OPTICAL RESPONSE OF STRAINED- AND UNSTRAINED-SILICON COLD-ELECTRON BOLOMETERS

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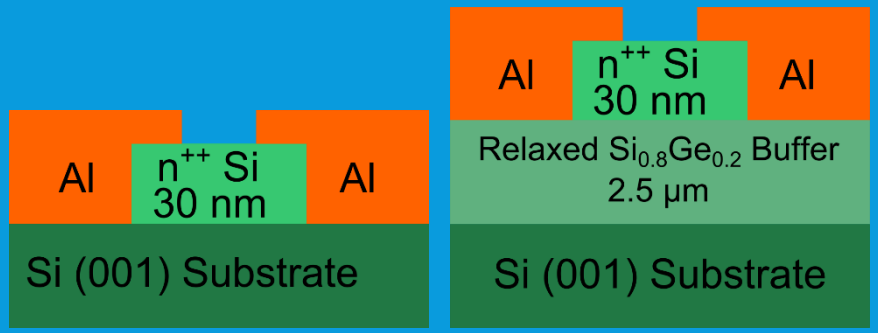
THE COLD-ELECTRON BOLOMETER

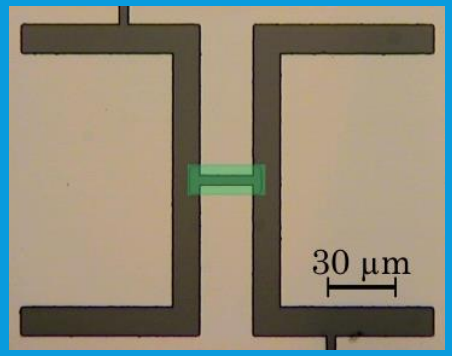
- Direct cooling of electrons in the absorber via superconducting tunnel contacts.

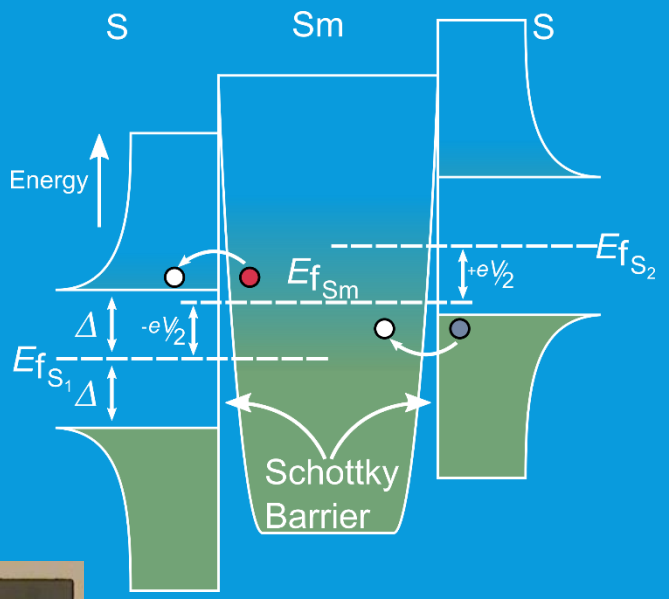


2 devices, unstrained (left) and strained (right). Strain reduces e-ph coupling

	Σ (W K^{-6} m^{-3}) × 10^7
Unstrained	52
Strained	2

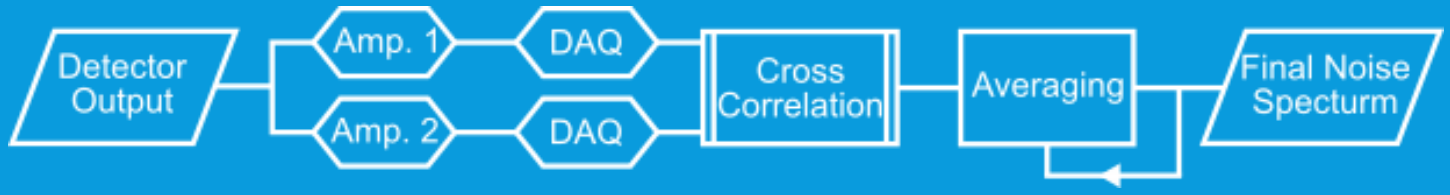
Prest et al., APL 99, 251908 (2011)



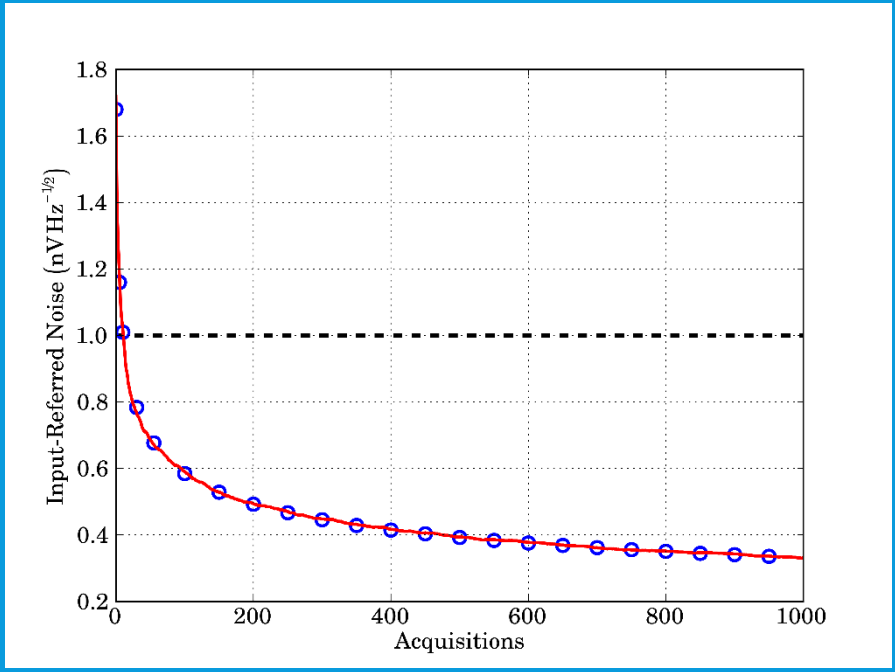


Under bias hottest electrons tunnel out of absorber (Sm) and are replaced by cooler carriers from contact. (See G3.12)

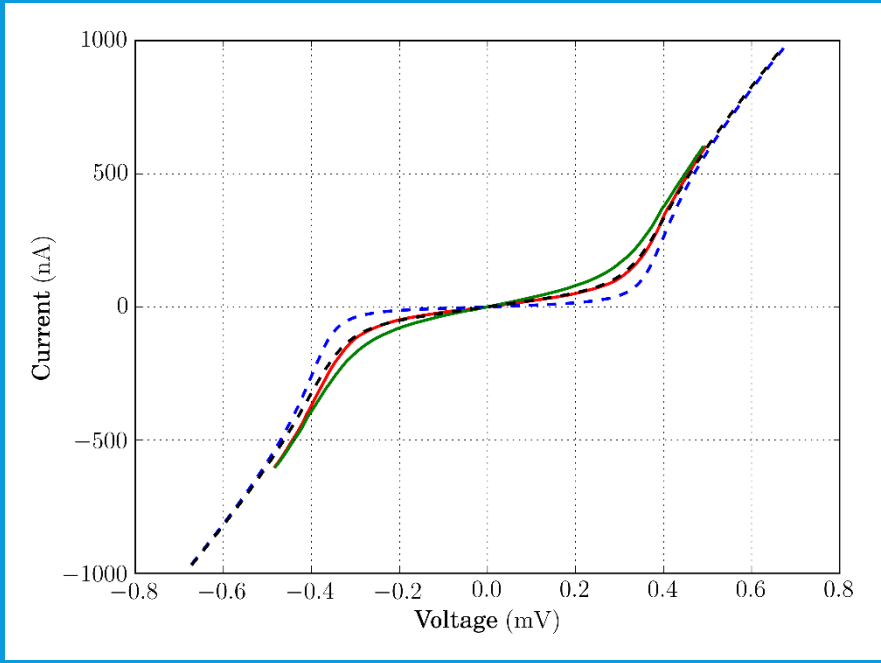
CROSS-CORRELATED NOISE REDUCTION



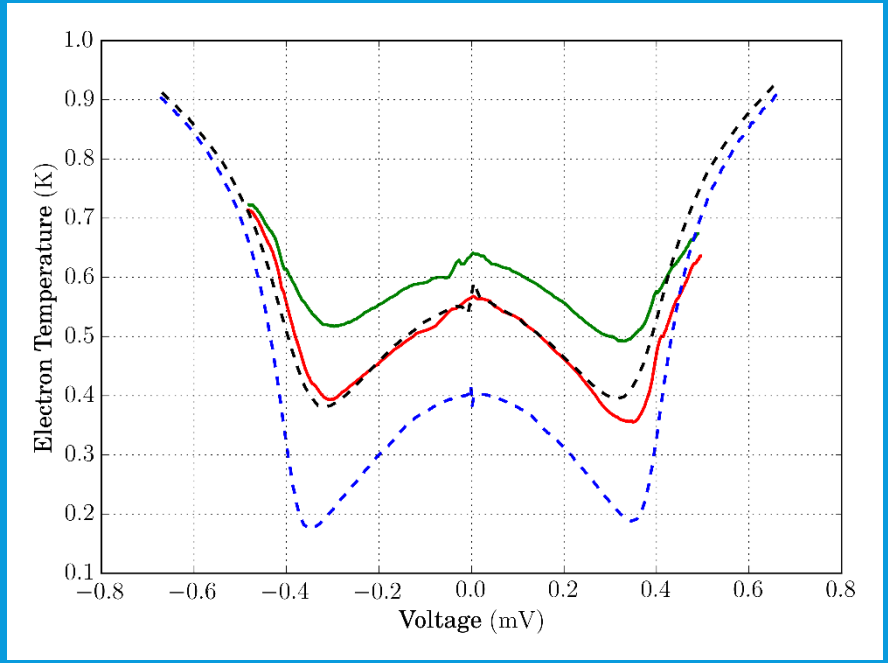
Process flow for cross-correlated noise reduction



RESULTS – ELECTRICAL



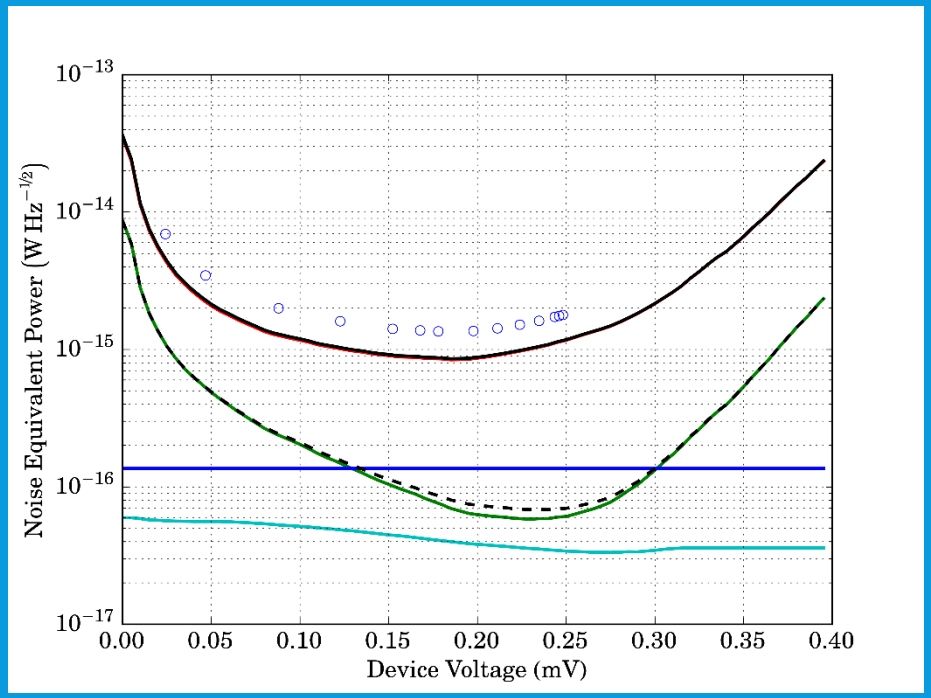
I-V



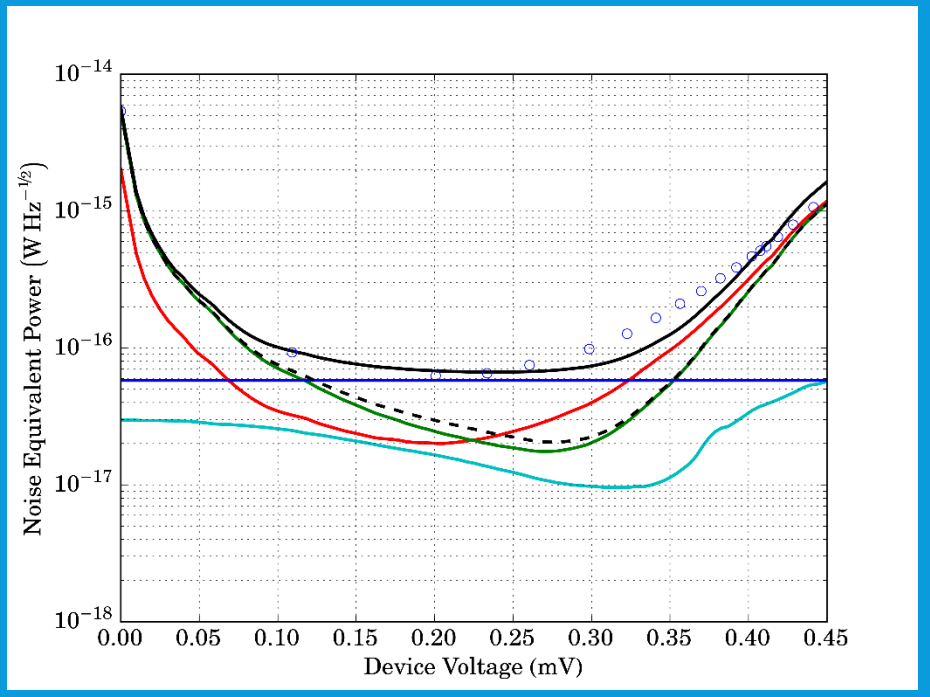
Electron Temperature

Blue – dark data, T_{bath} = 400 mK; black – dark data, T_{bath} = 550 mK;
red – optical data, 77-Kelvin source, T_{bath} = 350 mK;
green – optical data, 300-Kelvin source, T_{bath} = 350 mK.

RESULTS



Unstrained



Strained

Black – Total NEP; red – Amplifier NEP; green – tunnelling NEP; cyan – e-ph NEP; dashed – total device NEP; blue – photon NEP

Minimum NEP: Unstrained 2 × 10^{-15} $WHz^{-1/2}$, Strained 7 × 10^{-17} $WHz^{-1/2}$

SUMMARY

- Demonstrated cold-electron bolometer using strained and unstrained silicon.
- Used cross-correlated readout to try measure noise below the amplifier's limit.
- In NEP strained detector outperforms unstrained device by a factor of ~30. Unstrained $2 \times 10^{-15}\,WHz^{-1/2}$, Strained $7 \times 10^{-17}\,WHz^{-1/2}$.
- In line with reduction in e-ph coupling.

Thanks – Merci – Diolch