

# **Status of Vibration Measurement Work at BNL**

Superconducting Magnet Division, BNL

BNL-SLAC TeleConference: May 3, 2004

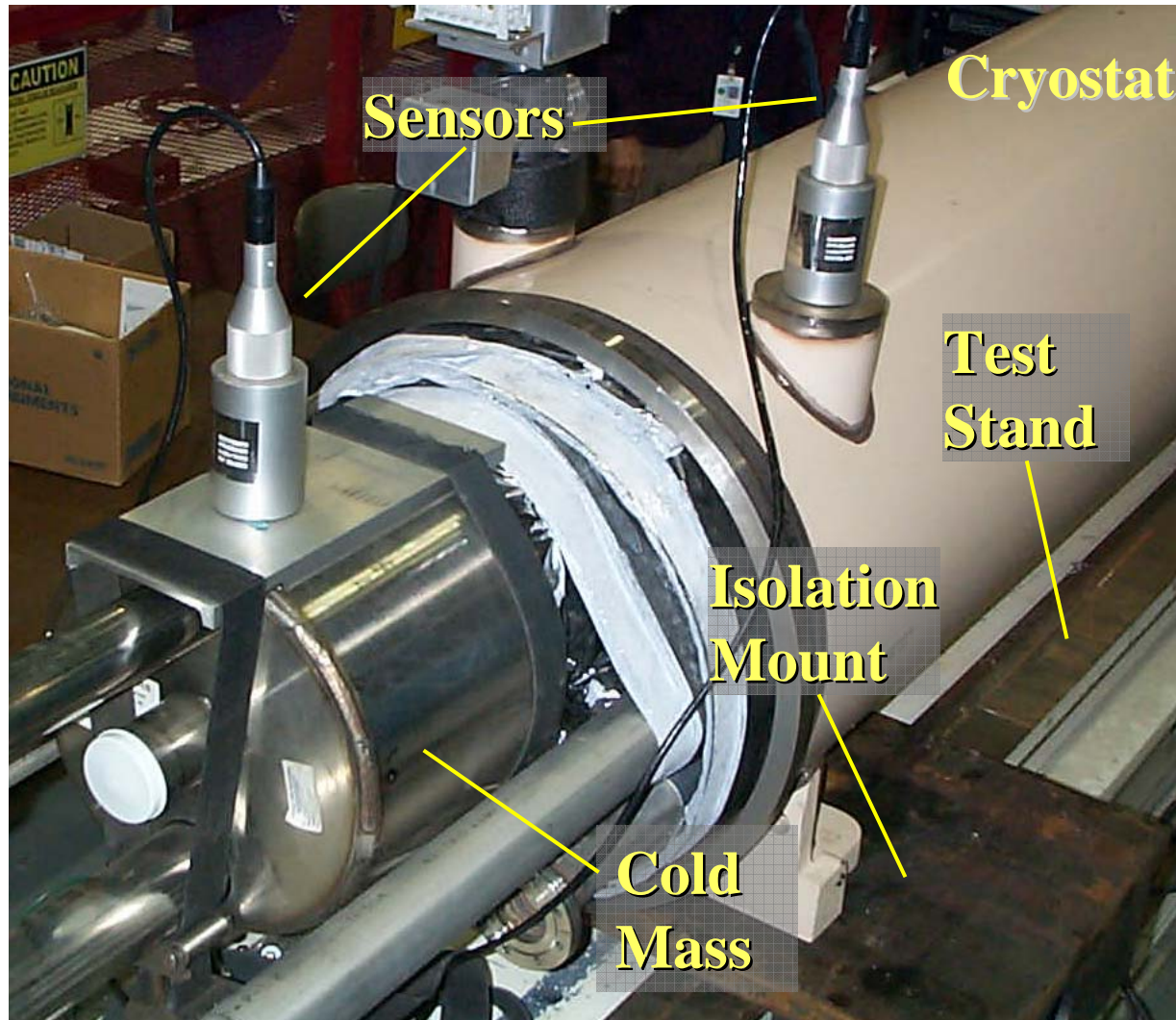
# Introduction

- Serious efforts at BNL kicked off with visit by Andrei Seryi of SLAC in February, 2004.
- Vibration measurements were carried out on a warm CQS magnet, as well as in the RHIC tunnel, during Andrei's visit.
- All the sensors, as well as the LabView software used for these measurements, were provided by SLAC.
- A Fortran program to read binary files from LabView and analyze the data was written later at BNL. An Excel macro reads the output and makes the desired plots. All plots shown later are from this package.

# Recent Activities

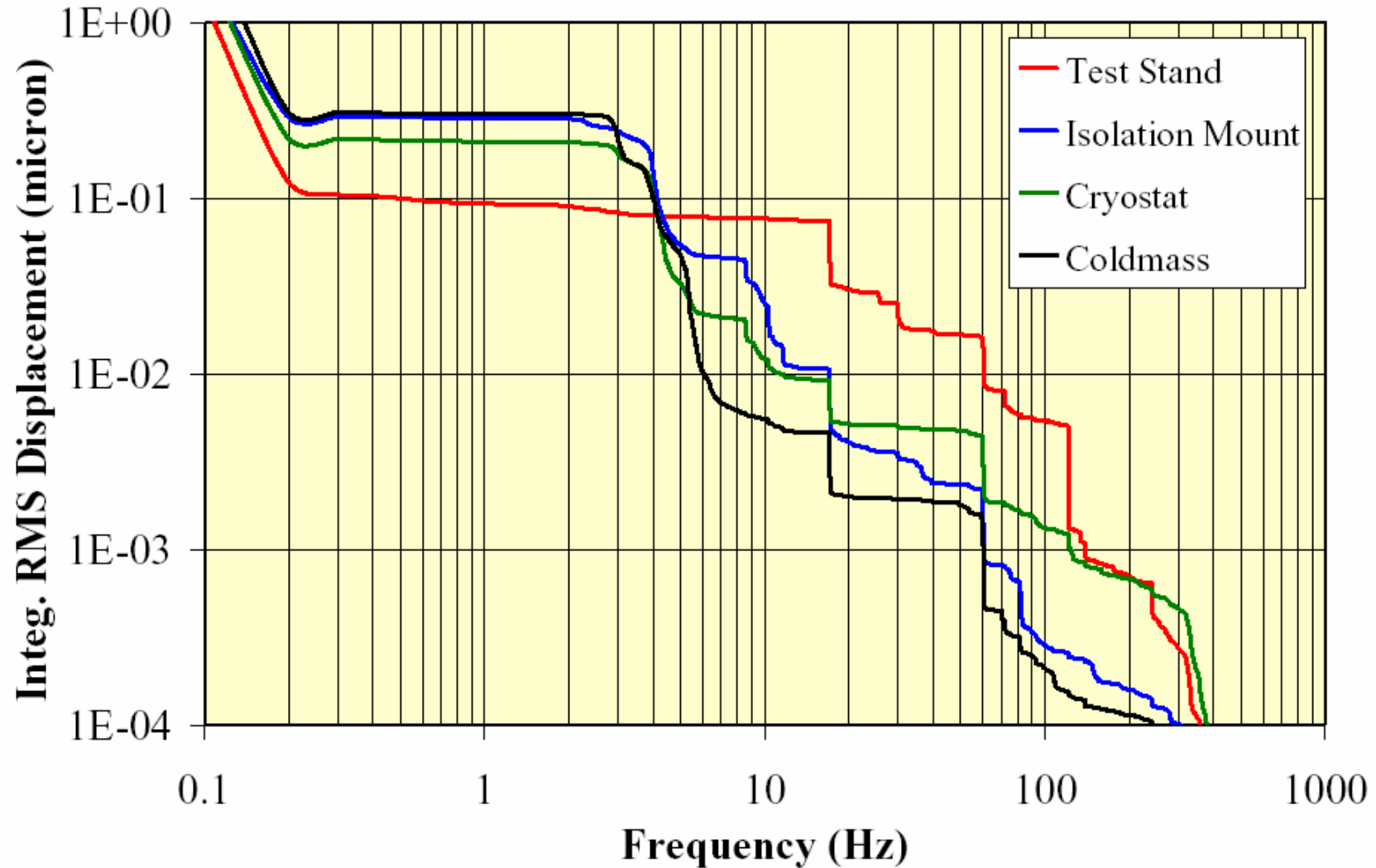
- A new LabView data acquisition application, similar to that at SLAC, but with somewhat more flexibility and a more detailed file header, is written.
- Representatives from PolyTec, Inc. demonstrated the Laser Doppler vibrometer system at BNL on April 14, 2004.
- A plan for measurements of the cold CQS was presented at a meeting on April 16, 2004.
- 2 horizontal and 2 vertical Mark L4 geophones were ordered, and have just been received at BNL.

# CQS Vibration Measurements (Feb'04)



# CQS Vibrations along Vertical Axis

(Measurements on a warm CQS)



# CQS Vibrations along Vertical Axis

(Measurements on a warm CQS)

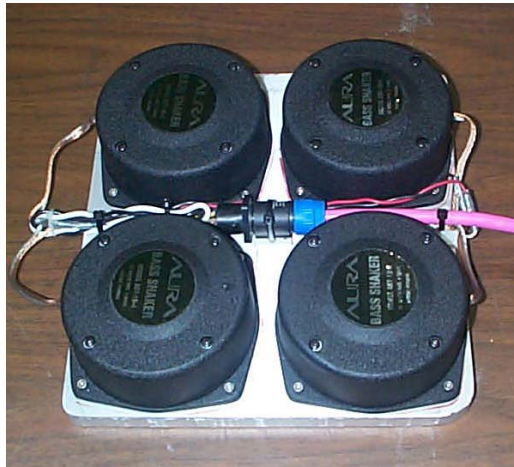
Location	Vibration RMS Amplitude in nm (Vertical)				
	0.3 to 6 Hz	> 6 Hz	~17 Hz	~60 Hz	~120 Hz
Ground	80	73	65	8	1
Test Stand	70	77	66	11	5
Isolation Mount	283	46	9	1	--
Cryostat	212	22	7	2	--
Cold Mass	304	10	4	1	--

# CQS Vibrations along Horizontal Axis

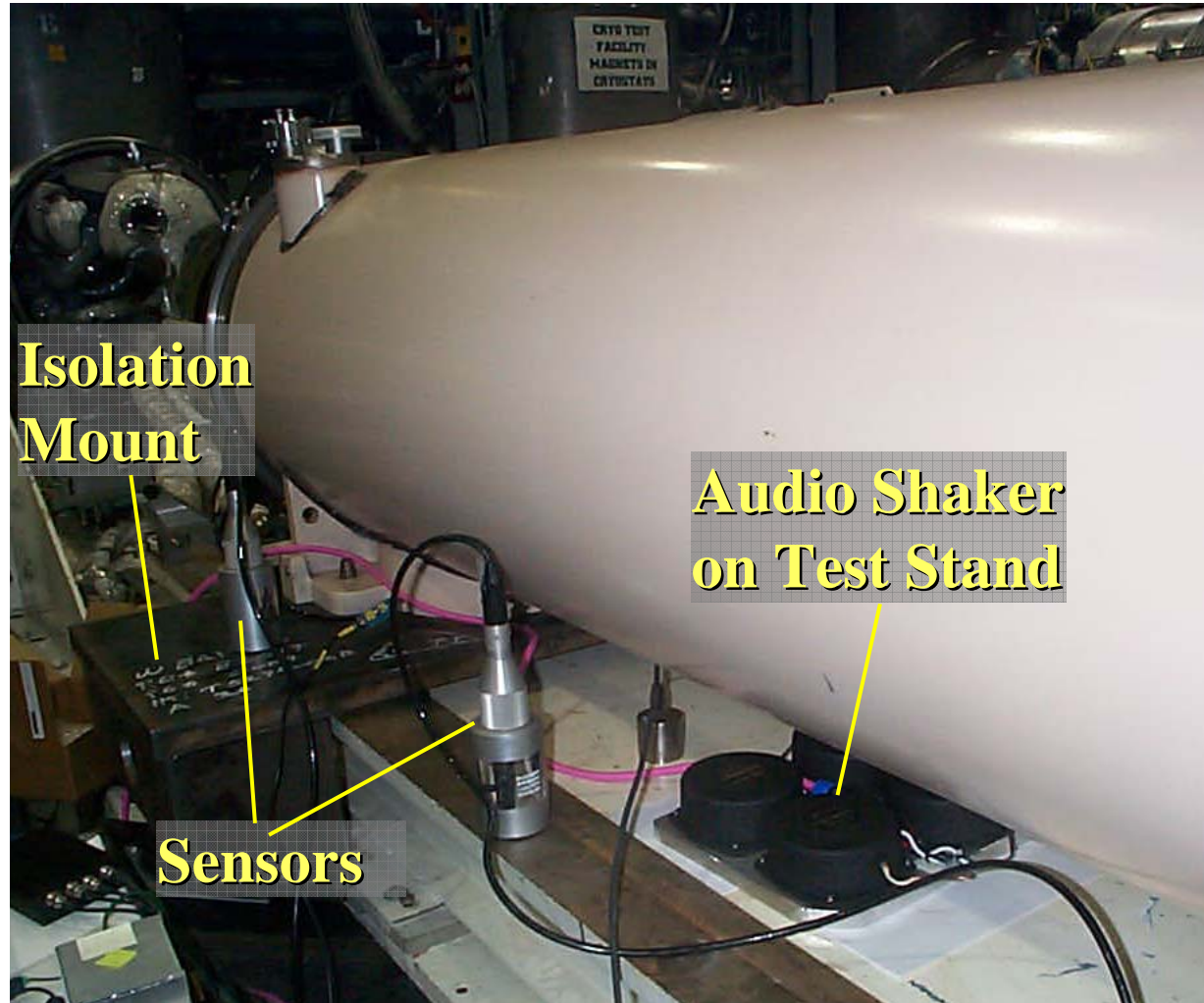
(Measurements on a warm CQS; transverse to magnet axis)

Location	Vibration RMS Amplitude in nm (Horiz.)				
	0.7 to 6 Hz	> 6 Hz	~17 Hz	~60 Hz	~120 Hz
Ground	117	42	30	6	1
Test Stand	96	29	12	12	8
Isolation Mount	189	8	1	--	--
Cryostat	132	5	1	--	1
Cold Mass	147	5	1	--	--

# CQS Vibration with Audio Shaker

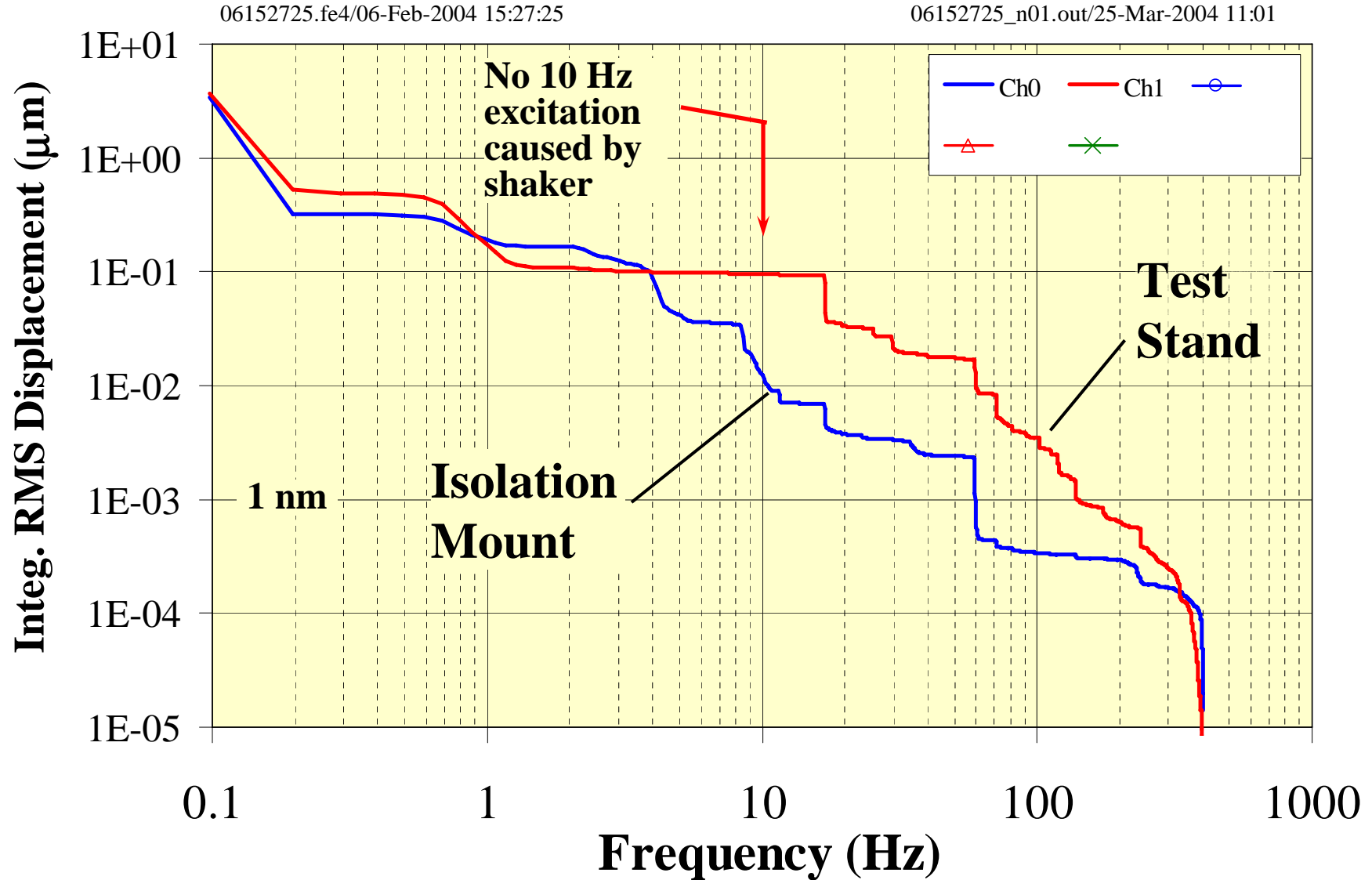


**Audio Shaker  
(Effective at  $>20$  Hz)**

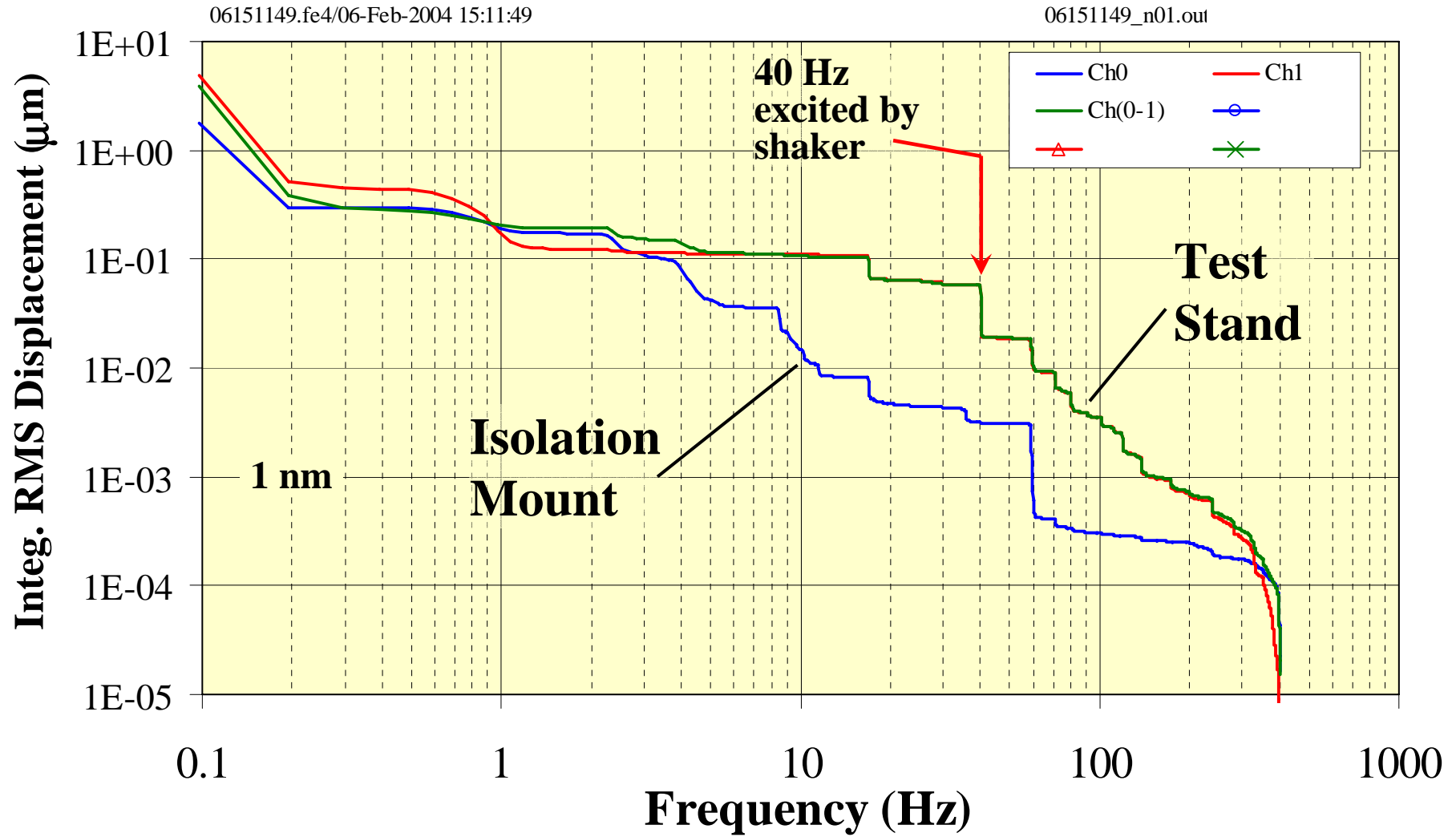




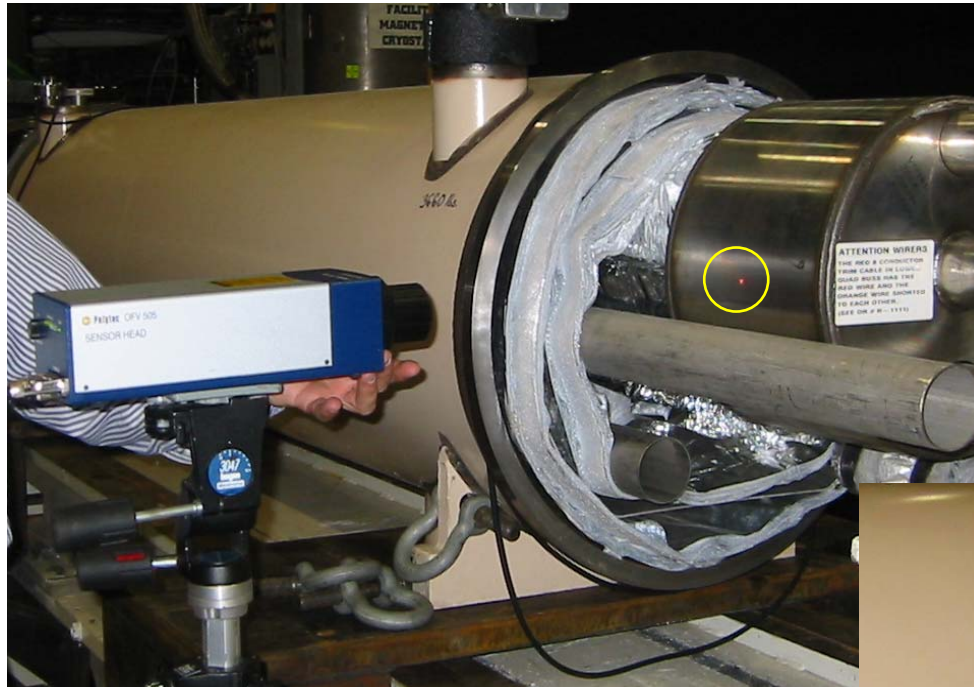
# Audio Shaker at 10 Hz



# Vibration Damping at 40 Hz



# PolyTec LDV Demo: April 14, 2004



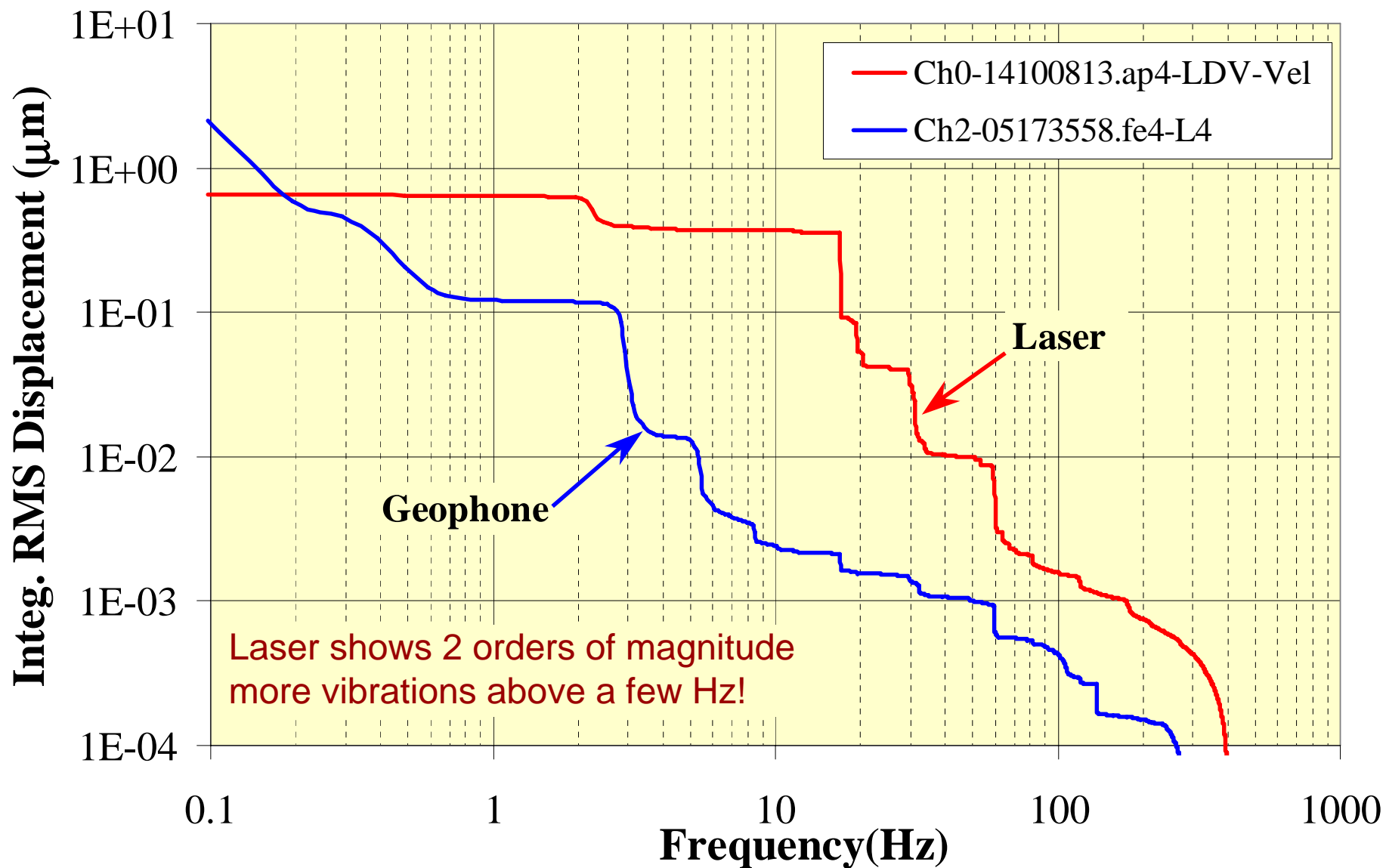
- OFV-5000 Controller
- OFV-505 Sensor Head
- VD-06 Velocity decoder
- DD-500 Displacement decoder

Data acquired using SLAC  
LabView program on Laptop

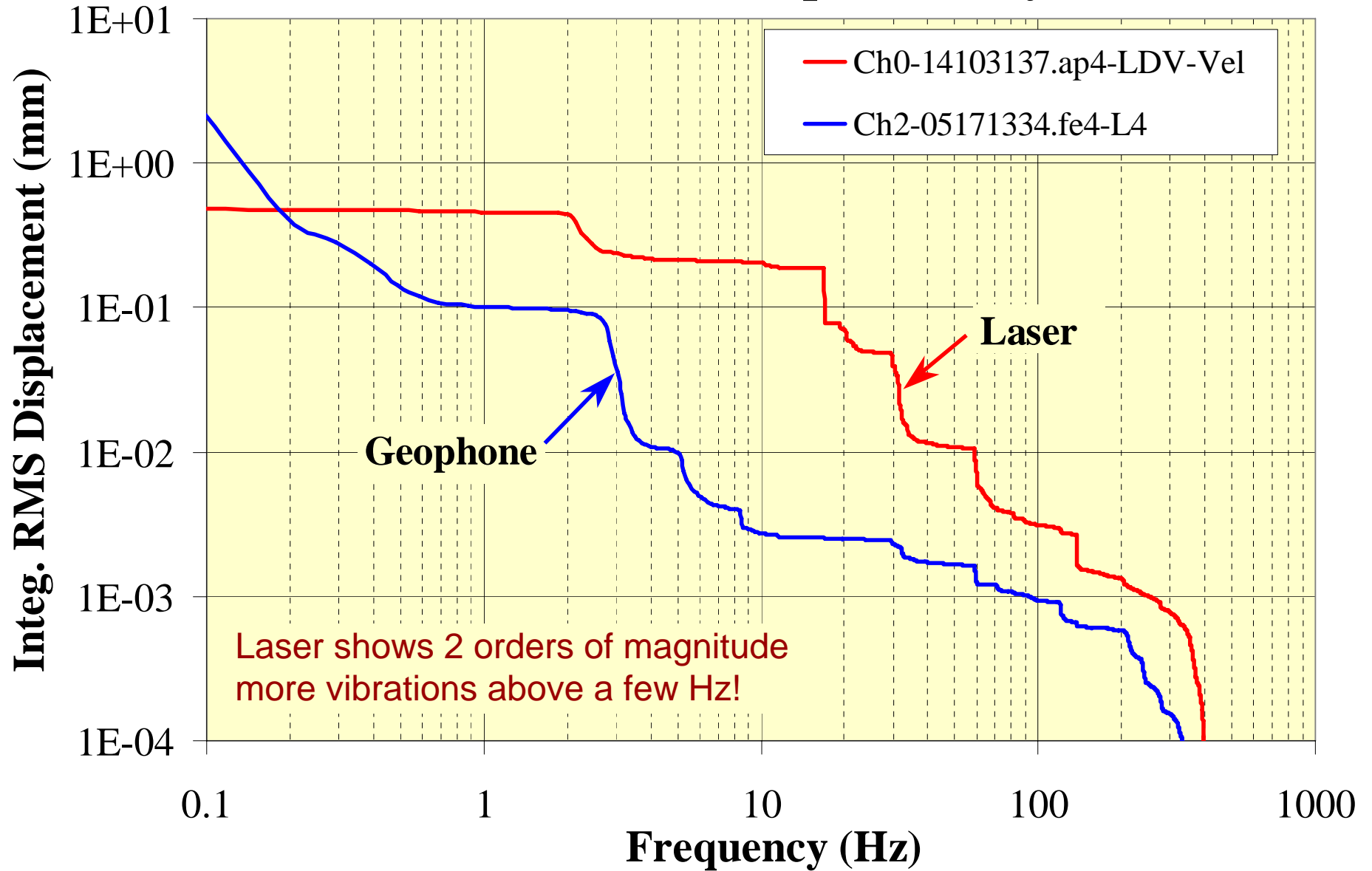
- All signals in the displacement mode had problems!
- Two types of amplitudes in velocity mode, differing by  $\sim 5X$
- Not clear if different ranges were used in different runs.



# Laser Vibrometer Vs Geophone: Cold Mass Data



# Laser Vibrometer Vs Geophone: Cryostat Data



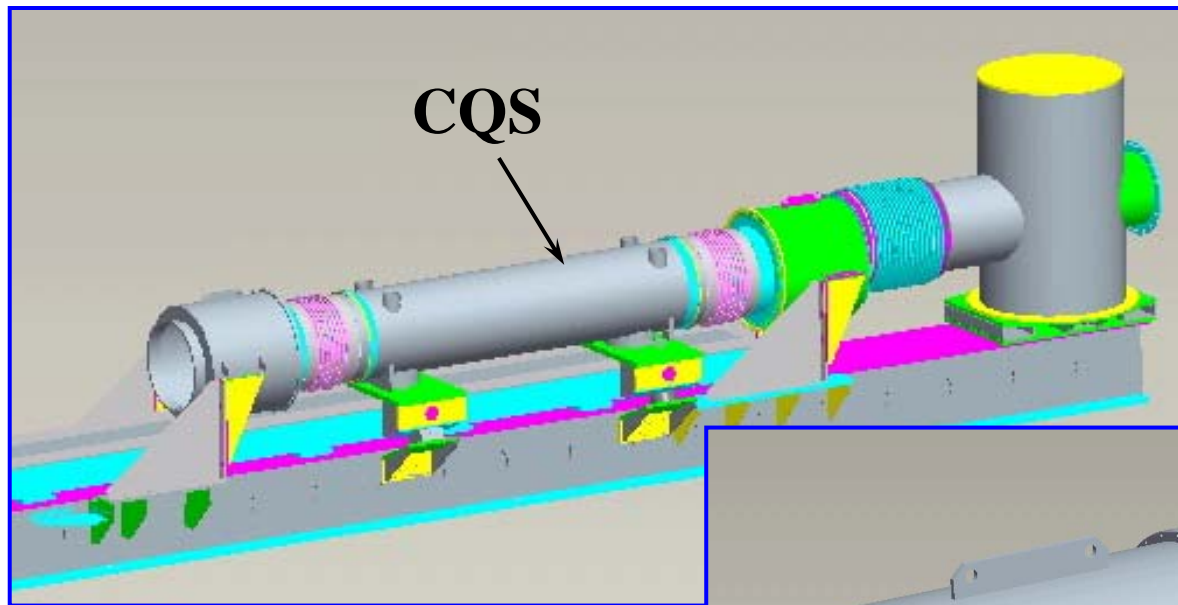
# Conclusions from the Laser Test

- First pass results are less encouraging than expected.
- Large discrepancies between laser and geophone results, BUT the two measurements were not done simultaneously. The area was in fact noisier than usual on the day of the laser test.
- No good displacement mode data were obtained. This appears to be a malfunction of the laser equipment.
- Questions remain about sensitivity to laser head motion, air currents, etc.
- It would be very interesting to carry out geophone and laser measurements simultaneously. This would involve renting the laser system for at least two days (~ \$2K).

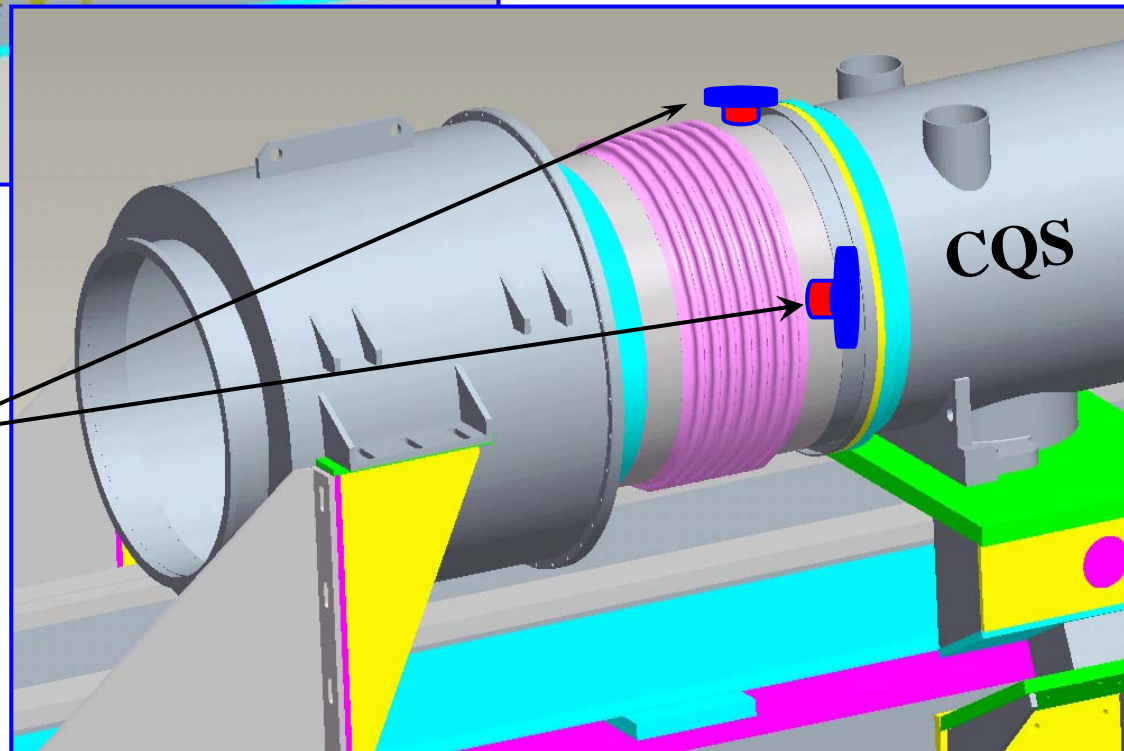
# Work Underway

- 4 geophones received recently will be calibrated, both using a built-in calibration coil, and the step response method.
- An amplifier is designed and built for use with the geophones. Its characteristics are being measured.
- Warm measurements on the CQS will be repeated with the new geophones and compared to the February 2004 data.
- Simultaneous measurements with the geophones and the laser system ??
- View ports are being installed in the cold test bench fixtures to do laser measurements cold.

# View Ports for CQS Cold Measurements



**Viewports**





# Summary

- A beginning has been made to develop capability of acquiring and analyzing vibration measurement data at BNL.
- Laser Doppler vibrometer was identified as a possible solution for measurements at cryogenic temperatures with good resolution.
- Preliminary demonstration results are not too encouraging, but the technique still deserves to be looked at more closely. Still is “Plan A” for cold measurements.
- Proceeding with the installation of view ports.
- Will rent the laser system due to the high purchase cost (~\$62K). May be useful to rent first for warm tests (~\$2K)