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Updates of frequency domain multiplexing for the X-ray Integral Field Unit (X-IFU) on board the Athena mission

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We are developing the frequency domain multiplexing (FDM) read-out of transition-edge sensor (TES) microcalorimeters for the X-ray Integral Field Unit (X-IFU) instrument on board of the future European X-Ray observatory Athena. The X-IFU instrument consists of an array of ∼3000 TESs with a high quantum efficiency (>90 % at 7 keV) and spectral resolution ΔE=2.5 eV @ 7 keV ($E/\Delta E$ ∼2800).

FDM is the baseline readout system for the X-IFU instrument. In FDM, TESs are coupled to a passive LC filter and biased with alternating current (AC bias) at MHz frequencies. Each resonator should be separated beyond their detector thermal response (< 10 kHz) to avoid crosstalk between neighboring resonators. To satisfy the requirement of the X-IFU, a multiplexing factor of 40 pixels/channel in a frequency range from 1 to 5 MHz required.
Using high-quality factor LC filters and room temperature electronics developed at SRON and low-noise two-stage SQUID amplifiers provided by VTT, we have recently demonstrated good performance with the FDM readout of Mo/Au TES calorimeters with Au/Bi absorbers. We have achieved a performance requested for the demonstration model (DM) with the single pixel AC bias mode. We have also demonstrated 14-pixel multiplexing with an average energy resolution of 3.3 eV, which is currently limited by non-fundamental issues related to FDM readout in our current lab setup.

In this paper we report on the concept of the focal plane assembly, their requirements, detector performance under FDM scheme, recent results from pre-demonstration model setup and future prospect.

Less than 5 years of experience since completion of Ph.D

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