



Design of Corrugated Horn Coupled MKID Focal Plane for CMB B-mode polarization satellite LiteBIRD

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Corrugated horn coupled to MKID focal plane has been designed for a next generation of CMB B-mode polarization observation, the LiteBIRD satellite [1]. To achieve sensitivity of the tensor-to-scalar ratio $r = 0.002$ (2σ), the LiteBIRD requires high beam quality to reduce systematic errors.

Microwave Kinetic Inductance Detector (MKID) is a Cooper-pair breaking photon detector, which consists of superconducting micro-resonators. The resonators with slightly change of their center frequencies (\sim GHz) enable frequency multiplexing. No bias line is required, so many pixels are easily realized. Because of a kind of quantum detector using Cooper-pair breaking, MKID is relatively robust over temperature variation and microphonic interferences. We fabricated and tested Al-MKID at NAOJ, whose dark NEP was around 10^{-18} W/rHz [2].

Corrugated horns have been widely used for CMB observations and millimeter astronomy due to their excellent beam properties. We designed a broadband corrugated horn array, which has been directly machined from an Aluminum block at the machine shop of NAOJ. The beam pattern was simulated with HFSS and CST softwares. A prototype of this direct machined horn array has been fabricated and measured to have a good beam shape and low cross polarization from 120 to 270 GHz [3]. Direct machined corrugated horns have a few merits compared with staked/platelet corrugated horns; 1)

the weight can be reduced, 2) the rim of the horn can be trimmed to reduce the reflection, 3) the Aluminum block of the horn acts as superconducting electromagnetic shield at 0.1 K.

We designed planar OMTs and MKIDs on an SOI (Silicon-on-Insulator) wafer for the horn array [4]. This prototype covers frequencies from 80 GHz to 160 GHz and has two frequency bands defined with planar bandpass filter/multiplexer, which will be tested on a ground telescope.

A focal plane has been designed with corrugated horn coupled MKIDs as shown in Figure. There are three kinds of hexagonal modules; 1) 55 - 108 GHz, 2) 80 - 160 GHz, 3) 165 - 330 GHz. Total number of MKIDs are around 2800. Sensitivity and thermal calculations will be presented.

- [1] M. Hazumi et al. 2012 SPIE; T. Matsumura et al. 2014 SPIE
- [2] M. Naruse et al. 2012; K. Karatsu et al. 2015 this workshop
- [3] S. Sekiguchi et al. 2015 this workshop
- [4] S. Shu et al. 2015 this workshop

