

# Further Development in Nondestructive Methods to Gauge Life Expectancy in Ferromagnetic Components

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Pacific Northwest NATIONAL LABORATORY

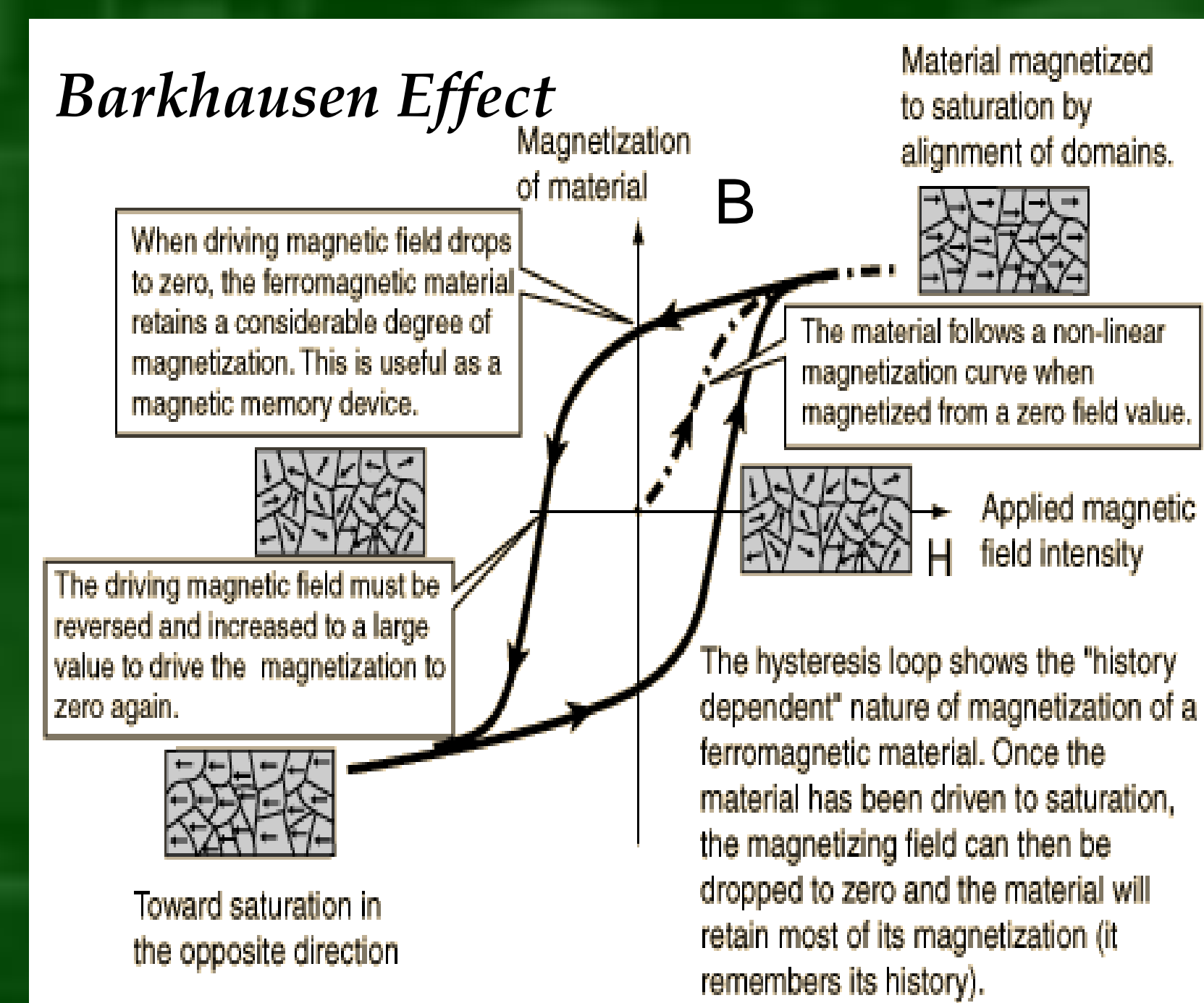
Proudly Operated by Battelle Since 1965

## Introduction

- Nuclear power plant components experience high stresses under extended life operations.
  - Thermal
  - Mechanical
  - Irradiation
- Need to quantify material condition & remaining service life

## Nondestructive Methods

- Magnetic Barkhausen Noise
  - Sensitive to crystal defects & dislocations in ferretic steels



From: "Hysteresis Loop." *Hysteresis*. Classle Learning is Social. 28.05.2009. Web. 1 Aug 2012. <<https://www.classle.net/book/hysteresis>>.

- Sources of measurement uncertainty
  - Magnetic direction (relative to strain direction)
  - Probe coupling
  - Measurement location

## Methods

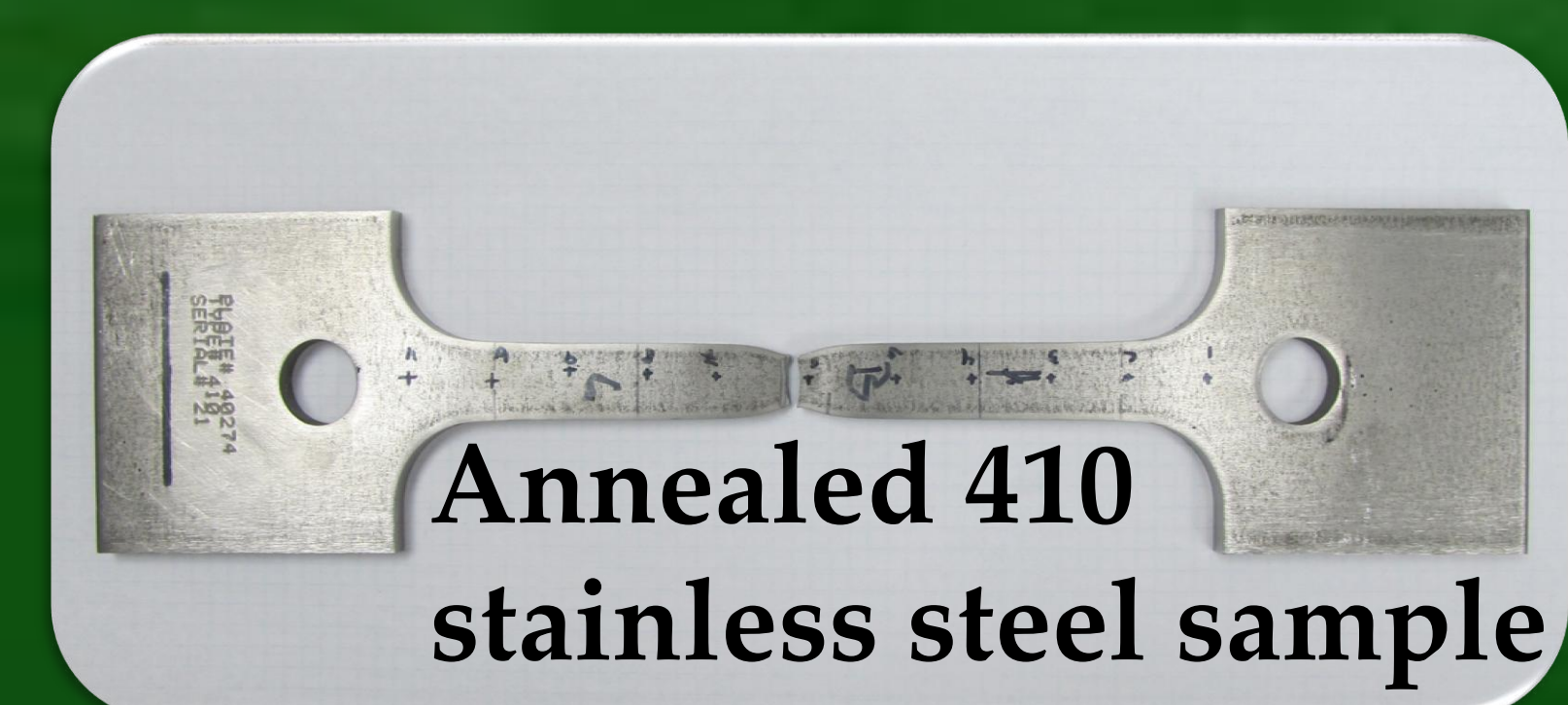
### Barkhausen Measurements Setup



Microscan 600 & Rollscan 300



Barkhausen Sensor



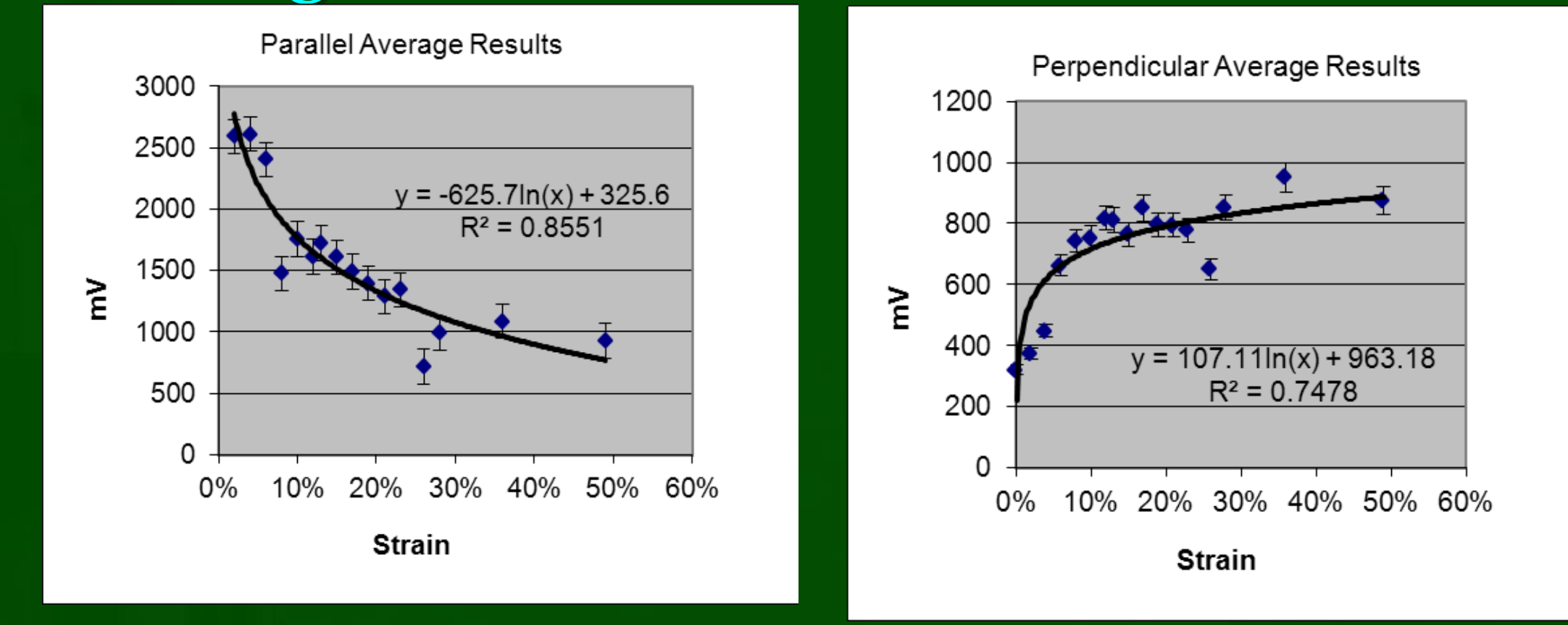
Annealed 410 stainless steel sample

### In-situ Measurement

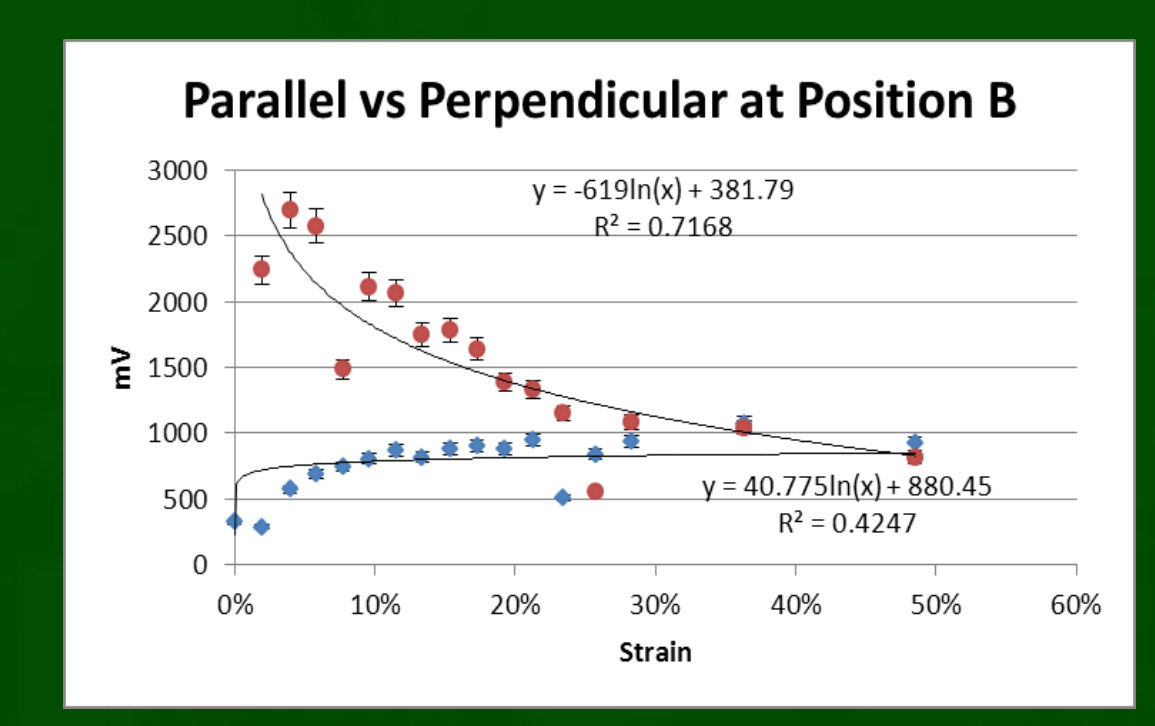
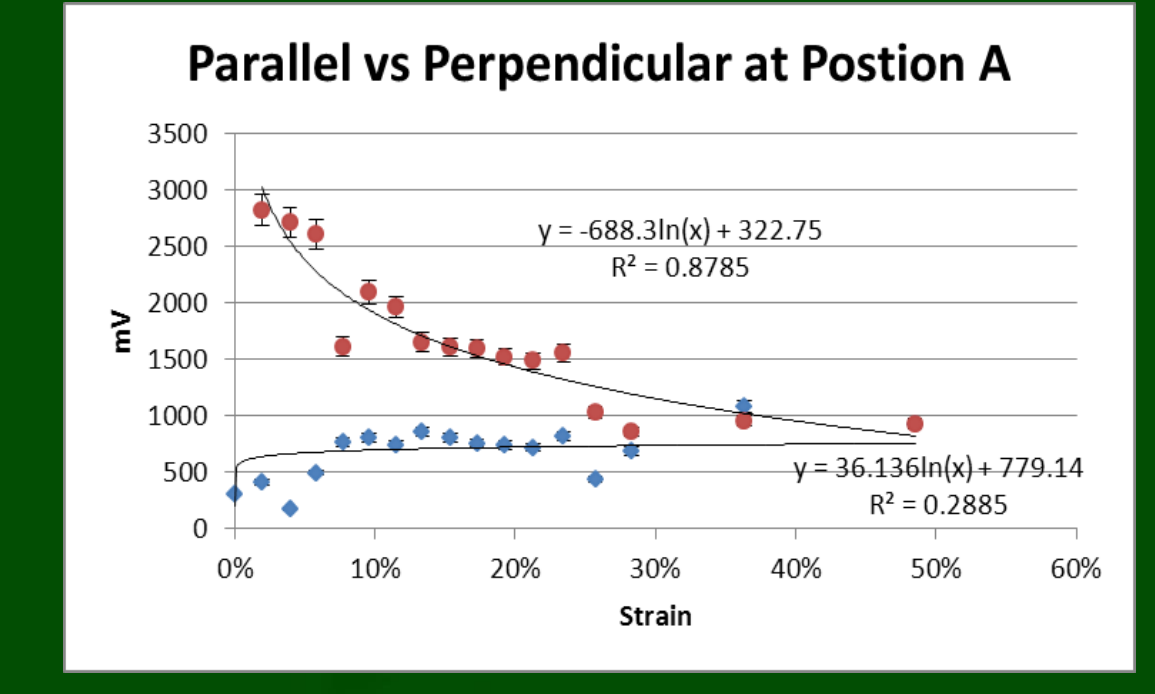
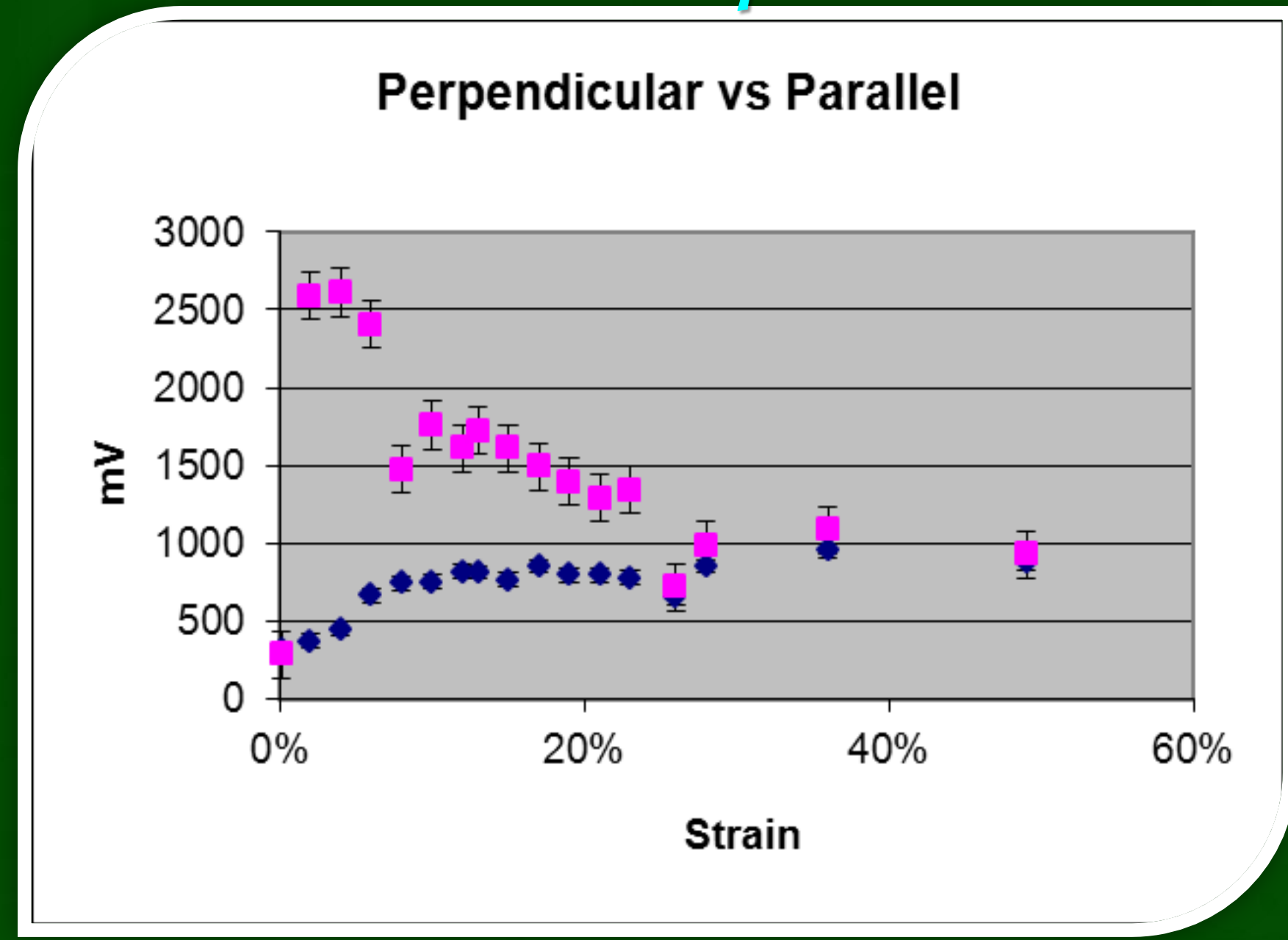


## Research and Results

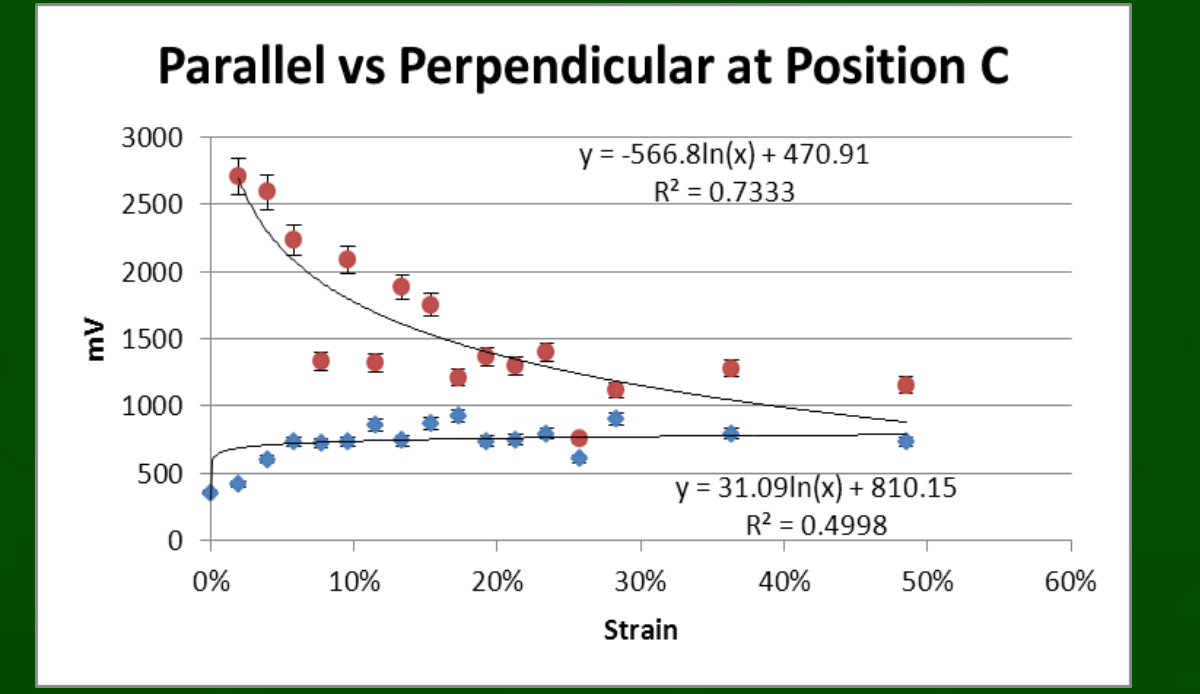
### Parallel vs Perpendicular Magnetization (relative to strain)



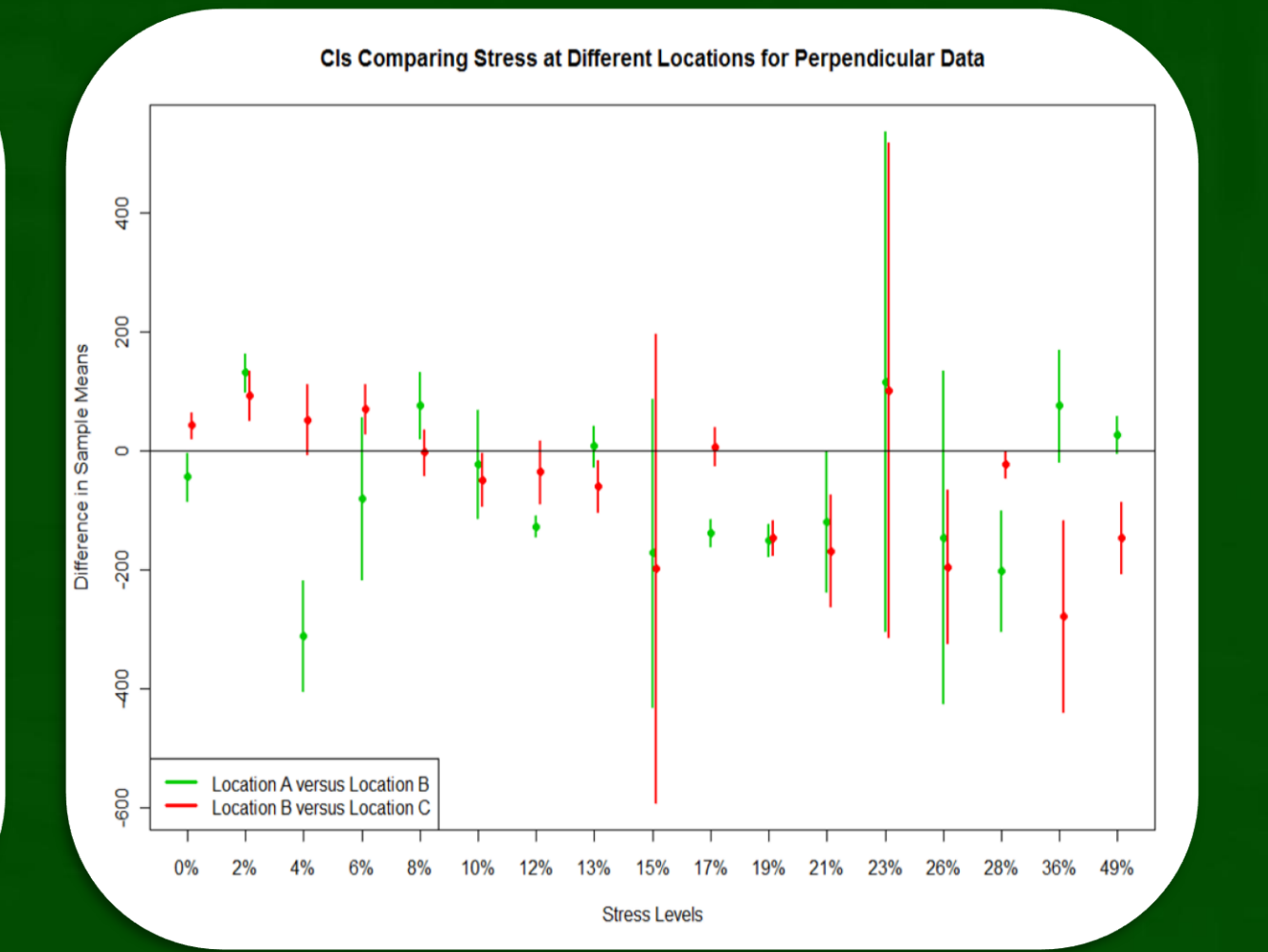
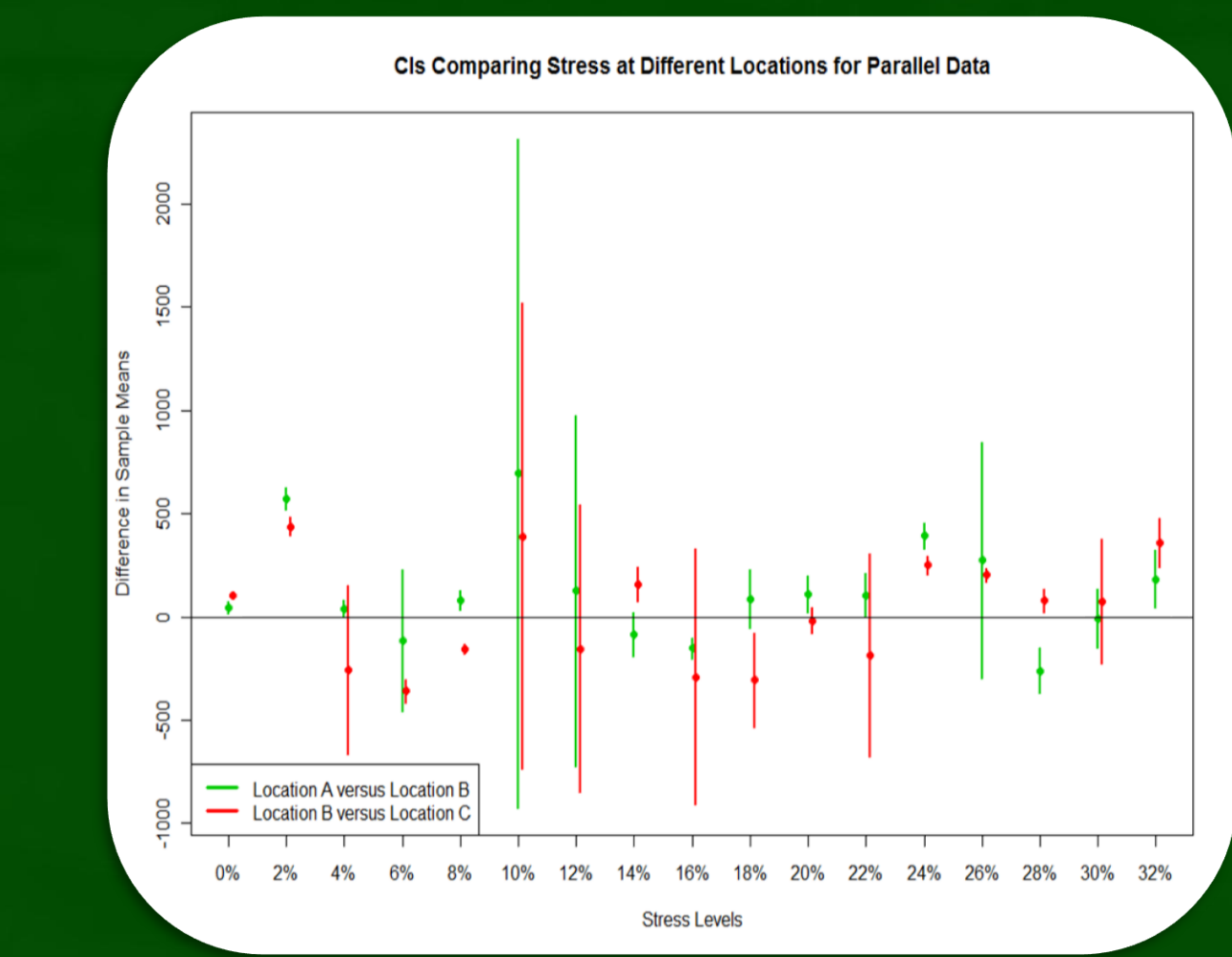
### Average Standard Deviation Parallel vs Perpendicular



### Parallel vs Perpendicular Magnetization (relative to strain and position)



### Measurement Difference (with Position) A - B C - B



## Future Research

- Quantify measurement uncertainty due to Barkhausen noise measurement
- Identify measurement features for better correlation with damage

References:

(1) Levine, David, Mark Berenson, and David Stephan. *Statistics for Managers Using Microsoft Excel*. Updated. Upper Saddle River, New Jersey: Simon & Schuster, 1998. 449-477. Print.

(2) Stark, Henry, and John Woods. *Probability, Random Processes, and Estimation Theory for Engineers*. 2nd Edition. Englewood Cliffs, New Jersey: Paramount Communications, 1994. 122-140. Print.

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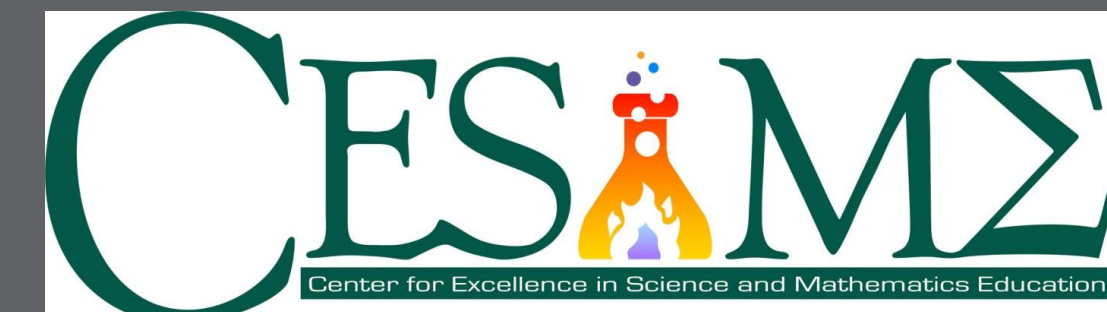
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