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# *An Exploration about a Micro-Cryocooler with Warm-Displacer Phase Shifter*

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The displacer type pulse tube cryocooler can theoretically achieve any phase angle between the pressure and volume flow oscillation, and recover the expansion work at the pulse tube warm end. Significant developments with the displacer approach have demonstrated very promising improvements to the efficiency, as compared with the other phase shifting options. Extending this same phase shifting approach to a miniature pulse tube cryocooler may provide advantages over the other alternatives, since for example even inertance tubes are severely limited in their phase shifting capability when the associated acoustic power decreases below 20W. The detailed design method associated with the displacer is shown in this work, introducing the method for choosing the major parameters of the displacer in order to obtain a desired phase angle for a micro-cryocooler. An example case displays the coupled relationship between the displacer radius and mass, piston axial length, frequency and spring stiffness. The same parameters couple the piston displacement to the phase angle between the piston displacement and piston force. A number of 3D parametric maps are generated relating the various key design parameters and providing the means for a rough initial displacer design. Additionally, the displacer-rod diameter ratio is shown to influence the micro displacer piston performance. Rod diameter ratios in the range of 0.14 to 0.32 were explored in this work.