## Frequency Division Multiplexed readout of TES detectors with Baseband Feedback

R.H. den Hartog<sup>1\*</sup>, M.D. Audley<sup>2</sup>, J. Beyer<sup>3</sup>, D. Boersma<sup>1</sup>, M.P. Bruijn<sup>1</sup>, L. Gottardi<sup>1</sup>, B. Jackson<sup>2</sup>, A. Nieuwenhuizen<sup>1</sup>, J. van der Kuur<sup>1</sup>, B-J van Leeuwen<sup>1</sup>, D. van Loon<sup>1</sup>

1 SRON Netherlands Institute for Space Research\*, Sorbonnelaan 2, 3584 CA, Utrecht, the Netherlands 2 SRON Netherlands Institute for Space Research, P.O. Box 800, 9700 AV, Groningen, the Netherlands 3 PTB, Abbestrasse 2-12, Berlin, D-10587, Germany

\* Contact: r.h.den.hartog@sron.nl, phone +31-88-777 5678

*Abstract*—SRON is developing an electronic system for the multiplexed read-out an array of transistion edge sensors (TES) by combining the techniques of frequency domain multiplexing (FDM) with base-band feedback (BBFB). FDM is based on the amplitude modulation of an orthogonal set of AC bias carriers with the signals detected by the TES detectors. It allows the read-out of multiple TES pixels in one channel using a single SQUID-based pre-amplifier, thus significantly reducing the heat-load on the array via the external wiring. BBFB cancels the error signal in the SQUID sumpoint and further improves the bandwidth and the loop gain.

The astronomical applications are the read-out of soft X-ray microcalorimeters in an instrument on the European X-ray mission-under-study Athena and far-infrared bolometers for the SAFARI instrument on the Japanese mission SPICA. In recent work we showed that the basic requirements on the electronic read-out noise were met, and demonstrated multiplexed closed-loop low-noise read-out of 51 pixels.

In this paper we present the baselined system design of the FDM read-out for the Safari instrument, and demonstrate multiplexed low-NEP operation for TES bolometers, as a step towards the Safari Demonstration Model. The cross-talk between pixels is measured and the relative contribution of various mechanisms discussed.