SOXS (Son Of X-Shooter): il cacciatore di transienti

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on behalf of the SOXS team

History

ESO call for new instruments at NTT (06/2014)

Proposal submission (02/2015)

SOXS selected by ESO (05/2015) out of 19

Signed MoU INAF-ESO

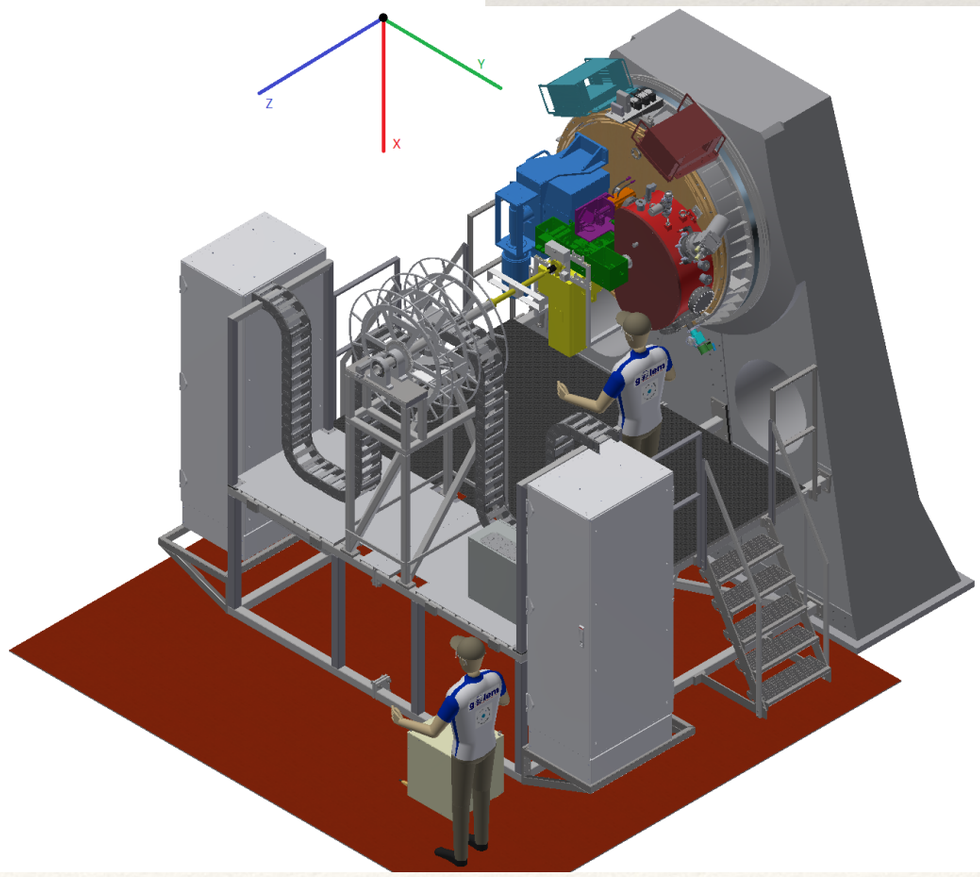
Signed MoU INAF-Partners

Project Phase	Start	End	Duration
Preliminary Design	08/2016	07/2017	12 months
Final Design	08/2017	10/2018	14 months
MAIT	11/2018	02/2022	39 months+COVID
PAE	02/2022	05/2022	3 months
Commissioning & SV & PAC	05/2022	02/2023	9 months
Operations & GTO	2023	2028	

SoXS in a nutshell

Main characteristics

- Broad band spectrograph 350-2000 nm
- R~4,500 (4,000-6,000)
- Two arms (UV-VIS + NIR) 350-850 nm + 800-2000 nm
- Acquisition camera to perform photometry ugrizY (3.5'x3.5', 0.2" pixel)
- S/N~10 spectrum - 1 hr exposure for R_{AB}~20.5



Kulkarni's comparison

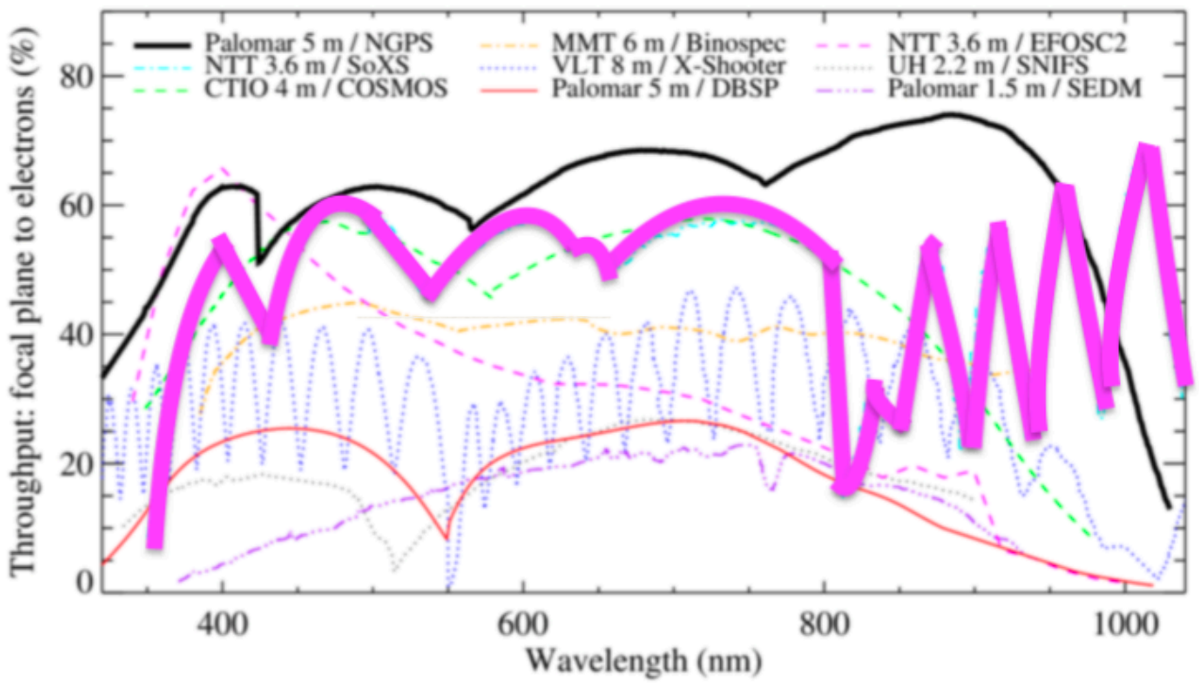


Figure 5. The throughput from the focal plan to photoelectrons of the Next Generation Palomar Spectrograph (NGPS; solid line). The throughput for other spectrographs varies between this measure to "from sky to photoelectrons". References: Son of X-Shooter (SoXS, Claudi et al. 2018, M. Genoni, pers. comm.), COSMOS (Martini et al. 2014), Binospec (Fabricant et al. 2019), X-Shooter (Vernet et al. 2011), DBSP (Oke & Gunn 1982), EFOSC2, which is part of PESSTO (Smartt et al. 2015), SNIFS (Lantz et al. 2004; Lombardo et al. 2017), and SEDM (Blagorodnova et al. 2018). Figure supplied by E. Kirby.

https://arxiv.org/abs/2004.03511

SOXS Consortium

Institutes from 6 Countries

- INAF (OA Brera, Capodimonte, Padova, Roma, Catania, FGG)
- Weizmann Institute (Israel)
- Queen's University Belfast (UK)
- Millenium Institute (Chile)
- Turku Univ. & FINCA (Finland)
- University of Tel Aviv (Israel)
- Neils Bohr Institute & Aarhus

Responsibilities

INAF ~ 49% (CP, NIR-arm, integration, management, etc.)

Wiezmann ~24% (UV-VIS arm optics and mechanics)

QUB ~8% (VIS-CCD, reduction pipeline)

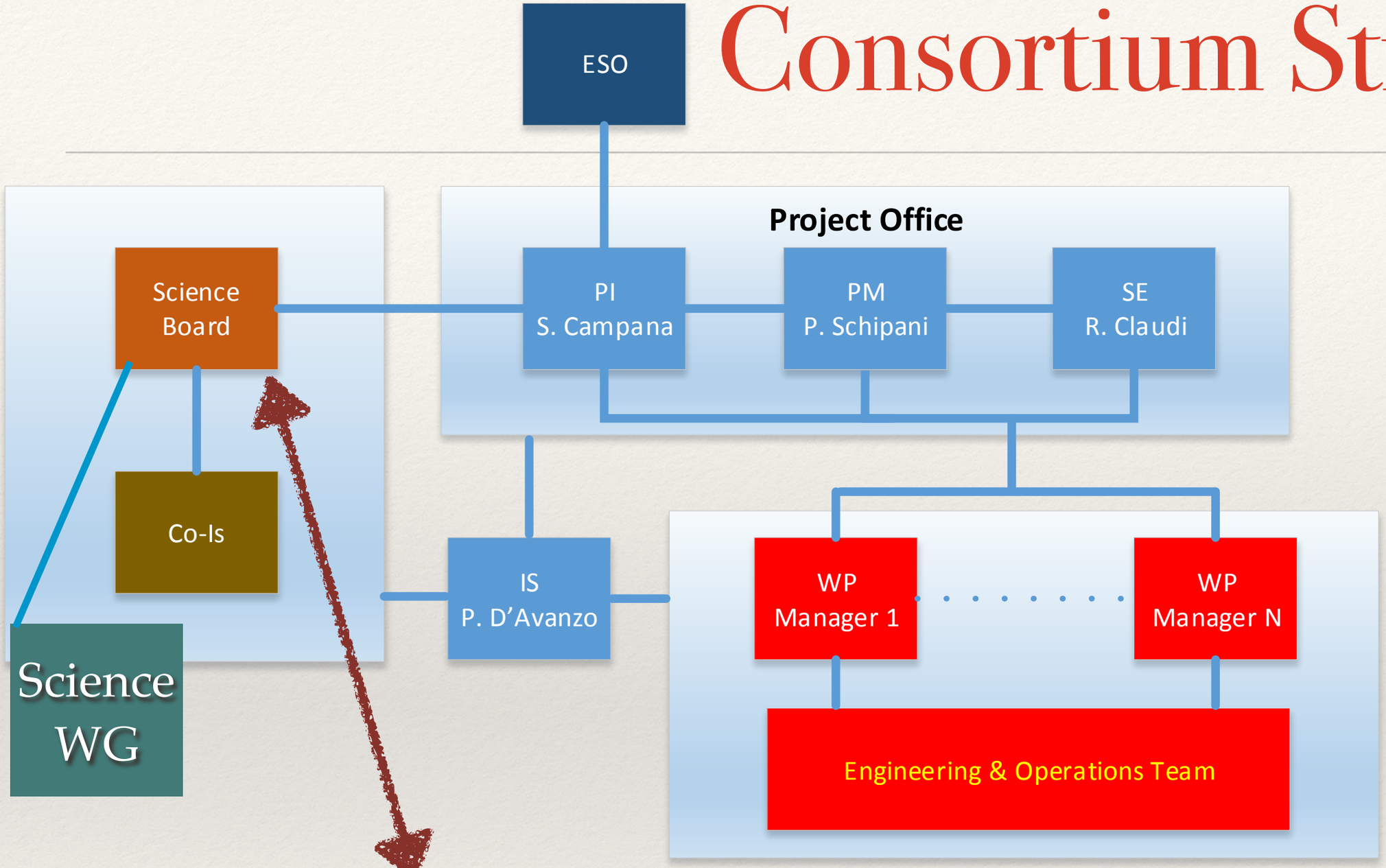
FINCA ~7% (Calibration Unit)

MAS ~6% (Acquisition camera)

Tel Aviv University ~4%

DAWN & Aarhus Univ. ~2%

Consortium Structure



- **E. Cappellaro** (INAF-OAPadova) - Italy
- **M. Della Valle** (INAF-OANapoli) - Italy
- A. Gal-Yam (Weizmann) – Israel
- S. Smartt (Univ. Belfast) – UK
- I. Arcavi (Tel Aviv University) – Israel
- S. Mattila (FINCA) – Finland
- M. Stritzinger (Aarhus U.) – Denmark
- **S. Campana** (INAF-OABrera) - Italy

Science Working Groups

WG	WG Topic	WG Leader	WG Deputy	Number of participants
1	Small bodies and comets	Fitzsimmond	**Dotto**	7/11
2	Stellar variability, exoplanets and Young Stellar Objects	**Pagano**	**Alcalà**	19/20
3	Transient X-ray binaries, magnetars, ultra-luminous	**Casella**	Veledina	16/20
4	Cataclysmic variables, novae and white dwarfs	**Della Valle**	Ben-Ami	5/9
5	Supernovae Ia and thermonuclear transients	Stritzinger	Kotak	4/15
6	Fast and extreme transients (including SLSNe)	Arcavi	Mattila	6/18
7	Intermediate luminosity transients	Kotak	**Pastorello**	9/20
8	Core Collapse Supernovae	Gal-Yam	Pignata	10/23
9	AGN and blazars	**Landoni**	—	11/19
10	Tidal Disruption and Nuclear Events	Mattila	Arcavi	3/10
11	Gamma Ray bursts & Fast radio bursts	**D'Avanzo**	Fynbo	8/10
12	Gravitational wave and neutrino counterparts	**Campana**	Smartt	16/29
13	Classification	**Benetti**	**Botticella**	14/27

Work-Packages

Giovani!

Optics WP Manager - **Matteo Munari** (INAF - Osservatorio astronomico di Catania)

Mechanics WP Manager - **Matteo Aliverti** (INAF - Osservatorio astronomico di Brera)

Electronics WP Manager - **Giulio Capasso** (INAF - Osservatorio astronomico di Capodimonte)

Software WP Manager - **Andrea Baruffolo** (INAF - Osservatorio astronomico di Padova)

Vacuum & Cryogenics WP Manager - **Salvo Scuderi** (INAF - Osservatorio astronomico di Catania)

AIT WP Manager - **Kalyan Radhakrishnan** (INAF - Osservatorio astronomico di Padova)

Instrument Model WP Manager - **Matteo Genoni** (INAF - Osservatorio astronomico di Brera)

VIS Spectrograph WP Manager - Sagi Ben-Ami (Weizmann Institute)

VIS Spectrograph Optics WP Manager - Adam Rubin (Weizmann Institute)

VIS Spectrograph Mechanics WP Manager - Ofir Hershko (Weizmann Institute)

VIS Detector WP Manager - **Rosario Cosentino** (INAF - Osservatorio astronomico di Catania)

NIR Spectrograph WP Manager - **Fabrizio Vitali** (INAF - Osservatorio astronomico di Roma)

NIR WP Manager - **Francesco D'Alessio** (INAF - Osservatorio astronomico di Roma)

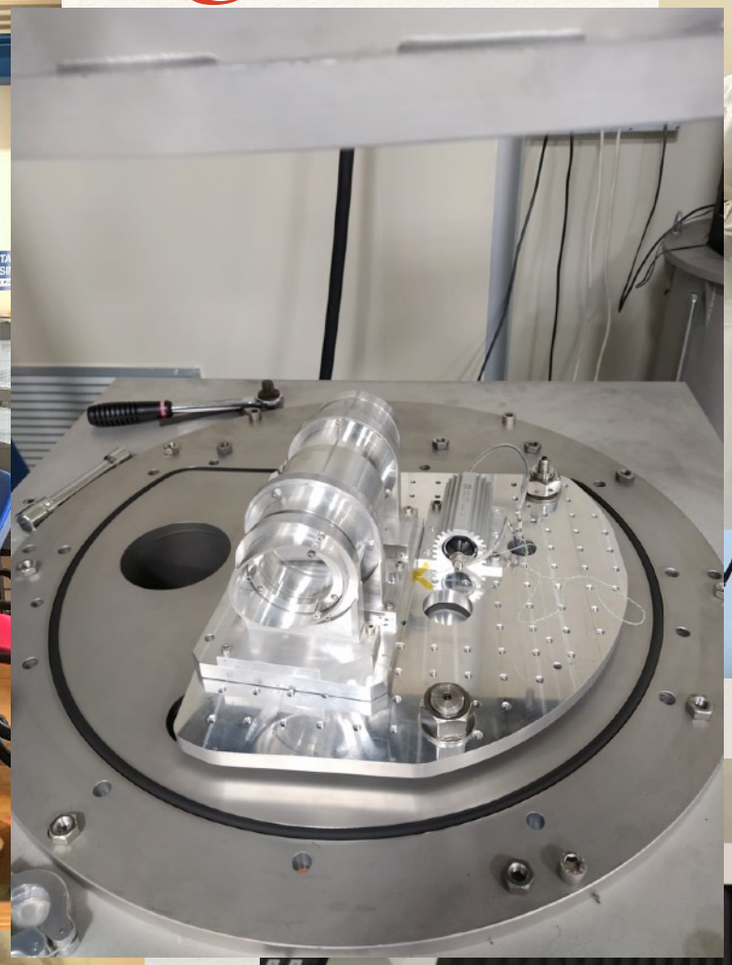
Acquisition Camera WP Manager - Anna Brucalassi (Millenium Institute & INAF)

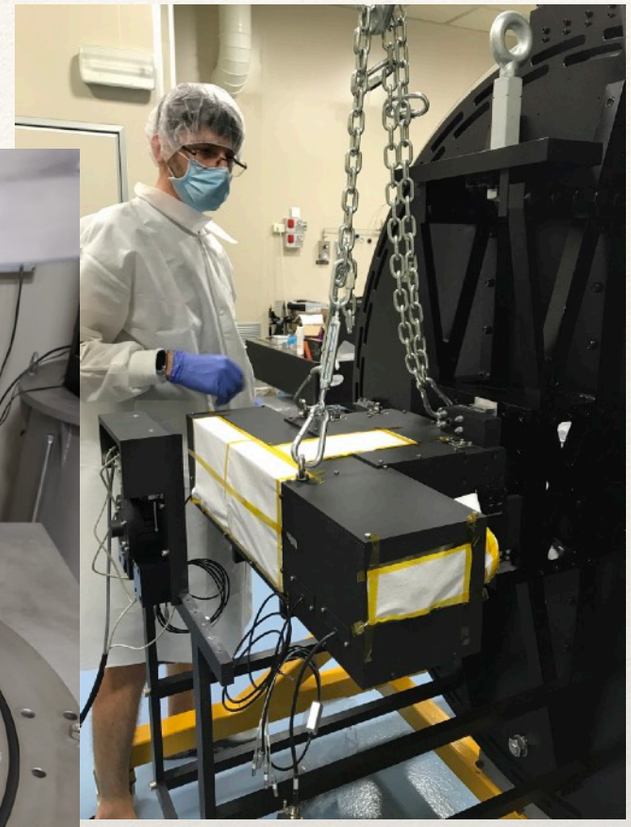
Calibration Unit Optics WP Manager - Haynino Kuncaraycti (Turku University)

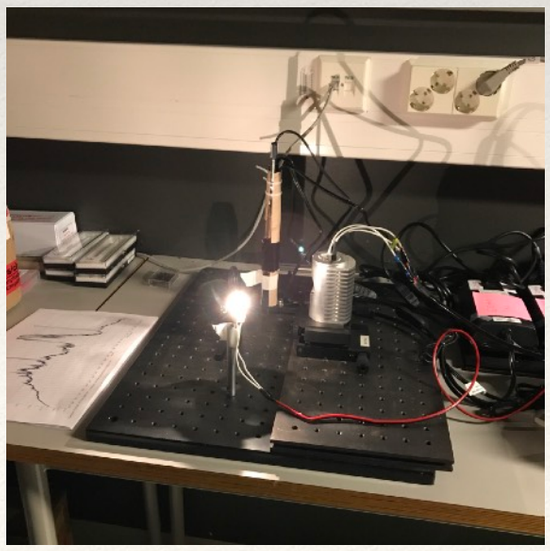
Operations software lead WP Manager - **Marco Landoni** (INAF - Osservatorio astronomico di Brera)

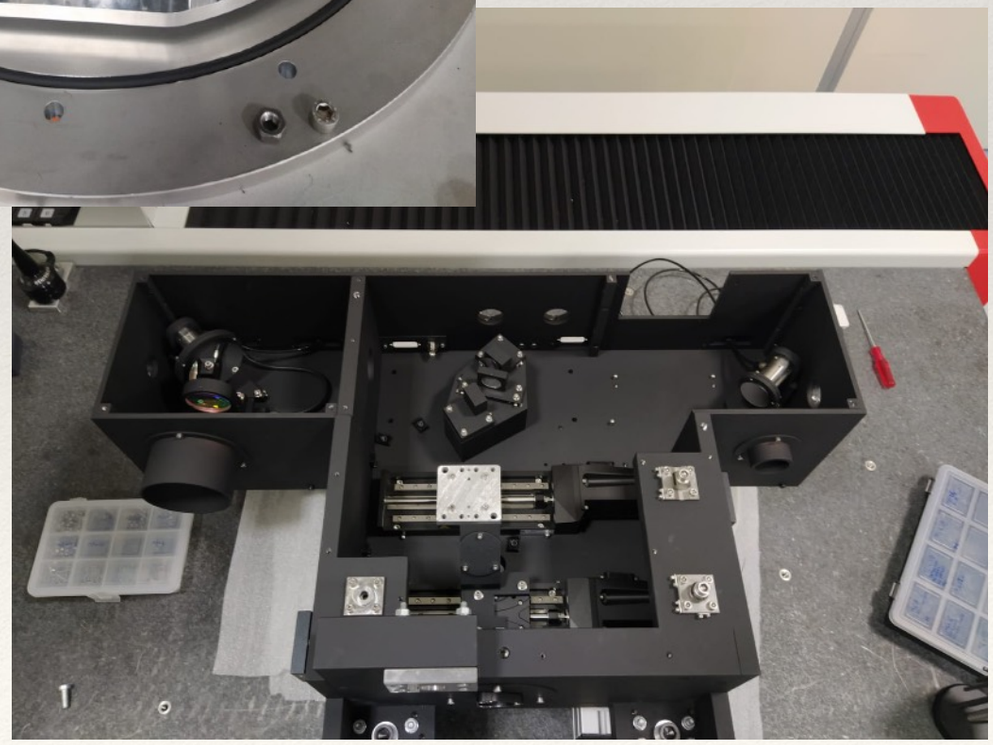
Pipeline WP Manager - David Young (Queens' University Belfast)

Working!









SOXS GTO

- 180 n/yr for 5 yr

- Bad weather shared with ESO

- Time: 8.5 hr * 0.75 eff * 0.9 good *180 n/yr ~ 1000 hr/yr

- SOXS GTO fully dedicated to Target of Opportunity observations for transient and variable sources, very limited time for long term monitoring of variable sources

Integrated approach

SOXS Consortium will manage the entire schedule including ‘SOXS’ time and ‘ESO’ time.

Schedule day-by-day, optimising for into account the Moon, airmass, seeing, water vapour, sky brightness, wind direction constraints. **One SoXS scientist always on duty.**

Possibility to change the observing schedule on the fly.

Overall balance among ESO and SOXS time in terms of dark-grey-bright time, water vapour, seeing, etc.

Mountain operations

After an initial period of training (of people) and instrument (set up and debug), no SOXS scientists will be in La Silla (unless for limited periods).

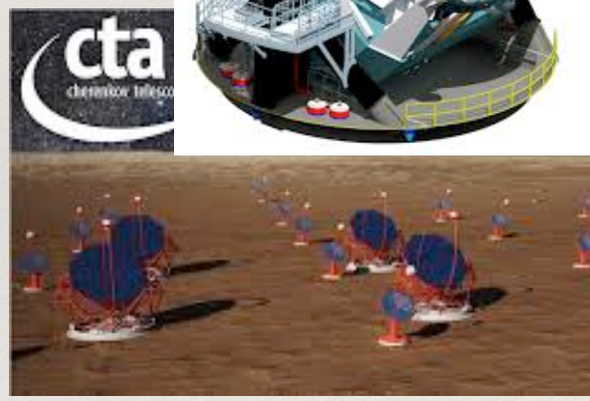
SOXS people
- will prepare the night schedule in advance
- one scientist will remain on-call for problems and for **changing** the schedule in case of unforeseen fast-track events

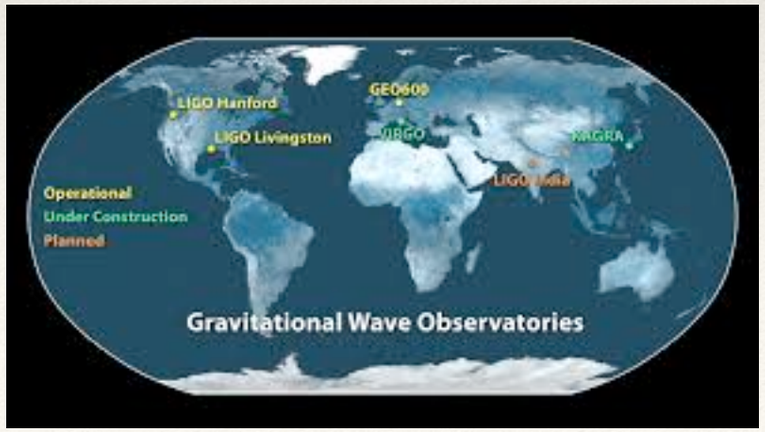
ESO people
- observations are carried out by the night operator at the NTT telescope

Why do we need SOXS

Current & new optical survey: ASAS-SN, ATLAS, ZTF, Rubin/LSST, …
Space optical missions: Gaia, EUCLID, …
Space high-energy missions: Swift, Fermi, eROSITA, SVOM, …
Radio new facilities: MeerKAT, SKA, …
VHE: MAGIC, HESS, Astri, CTA
Messengers: LIGO-Virgo, KM3Net, ANTARES, …

SOXS@NTT will have 180 n/yr (for 5 yr)
~3,000 - 4,000 spectra/yr

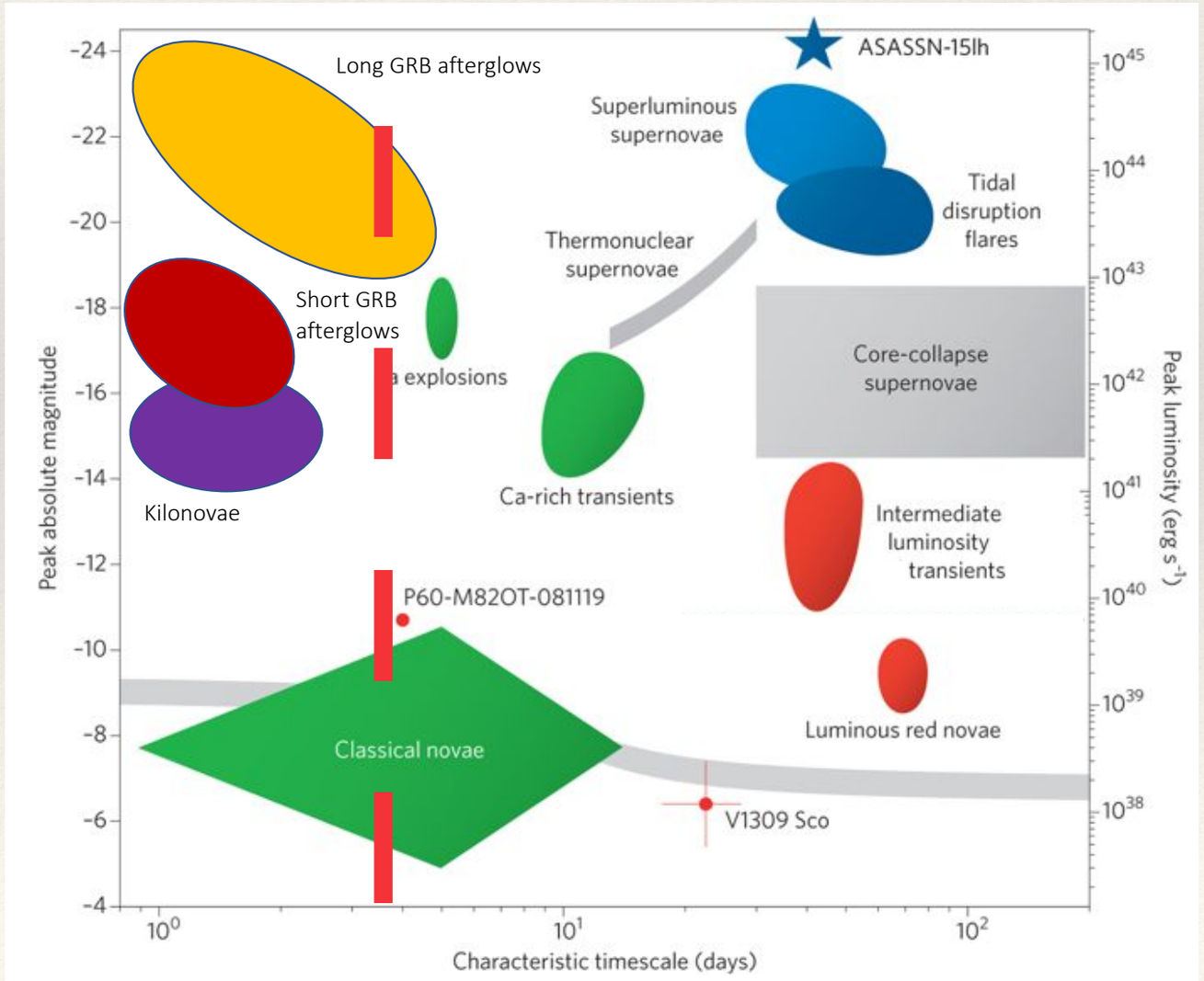




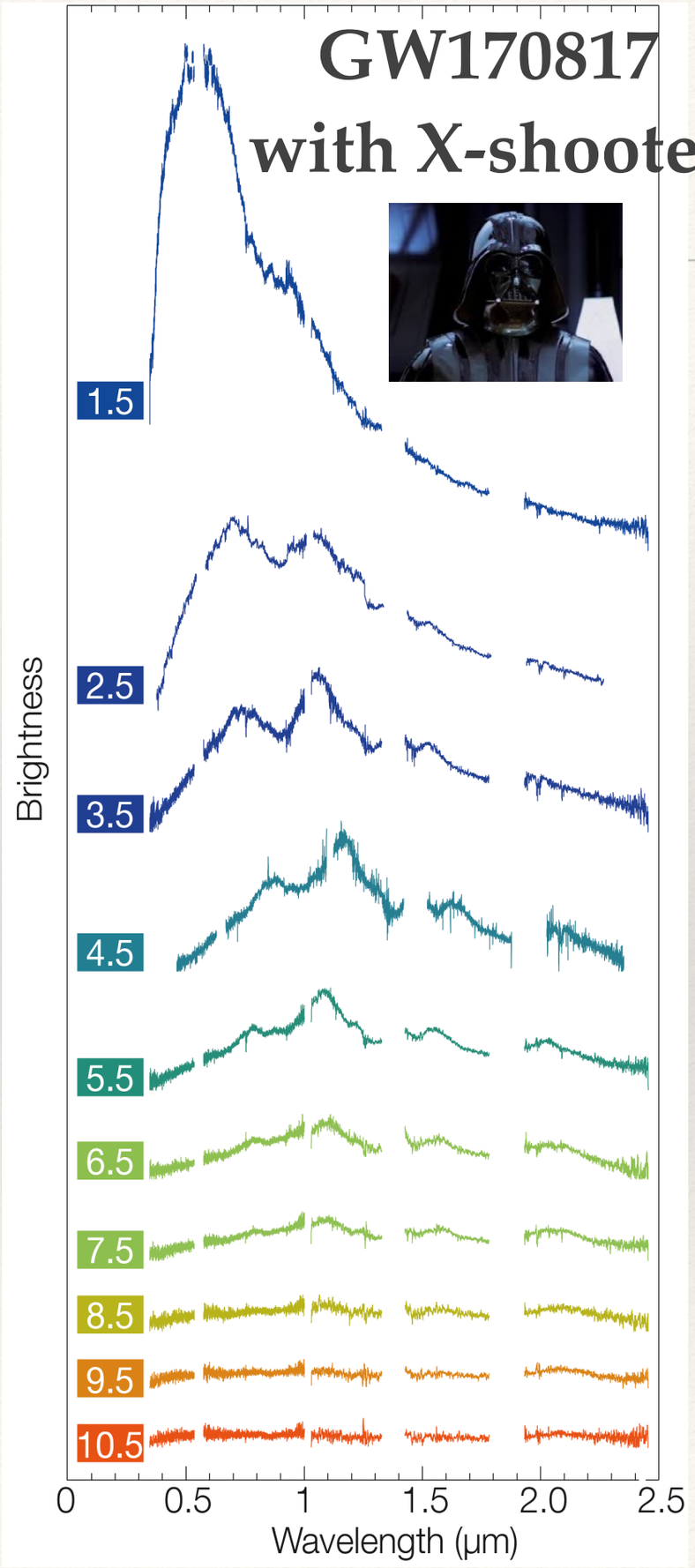
SOXS Science cases

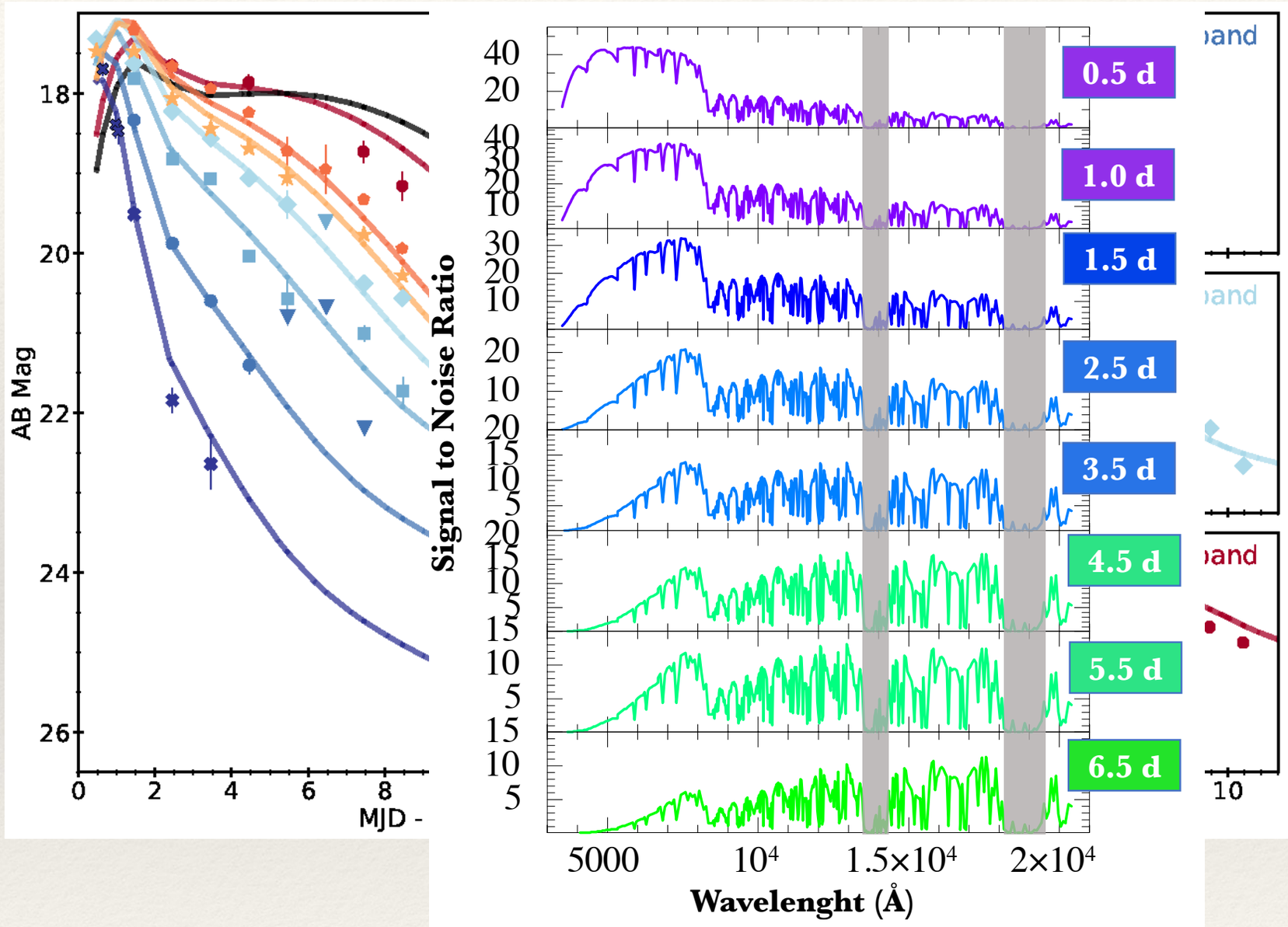
- Classification (service)
- **SN (all flavours)**
- **GW & ν**
- **TDE & Nuclear transients**
- **GRB & FRB**
- X-ray binaries & magnetars
- Novae & WDs
- Asteroids & Comets
- Young Stellar Objects & Stars
- Blazars & AGN
- Unknown

- **Rapid follow-up**
- **Dense monitoring**
- **Always available**



What can SOXS do?





Preliminary SoXS ETC

http://192.167.38.34/

Conclusions

- *Team: 72+4 signed the INAF scheda (only FTE>0)*
- *Time: 9 FTE TI - 6 FTE TD*

- *International project: 50% Italy - Italy leads*
- *Funds: ~500 kE/yr (now at peak, transition from technology to science).*

- *GTO: 180 n/yr for 5 years, fully dedicated to transient and variable sources. SOXS in charge for the NTT operations. Possibility to trigger every night with a fast reaction (~15min on source).*

- *Issues: Need for FTE for the operations*

Thanks