ADR based sub-Kelvin cryostats for applied quantum technologies

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In view of the increasing demand for the cooling of quantum electronic devices, the development of scalable cooling solutions providing low temperatures independent of rare helium-3 will be mandatory for the adoption and commercial use of next-generation quantum technologies. We present novel cryostats[1] specifically developed for the characterization and operation of quantum devices at sub-Kelvin temperatures, based on adiabatic demagnetization refrigeration (ADR). We describe how continuous sub-Kelvin cooling and wide-range temperature control can be achieved by combining multiple ADR units and mechanical thermal switches. We also present a novel sample loader mechanism[2] that allows cooling samples from room temperature to below 100 mK in less than 3 hours, as shown in Figure 1. Finally, we show how these novel tools can be used to study low-temperature characteristics of, e.g., superconducting films and resonators (Figure 2).

References

[1] Regnat et al. (2018) Cryogen-free cooling apparatus (EP 3163222). European Patent Office.
[2] Spallek et al. (2022) System and method for inserting a sample into a chamber (EP 3632560). European Patent Office.
[3] D. Zoepfl, et. al. | AIP Advances 7 | 2017 | 10.1063/1.4992070

Figures

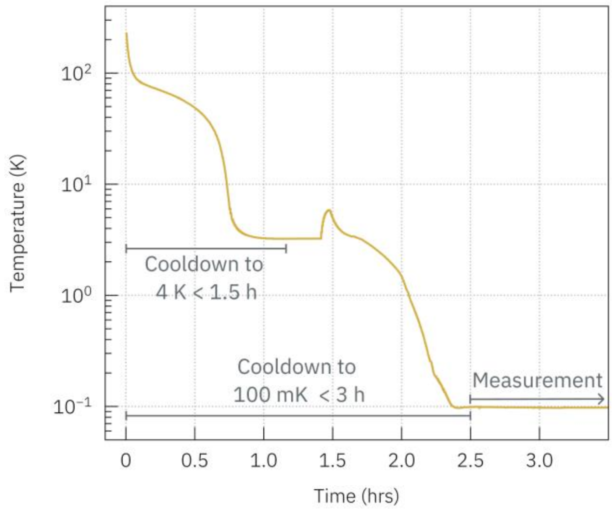

Figure 1: Sample cooldown curve from room temperature to 100 mK in less than 3 hours.

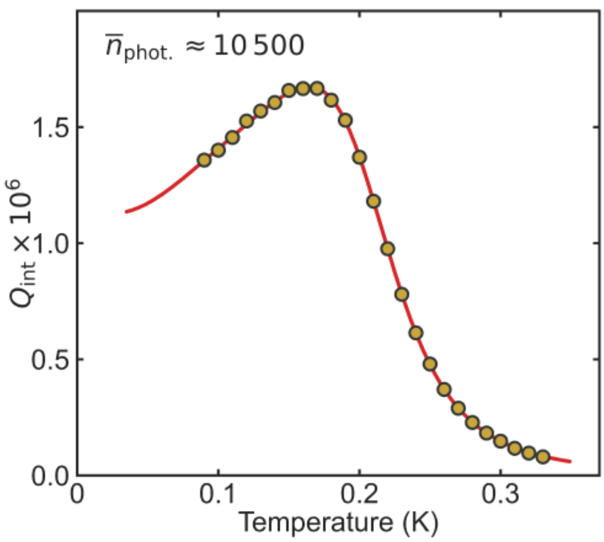

Figure 2: Temperature dependence of the internal Quality factor of an aluminium-based superconducting resonators at ~ 10 500 photon counts. The red line is a fit to a combined TLS + surface impedance model according to Ref. [3].