EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europaïsche Organisation für astronomische Forschung in der südlichen Hemisphäre

D09610

European Southern Observatory

Data Interface Control Document

Doc. No.: GEN-SPE-ESO-19400-0794

Issue: 3

Date: 1 February 2005

This document summarises the European Southern Observatory's official Data Interface specification. These specifications are defined and maintained by the ESO Data Interface Control Board (DICB).

	Name	Date	Signature
Prepared	DICB	1 February 2005	
Approved	DICB	1 February 2005	
Released	R.Gilmozzi	1 February 2005	
Released	A.Moorwood	1 February 2005	
Released	P.Quinn	1 February 2005	
Released	K.Wirenstrand	1 February 2005	

Change Record

Issue	Date	Section/Parag. affected	Reason/Initiation/Documents/Remarks
0.0	16 March 1995	All	First draft
0.91	25 July 1995	All	Review release
0.92	13 October 1995	WCS	Added RADECSYS
1.0/7	17 August 1996	All	ESO review
1.0/8	15 November 1997	All	First release
1.1	25 November 1997	All	NOV97 release
2.0/2	25 June 2001	All	Second release
2.0/3	20 August 2001	All	minor corrections
2.0/4	21 May 2002	All	Release 2.0
3	22 November 2004	All	Release 3

Items To Be Resolved

Major issues to be resolved in future versions of this document:

- File naming convention for files delivered to the end users.
- Data Reduction Software (DRS) category of hierarchical keywords, containing pipeline-specific parameters.

Contents

List of Tables

Chapter 1

Introduction

1.1 Purpose and scope

This document summarises the ESO official data interface specification. This specification applies to all data structures produced or used by the ESO optical telescopes since 1997. A description of the term *Data Interface* is given in Chapter 2 below, together with a summary of when and how such an interface is used.

The data structures mentioned in this document reflect the concepts and objects developed for the VLT Data Flow System (DFS) as implemented in the APR2004 release of the VLT Control Software (VCS) and DFS software. The DFS is described in [1], the VCS interfaces are described in [2] and [3].

This document is issued and maintained by the ESO Data Interface Control Board (DICB). The DICB Terms of Reference are given in [4] and reprinted for convenience in appendix A.

This document is meant as a technical reference and therefore its intended main audience is engineers and/or scientists who develop software to either produce, analyse or handle data files conforming to this specification.

The detailed data interface specifications are described in *data dictionaries*. There is one dictionary for each context, i.e. instrument, telescope system, observatory, etc.

The ESO DICB issues and maintains a dictionary for primary keywords (`ESO-VLT-DIC.PRIMARY-FITS`), which contains the definitions of all non-hierarchical keywords used anywhere at ESO. A template for Instrument Control Software (ICS) dictionaries (`ESO-VLT-DIC.XXX_ICS`) is also available. All new ICS dictionaries should be based on this one.

The format of the ESO Data Dictionaries is given in Chapter 7 on page 51.

In addition to data dictionaries, the DICB also releases and maintains specifications describing the layout of FITS frames and other file structures used by the observatory.

Examples in this document have been included for explanatory purposes only. The authoritative reference for keyword specifications are the ESO Data Dictionaries.

The on-line version of this document, the Data Dictionaries and other DICB information are located on the Science Archive server at `http://archive.eso.org/DICB`. Facilities for searching and selective display of keywords are also available.

Requests for changes or additions to this document or any of the ESO Data Dictionaries must be submitted to the DICB for consideration (`dicb@eso.org`). Please refer to Appendix A for details.

This document and the DICB data dictionaries supersede the older Archive specification, *Data Interface Requirements*, Ref No. ARC-SPE-ESO-00000-1/1.4 which becomes hereby obsolete.

1.2 Glossary

Calibration Frame A frame used in the process of data reduction to remove instrument signature from observations. Also a frame taken to obtain information about the performance of hardware components, e.g. telescope, instrument or detector.

Calibration product (also called master calibration) A pipeline-processed frame made of an input set of raw calibration frames. It typically provides instrument signature (like detector read noise level, fixed-pattern noise, dispersion relation etc.).

CD-ROM/DVD-ROM Storage media in use by the computer industry to store data and programmes. The CD-ROM and DVD-ROM support directory based file systems and structure.

(ESO) Data Flow Operations (DFO) The group responsible for VLT data processing, extraction of quality information, and distribution of data to the end users.

Data Interface Set of definitions that describe the contents of data files (see Chapter 2 for a detailed discussion).

(VLT) Data Flow System The system that handles the flow of scientific and calibration data and information for the ESO VLT. It includes subsystems for proposal handling, observation handling, science archiving, data pipeline and quality control (see [5] and [1]).

Data Preview A highly compressed view of an observation, mostly obtained by reducing observation frames via a suitable pipeline procedure.

Data File This term describes all data files resulting from the execution of ESO observing programmes or files created by pipeline processing. Data files include: raw observation frames, processed (by the pipeline) observation frames, observatory calibrations.

Flexible Image Transport System (FITS) A standard data format widely used in the astronomical community. FITS is defined in [6]. A FITS file consists of one or more Header + Data Units (HDUs), where the first HDU is called 'Primary HDU' or 'Primary Array'. The primary array contains an N-dimensional array of pixels, e.g. as a 1-D spectrum, a 2-D image or a 3-D data cube. Any number of additional HDUs may follow the primary array, these additional HDUs are called FITS 'extensions'. Three types of extensions are currently defined by the FITS standard: images (N-dimensional data arrays), binary or ASCII tables. Each HDU consists of a ASCII header unit and an (optional) data unit. The header part consists of `keyword = value` records that describe each a parameter. The FITS header describes the structure of the data part and also includes the description of the observation performed. The headers of ESO FITS files deviate from the FITS standard laid out in [6] beacuse of using hierarchical keywords.

FITS Keyword A string consisting of groups of maximum 8 alphanumeric characters, separated by blanks, used in FITS headers to encode parameter information related to the data formatted in the FITS file.

Graphical User Interface (GUI) A user interface based on the presentation of data and command options via graphical panels and user selection via mouse and keyboard data entry.

Log File A computer readable file containing log records. Log files are written by handlers that receive log requests from distributed applications running in the on-line environment. Typically, log handlers will record major normal operations as well as unforeseen events and errors. The format of log files is defined in Section 5.1.

Observation Block The smallest schedulable observational unit for the ESO VLT. An observation block contains a sequence of high level operations, called *templates* that need to be performed sequentially and without interruption in order to ensure the scientific usefulness of an observation. Observation blocks may include only one target acquisition.

Observation (Raw) Frame The data file containing the result of an observation. In general, different instrument modes produce different observation frames.

Observing Programme A list of observation descriptions and targets to be observed to achieve a scientific aim. Observing programmes are proposed by a PI and are granted observing time by a time allocation committee (e.g. the ESO OPC). For the VLT, observing programmes will be formulated during *Phase 2 Proposal Preparation* in terms of *Observation Blocks*. Observation programme may consist of one or more *Observing Runs*.

Observing Run Observation or set of observations, performed in unique telescope/instrument configuration, constituting a logical unit item of the observing programme, as specified by the proposer.

Phase 2 Proposal Preparation Detailed preparation of observations. This phase is used by astronomers who have been granted observing time in order to provide the detailed observation setup for each target within their *Observing Programme*.

Pipeline The software system used to process VLT raw data into calibration or science products. Pipelines consist of recipes which typically process a certain type of raw data. Pipelines require infrastructure for classification, grouping and association of data. They are running in on-line mode on Paranal, and in off-line mode at the Data Flow Operations group in Garching. The main purpose of pipelines are the extraction of instrument quality information, and the extraction (calibration data) or removal (science data) of instrument signature.

Quality Control The VLT Quality Control process comprises the following tasks: visual checks of observed science and calibration data, checks of ambient conditions for science observations against user-specified constraints, checking the formal correctness of the data files, creating master calibration data, extracting quality parameters for quality assessment of data files and of the instrument status, populating the master calibration archive and performing instrument trend analysis.

Quality Control (QC) Level 0 Quality control during or immediately after the execution of the observation. Involves monitoring of ambient parameters (e.g. seeing, humidity) against user constraints, and checking of flux levels. QC level 0 is typically done on-site.

Quality Control (QC) Level 1 Off-line quality control using the pipeline. Involves extraction of QC1 parameters (e.g. read noise, grating position, zero points) and comparison to reference and historical data (trending). QC level 1 is typically done by Data Flow Operations.

Processed Frame The result of a pipeline data processing applied to either raw science or calibration frames.

Setup File A computer readable file containing configuration information for either telescope, instrument, detector, etc.

Template High level VLT operation. Templates provide the means to group commonly used procedures in a well defined and standardised unit. Templates have input parameters described by a template *signature*, and produce results that can serve as input to other templates. As an example, an *Acquisition Template* takes target coordinates and produces through an interactive procedure the precise positions used later, e.g. to place the slit.

Translation/Alias Table A table containing alternative names for ESO standard keywords. This table is used by data delivery tools or control software to translate short names into ESO standard parameter keywords. The Science Archive can deliver FITS files with non-ESO keyword headers by translating the ESO standard into an external specification defined through a translation table.

VLT Control Software (VCS) The software tools and systems that are directly involved in the control of VLT instruments, telescopes and related hardware. It enables and performs the acquisition of scientific data.

1.3 Abbreviations and Acronyms

ASCII	American Standard Code for Information Interchange
CCD	Charge Coupling Device
DEC	Declination
DET	Detector Subsystem
DFS	(VLT) Data Flow System
DIC	Data Interface Control
DICB	(ESO) Data Interface Control Board
DID	Data Interface Dictionary
DMD	Data Management Division
ESO	European Southern Observatory
FITS	Flexible Image Transport System
GUI	Graphical User Interface
HDU	FITS Header + Data Unit
HST	Hubble Space Telescope
INS	Instrument Subsystem
IOT	Instrument Observing Template
LCU	(VCS) Local Control Unit
NTT	(ESO) New Technology Telescope
OPC	Observing Programmes Committee
OST	Observation Summary Table
PI/CO-I	Principal/Co-Investigator
QC1	Quality Control Level 1
RA	Right Ascension
STSDAS	Space Telescope Standard Data Analysis Software
TCS	Telescope Control Software
UTC	Universal Time Coordinated
VCS	VLT Control Software
VLT	(ESO) Very Large Telescope
WCS	World Coordinate System

1.4 Conventions used in this document

The following conventions are used throughout this document:

- Keywords appear in monotype font (e.g. `NAXIS`).
- Keyword data types are given in the tables of FITS keywords (e.g. Table 4.1) in the leftmost column with the following codes:

(L)	Boolean/logical
(I)	integer
(S)	character or string
(R)	double precision

- Character strings in keyword values are left justified, and trailing spaces are not significant.
- Angles are measured in degrees, the convention for optical elements is summarised below:

  Grism Angle The angle of grisms is defined as the angle between the grooves and the alignment pin on the front face of the instrument. The alignment pin is duplicated on the rotator and the instrument.

  Slit Angle The angle of a slit is defined as the angle between the slit and the alignment pin on the front face of the instrument. The alignment pin is duplicated on the rotator and the instrument.

- Angles that relate to the projected sky along the light path are measured with a right-hand orientation as shown in Figure 1.1. The position angle γ is measured East of North. Two tilt angles are needed to describe elements that are not perpendicular to the optical axis: α and β. They give respectively the tilt against the plane perpendicular to the optical axis along the celestial East-West axis and along the celestial North-South axis.
- Other angles measured following the conventions given in [7].

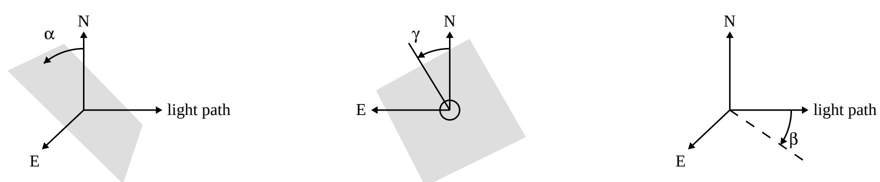


Figure 1.1: Conventions for angles related to the projected sky plane.

1.5 Acknowledgements

The following persons have contributed to the definition of the Data Interface specification: M. Albrecht, E. Allaert, D. Baade, S. Bogun, A. Dobrzycki, P. Grosbøl, J. Knudstrup, B. Leibundgut, F. Ochsenbein, B. Pirenne, G. Rupprecht, A. Wicenec and A. Zijlstra.
Much appreciated comments and suggestions have been received from G. Andreoni, P. Ballester, A. Balestra, P. Benvenuti, P. Biereichel, C. Cumani, R. Hanuschik, A. Kaufer, A. Longinotti, R. Mathar, J. Melnick, M. Peron, E. Pompei, P. Quinn, G. Raffi, J. Schwarz, J. Spyromilio and W. Zeilinger.

1.6 Release notes

The current release of this document is issued to document the features implemented in the VCS release APR2004 and the DFS release 4.8. There are, however, issues that have been discussed and agreed upon by the DICB, but are not yet fully implemented in the software.
Comments to this document will be greatly appreciated. Please send them to `dicb@eso.org`.

Chapter 2

Overview

Well defined data specifications are fundamental for the operation of large observing facilities. In a Data Flow System, data structures and parameters are used by a large number of people and systems at different places and times. Ensuring that parameters are given the same meaning and are used in a coherent way throughout the observatory is essential for a seamless flow. In fact, in the context of the Paranal Observatory, in which up to 14 instruments will be offered to the community, the task of defining, maintaining and controlling data flow structures and parameters becomes a key to the success of science operations.
The *data interface* of the observatory comprises the definition of:

- all data files that ESO delivers to or requires from its users community and
- data and parameters that are exchanged across modules of the VLT Control Software and the Data Flow System.

Such data structures include observation input data, acquisition data, instrumentation characteristics, setup files and parameters, among other.
The specifications included in the data interface give the syntax rules (file formats) and the semantic conventions (names, meaning, physical units) used to generate and handle data files.
In order to ensure stability and consistency in the long-term, data interface specifications are put under configuration control. This is achieved by defining and maintaining *data dictionaries* that define in detail all parameters used in a given context, e.g. for a given instrument (see Chapter 7). Changes and additions to these dictionaries are made only after all parties involved (instrumentation, data acquisition software, reduction software, archive, observatory operations) have screened the request and its execution throughout the data system is coordinated. The vehicle used at ESO to implement this is the Data Interface Control Board, a committee that brings together representatives from all groups involved (see the DICB Terms of Reference in appendix A). The DICB reviews new specifications and/or additions and changes to them, validates data files during the commissioning of instruments and their modes and coordinates the implementation schedule of data files.
The ESO usage convention for physical units is given in Chapter 8.
The naming convention for optical components is given in Chapter 9, the file naming convention is given in Chapter 10.

Chapter 3

Data structures

The general philosophy followed for the definition of ESO originated data files can be summarised as follows:

- frame headers contain only information that is relevant to data reduction and analysis and are recorded in astronomy oriented units such as arc seconds for slit widths, etc. (see Chapter 8);
- frame headers contain the non-standard hierarchical keywords, but ESO provides a tool — the so called *HIERARCH-TO-EIGHT (hierarch28)* — to translate headers from one semantic specification to another (e.g. hierarchical keywords with ESO names to e.g. IRAF-STSDAS naming conventions). Please find information about *hierarch28* in `http://archive.eso.org/saft/hierarch28/`.
- a number of log files record all information relevant to science operations; in particular, telescope operations, instrumental configuration, standard reduction steps and atmospheric conditions are recorded (see Section 3.2 below);
- a number of auxiliary files/tables provide a user-friendly view of the data harvest both at the telescope and at home during post-observation data analysis.

This section describes the rules and guidelines applicable to data files covered in this document.

3.1 Observation frames

The ESO data acquisition system delivers observations in FITS format (see [6]). They conform to the following rules:

Storage Format Each FITS file includes data from one exposure.

GUIDELINE 1 It is recommended that multiple-window and multiple-chip data related to the same exposure be stored in different image extensions of the same FITS file, with the data pixels belonging to one window/chip stored in one image extension. In those cases the primary HDU data array should remain empty. Considerations such as hardware or system setup, system performance, data transfer or data storage may make following this guideline impractical; it is nevertheless recommended that it be considered as the principal option. If this guideline is not followed — i.e. if a single exposure will generate more than one file — all individual files must still comply to the rules set forth in this document.

GUIDELINE 2 The data from single chip instruments data shall be stored in the primary HDU. This also applies to cases in which the file contains extensions with supporting data/information. An example of this situation would be if the file consisted of the data image and, e.g., the exposure map, the detector map, listing of MOS slits, etc. In this case, the data image shall be stored in the primary HDU, and the supporting data in the extension(s).

Headers The FITS headers delivered by ESO consist of the following groups of keywords: primary keywords, world coordinate system (WCS) keywords, ESO hierarchical keywords, selected operations log entries and possibly comments. Each of these keyword groups is described in detail in the next sections.

GUIDELINE 3 Keyword values always reflect the actual setting of the parameter or function in question, as opposed to the value that was requested at setup.

GUIDELINE 4 If a FITS file consists of more than one HDU, and the primary data array is empty (i.e. for multi-window or multi-chip data), then — unless explicitly specified otherwise by setting Boolean keyword `INHERIT` to `F` — keywords describing the dataset as a whole are written into the primary header, while keywords that are related to the data in a particular extension are written into the header of that extension, i.e. the keywords from the primary HDU are inherited into the extension. The required FITS keywords (`SIMPLE`, `NAXIS`, etc.) are not inherited. If a keyword appears both in the primary header and an extension header, the value in the extension header will apply to the extension. The commentary keywords are not inherited. If a file is modified resulting in a change of an inherited keyword, then such change will appear only in the extension header, not the primary header, i.e. the inherited keyword will appear in the extension header with its new value and the primary header value remains unchanged. It is recommended that all extension headers contain Boolean keyword `INHERIT` explicitly specifying whether keywords are inherited into the extensions. See [8].

At acquisition time, the FITS header of a given frame is assembled by the instrument Observation Software (OS) by collecting the contributions to the header from the different subsystems (TCS, INS, DET, etc). Each of these subsystems may contribute primary and/or hierarchical keywords.

GUIDELINE 5 Only optical elements intersecting the light path in a given exposure are recorded in the header.

GUIDELINE 6 Header records should be ordered such that primary keywords are listed first (at the header top), followed by hierarchical keywords (see Section 4.3) sorted by category in the following order: `DPR`, `OBS`, `TPL`, `GEN`, `TEL`, `ADA`, `INS`, `DET`, any other category.

The data description for VLTI is given in a separate document [9].

3.2 Log files

The following log files are produced during telescope operations:

- The *operations* log: records all major operations performed and their results (e.g. telescope presets, instrument operations, detector readouts and possible preprocessing); the operations log starts everyday at noon (UTC) and includes actions, acknowledgements, events and comments throughout the night.

- The *configuration* log: records the overall configuration in effect during operations such as pointing models, mounted filters, adaptive and active optics parameters; configuration log entries are written at the start of operations (usually at the beginning of the night) to record the configuration in place, and during operations when configuration parameters change.
- The *conditions* log: records main meteorological and seeing measurements, both ambient and within the dome; typically, ambient conditions would be checked by sensors periodically and their readings recorded in the log every *n* minutes.
- The *QC1* log: records all Quality Control parameters determined by the pipeline.

All log files will be stored and archived in the VLT Archive Facility. From there they will be available for engineering monitoring and other needs (see [2] for further details). Extracts from each of the logs will be stored on the medium handed over to PI's as part of the standard data distribution procedure. Some log records may also be included in the headers — this is governed by the 'class' attribute of a keyword in the corresponding dictionary (see Section 7.3 on page 52 for more details).

GUIDELINE 7 By convention, all keywords that identify the configuration in place on a given night are recorded on the *configuration* log at the beginning of the night and whenever the configuration changes.

A detailed description of log files is given in Chapter 5.

3.3 Observation preparation data and VLT parameter files

The preparation of observations, also called *Phase 2 Proposal Preparation* is supported by tools that assist the user in defining target and instrument requirements (see [10]). This information is grouped in units called *Observation Blocks*.
The format and syntax of the VLT *Parameter Files* is used by the VLT Control Software (VCS) to store Setup files.
The format of VLT Parameter Files is described in Chapter 6.

Chapter 4

Keyword Description

This chapter describes keywords used by ESO in FITS headers, log files and other data files. The main purpose here is to provide the overall structure of the keywords and their value/usage conventions. The precise specification for each keyword is given in separate data dictionaries (see Chapter 7).
Some of the keywords will be used only in headers, some in headers and setup files and again some other only in log files. The specification of where a keyword is included is given through the data dictionaries (see Section 7.3 on page 52).
A list of mandatory keywords is given in appendix B. Keywords are mandatory in the sense that they must be included if the information contained in them is applicable to the file in question; for example, RA and DEC keywords are not mandatory in a bias frame.

4.1 Primary FITS keywords

The FITS format, header syntax and standard keywords are described in [6]. In addition to the required FITS standard keywords, ESO uses a set of *primary* keywords in its data file headers. For those keywords, ESO follows common conventions for value formats and units. A dictionary containing the definitions of those primary keywords (`ESO-VLT-DIC.PRIMARY-FITS`) is available at `http://archive.eso.org/DICB`.
Keyword values can be either decimal integers, doubles (notations allowed: `1.`, `1.0`, `1.E+00`, `1E+00`), strings (enclosed within single quotes i.e. `'string'`) or Boolean, in which case the value can be either `T` (true) or `F` (false).

Values of the mandatory FITS keywords `SIMPLE`, `BITPIX` and `NAXIS`, and, if applicable, `NAXISn`, `XTENSION`, `PCOUNT`, `GCOUNT` and `EXTEND` must be written in FITS fixed format (see Section 5.2 of [6]).

`EXTEND` set to `T` is mandatory in the header of the primary HDU if the file contains extensions. It is not mandatory in single-HDU files, but it is recommended to include this keyword and to set it to `T` also in this case. This keyword must immediately follow `NAXIS` and (if applicable) `NAXISn` keywords.

`BZERO` and `BSCALE` give, respectively, the offset and the scale factor for data pixels when required. The principal use of those keywords is when storing unsigned 16-bit integer data in HDUs with `BITPIX=16`, in which case `BZERO=32768.0` and `BSCALE=1.0` are specified.

Table 4.1: Primary FITS keywords used at ESO in primary HDU and extensions

Type	Keyword	Example	Explanation
(L)	SIMPLE	T	Standard FITS format (NOST-100-2.0)
(I)	BITPIX	16	# bits storing pix values
(I)	NAXIS	2	# of axes in frame
(I)	NAXIS1	2080	# of pixels/row
(I)	NAXIS2	2048	# of rows (also # of scan lines)
(L)	EXTEND	T	Extensions may be present
(R)	BZERO	32768.0	real = fits-value*BSCALE+BZERO
(R)	BSCALE	1.0	real = fits-value*BSCALE+BZERO
(S)	BUNIT	'adu '	Physical unit of array values
(I)	BLANK	0	Value used for NULL pixels
(S)	ORIGIN	'ESO-PARANAL'	Observatory
(S)	DATE	'2001-08-19T09:34:52.676'	Date the file was written
(R)	DATAMAX	43212.0000000	Maximal pixel value
(R)	DATAMIN	323.0000000	Minimal pixel value
(S)	TELESCOP	'ESO-VLT-U3'	ESO Telescope Name
(S)	INSTRUME	'FORS1 '	Instrument used
(S)	OBJECT	'NGC1234'	Target designation as given by the user
(R)	RA	21.955217	01:27:49.2 Pointing (J2000.0)
(R)	DEC	-1.88210	-01:52:55.5 Pointing (J2000.0)
(R)	EQUINOX	2000.	Standard FK5
(R)	RADECSYS	'FK5 '	Reference system
(R)	EXPTIME	100.000	Total integration time (s)
(R)	AIRMASS	1.145	Averaged airmass
(R)	MJD-OBS	52140.39805498	MJD start (2001-08-19T09:33:11.950)
(S)	DATE-OBS	'2001-08-19T09:33:11.950'	Date the exposure was started (UTC)
(S)	TIMESYS	'UTC'	Time system used
(R)	UTC	34391.000	09:33:11.000 UTC at start (s)
(R)	LST	9766.777	02:42:46.777 LST at start (s)
(S)	PI-COI	'SCIENTIST'	Name of the PI/Co-I
(S)	OBSERVER	'OBSERVER'	Name of the observer
(S)	ORIGFILE	'FORS1-IMG231.19.fits'	Original file name
(S)	ARCFILE	'FORS1.2001-08-19T09:33:11.951.fits'	Archive file name
(S)	CHECKSUM	'ZHCbg99bZECbd99b'	HDU checksum
(S)	DATASUM	'57327645'	data unit checksum
	COMMENT		Comments
(S)	XTENSION	'IMAGE '	FITS Extension first keyword
(I)	BITPIX	16	# bits storing pix values
(I)	NAXIS	2	# of axes in frame
(I)	NAXIS1	2080	# of pixels/row
(I)	NAXIS2	2048	# of rows (also # of scan lines)
(I)	PCOUNT	0	Parameter count
(I)	GCOUNT	1	Group count
(I)	TFIELDS	13	number of fields in each row
(S)	EXTNAME	'WIN1.CHIP1.OUT1'	FITS Extension name
(S)	CHECKSUM	'CHNEFELDCELDCELD'	HDU checksum
(S)	DATASUM	'1153199447'	data unit checksum
(L)	INHERIT	T	Primary header keywords are inherited

`BUNIT` describes the physical unit of the array value. The value of this keyword must conform to the recommendations outlined in Chapter 8 on page 56.

`ORIGIN` specifies the observatory where the file was generated. ESO usage is either `'ESO-LASILLA'` or `'ESO-PARANAL'` for data obtained at the respective observatories. `'ESO-GARCHING'` shall be used for simulation data produced in Garching.

`DATE` gives the UTC date in which the FITS file was created. The value string for date uses the ISO 8601 format (`YYYY-MM-DDThh:mm:ss.sss`).

`DATAMAX` and `DATAMIN` give the maximal and minimal pixel value across the image (excluding special values, i.e. `BLANK`).

`TELESCOP` provides a standard designation of ESO telescopes.

Table 4.2: Usage of the `TELESCOP` keyword at ESO

Value for TELESCOP	**Telescope**
`ESO-NTT`	ESO 3.5m New Technology Telescope
`ESO-3.6`	ESO 3.6m Telescope
`MPG/ESO-2.2`	MPI 2.2m Telescope
`ESO-1.5`	ESO 1.5m Telescope
`DK-1.5`	Danish 1.5m Telescope
`NL-0.9`	Dutch 90cm Telescope
`ESO-CAT`	ESO coudé 1.4 Auxiliary Telescope
`ESO-1.0`	ESO 1.0m Telescope
`ESO-VLT-Ui`	ESO VLT, Unit telescope *i*
`ESO-VLT-Uijkl`	ESO VLT, incoherent combination of Unit Telescopes *i*, *j*, *k* and *l*
`ESO-VLTI-Uijkl`	ESO VLT, coherent combination of Unit Telescopes *i*, *j*, *k* and *l*
`ESO-VLTI-Amno`	ESO VLT, coherent combination of Auxiliary Telescopes *mno*
`ESO-VLTI-Uijkl-Amno`	ESO VLT, coherent combination of Telescopes U_{ijkl} and A_{mno}
`ESO-VLTI-Sij`	ESO VLT, coherent combination of test siderostat telescopes *i* and *j*.
`ESO-VST`	ESO VLT Survey Telescope
`ESO-VISTA`	ESO 4-meter Visible and Infrared Telescope for Astronomy

`INSTRUME` provides a designation of the instrument used. The complete identification of the instrument is described in the Instrument category (see Section 4.11); the instrument mode used, when several observing modes are available, is also to be found in this category.

`OBJECT` is either the target designation (as given by the astronomer) for science exposures or the exposure type for non-science frames.

GUIDELINE 8 `OBJECT` contains the value of `OBS TARG NAME` for observations of celestial objects and the value of `DPR TYPE` for all other exposures.

`RA` and `DEC` report the telescope pointing in mean places of equinox given in `EQUINOX`. For the VLT this is always J2000.0. `RA` is given in degrees without applying any $\cos\delta$ factor.

`EQUINOX` contains the epoch of the mean equator and equinox of the coordinate system used to express the WCS mapping. Should always be `2000.0` (FK5).

RADECSYS gives the frame of reference for the equatorial coordinate system. ESO uses FK5 for mean place coordinates new (post-IAU 1976) system.

EXPTIME provides the total integration time in seconds; it may have decimals. When the exposure is made of several periods, EXPTIME time is the sum of the exposure periods, and not simply the difference between end and start of exposure. Subintegrations, i.e. multiple exposures before a readout of the detector are described by the DIT and NDIT parameters, see Section 4.12.

AIRMASS gives the average airmass for the optical axis during the exposure computed for the time while the shutter is open.

MJD-OBS is the modified Julian Date $(JD-2400000.5)$ of the *start* of the observation. Two resolutions will be supported depending on the capabilities of the instrument: seconds and milliseconds. Five decimals are required for an accuracy of one second and 8 decimals for one millisecond. The reference frame for MJD-OBS at ESO is UTC (unless keyword TIMESYS specifies otherwise) and is given as known to the detector control system local control unit (LCU). The time on the LCU is synchronised with the observatory time system via the Network Time Protocol (ntp).

DATE-OBS gives the date in which the exposure was started. The value string for date uses the ISO 8601 format (YYYY-MM-DDThh:mm:ss.sss). This keyword repeats the value of MJD-OBS and is included mainly for human readability. The reference frame for this keyword is the same as for MJD-OBS.

TIMESYS lists the standard abbreviation of the principal time system used for the time-related keywords and the data. This keyword needs to be present only if the system used is other than UTC. Allowed values are listed in http://tycho.usno.navy.mil/systime.html.

UTC and LST give the time in seconds elapsed since midnight of the start of the exposure as known to TCS. The time on TCS is synchronised with the observatory time system via a dedicated time module. In principle, UTC and LST should correspond, within a second accuracy, to the UTC time given by the detector control LCU in MJD-OBS. In practice, MJD-OBS, UTC and LST provide for a redundant consistency check mechanism in case of malfunction.

PI-COI The PI or Co-I's initials followed by his/her surname.

GUIDELINE 9 The primary keyword PI-COI repeats the value of OBS PI-COI NAME.

OBSERVER The observer's initials followed by his/her surname.

ORIGFILE records the original file name, as assigned at the instrument workstation.

ARCFILE provides the name under which the file is stored in the archive.

CHECKSUM provides a Cyclic Redundant Check (CRC) calculation for each HDU. It uses the ASCII encoded 1's complement algorithm, see [11].

DATASUM gives the checksum calculated for the data sections only. For dataless records this keyword should be set to '0'. See [11].

COMMENT reports any comments associated with this frame.

The following keywords are used exclusively in FITS extensions:

XTENSION indicates start of an extension block in the FITS file. This keyword is mandatory for an extension header and must not appear in the primary header. Possible values are: 'TABLE   ' for ASCII tables, 'BINTABLE' for binary tables and 'IMAGE   ' for image extensions.

PCOUNT is mandatory in the extension header. It contains the number of bytes that follow the table in the associated extension data. In image and standard binary table extensions it should be set to 0. For variable-length-array binary tables (e.g. tile-compressed FITS files) it will be non-zero.

GCOUNT is mandatory in the extension header, and should always be set to 1.

EXTNAME is a string used to distinguish different extensions of the same type in the FITS file. EXTNAME should uniquely describe detector/chip/window/readout port used.

INHERIT is used to indicate that the keywords from the header of the primary HDU should be inherited into the extension.

4.2 Coordinate system keywords

The coordinate system keywords used at ESO are based on the World Coordinate System (WCS) documents by Greisen and Calabretta [12, 13]. Those documents are now officially recognized as part of the FITS Standard.
The keywords CRVALn, CRPIXn, CDn_m and CTYPEn give the coordinate system frame on which the data pixels are to be interpreted.
All ESO frames that contain data must contain WCS keywords in the relevant HDUs. The flavour of the WCS values used (see Sections 4.2.1 and 4.2.2) is dependent on the type of data and availability of mapping to celestial coordinates.

4.2.1 Pixel coordinates

The usage of detector coordinate system is shown in Table 4.3 and explained below.
Note that coordinates in FITS frames refer to the center of pixels, i.e. pixel 1 would integrate flux between 0.5 and 1.5 if the chip had uniform sensitivity.

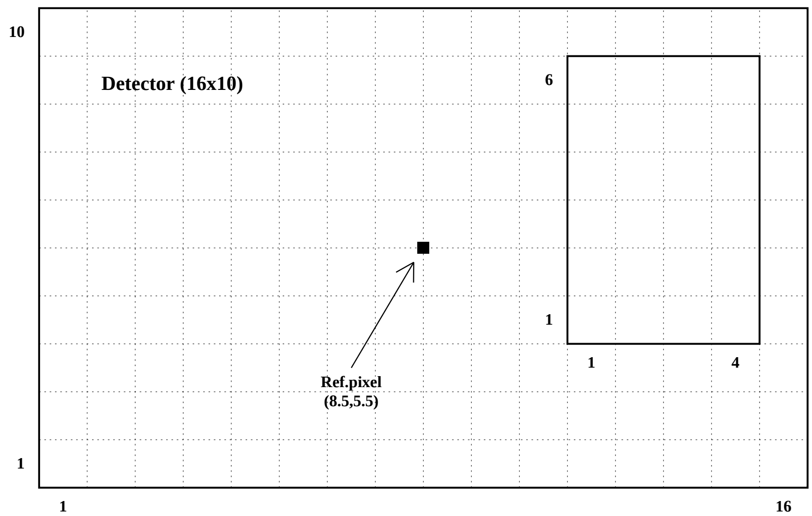
CRVALn give the reference pixel of the full detector matrix.

GUIDELINE 10 When possible, it is recommended to define the reference pixel (possibly with fraction if the accuracy is achieved) where the telescope's optical axis intersects the detector.

CRPIXn give the position of the reference pixel of the detector matrix (CRVALn) relative to the coordinate frame of the readout window. The following picture illustrates the use of CRVALn and CRPIXn for a window readout:

Table 4.3: ESO usage of World Coordinate System keywords for pixel coordinates

Type	Keyword	Example	Explanation
(S)	CTYPE1	'PIXEL'	Pixel coordinate system
(S)	CTYPE2	'PIXEL'	Pixel coordinate system
(R)	CRPIX1	315.	Value of X ref. pixel
(R)	CRPIX2	325.	Value of Y ref. pixel
(R)	CRVAL1	1020.	X ref. pixel of center of rotation
(R)	CRVAL2	1025.	Y ref. pixel of center of rotation
(R)	CD1_1	1.00000	1 image pixel per detector pixel
(R)	CD2_1	0.00000	no rotation, no skew
(R)	CD1_2	0.00000	no rotation, no skew
(R)	CD2_2	1.00000	1 image pixel per detector pixel



When the complete detector is read out, CRPIX1/CRPIX2 are equal to CRVAL1/CRVAL2, i.e. 8.5 and 5.5 respectively. In the case a window only is readout, CRPIX1=-2.5 and CRPIX2=2.5 while CRVAL1/CRVAL2 remain the same.

CDn_m give the elements of the coordinate translation matrix. For the detector coordinate system no rotation is applied, hence the non-diagonal elements of the matrix are 0. CD1_1 and CD2_2 give the number of detector pixels per data pixel in x- and y-direction, respectively. They are also known as the binning factors. These keywords replace CDELTn and CROTAn, the use of which is deprecated.

CTYPEn gives the coordinate system for CRPIXn. CTYPEn for raw frames is the string 'PIXEL' indicating that coordinate system refers to detector pixels.

GUIDELINE 11 Coordinate keywords describe the coordinate system for each chip. In case of a multichip instrument the coordinate keywords are therefore written to the header of each of the image extensions.

4.2.2 Celestial coordinates in imaging data

In order to obtain celestial coordinates for a given image, a mapping is required between the sky and the physical layout of the detector while making use of the VLT field astrometric calibration and detector orientation (see Section 4.12).

With the help of WCS keywords, analysis software can establish the celestial coordinates corresponding to any pixel in the frame. In the general case, WCS keywords will account for translation, rotation, mirroring and projection functions to accurately describe the mapping. However, in the case of the VLT it is expected that a simple tangential projection will provide the required transformation under normal conditions.

When the mapping has been applied, the coordinate system keywords have to be interpreted differently according to the value of `CTYPEn` (see [12, 13] for details).

Table 4.4 gives the ESO usage for WCS keywords when they describe the mapping of detector pixels to celestial coordinates.

GUIDELINE 12 It is recommended that raw imaging data include mapping to celestial coordinates in the WCS keywords whenever this information is available with reasonable accuracy, utilising the `CRDERi` and `CSYERi` keywords (see below) when appropriate.

Table 4.4: ESO usage of Celestial Coordinate System keywords in imaging data

Type	Keyword	Example	Explanation
(S)	CTYPE1	'RA---TAN'	TAN projection used
(S)	CTYPE2	'DEC--TAN'	TAN projection used
(R)	CRPIX1	1029.2	reference pixel in X
(R)	CRPIX2	1017.8	reference pixel in Y
(R)	CRVAL1	21.95522	RA at reference pixel in degrees
(R)	CRVAL2	-1.88210	DEC at reference pixel in degrees
(S)	CUNIT1	'deg '	Unit of coordinate transformation
(S)	CUNIT2	'deg '	Unit of coordinate transformation
(R)	CD1_1	-0.00277	10.0 arcsec per pixel
(R)	CD2_1	0.00000	no rotation, no skew
(R)	CD1_2	0.00000	no rotation, no skew
(R)	CD2_2	0.00277	10.0 arcsec per pixel

The `CDn_m` keywords express the transformation matrix to correct for scaling, rotation and skew (please refer to the WCS documents [12] and [13] for more information). The keywords `PCxxxx`, `CDELTi` and `CROTAi` are herewith obsolete and their use is deprecated.

If random or systematic errors in coordinate `i` are known, they should be recorded in keywords `CRDERi` and `CSYERi`, respectively, in units shown in relevant `CUNITi` keyword. They give a representative average value of the error over the range of the coordinate in the data file. The total error in the coordinate would be given by summing the two errors in quadrature.

More general transformations can also be described. Please refer to [12] and [13] for a detailed description.

4.3 Hierarchical Keywords

The FITS Format standard has been used largely by the astronomical community primarily as a format to transfer data. When it comes to use FITS as format to also archive observational data, the first question that arises is how to use FITS keywords to describe the parameters (instrumental, temporal, etc.) that define the configuration leading to the actual observation. In the absence of a widely accepted *semantic* standard, some communities have developed their own conventions.[1] In the Optical and the Infrared communities, however, different projects have diverged quite considerably, making the re-use of software packages for data reduction across observatories difficult.

One of the main drawbacks of FITS keywords is that they, being limited to names of 8 characters, do not provide enough name space to describe the sometimes hundreds of parameters required to describe the configuration of modern observing facilities.

ESO uses hierarchical keywords as a means to manage a structure of domain names, i.e. to group keywords that belong to the same logical entity. More generally, hierarchical keywords in FITS implement *a domain naming convention* allowing the definition of context-dependent keywords[2]. The advantage of hierarchical keywords is that they provide readable headers and support an easy to manage data interface based on context instead of managing keywords with cryptic names.

The main disadvantage of hierarchical keywords is that they are not a FITS standard and therefore only ESO data reduction software will be able to interpret parameters recorded in this way. This effectively limits the choice of software packages that ESO users can utilise. As a strategy to overcome this shortcoming, ESO has developed the *hierarch28* tool, which allows translation of hierarchical keywords into FITS standard, eight-character keywords (see Chapter 3 on page 15).

4.3.1 The domain name structure

A hierarchical keyword starts by convention with HIERARCH and is followed by words describing each a domain except the last one before the = sign which describes the parameter being reported.

The general scheme of hierarchical keyword used by ESO is

`HIERARCH ESO` category [subsystem(s)] parameter = value / comment

Examples of this scheme are

```
HIERARCH ESO DET WIN1 STRX  =           3 / Lower left pixel in X
HIERARCH ESO INS FILT1 NAME = 'OIII/3000' / Filter name
HIERARCH ESO OBS NAME       = 'NGC1275  ' / Observation block name
```

where `DET`, `INS`, `OBS` are categories, `WIN1` and `FILT1` are subsystems and `STRX`, `NAME` are parameters (see next sections).

Categories

The parameters are classified in a small number of broad *categories*. Seventeen such categories are presently defined, and designated by a 2- or 3-letter abbreviation:

`DPR` (originally 'DATA PRODUCT) describes the describe the category and purpose of the data file. It is defined for raw files only.[3]

[1] See recommendations of the HFWG, NASA/GSFC at `http://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/ofwg_intro.html`.

[2] Another example of a domain name management is the very well known structure of Internet network addresses (e.g. host.domain.country), except that here the hierarchy is reversed: from general (broad) to specific (narrow).

[3] Although the DPR category does apply to raw frames, which are specifically excluded in the ESO definition of *data products*, the name of this category is kept for historical reasons.

`OBS` (OBSERVATION) provides parameters that relate to the parent observation block to which this frame belongs (see Section 4.6).

`TPL` (TEMPLATE) gives information on parameters for templates (see Section 4.7).

`GEN` (GENERAL) provides parameters that relate to the observatory (see Section 4.8).

`TEL` (TELESCOPE) describes the telescope setup, typically position and tracking (see Section 4.9).

`ADA` (ADAPTER) includes all descriptive parameters, when an adapter and/or a rotator is located between the telescope and the instrument (see Section 4.10).

`INS` (INSTRUMENT) describes any element along the optical path between the telescope (or the adapter) and the detector (see Section 4.11).

`DET` (DETECTOR) describes the detector setting parameters (see Section 4.12).

`OCS` (OBSERVATION CONTROL SOFTWARE) describes parameters used by the Observation Software (OS), (see Section 4.13).

`DEL` (DELAY LINE) describes the VLTI delay lines (1 through 8), (see Section 4.14).

`COU` (COUDE) describes the VLTI coude optics (see Section 4.15)

`ISS` (INTERFEROMETRIC SUPERVISOR SOFTWARE) describes the VLTI supervisor software (see Section 4.16).

`AOS` (ADAPTIVE OPTICS SYSTEM) describes Adaptive Optics Systems (see Section 4.17).

`PAF` (PARAMETER FILE) describes VLT Parameter File header information (see Chapter 6).

`SIM` (SIMULATOR) describes simulator information like assumptions taken for the simulation process, e.g. sky emissivity or source brightness (see Section 4.18).

`ARC` (ARCHIVE) contains archiving remarks and parameters (see Section 4.19).

`PRO` (PROCESS) describe data processing parameters, it is defined in products files only (see Section 4.20).

`QC` (QUALITY CONTROL) contains results of the quality control process performed by the pipeline (see Section 4.21).

For each category there is one or more dedicated dictionary (see Chapter 7) that contains the definitions of all keywords belonging to this category.
A detailed description of each category is given in subsequent sections.

Table 4.5: List of commonly used subsystem keywords

Subsystem	Meaning
ACTO	Active Optics
ADAO	Adaptive Optics
ADC	Atmospheric Dispersion Corrector
AIRM	Airmass parameters
AMBI	Observatory ambient conditions
CAT	Target catalog
CHIP	Detector chip
COMP	Control computer
DLMT	Delay line metrology
DOME	Anything related to the telescope enclosure
DROT	Derotator
DPOL	Depolarizer assembly
DPOR	Depolarizer rotator
DPOS	Depolarizer slide
EXP	Exposure
FILT	Filter
FOCU	Focus
FRAM	Detector coordinate system
GRAT	Grating
GRIS	Grism
GRP	Group of some kind
GUID	Guiding system
LAMP	Any kind of lamp
MIRR	Instrument mirror
MOS	Multiple Object Spectrum details
OPTI	Optical element inserted in the light path
OUT	Detector readout Output
PRIS	Prism
PROG	Observing Programme (accepted proposal)
REDU	Data reduction
ROT	Rotating device
RETA2	Half-wave retarder plate
RETA4	Quarter-wave retarder plate
SEIS	Seismic monitor
SENSOR	Digital sensor
SHUT	Shutter
SLIT	Any kind of slit
SOFW	Identifies control software for a subsystem
TARG	Target (astronomical object observed)
TILT	Tilt
TRAK	Tracking system
WIN	Detector Window
WIND	Anything related to wind measurements
VLTI	Anything related to coherent modes

Subsystems

A *subsystem* keyword identifies a component in a category and can consist of zero or more words, generally consisting of maximum four characters. Subsystems commonly used by ESO are listed in Table 4.5.

An integer suffix `i` can be added to the last word of the subsystem when several identical components are available in order to differentiate them. As an example, `FILT1` and `FILT2` could be used to describe two filter elements along the light path. For historical reasons, it is acceptable to use a number as the last character of the subsystem name in individual cases, e.g. `RETA2` and `RETA4` for half- and quarter-wave retarders, respectively.

GUIDELINE 13 Subsystems can be concatenated for a particular context like e.g. `AMBI WIND` to describe ambient (instead of dome) wind measurements, however, only a maximum of two subsystems can be used.

Parameters

The last word in the hierarchy designates which parameter of the (sub)system is reported, and implies the *format* (Boolean, integer, real, character string) as well as the *unit* used for the parameter. In order to keep to a minimum the size required by the complete hierarchy, it is recommended to use names not exceeding 8 characters. Characters allowed are (as for primary FITS keywords) all uppercase letters, numbers, the dash and underscore characters.
The basic *parameter* keywords used in the following sections are described in Table 4.6, examples are given in Table 4.10 and Table 4.11, standard units are given when applicable.
A numeric suffix may be appended to the parameter name in the case of multidimensional parameters (e.g. a complex slit made of several slitlets), as it is done in standard FITS. As an example, `X1` refers to the x-position of the first component of the parameter.

GUIDELINE 14 Numeric suffixes must not contain leading zeroes, i.e. the second component of the `X` parameter must be spelled `X2`, not `X002`.

The dictionary definition of suffixed parameters contains the letter `i` as a placeholder for any number (see Chapter 7).
The following two parameters deserve special attention because of their usage:

`ID` provides a unique, ESO-wide identification for a component, part or element. It is built using the following guidelines:

- hardware serial numbers for passive parts (e.g. prisms);
- name/version.revision for software programmes;
- a combination of both for combined elements (e.g. a detector consists of both chip and controller) and
- the uniform identification scheme for all optical elements (filters, grisms, gratings, etc.) given in Chapter 9.

`NAME` provides a verbose name for the element that complements the ID. Names must follow the convention specified in Chapter 9.

As a rule, a component change/replacement or a subsystem upgrade should be reflected in the `ID` parameter, but not in the `NAME` parameter.

Table 4.6: Basic parameter keywords

	Parameter	Meaning
(R)	ALT	Altitude angle in the ALT-AZ system (°)
(R)	POSANG	Position angle (°, North=0, East=90)
(R)	AZ	Azimuth angle (° left handed)
(S)	DAYTIM	Civil date and time as 'ccyy-mm-ddThh:mm:ss.sss' (ISO 8601)
(S)	DATE	UTC date and time as 'ccyy-mm-ddThh:mm:ss.sss' (ISO 8601)
(R)	DEC	Declination d (°)
(S)	DID	Data Interface Dictionary to which a subsystem complies
(R)	DIST	Distance in m
(R)	DIMX	Size along x-axis (m)
(R)	DIMY	Size along y-axis (m)
(R)	ENC	Encoder value
(R)	ENCREL	Encoder relative displacement (in encoder units)
(R)	FWHM	Seeing measurements (arcsec)
(S)	ID	Identification which is *unique* for any component
(R)	LEN	Any angular length (arcsec)
(R)	LLEN	Any linear length (m)
(R)	LWIDTH	Any linear width (m)
	MAX	A maximum value
	MIN	A minimum value
(S)	MODE	Optional mode description
(S)	NAME	a clear designation of the item
(I)	NO	Integer number or identifier (e.g. a position on a wheel)
	POS	Position
(S)	PARM	Parameter in free format, e.g. Par=value
(R)	PRES	Pressure (Pa)
(R)	RA	Right ascension α (°)
(R)	RATEA	Tracking rate in RA (°/s)
(R)	RATED	Tracking rate in DEC (°/s)
(R)	RHUM	Relative humidity (%)
(R)	ROT	Rotation angle (°)
(R)	SCALE	Scale factor
(R)	SCALX	Scale factor along x-axis
(R)	SCALY	Scale factor along y-axis
(R)	SPEED	Speed of any system (m/s)
(L)	ST	a status binary flag, as True when the (sub)system is on, False when off
(S)	STATUS	a status of the system
(R)	TEMP	Temperature of any system (K)
(R)	TILTA	Tilt angle around the East-West axis (°). See Figure 1.1.
(R)	TILTB	Tilt angle around the North-South axis (°). See Figure 1.1
(R)	TIME	Elapsed Time (seconds)
(S)	TYPE	Type or class of component
(R)	UTC	Universal Time Coordinated (seconds since midnight)
(R)	WIDTH	Any angular width (arcsec)
(R)	WLEN	Wavelength in nm
(R)	X	Position along x-axis (m)
(R)	Y	Position along y-axis (m)
(R)	ZENITH	Zenithal distance (°)

4.4 Errors and statistics parameters

In some cases it is important to provide, in addition to the parameter value being reported, also an error or statistical indication. The convention for such cases is to provide auxiliary parameters whose names share the first 5 characters with their root parameter name and end with one of the strings given below:

- `ERR` error bars (e.g. `FWHMERR`), i.e. the uncertainty of the root parameter value in both directions (+ and −);
- `MIN/MAX` minimum and maximum values (e.g. `RHUMMIN`, `TEMPMAX`) during a given period of time (e.g. during the exposure);
- `RMS` root mean square of the parameter values during a given period of time;
- `AVG` average of the parameter values during a given period of time;
- `PTV` peak to valley variation of the root parameter values during a given period of time.

The unit of the `ERR`, `MIN`, `MAX`, `AVG` and `PTV` parameter is always the same as the root parameter.

GUIDELINE 15 In case of enumerated parameters, e.g. (`TEMP1`) the index suffix is added at the end as in `TEMPMAX1`.

4.5 Category *Data Product* (DPR)

The `DPR` category includes parameters related to the raw data files and their contents. As mentioned earlier, the name of this category is kept for historical reasons.
The corresponding dictionary can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.DPR.`
`DPR` keywords are set by instrument template software (sequencer scripts).

`DPR CATG`, `DPR TYPE` and `DPR TECH` provide unique high level description of the observation in terms of its purpose and technique.

Note that only certain combinations of these keyword values are meaningful. It is the task of the template designer to characterise the observation making use of a suitable combination of values.

`DPR CATG` gives the observation category. It can only take one of the values given in Table 4.7.

`DPR CATG = 'TEST'` is to be used to identify frames taken during instrument or software tests. The `TEST` frames are allowed to use relaxed header rules: except for valid entries in FITS mandatory keywords and in `MJD-OBS` and `INS ID` (and `DPR CATG`, naturally), those frames are not under obligation to follow any header/data rules specified in this document. However, the responsibility for proper description of those frames for any future use lies entirely with the individual/group taking the data.

`DPR CATG = 'TECHNICAL'` is to be used for frames taken to verify instrument setup/performance, which are obtained in operational setup, and are under obligation to conform to the standards set forth in this document. Examples of such frames are: focus tests, shutter errors, ccd linearity, charge transfer

Table 4.7: List of DPR CATG values

Value	**Explanation**
SCIENCE	Any scientific object
CALIB	Any calibration source
ACQUISITION	Any exposure taken to verify telescope pointing
TECHNICAL	Any exposure taken to verify instrument performance/setup (see text)
TEST	Any exposure taken to test instrument performance/setup/software/conditions (see text)
OTHER	Any other exposure

efficiency, etc. In contrast to calibration frames (DPR CATG = 'CALIB'), these frames are neither used to calibrate scientific data, nor to routinely measure instrument health. 'TECHNICAL' data are typically acquired rarely, during technical nights.

DPR TYPE gives the type of observation/exposure.

DPR TECH gives the technique used for the observation.

DPR TYPE and DPR TECH can each take more than one value; it is recommended to limit the number of entries to at most three. The values should be separated with commas, with no blank spaces. This provides the means to describe a wide range of observations. If more than one value is present, the entries should as a rule follow the "general-to-specific" order, i.e. the first entry should be a general term describing the type or technique, followed by qualifiers describing more specific details (e.g. 'FLAT,LAMP' and 'FLAT,SKY' should be used instead of 'LAMP,FLAT' and 'SKY,FLAT').

Tables 4.8 and 4.9 list commonly used values for DPR TYPE and DPR TECH keywords.

Tables 4.8 and 4.9 do *not* show complete lists of allowed values, since development of new instruments and new observation techniques will quickly render obsolete any list claiming to be complete. Instead, the tables are intended as guidelines showing what type of information is included in those keywords. In both tables, the first groups of values show the commonly used principal observation types or techniques, and those values will usually be the first entries in the DPR TYPE or DPR TECH value strings. Second groups of values show examples of qualifiers to the types or techniques. Third groups show few examples of instrument-specific qualifiers.

New values for the DPR keywords must be submitted for approval to the DIC Board.

As examples, a twilight sky flat is described with:

```
DPR CATG = 'CALIB'
DPR TYPE = 'FLAT,SKY'
DPR TECH = 'IMAGE'
```

and a jittered NACO polarimetry observation of a scientific target with the Wollaston prism is described with:

```
DPR CATG = 'SCIENCE'
DPR TYPE = 'OBJECT'
DPR TECH = 'POLARIMETRY,WOLLASTON,JITTER'
```

Table 4.8: DPR TYPE: examples of principal values (first group), qualifiers (second group) and instrument-specific qualifiers (third group).

Value	Explanation
OBJECT	any observation of an unspecified object
STD	any observation of a standard calibration source
ASTROMETRY	astrometric standard field
BIAS	readout frame
DARK	dark exposure (shutter closed)
FLAT	any flat field exposure
SKY	any observation of an empty field in the sky
LAMP	any lamp exposure
DOME	any exposure using the dome
SCREEN	any exposure using an illuminated screen
FLUX	flux standard (spectroscopy and photometry)
PSF-CALIBRATOR	reference star for PSF calibration
WAVE	any (instrument-internal) wavelength calibration
FOCUS	any focus exposure
SLIT	any non-spectroscopic exposure using a slit
FIBER	any exposure using fibers
FMTCHK	any arc-lamp exposure to obtain first-order guesses for dispersion sol. (UVES)
ORDERDEF	any flat-field exposure to derive order and background positions (UVES)
OzPoz	exposures taken using the Fibre Positioner (FLAMES)

4.6 Category *Observation* (OBS)

This category refers to ObservationBlock and frame identification and timing, and may apply to any kind of observation. The corresponding dictionary can be found at
http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.OBS.
OBS keywords are set by the Observation Handling Subsystem through its Phase 2 Proposal Preparation tool (P2PP). OBS keywords are added untouched to the header by the instrument OS software.
Subsystems in this category are:

PI-COI contains information about the programme PI/CoI:

OBS PI-COI NAME contains the name of the programme PI/CoI,

OBS PI-COI ID a numeric ID which was assigned to the PI/CoI by ESO.

PROG provides details about the observing programme.

The following keywords have a special meaning and usage convention:

OBS PROG ID is the identification code assigned to each observing run by the Observing Programme Committee (OPC) in the format ppp.c-nnnn(r), where

- programme type:
  - 2pp Director's Discretionary Time Programme
  - 1pp Large Programme
  - 0pp Normal Science Programme

Table 4.9: DPR TECH: examples of principal values (first group), qualifiers (second group) and instrument-specific qualifiers (third group).

Value	Explanation
IMAGE	any picture
SPECTRUM	single-order spectrum
ECHELLE	cross-dispersed spectrum
MOS	frame with spectra of several objects
MXU	frame with spectra of several objects using a pre-manufactured mask
IFU	Integral Field Unit observation
POLARIMETRY	polarimetric exposure
CORONOGRAPHY	coronography exposure
INTERFEROMETRY	coherent exposure with more than one telescope beam
TEL-THROUGH	telescope through-focus sequence
INS-THROUGH	instrument through-focus sequence
WEDGE	focus wedge frame
HARTMANN	Hartmann focus test
ABSORPTION-CELL	absorption lines included (e.g. Iodine cell)
DRIFTSCAN	drift scanning exposure
FABRY-PEROT	exposure using Fabry-Perot technique
WOLLASTON	Wollaston polarimetry
WIRE_GRID	Wire grid polarimetry
DIRECT	qualifier indicating direct imaging/spectroscopy
CHOPPING	exposure utilising M2 chopping
NODDING	exposure utilising telescope nodding
CHOPNOD	exposure utilising both chopping and nodding
JITTER	exposure utilising source jittering technique
SLIC#<i>	observation using image slicer #i (UVES)
HIT	high time resolution mode (FORS)
FILTERCURVE	spectroscopic flatfield with a narrowband filter included (FORS)
SPIDER	exposure using SkySpider (SINFONI)

- pp is the period number pp set to 60 indicates a technical programme, used for calibration),
- c is the programme scientific category as defined by the ESO OPC (currently A to D), and
- nnnn is the running number,
- r is the observing run identifier, an uppercase letter.

This keyword allows the archive facility to assign ownership to the data and consequently to enforce proprietary rights of observations. This keyword must be present in all data files.

TARG contains information about the target that was observed:

OBS TARG NAME gives the name of the target package which was used for the preparation of the OB with P2PP.

Keywords in this category are:

OBS ID contains a unique numeric id which was assigned to the observation block by the Observation Handling Subsystem.

OBS NAME contains the name of the observation block itself.

OBS OBSERVER contains the name of the observer.

OBS START gives the exact start time of the OB in ISO 8601 format.

OBS TPLNO gives the template sequence number within the observation block.

GUIDELINE 16 The first template in the observation block has the OBS TPLNO value of 1.

4.7 Category *Template* (TPL)

TPL keywords are set by the instrument template software (sequencer scripts). The corresponding dictionary can be found at
http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.TPL.
This category describes parameters needed by VLT observing templates. It include the following header keywords:

- TPL ID and TPL NAME to identify the observing template to which this frame belongs;
- TPL NEXP which gives the total number of exposures expected for this template;
- TPL EXPNO which gives the current exposure number within this template;
- TPL START which gives the exact start time of the template in ISO 8601 format;
- other template specific information such as loop parameters or parameters computed during the template execution.

GUIDELINE 17 The first exposure in a template has the TPL EXPNO value of 1.

4.8 Category *General* (GEN)

This category describes observatory information. GEN keywords are added to the header a posteriori by the Archive software. The corresponding dictionary can be found at
http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.GEN.
Subsystems in this category are:

- AMBI describes observatory ambient conditions such as temperature (TEMP), relative humidity (RHUM), wind speed and direction (WIND), seeing (FWHM, full width at half maximum at 0.5μm), airmass parameters (AIRM), seismic events (SEIS) and atmospheric coherent time (COTI).

4.9 Category *Telescope* (TEL)

TEL keywords are set by the Telescope Control Software (TCS). The corresponding dictionary can be found at
http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.TCS.
Subsystems in this category are:

- ACTO details Active Optics characteristics.
- ADC details Atmospheric Dispersion Corrector characteristics. This subsystem may be embedded in the INS category if the corrector is part of the instrument.
- AIRM gives airmass values at start and end of the observation.
- AMBI gives ambient parameters as received from the ambient server.
- CHOP gives parameters related to telescope chopping.
- DOME details dome conditions such as temperature (TEMP), wind speed and direction (WIND).
- FOCU gives details of the focal length, scale and focal station.
- M1/M2 give details about M1 and M2 status and general active optics information.
- PARANG gives parallactic angles at start and end of the observation.
- TARG gives details about the observation target.
- TRAK describes tracking parameters.

GUIDELINE 18 TEL DATE gives the installation date of the telescope control software system.

GUIDELINE 19 TEL ID gives the revision number of the telescope control software.

4.10 Category *Adapter* (ADA)

ADA keywords are set by the Telescope Control Software (TCS). ADA keywords are also described in the TCS dictionary
http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.TCS.
Subsystems used in this category are:

- GUID which gives guiding system information such as guide probe location and status;
- ABSROT which describes absolute adapter rotation angles. The reference frame is defined in the dictionary for the adapter.

4.11 Category *Instrument* (INS)

INS keywords are set by the Instrument Control Software (ICS) or by the Observation Support Software (OS). For each instrument exists at least one dictionary. For some instruments there's a separate ICS and OS dictionary. All instrument dictionaries can be found at

http://archive.eso.org/Tools/DidRep/DidRepWebQuery.

A template for ICS dictionaries (ESO-VLT-DIC.XXX_ICS) is also available from DICB.
Many subsystem keywords are used in this category. In some cases, a possible integer i suffix will be required when several similar subsystems can be mounted.

GUIDELINE 20 A suffix will be appended to a given subsystem name, if more than one instance of this subsystem are available for the instrument. The second instance does not even need to be mounted. For instance if a given instrument has two filter wheels, but in only one of them a filter is selected (and the other set to an open position) the subsystem describing this filter is FILT1.

The dictionary definition of parameters with suffixed subsystem names contains the letter i as a place holder for any number (see Chapter 7).
An example of the typical keywords required to describe an instrument setting is given in Table 4.10. It includes a general description of the instrument itself (the ID parameter, a possible MODE), followed by an accurate description of each element used.
While optical elements are described in the FITS headers by the corresponding keywords (FILT, GRIS, etc.), the generic OPTI subsystem gives the means to describe elements for engineering purposes. The OPTI subsystem may refer to any selectable optical element: filter, a grism, a polarimeter, a diaphragm, etc. Such elements are generally mounted on a wheel.
An example for OPTIi keywords is given when an instrument operates several wheels to implement a logical function (e.g. FILT1), i.e. the user selects one filter to be inserted into the light path and the instrument internal logic selects which wheel has the filter mounted. For such cases, FILTi keywords are used for instrument setup while the OPTIi set of keywords describe uniquely the internal instrument configuration.
Another example for the usage of OPTIi keywords is the case of 'multi-purpose' wheels. In this case a single wheel is used to mount different element types, e.g. grisms and a focus-wedge. Again here it is advisable to separate the user function (setup selection) from the actual instrument configuration recording. OPTIi keywords provide the mechanism to accurately describe the actual setup independently of user intention.
It is assumed that *n* wheels are available; for each of these wheels, the following parameters must be known:

- OPTIn NO specifies the actual slot number *n* in the wheel.
- OPTIn ID specifies the identification of the filter, grism, etc. The identification scheme is given in Chapter 9.
- OPTIn TYPE and OPTIn NAME provide an explanation of what is inserted along the optical path. These two parameters can normally be derived from the contents of the OPTIn ID keyword. OPTIn TYPE provides a generic name for the optical element, OPTIn NAME provides a verbose name for the optical element. The naming convention is given in Chapter 9.

  Angles that describe the orientation of a grism or polarimeter include:

  1. OPTIn POSANG specifies the position angle of the optical element on the sky, East of North.

Table 4.10: Example of the INS category

	Keyword	Example	Explanation
(S)	INS ID	'UVES '	Instrument ID
(S)	INS DID	'ESO-VLT-DIC.UVES_ICS-1.73'	Data dictionary for INS
(S)	INS SOFW ID	'$Revision: 1.73 $'	Instrument SW
(S)	INS SOFW MODE	'NORMAL '	Simulation mode
(S)	INS PATH	'RED '	Optical path used
(S)	INS MODE	'RED '	Instrument mode used
(S)	INS MIRR1 ID	'FREE '	Mirror unique ID
(S)	INS MIRR1 NAME	'FREE '	Mirror common name
(I)	INS MIRR1 NO	1	Mirror slide position
(S)	INS OPTI1 ID	'1 '	General Optical device unique ID
(S)	INS OPTI1 NAME	'OUT '	General Optical device common name
(I)	INS OPTI1 NO	1	Slot number
(S)	INS SLIT1 NAME	'FREE '	Slit common name
(I)	INS SLIT1 NO	1	Slide position
(S)	INS DROT MODE	'ELEV '	Instrument derotator mode
(I)	INS DROT RA	84442.230003	RA (J2000.0) pointing (deg)
(I)	INS DROT DEC	-544231.759900	DEC (J2000.0) pointing (deg)
(I)	INS DROT POSANG	0.0000	Position angle (deg)
(I)	INS DROT BEGIN	155.7380	Physical position at start (deg)
(S)	INS DPOL MODE	'OFF '	Instrument depolarizer mode
(S)	INS DPOS NAME	'OUT '	Instrument depolarizer slide posit
(I)	INS DPOS NO	1	Depolarizer slide position
(S)	INS FILT1 ID	'FREE '	Filter unique id
(S)	INS FILT1 NAME	'FREE '	Filter common name
(I)	INS FILT1 NO	13	Filter wheel position index
(S)	INS OPTI2 ID	'DIAPHR.27MM'	General Optical device unique ID
(S)	INS OPTI2 NAME	'OVRSIZ '	General Optical device common name
(I)	INS OPTI2 NO	3	Slot number
(S)	INS MIRR2 ID	'RED#1 '	Mirror unique ID
(S)	INS MIRR2 NAME	'RED '	Mirror common name
(I)	INS MIRR2 NO	1	Mirror slide position
(S)	INS SHUT1 NAME	'Telescope shutter'	Shutter name
(L)	INS SHUT1 ST	T	Shutter open
(R)	INS SLIT3 WID	0.30	Slit width (arcsec)
(R)	INS SLIT3 LEN	8.90	Slit length (arcsec)
(S)	INS FILT3 ID	'BS4 '	Filter unique id
(S)	INS FILT3 NAME	'SHP700 '	Filter common name
(I)	INS FILT3 NO	4	Filter wheel position index
(S)	INS DET6 NAME	'Red exp. meter PMT'	detector name
(R)	INS DET6 CTTOT	3.	Total counts during exposure
(R)	INS DET6 UIT	1.000	User defined Integration time
(S)	INS GRAT2 ID	'CD#3 '	Grating unique ID
(S)	INS GRAT2 NAME	'CD#3 '	Grating common name
(R)	INS PIXSCALE	0.182	Pixel scale
(R)	INS GRAT2 X	2048.0	X pixel for central wavelength
(R)	INS GRAT2 Y	2048.0	Y pixel for central wavelength
(I)	INS GRAT2 NO	1	Grating wheel position index
(R)	INS GRAT2 WLEN	520.0	Grating central wavelength
(I)	INS GRAT2 ENC	1363503	Grating absolute encoder position
(R)	INS TILT2 POS	0.0	Science camera tilt (pixels)
(R)	INS TILT2 POSMIN	-222.0	Minimum camera tilt (pixels)
(R)	INS TILT2 POSMAX	222.0	Maximum camera tilt (pixels)
(S)	INS TILT2 ENC	15927	Camera tilt absolute encoder position
(R)	INS DROT END	155.7550	Physical position at end (deg)

2. `OPTIn ROT` specifies the rotation angle in regard to the optical axis.
3. `OPTIn TILTA` specifies the tilt angle in regard to the plane perpendicular to the optical axis

along the East-West direction.

4. `OPTIn TILTB` specifies the tilt angle in regard to the plane perpendicular to the optical axis along the North-South direction.

All angles are expressed in degrees, and measured according to the conventions given in Section 1.4 on page 13.

For example:

```
INS OPTI3 TYPE = 'FILTER'    / Optical element used
INS OPTI3 NO   =           7 / Position of wheel used
INS OPTI3 ID   = '#590'      / ID of the element
INS OPTI3 NAME = 'OIII/3000' / Name of the element
```

would reflect filter `'#590'` (OIII/3000) being mounted on wheel 3 in position 7.

- `SOFW` identifies the detector control software and gives related parameters (see the log example in Section 5.1 on page 43).

GUIDELINE 21 `INS DATE` gives the installation date of the instrument control software system.

GUIDELINE 22 `INS ID` gives the revision number of the instrument control software.

4.12 Category *Detector* (DET)

`DET` keywords are set by the Detector Control Software (DCS) for optical instruments and by the Instrument Control Software for infrared instruments. The corresponding dictionaries can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.CCDDCS`
(for optical CCDs) and at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.IRACE`
(for infrared detectors).
Subsystems used in this category are:

- `CHIP` describes each CCD chip when an array of CCDs is exposed.
- `EXP` describes exposure parameters.
- `FRAM` describes the detector coordinate system (see Section 4.2).
- `OUT` describes the outputs used for read-out. This subsystem includes the description of detector orientation.
- `PARM` gives unspecified detector parameters.
- `READ` gives readout parameters.
- `SHUT` gives shutter parameters.

- `SOFW` identifies the detector control software and gives related parameters (see the log example in Section 5.1 on page 43).
- `WIN` describes read-out window(s) parameters.

GUIDELINE 23 The subsystem `CHIPi` always carries an index, even if there is only one detector device exposed. The keyword `DET CHIPS` gives the number of chips used.

GUIDELINE 24 `DET CHIP(i) NX` and `DET CHIP(i) NY`, respectively, refer to the number of *used* pixels of the chip, i.e. the number of pixels in x- and y-direction which actually are written to a unbinned, unwindowed image, excluding the prescan or overscan pixels. This number may deviate from the physical number of pixels of the chip.

GUIDELINE 25 The subsystem `OUTi` *always* carries an index, even if only one output is used. `DET OUTPUTS` gives the number of outputs used. Note that the pixel area which is covered by each output is not a setup parameter but rather static configuration of the detector chip and it is the task of the detector controller to assemble the selected window(s) properly.

GUIDELINE 26 The outputs are counted per chip, not over the whole instrument, i.e. there are subsystems `DET OUT1`, `DET OUT2`, ... for each chip.

GUIDELINE 27 `DET OUTi NX` and `DET OUTi NY`, respectively, contain the number of *image* pixels that are read out through port *i*, *excluding* any prescan and overscan pixels.

GUIDELINE 28 The subsystem `WINi` does always carry an index, even if only one window is used. `DET WINDOWS` gives the number of windows used.

`WINi` includes parameters that define the readout region used on the CCD: the location of the window on the chip (offset position), its size, and the binning factors used. The horizontal axis is named X, and the vertical axis Y.
Let us assume that the window is defined with its lower left corner at position (i_0, j_0), a size $\Delta i \times \Delta j$, and binning factors (f_i, f_j); the largest window has the values $(1,1)$ for the start position, and binning factors $(1,1)$. The window is described by:

- `NX` and `NY` give the number of pixels, i.e.: $\Delta i = \mathtt{NX} \times f_i$ and $\Delta j = \mathtt{NY} \times f_j$.

  The pixels in the pre- and overscan areas are included. The values are obviously identical to those given in NAXIS1 and NAXIS2;
- `BINX` and `BINY` give the binning factors f_i and f_j, respectively;
- `STRX` and `STRY` represent the start position of the window, i.e. i_0 and j_0, respectively.

GUIDELINE 29 In those cases in which several outputs are used to read-out the chip *and* disjoint windows are read, the subsystem combination `DET OUTn WINm` must be used.

The `FRAM` subsystem provides the description frame in detector (pixel) coordinates as opposed to the WCS keywords which provide *pixel* to *sky* mapping (see also Section 4.2).

GUIDELINE 30 `DET DATE` gives the installation date of the detector control software system.

GUIDELINE 31 `DET ID` gives the name and revision number of the detector control software.

4.13 Category *Observation Control Software* (`OCS`)

`OCS` keywords are set by the instrument's Observation Software. They are accordingly defined in the `OS` dictionaries of the different instruments.
This category includes parameters that are created by the OS upon creation of a frame.

4.14 Category *Delay Lines* (`DEL`)

`DEL` keywords are set by the VLTI Control Software. The corresponding dictionary can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.DEL.`
This category includes parameters that relate to the VLTI delay lines.

4.15 Category *Coude Optics* (`COU`)

`COU` keywords are set by the VLTI Control Software. The corresponding dictionary can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.COU.`
This category includes parameters that relate to the VLTI coude optics.

4.16 Category *Interferometric Supervisor Software* (`ISS`)

`ISS` keywords are set by the VLTI Interferometric Supervisor Software. The corresponding dictionary can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.ISS.`
This category includes parameters that relate to the VLTI telescope setup.

4.17 Category *Adaptive Optics System* (`AOS`)

`AOS` keywords are set by the Control Software, Observation Software or Real time Control Software of Adaptive Optics Systems (e.g. NAOS), the corresponding dictionaries can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery.`

4.18 Category *Simulator* (`SIM`)

`SIM` keywords are set by the Quality Control subsystem. Currently this category is only used by NAOS, the corresponding dictionary can be found at
`http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.NAOS_PS.`
This category includes parameters that relate to the simulation process, in particular those for which the simulator needs assumptions. Examples are sky emissivity in the infrared, object brightness or assumptions regarding the PSF.

4.19 Category *Archive* (ARC)

ARC keywords are set by the Archive Software. The corresponding dictionary can be found at `http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.ARC`.
This category is filled during the archiving process, mainly for data integrity-checking purposes.

4.20 Category *Process* (PRO)

PRO keywords are set by the Data Pipeline Software. The corresponding dictionary can be found at `http://archive.eso.org/Tools/DidRep/DidRepWebQuery?did=ESO-VLT-DIC.PRO`.
This category includes parameters used during a standard reduction process. This keyword category is found mainly in processed frames.

4.21 Category *Quality Control* (QC)

QC keywords are also set by the Data Pipeline Software. The QC dictionaries can be found at `http://archive.eso.org/Tools/DidRep/DidRepWebQuery`.
This category includes parameters describing results of the Quality Control process performed by the pipeline.

Table 4.11: Example DET category keywords

	Keyword	Example	Explanation
(S)	DET ID	'CCD FIERA - Rev 2.69'	Detector system Id
(S)	DET NAME	'ccdF - fors'	Name of detector system
(S)	DET DATE	'05-02-2001'	Installation date
(S)	DET DID	'ESO-VLT-DIC.CCDDCS-1.3'	Dictionary
(I)	DET BITS	16	Bits per pixel readout
(R)	DET RA	53.19183333	Apparent 03:32:46.0 RA
(R)	DET DEC	-27.69388611	Apparent –27:41:37.9 DEC
(S)	DET SOFW MODE	'Normal '	CCD sw operational mode
(I)	DET CHIPS	1	# of chips in detector array
(S)	DET CHIP1 ID	'TK2048EB4-1 160'	Detector chip identification
(S)	DET CHIP1 NAME	' '	Detector chip name
(S)	DET CHIP1 DATE	'31/10/1999'	Date of installation
(I)	DET CHIP1 X	1	X location in array
(I)	DET CHIP1 Y	1	Y location in array
(I)	DET CHIP1 NX	2048	# of pixels along X
(I)	DET CHIP1 NY	2049	# of pixels along Y
(R)	DET CHIP1 PSZX	24.0	Size of pixel in X
(R)	DET CHIP1 PSZY	24.0	Size of pixel in Y
(I)	DET EXP NO	911	Unique exposure ID number
(S)	DET EXP TYPE	'Dark '	Exposure type
(I)	DET EXP DUMDIT	0	# of dummy readouts
(R)	DET EXP RDTTIME	33.026	image readout time (s)
(R)	DET EXP XFERTIM	33.094	image transfer time (s)
(S)	DET READ MODE	'normal '	Readout method
(S)	DET READ SPEED	'normal '	Readout speed
(S)	DET READ CLOCK	'ABCD,1x1,high'	Readout clock pattern used
(I)	DET OUTPUTS	1	# of outputs
(I)	DET OUTREF	0	reference output
(S)	DET OUT1 ID	'A '	Output ID as from manuf
(S)	DET OUT1 NAME	'A '	Description of output
(I)	DET OUT1 CHIP	1	Chip to which the output belongs
(I)	DET OUT1 X	1	X location of output
(I)	DET OUT1 Y	1	Y location of output
(I)	DET OUT1 NX	2048	valid pixels along X
(I)	DET OUT1 NY	500	valid pixels along Y
(I)	DET OUT1 PRSCX	0	Prescan region in X
(I)	DET OUT1 OVSCX	0	Overscan region in X
(R)	DET OUT1 CONAD	1.46	Conversion from ADUs to e-
(R)	DET OUT1 RON	5.16	Readout noise per output (e-)
(R)	DET OUT1 GAIN	0.68	Conversion from e- to ADU
(I)	DET FRAM ID	1	Image sequencial number
(S)	DET FRAM TYPE	'Dark '	Type of frame
(I)	DET WINDOWS	1	# of windows readout
(I)	DET WIN1 STRX	1	Lower left pixel in X
(I)	DET WIN1 STRY	500	Lower left pixel in Y
(I)	DET WIN1 NX	2048	# of pixels along X
(I)	DET WIN1 NY	500	# of pixels along Y
(I)	DET WIN1 BINX	1	Binning factor along X
(I)	DET WIN1 BINY	1	Binning factor along Y
(I)	DET WIN1 NDIT	1	# of subintegrations
(R)	DET WIN1 UIT1	0.000000	user defined subint. time (s)
(R)	DET WIN1 DIT1	0.019151	actual subint. time (s)
(R)	DET WIN1 DKTM	0.0192	Dark current time (s)
(S)	DET SHUT TYPE	'Iris '	type of shutter
(S)	DET SHUT ID	'fors shutter'	Shutter unique identifier
(R)	DET SHUT TMOPEN	0.000	Time taken to open shutter (s)
(R)	DET SHUT TMCLOS	0.000	Time taken to close shutter (s)

Chapter 5

Logging

The log database defines all information that characterises the environment in which a specific observation was obtained. It represents the logbook of telescope operation. It uniquely associates a scheduled observing programme to a set of acquired exposures.
The log database includes night reports and the log files defined in Section 3.2 on page 16.
The log files will record a number of actions and parameters which are defined in the corresponding dictionaries. In addition, log files may temporarily include any number of parameter records to be used e.g. for trouble shooting purposes.
The log file format is designed to allow an accurate trace of VLT operations. Every log record is uniquely identified by the logging source (given through the source mask, see below) and its date/time stamp. This design allows to merge all log records in the log database independently of how many log files where created. The unique source mask also permits to trace the parallel operation of two instruments, e.g. one doing science exposures while the other is used to acquire calibration frames.

5.1 Log File format

A log file consists of maximum 250 byte long records terminated with a newline character (\n), however, keywords and values (see below) must be written within the first 72 characters. The restriction to 72 characters is due to the need to be able to include relevant log records in the FITS headers of observations.
Log records have the general format:
`hh:mm:ss`> *keyword / comments* [<*source mask*>]
or
`hh:mm:ss`> */ comments* [<*source mask*>]
where:

- `hh:mm:ss`> is the time stamp, consisting of the time (UTC). `hh:mm:ss.sss`> may be used if a higher time resolution is required;
- *keyword* is a hierarchical keyword (or set of words) which explains what happened (*action* keyword) or identifies the reported parameter (followed by = *value*). Note that the words `HIERARCH ESO` are omitted here.
- comments explain the keyword reported, and

- <*source mask*> is the event source identification mask (see Section 5.2).

A log file always starts at noon (UTC). The first record of a log is a *date stamp* record in the following format:

```
12:00:00> DATE = 'YYYY-MM-DD'     / Weekday Month Day, Year [source]
```

A *date stamp* record must also be the first record written on the log after midnight (UTC).
The following *classes* of records can be found in a log:

Action records reporting an action initiated by the observer/operator; typical examples are opening and closing operations, or moving the telescope. An action record starts with an *action* keyword (a verb starting with a dash); it cannot have any associated value, but may be followed by parameter record(s) like the telescope slew at the end of the log example on page 44. Subsystem names are taken from Table 4.5. See Section 5.1.1 for the record syntax.

Parameter records These can be meteorological parameters (wind speed, dome temperature), seeing conditions, or the status of some instrument. The parameter name is normally followed by a value. Such parameters are either acquired periodically (e.g. the dome temperature), or recorded as a result of a given action. See Section 5.1.2 for the record syntax.

Unforeseen event records, reporting unexpected events, like the failure of a lamp or the loss of synchronisation between modules. See Section 5.1.4 for the record syntax.

Alarm event records, reporting alarm conditions. See Section 5.1.5 for the record syntax.

Comments inserted by the PI/Co-I or science operations staff. See Section 5.1.6 for the record syntax.

Typical examples of what can be found in the *log* are given below.

```
12:00:00> DATE = '1995-03-31'          / Fri Mar 31, 1995                [wemmi]
12:46:19>-START COMP                   / Computer restarted              [wemmi]
12:46:19> COMP ID = 'HP RTE-A V5'      / Operating system identifier     [wemmi]
12:46:19> COMP NAME = 'NTI'            / Network node identifier         [wemmi]
12:46:19> TEL ID = 'ESONTT'            / Control NTT telescope           [wemmi]
12:47:35>-START OBS SOFW EMMI          / EMMI observ. prog. started      [wemmi]
12:47:35> OBS SOFW ID = 'OBST-V4.2'    / Programme name-version          [wemmi]
12:47:35> OBS SOFW MODE = 'NORMAL'     / Hw enabled for OBST             [wemmi]
12:47:48>-START INS SOFW EMMI          / EMMI control prog. started      [wemmi]
12:47:48> INS SOFW ID = 'EMMI-V4.1'    / Programme name-version          [wemmi]
12:47:48> INS SOFW MODE = 'NORMAL'     / Hw enabled for EMMI             [wemmi]
12:47:48>-START DET SOFW EMMI RED      / CCD control prog. started       [wemmiR]
12:47:48> DET SOFW ID = 'CCDR-V4.2'    / Programme name-version          [wemmiR]
12:47:48> DET SOFW MODE = 'NORMAL'     / Hw enabled for CCDR             [wemmiR]
12:47:49>-START DET SOFW EMMI BLUE     / CCD control prog. started       [wemmiB]
12:47:49> DET SOFW ID = 'CCDB-V4.2'    / Programme name-version          [wemmiB]
12:47:49> DET SOFW MODE = 'NORMAL'     / Hw enabled for CCDB             [wemmiB]
12:47:54>/UNFORESEEN: Error while initialising EMMI Red CCD              [wemmi]
12:47:57>/UNFORESEEN: Error while initialising EMMI Blue CCD             [wemmi]
12:47:57>-STOP ADA B LAMP-0            / Calibration lamp switched off.  [wemmiB]
12:48:50>-STOP ADA B LAMP-0            / Calibration lamp switched off.  [wemmiB]
12:50:17>-START DET EMMI RED           / Start wiping CCD EMMI RED       [wemmiR]
12:50:17>-START EMMI CALIBRATION       / Start cal. procedure            [wemmi]
12:50:17>-START ADA B OPTI             / Calibration unit moved in       [wemmiB]
```

```
12:50:17>-CLOSE EMMI CAL SHUT-ALL      / Close all cal. shutters         [wemmi]
12:50:18>-CLOSE ADA B SHUT-0           / Calibration shutter closed.     [wemmiB]
12:50:18>-STOP EMMI CAL LAMP-ALL       / Switch off all cal. lamps       [wemmi]
12:50:18>-STOP ADA B LAMP-0            / Calibration lamp switched off.  [wemmiB]
12:50:19>-START EMMI CAL LAMP14        / Switch on cal. lamp             [wemmi]
12:50:19>-START ADA B LAMP14           / Calibration lamp switched on.   [wemmiB]
12:50:19>-OPEN EMMI CAL SHUT14         / Open cal. shutter               [wemmi]
12:50:20>-OPEN ADA B SHUT14            / Calibration shutter open.       [wemmiB]
12:51:16>-START EXPO EMMI RED          / Start exp. on CCD EMMI RED      [wemmiR]
12:51:16> EXPO EMMI RED NO = 3107      / Exp. num. on CCD EMMI RED       [wemmiR]
12:53:17>-STOP EXPO EMMI RED           / Stop exp. on CCD EMMI RED       [wemmiR]
12:53:17>-READ DET EMMI RED            / Reading CCD EMMI RED            [wemmiR]
12:55:01>/UNFORESEEN: Failed image transfer to host                      [wemmiR]
12:55:08>/RECOVERY: Image transfer to host recovered                     [wemmiR]
12:55:08>-STOP TRANS DET EMMI RED      / Transf. OK from CCD EMMI RED    [wemmiR]
12:55:08> DET PARM(1) = -8.05, 3.00, 23.52 / DET: VLO1, VHI1, VDD1       [wemmiR]
12:55:08> DET PARM(4) = -4.06, 5.99, 13.77 / DET: HLO1, HHI1, VDR1       [wemmiR]
12:55:08> DET PARM(7) = -0.36, 12.00, 0.31 / DET: RLO1, RHI1, VGS1       [wemmiR]
12:55:08> DET PARM(10)=-14.73, 14.80, 27.34 / DET: -15V, +15V, +30V      [wemmiR]
12:55:15>-CLOSE EMMI CAL SHUT14        / Close cal. shutter              [wemmi]
12:55:15>-CLOSE ADA B SHUT14           / Calibration shutter closed.     [wemmiB]
12:55:15>-STOP EMMI CAL LAMP14         / Switch off cal. lamp            [wemmi]
12:55:18>-STOP ADA B LAMP14            / Calibration lamp switched off.  [wemmiB]
22:56:12>-MOVE TEL PRESET NTT          / Initiate new tel position       [wt5tcs]
22:57:37> TEL RA = 67.265296           / RA (deg) after move             [wt5tcs]
22:57:38> TEL DEC = -36.328608         / DEC (deg) after move            [wt5tcs]
```

5.1.1 Action records

The general structure of an action record is:
`hh:mm:ss`>-*action_verb category* [*subsystem(s)*] / *comments* [<*source mask*>]

Table 5.1: Logging action verbs

Keyword	Meaning
-ABORT	Abort an executing action (e.g. an exposure)
-PAUSE	Pause an executing action (e.g. an exposure)
-RESUME	Resume a paused action (e.g. an exposure)
-OPEN	Open any system (e.g. a shutter)
-CLOSE	Close any system
-MOVE	Move some piece (e.g. the telescope)
-CHANGE	Change some piece (e.g. a filter in a wheel)
-START	Start or switch on a system (e.g. the exposure)
-STOP	Stop or switch off (e.g. a lamp)
-READ	Start a reading procedure (typically detector readout)
-WRITE	Start a writing procedure

The first keyword in an *action* record is one of the verbs listed in Table 5.1; such keywords start with a dash, and can therefore easily be located, even visually, in the log. If any parameter is required (e.g. move the telescope to some (α, δ) position), an action record is normally followed by one or several *parameter records*. *Subsystem* names are taken from Table 4.5.

5.1.2 Parameter records

A parameter record will have the general structure
`hh:mm:ss`> *category* [*subsystem(s)*] *parameter* [(start_index)]*value(s) /comments* [<*srcmask*>]
where subsystem and parameter names follow the guidelines given in Section 4.3.

5.1.3 Parameter arrays

When necessary, *arrays* of numbers may be logged as several numbers separated by commas. Arrays are recognised by the parenthesised *start_index* preceding the '=' sign, like the `DET PARM` values logged in the log example on page 44.
The *start_index* starts from 1; if all values of the array cannot be recorded in a single line, similar lines with adequate values for *start_index* will be written.
Each value of the array is written in a free-format form, but the values must be separated by commas. Null (non-existent) values are allowed, they are given as a double hyphen `'--'`.

5.1.4 Unforeseen event records

The log files also include the record of events that are considered unforeseen by the control software. Such events are typically the failure of a calibration lamp or loss of time synchronisation.
The record format is
`hh:mm:ss>/UNFORESEEN:` *followed by a succinct description of the error event* [<*src mask*>]
Recovery records are used to signal the success of an action in response to an *unforeseen* event, they have the format
`hh:mm:ss>/RECOVERY:` *followed by a description of a recovery measure* [<*source mask*>]
In some cases it may be desirable to be able to match a recovery log entry to its corresponding unforeseen event. This can be done by filtering log records with the source mask, under the assumption that one single subsystem is issuing only few of such events at a given time.

5.1.5 Alarm records

Alarm events are recorded in the log with the following format
`hh:mm:ss>/ALARM:` *followed by a succinct description of the alarm event* [<*source mask*>]

5.1.6 Comment records

Two different comment record formats are provided. They have the following structure:
`hh:mm:ss>/` *free-format comment up to 50 characters*
or
`hh:mm:ss>/COMMENT NN` *free-format comment, possibly spanning several lines*
where `NN` is a two letter code meaning `'OB'`, `'NA'` or `'SA'` for observer, night assistant and staff/service astronomer respectively.

5.2 Event source mask

The format for the source mask is:
`[<host-name><attribute-1><attribute-2><attribute-3>]`
where

- `<host-name>` is the node name of the workstation or LCU on which the event originates (instrument workstation, telescope workstation, detector LCU, etc.). In test environment, where the node name may be different from the target node name, the target node name should be used. The list of VLT host names is given in [14].
- `<Attribute-i>` are three characters available to generate unique source masks within the same host-used by OS, ICS and DCS to identify multiple instrument arms.

The source mask is mandatory for all reporting systems.

5.3 Log file names

The names of log files shall be assembled according to the following scheme:
`<host-name>.YYYY-MM-DD.<log-type>`
where `<host-name>` is the node name of the computer generating the log file, `<log-type>` is the ESO log type and can take the values: `ops-log`, `cond-log`, `conf-log`, `reduc-log` or `qc-log`. `YYYY-MM-DD` stands for the date of the beginning of the night (ISO 8601 format: year-month-day).

Chapter 6

VLT parameter files

Observation preparation tools provide the means to create and edit *Observation Blocks* as the basic unit of an executable sequence of *Templates*. Each template, in turn, requires a given input configuration or parameter list, described by a so-called *template signature*. These parameters are stored in a format called *Parameter File Format*. Any template corresponds with a certain predefined mode of observation, and has consequently a *Reference Setup File* attached to it. Reference setup-files list the default configuration of all elements in the light path, and are also written in the parameter file format.

Observation blocks can be represented in *Parameter File Format*. They include information on the programme that owns the block, scheduling requirements and links to other blocks. They also include or refer via the templates to *Setup Files* for setting target positions, instrument and detector configurations, all of which can be re-used in a number of observations, e.g. when a list of target pointings are to be observed with the same instrumental configuration.

From the observation block information, the VLT Control Software (VCS) will eventually generate setup-commands for its own operations. Doing so it will complement the information contained in the reference setup-file corresponding with the running template.

6.1 Parameter File format

Many VLT files containing control information are written in the Parameter File Format. This is the case for e.g. setup-files, instrument configuration files and template parameter files. These files consist of a mandatory header and parameter records. Their syntax is optimised for fast parsing by the VLT Control Software and therefore it differs from other formats described in this document (see [15]).

A parameter record is written with the following syntax:

`<short FITS keyword>` *value*`; [#` *comment*`]`

where

- `<short FITS keyword>` is an ESO keyword following the same naming convention as defined in Section 4.3 except that for technical reasons the subsystems, categories and parameters of hierarchical keywords are connected by dots `'.'` rather than spaces (e.g. `INS.FILT1.NAME` instead of `INS FILT1 NAME`); also, the prefix `HIERARCH ESO` is not used. This syntax is called *short FITS keywords*.

- *value* can be one of the values defined in Section 4.1, however, strings must be enclosed in double rather than single quotes, i.e. `"string"`. The value part must be finished with a semicolon `';'` and must be given on the same line.

  Optional comments can be included at the end of a line by prefixing them with the hash sign (`"#"`).

6.1.1 Parameter File header

The header consists of a number of records identifying the purpose and type of the parameter file. Header records are mandatory. Parameter header records are grouped in the `PAF` category.
Table 6.1 gives an example of a parameter file header.

Table 6.1: Parameter file header keywords

```
PAF.HDR.START;                                  # Marks start of header
PAF.TYPE            "Template Signature";       # Type of parameter file
PAF.ID              "@(#) $Id: VIMOS_img_obs_Jitter.tsf,v 1.5 2001/08/06$"
PAF.NAME            "VIMOS_img_obs_Jitter";     # Name of PAF
PAF.DESC            "Jitter image";             # Short description of PAF
PAF.CRTE.NAME       "mvmgr";                    # Name of creator
PAF.CRTE.DAYTIM     "2001-08-06T14:17:49";      # Civil Time for creation
PAF.LCHG.NAME       "vmmgr";                    # Author of par. file
PAF.LCHG.DAYTIM     "2001-08-06T14:17:49";      # Timestamp of last change
PAF.CHCK.NAME       "vmmgr";                    # Name of appl. checking
PAF.CHCK.DAYTIM     "2001-08-06T14:17:49";      # Time for checking
PAF.CHCK.CHECKSUM   "hcHjjc9ghcEghc9g";         # Checksum for the PAF
PAF.HDR.END;                                    # End of PAF Header
#-----------------------------------------------------------------------
TPL.INSTRUM         "VIMOS";                    # Instrument
TPL.MODE            "imaging";                  # Mode of observation
TPL.VERSION         "@(#) $Revisions: 1.5 $";# Version of the template
TPL.ID              "VIMOS_img_obs_Jitter";     # Template signature ID
TPL.REFSUP          "VIMOS_img_Generic.ref";    # Reference Setup File
TPL.PRESEQ          "VIMOS_img_obs_Jitter";     # Sequencer script
TPL.GUI             "";                         # Template GUI panel
TPL.TYPE            "science";                  # Keyword type
TPL.EXECTIME        "computed";                 # Expected execution time
TPL.RESOURCES       "";                         # Required resources
#-----------------------------------------------------------------------
TPL.PARAM           "DET.WIN1.UIT1";            # Next template parameter
DET.WIN1.UIT1.TYPE  "number";                   # Keyword type
DET.WIN1.UIT1.RANGE "0.001..100000";            # Valid range
DET.WIN1.UIT1.DEFAULT"Nodefault";               # Default value
DET.WIN1.UIT1.LABEL "Exposure time";            # Label used in P2PP
DET.WIN1.UIT1.MINIHELP"Exposure time for each subframe";# Short help
```

The keyword `PAF.TYPE` identifies the kind of parameter file. It must take one of following the values:
`"Reference Setup"`

```
"Instrument Setup"
"Detector Setup"
"Telescope Setup"
"Reference Configuration"
"Configuration"
"Ambient Data"
"Template Signature"
"OB Description"
"Pipeline Result".
```

It is also possible to write a verbose description of the parameter file within the header. This description must be written as a number of description lines:

```
PAF.DESC <description heading>;
PAF.DESC <description line 2>;
PAF.DESC . . .
PAF.DESC . . .
```

The keyword `PAF.CHCK.CHECKSUM` provides a way by which the parameter files are protected against changes. The checksum is computed and written by the checking application according to the algorithm given in Section 4.3.

The header always starts with a `PAF.HDR.START` keyword and finishes with `PAF.HDR.END`.

Reference setup files can contain after the header a so-called *protected region*, which is a list of setup parameters which should not be overridden in this particular mode of observation. This region starts with a `PAF.PROT.START` keyword and finishes with `PAF.PROT.END`.

Chapter 7

Data Interface Dictionaries

The ESO Data Interface Dictionaries (DID) include the specification of all parameters used in a particular context. A specific dictionary is defined by its scope. e.g. a given instrument, observatory site, etc.
In the course of the history of a given system, e.g. an instrument, the data interface for that system may change as new keywords become necessary or modifications to old ones are made. In order to keep an archive of keywords, Data Interface Dictionaries are maintained under configuration control.
Data Interface Dictionaries are submitted for approval to the ESO DICB. The DICB maintains all dictionaries and amendments to them.

7.1 Format specification

The Data Interface Dictionary contains a DID Identification Record as the first record of the document and as many parameter description records as needed. A record is a set of lines each containing a field name and its value formatted in the following way (lines are restricted to 80 characters maximum):

```
<field name>:  <field value>
```

Records are separated by one or more empty lines. Comment lines can be included if starting with a hash sign ('#').

GUIDELINE 32 When the dictionary is stored as a file on a computer system the file name should be equal to the dictionary name (see below).

7.2 DID Identification Record

The DID identification record includes the following fields:

```
Dictionary Name:   ESO-VLT-DIC.<scope>
Scope:             <scope identifier>
Source:            <source identifier>
Version Control:   <configuration control version number>
Revision:          <version number>
Date:              <YYYY-MM-DD>
Status:            <release status>
Description:       <free text revision history, possibly spanning more
```

```
than one line>
```

GUIDELINE 33 The fields `Revision`, `Date`, `Status` and `Description` are repeated for each revision of the dictionary.

The following rules apply to the fields:

- the dictionary name is built as `ESO-VLT-DIC.<scope>-<version>`. It is therefore expected to have e.g. `ESO-VLT-DIC.FORS-1.34`, `ESO-VLT-DIC.TEL-2.5`, etc.;
- the scope identifier designates for which part of the overall data system the dictionary applies;
- the source must be the name of the person, organisation or consortium submitting the dictionary;
- the version control number should be automatically assigned by the configuration control software. This is accomplished by inserting the RCS tag `"@(#) $Id$"`;
- the revision number and date is assigned by the source;
- the date in which the DID is effective is assigned by DICB;
- the status is either `draft`, `submitted` or `released`;
- the description text may span over more than one line but it cannot include empty ones. It is suggested that it contains the revision history.

Example DID identification record:

```
Dictionary Name:   ESO-VLT-DIC.PRO
Scope:             PRO
Source:            ESO DFS/DMD
Version Control:   "@(#) $Id: ESO-VLT-DIC.PRO,v 1.12 2001/06/21 13:55:08 vltsccm Exp $"
Revision:          1.10
Date:              2001-03-07
Status:            submitted
Description:       Date field made ISO 8601 conform
Revision:          1.11
Date:              2001-03-12
Status:            submitted
Description:       Index j renamed to i
                   DATAMIN, DATAMAX removed
Revision:          1.12
Date:              2001-03-23
Status:            submitted
Description:       keywords PRO DATAMEAN, PRO DATAMEDI and
                   PRO DATASIG renamed for DICD compliance
```

7.3 DID Parameter Records

Parameter records include the following fields:

```
Parameter Name:   [<category> [<subsystem>] ]<parameter>
Class:            <class identifier>[|<class identifier>]
Context:          <context identifier>[|<context identifier>]
Type:             <the type of the parameter>
Value Format:     <format (ANSI C standard printf convention)>
Unit:             <SI or derived SI units as a text string>
Comment Format:   <standard comment>
Description:      <free text description of this parameter, possibly
                  spanning several lines>
```

The following rules apply to the fields:

- The subsystem and parameter elements of the parameter name may contain a suffix `i`, which is a placeholder for an integer describing multi-dimensional subsystems or parameters.

- The class can be any combination of the following separated with '`|`':

`setup`	keyword appears in a setup operation
`header`	keyword appears in science headers
`prim-header`	keyword appears in a primary header unit
`ext-header`	keyword appears in an extension header unit
`maint-header`	keyword appears in maintenance headers
`template`	keyword appears in a template script or signature file
`conf-log`	keyword appears in the configuration log
`cond-log`	keyword appears in the conditions log
`ops-log`	keyword appears in the operations log
`reduc-log`	keyword appears in the reduction log
`qc-log`	keyword appears in the quality control log
`config`	keyword appears in a configuration description
`private`	keyword is used only internally by the subsystem

- The context is the overall category to which the keyword belongs, for examples `instrument` or `telescope`.

- The type can be either `string`, `logical` (Booleans), `integer` or `double`.

- The value format defines the precision and representation of the value. For a string the precision defines the maximum length. The definition used for the ANSI-C function call `printf()` is applied for the format with the exception that the `"G"/"g"` option is forbidden. For booleans the value must be either `T` or `F` and the format will be `%c`.

- The unit can take one of the values of Table 8.1.

- The comment field gives a brief description of the keyword's meaning. It can include one of the replacement tags listed in the table below

	Unit					
Tag	s	mjd	deg	rad	arc min	K
%TIME	●					
%DAYTIM	●	●				
%DEGREE			●	●	●	
%HOURANG			●	●	●	
%CELSIUS						●

The tag gets replaced by the edited value of the keyword when the keyword is written to the header or log file.

- The field `Comment Format:` may also be named `Comment Field:`
- the description field includes the semantic meaning associated to this parameter.

GUIDELINE 34 Every dictionary must contain a parameter record describing the dictionary itself. It should look as follows:

```
Parameter Name:   <category> DID
Class:            <whatever is applicable>
Context:          <context identifier>
Type:             string
Value Format:     %30s
Unit:
Comment Format:   Data dictionary of <category>
Description:      Name-version of ESO DID to which <category>
                  keywords comply
```

The class should comprise the classes of all keywords defined in the dictionary. Accordingly, the keyword itself should be written to all subsystems described by the classes.
For example, the `DID` keyword describing the `PRO` dictionary release 1.14 is called `PRO DID` and a FITS header record for this keyword should look as follows:

`HIERARCH ESO PRO DID ='ESO-VLT-DIC-PRO-1.14' / Data dictionary for PRO`

It is written to the FITS header of all pipeline products (`Class = header`).

GUIDELINE 35 By convention, the comment part of the FITS/LOG/etc. record is appended the name of the physical unit in parentheses, if applicable (see example below).

An example of a parameter record is:

```
Parameter Name:   INS SLIT1 WIDTH
Class:            setup|header
Context:          Instrument
Type:             double
Value Format:     %.2f
```

```
Unit:               arcsec
Comment Format:     Width of slit 1 [arcsec]
Description:        Width of the slit in seconds of arc.
```

An example of a FITS header record for this keyword could then be:

```
HIERARCH ESO INS SLIT1 WIDTH = 2.51 / Width of slit 1 (arcsec)
```

Chapter 8

Physical Units

Physical units used in a DID must comply with basic or derived SI units, per IAU recommendation. A few exceptions are allowed for special units which are more convenient for astronomy.

Table 8.1: Physical units allowed for ESO DIDs

Quantity	**Unit String**	**Meaning or use**
	SI base & supplementary units	
length	`m`	meter or other derived SI units, e.g. `mm`, `mum` (i.e. μm), `nm`
mass	`kg`	kilogram
time	`s`	second of time (incl. sidereal time if appropriate)
plane angle	`rad`	radian
solid angle	`sr`	steradian
temperature	`K`	kelvin
electric current	`A`	ampere
	IAU-recognised derived units	
frequency	`Hz`	hertz
energy	`J`	joule
electric potential	`V`	volt
force	`N`	newton
pressure, stress	`Pa`	pascal
	Additional units allowed	
position or plane angles	`deg`	degrees of arc
dimension on the sky	`arcmin`	minutes of arc
offsets on the sky	`arcsec`	seconds of arc
magnitude	`mag`	magnitude (at given wavelength)
flux	`Jy`	jansky ($10^{-26} W m^{-2}$Hz^{-1})
wavenumber	`cm^-1`	wavenumber (used in interferometry)
angular spatial frequency	`arcsec^-1`	UV plane parameter (used in interferometry)
temperature	`C`	centigrade (degrees celsius)
pixel	`pixel` or `pix`	pixel
unit of A/D converter	`adu`	unit of A/D converter
encoder unit	`Enc`	Encoder unit

Chapter 9

Naming convention for optical components

This section describes how optical components in use at the VLT telescopes are named and identified.
Such identifiers are used:

- by astronomers when selecting a particular observing configuration;
- by operations staff when setting up the requested optical elements for the upcoming night;
- by operations staff when operating instruments and performing service observations;
- by VCS when writing FITS keywords on the data headers;
- by pipeline software when performing standard data reduction;
- by astronomers when reducing data off-line;
- by archive users who prepare archive research programmes.

Astronomers are likely to use names while observatory staff will mostly use identifiers. The convention described in this section was developed with the aim of facilitating all of the tasks mentioned above while at the same time maintaining the discipline needed in order to handle the few hundred elements that will be used at the VLT.
This naming convention will be applied to all VLT instruments.

9.1 Identification scheme

GUIDELINE 36 Each optical element, i.e. filters, grisms, etc., in use at any VLT, NTT or other VLT compliant instruments shall have a unique identifier and a verbose name.

Identifiers are typically sequential numbers which are given to each element when acquired. These identifiers are recorded in the keyword `ID`, e.g. `FILT ID`, `GRIS ID` or `OPTIi ID` (see Section 4.11 for more details). The `ID` serves as the reference to the full characterisation file (e.g. transmission and efficiency curves of filters and grisms etc.) which is the authoritative source of information for each component.
Verbose names are recorded in the keyword `NAME` (e.g. `FILT NAME`, `GRIS NAME` or `OPTIi NAME`) and follow the scheme described in Section 9.3.

GUIDELINE 37 Identifiers of elements that cease to exist (e.g. a broken filter) are retained in order to ensure the historical validity of the Science Archive.

GUIDELINE 38 Instrument Consortia who prepare Data Interface Dictionaries must foresee for the corresponding keywords at least 10 characters space for the `ID` keyword and 30 characters for the `NAME` keyword.

9.2 Usage of the `OPTIi` keywords

`OPTIi` keywords are used to setup the internal functions of the instrument and to record instrument engineering parameters usually on the operations and configurations logs (see description in Section 4.11).
The allowed `OPTIn TYPE` values are:

MIRROR	FABRYPEROT
FILTER	SLIT
GRISM	MASK
GRATING	FOCUSWEDGE
ECHELLE	HARTMANN
WOLLASTON	RETARDER
BEAMSPLITTER	DICHROIC
FIBER	LENS
PRISM	FREE (nothing mounted in the slot)

9.3 Naming scheme

This section describes the scheme applied when assigning a name to optical elements.

GUIDELINE 39 Optical elements have a *technical* name that describes its major physical characteristics and may have a short, commonly used conventional name.

Technical names describe the element independently of its context (camera or instrument). The basic rule for technical names is to prefix the name with a four letter mnemonic of the element in question followed by some of its optical characteristics. Conventional names are typically used in user interfaces.

GUIDELINE 40 Values for wavelengths and other characteristics are rounded to the nearest integer except for slit widths (see below).

9.3.1 Filters

Filters will be characterised by

- conventional names:
  - the commonly known name, e.g. `K`, `OG590`, `OIII/3000`, when applicable;
  - the system and the name within that system, e.g. `U_BESS`, `U_STRM`;
- technical names:

  - FILT_<*central wl in nm*>_<*FWHM in nm*> for general filters (at arbitrary wavelengths);
  - FILT_VARi for variable filters; i is a serial number;
  - FILT_<*50%wavelength in nm*>_<*cuton/-off*> for long-/shortpass filters, where <*cuton/-off*> is L for longpass filters or S for shortpass filters;

9.3.2 Grisms

Grisms will be characterised by

- GRIS_<*#grooves/mm*><*characteristic letter*>
  where <*characteristic letter*> indicates the approximate central wavelength (e.g. R, B).

9.3.3 Gratings

Gratings will be characterised by

- GRAT_<*#grooves/mm*><*characteristic letter*>
  where <*characteristic letter*> indicates the approximate blaze wavelength (e.g. R, B) or none if the grating is unblazed.
- ECHE_<*#grooves/mm*><*characteristic letter*>
  where <*characteristic letter*> indicates the approximate wavelength of use (e.g. R, B).

9.3.4 Wollaston prisms

Wollaston prisms will be characterised by

- WOLL_<*separation angle in arcmin*>

9.3.5 Retarder plates

Retarder plates will be characterised by

- RETA2 for lambda/2, RETA4 for lambda/4 plates.

9.3.6 Fabry-Perot etalons

Fabry-Perot etalons will be characterised by

- FPET_<*finesse*>
  where <*finesse*> is the dimensionless number characterising the resolving power of the Fabry-Perot interferometer.

9.3.7 Slits

Fixed width slits (e.g. in a punched plate) will be characterised by

- SLIT_<*width in arcsec*>

where <*width in arcsec*> is given with one decimal digit (e.g. 1.5 or 0.5).
Variable width slits, such as those on a decker or with a motorised function are named

- SLIT_DEKKER or SLIT_FUNCTION

Chapter 10

File Naming Convention

10.1 File names for frames

The names of frames are used by a variety of persons at different times, e.g.:

- the astronomer/operator to manage the data obtained during the run;
- the Data Flow Operations team to track programme completion and quality control the exposure levels;
- the Science Archive Operations team to check safe storage of the data, to maintain the data holdings and to service requests for archive data;
- the User Support team to answer queries from users after observations.

The requirements for file names from various users are vastly different, therefore ESO adopts several schemes for naming the data frames.

10.1.1 FITS files delivered to end users

TBD

10.1.2 FITS files used internally within the Data Flow System

The requirements for file names for Data Flow Operations can be summarised as follows. File names:

- shall be unique through the history of the VLT,
- should be easy to check against logs,
- should be easy to recreate in the case of directory/disk/media corruption (e.g. after being moved to “lost+found” directory)
- can be grouped into “nights” without additional information.

The scheme chosen for FITS file names is based on the time of start of exposure (given through the `MJD-OBS` keyword).
This scheme has the following advantages:

- names are easy to create and recreate by taking the `MJD-OBS` value;
- the “night” directory can be automatically generated together with the filename (one system call);
- simplicity: does not require extra processes or procedures;
- easily expandable to both VCS and DFS;
- names are easy to check in the operations log (`START EXP` event);
- data re-play (in Garching) is straightforward.

In this scheme the file names take the form (using ISO 8601 format for the time tag):

`<INS-PREFIX>.YYYY-MM-DDThh:mm:ss.sss.fits`

A TEL/INS prefix warranties the uniqueness of the name. The prefix itself is 4-10 characters long.
Examples:
`FORS2.2000-12-19T09:57:51.333.fits` (corresponds to `MJD-OBS=51897.41517746`)
`UVES.2000-03-14T09:14:24.988.fits` (corresponds to `MJD-OBS=51617.38501143`)
FITS files generated by the pipeline follow a similar scheme:

`r.<INS-PREFIX>.YYYY-MM-DDThh:mm:ss.sss_<iiii>.[t]fits`

or

`r.<INS-PREFIX>.YYYY-MM-DDThh:mm:ss.sss_tpl_<iiii>.[t]fits`

The first case refers to a FITS file which was created by a pipeline recipe as a result of a single input frame, the second case describes a file which results from the reduction of a set of frames created by an observation template. `<iiii>` is a four-digit integer which is automatically created by the pipeline.
ASCII dumps of FITS file headers will preserve the original frame’s file name, with ‘`[t]fits`’ replaced with ‘`hdr`’.

10.2 File names for files used internally within the VLT Control System

The scheme is described in [16].

10.3 File names for template scripts and signature files

The scheme is described in [16].

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Appendix A

Terms of Reference of the ESO Data Interface Board

This appendix reproduces here ESO Document GEN-TRE-ESO-19400-1138/1.0, Issue June 30, 1996, for convenience only.

A.1 Purpose and scope

The ESO Data Interface Control Board (DICB) will promote the standardisation of, and enforce configuration control on data structures:

1. used by ESO to deliver data products of any kind to the astronomical community,
2. needed by users of ESO facilities to submit observation related information to the organisation
3. flowing through the Data Flow System.

The data interface covers data and file formats, naming conventions, meanings and physical units when applicable. Examples include:

- the definition of all FITS headers of exposures acquired with ESO telescopes. In particular the keyword names (and possibly aliases), their meaning, format and physical units of their values if applicable;
- the definition of all data structures that represent and report events in the operations log. In particular the format of the log, name of events, their meaning, format and physical units of their values if applicable;
- the definition of all data structures needed for calibration purposes. In particular the format of tables, lists and other data collections describing instrumental characteristics, laboratory and astrophysical data, names of elements, their meaning, format and physical units of their values if applicable;
- the definition of all data structures applied to store data that has been calibrated using ESO standard reduction procedures;
- the definition of formats for target and instrument setup information as part of an observation preparation phase.

The board will maintain a list of existing specifications and identify those areas in which definitions do not exist. Existing specifications will be reviewed when applicable and updates will be commissioned. In those areas in which specifications do not yet exist, the board will invite a relevant group to produce a draft specification. The board should work out specifications in the following order of priorities:

1. definitions needed by the VLT project,
2. definitions needed within normal observatory operations.

The board will review new specifications and/or additions and changes to them, validate data products during the commissioning of instruments and their modes and coordinate the implementation schedule of data products.
The board establishes a control procedure which is described below.

A.2 Control Procedure

Requests for changes or additions to the Data Interface must be submitted to the DICB for approval. Any such request must be adequately documented and include at least one justification note. Requests will be submitted to the DICB chairperson who will distribute the documentation to the board members and include the request in the next meeting's agenda.
For new Data Interface definitions, the board shall invite relevant persons to prepare and submit specifications to be discussed and approved by the board.
The board shall aim at approving requests unanimously.
Upon approval of a given request the DICB will issue an amended Data Interface Control document and update the DICB definitions database (see Section A.5 below).
The decision on a given request shall in general, not be taken later than two months after its submission.
The board will solicit sample data products from instrument development teams at several stages during development and commissioning. These sample data products will be validated against compliance and a report submitted to the team.

A.3 Membership and organisation of meetings

The following groups shall be represented in the DICB:

- Instrumentation Division
- VLT Software Group
- Paranal Science Operations
- DMD Data Flow Systems Group
- DMD Data Flow Operations Group
- DMD Operations Technical Support Group

- La Silla Science Operations

The board designates a chairperson who will collect change requests, call the meetings and produce the minutes. The board shall choose a suitable way to conduct voting (e.g. e-mail).

A.4 Implementation of changes and additions

The implementation schedule for each change and/or addition to the Data Interface shall be coordinated by the DICB and a target implementation deadline shall be issued.
The DICB shall coordinate test and verification of changes and flag the corresponding status in the DICB definitions database (see below).

A.5 The Data Interface Control reference

The DICB shall issue and maintain a Data Interface Control (DIC) document. The DMD Data Flow Operations Group shall maintain a definitions database containing all keywords, data structures and formats included in the DIC. This database shall be available on-line for consultation by the community.

Appendix B

Mandatory header keywords

This appendix lists mandatory header keywords. These keywords are mandatory in the sense that they must be present in the header when applicable, that is when the parameter in question plays a role in the acquisition of the frame. Parameters not used for the exposure do not appear in the header even though present in the list below (e.g. no `TEL` keywords are included in bias frames).
WCS keywords (`CTYPEi`, `CRPIXi`, `CRVALi` and `CDi_j`) should be present only if the HDU does contain data.
Values of the mandatory FITS header keywords: `SIMPLE`, `BITPIX` and `NAXIS`, and, if applicable, `NAXISn`, `XTENSION`, `PCOUNT`, `GCOUNT` and `EXTEND` must be written in FITS fixed format.

B.1 Basic keywords

B.1.1 Primary header

```
SIMPLE  =                    T / Standard FITS format (NOST-100.0)
BITPIX  =                   %d / # of bits storing pix values
NAXIS   =                   %d / # of axes in frame
NAXIS1  =                   %d / # of pixels along x
NAXIS2  =                   %d / # of pixels along y
EXTEND  =                    T / Extensions may be present
BZERO   =                   %f / real=fits-value*BSCALE+BZERO
BSCALE  =                   %f / real=fits-value*BSCALE+BZERO
BLANK   =                   %d / Value used for NULL pixels
INSTRUME=                   %s / Instrument used
TELESCOP=                   %s / ESO Telescope designation
OBJECT  =                   %s / Target description
OBSERVER=                   %s / Name of observer
ORIGIN  =                   %s / European Southern Observatory
PI-COI  =                   %s / Name(s) of proposer(s)
EXPTIME =                   %f / Total integration time (sec)
RA      =                 %.6f / %HOURANG RA (J2000.0) pointing (deg)
DEC     =                 %.5f / %DEGREE DEC (J2000.0) pointing (deg)
EQUINOX =                 %.0f / Standard FK5 (years)
RADECSYS=                   %s / FK5
DATE    =                   %s / Date this file was written
MJD-OBS =                 %.8f / Obs start %DAYTIM (days)
DATE-OBS=                   %s / Date the exposure was started
```

```
TIMESYS =                      %s / Time system used
LST     =                    %.3f / %TIME LST at start (sec)
UTC     =                    %.3f / %TIME UTC at start (sec)
CTYPE1  =                      %s / pixel coordinate system
CTYPE2  =                      %s / pixel coordinate system
CRVAL1  =                      %f / Coordinate value of ref pixel
CRVAL2  =                      %f / Coordinate value of ref pixel
CRPIX1  =                      %f / Ref pixel in X
CRPIX2  =                      %f / Ref pixel in Y
CD1_1   =                      %f / Transformation matrix element
CD1_2   =                      %f / Transformation matrix element
CD2_1   =                      %f / Transformation matrix element
CD2_2   =                      %f / Transformation matrix element
CHECKSUM=                      %s / HDU checksum
DATASUM =                      %s / data unit checksum
```

B.1.2 Extension header

```
XTENSION=                      %s / extension  (fixed format)
BITPIX  =                      %d / # of bits storing pix values
NAXIS   =                      %d / # of axes in frame
NAXIS1  =                      %d / # of pixels along x
NAXIS2  =                      %d / # of pixels along y
PCOUNT  =                       0 / must be zero
GCOUNT  =                       1 / must be one
INHERIT =                       T / Primary header keywords are inherited
TFIELDS =                      %d / # of table columns                 [in tables]
TTYPEi  =                      %s / column name                        [in tables]
TFORM1  =                      %s / column data format                 [in tables]
TUNIT1  =                      %s / column units                       [in tables]
CTYPE1  =                      %s / pixel coordinate system
CTYPE2  =                      %s / pixel coordinate system
CRVAL1  =                      %f / Coordinate value of ref pixel
CRVAL2  =                      %f / Coordinate value of ref pixel
CRPIX1  =                      %f / Ref pixel in X
CRPIX2  =                      %f / Ref pixel in Y
CD1_1   =                      %f / Transformation matrix element
CD1_2   =                      %f / Transformation matrix element
CD2_1   =                      %f / Transformation matrix element
CD2_2   =                      %f / Transformation matrix element
CHECKSUM=                      %s / HDU checksum
DATASUM =                      %s / data unit checksum
```

B.2 Telescope

```
HIERARCH ESO TEL ID          =        %30s / Telescope Control SW ID
HIERARCH ESO TEL DID         =        %30s / Data dictionary for TEL
HIERARCH ESO TEL DATE        =        %10s / TCS installation date
HIERARCH ESO TEL ALT         =        %.3f / Tel ALT angle at start (deg)
HIERARCH ESO TEL AZ          =        %.3f / Tel Azimuth at start (deg)
HIERARCH ESO TEL GEOELEV     =        %.0f / Elevation above sea level (m)
HIERARCH ESO TEL GEOLAT      =        %.4f / Tel geographic lat (+=North) (deg)
HIERARCH ESO TEL GEOLON      =        %.4f / Tel geographic lon (+=East) (deg)
```

```
HIERARCH ESO TEL OPER        =        %30s / Telescope Operator
HIERARCH ESO TEL CHOP POSANG =        %.3f / Posang of chopping (N=0 E=90) (deg)
HIERARCH ESO TEL CHOP ST     =          %c / TRUE when chopping active
HIERARCH ESO TEL CHOP THROW  =        %.3f / Chopping throw (arcsec)
HIERARCH ESO TEL CHOP FREQ   =        %.0f / Chopping frequency (Hz)
HIERARCH ESO TEL CHOP CYCL   =          %d / # chopping cycles
HIERARCH ESO TEL FOCU ID     =        %10s / Telescope focus station ID
HIERARCH ESO TEL FOCU LEN    =        %.3f / Focal length (m)
HIERARCH ESO TEL FOCU SCALE  =        %.3f / Focus scale (arcsec/mm)
HIERARCH ESO TEL FOCU VALUE  =        %.3f / M2 setting (mm)
HIERARCH ESO TEL PARANG END  =        %.3f / Parallactic angle at end (deg)
HIERARCH ESO TEL PARANG START=        %.3f / Parallactic angle at start (deg)
HIERARCH ESO TEL TRAK RATEA  =        %.3f / Tracking rate in RA (mas/sec)
HIERARCH ESO TEL TRAK RATED  =        %.3f / Tracking rate in DEC (mas/sec)
HIERARCH ESO TEL TRAK STATUS =        %10s / Tracking status
HIERARCH ESO TEL AIRM START  =        %.3f / Airmass at start of exposure
HIERARCH ESO TEL AIRM END    =        %.3f / Airmass at end of exposure
```

B.3 Instrument

```
HIERARCH ESO INS ID          =        %30s / Instrument Control SW ID
HIERARCH ESO INS DID         =        %30s / Data dictionary for INS
HIERARCH ESO INS DATE        =        %10s / ICS installation date
HIERARCH ESO INS ADC STATUS  =        %10s / ADC status
HIERARCH ESO INS ADC POS     =        %10s / ADC position
HIERARCH ESO INS OPER        =        %30s / Instrument Operator
HIERARCH ESO INS FILTi ID    =        %10s / Filter i unique id
HIERARCH ESO INS FILTi NAME  =        %10s / Filter i name
HIERARCH ESO INS GRATi POSANG=        %.3f / Grating posang (N=0 E=90) (deg)
HIERARCH ESO INS GRATi ID    =        %10s / Grating unique ID
HIERARCH ESO INS GRATi NAME  =        %30s / Grating common name
HIERARCH ESO INS GRATi DISP  =        %.1f / Grating dispersion (nm/mm)
HIERARCH ESO INS GRATi WLEN  =        %.1f / Grating central wavelength (nm)
HIERARCH ESO INS GRISi POSANG=        %.3f / Grism posang (N=0 E=90) (deg)
HIERARCH ESO INS GRISi ID    =        %10s / Grism unique ID
HIERARCH ESO INS GRISi NAME  =        %30s / Grism common name
HIERARCH ESO INS GRISi DISP  =        %.1f / Grism dispersion (nm/mm)
HIERARCH ESO INS GRISi WLEN  =        %.1f / Grism central wavelength (nm)
HIERARCH ESO INS LAMPi NAME  =        %10s / Lamp name
HIERARCH ESO INS LAMPi EXPTIM=        %.3f / Lamp exp time (sec)
HIERARCH ESO INS MODE        =        %10s / Instrument mode used
HIERARCH ESO INS TEMP        =        %.1f / Instrument temperature (C)
HIERARCH ESO INS PATH        =        %10s / Optical path used
HIERARCH ESO INS OPTIi POSANG=        %.3f / Position angle (N=0 E=90) (deg)
HIERARCH ESO INS OPTIi ID    =        %10s / OPTIi unique ID
HIERARCH ESO INS OPTIi NAME  =        %10s / OPTIi name
HIERARCH ESO INS OPTIi NO    =          %d / OPTIi slot number
HIERARCH ESO INS OPTIi TYPE  =        %10s / OPTIi element
HIERARCH ESO INS MOS SETUP   =        %30s / MOS setup
HIERARCH ESO INS MOSi POSANG =        %.5f / MOSi posang (N=0 E=90) (deg)
HIERARCH ESO INS MOSi WID    =        %.2f / MOSi slit width (arcsec)
HIERARCH ESO INS MOSi LEN    =        %.2f / MOSi slit length (arcsec)
HIERARCH ESO INS MOSi RA     =        %.8f / RA of slit (deg)
```

```
HIERARCH ESO INS MOSi DEC    =        %.8f / DEC of slit (deg)
HIERARCH ESO INS SLIT WID    =        %.2f / SLIT width (arcsec)
HIERARCH ESO INS SLIT LEN    =        %.2f / SLIT length (arcsec)
HIERARCH ESO INS SLIT POSANG =        %.3f / SLIT posang (N=0 E=90) (deg)
HIERARCH ESO INS SLIT RA     =        %.8f / RA of slit (deg)
HIERARCH ESO INS SLIT DEC    =        %.8f / DEC of slit (deg)
HIERARCH ESO INS PIXSCALE    =        %.3f / Pixel scale (arcsec)
```

B.4 Detector

```
HIERARCH ESO DET DID         =        %30s / Data dictionary for DET
HIERARCH ESO DET ID          =        %30s / Detector Contro SW ID
HIERARCH ESO DET DATE        =        %10s / DCS installation date
HIERARCH ESO DET NAME        =        %10s / Name of detector system
HIERARCH ESO DET CCDS        =          %d / # of CCDs in detector array
HIERARCH ESO DET CHIPi ID    =        %30s / Detector CCD identification
HIERARCH ESO DET CHIPi DATE  =        %30s / Date of installation
HIERARCH ESO DET CHIPi NAME  =        %16s / Detector CCD name
HIERARCH ESO DET CHIPi NX    =          %d / # of pixels along X
HIERARCH ESO DET CHIPi NY    =          %d / # of pixels along Y
HIERARCH ESO DET CHIPi PSZX  =        %.1f / Size of pixel in X (mu)
HIERARCH ESO DET CHIPi PSZY  =        %.1f / Size of pixel in Y (mu)
HIERARCH ESO DET EXP TYPE    =          %s / Type of exp as known to the CCD sw
HIERARCH ESO DET EXP ID      =          %d / Unique exposure ID number
HIERARCH ESO DET EXP DUMDIT  =          %d / # of dummy readouts
HIERARCH ESO DET READ NO     =          %d / # of times the same pixel is read
HIERARCH ESO DET READ MODE   =        %10s / Readout method
HIERARCH ESO DET READ SPEED  =        %10s / Readout speed
HIERARCH ESO DET READ SHIFT  =          %d / # of lines shifted between exp
HIERARCH ESO DET READ CLOCK  =        %10s / Readout clock pattern used
HIERARCH ESO DET OUTPUTS     =          %d / # of outputs
HIERARCH ESO DET OUTREF      =          %d / reference output
HIERARCH ESO DET OUTi X      =          %d / X location of output
HIERARCH ESO DET OUTi Y      =          %d / Y location of output
HIERARCH ESO DET OUTi PRSCX  =          %d / Prescan region in X
HIERARCH ESO DET OUTi PRSCY  =          %d / Prescan region in Y
HIERARCH ESO DET OUTi OVSCX  =          %d / Overscan region in X
HIERARCH ESO DET OUTi OVSCY  =          %d / Overscan region in Y
HIERARCH ESO DET OUTi CF     =        %.2f / Conversion from e- to ADUs (e-/ADU)
HIERARCH ESO DET OUTi GAIN   =        %.2f / Gain for output
HIERARCH ESO DET CHIPi OUTPUTS=         %d / # of outputs
HIERARCH ESO DET CHIPi OUTREF=          %d / reference output
HIERARCH ESO DET CHIPi OUTi Y=          %d / Y location of output
HIERARCH ESO DET CHIPi OUTi PRSCX=      %d / Prescan region in X
HIERARCH ESO DET CHIPi OUTi PRSCY=      %d / Prescan region in Y
HIERARCH ESO DET CHIPi OUTi OVSCX=      %d / Overscan region in X
HIERARCH ESO DET CHIPi OUTi OVSCY=      %d / Overscan region in Y
HIERARCH ESO DET CHIPi OUTi CF=       %.2f / Conversion from e- to ADUs (e-/ADU)
HIERARCH ESO DET CHIPi OUTi GAIN=     %.2f / Gain for output
HIERARCH ESO DET CHIPi OUTi GAIN=     %.2f / Gain for output
HIERARCH ESO DET FRAM ID     =          %d / Image sequential number
HIERARCH ESO DET FRAM TYPE   =        %16s / Type of frame
HIERARCH ESO DET FRAM NAVER  =          %d / Number of images averaged
```

```
HIERARCH ESO DET FRAM BIAS   =          T / bias frame subtraction performed
HIERARCH ESO DET FRAM FLATF  =          T / flat field division performed
HIERARCH ESO DET WINDOWS     =         %d / # of windows readout
HIERARCH ESO DET WINi STRX   =         %d / Lower left pixel in X
HIERARCH ESO DET WINi STRY   =         %d / Lower left pixel in Y
HIERARCH ESO DET WINi NX     =         %d / # of pixels along X
HIERARCH ESO DET WINi NY     =         %d / # of pixels along Y
HIERARCH ESO DET WINi BINX   =         %d / Binning factor in X
HIERARCH ESO DET WINi BINY   =         %d / Binning factor along Y
HIERARCH ESO DET DKTM        =       %.3f / Dark current time (sec)
HIERARCH ESO DET REQTIM      =       %.3f / Requested exposure time (sec)
HIERARCH ESO DET WINi NDIT   =         %d / # of subintegrations
HIERARCH ESO DET WINi UITi   =       %.3f / requested subintegration time (sec)
HIERARCH ESO DET WINi DITi   =       %.3f / actual subintegration time (sec)
HIERARCH ESO DET SHUT TYPE   =       %16s / type of shutter
```

B.5 Adapter

```
HIERARCH ESO ADA POSANG      =       %.5f / Position angle at start (deg)
HIERARCH ESO ADA ABSROT START=       %.5f / Abs rot angle at exp start (deg)
HIERARCH ESO ADA ABSROT END  =       %.5f / Abs rot angle at exposure end (deg)
HIERARCH ESO ADA GUID STATUS =       %10s / Status of autoguider
HIERARCH ESO ADA GUID RA     =       %.5f / %HOURANG Guide star RA J2000.0 (deg)
HIERARCH ESO ADA GUID DEC    =       %.5f / %DEGREE Guide star DEC J2000.0 (deg)
HIERARCH ESO ADA GUID ROT    =       %.5f / Rot of guide probe arm (deg)
```

B.6 ObsBlock

```
HIERARCH ESO OBS DID         =       %30s / Data dictionary for OBS
HIERARCH ESO OBS ID          =         %d / Observation block id
HIERARCH ESO OBS NAME        =       %30s / Observation block name
HIERARCH ESO OBS GRP         =       %30s / linked blocks
HIERARCH ESO OBS PROG ID     =       %20s / ESO programme identification
HIERARCH ESO OBS TPLNO       =         %d / Template seq # in OB
```

B.7 Template

```
HIERARCH ESO TPL DID         =       %30s / Data dictionary for TPL
HIERARCH ESO TPL ID          =       %30s / Template ID
HIERARCH ESO TPL NAME        =       %30s / Template name
HIERARCH ESO TPL SEQNO       =         %d / Template seq # within OBS
HIERARCH ESO TPL NEXP        =         %d / Number of exposures within template
HIERARCH ESO TPL EXPNO       =         %d / Exposure number within template
```

B.8 Raw file categories (originally 'Data Product')

```
HIERARCH ESO DPR CATG        =       %30s / Observation category
HIERARCH ESO DPR TYPE        =       %30s / Observation type
HIERARCH ESO DPR TECH        =       %30s / Observation technique
```

___oOo___