Acoustic Impediography: A New Method for Fingerprinting and Navigation

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Intro

Fingerprinting is the most widely used biometric for human identification

Integrated into mobile devices and stationary applications increasingly replacing Password & PIN for access control

Market expectations > $ 10 Billion by 2015 *)

Current technology utilizes Electric Field variation due to fingerprint structure (ridges and valley) implemented in rigid ASIC's

Sonavation's goal: develop a line of swipe and touch sensors based acoustic impdiography , Ultra thin, flexible and inexpensive

Acoustic Fingerprinting Basics

The un-damped and damped rod extension vibration mode is the underlying principle differentiating ridge and valley structures in fingerprints

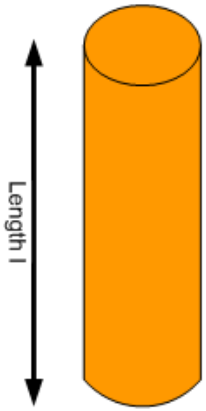
Fingerprint Structure

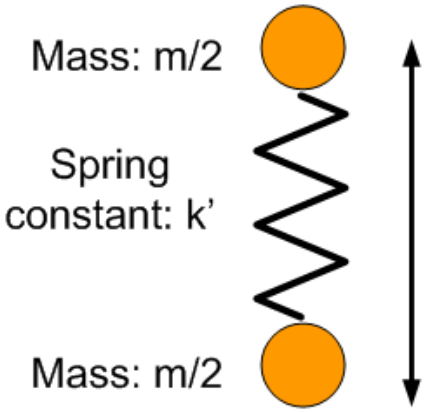
Valley

Ridge

Damping coefficient
R_m , k= R_m/m

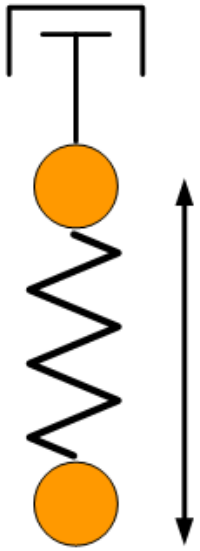
Longitudinal vibration of a cylinder
Rod Extension Mode





Damping: loss of mechanical energy Via oscillator/tissue interface

Spring constant:
k' = Y* A/l'
Y = Young's modulus
A- Crossection



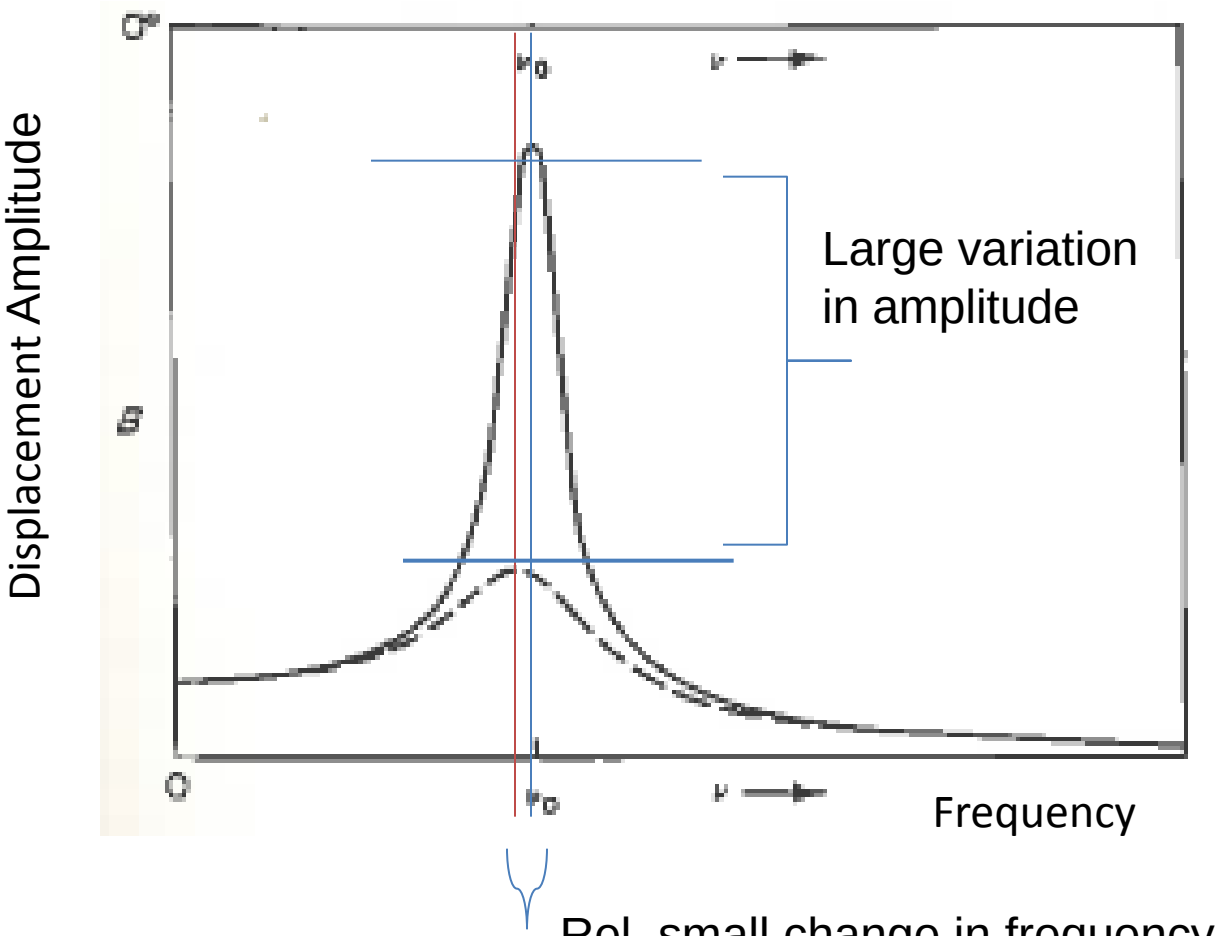
Cylinder: length l
Diameter : d
Density: ρ
Mass: m= ρ*l*(d/2)²

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{k'}{m/2}}$$

$$f = f_0\sqrt{1-(\frac{k}{2\pi f_0})^2}$$

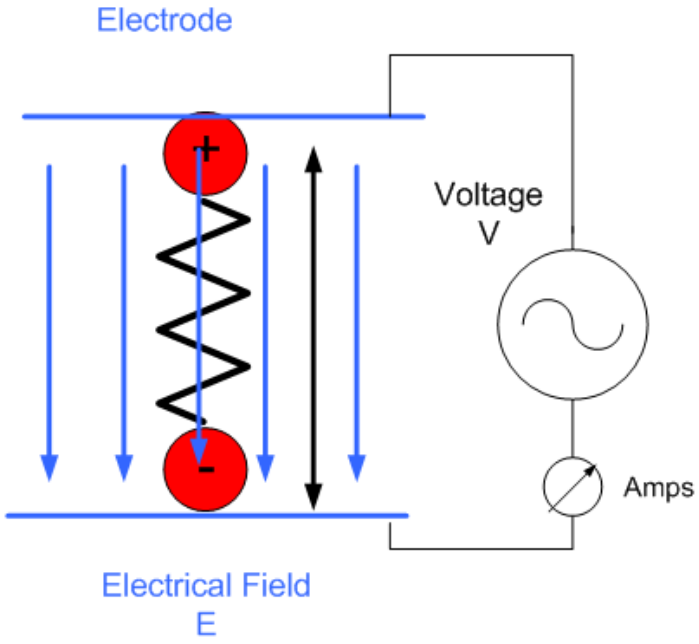
Sonavation Technology Basics

Low and highly (11x) damped mechanical resonator



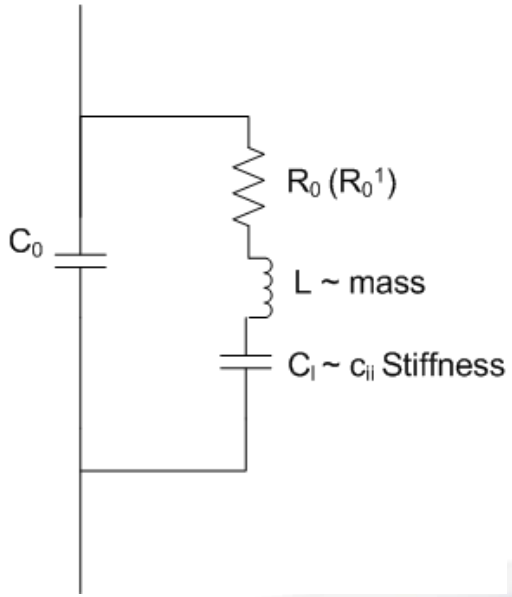
Sonavation Technology Basics

Piezoelectric Mechanical Oscillator
Masses carry el. Charge Q
El. Dipole Moment M= l*Q

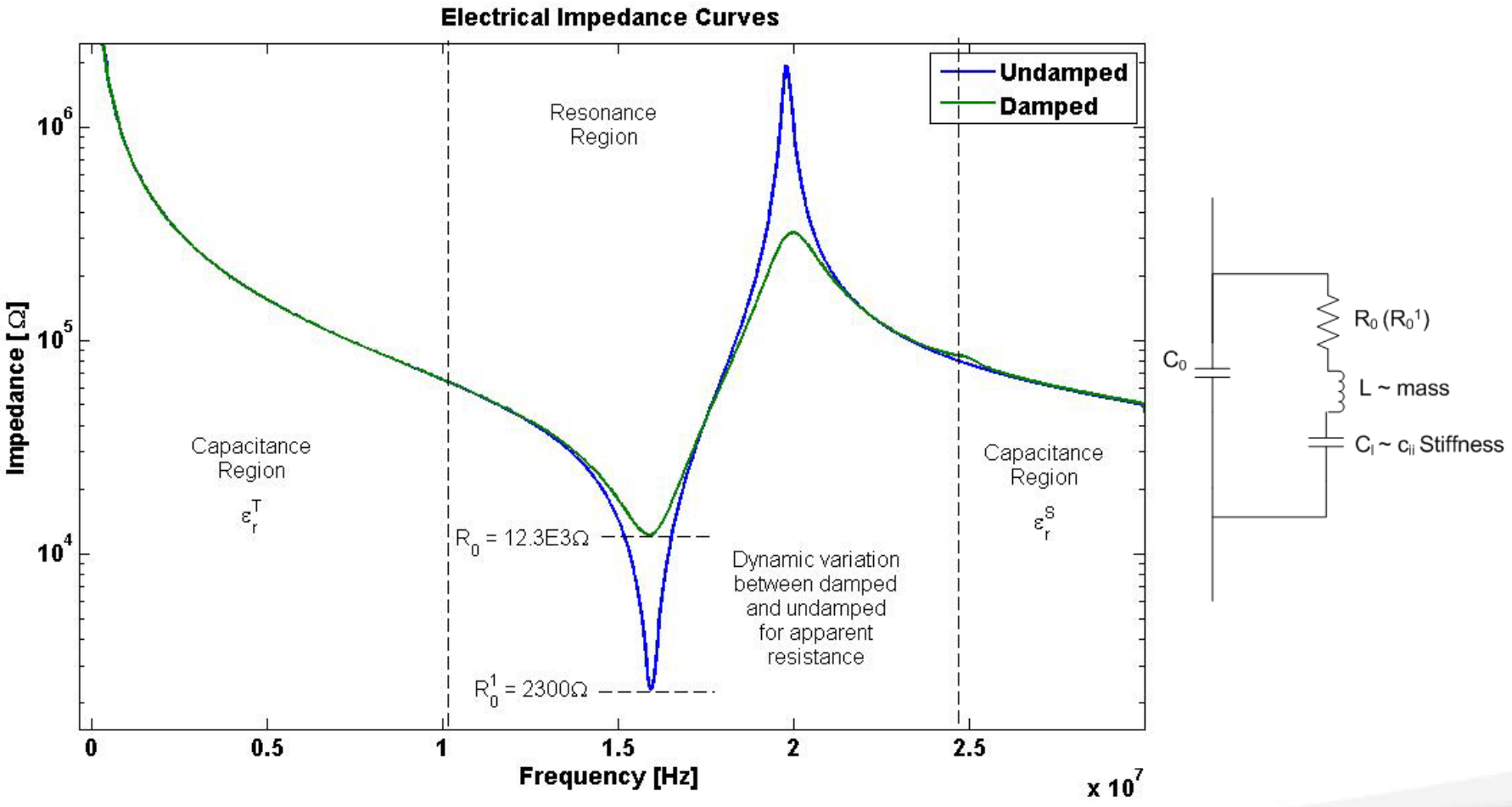


Use of piezoelectric mechanical resonator enables forced mechanical oscillations and detecting mechanical oscillation electrically

If a short pulse is applied the mech. response can be measured tracing the current



Electrical Impedance Loaded/Unloaded



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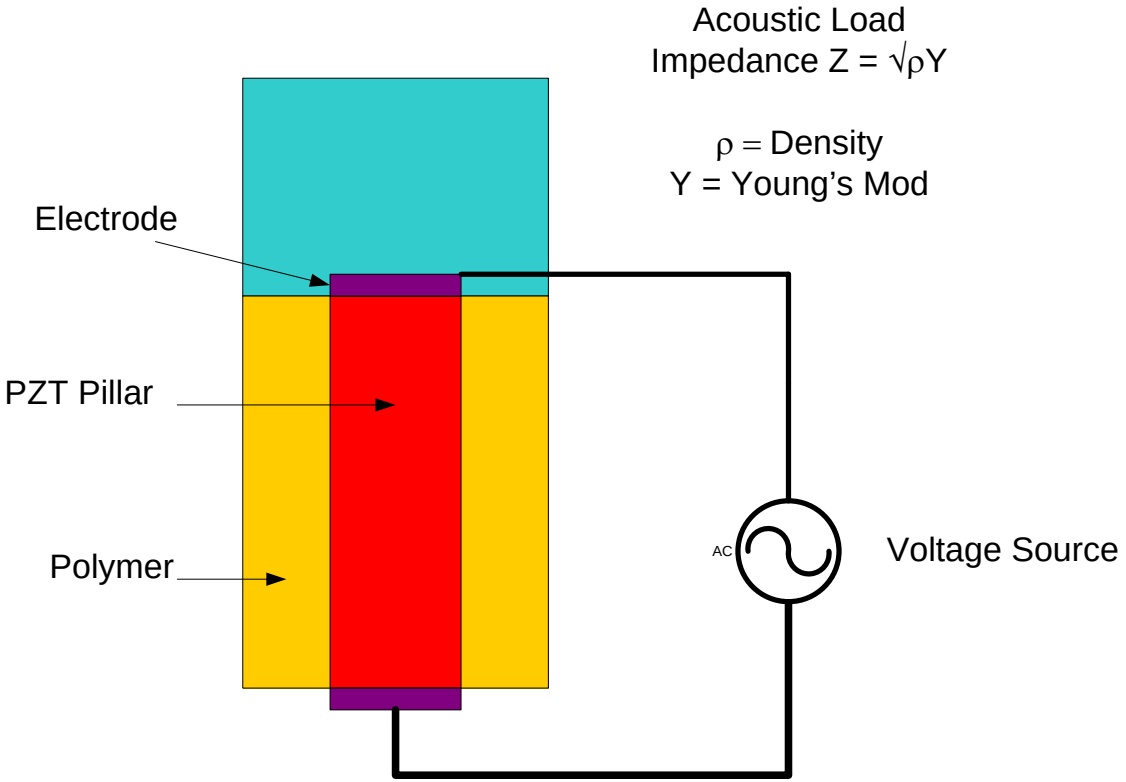
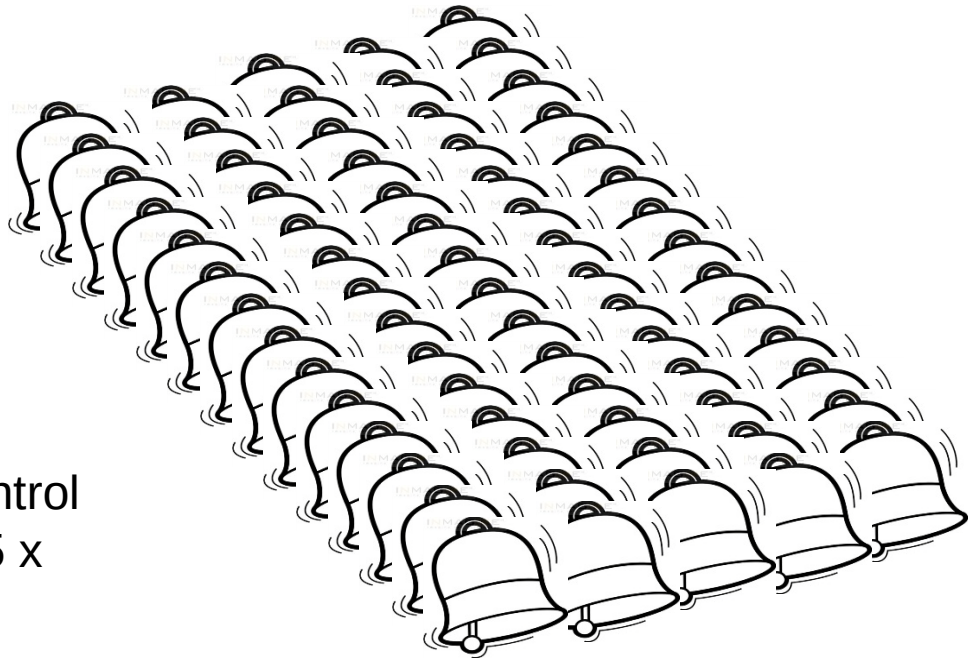
How the Acoustic Impediography works

Valley: free ringing bell

Ridge: bell ringing damped



Development Challenge

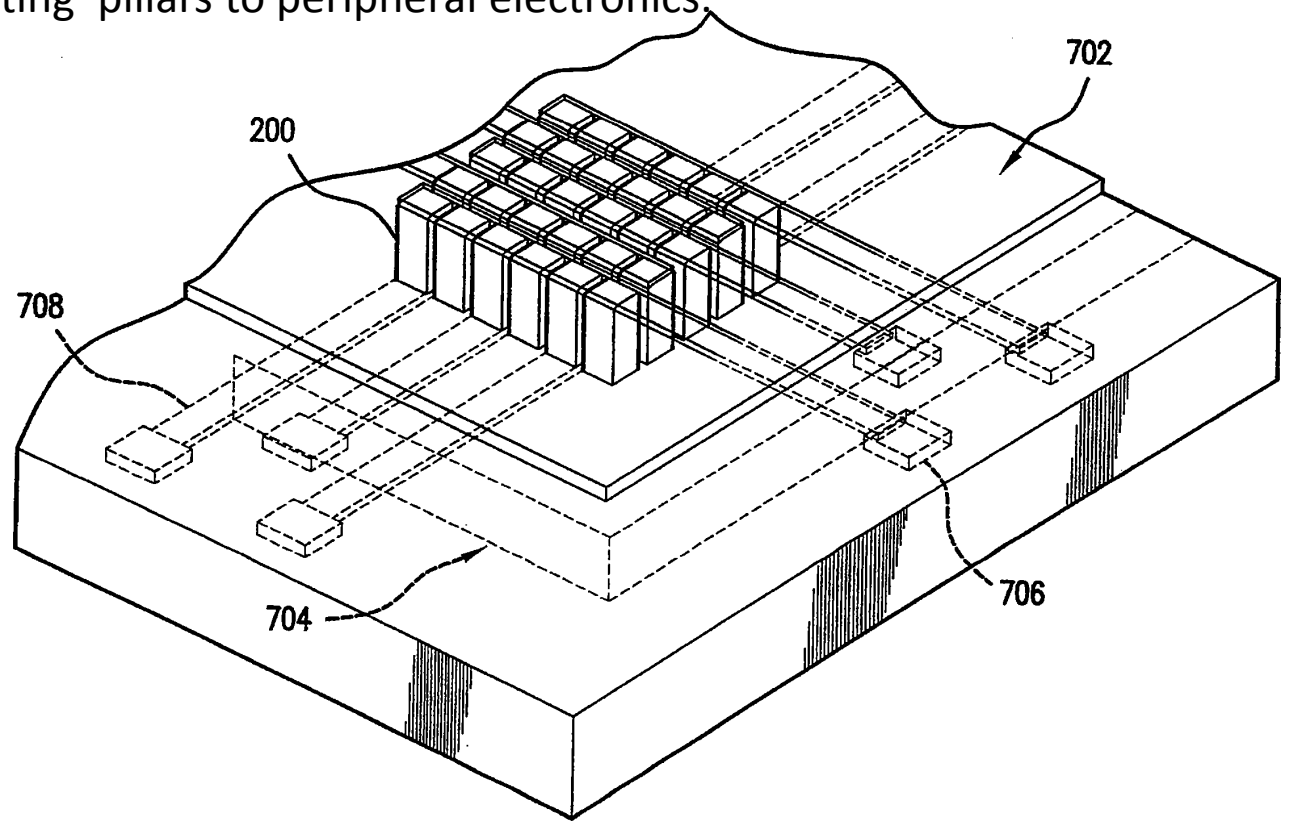


How to drive and control 250,000 bells in a 25 x 25 mm sensor **?**

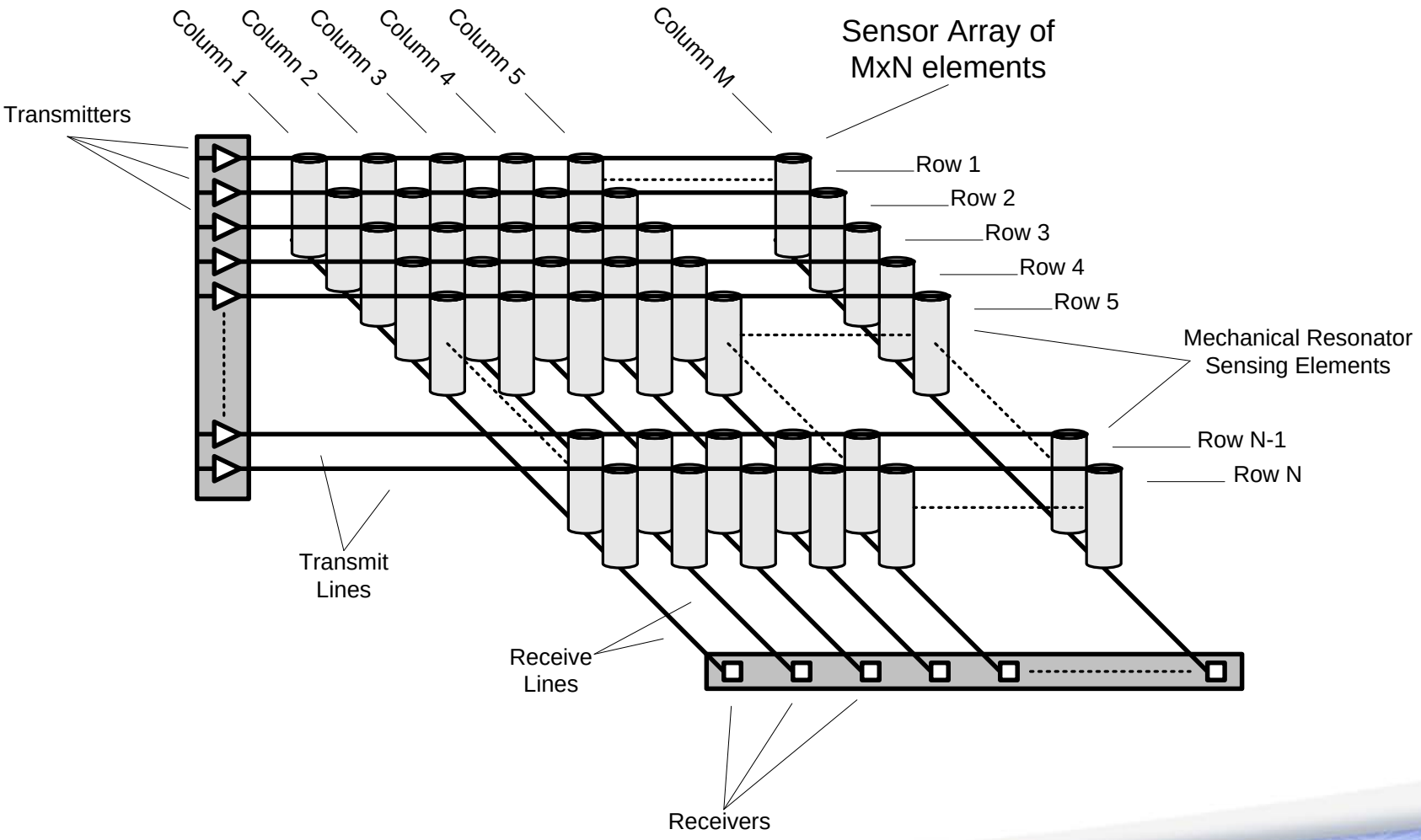
?

Matrix Addressing Scheme

Since 1000's of pillars are hard to be addressed individually a cross-hatched pattern of electrode lines is used for interconnecting pillars to peripheral electronics.



Sensor Topography



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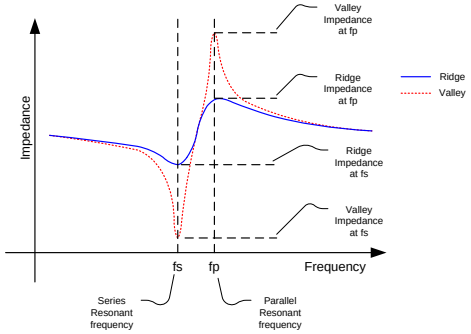
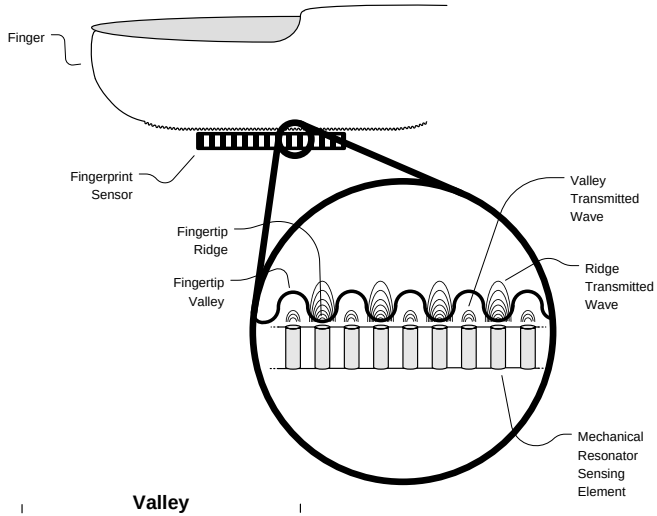
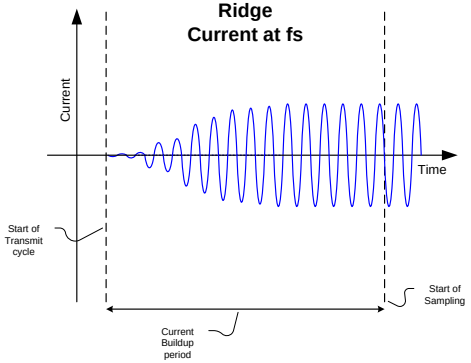
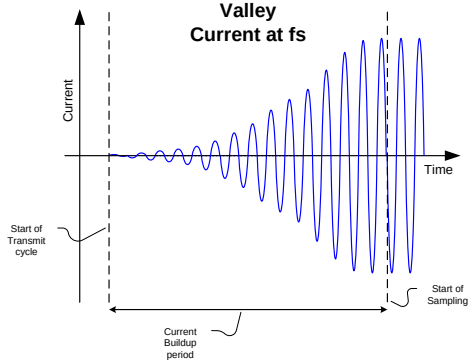
How Acoustic Impediography is implemented









Drawing: C. Liautaud

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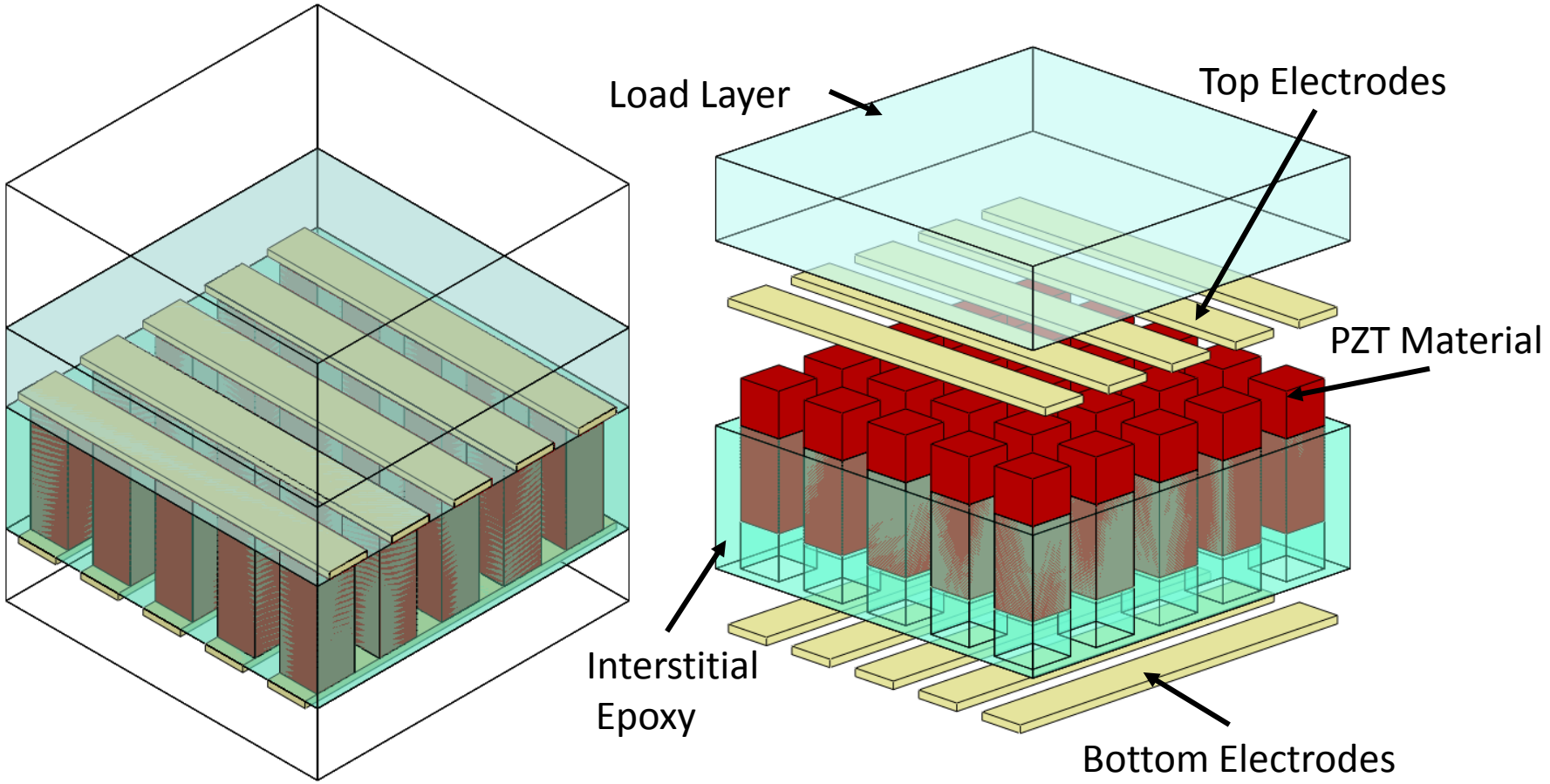
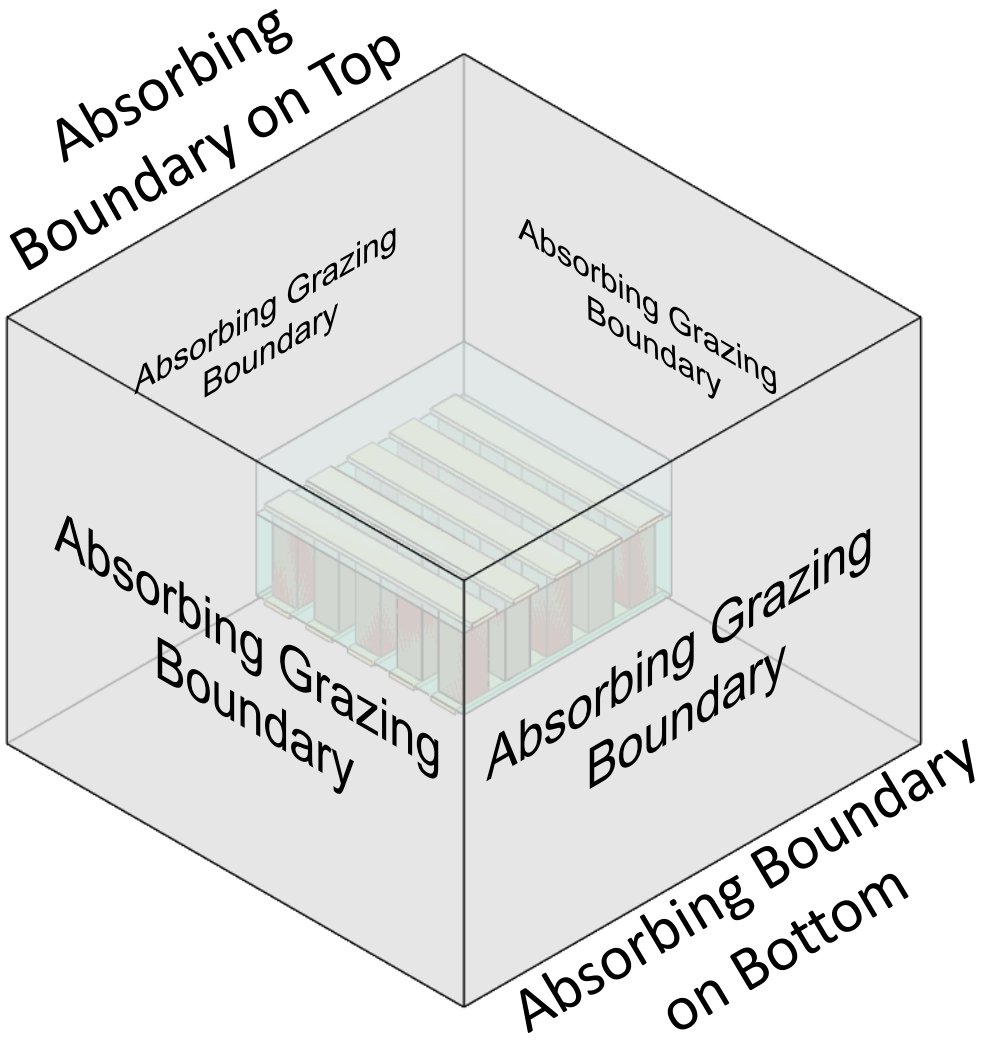
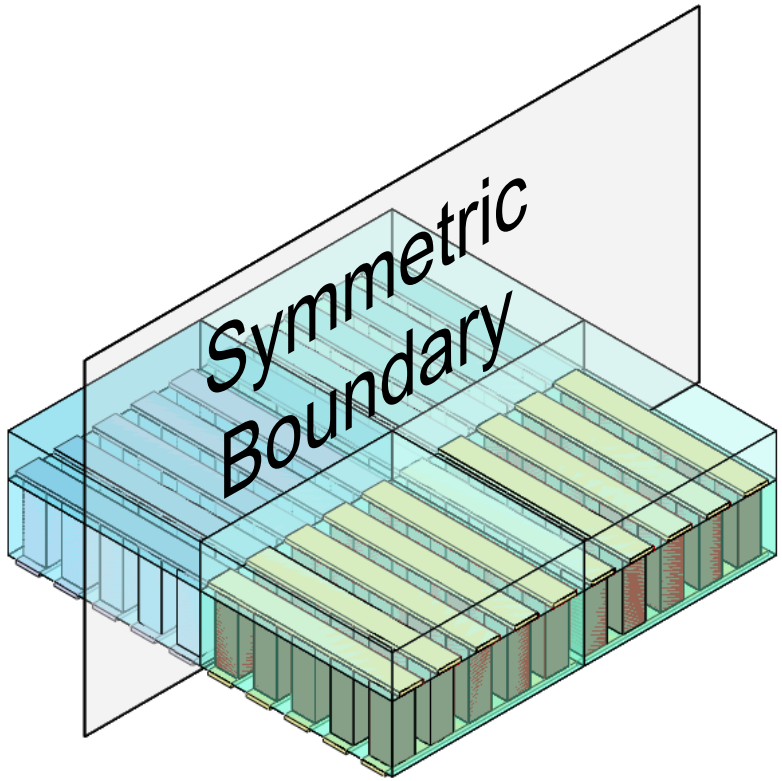
FEM Sensor Model



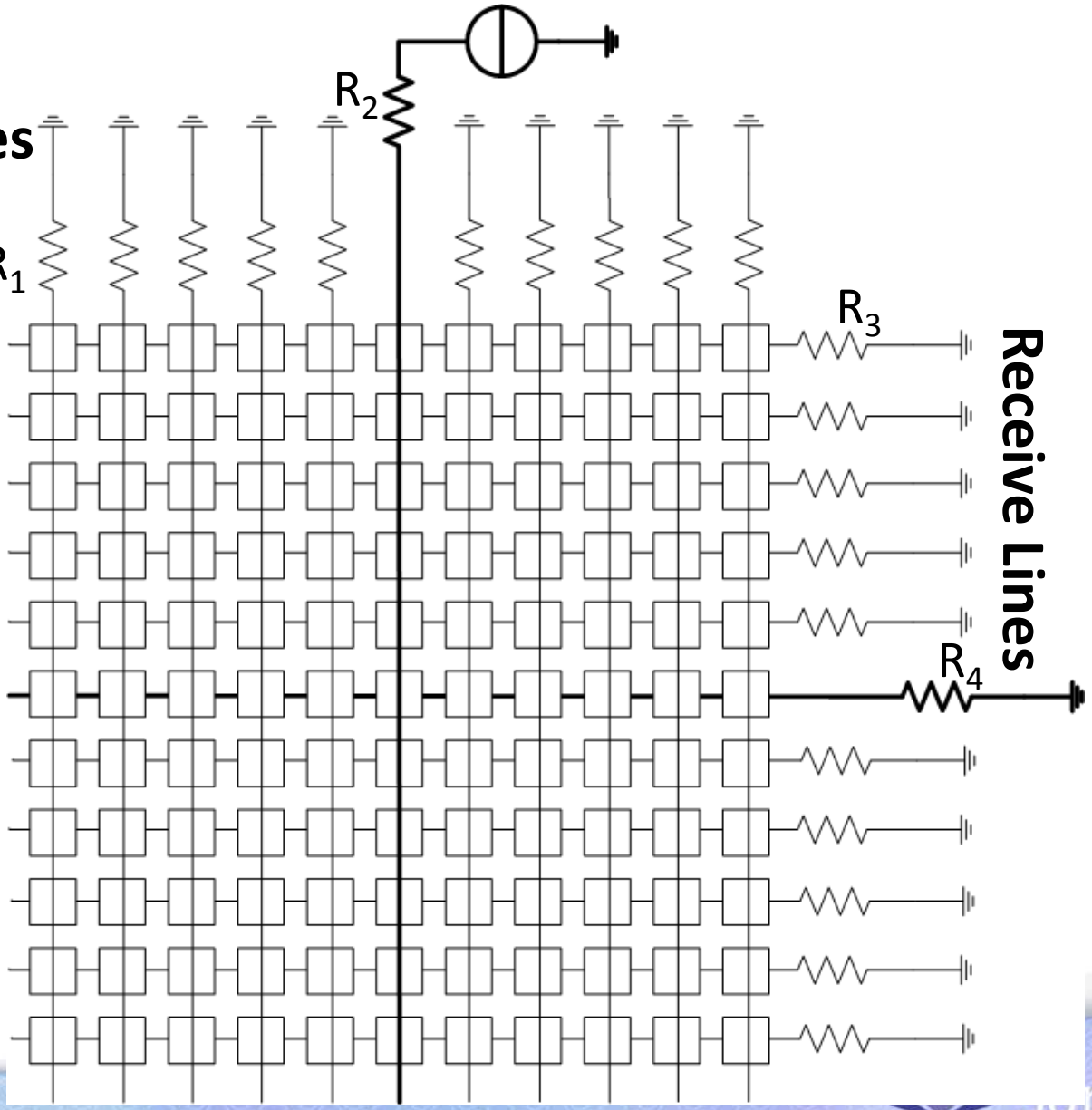
Model Boundary Conditions



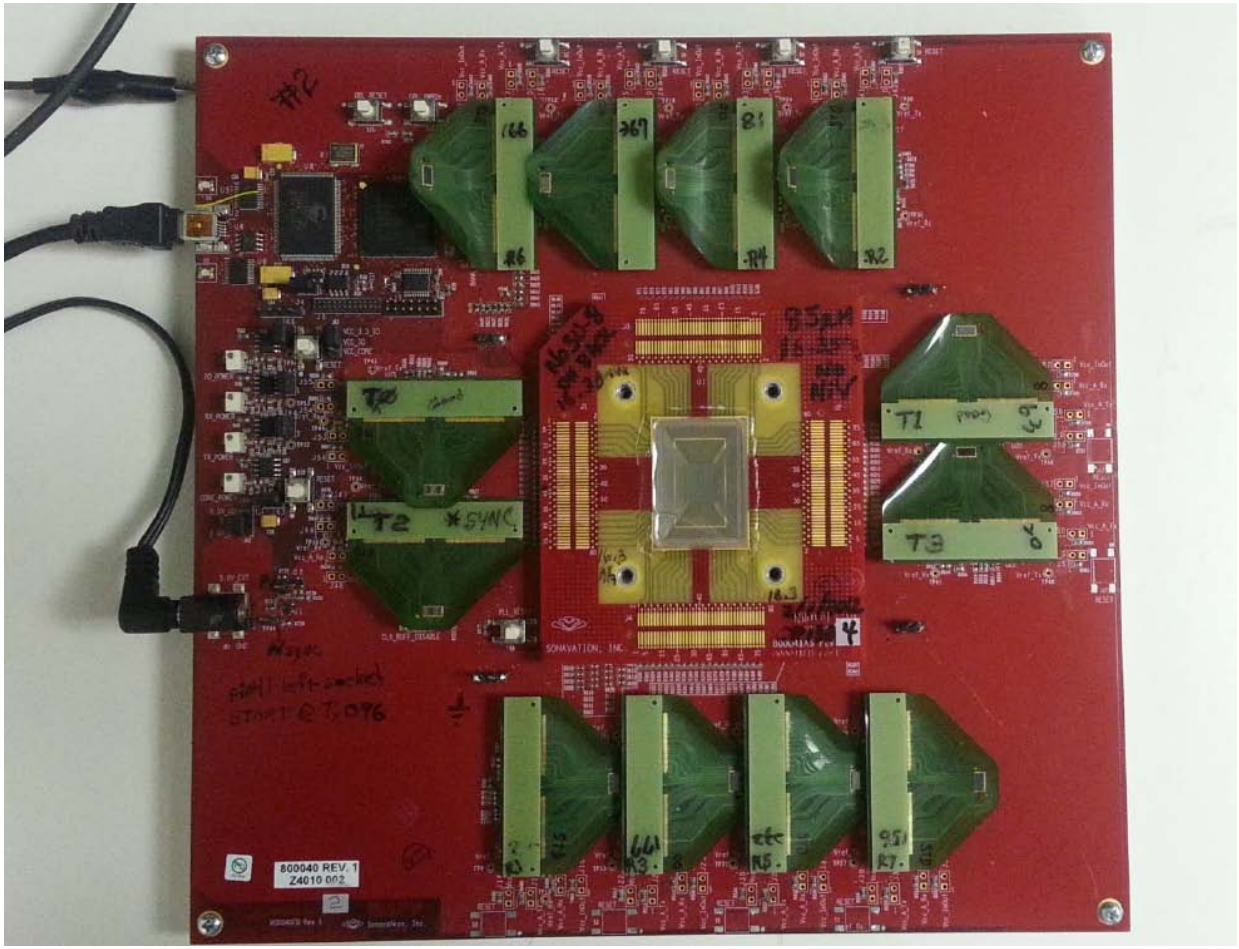


Electrical Interconnect

Transmit Lines



Test Platform



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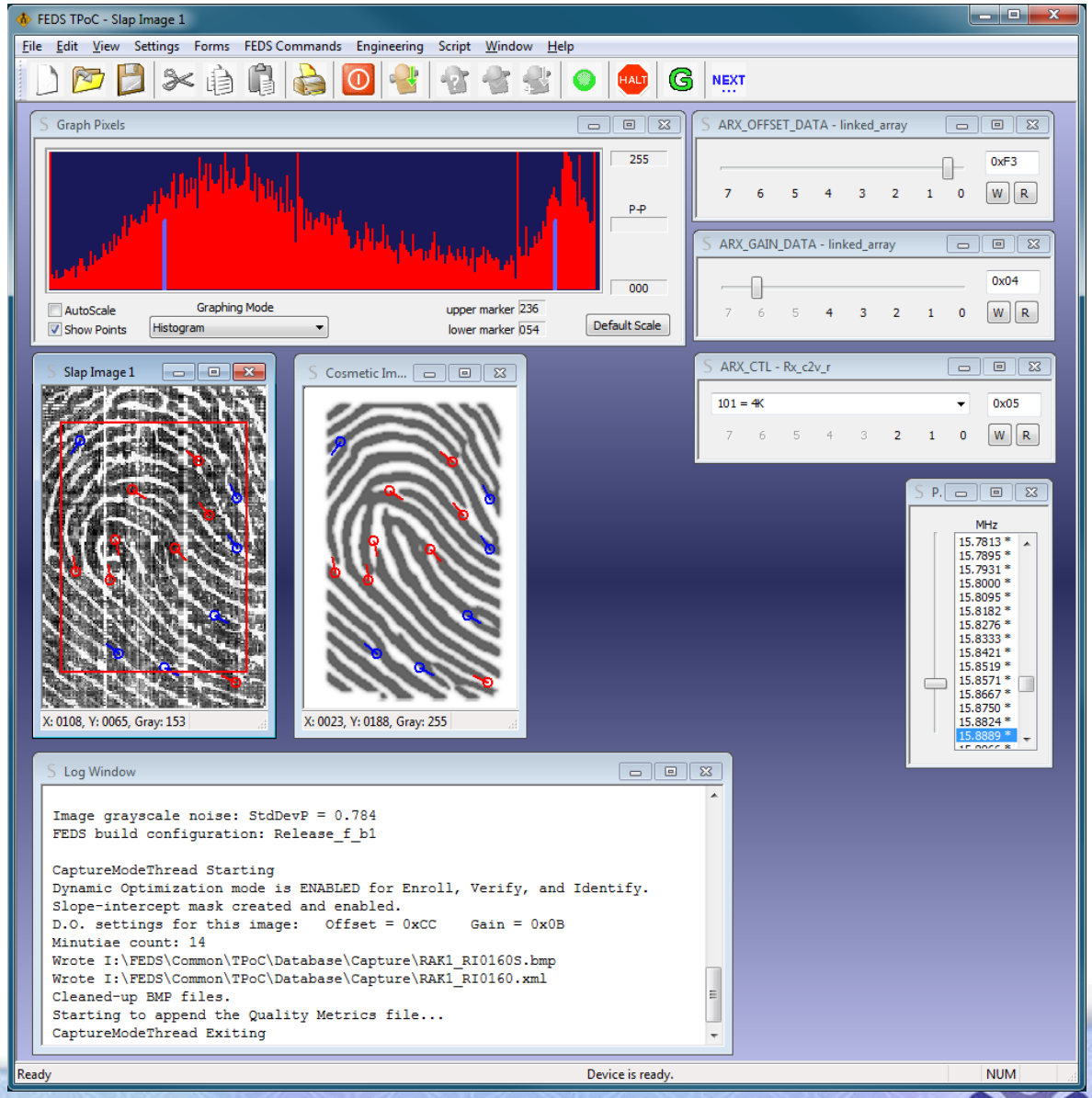
Interactive Sensor Test Platform



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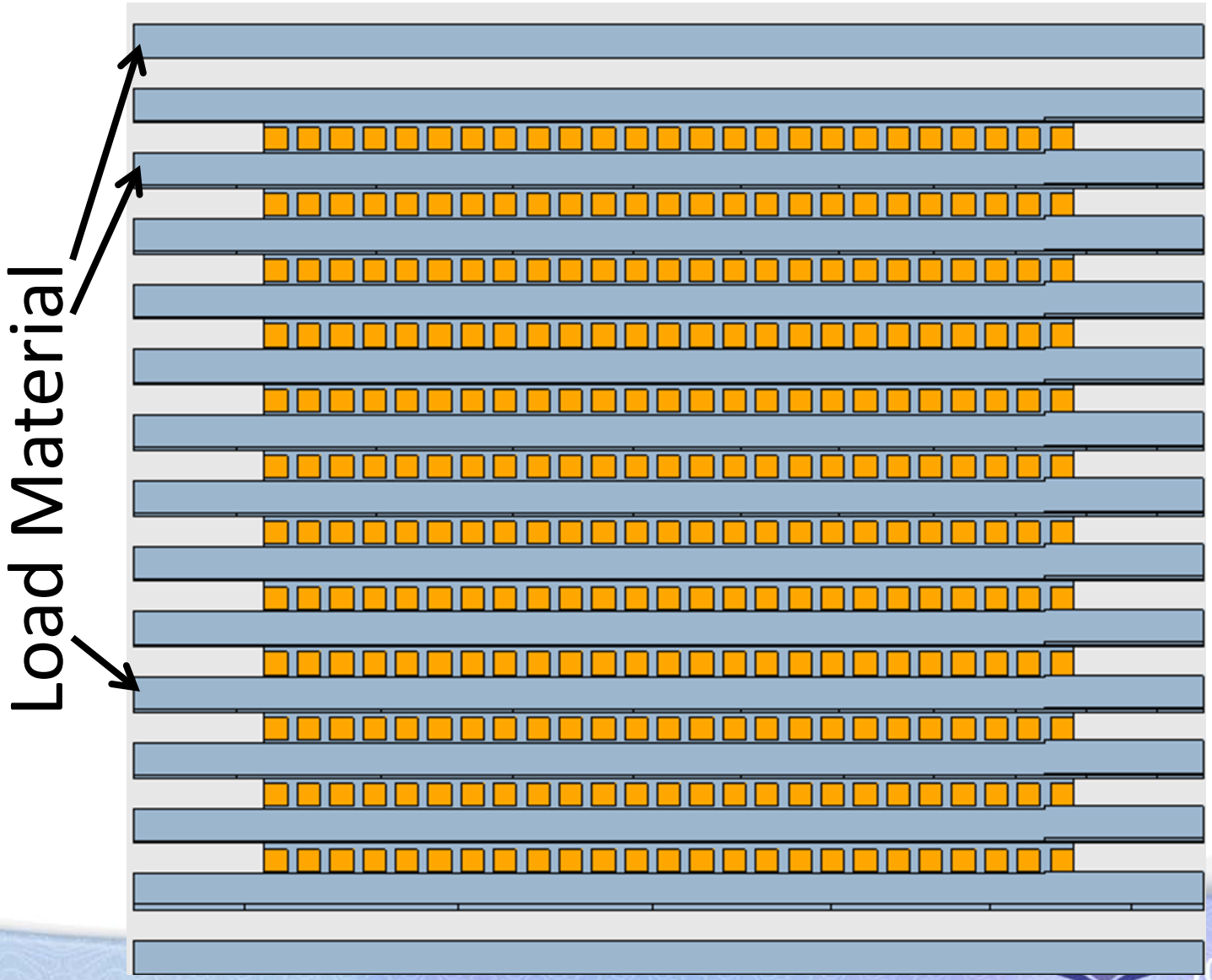
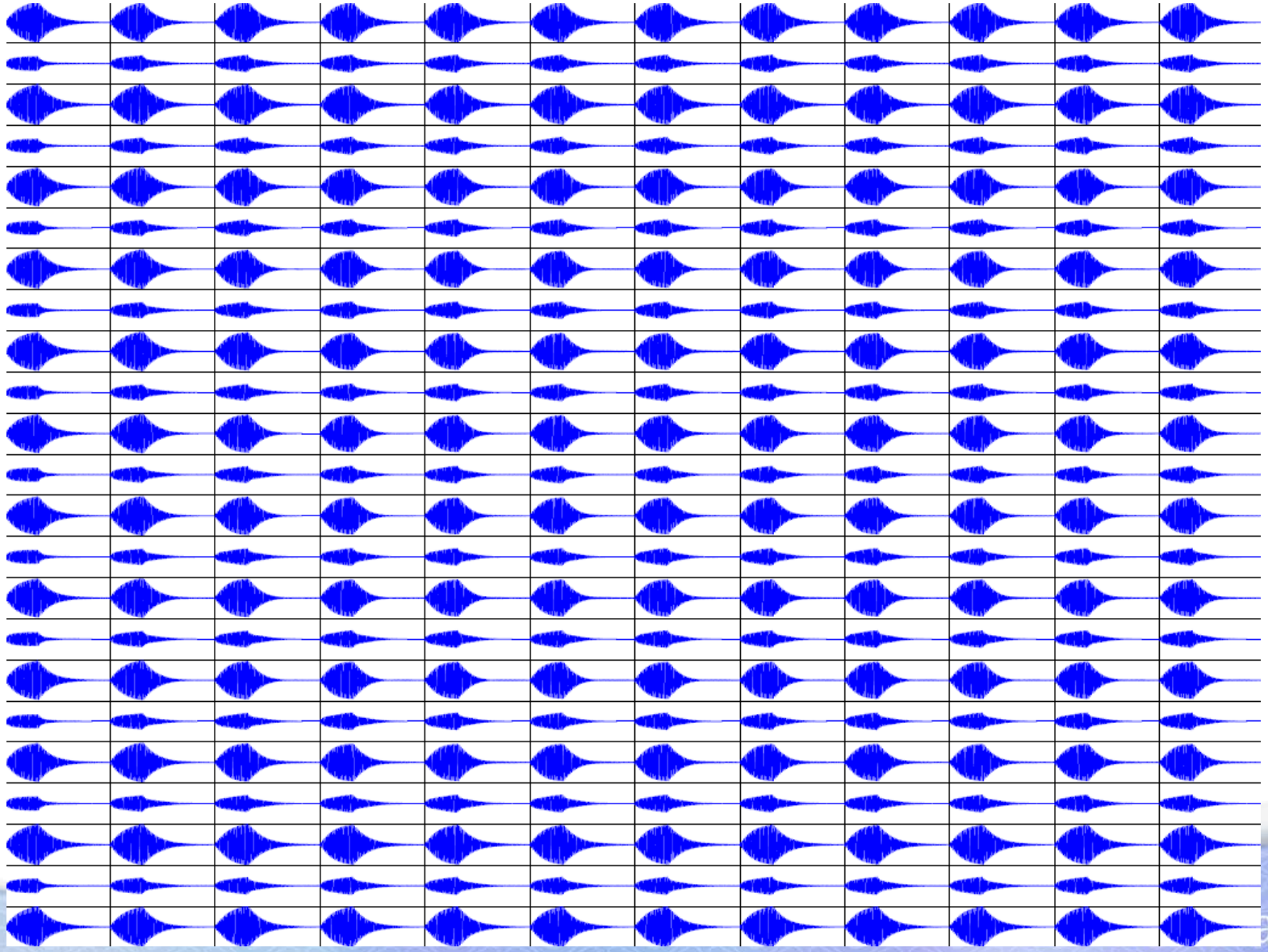
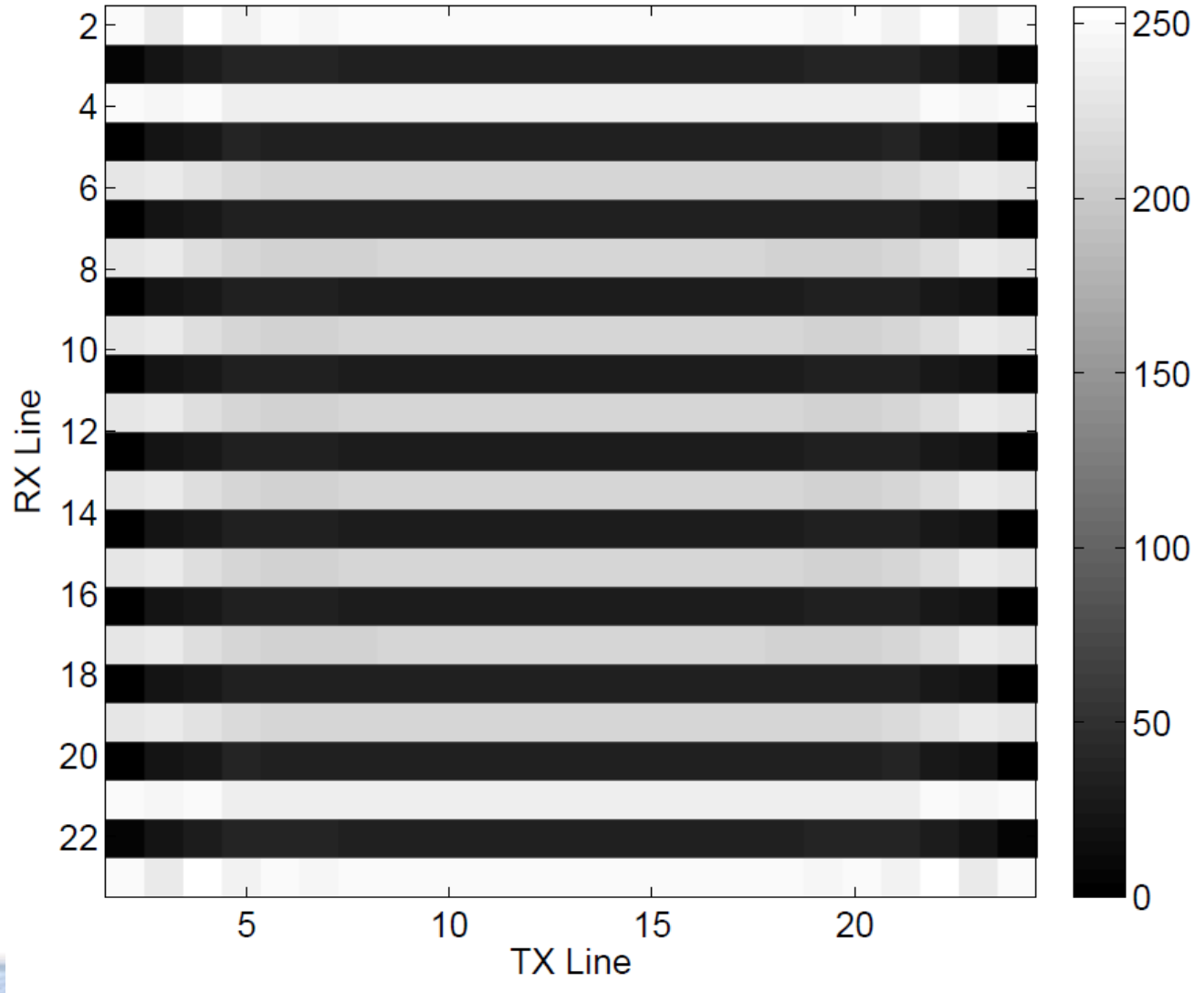
Spatial Resolution



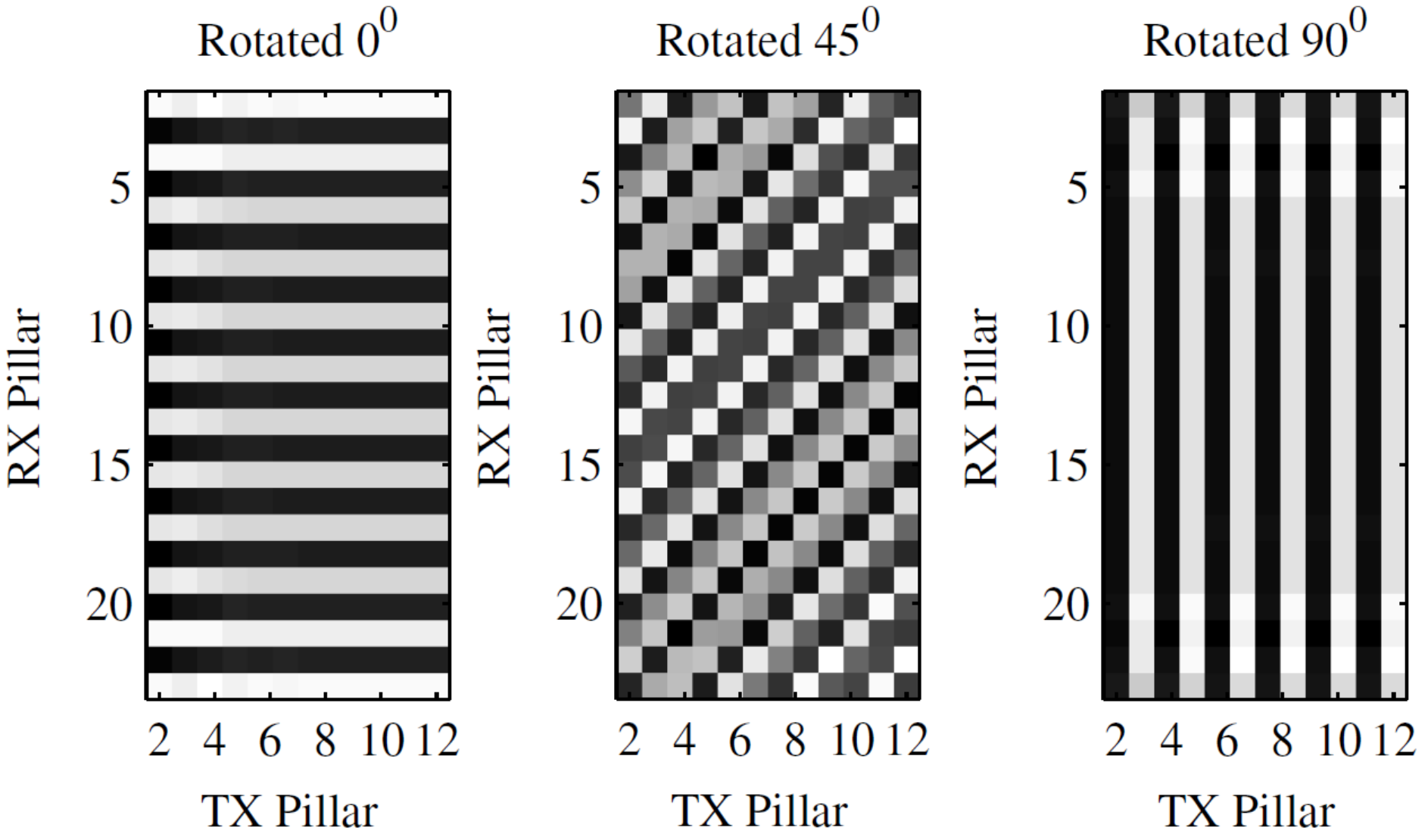
Modeled Ridges and Valleys



Result for 500 dpi Resolution Phantom

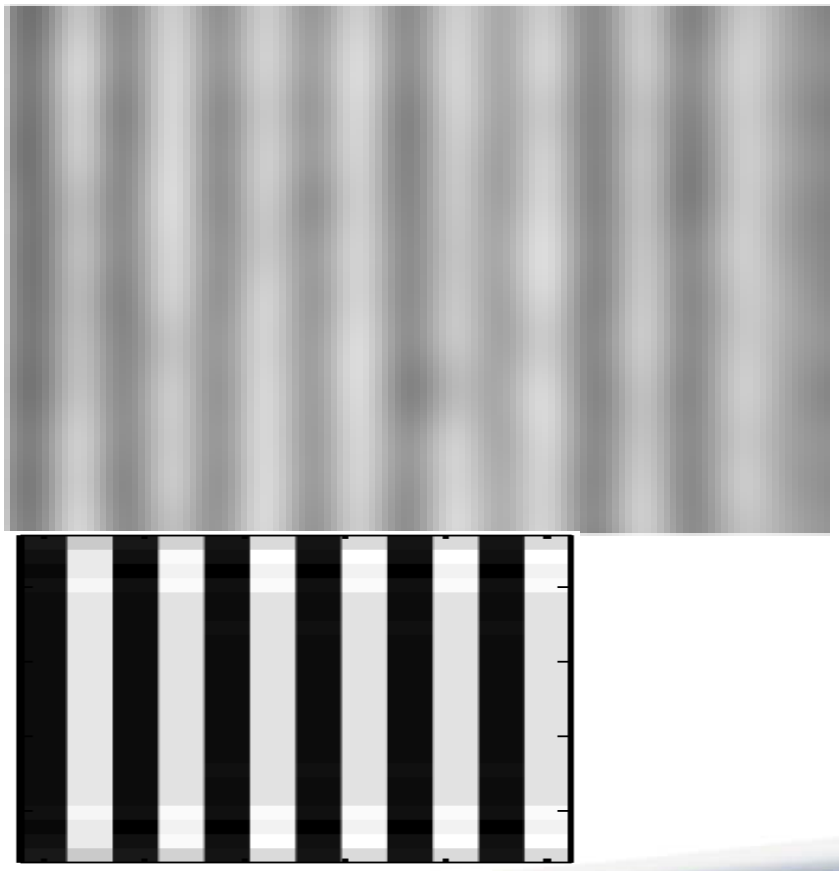


Modeled Phantoms



Comparison Optic Versus Acoustic

Measured Resolution
Resolution phantom: 10 cycl/mm



Navigation

Navigation is simply obtained by selecting a smaller center fingerprint and apply a 2-d cross-correlation between consecutive images to estimate in which direction the pattern has moved.

Conclusion

- The 1-3 piezo composite based acoustic fingerprint technology is proven to provide a robust, high-resolution and low cost sensor. The low thickness (< 300 um total) and the flexibility allows integration into many mobile devices and even smart cards.