

# Modular nitrogen boiling thermosyphons for multi-kiloampere current lead cooling

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A high cooling power, low-complexity and inexpensive system for pre-cooling of multi-kiloampere current leads based on nitrogen boiling thermosyphon flow in a modular heat interceptor part is presented. This heat interceptor module can be placed between the resistive and high temperature superconductive part of the current leads to minimize thermal loads to a connected cold mass. Two prototype heat interceptors with similar cross-sectional areas and wetted boiling surface areas but different coolant channel geometries were designed, manufactured, and characterized with artificial heat loads simulating current lead heat loads. The prototypes displayed a bottom temperature below 79 K up to top heat loads of  $(0.90 \pm 0.09)$  kW for the wide-channel design and  $(1.25 \pm 0.05)$  kW for the thin-channel design. The results show relatively simple designs of heat interceptor modules that offer cooling capacities sufficient for intercepting heat loads from high-power current leads using a passive system. These modules can form a cheap, compact, and passively safe current lead heat interception system for superconductive experiments. The system can be especially beneficial when combined with low-capacity cryocoolers or may be used as an additional or backup cooling system in current leads for large-scale high-current superconducting experiments such as ATLAS and CMS. A small storage Dewar can supply enough cooling power for a slow discharge of a cold mass in case of a power failure .

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