



**SP ENERGY  
NETWORKS**

# The *HVDC-OLPD* Monitor for High Voltage Direct Current (HVDC) Cable and Plant Condition Monitoring

Presented by Malcolm Seltzer-Grant, HVPD Ltd  
October 21<sup>st</sup>, LCNI Conference 2014



# Contents



- Introduction to Partial Discharge
- HVDC OLPD Monitoring System Project Summary
- Sensors Installation and Monitoring Results
- Conclusions

# Introduction

## What is partial discharge?

“A localised electrical discharge that only partially bridges the insulation between conductors and which can or can not occur adjacent to a conductor”

### **IEC60270 Definition**

## Why test for partial discharge?

PD activity is an indication of an **‘incipient fault’** in HV insulation and is widely regarded as the **best ‘early warning’** indicator of insulation deterioration.

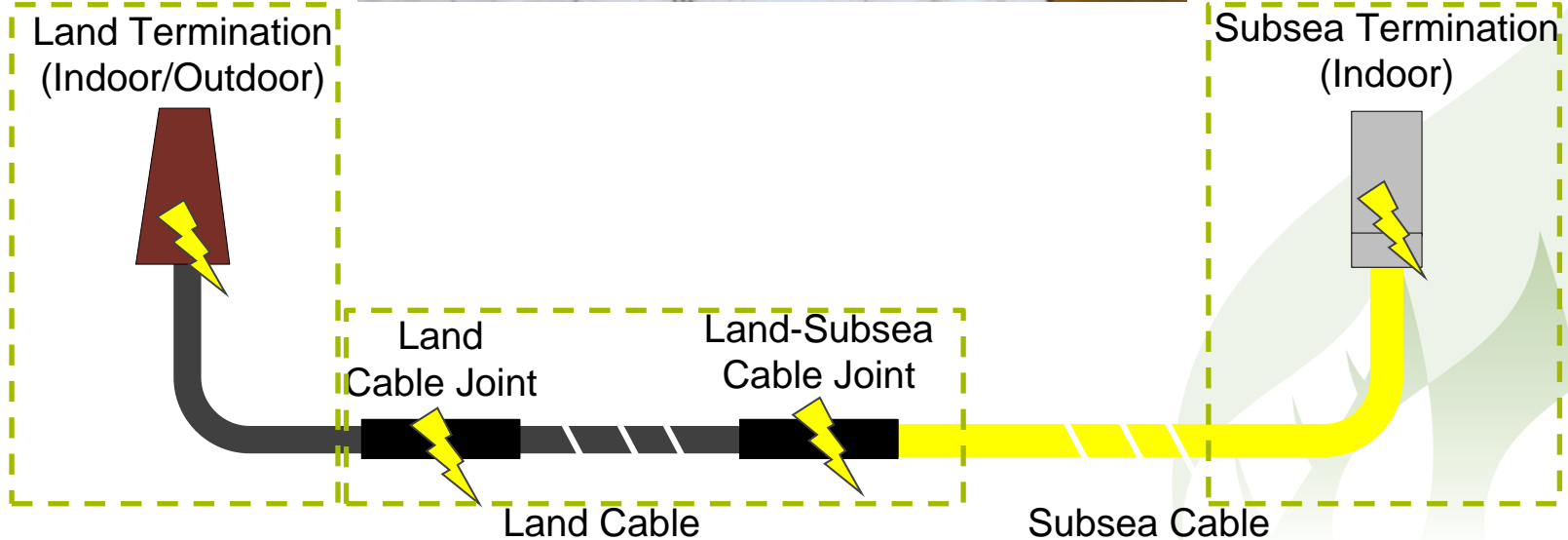
The detection of PD at an early stage enables preventative maintenance action **to avoid unplanned outages**.

## Why are SP Energy Networks interested?

SP Energy Networks are looking to use partial discharge condition monitoring on the Western HVDC Link, the subsea high-voltage interconnector being built between the west coasts of Scotland and England and have chosen to sponsor the development of devices from HVPD capable of providing this.



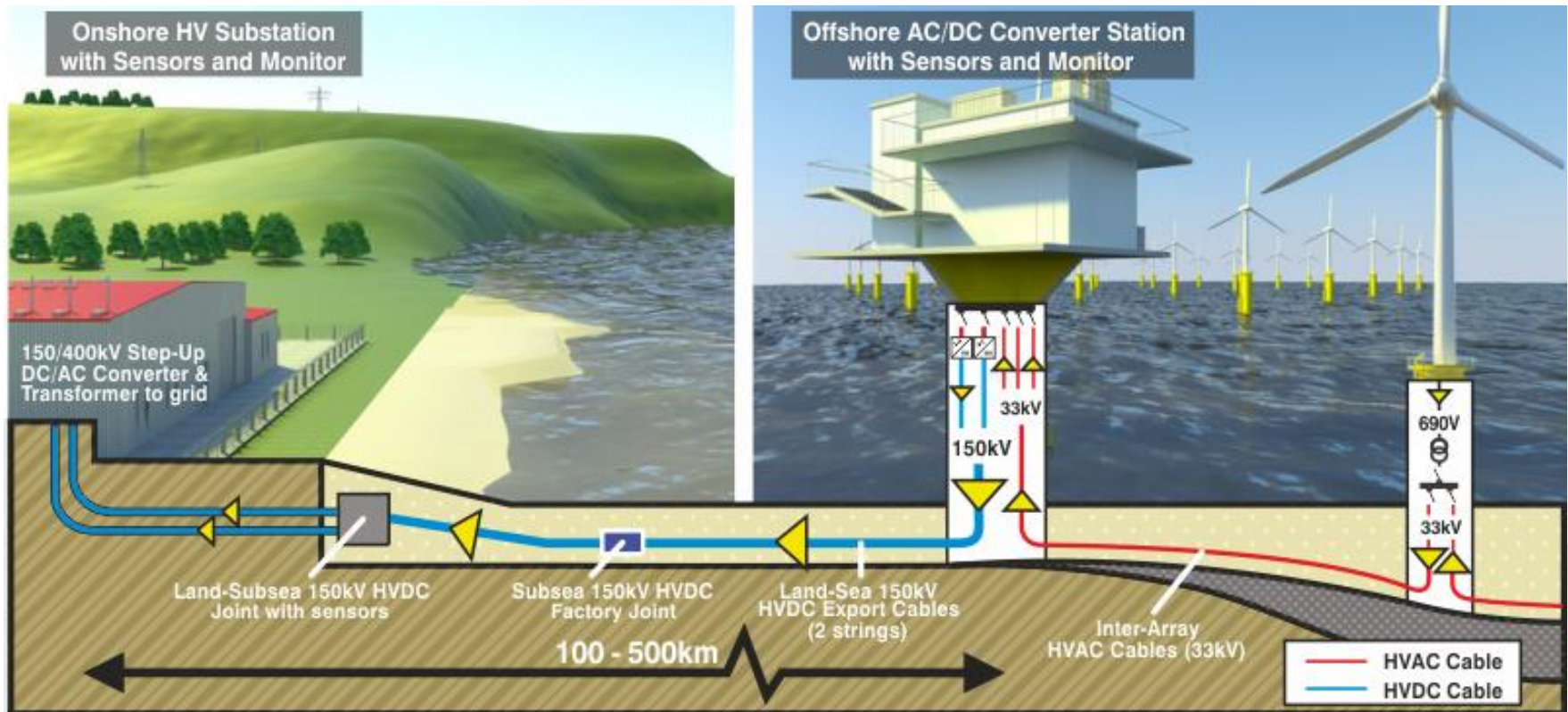
# Most Likely Sites of PD Activity in Subsea Cables





# HVDC Monitoring System Project Summary

- Condition monitoring technology for High Voltage Direct Current *HVDC subsea export cables and interconnectors*
- The application has been expanded to include the *state and condition monitoring of the connected AC/DC converter technology.*



# HVDC Monitoring System Project Summary



## HVDC-OLPD

**HVDC-OLPD Monitoring System Project Lifetime: 24 months  
(01/10/13 to 30/09/15)**

HVDC Subsea Export Cable and Interconnector Monitoring System

Supported by



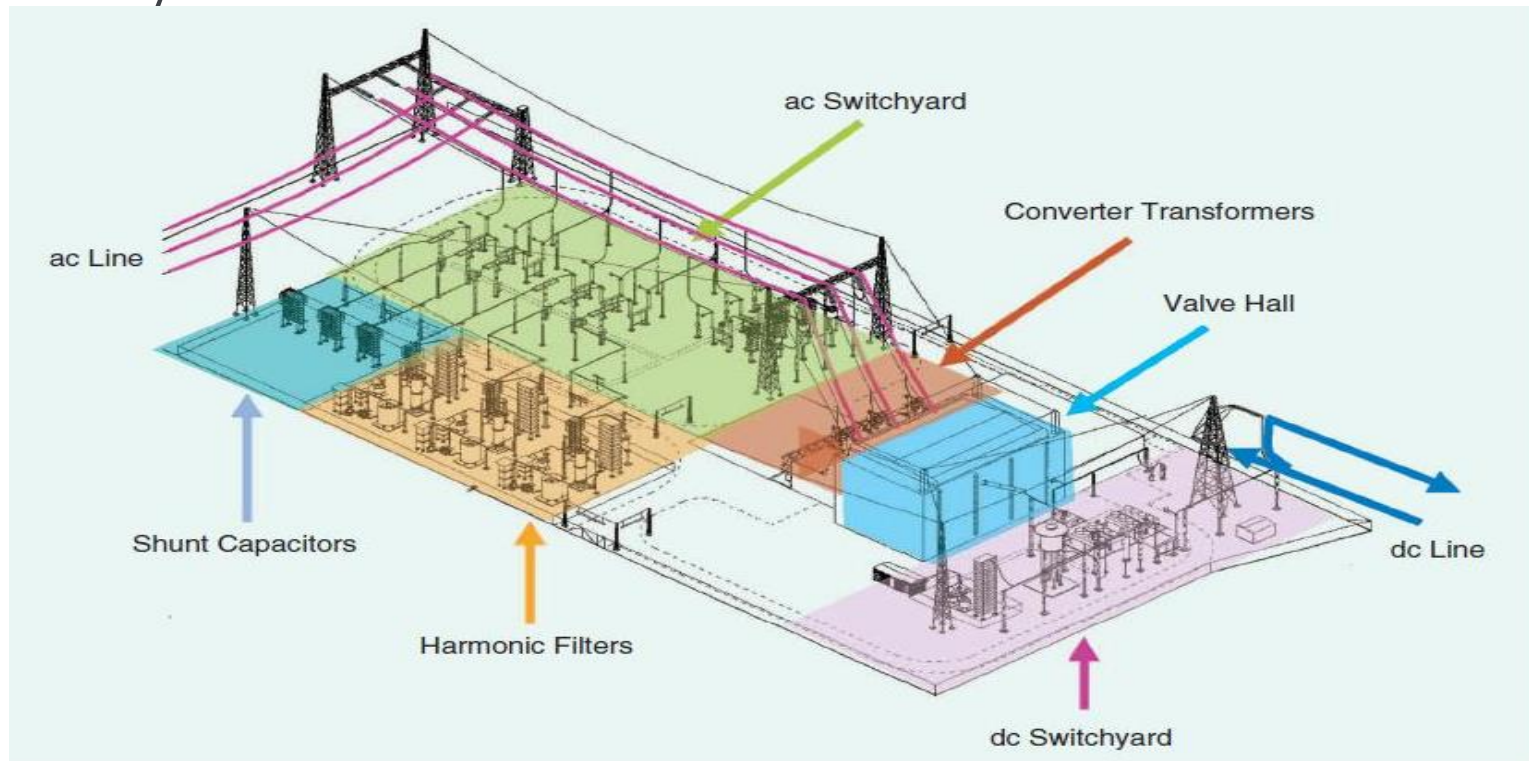
Developed with



- Suitable for the HVDC export cables and interconnectors that will be critical for to the development of a European electricity transmission supergrid and Round 3 offshore wind farms.
- The system will use on-line partial discharge (OLPD) detection combined with other electrical and thermal CM modules.
- The system is expected to enhance fault findings and provide early warning system for HVDC cable operators.
- Reduce electricity costs through lower operational and maintenance costs.

# HVDC Monitoring System Project Summary

- Definition of the first system **functional specification** was based on the topology of the HVAC/HVDC converter station and aims to monitor the **state and condition of parameters** which can interfere and undermine the reliability of the HVDC system.



Monopole HVDC converter station

# HVDC Monitoring System Project Summary



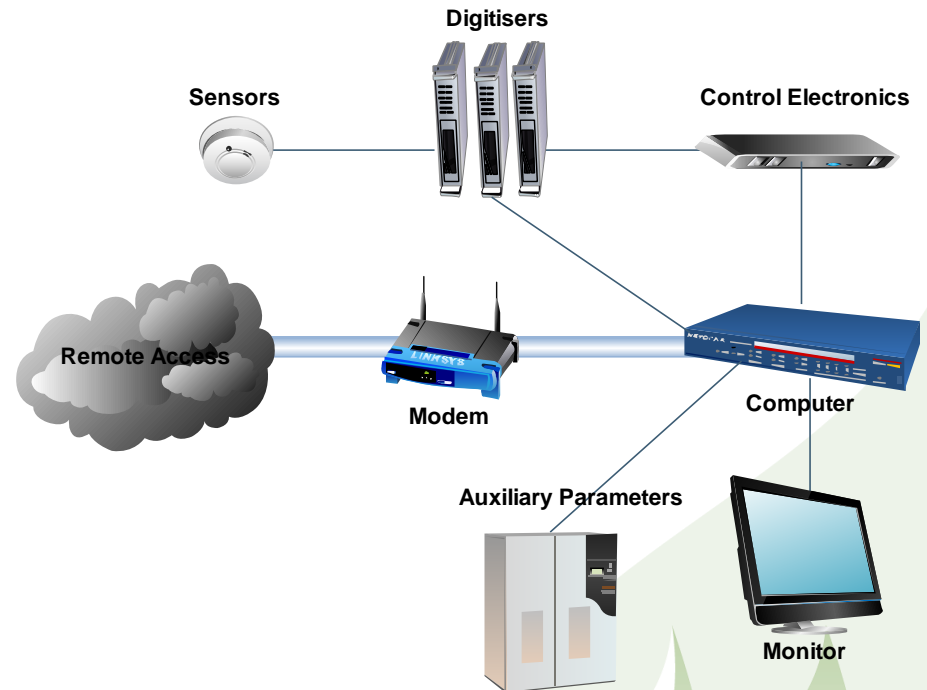
- The system will be based upon non-intrusive PD detection methods and investigatory work will include:
  - Evaluation of PD behaviour in HVDC cables
  - Cable Attenuation and PD Pulse Propagation
  - Noise and interference evaluation under DC
  - Power convertor monitoring
  - OLPD Sensor requirements
  - Cross-Correlation of OLPD Data with VSC Ripple, Transient Overvoltage and PQM Sensor requirements



# HVDC OLPD Monitoring System



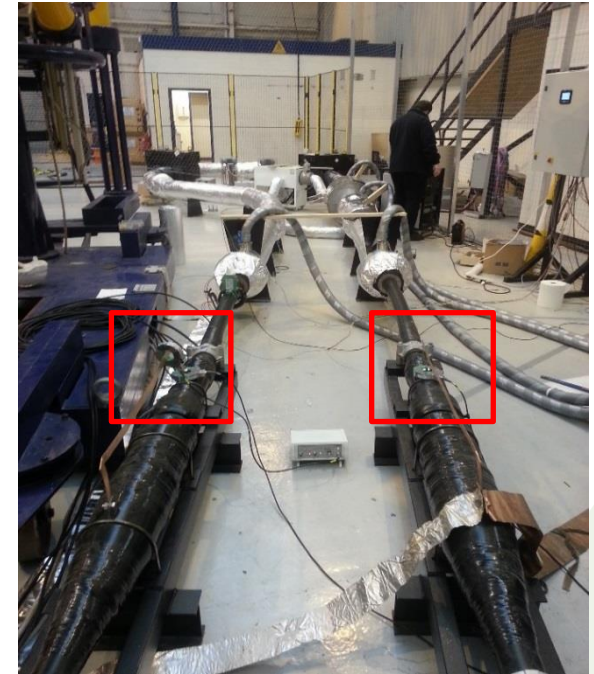
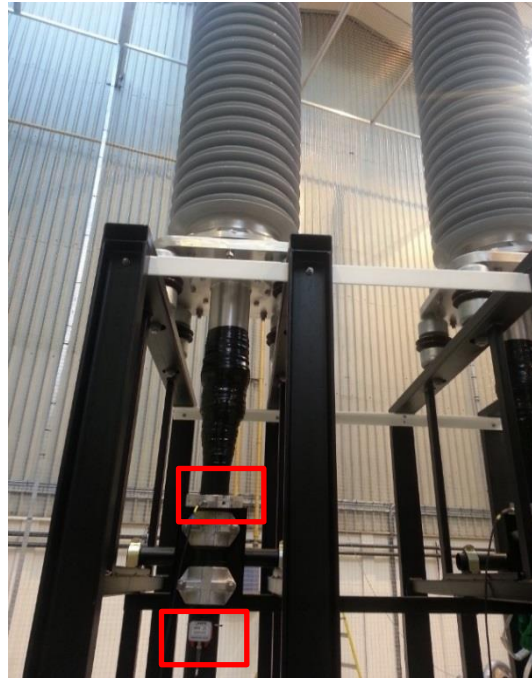
Photos of installed HVDC OLPD Alpha monitor systems at Alstom Grid HVDC Cable Ageing Facility and a HVDC interconnector



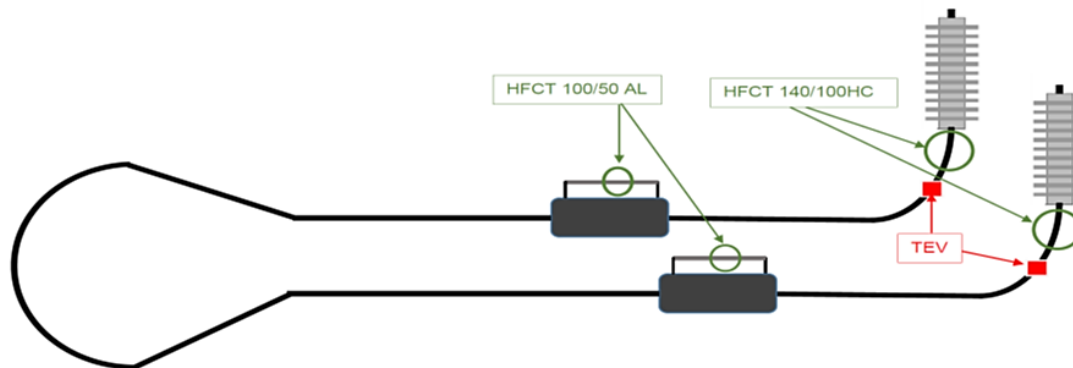
Block Diagram of the Alpha Monitor System

# Sensors Installation and Monitoring Results

## Alstom Grid HVDC Cable Ageing Facility



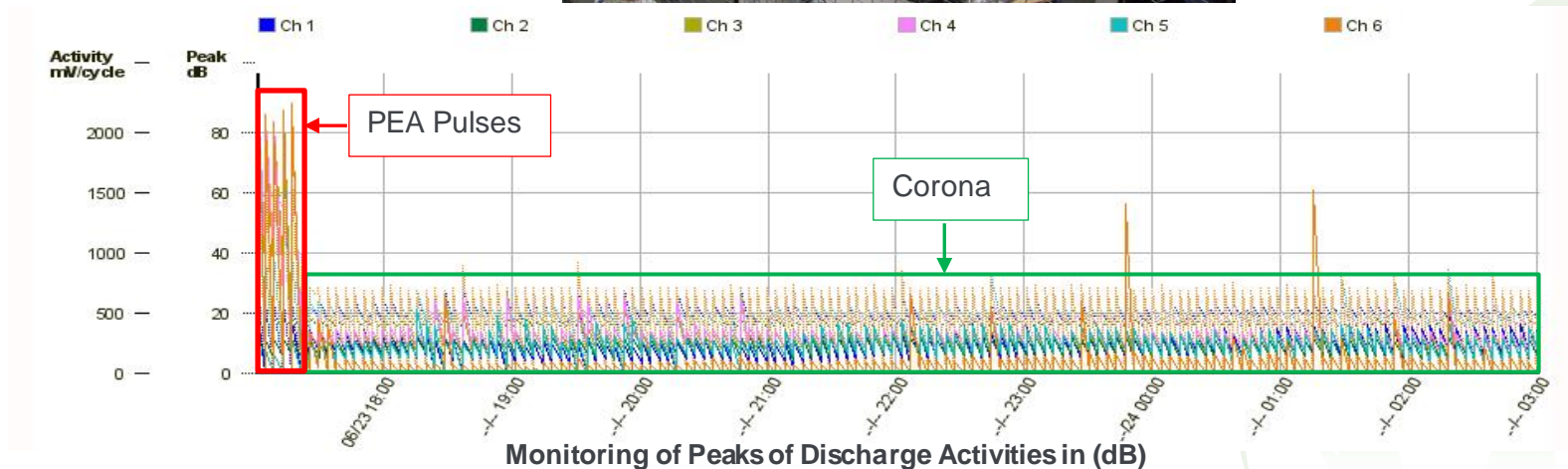
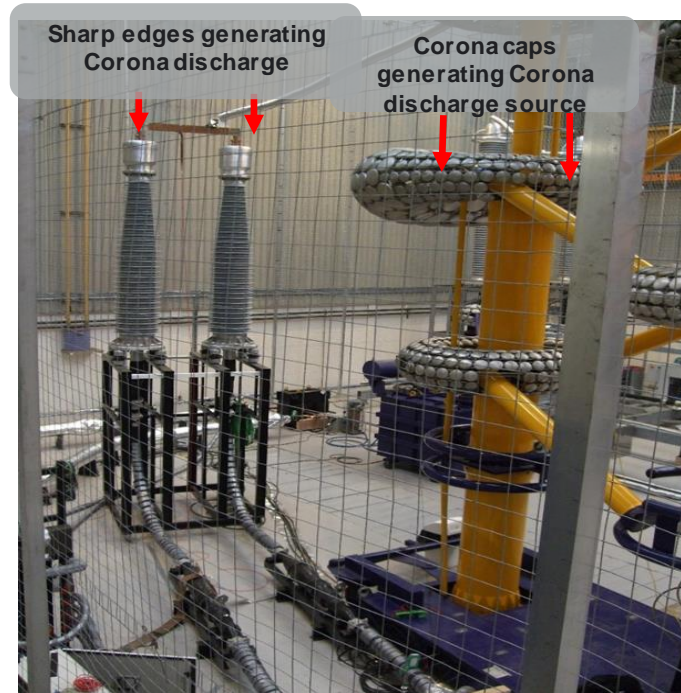
Positioning of three types of OLPD Sensor on the cable test Rig



# Sensors Installation and Monitoring Results

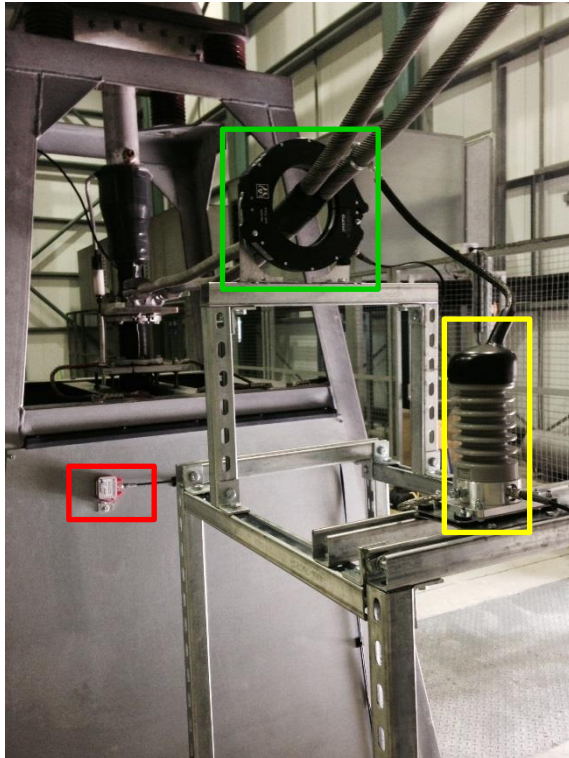
## Alstom Grid HVDC Cable ageing Facility

Corona Discharge Sources within the HVDC cable test bed



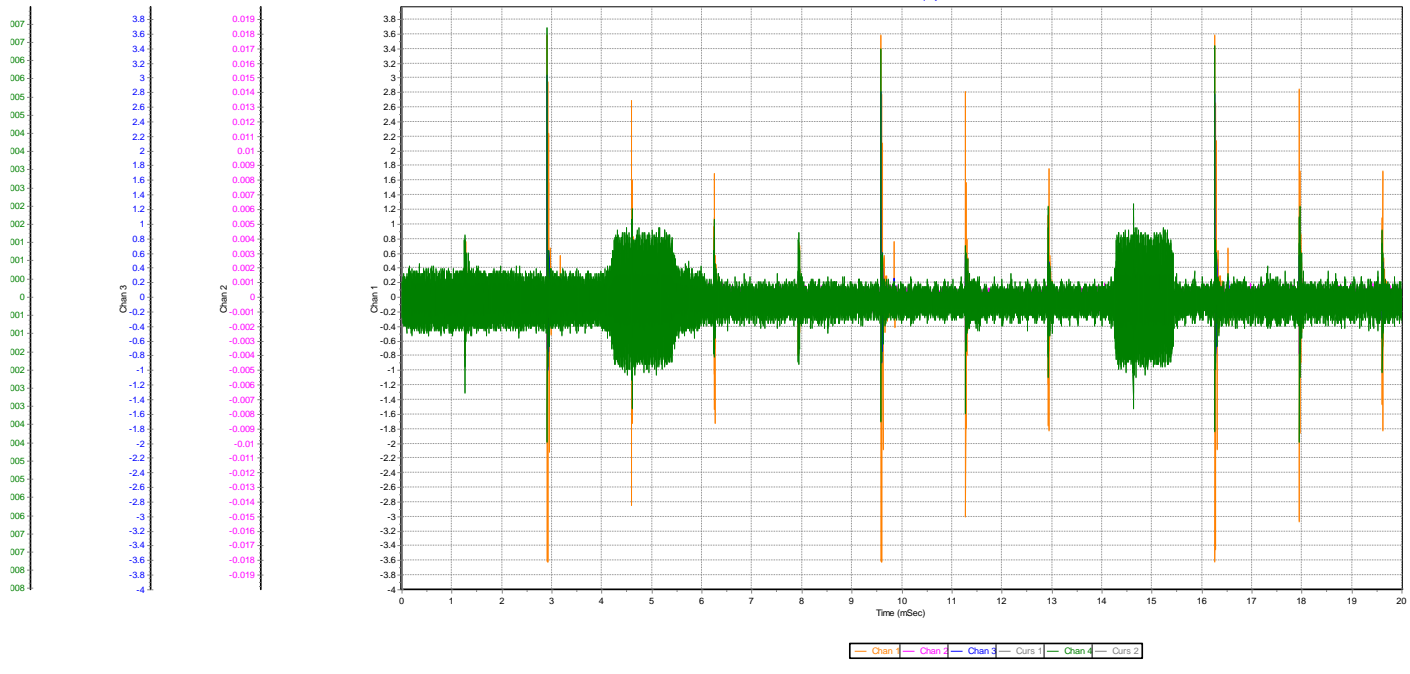


# Sensors Installation and Monitoring Results



Monitoring sensors installation of a HVDC cable interconnector

# Sensors Installation and Monitoring Results



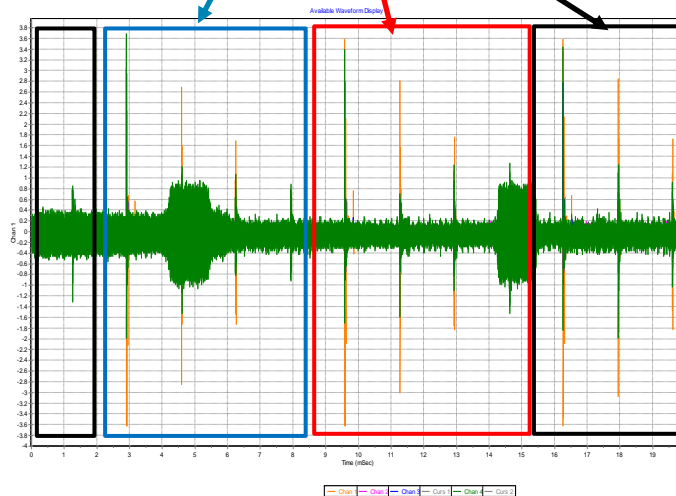
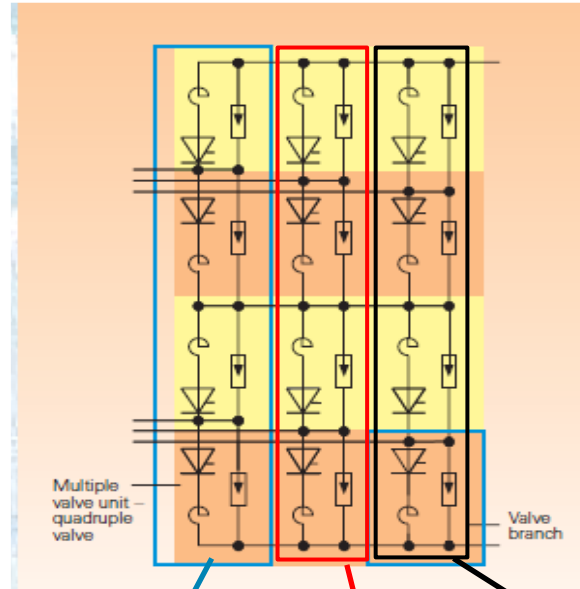
Acquired signals within the HVDC cable

- Signals peaks are the results of the 12 pulse quadruple valves (serial connection of two 6-pulse converter bridges coming from the two 3-phase systems).
- Decreasing peak height due to the transition of the signal through the quadruple valves



# Sensors Installation and Monitoring Results

Representation of the source of signals based on the circuit diagram of the quadruple valves



# Conclusion



- The OLPD-HVDC project aims to further the understanding of PD and insulation degradation on HVDC cable systems through both laboratory and field tests along with the development of monitoring hardware.
- Development monitoring systems are being deployed on operating HVDC cables to verify the functionality in a field environment.
- The system aim is to identify ‘incipient’ insulation defects prior to failure in order to enable preventative maintenance interventions to support condition-based management (CBM) and avoid unplanned outages.