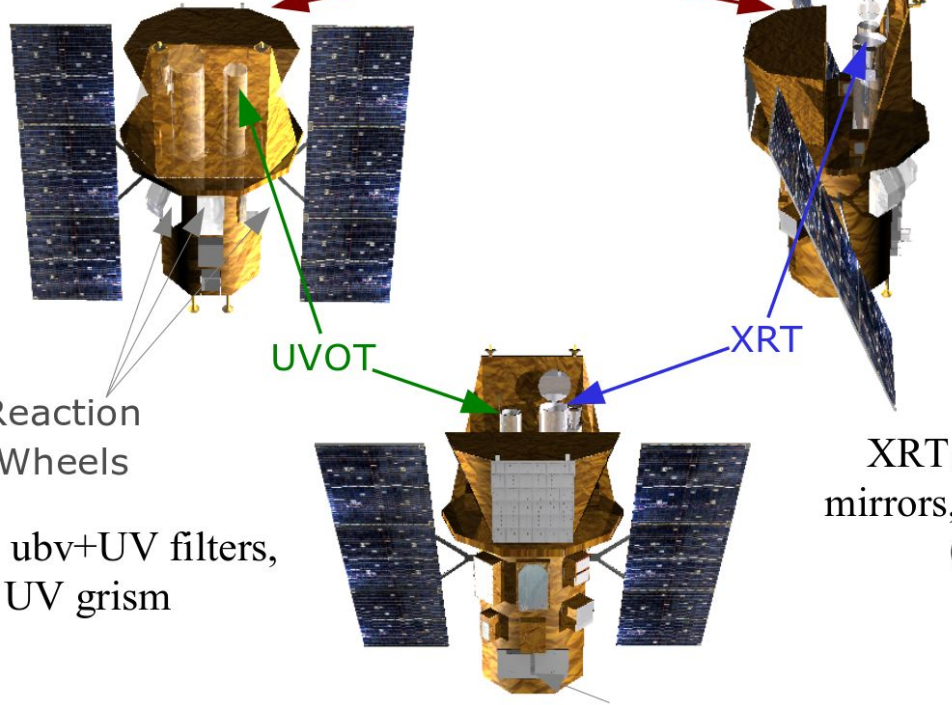
# Swift

BAT: Coded mask,
CZT detectors,
15-150 keV



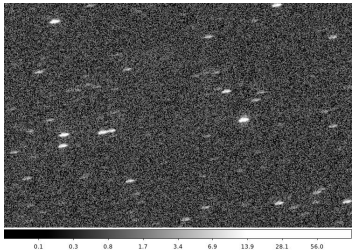

UVOT: ubv+UV filters,
+ UV grism

XRT: Wolter Type I
mirrors, CCD22 detector,
0.3-10 keV

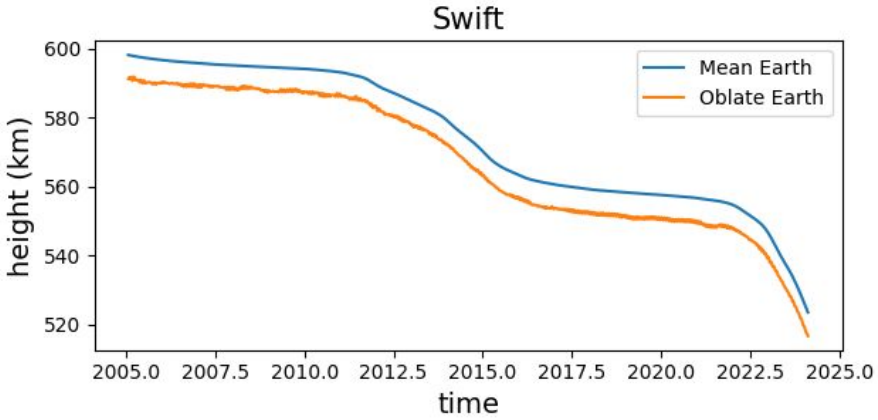
# Spacecraft Status

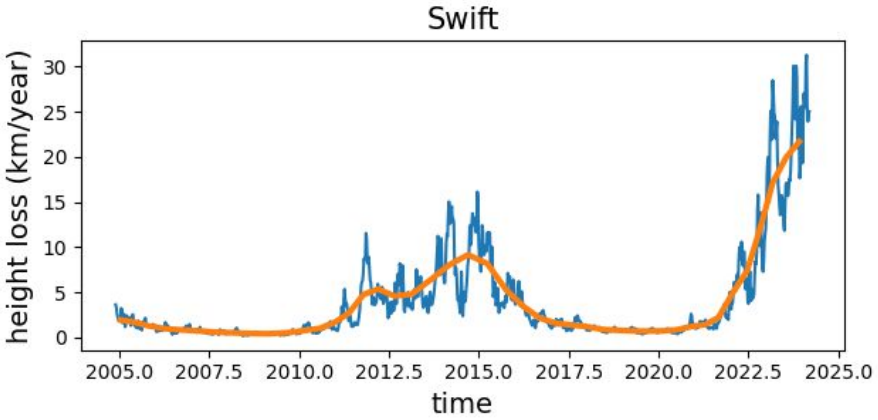
- Launched 2004-Nov-20T17:16 (~19.5 years ago)
- Pointing performance and safe hold episode
  - Pointing control performance degradation Summer 2023
  - One IRU (“gyro”) became noisy; only one other redundant gyro
  - Impacts
    - Significant pointing jitter increase, UVOT PSF degradation
    - Increased chance of star tracker “loss of lock” after long slews
    - IRU noise increased again in Spring 2024 leading to managed safe hold on March 15
  - Remedy
    - Spacecraft flight software upgrade required to fully utilize redundant gyro information
  - After update, Swift pointing is as good or better than after launch
    - XRT observations resumed Apr 03 and UVOT Apr 04.

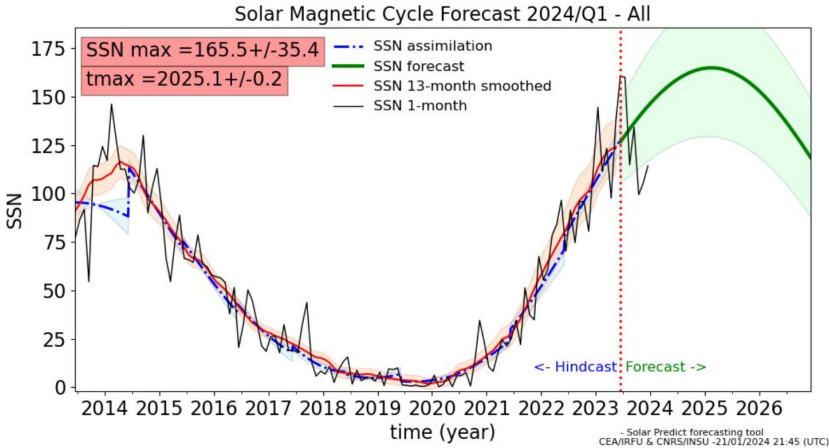
UVOT



# Swift Orbit



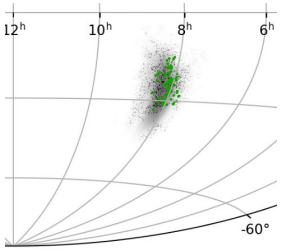



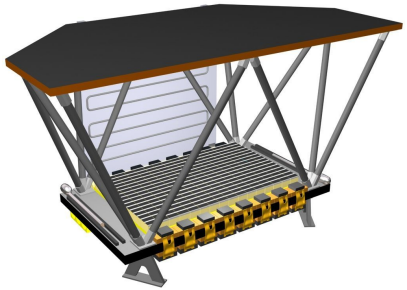

@esaspaceweathe
(2024-Apr-12)

# TOOs/GRBs/LIGO

- Swift still maintains a high acceptance rate of TOOs
  - 2023: 1612 submitted (84 declined)
  - 2022: 1472 (~month lost to RW failure), 2021: 1742, 2020: 1729
- Swift has now detected / followed 1738 GRBs since launch
  - 86 in 2023, 95 in 2022
- Regularly get ~2ks with NuSTAR targets (not observed by others)
- 20 Einstein Probe TOOs since beginning of Feb
- LIGO 04b started Apr 10.
  - 100 XRT fields on S240422ed
    - 240 X-ray sources - 3 fading (interesting)



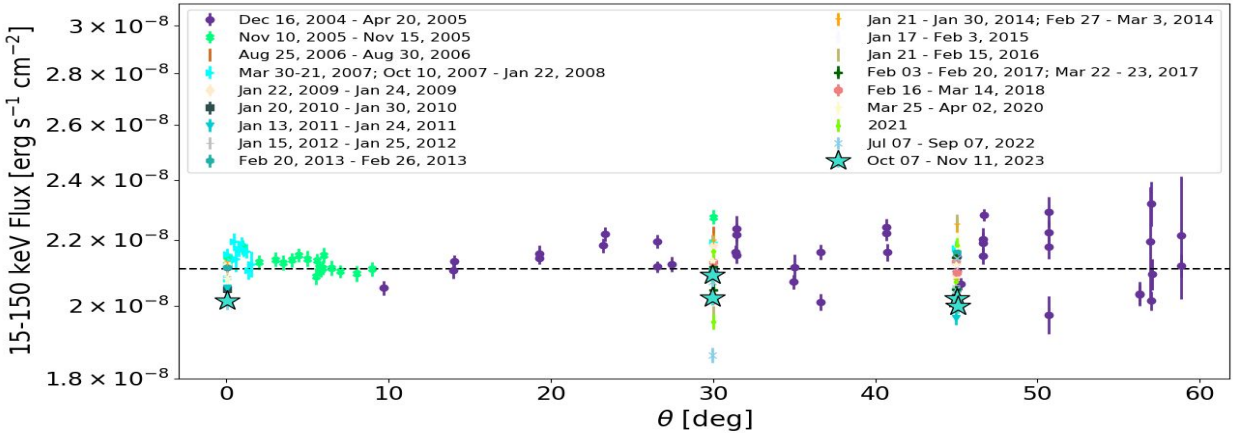
# BAT

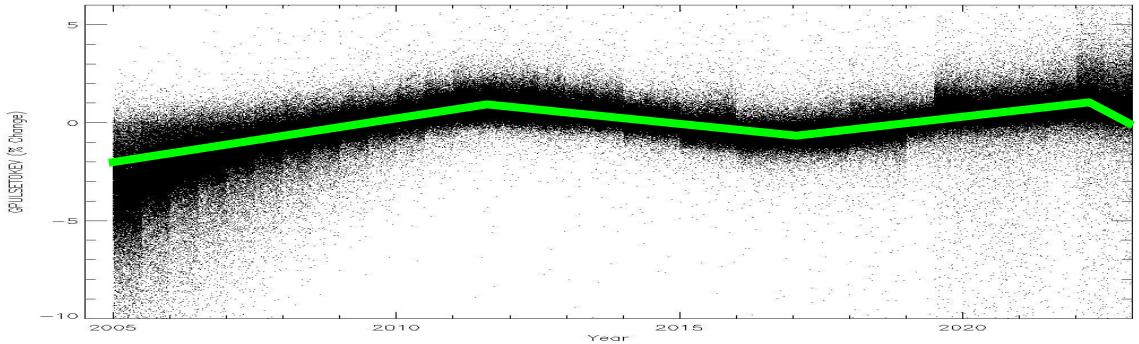


- GRB detector (15-200 keV)
  - Coded mask with 1 mm lead tiles, 1 meter focal length
  - 32,768 CZT detectors launched
- Status
  - BAT continues to operate nominally and detect GRBs
  - Typically 12,000 - 18,000 detectors enabled, others disabled due to noise
  - 3 of 4 redundant loop heat pipe controllers have failed, but 1 remaining controller is sufficient to maintain thermal requirements
- Recent updates
  - As noted in previous IACHEC, post launch gain degradation (due to radiation damage?)
    - reversed in years 2011-2017 (~half of degradation recovered)
    - gradual degradation has resumed (~4% lifetime energy scale shift)
  - BAT team has discovered ~1000 detectors where automatic calibration pulser has failed for unknown reason
    - Considering mitigations, including simply disabling those detectors

# BAT Performance History

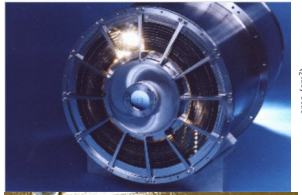
- Top: BAT flux scale remains consistent over time and off-axis angle
- Bottom: Energy scale shifts over mission lifetime due to radiation damage and recovery

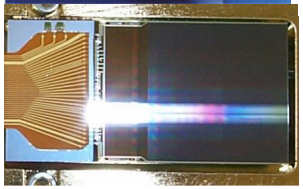


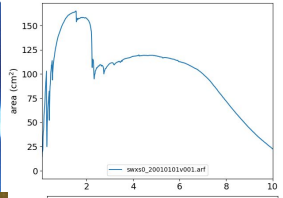



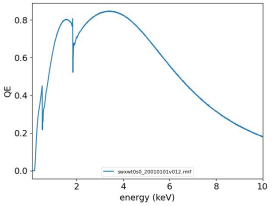
# XRT

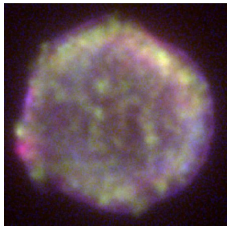
- Comprises
  - Wolter Type I mirror (Jet-X flight spare)
  - e2v CCD22 detector (same as XMM MOS)
- XRT continues to operate well
  - No new anomalies to report
  - Last reboot back in 2016
  - Despite failure of TEC in 2004, CCD thermal control is still well maintained in the range -65C to -50C by careful science target planning
- XRT Calibration Observations
  - Gain/trap mapping (Tycho, Cas A, E0102, N132D): 440 ks/yr
  - Other (including RXJ1856) : 100 ks/yr

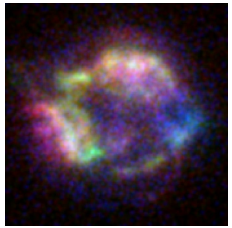






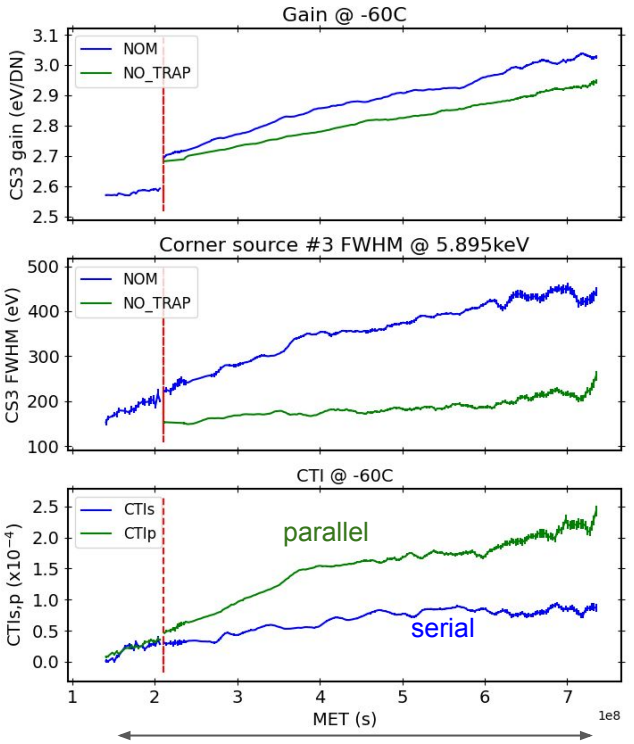





# XRT Gain

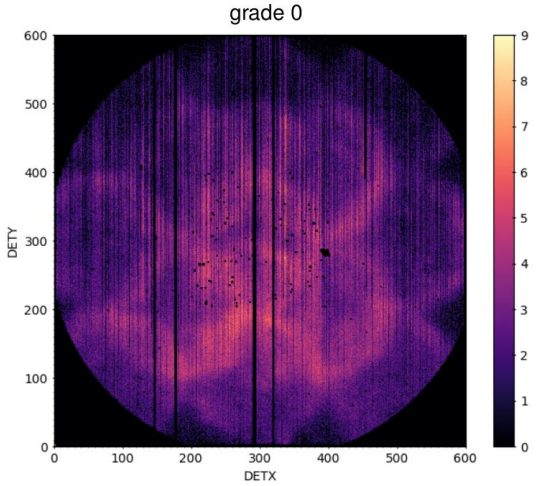
- Gain files released annually
  - Current CALDB released 2023-July, with coefficients to 2023-May
  - 2024 expected in the summer
- Gain and CTI measured from Fe-55 sources positioned around corners of CCD
  - Strongly temperature dependent due to failed CCD TEC - 3 temperatures stored in gain file
- Trap mapping observations performed yearly
  - PC mode: Tycho 15 pts x 20ks
  - WT mode: Cas A  6 pts x 10ks
  - Both modes: E0102  20ks, N132D 10ks




19 years

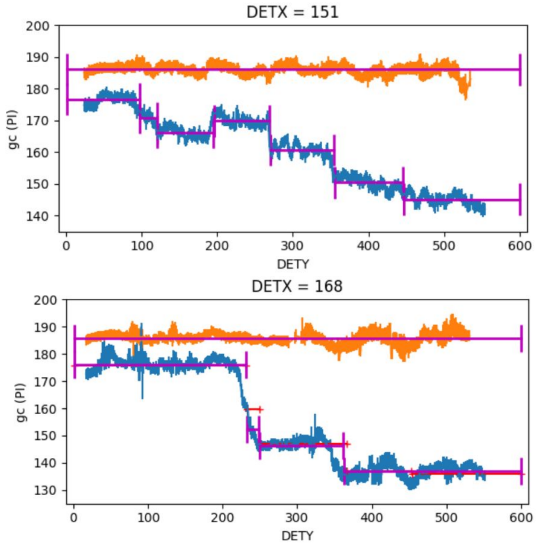
# XRT Trap Mapping - PC

Merged Tycho Data 2020-2022

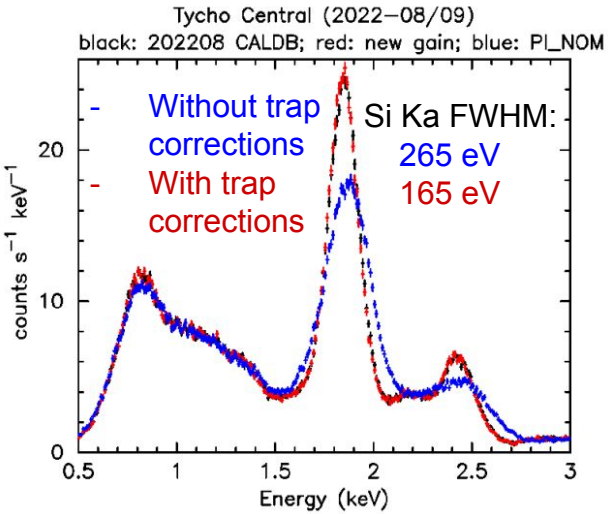



- Fifteen 20ks slew-in-place pointings per epoch
  - Denser coverage in the central 200 wide window
- 3 epochs merged (~1Ms)

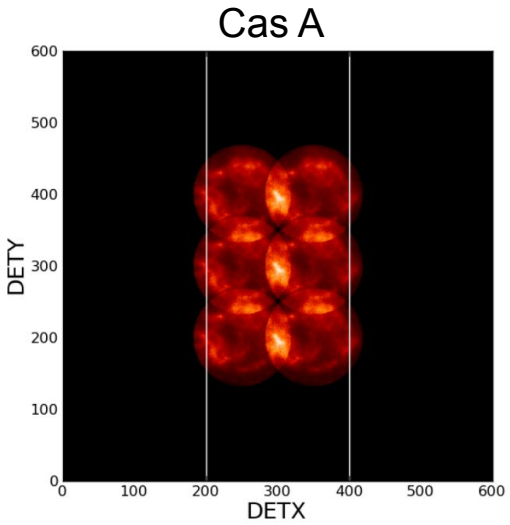
- Location and depth of traps measured for each column from Si-Ka line




- Energy, temperature and grade dependent corrections then applied

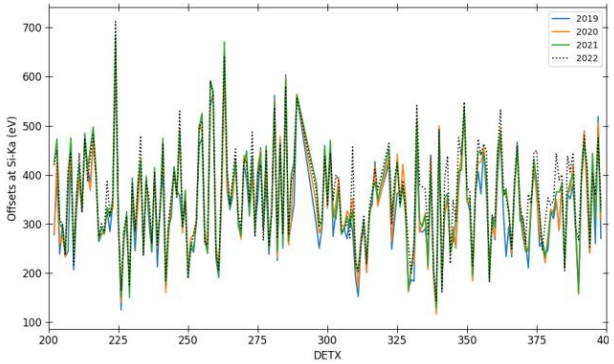


# XRT Trap Mapping - WT

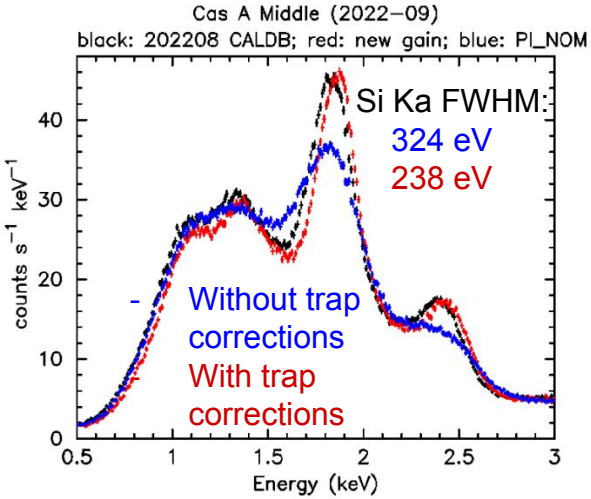



- 6 x 10ks pointings at specified positions
- 2 Cas A's fit the WT window width

- Trap offsets estimated in each column segment covered by remnant



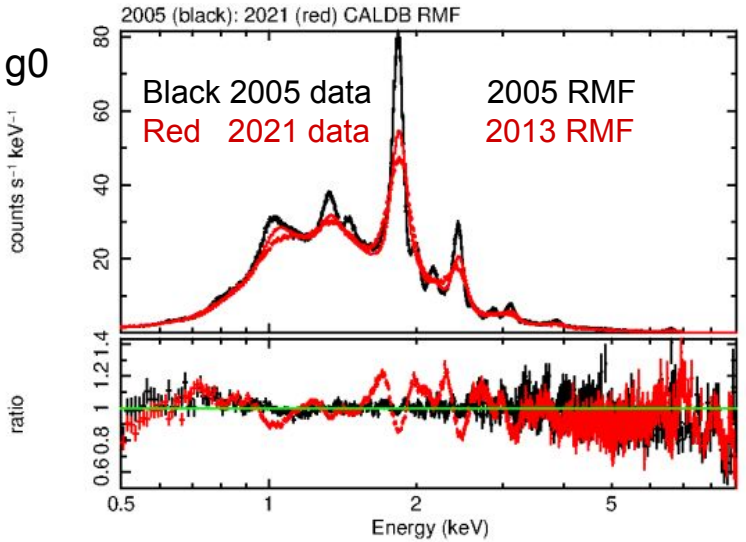

- As WT is 1D readout, event DETY is predicted from source RA, Dec when CTI / trap corrections applied

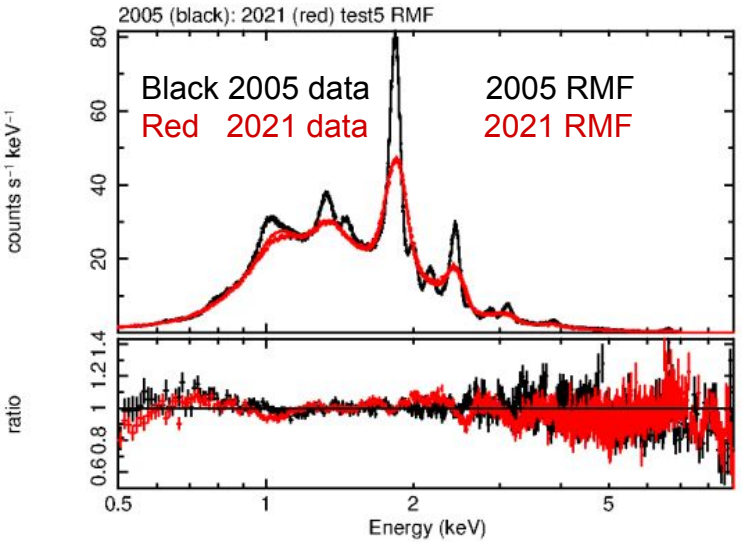


# XRT RMF

- New PC and WT RMFs release for post 2021 epoch
  - Resolution better matches calibration data
- Previous release 2013
  - Now creating new RMFs to fill in the gaps

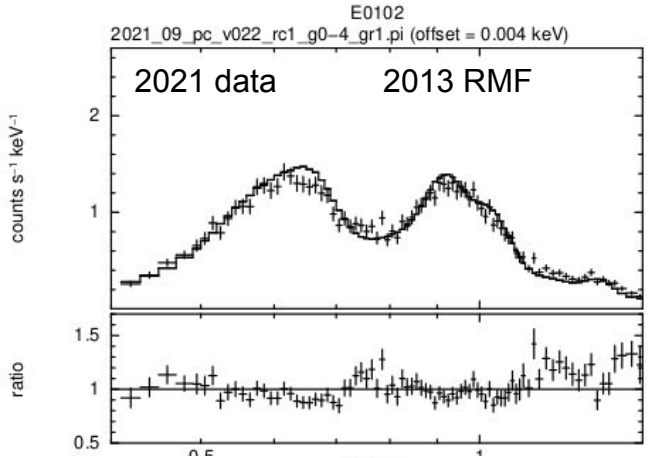
Cas A WT g0

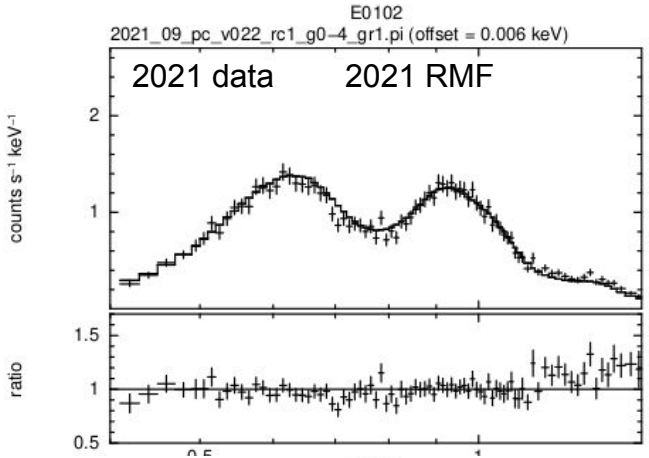


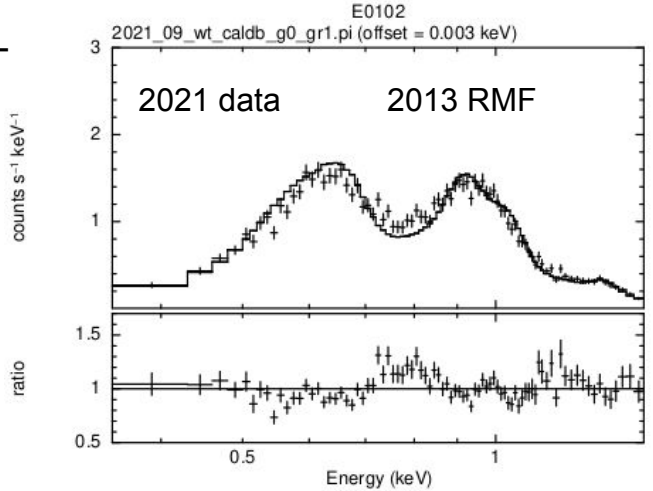
# XRT RMF

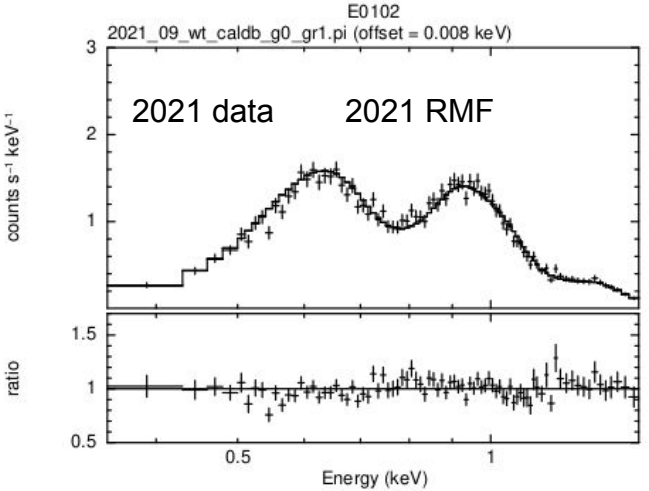
E0102 PC grade 0-4




E0102 WT grade 0



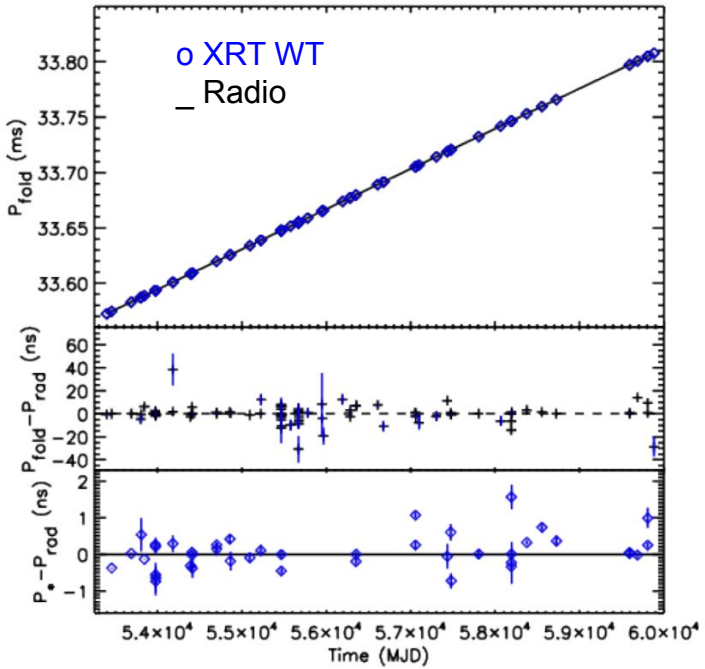



# XRT Timing

- XRT Windowed Timing (WT) mode
  - 1D readout; central 200 columns only; 10-rows at a time summed into serial register, then read out
  - Time resolution 1.78ms
  - Accurate time tagging requires knowledge of event position on detector
    - events predicted to come from *same* detector position for source location
- Timing accuracy was evaluated in 2012 (Cusamano et al., 2012, A&A, 548, A28)
- Since then, changes to ftools merited re-evaluation of data (Cusamano et al 2024, A&A, submitted)
  - *prefilter* task modified (2017) to apply Swift UTCFINIT correction when calculating attitude/orbit information (used by *barycorr*)
  - *barycorr* task significantly rewritten (2017), though no change to underlying corrections expected

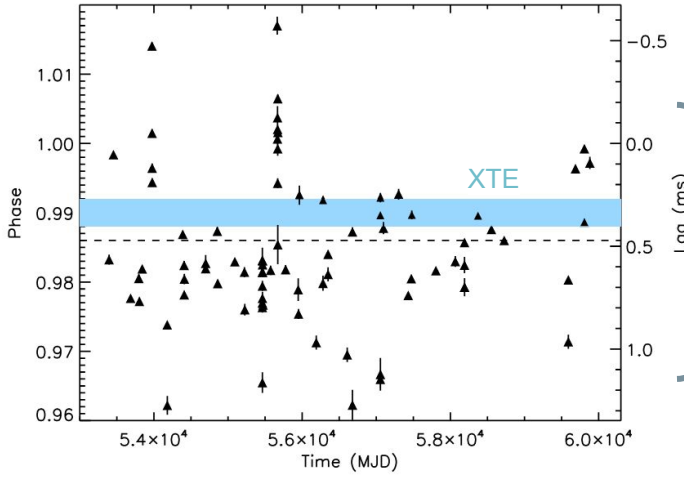
# XRT Timing

## Period



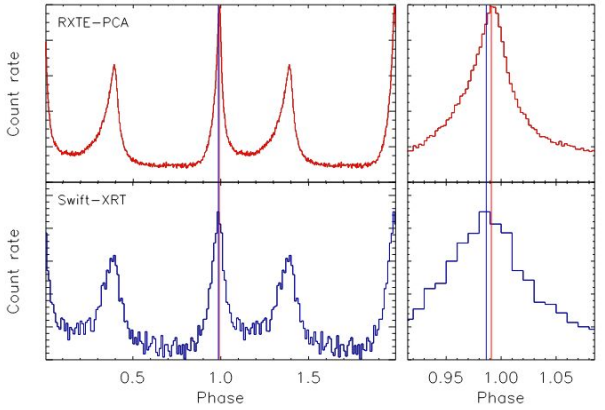

- Period better than 10s of ps to ns

## Phase




Scatter seen in WT only.

Mean 0.986 rms 0.06



# Summary

- Swift satellite now pointing more accurately than before after recent flight software upgrade
- The three instruments on Swift continue to operate well
- Look out for a “20 Years of Swift” meeting announcement
  - Location: Somewhere, Italy
  - Date: Spring 2025