Effects of mounting on accelerometer performance

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Topics

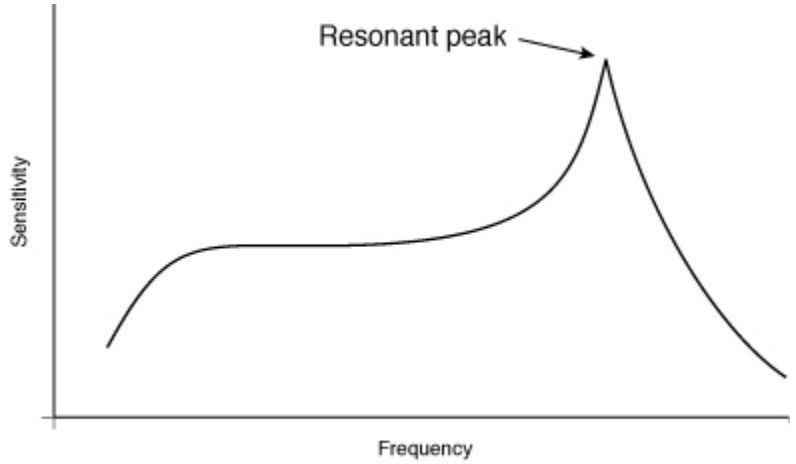
- Introduction
- Test set up
  - Hardware
  - Parameters
  - Test matrix
- Results
- Conclusions
- Future research

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

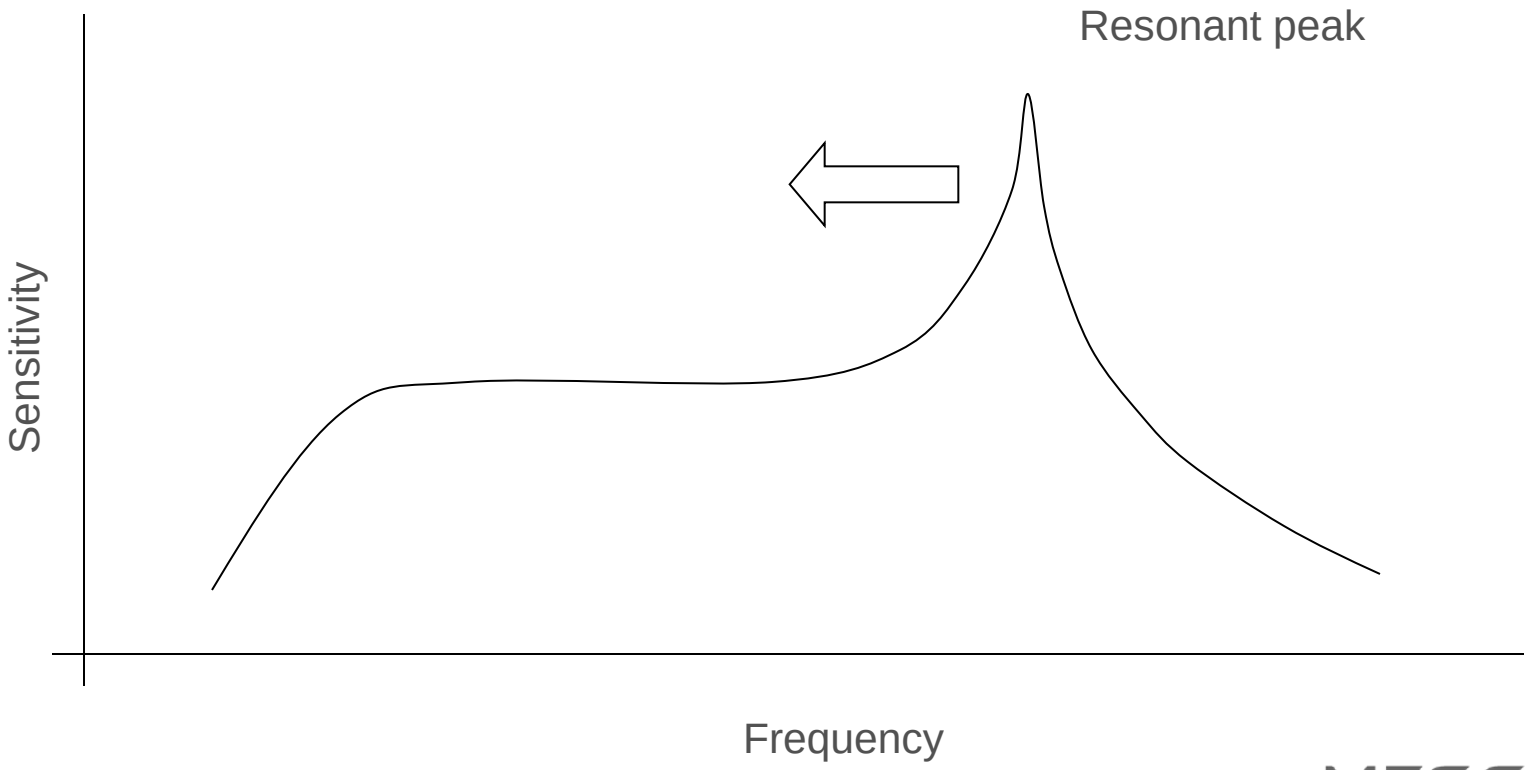
Introduction

- 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 µinch rms
    - Tapped hole perpendicularity: 0° ± 1°
    - 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)

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Test Methodology

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

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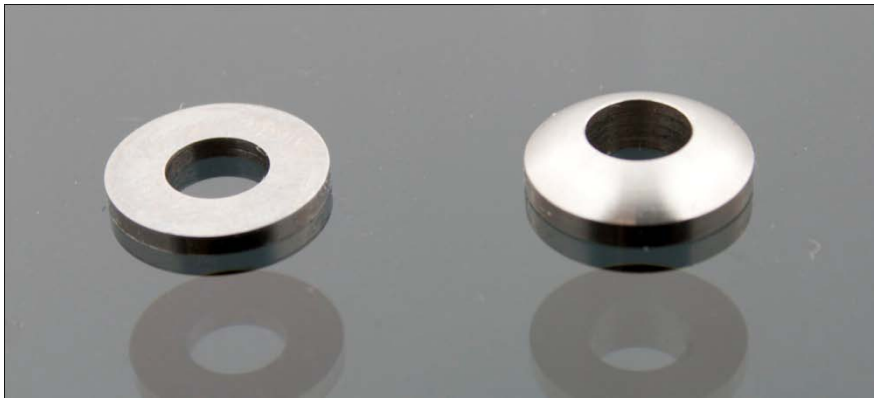
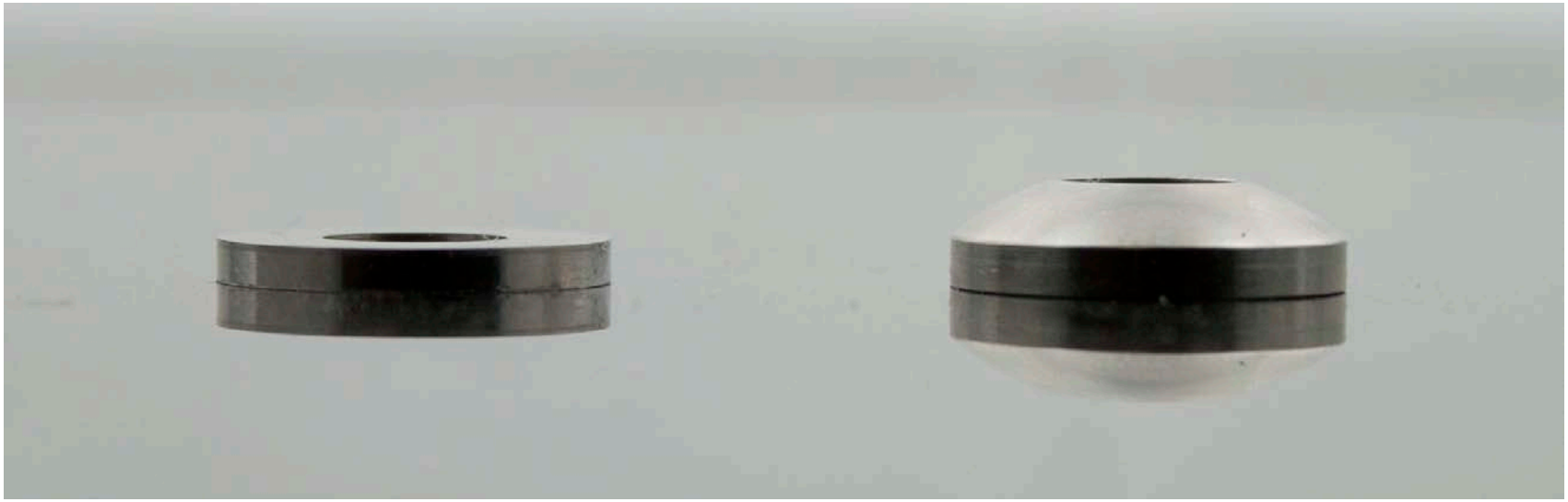
Test Methodology

- Parameters
  - Surface roughness: 16, 32, 64, 125, 250, 500 µinch rms

Test Methodology

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





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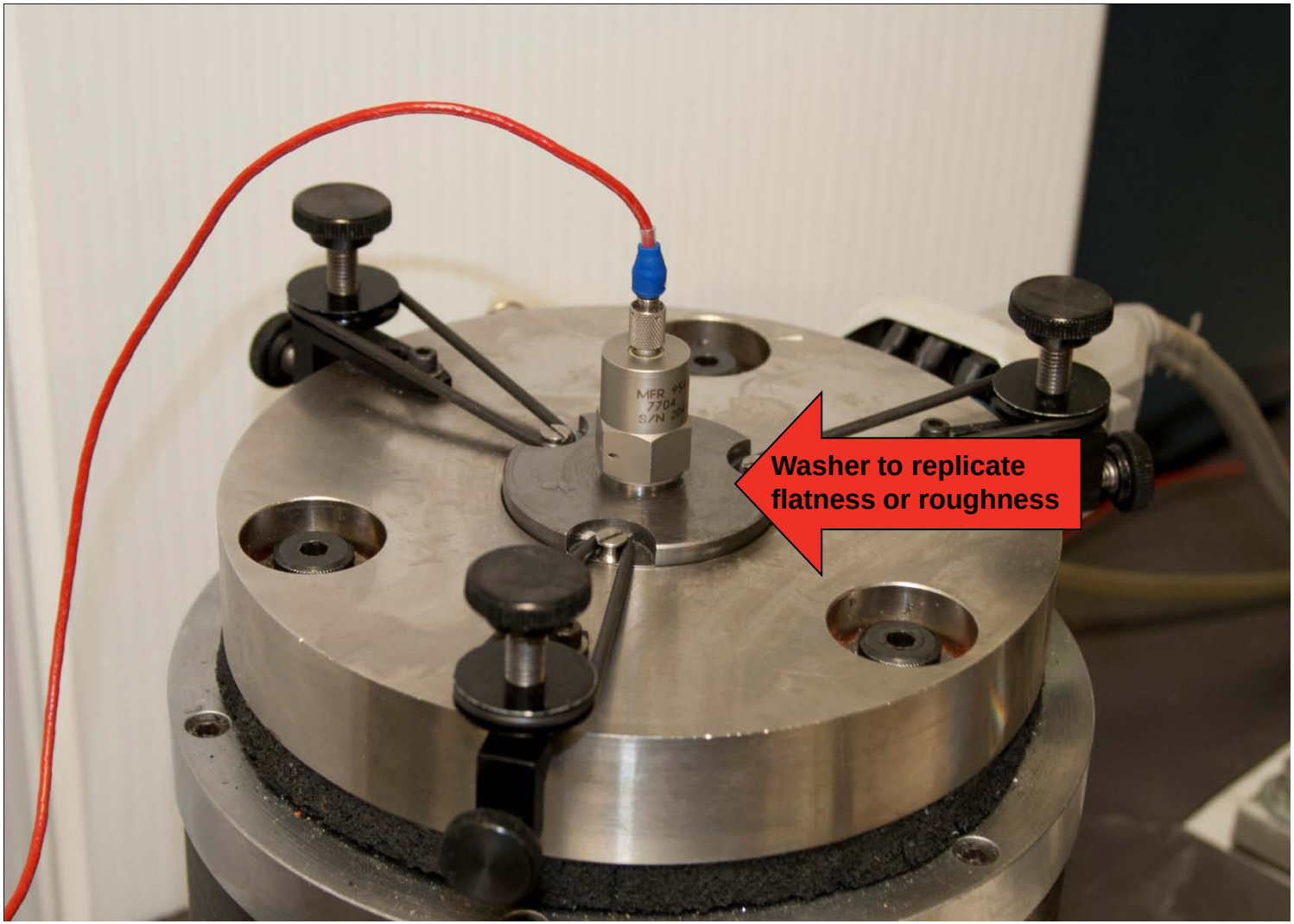
Test Methodology

- Parameters
  - Vary adhesives

Test Set up with shaker



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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	√

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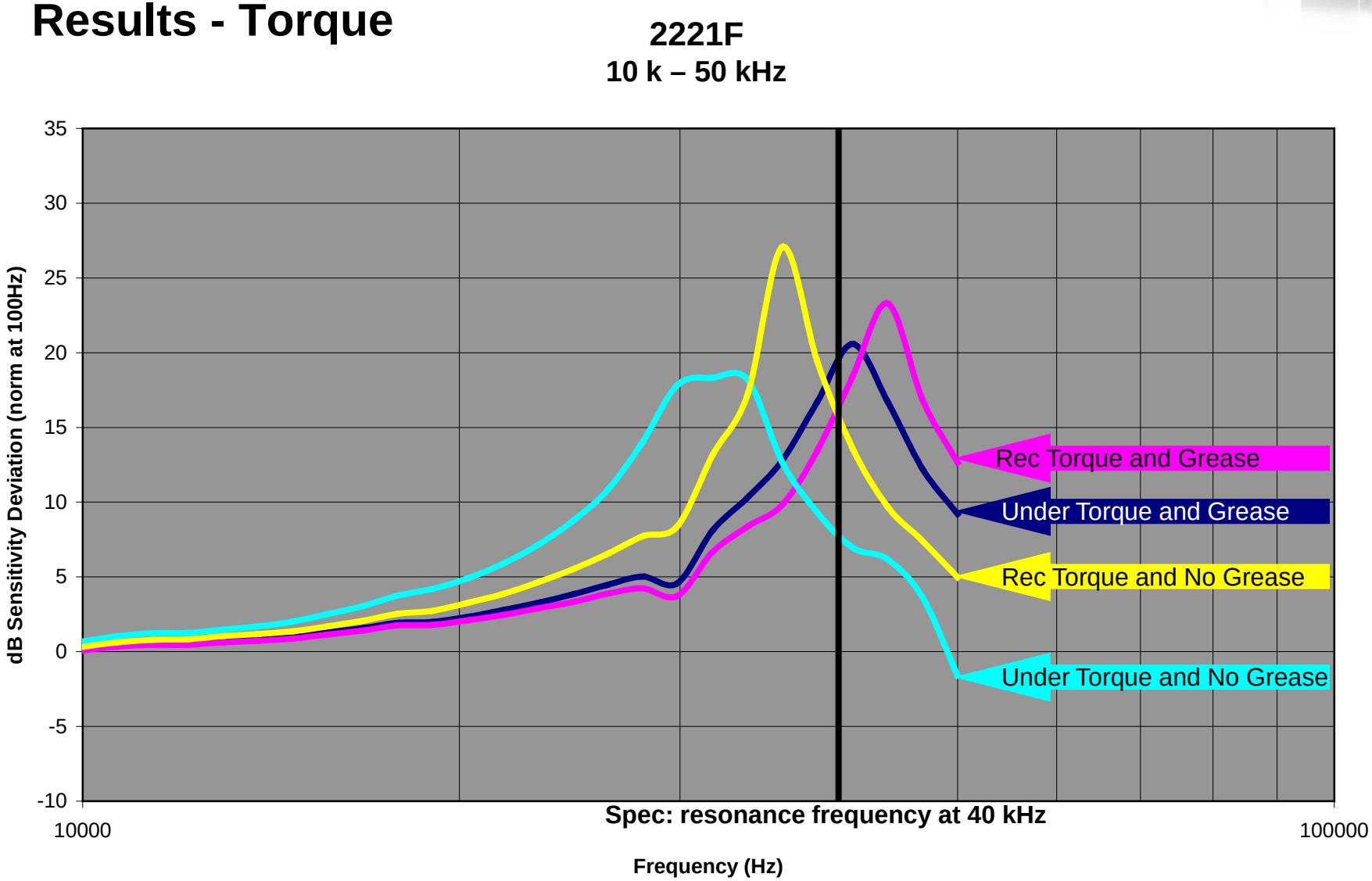
Results - Torque



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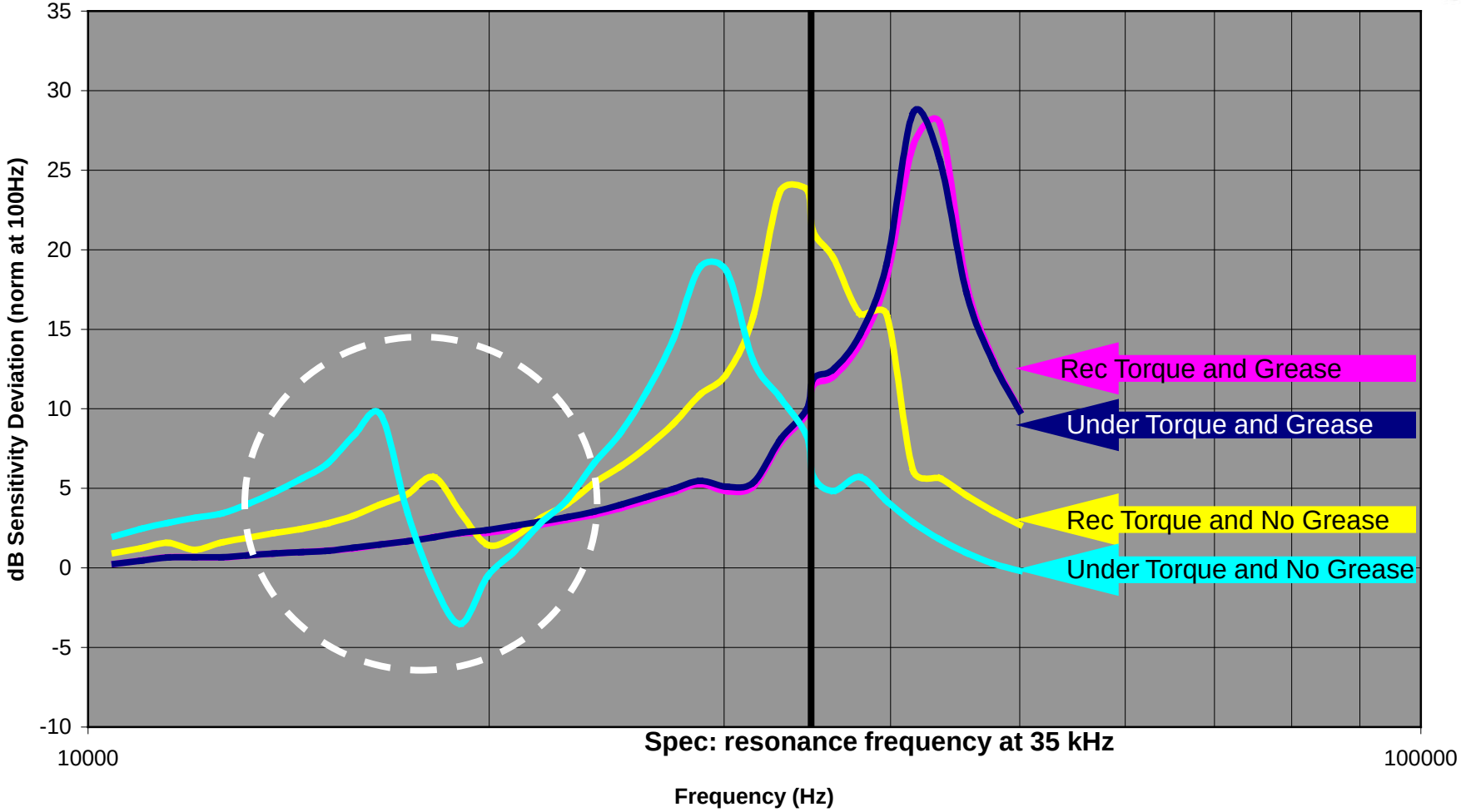
Results - Torque



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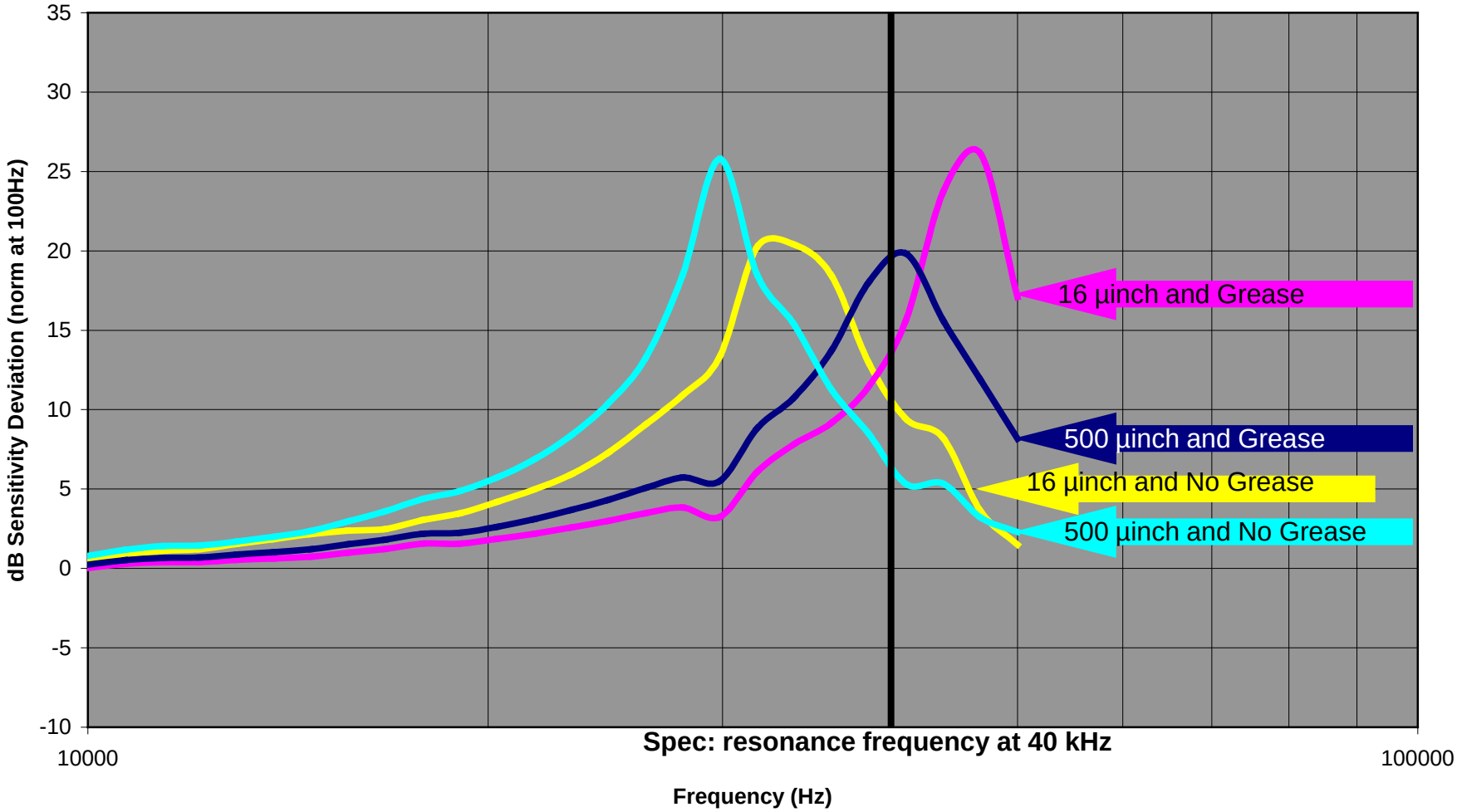
Results - Roughness

2221F
10 k – 50 kHz



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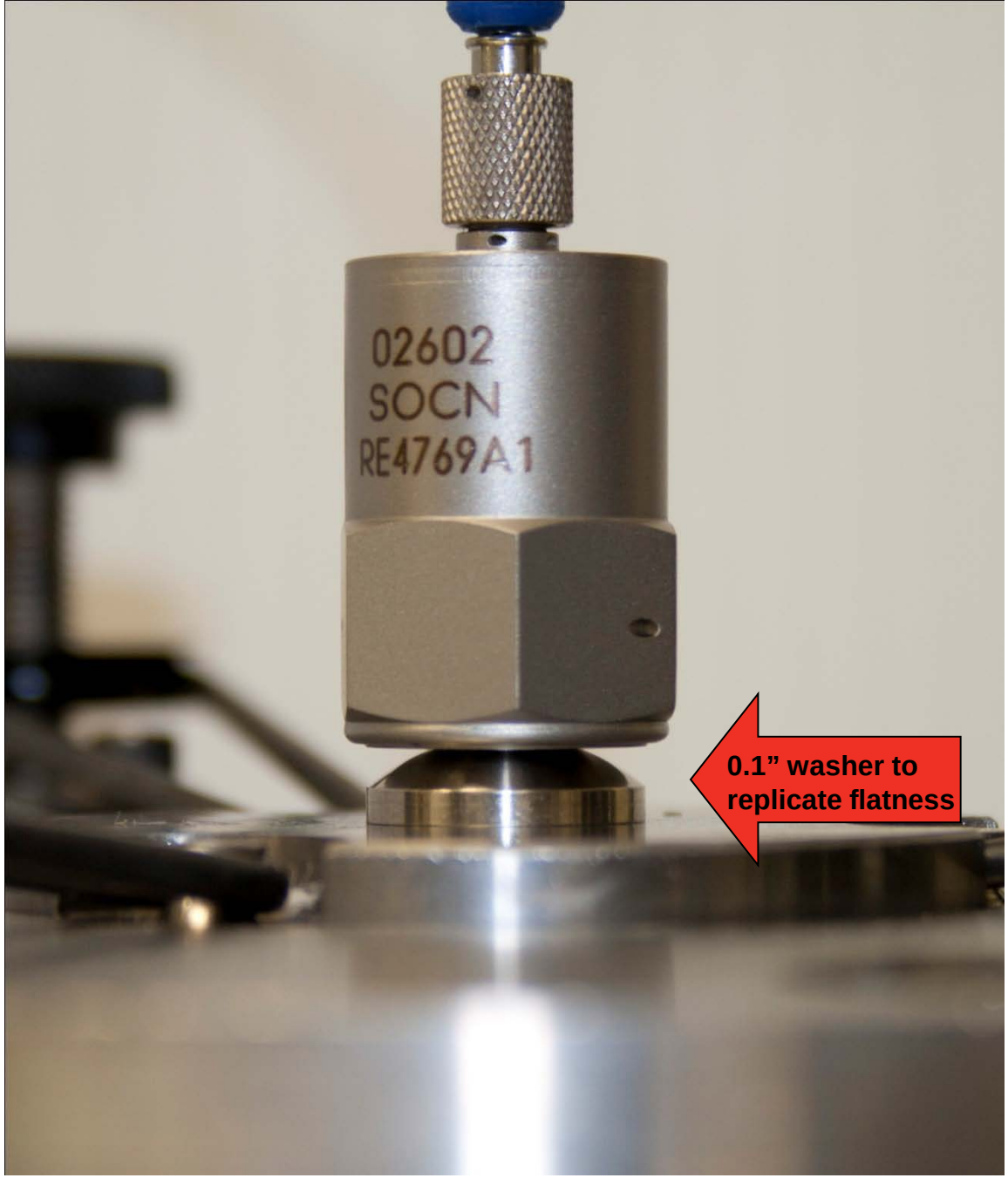
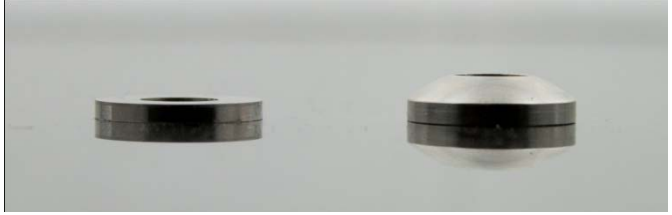
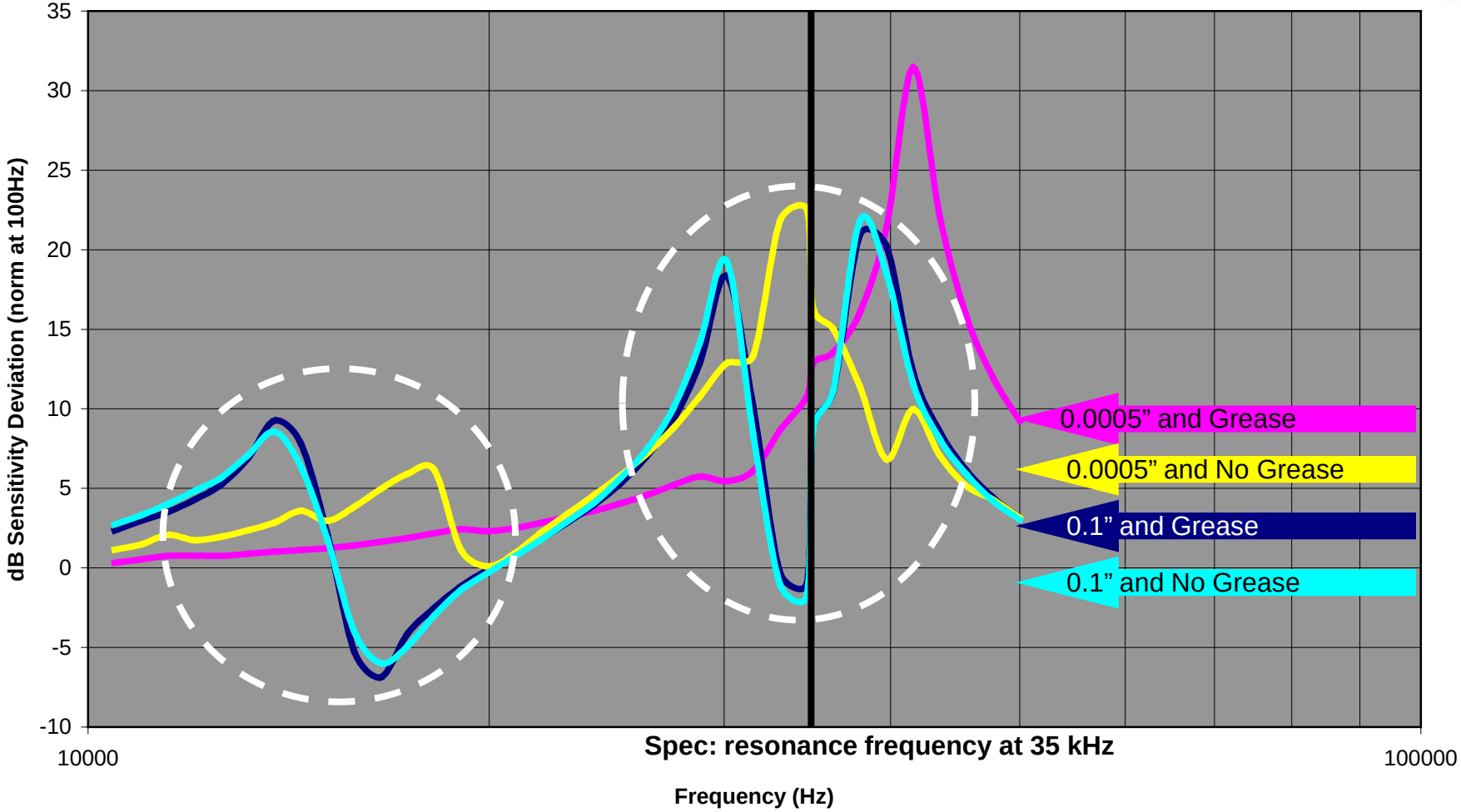


Results - Flatness



7704
10 k – 50 kHz



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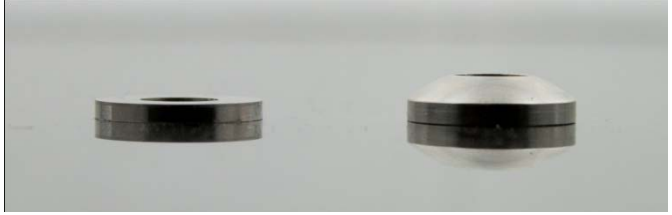
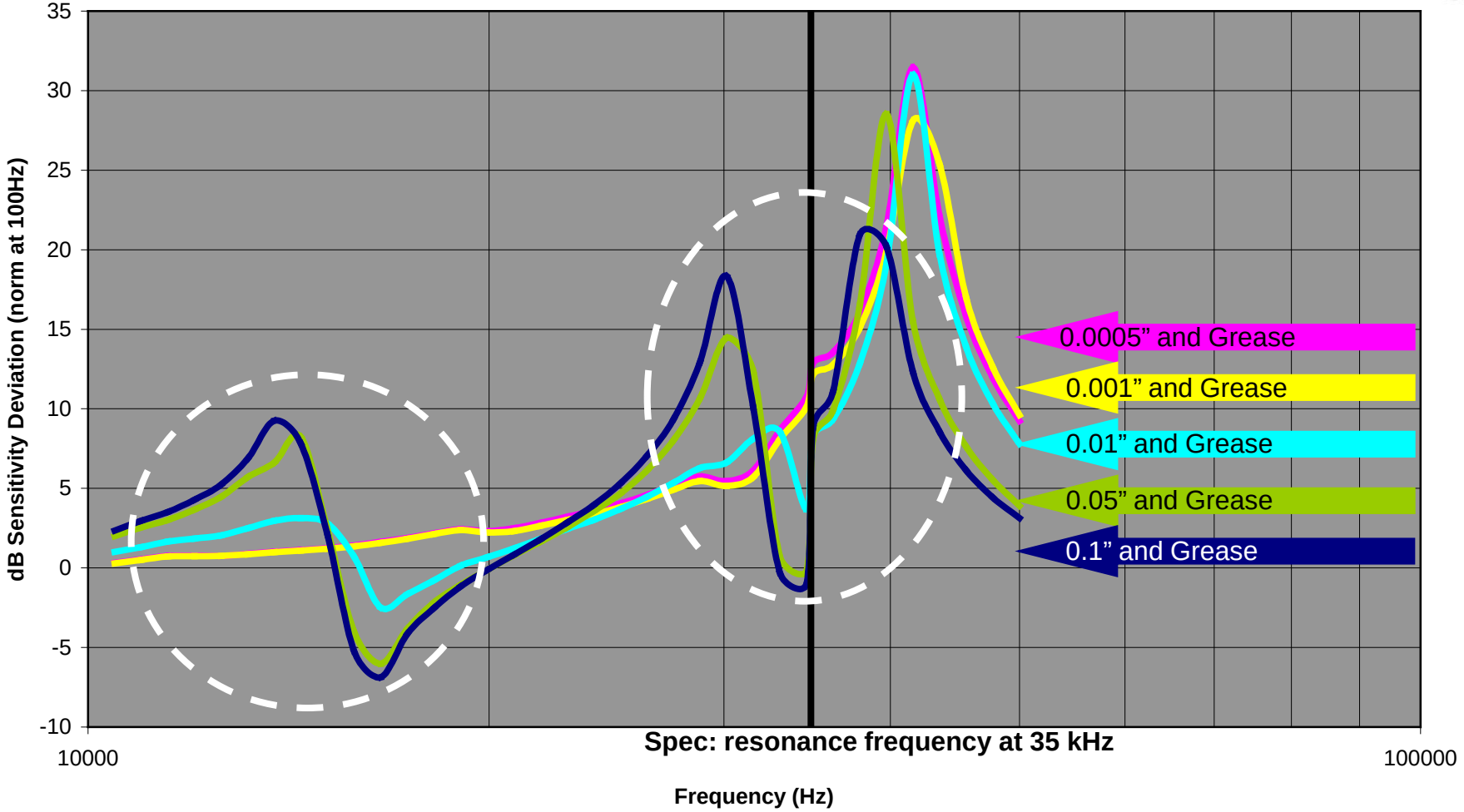
Results - Flatness



7704
10 k – 50 kHz



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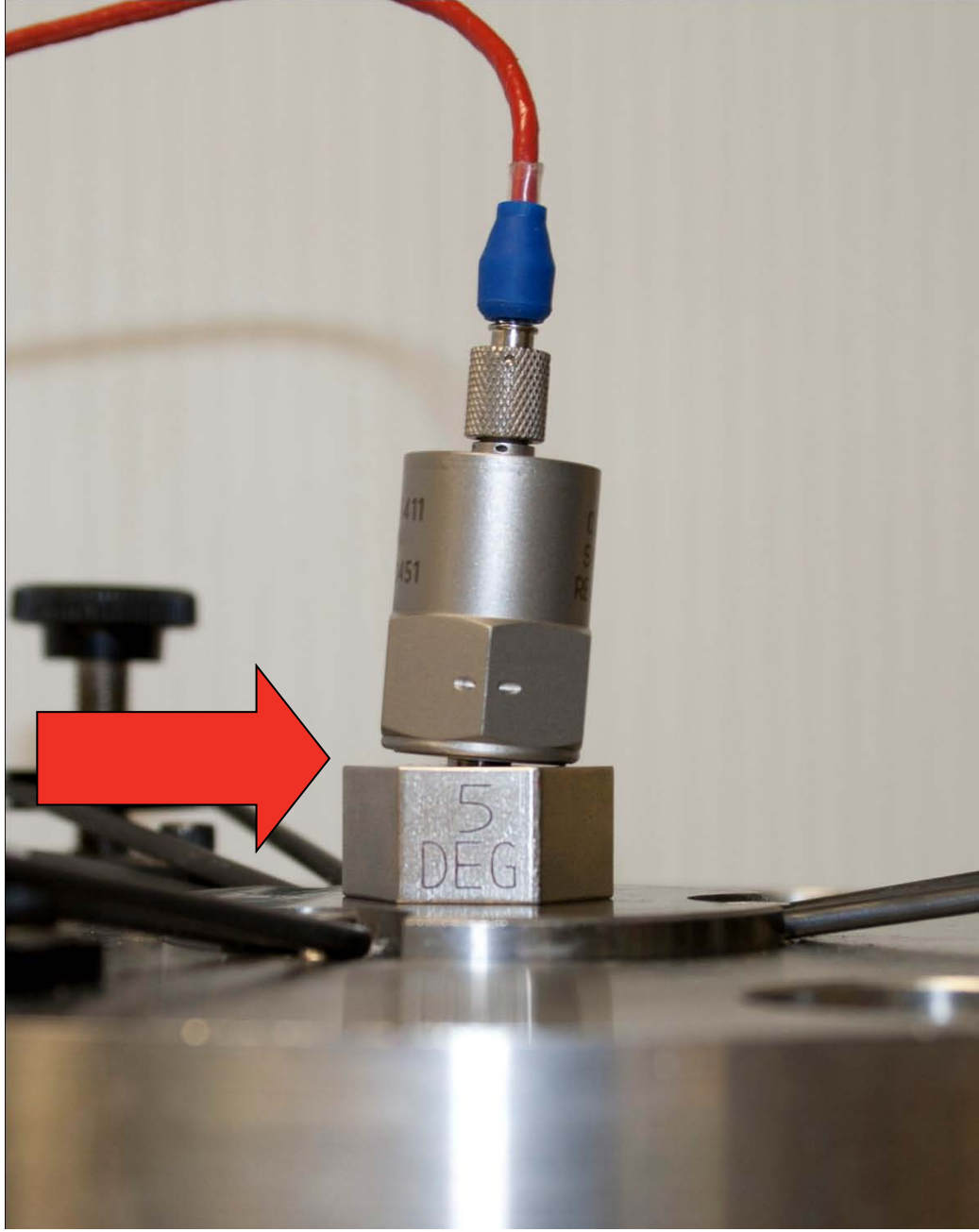
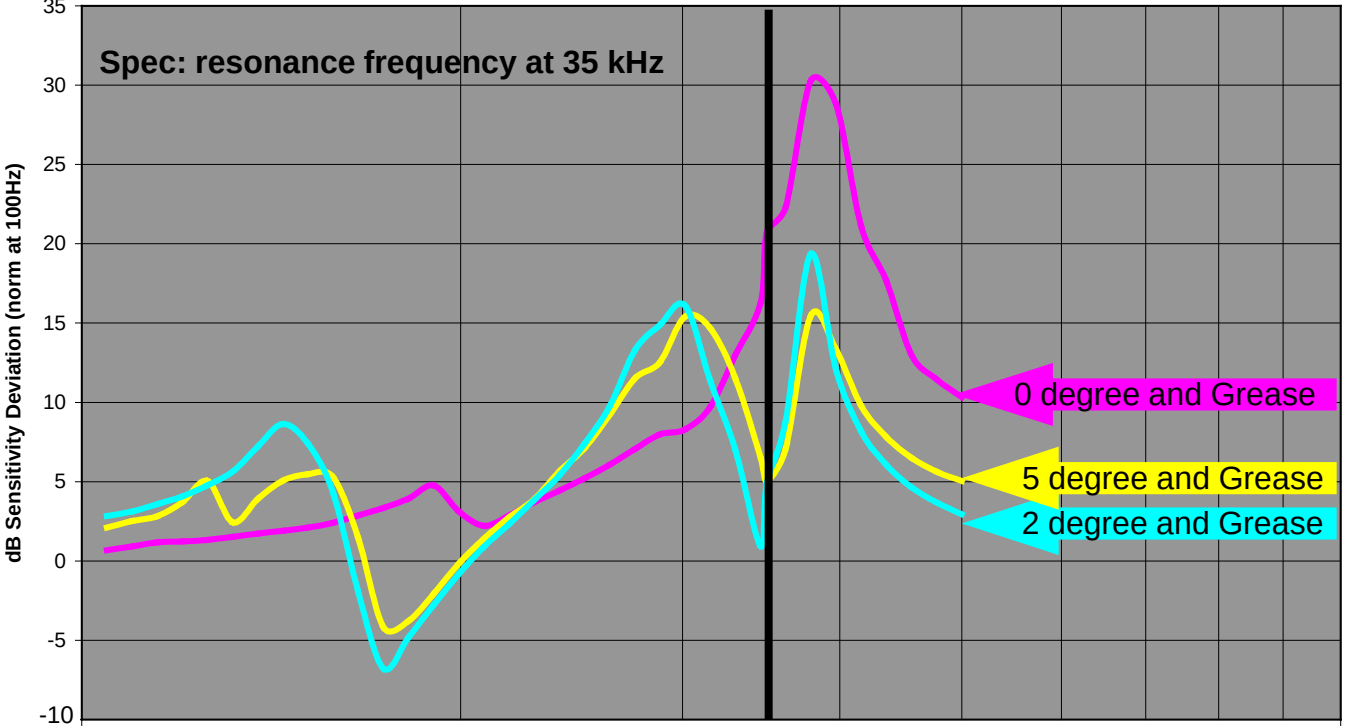
Test Set Up

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



Results - Perpendicularity



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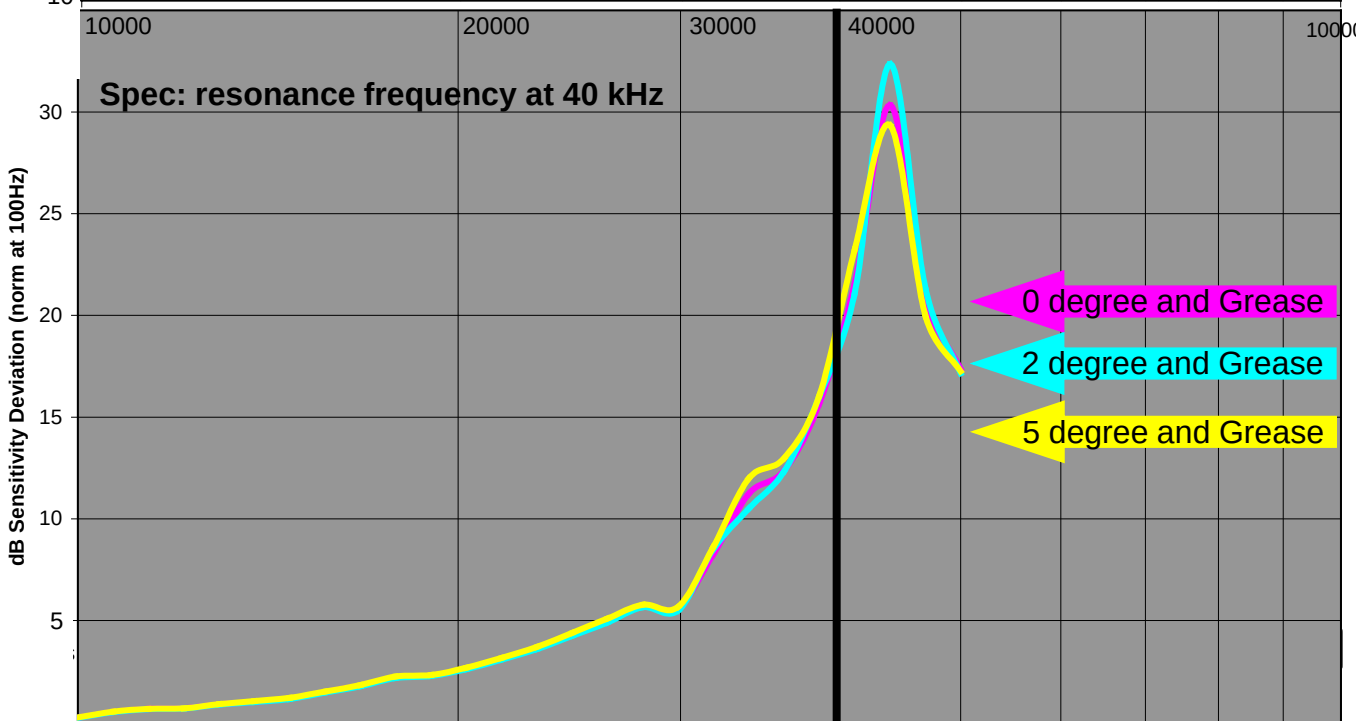
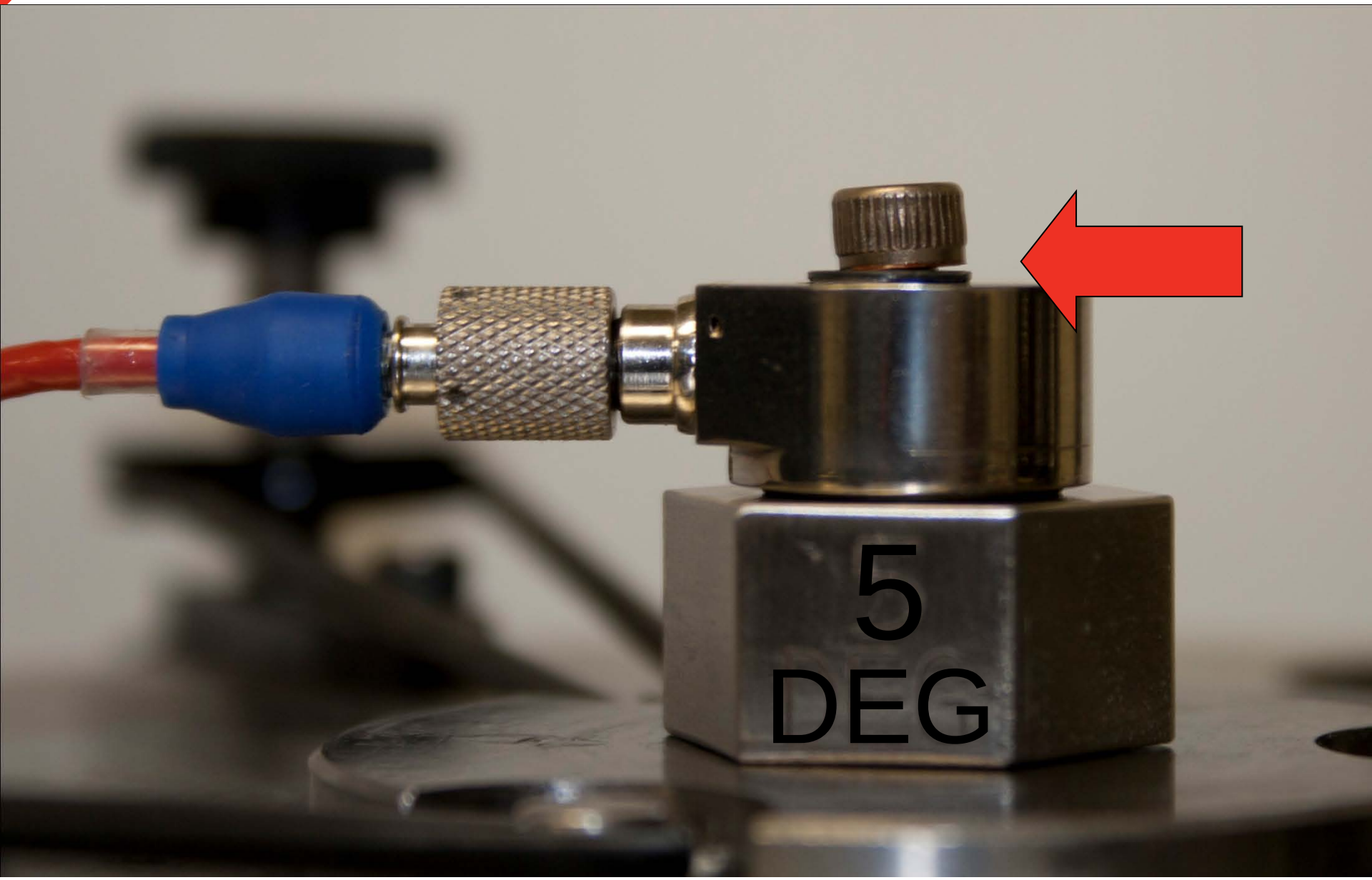
10 k – 50 kHz

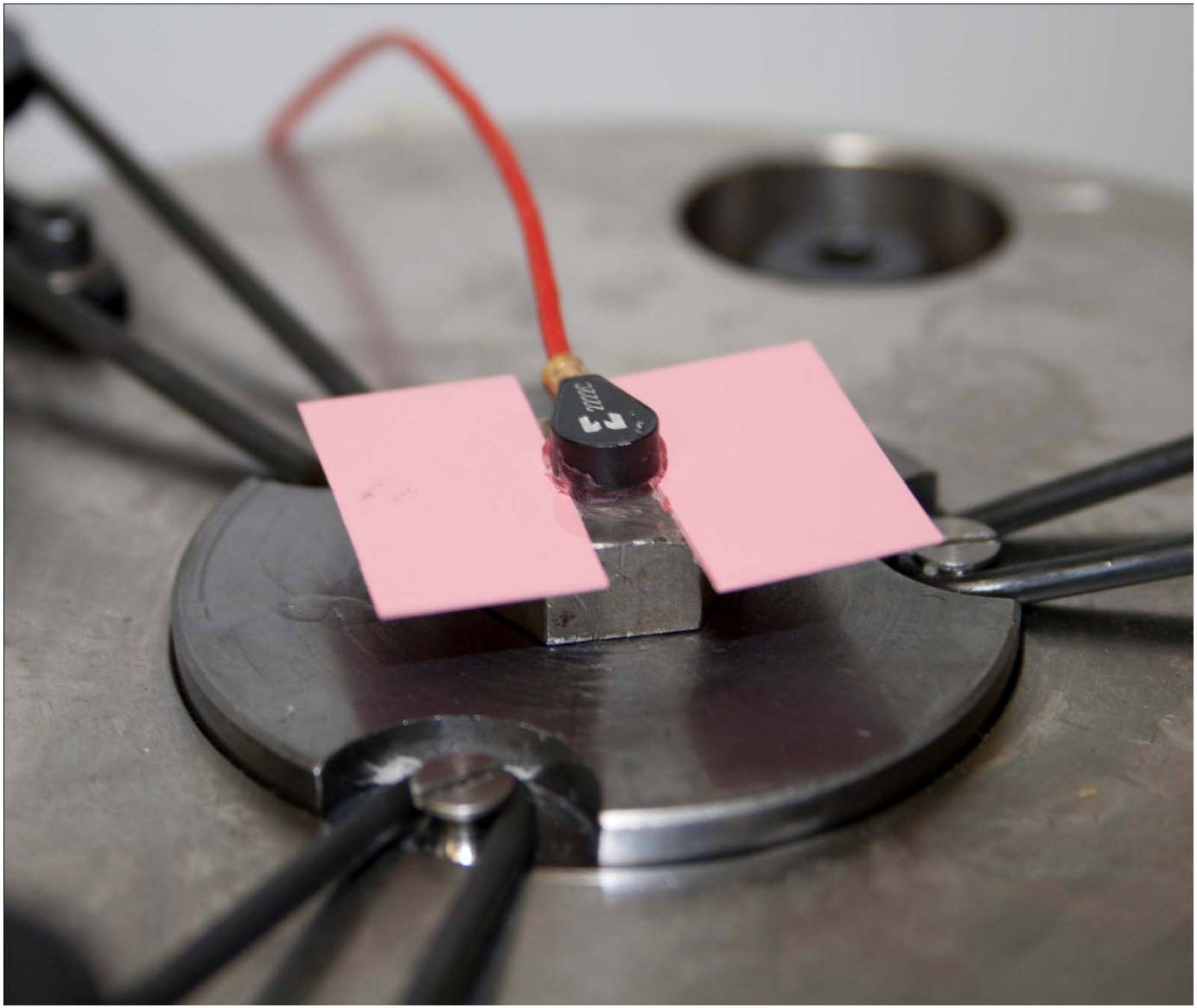


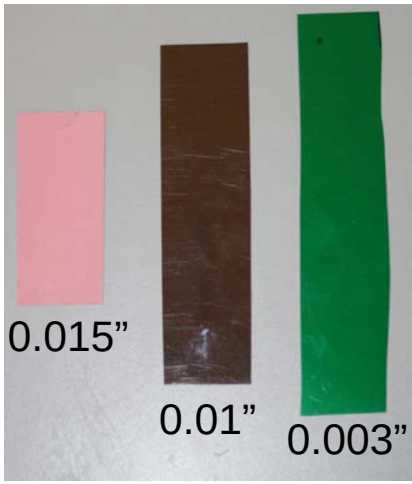
2221F

10 k – 50 kHz



Results – Adhesive with Petro Wax





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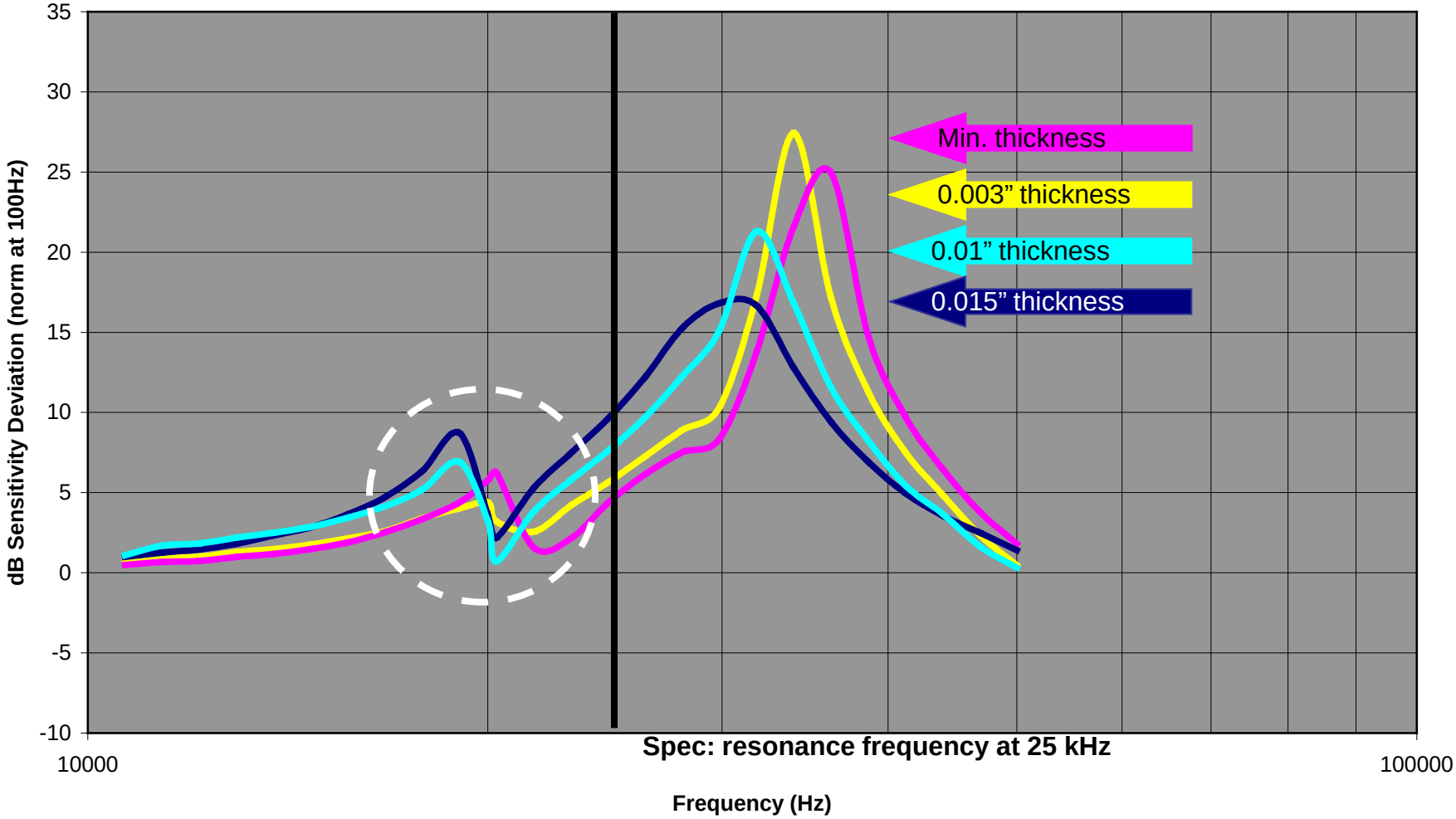
Results – Adhesive with Petro Wax

2222C – Wax
10 k – 50 kHz



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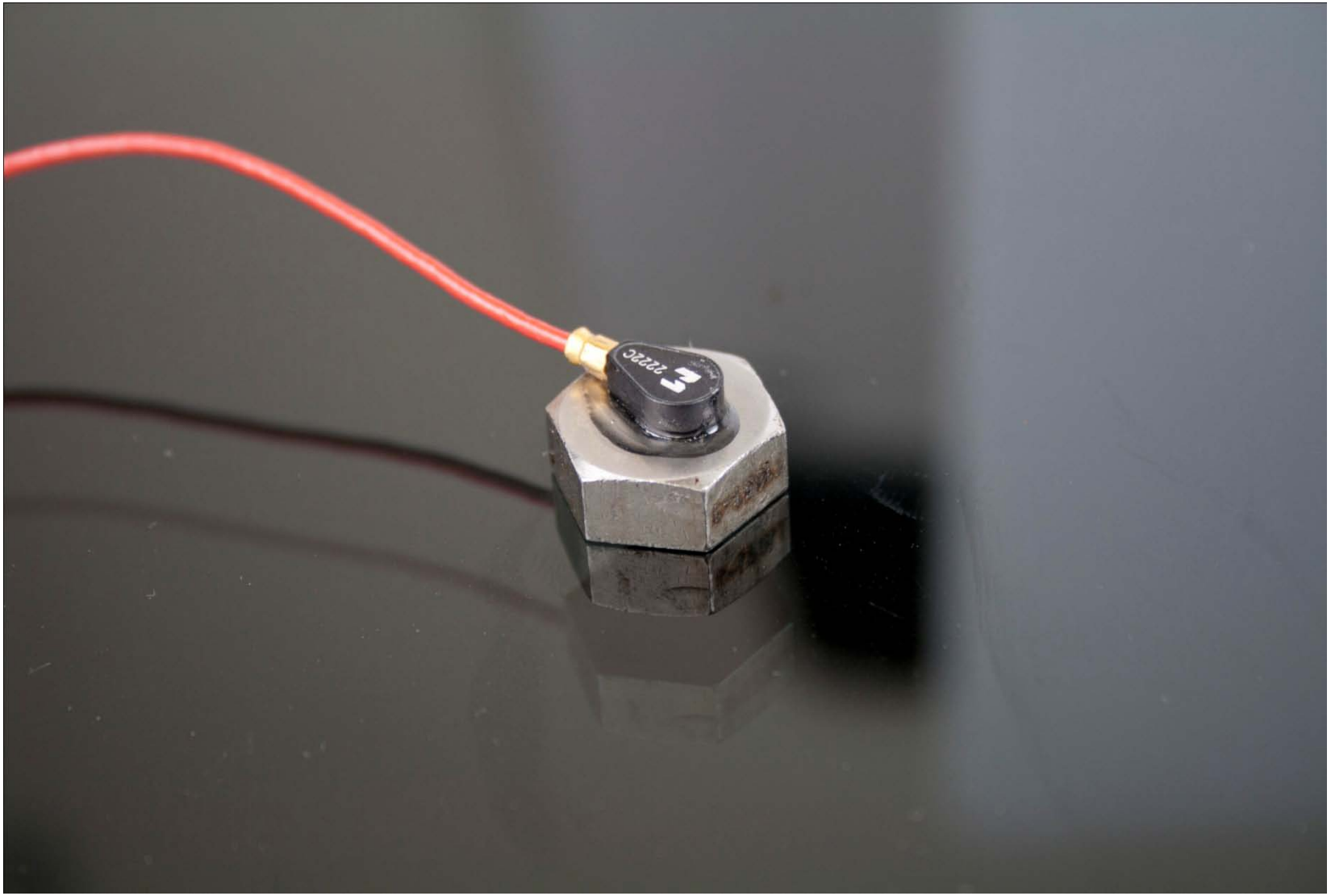
Results – Adhesive



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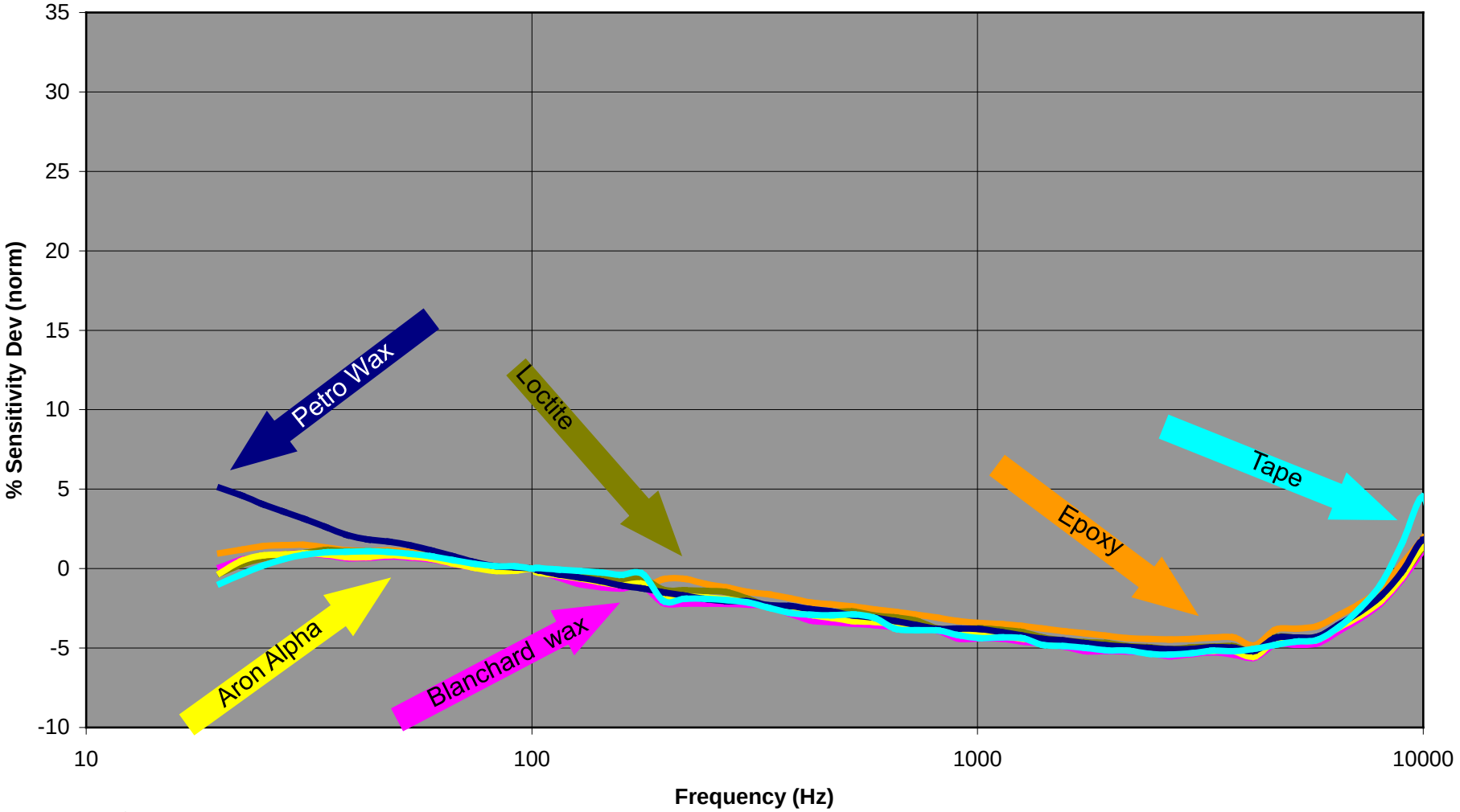
Results - Adhesive

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



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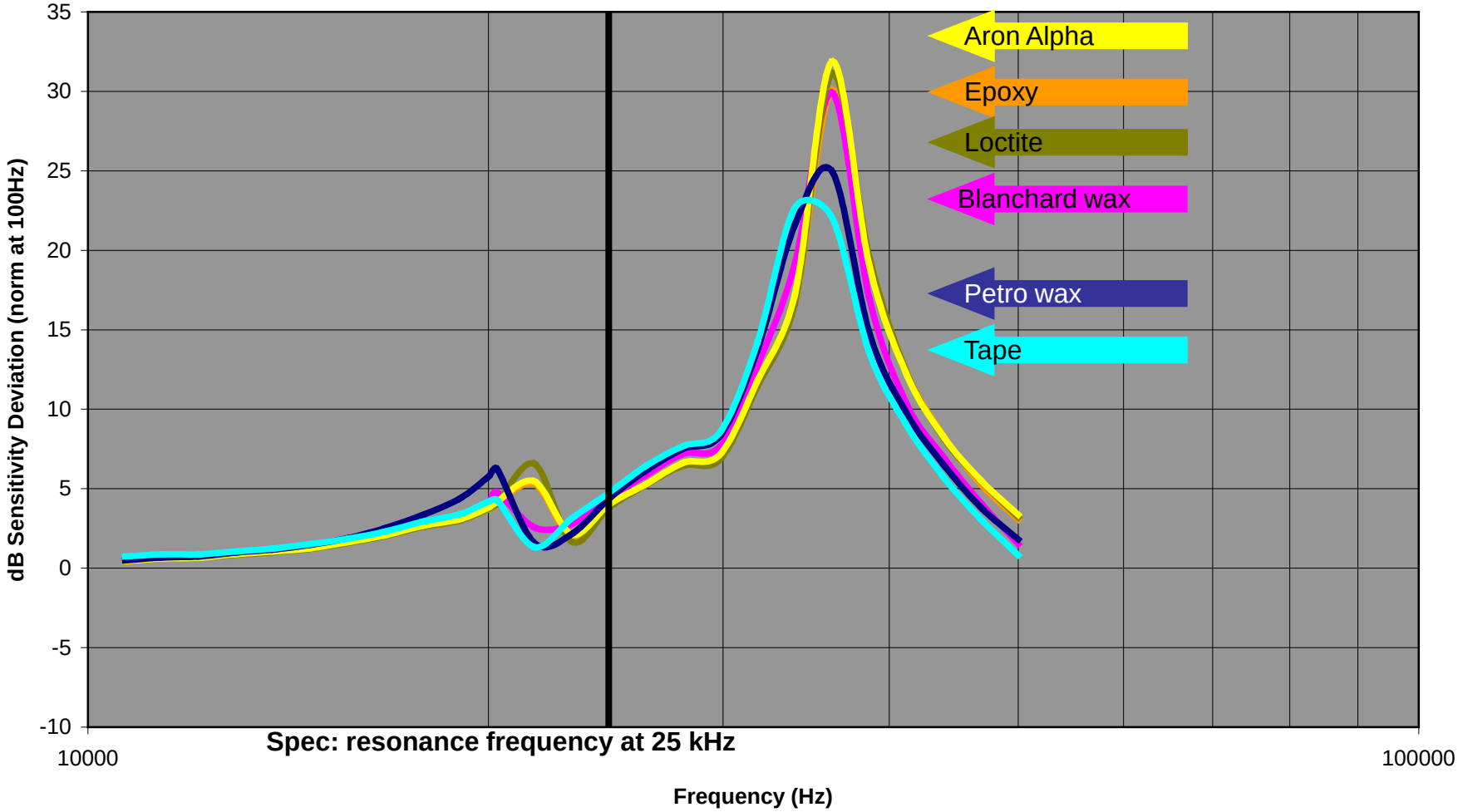
Results - Adhesive

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



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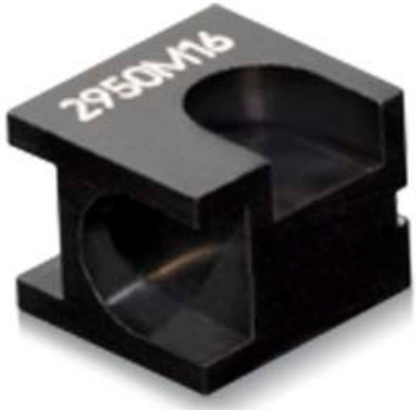
Conclusions

- 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?

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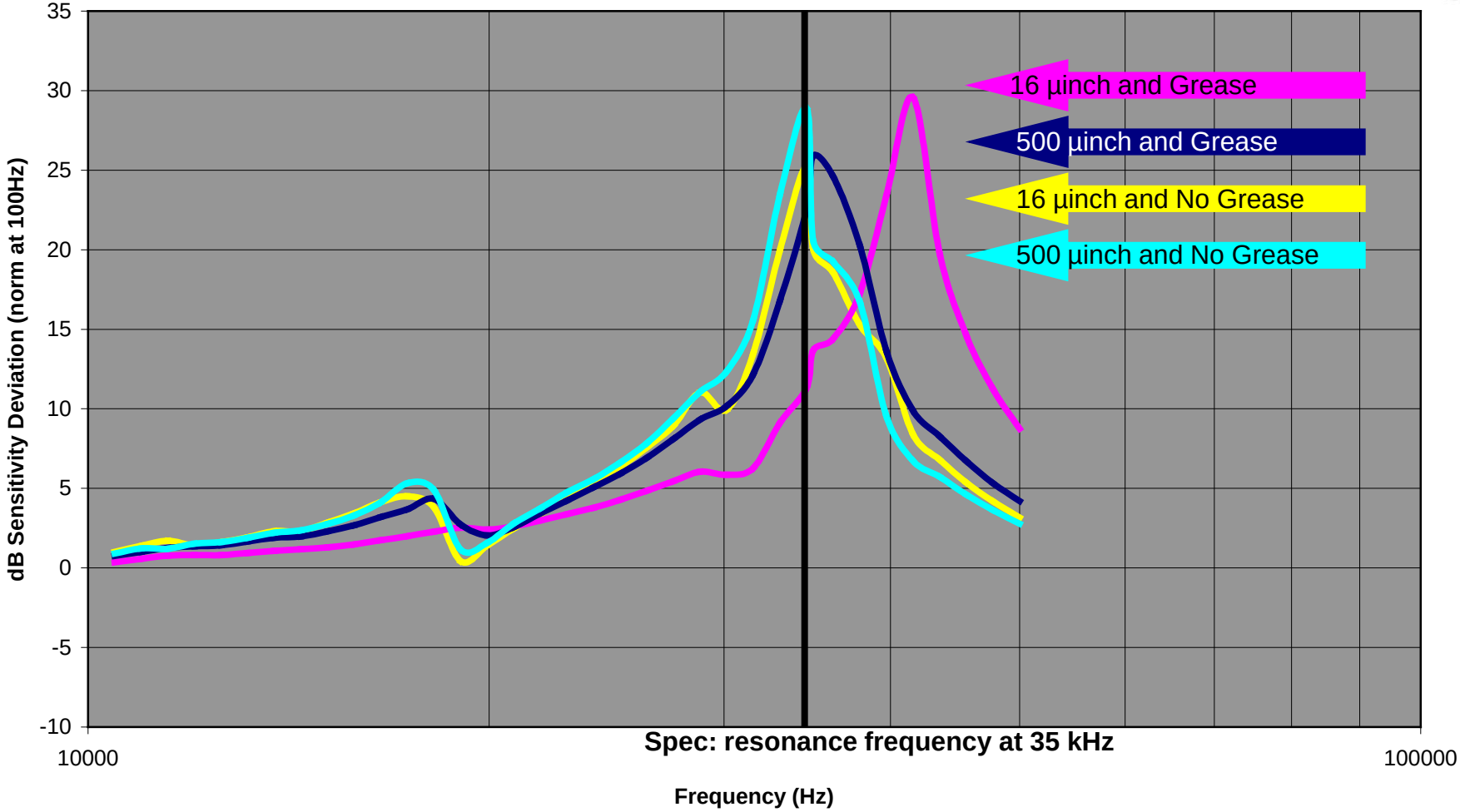
Results - Roughness

7704
10 k – 50 kHz



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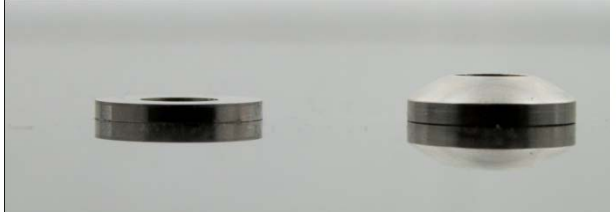
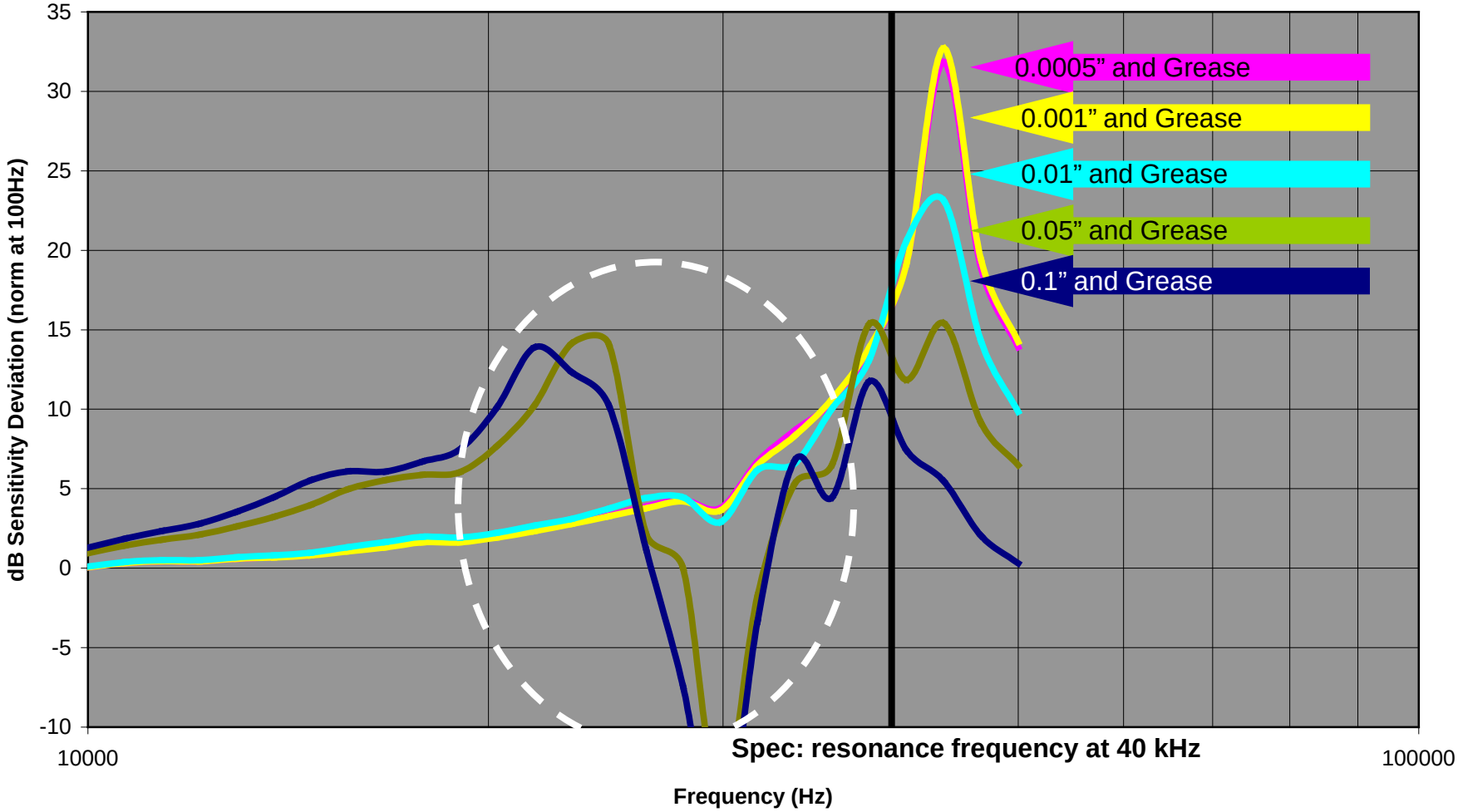
Results - Flatness



2221F
10 k – 50 kHz



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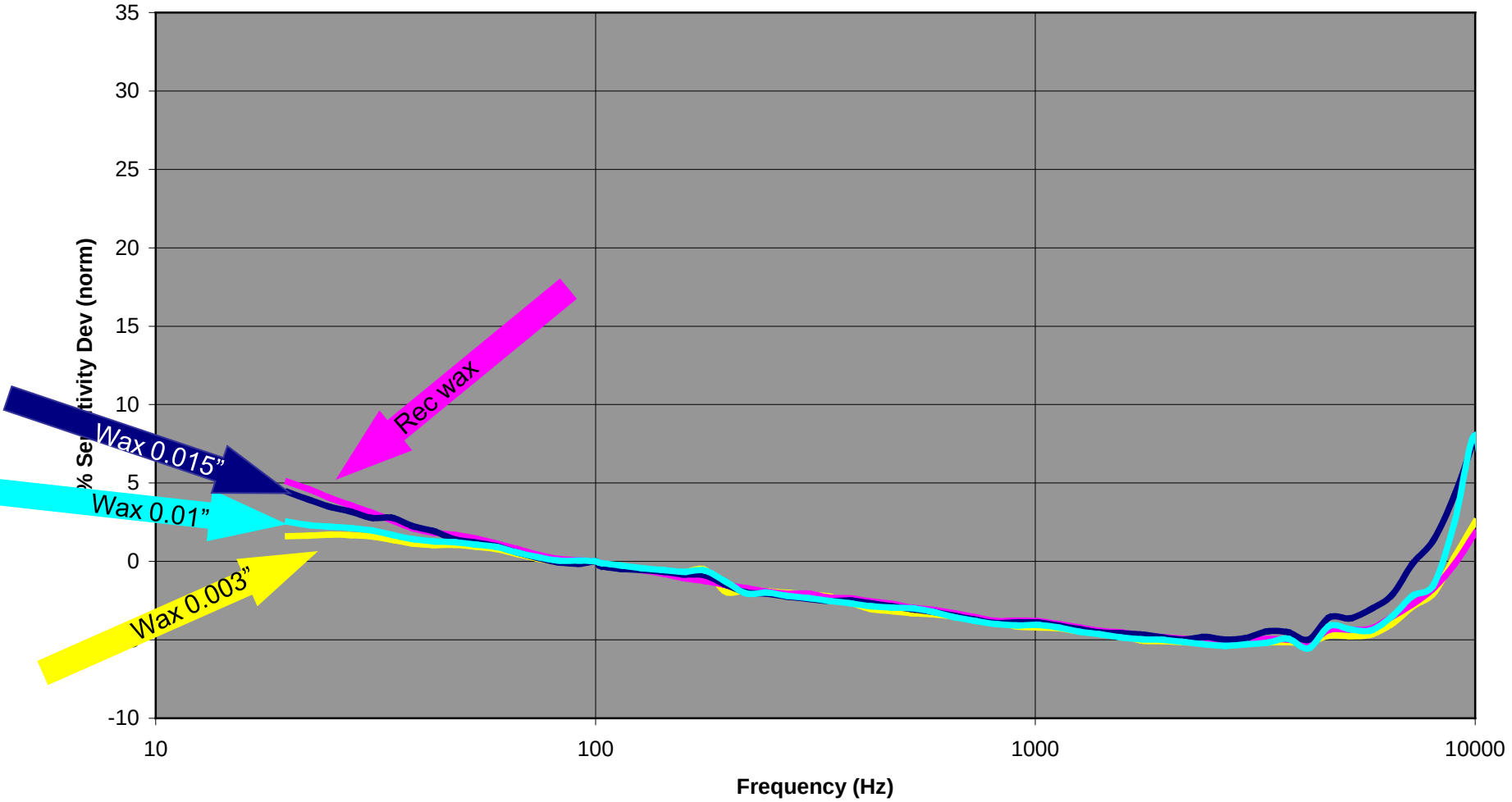
Results – Adhesive with Wax

2222C – Wax
20 – 10 kHz



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