

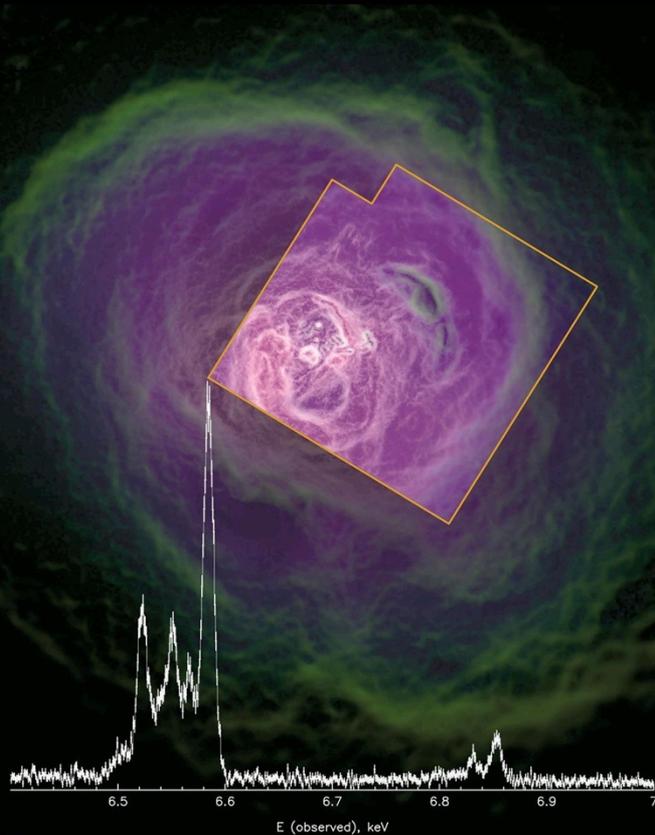
# XARM

X-ray Astronomy Recovery Mission

*Resolve*



## XARM Status



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NASA Project Scientist

NASA / GSFC

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# Hitomi Soft X-Ray Spectrometer



## Soft X-Ray Telescope

5.6 m focal length – *fixed optical bench*

203 concentric shells (1624 individual reflectors)

Outer Diameter: 45 cm  
Mass: CBE = 46 kg.

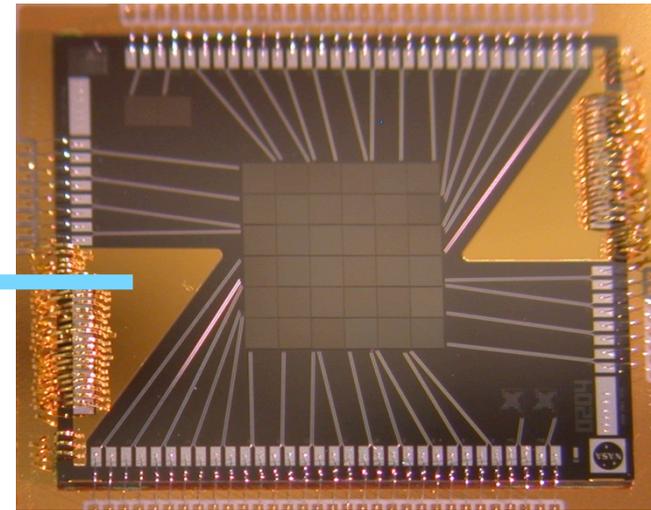
Half-Power Diameter of better than 1.2 arcmin



## X-ray Calorimeter Spectrometer

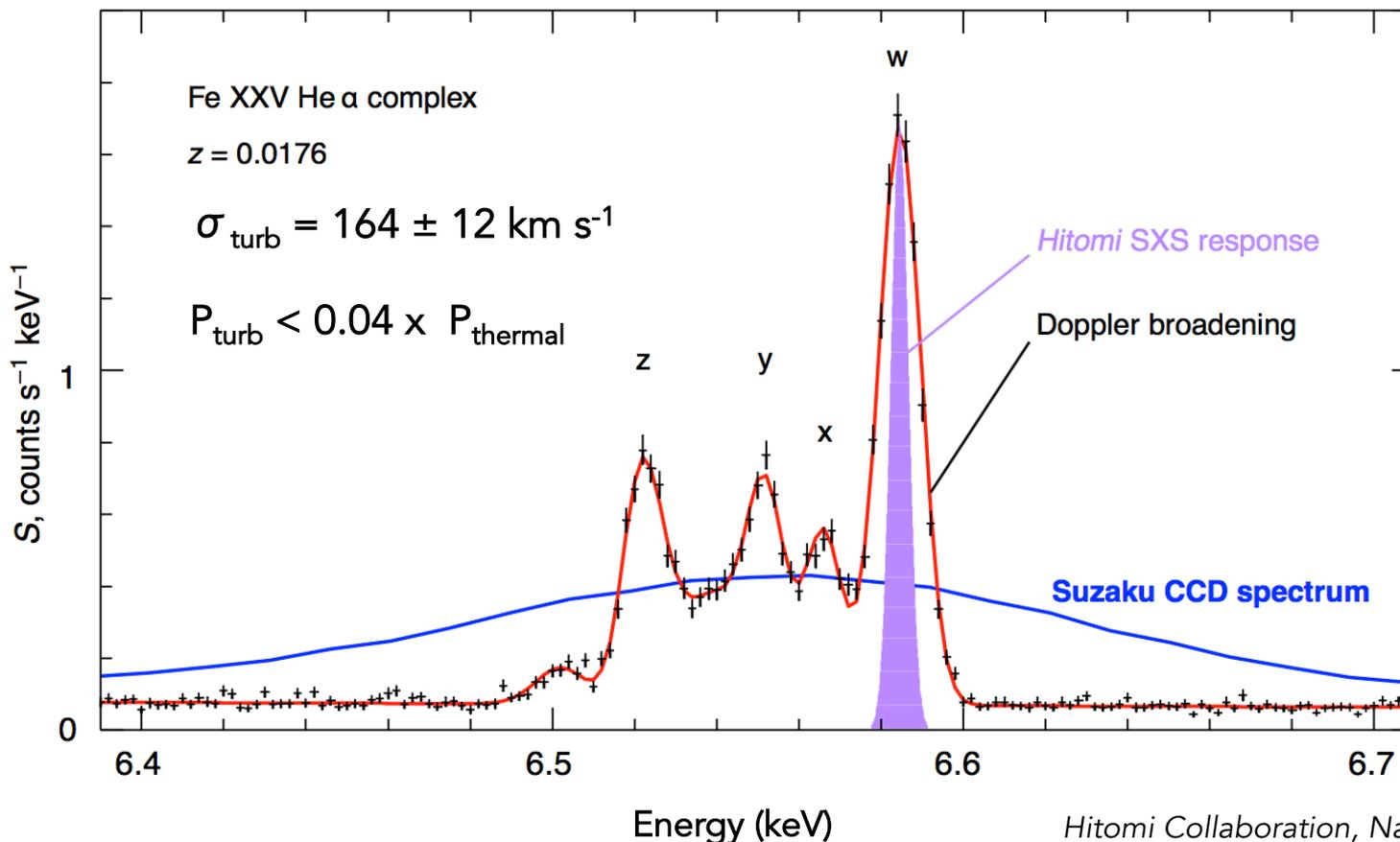
SXS – energy resolution better than 4.9 eV at system level

6 x 6 array of 30" x 30" pixels (3 arcmin FOV)



# Actual Hitomi SXS spectrum of Perseus: He-like Fe

5 eV energy resolution achieved in orbit, full array



BLACK: Hitomi SXS data  
PURPLE: Hitomi SXS line response function  
BLUE: Best previous spectrum (Suzaku CCD)

Notice how the high spectral resolution of Hitomi/SXS allows easy detection of the turbulent velocity broadening. This capability was eagerly anticipated for all nearby clusters.

JAXA approached NASA about a recovery mission, and NASA was receptive to this pending proposed reforms to address the anomaly. (Note that NASA and JAXA have long-term plans and this needs to be addressed.)

Several lessons learned meetings took place between NASA and JAXA in 2016.

NASA sought support from US community through Astrophysics Subcommittee during summer 2016.

NASA participation in XARM was recommended by the NASA Astrophysics Subcommittee, NASA Science Committee, and NASA Advisory Council.

President **Naoki Okumura** of JAXA came to Washington on September 22, 2016 to meet with NASA HQ, Astro-H team members and Goddard management, and also to give a speech at the ambassador of Japan's residence. He conveyed that a recovery mission is the highest priority of JAXA.

NASA HQ instructed GSFC to begin planning for a directed recovery mission at Goddard in September 2016.

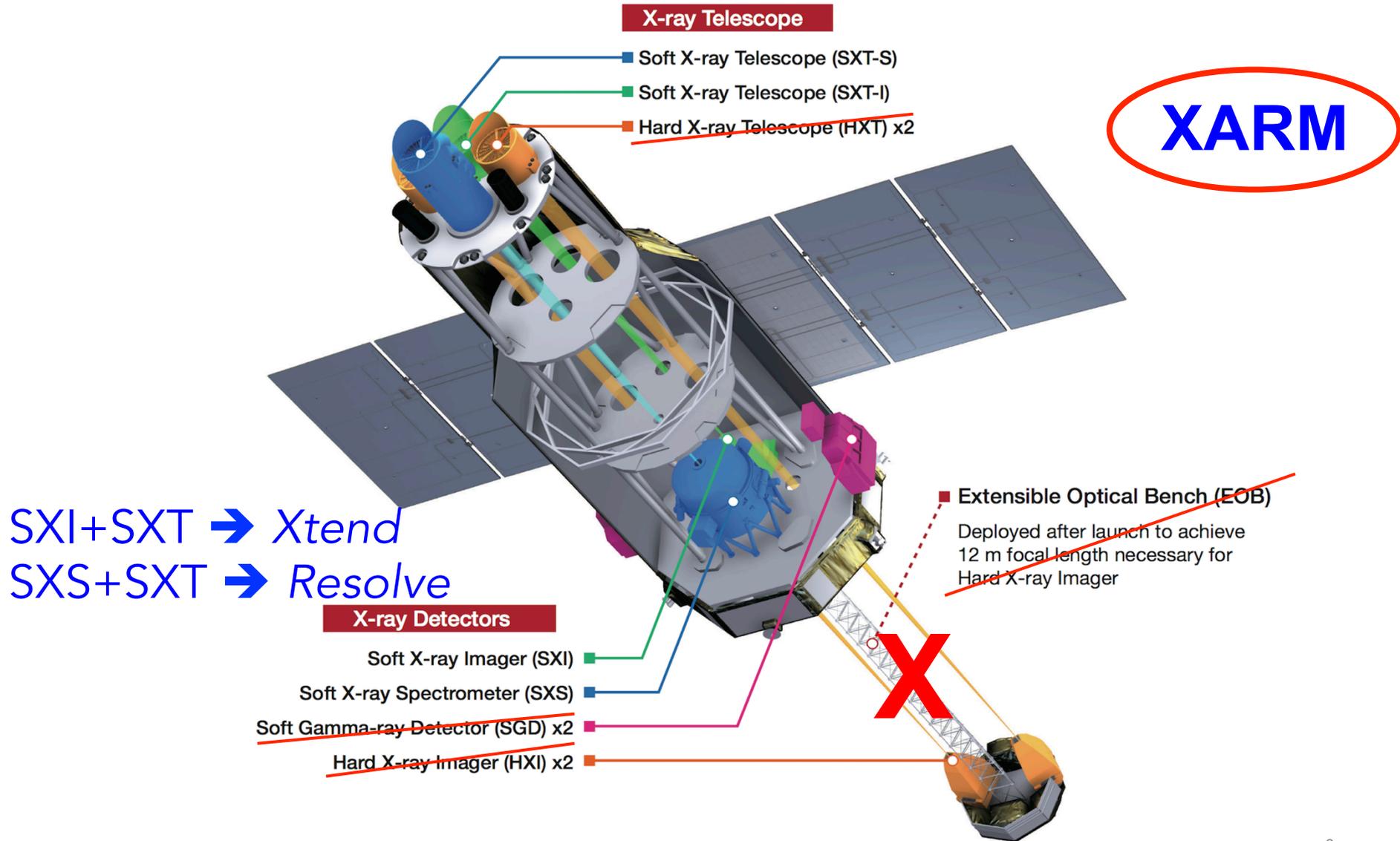
Charter was to prepare for a rapid recovery mission with only two instruments to be launched by March 2021!

The scope of our involvement is to increase beyond the instrument interfaces. NASA will have more of a review and advisory role to the JAXA mission.

NASA/HQ gave authority to proceed on Feb 3, 2017. The NASA XARM project entered Phase A in October 2017.

- The Hitomi Soft X-Ray Spectrometer met or exceeded all of its performance requirements verifiable up through the spacecraft mishap, but not everything was fully demonstrated:
  - The dewar aperture door was never opened (was planned for day 40; mishap occurred on day 38), so aperture system was not verified in-flight. We have revisited readiness and any risks for this as part of lessons learned process.
  - Modulated X-Ray Source (Netherlands) not taken to full power (was planned for day 39).
- Carry out lessons learned and review margins, and only make changes as warranted to reduce risk, fix changes made late in the Astro-H program to be more robust, etc.
- The early commissioning phase of the Perseus Cluster (through a Be window on the aperture door) indicated excellent performance and scientific return (3 papers published to date – 2 in *Nature*, 1 in *Ap.J.*). More papers on the way.
  - Recovery as quickly as possible is the guiding principle. Capability is still very timely, so no need to change science requirements.

# X-Ray Astronomy Recovery Mission



Parameter	Requirement	Actual*
Energy resolution	7 eV (FWHM)	5.0 eV
Energy scale accuracy	$\pm 2$ eV	$\pm 0.5$ eV
Residual Background	$2 \times 10^{-3}$ counts/s/keV	$0.8 \times 10^{-3}$ counts/s/keV
Field of view	2.9 x 2.9 arcmin	same, by design
Angular resolution	1.7 arcmin (HPD)	1.2 arcmin
Effective area (1 keV)	$> 160$ cm <sup>2</sup>	250 cm <sup>2</sup>
Effective area (6 keV)	$> 210$ cm <sup>2</sup>	312 cm <sup>2</sup>
Lifetime	3 years	4.2 years (projected)
Operational Efficiency	$> 90\%$	$> 98\%$

\* Hitomi in-flight performance

- Construction of Resolve/XRS components (mirror and detector system) is underway. Delivery of the Calorimeter Spectrometer Insert is scheduled for October 2019.
- NASA PDR/CDR was held in November 2017.
- NASA KDP-C review takes place on January 16.
- Work underway in Japan on the Xtend / Soft X-ray Imager.
- JAXA is evaluating proposals from two potential spacecraft suppliers (NEC and MHI). Decision expected in February.
- International project kick off meeting will take place in Spring 2018 (science, technical, and programmatic).

- By agreement with JAXA, XARM Project to establish data pipeline and US Science Data Center.
- US guest observer program starting at L+9 months. US observers will have a substantial share of the observing time, and access to the full data archive.
- NASA/HQ opportunity for XARM Science Participants (essentially mission science advisors) closed in December 2017. A total of 39 proposals was received for 5-6 positions. Proposal review is scheduled for later this month.
- NASA/JAXA working on agreement to allow additional scientists to participate in the mission Performance/Verification phase (spanning six months following activation).

# HIGH ENERGY ASTROPHYSICS IN THE 2020'S AND BEYOND

**18-21 MARCH 2018**

**ROSEMONT, ILLINOIS**

Photo: National Science Foundation/LIGO/Sonoma State University/A. Simonnet

