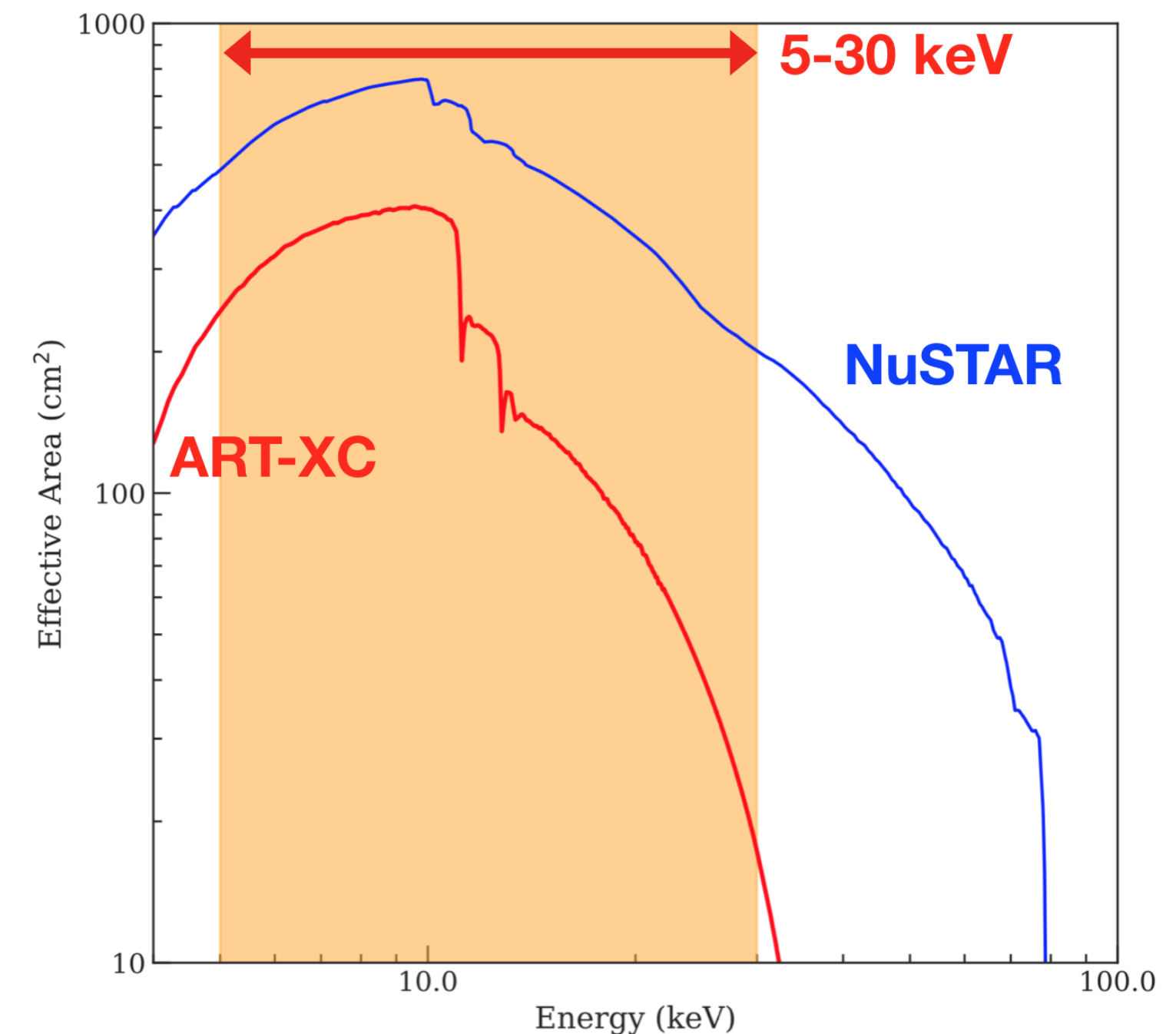
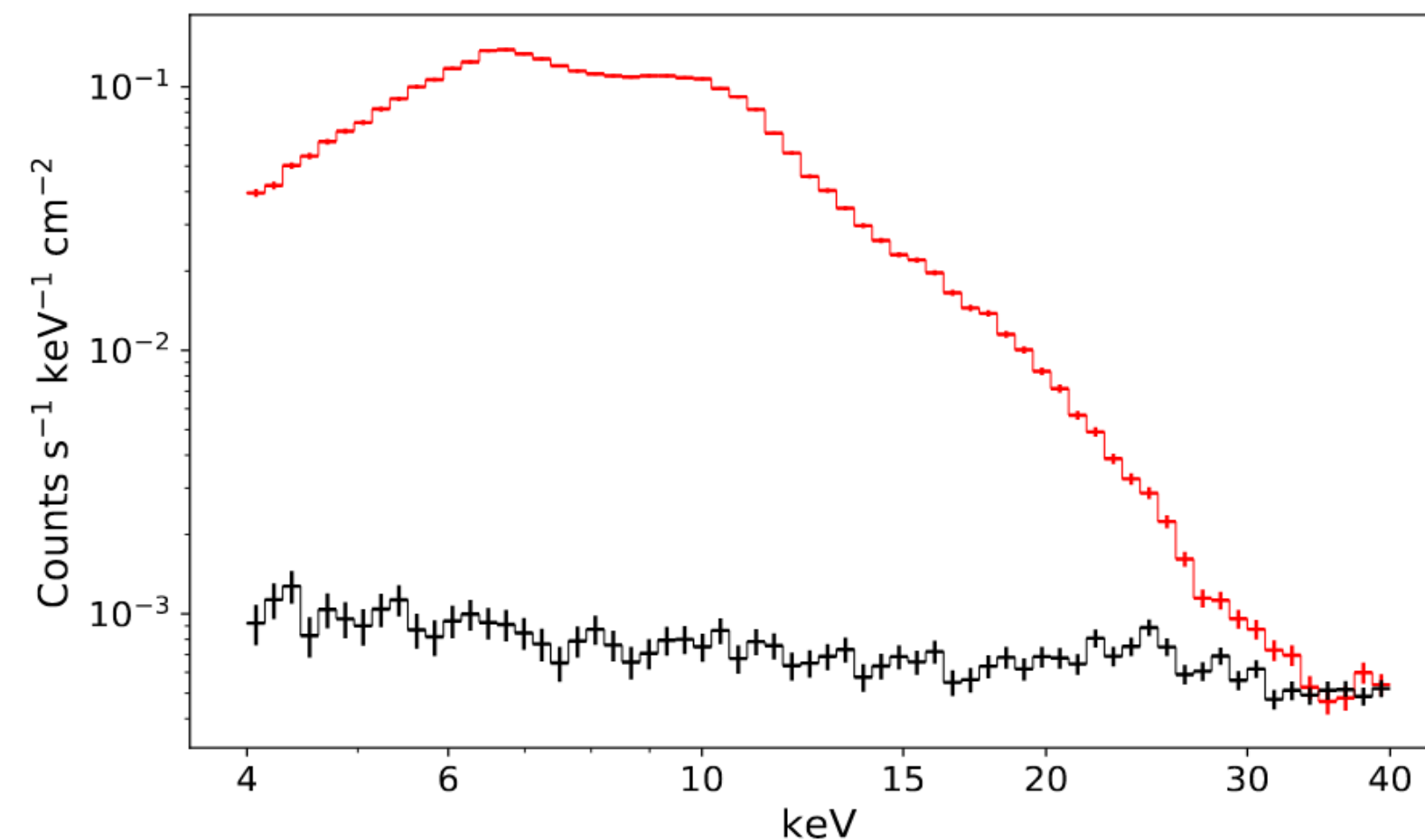
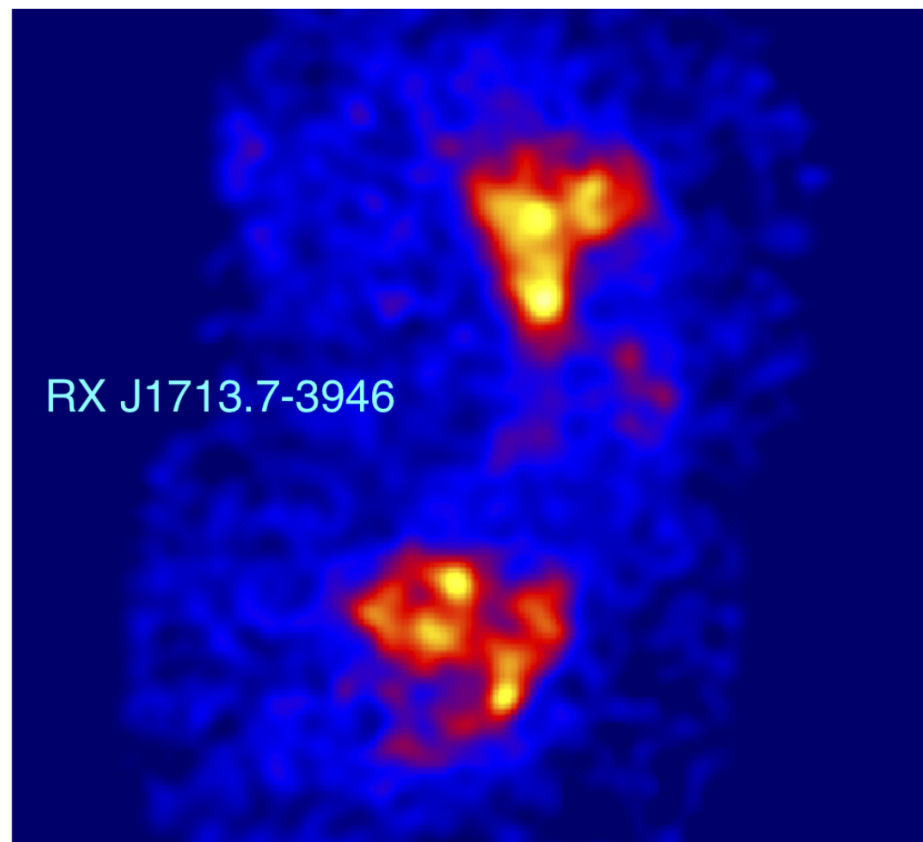
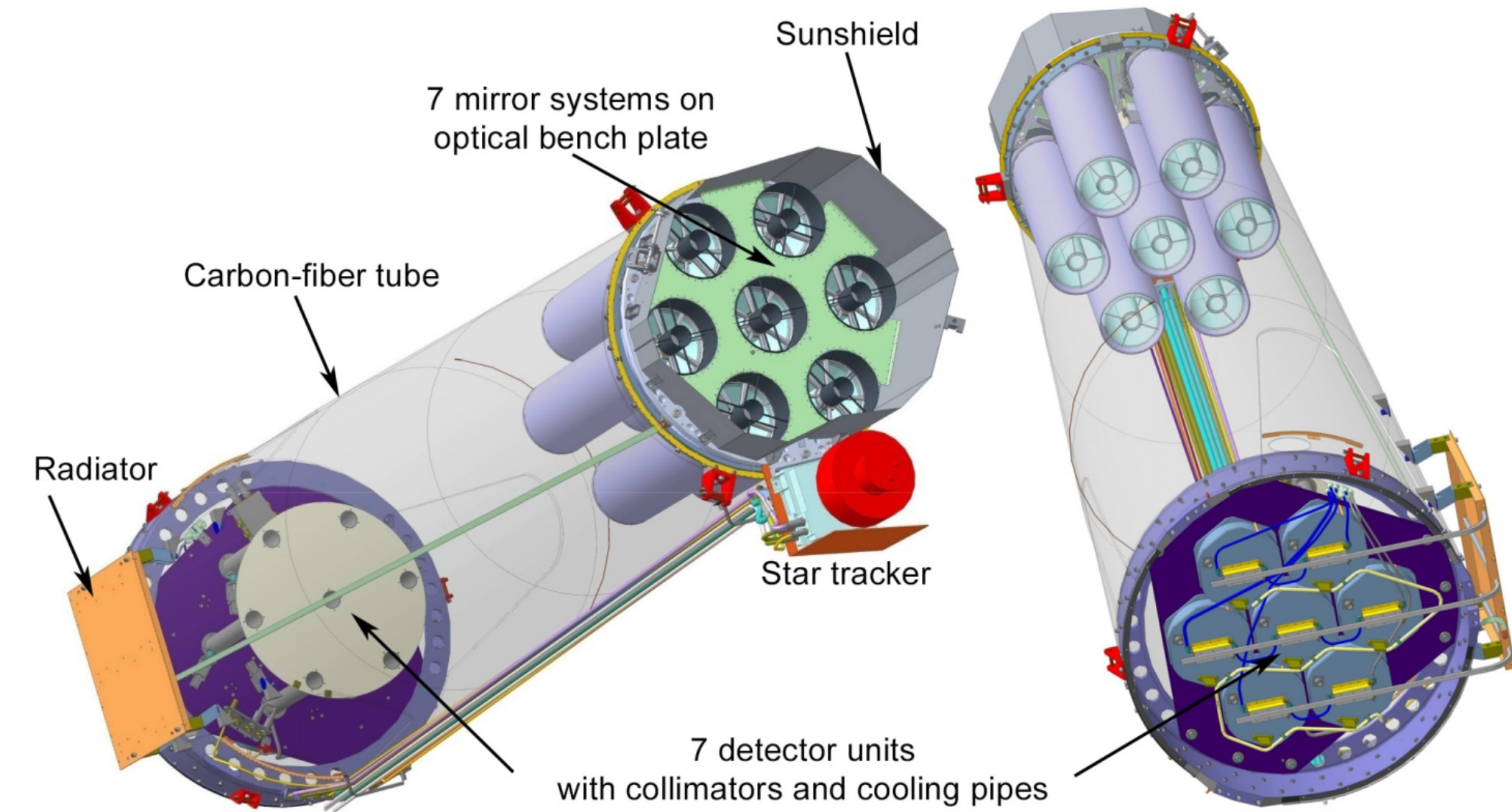


# **The 200 square degree ART-XC NEP survey**

**Chien-Ting Chen (USRA, NASA MSFC),  
with Steven Ehlert, Douglas Swartz, Dan Stern and the IKI ART-XC Team.**

# The Mikhail Pavlinsky ART-XC Telescope

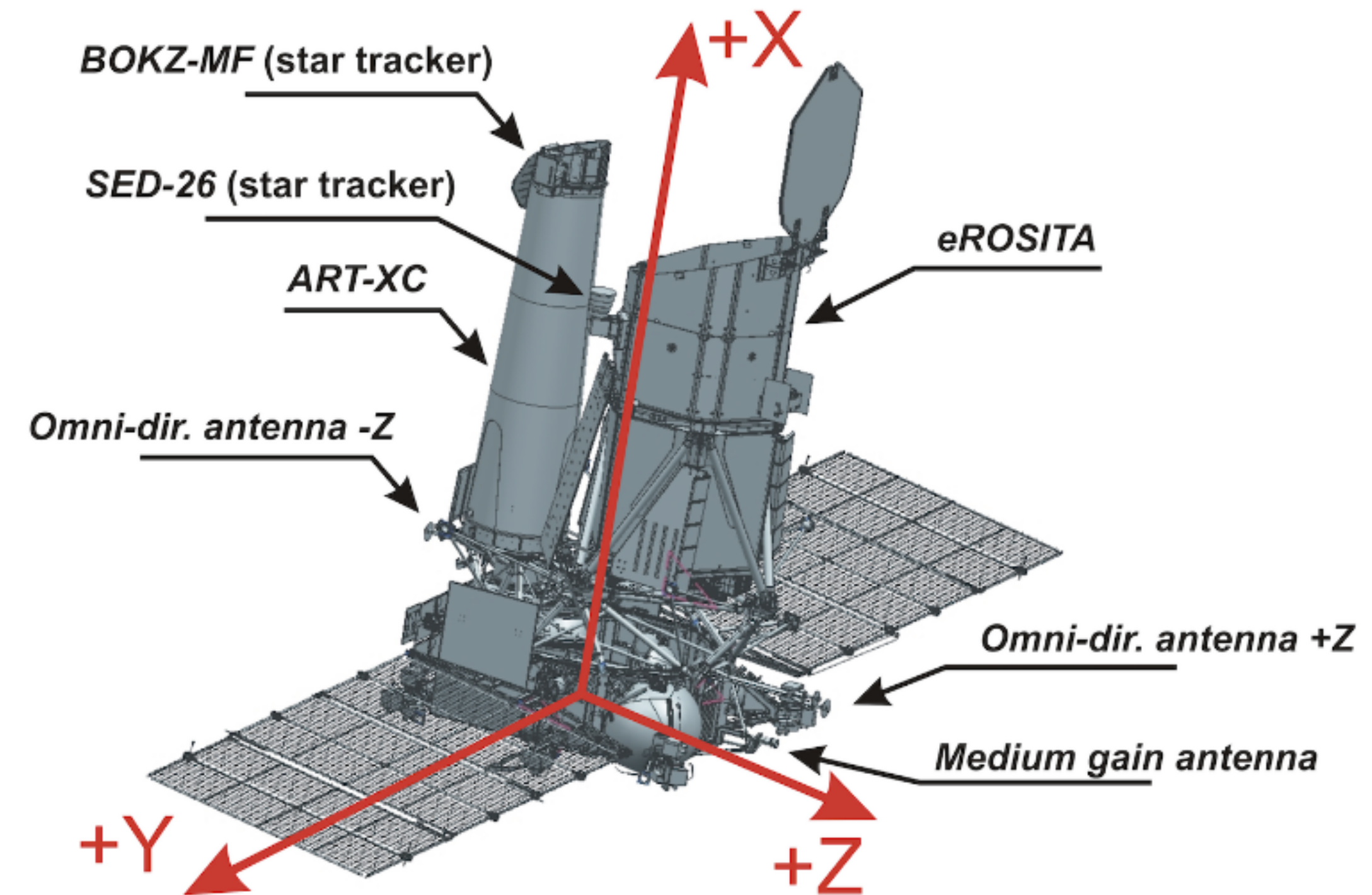
- ART-XC is one of the two instruments (the other is eROSITA) carried by the Spectrum-Roentgen-Gamma X-ray Observatory, a Russian-German mission
- ART-XC is comprised of 7 mirror modules (28 Ni/Co shells each) designed, fabricated and calibrated by MSFC, with a 30" HPD
- CdTe double-sided CdTe strip detector with 48x48 stripes, with a "pixel" size of ~ 46 arcsec
- Working energy range 5-30 keV





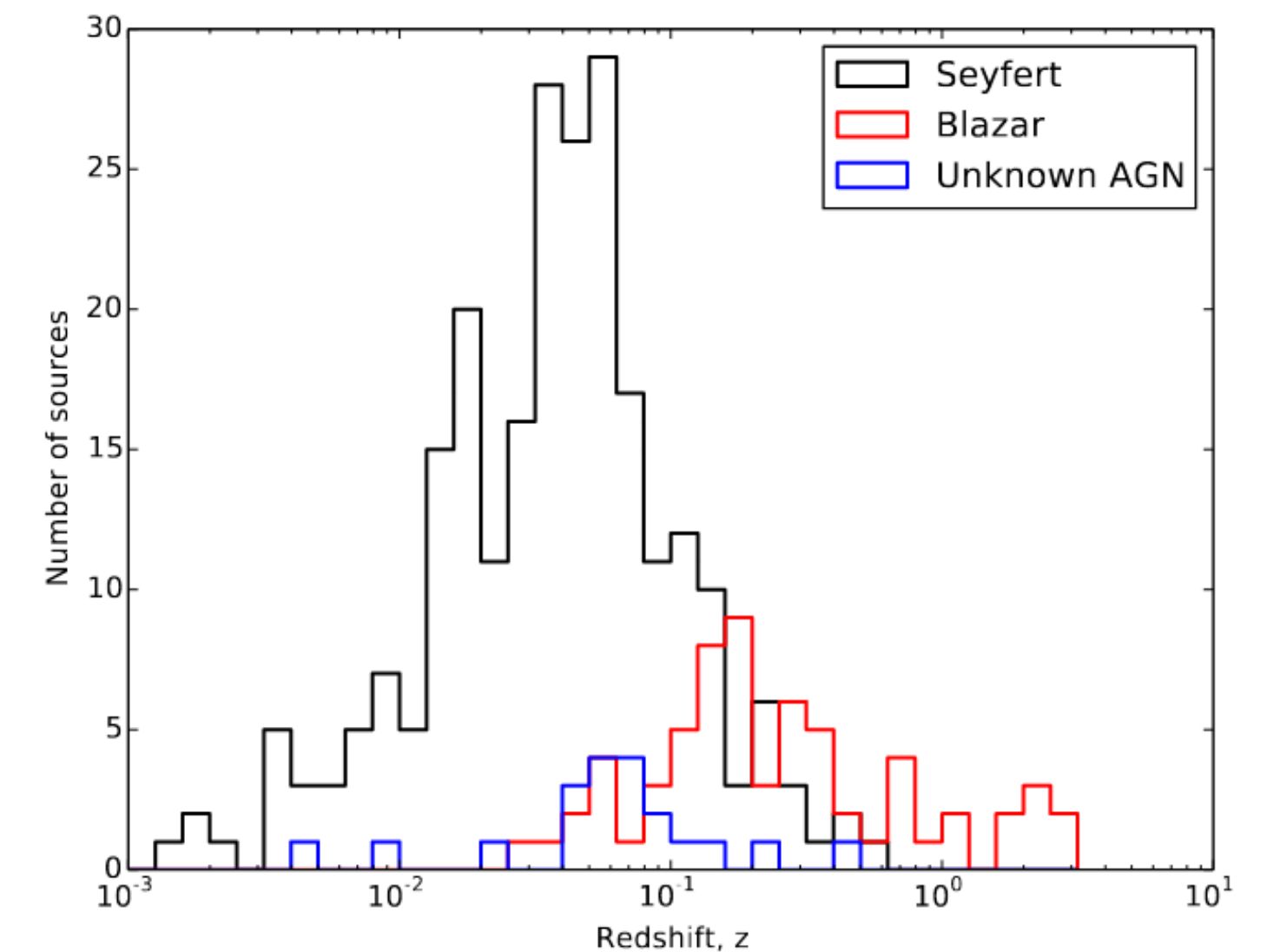
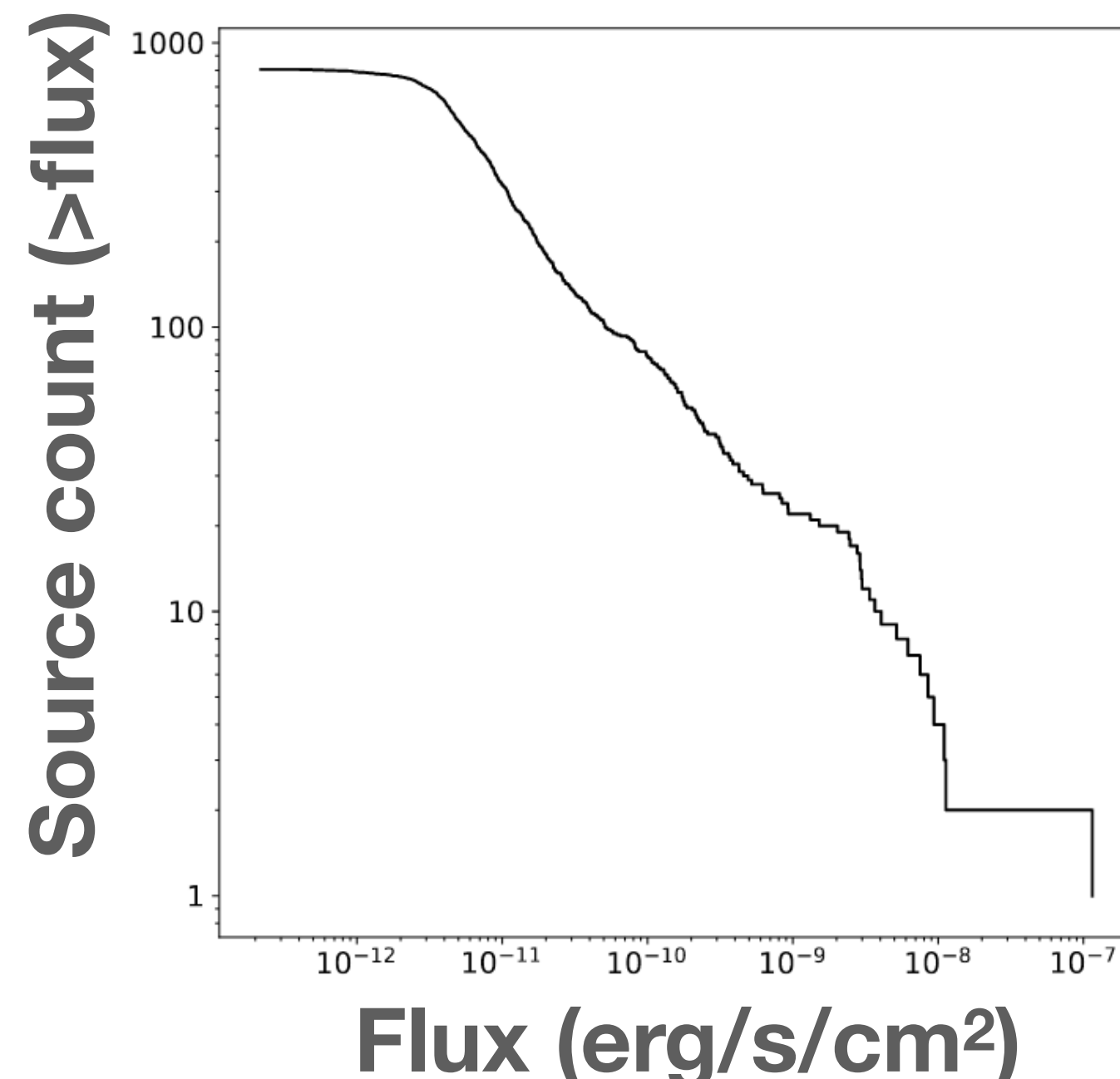
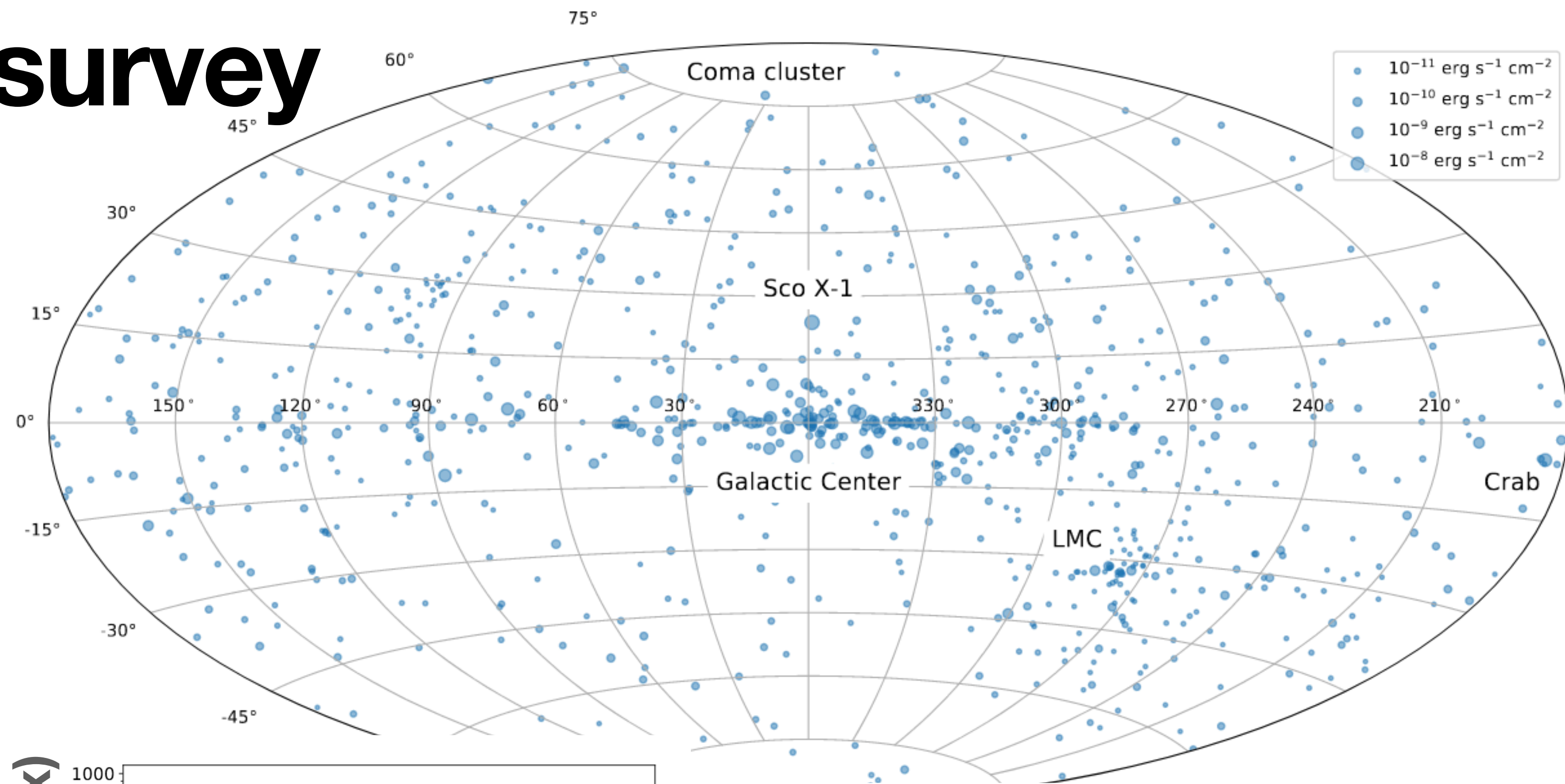
# Status

- SRG was launched in July 13, 2019, and started the all-sky survey since Dec. 2019.
- By the end of February, 2022, SRG has conducted 2+ years of the scheduled 4-year all-sky survey.
- eROSITA has been in safe mode since Feb. 26, 2022, but the eROSITA team will commence instrument health and technical checks later this year.
- ART-XC continues to operate and has been carrying out a galactic plane survey and occasional pointed observations more suitable for the hard X-ray telescope
- The SRG's schedule is available at [plan.srg.cosmos.ru/monthplan/](http://plan.srg.cosmos.ru/monthplan/)



# ART-XC all sky survey

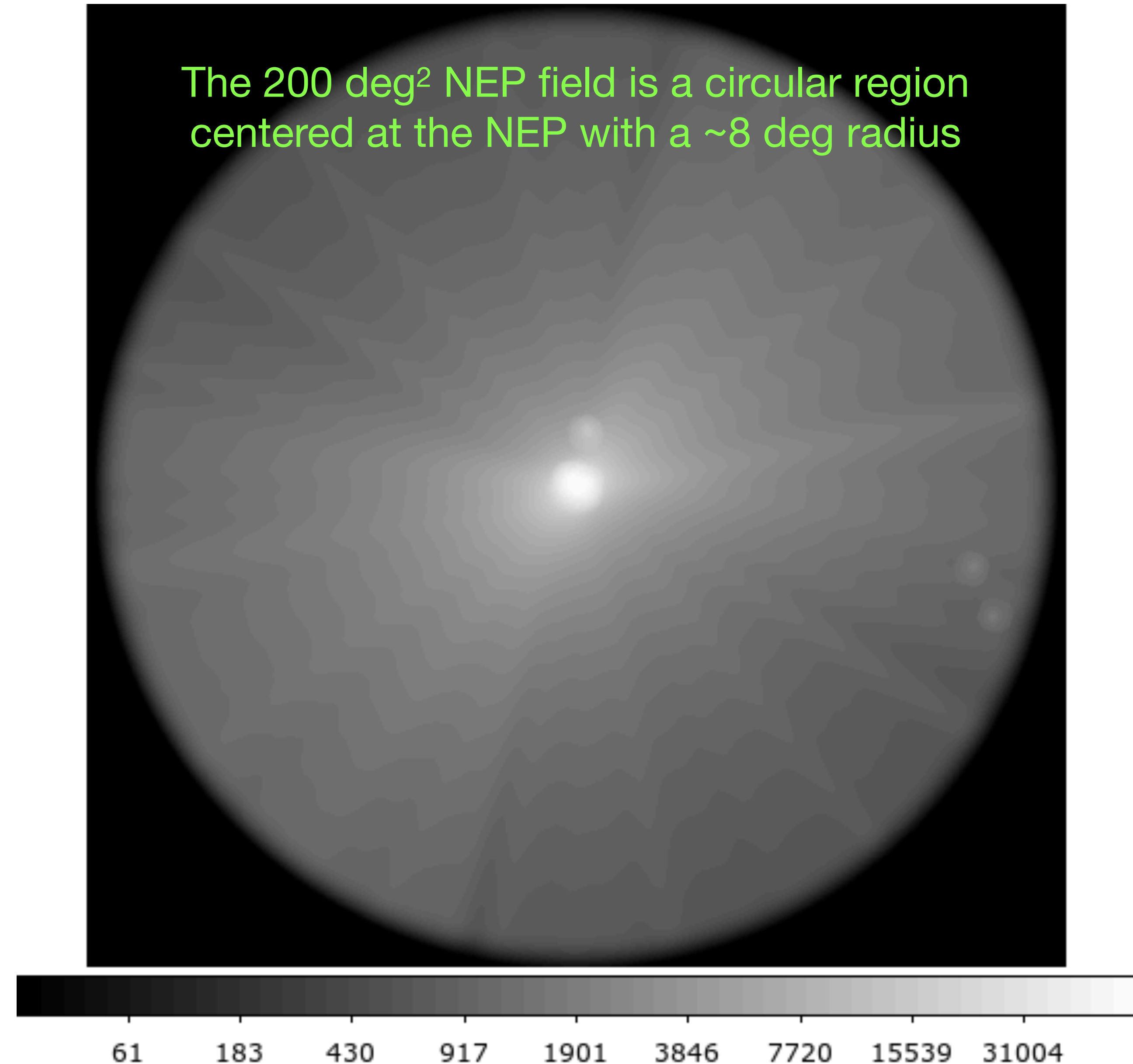
- First year all-sky survey results were published in Pavlinsky et al. (2021)
- Sensitivity is  $\sim 4 \times 10^{-12}$  erg/s/cm<sup>2</sup> in the ecliptic plane and  $8 \times 10^{-13}$  erg/s/cm<sup>2</sup> in the ecliptic poles
- 56% extragalactic sources





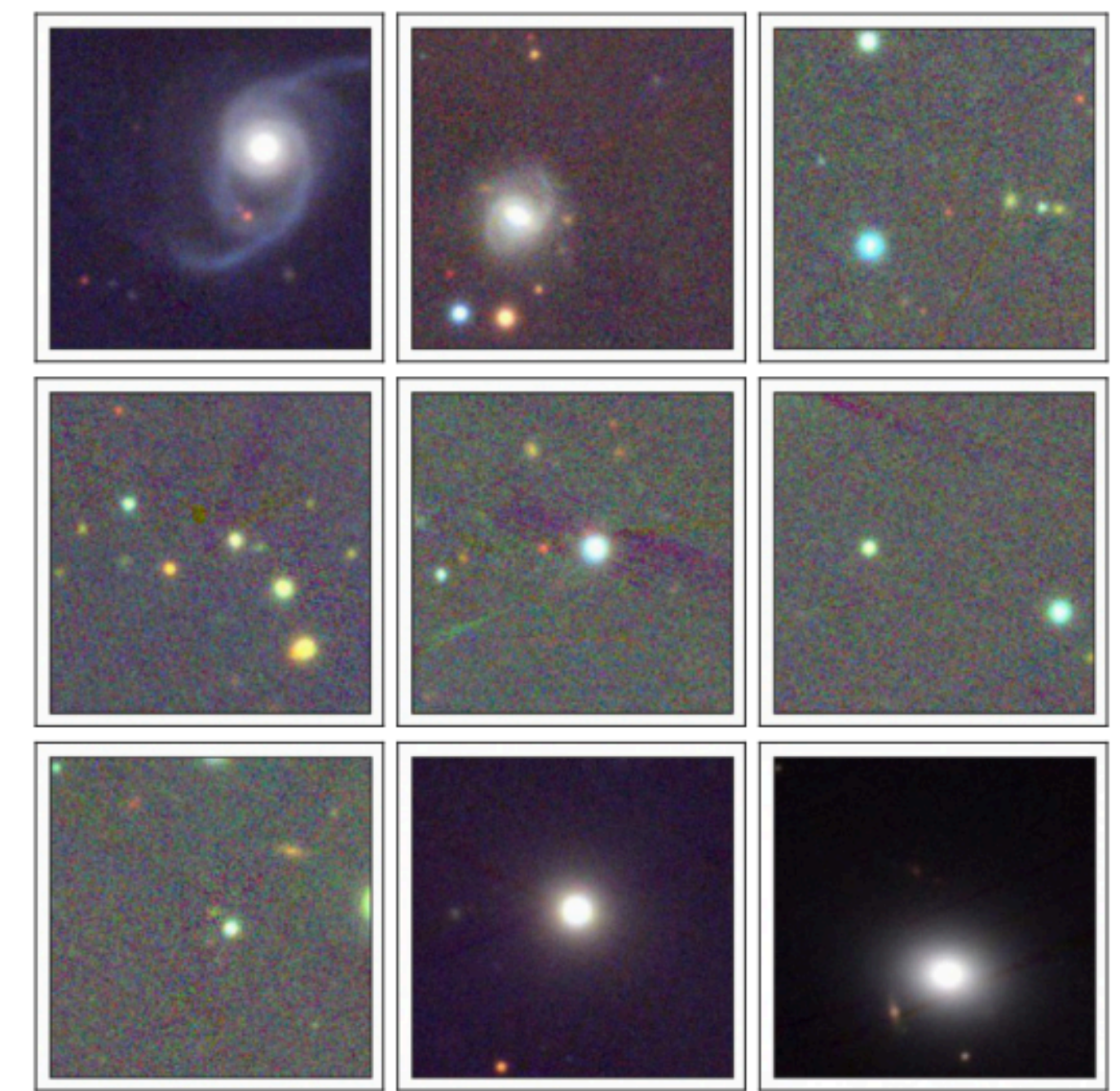
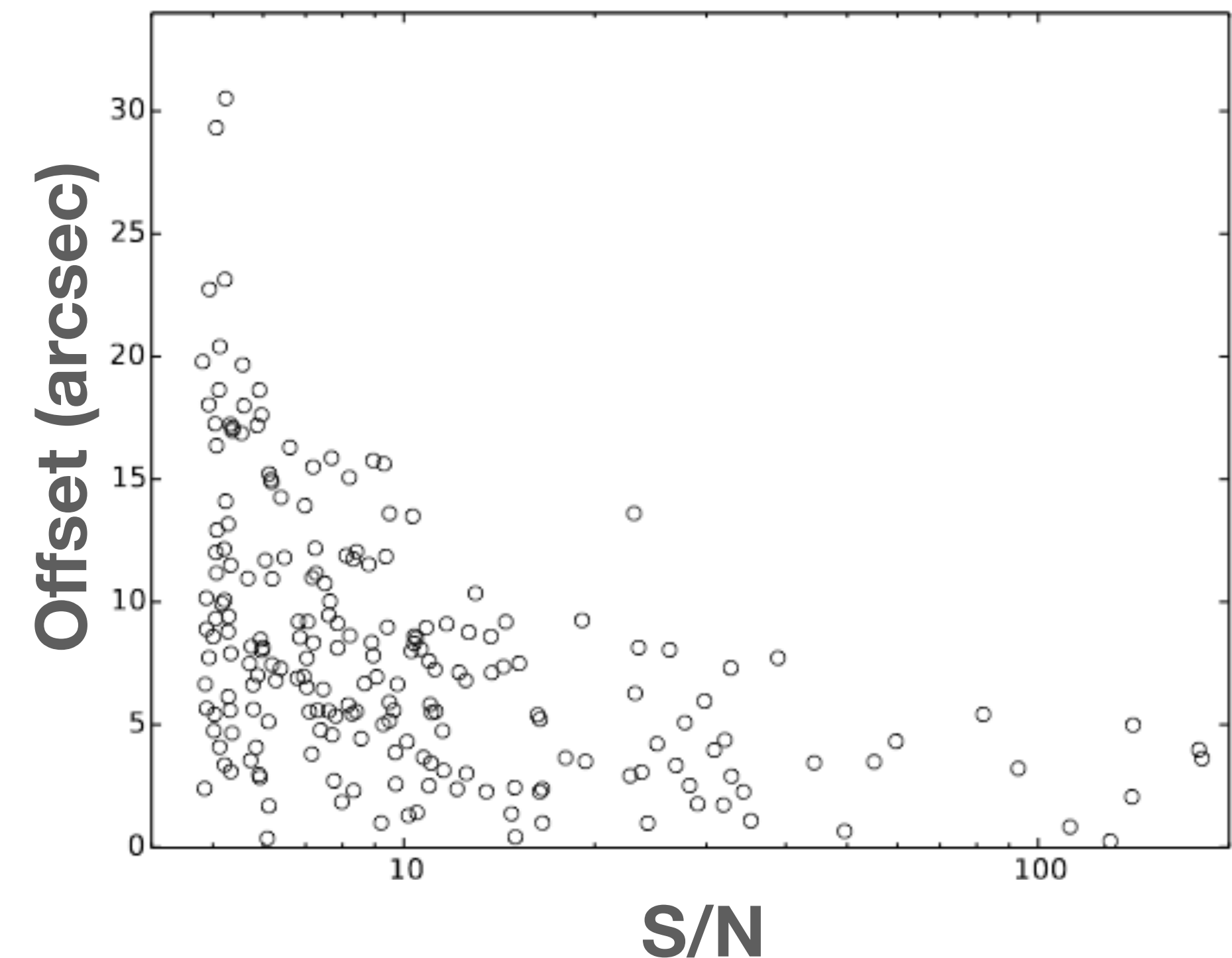
# ART-XC NEP Survey

- 2013 IKI and MSFC established a Cooperative Agreement to build the ART-XC mirror modules and 1 flight spare in exchange for data rights in the 200 square degree region centered at the North Ecliptic Pole
- SRG's all-sky survey pattern guarantees the ecliptic pole regions is sampled  $\approx 4\times$  deeper than the average sky position The first-year all-sky survey has 17 detected sources in the NEP region
- New data using the first two-years of data and updated source detection algorithms, and background studies have increased the number of sources to  $\sim 40$
- Flux limit in 4-12 keV is at  $>3\times 10^{-13}$  erg/s/cm<sup>2</sup>



# Multiwavelength matching

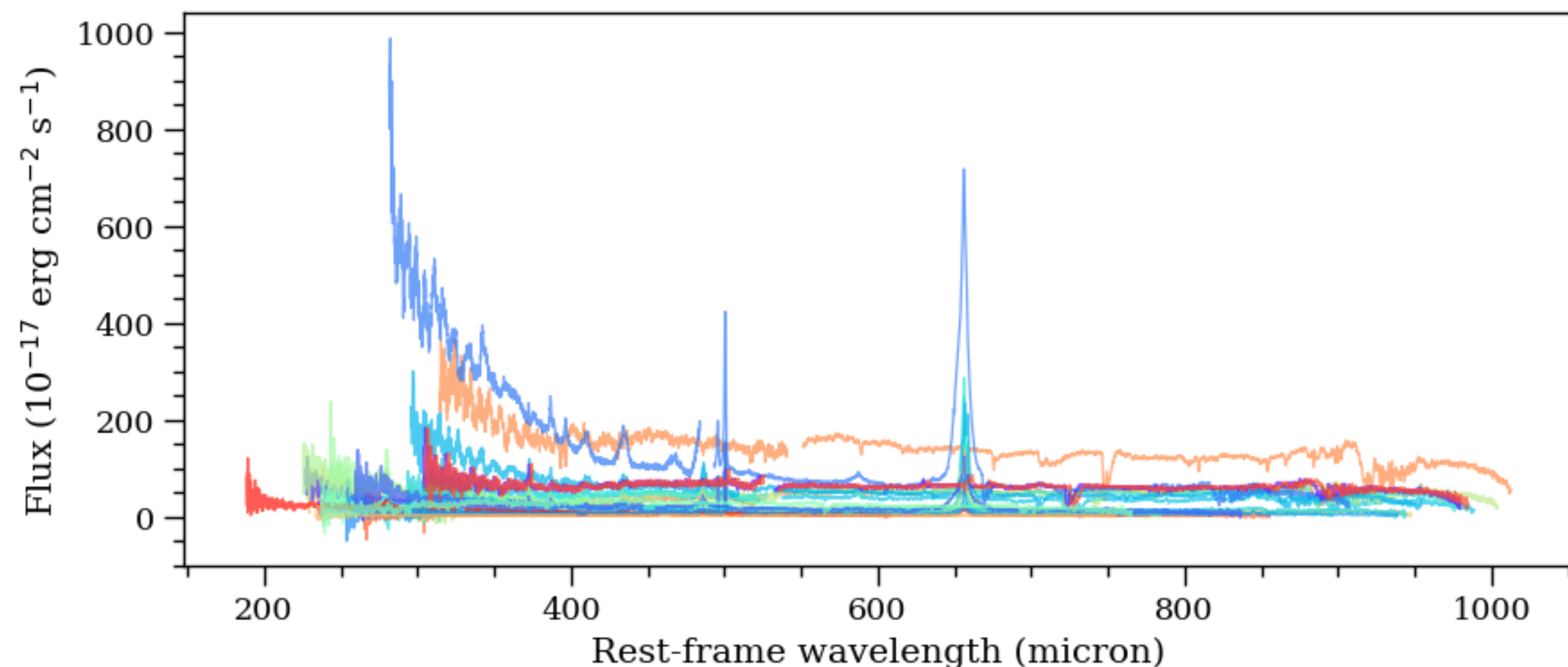
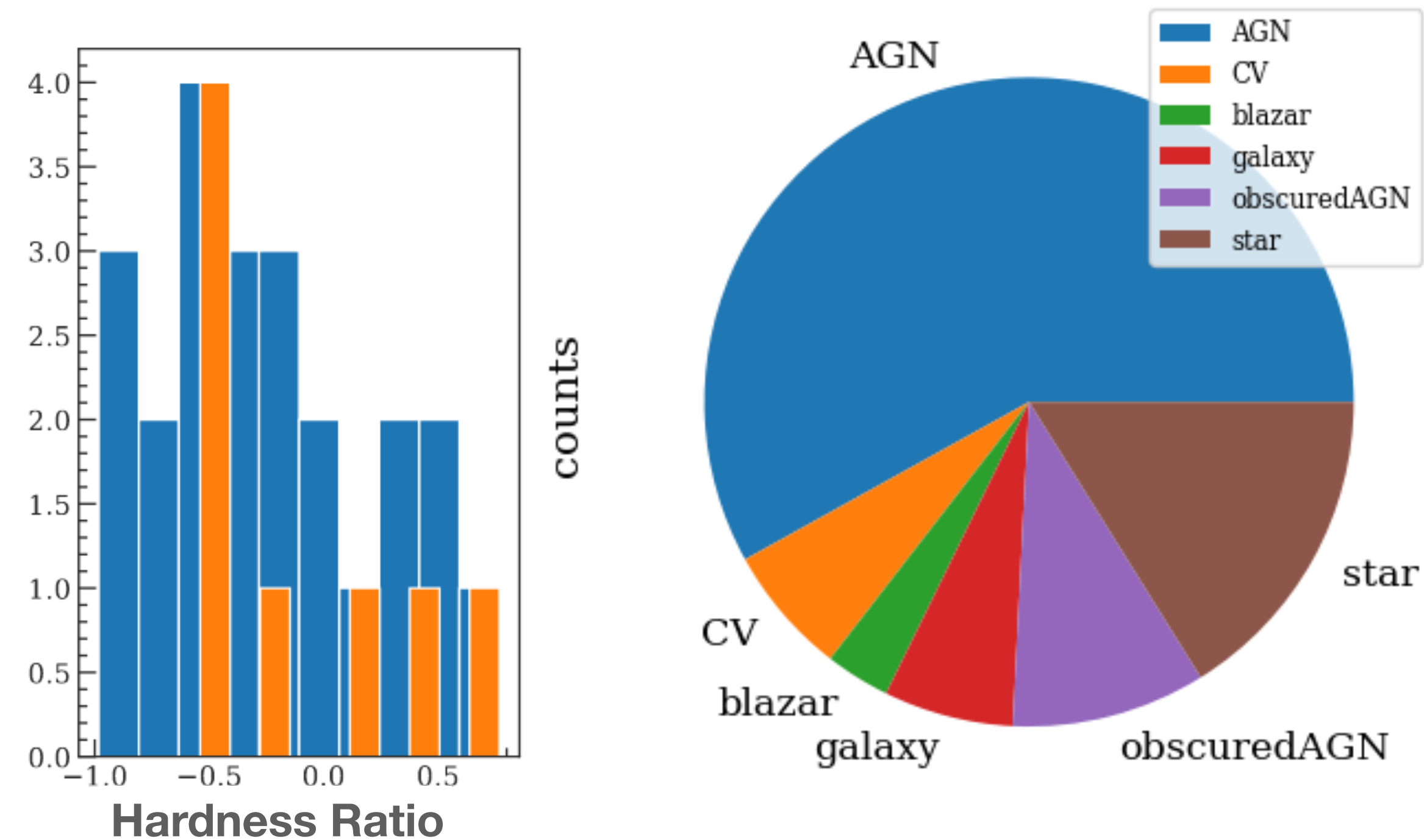
- All-sky survey results suggest the vast majority of the ART-XC sources has a reliable optical counterpart within  $\sim 10$  arcsec, with a small number of faint sources with offsets  $< 30$  arcsec
- ART-XC sources are generally bright targets, thus we first search for possible counterparts in existing X-ray and AGN catalogs, including Chandra CSC, 4XMM, Swift/BAT all-sky, Swift/XRT, ROSAT all-sky, and the Million Quasar Catalog within 30 arcsec
- Additional multiwavelength data from Pan-STARRS1 (PS1) DR2, 2MASS, and ALLWISE were retrieved for additional analysis
- We target  $\sim 30$  sources without existing spectroscopic redshifts with Palomar DBSP observations in 2022



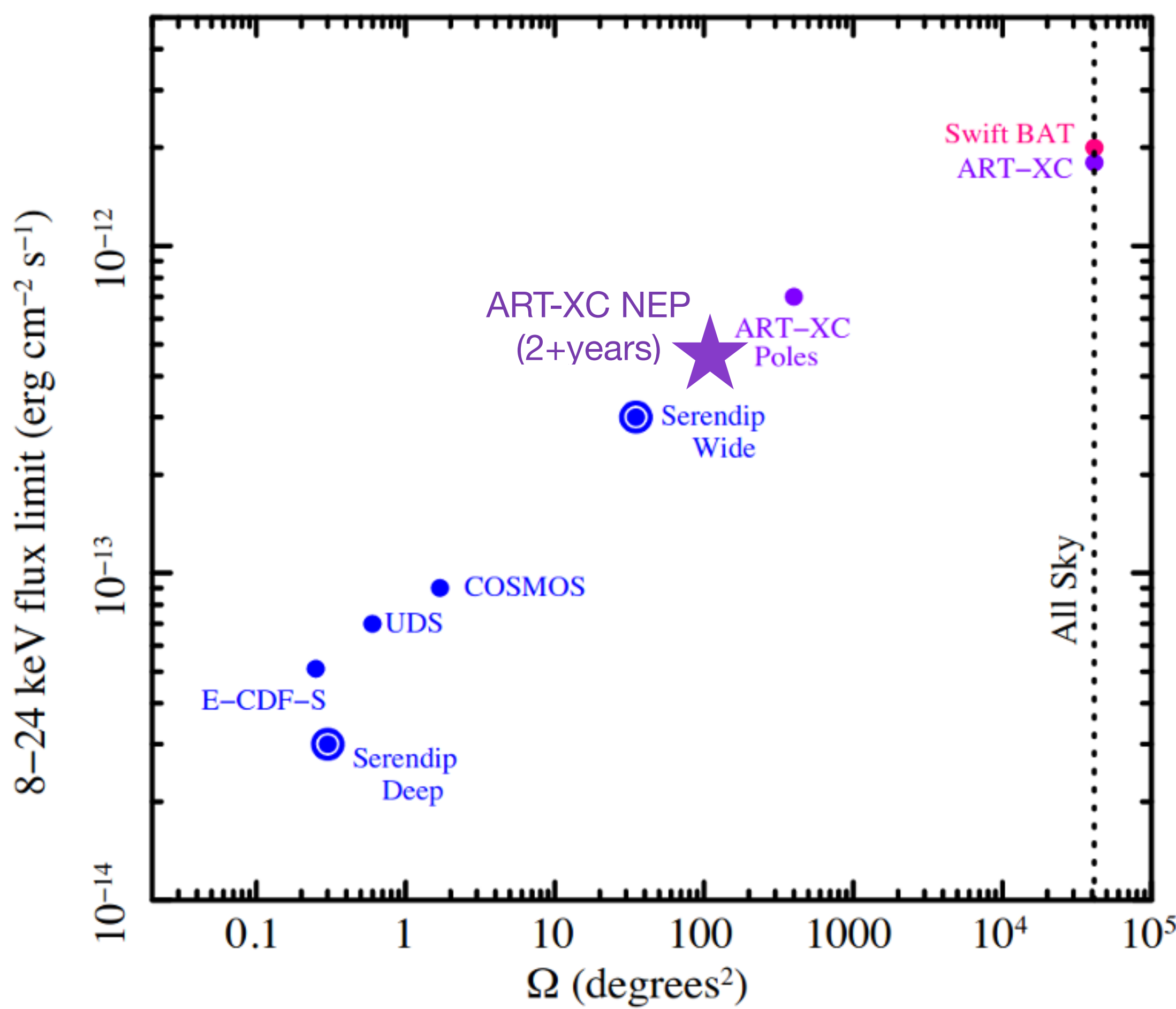
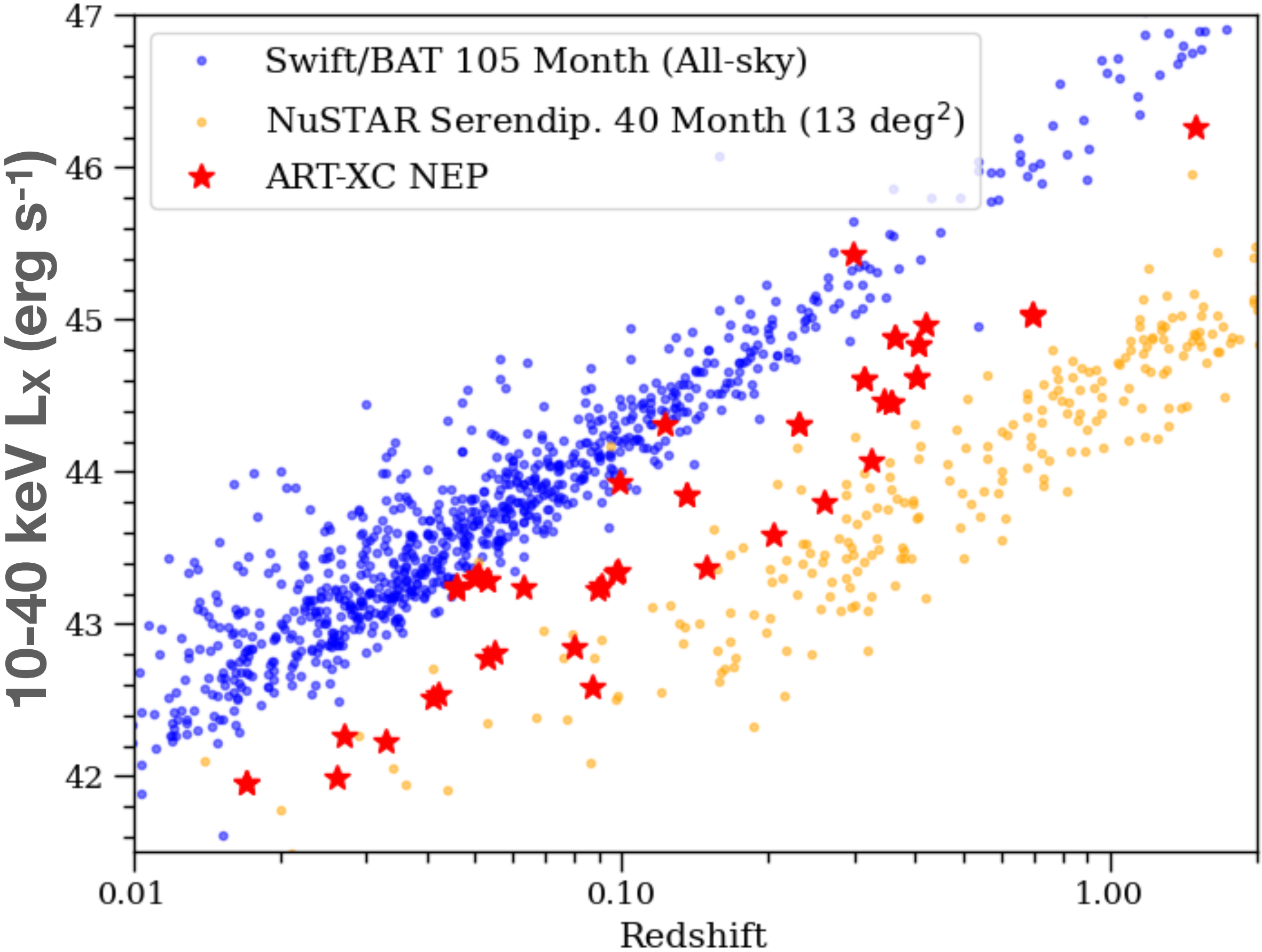


# Properties of the ART-XC NEP sources

- ART-XC shows a wide range of “hardness ratio” (with archival soft X-ray data, suggesting an unbiased hard X-ray selection)
- Majority of the ART-XC sources have AGN-like optical spectra.
- Optical counterparts show a wide variety of morphologies
- Redshift range 0.017-1.5 for extragalactic sources
- 2+year catalog paper is in preparation



# ART-XC NEP survey bridges the gap between the all-sky Swift/BAT and deep NuSTAR surveys



Brandt & Yang  
2021



# Conclusion and future updates

- MSFC is developing data analysis pipeline and software for processing ART-XC NEP data
- NEP data and software will be released via HEASARC upon the survey's completion
- Additional 3.5x3.5 deg "scan" observations are being conducted to increase the exposure depth at the edge of the NEP field
- A 2+year ART-XC NEP catalog will be released in the near future

