CDT-EI EPSRC CENTRE for Doctoral Training in Embedded Intelligence

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HERIOT WATT UNIVERSITY

Partial Discharge Monitoring for Gas Insulated Switchgear

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Introduction & Background

Switchgear covers a range of switching devices and assemblies in power transmission and distribution [2]. In gas insulated switchgear (GIS) all live parts of the system are contained in sulphur hexafluoride (SF_6) gas-tight enclosures. The value and critical function of these assets creates the need for accurate monitoring of switchgear health and detection of faults.

This poster presents a project in collaboration with Siemens Transmission and Distribution Ltd to develop a low-cost antenna for partial discharge detection.

Partial discharge (PD) is the local breakdown of the dielectric within the GIS chambers. PD produces UHF radiation pulses of up to 1.8GHz that can be detected by the use of UHF couplers attached to the GIS chamber barriers.

Project Aims

- Design, fabricate and test an antenna for external PD sensing
- Provide a state of the art review
- Produce a report containing a complete design methodology

Design Methodology

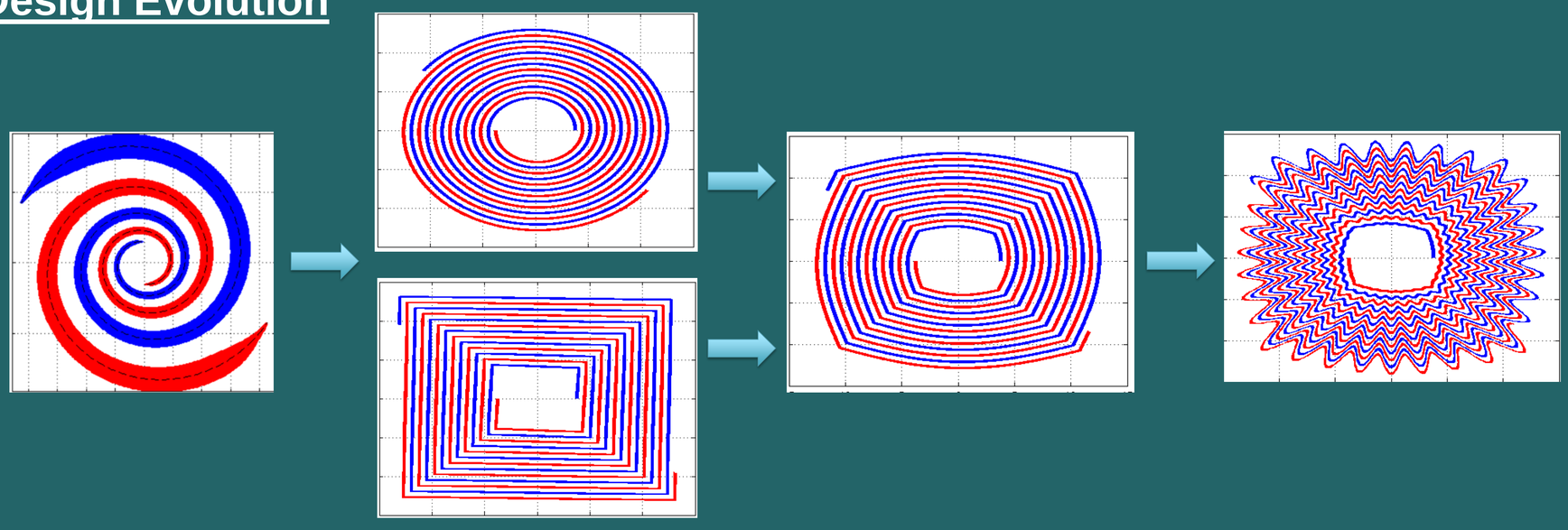
Main design challenge: Small antenna area available (30x90 mm) but required frequency range of 0.5 - 1.8 GHz.

Spiral Antennas

Many literature sources suggest spiral is a suitable geometry for antenna design for PD detection [1, 3 - 7].

- Ultra wide-band (UWB)
- Compact
- Circular polarization
- Low directivity

Design Evolution



Fabrication

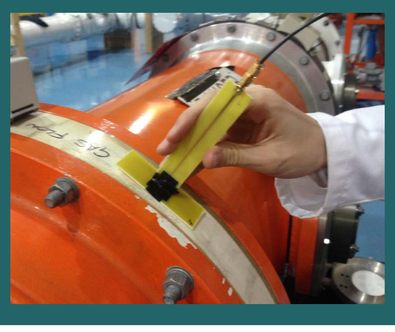
- Produced at Heriot Watt University
- Proof of concept: milled double sided FR4
- Prototypes: 15 different designs, produced by photolithography using FR4

Testing

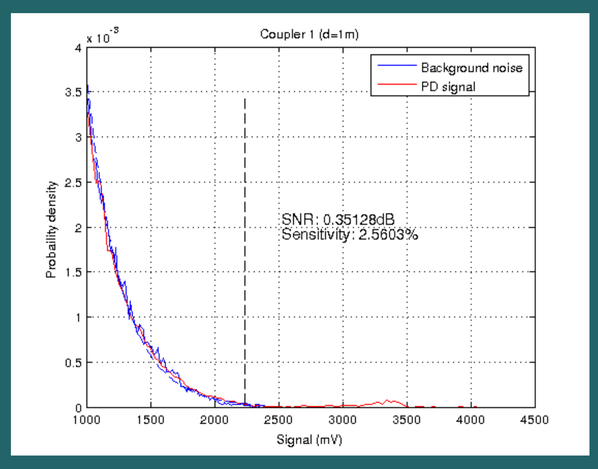
- Performed at Siemens' GIS test facility, Hebburn, England
- The prototypes were compared with each other using a spectrum analyzer
- The best prototype was then compared with two commercial PD sensors (Coupler 1 & 2)

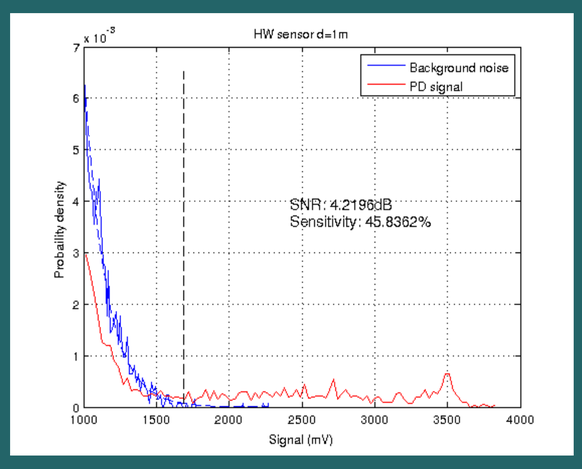
Results

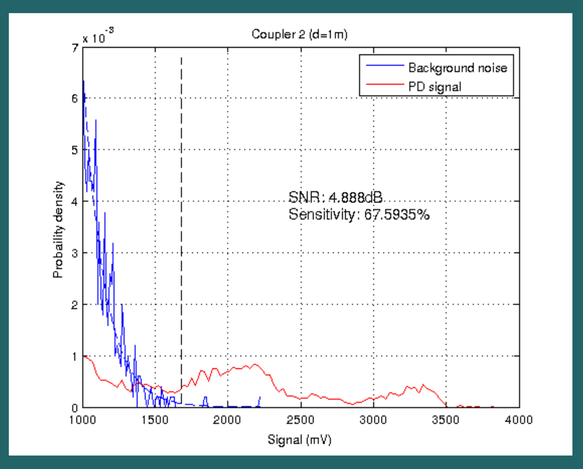
Below compares the results from the partial discharge monitoring system at Siemens. The prototype out performed the Coupler 1 sensor but was inferior to the Coupler 2 sensor.



	Coupler 1	Prototype (HW)	Coupler 2
SNR (dB)	0.351	4.220	4.888
Sensitivity (%)	2.560	45.836	67.594







Conclusion

This project has demonstrated that it is possible to produce a standalone antenna for partial discharge detection using basic materials, that is able to perform as well as some current pre-calibrated commercial solutions. Further research on this project will look at improving the feeding-line; planar manufacture; high-volume manufacture; further antenna geometry optimization; flexible substrates; packaging.

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