



TECHIMP **ROTATING MACHINES** CASE STUDIES

LIST OF CASE STUDIES

- ▣ 15 kV GT 120MW Generator – On-line PD Test
- ▣ 11 kV GT 100MW Generator – On-line PD Test
- ▣ 600 V TWMC LV Induction Motor – Off/On-line PD Test





LOCATION **EUROPE**

EUT **GAS TURBINE 120 MW
GENERATOR**

RATED VOLTAGE **15 kV**

INSULATION

VINTAGE

TYPE OF TEST **ON-LINE**

PD SENSOR **VARIOUS**

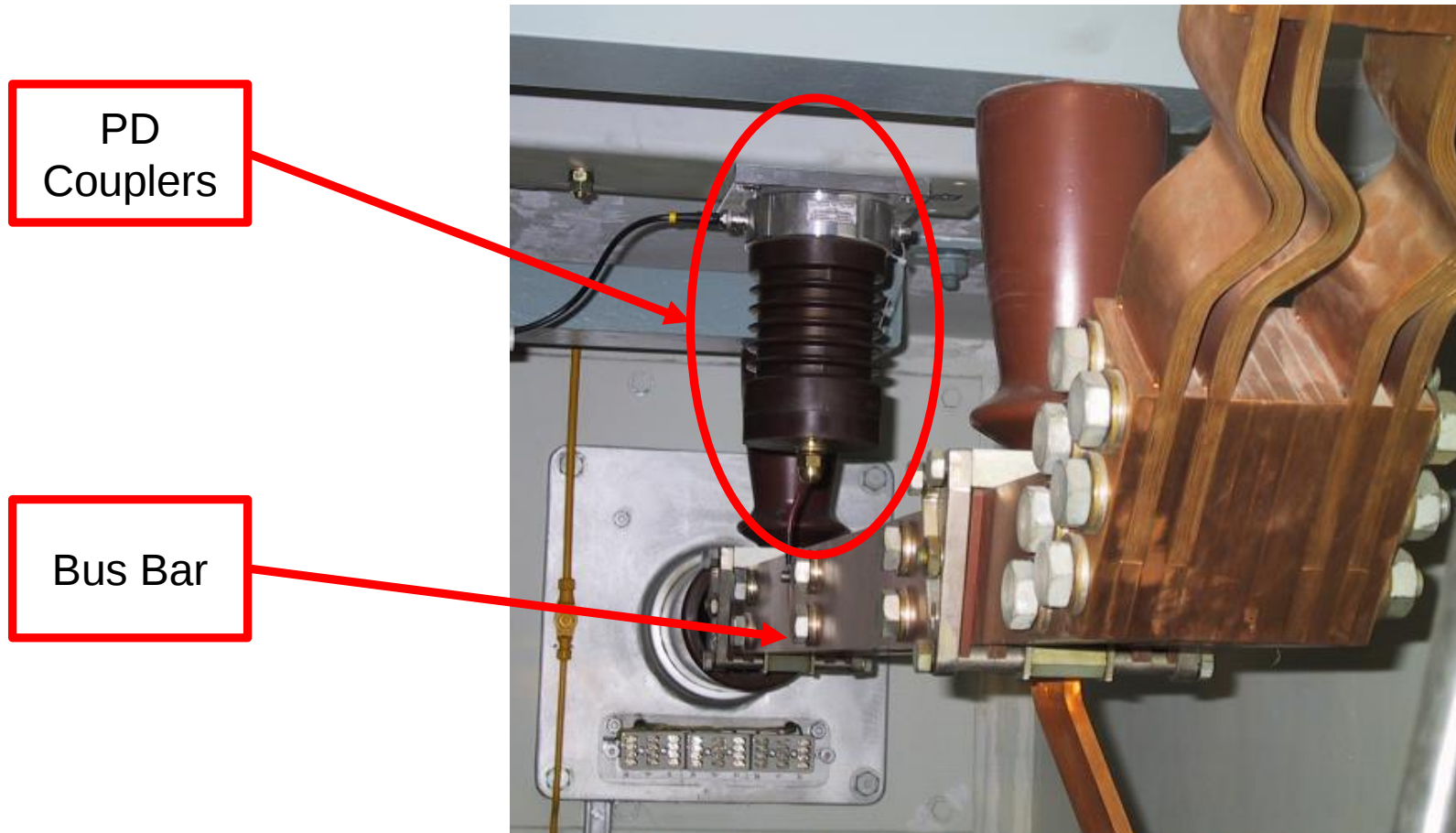
CASE STUDY

TechImp technology allows PD source separation and strengthens PD source identification. Boroscopic inspection confirms diagnosis.

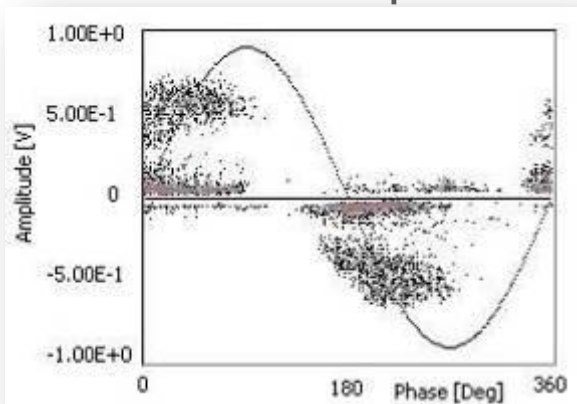
PD
Couplers



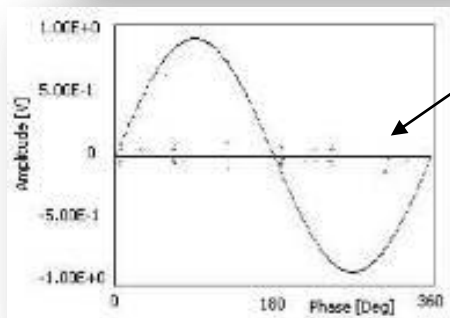
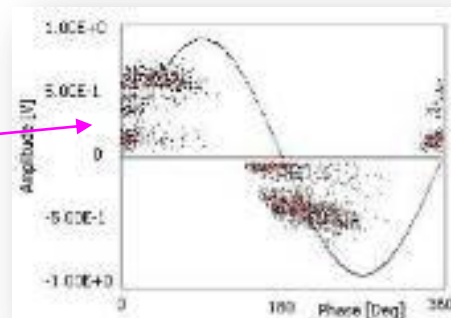
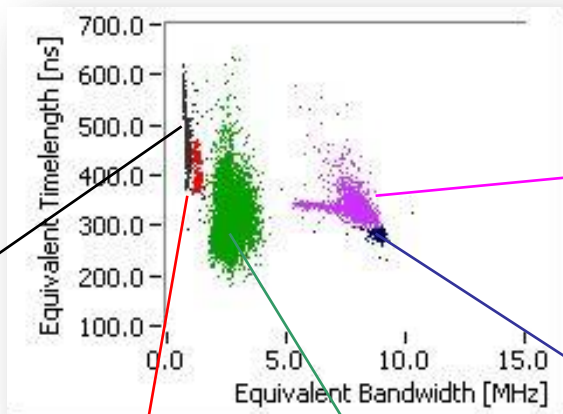
Online PD tests:
[Capacitive PD coupler on bus bars]



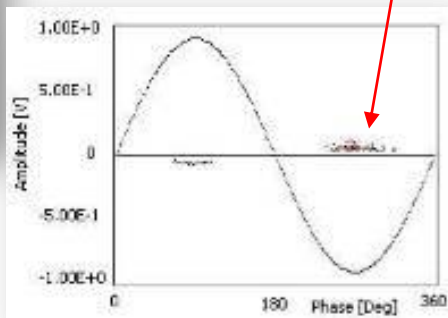
Entire Pattern acquisition



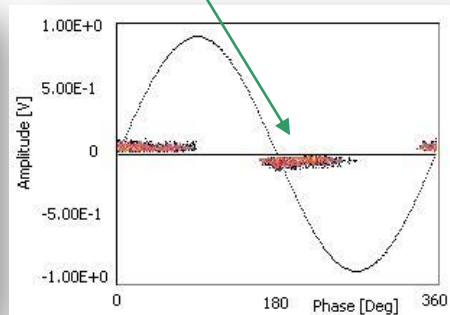
Classification map



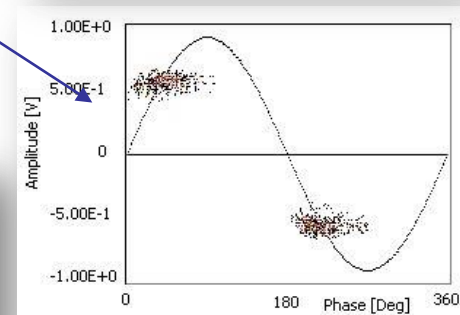
Exciter noise



External discharge to Phase U. Cross talk of distributed micro voids from Phase W

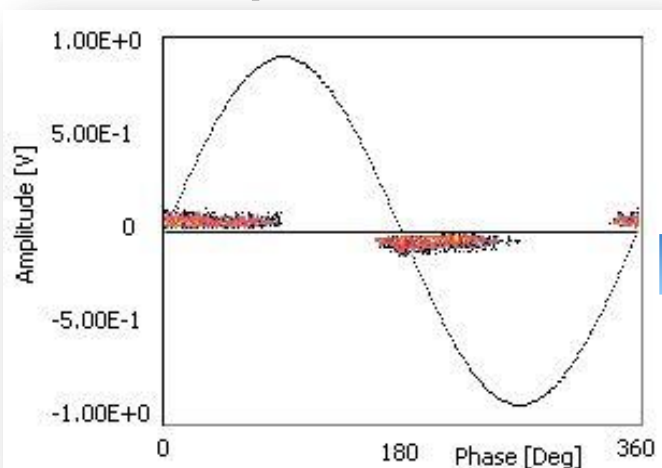


Distributed microvoids in phase U

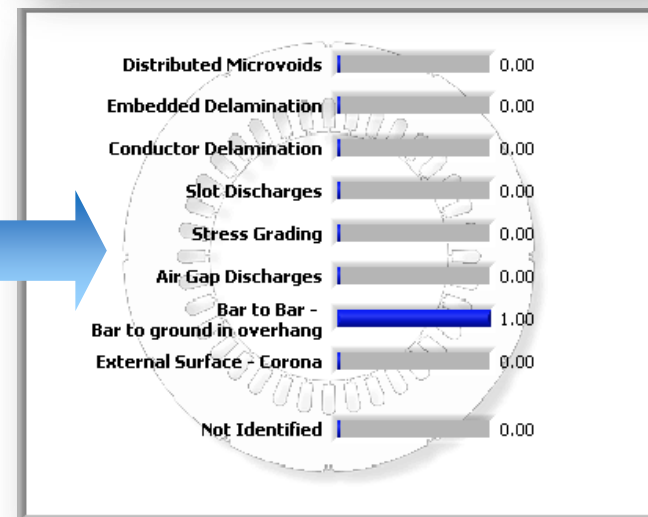
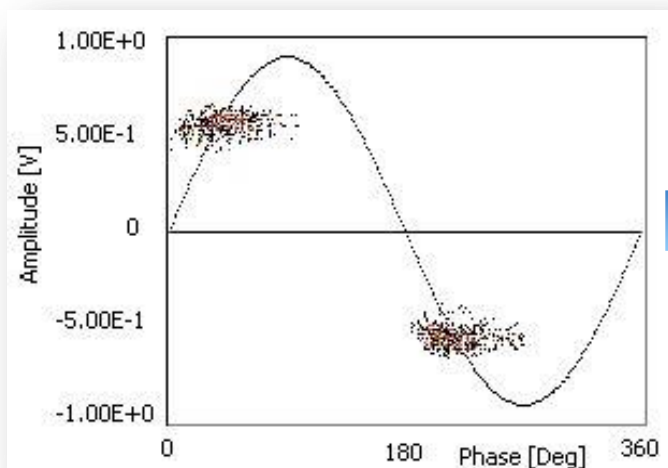
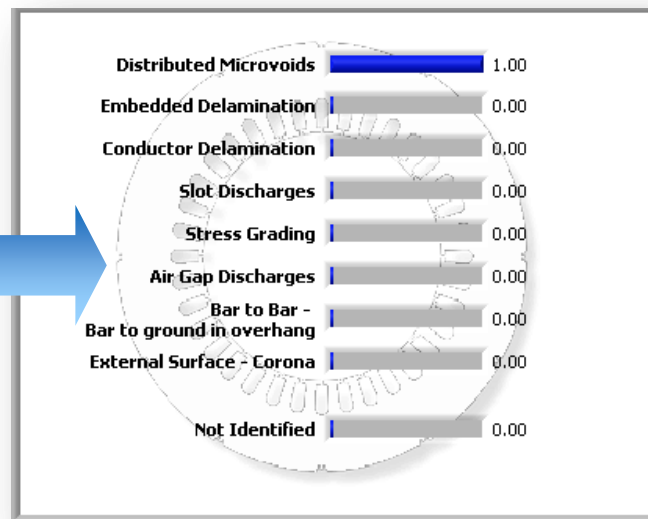


Discharges due to bar to bar or bar to ground activity in overhang

Sub patterns

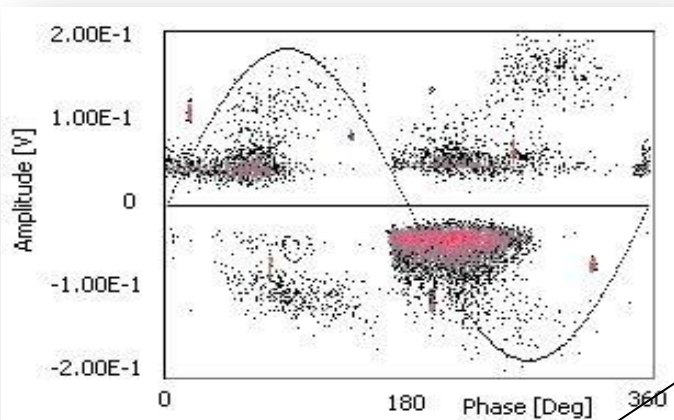


III Level identification

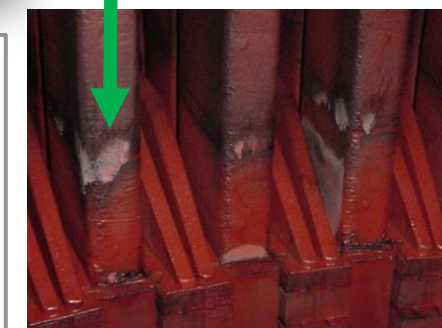
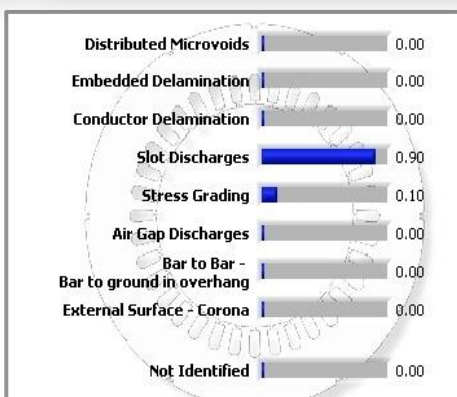
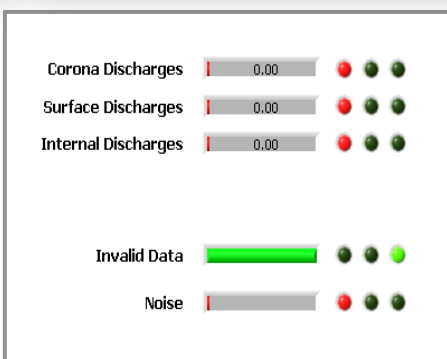
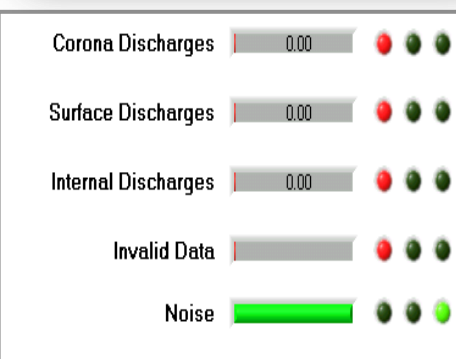
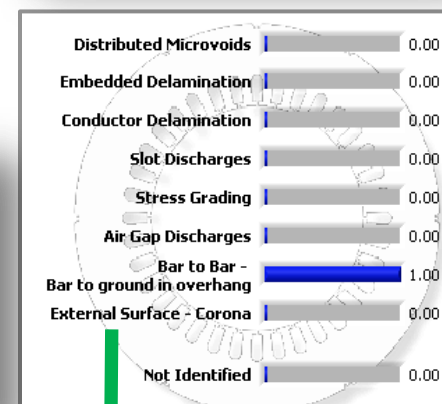
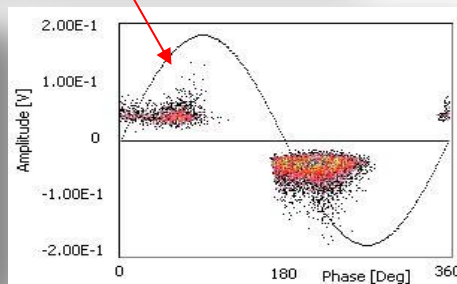
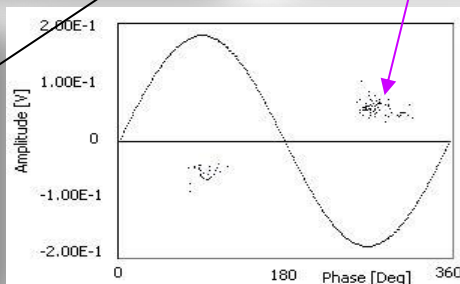
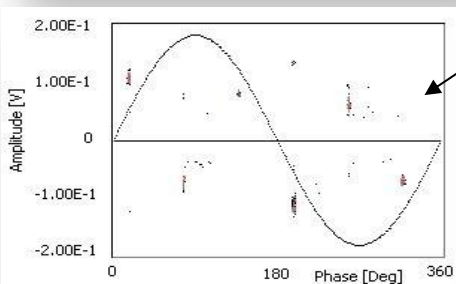
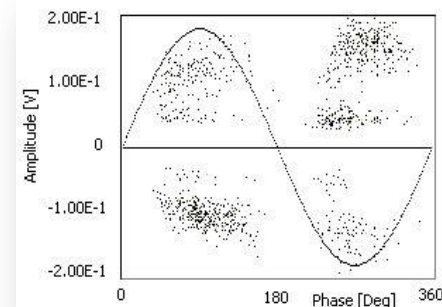
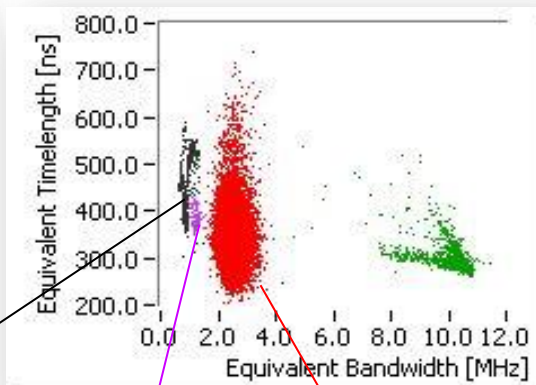


PD measurement results – U Phase

Entire Pattern acquisition



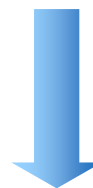
Classification map



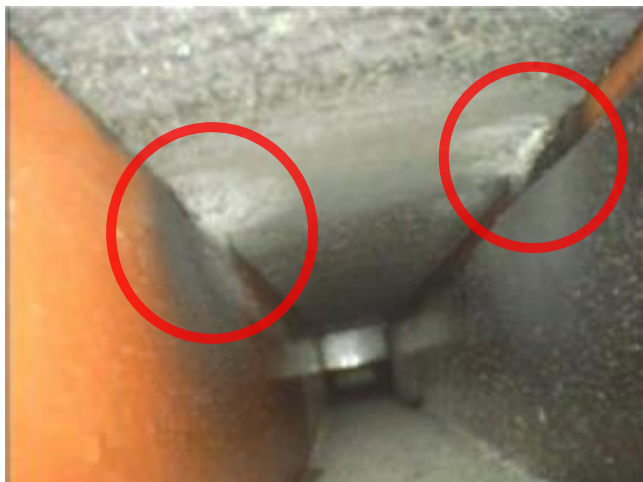
Visual Inspection

[Results of endoscopic inspection on generator]

PD traces found in 12 of the 60 slots
(7 white traces and 8 suspicious traces)



SLOT DISCHARGES



Final considerations

On-line PD measurements

Gather data to assess the whole machine conditions



In particular



Machine affected by:

- ▣ **Distributed micro-voids** (all three phases)



Unavoidable process in modern thermosetting insulation systems

- ▣ **Bar to bar (ground) discharges** (phase U)



The high frequency currents may degrade, in the course of time, both the stress grading system and the slot coating protection in the region where the bars leave the iron core (DEFINIZIONE DI STRESS GRADING)

- ▣ **Slot Discharges**



Dangerous phenomenon: inspection and maintenance required

LOCATION **ASIA**

EUT **Gas turbine 100 MW
Generator**

RATED VOLTAGE **11 kV**

INSULATION

VINTAGE

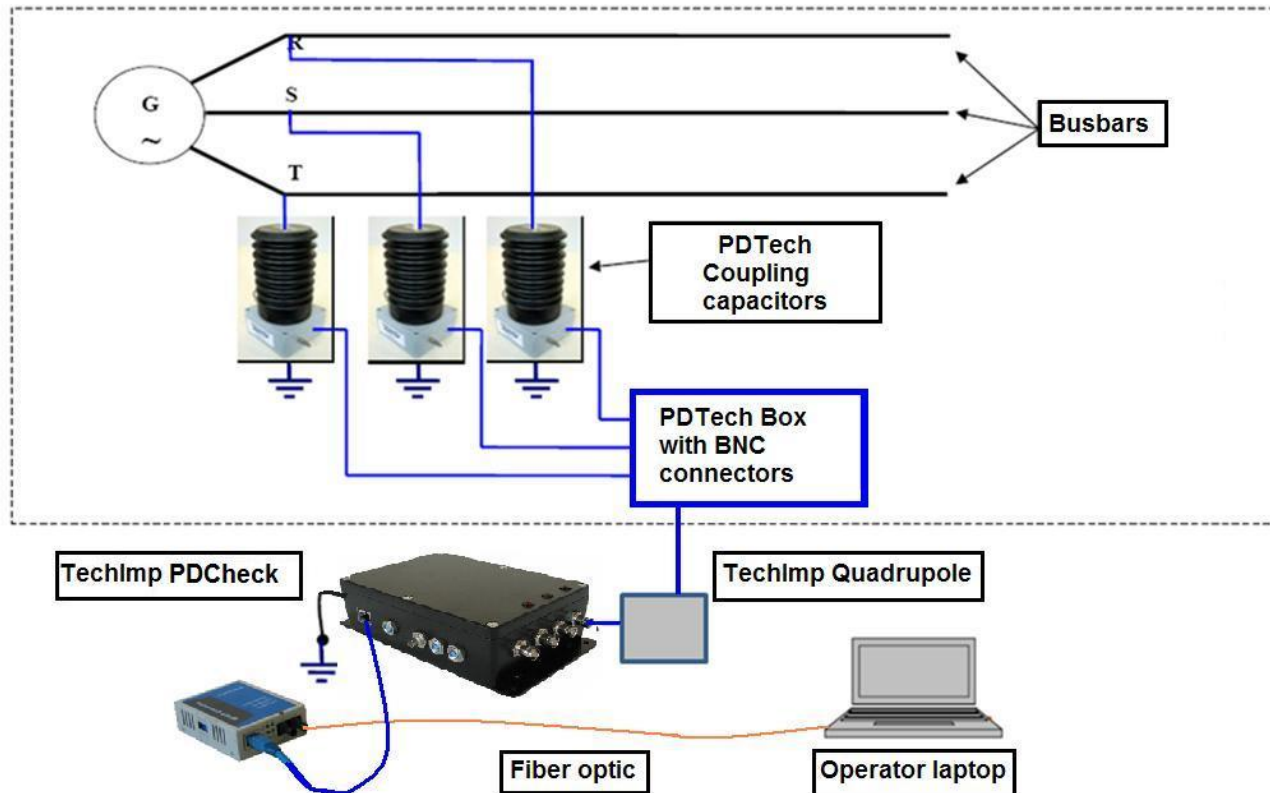
TYPE OF TEST **ON-LINE**

PD SENSOR **VARIOUS**

CASE STUDY

TechImp technology allows PD source separation and strengthens PD source identification. Visual inspection confirms diagnosis

PD measurement layout

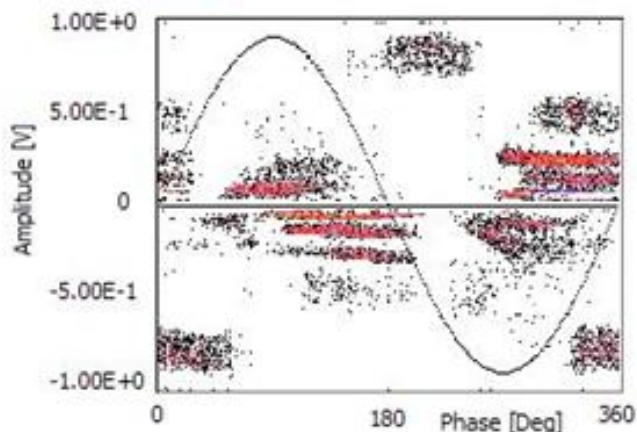
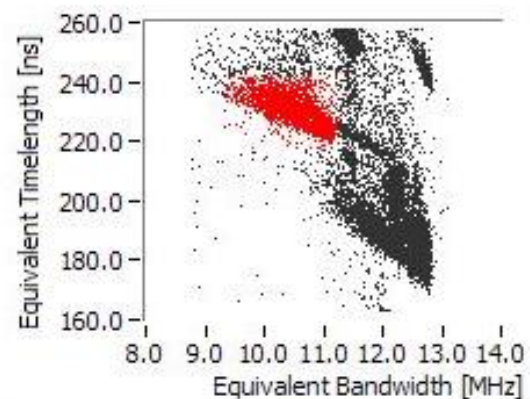


Generator	Phase 1 [U]	Bar to bar/ground discharges of high amplitude [≈ 3 V]	
	Phase 2 [V]	Bar to bar/ground discharges of high amplitude [≈ 13 V]	
	Phase 3 [W]	Bar to bar/ground [≈ 7 V], stress grading discharges of high amplitude [≈ 22 V]	

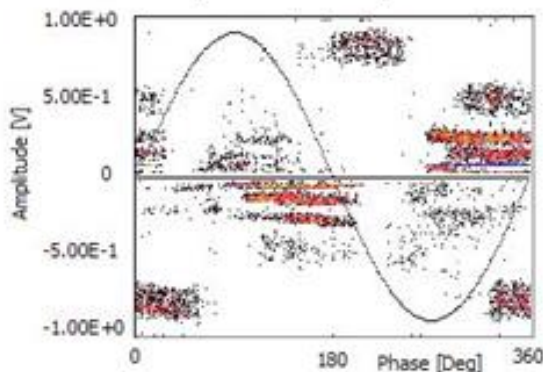
The analysis shows that:

- ▣ **Bar to bar/ground discharges** were detected on phase U.
- ▣ **Bar to bar/ground discharges** were detected on phase V.
- ▣ **Bar to bar/ground discharges, corona discharges** and **stress grading discharges** were detected in phase W.

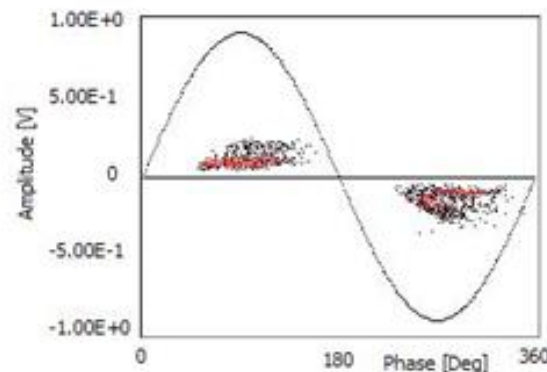
Phase U – PQ – 10 dB attenuator

Entire Pattern acquisitionClassification Map (T-W map)**Black phenomenon**

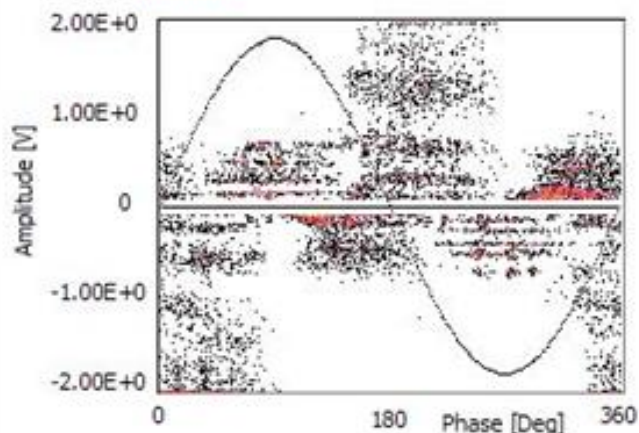
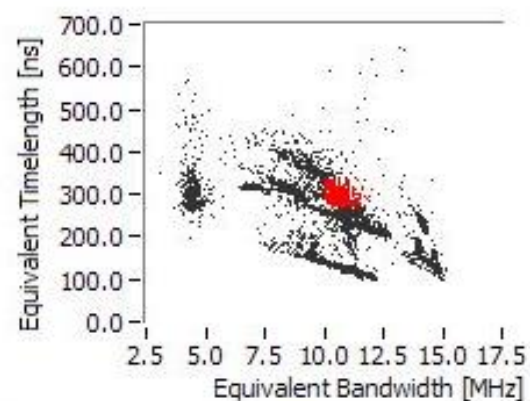
Bar to bar/ground discharges and cross talk of bar to bar/ground from phases V and W.

**Red phenomenon**

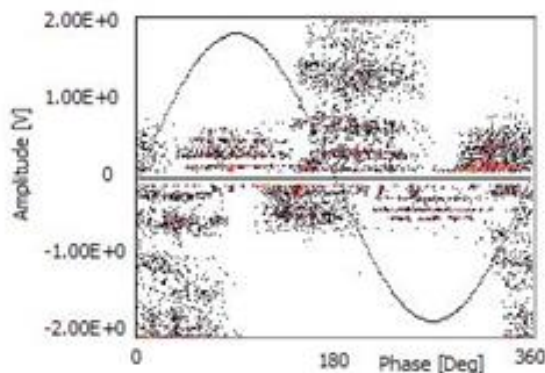
Cross talk of red phenomenon of phase W



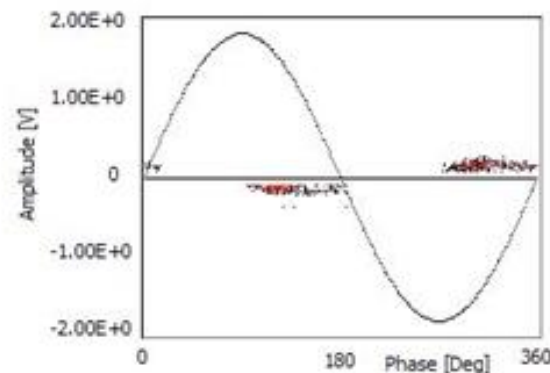
Phase V – PQ – 10 dB attenuator

Entire Pattern acquisitionClassification Map (T-W map)**Black phenomenon**

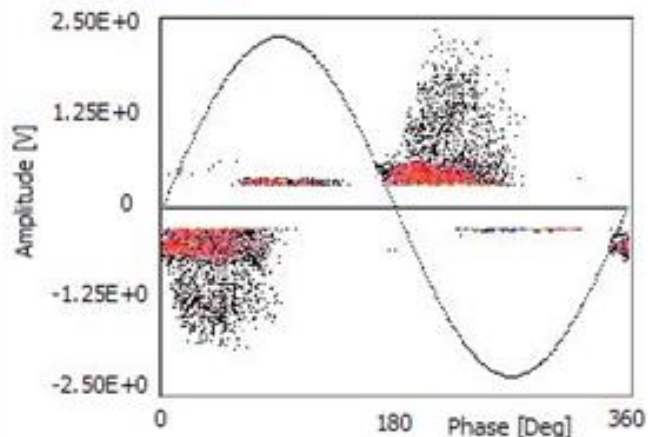
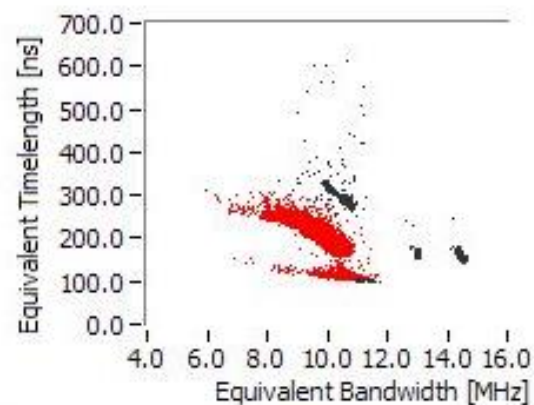
Bar to bar/ground discharges and cross talk of bar to bar/ground from phases U and W.

**Red phenomenon**

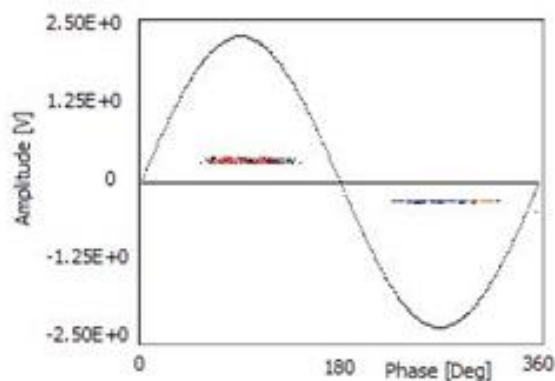
Cross talk of red phenomenon of phase W



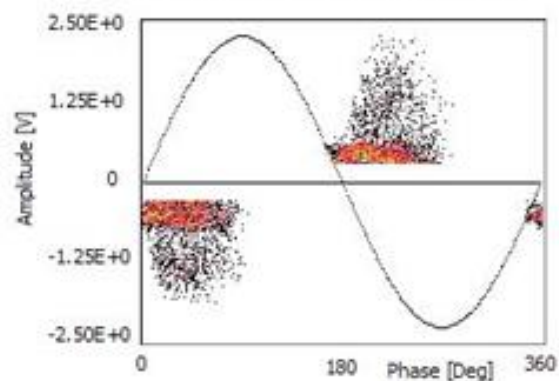
Phase W – PQ – 20 dB attenuator

Entire Pattern acquisitionClassification Map (T-W map)**Black phenomenon**

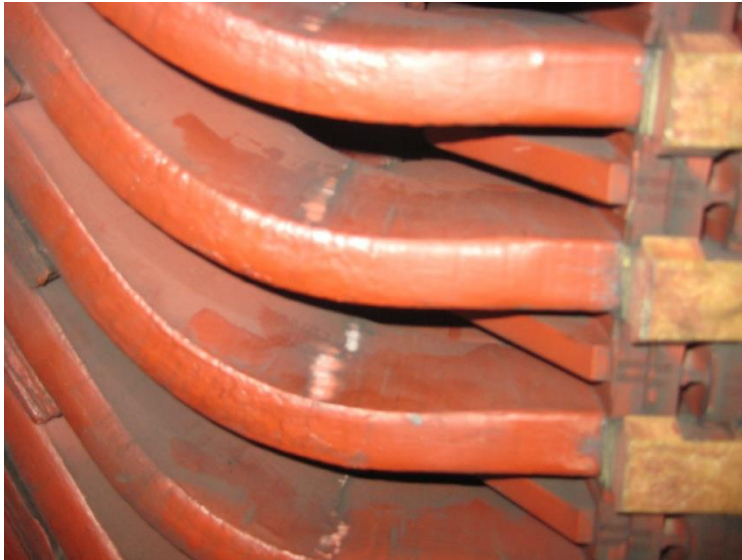
Bar to bar/ground discharges

**Red phenomenon**

Stress grading discharges

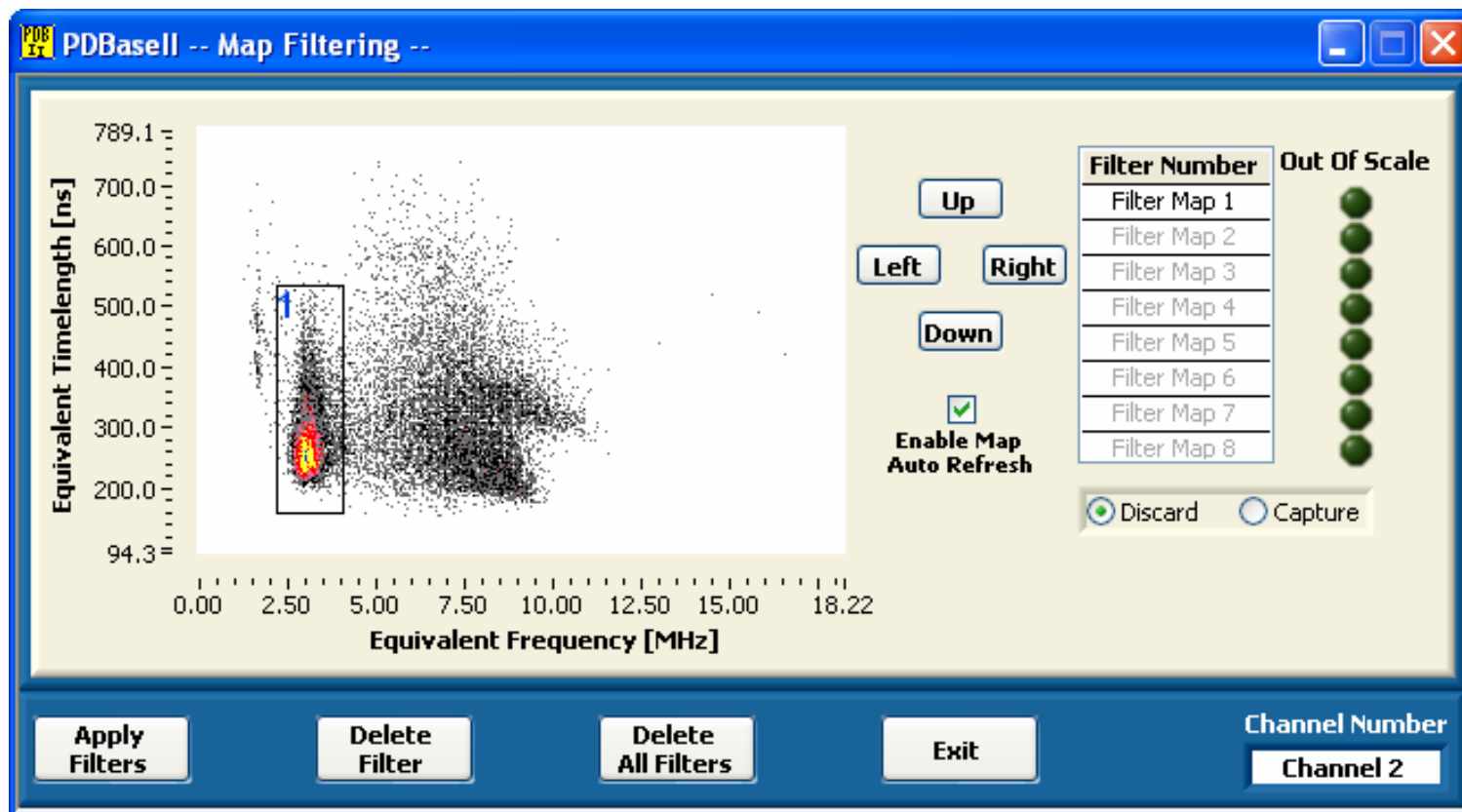


Visual inspection



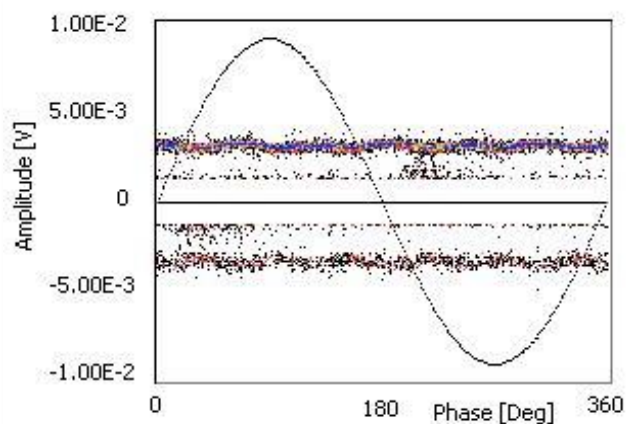
New features: Real Time Filtering Map

Using the Filtering Map it is possible to capture or discard single phenomenon **during the acquisition.**

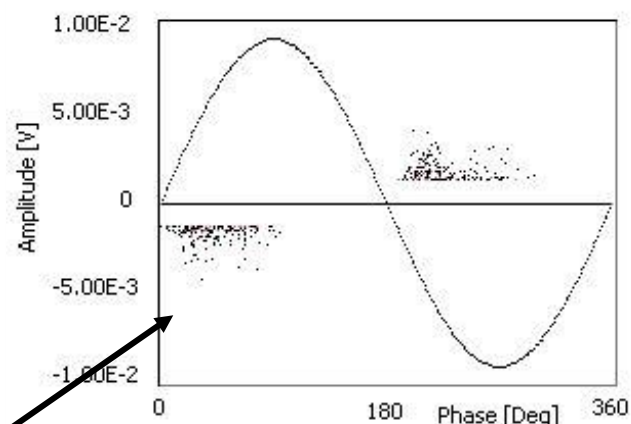


Filtering
Map NOT
Enabled

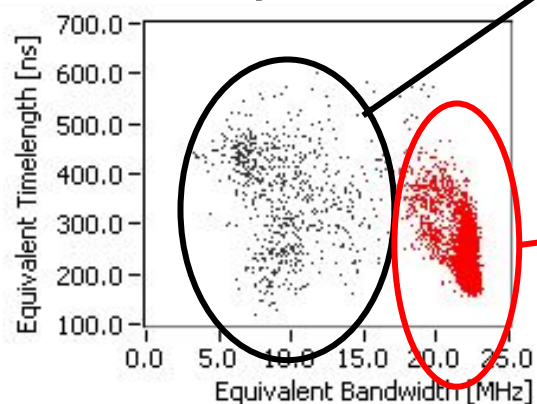
Complete acquisition: 10000 Pulses



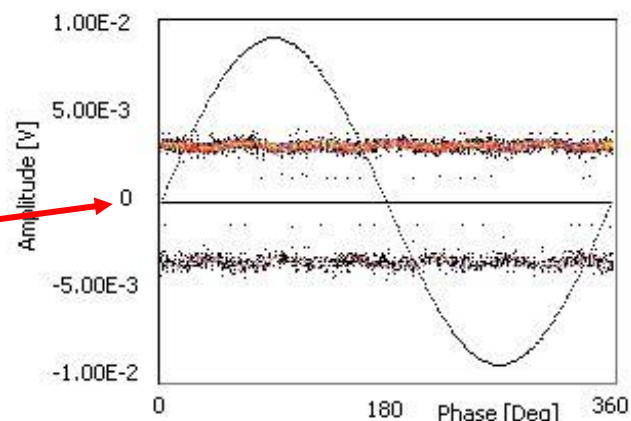
PD: 665 Pulses



TW Map

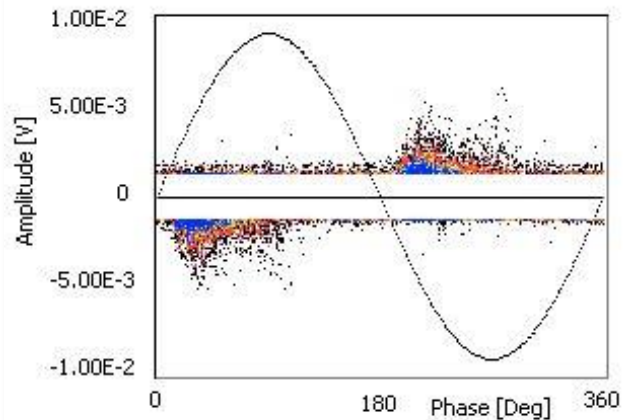


Noise: 9335 Pulses

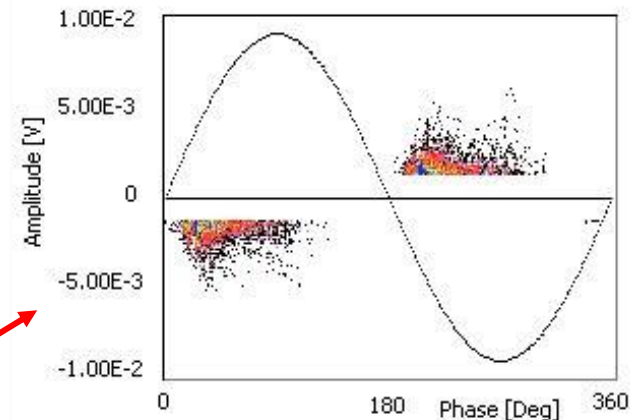


Filtering
Map
ENABLED

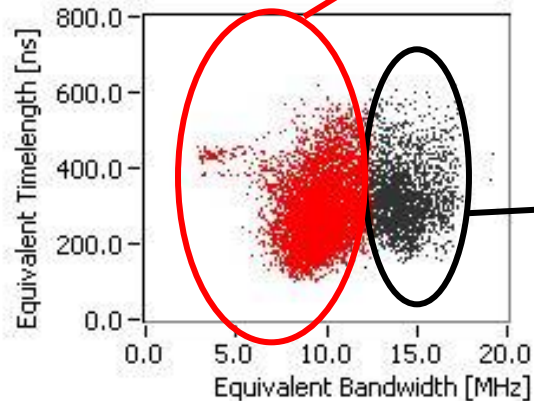
Complete acquisition: 10000 Pulses



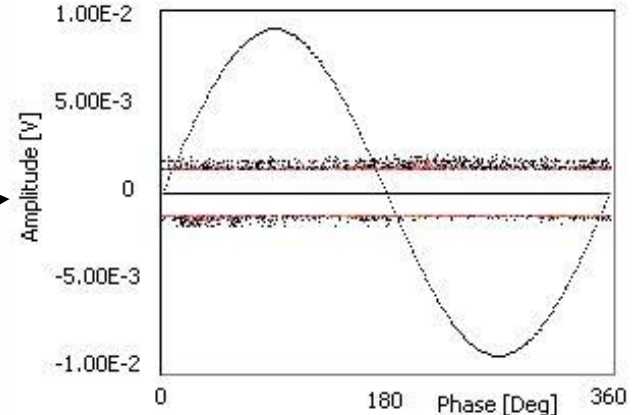
PD: 7700 Pulses



TW Map

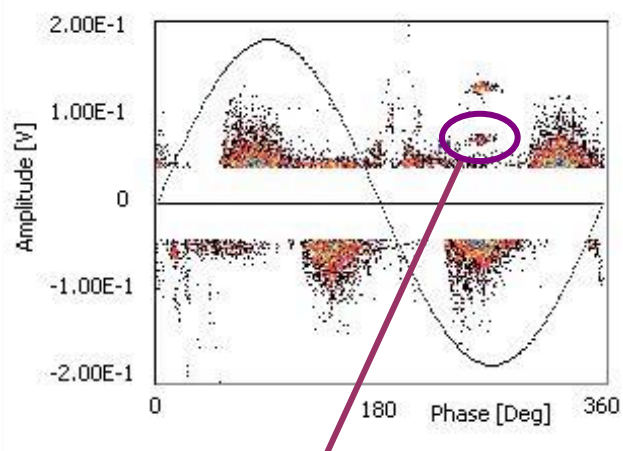


Noise: 2300 Pulses

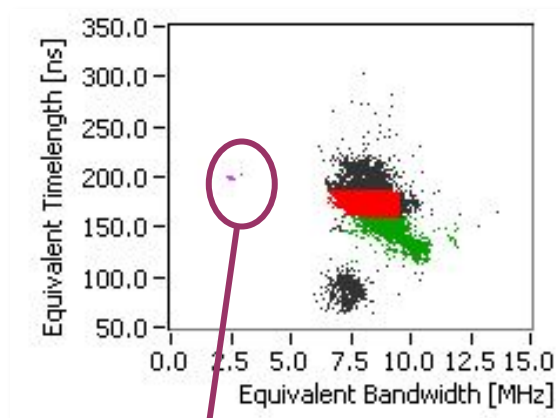


Filtering
Map NOT
Enabled

Complete acquisition

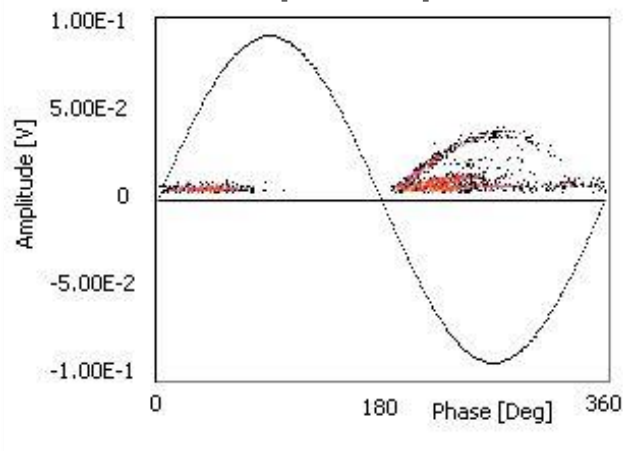


TW Map

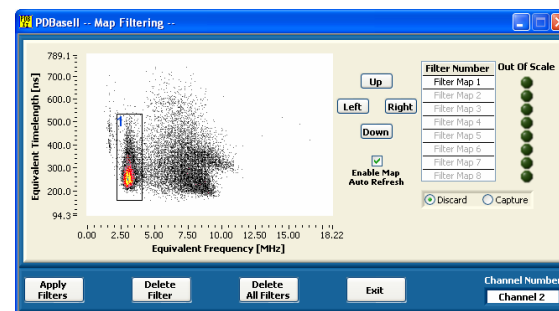


Filtering
Map
ENABLED

Complete acquisition



Real Time Filtering Map: Acquisition focused only on the **purple class**



INTERNAL CAVITIES

LOCATION **USA**

EUT **TWMC Low Voltage Induction
Motor**

RATED VOLTAGE **600 V**

INSULATION

VINTAGE

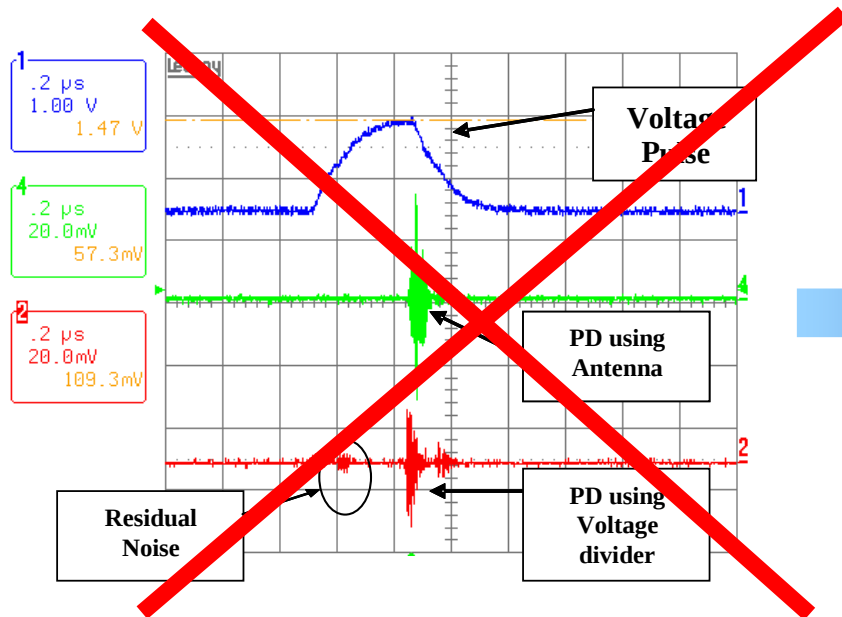
TYPE OF TEST **OFF/ON-LINE**

PD SENSOR **VARIOUS**

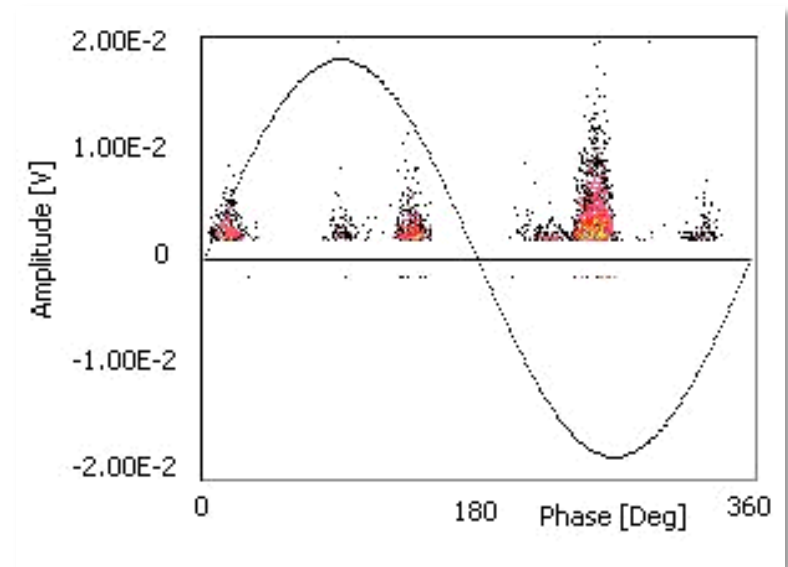
CASE STUDY

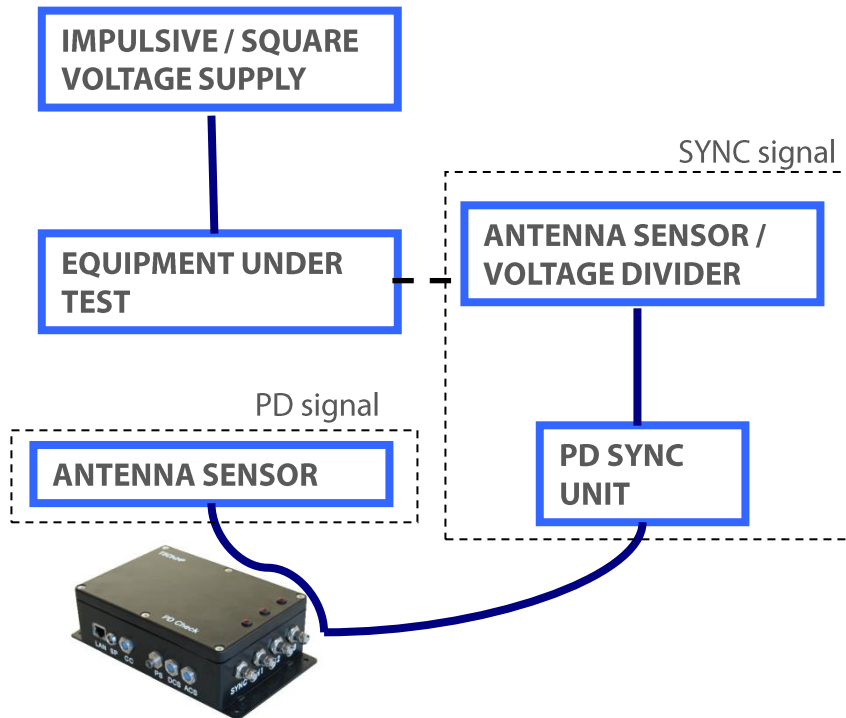
TechImp technology allows PD to be detected both during online and offline tests on motors controlled by Inverter Fed Drivers

Conventional PD measurement methods need the use of Digital Scopes during on-line and off-line tests

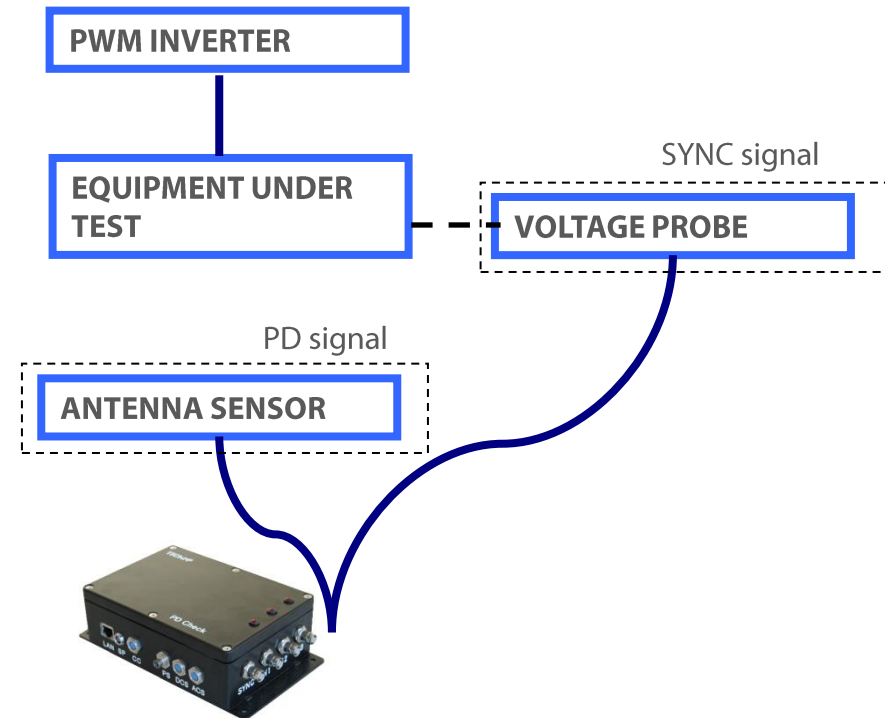


TechImp systems allow to get the PRPD pattern in order to interpret easily the measurement results, without using any Digital Scope.



Measurement setup for **off-line** test

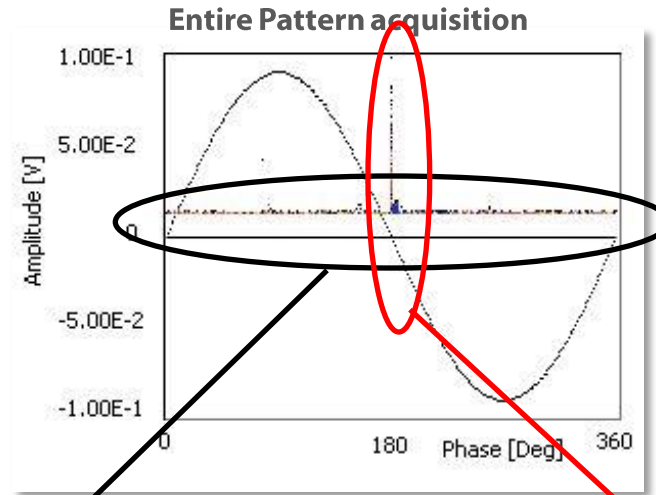
Voltage divider and antenna sensors can be used both contemporarily or individually.

Measurement setup for **on-line** test

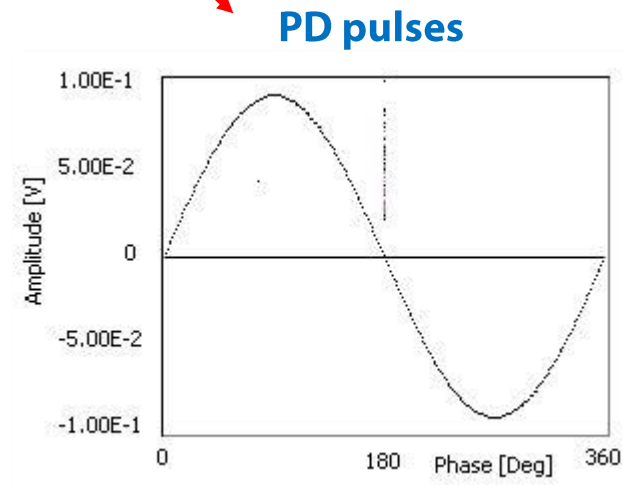
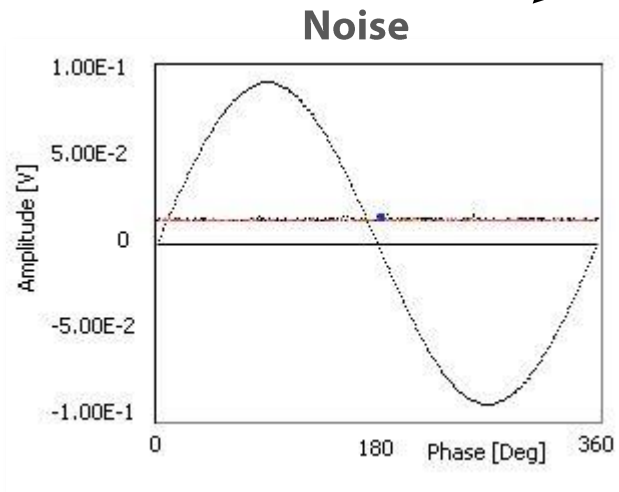
Using antenna sensor is possible to detect any PD activity.

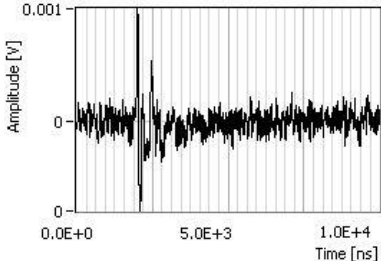
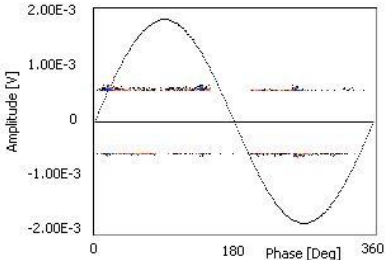
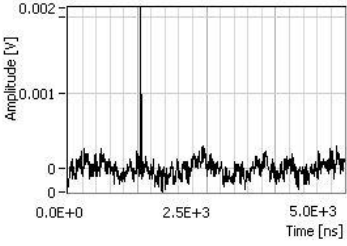
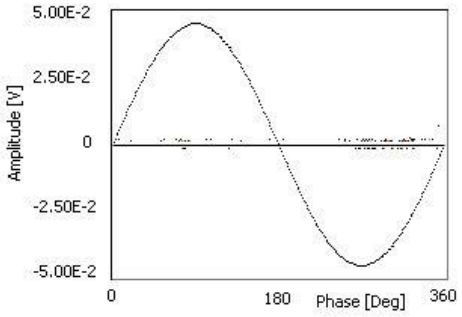
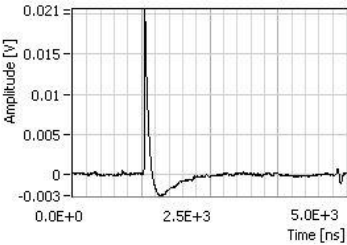
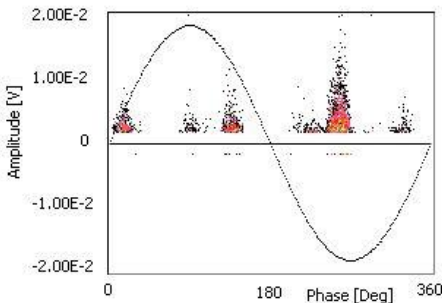
On line PD test on Motor

Getting the synchronization signal it is possible to recognize easily the PD pulses, that appear as vertical structures.



In the PRPD pattern, the residual noise and external disturbances are spread in all the phase domain.

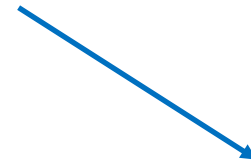
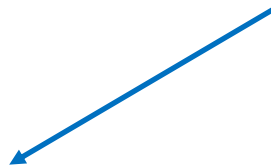


ON LINE TEST RESULTS			
EUT	PD waveform	PRPD Pattern	Diagnosis
Motor No 1			PD Free
Motor No 2			PD Free
Motor No 3			PD affected

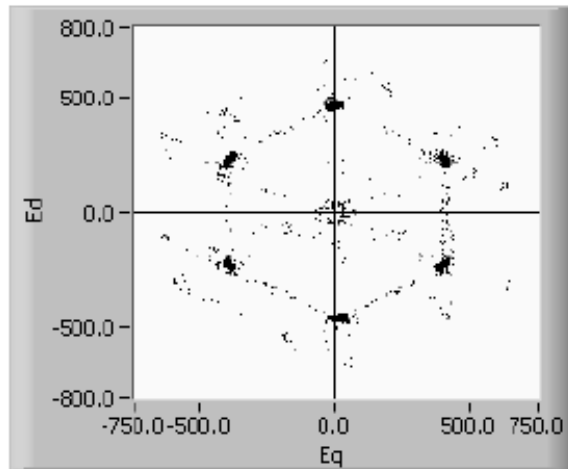
Interpretation of PD phenomena: Hexagon method applied to motorettes

The interpretation of PD measurements can be carried out resorting to the direct-quadrature (dq) transform of the three voltages at motor terminals at the instant a PD event occurs.

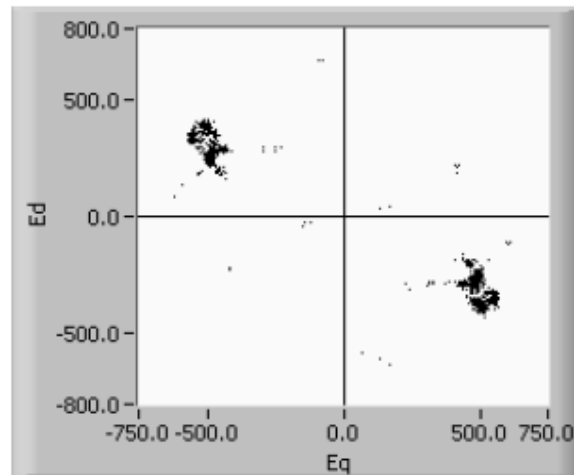
New tools (the **dq loci**, **dq Hq** and **dq Hn** patterns) are used to identify PD phenomena and monitor PD activity.



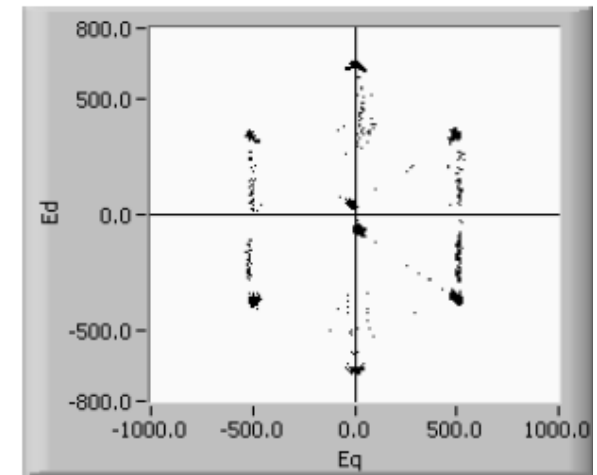
dq loci - Noise



dq loci - Phase To Phase PD

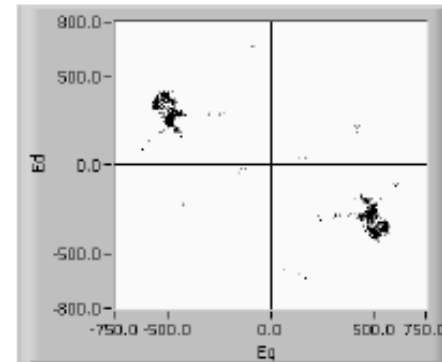


dq loci - Inter Turn PD

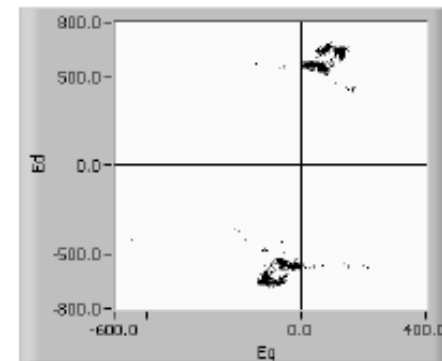


The hexagon analysis allows:

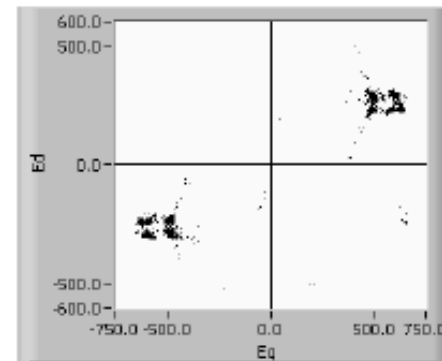
- ▣ Interference / Noise Rejection
- ▣ PD identification
- ▣ PD localization
- ▣ Motor degradation monitoring



U - V
Phase to Phase
Discharges



U - W
Phase to Phase
Discharges



V - W
Phase to Phase
Discharges

LOCATION **South America**

EUT **Generator**

RATED VOLTAGE **15 kV**

INSULATION

VINTAGE

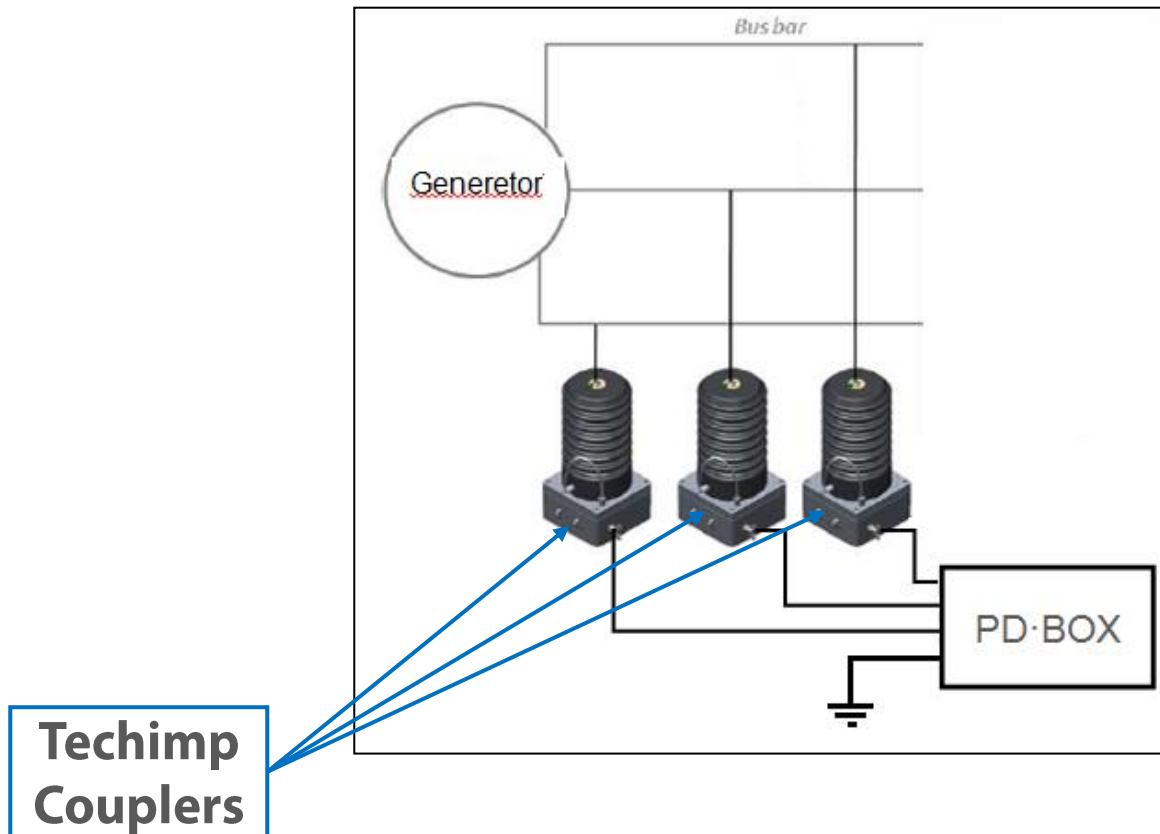
TYPE OF TEST **ON-LINE**

PD SENSOR **Cap. Coupler**

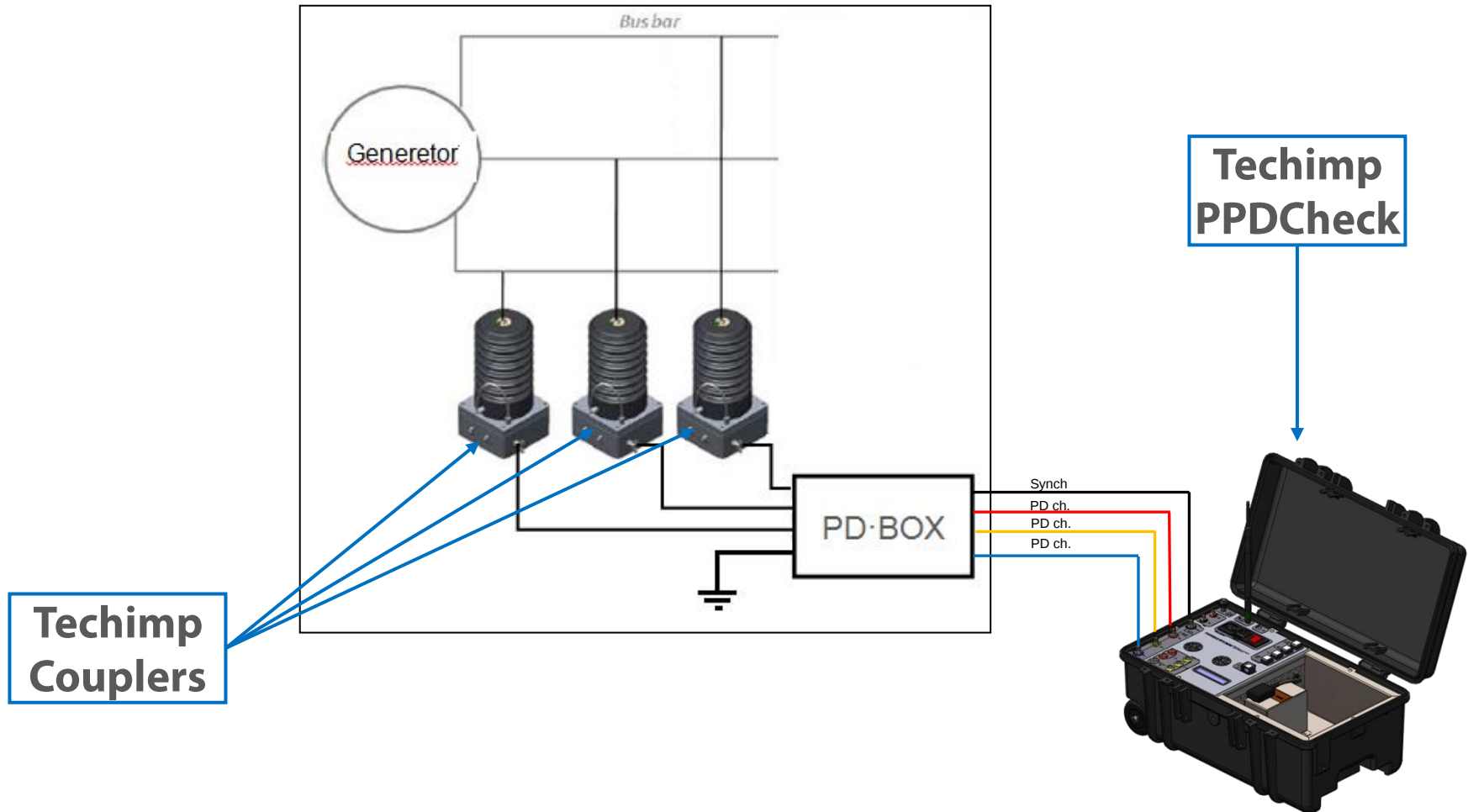
CASE STUDY

TechImp technology allows PD source separation and strengthens PD source identification.

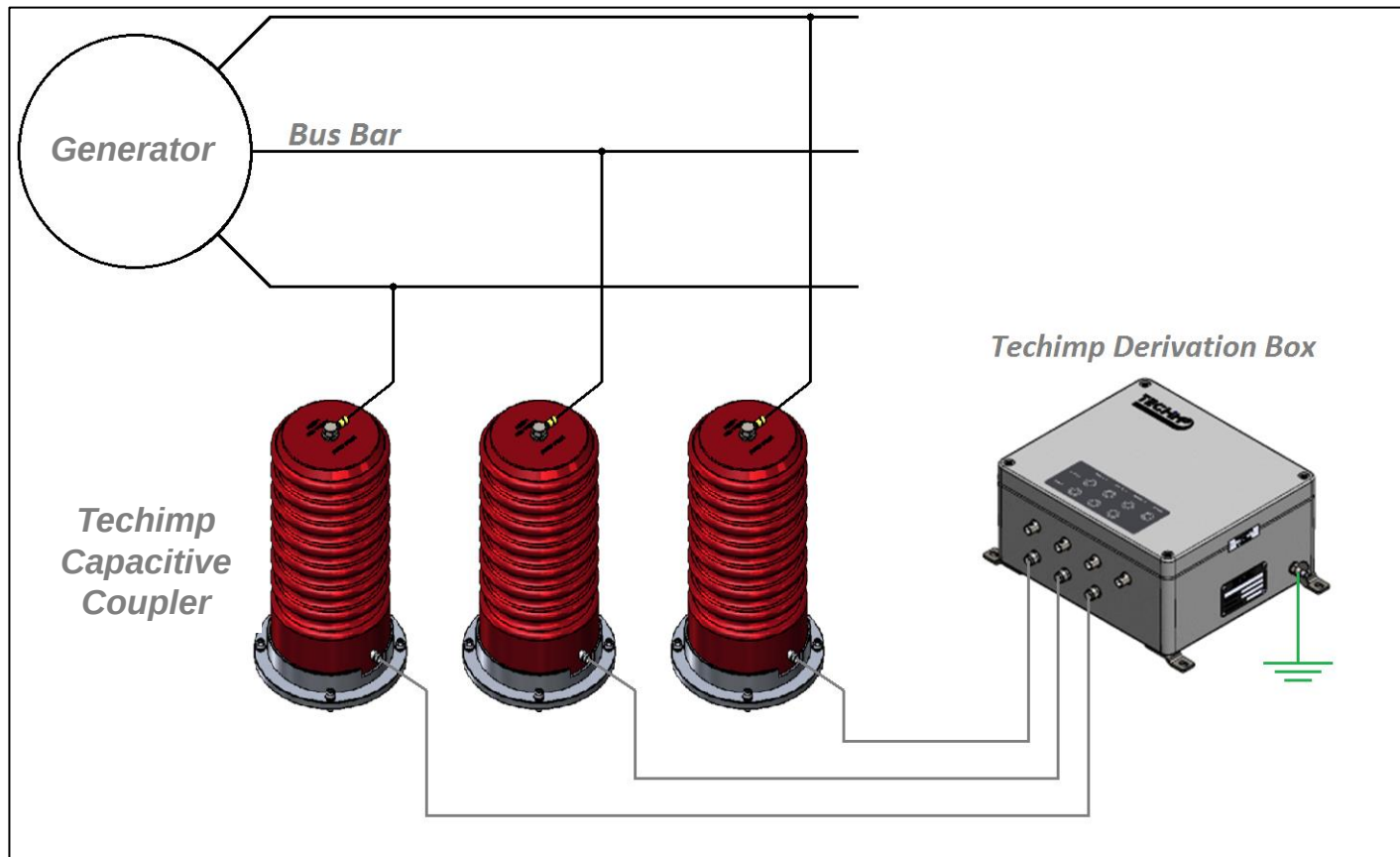
PD sensors already installed



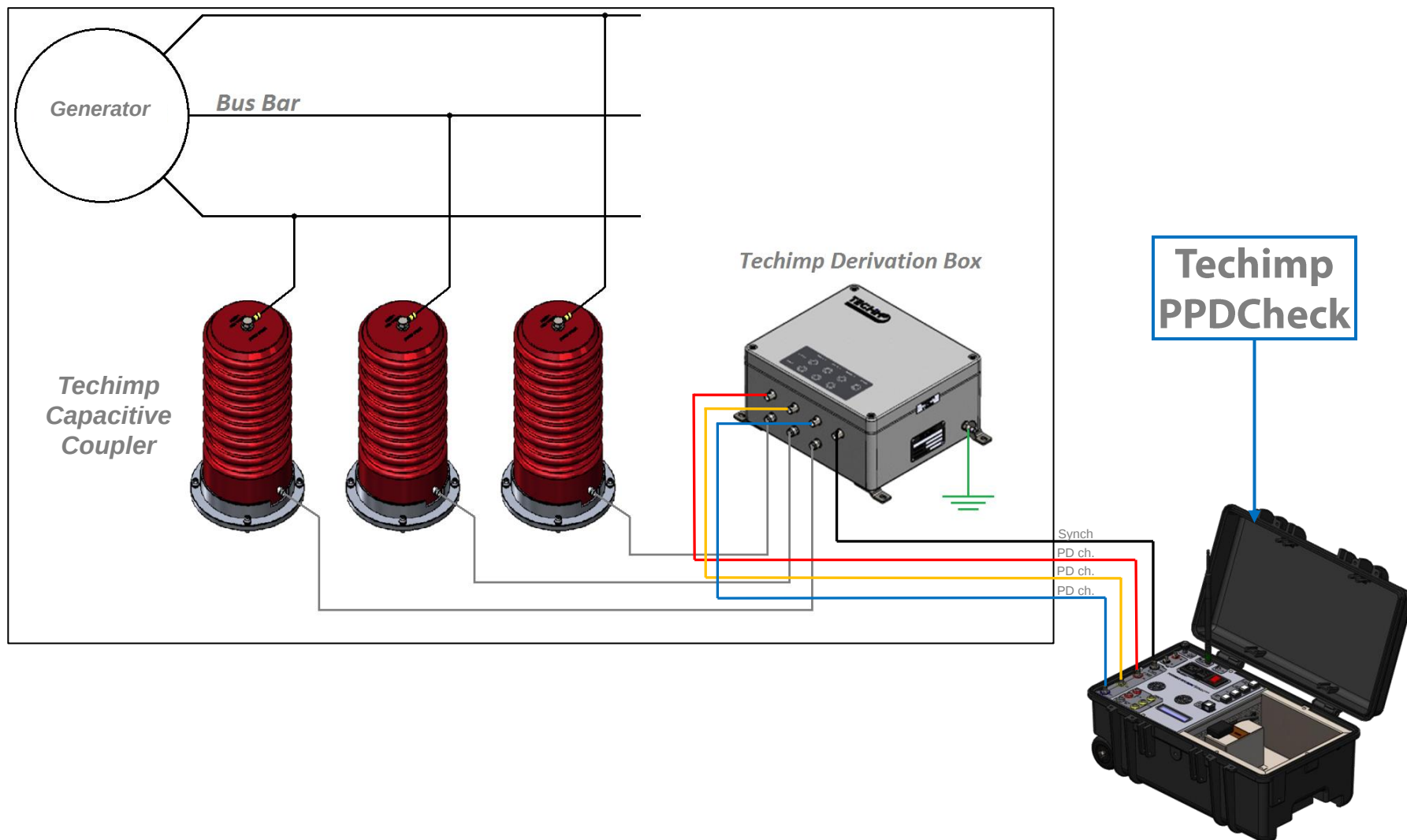
PD measurement layout



PD sensors already installed



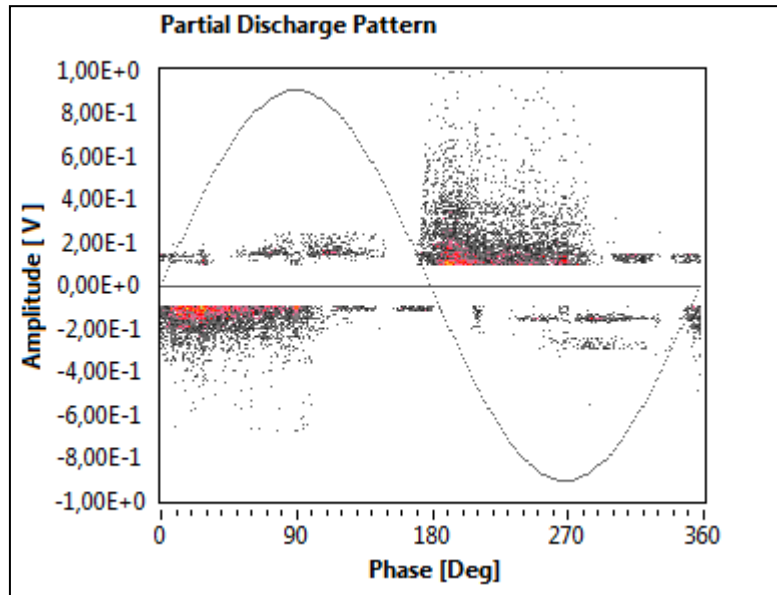
PD sensors already installed



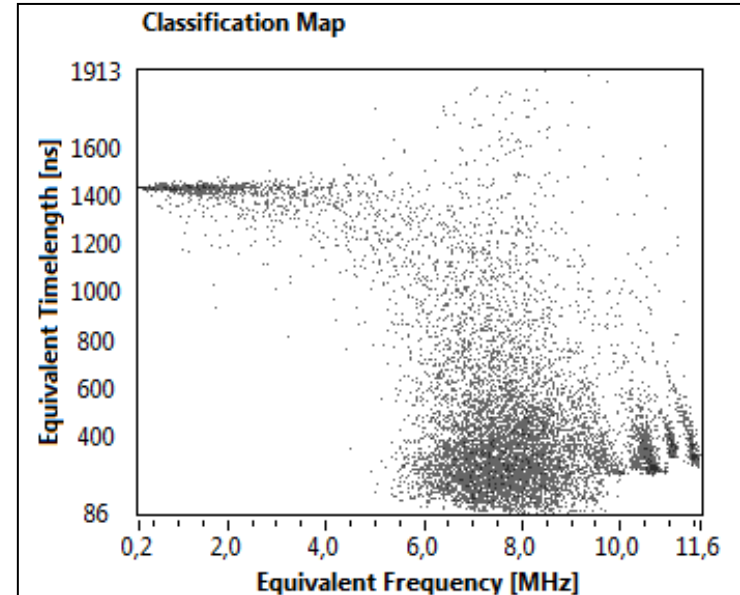
PD measurement: Acquisition

Red Phase

Complete PD pattern

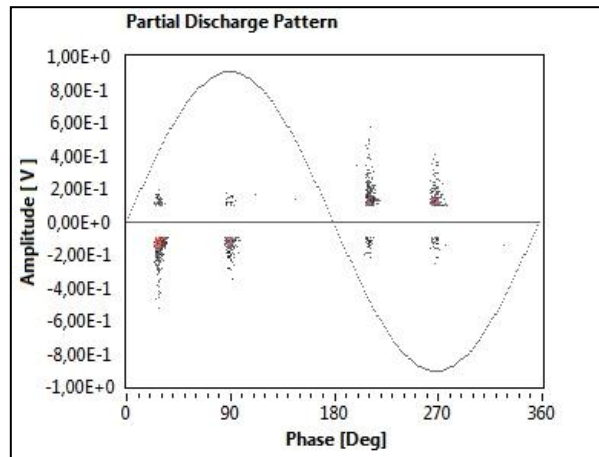
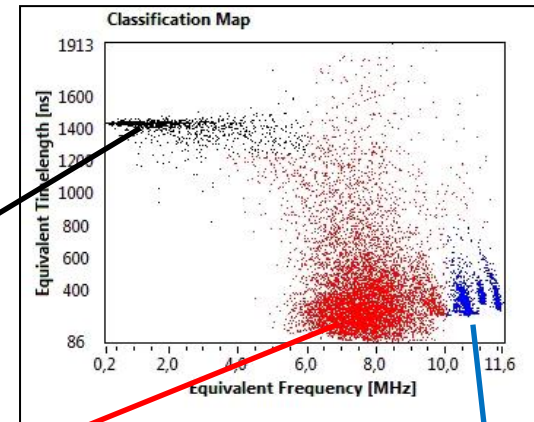
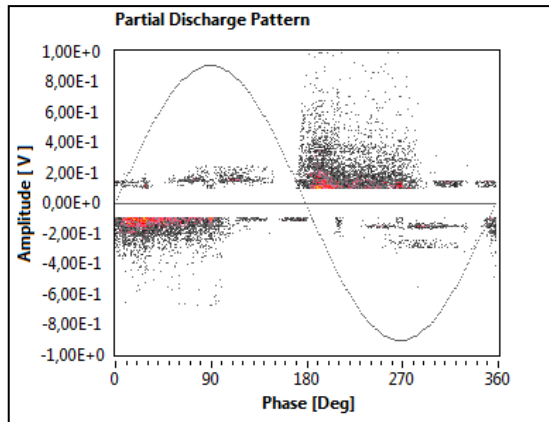


TECHIMP TF Map

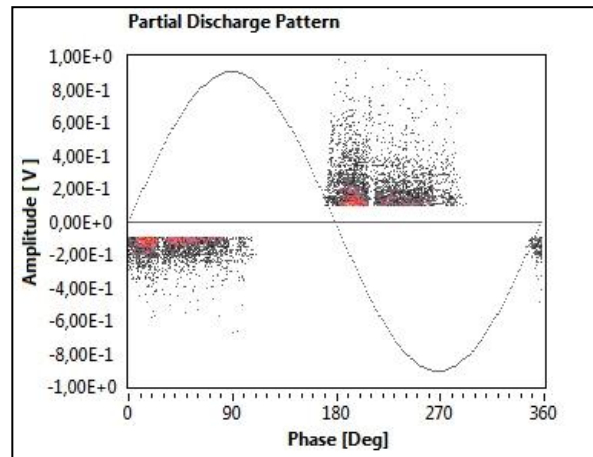


PD measurement: Separation

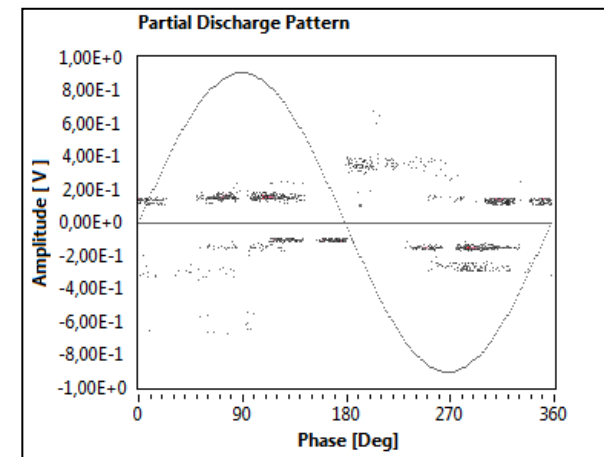
Red Phase



Black phenomenon



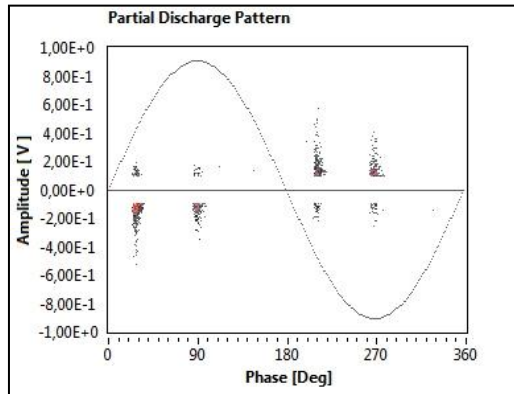
Red phenomenon



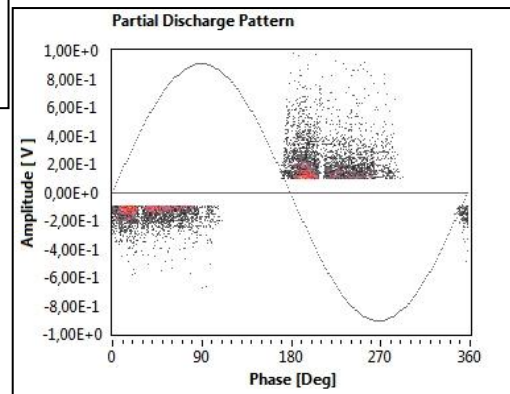
Blue phenomenon

PD measurement: Diagnosis

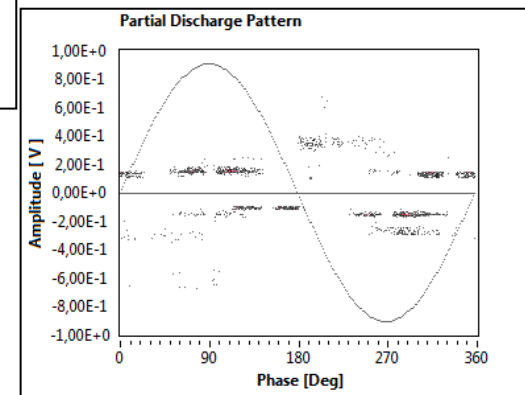
Red Phase



Black phenomenon
Exciter noise



Red phenomenon
Slot discharges

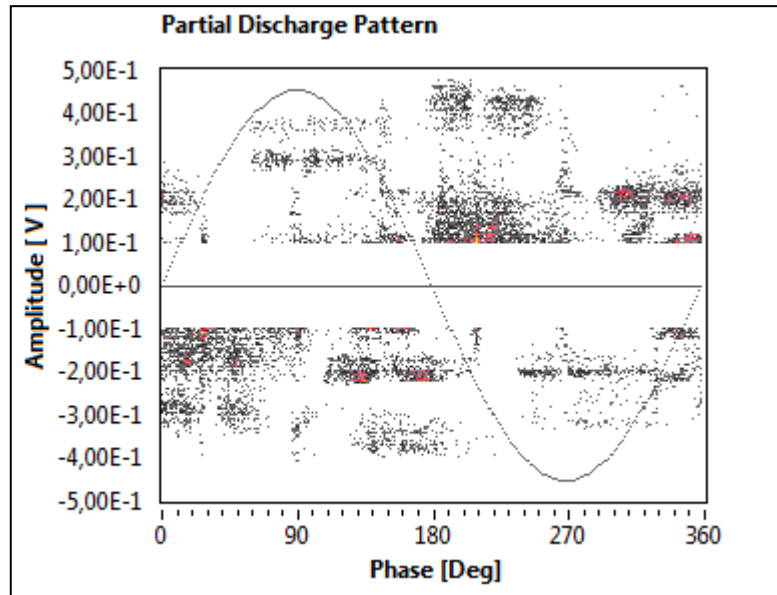


Blue phenomenon
Bar to Bar / Bar to Ground

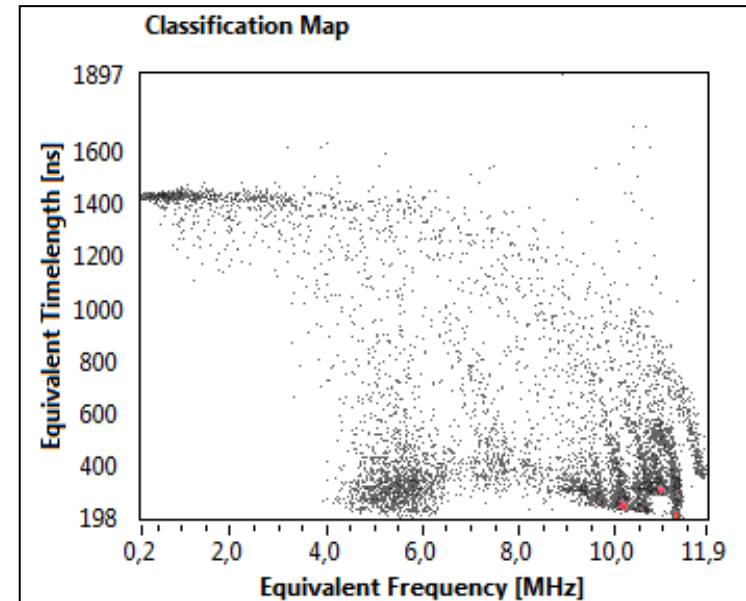
PD measurement Acquisition

Yellow Phase

Complete PD pattern

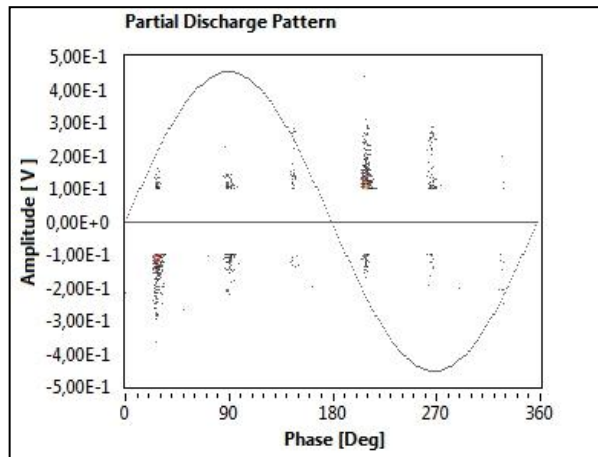
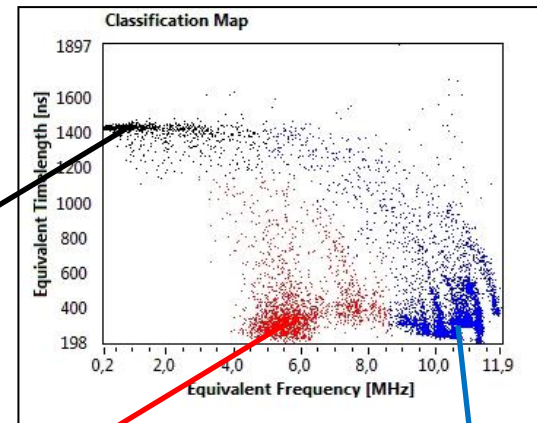
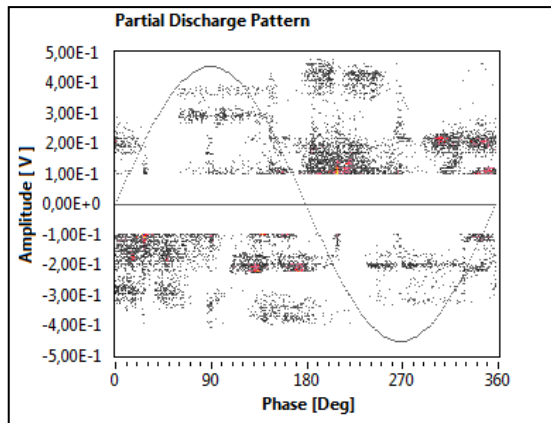


TECHIMP TF Map

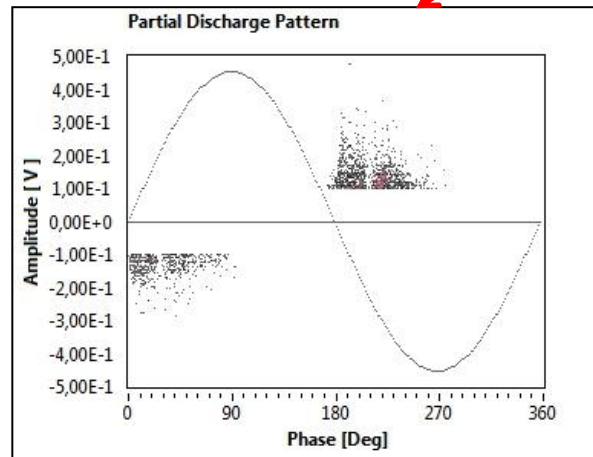


PD measurement: Separation

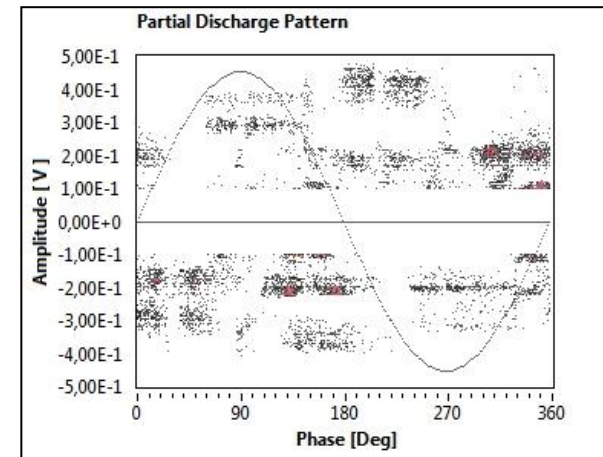
Yellow Phase



Black phenomenon



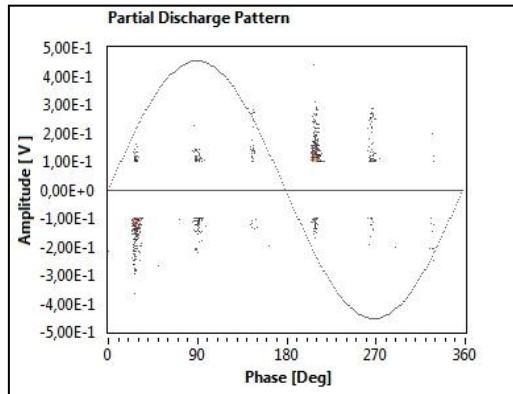
Red phenomenon



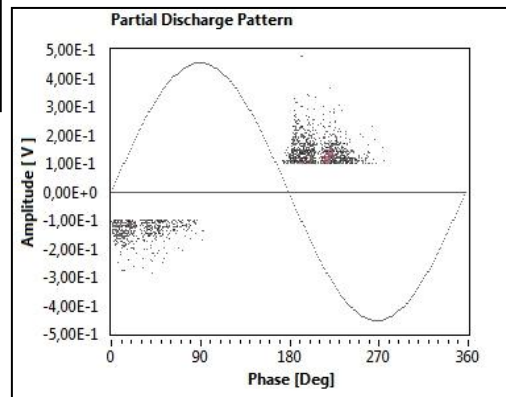
Blue phenomenon

PD measurement: Diagnosis

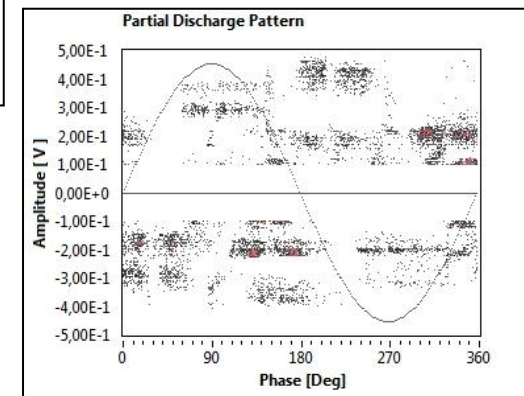
Yellow Phase



Black phenomenon
Exciter noise



Red phenomenon
Slot discharges

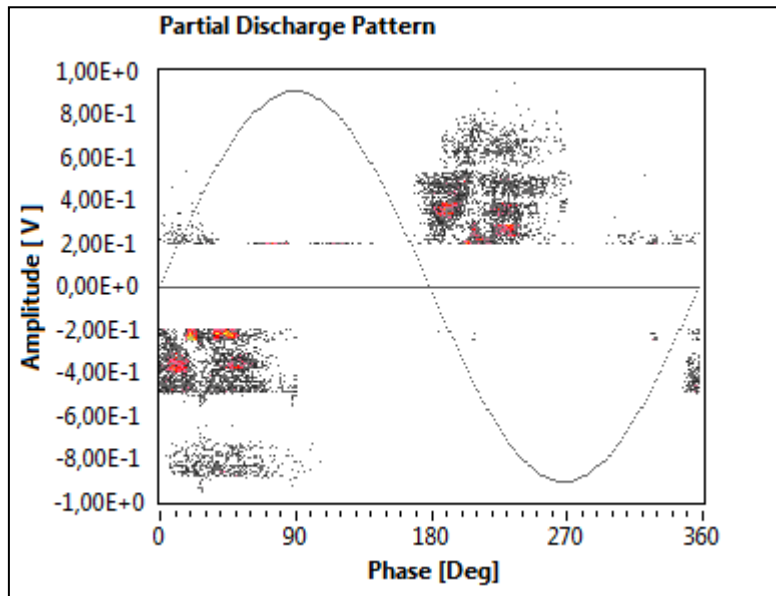


Blue phenomenon
Bar to Bar / Bar to Ground

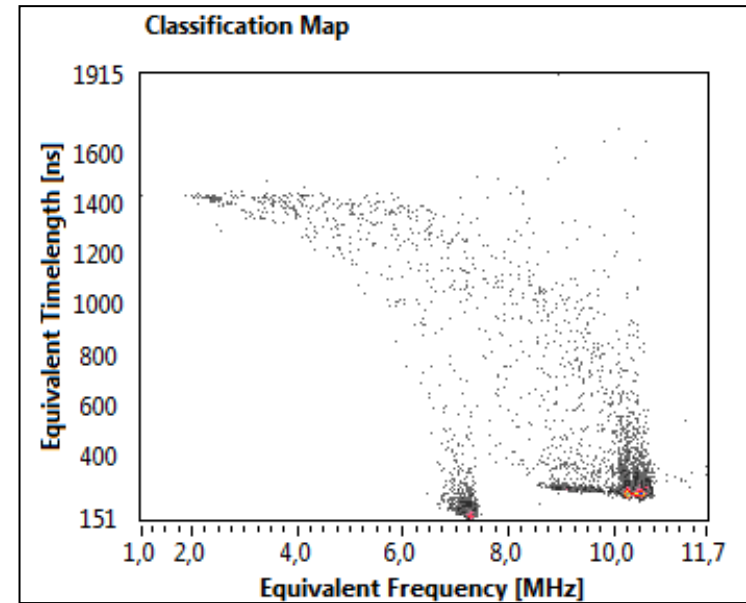
PD measurement Acquisition

Blue Phase

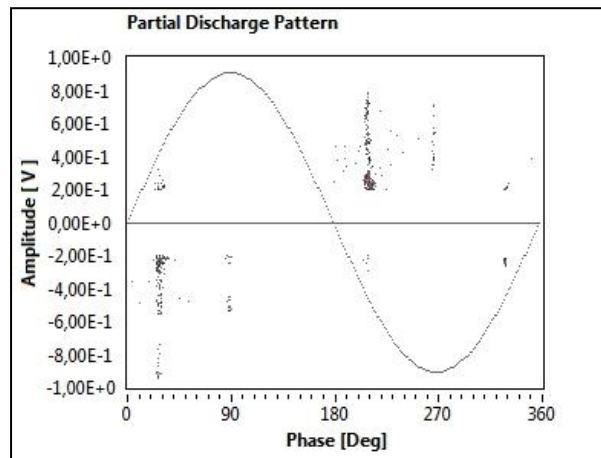
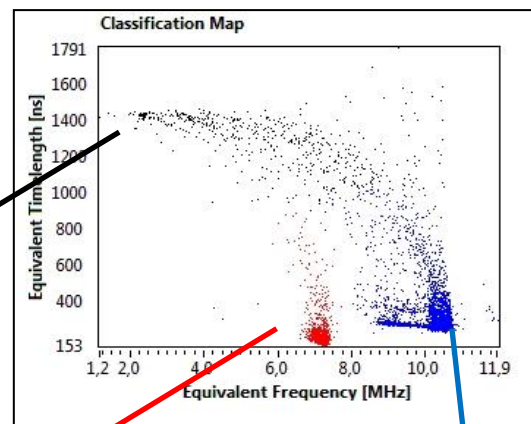
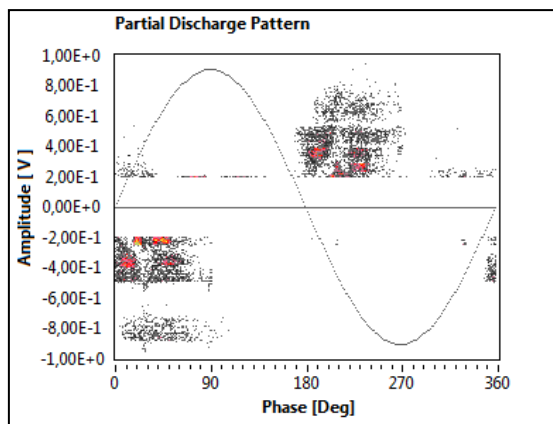
Complete PD pattern



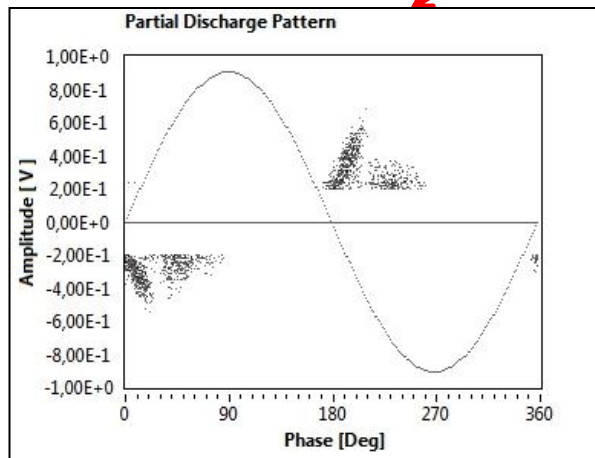
TECHIMP TF Map



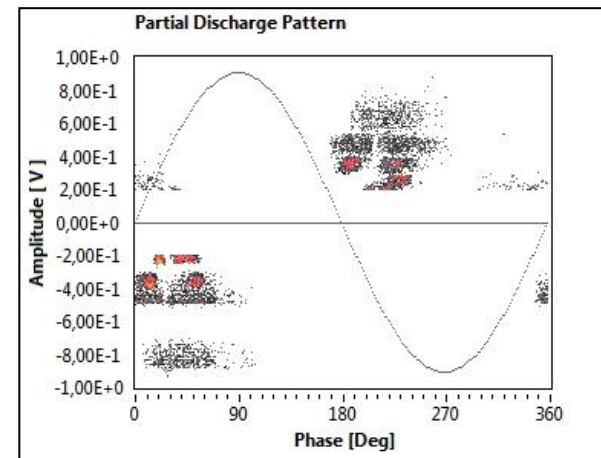
PD measurement: Separation Blue Phase



Black phenomenon



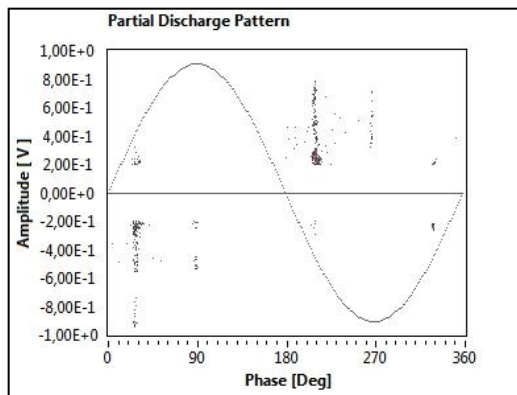
Red phenomenon



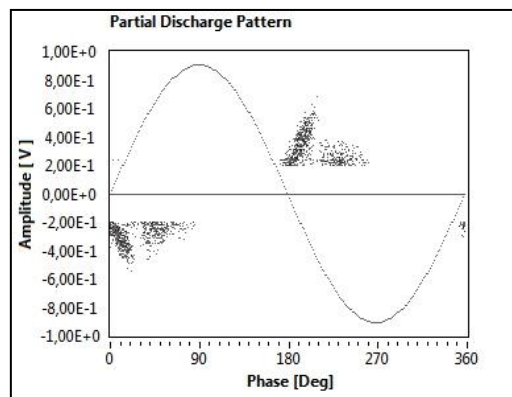
Blue phenomenon

PD measurement: Diagnosis

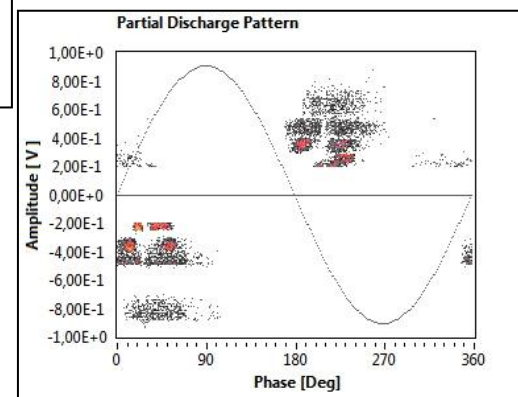
Blue Phase



Black phenomenon
Exciter noise



Red phenomenon
Slot discharges



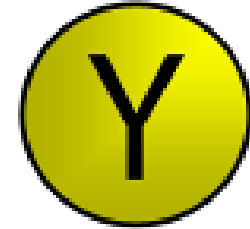
Blue phenomenon
Bar to Ground

PD measurement: Results

Red Phase: Slot discharges
Bar to Bar/ Bar to Ground



Yellow Phase: Slot discharges
Bar to Bar/ Bar to Ground



Blue Phase: Embedded discharges
Bar to Ground

