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Time-dependent thermal modeling for the TUCAN source

Wednesday 9 June 2021 13:05 (10 minutes)

I will discuss two time-dependent models of systems relevant to the cryogenic function of TRIUMF Ultra-Cold Advanced Neutron (TUCAN) source. The first is a natural circulation system (thermosyphon) which cools the LD_2 moderator. The moderator experiences a heat load of 60~W for the design proton beam current of 40~μA, and is cooled to 20~K using a distant cryocooler at higher elevation. The thermosyphon features no moving parts and single-phase (liquid) operation. A key discovery made through these studies is that the thermosyphon will continue to flow despite the finite duty cycle with the proton beam pulsing at minute-long timescales. The second example relates to time-dependent models of heat transport in superfluid helium (He-II). At full beam power, $\sim$10~W of heat must be transported by thermal conduction via a 2.5~m long, horizontal channel of He-II to a Cu heat exchanger, while keeping the UCN production bottle at $\sim$ 1~K. Normally, we think of He-II as having infinite thermal conductivity. But at lower temperatures or high heat loads, heat transport via the normal component is impeded by vortex tangles in the superfluid component. This Gorter-Mellink thermal conduction regime is expected to limit the cooling of the UCN production volume, and it has led us to drastically change the layout of our (horizontal) UCN source upgrade compared to the previous (vertical) source. I will discuss the time-dependence of temperatures, modelled for both sources, and compared with data in the case of the vertical source.

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