

INTEGRATED ASSET MONITORING SYSTEMS

Prysmian Electronics



PROJECT

Engineering and Commissioning of On Line
Motor Partial Discharge Monitoring System at
various locations

CUSTOMER

Prysmian Reference

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MONITORING SYSTEMS FOR ASSET MANAGEMENT

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Tails

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Contents

1. Combined Monitoring Solutions	5
2. Overview.....	8
2.1 Scope of Work	8
2.2 System Design.....	8
3. Description of the System	9
3.1 Pry-Cam Acquisition Unit.....	9
4. The Prysmian Electronics Integrated Platform	10
5. Training	16
5.1 Objective: Focusing on Theory of Partial Discharges	16
5.2 Objective: Learning Partial Discharges Measurements and Usage of PRY-CAM Monitoring Software	16
5.3 Objective: Introduction to Analyzing Partial Discharges Measurements.....	16
6. Expert Support for PD Analysis	16

List of Figures

Figure 1 : IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)	6
Figure 2 : Advantages of Combine Monitoring Systems	6
Figure 3 : Evolution of Maintenance Strategy	7
Figure 4: A Pry-Cam Grids acquisition unit.....	10
Figure 5: Prysmian Electronics Software Visualization (PD, Pressure, Current, DTS, DAS)	11
Figure 6: Prysmian Electronics Software Current visualization	12
Figure 7: Prysmian Electronics Software Circuit Visualization	12
Figure 8: Prysmian Electronics Software Main Page.....	13
Figure 9: Partial Discharge Alarm Settings	13
Figure 10: Third Party Sensors Alarm Settings	14
Figure 11 enhanced software environment of Prysmian Electronics	14
Figure 12 enhanced software environment of Prysmian Electronics	15

1. Combined Monitoring Solutions

Prysmian Electronics' portfolio of supply allows to monitor electrical equipment by means of Partial Discharge, Distributed temperature and acoustics technologies as well as monitoring of screen currents and pressures.

From such a solution, not only will Customer benefits from the full coverage of all the hazardous happening in the circuit and nearby it, but the customer will definitely achieve monetary saving mainly arising from:

- **Increased reliability** thanks to enhanced fault prevention
- **Downsized maintenance** efforts thanks to the continuous condition-assessment
- Quicker and **effective risk-based decision** thanks to load predictions and

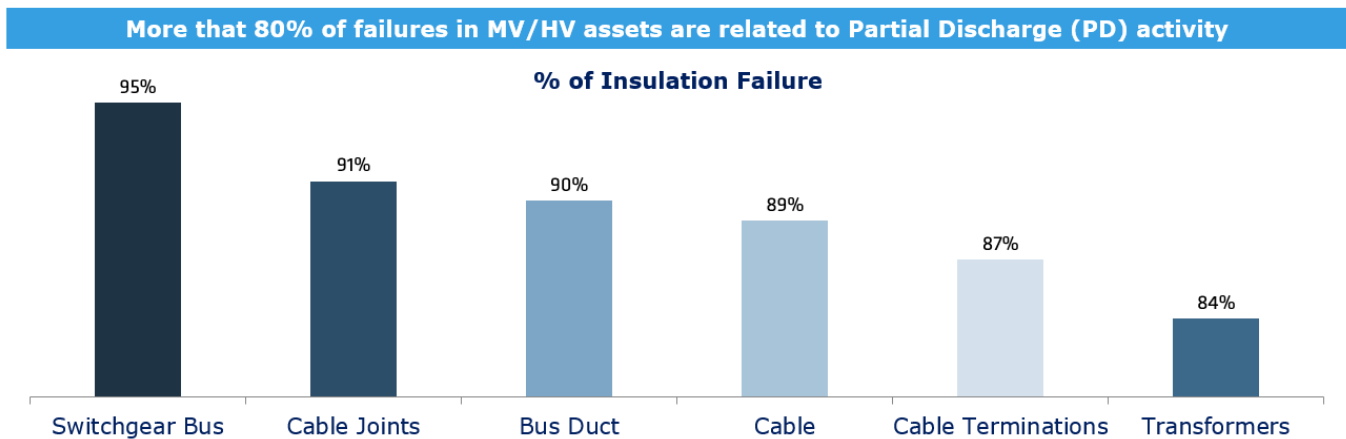


Figure 1 : IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)

MONITORING SYSTEMS	HVAC/HVDC CABLE SYSTEMS				
	After Installation test	Early Fire / Hot Spot Detection	Failure Prediction	Optimized Operation	Failure location
Partial Discharge	✓		✓	✓	
Distributed Temperature Sensing + Real time Thermal Rating	✓	✓		✓	✓
Distributed Acoustic Sensing	✓		✓		✓
Combined Monitoring System (PD+DTS+RTTR+DAS)	✓	✓	✓	✓	✓

Figure 2 : Advantages of Combine Monitoring Systems

Condition based maintenance for cables and electrical assets with Prysmian electronics has the following advantages:

- All systems integrated under **one platform**
- **World Wide support** from Prysmian PD experts thanks to our Internet of Things approach
- **Non-intrusive system:** reduce electrical risk, give the possibility to do retrofitting without switching off the circuit

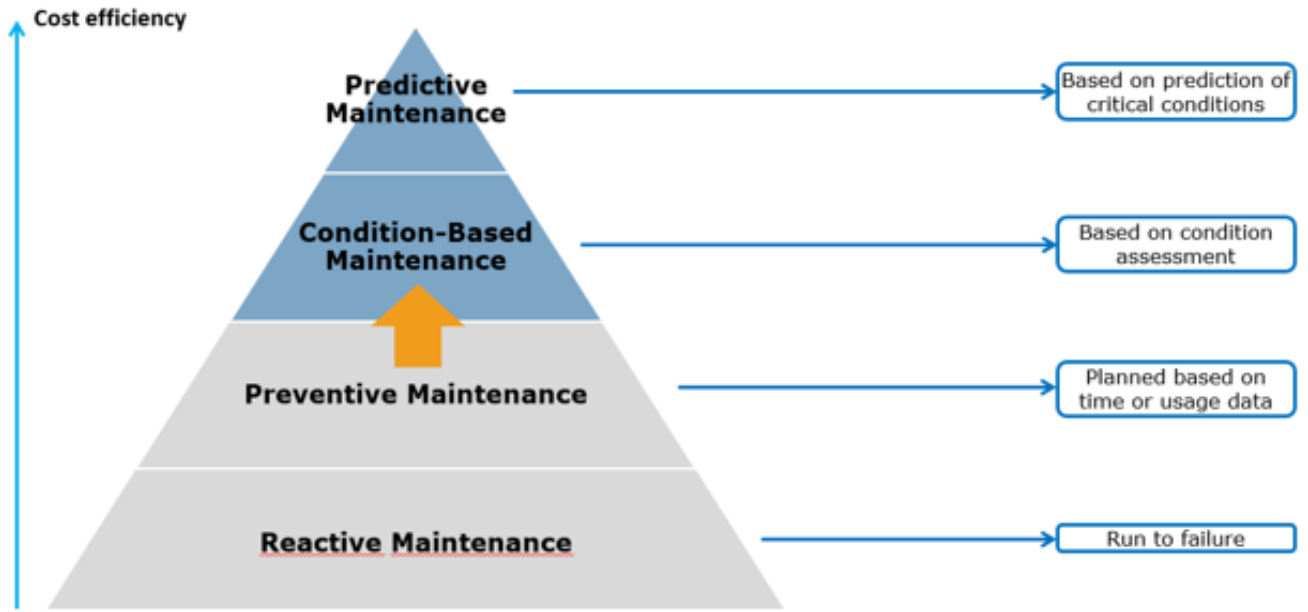


Figure 3 : Evolution of Maintenance Strategy

2. Overview

This a Technical Submittal for Engineering, Procurements construction, testing, Commissioning, and training of partial discharge Monitoring System for all Specified Motors in this project

2.1 Scope of Work

This document is to describe the details of the Online Partial Discharge monitoring systems to be installed permanently to monitor MV Motors in different locations in the country. The aim of our system is to provide an OLPD continuous monitoring system to monitor Partial Discharge (PD) activity of remote assets, such as rotating machines, connected via power cables to a central switchboard to provide complete circuit / network monitoring.

2.2 System Design

2.2.1 PD Measurement:

The PD Measurement will be consisting of two main items:

- PRY-CAM Grids: Acquisition Unit (Please check "Annex 3")
- No.3 Coupling Capacitor Sensors connected installed in the MV switchgear cable compartment:

Each PRY-CAM Grid will have 12 channels to accommodate and monitor at least 4 motors. In one Substation we will make the monitoring from both ends, one end using coupling capacitors and the other end (motor cable box) we will use Pry Cam Wings.

A local server will be included, to be housed close to one end of the circuit, including a server for control and storage purposes, the related UPS, communication equipment and Internet access. The local server will be connected with customer's network through SDH telecom card. For the Safety of the Customer's Network a cyber security system will be installed.

2.2.2 Communication:

FO cable(s) (MM) will be needed to transmit data from PRY-CAM Grids to server location. No.2 fibres per each PRY-CAM Grid are required for direct connection between each Grid and the local server.

The local server will be connected with Company's network through SDH telecom card. For the Safety of the Cpmpany's Network a cyber security system will be installed.

2.2.3 Power Supply:

The power requirement is maximum 15W on each side. The way to feed PRY-CAM Grids acquisition units inside the pumping station is as follows:

- Usage of LV Line: The proposal does not include any work related to LV Line drawn

2.2.4 Data Visualization:

Prysmian Electronics Integrated Platform will be implemented for data visualization. (Please check Chapter 4)

2.2.5 Applicable Standards

Tests according to EN/IEC 61010-1, IEC 61326, IEC 60034-27-2 Section 6.4.3

3. Description of the System

The Partial Discharge (PD) monitoring system has the purpose of continuously monitoring the PD activity in the Switchgear Termination and the Motor. The continuous monitoring of PD activity will provide information of the state of the Motors along the status of the cable and Cable termination connected to the switchgear. The monitoring system will be able to provide related alarms on its wear, aging and potential damages happening to the Rotating machine (Motor).

The PD monitoring system is composed by several electronics devices able to continuously acquire the PD at every single accessory in the circuit and inside the motor. PD data will be analysed in real-time and stored in a central server. This allows the circuit supervisor or a remote operator to browse each measure and to track the PD trend for each accessory. If anomalous conditions are met, specific alarms are automatically sent to the operator.

A coupling capacitor PD sensor will be installed on each termination in the cable compartment in the Switchgear, allowing it to measure and monitor PD activity in both switchgear termination and Motor. Sensors will be connected to PRY-CAM Grids (acquisition units). A Pry-Cam Grids acquisition unit will be installed in proximity of Switchgear. Each Pry-Cam unit will be connected to a central server where performed measures and data will be uploaded. The server executes further processing on the gathered data so to allow a simple and effective visualization of component status and trends. The server, as well as each Pry-Cam unit, can be accessed also from a remote location (e.g. HQ of Company) to perform remote diagnosis or specific measures.

3.1 Pry-Cam Acquisition Unit

The Pry-Cam™ Grids is an integrated, autonomous Partial Discharge (PD) monitoring systems for electric components (cables, joints, terminations, GIS, transformers, Motors, etc..) based on the exclusive Prysmian Pry-Cam wireless sensing technology. Pry-Cam Grids make possible to monitor the conditions of High Voltage and Medium Voltage assets by continuously tracking the Partial Discharges activity. The system performs periodic PD measurements that are locally analysed, stored and optionally sent to a remote server. The monitoring system automatically analyses each measure and it can send an alarm if an anomalous condition is detected. The measurements can be remotely viewed and controlled from any location via an Internet connection, this allows remote diagnoses to be made.

The Pry-Cam Grids is composed by a high-speed acquisition unit, an embedded computer handling the measurement process, analysis and communication tasks, a solid state local data storage and an optional communication module with the remote server (GPRS/UMTS or LAN connection). Each unit can handle up to 12 PD sensors.

The Pry-Cam™ Grids employs a high-performance data acquisition unit that allows to acquire the actual PD pulse waveforms with a time resolution of few nanoseconds. This allows to collect a very rich set of diagnostic information for every acquisition. This technology provides more information on the phenomena under test compared to other technologies (e.g. peak pulse detection, frequency band analysis, etc).

During the measurement, the control software allows the removal of environmental noise, the separation of different pulses with different shapes (and usually origins), and separately process them with classification, identification and diagnostic algorithms. This process lead to a complete assessment of all kind of defects present in the system under test, its wear level, and to estimate the residual lifetime of the tested system. A Pry-Cam Grids Unit is shown in figure below.



Figure 4: A Pry-Cam Grids acquisition unit

The technical specifications of the Pry-Cam Grids acquisition and processing unit can be found in the attached Data Sheet Annex 3.

4. The Prysmian Electronics Integrated Platform

Selected parameters among partial discharge, temperature/voltage/pressure/current sensing, DTS/DAS can be integrated on this platform depending on project configuration. Reporting can be provided upon the customer's request. The software can be configured to the client's virtual server and allows for easy export of any data desired. It is an easy, clean software, with a Google map view of all assets and schematic diagram of the circuit. Connection to the customer's SCADA network (if required) is simple and hassle-free. Below is an example of how data may be viewed.

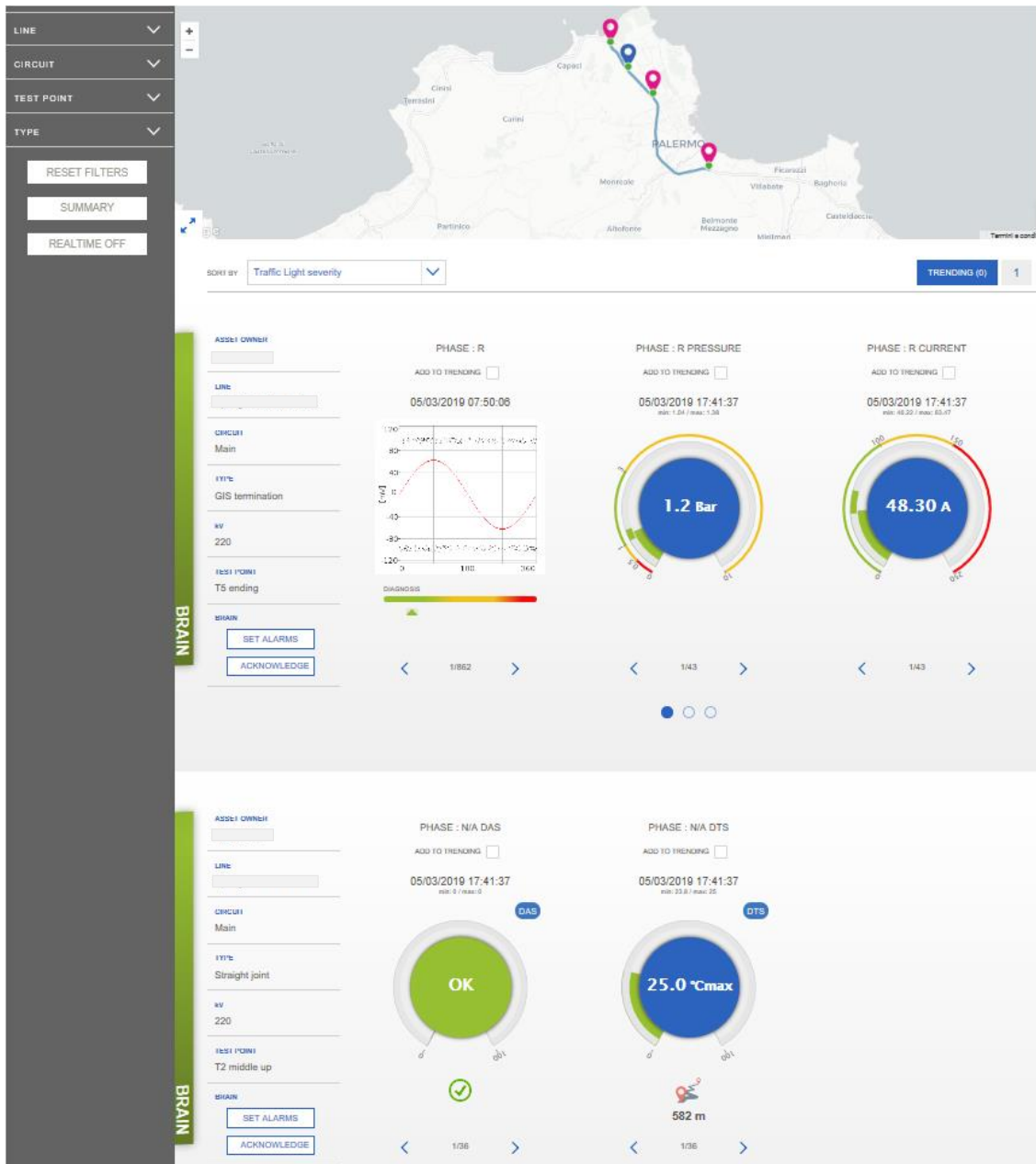


Figure 5: Prysmian Electronics Software Visualization (PD, Pressure, Current, DTS, DAS)

Here, the customer can see where the maximum value of the selected parameter is, and where the cable is located with this parameter.



Figure 6: Prysmian Electronics Software Current visualization

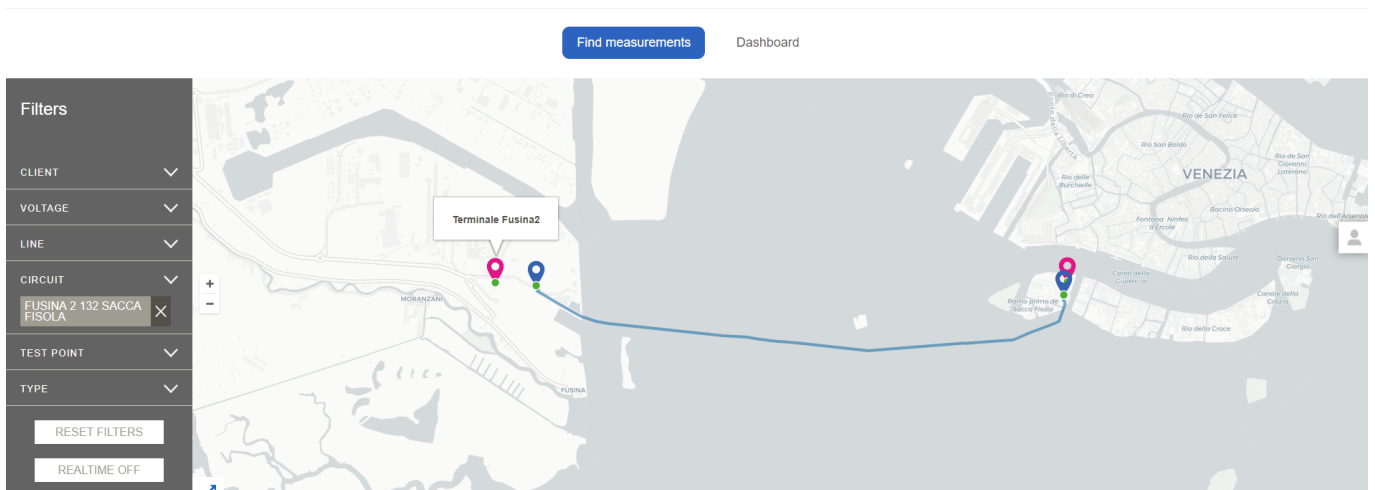


Figure 7: Prysmian Electronics Software Circuit Visualization

The customer may view exactly where all the assets are on a map view. A green indication means that there are no abnormalities, whereas a red signal means the customer should investigate deeper for any unusual activity. For DTS/DAS, exact location is given and whether it is temperature or fault localization, the system will give an alarm and notify the customer to take appropriate action.

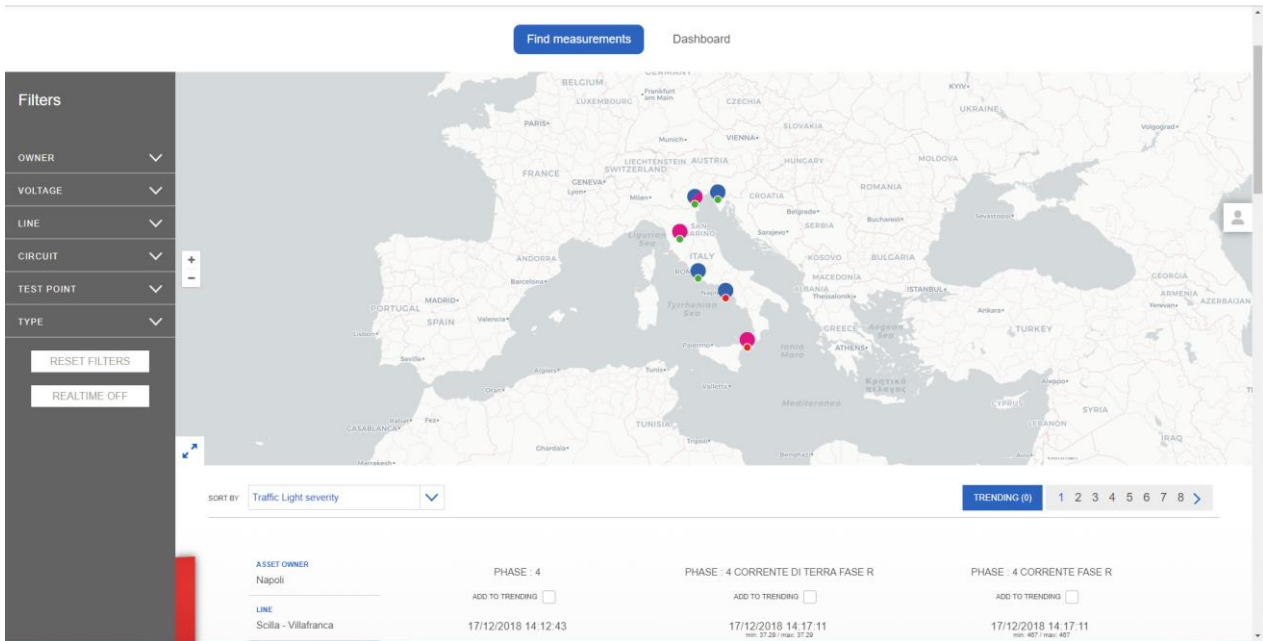


Figure 8: Prysmian Electronics Software Main Page

Using Software, multiple alarms can be configured for all parameters. Software is designed to have following features:

- Easy to use and configure
- Connection to the customer’s SCADA network is simple and hassle-free



Figure 9: Partial Discharge Alarm Settings



Figure 10: Third Party Sensors Alarm Settings

Additionally, multiple zones and phases along the circuit can be defined. Third party sensors can be implemented into software. It also gives possibility to have remote access by multiple users.

The enhanced software with artificial intelligence & self-learning algorithms

The Pry-cam software is user friendly and allows the client to directly analyze the Partial Discharge patterns and localize the source of the Partial Discharge. Pry-cam technology is using artificial intelligence and self-learning mechanisms to automatically detect Partial Discharges in the earliest stages.

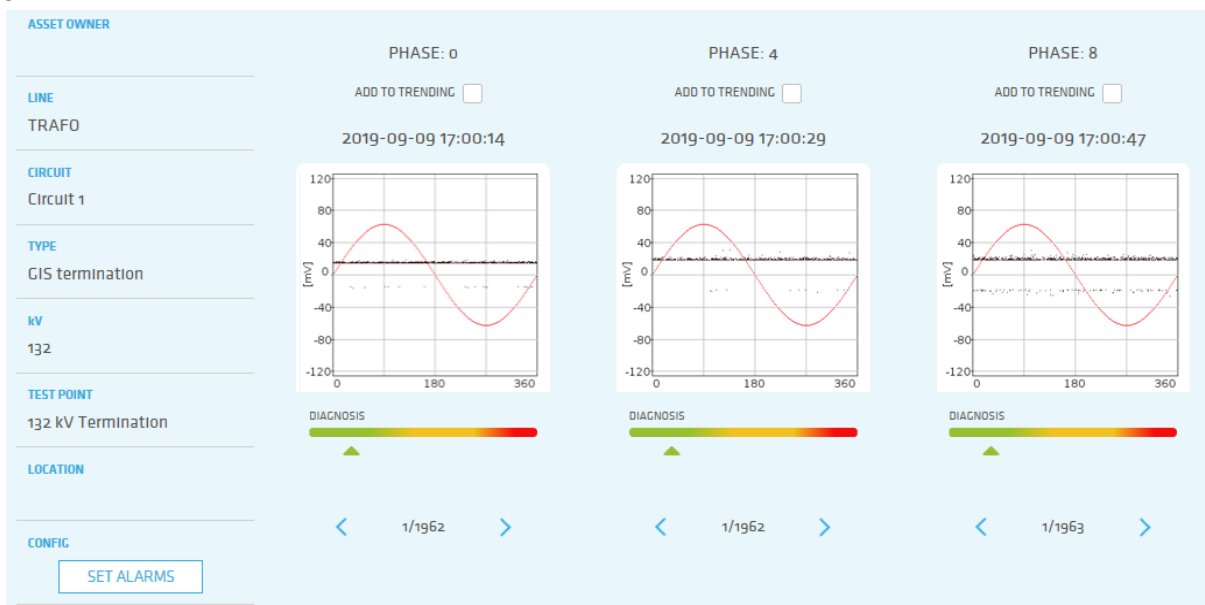


Figure 11 enhanced software environment of Prysmian Electronics

The GPS installation location of the Pry-cam Partial Discharge devices will be recorded and embedded in the Pry-cam software environment. All the worldwide PD measurements are being stored in the Pry-cam cloud environment and currently >6 million PD measurements have been stored here. This enables the Pry-cam technology to be highly accurate in the automatic detection of Partial Discharges since all the patterns in the database can be compared with each other.

The Pry-cam PD software enables you to analyze the PD pattern, wave form & Frequency (FFT) and based on all these indicators the engineer can determine whether there is Partial Discharges or not.

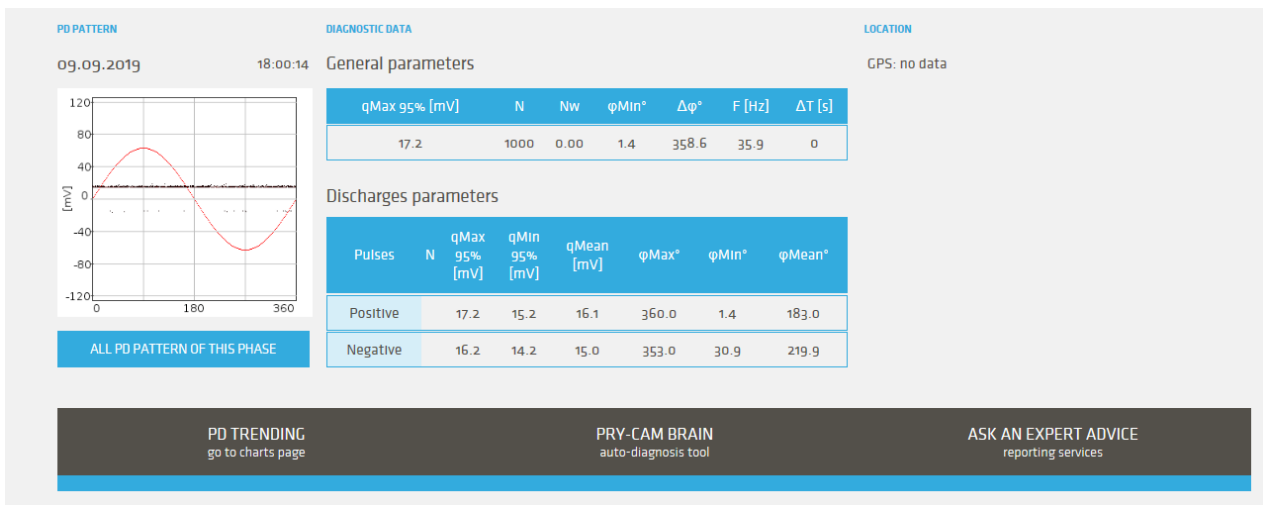


Figure 12 enhanced software environment of Prysmian Electronics

The software provides you to visualize the trend of the Partial Discharge on an hourly basis. Moreover, the Pry-cam brain gives the end client the possibility to assess the PD measurements automatically through artificial intelligence & self-learning machines. This enables the client to automatically detect Partial Discharges and get direct feedback on the status of the circuit.

Moreover, to get a full explanation and analysis of the Partial Discharge pattern, an expert from Prysmian Electronics who holds a PhD in electrical engineering will support with one click.

5. Training

5-days training about the software usage including, Partial Discharge pattern recognition will be held. The training will be given by a Partial Discharge expert who holds a PhD in Electrical engineering. The training will be given either in Company premise or by remote depending on the client's preference. Main objectives of the training has been identified as below for the client's approval.

5.1 Objective: Focusing on Theory of Partial Discharges

- Importance of PD detection
- Causes and Effects
- What is Partial Discharge
- Partial Discharge data interpretation
- PD classification and recognition

5.2 Objective: Learning Partial Discharges Measurements and Usage of PRY-CAM Monitoring Software

- Method of use
- Operating Modes
- Recommendations
- Navigation within PRY-CAM Monitoring Software and Cloud
- PRY-CAM cloud - <https://pry-cam.com/en/>

5.3 Objective: Introduction to Analyzing Partial Discharges Measurements

- Types of Partial Discharge
- Types of external noise or disturbance
- Analysis of PDs phenomena
- Partial discharges localization on MV circuits

6. Expert Support for PD Analysis

The bidder will provide PD expert support, free of charge, in the first three months of the initial phase should such situations arise. The client's questions will be answered and remote assistance will provided to make the operators confident while using the system. (Including comments on the analysis and other operational matters if needed).

Following first three months, Service Level Agreement can be detailed upon request to provide monthly or quarterly reports on each measurement points.