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DESIGN CONCEPTS FOR DESIGNING THE X-IFU CRYOSTAT

Abstract

The instrument X-IFU (X-ray Integral Field Unit) is one of the two instrument of the ATHENA (Advanced Telescope for High-ENergy Astrophysics) payload. Mission selected by ESA as L-mission and with the goal to be launched in 2031. The mission is lead by IRAP and CNES with a large participation of many European institutions as well American and Japanese.

The goal of X-IFU is to study the Hot Universe, the effect of Active Galactic Nuclei (AGN) in the intra-cluster medium (ICM) and obtaining the distribution and properties of the warm/hot baryonic filaments in the intergalactic medium. All those targets can be achieved with X-ray spectrometry.

The X-ray detectors are based on TES (transition-edge sensor) superconductor detectors that requires to operate at millikelvin temperature. Therefore one of the main challenges of the mission is the design a cryostat capable of maintaining the detectors in those stable condition.

Many cryogenic missions have been launched in the past. In some of them, to maintain low temperatures has been used helium liquid or pressurized gas, but with the drawbacks that the mission duration was associated to the gas depletion. In X-IFU, the design challenge is not to use helium anymore and keep the low temperature by cryocoolers.

This is a leap forward in the design of cryogenics missions that require to validate many aspects of cryostat engineering with two main goals: minimize the heat flux to the focal plane assembly (FPA, detector assembly) and isolate it from mechanical and electromagnetic perturbations from the exterior environment, at extreme levels.

To improve maturity in the X-IFU instrument design a dewar elegant breadboard is being developed to demonstrate the main technical challenging aspects of this new concept. With this breadboard, we will demonstrate that the heat flux to the FPA is according what is predicted by the models and in line with what is required by the mission. Also, that the mechanical perturbation generated by the cryocoolers are dumped at the level needed to minimize the noise also in the FPA, as well the electromagnetic isolation are enough to guarantee the detector performances.

In the presentation are shown the different design options selected beside in addition to the validation models and tests performed to support the analysis.