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OPERATIONS & MAINTENANCE  
CONFERENCE IN THE ARAB COUNTRIES

# Implementation And Experimental Analysis Of Finding Partial Discharge Source Between A Transformer And Its Peripheral High Voltage Devices Using Several Heterogeneous PD Sensors.

By Amer Alzahrani  
Electrical Engineer

**GCCLAB**

    #OmaintecConf

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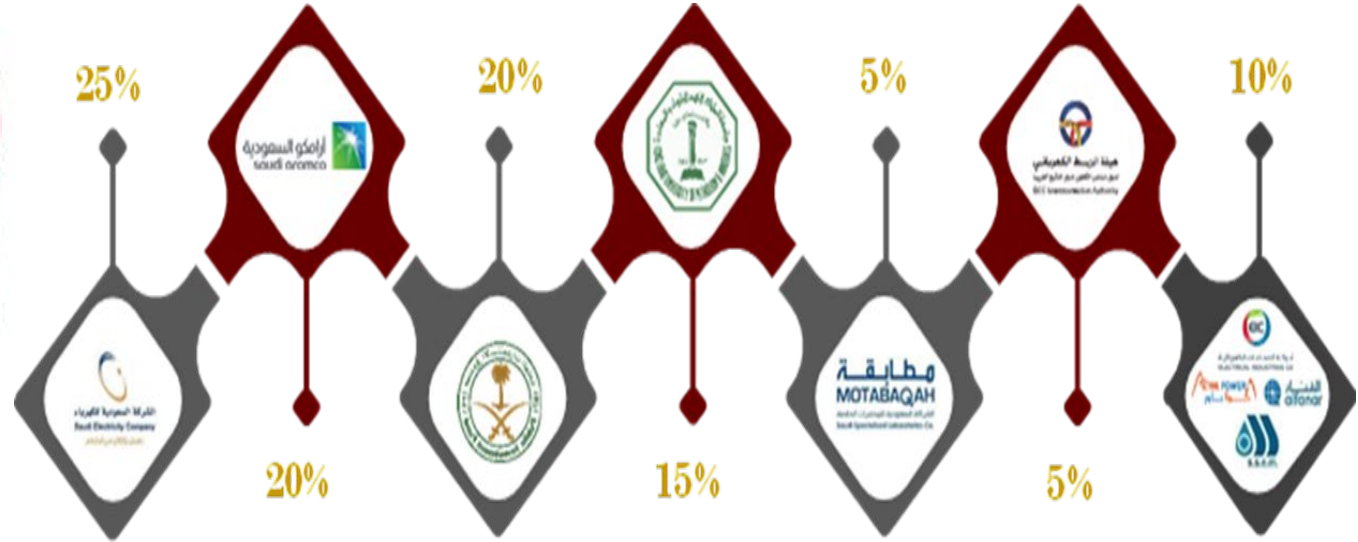
## Outlines

- GCC Lab Overview
- Introduction about PD
- Affect of PD
- Failures Statistic
- Type of PD
- How to Measure PD
- Type of Sensors and application
- Case Study
- Conclusion



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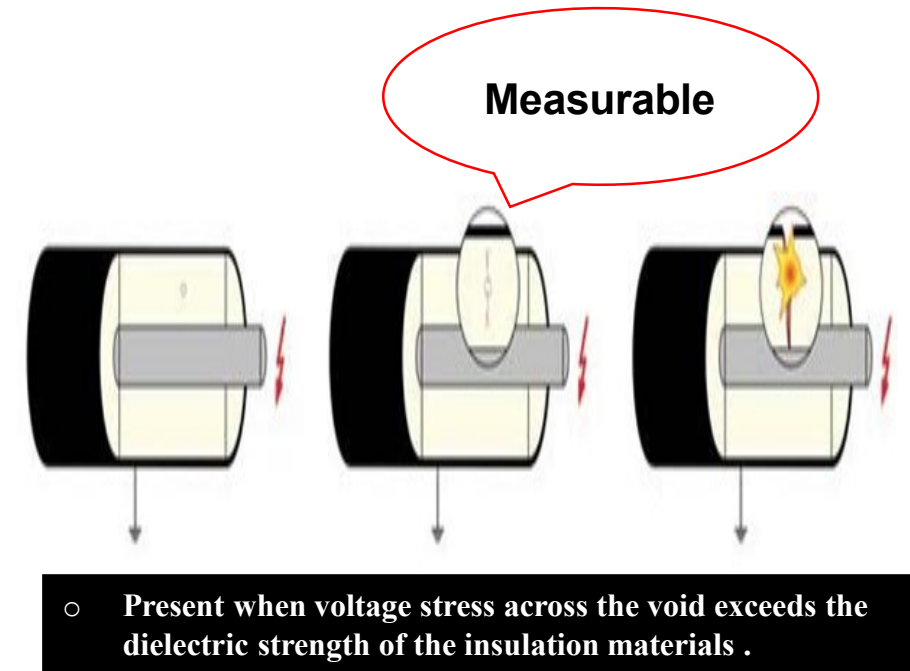
## GCC Lab المفتبر الفليبي



**GCC Electrical Testing Laboratory is a company owned by Saudi Electricity Company, Saudi Aramco, Saudi Public Investment Fund, GCC Interconnection Authority, and others in cooperation with top international companies in the field of power system/equipment from Europe and United States to provide a third-party service in engineering design validation, Testing, Inspection and Certification services as a local entity which is independent/unbiased organization. The below figure shows GCC Lab shareholders.**

## What is Partial Discharge ?

- ❑ **Partial discharge (PD)** is a localized dielectric breakdown of a small portion of a solid or liquid electrical insulation system under high voltage stress.
- ❑ **PD can manifest in multiple ways:**
  - Void discharge.
  - Surface discharge .
  - Corona discharge.



## Why the measurement of PD is so important?

- ❑ PD can be found in all types of medium and high voltage power equipment
- ❑ Detection of critical defects following a risk assessment
- ❑ In many cases PD phenomena are the preliminary stage of a complete insulation breakdown



## Affect of PD

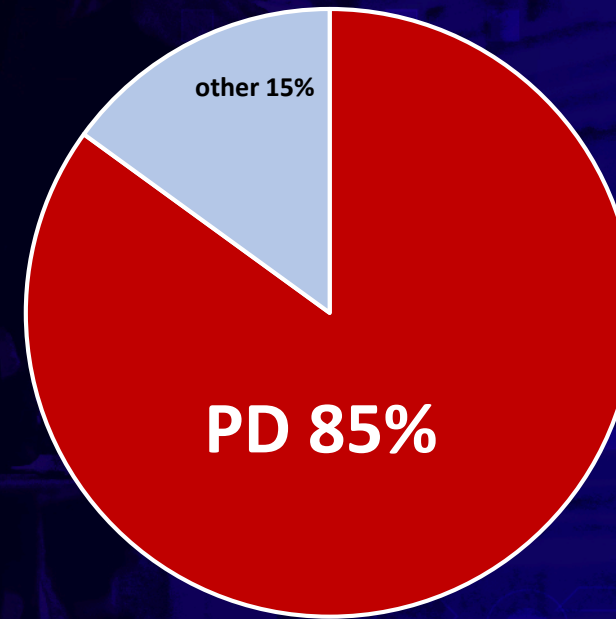


If PD Testing had been done at correct time, below breakdowns could have been avoided.

## Failures Statistic

- According to a study by IE partial discharge is responsible for 85 out of 100% disruptive failures in electrical substations
- ❖ According to the National Fire Protection Association (NFPA 70B), the leading cause of electrical failures is insulation breakdown.

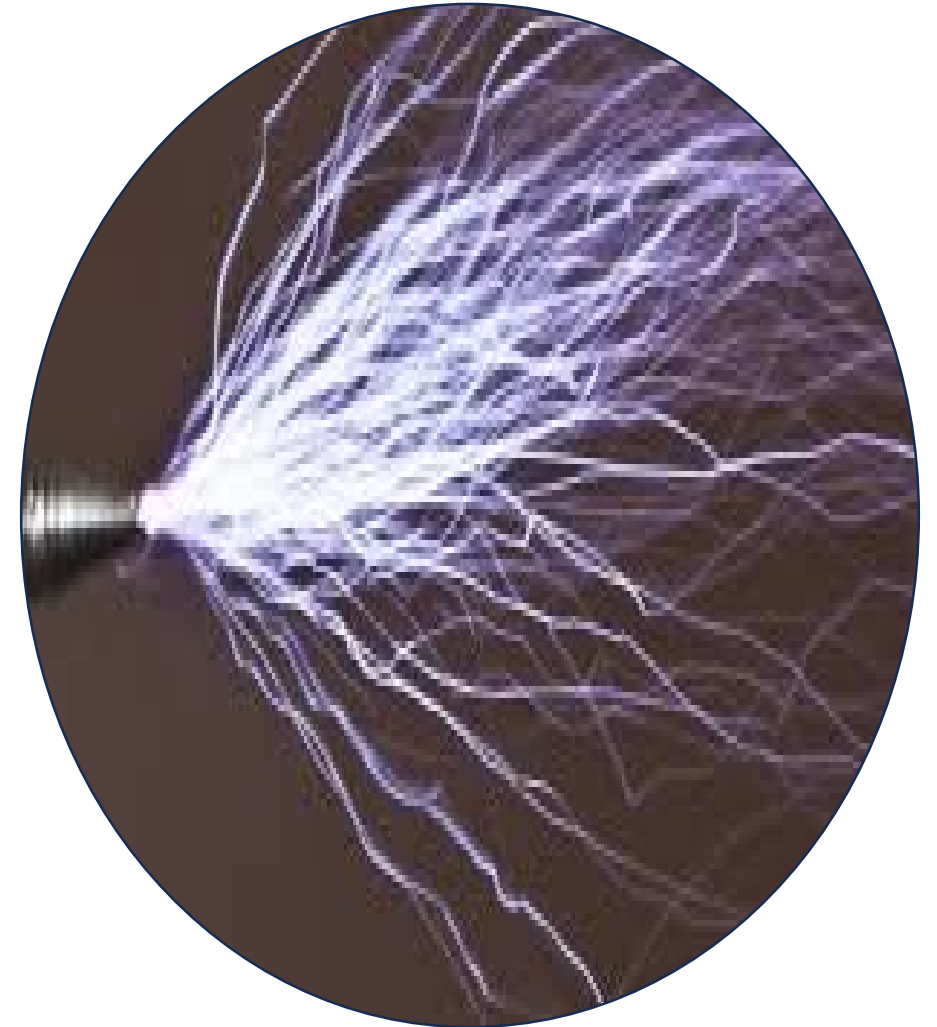
## Failures in Electrical Substations



■ partial discharge ■ another

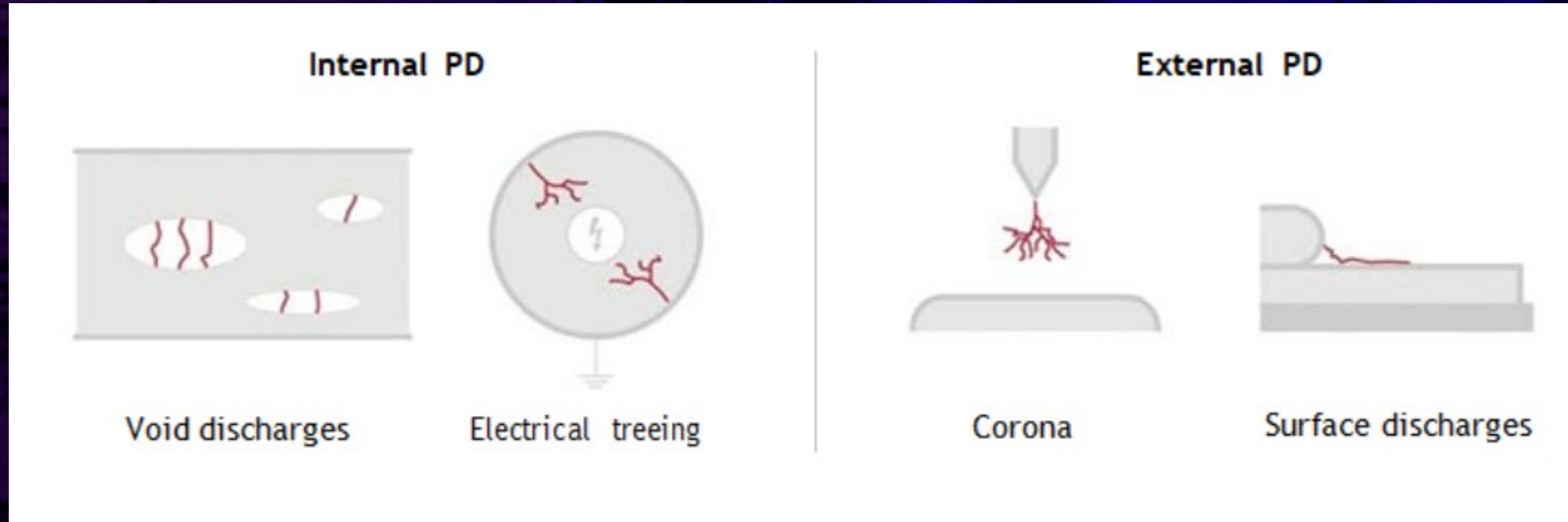
## General root causes of PD.

- Humidity.
- Assembling.
- Quality of insulation materials.
- Incomplete or improper processing.
- Aging of paper insulation.
- Fundamental design related problem.



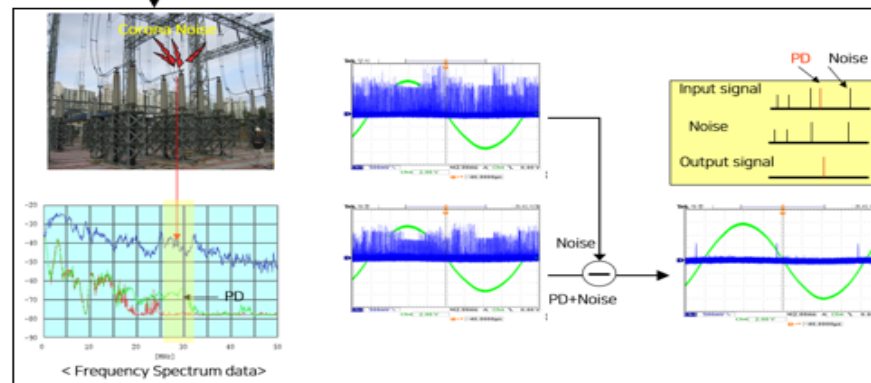
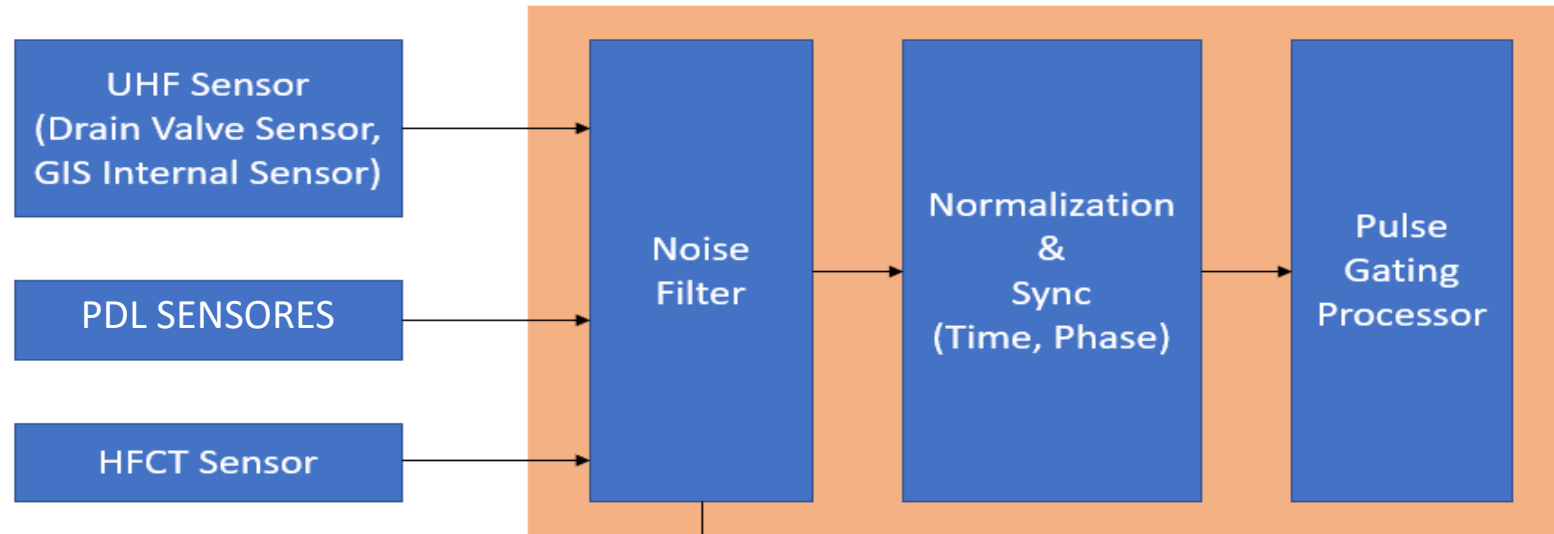


**Partial Discharge can be broken down into two categories.**



- ❖ **The Major causes of failure of high voltage power facilities are insulator defects and aging, which can be detected by measuring partial discharge using suitable techniques.**

# A method of finding Partial discharge by using PD SENSORES .



## A method of Partial discharge in an Experimental Environment in a Lab



# Sensors:

Electrical



Acoustic

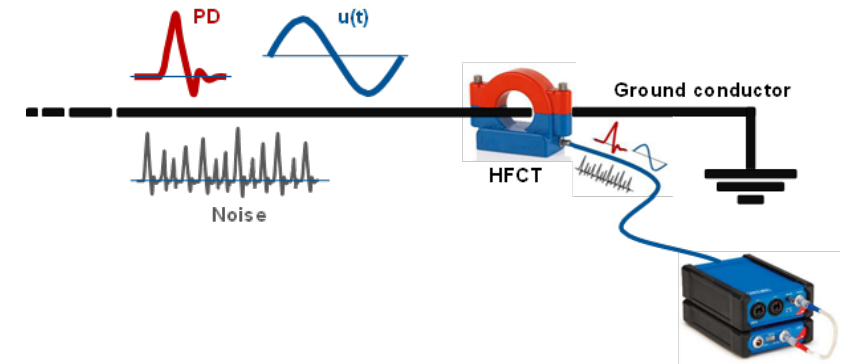
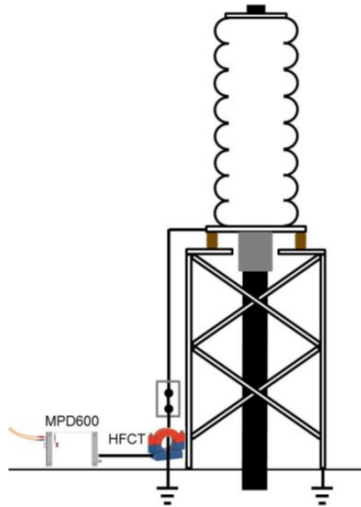


UHF



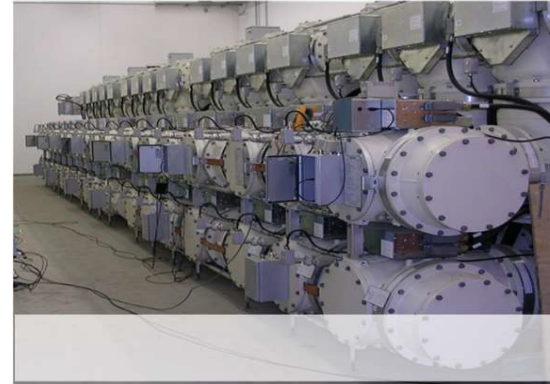
## Method High frequency current transformers (HFCT)

- HFCT's are used to detect and measure partial discharge in shielded Cables.
- Originally used for online PD measurement via the earthing system
- Designed to provide a very accurate, noncontact, nondestructive measurement of either a single or a repetitive bipolar or unipolar pulse.



## Ultra-High Frequency (UHF) PD measurement and analysis for:

- ❑ **Applicable assets:**
  - Gas-insulated switchgear (GIS).
  - Gas-insulated busbar (GIB).
  - Oil-filled **power transformers** .
  - High-voltage **cable terminations**.



**GIS**



**Power transformers**

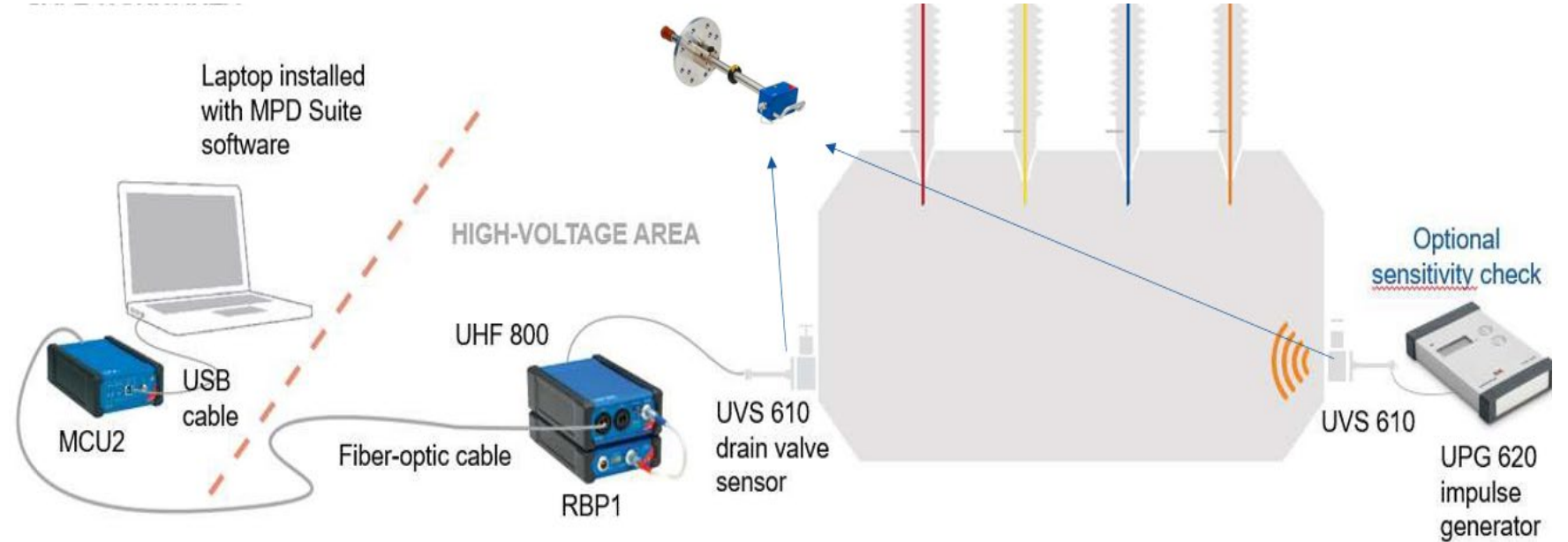


❖ **UHF Sensors**



**OHL cable terminations**

## Method Ultra-High Frequency (UHF) partial discharge (PD)



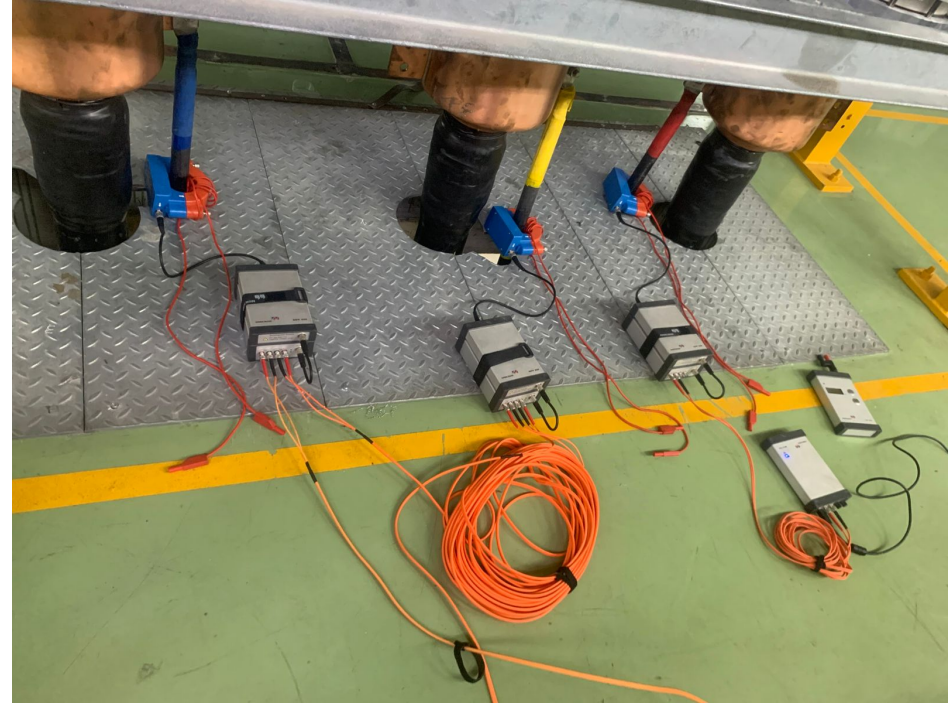
- ❑ **UHF valve sensor.**
- Compatible with DN 50 and DN 80 oil valves.
- Offers trigger signal for acoustic.
- PD measurements.



Method Online PD measurement.



TR cable side HV/LV



GIS cable high side.

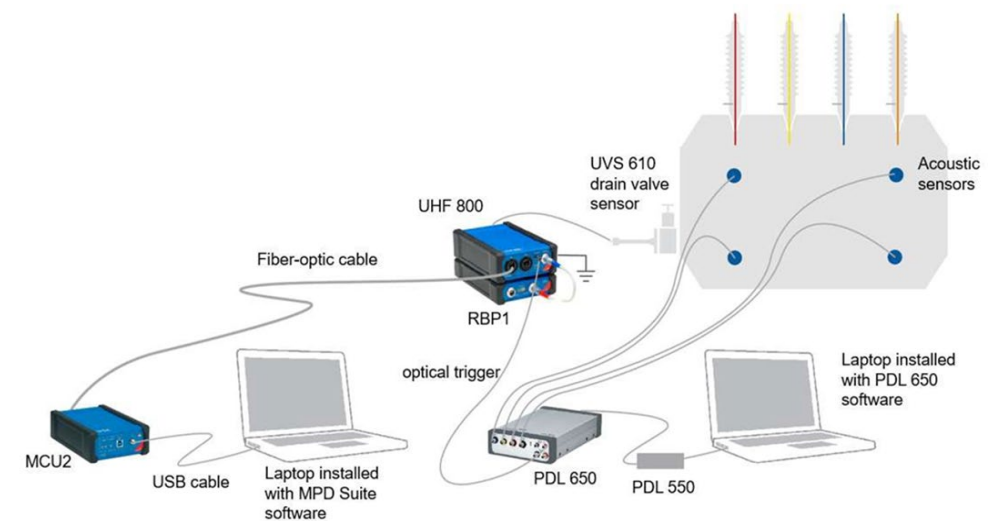


## Method of Partial discharge localization (PDL).

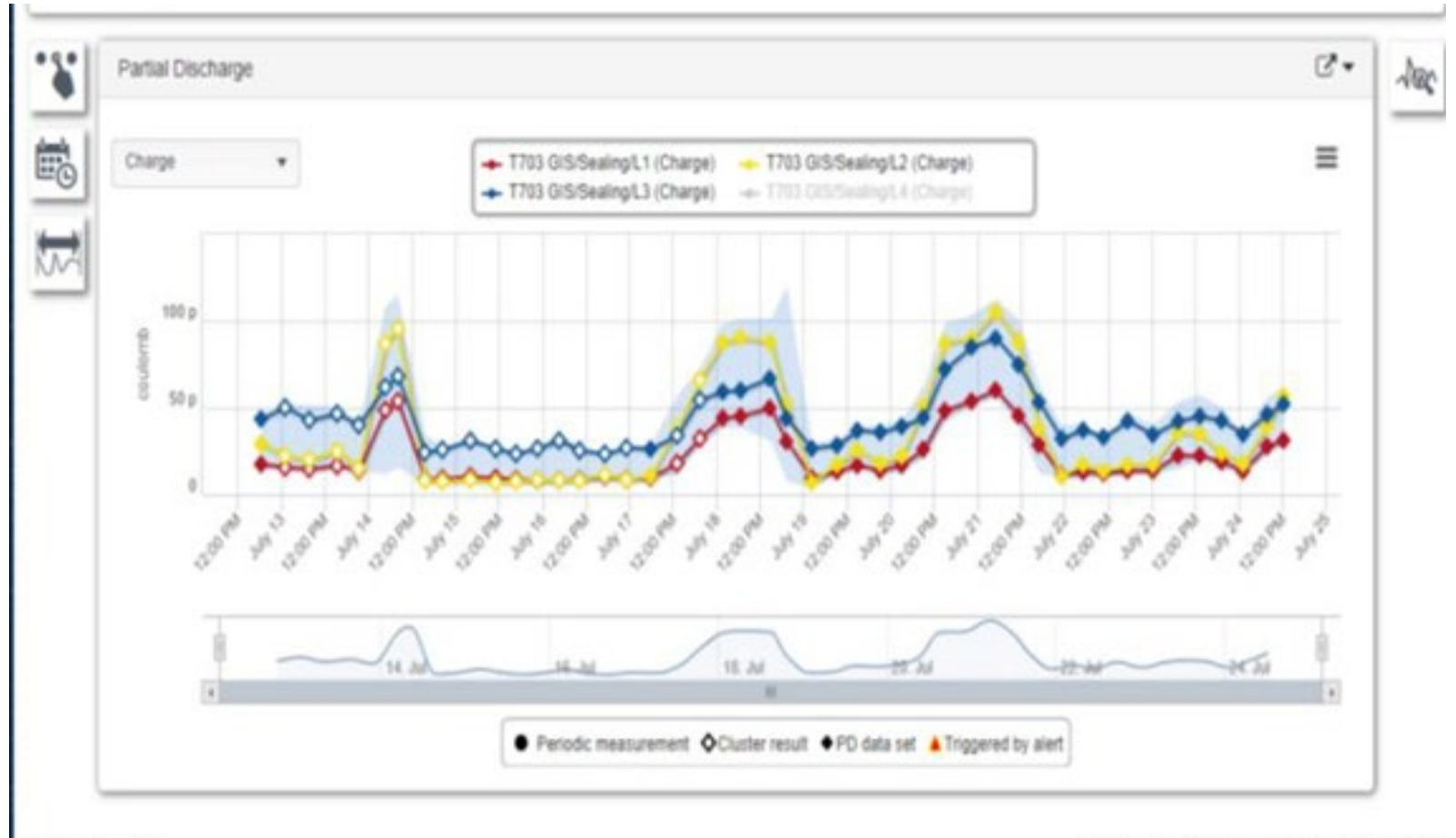
- PDL records the measured values of multiple acoustic sensors simultaneously (magnetically mounted to transformer).
- Partial discharge localization in oil-filled power transformers in the **Site** or in the **Factory**.



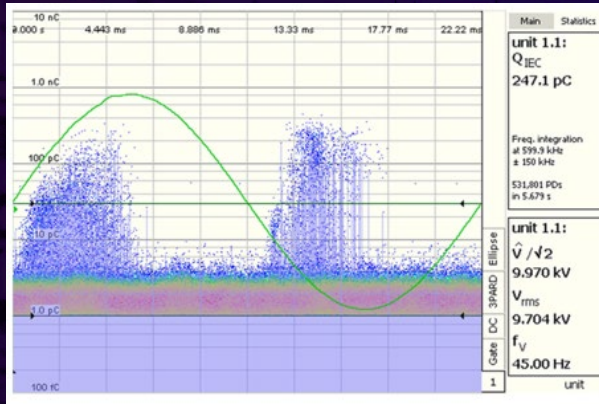
150 kHz acoustic sensor DT15L.



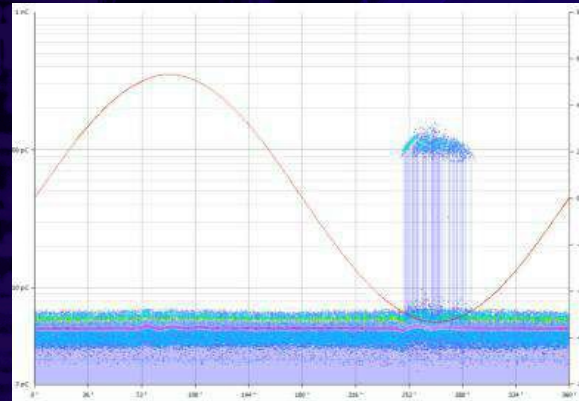
# Case Study



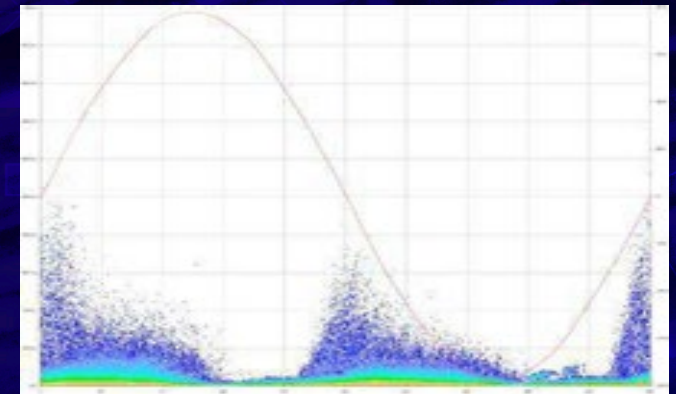
# PD Pattern.



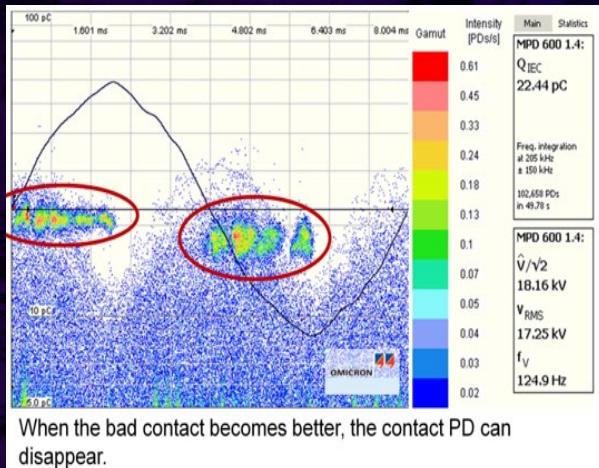
Surface discharge



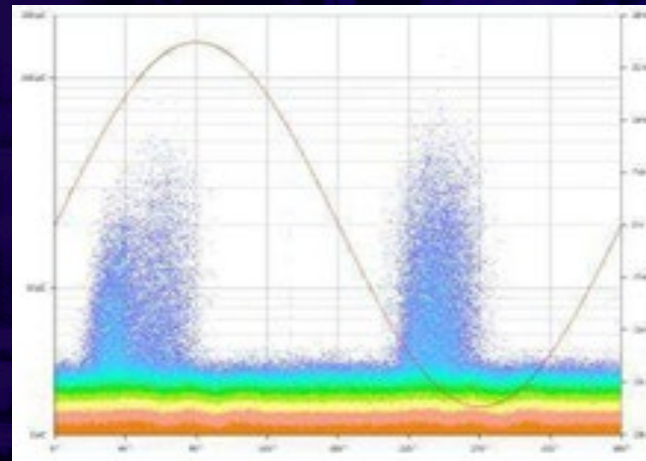
Corona HV



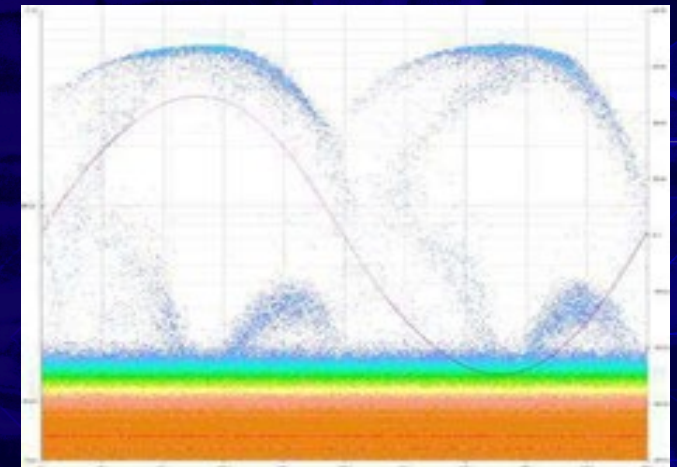
Internal PD Transformer



Contact PD



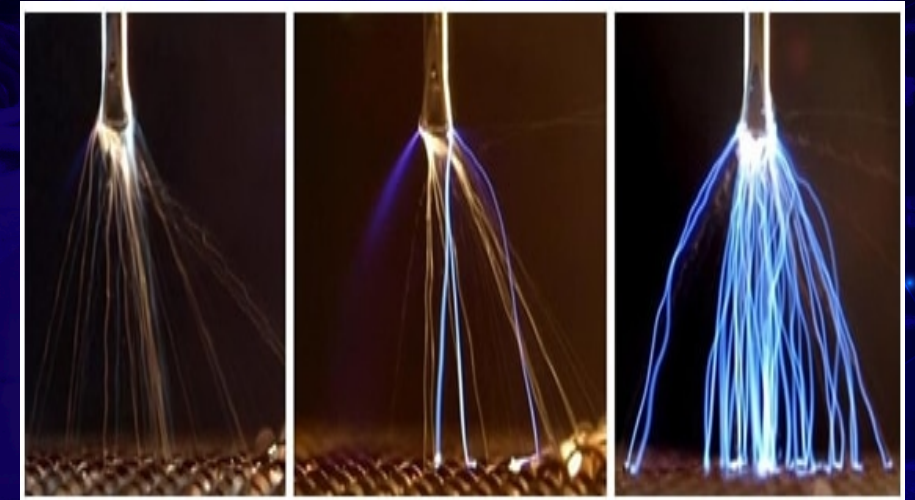
Cavity Cable Termination



Internal PD CT

## Conclusion

- Partial discharge (PD) can occur in medium and high-power equipment insulation.
- PD represents a breakdown between two conducting electrodes.
- If PD is not detected, the damage to the electrical equipment can be catastrophic and cause serious safety events in the workplace.
- Different methodologies for denoising the PD signals have been introduced.
- Periodic PD testing and analysis of the insulation will ensure safe operation of the electrical system.





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