A microKelvin cryogen-free platform

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Cryogen-free dilution refrigerators coupled with superconducting magnets[1] allow the possibility of extending the temperature range accessible using completely cryogen-free systems into the μK regime by adding an adiabatic demagnetisation[2] stage to the refrigerator.

Here we present results from a cryogen-free nuclear demagnetisation cryostat utilising $PrNi_5$ as the refrigerant. Initial tests have attained temperatures of below 700 μK, as measured with a current-sensing noise thermometer mounted on an experimental plate. We find a hold time in excess of 24 hours at temperatures below 1 mK is possible, corresponding to a residual heat-leak into the nuclear stage of ~ 5 nW.

The system requires only a modest (6 T) magnet to provide the initial entropy reduction and could be retrofitted to existing systems, that are suitable to operate such magnets, with minimal effort.

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2. Debye, P. (1926). "Einige Bemerkungen zur Magnetisierung bei tiefer Temperatur". Ann. Phys. (Leipzig) **81** 1154-1160

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