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C2Or2A-03: Implementation and testing of a 100 mK ADR cryocooler backed by a 4He/3He sorption fridge for CMB-S4 project

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CMB-S4 is a ground-based experiment that will use large-format bolometer arrays to map Cosmic Microwave Background (CMB) polarization with unprecedented sensitivity, including the search for a B-mode polarization pattern associated with cosmic inflation. The focal planes on which the superconducting detectors are mounted each weigh about 20 kg and must be cooled at 100 mK. To reach this temperature for a first receiver fielding prototype hardware, we have developed an Adiabatic Demagnetization Refrigerator (ADR) used in conjunction with an existing 4He/3He sorption refrigerator.
The ADR unit described here is based on a CPA pill (crystal alum, CrK(SO4)2 12 H2O). It is backed by a 3-stage (4He/3He/3He) sorption fridge, coupled through a 3He gas-gap heat switch. This heat switch is connected to a 3He stage of the sorption fridge to dissipate the heat generated by magnetization. The ADR is cycled with a 1.5 T magnetic field. The residual field at the location of the detectors is kept below 50 µT thanks to a ferromagnetic magnetic shield. The pill is supported by Kevlar lines, which are doubly intercepted by the 4He and 3He stages of the sorption fridge in order to reduce conductive heat losses. In these conditions, the ADR provides 2 µW of cooling power during 48 hours at 100 mK. This ADR has been designed by CEA/DSBT in France and is now implemented in a cryostat at Caltech.

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