

Report on the ESO workshop

# SOXS Day

held at ESO Headquarters, Garching, Germany, 1 July 2025

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A workshop was held at ESO Headquarters in Garching to introduce the newly installed and currently commissioned Son Of X-Shooter (SOXS) spectrograph. SOXS will be a new instrument on ESO's New Technology Telescope dedicated primarily to transient astrophysics, with the aim of spectroscopically following up on the events discovered by current and new all-sky surveys. The main objectives of the workshop were to present the instrument to the community, showcase its operational model, observational sequence, and guaranteed-time observation (GTO) areas. In addition to highlighting SOXS's technical capabilities and scientific prospects, the workshop also addressed operational policies in preparation for when SOXS will be offered to the community.

## The SOXS spectrograph

Son Of X-Shooter (SOXS)<sup>1,2</sup> is a compact and highly efficient instrument inspired by the well-known X-shooter spectrograph, currently in use on the Very Large Telescope. Developed through an international collaboration primarily led by the INAF research network in Italy, under the direction of Sergio Campana, the project also involves significant contributions from teams in Israel, the UK, Finland, Chile, and Denmark. Following a mutual agreement between the consortium and ESO, SOXS is being commissioned on ESO's New Technology Telescope (NTT) at the La Silla Observatory, which will then be dedicated to SOXS science in the years to come.

Designed along similar lines to X-shooter, SOXS can simultaneously observe across a wide spectral range — from the ultraviolet to the near-infrared. This makes it a powerful addition to the group of instruments working on telescopes of comparable size, enabling observations of transients over a wide brightness range along

with a fine analysis of their spectral features. SOXS will cover wavelength ranges between 350 and 2000 nm in medium to high resolution ( $R > 4000$  using a 1-arcsecond slit)<sup>3</sup>, which, combined with the 3.5-metre mirror of the NTT, will permit probing transients as faint as 20th magnitude or more.

The workshop held in Garching was motivated by the arrival of SOXS at La Silla earlier this spring, since when it has been installed at the Nasmyth focus of the NTT (Figure 1). The on-sky commissioning is currently underway. With the NTT transitioning to support SOXS as its primary spectroscopic instrument, it is important to update the community on SOXS's scientific capabilities, objectives and operation model.

## Workshop topics and discussions

The workshop featured a broad range of presentations focused on various aspects of the SOXS project, as well as the status of the commissioning process itself<sup>4</sup>.

The workshop started with a presentation by Celine Peroux, ESO VLT Programme Scientist, giving a brief overview of the status and concept of the instrument. SOXS is part of a campaign in which the community was invited to invest funding and expertise in installing and operating new instruments, in exchange for guaranteed observing time. Such a scheme is already in place and will be implemented further on other ESO telescopes in future. In this case, the selected SOXS consortium was rewarded by the granting of 900 nights of Guaranteed Time Observations (GTO) over five years.

Given that SOXS will observe for both GTO and community programmes during its first years of observations, extensive policies have been devised and agreed upon to describe the protected science of transient targets. Markus Schöller, ESO Project Scientist, presented these policies at the workshop. Given that SOXS will be an instrument for transient astrophysics, it will mainly operate in Target-of-Opportunity (ToO) mode, for which each of the investigators of active proposals will be able to submit targets to observe. As ESO and the consortium agreed, the

GTO programmes will protect science areas, instead of blocking specific targets or objects, which are then agreed upon and published in advance, allowing the community to propose in non-overlapping areas. While ESO will oversee the observations, the consortium will be in charge of operating SOXS on a daily basis.

Pietro Schipani, Project Manager of SOXS, provided an overview of the instrument's design and performance. The visual spectrograph employs a modern optical layout using dichroics and custom ion-etched gratings, developed and assembled by the Weizmann Institute (Israel) under the supervision of Sagi Ben-Ami, to produce a long-slit spectrum divided into four wavelength ranges — combining high efficiency while allowing for a compact layout (Schipani et al., 2016). A companion near-infrared spectrograph built by INAF, which follows an echelle design similar to X-shooter, completes SOXS's spectroscopic capabilities. In addition to spectroscopy, SOXS includes an acquisition camera built by the Chilean node that can be used for photometric follow-up in the optical bands as well.

Marco Landoni, responsible for the SOXS scheduler tool, presented how the ToO observations will be scheduled for SOXS. The planned scheduler allows investigators to submit targets to an automated system, enabling rapid and automated setup of the observing sequence without human intervention, which is ideal for the time-sensitive follow-up of transient phenomena. This capability will offset the fact that SOXS is installed on a 4-metre-class telescope, rather than a larger telescope. While reaching extremely faint transients might not be feasible this way, the rapid follow-up of sources will open up a multitude of scientific avenues.

Paolo D'Avanzo, SOXS Instrument Scientist, presented the planned GTO and topics planned for SOXS, which are defined in four main science areas: peculiar and rare types of supernovae, early-time observations of young supernovae, follow-up of gamma-ray bursts and kilonovae, and selected Milky Way targets such as variable stars and comets. While GTO programmes have priority for triggering observations in specific science areas,

the wider community will be encouraged to submit proposals on complementary scientific topics.

The data from SOXS will be automatically reduced and delivered in a science-ready format in real time, thanks to a pipeline developed by astronomers at Queen's University Belfast and INAF. Stephen Smartt, member of the SOXS Science Board, presented initial results from the pipeline and offered a direct comparison between SOXS and the ESO Faint Object Spectrograph and Camera 2 (EFOSC2) using data taken during the commissioning phase. The results confirmed that SOXS does indeed provide significantly deeper, higher-resolution observations, with further access to a wider selection of science cases. These observations were further compared to the expectations set by the SOXS specific exposure time calculator (ETC)<sup>5</sup>, which was calibrated to the instrument and the NTT following the already established ESO guidelines. The test yielded encouraging results as, while some of the input assumptions will need to be revised during commissioning, the ETC expectations and corresponding observations are in good agreement with one another. Finally, it was mentioned that the SOXS pipeline is developed openly and can already be tested by the community<sup>6</sup>.

Owing to the short duration of the workshop, virtual attendance was made available. In addition to SOXS collaboration members and ESO representatives, a significant number of the transient research community participated either on-site or remotely. In total approximately 80 participants attended the event — a high number of attendees which highlights well the interest in SOXS. This broad engagement was facilitated by the virtual format and the open nature of the meeting. During the workshop, the audience, both on- and offline, participated eagerly in the discussion, showing a strong interest in SOXS and the future observations with NTT.

### Summary and next steps

The workshop highlighted SOXS's potential as a versatile, high-performance spectrograph, set to make significant

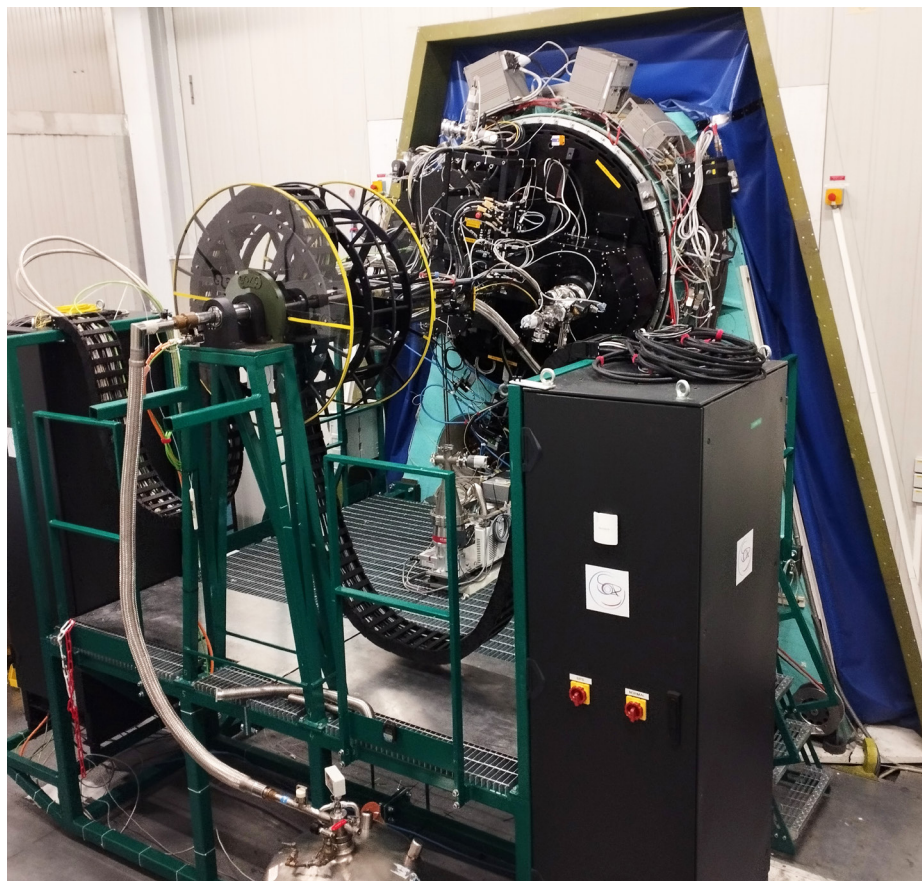


Figure 1. SOXS mounted on the NTT.

contributions to the field of transient astrophysics. The ongoing commissioning phase has already demonstrated the instrument's strong performance and the efficiency of some of its subsystems, both of which are within the technical specifications. In the coming months, the SOXS team and ESO will finalise the instrument's characterisation, validate the observing modes, and test all key components required for its operation, including the exposure time calculator, the scheduler, and the data reduction pipeline, for both the visual and near-infrared channels. Once complete, SOXS will begin observing for the consortium and will also be offered for community proposals. The instrument is expected to be fully available soon, possibly with an alternative call in Period 117, pending successful commissioning of all subsystems. The documents defining the SOXS operational policies and GTO target protection criteria, presented at the SOXS Day, will be made available to the community in due course.

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### References

Schipani, P. et al. 2016, Proc SPIE, 9908, 990841

### Links

- <sup>1</sup> Overview of the SOXS instrument: <https://www.eso.org/sci/facilities/develop/instruments/SoXS.html>
- <sup>2</sup> The SOXS consortium webpage: [http://www.brera.inaf.it/~campana/SOXS/Son\\_of\\_X-Shooter.html](http://www.brera.inaf.it/~campana/SOXS/Son_of_X-Shooter.html)
- <sup>3</sup> Technical specifications of SOXS <https://www.eso.org/sci/facilities/develop/instruments/SoXS.html>
- <sup>4</sup> Link to workshop programme: <https://www.eso.org/sci/meetings/2025/SOXSday.html>
- <sup>5</sup> SOXS exposure time calculator: <http://192.167.38.34/>
- <sup>6</sup> SOXS reduction pipeline code: <https://soxpipe.readthedocs.io/en/master/>