User Guide to the CAFOS 2.2

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1 Overview

The **C**alar **A**lto **F**aint **O**bject **S**pectrograph at the 2.2 m telescope,**CAFOS 2.2**, is a focal reducer which provides the facilities for

DIRECT IMAGING,

SPECTROSCOPY with grisms and a longslit or multi-object masks,

POLARIMETRY (direct and with grisms), and

IMAGING through a Fabry-Pérot-Etalon.

As detector system serves the MPIA CCD camera. Instrument and CCD camera are controlled from a Graphical User Interfaces (GUIs).

Parallel to the data aquisition, a QUICKLOOK package runs on the same computer. It is based on MIDAS and includes two important features:

- Automatic data transfer from the CCD camera and conversion to MIDAS data frames, and
- REMOTE CONTROL of the instrument and the CCD camera.

Many Quicklook commands for instrument setup as well as online analysis of direct imaging and spectroscopic data are available. In addition fully automatic exposure sequences for focussing, calibration and observations are incooperated.

Layout of this GUIDE: This user manual gives a short description of the instrument, describes STARTUP and SHUTDOWN procedures, and lines out the operation by typical procedures for instrument SETUP and astronomical OBSERVATIONS.

At the end of this GUIDE there is an APPENDIX which summarizes important parameters and properties of the instrument and lists all commands.

To give you a visual guide line several topics are copied on colored paper:

Red: STARTUP, SHUTDOWN and other procedures which are **vital** to operate the instrument and save the data on tape.

Blue: Setup procedures and examples for typical observational sequences which may help you to understand how to operate the instrument.

Yellow: Command lists.

2 Description and Status of the Instrument

2.1 The Focal Reducer / Spectrograph CAFOS 2.2

The imaging optics of the focal reducer consists of the collimator ($f = 310$ mm) which re-images the entrance pupil of the telescope in a secondary pupil of 40 mm diameter. A camera optics ($f = 163$ mm) focusses the beam onto the CCD detector (see Fig. A-1 in the Appendix). Thus the plate scale is reduced from 85.4 μm/arcsec to 45.32 μm/arcsec (i.e. from $f/8.0 \rightarrow f/4.2$). Since there is no space between the last lens of the camera (a biconcave field flattening lens) and the entrance window of the CCD dewar we had to place the shutter in front of the flattening lens, that is *inside* the instrument. A filter wheel with 12 positions (50 mm filter diameter) is placed directly in front of the shutter. The focus shift which is introduced by the filters is compensated by moving the main body of the camera (two tripletts and a single lens, see Fig. A-1) towards the secondary pupil. The instrument control automatically applies the appropriate focus shift when a filter is selected. In the collimated beam, near the pupil, 8 grisms can be moved in by rotation of the grism wheel (for their resolution and wavelength coverage see table A-1 in the appendix). In the grism wheel also a Lyot stop and a *narrow* pupil stop are available. In order to enable a narrow spectral resolution of extended objects and to reduce the sky background three different aperture mask can be inserted at the (first) telescope focus:

(1) A longslit of tuneble width ($30 \ldots 1000\,\mu$m = 035 …12") and a length of > 50 mm (= 9').

(2,3) Two focal plane masks which can be inserted by the user (during the night) in order to do multi-object spectroscopy.

Both the movement of the aperture mask and the rotation of the grisms are controlled by very accurate (absolute) encoders. Thus any spectroscopic configuration is reproduced to a fraction of a 15 μm pixel (0.33 arcsec) even after a complete reconfiguration of the instrument (*e.g.* for direct imaging in between spectroscopic observations). The mechanical stability is such, that the overall flexure of the different components (*e.g.* aperture unit, mounting of the optics, chip holder, *etc.*) does not exceed 15 μm even for extreme positions of the telescope and is $< 10\,\mu$m normally. Anyway an internal calibration unit containing 3 spectral lamps and a continuum lamp enable the wavelength and flatfield calibration at any telescope pointing.

Observations of standard stars and faint galaxies indicate that CAFOS 2.2 is at least 3× faster than the B&S spectrograph at the 2.2 m telescope. The *principal disadvantage* of spectroscopy with the CAFOS 2.2 in comparison with the B&S spectrograph is the fact that you cannot view the slit with the TV guiding unit. Thus the objects have to be positioned on the slit by means of an acquisition exposure, followed by a "blind" offsetting of the telescope. For spectroscopy of faint objects (m

> 18.) for which CAFOS is designed primarily this turns into an *advantage*, actually, since every object for which a decent spectrum can be obtained within a few hours will be visible on a 10 sec acquisition exposure without filter. The QUICKLOOK provides the necessary tools for the positioning.

Instrument Control: Since July 1997 CAFOS is controlled by a **G**raphical **U**ser **I**nterface (GUI). The updated version (January 1998) is much improved. Thus the *Instrument Status* should be more transparent.

New Optics: The new optics has been installed in May 1996. All former problems are solved and the profiles of spectral lines do not change along the dispersion. They are exactly as sharp as the finite slit width permits.

CCD Detectors: Currently, three CCD chips are available:

(i) The SITe-1d $2k \times 2k$ chip (24μm pixel, i.e. $0\farcs53$/pixel). It provides the widest field ($16'$ diameter) and the best performance regarding read-out noise and cosmetics. It is strongly recommend for most applications. This is currently the *standard CCD* for CAFOS2.2.

(ii) The Lor-8o $2k \times 2k$ chip (15μm pixel, i.e. $0\farcs33$/pixel). This is an engeneering chip with many bad columns and dark spots. It provides a field of $11' \times 11'$. ONLY useful for high resolution imaging at *sub-arcsec* seeing.

(iii) The Tek-13c $1k \times 1k$ chip (24μm pixel, i.e. $0\farcs53$/pixel). Backup only if none of the standard chips is available. **No Quicklook** support !

Special Modes:

(a) Imaging spectroscopy with Fabry-Pérot-Etalon: In the collimated beam a unit containing a Fabry-Pérot-Etalon can be mounted (this is alternative to the polarizer unit, see (b)).

Although the Etalon needs the entire free space in the collimated part of the beam, the astronomer may switch between grism- and Fabry-Pérot-spectroscopy within about 20 seconds. The Etalon has a rather moderate resolution of 1.5...2.3 nm and a seperation between adjacent orders of about $20\times$ this value (30...45 nm). Therefore, an order seperation filter of ≤ 30 nm FWHM has to be used in the filter wheel. Currently only a "red" Etalon is available for CAFOS 2.2 which operates in the range 600 nm$< \lambda <$1000 nm. For calibration a special filter (793/14) has to be mounted in the filter wheel.

(b) Polarimetry and Spectro-Polarimetry: For polarimetric observations the Fabry-Pérot-Etalon can be replaced by a polarizer unit consisting of a Wollaston prism and a rotatable, superachromatic $\lambda/2$ plate (for the entire optical band).

Imaging polarimetry in the entire field can be performed by moving in the polarizer and rotating the grism wheel to its free position. The beam seperation between the two polarized images is 18". The background may be reduced by putting a mask with blank and black stripes (18" blank, 18" black, 18" blank, and so on) into one of the mask holders in the aperture unit.

Since the polarizer unit can be combined with any of the 8 spectroscopic grisms the instrument is fully equipped for **spectro-polarimetric** observations.

2.2 The new CCD camera: MPIA-System

Since May'96 CAFOS 2.2 is equipped with a new CCD camera electronics which has been designed and built in the electronic lab of the MPIA. Together with the CAFOS GUI also the new GUI controled CCD camera has been installed. This system allows much more interaction between the main components of the entire system (telescope, TV guider, CAFOS 2.2 and CCD camera).

The GUI is much more user-friendly than the old control system `ccdacq` which run in an IRAF enviroment. The most notable improvments are:

- Simple and quick handling from the graphical user interface,
- quick and error-proof switching between different (pre-defined) CCD configurations (*e.g. binning, read-out area, read-out speed*) by a mouse-click,
- data are stored as FITS files on disk, which allows quick access to any data reduction package,
- short exposure times down to 0.1 sec.

In order to allow a quick inspection of the data and a first analysis *during* a (next) exposure, the data can automatically be transferred to a seperate QUICKLOOK session which runs under MIDAS. Several simple commands are provided which should allow also astronomers who are not familiar with MIDAS to visualize and pre-analyse their data.

3 STARTUP and SHUTDOWN procedures

STARTUP

Switch on the HARDWARE:

1. Make sure that the transmission electronics is on.

2. Switch on the CAFOS electronics at the instrument.
(If you are to the North of the telescope, facing the instrument, it is the box on the RIGHT hand side of the instrument.)

3. Switch on the CCD electronics (box on the LEFT hand side of the instrument).

Login onto pollux:

`username:` `obs22`
`password:` `***` (ask the staff).

Wait for startup of OpenWindows. Besides the Virtual desktop, four windows will appear on both the lower and the upper screen:

Console

2 XTERMS on the lower screen

1 XTERM on the upper screen

To start up the whole system you basically need only **one** of the XTERMs on the lower screen. You have to start the following 4 (optional 5) processes from this XTERM:

1. You start the CAFOS control GUI by:

```
pollux[obs22] > start_cafos
```

This will first display the (old) CAFOS Control Window and show you the actual SETUP and STATUS of the instrument. In this window you can use any CAFOS command as in the old version ! After 10 seconds the CAFOS GUI will show up on the left of the lower screen.

2a. Before you start the CCD control at the beginning of your observing run you should create a personel directory on which your images are stored in FITS format:

```
pollux[obs22] > cd /disk-a/obs22/images
pollux[obs22] > mkdir myarea
pollux[obs22] > cd brings you back to /disk-a/obs22.
```

2b. Now you may start the CCD control by

```
pollux[obs22] > start_ccd
```

After a while, the CCD Control GUI should pop up.

2c. Before you start the first exposure you have to define the `path` for storing your images: use >`Change Output-Filename`.

3. Since SAOIMAGE without running IRAF is almost useless for the observations, you have to start the MIDAS QUICKLOOK:

```
pollux[obs22]> quick
```

This opens the MIDAS foreground window on the lower screen You have to start the MIDAS Session in this window:

```
pollux[obs22]> inmidas -p 11
```

This will create both a DISPLAY window for image display and a GRAPHIC window for line plots on the upper screen. You may use any MIDAS command *plus* some simple `quicklook commands` which are designed to provide a fast estimate of the data quality or help to set up the observations.
Make sure that SAOIMAGE is disabled (use >`Utilities` − > `Quicklook`)

4. After the `midas001>` prompt has arrived in the Foreground window, you have to start the **CCD Receiver** which automatically transfers any new CCD image into MIDAS format. This should be done from the main XTERM by:

```
pollux[obs22] > receive
```

The window of the `MIDAS Background Receiver` process will appear on the upper screen. Every new FITS file will automatically be converted into a MIDAS frame, BIAS will be subtracted and ADUs will be converted into detected photo-electrons. Some statistical analysis will automatically set useful cuts for displaying the image.

5. (Optional) There exists the possibility to run automatic exposure sequences ("high level commands") from MIDAS. [1] In order to proceed with the data analysis in the MIDAS foreground these sequences should run in another background session (e.g. `midas> FFSEQ/DUSK`). Again, this should be started from the main XTERM by:

```
pollux[obs22] > expo
```

The window of the `MIDAS Background Exposure` process will appear on the upper screen.

The high level commands started in the Foreground window (e.g. `FFSEQ/dusk` will send a request to the Exposure Background which will run them without halting the Foreground monitor.

6. At the beginning of your observing run you should make sure that the **Instrument Setup** of CAFOS 2.2 is correct (see section 5. for details).

O.K.: now you are ready for observing !

[1] Some of these "high level" commands even interact with the TV guider. See Appendix E how to establish the connection.

SAVE of CCD–data on DAT:

For tape copies you have to use the POLLUX DAT drive in the computer room on the first floor. You may either use `tar` or the `fitscopy` which produces a standard FITS `tape` by using the `unix: dd` command (if `fitscopy` is not known to your process you have to install it by `pollux> getastro caha`). Type

`pollux> fitscopy` (no parameters)

to get an explanation how to use the procedure.

SHUTDOWN

1. The QUIT button in the CAFOS GUI is not fully operating! Thus, at the end of the observations you should set CAFOS into its sleep configuration by `FREE ALL` and only after execution >`QUIT`.

2. Leave the CCD control by `QUIT`.

3. Leave the MIDAS session by

   ```
   midas999> bye
   pollux > logout
   ```

   and QUIT (both) Background window(s) with the mouse.

4 How to Operate the Instrument

Astronomical observations with the CAFOS 2.2 require that one operates three components, the control of which is distributed between three programs (CAFOS and CCD GUIs and MIDAS Foreground on lower screen):

(1) the focal reducer / spectrograph **CAFOS 2.2**

(2) the **CCD-Camera** including the shutter,

(3) the **Quicklook** (MIDAS foreground and background sessions).

Although most astronomical observations require to operate the three components jointly, in the following the operation of each component is described seperatly. You may get a better idea of the operation of the entire system by reading through the procedures for instrument setup and typical observing procedures which are given in sections 5. and 6 (green pages).

4.1 Operating CAFOS 2.2

General Remark: The CAFOS GUI is based on standard tools provided for the EPICS data base. Select windows (e.g. >`Filter`) have to be clicked with the RIGHT mouse button. An important "feature" of the system is that it will not take any action when the user tries to change to a position which has already been reached previously. Since CAFOS can be controlled *remotely* the data base sometimes only "thinks" that e.g. the filter `Red` is in while in fact `Blue` is in the beam. So, always check the instrument status whether your selection caused any action. If not you have to choose another item and then go back to the one you really want.

As outlined in section 2.1 CAFOS 2.2 consists essentially of 6 components:

- The **focal reducer optics** – collimator and camera. The internal focus of the instrument is adjusted by moving the camera lens towards (focus value increasing) or away from the secondary pupil image. There are three operations which affect the focus:
  - changing the filter: >`Filter` adjusts the focus,
  - directly setting the focus: >`Positions` → `Focus`,
  - setting the *zero value* f_0: >`Setup`.
- The **shutter** which is mechanically a part of CAFOS 2.2 but is controlled by the CCD Acquisition (see 4.2, below).
- The **filter wheel**. Selection of filters is done by:

  > `Filter` → `abc`

  will move in filter `abc` and adjust the camera focus to the value $f_0 + df$ where the focus offset $df > 0$ is defined in the table `filter.tab`

The definitions in the actual filter table `filter.tab` have still to be changed in the old CAFOS text window by:

`cafos>` `FTAB` which asks for the filter names and characteristics as well as for the focus offset which has to be determined in advance of the observations (see section 5).

`cafos>` `FILTER ?` displays the list of filters

- The **aperture masks** which are contained in the aperture unit. They are choosen in the

  \> `Aperture` selection.

  There are 4 positions: `FREE, SLIT, MASK-1, MASK-2`. An additional `HOLE` of 50μm diameter can be used for focussing and setup.

  The width of the the longslit `SLIT` can be adjusted by:

  \> `Controls` → `SLIT` which opens up a Slit width control window. the width can be adjusted between 50 and 999 μm (i.e. $0\farcs6$ to $11\farcs7$)

- The spectral and polarimetric **analysers** which may be inserted into the collimated beam between the collimator and the camera. In the *standard configuration* you have 8 grisms available which are selected in the

  \> `Grism` selection.

  At the same position (pupil image) a Lyot stop and a very tight pupil stop (only for coronographic imaging) can be inserted.

- In front of the focal reducer there is a **calibration unit** installed which consists of 4 calibration lamps (3 spectral, 1 continuum) and a movable mirror to reflect the light into the instrument. You may choose the appropriate calibration by

  \> clicking onto on of the `lamp buttons`.

  WARNING: presently the `Mirror` has to be removed seperately after switching off the lamps (press `OUT` button below the lamps).

Besides the standard configuration the observer can choose (well before the observing run) between two non-standard configurations:

- **Imaging spectroscopy with a Fabry-Perot-Etalon** (see section 4.1.1 for details of operation), and
- **Imaging polarimetry** and **spectro-polarimetry** through a $\lambda/2$ plate and a Wollaston prism (see section 4.1.2).

In addition to these optical components and their operation, the instrument control provides several **general commands** which help to operate the instrument:

`FREE ALL`	will move everything out of the beam,
`REMOTE ''ON''`	sets CAFOS in REMOTE control (to accept commands from other programs (e.g. QUICKLOOK)
`REMOTE ''OFF''`	sets CAFOS back to direct control.
`HELP`	will provide some help (not implemented yet)

Another set of commands are designed to enable the **setup of the instrument** before the astronomical observations. They mainly serve to align the optical setup of the instrument, to adjust the instrument focus and define basic instrumental parameters which are used in the instrument control and the Quicklook analysis:

>`Positions` →Positioning	allows to position the Aperture unit to 1 micron and the Grism wheel to 0.02 degrees
>`Setup` →`SETUP`	define Instrument Setup (see section 5).

4.1.1 Operation of the Fabry-Pérot-Etalon

Final description has to be written when the control software is finished (the Etalon did not operate in the last commisioning run). There are two quicklook commands which allow to calibrate the Etalon:

`midas> CSEQ/ETA`	! starts a sequence of calibration ! exposures (using the focus-sequence in `ccdacq`). ! Follow the instructions on the screen !
`midas> CALIB/ETA` [*image*]	! analyses the calibration exposure.

4.1.2 Operation of the polarizer unit

The polarizer unit (which can be mounted *alternatively* to the etalon) consists of a Wollaston prism with fixed beam separation (18.9 arcsec N-S) and a rotatable $\lambda/2$–plate. It is moved in by pressing the `IN/OUT` button. The position angle is controlled in the Polarizer window which can be opened by

> `Controls` → `POLARIZER`

Changing the position angle will move in the polarizer unit (if not in).

`polarizer IN/OUT` removes the polarizers from the beam.

4.2 CCD Acquisition

The CCD control is documented elsewhere (web). What you urgently need to know is the following:

- There are **two types** of exposures:
  - **test** exposures are all named `test0001[.fits]`. Thus any new test exposure overwrites the previous one.
  - **normal** exposures are named according to the convention defined in `Output-Filename: >Change`

    The number of every new exposure is incremented by 1. For the standard use of the MIDAS Quicklook this mode is recommended.
- Although you could use SAOIMAGE as Quicklook system (with very limited capabilities) a full operation of CAFOS with all its facilities requires the automatic data transfer to the MIDAS Quicklook.
  CCD: >`Utilities` →`Quicklook` set Quicklook to "`other`".
- The quick change between different CCD configurations (*binning, read-out area, etc*) is done by loading pre-defined

  `Configuration files`.

  (Currently, standard configuration files are only available for the SITe-1d chip. Use `show *SITe.par` to see them only.)

4.3 Quicklook

The QUICKLOOK system is based on the standard data reduction package MIDAS (= Munich Image Data Analysis System, current Version: Nov 1996). It therefore provides all **standard MIDAS** commands including those of the **context longslit**.

In order to provide both the CAFOS user who is not familiar with MIDAS and the MIDAS expert with a quick and simple check of the quality of the incoming data and to set up the observations several *special QUICKLOOK commands are installed*: They can be devided into three groups:

(1) Commands for the quick inspection of incoming data.

(2) Commands to set up the instrument and/or support the observations (eg. sequence of focus exposures, routines to place an object onto the slit). These also include the possibility to perform any CAFOS command from the MIDAS monitor.

(3) Commands which start automatic exposure sequences.

4.3.1 Quicklook commands for data inspection

In all following commands the *default image* is the last **received** image. So any command without specifying the image will work on this last image !
IMPORTANT NOTE: If you use `test` images you should specify *image* = `test0001` !!!

midas>	`check[/image]` *image*	is designed to give a first idea about the quality of (direct imaging) data. It gives the number of photons received per pixel and checks whether the data are read-out limited.
midas>	`inspect[/image]` *image*	dispays *image* on the upper screen, using standard "cut" values derived from the background noise. Modification of the standard display can be selected by the keys `C` (=cuts), `Z` (=zoom) and `L` ("lookup", that is color table).
midas>	`look[/image]`	permanently displays the last image on the screen. It has to be stopped by `cntrl-C` !
midas>	`clear/ccd`	"clears" the CCD Receiver (for instance if frames have been send but not received since the Receiver was off).

More advanced quicklook commands are

midas>	`focus[/image]` *image*	evaluates a series of focus exposures (see `FSEQ/par` below) to find the optimum focus value.
midas>	`seeing[/image]` *image*	measures the seeing on a direct image (and saves the result in a SEEING log).
midas>	`photometry[/image]` *image*	measures the magnitudes on a direct image. Standard Star magnitudes can directly be compared with tabulated values in order to judge the photometric quality of the night.
midas>	`spectrum[/image]` *image*	carries out a quick extraction, wavelength and flux calibration of spectroscopic observations.

4.3.2 Quicklook commands for instrument setup and observations

As an optimum focus of the entire system (telescope + CAFOS22) requires to focus each of them seperately, there are two commands to perform a SEQUENCE of focus exposures:

midas>	`fseq/cafos`	carries out a focus sequence for the instrument (different setting of the CAFOS focus). The procedure is semi-automatically (please follow the instructions on the screen !)
midas>	`fseq/teles`	carries out a focus sequence for the telescope (different setting of the Telescope focus). The procedure is semi-automatically and controlls the telescope focus and offset (please follow the instructions on the screen !)

These focus exposures can be evaluated with

midas> `focus` *image* analyses focus exposure.

To help with an efficient aquisition and object centering on the slit there are the following commands:

midas>	`offset/slit` *image*	enables to mark an object on an aquisition exposure *image*. The offset between this object and a (clean) position on the longslit is calculated. The necessary telescope offset can automatically be performed and the centering can be checked by a control exposure.
midas>	`offset/axis` *image*	works essentially like `offset/slit`. But the object of interest is centered on the optical axis of the instrument.
midas>	`offset/polar` *image*	Similar `offset/slit` but for the spectropolarimetric Slit mask or the Multi-stripe Mask for imaging polarimetry.

NOTE that all `offset` commands DEMAND that the instrument parameters have been SETUP properly (see next section!)

User-written sequences which include both the control of the instrument and/or the telescope (relativ offsets and focus) are enabled by:

midas>	`cafos[/ima] cmd par`	where `cmd` is any CAFOS command (see 4.1) with its parameters `par`. CAFOS2.2 has to be set to REMOTE before the command is issued.
midas>	`cafos[/ima] local`	sets CAFOS2.2 back to interactive input.

IMPORTANT NOTE: If any of the Quicklook commands listed in this paragraph is aborted (eg. by `cntrl-C` or a wrong input) you have to switch `REMOTE OFF` to set the instrument back in interactive mode !

4.3.3 High Level Commands

To optimize the exposures of **Twilight Flat Fields** there exist automatic exposure sequences which determine the level of the twilight sky, wait for the appropriate brightness and then expose a sequence of Flat Fields in one filter:

midas>	`FFseq/dusk` *parameters*	automatic sequence for Flat Field Exposures. The program waits until a sufficently dark sky level is reached an then exposes N frames, taking into account the dimming of the twilight.
midas>	`FFseq/dawn` *parameters*	As `FFseq/dusk` but for morning twilight (increasing brightness !).

The high level commands are only working if the `Background Exposure` process has been startet (see Startup, Step 5).

4.3.4 Some standard MIDAS commands

There are some simple standard Midas commands which are worth to know:

For *image display:*

`midas> load[/ima]`	loads image on display
`midas> load/ITT` *itt*	loads Intensity Transfer Table (useful are: *itt* = `ramp, neg, log`)
`midas> load/LUT` *lut*	loads Look Up Table. Try: `ramp, heat, rainbow3`
`midas> display/chan` *n*	switch to another display channel, $n = 0, 1, 2, 3$

For *image analysis:*

`midas> stat[/ima]` *ima* `CURSOR`	Simple image statistic in area interactively chosen with cursor. Default image (i.e. *ima* = ?) is the actually displayed image.
`midas> get/cursor`	allows to measure coordinates image display
`midas> center/gauss`	measures accurate positions and width of objects on the displayed image.

Hardcopy on printer:

`midas> copy/display laser_c`	prints a hardcopy of the actually displayed image on laser_c
`midas> copy/graph laser_c`	prints a hardcopy of the graphic window on laser_c

Please use the MIDAS Manual or `midas> help` *command* for a full description.

5 Instrument Setup

For a complete instrument setup (from scratch) several steps have to be carried out. Some of them can be omitted if the instrument has been used in the same configuration before. The most important steps are:

(1) Align the rows of the CCD along the longslit.

(2) Determine the position of the optical axis on CCD detector.

(3) Determine the exact instrument focus.

(4) Setup the instrument with the actual parameters.

(5) Determine focus offset for each filter. Only necessary for filters which have not be used before.

(6) Define the filters in the filter wheel and their focus offsets.

If either the grism wheel or the aperture unit have been removed from the instrument and every two months, the Calar Alto staff should

(7) Check alignment of grisms (dispersion along columns of the CCD).

For spectroscopy with the longslit or with multi-object masks you may have to

(8) Determine the exact position angle of the instrument.

> **Important note:** The correct FITS header of your data and many QUICKLOOK commands (eg. `offset/slit`) depend critically on the correct **Setup** of the instrument parameters (step 4). Although the instrument setup is normally done by the staff, it is recommended to check the setup parameters at the beginning of your observing run (>`setup`).

On the following pages it is described briefly how the steps (1)–(8) should be carried out in practice. (A more detailed version for internal use of the Calar Alto staff will be provided soon.) The description of the setup procedures assumes that the complete STARTUP procedure (see section 3, steps 1.–4.) has been carried out. The prompt before each command indicates in which control program (terminal window) the command has to be given, for example:

cafos:	>`abc` →`xyz`	! choose `xyx` in selection window >`abc` of
		! CAFOS 2.2 control GUI
CCD:	`def`	! press `def` in CCD control window
midas>	`ghi`	! start command `ghi` in `MIDAS foreground`

5.1 Align rows of CCD along longslit.

For aligning the CCD it is sufficient to set the instrument focus f_0 to the nominal value for each chip which can be taken from the following table:

Table 1: CCD parameters

Chip ID	f_0 [μm]	field lens [mm]	pixel size [μm]	columns × rows	scale [mum/arcs]	CAFOS angle [degree]
SITe-1d	800	+2.1	24.0	2048 × 2048	45.32	0
Lor-8o	700	+1.9	15.0	2048 × 2048	45.43	180
SITe-xx			15	2048 × 4096	?	?
Tek-13c	1100	+2.3	24.0	1024 × 1024	45.3	0

Currently, the slit-image which is required for aligning the CCD has to be taken "by hand". Although an automatic procedure is in preperation it is instructive to read through the following procedure step by step.

- Set standard value f_0 from table 1:

  cafos: `>Setup →SETUP` and set `FOCUS` $= f_0$

- Setup Cafos 2.2 for slit alignment:

cafos:	`>FILTER →free`	! use no filter.
cafos:	`>GRISM →FREE`	! use no grism.
cafos:	`He ON`	! switch on He lamp, move in mirror.
cafos:	`>Controls →Slit`	! open slit control window
cafos:	in `Slit:` set width →100	! adjust width to 100 μm, move in slit.

- Setup and start exposure:

CCD:	`>load Configuration`	! open select window
CCD:	select `slit_SITe.par`	! slit exposure
CCD:	define `object name`	! e.g Slit-100
CCD:	define t_{int} = `1 sec`	! optimum integration time
CCD:	press `START`	

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will occur in Background Receiver window on the upper screen). Then display image:

  `midas> INSPECT` ! you may adjust the cuts

- Measure coordinates of the slit image:

`midas>`	`CENTER/GAUSS`	! adjust cursor box by arrow keys, click with left mouse-button near the right and the left edge of the slit image, leave procedure with the right mouse button. Mark a slightly different position if an error message ("iteration failed") occurs.

  Then calculate:

$$d = (Y_{left} - Y_{right})/(X_{left} - X_{right})$$

  The adjustment screws at the dewar mounting have to be changed by $125 \times d$ full revolutions to correct the mis-alignment d. For $d > 0$: rotate dewar counter-clockwise (as seen from below for SITe and LORAL, clockwise for the Tek#13.)

- Repeat exposure and measure orientation again. Normally you need 2 iterations to adjust the CCD to $d < 1/2000$. Make sure that fixing the screws does not cause new mis-alignment in the end !

5.2 Determine the position of optical axis on chip.

With the new optics of the CAFOS2.2 and an accurate adjustment of the field flattening lens (see seperate manual *Setting up CAFOS2.2*) there is no need to measure the instrument scale which is $45.32(\pm 0.1)\mu$m/arcsec ($= \pm 0, 2\%$, see Table 1) So one only has to determine of the optical axis on the chip. This is done in the following way:

- Setup Cafos 2.2 for `Hole 0` exposure:

cafos:	`>FILTER →free`	! use no filter.
cafos:	`>GRISM →FREE`	! use no grism.
cafos:	`He ON`	! switch on He lamp, move in mirror.
cafos:	`>Aperture →Hole`	! moves hole to reference position = `Hole 0`

- Setup and start exposure:

CCD:	`>load Configuration`	! open select window
CCD:	select `hole0_SITe.par`	! hole 0 exposure
CCD:	define `object name`	! *e.g* "hole_0"
CCD:	define t_{int} = `1 sec`	! optimum integration time for SITe-1d
CCD:	press `START`	

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will occur in background window). Then display image:

  `midas>` `INSPECT` ! you may zoom by factor 2.

- Measure coordinates of the hole image:

midas>	CENTER/GAUSS	! click with left mouse-button, leave ! procedure with the right mouse button.

The position of the central hole image is required in the instrument `Setup` (5.4) in order to calculate the position of the optical axis and the longslit image on the chip.

5.3 Determine the exact focus of the instrument.

With the new system **focus sequences** and their evaluation are extremely simple. All you have to do is:

- Start focus sequence by

midas>	fseq/cafos	and follow the instructions ! It is recommended to chose filter = `f(ree)`. You should place your focus sequence around the nominal value given in Tab. 1

- **Wait** (about 5 sec) until the image is received by MIDAS (`* image abc.bdf received *` will occur in background window) and analyse the sequence by:

midas>	focus	! analyse focus exposure. Result = f_0
midas>	focus test0001	! should be given when using *test mode* for focussing.

The value f_0 has to be set in the following **Setup**.

5.4 Setup the instrument with the actual parameters

This step is essential in order to produce correct FITS headers !

You have to carry out steps 5.1 to 5.3 first. Then the instrument is correctly set up in the SETUP window::

cafos: >Setup →SETUP		where you have to define the following parameters:
FOCUS without filter	f_0	as determined in 5.3
GRISM position offset	γ_0	leave as it is or see 5.7 below.
Hole 0 position on chip:	$X, Y =$	give X, Y coordinate of `hole 0` image on chip (as determined in 5.2).
SCALE at Instrument focus:		[μm/arcsec], use value from table 1.
Exact Instrument P.A. =		should be 0 ± 1 [degree] or 180 ± 1 depending on chip (see table 1).

5.5 Determine focus offset for each *new* filter.

(Only necessary if the filter has not been used previously and its focus offset is not documented in the Appendix A.1 or the Calar Alto filter list.)

- Start focus sequence by

`midas>`	`fseq/cafos`	and follow the instructions ! The expected focus value is $f_0 + df$ The focus offset is roughly $df = 357 \cdot d$ where d is the geometrical thickness of the filter in mm. You should place your focus sequence around the expected value.

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will occur in background window). Then you may analyse the focus sequence by:

`midas>` `focus` ! analyse focus exposure. Result = f

- After having determined the optimum focus value f for the filter you have to calculate the **focus offset**:

$$df = f - f_0$$

.

5.6 Define filter parameters.

Before starting your observations, you should update the actual table of filters (`filter.tab`) which are mounted in the filter wheel. Unfortunately this has still to be done in the old CAFOS Text window:

`cafos>`	`FTAB`	! command to update parameters of filter in wheel. For each filter you have to define:
	lambda-0 :	central wavelength (nm); refer to the CA filter list!
	delta-lambda :	width of the filter (nm),
	df :	focus offset $df = f - f_0$ (as determined in 5.5 or taken from the CA filter list. ATTENTION: Although focus values are measured in μm, `FTAB` expects df in **mm !** (sorry for this).
	filter-ID :	Filter identification; it is recommended to use the name from the CA filter list.

Note: You may use `cafos> $ more filter.tab` to see actual table.

At the moment it is necessary to restart the CAFOS control in order to get the new filter names in the >`Filter` selection window:

```
pollux[obs22]> start_cafos
```

O.K., now the instrument is setup properly for most astronomical observations.

5.7 Check alignment of grisms (optional)

This should be necessary only if either the aperture unit or the grism wheel have been removed from the instrument. But after we found some unexpected misalignments we recommend to check the grism alignment every months or so.

- Setup CAFOS 2.2 for grism check:

`cafos:`	`>Filter →free`	! No filter !
`cafos:`	`>Grism →green-100`	! green-100 has broadest efficiency.
`cafos:`	`He lamp OFF`	! (if still ON).
`cafos:`	`Co lamp ON`	! Continuum lamp can be dimmed at power
		! supply, make sure it is at 100%
`cafos:`	`Aperture →HOLE`	! move in 50 μm hole.

- Setup and start spectroscopic exposure:

```
CCD: Load Configuration: spectrum_SITe.par
CCD: Object name: grism check
CCD: time: 20 sec
CCD: type: flat
CCD: START
```

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will occur in background window). Measure coordinates of the slit image:

`midas>`	`CENTER/GAUSS`	adjust cursor box by arrow keys, click with left mouse-button in the upper and lower part of the spectrum, leave procedure with the right mouse button. Mark a slightly different position if an error message ("iteration failed") occurs.

  - calculate: $\gamma = \mathrm{atg}[(X_{upp} - X_{low})/(Y_{upp} - Y_{low})]$
  - if $|\gamma| \leq 0.03^o$: O.K., no further action requiered,
  - else:

- Adjust `Grism angle offset`:

cafos:	`>Setup →SETUP`	and set `GRISM position offset` to: $\gamma_0 = \gamma_0(\mathrm{old}) - \gamma$

5.8 Determine exact position angle of instrument (projected at sky).

Only in case you need to align the longslit or a mult-object mask on the sky to $< 0.3^o$ (that is < 1.6 arcsec over a length of 5') you have to carry out this step.

STARLIGHT required !

- Select `full_SITe.par` and do two exposures and move the telescope in between them by $\gtrsim 500''$ in DEC.
- Measure position angle of the displacement of a star which is common to both images:

`midas>`	`INSPECT` *image1*	! load first image.
`midas>`	`CENTER/GAUSS`	! adjust cursor box by arrow keys, click with left mouse-button on star, leave procedure with the right mouse button.
`midas>`	`INSPECT` *image2*	! load second image.
`midas>`	`CENTER/GAUSS`	! make sure you mark the same star !

- Calculate position angle

$$\alpha = \mathrm{atg}((y_1 - y_2)/(x_1 - x_2)),$$

where x_1, y_1 refers to the coordinates on the image pointed at *lower Declination* (that is $x_1 - x_2 > 0$!).

- Adjust `Instrument Position Angle:`

cafos: `>Setup` $\rightarrow$`SETUP` and set `Exact Instrument P.A.` $= \alpha$

5.9 Calibration of the Fabry-Pérot-Etalon

You have to mount the pre-filter 793/14 in Filter wheel !

- Setup CAFOS 2.2 for Etalon calibration:

cafos:	`Rb lamp ON`	! THIS should be done **5 min** before starting the calibration.
cafos:	`REMOTE ON`	! set CAFOS in remote control.

- Start calibration sequence by:

  `midas> cseq/etal` and follow the instructions !

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will show up in background window). Then you may analyse the calibration sequence by:

  `midas> calib/eta` ! analyse calibration exposure.

- Save the calibration:

cafos:	`>Controls →Etalon Calibration`	! allows to set Etalon calibration
cafos:	in Calibration window:	! set z_0 = fitted value
		! set width = fitted value

6 Examples of Astronomical Observations

In order to demonstrate the standard operation of the instrument and how the different components (CAFOS 2.2, CCD Camera, Quicklook) can most efficiently be used together, in the following several observing procedures are outlined which should cover most of the standard applications of the instrument.

6.1 Determination of the telescope focus.

The approximate focus of the 2.2 m telescope with CAFOS 2.2 can be calculated according:

$$f_{tel} = 23.50 - 0.087 \cdot T_{tel}$$

where T_{tel} is the temperature of the telescope structure in ^{o}C. A focus series around this nominal value should be sufficient to find the best focus. The following procedure will calculate the expected focus from T_{tel}.

- Start focus sequence by

  `midas>` `fseq/teles` and follow the instructions ! You may choose any filter for which *df* is known accurately. However, for a consistent seeing and focus statistic the use of a *broad R band* is recommended.

- **Wait** until the image is received by MIDAS (`* image abc.bdf received *` will occur in background window). Then you may analyse the focus sequence by:

  `midas>` `focus` ! analyse focus exposure. Result = f_{tel}
  ! if o.k. focus value and seeing are saved in SEEING LOG

  and **do not forget** to

- Adjust the telescope focus to this new value !

6.2 Straight-forward Direct Imaging.

By “straight-forward” is meant that no exact telescope pointing is required. Normally, this is the case for the observation of standard stars/fields or other objects which are much smaller than the field of view (11×11 arcmin^2).

- Enter coordinates of object at Absolute Position window and point telescope by “eXec”.
- Setup CAFOS 2.2 for imaging:

cafos:	`FREE ALL`	! Remove everything out of beam.
cafos:	>`FILTER` →`myfilter`	! moves in required filter, adjusts focus.
cafos:	>`GRISM` →`Lyot Stop`	! recommended for imaging.

- In the MIDAS Quicklook, you may start a procedure which displays the image immediately after being received:

`midas>`	`LOOK(/ima)`	! display image on arrival.

- Define and start exposure:

CCD:	>`load Configuration`	! open select window
CCD:	select `full_SITe.par`	! entire useful area
CCD:	define `object name`	! e.g NGC 4668
CCD:	define t_{int} = `xx sec`	! integration time
CCD:	press `START`	

- Use MIDAS Quicklook to display and analyse image e.g.:

`midas>`	`INSPECT(/ima)`	allows to select dynamical range (called “cuts” in MIDAS), look-up table, ZOOM, etc
`midas>`	`SEEING(/ima)`	analyses the seeing accross the field.
`midas>`	`PHOTOMETRY(/ima)`	allows to measure AB magnitudes of objects.

6.3 Photometric Standard Star Observation.

This is normally a straight forward imaging exposure. The only problem is that the exposures have to be short enough to avoid saturation of (brighter) standard stars. If you use a broad band filter, typically a 12th magnitude star is (just) saturated after 5 seconds (at 1.″2 seeing). Exposure times of 1 second are no problem if the star is within 3′of the field center. In order to judge the photometric quality of the sky, the CAFOS Quicklook has stored AB magnitudes of the following standard stars (finding charts can be found in the *HST Standards Book*). When using the command `midas> photometry` the tabulated values are compared with the measured one in *any filter* (provided the central wavelength and width of the filter have been carefully defined in `cafos> FTAB`).

HST (spectro-photometric) Standard Stars for CAFOS (most of them very blue):

Star	RA (2000)	DEC (2000)	AB(650nm)
GD 50	03 48 50.1	-00 58 30.	14.499
Hz 4	03 55 21.7	+09 47 19.	14.800
Hz 2	04 12 43.5	+11 51 50.	14.198
G 191 B2B	05 05 30.6	+52 49 54.	12.156
BD+75 325	08 10 49.3	+74 57 58.	9.886
GD 108	10 00 47.3	-07 33 31.	13.898
Feige 34	10 39 36.7	+43 06 10.	11.496
Hz 21	12 13 56.4	+32 56 31.	15.093
Hz 44	13 23 35.4	+36 08 00.	12.019
GRW+70 5824	13 38 51.8	+70 17 09.	13.108
BD+33 2642	15 51 59.9	+32 56 55.	11.024
BD+28 4211	21 51 11.1	+28 51 52.	10.850

Proceed as follows:

- Enter coordinates of star at Absolute Position window and point telescope by "eXec".
- Setup CAFOS 2.2 for imaging:

```
cafos:  FREE ALL               ! Remove everything out of beam.
cafos:  >FILTER →myfilter      ! moves in required filter, adjusts focus.
cafos:  >GRISM →Lyot Stop      ! recommended for imaging.
```

- Define and start exposure:

CCD:	`>load Configuration`	! open select window
CCD:	select `aqui_SITe.par`	! central $6 \times 6\square'$
CCD:	define `object name`	! e.g HZ 44
CCD:	define $t_{int} =$ `2 sec`	! avoid saturation !
CCD:	press `START`	

- **Wait** until image is received and use MIDAS Quicklook to display and analyse image:

`midas>`	`PHOTOMETRY(/ima)`	Mark the standard star with cursor box. Use right mouse button to proceed. The routine will evaluate the counts and convert it to instrumental AB magnitude which should be correct to within 0.1. It is subsequently compared with the tabulated value.

6.4 Direct imaging with accurate pointing.

Due to distortions of the plate scale near the edges of the field (see Fig. 3 the Appendix A), images can only be co-added if the telescope pointing agrees within $\leq 30''$. Therefore (or to place very extended objects in the field of view) it may often be required to point the telescope to better than a few arcseconds. Since this is not guaranteed by the standard telescope preset one needs to get an acqusition exposure on the basis of which the telescope then is offsetted to the recommended pointing. A procedure in the MIDAS Quicklook calculates and performs the required offset. During the procedure, the observer has to select an object on the acquisition exposure and to specify the coordinates (with respect to the optical axis) where the object should occur after the telescope offset (the current version does only allow to place the selected object right onto the optical axis).

- Use standard configuration: **Cassegrain position angle = 90°** !
- Enter coordinates of object at Absolute Position window and point telescope by "eXec".
- Set CAFOS 2.2 in remote control:

  cafos: `REMOTE ON` ! Remote control from MIDAS

- Search **guide star** in TV offset field and **start autoguider** (see instructions of tvg).
- Define and start acquisition exposure:

CCD:	>`load Configuration`	! open select window
CCD:	select `aqui_SITe.par`	! central 6×6 □′
CCD:	define `object name`	! e.g 3C273_aq
CCD:	define t_{int} = `50 sec`	! 50 sec are sufficient to reach V > 23.
		! with `Filter = free`.
CCD:	press `START`	

- After exposure is finished **wait** until the image is received by MIDAS (`* image abc.bdf received *` will show up in background window).
- Inspect acquisition exposure, identify reference object and offset telescope by the Quicklook command:

  `midas>` `OFFSET/AXIS` ! Follow the instructions on screen !

  Do not forget to re-start the AUTOGUIDER immediately after the telescope offset has been performed !!
- Setup CAFOS 2.2 for your science exposure, *for example* when using the FP Etalon:

cafos:	>`FILTER` →`myfilter`	! moves in etalon prefilter.
cafos:	`Etalon: IN`	! moves etalon into beam.
cafos:	>`Controls` →`ETALON lambda`	! open window for setting
		! wavelength and order.
cafos:	define λ and order and	
cafos:	press `SET` in window	! adjusts etalon to λ.

- Define and start **science exposure:**

CCD:	>`load Configuration`	! open select window (if not open)
CCD:	select `full_SITe.par`	! entire useful field
CCD:	define `object name`	! e.g 3C273_7666A
CCD:	define t_{int} = `1000 sec`	!
CCD:	press `START`	

- If more than 1 exposure is required (*e.g.* to remove the *cosmics* or to get a *flatfield* for the nightsky) you may offset the telescope in the telescope control GUI.
- Restart AUTOGUIDER and start **second** exposure:

CCD:	`LAST NAME`	! get last object name
CCD:	define `object name`	! e.g 3C273_7666A-2
CCD:	define t_{int} = `1500 sec`	! previous exposure too short!
CCD:	press `START`	

- During the exposure you may use the MIDAS Quicklook to display and analyse the last image e.g.:

`midas>`	`INSPECT(/ima)`	allows to select dynamical range (called "cuts" in MIDAS), look-up table, ZOOM, etc
`midas>`	`SEEING(/ima)`	analyses the seeing accross the field.
`midas>`	`PHOTOMETRY(/ima)`	allows to measure AB magnitudes of objects.

- Repeat the last 4 steps with appropriate telescope offsets until you have reached the required number of exposures.

Alternatively, the Quicklook provides a high level command to define, start and continue a series of exposures. (In order to use this command you have to start `expo`, see item 5. in the STARTUP procedure.) The same exposure sequence as described above would be carried out as follows:

- Define and start **first science exposure:**

  ```
  midas> NEXT(/ima) start:1 1000.  3C273_7666A 2.
  ```

  This will start the **first** exposure of the sequence. Exposure time (t_{int} = 1000 sec) and header as in the example above. The *fourth* parameter (= 2.) refers to the *Declination* of 3C273 and is necessary to perform the offsets (before subsequent exposures) in the U, V-*system*.
  As soon as the exposure has been read out, you

- start the **next** science exposure by:

  ```
  midas> NEXT(/ima) cont 1500.
  ```

  This will perform a (pre-defined) optimal standard *telescope offset*, after which you have to

- Restart the AUTOGUIDER

  When it runs properly, you quit `midas> ... done >` by $< CR >$ to start **next** exposure (the header is automatically incremented). Use

  ```
  midas> NEXT cont
  ```

  until you have reached the required number of exposures.

  Note: After using the `NEXT` command, you have to switch `REMOTE OFF` to operate CAFOS again.

6.5 Longslit spectroscopy with grisms.

Since the CAFOS 2.2 does not provide the possibility to view the slit and its surrounding field by the TV guiding unit it is necessary to position an object onto the slit by means of an acqusition exposure. With the new drives at the 2.2 m telescope, pointing and offsetting are sufficiently reliable, that the object is placed on the slit after the first iteration (if this is not the case you should check, whether the `hole 0` position is correctly defined in the `SETUP`).

The aquisition + offsetting procedure is well tested for the standard position of the longslit (= N-S, that is Cassegrain position angle = 90°), but the "blind" offsetting works also if the longslit is rotated away from this position. The spectroscopic observations with CAFOS 2.2 should be prepared and carried out as follows:

- Rotate Cassegrain flange to the requested position angle (use non-standard orientation $PA_{Cass} \neq 90^o$ only if absolutely necessary for your project).
- If $PA_{Cass} \neq 90^o$: Setup Telescope and CAFOS 2.2:

Telscope Control: Settings	set correct $P.A. = p$ for guiding.

- Select coordinates of object at **Absolute Position** window and point telescope by "eXec".
- Select slit width and set CAFOS 2.2 into REMOTE control:

cafos:	>`Controls` →`SLIT`	! opens SLIT Control window
cafos:	choose `slit width`	! changing the width will also
		! move the slit into the field.
cafos:	`REMOTE ON`	! allow REMOTE control from QUICKLOOK.

- Search **guide star** in TV offset field and **start autoguider** (see instructions of tvg).
- Define and start aquisition exposure:

CCD:	>`load Configuration`	! open select window (if not open)
CCD:	select `slit_SITe.par`	! $\pm 2'$ around slit
or		
CCD:	select `aqui_SITe.par`	! central $6 \times 6 \square'$.
CCD:	define `object name`	! e.g 3C273_aq
CCD:	define t_{int} = `50 sec`	! sufficient to reach V > 23.
CCD:	press `START`	

- After exposure is finished **wait** until the image is received by MIDAS (`* image abc.bdf received *` will show up in background window).

- Measure and perform required offset of telescope by the Quicklook command:

  `midas>` `OFFSET/SLIT` ! Follow the instructions on the screen !

  Do not forget to re-start the AUTOGUIDER immediately after the telescope offset has been performed !!

- Setup CAFOS 2.2 for your spectroscopic exposure:

cafos:	>`GRISM` →`green-100`	! select e.g. grism Green-100
cafos:	>`FILTER` →`GG495`	! e.g. use order separation filter

- Define and start **spectroscopic** exposure:

CCD:	>`load Configuration`	! open select window (if not open)
CCD:	select `spectrum_SITe.par`	! central 5′ of longslit
or		
CCD:	select `long_SITe.par`	! covers entire longslit
or		
CCD:	select `full_SITe.par`	! entire field WITH OVERSCAN
CCD:	define `object name`	! e.g 3C273_G100+GG495
CCD:	define t_{int} = `1000 sec`	!
CCD:	press `START`	

- Quick analysis of spectrum: Wait until frame has been received by MIDAS and use

`midas>`	`SPECTRUM(/ima)`	subtracts background, extracts 1-dim. spectrum, does standard wavelength and flux calibration.

- Although CAFOS2.2 is very stiff, for highest quality data analysis it is recommended to carry out a **Flat Field** exposure immediately after the science exposure. You should leave everything unchanged except switching on the continuum lamp:

  cafos: `Co lamp ON` ! switches on continuum lamp and moves mirror in.

- For the most accurate **wavelength calibration** it is recommended to use a slit image (without grism !) as it is produced as verification in `OFFSET/SLIT` *plus* lamp exposures through a *narrow slit* (*e.g.* 50μm). See 7.2 for more details.

7 Calibration Exposures

7.1 Flat Field exposures for direct imaging

Has still to be written !

7.2 Calibration exposures for spectroscopy

Has still to be written !

8 Trouble-Shooting

The complexity of the entire system – which consists of the CCD, the CAFOS2.2 and its control and the 2.2 m Telescope with its TV guider – may lead to mal-functions of one or several components if one deviates from the standard ways of operation (not everything can be tested). Here we list known cases of operation failures and demonstrate how to solve them. If you come accross problems which are not mentioned here, please, report them by using the Quicklook command:

`midas>` `REPORT/CAFOS` ! follow instructions on screen

This will store your report to the REPORTS area and automatically send them by Email to the local staff and K. Meisenheimer.

8.1 Problems with the instrument control of CAFOS 2.2

- Whem starting the CAFOS 2.2 control by `pollux>` `start_cafos` one of the following ERROR messages may appear:
  `''no connection to CAFOS''` or `''handshaking failed.''`
  Both messages indicate that there is a problem in the communication between pollux and the CAFOS electronics.

  You should:

→ (1) check whether the CAFOS electronics is switched ON and the power cable is connected (don't worry: the switch is not illuminated to avoid stray-light).

→ (2) If (1) is o.k., the most likely reason for the failure is a problem in the cable connection between the pollux and the CAFOS electronics. Before alarming the staff, however, you should repeate the complete STARTUP procedure for CAFOS 2.2 (including switching OFF and ON the CAFOS electronics).

→ (3) If (2) does not help, you could try a reboot of the pollux but most likely there is a problem in the cable connection.

- After some CAFOS commands (*e.g.* `>Grism`, `>Aperture`) the ERROR message
  `''position not reached''` may appear.
  Normally this is not a severe problem but only the result of rather strict tolerances in the instrument control.

You should:

→ check whether the attempted operation is possible at all. (*E.g.* `>GRISM` will not work as long as the Etalon is in the beam.)

→ Select an adjacent position (e.g. the grism next to the requested one). If this is correctly positioned, go back to the one originally requested.

- The metal vapor spectral lamps (1,3) cannot be switched ON within a few minutes after beeing switched OFF. If you try the message
`‘‘Warning: lamp x cooling down, wait 3 minutes’’`
will be displayed.

  You should:

  → Wait for up to 3 minutes and try again.

- After setting `REMOTE ON` the CAFOS control program has to be re-activated for interactive control. This normaly is done by all Quicklook commands and sequences which remotely control CAFOS 2.2. However, in case of error exits this re-activation may not happen.

  You should:

  → Switch `REMOTE OFF` in CAFOS Control or

  → use `midas> CAFOS LOCAL` in the Quicklook.

- Timeout for communication CAFOS — Telescope:

  You should:

  → use `RESET-tecs-dacs-tvg` on the telescope control terminal (click with right mouse button on background).

8.2 Problems with CCD Acquisition program

- Shortly after starting an exposure the error message:

  `Telescope data not available`

  might occur. You should:

  → use `RESET-tecs-dacs-tvg` on the telescope control terminal (click with right mouse button on background).

8.3 Problems with Quicklook

- If there appears a ERROR message in the Quicklook:

  You should:

  → **first** check whether you have used the correct syntax.

- If after a Quicklook command without explicitly giving the image name (*e.g.* `midas> FOCUS`) the wrong image is displayed

  You should:

  → stop the process by `CTRL-C`,

  → check the background window whether the image of interest has already been received,

  → check `ccdacq` whether the image has in fact been sent, and

  → restart the command:
  `midas> COMMAND image` where you explicitly give the image name.

- If any Quicklook procedure which controls the CAFOS 2.2 stops with the ERROR message:
  `‘‘CAFOS command without success’’`

  You should:

  → check whether CAFOS 2.2 was set to remote

  → if not, re-initialize the connection and start again:

`midas>`	`CAFOS LOCAL 0`	! reset connection,
cafos:	`REMOTE ON`	! set CAFOS 2.2 in remote mode,
`midas>`	`COMMAND`	! start Quicklook command again.

- If `OFFSET/SLIT` fails to position the marked object onto the slit,

  you should:

  → check whether the `hole 0` coordinates are correctly defined in the `SETUP`. If you resently measured the position you only have to check the `SETUP` parameters by

  cafos: `>Setup` →`SETUP` ! check X,Y coordinates.

  → if not, you should follow the procedure described in section 5.2 and correct the `SETUP`.

8.4 If nothing else works: Restart the system !

SHUTDOWN: leave CAFOS 2.2 control with `cafos: QUIT`. Switch OFF CAFOS electronics. Leave CCD control and Quicklook.

STARTUP: proceed along the description in section 3.

A Instrument Layout and Parameters

Table 2: Available CCD chips and their parameters

CCD/Dewar:	Tek#13	Lor#8o	SITe#1d	tbd
Number of Columns	1024	2048	2048	
Number of Rows	1024	2048	2048	
Last column on frame	?	?	2168	
$e-/ADU$ (standard gain)	1.7	1.5	2.3	
R.O.N.	8.	8.	< 6	
Saturation [cts]	> 65000	~ 35000	~ 50000	
at stand. gain [e-]	> 110000	~ 53000	~ 115000	
Pixel size [μm]	24.0	15.0	24.0	
Setup: 1-Nov-1997				
Plate scale [μm/arcsec]	~ 45.2	45.43	45.32	
i.e. [arcsec/pixel]	~ 0.53	0.330	0.530	
Field [arcmin]	9.0×9.0	11.3×11.3	16.0 Ø	
Focus f_0	~ 1100	700	800	
Field lens position	+2.3 mm	+1.9 mm	+2.1 mm	

NOTE: Under normal circumstances and using the standard gain the CCDs should be linear to better then 1% up to the saturation level given here !

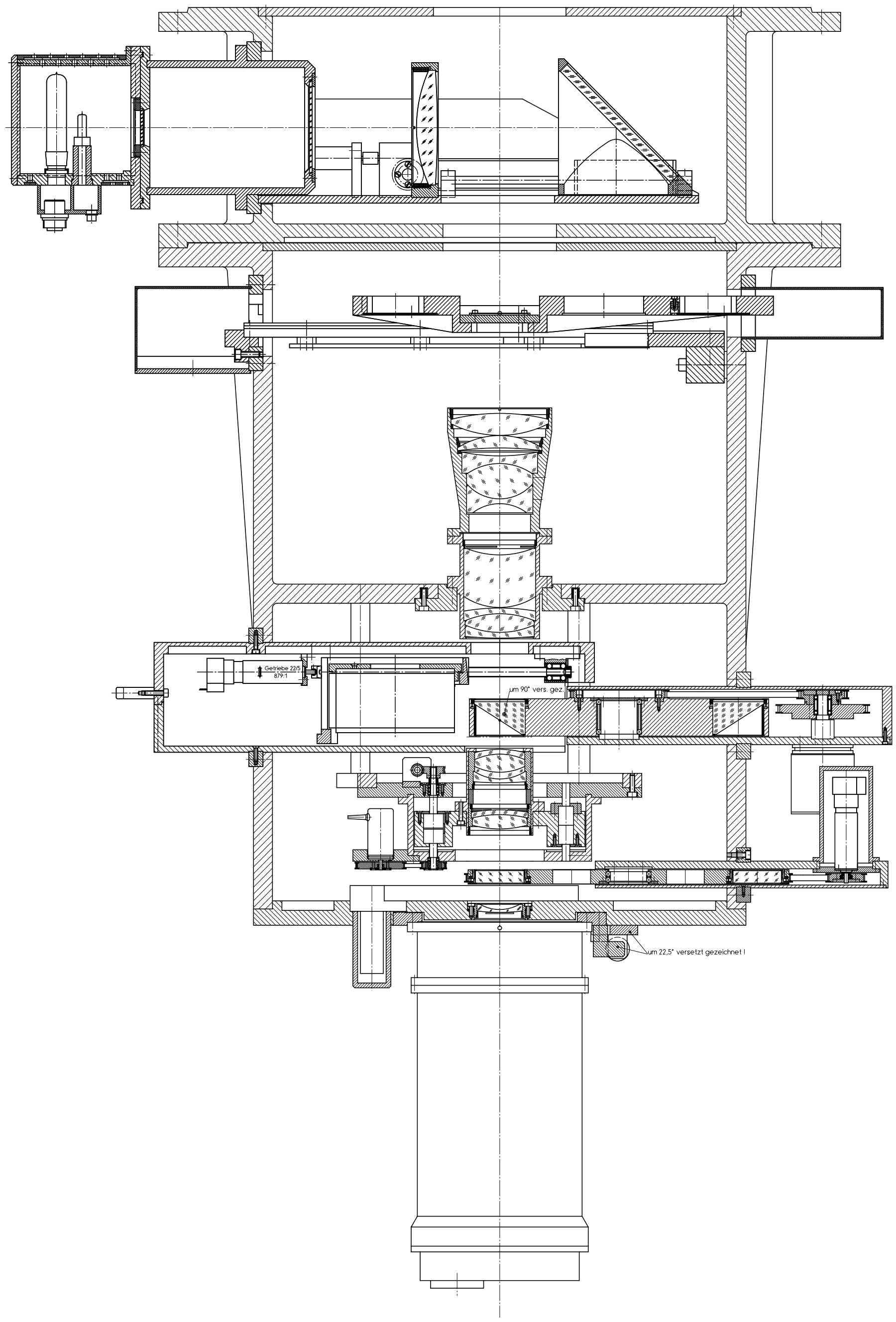

Figure 1: Layout of CAFOS 2.2.
Its optical components are (from top to bottom): Calibration Unit, Aperture Unit, Collimator, Etalon (here: moved out), Grism Wheel, Camera Optics (adjustable focus), Filter Wheel, Shutter, Field Flattening Lens, Dewar containing the CCD detector.

A.1 Direct Imaging

Table 3: Limiting magnitudes for imaging.

Filter	$\lambda, \Delta\lambda$ [nm]	t_{short} [sec]	m_{lim}	t_{long} [sec]	m_{lim}
free	600,600	10	23.0	100	24.3
B	455,100	100	23.7	3000	25.6
R	650,170	50	22.9	3000	25.2
I	850,150	50	~ 22.1	3000	~ 24.4

The values refer to a typical seeing of $1\farcs4$ (FWHM) and to the SITe-1d. The short exposure times give roughly the lower limit for background limited exposures.

Figure 2: Quantum Efficiency of CCDs for CAFOS 2.2.

Currently, there are NO measured quantum efficiencies available for any of the CCDs.

Figure 3: Distortion of plate scale.

The distortion (fitted curve) can be described by:
$\delta['']=3.72\times10^{-6}(r[''])^2+1.40\times10^{-10}(r[''])^4$ where r is the radial distance from the optical axis.

Figure 4: Shutter performance

A.2 Grism spectroscopy

Table 4: Grism Parameters.

Grism	No.	nm/arcsec	nm/24μm	σ_{rms}	λ range [nm]	λ_{2nd} [nm]
B-400	7	1.830	0.976	0.05	320 ... 800	650
R-400	4	1.809	0.965	0.05	475 ... 1100	860
B-200	8	0.883	0.470	0.03	320 ... 700	650
G-200	9	0.859	0.458	0.016	400 ... 850	720
R-200	10	0.817	0.435	0.02	630 ... 1100	1000
B-100	1	0.374	0.200	0.009	320 ... 580	-
G-100	2	0.397	0.212	0.005	490 ... 780	720
R-100	3	0.383	0.204	0.010	590 ... 900	-

The useful range refers to the `SITe-1d` chip and may be affected by the **second order** at the red end (especially for the green grisms). σ_{rms} gives the RMS deviation of spectral calibration lines from a fit of 4^{th} order. The wavelength λ_{2nd} refers to the blue end of the second order contamination.

Table 5: Limiting magnitudes for spectroscopy.

A.2.1 Grisms B-400 & R-400:

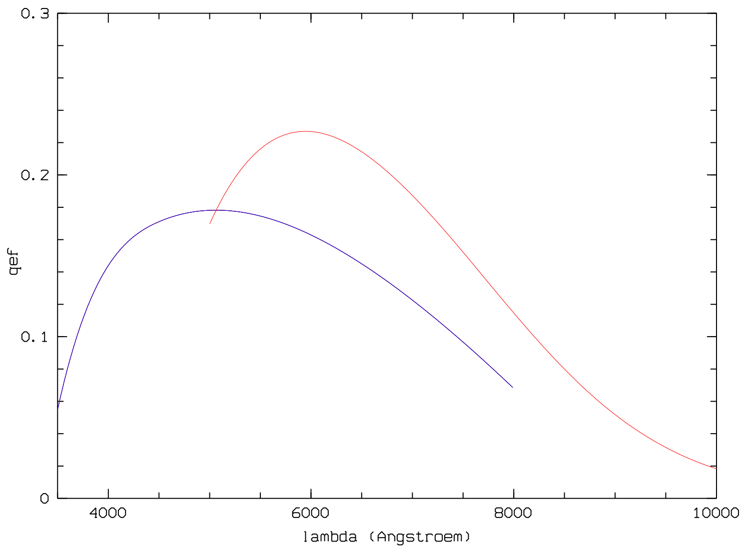

Figure 5: Efficiencies of Grisms: B-400, R-400.

The efficiency gives the number of detected photo-electrons per incoming photon and includes the transmissions of the telescope, CAFOS 2.2, as well as the Quantum Efficiency of a blue sensitive CCD. Current measurements indicate that the SITe-1d has an about 30% lower quantum efficiency.

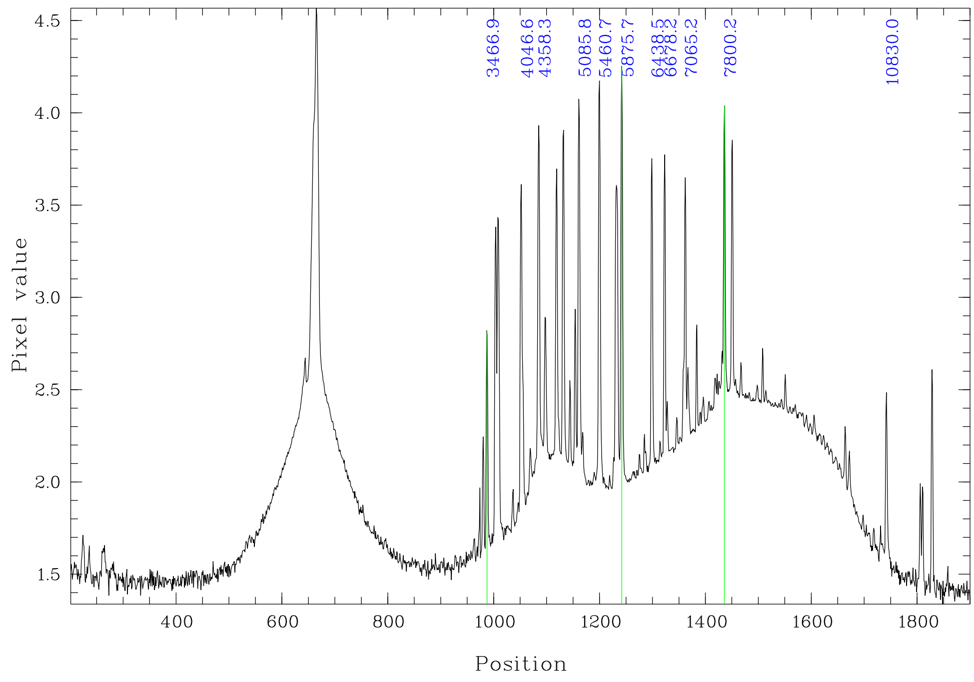

Figure 6: Identification of spectral lines for Grism B-400.

In order to show also faint lines we use a *logarithmic* scale. The pixel scale refers to the SITe-1d chip.

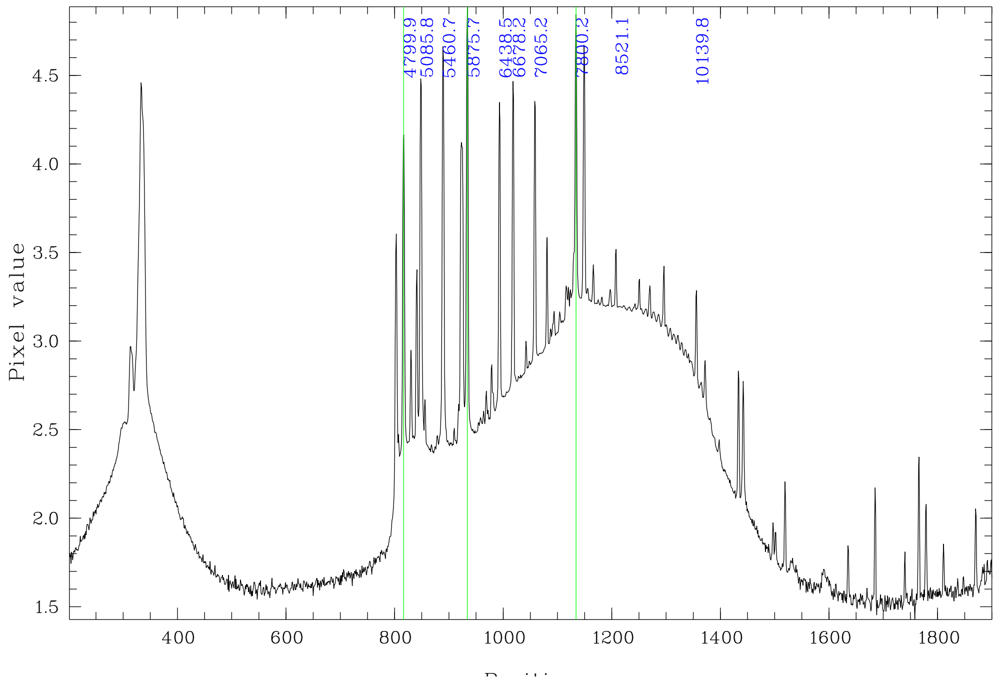

Figure 7: Identification of spectral lines for Grism R-400.

A.2.2 Grisms B-200, G-200 & R-200:

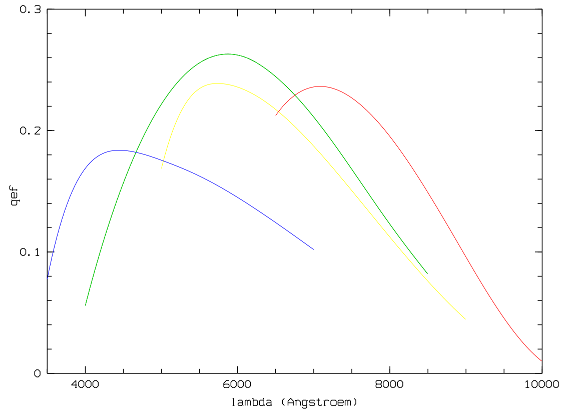

Figure 8: Efficiencies of Grisms: B-200, G-200, R-200.
The lower curve shown for grism G-200 refers to the overall QE when using a GG495 filter to suppress the second order longwards of about 750 nm.

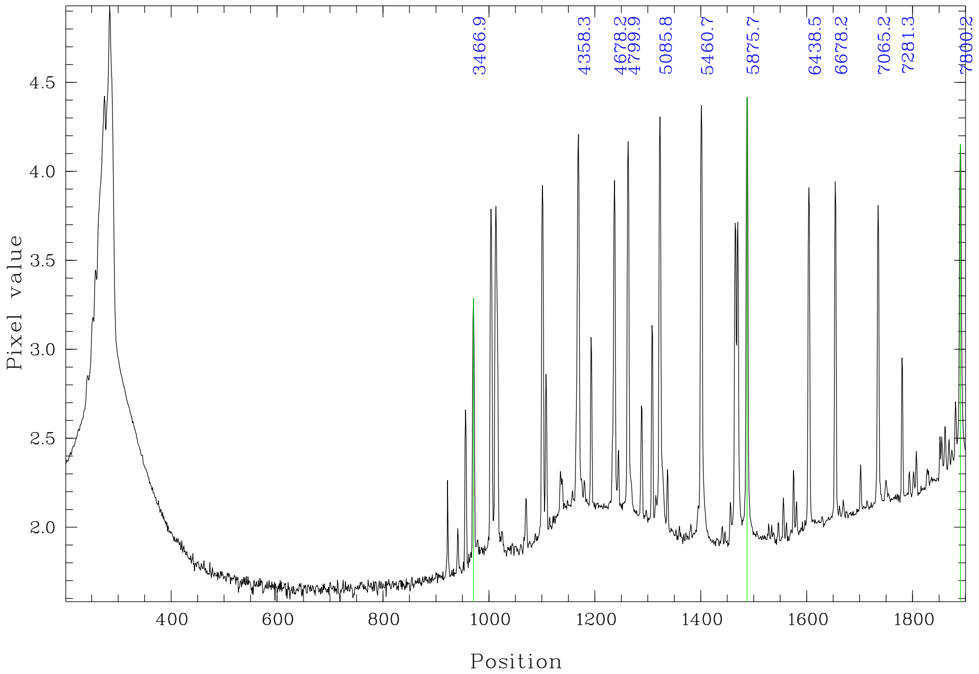

Figure 9: Identification of spectral lines for Grism B-200 (logarithmic scale).

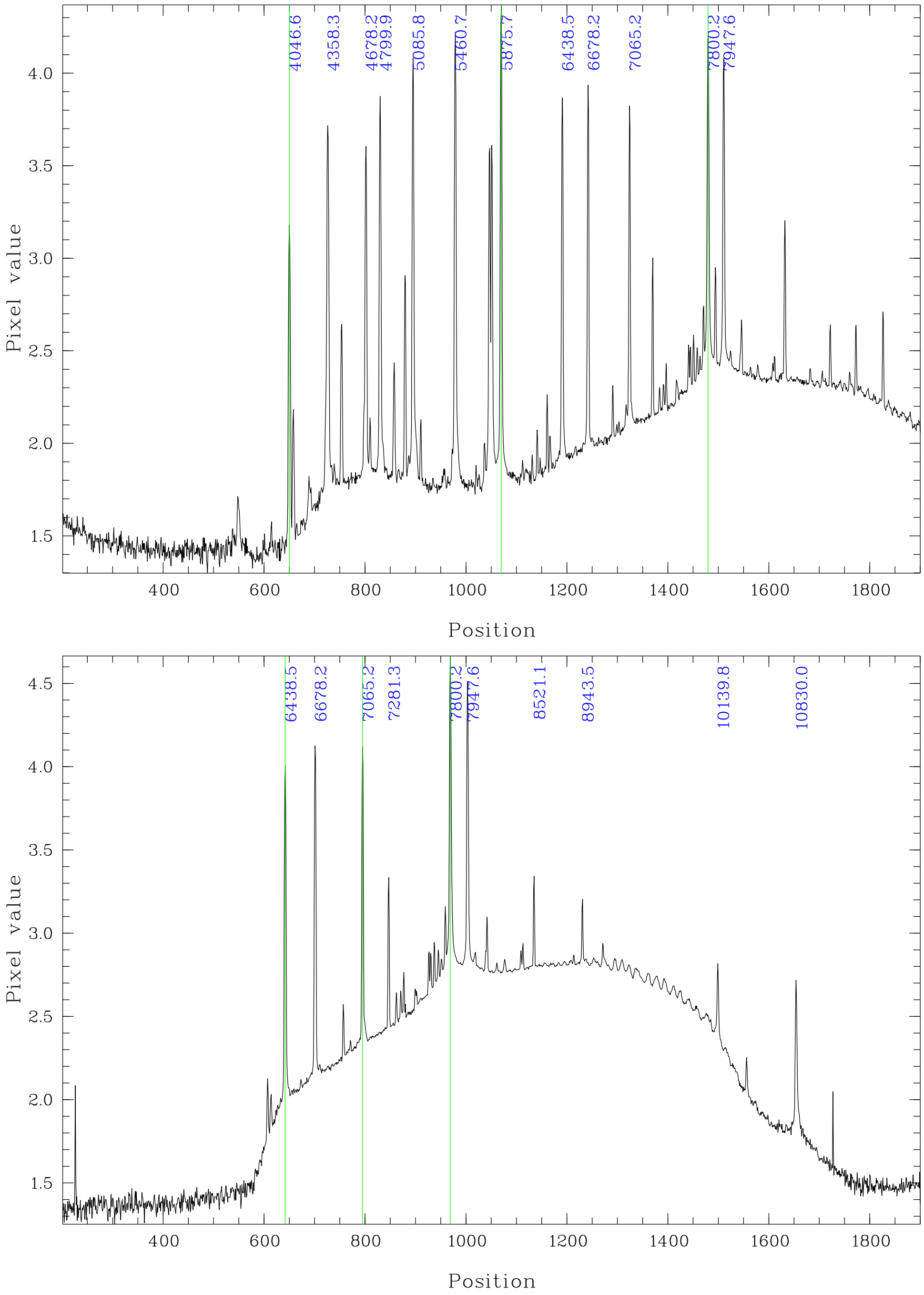

Figure 10: Identification of spectral lines for Grisms G-200 and R-200.

A.2.3 Grisms B-100, G-100 & R-100:

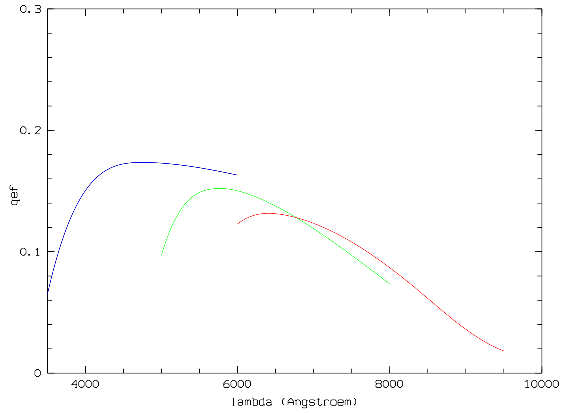

Figure 11: Efficiencies of Grisms: B-100, G-100, R-100

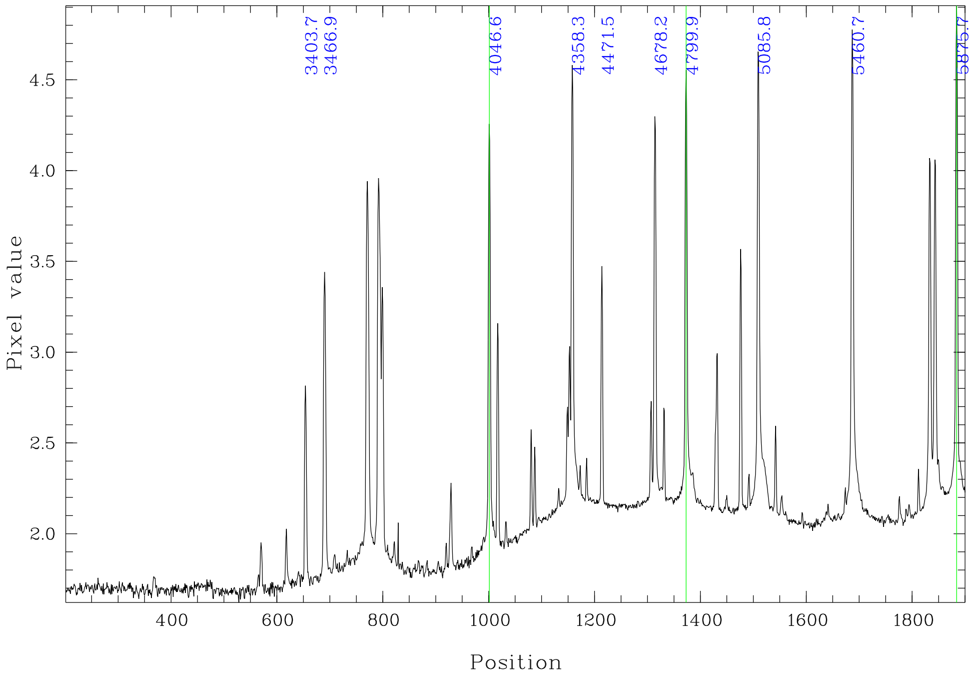

Figure 12: Identification of spectral lines for Grism B-100.

In order to show also faint lines we use a *logarithmic* scale. The pixel scale refers to the SITe-1d chip.

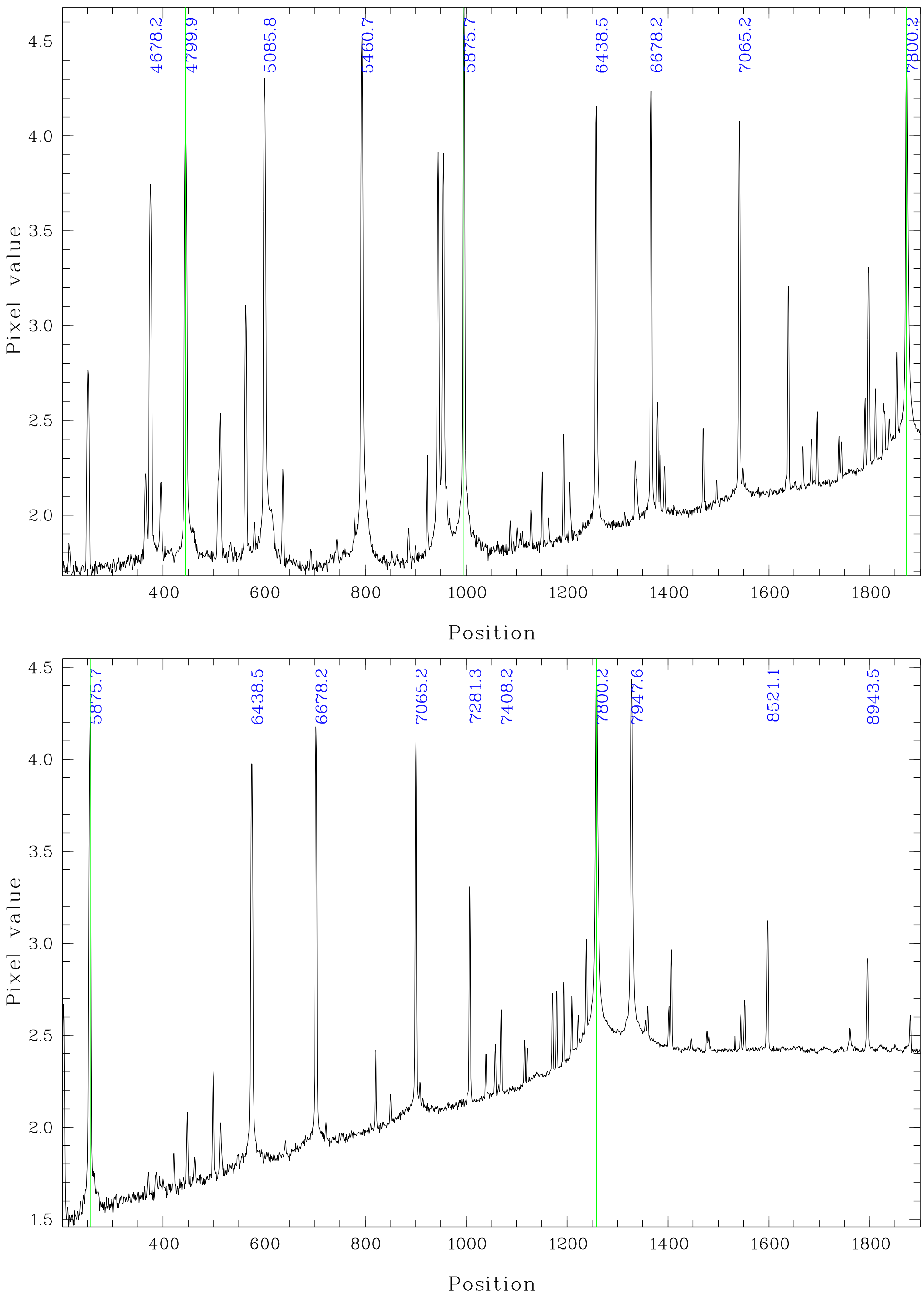

Figure 13: Identification of spectral lines for Grisms G-100 and R-100.

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B Commands for Quicklook

B.1 General Information

The QUICKLOOK is based on the MIDAS system. The CCD camera writes FITS files onto `.../images/myarea`. They have to be transformed into the MIDAS BDF format.

The background receiver (which is started by `receive`, see STARTUP, step 5) converts the FITS file to the MIDAS BDF format. In order to prepare the frame for a quick and **reliable** analysis in the Quicklook system the following steps are taken:

- Coordinates are set to absolute chip coordinates (i.e. the Quicklook coordinates are *independant* of the chosen sub-frames and the binning.
- The electronic bias is subtracted
- The counts in the ADC ("ADU") are converted to detected *photo electrons*. After this the local noise value $\sigma(x, y)$ should be $\sigma = \sqrt{N_e + RON^2}$.
- The level and dynamical range of the image is analysed and the "cuts" (which control the dynamical range on the image display) are set appropriately.

The total time between CCD readout and the message `received` is 20 seconds (for a full frame = 2100×1750 pixel). About 6 seconds of this (= 27%) are needed for the above preperatory steps. For (small) aquisition frames the total transfer time is < 10 seconds, including 3 seconds for the preperatory steps.

Many commands in the QUICKLOOK refer per default to the last image which was RECEIVED (look into the background window !).
The command `midas> look` permanently displays the last image.

On the following pages all available commands are described in alphabetical order.

GENERAL REMARK: Many commands ask `''o.k. ?''` or `''... done >''`
You may just hit $< cr >$ to continue.

B.2 Commands in alphabetical order.

CAFOS[/image]

Purpose: send command for remote control of CAFOS22

Syntax: `CAFOS[/image] command [parameters]`

Parameters:

`command` any CAFOS command
`parameters` the parameters of this command

Function: performs CAFOS command `cafos> command parameter`.

Example: `CAFOS filter 3` moves in filter 3
`CAFOS local` sets CAFOS back to interactive mode

CALIB/ETALON

Purpose: analyses calibration exposure for Etalon

Syntax: `CALIB/ETAL [image]`

Parameters:

`image` image whith calibration exposure (produced by `CSEQ/ETA`), default is the last image recieved.

Function: FOLLOW the instructions on the SCREEN !
The program automatically analyses the image taken with `CSEQ/ETA`. The (central) intensity level of the slit images taken with differnt wavelength settings are determined and filled into a table which contains λ and the intensity. The values are plotted and fitted by a Gaussian. The peak position z_0 is the new wavelength calibration for the Rb λ7946 line.

Example: CALIB/ETA analyses last exposure.

CHECK/CCD

Purpose: checks whether image is background limited.

Syntax: `CHECK/CCD [image]`

Parameters:

`image` CCD image, default is the last one received.

Function: compares frame level with read-out noise

CLEAR/CCD

Purpose: clears CCD Receiver

Syntax: `CLEAR/CCD`

Parameters: none

Function: the transmission signal from the `CCD` is removed.

CSEQ/ETALON

Purpose: Performs calibration exposure for FPI Etalon.

Syntax: `CSEQ/ETA[LON]` (no parameters)

Parameters: none

Function: Uses a focus exposure with shifting the charge on the detector to get a multiple image of the longslit for different wavelength of the Etalon around a calibration line. Follow the instructions on the screen. Use `CALIB/ETALON` to analyse the exposure.

EXPLAIN[/ima]

Purpose: Online help for the Quicklook system

Syntax: `EXPLAIN command/qual`

Parameters:

`command[/qual]` Any Quicklook Command. The qualifier has only to be specified if several different qualifiers exist for this command. For instance `OFFSET/SLIT` and `OFFSET/AXIS`. If NO parameter given all available commands are listed.

Function: Displays help file

Example:

`EXPLAIN` lists all Quicklook commands.
`EXPLAIN look` provides explanation for the command `LOOK`.

FOCUS[/ima]

Purpose: Analyses FOCUS exposure (produced by the `FSEQ` commands).

Syntax: `FOCUS[/image] image`

Parameters:

`image` CCD image containing a focus exposure, default is the last one received.

Function: FOLLOW the INSTRUCTIONS on the screen !
Mark the images of the focus star (or internal hole) on the display. Focus will determine their widths and plot them as a function of the focus value. A parabolic fit determines the position of the minimum (= best focus) and the seeing value at the best focus. If everything is ok, the focus and seeing value are saved in the SEEING LOG.

Example: `FOCUS` analyses last image which has been received by the Background Receiver.

FSEQ/CAFOS

Purpose: Performs focus exposure sequence for internal CAFOS2.2 focus.

Syntax: `FSEQ/CAFOS [N-step] [N-shift]`

Parameters:

`N-step` Number of exposures.
`N-shift` Number of pixels for detector shift (not used yet).

Function: FOLLOW the INSTRUCTIONS on the screen !

Example: `FSEQ/CAFOS` performs default focus sequence for CAFOS. The CAFOS focus is changed and the images are shifted in between each exposure by shifting the charge on the chip.

FSEQ/TELES

Purpose: Performs focus exposure sequence for telescope focus.

Syntax: `FSEQ/TELES [N-step] [N-shift]`

Parameters:

`N-step` Number of exposures.
`N-shift` Number of pixels for shift in between exposures.

Function: FOLLOW the INSTRUCTIONS on the screen !

Example: `FSEQ/TELES 9` performs focus sequence for the telescope containing 9 exposures.

INSPECT[/image]

Purpose: Allows closer look to a received CCD image.

Syntax: `INSPECT[/image] [image]`

Parameters:

`image` CCD image, default is the last one received.

Function: Displays image in standard format (i.e. full image, standard cuts). The user can choose new cuts, another Look-Up Table and zoom into sub areas of the displayed image.

Example: `INSPECT` displays last image received.

INSPECT/PHOTO

Purpose: Plot and analyse PHOTOMETRY LOG produced by the command `PHOTOMETRY`.

Syntax: `INSPECT/PHOTO nights ...` (NOT IMPLEMENTED YET)

Parameters:

`nights` numbers of nights to look back
`p2...` to be decided

Function:

Example:

INSPECT/SEEING

Purpose: Plot and analyse the CAFOS SEEING LOG.

Syntax: `INSPECT/SEEING [nights] [Xaxis] [Yaxis] [select]`

Parameters:

- `nights` number of nights to look back. Default: the current night only.
- `Xaxis` parameter to be plotted along X. Default: Jul. Date.
- `Yaxis` parameter to be plotted along Y. Default: FWHM.
- `select` selection of the entries in the SEEING LOG. Syntax as in standard MIDAS, e.g. :XFWHM.EQ.:YFWHM

Function: Plots (selected) entries of the CAFOS2.2 SEEING LOG table. See command `SEEING` for a documentation of the most important table columns.

Example: `INSP/SEEING` Plots the seeing FWHM of the current night (FWHM along X is shown in blue).
`INSP/SEEING` ? ? ? :XFWHM.EQ:YFWHM same as above but only the values from FOCUS exposures (which have XFWHM=YFWHM) are plotted.
tt INSP/SEEING 5 T_tel F_tel Plots telescope focus for the last 5 nights as function of the temperature of the telescope structure. A linear fit gives the slope of the focus change.

LOOK[/image]

Purpose: Permanent display of incoming CCD images.

Syntax: `LOOK[/ima] (no parameters)`

Parameters: none

Function: The LOOK process permanently checks whether a new image has arrived at the background receiver. The latest image is displayed. USE `cntrl-C` to stop the process !!

OFFSET/AXIS

Purpose: Position object of interest on the optical axis.

Syntax: `OFFSET/AXIS [image]`

Parameters:

`image` Aquisition exposure, default is the last one received.

Function: Object which should be placed on the optical axis has to be marked with cursor. The telescope offsets are calculated and (on request) automatically carried out.

Example:

OFFSET/MASK

Purpose: NOT IMPLEMENTED YET !!!

Syntax:

Parameters:

`image` Aquisition exposure, default is the last one received.

Function:

Example:

OFFSET/POLAR

Purpose: Bring object of interest into central stripe of polarization mask or the spectro-polarimetric slitlets

Syntax: `OFFSET/POLAR [image]`

Parameters:

`image` Aquisition exposure, default is the last one received.

Function: Follow the INSTRUCTIONS on the screen !

Example: `OFF/POLAR` displays last image and allows to mark an object which will then be placed in the middle of the central stripe of the *polarimetric mask*.

OFFSET/SLIT

Purpose: Bring object of interest onto the longslit.

Syntax: `OFFSET/SLIT [image]`

Parameters:

`image` Aquisition exposure, default is the last one received.

Function: FOLLOW the INSTRUCTIONS on the screen! The AQUISITION exposure (which has to preceed the command) will be displayed. Mark the object of interest with the cursor box. The necessary telescope offsets to place the object on the slit will be calculated and (on request) automatically performed. Repeating the aquisition exposure is possible if the accuracy of the positioning has to be checked.

Example: `OFFSET/SLIT (no parameter)` displays last exposure received. The object of interest has to be marked with the cursor.

PHOTOMETRY[/image]

Purpose: Measure AB magnitudes of program or standard stars.

Syntax: `PHOTOMETRY[/image] [image]`

Parameters:

`image` Any direct CCD image, default is the last one received.

Function:

Example: `PHOTO day50001` measures AB magnitudes on frame `day50001`.

SEEING[/image]

Purpose: Measures seeing FWHM on direct images

Syntax: `SEEING[/ima] [image]`

Parameters:

`image` Any direct CCD image, default is the last one received.

Function: The user has to mark several stars ACCROSS the entire field on the display. Their widths are determined by Gaussian fits. A plot of the radial dependance of the seeing values allows to identify field effects in the PSF. The best seeing value ist stored in the SEEING LOG of Cafos2.2.

Example: `SEEING day50003` measures the seeing PSF on the direct frame `day50003`.

SET/CCD

Purpose:	Select parameters of non-standard CCD detector in the the Quicklook system.
Syntax:	`SET/CCD chip`
Parameters:	
`chip`	One of the CCDs available for CAFOS. At the moment there are: SITe-1d and Lor-8o
Function:	Sets some parameter keywords and loads in the appropriate dispersion table for wavelength calibration.
Example:	`SET/CCD Lor-8o` Change to parametres of Lor-8o.

SPECTRUM[/image]

Purpose: Reduce spectroscopic exposures

Syntax: `SPECTRUM[/ima] [image] [type] [FF_frame] [range] [confirm] [sky]`

Parameters:

`image`	Any spectroscopic CCD image, default is the last one received.
`type`	*image type = science, flat or arc*, when `type = ?` the image type will be taken from the fits header.
`FF_frame`	normalized Flat Field frame [default = noflat].
`range`	range along slit for searching the object spectrum, default = [<:>]
`confirm`	confirm identification of (brightest) spectrum, [default = confirm]
`sky`	Sky range. Default="SKY", takes 50 columns on each side of the object.

Function: The procedure automatically finds the brightest spectrum (but you can select another one interactively), subtracts the night sky and extracts the 1 dimensional spectrum (Horne algorithm). After that a standard wavelength calibration is applied.

Example: `SPECTRUM` will extract 1-dim spectrum from last frame and perform standard calibration.

B.3 High Level Quicklook Commands

FFSEQ/DUSK

Purpose: Performs twilight Flat Field exposure sequence.

Syntax: `FFSEQ/dusk Filt_ID Filt_NR [t1,t2] [Nmax] level`

Parameters:

`Filt_ID`	Filter Name (only used for header)
`Filt_NR`	Filter Position in CAFOS filter wheel
`t1,t2`	Minimum, maximum integration time (sec) [= 5,100]
`Nmax`	requested number of Exposures [= 4]
`level`	requested FF level (electrons) [= 30000]

Function: Runs in Background !

Example: `FSEQ/DUSK B 1 10,100 3 25000` performs Flat Field exposure sequence for the B filter (at position 1) in the evening. The minimum integration time (to start with) is 10 sec and 3 exposures (none longer than 100 sec) are requested. The level of each exposure will be *around* 25000 electrons.

FFSEQ/DAWN

Purpose: Performs twilight Flat Field exposure sequence.

Syntax: `FFSEQ/dawn Filt_ID Filt_NR [t1,t2] [Nmax] level`

Parameters:

`Filt_ID`	Filter Name (only used for header)
`Filt_NR`	Filter Position in CAFOS filter wheel
`t1,t2`	Minimum, maximum integration time (sec) [= 5,100]
`Nmax`	requested number of Exposures [= 4]
`level`	requested FF level (electrons) [= 30000]

Function: Runs in Background !

Example: `FSSEQ/DAWN B 1 10,100 3 50000` performs Flat Field exposure sequence in the morning. The maximum integration time (to start with) is 100 sec and 3 exposures (none shorter than 10 sec) are requested. The level of each exposure will be *around* 50000 electrons.

NEXT[/ima]

Purpose: Performs first and subsequent exposures of a sequence of imaging observations. Offsets telescope in between exposures.

Syntax: `NEXT[/ima] mode:`n `t_int [header] [Dec] [Flags]`

Parameters:

`mode:`n = `start:`n or `continue`. `start:1` will start the first exposure of the sequence (at offset 0,0), `start:5` will start the fifth exposure by moving to position 5 before integrating. `continue` starts next exposure of sequence.

Function: Runs in Background ! Does telescope offset and starts next exposure.

Example: `NEXT start:1 600. NGC6618` will start the first 600 sec integration on NGC 6618.
`NEXT cont 800.` starts the next 800 sec integration on the same object (after offsetting the telescope).

C CAFOS 2.2 Control

C.1 GUI windows and their purpose

C.2 Commands to be used in Text window and Quicklook

CONFIG

```
Syntax: CO(NFIG)   -> get actual status of CAFOS 2.2

The string: S_1_223000_100_315.00_2000_12_0_345.01_0_0_0_0_0
             (1)  (2)  (3)  (4)   (5) (6)(7) (8)  (9)(..10..)
contains all information about the instrument:
(1) POL mounted, (2) absolute position of MASK, (3) SLIT width,
(4) GRISM pos. angle, (5) FOCUS setting (+2000), (6) FILTER
(7) POL/ETALON in/out, (8) Wollaston angle, (9) CALIBration
mirror in/out, (10) lamps 1...4 on/off

Purpose:  Check status of instrument.
```

CALIB

```
Syntax: CAL(IB) parameter  :  set calibration unit
                parameter = 1(234) -> switch on  lamps 1 (, 2, 3, 4)
                                      and move mirror in
parameter = -1(234)-> switch off lamps 1 (, 2, 3, 4)
parameter = 0      -> switch off all lamps and move mirror out
parameter = *    -> look which grism is used. Switch on
                                      the appropriate lamps and move mirror
                                      in. Propose exposure time.

NOTE: Lamp 4 (=continuum) can be dimmed by turning the knob at the
      power supply box of the calibration unit.

See also: MIRROR, CTAB, GTAB
```

CTAB

```
Syntax: CTA(B) -> edit CALIB.TAB to change IDs and filter names
   for lamps
```

ETALON

```
Syntax:     ET(ALON) [parameter]
parameter = IN  : move Etalon in
          = OUT : move Etalon out
          = CAL : define wavelength calibration of etalon
          = TEM : temp. input for calibration correction
          = RES : reset etalon controller (when problems)
          = XAD : parallelity adjustment in x-direction
          = YAD : parallelity adjustment in y-direction
          = PAR : type out etalon parameters
```

FOCUS

```
Syntax: FOC(US) +/-xxxx ->  set position of camera focus (in mue)
                            min = -1990,  max = 3990

Purpose: used to perform an internal focus series of the
         instrument (e.g. after mounting the CCD). Also
         necessary to determine the focus offset df for
         new filters of unknown thickness.

See also: FTAB, FZERO, HOLE
```

FREE

```
Syntax: FRE(E) -> move all analysators out of the beam
                   and set the appropriate focus.

Purpose: This command will make sure that the telescope beam
         passes unobscured through the instrument.
         In case you do not get the expected signal:
         Check telescope / TV guider. If o.k. there might
         be a severe problem with CAFOS 2.2.
         Check status by CONFIG !
```

FILTER

```
Syntax: FIL(TER) nn -> move filter wheel to position nn and
                           set camera to appropriate focus:

                           focus = FZERO + df
                                   where FZERO = focus (no filter)
                                   df = focus offset of filter nn

                FILTER F[ree]   -> move to free position
                FILTER ?        -> show filter list (= filter.tab)

        See also: FTAB, FZERO
```

FTAB

```
Syntax: FTA(B) -> edit FILTER.TAB to assign and set
                        parameters for new filters.

         After a focus exposure you have to set the
         focus offset df of the filter to
       df = best_focus - FZERO (= focus: no filter)

WARNING: df has to be given in mm (NOT micron !!)

See also: FOCUS, FZERO, FILTER
```

FZERO

```
Syntax: FZE(RO) +/-xxxx -> define value of NO-FILTER focus (in mue)

Purpose: If the CCD is remounted the focus of the instrument
         may have changed. You should refocus CAFOS 2.2
         without filter (= FILT FREE) and define the newly
         determined value.

See also: FOCUS
```

GRISM

```
Syntax: GRI(SM) nn -> move grism to position nn
        GRI(SM) free    -> move grism wheel into free position.

        GRISM ?         shows list of available grisms (grism.tab)

Note: If you get the warning > Position not reached < do not panik !
      Just repeat the command; The tolarances of the grism wheel
      positions are extremly small in order to get perfectly
      aligned spectra.

See also: GTAB, GPOS, CALIB
```

GPOS

```
Syntax: GPO(S) xxx.xx -> move grism wheel to position xxx.xx (degree)

ONLY for MAINTANANCE !    Observers should'nt do this !!!
```

GTAB

```
Syntax: GTA(B) -> edit GRISM.TAB to assign grism number to
                        position angles, and define the
                        relevant parameters of each grism.

ONLY used for MAINTANCE !!   Observers should NOT do this !
```

GZERO

```
Syntax: GZE(RO) +/-xxx.xx -> define offset for position angle
                             of all grisms.

Purpose: in case the grism wheel or the aperture unit have
         been removed it may be necessary to align the
         spectra with the columns (rows). Set GPOS 240.00
         and expose the HOLE through GRISM 9 !
         Measure the angle of the spectrum on the chip.
         This is your GZERO value (check +/- by
         rotating to GPOS 240.00.
```

HELP

```
HE(LP) [?]  without parameter -> get command list
HE(LP) cmd       -> info about every cmd
```

HOLE

```
Syntax:  HOL(E) +/-xxx.xx -> move hole (50 micron diameter)
                             in aperture unit to position
                             +/-xxx.xx [mm] with respect to its
                             central position.

Purpose: to perform a focus series to measure the internal
         focus of CAFOS 2.2 or the focus offset of a new
         filter you should use the HOLE. Moving it gives
         you the opportunity to expose all focus exposures
         on ONE FRAME.

See also: FOCUS, FZERO, MASK
```

INIT

```
Syntax: INI(T) -> move CAFOS to a defined position,
                  initialize encoder

SOFT RESET: try if either CONFIG or FREE give unexpected
            results

NOTE:  If you get ERROR messages like > Handshaking failed <
       etc. you better switch off the CAFOS 2.2 electronic
       box (HARD RESTART) and restart the program by:
       cafos > STOP
       ccdham> /disk-a/cafos/source/cafos
```

LAMBDA

```
Syntax: LA(MBDA) [wlen [ord]] -> set etalon to observing wavelength
                                 wlen = wavelength in nm
                                 ord  = interference order

                                 ONLY allowed when ETALON IN
```

MASK

```
Syntax: MAS(K) [1, 2, F(REE), S(LIT)]
                 --> move aperture mask to desired position

                 USE MASK 1 to access MASK_2 for change
                            and vice versa.
```

MPOS

```
Syntax: MPO(S) xxx.xxx -> move aperure unit with masks to
                           desired position xxx.xxx (in mm)

Mostly used for MAINTENANCE but could also help to center
Multi-Object Masks.
```

MTAB

```
Syntax: MTA(B) -> edit MASK.TAB to assign positions (mm) to
                                 each MASK in the aperture
                                 unit.

See also: MPOS, MASK
```

MIRROR

```
Synatx: MIR(ROR) in/out -> moves mirror in/out of the
                                   calibration unit.

                         WARNING:  MIRROR IN will block the light from
                                   the telescope without switching the
                                   lamps on!
                                   MIRROR OUT will leave the lamps ON !

See also: CALIB
```

POLA

```
Syntax: PO(LA) [F(REE), I(N), ppp.pp]
        -> move polarisator in/out
   ppp.pp = move in and rotate lambda/2 plate to
                            desired position angle.

                            Wollaston splits beam along N-S
```

SETUP

```
Syntax: SET(UP) -> change parameters of the instrument
                   setup in table CAFOS.TAB

                   THIS IS ESSENTIAL for getting CORRECT FITS HEADERS

IMPORTANT: you have to change Position Angle of
           Cassegrain Adaptor when rotating the
           instrument.
```

SLIT

```
Syntax: SLI(T) xxx -> move aperture unit to longslit
                           and change slit width to xxx (in mue)

                        >> use MASK S(LIT) instead if you do not
                           want to re-adjust the slit width.

See also: MASK
```

TFOC

```
Syntax:  TFOC ff.fff   -> move telescope focus to ff.fff [mm]
```

TOFF

```
Syntax:  TOFF aaaa.a,dddd.d  -> move telescope by aaaa.a
                                [arcsec/cos DEC] in RA and
                                dddd.d [arcsec] in DEC.
```

REMOTE

```
Syntax:  REMOTE (no parameter)   -> set CAFOS in REMOTE control
                                    NOTE: CAFOS prompt disappears, but
                                    no further message is returned

                                    Set back to LOCAL by
                                    midas> CAFOS LOCAL   in QUICKLOOK
```

D Overview over CCD control