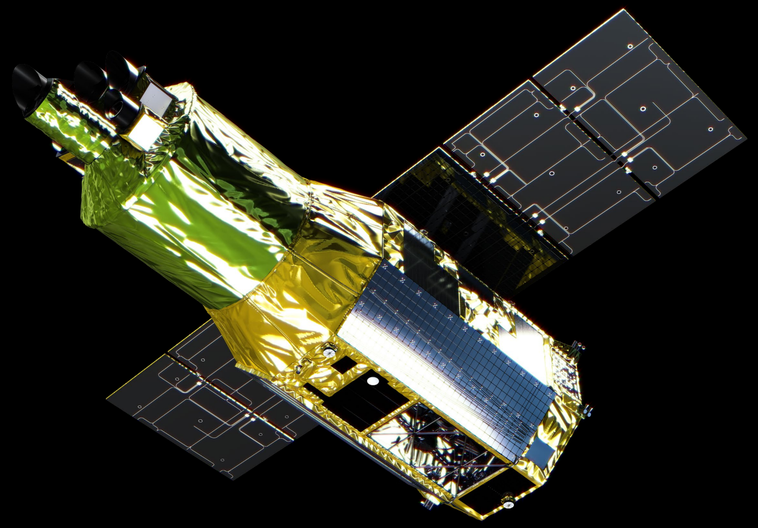
XRiSM

X-Ray Imaging and Spectroscopy Mission

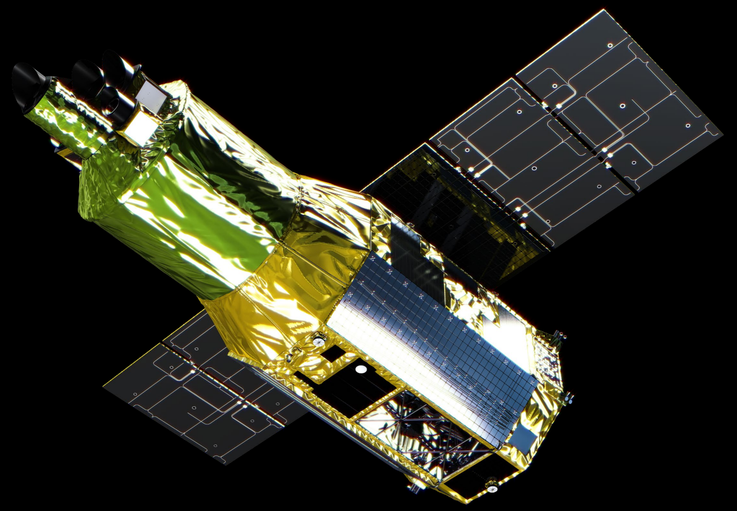
Mission Status Update

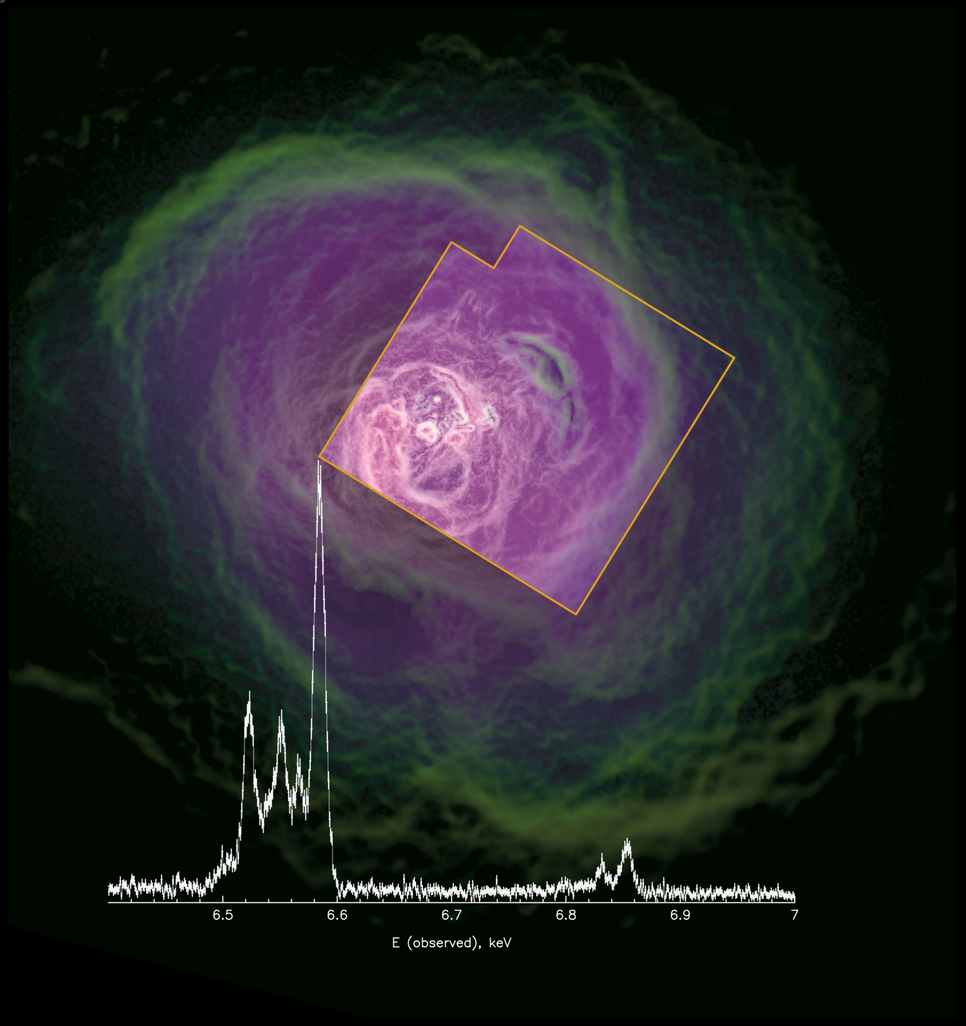


Richard Kelley and Brian Williams
NASA Goddard Space Flight Center

XRISM

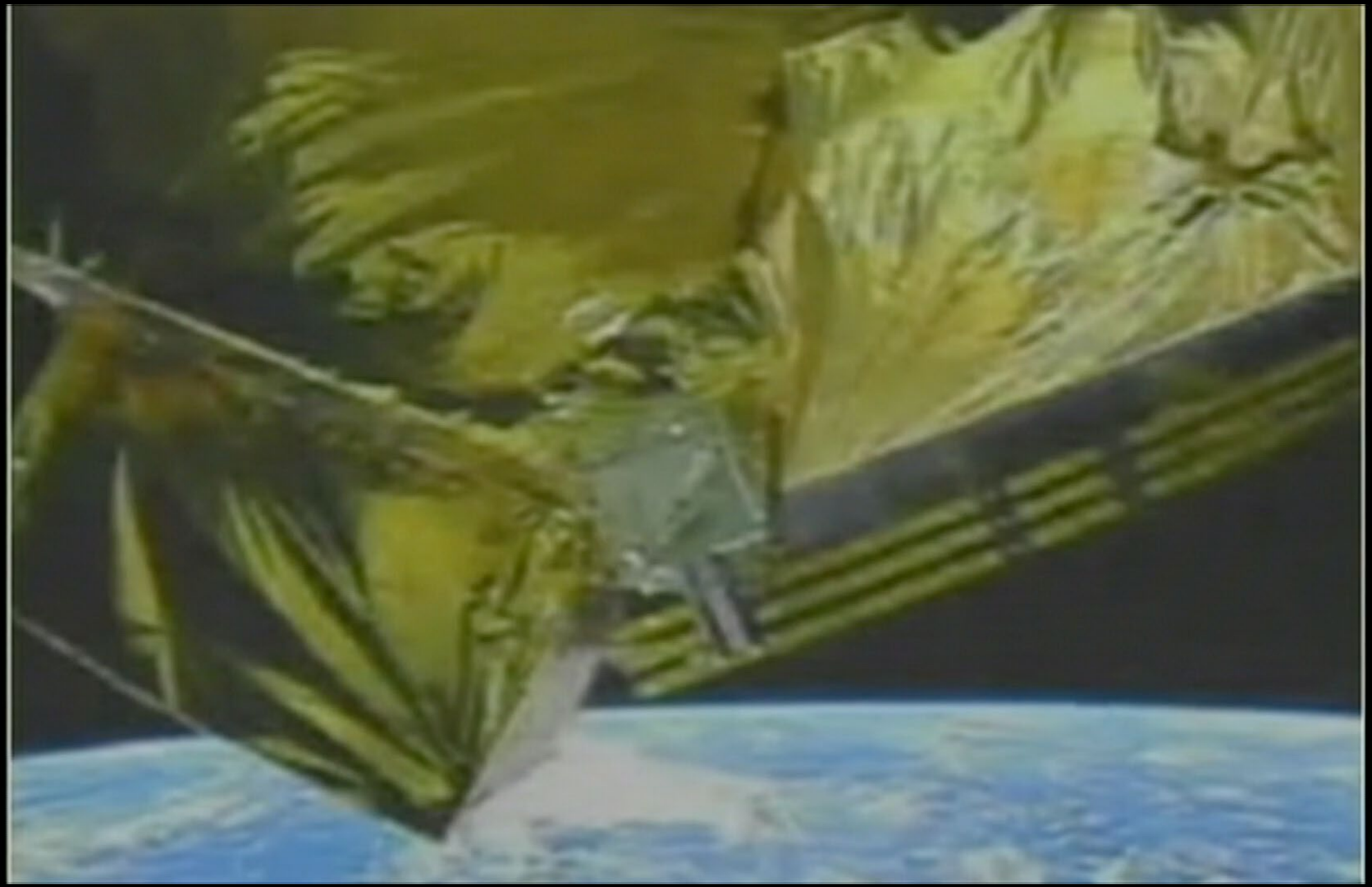
X-Ray Imaging and Spectroscopy Mission





XRISM Quick Summary

- JAXA/NASA Collaborative Mission with ESA participation
- Two instruments
  - *Resolve* - a soft X-ray (0.3-12 keV) spectrometer providing non-dispersive high-resolution X-ray spectroscopy
  - *Xtend* - a 38’ field of view soft X-ray imager
- Launched Sep 7th, 2023
- Mission is to recover science lost with demise of *Hitomi* in 2016
- After a 10-month calibration and performance verification phase, rest of mission lifetime will be for General Observers worldwide



14 minutes, 9 seconds after launch

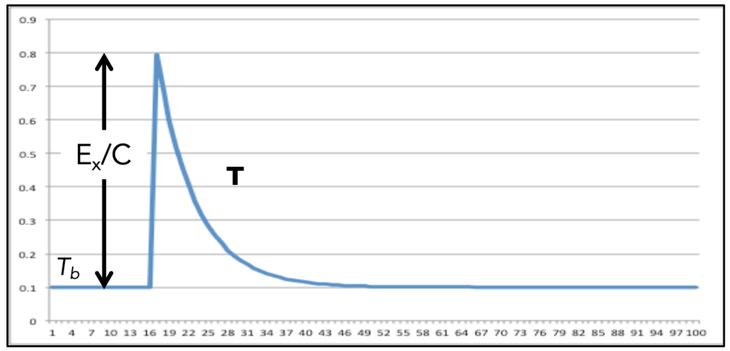
Single Photon ("quantum") Calorimeter

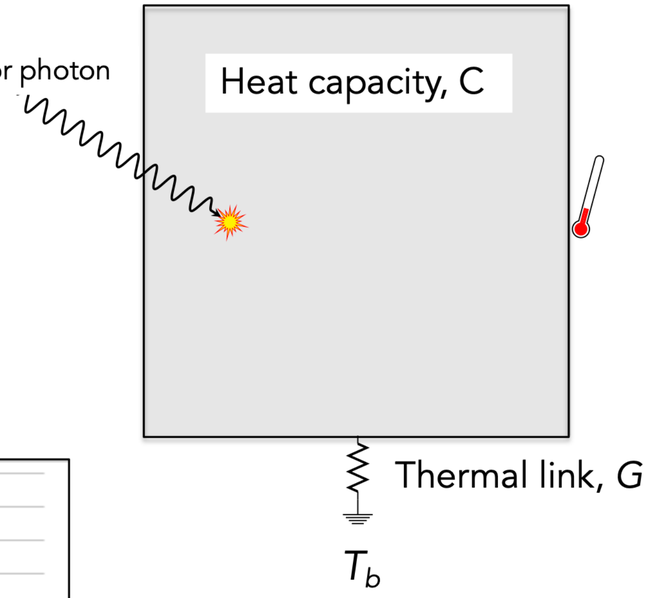
$$\Delta Q = C\Delta T$$

$$C\frac{dT}{dt} = E_x\delta(t) - G(T - T_b)$$

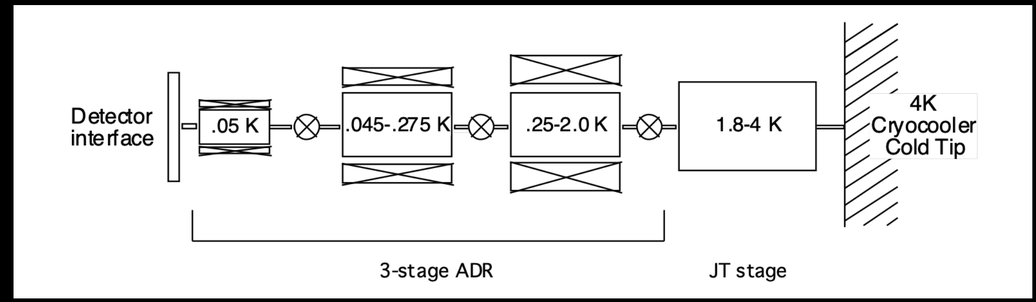
$$T = T_b + \frac{E_x}{C}e^{-t/\tau}$$

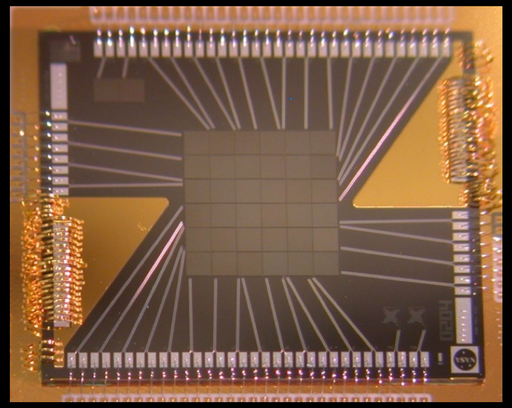
$\tau = C/G$ Thermal time constant

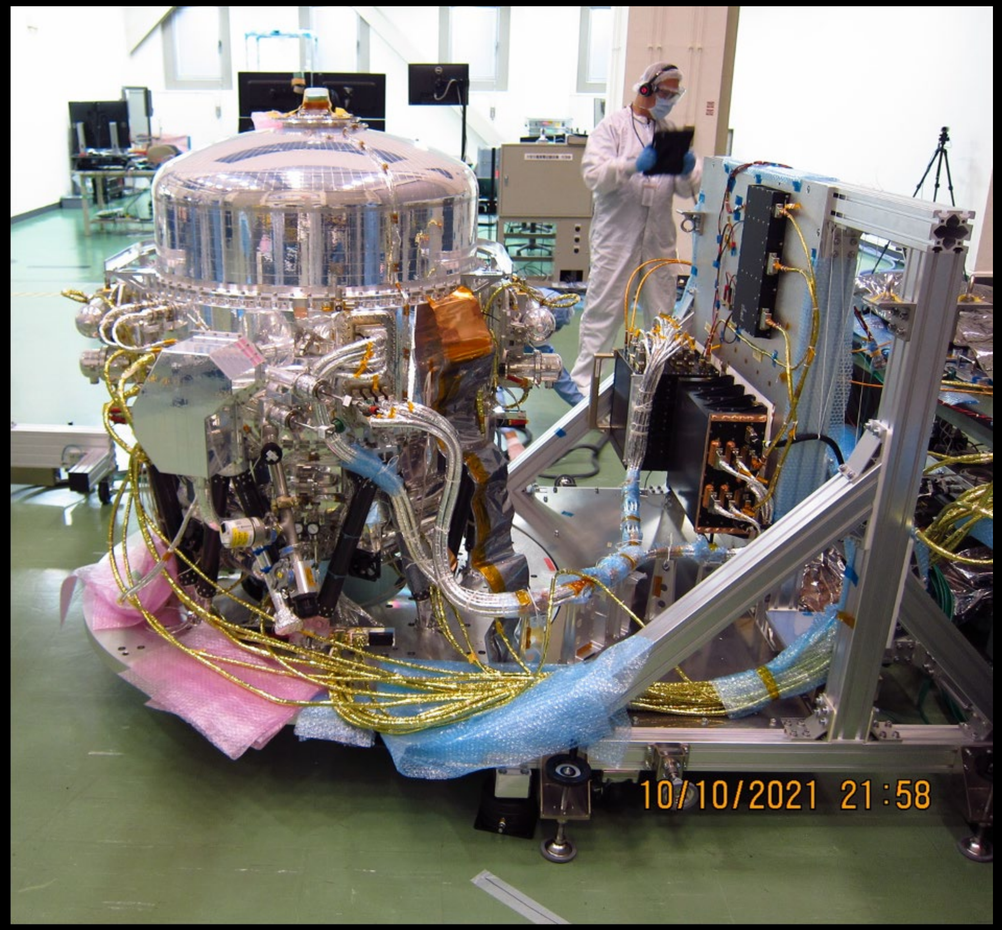




Requires ultra-low temperature: < 0.1K



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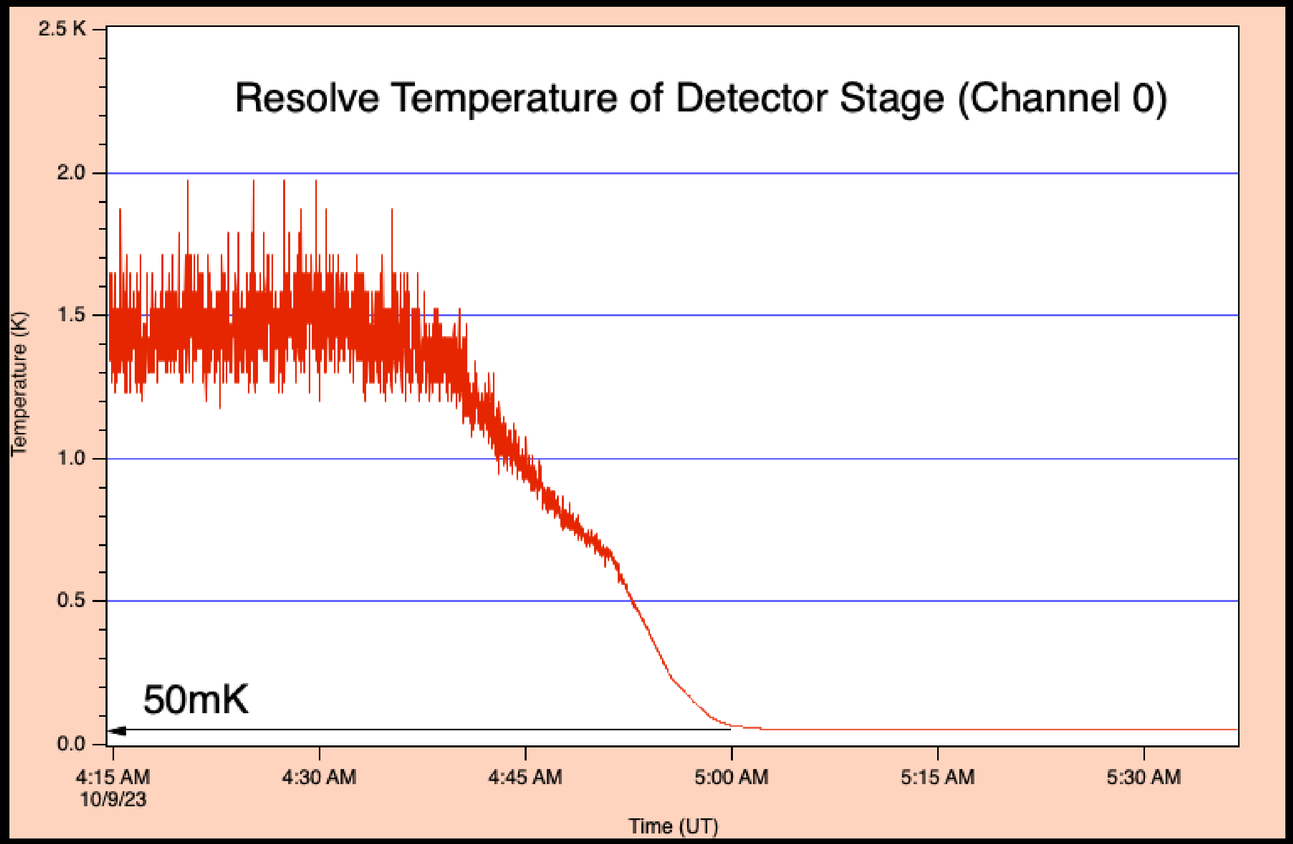
Resolve Temperature of Detector Stage (Channel 0)
2.5 K
2.0
1.5
1.0
0.5
0.0
Temperature (K)
50mK
4:15 AM
10/9/23
4:30 AM
4:45 AM
5:00 AM
5:15 AM
5:30 AM
Time (UT)


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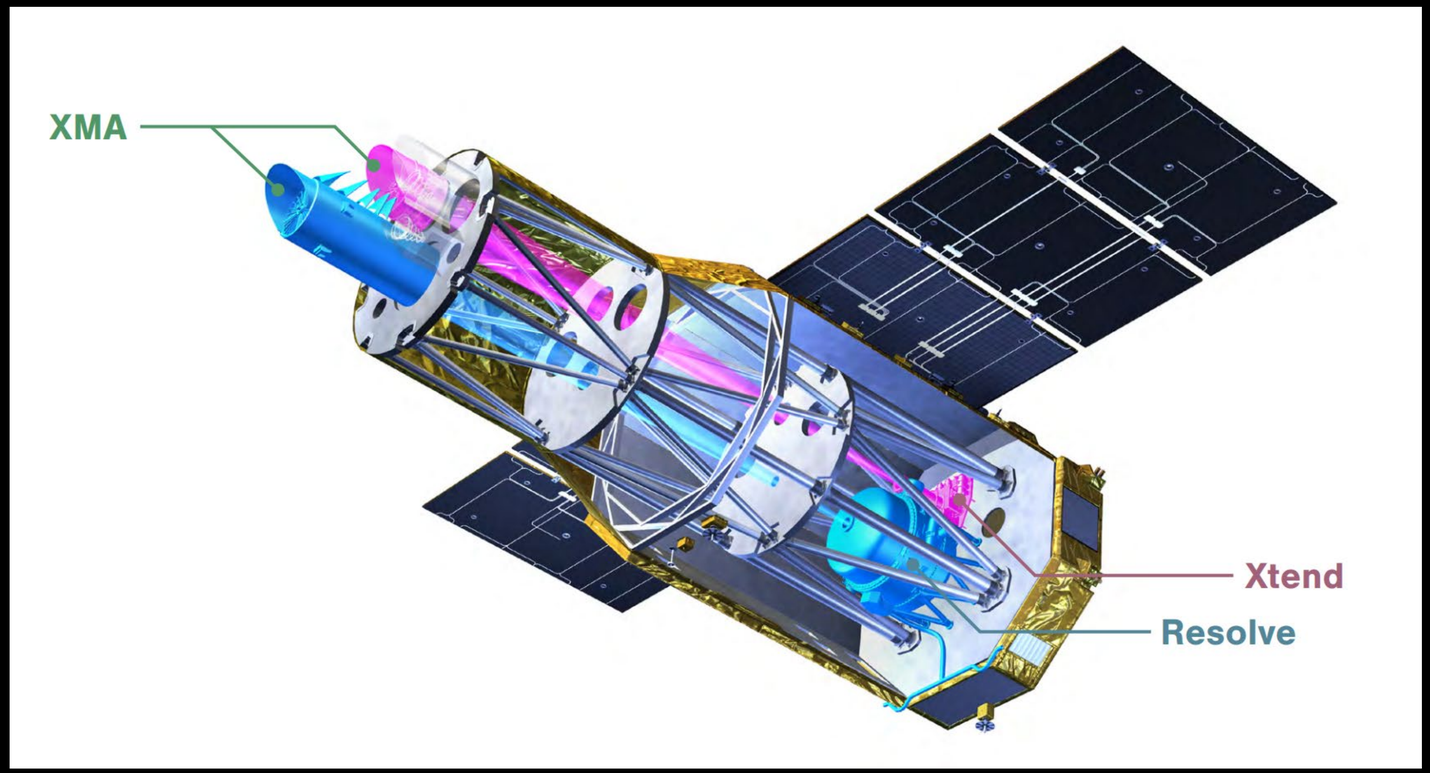
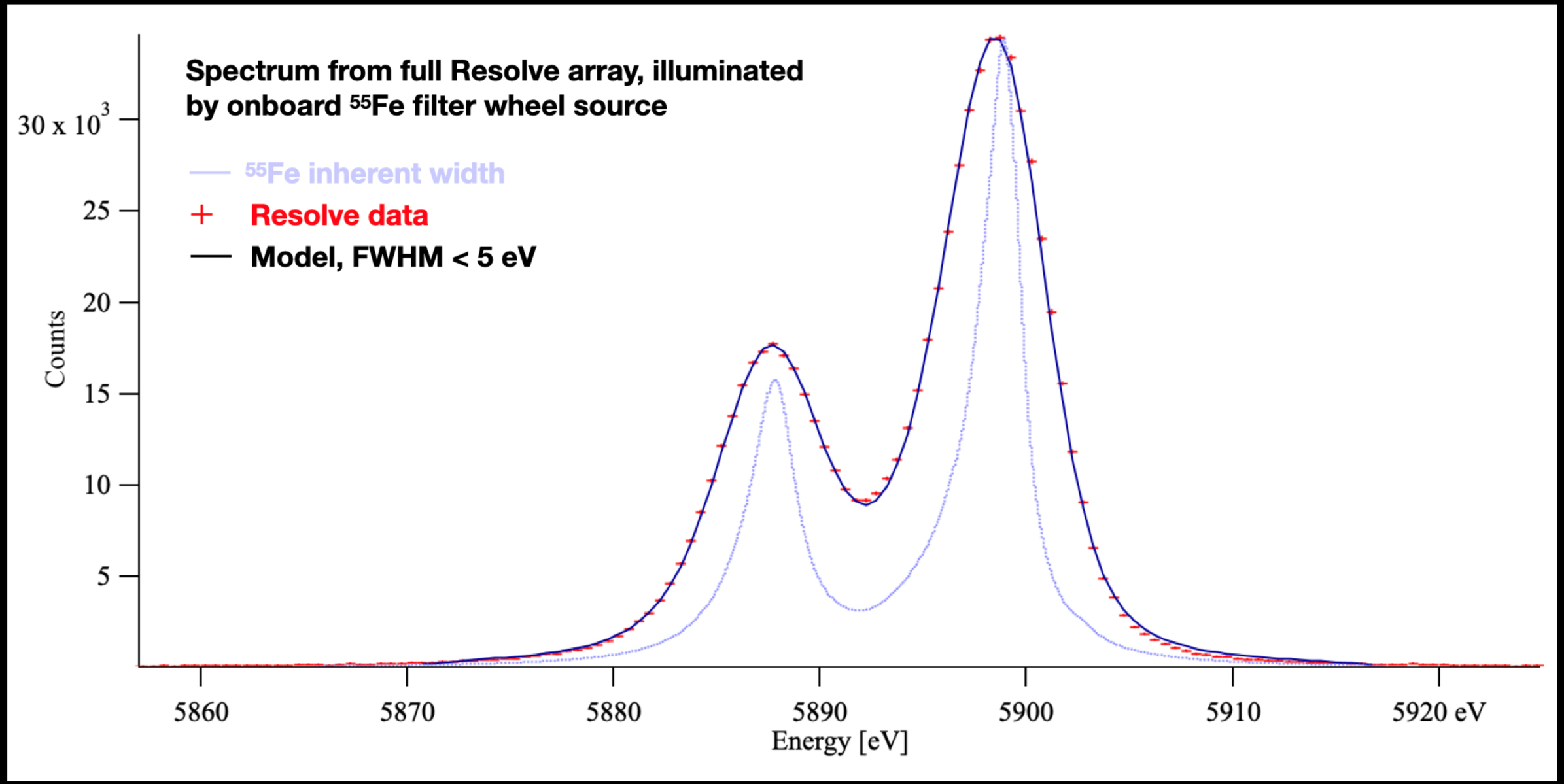
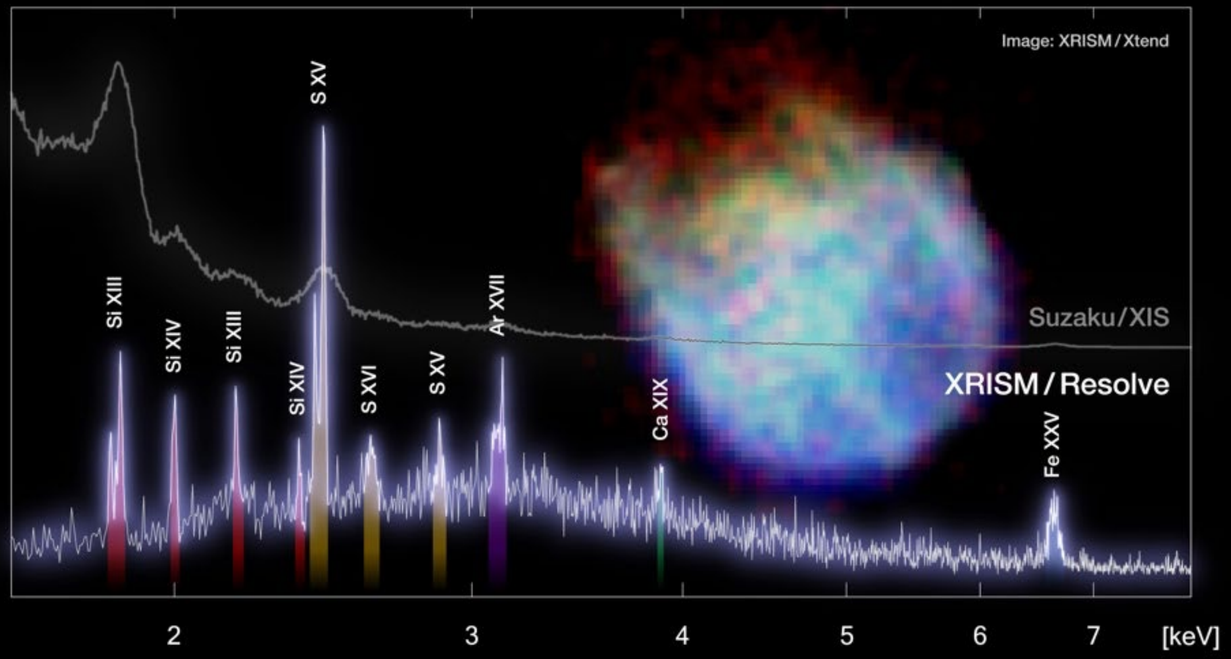

XMA
Xtend
Resolve

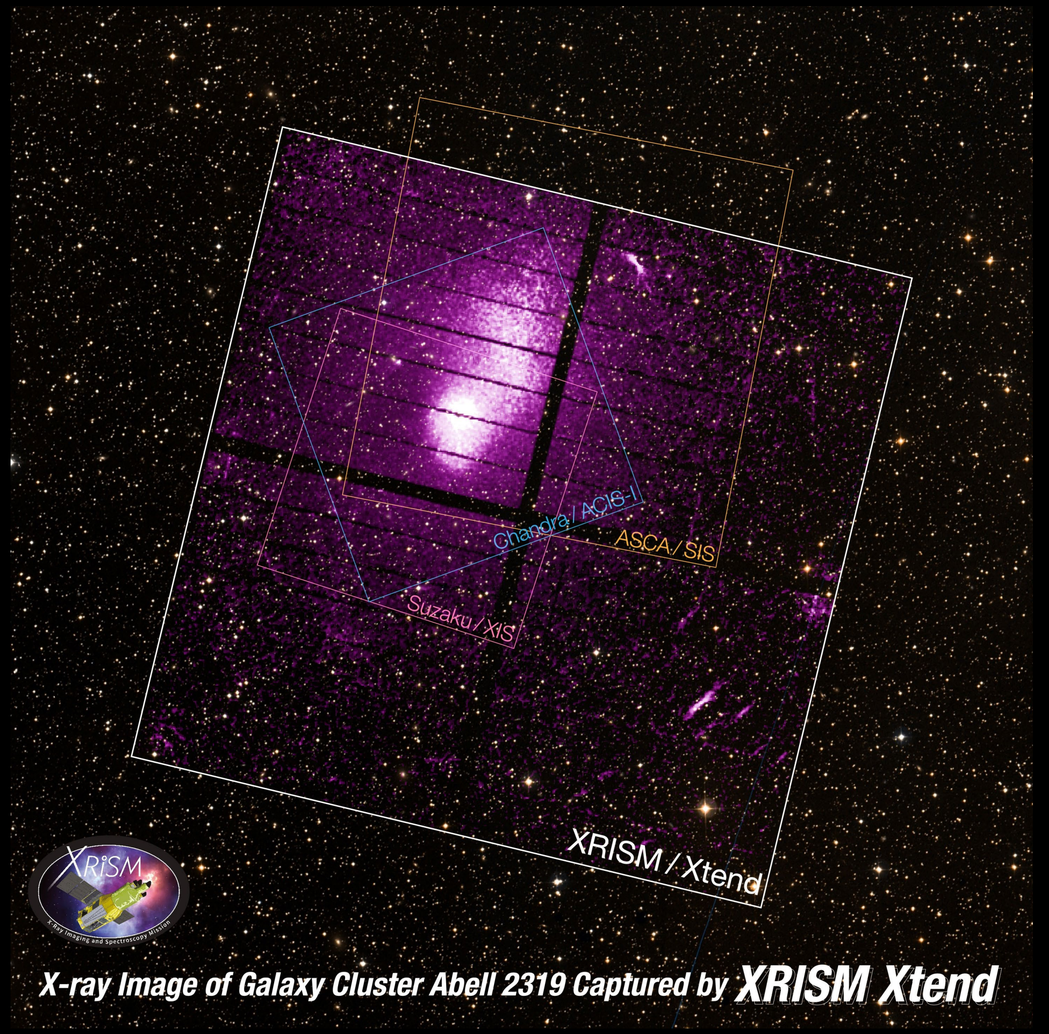
On-orbit spectrum of onboard calibration source, ~4.5 eV resolution



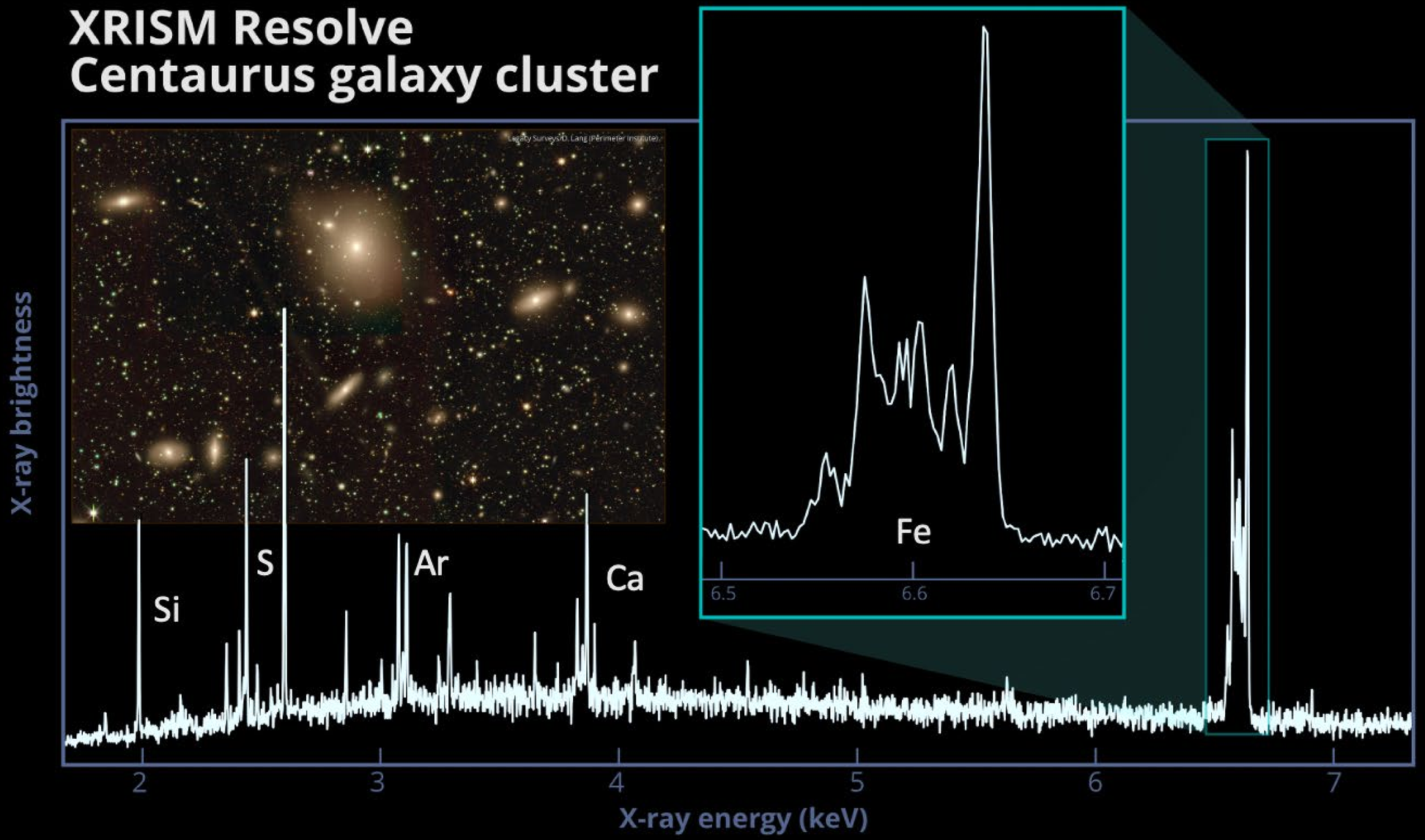
X-ray Spectrum of Supernova Remnant N132D Measured by XRISM Resolve



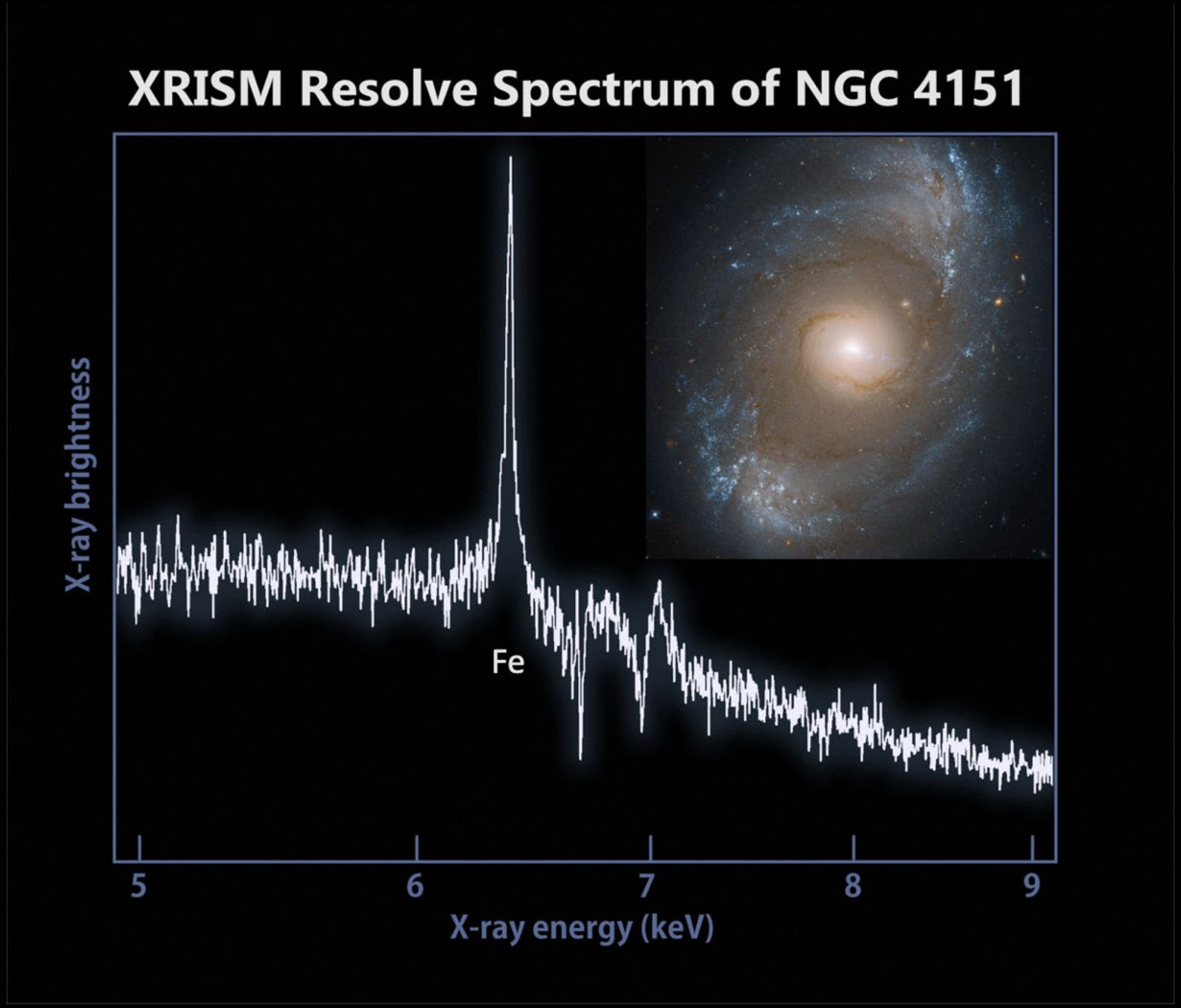
First Light, released January 5th, 2024



X-ray Image of Galaxy Cluster Abell 2319 Captured by XRISM Xtend

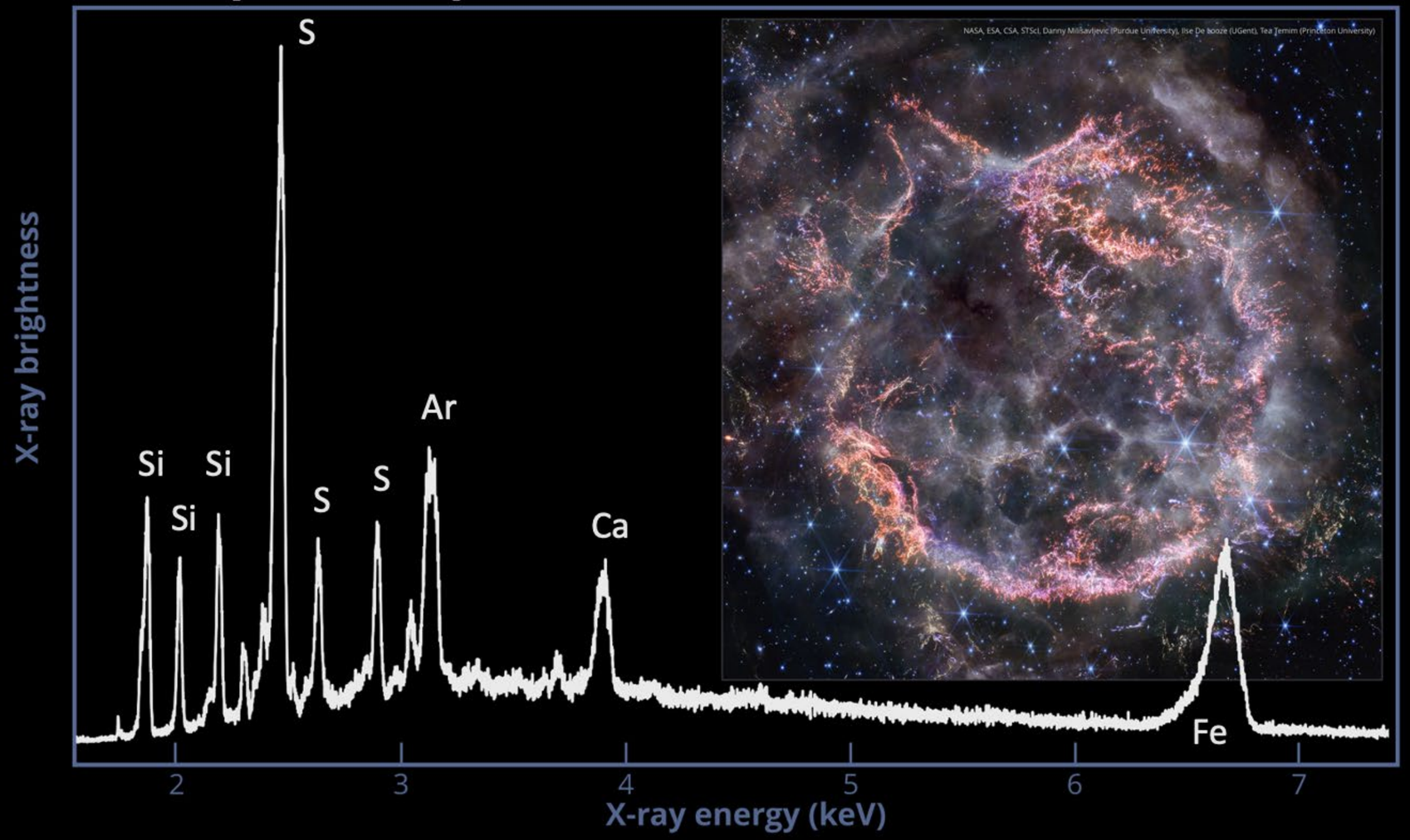


XRISM Resolve spectroscopy reveals plasma conditions (temperature, elemental abundance) within the hot gas in the galaxy cluster, which constitutes most of the mass of normal matter in the universe



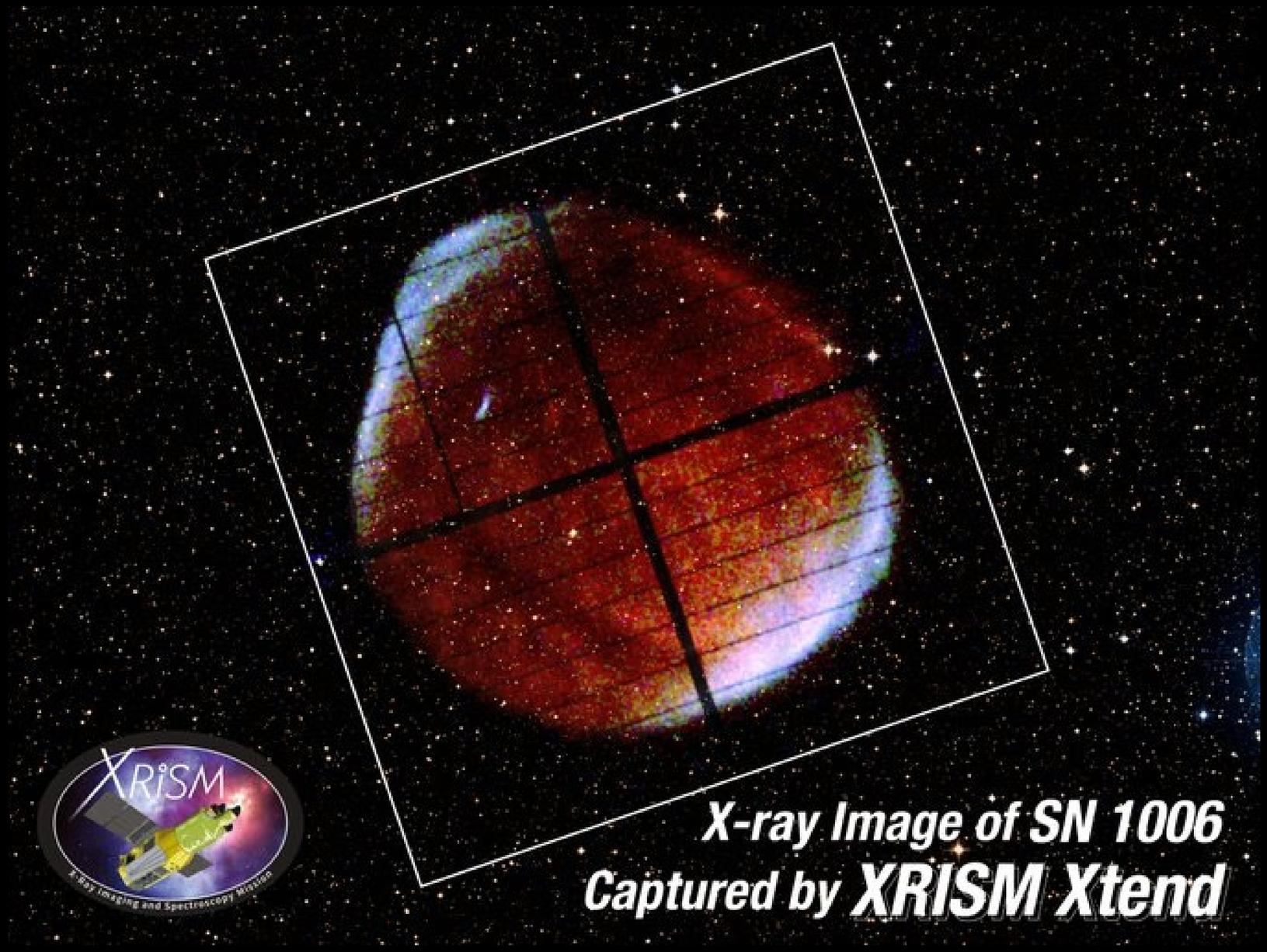
The shape of this line from ionized iron and the absorption features (dips) tell us about the fate of matter at the last moments before it falls into the super-massive black hole at the center of this galaxy

XRISM Resolve
Cassiopeia A supernova remnant



JWST image,
XRISM/Resolve spectrum

XRISM shows elements produced in the supernova explosion. Note broadness of lines, which is a real effect and shows the extreme velocities of the ejected material



XRISM is already detecting new transients in the Xtend FoV, and recently posted our first Astronomer's Telegram

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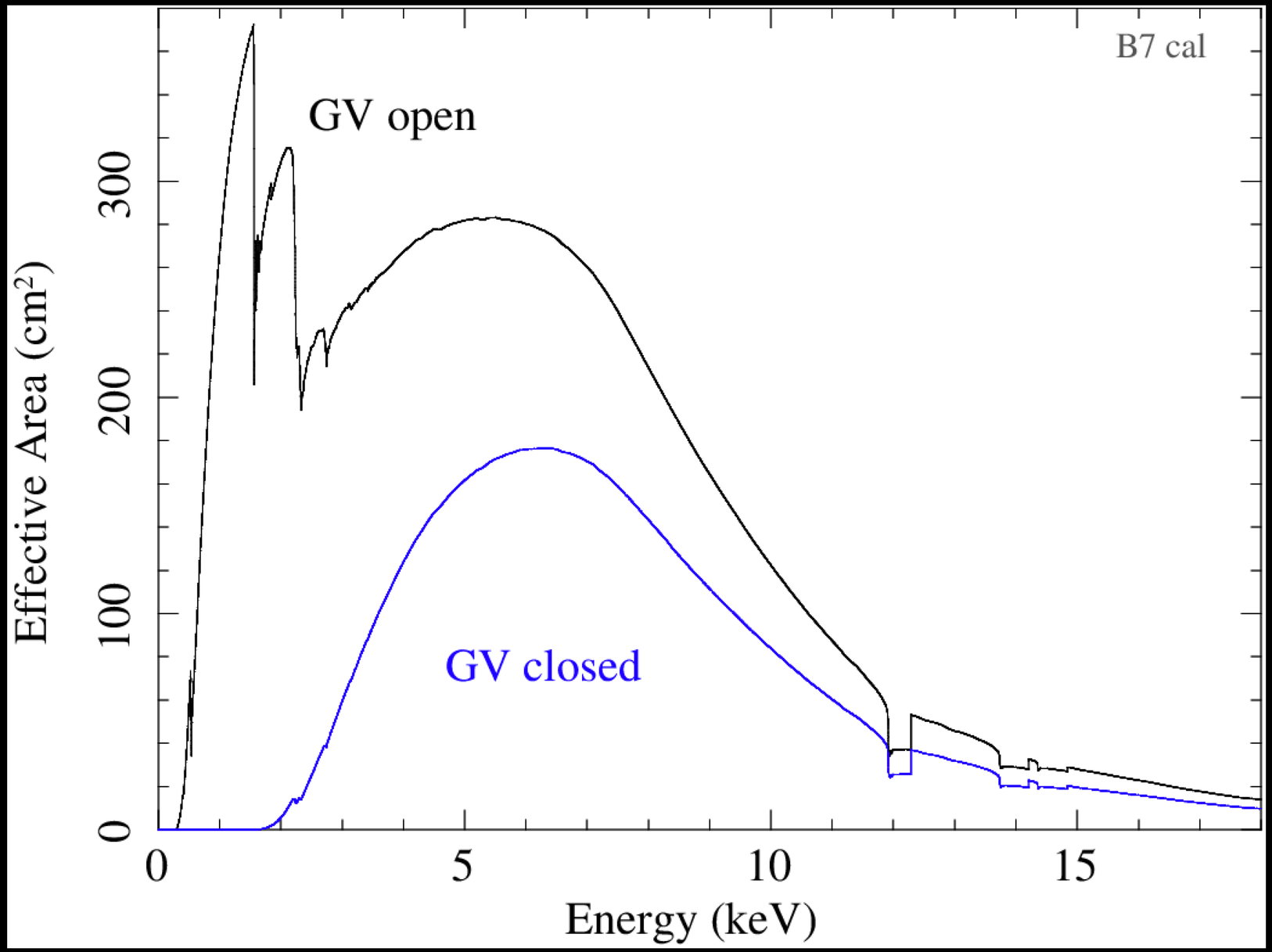
XRISM/Xtend Transient Search (XTS) detected an X-ray flare from a plausible optical counterpart LP 593-21

ATel #16532; *M. Yoshimoto (Osaka U.), K. Hayashi, Y. Kanemaru, S. Ogawa, T. Yoshida (JAXA), K. Akasu (Chuo U.), M. Audard (U. de Geneve), E. Behar (Technion), S. Inoue (Kyoto U.), T. Kohmura (TUS), Y. Maeda (JAXA), M. Mizumoto (UTEF), N. Nemoto (Chuo U.), M. Nobukawa (NUE), K. Pottschmidt (UMBC, NASA GSFC, CRESST), M. Shidatsu (Ehime U.), Y. Terada (Saitama U.), Y. Terashima (Ehime U.), Y. Tsuboi (Chuo U.), H. Uchida (Kyoto U.), T. Yoneyama (Chuo U.)*
*on **15 Mar 2024; 13:38 UT***
Credential Certification: Yohko Tsuboi (tsuboi@phys.chuo-u.ac.jp)

Subjects: X-ray, Binary, Star, Transient, Variables

𝕏 Post

XRISM/Xtend Transient Search (XTS) detected an X-ray flare from a new X-ray source candidate XRISM J0335+0025 at 2024-03-09 TT. The source position is determined to be (R.A., Dec.) = (53.897 deg, 0.422 deg) with a systematic uncertainty of ~ 40 arcsec.



- Resolve's aperture door (gate valve) has not yet opened, despite multiple attempts
- The door blocks soft X-rays, shifting Resolve's energy band and reducing the effective area
- The investigation into this anomaly is still underway, and the XRISM team is assessing future options and the possibility of additional opening attempts
- Most Level-1 science requirements are still achievable with longer exposures
- Xtend is unaffected by this

Summary of Gate Valve Open (GVO) operations

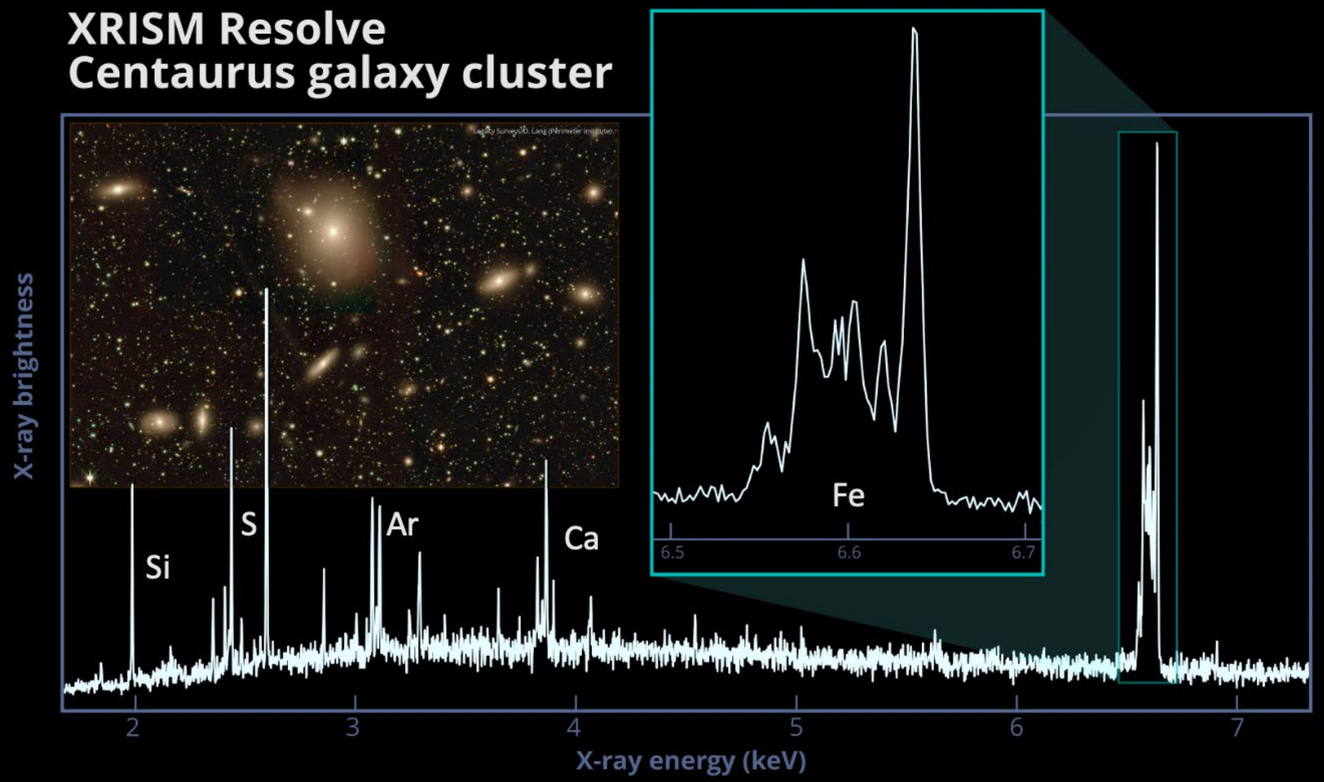
- GVO1 made, as planned, on November 4, 2023. Single signal sent to fire non-explosive actuators (NEAs) holding GV down. System quadruply-redundant
- GVO2 made on November 19, 2023. Multiple signals sent; evidence that NEAs did release during GVO1, but GV is stuck in closed position
- GVO3 performed Dec 19-24, 2023. Strategy: warm and vibe. Involved orienting spacecraft to heat up dewar (achieved temp increase from -15C to 0C), then applying a shock from a single spacecraft balancer for 5 minutes (done 3 times)
- GVO4 plan (under assessment) similar to GVO3, but with more intensity. 4 balancers, longer operation, all to increase vibration

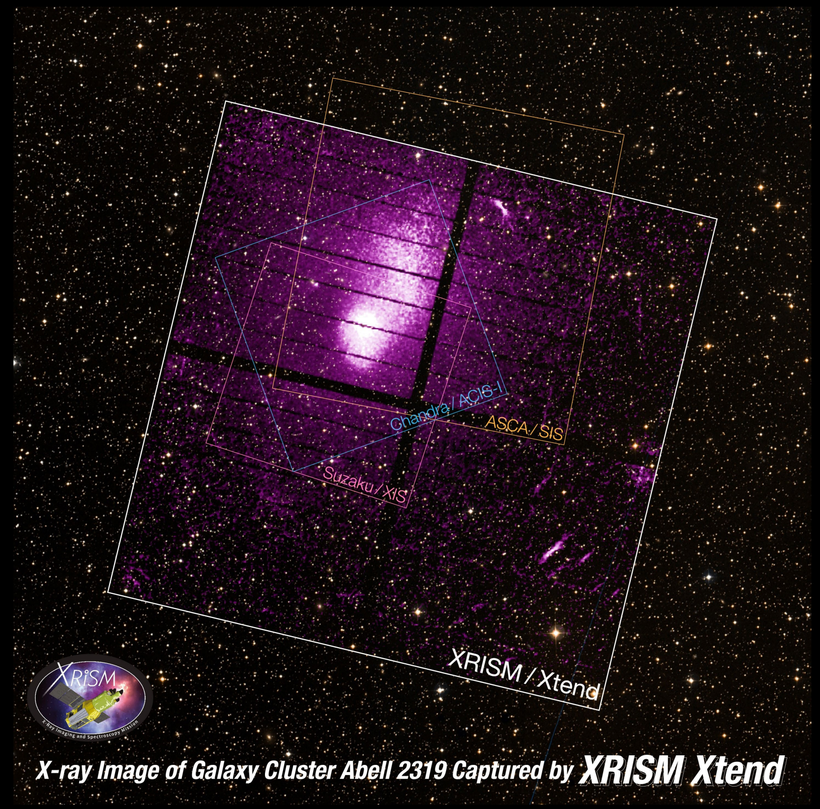
Assessment of GVO4

- NASA is working closely with our JAXA colleagues to assess the viability of another operation
- The Resolve instrument is producing groundbreaking spectra even with the GV closed, and the GO program has instructed proposers to proceed for Cycle 1 proposals assuming it remains closed.
- The 4-balancer operation constitutes carrying out another operation that was not conducted in ground tests on the flight system, and thus constitutes a risk from the perspective of unintended consequences. We believe the risk of this operation is low, but non-zero.
- **At this time, the project believes it is not prudent to risk damaging a well-performing, irreplaceable instrument so early in its operational life.**
- Plan to revisit GVO4 assessment near end of PV phase, in summer 2024

Closing Thoughts

- High-resolution X-ray spectroscopy is a rich and largely unexplored space. We're excited about the discoveries we know we'll make, but we're even more excited about the things we **don't** know we'll find…
- The spacecraft and instruments are working exceptionally well, and exceeding every performance requirement. We are hopeful for future prospects to open aperture door, but even in its present state, XRISM will get excellent results over the 1.7-12 keV band.
- XRISM is a general purpose astronomical observatory. We can and will make contributions to virtually every area of astronomy
- XRISM is a ***pioneering*** mission that will pave the way for NewAthena and future missions.





Backup Slides

Baseline Science Requirements	Achievability if GV remains closed
BSR1: Observe galaxy clusters and groups to determine their dynamical state via measurement of broadening of the Fe Kα lines to an accuracy of 300 km/s	Achievable
BSR2: Observe galaxy clusters and groups to measure the abundances of the elements to an accuracy of 20%	Mostly achievable. Only for lines >1.7 keV
BSR3: Observe starburst galaxies to measure the chemical composition and velocities of outflowing gas. Determine line centroids and widths to an accuracy of 100 km/s	Mostly achievable. Only for lines >1.7 keV
BSR4: Observe active galaxies to determine state of accreting matter around central SMBH. Fe Kα line equivalent widths, broadening, and centroids measured to accuracy of 400 km/s	Achievable
BSR5: Observe Type Ia supernova remnants to infer composition and velocity of material. Measure Cr and Mn line strengths; measure doppler shifts of S, Ar, Ca, and Fe to 400 km/s	Achievable

Resolve Baseline Technical Requirements	Status if GV remains closed
BTR1: Instrument shall be designed and fabricated to sustain science operations at the level required to achieve the BSRs	Pass, with increased exposure times
BTR2: Instrument shall have an energy resolution of 7 eV (full-width at half-maximum) measured at 6 keV	Pass (FWHM ~4.5 eV)
BTR3: Instrument shall have a detection bandwidth of 0.3-12 keV and an energy determination accuracy of <2 eV	Bandwidth limited to 1.7-12 keV, but energy accuracy is <1 eV
BTR4: Instrument shall have an angular resolution with a half power diameter of >1.7’	Pass (resolution ~1.3’)
BTR5: Instrument shall have effective area of at least 160 sq. cm. at 1 keV and 210 sq. cm. at 6 keV	Not achieved. Effective area is 0 sq. cm. at 1 keV, ~180 sq. cm. at 6 keV, mitigated with longer exposure times >1.7 keV
BTR6: Instrument shall have a net operational efficiency of more than 90% while in nominal cryogen mode	Pass. Operational efficiency ~98%