

# Passive Wireless Sensing Using Ultrasonic Channels

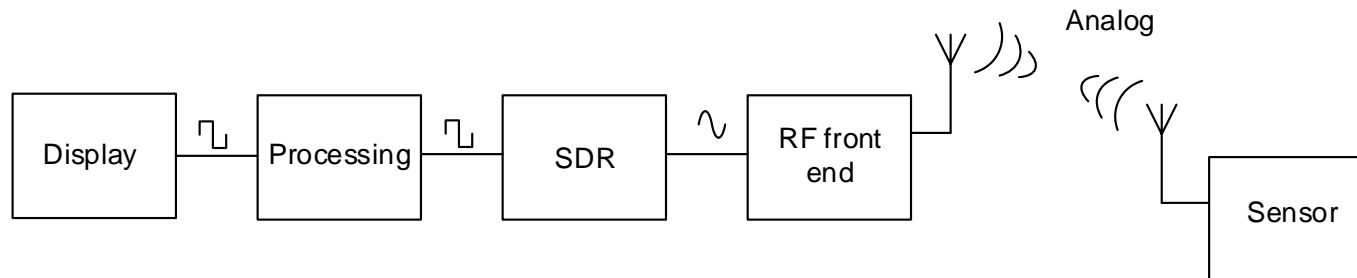
Taimur Aftab, Thomas Schaechtle, Leonhard Reindl

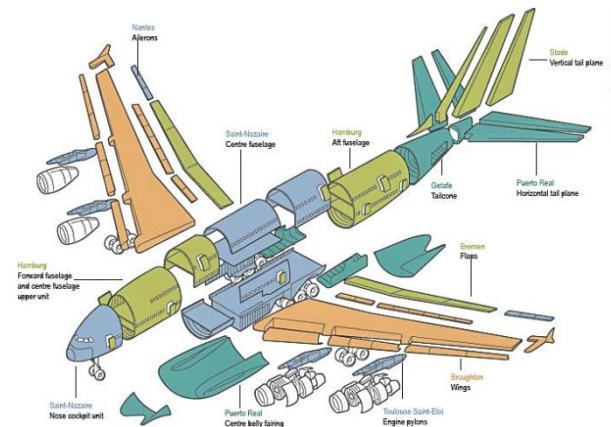
Albert-Ludwigs-Universität Freiburg



- State of the art
- Motivation
- Wireless sensor technology
  - Novel concept
  - Proof of concept
  - Results

- Passive wireless sensor technology
  - Maintenance-free
  - Few electronic components
  - Cost and energy efficient



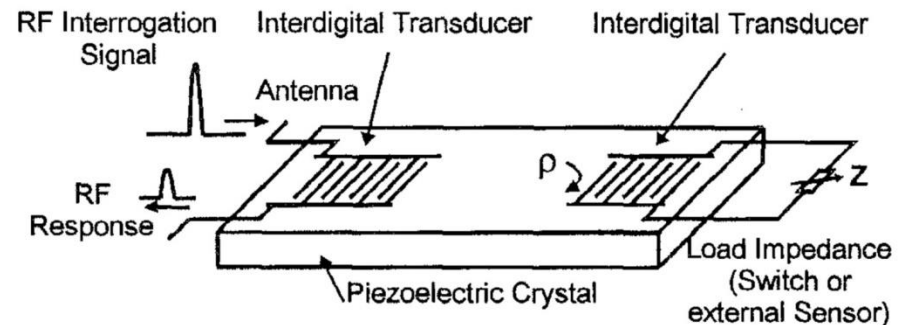


- Passive wireless sensor technologies

- RFID, NFC-, SAW-based
- Active readout unit, passive sensor tag
- No dedicated energy storage

- Passive sensing with SAW

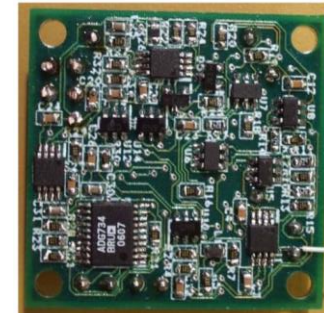
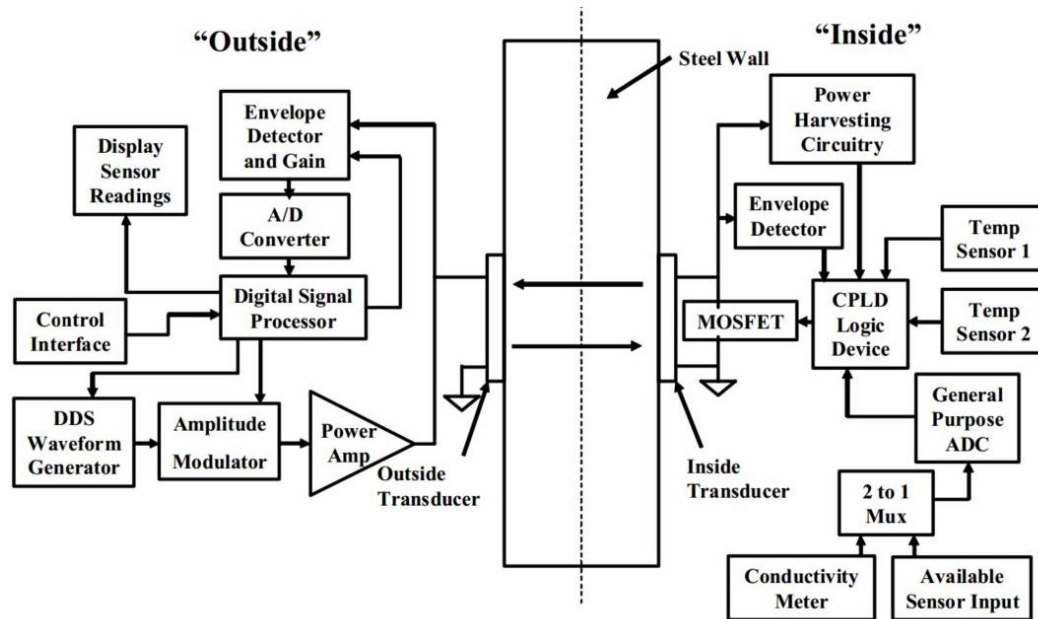
- Prof. Dr. L. Reindl,  
University of Freiburg, Germany



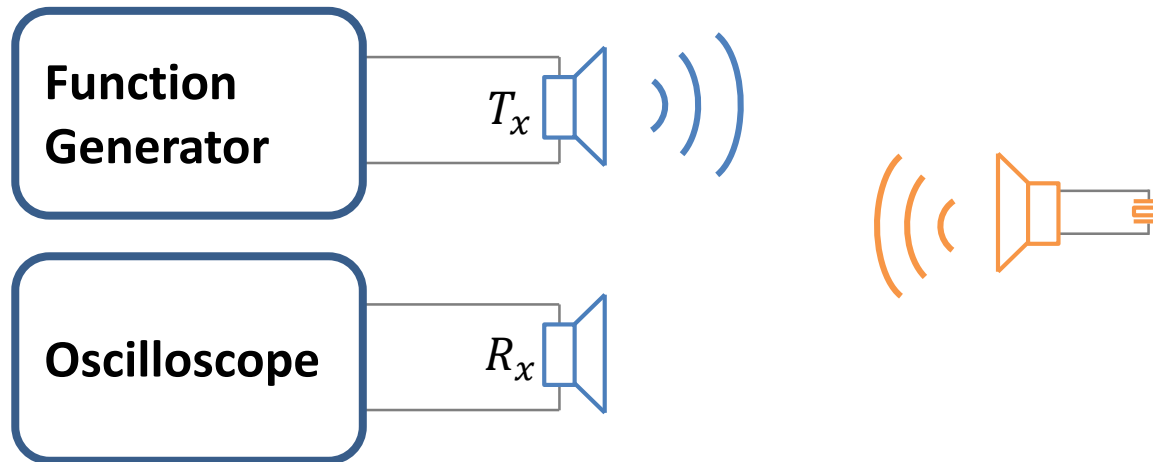
# State of the art



- Ultrasonic through Wall Communication with energy harvesting
  - D. A. Shoudy, Polytechnic Institute, New York, USA, 2007



# Novel concept



- Readout unit:

- $T_x$ : Excitation burst

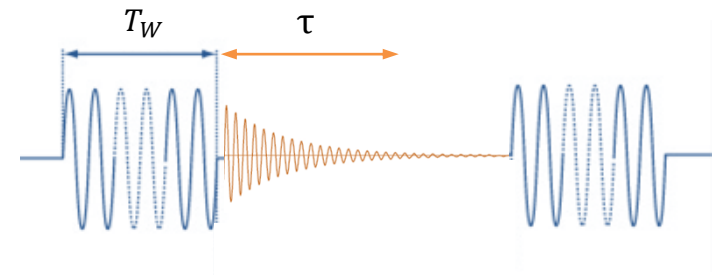
$$BW \sim \frac{1.2}{T_W}$$

- $R_x$ : Data analysis

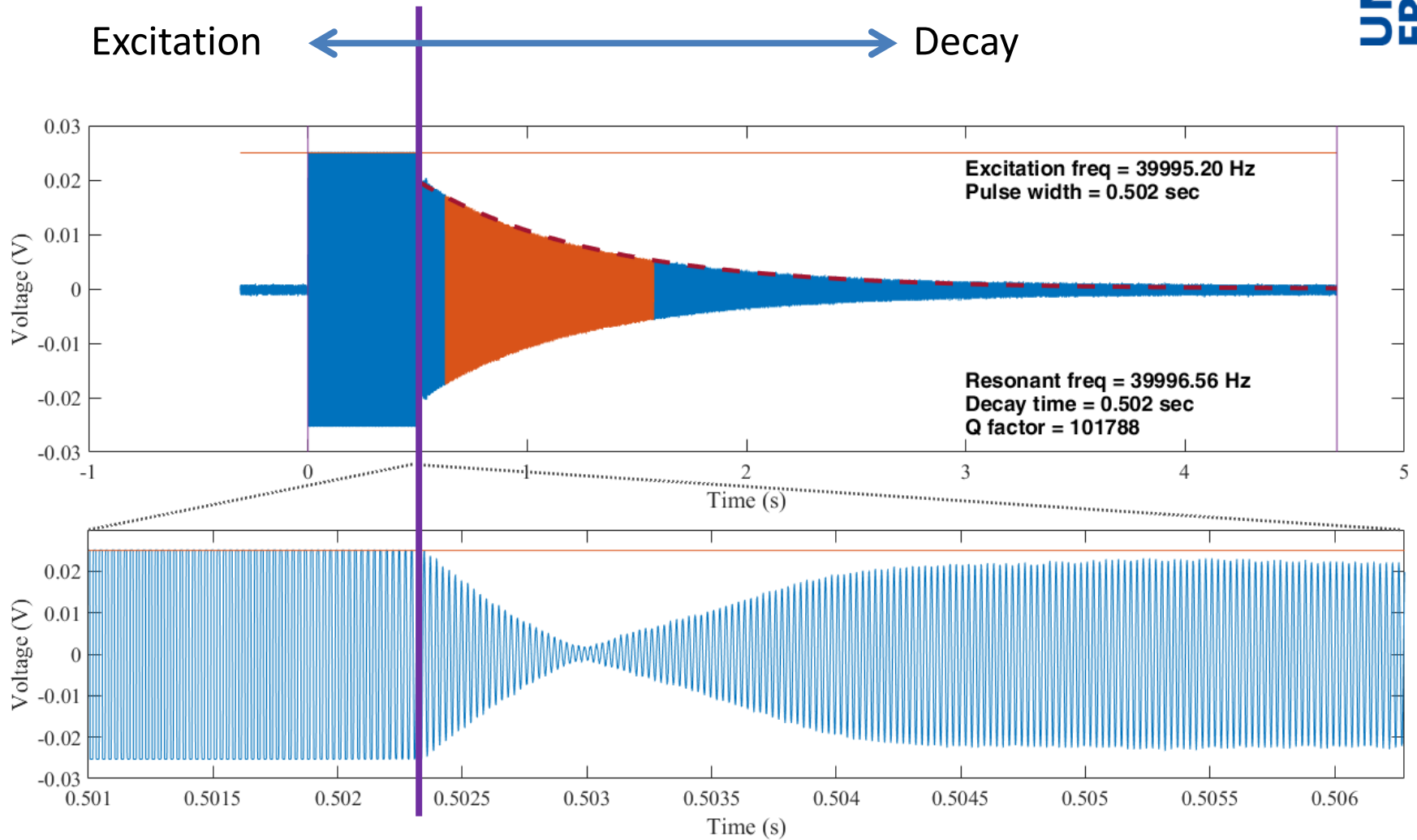
- Passive sensor node

- Backscattering signal

$$\tau = \frac{Q}{\pi f_0}$$

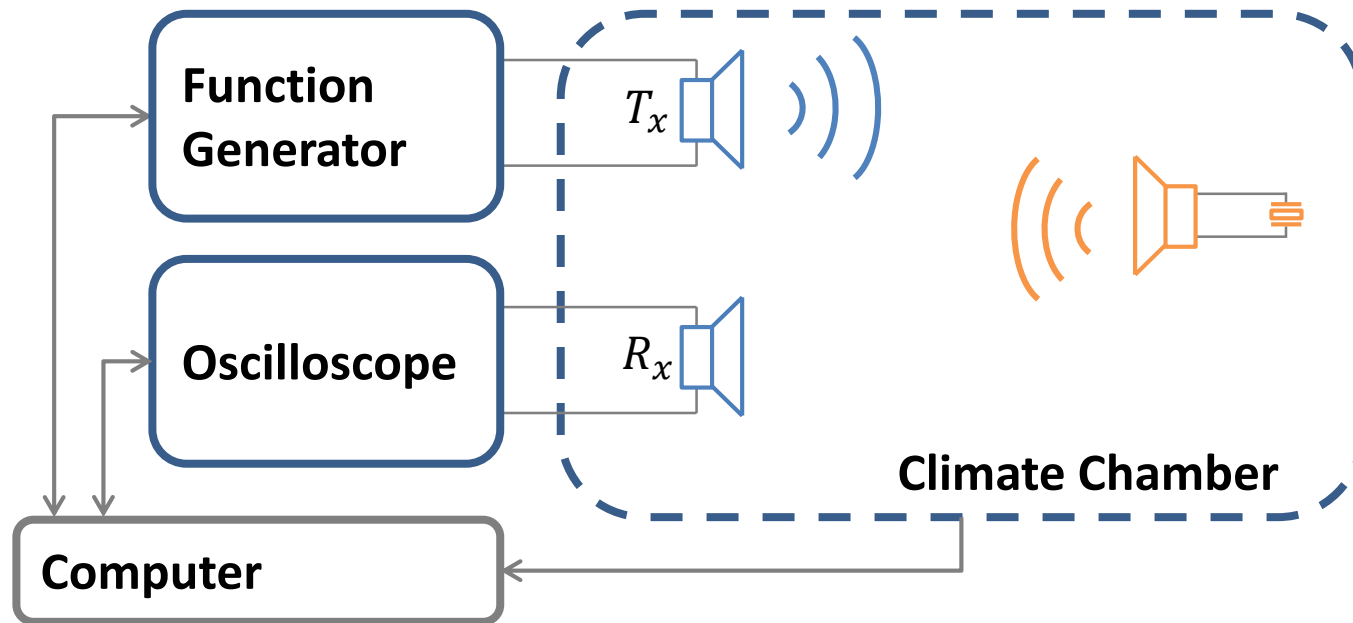


# Proof of concept



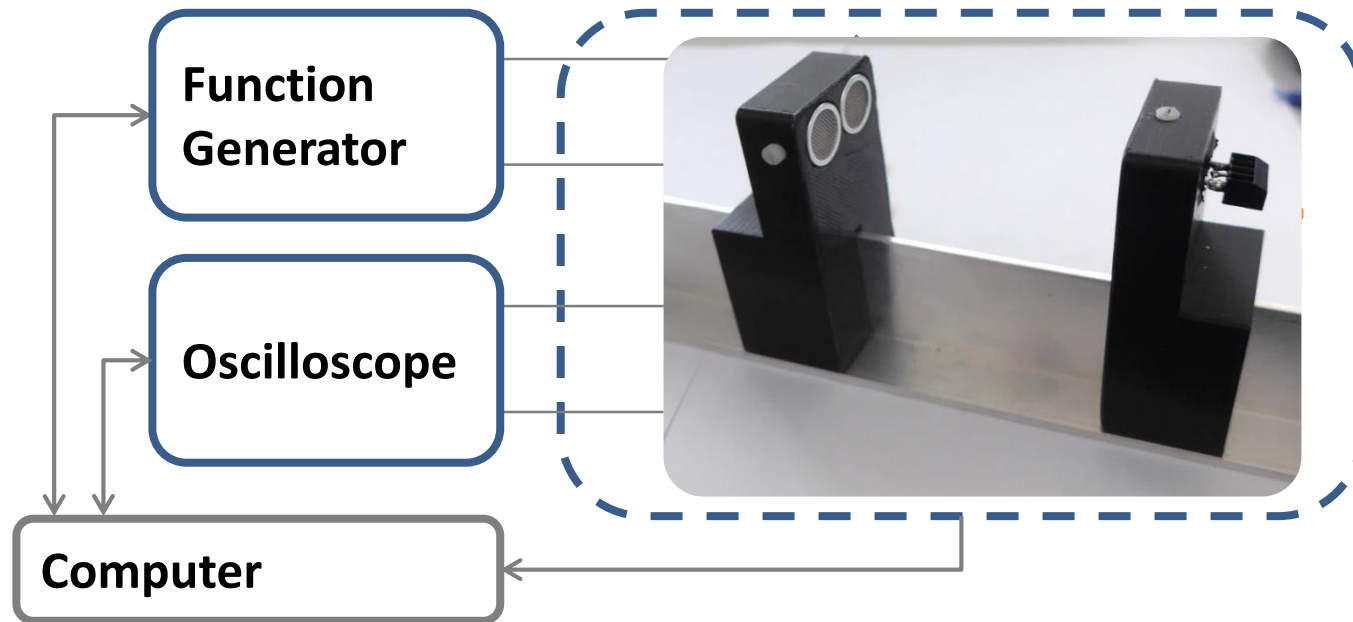


# Experimental Setup



- Temperature Ramp:  $-5$  to  $+50^{\circ}\text{C}$
- Tracking of the resonance frequency

# Experimental Setup

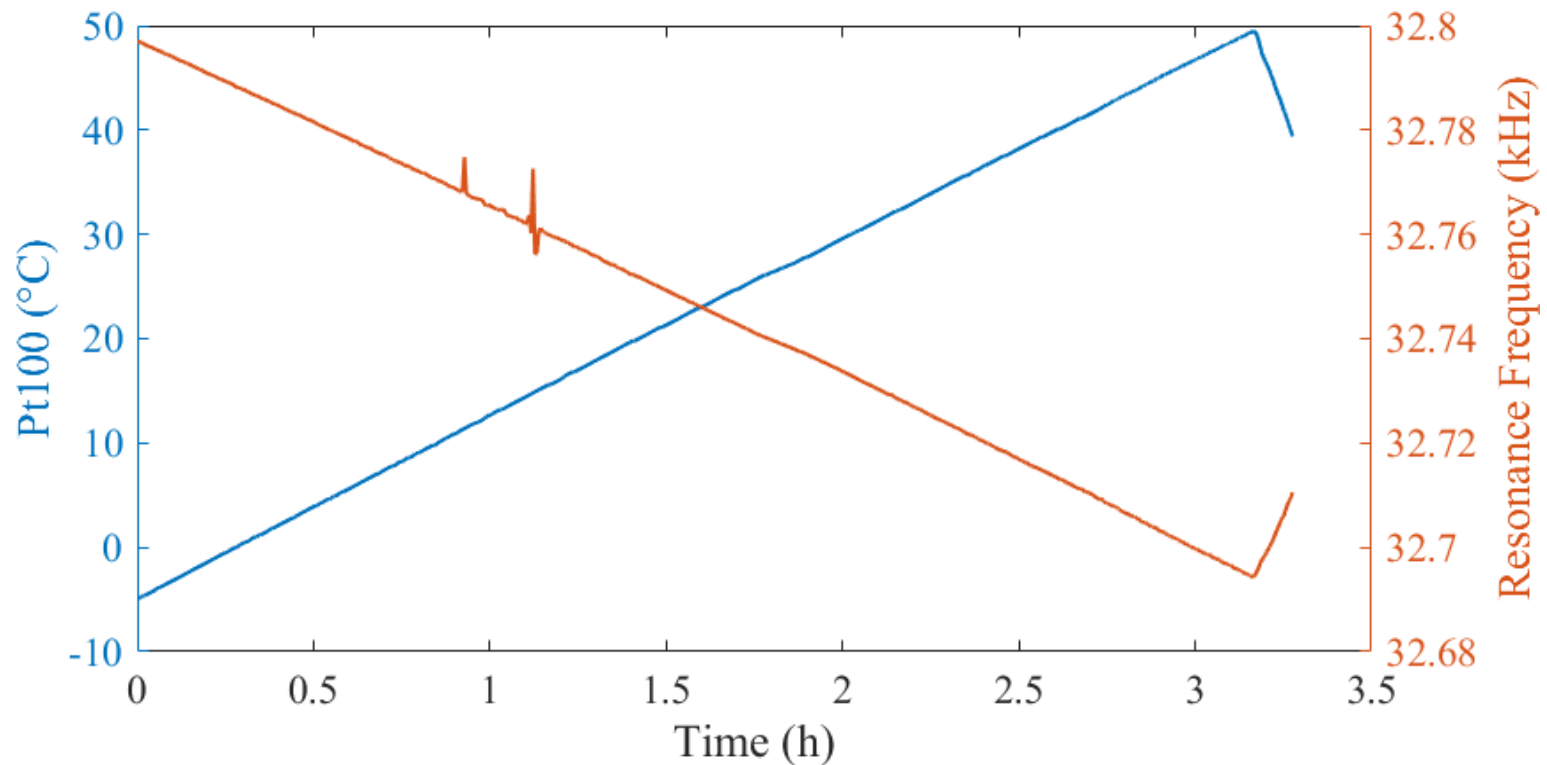


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- Tracking of the resonance frequency

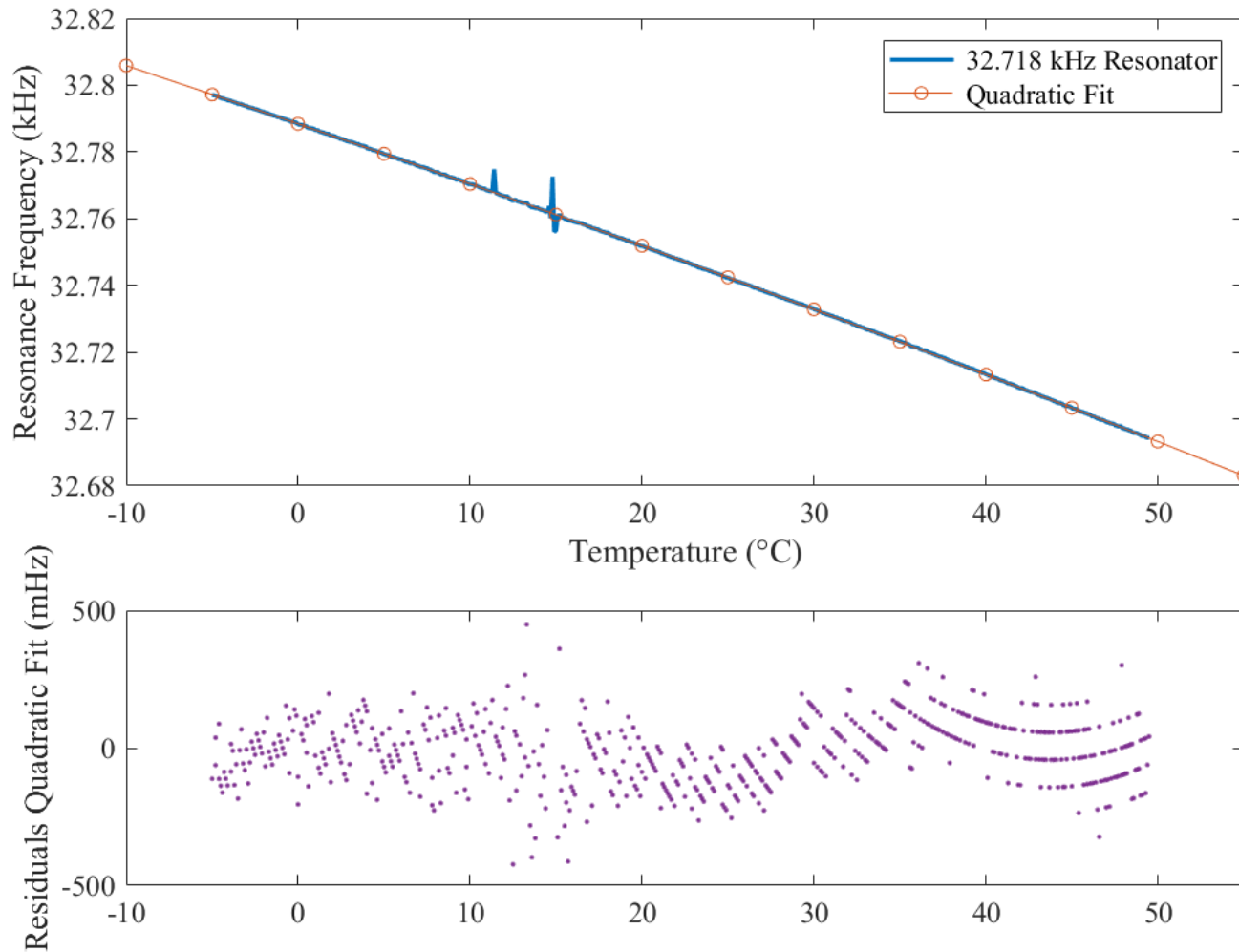
# Measurement Results



- Experiment performed at 10 *cm* distance



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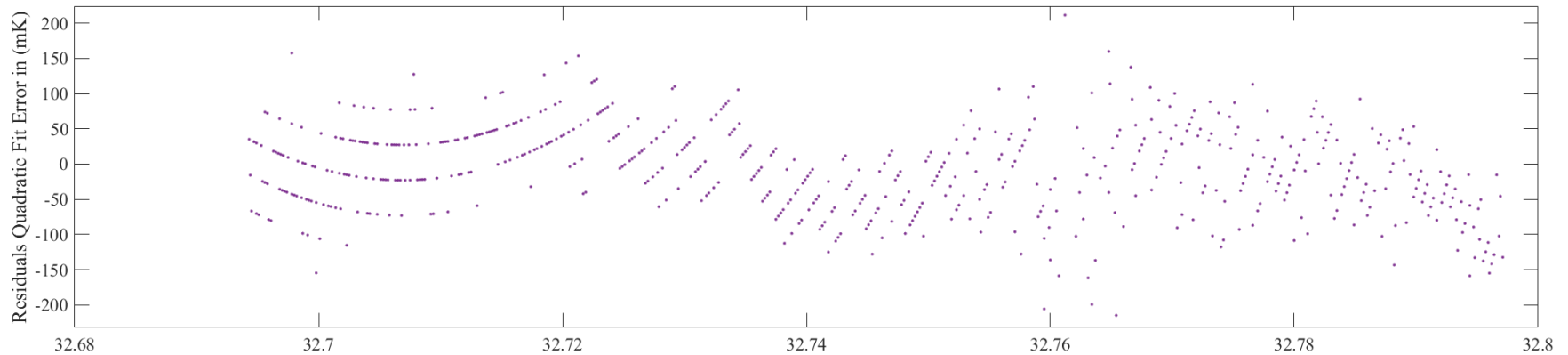
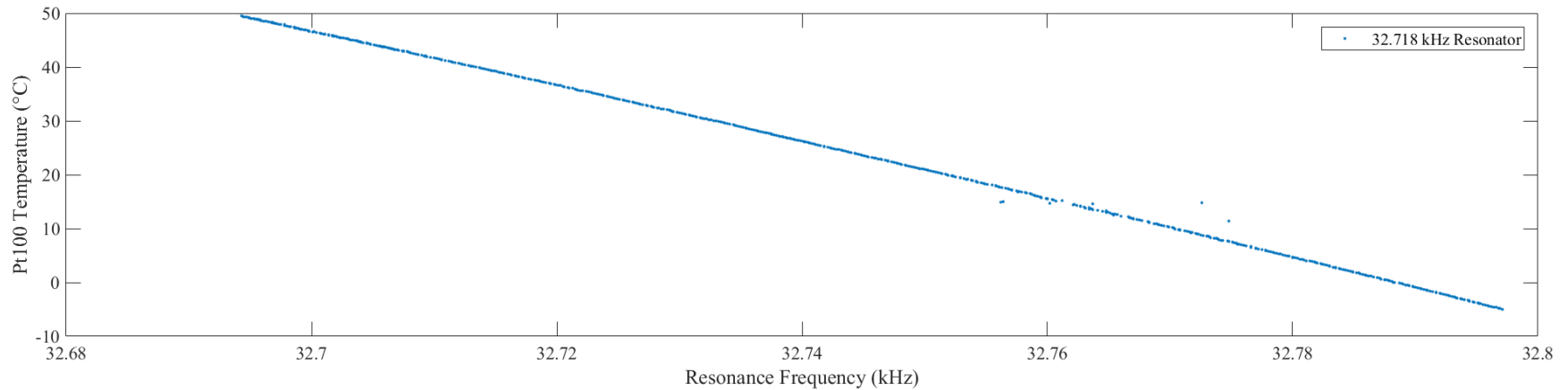


# Conclusion

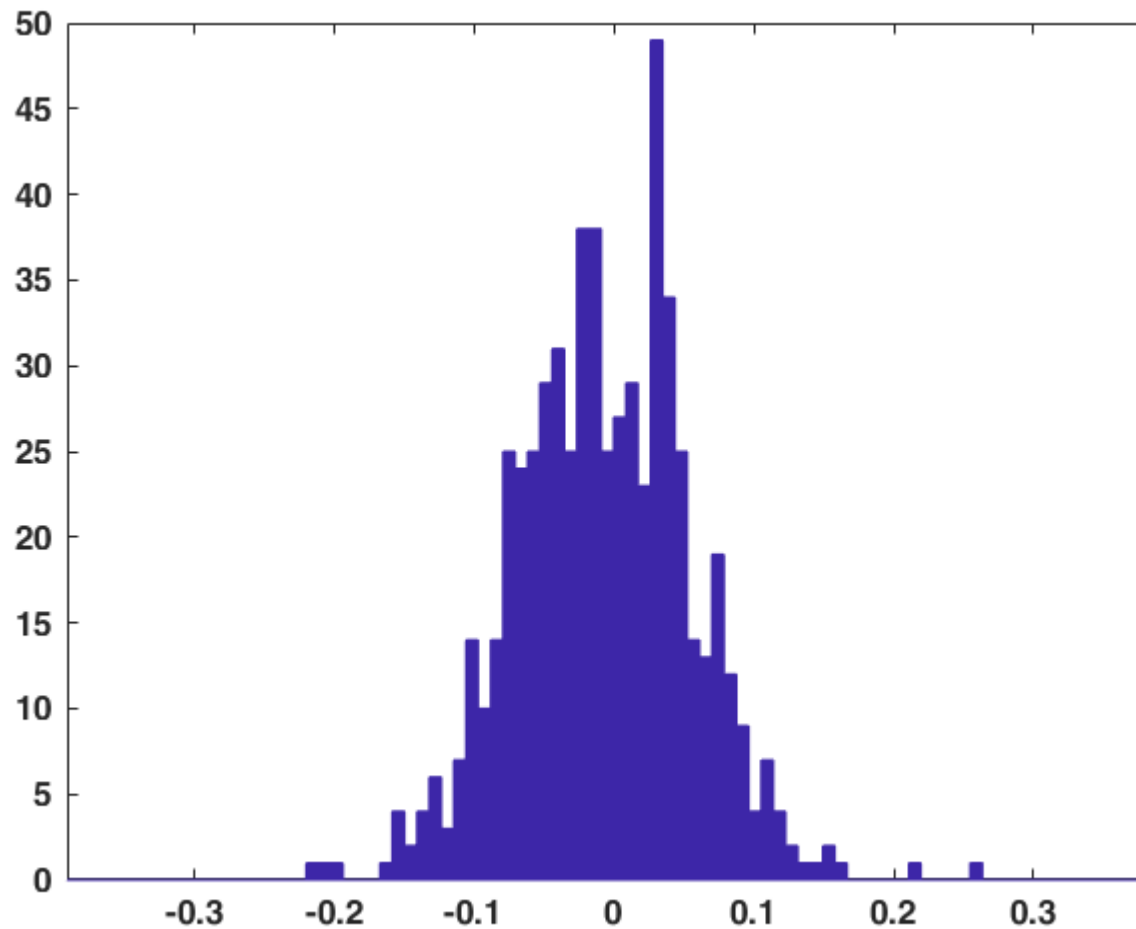


- Experiment performed at 10 *cm* distance
- Temperature sensitive tuning fork oscillator
  - Temperature sensitivity:  $-0.52 \text{ K/Hz at } 25 \text{ }^{\circ}\text{C}$
  - Temperature resolution: 52 *mK*

# Quadratic Fit - Residuals



# Quadratic Fit – Residuals histogram



# Linear Fit - Residuals

