16	15:56:42.2065 work	a5a fod	fodit DMarc	fodPP.C:123 301 1472 1 W fodERR GENERIC : Rtd init.	
2002-05-16	15:56:42.2081 worth	a5a fod	fodexp	Sending command INIT to fodtm_DMarc.	
2002-05-16	15:56:42.9472 wodt	a5a fod	fodtm_DManc	fodtimOpen: failed to open TIM device.	
2002-05-16	15:56:42,9496 wodt	a5a fod	fodtm_DManc	TIM module is NOT available.	
2002-05-16	15:56:42,9533 work-	a5a fod	fodtm_DMarc	Initialising PULPO controler.	
FITS_LOG	15:56:43 -	-	-	DET TELE NO = 3 / # of sources active Codta51	
FITS_LOG	15:56:43 -	-	-	DET TLM1 NAME = 'CCD T1' / Description of telenetry param. Codta5]	
FITS_LOG	15:56:43 -	-	-	DET TLM1 ID = 'CCD Sensor1' / ID of telemetry sensor Codta53	
FITS_LOG	15:56:43 -	-	-	DET TLM2 NAME = 'CCD T2' / Description of telenetry param. Lodta51	
FITS_LOG	15:56:43 -	-		DET TLM2 ID = 'CCD Sensor2' / ID of telewetry sensor [odta5]	
FITS_LOG	15:56:43 -			DET TLM3 NAME = 'EBOX T' / Description of telemetry param. Codta5]	
FITS_LOG	15:56:43 -		- T. (1997)	DET TLM3 ID = 'Box Temp' / ID of telemetry sensor Codta53	
2002-05-16	15:56:43.2526 wodt	a5a fod	fodexp	Sending command INIT to fodrat.	
2002-05-16	15:56:44.0032 wodt	a5a Fod	fodrdt	FodtialDen: failed to open TIM device.	
2002-05-16	15:56:44.0065 wodt	aba rod	fodrat	I'll module is NUL available.	
2002-05-16	15:56:44.0093 wodt.	aba fod	fearat	toddennerit,C:101 301 3129 1 W todbkk_GENERIC : locti benner talled.	
2002-05-16	15:56:44 9647	aba roo	Fodeep DMane	Fortistic completes,	
2002-05-16	15:56:44.9677 vodt	aba rou a5a £od	Fodcon_Dhanc	TIM pockas in NOT and table	
2002-05-16	15:56:45,1375 work	a5a fod	fodexp	Online.	
2002-05-16	15:56:45 1384 world	a5a fod	Fodevo	Toit	
2002-05-16	15:56:45,1392 wordt.	a5a fod	fodexp	Sending command INIT to fedint_DMarc.	
2002-05-16	15:56:45,1409 wordt.	a5a fod	fodexp	Sending compand INIT to fedit Marc.	
2002-05-16	15:56:45,1429 work	a5a fod	fodexp	Sending conwand INIT to fcdtm_DMarc.	
2002-05-16	15:56:45.1446 wodt	a5a fod	Fodexp	Sending conwand INIT to fodrat.	
2002-05-16	15:56:45.1465 wodt	a5a fod	fodexp	Init complete.	
2002-05-16	15:56:50.5474 wodt	a5a fod	fodexp	Online complete.	_
21					M
2					2
Clear Sc	reen Show Erro	or Stack	🔲 Help On Error 🛛 📕	I Automatic Scrolling 🔲 Filter	
Filter Sele	ction :				
📕 Env. ~	🕂 📕 Mod	ule ~	🕂 📕 ProcID 🛛	📕 Proc. Name ~	

Figure 41 Messages in the logMonitor when ONLINE is invoked

3.3.4 The fcdtserver server

The testbench server (command: fcdtserver; item n. 3 in the "Start testbench processes" menu, then choose a verbosity level; Figure 42). You can find a version of the binary <u>here</u> (build June 12th, 2002) and the source code <u>here</u>, June 12th, 2002 version. On the WS, the binary could be found there "{root}/tbenchSoft/tbenchTest/bin/fcdtserver" build June 12th, 2002 and the source code here: "{root}/tbenchSoft/tbenchTest/src/" (June 12th, 2002 version) and can be compiled by using make clean all.

Before starting this server, the following devices must be switched on: GPIB to SCSI box, the two monochromators MS257, the ke486 ammeter, the ke6514 ammeter and the MM4000 motion controller optionally. If one of the devices fails, you will be informed in the logMonitor; the program will proceed with the rest of the initialisation. The fcdtserver can run with all or only some of these devices online.

-	_	odta5		Ī
		Testbench management script Start testbench's process menu		
		1) All the servers 4) rtdServer 7) Panel 2) fcdNoVltSrv 5) All the interfaces 8) logMonitor 3) fcdtserver 6) fcdSlcuCon 9) Return to main menu Which process or interface do you want to start?> 3		

Figure 42 Testbench management script: starts fcdtserver

Then, you are invited to choose a verbosity level in the range [0,5], 0 provide the lowest amount of messages and 5 the maximum (Figure 43).

ŀ	-	odta5		
	-	Testbench management script Start fcdtserver menu		
	1 2 2 2) fodtserver verbose 0 5) fodtserver verbose 4 2) fodtserver verbose 1 6) fodtserver verbose 5 3) fodtserver verbose 2 7) Return to previous menu 4) fodtserver verbose 3 4hich verbose level?>		

Figure 43 Testbench management script: chooses fcdtserver verbosity level

First, fcdtserver tries to initialise the two monochromators (Figure 45 & Figure 46). It does the following actions in this order:

- Open the logical UNIX devices /dev/mono1 and /dev/mono2.
- Clear these devices.
- Configure the End Of String character on the GPIB (on both devices) to '>' which is the character used by the MS257 to end the messages it sends.
- Query the ID of /dev/mono1 (version number of internal software).
- Query the wavelength unit and changing it to 'NM' (nanometer) if needed (on both devices).
- Set the output port of /dev/mono2 to B.
- Set the filter number 1 on the density filter wheel on /dev/mono1 (1: attenuation of 100%, 2: 10%, 3: 1%, 4: 50%, 5: 25%); the density filter wheel is attached to /dev/mono1.
- Set the order sorting filter wheel so that below 500 nm the filter 1 is used, between 500 and 700 nm the filter 2 and over 700 nm the filter 3.
- Set the bandpass at 10 nm on both devices.
- Query the maximum wavelength reachable with the grating.
- Set the current wavelength at 632nm.

Special characteristics of the MS257:

• The MS257 does not have service request (SRQ) capabilities. So that, we have to wait between the moment we send a command and the moment we can read the result. A standard time out of 2 seconds is needed; for the commands that invoke movements (gratings rotation, slit width, ...), the time-out must be of 5s. These values have been determined experimentally.

• Sometimes, after a long time online, it is impossible for fcdtserver to get connected with the MS257 and initialise it. The only solution is to turn the power off of the two monochromators and then to turn them on in the right order (first MS257_1, next MS257_2).



Figure 44 Software architecture from the client PC to the monochromator MS257

-			VLT Log Monitor – @odta5 – Release 3.51.1.1	
<u>File</u> Scre	en Field Selection Store Log	js Filters		<u>H</u> elp
 STOP 	♦ MONITOR ♦ INSPECT	ALL 💠 INSPECT I	last 500 lines	Normal Logs
Date	Time Environ Module	Process	Log Text	
2002-06-05	13:41:34,7515 wodta5a fodt	fodtserver	fodtserver::wain -> Server is running in verbose wode 4	1
2002-06-05	13:41:34.7731 wodta5a fodt	fodtserver	Ms257::Ms257 -> Opening /dev/wono1 Use GPIB function ibfind (see GPIB wanual p. 5-44)	
2002-06-05	13:41:34.7739 wodta5a fodt	fodtserver	Ms257::Ms257 -> /dev/wono1 opened!	
2002-06-05	13:41:34,7746 wodta5a fodt	fodtserver	Ms257::Ms257 -> Opening /dev/wono2 Use GPIB function ibfind (see GPIB wanual p. 5-44)	
2002-06-05	13:41:34.7/53 wootaba Foot	Fodtserver	Ms2o7::Ms2o7 -> /dev/wono2_opened1	
2002-06-05	13:41:34.7759 wodtaba fodt	fodtserver	Uniel:(Uniel -> initialization begins)	
2002-06-05	13:41:34.7766 Wootaba Foot	foctserver	MS20/::int -> Initialization of MS20/ Degins	
2002-06-05	17:41:34.7772 Wootaba Foot	Calkserver	MSCOTTINT TO LEAR MSCOTTINGTO TONOTON DOCTS SEE GTD MANUAL P. 57237	
2002-06-05	13:41:34 7787 uodta5a Fodt	Fortserver	MeConstitute to Clear accord according to the line term (according to the line of the line of the line term (according to the line term (according to the line term)	
2002-06-05	13:41:34,7794 worlta5a Fort	Forthserver	MoST tinit -> Clear asST 2 successfullul	
2002-06-05	13:41:34,7801 wodta5a fodt	fodtserver	Ms257;:init -> Configure EDS character to '>' on ws257_1 (GPIB function ibconfig: see GPIB wanual p. 5-26)	
2002-06-05	13:41:34,7807 wodta5a fodt	fodtserver	Ms257;;init -> Configure EDS character to '>' on ms257_1 successfully	
2002-06-05	13:41:34.7814 wodta5a fodt	fodtserver	Ms257::init -> Enable previously defined EOS character on reading operations on ws257_1 (GPIB function ibconfig: see GPIB wanual p. 5-26)	
2002-06-05	13:41:34.7821 wodta5a fodt	fodtserver	Ms257::init -> Enable previously defined EOS character on reading operations on #s257_1 successfully!	
2002-06-05	13:41:34.7830 wodta5a fodt	fodtserver	Ms257::init -> Set EDS character comparison on 8 bits on ws257_1 (GPIB function ibconfig: see GPIB wanual p. 5-26)	
2002-06-05	13:41:34.7836 wodta5a fodt	fodtserver	Ms257::init -> Set EDS character comparison on 8 bits on ws257_1 successfully!	
2002-06-05	13:41:34.7843 wodta5a fodt	fodtserver	Ms257::init -> Configure EOS character to '>' on ms257_2 (GPIB function ibconfig: see GPIB manual p. 5-26)	
2002-06-05	13:41:34.7850 wodta5a fodt	fodtserver	Ms257::init -> Configure EOS character to '>' on ws257_2 successfully!	
2002-06-05	13:41:34.7859 wodta5a fodt	fodtserver	Ms257::init -> Enable previously defined EDS character on reading operations on ms257_2 (GPIB function ibconfig: see GPIB manual p. 5-26)	
2002-06-05	13:41:34./866 wootaba Fodt	Fodtserver	Ms20/::init -> Enable previously defined EUS character on reading operations on ws20/_2 successfully	
2002-06-05	13:41:34.7873 wodtaba fodt	Fodtserver	Ms2b/;:init -> Set EUS character comparison on 8 bits on ms2b/2 (GPIB function ibconfig; see GPIB manual p, 5-26)	
2002-06-05	13:41:34.7890 Wootaba Foot	toatserver	Ms20/::init -> Set EUS character comparison on 8 bits on Ms20/2 Subcessfully!	
2002-06-05	13:41:34,7086 Voltaba Folt	Footserver	MoSCF::init =/ Set timeout on MSCF_1 (write Function 10000) see Grip Manual p. 57/57 MoSCF::init =. Set timeout on MSCF_1 = proceedfullul	
2002-06-05	13:41:34 7900 works5a Fort	Fordt servier	Model with a set through a model a subcost and get a subcost and get a set of the set of	
2002-06-05	13:41:34 7907 work a5a Fork	Foolt server	MoST ** init -> Set timest on as257 2 successfullul	
2002-06-05	13:41:34,7914 uodta5a fodt.	fodtserver	Ms277::init -> Query as277 1 ID (version puber of internal software: see us277 programming manual p. 31): send command "2VEP"	
2002-06-05	13:41:37.9057 uodta5a fodt	Fodtserver	Ms257::init -> Read as257 1 ID successfully/ as257 1 ID= 1.72	
2002-06-05	13:41:37.8064 wodta5a fodt	fodtserver	Ms257;:init -> Query wavelength units of ws257_1 (see ws257 programming wanual p. 31); send command "?UNITS"	
2002-06-05	13:41:40.8251 wodta5a fodt	fodtserver	Ms257::init -> Query wavelength units for as257_1 successfully! Units= NM	
2002-06-05	13:41:40.8255 wodta5a fodt	fodtserver	Ms257::init -> Query wavelength units for ws257_2 (see ws257 programming wanual p. 31); send command "?UNITS"	
2002-06-05	13:41:43.8451 wodta5a fodt	fodtserver	Ms257::init -> Query wavelength units for ws257_2 successfully! Units= NM	
2002-06-05	13:41:43.8455 wodta5a fodt	fodtserver	Ms257::init -> Set ws257_2 output port to B (see ws257 programming manual p. 39); use function setPortout	
2002-06-05	13:41:43.8459 wodta5a fodt	fodtserver	Ms257::setPortout -> Set timeout on ms257_2 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	13:41:43.8463 wodta5a fodt	fodtserver	Ms257::setPortout -> Set timeout on ws257_2 successfully!	
2002-06-05	13:41:43.8467 wodtaba Fodt	Fodtserver	Ms25/::setPortout -> Set ms25/_2 output port to B (see ws25/ programming wanual p. 39); send command PDRTDUT B	
2002-06-05	13:41:53.8645 wodtaba Fodt	Fodtserver	Ms2b/::setPortout -> Set ms2b/_2 output port to B successfully!	
2002-06-05	17:41:55:6645 Godtaba Fodt	Calkannum	MS20/:SetConcold =/ Set Cimedua on MS20/_2 (with function locat) set with wandar p. 54/57	
2002-06-05	17:41:57 9657 workt also foot	Foutserver	Moder state of tool of the common of the set of the account of the set of the	
2002-06-05	13:41:53.8660 wordta5a. Fordt	Forthserver	MSS7:tinit -) Set asS71 nethod depoint (filter whell on position 1 (see as257 programming separat p. 25); we function set [iter	
2002-06-05	13:41:53,8664 worka5a fort	fodtserver	MeSS7:testFilter -> Set tissout on as257 1 (GPIB function ibtack see GPIB samual or 5-79)	
2002-06-05	13:41:53,8668 wodta5a fodt	fodtserver	Ms257:::setFilter -> Set timeout on ms257 1 successfully!	
2002-06-05	13:41:53.8671 wodta5a fodt	fodtserver	Ms257::setFilter -> Set ws257_1 filter position 1 for filter wheel 2 (see ws257 programming manual p. 35): send command (FILT2	
2002-06-05	13:42:03,8846 wodta5a fodt	fodtserver	Ms257::setFilter -> Set ws257_1 filter position 1 for filter wheel 2 successfully!	
2002-06-05	13:42:03.8851 wodta5a Fodt	Fodtserver	Ms257::setFilter -> Set timeout on ms257_1 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	13:42:03.8854 wodta5a fodt	fodtserver	Ms257::setFilter -> Set timeout on ms257_1 successfully!	
2002-06-05	13:42:03.8858 wodta5a fodt	fodtserver	Ms257::init -> Set as257_1 neutral density filter whell on position 1 successfully!	
2002-06-05	13:42:03.8861 wodta5a fodt	fodtserver	Ms257::init -> Set ws257_1 order sorting filter whell on AUTO filter selection (see ws257 programming manual p. 35); send command	
2002-06-05	13:42:06,9047 wodta5a Fodt	rodtserver	Ms2b/:11nt -> bet ms2b/_1 order sorting filter whell on HUTO filter selection successfully	
2002-06-05	13142106.9002 Wodtaba Fodt	+ catserver	mscor::iiit -> Set wscor_i snutter to norwally closed with autowatic closure (see wsCor programming wanual p. 42); send comwand "=SHIRIYPE	
2002-06-05	13:42:09.9246 wodtaba Fodt	Catserver	mscor;;;init =/ bet mscor_s smutter to normally closed with automatic closure successfully: ModStructle Descentioned of the theory of the second successful (1) areas of (10)/1710 of	
2002-06-05	13:42:09.9200 Vootaga + cot	Forteener	reconstruct -> Departurate reconstruction value reconstruction of programming wanual p. 427; send command "ISHUITER 0 MeXP2:sint -> Departurate arXP2:1 doubter surgeorDubul	
2002-06-05	13:42:12 9452 wolt a5a Foot	Footserver	MSOFT: init - DescuasofT 1 filter chargement (see as257 programming annual p. 37); seed command "20NNEFLO"	L
				M
Clear St	creen Show Error Stack	Help On Error	Automatic Scrolling Filter	
Eilter Sele	ection :		•	
Env	+ 🖬 Module ~	+ 🔳 ProciD	Proc. Name ~	
L				

Figure 45 Messages in the logMonitor during the initialisation of the monochromator (verbosity level 4)



Figure 46 Messages in the logMonitor during the initialisation of the monochromator and the ke486 (verbosity level 4)

Then, the ammeter Ke486 (Figure 46 & Figure 48):

- Open the logical UNIX device /dev/amp1.
- Clear this device.
- Query the ID of /dev/amp1 (model number and firmware revision).
- Set ASCII format without prefix and without terminator sequence for the data transfer.
- Enable zero check and performing zero correction.
- Enable digital + analog filters.
- Query the complete status word.



Figure 47 Software architecture from client PC to the ammeter ke486

-	VLT Log Monitor – @odta5 – Release 3.51.1.1			
<u>File</u> Scre	en Field Selection Store Log	s Filters		Help
+ STOP		ALL 💠 INSPECT las	t 500 lines	Normal Loos
Date	Tine Environ Module	Process	Increase.	
2002-06-05	13:43:10.1544 wodta5a fodt	fodtserver	Kel85:tmakeZeroCheck -> Enable zero check and perform zero correction successfully!	2
2002-06-05	13:43:10,1549 wodta5a fodt	fodtserver	Ke486::init -> Enable zero check and performs subtraction successfully	
2002-06-05	13:43:10.1552 wodta5a fodt	fodtserver	Ke486::init -> Enable digital + analog filters (see ke486 manual p. 4-27); send command: P3K	
2002-06-05	13:43:30.9747 wodta5a fodt	fodtserver	Ke486::init -> Enable digital + analog filters successfully	
2002-06-05	13:43:30.9/51 Wootaba + cot 17:47:71 0717 weak = En fact	footserver	Ke495:[Init -> Request the complete status string (see Ke485 manual p. 4-52); send command: UVX	
2002-06-05	13:43:31 0721 uodta5a fodt	Footserver	Kedőszinit –) kedős initalization endel szincessfullu	
2002-06-05	13:43:31.0727 wodta5a fodt	fodtserver	Keithleg::Keithleg -> initialization went successfully!	
2002-06-05	13:43:31.0730 wodta5a fodt	Fodtserver	fcdtserver::main -> Ke486 initialized!	
2002-06-05	13:43:31.0736 wodta5a fodt	fodtserver	Ke6514::Ke6514 → Opening /dev/amp2	
2002-06-05	13:43:31.0741 wodta5a fodt	fodtserver	Ke6514;tke6514 -> /dev/asp2 opened	
2002-06-05	13:43:31.0749 workasa foot	footserver	Kettniegeo14: Kettniegeo14 -> Initialization degins:	
2002-06-05	13:43:31,0752 uodta5a Fodt	Fortserver	KeSSI4: init -> initialization of KeSSI4 begins	
2002-06-05	13:43:31.0756 wodta5a fodt	fodtserver	Ke6514::init -> Clears ke6514 (use GPIB function ibolr: see GPIB sanual p. 5-23)	
2002-06-05	13:43:31.0874 wodta5a fodt	fodtserver	Ke6514::init -> Clear Ke6514 successfully!	
2002-06-05	13:43:31.0878 wodta5a fodt	fodtserver	Ke6514;:init -> Querry Identification (manufacturer, model, number, serial number and firmware revision levels of ke6514; see ke6514 manual p	o. 14-2);
2002-06-05	13:43:31.1022 wodta5a fodt	fodtserver	Ke6514::init -> Query identification successfully! ID: KEITHLEY INSTRUMENTS INCMODEL 6514.0743174.A03 Jul 23 1999 14:19:13/A02 /B	
2002-06-05	13:43:31,1026 wodta5a fodt	fodtserver	Ke6514;iinit -> Clear the error buffer (see ke6514 manual p. 16-8); send command SYST;CLE	
2002-06-05	12:43:31.1000 Wootaba Foot	f catserver foat conver	KepS14:1111 -> Liear the error buffer successfully: KepS14:1111 -> Detrop kepS14 to BS14 to Compare the 1400 to compare ABST	
2002-06-05	13:43:31, 1068 work a5a, Fork	Fodtserver	KeSSI4: init -> Neturn KeSSI4 to RSI defaults successfullul	
2002-06-05	13:43:31.1072 wodta5a fodt	fodtserver	ke6514;:init -> Set data format to REAL (see ke6514 manual p. 16-4); send command FORM REAL	
2002-06-05	13:43:31.1084 wodta5a fodt	fodtserver	Ke6514::init -> Set data format to REAL successfully	
2002-06-05	13:43:31,1088 wodta5a fodt	fodtserver	ke6514::init -> Set data format element to READ (Specify to include voltage, current, resitance or charge reading in the data	
2002-06-05	13:43:31,1105 wodta5a fodt	fodtserver	Ke6514::init -> Set data format element to READ successfully!	
2002-06-05	13:43:31.1109 wodta5a fodt	fodtserver	ke6514:iinit -> Enable autozero control (see ke6514 nanual p. 16-8); send command SYST:RZER ON	
2002-06-05	13:43:31,1124 Woltaba Foot	Footserver	NeSSI::Init -/ Mutazero control enables successfully: NeSSI::Init -/ Nucleic successfully:	
2002-06-05	13:43:31,1142 uodta5a fodt	fodtserver	KefSittinit -> Zen deck diskied successfullation p. 10 07 Self Content Jor. 2010	
2002-06-05	13:43:31,1147 wodta5a fodt	fodtserver	ke6514;;init -> Disable zero correction (see ke6514 aanual p. 16-8); send coamand SYST;ZCOR OFF	
2002-06-05	13:43:31.1163 wodta5a fodt	fodtserver	Ke6514::init -> Zero connect disabled successfully!	
2002-06-05	13:43:31.1167 wodta5a fodt	fodtserver	ke6514::init -> Enable anneter auto range (see ke6514 manual p. 17-6); send command CURR:RANG:AUTO CN	
2002-06-05	13:43:31.1187 wodta5a fodt	fodtserver	Ke6514::init -> Ammeter auto range enabled successfully!	
2002-06-05	13:43:31,1191 wodtaba foot	footserver	Kebbl4(init -> set measurement function to current (see Kebbl4(init annual p. 1/-6); send command FUNL (LURK)	
2002-06-05	13:43:31,1200 uodta5a fodt	Foduserven	Nepole: Linut -/ Set measurement function to current successfully: LeoSitivisit -> Deale and data triamen (see LeoSitivisen) = 17-13); send created TRIC/TRI -QUID (N	
2002-06-05	13:43:31,1227 wordta5a foot	fodtserver	Ke6514:init -> Auto delay trizzer enabled successfully	-
2002-06-05	13:43:31,1231 wodta5a fodt	fodtserver	ke6514;;init -> Set anmeter intergration rate to 2 (in line cycles) (see ke6514 manual p. 17-6); send command CURR:NPLC 2	
2002-06-05	13:43:31.1246 wodta5a fodt	fodtserver	Ke6514::init -> Set anneter integration rate to 2 (in line cycles) successfully!	
2002-06-05	13:43:31,1250 wodta5a fodt	fodtserver	ke6514::init -> Query the status byte register (see ke6514 manual p. 14-2); send command *STB?	
2002-06-05	13:43:31.2841 wodtaba Fodt	Fodtserver	Kebbl4::init -> Keads the status byte register successfully SIB=65	
2002-06-05	13:43:31,2046 Voltaba Folt	Foduserven	Kettble 511/14/16/16/16/16/16/16/16/16/16/16/16/16/16/	
2002-06-05	13:43:31,2853 uodta5a fodt	fodtserver	followerthan -> Kef514 initialized	
2002-06-05	13:43:31,2858 wodta5a fodt	fodtserver	nn4000;:nn4000 -> Opening /dev/MM4000	
2002-06-05	13:43:31,2963 wodta5a fodt	fodtserver	nn4000;tnn4000 -> /dev/MM4000 opened!	
2002-06-05	13:43:31,2866 wodta5a fodt	fodtserver	MotionControlerMM4000;;MotionControleurMM4000 -> initialization begins!	
2002-06-05	13:43:31.2870 wodta5a fodt	fodtserver	<pre>ma4000::init -> Initialization of mm4000 begins</pre>	
2002-06-05	13:43:31.28/3 Wodtaba foot	fotserver	and/000(1111) -> Liear and/000 (GPLB function IDDIP) see GPLB manual p. 5-25)	
2002-06-05	13:43:31,2950 uodta5a fodt	Fortserver	and/00112111 -> Clear infloor accessingly and/00112111 -> Departed and/001 TB (controller ande) a versiont see and/00 acruel n 3 1051t send created (VEC	
2002-06-05	13:43:31.2960 wodta5a fodt	fodtserver	an4000:::init -> Error while requesting an4000 ID! writeBuffer function error! init failed!	
2002-06-05	13:43:31.2964 wodta5a fodt	fodtserver	MotionControlerMM4000::MotionControleurMM4000 -> initialization error: GPIB error: write error aw4000 (ibwrt function)	
2002-06-05	13:43:31,2967 wodta5a fodt	fodtserver	fodtserver::main -> GPIB error: write error mm4000 (ibwrt function) mm4000 not initialized	-
2002-06-05	13:43:31.2971 wodta5a fodt	fodtserver	fodtserver::main -> 3/4 of the devices initialized!	7
4				
Clear St	creen Show Error Stack	💷 Help On Error 🛛 📕	Automatic Scrolling 🔲 Filter	
Filter Sele	ction :			
📕 Env. ~	🛨 📕 Module ~	🛨 🗖 ProciD	📕 Proc. Name -	

Figure 48 Messages in the logMonitor during the initialisation of the 486, the ke6514 and the MM4000 (verbosity level 4)

Next, the ammeter Ke6514 (Figure 48):

- Open the logical UNIX device /dev/amp2.
- Clear this device.
- Query the ID of /dev/amp1 (manufacturer, model, number, serial number and firmware revision).
- Clear the error buffer.
- Reset to the default conditions and cancel all pending commands.
- Set data format to real.
- Enable autozero control and disable zero check.
- Enable auto range selection.
- Select current measurements.
- Enable auto delay trigger
- Set integration rate to 2 cycles/mn.
- Query the status byte register.



Figure 49 Software architecture from the client PC to the ammeter ke6514

Finally, the motion controller mm4000 (Figure 48): Open the logical UNIX device /dev/MM4000. Clear this device. Query the ID of /dev/MM4000 (controller model and version). Set motor power ON.



Figure 50 Software architecture from the client PC to the motion controller MM4000

Special characteristics of the MM4000:

• Like the MS257, the MM4000 does not have service request (SRQ) capabilities. Therefore, we have to wait between the moment we send a command and the moment we can read the result. A time-out of 2 seconds is needed. This value has been determined experimentally.

Meaning of the verbosity levels:

- 0: this is the default; only messages coming from the main program are provided.
- ◆ 1: previous messages + error messages from the "client communication object".
- 2: previous messages + information messages from the "client communication object".
- 3: previous messages + error messages from the "driver object".
- ◆ 4: previous messages + information messages from the "driver object".
- 5: previous messages + messages from GPIB based functions readBuffer() and writeBuffer().

This is a typical output provided by the daemon start up with verbosity level 4.

For other unexpected behaviours of the testbench, the user can refer to the TestbenchLog.doc file (a shortcut to this file is present on the desktop). This file contains the problems we have already experienced.

An FTP server must be running (port 21) at the workstation's side, so that PRiSM will be able to pick up image FITS files from the /DETDATA directory.

3.3.5 The rtdServer

Next, you have to launch the Real Time Display Server (command: rtdServer; item n. 4 in the " Start testbench's process" menu) that is needed by the RTD software to display images (RTD software can be launched threw the fcdSlcuCon interface). See "Real Time Display User Manual" for more information (Doc.No. VLT-MAN-ESO-17240-0866).



Figure 51 Testbench management script: starts rtdServer



Figure 52 rtd interface

3.4 Interface

The only tool available is a local control panel (item n. 7 in the "Start testbench processes" menu) located at {root} /tbenchTest/interface/panel.pan (Figure 53).



Figure 53 Testbench management script: starts panel.pan

🔀 FIERA - MS Engineering - @wodta2a		X
Monochromator (ms257) Wavelength 632 (NM) Apply Bandwidth : 10 (NM) Apply	Ammeter (ke486) Function : 4 Mesure number : 10 Integration time : 0,02	
Neutral density filters (T%) : 100% - Output Monochromator port : Sphere - Shutter Command Feedback Window Options	Start trigger get Buf	fer
10:07:24 OINIT > INVOKED 10:08:24 OINIT > REPLY/ 1 rep 10:08:24 KINIT > INVOKED	bly timed out	

Figure 54 The panel.pan interface

This panel controls the monochromators and the ke486 ammeter locally and interactively. Press buttons and sometime it takes time to get the reply, but please be patient (Figure 54). For instance:

11:57:57 OSWAV > INVOKED 11:58:12 OSWAV > REPLY/ L OK

4 From the client's side

4.1 Network configuration

A wrong network configuration can cause connection problems (such as timeout error) not so obvious to understand.

Open the properties menu from Network and Dial-up Connection icon on the desktop. You should obtain this window (Figure 55):



Figure 55 Network configuration: network and dial-up connection properties

Then, open the properties menu of Local Area Connection. You should obtain that (Figure 56):

ocal Area Connection Properties
General
Connect using:
3Com 3C918 Integrated Fast Ethernet Controller (3C905B-
Configure
Components checked are used by this connection:
Client for Microsoft Networks Pie and Printer Sharing for Microsoft Networks Pie and Printer Sharing for Microsoft Networks Pie Netbell Protocol Protocol Protocol Pie Network Monitor Driver Pie Network Monitor Driv
Install Uninstall Properties
Description
Allows your computer to access resources on a Microsoft network.
OK Cancel

Figure 56 Network configuration: local area connection properties

Select the configure button and check the configuration in each tab (Figure 57 & Figure 58 & Figure 59):



4.2 Prism SW

It's needless to say that all the servers (Pulpo, FIERA and testbench devices) must be running on the workstation.

4.2.1 The monochromator

Selecting the following menu initiate the connection with the monochromator (Figure 60):



Figure 60 PRiSM software: monochromator menu

The following window should appear (Figure 61):

INIT MONOCHROMATOR	×
Host name: Port number (/etc/services, 2331) : RTAP environment (echo \$RTAPENV):	odta5 2331 wodta5a
	<u>D</u> K <u>C</u> ancel

Figure 61 PRiSM software: monochromator init box

The parameters are:

- "Host name": The name of the UNIX workstation (for example: "odta5" or "134.171.5.155").
- "Port number": The tcp-ip socket port number (here 2331).
- "RTAP environment": The name of the RTAP environment. See the \$RTAPENV value in the UNIX station environment.

After a while (~90s), a dialog box appears, the parameters that you want to apply to the testbench can be set here (Figure 62).

Monochromator (ms257)	×
Wavelength (NM) : 📴	Filter : 100%
Bandwidth (NM): 10	Port : Sphere (B) 💌
Apply	
17/05/2002 09:37:42 · All inits de	
11770372002 03.37.42 . All Inits ut	one!
1770372002 03.37.42 . All Inits ut	one !
11770372002 03.37.42 . All Inits di	one !
17703/2002 03.37.42 . All Inks di	one !



The script commands available for the monochromator are:

- "SetMonochromatorWav" This function sets a wavelength value in nanometer (between 0 and 2500). Example: # Set the monochromator value to 620nanometer SetMonochromatorWav 620
- "SetMonochromatorFilter"

This function selects the neutral density filter. Each value corresponds to a specific filter: for 100%, value = 1 for 50%, value = 2 for 25%, value = 3 for 10%, value = 4 for 1%, value = 5 Example: # Set the monochromator filter position to 50% SeMonochromatorFilter 2

 "SetMonochromatorBandwidth" This function sets the monochromator bandwidth (in nanometer). Example: # Set the monochromator bandwidth to 10 nanometers SetMonochromatorBandwidth 10

• "SetMonochromatorPort"

This function sets the monochromator output port (B or C). For port B, value =1 (For port C, value =2 (Example: # Set the output port monochromator B SetMonochromatorPort 1

• "MonochromatorShutter"

Set the monochromator shutter stats. For open position, value=0. For closed position, value=1. Example: # Close the shutter MonochromatorShutter 1

Here an example of the monochromator interface in use (Figure 63):



Figure 63 PRiSM software: monochromator dialogs box in use

And here a typical output in the logMonitor when we ask for a new wavelength (Figure 64):

				VLT Log Monitor – @odta5 – Release 3.51.1.1	- I - I -
Pilé Screi	en Field Selecti	ion Store Logs	i Filters		<u>H</u> elp
 STOP 		♦ INSPECT A	ALL 💠 INSPECT las	500 lines Norr	mal Logs
Date	Tixe 8	Environ Module	Process	Log Text	
2002-06-05	14:13:53,6799	wodta5a FodNoV1	fcdNoVltSrv_14837	FodNoVltSrvEDMM::manageConnection -> Wait for new connection or new message!	A
2002-06-05	14:14:37,2129	wodta5a FodNoV1	fcdNoVltSrv_14837	FodNoVItSrvCDMM::manageConnection -> select function has detected a new connection or a new wessage!	
2002-06-05	14:14:37,2133	wodta5a fodNoV1	fcdNoVltSrv_14837	FodNoVLtSrvCOMM::wanageConnection -> New wessage has just arrived!	
2002-06-05	14:14:37,2136	wodta5a fodNoV1	fcdNoVltSrv_14837	fcdNoVltSrvCDMM::manageMessage -> Begin!	
2002-06-05	14:14:37,2140	wodta5a FodNoV1	fcdNoV1tSrv_14837	FodNoVltSrvCDMM::nanageMessage -> Message is a command! Must receive 468 bytes	
2002-06-05	14:14:37.2144	wodta5a FodNoV1	FcdNoVitSrv_14837	FodNoVltSrvCDMM::nanageMessage -> First part of message received! Command= OSWAV, Desterv= wodta5a, Destproc= Fodtserver	
2002-06-05	14:14:37,2613	wodta5a fodNoV1	fcdNoVltSrv_14837	FodMoVitSrvDDMM::manageMessage -> Second part of message received successfully! Parameter= 500	
2002-06-05	14:14:37,2617 (wodta5a fodNoV1	fcdNoVltSrv_14837	- fcdNoVltSrvDDMM::manageMessage -> Send the previously received command to the environment wodta5a and the process fcdtserver winthin the timeout 90000	01
2002-06-05	14:14:37,2620	wodta5a fodNoV1	fcdNoVltSrv_14837	fodNoVltSrvMSG::Call -> Set filter on message!	
2002-06-05	14:14:37,2625	wodta5a FodNoV1	FcdNoVltSrv_14837	FodNoVltSrvMSG::Call -> Set filter on message successfully/	
2002-06-05	14:14:37,2630	wodta5a fodt	fodtserver	Oriel::setHavelenth -> setHavelength begins!	
2002-06-05	14:14:37.2634	wodta5a fodt	fodtserver	Ms257::setWavelength -> Set timeout on ms257_1 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	14:14:37,2638	wodta5a fodt	fodtserver	Ms257::setWavelength -> Set timeout on ms257_1 successfully!	
2002-06-05	14:14:37,2642	wodta5a fodt	fodtserver	Ms257::setWavelength -> Set timeout on ms257_2 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	14:14:37.2646	wodta5a fodt	fodtserver	Ms257::setHavelength -> Set timeout on ms257_2 successfully!	
2002-06-05	14:14:37,2650 (wodta5a fodt	fodtserver	Ms257::setWavelength -> Set ws257_1 wavelength to 500 nm (see ws257 programming wanual p. 20); send command !GW 500	
2002-06-05	14:14:37,2654	wodta5a fodNoV1	fcdNoVltSrv_14837	fcdNoVltSrvMSG::Call -> Send command OSWAV to process fcdtserver successfully!	
2002-06-05	14:14:47,2827	wodta5a fodt	fodtserver	Ms257::setWavelength -> Set ms257_1 wavelength to 500 nm successfully!	
2002-06-05	14:14:47.2831	wodta5a fodt	fodtserver	Ms257::setHavelength -> Set ms257_2 vavelength to 500 nm (see ms257 programming manual p. 20); send command IGM 500	
2002-06-05	14:14:57.3027	wodta5a fedt	fodtserver	Ms257::setWavelength -> Set ws257_2 vavelength to 500 nw successfully!	
2002-06-05	14:14:57,3031	wodta5a fodt	fodtserver	Ms257::setWavelength -> Set timeout on ms257_1 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	14:14:57,3035	wodta5a fodt	Fodtserver	Ms257::setWavelength -> Set timeout on ms257_1 successfully!	
2002-06-05	14:14:57.3039	wodta5a fodt	Fodtserver	Ms257::setHavelength -> Set timeout on ms257_2 (GPIB function ibtmo; see GPIB manual p. 5-79)	
2002-06-05	14:14:57.3043	wodta5a fedt	fodtserver	Ms257::setWavelength -> Set timeout on ws257_2 successfully!	
2002-06-05	14:14:57,3046	wodta5a fodt	fodtserver	Oriel::setWavelenth -> setWavelength ended successfully!	
2002-06-05	14:14:57,3055	wodta5a FodNoV1	fcdNoVltSrv_14837	fodNoVltSrvMSG;;Call -> LastReply= ccsTRUE!	
2002-06-05	14:14:57.3060	wodta5a FodNoV1	FedNoV1tSrv_14837	FcdNoVLtSrvDDMM::manageMessage -> Send the previously received command successfullyto the environment wodta5a and the process fodtserver winthin the t	incout
2002-06-05	14:14:57.3063	wodta5a fcdNoV1	fcdNoVltSrv_14837	FodNoVIESrvCDMM::wanageMessage -> Send the reply! Return= DK	
2002-06-05	14:14:57.3067	wodta5a FodNoVI	FodNoVItSrv_14837	FochVVItSrvUUMM::manageMessage -> Send the reply successfully!	
2002-06-05	14:14:57,3071	wodta5a FodNoV1	fcdNoV1tSrv_14837	FodNoVItSrvCDMM::manageConnection -> Wait for new connection or new message!	
<u>s</u>				I	
Clear St	creen Show	Error Stack	💷 Help On Error 🛛 📕	Automatic Scrolling 🔲 Filter	
Filter Sole	otion				
Filler Sele	cuon :				
📕 Env. 👻	+ 🗖	Module ~	🛨 📕 ProciD == 📗	📕 Proc. Name ~	
1			·		

Figure 64 Messages in the logMonitor while a command is executed by the monochromator

4.2.2 The ammeters (ke486 and ke6514):

You have to initialise the ammeter by selecting the following menu (Figure 65):

4.01 12/	02/20	00 > 266kb	L			
<u>T</u> elescope	E <u>S</u> O	<u>D</u> ata Base	<u>W</u> indov	v <u>O</u> ptions	<u>H</u> elp	
(®, 🗩	<u>(</u>	CDTest-Ben	ch 🔸	<u>M</u> onocl	hromator (ms257)	
				Ammete	er (ke486)	
				A <u>m</u> mete	er (ke6514)	
				M <u>o</u> tion	controler (MM4000)	
			_			-

Figure 65 PRiSM software: Ammeter menu

The following window should appear (Figure 66):

INIT AMMETER	×
Host name: Port number (/etc/services, 2331) : RTAP environment (echo \$RTAPENV):	odta5 2331 wodta5a
	<u>O</u> K <u>C</u> ancel

Figure 66 PRiSM software: ammeter init box

The parameters are the same for the monochromator:

- "Host name": The name of the UNIX station (for example: "odta5" or "134.171.5.155").
- "Port number": The tcp-ip socket port number talking to the fcdNoVLTSrv: 2331.
- "RTAP environment": The name of the RTAP environment. See the \$RTAPENV value in the UNIX station environment.

After a small time (~20s for the ke486 and almost instantaneously for the ke6514, a dialog box appear in which you can choose the parameters that you want to apply on the ammeter. For example, you can get the current ammeter value by pushing the "Measure" button (Figure 67).



Figure 67 PRiSM software: ammeter dialogs box in use

The script function available for the ammeter is:

"GetAmmeterMeasure" This function gets the ammeter value. The parameters are: The kind of measurement: in general, the value is 4 (see the ammeter documentation information) The sample number: from 1 to 50 measurements The integration time: from 0.01 s to 999.999 s The "MeasureValue" as output Example: #Get the ammeter value for the variable "MeasureValue" with a kind of measurement 4, a sample #number of 50 and an integration time of 0.02 s GetAmmeterMeasure 4 50 0.02 MeasureValue

Here a typical output in the logMonitor when we ask for a measurement with the ke486 (Figure 68):

	– VLT Log Monitor – @odta5 – Release 3.51.1.1					
Eile Screi	en Field Selec	tion Store Logs	Filters		∐elp	
 STOP 		INSPECT #	ALL 💠 INSPECT las	t 500 lines Norm	al Logs	
Date	Time	Environ Module	Process	Log Text		
2002-06-05	14:14:57.3071	wodta5a fcdNoV1	fcdNoVltSrv_14837	fcdNoVltSrvCOMM::wanageConnection -> Wait for new connection or new wessage!	A	
2002-06-05	14:20:45.7368	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvCDMM::wanageConnection -> select function has detected a new connection or a new wessage!		
2002-06-05	14:20:45,7372	wodta5a fcdNoV1	fcdNoV1tSrv_15059	fcdNoVitSrvCDMM;;manageConnection -> New message has just arrived!		
2002-06-05	14:20:45,7376	wodta5a fcdNoV1	fcdNoV1tSrv_15059	fcdNoVltSrvCDMM::manageMessage -> Begin(
2002-06-05	14:20:45.7379	wodta5a FodNoV1	fcdNoV1tSrv_15059	fcdNoVltSrvCDMM::manageMessage -> Message is a command! Must receive 468 bytes		
2002-06-05	14:20:45.7384	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvCOMM::wanageMessage -> First part of wessage received! Coxwand= KM, Desterv= wodta5a, Destproc= fcdtserver		
2002-06-05	14:20:45,7866	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvCDMM::manageMessage -> Second part of message received successfully! Parameter= 5		
2002-06-05	14:20:45,7870	wodta5a fcdNoV1	fcdNoV1tSrv_15059	- fcdNoVltSrvCDMM::manageMessage -> Send the previously received command to the environment wodta5a and the process fcdtserver winthin the timeout 600001		
2002-06-05	14:20:45,7874	wodta5a FodNoV1	fcdNoV1tSrv_15059	<pre>fcdNoVltSrvMSG::Call -> Set filter on message!</pre>		
2002-06-05	14:20:45.7878	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvMSG::Call -> Set filter on wessage successfully!		
2002-06-05	14:20:45.7882	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvMSG::Call -> Send command KM to process fcdtserver successfully!		
2002-06-05	14:20:45,7891	wodta5a fodt	fodtserver	Keithley::mesure -> mesure begins!		
2002-06-05	14:20:45,7895	wodta5a fodt	fodtserver	ke486;:measure -> Check current status of the ammeter's settings (see ke486 manual p. 4-32); send command; UOM		
2002-06-05	14:20:45.8183	wodta5a fodt	fodtserver	ke486::measure -> Check current status of the awaeter's settings successfully! Status= 486A0B0C0G1H00J0K0M000N000P3R11S1T6Y4Z0c0G		
2002-06-05	14:20:45.8187	wodta5a fodt	fodtserver	Ke486::measure -> Set trigger mode to one-shot on X (see ke486 manual p. 4-31); send command T5X		
2002-06-05	14:20:45,8365	wodta5a fodt	fodtserver	ke486::measure -> Set trigger mode to one-shot on X successfully!		
2002-06-05	14:20:45,8369	wodta5a fodt	fodtserver	Ke486::measure -> Wait for the ke486 to perform the measurement!		
2002-06-05	14:20:47.0451	wodta5a fodt	fodtserver	Ke486::measure -> Measurement completed on Ke486 after 16 check(s)!		
2002-06-05	14:20:47.0488	wodta5a fodt	fodtserver	Ke486::measure -> Acquire data: each data packet consists of 13 bytes (with G1 option set)		
2002-06-05	14:20:47.0667	wodta5a fodt	fodtserver	Ke486::measure -> Acquire data successfully! Data= -0.00042E-09		
2002-06-05	14:20:47.0674	wodta5a fodt	fodtserver	Keithley::nesure -> nesure value= -4.2E-13		
2002-06-05	14:20:47.0681	wodta5a fodt	fodtserver	Keithley::mesure -> mesure ended successfully!		
2002-06-05	14:20:47.0689	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvMSG::Call -> LastReply= ccsTRUE!		
2002-06-05	14:20:47.0693	wodta5a fcdNoV1	fcdNoVltSrv_15059	- fcdNoVltSrvCOMM::wanageMessage -> Send the previously received command successfullyto the environment wodta5a and the process fcdtserver winthin the ti	neout	
2002-06-05	14:20:47.0697	wodta5a fcdNoV1	fcdNoVltSrv_15059	fcdNoVltSrvCDMM::manageMessage -> Send the reply! Return= -4,2E-13		
2002-06-05	14:20:47.0701	wodta5a fcdNoV1	fcdNoV1tSrv_15059	fcdNoVltSrvCDMM::manageMessage -> Send the reply successfully/		
2002-06-05	14:20:47.0705	wodta5a FodNoV1	fcdNoVltSrv_15059	fcdNoVitSrvEDMM::wanageConnection -> Wait for new connection or new wessage!		
					7	
<u> 1</u>						
Clear So	oreen Sho	w Error Stack	💷 Help On Error 🛛 🗖	Automatic Sorolling 🔄 Filter		
Filter Sele	ction :					
🔳 Env	+ =	Module ~	+ ProciD ==	Froc. Name -		
			· /			

Figure 68 Messages in the logMonitor while the ke486 performs measurements

And here with the ke6514 (Figure 69):

-	- VLT Log Monitor - @odta5 - Release 3.51.1.1				
Eile Scree	en Field Selection Store Logs	Filters		Help	
🔹 ѕтор	♦ MONITOR ♦ INSPECT A	ALL 🔷 INSPECT last	500 lines	Normal Logs	
Date	Time Environ Module	Process	Log Text		
2002-06-05	14:24:14.3961 wodta5a FodNoV1	fcdNoVltSrv_15162	FodNoVltSrvCOMM::manageMessage -> Begin!	二	
2002-06-05	14:24:14,3965 wodta5a fcdNoV1	fcdNoVltSrv_15162	FodMoVitSrvCOMM::manageMessage -> Message is a command! Must receive 468 bytes		
2002-06-05	14:24:14,3969 wodta5a fcdNoV1	fcdNoVltSrv_15162	fodNoVltSrvCDMM::nanageMessage -> First part of nessage received! Connand= K6SM, Desterv= vodta5a, Destproc= fodtserver		
2002-06-05	14:24:14,4395 wodta5a fodNoV1	fcdNoVltSrv_15162	fodNoVltSrvCDMM::manageMessage -> Second part of message received successfully! Parameter= 1		
2002-06-05	14:24:14.4399 wodta5a FcdNoV1	FcdNoV1tSrv_15162	FolNoVLEDvCDMM:imenageMessage -> Send the previously received command to the environment wodta5a and the process Fodtserver winthin the timeout 6	600001	
2002-06-05	14:24:14.4403 wodtaba FcdNoVI	FedNoVItSrv_15162	FodboltSrvHSG::Dall -> Set filter on nessage!		
2002-06-05	14:24:14,4407 woodcaba Fodhovi 14:24:14 dd11 wordta5a Fodhovi	FodNoV105FV_15162	Forbidistrinda; Call -/ Set Files of Message Subdessfully: ForbidissumSC+(SL) -/ Set Files of Message Subdessfully:		
2002-06-05	14:24:14, 4420 worlt a5a Forth	Fodtserver	Kaithleu6514ttserialNeure => serialNeure heurst		
2002-06-05	14:24:14,4426 wodta5a fodt	fodtserver	Ke6514; mesureSerie -> wesureSerie besins!		
2002-06-05	14:24:14.4431 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> Clear the error buffer (see ke6514 manual p. 17-11); send command SYST:CLE		
2002-06-05	14:24:14.4503 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> Clear the error buffer successfully!		
2002-06-05	14:24:14,4507 wodta5a Fodt	fodtserver	ke6514::nesureSerie -> Query the status byte register (see manual p. 14-2); send command *STB?		
2002-06-05	14:24:14.4599 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Query the status byte register successfully: STB= 65		
2002-06-05	14:24:14.4603 wootaba Foot	fodtserver	Kebsi4: Resuresence -> Return status registers to default states and cleans all event registers and error queue (see Kebsi4 wanual p. KeSSi4: Resuresence -> Return status registers to default states and cleans all event registers and error queue (see Kebsi4 wanual p. KeSSi4: Resuresence -> Return status registers to default states and cleans all event registers and error queue (see Kebsi4 wanual p.		
2002-06-05	14:24:14.4710 woodcaba Fodc	Fodtserver	Nebol4: Resurgering - > recurn status registers to denaut states and others all event registers and error queue successfully: LaSS(4): reguingering - D many the status hut provider (see LaSS(4) and (see LaS)); and (see LaST(2));		
2002-06-05	14:24:14,4816 wodta5a Fodt	fodtserver	Ke5141: InsureSerie -> Query the status but resister successfully: SIB- 5		
2002-06-05	14:24:14.4820 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Program the enable Buffer (see ke6514 manual p. 17-9); send command STAT:MEAS:ENAB 512		
2002-06-05	14:24:14,4912 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> Program the enable buffer successfully!		
2002-06-05	14:24:14.4916 wodta5a fodt	fodtserver	ke6514::mesureSerie -> Query the status byte register (see ke6514 manual p. 14-2); send command *STB?		
2002-06-05	14:24:14,4999 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Query the status byte register successfully: STB= 65		
2002-06-05	14:24:14.5003 wodtaba Fodt	fodtserver	Kebbl4: nesureberie -> Program the service request enable register (set bit BO; measurement status)(see kebbl4: manual p. 14-2); send command *SKE		
2002-06-05	14:24:14.5102 woldaba Fold	Fodtoppuon	KeSAI transmissione -> mogram one service request enable register successfully: KeSAI transmissione -> Distribute hybrid content of the use of the hybrid transmission (and hybrid transmission) and the hybrid content TPC/IEEE if	CONT	
2002-06-05	14:24:14.5126 worka5a Fort	fodtserver	KeSidi magueSenie -> Disable buffer control currently gu can compe che curren sizer dee KeSidi Markai P. 17 127, seni comano recurrezzo	2011	
2002-06-05	14:24:14,5130 wodta5a Fodt	fodtserver	Ke6514;;mesureSerie -> Set measure count to 1 (see ke6514 manual p. 17-13); send command TRIG:COUN 1		
2002-06-05	14:24:14.5144 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Set measure count to 1 successfully		
2002-06-05	14:24:14.5148 wodta5a fodt	fodtserver	ke6514::mesureSerie -> Query the status byte register (see ke6514 manual p. 14-2); send command +STB?		
2002-06-05	14:24:14.5289 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> Query the status byte register successfully! STB= 65		
2002-06-05	14:24:14,5293 wodtaba Fodt	fodtserver	Reb514; ResureSerie -> Specity buffer size to 1 (see Keb514 manual p. 1/-12); send command (KHL(PUIN 1 Ke5514); ResureSerie -> Specity buffer size to 1 (see Keb514 manual p. 1/-12);		
2002-06-05	14:24:14.5410 woltaba Fold	Fodtserver	Neb514: Mesurements -) During ourner size for a doctarring (Me5514: Mesurements -) During the status but a resister (see ke5514 annual n. 14-2); send compand #STR2		
2002-06-05	14:24:14.5499 wodta5a Fodt	fodtserver	Ke514: the supserie -> Dury the status bute register successfully STR= 55		
2002-06-05	14:24:14,5503 wodta5a fodt	fodtserver	Ke6514;;mesureSerie -> Raw input readings are stored in the buffer and the buffer is enabled (see ke6514 manual p. 17-12);		
2002-06-05	14:24:14,5623 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Raw input readings are stored in the buffer and the buffer is enabled successfully!		
2002-06-05	14:24:14.5627 wodta5a Fodt	fodtserver	ke6514::mesureSerie -> Query the status byte register (see ke6514 manual p. 14-2); send command *STB?		
2002-06-05	14:24:14.5744 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> Query the status byte register successfully! STB= 65		
2002-06-05	14:24:14.5748 wodtaba fodt	fodtserver	Rebold (Resurescence -> Read the event register (see Rebold Rahus) 1/-3/) send command S(H)(REHS/		
2002-06-05	14:24:14.5904 worka5a Fork	Fodtserver	Ke514*, Mesure Center -> Instructive control (egister) successionary is device - doz		
2002-06-05	14:24:14.5999 wodta5a Fodt.	fodtserver	Ke5514::mesureSerie -> Initialize measure successfullu!		
2002-06-05	14:24:14.6003 wodta5a fodt	fodtserver	Ke6514::mesureSerie \rightarrow Enter loop to wait for the ke6514 to achieve his measurements		
2002-06-05	14:24:14,6007 wodta5a Fodt	fodtserver	Ke6514;:mesureSerie -> Wait for ke6514 to assert Service Request (see GPIB manual p. 4-36); use GPIB WaitSRQ function		
2002-06-05	14:24:20,1422 wodta5a Fodt	fodtserver	Ke6514;;mesureSerie -> Ke6514 asserts Service Request successfully!		
2002-06-05	14:24:20,142/ wodta5a Fodt	Fodtserver	Kob514::MesureSerie -> Mesurest serial poll response (see UHB wanuel p. 5-70); use GPIB IBRSP function		
2002-06-05	14:24:20.1495 wootaba Foot	fodtserver	Report (Resurgesence -> Request serial poil response successfully poil- VAIVV ResEditionarysCente -> Leve to unit for the LevEdit to advise the response and a respectfully after 1 logs(a)) forteening our allowed		
2002-06-05	14:24:20,1504 wolta5a Folt	fodtserver	ke6514: insureSerie -> Read the contents of the buffer (data store) (see ke6514 annual p. 17-12); and content TATA?		
2002-06-05	14:24:20,1604 wodta5a Fodt	fodtserver	Ke6514::mesureSerie -> Read the contents of the buffer (data store) successfully		
2002-06-05	14:24:20.1610 wodta5a fodt	fodtserver	Ke6514::mesureSerie -> wesureSerie ended successfully!		
2002-06-05	14:24:20,1614 wodta5a fodt	fodtserver	keithley6514::serialMesure -> Measured value n. 0 = 3.2889E-14		
2002-06-05	14:24:20,1618 wodta5a fodt	fodtserver	keithley6514::serialMesure -> Mesure a serie of data successfully! Mean value= 3,2888E-14		
2002-06-05	14:24:20,1626 wodta5a FodNoV1	FcdNoV1tSrv_15162	FodNeVLtSrvMSG;:Call => LastRepLy= ccsTRUE1		
2002-06-05	14:24:20,1631 Wodtaba FodNoVI 14:24:20,1674 work also Control	Formovitory_15162	Fromovitorycumminenagemessage -> Send the previously received command successfullyto the environment woltable and the process Fodtserver winthin the Dealbelt ScuPDMitting assessmences -> Send the previously Patterner -> 2000E-14	the timeout	
2002-06-05	14:24:20.1639 wordta5a Feeblovi	fodNoVLtSrv_15162	For hystocky source in the mega reasons = > Send the really is increased [1] u1		
2002-06-05	14:24:20,1642 wodta5a FodNoV1	fcdNoVitSrv_15162	FodWoVItSrvEDMM::manageConnection -> Wait for new connection or new message!	_	
4					
Clear Sc	sreen Show Error Stack	🔟 Help On Error 🛛 🗖	Automatic Scrolling 🔟 Filter		
Filter Sele	ction :				
🔳 Env. 👻	🛨 📕 Module ~	🛨 📕 ProciD ==	📕 Proc. Name -		

Figure 69 Messages in the logMonitor while the ke6514 performs measurements

4.2.3 The MM4000:

You have to initialise the ammeter by selecting the following menu (Figure 70):

E <u>S</u> O <u>D</u> ata Base	<u>W</u> indow	<u>O</u> ptions	<u>H</u> elp
<u>C</u> CDTest-Bench	h 🔸	<u>M</u> onocł	nromator (ms257)
		Ammete	er (ke486)
		Amm <u>e</u> te	er (ke6514)
		M <u>o</u> tion	controler (MM4000)

Figure 70 PRiSM software: MM4000 menu

The following window should appear (Figure 71):

INIT MOTION CONTROLER	×
Host name: Port number (/etc/services, 2331) : RTAP environment (echo \$RTAPENV):	odta5 2331 wodta5a
	<u>D</u> K <u>C</u> ancel

Figure 71 PRiSM software: MM4000 init box

The parameters are the same for the monochromator:

- "Host name": The name of the UNIX station (for example: "odta5" or "134.171.5.155")
- "Port number": The tcp-ip socket port number talking to the fcdNoVLTSrv: 2331.
- "RTAP environment": The name of the RTAP environment. See the \$RTAPENV value in the UNIX station environment.

After a small time, a dialog box appear in which you can choose the parameters that you want to apply on the MM4000 (Figure 72).







The script commands available for the MM4000 are:

- "MotionControlerMove" This function asks mm4000 to move one motor. The input parameters are: The ID of the motor you want to move (1 -> Y CCD, 2 -> Z CCD, 3 -> X CCD) (Figure 71). The position to reach (in mm). No output parameters. Example: #Move the motor number 1 of 5 mm MotionControlerMove 1 5
- "MotionControlerSearchForHome" This function asks the mm4000 to search for home position. No parameter needed.

"MotionControlerGetPosition" This function reads the actual position of one motor. The input parameter is the ID of the motor (1 -> Y CCD, 2 -> Z CCD, 3 -> X CCD). The output parameter is the actual position of the motor. Example: #Get the position in mm of motor number 1 in the variable "ActualPosition" MotionControlerGetPosition 1 "ActualPosition"

4.2.4 The fiera controller:

To have a complete description of the standard camera acquisition functions in Prism, see the following address: <u>http://www.astrosurf.org/saturne/pap/PAP_help/recherche.html</u>. At first, you must choose FIERA as the standard controller in Prism For that, you can call the following menu (Figure 74):



Figure 74 PRiSM software: camera controller menu

Now, you can call the CCD acquisition module and fill up this panel (Figure 75):

Host name:	odta5	
Port number:	2331	
RTAP environment:	wodta5a	
CCD name:	DMarc	
FTP login:	fiera	
FTP password:	*****	
TP image directory:	/disk1/INS_ROOT/SYSTEM/DETDATA	
PULPO Unit (0-1) :	1	

Figure 75 PRiSM software: camera controller init box

"Host name"	The name of the UNIX workstation hosting the FIERA-SW (for instance:				
	"odta5" or "134.171.5.155").				
"Port number"	The tcp-ip socket port number to talk to the fcdNoVltSrv. This one must be				
	defined as 2331.				
"RTAP environment"	The name of the RTAP environment. See the echo \$RTAPENV value in the				
	UNIX workstation environment.				
"CCD name"	The name of the current CCD. It should be the value of the environment				
	variable by echo-ing \$CCDNAME on the Solaris workstation.				
"FTP login"	The login of the FTP server, this FTP account should have read access to the				
-	"Image directory", otherwise it will fail.				
"FTP password"	The password of the workstation's FTP server.				
"Image directory"	Where FIERA drops by default the image, {\$INS_ROOT}/DETDATA				
	usually.				

4.2.5 FIERA parameters

The common FIERA parameters are available in the "Camera" panel:

4.2.6 CCD temperature, vacuum and heaters power

All monitoring values are available in the "CCD monitoring panel":

	0%	
Script ACQ	Température I	CCD Sta
Sensor1	-102.8ºC	Ok 🔺
Sensor2	-92.8ºC	Ok 🚽
Temp. à attei Regulation d	indre (°C) 🛛 -	20 Apply
Heater numb	er: 1 💌	1
Refresh perio	od: 5s 💌	
Températur	e dans le heac	ler image 🛛 🔽
Températur	es dans fichier	"tempt tyt"

Figure 76 PRiSM software: monitoring values in the camera controller dialog box

All sensor values are available automatically through an array (Figure 76). If you want to display a real time variation graph, you need only to click to the value.

4.2.7 Prism programming language

If you want to have complete and explicit help about the Prism programming language, see the following page:

To launch a Prism script, click the button in the "Script ACQ" panel:

To have some examples, see the "tbenchScriptPack".

5 Testbench cookbook

5.1 Testbench calibration

5.1.1 Principle

To be able to monitor the photon flux at the CCD surface during a serie of measurement, you have to know the ratio between the flux at the diode sphere position and the flux at the CCD surface position. For that purpose, a si-Photodiode (Hamamatsu S5287-1010R), that has been previously calibrated by the "Physikalisch-Technische Bundesanstalt" on April 2001 (see Table 3 that give the response of the photodiode in function of the wavelength), is placed at the position normally occupied by the CCD.

Wavelength	$S\phi(\lambda)$ (mA.W ⁻¹)	Relative	Wavelength	Sφ(λ) (mA.W ⁻¹)	Relative
(nm)		Error (%)	(nm) _		Error (%)
300.0	34.7	1	660.0	400.4	1
310.0	119.3	1	680.0	414.1	1
320.0	132.6	1	700.0	427.6	1
330.0	142.1	1	720.0	441.3	1
340.0	150.6	1	740.0	454.7	1
350.0	155.2	1	760.0	468.2	1
360.0	155.3	1	780.0	481.8	1
370.0	160.2	1	800.0	495.2	1
380.0	175.9	1	820.0	508.5	1
390.0	191.4	1	840.0	521.8	1
400.0	204.2	1	860.0	534.6	1
420.0	224.8	1	880.0	547.3	1
440.0	242.6	1	900.0	559.0	1
460.0	259.0	1	920.0	571.0	1
480.0	274.4	1	940.0	583.7	1
500.0	289.1	1	960.0	593.1	1
520.0	303.5	1	980.0	593.4	1
540.0	317.6	1	1000.0	573.6	1
560.0	331.5	1	1020.0	520.3	1

580.0	345.4	1	1040.0	419.2	1
600.0	359.2	1	1060.0	284.3	1
620.0	372.9	1	1080.0	193.4	1
640.0	386.8	1	1100.0	126.3	1

Table 3 Response of the Photodiode (Sf) in function of the wavelength



Absolute calibration of the reference diode









For this measurement, you need the monochromators, the two ammeters, the fcdNoVltSrv and fcdtserver running on the workstation, PRiSM running on the client PC. See section 3 for more information.

The PRiSM script "calibrate.pgm" performs measurements at the same wavelengths provided by Table 3. For each wavelength, it associates the photon flux at the calibrated Photodiode with the current value of the Sphere photodiode. Therefore, the Sphere photodiode is calibrated and can be used as a photon flux monitoring system that does not perturb the measurements.

As a result, the script gives you a file containing ...

Wavelength (nm)	Flux (Photons/sec/cm2)	Current (Amps)	Error (Photons/sec/cm2)	Error (Amps)
300	1.146E+08	8.78E-11	2.4E+05	1.5E-13
310	1.606E+08	1.76E-10	5.2E+05	4.6E-13
320	3.264E+08	3.20E-10	3.2E+05	2.2E-13

330	5.488E+08	5.28E-10	7.5E+05	8.3E-13
340	8.573E+08	8.11E-10	1.0E+06	1.0E-12
350	1.295E+09	1.19E-09	9.9E+05	5.5E-13
360	1.866E+09	1.64E-09	1.4E+06	8.4E-13
370	2.596E+09	2.24E-09	4.7E+06	1.1E-12
380	3.419E+09	3.13E-09	4.0E+06	1.4E-12
390	4.423E+09	4.29E-09	4.0E+06	2.3E-12
400	5.474E+09	5.55E-09	4.2E+06	2.0E-12
420	7.890E+09	8.45E-09	4.4E+06	7.9E-12
440	1.042E+10	1.15E-08	6.7E+06	8.6E-12
460	1.277E+10	1.44E-08	7.4E+06	7.2E-12
480	1.498E+10	1.72E-08	5.3E+06	9.2E-12
500	1.418E+10	1.64E-08	9.8E+06	1.3E-11
520	1.532E+10	1.79E-08	8.2E+06	1.4E-11
540	1.550E+10	1.82E-08	2.8E+06	8.5E-12
560	1.615E+10	1.91E-08	1.1E+07	8.3E-12
580	1.518E+10	1.81E-08	5.3E+06	7.3E-12
600	1.552E+10	1.86E-08	9.9E+06	7.2E-12
620	1.537E+10	1.85E-08	6.8E+06	1.2E-11
640	1.452E+10	1.76E-08	6.9E+06	9.2E-12
660	1.344E+10	1.63E-08	4.7E+06	2.7E-12
680	1.233E+10	1.48E-08	4.3E+06	6.3E-12
700	1.162E+10	1.37E-08	1.5E+07	2.2E-11
720	1.062E+10	1.21E-08	4.4E+06	2.9E-12
740	9.486E+09	1.05E-08	4.4E+06	1.4E-12
760	8.220E+09	8.72E-09	3.2E+06	2.5E-12
780	7.016E+09	7.13E-09	3.1E+06	1.8E-12
800	5.626E+09	5.44E-09	4.1E+06	3.3E-13
820	6.120E+09	5.56E-09	2.1E+06	5.6E-13
840	5.934E+09	4.97E-09	3.4E+06	7.5E-13
860	5.865E+09	4.44E-09	5.6E+06	3.7E-12
880	5.830E+09	3.93E-09	6.7E+06	2.2E-12
900	5.160E+09	3.03E-09	3.3E+06	1.6E-12
920	8.164E+09	4.06E-09	3.1E+06	1.8E-12
940	1.124E+10	4.56E-09	6.8E+06	2.0E-12
960	1.204E+10	3.81E-09	7.0E+06	1.1E-12
980	1.166E+10	2.76E-09	2.8E+06	1.3E-12
1000	1.101E+10	1.84E-09	6.0E+06	4.3E-13
1020	1.018E+10	1.14E-09	8.5E+06	4.0E-13
1040	9.487E+09	6.75E-10	6.1E+06	3.1E-13
1060	9.041E+09	4.02E-10	4.9E+06	8.3E-14
1080	8.573E+09	2.54E-10	5.8E+06	1.2E-13
1100	8.348E+09	1.58E-10	3.6E+06	9.3E-14

Table 4 Calibration with the halogen lamp

Wavelength	Flux	Current	Error	Error
(nm)	(Photons/sec/cm2)	(Amps)	(Photons/sec/cm2)	(Amps)
	0.0705.00	4 505 00		4 45 40
300	2.076E+09	1.53E-09	5.8E+05	1.4E-12
310	2.550E+09	2.54E-09	1.1E+06	1.6E-12
320	3.911E+09	3.77E-09	3.0E+06	1.4E-12
330	5.326E+09	5.06E-09	4.0E+06	2.5E-12
340	6.837E+09	6.46E-09	3.0E+06	3.1E-12
350	8.570E+09	7.94E-09	7.8E+06	4.1E-12
360	1.053E+10	9.34E-09	8.2E+06	9.3E-12
370	1.242E+10	1.08E-08	3.6E+06	7.2E-12

380	1.395E+10	1.29E-08	8.3E+06	7.6E-12
390	1.545E+10	1.51E-08	4.0E+06	1.9E-11
400	1.723E+10	1.75E-08	7.3E+06	5.2E-12
420	1.864E+10	1.99E-08	1.2E+07	9.7E-12
440	1.928E+10	2.12E-08	9.0E+06	1.5E-11
460	2.252E+10	2.54E-08	8.6E+06	1.2E-11
480	2.163E+10	2.47E-08	6.0E+06	1.3E-11
500	1.551E+10	1.80E-08	1.2E+07	7.8E-12
520	1.434E+10	1.67E-08	7.4E+06	9.0E-12
540	1.277E+10	1.50E-08	5.6E+06	7.5E-12
560	1.196E+10	1.41E-08	6.8E+06	6.1E-12
580	1.026E+10	1.21E-08	8.8E+06	4.4E-12
600	9.397E+09	1.11E-08	5.9E+06	5.8E-12
620	9.279E+09	1.10E-08	1.5E+06	5.0E-12
640	7.507E+09	8.87E-09	6.7E+06	5.4E-12
660	6.448E+09	7.60E-09	9.0E+06	2.9E-12
680	6.066E+09	7.10E-09	6.2E+06	4.8E-12
700	5.032E+09	5.79E-09	7.0E+06	4.7E-12
720	4.544E+09	5.07E-09	1.5E+06	2.2E-12
740	4.357E+09	4.71E-09	3.5E+06	3.1E-12
760	4.093E+09	4.27E-09	5.9E+06	1.4E-12
780	2.161E+09	2.16E-09	1.9E+06	7.4E-13
800	2.105E+09	2.02E-09	4.9E+06	9.2E-13
820	9.628E+09	8.64E-09	8.6E+06	5.3E-12
840	4.678E+09	3.95E-09	3.8E+06	2.3E-12
860	1.583E+09	1.21E-09	4.8E+05	3.2E-13
880	1.510E+10	1.02E-08	8.1E+06	6.3E-12
900	7.900E+09	4.75E-09	3.9E+06	1.6E-12
920	1.676E+10	8.66E-09	6.7E+06	4.2E-12
940	1.295E+10	5.41E-09	7.9E+06	1.6E-12
960	5.542E+09	1.84E-09	2.2E+06	9.1E-13
980	2.587E+10	6.34E-09	4.9E+06	1.4E-12
1000	7.870E+09	1.41E-09	7.0E+06	9.8E-13
1020	3.656E+09	4.33E-10	3.4E+06	1.9E-13
1040	2.128E+09	1.59E-10	8.9E+05	6.6E-14
1060	2.439E+09	1.13E-10	5.4E+05	1.1E-13
1080	2.890E+09	8.94E-11	9.0E+05	8.4E-14
1100	1.517E+09	2.92E-11	7.0E+05	1.0E-13

Table 5 Calibration with the xenon lamp





Figure 79 Spectra of the Halogen (short dashed line) and Xenon (continuous line) lamp at the CCD position

5.2 CCD measurements

5.2.1 Preliminary



Figure 80 Detector head used on the testbench: (1) Pre-ampli connector (FIERA), (2) Liquid Nitrogen input (nitrogen line), (3) Nitrogen output (vacuum controller) and (4) vacuum tap (vacuum pump).



Figure 81 Detector head used on the testbench: (5) pulpo connector (pulpo), (6) system connector (FIERA), (7) bias connector (FIERA) and (8) vacuum gauge (vacuum controller).

First of all, you should mount, in the clean room, the two CCDs you want to test in the D Marconi detector head. You must spot the position (A or B) of the two CCDs, as suggested by Figure 82.



Figure 82 Denomination of the position of the two CCDs in the D Marconi head

After installing the head on the testbench as shown by Figure 2, you have to connect it to the vacuum pump, the vacuum controller, the liquid nitrogen (LN) line, the video pre-amp, FIERA and pulpo (**do not forget to connect yourself to the ground**). All the connection points are shown on Figure 80 and Figure 81. At that point, you can put online the cooling system (Figure 86), FIERA and pulpo (Figure 87) (**in this order please!**).

Then you should put online the vacuum pump. When the vacuum is good enough ($< 10^{-3}$ mbar), you can begin to fill the dewar with LN. A few hours later, the vacuum and the temperature should be stabilised respectively around 10^{-5} mbar and -120 °C (typical temperature target).



Figure 83 Vacuum pump controller



Figure 84 Testbench vacuum pump



Figure 85 Video pre-amp





Figure 87 Fiera and pulpo controllers

Figure 86 Fiera cooling system

On the software part, you need fcdNoVltSrv FIERA software running (see sections 3.3.2 and 3.3.3). It is recommended to readout continuously the CCDs during their cooling down to prevent charge accumulation. Use the fcdSlcuCon interface (Figure 39). In the up left corner of the panel, check the item "forever", choose a short exposure time (e.g. 1s) and a readout mode (e.g. 2). Then, press the START button.

You should be aware that the images given by the system are the concatenation of the images of the 2 CCDs. Therefore, you must know precisely the position and the size of each CCD array to be able to extract the subimage corresponding to each CCD.

5.2.2 Dark acquisitions

Be careful: the lamp must be switched off and the shutter closed.

The script "DarkandBiasAcquisition.pgm" drives these kinds of measurements.

After initialising the file names, the path directories... and checking whether the temperature is locked on the desired value (typically -120 °C), the script reads the "InfoDark.txt" file that contains the acquisitions to perform and then executes the lines sequentially.

As you can see, 3 readout modes (225kpix, 625kpix and 50kpix), 3 exposure times (1 hour, 15 minutes and bias) and two gains (low gain=LG and high gain=HG) are tested. For each configuration, 5 images are requested. Throughout its execution, the script updates the first field of this file so that if for any reason the script has to be interrupted, the next time it will be launched it would restore the execution at the same level.

Number of	Initial start	Number of	Info string
acquisitions	number of	acquisitions	
already done	acquisitions	to perform	
1	1	5	Acquisition dark LG 225kpix 1h
1	1	5	Acquisition dark LG 225kpix 15mn
1	1	5	Acquisition bias LG 225kpix
1	1	5	Acquisition dark HG 625kpix 1h
1	1	5	Acquisition dark HG 625kpix 15mn
1	1	5	Acquisition bias HG 625kpix
1	1	5	Acquisition dark HG 225kpix 1h
1	1	5	Acquisition dark HG 225kpix 15mn
1	1	5	Acquisition bias HG 225kpix
1	1	5	Acquisition dark HG 050kpix 1h
1	1	5	Acquisition dark HG 050kpix 15mn
1	1	5	Acquisition bias HG 050kpix

Table 6 Acquisitions performed by the script "DarkandBiasAcquisition.pgm" as it appears in the "InfoDark.txt" file

When the acquisitions are done, the script performs a basic reduction. For each group of acquisitions, it extracts and saves separately the images of the two CCDs and then for each CCD calculates a median image and also a binned one. Every image is saved in an appropriate directory. For example, see Figure 88: the dark and bias of the CCD named "Lepus" are archived first by gain (LG or HG), then by frequency readout (50kpix, 225 kpix and 625 kpix) and finally by type (bias, dark of 15min and dark of 1 hour).



Figure 88 Dark acquisition directories

5.2.3 Light acquisitions

The script "LightAcquisition.pgm" drives these kinds of measurements. The lamp should be switched on 2 hours before the acquisitions.

After initialising the file names, the path directories... and checking whether the temperature is locked on the desired value (typically -120 °C), the script reads the "InfoLight.txt" file that contains the acquisitions to perform and then executes the lines sequentially.

Acquisition state	Info string
1	Conversion factor and noise 0= To do; 1= Done
1	Cosmetic 0= To do; 1= Done
1	Linearity method TDI 0= To do; 1= Done
1	Pocket pumping 0= To do; 1= Done
1	Quantum efficiency 0= To do; 1= Done

Table 7 Acquisitions performed by the script "LightAcquisition.pgm" as it appears in the "InfoLight.txt" file

This script has the same capability as "DarkandBiasAcquisition.pgm" concerning the recovery of the session after an interruption of the script.

- Conversion factor and noise: for readout frequency at 50kpix and 225kpix, 2 bias and 2 flats are taken and passed to the PRiSM function "GetConvertfactor" that calculates the conversion factor and the noise for each CCD; then, the results are written in a text file.
- Cosmetic: for 5 wavelengths (350, 475, 600, 750, 900 nm), 2 readout frequencies (50kpix and 225kpix) and 2 gains (LG and HG), 2 flats are taken ...
- Linearity: at 632 nm, 1 specific exposure and 2 flats
- Pocket pumping:
- Quantum Efficiency:

Every image is saved in an appropriate directory. For example, see Figure 89 (CCD named "Lepus").



Figure 89 Light acquisitions directories

6 Data reduction

This section is not up to date. See F. Christen and C. Cavadore.



Figure 90 Menus of the CCD test data reduction package

This user manual is intended to explain how the images have to be acquired and processed with the PRiSM CCD testing package.

The parameters determining the CCD performances (such as linearity, dark current, conversion factor...) will not be explained in this page. The user should have the basic knowledge about CCDs. Many books about this subject has been written (see references section).

Those procedures are used at <u>ESO</u> in order to characterise CCD cameras before being installed to the telescope or for <u>CCD preliminary testing</u>.

For a given test, requiring many images, they ALL must have the same amount of pixels (i.e.

width/height) and being the same data file type (i.e.: integer or floating point data). Mixtures of image seize and/or data type will result directly in a failure.

6.1 Non-Linearity and Conversion Factor (e-/ADU)

This measurement is used to get the conversion factor (e-/ADUs) and the CCD linearity. The CCD must be illuminated by a very stable light source, the resulting image has to be as "flat" as possible.

10 couples of images, at least, must be acquired with different exposure times, ranging from the full dynamic (intrinsic CCD dynamic or Analog to Converter dynamic) to the bias level. For instance: (16 bit camera ranging from 0 to 65535 ADU)

PRISM file image (CPA of	Exposure time (Sec)	Mean (ADU)	
FITS file type)			
image1.cpa	10	12152	
image2.cpa	10	12155	
image3.cpa	2	2178	
image4.cpa	2	2185	
image5.cpa	50	62535	
image6.cpa	50	62534	

Take at least 16 couples of images and try to achieve up to 95% of saturation level, to explore the all range.

Avoid to take images with increasing or decreasing exposure times as for instance 2,5,10,50 sec, use instead a random order as 2,50,10,5 sec.

When the PRISM software dialog box pops up, you have to enter a window where the statistics will be achieved (X1,X2,Y1,Y2). Keep in mind not to include defects in this window. The statistics can be either "median" or "classic" type. Set the "median" to avoid the effect of out of range or defective pixels, median is less sensitive to local contaminants.





Figure 92 Linearity curve according to exposure time

Figure 91 Linearity dialog box

The range (offset min et max.), comes from the offset image mean. In that case supply : Offset/bias level min = Offset -10% and Offset max= offset +10%), this allows to optimize the offset deviation effect with respect to shutter errors. To known this figure (Bias level), you have to measure it form a set of bias images.

!! Multiples files can be selected by keeping the ALT key down while selecting files in the open dialog box!!

PRISM software computes automatically the conversion gain in e-/ADU and the residual non-linearity expressed in % units, using the whole double exposure set of images. A photon-transfer curve is plotted as an output.

<u>Results</u> Console output : Optimum offset(ADU) (1): 368 Non linearity (Peak to peak) : (1): 0.4367% / -0.8695% Optimum offset(ADU) (2): 368 Non linearity (Peak to peak) : (2): 0.3741% / -0.1807% Conversion factor e-/ADU: 1.9926 -> *RMS error* : 0.12428 Readout noise (e-): 4.7822

The data(1) uses the first set of images and data(2) the second set.



Figure 93 Residual non linearity curve



Figure 94 Photon transfert curve (used to compute the conversion factor e-/ADU)

The method used is described by Janesick [2].

VERY IMPORTANT: be aware that FITS files are coded sometime as a true 16 bit data (0-65535). PRISM adapts data type according to the input file and to save memory space, but we recommend strongly to open the "Option/FITS options" menu, and to set the "Load 16bits unsigned FITS file to floating point data" as checked.

Load 16bits ur	nsigned (0-65535	5) FITS file to floa	ating point da	ta 🗖		
FITs dynamic r	escale factor to	fit small integer (-	327683276	7):	0.5	
Show FITS he	ader loading DE	BUG window :				

Figure 95 FITS option loading

6.2 Charge transfer Efficiency (CTE): EPER method

The dialog box related to CTE measurement is presented in Figure 96.



Figure 96 CTE dialog box

For this purpose, you should acquire a single flat field image reaching 95% of the ADC dynamic range. The camera shall be able to read the array beyond the photosensitive area. This area beyond the image is called "OVERSCAN", and contains fake pixels having the bias value provided by the electronic readout chain and CCD. This area shall be extended both in X and Y directions. This kind of image has to be provided to PRISM software to compute CTE.

Y1, Y2 is the area to perform the mean of the last light sensitive row and the X1, X2 is the range to compute the last mean column (Figure 97). The number of transfer across X and Y is typically the light sensitive image part.

Console output:

Loading: F:\Images\Frankie\CTE\Cte_0001

Mean -> Last X: 58491.6583936574 Last X+1: 469.123061013444 Overscan area: 449.922095829024 Horizontal CTE = 0.999999838470179 / 6 nines

Mean -> Last Y: 65510.6978248089 Last Y+1: 495.093474426808 Overscan area: 445.12810646144 Vertical CTE = 0.999999625037444 / 6 nines

Method used:

The method employed here is the EPER (Extended Pixel Edge Response). This method is not really accurate and the IRON 55 tests are much more reliable. Some CTE figures greater than one can be measured with this method!

References:

http://www.stsci.edu/instruments/acs/ctewg/papers/jones_fpr.pdf

6.3 Quantum efficiency and PRNU (Photo Response Non uniformity)

This is a really difficult measurement, because the result has to be provided in absolute values, and you MUST have to input calibration data.

Basic knowledge regarding QE measurement must be known!! <u>Read this document for more</u> information about how QE is computed.

The usual scheme is to use absolute quantum efficiency calibrated photodiode installed at the same position as the CCD will be, and to use flat field images made in the front of an integrating sphere, fed by one or two monochromators. This setting allows you to get different flat field images at different wavelengths and short bandwidth.

The incoming light wavelength is typically ranging from 300 to 1100 nm, with a short bandwidth, such as 5nm. The photodiode current is measured, and the photodiode manufacturer calibration curve

enables you to compute the amount of photons per square centimetre and per second. This is an example of a photodiode calibration file (as a text file):

No TABS

ratio bdw 4 # col 1 Wavelength

col 2 Flux on the CCD surface, expressed in photons/sec/cm2

col 3 Current that is measured at integrating sphere level or closeby to the CCD

320 1.1e+8 0.209e-9

340 2.55e+8 0.544e-9

360 5.18e+8 1.115e-9

380 9.27e+8 2.124e-9

400 1.44e+9 3.646e-9

450 2.9e+9 7.94e-9

500 3.54e+9 10.207e-9

550 3.9e+9 11.5e-9

600 3.97e+9 11.74e-9

650 3.6e+9 10.85e-9

700 3.09e+9 8.96e-9

750 2.35e+9 6.67e-9

800 1.54e+9 4.224e-9

850 1.66e+9 4.52e-9

900 1.42e+9 3.871e-9

950 3.4e+9 8.6e-9

1000 3.16e+9 7.65e-9

1100 2.42e+9 1.224e-9 Afterward, the optical transmission of the dewar window according to the wavelength as to be provided (as a text file).# Window transmission

col 1 Wavelength

col 2 Relative transmission

 320
 0.94

 340
 0.97

 360
 0.98

 380
 0.98

 400
 0.99

 400
 0.99

 500
 0.99

 500
 0.99

 500
 0.996

 600
 0.9856

 650
 0.9615

 700
 0.926

 750
 0.889

 800
 0.8517

 850
 0.8153

 900
 0.7873

900 0.7873 950 0.7627 1000 0.7466

 $1000 \ 0.740$ $1100 \ 0.723$

IMPORTANT: For all the wavelengths used, calibration photodiode text file and window calibration transmission file MUST match each other. It means that the same wavelengths must be entered in the two calibration files (Otherwise an error will occur). FITS files must include the following HEADER Keywords:

WAVLG = 550 // Central wavelength: Expressed in mn

BANDW = 5 // Bandwith : Expressed in mn

FLUX = 1.2E-5 // Photodiode current expressed in Amps

or

 $1_FLUX = 1.2E-5$ // Photodiode current expressed in Amps

Regarding the CPA image file: if images have been acquired with PRISM, the previous figures are entered automatically into the CPA file header.

A reference offset/Bias image (resulting from a median stack of 10 offset/bias images) is mandatory, also the integration time must be limited in a way that the CCD dark current remains negligible.

Once having entered all the calibration files in the software dialog box, the analysis window X1,X2,Y1,Y2 must be chosen so that it must not contain any serious defects (black hole, bright pixels).

Juantum efficiency	×
Select files :	
X1 window coordinate:	100
X2 window coordinate:	200
Y1 window coordinate :	100
Y2 window coordinate:	400
Bias Rename :	Bias.cpa
Conversion Factor e-/4DU :	2
× Pivel size an (over den, if figure found in header rile)	15
Y Pivel obe an (overden, if figure found in header file) :	15
Photodiode calibration file :	Pdiade@4.txt
Window Interentiosian (ite :	Rumier_ELAN.txt
Distance during calibration:	1
Distance during measurements	1
	QK Cencel

Figure 98 QE computation dialog box

Conversion factor must have been measured previously (see method 1 or 2). Distance during calibration/measurements allows the reference photodiode not to be at the same distance as the CCD, and to apply a $1/d^2$ correction. This correct for few centimetres effects. <u>Results:</u>

This is the console output results, for each FITS files, it yields to:

Wavelength in nm; Flux in Amps; Exposure in sec; Count values in e-

Filename	Wave	length Flux	Exposu	re Mea	n Stddev	.Rms Me	dian Mea	n-Median
QE0002.fits	320	1.749E-10	180	21400	484.08	21400 -	-0.051972	
QE0034.fits	340	4.754E-10	180	60662	1281.8	60678 -	-15.768	
QE0004.fits	360	1.0234E-9	79.523	60965	1260.3	60976	-11.264	
QE0032.fits	380	2.0072E-9	36.67	60579	832.35	60568	10.537	
Qe0006.fits	400	3.5871E-9	20.472	60341	578.48	60342	-1.3613	
QE0030.fits	450	8.4612E-9	9.223	60576	473.26	60582	-6.0853	
QE0008.fits	500	1.1307E-8	7.248	60050	462.21	60052	-2.3795	
QE0028.fits	550	1.3328E-8	6.904	64220	478.24	64226	-5.6408	
QE0010.fits	600	1.4012E-8	6.438	59948	446.82	59952	-4.0484	
QE0026.fits	650	1.3279E-8	7.296	59910	442.79	59914	-4.2144	
QE0012.fits	700	1.1196E-8	9.48	59680	450.23	59686	-5.5382	
QE0024.fits	750	8.4697E-9	14.39	59830	481.27	59838	-8.0172	
QE0014.fits	800	5.4537E-9	27.831	59990	533.66	60004	-13.601	
QE0022.fits	850	5.9775E-9	33.177	59951	508.76	59960	-9.061	
QE0016.fits	900	5.1913E-9	58.056	59327	941.36	59162	165.3	
Qe0020.fits	950	1.2662E-8	49.111	61606	2471.5	62156	-549.94	
QE0018.fits	1000) 1.0568E-8	171.99	6273	9 3667.6	64178	-1438.6	
QE0036.fits	1100) 1.7114E-9	180	1006	82.472	994 1	2.022	
Image #1 Ban	dwidth	n :5						
PhotoDiode co	alibrat	ion Bandwidth	:4					
Filename	Wav.	PRNU% QI	E% 1	FDio/FL	Dio.cal Pl	ı/pix/sec e	e-/pix/sec	%Wind
QE0002.fits	320	2.262 61.06	5 0.83	684	207.12	118.89	94	
QE0034.fits	340	2.1125 69.3	12 0.8	7389	501.4	337.1	97	
QE0004.fits	360	2.0669 73.1.	39 0.9	1787	1069.8	766.77	98	
QE0032.fits	380	1.3742 85.5	1 0.94	499	1971	1651.7	98	
Qe0006.fits	400	0.95867 93.4	01 0.9	8385	3187.7	2947.5	99	
QE0030.fits	450	0.7812 95.42	21 1.0	656	6953.3	6568.6	99	
QE0008.fits	500	0.76969 94.8	847 1.1	078	8823.7	8285.3	99	
QE0028.fits	550	0.74462 91.8	842 1.1	589	10170	9302.7	99.6	
QE0010.fits	600	0.7453 88.62	22 1.1	935	10661	9312.2	98.56	
QE0026.fits	650	0.73904 86.1	51 1.2	239	9913.7	8211.9	96.15	

QE0012.fits	700	0.75434	78.263	1.2496	8687.5	6296	92.6
QE0024.fits	750	0.8043	69.666	1.2698	6714.2	4158.3	88.9
QE0014.fits	800	0.88938	56.584	1.2911	4473.7	2156	85.17
QE0022.fits	850	0.8485	44.878	1.3225	4939.4	1807.3	81.53
QE0016.fits	900	1.5912	30.209	1.3411	4284.7	1019.1	78.7 <i>3</i>
QE0020.fits	950	3.9762	14.732	1.4724	11264	1265.6	76.27
QE0018.fits	1000) 5.7147	5.0888	1.3814	9821.7	373.16	74.66
QE0036.fits	1100	8.297	0.10033	1.3982	7613.2	5.5222	72.3





Figure 99 Quantum efficiency as a function of wavelength



The PRISM software provides the quantum efficiency plot in Figure 99 and a PRNU curve (Figure 100).

The following images (Figure 101, Figure 102 and

Figure **103**) were taken at different wavelength, from the same area of the CCD (bandwidth=5nm and CCD EEV44 backside illuminated).



Figure 101 At 320 nm uniformity degraded by the implantation of P+ passivation layer annealed by laser after thinning)

Figure 102 At 650 nm, very good uniformity



Figure 103 At 950 nm, nice fringing!

The method employed here for QE is straightforward and based on the ratio between the amount of photon falling to the CCD surface for a given wavelength and the effective amount of photoelectrons read out at the output of the CCD. This is achieved by all the data coming from the calibration text files and figures found in the image file header, such as pixel size, exposure time, flux, wavelength, etc ... The PRNU computes the histogram (Figure 104) of the selected (X1,X2,Y1,Y2) area, and provide two figures : the intensities at 5% and 95% percentile. Let's call those figures Int1 and Int2, the PRNU is (Int2-Int1)/(Int1+Int2)*100%



Figure 104 PRNU Histogramm

6.4 Readout noise

The data acquisition process is straightforward: acquire at least five images in the total darkness having all zero sec exposure.

Noise test		
X1 window coordinate : 100 X2 window coordinate : 200	Dom 100 000000000000000000000000000000000	
Y1 window coordinate : 100 Y2 window coordinate : 400	Figure 106 Noise collapse	
<u>O</u> K <u>C</u> ancel		Figure 107 Noise of the figure of the figure 107 Noise

Figure 105 Noise test dialog box

efects

The input window X1,X2,Y1,Y2 is the window where the noise computation will take place. Take a window without any kind of defect and showing pure random noise (avoids hots pixels clusters). **Results:**

The curve in Figure 106 is a stacked column mean over all the columns, and allows you to display effect that would be drown or hidden by the readout noise.

To trace noise patterns, a Fast Fourier Transform (FFT) of the image is sometime recommended. This image (Figure 107) shows cosmetic defects (green cross) over a CCD bias image: these are pixels that are 5 sigma above the median noise + mean. <u>Console output</u>: *Pixel amount taken to provide median frame: noise0005* ->1 42.53% *noise0003* ->2 57.43% *noise0004* ->3 57.65% *noise0002* ->4 42.39% *Noise*: 2.286 \pm 0.005463 ADU *Pixel amount above* 5 sigma: 17100 threshold (ADU): 6.584

BEWARE: This measurement could be biased if care has not been taken concerning the file format.

The RMS value is computed throughout the selected area. The final noise is the median noise from the set of the images. To trace bias defect, a median stack is performed to get rid of cosmic rays, and every pixel which is above or below five 5σ is referenced as a bad pixel and mapped.

See also section 6.7.

6.5 Dark current

As input image data, at least 3 images in total darkness have to be achieved, having the same exposure time for each (from 5 minutes to 2 hours depending on the cooling efficiency and CCD temperature). A mean clean Offset or Bias image MUST to be done as the result of the median stack of many individual bias frames. Also the conversion factor must be known accurately.

Be aware that sometimes residual image can disturb dark current measurement, especially if the CCD is cooled at -120C. Avoid acquiring the data just after having acquired high level flat fields. To watch this out, take ten dark frames at the same temperature and check whether or not the mean dark level is decreasing. Wipe the CCD many times before in the darkness. For instance take 10 dark exposures of one hour, and do not use the first four images.

۵	Dark current	×
	Select files :	
	X1 window coordinate :	100
	X2 window coordinate :	200
	Y1 window coordinate :	100
	Y2 window coordinate :	400
	Bias filename :	Bias.cpa
	Conversion Factor e-/ADU :	2
	\times Pixel size μm (overridden, if figure found in header file) :	15
	Y Pixel size μm (overridden, if figure found in header file) :	15
		<u>D</u> K <u>C</u> ancel

Figure 108 Dark dialog box

As usual, the X1, X2, Y1, Y2 window is the window where the computation will be performed and must be clean of bright defects. Results



Figure 109 Dark collapse



Figure 110 Dark defect: hot pixels map

This is the mean of all the columns sent to a single resulting column (Figure 109). The steps in the curve show the defect induced by defect columns... The same is displayed for the rows.

Here a hot pixels map is provided (Figure 110). All pixels above 5σ (noise+mean) are shown and could be regarded as defects.

Console output: Loading: F:\Images\Frankie\dark\run1@-120\dark0004.fits Pixel size information NOT present or NULL in file header, so I take 15 x 15(µm) Loading: F:\Images\Frankie\dark\run1@-120\dark0003.fits Loading: F:\Images\Frankie\dark\run1@-120\dark0002.fits Loading: F:\Images\Frankie\dark\run1@-120\NoiseMedian.cpa Integer data type... Median search: Compute median frame... Pixel amount taken to provide median frame : dark0004.fits ->1 27.92% dark0003.fits ->2 44.71% dark0002.fits ->3 27.37% Offset -> Mean: 327.1 Median: 327 ADU Exposure time (s) = 1800*Dark current:* 1.333 ± 0.4714 ADU Dark current: 5.333 ± 1.886 e-/hour/pixel Cosmic event rate: 1.195 ± 0.04297 events/min/cm² Pixel amount above 5 sigmas: 10659 threshold (ADU) : 10.51 Dark current using median frame after median filtering: 5.128 e-/hour/pixel

Even, the software is able to provide the cosmic ray hit rate automatically.

The software computes a median stack out of the N provided images and subtracts the bias file to it. The dark current is the remaing amount of adu above the bias image (positive data). The defects are subtracted automatically as the difference between individual frames and the median stacked frame.

6.6 Linearity using TDI method

This method provides the same results as the classical method (section 6.1), the differences are the following:

- Only one image is necessary (whereas the other method requires many images and takes long time to be carried out).
- Absolutely insensitive to shutter errors.
- The output curve providing the residual non-linearity versus the measured signal is continuous (whereas the other method provide discrete points)
- The measurement accuracy is much better than the one obtained by the classical different exposure method (section 6.1).
- Not limited by the PRNU of the CCD

This method has, nevertheless, constraints, where the main drawbacks are:

• The ability to open the shutter while the CCD readout process has already began, moreover the shutter must be placed at the entrance of the integrating sphere, but in any case to share the same focal plane as the CCD. This, sometimes, can not be achieved with CCD controllers that do not allow to open the shutter during the readout process. Nevertheless, manual opening can be used if the CCD is not read out to fast.

The method consists in illuminating the CCD by flat field illumination as uniform as possible. The intensity of this flat field light (called here Flux=Fl) must be such as the resulting image must be like a flat field of intensity close to 95% the full ADC dynamic, the CCD being exposed during a T exposure time yielding to a light intensity of Fl.

In an another way, if the dynamic is equal to 16bits, the image must shows up a uniform spatially Flat Field at about 62000 ADUs (in T seconds and with a Fl flux). Let assume that the flux has been set so as to get 62000 ADUs in 20sec (neutral filter, slit settings). It means that the CCD MUST be clocked in the way that it takes about 20 sec to read it out to achieve TDI linearity method.

The image used for the measurement must be acquired using this way. The CCD is started to be readout (shutter closed) and, once the readout of the first 100 first row has been achieved, the shutter is opened (the shutter open delay must be neglected compared to the row readout time). The CCD must be let reading out, being continuously illuminated with a flux equal to Fl. It is advised to hide also the first 100 rows using a mask (light shielded), because the readout circuitry might be disturbed (depends on the CCD) during readout by the continuous light flux to it, and might bias the results.



Figure 111 Resulting image (display cuts are set to +/-1% of the Bias level)



Figure 112 Same image as the right one, with display cuts having the full ADC dynamic range from 0 to 65535, the ramp must be uniform and smooth

So, to reduce this data, the TDI dialog box (Figure 113) has to be filled up as following:

- X1 and X2 horizontal defines the vertical stripe.
- The last and the first row exposed to light (sometimes it's better to take the 5th row exposed to light).

- The last row that defines the CCD Bias frame level.
- Minimum flux value is meant to threshold the lower range of the intensity dynamic, to be taken into account for computations and plots.
- Filter: sets how far the output plot curve will be filtered.
- Flat field image is mandatory to correct the data from pixel to pixel non-uniformity: it must be an image taken with the same wavelength and bandwidth as the TDI image and subtracted from by its bias image.
- Folder: location of the flat field folder (TBC).



Figure 113 TDI dialog box



Figure 114 Residual non linearity curve, this CCD is linear with +0.43/-0.3 peak-peak and 0.16% rms deviation from the perfect slope



Figure 115 This curve is a vertical cross section from the selected area, more exactly the median across this area

Console output: Loading: G:\CCDtest\UvesRed\NewLin\eevLeftPort.cpa Regression slope: 17.978; regression Offset :-5956.5 Regression slope: 18.028 Regression optimum Offset: -6037 Non linearity (Peak to peak): 0.43% / -0.2912% Non linearity (Mean dev.): -1.875E-13% / rms dev 0.1569%

The TDI image is median collapsed towards a single column : a 1D slope is achieved. The flat field image is used to correct the slope from the fact that all the pixels of the CCD do not have the same

sensitivity. A best linear fit is found from the slope and non-linearity plot computed. Beware that an infinity of slope can be found out of a cloud of points, depending on the criteria: less mean square, weighted points, etc etc...

This is a new method developed at ESO.

6.7 Conversion factor using two dark and two flats method

This method is very useful for computing the conversion factor during system development because it is fast and the accuracy is pretty good.

It just needs two biases and two flat field images. It performs conversion factor measurement using NxM sub windows to avoid any problems due to local defects. PRISM asks for the amount of windows that are needed across the X and Y-axis. Note that subwindows less than 50x50 pixels can lead to wrong results, so for a 1x2K CCD for instance, set 10 windows for the X direction and 20 for the Y direction. To remove any prescan/overscan area set the X1,Y1,X2,Y2 windows so as to avoid them and then select the files.



Figure 116 BF dialog box

Console output: Loading :Flat1.fits Loading :Flat2.fits Loading :Bias1.fits Loading :Bias2.fits For all the windows (540) the results are the following : window 1=4.49799e-/ADU X1=120 Y1=50 X2=158 Y2=78 window 2=4.11412e-/ADU X1=120 Y1=79 X2=158 Y2=107 window 3=4.31269e-/ADU X1=120 Y1=108 X2=158 Y2=136 window 4=4.14792e-/ADU X1=120 Y1=137 X2=158 Y2=165 window 5=4.0549e-/ADU X1=120 Y1=166 X2=158 Y2=194 window 536=4.45689e-/ADU X1=1836 Y1=253 X2=1874 Y2=281 window 537=4.55087e-/ADU X1=1836 Y1=282 X2=1874 Y2=310 window 538=4.23658e-/ADU X1=1836 Y1=311 X2=1874 Y2=339 window 539=4.01395e-/ADU X1=1836 Y1=340 X2=1874 Y2=368 window 540=4.50764e-/ADU X1=1836 Y1=369 X2=1874 Y2=397 Conversion Factor=4.3775e-/ADU ± 0.012608 for 3457.054ADU*RMS noise* = $7.0774e - \pm 0.092687$

Note that the algorithm supports flats fields that have different levels of illuminations, tests have been carried out with flats having means with factor of 50 between the two images and the feature passed it pretty well! This method subtracts the biases from the flat field images, divides the two previous flat images and computes the RMS value (named N here) and the mean Signal for each window. Then computes the D= $2*S/N^2$ figure, from D, the bias noise is removed and yields to the conversion factor. The corrections due to the different flat field levels are performed by the software, but not mentioned in this explanation (to remain clear).

6.8 Charge transfer efficiency using Fe55 source

This is a very powerful experiment used to derive the vertical and horizontal CCD charge transfer efficiency (CTE) and also can provide a extremely accurate measurement of the conversion factor. An Iron (Fe55) radioactive source is installed 100 mm from the CCD, in the vacuum. This source produces X-rays (5.9Kev photons) that reaches the CCD surface, creating inside the CCD bulk 1620e- in a 0.5/1um sphere. If these 1620e- are produced within a single pixel, they should be detected at the output of the CCD readout node as 1620e- times the conversion factor. Because of "failures" during the charge transfer, some electrons are lost and remain in the next pixel, and this is not. This can happen either during the vertical transfer or the horizontal transfer (serial register). Since the amount of electrons produced by the Fe55 are well defined, it is possible to compute the horizontal and vertical CTE.



Figure 117 A 30 seconds exposure image, CCD in front of a Fe55 source



Figure 118 Histogram plot of the whole CCD, pixels from the bias level and the two peeks of Fe55 (Ka1620e- Kb1778e-) are visible

In the dialog form, enter the window to be processed (X1,Y1,X2,Y2). Then the readout direction (CCD output port direction left/right). The conversion factor must be known within 5% accuracy. The bias offset level as also to be provided (accurate, from overscan areas or master bias frame). Select more than one image is recommended for better accuracy, as so as to enter more than 2 lines for each packet. Those packets are used to bin the histogram of a line/column N time.

<1=	100
r′1=	100
<2=	1900
/2=	4000
Readout port position:	Bottom Left 💌
Conversion factor:	0.6
Bias:	500
Number of line for each packet:	2
mages:	

Figure 119 Fe55 dialog box

Console output:

Load image: iron-1.cpa Load image: iron-3.cpa Load image: iron-2.cpa Load image: iron-4.cpa CTEV=1.000000101 CTEH=0.999997222 Conversion factor=0.680809



Figure 121 Vertical CTE histogram as a printable plot (very good V.CTE)



Figure 122 Horizontal CTE histogram as a printable plot (H.CTE =0.999997222)



Figure 120 Horizontal CTE histogram as an image the fact that the slope is left tilted showed that CTE is lower than 1.0

The software performs vertical histogram gathering N columns so as to have a better Signal to Noise measurement, it also uses more than one image to improve the measurement. Then displays an image where the X-axis is the counts in ADUs, Y the column number and Z the number of pixels having the given X counts. The softwarefinds the histogram peaks for every column and fits the best slope. As you can see on the image above, the slope that joins all the peak is slightly tilted to the left, showing that the 1620e- created at the end of the serial register (column 2048) are indeed less than 1620e-, thus showing a CTE not equal to 1. The software, according to the histogram peak slope can compute the HCTE.

The same method applies for the horizontal CTE, just swap the word vertical with horizontal and the word column with rows.

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