First development model of the X-IFU Focal Plane Assembly ready for test

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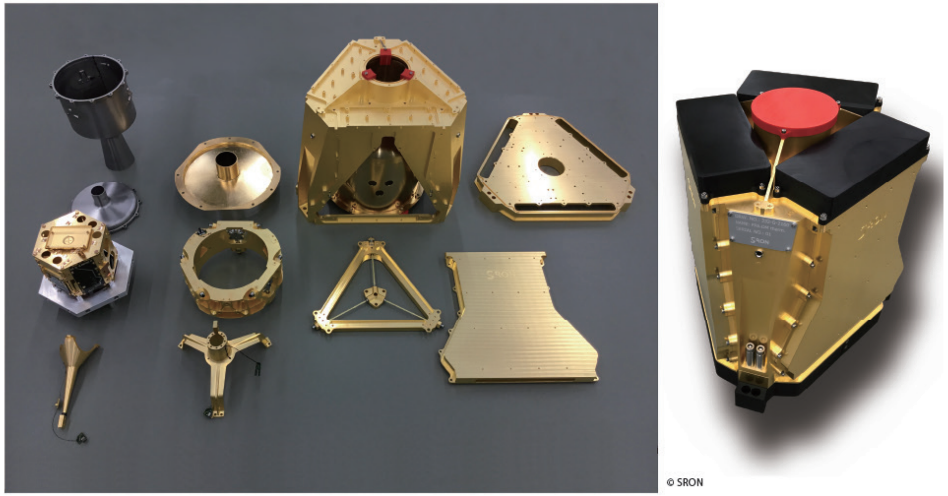
Within *Athena*, the primary mirror concentrates the X-ray photons from distant objects in a focal plane. Inside the X-IFU instrument, these photons are collected on the 3168 pixel detector array (read out by Transition edge sensors TES, see #*Athena*Nuggets 21), which is operated at only 0.1 Kelvin from absolute zero. The main detector is combined with an anti-coincidence detector which flags those events which originate from the interaction with particles and have energies outside the range of interest. Both detectors, together with several readout electronic components, magnetic, and electric shields, are assembled in the X-IFU Focal Plane Assembly (FPA). To minimize the heat load of the FPA on the various coolers, only the detector, first amplifiers, and one magnetic shield are placed at the lowest temperature (T_0) of nominally 0.05 K. Another magnetic shield, the second amplifier stages and remaining cold electronics are placed at 2 K (T_2) instead. These two stages are separated by a heat intercept at 0.3 K (T_1). For the successful realisation of this FPA several technology developments related to electrical, thermal, and mechanical aspects are needed and a long term development is ongoing at SRON to assure the required technologies are demonstrated in time. Recently, the first development model of the X-IFU FPA has been integrated in which all these elements are combined for the first time.

An important aspect of the FPA is the proper suspension of the coldest detector stage and intermediate heat intercept from its outer structure at 2 K. An optimization is required since the mechanical requirements on the strength of the suspension during the launch of the satellite need to be balanced against the heat load of the suspension while the instrument is in operation. Here the unique strength and thermal conduction properties of Kevlar cords are used. *This poses additional challenges since Kevlar elongates at low temperature while other metallic parts contract.*

The magnetic shielding of the main detector is also a critical element in achieving the required performance. The field level at the FPA needs to be reduced by a factor of more than 10^5! A special combination of superconducting Niobium and cryogenic mu-metal is used, to allow for a high shielding while minimizing the total mass of the shields. Characterization of these shields and proper modelling has been a separate development over the last years within the FPA team.

Currently, our group is preparing the thermal, mechanical, and functional & performance test program on the FPA Demonstration Model (DM). These test results will be used to adapt our simulation models where needed such that these validated models can be used to make predictions for subsequent FPA design iterations.



Left: The various sub-assemblies of the FPA-DM during integration. At the top left the Niobium shield is shown. The triangle in centre is one of three Kevlar cord assemblies which together form the suspension of the T_1 stage. The hexagonal structure on the left is the partially assembled detector stage. Right: The FPA-DM #1 completely assembled. The front-side red cap is a protective cover to avoid contamination of the optical filter. The three front black covers will be replaced by the readout harness during further tests. The black back-side cover protects the sensitive electronics and internal harness of the FPA during transport and handling.

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