The SAFARI Focal Plane Array Design Concept

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***Abstract*— The SAFARI instrument is a far-infrared imaging Fourier transform spectrometer (FTS) for JAXA's SPICA mission. Taking advantage of the low thermal emission of SPICA's 5 K telescope, SAFARI will provide background-limited, Nyquist-sampled spectroscopic imaging of a 2'x2' instantaneous field-of-view over 34-210 μm. The extremely low-noise detector performance that SAFARI requires is provided by 3 large-format Transition Edge Sensor (TES) detector arrays operating at 50 mK base temperature, with operation of 4000 pixels within SPICA's tight thermal constraints enabled by a unique frequency division multiplexed SQUID readout system in which 160 pixels are simultaneously read-out using a single SQUID amplifier chain.**

The extreme sensitivity of the SAFARI detectors and their first-stage SQUID amplifiers cause this system to be sensitive to environmental disturbances such as quasi-static magnetic fields, thermal radiation from the instrument's 1.7 and 4.5 K temperature stages, and high-frequency radiated E-fields from (for example) the satellite transponders. Also, the 50 mK detectors and first-stage readout electronics must be thermally isolated from the 1.7 K environment of the instrument's cold optical box. Finally, SAFARI's large TES chips must be mounted and aligned with respect to their optical coupling elements (horn and backshort arrays) while also surviving repeated deep cryogenic thermal cycles and launch vibration loads.

These shielding, thermal isolation, and detector chip mounting functions are combined in the instrument's Focal Plane Arrays (FPAs), with one FPA for each of the instrument's 3 detector arrays. This paper describes the preliminary design concept for the SAFARI FPAs and their critical enabling technologies, including an isostatic and modular Kevlar suspension system; an isostatic and thermal expansion compensating mounting technique for the TES wafers; and the shielding of the detectors from the spacecraft environment.