

Effects of mounting on accelerometer performance

Scott Mayo
Line Moisan

The information contained in this document is the property of Meggitt Sensing Systems and is proprietary and/or copyright material. This information and this document may not be used without the express authorization of Meggitt Sensing Systems. Any unauthorized use or disclosure may be unlawful.

Information contained in this document is subject to U.S. Export Control regulations, specifically the (choose as appropriate) International Traffic in Arms Regulations and / or Export Administration Regulations. Each recipient of this document is responsible for ensuring that transfer or use of any information contained in this document complies with all relevant (choose as appropriate) International Traffic in Arms Regulations and / or Export Administration Regulations.

MEGGITT

Topics

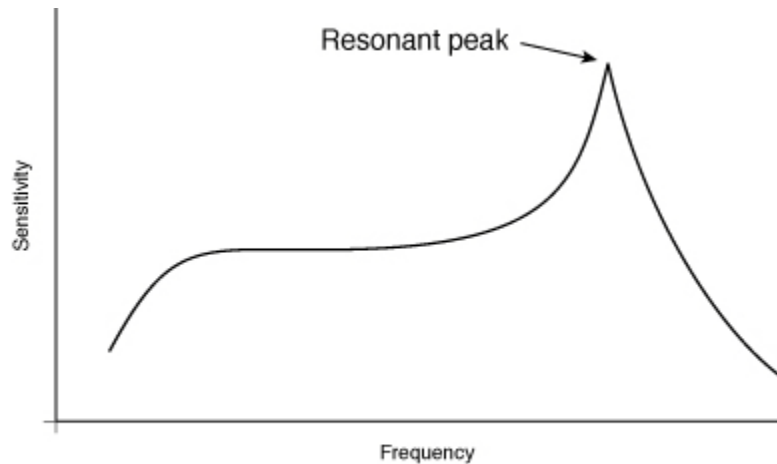
- Introduction
- Test set up
 - Hardware
 - Parameters
 - Test matrix
- Results
- Conclusions
- Future research

Introduction

- Accelerometer users often have questions about how to properly mount their accelerometers
 - Sensor manufacturers publish ideal installation parameter requirements
 - Users must balance ideal requirements with practical limitations on their particular applications
 - What does the user trade-off by not following the ideal requirements?
- We will explore the affects of varying installation parameters on accelerometer performance
 - Focus is on frequency (amplitude) response, in particular the mounted resonant frequency

Introduction

- Mounted resonant frequency: the point of maximum sensitivity in the sensor's amplitude response
 - Result of the natural resonance of the sensor's mechanical structure
 - Typical values are 20 kHz and above



- Specified as a minimum
 - Used as a rough measure that sets the upper limit for the sensor's bandwidth

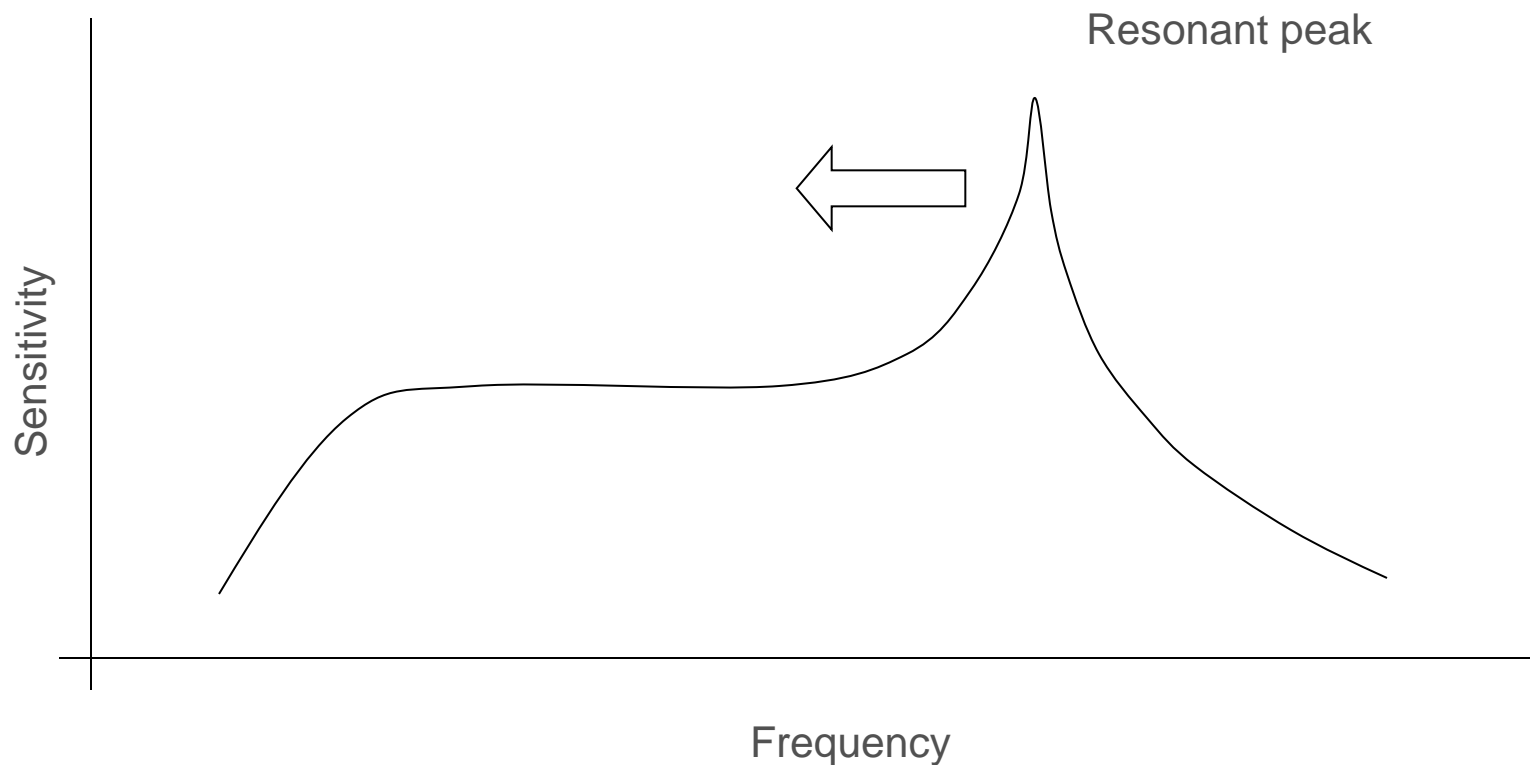
Introduction

- Piezoelectric accelerometers, in particular, have very high amplitude resonant peaks
 - Sensitivity at the peak is many times the reference sensitivity
 - Vibrations in this region can be highly amplified, possibly resulting in distorted measurements
- Manufacturer's specification assumes ideal mounting conditions
 - Less than ideal mounting decreases stiffness and increases damping, causing resonant peak to move down in frequency

Introduction

Installation considerations

- How the accelerometer is mounted can have a significant affect on the sensor's amplitude response



Introduction

- Ideal installation parameters
 - Threaded stud mount type
 - Surface flatness, max: 0.0003 inch TIR
 - Surface roughness, max: 32 μ inch rms
 - Tapped hole perpendicularity: $0^\circ \pm 1^\circ$
 - Recommended torque
 - Use coupling grease (ultrasonic couplant)
 - Adhesive mount type
 - Bond line as thin as possible

Test Methodology

Hardware

- Endevco shaker
- CAACS
- Accelerometers
 - Piezoelectric (PE)



7704
0.9 oz (25 gm)



2221F
0.4 oz (11 gm)



2222C
0.02 oz (0.5 gm)

Test Methodology

Parameters

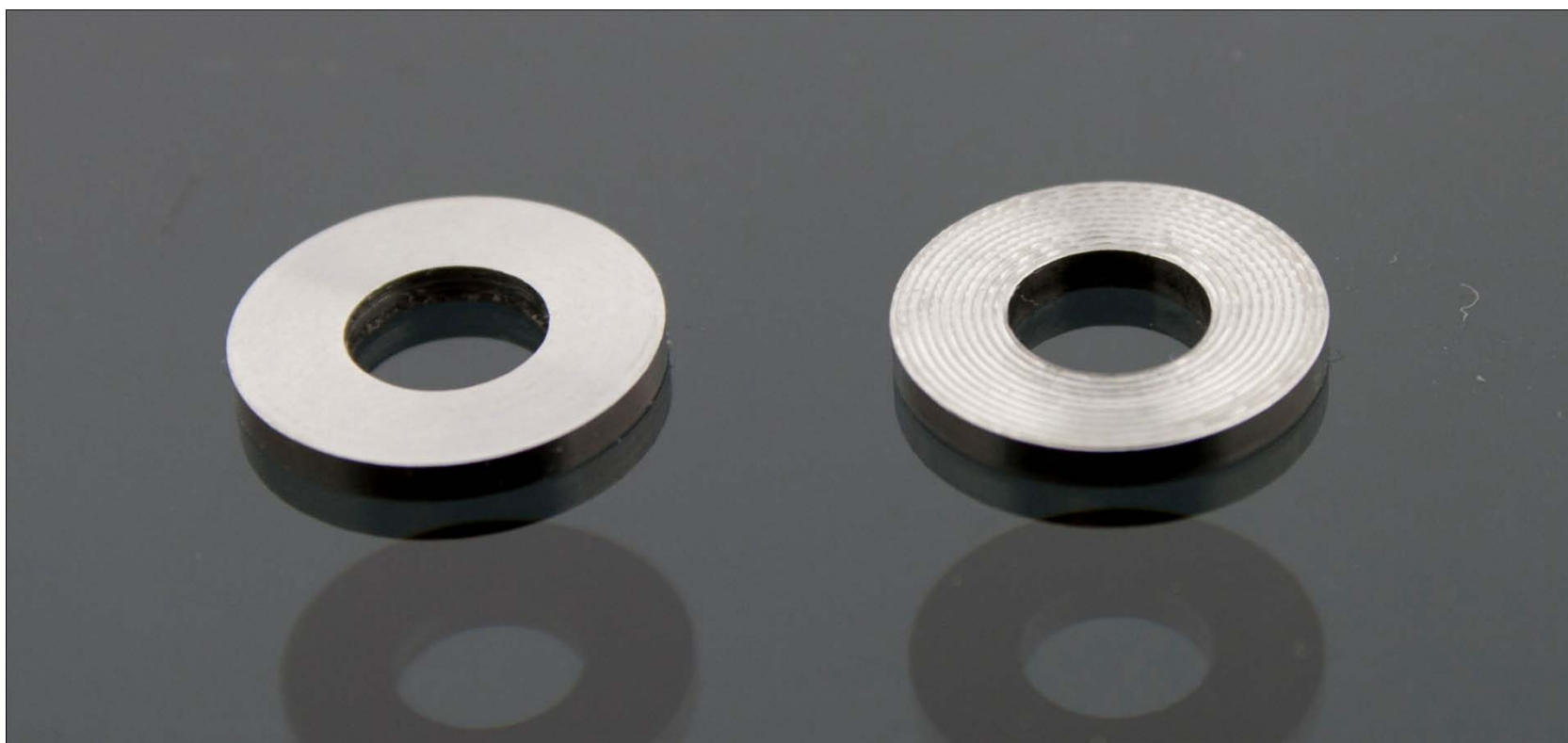
- Vary torque from recommended value to under value (50% of recommended torque)
- Try grease and dry (no grease) conditions



Test Methodology

Parameters

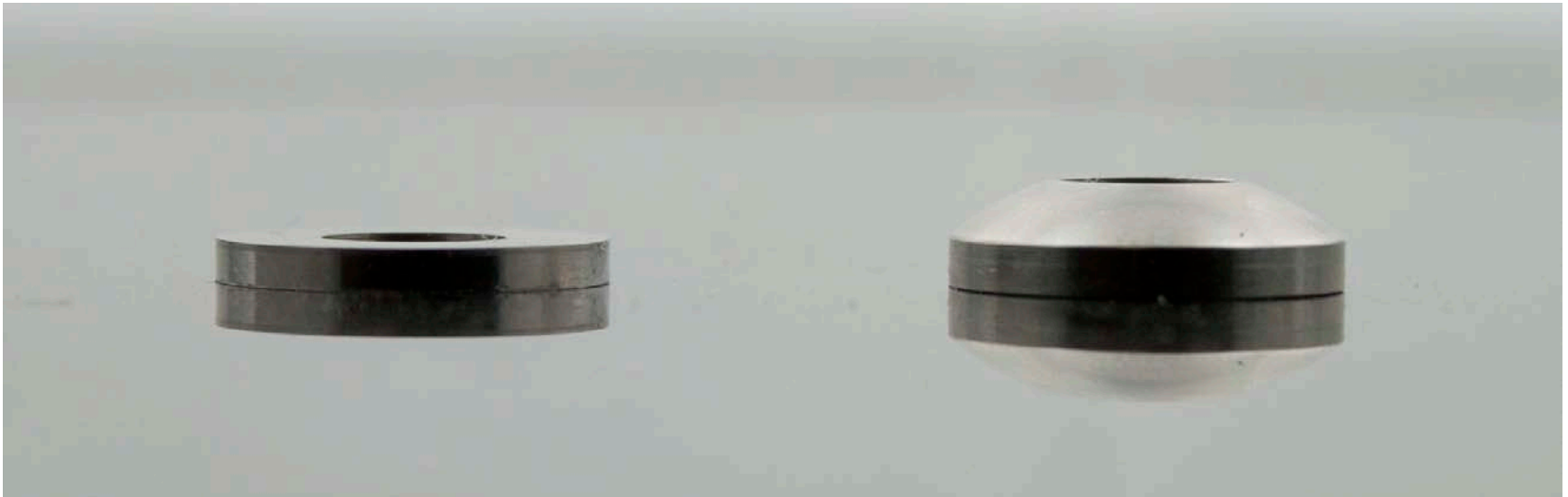
- Surface roughness: 16, 32, 64, 125, 250, 500 μ inch rms



Test Methodology

Parameters

- Surface flatness: 0.0005, 0.003, 0.001, 0.01, 0.1 inch TIR

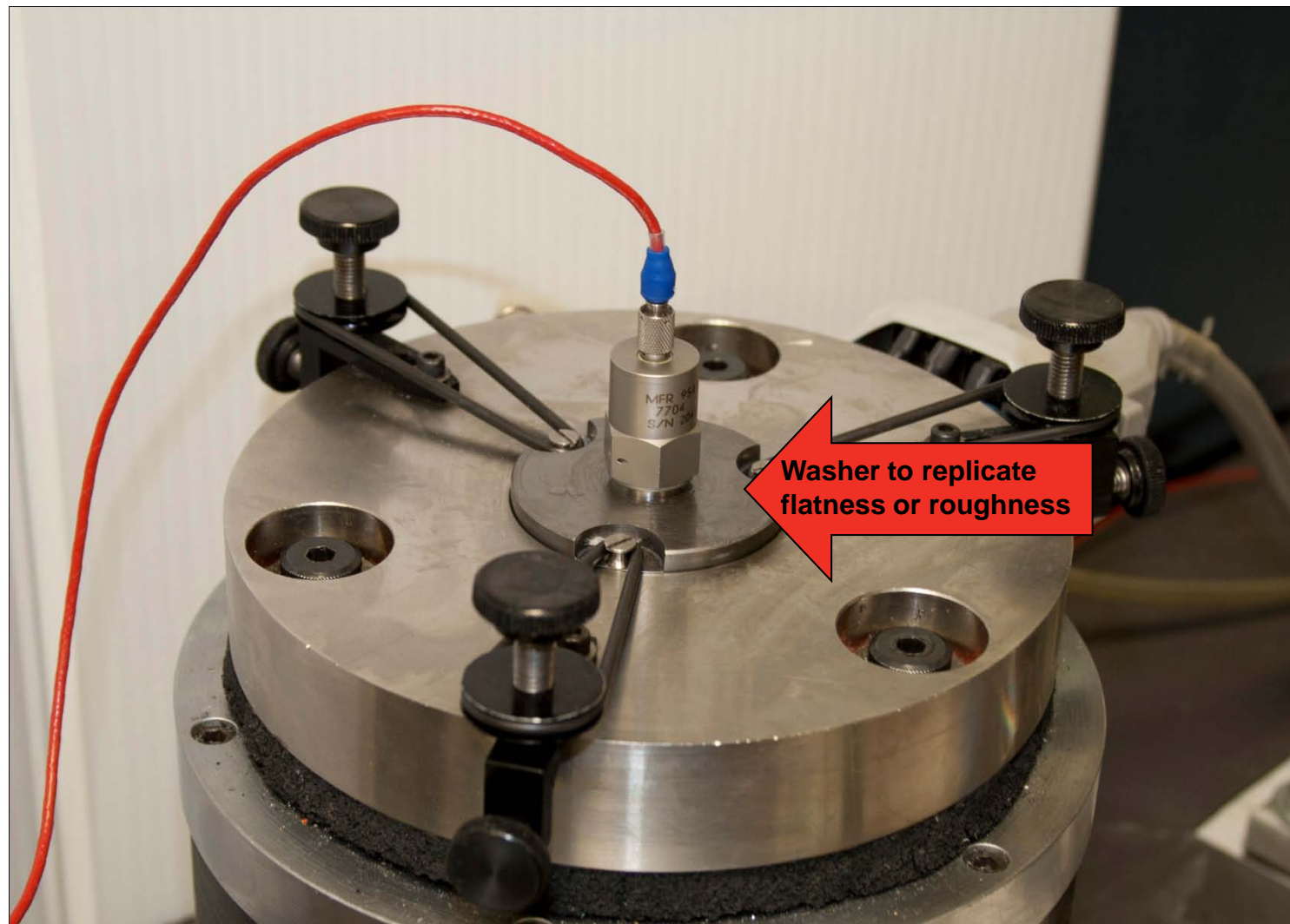


Test Methodology

- Parameters
 - Vary adhesives



Test Set up with shaker



Test Matrix

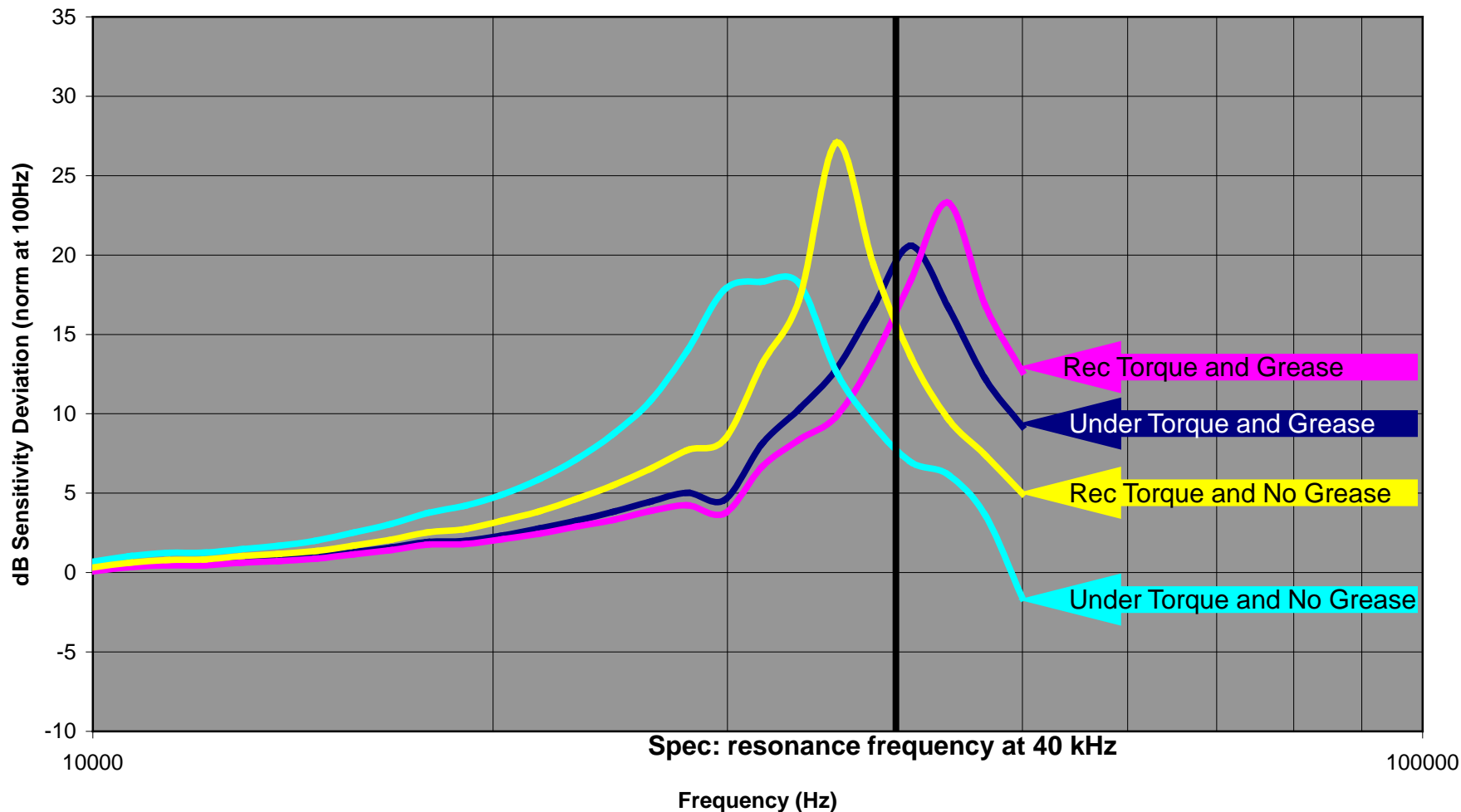


	7704 stud mounted	2221F thru-hole stud mounted	2222C adhesive mounted
Torque/Under torque	√	√	X
Roughness	√	√	X
Flatness	√	√	X
Perpendicularity	√	√	X
Adhesive	X	X	√



Results - Torque

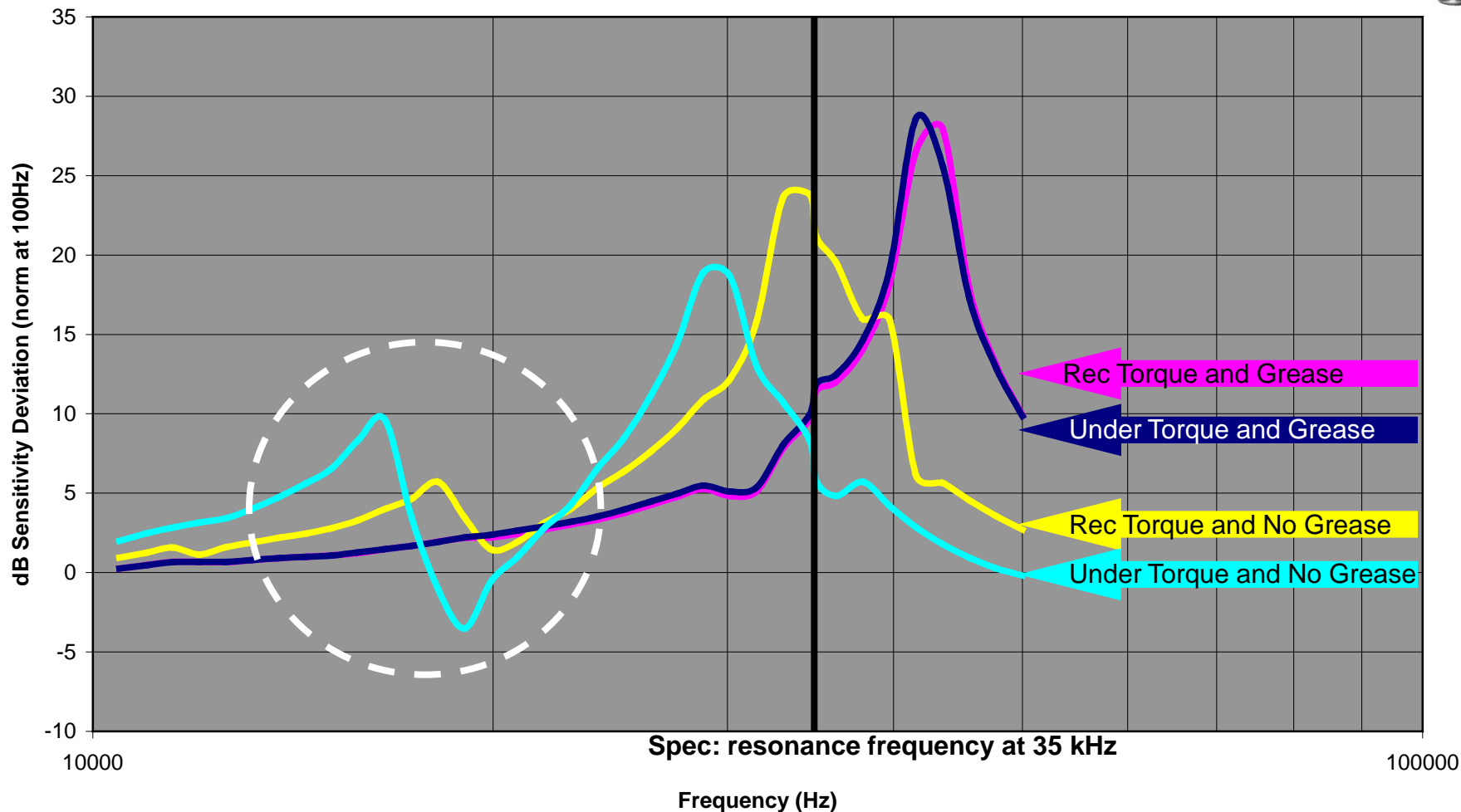
2221F
10 k – 50 kHz





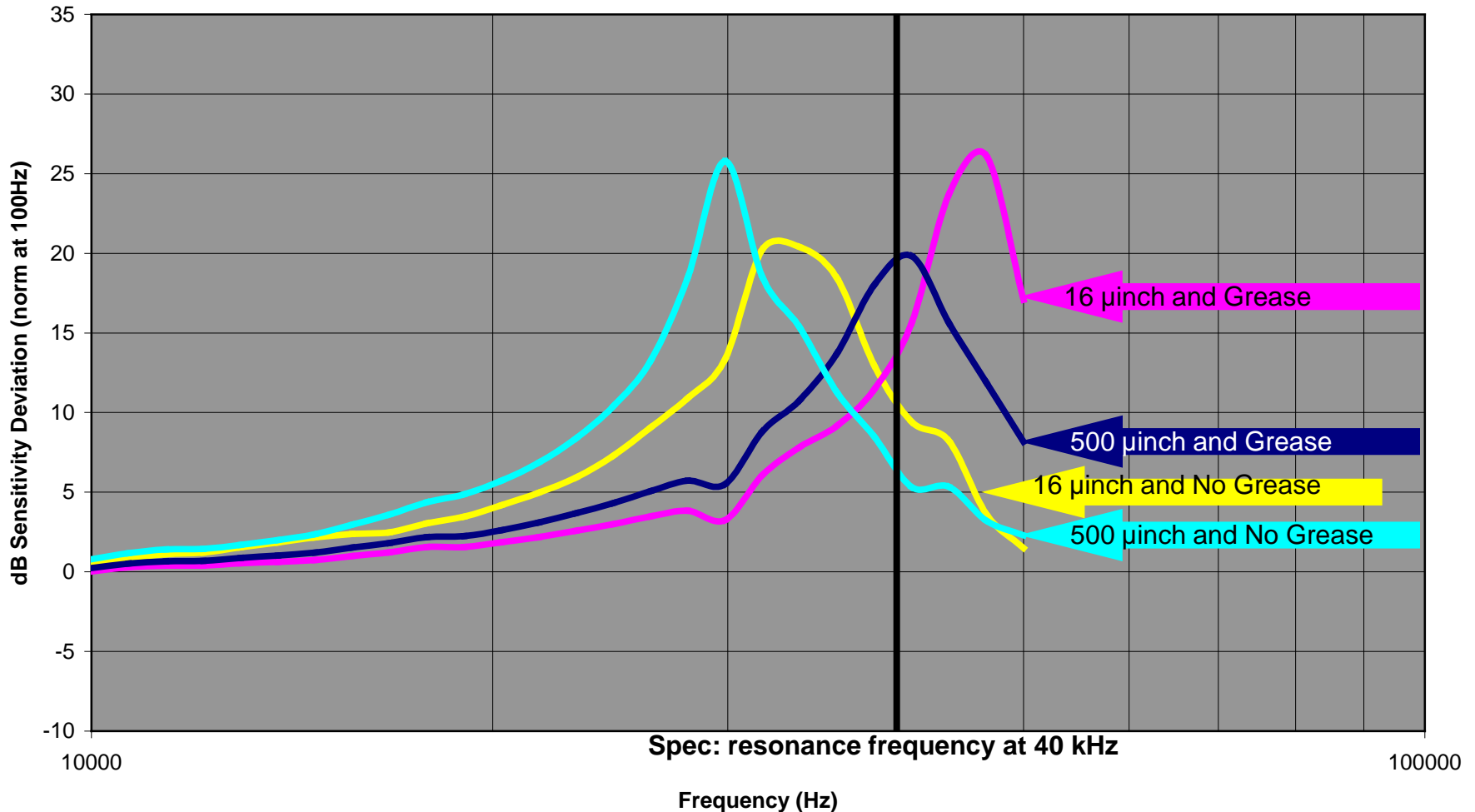
Results - Torque

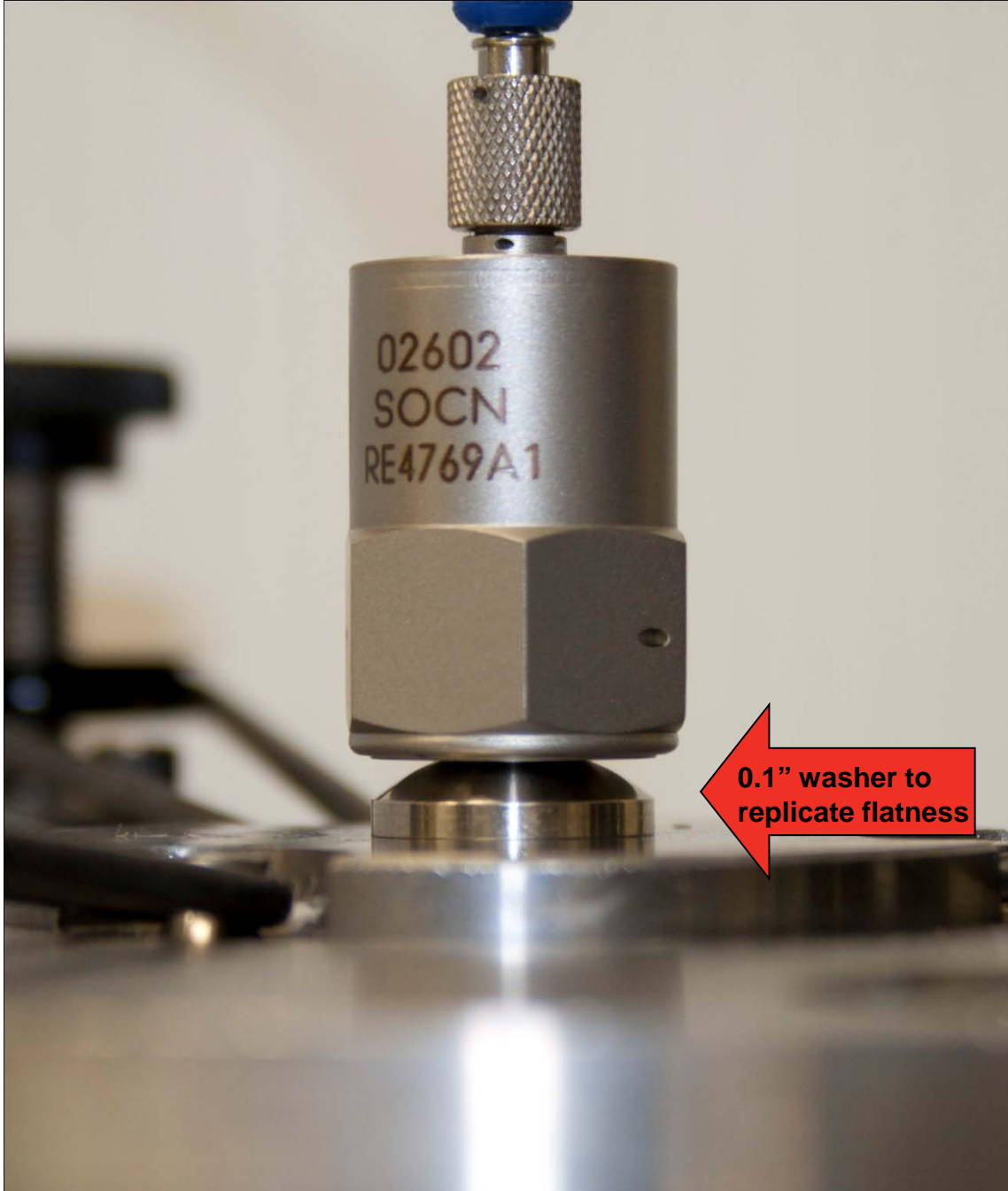
7704
10 k – 50 kHz



Results - Roughness

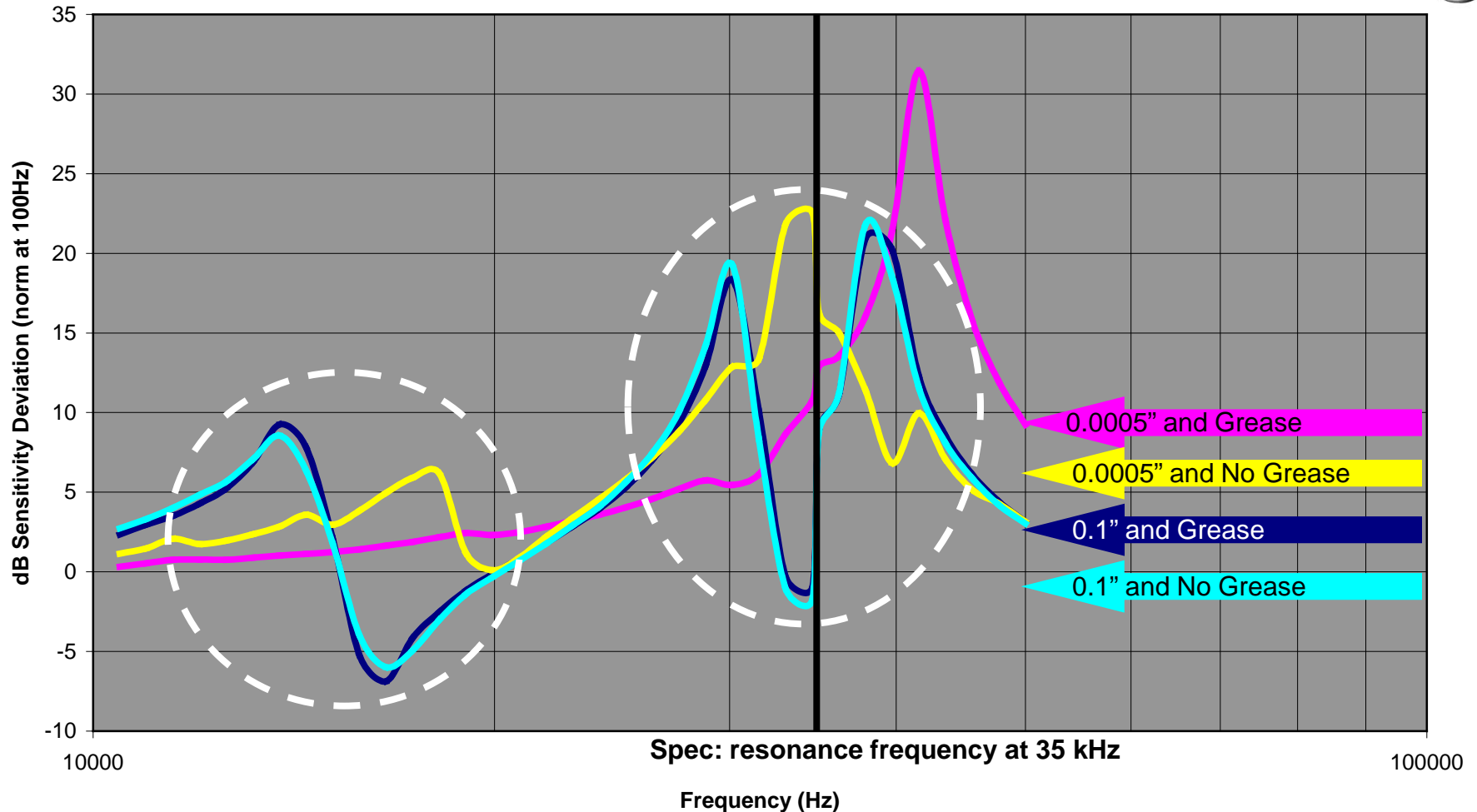
2221F
10 k – 50 kHz





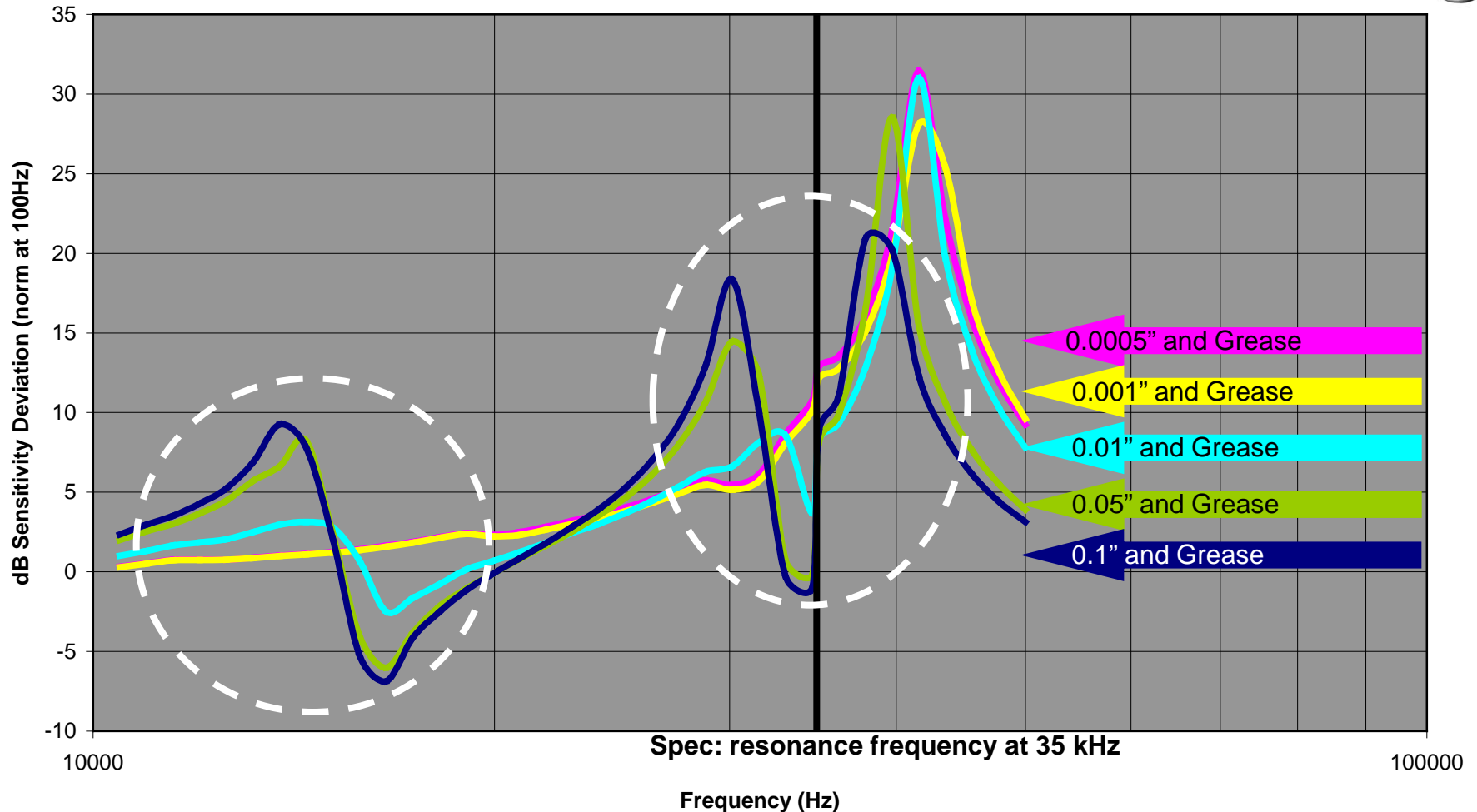
Results - Flatness

7704
10 k – 50 kHz



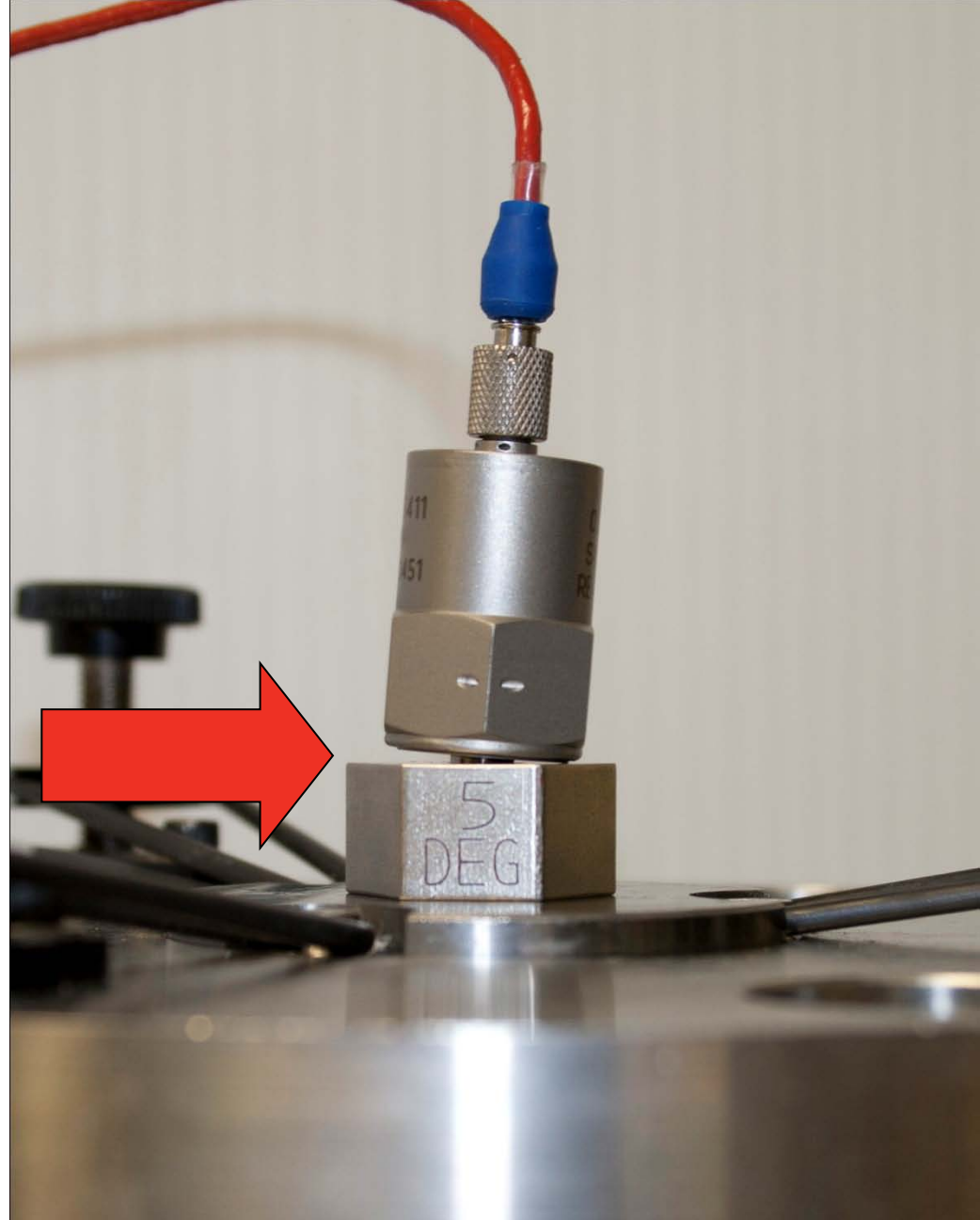
Results - Flatness

7704
10 k – 50 kHz

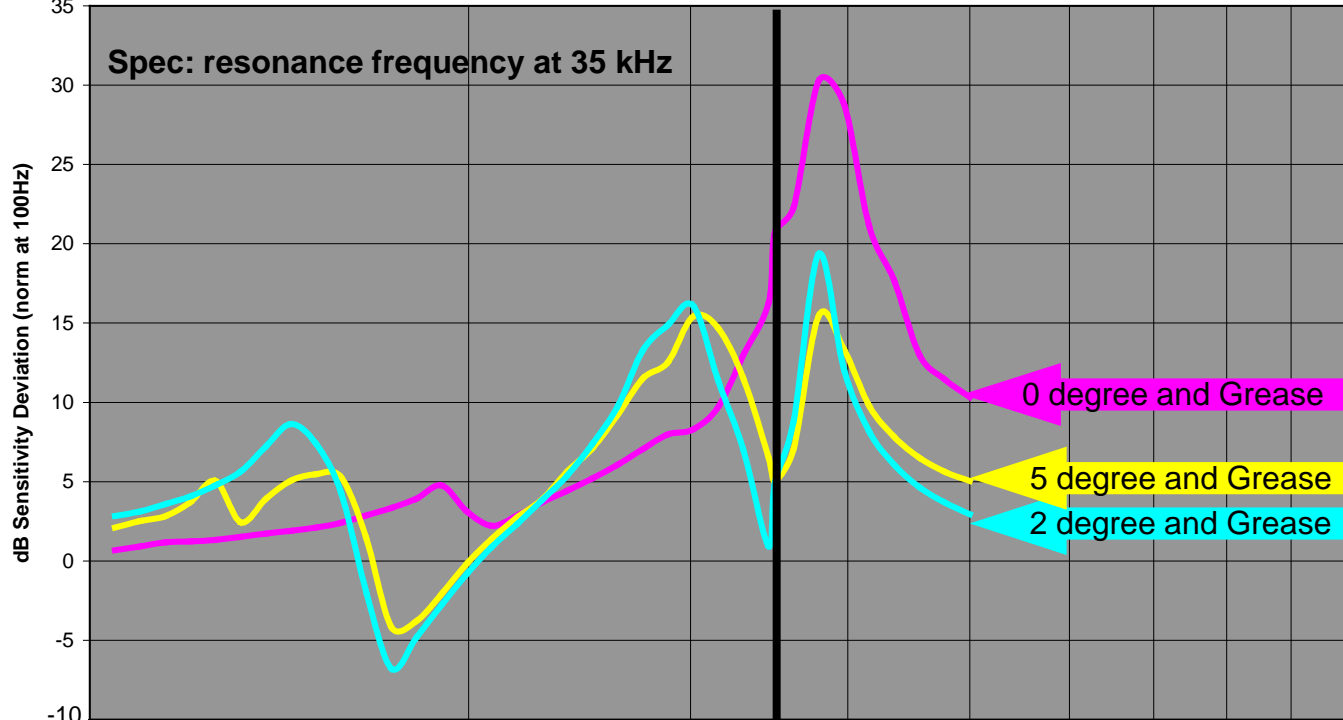


Test Set Up

- Parameters
 - Perpendicularity with 0, 2 and 5 degree angle

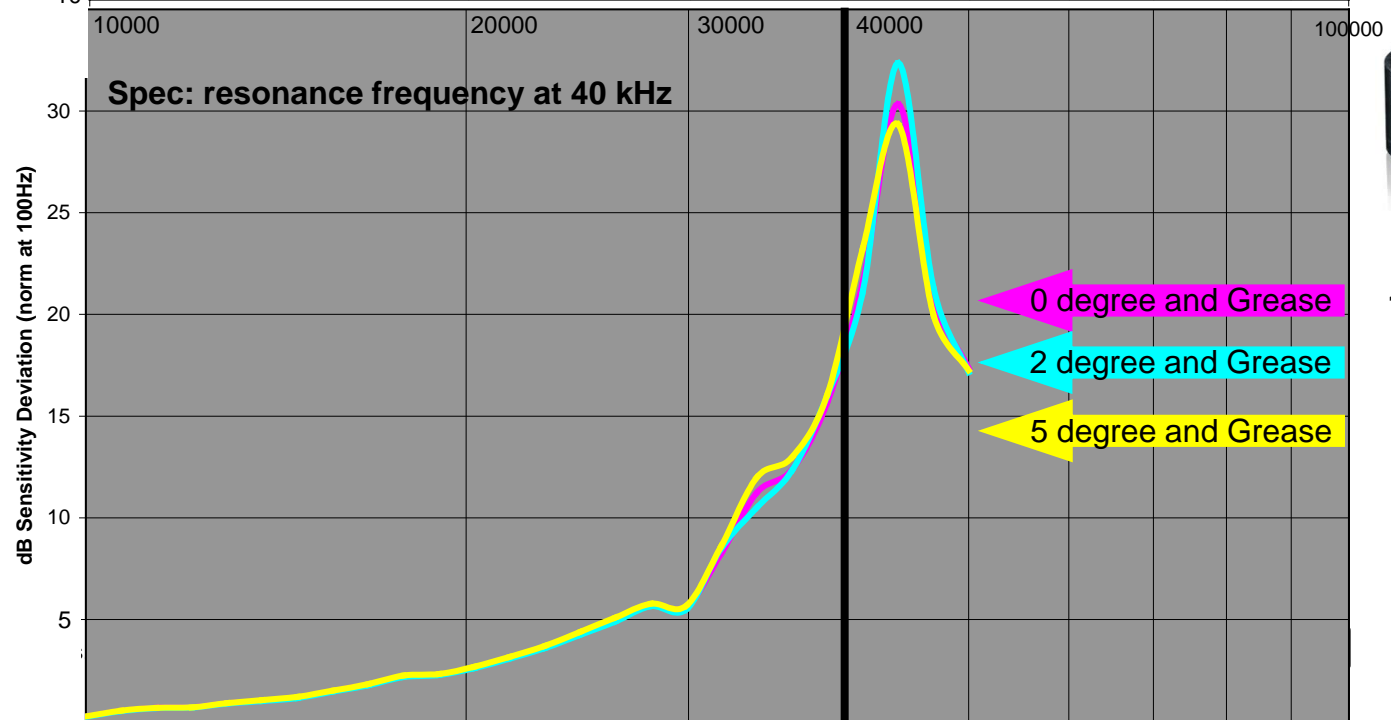


Results - Perpendicularity



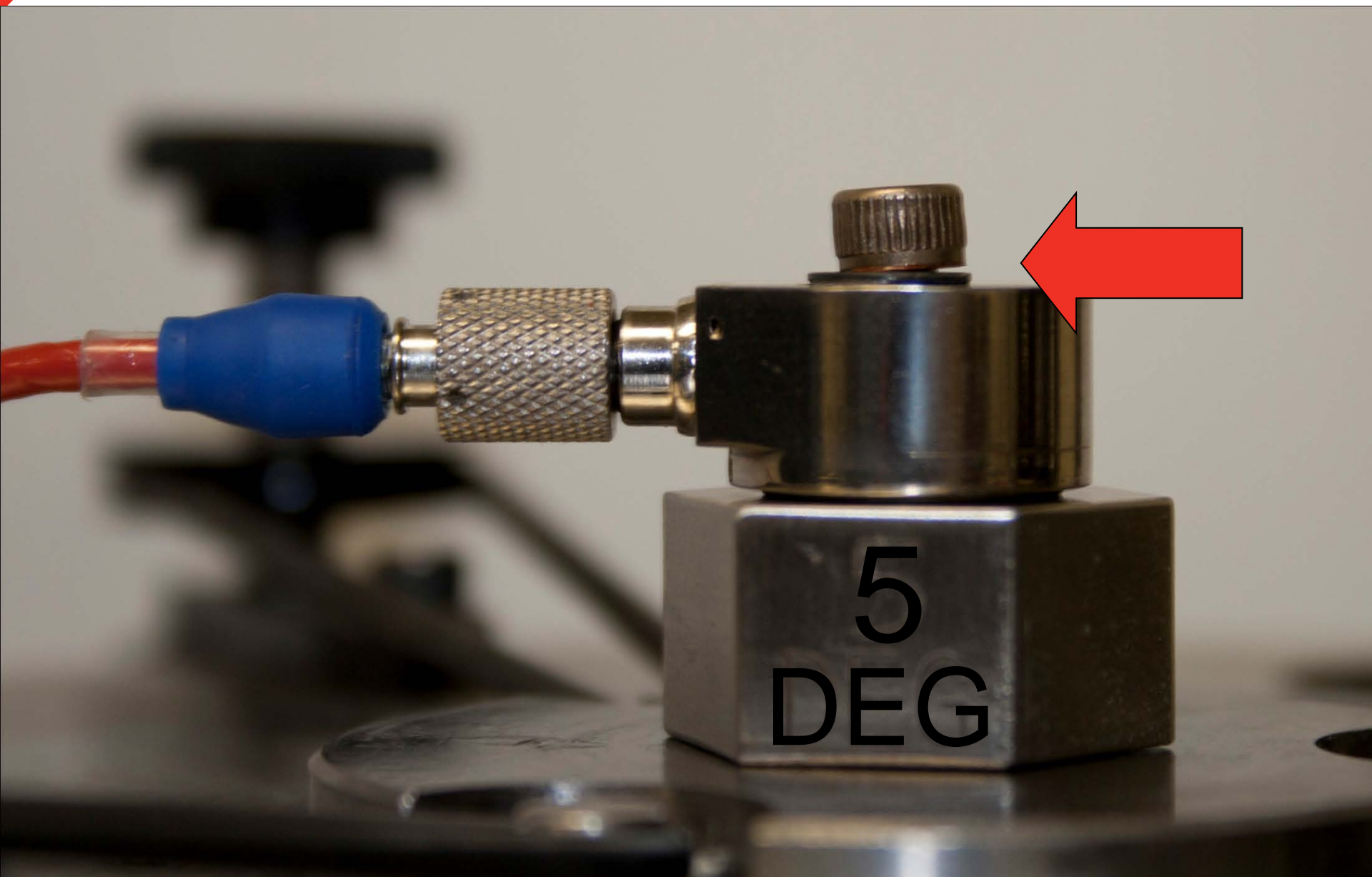
7704

10 k – 50 kHz

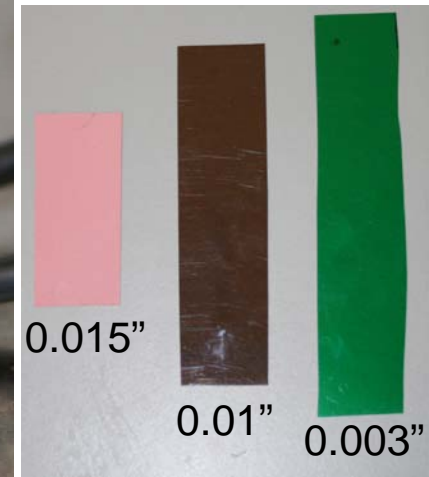
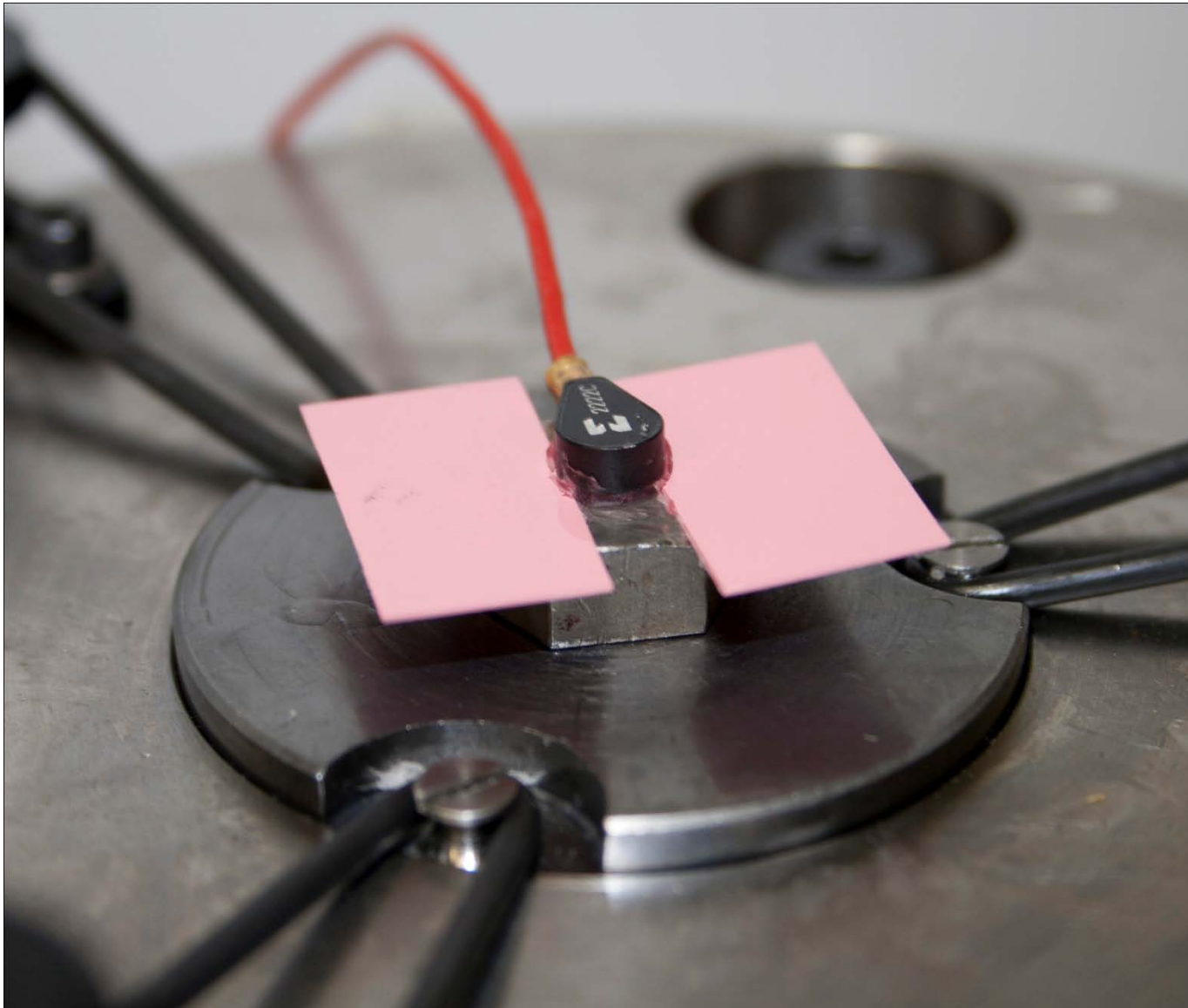


2221F

10 k – 50 kHz

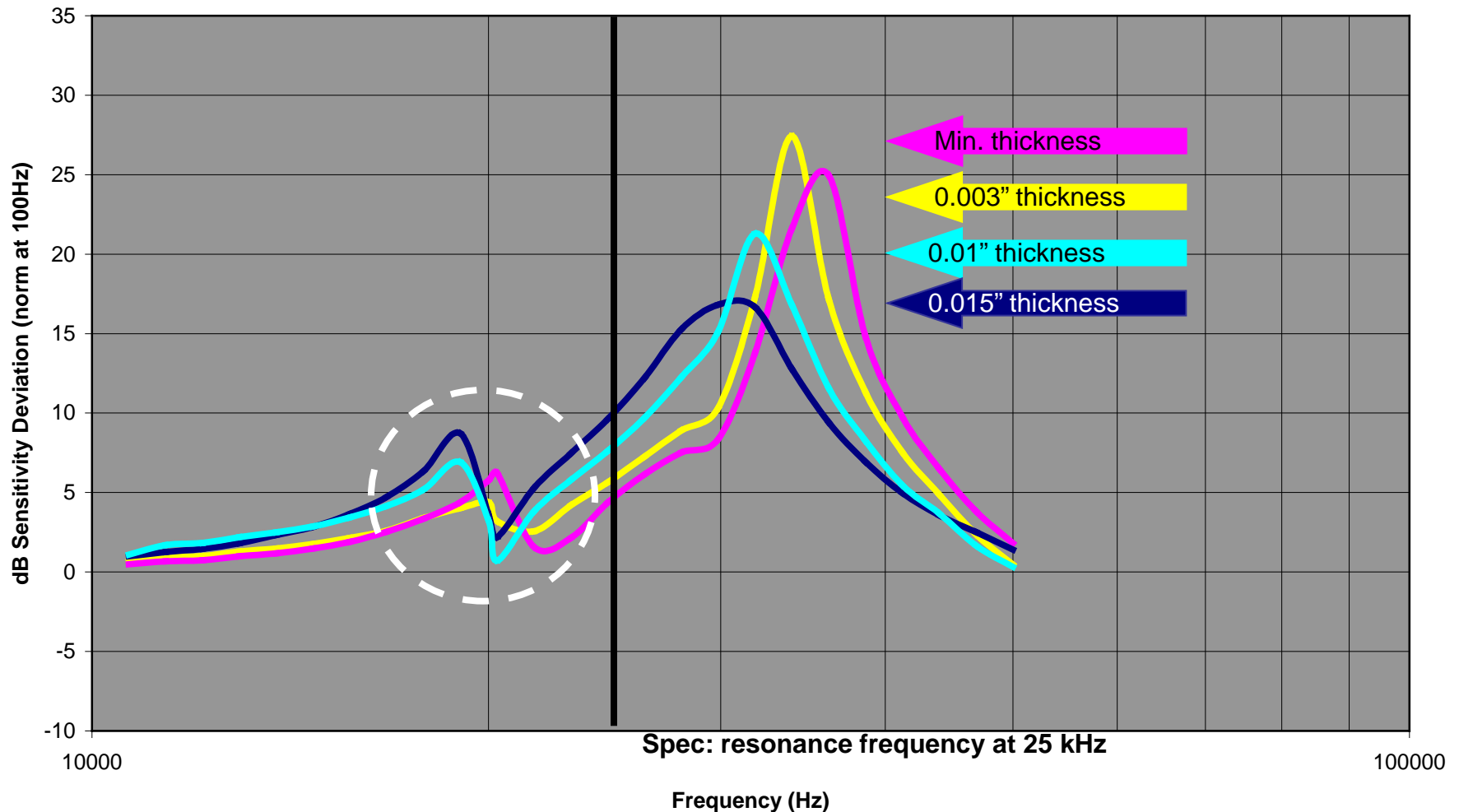


Results – Adhesive with Petro Wax

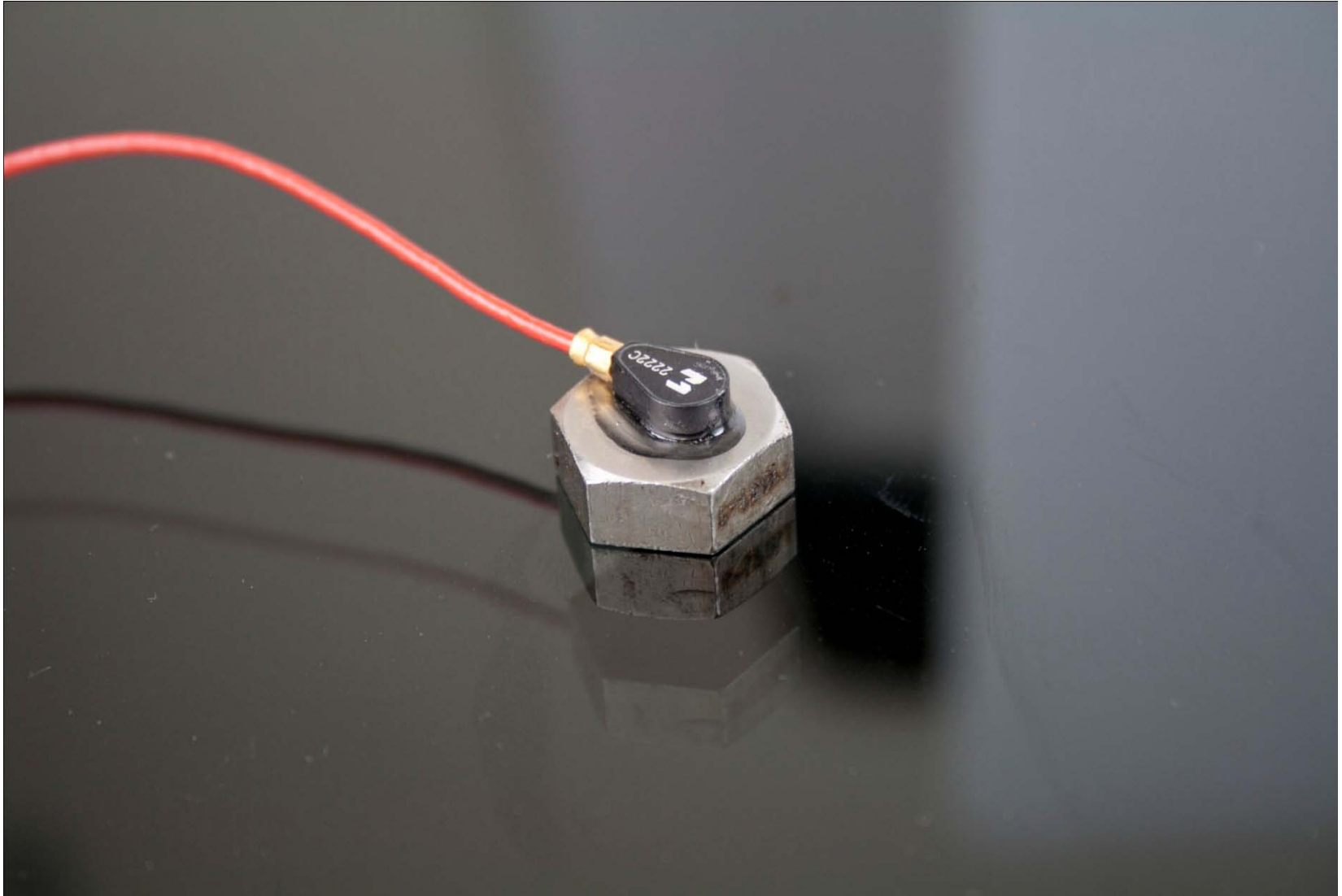


Results – Adhesive with Petro Wax

2222C – Wax
10 k – 50 kHz

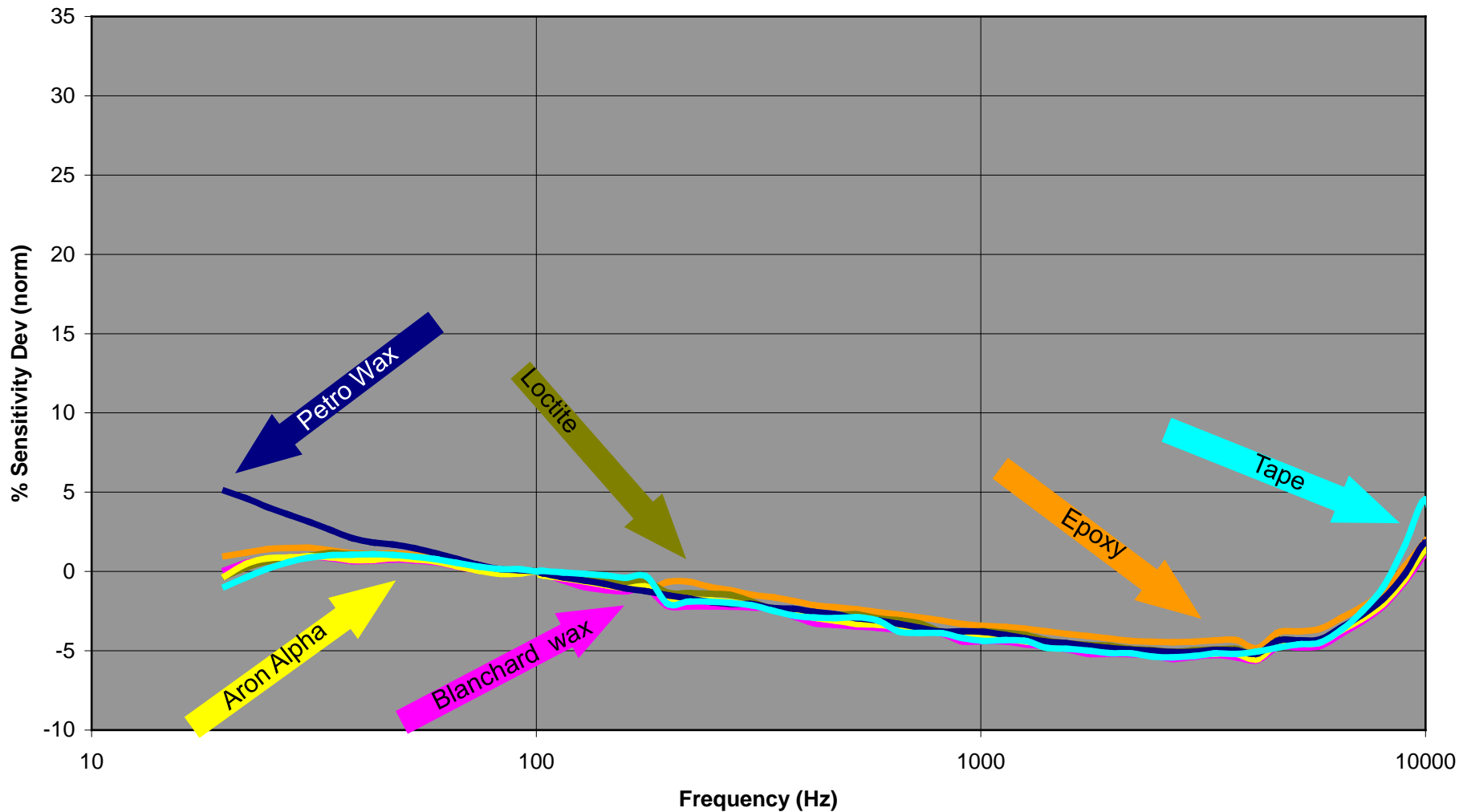


Results – Adhesive



Results - Adhesive

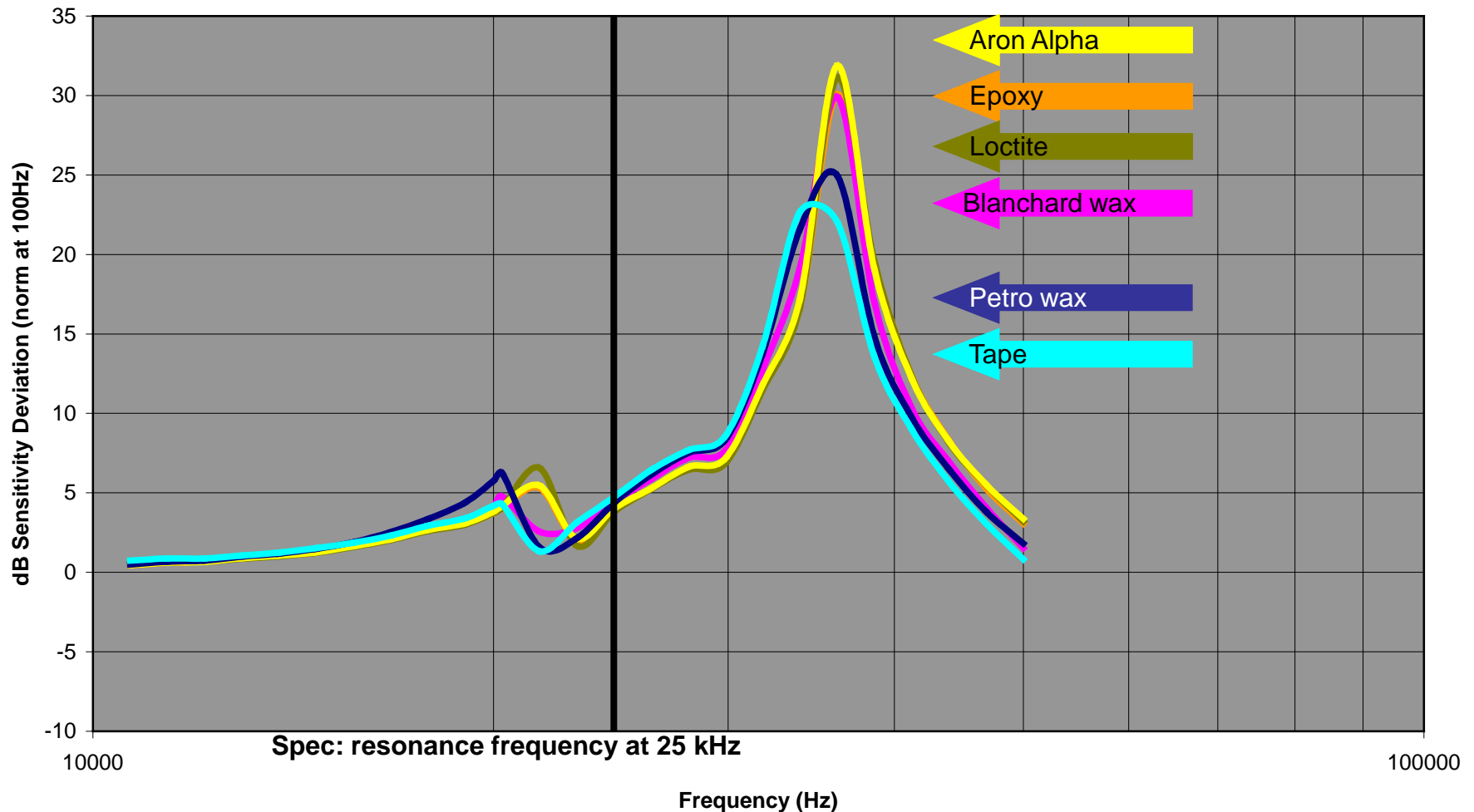
2222C – Glues, Wax and Tape
20 – 10 kHz



Results - Adhesive



2222C – Glues, Wax and Tape 10 k – 50 kHz



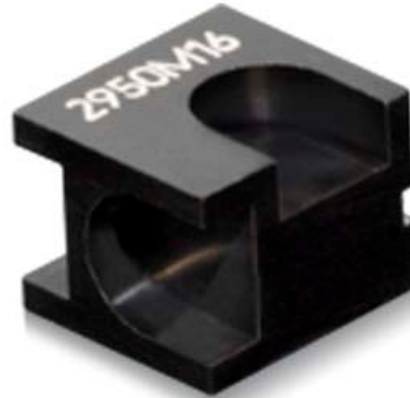
Conclusions

- Coupling grease versus dry mounting conditions
 - Grease solves a lot of mounting problems
- Most critical parameters
 - Stud mounted
 - Perpendicularity
 - Flatness
 - Torque
 - Thru-hole stud mounted
 - Flatness
 - Torque
 - Adhesive mounted
 - Thickness of a material is more important than the material itself
- Surface finish (roughness) is not an important parameter as long as grease is present
- Accelerometer design
 - Thru-hole stud mounted is less affected by perpendicularity
- Hard adhesive (Blanchard wax, epoxy, Loctite, Aron Alpha) is more effective than soft adhesive

Future Research

➤ Accelerometers

- IEPE
- Piezoresistive
- Variable capacitance
- Triaxial accelerometers
- Triax mounting blocks



➤ Parameters

- Different coupling viscosity materials (grease, oil, etc)
- Roughness with random patterns
- Magnetic base
- Handheld stinger



Thanks to

➤ Meggitt SJC

- Marketing/Engineering: Michael Phan (testing), Sandy Smith (console)
- Tools and material: Don Deccico (tools and material), Thu-Van Nguyen (material), Troy Nguyen (material), Dirk Lobbenmeier (factory), Rick Guild (machine shop), Pete Leonhardt (manufacturing)
- Product management: Andy Hohla, Stacy Belanger, Mike Laser (pictures)

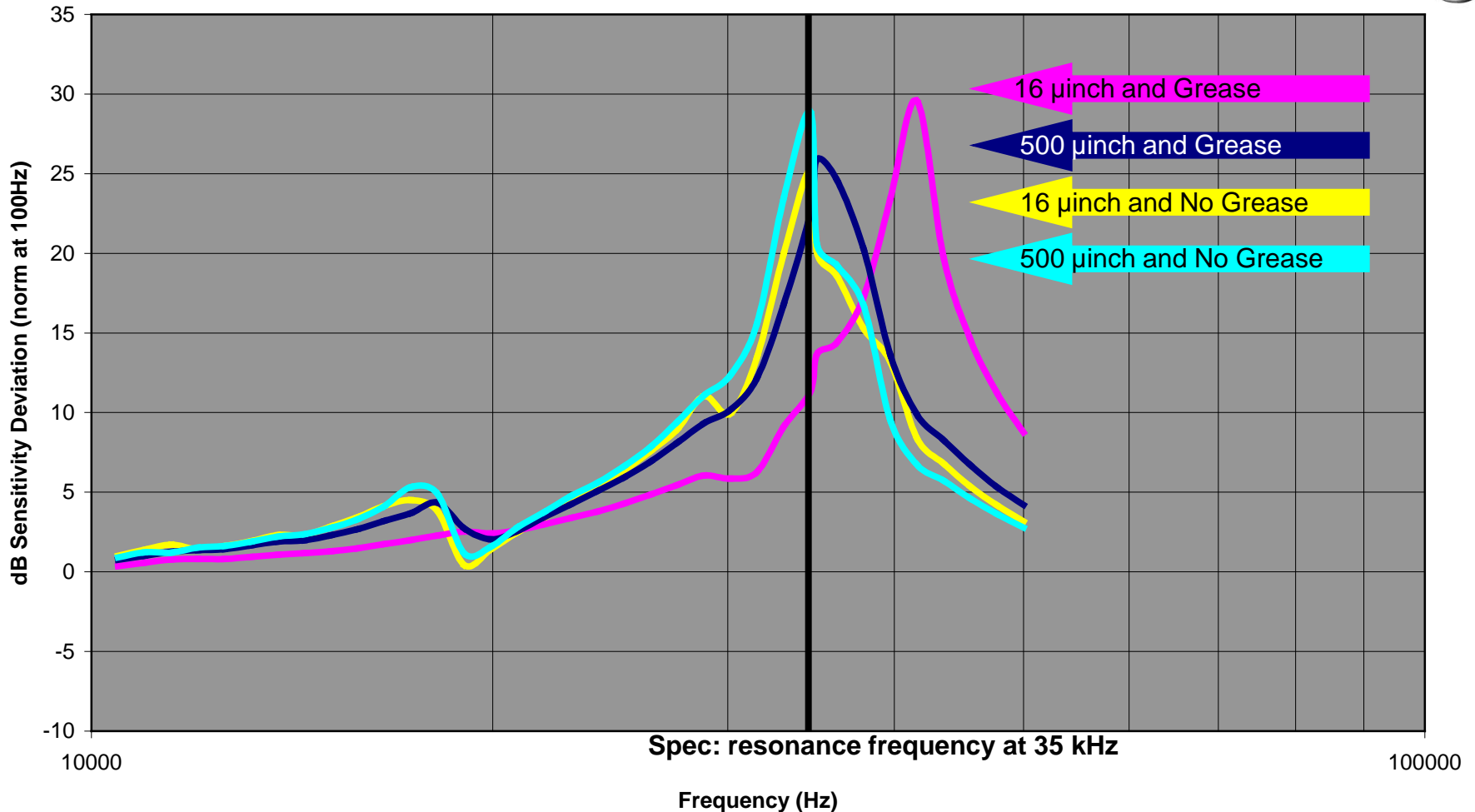
Questions?

The information contained in this document is the property of Meggitt Sensing Systems and is proprietary and/or copyright material. This information and this document may not be used or disclosed without the express authorization of Meggitt Sensing Systems. Any unauthorized use or disclosure may be unlawful.

The information contained in this document may be subject to the provisions of the Export Administration Act of 1979 (50 USC 2401-2420), the Export Administration Regulations promulgated thereunder (15 CFR 730-774), and the International Traffic in Arms Regulations (22 CFR 120-130). The recipient acknowledges that these statutes and regulations impose restrictions on import, export, re-export and transfer to third countries of certain categories of data, technical services and information, and that licenses from the US Department of State and/or the US Department of Commerce may be required before such data, technical services and information can be disclosed. By accepting this document, the recipient agrees to comply with all applicable governmental regulations as they relate to the import, export and re-export of information.'

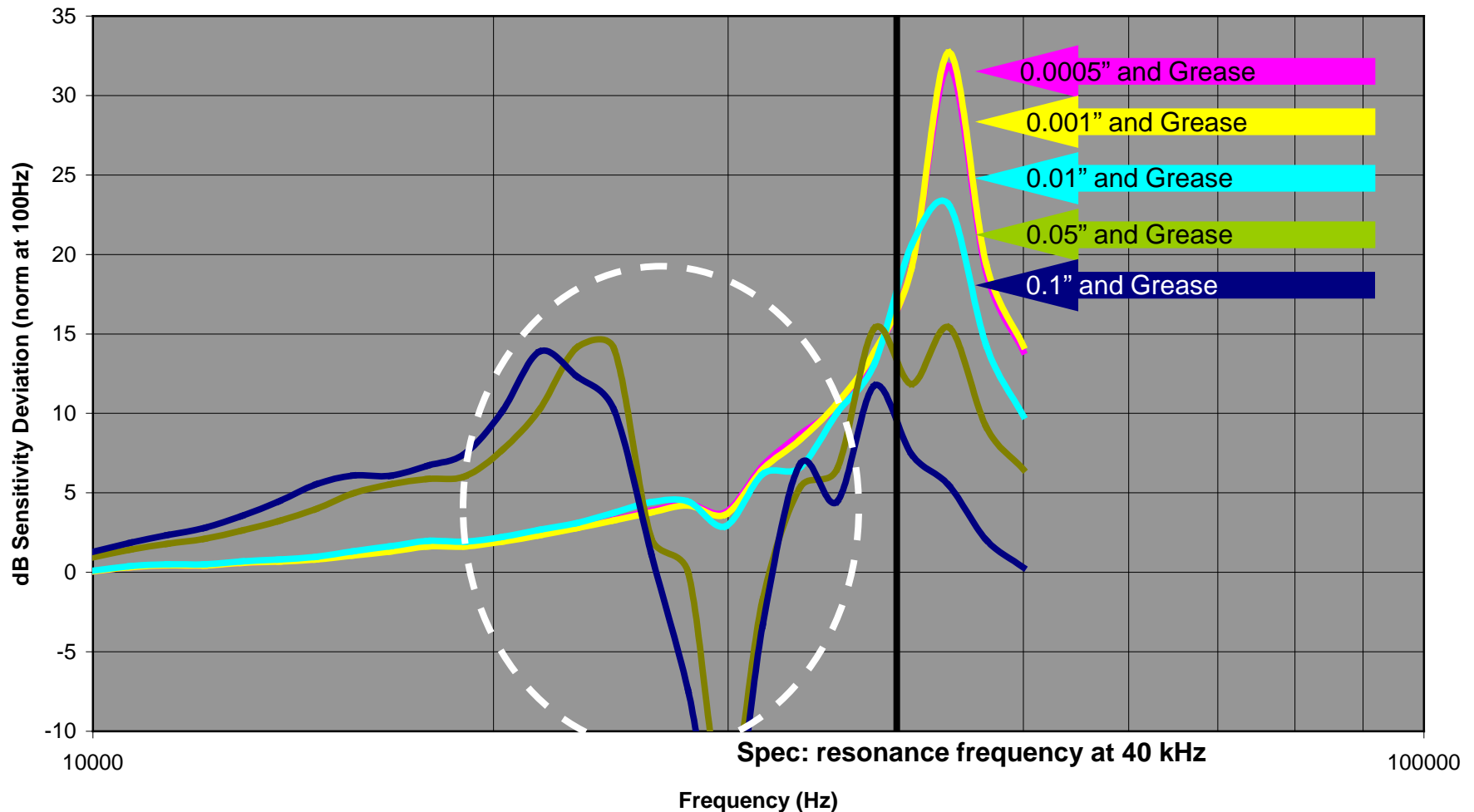
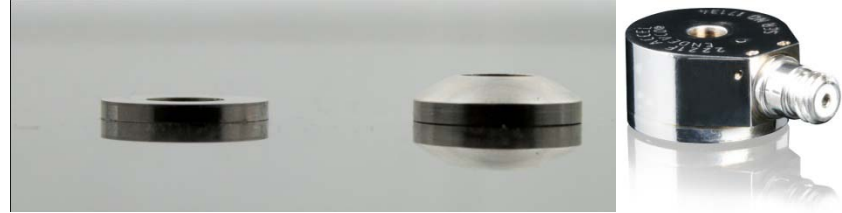
Results - Roughness

7704
10 k – 50 kHz



Results - Flatness

2221F
10 k – 50 kHz



Results – Adhesive with Wax

2222C – Wax
20 – 10 kHz

