ATHENA

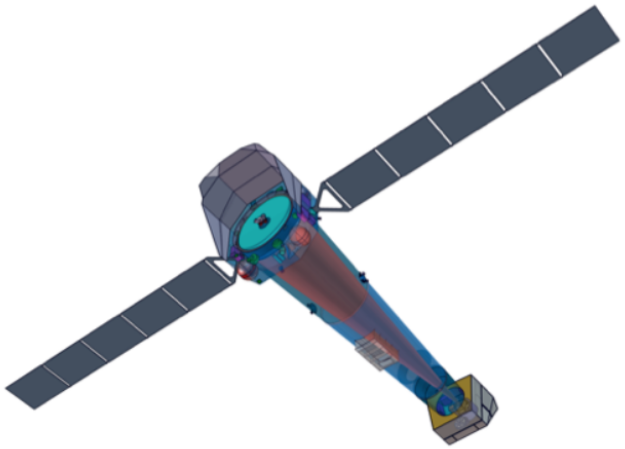
The Athena X-ray Observatory

On behalf of Athena Science Study Team: Paul Nandra, Didier Barrett, Xavier Barcons, Anne Decourchelle, Jan-Willem den Herder, Andy Fabian, Hiro Matsumoto, Luigi Piro, Randall Smith, Dick Willingale, the Athena Working Groups and Topical Panels

- Scientific theme: The Hot and Energetic Universe
  - How does ordinary matter assemble in the large-scale structures?
    - Tool: X-ray emitting hot gas in clusters
  - How do black holes grow and shape galaxies?
    - Tool: Accretion powered X-rays onto compact objects
- Together with:
  - Observatory science from planets, stars, supernova remnants, interstellar medium…
  - Discovery science enabled in particular through a fast ToO capability to study the transient sky

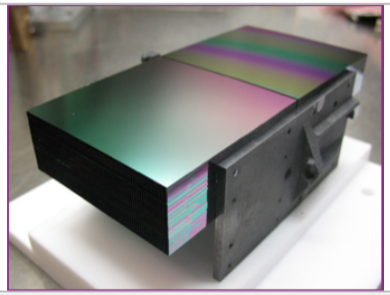
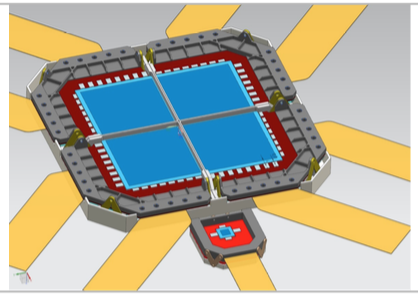
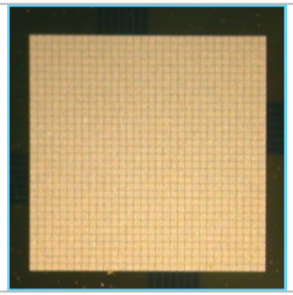
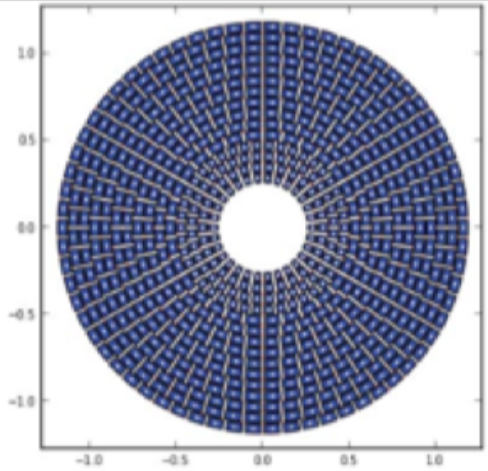
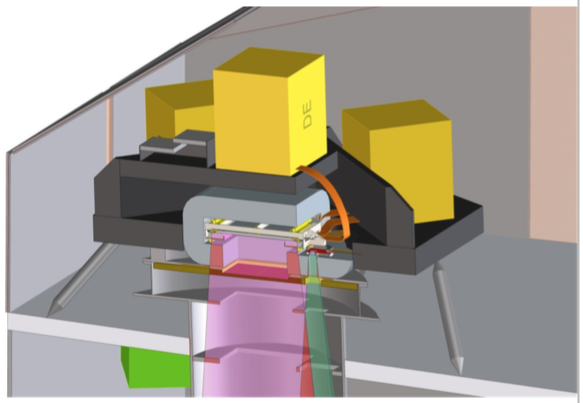
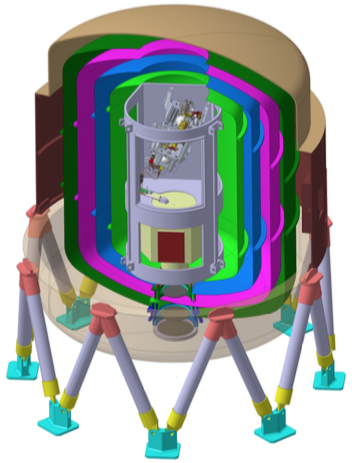
Need to combine a large aperture X-ray telescope, wide field imaging, high-resolution spectroscopy and an agile spacecraft

- Second Large (L) mission of the ESA Cosmic Vision 2015-2035
- Launch year: end of 2028
  - with the newly developed Ariane 6 (64)
- A 7 ton spacecraft to be placed in a L2(L1) orbit
- Unprecedented collecting area in X-rays:
  - 2 m^2 at 1 keV and 0.17 m^2 at 7 keV
  - 5'' angular resolution

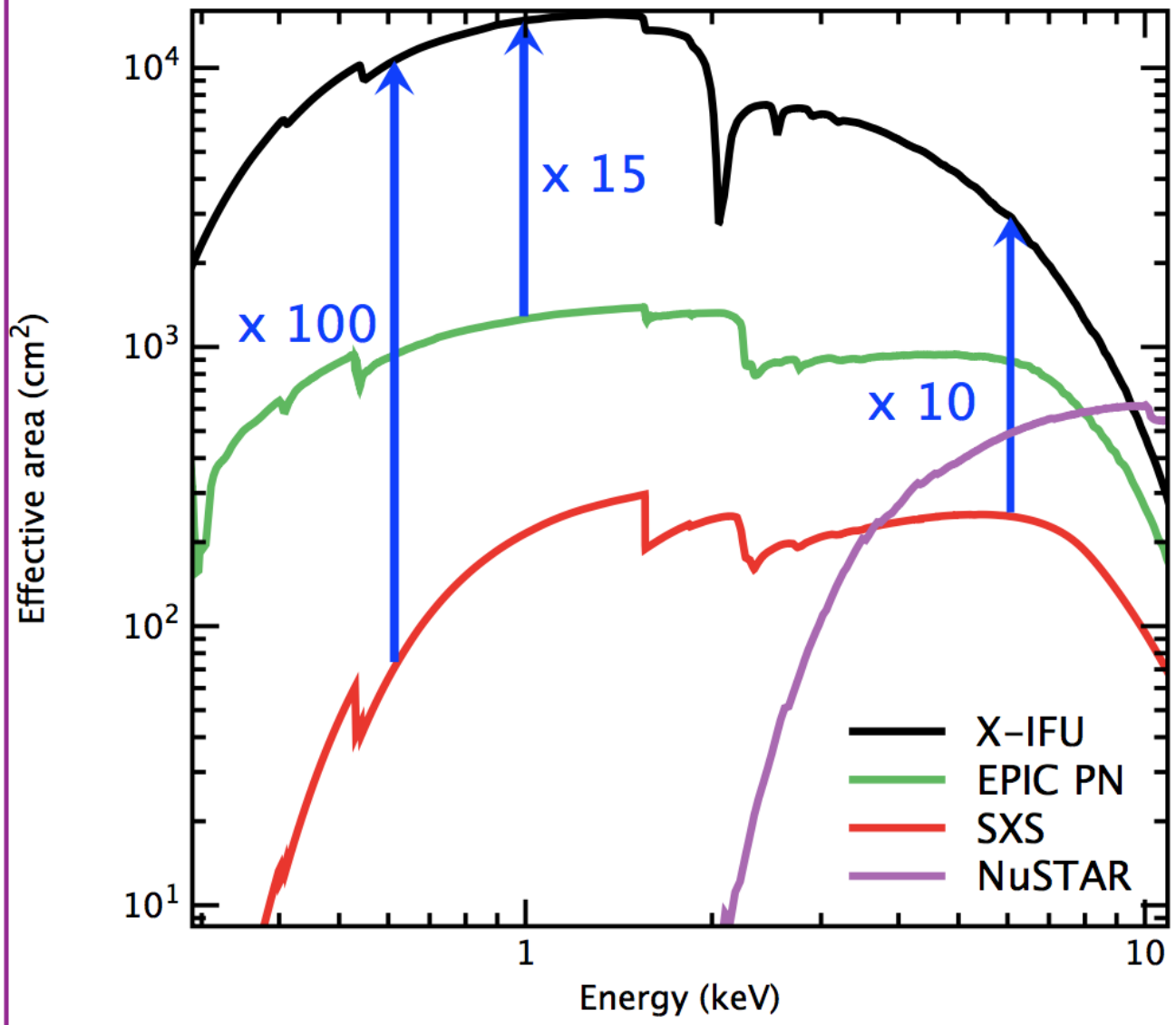


- Two focal plane instruments with a movable mirror assembly
  - The Wide Field Imager (WFI) optimized for fine imaging and bright sources
  - The X-ray Integral Field Unit (X-IFU) optimized for high-resolution spectroscopy

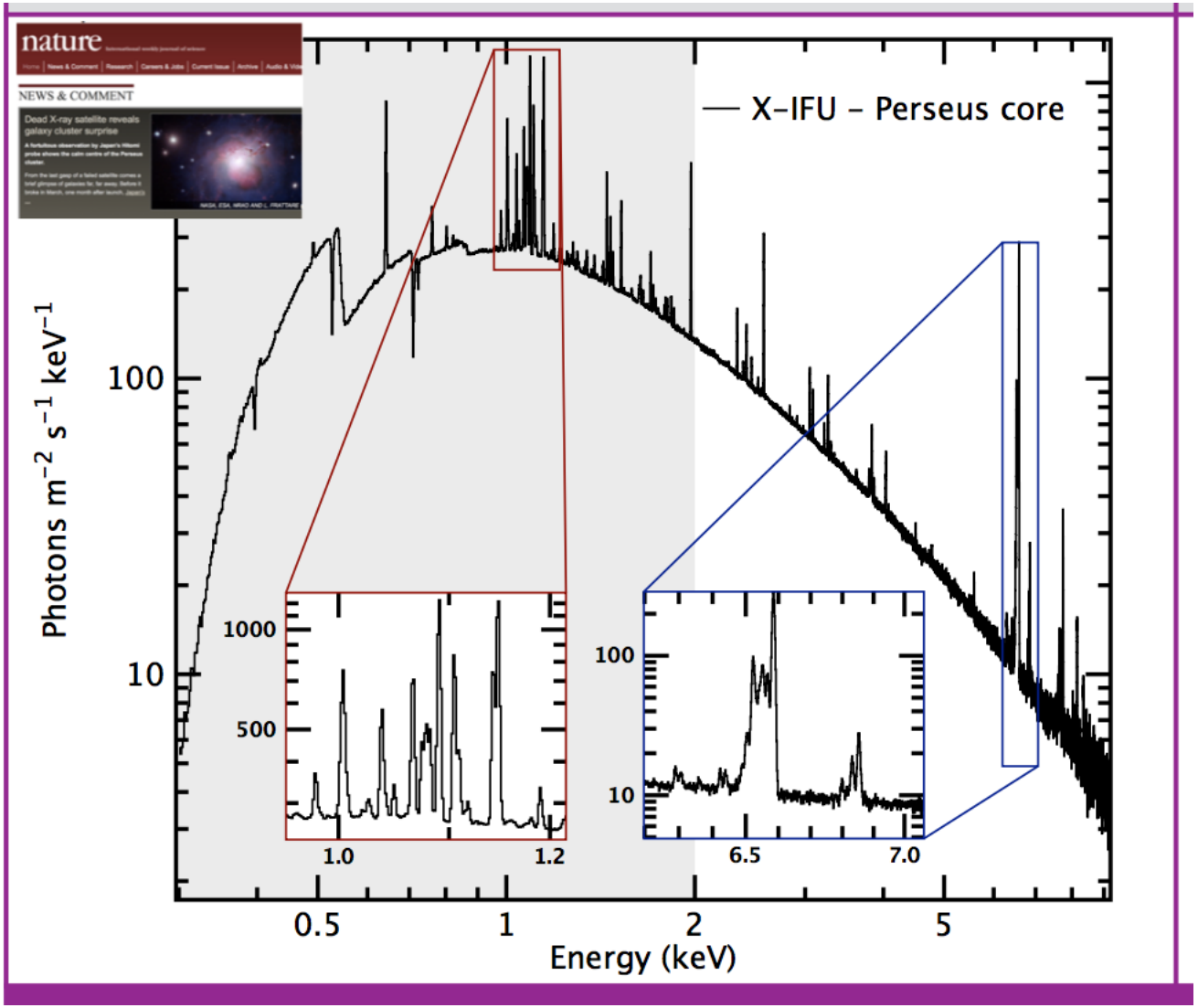
Parameter	Value	Driving science goals
Optics		
Effective area at 1 keV	2 m^2	Early groups, cluster entropy and metal evolution, WHIM, high redshift AGN, census of AGN, first generation of stars
Effective area at 7 keV	0.17 m^2	Cluster energetics (gas bulk motions & turbulence), AGN winds & outflows, SMBH & GBH spins
PSF HEW (< 8 keV)	5'' on axis, 10'' off axis	High z AGN, census of AGN, early groups, AGN feedback on cluster scales
X-IFU		
X-IFU spectral resolution	2.5 eV	WHIM, cluster hot gas energetics and AGN feedback on cluster scales, energetics of AGN outflows at z~1-4
X-IFU field of view	5' diameter	Metal production & dispersal, cluster energetics, WHIM
X-IFU background	< 5 10^{-3} counts/s/cm^2/keV	Cluster energetics & AGN feedback on cluster scales, metal production & dispersal
X-IFU count rate capability	1 mCrab 80% high-res events	WHIM using GRB afterglows
WFI		
WFI spectral resolution	150 eV	GBH spin, reverberation mapping
WFI field of view	40' x 40'	High-z AGN, census AGN, early groups, cluster entropy evolution, jet-induced ripples
WFI count rate capability	80% throughput at 1 Crab	GBH spin, reverberation mapping, accretion physics
WFI background	< 5 10^{-3} counts/s/cm^2/keV	Cluster entropy, cluster feedback, census AGN at z~1-4
Recons. astrometric error	1'' (3 sigmas)	High z AGNs
Satellite		
ToO trigger efficiency	40% in less than 4 hours	WHIM, first generation of stars

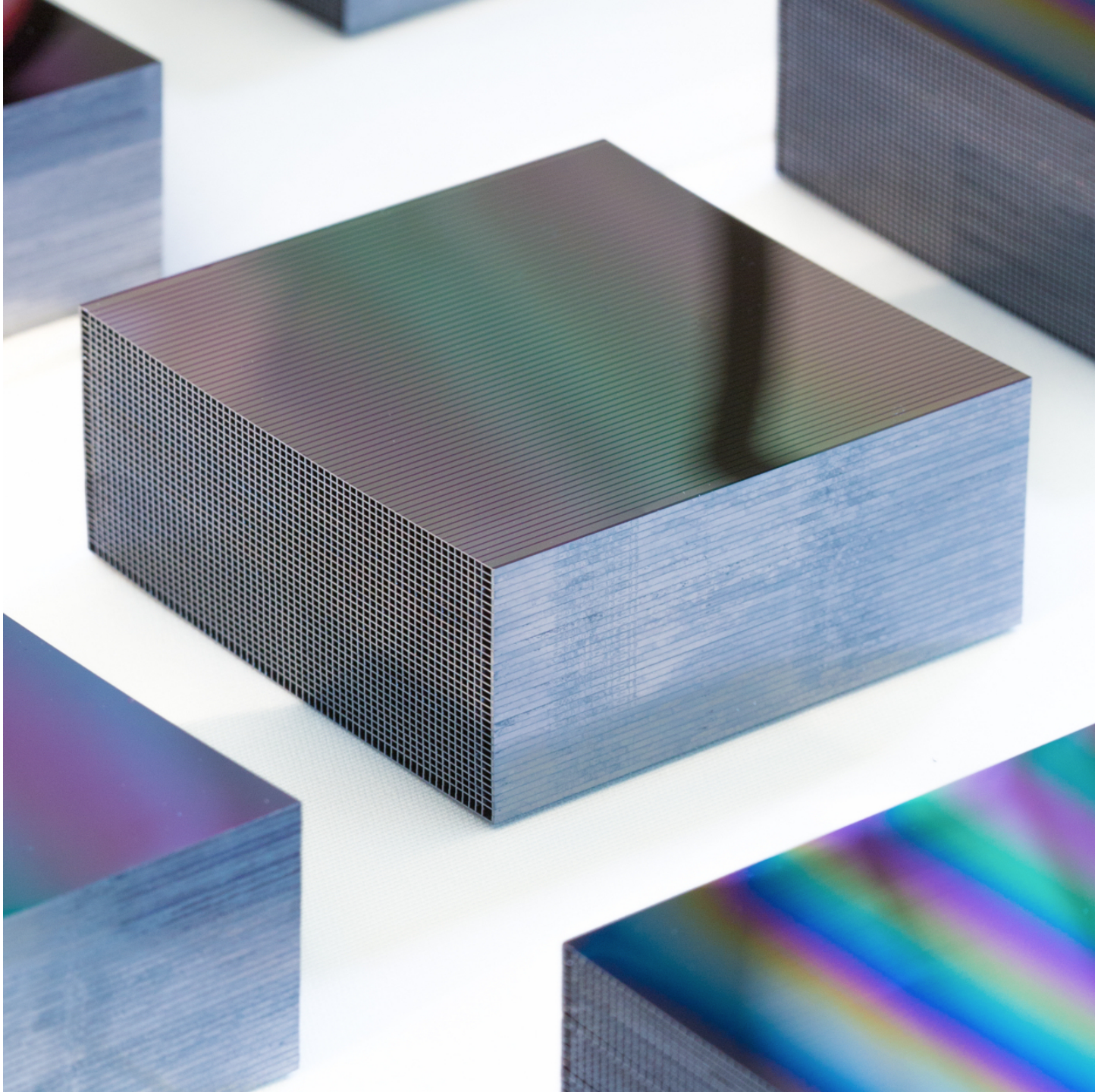
Optics	Wide Field Imager	X-ray Integral Field Unit
Light-weight Si-pore optics	Active Pixel Sensors based on DEPFETs	Cryogenic imaging spectrometer, based on a large format of Transition Edge Sensors cooled at 50 mK with an active background shielding
		
		
ESA & industry	Consortium led by MPE (K. Nandra), with other European partners and NASA	Consortium led by IRAP/CNES-F (D. Barret), with SRON-NL (J.W. den Herder), INAF/IAPS-IT (L. Piro) and other European partners, NASA and JAXA.

Effective area comparison between X-IFU and other facilities

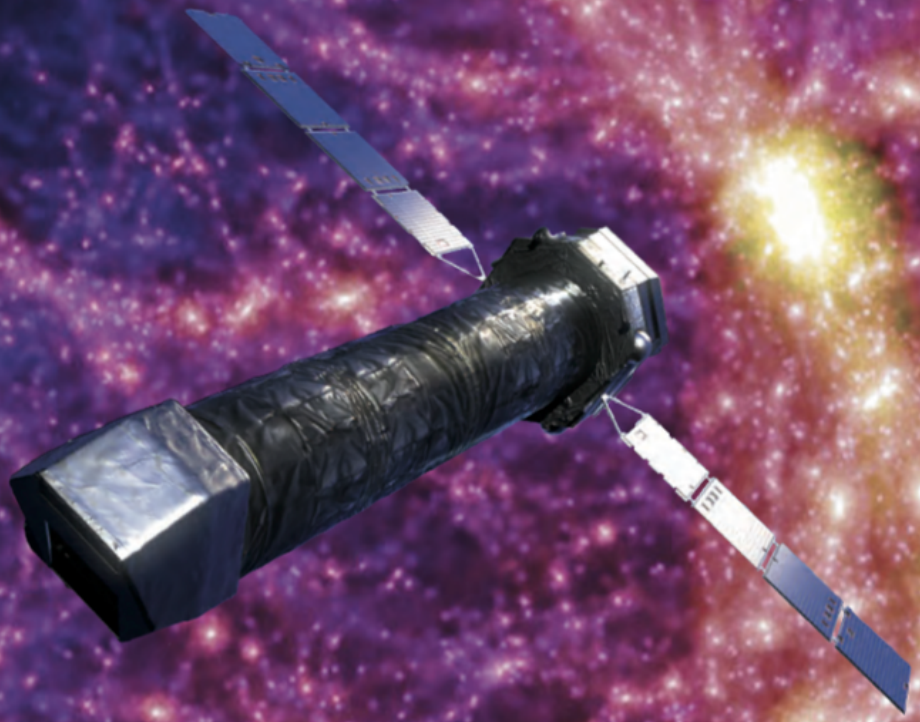


- Mission Consolidation Review (May 2016) concluded that:
  - The two missions concepts studied (small and large mirrors) are sound
  - The instrument switching mechanism is through a movable mirror assembly
    - Offers also defocussing to increase the X-IFU count rate capability
  - The instrument resources are challenging: all being addressed or fixed
  - The mass lift capacity of Ariane 64 up to 7 tons
  - Consolidation of the cost at completion is required (transfer of focal plane module to the instrument consortia, firming up international contribution to the mission and some payload elements, industrial costs, …)
  - **Mission concept to be carried over considers the large mirror**


nature
NEWS & COMMENT
Dead X-ray satellite reveals galaxy cluster surprise
X-IFU – Perseus core
Photons m^{-2} s^{-1} keV^{-1}
100
10
0.5
1
2
5
Energy (keV)
1000
500
1.0
1.2
100
10
6.5
7.0



A mission addressing *The Hot and Energetic Universe* science theme



http://www.the-athena-x-ray-observatory.eu/