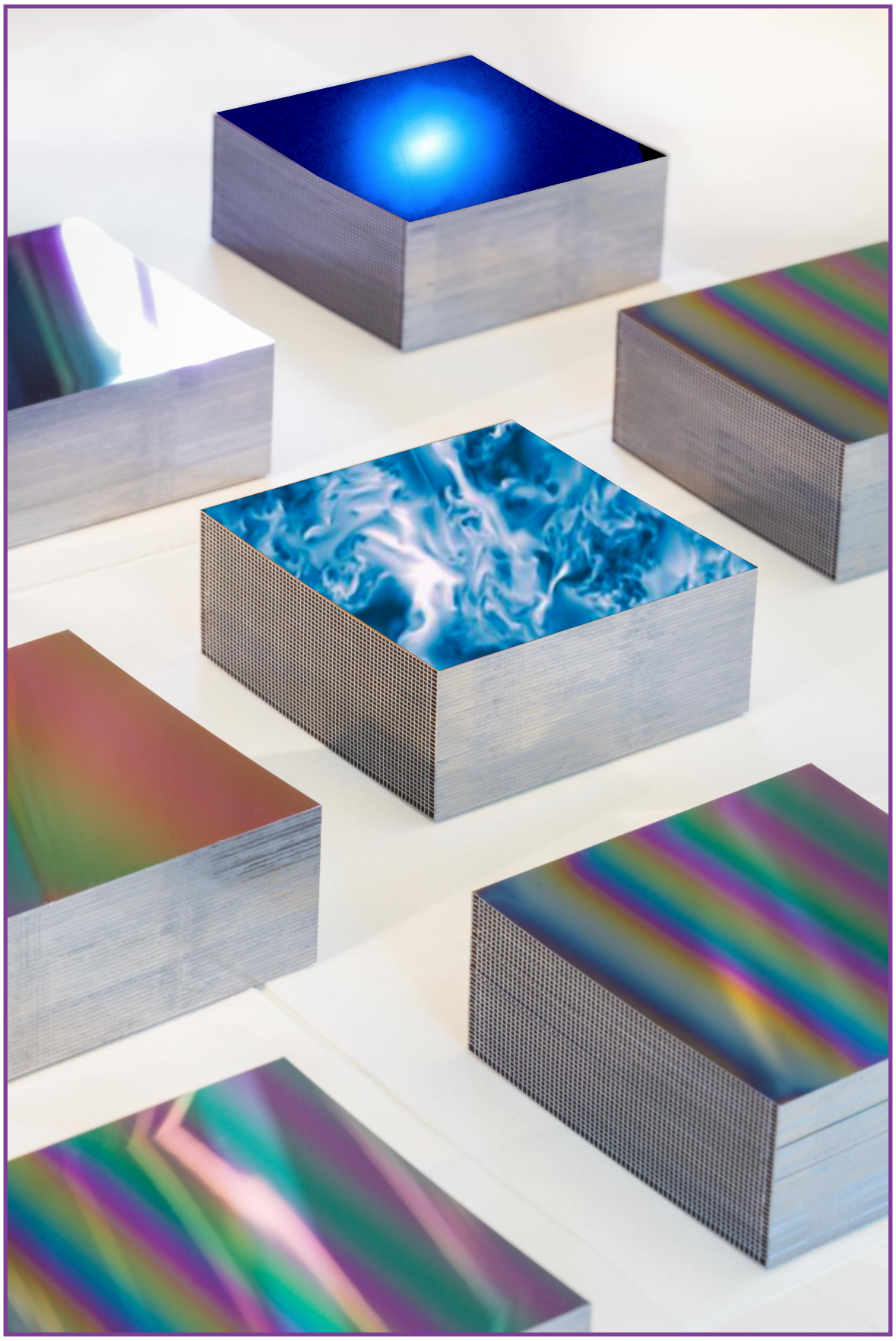
ATHENA: Community



Newsletter #6 December 2018

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*Front Cover image credits: Background image: Silicon pore optics stacks (Credit: cosine Research/ESA). Top image: *Athena* WFI image of a simulated Coma-like cluster at a redshift of 0.1. (Credit: WFI Team). Middle image: Cross-section of the total turbulent velocity magnitude (in km/s) for a turbulent ICM simulation in a massive Coma-like cluster (Credit: Gaspari et al. 2014).

Welcome

K. Nandra (ASST Lead Scientist) on behalf of the Athena Science Study Team (ASST)

It was a pleasure to see so many of the *Athena* community in September at our second scientific conference in Palermo. This was a great meeting, hosted by Salvo Sciortino and Laura Daricello in the historical surroundings of the Real Teatro Santa Cecilia. You can find a report on the conference in this edition of the newsletter, from Luigi Piro and the *Athena* Study Scientist Matteo Guainazzi, a Palermo native and indispensable tour guide. Apparently, Plato once said that Sicilians "build like they will live forever and eat like they will die tomorrow". Several of us can confirm at least half of this to be true.

A major development since the last newsletter has been the official recognition of the X-IFU and WFI instrument teams by ESA, via the Instrument Consortia Consolidation process. Further information on this and the instrument development is provided in the individual articles.

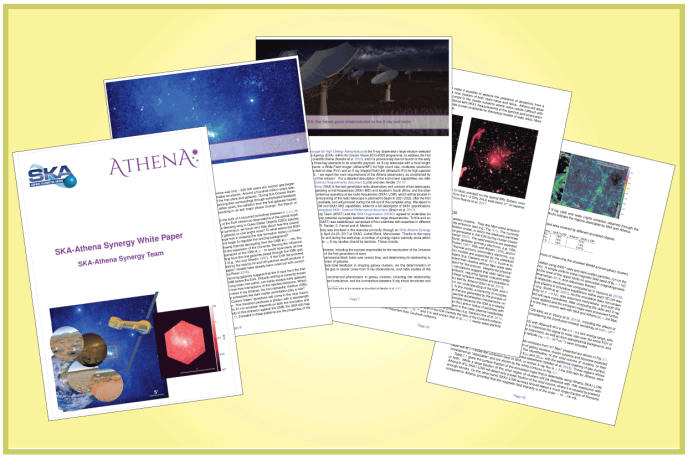
Our science highlight focusses on the outskirts of galaxy clusters. These huge structures pinpoint the nodes of the cosmic web, growing by accretion. Understanding this growth is one of *Athena*'s key scientific objectives. This, like almost all *Athena* science objectives, requires a proper understanding of the calibration, and the activities of the inter-calibration working group is the subject of an article by its co-chairs in this edition.

Our newsletter as usual features profiles of three prominent members of the *Athena* science team. If you too would like to join the *Athena* community, you will find an announcement of the latest call for memberships of the topical panels and working groups. The success of the mission depends critically on inputs from the science community - **please join us!**

SKA-Athena Synergy White Paper

Rossella Cassano (INAF-Istituto di Radioastronomia, Bologna, Italy)

The *Athena* Science Study Team (ASST) and the Square Kilometre Array (SKA) Organisation agreed to undertake an exercise to identify and develop potential synergies between both large observatories. The coordination of this exercise was assigned to the SKA-*Athena* Synergy Team (SAST: R. Cassano, R. Fender, C. Ferrari and A. Merloni) who, in close collaboration with experts of the astrophysical community produced the SKA-*Athena* Synergy White Paper. The White Paper was published (July 24th) and offered to the astronomical community (open access) as a resource to inspire the combined exploitation of *Athena* and SKA in early 2030s.



It describes in detail a number of scientific opportunities that will be opened up by the combination of *Athena* and SKA observations in a great variety of scientific areas, covering the following main topics:

» Tracing the history of cosmic structures thanks to SKA and *Athena* surveys.
» Understanding the feedback of active galactic nuclei in galaxy clusters.
» Studying non-thermal phenomena in galaxy clusters.
» Detecting both thermal and non-thermal emission of the cosmic web, to constrain its unknown physical conditions
» Unravelling the physics behind extreme accretion conditions in neutron stars and black holes
» Comprehending the nature of and mechanisms behind many Galactic objects (e.g. young stellar objects, ultracool dwarfs, star-planet magnetic interaction, massive stars, pulsars and supernova remnants).

The SKA-*Athena* White Paper is available at the arXiv website.

Athena Project Status

K. Nandra (MPE), D. Barret (IRAP) and M. Guainazzi (ESA) for the Athena Science Study Team

The *Athena* mission has recently passed some important milestones.

At system level, **Status Review 2 (SR2)** was successfully completed in October, ending Phase A1. This encompassed a review of the work done by the industrial primes during the Phase A1 extension, a large component of which was the study of a spacecraft concept with the current 15-row mirror configuration baseline. During the Phase A2, which follows next, responsibility for the design of the Science Instrument Module (SIM), which currently lies with ESA, will be handed back to the spacecraft primes. The Mission Formulation Review (MFR) that will signify the end of the entire Phase A is currently scheduled for Q4 2019, with mission adoption in Q4 2021. The implementation schedule is less certain, with optimization options still being investigated, and launch currently envisioned in the early 2030s.

As far as the instruments are concerned, the primary activities have been related to the **Instrument Preliminary Requirements Reviews (I-PRRs)**. These are first formal reviews of the instruments, which are co-chaired by ESA and the responsible lead funding agency. The WFI I-PRR, co-chaired by the German Space agency DLR, kicked off on September 19th this year, concluding successfully on October 31st 2018. Preparations for the X-IFU I-PRR, co-chaired by the French space agency CNES, are underway with kickoff expected January 18th 2019, and is expected to run until mid-April.

ESA has recently recognized the *Athena* instrument teams formally, via the so-called Instrument Consortium Consolidation (ICC).

At the heart of the *Athena* observatory are the X-ray optics. In terms of development activities, the main focus in 2018 has been on improving the angular resolution at 12m focal length. As part of this SPOHO (SPO HEW Optimization) technology development activity, optics at the median radius have been tested. Continuous and systematic performance improvement has been demonstrated since the start of SPOHO (summer 2017). The latest 12m stacks are already approaching the best performance achieved at 20m focal length. In July 2018, testing at BESSY and the MPE PANTER facility showed a PSF HEW of ~9 arcseconds over 70% of the SPO area. The next round of tests are expected in December 2018. The SPOHO activity features regular reviews, with the participation of two experts from the science community. The latest review was undertaken in August, while the next is due in January of next year. The SPO development program has also achieved an important milestone with the selection of the Assembly, Integration and Testing methodology. The selected method – based on indirect metrology in the UV similar to that employed in other X-ray missions such as XMM-*Newton* and eROSITA – has proven performance well exceeding the requirements.

Immediately after the 2nd *Athena* science conference (see the contribution by Piro & Guainazzi in this Newsletter), the ASST met in the beautiful surroundings of the Palermo Astronomical Observatory "Giuseppe Vaiana", with commanding views of the surrounding city and beyond. Extensive status reports had already been provided during the preceding conference, and the ASST meeting focused on issues such as updates to the Science Requirements and the status of the so-called Science Sensitivity Analysis. The latter involves an evaluation of the sensitivity of the core science objectives of *Athena* to a possible degradation of the mirror performance, as requested by the ESA Study Team. A more complete report on this exercise will be published in a future Newsletter. This ASST meeting also featured an extensive report from Francisco Carrera on the activities of the *Athena* Community Office (ACO) – who produces and distributes this Newsletter – whose efforts continue to be greatly appreciated by the ASST and, we hope, by the whole *Athena* community.

Despite the wonderful hospitality of our Palermo colleagues, and the extraordinary historical and natural attractions that this ancient capital offers, the next ASST meeting will return to its usual location at ESTEC, and has been scheduled for February 6th-7th. This agenda is expected to include extensive reports on the WFI I-PRR and the optics status, including the results of the latest SPOHO review.

The *Athena* Science Study Team (without D. Barret) gathers at the top of the "Giuseppe Vaiana" Observatory, during its meeting on September 27th/28th 2018. In the background, the 25-century old Sicilian capital, peacefully resting under the imposing Monte Pellegrino.

Fifth Announcement of Opportunity to join the Athena Community Working Groups/Topical Panels

Athena Science Study Team

Dear Colleague,

The mandate established by ESA to the *Athena* Science Study Team (ASST) includes serving "... as focus for the involvement of the broad scientific community" in *Athena*. In order to fulfil this duty, and to gain the needed support for the studies and development of the *Athena* mission, the ASST has established a structure of Working Groups (WG) and Topical Panels (TP), which has been populated via open calls to the community. The *Athena* Community currently consists of ~800 researchers from around the world participating in these WG/TPs. Full information about the terms of reference, structure and membership of the WG/TPs can be found here.

In order to offer new opportunities to join the *Athena* Community, a yearly call to serve in the WG/TPs will be issued. Applications are open to all researchers with appropriate background and a strong interest in scientific and technical matters related to the *Athena* mission, especially –but not only- to early career researchers.

Applications will be internally assessed by the ASST, with the help from the WG/TP chairs. Successful applicants will be appointed as members of a particular WG/TP.

Candidates fulfilling the above requirements and willing to join the *Athena* Community are invited to fill the following form (only one per applicant).

We expect applicants to apply for membership of one single WG/TP. In exceptional circumstances, the membership of two panels could be considered, but in this case, a strong justification needs to be provided.

The deadline for applications is **31 January 2019, 14:00 CET**. The expectation is that appointments to successful applicants will be issued within Q1 2019. Should you have any questions about this call, please contact the *Athena* Community Office.

Thanks for your support

News from the Instruments

News from the WFI

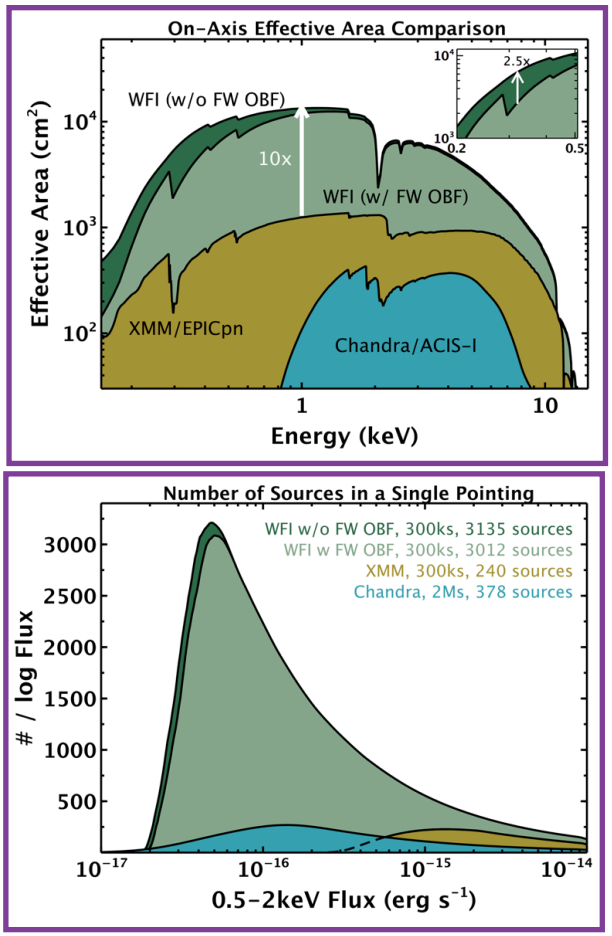
A. Rau (MPE, WFI Project Scientist) and K. Nandra (MPE, WFI Principal Investigator)

At the end of October, the WFI passed a critical milestone with the successful completion of the Instrument Preliminary Requirements Review (IPRR). The review was held jointly by ESA and the German Space Agency (DLR) over a period of six weeks and addressed important issues related to the instrument and the consortium. A substantial aspect of the IPRR was a review of the completeness, adequacy, and consistency of the flow down of the requirements into instrument system and subsystem specifications. In simpler terms, the review verified that the design and expected performance of the instrument match the scientific and technical requirements needed to achieve the WFI-related *Athena* science objectives. The conceptual design of the instrument and the compliance with the technical interface requirements (with the Science Instruments Module and within the WFI) were assessed and the design and development plans were examined. Emphasis was also put on ensuring compliance of the instrument schedule with the overall mission schedule. The successful IPRR concluded Phase A (Feasibility Study) of the instrument and officially started Phase B (Preliminary Definition). The next milestones are the Instrument System Requirements Review (~2020) and Instrument Preliminary Design Review (~2022).

The Instrument Consortia Consolidation (ICC) Process was completed just a few days ago with the official endorsement of the WFI Consortium by ESA.

The instrument and technology development activities are progressing steadily. The DEPFET pre-flight production at the Semiconductor Laboratory of the Max Planck Society is ongoing. This production run includes flight-size and flight-like 512x512 pixel sensors for the Large Detector Array as well as 64x64 pixel devices for the Fast Detector. Following a trade-off study based on an extensive test campaign using the output of the previous production run, the decision about the DEPFET readout mode was taken. The mode of choice (so called Drain Readout) will enable the required fast readout while ensuring an excellent spectroscopic performance.

The 8th WFI Consortium Meeting was held at the Faculty of Science of Lisbon University, Portugal on November 20th-22nd. More than 70 engineers and scientist celebrated the successful IPRR and discussed the next steps in the development of the instrument. One of the many points explored during the meeting was the option to observe with the WFI Large Detector Array without the optical/UV blocking filter in the Filter Wheel Assembly (see also *Athena* Nugget #23). This filter minimizes optical loading for observations of targets that are very bright in the optical/UV. However, for observations of fainter sources, the blocking of visual light provided by the entrance window of the DEPFET sensors should suffice, while providing higher quantum efficiency at soft X-ray energies. Scientists performing simulations of WFI observations that would benefit from an enhanced soft response are recommended to use the response files without the external filter.



WFI Figures of Merit showing the difference between observations with and without the optical/UV light-blocking filter in the Filter Wheel and in comparison to XMM-*Newton* and *Chandra*. Top: Effective Area as function of Energy. The improvement at soft X-ray energies is emphasized in the inset. Bottom: Number of sources detected in a single pointing as function of flux.

News from the X-IFU

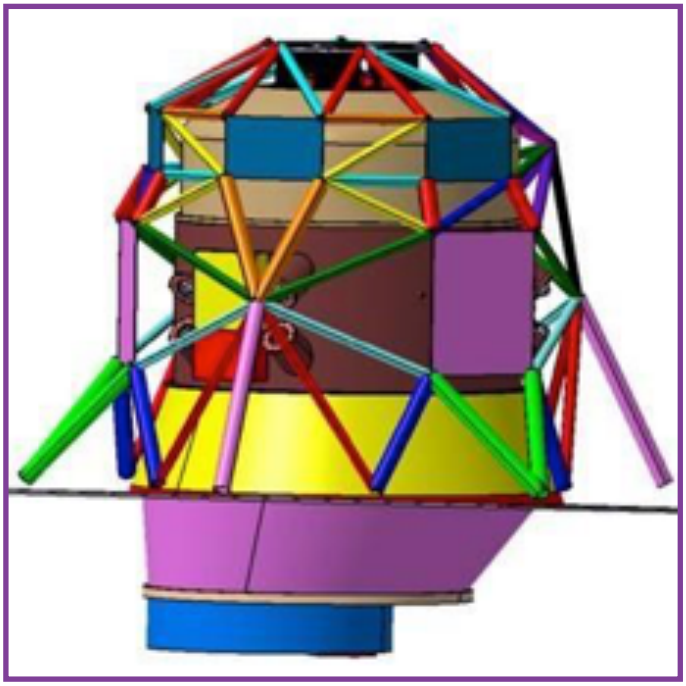
What's up with the X-IFU?

D. Barret (IRAP, X-IFU Principal Investigator)

The X-IFU consortium meeting #8 took place between September 10th and 15th and was hosted by the University of Geneva. It provided the opportunity to review the status of the X-IFU study, prior to the Instrument Preliminary Requirement Review (IPRR). In the same month of September, the X-IFU Consortium responded to the Instrument Consortia Confirmation (ICC) call, issued by ESA earlier in July. The ICC was an exercise focused mostly on programmatic issues, to ensure that the *Athena* lead funding agencies were ready to support the overall *Athena* study phase and related activities (e.g. technology demonstration) until mission adoption. The ICC was completed successfully leading to the formal appointment by ESA of the two instrument consortia to provide WFI and X-IFU for *Athena*.The ICC thus provided the opportunity to review and consolidate the contributions of the 13 countries participating or planning to contribute to the development of the X-IFU and its associated X-IFU Instrument Science Center, namely France, Netherlands, Italy, Belgium, Czech Republic, Finland, Germany, Ireland, Japan, Poland, Spain, Switzerland and United States. The Japanese hardware contribution, earlier limited to the procurement of the 4K Joule-Thomson cooler, was extended to the procurement of the 2K Joule-Thomson cooler, with an associated development plan agreed between JAXA, CNES and ESA. Czech Republic and Ireland are the latest countries willing to join the X-IFU Consortium. The Czech Republic hardware contribution is materializing around the procurement of data handling units for the instrument. On the other hand, the Irish contribution is supporting the development of the X-IFU science simulator.

The next milestone ahead of us is the IPRR, which is foreseen to take place early 2019. The whole consortium is currently active in getting the documentation required for the IPRR, while the practical details of the organization of the review have been agreed between CNES and ESA, which will Co-chair the review board. There is obviously much less design work on-going, as the baseline configuration of the instrument must be frozen in view of the upcoming IPRR. The remaining design activities focus primarily on the Dewar assembly for which an innovative truss like structure, surrounding the outer vessel is now considered to support mechanically some elements previously mounted directly on the outer vessel (e.g. electronics boxes). This approach is expected to be mass efficient, allowing us to lighten the outer vessel, while addressing simultaneously micro-vibration issues.

It is worth noting that at the end of Phase A, the baseline configuration of the X-IFU meets its top-level performance requirements (field of view, spectral resolution, count rate capability, background, target of opportunity response), and thanks to the latest round of optimization on some key components of the instrument (e.g. the physical and functional parameters of the Transition Edge Sensor array) performance margins do exist, which is an excellent prospect for the upcoming phase of the instrument development.



One of the options under study of the new truss structure of the X-IFU Dewar. Courtesy of the CNES project team.

Shaken and Stirred Galaxy Clusters Through Athena's Eyes

E. Bulbul[1], M. Gaspari[2], V. Ghirardini[1] and J. ZuHone[1]
1) Harvard- Smithsonian Center for Astrophysics, MA, USA, 2) Princeton University, USA

Galaxy clusters are metropoles of interconnected galaxies embedded in hot plasma atmospheres and dark matter halos.

As the largest organized structures of the Universe, they provide important clues on how structure forms and evolves in the deep, dark-matter potential wells. Located in the connecting knots of the cosmic web, they grow by accreting material from their surroundings.

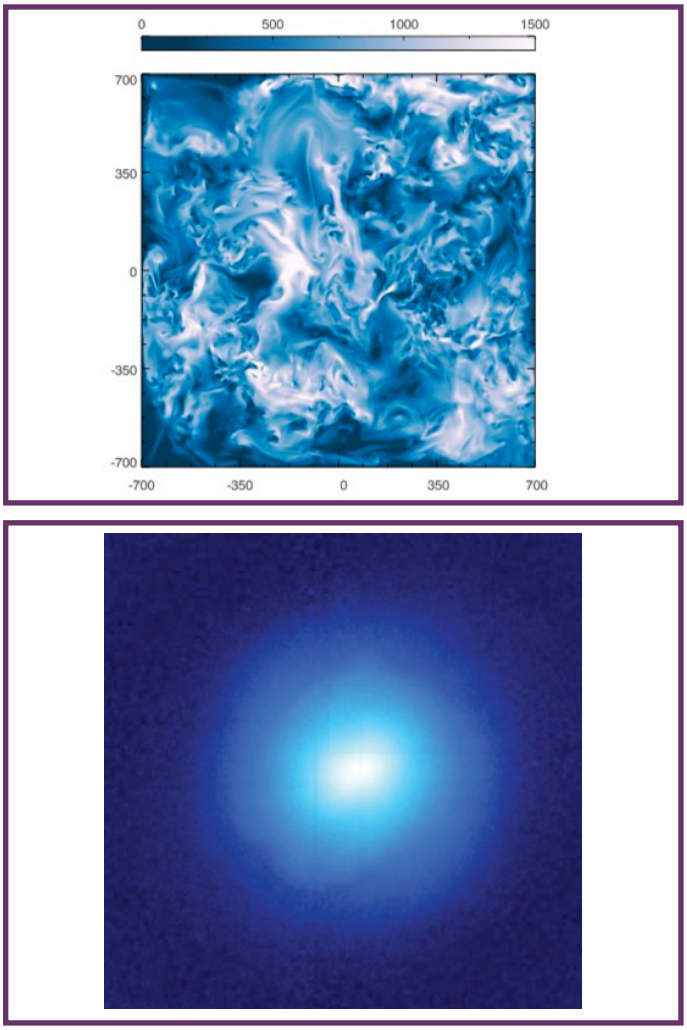
The pristine material accreting onto the cluster outskirts stirs the gas, generating plasma instabilities and increasing the total pressure within the cluster. While often neglected, such non-thermal pressure support (in particular in the form of turbulence) is a vital part of the galaxy cluster ecosystem.

The hot plasma found within clusters, i.e., the intracluster medium (ICM), primarily emits in the X-ray band and can be exquisitely detected with the *Athena* Observatory. Moreover, the electrons within the ICM interact with the cosmic microwave background in a phenomenon known as the Sunyaev-Zel'dovich (SZ) effect. Combined X-ray and SZ observations of cluster outskirts will provide key clues on how the structures in our Universe form and evolve.

Owing to its large effective area and superb spectral/spatial resolution, *Athena* will be the most sensitive X-ray telescope probing the faint suburbs of clusters. *Athena* X-ray Integral Field Unit (X-IFU) observations will provide direct measurements of the bulk and turbulent motions, which strongly shape the cluster outskirts. This can be done through the detection of X-ray line broadening and centroid shifts (e.g., highly ionized Fe).

At the same time, the *Athena* Wide Field Imager (WFI), due to its large field-of-view, will map the entire cluster in a single pointing and provide the most precise measurement of the variations in X-ray surface brightness generated by the turbulent and bulk flows from the surrounding cosmic web.

Together with the pressure fluctuations measured via SZ maps from ground-based radio telescopes (such as the South Pole Telescope, CMB-S4, CCAT-prime, and the Simons Observatory), *Athena* will provide groundbreaking information on the magnitude of turbulence, the level of thermal conduction, and energy transport mechanisms (e.g., sound waves versus buoyancy waves) in the cluster outskirts.



Top: Cross-section of the total turbulent velocity magnitude (in km/s unit) for a turbulent ICM simulation in a massive Coma-like cluster (Gaspari et al. 2014). Bottom: *Athena* WFI image of a simulated Coma-like cluster at a redshift of 0.1. Credit: Gaspari, M., Churazov, E., Nagai, D., Lau, E. T., & Zhuravleva, I. 2014, A&A, 569, A67

Athena inter-calibration working group

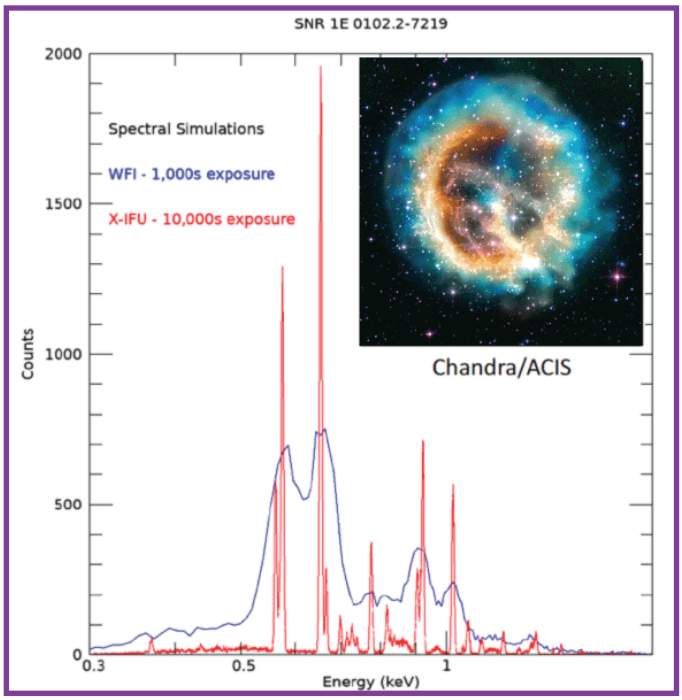
S. Sembay[1], V. Burwitz[2] and F. Pajot[3], 1) University of Leicester, United Kingdom, 2) MPE, Germany, 3) IRAP, France

The general purpose of calibration is essentially twofold: 1) to inform the mathematical model of an instrument used in calculating the instrument response used in science data analysis and 2) to quantify the uncertainty of our knowledge of the true instrument response compared with the model. The *Athena* telescope (mirror system plus instruments) essentially measures three things: 1) a signal proportional to the number of electrons or to the heat deposited by a photon (or charged particle) within a pixel of the detector, 2) the detector coordinates of the pixel the event occurred in and 3) the time of the event. The response of the instrument is essentially a set of probability functions which provide a prediction of the distribution of recorded signals for an ensemble of events with a given input energy and the distribution of detector positions for an ensemble of events with a given input direction relative to the telescope. Only the recorded time of the event has a one to one correspondence with the physical attribute of the input event, i.e. the arrival time. Calibration data is acquired from test campaigns on the ground in dedicated facilities and in-orbit from X-ray source signals which have known characteristics, e.g. emission lines at known energies.

In *Athena*, the responsibility for the ground calibration resides with ESA for the mirror system and the X-IFU and WFI instrument teams for the focal plane. The concept of inter-calibration is to have an advisory group (taken largely from ESA and instrument team members) that ensures that, taken as whole, the *Athena* calibration plan for all elements is sufficient to meet the science requirements of the mission and forms a coherent strategy.

The philosophy behind inter-calibration goes beyond the needs of a single mission. *Athena* is part of a long development of X-ray astronomy missions with overlapping capabilities. As instruments have become more capable in collecting power the uncertainty in interpretation of scientific results has tended to become ever more dominated by our knowledge error of the instrument responses (i.e. calibration) in each mission. Inter-calibration, or cross-calibration, is also the process by which different missions compare results and attempt to form a consensus view of the X-ray sky given that formally they can disagree when considering only the statistical component (due to photon noise) of the uncertainty of a given measurement.

The International Consortium for High Energy Calibration (IACHEC) is an advisory group formed from calibration experts from many X-ray and Gamma-ray current and future missions (e.g. *Chandra*, XMM-*Newton*, *Suzaku*, *Swift*, INTEGRAL, NuSTAR, XRISM and *Athena*) which explores various methods for studying the cross-calibration between missions and defining standardized analyses of reference sources (see Figure) which current, and future missions such as *Athena*, can use as an in-orbit calibration reference.



The SNR 1E 0102.2-7219 is used as a calibration standard in X-ray astronomy. The IACHEC spectral model of the whole remnant has been used to simulate Athena WFI and X-IFU spectra. The insert shows the Chandra/ACIS image of the SNR color-coded by energy.

The 2nd Athena scientific conference Sharpening the community view on the Athena science

L. Piro (IAPS/INAF), M. Guainazzi (ESA)

The 2nd scientific conference dedicated to the *Athena* X-ray observatory was held between September 24th and 27 in the historical framework of the Real Teatro Santa Cecilia in Palermo (Sicily). More than 200 participants discussed the science cases underpinning "The Hot and Energetic Universe" science theme, and the status of the mission that will make these cases a reality.

The scientific program featured 41 invited and solicited talks, and 31 contributed talks. The latter were selected from a total of 110 oral contribution requests. This large over-subscription factor is a clear signature of the great interest that this scientific event has arisen in the high-energy community at large.

The conference was introduced by the Director of Science of the European Space Agency, prof. Günther Hasinger, who stressed that the ESA Science Program shall adapt to the new scientific opportunities offered by the advent of the "multi-messenger astrophysics". He envisions that the science program shall be adequately funded to ensure that the future ESA L-class missions can be operated as close as possible, to ensure the full potential of high-energy astrophysics and gravitational waves in studying black hole growth and cosmological evolution. The potential synergies of *Athena* with ground-based (CTA, ESO, SKA, VIRGO and LIGO) and space-borne facilities (Juice, LISA, THESEUS) were a central point of discussion across the whole meeting.

The main part of the conference was devoted to updating of the state of the *Athena* science objectives, outlined in a series of talks given by the *Athena* Topical Panels. While it would be impossible to provide in this short article a fair picture of the wealth of new results strengthening the need for the capabilities provided by *Athena*, we dare providing here a few examples: the first unambiguous detection of the signatures of the Warm Hot Intergalactic Medium in an extra deep observational campaign with XMM-*Newton* (Nicastro), proving the existence of this so far elusive component of the "missing baryons", advocates for *Athena* to study its cosmic variance via absorption spectroscopy, and its physics with emission spectroscopy; the analysis of the combined XMM-*Newton*/RGS and *Hitomi* spectrum of the Perseus Cluster (Simionescu) provides new constraints on supernova nucleosynthesis that highlight once again the transformational power of micro-calorimeter spectroscopy in addressing the cosmological evolution of large-scale structures; and the latest results on the spectral and timing properties of the X-ray afterglow of the neutron star coalescence event triggering GW170807 (Troja), who also outlined the unique capabilities of *Athena* in the multimessenger era.

All the presentations given at the conference are available at the following link of the *Athena* Community Office document repository.

This highly successful and enjoyable event would have not been possible without the extraordinary efforts of the Local Organizing Committee. The whole *Athena* Science Team owns a debt of gratitude to its members, in particular to Prof. Salvatore Sciortino and Dr. Laura Daricello. A generous sponsorship by AHEAD greatly contributed to the success of the conference.

Athena Community People

Aya Bamba

bamba@phys.s.u-tokyo.ac.jp

Aya works on X-ray astronomy in the University of Tokyo, Japan, as an associate professor.

Her main major is studying thermal and non-thermal properties of supernova remnants, which distribute heavy elements and cosmic rays into the interstellar space, or, other words, create the diverseness of the Universe.

The most recent work is examining the explosion isotropy of the remnants using *Hitomi* SXS spectroscopy and *Chandra* imaging spectroscopy. Aya also works on the measurement of cosmic ray acceleration/escape efficiency on shocks of supernova remnants.

On *Athena*, she is co-chair of the topical panel SWG 3.4 The astrophysics of supernova remnants and the interstellar medium.

Aya really loves beautiful X-ray images of supernova remnants, which contains not only "the end of a world" but also "the beginning of the story for the next generation stars".

Massimo Cappi

massimo.cappi@inaf.it

Massimo is a Senior Researcher at the Astrophysical and Space Science Observatory (OAS) of the National Institute of Astrophysics (INAF) in Bologna, and currently head of the High-Energy Astrophysics Division of INAF. Starting next January 2019, he will also be a member of the ESA Astronomy Working Group.

His research is focused on the study of high-energy observations of Active Galactic Nuclei (AGN) to understand how supermassive black holes in galaxies form, evolve, and accrete and eject matter along cosmic time. In particular, he has been deeply involved in probing and understanding the existence and characterization of massive, relativistic outflows (aka Ultra Fast Outflows) in nearby AGN and more distant quasars.

His primary focus today is to use XMM-*Newton* to understand better UFOs and as pathfinder for more detailed studies with *Athena*.

On *Athena*, he is currently chair of the X-IFU Science Advisory Team (XSAT) and co-chair of the Science Working Group 2 (the one for the Energetic Universe), and looking forward to playing a bit with new exciting high energy resolution XRISM and, of course, *Athena* spectra.

Jelle Kaastra

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Jelle is an X-ray astronomer based at SRON-Utrecht in the Netherlands, and holds a second affiliation at Leiden University.

After obtaining his PhD on Solar flares at Utrecht University he started working on X-ray spectroscopy of active galaxies and clusters of galaxies at SRON-Leiden. Together with Rolf Mewe he developed the SPEX spectral analysis package. Making the plasma models and atomic data in this software ready for *Athena* is presently one of his major challenges.

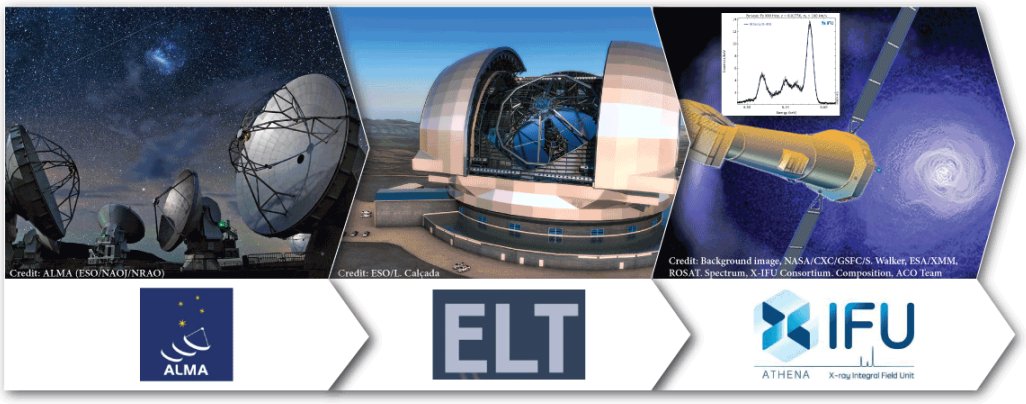
One of his most recent astrophysical interests are the complex, shielding outflows from active galaxies. Disentangling complex spectra is one of his favourite activities.

He is currently co-chair of the *Athena* working group SWG 1.4 on the WHIM and member of the X-IFU Science Advisory Team.

Conferences (January-July 2019)

Athena in Conferences

- 233rd meeting of the American Astronomical Society, Seattle (USA), 6 –10 January.
- X-ray Surveys of the Hot and Energetic Universe, Harbin (China), 14-19 January.
- 12th INTEGRAL conference: 1st AHEAD gamma-ray workshop, Geneva (Switzerland), 11-15 February.
- HEAD 17th Divisional Meeting, Monterey (California), 17-21 March.
- The New Era of Multi-Messenger Astrophysics, Groningen (Netherlands), 25-29 March.
- The Space Astrophysics Landscape for the 2020s and Beyond, Potomac (USA), 1-3 April.
- Supermassive Black Holes: environment and evolution, Corfu (Greece), 19-22 June.
- EWASS 2019 (European Week of Astronomy and Space Science), Lyon (France), 24-28 June:
  - » SS31: 3-D spectroscopy from sub-mm to X-ray: the promise of *Athena* in the 2030s multiwavelength context.



- XCalibur 2019 - High resolution X-ray spectroscopy as a probe of strong gravity and dark matter: From *Hitomi* to XRISM and beyond to *Athena*, Southampton/Winchester (United Kingdom), 15-18 July.

Coming conferences of interest

- Extremely big eyes on the early universe, Los Angeles (USA), 28-29 February.
- 1st Science Symposium, Exploring the High-Energy Universe with CTA, Bologna (Italy), 6-9 May.
- IAU Symposium 352: Uncovering early galaxy evolution in the ALMA and JWST era, Viana do Castelo (Portugal), 3-7 June.
- 234th meeting of the American Astronomical Society, St. Louis (USA), 9-13 June.
- XMM-*Newton* Science Workshop 2019: Astrophysics of Hot Plasma in Extended X-ray Sources, ESAC (Spain), 12-14 June.