

**Megger**<sup>®</sup>

# Power Diagnostix Solutions for Partial Discharge Testing and Monitoring



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# Our monitoring devices for all your assets

## ICMmonitor

### What makes it special?

- Monitor insulation condition (MV & HV)
- Remote access with Monitor Web Server (MWS)
- Always aware of asset's conditions
- Ideal noise handling
- Various versions specified for intended purpose



ICMmonitor DIN rail with MWS

### Customer groups

- Power utilities\*
- Heavy industry\*
- OEM (indirect customer)

### Applications

- Permanent online monitoring
- On-site online test
- On-site offline test

### Assets

- Transformer
- Rotating
- GIS
- AIS
- Cable

\*more common usage for these customer groups

## ICMmonitor Portable

### Why it might be a better fit?

- Portable solution of a monitoring system
- Flexibility to monitor one asset after another for a limited period
- With ICMoutlander (Protective housing) monitoring under all weather conditions and environments
- Reliable and precise results



### Customer groups

- Power utilities\*
- Heavy industry\*
- Service providers\*
- Repair shops

### Applications

- Temporary online monitoring
- On-site online test
- On-site offline test

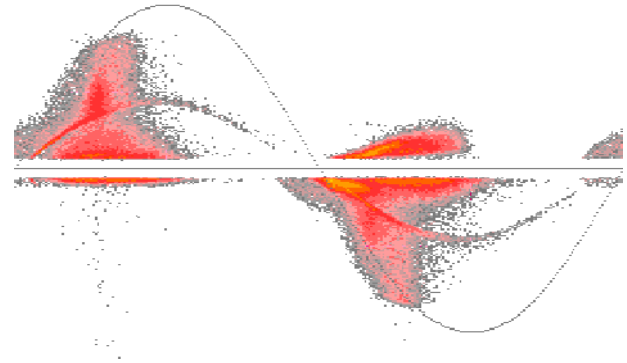
### Assets

- Transformer
- Rotating machine
- GIS
- AIS
- Cable

## Részkisülés-monitoring (PDM) teljesítménytranszformátorokon

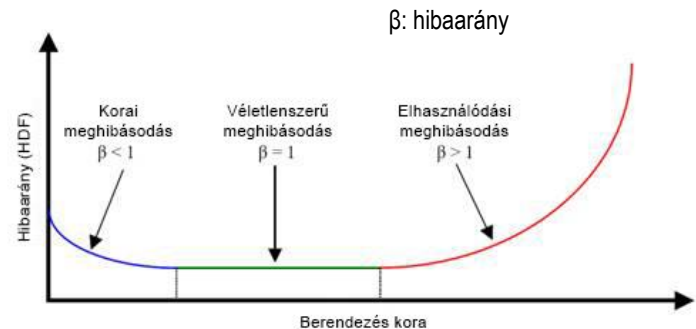
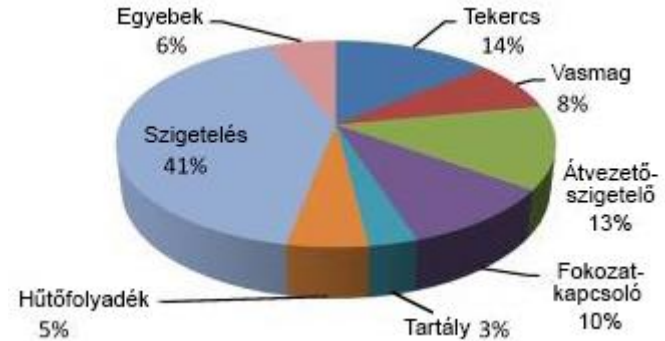


- **Miért kell részkisülés-monitoring?**
- Műszaki adatok
- Tulajdonságok és előnyök
- Referenciák



# Miért kell részkisülés-monitoring a transzformátorokon?

- A meghibásodások nagy része szigetelési problémákkal kapcsolatos
- A részkisülés-monitoring kimutatja az átvezetőszigetelő- és tekercshibákat
- Korai hibák a gyári vizsgálat, szállítás, helyszíni üzembe helyezés hiányosságai miatt
- Véletlenszerű meghibásodások speciális igénybevétel miatt (pl. magas terhelés, villám- vagy kapcsolási impulzusok vagy környezeti hatások)
- Az élettartam végén fellépő meghibásodások a szigetelőanyagok előregedése miatt



- **A részkisülések kiváltó okai**

- Szigetelőanyagok rossz minősége
- Alapvető tervezési hibák
- Hiányos vagy nem megfelelő gyártás
- Összeszereléssel kapcsolatos hibák
- Olaj nedvességtartalma



- **Részkisülések hatása a transzformátor szigetelésére**

- A hatás súlyossága a részkisülés jellegétől és helyétől függ
- Szigetelőanyagok gyorsabb károsodása
- A villamosenergia-hálózat várható élettartama csökken
- A legrosszabb esetben: váratlan átütés → áramszünet





# Miért kell részkisülés-monitoring a transzformátorokon?

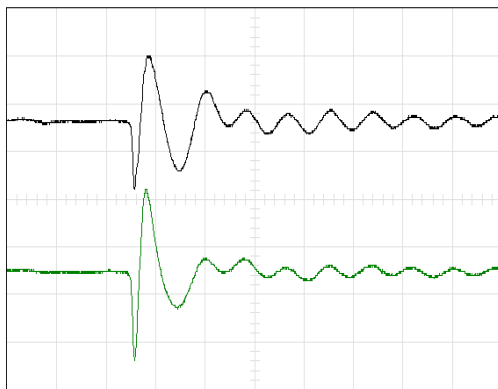
- Online PDM teljesítménytranszformátorok és transzformátor-tartozékok szigetelésének állapotfelügyeletéhez
- PD-trend és PD-minták változása kezdeti meghibásodást jelez
- A PD-mintaelemzés segít a meghibásodások kivizsgálásában (kiváltó okok elemzése – RCA root cause analysis)
- Még jobb eredmény, ha a PD-monitoring HGA-val, feszültség-, hőmérséklet- és terhelésállapot monitoringgal van kiegészítve



Kép: Az első PDM berendezés egy 400 kV-os hálózati transzformátoron (RWE) 1998

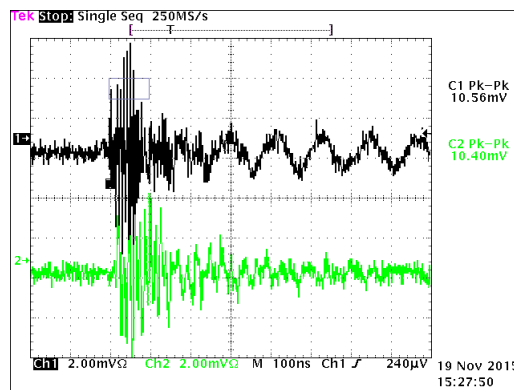


Egy átvezetőszigetelő mérőmegcsapolásából vett elektromos PD-impulzus

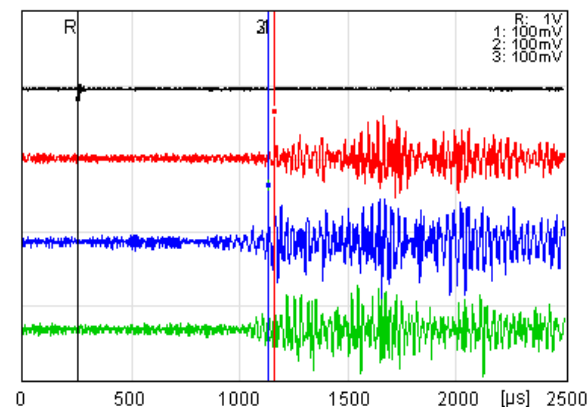


X Scale	Y Scale CH1	Y Scale CH2
10.00 $\mu$ s / DIV	1.00 V / DIV	1.00 V / DIV
Y Position CH1	Y Position CH2	
1.72 DIV	-1.56 DIV	

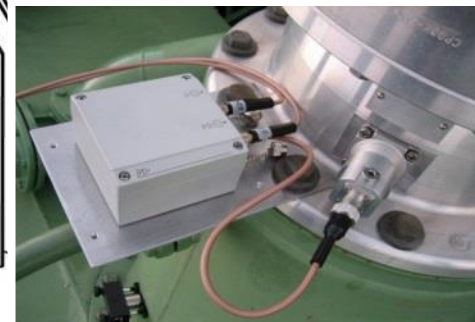
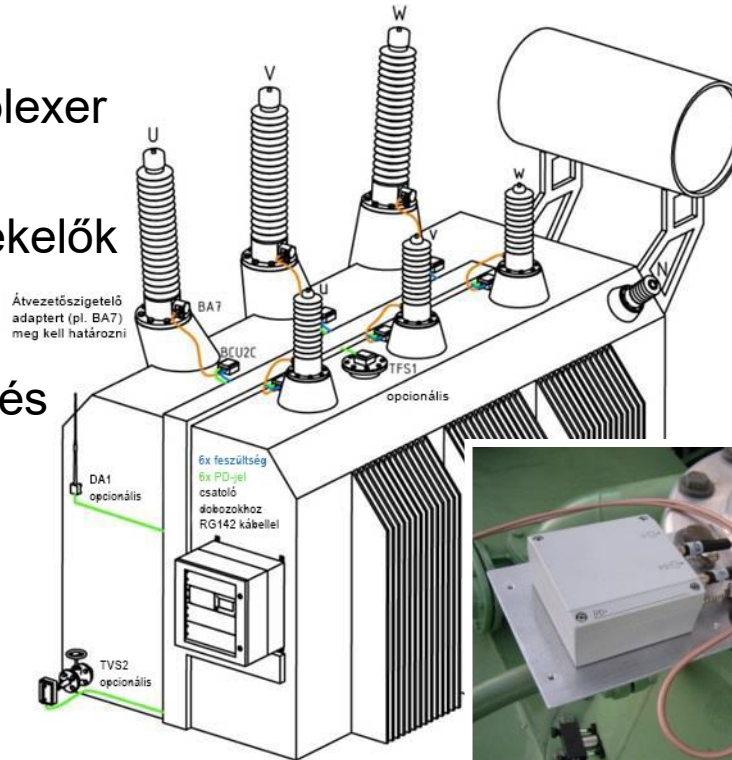
UHF-antennáról vett UHF PD-impulzus az olajleeresztő csapnál



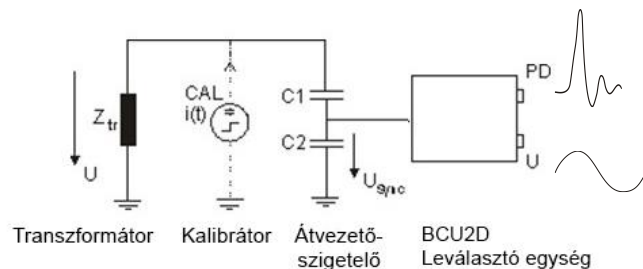
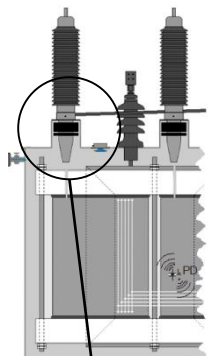
A tartály falán mért akusztikus jel



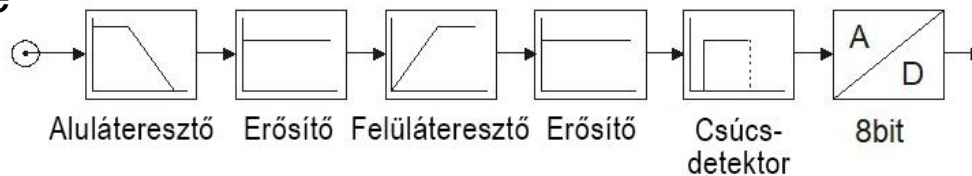
- PD- és Sync-jel az átvezetőtől a Multiplexer bemenetéig
- HF- vagy UHF-érzékelők
- (DA1) zajkapuzás
- Spektrum szkennelés
- PD-minta és -trend
- OEM megoldások Koncar és mások számára



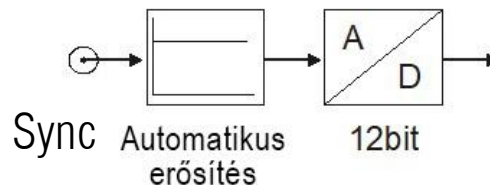
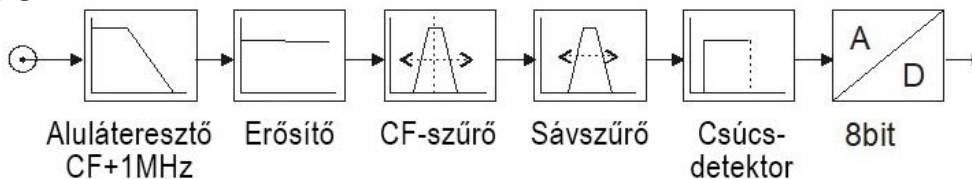
## PD-jelek jelfeldolgozása



### AMP Mode

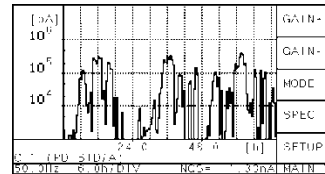
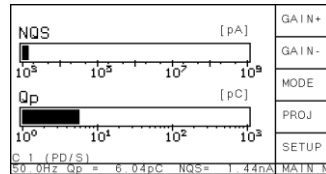
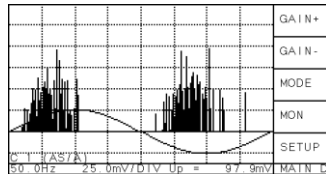
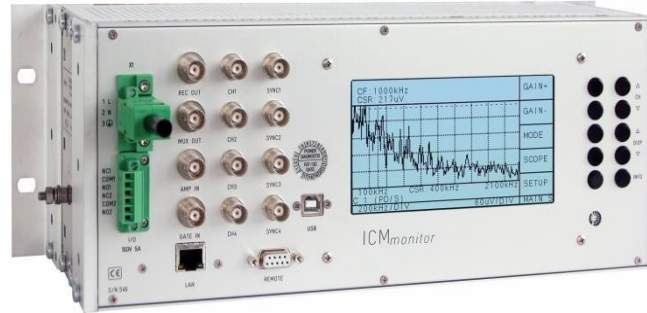


### SPEC Mode



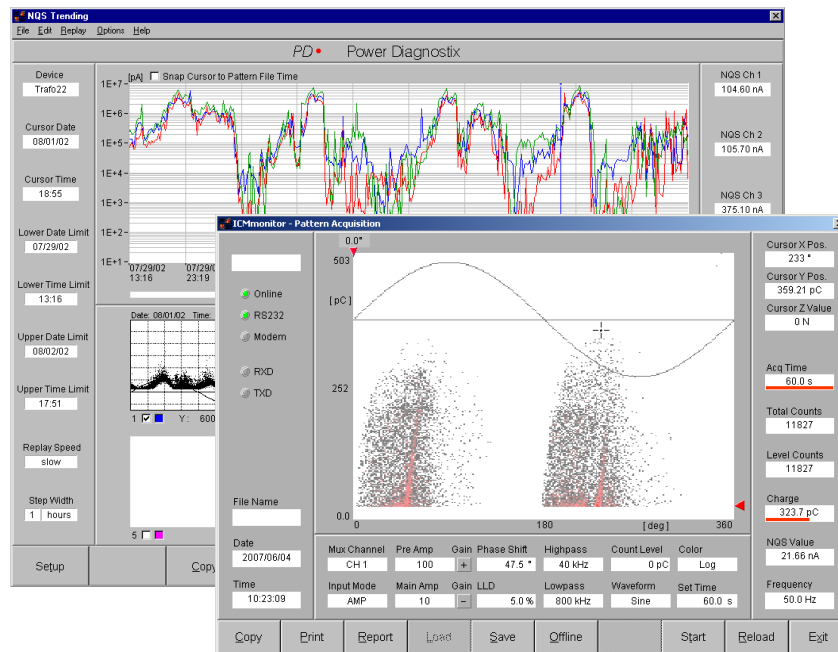
## ICMmonitor Feldolgozóegység

- Választható frekvenciájú mérés
- Széles sávú és keskeny sávú szűrő
- Spektrumanalízis
- UHF-mérés
- Relés kimenetek
- IEC61850 kapcsolat (hardver vagy szoftver)



- Távoli hozzáférés több monitoring műszerhez
- Hosszú távú trendképzés, History-struktúra
- Riasztáskezelés
- Színes PD-mintafeldolgozás
- Automatikus adatfeldolgozás
- USB-n vagy LAN-on keresztüli csatlakozások

## Windows szoftver: ICMmonitor



## 3 possibilities:

- Spot testing
- Temporary monitoring
- Permanent monitoring

## AICompact

### The right additional support

- Light-weight compact instrument for acoustic & electric (UHF) PD
- Easy setup – automatic sensor detection
- Works independently with battery



### Customer groups

- Power utility
- Heavy industry
- Service providers
- Test laboratories

### Applications

- On-Site offline test
- On-site online test

### Assets

- GIS
- Transformer
- Cable accessories

# Our specialized solutions for GIS monitoring

## GISmonitor

### What makes our GISmonitor unique?

- Specialized continuous monitoring device for GIS
- Suitable for embedded + external UHF sensors available in the market
  - Allows retrofitting of existing GIS
- Real-time monitoring of multiple assets with multichannel system
- Up to **120** measurement channels in parallel
- Available in different versions



#### Customer groups

- Power utilities\*
- Heavy industry\*
- OEM (indirect customer)

#### Applications

- Permanent online monitoring
- On-site online test

#### Asset

- GIS

\*more common usage for these customer groups

## GISmonitor Portable

### Reasons for the portable version

- Offered as a standardized solution
- Portable monitoring version for GIS
  - For temporary GIS monitoring
- Flexible solution, can be used for several GIS at your site
- Up to 40 measurement channels in parallel



**Recommended:** HV testing on single or three phase encapsulated GIS

#### Customer groups

- Power utilities\*
- Heavy industry\*
- Service providers
- Repair shops

#### Applications

- Temporary online monitoring
- On-site online test
- On-site commissioning

#### Asset

- GIS



# PD in Maintenance Strategies

	No PD	Offline PD Testing	Online PD Testing	Temporary PD Monitoring	Permanent PD Monitoring
Condition based maintenance	-	- (+)	+	+	+
Mobile solution	-	+	+	+	-
Flexibility	-	-	+	++	-
Immediate PD notifications	-	-	-	+ / -	+
PD Trending	-	-	-	+	+
Cost effectiveness	No cost?	-	+	++	+

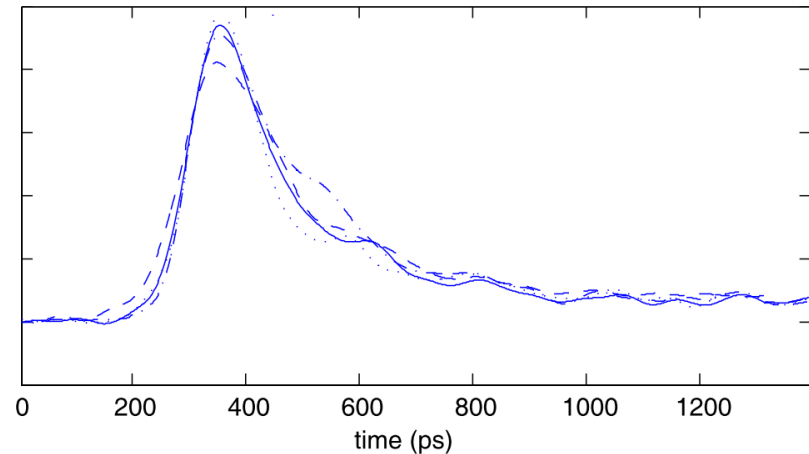
## Partial Discharge in SF6

- Electronegativity leads to a rise time of ~100ps
- Frequency spectrum up to several GHz

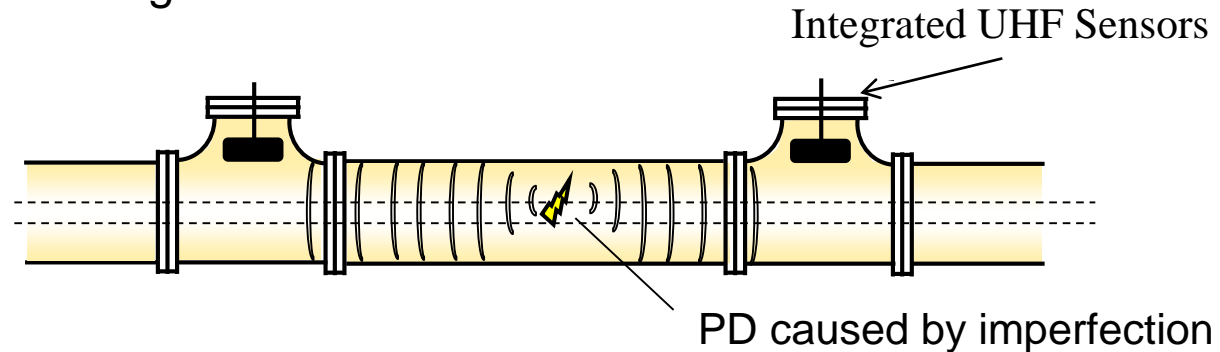
## While Partial Discharge in Nitrogen

- Rise time of ~1ns
- Frequency spectrum up to some hundred MHz

## Discharge Current in SF6

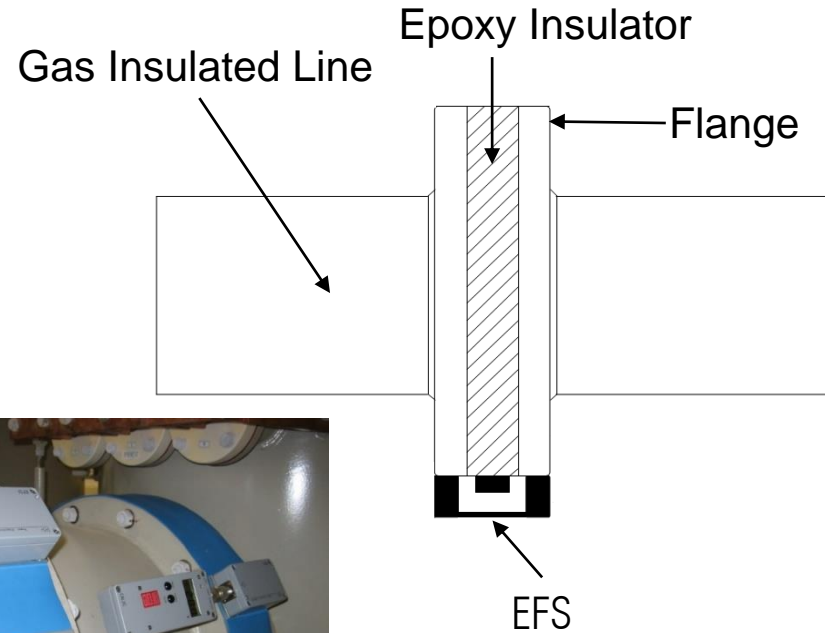


- Wide band measurement is required to achieve a good sensitivity in the entire GIS
- Not one coupling capacitor, but multiple UHF sensors are required
- UHF sensors act like antenna and convert the electromagnetic wave to a voltage



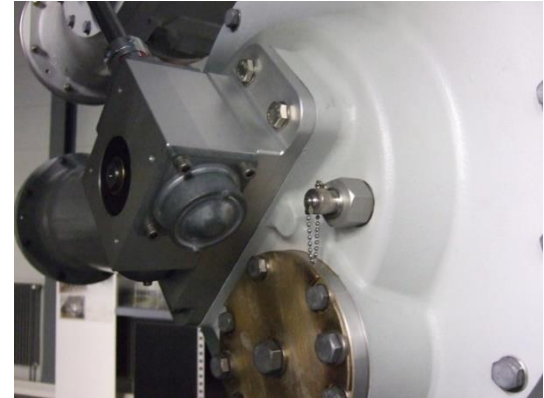
## External Flange Sensors (EFS)

- Usage of unshielded spacers
- Retrofitting without opening of GIS
- Low sensitivity



## Integrated / embedded UHF sensors

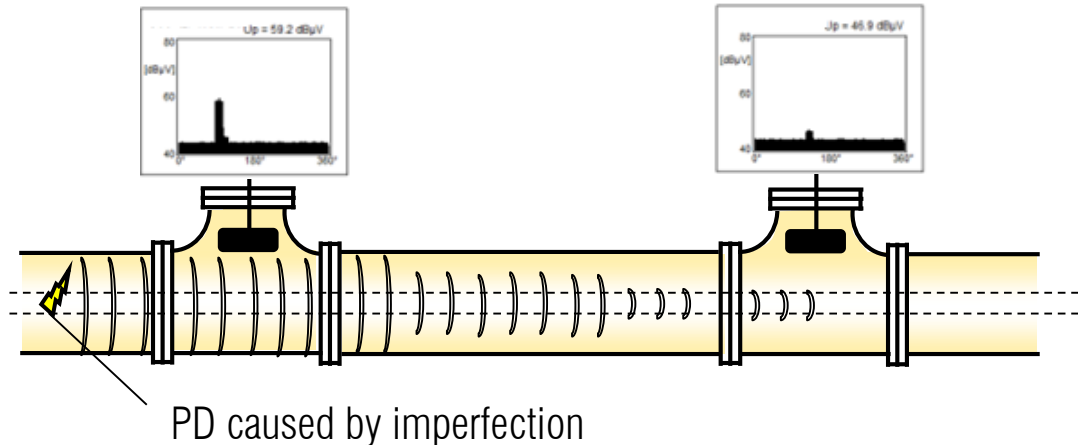
- Frequency range ~ 200MHz to 2000MHz
- Best signal to noise ratio
- Often provided by GIS manufacturer
- Implementation of our IFP1 requires close corporation with GIS manufacturer



# Unconventional PD Measurement

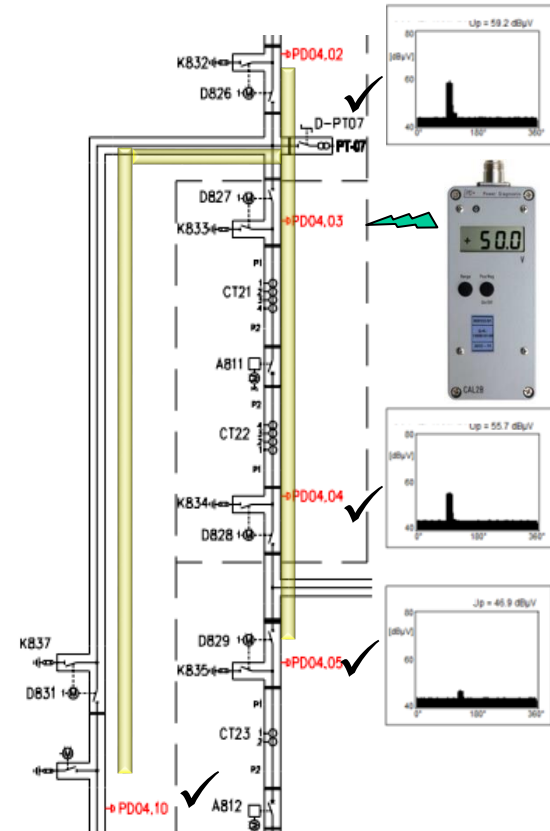
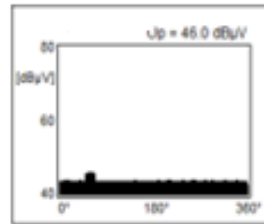
“For the unconventional (UHF) method a calibration to apparent charge in pC is not possible” [CIGRE TBA654, page 4]

- Measurement in dB $\mu$ V or dBm  
dB $\mu$ V – 107 = dBm when considering a 50  $\Omega$  system



## Sensitivity Check Step 2 – On-Site

1. Injection of voltage signal as per Step 1 in UHF sensor
2. Check of sensors in surrounding area
  - Visibility of signal above noise floor required
3. Check of every measurement path of the system



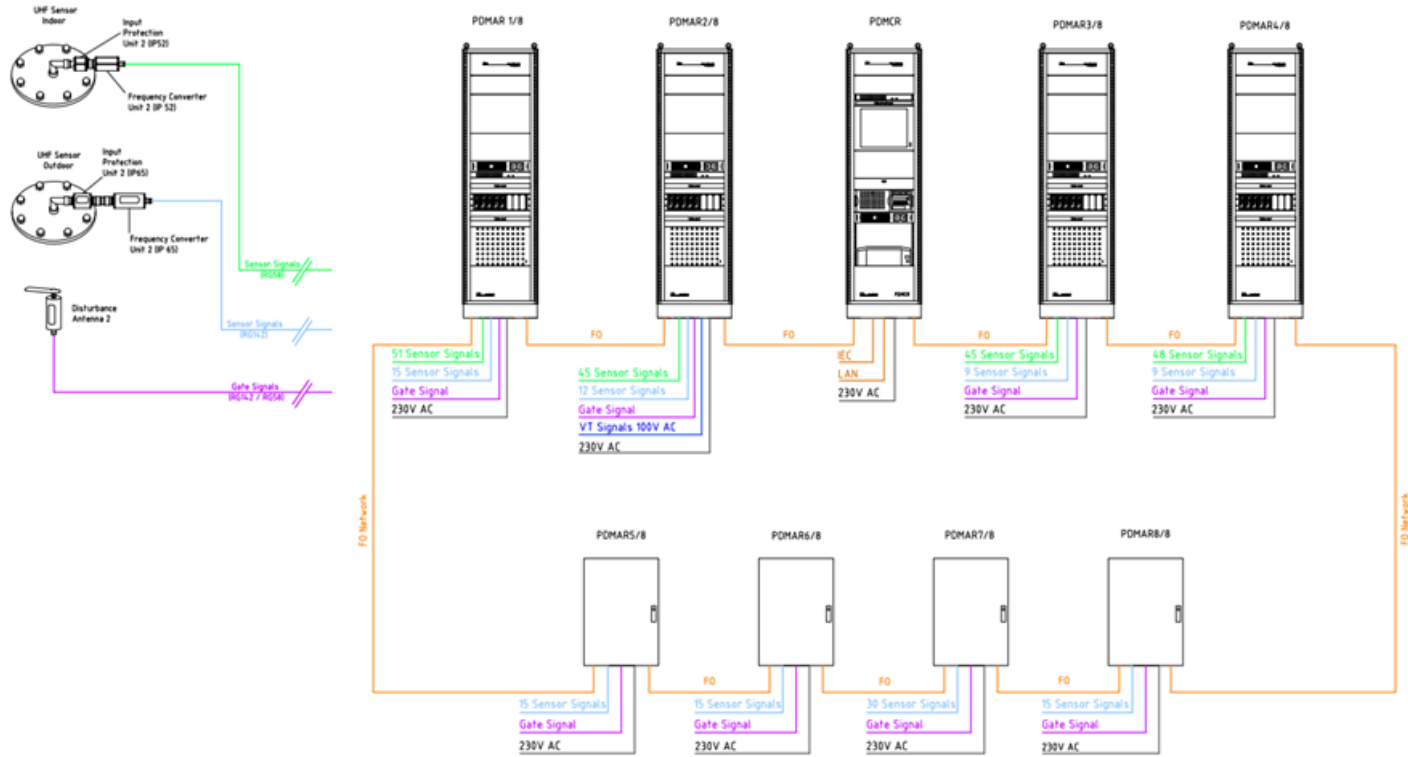


## Partial Discharge Monitoring Acquisition Rack (PDMAR)

- Part of the continuous online monitoring (further hardware required)
- Up to 15 GISmonitor plug-in boards
- Up to 120 measurement channels in parallel
- Temperature controlled
- Backup UPS
- Self monitoring
- Sync Switching Box (SSB)
- Any Object Running signal

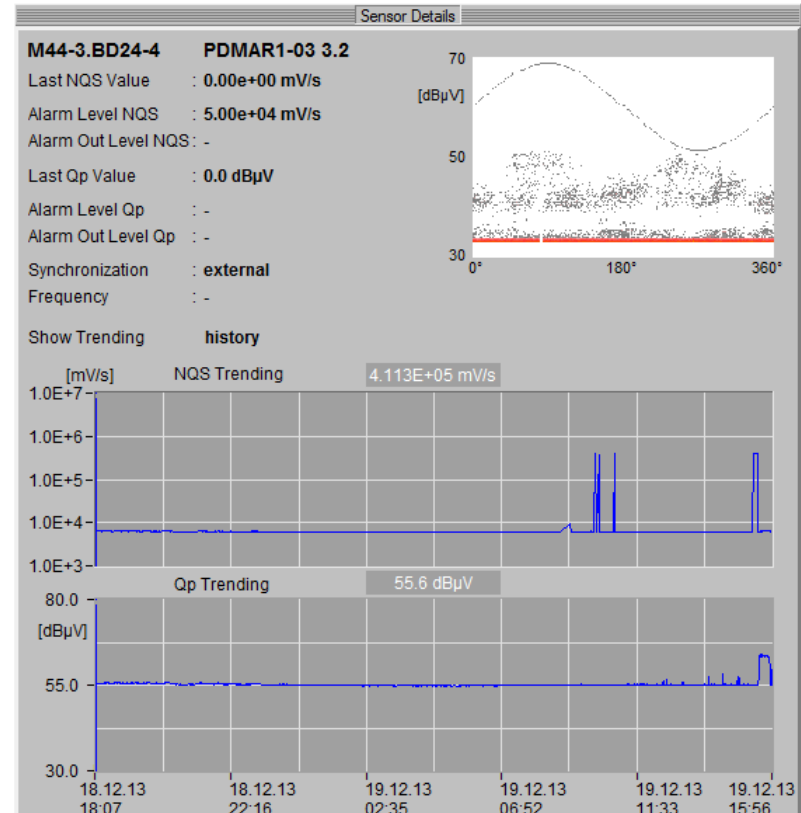


# Continuous Online Monitoring



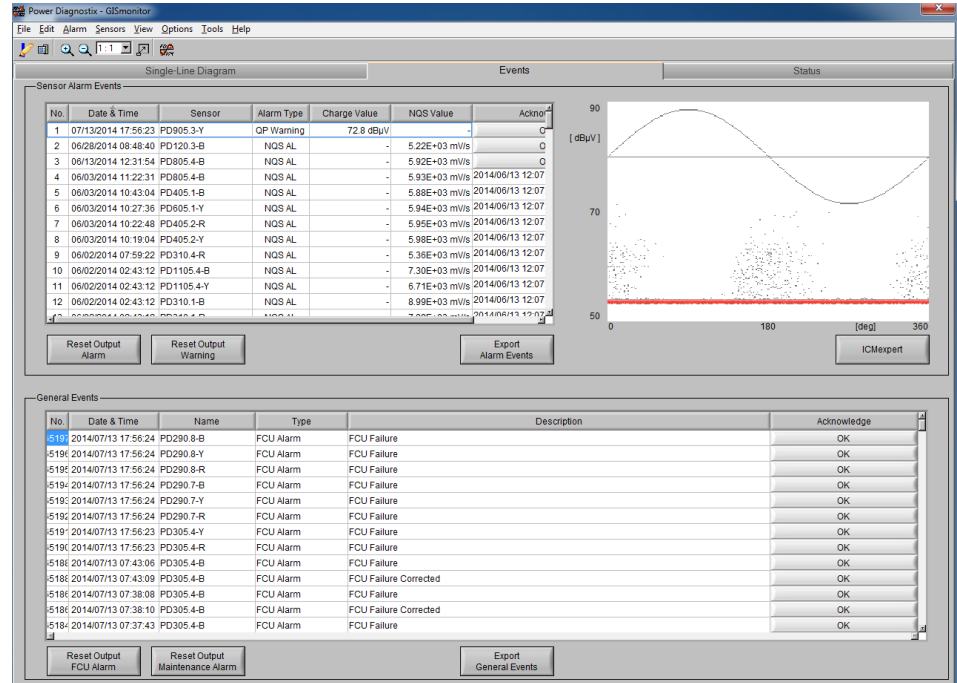
## Full monitoring control software

- Detailed data of all sensors
- Current and past measurement data over the lifetime of the system
- Details of alarm configuration and alarm status
- Synchronization



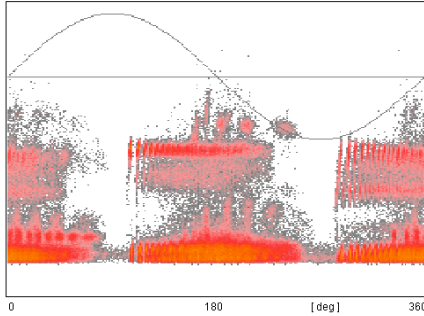
## Full monitoring control software

- Detailed alarm event list
  - Date & Time stamp for each entry
  - PRPD for each suspicious measurement
- Detailed general events list
  - Status changes
  - System alarms
  - Detailed logging

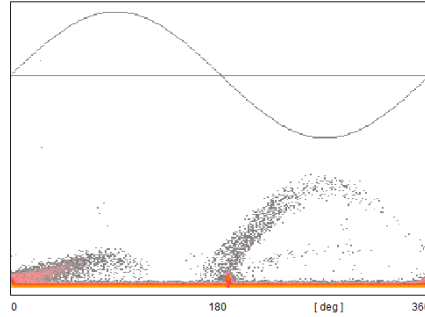


## Limited amount of defect types in GIS

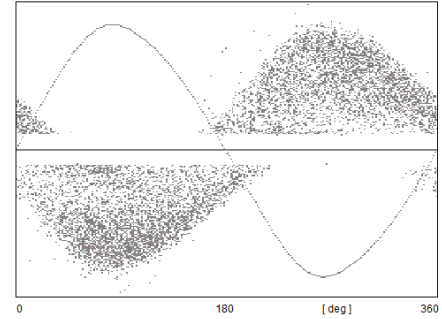
- Moving Particles
- Floating Elements
- Protrusion
- Voids



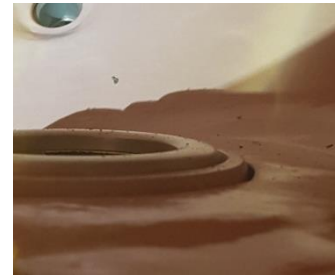
Contact Problem



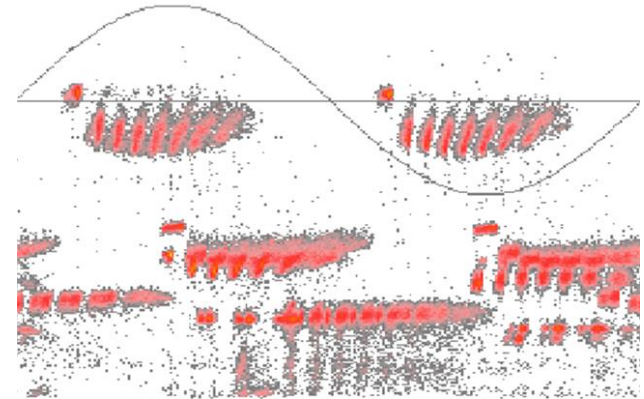
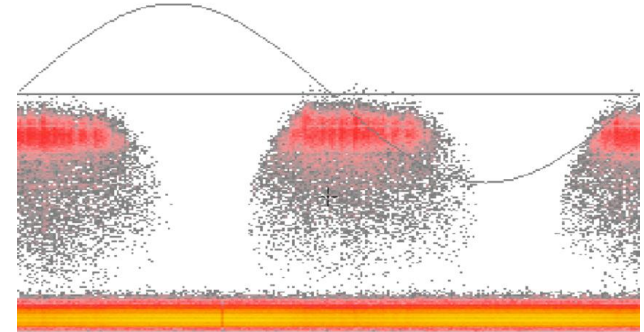
Faulty Insulator Disc



Mobile Particles



- Incorrect fixed elements can start to vibrate
  - Strong acoustic signal with 100Hz/120Hz envelope related to zero crossing of voltage
  - Vibration alone does not lead to electrical signals
- If  $E_{crit}$  is exceeded in a gap between electrode and floating element
  - > PD inception
    - No short term spontaneous breakdown expected

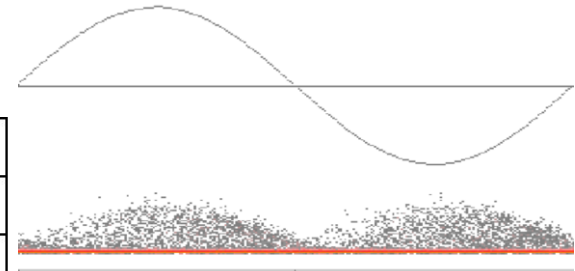
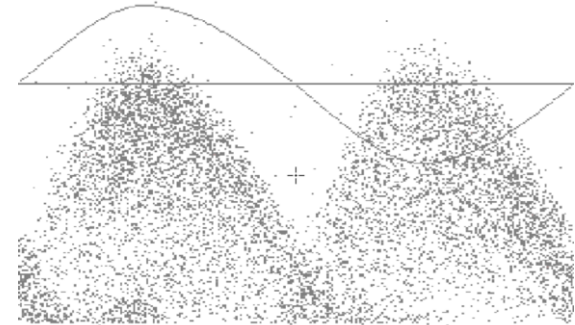
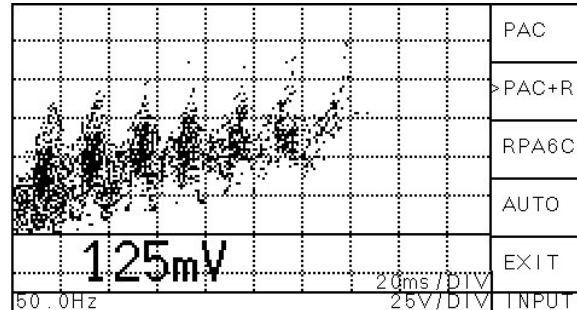




## Moving Particles

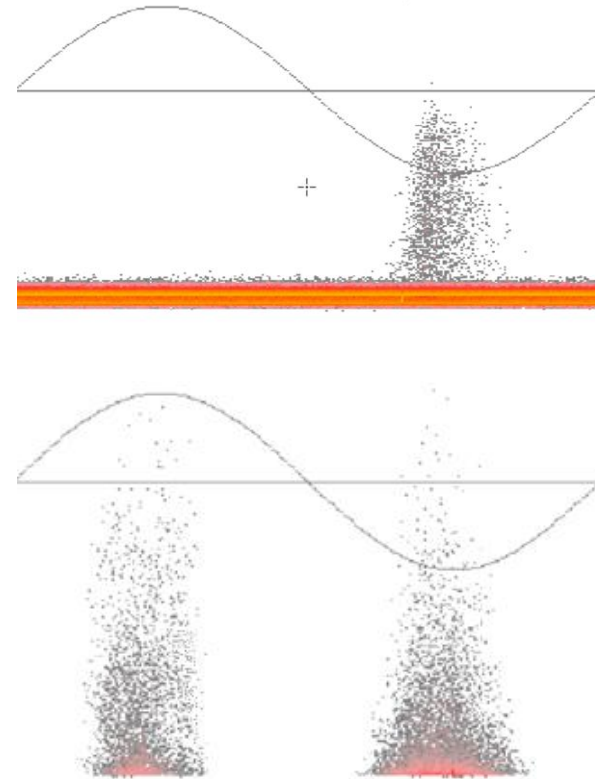
- Mostly enter GIS during assembly
- Can be lifted by electrostatic forces and jump towards HV conductor
- Breakdown when it gets too close to HV conductor or through contact with insulators

$$H = \frac{1}{2} g \left( \frac{t_{\max/h}}{2} \right)^2$$



## Protrusion

- Mostly scratches due to insufficient care during assembly
- Often low PD level
- The sharper the tip, the easier to detect
- Shape of the tip can change over time
- Significant polarity effect



## Void

- PD inception requires a starting electron
  - Voids are difficult to detect during acceptance testing
  - GIS manufacturers have implemented PD tests under x-ray to detect voids
- Aging effects in insulators



## Köszönjük a figyelmet !

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