ADR based sub-Kelvin cryostats for applied quantum technologies

Pau Jorba[1]
Felix Rucker[1], Steffen Säubert[1], Alexander Regnat[1], Jan Spallek[1], and Christian Pfleiderer[2]

1 kiutra GmbH, D-81369 Munich, Germany
2 Physics Department, Technical University of Munich, D-85748 Garching, Germany

pau.jorba@kiutra.com

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 adiabatic demagnetization refrigeration (ADR) based sub-Kelvin cryostats[1] specifically developed for the characterization and operation of quantum devices. We address how known challenges of ADR systems such as limited hold time and magnetic stray fields can be overcome. Specifically, 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 taking advantage of the solid-state nature of ADR to cool samples from room temperature to 100 mK in less than 3 hours, as shown in Figure 2. Finally, we show how these novel tools can be used to study low-temperature characteristics of, e.g., superconducting films and resonators.

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.

Figures

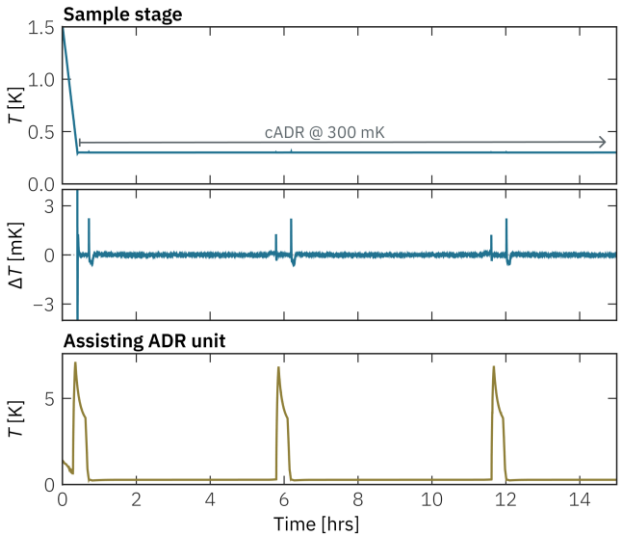

Figure 1: Accurate temperature control of the sample stage during continuous ADR (cADR) cooling. The temperature *T* of the sample stage and its stability Δ*T* are shown. The assisting ADR unit recharges automatically during operation.

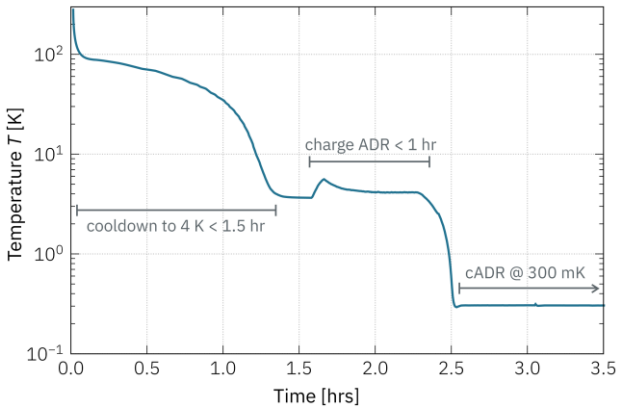

Figure 2: Cooldown curve of a sample from room temperature to continuous operation at 300 mK.