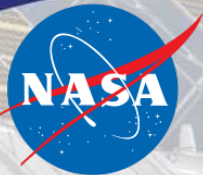


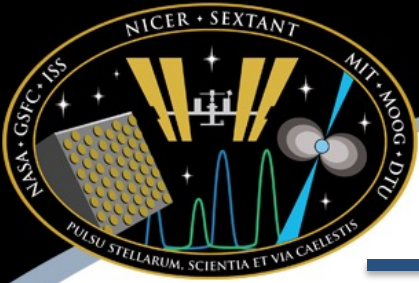
NICER

Neutron star Interior Composition Explorer

NICER 2021 Analysis and Science Workshop

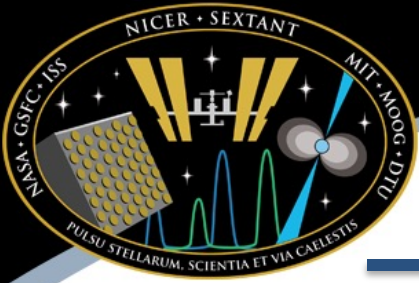
Keith Gendreau
(NASA/GSFC)



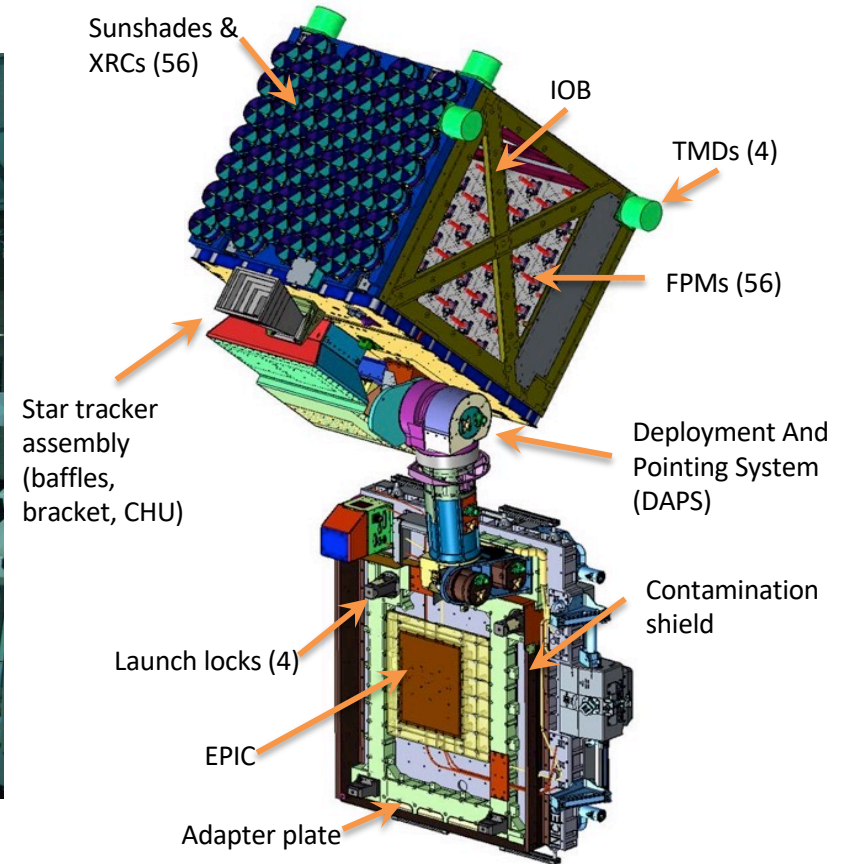


Agenda

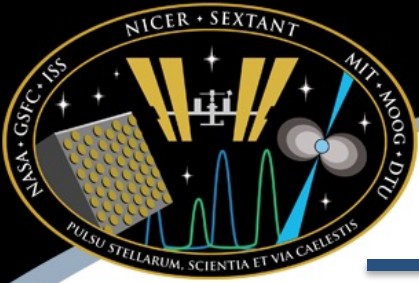
Date	Time	Subject
Monday, May 10	9:00-10:50	Tutorial 1
	10:50-11:10	Break
	11:10-13:00	Tutorial 2
Tuesday, May 11	9:00-10:50	Tutorial 3
	10:50-11:10	Break
	11:10-13:00	Isolated Neutron Stars
Wednesday, May 12	9:00-11:00	Analysis Q&A
Thursday, May 13	9:00-11:15	Accreting Neutron Stars
	11:15-11:30	Break
	11:30-13:00	Main Sequence and Other Stars
Friday, May 14	9:00-10:00	AGN and Galaxies
	10:00-10:20	Break
	10:20-13:00	Accreting Black Holes



The NICER Payload

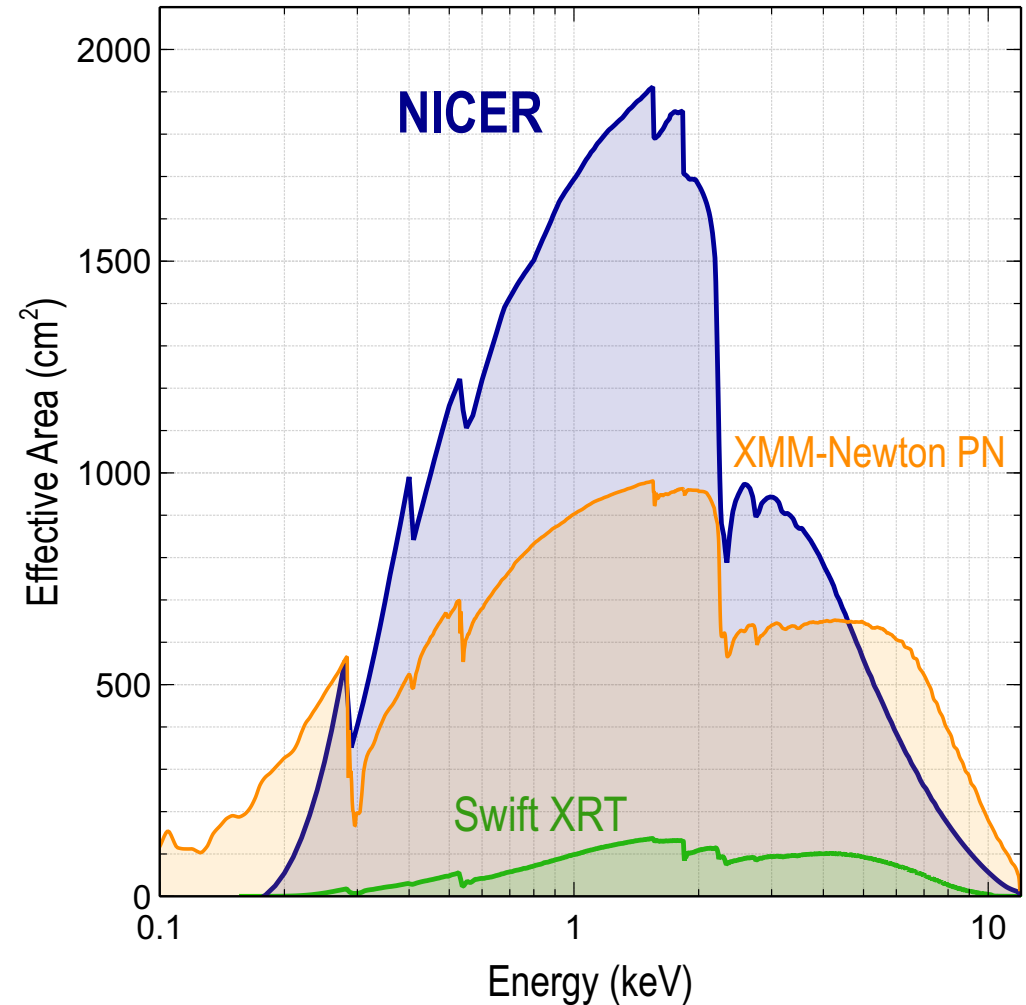


- **X-ray Timing Instrument (XTI)**
 - Assembly of 56 X-ray concentrators (XRCs) and Focal Plane Module detectors (FPMs)
 - > **52 are functioning**
 - Detects individual X-ray photons, returns energy and time of arrival
 - Held together in the Instrument Optical Bench (IOB)
- **Pointing System**
 - Enables XTI tracking of targets, and slewing between them



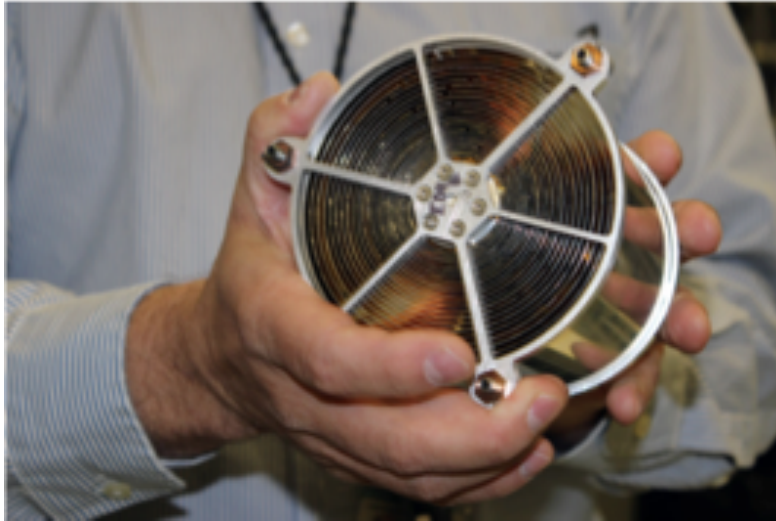
Science-enabling capabilities

- Spectral band: 0.2–12 keV
 - Well matched to neutron stars
 - Overlaps RXTE and XMM-Newton
- Timing resolution: < 100 nsec RMS absolute
 - 50x better than RXTE
 - >~100x better than XMM-Newton
- Energy resolution: 2.5% @ 6 keV
 - 10x better than RXTE
- Angular resolution: ~6 arcmin (non-imaging)
 - 10x better than RXTE
- Sensitivity, 5σ : 7×10^{-14} erg/s/cm²
 - 0.5–10 keV in 10 ksec (Crab-like spectrum)
 - 10x better than RXTE
 - 3x better than XMM-Newton's timing capability

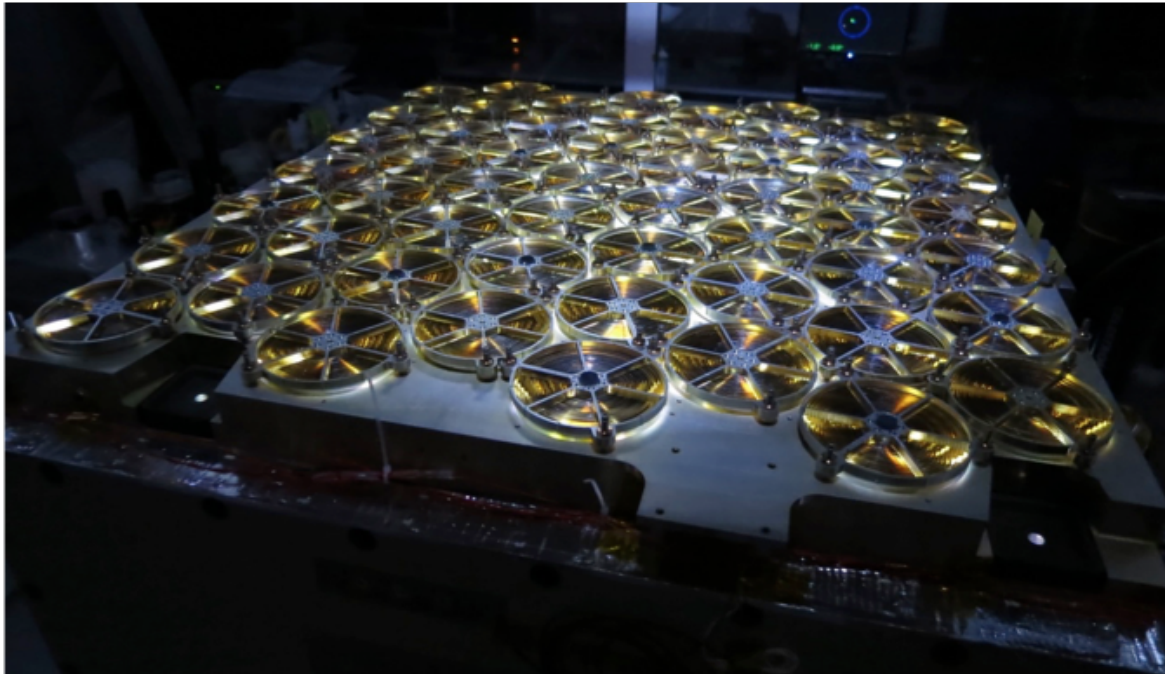


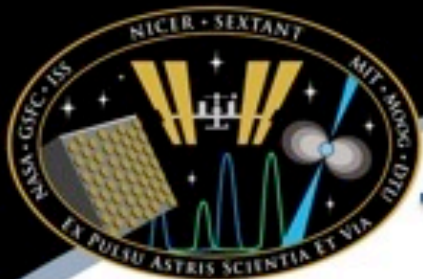


Concentrator optics



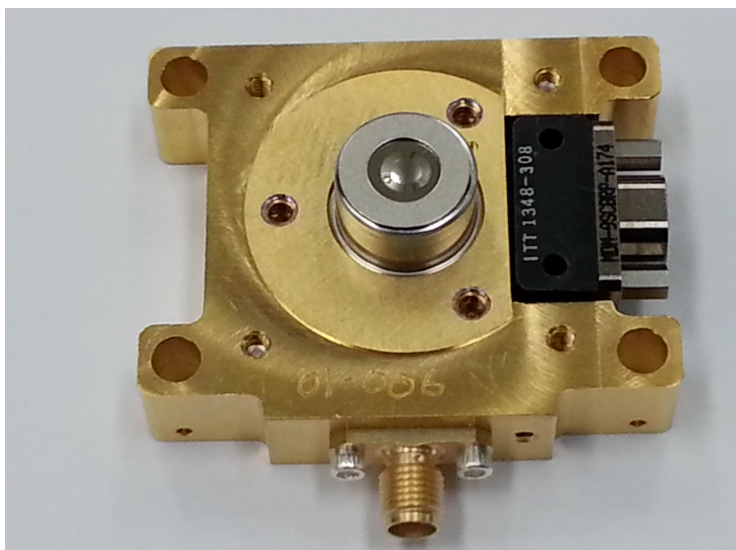
- Thin-foil optics with heritage from *ASCA*, *Suzaku*, and *Astro-H*
- Single-reflection optic to maximize throughput, with limited mass, for isolated point-like sources
- Advances compared to previous GSFC optics:
 - Single shell, not quadrants
 - Parabolic shape, not conical approximation
 - Improved replication and alignment techniques



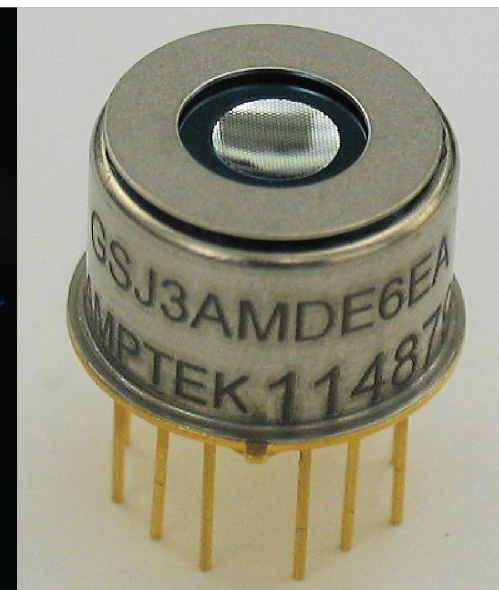
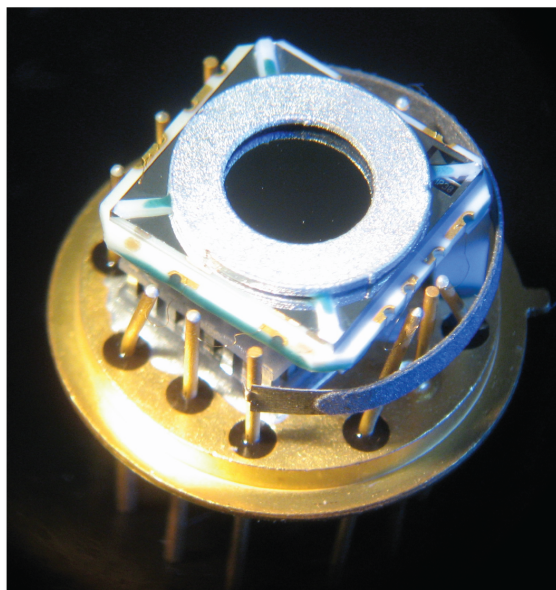
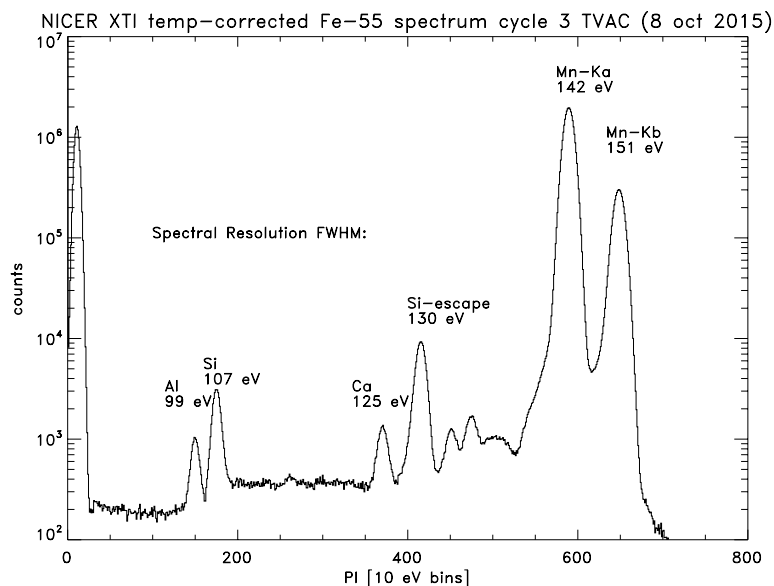


Focal Plane Module (FPM)

Flight-lot detector in flight housing



- Commercial silicon drift detectors (SDD) from Amptek Inc. provide CCD-like energy resolution and < 100 ns time resolution with built-in thermo-electric cooling
- Detector window consists of 40 nm of Si_3N_4 and 30 nm of Al. Transmits very low energy X-rays (better than 200 eV) while maintaining a hermetic seal.





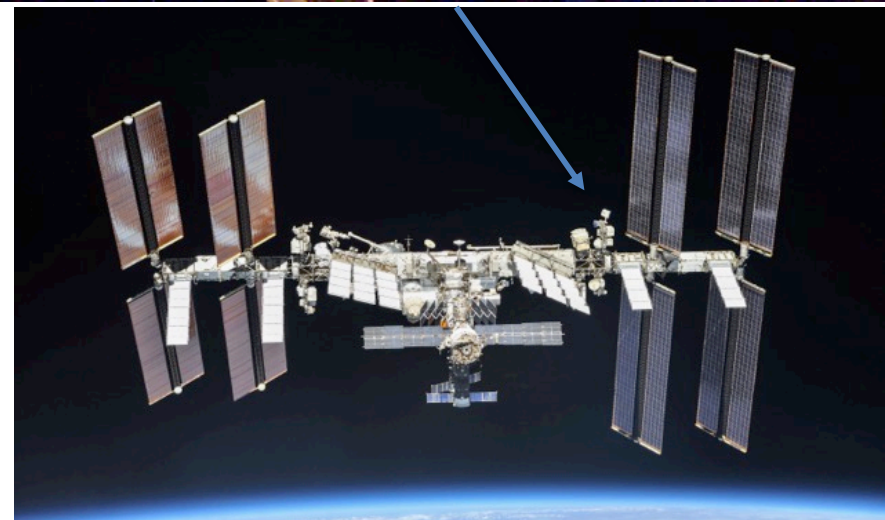
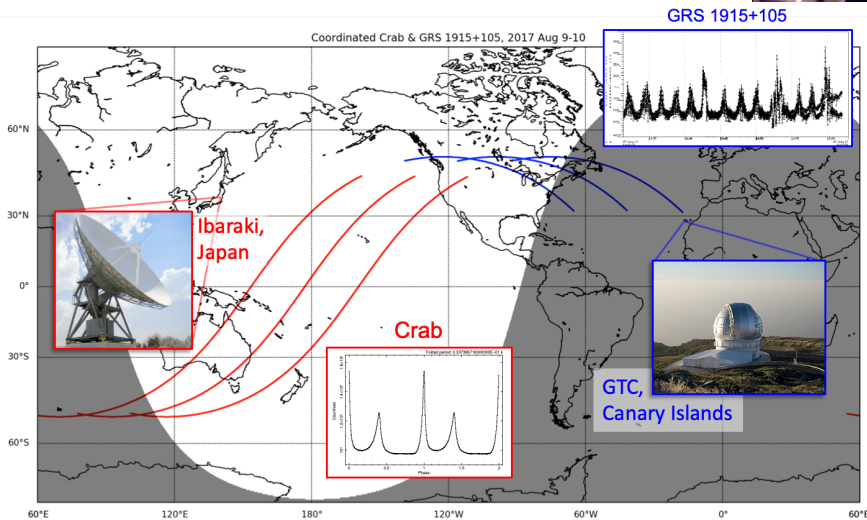
NICER on the ISS

Operating on ISS since June 2017

24/7 Science except for relatively rare interruptions due to nearby EVA/EVR operations or ISS anomalies

Flexible Scheduling that enables multiwavelength coordination as well as overlapping short term and long term monitoring science programs

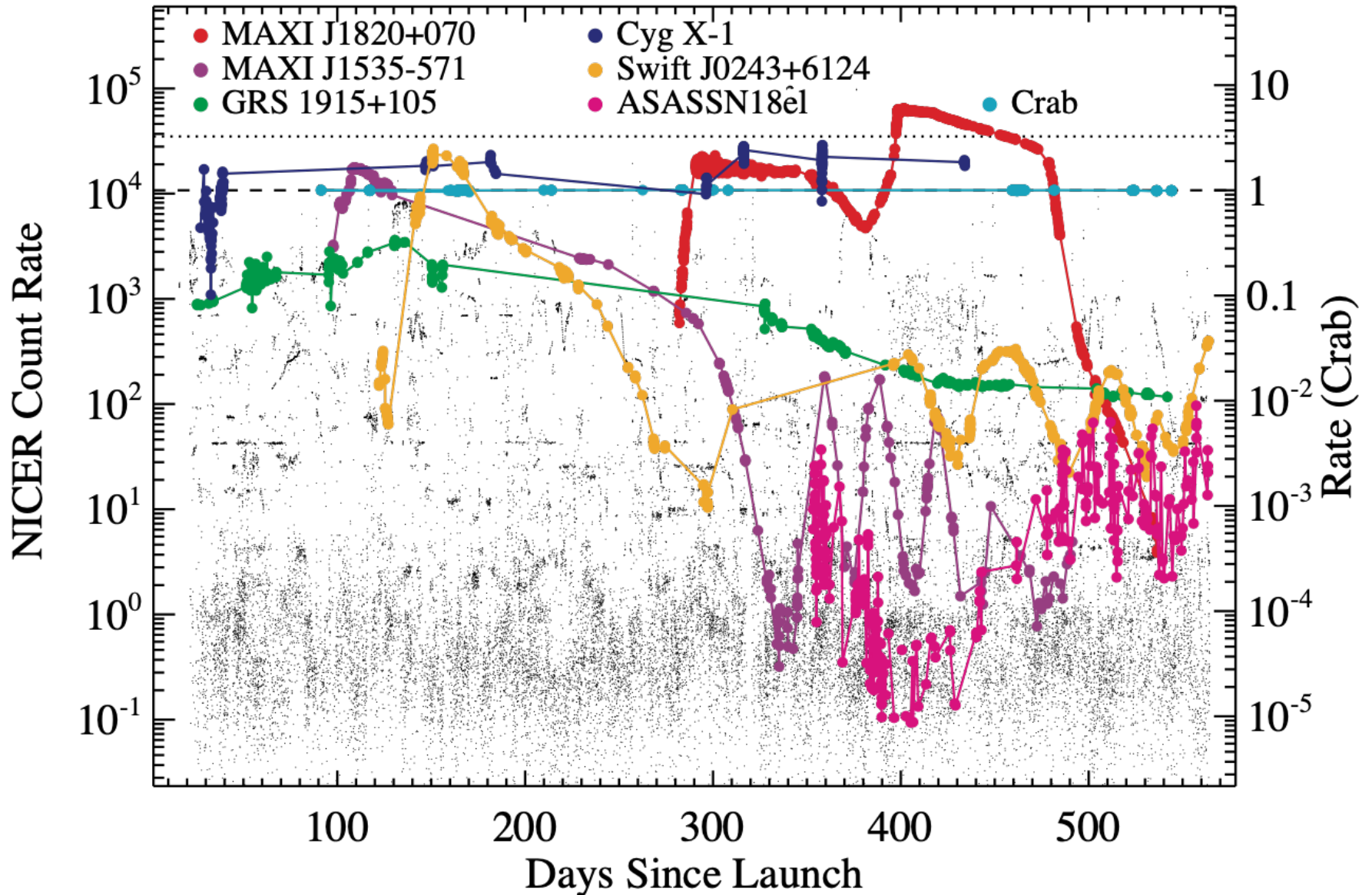
Improving Target of Opportunity Capabilities that include ground and in-flight capabilities (e.g. OHMAN)





NICER expands the dynamic range of X-ray astrophysics

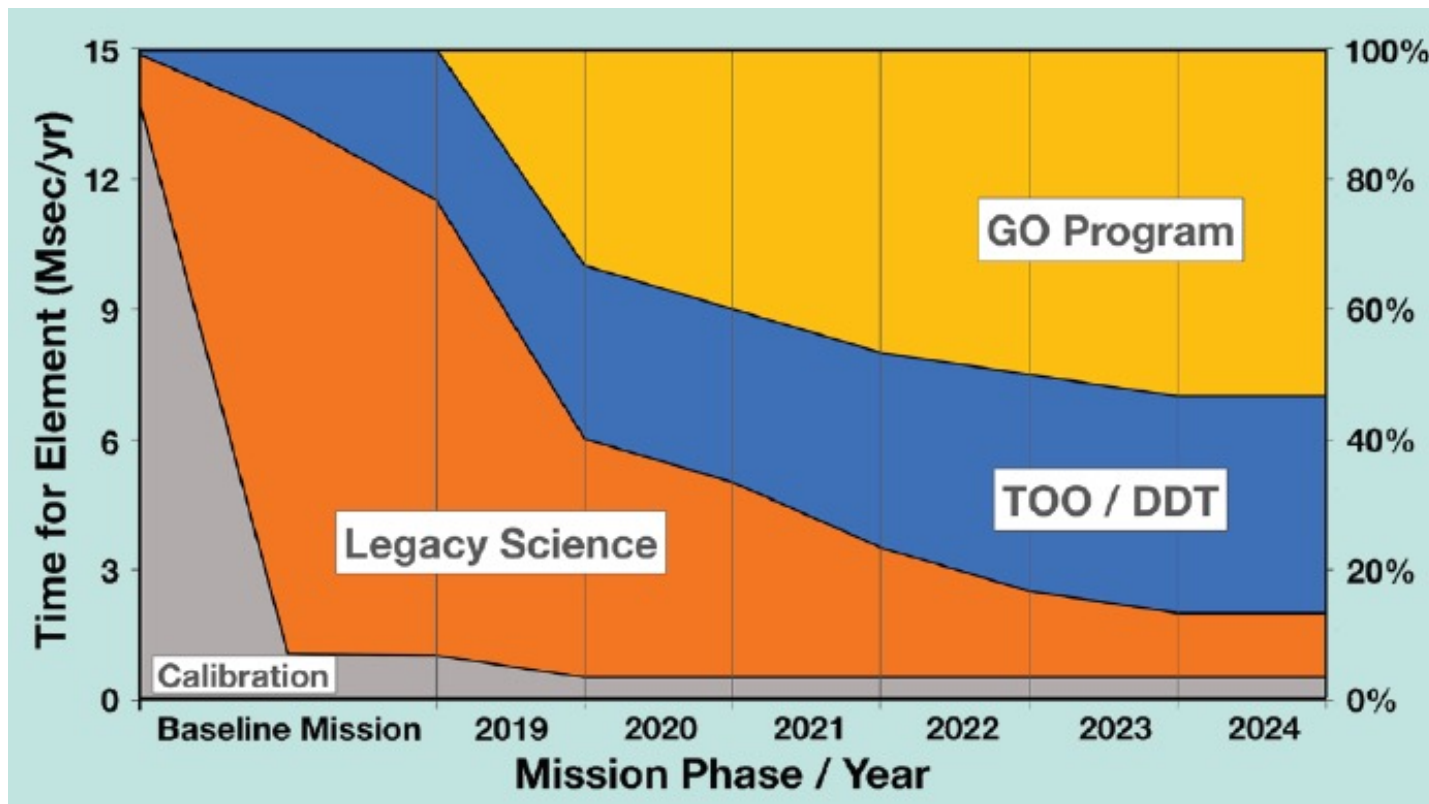
NICER's Observing History

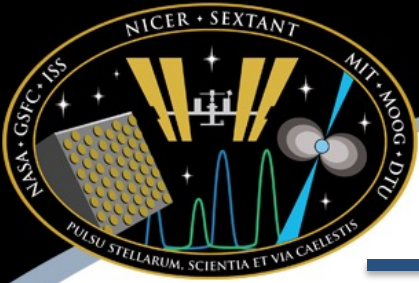




NICER Science Program

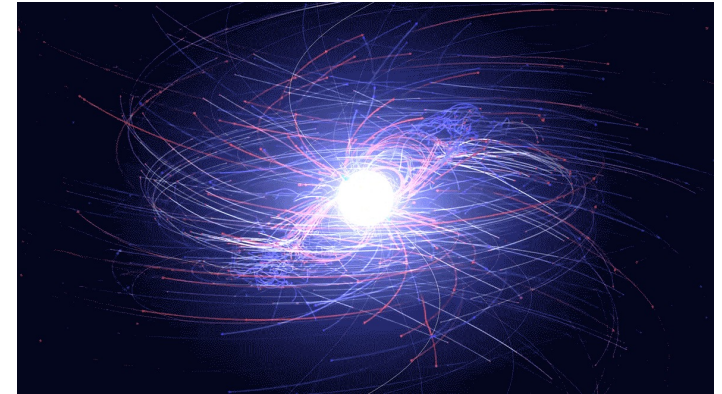
- Legacy Science and Observatory Science
- Guest Observer (GO) Science Program
- Target of Opportunity (TOO) Enhancements





Legacy Science Program

- Neutron Star Interior Composition Explorer
- Deeper (and more) neutron star mass and radius measurement
 - 2019 papers on PSR J0030 mass and radius
 - Just Released PSR J0740 radius (2 Msun)
 - Upcoming PSR J0437, and more
 - => better constrain nuclear theory
- Finding new neutron stars with pulsation searches
 - TOO follow-ups from eROSITA, INTEGRAL, MAXI, and others
 - Fermi sources
- Bursting neutron star LMXBs
 - Based on TOO triggers, including OHMAN
- Magnetars
 - Connection to FRBs?
- Long term monitoring of “stable” pulsars



The golden age of neutron-star physics has arrived

Nature feature article
4 March 2020





Using the ISS as a multitool laboratory

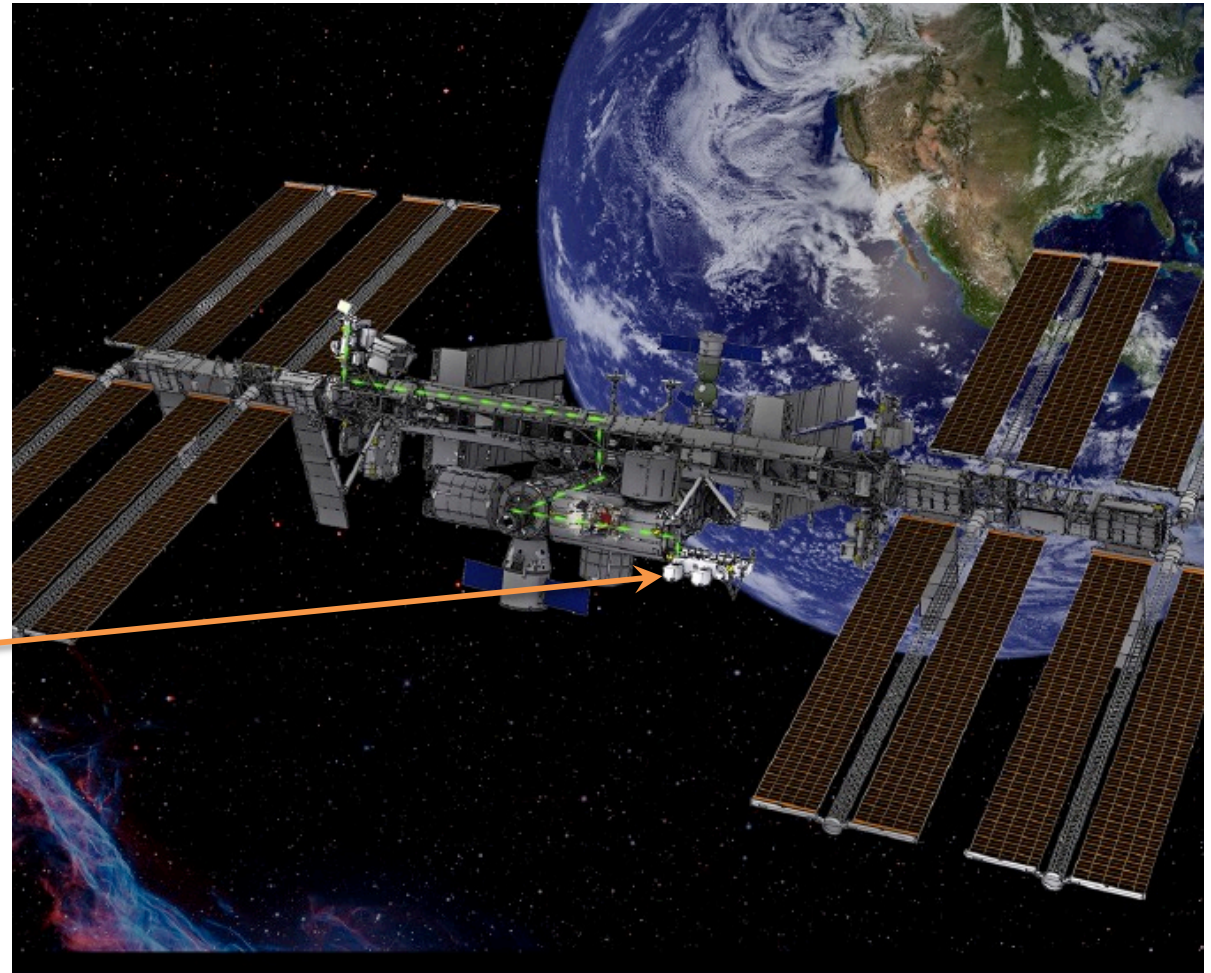
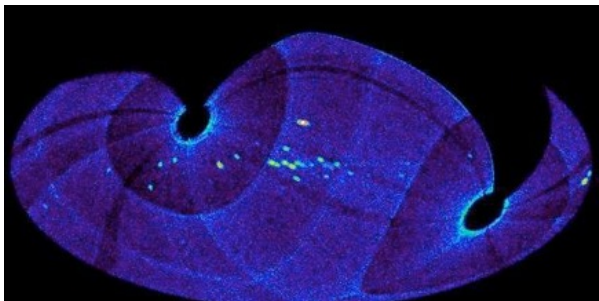
OHMAN: Connecting two ISS payloads using ISS infrastructure to enable science of fast transients that would otherwise be inaccessible.

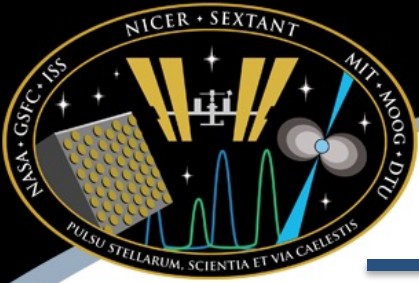


© NASA

JAXA's Monitor of All-sky X-ray Image (MAXI)

- $> 900 \text{ deg}^2$ instantaneous
- $> 95\%$ of the sky each orbit





Thank you for your participation!

- This is NICER's 1st workshop
 - We would like to hear from you about what we did right and what we could improve upon
 - Please fill out the survey form that Elizabeth Ferrara will email to all participants
- Presentations will be recorded when permitted
- Please enjoy the workshop