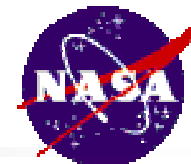


Approaching the fundamental noise limit in MoAu TES bolometers with transverse normal metal bars

Johannes Staguhn,
S. Harvey Moseley, Dominic Benford,
Christine Allen, Jay Chervenak, Thomas
Stevenson, Wen-Tin Hsieh

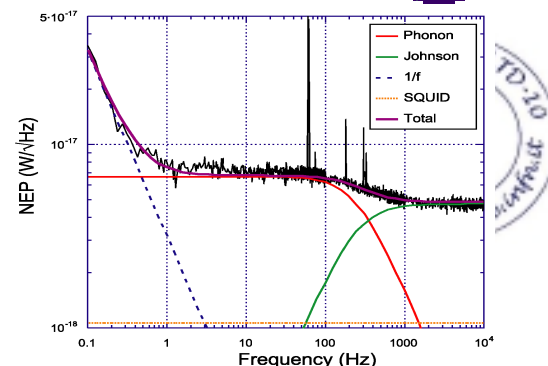
NASA/GSFC

Noise mechanisms in TES

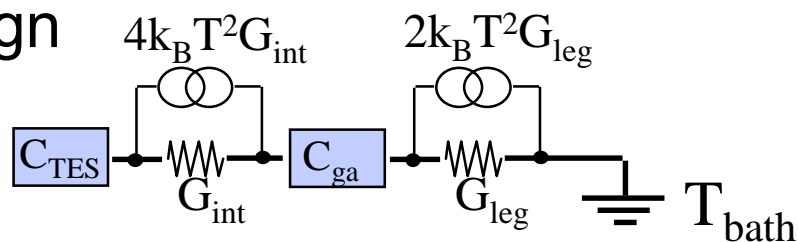


Negative electrothermal feedback limit:

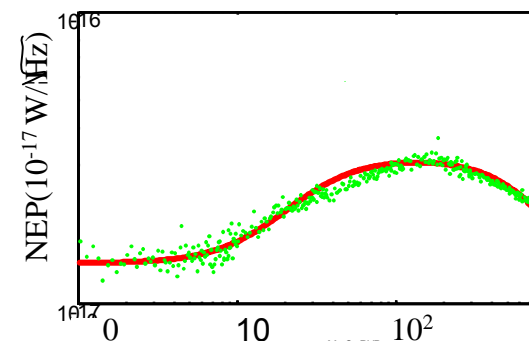
- Phonon noise limit in signal band
- Out-of-band, Johnson noise rolls off to SQUID noise floor



Thermal design

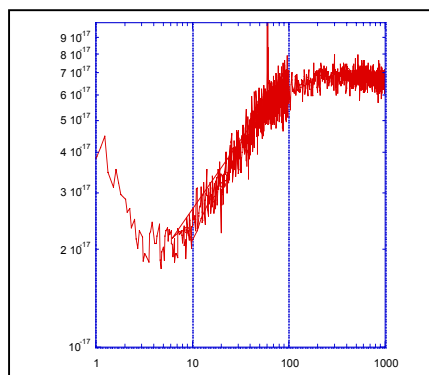


Non-ideal noise performance with intrinsic time constants

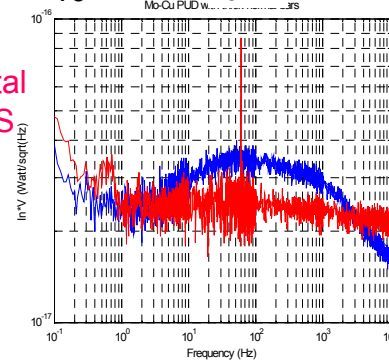


Electrical effects

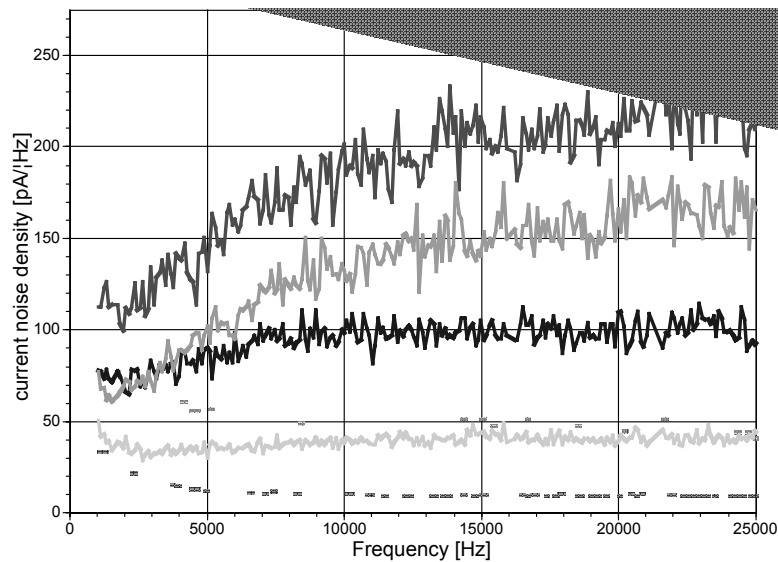
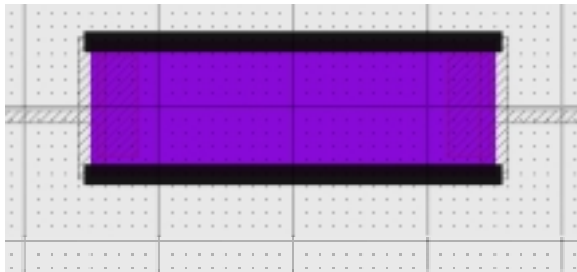
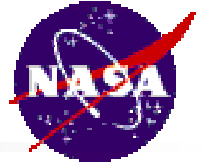
Dynamics of superconducting/normal regions. Shows geometric dependences.



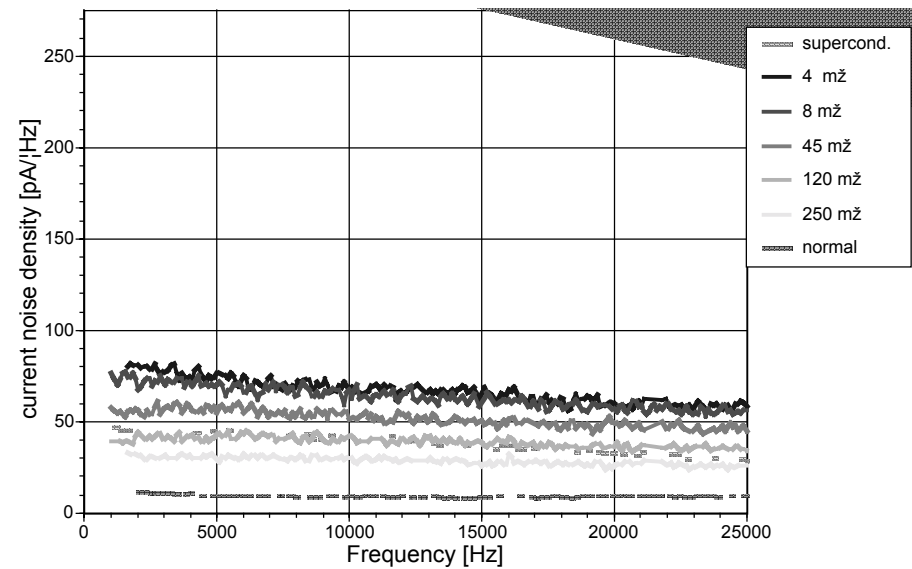
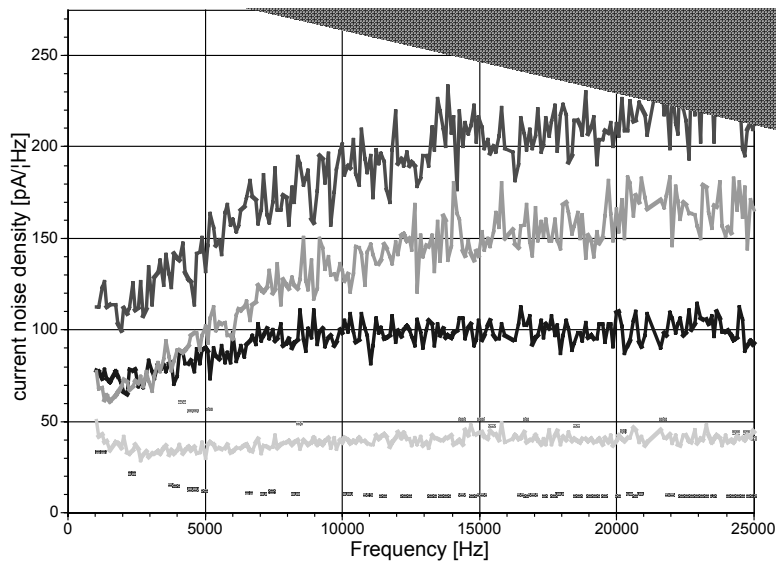
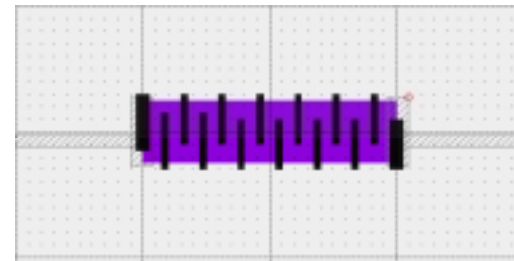
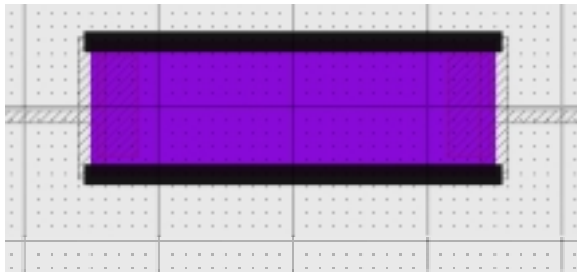
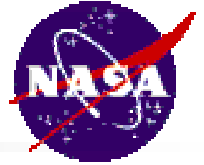
Normal metal bars on TES bolometer



Noise performance of TES devices with different normal metal geometries



Noise performance of TES devices with different normal metal geometries

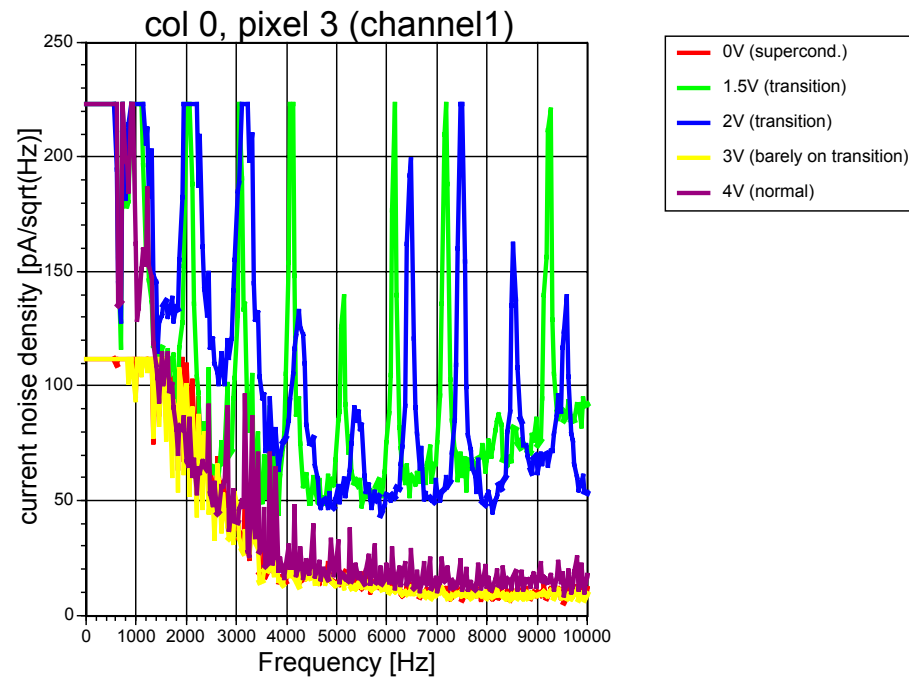
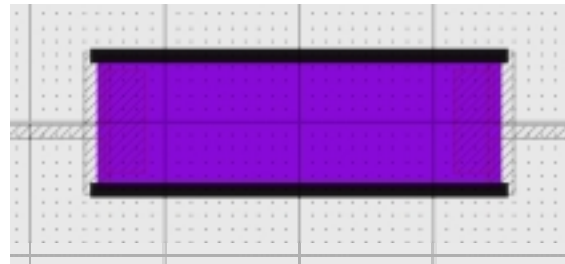
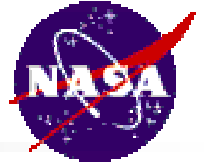


July 9, 2003

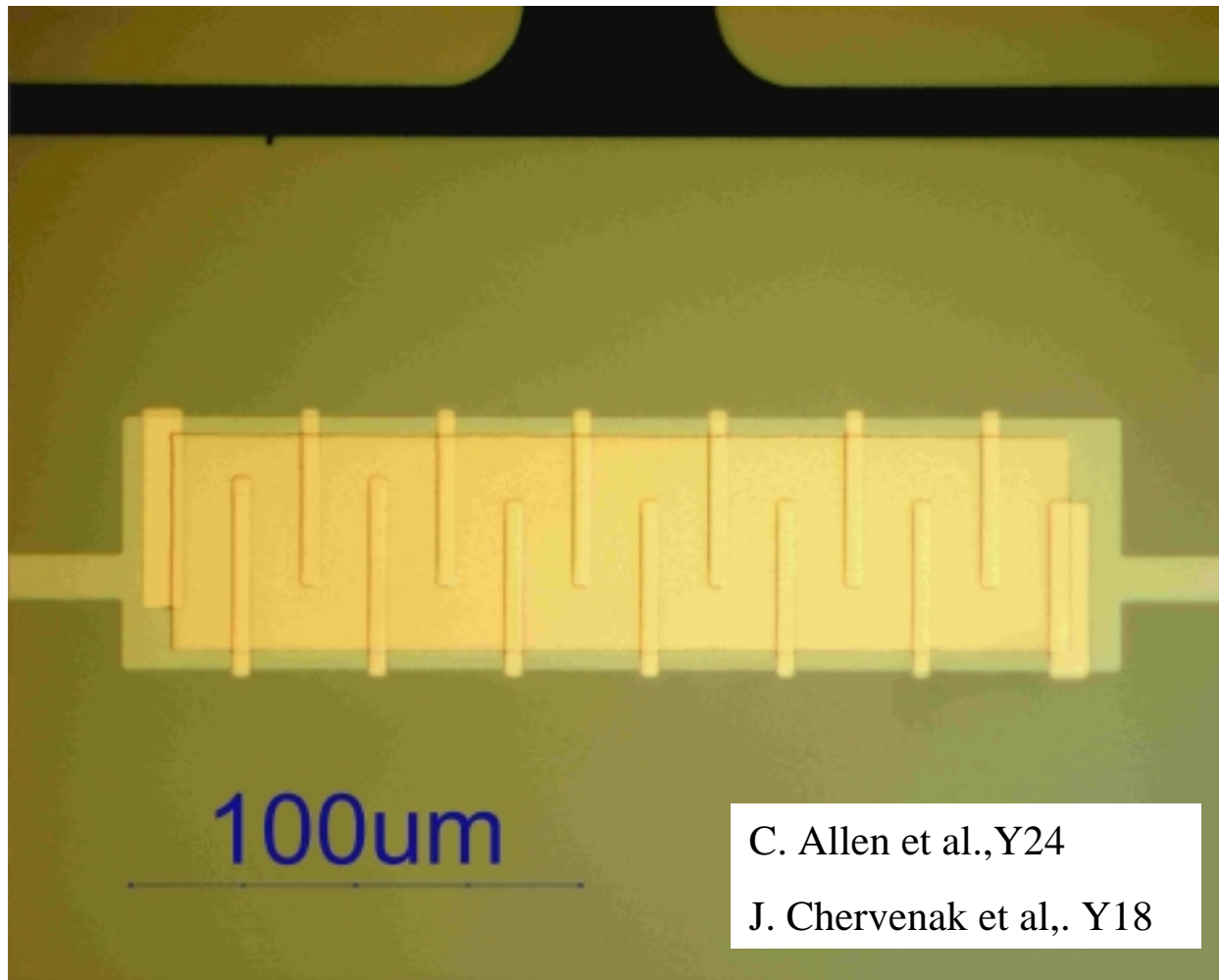
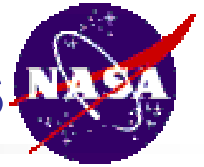
LTD-10 Genoa

R05

Noise performance of TES devices with different normal metal geometries



Noise performance of TES devices with different normal metal geometries



C. Allen et al., Y24
J. Chervenak et al., Y18

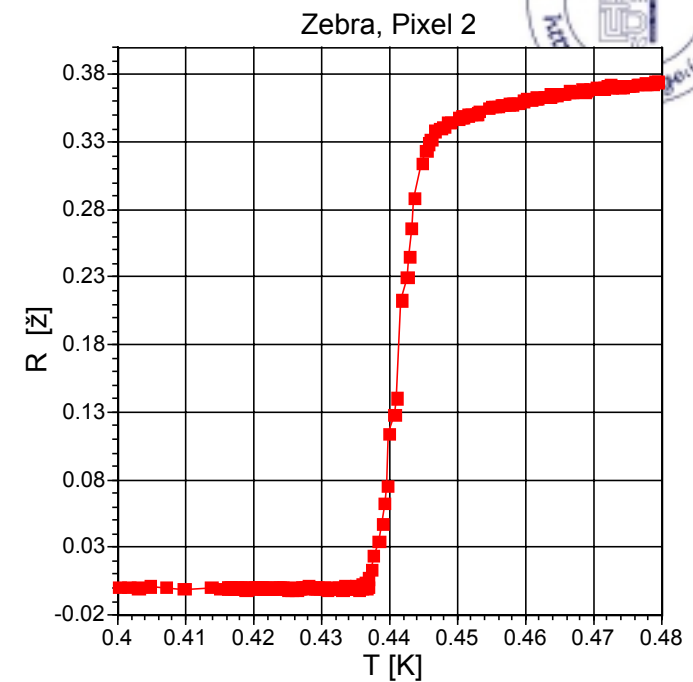
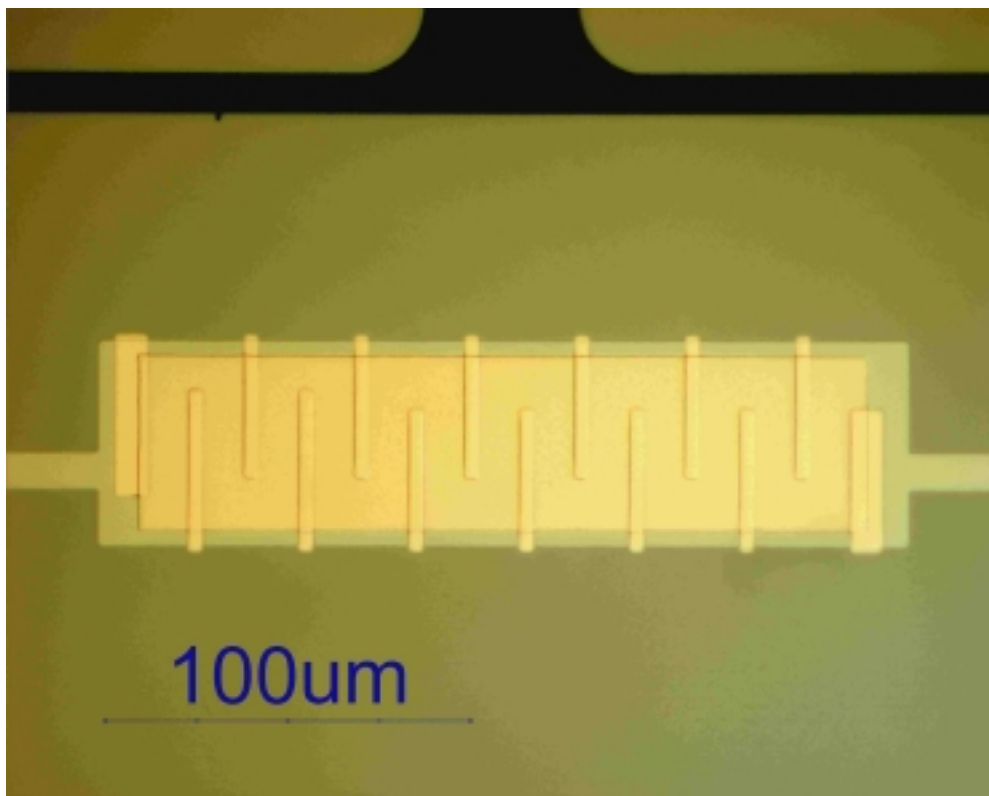
Noise performance of TES devices with different normal metal geometries



Observations

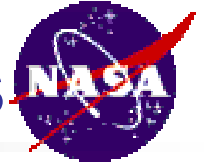
- Significant reduction of out-of-band excess noise in same wafer TES with perpendicular bars (“modified zebra”) as compared to lateral bar device (suppression of out-of-band noise essential for multiplexing)
- “Modified zebra” geometry of TES apparently imposes beneficial constraints on superconducting-normal boundaries
- Device with perpendicular bars possibly less prone to resonant noise on lower part of transition

Noise performance of TES devices with different normal metal geometries



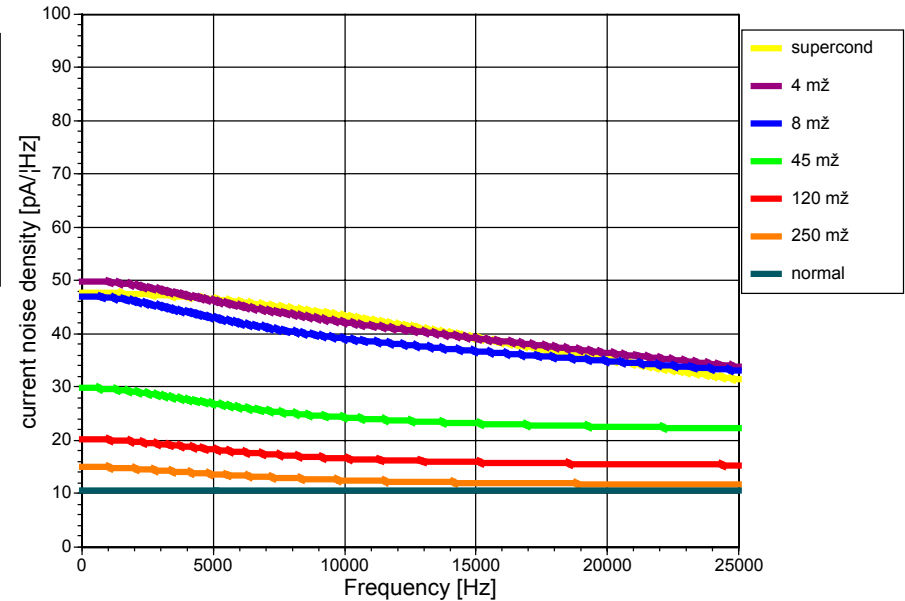
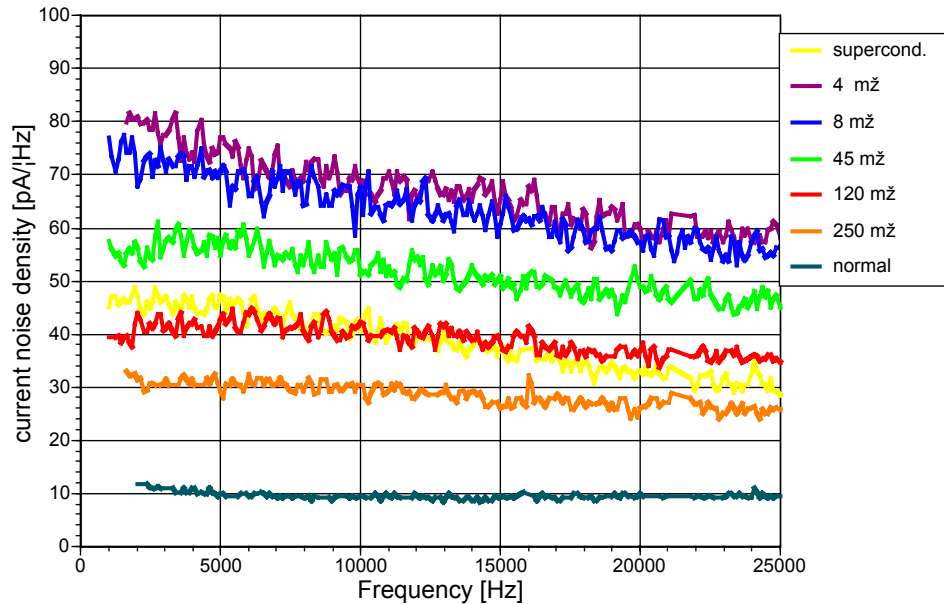
- sufficiently high α
 - $Z(\omega) \Rightarrow$ reasonable τ_e
- (Benford et al., T02)

Noise performance of TES devices with different normal metal geometries

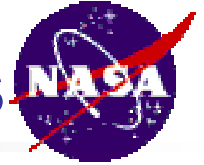


Measurement

Theory



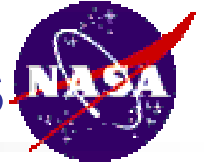
Noise performance of TES devices with different normal metal geometries



Observation

- Deposition of Bi (absorber) on TES does NOT degrade noise performance (no additional “hanging” heat capacity)
- However: still some excess noise in device
- Excess noise spectral density not consistent with white noise source in detector
- Note: Device has high normal resistance ($R_{\text{normal}} \sim 400 \text{ m}\Omega$)
=> possible excess noise source: thermal fluctuations known to be present in high R devices
- Mo leads have high heat capacity ($\sim 10\%$ of TES)
- Device has no lateral bars (parallel to current)

Noise performance of TES devices with different normal metal geometries



Outlook

- Reduce heat capacity of leads
- Lower R_{normal} devices
- Map out modified “zebra phase” space
- Use better model for devices
- Make astronomical observations with new devices (FIBRE, SAFIRE, and many more)

