FDM read out assembly with flexible, superconducting connection to cryogenic kilo-pixel TES detectors

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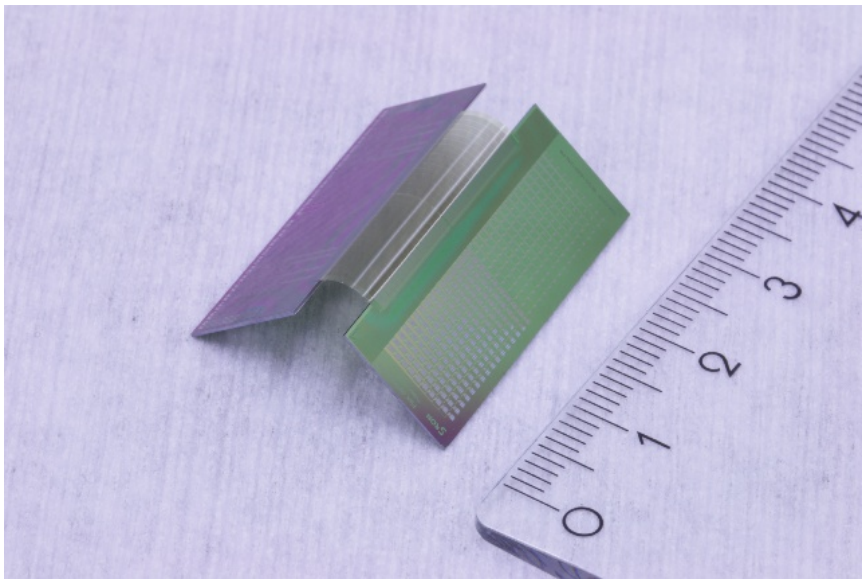
For application in Astronomical space missions, large arrays (hundreds to thousands of pixels) of superconducting Transition Edge Sensors (TES) are under development. Our development was directed to the SAFARI instrument on JAXA's SPICA mission (infra-red), but equally suited for application in the X-IFU instrument on the recently approved L-class ESA mission Athena (X-ray).

The arrays will be read out by a Frequency Division Multiplexed (FDM) SQUID system with passive filtering elements and SQUIDs at the base operating temperature of 50 mK. The design is extremely complex, due to constraints on thermal load, focal plane area, mass, and magnetic, stray-light and EMI shielding. In the compact design there is the need for flexible, detachable, and superconducting connecting structures from the detector array to the electronics with 90 degree bendings.

The process development of these connectors has made considerable progress the past year. A connector consists of two bulk silicon chips, connected by a flexible polyimide foil. Niobium double strip wiring with Tc > 4.2 K ends in coils on one piece and bump bonding pads on the other. Low resistance electroplated gold bumps are used to (permanently) connect to LC filter chips. The connection to the detector chip is demountable. Accurate alignment of the coils on mating sides is achieved by using deep-RIE etched holes and miniature bolts/nuts with metal inserts and polyimide spacers. The quality of the connection is demonstrated by DC resistance bridge measurements and LC filter resonance measurements of the bump connected chips at cryogenic temperatures. The contact resistance for a single connection is lower than $1 \times 10^{-5}\ \Omega$; at 4.2 K, considerably below the requirement for application in a TES detector readout circuit.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