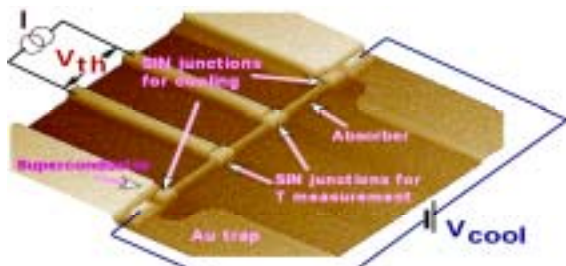


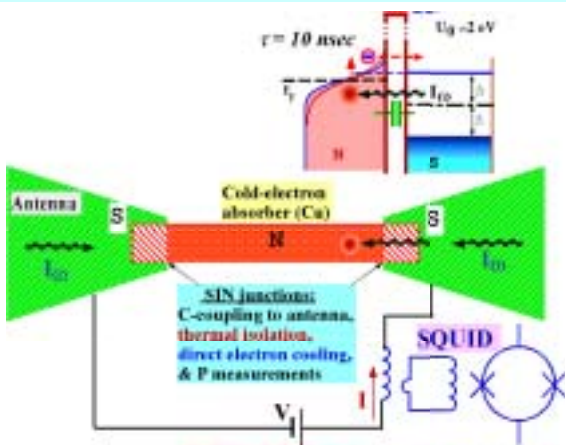
First experimental results with the new HelioxAC-V™ – demonstration of electron cooling for superconducting bolometer applications

In the last decade superconducting detectors have become the most sensitive radiation detectors of sub-mm, infrared, and optical radiation. A few modest imaging arrays for ground-based sub-mm observations are already operational and plans for building significant larger arrays are approved. Ultra-low-noise bolometers are required for space-based astronomical observations. Currently the most highly developed superconducting bolometer is the transition-edge sensor (TES). However, the TES has some disadvantages due to excess noise, saturation, and the most drastic problem of artificial overheating by dc power for feedback.

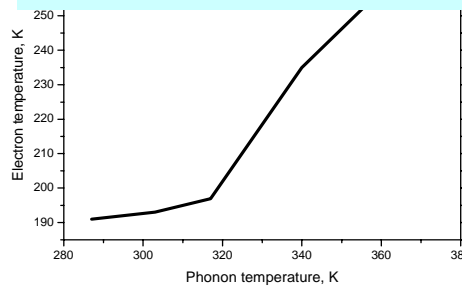
A novel concept of the Cold-Electron Bolometer (CEB) based on strong direct electron cooling of the absorber has been proposed. This concept is aimed at overcoming the unavoidable contradiction of superconducting detectors, between supersensitivity and supersaturation due to background power load. The effective electron cooling can be treated as strong electrothermal feedback.



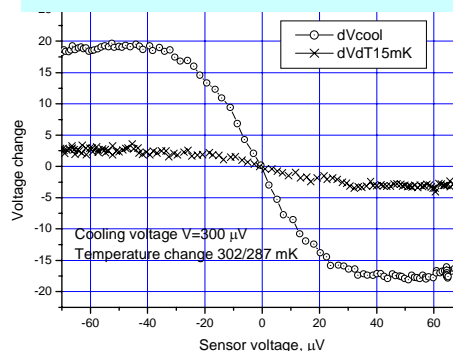
Capacitively coupled CEB with SIN tunnel junctions for direct electron cooling and power measurement.



Electron temperature vs. phonon temperature showing effective electron cooling down to 190mK



Changes in sensor voltage under electron cooling (O), and with temperature change by 15 mK (X)



These data have recently been produced to demonstrate electron cooling using the new HelioxAC-V™ 3He refrigerator; the first time that this has been achieved with such a compact and versatile system.

In contrast to TES, an additional artificial dc heating for electrothermal feedback is replaced by deep electron cooling removing all incoming power from the absorber to the next stage and keeping minimum temperature (less than phonon temperature for small level of power). Noise properties (NEP) are considerably improved by decreasing the electron temperature. All incoming power is removed from the supersensitive absorber to the next stage of readout system – a SQUID with considerably higher dynamic range.

These developments could lead to a breakthrough in the realisation of supersensitive detectors. Additional advantages of such detectors are easy integration in arrays and the possibility of polarisation measurements. The HelioxAC-V™ will provide opportunities to exploit this technology through better integration into more demanding experimental environments.

Acknowledgements and research programme contacts

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HelioxAC-V™ product profile

The HelioxAC-V™ 3He refrigerator is a breakthrough in ultra low temperature cold stage technology for <300mK applications. This system employs ActivelyCooled™ technology, using a compact state of the art pulse tube refrigerator, enabling operation without the need for liquid cryogen services.



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