FEMCI Poster

Development of Cryogenic Accelerometers for 4K

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Proposal Title: Development of Cryogenic Accelerometers for 4K

Background:

- Acceptable finite element model validation requires accurate measurement of the hardware's response which is complicated for cryogenic hardware due to poor availability of cryogenic material property data.
- To obtain accurate analytic models, it is desirable to measure the structural response of hardware while it is subjected to both a cryogenic temperature environment (~4K) and a controlled vibration test.
- It is currently difficult to perform these measurements because:
  - Few commercially available accelerometers rated for cryogenic temperatures are small enough (~<.5"cube) to be useful;
  - Accelerometers rated for only 77K and need to be tested for 4K;
  - Need to develop a method to attach accelerometers to flight hardware without damage to hardware.

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Objectives:

This proposal will:

- Provide scientists and engineers a new capability to measure the structural performance of their cryogenic hardware.
- Verify certain types of accels will operate at 4K and structural loading.
- Investigate accel attachment methods to obtain a clean signal without damaging the hardware.

Context and Innovation:

- Being able to develop this capability will enhance the data measurement and analysis technology at GSFC, which supports the Mission and Science Measurement Technologies section of the GSFC Strategic Implementation Plan.
- This capability will be essential for planned missions, ie. Constellation X, in the development of detectors and low temperature hardware.
- Other proposed missions, such as Missing Baryon Explorer (MBE) and ASTRO-G will have hardware development that requires low temperature measurement.

Context and Innovation (cont):

- Being able to provide small, accurate 4K accels will enable engineers and scientists to more accurately determine the structural performance of cryogenic instruments. This in turn will provide:
  - More efficient, lightweight designs of components;
  - Reduce development time of designs;
  - Eliminate additional ambient temperature structural testing.

Schedule: Purchase instrumentation-2 months, investigate bonding materials-1 month, cryogenic testing and data evaluation-2 months

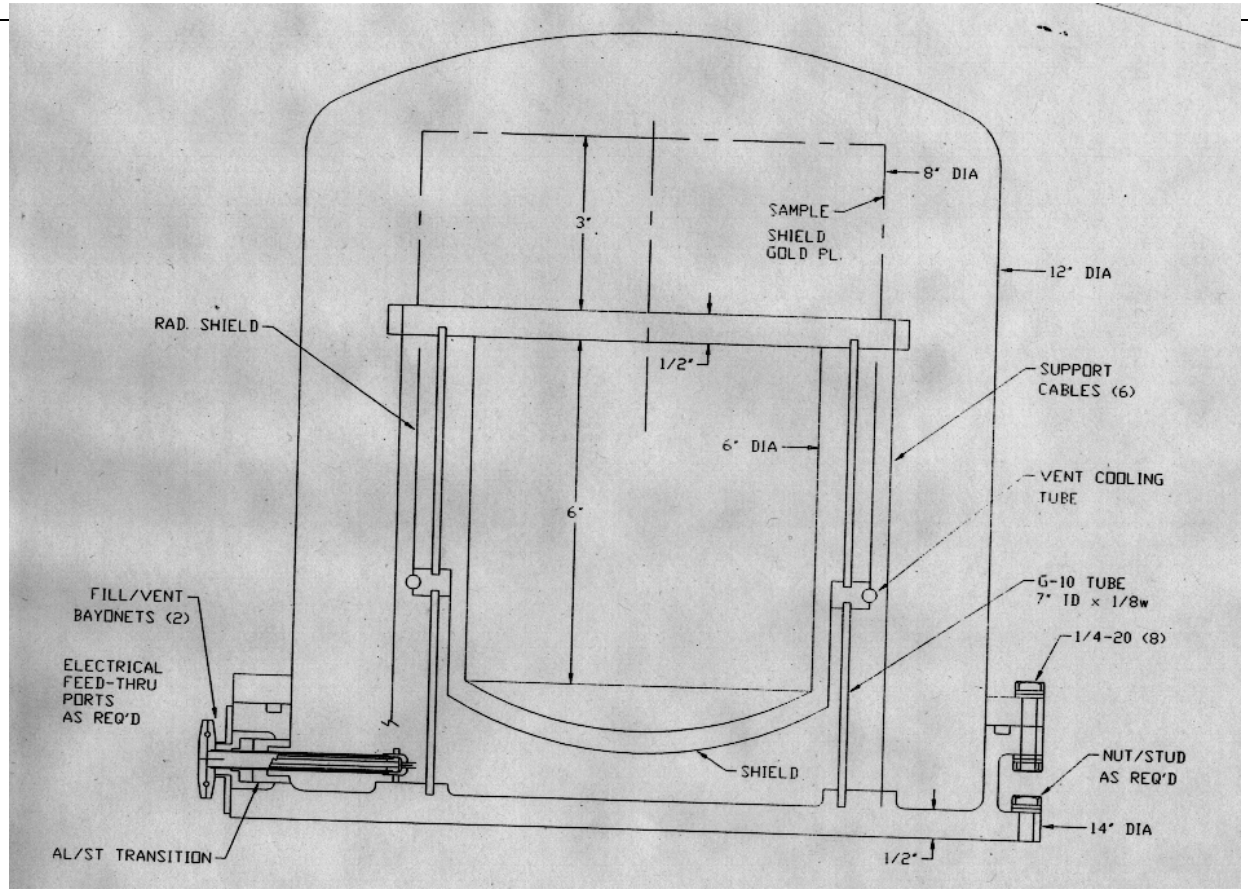
Budget: 15K total for vibration facility, instrumentation, cryogen for dewar, and materials consultation

Manpower Estimate:

.2 manyear: vibration test engineer
.1 manyear: dewar engineer,
.1 manyear: ManTech-vibration testing
.2 manyear: analytical systems engineer
.1 manyear for technical advisor,
.1 manyear: Swales materials expert

FEMCI Poster: Vibratable Dewar

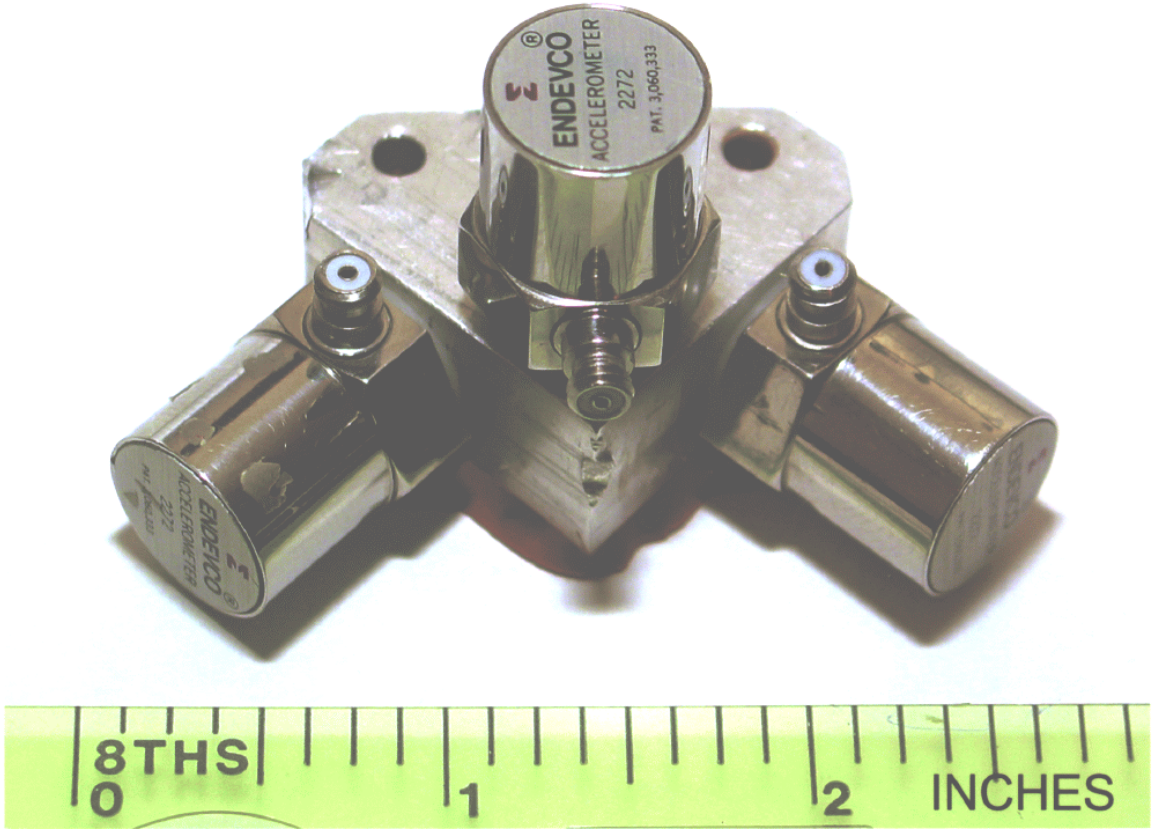
Development of Cryogenic Accelerometers for 4K



XRS Filter Vibratable Dewar: Used to Perform LHe Vibration Testing
(units are inches, 10 p.s.i burst disc and dewar mounting plate to shaker are not shown)

FEMCI Poster: Current Accelerometers

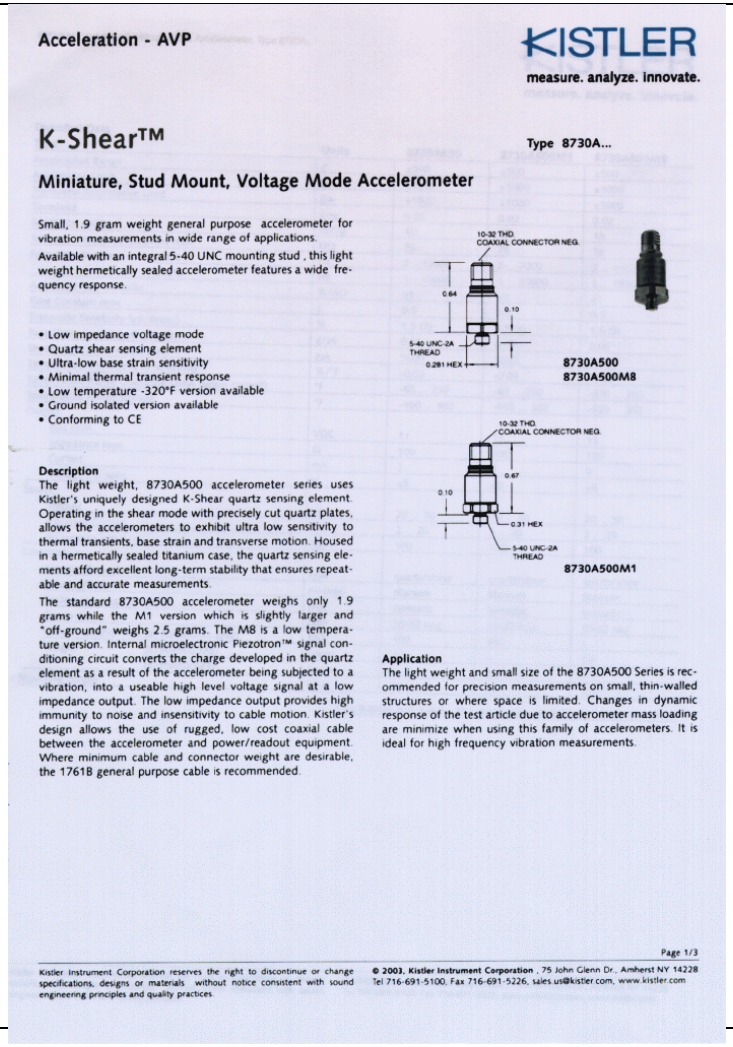
Development of Cryogenic Accelerometers for 4K



Current accelerometers are too large and heavy to measure the responses of small, cryogenic components.

FEMCI Poster: New Accelerometers

Development of Cryogenic Accelerometers for 4K



Acceleration - AVP

KISTLER
measure. analyze. innovate.

K-Shear™

Type 8730A...

Miniature, Stud Mount, Voltage Mode Accelerometer

Small, 1.9 gram weight general purpose accelerometer for vibration measurements in wide range of applications.

Available with an integral 5-40 UNC mounting stud, this light weight hermetically sealed accelerometer features a wide frequency response.

- Low impedance voltage mode
- Quartz shear sensing element
- Ultra-low base strain sensitivity
- Minimal thermal transient response
- Low temperature -320°F version available
- Ground isolated version available
- Conforming to CE

8730A500
8730A500M8

8730A500M1

Description

The light weight, 8730A500 accelerometer series uses Kistler's uniquely designed K-Shear quartz sensing element. Operating in the shear mode with precisely cut quartz plates, allows the accelerometers to exhibit ultra low sensitivity to thermal transients, base strain and transverse motion. Housed in a hermetically sealed titanium case, the quartz sensing elements afford excellent long-term stability that ensures repeatable and accurate measurements.

The standard 8730A500 accelerometer weighs only 1.9 grams while the M1 version which is slightly larger and "off-ground" weighs 2.5 grams. The M8 is a low temperature version. Internal microelectronic Piezotron™ signal conditioning circuit converts the charge developed in the quartz element as a result of the accelerometer being subjected to a vibration, into a useable high level voltage signal at a low impedance output. The low impedance output provides high immunity to noise and insensitivity to cable motion. Kistler's design allows the use of rugged, low cost coaxial cable between the accelerometer and power/readout equipment. Where minimum cable and connector weight are desirable, the 1761B general purpose cable is recommended.

Application

The light weight and small size of the 8730A500 Series is recommended for precision measurements on small, thin-walled structures or where space is limited. Changes in dynamic response of the test article due to accelerometer mass loading are minimize when using this family of accelerometers. It is ideal for high frequency vibration measurements.

Purchased Kistler Type 8730A, small accelerometer. It is .67" tall and .281" diameter and weighs 1.9 grams.

This accelerometer is being tested for use at LN2 and LHe temperatures.

FEMCI Poster: Kistler Accelerometers Mounted to Cold Plate of Vibratable Dewar

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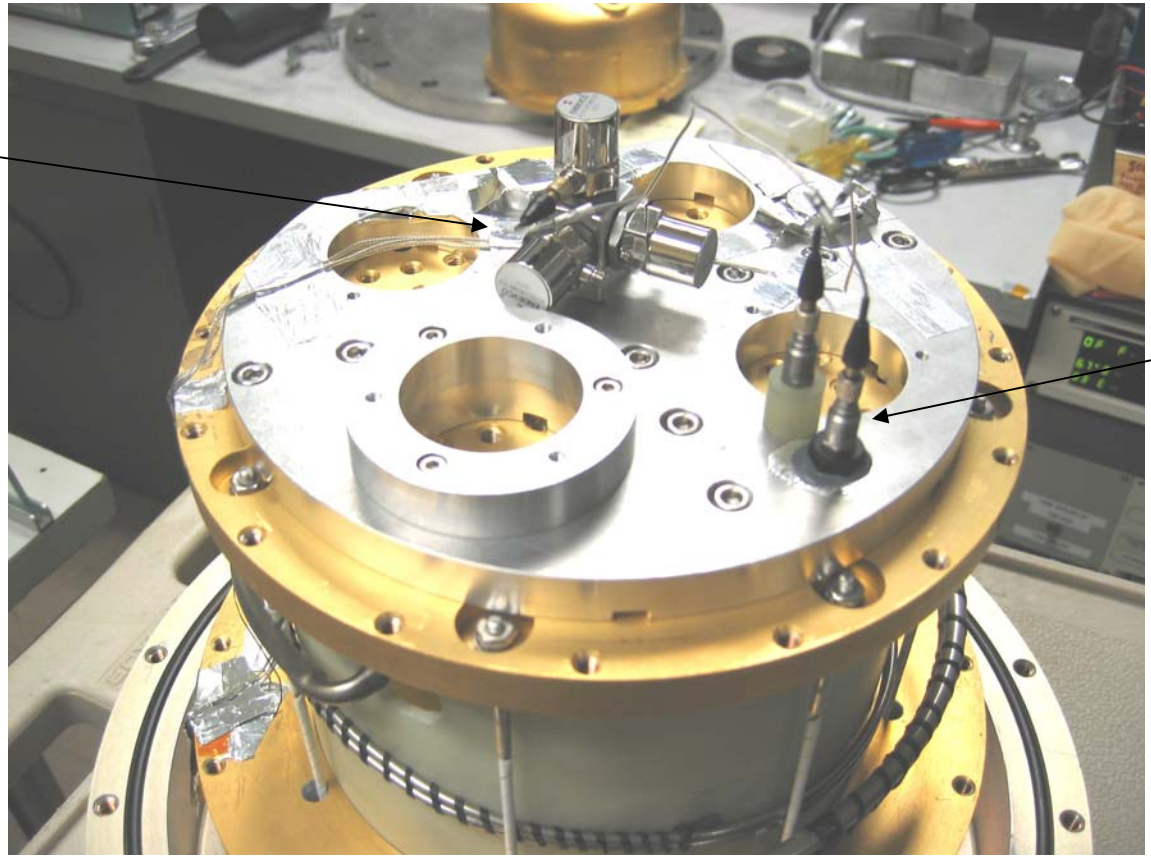
Current Accels

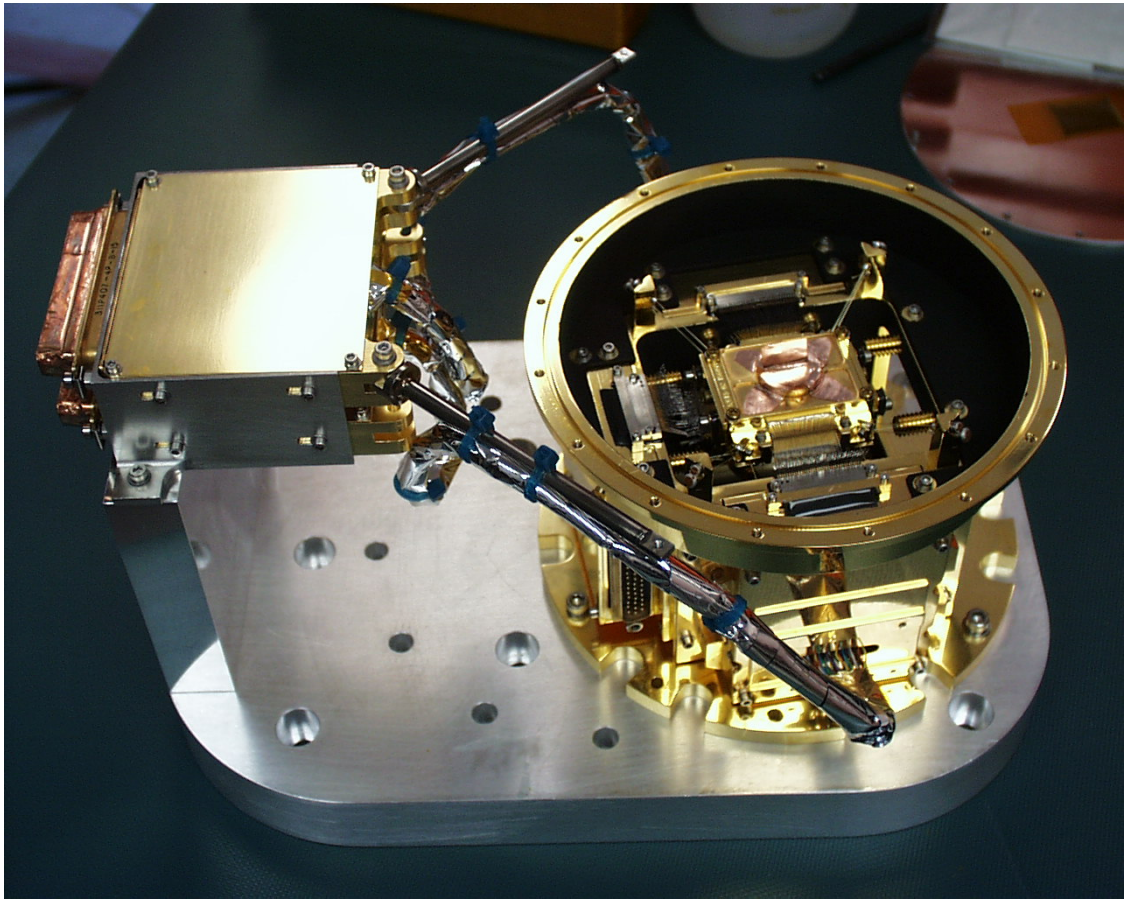


Kistler Accels

Kistler accelerometers are shown here mounted to the cold plate of the vibratable dewar. One is bonded to the plate using Scotchwell 2216 and the other is bolted to the plate with a Fiberglass G-10 block needed for electrical isolation.

FEMCI Poster: Examples of Small Cryogenic Components

Development of Cryogenic Accelerometers for 4K



FEA and the FEA Transition Box contains a small (~ 1” x 1” square) suspended area that houses the detector. This detector is kept at .065 K for launch. It was very difficult to predict the structural resonance of the suspended hardware and this was only measured at ambient temperature since instrumentation did not exist that would allow accurate measurement at cryogenic temperature.

FEMCI Poster: Examples of Small Cryogenic Components

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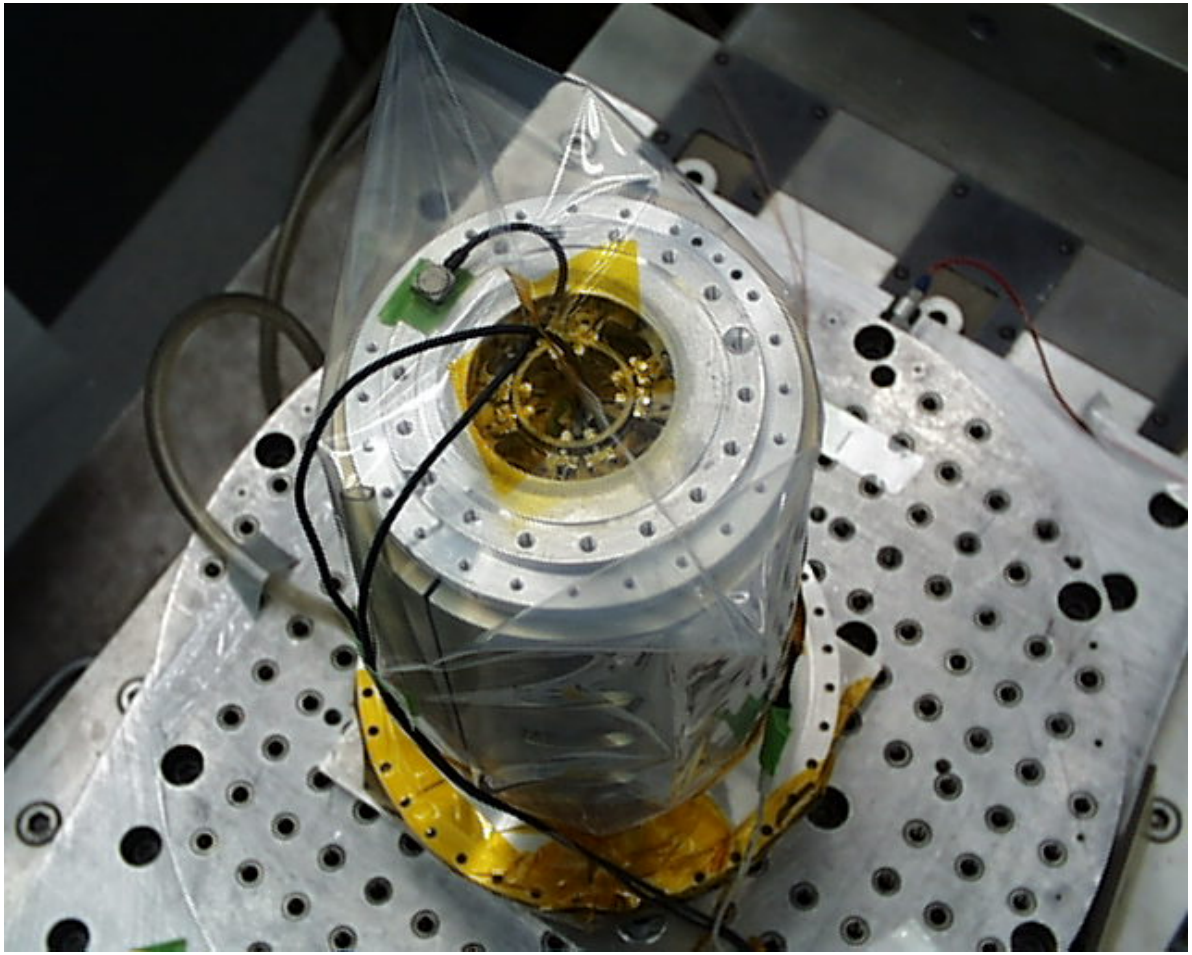

ADR contains a salt pill which is ~ 6” tall and 1.5” diameter. It is suspended from Kevlar straps. This component is at 4K for launch. The picture here shows the ADR being tested at ambient conditions with an accelerometer mounted on the top, outer cylinder and one mounted on the top of the salt pill (only the accel cable is shown). These accelerometers were removed for cryogenic testing since this instrumentation was not acceptable for such cold temperatures. Structural test data was required but not obtained at cold temperatures.