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Development of Eddy Current Probe using FEM for Matte Level Detection in Pyrometallurgical Furnaces

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COMSOL
CONFERENCE
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Outline

- Overview
- Eddy current testing
- COMSOL model
- Experimental validation
- Summary

Introduction



- Determine when to tap excess matte
- Better understanding of melt times

Common practice

- Sounding Bar
 - Low accuracy
 - Human interpretation
 - Not continuous
 - Furnace shutdown
 - Safety concerns
 - Inconsistent reproducibility



Figure: Sounding bar at Vale

Eddy current NDT

- Matte/slag = conductive/non-conductive interface

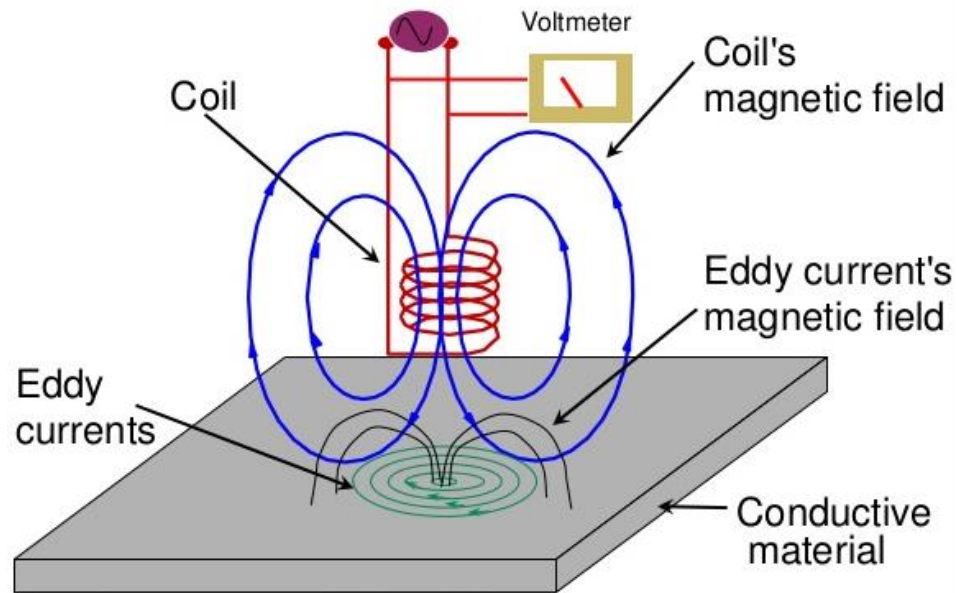


Figure: Eddy Current System

Challenges

- Sensor location
- Refractory erosion
- High temperature
- Remote detection
- Metal shielding
- Background noise

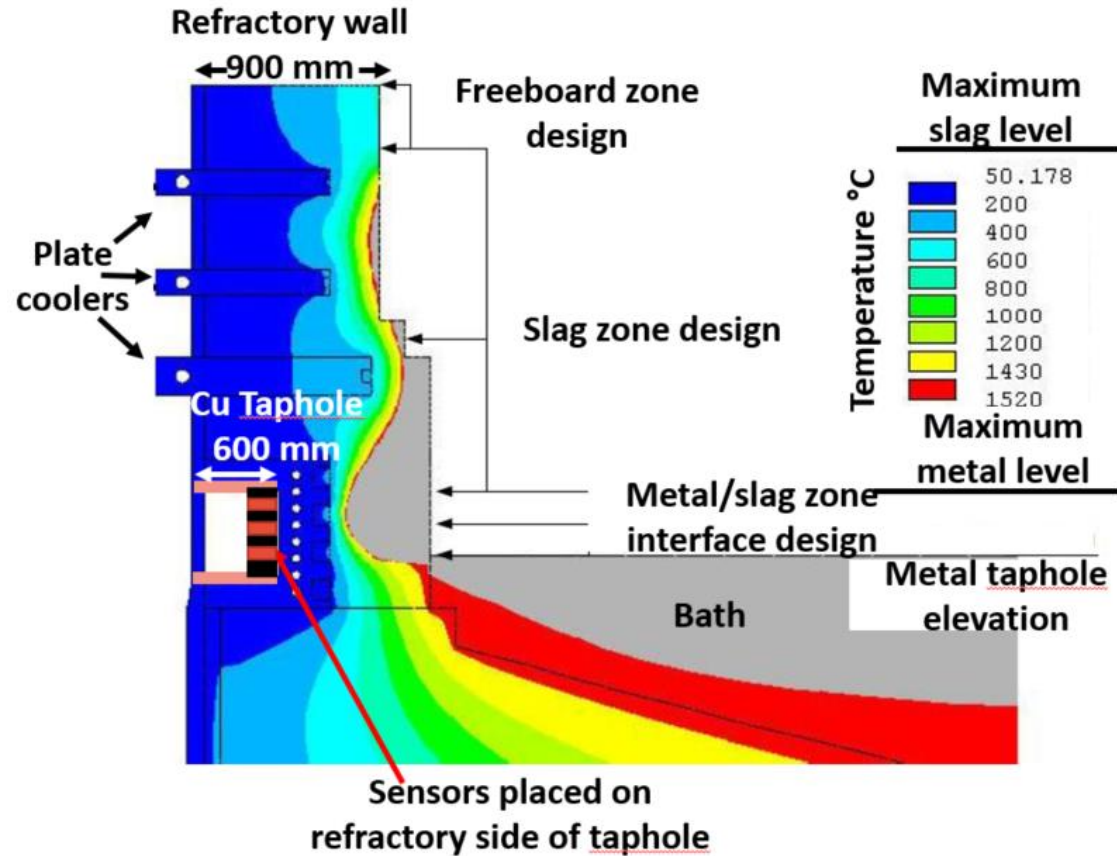
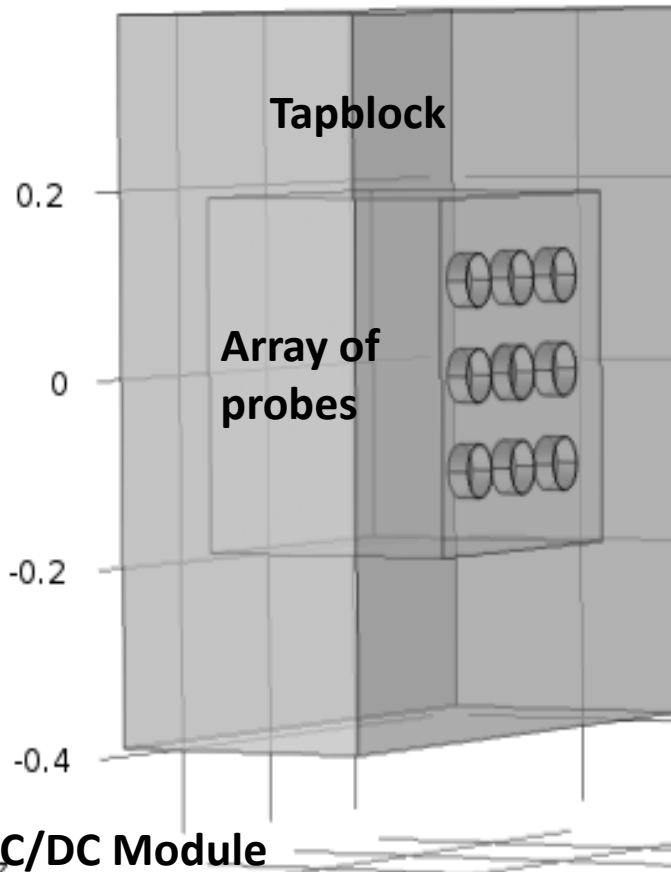


Figure: EAF Thermal Profile

Sidewall embedded sensor



AC/DC Module
COMSOL Multiphysics 5.3

Figure: Modelled Tapblock Setup

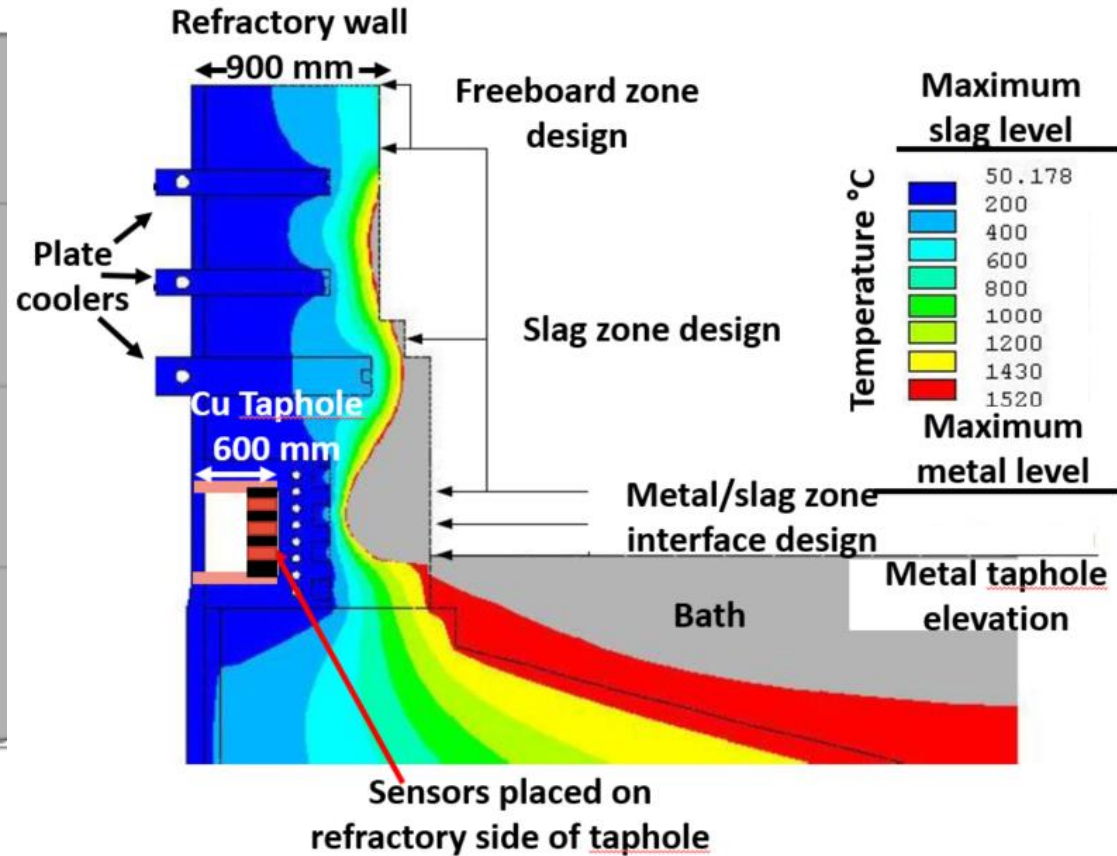


Figure: Proposed Tapblock Setup

Tapblock design

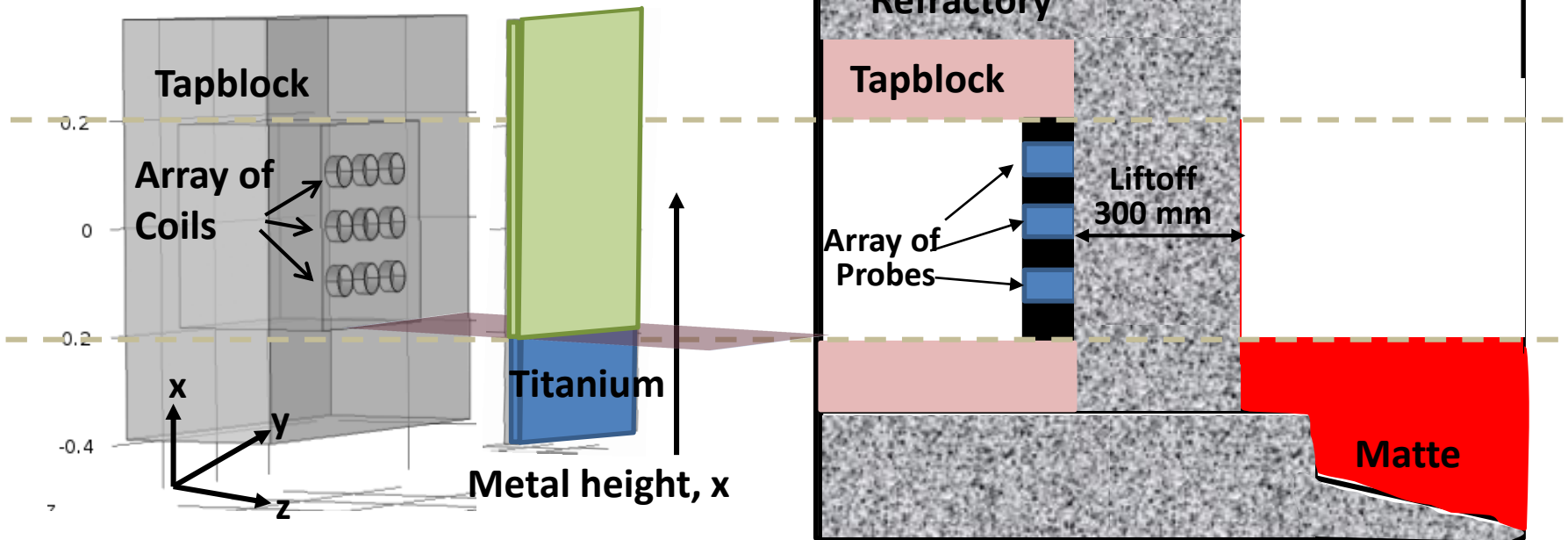


Figure: Modelled tapblock geometry

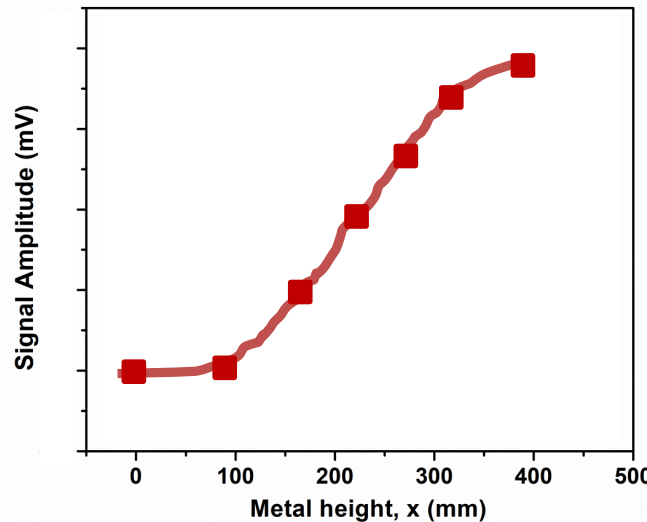
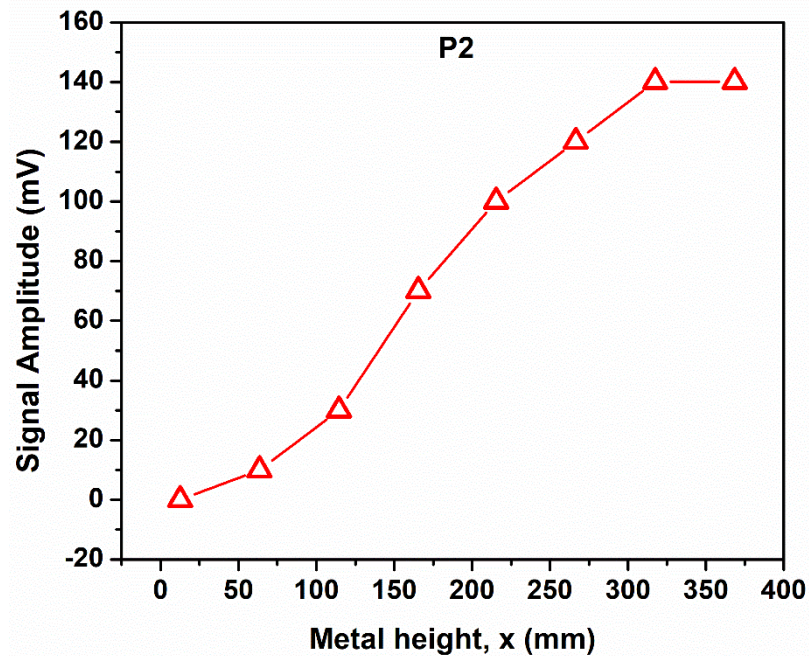
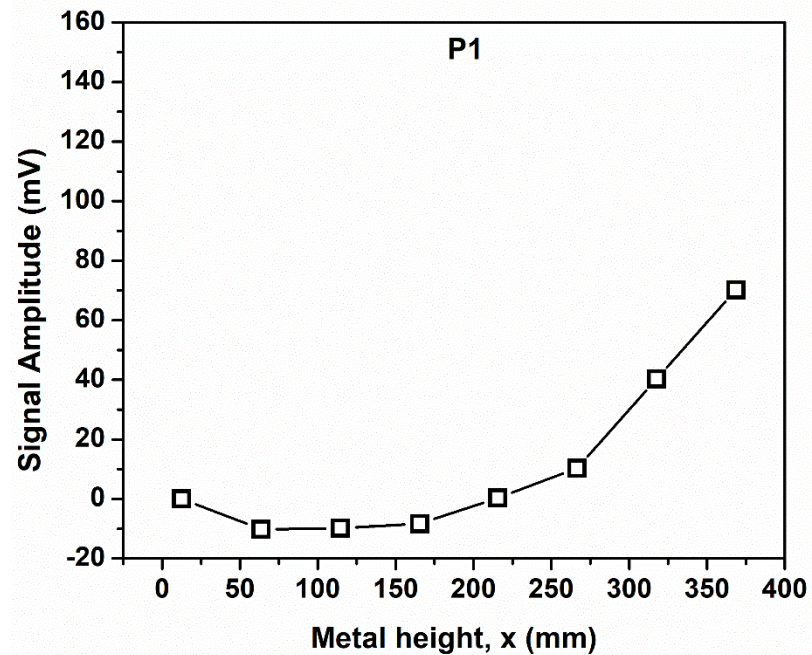
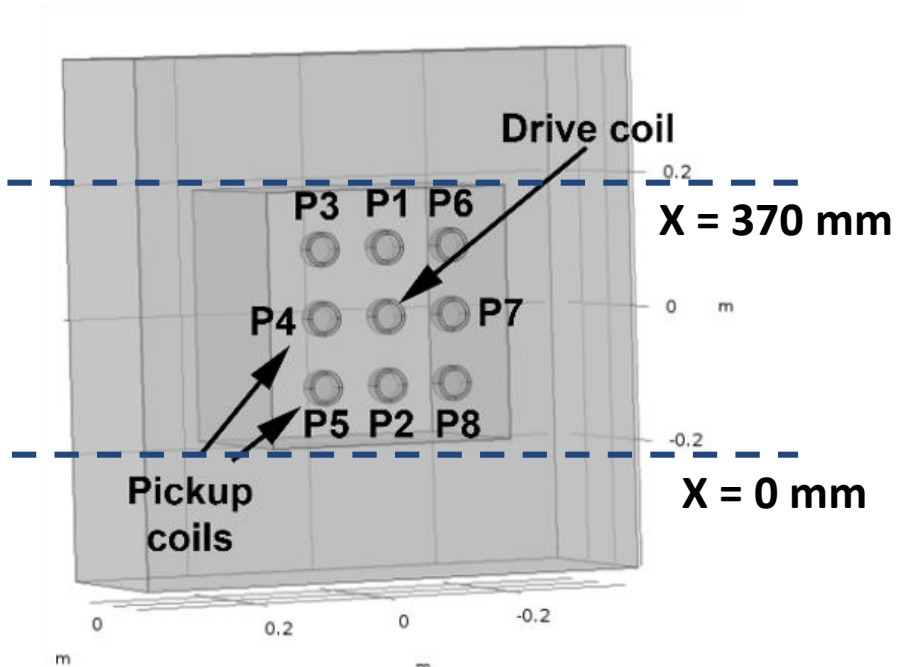


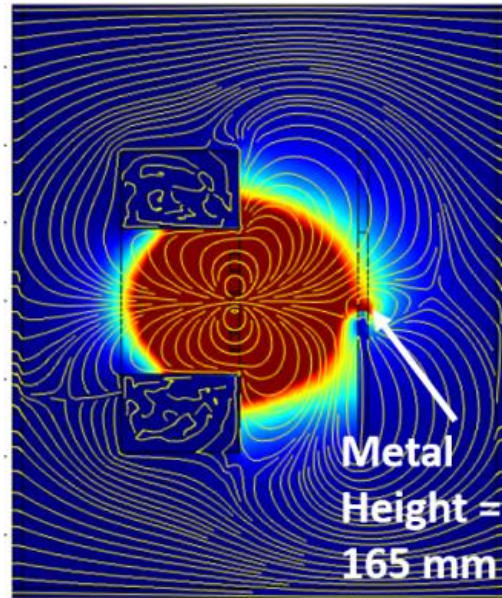
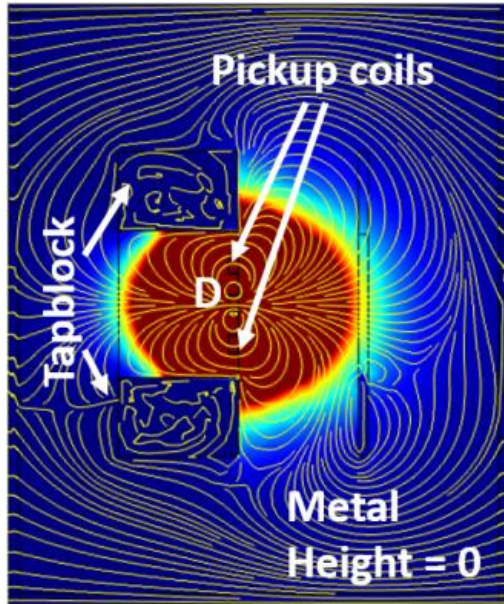
Figure: Output signal

Figure: Rising matte level in a furnace

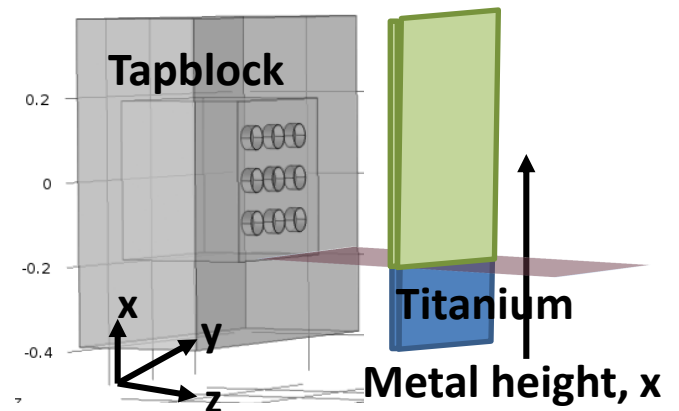
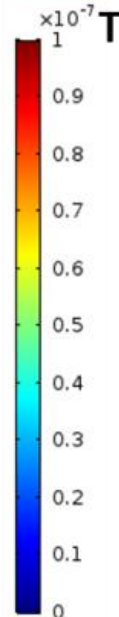
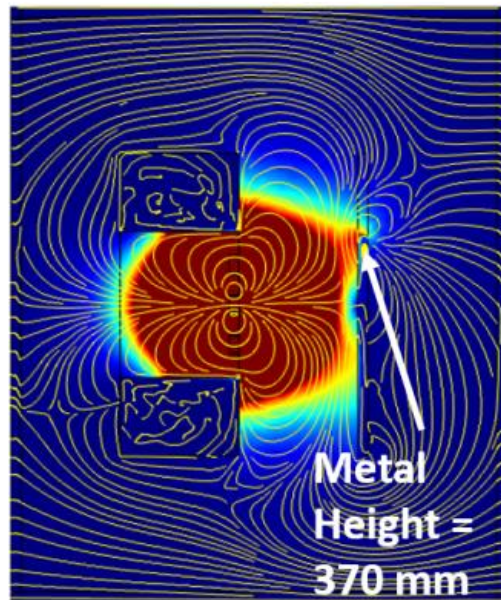
Model results



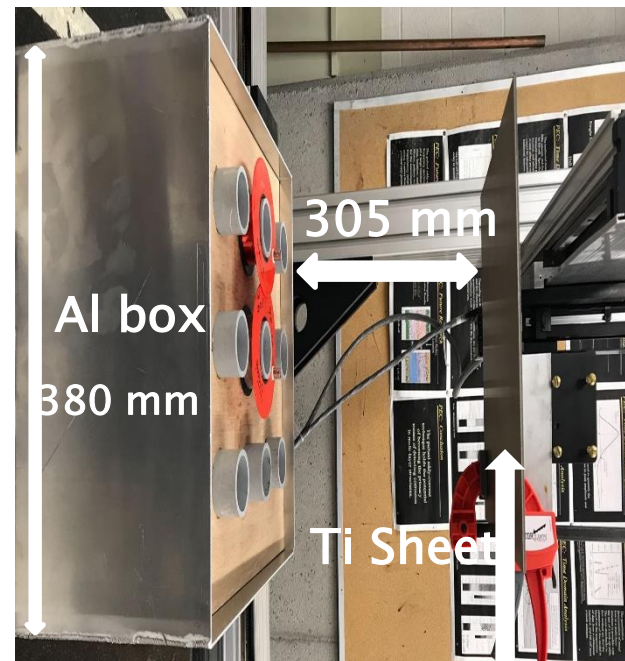
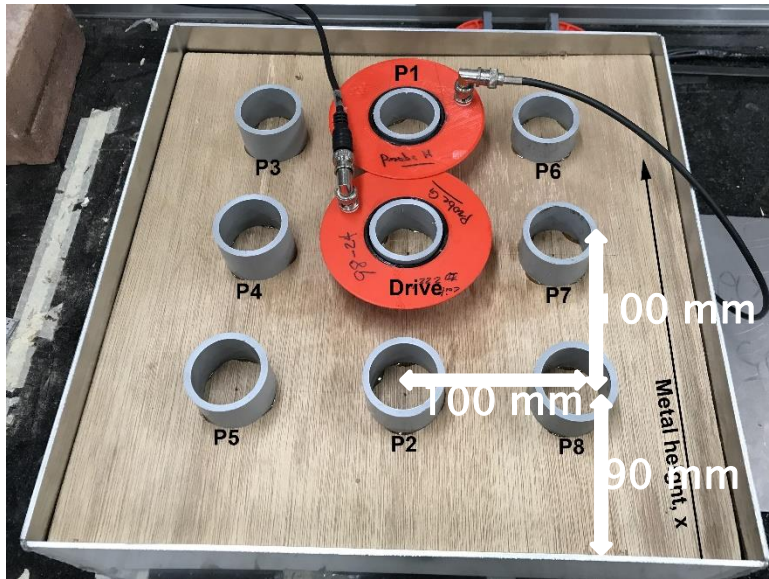
Magnetic flux



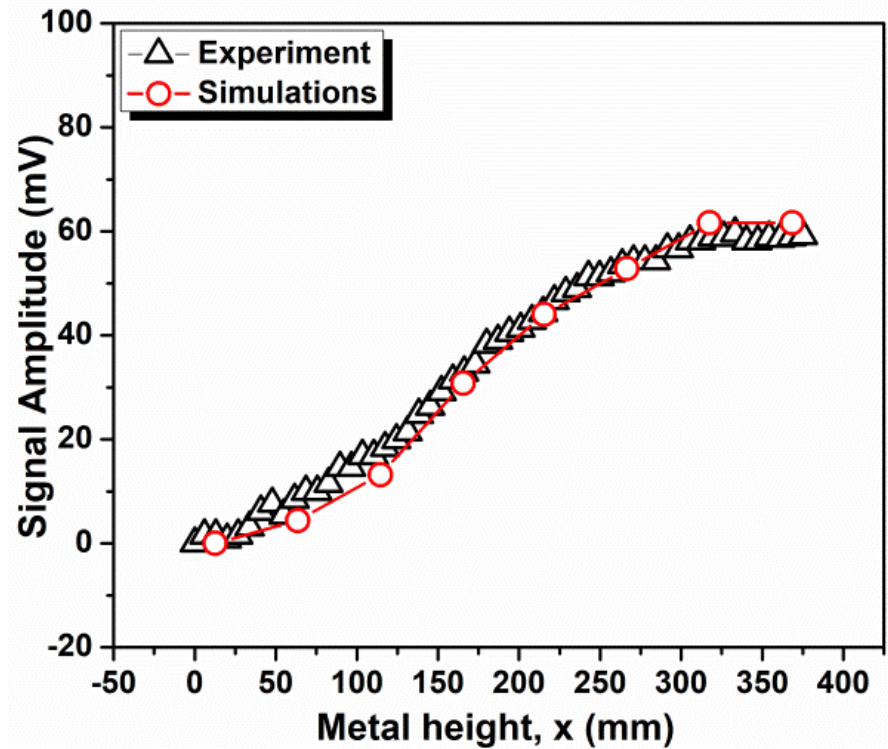
xz plane



Experiment



Experimental validation



Summary

- Eddy Current Sensor modelled in COMSOL detected signal at 300 mm liftoff.
- The trend of the voltage signal received by the pickup coil depends on the position of the coil and the metal height.
- The COMSOL model results were in good agreement with experiments.
- The use of COMSOL permits the investigation of parameters affecting the sensor design before building the prototype.

Acknowledgements



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Ontario Centres of
Excellence

Where Next Happens

Thank you