

# 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***

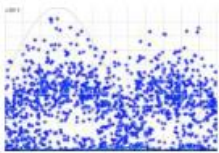

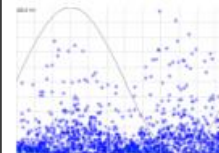

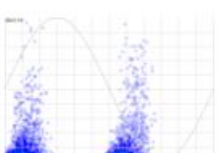
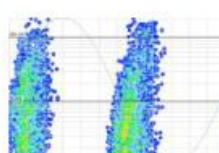
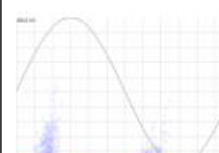
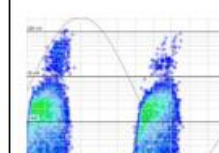
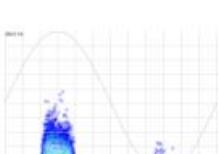
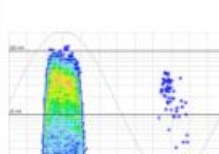
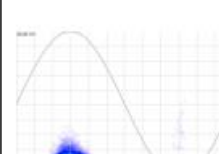
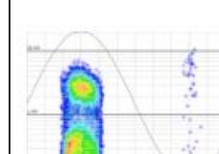
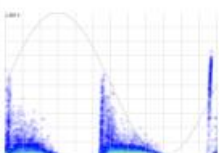
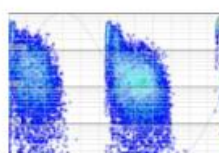
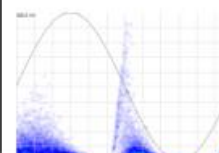
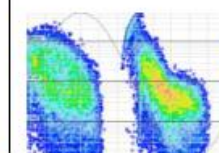
*RE and Elewit has launched this project in collaboration with Academia (LCOE) and a PD instruments Manufacturer (AMPACIMON):*

- 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

TRUE	PREDICTION															
	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	Green	Red	Red	Red	Red	Red	Red	Red	Yellow	Yellow	Green	Red	Red	Red	Red	Red
Surface SF6	Red	Green	Yellow	Yellow	Yellow	Yellow	Blue	Blue	Red	Red	Red	Blue	Blue	Blue	Blue	Blue
Moving particles SF6	Red	Yellow	Green	Yellow	Yellow	Yellow	Blue	Blue	Red	Red	Red	Blue	Blue	Blue	Blue	Blue
Protusion SF6	Red	Yellow	Yellow	Green	Yellow	Yellow	Blue	Blue	Red	Red	Red	Blue	Blue	Blue	Blue	Blue
Cavity SF6	Red	Yellow	Yellow	Yellow	Green	Yellow	Blue	Blue	Red	Red	Red	Blue	Blue	Blue	Blue	Blue
Floating SF6	Red	Yellow	Yellow	Yellow	Yellow	Green	Blue	Blue	Red	Red	Red	Blue	Blue	Blue	Blue	Blue
Cavity Cable	Red	Blue	Blue	Blue	Blue	Blue	Green	Yellow	Red	Red	Red	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Internal Surface Cable	Red	Blue	Blue	Blue	Blue	Blue	Green	Green	Red	Red	Red	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Floating Air	Yellow	Red	Red	Red	Red	Red	Red	Red	Green	Yellow	Yellow	Red	Red	Red	Red	Red
Surface Air	Yellow	Red	Red	Red	Red	Red	Red	Red	Yellow	Green	Yellow	Red	Red	Red	Red	Red
Corona Air	Green	Red	Red	Red	Red	Red	Red	Red	Yellow	Green	Yellow	Red	Red	Red	Red	Red
Surface Oil	Red	Blue	Blue	Blue	Blue	Blue	Light Blue	Light Blue	Red	Red	Red	Green	Yellow	Yellow	Yellow	Yellow
Moving particles Oil	Red	Blue	Blue	Blue	Blue	Blue	Light Blue	Light Blue	Red	Red	Red	Yellow	Green	Yellow	Yellow	Yellow
Protusino Oil	Red	Blue	Blue	Blue	Blue	Blue	Light Blue	Light Blue	Red	Red	Red	Yellow	Green	Yellow	Yellow	Yellow
Cavity Oil	Red	Blue	Blue	Blue	Blue	Blue	Light Blue	Light Blue	Red	Red	Red	Yellow	Yellow	Green	Yellow	Yellow
Floating Oil	Red	Blue	Blue	Blue	Blue	Blue	Light Blue	Light Blue	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Green

Green	Result is 100% satisfactory
Yellow	Result is acceptable
Orange	Possible issue in insulation not detected
Blue	Possible defect with confusion of insulation material (SF6-Cable): Without localization of the defect is required additional measurement
Dark Blue	Possible defect with confusion of insulation material (SF6-Oil): Without localization of the defect is required additional measurement
Light Blue	Possible defect with confusion of insulation material (Oil-Cable): Without localization of the defect is required additional measurement
Red	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 !**