FORS

Documentation of the
Data Reduktion Software

Chapter QUICK-LOOK

VLT Instrument Consortium

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Chapter 6

Quick look data reduction of FORS

6.1 Introduction

The Midas context QUICK was designed to do an entire data reduction of direct imaging data, long slit spectroscopic data and multi object spectroscopic data.
The package was designed for FORS which is a very efficient instrument. Therefore we expect a very strong influence of the night sky and we need a powerful reduction tool to see anything but the light pollution. However the files will be reduced – it will take some time to perform the quick look reduction of the entire images in this case. Therefore the quick look packages offers the possibility to extract parts of the images `USEAREA` ([<,<:>,>]) to be reduced quickly, like an extracted rectangle around the most interesting part of the direct image or around an interesting object on the slit in the case of long slit spectroscopy. The boundary of the rectangle has to be specified like in Midas command `EXTRACT/IMAGE`.
Using this package, the first steps of the reduction will be to create an observation summary table `OSTABLE` (**ost**) with the midas data organizer. Then the subsequent keywords of the data reduction packages has to be set up by reading the fits keywords of the input file's headers. Preferably at daytime one would average the existing bias, dark and flat field exposures of the entire CCD frames. The final reduction steps during the nightly observations depend on the context of the observations. It will be discussed below.
A graphical user interfaces `xquick` is provided to submit the commands to the midas session. The graphical user interface has to be started in the midas session to communicate properly with the midas session. The graphical user interfaces are written in C using the xforms libraries. The executable programs are then very compact and extremely fast compared to similar GUIs which can not be compiled. To make sure that the software is portable to other systems which can operate X11 the software has been tested on PCs under Linux and HP-workstations under HP-UX.
To start the graphical user interface is most easy, if the start up Midas task ∼/xqu/config/xqusetupquick has been copied to the working directory with the fits files. Then @@ xqusetupquick would copy the set of tables with instrument parameters to the working directory (eq. grism parameters) and the graphical user interface would start properly.

6.2 The Midas context `QUICK`

6.2.1 General setup of the context

Similar to the other midas contexts the quick context is initialized by the `INIT/QUICK` command. The actual values of the keywords can be seen with the command `SHOW/QUICK` and modified by the `SET/QUICK` command. To save the keyword value modified by the user one can type `INIT/QUICK`.
While initializing the quick context the data organizer is started, too. First of all one has to create an observation summary table (we call it OST later on) with the command `CREATE/OST` — e.g.

Midas ... > `CREATE/OST *.fits ?  quick ostable FC`

In this example the descriptor table `quick.tbl` DLIST (**quick**) contains the subsequent descriptors that will be reed from the input files `dut*.bdf` while creating `ostable.tbl`. The OST `ostable.tbl` will have as many rows as input files are specified and columns with the descriptor values specified in `quick.tbl`. A set of classification rules CRBIAS CROBJ1 CRFF1 CROBJ2 CRFF2 ... CROBJ5 CRFF5 is provided to the observer to distinguish, if the subsequent files of the OST are bias frames, one of three different types of flat fields or one of three different types of scientific exposures. One can create more classification rules or replace classification rules with the commands:

Midas ... > `setup/quick new ostable`

Midas ... > `setup/quick replace ostable`

The classification rules are stored as character descriptors of the observation summary table (OST) by the DO context and to a midas keyword by the QUICK context to offer the possibility to check the status of the classification by the call of `SHOW/QUICK`.

6.2.2 Average bias and flatfield images

Typical bias exposures are not "flat" and a slope in the bias frame should be considered in the data reduction. Additionally one has to take into account that the average bias value is not constant. To consider both `BIAS/QUICK` can subtract the mean bias value of the single input frames meassuered in the overscan region OVERSCAN (**?**) of the detector. The resulting frames are then averaged to a two dimensional median frame BIAS (**bias**), while the absolute bias value of the flat field and science images must be measured later on in the overscan region.
A special routine to compute the median `MEDIAN/QUICK` of an unlimited number of frames is provided to the users. The code reads single rows of all the images, calculates the median and writes the result to the output frame. Using this routine only very little memory is allocated.
The flat fields can be averaged by the `FLAT/QUICK` command. First the bias values meassuered in the overscan area and the two dimensional mean bias frame are subtracted. Finally the single frames are normalized and the median of the resulting frames FF1 (**FF1**), FF2 (**FF2**), FF3 (**FF3**) are calculated by `MEDIAN/QUICK` which is called by the `FLAT/QUICK` command automatically.

6.2.3 Direct imaging

The reduction of direct images is done by the command `DIRECT/QUICK`. Bias is subtracted and the result is flat fielded using the reduced bias and flat fields as specified by the keyword. The reduction can be done for a single image or the entire data set of the observation summary table (OST).

6.3 Graphical user interfaces

6.3.1 xquick: the main panel

The main panel is mainly used to initialize the context with button set/con quick to restore and save the user's preferences with init/quick and save/quic, respectively. The session parameters will be strored in Midas table files with the prefixes specified by the user (eg: SAVEDIRECT.tbl & SAVEDESCR.tbl) in the input field (here SAVE).
Secondly the sub-panels can be started with `xquick` like

- xsetquic to change the user preferrences
- xexecute to start the data reduction precedures
- xeditopti to change the instrument setup parameters like filter wheel contents
- xbrowser to create a list of the exposures including all information about filters and grisms
- xdisplay to change the parameters of the display windows such as scales and look-up tables

Some basic midas program (e.q. `GET/CURS...`) are provided. If button midas is pressed a menu with a set of Midas commands will be poped up. Finally the exit-buttom starts a quit/verification dialog.

6.3.2 xsetquic — setting the user preferences and defaults

The `xsetquic` panel summarize the content of the Midas session keywords and provides an interface to change the keywords to the user's preferences. It consists of two parts the `xsetquic` part on the left to set the fundamental parameters like the overscan region `overscan` (**N**) and the a more complex tool to classify the CCD frames on the disc reading the fits-file descriptors. The input fields are exactly the same as can be changed with the `SET/QUICK` within a midas session or which can be summarized with Midas command `SHOW/QUICK`.

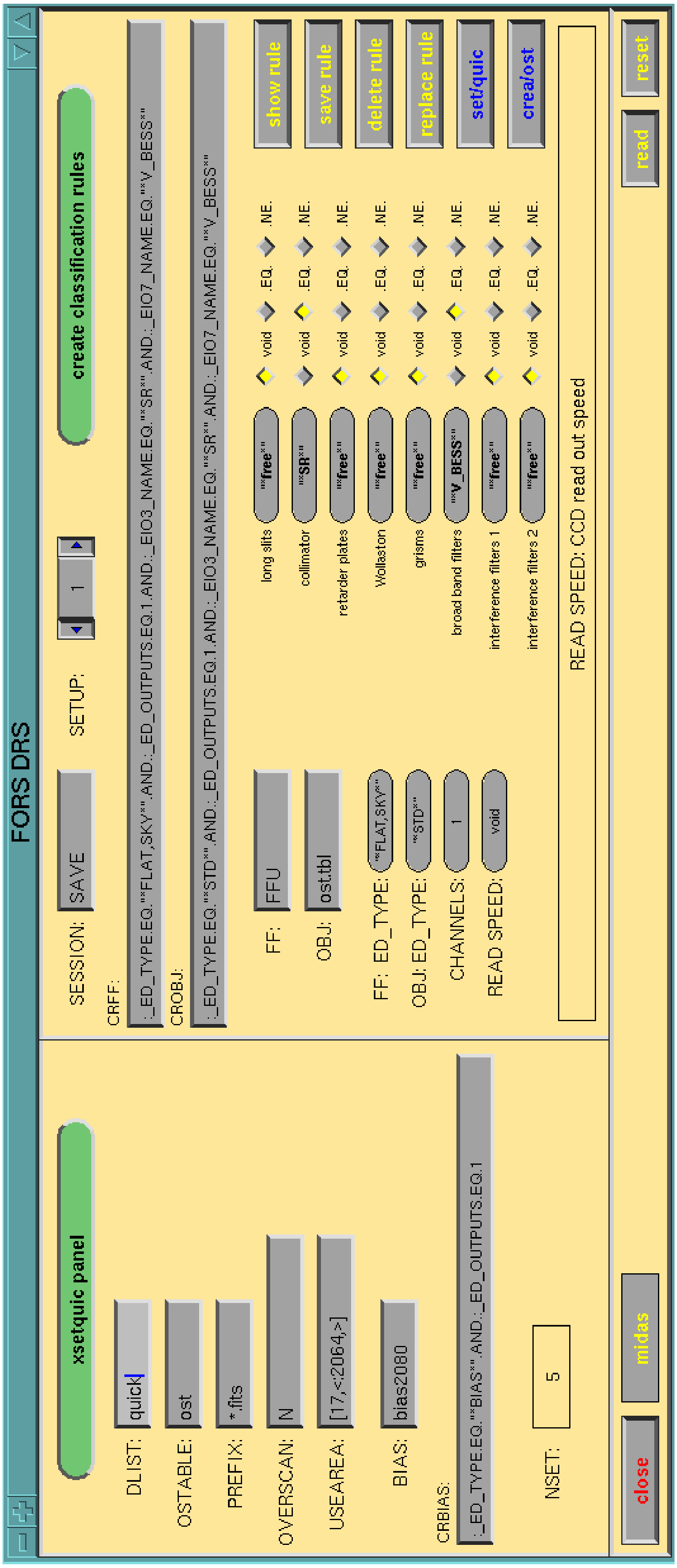
Fundamental parameters:

During the startup the data of the setup is read from the table descriptors of table `SAVE DIRECT.tbl`. The table file name consists of the prefix specified in input field `SESSION` which contains here the string `SAVE`, the extension `DIRECT` and the suffix `tbl`. The keywords and descriptors are not updated automatically after the interactive changes by the user, but button set/quic has to be pressed to update all.
The fundamental input parameters on the left side of the panel are the input tables with the list of descriptors to be read DLIST: quick and the name observation summary to be created OSTABLE: ost with command crea/ost. In input field PREFIX: *.fits one can specify the file names of the input CCD frames which will be included in the quick look data reduction. Optionally the overscan area of the CCD detector can be given with OVERSCAN: [@1,<:@15,>] but in the give example OVERSCAN: N the overscan region is not considered, which means that a variable bias value would not be corrected. A part of the CCD frame as given in field USEAREA: [<,<:>,>] can be optionally extracted before the data reduction processes will be started. For both parameters `OVERSCAN` and `USEAREA` the rectangle must be specified like in Midas command `EXTRACT/IMAGE`. In the next field BIAS: bias the file name of the average bias frame is set. The xexecute panel (see below) will provide a command to average the bias frames. All frames which follow the classification rule CRBIAS: :_EDE_TYPE.EQ."Dark".AND.:EXPTIME.LT.0.1 will be used while calculating the median bias frame. Note that the fits descriptors "HIERARCH ESO DET EXP TYPE" will be converted to midas descriptors "ESO_DET_EXP_TYPE" while we use an appriviation of the long keyword ":_EDE_TYPE" which is the table column name of the observation summary table which contains the data content of the subsequent fits- or Midas descriptors. The context of the classification rule is the same as for Midas commands `CLASSIFY/IMAGE` of the `DO` context and `SELECT/TABLE` respectively.

Creating classification rules:

Classification rules help to sort large data sets and allow to classify the input frames taken with a distinct instrument setup. As descriped earlier the desciptors of the input frames are copied to the observation summary table (OST). The classification rule is then a (long) string to select the OST similar to the `SELECT/TABL` command of Midas. The right hand side of the `xsetquic` panel assists the user to generate the classification rules interactively, selecting the subsequent content of the filter wheel menues with the left mouse button.
Starting the program 5 different setups are pre-defined but more setups can be created by the users. The number of setups is displayed in field NSET:: 5. To change one distinct of the predefined 5 setup one has to press the SETUP:: ◀ 1 ▶ counter. It is also possible to change to another session which was saved with button save/quic on the main panel earlier on.
One could start now editing the long input fields CRFF: :_ED_TYPE.EQ. . . . and CROBJ: :_ED_TYPE.EQ. . . . , but editing by hand would most likely cause typos and therefore it is recommended to select the seleup by selecting the optical setup by use of the menues provider below.
The first two input fields can be used to set the output file names of the average flatfield frame FF: FFsetup6 and the reduced data file OBJ: OBJ6 in the case of imaging data. All oval symbols stand for menus with which the user can select the instrumental setup. The menus will popup if they are clicked with the mouse buttons. The left two menues provide a selection of exposure types to classify the flat fields FF: ED_TYPE: ("*FLAT,LAM*") and the science exposures OBJ: ED_TYPE: ("*STD*"). Secondly the CCD readout mode and readout speed can

be selected with READ_MODE: ("*void*") and READ_SPEED: ("*normal*") respectively. Selecting the entry "void" mean in this case and later on that the rad out mode is not considered at any classification of the image and flat field frames.
The 8 menues in the center represent the 8 independently changeable instrument componenents of FORS, which can be selected by the observer. Pressing the buttons (eq: grisms: ("*600B*")) a menu with all grisms of the grism wheel would appear. One can additionally select if the content of the filter/grism shall be not considered (case "void") if the subsequent filter/grism shall be in the beam (case ".EQ.") or if the subsequent filter/grism shouldn't be there (case ".NE.").
Pressing the command button show rule on the outermost right side would the display the new classification rules in the fields CRFF: :_ED_TYPE.EQ. ... and CROBJ: :_ED_TYPE.EQ. ... . After previewing the resulting rule one can save the rules with save rule or replace the old selected rule with the new created rule with replace rule. It is also possible to delete the selected old rule with delete rule. After creating new rules the parameters and user preferences can be saved and initialized with midas command set/quic. Please note that the changes are only considered during the next steps if the button set/quic was pressed! A new observation summary table can then be created with crea/ost from this panel.


FORS DRS
xsetquic panel
DLIST: quick
OSTABLE: ost
PREFIX: *.fits
OVERSCAN: N
USEAREA: [17,<:2064,>]
BIAS: bias2080
CRBIAS:
:_ED_TYPE.EQ."*BIAS*".AND.:_ED_OUTPUTS.EQ.1
NSET: 5
close
midas
create classification rules
SESSION: SAVE
SETUP: 1
CRFF:
:_ED_TYPE.EQ."*FLAT,SKY*".AND.:_ED_OUTPUTS.EQ.1.AND.:_EIO3_NAME.EQ."*SR*".AND.:_EIO7_NAME.EQ."*V_BESS*"
CROBJ:
:_ED_TYPE.EQ."*STD*".AND.:_ED_OUTPUTS.EQ.1.AND.:_EIO3_NAME.EQ."*SR*".AND.:_EIO7_NAME.EQ."*V_BESS*"
FF: FFU
OBJ: ost.tbl
FF: ED_TYPE: "*FLAT,SKY*"
OBJ: ED_TYPE: "*STD*"
CHANNELS: 1
READ SPEED: void
long slits "*free*" void .EQ. .NE.
collimator "*SR*" void .EQ. .NE.
retarder plates "*free*" void .EQ. .NE.
Wollaston "*free*" void .EQ. .NE.
grisms "*free*" void .EQ. .NE.
broad band filters "*V_BESS*" void .EQ. .NE.
interference filters 1 "*free*" void .EQ. .NE.
interference filters 2 "*free*" void .EQ. .NE.
show rule
save rule
delete rule
replace rule
set/quic
crea/ost
READ SPEED: CCD read out speed
read
reset

6.3.3 xexecute — starting data reduction batches

The `xexecute` panel generates midas command lines which can be submitted to the active Midas session by pressing the command buttons (e.g: CREA/OST). The input parameters of the command line will be read from the input fields and counters respectively. Similar to other Midas commands up to 8 parameter could be specified. With command e.g: `HELP CREA/OST` typed within the midas session one can get the online help. Information about the parameters will also appear as soon as the buttons and fields will be entered with the pointer (Here : PREFIX: prefix of the input filenames. On the right side of the panel one can press buttons read to read the default values of the subsequent input parameters, which have been typed in by the user on the `xsetquic` panel earlier. Pressing reset would change the first input fields to {PREFIX}, ?, {DLIST} and {OST} which means that the parameters of the command are read from the Midas keywords `PREFIX`, `DLIST` and `OST`, respectively. This provides an overview of the keyword names which can be set be the users with the xsetquic panel or with Midas comannd

```
Midas ...> SET/QUIC OST=ost PREFIX=*.fits DLIST=quick
```

Some core Midas commands can be started from the menu, which will appear while pressing the midas button

crea/ost — creating the observation summary table

Pressing the button CREA/OST would generate and submit the command

```
Midas ...> CREA/OST *.fits ?  quick ost FA
```

to the active Midas session. This would then start a process to append all files with suffix fits to an existing observation summary table ost.tbl with the columns specified in table quick.tbl. For any file with suffix fits a table row will be generated containing all descriptor data specified in table quick.tbl.

bias/quic — averaging biases

With bias/quic an average bias frame bias can be calculated from the files of the observation summary table ost which fulfill the classification rule `:_EDE_TYPE.EQ."*Dark*".AND.:EXPTIME.lt.0.1`. In example no overscan region was specified in the third input field N. Alternatively one could calculate the bias value to be subtracted from the input frame before the averageing of the frames is done if one would enter [@1,<:@15,>] at the third input field. From the given input the command

```
Midas ...> bias/quic ost bias N :_EDE_TYPE.EQ.''*Dark*''.AND.:EXPTIME.lt.0.1
```

would be generated and submitted to the Midas session.

flat/quic — averaging screen and sky flat fields

With flat/quic an average flatfield for setup 1 is calculated from all files which fulfill the first classification rule `CRFF1`. The first parameter the number of the setup to be reduced can be set with : ◀ 1 ▶. Therefore it is required to create an appropiate classification rule before starting the command. Next parameter ost is the observation summary table, then FF1 the name of the output file with the average flat field and bias the name of the bias frame to be subtracted from the files. The last two input fields N and [<,<:>,>] contain the overscan region and the userea region to be reduced, respectively. This would result in the following Midas command:

```
Midas ...> flat/quic 1 ost FF1 bias N [<,<:>,>]
```

dire/quic — reducing direct imaging data

dire/quic is used to reduce a single direct imaging exposure or a complete series of exposures which fulfill the clasification rule `CROBJ1`. The input parameter and input field are the same as for the flat/quic command, except of the second field OBJ1. If this field contains an input file with extension `.tbl` is is assumed that the input file is an observation summary table and all file which fulfill `CROBJ1` will be reduced. The output files will have the same name as the input file names but with an adittional suffix "D". If no extension or another extension is given in the second input field the file is assumed to be an single exposure in Midas or fits format respectively. Given parameters in the example would be use to submit the following command while pressing the button dire/quic:

Midas ... > `dire/quic 1 OBJ1 FF1 bias N [<,<:>,>]`

prelon/quic — preliminary reduction of long slit spectroscopy

The quick look reduction of long slit spectroscopy includes sky subtraction, an interactive process at which the user can define the boundaries were objects will be extracted, extraction of objects, raw wave length calibration calculated from the optcal parameters of the camera and the grisms and a raw flux calibration. Because we don't expect to have flat field and wave length calibration exposures at the time of a first look on the spectra no flat field correction is done at this time.
Input parameters of the command are the file name target.fits, the wave length range to be displayed 3400,9100, the x-position were columns shall be averaged to find the objects 1024, and the y-position in pixel units in between the search for objects will be done 1283,1433. The following command would be send to the Midas session:

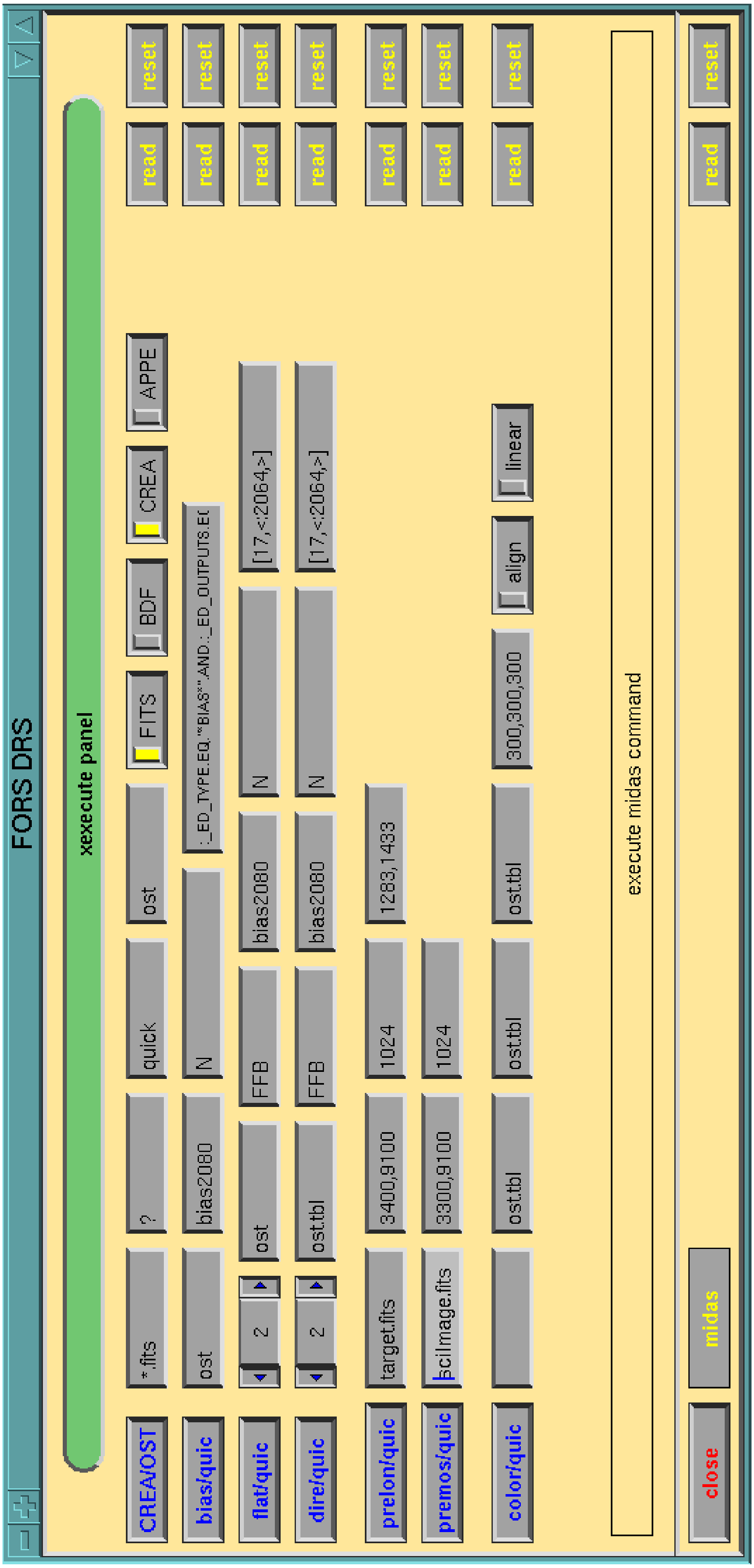
Midas ... > `@s fors_extract_slit target.fits 3400,9100 1024 1283,1433`

premos/quic — preliminary reduction of multi object spectroscopy

The premos/quic function uses the identical routines as the quick look reduction for long slit mode. Again the sky is subtracted, an interactive step is required to define the boundaries of the object extraction and a raw wave length and flux calibration is done.
Input parameters of the command are the file name sciImage.fits, the wave length range to be displayed 3400,9100, the x-position were columns shall be averaged to find the objects 1024 The following command would be send to the Midas session:

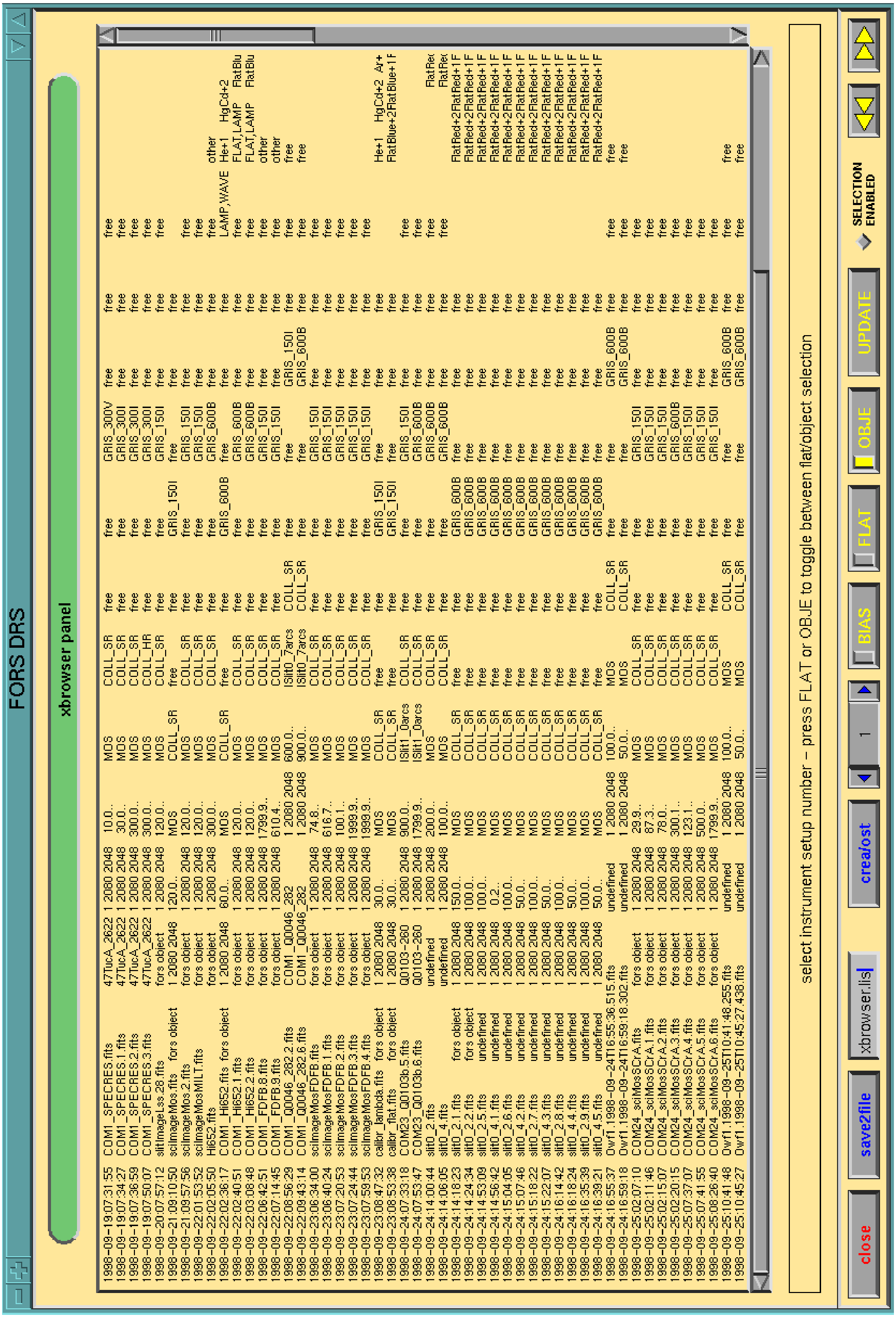
Midas ... > `@s fors_extract_slit sciImage.fits 3400,9100 1024`

The spectra of an object on slitlet 15 and y-position 450 in pixel units would be named as fobjsciImage.15.450.bdf and objsciImage.15.450.bdf. The two files contain the flux calibrated and uncalibrated spectra, respectiveley.


FORS DRS
xexecute panel
CREA/OST
*.fits
?
quick
ost
FITS
BDF
CREA
APPE
read
reset
bias/quic
ost
bias2080
N
:_ED_TYPE.EQ."*BIAS*".AND.:_ED_OUTPUTS.E(
flat/quic
2
ost
FFB
bias2080
N
[17,<:2064,>]
dire/quic
ost.tbl
prelon/quic
target.fits
3400,9100
1024
1283,1433
premos/quic
scilmage.fits
3300,9100
color/quic
ost.tbl
300,300,300
align
linear
execute midas command
close
midas

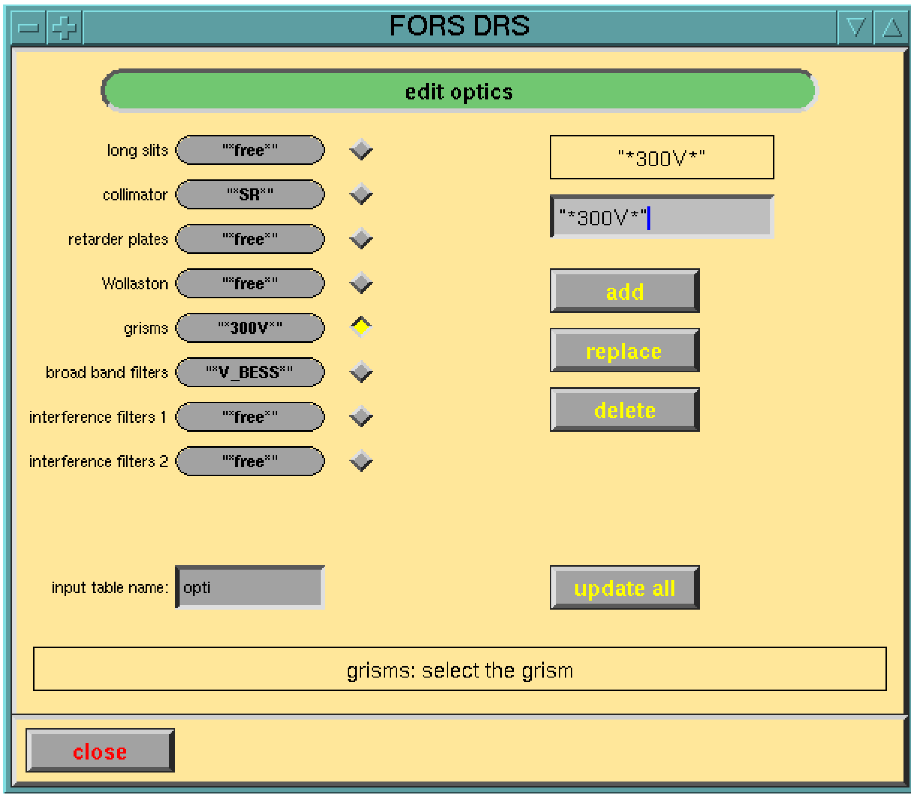
6.3.4 xbrowser — summarizing descriptor information and selecting files

The `xbrowser` is a tool to generate an overview of all files of an observation summary table created with command `CREATE/OST` started from the Midas session or with the button CREA/OST on this panel or the `xexecute` panel. The browsers also summarize selected file descriptors informations. It is also possible to select files using the classification rules or interactively clicking the subsequent row of the browser. With a double click on a row of the browser the files will be loaded to the Midas display window.
On the buttom of the panels some functions are provided to mark and select the files which fulfull the classification rules defined by the user. Pressing button BIAS the bias frames which fulfill rule CRBIAS would appear white. Pressing buttons FLAT and button OBJE the flat field and object exposures of the selected setup would appear white. The setup can be selected with counter : ◄ 1 ►. Here in the example the flat fields of setup 1 appear white. Pressing button flat/quic on the `xexecute` panel would calculate the median of the frames gri_if3.18.fits ... gri_if3.21.fits.
Another possible application would be to select the input bias frames to be averaged by the command `bias/quic` on the `xexecute panel`: First one has to press BIAS than one would select the frames clicking the subsequent rows of the browser and finally one would press UPDATE to save the user's selection. Pressing button bias/quic on panel `xexecute` would then calculate the average bias frame.
If the subsequent line are clicked with the mouse button by the user the selection will be toggled. To save the interactive selection the observation summary table can be updated with the button UPDATE. After this button was pressed the control light ♦ SELECTION ENABLED will be swiched on. Pressing the control light will disable the interactive selection. Pressing the symbols forward ►► and backward ◄◄ on the lower right corner of the panel would display the next page of the browser. Like for all panel the close button would close the panel but all data will be kept in the buffer.
If the button save2file is pressed an observation log file is created xbrowser.lis, which contains the most important fits descriptors. The resulting file is in ASCII format.


FORS DRS
xbrowser panel
select instrument setup number – press FLAT or OBJE to toggle between flat/object selection
close
save2file
xbrowser.lis
crea/ost
BIAS
FLAT
OBJE
UPDATE
SELECTION ENABLED

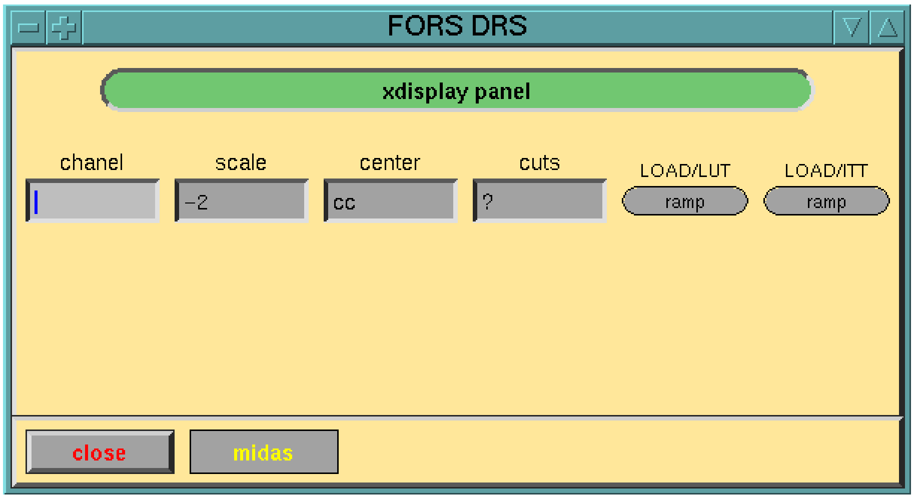
6.3.5 xeditopti — changing the filter wheel contents

The `xeditopti` panel allows to change content of the menues which contain the selectable optical components. This is necessary if new component (e.q: filters) are mounted to the instrument. The name of the Midas table (here opti.tbl) which contains the instrument information can be selected in input field (input table name: opti). To get started the user has to press one of menu buttons and the previously defined menues will pop up. Then one of the menu lines can be selected, which shall be edited by the user. The text will appear in input field "*300V*" and can then be edited interactively. The previous content of the selected entry is displayed in the display field : "*300V*" With the button add a new entry is appended to the active menu. With replace the selected entry of the active menu will be replaced. It is also possible to delete the selected entry pressing the delete button. Finally it is required to press the button update all to update the content of all menues including the menues of the `xsetquic` panel.



6.3.6 xdisplay — changing user preferences of the image display

With the xdisplay panel the parameters of the display window can be set to the user's preferences. The parameters are read if an image is loaded to the display window with a dobble click on the `xbrowser` panel. With chanel: the display window can be selected, if there are more then one display windows, created with the Midas command `CREA/DISP`. Secondly the image scale is set in the input field scale: -2 and the center of the image can be selected in field center: cc. Here `cc` denotes that the center of the frame will apear in the center of the display window. Typing center: 500,1000 would denote that pixel coordinate $x = 500, y = 1000$ would appear in the center of the display window. Cut values can also be set in field cuts: ?. Additionally it is possible to select look up tables from the `LOAD/LUT` menu and intensity transfer table from menu `LOAD/ITT`. Finally some Midas commands can be submitted from the panel if the midas menu is poped up. Pressing the close button would close the panel but all data will be kept in the buffer.



6.4 Installation proceedure

The tar file with the sources should be unpacked on your home direcory. This will create a directory $\sim/xqu/$ with the sources on $\sim/xqu/src/$ the required xforms library on $\sim/xqu/lib/$ and the configuration tables on $\sim/xqu/config/$. One can compile the sources with command $make - fmakefile\_linux$ and $make - fmakefile\_hpux$ executed on $\sim/xqu/src/$ for the Linux and HP-UX operating systems, respectiveley. If the Midas home directory is not $/midas$ one has to add the option $MIDHOME = /usr/midas$ or similar and $MIDVERS = 96NOV$ or similar if you have not installed the 97NOV release of Midas.
To start the graphical user interface is most easy if the start up file is linked to the working directory:
$ln - s \sim /xqu/config/xqusetup\_quick.prgxqusetup\_quick.prg$
The following command send to the Midas session would start the GUI

Midas ... > `@@ xqusetup_quick.prg`

If you don't have the setup tables and the executable on your home directory you can specify the path's as the first two parameters:

Midas ... > `@@ xqusetup_quick.prg /mydir/xqu/config/ /mydir/xqu/bin/`

6.5 Configuration tables

A set of configuration tables is provided together with the software. It consists of tables, which describe the instrument parameters like the positions of the longslits and the MOS-unit or the grism parameters. Secondly some tables with the laboratory wave lengths of the calibration lamps and finally some start up tables for the quick look software.

long_slit.tbl	position of the longslits in x-direction
fors_grism.tbl	parameters of the FORS grisms
fors_resp.tbl	FORS instrument response
mos_SR.tbl	y-positions in pixel units of the MOS slitlets in SR mode
mos_HR.tbl	y-positions in pixel units of the MOS slitlets in HR mode
opti.tbl	content of the filter and grism wheels
atmoexan.tbl	atmospheric extinction function
HgCd300.tbl	Catalog with Mercury and Cadmium lines for the typical spectral resolution of FORS
HeAr300.tbl	same for Helium and Argon
HeNeAr300.tbl	same for Helium, Neon and Argon
HgCdAr300.tbl	
HgCdHeAr300.tbl	
HRBESSDESCR.tbl	setup table for the Quick Look for observations in HR-mode with Bessel filters — here the descriptor to be read from the fits files
HRBESSDIRECT.tbl	a raw observation summary table for HR mode and Bessel filters
HRBESSKEYW.bdf	a dummy image which contains the Midas keywords
SRBESSDESCR.tbl	setup table for the Quick Look for observations in SR-mode with Bessel filters — here the descriptor to be read from the fits files
SRBESSDIRECT.tbl	a raw observation summary table for SR mode and Bessel filters
SRBESSKEYW.bdf	a dummy image which contains the Midas keywords

These tables are automatically copied and converted from $\sim /xqu/config/$ to the working directory. The original files are in fits format.

6.6 Next work to be done

Some more functions will be included to the panels and more assistance should be offered selecting the input files for the spectroscopic quick look functions prelon/quic and premos/quic.