Paris Session 2022

Requirements for Artificial Intelligence Platform addressed to Automatic Assessment of Insulation Condition of Indoor and Outdoor Installations through Partial Discharge Monitoring Contribution

SC D1 Materials and Emerging Test Techniques

PS-1 Testing, Monitoring and Diagnosis

Q1.06

Would industry and academia working together more closely lead to new or improved algorithms?

Antonio Sánchez Esteban (Spain)

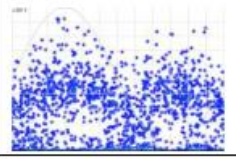
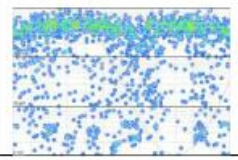
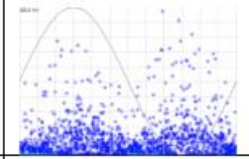
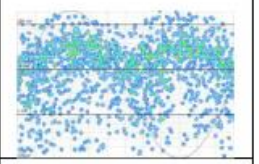
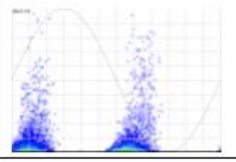
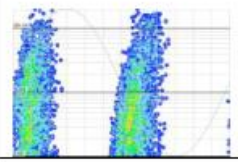
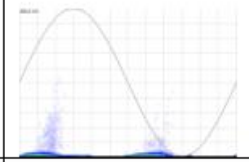
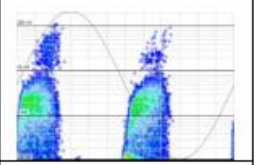
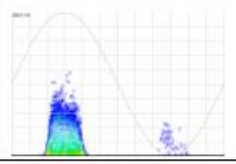
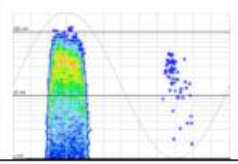
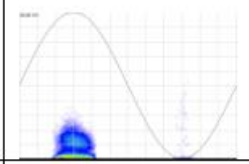
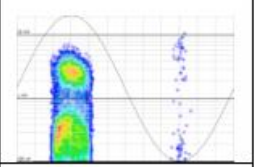
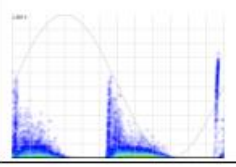
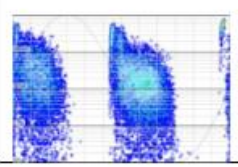
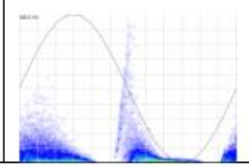
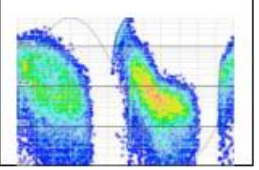
Platform for Automatic Insulation Diagnosis

RE and Elewit has launched this project in collaboration with Academia (LCOE) and a PD instruments Manufacturer (AMPACIMON):

- Adaptable to any PD monitoring system for use in HV installations.
- Project aims
  - Recognize different insulation defects.
  - Applicable to AIS, GIS, Cable Systems and Power Transformers.
  - Based on advanced PRPD pattern recognition techniques.

Platform for Automatic Insulation Diagnosis

A Convolutional Neural Network (CNN) has been developed using the images of the PRPD patterns represented in logarithmic and linear scales.

PRPD Patterns in Linear and logarithmic Scales		Sensor Type			
		UHF Sensor		HFCT Sensor	
H.V. installation	Example of defect type	Linear Scale	Logarithmic Scale	Linear Scale	Logarithmic Scale
GIS	Moving Particles				
	Particles on insulation				
	Protrusion				
Cable System	Void				

Platform for Automatic Insulation Diagnosis

- **The AI tool learns** the differential and representative characteristics of each PRPD pattern corresponding to each type of defect measured by different sensor types.

- **The most difficult issue** in developing an automatic insulation diagnosis tool is **to have a wide collection of PRPD patterns:**
  - related to different insulation defects
  - with different levels of degradation (aging),
  - occurring in different high voltage installations
  - acquired by means of different types of PD sensors.

- A large number of PRPD patterns are needed for the learning process of an AI tool to reach a good level of **reliability**, not only to **identify** a defect in a specific type (for example in GIS), but also **not to confuse** it with other defects that occur in other installations (for example, in a cable system or in a power transformer).

Platform for Automatic Insulation Diagnosis

Allowed/forbidden misdiagnoses of the automatic IA tool

	PREDICTION															
TRUE	Noise	Surface SF6	Moving particles SF6	Protusion SF6	Cavity SF6	Floating SF6	Cavity Cable	Internal Surface Cable	Floating Air	Surface Air	Corona Air	Surface Oil	Moving particles Oil	Protusino Oil	Cavity Oil	Floating Oil
Noise																
Surface SF6																
Moving particles SF6																
Protusion SF6																
Cavity SF6																
Floating SF6																
Cavity Cable																
Internal Surface Cable																
Floating Air																
Surface Air																
Corona Air																
Surface Oil																
Moving particles Oil																
Protusino Oil																
Cavity Oil																
Floating Oil																

	Result is 100% satisfactory
	Result is aceptable
	Possible issue in insulation not detected
	Posible defect with confussion of insulation material (SF6-Cable): Without localization of the defect is required additional measurmement
	Posible defect with confussion of insulation material (SF6-Oil): Without localization of the defect is required additional measurmement
	Posible defect with confussion of insulation material (Oil-Cable): Without localization of the defect is required additional measurmement
	Critical failure (false positive or false negative of a defect)

A Convolutional Neural Network (CNN) has been developed for a *Platform for Automatic Insulation Diagnosis*

CONCLUSIONS:

Good recognition results for different insulation defects.

Identifies where the defect is in: AIS, GIS, Cable System or Power Transformer.

Based on advanced PRPD pattern recognition techniques.

The allowed/forbidden misdiagnosis table must be met.

Thank you for your attention !