Padova, March 3, 2017

SON OF X-SHOOTER SOXS

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OSSERVATORIO ASTRONOMICO DI BRERA

ON BEHALF OF THE SOXS CONSORTIUM

WHAT IS SOXS?

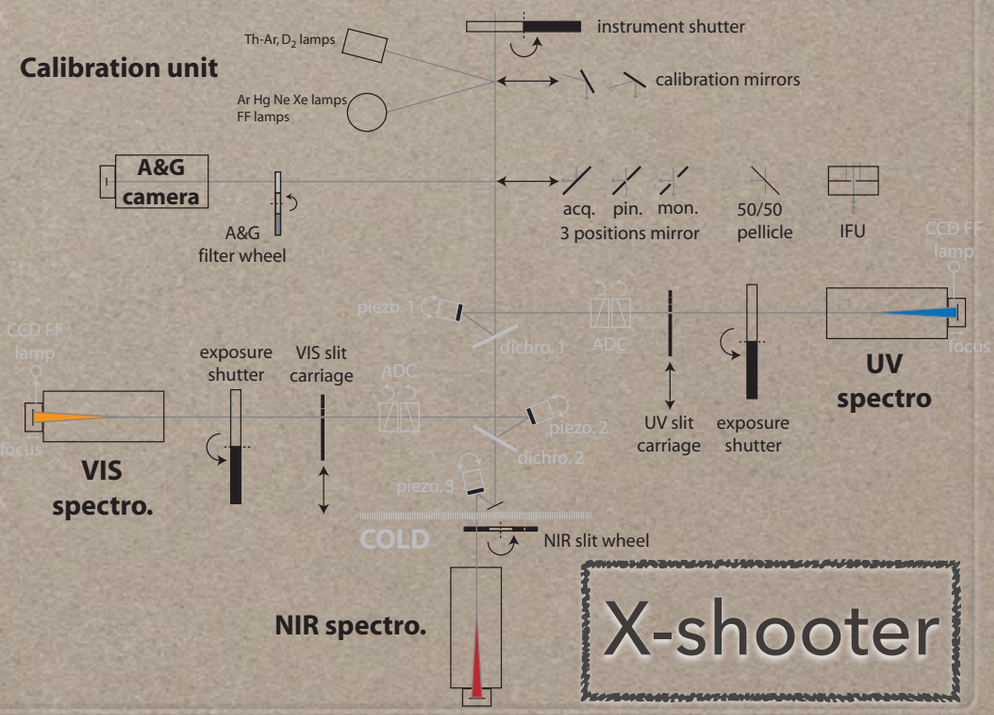
ESO call for new instruments at NTT (06/2014)

Proposal submission (02/2015)

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

Single-object spectrograph R~4,500 from U to H (350-1750 nm) @ ESO/NTT
1 hr - SNR~10 - R~20-20.5

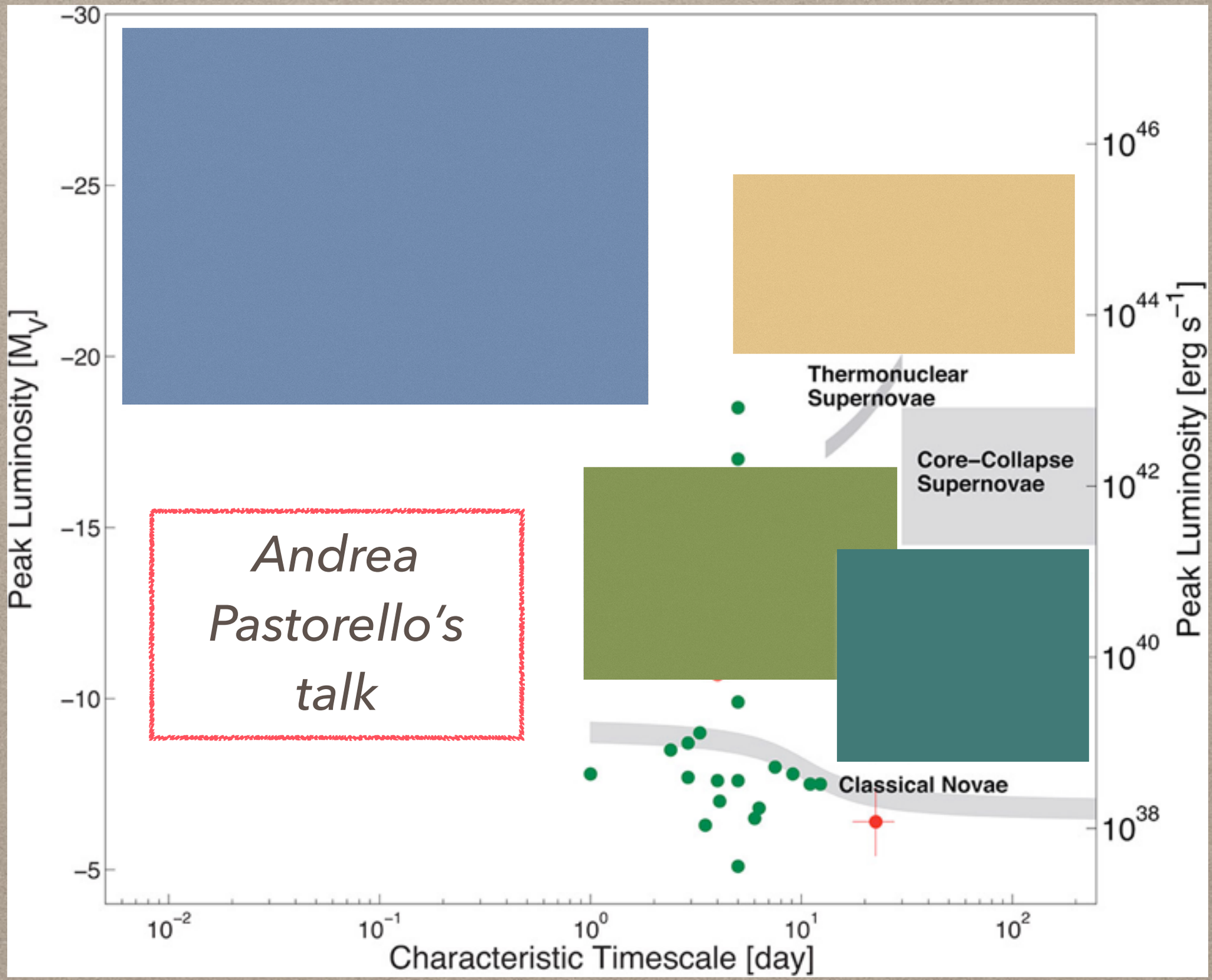
Similar to X-shooter
.. but also different, only two arms with partial overlap around 800 nm to cross-calibrate spectra



SOXS@NTT IN A NUTSHELL

- *Broad band spectrograph 350-1750 nm*
- *R~4,500 (3,500-6,000)*
- *Two arms (VIS + NIR)*
- *S/N~10 spectrum - 1 hr exposure for R~20-20.5*
- *Acquisition camera to perform photometry ugriz (2'x2')*

EVOLUTION OF TRANSIENTS



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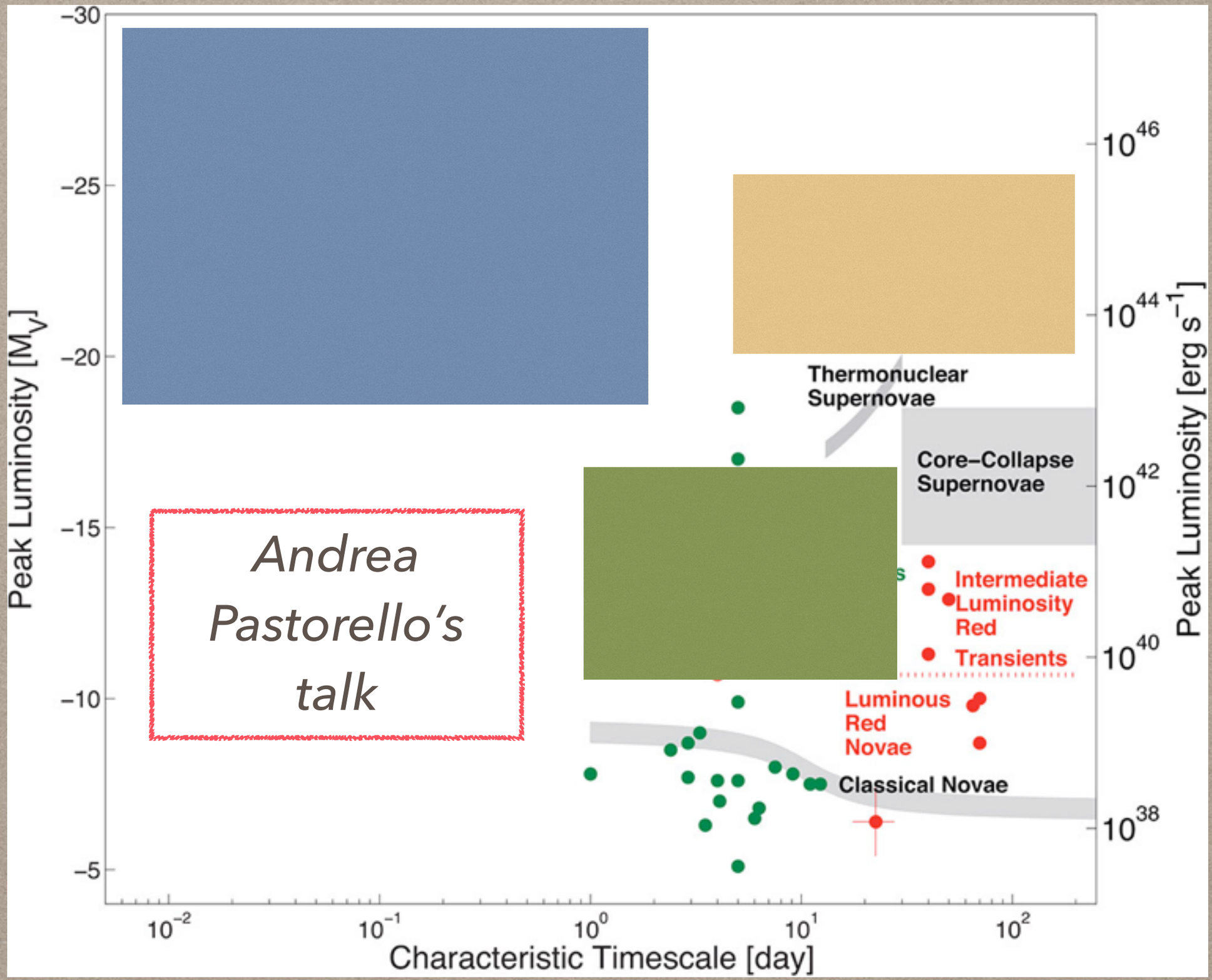

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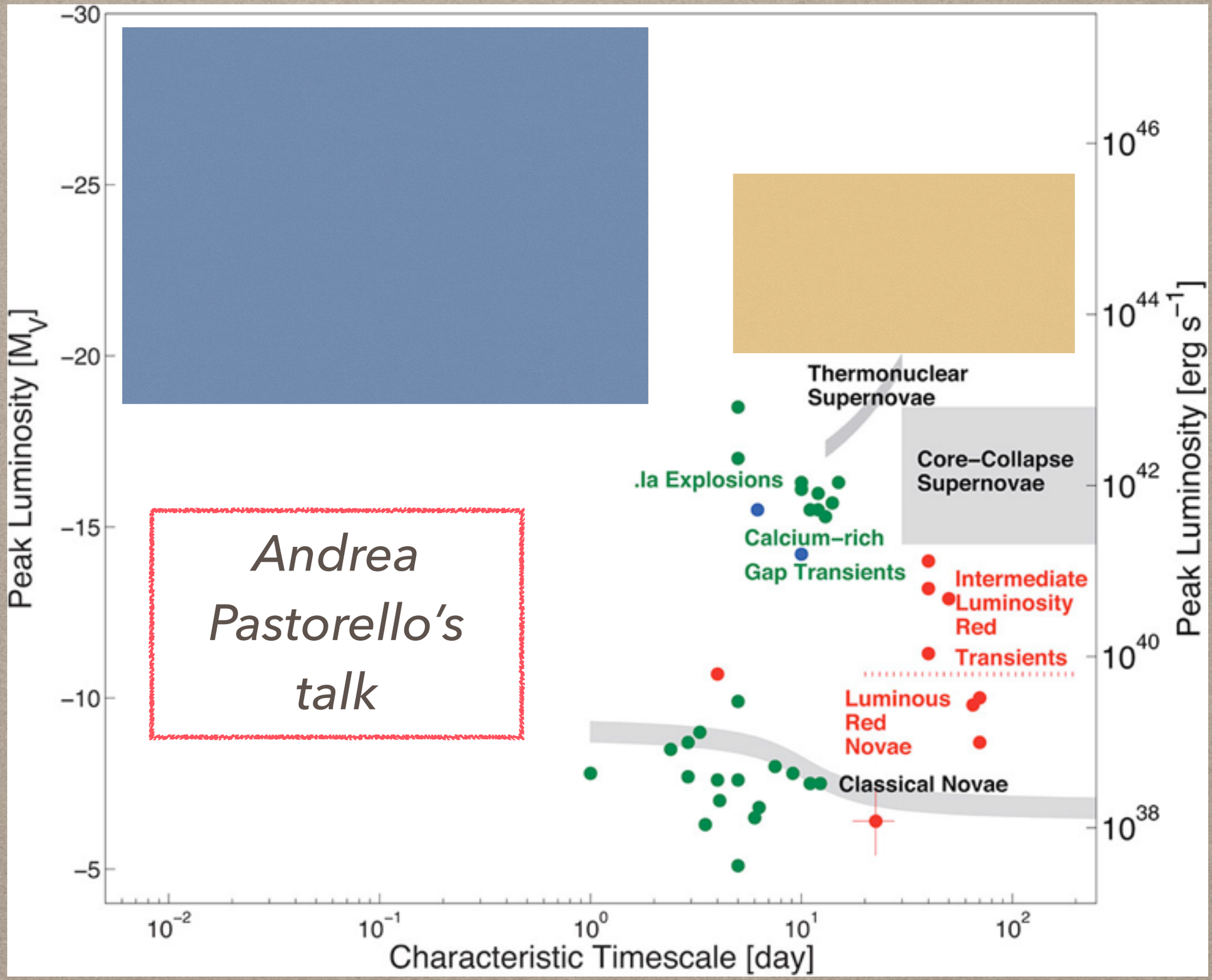
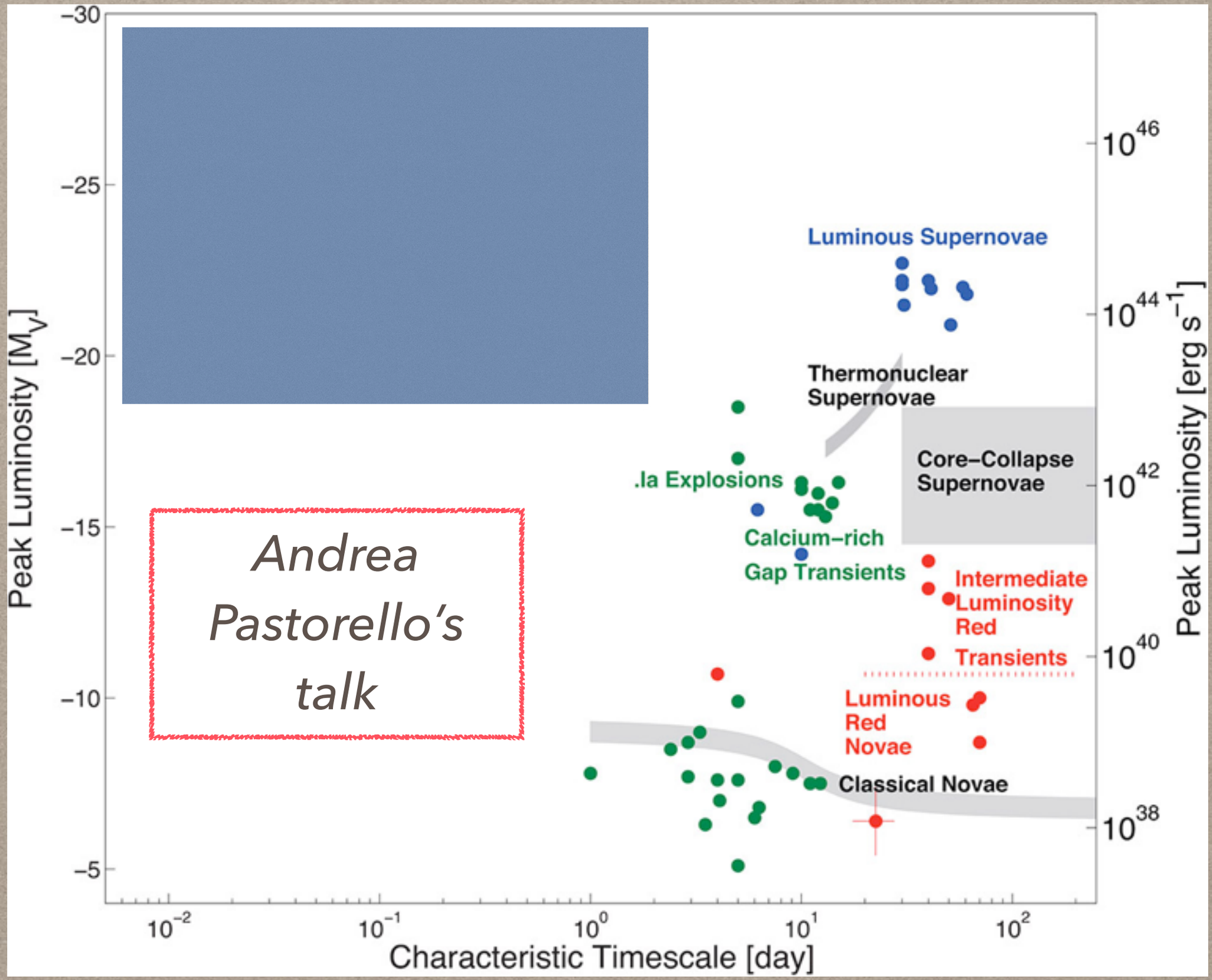


Andrea Pastorello's talk

EVOLUTION OF TRANSIENTS



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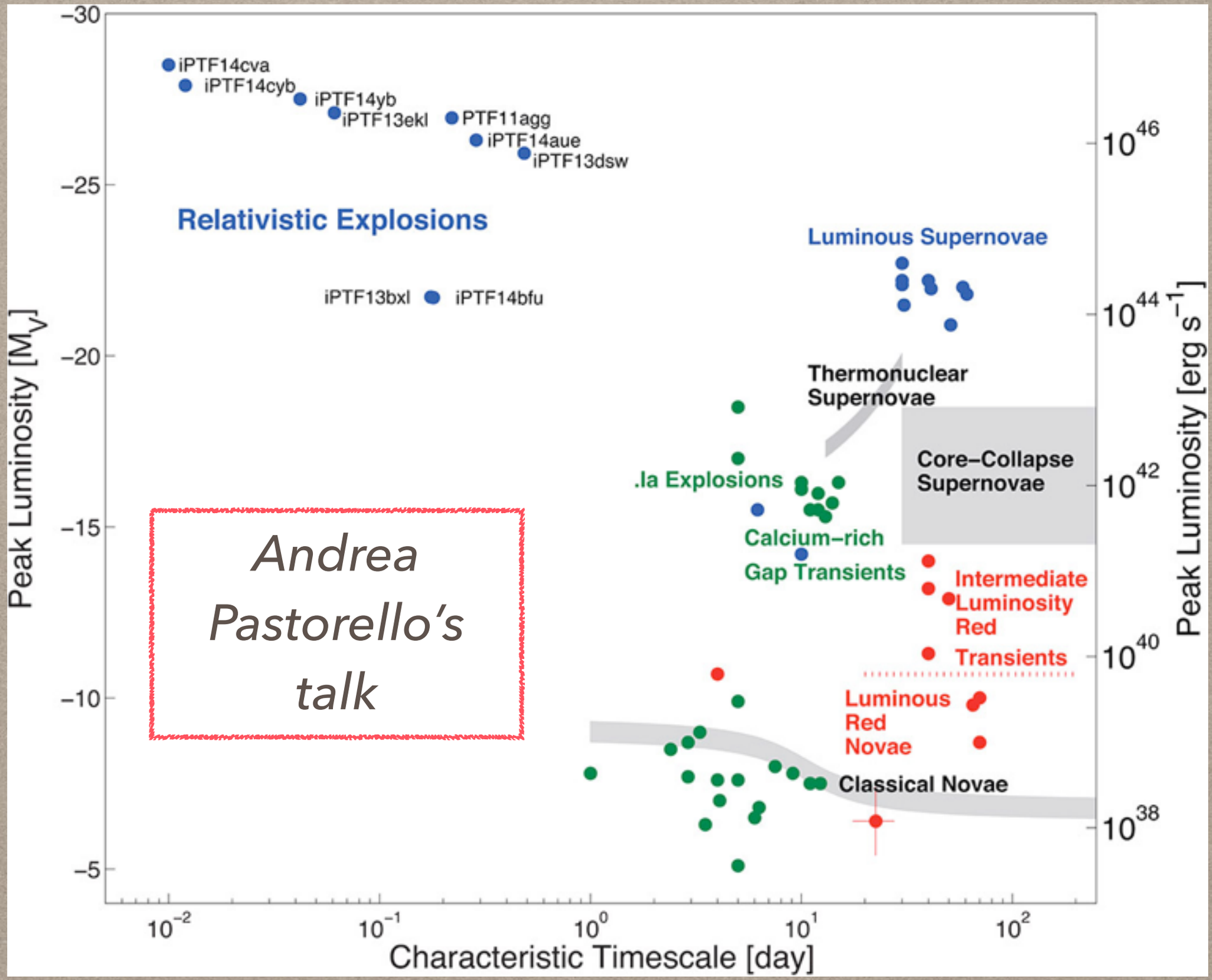
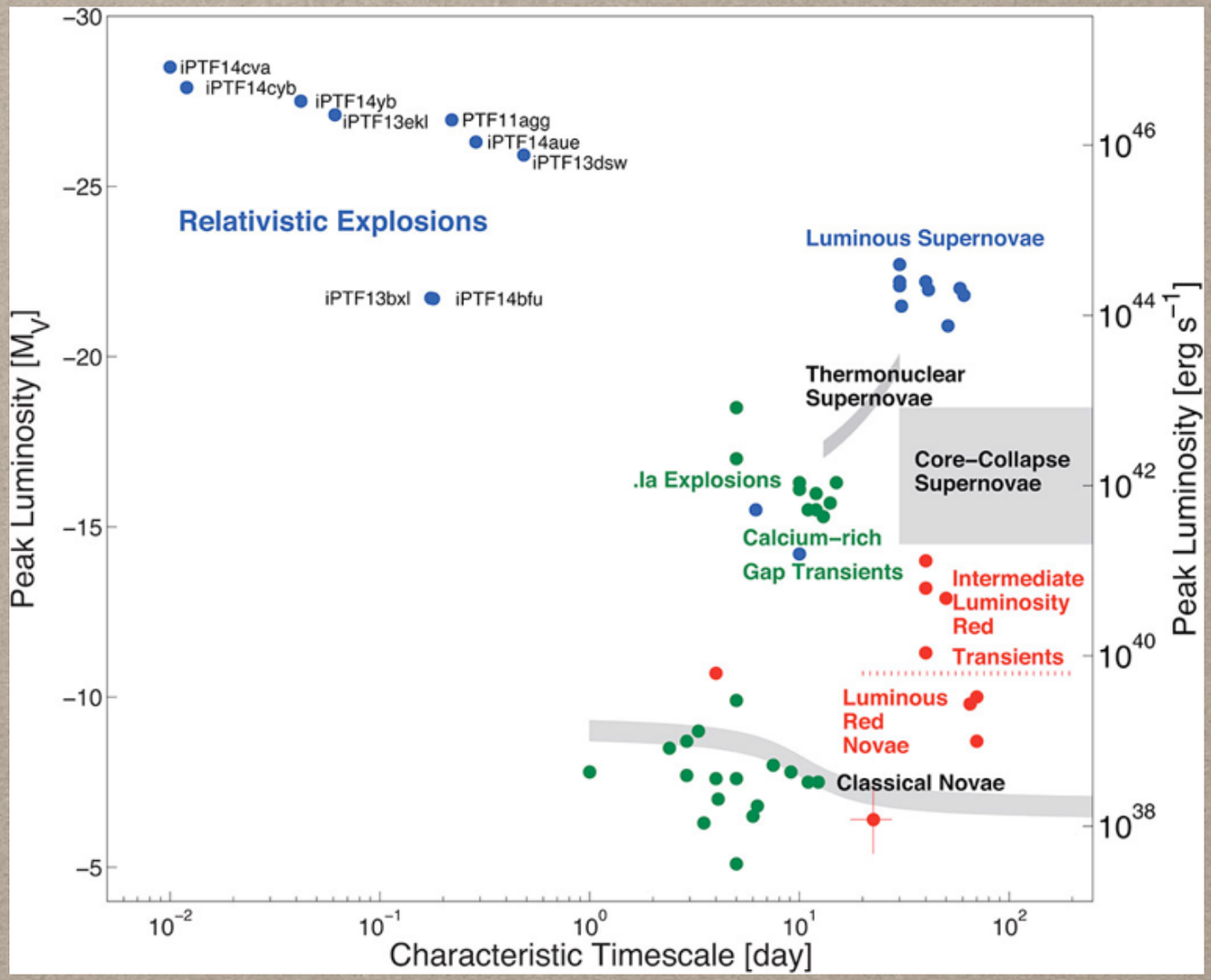


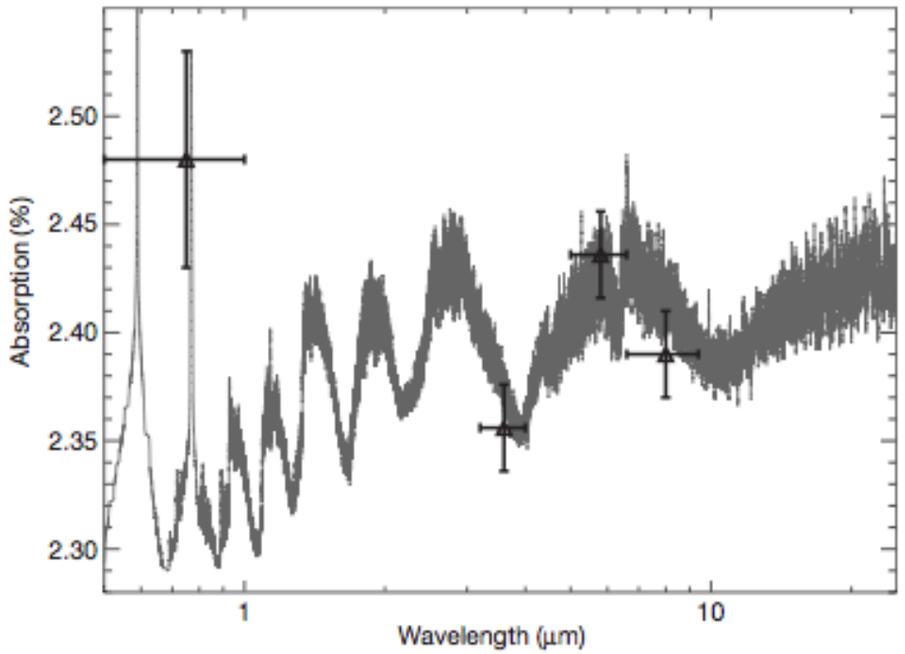
SOXS IS FULLY DEDICATED TO THE SPECTROSCOPIC FOLLOW UP OF TRANSIENT

- Minor planets and asteroids
- Young stellar objects
- Planetary transits
- X-ray binary transients
- GRB
- GW-&neutrino EM counterparts
- Radio sky transients & fast radio bursts

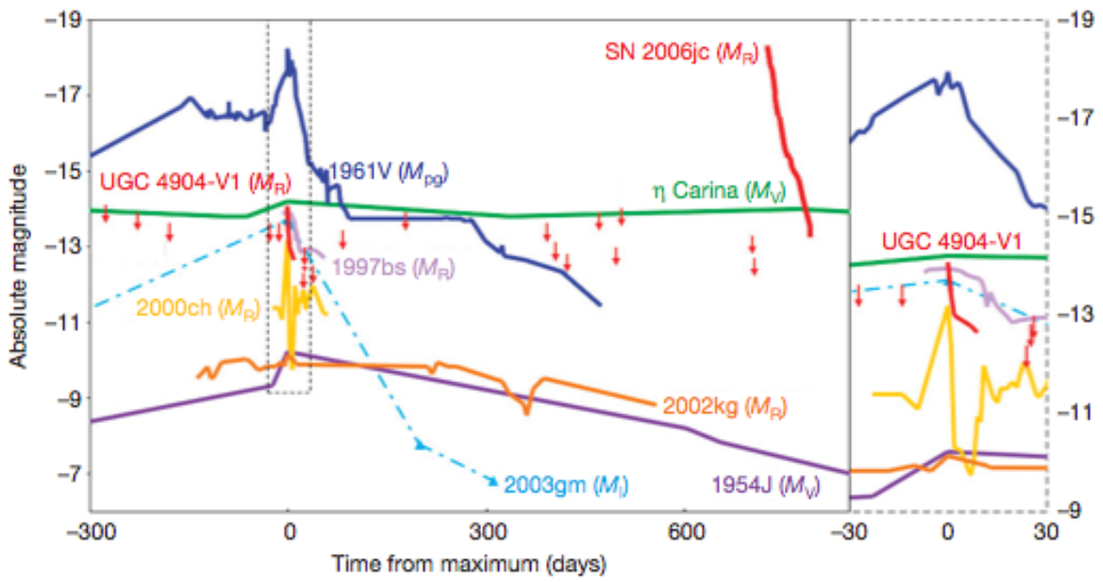


Discovery space

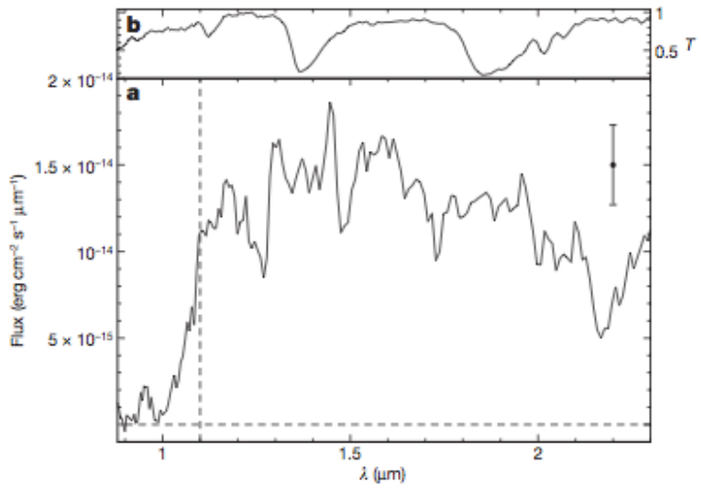
First SN shock break out



Water vapor in the atmosphere of a transiting planet



Major outburst 2 yr before the (probable) SN explosion



The most distant object in the Universe (at the time of discovery)

A working example

During 2005-2013 Nature published ~180 astronomical papers with more than 50 citations.

Among them **36%** are on transients

and variable objects

PAST

PESSTO

- ~20% of selected candidates from SN searches enter into the observing queue
- ~ 50% of the transients are eventually observed and classified

90% remain unclassified

GAIA is coming

GAIA Transient Alerts

	alerting object	5-yrs (Entire Mission)	main location
interesting	Supernovae <19 mag	6000	out of plane
	Microlensing (bulge)	~1000	bulge/plane
	Microlensing (all sky)	~700	out of plane
	GRB optical counterparts	~hundreds (?)	out of plane
	R CrB-type stars	~hundreds (?)	gal. plane
	CN	150	gal. plane
	FU Ori	14	gal. plane
contaminants(?)	Eclipsing binaries	a million (?)	gal. plane
	AGNs	500,000 (?)	out of plane
	Asteroids	thousands (?)	out of plane
	Be stars	thousands (?)	gal. plane
	Long period variables/Miras	thousands (?)	gal. plane
	M-dwarf flares	2000	gal. plane
	DN (U Gem) (except rare big flares)	500 (?)	gal. plane

EPESSTO

PRESENT

PESSTO evolved into **ePESSTO**

- Large program at ESO
- No longer fully public (even if there is still a service activity to classify transients)
- Approved for 4 semester for 90n/yr
- Not only SNe but **open** to other science cases
- Pathway to SOXS
- Italy involved (also thanks to SOXS)
- Two Italian scientists (out of 12) within the ePESSTO board

WHY SOXS?

FUTURE

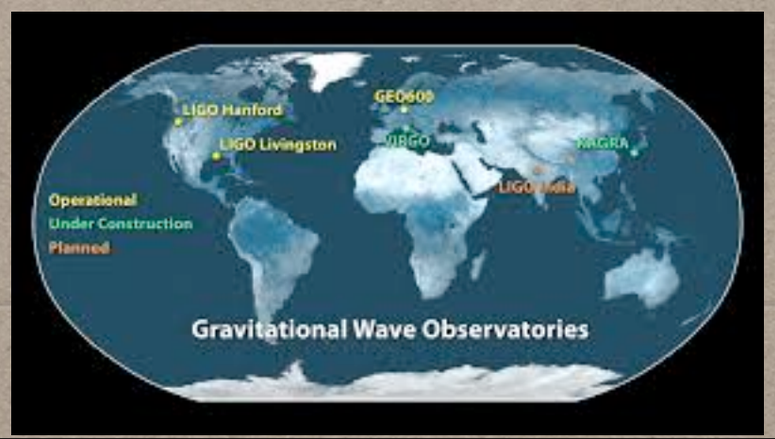
Spectroscopic machine for the transient sky.

Even now with PESSTO in place >70% of newly discovered transients remain without spectroscopic follow-up.

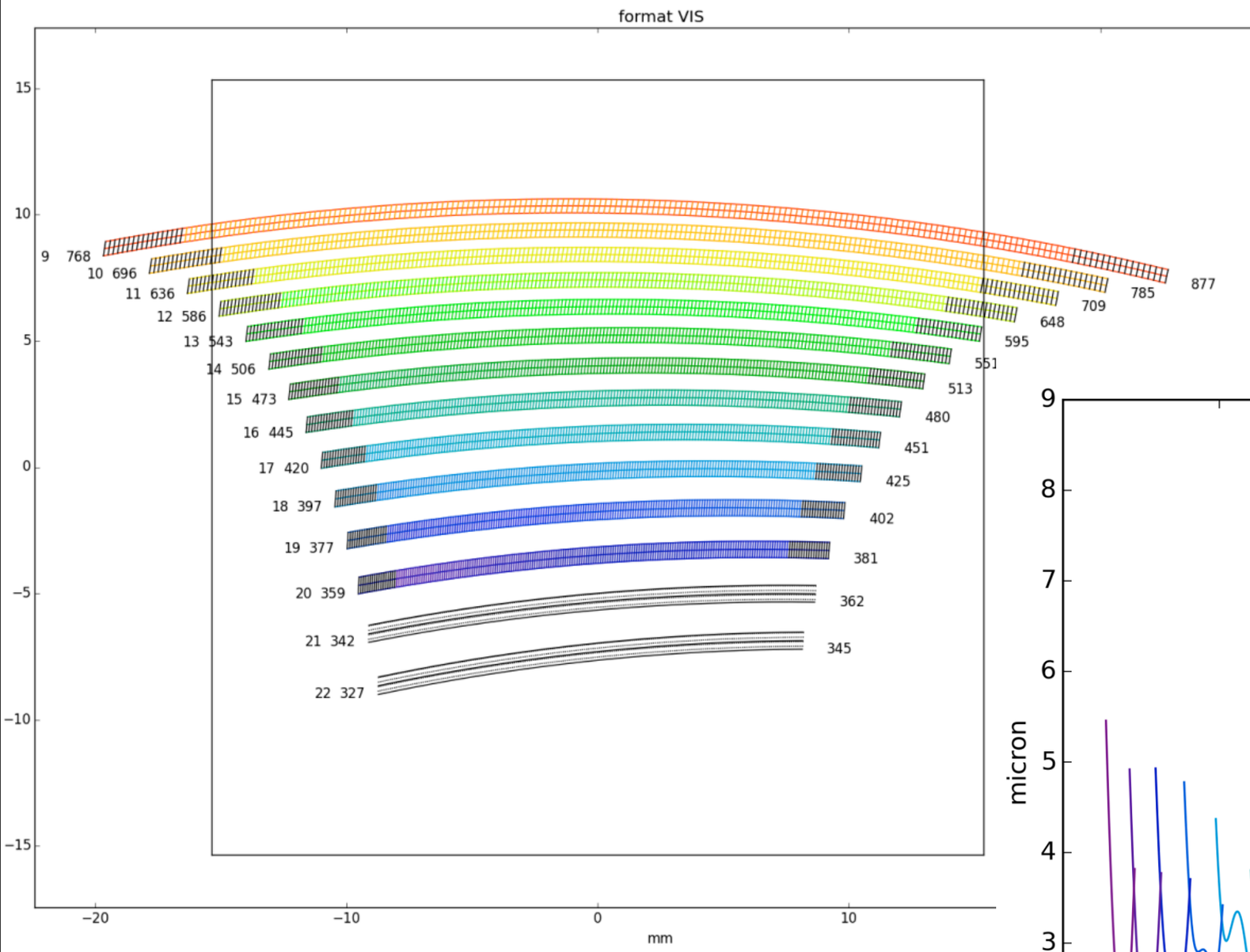
In the near future years there will be many <u>imaging</u> survey wide-field telescopes (iPTF, DES, Pan-STARRS, LSST) as well as high-energy transients (Swift, INTEGRAL, MAXI), GAIA-alters GW-alters, TeV alerts, etc. but very limited spectroscopic follow-up

SOXS@NTT will have 180 n/yr (for >5 yr)

~3,000 - 4,000 spectra/yr

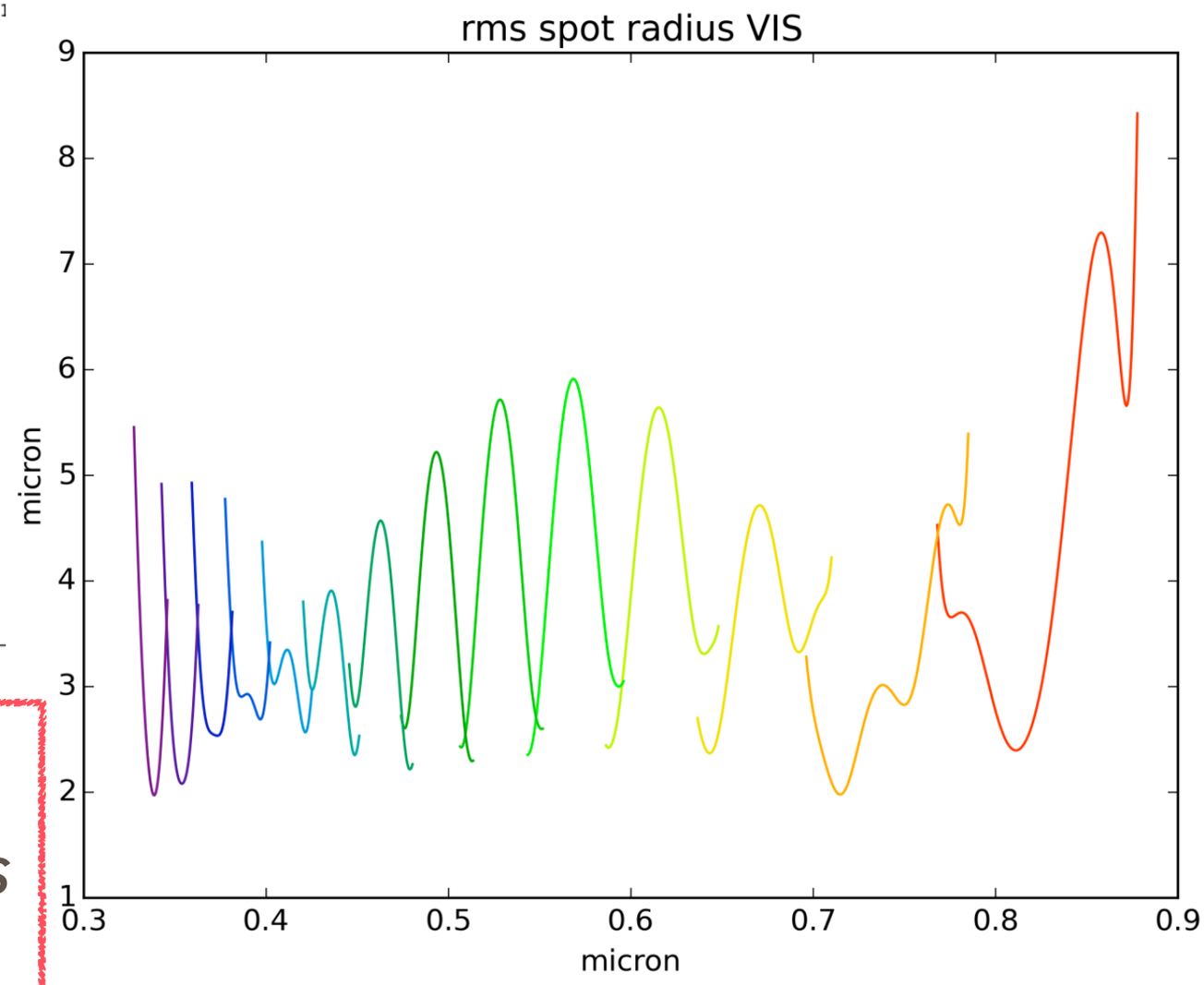


VIS/BLUE spectrograph *BASELINE*



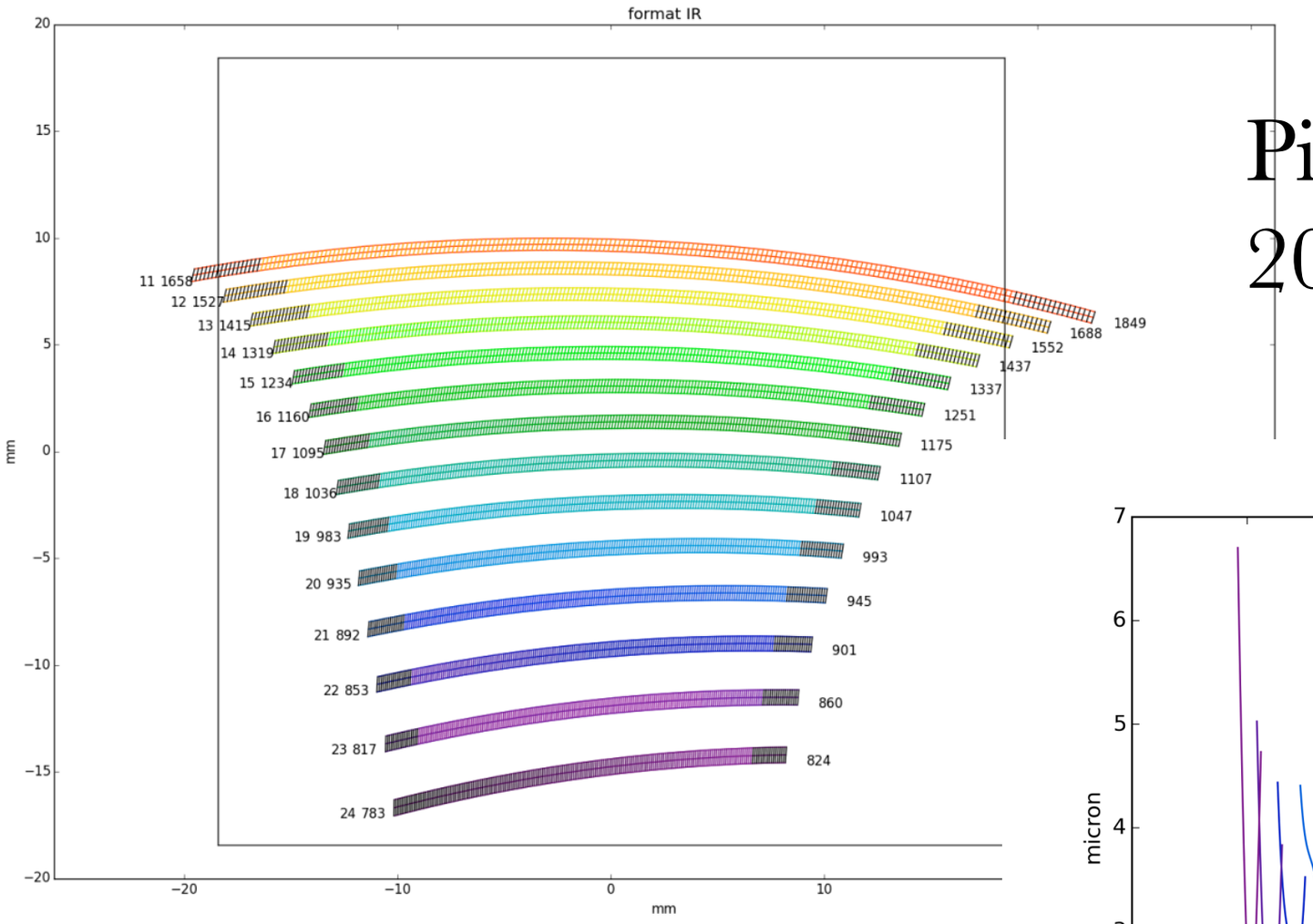
Pixel size 15 micron

2048x2048

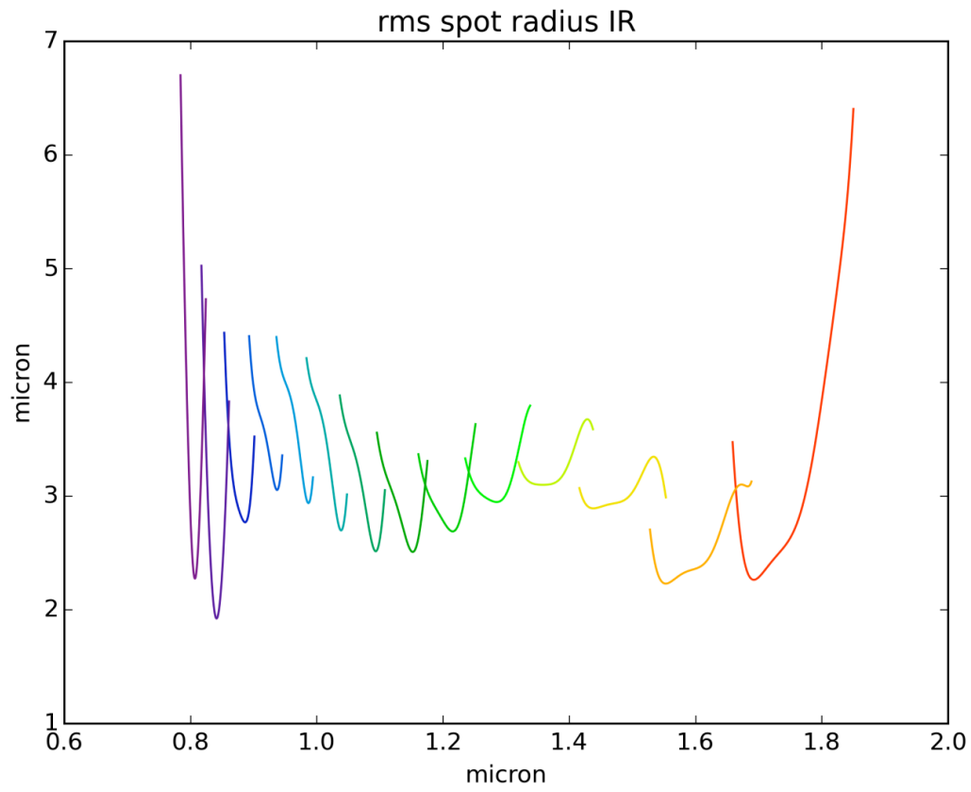


Innovative design with VPHs and 4 different optical cameras (Israel)

NIR/RED spectrograph



Pixel size 18 micron
2048x2048



TIMELINE (TIGHT!)

Date to be operational on sky: end 2020

PDR	July 2017
FDR	July 2018
End of Procurement	April 2019
AIT & Test in Europe	June 2020
Instrument in Chile	August 2020
End of Commissioning	December 2020

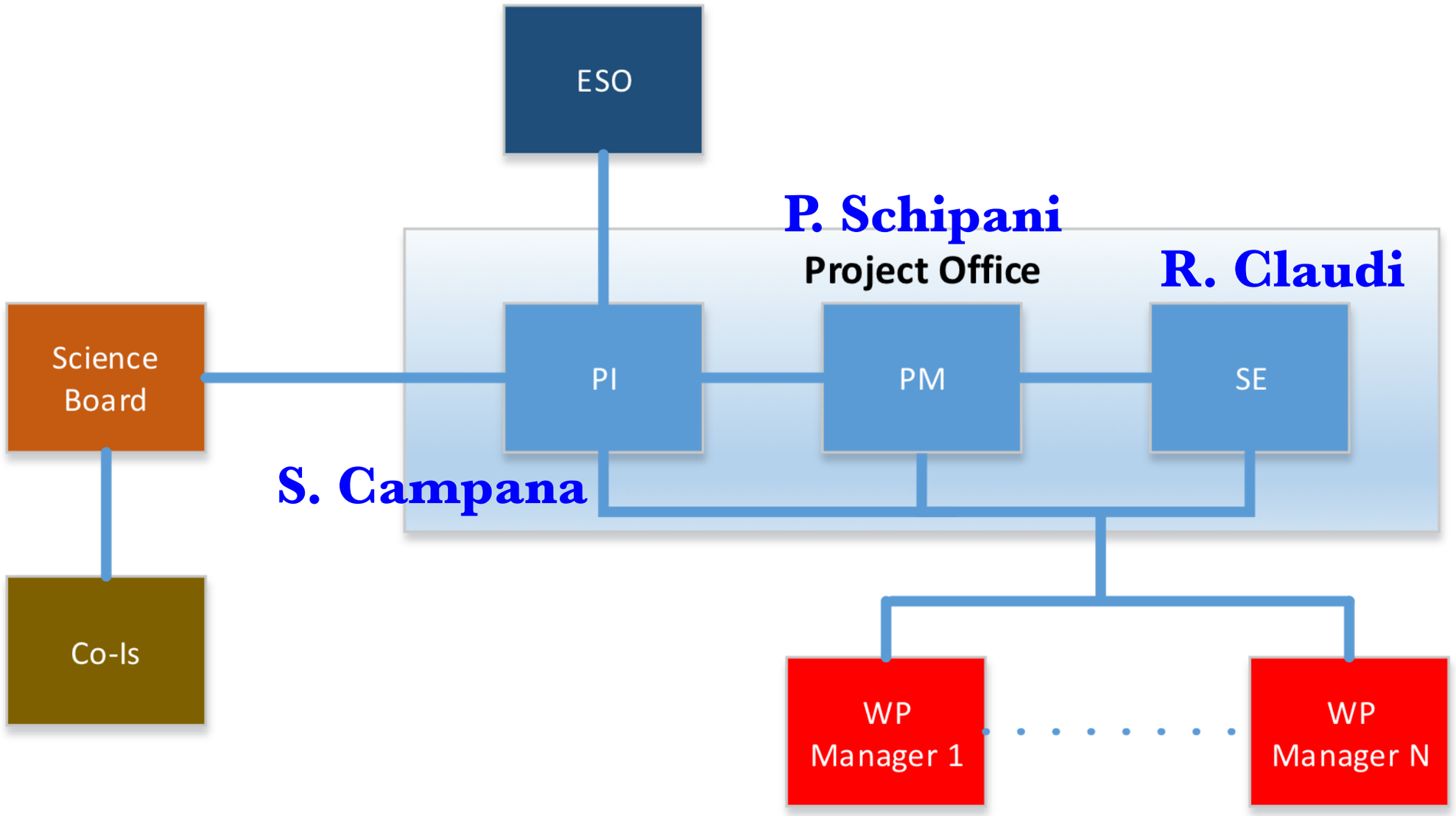
LSST - CTA - SKA

*good timing with **GW experiments** (4 detectors) -*

FUNDS SITUATION

- SOXS fully funded up to PDR
- SOXS has been selected by INAF to participate to the ‘best practice’-project competition (to cover ~40% of the total Italian involvement)
- MoU up to PDR signed with ESO

Consortium structure



Science Board

E. Cappellaro (INAF-OAPadova) - Italy

M. Della Valle (INAF-OANapoli) - Italy

G. Pignata (Millenium Inst.) - Chile

S. Smartt (Univ. Belfast) – UK

A. Gal-Yam (Weizmann) – Israel

I. Arcavi (Tel Aviv University) – Israel

S. Mattila (FINCA) – Finland

S. Campana (INAF-OABrera) - Italy

still contacts with NL, DK, F, USA, UK

OBSERVING TIME/MONEY SHARE

- Still evolving…

  Italy ~50%

  Israel ~25% (VIS-ARM optics and mechanics)

  Chile ~10% (Acquisition camera)

  UK ~10% (VIS-CCD, reduction pipeline)

  Finland ~5% (Calibration Unit?)

OPERATIONS

ESO will reward the SOXS consortium with NTT observing time.

now ePESSTO 90n/yr
future SOXS 180n/yr

Observers on-site and instantaneous response to fast alerts. Possibility to trigger fast ToO out of consortium time.

<5% of the consortium time open to the community as fast ToO (Swift-like) observations (public data)

Relevant information (redshift, peculiar sources, etc.) announced in real time through GCN, ATEL, IAUC, etc.

Consortium data public after a short (6-12 months TBD) proprietary period.

Source class	Obs. Time	Key project & Aim
All	500 hr	Fast characterization of transients from other surveys
Open	500 hr	Open time for spectroscopic ToO observations
Asteroids & TNO	200 hr	Characterization of populations of minor bodies, input to models of solar system formation and mitigation of impact hazard
Comets and new comets	100 hr	
Planetary transits	200 hr	Monitor of >5 bright stars for primary and secondary eclipses
Young stellar objects	100 hr	
Stars	100 hr	
X-ray binary transients	200 hr	Derive the mass function of >10 XRB transients in outburst
Magnetars	50 hr	Fast follow up of >10 magnetar's flares
Novae	100 hr	
ILOT	300 hr	
SN Ia	500 hr	Statistical sample of >150 SNe Ia in the low-z Universe to study the local properties and dust extinction
CC-SN	500 hr	
Super-luminous supernovae	500 hr	Build a statistical spectroscopic sample of SLSN
Prompt GRB	100 hr	Fast spectroscopy of >50 GRBs to probe the galaxy host medium
High-z (z>5) GRB	50 hr	Transmission spectra of >5 high-redshift GRBs
GRB-SNe	100 hr	Follow the evolution of >5 SN associated to nearby (z<0.3) GRBs
Active galactic nuclei and blazars	200 hr	
Tidal disruption events	100 hr	Study the spectral evolution of >10 TDEs
Gravitational Wave triggers	200 hr	Spectroscopic follow up of candidate GW counterparts. This includes kilonovae from short GRBs.
Neutrino triggers	100 hr	Spectroscopic follow up of candidate neutrino counterparts
Unknown	300 hr	

working...

thank you