

Cryogenic Multi-Channel Readout System for Submillimeter/Terahertz Photon Detectors

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Abstract—We have been investigating the submillimeter/terahertz camera with the large format SIS (Superconductor - Insulator - Superconductor) photon detector array. The SIS photon detectors are one of the most promising candidates for the submillimeter/terahertz camera, because the SIS detectors have higher response speed to input photon and higher dynamic range to input energy than other type of detectors. These detectors must be cooled below 1 K and have relatively high impedance, the cryogenic readout system matching these properties is necessary to realize the submillimeter/terahertz camera. For this readout system, we have developed several kind of ICs (Integrated Circuits) constructed with n-channel GaAs-JFETs.

We confirmed that the n-channel GaAs-JFETs have good cryogenic performances even when those power dissipation are low ($<1 \mu\text{W}$). We designed several kinds of ICs constructed with those GaAs-JFETs and demonstrated their cryogenic performance. We also designed and manufactured the 32-channel multi-chip-module with these ICs. Size of this is 40 mm x 30 mm x 2 mm. This module is able to make 32-channel parallel input current signals into 2 serial voltage signals. We have demonstrated those functions of the modules at the reset frequency of charge integration amplifier from 1 kHz to 1 Hz. As input current signal, this frequency range is corresponding to from 1 nA to 1 pA. The power dissipations of the modules are around 350 μW . We also have investigated those output voltage noise performances and confirmed that the noise value is appropriate. In parallel, we have investigated to connect the SIS photon detectors with the readout circuits.

In this presentation, we show the cryogenic performances of the module and the results of combination test the SIS detectors and the readout circuits. We also show applicable possibilities of this cryogenic readout system.