
Supergen Offshore Renewable Energy

Early Career Researchers Forum

# Upgrade of Power electronic Grid Emulator to Multi-Channel System and High Current Continuous Power Semiconductor Tests for Next Generation Offshore Wind, Tidal & Wave Converters

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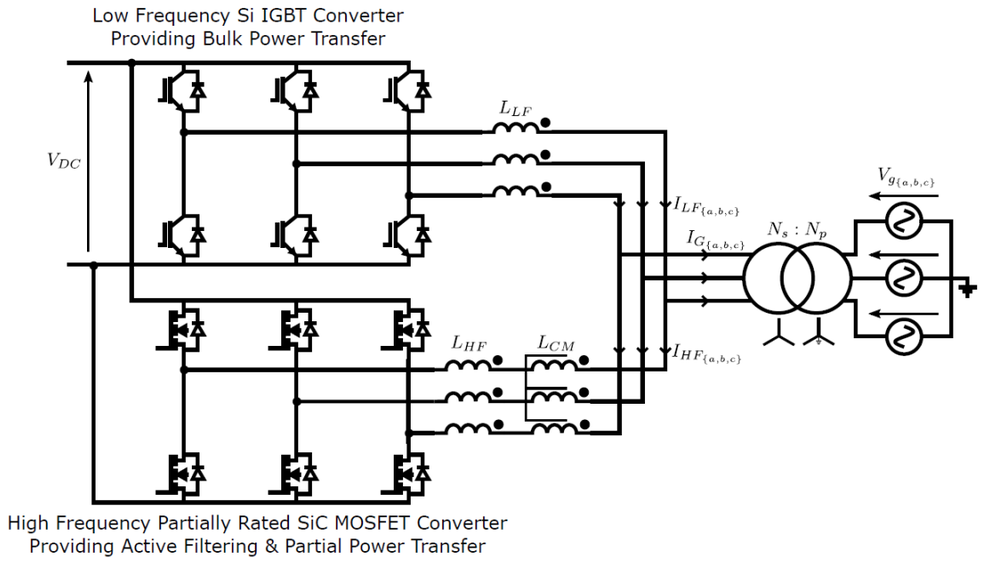
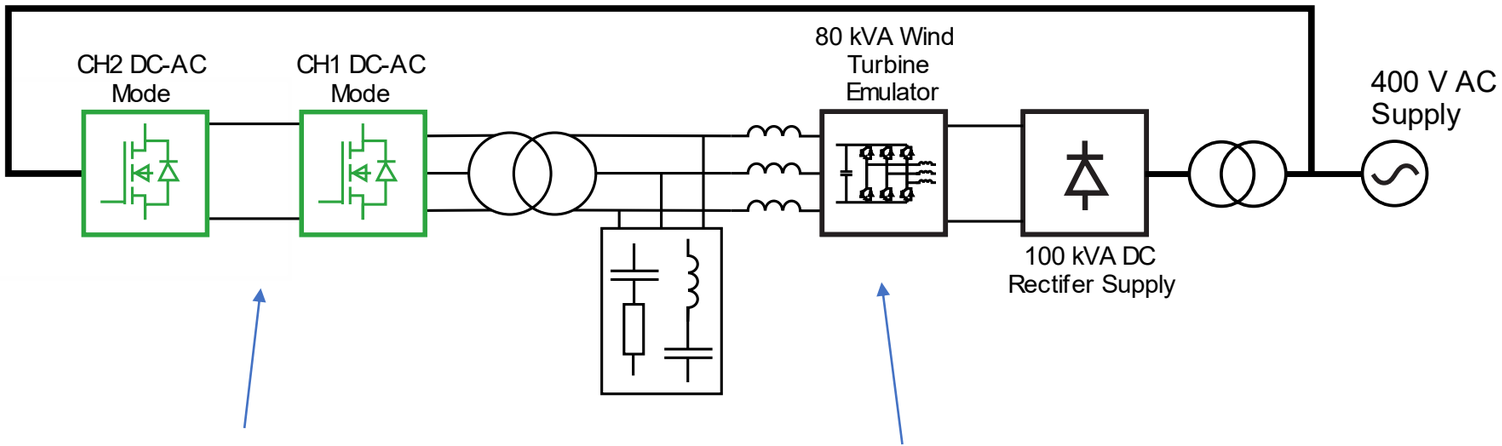
# Background - Hybrid Converter Topologies




Have established a research trend investigating the design and control of Hybrid Silicon Carbide based converter topologies for wind, wave & tidal applications

<u>Silicon Carbide MOSFETs provide lower switching loss but numerous practical challenges (higher dV/dt, more challenging busbar and gate-drvie design etc.)</u>

# Grid Emulator System




Grid Emulator System

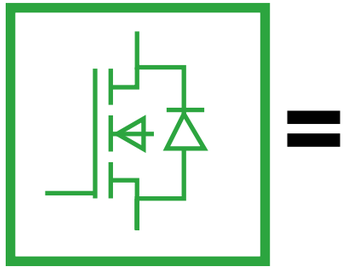
Converter Under Test

Ambition is to be capable of performing advanced experimental testing these hybrid converter topologies:

- Grid Interaction studies.
- Fault ride through testing.
- Harmonic interaction studies.

Commercial grid emulator units capable of doing the above with power ratings of ~100 kVA cost upwards of £200k.

# Design of Custom Grid Emulator



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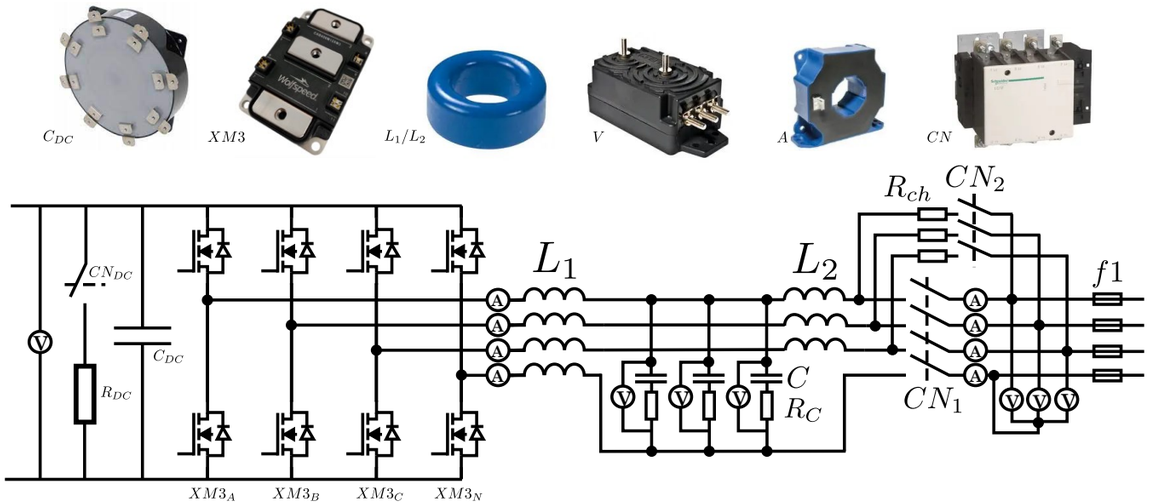
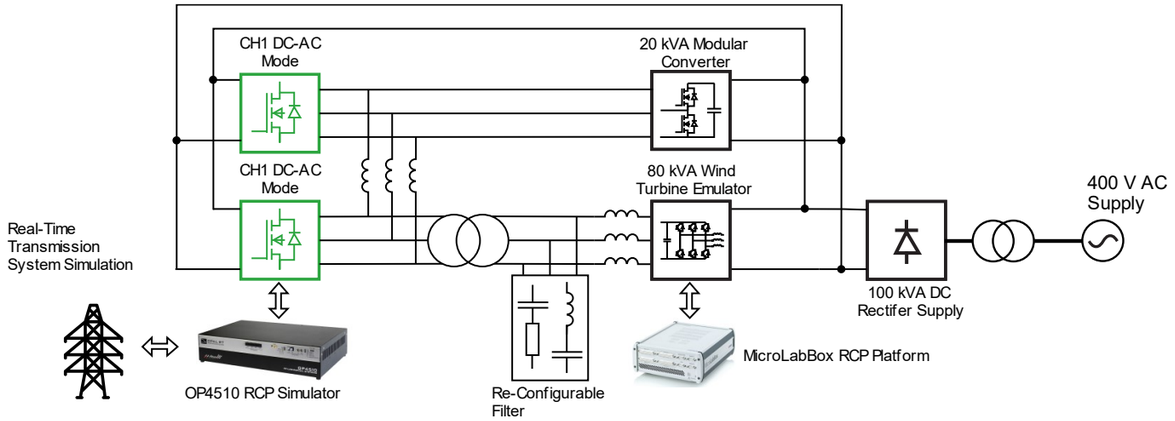


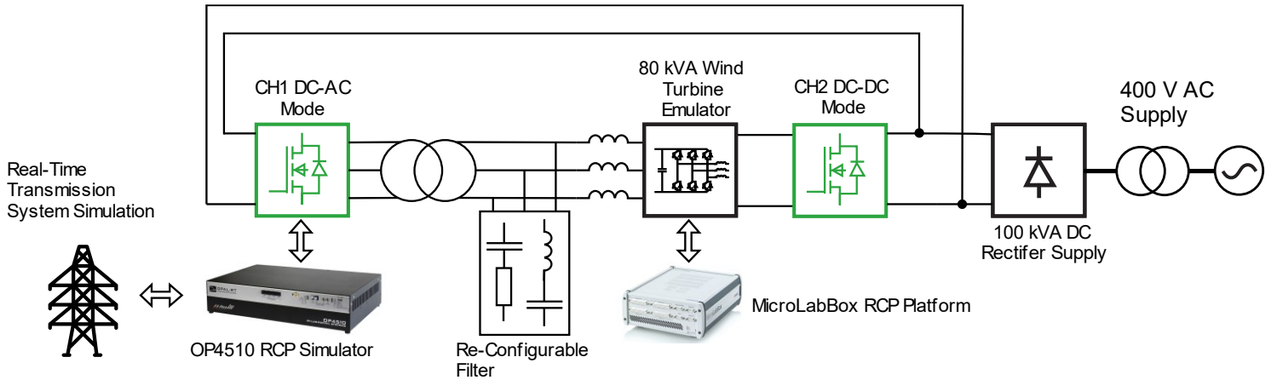

- The grid emulator will use the latest generation Silicon Carbide MOSFETs to achieve high efficiency and control bandwidth.

- FPGA based Model Predictive Controller implemented on an Opal-RT Simulator
  - 200 kHz Control Frequency -> ~50 kHz Switching Frequency -> ~5 kHz Converter Bandwidth
  - Supports future expansion of research to aerospace and automotive.

# Dual Channel Experimental Arrangements

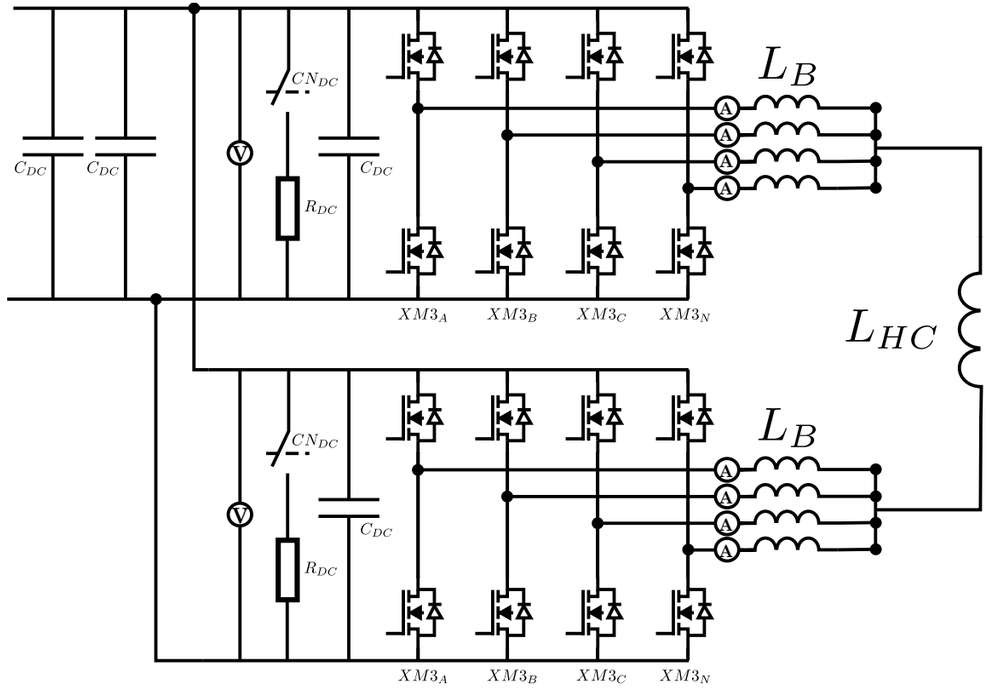



**Multi-Terminal MicroGrid Arrangement**



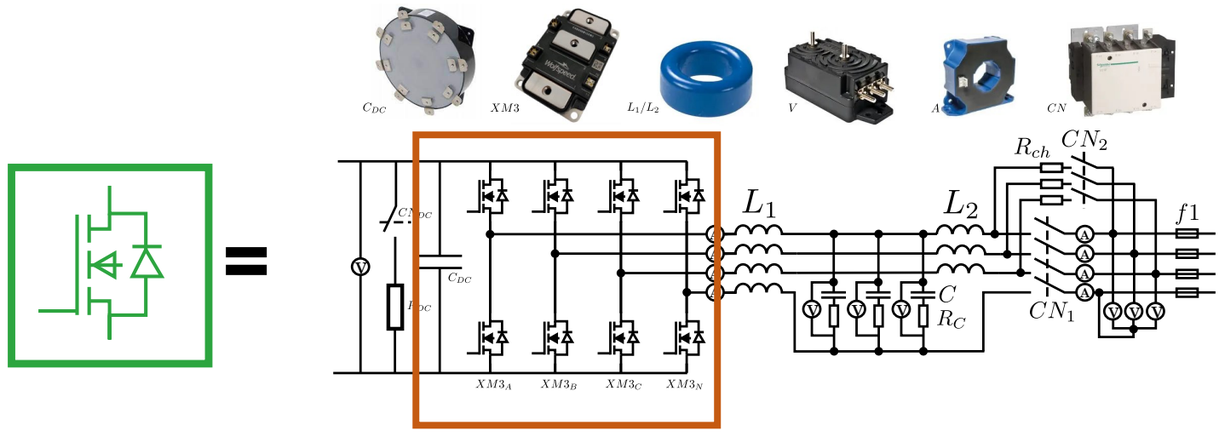

**DC & AC Emulation for Converter Fault-Ride Through Testing**

# Continuous Circulating Current Tester

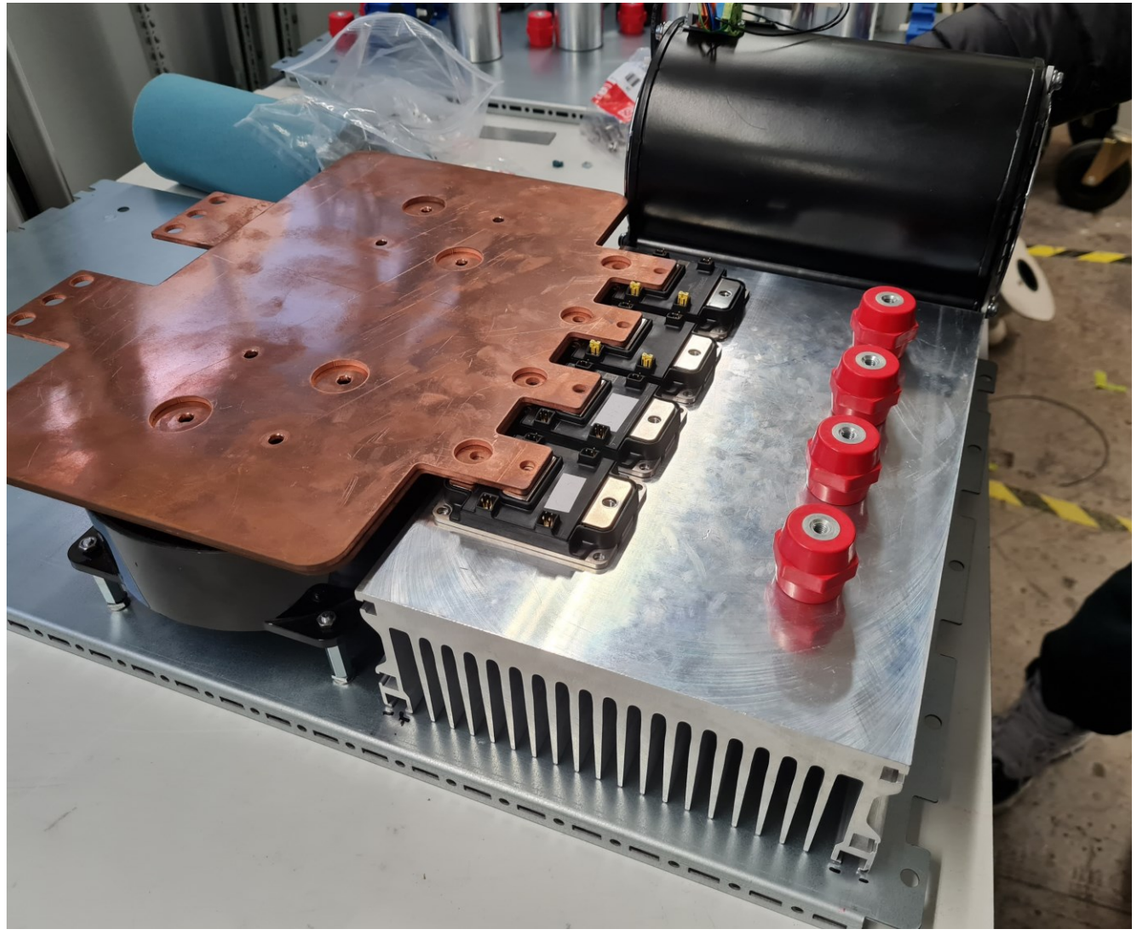


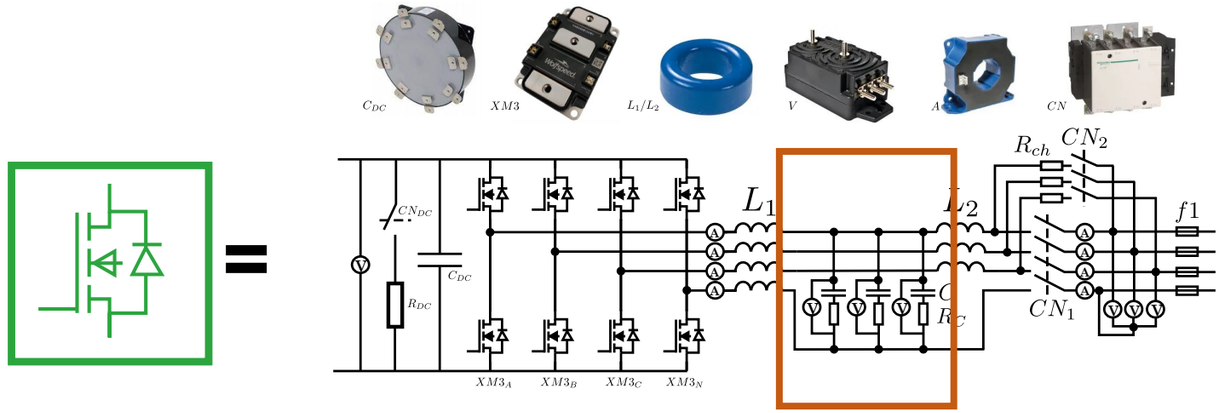

System is also being designed so that it can function as a continuous circulating current tester

Will enable advanced gate-driving and power-semiconductor testing work

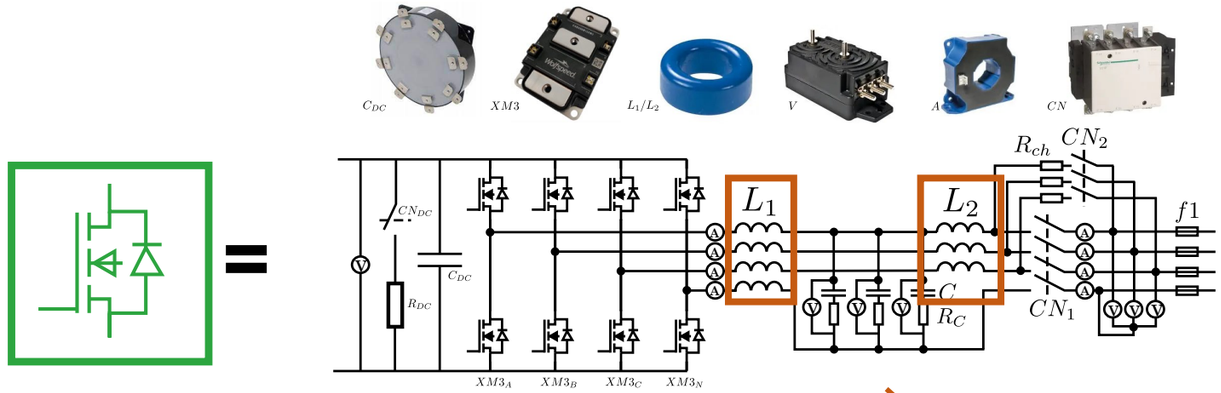



# Four-leg Silicon Carbide MOSFET Bridge Design

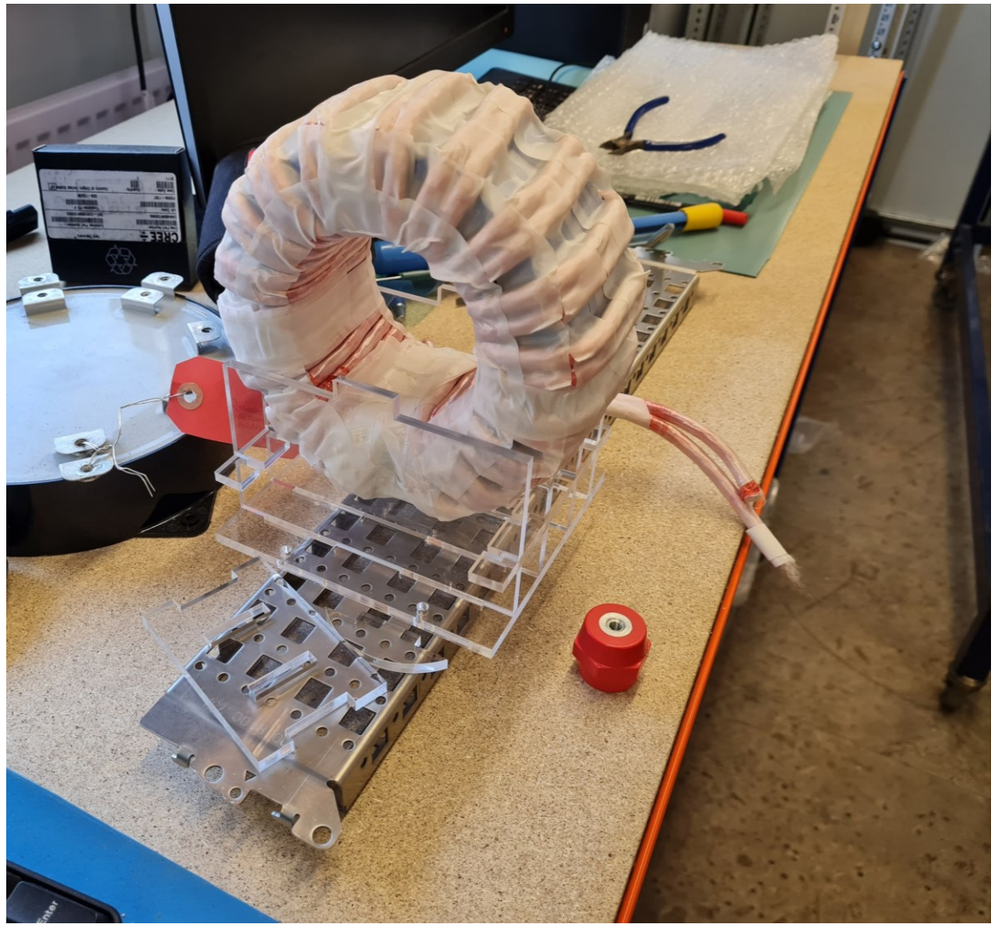




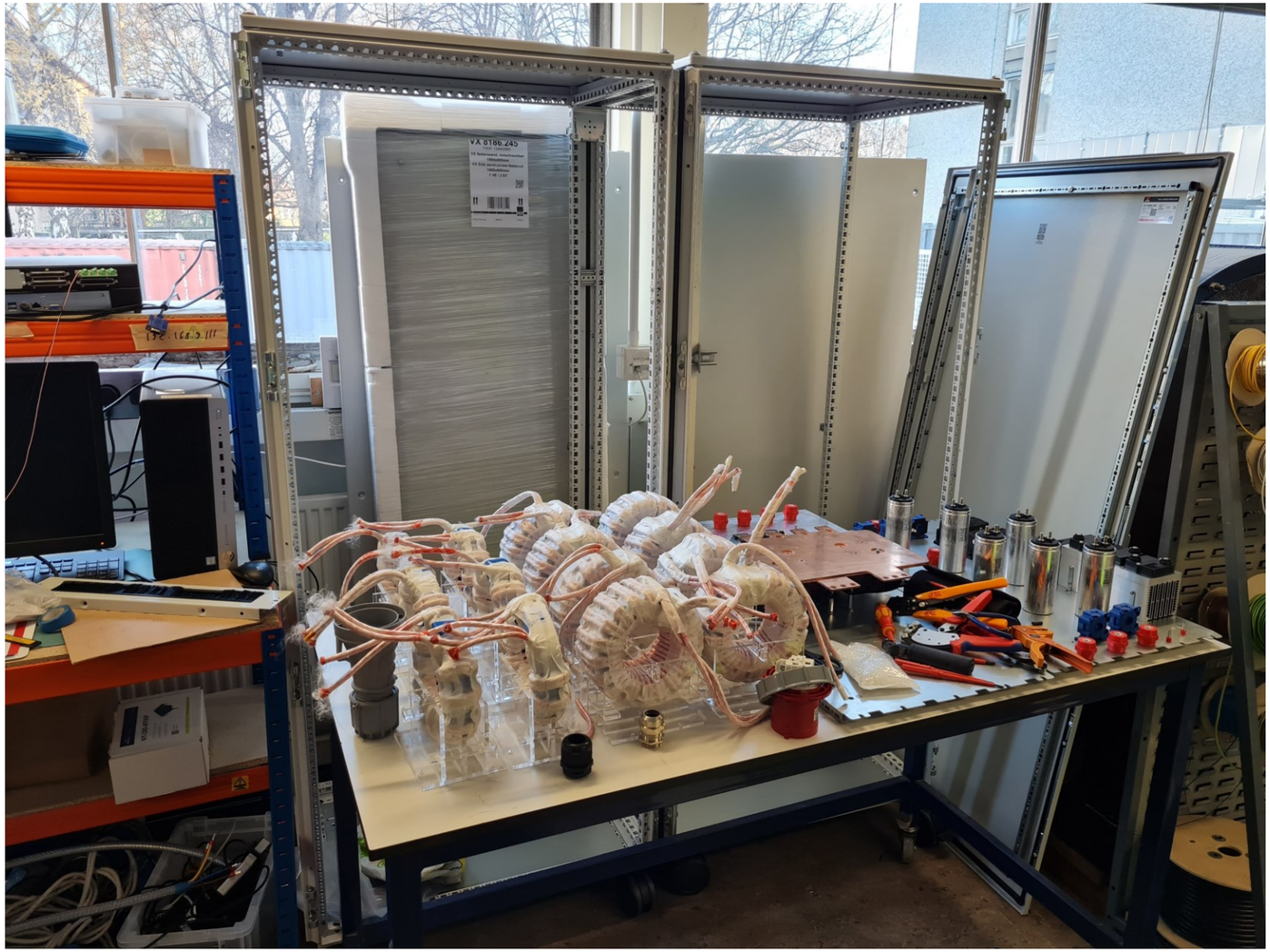

# LCL Filter Capacitor & Voltage/Current Sensors

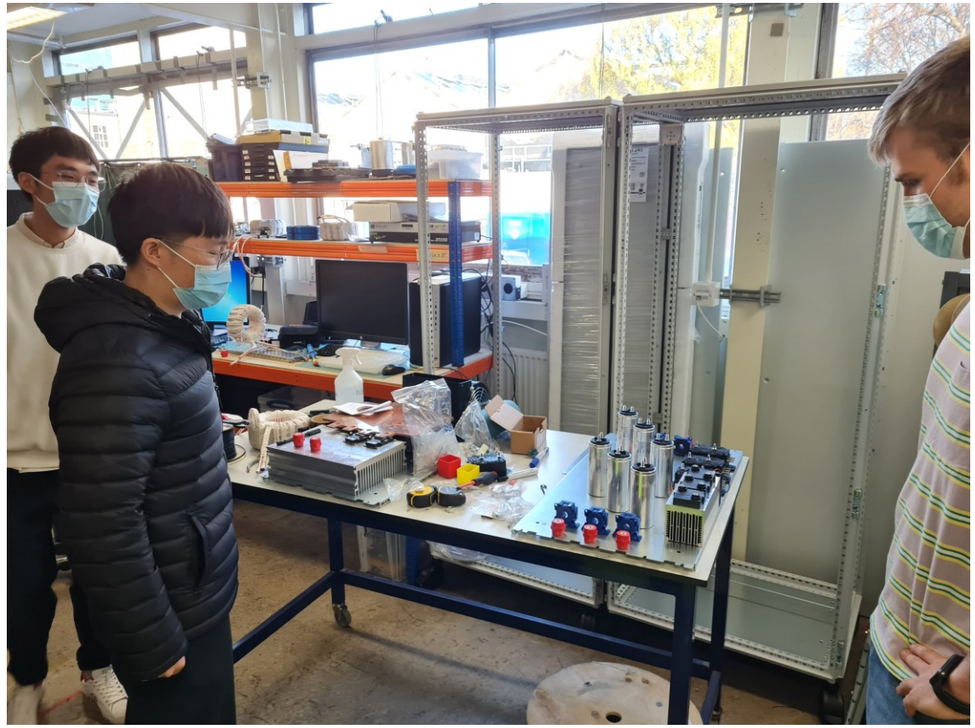



# Custom High Frequency LCL Filter Inductors



# One Channel almost ready to be installed into cabinet





Excellent design & build experience for PhD students – Project also provides an experimental platform for their work

# Thank You – Any Questions?