



Son Of X-Shooter

SOXS

User Manual

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CHANGE RECORD

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1 Purpose and Scope of the Document

The SOXS User Manual provides extensive information on the technical characteristics of the instrument, its performances, observing and calibration procedures and data reduction.

1.1 SOXS in a nutshell

SOXS is a single target spectrograph for the ESO-NTT (covering in a single exposure the spectral range from the UV to the H band through the splitting into two arms. The spectrograph operates at intermediate resolutions ($R > 3500$, with a $1''$ slit) and will be mainly aimed at the study of astrophysical transients. The instrument is complemented by an acquisition camera with optical imaging capabilities and a calibration box. A view of the instrument is shown in Figure 1. The main instrument characteristics are summarised in Table 1.

SOXS was built by a Consortium involving institutes from Italy, Israel, the UK, Finland, Chile and with the supporting participation of institutes from Israel and Denmark. The names of the institutes and their respective contributions are given in Table 2.



Figure 1: The SOXS spectrograph installed at the Nasmyth focus of the ESO-NTT.



Table 1: SOXS characteristics and observing capabilities.

Wavelength range	350-2000 nm split in two arms
UV-VIS arm	Range: 350-850 nm in 4 orders Resolution: 5000 (1" slit) Slit width: 0.5", 1", 1.5", 5" Detector: 4k x 2k E2V CCD
NIR arm	Range: 800-2000 nm in 15 orders Resolution: 6000 (1" slit) Slit width: 0.5", 1", 1.5", 5" Detector: 2k x 2k Hawaii 2RG
Slit length	12"
Beam separation	One dichroic
Atmospheric dispersion compensation	In the UV-VIS arm
Acquisition & imaging camera	Field of View: 3.5' (diameter) Filters: ugVrizY Pixel scale: 0.21"/pixel Detector: 2k x 2k BEX2-DD

Table 2: Collaborating institutes and their contributions.

Collaborating institutes	Contribution
INAF (Astronomical Observatories of Brera, Padova, Roma, Napoli, Catania)	Common Path, NIR-arm, cryogenics, integration, management
Israel (Weizmann Institute of Science)	UV-VIS arm optics and mechanics
UK (Queen's University of Belfast)	UV-VIS CCD, reduction pipeline
Finland (Turku University)	Calibration Unit
Chile (Millennium Institute)	Acquisition & imaging camera
Israel (Tel Aviv University)	Contribution to operations
Denmark (DAWN & Aarhus University)	Contribution to operations



1.2 Acknowledgements

Please consider citing the following articles if you publish SOXS data:

- reference paper: Campana et al. 2026, A&A, in preparation; Schipani et al. 2024, SPIE 13096 1.
- Pipeline paper: Young et al. 2026, A&A, in preparation; Young et al. 2022, SPIE 12189, 1.
- Scheduler paper: Brivio & Guidolin et al. 2026, A&A, in preparation; Asquini et al. 2024 SPIE 13101, 1.
- SOXS Instrument AIV (or Development) paper: Radhakrishnan Santhakumari & Battaini et al. 2026, JATIS, in preparation (SPIE Radhakrishnan Santhakumari et al. 2024, 13096, 1.

1.3 Contact

For instrument related questions, please contact soxs@inaf.it. For Phase 1 and Phase 2 related questions, please check out our Operations Helpdesk at

<https://soxs-help.brera.inaf.it/hc/978934077> where you can browse our knowledge base and contact us through the dedicated form.

1.4 News

Please check the news page of SOXS for recent news:

<https://soxs.inaf.it/news.html>



1.5 Abbreviations and Acronyms

AC	Acquisition Camera
AD	Applicable Document
ADC	Atmospheric Dispersion Corrector
AFC	Active Flexure Compensation
CBX	Calibration Box
CP	Common Path
ETC	Exposure Time Calculator
INS	Instrument Software
NISE	Near Infrared Slit Exchanger
NTT	New Technology Telescope
OB	Observing Block
PAC	Preliminary Acceptance in Chile
PAE	Preliminary Acceptance in Europe
QTH	Quartz Tungsten Halogen
RD	Reference Document
SNR	Signal to Noise Ratio
SOXS	Son Of X-Shooter
TIO	Telescope and Instrument Operator



2 List of Applicable and Reference Documents

2.1 Applicable Documents

Ref.	Document title	Document ID
[AD1]	Memorandum of Understanding No. 11378/LET/CP/AMA for the SOXS Instrument on the NTT Telescope	N/A

2.2 Reference Documents

Ref.	Document title	Document ID
[RD1]	SOXS Calibration Plan	SOXS-PLA-0006
[RD2]	SOXS Pipeline Manual	SOXS-MAN-0006
[RD3]	SOXS Template Manual	SOXS-MAN-0001



3 Technical description of the instrument

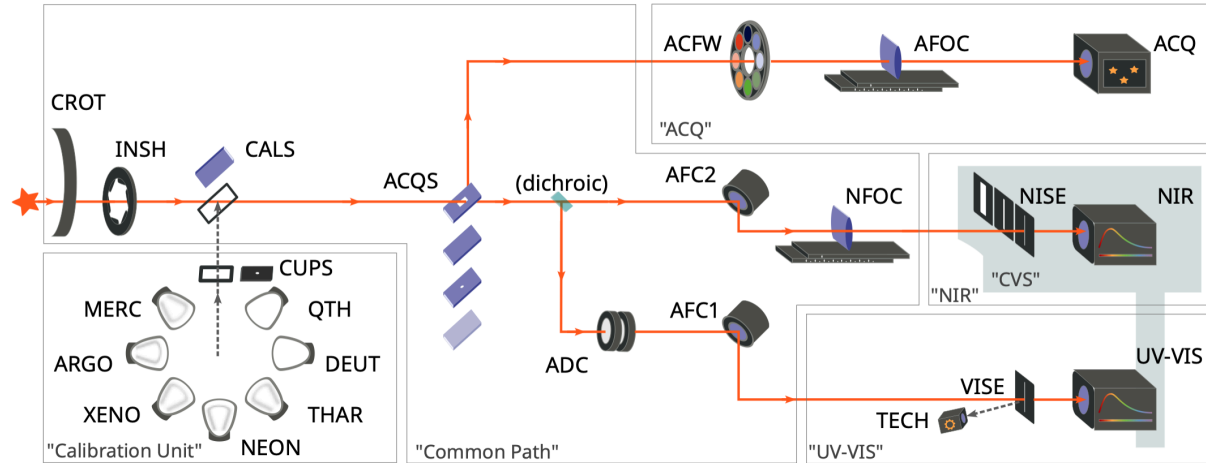


Figure 2: Schematic overview of SOXS. Quoted labels refer to subsystem names. The grey-filled box includes the parts under cryogenics. In this schematic, AFC1 and AFC2 are the tip-tilt mirrors that will be used for active flexure compensation. The NISE and VISE are the NIR and UV-VIS slit exchange linear stages, respectively.

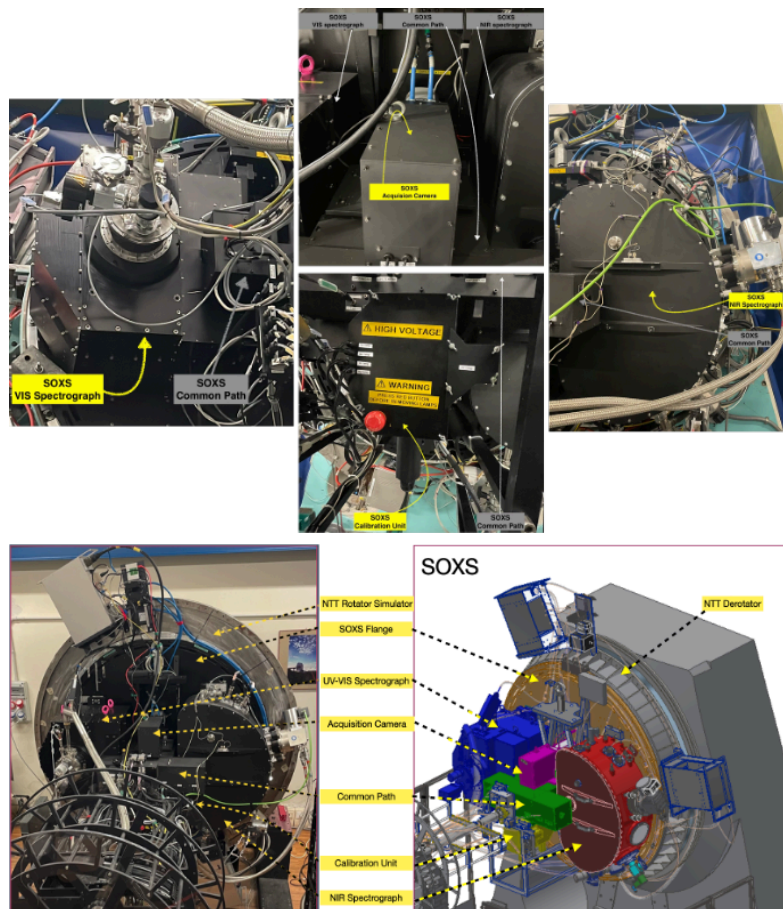


Figure 3: Pictures showing the sub-systems of SOXS.



3.1 Overview of the opto-mechanical design

Figures 2 and 3 show a schematic view of the layout of the instrument. It consists of five main components:

- the common path (CP) is the subsystem directly mounted on the telescope that relays light from the NTT focal plane to the entrance of the two spectrographs (UV-VIS and NIR). In doing that, the CP selects the wavelength range for the spectrographs (using a dichroic, see Fig. 4) and changes the focal ratio. The CP contains the ADC for the UV-VIS spectrograph and two tip-tilt mirrors to correct for misalignment between the two spectrographs due to flexures;
- the calibration box (CBX);
- the UV-VIS spectrograph, which covers the 350 - 850 nm wavelength range with a resolving power of 5000 (for a 1" slit);
- the NIR spectrograph, which covers the 800 - 2000 nm wavelength range with a resolving power of 6000 (for a 1" slit). This arm is fully cryogenic;
- the acquisition camera (AC).

3.2 Description of the instrument sub-systems

This section describes the different SOXS sub-systems (see Fig. 2).

3.2.1 The common path

The SOXS CP is composed of a T-shaped structure (Fig. 4). The first part of the CP is composed of an instrument shutter (which allows safe daytime use of SOXS for test and calibration without stray-light contamination), the Calibration Box selector, the Acquisition Camera selector, and a dichroic. The light reflected from the dichroic goes to the UV-VIS spectrograph; in the CP, there is a flat mirror, an ADC with 2 counter-rotating prisms and a piezo tip-tilt. The light transmitted by the dichroic will go to the NIR spectrograph; in the CP, there is a flat mirror, a piezo tip-tilt and a refocuser.

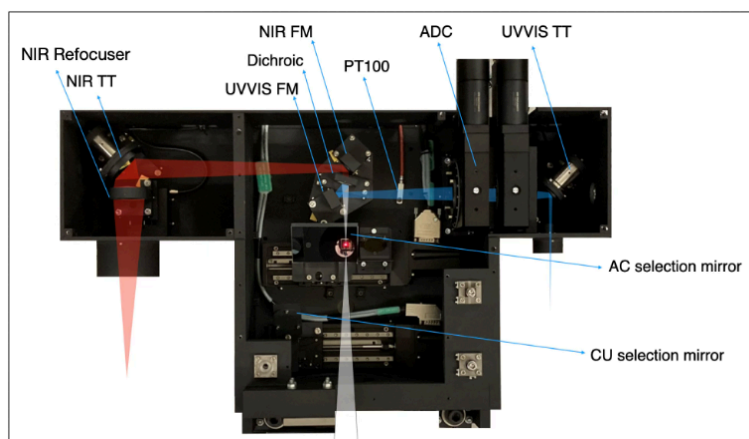


Figure 4: The SOXS Common Path. The light received from the telescope (white beam) is split into UV-VIS (blue beam) and NIR (red beam) wavelengths by the dichroic.



The common path UV-VIS arm

The CP UV-VIS arm hosts an ADC (Atmospheric Dispersion Corrector). The light coming from the Telescope Focal Plane (TFP) is reflected by the CP-Dichroic (CP_DCR) and a flat folding mirror (CP_FM_VIS) into the ADC assembly (CP_LVIS_01 and CP_LVIS_02). The ADC assembly creates a collimated beam for the ADC and transforms the telescope F/11 beam into an F/6.5. After the ADC, the beam is reflected by the tip/tilt mirror (CP_TT_VIS). Finally, a field lens (CP_LVIS_03) matches the exit pupil on the UV-VIS spectrograph pupil. The whole CP UV-VIS Arm layout is presented in Figure 5 (left).

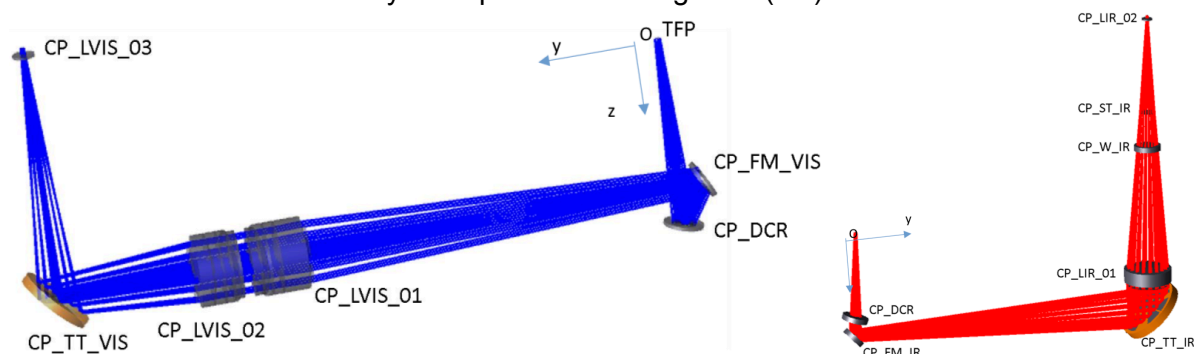


Figure 5: UV-VIS (left) and NIR (right) arm common path layout.

The common path NIR arm

The CP-NIR arm is similar to the UV-VIS arm (same first-order parameters, except the wavelength range). Unlike the UV-VIS, the NIR arm does not include an ADC, since the atmospheric dispersion is less severe than in the UV-VIS range. The CP NIR Arm includes a doublet (CP_LIR_01) in order to reduce the telescope F/11 beam to an F/6.5 beam. Two flat mirrors (CP_FM_IR and CP_TT_IR) relay the light to the slit. In order to allow the entering of light in the NIR spectrograph Dewar, the CP NIR Arm includes a flat window (CP_W_IR), and to reduce noise in the NIR spectrograph, a cold stop was introduced after the window itself (CP_ST_IR). A field lens (CP_LIR_02), placed near the slit, remaps the telescope pupil on the grating of the spectrograph (as in the UV-VIS arm). The whole CP NIR Arm layout is presented in Figure 5 (right).

The flexure compensation tip-tilt mirrors

The light reflected and/or transmitted by the dichroic encounters the AFC1 and AFC2 folding mirrors mounted on a piezo tip-tilt mount. These mirrors are used to fold the beam and correct for CP flexure to keep the relative alignment of the two spectrograph slits at any position of the instrument.

The Atmospheric Dispersion Correctors

The UV-VIS pre-slit arm contains two ADCs. These ADCs consist of two counter-rotating double prisms. The ADCs compensate for atmospheric dispersion in order to minimize slit losses (down to a factor $< 10\%$) and allow orienting the slit to any position angle on the sky. The NIR arm is not equipped with an ADC. If measurement of the absolute flux is an important issue, the slit should be placed at the parallactic angle.



3.2.2 The Calibration Box

The calibration unit (CBX; Fig. 6) is used to provide calibration spectra for the SOXS spectrographs, which are necessary to remove instrument signatures and convert the observed spectrum into one with physical units. Calibration spectra are generated using a synthetic light source, whose light is directed so as to enter and to be dispersed by the spectrographs in the same manner as light from a celestial object would be.

The light source takes form in an integrating sphere, equipped with lamps suitable for wavelength and flux calibrations across the full wavelength range of the instrument (350-2000 nm). The following lamps are used:

- Quartz-tungsten-halogen (QTH) lamp, for flat-field calibration 350-2000 nm.
- Deuterium (D2) lamp, for flat-field calibration 350-500 nm¹.
- NeArHgXe penray lamps bundled together, for IR wavelength calibration. The individual lamps are controlled to operate together as one lamp.
- ThAr hollow cathode lamp, for UVVIS wavelength calibration.

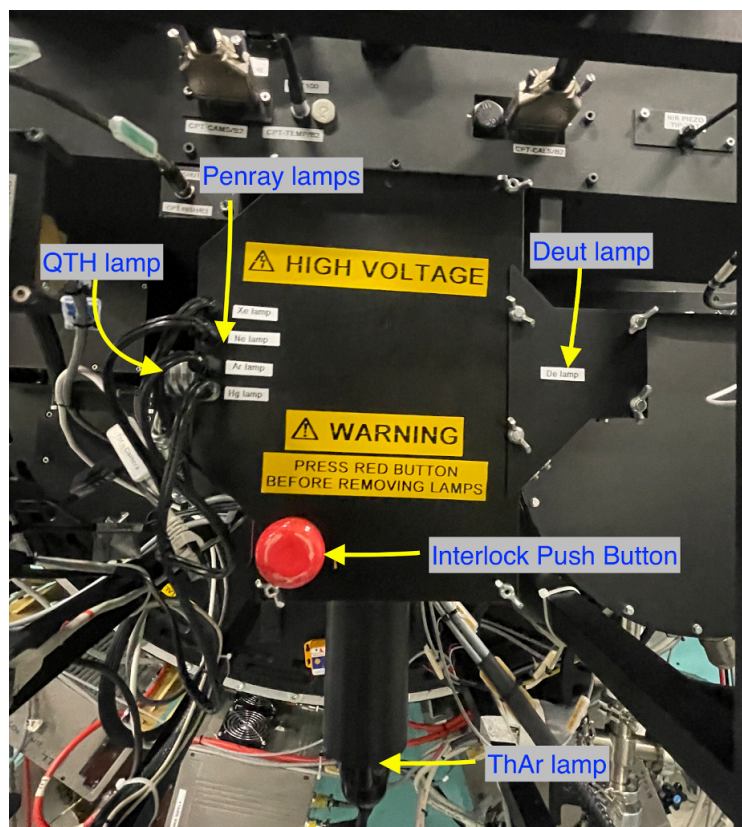


Figure 6: The SOXS Calibration Unit.

¹ Not currently used.



3.2.3 The UV-VIS spectrograph

The SOXS UV-VIS spectrograph (Fig. 7) is based on a novel concept in which the incoming beam is partitioned into four polychromatic beams (quasi-orders) using dichroic surfaces, each covering a waveband range of ~100-200 nm. Each quasi-order is diffracted by a custom-made ion-etched grating. The four beams enter a three-element catadioptric camera that images them onto a common detector. The resolution is with $R=3500-7000$ (for 1 arcsec slit).

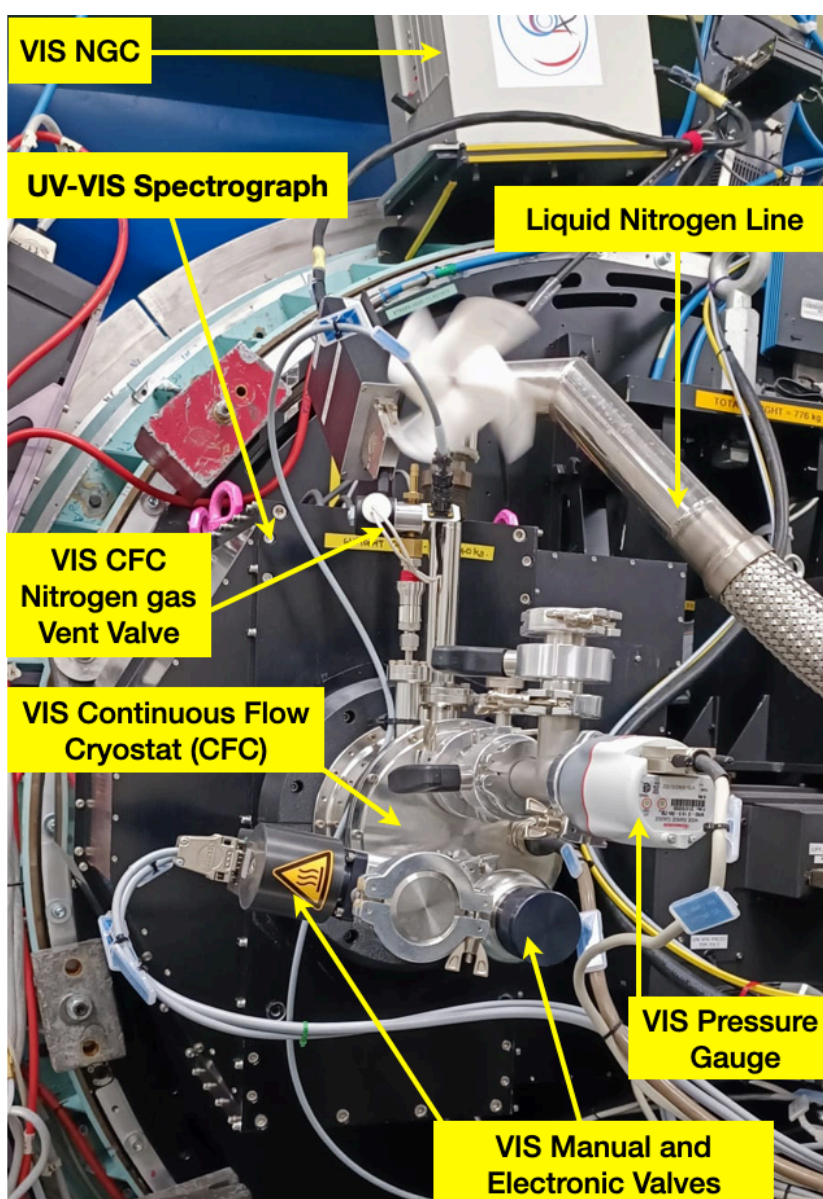


Figure 7: The SOXS UV-VIS spectrograph.



The Visible Slit Exchanger (VISE)

The Visible Slit Exchanger (VISE; Fig. 8) allows a precise slit change by linear translation of the slit mask plate. In addition, it allows folding the beam towards the slit-viewing camera. It is mounted on a motorised slide enabling one to select one of the nine positions available. All science observation slits have a height of 12" and different widths of 0.5", 1", 1.5", 5" (the latter for the observation of spectro-photometric standard stars). In addition, a single pinhole for spectral format check and a 9-pinhole mask for wavelength calibration and spatial scale mapping are available. Each pinhole has a 0.5" diameter.



Figure 8: The SOXS VISE unit.

Optical layout

The SOXS UV-VIS spectrograph is divided into two levels, both conceptually and mechanically (Fig. 9). The first level divides the CP beam into four collimated beams, each covering a different wavelength range. The second level includes the dispersers and camera – imaging the spectra of each quasi-order to a common detector.

The beam from SOXS CP is directed into the UV-VIS enclosure and is folded by a flat pickup mirror with a diameter of $\phi=25.4$ mm located 70 mm downstream from the CP focus. The beam intercepts a $\phi=62$ mm off-axis-parabolic (OAP) mirror at an angle of 30° , creating a collimated beam with a diameter of $\phi=45$ mm (The F/# is matched to the CP, i.e. F/6.5). The collimated beam is partitioned into four beams using flat dichroic mirrors at $\sim 45^\circ$ angle of incidence. The system includes three dichroic surfaces to divide the beam into four quasi-orders. Each quasi-order beam is reflected/transmitted by two dichroic surfaces. The first one is a dichroic mirror tilted at $\sim 45^\circ$ reflecting u+g and transmitting r+i. The two beams are then further divided by secondary dichroic mirrors, which are tilted at $\sim 45^\circ$ to ensure proper positioning of the beams on the gratings. The transmitted beams (g + i) are finally reflected towards their gratings by dielectric mirrors at $\sim 45^\circ$. The mirrors are rotated by a few degrees to feed the gratings at the designed 41° angle of incidence, and the central wavelength ray is parallel to the camera's optical axis. The dispersed beams are then imaged by the catadioptric camera onto the common detector. The field flattener also serves as a cryostat window and is inserted through a rectangular aperture in the camera's corrector.

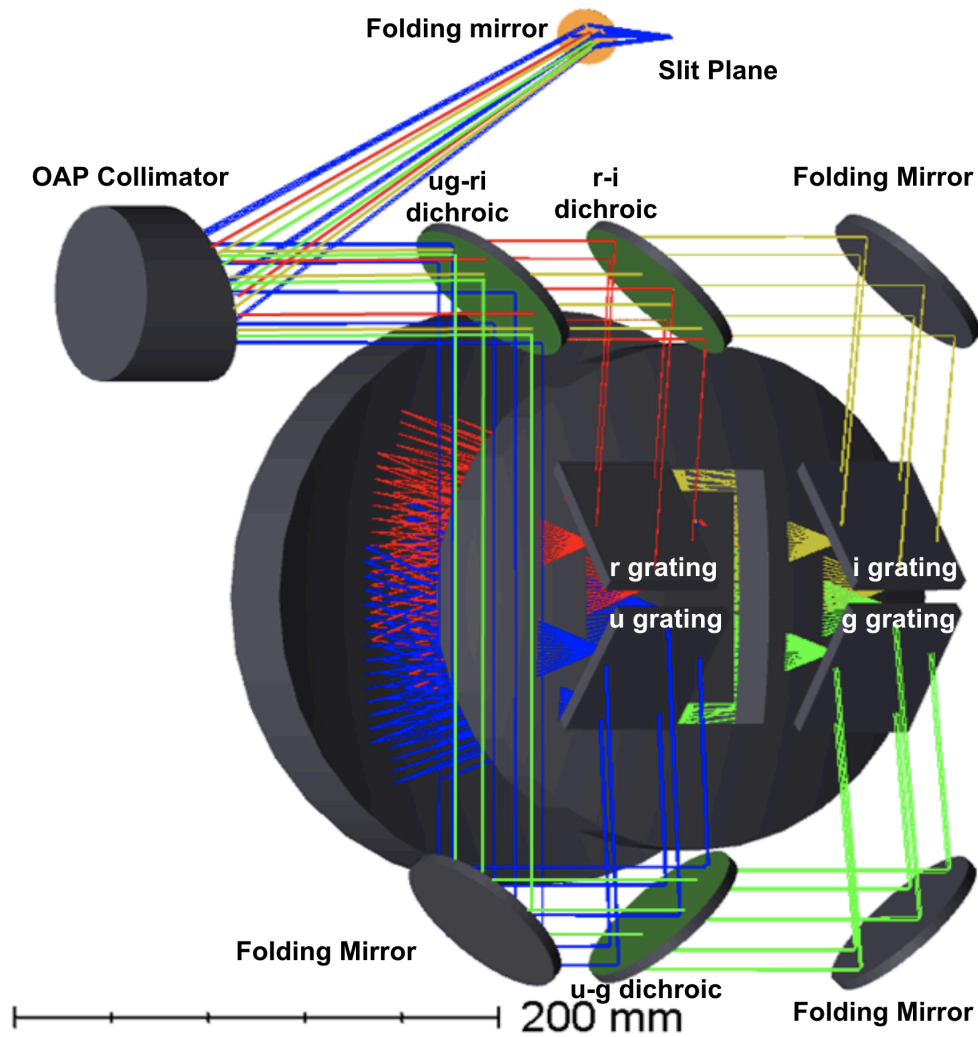


Figure 9: The UV-VIS spectrograph optical layout.

Detector

The UV-VIS detector is a 2098x4096, 15.0 μm pixel CCD from e2V (type CCD44-82) of which only an 858x4096 pixel box is used. The operating temperature is between 156 K and 160 K. The CCD control system is an ESO NGC (New General detector Controller) controller. The list of readout modes is given in Table 3, while the overall detector properties are summarised in Table 5.



Table 3: List of UV-VIS detector readout modes offered for science observations.

Readout mode number	Readout mode name	Gain [e-/ADU]	Speed [kpix/s]	RON [e-]	Binning (Spatial dir.)	Binning (Dispersion dir)
1	Slow High Gain	1.1	263	3.6	1 2 2	1 1 2
2	Fast Low Gain	2.0	500	5.7	1 2 2	1 1 2

During image acquisition, especially for the selected region for the instrument (858 x 4096), it is important to account for the dead times associated with image acquisition and the skipping of non-relevant parts of the image. Table 4 summarizes the readout times for the specific 858x4096 pixel box SOXS region.

Table 4: Readout time for the UV-VIS arm for different reading modes and binning combinations.

Readout Time (s)	Mode	BINX	BINY
25	1	1	1
10	1	2	2
19	1	2	1
17	2	1	1
14	2	2	1



3.2.4 The NIR spectrograph

The SOXS NIR spectrograph (Fig. 10) is a near-infrared echelle spectrograph, fully cryogenic, with $R=6000$ (for 1 arcsec slit), covering a wavelength range from 800 to 2000 nm with 15 orders. The operating temperature is 140 K for the spectrograph bench and 45 K for the detector.

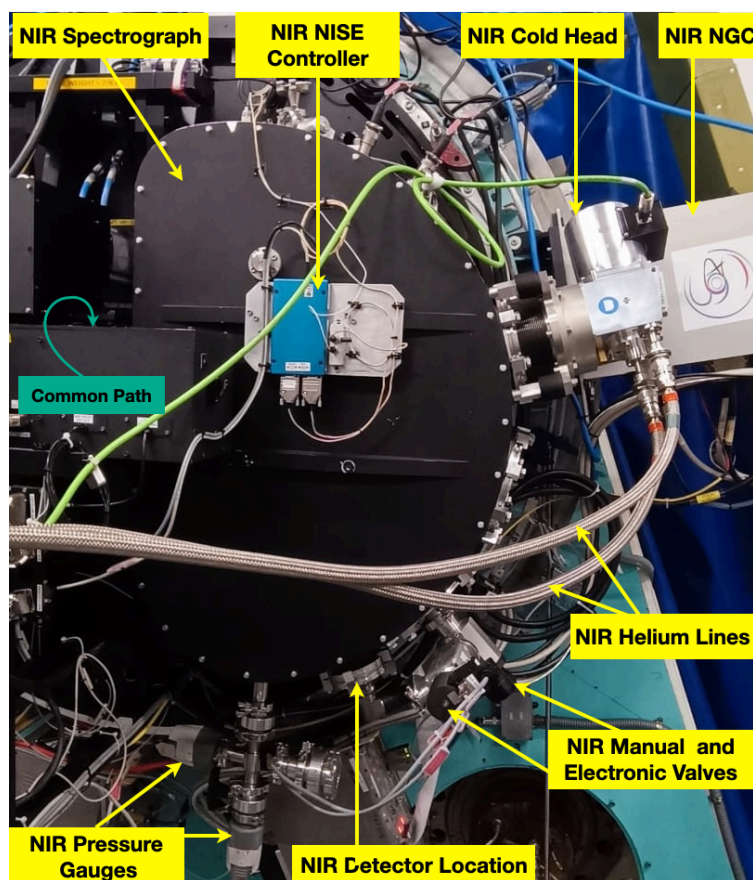


Figure 10: The SOXS UV-VIS spectrograph.

The Near-Infrared Slit Exchanger (NISE)

The Near-Infrared Slit Exchanger (NISE; Fig. 11) allows for a precise slit change by linear translation of the slit mask plate. In addition, it allows folding the beam towards the slit-viewing camera. It is mounted on a motorised slide enabling one to select one of the nine positions available. All science observation slits have a height of 12" and different widths of 0.5", 1", 1.5", 5" (the latter for the observation of spectro-photometric standard stars). In addition, a single pinhole for spectral format check and a 9-pinhole mask for wavelength calibration and spatial scale mapping are available. Each pinhole has a 0.5" diameter.

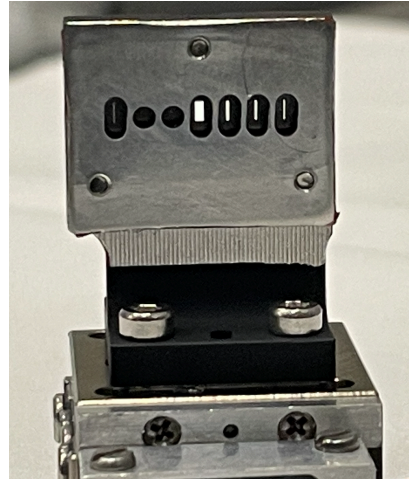


Figure 11: The SOXS NISE unit.

Optical layout

The NIR spectrograph is composed of a double pass collimator and a refractive camera, a disperser (grating) and a cross disperser. The folding mirror is a small mirror placed 60mm after the slit plane, whose aim is to bend the beam by 90°, allowing the accommodation of the spectrograph. The collimator of the system is a Maksutov telescope, used off-axis (and consequently cut). The system has an input $f/\#$ of 6.5 (produced by the CP NIR arm) and produces a collimated beam of diameter 50mm. Three Cleartran prisms used in a double pass are the cross-dispersers of the system. The Grating is the main disperser of the system. The Spherical Fold Mirror is a spherical mirror, placed after the second pass through the collimator, whose aim is to fold the beam after the dispersion and before the camera, in order to obtain a more compact design. The mirror, placed approximately in the position of the focus of the collimator, creates a pupil, reducing the necessary diameter of the camera lenses. The design is depicted in Fig. 12.

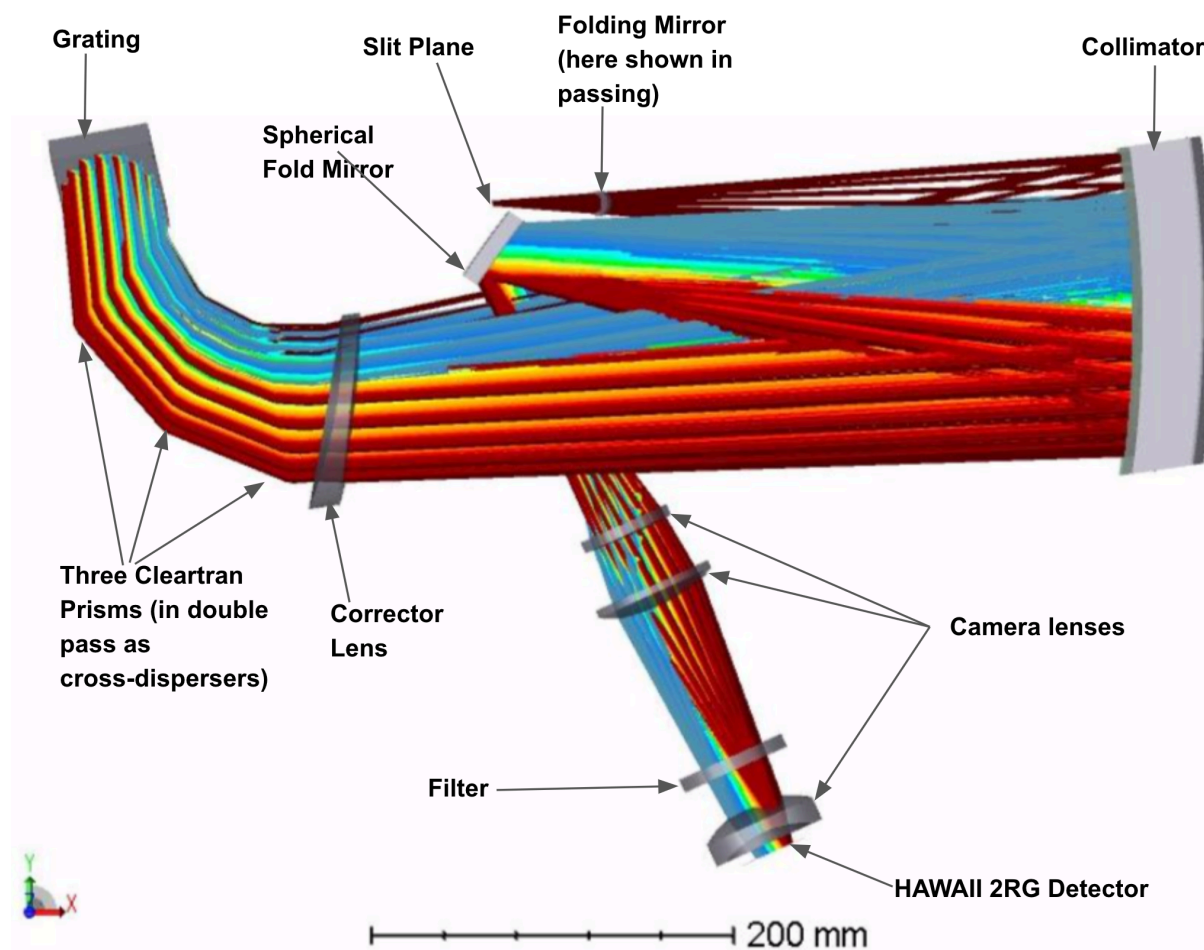


Figure 12: The NIR spectrograph optical layout.

Detector

The detector is a Teledyne substrate-removed HgCdTe 2k x 2k, 18.0 μm pixel HAWAII 2RG detector. The operating temperature is 45 K. The detector control system is an ESO NGC (New General detector Controller) controller. Up-the-ramp readout mode is used. The NIR spectrograph detector properties are summarised in Table 5.



3.2.5 The Acquisition Camera

The SOXS Acquisition Camera (AC; Fig. 13) has the primary function of acquisition of the target for the spectrographs. It can be effectively used as a science multi-filter imager and for technical purposes (e.g. monitoring of spectrographs co-alignment). It consists of a CCD camera, focal reducer optics, filter wheel, folding mirror and a mirror carriage.

At the level of the Nasmyth focal plane, a linear stage carries a single mirror with three positions for different functions and a pellicle beam splitter. The mirror and the pellicle are tilted at 45° and direct light from the sky or from the slits, respectively, to the camera optics. A refocuser linear stage is foreseen at the level of the first collimator lens.

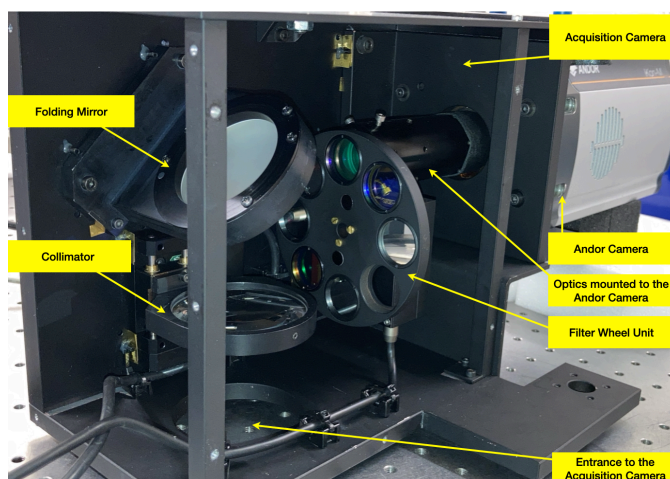


Figure 13: The Acquisition Camera optical layout.

The AC main characteristics are:

- a circular Field of View with a diameter of $3.5'$.
- a filter wheel with the u, g, r, i, z, Y (LSST) and V Johnson bands.
- a 1024×1024 pixel detector CCD optimised for NIR QE with a pixel size of $13.0 \mu\text{m}$ and a pixel scale of $0.21''/\text{pixel}$.

The properties of the three SOXS detectors are summarised in Table 5.



Table 5: Measured properties of the SOXS detectors.

	UV-VIS	NIR	AC
Detector type	e2V CCD44-82	H2RG	BEX2-DD: Back Illuminated, Deep Depletion with fringe suppression, extended range dual AR coating
Operating temperature	158 K	45 K	173 K
QE	37.4 % at 350 nm 79.3 % at 400 nm 75.3 % at 500 nm 78.4 % at 650 nm 54.4 % at 900 nm 4.0 % at 1000 nm	70.0 % at 800 nm 82.0 % at 1000 nm 77.0 % at 1200 nm 78.0 % at 1400 nm 78.0 % at 1600 nm 83.0 % at 2000 nm	50.0 % at 350 nm 90.0 % at 450 nm 88.0 % at 550 nm 92.0 % at 650 nm 94.0 % at 750 nm 60.0 % at 950 nm
Number of pixels	2048 x 4096	2048 x 2048	1024 x 1024
Pixel size	15.0 μm	18.0 μm	13.0 μm
Gain (e-/ADU)	Slow High Gain: 1.1 Fast Low Gain: 2.0 Slow Low Gain: 2.1 Fast High Gain: 1.0	2.3	1.0
Readout noise (e- rms)	Slow High Gain: 3.6 Fast Low Gain: 5.7 Slow Low Gain: 4.0 Fast High Gain: 4.9	16.3	3.1
Dark current level	< 2 e-/pix/h	< 30 e-/pix/h	< 7 e-/pix/h
Non-linearity (deviation)	< 1% (mode 1)	< 5% @ ~ 40k counts	< 1%



3.3 Spectral format, resolution and overall performances

3.3.1 Spectral format

The spectral format of SOXS is fixed. The spectral ranges on the detectors and blaze wavelength for each order are given in Tables 6 and 7. The whole spectral range is covered by 4 straight quasi-orders in the UV-VIS and by 15 curved orders in the NIR. In both spectrographs, the spectral lines tilt varies along orders. An example of a halogen (QTH) flat slit frame for each arm is shown in Fig. 14. The dichroic crossover region between UV-VIS and NIR is at 850 nm.

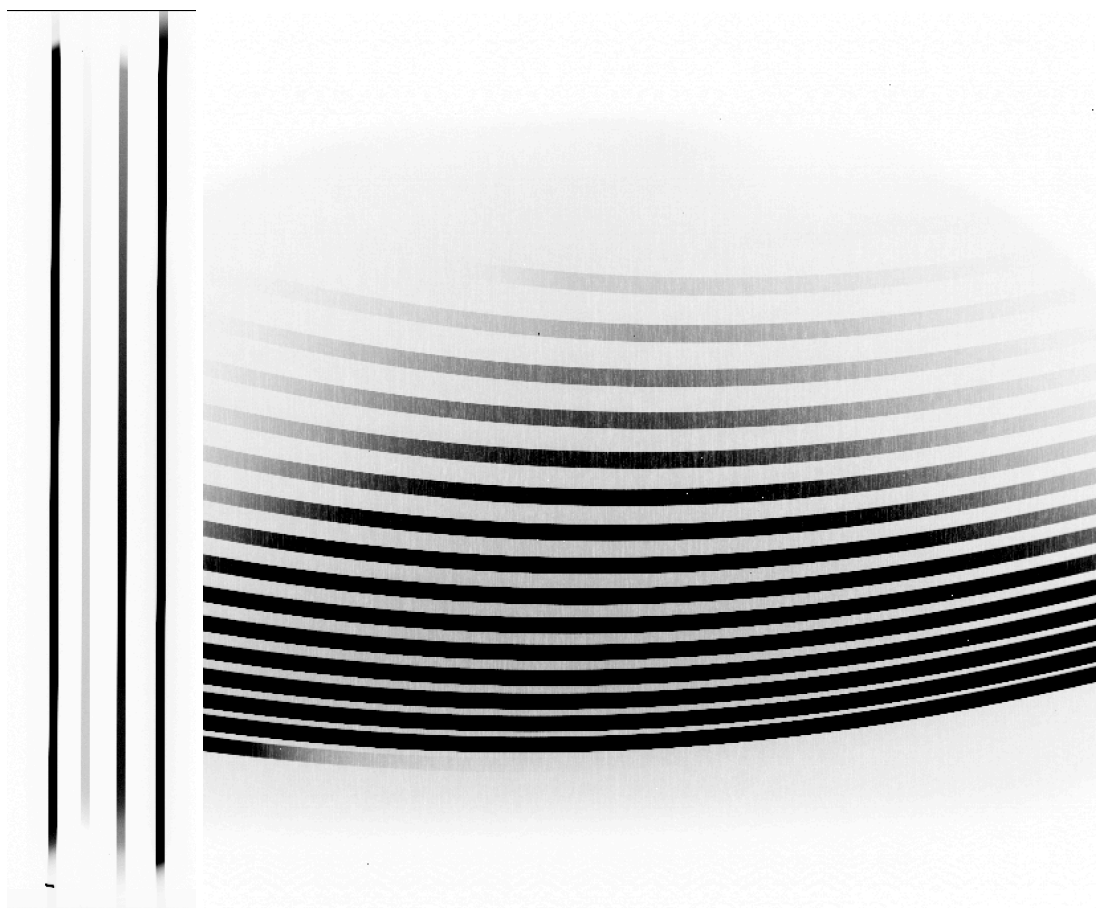


Figure 14: Example of UV-VIS (left) and NIR (right) halogen lamp (QTH) flat calibration frames. In the UV-VIS spectrograph, the orders are (from left to right): r, u, g, i.



Table 6: SOXS UV-VIS Quasi-Orders.

Quasi-order	Wavelength Range (nm)	Blaze wavelength (nm)
<i>u</i>	349.9 - 433.3	391.2
<i>g</i>	433.4 - 533.5	483.0
<i>r</i>	533.6 - 668.5	600.4
<i>i</i>	668.6 - 850.1	758.4

Table 7: SOXS NIR orders.

Order	Wavelength Range (nm)	Blaze wavelength (nm)
24	793.2 - 826.8	809.8
23	826.9 - 863.5	845.0
22	863.6 - 903.6	883.4
21	903.7 - 947.7	925.5
20	947.8 - 996.1	971.7
19	996.3 - 1049.9	1022.9
18	1050.0 - 1109.8	1079.7
17	1110.2 - 1176.8	1143.2
16	1177.3 - 1252.7	1214.6
15	1253.1 - 1338.8	1295.5
14	1339.2 - 1437.8	1388.0
13	1438.3 - 1552.4	1494.8
12	1553.0 - 1686.9	1619.3
11	1687.6 - 1846.8	1766.4
10	1847.7 - 2040.2	1943.0



3.3.2 Spectral resolution and sampling

The user can only affect the spectral resolution through the choice of the slit width (and, to some extent, with the binning in the spectral direction). The resolution and pixel sampling (without binning) as a function of the slit width are given in Tables 8 and 9 for the UV-VIS and NIR spectrographs, respectively.

Table 8: UV-VIS resolution as a function of the slit width.

Slit width (arcsec)	R ($\lambda/\Delta\lambda$)	Sampling (pix/FWHM)
0.5	9200	1.8
1.0	5500	3.0
1.5	3500	4.8

Table 9: NIR resolution as a function of the slit width.

Slit width (arcsec)	R ($\lambda/\Delta\lambda$)	Sampling (pix/FWHM)
0.5	12300	1.9
1.0	6800	3.4
1.5	4600	5.0

3.3.3 Overall sensitivity

The total efficiency has been measured on sky using several standard stars observed during commissioning. Based on these values, the expected limiting AB magnitudes at blaze wavelength in 1 hour for a S/N of 10 per spectral bin are given in Figure 15.

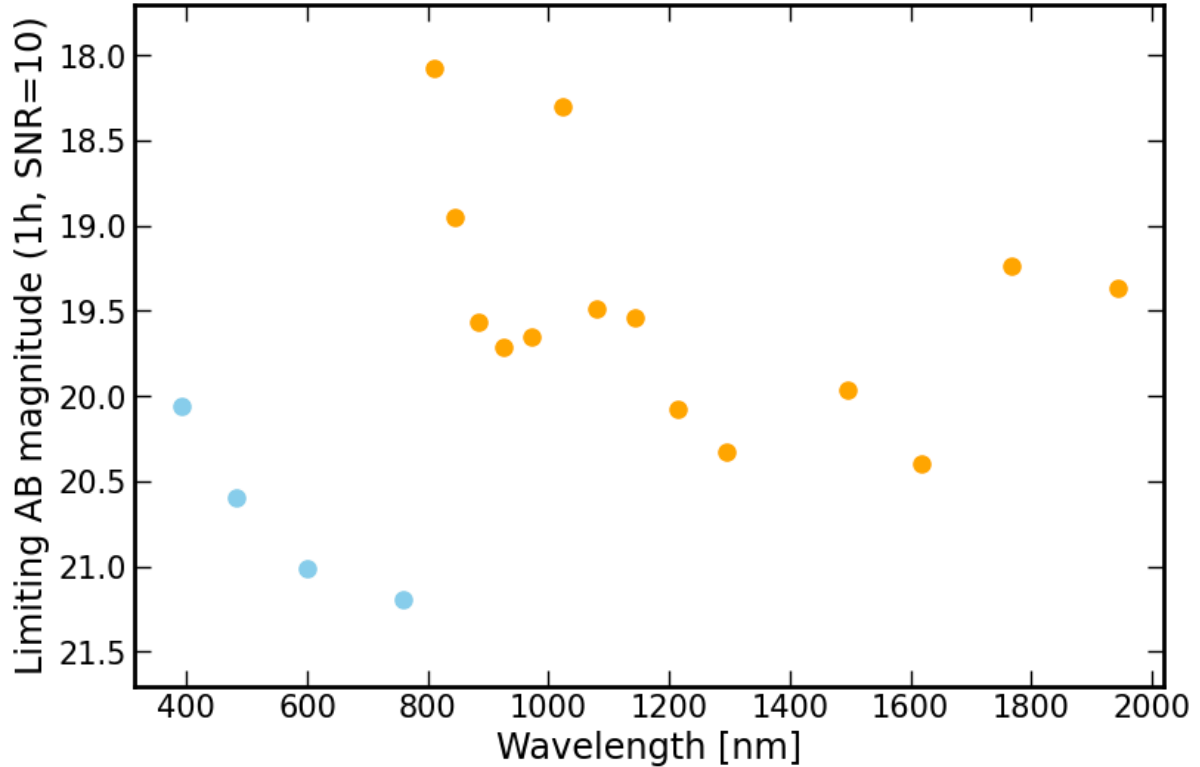


Figure 15: Limiting AB magnitude of SOXS at S/N=10 in a 1-hour exposure. Other parameters: airmass 1.2, 0.8" seeing, 3 days from new moon, 1" slit for both UV-VIS and NIR. The model uses the overall efficiencies measured during commissioning.

3.4 Instrument features and problems

3.4.1 Persistence in the NIR

From tests carried out during commissioning, persistence effects are found in the NIR spectrograph. The persistence effect for a source with a brightness of ~ 50000 counts/pixel becomes negligible after ~ 600 seconds. Further characterisation of this effect for brighter sources is ongoing.

3.4.2 Spectrograph Flexures

For any rotator angle, the spectral format in both arms stays on average within ~ 2 pixels for both the UV-VIS and NIR arm, from the zenith position. Considering the dispersion scales, this equals to shifts in the wavelength solution of the order of 1 Angstrom. However, long term tests carried out during commissioning revealed deviations up to ~ 4 Angstrom. Therefore, If a precise wavelength solution is an important issue, we recommend carrying out a multi-pinhole arc as nighttime attached calibration, keeping in mind the need to wait for ~ 600 s for any persistence effect to vanish (see Sect. 3.4.1) before starting the next OBs.



Considering that the whole procedure of pointing / acquisition / spectroscopic setup takes about 400 s (see Sect. 3.4.1), this would translate in an overhead of about 200 s.

3.4.3 Efficiency with narrow slits

Tests carried out during commissioning revealed that the throughput measured with the 1.0" and 0.5" slits can sometimes be variable. The underlying cause might be related to instabilities of the NTT guiding, although a full investigation of the issue is still ongoing. We recommend the users to apply a conservative correction factor of 1.5 and 1.3 when estimating the exposure times for spectroscopic observations to be carried out with the 0.5" and 1.0" slit, respectively.

4 Observing with SOXS

For science observations, SOXS can be used in imaging or spectroscopic mode. The two modes are mutually exclusive, i.e. it is not possible to simultaneously carry out imaging and spectroscopy on the same target. The spectral format is fixed. The two arms (UV-VIS and NIR) can operate in parallel. The user can select, for each arm independently, a slit width among those listed in Tables 8 and 9.

All SOXS science observing blocks (OB) are composed of an acquisition template followed by one or several science templates selected depending on the observing strategy chosen by the user.

4.1 Observing modes: Imaging

A simple imaging mode with limited functionalities, which uses the AC camera and its set of filters, is offered. Acquisition images can be used to flux calibrate spectra in addition to the usual spectrophotometric observations and to determine the magnitudes of transient objects. A minimal calibration plan is provided (Sect. 5.11), and no pipeline support is currently planned to be provided for the imaging data.

The AC zeropoints were determined during commissioning for each filter under photometric conditions (Table 10).

Table 10: Average photometric zeropoints measured for the AC camera filters during commissioning.

Filter	Mean Zeropoint (AB mag)
u	23.25 +/- 0.09
g	25.70 +/- 0.08
r	25.54 +/- 0.06
i	25.08 +/- 0.06
z	24.83 +/- 0.06



4.2 Observing modes: Spectroscopy

4.2.1 Target Acquisition

The main steps of a typical target acquisition sequence are the following:

1. Preset the telescope to the target coordinates and set the adaptor-rotator to the chosen position angle.
2. The UV-VIS ADCs start tracking to compensate for atmospheric dispersion.
3. Commands are sent to the two tip-tilt mirrors based on the flexures lookup table.
4. The AC slide is set to the acquisition position: the field is now visible in the acquisition camera, and an acquisition image can be acquired.
5. The spectroscopic target is identified (or the reference object in case of blind offset) and its coordinates on the detector are determined by a centering algorithm.
6. The telescope is offset to the reference pixel on the detector (corresponding to the AC physical detector coordinates $x,y = 526.5, 518.5$), corresponding to the position of the image in the AC reference pinhole.
7. When the observer is satisfied with the object centering, an acquisition image is saved, and the AC slide is set to the spectroscopic observation position.
8. In case of a blind offset (recommended for targets fainter than mag 21), the offsets are applied. Another image is saved after the offset.

This acquisition sequence is performed by the acquisition template, *SOXS_slit_acq*.

4.2.2 Spectroscopy Observations

SOXS science templates support different observing strategies: staring (commonly used for UV-VIS observations), nodding along the slit (classical near-IR observations), offsetting to a fixed sky position (for extended objects) or letting the user free to choose any sequence of offsets (e.g. for mapping). Effects of the atmospheric dispersion are automatically corrected in the UV-VIS arm thanks to the two ADCs.

4.2.3 Staring

With the *SOXS_slit_obs_Stare* template, one or more spectra are taken with each arm independently at a fixed position on sky. For each arm, the user chooses the exposure time and the number of exposures. Exposures are completely asynchronous, i.e. in each arm, whenever an exposure is finished, the next one starts immediately, independently of what is happening with the other arms.

4.2.4 Staring synchronised

Whenever exposures in the two arms have to be parallel, the template *SOXS_slit_obs_StareSynchro* should be used. In this case, the number of exposures is fixed to one per arm. Exposure times can still be different in each arm, but the exposures are



synchronised to their mid-time. In case the exposure times in both arms are identical, exposures in the two arms will have the same start time within approximately one second. In case of different exposure times, the mid-exposure time of the two will coincide within about one second. Synchronised exposures might represent the preferred choice when observing science targets characterised by variability over time scales comparable with the chosen exposure time.

4.2.5 Nodding along the slit

This corresponds to the standard way of observing in the NIR, primarily aimed at a double pass sky subtraction. The template *SOXS_slit_obs_AutoNodOnSlit* automatically nods the telescope between two positions (A and B) along the slit. The user defines a Nod Throw and optionally a small jitter box (in the slit direction). The Nod Throw is defined as the distance between the two nodding positions, i.e. the centre of the two jitter boxes inside the slit (see Figure 16). One cycle is a pair of AB or BA observations. Cycles are repeated in ABBA sequences. For each arm, the user chooses the number of exposures at each position and the exposure time (both identical for all A and B positions). Exposures are asynchronous.

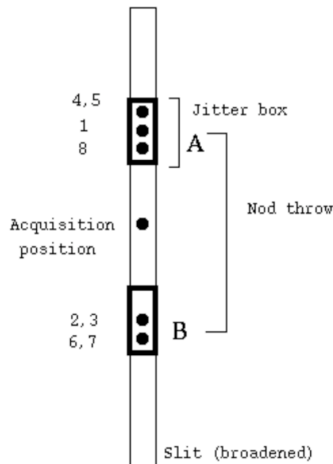


Figure 16: Conventions used for nodding along slit observations. The sequence illustrated here corresponds to 4 cycles (8 exposures, ABBAABBA) with a non-zero jitter box.

4.2.6 Fixed offset to sky

When observing extended objects for which there is no or not enough pure sky in the 12" slit to perform a good sky subtraction, one should use the template *SOXS_slit_obs_FixedSkyOffset*. It allows alternating between an object (O) and sky position (S), with the possibility of adding a small jittering around the object and the sky position. One cycle is a pair of OS or SO observations. Cycles are repeated in OSSO sequences. For each arm, the user chooses the number of exposures taken at each position and the exposure time (both identical for all A and B positions). Exposures are asynchronous.



4.2.7 Generic offset

The *SOXS_slit_obs_GenericOffset* template allows the user to define any pattern by providing a list of (cumulative) telescope offsets. This is particularly useful in case one wants to map on an object with several slit positions. The number of exposures taken at each position and the exposure time (both identical at all positions) have to be defined. Exposures are asynchronous.

4.2.8 Mapping

The mapping template *SOXS_slit_obs_Mapping* allows the user to define any pattern by providing a list of (cumulative) telescope offsets. This is particularly useful for mapping an object with several positions. The number of exposures taken at each position and the exposure time has to be defined. Exposures are asynchronous. This template allows for different numbers of sky and object positions.

4.3 Instrument and telescope overheads

4.3.1 Summary of telescope and instrument overheads

Table 11: SOXS overheads

Acquisition and setup	
Telescope pointing, guide star acquisition, flexure measurement.	210s
AC detector readout	21s
Interactive acquisition loop	120s
Instrument setup at the end of the acquisition	30s
Observations	
UV-VIS detector readout	1x1 slow / fast: 25s / 17s 2x1 slow / fast: 19s / 14s 2x2 slow / fast: 10s / 8s
NIR detector readout	5s
Each telescope offset	15s



4.3.2 Example of execution time computation

Below is a generic example of how total execution time shall be estimated, taking into account the overheads reported in Table 11. For a nod on the slit sequence with:

- 1 acquisition image (exposure time: 1s, readout time: 21s)
- 1 cycle (AB sequence)
- 1 UV-VIS and 2 NIR exposures per position
- integration times 900s in UV-VIS in 1x1 slow, and 450 in NIR

the total execution time splits as follows:

- Pointing / acquisition / spectroscopic setup: $232s + 120s + 30s = 382s$

At each position, the total integration and readout time per arm is:

- UV-VIS: $1 \times (900 + 25) = 925s$
- NIR: $2 \times (450 + 5) = 910s$

With the two arms operating in parallel, the total time spent at each position is given by the slowest arm, in this case, the UV-VIS one: 925s. So the total integration and readout time is $2 \times 925s = 1850s$

Total telescope offsets: $2 \times 15 = 30s$

So, the total execution time for this observing block is: $382s + 1850s + 30s = 2262s$

An additional overhead of 220s has to be taken into account if a multipinhole arc lamp is taken during the night to improve the dispersion solution (see Sect. 3.4).



5 Calibrating and reducing SOXS data

5.1 SOXS calibration plan

The calibration plan of SOXS is described in detail in document [RD 1]. A summary is given in Table 12 for the spectroscopic calibrations and in Table 13 for the imaging calibrations.

Table 12: SOXS calibration plan summary for spectroscopic observations.

Calibration	UV-VIS frames	NIR frames	Frequency	Purpose
Bias	5/read mode		daily	Master bias and CCD properties
NIR darks		5 per DIT: 2s, 5s, 10s, 15s	daily	Master dark, bad pixels map
Slit flat	20/setting	20/setting	daily	Pixel-to-pixel variations, blaze function correction
Arcs single pinhole	1	1	daily	First guess disp. solution
Flat single pinhole	1	1	daily	Order localization
Arcs multi-pinhole	1	1	daily	Wavelength and spatial scale determination.
Arcs Through slit	1/setting	1/setting	daily	Wavelength shift between multi-pinholes and slits, spectral resolution
Radial velocity standard	1	1	On request	Accurate radial vel. calibration
Telluric standard	2	2	On request	Correct for telluric abs.
Spectrophotometric standard	2	2	daily (twilight)	Response curve, absolute flux calib.



Table 13: SOXS calibration plan summary for imaging observations.

Calibration	AC frames	Frequency	Purpose
Bias	10	daily	Master bias and check CCD bias properties
Sky flats	3/filter	Monthly (or on request)	Pixel-to-pixel response variation
Photometric standards	2	On request	Absolute flux calibration

5.2 Wavelength and spatial scale calibration

As described in sections 3.3.1, the spectral format of SOXS is relatively complex with curved orders (NIR), variable line tilt (UV-VIS and NIR), dispersion and spatial scale along each order (UV-VIS and NIR). Using just long slit arc spectra is not sufficient because it is essential to also calibrate the change of spatial scale.

Wavelength and spatial scale are well calibrated simultaneously with a dedicated mask of 9 equidistant pinholes present in each slit unit, in combination with the ThAr lamp. Exposure time for each arm is given in Table 14. An example of such frames is given in Figure 17. The templates used for this calibration are *SOXS_slit_cal_VISArcsMultiplePinhole* and *SOXS_slit_cal_NIRArcsMultiplePinhole*.

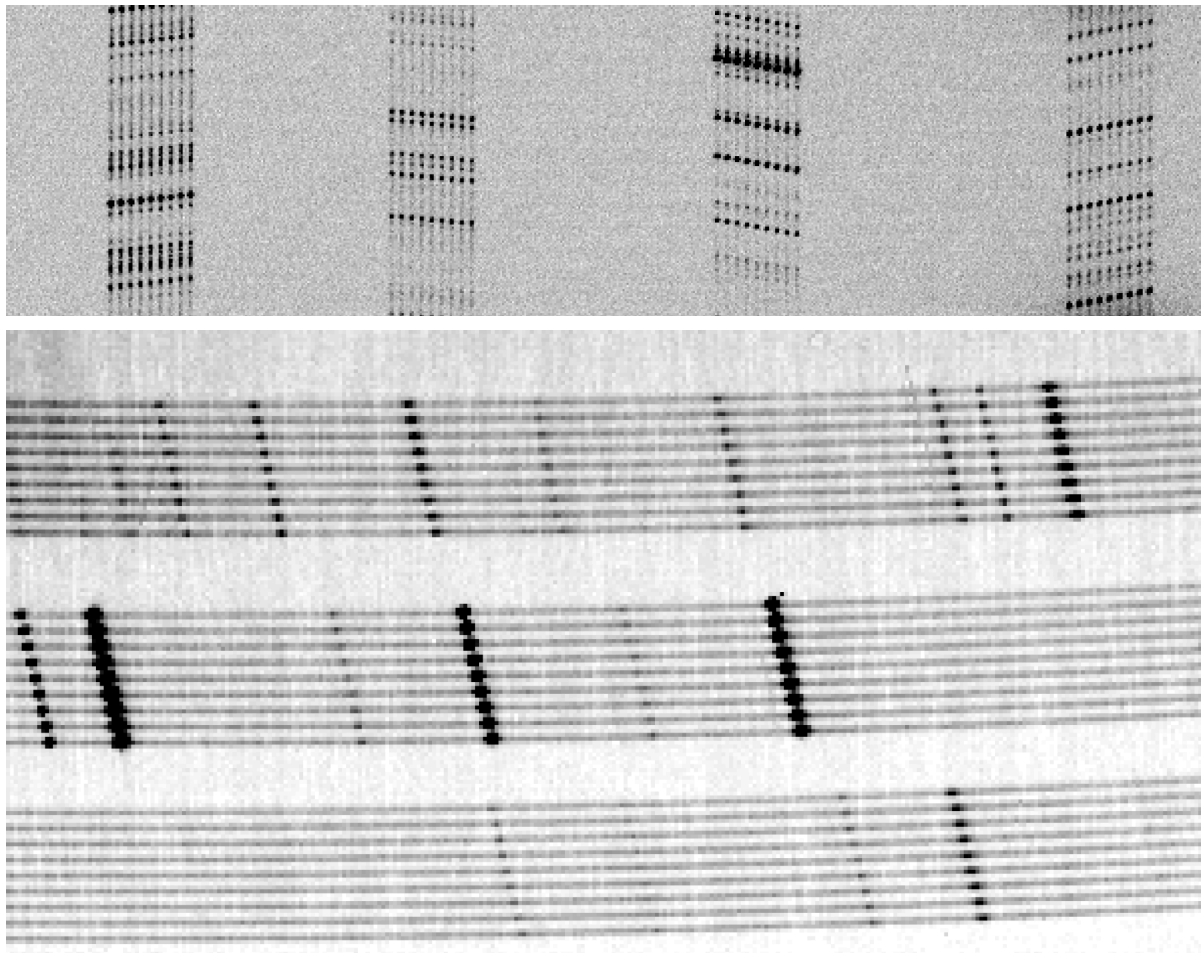


Figure 17: Portion of the 9-pinhole ThAr VIS (top) and NIR (bottom) frame.

Table 14: exposure times for the ThAr (UV-VIS) and ArHgNeXe (NIR) arc frames.

UV-VIS	NIR
Slit 0.5" 20s	Slit 0.5" 5s
Slit 1.0" 15s	Slit 1.0" 4s
Slit 1.5" 10s	Slit 1.5" 3s
Pinhole 30s	Pinhole 15s
9-pinhole 30s	9-pinhole 15s



5.3 Flat-field

Flatfield spectra allow correction for the pixel-to-pixel variations in detector sensitivity as a function of wavelength of the light, and to correct for the structures introduced by imperfections of the slits. They also provide a good correction of the blaze function of the echelle.

For both arms, the QTH halogen lamp is available to give well-exposed, flat continuum spectra at all wavelengths within a reasonably short exposure time (see Table 15).

Table 15: exposure times for the halogen flat field frames.

UV-VIS	NIR
Slit 0.5" 20s	Slit 0.5" 7.5s
Slit 1.0" 10s	Slit 1.0" 3.75s
Slit 1.5" 7s	Slit 1.5" 2.5s
Pinhole 10s	Pinhole 10s
9-pinhole 10s	9-pinhole 10s

5.4 Spectrophotometric calibration

5.4.1 Telluric absorption correction

The visible-red and the near-IR part of the spectrum are strongly affected by the absorption lines of the Earth's atmosphere. Many of these telluric lines do not scale linearly with airmass, so it is necessary to observe a star with a well-known spectrum at the same airmass and with the same instrument setup as that used for the science target. Furthermore, the strength of the telluric lines varies with time, so it is also necessary to observe the telluric standard soon after or soon before the science observation. Two templates are designed for this purpose: `SOXS_slit_cal_TelluricStdNod`, `SOXS_slit_cal_TelluricStdStare`.

However, after a first period of commissioning and testing, routine telluric correction will be carried out with dedicated software packages (e.g. *MolecFit*²).

5.4.2 Absolute flux calibration

Spectrophotometric standard stars can be used to obtain the absolute efficiency of the instrument and derive an absolute flux calibration of the science data. These observations are done with the wide 5.0" slit with the dedicated templates `SOXS_slit_cal_SpecphotStdNod`, `SOXS_slit_cal_SpecphotStdStare`.

² <https://www.eso.org/sci/software/pipelines/skytools/molecfit>



The set of spectrophotometric standard stars used for the same purpose with the ESO X-shooter spectrograph³ is perfectly suitable for SOXS, covering the same spectral range.

5.4.3 The SOXS pipeline

The SOXS data reduction pipeline⁴ [RD 2] is being developed and tested. It is expected to be fully ready by the start of operations. It will deliver the following products:

- Sky subtracted, cosmic ray hits cleaned, flux and wavelength calibrated 2D spectra, rectified to a regular grid in wavelength and spatial directions. 1D extracted spectra will be produced whenever a bright enough object is detected.
- Additional products to verify the quality of the results, a set of Quality Control parameters, an instrument health check and trend analysis.

6 Reference material

6.1 Templates reference

In the following sections, all the currently defined SOXS templates are listed with their free and fixed parameters. When using the p2ls⁵ tool, the user has to fill only the fields (keywords) shown on a white background in the following tables. Keywords shown on a grey background colour are fixed within the template itself and can only be modified by the astronomer operating the instrument during the night or during daytime calibration activities.

6.1.1 Orientation and conventions

SOXS follows the standard astronomical orientation and offset conventions and definition.

The positive position angle (PA) is defined from North to East. Offsets are always given in arc seconds, but the reference system can be chosen to be the sky (Alpha, Delta) or the SOXS slit coordinate system (X, Y). As can be seen from Fig. 18, an offset of 90 deg - PA must be applied to position the slit along a given position angle. The slit can be aligned along the parallactic angle (calculated at the start of the OB) automatically by specifying a value of 9999 for the Rotator Offset Angle in the acquisition templates.

³ https://www.eso.org/sci/facilities/paranal/instruments/xshooter/tools/specphot_list.html

⁴ <https://soxspipe.readthedocs.io/en/main/>

⁵ <https://www.eso.org/p2ls/home>

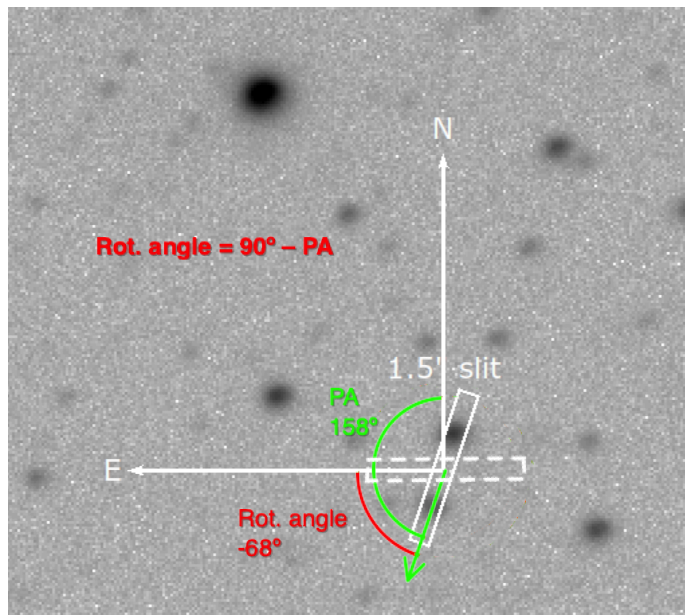


Figure 18: The slit coordinate system. A positive offset in the x or y direction will move the object in the direction of the +x or +y axis.

Templates use cumulative offsets: the position at a given time is derived from the sum of all offsets specified so far in the template. For example, the series of offsets: 0, -10, 0, 10 brings the telescope back to the original position for the last exposure. This example could have been, for instance, the definition of a series in which we define an exposure on an object, followed by two sky exposures at -10" of the original position, before pointing back on the object for the fourth exposure.



6.1.2 Acquisition templates

Slit acquisition templates

We encourage the users to select the filter in which the target is best visible and to use the shortest possible acquisition exposure time for a minimum acquisition overhead.

SOXS_slit_acq			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.TIME	no	0..3600 (1.0)	ACQ Exposure time
INS.ACFW.NAME	no	SDSS-u SDSS-g SDSS-r SDSSi SDSS-z VIMOS-Y VIMOS-V FREE (SDSS-u)	Filter Wheel
SEQ.PRESET	no	F T (T)	Preset flag
TEL.AG.GUIDESTAR	no	CATALOGUE SETUPFILE NONE (CATALOGUE)	Get Guide Star from
TEL.GS1.ALPHA	no	ra (0)	RA of guide star
TEL.GS1.DELTA	no	dec (0)	DEC of guide star
TEL.ROT.OFFANGLE	no	-179.99..179.99 9999.0 (0.0)	Position Angle on Sky
TEL.TARG.ADDVELALPHA	no	(0.0)	Additional Velocity RA in arcsec/s on the sky
TEL.TARG.ADDVELDELTA	no	(0.0)	Additional Velocity DEC in arcsec/s on the sky
TEL.TARG.ALPHA	no	0..240000 (170000.000)	RA
TEL.TARG.DELTA	no	-900000..900000 (-870000.000)	DEC
TEL.TARG.EPOCH	no	1950 2050 (2000)	Epoch
TEL.TARG.EQUINOX	no	QUERY-TARG getEquinoxList (2000)	Equinox
TEL.TARG.OFFSETALPHA	no	(0.)	Offset RA
TEL.TARG.OFFSETDELTA	no	(0.)	Offset DEC
TEL.TARG.PMA	no	-10..10 (0)	Proper motion in RA
TEL.TARG.PMD	no	-10..10 (0)	Proper motion in DEC
TEL.TRACK.WLEN	no	350..1800 (650)	Wavelength for target centering and tracking
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	ACQUISITION	Data Product Category
DPR.TECH	no	ECHELLE	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



6.1.3 Science templates

Slit observations

SOXS_slit_obs_Stare			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,STARE	Data Product Technique
DPR.TYPE	no	OBJECT,ASYNC	Data Product Type



SOXS_slit_obs_StareSynchro			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,STARE	Data Product Technique
DPR.TYPE	no	OBJECT,SYNC	Data Product Type



SOXS_slit_obs_AutoNodOnSlit			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.JITTER.WIDTH	no	0..2 (1)	Width of the jitter box (arcsec)
SEQ.NCYCLE	no	1..300 (1)	Number of cycles
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
SEQ.NOD.THROW	no	1..10 (6)	Nod throw length (arcsec)
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,NODDING	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



SOXS_slit_obs_FixedSkyOffset			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.FIXOFF.DEC	no	-100..100 (1)	Fixed DEC offset (arcsec)
SEQ.FIXOFF.RA	no	-100..100 (1)	Fixed RA offset (arcsec)
SEQ.JITTER.WIDTH	no	0..2 (1)	Width of the jitter box (arcsec)
SEQ.NCYCLE	no	1..300 (1)	Number of cycles
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,OFFSET	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



SOXS_slit_obs_GenericOffset			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (1)	Number of exposures for VIS
SEQ.OBS.TYPE	no	0 S (0 S 0 S)	List of TYPE of images at each offsets
SEQ.OFFSET.COORDS	no	SKY SLIT (SKY)	Offset coord type (RA/DEC - X/Y) in arcsec
SEQ.RELOFF1	no	-1000..1000 (1 3 5 7)	List of RA/X offsets
SEQ.RELOFF2	no	-1000..1000 (2 4 6 8)	List of DEC/Y offsets
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,GENOFFSET	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



SOXS_slit_obs_Mapping			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT.LIST	no	0..3600 (1 1 1)	NIR Exposure time (DIT)
DET1.NDIT.LIST	no	1..20 (1 1 1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1.LIST	no	0..3600 (1 1 1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR.LIST	no	0..200 (1 1 1)	Number of exposures for NIR
SEQ.NEXPO.VIS.LIST	no	0..200 (1 1 1)	Number of exposures for VIS
SEQ.OBS.TYPE	no	O S (O O S)	List of TYPE of images at each offsets
SEQ.OFFSET.COORDS	no	SKY SLIT (SKY)	Offset coord type (RA/DEC - X/Y) in arcsec
SEQ.RELOFF1	no	-1000..1000 (5 0 5)	List of RA/X offsets
SEQ.RELOFF2	no	-1000..1000 (0 5 5)	List of DEC/Y offsets
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,MAP	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



6.1.4 Night-time calibration templates

Spectro-photometric Standard Stars

SOXS_slit_cal_SpecphotStdStare			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,STARE	Data Product Technique
DPR.TYPE	no	STD,FLUX	Data Product Type



SOXS_slit_cal_SpecphotNod			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.JITTER.WIDTH	no	0..2 (1)	Width of the jitter box (arcsec)
SEQ.NCYCLE	no	1..300 (1)	Number of cycles
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
SEQ.NOD.THROW	no	1..10 (6)	Nod throw length (arcsec)
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,NODDING	Data Product Technique
DPR.TYPE	no	STD,FLUX	Data Product Type



SOXS_slit_cal_SpecphotStdOffset			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.FIXOFF.DEC	no	-100..100 (1)	Fixed DEC offset (arcsec)
SEQ.FIXOFF.RA	no	-100..100 (1)	Fixed RA offset (arcsec)
SEQ.JITTER.WIDTH	no	0..2 (1)	Width of the jitter box (arcsec)
SEQ.NCYCLE	no	1..300 (1)	Number of cycles
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,OFFSET	Data Product Technique
DPR.TYPE	no	STD,FLUX	Data Product Type



SOXS_slit_cal_TelluricStdStare			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,STARE	Data Product Technique
DPR.TYPE	no	STD,TELLURIC	Data Product Type



SOXS_slit_cal_TelluricStdNod			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (1)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.JITTER.WIDTH	no	0..2 (1)	Width of the jitter box (arcsec)
SEQ.NCYCLE	no	1..300 (1)	Number of cycles
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
SEQ.NOD.THROW	no	1..10 (6)	Nod throw length (arcsec)
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT,NODDING	Data Product Technique
DPR.TYPE	no	STD,TELLURIC	Data Product Type



Attached night calibrations

These must be taken after the science template in order to have the correct instrument setup.

SOXS_slit_cal_LampFlatAtt			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,FLAT,ATT	Data Product Type



SOXS_slit_cal_VISArcsAtt			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,WAVE,ATT	Data Product Type

SOXS_slit_cal_NIRArcsAtt			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (2)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,WAVE,ATT	Data Product Type



To achieve a better wavelength calibration, it is possible to attach ARC multipinhole templates.

SOXS_slit_cal_VISArcsMultiplePinhole			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,MULTI-PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type

SOXS_slit_cal_NIRArcsMultiplePinhole			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (2)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,MULTI-PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type



6.1.5 Daytime calibration templates

Arc lamp calibrations

SOXS_slit_cal_VISArcs			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type

SOXS_slit_cal_NIRArcs			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (2)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type



Flatfield

SOXS_slit_cal_LampFlat			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
INS.NISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN BLANK (SLIT1.0)	NIR slit exchanger
INS.VISE.NAME	no	SLIT0.5 SLIT1.0 SLIT1.5 SLIT5.0 PINHOLE MULTPIN SLTVIEW (SLIT1.0)	VIS slit exchanger
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,SLIT	Data Product Technique
DPR.TYPE	no	LAMP,FLAT	Data Product Type



Format check

SOXS_slit_cal_VISArcsPinhole			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
SEQ.NEXPO	no	1..100 (1)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type

SOXS_slit_cal_NIRArcsPinhole			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (2)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
SEQ.NEXPO	no	1..100 (1)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type



Order definition

SOXS_slc_cal_LampFlatPinhole			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
SEQ.NEXPO.NIR	no	0..200 (1)	Number of exposures for NIR
SEQ.NEXPO.VIS	no	0..200 (2)	Number of exposures for VIS
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,FLAT	Data Product Type



Arcs multi-pinhole: wave maps

SOXS_slit_cal_VISArcsMultiplePinhole			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
DET2.UIT1	no	0..3600 (2)	VIS Exposure time
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,MULTI-PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type

SOXS_slit_cal_NIRArcsMultiplePinhole			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (2)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	ECHELLE,MULTI-PINHOLE	Data Product Technique
DPR.TYPE	no	LAMP,WAVE	Data Product Type



Detector calibrations

SOXS_gen_cal_VISBias			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET2.BINX	no	1..2 (1)	VIS X binning
DET2.BINY	no	1..2 (1)	VIS Y binning
DET2.MODE.CURID	no	1..2 (1)	VIS readout mode id
SEQ.NEXPO	no	1..100 (3)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	BIAS	Data Product Type

SOXS_gen_cal_NIRDark			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET1.DIT	no	0..3600 (1)	NIR Exposure time (DIT)
DET1.NDIT	no	1..20 (1)	Num of NIR sub-integrations (NDIT)
SEQ.NEXPO	no	1..100 (3)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	DARK	Data Product Type



6.1.6 Imaging templates

SOXS_img_acq			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.TIME	no	0..3600 (1.0)	ACQ Exposure time
INS.ACFW.NAME	no	SDSS-u SDSS-g SDSS-r SDSSi SDSS-z VIMOS-Y VIMOS-V FREE (SDSS-u)	Filter Wheel
SEQ.PRESET	no	F T (T)	Preset flag
TEL.AG.GUIDESTAR	no	CATALOGUE SETUPFILE NONE (CATALOGUE)	Get Guide Star from
TEL.GS1.ALPHA	no	ra (0)	RA of guide star
TEL.GS1.DELTA	no	dec (0)	DEC of guide star
TEL.ROT.OFFANGLE	no	-179.99..179.99 9999.0 (0.0)	Position Angle on Sky
TEL.TARG.ADDVELALPHA	no	(0.0)	Additional Velocity RA in arcsec/s on the sky
TEL.TARG.ADDVELDELTA	no	(0.0)	Additional Velocity DEC in arcsec/s on the sky
TEL.TARG.ALPHA	no	0..240000 (170000.000)	RA
TEL.TARG.DELTA	no	-900000..900000 (-870000.000)	DEC
TEL.TARG.EPOCH	no	1950 2050 (2000)	Epoch
TEL.TARG.EQUINOX	no	QUERY-TARG getEquinoxList (2000)	Equinox
TEL.TARG.OFFSETALPHA	no	(0.)	Offset RA
TEL.TARG.OFFSETDELTA	no	(0.)	Offset DEC
TEL.TARG.PMA	no	-10..10 (0)	Proper motion in RA
TEL.TARG.PMD	no	-10..10 (0)	Proper motion in DEC
TEL.TRACK.WLEN	no	350..1800 (650)	Wavelength for target centering and tracking
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	ACQUISITION	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



SOXS_img_obs			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.TIME	no	0..3600 (1.0)	ACQ Exposure time
INS.ACFW.NAME	no	SDSS-u SDSS-g SDSS-r SDSSi SDSS-z VIMOS-Y VIMOS-V FREE (SDSS-u)	Filter Wheel
SEQ.NEXPO	no	1..100 (1)	Number of exposures
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type

SOXS_img_obs_GenericOffset			
<i>To be specified:</i>			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.TIME	no	0..3600 (1.0)	ACQ Exposure time
INS.ACFW.NAME	no	SDSS-u SDSS-g SDSS-r SDSSi SDSS-z VIMOS-Y VIMOS-V FREE (SDSS-u)	Filter Wheel
SEQ.NEXPO	no	1..100 (1)	Number of exposures
SEQ.OBS.TYPE	no	O S (O S O S)	List of TYPE of images at each offsets
SEQ.OFFSET.COORDS	no	SKY SLIT (SKY)	Offset coord type (RA/DEC - X/Y) in arcsec
SEQ.RELOFF1	no	-1000..1000 (1 3 5 7)	List of RA/X offsets
SEQ.RELOFF2	no	-1000..1000 (2 4 6 8)	List of DEC/Y offsets
TEL.RETURN	no	T F (T)	Go to zero offset position at the end
<i>Fixed values:</i>			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	SCIENCE	Data Product Category
DPR.TECH	no	IMAGE,OFFSET,POINT	Data Product Technique
DPR.TYPE	no	OBJECT	Data Product Type



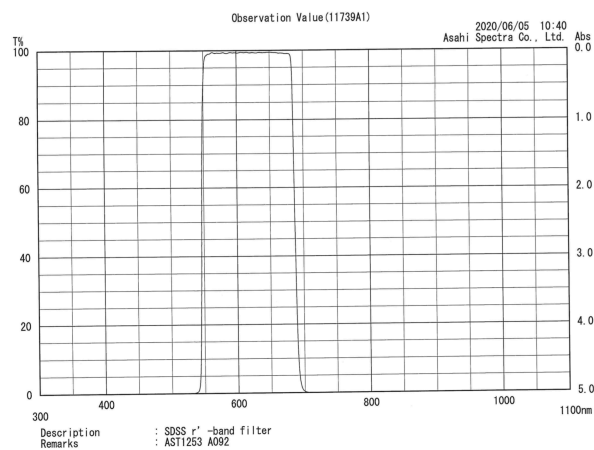
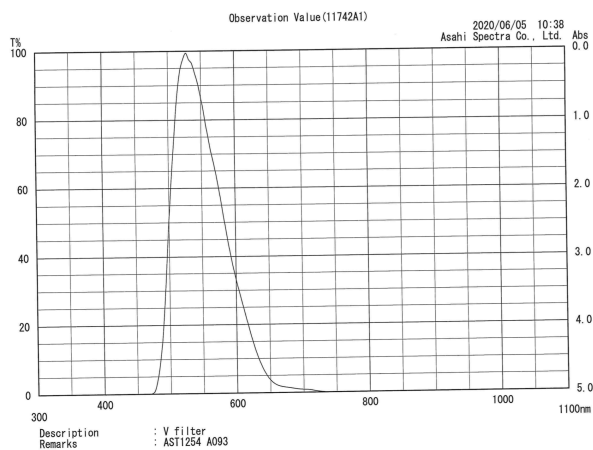
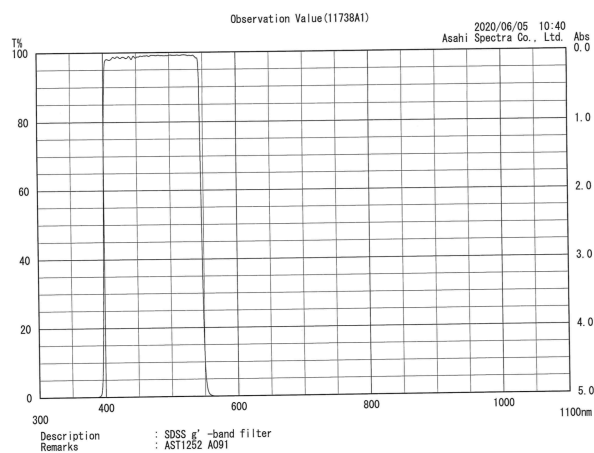
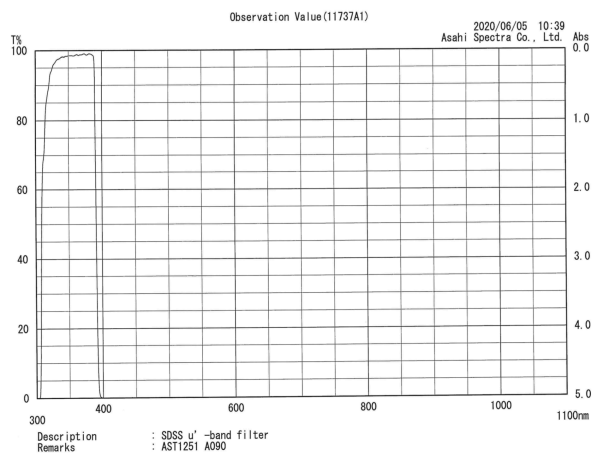
SOXS_img_cal_Bias			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
SEQ.NEXPO	no	1..100 (3)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	BIAS	Data Product Type

SOXS_img_cal_Dark			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.TIME	no	0..3600 (1.0)	ACQ Exposure time
SEQ.NEXPO	no	1..100 (3)	Number of exposures
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	DARK	Data Product Type

SOXS_img_cal_SkyFlat			
To be specified:			
Header Keyword	Hidden	Range (Default)	Parameter
DET3.EXPO.LEVEL	no	1..55000 (35000)	ACQ Exposure time Filter Wheel
DET3.EXPO.TIME	no	0..3600 (1)	
INS.ACFW.NAME	no	SDSS-u SDSS-g SDSS-r SDSSi SDSS-z VIMOS-Y VIMOS-V FREE (SDSS-u)	
SEQ.NEXPO	no	1..100 (3)	Number of exposures
TEL.TARG.OFFSETSIZE	no	0..100 (30)	
Fixed values:			
Header Keyword	Hidden	Value	Parameter
DPR.CATG	no	CALIB	Data Product Category
DPR.TECH	no	IMAGE	Data Product Technique
DPR.TYPE	no	FLAT,SKY	Data Product Type



6.2 Acquisition Camera filter curves





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