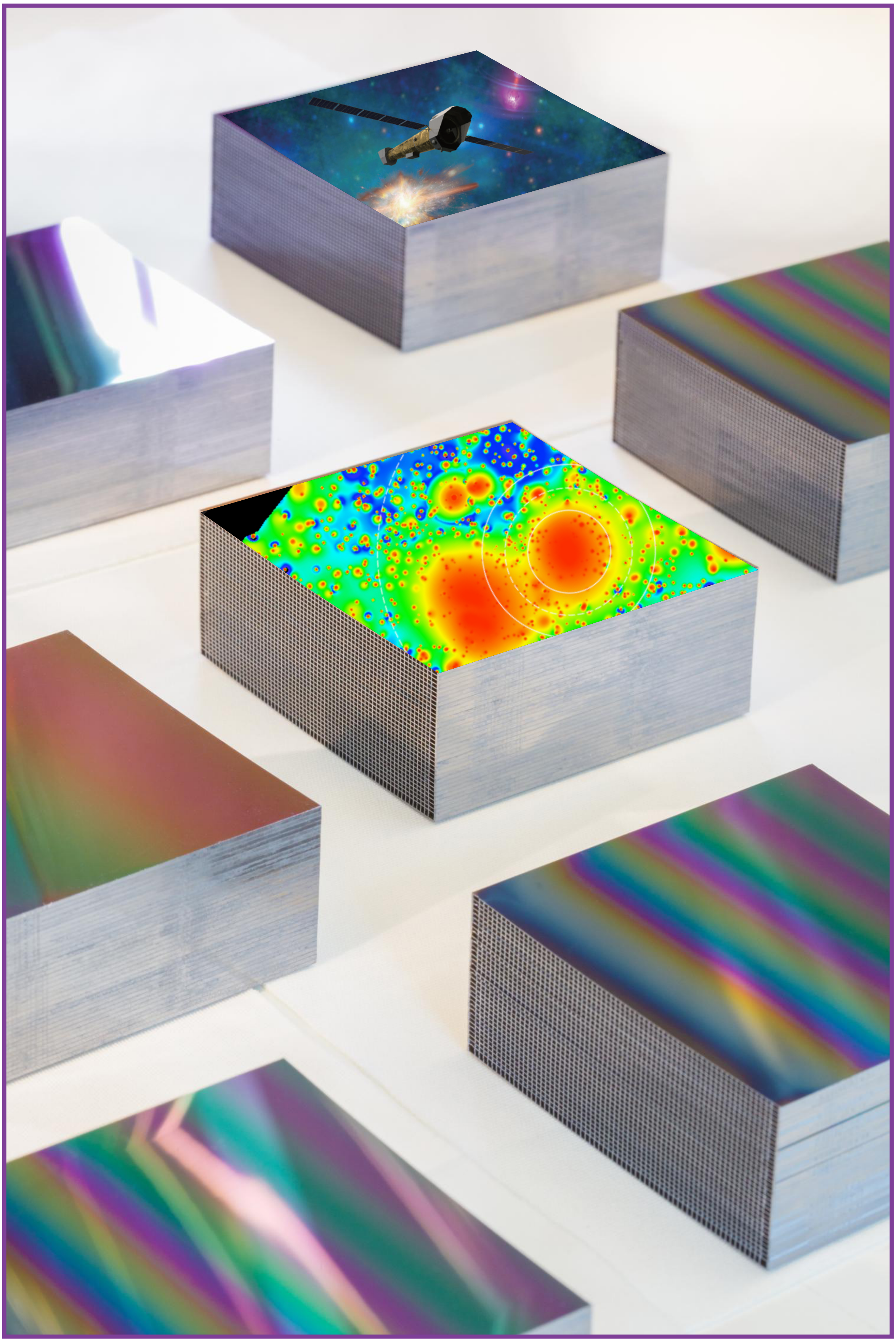
ATHENA Community



Newsletter #9

January 2022

Contents

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*Front Cover image credits: Background image: Silicon pore optics stacks (Credit: cosine Research/ESA). Top image: it is a subset of the artistic view of *Athena* and transients events shown in the technical nugget of this newsletter (see page 9 for details and credits). Middle image: wavelet-filtered eROSITA image of the A3391/95 system presented with a color scaling to highlight faint regions (~15 Mpc at the cluster redshift from the upper right corner to the lower left corner). (c) Reiprich et al. (2021), *Astronomy & Astrophysics, 647, 2*

Welcome

Francisco J. Carrera (ACO Director)

This Newsletter heralds an exciting year for the *Athena* mission, with the payload and SIM Requirement Reviews (RR) in Q1-Q2 2022, the Mission and Spacecraft System RR in Q2-Q3 2022 and the Definition Study Report (a.k.a. Red Book) due at the end of 2022. This long process paves the way to the decision on the "Adoption" of the mission in the ESA Science Program at the February 2023 meeting of the Science Program Committee. The *Athena* Science Study Team, the Instrument Consortia, the Athena community and our international partners, NASA and JAXA, are already working hard towards these milestones.

The continuing COVID-19 crisis has not stopped the vigorous technical and scientific development of the mission, supported by the more than 1000 members of the *Athena* community, which we seek to enlarge even more with a new call for members. The 3rd *Athena* conference in Barcelona (7-10 November 2022) will be an excellent occasion to showcase the transformational science that *Athena* will deliver in the facility-rich environment of the 2030s. then onto MAR. In all this, the contribution of our international partners, JAXA and NASA, presented in this instalment, is fundamental and greatly appreciated.

Two examples of the revolutionary capabilities of *Athena* are highlighted in the nuggets of this issue. *Athena* will have excellent capabilities to follow-up Target-of-Opportunity events, allowing it to play an essential part in the quest to understand the transient and variable Universe. At the other end of the size, mass and timing ranges, *Athena* will open new perspectives into the growth and physics of the large structures in the Universe.

We hope that you enjoy your reading.

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

The yearly call to join the *Athena* Community is open to all researchers with appropriate background and a strong interest in scientific and technical matters related to the *Athena* mission. Early career researchers are particularly encouraged to apply. Candidates fulfilling the above requirements and willing to join the *Athena* Community are invited to fill this form (only one per applicant).

The deadline for applications is **15 February 2022, 14:00 CET**.

Latest news

Silvia Martínez-Núñez (ACO Manager)

In this section, we would like to draw your attention to the latest news:

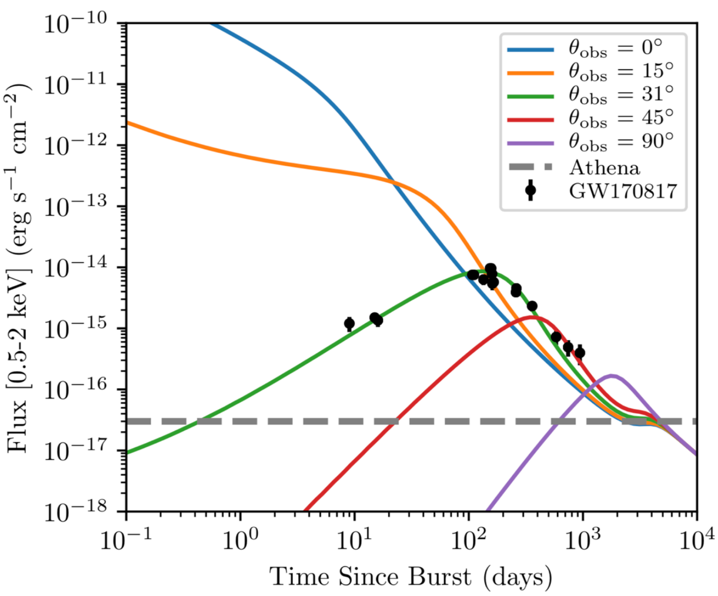
- The "*Athena* X-ray Advances: ASST & ACO Science Webinars" start next Monday 31st of January at 15 CET with a seminar by Hendrik van Eerten: Revealing the physics of multi-messenger events using X-ray observations. Each webinar in the series will be broadcast via Zoom Webinars. The programme of the first block of this series is accessible at the dedicated webportal here.
- In the general interest category of the *Athena* repository, you can find documents of interest for your work in the *Athena* project. Some recent additions include technical notes on the updated *Athena* extragalactic and total cosmic backgrounds, and the spectrum-weighted and field-of-view-averaged point spread function.

The *Athena* multi-messenger synergy White Paper

Luigi Piro (Athena Science Study Team, INAF/IAPS)

Recent years have witnessed a blossoming of multi-messenger astrophysics, in which gravitational waves (GW), neutrinos, and photons provide complementary views of the universe. The astounding results obtained from the joint electromagnetic-gravitational wave observations of the compact binary merger GW170817 or from the neutrino-electromagnetic (EM) observations of the blazar TXS 056+056 showed the tremendous discovery potential of this field, that will be progressively exploited throughout the next decade, as observing facilities are deployed. A substantial step forward can be expected by the early 2030s, when the second and third generations of GW and neutrino detectors will become operational. A full exploitation of the potential of multi-messenger astronomy demands capabilities in the X-ray band that are beyond those achievable by current and near-future missions, but consistent with the performance planned for *Athena*. For example, population studies of X-ray counterparts to GW mergers at the distances probed by the next generation of GW detectors require an X-ray sensitivity that only *Athena* can provide.

The multi-messenger-*Athena* Synergy Team has been tasked by the ASST to develop the scientific synergies between *Athena* and some of the key multi-messenger facilities that should be operative concurrently with *Athena*. These facilities include LIGO A+, Advanced Virgo+ and future detectors for ground-based observation of GW, such as Einstein Telescope and the Cosmic Explorer, LISA for space-based observations of GW, IceCube and KM3NeT for neutrino observations, and CTA for very high energy observations. Most of the sources targeted by multi-messenger facilities are transient. Synergy with wide-field high-energy monitors were therefore also studied, assuming a THESEUS-like mission, i.e. an experiment based on Lobster-eye mirrors, a broad-band X- and γ-ray monitor, a 70-cm class IR telescope, and spacecraft fast autonomous repointing capabilities. This study has been recently published in a White Paper in arXiv. Pressing issues in the field of astrophysics, cosmology and fundamental physics are covered such as: the central engine and jet physics in compact binary mergers, accretion processes and jet physics in super-massive binary black holes and in compact stellar binaries, the equation of state in neutron stars, cosmic accelerators and the origin of cosmic rays, the origin of intermediate and high-Z elements in the Universe, the cosmic distance scale and tests of general relativity and the standard model. Observational strategies for implementing these science topics are also discussed. Among the numerous and exciting science topics, we present in the figure one example related to *Athena* observations of binary mergers from ground GW interferometers.



X-ray light curves for a GW170817-like event, demonstrating the diversity of observable off-axis afterglow light curves. A fiducial *Athena* sensitivity of 3×10^{-17} erg s^{-1} cm^{-2} in the 0.5-2 keV energy band is adopted. *Athena* will allow to extend the merger population studies up to z ~ 1 (the range of the third-generation GW detectors, like Einstein Telescope and Cosmic Explorer) for neutron star mergers, if the jet viewing angle is within ≈ 15 deg. Likewise, jets pointing in the orthogonal plane, can be observed up to ~ 100 Mpc.

Rubin-*Athena* synergy status

Mike Watson (Leicester University)

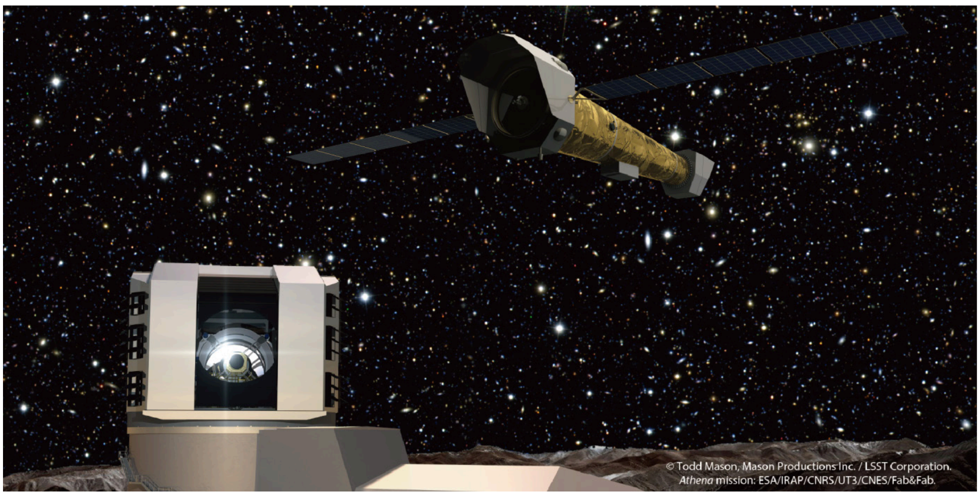
The *Athena* project has organised a number of synergy exercises over the last few years, designed to explore the ways that *Athena* can work with other global astronomical facilities operating in the coming decades, to enhance the science that can be achieved. The first was the ESO-*Athena* synergy exercise, followed by the SKA-*Athena* and Multi-messenger-*Athena* ones (cf. the contribution by Luigi Piro in this Newsletter). The latest in this series of synergy exercises started in late 2019 when a core team was set up to look at synergy between the Vera C. Rubin Observatory and *Athena*.

The Vera C. Rubin Observatory, previously referred to as the Large Synoptic Survey Telescope (LSST), is an astronomical observatory currently under construction in Chile. Its main task will be an astronomical survey, the Legacy Survey of Space and Time (LSST). The Rubin Observatory is a wide-field telescope with an 8.4-metre primary mirror that will image the entire available sky every few nights. It will provide an optical survey of the sky with unprecedented breadth and depth, coupled with multiple imaging providing a crucially important time-domain capability. Survey operations are scheduled to start in 2024.

We planned a workshop to explore synergy between *Athena* and Rubin in detail and were all set to hold the meeting in-person in May 2020 at MPE, Garching. Unfortunately, the global pandemic forced us to postpone the meeting, hoping that the situation would soon improve. In the end it became clear that holding an in-person meeting was going to be problematic for an extended period of time, so we decided to move to an online virtual workshop which finally took place in April 2021.

The workshop proved to be very successful, despite the restrictions of the online format. The meeting was attended by more than 60 enthusiastic participants from both sides of the Atlantic and representing both the *Athena* and Rubin communities. Organised over 5 days, each day was devoted to a different science area: clusters, AGN, galaxies, stars/stellar systems and transients, and featured both excellent invited talks from leaders in their fields and dedicated parallel discussion sessions aiming at distilling the key science questions that can be pursued using both Rubin and *Athena* data. The science discussed ranged from cosmology with clusters, through AGN demographics, extreme stellar systems and transient systems of all types, often revealing synergies that had previously not been appreciated. Of particular note was the discussion of the exciting possibilities offered by the Rubin survey's time-domain capabilities, for example in identifying and studying tidal disruption events and kilonovae, but there were a host of other highlights.

The formal output of the Rubin-Athena synergy exercise is a white paper highlighting the key science that can be tackled by using both facilities in concert. The white paper is planned to be published in 2022, in time for the upcoming Athena Mission Adoption Review.



Artistic representation of Vera Rubin Observatory and *Athena*

Athena study status

Matteo Guainazzi (ESA Study Scientist), Didier Barret (X-IFU PI), Kirpal Nandra (WFI PI)

The *Athena* Study is in Phase B1. This is a "definition phase", aiming at the convergence between the scientific requirements and a mission design that is affordable in terms of resources, cost and schedule. The process will be completed with the formal "Adoption" of *Athena* into the ESA Science Program, marking the start of its implementation. This key gateway is scheduled for the February 2023 meeting of the ESA Science Program Committee. The next milestones are the System Requirement Reviews for the instruments (first half of 2022) and for the spacecraft and Science Instrument Module (SIM) (to be closed by summer 2022). They will provide inputs for the final Mission Adoption Review, whose Board is expected in November 2022.

In 2021, *Athena* successfully passed two important gateways: the "Intermediate Reviews" for the spacecraft, and for the SIM. The Board of the latter unveiled a risk of mass noncompliance in the design of both industrial Primes. This led to an intense phase of activities in industry, at ESA and in the Instrument Consortia to identify additional resources and optimization options at all levels (spacecraft, SIM, instruments). The hard work of a cohort of scientists, engineers and technicians has been eventually rewarded: in November 2021, ESA announced that the mass risk was solved, in large part thanks to the increase of the lift-off capability of Ariane 6. Even more importantly, this result has been achieved, with almost no impact on the ultimate scientific performance of the mission. The instrument optimizations introduced through this exercise constitute important steps to strengthen the reliability of their design (cf. the reports by the Instrument Consortia in this Newsletter).

The development program of the optics continues according to schedule on all fronts: the manufacturing of a set of representative mirror modules for the qualification of the mirror assembly demonstrator and the verification of the optics performance prior to Adoption; the flight qualification of the mirror assembly; the integration, validation, and calibration facilities (cf. the NASA report in this Newsletter on the on-going work at the Marshall Space Flight Center X-Ray Calibration Facility). Vibration tests on mirror modules at all radii, and shock tests on mirror modules at inner and middle radii have been successfully performed.

The latest measurements of the angular resolution on a 34-plate stack (November 2021) show a Half Energy Width (HEW) of about 8" (6.9") over the 100% (70%) of the plate area, corresponding to a 2.4" improvement with respect to similar stacks measured just a few months earlier. Such a pace of improvement yields optimism that performance closer to the nominal requirement (5") can be demonstrated prior to Adoption[1]. However, these measurements still refer to a configuration different from the reference one to be used at Adoption. ESA has therefore warned the ASST that the risk exists that performance not better than 10" could be considered for the presentation of the Athena science case in the Red Book. The ASST has therefore decided to undertake a study on the optimal scientific usage of the *Athena* scientific payload at 10" HEW, with particular focus on the implications for the WFI survey strategy. This study shall be completed in March 2022, and will constitute one of the inputs that the ASST will use to decide how to present the *Athena* science case in the Red Book.

ESA has also recently announced the flight qualification of Ir coating. The qualification of the two bi-layer options still under study – Ir+SiC and Ir+B4C – is ongoing, with the ultimate selection to be carried out in the first quarter of 2022. The coating machine installed at the industrial Prime is also able to support "multi-layer" coating, recommended by the ASST to compensate for the shortfall of the predicted effective area at 7 keV with respect to the nominal requirements. This noncompliance is about 40%, following the latest estimates of the mirror effective area and instrument efficiencies. Despite that, ESA has recently communicated that multi-layer coating shall not be assumed as a baseline for the Red Book.

[1]ESA requires the performance to be demonstrated on a coated mirror module corresponding to a middle row of the mirror structure, with optimised parameters as recommended by the *Athena* Science Study Team (ASST), most notably a membrane thickness of 110 µm and a rib pitch larger than 2.3 mm.

The ASST has been closely following this intense phase of the Study, adapting the schedule for the preparation of the Red Book and the associated Special Issue of Astronomy and Astrophysics to the continuously changing boundary conditions. The corresponding milestones look now as follows:

Red Book preparation milestones

- May 2022: the ASST defines the Table of Contents of the Red Book, as well as the list of expected contributions by each Topical Panel.
- June 2022: ESA and the Instrument Consortia deliver payload responses for the Red Book simulations.
- July 2022: The *Athena* community (ASST and Topical Panels) starts working on the Red Book.
- 24 December 2022: the ASST delivers the Red Book to ESA.

A&A Special issue milestones

- ≤15 November 2022: delivery of the first draft of the A&A Special Issue papers.
- ≤15 December 2022: the ASST completes an internal review of the A&A Special issue draft papers.
- ≤31 January 2023: submission of the Special Issue papers to A&A.

News from the instruments

News from the WFI

Arne Rau (WFI Project Scientist), D. Coutinho (MPE, WFI System Engineer), Kirpal Nandra (PI)

The WFI is progressing steadily towards its next major milestone, the upcoming Instrument System Requirements Review (I-SRR). As its name suggests, the purpose of the review, which is being organized by ESA and will be held in March 2022, is to ensure that the WFI requirements are complete, consistent and fully defined. The I-SRR, together with a dedicated Technology Readiness Assessment (TRA) later in 2022, will provide important inputs towards the Athena Mission Adoption Review. In preparation for the I-SRR the team, together with ESA colleagues, performed a review of the User Requirements. The WFI continues to meet its top-level requirements, in particular with regard to instrument efficiency, field of view, spectral resolution, and bright source capability.

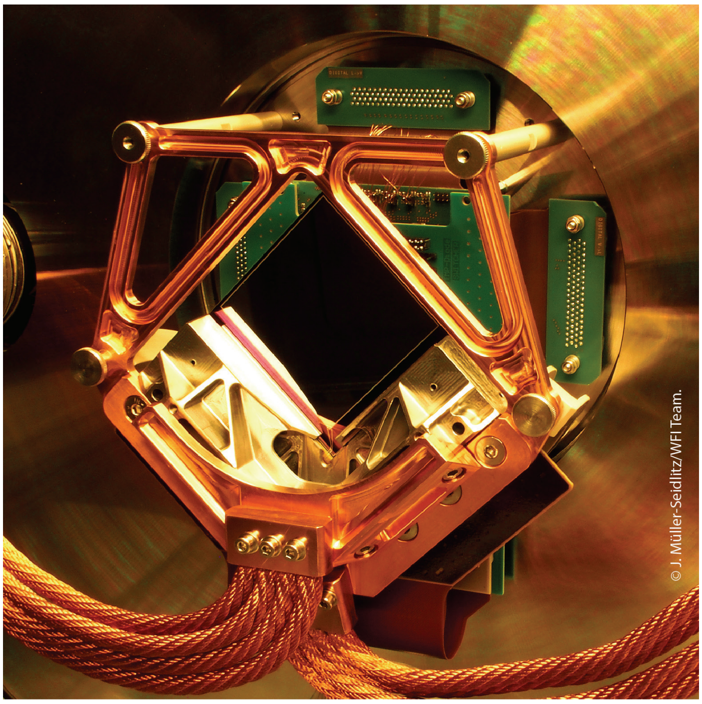
Besides preparing the documentation for the I-SRR, the main focus of the WFI consortium has been the continuation of the steady progress on the most critical technology development activities, in preparation for the TRA. The TRA will focus on three main areas, the detector system (including DEPFETs, control and readout ASICs, and bond wires), the optical blocking filter in the Filter Wheel, and the graphene thermal straps.

After some early complications with the very first full-scale 512×512 pixel DEPFETs for the WFI Large Detector Array (LDA), a sensor matrix delivered by the Semi-Conductor Lab of the Max Planck Society in June is currently in operation at MPE and is undergoing test and validation. The vibro-acoustic and mechanical vibration tests of the optical blocking filter were successful. Representative thermal straps, required to ensure stable and operation temperatures for the DEPFETs and front-end electronics, have been designed and manufactured by industry and will now be tested at MPE.

The first fully-representative 64×64 pixel WFI Fast Detector (FD) DEPFETs have also been assembled and tested. These show excellent spectral performance (129 eV FWHM at 5.9 keV). While similar results have been reported for earlier 64×64 pixel DEPFETs, the new FD prototype provides for the first time the full functionality required, including readout in two hemispheres to enable the frame rate of 12500 per second, as well as windowing mode. The science enabled by the FD was the focus of a recent study by the ASST, who confirmed this as an integral part of the *Athena* case overall. The FD will cover a unique parameter space for studying accreting compact objects, estimating stellar mass black hole spin, disk-jet-interaction and the structure of the corona in X-ray binaries and AGN.

A further activity over the summer was the investigation of possible mass-saving options, as requested by ESA. This was successfully concluded without any impact on the scientific capabilities of the WFI.

In December 2021 the WFI consortium welcomed its newest member, the Czech Republic. The Astronomical Institute of the Czech Academy of Sciences (ASU) will provide the Galvanic Isolation Module, which provides the primary power supply interface between the WFI Detector Electronics and the spacecraft power distribution system. Among other things, it generates the secondary supply voltages for the Detector and Frame Processor Module.



Athena/WFI detector module mounted in a vacuum chamber. The sensor's entrance window is surrounded by the copper mounting and cooling interface. The full scale DEPFET sensor and the detector electronics are cooled separately to different temperatures.

News from the X-IFU

Didier Barret, X-IFU Principal Investigator (IRAP, France) @DidierBarret, Vincent Albouys, X-IFU Project Manager (CNES, France) @VincentAlbouys

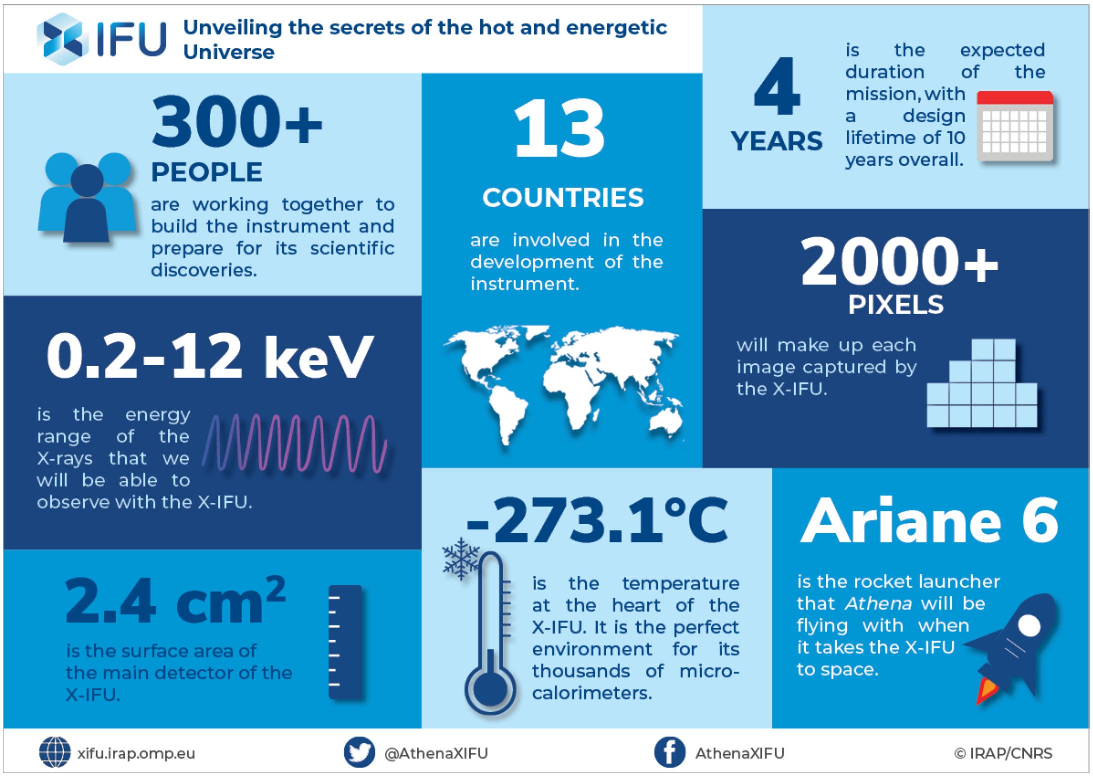
Since the last issue of the *Athena* newsletter, the X-IFU cryostat and cooling chain have been studied, as components of the *Athena* Science Instrument Module (SIM). The studies are supervised by ESA and conducted by two Primes: Airbus Defence and Space (Toulouse, France) and Thalès Alénia Space (Cannes, France). Providing inputs to the two Primes in a timely manner has required a major effort from the X-IFU team, ensuring that key elements of the instrument, e.g. the 2K core, have properly defined interfaces with the cryostat.

The first round of activities, concluded by the intermediate review of the SIM, indicated that both Primes had a SIM/cryostat design able to accommodate X-IFU. On the other hand, the review identified a risk that the mass of the SIM may be exceeded by 200 kg. The ESA study team thus requested the X-IFU team to propose mass reduction options. The X-IFU team took up the ESA request with the objective of simplifying the instrument.

Of all the simplifying options considered, the one leading to the reduction of the overall number of readout channels from 96 to 72 was retained. For an unchanged multiplexing factor of 33, this led to reducing the number of image pixels from 3168 to 2376. To preserve the field of view of the instrument, the pixel pitch was increased from 275 µm to 317 µm. Projected on the sky, 317 µm corresponds to ~5.4”, a value commensurable with the required angular resolution of the optics. This instrument simplification is performance neutral, with respect to the spectral resolution, quantum efficiency, and background. Similarly, the count rate capability requirements are still exceeded, yet with a modest reduction of the margins.

This new baseline will now be assumed for the Instrument System Requirement Review that will span from April to June 2022. This review shall address the flow down of the requirements to the various subsystems of the instrument and confirm its critical interfaces with the cryostat and the SIM. It shall also describe a preliminary design of the X-IFU, a preliminary verification program and list the major risks and their mitigation strategies.

The X-IFU Consortium met virtually twice in July and November. These meetings remain the central point for the whole team (about 300 members at this time) to get updated on the instrument development, its science, and Consortium activities. At Consortium level, we are performing a life cycle assessment of the X-IFU, in order to determine the full environmental impact associated with its development and operations, e.g. its contribution to global warming, waste, water consumption, raw materials consumption, human health, biodiversity... This involves running through all the subsystems, and collecting physical data such as power consumption, materials, process, travel information, etc. Such analysis should eventually lead to recommendations to reduce the carbon footprint of X-IFU. One of the objectives is to make the X-IFU compliant with the requirement to reduce its associated greenhouse gas emissions by ~50% by 2030, the year we will deliver the flight model of X-IFU. Adopting better practices, e.g. reducing travels by plane, optimizing energy usage, etc, is clearly the easiest step to be taken for making astronomy more sustainable.



Infographic presenting key facts about X-IFU (Courtesy of M. Voltz, IRAP/CNRS).

News from JAXA

Hironori Matsumoto (Osaka University)

The Japanese *Athena* team will contribute to the 2K-Joule Thomson (JT) cooler and its driver, which are one of the main components of the X-IFU cooling chain on board the Science Instrument Module (SIM). JAXA and ESA are coordinating the technical details with the Prime candidates for the SIM. The JT cooler combined with the pulse tube cooler provided by ESA will realize a suitable environment required for the operation of X-IFU. We will improve the reliability of the JT cooler through the cooling tests of the Detector Cooling System (DCS). In addition to the DCS, the X-IFU Consortium and JAXA continue discussing topics of common interests such as calibration, science, and the overall feasibility.

We also participate in the development of the driver circuit for the WFI DEPFET sensor with MPE and Czech groups. In particular, we built a prototype circuit that supplies stable analog voltage to the front-end ASIC which reads the signals from the DEPFET sensor. We are now testing the operation of the circuit. Once the verification is complete, an integrated test with the MPE system will be performed. However, it seems difficult to secure a budget for the development of the flight model.

The Japanese *Athena* team would like to contribute to the optics of Athena. For example, we have tried Diamond-Like Carbon coating to a sample of the *Athena* SPO in order to mitigate the decrease of the effective area due to the Si edge. The reflectivity of the sample is now under investigation. We also made a prototype of a light-weight baffle using glass meshes to reduce the stray light.

News from NASA

Randall Smith (Smithsonian Astrophysical Observatory)

After substantial discussions, the overall US contributions to *Athena* have been finalized. They include providing hardware for the X-IFU focal plane, an isolation system that will reduce vibrations reaching *Athena*'s mirrors during launch, X-ray mirror testing and calibration at NASA's MSFC X-ray & Cryogenic Facility (XRCXF), and ASIC design and background characterization for the WFI. NASA will also be establishing a NASA *Athena* Science Center and will be contributing to the *Athena* Science Ground Segment (SGS). More information about NASA's involvement in *Athena* can be found on a new website, https://asd.gsfc.nasa.gov/athena/.

The big news is the 2020 Decadal survey of astronomy and astrophysics release, which contains strong support for *Athena*. The NASA *Athena* Science Team (NAST) co-chairs Jon Miller and Laura Brenneman, on behalf of NAST and the U.S. *Athena* community, released a statement about the results:

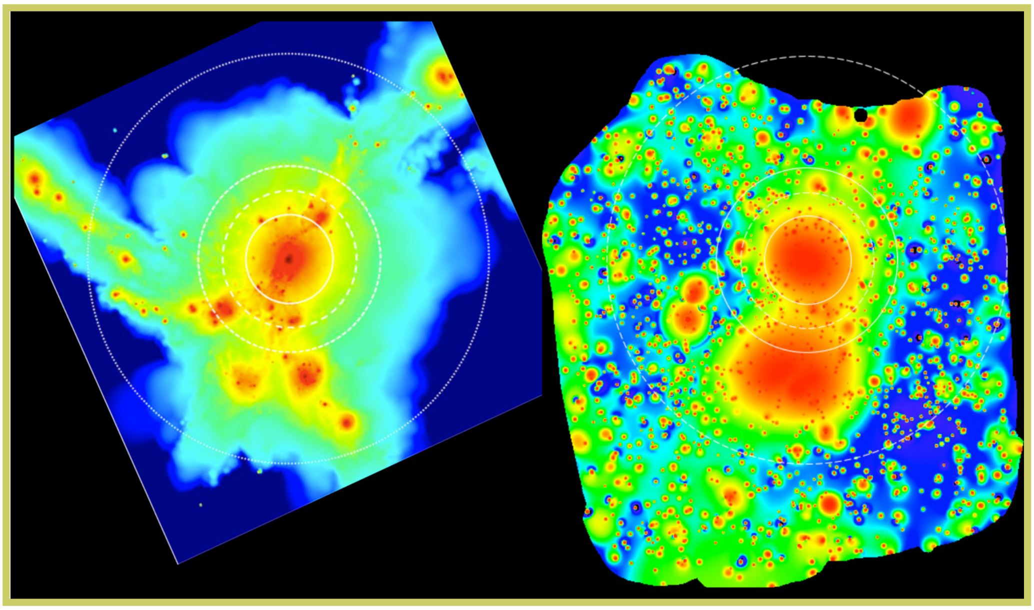
On behalf of the community of *Athena* users in the U.S., the NASA Athena Study Team (NAST) would like to thank the Decadal Survey leadership and membership for their tremendous efforts. The NAST is also grateful to the scientists and teams who wrote white papers to explain the transformative impact that *Athena* will make. Pathways to Discovery in Astronomy and Astrophysics for the 2020s highlights the incredible breadth of science that can only be achieved with *Athena*, and its capability to explore 19 of the 30 key science topics identified by the Survey. In advocating for continued NASA support for *Athena*, Astro2020 not only recognizes the thousands of U.S. scientists who will use the mission, it also underscores the importance of maintaining key international partnerships over the timescale that is necessary to build major observatories. The development of *Athena* continues toward its goal of delivering unique perspectives on the Universe, and it is exciting to glimpse the future facilities that will share in this endeavor.

Athena's discovery potential for nearby X-ray emitting large-scale filaments

Thomas H. Reiprich (Argelander-Institut für Astronomie, Universität Bonn, Germany)

Almost half of the normal matter in the local Universe is still hidden from us. Simulations predict it to reside in thin warm/hot filaments connecting galaxy clusters. But the hot phase has been difficult to robustly detect as spatially-resolved emission around individual systems – until recently: with eROSITA a ~15 Mpc long filament has now been discovered. The left panel of the figure shows the environment around a simulated galaxy cluster. The innermost white circle indicates the region of a galaxy cluster typically observable with previous X-ray telescopes (the so-called r500), as well as other radii of interest, also expressed in units of the radius where the total matter densisy exceeds the avarage by a certain factor. One notes the large amount of structure outside that innermost circle. Those are the cluster outskirts where many interesting physical effects are expected to occur. The right panel of the figure shows an eROSITA image centered on a nearby galaxy cluster system. The same characteristic radii as on the left are indicated as white circles for the cluster A3391. The X-ray emission can be traced much further than previously possible: from the "Northern Clump" in the upper right corner, through A3391, the bridge, A3395, and the "Little Southern Clump," down to a known galaxy cluster just outside the field of view in the lower left corner. Such a continuous ~15 Mpc long emission strip including filamentary emission beyond the characteristic radii of clusters has never been observed before for an individual system, but it confirms our expectations from simulations.

Athena is the ideal mission to discover and study X-ray emitting filaments around nearby large galaxy clusters systematically. Its tremendous effective area at soft X-ray energies and its large field-of-view (WFI) will allow us to discover many more such filaments and trace their morphology, assuming that an efficient scanning mode to homogeneously cover few tens of square degrees is implemented. *Athena*'s spatially resolved high-resolution spectroscopy (X-IFU) will allow us to quantify density, temperature, and metallicity structure in the most interesting regions;, enabling *Ahena* to shed light on currently poorly understood enrichment and feedback processes in the warm/hot filaments.



Left: This image shows the gas density distribution in a simulation. (Reiprich et al. (2013), Space Science Reviews, 177, 195). Right: A wavelet-filtered eROSITA image of the A3391/95 system presented with a color scaling to highlight faint regions (~15 Mpc size from the upper right corner to the lower left corner at the cluster redshift). (Reiprich et al. (2021), Astronomy & Astrophysics, 647, 2).

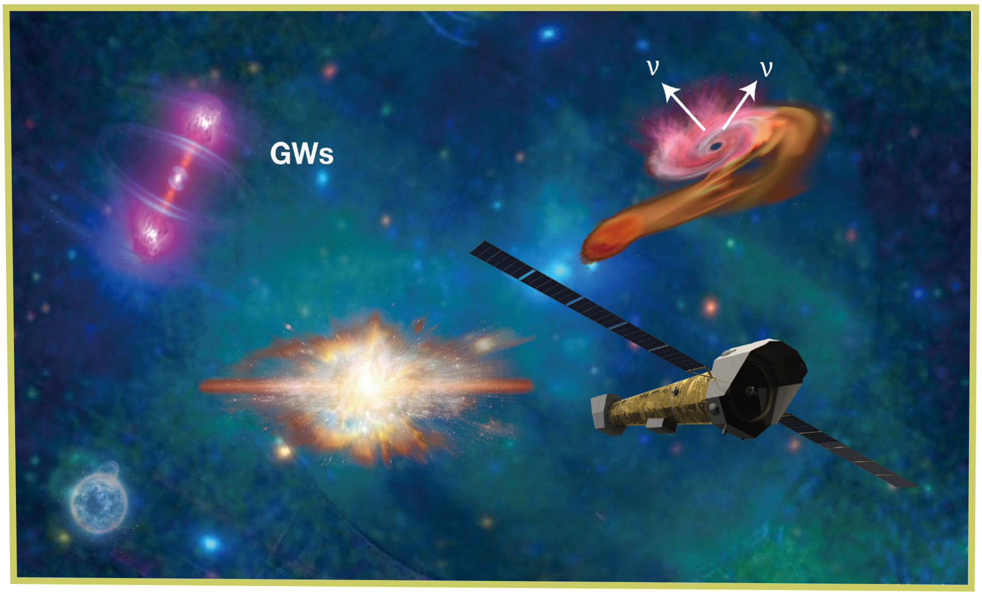
Anticipating the unexpected

Eleonora Troja (Università degli Studi di Roma 'Tor Vergata", Italy)
Stéphane Basa (Laboratoire d'Astrophysique de Marseille, France.)

Ancient cultures depicted the night sky as an immutable ensemble of fixed stars. Modern astronomy facilities reveal to us a ricly dynamic and ever-changing sky. The X-ray sky is no exception, as it hosts some of the most violent and energetic phenomena: from the explosive death of massive stars to the catastrophic collisions of neutron stars, from the ejection of relativistic outflows at the center of galaxies to the tragic end of stars devoured by the heaviest black holes. These events allow us to explore the most extreme environments through multiple cosmic messengers (such as photons, neutrinos, cosmic rays and gravitational waves) and to reach the earliest epochs of our universe, when the first stars and galaxies were formed.

To catch these sudden and unpredictable fireworks of X-ray radiation, *Athena* must quickly readjust its plans and turn its instruments to look at the right place in the sky. This observational capability, known as Target of Opportunity (ToO), is key to unlocking the discovery potential of time-domain astronomy. As an example, let's consider the case of a long duration Gamma-Ray Burst (GRB) illuminating the infant universe with its bright but very fast-fading X-ray afterglow. Long GRBs are produced by the gravitational collapse of the most massive stars. The *Athena* X-ray Integral Field Unit (X-IFU) will use the GRB afterglow as a backlight to snap a detailed picture of the gas content in the immediate surroundings of the GRB explosion. By showing how the X-ray light is absorbed, high-resolution spectroscopy will probe the birthplaces of the very first stars, revealing their gas metallicities, abundance pattern, and fraction of neutral hydrogen. However, X-ray afterglows are short-lived and their brightness can drop by a factor of a hundred in just a few hours. To use them as cosmic beacons, *Athena* must observe while they shine.

This is only an example, and many other scientific cases need this mode of observation. Other examples are supernova shock breakouts marking the first escape of photons related to the explosion (all core-collapse supernovae are expected to show a X-ray/ultra-violet flash upon break out) and a tidal disruption events signalling that a dormant black hole is cannibalizing a star that has come too close. Basically, the ToO mode offers *Athena* the opportunity to react to any new phenomenon that could not be foreseen in the observation planning. The *Athena* Ground Segment will allow us to communicate with the spacecraft every few hours, and to alert it of any new important event that needs to be rapidly observed. *Athena* will be able to send us the data within 4 hours for 40% of the events anywhere in the sky.



Thanks to its Target of Opportunity mode, *Athena* will be able to observe sudden and unpredictable flashes of X-ray radiation coming from the most extreme environments. For example, magnetars outbursts, exploding massive stars, erupting supermassive black holes, and neutron star mergers.

Credit: Background: XMM-*Newton*; *Athena* satellite: ESA/IRAP/CNRS/UT3/CNES/Fab&Fab; Insets: Brian Monroe -NASA VE (top-left); ESA/C. Carrue (top-right); NRAO (middle); XMM-*Newton* (bottom-left).

Athena Community People

Matteo Guainazzi

Matteo has been a staff astronomer at the European Space Agency (ESA) for almost 25 years. He was involved in the science operations of BeppoSAX, XMM-*Newton*, and Hitomi, and led the International Consortium for High-Energy Calibration until 2017. Then Matteo joined *Athena* as Study Scientist, the interface between the Study Team at ESA and the *Athena* scientific community. His main tasks are: maximizing the scientific return of *Athena* while ensuring that it remains technically feasible and programmatically affordable; and chairing the Science Study Team, which coordinates all *Athena* science activities.

Athena will enable fundamental breakthroughs in several areas at the core of his scientific interests, such as relativistic outflows in Active Galactic Nuclei; feeding of, and feedback by accreting super-massive black holes; or General Relativity effects shaping the innermost regions of the accretion flow. More fundamentally, *Athena* will be the large X-ray observatory in the 2030s, open to the whole astronomical community worldwide.

Esra Bulbul

Born and raised as a true (I)Spartan, Esra has followed her childhood dreams, becoming an astrophysicist, from her native Turkey to the U.S. She received her Ph.D. in the NASA MSFC. She has held postdoctoral fellow positions at the Harvard Smithsonian CfA, and MIT prior to her appointment as a staff scientist at MPE. She currently is the lead scientist for eROSITA cluster science and cosmology.

Esra's broad research interests lie in utilizing multi-wavelength surveys in understanding the evolution of baryons, constraining cosmological parameters, mapping the large-scale structure, and constraining dark matter models.

Esra served as the co-chair of the U.S. *Athena* Study Team while she was in the United States. She currently is the co-chair of the new *Athena* topical panel on Physics Beyond Standard Model.

Stefano Ettori

Stefano is a senior researcher at the Astrophysical and Space Science Observatory (OAS) of the National Institute of Astrophysics (INAF) in Bologna. He studied physics in Italy, completed a PhD in the UK, became an ESO fellow in Germany and then a staff researcher in Italy in 2004.

His research activities focus on the formation and evolution of clusters of galaxies, with particular interest in the properties of their X-ray emitting plasma from the core to the outskirts where mass accretion is occurring, and in using them as cosmological probes through the measurement of their mass content. He is co-leading the international collaboration CHEX-MATE, that will invest time from the first XMM-*Newton* Multi-Year Heritage Program to study these ultimate products of structure formation in mass and time, also in preparation of *Athena*'s exploration.

In the *Athena* community, Stefano is member of the XSAT team, and has recently become the co-chair of the *Athena* SWG1, the "Hot Universe", after serving as co-chair of SWG1.2 "Astrophysics of galaxy groups and clusters" since its foundation. He is definitely motivated to see *Athena* to flight -at last-, but is enjoying the travel to be there.

AHEAD2020 Announcement of Opportunity Cycle 3

The AHEAD2020 (Integrated Activities for High Energy Astrophysics Domain) calls for a program of transnational visits and remote access activities to be performed starting ~mid April 2022. **AO-3 Calls Opening**: 20 January 2022 **Submission Deadline**: 4 March 2022

Further information and links to the AO-3 calls at the AHEAD web portal.

Coming conferences of interest

- The Nineteenth Divisional Meeting of HEAD, Pittsburgh (USA), 13-17 March
- Large-Volume Spectroscopic Analyses of AGN and Star-Forming Galaxies in the Era of JWST, virtual, 21-24 March
- Galaxy Clusters 2022: Challenging Our Cosmological Perspectives, virtual, 25-29 April
- Intermediate-Mass Black Holes: New Science from Stellar Evolution to Cosmology, San Juan (Puerto Rico), 30 April - 3 May
- Latest Advances in X-ray Spectroscopy and Polarimetry, Mondragone (Italy), 18-20 May
- BH accretion under the X-ray microscope, ESAC (Spain), 15-17 June
- Ten Years of the High-Energy Universe in Focus: NuSTAR 2022, Cagliari (Italy), 20-22 June
- Multiphase AGN Feeding & Feedback II: Linking the Micro to Macro Scales In Galaxies, Groups, and Clusters, Sexto (Italy), 20-24 June
- From Stars to Galaxies II Connecting our understanding of star and galaxy formation, Gothenburg (Sweden), 20-24 June
- **EAS 2022 S5: Towards the next generation of X-ray surveys with *Athena*, Valencia (Spain), 27 June - 1 July**
- Physics of Neutron Stars, Saint Petersburg (Russia), 11-15 July
- SPIE Astronomical Telescopes + Instrumentation 2022, Montréal (Canada), 17-22 July
- COSPAR Assembly 2022, Athens (Greece), 16-24 July : Event E1.11: Supermassive Black Holes at High Redshift
- Division D workshop at the IAU General Assembly 2022: Across the Mass Spectrum of Neutron Stars and Black Holes, Busan (Korea), 5-8 August
- Focus Meeting 6 at the IAU Generay Assembly 2022: Dynamics of the ICM: Radio and X-ray Observations and Theory, Busan (Korea), 5-8 August
- What matter(s) around galaxies 2022: connecting the dots between the circumgalactic medium and the larger-scale environment, Champoluc (Italy), 12-16 September
- Origin, growth and feedback of black holes in dwarf galaxies, San Sebastián (Spain), 15-22 September
- International conference Probing the Universe with Multimessenger Astrophysics, Sestri Levante (Italy), 26-30 September
- **Exploring the Hot and Energetic Universe: The third scientific conference dedicated to the *Athena* X-ray observatory, Barcelona (Spain), 7-10 November**