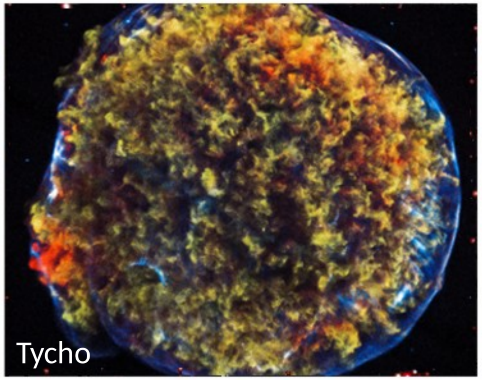
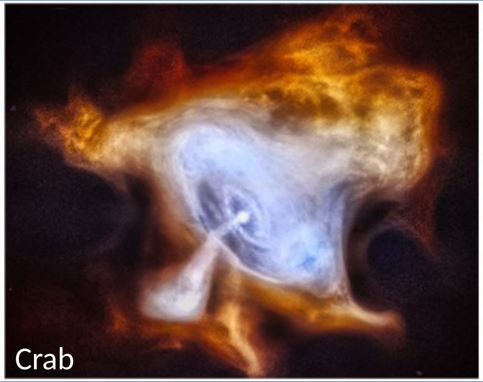
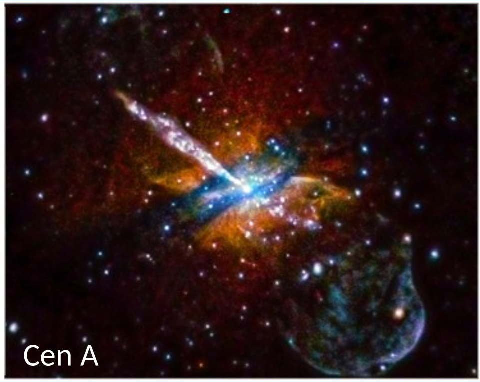
From Chandra to Lynx: Chandra Status







Current major events:

- Planning for 20 year anniversary celebrations in 2019
- Preparing proposal for NASA contract for next 12 years , 2018-2030

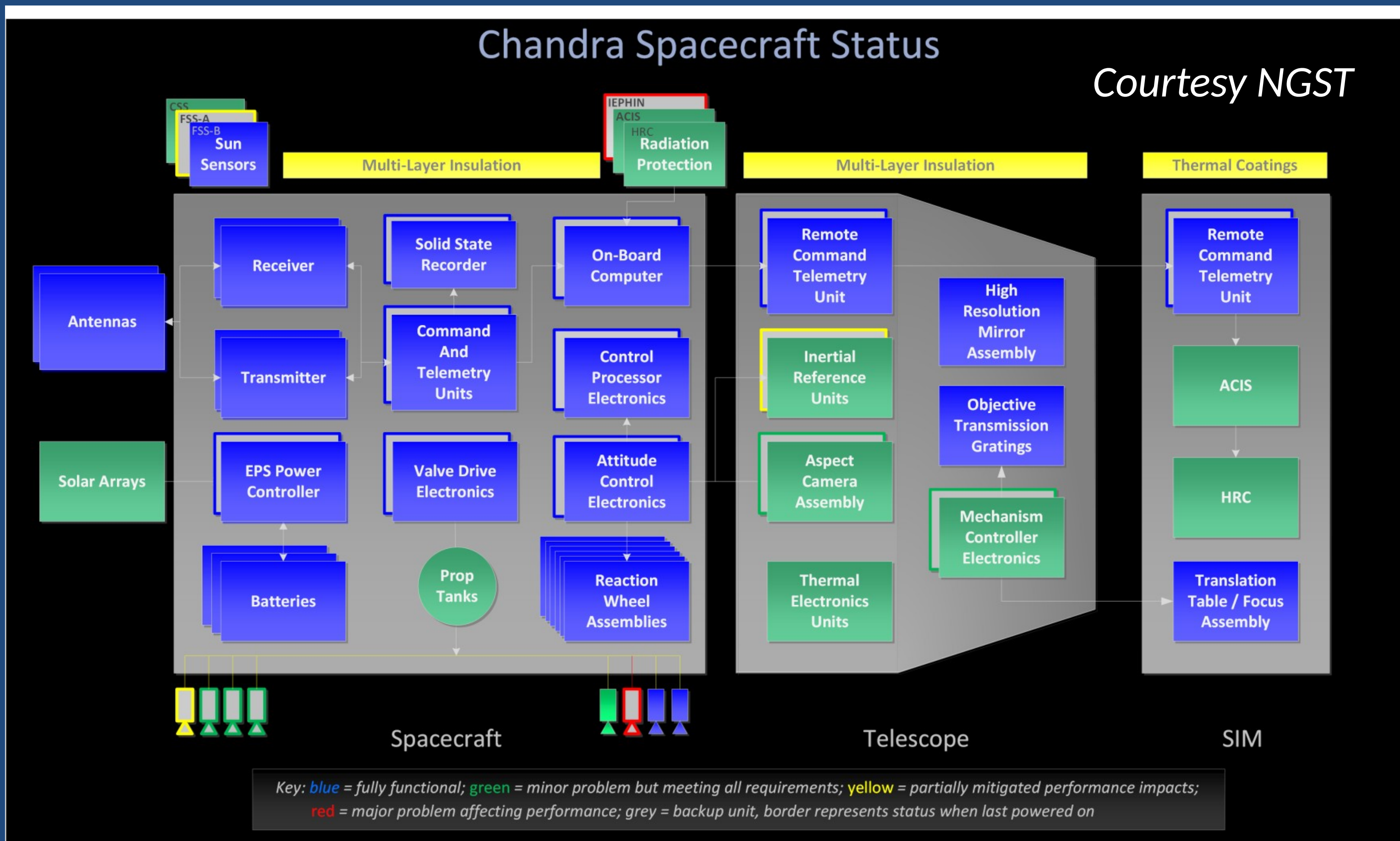
Belinda Wilkes

Director

Chandra X-ray Center

Chandra:18 years and counting!

Detailed 2014 engineering review showed no show-stoppers to ***10(+) more years*** *of observing*



****Little red or yellow!****

Basic Information

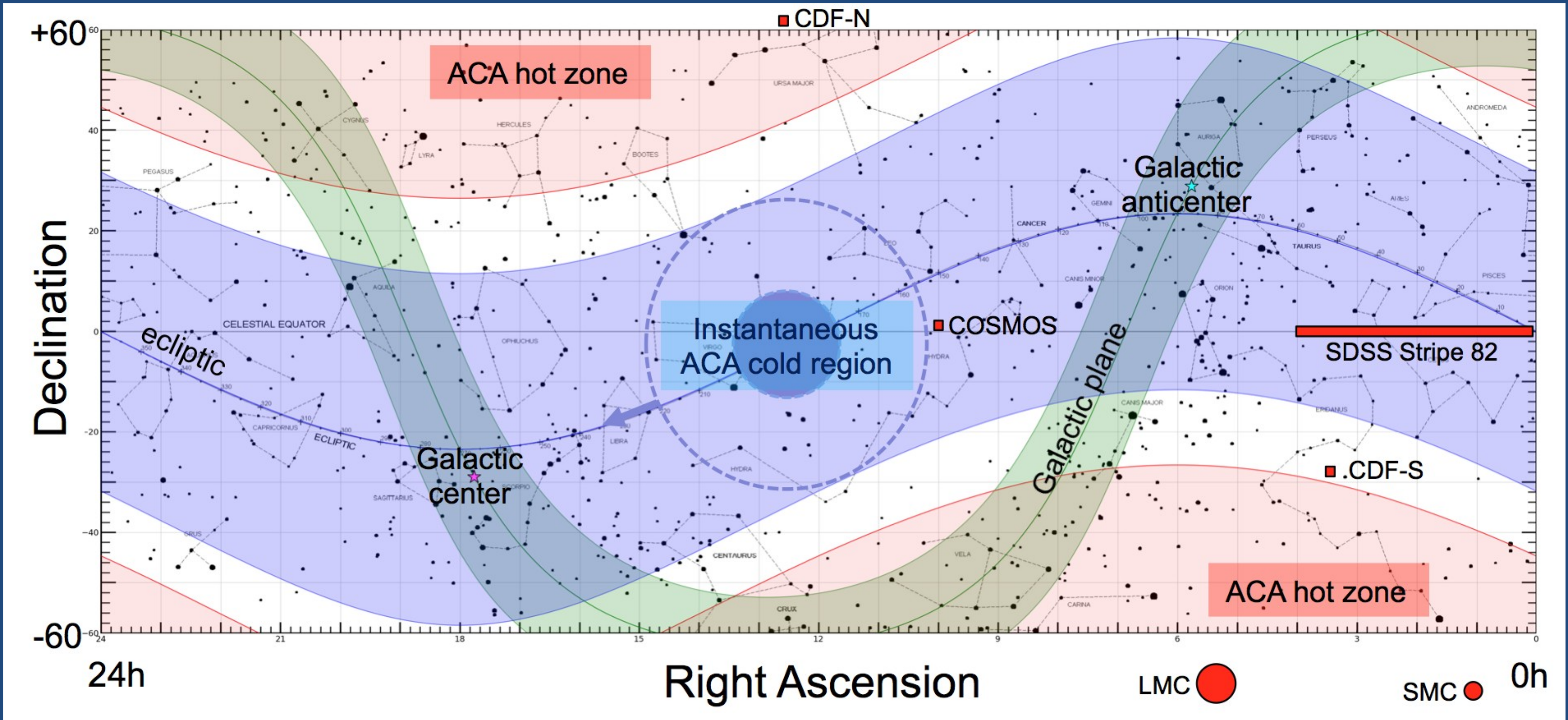
- ~3 day orbit
- ~70% observing efficiency (~16-18 hr radzone)
- Mission Planning:
  - 1-week schedule, DSN COM every 8 hrs
- Resolution:
  - Spatial ~0.5”
  - Spectral, gratings: ~200-1000; 0.1-10 keV
  - Highest time resolution, HRC: 60µs
- 25+ year lifetime expectation

Chandra Challenges

- Contaminant build-up on ACIS OBF
  - Significantly reduced A_{eff} < 2 keV since launch
  - Longer exposures for science requiring low energy data
  - Bakeout: risk vs reward study is ongoing

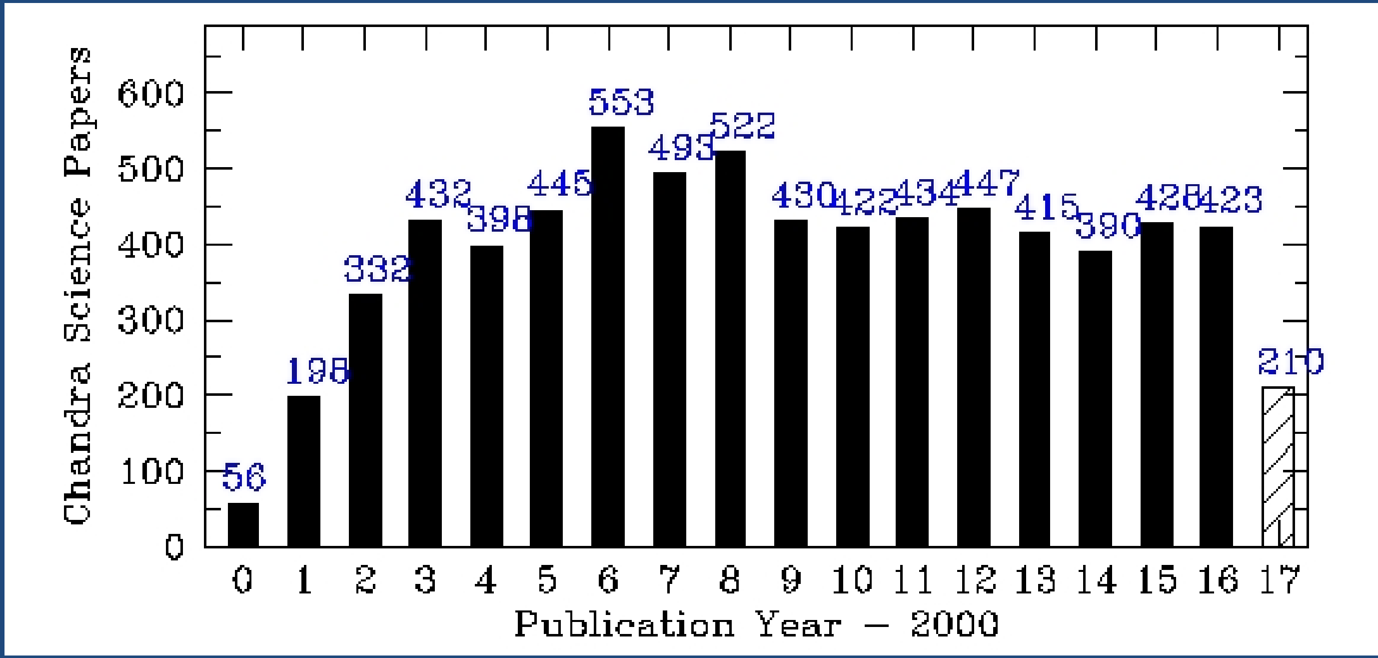
- Thermal degradation:
  - Spacecraft insulation is degrading → general warming
  - Monitor, and predict temperatures of many components
  - Limits dwell time over most solar pitch angles
  - Complex scheduling:
    - Limits on constrained time to maintain an efficient schedule
    - Long exposures are split into multiple shorter ones
  - Restrictions on observing time:
    - VLPs < 2Msec observing time close to ecliptic poles
    - In ~2 years, likely to be applied to shorter proposals as well

Constraints on the Sky
due to thermal degradation



Chandra's high impact on astrophysics

Refereed papers per year

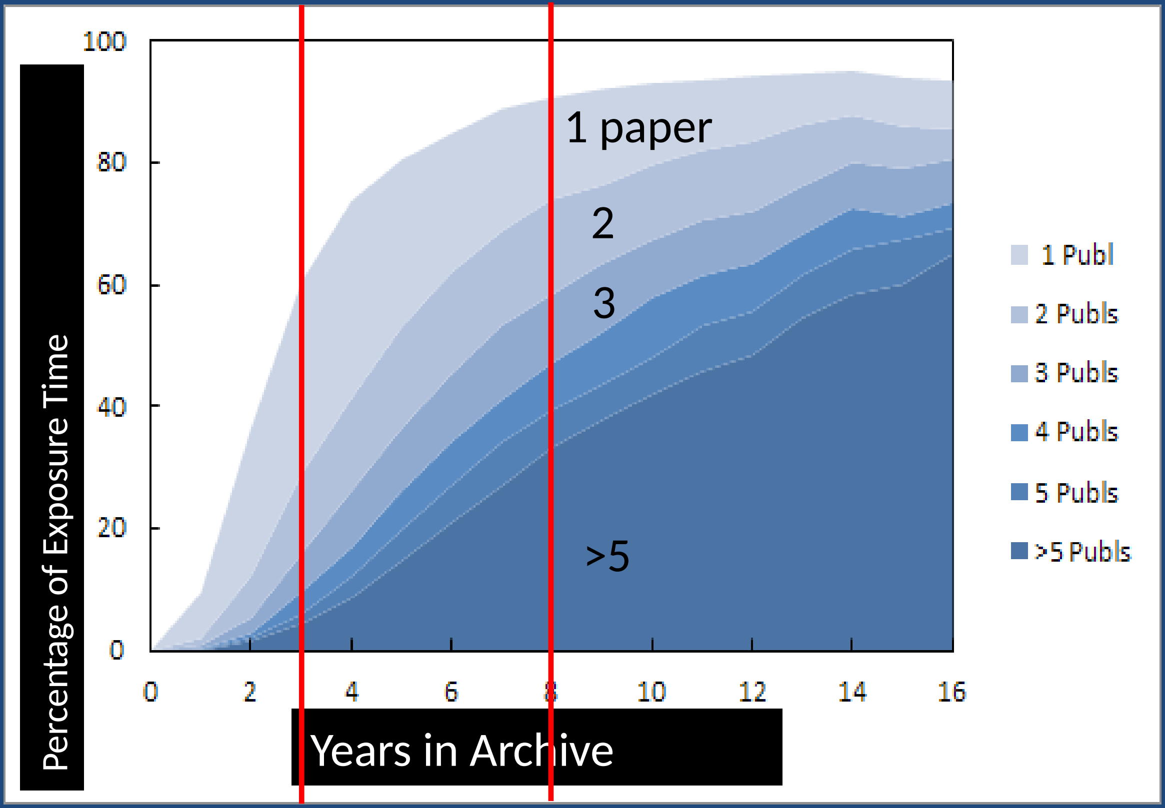


Refereed science papers

- 7029 total Chandra papers (to 08/01/2017)
- 450 mean # papers/year (2005-2017)
- 35 mean # citations/paper after 6 years (84 after 14 yrs)
- >320 PhD theses (worldwide)

Metric measures productivity and data utilization

% of data published in # refereed papers vs. # years in archive



Rots et al. (2012)

Publications:

- Median time to publication: 2.4 yrs
- After 3 years: 60% of data are published in 1 or more papers
- After 8 years: 90% of data are published in 1 or more papers, 60% in 3 or more

Science covers full range of astrophysics: Cosmology, black holes, clusters, galaxies, stellar birth and death , exo-planets, planets (including Pluto (New Horizons), Jupiter (Juno))

Chandra Proposal Opportunities

Category (Cycle 19)	**Exposure Time Allocation (Ms)**
General Observer	10-12
Large Projects (>400 ks)	4
Director's Discretionary	1
Joint*	~ 2.5 weeks of time
Archive	$1500K*
Theory	$650K*
Very Large Projects (> 1 Ms)	2-3
Past Categories:	
X-ray Visionary Projects (> 1 Ms)	5-8 (enabled by orbit evolution)

*XMM-Newton, HST, NRAO, NOAO, Swift, NuSTAR

*Total GO Budget: ~$11M

Cycle 19 updates
(based on *Chandra: The Next Decade*)

- Very Large Projects:
  - VLPs > 1Ms observing time
  - allocated 2.7 Ms to 2 proposals
  - including 2 Ms at high ecliptic latitude!
  - Large Projects (LPs) allocated 3.9 Ms (7 proposals)
- Increased Joint time to include LPs:
  (also facilitates large, joint, transient proposals)
  - XMM: 1 Ms (600 ks for LP/VLP)
  - HST: 250 hrs (150 hrs (for LP/VLP)
  - NuSTAR: 1 Ms (500 ks for LP/VLP)
  - Swift: 500 ks
- Increased archival funding by 50% ($1.5M)
- Director's Discretionary Time expanded to include:
  - non-transient, timely science
  - 1-page science justification

- **“*Chandra*: The Next Decade”,** last year’s workshop discussed:
  - where Chandra’s science is going?
  - the many science questions Chandra can address over the next 10 years

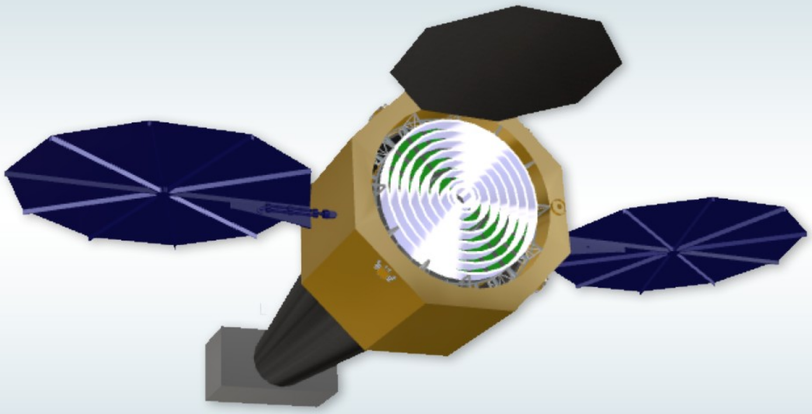
- **“From *Chandra* to Lynx”,** this year’s workshop looks further into the future, to a Chandra successor:
  - where is Chandra’s scientific legacy leading?
  - what key observations and science questions can Chandra NOT address?
  - what do we need to address them?

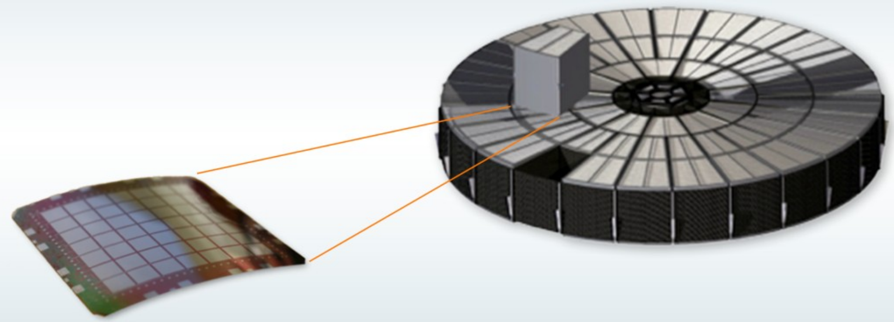
The Longer-term Future of X-ray Astronomy

- ESA Athena (**XMM successor):**
  - 5” resolution, A_{eff}~2m^2
  - Launch: 2028
  - Silicon pore optics: light-weight mirror stacks
  - X-ray Integral Field Unit (XIFU) – micro-calorimeter
  - Wide Field Imager (WFI) – Si depleted p-channel field effect transistor (DEPFET) active pixel camera
- NASA Lynx (Chandra successor):
  - Concept study in advance of decadal survey
  - 0.5” resolution, ~100* higher sensitivity
  - Light-weight optics

LYNX

A NASA-Funded Study for the Decadal Large X-ray Mission Concept

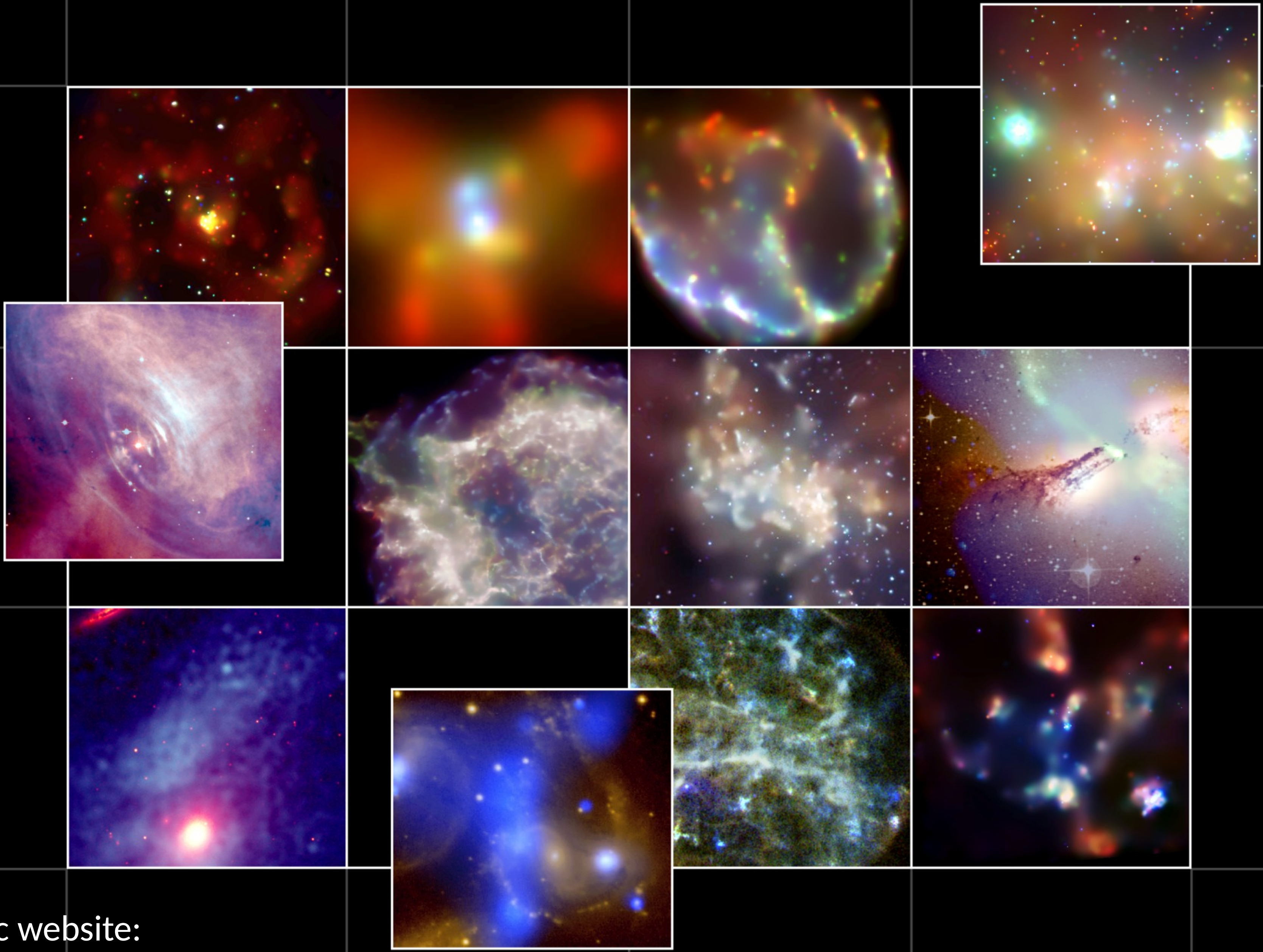




Sub-arc-second imaging over 20’ field of view
- Gratings and a micro-calorimeter for very high energy resolution
- Two orders of magnitude leap in sensitivity compared to Chandra and Athena
- Lynx will detect X-rays from First Black Holes in the Universe, map the Baryons in the Cosmic Web, shed light onto Feedback on All Scales.

And much more science to be discussed over the coming days!!

Backup Slides



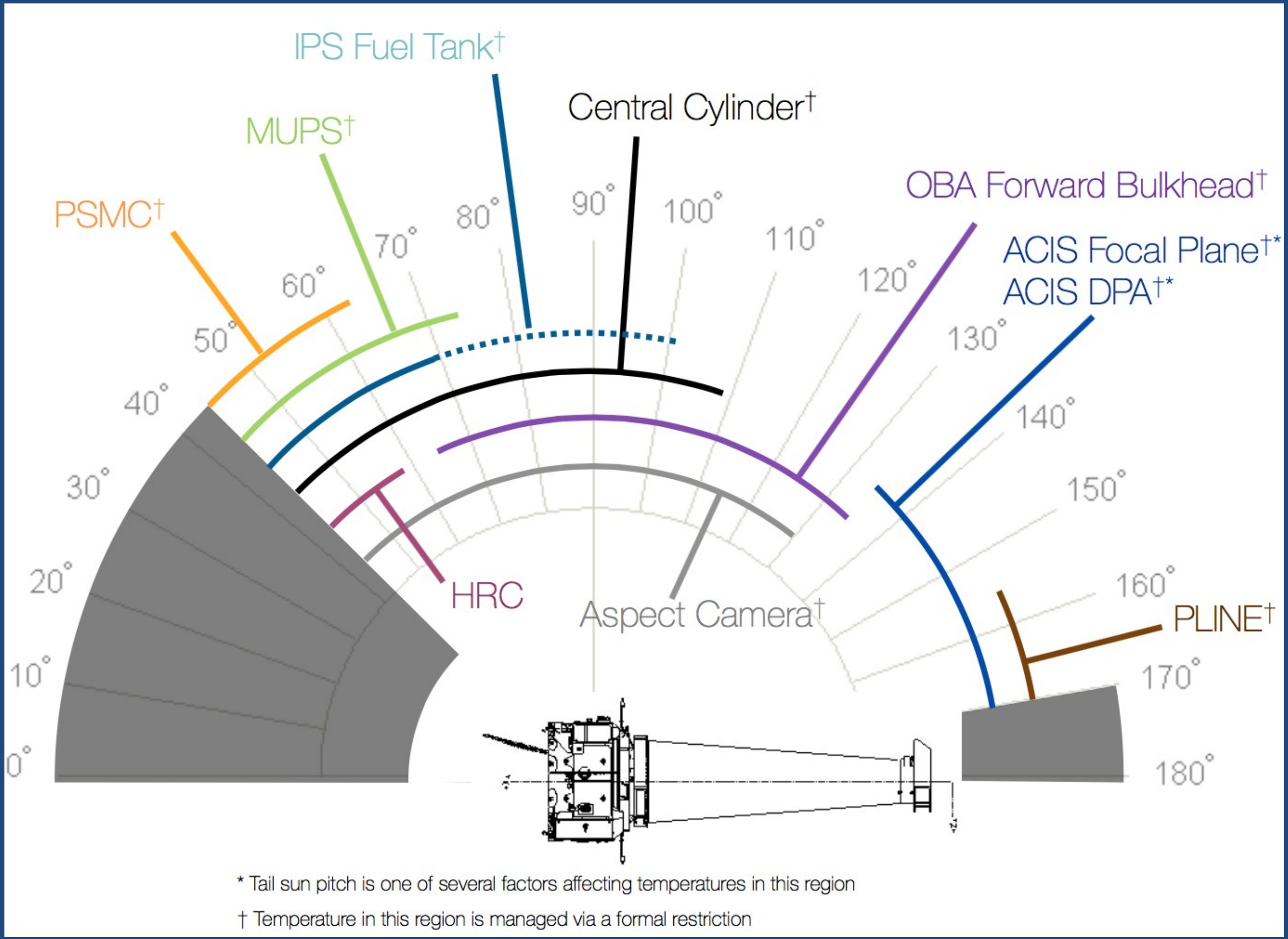
Public website:
chandra.si.edu

Thermal issues in aging spacecraft

- Insulation is degrading → general heating
- Temperature managed via spacecraft attitude control
- Many subsystems monitored continuously
- Limited dwell times at most pitch angles
- Scheduling is complex, most observations are split
- So far only one limit on time allocation: < 2 Ms >60^{o} ecliptic latitude

Thermal issues in aging spacecraft

Limited dwell times at ~all pitch ranges



Time Constraints (TC)

- Limit # TC observations (<90ks) → maximize observing efficiency
- Categories (Cycle 19):
  - Easy (48), Average (25), Difficult (17)
- Demand is high → most passing-ranked TC proposals are approved

TOO Allocations per cycle
(excluding DDT)

#	Category	Time/days
8	Very Fast	0-5
20	Fast	5-15
26	Slow	15-30
26	Very Slow	>30