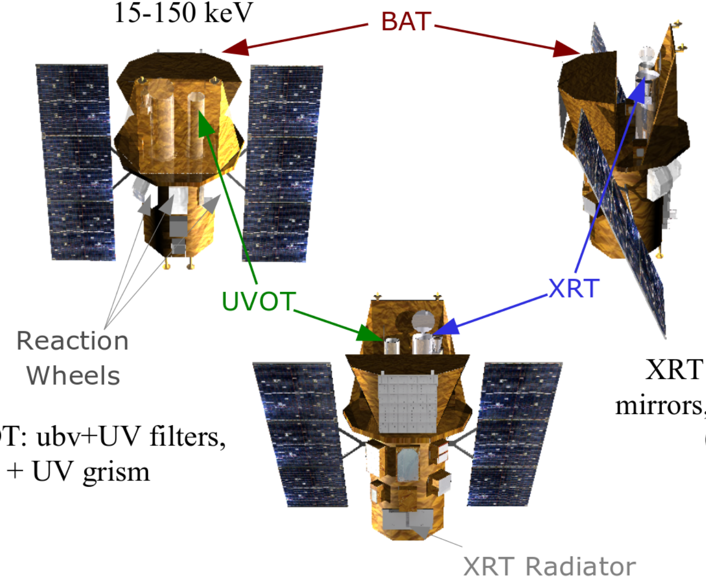
Swift Update

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



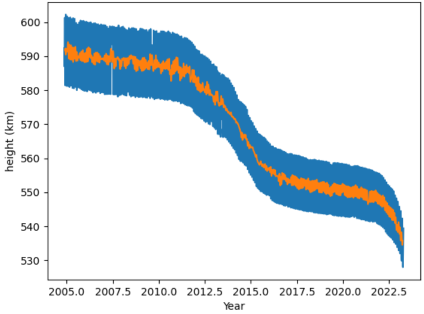
XRT: Wolter Type I
mirrors, CCD22 detector,
0.3-10 keV

UVOT: ubv+UV filters,
+ UV grism

Spacecraft Status

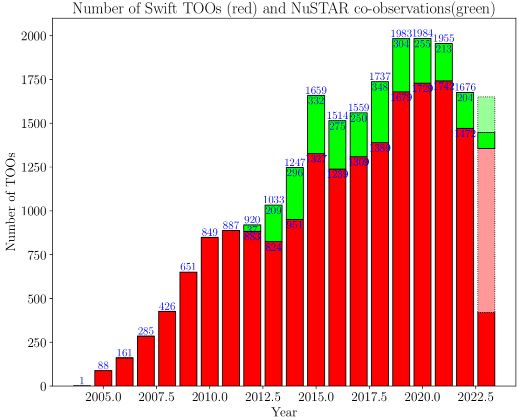
- Launched 2004-Nov-20T17:16 — 18.42 years old.
- Ranked 1st in 2022 NASA Senior Review
- Recent anomalies:
  - 2021-Apr-08 : degraded performance from one of the two primary antennae
    - No science data lost — affected real time alerts through TDRSS 50% of time
    - Resolved 2021-May-19 when back-up/dual antennae mode brought into operation (with 3% TDRSS dropouts).
  - 2022-Jan-18 : Safehold caused by a failure of Reaction Wheel #5 (RW5) of 6
    - Resolved 2022-Feb-17 by operating with remaining 5 RWs.
    - Minimal impact on slews (typically 20s longer for new GRBs).
    - Observing efficiency fell from 75.1% to 72.9%

- Orbit : now feeling the effects of a 2nd solar maximum, though should be OK for another $\sim$ 10 years.



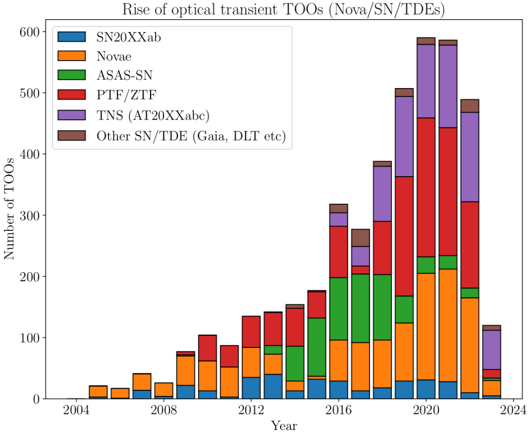
TOO Submission Statistics

- Swift Maintains a high acceptance rate of TOOs.
- Peak 2021, 1742 TOOs in 1 years
- ~200-250 observations per year in coordination with NuSTAR.
- 2022 TOOs were surpressed as TOO page was taken offline for ~29 days due to reaction wheel failure.



Optical Transients drive Swift TOOs

- Optical transient surveys drive a large amount of the rise in TOOs to Swift.
- Surveys like ASAS-SN and PTF / ZTF seed large amounts of SN and TDE TOOs.
- Will Rubin break Swift?
    - Maybe, but likely number of transients bright enough for Swift to observe won't add significant numbers.

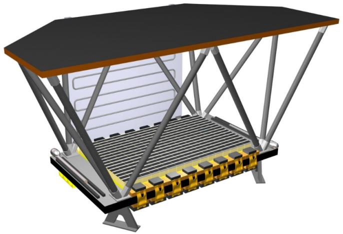


Swift and O4

- In O4, Swift will be utilizing a new comms technique, we will establish a near continuous commanding link to Swift via TDRSS.
    - This will allow for contact with Swift 90-95% of the time.
    - TOOs can now be sent in realtime, and automated in order to reduce latency.
    - Tests of new system show that the time from SOT computer initiating a TOO command, and S slewing, is around **6 seconds total latency.**
    - Essentially we can now “joystick” Swift.
- What does this mean for O4?
    - Faster initiation of TOO response to GW triggers, e.g. tiling of error regions now will start in minutes instead of hours.
    - Slew to Early Warning alerts? Maybe if LVK can deliver the alerts fast enough.
    - More flexibility to observe possible counterparts from other observatories.

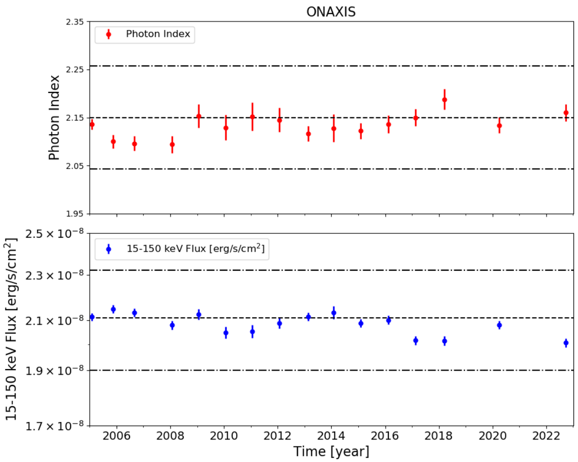
BAT Status

- BAT is a coded mask instrument
  - 32768 CZT detectors
  - 16 detector blocks
  - 15 – 150 keV
  - Wide FOV (2 sr)
- Status
  - BAT continues to operate and detect GRBs
  - Internal communication link problem prevents 6/16 blocks from functioning properly
    - Loss of area / sensitivity
    - Plans developed to restore communication
  - Some periods, BAT detector enable/disable map has been corrupted
    - Increases coded mask imaging noise



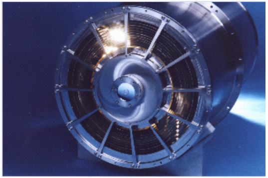
BAT Calibration Status

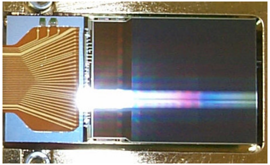
- BAT performs ~yearly Crab observations, both on- and off-axis
- Observations indicate very stable performance
- Flux variations consistent with known Crab instrinsic flux calibrations
- However, BAT detector/enable map corruption has occasionally biased flux values

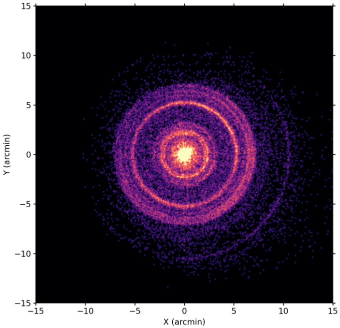


XRT Status

- 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
- Still capturing great science. E.g. GRB221009A





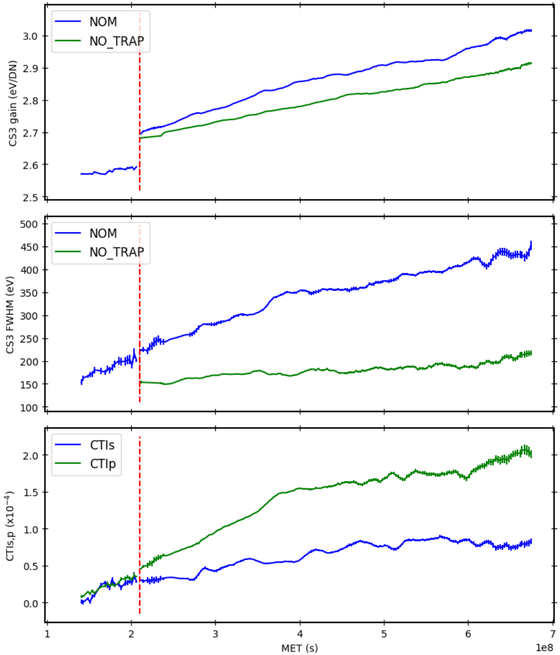


Gain File Calibration

Executive Summary

- Fe-55 corner source analysis updated yearly
  - Gain file GCn, GCn_TRAP coefficients updated to 2022-May-15
- Gain file Trap Tables updated yearly
  - PC : Tycho 15 $\times$ 20ks $=$ 300ks from 2021-Jul-31 to 2021-Nov-21
  - WT : Cas A 6 $\times$ 10ks $=$ 60ks from 2021-Sep-01 to 2021-Oct-04
- Current gain files : finalised 2022-Jun-15, released into CALDB 2022-Aug-03
- Work just started on next gain file release – expected late summer

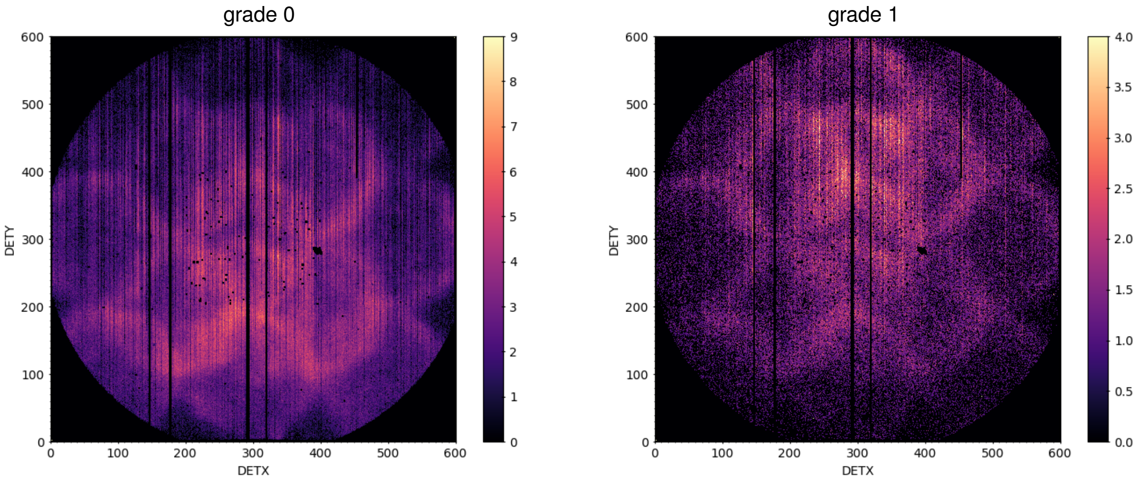
Gain and CTI evolution at -60C



- Gain from Fe-55 Source #3 (CS3):
  - NOM : Nominal (all columns in CS3)
  - NO_TRAP : trap-corrected energy scale ('best 7 columns' in CS3)
- CS3 (Fe-55) FWHM :
  - NOM : all columns in CS3
  - NO_TRAP : best 7 columns in CS3
- CTI :
  - Serial
  - Parallel – flattened off from 2013-Sept to 2020-Jan

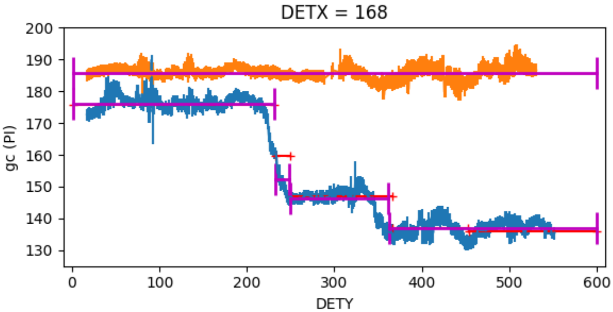
PC Trap Mapping

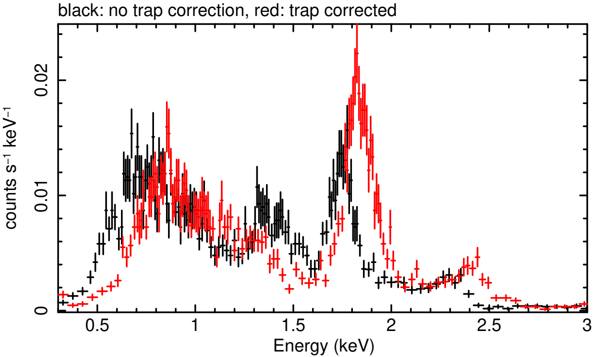
Merged Tycho data from 2019 – 2021 (1.1 Ms)



- Grade 0 (1.7–2.0 keV) : dark striations
- Grade 1 (0.5–1.0 keV) : bright striations
  - Grade migration (grade 0 $\rightarrow$ grade 1) due to traps

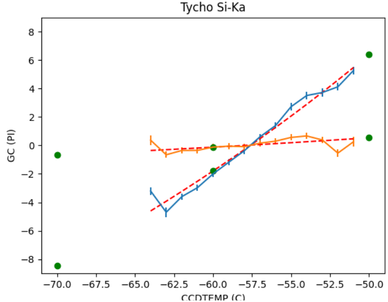
PC Trap Mapping - Before / After



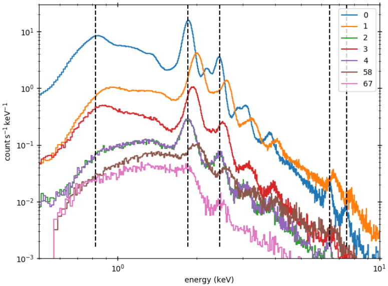


PC Mode Si-Kα CCDTEMP & Grade Dependence

- Gain, CTI and trap-offsets are CCD temperature dependent
  - Blue: same trap offset correction for all CCDTemps
  - Orange: CCDTemp dependent trap depths
  - Stored in gain file at -70C, -60C, -50C and interpolated



- Trap-offsets are also grade dependent
  - Offsets Scaled depending on the grade



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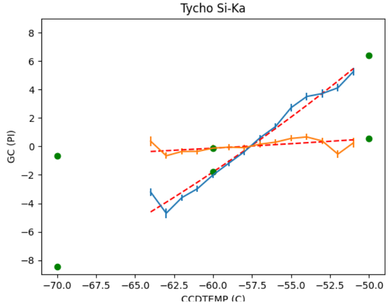

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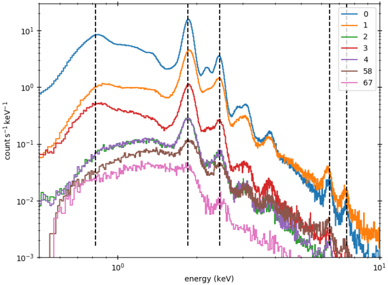
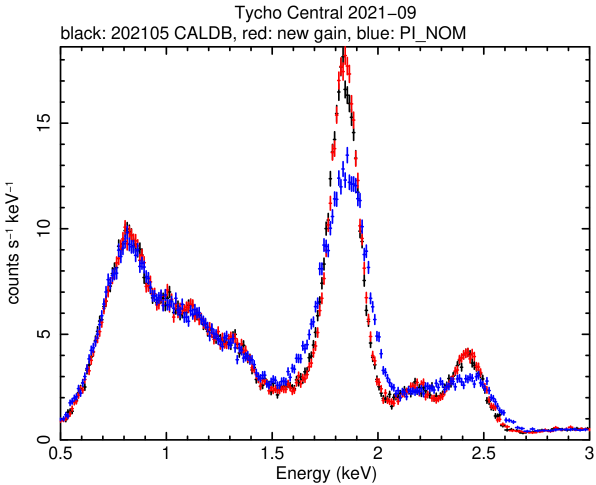


Tycho Central

- Tycho central pointing :
  current CALDB, new gain, no trap corrections



Si-Kα FWHM :

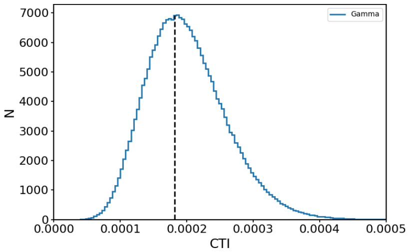
165 eV

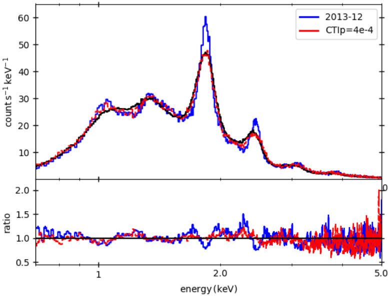
155 eV

240 eV

RMF Calibration Activities

- RMFs were last updated in 2014
  - Apparent that, in recent years, their resolution does match SNR calibration data
- CCD22 simulator modified to use an asymmetric distribution of CTI values
- Simulated Tycho and E0102 spectra to probe the CTI and intrinsic detector noise parameter space required to broaden the CCD response in PC mode
- Repeated on Cas A, E0102, N132D for WT mode
  - Example Cas A spectrum from 2021 in black, with 2013 RMF model in blue and preliminary broadened RMF model in red
- Aim to release further 2 or 3 epoch dependent RMFs matching the response broadening over years 2016–2022





Swift Conclusions

- Despite signs of age, Swift remains highly capable and productive.
- Although RW failure was dramatic, the end result has been a small drop in observing efficiency, and a slightly slower GRB response time.
- Swift TOO submissions remain very popular.
  - Note that Swift TOO page will now actively push people to use NICER in case where TOO is more suitable for them, so we are actively turning away people now, or at least, nudging them in a different direction!
- Expect Swift to remain at the forefront of TDAMM astrophysics for a few more years yet!