

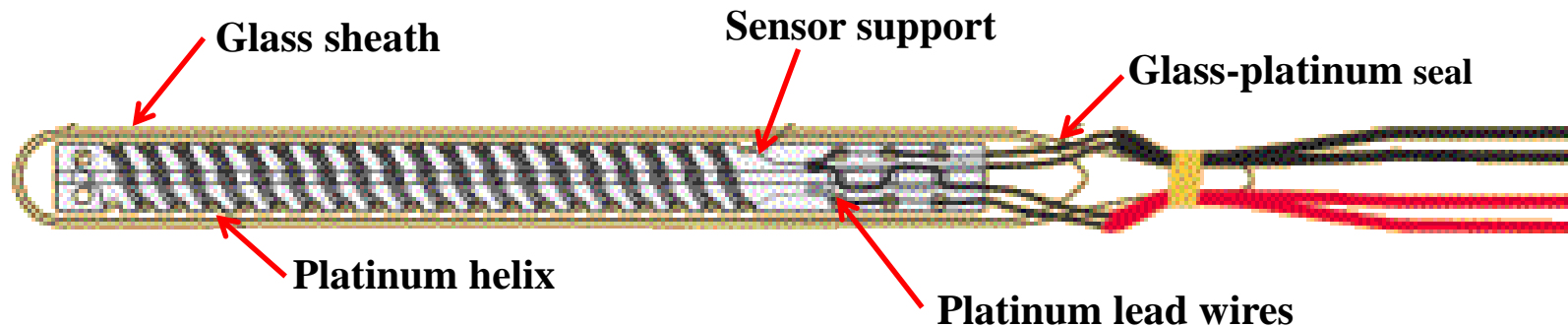
Mechanical Robustness of Cryogenic Temperature Sensors Packaged in a Flat, Hermetically Sealed Package

2015 CEC-ICMC, Tucson, AZ, C30rG-1, 1 July 2015

Dr. Scott Courts

Background – Strain Free Mounting

- Historically, cryogenic thermometers required strain free mounting for optimum stability



**Fluke 5686 Glass Capsule Standard Platinum
Resistance Thermometer Construction**

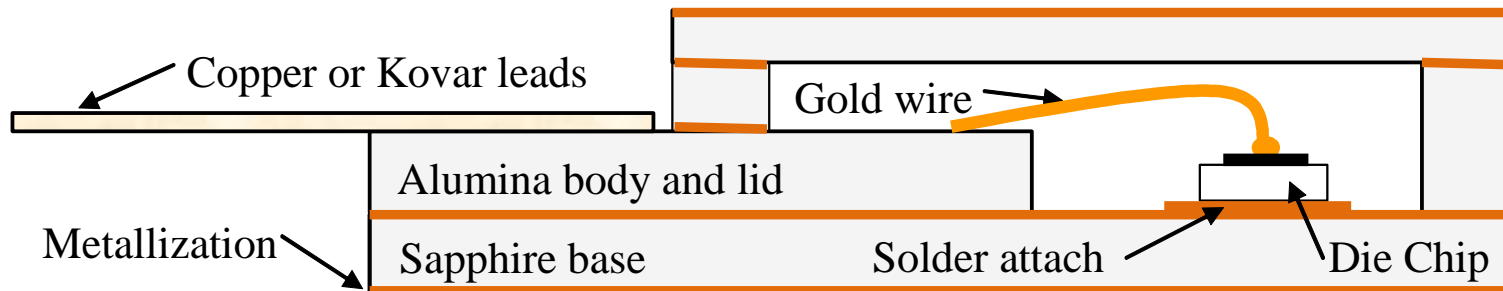
Background

- The most stable devices were fragile and subject to damage from mechanical shock
- True for Platinum, Rhodium-Iron, and Germanium resistance thermometers
- With a small sacrifice in stability, newer devices can be packaged much more robustly

This work examines the mechanical robustness of cryogenic temperature sensors mounted in a flat, hermetically sealed package

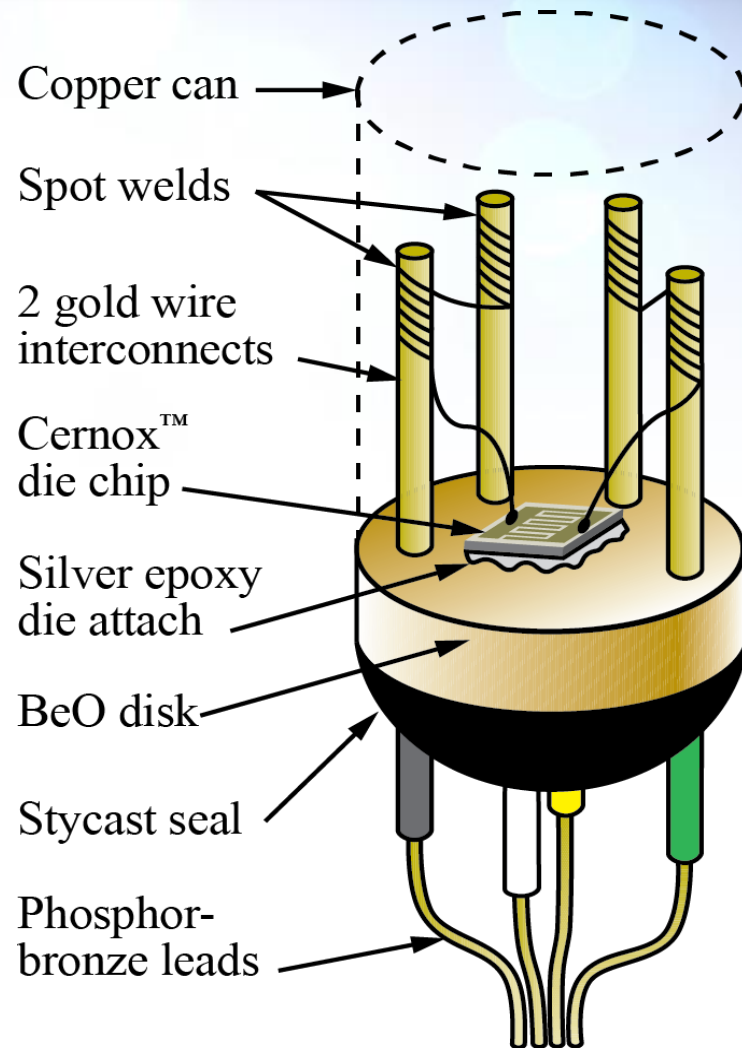
Device types tested in –SD package

- All devices manufactured by Lake Shore Cryotronics, Inc.
- 2 Models packaged in flat, hermetically sealed –SD package:
 - Cernox™ model CX-1050-SD
 - Diode model DT-670-SD

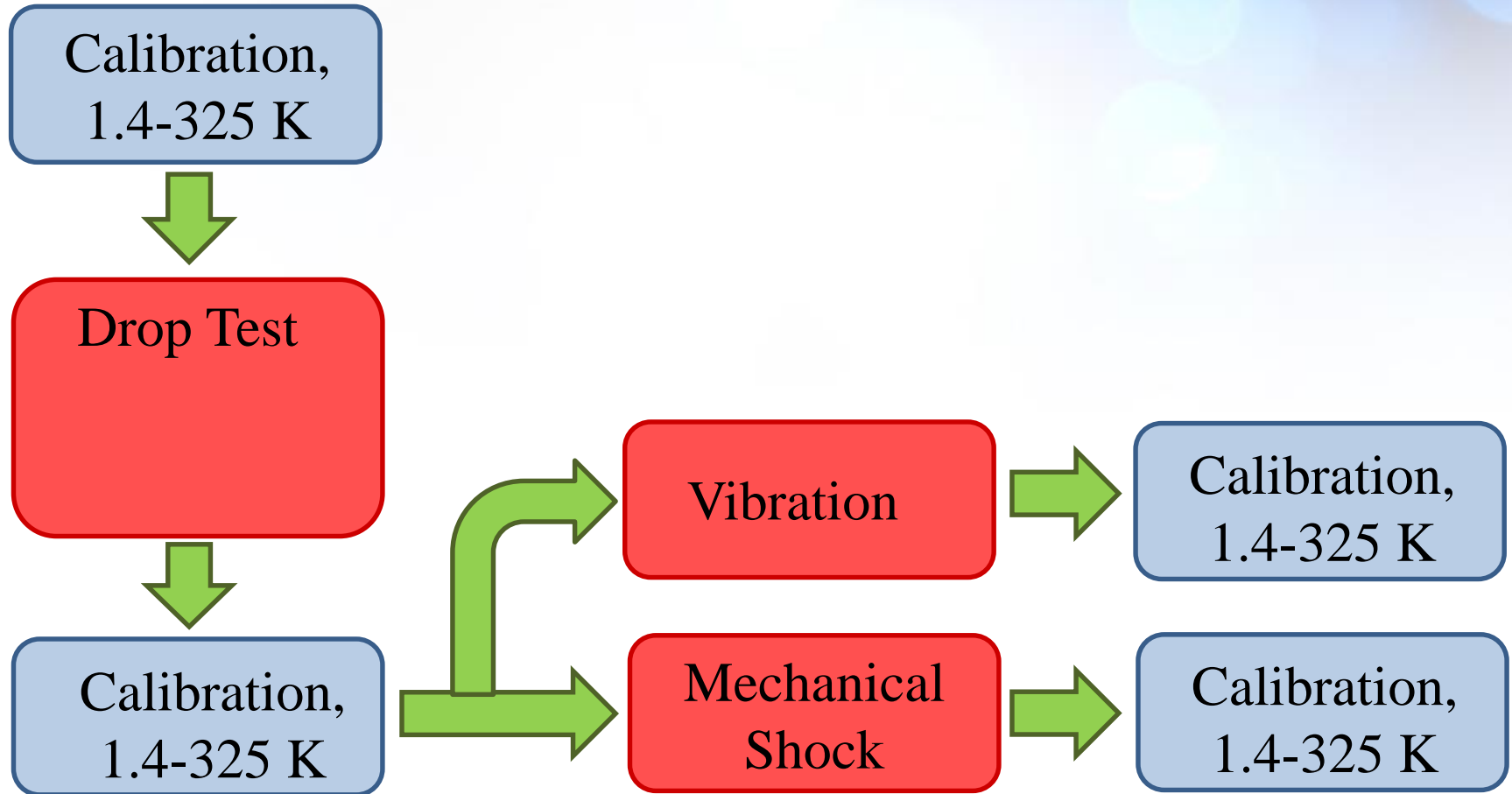


Device type tested in copper A-can

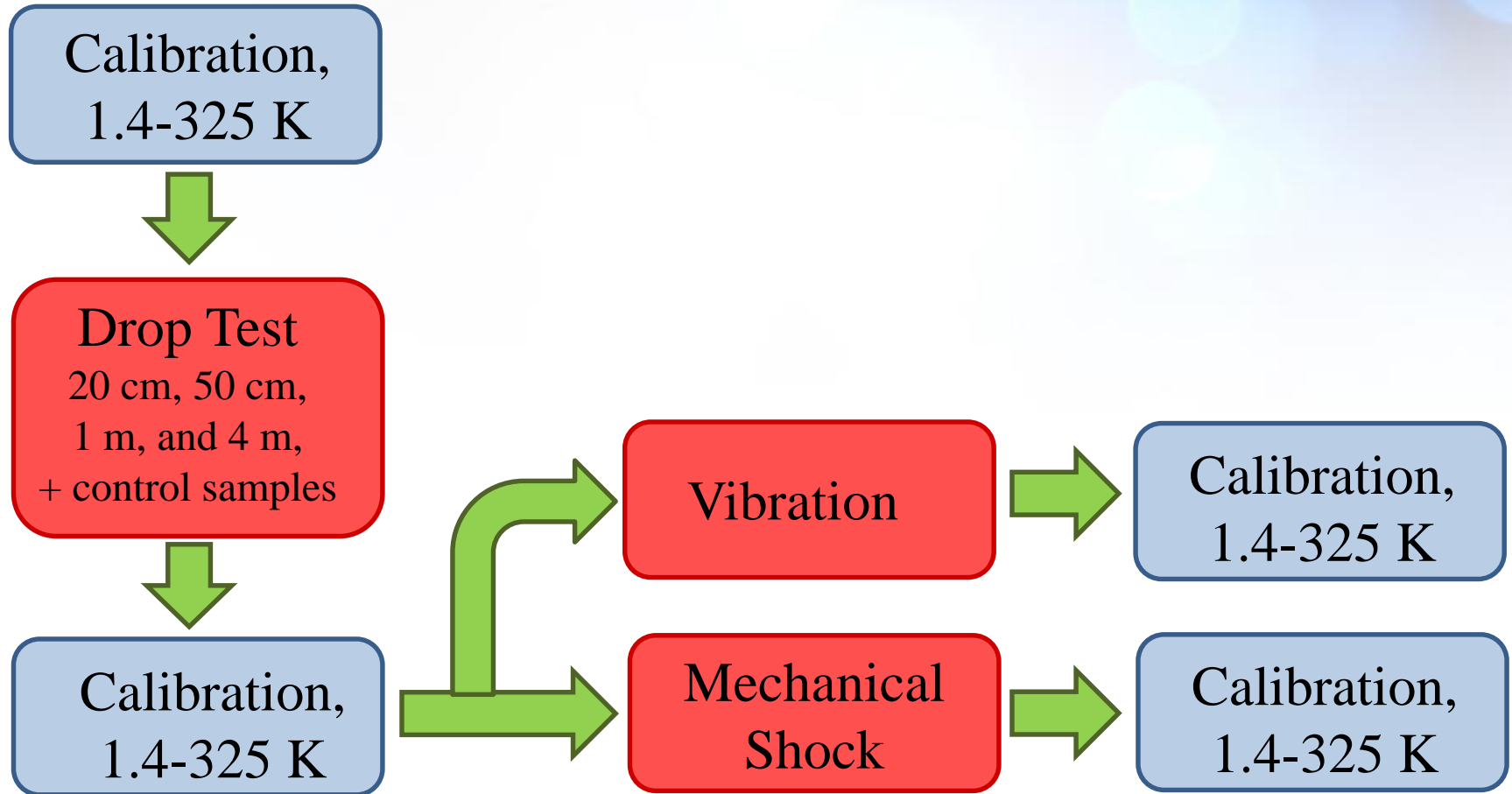
- For comparison, also tested a Cernox™ model CX-1050-AA



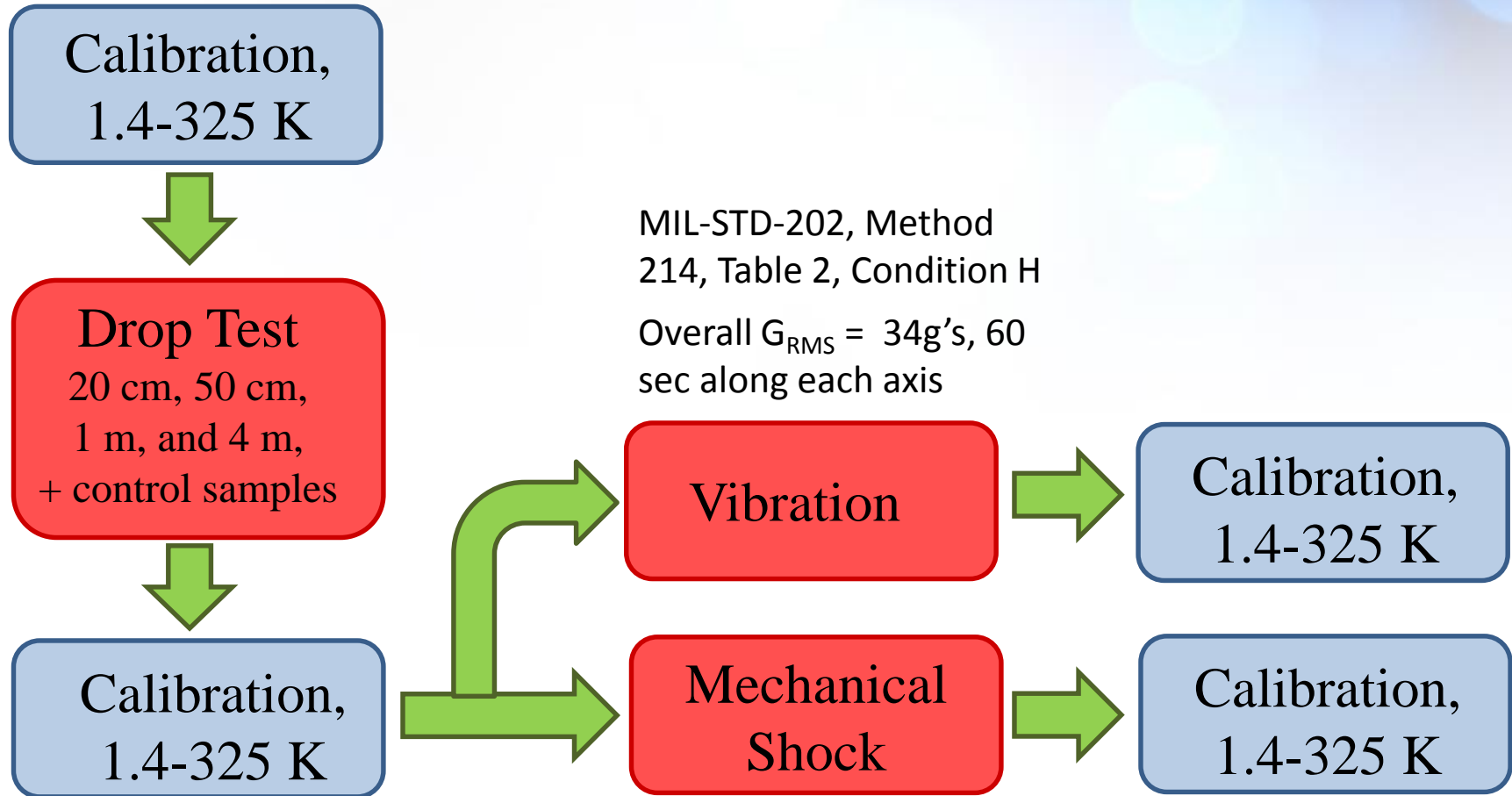
Test Protocol – 20 Devices of Each Type



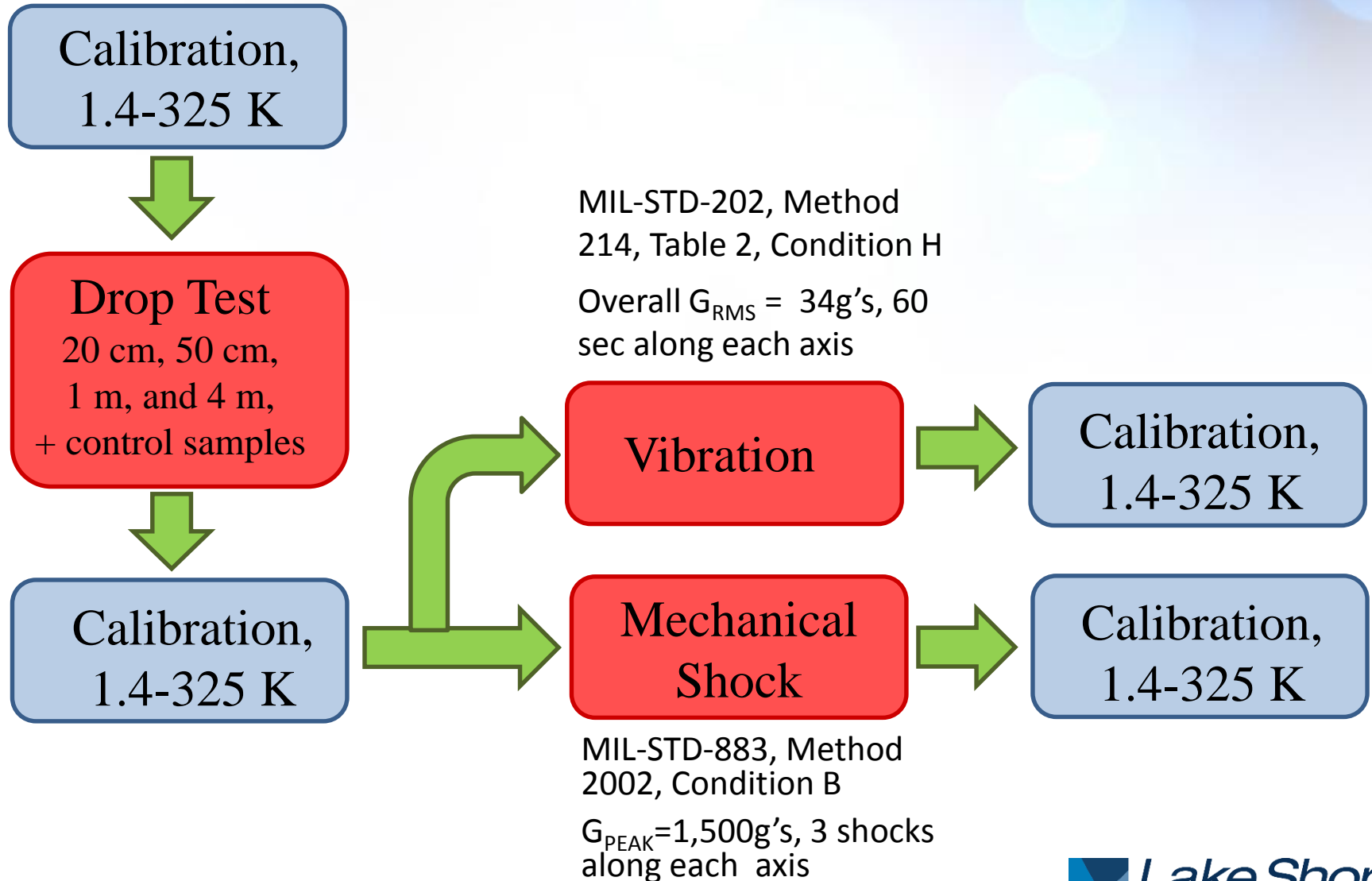
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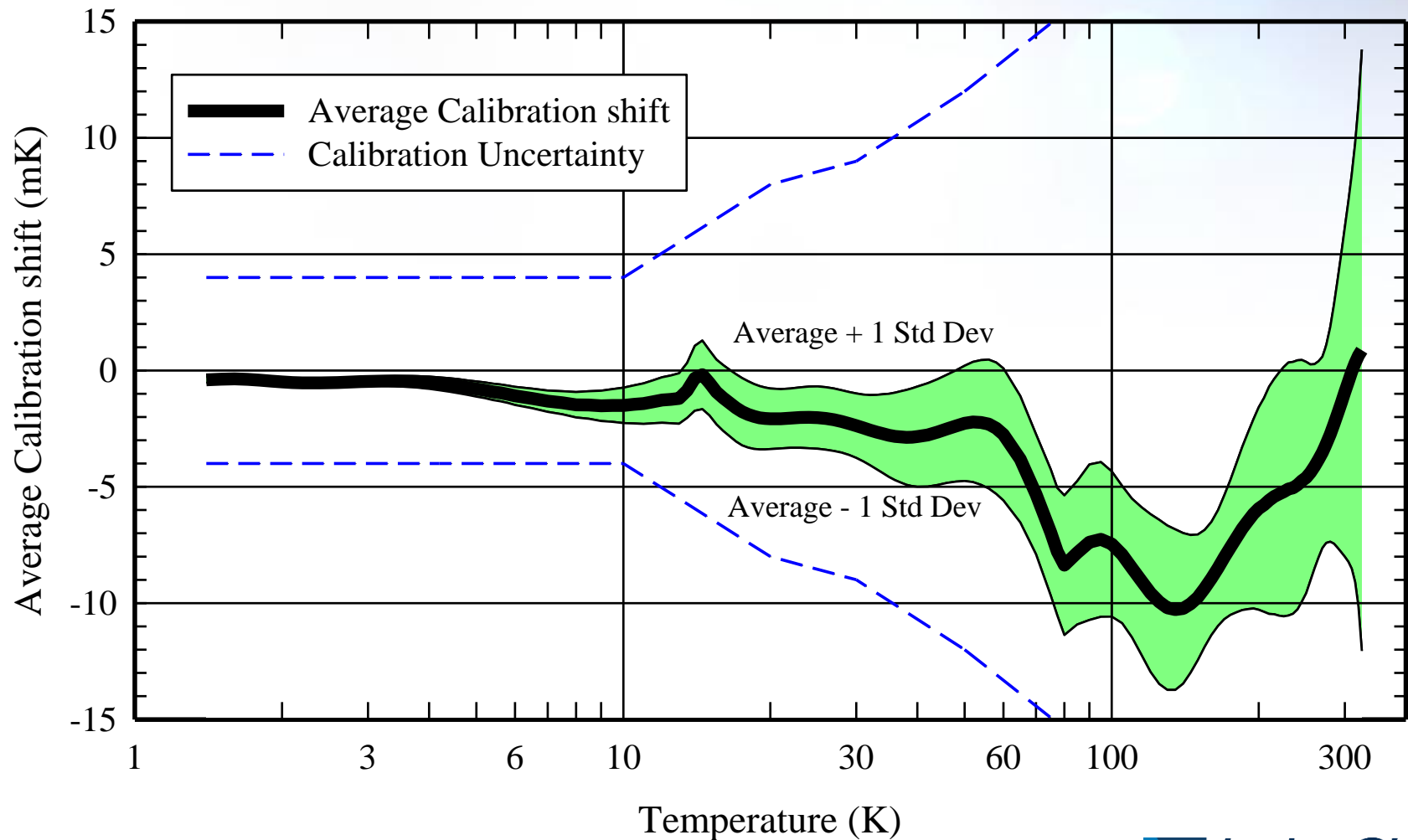


Test Protocol – 20 Devices of Each Type



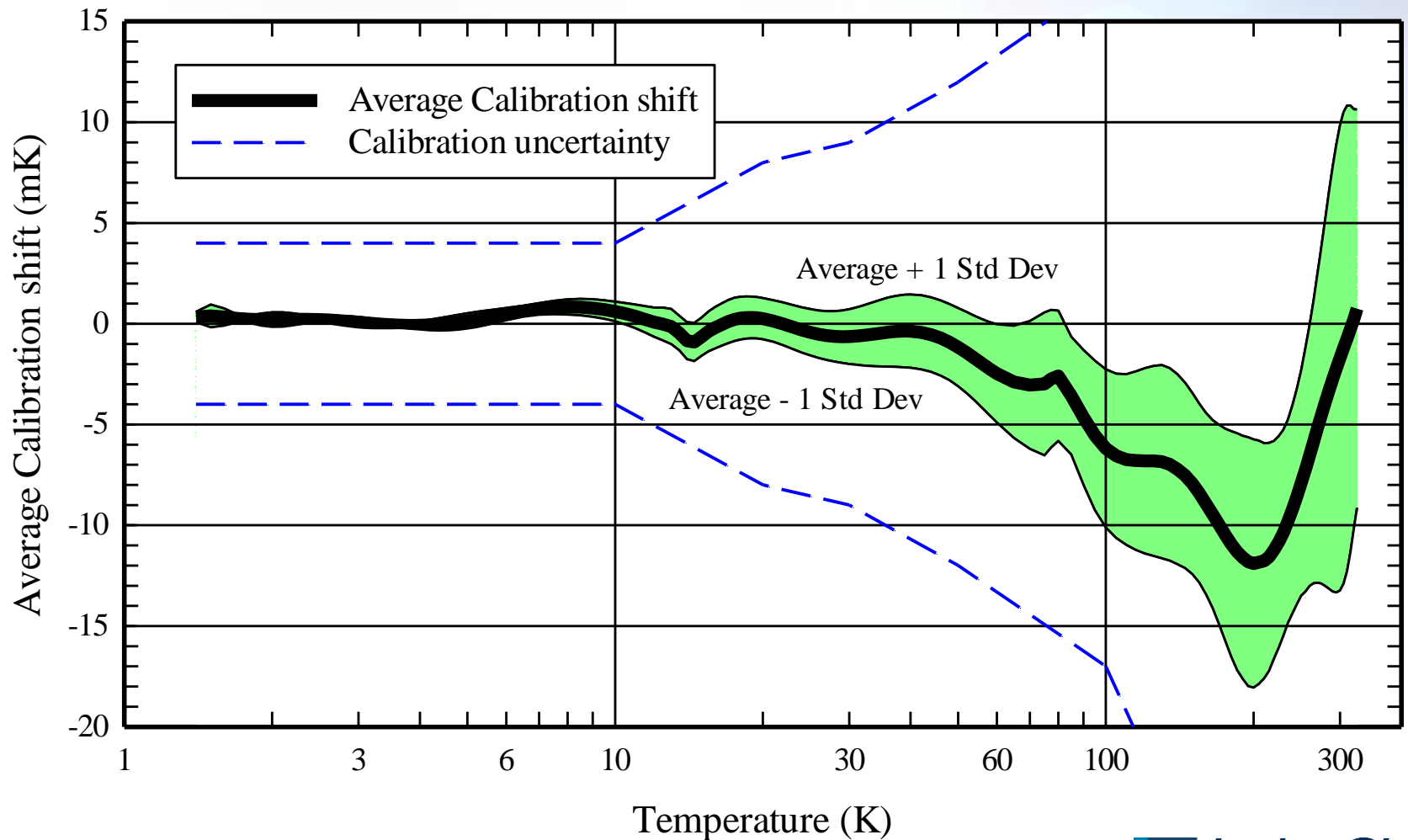
CX-1050-SD Drop Test Results

No discernable effects for any drop height



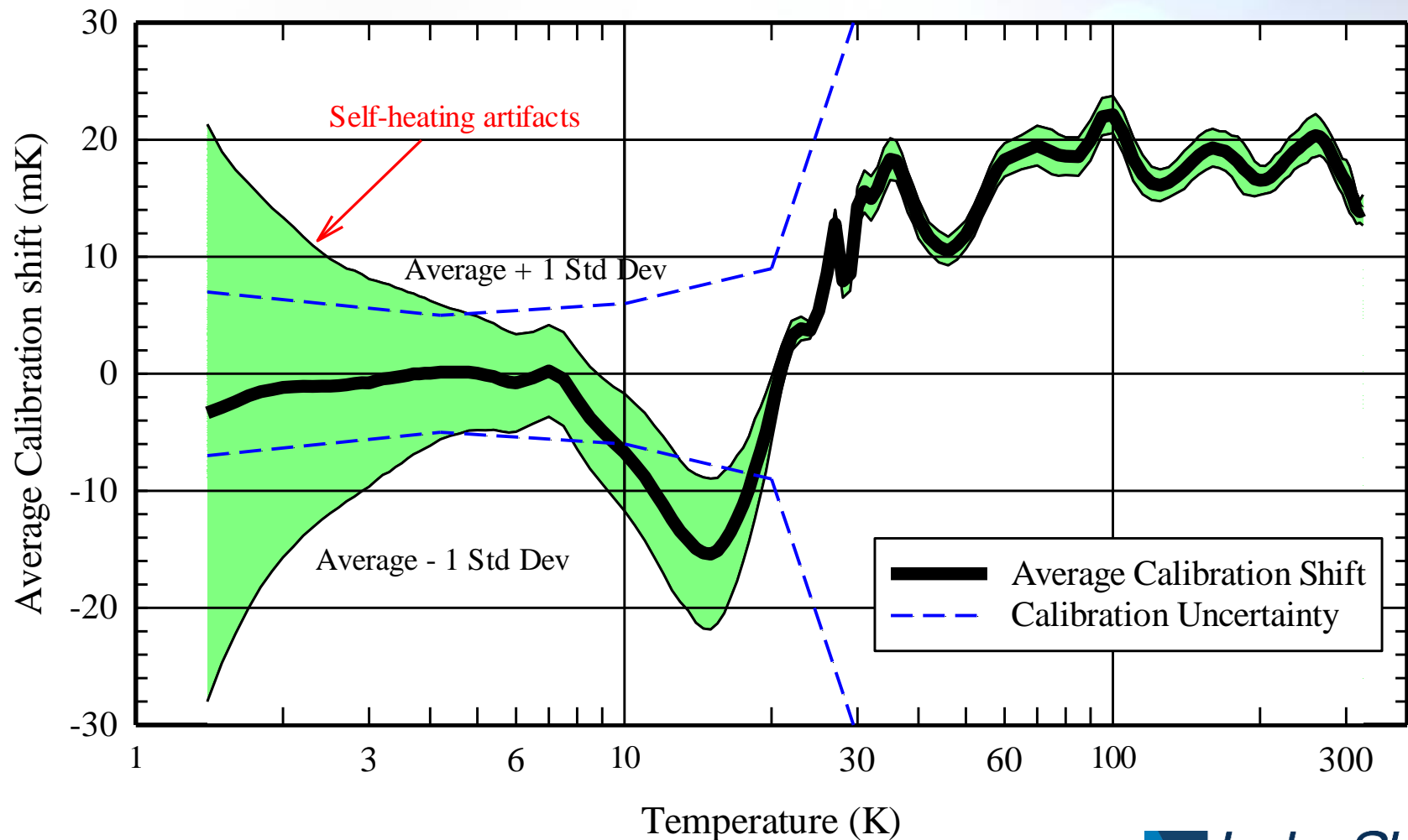
CX-1050-SD Vibration/Mechanical Shock Results

No discernable effects from vibration or mechanical shock



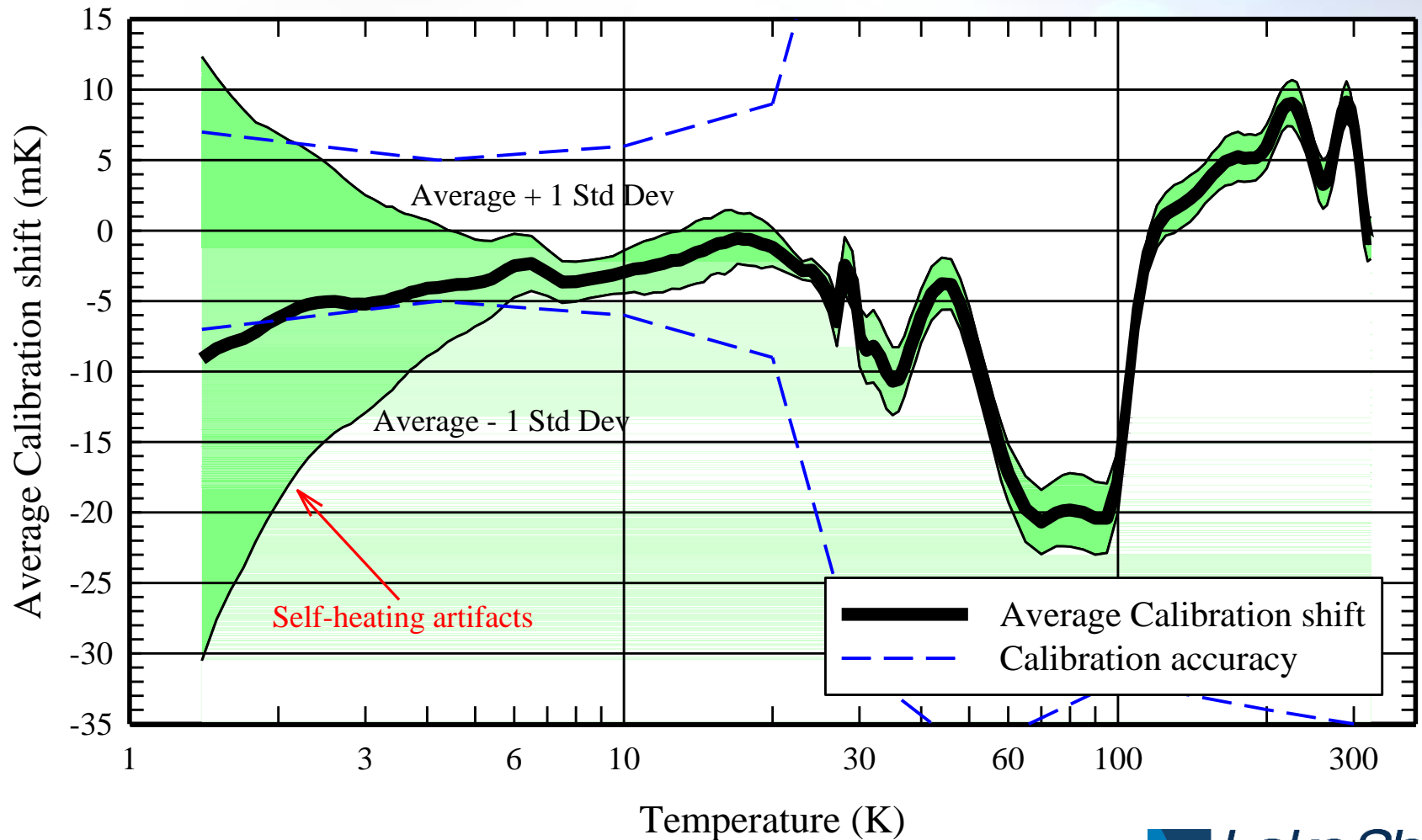
DT-670-SD Drop Test Results

No discernable effects for any drop height



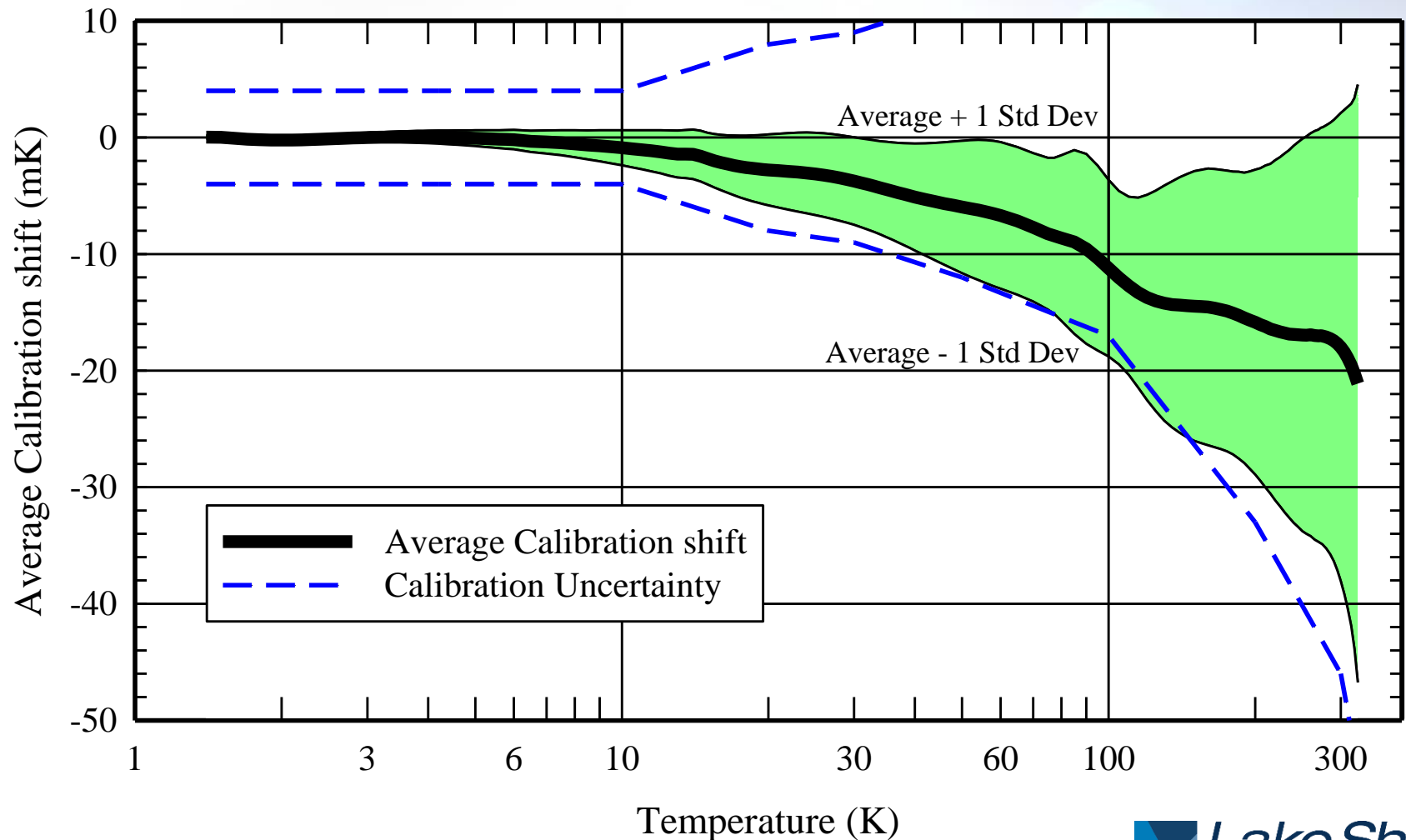
DT-670-SD Vibration/Mechanical Shock Results

No discernable effects from vibration or mechanical shock



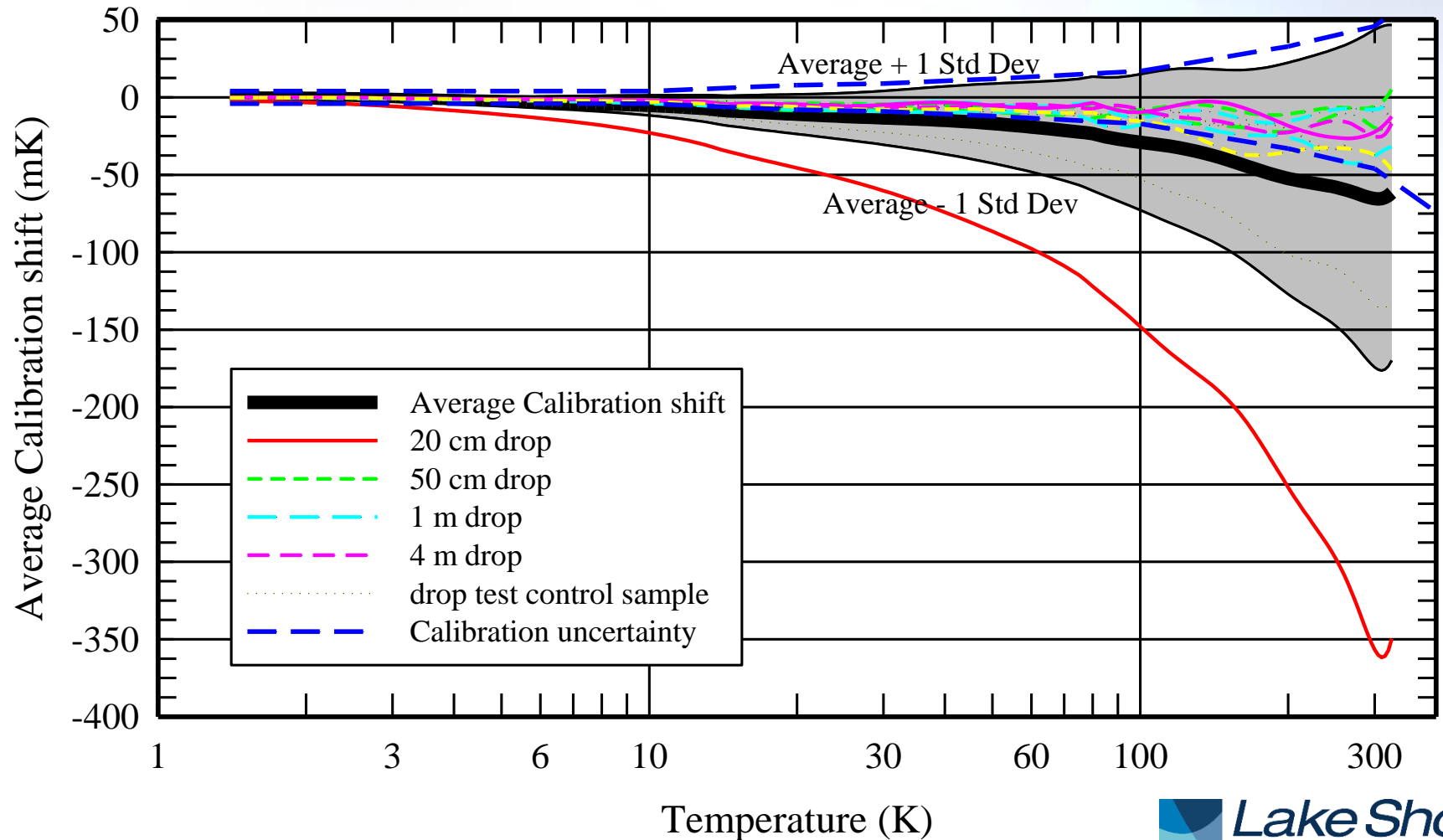
CX-1050-AA Drop Test Results

No discernable effects for any drop height



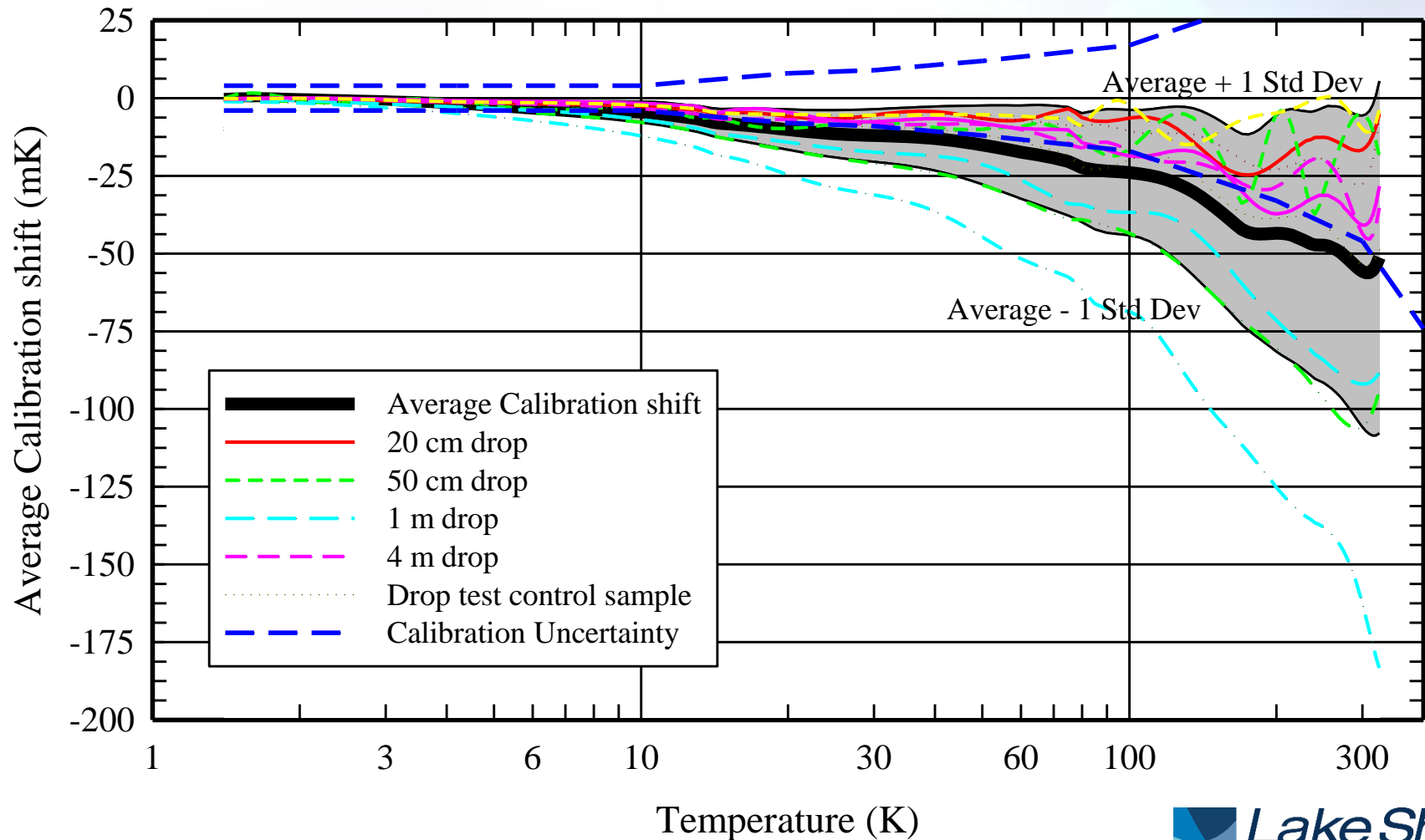
CX-1050-AA Vibration Test Results

**Negative trend in ΔT , but results skewed by two devices.
Offset uncorrelated to initial drop height.**

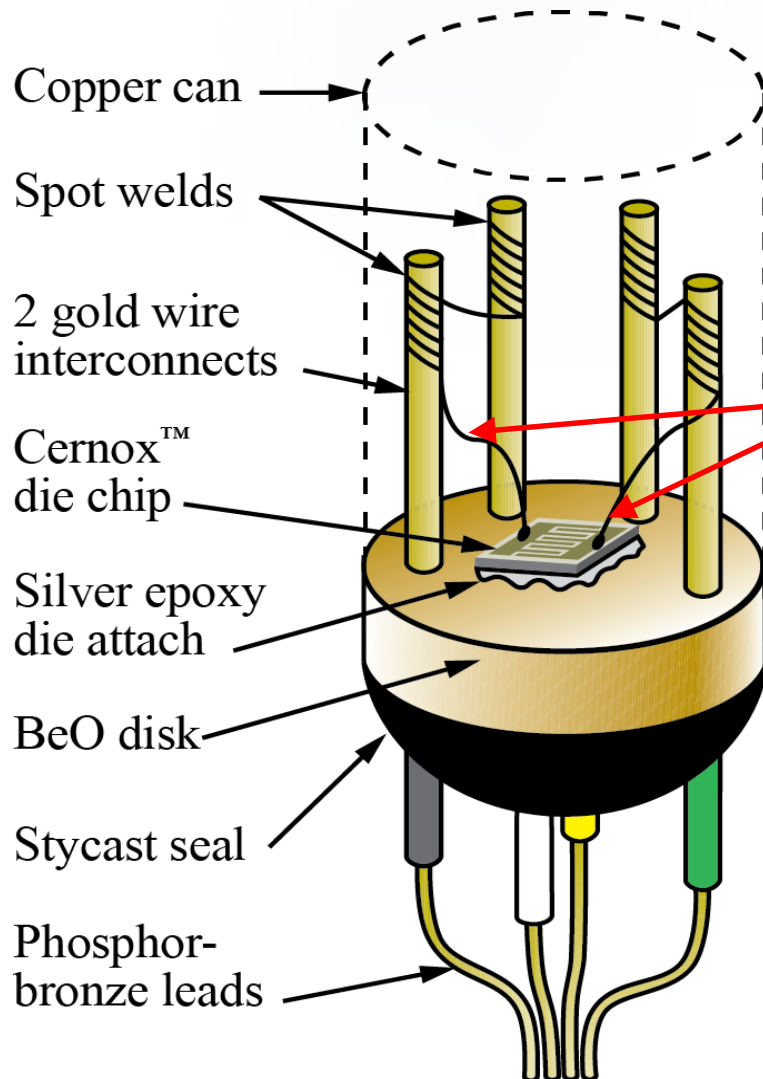


CX-1050-AA Mechanical Shock Test Results

**Negative trend in ΔT , but results skewed by three devices.
Offset uncorrelated to initial drop height.**



CX-1050-AA Offset Cause



Negative $\Delta T \rightarrow$ Positive ΔR ;

Most likely cause of increased resistance is stretching of the ≈ 3 mm long 2-lead portion of the $50 \mu\text{m}$ diameter gold lead connecting the sensor die to the phosphor bronze post.

(For comparison, the connecting gold leads in the -SD package are $25 \mu\text{m}$ diameter by ≈ 0.75 mm long)

Conclusions

This work has shown:

- For models CernoxTM CX-1050-SD and diode DT-670-SD
 - No discernable effect when dropped from heights up to 4 m
 - No discernable effect from vibration with $G_{\text{RMS}} = 34\text{Gs}$
 - No discernable effect from mechanical shock of $G_{\text{PEAK}} = 1,500\text{Gs}$

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- For model CernoxTM CX-1050-AA
 - No discernable effect when dropped from heights up to 4 m
 - A negative trend in ΔT after vibration with average offset approaching -60 mK at 300 K, but uncorrelated to drop height
 - A negative trend in ΔT after mechanical shock with average offset approaching -60 mK at 300 K, but uncorrelated to drop height

CEC/ICMC

2015

Thank You!