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Heat transfer and thermodynamic stability study of a self-sustained vertical cooling loop in He I and He II

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One of the cooling concepts of prototype cavity structures for the FCC is based on a self-sustained convection loop (open thermosyphon) with liquid Helium as a cooling fluid. A suggested novel cavity type is named Slotted Waveguide Elliptical Cavity (SWELL) with an estimated heat load for the 1.3 GHz prototype of 70 W. A vertically oriented 131 mm high cooling channel of 30 mm-diameter and needs to cool the main copper body of the niobium coated cavity quadrants. A stability effectiveness and thermal stability study will be presented for saturated liquid helium conditions at 4.2 K and 1.9 K He bath temperatures. The generated He flow in this cooling loop is generated in a self-sustained loop from a supply LHe bath. Tests of the heat transfer and flow stability have been conducted in a glass cryostat to compare recorded temperature data with the filmed flow behavior in the cooling channel. Short bursts of helium gas blowouts are recorded in the 30 mm tube cross section for a heat flux of 2.5 W/cm2 in He II conditions. The observed effects can be traced back to exceeding the critical heat flux in He II vertical cooling arrangement. The heat transfer data of nucleate boiling in He I and saturated conditions in He II are compared.

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