EUROPEAN SOUTHERN OBSERVATORY
Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
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LA SILLA OBSERVATORY

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FEROS:
User's Manual

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Change Record

Issue/Rev.	Date	Sect./Parag. affected	Reason/Initiation/Documents/Remarks
1.1.1	20/07/2003	All	Version 1.1 in new format
1.2	20/07/2003	All	First step toward V-2.0
1.3	20/07/2003	All	Removed old irrelevant text

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1 Foreword

This version of the manual is far from complete. Basically it includes only the bits of the old manual still relevant now for FEROS-II at the MPG/ESO-2.20m telescope.
Of course a complete revision will be forthcoming soon.
John Pritchard, 2003-Dec-01.

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2 Introduction

FEROS, the Fiber fed Extended Range Optical Spectrograph is a fiber-fed bench-mounted prism-crossdispersed echelle spectrograph at the ESO 1.52-m telescope at La Silla. For the object and the nearby sky, the complete optical spectrum from 356-920nm is recorded in one exposure with a resolving power of by the use of a two-beam, two-slice image slicer.

The main parameters and the performance for FEROS are summarized in Table E.1.1:

Wavelength range in one exposure (object + sky)	356 - 920 nm (39 orders, 2 fibers)
Resolving Power (with 2-slice image slicer)	$R = 48000$
Entrance Aperture	2.7 arcsec
Fiber Input/Output Focal Ratio	F/4.6
Spectrograph Beam Size	136 mm diameter
Off-axis Collimators	F/11, cut from one parent paraboloid
Echelle	R2, 79 lines/mm, 154 mm by 306 mm
Crossdisperser Prism	LF5 glass, 55^o: apex angle
Dioptric Camera	
Wavelength Range	350 - 900 nm
$F/\#$	$F/3.0$
Focal Length	410 nm
Field Diameter	69 mm
Image Quality (E80)	$< 25\ \mu$m
Efficiency	> 85 %
CCD	2048 x 4096, 15 μm, thinned
Detection Efficiency (without telescope)	7% (3 700 Å), 27% (5 000 Å), 8% (9 000 Å)
Limiting Magnitudes at the ESO 1.52	16 mag in V (S/N = 15, 2 h) 12.5 mag in V (S/N = 100, 2 h)
Radial-Velocity Accuracy	< 30 m/s

The schematic layout of the FEROS instrument is shown figure 1.

2.1 Purpose

The aim of this document is to provide the user with the basic information on the FEROS spectrograph installed at the ESO 1.52m telescope. This information may be used to in the preparation of observing proposals and for an optimal operation of the instrument.

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2.2 Abbreviations and Acronyms

1.52m	The ESO-1.52 m telescope at the LSO
2.20m	The MPG/ESO-2.20 m telescope at the LSO
ADU	Analog to Digital conversion Unit
AG	Autoguider
BIAS	Brorfelde Image Acquisition System
CCD	Charge-Coupled Device
DCS	Detector Control System
DICB	Data Interface Control Board
DRS	Data Reduction Software
ESO	European Southern Observatory
eu	encoder units
FEROS	Fibrefed, Extended Range Optical Spectrograph
FF	Flat-Field
FFHV	FEROS Fibrehead Viewer
FITS	Flexible Image Transport System
FRD	Focal Ratio Degradation
GUI	Graphical User Interface
ICS	Instrument Control System
LED	Light Emitting Diode
LSO	La Silla Observatory
MPG	Max-Planck-Gesellschaft
OC	Object-Calibration
OS	Object-Sky
PSF	Point Spread Function
SWC	Software and Communications team at LSO
S/N	Signal to Noise
TBD	To Be Done/Discussed/Decided
TCS	Telescope Control Software
TIO	Telescope & Instrument Operator
VLT	Very Large Telescope
WC	Wavelength Calibration
ZD	Zenith Distance

2.3 Release Notes

This is version 1.3, the first preliminary release for FEROS-II at the MPG/ESO-2.20m telescope. Irrelevant sections from version 1.1.1 have been removed and new section headings have been added but still have to be populated.

Version 1.1.1 was the final version released for use at the ESO-1.52m telescope. It was written by Patrick François. It was slightly modified in format but NOT in content by John Pritchard in order to form a starting point for version 2.0, which will be the user's manual for FEROS-II at the MPG/ESO-2.20m telescope.

Please mail comments to `jpritcha@eso.org`.

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3 Instrument Description

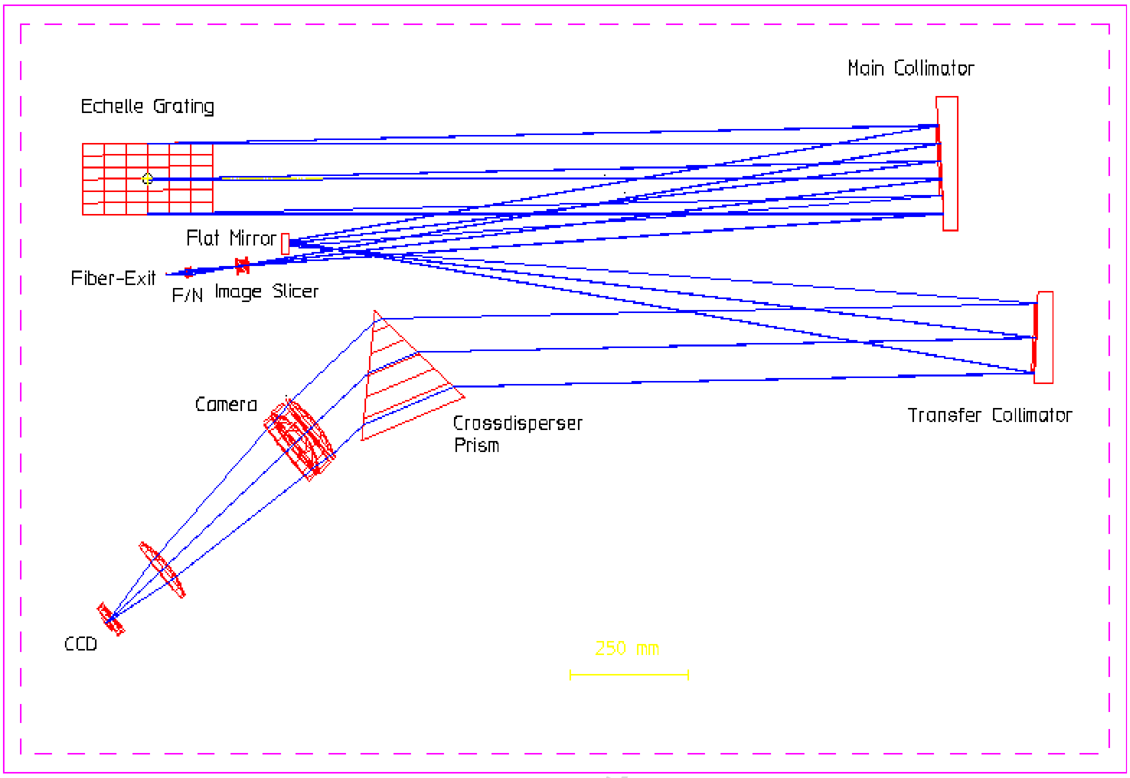

Figure 1: FEROS optical system from fiber exits to detector.

3.1 Instrument Configurations

The bench-mounted part of the spectrograph contains no movable or remotely controlled components besides the CCD shutter. Therefore, FEROS works in a fixed configuration only to guarantee the best possible long-term stability of the spectrograph.

All changes between the operational modes are carried out with/at the FEROS Calibration Unit **(FCU)** attached to the B&C instrument.

The two fibers simultaneously recorded on the detector allow basically two fundamental observing modes:

- Object-Sky (OS)
- Object-Calibration (OC)

Between these two modes, the observer has to switch manually (cf. below).

In both modes, the internal flatfield **(FF)** and wavelength calibration **(WC)** light sources are available for the two fibers via remote control of the FCU:

fiber	mode light sources
1 (object)	OS/OC object, FF, WC
2 (sky)	OS sky, FF, WC
2 (calibration)	OC FF, WC (along with object exposure)

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3.1.1 The Object+Sky Configuration

In the OS mode two fibers record the star light and nearby sky background simultaneously. For this mode, the second fiber has to be plugged into the fiber connector named **sky** at the **FCU**.

Both fibers have a projected entrance aperture of 2.7 arcsec. This keeps slit losses below 12 % for a seeing of 1.5 arcsec and keeps the effect of differential atmospheric refraction up to z = 60^o (airmass = 2) negligible.

For calibration purposes, the internal flatfield or the wavelength calibration source are recorded through the two fibers.

3.1.2 The Object+Calibration Configuration

In the OC mode the object fiber is used as in the OS mode described above. The second fiber has to be plugged into the fiber connector named **Calibration** at the FCU.

Then, the light of the calibration source (WC) can be recorded throughout the whole object exposure to monitor the stability of the spectrograph. The position of the neutral density filter wheel is set automatically according to the exposure time.

With the OC observing mode and the software techniques described below, a long-term radial velocity accuracy of $<$ 25m/s is reached for sharp-lined solar-like stars.

3.2 Spectral Characteristics

3.2.1 Spectral Coverage

For the two fibers, the complete wavelength range from 356 - 920 nm is recorded in 38 orders on the detector.

3.2.2 Spectral Resolution

By the use of the two-slice image slicer, the resolving power of FEROS is 48, 000 with a degradation less than 10

3.2.3 Efficiency and Limiting Magnitudes

FEROS has a high throughput with 27 % peak efficiency, 7 % in the extreme blue at 370 nm and 8 % in the extreme red at 900 nm. With these efficiencies and an efficiency of 60 % for the 1.52-m telescope, a spectrum of a 10th magnitude star can be taken in 15 minutes with a S/N 100 in V . Within one hour for a star of 16th magnitude still a S/N of 10 is reached.

3.3 Detector

3.3.1 CCD

The spectrograph is equipped with a CCD camera incorporating a monolithic thinned and back-illuminated CCD chip by EEV with 2048x 4096 pixels of 15x 15 μm size.

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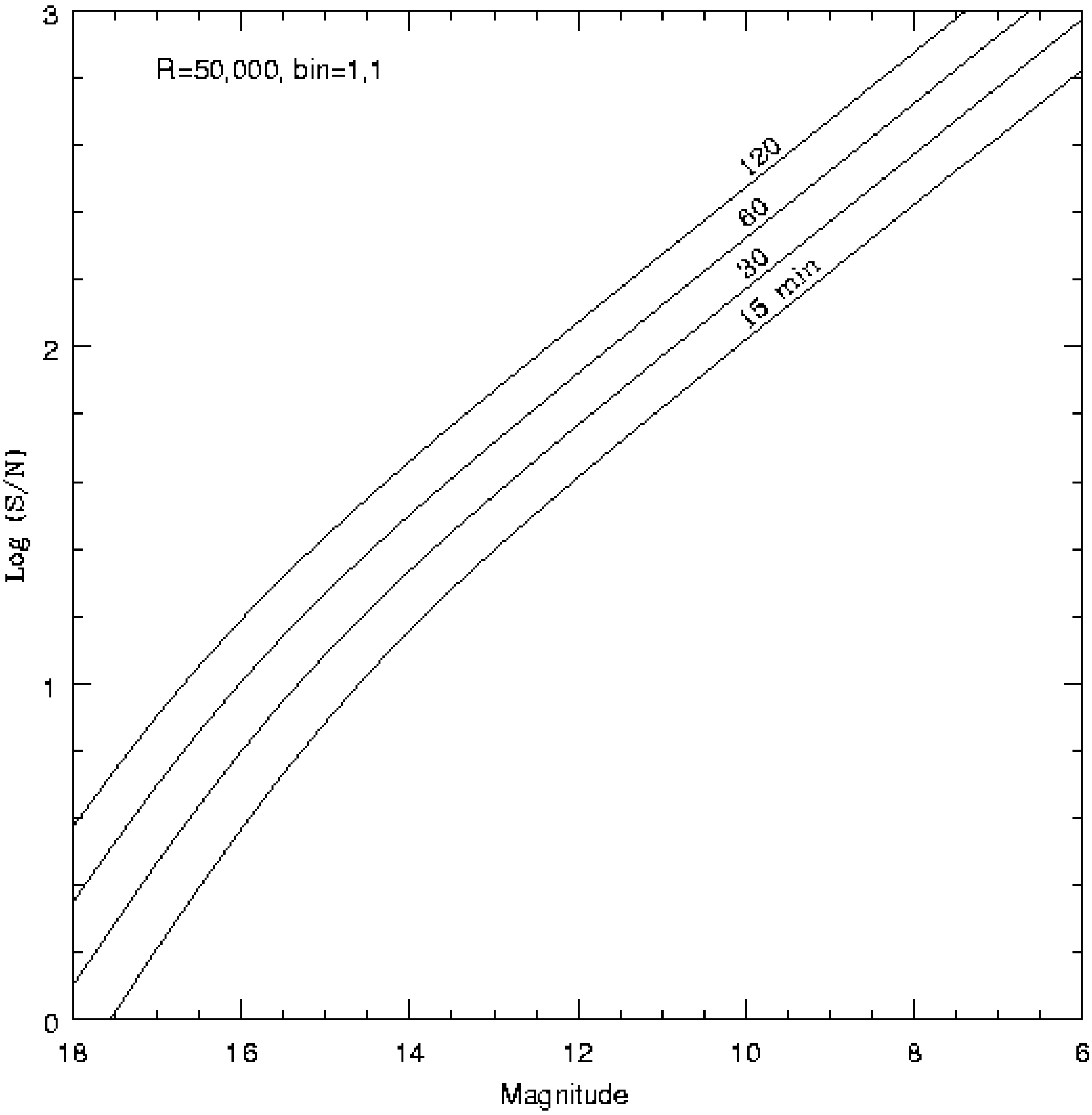

Figure 2: Reachable S/N ratio per wavelength bin for different exposure times.

The chip is mounted in a continuous-flow cryostat capable of maintaining any desired operating temperature in the range -80^o to -130^o C to within 0.1^o C.

The camera uses an EEV CCD detector of the design specified for FEROS, i.e., 2048×4096 pixels of $15 \times 15 \mu m$, mounted in a continuous-flow cryostat. The CCD can only be mounted with the columns in the main dispersion direction.

The thinned $2k \times 4k$ CCD and the standard ESO-VLT continuous-flow cryostat are provided by ESO.

3.3.2 Detector Head and Cryostat

The CCD detectors is mounted in a standard ESO-VLT continuous-flow cryostat. Further, ESO has provided the mechanical parts for the detector head for mounting the CCD and the appropriate wiring for the inside of the detector head. This is a copy of the parts being made for the UVES Blue detector system.

The continuous flow dewar is supplied from a 120l LN2 tank outside of the spectrograph room. The tank has to be exchanged every 20 days.

4 Calibration Unit

TBD.

5 FEROS/WFI Adapter

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6 Service Mode Observing Runs

TBD.

6.1 p2pp

TBD.

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7 Visitor Mode Observing Runs

TBD.

7.1 The day before your run begins

TBD.

7.2 The first day of your run

TBD.

7.3 At the 2.20m Console

8 On-line Data Reduction Software

The FEROS on-line data reduction software (DRS) gives the possibilty for a complete standard reduction of the science spectra which arrive during the night from the CCD system.

The on-line DRS is based on the MIDAS context feros which will be distributed from MIDAS version 98NOV on. A short intoduction to the MIDAS context feros is found here.

To install the on-line DRS after the DRS is installed, all MIDAS programs of the directory

/midas/97NOV/contrib/feros/locproc/ have to be copied to the local midwork directory.

After CCD readout, the BIAS program :

- includes the status informations from the CCD, the Telescope Control System (TCS), and the Instrument Control System (ICS) in the FITS header
- transfers the 2D spectra are to the instrument workstation (IWS) if the remote autosave is turned on (BIAS command remsave+)
- starts on the IWS the MIDAS programm

@@ loadccd fero [filenum]

where filenum is the running 4-digit filenumber of the CCD frame.

The loadccd program itself

- loads the frame fero[filenum].mt into the display
- adds the incoming file to the catalogue Feros.cat
- writes the FITS file to the DAT drive /dev/rmt/1mn (Blocksize 2880)
- starts the automatic reduction via **@@ autoreduce fero [filenum]**

According to the four possible exposure types (SCIENCE FLATFIELD, CALIBRATION, and DARK) given in the descriptor EXPTYPE, the autoreduce program starts the following actions:

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- FLATFIELD

  adds the incoming file to the catalogue FF.cat
- CALIBRATION

  adds the incoming file to the catalogue ThAr.cat
- DARK

  adds the incoming file to the catalogue Dark.cat
- SCIENCE

  adds the incoming file to the catalogue Objects.cat

  start the pre-reduction of the the file (**@@ prered [filenum] raw_image**) where raw_image is the name of the inputfile for the following on-line reduction.

  computes the barycentric velocity according to the telescope position and writes the result to the descriptor BARY_CORR

  computes and subtracts the interorder background of the echelle spectrum **(BACK/FEROS)**

  straightens the echelle orders **(STRAIGHTEN/FEROS)**

  extracts the echelle orders **(EXTRACT/FEROS)**

  removes the blaze function and the pixel-pixel variations **(UNBLAZE/FEROS)**

  rebins the echelle orders to wavelengths **(REBIN/FEROS)** acording to beforehand determined dispersion coefficients. In this step also the barycentric correction is applied.

  merges the echelle orders **(MERGE/FEROS)** into two 1D spectra named f[filenum]1 and f[filenum]2 where the spectrum with the ending 1 referes to the spectrum recorded on the object fiber and the spectrum with the ending 2 to the spectrum recorded on the sky/calibration fiber.

This standard reduction is controlled by the FEROS context keywords which can be listed together with their current contents by the command **SHOW/FEROS** and are set with the command **SET/FEROS key=[value]**. See below for useful keywords to be used during the observing session.

8.1 Startup of MIDAS

- Login at the IWS as user: feros, passwd: (see on the botton of the screen)
- Click on workspace FEROS
- Type startup in window hpterm
- The MIDAS session 9 is started which is able to communicate with the BIAS CCD control program
- A graphics and a display window is created.

If - for any reason - the automatic reduction has not been remotely started by the BIAS program, it can be started manually with the command

@@ loadccd fero [filenum]

8.2 Initialization of the DRS at the beginning of the night

To use the automatic data reduction as described above, the DRS has to be initialized at the beginning of the night. For this purpose several flatfield and wavelength calibration exposures have to be taken in the Object-Sky mode of FEROS before the beginning of the night following the following sequence:

- Reset the image catalogues FF.cat, ThAr.cat, Dark.cat, Object.cat by the command **@@ init ? reset**
- Insert a new write-enabled DAT in the drive */dev/rmt/1m*. Note that this DAT will be overwritten from the beginning erasing any contents ! One 60m DAT can carry about 70 files. If you are to take more than 70 full frames, it is advisable to change the DAT right before.
- Use the instrument control software XFCU running on the CCD control PC next to the ISW to turn on the wavelength calibration lamp and use the BIAS CCD control software to take several (typical 2) exposures of 15 sec each (For details on the XFCU software see here, for the BIAS software see here. The resulting frames are automatically transfered to the IWS and added to the catalogue ThAr.cat.
- Switch with the XFCU program to the flatfield lamp and take, depending on the S/N needed for a appropriate reduction of the planned science exposures, 3 to 10 exposures of 30 sec. The frames are automatically transfered to the IWS and added to the catalogue FF.cat.
- Initialize the DRS for the night with the command *@@ init [guess]* where guess is the name of a previously saved guess session. Typically this is the session saved in the night before. The seesion names are formed automatically from the filenumber of the first calibration exposure in the catalogue ThAr.cat and the prefix ThAr, e.g., ThAr0741.

Now the following initialization steps are performed:

- Initialization of the session keywords and tables **(INIT/FEROS)**
- Averaging of the frames of the respective catalogues FF.cat, ThAr.cat.
- Setting of the CCD gain keyword according to descriptor **CCD_GAIN** and the values specified in init.prg
- Locating of the echelle orders in the averaged flatfield (**LOCATE/FEROS**); the fitted positions are shown in the display window.
- Standard reduction of the flatfield (**BACK/FEROS**, **STRAIGHTEN/FEROS**, **EXTRACT/FEROS**). The extraction is done twice: the first time, the cross-order profiles are determined for an optimum extraction with cosmic removal for the science exposures; the second time the flatfield orders are extracted. The name of the reduced flatfield is found in the keyword **FLAT_IMG**.
- Standard reduction of the wavelength calibration (**BACK/FEROS**, **STRAIGHTEN/FEROS**, **EXTRACT/FEROS**). The name of the reduced calibration is found in the keyword WLC_IMG
- Search for emission lines in the reduced calibration frame (**FIND/FEROS**).
- Wavelength calibration by iterative fitting of the dispersion coefficients (**CALIBRATE/FEROS**). The residuals of the individual lines are plotted over the order number. The spread should not exceed a peak-to-peak of 0.02 Angstroms.
- The session parameters are saved as session **WLC_IMG**.

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With this step completed, the FEROS on-line DRS is initialized.

Every new incoming spectrum will be saved and reduced now as described above.

8.3 On-line Reduction Options During the Night

The context keywords allow to control the parameters of the reduction process. The keywords can be listed together with their current contents by the command **SHOW/FEROS** and are set with the command **SET/FEROS key=[value]**. Alternatively the keywords can be set using the FEROS GUI which is started by the command **CREATE/GUI feros**.

If the keywords are set to new values, they will only affect the automatic on-line DRS for next incoming files. If one of the files already transfered to the IWS (fero[filenum].mt should be reduced again according to the new settings of the keywords, this is easily achieved by re-starting the **@@ autoreduce** command manually as follows:

@@ autoreduce fero [filenum]

Useful keywords for the observing session might be:

1. EXT_MODE controls the method used for the extraction of the spectra.

   The three options are:

   SET/FEROS EXT_MODE=S the standard extraction is performed where the flux across the slit is ust summed.

   SET/FEROS EXT_MODE=M the standard extraction is performed as above but with clipping of cosmics

   SET/FEROS EXT_MODE=O the optimum extraction is performed with clipping of cosmics

2. MERGE_MTD controls the merging of the orders.

   The options are:

   SET/FEROS MERGE_MTD=SINC the default merging into a 1D spectrum with weighted adding of overlapping regions. The lengths of the orders are determined from table BLAZE.tbl

   SET/FEROS MERGE_MTD=AVE should not be used

   SET/FEROS MERGE_MTD=NOAPP the orders are not merge but written into individual 1D spectra; the order number is appended to the filename as 4-digit number.

3. REBIN_MTD controls the rebinning of the spectra.

   The options are:

   SET/FEROS REBIN_SCL=I the rebinning is done into a linear wavelength scale. The stepsize has to be set in the keyword REBIN_STEP.

   SET/FEROS REBIN_SCL=O the rebinning is done into a logartithmic wavelength scale. The stepsize has to be set in the keyword REBIN_STEP.

8.4 Utility programs

8.4.1 List of files

An extended list of files with the most important header informations can be obtained with the command

@@ listferos [tablename] [filenum_start,filenum_end]

where tablename is the name for the output table; filenum_start,filenum_end are the 4-digit filenumbers of the interval of files to be listed. The program will ask at the end to prepare a printout on the laser printer. It will take care of the proper formatting of the printer output.

It is recommended to use this program at the end of the night to check the integrity and completeness of the data files obtained during the night before archiving them on the COPY DAT.

8.4.2 Plot of temperatures

A plot (and a table) with the spectrograph and room temperatures corresponding to the obtained CCD frames can be obtained with the command

@@ temperature [tablename] [filenum_start,filenum_end]

where tablename is the name for the output table; filenum_start,filenum_end are the 4-digit filenumbers of the interval of files to be used. In the table also the measured relative humidity is stored and can plotted with the command

plo/table [tablename] :JD24 :RHUM

8.4.3 Signal-to-Noise Ratio

After a spectrum fero[filenum].mt of a science object has been passed the on-line DRS, the achieved Signal-to-Noise Ratio (SNR) can be tentatively measured in a line-free region of the spectrum with the following command

@@ snr [filenum] [start,end] [fibernum]

where the parameters start,end determines the wavelength interval to be used for the SNR estimate; fibernum refers to the fiber to be used, i.e., 1 for the object fiber (default), 2 for the sky fiber.

Note that the performance of this procedure is heavily affected by sharp spectral features as spectral lines or cosmic ray hits. Further, the SNR of the used flatfield may limit the SNR measured.

8.4.4 Spectrograph focus test

After a wavelength calibration spectrum fero[filenum].mt has been taken and the DRS is initialized as described above, the command

@@ focus [filenum]

reduces the calibration spectrum, measures the FWHM of the emission lines and plots the FWHMs over the position in dispserion direction. A FWHM of 2.2 pixels corresponds to a resolving power of R=48,000.

8.4.5 System efficiency test

After a spectrum fero[filenum].mt of a standard star has been taken and the spectrum has be passed the automatic standard reduction, the command

@@ efficiency [filenum] [standard star flux table]

computes the efficiency of the instrument including the telescope, fibers and the detector as function of the wavelength.

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The flux tables of the standard star must be available in the subdirectories of **/midas/calib/data/spec/** and have to be given with the subdirectory, e.g. as **ctio/hr9087**.

8.4.6 Radial Velocities by Cross-Correlation

Radial velocities with high precision can be obtained in the OC mode of FEROS. The on-line DRS

provides a very simple cross-correlation tool to obtain online radial velocities with respect to one reference exposure of the object.

It should be emphasized that the routines described here are meant as on-line tools to obtain an estimate for the measured radial-velocity shifts. However, to obtain high precision radial velocities over long periods, dedicated reduction software and special operational precautions have to be taken. This is beyond the scope of the FEROS on-line DRS.

The algorithm works as follows: The program crosscorrelates the calibration spectrum (thar) from

the initialization of the night order by order with the corresponding calibration spectrum from the reference night (tharref) to obtain the zero point of the night.

For the object spectrum obtained during the night (object), the program crosscorrelates the simultaneous calibration spectrum on the calibration fiber with the calibration spectrum on the calibration fiber from the initialization to obtain the drift correction between the zero point of the night and the actual object exposure. The object spectrum (object) is crosscorrelated with the object spectrum from the reference night (objectref). The measured radial velocity shift is corrected for the zero point, the drift during the night, and the barycentric correction. The final radial velocity is obtained by gaussian fitting of the histogram of the derived radial velocities of all orders.

To use the corresponding **@@ xcorall** program, the following steps are necessary:

- initialize the DRS as described above in the Object-Sky mode. The calibration exposure has to be flatfielded with the command

  UNBLAZ/FERO ThAr[thar]ext FF[flat]ext f[thar]ext

  where thar, flat correspond to the 4-digit numbers of the intialization frames of the night.

- .observe the object in Object-Calibration mode and let the on-line DRS reduce the spectrum as usual. Make sure that the EXT_MODE=S is used.

- Use afterwards the crosscorrelation program:

  @@ xcorall [table] [object] [objectref] [thar] [tharref] [hbin] [action]

  where table is a name for the table with the results (the results from subsequent calls of the program will be appended to the table); object, objectref, thar, tharref refer to the 4-digit numbers of the files described above. With hbin the size of the histogram bins to be used for the final determination of the radial velocity; defaulted to 0.150 km/s.

  If the program is called the very first time, action should be set to create; to add the results from new reductions action has to be set to enter

- The results can be plotted over the modified julian date (MJD) with the command

  plot/table [table] :jd24 :dbc

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5.Example for the first (reference) night:

```
Midas 11> UNBLAZ/FERO ThAr1200ext FF1202ext f1200ext
Midas 12> @@ xcorall 51Peg 1212 1212 1200 1200 ? ? create
Midas 13> @@ xcorall 51Peg 1212 1212 1200 1200 ? ? enter
```

For an observation from a later night:

```
Midas 698> UNBLAZ/FERO ThAr1410ext FF1212ext f1410ext
Midas 699> @@ xcorall 51Peg 1417 1212 1410 1200 ? ? enter
Midas 700> plo/tab 51Peg :jd24 :dbc
```

If a large number of Object-Calibration exposures has been obtained for one object, the command

@@ radvel [objectcat] [objectref] [tharcat] [refthar] [hbin]

gives the possiblity to reduce all files at once. For this, a MIDAS catolgue objectcat with all f[object]ext1.bdf files and a MIDAS catolgue tharcat with the corresponding f[thar]ext1.bdf files has to be provided. The catalogue names have to entered without the extension .cat; the result table will carry the name objectcat. Example:

```
Midas 897> read/icat 51Peg

Image Catalog:  51Peg.cat
--------------
No    Name                Ident                                   Naxis  Npix
#0001 f1212ext1.bdf                                                  2 4102,39
.
.
.
#0015 f1417ext1.bdf                                                  2 4102,39


Midas 897> read/icat 51Pegthar

Image Catalog:  51Pegthar.cat
--------------
No    Name                Ident                                   Naxis  Npix
#0001 f1200ext1.bdf                                                  2 4102,39
.
.
.
#0015 f1410ext1.bdf                                                  2 4102,39

Midas 899> @@ radvel 51Peg 1212 51Pegthar 1200
Midas 900> plot/tab 51Peg :jd24 :dbc
```

9 Data Archiving

TBD.

A The FEROS FITS header

TBD.

The corresponding FEROS MIDAS descriptors

When converting FITS files to MIDAS bdf, some of the standard FITS keywords are converted into standard MIDAS descriptors. The following table lists the most important conversions:

```
 FITS     MIDAS
OBJECT   IDENT
RA       O_POS(1)
DE       O_POS(2)
DATE-OBSO_TIME(1)
TM-STARTO_TIME(5)
EXPTIME O_TIME(7)
```

Note that the OBJECT key is set according to the name set with the BIAS command object whereas the CIDENT key carries the TCS catalogue object entry from the the last telescope preset.

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B On-line DRS filename conventions

@@ init

- **Filename :** fero[filenum].mt
  Content:rawimage in FITS format as transferred to the instrument
  Format: pixel-pixel
- **Filename :**FF.cat
  Content: Catalogue with FLATFIELD exposures
  Format:MIDAS catalogue
- **Filename :**ThAr.cat
  Content: Catalogue with CALIBRATION exposures
  Format: MIDAS catalogue

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- **Filename :** Dark.cat

  Content: Catalogue with DARK exposures

  Format: MIDAS catalogue

- **Filename :**Objects.cat

  Content: Catalogue with SCIENCE exposures

  Format: MIDAS catalogue

- **Filename :**FF[filenum].bdf

  Keyword: RAW_IMG

  Content: average flatfield frame from catalogue FF.cat; filenum is taken from the first file in the catalogue

  Format: position[mm]-position[mm]

- **Filename :**FF[filenum]ext1.bdf

  Keyword: RAW_IMG,FLAT_IMG

  Content: Extracted flatfield orders of object fiber

  Format: position[mm]-order

- FilenameFF[filenum]ext2.bdf

  Keyword: RAW_IMG, FLAT_IMG

  Content: Extracted flatfield orders of sky fiber

  Format: position[mm]-order

- **Filename :**ThAr[filenum].bdf

  Keyword: WLC_IMG

  Content: average calibration frame from catalogue ThAr.cat filenum is taken from the first file in the catalogue

  Format: position[mm]-position[mm]

- **Filename :**ThAr[filenum]ext1.bdf

  Keyword: WLC_IMG

  Content: Extracted calibration orders of object fiber

  Format: position[mm]-order

- **Filename :**ThAr[filenum]ext2.bdf

  Keyword: WLC_IMG

  Content: Extracted calibration orders of sky fiber

  Format: position[mm]-order

- **Filename :**ThAr[filenum]lines1.bdf

  Keyword: LINE_POS_TBL

  Content: Table with found calibration lines of object fiber; order-by-order dispersion coefficients are stored in the descriptor DCOEF/D/1/195 with 5 polynomial coefficients per order (used for rebinning). Saved to ThAr[filenum]_LINE1.tbl by SAVE/FEROS ThAr[filenum]

  Format: MIDAS table

- **Filename :**ThAr[filenum]lines2.bdf

  Keyword: LINE_POS_TBL

  Content: Table with found calibration lines of sky fiber; order-by-order dispersion coefficients are stored in the descriptor DCOEF/D/1/195 with 5 polynomial coefficients per order (used for rebinning). Saved to ThAr[filenum]_LINE2.tbl by SAVE/FEROS ThAr[filenum]

  Format: MIDAS table

- **Filename :** ThAr[filenum]_INIT.bdf

  Content: Table with session keywords in descriptors; session keywords and defaults in table rows. Session keywords are restored by command INIT/FEROS

  MIDAS Table

- **Filename :** template.bdf

  Content: Image with cross-correlation template for order definition; Copied to ThAr[filenum]_TEMP by command INIT/FEROS ThAr[filenum]

  Format: pixels, template must be centered to central pixel

- **Filename :**echpos.tbl

  Keyword: GUESS_TBL

  Content Table with guess for order definition; Copied to ThAr[filenum]_GORDER.tbl by command INIT/FEROS ThAr[filenum]

  Format: MIDAS Table

- **Filename :**centers.tbl

  Keyword: CENTER_TBL

  Content Table with order definition; Copied to ThAr[filenum] by command INIT/FEROS

  Format: MIDAS table

- **Filename :**cop_coeffs1.tbl

  Keyword: COEF_COP

  Content Table with cross-order profile definition of object fiber; Copied to ThAr[filenum]_COP1.tbl by command INIT/FEROS ThAr[filenum]

  Format: MIDAS Table

- **Filename :**cop_coeffs2.tbl

  COEF_COP

  Content Table with cross-order profile definition of sky fiber; Copied to ThAr[filenum]_COP2.tbl by command INIT/FEROS ThAr[filenum]

  Format: MIDAS Table

- **Filename :** wlc_coeffs1.tbl

  Keyword: COEF_WLC

  Content Table with wavelength-calibration coefficients of object fiber from global fit; Copied to ThAr[filenum]_WLC1.tbl by command INIT/FEROS ThAr[filenum]

  Format: MIDAS Table

Warning:: Not yet updated for 2.2.0m

- **Filename :** wlc_coeffs2.tbl

  Keyword: COEF_WLC

  Content Table with wavelength calibration coefficients of sky fiber from global fit; Copied to ThAr[filenum]_WLC2.tbl by command INIT/FEROS ThAr[filenum]

  Format: MIDAS Table

- **Filename :** ThAr50000.tbl

  Keyword: COEF_WLC

  Content: Table with wavelengths of calibration lines optimized for resolving power R=50000. Used for wavelength calibration; Available in MIDAS directory /midas/97NOV/contrib/feros/data/calib/calib0

  Format: MIDAS Table

- **Filename :**BLAZE.tbl

  Keyword: COEF_WLC

  Content: Table with blaze wavelengths of orders. Used for order merging; Available in MIDAS directory /midas/97NOV/contrib/feros/data/calib/calib0002.mt

  Format: MIDAS Table

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- **Filename : fero[filenum].mt**

  Content :rawimage in FITS format as transferred to the instrument workstation

  Format: pixel-pixel

- **Filename : raw_image.bdf**

  Content : MIDAS frame after prereduction of the rawimage

  Format: position[mm]-position[mm]

- **Filename : back.bdf**

  Content : Background subtraced frame

  Format: position[mm]-position[mm]

- **Filename : back_str_C1.bdf**

  Content : Straightened frame of object fiber

  Format: position[mm]-pixel

- **Filename : back_str_C2.bdf**

  Content : Straightened frame of sky fiber

  Format: position[mm]-pixel

- **Filename : b[filenum]ext1.bdf**

  Content : Extracted orders of object fiber

  Format: position[mm]-order

- **Filename : b[filenum]ext2.bdf**

  Content : Extracted orders of sky fiber

  Format: position[mm]-order

Warning:: Not yet updated for 2.20m

- **Filename : f[filenum]ext1.bdf**

  Content : Extracted and flatfielded orders of object fiber

  Format: position[mm]-order

- **Filename : f[filenum]ext2.bdf**

  Content : Extracted and flatfielded orders of sky fiber

  Format: position[mm]-order

- **Filename : rebinned1.bdf**

  Content : Wavelength rebinnded orders of object fiber

  Format: wavelength[Å]-order

- **Filename : rebinned2.bdf**

  Content : Wavelength rebinnded orders of sky fiber

  Format: wavelength[Å]-order

- **Filename : f[filenum]1.bdf**

  Content : Merged and wavelength calibrated spectrum of object fiber

  Format: wavelength[Å]

- **Filename : f[filenum]2.bdf**

  Content : Merged and wavelength calibrated spectrum of sky fiber

  Format: wavelength[Å]

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Warning:: Not yet updated for 2.20m