IACHEC: The International Astrophysical Consortium for High Energy Calibration

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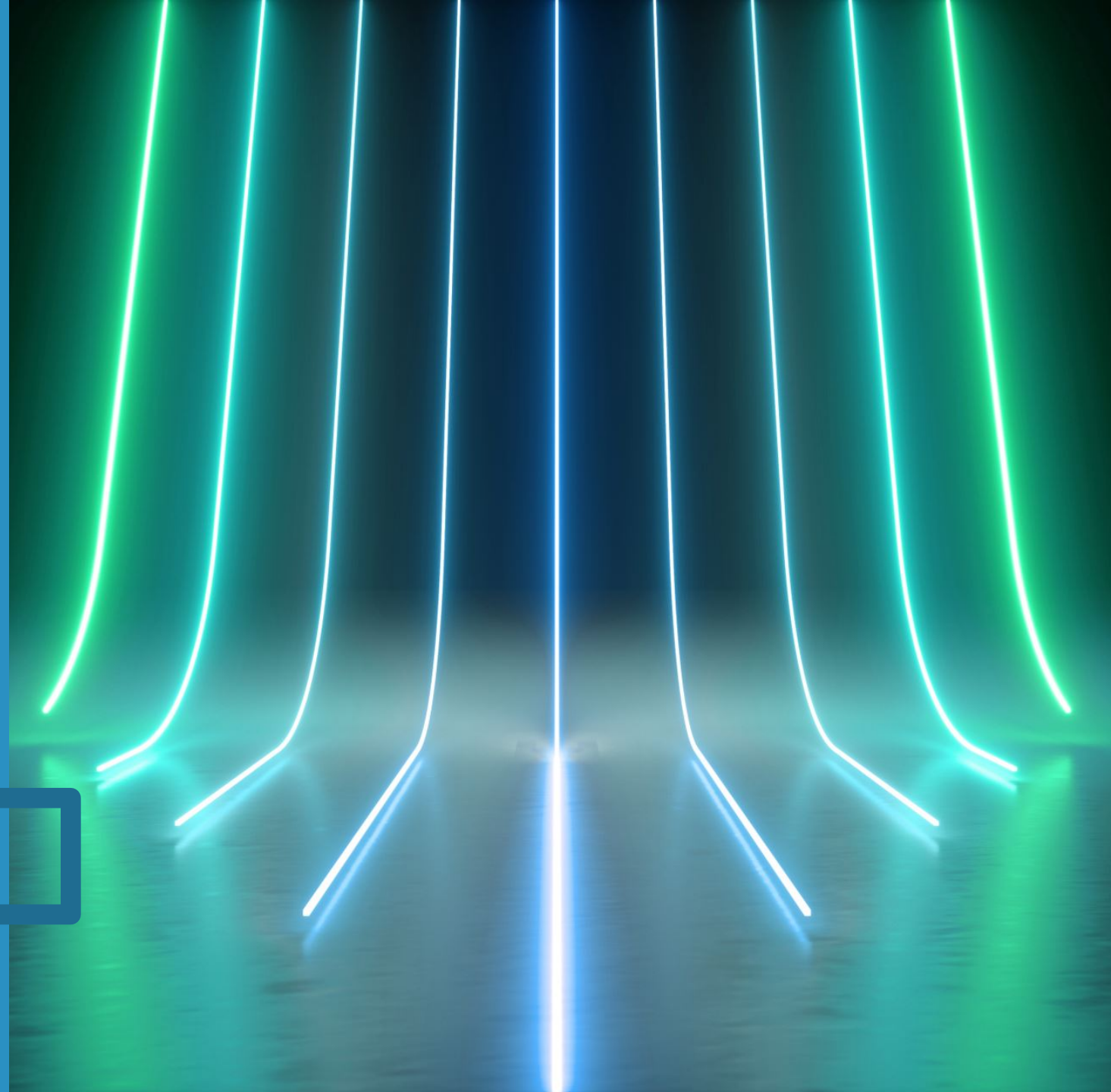
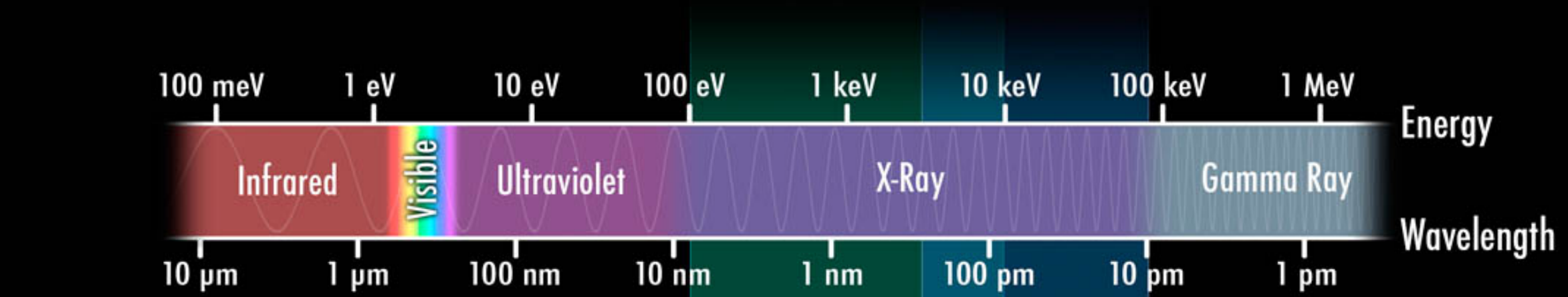


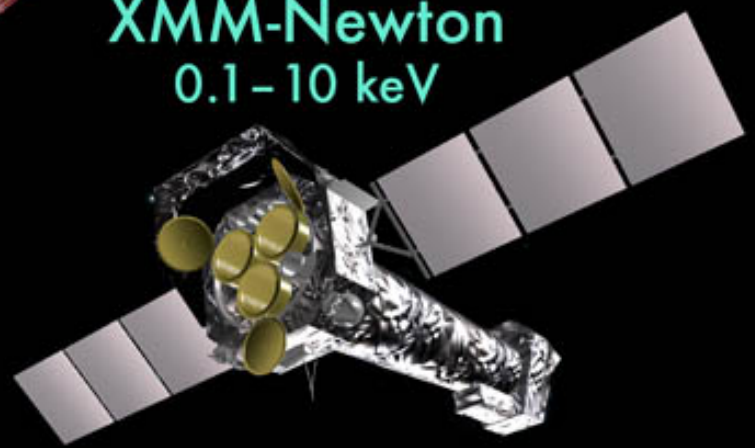
IACHEC: Multi-mission calibration ~~arguments~~

- Understanding X-ray sources requires **broadband** spectral coverage (usually by >1 instrument)
- The problem: There are no standard X-ray candles in space
- Why is this a problem?

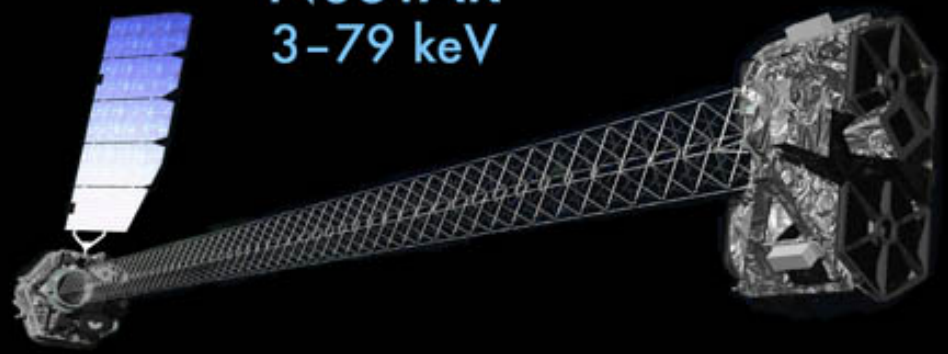
X-Ray Telescopes & the Electromagnetic Spectrum



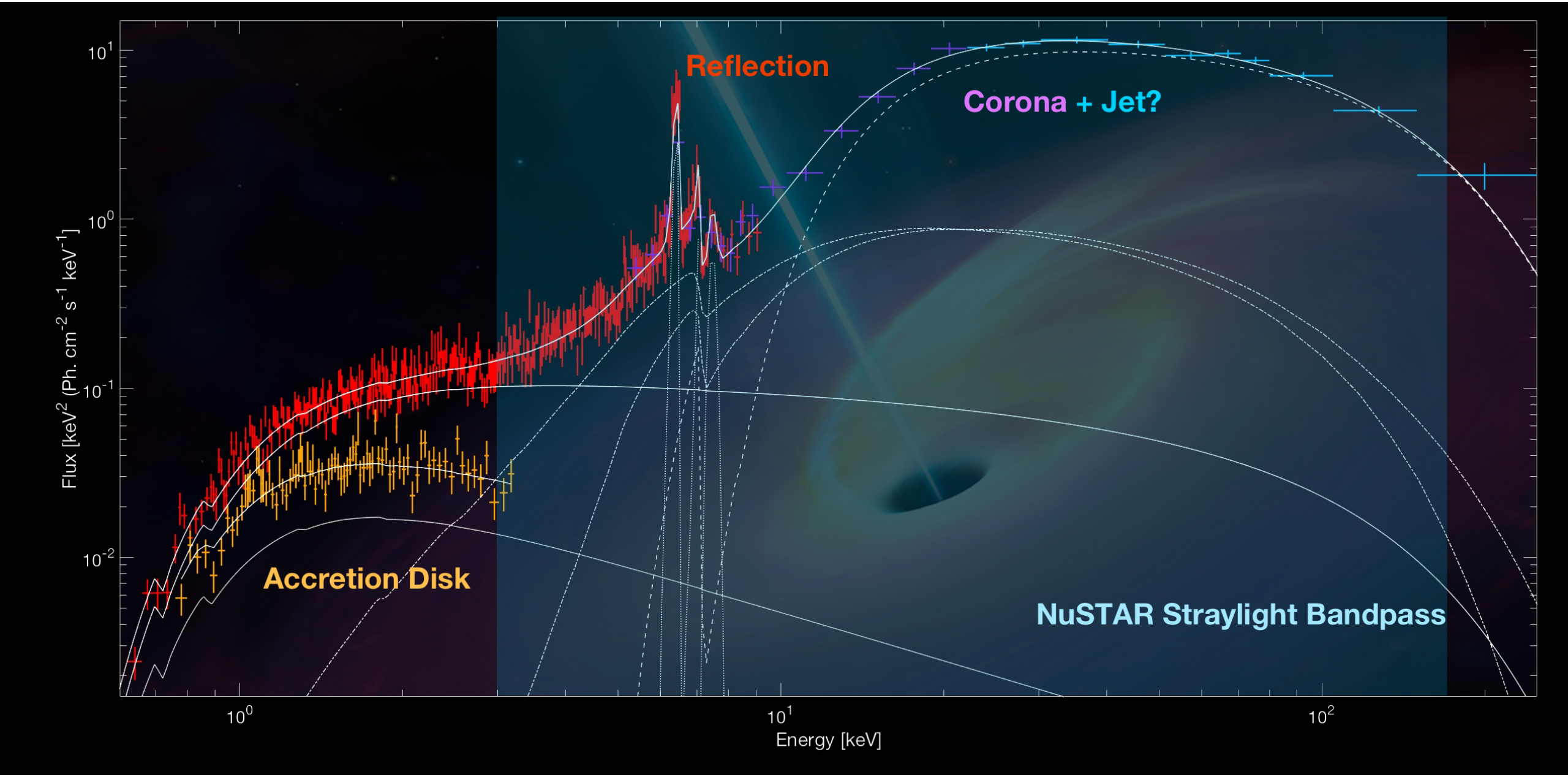
Chandra &
XMM-Newton
0.1 – 10 keV



NuSTAR
3 – 79 keV

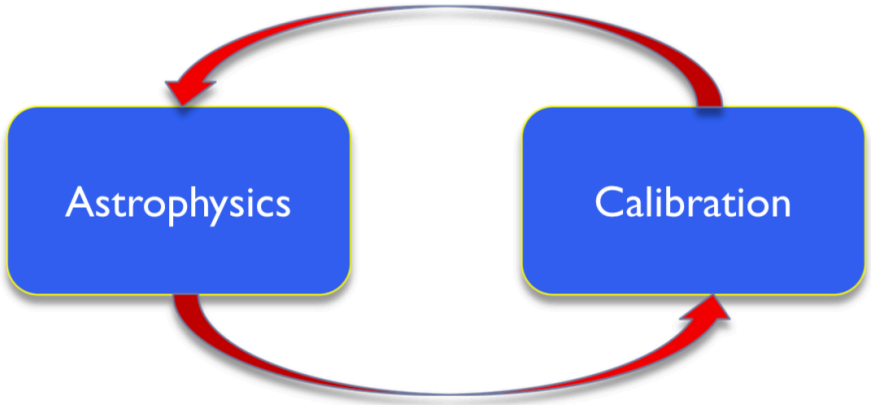


X-Ray Telescopes & the Electromagnetic Spectrum


Reflection
Corona + Jet?
Accretion Disk
NuSTAR Straylight Bandpass
Flux [keV^2 (Ph. cm^{-2} s^{-1} keV^{-1}]
Energy [keV]
10^1
10^0
10^{-1}
10^{-2}
10^0
10^1
10^2

Why is this a problem?

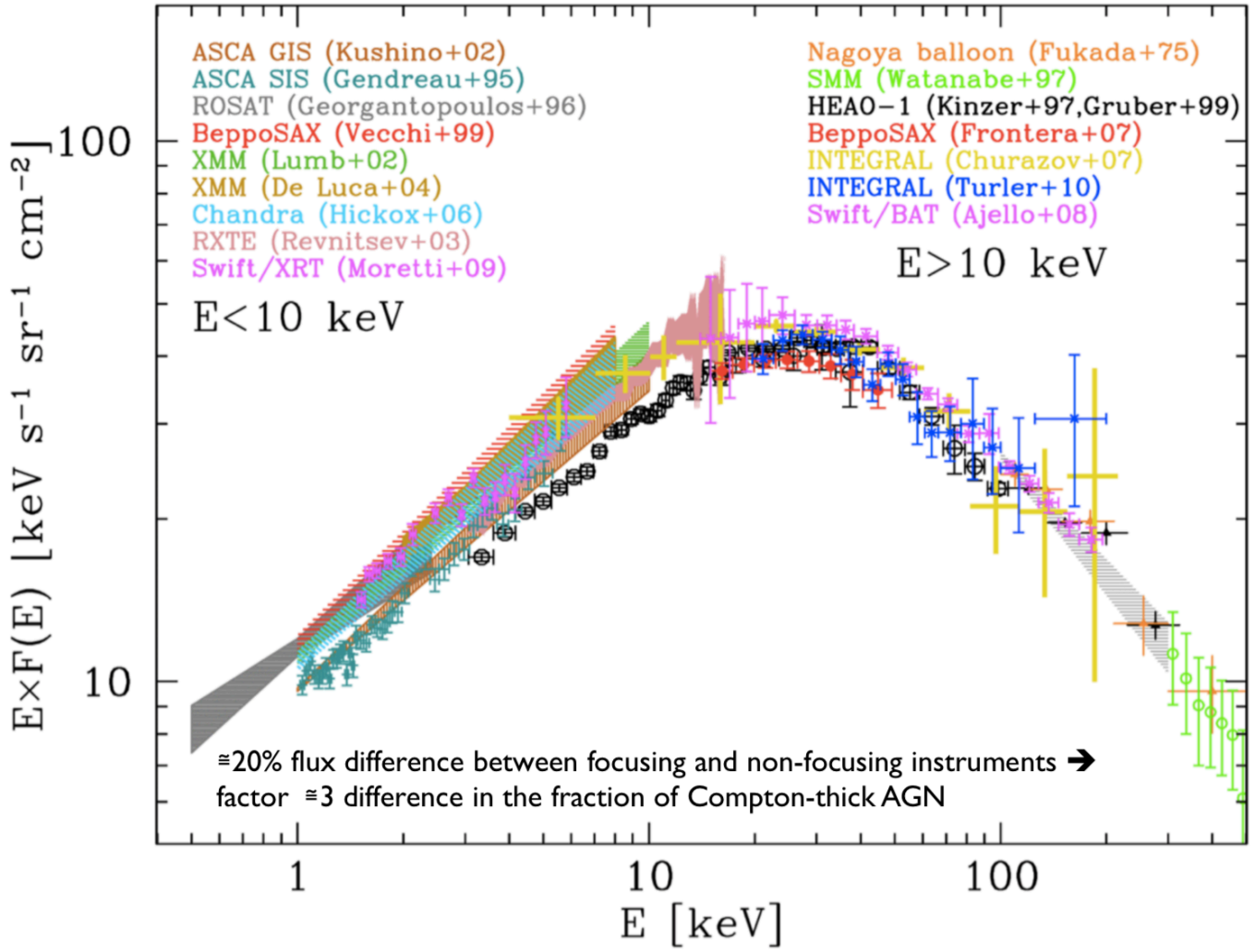
- What you say in a proposal:
  - Extensive ground calibration → instrument response models → Science!
- In practice:
  - Extensive ground calibration first thing to go…
  - People who perform calibration != people who do science
  - Space is messy: on-orbit performance changes with time



Calibration of X-ray instruments is always "with respect to ..."

Borrowed from Matteo Guainazzi

A textbook example: the XRB



(Credit: A.Comastri, Un. Bologna)

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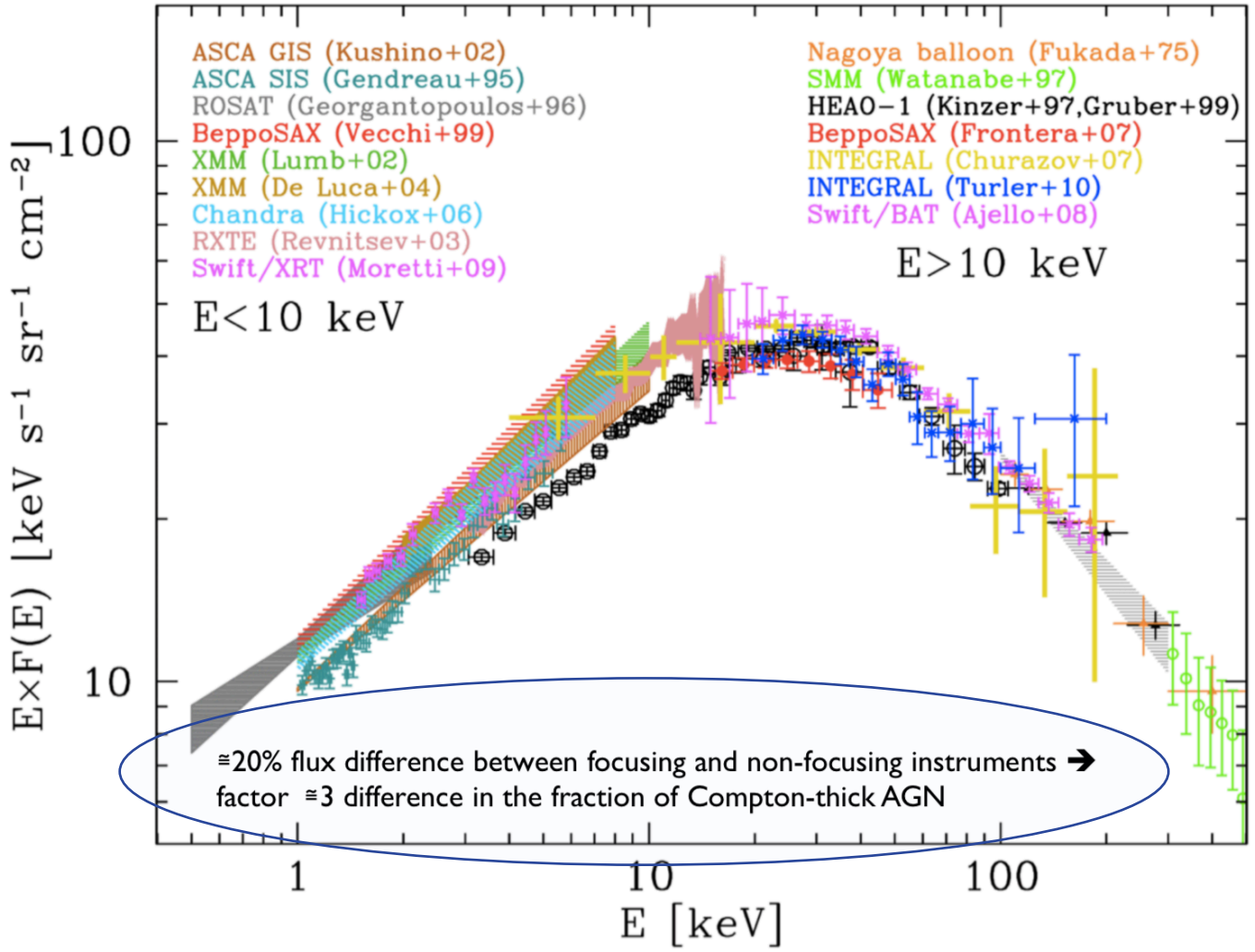
A textbook example: the XRB



(Credit: A.Comastri, Un. Bologna)

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About IACHEC:

- The IACHEC is the *International Astronomical Consortium for High- Energy Calibration*
- Founded in 2006 on impulse by Marcus Kirsch (ESA) and Steve Sembay (University of Leicester)
- It acts as a forum where astronomers involved in calibration of past, operational, and future missions work together to:
  - Define calibration standards
  - Document calibration and cross-calibration status
  - **Improve the cross-calibration among their instruments**
- Not funded by any Agencies or institutions. Individual projects/missions contribute through the work and mission budget of their calibration teams.

What does IACHEC do?

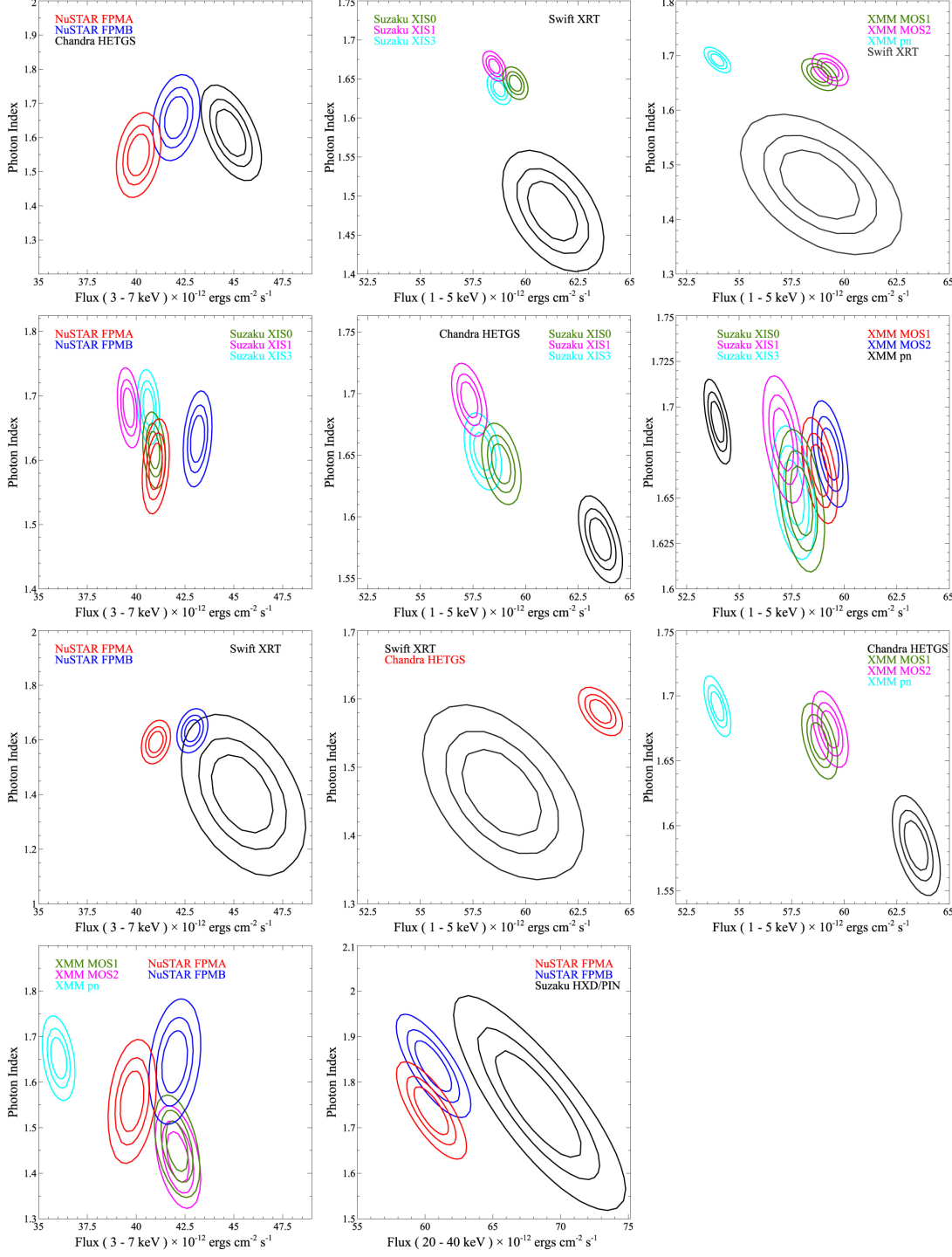
- Define new calibration standards
  - Characterize sources and compare results from difference missions
- Document cross-calibration issues and calibration status
  - What happens you combine NICER+XMM? How do you fix it?
  - Forum for on-going calibration plans and advise on ground- and in-flight calibration for new missions
- Work
  - Working meetings once / year
  - Topical working groups once / month (ish)
  - Publish results from calibration campaigns
  - Define standards for analysis and statistical techniques
- Advise upcoming missions on ground calibration:
  - IXPE, XRISM, Athena, Lynx

Who is IACHEC?

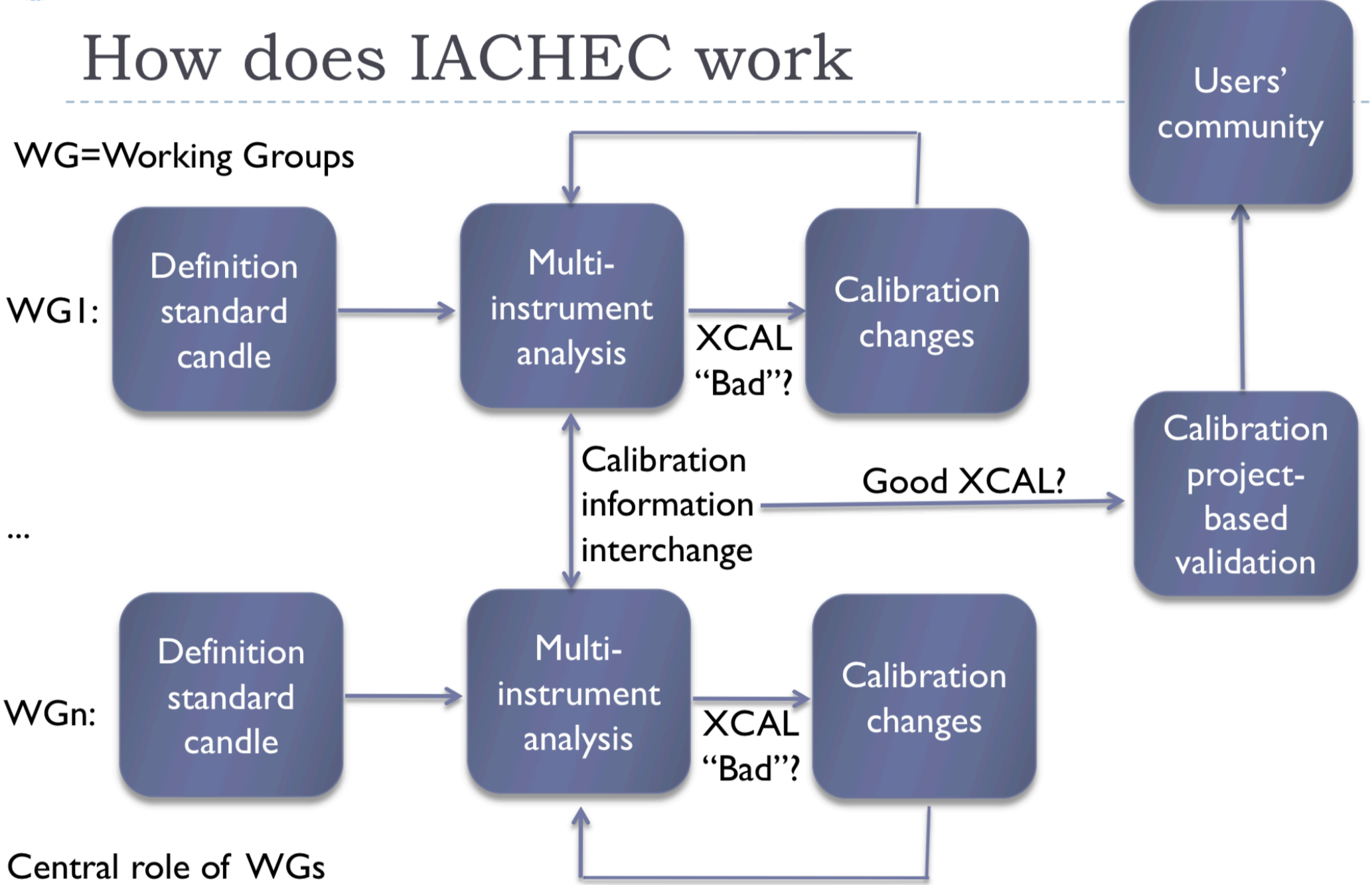
- https://iachec.org/
- Member missions:
  - Chandra, XMM-Newton, Suzaku*, RXTE*, Swift, INTEGRAL, NuSTAR, Hitomi*, ASTROSAT, NICER, Insight-HXMT, eROSITA
- Members mostly instrument scientists / research staff
- Usually includes postdocs / students from new or in-progress mission

Example:
3C 273 Cross-Calibration

- Joint observing campaign in 2012
- Included operating X-ray telescopes (at the time)
- Demonstrates the *intrinsic* differences in the measurements that needs to be accounted for.



How does IACHEC work



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Active Working Groups

- Methods (how to analyze data)
  - Background (particles / space weather / CXB)
  - X-ray Detectors / physics (CCDs, CdZnTe/CdTe, microcalorimeters, prop counters)
  - Coordinated observations
  - Line spectroscopy and interface with lab astrophysics models (ATOMDB)
  - Statistics (~~chi~~ W-statistics / background treatment / MCMC methods, etc)

- Sources (defining standard models for unknown candles):
  - Galaxy clusters
  - Non-thermal SNR (Crab, G21.5+0.9)
  - Thermal SNR (E0102, N132D)
  - WD and isolated NS

- Infrastructure:
  - Outreach, communication, Legacy

Remember:

- Be wary when combining multiple detectors, even from a single mission.
  - When in doubt, ask an instrument team members for advice.

- If you have something funny looking in your data:
  - http://iachec.org

- 2020 working meeting → open virtual meeting planned for November 23/24

  a.k.a. Everything you wanted to know about instrument calibration but were afraid to ask