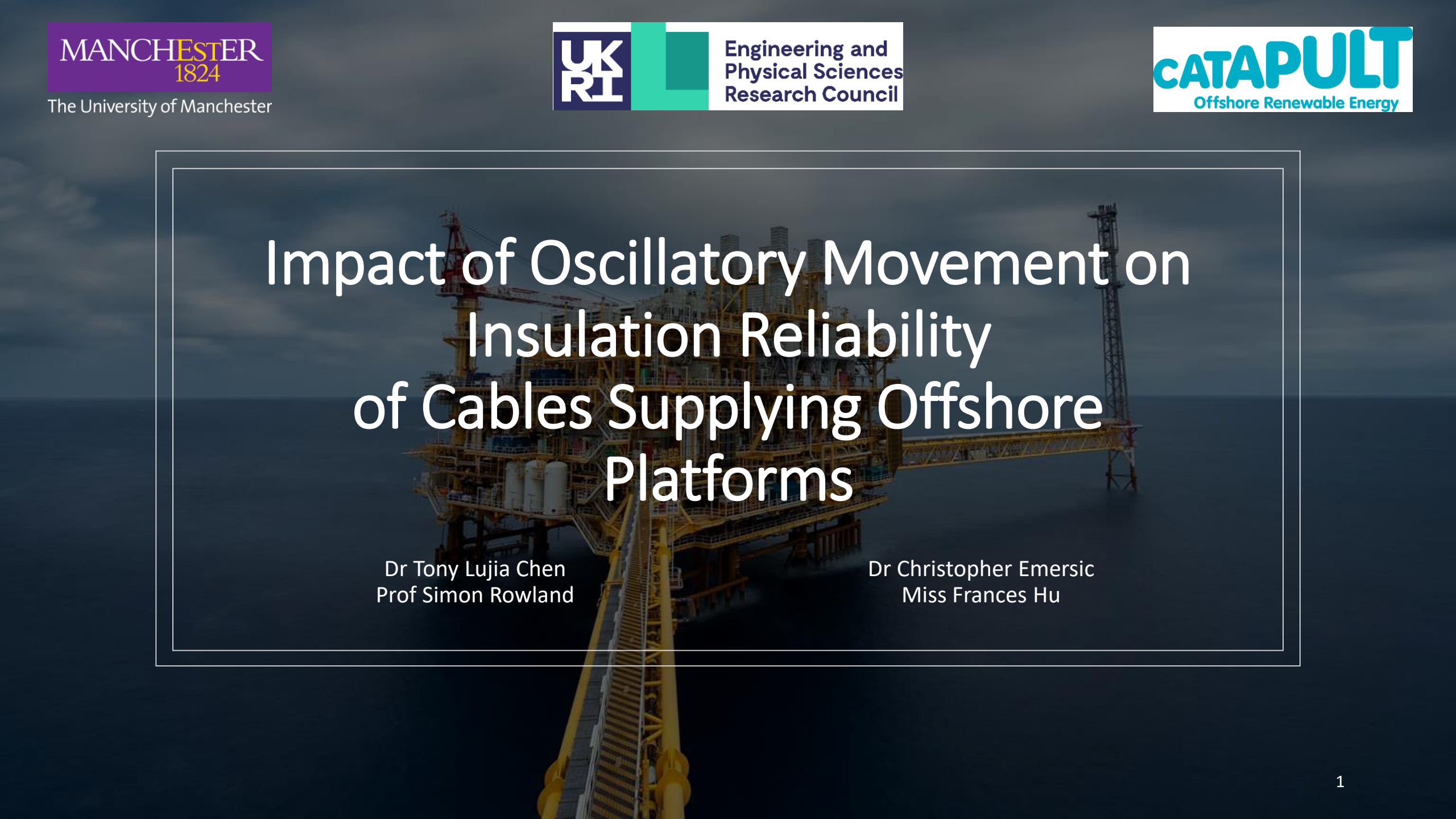

Impact of Oscillatory Movement on Insulation Reliability of Cables Supplying Offshore Platforms

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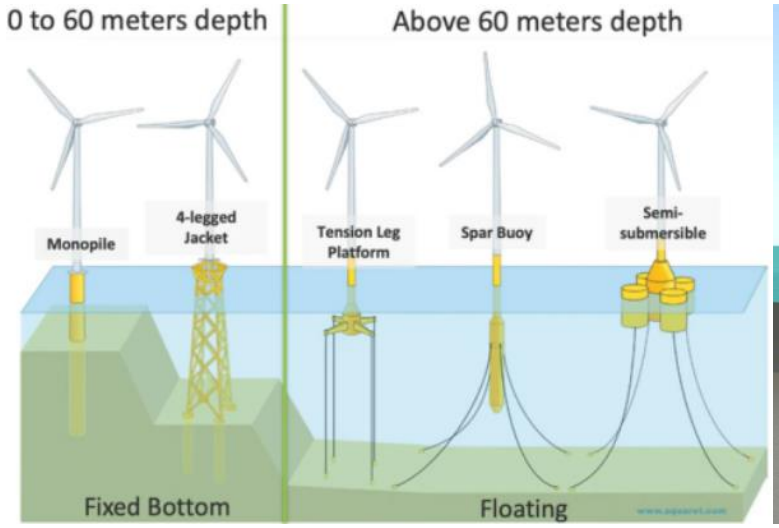
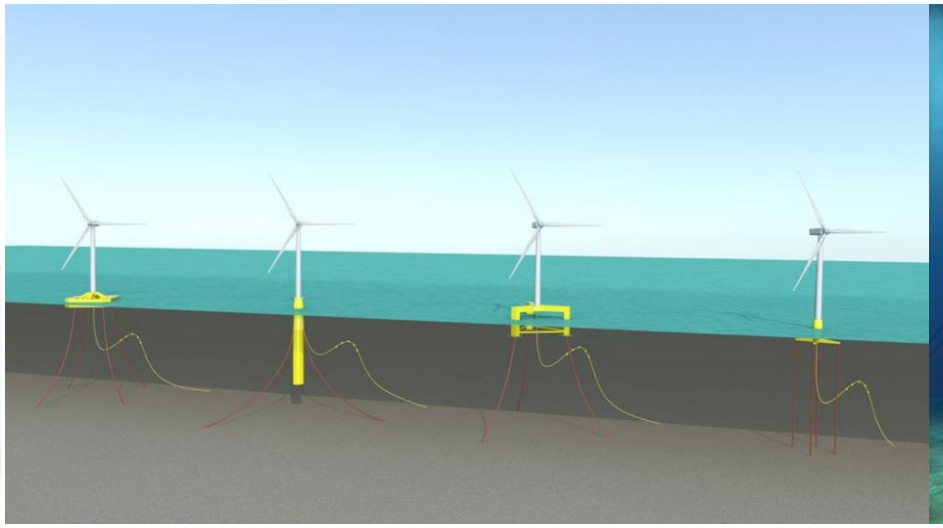
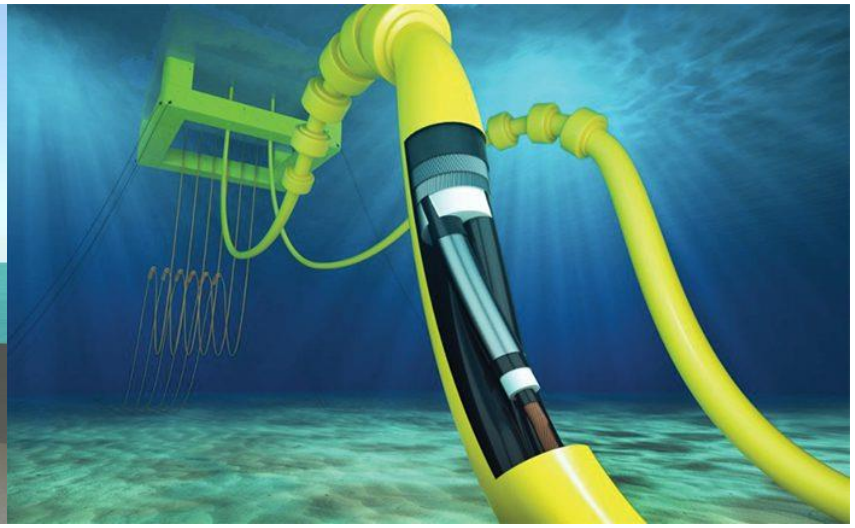
Background

- A rise in offshore deep-water wind farm power generation is required to achieve net zero targets
- UK has the highest capacity of offshore wind turbines in operation globally
- Electrical faults in subsea cables are the main cause of failure







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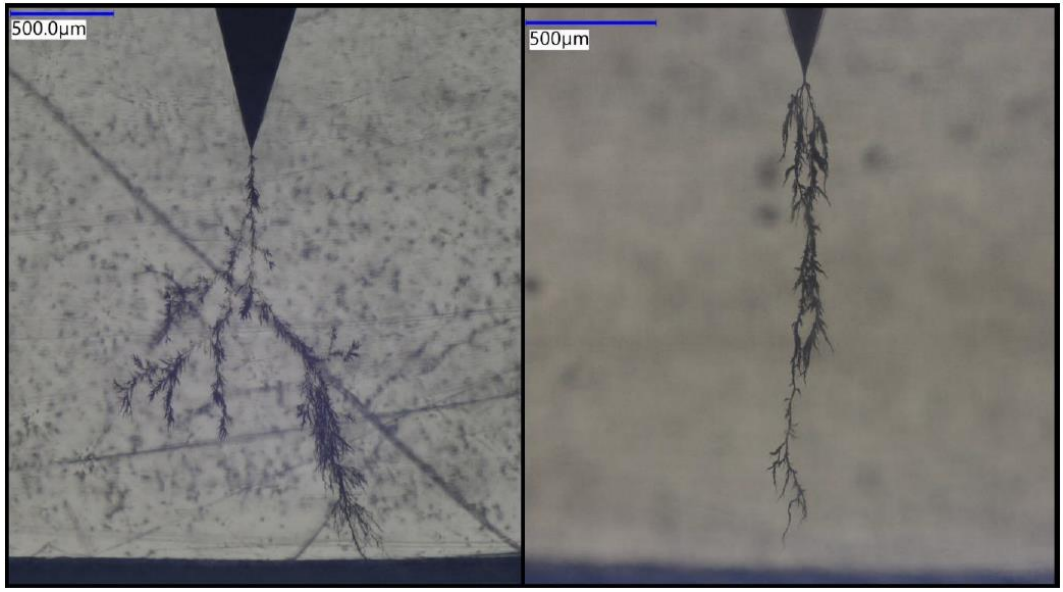
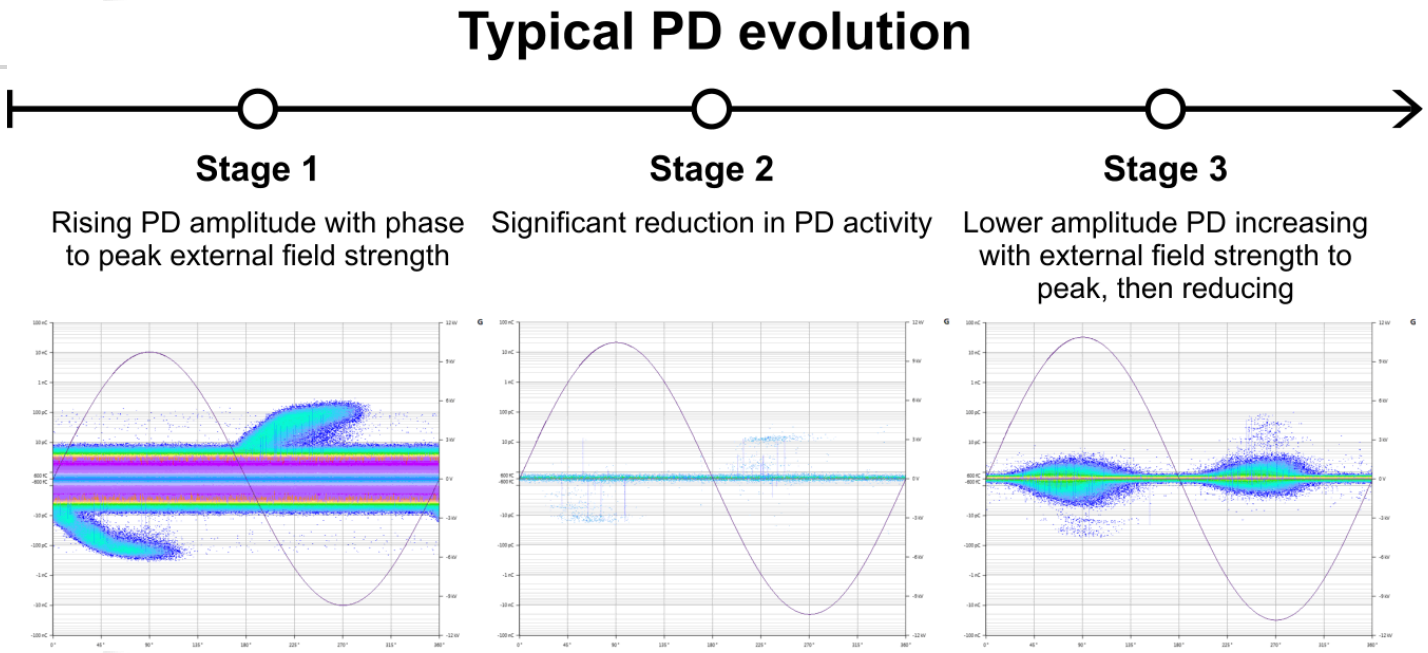
Overview

- Electrical treeing is a known failure mechanism in cable
- Dynamic flexing of cables could affect electrical properties and tree growth
  - Limited literature on compressive strain shows possible influence; very little on tensile strain
- Our research has looked into the influence of mechanical strain on the properties of electrical trees
- Testing has also occurred on full-scale cables to assess the representativeness of laboratory scaled testing



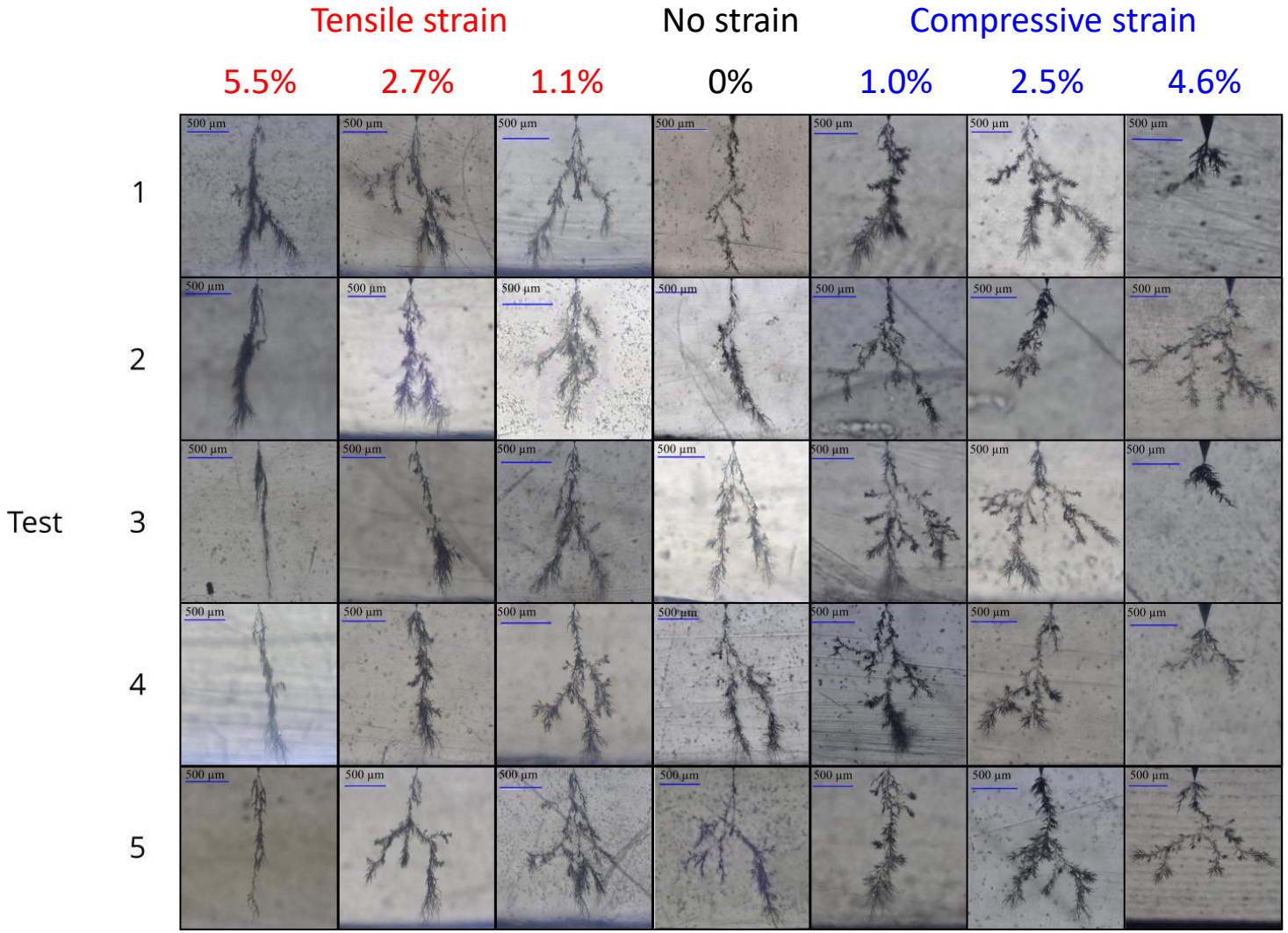
Partial Discharge (PD) Evolution

- Distinct behaviour commonly observed in tree growth is able to be correlated with PD activity.
- Three distinct stages of PD evolution observed in trees grown under different strains



Electrical Treeing Results

- Data shows tree geometry is influenced by strain
- Increasing tensile strain
  - Reduces tree radial extent
  - Reduces relative change in bifurcation and bend angles (reduces tortuosity)



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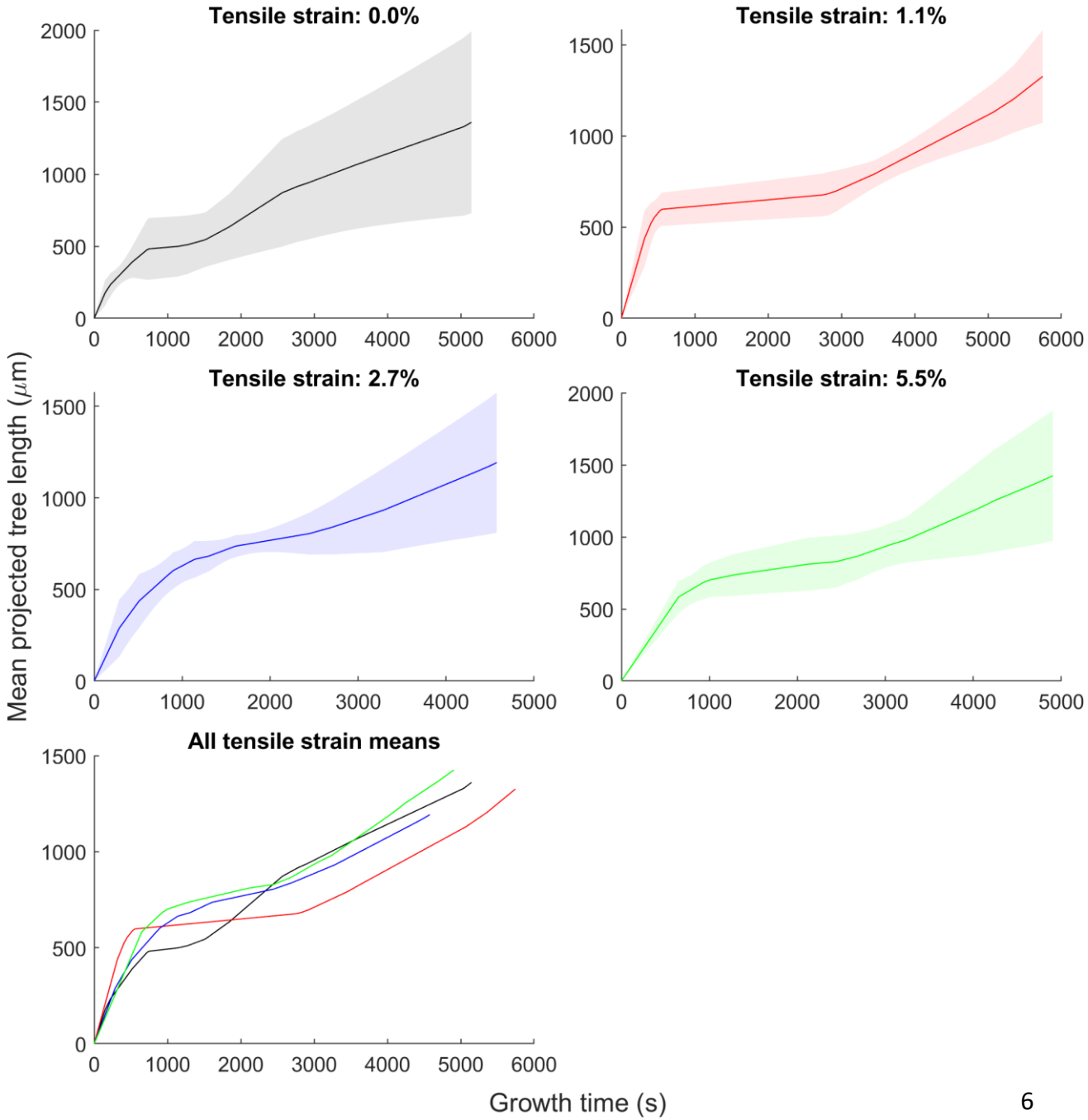
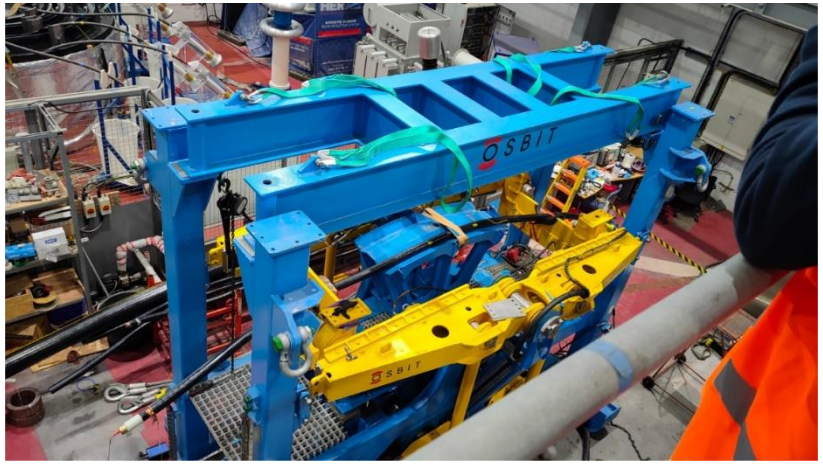
Electrical Treeing Results

- Compressive strain has the opposite influence
- Electrical (PD) behaviour is not affected
- Growth rate, fractal dimension, initiation time, and time to failure are not influenced by strain
- Strain values of less than 2% have little influence on the tree behaviour
- Strain limits of 1% are typically observed for in-service offshore cables



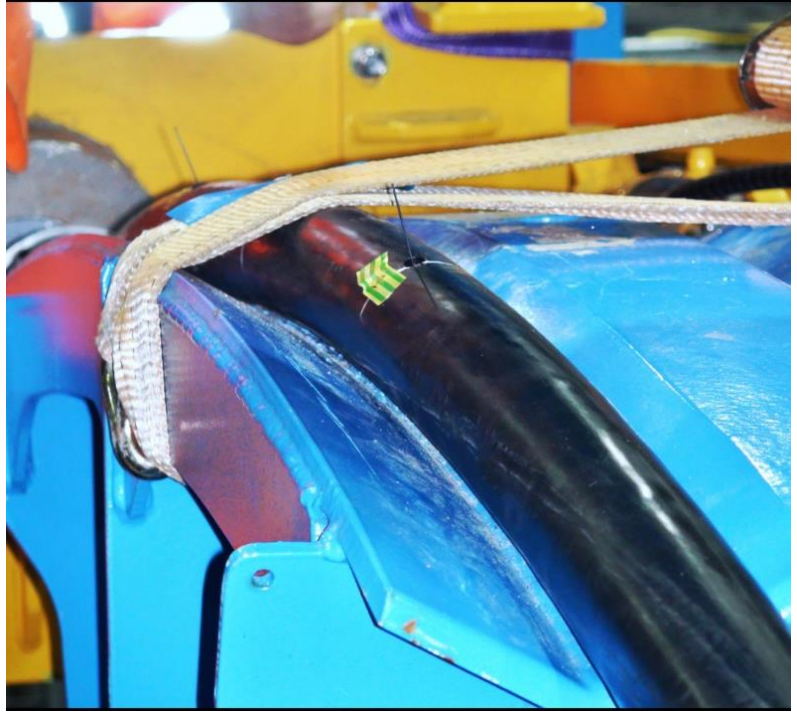
Full-scale Testing

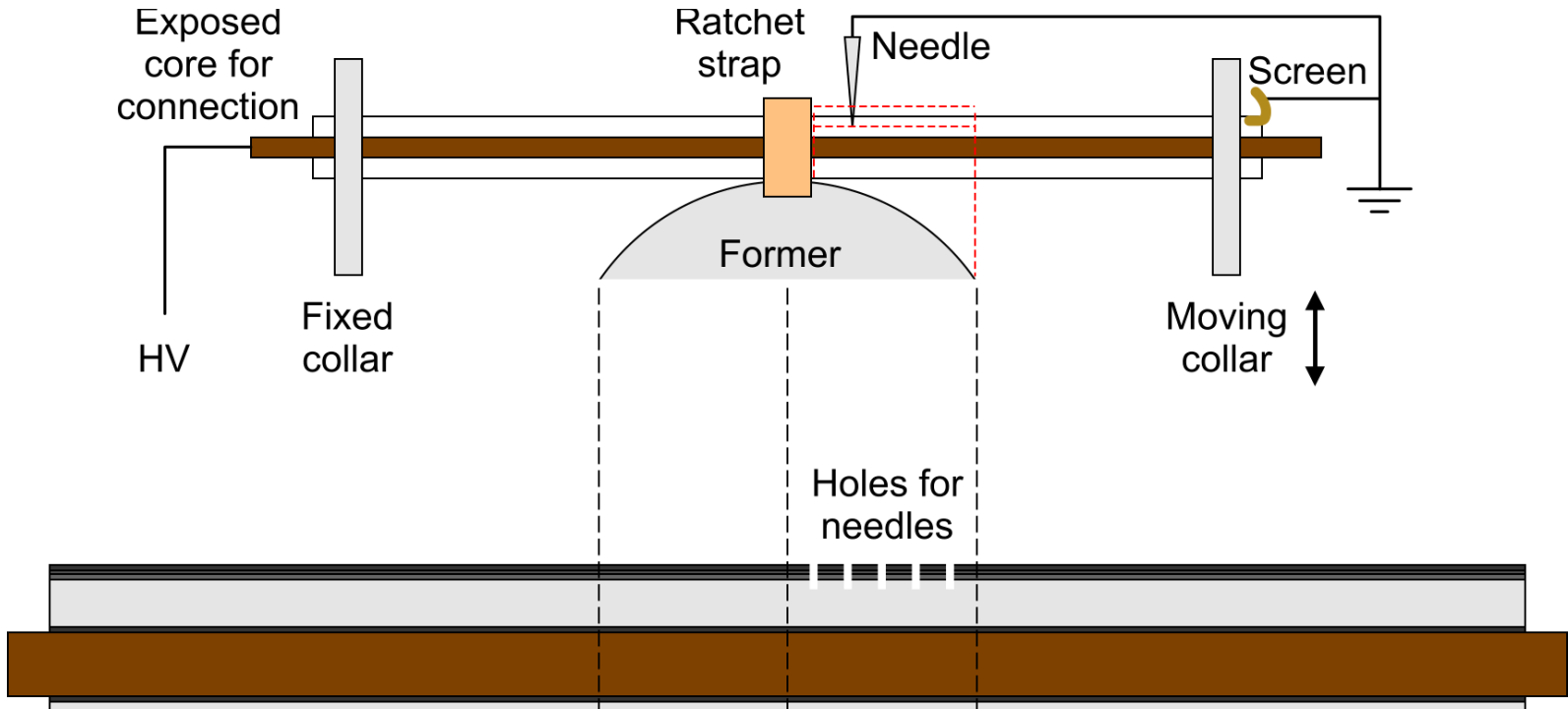
- Is laboratory scale testing representative of large-scale testing?
- Using ORE Catapult's bend fatigue rig
- 5 m cable samples
- 1% strain achieved over 2.5 m former
- Trees grown under three cable test categories:
  - Unstrained
  - Statically strained
  - Dynamically strained



Full-scale Testing

- Considerable knowledge and experience gained in larger scale testing, including field management of cable ends, noise reduction and practical approach





Summary of Full-scale Testing

Large scale testing showed electrical treeing behaviour comparable to that observed in smaller scale samples

Deviations from this were limited to the fine detail of PD signature and evolution and no new or fundamentally different behaviour was observed

Such deviations are most likely attributed to difficulties in precisely controlling key parameters during testing that are inherent and unavoidable at larger scales

The evidence gathered suggested that small scale laboratory testing is representative of what is observed at larger scales