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Contents

0.1 Introduction . . . 1
0.1.1 Applicable Documents . . . 1
0.1.2 Reference Documents . . . 1
0.1.3 Abbreviations and Acronyms . . . 2
0.1.4 Release Notes . . . 2
0.2 Instrument Modes . . . 3
0.3 Template Modes . . . 3
0.4 Templates: General Remarks . . . 3
0.4.1 Notation . . . 3
0.4.2 Detector Setups . . . 3
0.4.3 FEROS Calibration Unit Setup . . . 4
0.4.4 FEROS/WFI Adapter Setup . . . 5
0.4.5 Moving the ADC and/or SCSM . . . 5
0.5 Acquistion Template . . . 7
0.5.1 *FEROS_ech_acq* . . . 7
0.6 Science Templates . . . 9
0.6.1 *FEROS_ech_obs_objsky* . . . 9
0.6.2 *FEROS_ech_obs_objcal* . . . 10
0.7 Calibration Templates . . . 12
0.7.1 *FEROS_ech_cal_bias* . . . 12
0.7.2 *FEROS_ech_cal_dark* . . . 13
0.7.3 *FEROS_ech_cal_wave* . . . 13
0.7.4 *FEROS_ech_cal_ThAr_Ne* . . . 14
0.7.5 *FEROS_ech_cal_flat* . . . 15
0.7.6 *FEROS_ech_cal_df* . . . 16
0.7.7 *FEROS_img_cal_focus* . . . 17
.1 Execution times . . . 20
.2 FEROS Template Signature Files . . . 21

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0.1 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[1] spectral coverage from $\sim$ 350–920 nm. Precise radial velocity work (accuracies of $\sim$ 25 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 $\sim$ 350–920 nm spread over 39 eć helle orders. The detector is an EEV 2k×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),...

0.1.1 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

0.1.2 Reference Documents

The following documents are referenced in this document.

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

[1] 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.

0.1.3 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

0.1.4 Release Notes

This is version 77.0, the first official (non-draft) release. It is intended for use for Period-77, but is (mostly) valid also for the current period (P76).

Version 0.8, was a draft release intended as *the* reference for Period-75 observers and Period-76 proposal preparation. Version 0.7 was VERY close to being a final release. It was, despite still being a draft version, 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`.

0.2 Instrument Modes

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

0.3 Template Modes

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

1. Aquisition 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 via Dome Flatfield screen (*FEROS_ech_cal_df*)
   (g) Focus telescope exposures (*FEROS_img_cal_focus*)

0.4 Templates: General Remarks

0.4.1 Notation

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

Keyword Name	`Parameter Range`	*Label in P2PP*

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 .2.

0.4.2 Detector Setups

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

DET1.READ.SPEED	`60kHz,1,high 225kHz,1,low 625kHz,1,med`	*Readout Mode*
DET1.WIN1.UIT1	`0...36000`	*Exposure Time*
DET1.WIN1.BIN	`1..2`	*CCD Binning (Sets both x AND Y)*

SEQ.NEXPO	`1...999`	*Number of exposures*

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 *<speed><No. o ports><gain>* where `number of ports` is the number of readout ports. The CCD system infact 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 which will not happen unless there is a well defined and strong scientific case for doing so. It is definitely NOT offered in Service Mode. Visitor's wishing to use this readout mode must contact the FEROS instrument Scientist well in advance of preparing their Phase 1 proposal.

Readout Mode	*CF*	*RON*	*ROT*		
"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^-/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	*CF*	*RON*	*ROT*,1×1	*ROT*,2×2
"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^-/ADU], RON is Read Out Noise [e^- RMS] and ROT is Read Out Time [sec] and is shown for both 1×1 and 2×2 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.

0.4.3 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:

INS.LAMP1	`ON|OFF`	*ThArNe Wavelength Calibration Lamp*
INS.LAMP2	`ON|OFF`	*Hal+Hal Flatfield Lamp*
INS.LAMP3	`ON|OFF`	*ThAr+Ne Wavelength Calibration Lamp*
INS.LAMP4	`ON|OFF`	*D2+Hal Flatfield Lamp*
INS.LED1	`ON|OFF`	*Red CCD Test LEDs*
INS.LED2	`ON|OFF`	*Green CCD Test LEDs*
INS.LED3	`ON|OFF`	*Blue CCD Test LEDs*
INS.RSM	`DARK|LAMP1|LAMP2|LAMP3|LAMP4`	*Rotating Selection Mirror*
INS.FCSH	`DARK|BOTHFIBS|SKYFIB|OBJFIB`	*FCU Shutter*
INS.NDFW	`0.0...2.5`	*FCU Neutral Density Filter Wheel*

All four lamps are now operable from software and electronics, however optics have yet to be installed in the Calibration Unit for LAMP4 (the D2+Hal Flatfield Lamp) so it is not available. [2]

0.4.4 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 Mirror*
INS.ADCA	`IN|OUT|AUTO`	*Atmospheric Dispersion Corrector*
INS.ADC1	`OFF|AUTO|0.0...360.0`	*ADC Prisms-A*
INS.ADC2	`OFF|AUTO|0.0...360.0`	*ADC Prisms-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.

The ADC can either be set to IN, OUT or AUTO[3]. Currently IN and AUTO are exactly the same and result in the ADC being used with the prisms automatically following parallactic angle and compensating for atmospheric dispersion (i.e. in mode AUTO) with a positional update frequency of 10secs.

0.4.5 Moving the ADC and/or SCSM

Due to technical constraints, the ADC and SCSM can NOT both be `IN` simultaneously. The ADC can therefore ONLY be used in the focus, OBJSKY and DomeFlat templates. Moreover when moving one or other function the following rules MUST be adherred to (all templates adhere to these rules automatically):

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.

[2] The ThArNe lamp is a single Thorium cathode, Argon (10%) and Neon (90%) filled Juniper lamp. The Hal+Hal lamp in fact consists of two halogen bulbs one 12W and the other 50W, to provide flux in the blue and red parts of the spectrum (filters are used to cut the red flux of the blue bulb and to optimise it for the bluest orders). Light from the two bulbs are combined via a 50% transmission, 50% reflection mirror. The ThAr+Ne consists of a Thorium cathode, Argon (100%) filled Juniper lamp and a $100\,k\Omega$, $220\,V$ Neon bulb. Light from the two bulbs are combined via a 50% transmission, 50% reflection mirror. The D2+Hal lamp is a commercial unit consisting of a Deuterium source and a halogen source.

[3] Eventually the AUTO mode may be implemented in such a way that the templates 'cleverly' determine whether using the ADC for the current exposure would be beneficial or not and move it IN or OUT accordingly. No date for implementing this AUTO mode is currently forseen.

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.

0.5 Acquistion Template

0.5.1 *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 ADC is moved to OUT, the FCU-Shutter is moved to DARK and the telescope presets to the specified RA and Dec. The TCS database point `@w2p2tcs:Appl_data:TCS:LCU:m2.feFocOffset` is updated with the ADC OUT focus offset (read from the INS database point `<alias>feoFocus.focOffsetAdcOut`). Template waits for the completion of the preset. **[3min]**
2. If a blind offset acquisition is required, the telescope will offset to the specifed *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 of `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 **5min** since blind offset target acquisition is not typically required. Of course if blind offsets are required then aquisition time can be upto **7min**. Of course the time to complete the actual telescope preset depends on the 'distance' from the current telescope position to the next position, therefore 3min is an upper limit, none the less for Service Mode programmes we must always assume the 'worst case scenario'.

The ADC is always moved OUT for acquisitions to avoid the occultation of the TCCD field of view caused by the ADC mechanism.

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 Ascencion*
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 infromation is for the header.

For faint ($B \geq\sim 20.0$, $V \geq\sim 20.0$), extended objects or emmission 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:

$$\textbf{TEL.TARG.ALPHA} + \textbf{TEL.TARG.OFFSETALPHA} = RA(PointingReference)$$

$$\textbf{TEL.TARG.DELTA} + \textbf{TEL.TARG.OFFSETDELTA} = Dec(PointingReference)$$

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

ADA.POSANG	`-10.0...+10.0`	*Adapter Rotator Position Angle*

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:

TEL.TARG.PMA	`-500.0...+500.0`	*Proper motion RA*
TEL.TARG.PMD	`-500.0...+500.0`	*Proper motion RA*
TEL.TARG.ADDVELALPHA	`-25.0...+25.0`	*RA diff tracking*
TEL.TARG.ADDVELDELTA	`-25.0...+25.0`	*Dec diff tracking*

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

TEL.AG.FIBSELEC	`OBJFIB|SKYFIB`	*Fibre to Place Object on*

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

ADA.AG.STATUS	`T|F`	*Autoguiding*

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

TEL.PRESET.NEW	`T|F`	*Preset telescope*

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.

0.6 Science Templates

The science templates allow the observer to specify the detector parameters, Readout Mode, Exposure Time, Binning and Number of expsoures, see section 0.4.2.

0.6.1 *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. The TCS database point `@w2p2tcs:Appl_data:TCS:LCU:m2.feFocOffset` is updated with the ADC IN or ADC OUT focus offset (read from the INS database point `<alias>feoFocus.focOffsetAdcIn` or `<alias>feoFocus.focOffsetAdcOut` as appropraite)
6. Template waits for completion of all above setups
7. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL **[NEXPO×(UIT+ROT)sec]**
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+**NEXPO**×(**UIT**+*ROT*)sec
With binning 2×2 *ROT* is approximately half those given in table 1.

The Standard Star Flag must be set according to:

SEQ.TYPE	`SCIENCE (default)`
	`STANDARD`
	`FLUX_STD`
	`RV_STD`
	`TELLURIC_STD`
	`SKY`
		Standard Star Flag

The FITS header keywords DPR.CATG and DPR.TYPE are then set as follows:

- SEQ.TYPE = SCIENCE, DPR.CATG = SCIENCE, DPR.TYPE = OBJECT,SKY
- SEQ.TYPE = STANDARD, DPR.CATG = CALIB, DPR.TYPE = STD,SKY
- SEQ.TYPE = FLUX_STD, DPR.CATG = CALIB, DPR.TYPE = FLUX,SKY

- SEQ.TYPE = RV_STD, DPR.CATG = CALIB, DPR.TYPE = VELOC,SKY
- SEQ.TYPE = TELLURIC_STD, DPR.CATG = CALIB, DPR.TYPE = TELLURIC,SKY
- SEQ.TYPE = SKY, DPR.CATG = CALIB, DPR.TYPE = SKY,SKY

If TEL.AG.FIBSELEC = SKYFIB then the order of the two parts of the DPR.TYPE keyword are reversed, i.e. OBJECT,SKY would become SKY,OBJECT.

Note: the value of DPR.CATG has important consequences for the proprietory period of the data. Any data with DPR.CATG = CALIB are classified as calibrations (obviously) and as such have **no proprietory period**. They are available to anyone from the ESO archive as soon as they arrive in the archive.

Note: The ADC was installed and commissioned at the end of Period-74.

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

INS.ADC.STATUS `IN|OUT|AUTO` *ADC*

If the ADC mode is `IN` or `AUTO` it will automatically track the atmospheric dispersion with an update frequency of approximately once every ~ 10 sec.

No further parameters can be specified for this template.

0.6.2 *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[4], wait for ADC preset to complete. SCSM to `SKYFIB` or `OBJFIB` position accoridng 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 accoridng 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. The TCS database point `@w2p2tcs:Appl_data:TCS:LCU:m2.feFocOffset` is updated with the ADC OUT focus offset (read from the INS database point `<alias>feoFocus.focOffsetAdcOut`)
6. Template waits for completion of all above setups
7. Templates waits for specified Lamp Warmup time. [**LAMPWAIT sec**]
8. Execute **SEQ.NEXPO DET1.WIN1.UIT1** second exposures in mode NORMAL [**NEXPO**×(**UIT**+**ROT**)**sec**]

[4] 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`.

9. At the end of the template the calibration lamps are 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+**LAMPWAIT**+**NEXPO**×(**UIT**+*ROT*)sec
With binning 2×2 *ROT* is approximately half those given in table 1.

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

INS.OCLAMP	`WLC|FF|ThAr+Ne`	*Calibration source*

The *equivalent exposure time* must be specified:

SEQ.CALTIME	`0..43200`	*Equivalent exposure time*

The *equivalent exposure time* is used to calculate the density to set the Neutral Density Filter wheel to 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:

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

A lamp warmup period can be specifed.

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.

The Standard Star Flag must be set according to:

SEQ.TYPE	`SCIENCE (default)`
	`STANDARD`
	`FLUX_STD`
	`RV_STD`
	`TELLURIC_STD`
	`SKY`
		Standard Star Flag

The FITS header keywords DPR.CATG and DPR.TYPE are then set as follows:

- SEQ.TYPE = SCIENCE, DPR.CATG = SCIENCE, DPR.TYPE = OBJECT,WAVE
- SEQ.TYPE = STANDARD, DPR.CATG = CALIB, DPR.TYPE = STD,WAVE
- SEQ.TYPE = FLUX_STD, DPR.CATG = CALIB, DPR.TYPE = FLUX,WAVE

- SEQ.TYPE = RV_STD, DPR.CATG = CALIB, DPR.TYPE = VELOC,WAVE
- SEQ.TYPE = TELLURIC_STD, DPR.CATG = CALIB, DPR.TYPE = TELLURIC,WAVE
- SEQ.TYPE = SKY, DPR.CATG = CALIB, DPR.TYPE = SKY,WAVE

If TEL.AG.FIBSELEC = SKYFIB then the order of the two parts of the DPR.TYPE keyword are reversed, i.e. OBJECT,WAVE would become WAVE,OBJECT.

If INS.OCLAMP = FF then WAVE is replaced by FLAT.

Note: the value of DPR.CATG has important consequences for the proprietory period of the data. Any data with DPR.CATG = CALIB are classified as calibrations (obviously) and as such have **no proprietory period**. They are available to anyone from the ESO archive as soon as they arrive in the archive.

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

The following p2pp parameters are currently **not** implemented in the template signature files, i.e. their values are ignored:

SEQ.DFL	`0`	*Desired Flux Level*
SEQ.DFLTESTDIT	`0`	*Desired Flux Level Test Spectrum exposure time*
SEQ.DFLUSEDB	`F`	*Use database values to estimate flux*

No further parameters can be specified for this template.

0.7 Calibration Templates

The calibration templates allow the observer to specify the detector parameters, Readout Mode, Exposure Time, Binning and Number of expsoures, see section 0.4.2.

0.7.1 *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 the template no change to FEROS Calibration Unit or FEROS/WFI Adapter setups

0.7.2 *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 the template no change to FEROS Calibration Unit or FEROS/WFI Adapter setups

0.7.3 *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 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.

The following p2pp parameters are currently **not** implemented in the template signature files, i.e. their values are ignored:

SEQ.DFL	`0`	*Desired Flux Level*
SEQ.DFLTESTDIT	`0`	*Desired Flux Level Test Spectrum exposure time*
SEQ.DFLUSEDB	`F`	*Use database values to estimate flux*

0.7.4 *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 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 specifed.

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.

The following p2pp parameters are currently **not** implemented in the template signature files, i.e. their values are ignored:

SEQ.DFL	`0`	*Desired Flux Level*
SEQ.DFLTESTDIT	`0`	*Desired Flux Level Test Spectrum exposure time*
SEQ.DFLUSEDB	`F`	*Use database values to estimate flux*

0.7.5 *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 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 specifed.

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.

The following p2pp parameters are currently **not** implemented in the template signature files, i.e. their values are ignored:

SEQ.DFL	`0`	*Desired Flux Level*
SEQ.DFLTESTDIT	`0`	*Desired Flux Level Test Spectrum exposure time*
SEQ.DFLUSEDB	`F`	*Use database values to estimate flux*

0.7.6 *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: 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**]
   - 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**]
   - Setup FEROS Calibration Unit: all lamp `OFF`, the RSM is moved to `PARK`, 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 the template the FCU-Shutter to `DARK` position, lamps and RSM left in current status. No change to FEROS/WFI Adapter setups

Note: The ADC was installed and commissioned at the end of Period-74.

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

INS.ADC.STATUS	`IN|OUT|AUTO`	*ADC*

If the ADC mode is `IN` or `AUTO` it will automatically track the atmospheric dispersion with an update frequency of approximately once every ~ 10 sec.

Which fibre(s) to illuminate must be specified.

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

This keyword is currently **IGNORED**. Both fibres are ALWAYS illuminated.

A lamp warmup period can be specifed.

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.

The *Leave Lamp on* keyword is ignored by the template as the turning On and OFF of the dome flatfield lamps is controlled manually by the TIO.

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

The following p2pp parameters are currently **not** implemented in the template signature files, i.e. their values are ignored:

SEQ.DFL	`0`	*Desired Flux Level*
SEQ.DFLTESTDIT	`0`	*Desired Flux Level Test Spectrum exposure time*
SEQ.DFLUSEDB	`F`	*Use database values to estimate flux*

0.7.7 *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.

$$F_{\mathrm{T}} = 23740 - 66{\times}T_{\mathrm{LS}} + 2{\times}ZD + FO$$

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).

Focusing can can be made either with ADC IN or OUT.

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 acquisiton 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 expsoures 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 Expsoure Time off Fibre**.
4. The template will then 'GRAB' one TCCD image at a Focus Offset of the current database value `<alias>feoFocus.focOffsetAdcOut` or `<alias>feoFocus.focOffsetAdcIn` according to whether the ADC is IN or OUT. If the database values have not been set (which is detected by the fact that the two values will be equal) the nominal ADC OUT focus offset of 1440 will be used. The relevant value is then the 'current estimated focus offset' (CEFO). This image will be displayed in a MIDAS PCO session display 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 image quality in this image should be close 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 CEFO+**Offset Start** to CEFO+**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 TIO has the possibility to accept the reported value, re-measure using an alternative star in the images, to enter a value manually, or to cancel. In all cases (except the abort) the relevant values will be written to the `<alias>feoFocus.focOffsetAdcOut` and `<alias>feoFocus.focOffsetAdcIn` database points where the value for the ADC OUT focus offset if the focus was done with ADC IN or vice versa is calculated according to:

$$\texttt{focOffsetAdcIn} = \texttt{focOffsetAdcOut} + 440$$

Typically in this mode the template takes as little as 5mins and usually 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 correspondance 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 0.6). 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 expsoure time would be way too much[5].

[5] 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.

The Standard Star Flag must be set according to:

SEQ.TYPE	`SCIENCE (default)`
	`STANDARD`
	`FLUX_STD`
	`RV_STD`
	`TELLURIC_STD`
	`SKY`
		Standard Star Flag

The FITS header keywords DPR.CATG and DPR.TYPE are then set as follows:

- SEQ.TYPE = SCIENCE, DPR.CATG = SCIENCE, DPR.TYPE = OBJECT,SKY
- SEQ.TYPE = STANDARD, DPR.CATG = CALIB, DPR.TYPE = STD,SKY
- SEQ.TYPE = FLUX_STD, DPR.CATG = CALIB, DPR.TYPE = FLUX,SKY
- SEQ.TYPE = RV_STD, DPR.CATG = CALIB, DPR.TYPE = VELOC,SKY
- SEQ.TYPE = TELLURIC_STD, DPR.CATG = CALIB, DPR.TYPE = TELLURIC,SKY
- SEQ.TYPE = SKY, DPR.CATG = CALIB, DPR.TYPE = SKY,SKY

If TEL.AG.FIBSELEC = SKYFIB then the order of the two parts of the DPR.TYPE keyword are reversed, i.e. OBJECT,SKY would become SKY,OBJECT.

Note: the value of DPR.CATG has important consequences for the proprietory period of the data. Any data with DPR.CATG = CALIB are classified as calibrations (obviously) and as such have **no proprietory period**. They are available to anyone from the ESO archive as soon as they arrive in the archive.

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

Based on experience, the useful values of **Offset Start**, **Offset End** and **Step** seem to be -200, +200 and 50 respectively. 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 preseting 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'.

.1 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 calulations made by p2pp take precedence over calculations based on the information provided here.

- FEROS_ech_acq

  ExecTime = 5mins

  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

  ExecTime = NEXPO * (ROT[ROM])

- FEROS_ech_cal_dark

  ExecTime = NEXPO * (UIT + ROT[ROM])

- FEROS_ech_cal_flat

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_cal_D2

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_cal_df

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_cal_wave

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_cal_ThAr_Ne

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_obs_objcal

  ExecTime = IST + NEXPO * (UIT + ROT[ROM])

- FEROS_ech_obs_objsky

  ExecTime = IST + NEXPO * (UIT + ROT[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

   ROT[60kHz,1,high] = 145sec

   ROT[225kHz,1,low] = 42sec

   ROT[625kHz,1,med] = 22sec

2. IST = Instrument Setup Time: maximum is 1min.

3. UIT = User Integration Time

4. NEXPO = Number of exposures.

.2 FEROS Template Signature Files

TBD

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