



# EUROPEAN SOUTHERN OBSERVATORY

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

## LA SILLA OBSERVATORY

┌  
└

### FEROS-II: Template Manual

Doc. No. 2p2-TRE-ESO-22400-0001

Issue 0.7

July 9, 2004

┌  
└

Prepared . . . . . J.D.Pritchard . . . . . Xxxx xx, xxxx . . . . .  
Name Date Signature

Approved . . . . . T.Dall . . . . . Xxxx xx, xxxx . . . . .  
Name Date Signature

Released . . . . . O.Hainaut . . . . . Xxxx xx, xxxx . . . . .  
Name Date Signature

Draft

This page was intentionally left blank

Draft :: Version 0.7

**Change Record**

Issue/Rev.	Date	Sect./Parag. affected	Reason/Initiation/Documents/Remarks
0.1	20/07/2003	All	Creation, First Internal release for comment
0.2	18/08/2003	All	CMM Archive with doc number
0.3	18/08/2003	All	Further work
0.4	15/10/2003	All	Bringing into line with reality after Comm-VI
0.5	16/11/2003	All	Bringing into line with reality after Comm-VII
0.6	01/12/2003	All	First Draft release suitable for public
0.7	10/07/2004	All	Release for Period-74

Draft :: Version 0.7

This page was intentionally left blank

Draft :: Version 0.7

## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Applicable Documents . . . . .	1
1.2	Reference Documents . . . . .	1
1.3	Abbreviations and Acronyms . . . . .	2
1.4	Release Notes . . . . .	2
<b>2</b>	<b>Instrument Modes</b>	<b>3</b>
<b>3</b>	<b>Template Modes</b>	<b>3</b>
<b>4</b>	<b>Templates: General Remarks</b>	<b>3</b>
4.1	Notation . . . . .	3
4.2	Detector Setups . . . . .	3
4.3	FEROS Calibration Unit Setup . . . . .	4
4.4	FEROS/WFI Adapter Setup . . . . .	5
4.5	Moving the ADC and/or SCSM . . . . .	5
4.5.1	Moving the ADC . . . . .	5
4.5.2	Moving the SCSM . . . . .	5
<b>5</b>	<b>Acquisition Template</b>	<b>6</b>
5.1	<i>FEROS_ech_acq</i> . . . . .	6
<b>6</b>	<b>Science Templates</b>	<b>8</b>
6.1	<i>FEROS_ech_obs_objsky</i> . . . . .	8
6.2	<i>FEROS_ech_obs_objcal</i> . . . . .	8
<b>7</b>	<b>Calibration Templates</b>	<b>10</b>
7.1	<i>FEROS_ech_cal_bias</i> . . . . .	10
7.2	<i>FEROS_ech_cal_dark</i> . . . . .	10
7.3	<i>FEROS_ech_cal_wave</i> . . . . .	11
7.4	<i>FEROS_ech_cal_ThAr_Ne</i> . . . . .	12
7.5	<i>FEROS_ech_cal_flat</i> . . . . .	12
7.6	<i>FEROS_ech_cal_D2</i> . . . . .	13
7.7	<i>FEROS_ech_cal_df</i> . . . . .	14
7.8	<i>FEROS_img_cal_focus</i> . . . . .	15
7.9	<i>FEROS_ech_cal_DRS</i> . . . . .	17
<b>A</b>	<b>Execution times</b>	<b>18</b>
<b>B</b>	<b>FEROS Template Signature Files</b>	<b>19</b>

*Draft :: Version 0.7*

## 1 Introduction

This document (2p2-TRE-ESO-22400-0001) describes the **Templates** defined for the Fibre-fed, Extended Range, Échelle Spectrograph (FEROS). FEROS is a bench-mounted, thermally controlled, prism-crossdispersed échelle spectrograph. It is designed to be a high resolution, high efficiency, versatile spectrograph providing in a single spectrogram almost complete<sup>1</sup> spectral coverage from  $\sim 350\text{--}920\text{ nm}$ . Precise radial velocity work (accuracies of  $\sim 25\text{ m/s}$  or better) is also possible, especially via the Object-Calibration mode.

The spectrograph is fed by two fibres providing simultaneous spectra of object plus either sky or one of the two calibration lamps (wavelength calibration and flat-field). The fibres are illuminated via 2.0 arcsec apertures on the sky separated by 2.9 arcmins. A small amount of rotation of the telescope adapter is possible in the rare case that a field star by chance falls on the sky fibre. The resolving power is 48,000 achieved with a two-slice image slicer over the spectral range of  $\sim 350\text{--}920\text{ nm}$  spread over 39 échelle orders. The detector is an EEV 2k $\times$ 4k CCD.

In October of 2002 FEROS was transferred from the ESO-1.52m telescope to the MPG/ESO-2.20m telescope. In October-November of 2003 it was upgraded to full VLT-compliance (i.e. OB controlled observing).

The reader is referred to the FEROS user's manual [3] for a full description and detailed of FEROS.

This manual is intended to guide observers through the creation of observation blocks (OBs) with which to make scientific and calibration observations.

The FEROS **Templates** are characterised by the Template Signature Files (TSFs),...

### 1.1 Applicable Documents

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall be considered as a superseding requirement.

- [1] 2p2-SRS-ESO-22400-0001, Pritchard: FEROS-II Software User Requirements
- [2] LSO-URS-ESO-90400-0002, Saviane: Implementation of ADC for FEROS: User requirements

### 1.2 Reference Documents

The following documents are referenced in this document.

- [3] LSO-MAN-ESO-22200-0001, Pritchard: FEROS-II Users Manual

---

<sup>1</sup>The two spectral ranges 853.4–854.1 nm and 886.2–887.5 nm are lost due to non overlap of the spectral orders.

### 1.3 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
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
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
$ZD$	Zenith Distance

### 1.4 Release Notes

This is version 0.7, is officially still a draft release, though it is VERY close to being a final release. It is none the less intended as *the* reference for Period-74 observers.

Version 0.6 was the release made available to Period-72 Service Mode observers. Version 0.5 was a further draft release primarily aimed at the Period-72 Service Mode observers. Versions 0.3 – 0.4 were draft releases circulated for comments. There was no version 0.2 release. Version 0.1 was the first release circulated for comments.

Please mail comments to [jpritcha@eso.org](mailto:jpritcha@eso.org).



## 2 Instrument Modes

FEROS has two observing modes, Object-Sky and Object-Calibration. These are implemented in separate templates.

## 3 Template Modes

FEROS templates are split into three groups according to *function*:

1. Acquisition Templates (AT)
  - (a) Acquisition on fibre (*FEROS\_ech\_acq*)
2. Observation Templates (OT)
  - (a) Science Exposure in Object-Sky mode (*FEROS\_ech\_obs\_objsky*)
  - (b) Science Exposure in Object-Calibration mode (*FEROS\_ech\_obs\_objcal*)
3. Calibration Templates (CT)
  - (a) Calibration of detector BIAS (*FEROS\_ech\_cal\_bias*)
  - (b) Calibration of detector DARK current (*FEROS\_ech\_cal\_dark*)
  - (c) Calibration exposures for wavelength (*FEROS\_ech\_cal\_wave*)
  - (d) Calibration exposures for wavelength (*FEROS\_ech\_cal\_ThAr\_Ne*)
  - (e) Calibration exposures of continuum lamp (*FEROS\_ech\_cal\_flat*)
  - (f) Calibration exposures of continuum lamp (*FEROS\_ech\_cal\_D2*)
  - (g) Calibration exposures of continuum lamp (*FEROS\_ech\_cal\_df*)
  - (h) Focus telescope exposures (*FEROS\_img\_cal\_focus*)
  - (i) Manage DRS initialisation (*FEROS\_ech\_cal\_DRS*)

## 4 Templates: General Remarks

### 4.1 Notation

In this document all template keywords are given in the following notation:

<b>Keyword Name</b>	<b>Parameter Range</b>	<i>Label in P2PP</i>
---------------------	------------------------	----------------------

Within one template the keywords are ordered according to the sequence **DET-SEQ-TEL-INS**. A detailed listing of all free and fixed keywords is given in Appendix B.

### 4.2 Detector Setups

In all OTs and CTs the detector readout mode, integration time, binning and number of exposures must be specified:

<b>DET1.READ.SPEED</b>	60kHz,1,high 225kHz,1,low 625kHz,1,med	<i>Readout Mode</i>
<b>DET1.WIN1.UIT1</b>	0...36000	<i>Exposure Time</i>
<b>DET1.WIN1.BIN</b>	1..2	<i>CCD Binning (Sets both x AND Y)</i>
<b>SEQ.NEXPO</b>	1...999	<i>Number of exposures</i>

To optimize the  $S/N$  in different type of observations while keeping the number of modes to be calibrated reasonable, three standard readout modes have been defined. A readout mode defines the readout speed, the gain, and the binning factors, see table 1. Comparison properties of the previous BIAS system are given in table 2. The format of the readout mode label is  $\langle \text{speed} \rangle \langle \text{No. of ports} \rangle \langle \text{gain} \rangle$  where **number of ports** is the number of readout ports. The CCD system in fact has 2 readout ports, but two port readout is NOT a support readout mode.

**Note: the 625kHz,1,med readout mode should be considered *EXPERIMENTAL* and should not be used for science data until it has been properly commissioned. This might happen during Period-74. It is *NOT* offered in Service Mode.**

Readout Mode	<i>CF</i>	<i>RON</i>	<i>ROT</i>		
"60kHz,1,high"	1.0	3.0	148	Service/Visitor	For faint, RON-limited sources
"225kHz,1,low"	3.2	5.1	41	Service/Visitor	For high S/N observations
"625kHz,1,med"	2.7	7.2	21	Service/Visitor	For fast monitoring observations

Table 1: FIERA controller Detector Readout Modes: *CF* is Conversion Factor (i.e. inverse of Gain) [ $e^-/\text{ADU}$ ], *RON* is Read Out Noise [ $e^-$  RMS] and *ROT* is Read Out Time [sec]. For the 625kHz mode the Read Out Time is limited by the 10Mbit ethernet connection between the FIERA Sparc and the FEROS instrument workstation (wferos).

Readout Mode	<i>CF</i>	<i>RON</i>	<i>ROT</i> , $1 \times 1$	<i>ROT</i> , $2 \times 2$
"60kHz,high,1 Output"	0.55	3.5	152	52
"60kHz,low,2 Outputs"	2.8	5.0	77	29

Table 2: BIAS Controller Detector Readout Modes: *CF* is Conversion Factor (i.e. inverse of Gain) [ $e^-/\text{ADU}$ ], *RON* is Read Out Noise [ $e^-$  RMS] and *ROT* is Read Out Time [sec] and is shown for both  $1 \times 1$  and  $2 \times 2$  binning. The readout times for high gain are for 1 output while those for low are for two outputs, though of course both 1 and 2 outputs were possible for both gain settings.

### 4.3 FEROS Calibration Unit Setup

The FEROS Calibration Unit consists of two lamps (wavelength calibration and flatfield), the RSM, the FCU-Shutter and the NDFW. Their positions are specified as follows:

<b>INS.LAMP1</b>	ON OFF	<i>ThArNe Wavelength Calibration Lamp</i>
<b>INS.LAMP2</b>	ON OFF	<i>Hal+Hal Flatfield Lamp</i>
<b>INS.LAMP3</b>	ON OFF	<i>ThAr+Ne Wavelength Calibration Lamp</i>
<b>INS.LAMP4</b>	ON OFF	<i>D2+Hal Flatfield Lamp</i>
<b>INS.LED1</b>	ON OFF	<i>Red CCD Test LEDs</i>
<b>INS.LED2</b>	ON OFF	<i>Green CCD Test LEDs</i>
<b>INS.LED3</b>	ON OFF	<i>Blue CCD Test LEDs</i>
<b>INS.RSM</b>	DARK LAMP1 LAMP2 LAMP3 LAMP4	<i>Rotating Selection Mirror</i>

INS.FCSH	DARK BOTHFIBS SKYFIB OBJFIB	FCU Shutter
INS.NDFW	0.0...2.5	FCU Neutral Density Filter Wheel

Only two calibration lamps can be active at any time, the other two being in SIMULATION mode. Currently the ThArNe lamp and the Hal+Hal lamps are active.<sup>2</sup>

#### 4.4 FEROS/WFI Adapter Setup

The FEROS/WFI Adapter consists of the M3, the SCSM and the ADC. The ADC itself consists of two prisms. Their positions are specified as follows:

INS.M3	FEROS WFI	Mirror 3
INS.SCSM	PARK BOTHFIBS SKYFIB OBJFIB	Sliding Calibration Selection
INS.ADCA	IN OUT	Mirror Atmospheric Dispersion Cor- rector
INS.ADC1	0.0...360.0	ADC Prism-A
INS.ADC2	0.0...360.0	ADC Prism-B

As is common practice at La Silla, the M3 is **NOT** controlled via templates, but must be moved into the appropriate position according to whether FEROS or WFI observations are being made by the TIO. This is to allow the acquisition of FEROS LED and BetaLight exposures for technical tests, without interference with WFI.

#### 4.5 Moving the ADC and/or SCSM

Due to technical constraints, the ADC and SCSM can NOT both be IN simultaneously. Therefore when moving one or other function the following rules MUST be adhered to:

##### 4.5.1 Moving the ADC

Before starting an ADC preset, it must first be verified that the SCSM is in the PARK position. If not it must be preset to that position and it must arrive there BEFORE the ADC preset can begin.

##### 4.5.2 Moving the SCSM

Before starting an SCSM preset, it must first be verified that the ADC is in the OUT position. If not it must be preset to that position and it must arrive there BEFORE the SCSM preset can begin.

---

<sup>2</sup>The ThArNe lamp is a single lamp containing a thorium cathode and a gas mix of of ???? (??%), Argon (??%) and Neon (??%). The Hal+Hal lamp in fact consists of two halogen bulbs operated and different currents to provide flux in the blue and red parts of the spectrum (a filter cuts the red flux of the blue bulb). The ThAr+Ne consists of one bulb with a thorium cathode and a gas mix of ???? (??%) and Argon (??%). The D2+Hal lamp is a commercial unit consisting of a Deuterium source and a halogen source.

## 5 Acquisition Template

### 5.1 *FEROS\_ech\_acq*

The FEROS fibre acquisition template. The template will perform the following actions sequentially:

1. If *Preset flag* is TRUE the SCSM is moved to PARK, the FCU-Shutter is moved to DARK and the telescope presets to the specified RA and Dec. Template waits for the completion of the preset. [**5min**]
2. The telescope will offset to the specified *Alpha offset* and *Delta offset* (if non-zero). Template waits for the completion of the offset. [**1min**]
3. Template then pauses to allow TIO to acquire target (or Pointing reference star as appropriate) onto the fibre specified by *Target Fibre* and if *Autoguider flag* is TRUE start guiding. Either Guiding on Fibre on the *Feros FibreHead Viewing TCCD* or the *WFI Tracker Chip*. Which guiding system to use is generally decided upon by the TIO. [**2min**]
4. Apply the reverse *Alpha offset* and *Delta offset* (if non-zero). Template waits for the completion of the offset. Restart guiding if necessary. [**1min**]
5. An image from the FFHV TCCD is acquired and copied to the Visiting Astronomer's DRL. This image is NOT archived in the ESO Data Archive. It is intended to provide proof of correct acquisition of the requested target. [**10sec**]

Typical times to complete each step of this template are given above, giving a total maximum typical execution time of about **9min**.

The target RA (*Right Ascension*) and Dec (*Declination*) are specified via the keywords:

**TEL.TARG.ALPHA**                    00:00:00.000...23:59:59.999     *Target Right Ascension*  
**TEL.TARG.DELTA**                    +90:00:00.000...-90:00:00.000    *Target Declination*

Target *Name*, *Equinox*, *Epoch*, *Class* should also be specified.

**TEL.OBS.TARG.NAME**                *String*                                *Target Name*

Target proper motions (*proper motion RA* and *proper motion Dec*), and differential tracking rates (*Diff RA* and *Diff Dec*) can also be specified if relevant – this information is for the header.

For faint ( $B \gtrsim 20.0$ ,  $V \gtrsim 20.0$ ), extended objects or emission line objects a nearby (within 10 arcmin) a pointing reference star should be used. In this case non-zero Telescope Offsets (*Alpha offset* and *Delta offset*) should be specified:

**TEL.TARG.OFFSETALPHA**    -600.000...+600.000                *RA offset [arcsec]*  
**TEL.TARG.OFFSETDELTA**    -600.000...+600.000                *Dec offset [arcsec]*

The offsets are defined as follows:

$$\begin{aligned} \text{TEL.TARG.ALPHA} + \text{TEL.TARG.OFFSETALPHA} &= \text{RA}(\text{PointingReference}) \\ \text{TEL.TARG.DELTA} + \text{TEL.TARG.OFFSETDELTA} &= \text{Dec}(\text{PointingReference}) \end{aligned}$$

The Adapter can be rotated a small amount if necessary if by chance a field star falls on the sky fibre:

<b>ADA.POSANG</b>	-10.0...+10.0	<i>Adapter Rotator Position Angle</i>
-------------------	---------------	---------------------------------------

This is a manual adjustment at the telescope and should be avoided if at all possible!

Differential tracking rates (*Differential tracking in RA* and *Differential tracking in Dec*) can be specified if relevant:

<b>TEL.TARG.PMA</b>	-500.0...+500.0	<i>Proper motion RA</i>
<b>TEL.TARG.PMD</b>	-500.0...+500.0	<i>Proper motion RA</i>
<b>TEL.TARG.ADDVELALPHA</b>	-25.0...+25.0	<i>RA diff tracking</i>
<b>TEL.TARG.ADDVELDELTA</b>	-25.0...+25.0	<i>Dec diff tracking</i>

The required fibre to position the target on must be specified (*Target fibre*):

<b>TEL.AG.FIBSELEC</b>	OBJFIB SKYFIB	<i>Fibre to Place Object on</i>
------------------------	---------------	---------------------------------

Whether or not to guide must be specified (*Autoguider flag*):

<b>ADA.AG.STATUS</b>	T F	<i>Autoguiding</i>
----------------------	-----	--------------------

Whether or not to actually make the preset must be specified by (*Preset flag*):

<b>TEL.PRESET.NEW</b>	T F	<i>Preset telescope</i>
-----------------------	-----	-------------------------

This option is usually used when an an OB is executed for the same target as the previous OB and hence a new preset is generally not required.

## 6 Science Templates

The science templates allow the observer to specify the detector parameters, Readout Mode, Exposure Time, Binning and Number of exposures, see section 4.2.

### 6.1 *FEROS\_ech\_obs\_objsky*

The FEROS science Object-Sky mode exposure template. The template will perform the following actions sequentially:

1. Set LEDs OFF [**1sec**]
2. Setup FEROS/WFI Adapter: SCSM to PARK position, wait for SCSM preset to complete. ADC to IN/OUT position according to the specified mode of operation. If ADC is IN ADC prisms will begin tracking. [**1min**]
3. Setup FEROS Calibration Unit: FCU-Shutter to DARK position. Status of lamps and position of RSM will NOT be changed (to minimise overheads for attached calibrations by minimising function movements and lamp warmup times). [**1min**]
4. Setup Detector according to selected readout mode and windowing
5. Template waits for completion of all above setups
6. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL [**NEXPO**×(**UIT**+**ROT**)**sec**]
7. At the end of EACH exposure submit image for processing by FEROS-DRS [**5sec**]
8. At the end of the template the status of the FCU lamps and the position of the RSM are unchanged, FCU-Shutter and NDFW and the M3, SCSM and ADC are left in their positions as at the end of the exposure. [**5sec**]

The total execution time for this template is thus approximately:

$$130 + \text{NEXPO} \times (\text{UIT} + \text{ROT}) \text{sec}$$

With binning  $2 \times 2$  *ROT* is approximately half those given in table 1.

Whether to use the Atmospheric Dispersion Corrector or not must be specified:

<b>INS.ADC.STATUS</b>	IN OUT	<i>ADC</i>
-----------------------	--------	------------

If the ADC is IN it will automatically track the atmospheric dispersion with an update frequency of approximately once every  $\sim 10$  sec.

**Note: The ADC is not yet implemented and will likely not be implemented till some time during Period-74.**

No further parameters can be specified for this template.

### 6.2 *FEROS\_ech\_obs\_objcal*

The FEROS science Object-Calibration mode exposure template. The template will perform the following actions sequentially:

1. Set LEDs OFF [1sec]
2. Setup FEROS/WFI Adapter: ADC to OUT position<sup>3</sup>, wait for ADC preset to complete. SCSM to SKYFIB or OBJFIB position according to whether OBJFIB or SKYFIB fibre was specified for the fibre to position the target on (in Acquisition). [1min]
3. Setup FEROS Calibration Unit: Selected calibration lamp ON if not already on, other lamp(s) OFF, the RSM is moved to the appropriate position according to the selected calibration lamp, FCU-Shutter to SKYFIB or OBJFIB position according to whether OBJFIB or SKYFIB fibre was specified for the fibre to position the target on, Neutral Density Filter Wheel to appropriate position according to specified calibration lamp equivalent time. [1min]
4. Setup Detector according to selected readout mode and windowing
5. Template waits for completion of all above setups
6. Template waits for specified Lamp Warmup time. [LAMPWAIT sec]
7. Execute SEQ.NEXPO DET1.WIN1.UIT1 second exposures in mode NORMAL [NEXPO×(UIT+ROT)sec]
8. At the end of EACH exposure submit image for processing by FEROS-DRS [5sec]
9. At the end of the template the calibration lamps are left on and off respectively and the RSM, FCU-Shutter and NDFW and the M3, SCSM and ADC are left in their positions as at the end of the exposure. [5sec]

The total execution time for this template is thus approximately:

$$130 + \text{LAMPWAIT} + \text{NEXPO} \times (\text{UIT} + \text{ROT}) \text{sec}$$

With binning  $2 \times 2$  ROT is approximately half those given in table 1.

The calibration lamp to use must be selected here, either ThArNe Wavelength calibration (default) or Hal+Hal continuum source lamp.

<b>INS.OCLAMP</b>	WLC FF	<i>Calibration source</i>
-------------------	--------	---------------------------

The *equivalent exposure time* must be specified:

<b>SEQ.CALTIME</b>	0..43200	<i>Equivalent exposure time</i>
--------------------	----------	---------------------------------

The *equivalent exposure time* is used to calculate the density to set the Neutral Density Filter wheel in order that in the specified object exposure time, the same flux level is obtained in the calibration spectrum as would be obtained in the *equivalent exposure time* at the NDFW reference density (currently 0.0), i.e. the density will be given by:

$$\text{density} = \log_{10}[\text{DET1.WIN1.UIT1}/\text{SEQ.CALTIME}]$$

A lamp warmup period can be specified.

<b>SEQ.LAMPWAIT</b>	0..43200	<i>Lamp warmup delay</i>
---------------------	----------	--------------------------

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

---

<sup>3</sup>At this time it is NOT clear if the ADC can be used in Object-Calibration mode since under the current design of the ADC unit it is not possible to have both the ADC IN and the SCSM in any position other than PARK???

**SEQ.LEAVELAMPON**

T|F

*Leave Lamp on at end of exposure*

The idea here is to avoid having to wait for the lamp to warmup for the following objcal exposure. For Service Mode the lamp should never be left on at the end of an OB, since in general OBs from a given program are NOT executed in sequence.

**The ADC can NOT be used in Object-Calibration mode.**

**Note: The ADC is not yet implemented and will likely not be implemented till Period-73.**

## 7 Calibration Templates

The calibration templates allow the observer to specify the detector parameters, Readout Mode, Exposure Time, Binning and Number of exposures, see section 4.2.

### 7.1 *FEROS\_ech\_cal\_bias*

The FEROS calibration BIAS exposure template. The template will perform the following actions sequentially:

1. Set LEDs **OFF**
2. No change to FEROS Calibration Unit setup
3. No change to FEROS/WFI Adapter setup
4. Setup Detector according to selected readout mode and windowing
5. Template waits for completion of all above setups
6. Execute **SEQ.NEXPO** 0.0 second exposures in mode DARK.
7. At the end of EACH exposure submit image for processing by FEROS-DRS
8. At the end of the template no change to FEROS Calibration Unit or FEROS/WFI Adapter setups

### 7.2 *FEROS\_ech\_cal\_dark*

The FEROS calibration DARK exposure template. The template will perform the following actions sequentially:

1. Set LEDs **OFF**
2. No change to FEROS Calibration Unit setup.
3. No change to FEROS/WFI Adapter setup.
4. Setup Detector according to selected readout mode and windowing
5. Template waits for completion of all above setups



6. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL
7. At the end of EACH exposure submit image for processing by FEROS-DRS
8. At the end of the template no change to FEROS Calibration Unit or FEROS/WFI Adapter setups

### 7.3 *FEROS\_ech\_cal\_wave*

The FEROS calibration WAVELENGTH CALIBRATION exposure template using the default wavelength calibration lamp, the **ThArNe**, i.e. LAMP1. The template will perform the following actions sequentially:

1. If non-zero Lamp Wait is specified the ThArNe is turned on and then the template sleeps for the specified duration (to allow the lamp to warmup)
2. Set LEDs OFF and setup Adapter, Calibration Unit and Detector
  - Set LEDs OFF
  - Setup FEROS/WFI Adapter: ADC to OUT position, wait for ADC preset to complete. SCSM to appropriate position according to which fibre(s) are selected (BOTHFIBS|OBJFIB|SKYFIB). Template will not at this time wait for completion of preset.
  - Setup FEROS Calibration Unit: ThArNe Wavelength calibration lamp ON if not already on, other lamp(s) OFF, the RSM is moved to the appropriate position, FCU-Shutter to appropriate position according to which fibre(s) are selected (BOTHFIBS|OBJFIB|SKYFIB), Neutral Density Filter Wheel to reference density (*configurable by SciOps*). Template will not at this time wait for completion of presets.
  - Setup Detector according to selected readout mode and windowing
3. Template waits for completion of all above setups
4. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL
5. At the end of EACH exposure submit image for processing by FEROS-DRS
6. At the end of the template the FCU-Shutter to DARK position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Which fibre(s) to illuminate must be specified.

**SEQ.CALFIBER**                      BOTHFIBS|OBJFIB|SKYFIB                      *Fibre(s) to illuminate*

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

**SEQ.LEAVELAMPON**                      T|F                      *Leave Lamp on at end of exposure*

The idea here is to avoid having to wait for the lamp to warmup for the following objcal exposure. For Service Mode the lamp should never be left on at the end of an OB, since in general OBs from a given program are NOT executed in sequence.

#### 7.4 *FEROS\_ech\_cal\_ThAr\_Ne*

The FEROS calibration WAVELENGTH CALIBRATION exposure template using the alternative wavelength calibration lamp, the **ThAr+Ne**, i.e. LAMP3. The template will perform the following actions sequentially:

1. If non-zero Lamp Wait is specified the ThAr+Ne lamp is turned on and then the template sleeps for the specified duration (to allow the lamp to warmup)
2. Set LEDs **OFF** and setup Adapter, Calibration Unit and Detector
  - Set LEDs **OFF**
  - Setup FEROS/WFI Adapter: ADC to **OUT** position, wait for ADC preset to complete. SCSM to appropriate position according to which fibre(s) are selected (**BOTHFIBS|OBJFIB|SKYFIB**). Template will not at this time wait for completion of preset.
  - Setup FEROS Calibration Unit: ThAr+Ne Wavelength calibration lamp **ON** if not already on, other lamp(s) **OFF**, the RSM is moved to the appropriate position, FCU-Shutter to appropriate position according to which fibre(s) are selected (**BOTHFIBS|OBJFIB|SKYFIB**), Neutral Density Filter Wheel to reference density (*configurable by SciOps*). Template will not at this time wait for completion of presets.
  - Setup Detector according to selected readout mode and windowing
3. Template waits for completion of all above setups
4. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode **NORMAL**
5. At the end of EACH exposure submit image for processing by FEROS-DRS
6. At the end of the template the FCU-Shutter to **DARK** position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Which fibre(s) to illuminate must be specified.

**SEQ.CALFIBER**                      **BOTHFIBS|OBJFIB|SKYFIB**                      *Fibre(s) to illuminate*

A lamp warmup period can be specified.

**SEQ.LAMPWAIT**                      **0..43200**                      *Lamp warmup delay*

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

**SEQ.LEAVELAMPON**                      **T|F**                      *Leave Lamp on at end of exposure*

The idea here is to avoid having to wait for the lamp to warmup for the following objcal exposure. For Service Mode the lamp should never be left on at the end of an OB, since in general OBs from a given program are NOT executed in sequence.

#### 7.5 *FEROS\_ech\_cal\_flat*

The FEROS calibration FLATFIELD exposure template using the default flatfielding lamp, the **Hal+Hal** lamp, i.e. LAMP2. The template will perform the following actions sequentially:

1. If non-zero Lamp Wait is specified the Hal+Hal lamp is turned on and then the template sleeps for the specified duration (to allow the lamp to warmup)
2. Set LEDs OFF and setup Adapter, Calibration Unit and Detector
  - Set LEDs OFF
  - Setup FEROS/WFI Adapter: ADC to OUT position, wait for ADC preset to complete. SCSM to appropriate position according to which fibre(s) are selected (BOTHFIBS|OBJFIB|SKYFIB). Template does not wait for completion of setup.
  - Setup FEROS Calibration Unit: Hal+Hal Flatfield calibration lamp ON if not already on, other lamp(s) OFF, the RSM is moved to the appropriate position, FCU-Shutter to BOTHFIBS position, Neutral Density Filter Wheel to reference density (*configurable by SciOps*). Template will not at this time wait for completion of presets.
  - Setup Detector according to selected readout mode and windowing
3. Template waits for completion of all above setups
4. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL
5. At the end of EACH exposure submit image for processing by FEROS-DRS
6. At the end of the template the FCU-Shutter to DARK position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Which fibre(s) to illuminate must be specified.

**SEQ.CALFIBER**                      BOTHFIBS|OBJFIB|SKYFIB                      *Fibre(s) to illuminate*

A lamp warmup period can be specified.

**SEQ.LAMPWAIT**                      0..43200                      *Lamp warmup delay*

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

**SEQ.LEAVELAMPON**                      T|F                      *Leave Lamp on at end of exposure*

The idea here is to avoid having to wait for the lamp to warmup for the following objcal exposure. For Service Mode the lamp should never be left on at the end of an OB, since in general OBs from a given program are NOT executed in sequence.

## 7.6 *FEROS\_ech\_cal\_D2*

The FEROS calibration FLATFIELD exposure template using the alternative flatfielding lamp, the D<sub>2</sub>+Hal lamp, i.e. LAMP2. The template will perform the following actions sequentially:

1. If non-zero Lamp Wait is specified the D<sub>2</sub>+Hal lamp is turned on and then the template sleeps for the specified duration (to allow the lamp to warmup)
2. Set LEDs OFF and setup Adapter, Calibration Unit and Detector
  - Set LEDs OFF

- Setup FEROS/WFI Adapter: ADC to OUT position, wait for ADC preset to complete. SCSM to appropriate position according to which fibre(s) are selected (BOTHFIBS|OBJFIB|SKYFIB). Template does not wait for completion of setup.
  - Setup FEROS Calibration Unit: D<sub>2</sub>+Hal Flatfield calibration lamp ON if not already on, other lamp(s) OFF, the RSM is moved to the appropriate position, FCU-Shutter to BOTHFIBS position, Neutral Density Filter Wheel to reference density (*configurable by SciOps*). Template will not at this time wait for completion of presets.
  - Setup Detector according to selected readout mode and windowing
3. Template waits for completion of all above setups
  4. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL
  5. At the end of EACH exposure submit image for processing by FEROS-DRS
  6. At the end of the template the FCU-Shutter to DARK position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Which fibre(s) to illuminate must be specified.

**SEQ.CALFIBER**                      BOTHFIBS|OBJFIB|SKYFIB                      *Fibre(s) to illuminate*

A lamp warmup period can be specified.

**SEQ.LAMPWAIT**                      0..43200                      *Lamp warmup delay*

**A minimum warmup of 30 sec is required to insure that the D<sub>2</sub> lamp is on.**

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

**SEQ.LEAVELAMPON**                      T|F                      *Leave Lamp on at end of exposure*

The idea here is to avoid having to wait for the lamp to warmup for the following objcal exposure. For Service Mode the lamp should never be left on at the end of an OB, since in general OBs from a given program are NOT executed in sequence.

## 7.7 *FEROS\_ech\_cal\_df*

The FEROS calibration **dome** FLATFIELD exposure template using dome flatfield screen mounted on the interior of the telescope dome. The template will perform the following actions sequentially:

1. Prompt the TIO to preset the telescope and dome to the predefined Dome FF position and to turn on the dome flatfield lamps.
2. Set LEDs OFF and setup Adapter, Calibration Unit and Detector
  - Set LEDs OFF
  - Setup FEROS/WFI Adapter: ADC to OUT position, wait for ADC preset to complete. SCSM to appropriate position according to which fibre(s) are selected (BOTHFIBS|OBJFIB|SKYFIB). In this case the SCSM is either moved to the PARK position for BOTHFIBS or in front of the opposite fibre to that selected in the template in order to act as a block against the telescope beam. Template does not wait for completion of setup.

- Setup FEROS Calibration Unit: all lamp OFF, the RSM is moved to thePARK, FCU-Shutter to DARK position, Neutral Density Filter Wheel to reference density (*configurable by SciOps*). Template will not at this time wait for completion of presets.
  - Setup Detector according to selected readout mode and windowing
3. Template waits for completion of all above setups
  4. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL
  5. At the end of EACH exposure submit image for processing by FEROS-DRS
  6. At the end of the template the FCU-Shutter to DARK position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Which fibre(s) to illuminate must be specified.

**SEQ.CALFIBER**                      BOTHFIBS|OBJFIB|SKYFIB                      *Fibre(s) to illuminate*

A lamp warmup period can be specified.

**SEQ.LAMPWAIT**                      0.43200                      *Lamp warmup delay*

It is essential that the TIO remembers to turn the dome flatfield lamps on at the appropriate moment, otherwise this action will be meaningless.

Normally the lamp will be turned off at the end of the exposure. The lamp can be left on by setting to true the *Leave Lamp on*:

**SEQ.LEAVELAMPON**                      T|F                      *Leave Lamp on at end of exposure*

This keyword is ignored by the template as the turning On and OFF of the dome flatfield lamps is controlled manually by the TIO.

### 7.8 *FEROS\_img\_cal\_focus*

The FEROS calibration FOCUS exposure template.

This template uses images from the FEROS FibreHead Viewer TCCD to measure the so-called ‘Focus-Offset’, relative to the theoretical focus equation of the 2.20-m telescope.

$$F_T = 23740 - 66 \times T_{LS} + 2 \times ZD + FO$$

Where  $F_T$  is the theoretical focus,  $T_{LS}$  the temperature of the Long Surririer of the telescope,  $ZD$  the Zenith Distance and  $FO$  the focus offset (to be determined by this template).

The template can be used either within a stand-alone CalBlock, or attached to a ObsBlock. When attached to an ObsBlock it will perform as follows:

1. Execute a "normal" acquisition to the spectrophotometric standard star. Acquire the spectrophotometric standard star onto the OBJECT fibre and start guiding as usual.

2. Once the acquisition template is complete the focus template will offset the telescope according to the **Alpha offset** and **Delta offset** specified in the focus template (as distinct from the parameters with the same name in the acquisition template). The idea of these offsets is to offset the telescope to a field containing stars suitably faint so as not to saturate in TCCD exposures of typically 3 seconds integration time, when the target that was preset to is a much brighter star, e.g. a spectrophotometric standard star from the calibration plan.
3. The template will change the TCCD exposure time to the **TCCD Exposure Time off Fibre**.
4. The template will then 'GRAB' one TCCD image at a Focus Offset of -100. This image will be displayed in a MIDAS window and the TIO will be prompted to select a star on which to perform the image analysis. More than one star can be selected but it is not necessary, and is not always helpful). The focus offset of -100 has been chosen based on the experience that the measured focus offset tends to be somewhere between -200 and -50. Therefore this is a reasonable guess. More importantly the image quality in this image should be close to the best thereby making it easier to choose faint stars that even at the best focus will not be saturated.
5. The template will then step the M2 telescope focus from a **Offset Start** to **Offset End** in steps of **Step**. At each step it will "GRAB" **Number of TCCD Exposures** TCCD images, display them, measure the image quality and plot the results in the MIDAS PCO session graphic window.
6. After completing the focus scan, the template will fit parabolas to the measured image quality major and minor axes and then calculate the focus offset corresponding to the minima, which will be reported in a template popup. The reported values are then entered in the TCS Control panel by the TIO.

Typically in this mode the template takes as little as 5mins and always less than 10mins to complete. It can also be used in a mode where a SCIENCE spectrum of the spectrophotometric standard star is taken at each focus offset value (if **Acquire Spectrum** is True), but since this mode of the OB typically takes 40mins to complete it is used only during technical nights to verify the correspondence between optimum image quality and optimum S/N in the science spectra. In this case the **CCD readout speed**, **Exposure time**, **CCD X & Y Binning** and **Number of Exposure** parameters have their usual meanings for SCIENCE exposures (see section 6). The additional parameter **TCCD Exposure Time on Fibre** allows the specification of a different TCCD exposure time to use for guiding during the SCIENCE exposures, when for most bright sources a 3 sec TCCD exposure time would be way too much<sup>4</sup>

The **Loop time** parameter is (currently) ignored.

Based on recent experience, the useful values of **Offset Start**, **Offset End** and **Step** seem to be -400, +100 and 100 respectively. Slightly better results are achieved with a stepsize of 50, but of course with the trade off that it then takes longer to complete the template. These limits are NOT the current default values when creating a new focus template. Needless to say, the IP will be updated at the next opportunity so that the above are the default values...

Finally as a standalone CalBlock, the focus template is best executed from a 2nd instance of Bob after presetting to the desired SCIENCE field in the 1st Bob instance, but pausing before starting the SCIENCE exposure(s).

It is generally useful to redetermine the focus offset two or three times during a typical night.

It is not necessary for Service Mode programmes to worry about focus templates as this is taken care of in the course of 'normal operations'.

<sup>4</sup>For the spectrophotometric stars used in the calibration plan (3rd to 5th magnitude stars) even the shortest possible TCCD exposure time (0.001 sec) still results in saturation during nights of reasonable or better quality.

### 7.9 *FEROS\_ech\_cal\_DRS*

This template is obsolete. **Do NOT use.**

Draft :: Version 0.7

## A Execution times

The following are correct at the time of writing and accurate enough for Phase I proposal preparation. For Phase II the OB execution times are accurately computed by p2pp, and in all circumstances the calculations made by p2pp take precedence over calculations based on the information provided here.

- FEROS\_ech\_acq

$$\text{ExecTime} = 5\text{mins}$$

4mins as per SM instructions for special presets including acquisition onto fibre plus 1min to allow for GRAB of TCCD image.

- FEROS\_ech\_cal\_bias

$$\text{ExecTime} = \text{NEXPO} * ( \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_dark

$$\text{ExecTime} = \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_flat

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_D2

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_df

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_wave

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_cal\_ThAr\_Ne

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_obs\_objcal

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

- FEROS\_ech\_obs\_objsky

$$\text{ExecTime} = \text{IST} + \text{NEXPO} * ( \text{UIT} + \text{ROT}[\text{ROM}] )$$

where

1. ROT = ReadOut Time for each exposure, depends on ROM = ReadOutMode, which is one of 60kHz,1,high—225kHz,1,low—625kHz,1,med

$$\text{ROT}[60\text{kHz},1,\text{high}] = 145\text{sec}$$

$$\text{ROT}[225\text{kHz},1,\text{low}] = 42\text{sec}$$

$$\text{ROT}[625\text{kHz},1,\text{med}] = 22\text{sec}$$

2. IST = Instrument Setup Time: maximum is 1min.
3. UIT = User Integration Time
4. NEXPO = Number of exposures.



## **B FEROS Template Signature Files**

*TBD*

\_\_oOo\_\_

*Draft :: Version 0.7*