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Title
MEMS Piezoelectric Energy Harvesting From Ambient Vibrations

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MEMS piezoelectric energy harvesting from ambient vibrations

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Vision

Ubiquitous wireless sensor networks have extraordinary potential for use in applications such as demand response, environmental and manufacturing monitoring, & medical devices. Realization of these networks for wide-spread use requires that sensor nodes be low-cost, non-intrusive, & maintenance free. A micro-scale energy harvester addresses these needs by harnessing environmental vibrations to provide a replenishable source of power for the sensor node while reducing the volume of the power generator.
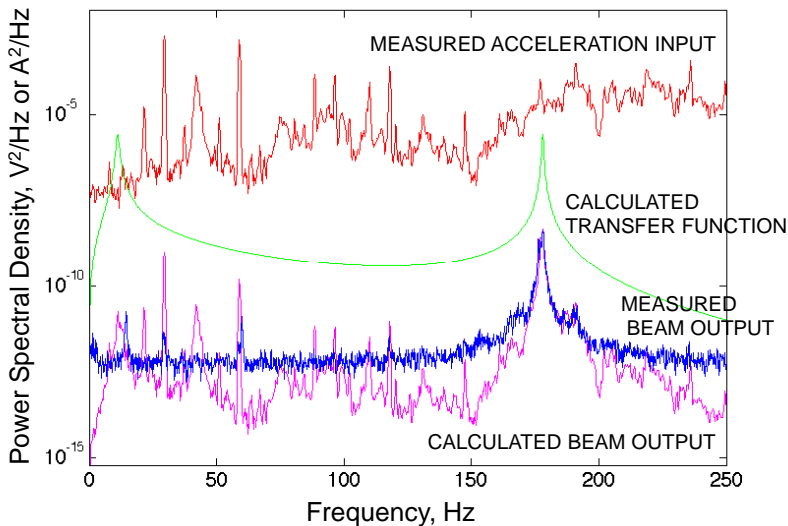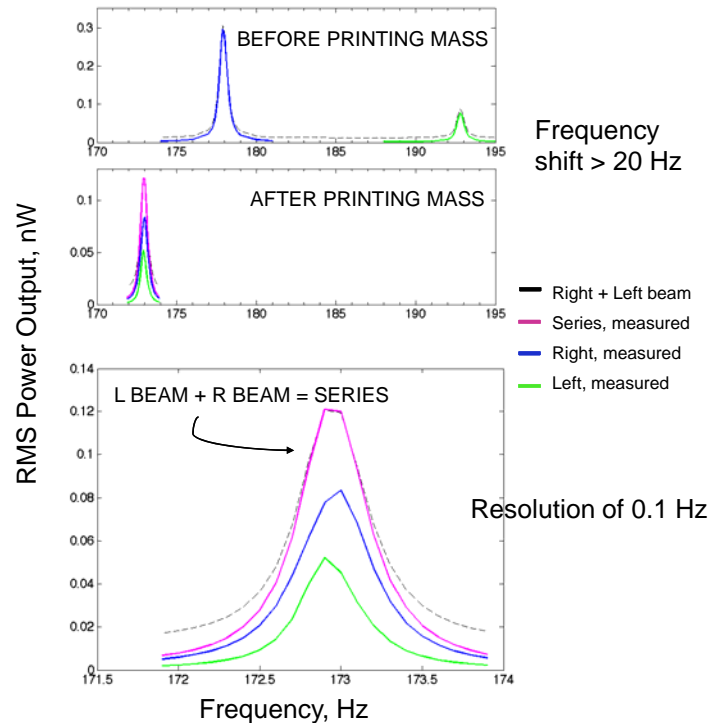
Ambient vibrations

1.3 cm
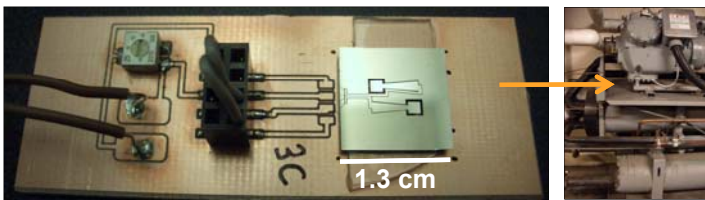
Printed proof mass

2.5 mm   1.5 mm
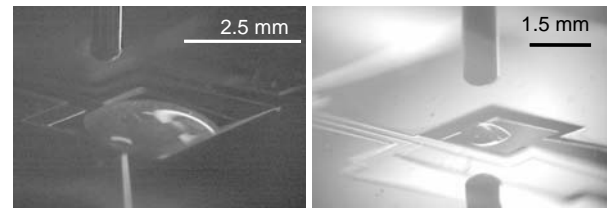
**Power Spectral Density vs Frequency.
Ambient vibration source: compressor.**

MEASURED ACCELERATION INPUT

CALCULATED TRANSFER FUNCTION

MEASURED BEAM OUTPUT

CALCULATED BEAM OUTPUT

Power Spectral Density, V^2/Hz or A^2/Hz

Frequency, Hz

Tested 9 beams on 7 ambient sources:
P_{rms} = 1 pW/beam - 1 nW/beam (ambient vibration input).
Model: measured accel. input → predicted beam output.

RMS Power Output vs Frequency

BEFORE PRINTING MASS

AFTER PRINTING MASS

L BEAM + R BEAM = SERIES

RMS Power Output, nW

Frequency, Hz

Frequency shift > 20 Hz

Resolution of 0.1 Hz

- Right + Left beam
- Series, measured
- Right, measured
- Left, measured

Beam signals add if connected in series.

Next steps

Use model to redesign & optimize harvester for use with ambient input vibrations (goal: P_{rms} = 1 µW).
Fabricate & test next generation harvester.
Integrate with power conditioning and other components.