Characterizing Vibrations in Qdrive Cryocoolers

What is a Cryocooler?

- Standalone cooler that uses an acoustic Stirling cycle to cool a system to 60-80 Kelvin

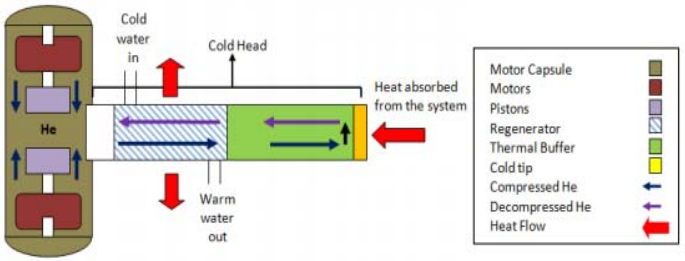


Figure 1: Cryocooler Schematic

Long Term Objective:

- Minimize vibrations of the cryocooler for operation in sensitive environments.

Past Work:

- Measured acceleration at critical points of vibration at various power levels, phase shifts and motor configurations

Semester Objective:

- Determine forces at the coldhead and PWG in X, Y & Z directions under four different conditions
  - Massive and Isolated Mounting
  - Rigid and Flexible Transfer Lines

Testing Design:

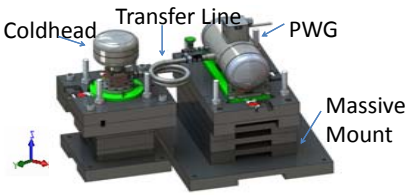
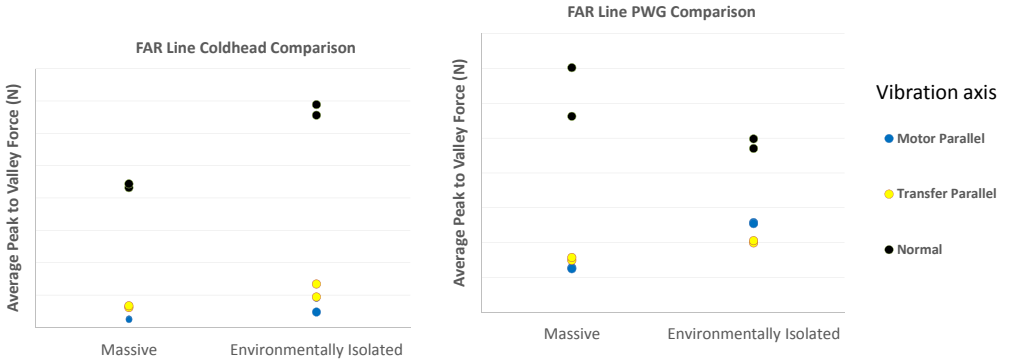


Figure 2: Rigid Line, Massive Mount

Figure 2: Flexible Line, Isolated Mount

Typical Results:

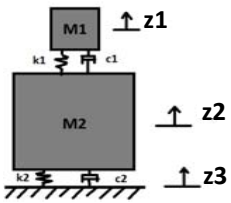


Peak to Valley Forces at different conditions

Dynamic Model:

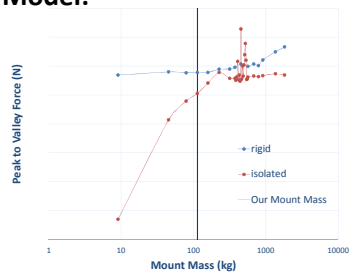
$$\ddot{z}_1 = \frac{k_1}{m_1}(z_2 - z_1) + \frac{c_1}{m_1}(\dot{z}_2 - \dot{z}_1)$$

$$\ddot{z}_2 = \frac{k_2}{m_2}(z_3 - z_2) + \frac{c_2}{m_2}(\dot{z}_3 - \dot{x}_2) - \frac{k_1}{m_2}(z_2 - z_1) - \frac{c_1}{m_2}(\dot{z}_2 - \dot{z}_1)$$

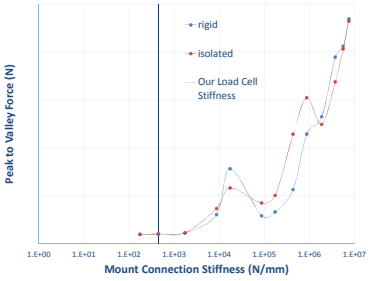


Free Body Diagram

Parametric Evaluation of Dynamic Model:



varying mass



varying mounting stiffness

Accomplishments

- Successful three axis characterization of forces: two components, two cooler configurations, two mount/ support configurations
- Dynamic model used to compute an equivalent forcing function