Noise measurement of a SQUID and LNA in a FDM readout system for SAFARI

Q.Wang^{1,2}, D. Audley¹, P. Khosropanah¹, G. de Lange¹, J. van der Kuur¹, A. Aminaei, FFS van der Tak^{1,2}, J.R. Gao^{1,3}

INTRODUCTION

- SAFARI is a far-infrared grating instrument for SPace Infrared telescope for Cosmology and Astrophysics (SPICA).
- The ultra-sensitive transition edge sensor (TES) bolometer arrays of 3000 pixels, with an NEP of $2 \times 10^{-19} \mathrm{W}/\sqrt{\mathrm{Hz}}$.
- Frequency domain multiplexing (FDM) readout system for SAFARI, the readout noise should be dominated by the detector noise.
- FDM consists of LC filters, a SQUID, a roomtemperature LNA, and a DEMUX
- To identify the contribution of the SQUID and the





LNA, we measure and analysis the current and voltage noise of the LNA.

SPICA: http://spica-mission.or

FDM READOUT SYSTEM



READOUT NOISE MEASUREMENT (Details in Damian Audley's poster-270

Voltage Noise

Flux Noise in logarithmic scale

AC Transresistance



V_{DEMUX} is 173 nV/sqrt(Hz)

The measured voltage noise versus source resistance at 50 mK, with different input resistance, together with the fits , and errors $(\pm 20pV/\sqrt{Hz}, \pm 0.2pA/\sqrt{Hz})$



Source resistance Rs [Oh



 $V_n = 390 \ pV / \sqrt{Hz}$ $I_n = 5.4 \ pA / \sqrt{Hz}$



- The readout noise of the FDM dominated by the LNA and SQUID noise, the current noise referred to the input of SQUID is 18 pA/ \sqrt{Hz} in the operation mode
- Extracting the LNA noise out is hard due to the SQUID noise, determined by its settings
- To identify the contribution of the LNA, we need to measure it separately

LNA MEASUREMENT SET UP



The measured voltage noise versus source resistance at 1.3 K, with different input impedance, together with the fits , and errors $(\pm 20pV/\sqrt{Hz}, \pm 0.2pA/\sqrt{Hz})$





The voltage noise of the LNA measured with different input impedance in open and shorted circuit at room temperature



Noise temperature



 $V_n = 390 \ pV / \sqrt{Hz}$ $I_n = 5.4 \ pA / \sqrt{Hz}$



$V_n = 310 \ pV / \sqrt{Hz}$ $I_n = 5.4 \ pA / \sqrt{Hz}$ CONCLUSION

- $V_n = 390 \, pV/\sqrt{Hz}$ • $I_n = 5.4 \ pA/\sqrt{Hz}$ • $R_c = 50 \Omega$ • $k_B = \text{Boltzmann constant}$
- The readout noise of the FDM is 18 pA/ \sqrt{Hz} in SQUID's operation mode The equivalent current and voltage noise of the LNA is 5.4 pA/ \sqrt{Hz} and 390 pV/\sqrt{Hz} respectively.
- Both SQUID and the LNA have low enough noise to read out SAFARI TES array $S \Lambda F \Lambda R I$





¹ SRON Netherlands Institute for Space Research, Groningen/Utrecht, the Netherlands ² Kapteyn Astronomical Institute, University of Groningen, 9747 AD, Groningen, The Netherlands Faculty of Applied Science, Delft University of Technology, Delft, the Netherlands

Netherlands Institute for Space Research / www.sron.nl



university of groningen