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Project: Vanadium Superconducting Heat Switch
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Sponsor: NASA

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Background

- Advanced astrophysics mission instruments require cooling to <1K
  - Modern tech for this is the CADR: Continuous Adiabatic Demagnetization Refrigerator
  - The CADR needs a superconducting heat switch to operate
    - Higher switching ratio → more efficient cycle
    - **Improving the heat switch will increase the volume and quality of space data collected by future missions**
- Current superconducting heat switches use lead as the switching element
  - Primarily because it is easy to source in high purities
  - Switching ratio x $T_{operating}^2$ = 900
    - Workable, but not ideal
- **Using vanadium as the switching element could significantly improve the first (of four) CADR cycle stage**
  - Switching ratio x $T_{operating}^2$ = 15300
    - 17x more efficient
  - Potential to increase cooling power by 39%
  - Potential to reduce physical size by ~30%

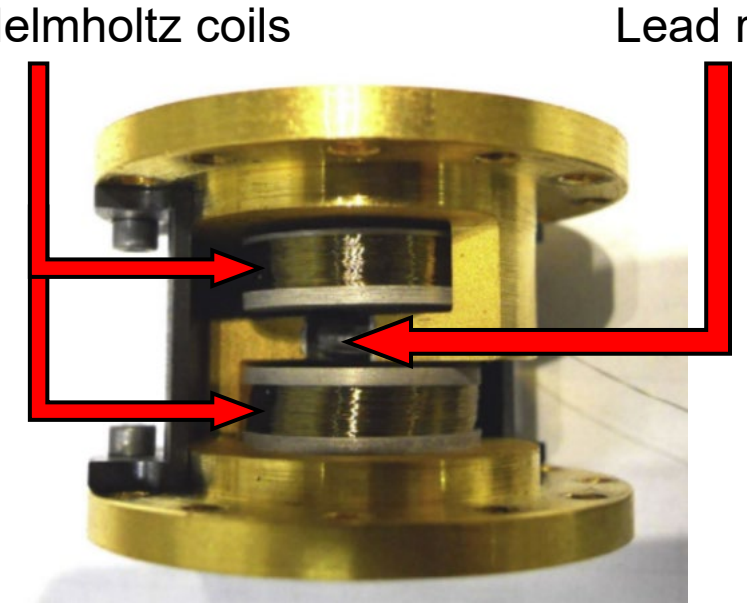

Figure 1: Superconducting heat switch

Project Goals

1. Make high-purity vanadium foils
   - Test out purification procedure from AMES lab
   - Construct the required electrotransport purification apparatus
   - Build thermal conductivity test holder (Figure 2)
   - Compare performance of unpurified and purified vanadium
2. Design superconducting magnet that will actuate the vanadium foils
   - Create a holder for the foils
   - Characterize the thermal conductivity of the foils while in the holder
3. Develop preliminary designs for a vanadium-based heat switch

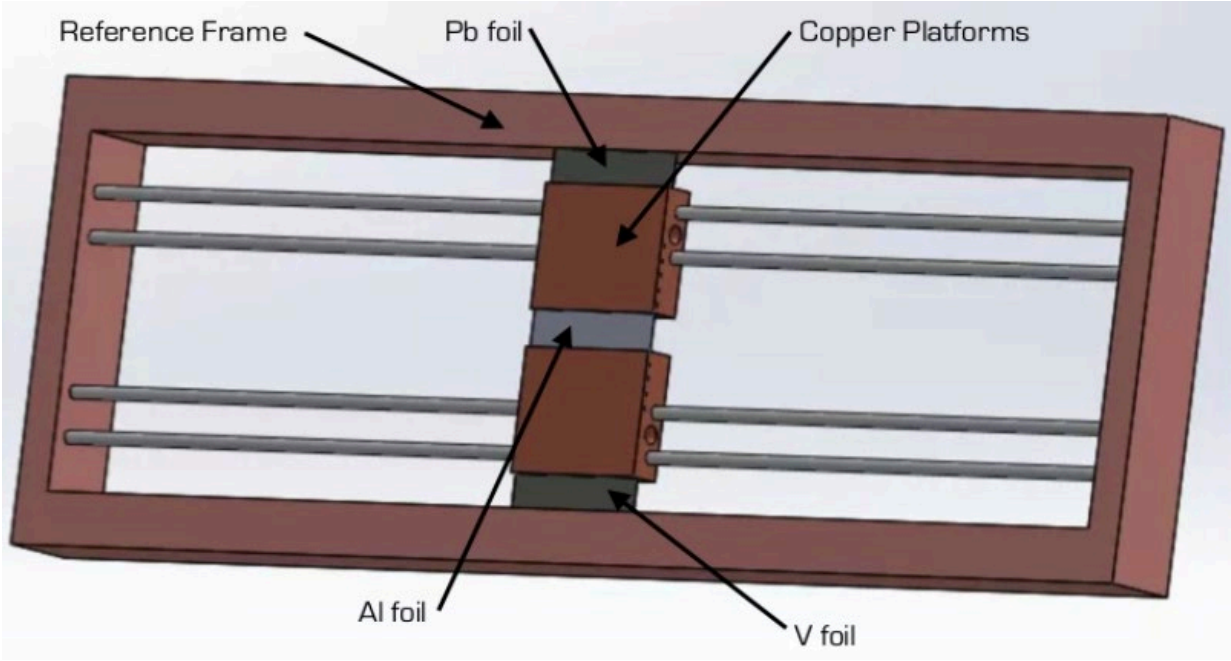

Figure 2: Proposed design of a thermal conductivity test holder. This will compare thermal conductivity of vanadium to other candidate switching materials.