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[Invited Oral] Low-loss damping of the intrinsic temperature oscillations of 4 K pulse tube coolers

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The absence of moving parts inside their cold head, which results in low vibration level and high reliability, distinguishes pulse tube coolers (PTC) from other regenerative cryocoolers. However, residual disturbances originating from the periodic pressure oscillation remain for PTCs just like for Gifford-McMahon coolers. One of these effects is the variation of the cold flange temperature with the periodic pressure cycles. Depending on the application, this variation in temperature can disturb the cooling of detectors or superconducting voltage standards where stable temperatures are mandatory.

Here, a concept for damping the intrinsic temperature variations of PTCs suitable for high cooling powers is presented. As a key component, a small pot made of copper (volume approx. 0.2 liters) located at the cold flange of a two stage 4 K PTC. From an outer tank (e.g. 4 l gas bottle), helium can be liquefied into the pot by use of precooling heat exchangers at the two cooling stages. The high specific heat of the liquid helium together with the heat transfer through two-phase-flow ("thermosyphon") stabilizes the temperature without notable losses of cooling power over a temperature range from 2.2 K to 5.0 K. An amount of 35 cm^3 of liquid helium dampens the peak-to-peak temperature oscillation from 240 mK down to 15 mK near 4.2 K with 0.7 W of heat load on the cold stage. The unit can be included in a 4 K PTC as a closed cycle system and is maintenance free.

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