Neil Gehrels Swift Observatory

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27 June 2023

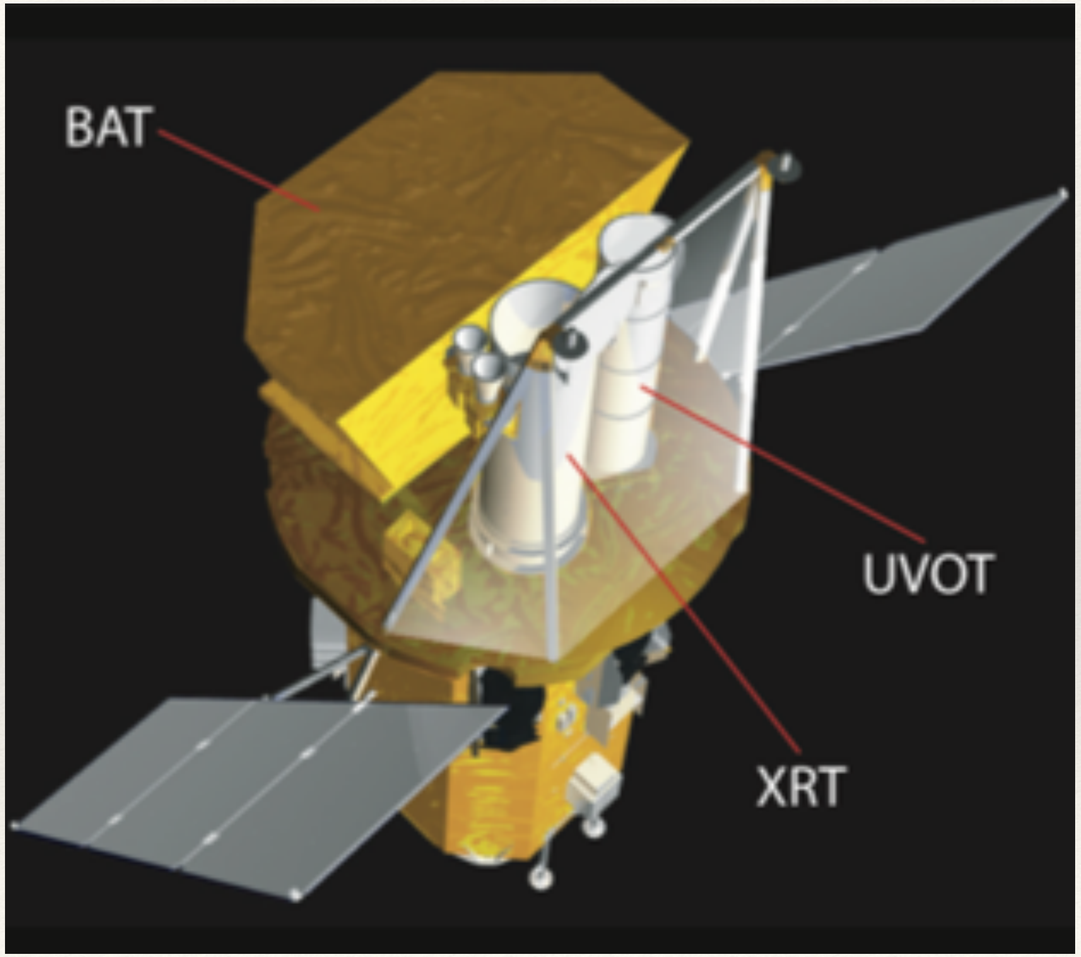
“The test of a first-rate intelligence is the ability to hold two opposing ideas in mind at the same time and still retain the ability to function.”

–F. Scott Fitzgerald

Part I: The Present

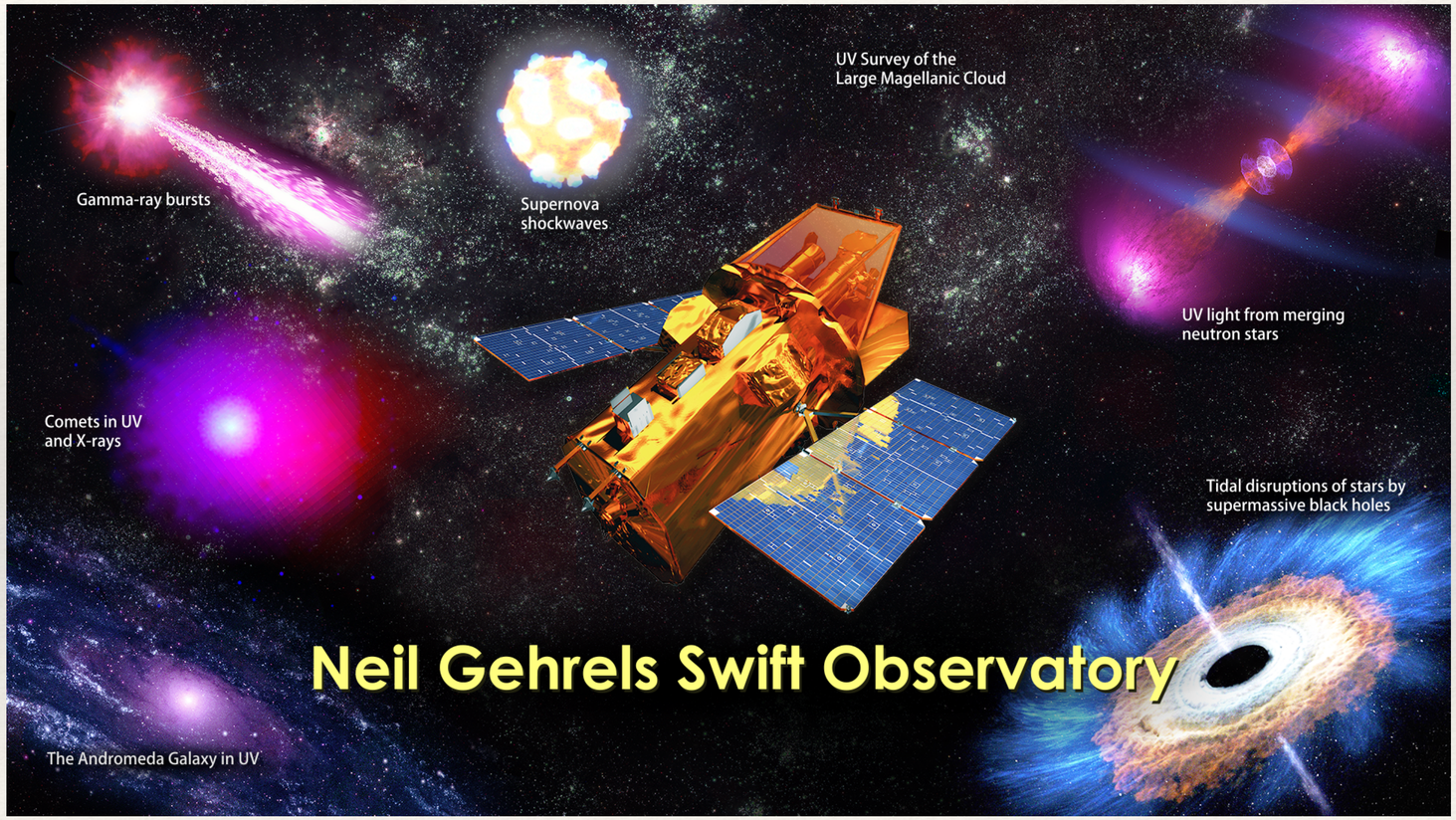
Swift Observatory Overview

- Multi-wavelength observatory:
  - Burst Alert Telescope (BAT): Coded mask hard X-ray, large FOV, 15-150 keV
  - X-Ray Telescope (XRT): Focusing soft X-ray, 0.3-10.0 keV
  - UV/Optical Telescope (UVOT): 30 cm, 170-650 nm
  - Fast-slewing spacecraft
- Launched 19 Nov 2004 (2 year prime phase)
- Initial science objectives: detect, localize, and characterize gamma-ray bursts and their afterglows

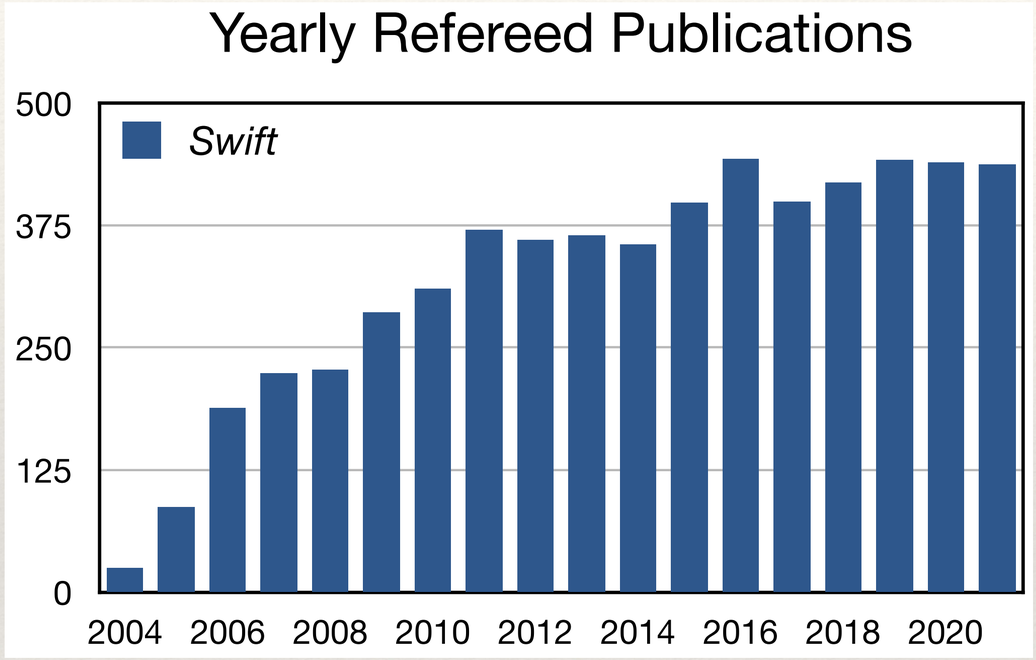


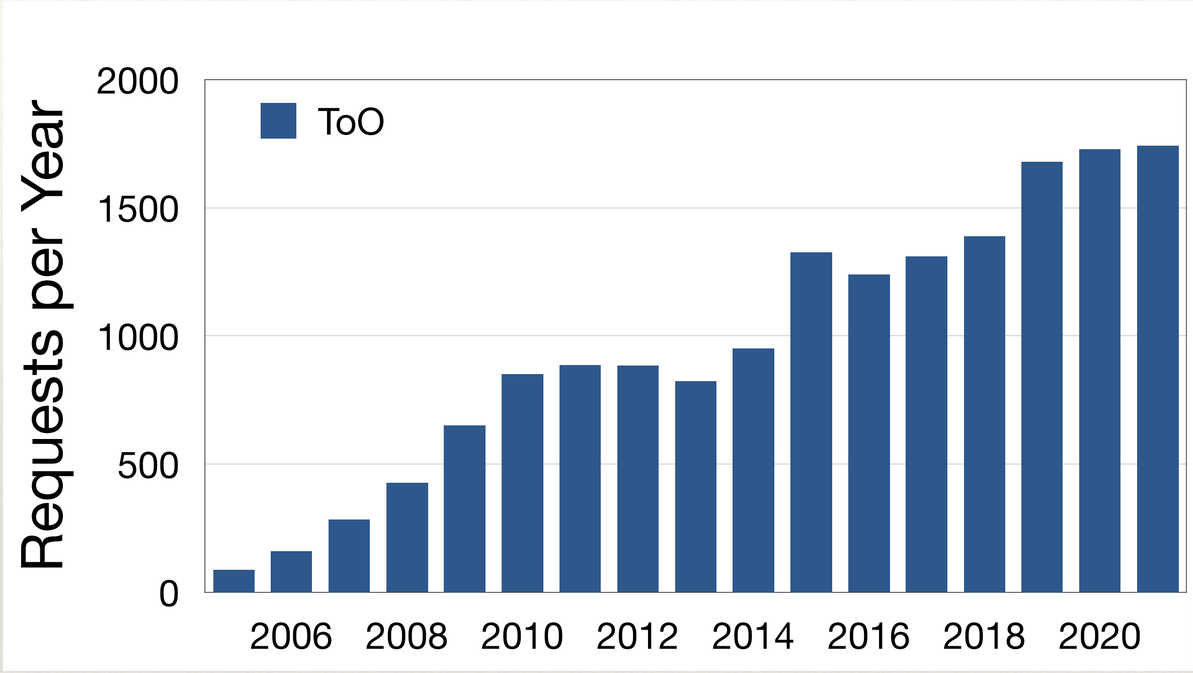
Swift's role in the Astrophysics Portfolio

- Prompt multi-wavelength follow-up
- Precise gamma-ray burst localization
- Multi-wavelength monitoring
- Mission synergies
- Hard X-ray sky survey



Scientific Productivity



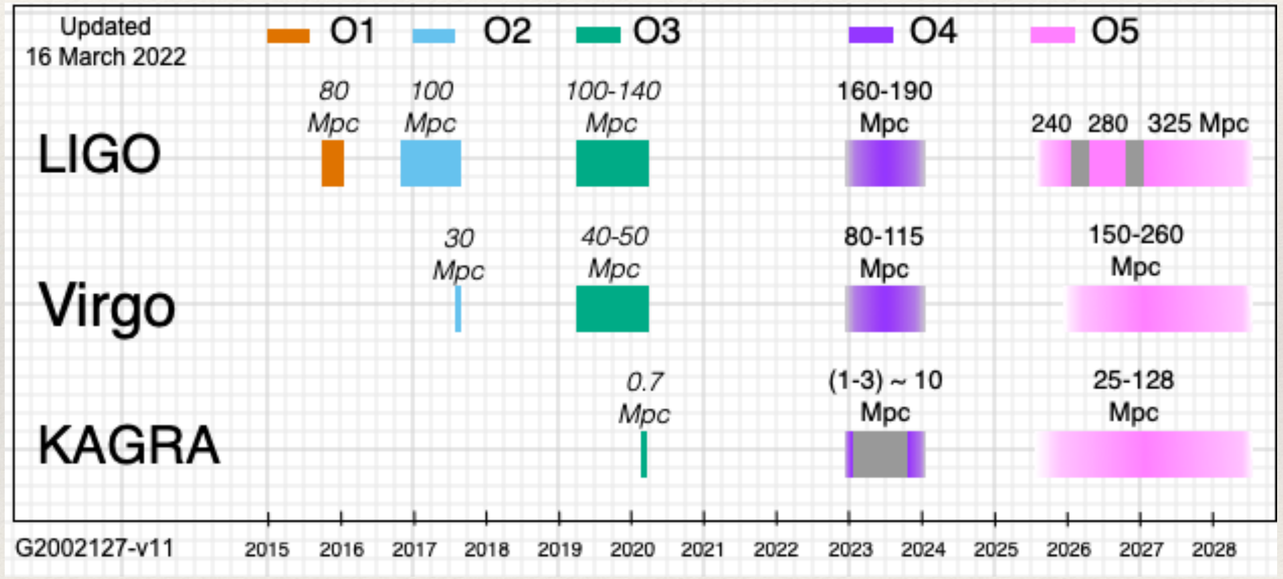


Publication Rate: Over 1300 refereed publications including *Swift* data in last 3 years (standard deviation of 2 papers!)

Target-of-Opportunity Requests: Average of 4.8 per day in 2021, with significant increase seen since last Senior Review

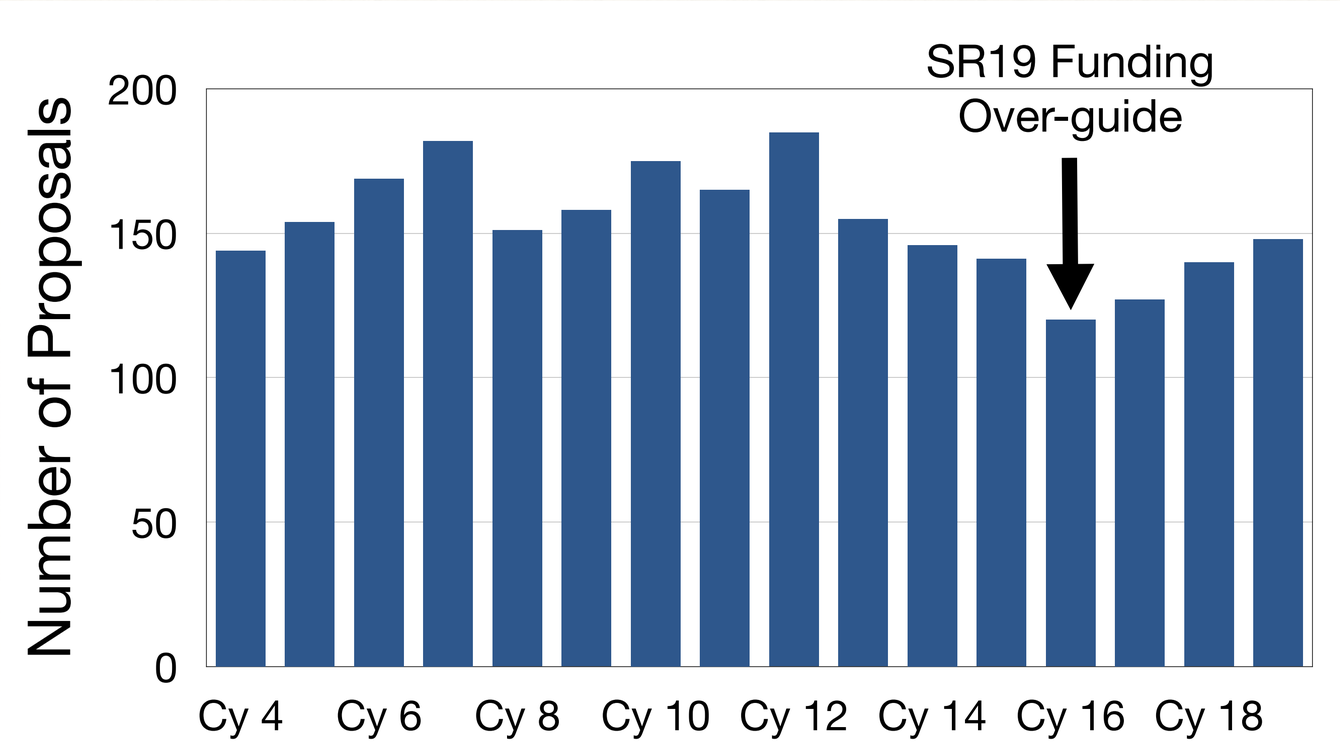
Scientific Priorities

- **1: Realizing the Promise of Multi-Messenger Astrophysics**
  - Where are heavy elements synthesized?
  - How are relativistic jets launched?
  - How are high-energy particles accelerated?
- **2: Rubin and the Time-Domain Revolution**



Guest Investigator Program

- Award $1.5M and 5 Ms of *Swift* observing time
- Critical component of community input for *Swift* observing program
- Reasonable oversubscription factor with uptick in number of submissions
- **Update: Joint *NICER* program commenced in Cycle 19**



DEIA Activities

Swift ToO Submitters - 2021

Person submitting the TOO	Submitted TOOs Per Year	Submitted TOOs Per Month	Approved Time Per Year (s)
Totals	**1,183**	**99**	**15,313,930**
Miller Jon	6	0.50	678,000
Schulze Steve	30	2.50	530,300
Severgnini Paola	1	0.08	450,000
Romano Patrizia	3	0.25	354,000
Brown Peter	27	2.25	333,000
Hinkle Jason	17	1.42	290,300
Yao Yuhan	28	2.33	277,800
Motta Sara Elisa	17	1.42	262,000
Salvaggio Chiara	7	0.58	254,000
Middei Riccardo	4	0.33	234,000
Verrecchia Francesco	1	0.08	220,100
Ambrosi Elena	3	0.25	211,000
Oknyansky Victor	4	0.33	210,500
Corrales Lia	6	0.50	204,800
Irani Ido	33	2.75	204,750
Jacobson-Galan Wynn	29	2.42	203,300
Brightman Murray	5	0.42	200,000
Kennea Jamie	11	0.92	199,000
Pinto Ciro	2	0.17	188,500
Grupe Dirk	6	0.50	179,000

Chandra PIs - 2021

PI	Time (ks)
Canizares	1260
Bogdan	945
Kraft	642
Maksym	615
Earnshaw	572
Guarcello	554
Williams	542
Jackman	503
Guenther	485
Garmire	448

Grad Student
Early Career

DEIA Activities

- Internally Focused Efforts
  - Code of Conduct instituted within Swift team
  - New process for new hires at GSFC and PSU following best practices at both institutions
    - New Science Data Center (SDC) lead Tyler Parsotan
    - GRB221009A paper led by PSU postbac Maia Williams
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- Externally Focused Efforts
  - Quantify/broaden pool of GI reviewers (across multiple axes)
  - Early career and geographic diversity included in programmatic considerations for GI selection
  - Continued partnership with Howard University faculty
  - Development of new software analysis tools (including interactive demonstration workshops) for UVOT and BAT
  - Continued support of early career researchers through DDT/ToO program

DEIA Activities

- 2022 Senior Review over-guide request: shared DEIA consultant shared between GSFC missions
- "The Panel recommends that the Science Mission Directorate fund the coordinated DEIA Initiative for the Guest Observer Facilities at NASA Goddard without impact on mission budgets for these activities. The panel strongly feels that if inclusion is a core value at NASA, these important efforts should not come at the expense of the already strained resources of the missions." (April 1, 2022)
- **Still awaiting outcome of this request from APD**

Part II: The Future

Swift in the TDAMM Portfolio

- NICER “nudge”
  - Both *Swift* and NICER capable of rapid response X-ray follow-up
  - *Swift* ToO page auto-populates NICER requests for relevant sources (bright X-ray, no UV requested)
- Continuous forward commanding
  - (Near) 100% real-time downlink (return) in place since launch - needed for prompt GRB alerts
  - New for LIGO/Virgo/KAGRA O4 run: continuous uplink for decreased commanding latency
  - TDRSS 275 offline (due to typhoon in Guam) has impacted this

Observatory Status

- No consumables on-board
- Hardware issues:
  - Gyro anomaly: May 2023
  - Reaction wheel failure: Jan 2022
  - Antenna switch failure: May 2021
- 2022 Senior Review: funding through 2025 (2027?)
- Expected orbital re-entry: May 2033

Table 13: SWIFT Re-entry Probability

Date	Probability (%)
3/4/2027	10
4/29/2028	20
10/17/2029	30
9/14/2031	40
5/11/2033	50
3/29/2034	60
1/2/2035	70
10/22/2035	80
12/24/2036	90

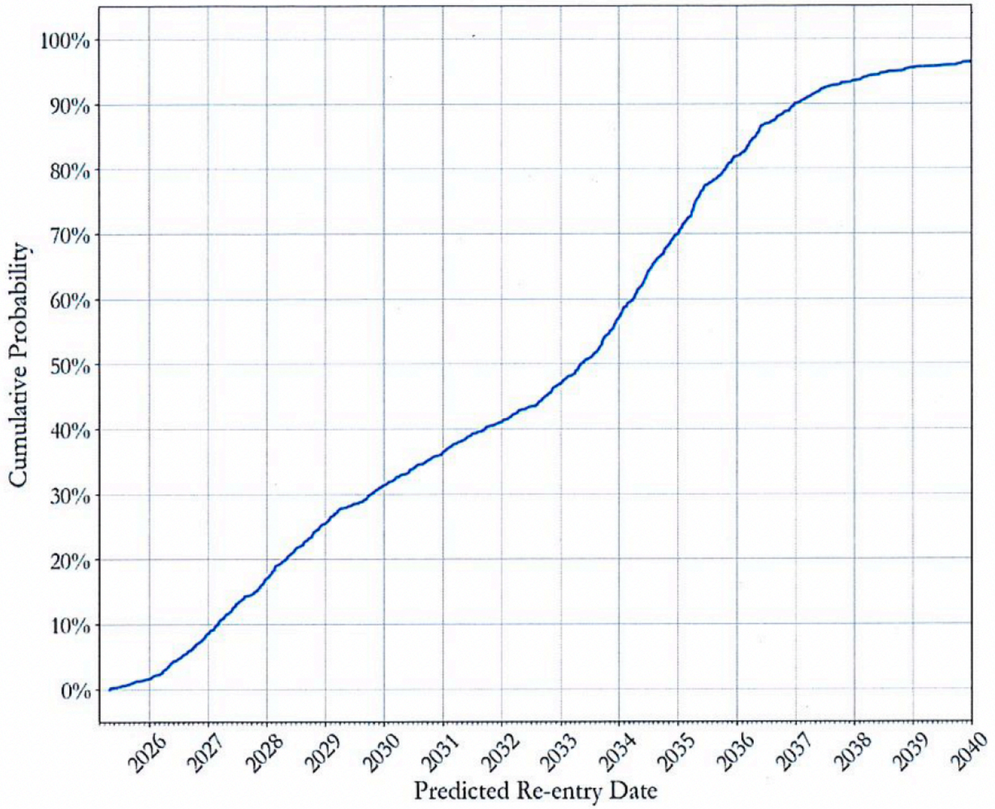

Figure 23: SWIFT Cumulative Probability Distribution

Swift's role in the Astrophysics Portfolio: Future

- Prompt multi-wavelength follow-up: Maybe (STAR-X or UVEX)
- Precise gamma-ray burst localization: No
- Multi-wavelength monitoring: Maybe (STAR-X)
- Mission synergies: No
- Hard X-ray sky survey: No

2020 Decadal Survey Recommendations

- In space, the highest-priority sustaining activity is a space-based time-domain and multi-messenger program of small and medium-scale missions. In addition, the survey recommends a new line of probe missions to be competed in broad areas identified as important to accomplish the survey's scientific goals. For the coming decade, a far-IR mission, or an X-ray mission designed to complement the European Space Agency (ESA's) Athena mission, would provide powerful capabilities not possible at the Explorer scale.

2020 Decadal Survey Recommendations

Conclusion: A standing planning committee or advisory structure could provide tactical advice to NASA on impending needs and priority capabilities for time domain and multi-messenger follow-up, evaluating these needs in the international landscape.

Recommendation: NASA should establish a time-domain program to realize and sustain the necessary suite of space-based electromagnetic capabilities required to study transient and time-variable phenomena, and to follow-up multi-messenger events. This program should support the targeted development and launch of competed Explorer-scale or somewhat larger missions and missions of opportunity.

The estimated cost of this program would range from $500 million–$800 million over the decade. This lower range would support competed missions of opportunity, SMEX and MIDEX scale missions. As described in Section 6.2.1.1.3, the survey notes this funding is intended to be added above the current funding level of the Explorer program, so as not to negatively impact the rate of selections through entirely open, non-targeted calls. These expenditures would take place throughout the decade.

Conclusions

- Nearly 19 years after launch, *Swift* continues to be extremely scientifically productive, playing a key role in the NASA TDAMM portfolio
- While there is no immediate threat to *Swift* operations, an increased rate of hardware anomalies in the last few years reinforce that the mission lifetime is finite
- Replacing/improving upon *Swift's* contribution to the NASA portfolio prior to its demise is unlikely - at this stage, a sense of urgency is required simply to minimize the gap until the launch of future successor facilities