VERY LARGE TELESCOPE

INSTRUMENTATION DIVISION

New General detector Controller

Optical DCS - User Manual

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Date 5/3/2010

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Mark Casali
## CHANGE RECORD

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# Table of contents

1. Introduction ........................................................................................................................ 7  
   1.1. Purpose ...................................................................................................................... 7  
   1.2. Scope ....................................................................................................................... 8  
   1.3. Applicable Documents .............................................................................................. 8  
   1.4. Reference Documents .............................................................................................. 8  
   1.5. Abbreviations and Acronyms ...................................................................................... 8  
   1.6. Glossary ..................................................................................................................... 8  
   1.7. Stylistic Conventions ................................................................................................. 8  
   1.8. Naming Conventions ................................................................................................. 8  
   1.9. Problem Reporting/Change Request .......................................................................... 9  
   1.10. Acknowledgments ..................................................................................................... 9  

2. Installation and configuration ........................................................................................... 10  
   2.1. Software Modules ..................................................................................................... 10  
   2.2. Installation ............................................................................................................... 10  
      2.2.1. Using installation scripts .................................................................................... 10  
      2.2.2. Using pkgin ........................................................................................................ 11  
   2.3. Online database environment ................................................................................... 11  
      2.3.1. IWS online database generation ........................................................................ 11  
      2.3.2. NGC-LLCU online database generation ............................................................ 13  
      2.3.3. Online database verification .............................................................................. 13  
      2.3.4. Online database automatic startup .................................................................... 14  
      2.3.5. Detector user ..................................................................................................... 14  
   2.4. NGC-LLCU logging system configuration ................................................................. 14  
   2.5. INS_ROOT population .............................................................................................. 14  

3. Startup/Shutdown Procedure ........................................................................................... 16  
   3.1. System Configuration ............................................................................................... 16  
      3.1.1. NGCOSW operational modes ............................................................................ 18  
      3.1.2. NGC General Purpose Control Server operational modes ................................ 18  
      3.1.3. Simulation of the NGC detector electronics ....................................................... 19  
   3.2. System Startup ......................................................................................................... 19  
      3.2.1. Startup Procedure .............................................................................................. 19  
      3.2.2. Changes with respect to FIERA ......................................................................... 21  
      3.2.3. Configuration Examples ..................................................................................... 23  
         3.2.3.1 Startup Configuration file <xx>dcfgCONFIG.cfg ...................................... 23  
         3.2.3.2 Configuration Set <xx>dcfgDCS.cfg......................................................... 24  
         3.2.3.3 Configuration Set <xx>dcfgCAMERA.cfg ................................................. 26  
   3.3. NGCOSW operational states .................................................................................... 30  
      3.3.1. Changes with respect to FIERA ......................................................................... 31  
   3.4. System Shutdown ..................................................................................................... 31  
      3.4.1. Changes with respect to FIERA ......................................................................... 31  

4. Command Interface ......................................................................................................... 32  
   4.1. Changes with respect to FIERA ................................................................................ 34  

5. Multiple Instances of DCS ............................................................................................... 35  
   5.1. Customization of the super control process ............................................................... 35
5.2. Startup of a system using multiple instances of DCS ........................................ 35
6. Database Interface ........................................................................................................ 36
   6.1. Interface between NGCOSW and the external environment .......................... 36
   6.2. Interface between NGCOSW and TCS ............................................................... 37
   6.3. Image post-processing interface ..................................................................... 38
   6.4. ngcoDbPublic.h .................................................................................................. 38
   6.5. Changes with respect to FIERA ................................................................. 38
7. Setup Command ............................................................................................................ 39
   7.1. Changes with respect to FIERA ................................................................. 41
8. Status Command ........................................................................................................... 42
   8.1. Changes with respect to FIERA ................................................................. 42
9. Exposure Handling ........................................................................................................ 43
   9.1. Description ......................................................................................................... 43
   9.1.1. Exposure types .............................................................................................. 43
   9.1.2. Exposure status ............................................................................................. 43
   9.1.3. Image data ..................................................................................................... 44
   9.1.4. Exposure Id .................................................................................................. 44
   9.1.5. Changes with respect to FIERA ............................................................... 45
   9.2. Commands ......................................................................................................... 45
   9.2.1. Changes with respect to FIERA ............................................................... 46
   9.3. File Formats ....................................................................................................... 46
   9.3.1. Changes with respect to FIERA ............................................................... 46
9.4. Naming Schemes ...................................................................................................... 46
9.5. FITS-Header Contents .......................................................................................... 46
   9.5.1. Changes with respect to FIERA ............................................................... 47
9.6. Image post-processing ........................................................................................... 47
   9.6.1. Creating a module which implements post-processing .............................. 47
   9.6.2. How to run the process which implements post-processing ......................... 48
10. Synchronisation .......................................................................................................... 51
11. Error Definitions ........................................................................................................... 52
12. Erro and Logging Handling ....................................................................................... 54
13. Real-Time Display Interface ....................................................................................... 55
   13.1. Changes with respect to FIERA ................................................................. 55
14. Graphical User Interface ............................................................................................ 56
   14.1. Control Panel .................................................................................................. 56
   14.2. Engineering Interface ...................................................................................... 57
15. Special functionalities for Optical Instruments ........................................................ 59
   15.1. Shutter Control ............................................................................................... 59
   15.2. Temperature/pressure Monitoring ................................................................. 59
   15.2.1. Changes with respect to FIERA ............................................................... 59
   15.3. Adaptive Optics .............................................................................................. 59
16. Manpages ................................................................................................................... 60
   16.1.1. ngcoDcsOdb ............................................................................................... 60
   16.1.2. ngcoDcsInstall .......................................................................................... 62
   16.1.3. ngcoDcsStart ............................................................................................ 64
   16.1.4. ngcoDcsStop ............................................................................................. 66
16.1.5. ngcoGetProcNum ............................................................................................ 68
16.1.6. ngcoDcsClean ................................................................................................. 69
16.1.7. ngcoDcsTemplate ........................................................................................... 70
17. Example of NGCOSW usage .................................................................................. 71

List of Figures

Figure 1 - Optical NGC software Architecture ............................................................. 17
Figure 2 - Operational states and state transitions ......................................................... 31
Figure 3 – Post Processing: Image Transfer Client class .............................................. 49
Figure 4 – Post Processing: Image Transfer Client sequence diagram ......................... 50
Figure 5 - Optical NGC Control Panel ......................................................................... 57
Figure 6 - NGC Engineer Panel .................................................................................... 58

List of Tables

Table 1 - Startup Configuration Keywords .................................................................... 21
Table 2 - Command list ................................................................................................. 33
Table 3 - Special command list .................................................................................... 34
Table 4 - Online database attributes for detector system monitoring ......................... 37
Table 5 - Online database attributes for TCS ............................................................... 37
Table 6 - Basic Setup keywords for single exposure ..................................................... 39
Table 7 - Additional Setup keywords for loops of exposures ....................................... 40
Table 8 - Setup keywords for multistep exposures ....................................................... 40
Table 9 - Setup keywords for windowing (not yet implemented) .................................... 40
Table 10 - Setup keywords for image display ............................................................... 41
Table 11 - Errors common to all NGCOSW modules .................................................... 53
Table 12 - Errors specific to the ngcoit module ............................................................ 53
1. Introduction

The software described in this manual is intended to be used in the ESO VLT project by ESO and authorized external contractors only.

While every precaution has been taken in the development of the software and in the preparation of this documentation, ESO assumes no responsibility for errors or omissions, or for damage resulting from the use of the software or of the information contained herein.

1.1. Purpose

This document is the User Manual of the Next Generation detector Controller (NGC) Control Software for optical instruments (NGCOSW).

It is intended to provide people, who intend to use the NGC Controller for optical Instruments, with all the necessary information to install from scratch the NGCOSW, interact programmatically with the NGCOSW, operate an optical camera as a simple standalone instrument.

The manual assumes that the reader has some knowledge of C/C++ and Tcl/Tk languages, UNIX Operating System, VLT Software, in particular CCS. It is not intended to be an introduction to optical CCD cameras, and therefore it uses common terminology in this field (e.g. pixel, binning, readout, frame-transfer chip, etc.) without further explanation.

The control software for infrared applications (NGCIRSW) is described in a separate manual [RD77]. Basically the NGC electronics [AD8] is the same for both infrared and optical applications. Nevertheless there are many differences concerning the usage of the controller and the data acquisition and data handling procedures. To cover both applications in an effective way and also to have a certain backwards compatibility with the predecessors FIERA and IRACE, different SW-architectures have been chosen, which are described in detail in the NGC SW design documents [AD9], [AD10] and [AD11]. The following paragraph summarizes the main differences:

- **Detector Read-Out Schemes**
  For an infrared detector (CMOS / non destructive readout) the clock-pattern generation runs in an infinite loop and the detector is read-out/reset all the times. An optical detector (CCD / destructive readout) is read-out just once at the end of an exposure.

- **Data Handling**
  The optical application delivers one frame at the end of the exposure and the only processing to be done is pixel sorting, centroiding and possibly and offset correction (if not yet done in HW). The infrared data require some pre-processing depending on the read-out mode of the detector in use. The read-out modes, the pre-processing algorithms and the setup-parameters for these algorithms are manifold and require a very high degree of flexibility. The pre-processing task produces an arbitrary number of different result frame types, which all have to be transferred and/or displayed on demand. This also has an impact on the RTD-interface.
• Exposure Loops

For infrared applications starting an exposure basically means starting to transfer the acquired data to a FITS-file (i.e. the server has to attach to and keep step with a running procedure). The end-of-exposure condition is flexible and depends on both the requested frame types and on the number of frames of each type to be produced and stored. The optical exposure always terminates with the saving of the data, which are read at the end of the exposure and follows a much more rigid scheme (“inactive” - “wiping” [- “pending”] - “integrating” - “reading” - “transferring” - “inactive”). This scheme implies an active intervention of the control-server during the exposure like the application of new voltages in each state and the additional shutter-control, whereas the infrared control-server mainly reacts passively on incoming data-frames once the exposure is started. So basically the demands on process concurrency are very different in both cases.

A conscious effort has been made to maintain a certain degree of backwards compatibility of NGCOSW with FIERASW. Where applicable, a hint to the major changes with respect to FIERASW can be found at the end of each section.

1.2. Scope

Scope of this document is the NGC Control Software for optical instruments (NGCOSW).

1.3. Applicable Documents

Applicable documents used in the NGC project are listed in the document VLT-LIS-ESO-13660-3906 "NGC Project Documentation".

1.4. Reference Documents

Reference documents used in the NGC project are listed in the document VLT-LIS-ESO-13660-3906 "NGC Project Documentation".

1.5. Abbreviations and Acronyms

Abbreviations and acronyms used in the NGC project are listed in [RD64].

1.6. Glossary

All the relevant concepts used within the NGC project are listed in [RD63].

1.7. Stylistic Conventions

The following styles are used:

**bold** in the text, for commands, filenames, pre/suffixes as they have to be typed.

*italic* in the text, for parts that have to be substituted with the real content before typing.

courier for examples, commands, filenames as they have to be typed.

<name> in the examples, for parts that have to be substituted with the real content
The **bold** and *italic* styles are also used to highlight words.

### 1.8. Naming Conventions

This implementation follows the naming conventions as outlined in [AD27].

### 1.9. Problem Reporting/Change Request

The form described in [AD72] shall be used.

### 1.10. Acknowledgments

Special thanks to Andrea Balestra for his fundamental contribution to the development of the NGCOSW and Luigi Andolfato for his precious support and suggestions on wsf.
2. Installation and configuration

NGCOSW runs on ESO standard Instrument Workstations (IWS) and NGC-LLCU\textsuperscript{1}. The VLTSW (version 2008 or more recent) must have been already installed on the hosts.

2.1. Software Modules

All software modules are under CMM configuration control. Before installing the NGC optical detector control software package (NGCOSW), the NGC base software package must be installed (see [RD9] and [AD10]). The NGCOSW package consists of:

- **ngco** - This module contains all required scripts for system startup and shutdown, plus a set of utilities.
- **ngcocon** - The NGC system coordination module for optical applications. This includes all required scripts for system startup and shutdown.
- **ncgoctr** - The NGC exposure Control module for optical applications.
- **ncgoexp** - The NGC Exposure Coordination module for optical applications.
- **ngcoits** - The NGC Exposure Coordination module for optical applications.
- **ncgoitc** - The NGC Image Transfer Server module for optical applications.
- **ncgosc** - The NGC super system coordination module for optical applications. This process is needed only for instruments controlling multiple DCS instances (see 5).
- **ngcoui** - Engineering GUI used for direct system interaction and data acquisition.
- **ngcoarc** - Installation scripts for the overall NGCOSW software package.

2.2. Installation

2.2.1. Using installation scripts

Before installing the NGCOSW package via the installation scripts, be sure that the NGC base software package has been already installed (see [RD9]).

Installation scripts for the software package are provided in the ngcoarc software module and work on both the IWS and on the NGC-LLCU.

The procedure to create the package consists of the following steps:

1. Retrieve from the archive and install the module ngcoarc:

   ```
   mkdir <NGCOROOT>
   cd <NGCOROOT>
   cmmCopy ngcoarc
   ```

\textsuperscript{1} ESO Standard hardware is described in http://websqa.hq.eso.org/sdd/bin/view/SDDInfo/LinuxStandardHw
2. Retrieve all needed modules from the archive and install them:

   cd ngcoarc/src
   make all install

Note: unless an INTROOT is defined, all the NGCOSW code will be installed in the VLTROOT. Therefore these scripts must be run by a user with the appropriate read/write privileges.

2.2.2. Using pkgin

The ngcins software module contains a pkgin installation-configuration (for both NGC IR and OPT software):

   cmmCopy ngcins
   pkginBuild ngcins

2.3. Online database environment

To automatically generate the online database, the environment variables RTAPENV, CCDLENV and CCDNAME must be defined:

- RTAPENV defines the name of the local online database environment
- CCDLENV on the IWS defines the name of the remote online database environment, on the NGC-LLCU it must be set to 0
- CCDNAME defines the name of the detector camera

NOTE: on the NGC-LLCU the environment variables are defined in the files /etc/pecs/releases/000/etc/locality/apps-all.env /etc/pecs/releases/000/etc/locality/apps-${HOST}.env

On the IWS you could define them in the same files or in

   ~/.pecs/apps-${HOST}.env

The script ngcoDcsOldb performs a preliminary system check: if the environment variables are defined, if the ACC server is defined and running, if local and remote environments are defined on the local computer and in the ACC server, if the scanning has been properly configured, if the user which shall run the software is defined on the local and the remote computer, etc. (manpage of ngcoDcsOldb is available in 16.1.1.)

The same script then handles the online database generation, acting in different ways on the IWS (see 2.3.1) and the LLCU (see 2.3.2).

2.3.1. IWS online database generation

On the IWS, the DATABASE.db.NGCOSW and USER.db.NGCOSW templates for the online database environment are installed in the $VLTDATA/ENVIRONMENTS/$RTAPENV/dbl directory by running:

   ngcoDcsOldb -renv $CCDLENV -host IWS

(manpage of ngcoDcsOldb is available in 16.1.1.)
Use the DATABASE.db.NGCOSW and USER.db.NGCOSW templates to edit the DATABASE.db and USER.db files.

In the template DATABASE.db.NGCOSW it is described how to describe different configurations (instrument controlling only one camera, instrument controlling more cameras).

Examples:

- **Instrument controlling one camera:**
  
  Add in the DATABASE.db the following, replacing `<myCCDNAME>` with the name of the camera (e.g., `$CCDNAME`), `<:myPATH>` with the preferred oldb location (e.g., `:DCS:optical`):

  ```
  #undef CCDNAME
  #undef ngcdcsINSTANCE
  #undef NGCROOT

  #define CCDNAME <myCCDNAME>
  #define ngcdcsINSTANCE ngcdcs_<myCCDNAME>
  #define NGCROOT :Appl_data<:myPATH>:CCDNAME
  ```

- **Instrument controlling four cameras:**
  
  Add in the DATABASE.db the following, replacing `<myINSTRUMENT>` with the instrument name, `<myCCDNAME>`, `<myCCDNAME2>`, `<myCCDNAME3>`, `<myCCDNAME4>` with the camera names (the values of `$CCDNAME` on the different LLCUs), `<:myPATH>` with the preferred oldb location (e.g., `:DCS:optical`):

  ```
  #undef DCSNAME
  #undef CCDNAME
  #undef ngcdcsINSTANCE
  #undef CCDNAME2
  #undef ngcdcsINSTANCE2
  #undef CCDNAME3
  #undef ngcdcsINSTANCE3
  #undef CCDNAME4
  #undef ngcdcsINSTANCE4
  #undef NGCROOT

  #define DCSNAME <INSTRUMENT>
  #define CCDNAME <myCCDNAME>
  #define ngcdcsINSTANCE ngcdcs_<myCCDNAME>
  #define CCDNAME2 <myCCDNAME2>
  #define ngcdcsINSTANCE2 ngcdcs_<myCCDNAME2>
  #define CCDNAME3 <myCCDNAME3>
  #define ngcdcsINSTANCE3 ngcdcs_<myCCDNAME3>
  #define CCDNAME4 <myCCDNAME4>
  #define ngcdcsINSTANCE4 ngcdcs_<myCCDNAME4>
  #define NGCROOT :Appl_data<:myPATH>:DCSNAME
  ```
Once the DATABASE.db and USER.db files have been properly edited, generate the environment: in $VLTDATA/ENvironments/$RTAPENV/db, run

    make clean db

To initialize and start the environment run:

    vccEnvInit -e $RTAPENV
    vccEnvStart -e $RTAPENV

2.3.2. NGC-LLCU online database generation

On the NGC-LLCU, the RTAPENV online database environment is automatically generated and started by running:

    ngcoDcsOldb -renv <IWS_RTAPENV> -host LLCU

Manpage of ngcoDcsOldb is available in 16.1.1.

2.3.3. Online database verification

On both the IWS and the LLCU verify that the environment has been generated:

    dbRead "<alias><myCCDNAME>:exposure:control.state"

replacing <myCCDNAME> with the name of the camera (e.g., $CCDNAME).

Verify that the needed processes are running in the CCS environment, by using ccsPerfMon. A view similar to the following should be displayed:

<table>
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<th>Process Name</th>
<th>PNUM</th>
<th>PID</th>
<th>UID</th>
<th>GID</th>
<th>MSGID</th>
<th>MONPID</th>
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<td>3227</td>
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<td>-1</td>
<td>-1</td>
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<td>3227</td>
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<td>scanMngr</td>
<td>6</td>
<td>4248</td>
<td>300</td>
<td>300</td>
<td>1583284234</td>
<td>-1</td>
</tr>
<tr>
<td>ccsScan</td>
<td>7</td>
<td>4259</td>
<td>300</td>
<td>300</td>
<td>1583480856</td>
<td>-1</td>
</tr>
<tr>
<td>ccsCmdServer</td>
<td>8</td>
<td>4243</td>
<td>3227</td>
<td>300</td>
<td>1583153160</td>
<td>-1</td>
</tr>
<tr>
<td>alrmServer</td>
<td>9</td>
<td>4247</td>
<td>3227</td>
<td>300</td>
<td>1583218697</td>
<td>-1</td>
</tr>
<tr>
<td>ccsPerfMon</td>
<td>22</td>
<td>6532</td>
<td>3227</td>
<td>300</td>
<td>1589313576</td>
<td>-1</td>
</tr>
</tbody>
</table>
2.3.4. Online database automatic startup

On both the IWS and the LLCU the online database environment start automatically at boot by adding the following line to the file /etc/rc.local:

```
su - <myUser> -c 'rm -f
  ${VLTDATA}/ENVIRONMENTS/$(RTAPENV)/.$(RTAPENV).lock;
  vccEnvStart -e $RTAPENV'
```

where <myUser> is the user managing the online database.

2.3.5. Detector user

In order for the online database to function correctly, the user which runs NGCOSW must be defined on both the IWS and the LLCU, with the same user id.

2.4. NGC-LLCU logging system configuration

To configure the LLCU to log messages onto the IWS, edit the file /etc/syslog.conf while logged in as the user “root”.

```
# ===========================================================
# The following three lines configure the VLT logging system
# ===========================================================
#*info;mail,local1,local2.none /var/adm/messages
#local1.warning /vltdata/tmp/logFile
#local2.warning /vltdata/tmp/logAuto
*.info;mail,local1,local2.none @myIws
local1.warning @myIws
local2.warning @myIws
```

Substitute the IWS hostname for "myIws".

IMPORTANT: use tabs for spacing!

This change will take effect after rebooting the LLCU, or run

```
kill -HUP `ps -C syslogd -o pid=`
```

to restart the logging daemon.

2.5. INS_ROOT population

To automatically populate the INS_ROOT (instrument directory), the environment variable INS_ROOT must be defined, the directory $INS_ROOT must exist and the “instrument module” must have been installed (“instrument module” is the cmm module containing the detector startup configuration file <xx>dcfgCONFIG.cfg and the configuration sets <xx>dcfgDCS.cfg and <xx>dcfgCAMERA.cfg - see 3.2.3.1 and 3.2.3.2 - and the voltages, patterns and sequences to drive the detector).

Assuming <xxdcfg> be the name of the instrument module, install it:

```
cmmCopy <xxdcfg>
cd <xxdcfg>/src; make all install
```
then populate the **INS_ROOT**:

```
ngcoDcsInstall -config <xxdcfg>
```

**Manpage of ngcoDcsInstall is available in 16.1.2.**
3. Startup/Shutdown Procedure

3.1. System Configuration

NGCOSW usually (see section 3.1.1) runs partly on the IWS and partly on the NGC-LLCU, where the physical interface(s) to the NGC detector front end reside (see Figure 1).

From now on, we will call IWSENV the online database environment which "usually" runs on the IWS and LCUENV the online database environment which "usually" runs on the NGC-LLCU (see section 3.1.1)
For each detector system, the configuration files are kept in a separate instrument specific configuration module <xx>dcfg, which is under CMM-control. The configuration module will take care of installing all files at the proper location (i.e. $INS_ROOT/$INS_USER/COMMON/CONFIGFILES). In addition to the system and detector configuration file(s) there are still various other files to be maintained in such a
module (e.g. voltage tables, clock pattern definitions, sequencer programs and the startup configuration as described in section 3.2.1).

### 3.1.1. NGCOSW operational modes

NGCOSW operates in the following different modes:

- **Normal mode**
  
  In Normal mode, the NGC detector electronics is connected. The NGCOSW can either be distributed on both the IWS (where the `IWSENV` online database environment is active) and the NGC-LLCU (where the `LCUENV` online database environment is active) or run completely on the NGC-LLCU (where both the `IWSENV` and the `LCUENV` online database environments are active).

- **Hardware-Simulation mode**
  
  In Hardware-Simulation mode, the NGC detector electronics is simulated (see section 3.1.3). The NGCOSW can either be distributed on both the IWS (where the `IWSENV` online database environment is active) and the NGC-LLCU (where the `LCUENV` online database environment is active) or run on a single host (where both the `IWSENV` and the `LCUENV` online database environments are active).

  This mode can be used by the higher level OS software to test the interface with the NGCOSW, when no NGC detector electronics is available.

  By using the ESO VLT message system, the system configuration (i.e., where the NGCOSW processes are running) is completely transparent to the actors (instrument software, operator, engineer, etc.), because the communications between the different processes are performed through the online database environments `IWSENV` and `LCUENV`, independently from the host where these are active.

  In this way, always the same software is used in all the different scenarios, in order to guarantee system robustness and behavior consistency.

  NGCOSW operational mode is set by the DET.CON.OPMODE setup keyword in the camera configuration set (see section 3.2.3.2) or defined at startup (see section 3.2.1). Valid values are defined in `ngco.h`.

### 3.1.2. NGC General Purpose Control Server operational modes

NGCOSW interacts with the NGC back-end boards through the NGC General Purpose Control Server (ngcdcsEvh, see [AD72]). Within NGCOSW, the server operates in the following different modes:

- **Normal mode**
  
  In Normal mode, the NGC detector electronics is connected.

  This is the normal operational mode (default).

- **Hardware-Simulation mode**
  
  In Hardware-Simulation mode, the NGC detector electronics is simulated (see
section 3.1.3).

- **LCU-Simulation mode**
  
  For NGCOWS, this mode is equivalent to Hardware-Simulation.

Server operational mode is set by the DET.CON.DFEMODE setup keyword in the camera configuration set (see section 3.2.3.2) or defined at startup (see section 3.2.1). Valid values are defined in ngco.h.

### 3.1.3. Simulation of the NGC detector electronics

When the NGC detector electronics is simulated, the images produced by NGCOSW contain a predefined pattern.

### 3.2. System Startup

#### 3.2.1. Startup Procedure

The startup procedure is based on the common VLTSW configuration tool ("ctoo", [RD75]).

Among the other files, an instrument module `<xx>dcfg` (see section 3.1) contains:

- a startup configuration file `<xx>dcfgCONFIG.cfg`
- one configuration set `<xx>dcfgDCS.cfg`
- one configuration set `<xx>dcfgCAMERA.cfg`

The configuration set describes an instance of the NGCOSW, in short FITS format, where (*) means that their usage is not yet implemented:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.CON.INSTANCE</td>
<td>String</td>
<td>Defines the instance label for the control server and the database. Used to define the database branch and the appendix &quot;<em>&lt;label&gt;</em>&quot; for the Control Coordination Process registered with the CCS environment. If the keyword is not present and not passed as a parameter to the startup script, the value of the $CCDNAME environment variable is used.</td>
</tr>
<tr>
<td>DET.CON.ENV</td>
<td>String</td>
<td>Defines the local online database environment under which the NGCOSW instance must run. If the keyword is not present and not passed as a parameter to the startup script, the value of the $RTAPENV environment variable is used.</td>
</tr>
<tr>
<td>Keyword</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>DET.CON.LENV</td>
<td>String</td>
<td>Defines the remote online database environment under which the NGC-LLCU part of NGCOSW instance must run. If the keyword is not present and not passed as a parameter to the startup script, the value of the $CCDLENV environment variable is used.</td>
</tr>
<tr>
<td>DET.CON.OPMODE</td>
<td>String</td>
<td>Defines the operational mode after starting up. Valid values are “NORMAL”, “HW-TEST”, “HW-SIM” or “LOCAL-HW-SIM”. Default is &quot;NORMAL&quot;, in case the keyword is not present.</td>
</tr>
<tr>
<td>DET.CON.DFEMODE</td>
<td>String</td>
<td>Defines the operational mode of the NGC General Purpose Control Server after starting up. Valid values are “NORMAL”, “LCU-SIM” or “HW-SIM”. Default is &quot;NORMAL&quot;, in case the keyword is not present.</td>
</tr>
<tr>
<td>DET.CON.AUTONLIN</td>
<td>Logical</td>
<td>When set to T, the detector system automatically goes to ONLINE at startup. Default is &quot;F&quot;, in case the keyword is not present.</td>
</tr>
<tr>
<td>DET.CON.GUI</td>
<td>String</td>
<td>Launch graphical user interface with the specified process name. At the moment, only the default program ngcouiPanel is used, independently from the process name which is specified.</td>
</tr>
<tr>
<td>DET.CON.DICT</td>
<td>String</td>
<td>Defines a list of dictionaries to be loaded. The common “ESO-VLT-DIC.NGCDCS” is always loaded into the system and needs not to be specified. The entries are separated by whit-space. Only the last descriptor of the full dictionary name is needed here (e.g. “NGCDCS STOO_CFG ...”).</td>
</tr>
<tr>
<td>DET.CON.XTERM</td>
<td>Logical</td>
<td>Start all (sub-) processes in new terminal.</td>
</tr>
<tr>
<td>DET.CON.LOG</td>
<td>Integer</td>
<td>Logging level. Logs system messages in the standard log-file, so that they can be seen in the CCS logMonitor. The level gives the detail of the messages. Default value is 0 (= no debugging, only error logging), in case the keyword is not present.</td>
</tr>
</tbody>
</table>
Table 1 - Startup Configuration Keywords

The startup configuration file assigns a name and some access-right attributes to the configuration set.

The system startup is performed through a startup script:

```bash
ngcoDcsStart [options]
```

The startup scripts loads the startup configuration defined by the `CCDNAME` environment variable or by the option `-instance` option, starts the coordination control process and waits - with a default timeout - until the coordination control process is active (i.e., it responds to `PING` commands).

`options` can be used to overwrite the values of the parameters in the configuration set keywords:

- `-instance` - overwrites `DET.CON.INSTANCE`
- `-env` - overwrites `DET.CON.ENV`
- `-lenv` - overwrites `DET.CON.LENV`
- `-opmode` - overwrites `DET.CON.OPMODE`
- `-dfemode` - overwrites `DET.CON.DFEMODE`
- `-autonlin` - overwrites `DET.CON.AUTONLIN`
- `-gui` - overwrites `DET.CON.GUI`
- `-dict` - overwrites `DET.CON.DICT` (*)
- `-xterm` - overwrites `DET.CON.XTERM`
- `-log` - overwrites `DET.CON.LOG` (*)
- `-itc` - overwrites `DET.CON.ITCPROC`

If no configuration set is given, only the `options` are used.

If no configuration is defined and no `options` are given, the system startup is performed using the environment variables `CCDNAME, RTAPENV, CCDLENV, INS_ROOT, INS_USER` (in the same way as in the case of the FIERA controller).

Further special options are:

- `-kill` - kill existing NGCOSW processes, if any, before starting

### 3.2.2. Changes with respect to FIERA

FIERAsw configuration was online-database-driven, i.e., the configuration of a detector was described within a `.dbcfg` (database configuration) file, which was loaded at startup.
NGCOSW uses ctoo, the .dbcfg file is now substituted by the startup configuration file and the configuration set.

The script ngcoDcsStart replaces the script fcdDcsStart.

If the startup script of NGCOSW is used without the options, NGCOSW will be started using the CCDNAME, RTAPENV, CCDLENV, INS_ROOT, INS_USER, similar to the procedure followed by the FIERASW.
3.2.3. Configuration Examples

3.2.3.1 Startup Configuration file <xx>dcfgCONFIG.cfg

```
# # Startup Configuration File
# ----------------------------------
PAF.HDR.START;
PAF.TYPE "Configuration"; # Type of PAF
PAF.ID "@(#) $Id: $";
PAF.NAME "NGCOSW"; # Name of PAF
PAF.DESC "NGCOSW Test Camera Startup Configuration";
PAF.CRTE.NAME "ccumani"; # Name of creator
PAF.CRTE.DAYTIM "2006-08-21"; # Civil Time for creation
PAF.LCHG.NAME " "; # Name of person/appl. changing
PAF.LCHG.DAYTIM " "; # Timestamp of last change
PAF.CHCK.NAME " "; # Name of appl. checking
PAF.HDR.END;

# # GENERAL CONFIG Keywords (optional)
# ----------------------------------
CONFIG.CON.LOG T;
CONFIG.CON.BACKUP T;
CONFIG.CON.BAKDIR $VLTDATA/config;

# # CAMERA CONFIG SET
# -----------------
CONFIG.SET1.NAME "opd"
CONFIG.SET1.DICT "NGCDCS NGCCON"
CONFIG.SET1.FILE1 "opdDCS.cfg"
CONFIG.SET1.PERM1 644;
CONFIG.SET1.FILE2 "opdCAMERA.cfg"
CONFIG.SET1.PERM2 644;
CONFIG.SET1.FILE2 "opdCAMERA_TARGET.cfg"
CONFIG.SET1.PERM2 664;

# # ctooConfigArchive CONFIG
# ------------------------
CONFIG.ARCHIVE.NAME "NGCOSW"
CONFIG.ARCHIVE.USER ""
CONFIG.ARCHIVE.MODULE "opdfig"
CONFIG.ARCHIVE.FILE1 "opdfig*.cfg"
CONFIG.ARCHIVE.FILE2 "opdfig/*"

# ___oOo___
```
3.2.3.2 Configuration Set <xx> dcfgDCS.cfg

```plaintext
PAF.HDR.START;                 # Start of PAF Header
PAF.TYPE         "Configuration"; # Type of PAF
PAF.ID           "";   # ID for PAF
PAF.NAME         "NGCOSW";   # Name of PAF
PAF.DESC         "NGCOSW Startup Configuration";   # Short description of PAF
PAF.CRTE.NAME    "ccumani";   # Name of creator
PAF.CRTE.DAYTIM  "2007-08-31";   # Civil Time for creation
PAF.LCHG.NAME    "";   # Name of person/appl. changing
PAF.LCHG.DAYTIM  "";   # Timestamp of last change
PAF.CHCK.NAME    "";   # Name of appl. checking
PAF.HDR.END;                   # End of PAF Header

####################################################################
# System configuration
####################################################################

DET.CON.INSTANCE      "ngcopt";            # Instance label
DET.CON.ENV           "myrtap";            # Local online database environment
DET.CON.LENV          "mylenv";            # Remote online database environment
DET.CON.OPMODE        "NORMAL";            # Operational mode
DET.CON.AUTONLIN      F;                   # Go online after start
DET.CON.GUI           "ngcoui";            # GUI Name
DET.CON.DICT          "NGCDCS NGCCON";     # Dictionary list
DET.CON.XTERM         F;                   # Start in new terminal
DET.CON.LOG           0;                   # Logging level

####################################################################
# DEV description
####################################################################

DET.DEV1.NAME   "/dev/ngc0_com";    # associated device name
DET.DEV1.HOST   "$HOST";            # host where interface resides
DET.DEV1.ENV    "myrtap";           # server environment name
DET.DEV1.SRV    "";                 # optional server name
DET.DEV1.TYPE   "";                 # optional type

####################################################################
# CLDC description
####################################################################

DET.CLDC1.DEVIDX   1;               # associated device index
DET.CLDC1.ROUTE    "2";            # route to module
DET.CLDC1.NAME     "CLDC 1";        # optional name
DET.CLDC1.AUTOENA  F;               # auto-enable at online
DET.CLDC1.DCGN     2.0;             # bias gain
DET.CLDC1.CLKGN    1.0;             # clock gain
DET.CLDC1.TELCLKGN 1.0;             # telemetry gain
DET.CLDC1.TELDCGN  3.0;             # telemetry gain
```

# SEQ description

DET.SEQ1.DEVIDX 1; # associated device index
DET.SEQ1.ROUTE "2"; # route to module
DET.SEQ1.NAME "Sequencer 1"; # optional name
DET.SEQ1.RUNCTRL T; # Run-control active
DET.SEQ1.CVTEXT F; # External convert active

# ADC description

DET.ADC1.DEVIDX 1; # associated device index
DET.ADC1.ROUTE "2"; # route to module
DET.ADC1.NAME "ADC Module 1"; # optional name
DET.ADC1.OFFSET 1.5; # offset value for ADC (volt)
DET.ADC1.NUM 4; # number of ADCs on board
DET.ADC1.BITPIX 16; # ADC bits per pixel
DET.ADC1.MON1 1; # ADC channel to monitor
DET.ADC1.SIMMODE 0; # simulation level of ADCs
DET.ADC1.OPMODE 0; # operational mode of ADC-module
DET.ADC1.FIRST T; # first in chain
DET.ADC1.CONVERT2 F; # convert on strobe 2
DET.ADC1.CONVERT1 T; # convert on strobe 1
DET.ADC1.PKTCNT 0; # packet routing length
DET.ADC1.PKTSIZE 2; # packet size
DET.ADC1.FILTER 0; # Filter (0 = 0.5us, 1 = 5us)
DET.ADC1.CLAMP T; # Analog Clamp-and-Sample
DET.ADC1.ENABLE 4; # Number of enabled ADCs on board

# Preamp description

DET.PREAMP1.DEVIDX 1; # Device index
DET.PREAMP1.ROUTE "2"; # Route to module
DET.PREAMP1.NAME "Preamp 1"; # Optional module name
DET.PREAMP1.REV 2.0; # Preamp revision

# SHUT description

DET.SHUT1.DEVIDX 1; # Device index
DET.SHUT1.ROUTE "2"; # Route to module
DET.SHUT1.NAME "Shutter-1"; # Optional module name

# ___oOo___
3.2.3.3 Configuration Set <xx>dcfgCAMERA.cfg

```
PAS.HDR.SSTART;  # Start of PAF Header
PAS.TYPER " Configuration";  # Type of PAF
PAS.ID "";  # ID for PAF
PAS.NAME "NGCSSW";  # Name of PAF
PAS.DESC "NGCSSW Startup Configuration";  # Short description of PAF
PAS.CRTD.NAME "ccumani";  # Name of creator
PAS.CRTD.DAYTIM "2007-08-31";  # Civil Time for creation
PAS.LCHG.NAME "";  # Name of person/appl. changing
PAS.LCHG.DAYTIM "";  # Timestamp of last change
PAS.HDR.END;  # End of PAF Header

####################################################################
# Global info
####################################################################
DET.ID "NGCOPT";  # Detector system Id
DET.DATE "2009-05-18";  # Installation date
DET.NAME "NGC-OPT-DCS";  # Name of detector system
DET.CHIPS 1;  # Number of chips in the mosaic
BITPIX 16;  # Number of bits per pixel
CTYPE1 "PIXEL";  # Pixel coordinate system
CRVAL1 1;  # Coordinate value of ref. pixel
CTYPE2 "PIXEL";  # Pixel coordinate system
CRVAL2 1;  # Coordinate value of ref. pixel

####################################################################
# DET configuration
####################################################################
DET.CON.GUI "ngcoui";  # GUI Name
#DET.CON.ITCPROC "muditc";  # Image Transfer Client

####################################################################
# DCS configuration
####################################################################
DET.CON.SYSCFG "ngcoptDCS.cfg"  # HW system configuration file

####################################################################
# CHIP description
####################################################################
DET.CHIP1.ID "SER-NO=053";  # Detector chip identification
DET.CHIP1.NAME "Marlene";  # Detector chip name
DET.CHIP1.DATE "2006-11-22";  # Date of installation [YYYY-MM-DD]
DET.CHIP1.NX 2048;  # Physical active pixels in X
DET.CHIP1.NY 4096;  # Physical active pixels in Y
DET.CHIP1.PRSCX 50;  # Physical prescan pixels in X
DET.CHIP1.PRSCY 0;  # Physical prescan pixels in Y
DET.CHIP1.OVSCX 50;  # Physical overscan pixels in X
```
DET.CHIP1.OVSCY 0;  # Physical overscan pixels in Y
DET.CHIP1.PSZX 15.0;  # Size of pixel in X (mu)
DET.CHIP1.PSZY 15.0;  # Size of pixel in Y (mu)
DET.CHIP1.OUTPUTS 2;  # Number of outputs per chip

DET.CHIP1.X 1;  # X location in array
DET.CHIP1.Y 1;  # Y location in array
DET.CHIP1.XGAP 0.0;  # Gap between chips along x (mu)
DET.CHIP1.YGAP 0.0;  # Gap between chips along Y (mu)
DET.CHIP1.RGAP 0.0;  # Angle of gap between chips
DET.CHIP1.INDEX 1;  # Chip index
DET.CHIP1.LIVE T;  # Detector alive
DET.CHIP1.TYPE CCD;  # The Type of detector chip
DET.CHIP1.PXSPACE 1E-6;  # Pixel-Pixel Spacing

DET.CHIP1.OUT1.NAME "NO1";  # Description of output
DET.CHIP1.OUT1.INDEX 1;  # Output index
DET.CHIP1.OUT1.ID "IdO1";  # Output ID as from manufacturer
DET.CHIP1.OUT1.X 1;  # X location of output
DET.CHIP1.OUT1.Y 1;  # Y location of output
DET.CHIP1.OUT1.READX -1;  # Horizontal readout direction
DET.CHIP1.OUT1.READY -1;  # Vertical readout direction

DET.CHIP1.OUT2.NAME "NO2";  # Description of output
DET.CHIP1.OUT2.INDEX 2;  # Output index
DET.CHIP1.OUT2.ID "IdO2";  # Output ID as from manufacturer
DET.CHIP1.OUT2.X 2048;  # X location of output
DET.CHIP1.OUT2.Y 1;  # Y location of output
DET.CHIP1.OUT2.READX 1;  # Horizontal readout direction
DET.CHIP1.OUT2.READY -1;  # Vertical readout direction

# MODE description

# MODE1

DET.MODE1.NAME "Test1";  # Exposure mode name
DET.MODE1.DESC "Test mode 1";  # Exposure mode description
DET.MODE1.TRIGGER F;  # Enable trigger
DET.MODE3.GAIN1 13;  # Gain used
DET.MODE3.GAIN2 13;  # Gain used
DET.MODE3.GAIN3 13;  # Gain used
DET.MODE3.GAIN4 13;  # Gain used
DET.MODE3.BNDWTH1 0;  # Bandwidth used
DET.MODE3.BNDWTH2 0;  # Bandwidth used
DET.MODE3.BNDWTH3 0;  # Bandwidth used
DET.MODE3.BNDWTH4 0;  # Bandwidth used
DET.MODE1.WREP 1;  # Wipe sequence repetition number
DET.MODE1.WCLDFIL1 "wipe1.v";  # Name of CLDCi FILE for wipe
DET.MODE1.WCLKFIL1 "wipe1.bclk";  # Name of SEQi CLKFILE for wipe
DET.MODE1.PPRGFIL1 "wipe1.seq";  # Name of SEQi PRGFILE for wipe
DET.MODE1.PREP 1;  # Preint sequence repetition number
DET.MODE1.PCLDFIL1 "preint1.v";  # Name of CLDCi FILE for preintegration
DET.MODE1.PCLKFIL1 "preint1.bclk";  # Name of SEQi CLKFILE for preintegration
DET.MODE1.PPRGFIL1 "preint1.seq";  # Name of SEQi PRGFILE for preintegration
DET.MODE1.RREP 1;  # Readout sequence repetition number
DET.MODE1.RCLDFIL1 "read1.v"; # Name of CLDCi FILE for readout
DET.MODE1.RCLKFIL1 "read1.bclk"; # Name of SEQi CLKFILE for readout
DET.MODE1.RPRGFIL1 "read1.seq"; # Name of SEQi PRGFILE for readout
DET.MODE3.RTYPE "Standard"; # Readout type: Standard or FastACS

DET.MODE1.ADCSAMPL "-1,1"; # ADC data sampling factors
DET.MODE1.OUTPUTS 1; # Number of outputs used for readout
DET.MODE1.ADC1.ADCS "1"; # Outputs used for readout

DET.MODE1.OUT1.CHIP 1; # Index of chip the output belongs to
DET.MODE1.OUT1.INDEX 1; # Output index on the chip
DET.MODE1.OUT1.XIMA 1; # Horizontal location of data in image
DET.MODE1.OUT1.YIMA 1; # Vertical location of data in image
DET.MODE1.OUT1.NX 2048; # Output data pixels in X
DET.MODE1.OUT1.NY 500; # Output data pixels in Y
DET.MODE1.OUT1.PRSCX 50; # Output prescan pixels in X
DET.MODE1.OUT1.PRSCY 0; # Output prescan pixels in Y
DET.MODE1.OUT1.OVSCX 50; # Output overscan pixels in X
DET.MODE1.OUT1.OVSCY 0; # Output overscan pixels in Y
DET.MODE1.OUT1.GAIN 0.3; # Conversion from electrons to ADU
DET.MODE1.OUT1.CONAD 3.33; # Conversion from ADUs to electrons
DET.MODE1.OUT1.RON 123; # Readout noise per output (e-)

DET.MODE2.SHACTHI F; # Open active high
DET.MODE2.SHMODE "Direct"; # Shutter operational mode

# MODE2

DET.MODE2.NAME "Test2"; # Exposure mode name
DET.MODE2.DESC "Test mode 2"; # Exposure mode description
DET.MODE2.TRIGGER F; # Enable trigger
DET.MODE2.GAIN1 13; # Gain used
DET.MODE2.GAIN2 13; # Gain used
DET.MODE2.GAIN3 13; # Gain used
DET.MODE2.GAIN4 13; # Gain used
DET.MODE2.BNDWTH1 0; # Bandwidth used
DET.MODE2.BNDWTH2 0; # Bandwidth used
DET.MODE2.BNDWTH3 0; # Bandwidth used
DET.MODE2.BNDWTH4 0; # Bandwidth used

DET.MODE2.WREP 4; # Wipe sequence repetition number
DET.MODE2.WCLDFIL1 "wipel.v"; # Name of CLDCi FILE for wipe
DET.MODE2.WCLKFIL1 "wipel.bclk"; # Name of SEQi CLKFILE for wipe
DET.MODE2.WPRGFIL1 "wipel.seq"; # Name of SEQi PRGFILE for wipe
DET.MODE2.PREP 1; # Preint sequence repetition number
DET.MODE2.PCLDFIL1 "preint1.v"; # Name of CLDCi FILE for preintegration
DET.MODE2.PCLKFIL1 "preint1.bclk"; # Name of SEQi CLKFILE for preintegration
DET.MODE2.PPRGFIL1 "preint1.seq"; # Name of SEQi PRGFILE for preintegration
DET.MODE2.RREP 1; # Readout sequence repetition number
DET.MODE2.RCLDFIL1 "read1.v"; # Name of CLDCi FILE for readout
DET.MODE2.RCLKFIL1 "read1.bclk"; # Name of SEQi CLKFILE for readout
DET.MODE2.RPRGFIL1 "read1.seq"; # Name of SEQi PRGFILE for readout

DET.MODE2.ADCSAMPL "-1,1"; # ADC data sampling factors
DET.MODE2.OUTPUTS 2; # Number of outputs used for readout
DET.MODE2.ADC1.ADCS "1,3"; # Outputs used for readout

DET.MODE2.OUT1.CHIP 1; # Index of chip the output belongs to
DET.MODE2.OUT1.INDEX 1; # Output index on the chip
### DET.MODE2.OUT1
- DET.MODE2.OUT1.XIMA: 1;  # Horizontal location of data in image
- DET.MODE2.OUT1.YIMA: 1;  # Vertical location of data in image
- DET.MODE2.OUT1.NX: 1024;  # Output data pixels in X
- DET.MODE2.OUT1.NY: 500;  # Output data pixels in Y
- DET.MODE2.OUT1.PRSCX: 50;  # Output prescan pixels in X
- DET.MODE2.OUT1.PRSCY: 0;  # Output prescan pixels in Y
- DET.MODE2.OUT1.OVSCX: 0;  # Output overscan pixels in X
- DET.MODE2.OUT1.OVSCY: 0;  # Output overscan pixels in Y
- DET.MODE2.OUT1.GAIN: 0.3;  # Conversion from electrons to ADU
- DET.MODE2.OUT1.CONAD: 3.33;  # Conversion from ADUs to electrons
- DET.MODE2.OUT1.RON: 100;  # Readout noise per output (e-)

### DET.MODE2.OUT2
- DET.MODE2.OUT2.CHIP: 1;  # Index of chip the output belongs to
- DET.MODE2.OUT2.INDEX: 2;  # Output index on the chip
- DET.MODE2.OUT2.XIMA: 2;  # Horizontal location of data in image
- DET.MODE2.OUT2.YIMA: 1;  # Vertical location of data in image
- DET.MODE2.OUT2.GAIN: 0.3;  # Conversion from electrons to ADU
- DET.MODE2.OUT2.CONAD: 3.33;  # Conversion from ADUs to electrons
- DET.MODE2.OUT2.RON: 200;  # Readout noise per output (e-)

### DET.SHACTHI
- DET.SHACTHI: T;  # Open active high

### DET.SHMODE
- DET.SHMODE: "Sequencer1";  # Shutter operational mode

---

# SHUT description
---

### DET.SHUT1.AVAIL
- DET.SHUT1.AVAIL: T;  # Shutter available or not

### DET.SHUT1.CTRL
- DET.SHUT1.CTRL: "ngc";  # Shutter controller

### DET.SHUT1.TYPE
- DET.SHUT1.TYPE: "nostatus";  # Shutter type

### DET.SHUT1.ID
- DET.SHUT1.ID: "eso-01";  # Shutter unique identifier

### DET.SHUT1.MODE
- DET.SHUT1.MODE: "Normal";  # Shutter operational mode

### DET.SHUT1.OPACTHI
- DET.SHUT1.OPACTHI: T;  # Open active high

### DET.SHUT1.EVTEDG1
- DET.SHUT1.EVTEDG1: F;  # Event rising edge

### DET.SHUT1.EVTEDG2
- DET.SHUT1.EVTEDG2: T;  # Event rising edge

### DET.SHUT1.EVTEDG3
- DET.SHUT1.EVTEDG3: F;  # Event rising edge

### DET.SHUT1.EVTEDG4
- DET.SHUT1.EVTEDG4: T;  # Event rising edge

---

# __oOo__
3.3. NGCOSW operational states

The NGCOSW can be in the following operational states (see [AD28]):

- **OFF.** The NGCOSW is OFF when it is not running. Consequently, the NGCOSW can never reply when it is in the OFF state.

- **LOADED.** When the NGCOSW goes to LOADED state, the database is loaded and all processes are activated. Anyway the access to hardware is not allowed.
  
  This is the state at the end of a successful startup.

- **STANDBY.** The software and the hardware interfaces are initialized, all hardware components are checked.
  
  This is the state at the end of a successful **STANDBY** command.

In detail all actions needed to bring the whole camera to STANDBY state are very dependent on the system hardware architecture and therefore cannot be defined in this document for all cameras. Typically the following actions are implemented:

a. Detector disconnected (voltages not applied).

b. Shutter control hardware is switched off, whenever the hardware architecture allows it.

c. Temperature monitoring remains active

d. LAN connection active (command reception enabled)

- **ONLINE.** This is the only state where the NGCOSW can perform exposures. All software and hardware is loaded, initialized and active. All voltages have been loaded. Telemetry has been acquired and checked. All the voltage switches are closed.

  This is the state at the end of a successful **ONLINE** command.
Figure 2 illustrates the NGCOSW operational states and the commands to switch between them (see [AD28]).

![Operational states and state transitions](image)

**Figure 2 - Operational states and state transitions**

### 3.3.1. Changes with respect to FIERA

NGCOSW implements the same operational states of the FIERASW.

### 3.4. System Shutdown

The system is shutdown by sending an `EXIT` command (see section 4) to the coordination control process `ngcocon_<label>`. The coordination control process will then shutdown all sub-processes.

A shutdown script is also available:

```
ngcoDcsStop [option]
```

The option is:

- `-kill` - kill NGCOSW processes not terminated by `EXIT` command

### 3.4.1. Changes with respect to FIERA

NGCOSW is still shutdown by an EXIT command, like the FIERASW.

The script `ngcoDcsStop` replaces the script `fcdDcsStop`. 
4. Command Interface

The coordination control process `ngcocon_<label>` is the only command interface between ICS and NGCOSW.

The commands which can be issued to the coordination control process are listed in the following table, where (*) means that they are not yet implemented:

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameters</th>
<th>Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABORT</td>
<td>none</td>
<td>-</td>
<td>AbORT running exposure.</td>
</tr>
<tr>
<td>BREAK</td>
<td>none</td>
<td>-</td>
<td>Interrupt NGC server.</td>
</tr>
<tr>
<td>CONT</td>
<td>-at String</td>
<td>&lt;YYYY-MM-DD&gt;T<a href="">hh:mm:ss</a> or &quot;now&quot;</td>
<td>Continue a paused exposure at a given time (default now).</td>
</tr>
<tr>
<td>DUMP (*)</td>
<td>none</td>
<td>-</td>
<td>Dump the image in memory to disk.</td>
</tr>
<tr>
<td>END</td>
<td>none</td>
<td>-</td>
<td>End the current exposure(s) and read out the data.</td>
</tr>
<tr>
<td>EXIT</td>
<td>none</td>
<td>-</td>
<td>Bring the system to operational state OFF and terminate it.</td>
</tr>
<tr>
<td>INIT</td>
<td>none</td>
<td>-</td>
<td>Initialize the system. The system status goes to LOADED.</td>
</tr>
<tr>
<td>OFF</td>
<td>none</td>
<td>-</td>
<td>Bring the system to operational state LOADED.</td>
</tr>
<tr>
<td>ONLINE</td>
<td>none</td>
<td>-</td>
<td>Bring the system to operational state ONLINE.</td>
</tr>
<tr>
<td>PAUSE</td>
<td>-at String</td>
<td>&lt;YYYY-MM-DD&gt;T<a href="">hh:mm:ss</a> or &quot;now&quot;</td>
<td>Pause exposure at a given time (default now).</td>
</tr>
<tr>
<td>SELFTST (*)</td>
<td>-function String</td>
<td></td>
<td>Execute a self-test (sw and hw) of the specified function(s).</td>
</tr>
<tr>
<td>SETUP</td>
<td>-file String</td>
<td></td>
<td>Setup for the next exposure, or the running - but PAUSEd - one.</td>
</tr>
<tr>
<td></td>
<td>-function String</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Command</td>
<td>Parameters</td>
<td>Format</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>STANDBY</td>
<td>none</td>
<td>-</td>
<td>Bring the system to operational state STANDBY.</td>
</tr>
<tr>
<td>START</td>
<td>-expoid Integer</td>
<td>String $YYYY-MM-DD&gt;T<a href="">hh:mm:ss</a>$ or &quot;now&quot;</td>
<td>Exposure ID</td>
</tr>
<tr>
<td></td>
<td>-at</td>
<td></td>
<td>Start an exposure or an exposure loop (depending on the value of DET.EXP.NREP keyword, see section 7) at a given time (default now).</td>
</tr>
<tr>
<td>STARTTL (*)</td>
<td>-period Integer</td>
<td>-logperiod Integer</td>
<td>Start monitoring of telemetry values.</td>
</tr>
<tr>
<td>STARTWP (*)</td>
<td>-periodic Integer</td>
<td>-</td>
<td>Wipe chip(s) once or periodically.</td>
</tr>
<tr>
<td>STOPLP</td>
<td>none</td>
<td>-</td>
<td>Stop a loop of repeated exposures, at the end of the running exposure.</td>
</tr>
<tr>
<td>STOPTL (*)</td>
<td>none</td>
<td>-</td>
<td>Stop monitoring of telemetry values.</td>
</tr>
<tr>
<td>STOPWP (*)</td>
<td>none</td>
<td>-</td>
<td>Stop a periodic wipe.</td>
</tr>
<tr>
<td>VERBOSE</td>
<td>-on</td>
<td>-</td>
<td>Set verbose mode on/off.</td>
</tr>
<tr>
<td></td>
<td>-off</td>
<td></td>
<td>If -on, the level of the logging is defined by the logging level value (which can be set/modified through the setup keyword DET.CON.LOG)</td>
</tr>
<tr>
<td>VERSION</td>
<td>none</td>
<td>-</td>
<td>Return current version of the NGCOSW.</td>
</tr>
<tr>
<td>WAIT</td>
<td>-waitMode String &quot;Single&quot; / &quot;Global&quot;</td>
<td>-</td>
<td>Wait for exposure completion. Two replies are issued: one immediate with the exposure status, one at the end of the exposure.</td>
</tr>
</tbody>
</table>

Table 2 - Command list
Special commands which can be issued directly to the different processes are listed in the following table, where (*) means that they are not yet implemented:

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameters</th>
<th>Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KILL</td>
<td>none</td>
<td>-</td>
<td>Kill the process. The system status goes to OFF.</td>
</tr>
<tr>
<td>PING</td>
<td>none</td>
<td>-</td>
<td>Verify whether the process is able to send or receive messages</td>
</tr>
<tr>
<td>SIM/SIMULAT (*)</td>
<td>none</td>
<td>-</td>
<td>Put the process into simulation mode.</td>
</tr>
<tr>
<td>STATUS</td>
<td>none</td>
<td>-</td>
<td>Get the status of the process.</td>
</tr>
<tr>
<td>STOPSIM (*)</td>
<td>none</td>
<td>-</td>
<td>Stop the simulation.</td>
</tr>
</tbody>
</table>

Table 3 - Special command list

4.1. Changes with respect to FIERA

NGCOSW implements the same commands of the FIERASW.

To keep backward compatibility with the FIERASW as much as possible, but reducing at the same time differences with the NGC software for the infrared detectors, some command aliases have been provided (e.g., SIM/SIMULAT).

The command **STOPLP replaces STOP.**
5. Multiple Instances of DCS

For instruments controlling a single DCS, the system coordination control process `ngcocon_<CCDNAME>` is the only command interface between ICS and NGCOSW (see section 4).

If multiple instances of DCS are used (e.g., for instruments which control more than one NGC-LLCU), a super system coordination control process (briefly, “super control process”) `ngcocon_<label>` is the only command interface between ICS and NGCOSW.

The super system coordination control process is contained in the `ngcosc` module.

5.1. Customization of the super control process

The possibility of performing customized actions at STANDBY/ONLINE/OFF/EXIT/SETUP is implemented by means of a virtual `Execute` method added to the corresponding action classes of the super control process.

The application that needs to implement some specific post processing must define a class that inherits from the corresponding `ngcoscACTION_XXX` and that overrides the `Execute` method. The new class must then substitute the default action manager for the event.

A template is provided in the `xxxosc` module which is installed in the `$VLTTOP/templates/forNGC` directory.

To create a module (for instance `newosc`) which customizes actions of the super control process, go into the appropriate directory and run

```
ngcoDcsTemplate.sh -template xxxosc -module newosc
```

In the local directory a `newosc` module is then created.

Shortly:

- In the appropriate `newosc ACTION_XXX.C` file (where XXX can be any of STANDBY/ONLINE/OFF/EXIT/SETUP) implement your `Execute` method;
- In the `newoscControl.C` file, check which actions should be overridden and which should not be overridden;
- In the `Makefile` file, remove from `newoscControl_OBJECTS` the actions that you do NOT want to override.

5.2. Startup of a system using multiple instances of DCS

The standard procedure described in 3.2 applies also to the startup of a system using multiple instances of DCS.

Proper configuration files are needed also for the startup of the super control process.

In particular, the `<label>CAMERA.cfg` file must contain the `DET.CON.INSTi` keywords, defining the DCSs which are used.
6. Database Interface

Some attributes of the NGCOSW online database are made public for direct read operations from external software (note: they are read only).

When accessing NGCOSW database attributes with direct CCS db calls, applications are requested to use the macros defined in `ngcoDbPublic.h` (see section 6.4): in this way, any change in name or location of the attribute only requires a new compilation.

All database paths below are meant to be relative to the root point for the NCG database branch.

### 6.1. Interface between NGCOSW and the external environment

<table>
<thead>
<tr>
<th>Point</th>
<th>Attribute</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>system</td>
<td>opmode</td>
<td>dbINT32</td>
<td>Camera operational mode</td>
</tr>
<tr>
<td>system</td>
<td>state</td>
<td>dbINT32</td>
<td>System operational state</td>
</tr>
<tr>
<td>exposure:config</td>
<td>id</td>
<td>dbINT32</td>
<td>Exposure identification number</td>
</tr>
<tr>
<td>exposure:config</td>
<td>expMode</td>
<td>dbINT32</td>
<td>Exposure mode index</td>
</tr>
<tr>
<td>exposure:config</td>
<td>expModeDescr</td>
<td>dbBYTES32</td>
<td>Exposure mode description</td>
</tr>
<tr>
<td>exposure:config</td>
<td>wipeSeq</td>
<td>dbBYTES128</td>
<td>Name of the wipe sequence</td>
</tr>
<tr>
<td>exposure:config</td>
<td>wipeClock</td>
<td>dbBYTES128</td>
<td>Name of the wipe clock pattern</td>
</tr>
<tr>
<td>exposure:config</td>
<td>wipeVolt</td>
<td>dbBYTES128</td>
<td>Name of the wipe voltage set</td>
</tr>
<tr>
<td>exposure:config</td>
<td>wipeRep</td>
<td>dbINT32</td>
<td>Wipe sequence repetition factor</td>
</tr>
<tr>
<td>exposure:config</td>
<td>preintSeq</td>
<td>dbBYTES128</td>
<td>Name of the preintegration sequence</td>
</tr>
<tr>
<td>exposure:config</td>
<td>preintClock</td>
<td>dbBYTES128</td>
<td>Name of the preintegration clock pattern</td>
</tr>
<tr>
<td>exposure:config</td>
<td>preintVolt</td>
<td>dbBYTES128</td>
<td>Name of the preintegration voltage set</td>
</tr>
<tr>
<td>exposure:config</td>
<td>preintRep</td>
<td>dbINT32</td>
<td>Preintegration sequence repetition factor</td>
</tr>
<tr>
<td>exposure:config</td>
<td>durintSeq</td>
<td>dbBYTES128</td>
<td>Name of the during integration sequence</td>
</tr>
<tr>
<td>exposure:config</td>
<td>durintClock</td>
<td>dbBYTES128</td>
<td>Name of the during integr. clock pattern</td>
</tr>
<tr>
<td>exposure:config</td>
<td>durintVolt</td>
<td>dbBYTES128</td>
<td>Name of the during integration voltage set</td>
</tr>
<tr>
<td>exposure:config</td>
<td>durintRep</td>
<td>dbINT32</td>
<td>During integr. sequence repetition factor</td>
</tr>
<tr>
<td>exposure:config</td>
<td>readSeq</td>
<td>dbBYTES128</td>
<td>Name of the readout sequence</td>
</tr>
<tr>
<td>exposure:config</td>
<td>readClock</td>
<td>dbBYTES128</td>
<td>Name of the readout clock pattern</td>
</tr>
<tr>
<td>exposure:config</td>
<td>readVolt</td>
<td>dbBYTES128</td>
<td>Name of the readout voltage set</td>
</tr>
<tr>
<td>exposure:config</td>
<td>readRep</td>
<td>dbINT32</td>
<td>Readout sequence repetition factor</td>
</tr>
</tbody>
</table>
Table 4 - Online database attributes for detector system monitoring

<table>
<thead>
<tr>
<th>Point</th>
<th>Attribute</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>exposure:config</td>
<td>expType</td>
<td>dbBYTES32</td>
<td>Exposure type (Normal/Bias/Dark/etc)</td>
</tr>
<tr>
<td>exposure:config</td>
<td>expRepeat</td>
<td>dbINT32</td>
<td>Number of exposure repetitions</td>
</tr>
<tr>
<td>exposure:config</td>
<td>expTime</td>
<td>dbDOUBLE</td>
<td>Exposure time</td>
</tr>
<tr>
<td>exposure:config</td>
<td>pWipeEnabled</td>
<td>dbLOGICAL</td>
<td>Periodic wipe enabled or not</td>
</tr>
<tr>
<td>exposure:config</td>
<td>pWipePeriod</td>
<td>dbINT32</td>
<td>Wipe period</td>
</tr>
<tr>
<td>exposure:config</td>
<td>fileName</td>
<td>dbBYTES128</td>
<td>Name of FITS file with image</td>
</tr>
<tr>
<td>exposure:control</td>
<td>state</td>
<td>dbINT32</td>
<td>Current state of exposure</td>
</tr>
<tr>
<td>exposure:control</td>
<td>stateDescr</td>
<td>dbBYTES32</td>
<td>Description of current state of exposure</td>
</tr>
<tr>
<td>exposure:control</td>
<td>shutter</td>
<td>dbINT32</td>
<td>Shutter status</td>
</tr>
<tr>
<td>exposure:control</td>
<td>shutterDescr</td>
<td>dbBYTES32</td>
<td>Description of shutter status</td>
</tr>
<tr>
<td>exposure:control</td>
<td>remTime</td>
<td>dbDOUBLE</td>
<td>Remaining time to complete exposure</td>
</tr>
<tr>
<td>exposure:control</td>
<td>readTime</td>
<td>dbDOUBLE</td>
<td>Time to read image data from detector</td>
</tr>
<tr>
<td>exposure:control</td>
<td>tranPercent</td>
<td>dbINT32</td>
<td>Percentage of image transferred to WS</td>
</tr>
<tr>
<td>telemetry:config</td>
<td>enabled</td>
<td>dbLOGICAL</td>
<td>Telemetry enabled or not</td>
</tr>
<tr>
<td>telemetry:control</td>
<td>state</td>
<td>dbINT32</td>
<td>Current state of telemetry monitoring</td>
</tr>
<tr>
<td>telemetry:control</td>
<td>current</td>
<td>vector of dbDOUBLE</td>
<td>Current telemetry values</td>
</tr>
</tbody>
</table>

NOTE: the interface with BOSS is still under verification, therefore the attributes above could be modified (and the definitions in ngcoDbPublic.h will be updated).

6.2. Interface between NGCOSW and TCS

Table 5 - Online database attributes for TCS

<table>
<thead>
<tr>
<th>Point</th>
<th>Attribute</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>wcs</td>
<td>ra</td>
<td>dbDOUBLE</td>
<td>Centre right ascension in degrees for World Coordinates display</td>
</tr>
<tr>
<td>wcs</td>
<td>dec</td>
<td>dbDOUBLE</td>
<td>Centre declination in degrees for World Coordinates display</td>
</tr>
</tbody>
</table>
6.3. Image post-processing interface

The way image post-processing can be implemented is described in 9.6.

The name of the new Image Transfer Client process to be used for image post-processing can be defined in the `<xx>dcfgCAMERA.cfg configuration set (DET.CON.ITCPROC keyword).

6.4. ngcoDbPublic.h

For all the above attributes, a macro is defined in the ngcoDbPublic.h.

When accessing NGCOSW database attributes with direct CCS db calls, applications are requested to use the macros defined in ngcoDbPublic.h: in this way, any change in name or location of the attribute only requires a new compilation.

6.5. Changes with respect to FIERA

NGCOSW keeps the same public online database attributes of the FIERASW.
7. Setup Command

All the parameters which are relevant for an exposure are set via a **SETUP** command, which must therefore be issued before starting an exposure (unless the new exposure is a perfect copy of the previous one, i.e., no parameter needs to be modified) or while an exposure is paused.

Here is a selection of the most important setup keywords (to be completed), where (*) means that their usage is not yet implemented:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.MODE.CURID</td>
<td>Integer</td>
<td>Index of mode used for an exposure (wipe, integrate, readout)</td>
</tr>
</tbody>
</table>
| DET.EXP.TYPE     | String  | Exposure type:  
|                  |         | *Normal*: one integration, shutter (if any) open  
|                  |         | *Dark*: one integration, shutter (if any) closed  
|                  |         | *Bias*: one integration, 0 integration time, shutter (if any) closed  
|                  |         | *Flat*: one integration, shutter (if any) open  
|                  |         | *Led*: one integration, shutter (if any) closed, LED light source on  
|                  |         | *LedShut*: one integration, shutter (if any) open, LED light source on  
|                  |         | *Multiple*: DET.WIN<i>.NDIT sub-integrations, shutter (if any) open for each integration  
|                  |         | *Burst*: Multiple frames are read out, shutter (if any) always open  
| DET.WIN<i>.UIT1  | Double  | Integration time (in seconds)                  |
| DET.WIN<i>.BIXX | Integer | Binning factor along X                         |
| DET.WIN<i>.BIXY | Integer | Binning factor along Y                         |

Table 6 - Basic Setup keywords for single exposure
<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.EXP.NREP</td>
<td>Integer</td>
<td>Number of repeated exposures. &quot;0&quot; means &quot;forever&quot;</td>
</tr>
<tr>
<td>DET.EXP.TIMEREP</td>
<td>Double</td>
<td>Time between two repeated exposures</td>
</tr>
<tr>
<td>DET.EXP.WIPETIM</td>
<td>Integer</td>
<td>Wipe or not before starting exposure in a loop</td>
</tr>
</tbody>
</table>

Table 7 - Additional Setup keywords for loops of exposures

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.WIN&lt;i&gt;.NDIT</td>
<td>Integer</td>
<td>Number of sub-integrations</td>
</tr>
<tr>
<td>DET.WIN&lt;i&gt;.UIT&lt;j&gt;</td>
<td>Double</td>
<td>Subintegration time (in seconds)</td>
</tr>
<tr>
<td>DET.READ.SHIFT&lt;i&gt;</td>
<td>Integer</td>
<td>Lines shifted between integrations</td>
</tr>
<tr>
<td>DET.READ.SHIFTYP</td>
<td>String</td>
<td>Line shift type: 'alternate': +SHIFT1,-SHIFT1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>'idem' as SHIFT1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>'list' as defined in list SHIFTi</td>
</tr>
</tbody>
</table>

Table 8 - Setup keywords for multistep exposures

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.WIN&lt;i&gt;.STRX</td>
<td>Integer</td>
<td>First (lower left) window pixel in X direction</td>
</tr>
<tr>
<td>DET.WIN&lt;i&gt;.STRY</td>
<td>Integer</td>
<td>First (lower left) window pixel in Y direction</td>
</tr>
<tr>
<td>DET.WIN&lt;i&gt;.NX</td>
<td>Integer</td>
<td>Number of pixels along X</td>
</tr>
<tr>
<td>DET.WIN&lt;i&gt;.NY</td>
<td>Integer</td>
<td>Number of pixels along Y</td>
</tr>
</tbody>
</table>

Table 9 - Setup keywords for windowing (not yet implemented)

**NOTE**: in the actual version of NGCOWS, windowing is not implemented.
<table>
<thead>
<tr>
<th>Keyword</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET.DISPLAY (*)</td>
<td>Integer</td>
<td>Real Time image display</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1 no display</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 full frame display 16 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 rapid frame display 16 bits</td>
</tr>
<tr>
<td>DET.CHIP&lt;i&gt;.CRPIX&lt;i&gt; (*)</td>
<td>Integer</td>
<td>Reference pixel in &lt;i&gt; direction.</td>
</tr>
<tr>
<td>DET.FRAMESAMPLE (*)</td>
<td>Integer</td>
<td>Image sampling on workstation.</td>
</tr>
<tr>
<td>DET.READ.NFRAM (*)</td>
<td>Integer</td>
<td>Defines how many sequential image data shall be stored inside a single FITS file. Default is &quot;1&quot;</td>
</tr>
<tr>
<td>DET.FRAMESMTD (*)</td>
<td>Integer</td>
<td>Data storage method. Possible values:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = 'none' (image is not saved on disk)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = 'compressed'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = 'uncompressed'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = 'both'</td>
</tr>
<tr>
<td>DET.FRAMEFILENAME</td>
<td>String</td>
<td>Define the base filename for the data files produced during the exposure</td>
</tr>
</tbody>
</table>

Table 10 - Setup keywords for image display

Arguments of the SETUP command can be file containing sets of keywords (-file option) or keywords (-function option). For example:

```
msgSend $RTAPENV ngcocon_<label> SETUP \
"-file mysetup.det"
msgSend $RTAPENV ngcocon_<label> SETUP \
"-function DET1.WIN1.UIT1 2.5"
```

7.1. Changes with respect to FIERA

The setup keyword DET.MODE.CURID replaces DET.READ.CLKIND.

The setup keyword DET.FRAMEFILENAME replaces DET.FRAME.FITSUNC.

The setup keyword DET.FRAMESMTD is obsolete and not accepted any more.
8. Status Command

The `STATUS` command issued to the coordination control process `ngcocon_<label>` returns the status of all the processes.

For debugging, the `STATUS` command can also be sent to the NGC general Purpose Control Server `ngcdscEvh_<label>` (see section 3.1.2), using the parameters described in [RD77].

8.1. Changes with respect to FIERA

The `STATUS` command was not implemented in the FIERASW.
9. Exposure Handling

9.1. Description

9.1.1. Exposure types

NGCOSW distinguishes among the different types of exposure defined in the Glossary (see [AD63] for a more detailed description):

- **Normal exposure** (single integration, shutter opened and closed)
- **Dark exposure** (single integration, shutter kept closed)
- **Bias exposure** (0 integration time Dark)
- **Flat Field exposure** (normal exposure, chip exposed to a uniform flux of radiation)
- **LedAndShutter exposure** (normal exposure, chip exposed to the radiation generated by a LED, which is located between the chip and the shutter).
  
  **NOTE:** this kind of exposure will be supported or not depending on the capability of the hardware that will be finally chosen.
- **Led exposure** (dark exposure, chip exposed to the radiation generated by a LED, which is located between the chip and the shutter)
  
  **NOTE:** this kind of exposure will be supported or not depending on the capability of the hardware that will be finally chosen.
- **Multiple or Multi-step exposure** (single exposure consisting of more integrations, with same or different duration. After each integration, the exposure is paused. During pauses, rows may be shifted on chip)
- **Burst or Drift Scanning exposure** (during the integration the charges on the CCD are continuously shifted along the parallel registers and read out)

The exposure type is defined by setting the \texttt{DET.EXP.TYPE} setup keyword (see section 7).

Accepted values for the \texttt{DET.EXP.TYPE} setup keyword are listed in macros which are defined in ngco.h.

9.1.2. Exposure status

When the detector system is **ONLINE**, an exposure can be prepared with a SETUP command (see section 7) and executed with a START command.

Schematically, starting an exposure means to:

- wipe a chip (depending on setup) : the exposure status will be **wiping**
- wait for the time to open the shutter (depending on START “-at” parameter, usually is “now”) : the exposure status will be **pending**
- open a shutter (depending on setup) : the exposure status will be **integrating**
- collect the radiation on the chip
• close a shutter (depending on setup)
• read the chip : the exposure status will be reading
• transfer the data to the IWS: the exposure status will be transferring

When the image data have been stored on disk, the exposure status goes to completed. If an error occurred during the exposure, the status goes to failed. If the exposure was aborted, the status goes to aborted.

Generally the field of view can already be changed (e.g. telescope can be moved) when the exposure status changes to transferring (all data for this exposure have been read-out).

By default, with NGCOSW it is possible to start an exposure only when one of the completion states (success, failure, aborted) have been reached (i.e., after the image data produced by the previous exposure have been saved on disk).

If the time between end of detector readout and availability of the FITS file on disk becomes a significant overhead, NGCOSW can be instructed to start an exposure right after the end of the transmission of the image date of the previous exposure to the IWS, by using the setup keyword TBD.

The current exposure status value is stored in the database attribute

<alias>${CCDNAME}:exposure:control.state

The value of the current exposure status can be:

INACTIVE
PENDING
WIPIING
INTEGRATING
PAUSED (i.e., shutter temporary closed)
READING
PROCESSING (i.e., processing image data, if requested by SETUP)
TRANSFERRING (i.e., transferring image data to IWS)
COMPLETED (i.e., completed successfully)
FAILED (i.e., completed with error)
ABORTED (i.e., completed without data readout, on request)

Macros for the exposure status values and descriptions are defined in ngco.h.

9.1.3. Image data

Image data are provided by NGCOSW in two ways:

• Raw-data for Real-time display (see section 13)
• FITS files (see section 9.3)

Whenever a new data file is created, the full path name is written into the database attribute

<alias>${CCDNAME}:exposure:config.fileName

9.1.4. Exposure Id

In order to be able to uniquely identify an exposure, an identification number (exposure Id)
is associated to each exposure. The exposure Id should be passed to the NGCOSW as a parameter of the command START (as defined in [AD28]). If the command START has no exposure Id parameter, the exposure Id is defined by NGCOSW.

The exposure Id is returned as a reply parameter to the command START.

### 9.1.5. Changes with respect to FIERA

NGCOSW implements the same exposure and status types of the FIERASW.

NGCOSW defines the same exposure status numerical values of the FIERASW, a part from the one labelling the WIPPING status (see ngco.h).

NOT YET IMPLEMENTED: Has a new feature, it will be possible to start a new exposure when the data of the previous one have been transmitted to the IWS, but not stored on disk yet (although this will NOT be the default behavior).

### 9.2. Commands

Exposures are prepared using the `SETUP` command and started using the `START` command.

A timed exposure start can be done using the `-at` option:

```
START -at <YYYY-MM-DD>T<hh:mm:ss>
```

The value of the `-at` parameter defines an absolute time (UTC) for the opening of the shutter (an absolute time for a dark exposure has no sense). Until the actual start time is reached, the exposure status is set to “pending”, which will limit the set of accepted commands during that time.

An exposure can be paused using the command `PAUSE` (note that the time the exposure is PAUSE'd will be added to the dark's time, see [RD63]). The shutter is closed and the counting of the remaining exposure time suspended. The exposure is then restarted by the command `CONTINUE`.

The exposure can be aborted using the command `ABORT`. In this case no data file is generated unless a frame was already received at the time when the command was issued.

The command `END` makes the acquisition process terminate the exposure as soon as possible and generate a data file.

The command `WAIT` can be used to wait for an exposure to complete. A reply message with the current exposure status is sent immediately. When the exposure status is (or becomes) “completed” (i.e. “success”, “failure” or “aborted”), NGCOSW sends the last reply, which again contains the actual exposure status. A running exposure always has to be waited for completion before starting the next one or before issuing a new setup.

Typical command sequences are:

a) `START - WAIT`
b) `START - PAUSE - CONTINUE - WAIT`
c) `START - END - WAIT`
d) **START - ABORT - WAIT**

Alternatively, the exposure status attribute in the database (see section 6.1) may be used to wait for a specific state (e.g. transferring).

### 9.2.1. Changes with respect to FIERA

NGCOSW implements the same exposure commands of the FIERASW.

### 9.3. File Formats

If data storage is enabled, images are saved in the `$INS_ROOT/$INS_USER/DETDATA` directory as FITS files compliant with [RD37], i.e., using the “image extension per chip” format. In this format, data are ordered by chip: each CCD corresponds to an extension. A primary header sits on the top of the file.

**NOT YET IMPLEMENTED:** To enable "data cubes" (i.e., saving n successive frames into a single FITS file) the setup parameter `DET.READ.NFRAM` must be set to a value different from TBD (see section 7).

Currently the formats supported for pixels values are 16-bits and 32-bits.

Independently from the readout mode used, the complete physical image is stored in one single FITS file per camera head (provision for one single FITS file per instrument is under development). Multiple windows are also stored in different IMAGE extensions of a single FITS file. Different frames in data-cube files are also stored in different IMAGE extensions of a single FITS file (see [RD37]).

#### 9.3.1. Changes with respect to FIERA

NGCOSW implements the same file format of the FIERASW.

### 9.4. Naming Schemes

FITS file names are defined by the setup keyword `DET.FRAME.FILENAME` (see section 7). In case the number of FITS file to be produced is more than one (`DET.EXP.NREP` setup parameter: see section 7), NGCOSW assumes that all files will have the same name, followed by a sequential integer index, starting from 0.

**Example:** if `DET.EXP.NREP` is set to 3 and `DET.FRAME.FILENAME` is set to `myImage.fits`, NGCOSW will look for files `myImage.fits` (first exposure), `myImage.1.fits` (second exposure) and `myImage.2.fits` (third exposure).

#### 9.4.1. Changes with respect to FIERA

NGCOSW implements the same naming scheme of the FIERASW.

### 9.5. FITS-Header Contents

Basic and mandatory primary FITS keywords are included from the dictionary (`dicFITS CMM module`) `ESO-VLT-DIC.PRIMARY-FITS`. 
NGC specific FITS keywords are defined within the `ESO-VLT-DIC.NGCDCS` dictionary (*dicNGC* CMM module).

Apart from the image raw data, NGCOSW is also responsible for providing keywords for the FITS header. Depending on their type, keywords are treated in two different ways.

- **Standard keywords.** Some basic keywords, needed by any image analysis system to read the FITS file, are written at the beginning of the file.

- **Hierarchical keywords.** They are not strictly needed to interpret the pixel values and normally do not appear at the beginning of the FITS header.

**NOTE:** at the moment, NGCOSW writes all the information directly in the FITS file, removing the usage of an intermediate `.det` file to be merged with the FITS file by OS, as was done by FIERA. This implementation is still under discussion.

### 9.5.1. Changes with respect to FIERA

NGCOSW implements the same FITS structure of the FIERASW.

If actual scheme is accepted, no more separate `.det` files are created: NGCOSW writes all the information directly in the FITS file.

### 9.6. Image post-processing

The possibility of performing customized post processing is implemented by means of a virtual `PostProcessing` method added to the `DATA_IN` action class of the Image Transfer Client process (module ngcoitc).

The application that needs to implement some specific post processing must define a class that inherits from `ngcoitcACTION_DATA_IN` and that overrides the `PostProcessing` method. The new class must then substitute the default action manager for the `DATA_IN` event.

Among procedures that can be implemented in this way are e.g. centroiding and bias subtraction.

Figure 3 and Figure 4 describe the class and the sequence diagrams of the mechanism.

### 9.6.1. Creating a module which implements post-processing

Instructions and a template are provided in the `xxxoitc` module which is installed in the `$VLTTOP/templates/forNGC` directory.

To create a module (for instance `newoitc`) which implements post-processing, go into the appropriate directory and run

```
ngcoDcsTemplate.sh -template xxxoitc -module newoitc
```

In the local directory a `newoitc` module is then created.
By running:

```
        cd newoitc/src ; make man
```

the documentation concerning the implementation of post-processing is the installed in the newoitc/doc directory (in MagicDrawXML and html format)

Shortly:

- In the newoitc ACTION_MYDATA_IN.C file, implement your PostProcessing method;
- In the newoitcControl.C file, check which actions should be overridden and which should not be overridden (e.g., do you need or not to override the SETUP command?);
- In the Makefile file, remove from newoitcControl_OBJECTS the actions that you do NOT want to override (e.g, SETUP).

9.6.2. How to run the process which implements post-processing

Assuming newoitc to be the name of the module containing the post-processing implementation, in order to use the new newoitc process, two possibilities are offered:

1) define the DET.CON.ITCPROC setup keyword in the <xx>dcfgCAMERA.cfg configuration set:

   DET.CON.ITCPROC     “newoitc”

2) launch the startup script with the -itc <newoitc> option:

   ngcoDcsStart -itc <newoitc>
Figure 3 – Post Processing: Image Transfer Client class
Figure 4 – Post Processing: Image Transfer Client sequence diagram
10. Synchronisation

Synchronization points can be inserted at any place in any clock pattern executed by the sequencer program (i.e. set the “wait-for-trigger” bit in the particular state). When reaching such a point, the pattern execution is suspended until the arrival of an external trigger signal (see [RD9] and [RD8] for signal timing and accuracy). Via this external trigger input it is possible to synchronize exposures on multiple NGCOSW instances. The external trigger signal is also used to synchronize detector read-outs with external devices. Using the VLT-TIM for generating the trigger pulse(s), synchronization at absolute times is possible. Some signal lines are available to in turn trigger external devices (e.g. tell another device, that a read-out has finished).

If several sequencers are installed in the same system (i.e. the same instance of NGCOSW), then the exposure start can be synchronized by using the global run-signal, which is raised by one sequencer instance and is propagated to all other sequencer instances having the external run-control enabled (“DET.SEQi.RUNCTRL = T” in the detector configuration file, see [RD77]).

If no high accuracy is needed, the synchronization can be also done at command interface level (e.g. issue an exposure start command at the proper time or use the command “START -at <start-time>”).
11. Error Definitions

The CCS error mechanism [RD32] provides a classification scheme for application specific errors.

The meaning of the error class and the possibly needed interactions are described in a help file (.hlp), which can be displayed with the standard CCS-tools (also with the logMonitor).

The detailed error reason (e.g., command which failed, wrong parameter issued and boundary values, etc) is given in an associated error message string.

NGCOSW uses the errors defined by ngcb (see [RD77]).

In addition, NGCOSW modules define their own errors. The errors which are common to all the modules are listed in the following table:

<table>
<thead>
<tr>
<th>Error</th>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ngco&lt;mod&gt;ERR_FATAL</td>
<td>fatal</td>
<td>Fatal internal error: %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_CREATE</td>
<td>serious</td>
<td>Failure creating: %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_INIT</td>
<td>serious</td>
<td>Failure initializing: %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_FUNCTION</td>
<td>serious</td>
<td>Failure invoking function: %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_NULL_POINTER</td>
<td>warning</td>
<td>Pointer to %.40s is NULL</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_ZERO</td>
<td>warning</td>
<td>Division by zero while %.20s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_NOTFOUND</td>
<td>warning</td>
<td>Object %.20s (ID: %d) not found</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_DB_READ</td>
<td>serious</td>
<td>Failed to read from DB %.35s %.35s%.35s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_DB_WRITE</td>
<td>serious</td>
<td>Failed to write to DB %.35s %.35s%.35s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_SEND_COMMAND</td>
<td>serious</td>
<td>Failed to send command %.20s to %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_SEND_REPLY</td>
<td>serious</td>
<td>Failed to send %.20s reply for command %.20s to %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_REPLY</td>
<td>serious</td>
<td>Error reply to command %.20s received from %.40s</td>
</tr>
<tr>
<td>Error</td>
<td>Severity</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_TIMEOUT</td>
<td>serious</td>
<td>Command %.20s sent to %.40s timed out</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_PARAMETER</td>
<td>warning</td>
<td>Parameter %.20s has invalid value</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_ABORTED</td>
<td>warning</td>
<td>Command %.20s aborted</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_STATE</td>
<td>serious</td>
<td>Command %.20s not allowed in state %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_ACTION</td>
<td>serious</td>
<td>Action %.20s (%.15s) failed in state %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERR_EVENT</td>
<td>serious</td>
<td>Event %.20s not handled in state %.40s</td>
</tr>
<tr>
<td>ngco&lt;mod&gt;ERRASSERT</td>
<td>serious</td>
<td>Assertion Failed %.20s %.40s %d.</td>
</tr>
</tbody>
</table>

Table 11 - Errors common to all NGCOSW modules

The errors which are specific to certain modules of the NGCOSW are listed in the following tables:

<table>
<thead>
<tr>
<th>Error</th>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ngcoitcERR_NOT_DEFINED</td>
<td>serious</td>
<td>Variable %.20s not defined</td>
</tr>
<tr>
<td>ngcoitcERR_RTD</td>
<td>serious</td>
<td>Error communicating to RTD %.40s</td>
</tr>
</tbody>
</table>

Table 12 - Errors specific to the ngcoit module

**NOTE**: it is under investigation the usage of an error definition file common to all the modules.
12. Error and Logging Handling

Error and system logging is performed using the standard CCS error and logging systems (see [RD32]).

NOT YET IMPLEMENTED: Additionally the verbose output can be logged in a detail depending on the given log-level (see setup keyword DET.CON.LOG in section 3.2.1 and command VERBOSE in section 4) for maintenance and debugging purposes.

Operational logs are TBD.
13. Real-Time Display Interface

NGCOSW provides raw data for the VLTSW real-time display utility rtd. The mechanism to deliver raw data is the same as defined in [RD40].

Raw-data are written in shared memory as they come out from the Detector Electronics, namely with full resolution (16 or 32-bits unsigned integer). No reduction (e.g. to 8-bits) is done by NGCOSW.

In addition to the display of the raw-data, NGCOSW supports also the display of World Coordinates through rtd. One point in the NGC branch of the online database is dedicated to this feature (see section 6.2).

13.1. Changes with respect to FIERA

NGCOSW provides the same interface to rtd of the FIERASW.
14. Graphical User Interface

14.1. Control Panel

A graphical user interface is provided to operate NGCOSW in standalone mode.

One single panel, shown in Figure 5, provides all functionality needed to startup/shutdown the NGC software, define an exposure setup, start and control an exposure, display an image as result of an exposure.

The same panel is used, independently if and which parts of the CCD system used are simulated.

To startup the optical NGC Control Panel run

```
ngcouiPanel &
```
14.2. Engineering Interface

A GUI panel is provided to help engineers in case of trouble (see Figure 6). It is evoked from the Control Panel and enables the most common operations needed for engineering.

The panel gives freedom to do actions at a low level and must be used with care!
It is assumed that the user knows the NGC sw and the VLT sw environment and is fully aware of the actions associated to each button and possible consequences.

Figure 6 - NGC Engineer Panel
15. Special functionalities for Optical Instruments

15.1. Shutter Control

Shutter configuration for each system is stored within the instrument specific configuration module `<xx>dcfg`, which is under CMM-control.

At the moment, shutter control is performed via the Pulpo Server (although this should change in a near future). The device used to physically connect to the shutter is defined in the file

```
$INS_ROOT/$SYSTEM/COMMON/CONFIGFILES/$CCDNAME/pulpo.cfg
```

which must correctly set.

Here is a self-explanatory example of a pulpo.cfg file for a system with 2 shutters connected via ttyc and ttyd:

```
# "@(#) $Id: pulpo.cfg,v 1.44 2004/05/10 22:47:31 vltsccm Exp "$'
#
#
# Pulpo configuration
#
# format is: Pulpo_Unit_Number  Full_Device_Path
1 /dev/ttyc
2 /dev/ttyd
```

15.2. Temperature/pressure Monitoring

At the moment, the way the temperature/pressure monitoring will be handled by NGC is under evaluation.

15.2.1. Changes with respect to FIERA

If NGCOSW will provide facilities to monitor temperature and pressure values from the detector, no changes are foreseen with respect to the monitoring interface provided by the FIERASW.

15.3. Adaptive Optics

TBD
16. Manpages

16.1.1. ngcoDcsOldb

NAME
ngcoDcsOldb.sh - Install and generate the online database environment.

SYNOPSIS
ngcoDcsOldb -host <IWS | LLCU> -renv <renv> [<renv2> [<renv3> <...>]]
[-instance <ccdname>] [-env <env>] [-user <user>]

DESCRIPTION
On both the Instrument Workstation (IWS) and the NGC Linux LCU (LLCU) this shell script preliminary performs a system check (definition of environment variables, definition of local and remote environments on the local machine and in the ACC server, scanning, user running the software, etc.).

On an IWS this shell script then installs in the directory
$VLTDATA/ENVIRONMENTS/$RTAPENV/dbl/
the template files (DATABASE.db.NGCOSW and USER.db.NGCOSW) which can be used to generate the online database for an optical NGC system.

On a LLCU this shell script generates and starts the online database environment.

-host <IWS|LLCU> Defines if the database must be generated on an IWS or on a NGC LLCU

-renv <renv> name of remote online database environment
(on the IWS this is $CCDLENV, on the NGC LLCU this is the $RTAPENV of the IWS).
ONLY IN THE "IWS" CASE, more <renv> can be given, to check if they are all known by the ACC server.

-instance <ccdname> detector name (default $CCDNAME)

-env <env> name of local online database environment
(default $RTAPENV).

-user <user> name of the user running NGCOSW

FILES
Source files:
$VLTTOP/ENVIRONMENTS/ngco/DATABASE.db
$VLTTOP/ENVIRONMENTS/ngco/USER.db

Generated files on IWS:
$VLTDATA/ENVIRONMENTS/$RTAPENV/dbl/DATABASE.db.NGCOSW
$VLTDATA/ENVIRONMENTS/$RTAPENV/dbl/USER.db.NGCOSW

Generated files on LLCU:
$VLTDATA/ENVIRONMENTS/$RTAPENV/dbl/DATABASE.db
$VLTDATA/ENVIRONMENTS/$RTAPENV/dbl/USER.db

ENVIRONMENT
CCDNAME CCD camera name
RTAPENV Online database environment name
RETURN VALUES

0 if SUCCESS
1 if FAILURE

EXAMPLES

> ngcoDcsOldb -host LLCU -renv wte98
> ngcoDcsOldb -host IWS -renv wodt8
> ngcoDcsOldb -host IWS -renv wodt6 wodt8 -ccdname mycam -user myuser
16.1.2. ngcoDcsInstall

NAME
ngcoDcsInstall.sh - Install NGCOSW files in INS_ROOT

SYNOPSIS
ngcoDcsInstall -config <detector_module> [-root <ins_root>] [-usr <ins_usr>]
[-instance <ccdname>] [-env <rtapenv>] [-lenv <ccdlenv>]
[-opmode <NORMAL | HW-SIM>]

DESCRIPTION
This shell script installs all files needed to run an optical NGC system (configuration files, CCD voltages, clock patterns and sequences) in the instrument directory <ins_root>/SYSTEM/COMMON/CONFIGFILES/
- config <detector_module>   Name of the detector module containing
the detector configuration.
(xxopt is the optical detector template)
- root <ins_root>            Root directory for the instrument the
NGCOSW belongs to
  Default: $INS_ROOT (env. variable)
-usr <ins_user>             User directory for the instrument the
NGCOSW belongs to
  Default: $INS_USER (env. variable)
-instance <ccdname>         detector name.
  Default: $CCDNAME (env. variable)
-env <rtapenv>              Local online database environment
to be used
  Default: $RTAPENV (env. variable)
-lenv <ccdlenv>             Remote online database environment
to be used
  Default: $CCDLENV (env. variable)
-opmode <opmode>            NGCOSW operational mode
  Default: "NORMAL"

FILES
Source files:
$VLTTOP/config/??dcfgCONFIG.cfg  ctoo configuration file for
the optical NGC detector.
$VLTTOP/config/??dcfgDCS.cfg     DCS configuration file for
the optical NGC detector.
$VLTTOP/config/??dcfgCAMERA.cfg  system configuration file for
the optical NGC detector.
$VLTTOP/config/??dcfgCAMERA_TARGET.cfg  target configuration file for
the optical NGC detector.
$VLTTOP/config/??dcfg/*          Files defining the detector
voltages, clock patterns
and sequences.

Optical detector template files:
$VLTTOP/templates/forNGC/xxopt/xxoptCONFIG.cfg
ctoo configuration file for
the optical NGC detector.
$VLTTOP/templates/forNGC/xxopt/xxoptDCS.cfg
DCS configuration file for the optical NGC detector.
$VLTTOP/templates/forNGC/xxopt/xxoptCAMERA.cfg
system configuration file for the optical NGC detector.
$VLTTOP/templates/forNGC/xxopt/xxoptCAMERA_TARGET.cfg
target configuration file for the optical NGC detector.
$VLTTOP/templates/forNGC/xxopt/xxopt/*
Files defining the detector voltages, clock patterns and sequences.

Destination files:
<ins_root>/SYSTEM/COMMON/CONFIGFILES/${CCDNAME}CONFIG.cfg
<ins_root>/SYSTEM/COMMON/CONFIGFILES/${CCDNAME}DCS.cfg
<ins_root>/SYSTEM/COMMON/CONFIGFILES/${CCDNAME}CAMERA.cfg
<ins_root>/SYSTEM/COMMON/CONFIGFILES/${CCDNAME}CAMERA_TARGET.cfg
<ins_root>/SYSTEM/COMMON/CONFIGFILES/${CCDNAME}/*

ENVIRONMENT
CCDNAME                     CCD camera name
INS_ROOT                     default instrument root directory
INS_USER                     default to SYSTEM

RETURN VALUES
0 if SUCCESS
1 if FAILED

EXAMPLES
> ngcoDcsInstall -config opdcfg
Install all what needed for scientific CCD whose configuration files are stored in the "opdcfg" module
16.1.3. ngcoDcsStart

NAME
ngcoDcsStart - startup of optical NGC DCS

SYNOPSIS
ngcoDcsStart [-instance <ccdname>] [-env <env>] [-lenv <lenv>]
[-opmode <opmode>] [-gui <guiname>] [-xterm <T|F>]
[-autonlin <T|F>] [-verbose <level>] [-itc <itcproc>]
[-kill]

DESCRIPTION
This shell script performs a startup of NGC optical DCS.

-instance <ccdname> detector name (default $CCDNAME)

-env <env> name of workstation online database environment
(default $RTAPENV).

-lenv <lenv> name of remote online database environment
(default $CCDLENV)
If lenv=0, only the NGC LCU processes are started.

-opmode <opmode> NGCOSW operational mode (default "NORMAL")
Valid values are:
NORMAL - Normal Operational Mode (Default)
NGC HW is used, NGC SW runs on Instrument Workstation (IWS) and NGC-LCU
HW-SIM - HW is simulated

-gui [<guiname>] Launch the specified grafical user interface.
If <guiname>=NONE, no gui is started.
If no <guiname> is given, the default ngcouiPanel is used.
At the moment, only the default program ngcouiPanel is used, independently from the process name which is specified.

-xterm <T|F> When set to T, all processes are started
in new xterminals.
Default is "F".

-autonlin <T|F> When set to T, the detector system automatically
goes to ONLINE at startup.
Default is "F".

-verbose <level> Verbose level. Prints out system messages to the
standard output. The level gives the detail of the
messages. Default value is 0 (= no verbose output).

-itc <itcproc> Name of the image transfer client process to be
launched in alternative to NGC Image Transfer Client.
Default is "" (ngcoitc is used).

-kill kill all already running processes before starting
ENVIRONMENT
CCDNAME default for camera name (e.g. myccd)
RTAPENV default for WS local environment (e.g. myws)
CCLDENV default for LCU environment (e.g. myngc)
INS_ROOT default root directory for instrument data

RETURN VALUES
0 if SUCCESS
1 if FAILURE

CAUTIONS
.rhosts file on LCU system must contain user and hostname
where this script runs, since it performs remote shell commands

EXAMPLES
> ngcDcsStart -instance myccd -env myws -lenv myngc
Start the NGCOSW for camera "myccd",
WS environment "myws", LCU environment "myngc".

> ngcDcsStart -instance myccd -env myws -lenv 0
Start only the NGCOSW LCU processes
for camera "myccd", WS environment "myws".

> ngcDcsStart -instance myccd -env myws -lenv myngc -kill -gui
Kill and restart the NGCOSW for camera "myccd",
WS environment "myws", LCU environment "myngc".
Gui is also started

SEE ALSO
ngcoDcsStop, ngcoGetProcNum
16.1.4. ngcoDcsStop

NAME

gngcoDcsStop - shut-down optical NGC DCS

SYNOPSIS

ngcoDcsStop [-instance <ccdname>] [-env <env>] [-lenv <lenv>] [-kill]

DESCRIPTION

This shell script performs a shut-down of NGC optical DCS.
It does the following steps:
1 - Verify if the main process is running.
2 - Try to terminate NGC optical processes in a 'soft' way
   (command EXIT)
3 - Try to terminate NGC optical processes in a 'hard' way
   (kill) - optional

-instance <ccdname> detector name (default $CCDNAME)
-env <env> name of workstation online database environment
   (default $RTAPENV).
   If value is "FALSE", no action on WS part
   of NGCOSW is taken
-lenv <lenv> name of remote online database environment
   (default $CCDLENV)
   If value is "FALSE", no action on LCU part
   of NGCOSW is taken
-kill kill all processes
-killpulpo kill also pulpo server

ENVIRONMENT

CCDNAME default for camera name (e.g. myccd)
RTAPENV default for WS local environment (e.g. myws)
CCDLENV default for LCU environment (e.g. myngc)

RETURN VALUES

0 if SUCCESS
1 if FAILURE

CAUTIONS

a) .rhosts file on LCU system must contain user and hostname
   where this script runs, since it performs remote shell commands
b) The "-kill" options should be used with care. By killing
   processes 'blindly', the system could remain in a dangerous
   state. To be used only to recover when the system gets stuck.

EXAMPLES

> ngcDcsStop -instance myccd -env myws -lenv myngc
   Terminate in a 'soft' way the NGCOSW both at WS and LCU level
   for camera "myccd", WS environment "myws",
   LCU environment "myngc"

> ngcDcsStop -instance myccd -env myws -lenv myngc -kill
   Terminate in a 'hard' way the NGCOSW both at WS and LCU level
   for camera "myccd", WS environment "myws",
   LCU environment "myngc"

> ngcDcsStop -instance myccd -env myws -lenv FALSE -kill
   Terminate in a 'hard' way the NGCOSW at WS level only
for camera "myccd", WS environment "myws"

> ngcDcsStop -instance myccd -env FALSE -lenv myngc
  Terminate in a 'soft' way the NGCOSW at LCU level only
  for camera "myccd", LCU environment "myngc"

SEE ALSO
  ngcoDcsStart
16.1.5. ngcoGetProcNum

NAME
ngcoGetProcNum - get process number

SYNOPSIS
ngcoGetProcNum <envName> <procName>

DESCRIPTION
Utility to retrieve the process number for the indicated
process from the environment in which it is running.
It is used by the script ngcoDcsStart.
<envName>    environment name
<procName>   process name

RETURN VALUES
Process number if SUCCESS
0 if FAILURE

EXAMPLES
> ngcoGetProcNum $RTAPENV ngcoexp_$CCDNAME ; echo $?

SEE ALSO
ngcoDcsStart
### 16.1.6. ngcoDcsClean

**NAME**
ngcoDcsClean - Clean oldb environment and shared memory

**SYNOPSIS**
ngcoDcsClean

**DESCRIPTION**
This shell script performs a shutdown of the online database environment (defined by $RTAPENV), removing shared memory segments and zombie processes.

**ENVIRONMENT**
- RTAPENV: default for oldb environment

**RETURN VALUES**
- 0 if SUCCESS
- 1 if FAILURE

**EXAMPLES**
```
> ngcoDcsClean
```
16.1.7. ngcoDcsTemplate

NAME
ngcoDcsTemplate.sh - Install and generate template module.

SYNOPSIS
ngcoDcsTemplate -template <template> -module <module>

DESCRIPTION
Generate a new module from a template.
To be used to generate a new image transfer process implementing
image data post-processing or a super control process implementing
new actions for standard commands.

-template <template> Template to start from
It must exist in $VLTTOP/templates/forNGC

-module <module> Module to be generated from template

FILES
$VLTTOP/templates/forNGC/template

RETURN VALUES
0 if SUCCESS
1 if FAILURE

EXAMPLES
Create module to implement image data post-processing
> ngcoDcsTemplate -template xxxoitc -module newoitc
Create new super control process
> ngcoDcsTemplate -template xxxosc -module newosc
17. Example of NGCOSW usage

Assuming that we are using an XX system (xxdcfg instrument module) and that we want to pass relevant parameters using environment variables "à la FIERASW", in the following example the NGCOSW is started and some exposures are performed.

1. Start NGCOSW from the Instrument Workstation
   
   ```
   ngcoDcsStart -instance $CCDNAME -env $RTAPENV -lenv $CCDLENV \n   -kill
   ```

2. Put NGCOSW in STANDBY
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME STANDBY ""
   ```

3. Put NGCOSW ONLINE
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME ONLINE ""
   ```

4. Perform periodic wiping
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME STARTWP ""
   ```

5. Prepare the next exposure (set exposure mode, type, time and binning)
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME SETUP \n   "-function DET.MODE.CURID 1 DET1.EXP.TYPE Normal \n   DET1.WIN1.UIT1 10 DET1.WIN1.BINX 1 DET1.WIN1.BINY 1"
   ```

6. Start the exposure
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME START ""
   ```

7. Wait until the exposure has been completed
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME WAIT ""
   ```

8. Check the exposure status
   
   ```
   dbRead "<alias>${CCDNAME}:exposure:control.state"
   ```

9. Prepare the next exposure (change exposure mode, type, time and binning)
   
   ```
   msgSend $RTAPENV ngcocon_$CCDNAME SETUP \n   "-function DET1.MODE.CURID 3 DET1.EXP.TYPE Dark \n   DET1.WIN1.UIT1 20 DET1.WIN1.BINX 2 DET1.WIN1.BINY 2"
   ```

10. Prepare the next exposure (define a loop of exposures)
    
    ```
    msgSend $RTAPENV ngcocon_$CCDNAME SETUP \n    "-function DET1.EXP.NREP 10"
    ```

11. Start the loop of exposures
    
    ```
    msgSend $RTAPENV ngcocon_$CCDNAME START ""
    ```

12. Wait until the last exposure has been completed
    
    ```
    msgSend $RTAPENV ngcocon_$CCDNAME WAIT ""
    ```
13. Check the exposure status
   
   \[ \text{dbRead "}<\text{alias>}{\text{CCDNAME}}:\text{exposure:control.state}" \]

14. Prepare the next exposure (single exposure)
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME SETUP } } \]
   \[ "-\text{function DET1.EXP.NREP 1}" \]

15. Start the exposure
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME START "} \]

16. Pause the exposure
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME PAUSE "} \]

17. Modify the exposure time
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME SETUP } } \]
   \[ "-\text{function DET1.WIN1.UIT1 60}" \]

18. Continue the exposure
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME CONT "} \]

19. Wait until the exposure has been completed
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME WAIT "} \]

20. Check the exposure status
   
   \[ \text{dbRead "}<\text{alias>}{\text{CCDNAME}}:\text{exposure:control.state}" \]

21. Stop periodic wiping
   
   \[ \text{msgSend $\text{RTAPENV ngcocon}_\text{CCDNAME STOPWP "} \]

22. Exit
   
   \[ \text{ngcoDcsStop -kill} \]