HIGH-ENERGY ASTROPHYSICS

Exploring the Universe with NuSTAR

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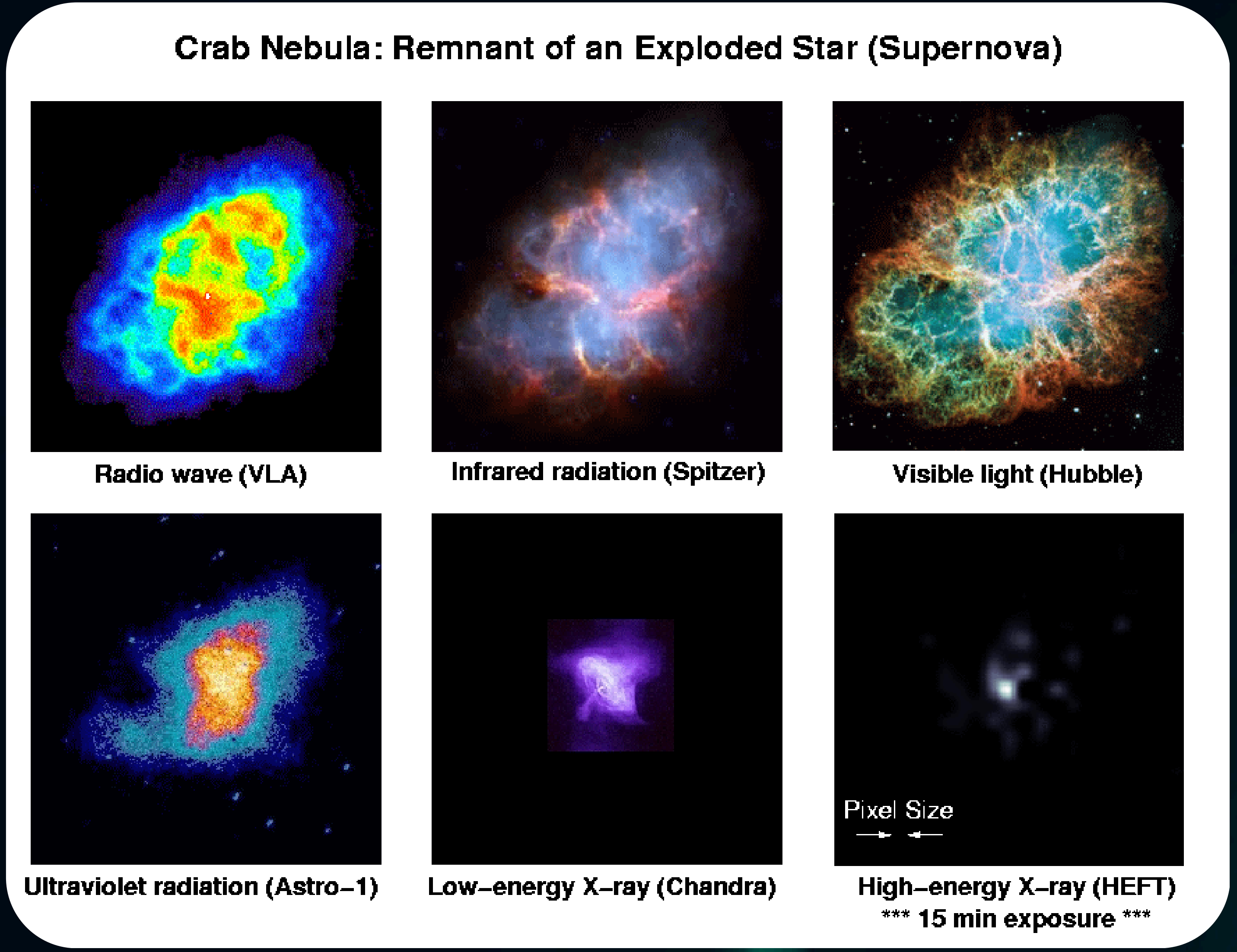
Overview of High-Energy Astrophysics

- Study on cosmic sources emitting X-rays and gamma rays (black holes, neutron stars, supernovae)
- Reveals extreme physical processes invisible to optical telescopes
- Earth's atmosphere blocks X-rays, requiring space-based observatories
- Helps understand compact objects, energetic jets, and cosmic explosions

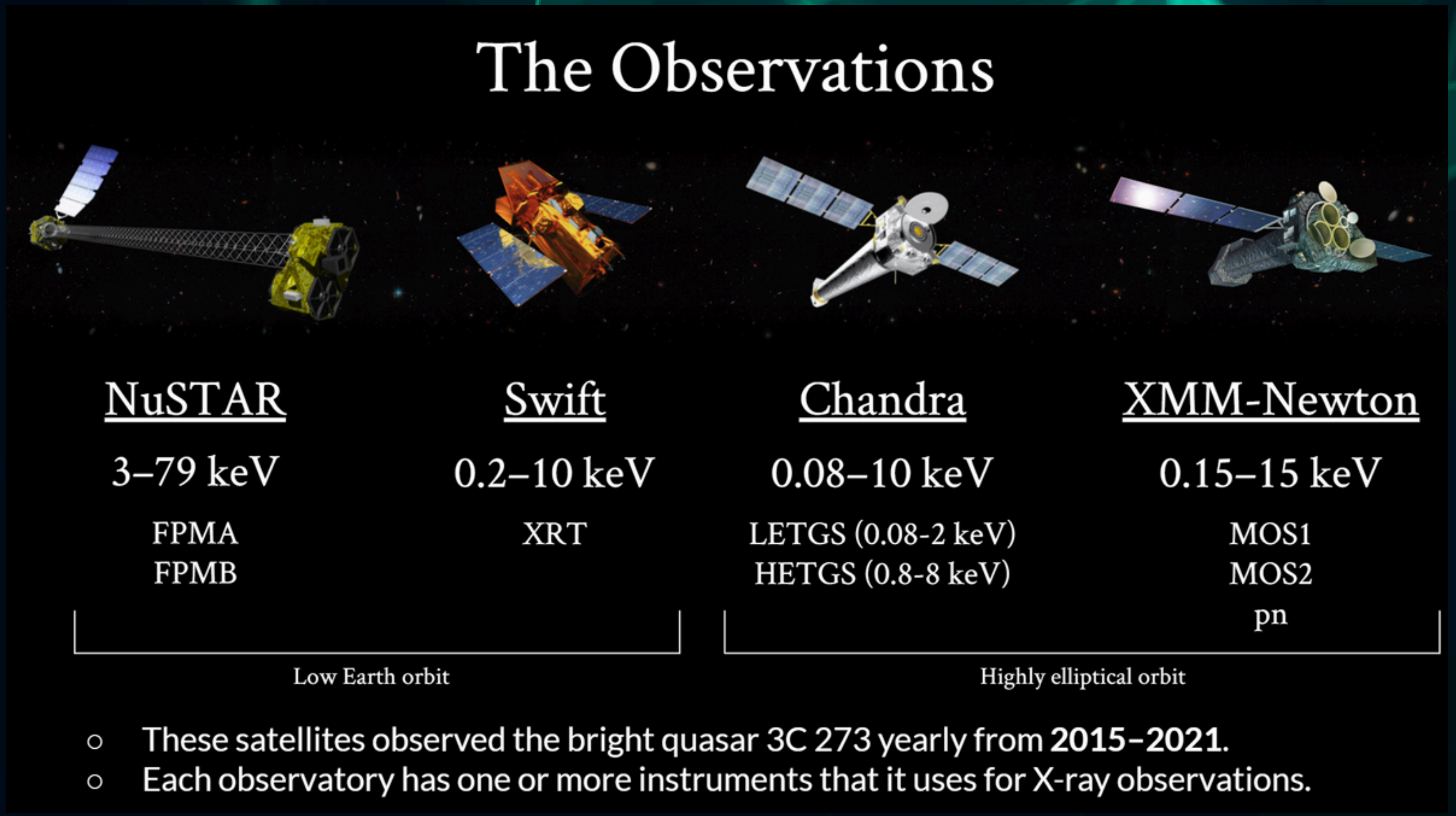
Challenges in X-ray Observation

- X-rays penetrate matter, not reflect like light.
- Special optics needed to focus high-energy rays
- Earth's atmosphere blocks all incoming X-rays
- Space telescopes required for effective observation



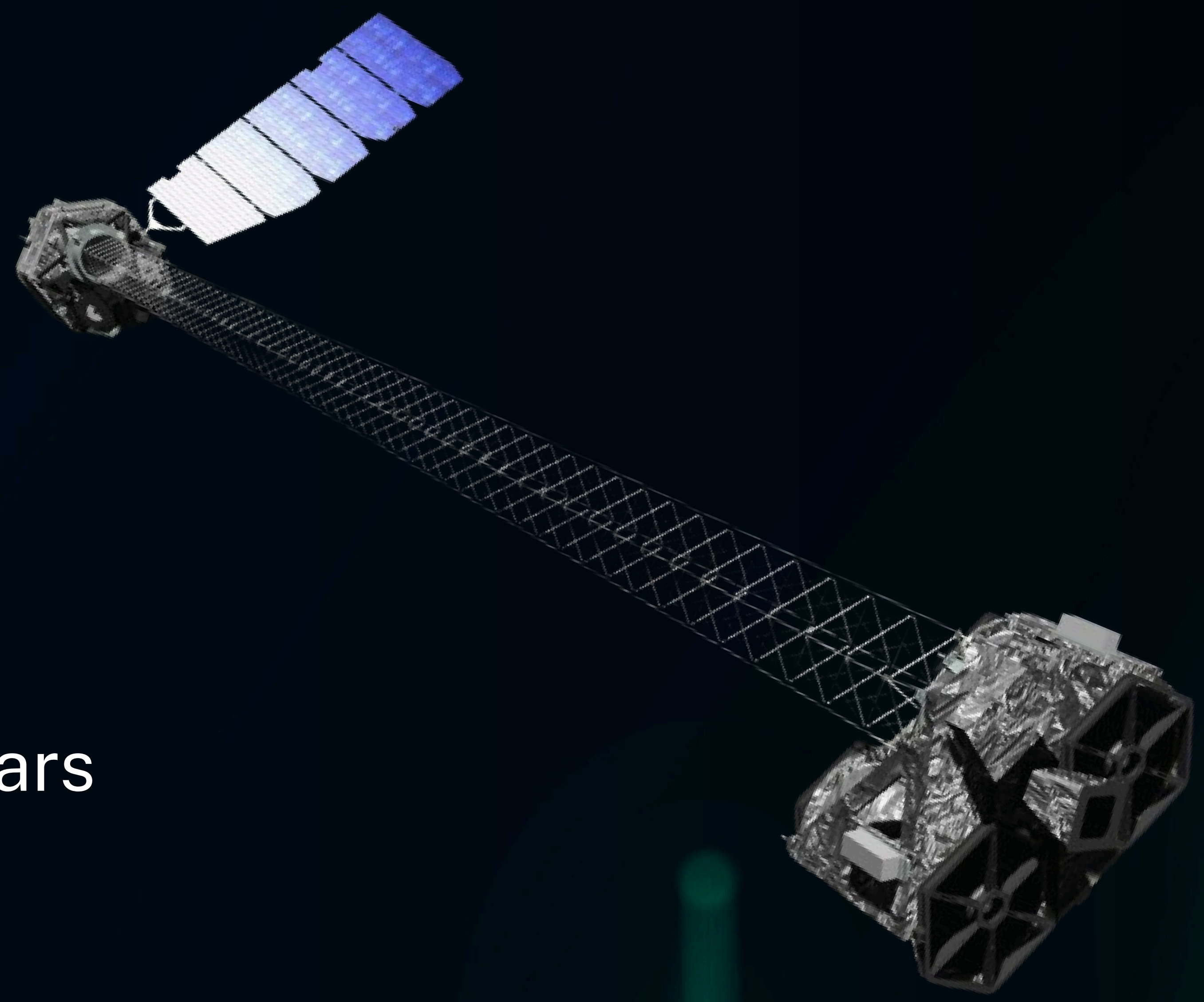
Evolution of X-ray Astronomy

- UHURU (1970) was first X-ray space telescope
- Chandra (1999) provided high-resolution soft X-rays
- XMM-Newton (1999) improved European X-ray observations
- NuSTAR (2012) pioneered hard X-ray imaging technology



Introduction to NuSTAR

- NASA launched NuSTAR in June 2012
- Observes X-rays in 3–79 keV energy range
- Studies black holes, supernovae, and neutron stars
- Developed by NASA, Caltech, and JPL team

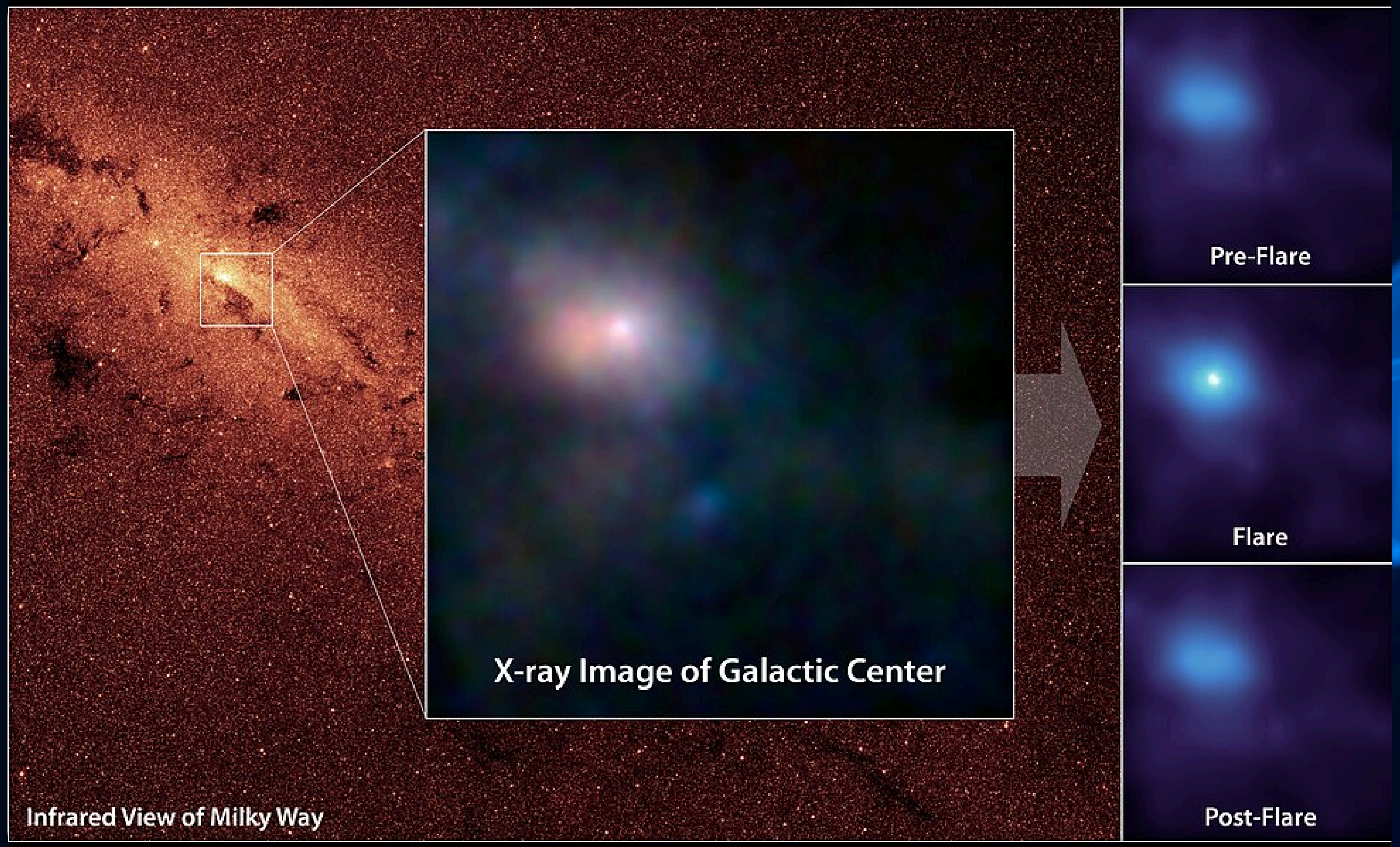


NuSTAR’s Technology

- First space telescope for hard X-ray imaging
- Uses grazing-incidence optics for focusing X-rays
- Employs a 10-meter deployable mast for resolution
- Detects X-rays in the 3–79 keV range
- Cadmium Zinc Telluride detectors improve sensitivity
- Uses solar panels for efficient power generation
- Achieves 100 times better background reduction
- Operates in a low-Earth orbit at 550 km

Scientific Goals of NuSTAR

- Studies black hole formation and cosmic growth
- Observes heavy element creation in supernova explosions
- Analyzes neutron stars, pulsars, and magnetars
- Investigates cosmic X-ray background and galaxy evolution



Major Discoveries

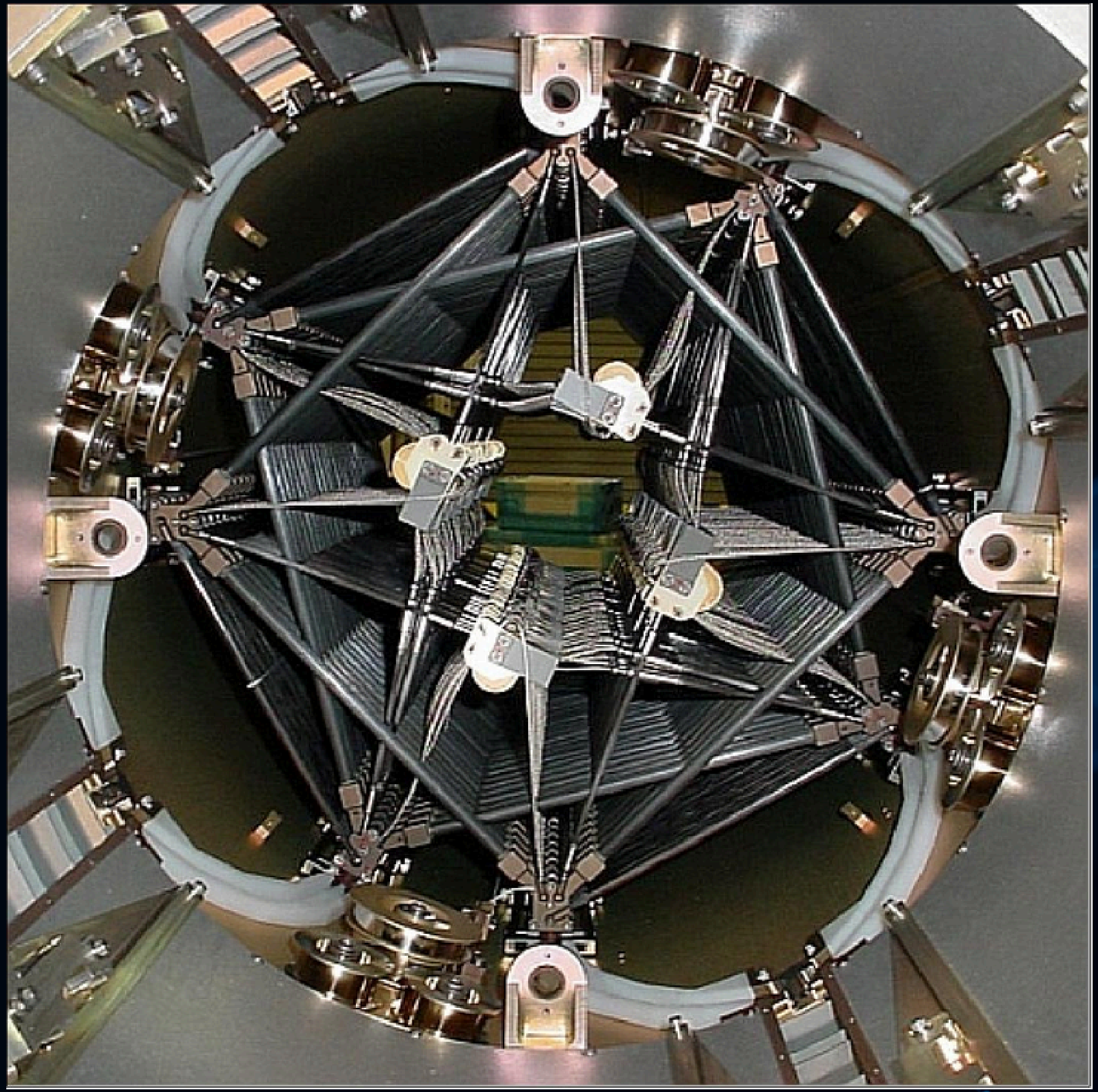
- Found hidden black holes in distant galaxies
- Mapped radioactive titanium in Cassiopeia A
- Detected unexpected high-energy pulsar emissions
- Resolved sources of cosmic X-ray background

Key Scientific Contributions of NuSTAR

- Revealed hidden black holes in distant galaxies
- Mapped radioactive elements in supernova remnants
- Studied high-energy emissions from neutron stars
- Resolved cosmic X-ray background sources
- Tracked evolution of active galactic nuclei (AGNs)

NuSTAR's Limitations

- Small field of view limits observational coverage
- Lower spatial resolution than Chandra X-ray Observatory
- Requires multi-wavelength data for complete analysis
- Long exposure times needed for detailed observations



Conclusion

- NuSTAR revolutionized hard X-ray space astronomy
- Helped find hidden black holes in space
- Studied supernovae, pulsars, and neutron stars
- Paved the way for future X-ray missions

References

- https://shorturl.at/OzsQa
- https://shorturl.at/l02eP
- https://shorturl.at/6nW1f
- https://shorturl.at/deyMq

THANK YOU!