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Towards 100,000-pixel microcalorimeter arrays using multiabsorber transition-edge sensors

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We report on the development of large format arrays using multiabsorber transition edge sensors (TESs), commonly referred to as 'hydras'. A hydra consists of multiple x-ray absorbers each with a different thermal conductance to a TES. Position information is encoded in the pulse shape. With some trade-off in performance, hydras enable the development of very large format arrays without the prohibitive increase in bias and read-out components associated with arrays on individual TES pixels. These devices are under development for the next generation of space telescope such as Lynx. Lynx is a mission concept under study for the Astro 2020 decadal review that will revolutionize x-ray astronomy by combining a < 1"angular resolution optic with 100,000-pixel microcalorimeter array that will achieve ~3 eV energy resolution in the soft x-ray energy range.

Here we present the design optimization and trade-off's between key performance metrics such as resolution, position-discrimination and count-rate for multiabsorber TESs with up to 25-pixels/hydra. We present results from prototype hydras with pixels on a 25 micron and 50 micron pitch. Arrays incorporate, for the first time, microstrip buried wiring layers of suitable pitch and density required to readout a full-scale Lynx array. The average spectral energy resolution across all 25 pixels was <ΔEFWHM> = 2.51±0.97 eV and <ΔEFWHM> = 3.44±1.00 eV at an energy of 1.25 keV for the 25 and 50 micron pitch designs respectively.

To match the bandwidth and dynamic range requirements of the state-of-the-art multiplexing schemes TESs are typically operated in or close-to critical damping. Although some inductance can be used to reduce the pulse slew-rate it is undesirable to critically damp the hydra since this would suppress the position discrimination. We examine the trade-off between position discrimination and pulse slew-rate and explore alternative approaches to slow the pulse rise-time by optimization of the thermal design.

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

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Student (Ph.D., M.Sc. or B.Sc.)

N

Primary authors: SMITH, Stephen (NASA GSFC / UMBC); Dr ADAMS, Joseph S. (NASA-GSFC / UMBC); Dr BANDLER, Simon, R. (NASA-GSFC); BEAUMONT, Sophie; Dr CHERVENAK, James, A.; DATESMAN, Aaron (NASA Goddard space flight center / Science Systems and Applications, Inc.); Dr FINKBEINER, Fred, M. (NASA-GSFC / Sigma Space Corp.); Dr HUMMATOV, Ruslan (NASA-GSFC / UMBC); Dr KELLEY, Richard, L (NASA-GSFC); Dr KILBOURNE, Caroline (NASA-GSFC); MINIUSSI, Antoine (NASA/GSFC - UMBC); Dr PORTER, Frederick, S. (NASA-GSFC); Dr SADLEIR, John, E. (NASA-GSFC); SAKAI, Kazuhiro (NASA/GSFC); Dr WAKEHAM, Nicholas, A. (NASA-GSFC / UMBC); Dr WASSELL, Edward, J. (NASA-GSFC / KBRwyle); Dr WITTHOEFT , Michael (NASA GSFC); Dr RYU, Kevin (MIT Lincoln Labs)

Presenter: SMITH, Stephen (NASA GSFC / UMBC)

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