ATHENA

The Hot and Energetic Universe with Athena

Luigi Piro
(IAPS/INAF)

Programmatics

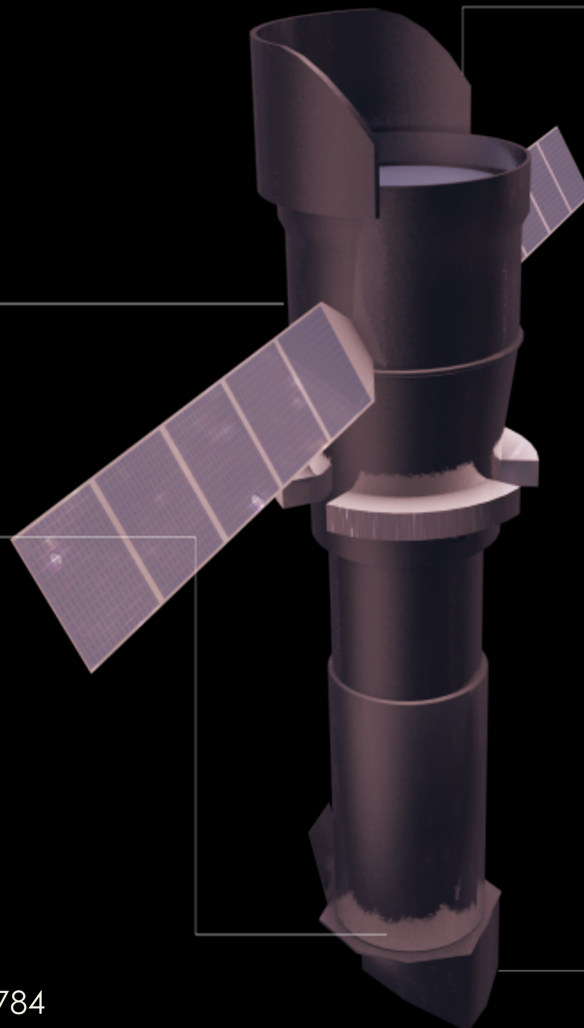
- ESA 2nd Large mission
- Science Theme; The Hot and Energetic Universe
- NASA and JAXA are partners
- ESA responsible of mission systems, spacecraft, launcher, mirror, operations and SOC
- Instruments and Science Ground Segment elements to be provided by the Member States
- Currently phase A (ending 2018)
- Launch 2030

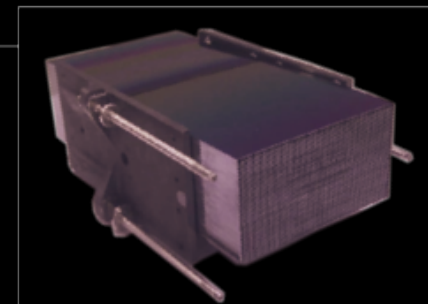
ATHENA

The Athena Observatory

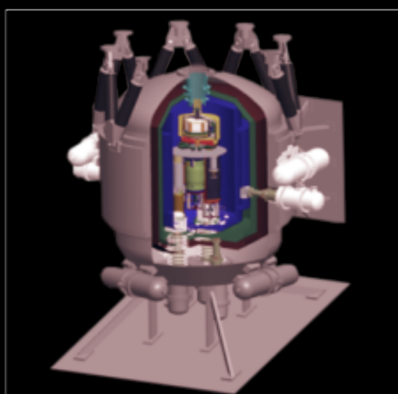
Willingale et al, 2013
arXiv1308.6785

L2 orbit Ariane V
<5100 kg
power 2500 w
4 year mission
FoR=50%
TOO in 4hrs



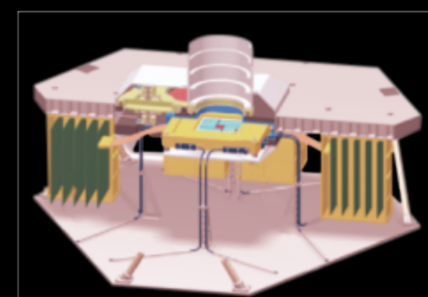


Silicon Pore Optics:
1.4-2 m^2 at 1 keV
5 arcsec HEW
Focal length: 12m
Sensitivity: 3 10^{-17} erg cm^{-2} s^{-1}



X-ray Integral Field Unit:
ΔE: 2.5 eV
Field of View: 5 arcmin
Operating temp: 50 mk

Barret et al., 2013 arXiv:1308.6784



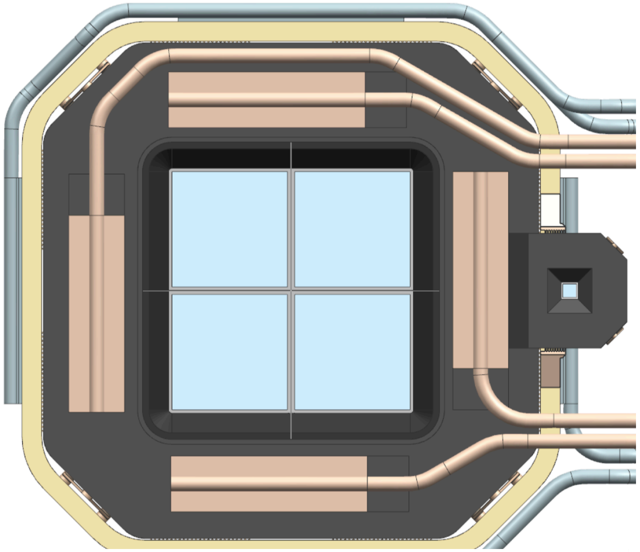
Wide Field Imager:
ΔE: 125 eV
Field of View: 40 arcmin
High countrate capability

Rau et al. 2013 arXiv1307.1709

Wide Field Imager

WFI consortium lead: Germany

FoV = 40 arcmin ↔ Size = 140 mm



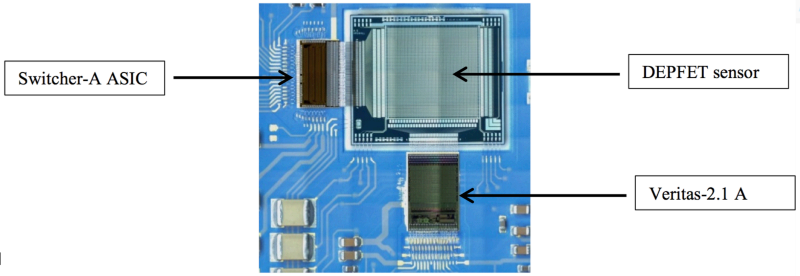
4 large DEPFET sensor chips

512 x 512 pixels with 130 µm x 130 µm

sensitive area → 67 x 67 mm^2

Time resolution: **1.28 ms**

1 fast timing DEPFET sensor



64 x 64 pixels with 130 µm x 130 µm

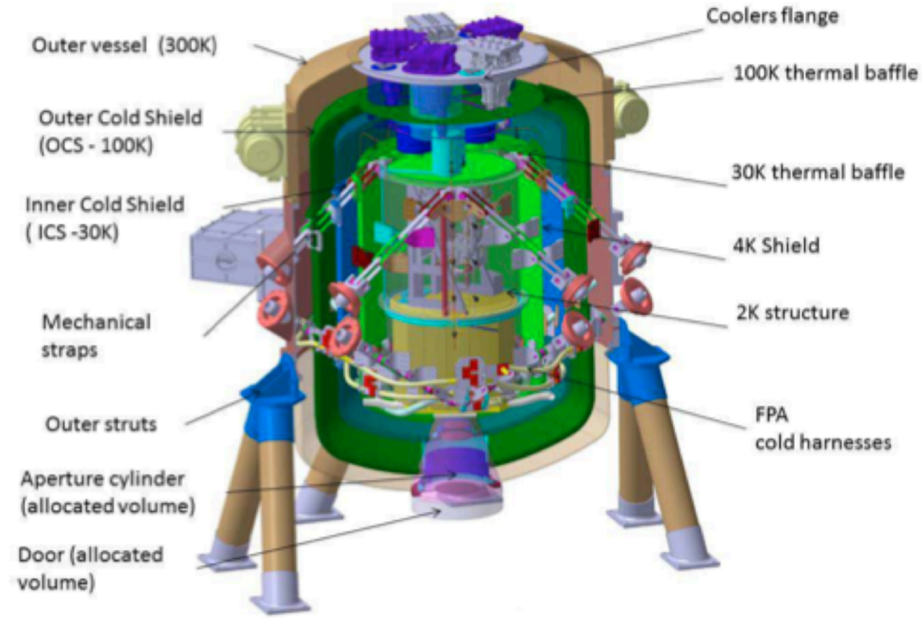
sensitive area → 8.3 x 8.3 mm^2

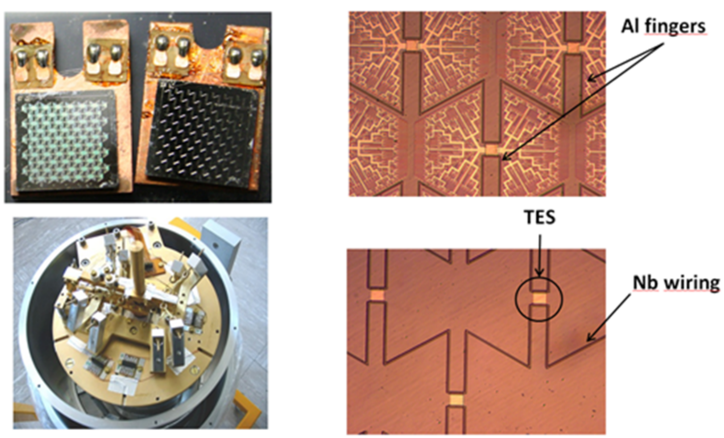
Time resolution: **160 µs** (or **80 µs** with 2-line readout optio

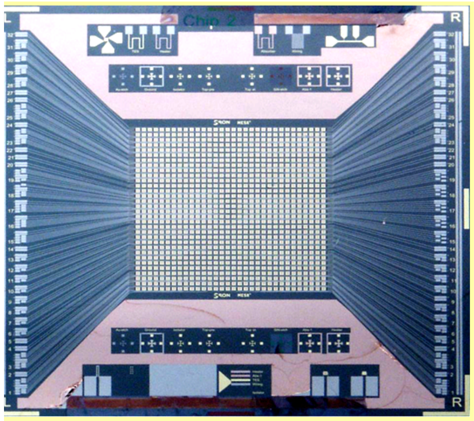
Window mode: 8+8 lines (36 arcsec ≈ 7 x PSF): **20 µs** (or **10 µs** with 2-line readout option)

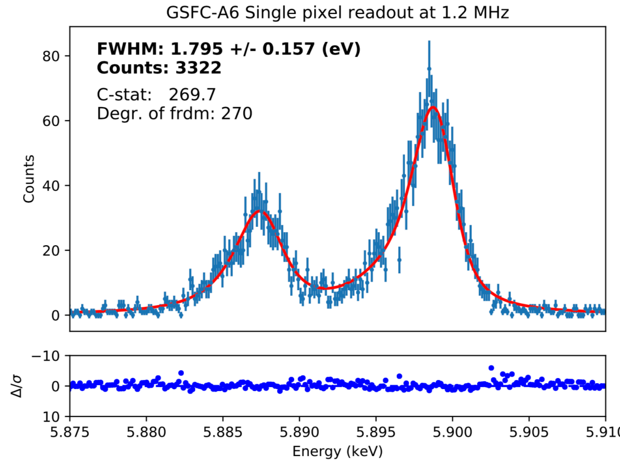
X-Ray Integral Field Unit

- XIFU consortium lead: France (PI), Italy & Holland (CoPI)
- Transition Edge Sensor microcalorimeter in cryo (50 mK)
- 4-kpixel array with 2.5 eV
- Large TES-based CryoAC for Low instrumental background
- Read-out: FDM multiplexing









ATHENA

Community Organization

ESA Athena Science Study Team (ASST)

M. Guainazzi (Chair), K. Nandra (Science Lead & WFI), D. Barret (X-IFU), A. Decourchelle, J.W. den Herder, A.C. Fabian, H. Matsumoto (JAXA), L. Piro, R. Smith (NASA), R. Willingale.

SWG1 Hot Universe
Fabian, Reiprich, Ohashi

- **SWG1.1** **Evolution of galaxy group and clusters** *Allen, Ota, Pointecouteau*
- **SWG1.2** **Astrophysics of galaxy group and clusters** *Ettori, Pratt, Eckert*
- **SWG1.3** **AGN feedback in galaxy group and clusters** *Croston, Sanders, McNamara*
- **SWG1.4** **Missing baryons and warm-hot intergalactic medium** *Kaastra, Finoguenov*

SWG2 Energetic Universe
Nandra, Cappi, Brenneman

- **SWG2.1** **Formation and growth of earliest SMBH** *Aird, Comastri*
- **SWG2.2** **Understanding the build-up of SMBH and galaxies** *Georgakakis, Carrera, Ueda*
- **SWG2.3** **Feedback in local AGN and star forming galaxies** *Ponti, Ptak, Terashima*
- **SWG2.4** **Close environments of SMBH** *Dovciak, Matt, Miniutti*
- **SWG2.5** **Physics of accretion** *Done, Miller, Motch*
- **SWG2.6** **Luminous extragalactic transients** *Jonker, O´Brien*

SWG3 Observatory
Decourchelle, Matsumoto, Smith

- **SWG3.1** **Solar System & exoplanets** *Branduardi-Raymont, Güdel*
- **SWG3.2** **Star formation and evolution** *Rauw, Sciortino*
- **SWG3.3** **End points of stellar evolution** *Bozzo, Schwope*
- **SWG3.4** **Supernova remnants & Interstellar medium** *Bamba, Costantini*
- **SWG3.5** **Multiwavelength synergy** *Combes, Salvato*

TWG4 Telescope
Willingale, Pareschi

MWG5 Mission Performance
den Herder, Piro, Rau

- **MWG5.1** **Science ground segment** *Watson, Webb*
- **MWG5.2** **Background** *Laurent, Molendi*
- **MWG5.3** **Inter-calibration** *Burwitz, Pajot, Sembay*
- **MWG5.4** **End-to-end simulations** *Peille, Wilms*
- **MWG5.5** **Advanced analysis tools** *Fiore, Haberi*
- **MWG5.6** **Targets of opportunity** *Basa, Troja*

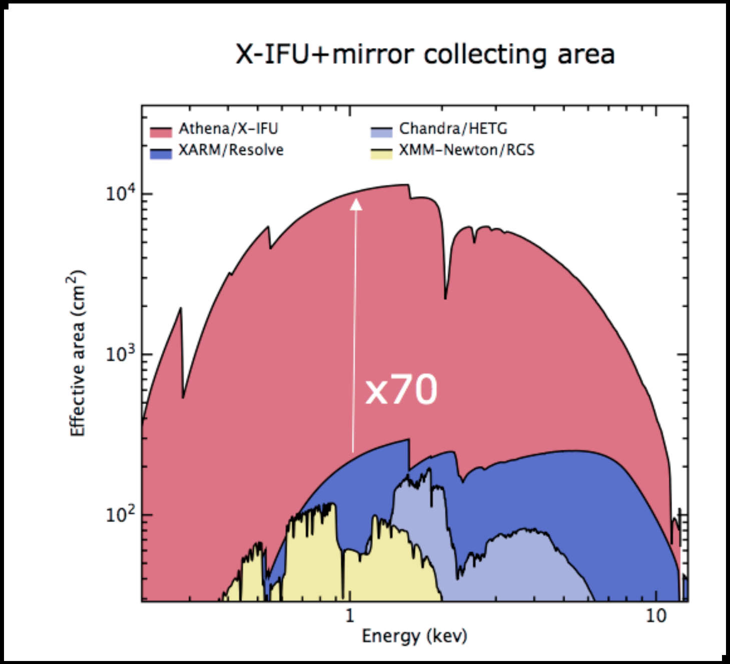
This map shows the members of our community and their working groups positioned in their institutes of reference. Please, in case you do not find yourself, contact us at aco@ifca.unican.es

Athena Community map

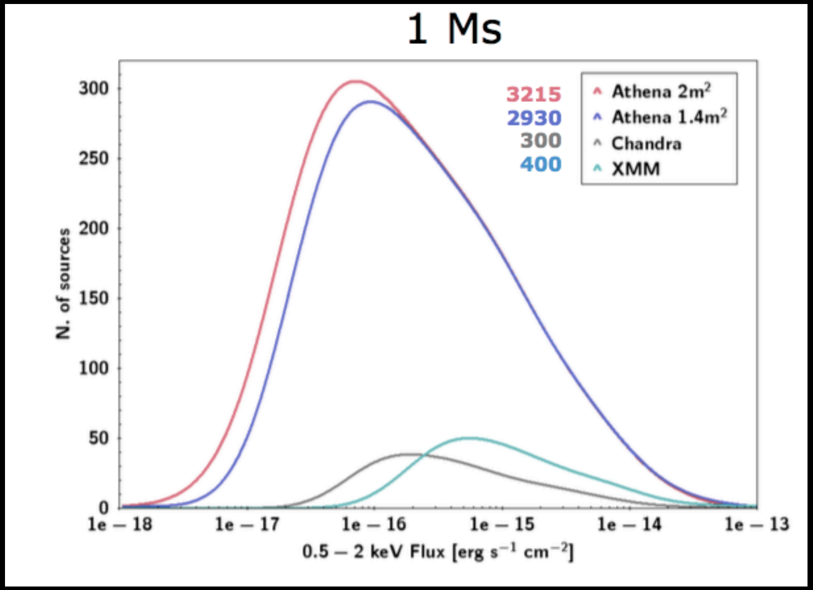
ATHENA

The first Deep Universe X-ray Observatory

Athena has vastly improved capabilities compared to current or planned facilities, and will impact on virtually all areas of astrophysics

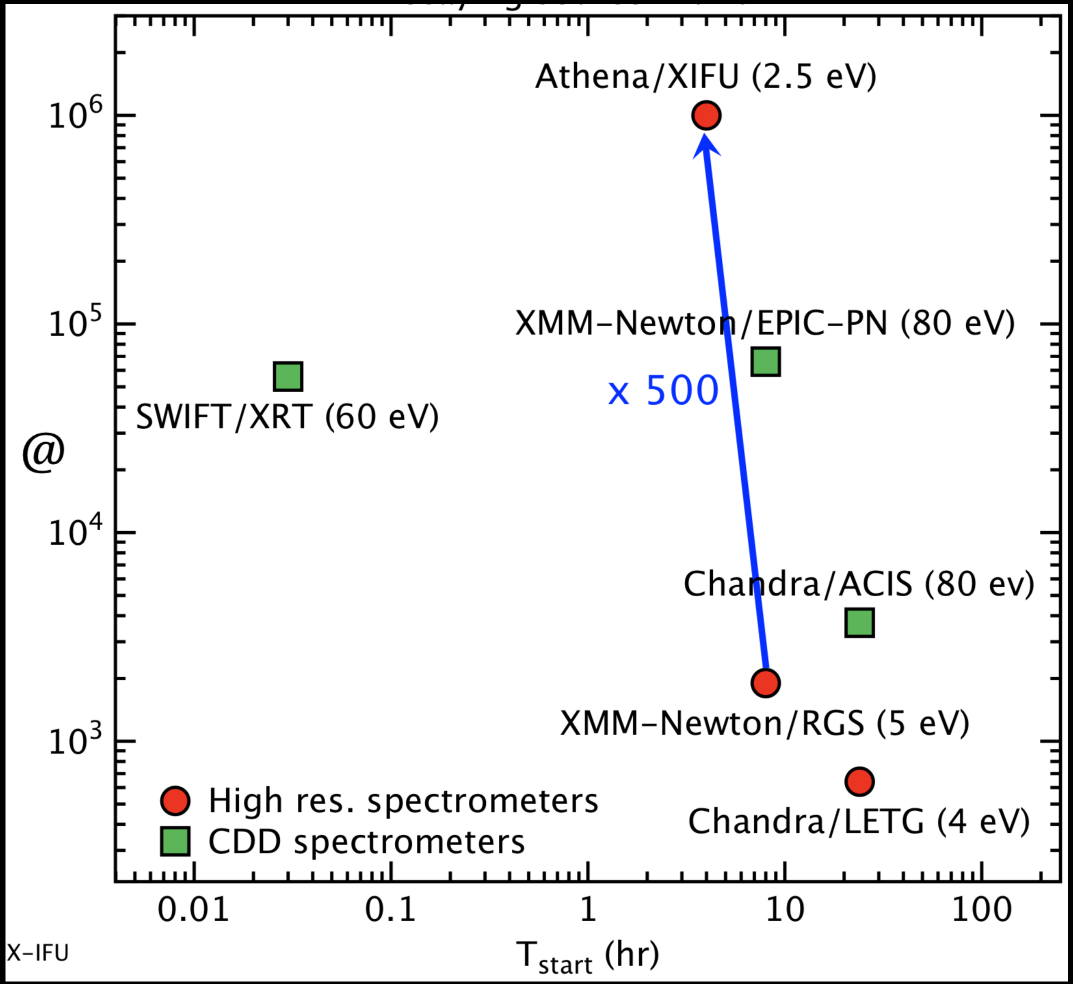


X-ray spectroscopy at the peak of the activity of the Universe



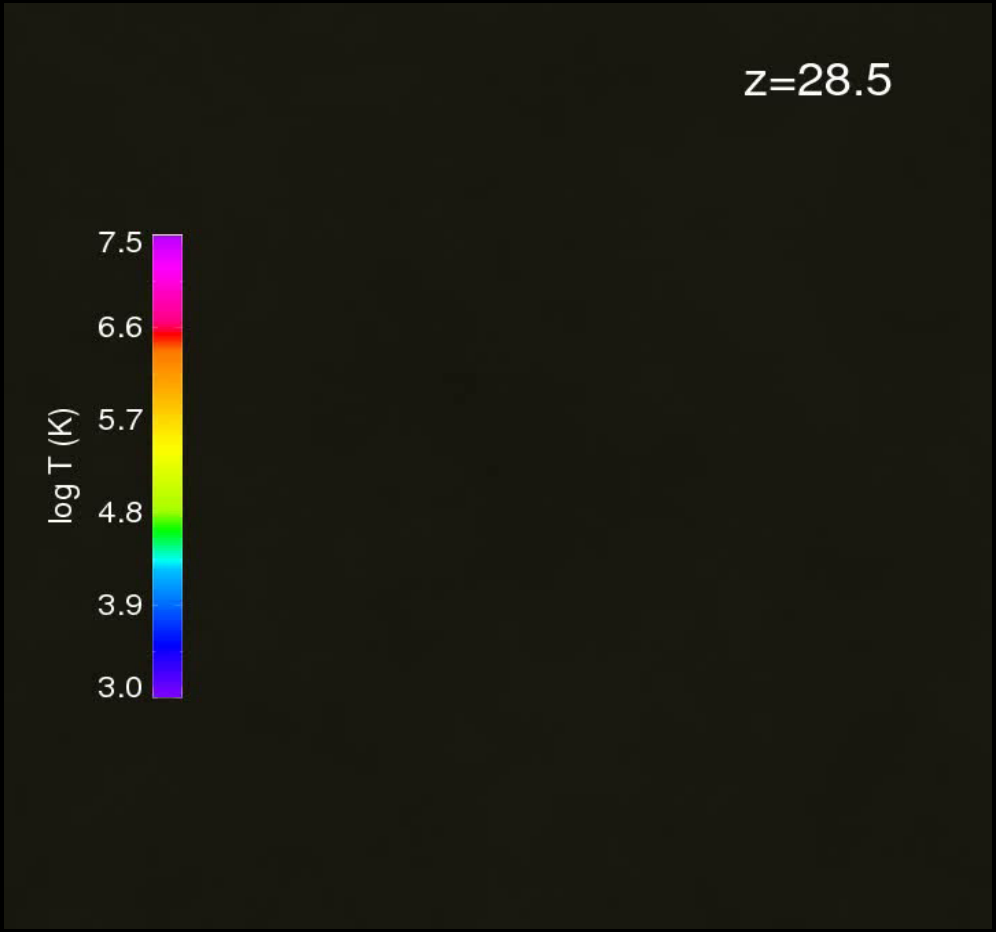
Deep survey capability into the dark ages and epoch of reionization

Athena TOO capability on GRBs



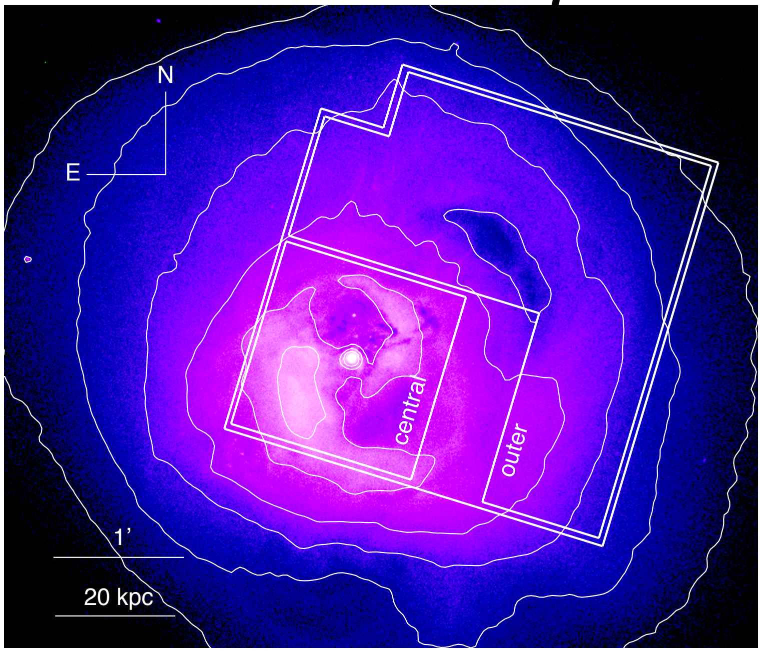
Key questions for observational astrophysics

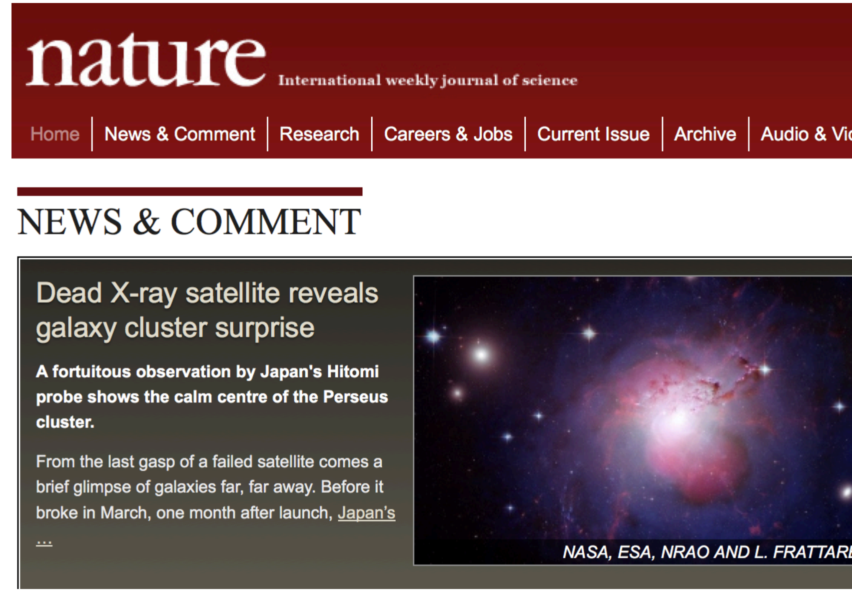
1. How does ordinary matter assemble into the large scale structures we see today?



Oppenheimer et al. 2009

HITOMI and the Spectrum of the Perseus Cluster





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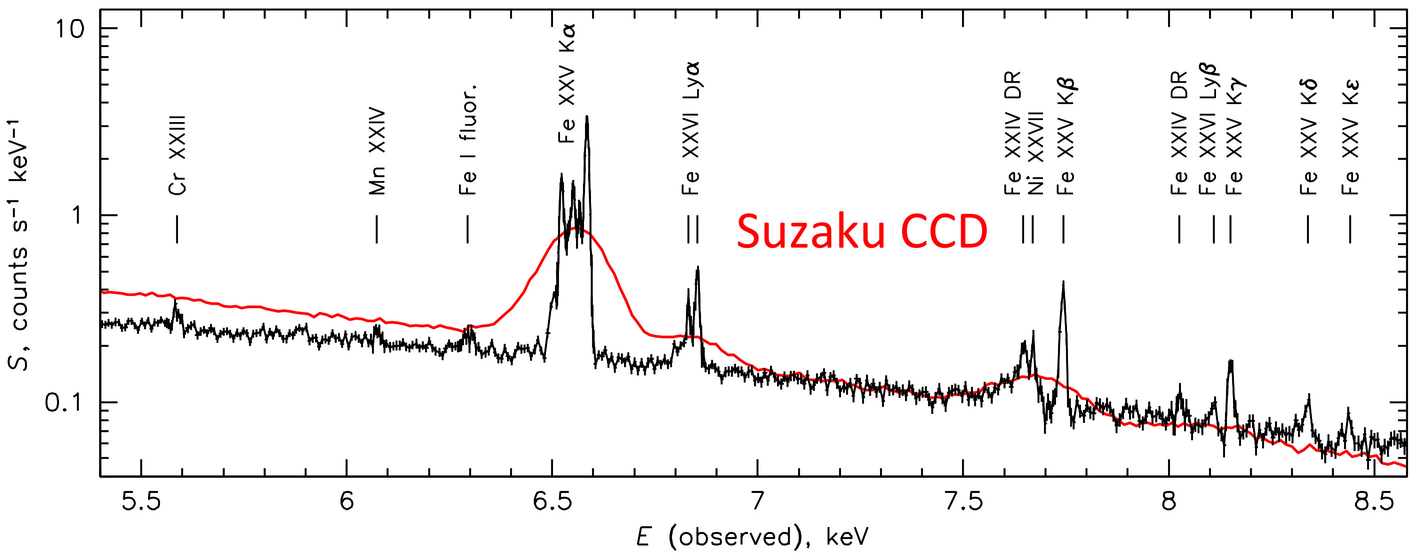
NEWS & COMMENT

Dead X-ray satellite reveals galaxy cluster surprise

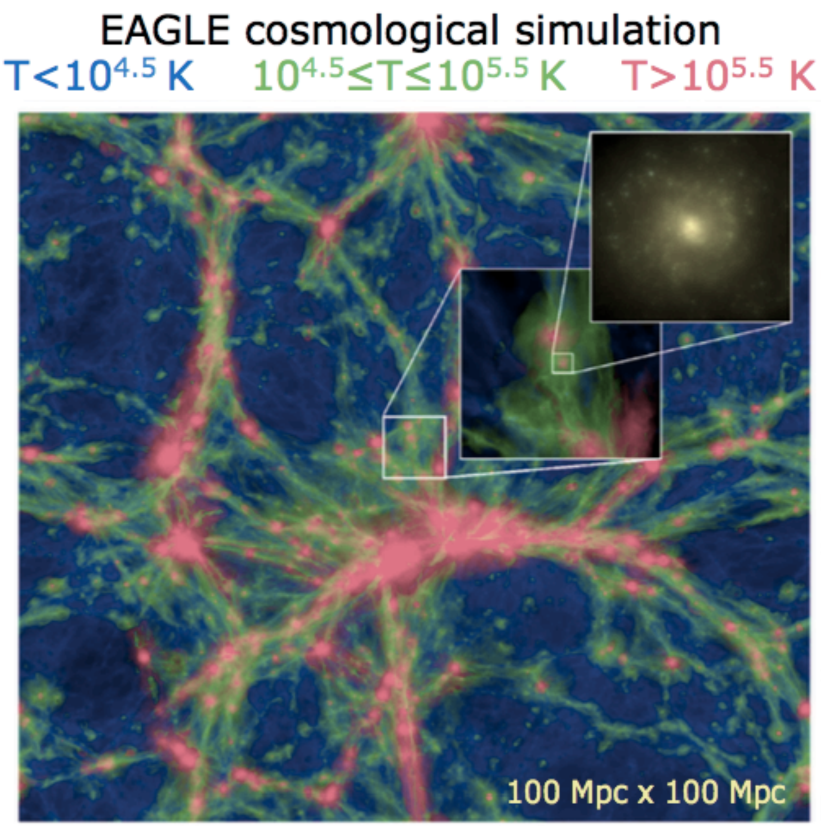
A fortuitous observation by Japan's Hitomi probe shows the calm centre of the Perseus cluster.

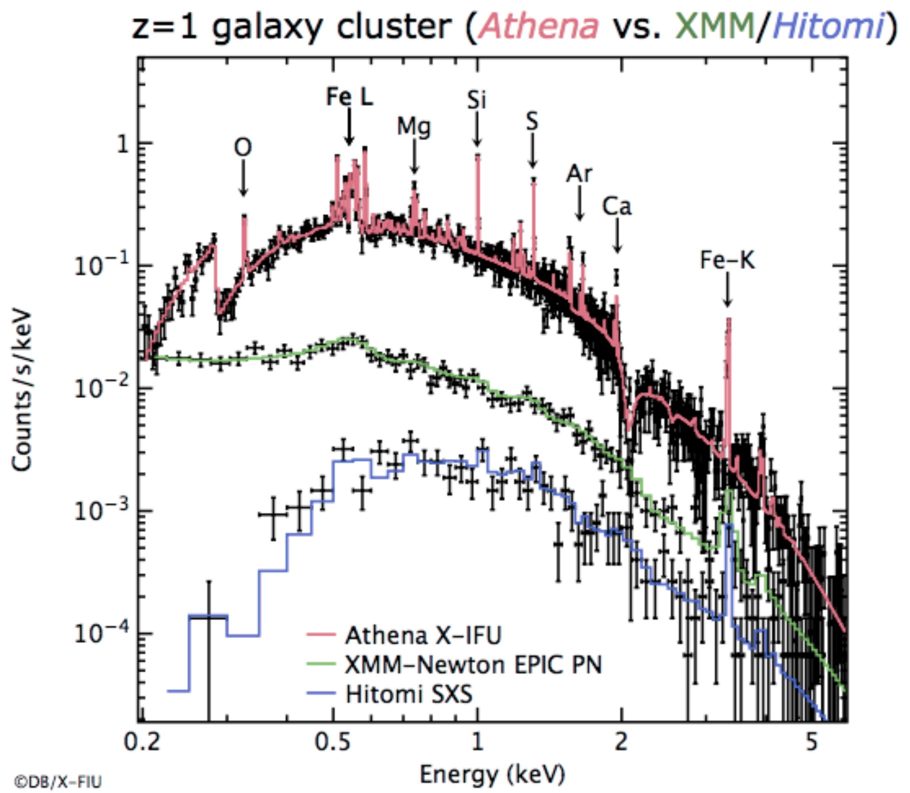
From the last gasp of a failed satellite comes a brief glimpse of galaxies far, far away. Before it broke in March, one month after launch, Japan's ...

NASA, ESA, NRAO AND L. FRATTARE



The chemical evolution of hot baryons





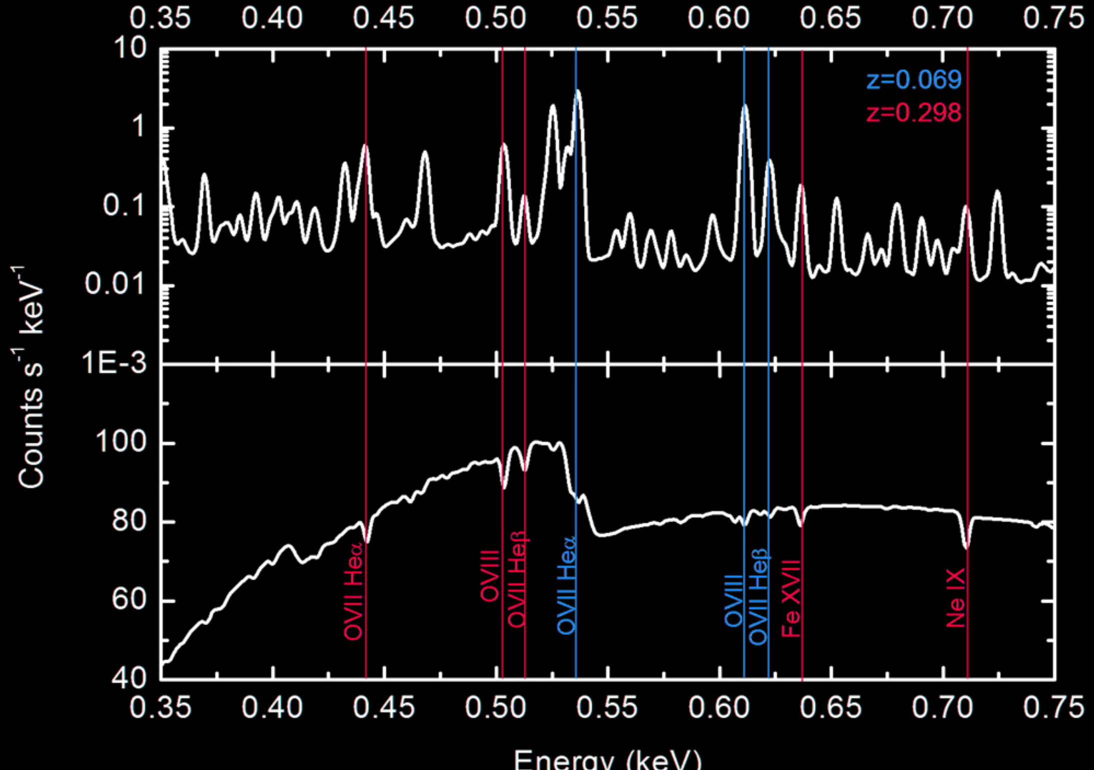
Athena will trace the evolution of heavy elements from z~2 to the local Universe

How does ordinary matter assemble into the large-scale structures that we see today?

ATHENA

The Warm-Hot intergalactic medium (WHIM)

Athena high resolution spectroscopy observations towards a bright GRB afterglow will disclose the weka absorption metal features of the cosmolofical filament and, once the afteglow decays, will also detect the emission line counterpart

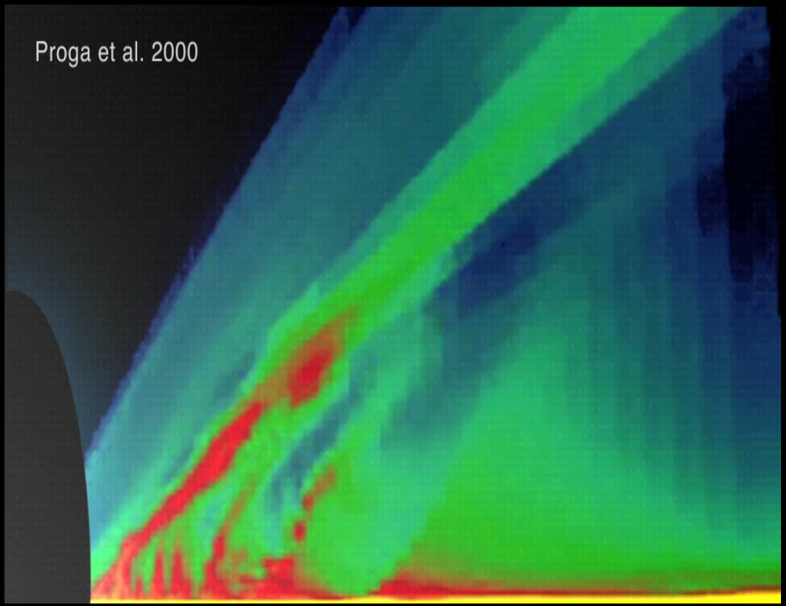


How does ordinary matter assemble into the large-scale structures that we see today?

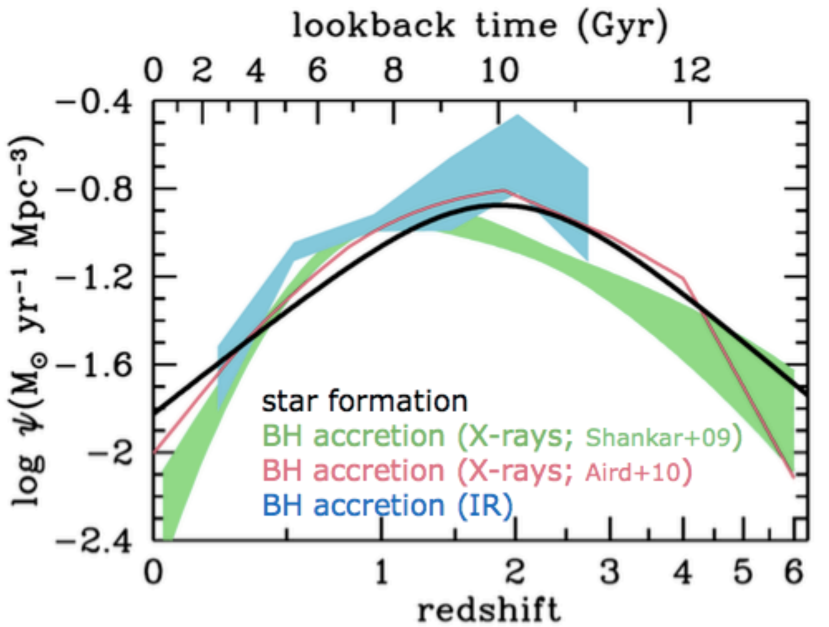
Key questions for observational astrophysics in 2030

1. How does ordinary matter assemble into the large scale structures we see today?

2. How do black holes grow and shape the Universe?

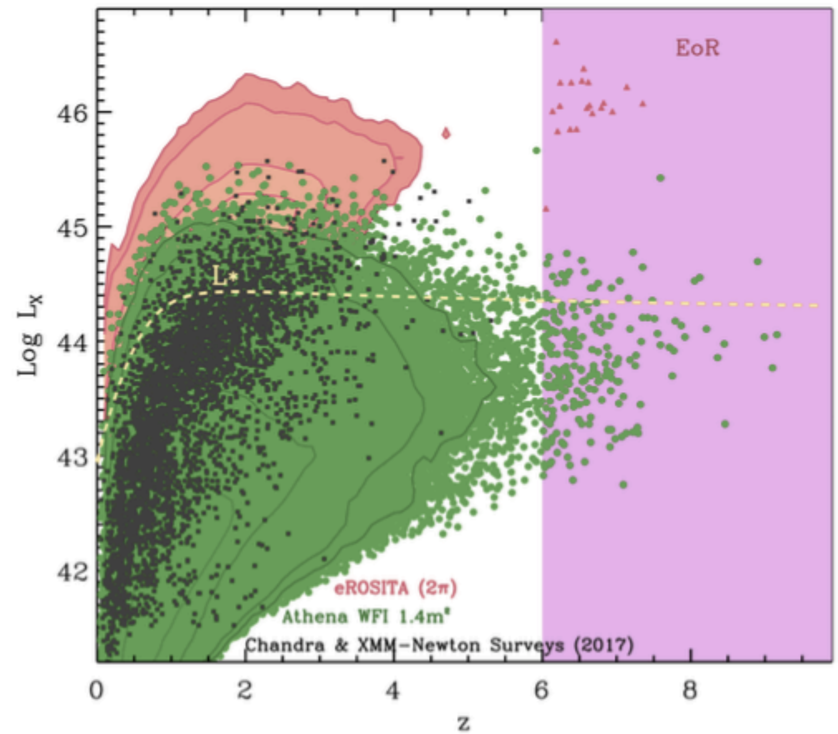


The Energetic Universe



The cosmological history of black hole accretion
is **uncertain** at z>3, **unknown** at z>6

AGN L_X versus z plane



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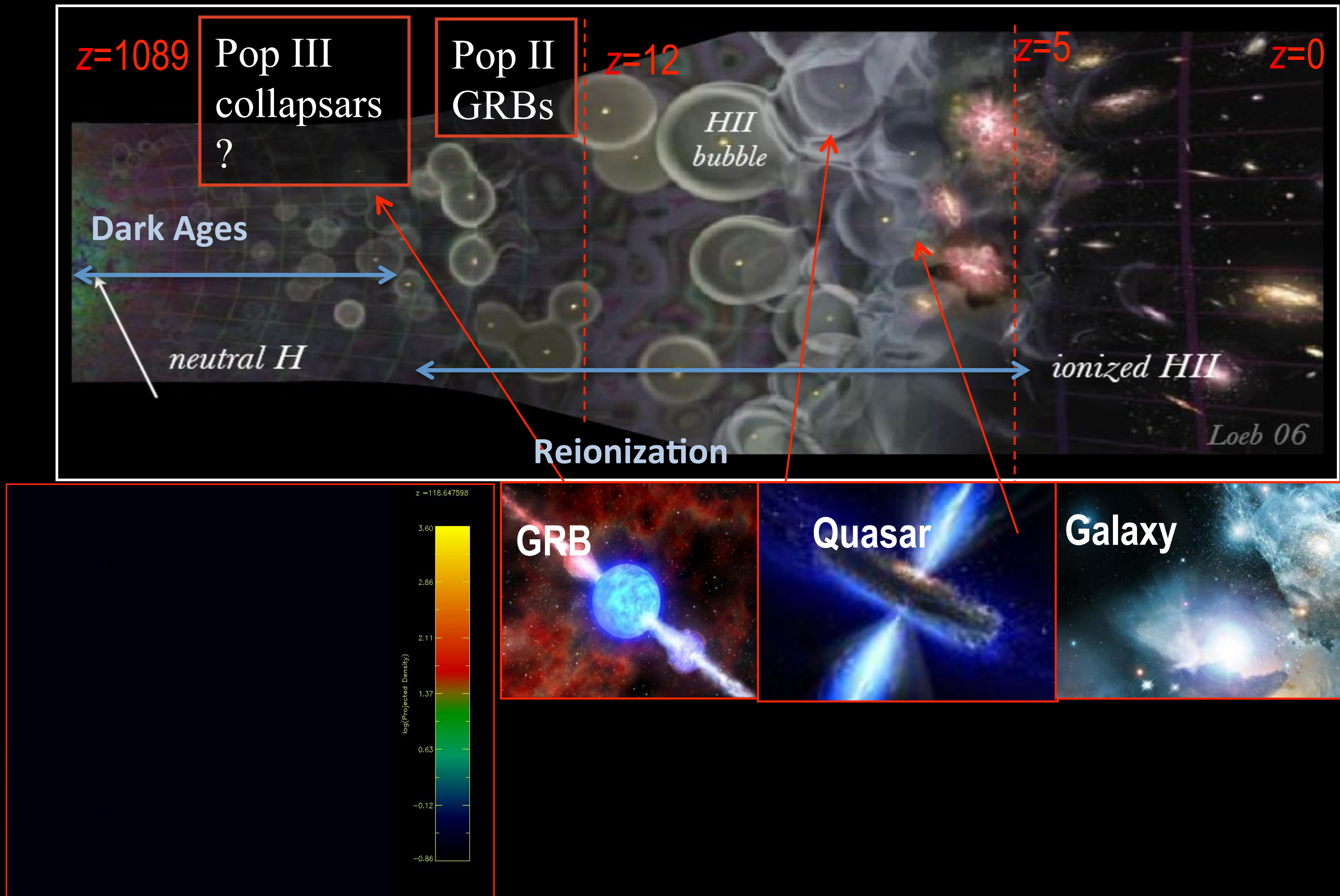
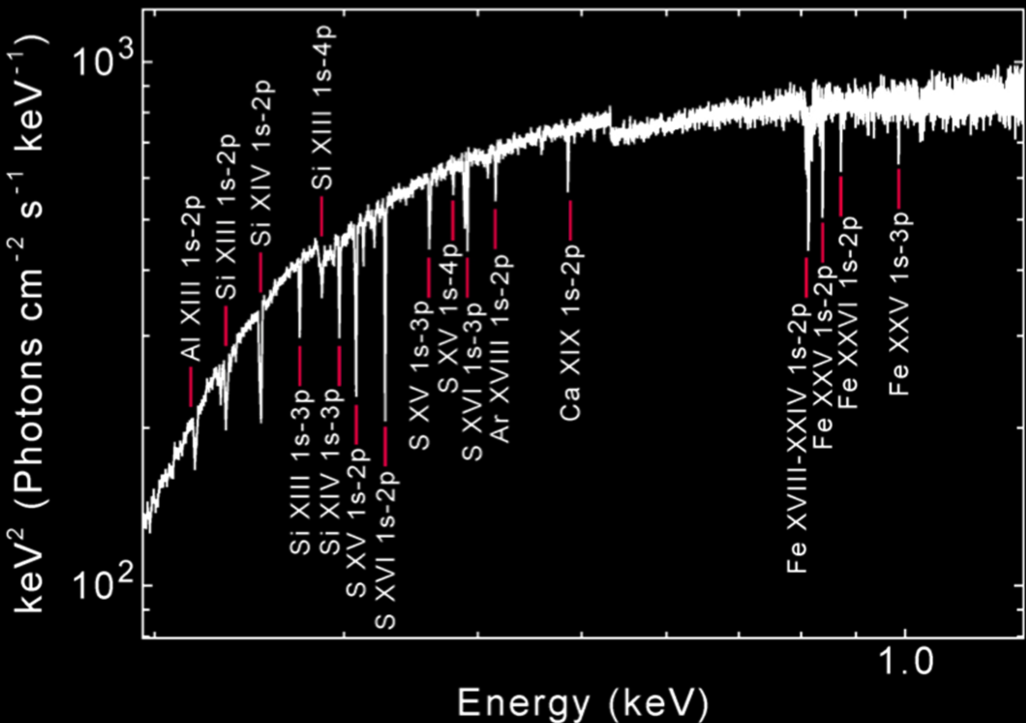
The first stars, the first BH, the first metals

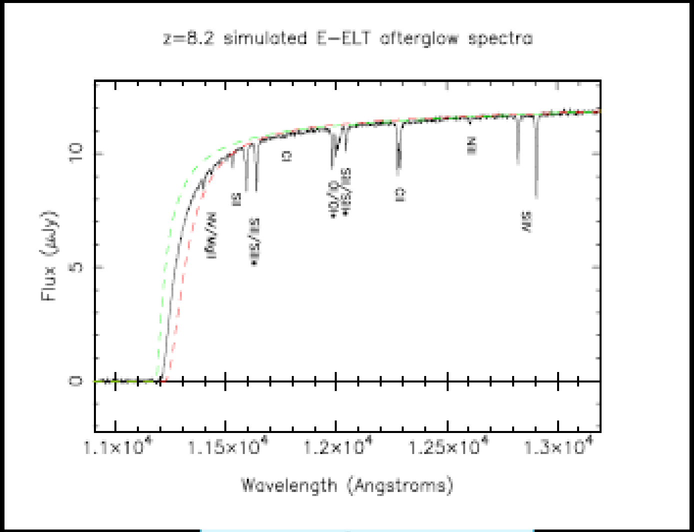


High-Z GRBs: The first stars and black holes

When did the first generation of stars explode to form the first seed black holes and disseminate the first metals in the Universe?

Gamma Ray Burst at z=7



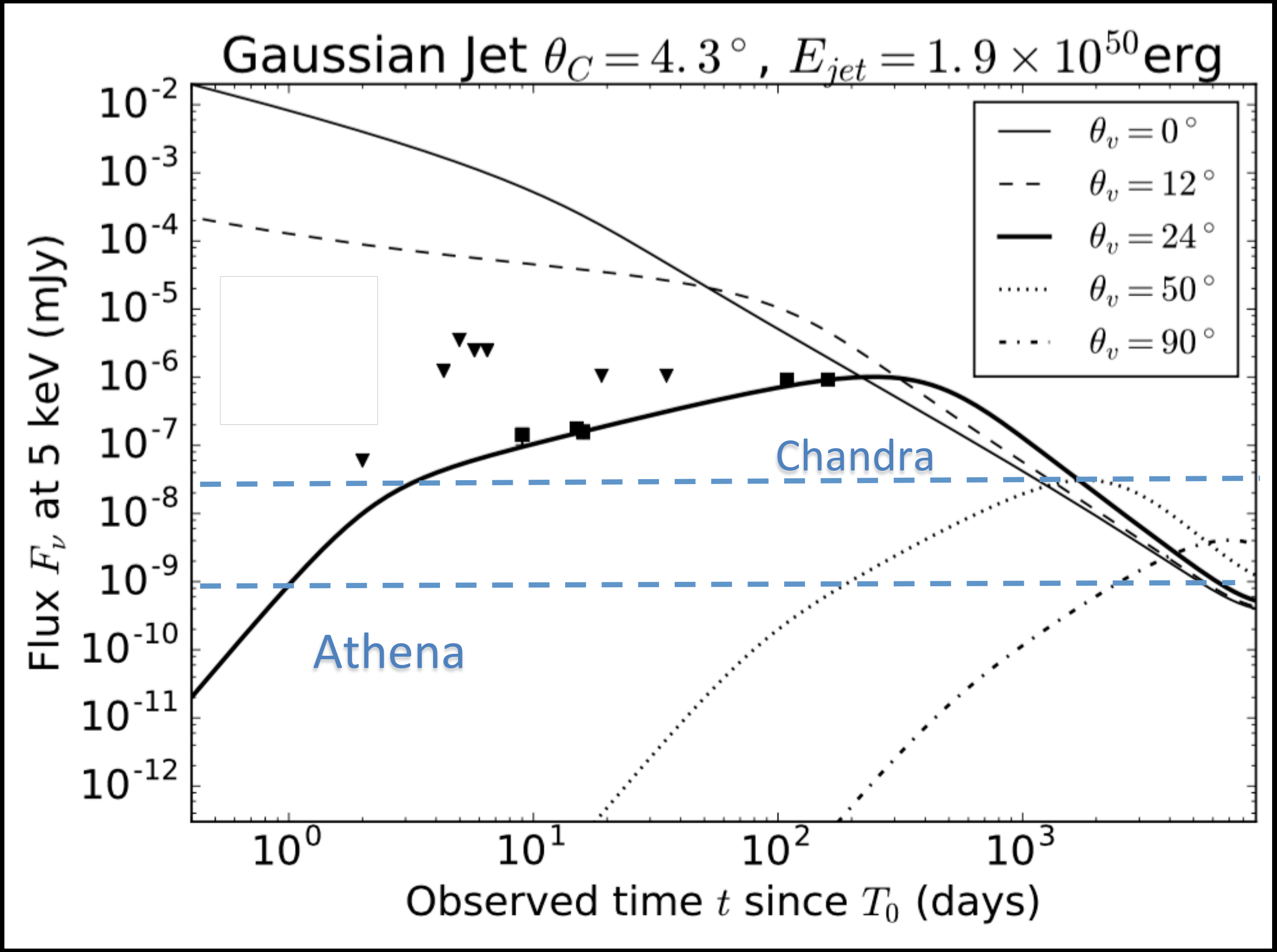


30+ m class ELTs

Jonker, O'Brien et al., 2013 arXiv1306.2336

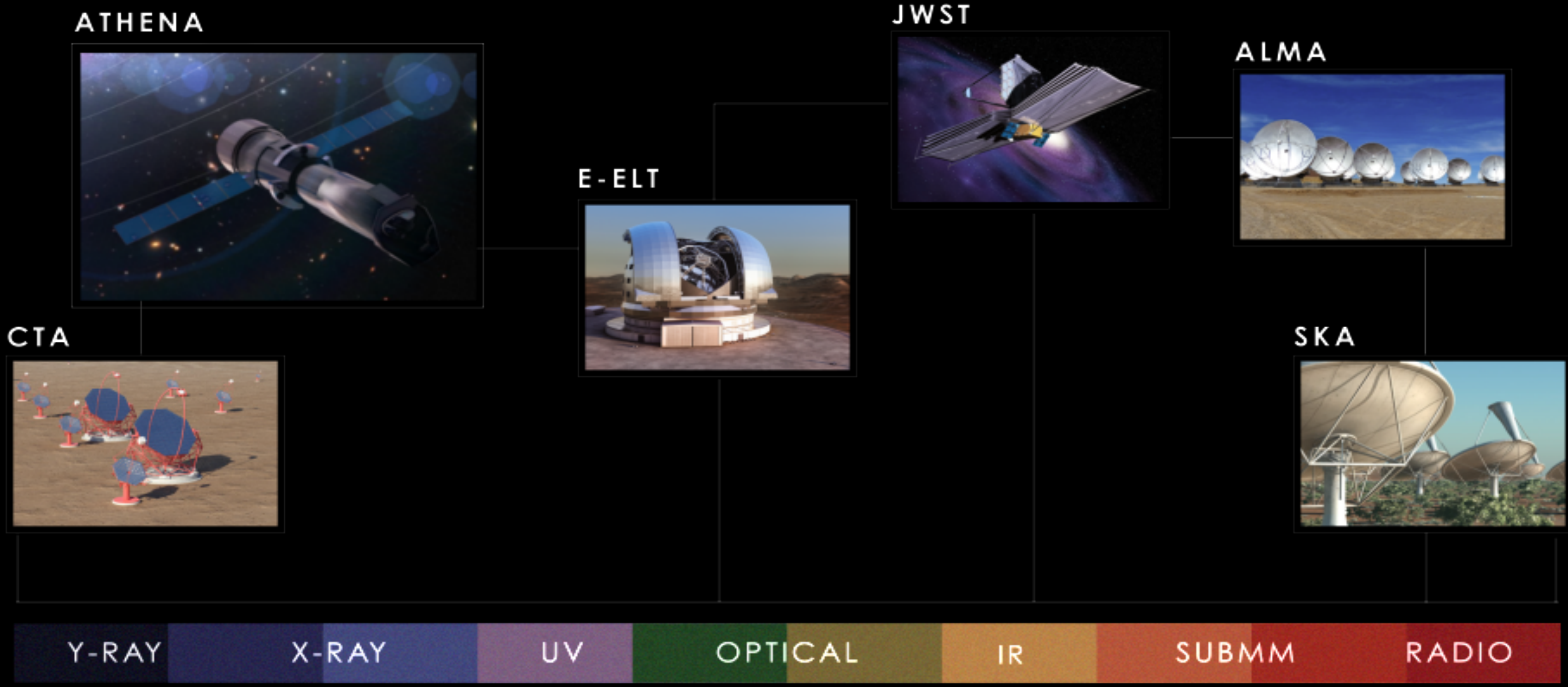
X-ray counterparts of GW mergers

Athena will detect them all



Troja,Piro,Ryan+18

Athena science in context



Athena is a crucial part of the suite of large observatories needed to reach the science objectives of astronomy in the coming decades

Athena science in context

Synergy with multi-messenger facilities undergoing

Athena is a crucial part of the suite of large observatories needed to reach the science objectives of astronomy in the coming decades

Outlook

- ✓ Athena is the evolution of Chandra and XMM with unique transformational capabilities
- ✓ The large X-ray observatory of the international community for the next 20 years
- ✓ Complement the suite of major class facilities at other ν's and multimessenger

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esa
Exploring the Hot and Energetic Universe:
The second scientific conference dedicated to the
Athena X-ray observatory
24-27 September 2018, Palermo, Italy
Credit: ESO/M. Kornmesser & ACO Team

end