Contribution ID: **398** Type: **Oral**

High resolution imaging non-dispersive X-ray spectrometers based on superconducting transition-edge sensor for astrophysics, fusion science and particle physics.

Thursday, 26 May 2022 09:30 (15 minutes)

Large arrays of superconducting transition-edge sensor (TES) X-ray microcalorimeters are becoming the key technology for space and ground-based observatory in the field of astrophysics, laboratory astrophysics, particle-physics, plasma physics and material analysis. TES based X-ray detectors are non-dispersive spectrometers bringing together high-resolving power, imaging capability and high-quantum efficiency.
The TES X-ray calorimeters technology is entering a new era where arrays with more than 1000 pixels are routinely fabricated and cutting-edge instruments with dozen of multiplexing channels are being build for fundamental research at synchrotron and free electron laser facilities and plasma sources.
At SRON, we are developing the focal plane assembly and the back-up detector array for the the X-ray Integral Field Unit (X-IFU) on board of Athena. X-IFU will host an array of more than 3000 TES pixels with a $T_c \simeq 90\,\mathrm{mK}$, sensitive in the energy range of 0.2–12 keV, with~an unprecedented energy resolution of 2.5~eV at 7 keV.
We have recently demonstrated the Frequency Division Multiplexing (FDM) read-out of 37 TiAu TES calorimeters with an exquisite energy resolution of 2.23 eV at 5.9 keV. Our FDM technology has proven to have low electrothermal cross-talk and to be relatively insensitive to external magnetic field, with respect to other multiplexing schemes.
We will discuss the prospects of using our cryogenic high-resolution X-ray imaging spectrometer based on TES detectors and FDM read-out as a diagnostic instrument for the existing and future fusion reactors. Moreover, our detectors could contribute in the study of atomic properties of high-Z metals, like tungsten and its many ionization stages.
We will finally show the challenges of developing and reading-out very large arrays of TES X-ray calorimeters with more than 10000 pixels for future astrophysics and fundamental research in particle physics, such as the detection of solar axions and the direct detection of the neutrino mass.

Collaboration

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Session Classification: Cryogenic, Superconductive and Quantum Devices