Passive MEMS Current Sensing

Fall 2010 Status Update

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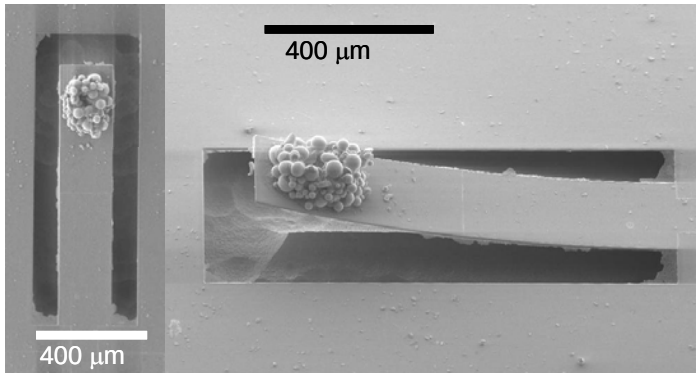
September 14, 2010

Key Takeaways

- New apparatus and testing instrumentation developed for characterization of 1st gen. MEMS sensors.
- Exhaustive device testing now possible, enabling better characterization of 1st gen sensors and better design of 2nd generation.

Outline

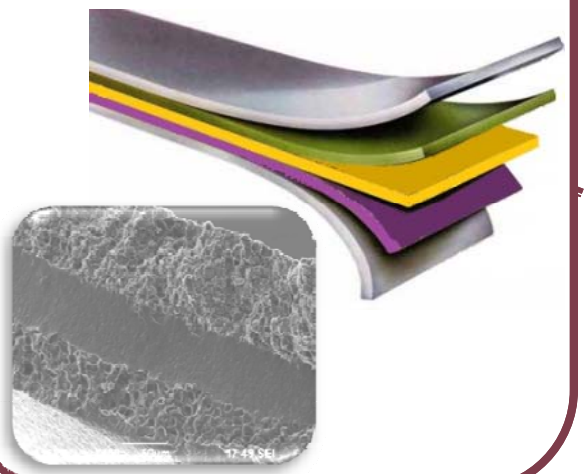
- Overview
  - System on a chip
  - Some background on current sensing
  - Significance of the technology being developed
- Project history
  - Development
  - Status as of last update
- Recent developments
  - System advances
  - New results
- Planned work



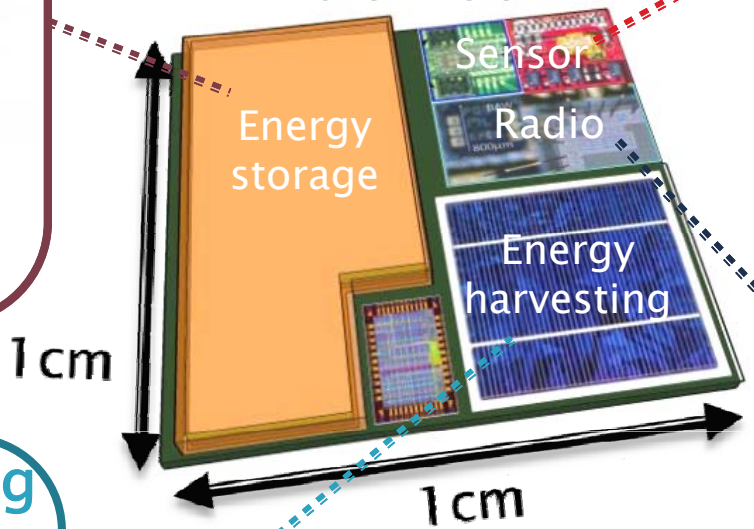
Courtesy of E. S. Leland

System on a Chip

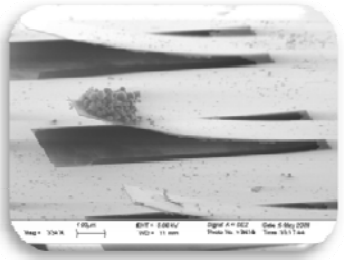
Energy Storage

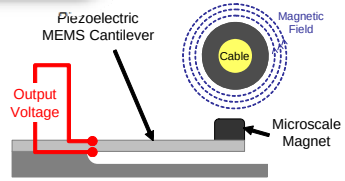


Wireless Sensor Micro-device

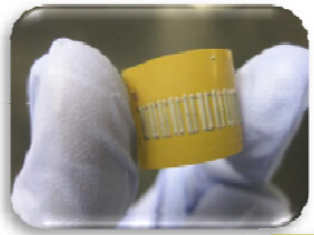


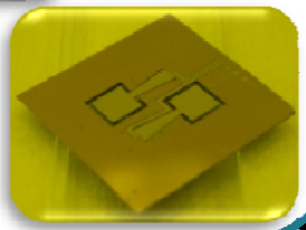
MEMS Sensor



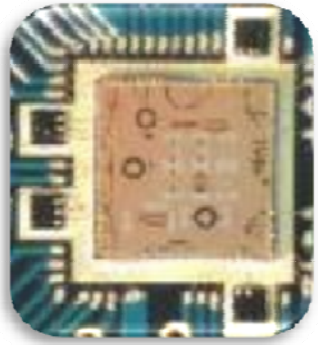


Energy Harvesting





Radio

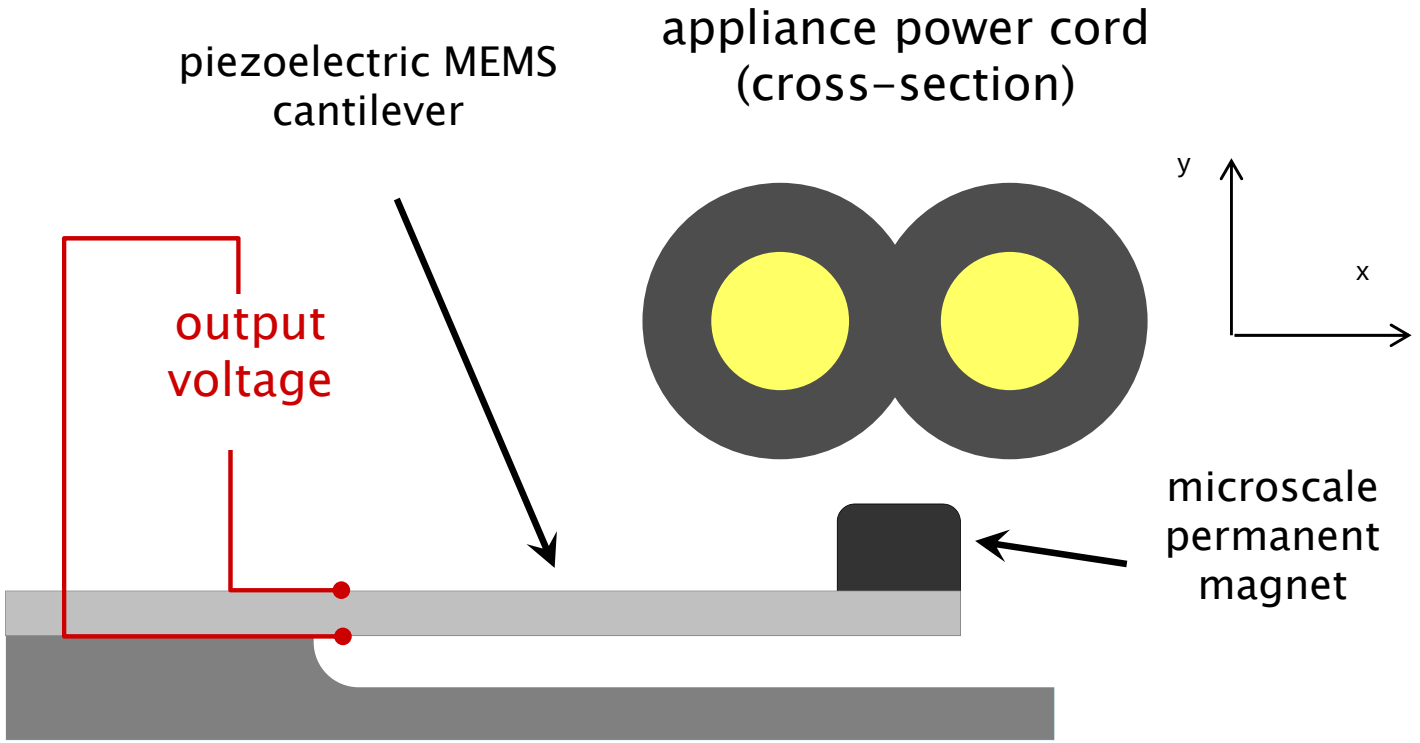


Current Sensing: Background

- Better grid data key to understanding power flow.
- Traditional sensor techniques
  - Series resistor.
  - Current transformer coils

A traditional current transformer on a wire.

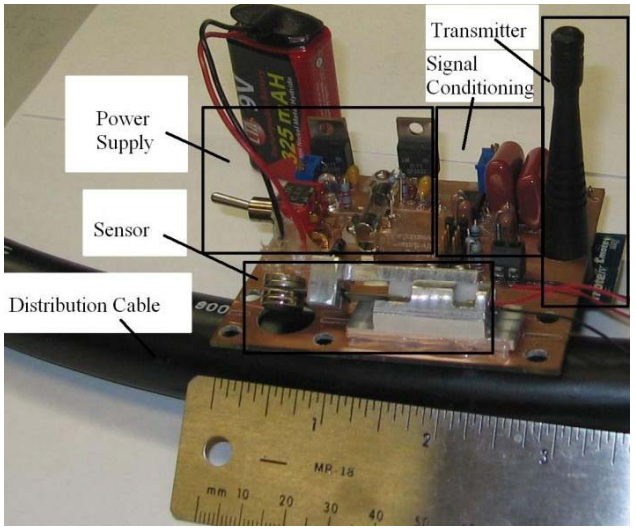
Passive Proximity-Based Current Sensing



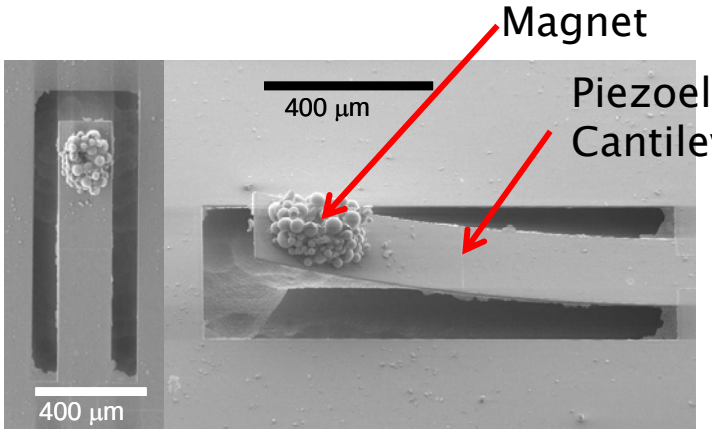
- Methodology
- Benefits

A Brief Development History

- Initial concept development 2006–2009
- Extensive verification 2008–2009.
- First working MEMS 2009.



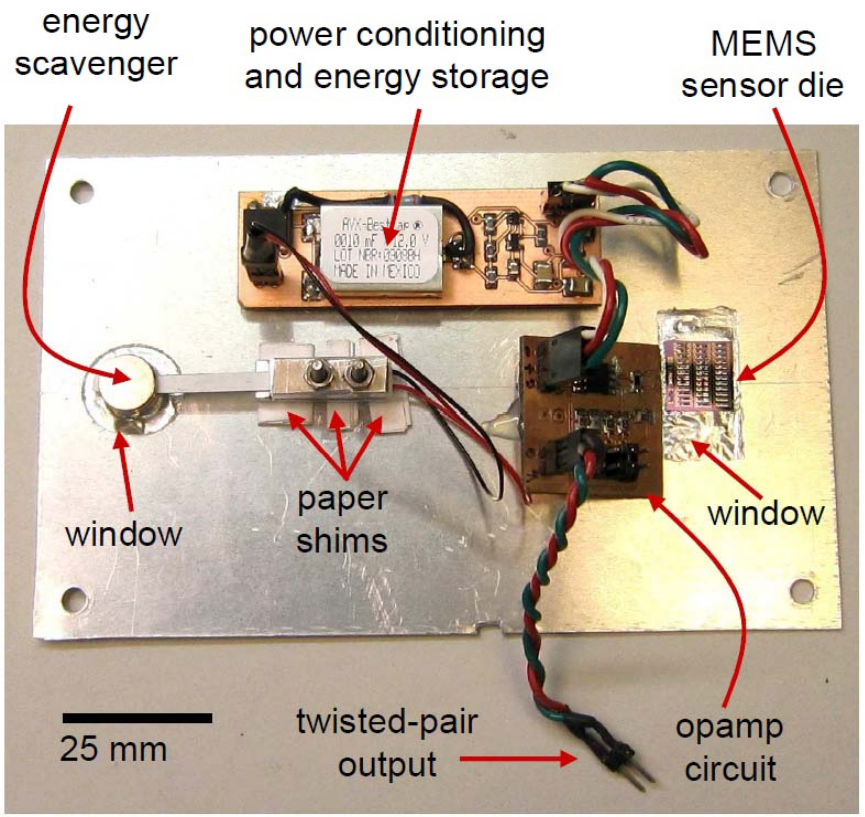
A meso-scale sensor package on a distribution-type cable.



A 1st-gen. MEMS Current Sensor

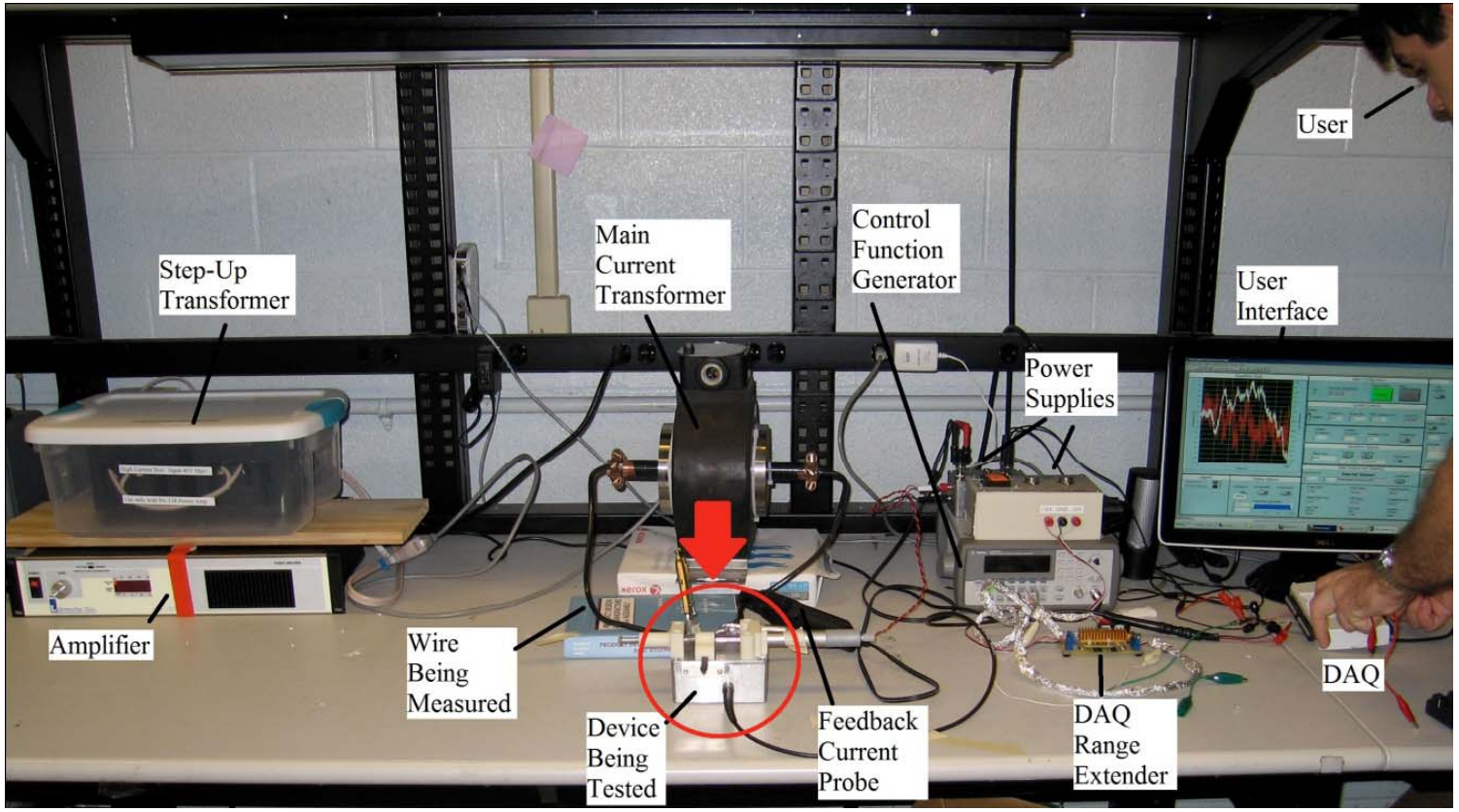
Status as of Last Update

- Initial prototype using MEMS sensor constructed and tested.
- Range of experiments limited due to apparatus.
- Limited number of sensors tested due to system layout.



First-generation experimental apparatus (from E.S. Leland thesis).

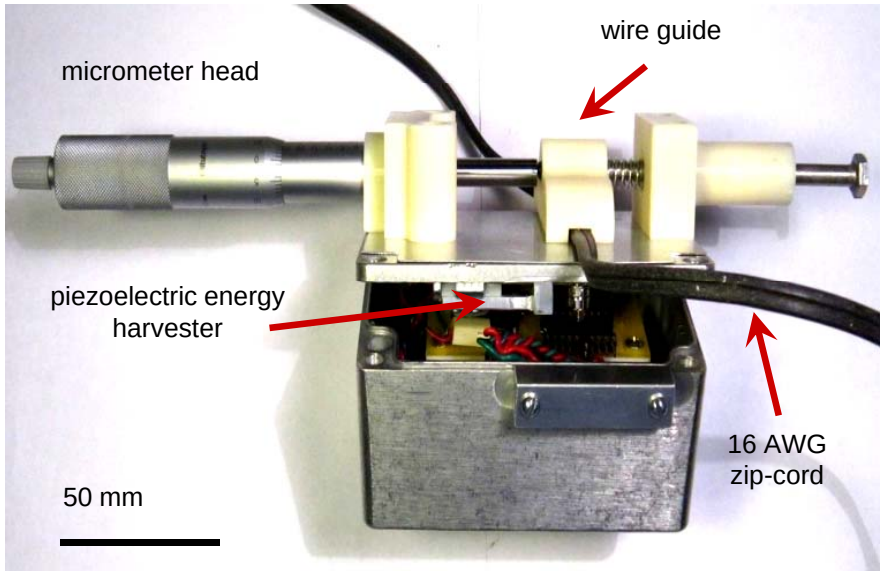
What's New: Supporting Instrumentation

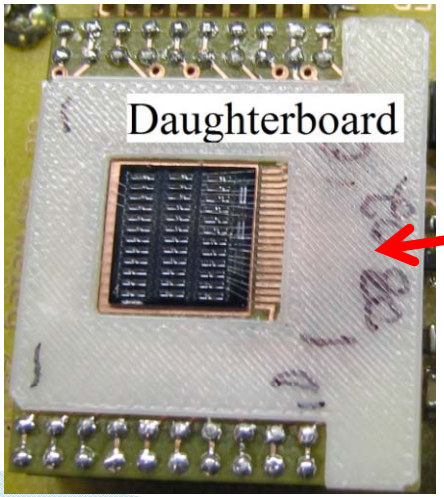


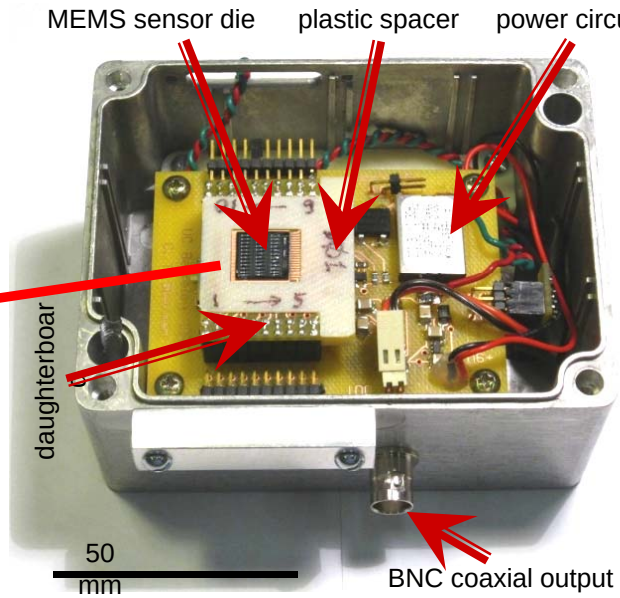
- Extended-range testing apparatus.
- Automated control and logging.
- Allows for exhaustive sensor testing.

What's New: Improved Test System

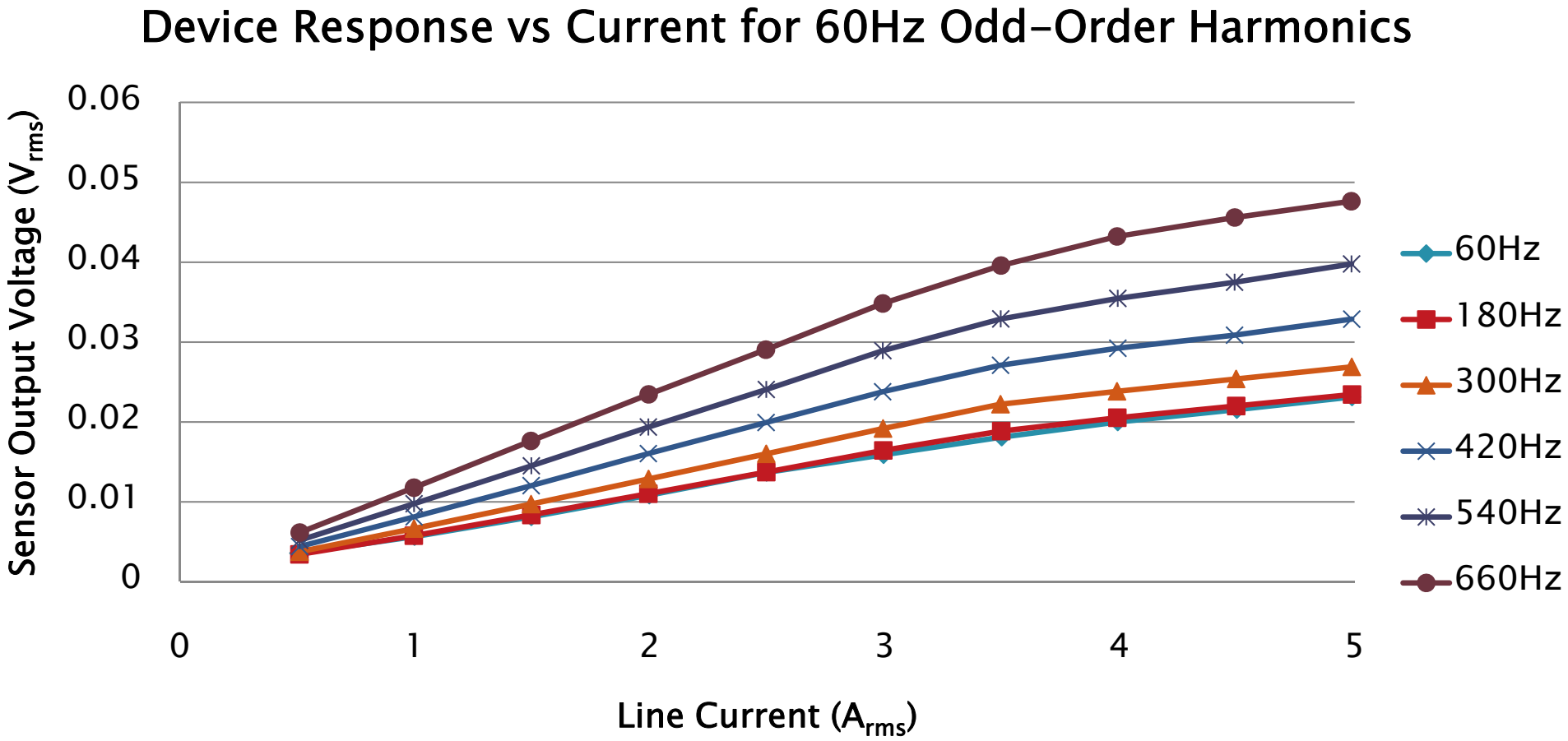
- Supporting circuitry completely redesigned
- Sensor mounting redone





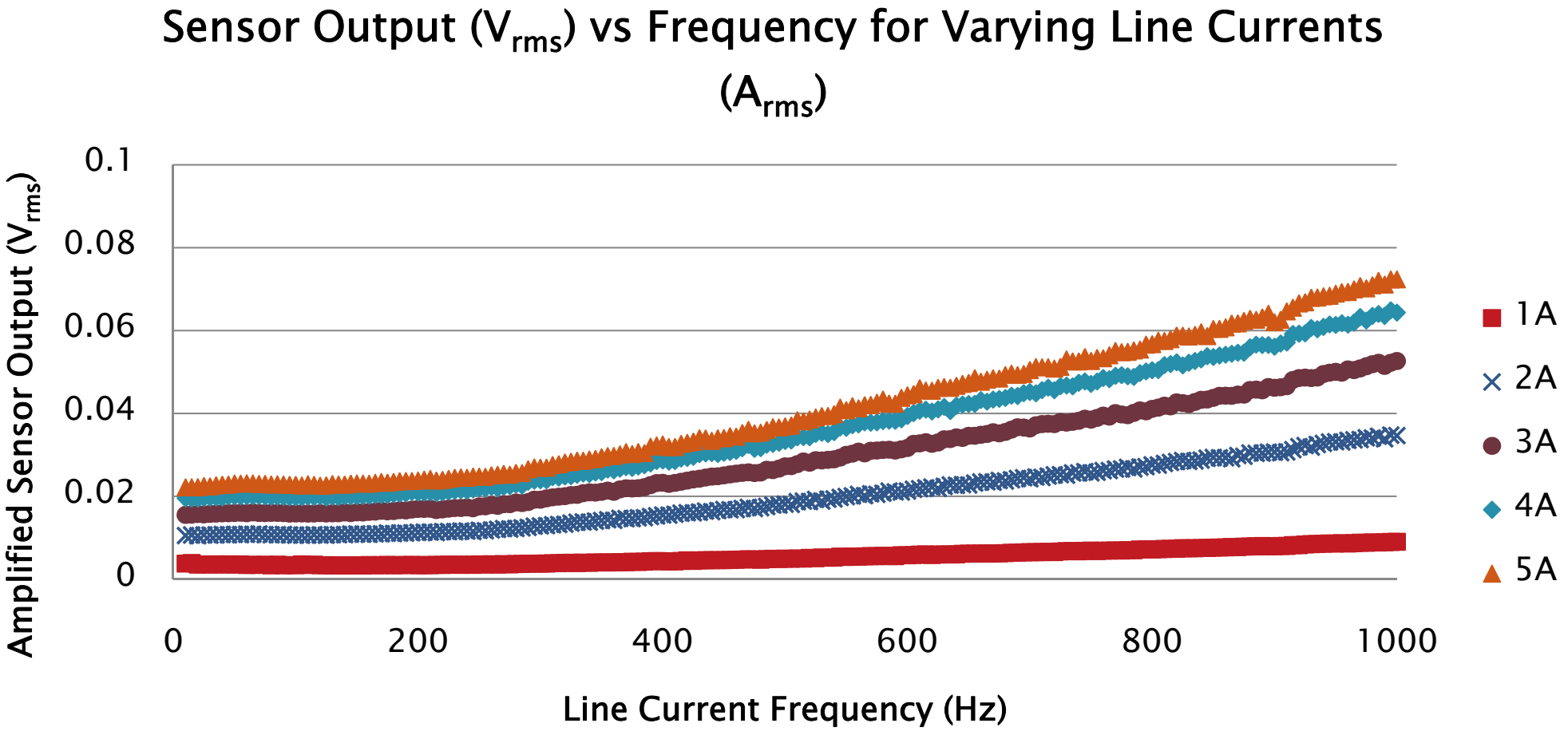


What's Brand New: Results of the First Exhaustive Testing Session



Power quality odd harmonic results from frequency sweep.

First Extensive Session, Continued



Sensor output vs. line frequency showing development of nonlinearities.

What's Next – Short Term

- In the next few weeks, remaining sensors will be tested.
- Additionally, specially-fabricated micro-scale magnets have been ordered for further sensor testing.

What's Next – Longer Term

- Optimization (Fall/Winter 2010).
  - Individual sensor components will be run through optimization analysis to maximize output.
  - Results of individual optimization will be used to model multiple devices together to effect a self-calibrating system of devices.
- Fabrication (2011) – 2nd gen. devices will be produced in Berkeley Micro/Nanolab
- Device testing – further out. Comparison of 2nd gen. to 1st gen. devices.

Summary

- New apparatus and testing instrumentation developed for characterization of 1st gen. MEMS sensors.
- Exhaustive device testing now possible, enabling better characterization of 1st gen sensors and better design of 2nd generation.
- This testing has already begun and will continue over the next few weeks.

Thank You. Questions?