X-IFU Gazette #23 - February 2023 View this email in your browser

This version of the newsletter is intended for X-IFU Consortium members.

EDITO

Welcome to the 23rd issue of the X-IFU Gazette!
In this issue, the X-IFU Instrument Manager, Philippe Peille (CNES), introduces the new configuration for the X-IFU instrument. Resulting from more than half a year of hard work from all teams working on the instrument, the new X-IFU places the Athena mission on the right path forward.

In December 2022, results from the First Phase of the Life Cycle Assessment conducted by IRAP in partnership with SCALIAN, were published. Here, Xavier Loizillon from SCALIAN explains briefly what the results mean for X-IFU and presents opportunities to reduce the footprint of a large space mission such as Athena.

Yaël Nazé, from the Université de Liège, gives us insight on X-IFU's revolutionizing capabilities in stellar wind observation.

Lastly, we interviewed Elise Bellouard, X-IFU Procurement Manager from CNES, who talks about her professional career, her role in the project and the long road ahead to reach completion.

Happy reading!

Florian Zablot
Athena X-IFU Project Communications Manager

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Newsflash

1. X-IFU Consortium Meeting #15

The last Consortium Meeting took place

3. X-IFU Video #3

We released a third video describing

outcomes in this article.

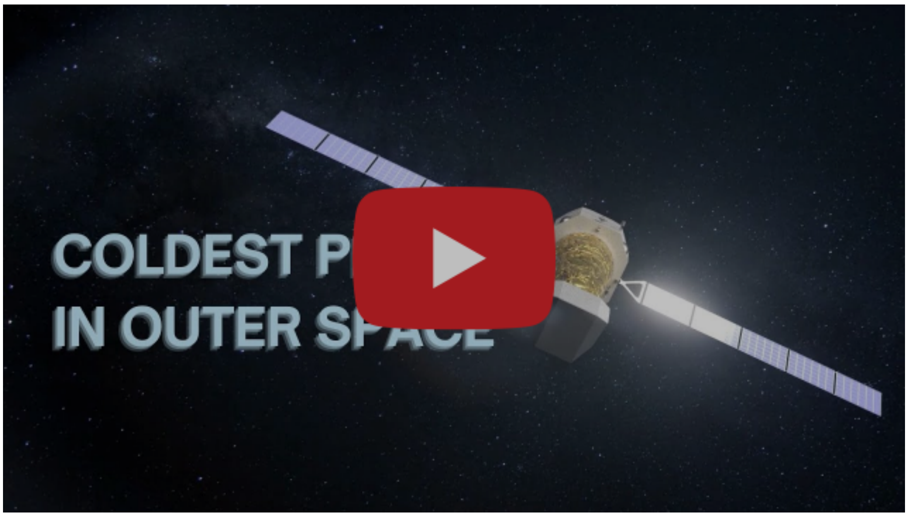
2. X-IFU Consortium Meeting #16

The next X-IFU Consortium Meeting will be held face to face in Toulouse around June 2023. More information will be given in the coming months.

brings in high-energy astrophysics. Be sure to check it out if you haven't yet!

4. International Day of Women and Girls in Science 2023

To celebrate the **International Day of Women and Girls in Science 2023** on February 11, the X-IFU Consortium partners with XMM2Athena, the Athena Community Office, AHEAD2020, and the WFI Consortium to produce a crossword puzzle contest which will honor renown women in our respective fields of study.



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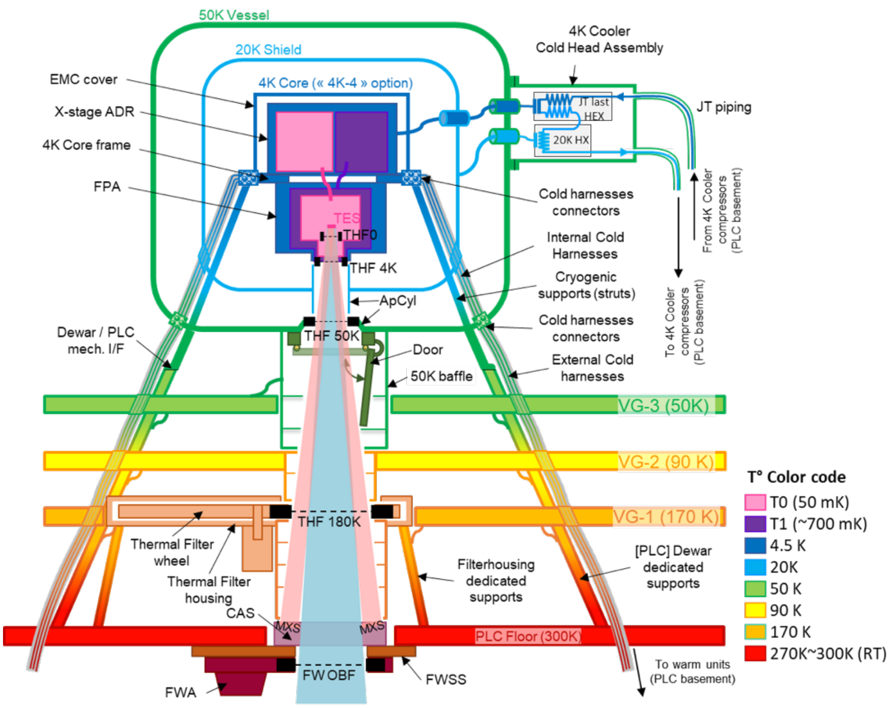
The New X-IFU Configuration



Following the necessity to bring the ESA Cost at Completion below €1.3 billion, the Athena mission and the X-IFU have entered a reformulation phase shortly after last summer. Two boundary conditions were soon identified by ESA for this exercise: First, the responsibility of the X-IFU dewar should come back in the X-IFU Consortium, enabling also a drastic simplification of the interfaces between X-IFU and the payload module. Second, its active cryogenic chain shall be significantly reduced, in both scope and complexity. This led to study of two scenarios: the first consisted in using a large US 4K cooler to replace most of the X-IFU cryogenic chain while keeping a room temperature cryostat similar to the previous X-IFU. The second involved the introduction of significant passive cooling within the payload module in order to provide a colder interface to a smaller X-IFU dewar.

After studying both options during the last quarter of 2022 in collaboration with ESA and our X-IFU partners, we selected the so-called passive architecture (see figure above) as the best solution for the X-IFU and Athena to move forward. The instrument dewar is now a relatively small enclosure accommodated inside a series of increasingly colder V(L)-grooves with an interface temperature of ~ 50 K. Its colder stages (~ 20 and 4.5 K) are cooled down via JT lines by remote compressors located several meters away in the payload module “basement”. From there, the 2K JTs and hybrid cooler were replaced by a multi-stage ADR cooler to provide 4.5 K to 50 mK cooling, with the 2K core evolving towards a now 4K core. The instrument aperture is also modified with a thicker filter accommodated outside of the vacuum vessel and protected from acoustics during launch by an enclosure akin to the WFI filter wheel, for a modest penalty of low energy effective area.

From the readout perspective, very encouraging results were obtained during the summer time on new detector designs at GSFC. These slower pixels allow for a larger multiplexing factor (up to ~ 50) for the same readout performance. The loss of field of view from a reduction of the number of readout channels can thus be mitigated for an acceptable loss of count rate capability. With only 36 channels (half of the T-SRR baseline), the instrument could for instance retain more than a 4’ field of view (equivalent diameter).

Of course, this configuration departs from the previous baseline and presents a number of new technical challenges associated with a cold outer vessel, but no technical showstopper has been identified so far. Overall, we are confident that we will be able to develop a new X-IFU providing flagship science within this renewed context and look forward to the continued support of the X-IFU consortium for this challenge!

Philippe Peille
X-IFU instrument manager

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X-IFU Life Cycle Assessment First Phase Results

At a time when one can observe the concrete effects of pollution or climate change, and with growing tensions on the energy market, the legitimacy of space projects could be questioned.

Unveiling the secrets of the hot and energetic universe is no mean feat. But doing so while minimizing the impact of science on the environment is even more challenging.

To tackle this issue, a pilot case started in 2022 to efficiently reduce the burden of X-IFU related activities on the environment. In the first place we wish to identify which activities have the largest footprints.

To do so, a Life Cycle Assessment (LCA) was carried out by IRAP with the support of (climate change, acidification, water consumption…). It takes into account every life cycle phase of a product or service : from design to waste.

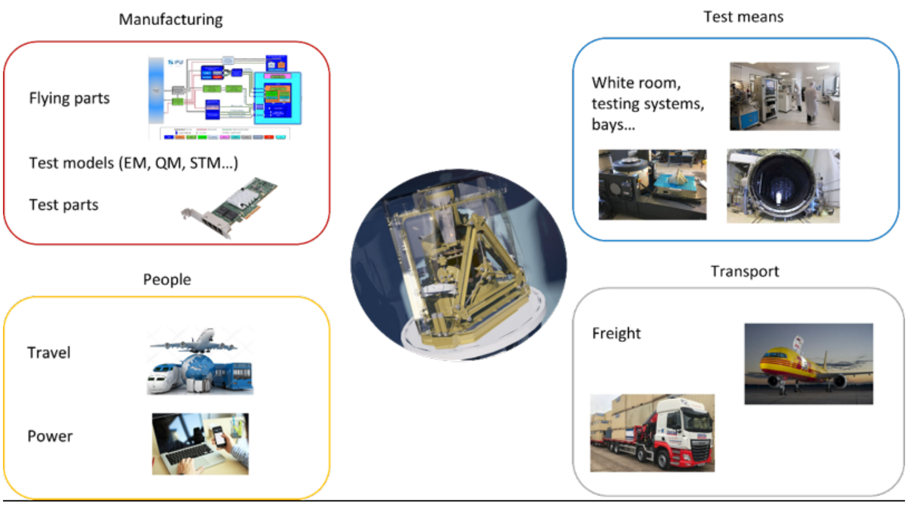

Figure 1: Significant physical flows related to X-IFU activities leading to environmental impacts

Interviews were performed with each subsystem responsible to identify all the flows that will contribute to the overall X-IFU footprint. These flows were matched with existing LCA databases, or data benchmarked from space sector and industries, to compute the resulting environmental impacts.

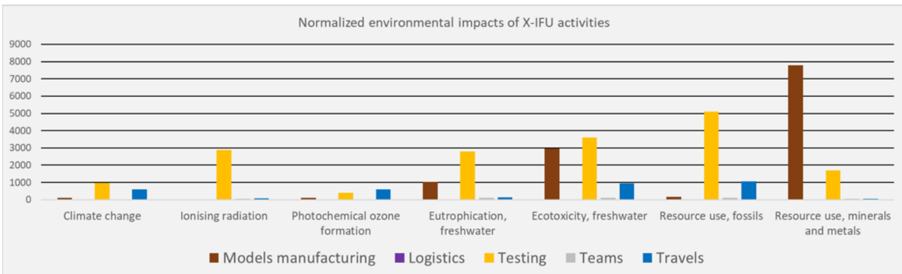

Figure 2 : Results of the first phase of X-IFU LCA : most significant indicators

Environmental indicators have been translated into the yearly environmental impact of an average european citizen. This means, if we look at climate change, that test campaigns for X-IFU subsystems will amount as much as 1000 europeans for one year in terms of CO2 emission.

The results put the stress on two sets of activities:

- Testing, because of the use energy-intensive facilities and equipment, such as clean rooms.
- Manufacturing, as space technologies need high-end components with high contents of rare earth and precious metals, which refining processes put a heavy toll on the environment. This impact is probably underestimated with the current model.

This LCA will be updated to take into account changes in project or modeling data.

Xavier Loizillon
SCALIAN

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X-IFU Stellar Capabilities Bring a Wind of Change

Artist's rendering of a colliding wind binary. (Credit: NASA/C. Reed)

Not all stars are born equal. The most massive amongst them, in particular, appear exceptional on all grounds. With their substantial surface temperatures (>30,000 Kelvin) and extreme luminosities (>100,000 times more luminous than the Sun), their upper layers cannot stay in place: light literally pushes matter out, creating dense and fast stellar winds.

For these stars, X-rays are intimately linked to these winds (Rauw, 2022). Indeed, the acceleration process is unstable, giving rise to shocks between the fragmented pieces of the wind. This leads in turn to heated plasma hence to X-ray emission. These soft (~0.6 keV) intrinsic X-rays constitute the basis, but much more can happen.

For example, the overall isotropy (in all directions) and uniformity of the wind flows can be broken, with large-scale structures appearing in the winds. This can have several origins, notably strong magnetic fields confining the winds near the equator, as well as photospheric spots or pulsations propulsing a slightly different wind flow. Up to now, only very general information is available (e.g. detection of X-ray brightness changes recurring with rotational periods). With high-resolution spectrometers such as X-IFU, we will finally get a direct view of what happens. Sensitive monitoring of the X-ray lines will be performed and the recorded variations will directly probe the dynamics and geometry of the hot plasma, allowing us to unveil the exact processes at the source of such high-energy emissions.

Moreover, when two massive stars live together, their winds collide, which generates copious X-ray emitting plasma in some cases. Such collisions have been studied with current X-ray facilities, but much remains to be done. Indeed, the profiles of the X-ray lines, formed in the interaction zone, directly reflect the dynamics of the post-shock plasma hence encode the shock properties (Mossoux & Rauw, 2021).

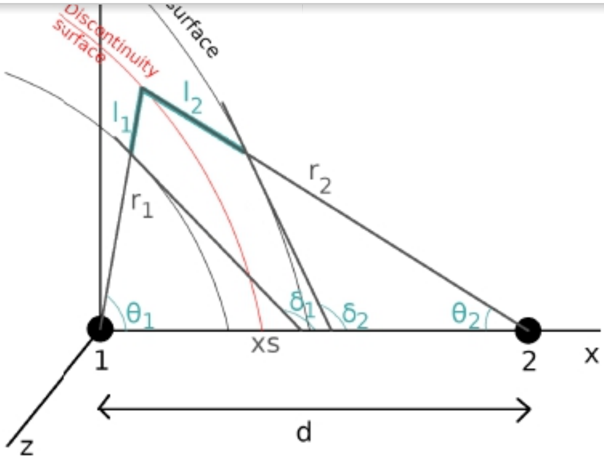

Figure 1 : Schematic view of the wind shock region. Star 1 orbits star 2 in the direction of the z-axis (Mossoux & Rauw, 2021).

X-IFU and its high-resolution spectrometers will dramatically improve our view of this phenomenon. By observing how the line profile changes throughout the orbital cycle of binary stars, the morphology of emission regions in the velocity space (what is called Doppler tomography) will be reconstructed, revealing details of the wind-wind collisions.

This method is, in principle, akin to medical Doppler tomography where an X-ray detector rotates around the patient to produce an image of the internal structure of parts of their body. In our case, the patients are stars and the detector is X-IFU and there is no need to rotate the instrument as the stars kindly do it during their orbital cycle.

Yaël Nazé
Senior Research Associate, Université de Liège

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Meet the People of X-IFU:An Interview with Elise Bellouard

We are glad to introduce X-IFU Procurement Manager Elise Bellouard from CNES, the French Space Agency

Can you briefly present yourself, and your work in general?

Elise Bellouard: I have been working at CNES for about 20 years, firstly as a thermal engineer, then as a mechanical and thermal architect, before taking on responsibilities within different space science project teams : instrument project manager for RPW (one of ESA's Solar Orbiter instruments), TARANIS satellite and I am more specifically procurement manager for the subKelvin cooler, developed by CEA in Grenoble. I am also involved in cryo-harness demonstration activities, and in the follow-up of the development of a prototype of DRE DC/DC converter, contracted with the French company STEEL Electronics.

What is the biggest challenge about your work on X-IFU?

What is your role and your main tasks within the X-IFU project?

EB: My main task is to lead the X-IFU subsystem procurement team at CNES, and to interact with related partners, mainly in order to insure compliance and consistency of the different procurement schedules and to oversee the monitoring of the risks. For French contributions, I am in charge of the implementation of the contracts, the different models (DM, EM, FM…) of all (more than 15 !) the challenging subsystems, provided by more than 10 different entities, ready on time, to deliver the different models of X-IFU to ESA.

What was your biggest surprise while working on X-IFU?

EB: One of my biggest surprise was the small number of women involved in the project (equal to zero within some partner teams). It would be great to motivate women (engineers and scientists) to join the "new X-IFU" team in a near future, in order to participate to this challenging mission !

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You can read our previous interviews with Alexis Finoguenov and Anne Decourchelle.

Thank you for reading!

Please feel free to send any feedback or suggestions for future contributions to xifu@irap.omp.eu. We would be glad to hear from you.

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