TECHIMP SpA
Italy

TECHIMP **HV TRANSFORMER** CASE STUDIES

LIST OF CASE STUDIES

- 220kV Power System – PD inside the bushing
- 220/132kV Autotransformer– Permanent monitoring system
- 500kV Transformer – PD inside the Transformer
- 400kV Current Transformer - PD inside the bushing
- 220/132kV Autotransformer– Permanent monitoring system

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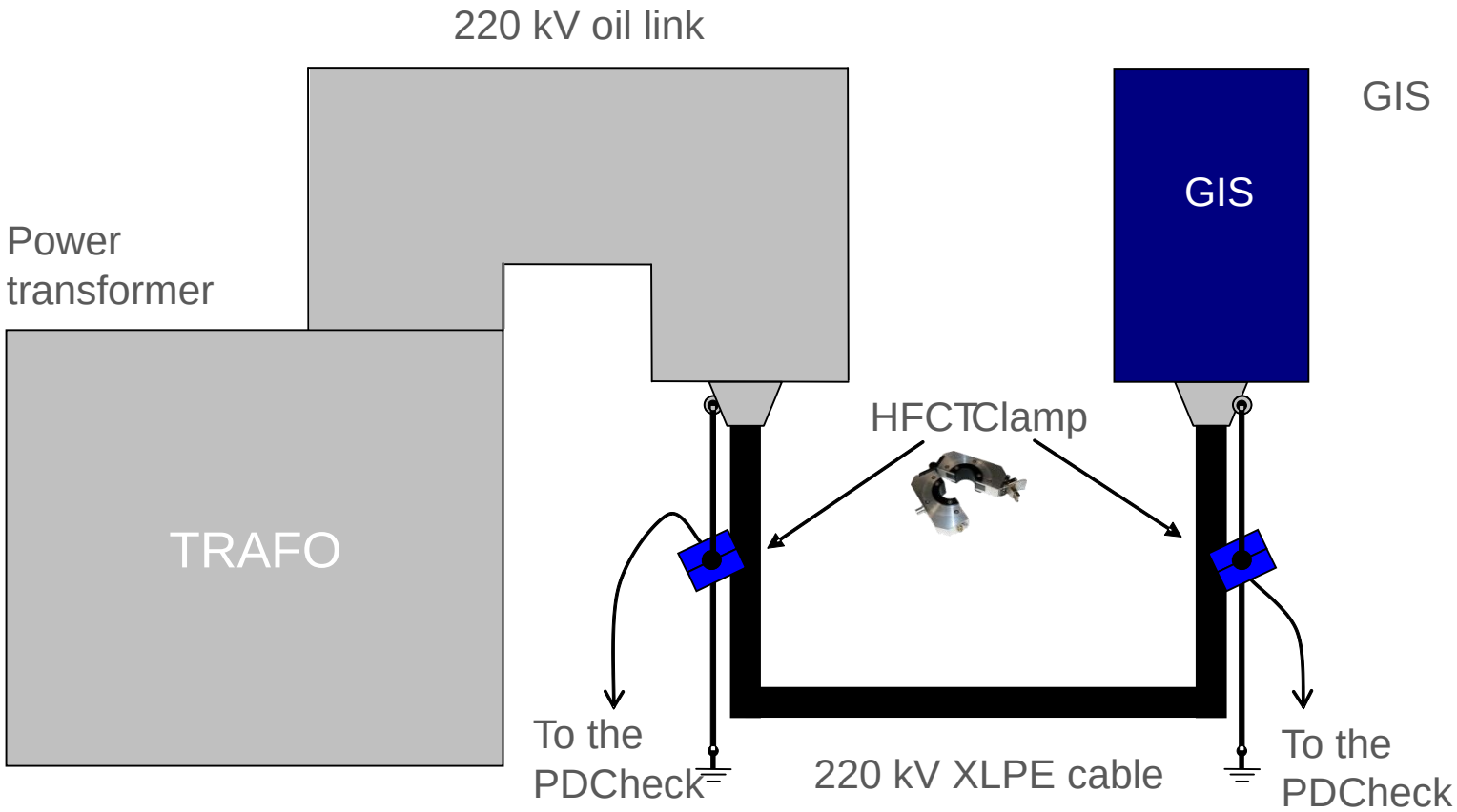
LOCATION	**Middle East**
EUT	**HV CABLES**
RATED VOLTAGE	**220 kV**
INSULATION	**XLPE**
LENGTH	
VINTAGE	
TYPE OF TEST	**ON-LINE**
PD SENSOR	**HFCT**

CASE STUDY

On-line PD detected inside the bushing

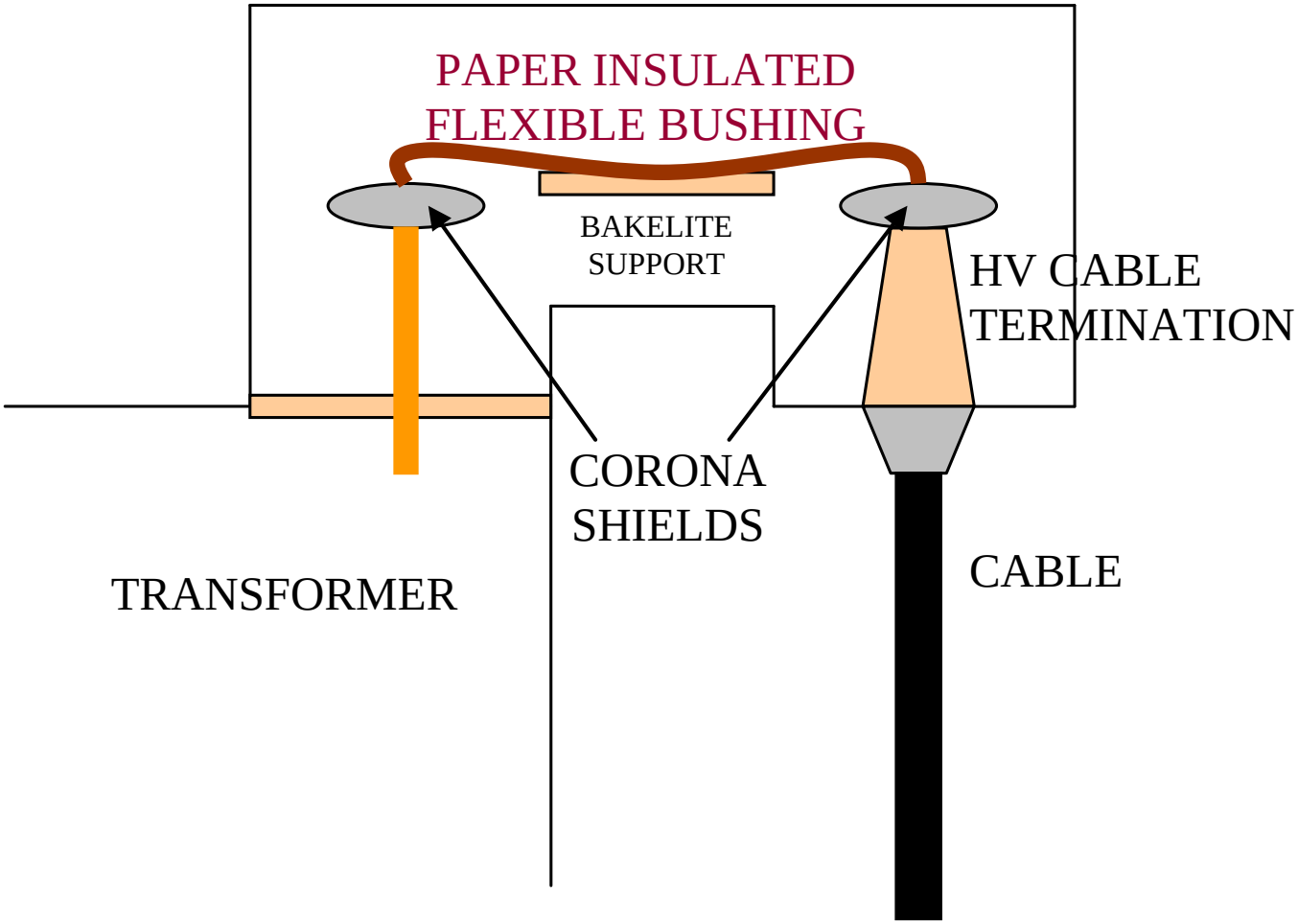
PD measurement setup – System Layout

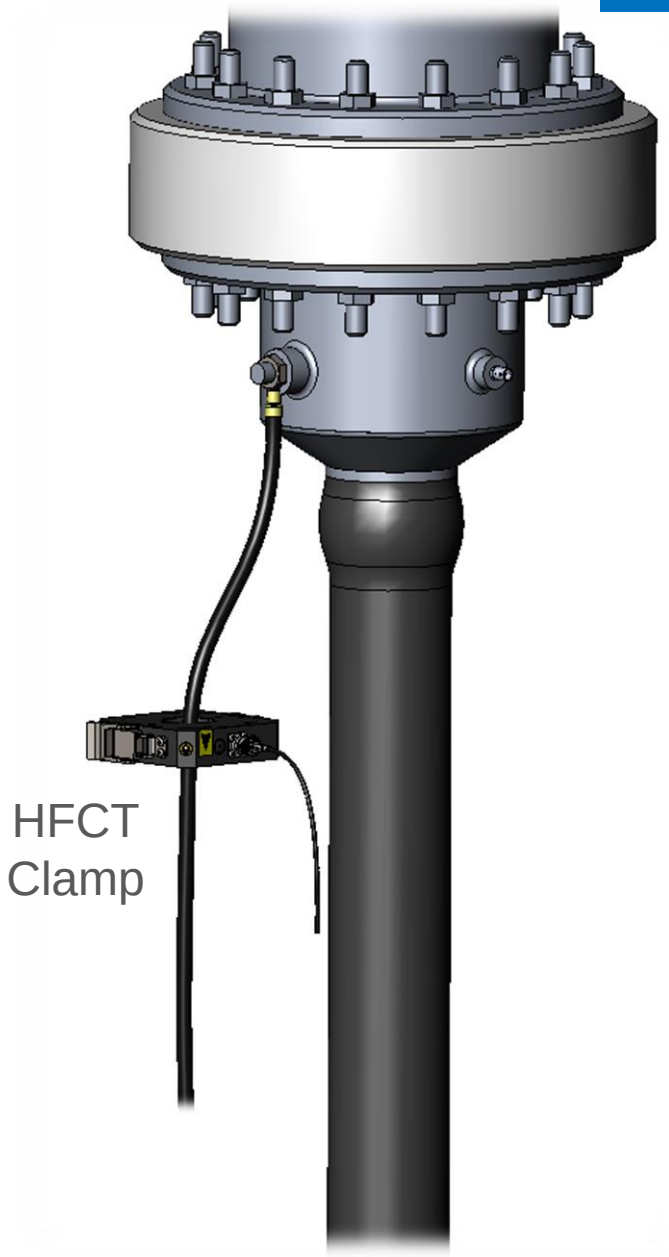
220 kV System, online PD test, 2 measurement points



[Insulation Technology]

OIL FILLED LINK between Transformer and HV cable





GIS Termination

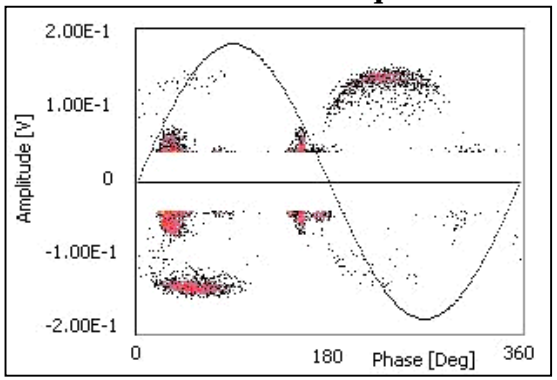
High Frequency PD pulses were achieved by means of Clamp HFCT 39mm placed around the ground connection of the GIS Termination.

Thanks to the Clamp version of the HFCT it is possible to perform on-line PD measurements without ground lead disconnection or out of service of the EUT.

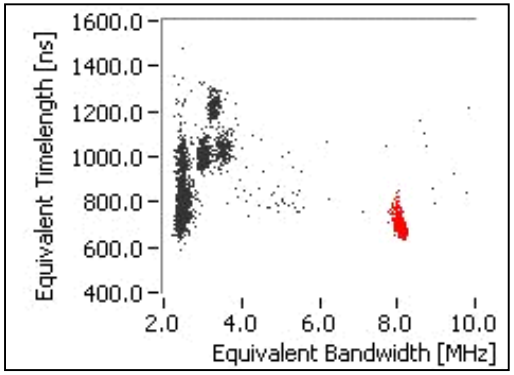
PD measurement results

Phases 0 and 4

Entire Pattern acquisition

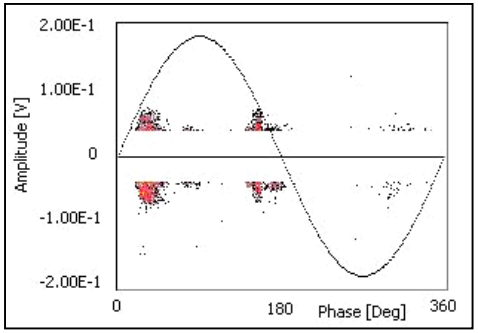


Classification Map

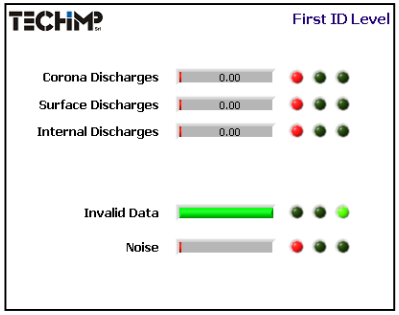


Black phenomenon (3 - phase Corona)

Sub-pattern



Identification

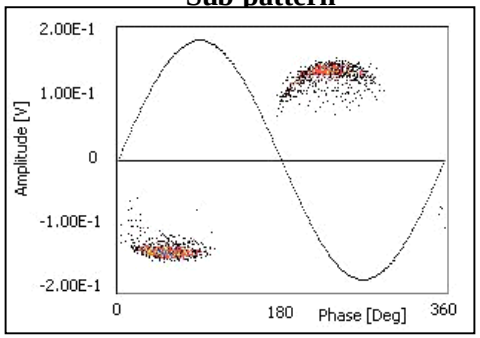


Typical acquisition from phases 0 and 4:

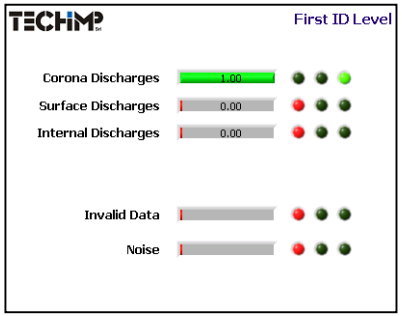
PD FREE

Red phenomenon (Corona)

Sub-pattern

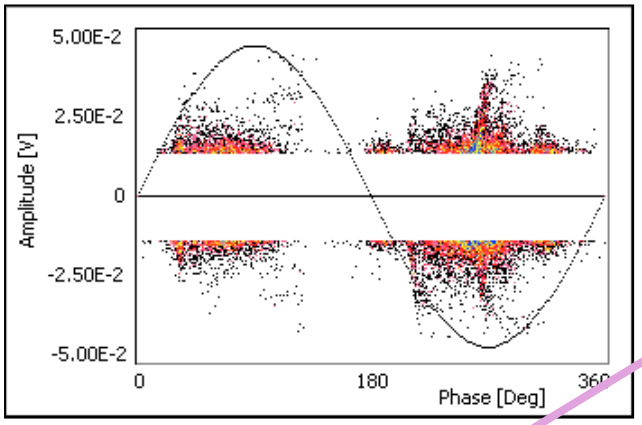


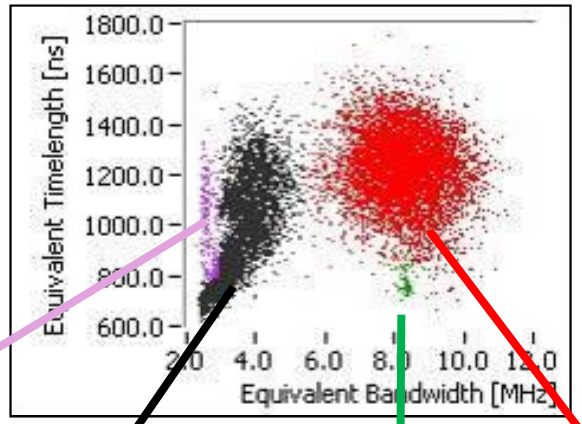
Identification

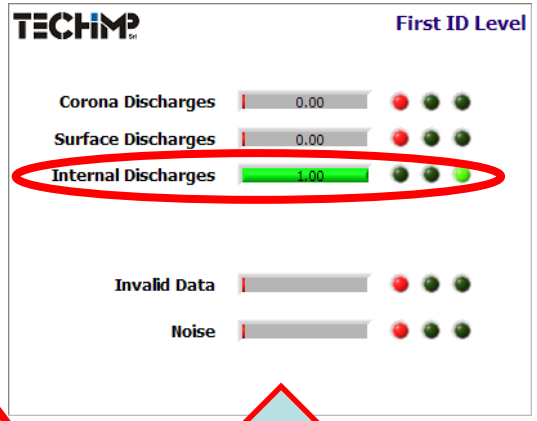


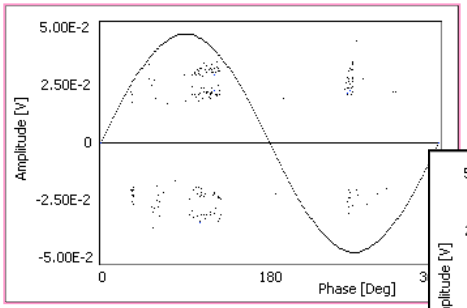
PD measurement results

Phase 8

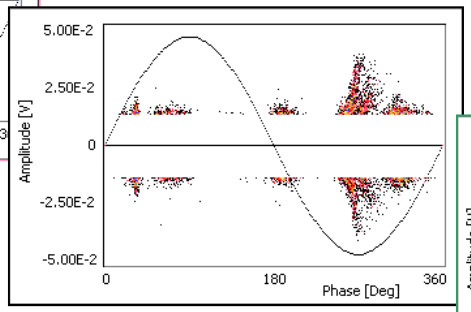




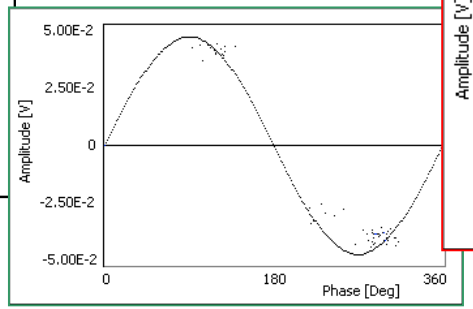




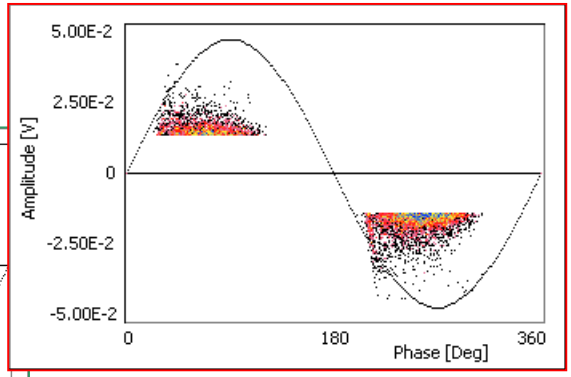
Voltage correlated disturbance



Three-phase corona



Cross talk phase 4



PD Activity

PD measurement results

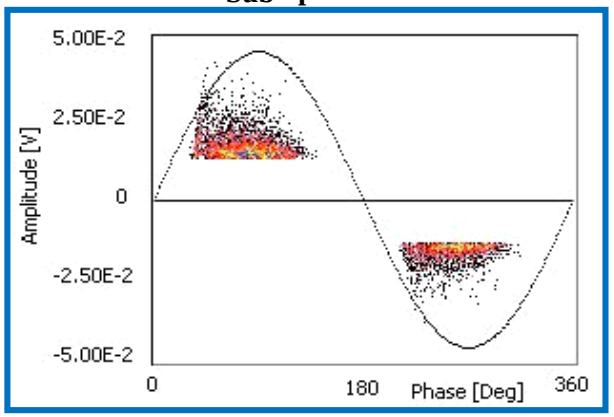
Acquisitions from phase 8 : 4 different phenomena

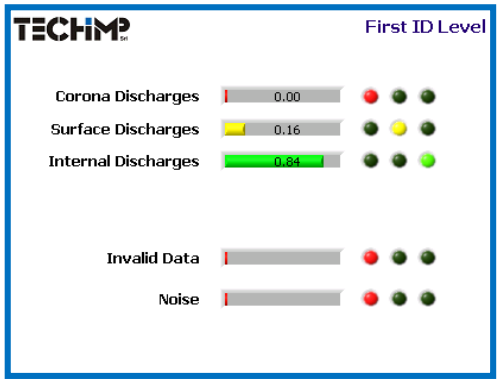
Test results:

internal/surface discharge occurring on paper surface and interface cavities of bushing of phase 8.

Red phenomenon PD activity

Sub pattern





…. Customer's decision: to replace bushing

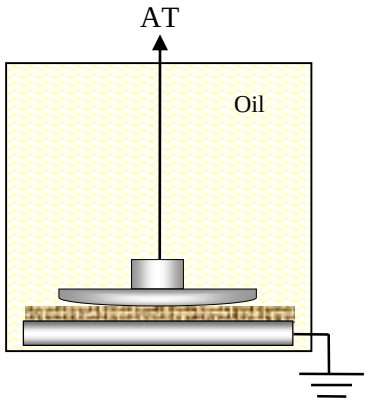
Finding of bushing inspection: **TRACKS IN PAPER!!!**

PD INFERENCE RESULTS TO BE EFFECTIVE!!!

PD measurement results

On field measurement

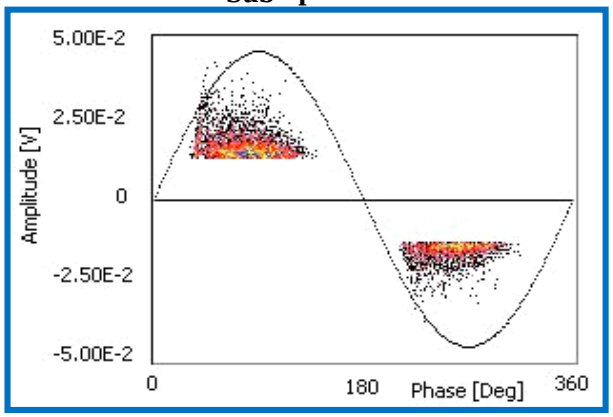
Rogowski electrode on pressboard

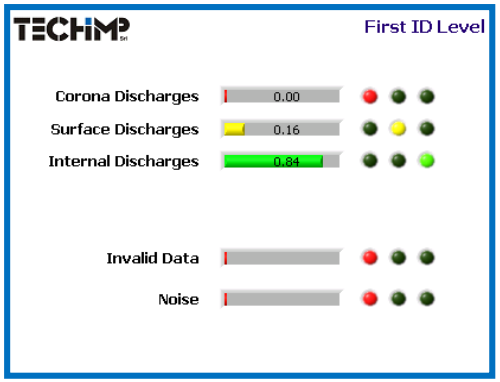


Red phenomenon

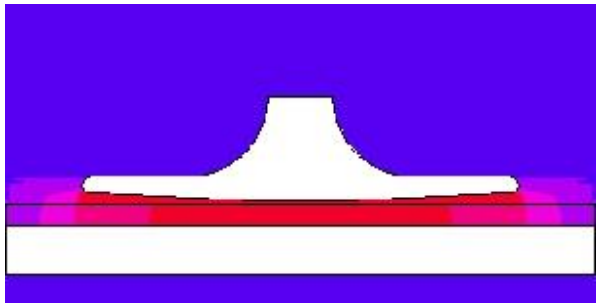
Sub pattern

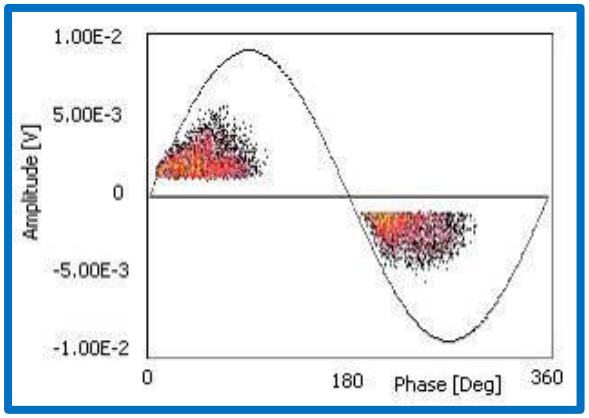
PD activity





Laboratory measurement





Pressboard internal discharges

Inspection results

Degradated oil/paper insulation

HV Cable termination

Degradated oil/paper insulation

TECHIMP

LOCATION	**EUROPE**
EUT	**POWER TRANSFORM**
RATED VOLTAGE	**220/132 kV**
INSULATION	
LENGTH	
VINTAGE	
TYPE OF TEST	**VARIOUS**
PD SENSOR	**VARIOUS**

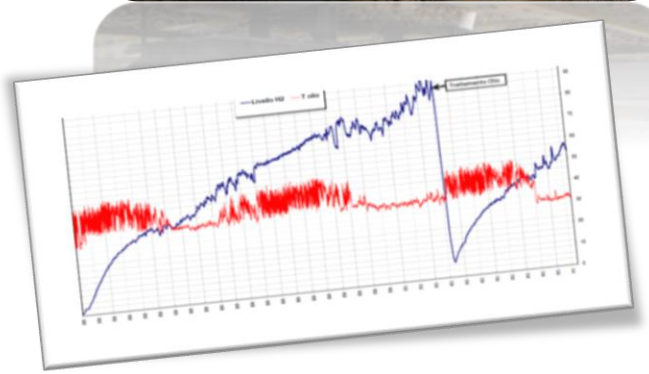
CASE STUDY

Global Condition Monitoring System for Power Transformer

Problem:

- *After the installation of a HV transformer, the utility started immediately to see a critical level of equivalent gas (using a 2 gas DGA unit)*

Is it now necessary to take out of service the transformer?
Why the H2 is so high? Electrical or thermal problem? PD?



Solution: ***GLOBAL MONITORING SYSTEM***

PD measurement - Setup

Global monitoring:

- Partial Discharges: through Tap Adapter installed in the bushings capacitive taps
- DGA: integrated DGA unit monitoring dissolved H2 +CO and Moisture
- Tan-δ: integrated TD-Guard unit monitoring tan-δ, Capacity and Bushing Insulation Resistance
- And even more: temperature, environmental parameters

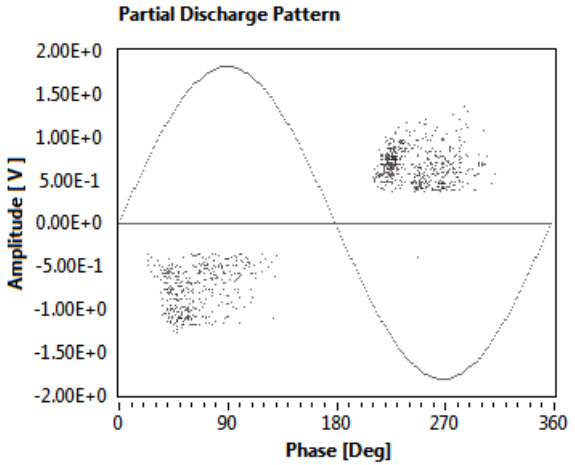
TD-Guard

DGA

Tap Adapter

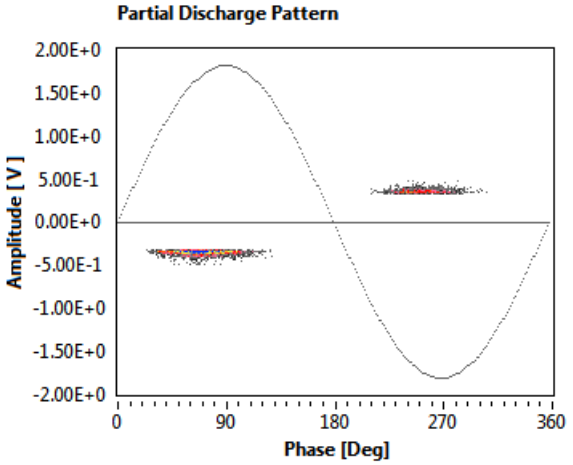
Monitoring Results (1st month): Different PD activities

A sporadic activity due to small **GAS BUBBLES** in the oil not yet harmful. This activity was intermittent and detected few times in a month. The probability of triggering such activities increases significantly installing PERMANENT monitoring systems.



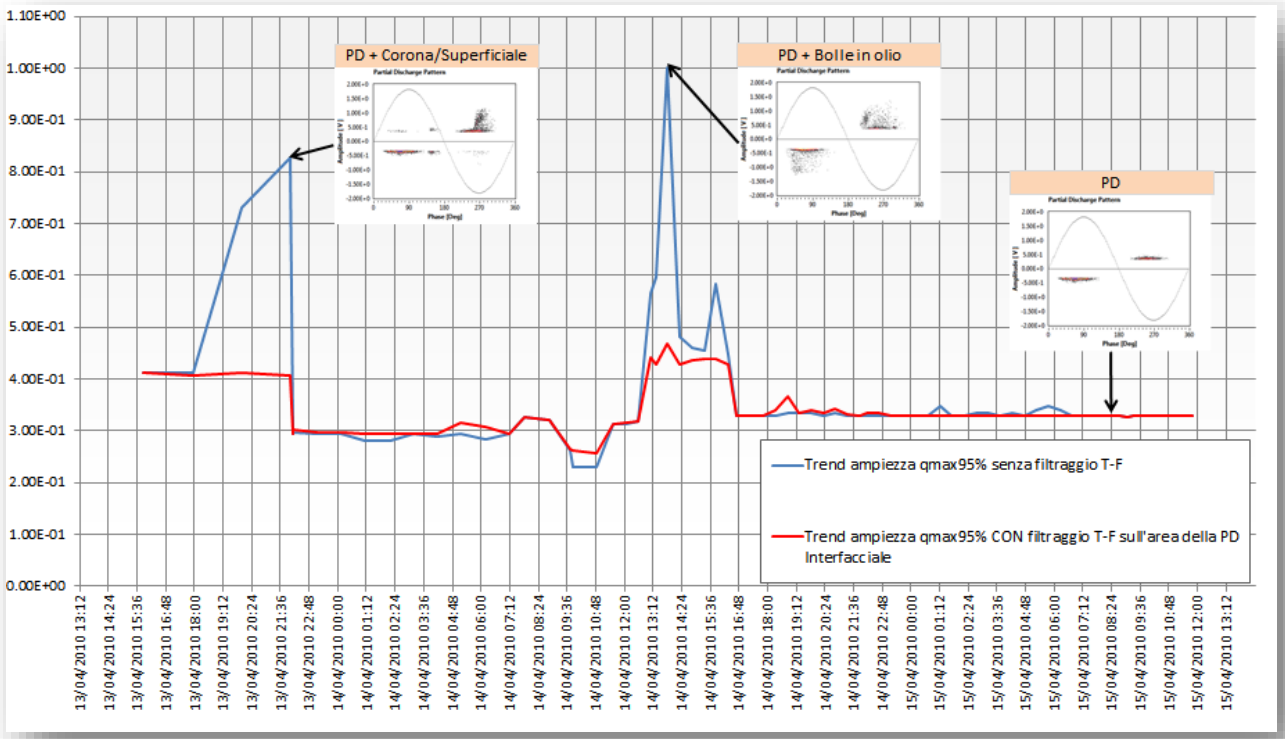
A strong activity with very high amplitude and repetition rate was detected in all the HV phases. This activity was identified as **INTERFACE PD**.

INTERFACE PD: discharges due to the high electric field gradient in correspondence of the junction of two different insulation materials (example in the transformer air/oil o oil/paper).



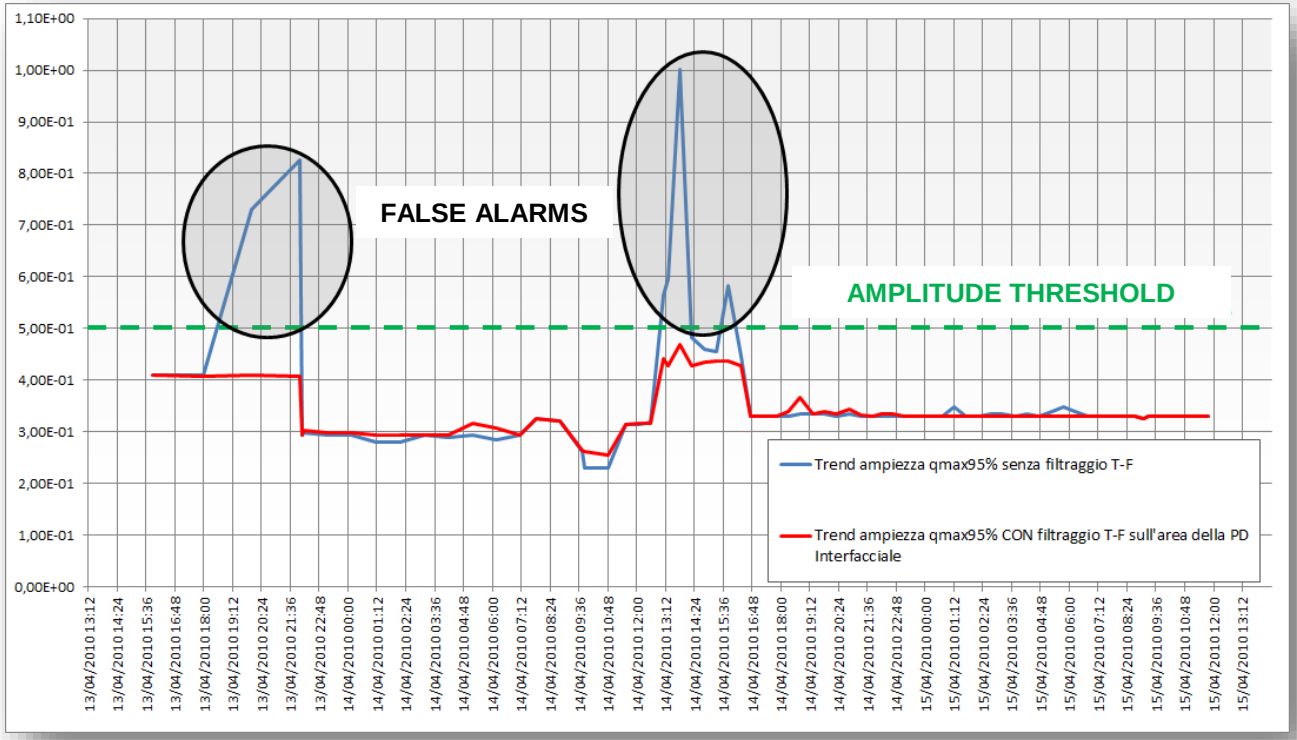
PD measurement - Results

Effectiveness of monitoring: possibility to get alerts about only dangerous phenomenon rather than the maximum amplitude detected.



SEPARATION OF PHENOMENA AND NOISE REJECTION

Effectiveness of monitoring: possibility to get alerts about only dangerous phenomenon rather than the maximum amplitude detected.



Possibility of avoiding FALSE ALARMS, acting on the amplitude and on trend of moving average of acquisitions.

Actions :

Oil treatment was carried out by the utility after 2 weeks from PDM system installation:

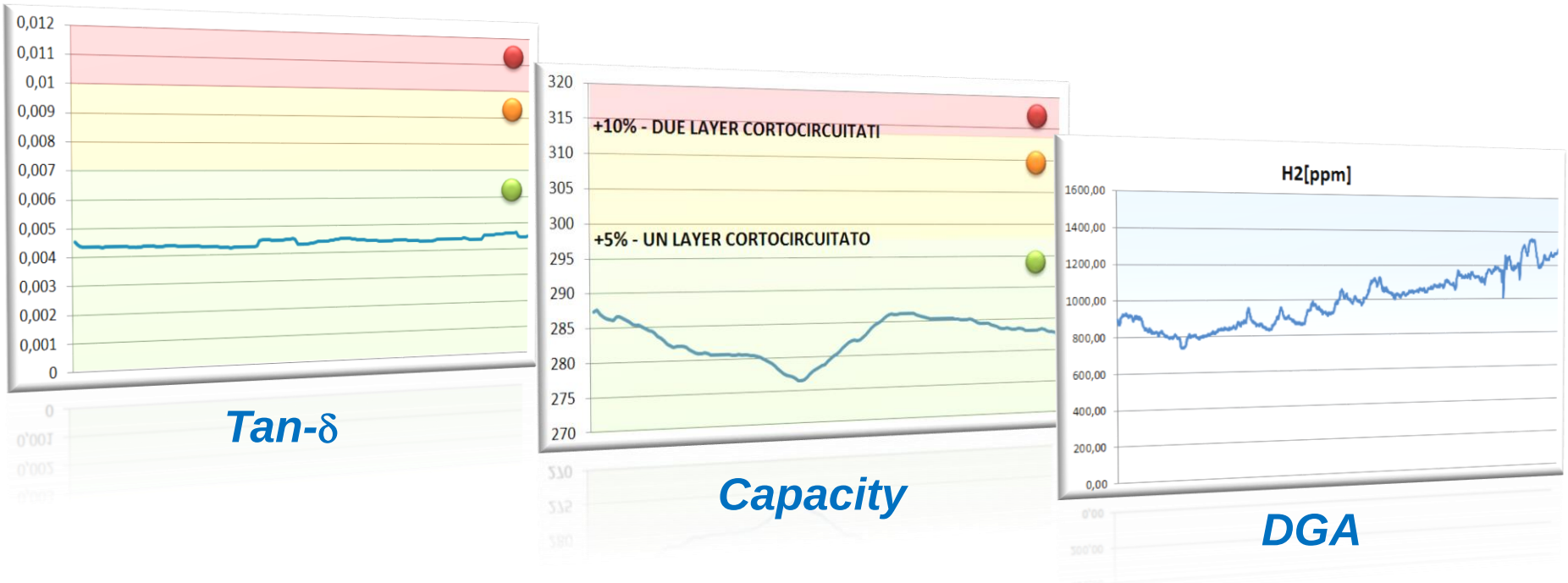
- The first activity, due to the bubbles, disappeared after the oil treatment.

- After the oil treatment, the second activity immediately appeared again. The oil treatment did not cause any kind of change on such a phenomenon.

- Thus, the permanent PD monitoring was run in the transformer for a period of 6 months.

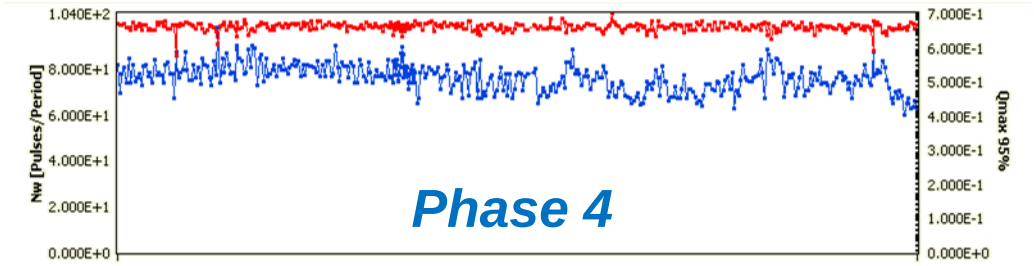
Results of On Line Monitoring (6 month):

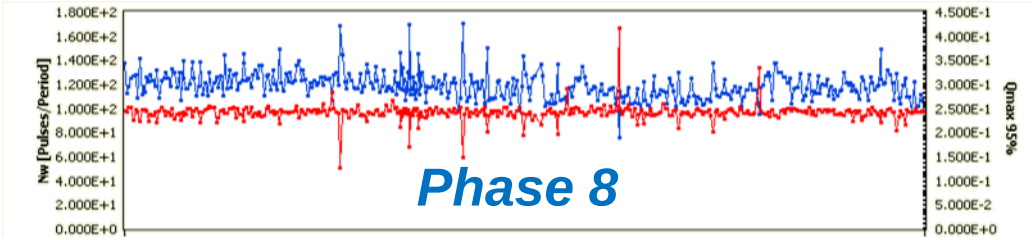
- No significant changes in bushing Tan-δ values were noted over the monitoring period (6 months) highlighting that there are no problems inside the bushings.
- The H2 gas levels increased during the monitoring period with rates around 30 ppm/day highlighting that there is a problem inside the transformer.

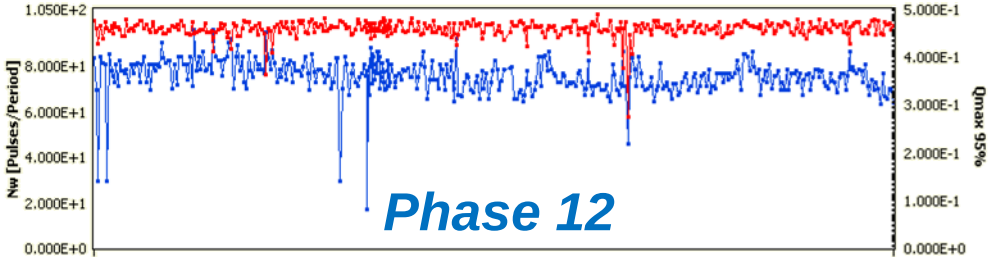


Results of On Line Monitoring (6 month):

- PD activities were detected in correspondence of all the three HV phases, demonstrating that such phenomena (interface PD) were directly connected to the H2 gas increase.







Diagnosis:

- The PD pattern polarity and characteristics indicated clearly that the PD was located into the transformer; the very high frequency of the phenomenon has allowed us to locate the defect in the upper part of the transformer close to the bushings.

- The constant trend over time leads to the conclusion that the three defects are not harmful in the short term.

- The characteristics of the PD entirely comparable in all three phases, together with the location in the upper part of the transformer, have led to the conclusion that the problem was generated from an interface air / oil.

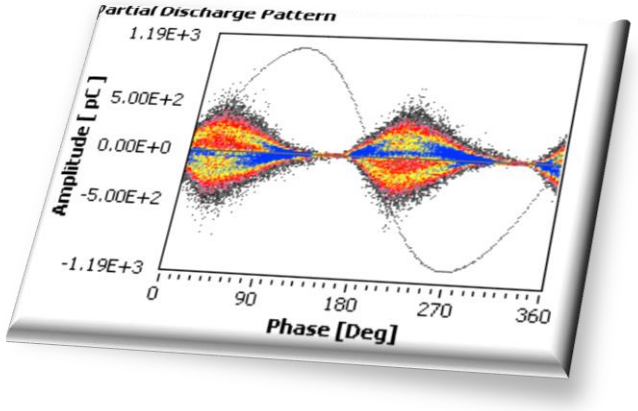
The presence of air in the upper part of the transformer has been attributed to the imperfect filling of oil in the three bushings, resulting in the creation of interface air / oil.

PD measurement - Actions

***Off-line** tests:*

- ✓ Tan-δ of the bushings.
- ✓ DGA of bushings oil.
- ✓ PD TEST in both UWB and IEC bandwidth :

- The first two measurements were carried out in order to be 100% sure that the bushings were problem-free. *Techimp diagnosis confirmed*.
- The third measurement was carried out because the utility wanted to be 100% sure that the PD detected by Techimp was not relevant to an external interference. *Techimp diagnosis confirmed : the Interface PD (filtered from noise and external disturbances) detected during the on-line monitoring were relevant to internal phenomena inside the transformer. Amplitude of the phenomenon is about 500pC and with Inception Voltage 60% Un.*

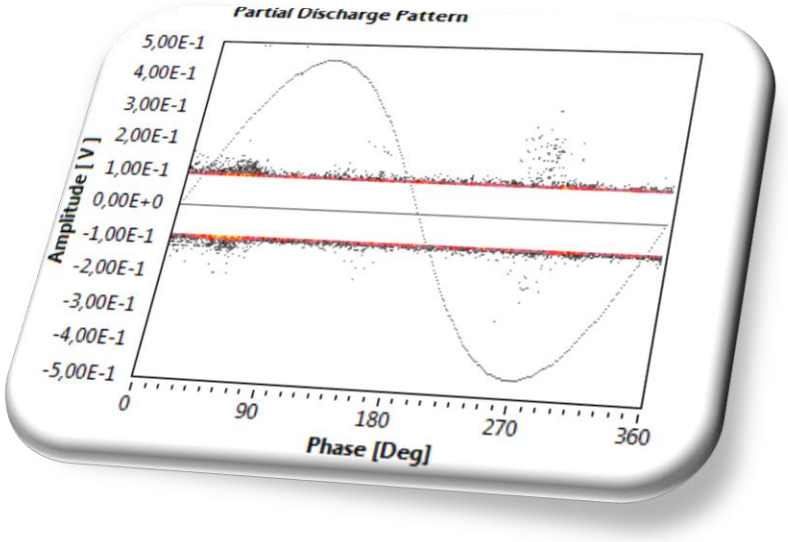


Final maintenance of the Transformer:

After all the tests, the transformer has been emptied and refilled with hot oil and degassed under vacuum, so as to avoid the formation of interfaces air / oil.

- The monitoring period following this treatment has CONFIRMED THE ELIMINATION OF THE DEFECT ON ALL THREE PHASES.

The analysis carried out by Techimp has been very accurate.



PD measurement - Conclusion

Conclusions :

- The On-line analysis carried out by Techimp were confirmed by the off-line measurements.

- Techimp on-line system is able to achieve sensitivity comparable to that of off-line tests, without the necessity of any external power supply or shutdown of the transformer and allow to plan a proper maintenance only when needed.

- Monitoring of the most sensitive transformers (those without backup, Phase Shifter and those transformers whose power Off-line is not possible) carried out by Techimp, would avoid them being out of service but at the same time allows to avoid being out of service while allowing real time diagnosis equally effective.