**Introduction**

Future X-ray astronomy missions require radiation detectors with high detection efficiency over a large energy band in combination with high energy resolution and imaging. Imaging arrays of microcalorimeters, operating at sub-Kelvin temperature, are considered one of the most promising options. Application of transition edge sensors (TES)-based microcalorimeters arrays are presently under consideration for Constellation-X (NASA) or the X-ray satellite mission XEUS (ESA and ISAS) as well as for several smaller missions.

**Experimental Setup**

- Voltage source $V_s$ with series resistance $R_s = 4 \, n\Omega$
- TES is voltage biased (ETB): $R_s < Z_B$
- $C_B$ is a lithographically made superconducting condensator with a dielectricum Ta-Oxide
- SQUIDs are NIST SQUID arrays with a low T$_c$ of 1.8 K
- Positive feedback via $R_{FB}$ induces a negative resistance which reduces the series resistance in the bias circuit

**Decoupling**

- For $T_{SET}=54 \, mK$ the TES switches to the superconducting state at about 1/3 of the voltage required to reach the normal state. The resistive state a voltage of about 1/2 the normal state voltage is required. For $T_{SET}=60 \, mK$ the TES becomes superconducting at 1/8 of the normal state voltage or at $< 0.04 \, R_N$. The resistive state is reached again at 1/4 of the normal state voltage.

**Q-factor**

- for good voltage bias $Q = \omega L / R_s \approx 800$
- measured $Q = 70$ due to dielectric losses in the Ta-Oxide capacitor $C_B$
- Dielectric losses characterized by loss tangent $\tan \delta = 1 / Q = R_{FEED} / (\omega C_B)$
- extra series resistance compensated by positive feedback, to the bias circuit

**Hysteresis in the I-V curves**

- $\Delta \chi = 0.90 \sim 1 \sim 1.05$
- $\tau_{EFF} \sim 10 \, mK$
- $C/G = 54 \, mK$ the TES switches to the superconducting state when $I_{FB} \sim 4 \, m\Omega$ the TES switches to the superconducting state when $\Delta \chi = 0.90 \sim 1 \sim 1.05$
- $\Delta \chi = 0.90 \sim 1 \sim 1.05$

**Acknowledgement**

This work is supported by the Nederlands organisatie voor Wetenschappelijk Onderzoek (NWO). We also acknowledge supportive discussion with Mikko Kiviranta of VTT microsensing, Espoo, Finland and the use of SQUID arrays made available to us by Martin Huber of the University of Colorado Denver, USA.

**Figures**

- First results of an AC-biased TES-microcalorimeter at 500 kHz
- Transition Edge Sensor Principle
- Frequency Domain Multiplexing
- Experimental Setup

**Discussion**

- Architecture: noise-blocked biasing, cross talk reduction
- Bias frequency defines capacitor

**Table**

<table>
<thead>
<tr>
<th>Material</th>
<th>$\varepsilon_r$</th>
<th>$\tan \delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta$_2$O$_3$</td>
<td>17.6</td>
<td>0.0004</td>
</tr>
<tr>
<td>Nb$_2$O$_5$</td>
<td>9.8</td>
<td>0.0002</td>
</tr>
<tr>
<td>Al</td>
<td>8.8</td>
<td>0.0007</td>
</tr>
<tr>
<td>Nb$_2$O$_5$</td>
<td>10.0</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

$G_{FLL} = G_{AMP} \frac{M_{BAD}}{M_{BAD}}$

$\Delta L \Rightarrow \Delta \chi \Rightarrow R_N$

$SQUID$ response in open loop for a signal on the feedback coil (red) and a signal on the TES (blue). The resistance peak at $\omega = 1 / \sqrt{(L_{FB} + L_B)C}$ and the resonance valley at $\omega = 1 / \sqrt{(L_{FB} - L_B)C}$ for $L_C = 230 \, nH$. The resonance frequency in FLL (magenta)