Characterization System of 64 Pixel Array TES Microcalorimeters

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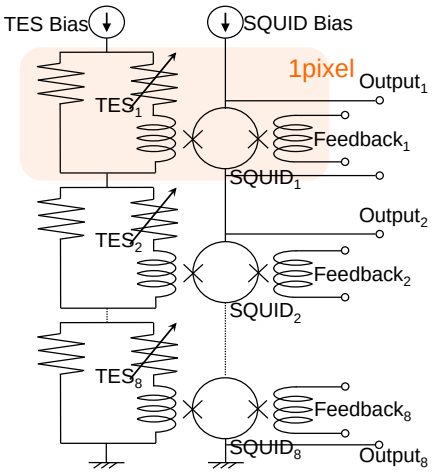
Background

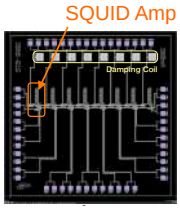
X-ray energy dispersive spectroscopy (EDS) performed on electron microscopes allows elemental composition analysis within a nano-scale structure. For element identification with high accuracy X- ray detectors with excellent energy resolution are desired in the EDS system.

The energy resolution of the SSD (Si(Li) semiconductor detector) has been achieved theoretical limit. To improve performance of EDS on electron microscopy Single pixel TES microcalorimeter EDS system has been conducted (Maehata et al. in this workshop).

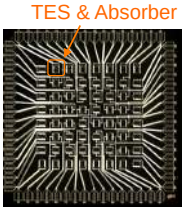
64 pixel array TES microcalorimeter
for EDS on STEM
energy resolution < 10 eV
count rate ~ 5 kcps



readout circuit
with common TES bias and common SQUID bias



8ch serial connected SQUID chip



64 pixel array TES microcalorimeter

common TES bias
common SQUID bias

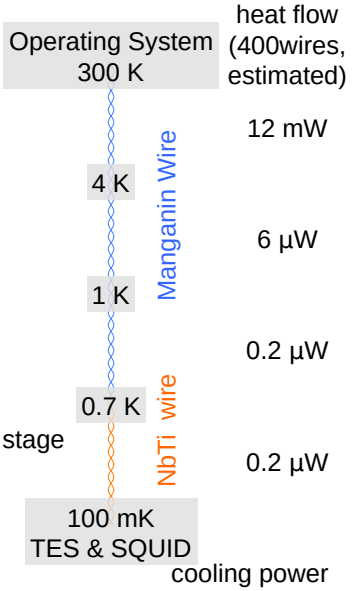
512 ⇒ 288 wires

cooling system with a number of wires
- to characterize TES and SQUID chips
- to obtain experimentally knowledge for cryogen-free DR with a number of wires for STEM

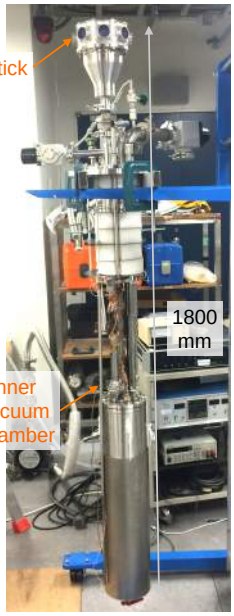
Inserted Stick with Wires

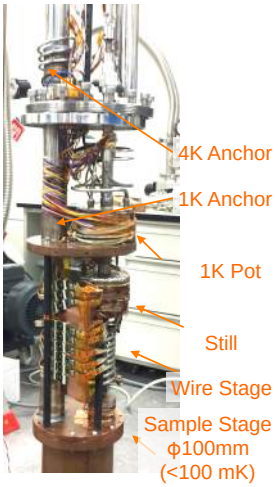
384 wires (Manganin + NbTi) are installed and thermally anchored at 4 K, 1 K, 0.7 K

stick with wires is inserted to 1K stage in the IVC into vacuuming pipe

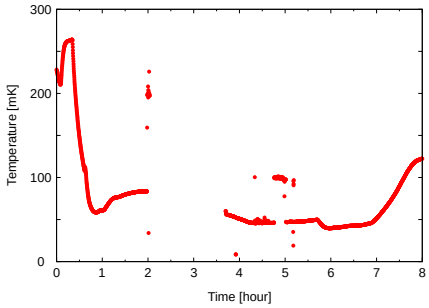


cooling power
60 μW@100 mK





- At 4K and 1K anchor wires are contacted to inside wall of the pipe by stycast
- At wire holder(contacted to 0.7K stage) wires are thermally anchored and switched from Manganin to NbTi superconducting wire



- lowest temperature ; 50 mK
- temperature holding time (<100mK) ; 7 hours
- continuous operation ; 1.5 day

Dilution Refrigerator

Mixing Chamber
- phase separating (^{3}He rich / dilute phase)
- cooled to <100 mK

Still
- distilling ^{3}He in dilute phase
- 700 mK

1K Pot
- condensing circulating gas
- cooled to 1.3 K by pumping liquid ^{4}He