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Fast readout cryogenic electronics for SIS photon detectors

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Photon counting detectors for terahertz frequencies will open new frontiers in terahertz astronomy by measuring photon statistics and applying to intensity interferometry. To count large number of terahertz photons, we work on SIS (or STJ) photon detectors. In this presentation we discuss the readout cryogenic electronics with GHz bandwidth made of semiconductor circuits for the SIS photon detectors.
Single terahertz photon creates single quasi-particle current through SIS junction by photon assisted tunneling. We have successfully developed an SIS junction with low leakage current in the order of pA. The photo-voltage of the SIS junction is to be read out by cryogenic FETs with low gate leakage and capacitance. We selected two types of Gallium Arsenide FETs with junction gates (GaAs-JFET and Junction pHEMT) for this purpose. We have evaluated both types of FETs with various gate sizes at cryogenic temperature of 4 K, most of which show good I-V characteristics without anomalies such as kink or hysteresis. Typical drain current at 4 K is about half compared to that at 300 K. Gate leakage of GaAs-JFET was confirmed to be lower than fA, and Junction pHEMT is now under evaluation.
We plan to use two source followers in series, one at 0.8 K and another at 4 K, in order to decrease the output impedance down to 50 ohm to feed to the SiGe low noise amplifier. To detect a single terahertz photon, the FETs need to exhibit low gate capacitance of the order of fF to obtain signal significantly above the FETs' voltage noise. The gate capacitance of the FETs are also to be evaluated. We will present the measured performance of the FETs and discuss the prospects of terahertz photon counting.

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

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