Motivation
With the miniaturization of power systems, we need more efficient heat transportation/dissipation technology. Pulsating heat pipes are a type of system that shows great promise since it is a two-phase flow passive transportation system that can, depending on the number of loops, work regardless of the orientation. The development of such systems, however, is hindered by the rate of prototyping and testing. Therefore, a simulation code is required to estimate the heat load of pulsating heat pipes that can solve for the thermal and dynamic behaviors within a reasonable timeframe.

Purposes
Optimize the already existing code to represent more accurately the physical behaviors of CLPHPs. Resolve the energy unbalance between the heat entering and leaving the system. Introduce additional models: ◊ Nucleation model to identify the local superheated threshold ◊ Pressure Drop in the Bends ◊ Implement Uniform Heat flux boundary condition with wall storage capacity and wall axial conduction Validate the various selection of models through a quantitative comparison with the results of an experiment conducted externally

Heat Transfer
◊ Applying the Three-Zone Model for heating and cooling in bi-directional flow with temperature boundary conditions
◊ Developing flow in liquid slug ◊ Thin film conduction in elongated bubble

Kinetic
◊ Solving for only the motion of the slug using Runge-Kutta 4th order iteration scheme ◊ Neglecting the dynamic of the vapor plugs and liquid film

Wall Temperature Analysis
• Temperature in the Evaporator is dependent on the loop’s ability to evacuate heat through the flow instead of axial conduction.
• Higher flow thermal resistance ⇒ Higher wall temperature in the Evaporator • evaporators with lower average fraction of liquid evacuates more heat through the wall.
• Center of oscillation has higher HTC through film conduction and thus less heat dissipation axially through the wall.

Validation with uniform Heat Flux B.C. in the Evaporator
• Most of the results are within 30% • Can use a scaling factor (J1) to fit results to a prototype • Saturation of the effect of increasing nucleation when the heat load is increased

Initial Film Thickness Model
\[ \delta_0 = C_{fb} \left( \frac{V}{\rho_{fb} g \beta T_{wall} / X} \right) \left( (0.0735u^{0.4}) + 0.1 \right) \] 
\[ C_{fb} = 1.0 \]

Conclusions
The updates presented improved the energy balance and physical representation of the simulation code. Furthermore, the results follow closer the experimental trend. The dynamic of the film and vapor should be included since they can have a significant impact. When the orientation is not horizontal, the falling of film into or from the evaporator would drastically change the amount of film available for evaporation.

The introduction of wall heat capacity and axial conduction allowed the use of a greater variety of boundary conditions. In addition, the validation of the new version of the code with the wall capacity and axial conduction shows greater promise. Further validation should be performed using a larger database as it would allow a more robust selection of models.