Bryant Mueller
PhD Candidate
Mechanical Engineering

Room 1335 ERB

Email: bwmueller@wisc.edu
Hometown: Two Rivers, WI

A two condenser pulsating heat pipe for use as a passive thermal disconnect with redundant cryocooler implementations

- Pulsating heat pipes (PHPs) are multi-pass, closed-loop serpentine tubes containing a two-phase fluid [see Figure 1]
- Oscillating flow of fluid slugs in the PHP fluid is driven by evaporation (via heat input in the evaporator) and condensation (via heat removal in the condenser); No mechanical pumps are needed
- PHPs can provide improved effective conductivity compared with copper cylinders of equal cross section

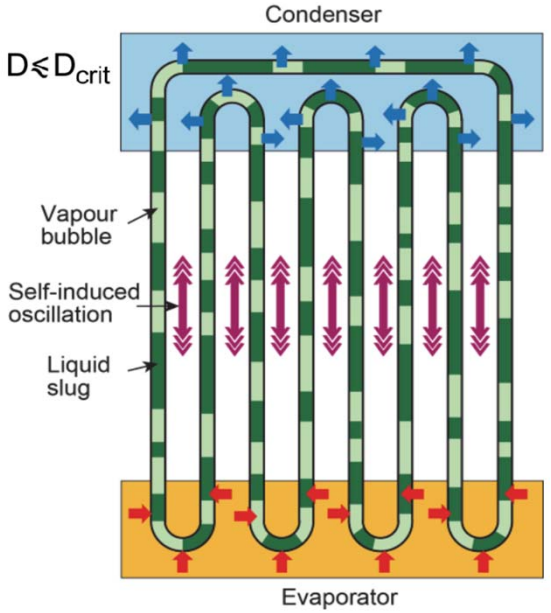

Figure 1: Schematic of a PHP

- PHPs consisting of a single closed fluid circuit + multiple evaporators thermally isolated from each other + a single condenser have been previously built and tested
- In such devices, excessively high heat loads applied to a single evaporator causes dry-out (evaporation of liquid slugs) *in only that evaporator*, while the remaining evaporators continue to operate with liquid slugs present (see 'Evap2' temperature runaway with stable 'Evap1' and 'Evap3' temperatures in Figure 2)
- The linear temperature increase in time of the dry evaporator [see Figure 2] indicates that the evaporator subjected to high heat load becomes thermally isolated from the operating evaporators

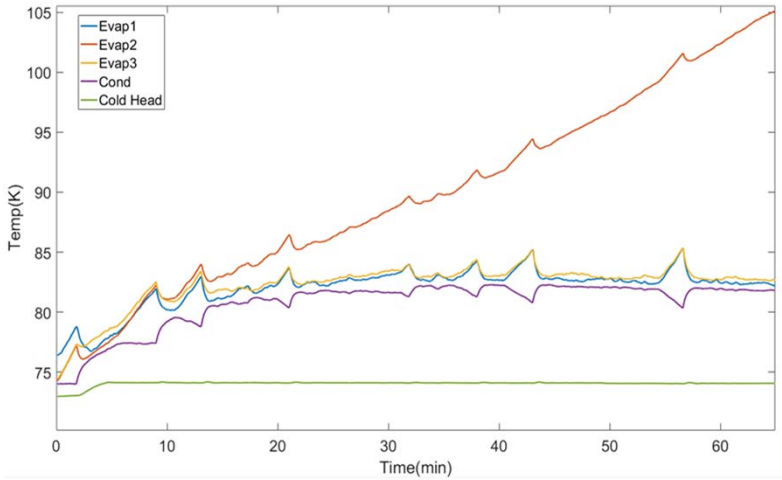

Figure 2: Single evaporator temperature increase due to dry-out in a multi-evaporator PHP.
[Development of a Multiple Evaporator Nitrogen Pulsating Heat Pipe for Space Cryogenics Applications, Mok 2017]

- This project is a proof-of-concept for a similar PHP device, but instead with two condensers thermally isolated from each other + a single evaporator + a single closed fluid circuit [see Figure 3].
- The PHP in Figure 3 is designed to take advantage of dry-out in a single condenser if a single cryocooler is removed. In such a scenario, a parasitic heat load is introduced to the condenser with the removed cryocooler and dry-out should occur in that condenser. The dry-out should create sufficient thermal resistance to allow the cooling of the evaporator with the remaining cryocooler
- Proof-of-concept will be demonstrated with nitrogen as the working fluid, followed by helium
- Key design features include
  - the use of a PHP as a passive thermal switch, allowing redundant cryocooler connections to the heat load
  - high reliability due to lack of moving mechanical parts

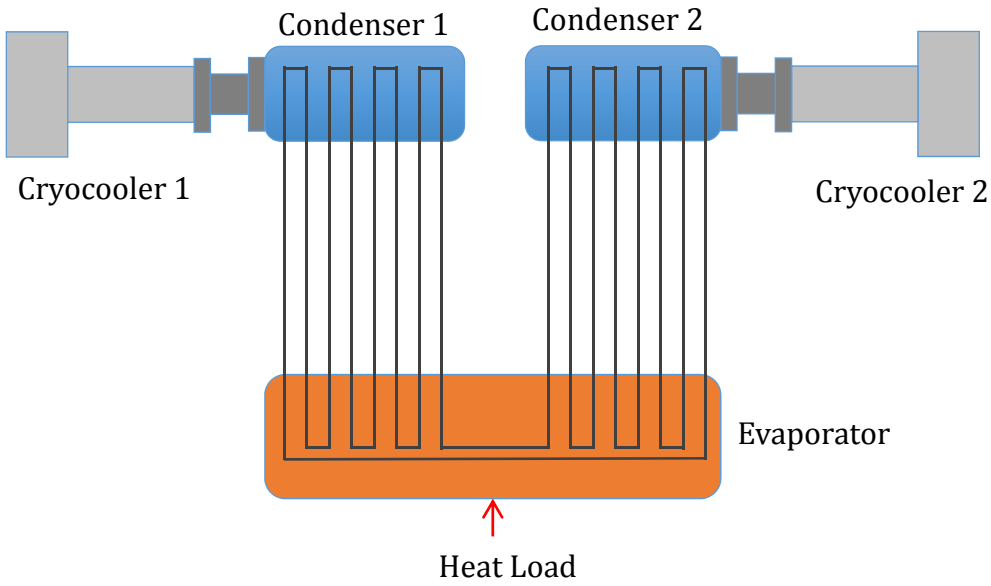

Figure 3: Schematic of a PHP intended for use as a passive thermal disconnect with redundant cryocoolers