



李政道研究所
TSUNG-DAO LEE INSTITUTE

Systematic monitoring and search of AGN and TDEs with EP



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2024-10-16@LITD, Shanghai

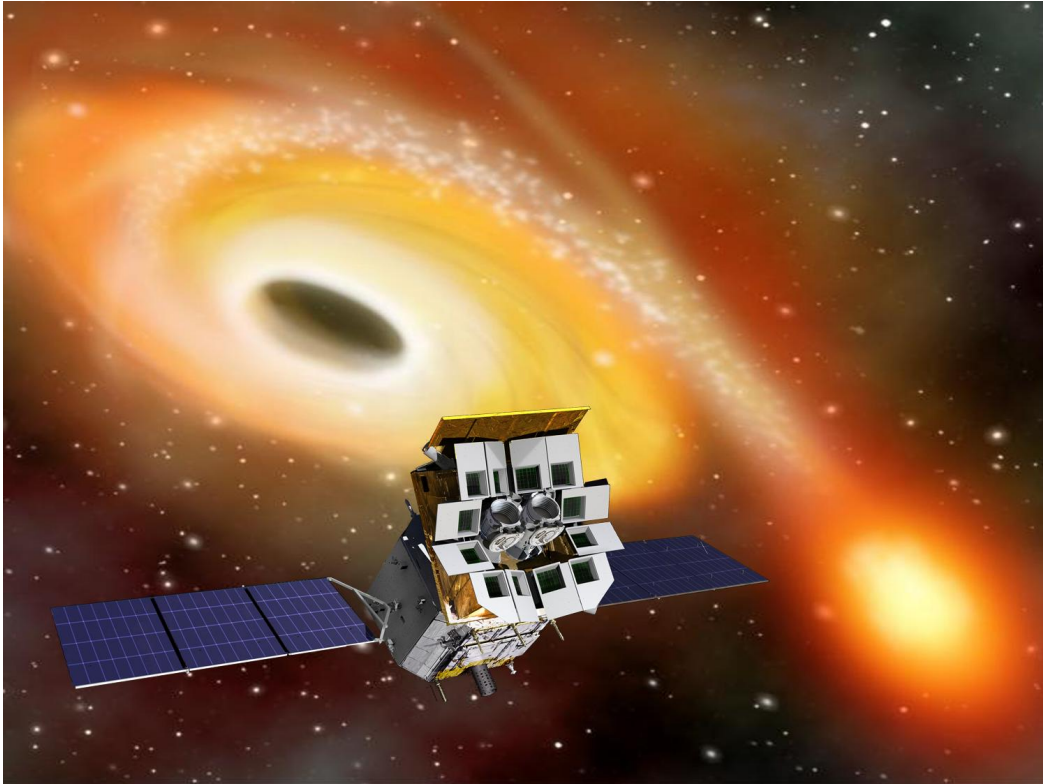


中国科学院国家天文台
NATIONAL ASTRONOMICAL OBSERVATORIES, CAS





Outline



EP-WXT:

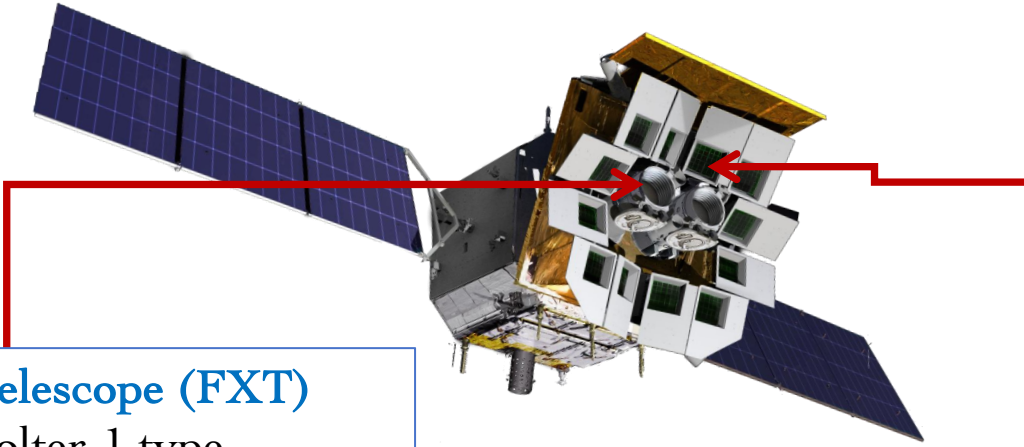
- ✓ Systematic monitoring of known AGN, TDEs at different cadence
- ✓ Discover new TDE candidates, long-term transients
- ✓ Catch flares at real-time

EP-FXT:

- Monitoring of Highly Variable AGN with EP-FXT
- Monitoring of tidal disruption events with EP-FXT
- QPEs.....



EP overview

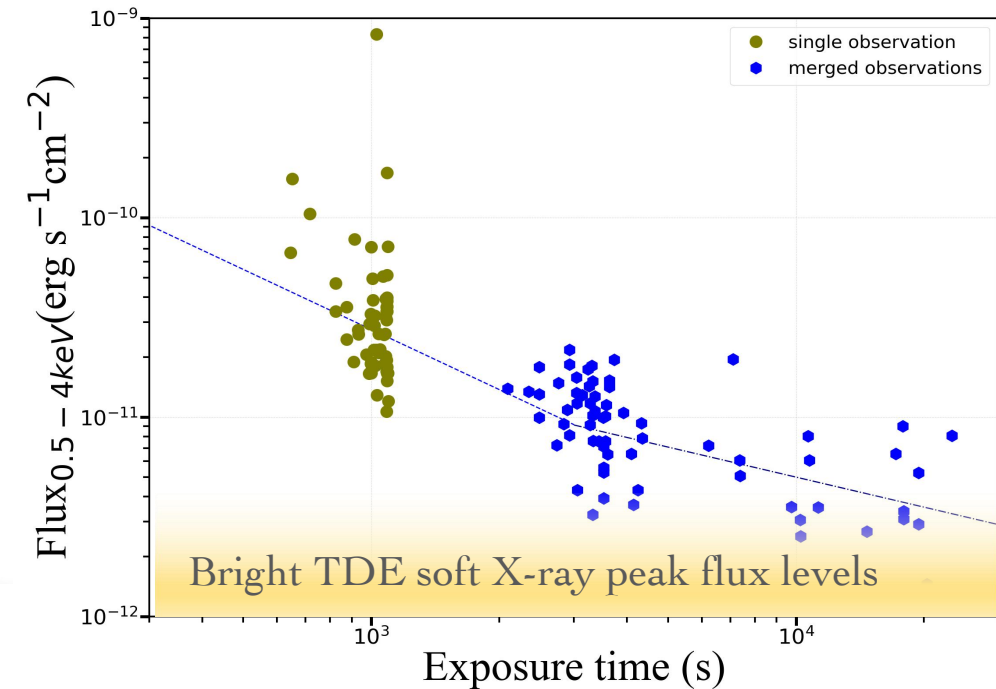
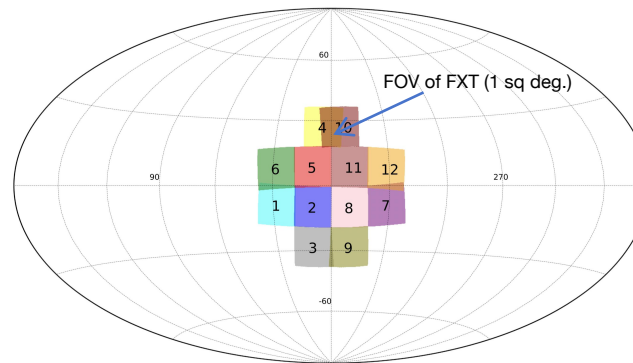
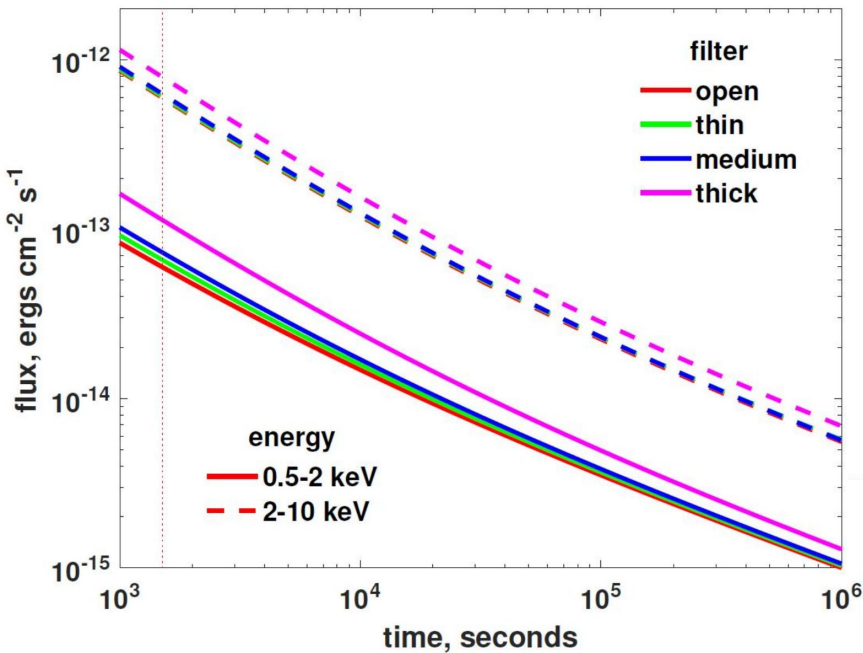


Wide-field X-ray Telescope (WXT)

- X-ray optics: lobster-eye MPO, 12 modules
- Total FoV: ~ 3600 square degrees
- Sensitivity @1ks: $(2 - 3) \times 10^{-11} \text{ erg s}^{-1} \text{ cm}^{-2}$
- Cover whole night sky in 3 orbits ($< 5\text{h}$)

Follow-up X-ray Telescope (FXT)

- X-ray optics: Wolter-1 type

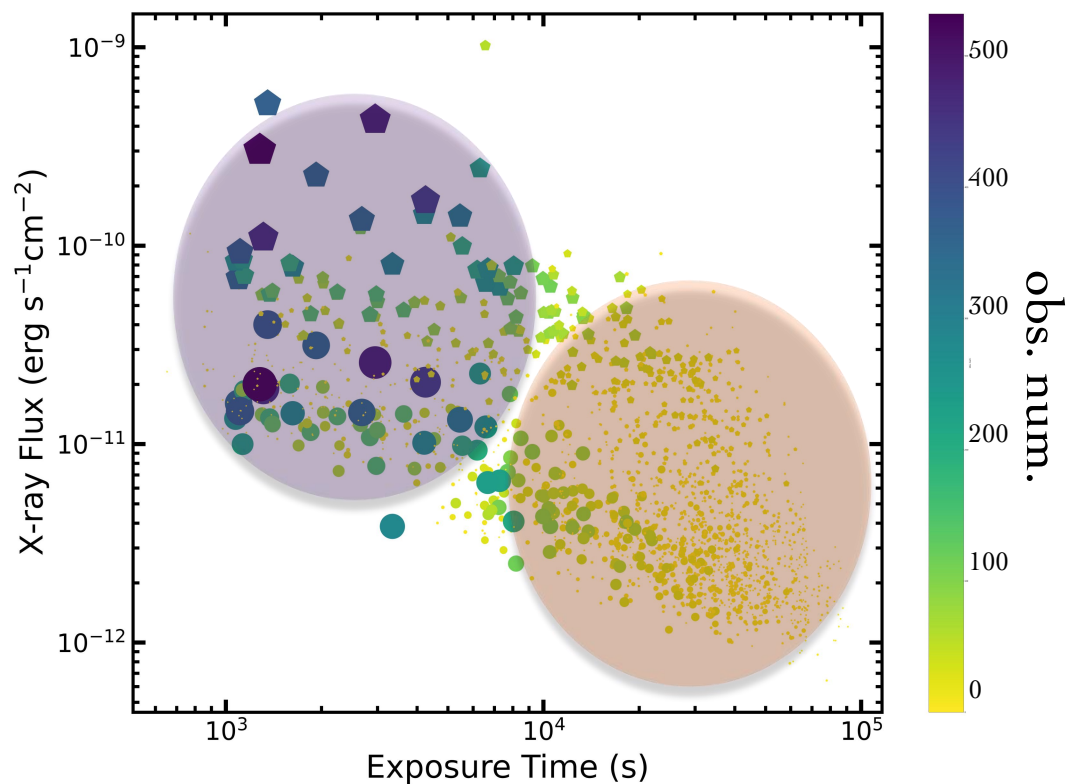




WXT result: bright AGNs

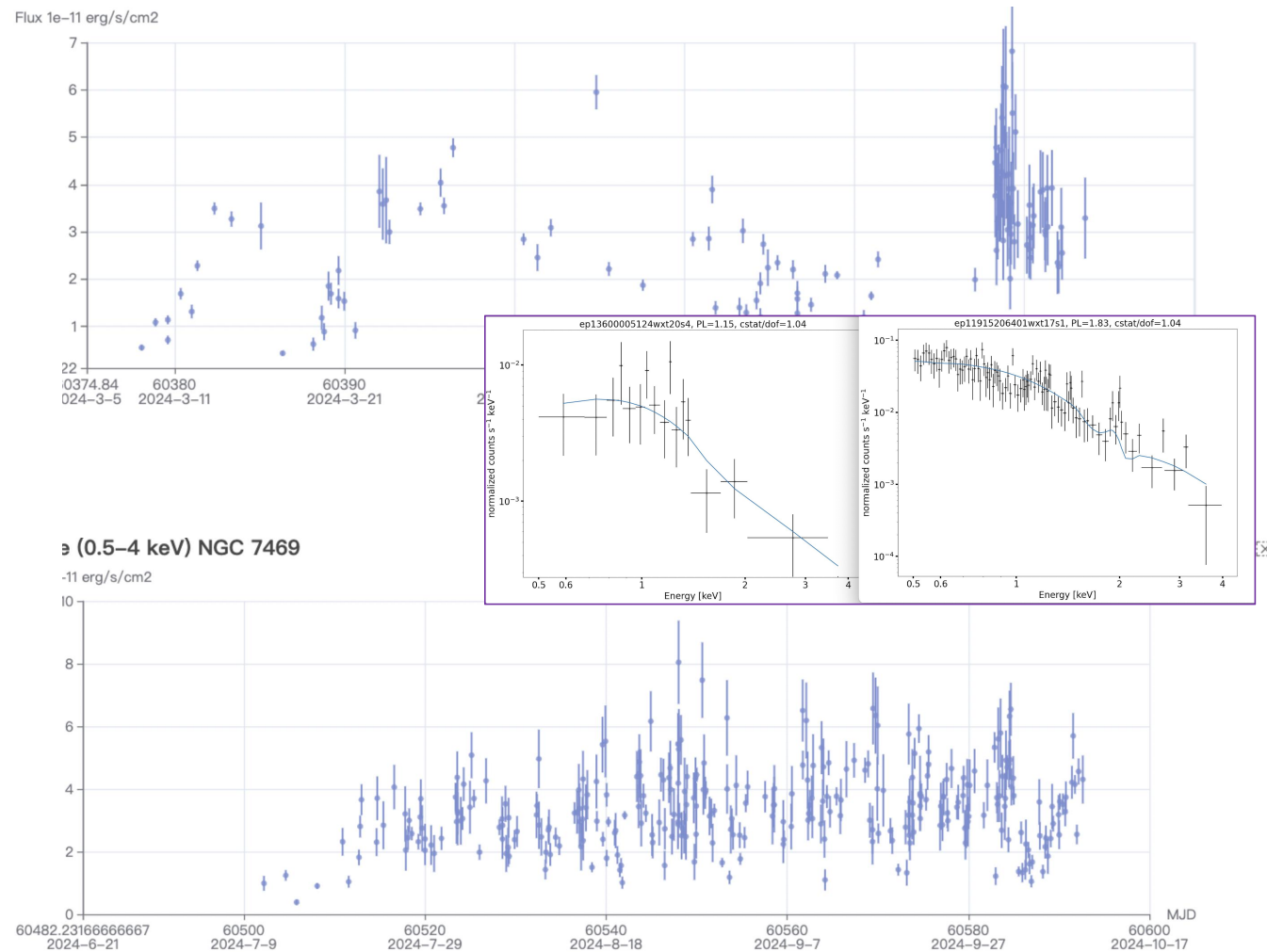


EP in operation: 281 days
around 1000 AGNs by EP-WXT



symbol size and color: number of detection
pentagon: highest flux, circle: lowest flux

highly variable AGNs: high/low > 10, more than 50



bright AGN: $\sim 1e-11$ erg/s/cm²

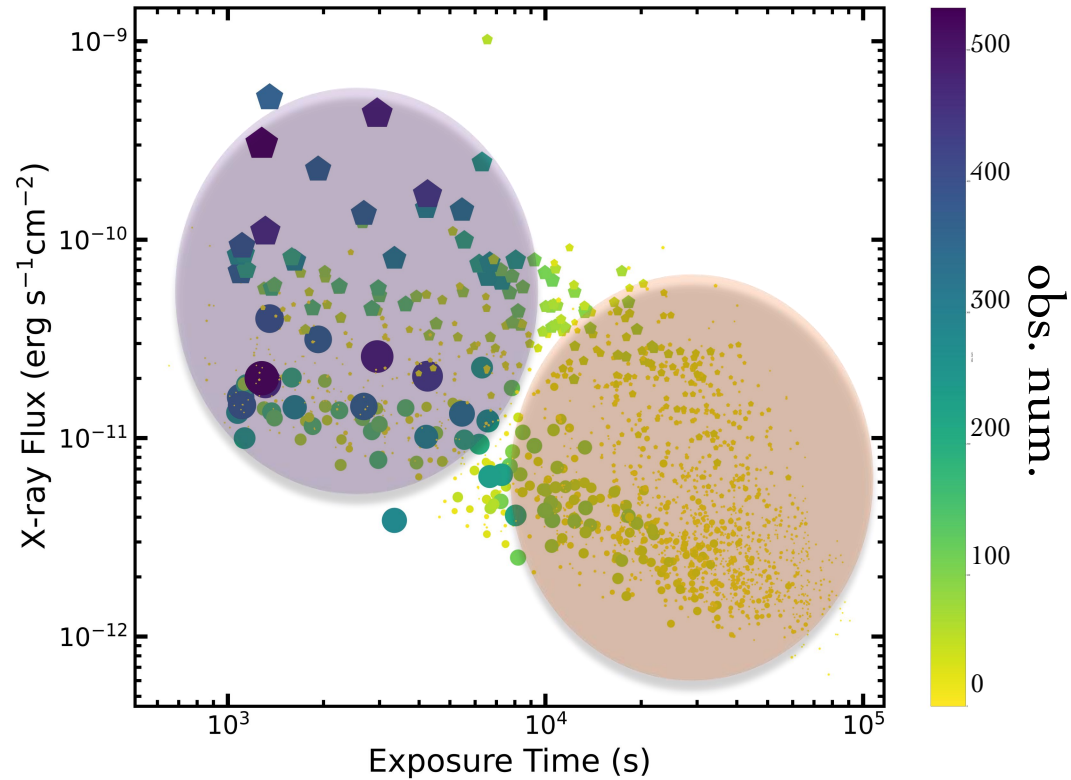
high cadence (daily, even inter-day) monitoring



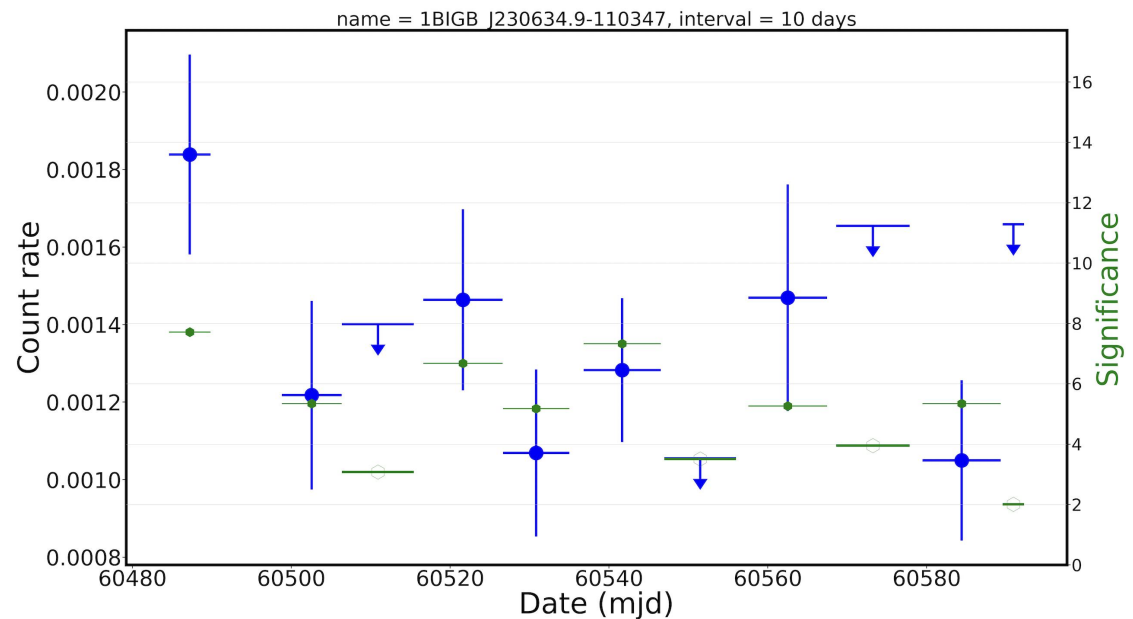
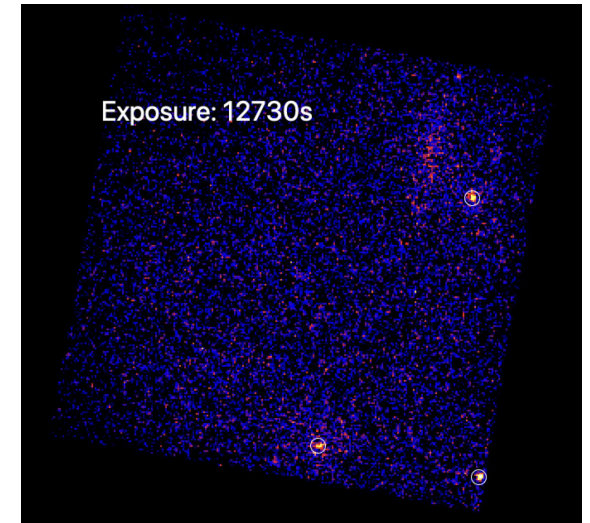
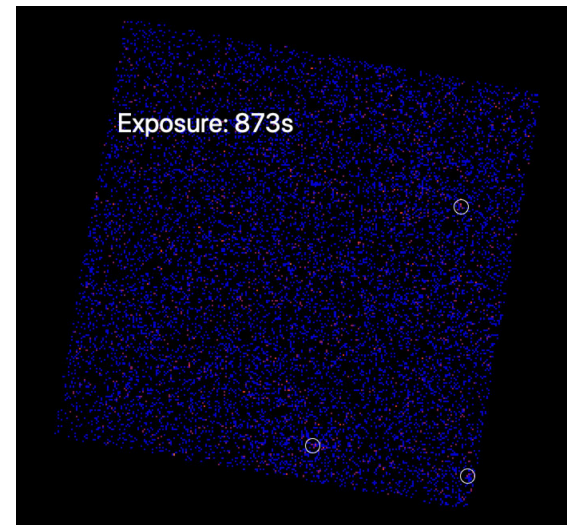
WXT result: fainter AGN



EP in operation: 281 days
around 1000 AGNs by EP-WXT



fainter sources: $> 1\text{e-}12 \text{ erg/s/cm}^2$
data stacking, weekly to monthly monitoring

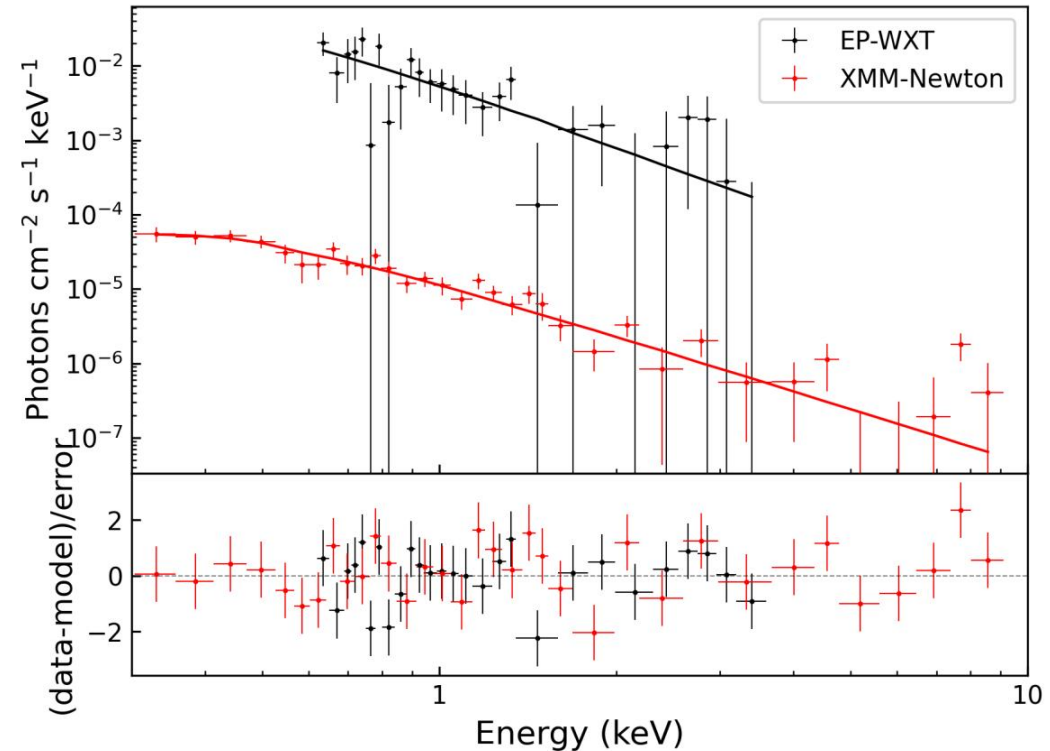
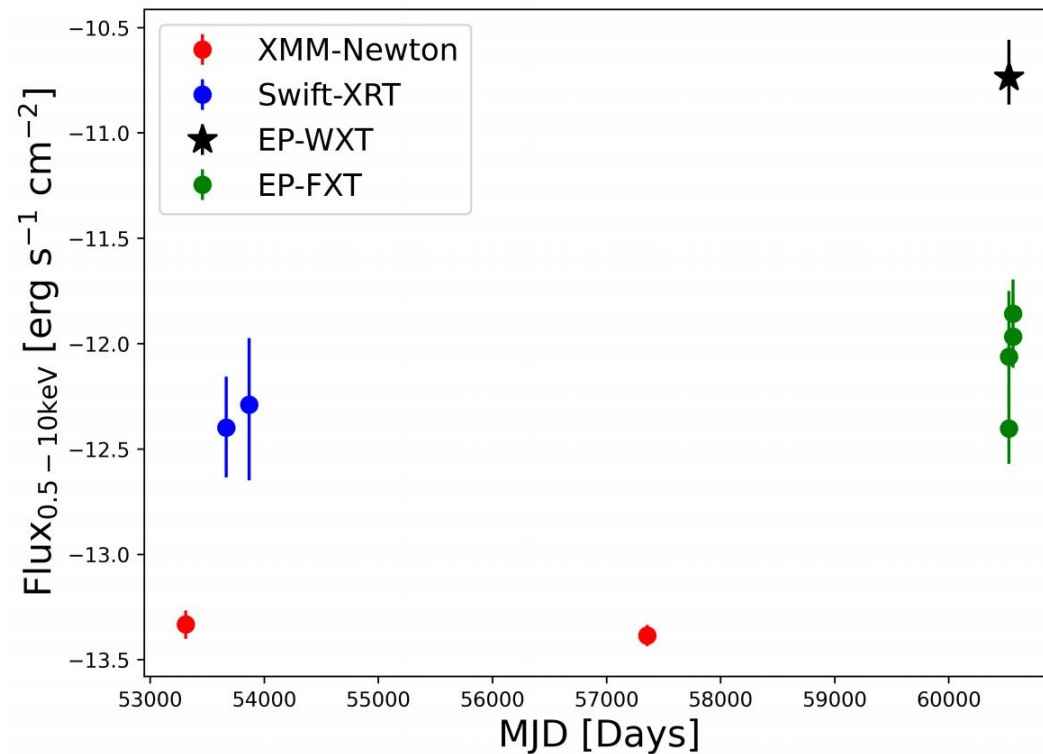




Highly variable AGN: PHL 1811



Catch bright flare (EP-WXT) in real-time and trigger quick follow-up observations (EP-FXT)



Drastic X-ray flare detected by EP-WXT in real time from the famous weak-line quasar PHL 1811

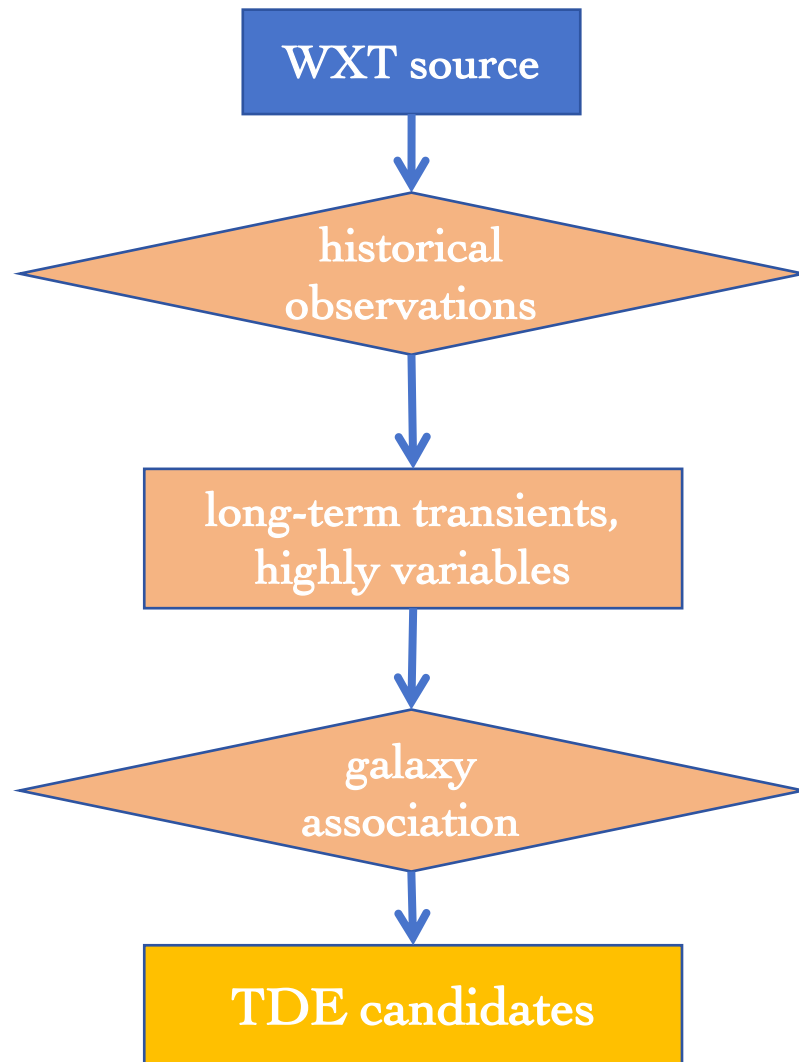
credit: T.Y. Lian



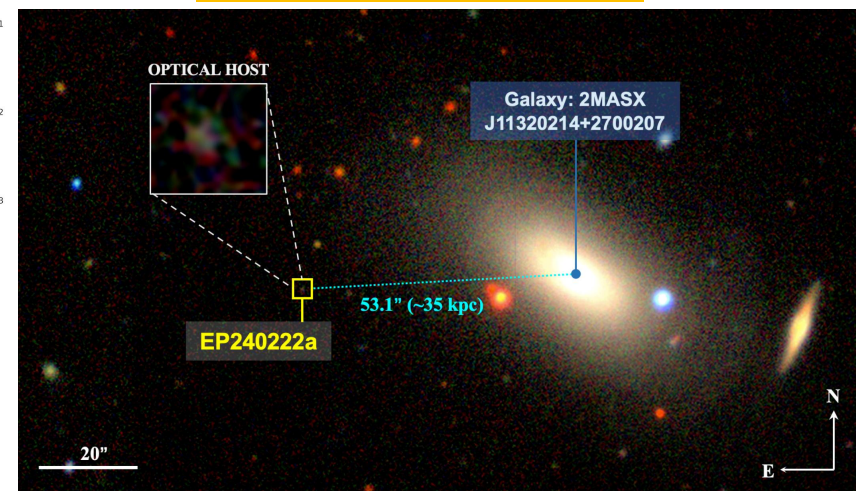
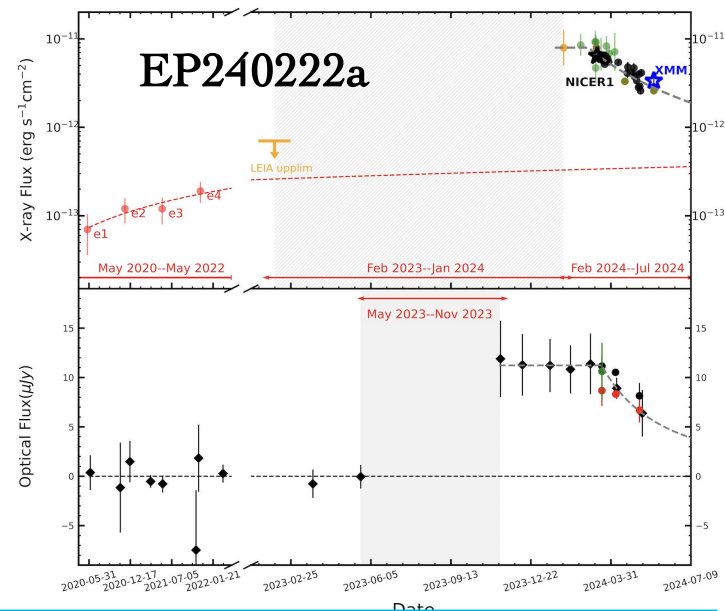
WXT result: TDE candidates



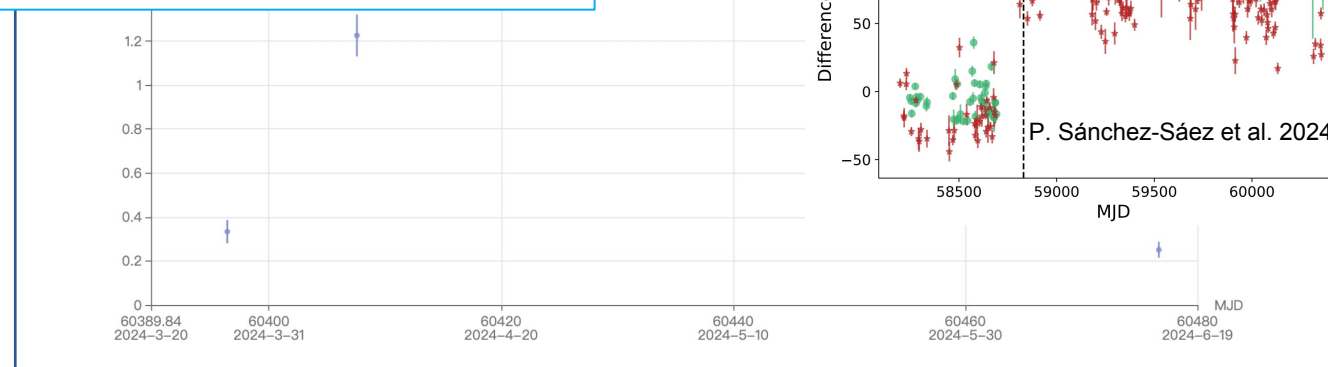
How do we find TDEs (candidates) in WXT data?



Chichuan Jin's talk



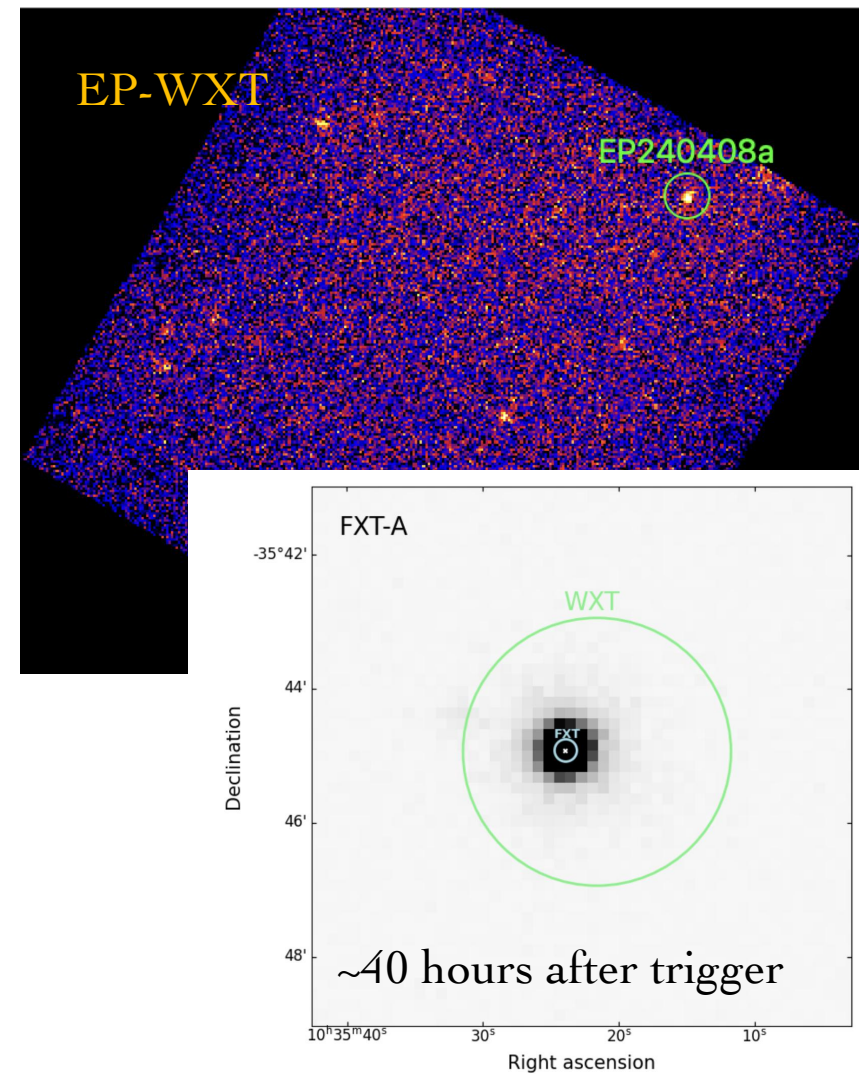
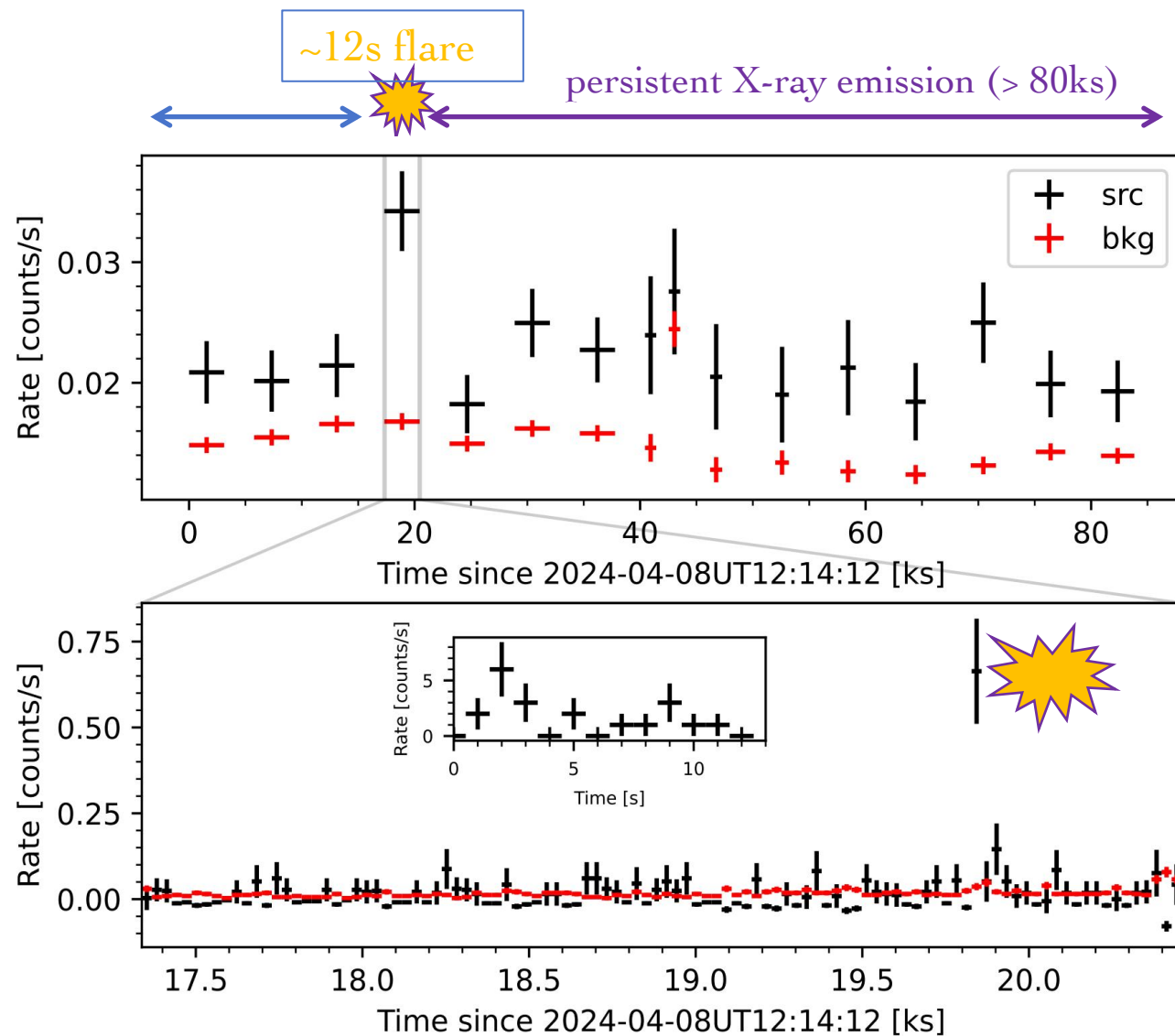
EP240327a (SDSS1335+0728)
The awakening of a SMBH



P. Sánchez-Sáez et al. 2024



EP240408a

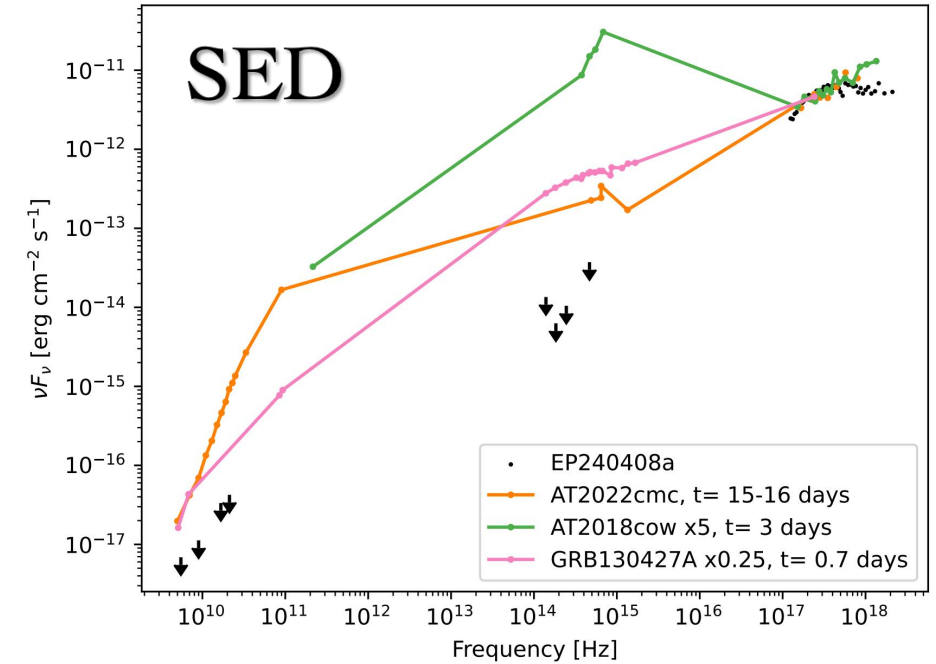
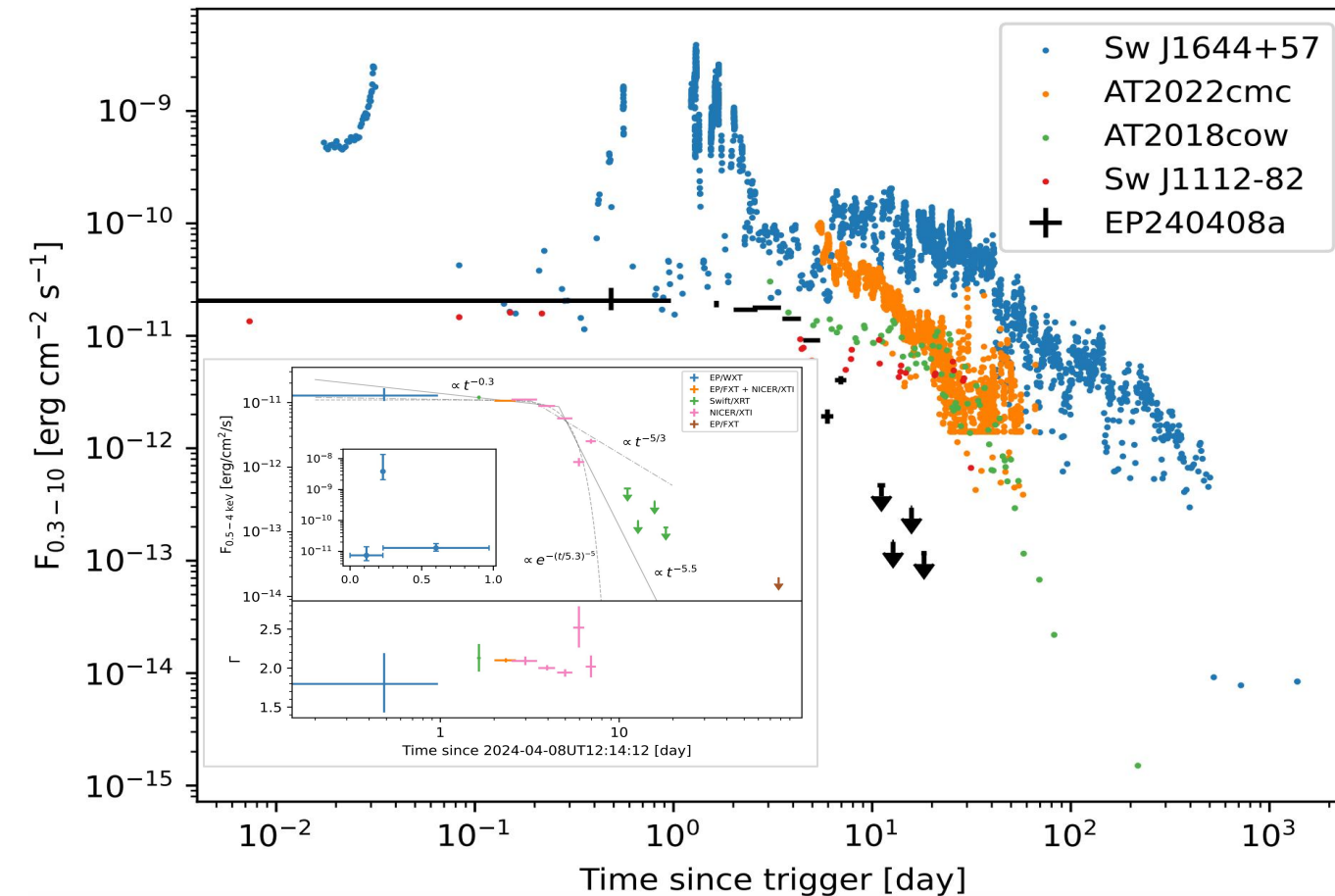




EP240408a



Long-term X-ray light curve of EP240408a compared with jetted TDEs and FBOT (AT2018cow)



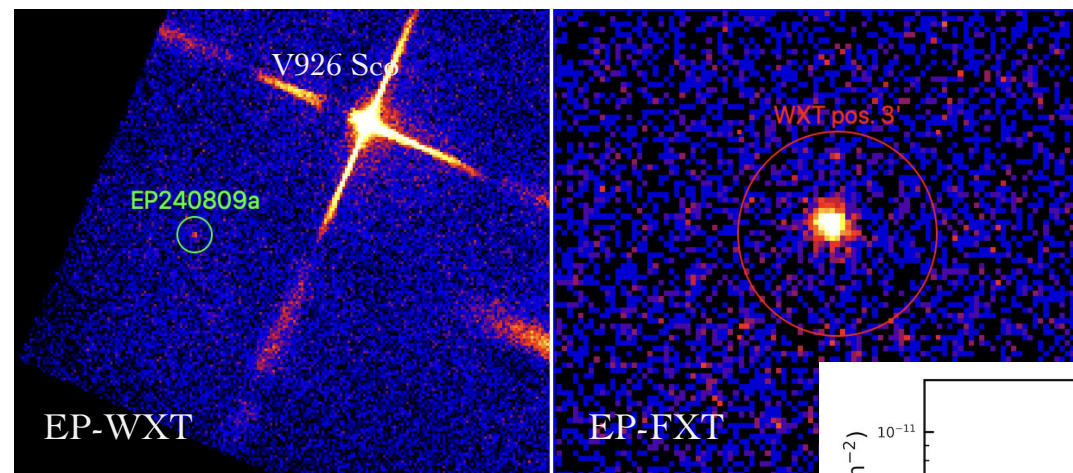
- intense X-ray flare ~ 12 s, >300 higher than persistent X-ray emission
- plateau phase ~ 4.6 days, followed by a steep decay
- non-thermal spectra, photon index $1.8\sim 2.5$
- intermediate timescale: $7\sim 20$ days
- no IR, optical, radio counterparts



EP240809a



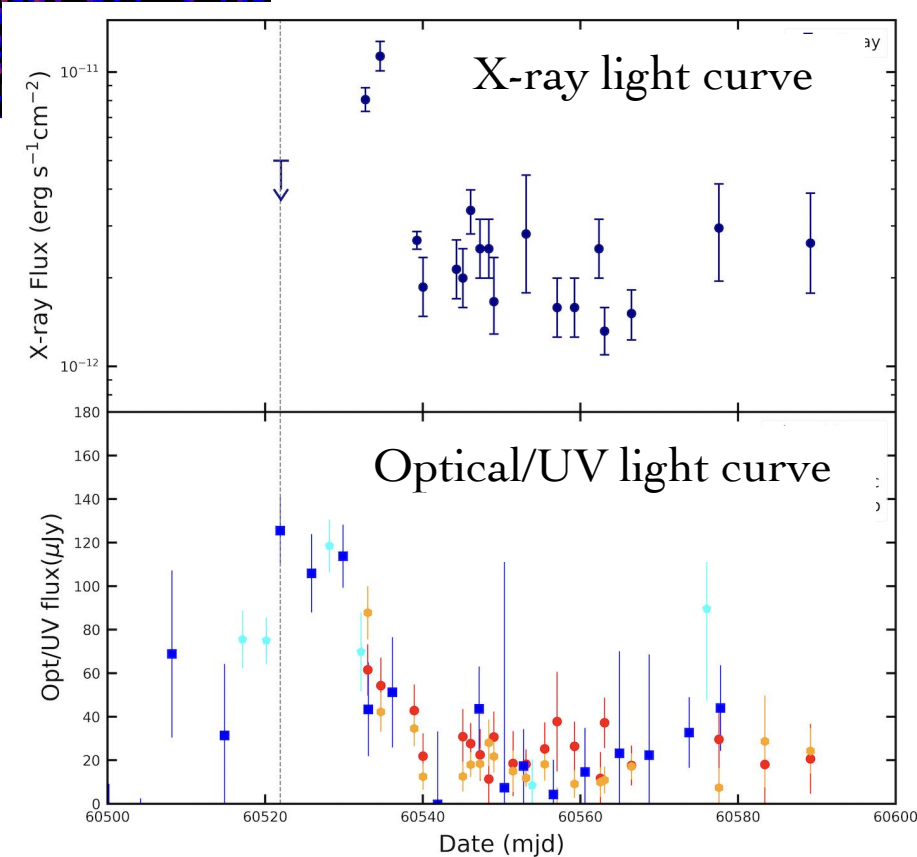
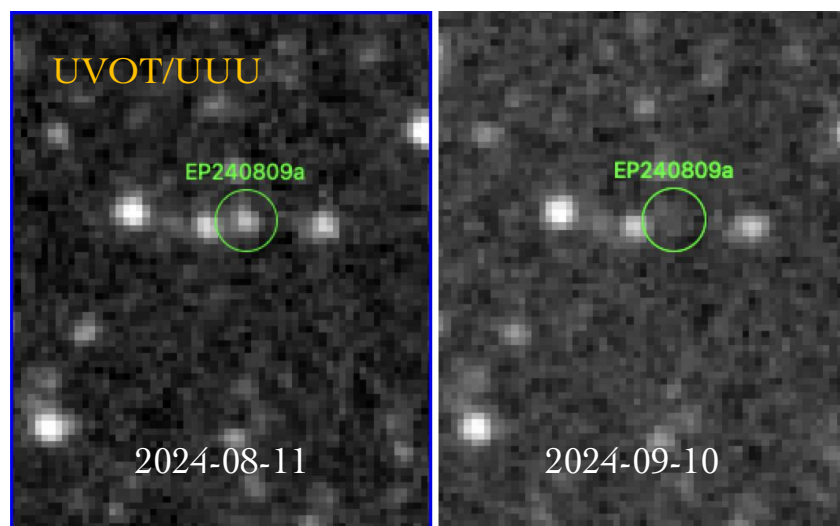
- Discovery:
- X-ray band:
 - 2024-08-09 by EP-WXT
- optical band:
 - brightening from 2024-07



photon index ~ 2

Follow-up monitoring:

- X-ray: EP-FXT, Swift, NICER
- optical/UV: Swift, GROND
- Radio: ATCA
- spectroscopy: SALT(?)
- ...





FXT: monitoring of highly variable AGN

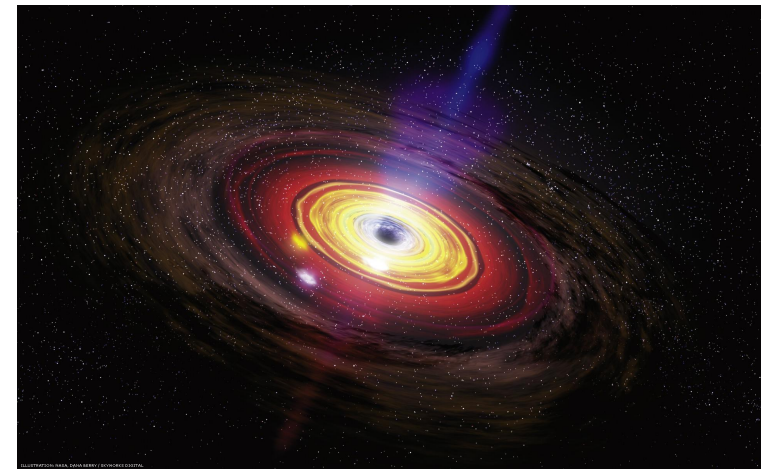


□ The selection procedure:

- ✓ highly variable AGN, particularly the 'changing-look' (CL) AGN
- ✓ mainly focus on those of which the historical CL phenomena is more likely caused by accretion state transitions instead of varying obscurations
- ✓ exclude those too dim to be detected by FXT ($F \leq 10^{13} \text{ erg s}^{-1} \text{ cm}^{-2}$, sensitivity for an exposure of $\sim 1000 \text{ s}$)
- ✓ exclude those have been scheduled for long-term and regular monitoring by other X-ray telescopes

□ Cycle-1 (pre planned target, PI: Hu@EPSC):

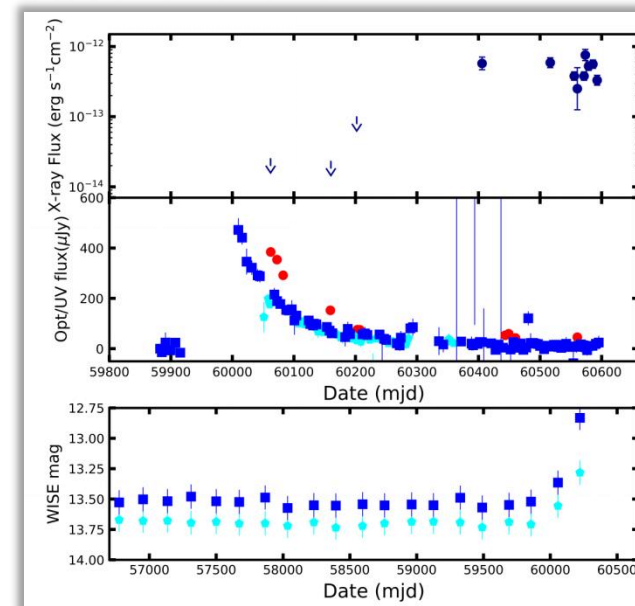
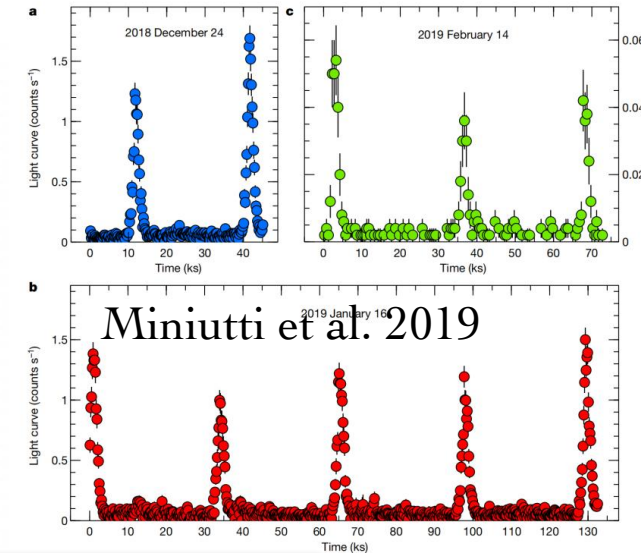
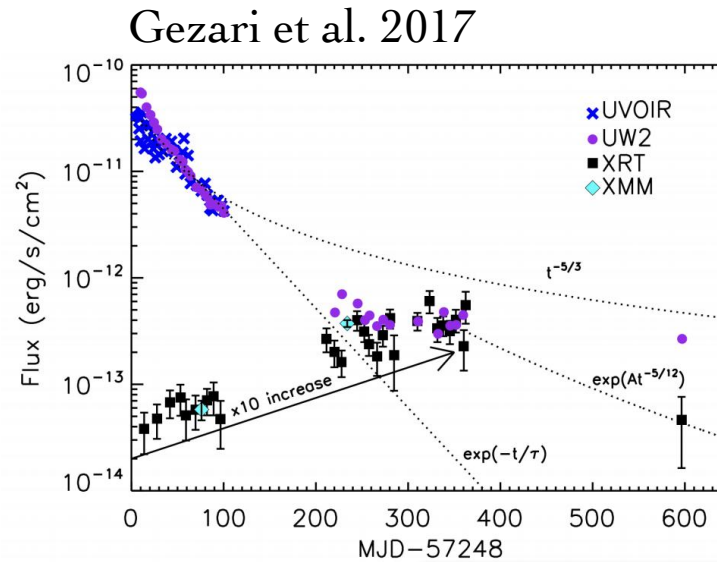
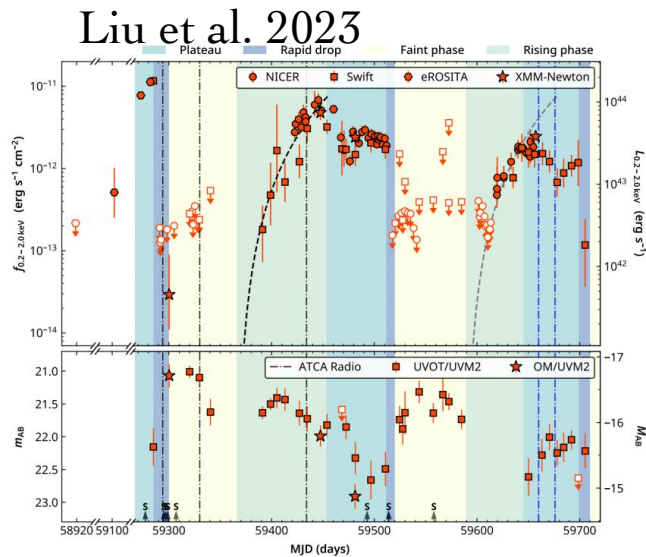
- ✓ perform monthly observations
- ✓ total number: 43 sources
- ✓ requested total exposure: $\sim 220 \text{ ks}$
- ✓ already observed: 30 observations of 18 sources
- ✓ analysis in progress



J.W. Hu, H.Q.Cheng, W.J. Zhang



FXT: monitoring of know TDEs



DIVERSE VARIABILITY PATTERNS !

Frequent monitoring of possible late time X-ray emission for > 30 TDEs (from late July)

Exposure time: ~ 1200 s per observation

Cadence: once (twice) per month

QPEs: cadence of few orbits, longer exposure
longer exposure time for known QPEs

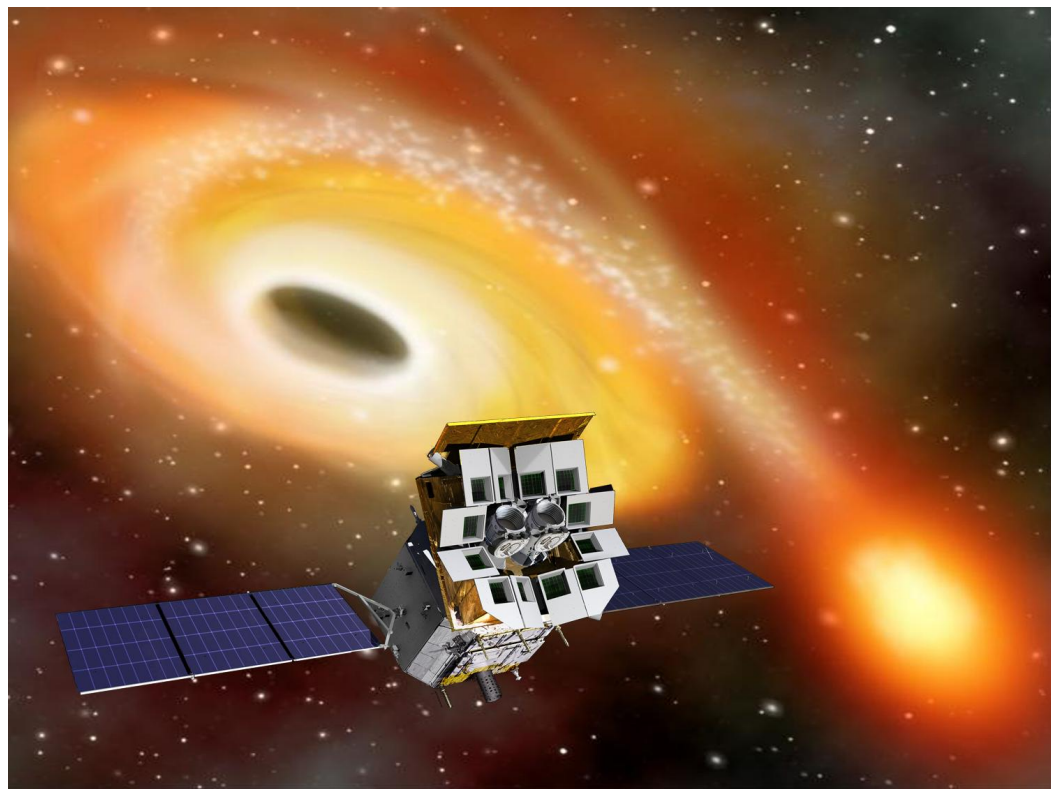
delayed X-ray
thermal emission: ~ 70 ev

optical outburst: 2023

IR brightening: 2023



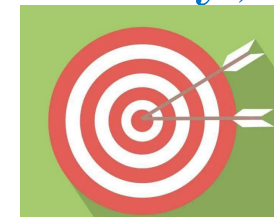
Summary



EP-WXT:

- ✓ Monitoring of known AGN at different cadence
 - > 1000 AGNs, with > 50 showing variability > 10
- ✓ Discover new TDEs candidates, long-term transients
 - several TDE (candidates), IMBH-TDE, jetted TDE, peculiar long-term transients
- ✓ Catch flares at real-time
 - e.g. PHL 1811, varies > 100 within few days
- Monitoring of nearby galaxies ('foced photometry')

有的放矢



EP-FXT:

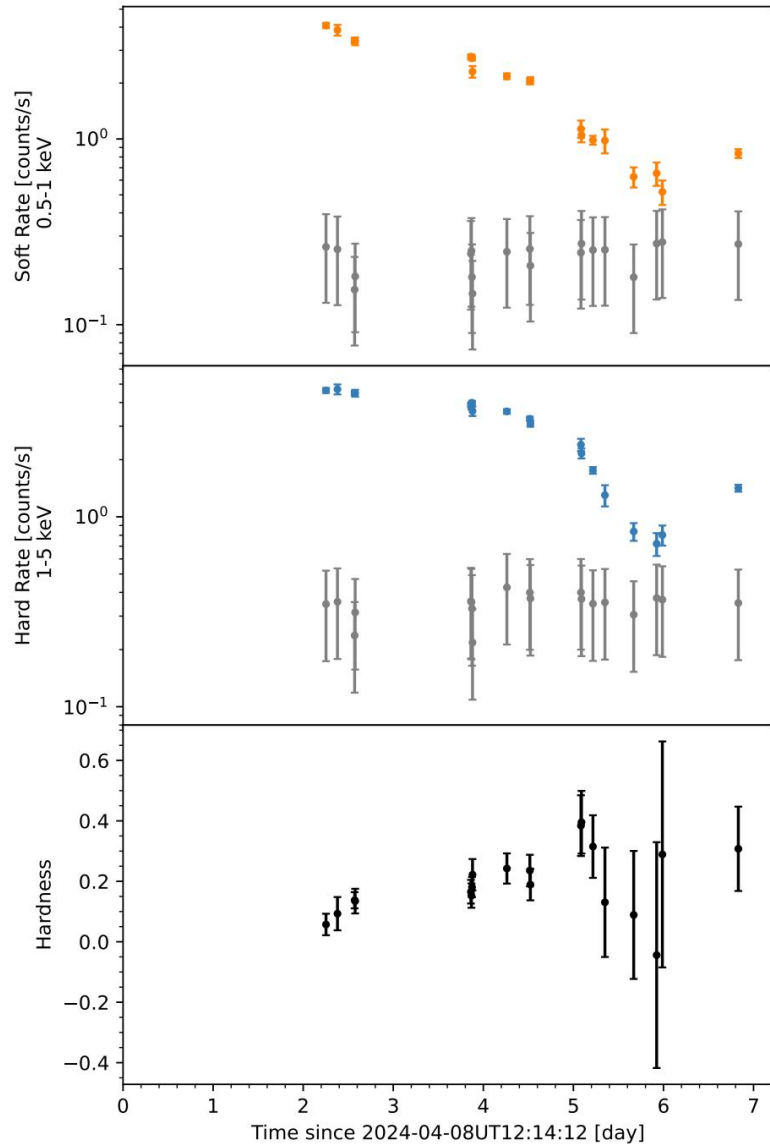
- Monitoring of Highly Variable AGN with EP-FXT
- Monitoring of TDEs with EP-FXT
 - catch one with delayed X-ray brightening
- QPEs.....

please visit: <https://ep.bao.ac.cn/ep/>

contact us: ep@nao.cas.cn, Prof. Yuan, Prof. Jin



EP240408a

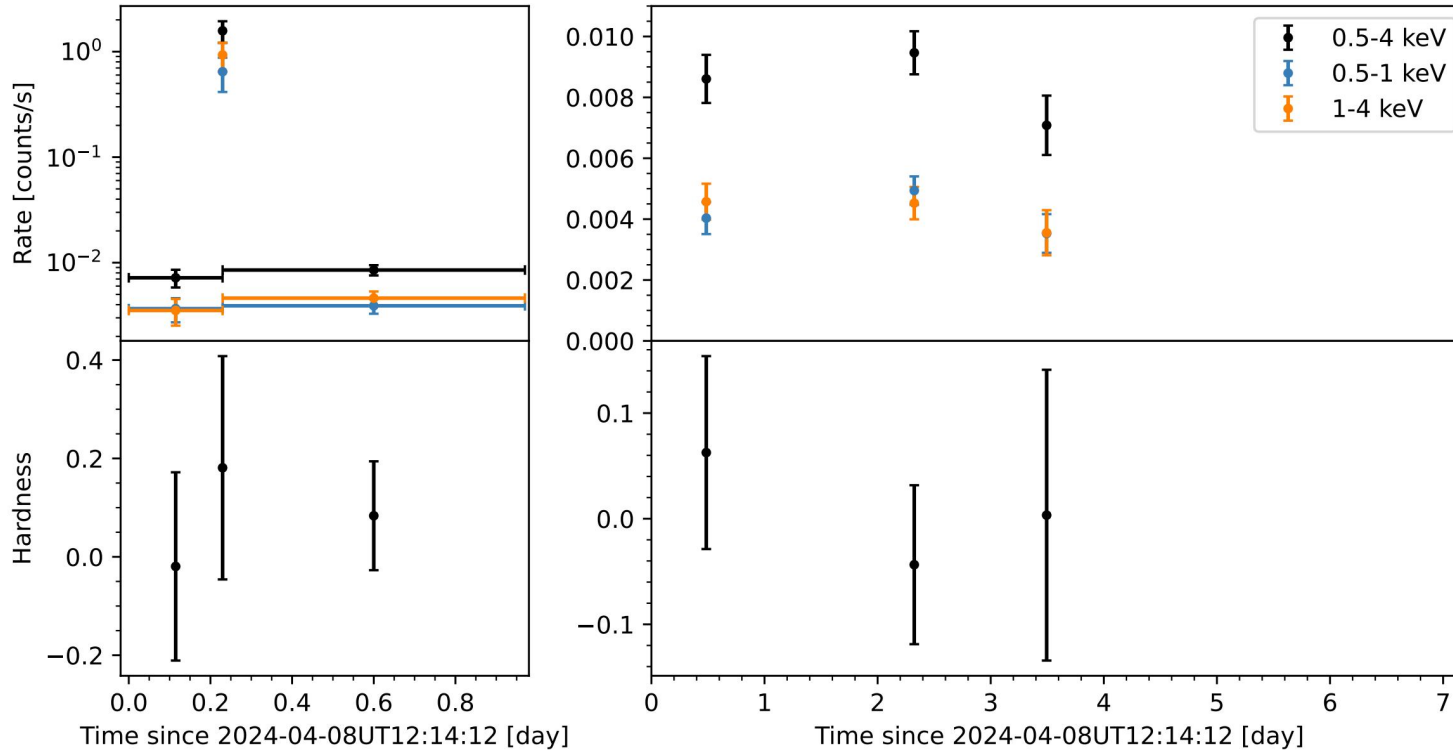


The spectrum hardens during the shallow decay phase, and becomes softer in the observation 7204340101 that was taken ~ 6 days after the trigger. We also present the evolution of the XTI spectrum in Fig. 8, where an apparent hardening of the spectrum with time can be seen in the first 4 observations. The best-fit parameters of the absorbed power-law model are summarised in Table 2

Interestingly, the count rate shows some what increase again on day 7 as measured by NICER (Obs ID 7204340106).



EP240408a



(ObsID 1360000515). The spectral shape cannot be constrained due to limited source counts. Interesting enough, the flare reaches a flux of a few times 10^{-9} erg cm $^{-2}$ s $^{-1}$, 300 times the averaged value of the persistent emission before and after the flare. The measured fluence of the flare is $5^{+12}_{-2} \times 10^{-8}$ erg cm $^{-2}$.



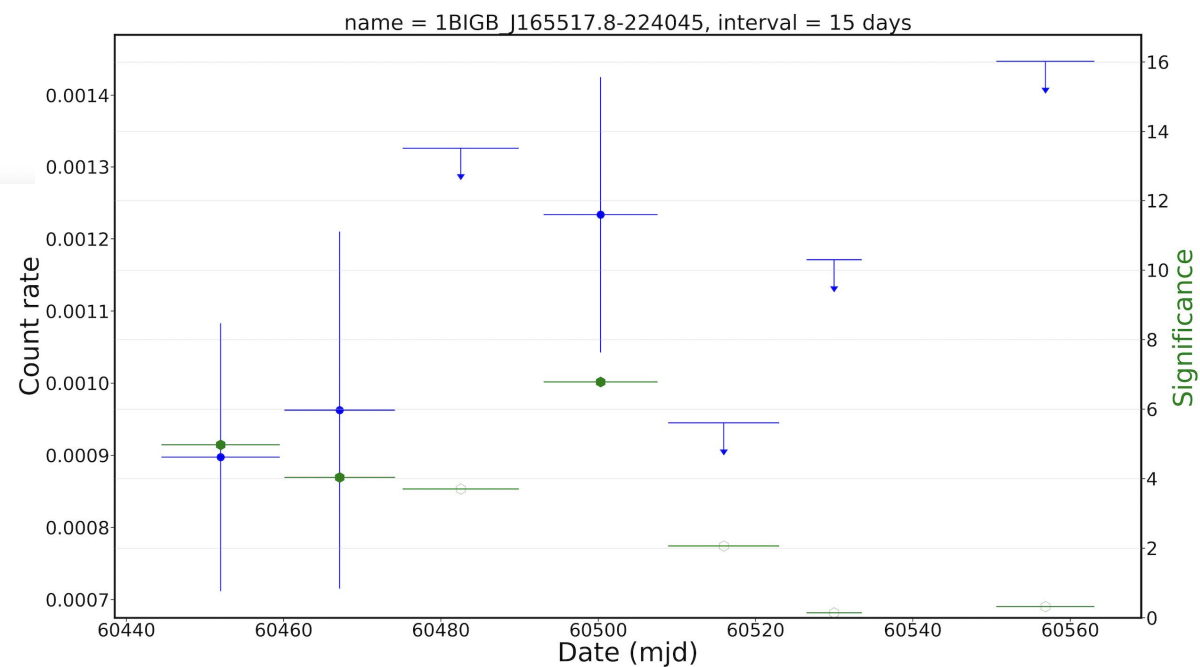
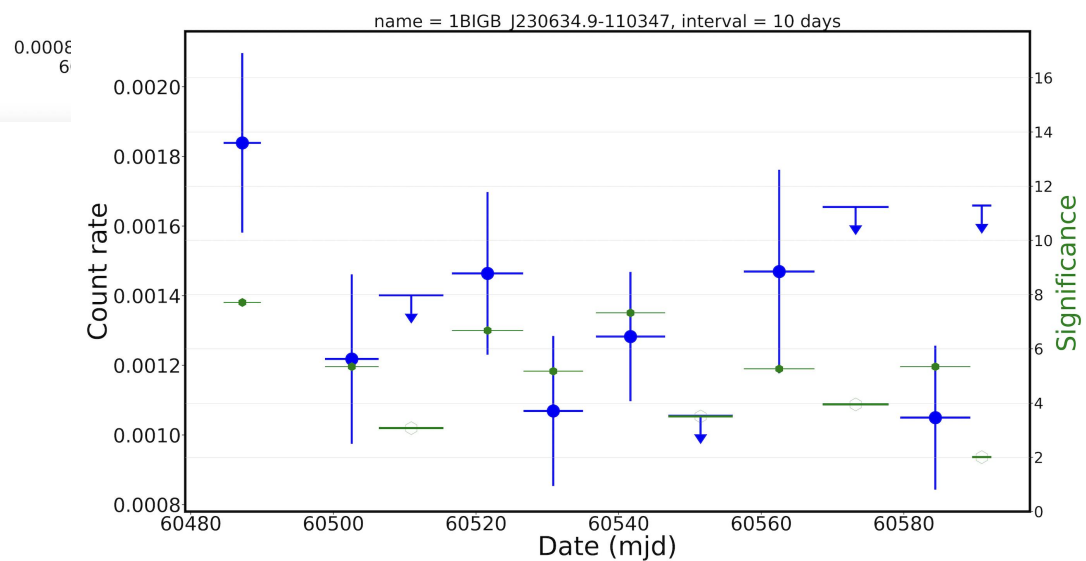
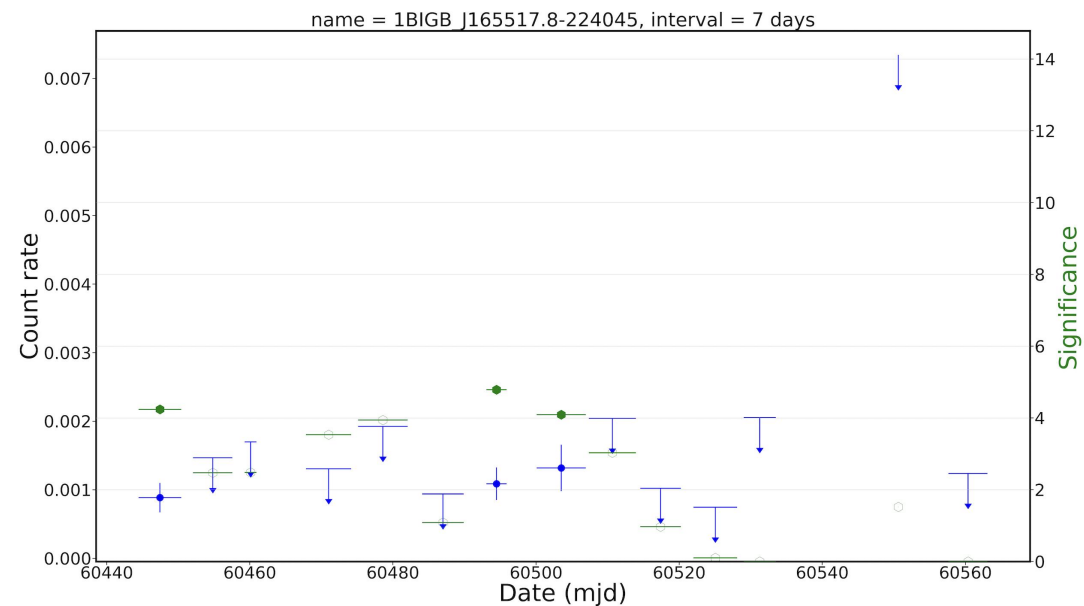
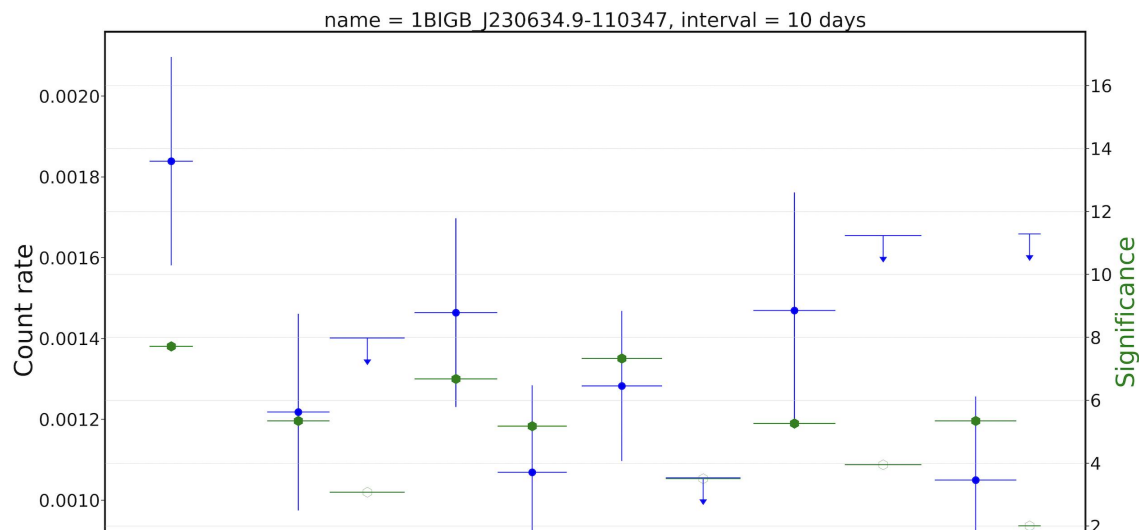
TDE key project





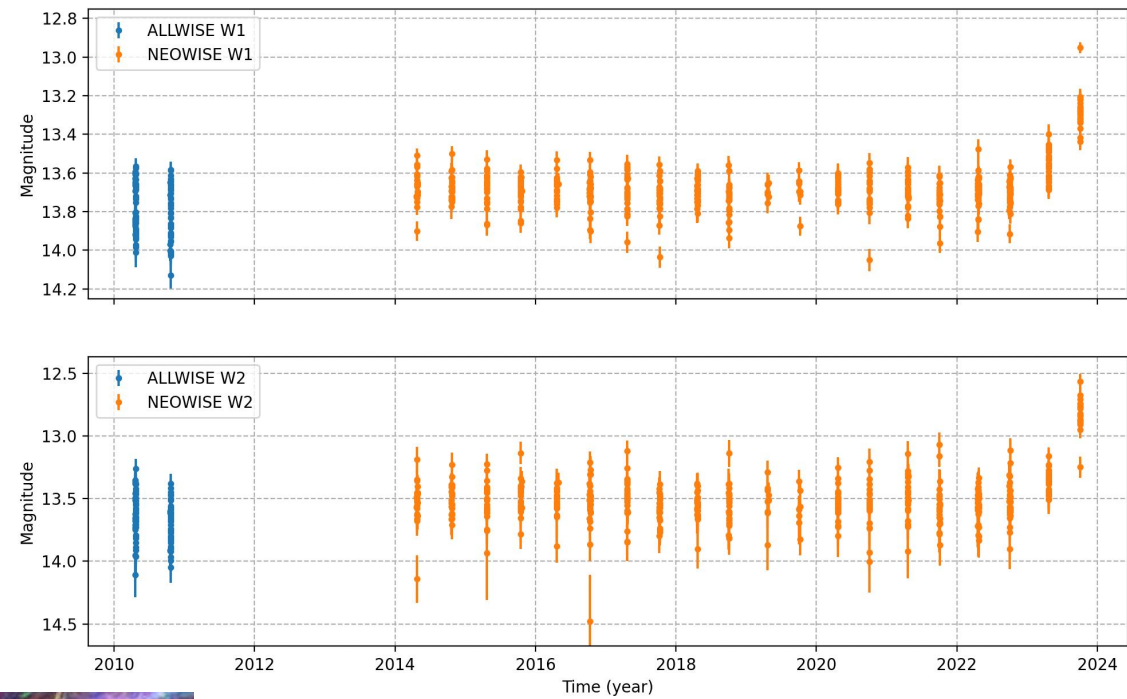
AGN key project





AT2023cvb

- ra: 288.607000 dec: 41.669244



AT 2023cvb

RA/DEC (2000)

19:14:25.680 +41:40:09.28

288.6069997 +41.6692434

Type

TDE

Redshift

0.071

Discovery Report

Classification Report

Related AstroNotes: 2023-102

Reporting Group	Discovering Data Source	Discovery Date	TNS AT	Public	Discovery Mag
ATLAS	ATLAS	2023-03-06 14:47:31.776	Y	Y	17.33

Filter

orange-ATLAS

Reporter/s

J. Tonry, L. Denneau, H. Weiland, A. Lawrence, R. Siverd (IfA, University of Hawaii), N. Erasmus, W. Koorts (South African Astronomical Observatory), J. Anderson (ESO), A. Jordan, V. Suc (UAI, Obstech), K. W. Smith, S. Srivastav, D. R. Young, S. J. Smartt, J. Gillanders, M. Fulton, M. McCollum, T. Moore, J. Weston (Queen's University Belfast), L. Shingles (GSI/QUB), A. Rest (STScI), T.-W. Chen (TUM/MPA), M. Nicholl (Birmingham), C. Stubbs (Harvard), J. Sommer

N

E

S

W

is outside the SDSS footprint.

J2000

19:14:25.680

+41:40:09.280

FoV: 2.38"

NED

PanSTARRS-1

WISE

SIMBAD

SkyMapper

DSS

DECaLS

VizieR

ADS

summary