Integrated Testing of the Thales LPT9510 Pulse Tube Cooler and the Iris LCCE Electronics

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Outline

- Objectives
- Thales cryocooler hardware at JPL
- Testing facilities
- Top level test plans
- Test data obtained to date
- Path to needed improvements
- Summary

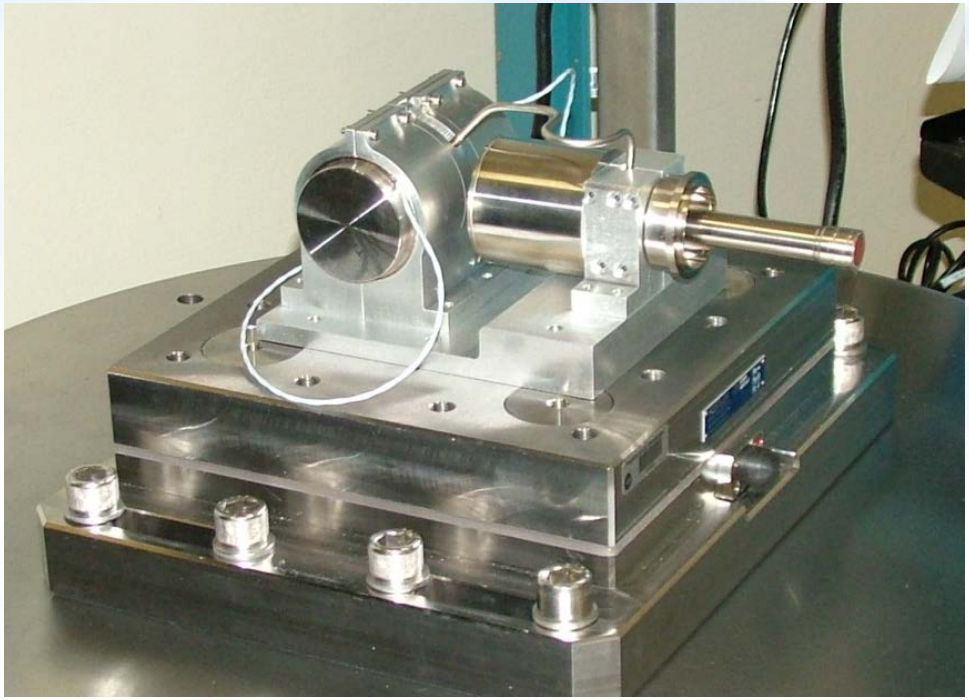
Overall Objectives

- NASA's new paradigm is to fly more missions at lower cost
  - Earth Ventures is one example
  - Even at lower cost, NASA still expects multi-year mission operations
- Instrument budgets keep thermal/cryogenic engineering at certain percentage of overall instrument cost
- As missions are cost-capped, so must the thermal/cryogenic engineering to maintain balance for the various project disciplines
- Objective is to look for lower cost tactical coolers and electronics to fit the small cost-capped missions
- JPL selected the Thales LPT9510 pulse tube cooler and the Iris Technology Low Cost Cooler Electronics (LCCE) to flight qualify by end of Sept 2013
  - TRL 6 is required for Earth Ventures and other science instrument Announcement of Opportunities (AOs)

Thales LPT 9510 Pulse Tube Cooler

Standard LPT 9510 pulse tube cooler package

Thales LPT 9510 cooler with JPL-built thermal support clamp



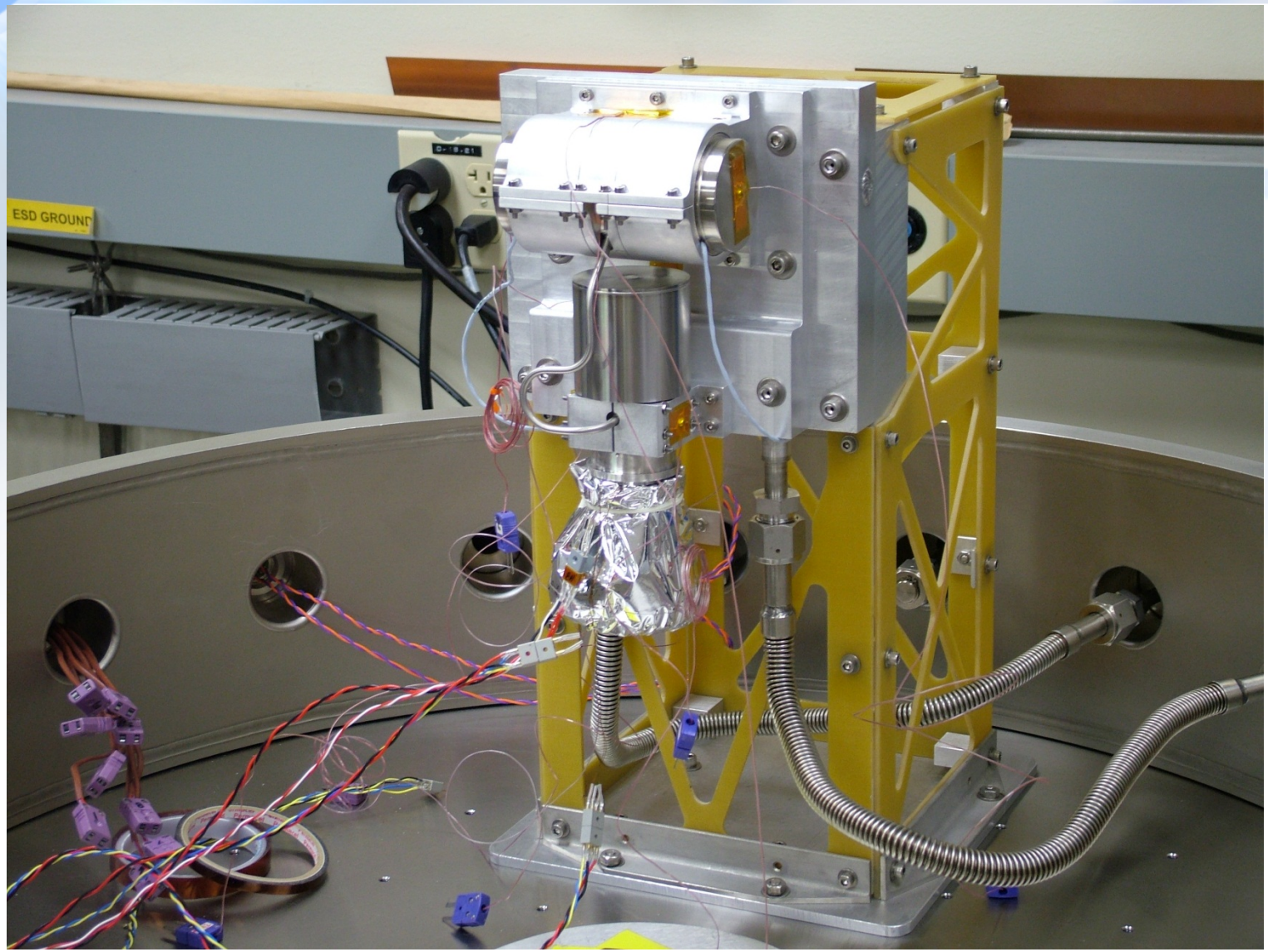
Iris Technology LCCE

Rad-hard LCCE electronics developed under an AFRL SBIR; brass board version under test at JPL

Iris Technology LCCE

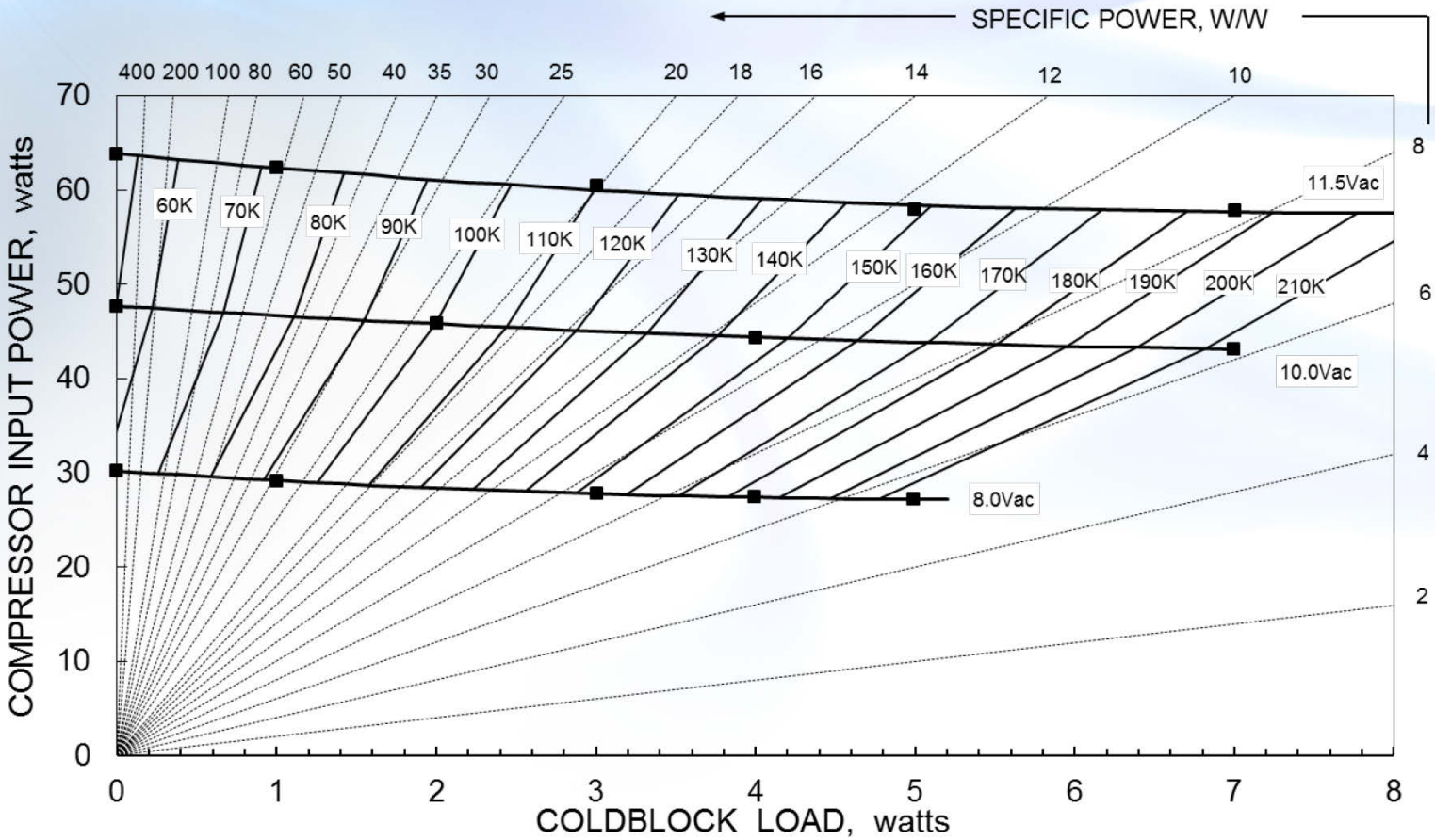
Input Voltage	22 - 37 V_{dc}
Max Output Current	6 A_{ac}
Max Output Voltage	15.2 V_{ac}
Mass	725 gr Total (<225 gr PCB)
Operating Temperature	-50 to 65°C
Non-operating Temperature	-60 to 75°C
Efficiency	>90% @ 40W >85% @ 70W
Output Frequency	40-150 Hz

Thermal-Vacuum Test Setup with Instrumentation and MLI on Coldfinger



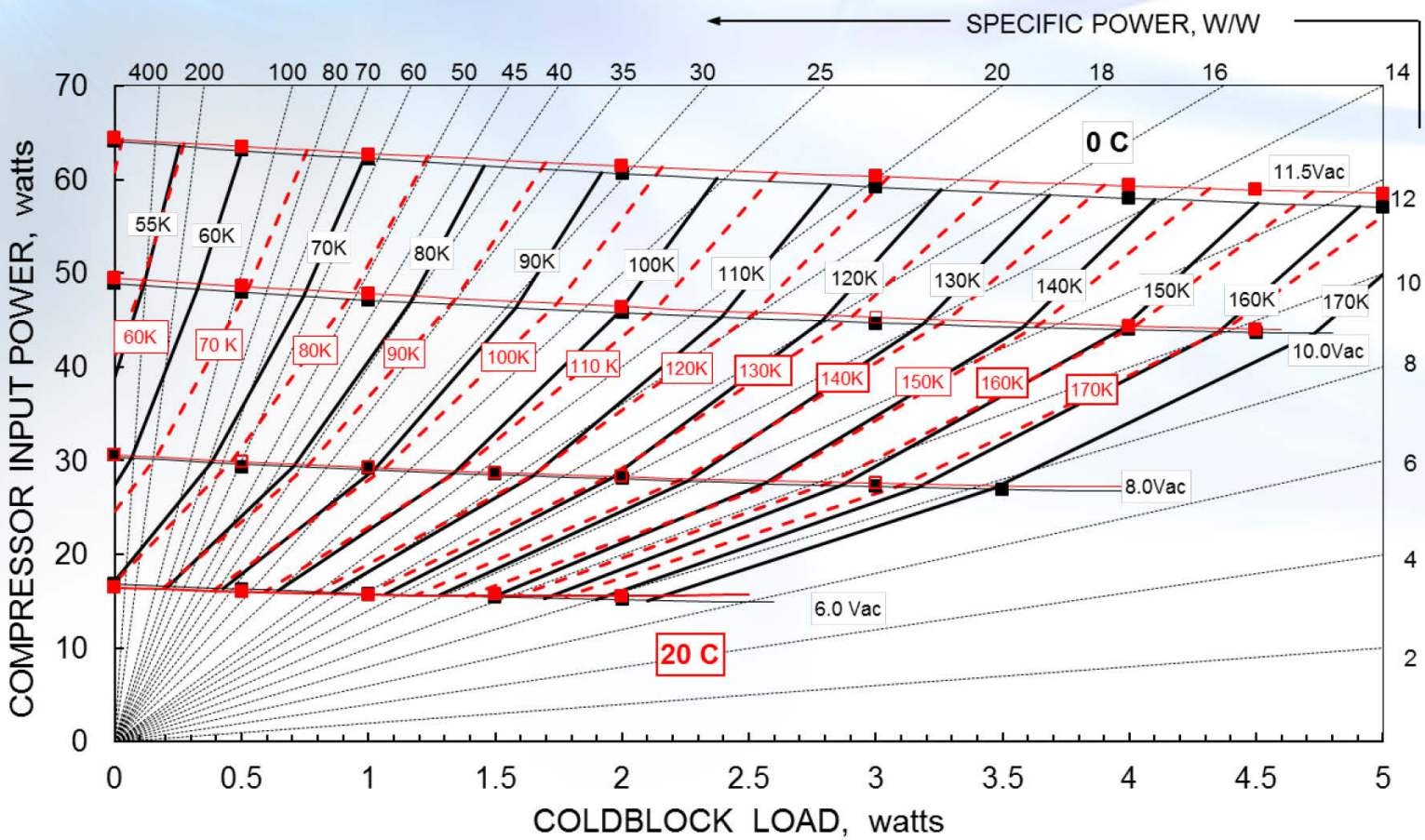
Variable Input Voltage Sensitivity

20°C compressor skin temperature; 45 Hz drive frequency



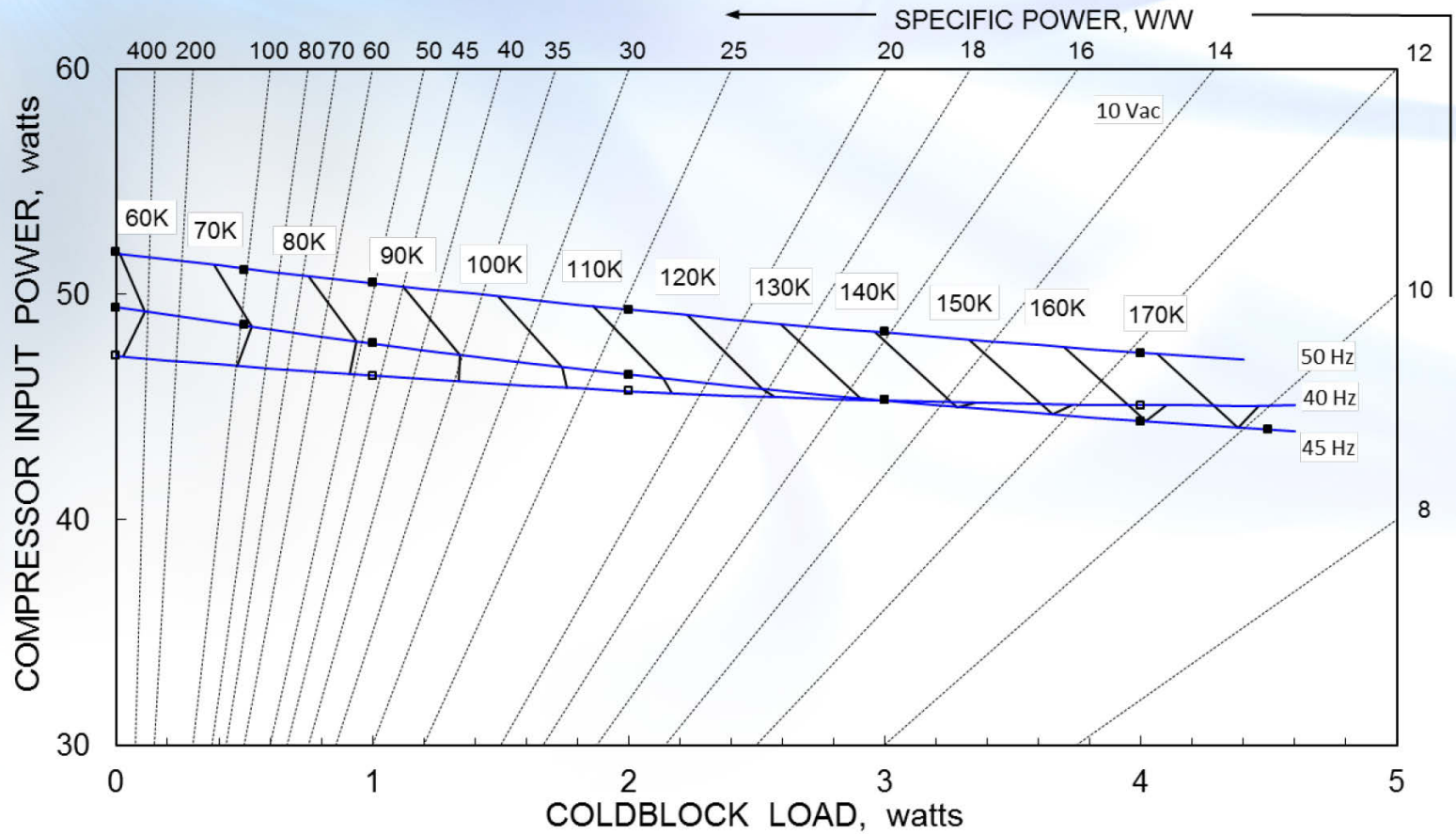
Variable Heat Sink Temperature Sensitivity

45 Hz drive frequency

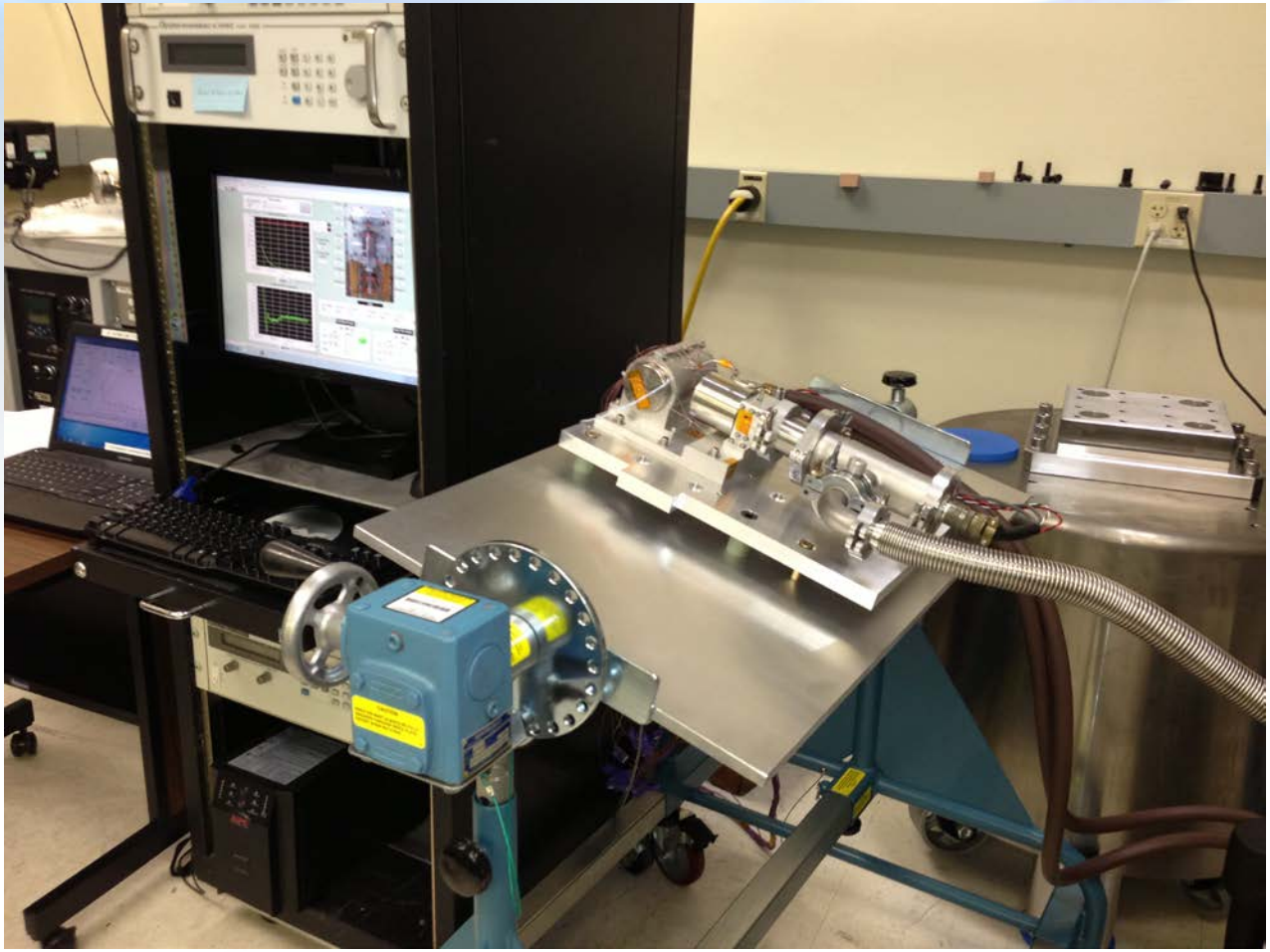


Variable Drive Frequency Sensitivity

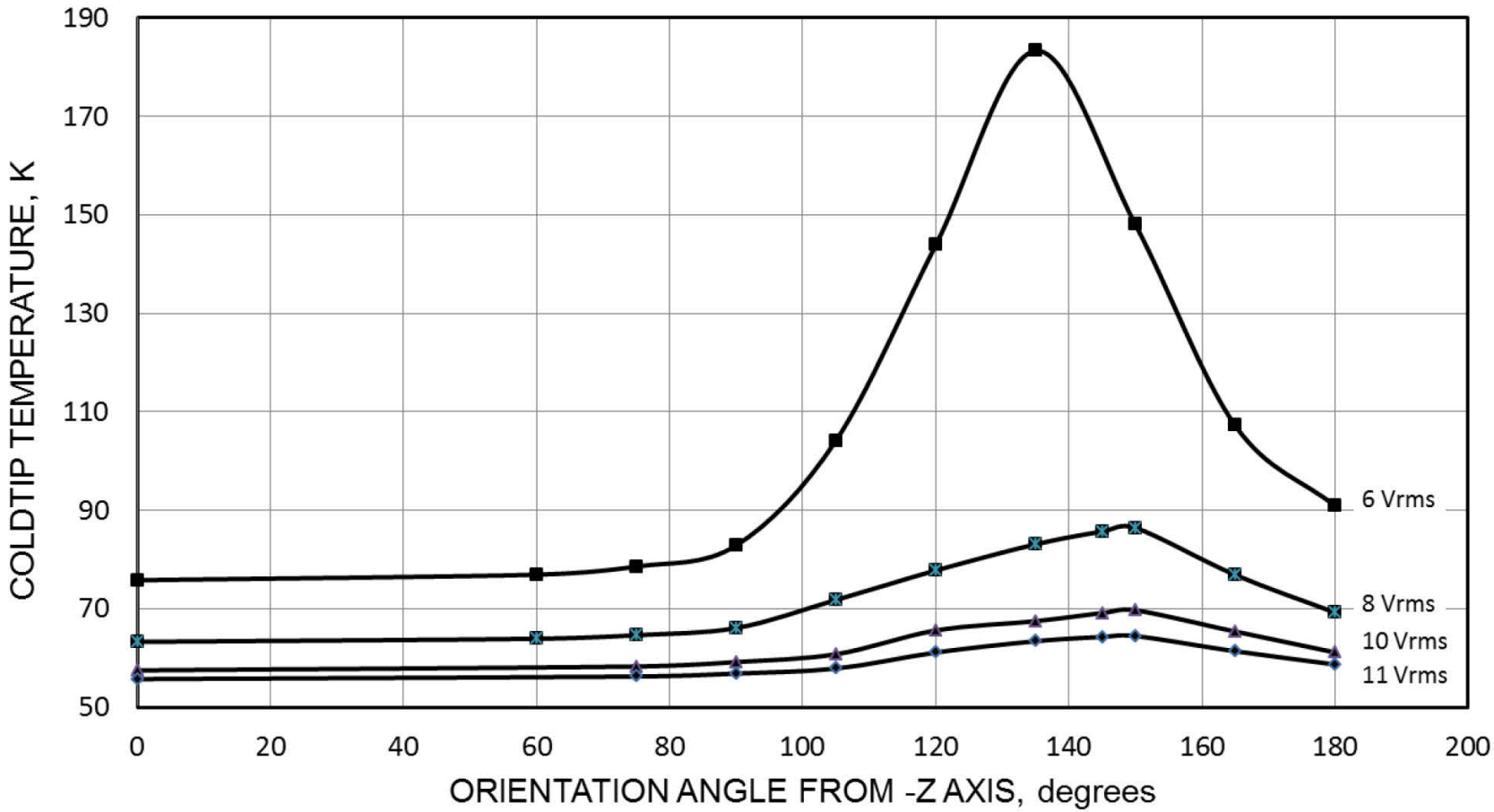
20°C compressor skin temperature; 10 Vrms input



Orientation Dependence Test Setup

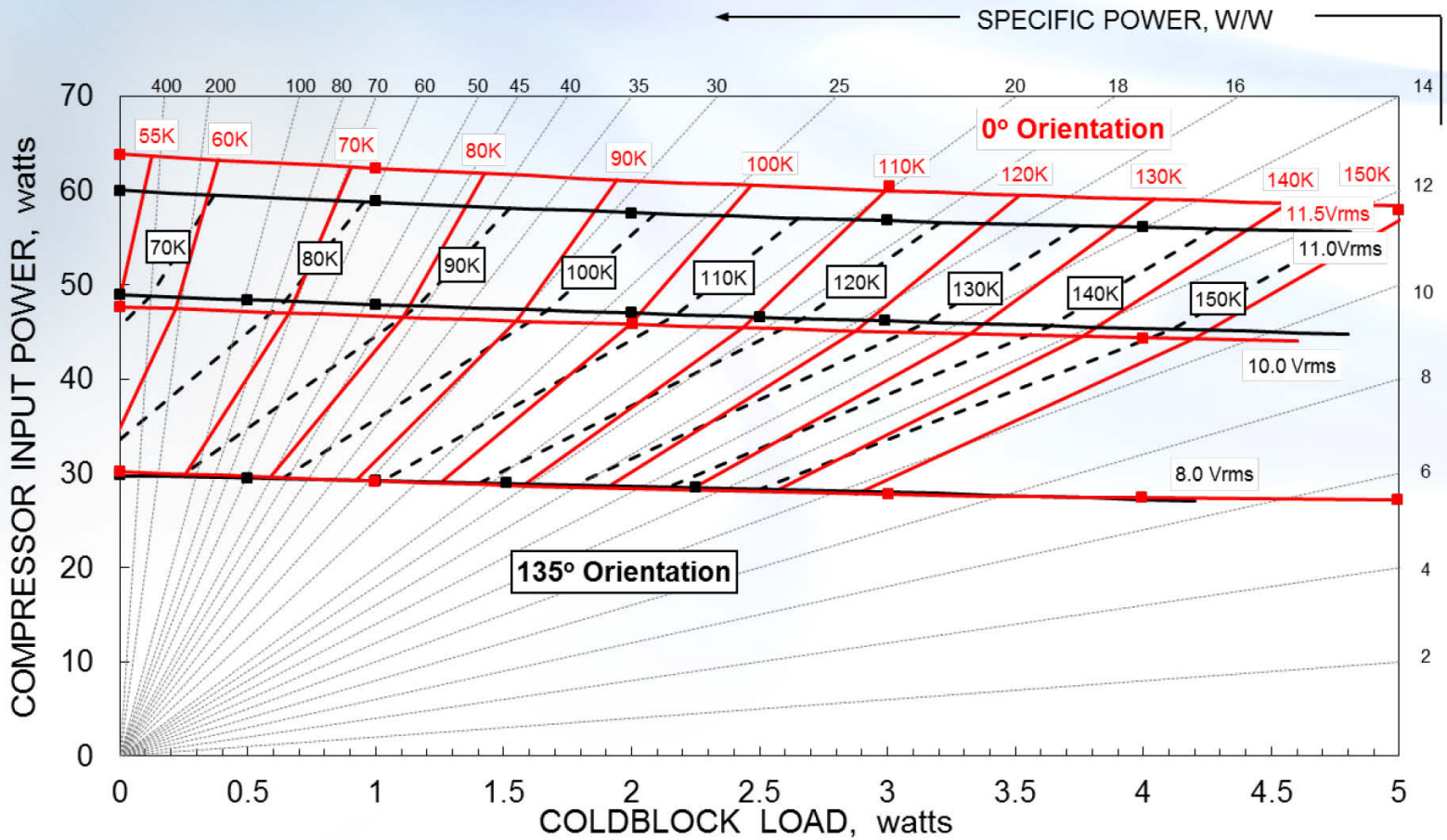


No-Load Orientation Effects

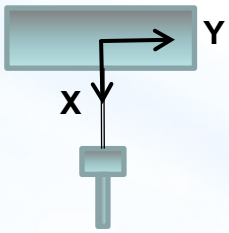


Orientation Effects on Performance

45 Hz drive frequency

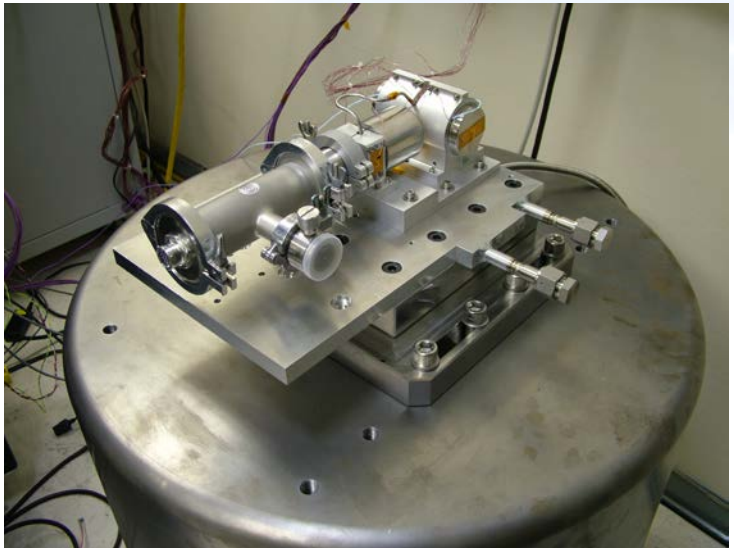


Exported Vibration Test Facility



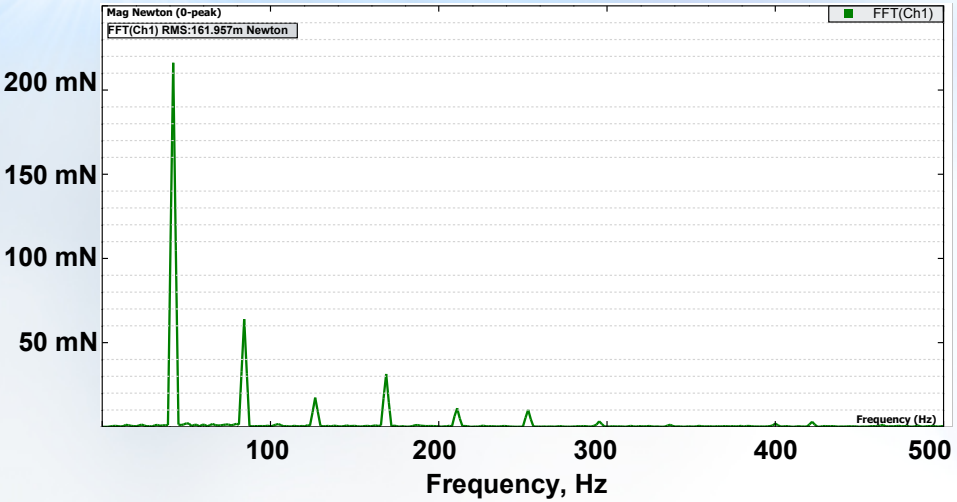
3-Axis Kistler force table for measuring cryocooler exported vibration

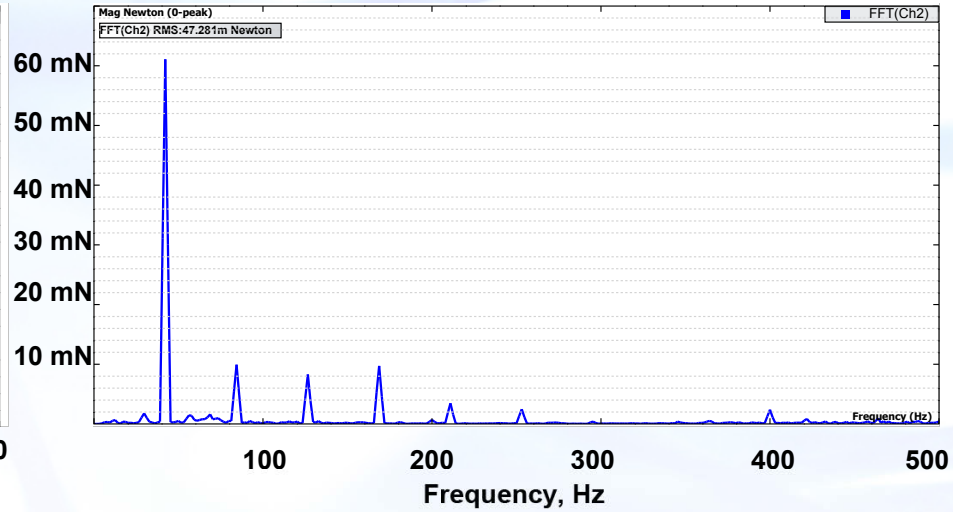
- Measures Fx, Fy, Fz and Mx, My, Mz
- Dynamic force measurement accuracy to 10mN

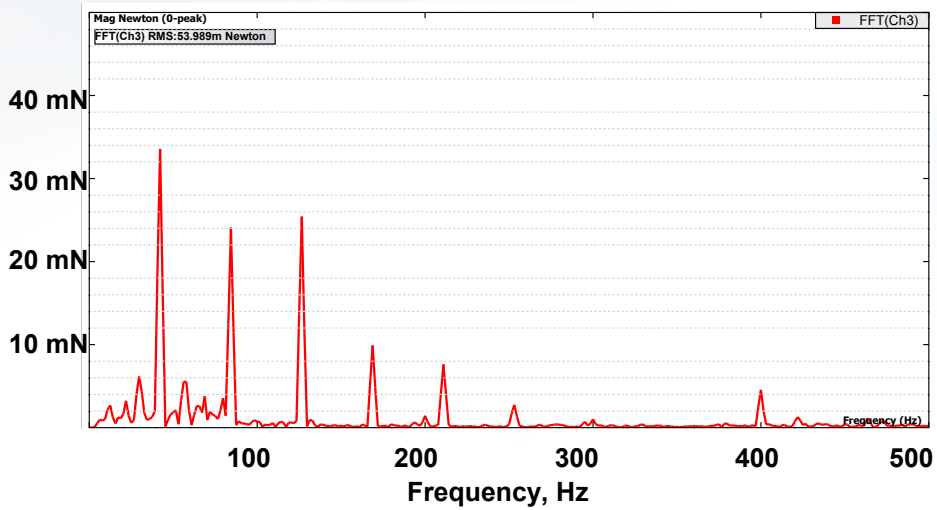


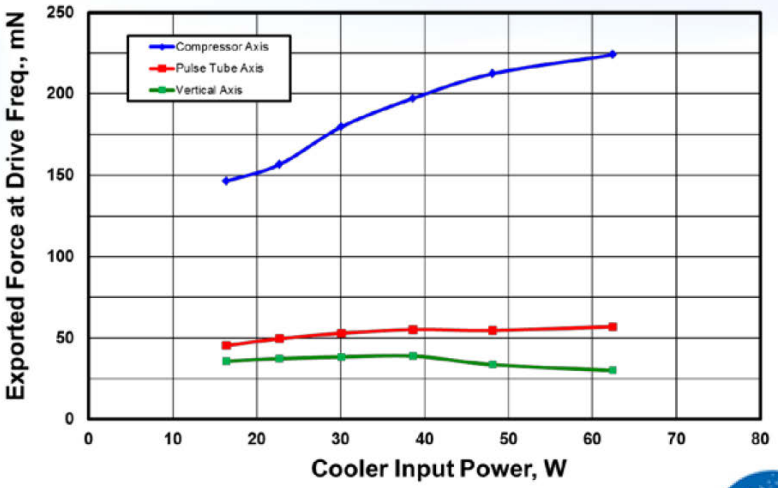
LPT9510 Exported Vibration

11.4 Vrms; 62 W input; 42 Hz drive frequency









Summary

- Significant progress has been made towards the testing of the LPT9510 at JPL, working towards completing flight qualification by the end of September
  - Random vibration and thermal cycling tests remain
- The cooler thermal performance has been measured under a variety of operating conditions (input voltage, frequency and reject temperature)
- This particular LPT9510 cooler unit displayed very low exported vibration levels, and depending on the application, may only need vibration control at the drive frequency
- The Iris Technology brass board LCCE has demonstrated high efficiency and has functioned well during testing
  - Future work includes input filtering and vibration control capability