

Electricity  
Transmission

# Silicon Oil Research

LCNI

October 2019

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# Silicon Oil Research

- **Driver**
- **Research Projects Started by NGET**
- **Outcomes to date**
- **Further Information and Getting involved**
- **Q&A**

# 01

## Driver

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# Frequent issues with XLPE 132 kV Terminations

**Driver: Multiple large scale replacements in the UK and World wide over the last 30 years**

- Operating Environment of CSE is not well understood
- Silicon oil is frequently used but not well understood
- Impacts of electrical design & contaminants was not well understood
- Specifications for cable accessories appear to be limited



***NGET wanted to understand the assets and materials in more detail to inform our specifications and practices – leading to a large research programme focused on silicon oil***

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02

Research  
Projects

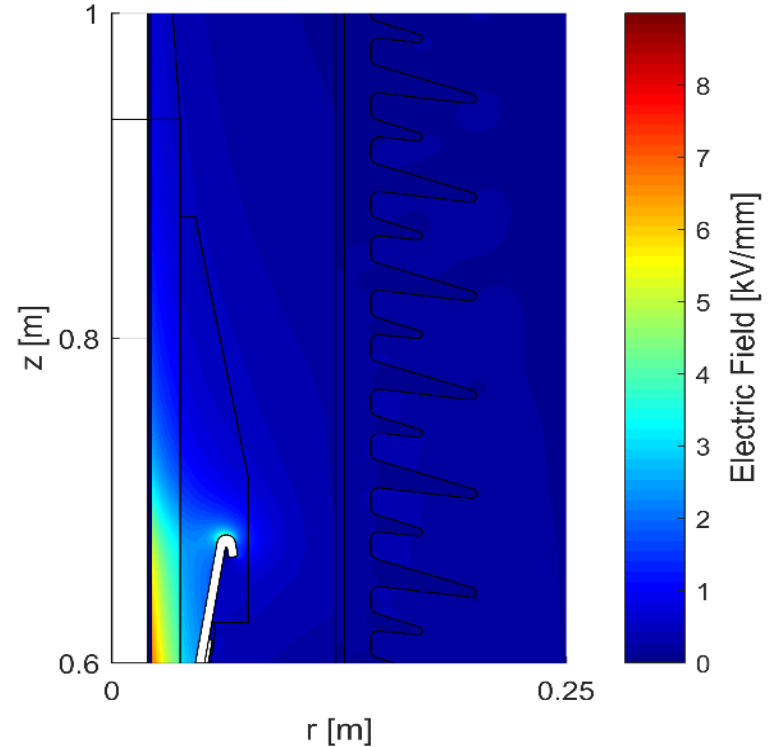
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# Liquids for Cable Sealing Ends (LiCaSE)

**Aim: To inform cable system specifications for oil filled XLPE CSEs**

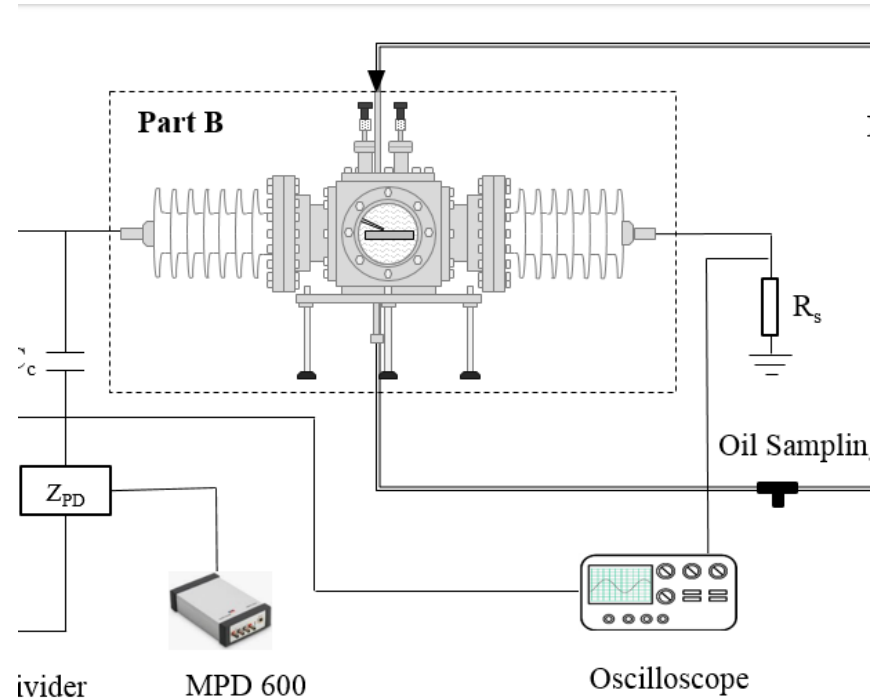
- Understand the operating environment of the CSE in more detail through detailed modelling.
- Investigate chemical interactions within cable sealing ends and identify possible degradation modes.
- Evaluate different oil types and rank performance.
- Identify methods of detecting poor quality oil on site.



# Electrical Characterisation of Silicon Oil (ECOSO)

**Aim: To understand the partial discharge characteristics of silicon oil and solid insulation.**

- Investigate and understand PD in silicon oil
- Investigate the impact of stress cone materials on the PD
- Understand the tracking process along
- Understand DGA development in the oils
- To better inform condition monitoring practices



# 03

## Outcomes to date

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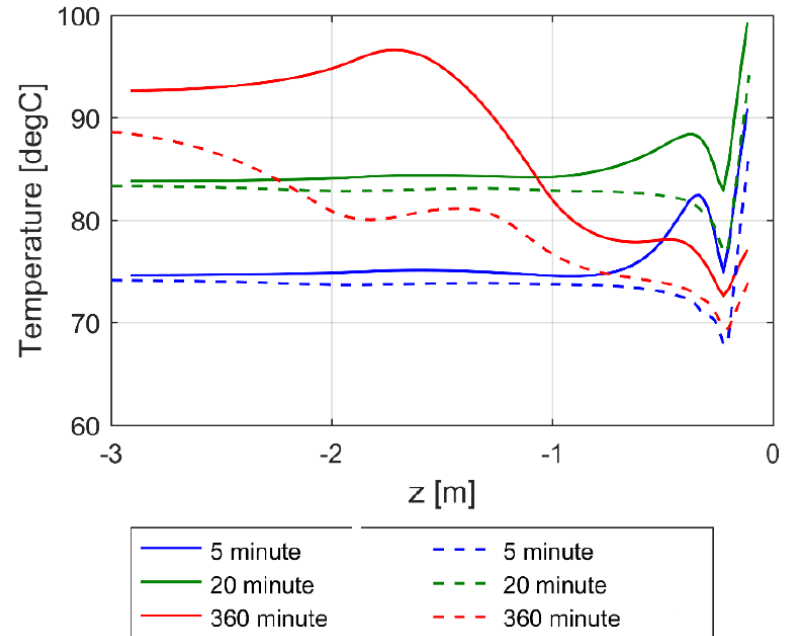




# LiCaSE - COMSOL Modelling of terminations

**Aim: to determine the normal operating temperatures & electric fields**

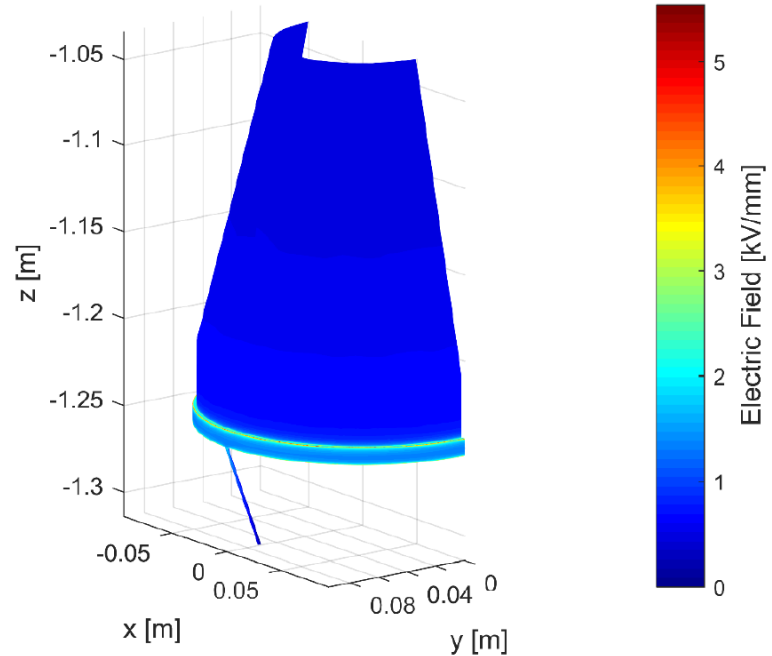
- Significant temperature rise only occurs under emergency rating scenario
- Worst case the CSE will reach 95°C; could be higher with a different ambient and direct sunlight
- Under full load – internal temperatures only reach around 60 °C
- Under ‘typical load 30%’ the temperatures are around 30-40 °C internal temperature



# LiCaSE - COMSOL Modelling of terminations

**Aim: to determine the normal operating temperatures & electric fields**

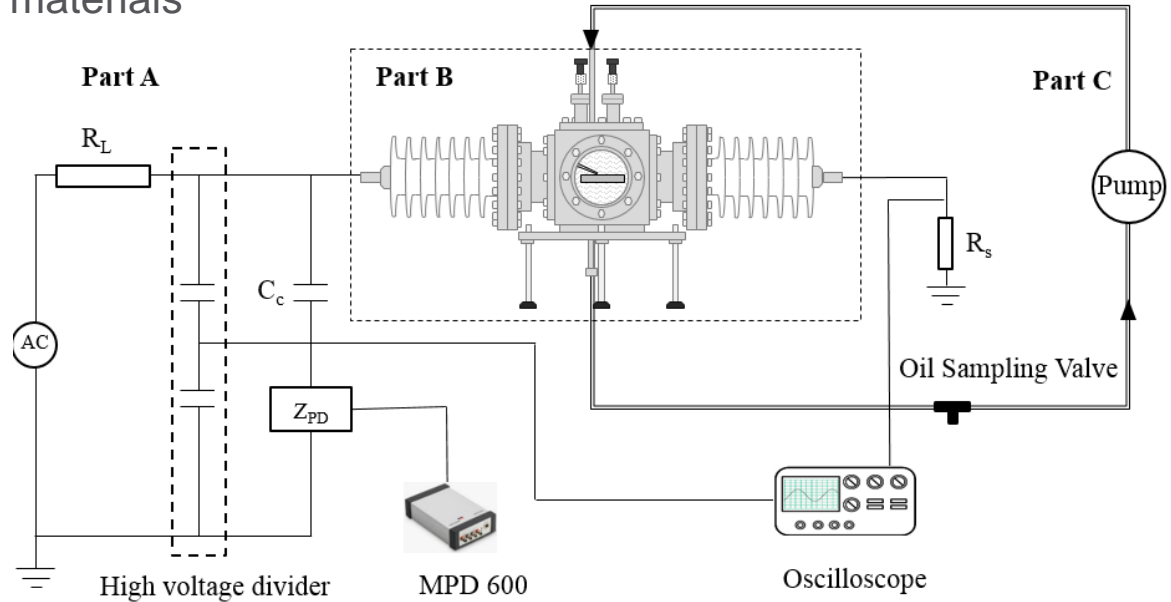
- Different designs have different peak electric fields
- Low stress design typically operate around 1 kV/mm
- High stress designs also exist – which may have inferior performance.
  - *Debris collection*
  - *Increased probability of PD / Tracking initiation*



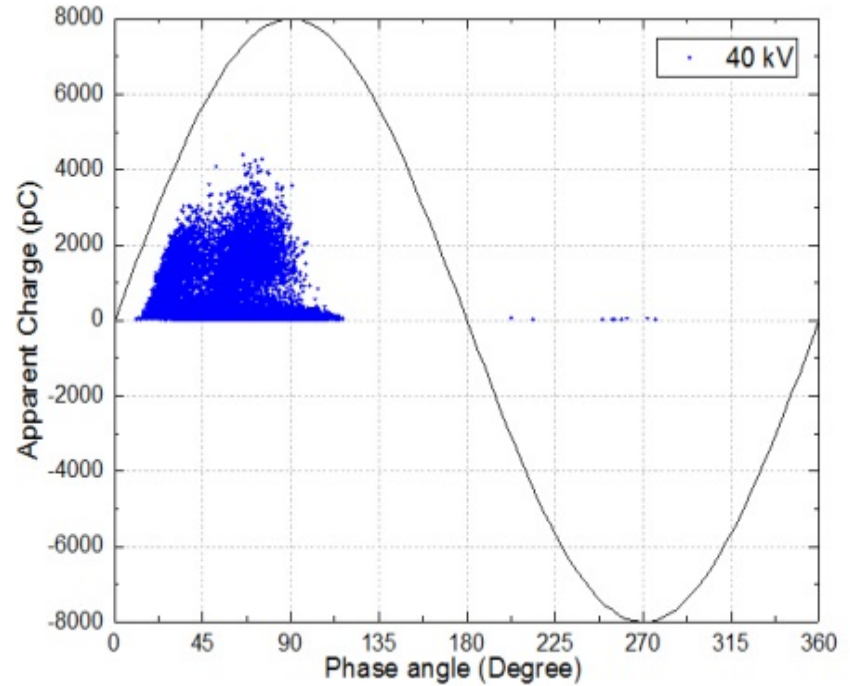
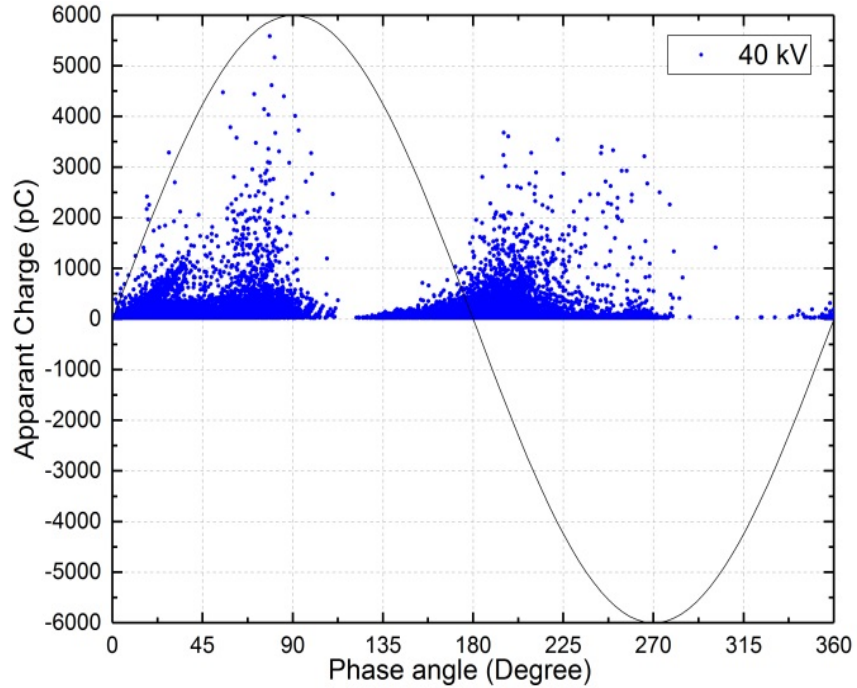
# ECOSO - PD testing of Silicon Oil

**Aim: To understand the behaviour of PD in silicon oil**

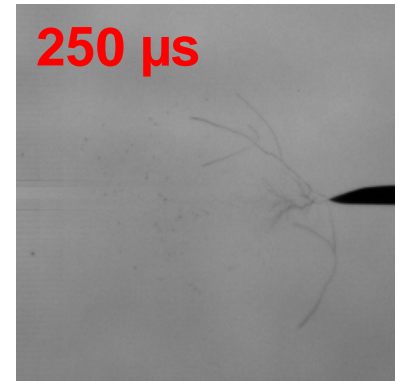
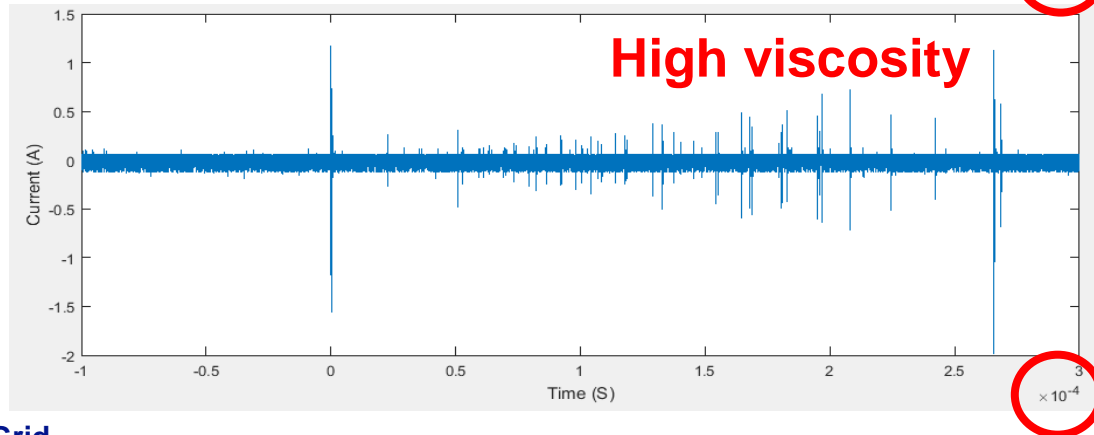
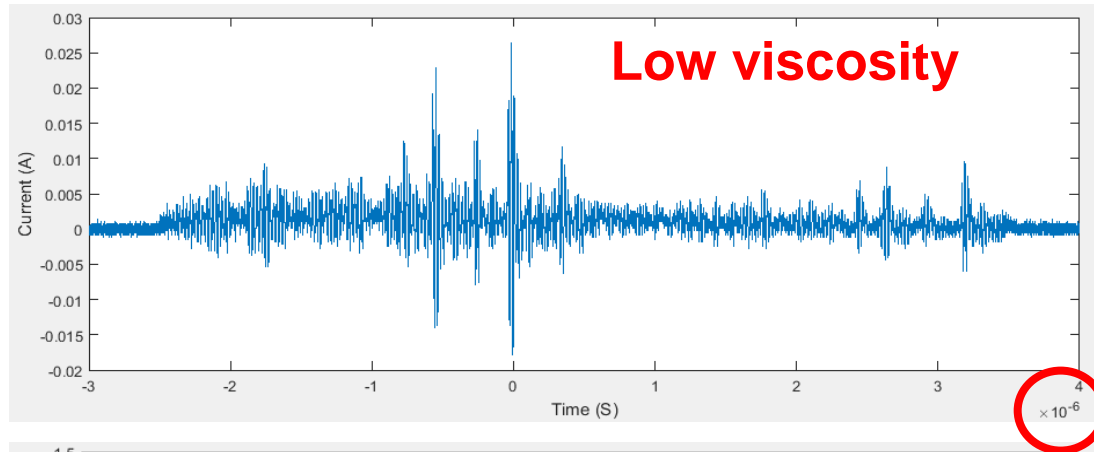
- PD testing of the Oils in isolation
- Then introduce solid insulation materials



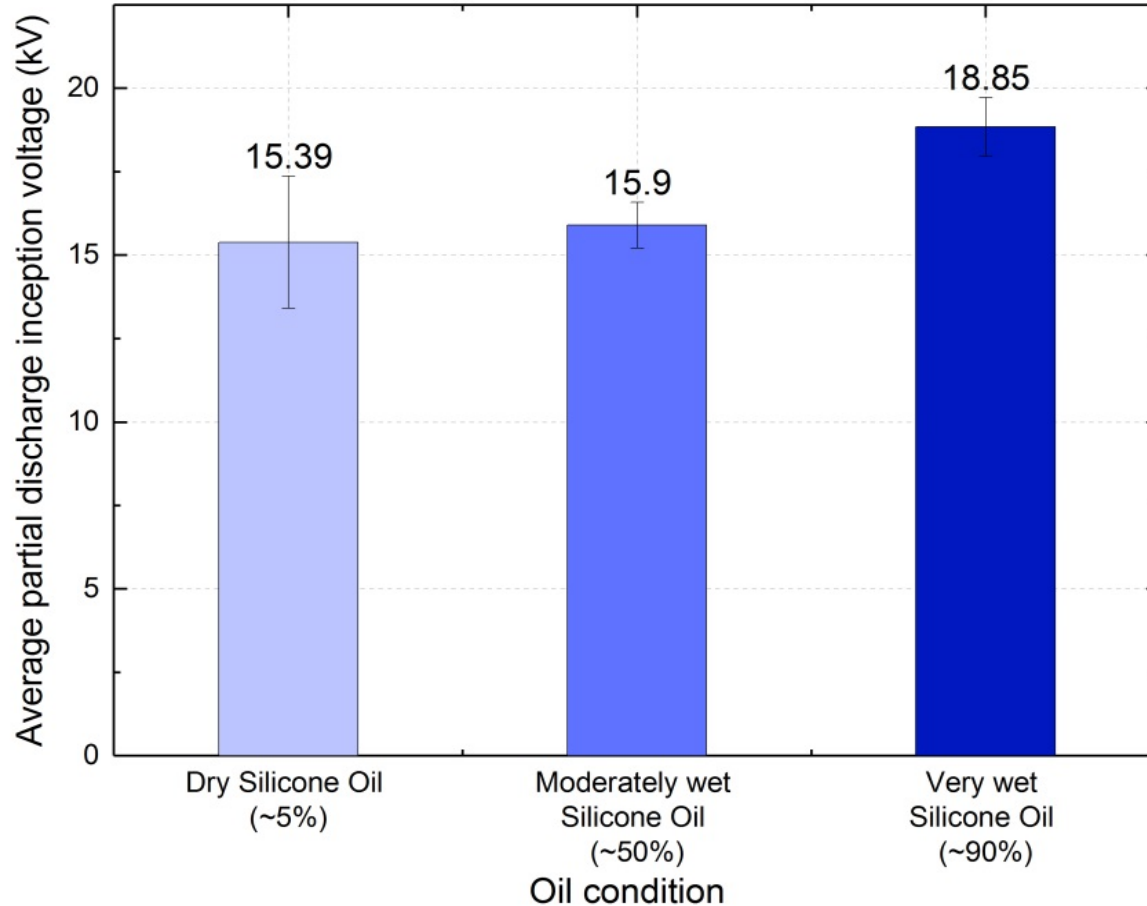
# Which one is PD?



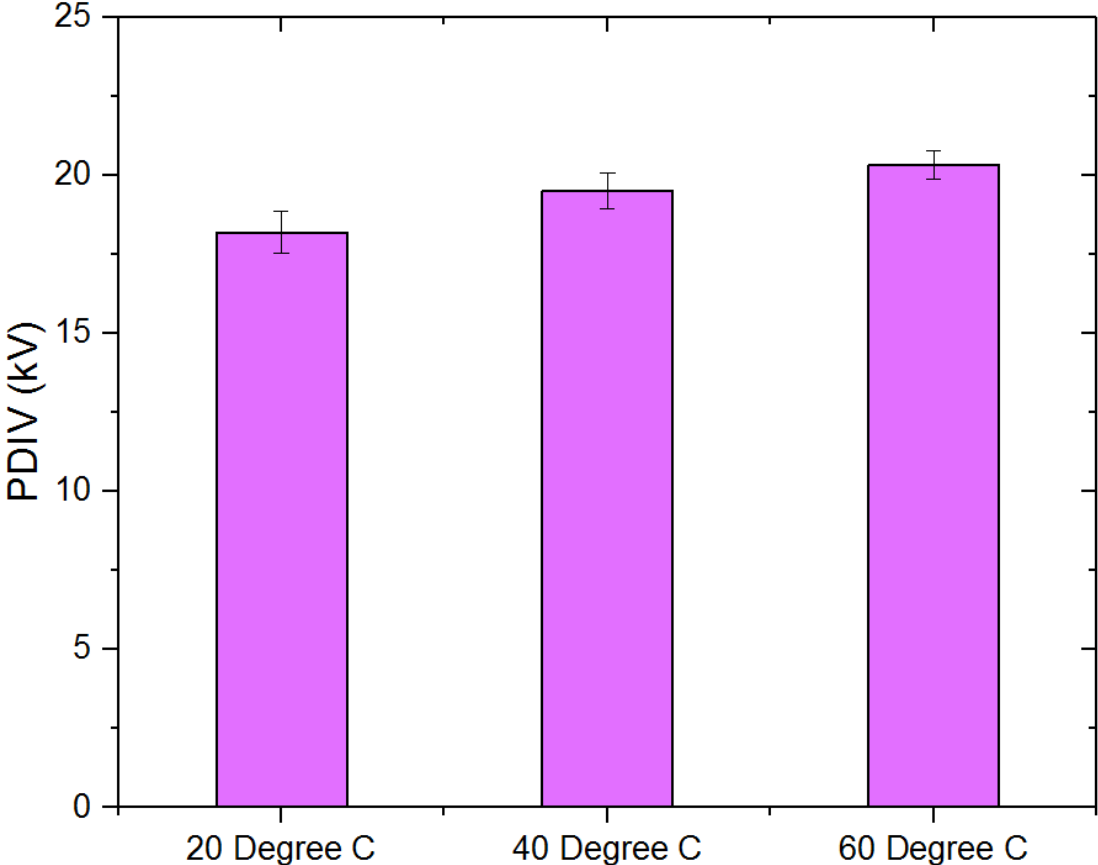
# Viscosity impacts the PD pattern



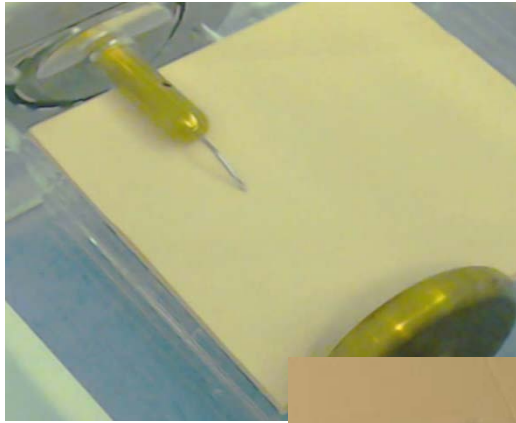
# Moisture increases PDIV



# Temperature also increased PDIV slightly

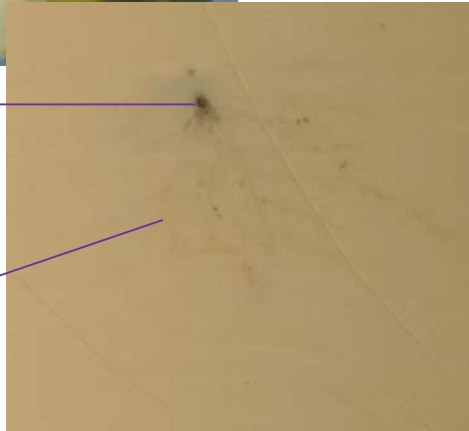


# PD Characteristics of Silicon Oil & Solid Insulation



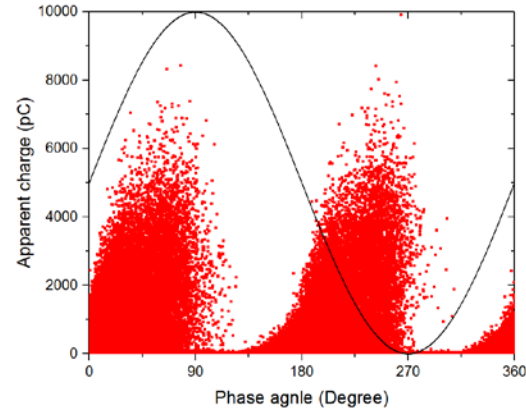
Needle tip

'Tree-like'  
tracking

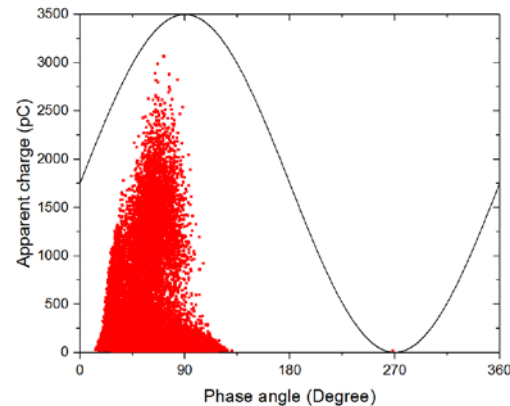


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## Preliminary results



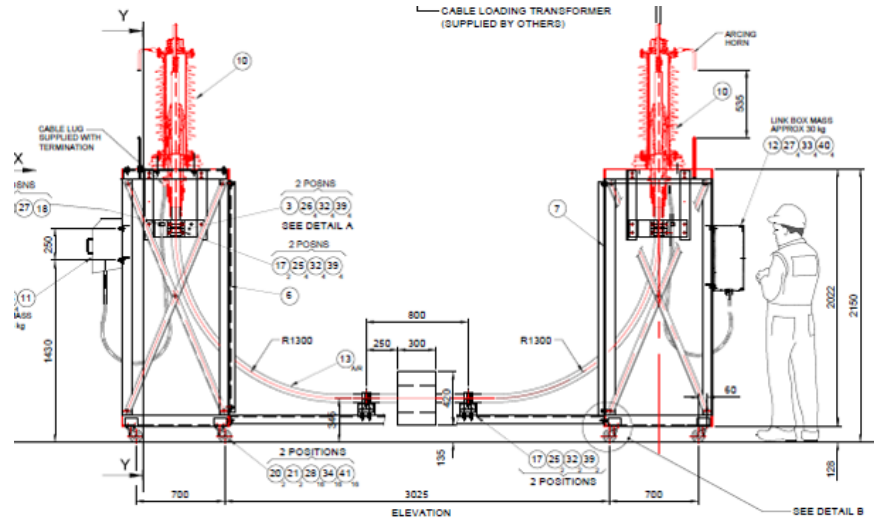
With EPR sheet



Without sheet



# What's Next?



# What to find out more?

**Further information can be found here:**

ECOSO:

[https://www.smarternetworks.org/project/nia\\_ngto009](https://www.smarternetworks.org/project/nia_ngto009)

LiCaSE:

[https://www.smarternetworks.org/project/nia\\_ngto010](https://www.smarternetworks.org/project/nia_ngto010)

Novel O-Ring Designs (NORD) – Investigating the performance of CSE O-rings

[https://www.smarternetworks.org/project/nia\\_ngto032](https://www.smarternetworks.org/project/nia_ngto032)

- 3 Papers are also currently under review for publication

# Want to get involved in Innovation?

- Go to:  
[www.ukeic.com](http://www.ukeic.com)



## Power Dense Underground Transmission Call DNO-19-03



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When demand grows in parts of the country or a new generator is being built, further investment in the transmission network may be required to transmit the increased power levels. Key boundaries between regions in the UK are identified and studied to decide how much investment is required, where it is needed, and when this investment in the transmission system should be made.

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04

Q&A

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