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Advances in time-division SQUID multiplexing for TES X-ray-microcalorimeter arrays

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Time-division multiplexing (TDM) is the most mature readout technology for transition-edge sensor (TES) microcalorimeter arrays. Our TDM architecture is routinely deployed to read out 250-pixel scale TES X-ray spectrometer arrays at synchrotron and accelerator beamlines, in table top X-ray spectroscopy experiments, and at electron beam ion trap (EBIT) facilities in applications ranging from materials science to nuclear physics. We continue to develop TDM to offer expanded capabilities in these applications and as a backup TES readout technology for the 3,168-pixel X-IFU instrument on the Athena satellite mission.
We will present results from a proxy 40-row TDM demonstration using NASA TESs that are within the design envelope under consideration for X-IFU. Since our existing 250-pixel TDM readout systems only have wiring to support 32 physically distinct TDM rows, the experiment read out 32 distinct TDM rows plus eight repeat rows for a total of 40 TDM timing rows, simulating the timing and noise of the true 40-row readout planned for X-IFU. Single-column measurements have a best-fit energy resolution of (1.91 ± 0.01) eV for Al Kα (1.5 keV), (2.10 ± 0.02) eV for Ti Kα (4.5 keV), (2.23 ± 0.02) eV for Mn Kα (5.9 keV), (2.40 ± 0.02) eV for Co Kα (6.9 keV), and (3.44 ± 0.04) eV for Br Kα (11.9 keV). Three-column measurements have a best fit energy resolution of (2.03 ± 0.01) eV for Ti Kα and (2.40 ± 0.01) eV for Co Kα. The demonstrated performance meets the dynamic range, energy-resolution, and crosstalk requirements of X-IFU. Larger scale true 40-row readout demonstrations will be conducted with a kilopixel scale TDM readout system that will come online in 2019.
We also report significant progress reducing crosstalk, with the goal of enhancing TDM performance in applications requiring tens or hundreds of X-ray counts per second per pixel. We will describe recent modifications to our cryostat wiring and SQUID multiplexer chips as well as performance in this regime.

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

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