# Diagnostic Measurements on GIS and their Components

Dr. Michael Krüger, OMICRON Austria

# Diagnostic Measurements on GIS Components

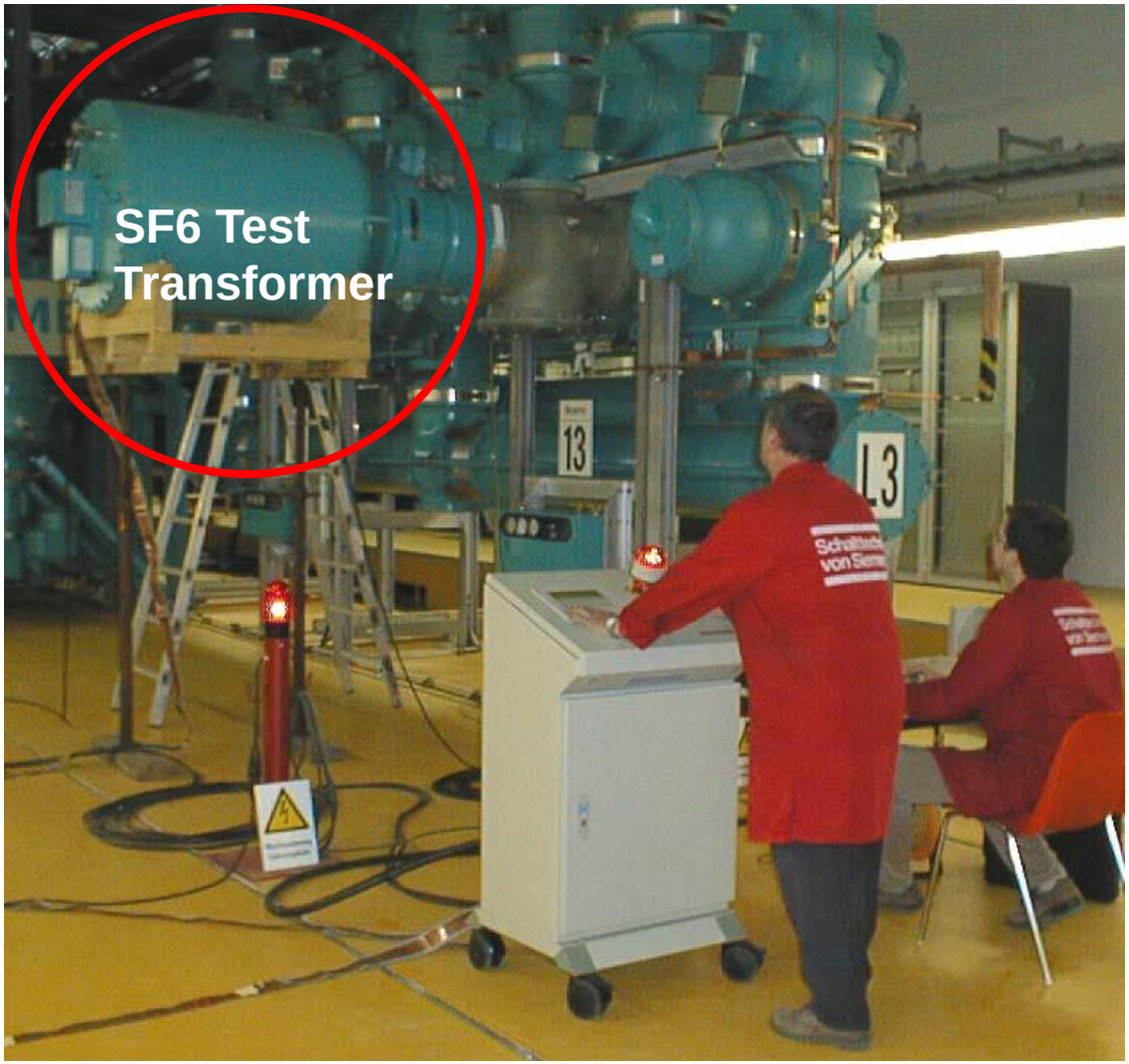
## PD Measurement on GIS Voltage Transformers

Diagnostic Measurement on GIS HV Bushings

# GIS HV Testing with a Series Resonance Circuit via the Outdoor Bushings

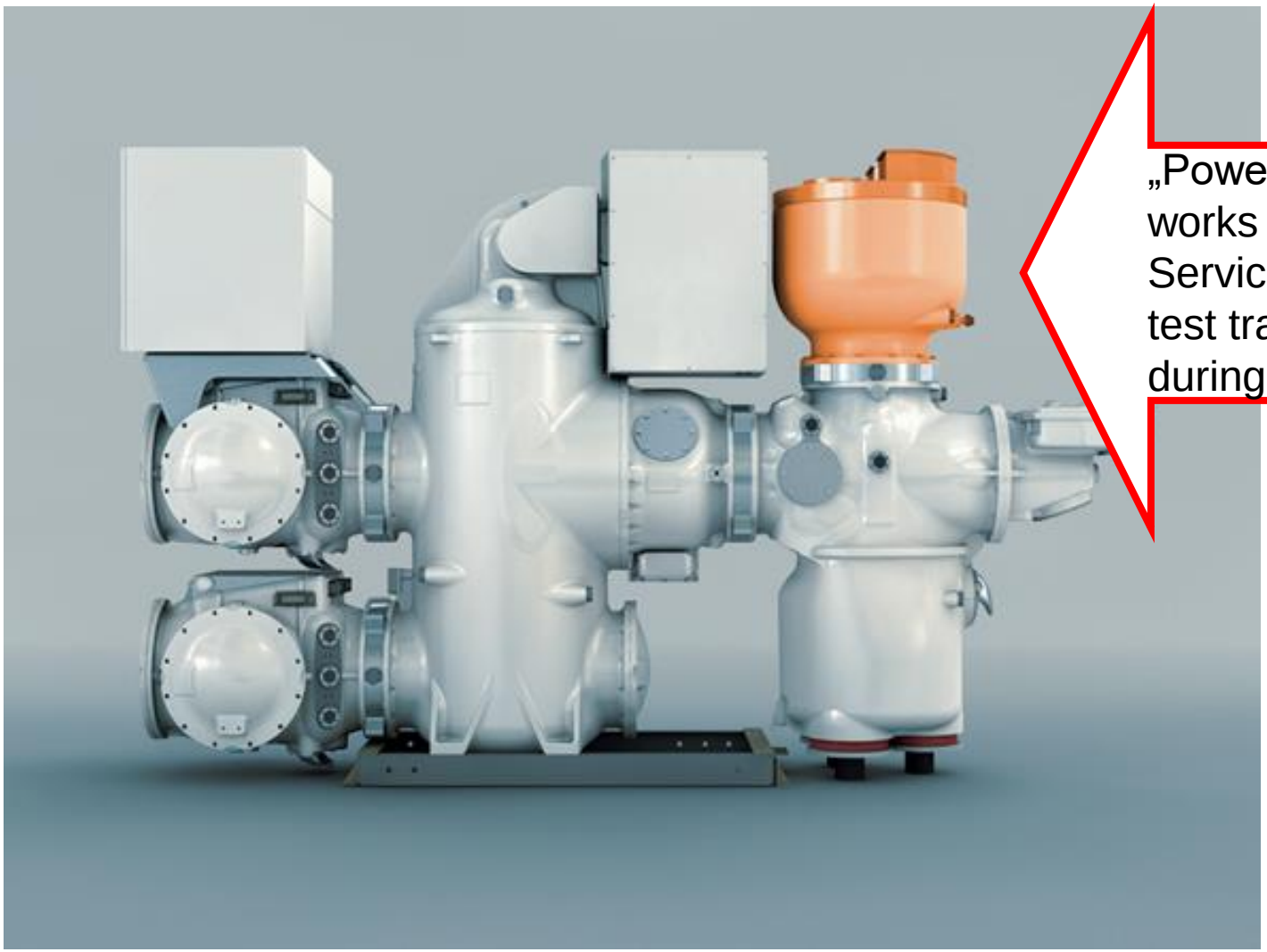

Source: FKH Schweiz

# GIS HV Testing with a Test Transformer Mounted to a GIS Flange




Source: E. Kynast, „Prüfungen von der Herstellung bis zur Inbetriebnahme“,
Gasisolierte Hochspannungs-Schaltanlagen, Technische Akademie Esslingen, 11. März 2008

# GIS HV Testing with Power VT

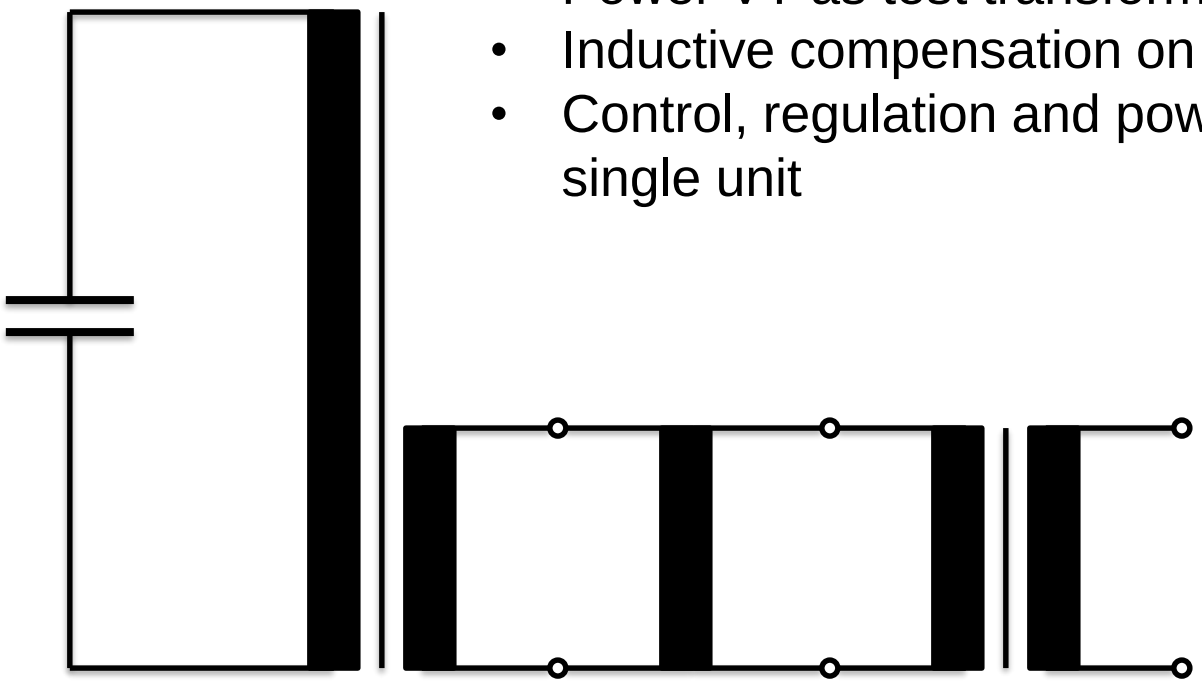


„Power-VT“ = works as VT in Service and as test transformer during testing

Source: Siemens

# Equivalent Circuit Diagram od the Test Setup

- GIS as test capacitance
- Power VT as test transformer
- Inductive compensation on the LV side
- Control, regulation and power supply out of one single unit



GIS

Power VT

Resonance inductors

Matching-transformer


Frequency variable control and power supply

# Mobile Test Solution

- Power VT is part of the GIS
- Modular setup with fix inductors
- Fix inductors are compact and lightweight
- Heaviest part of the test system is < 30 kg

CPC100
29kg


CP CR4 20kg
CP CR6 20kg

CP TR8
19kg

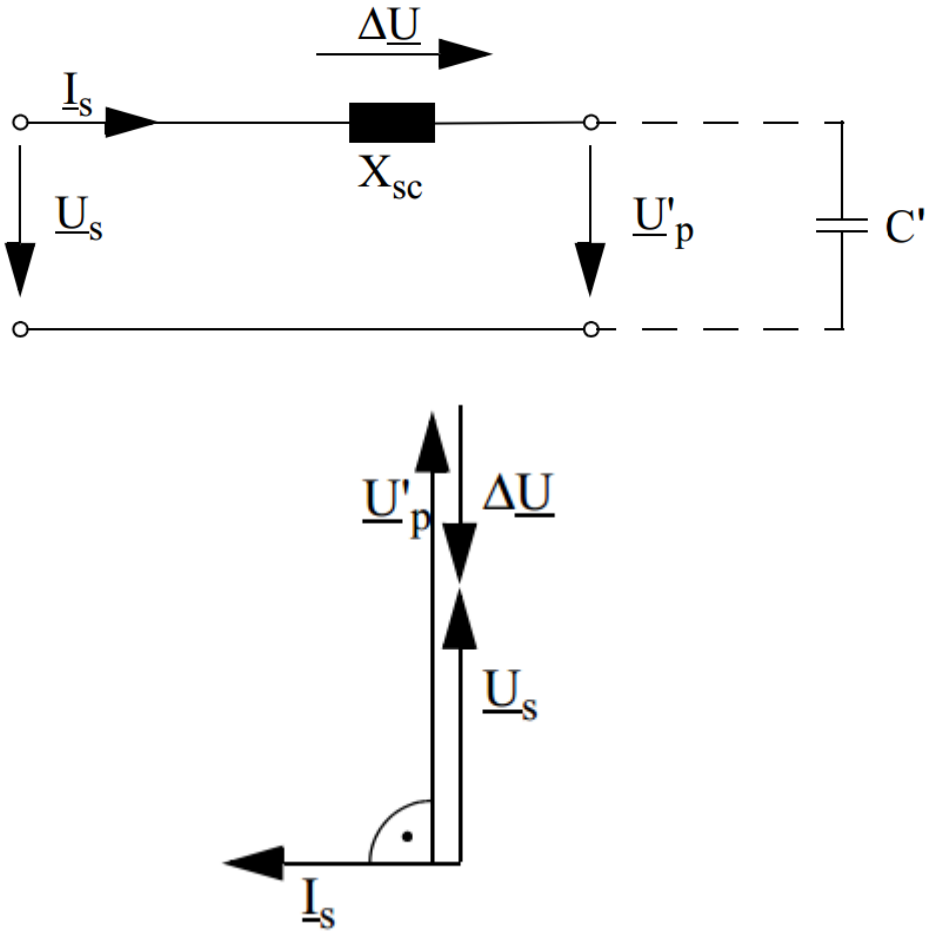
GIS Power VT

Inductors
4mH und 6mH

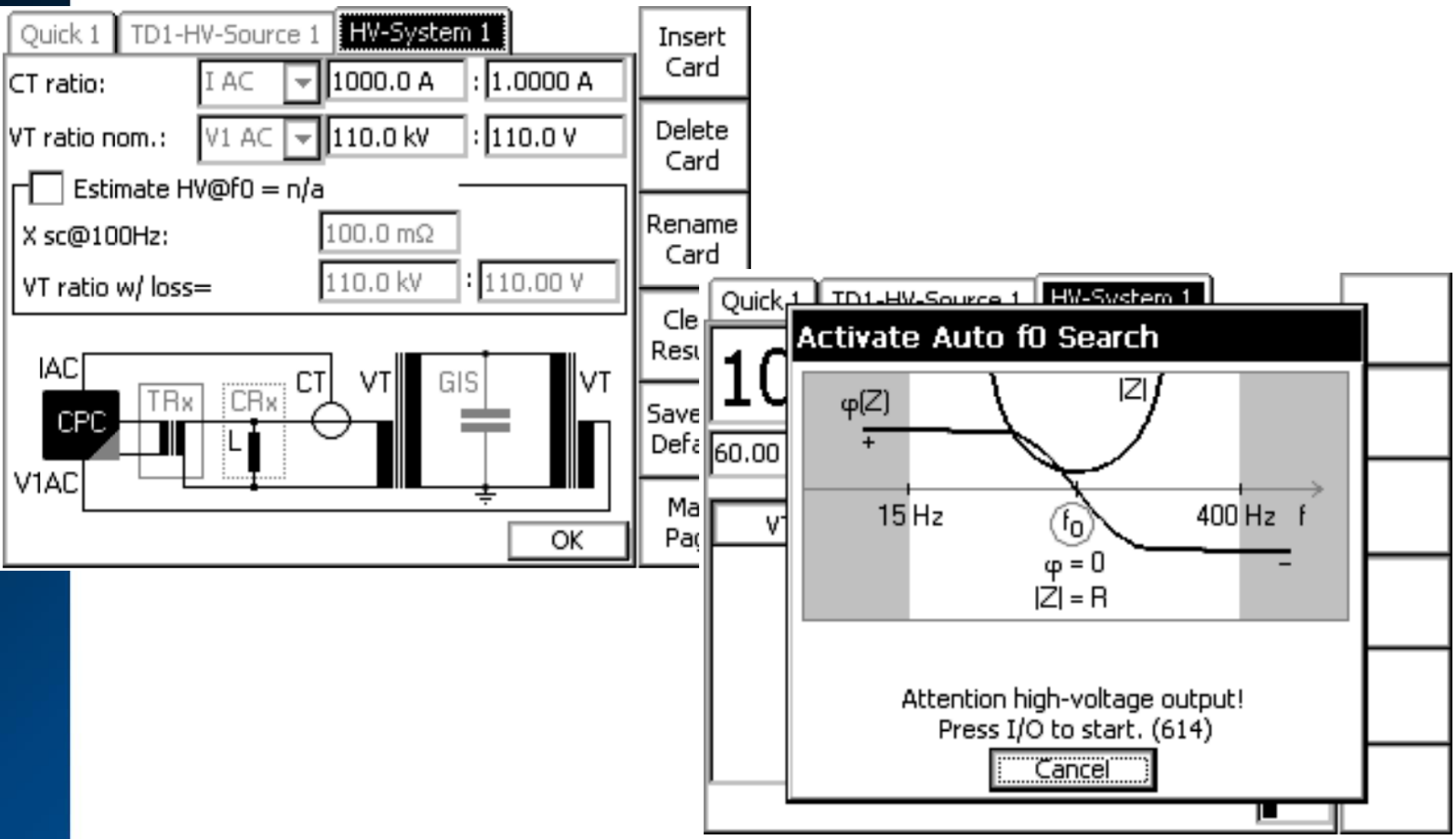
Matching
transformer

Frequency
variable control
and power supply

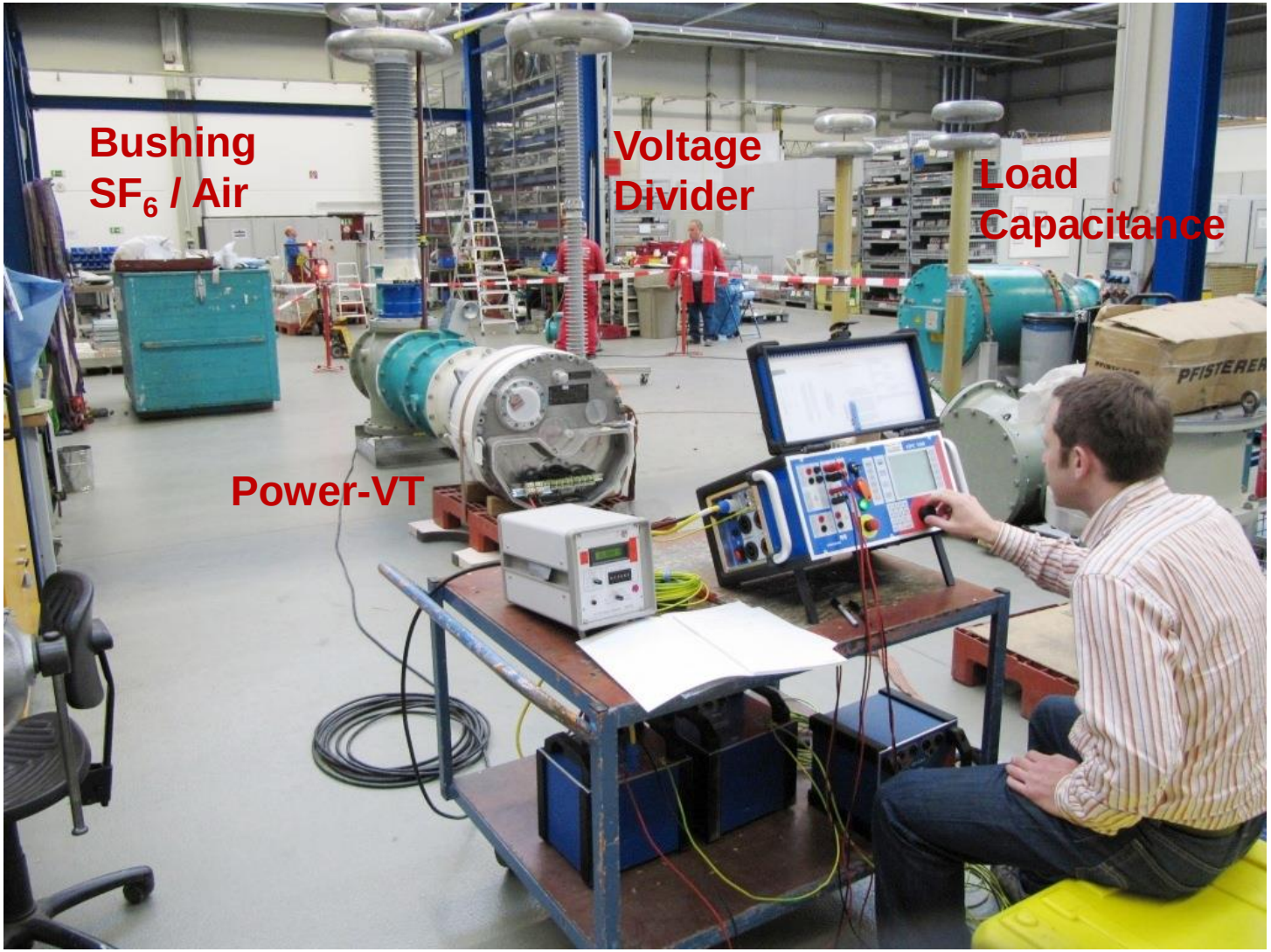
# Measurement of the High Voltage on the Low Voltage Side



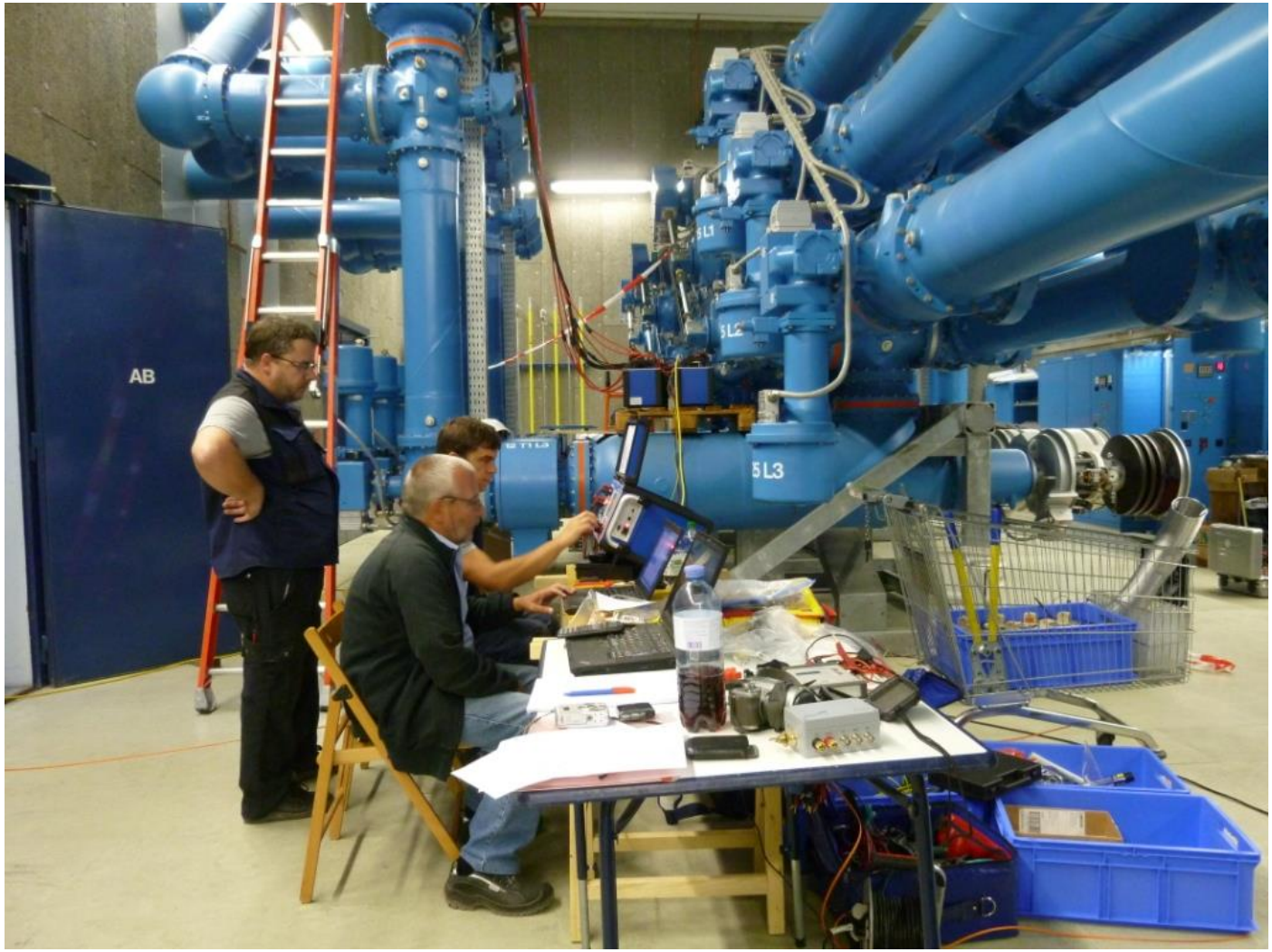
# Automatic Search of the Resonance Frequency



# Test Setup for 235kV

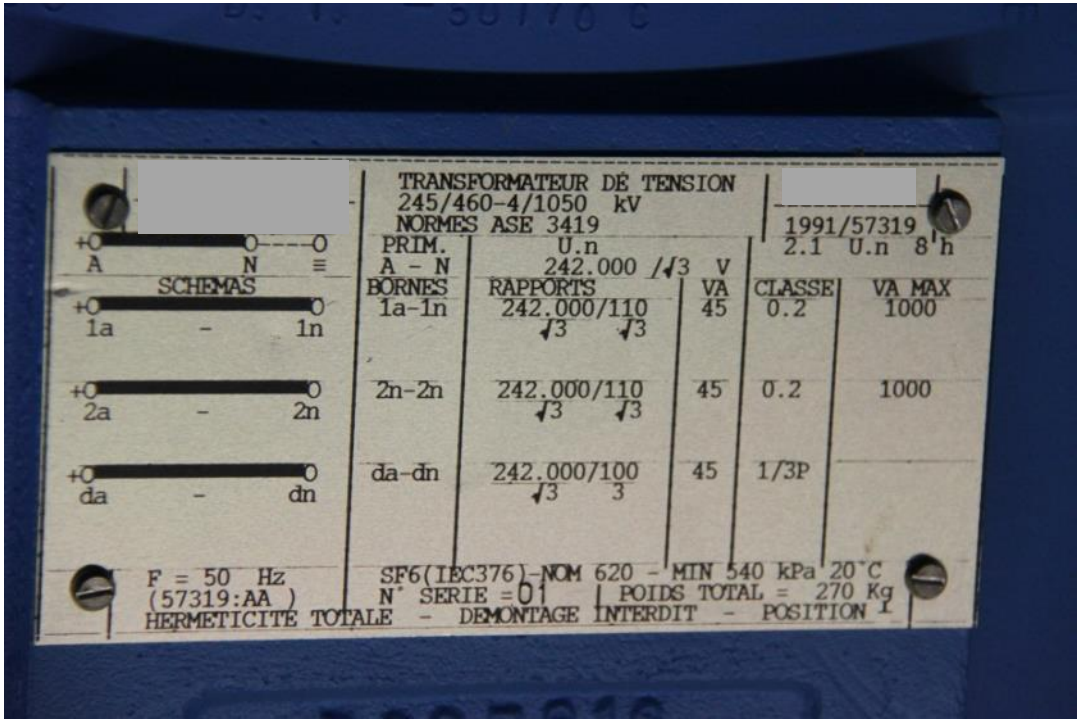


# PD Measurement on GIS VT's 245kV



# Technical Assessment

**Test voltage: 1.2 x Um / √3 = 1.2 x 242 / √3 = 170 kV**

# Technical Assessment

| Asset | Approximate Value |
|---|---|
| Insulator | 20 pF |
| Bushings | 100 pF ... 500 pF |
| Inductive voltage transformer | 200 pF ... 500 pF |
| Power transformers < 1MVA | 1 nF ... 3 nF |
| Power transformers < 1MVA | 1 nF ...25 nF |
| Cables | 200 pF/m ... 700 pF/m (300 pF/m) |
| GIL | 60 pF/m |
| GIS | 1 nF ... 10 nF |

Quelle: V. Hinrichsen, Hochspannungstechnik, Vorlesungsskript, TU Darmstadt

# Technical Assessment

## Calculation of the Test Current

### VT

| | | |
|---|---|---|
| | | 242 [kV] |
| | $U_{Sec}$ | 0,11 [kV] |
| | $U_m$ | 245 [kV] |
| | U | 230 [kV] |

### GIS

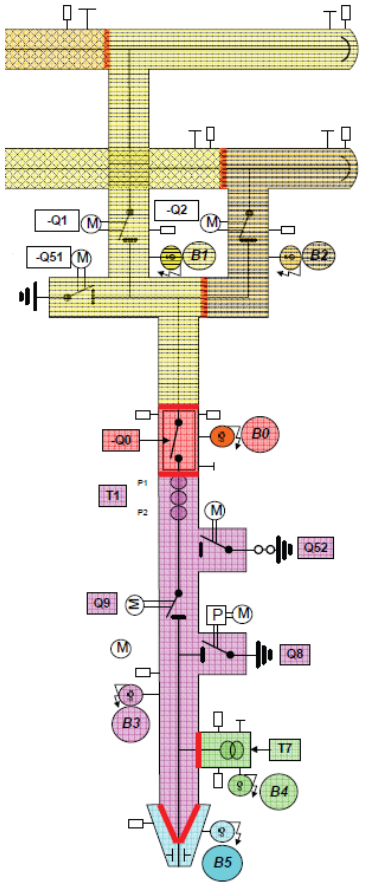
| | | |
|---|---|---|
| | $C_{GIS}$ | 500 [pF] |
| | $C_{TP}$ | 250 [pF] |
| | $C_{Trav}$ | 400 [pF] |
| | $C_{Condo}$ | 300 [pF] |
| | $C_{tot}$ | 1450 [pF] |

### Test voltage

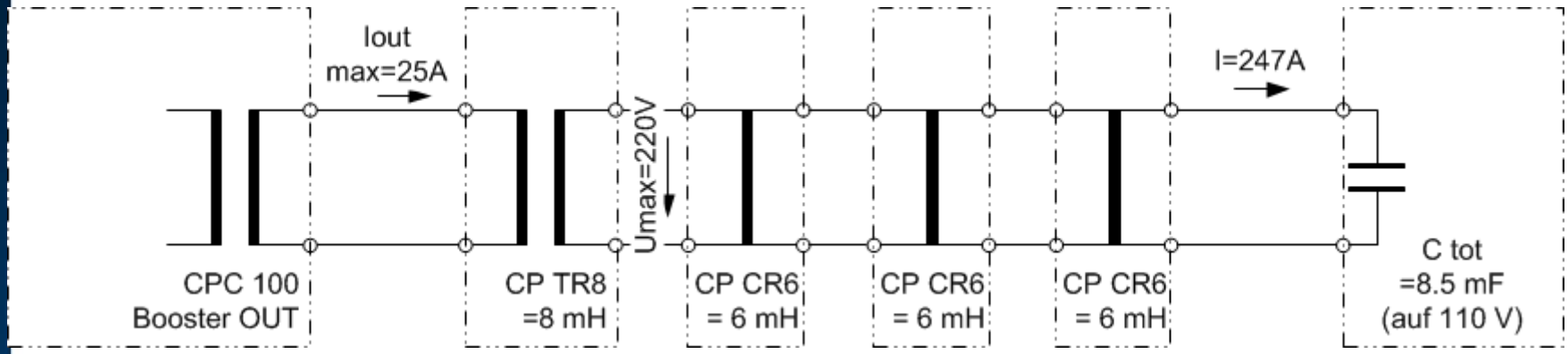
| | | |
|---|---|---|
| | 1.2 * Um / V3 | 170 [kV] |
| | f | 60 [Hz] |

### Current calculation

| | | |
|---|---|---|
| | $I_{Prim}$ | 0,093 [A] |
| | $I_{Sec}$ | **204** [A] |
| | S | **15,3** [kVA] |



# 110V Measuring Circuit

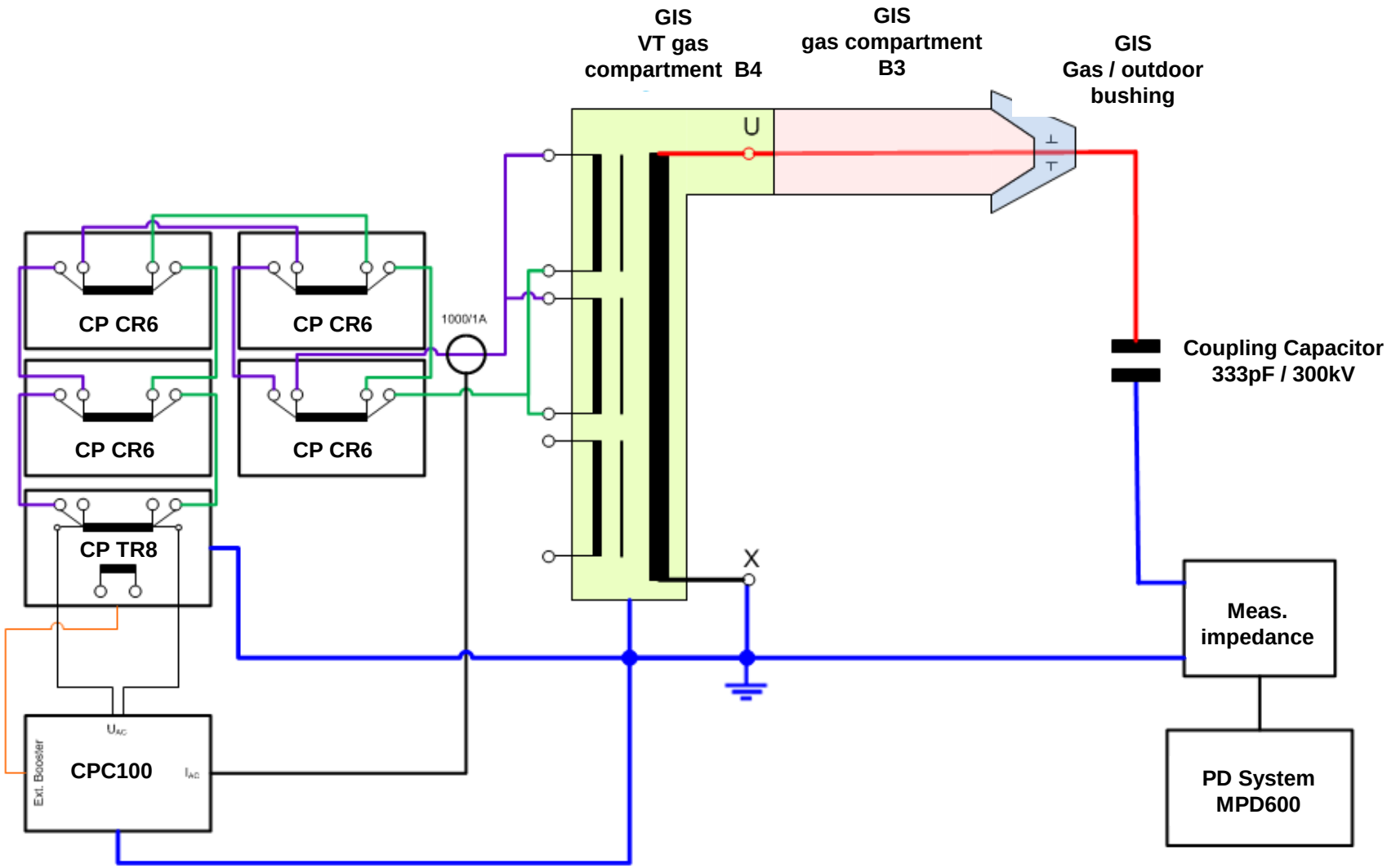



$$C_{110\,V} = \frac{Ctot}{ü^2} = \frac{1750^{-12}}{(242\ /\ 0.11)^2} = 8.5\,mF$$

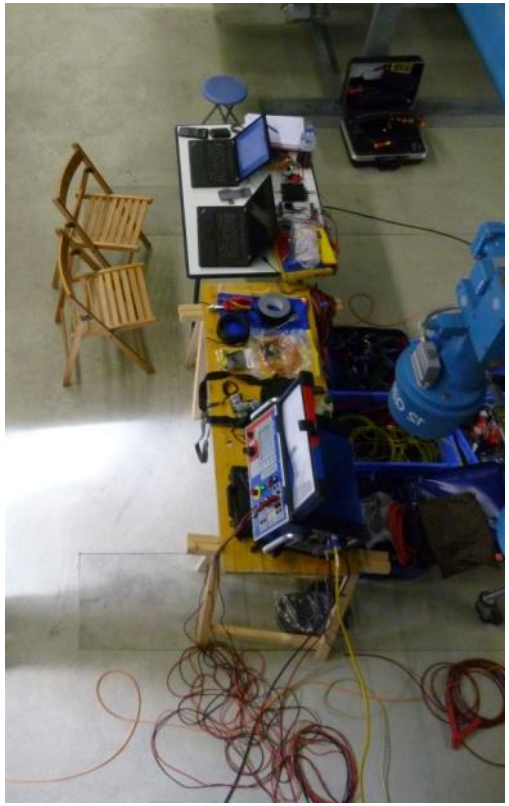
Resonanzkreis: $\omega = \frac{1}{\sqrt{LC}}$

$$L = \frac{1}{\omega^2 C} = 1.2\,mH$$

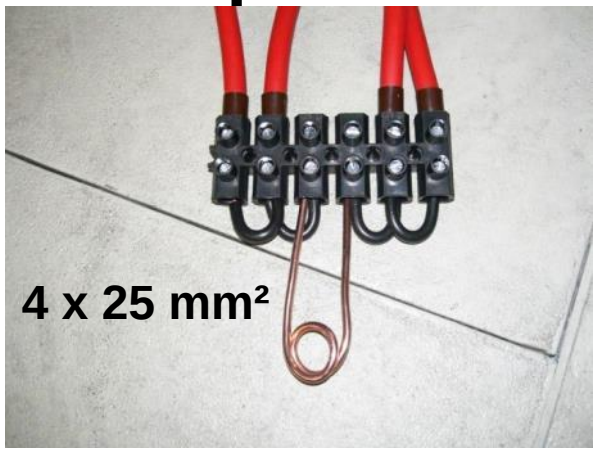
# Measurement Setup

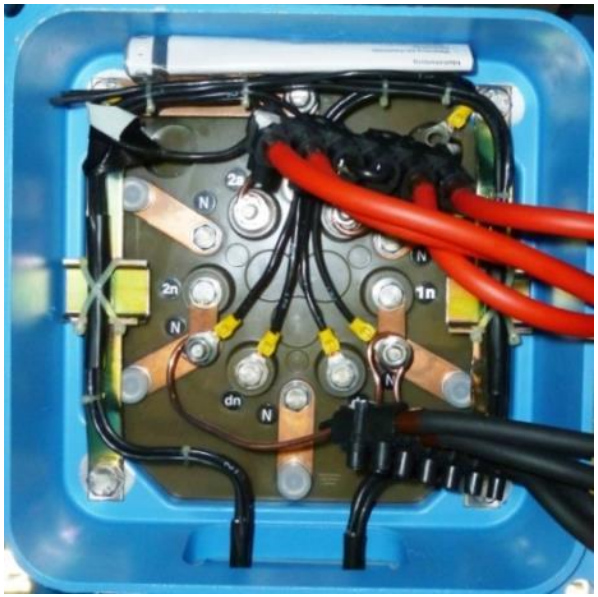


# Measurement Setup - 110V Side



Power source: CPC100




Connection clamps sec.

Matching transformer and inductors

# Setup HV 242kV Side

**Coupling Capacitor 333pF 300kV with Measurement Impedance and MPD600**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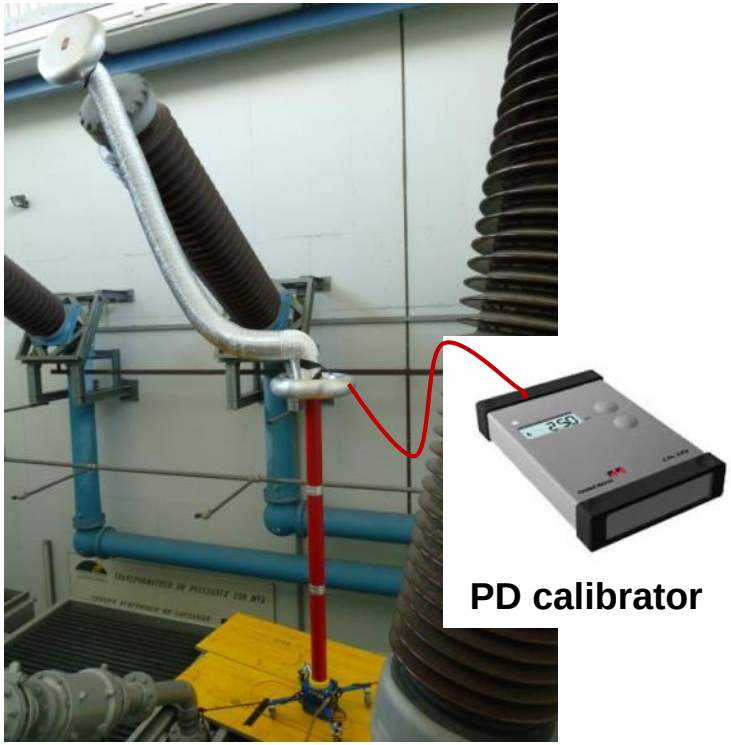
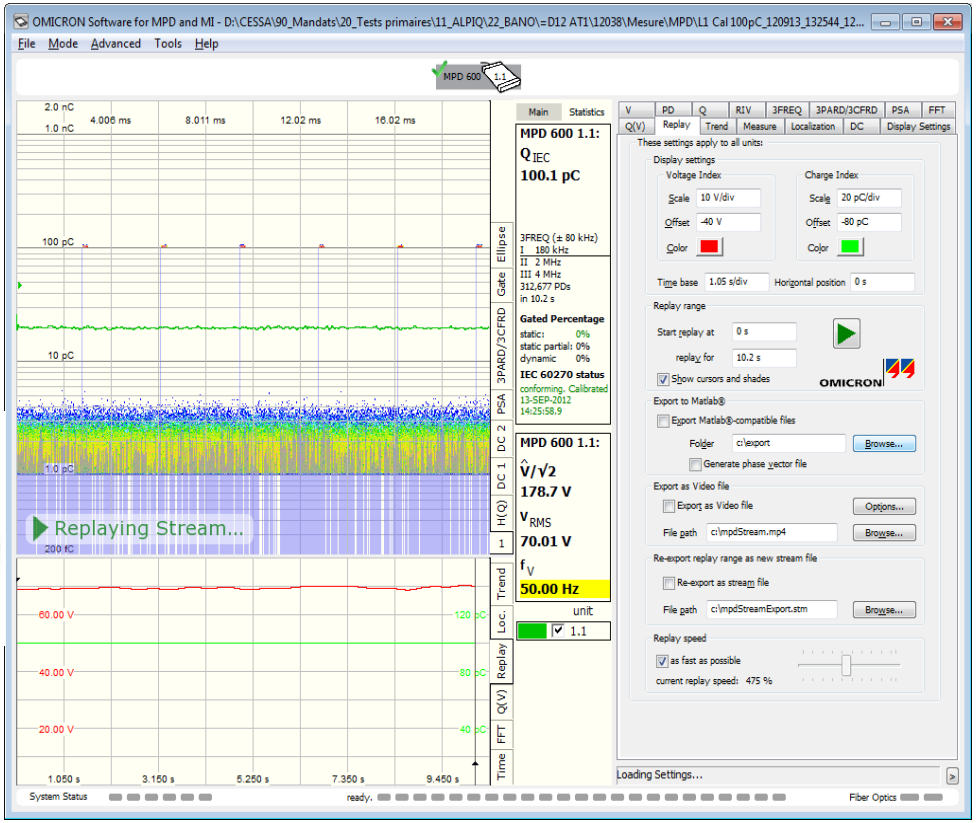
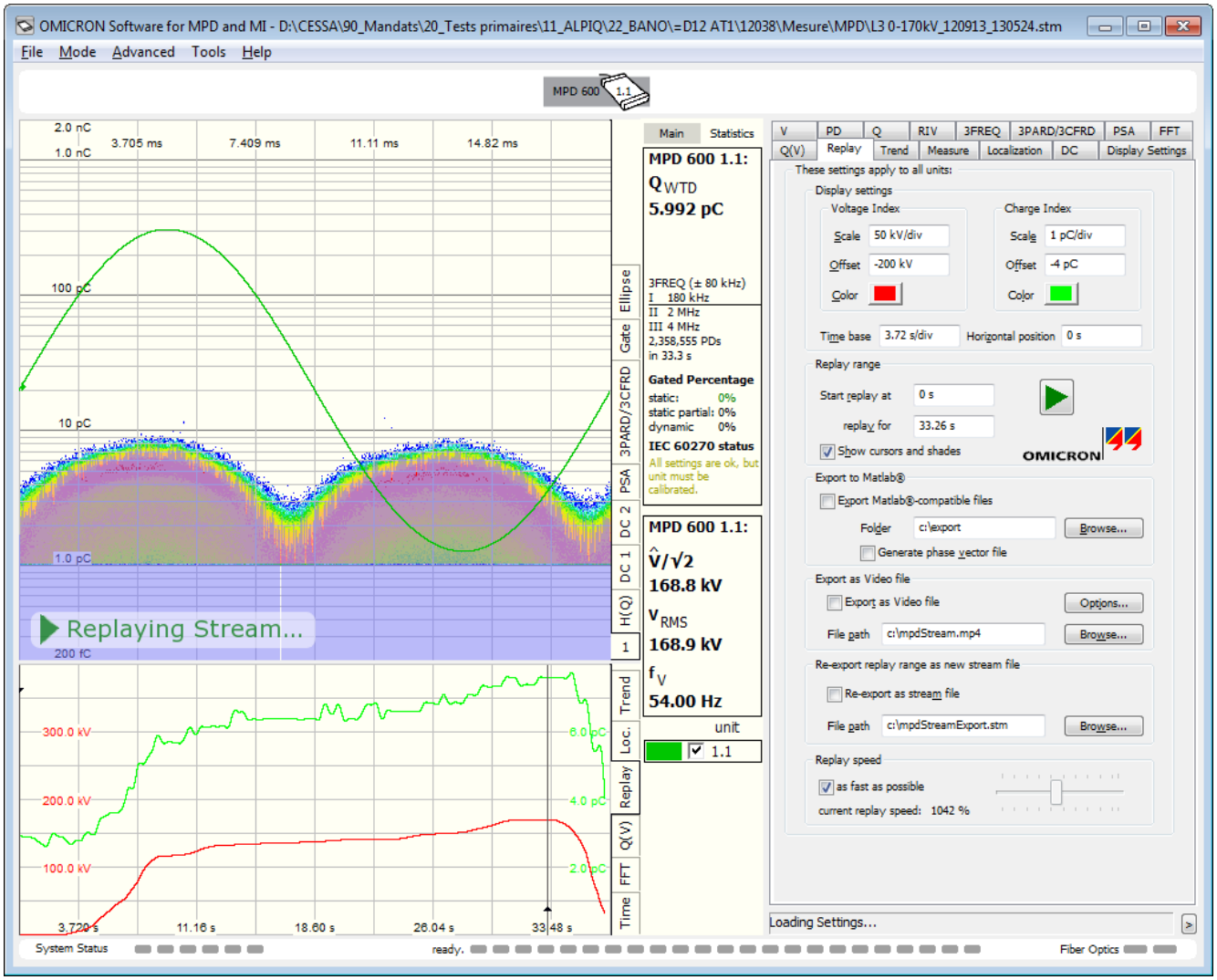
# PD Calibration with 100pC



PD calibrator



# PD Noise Level < 6pC at 170kV



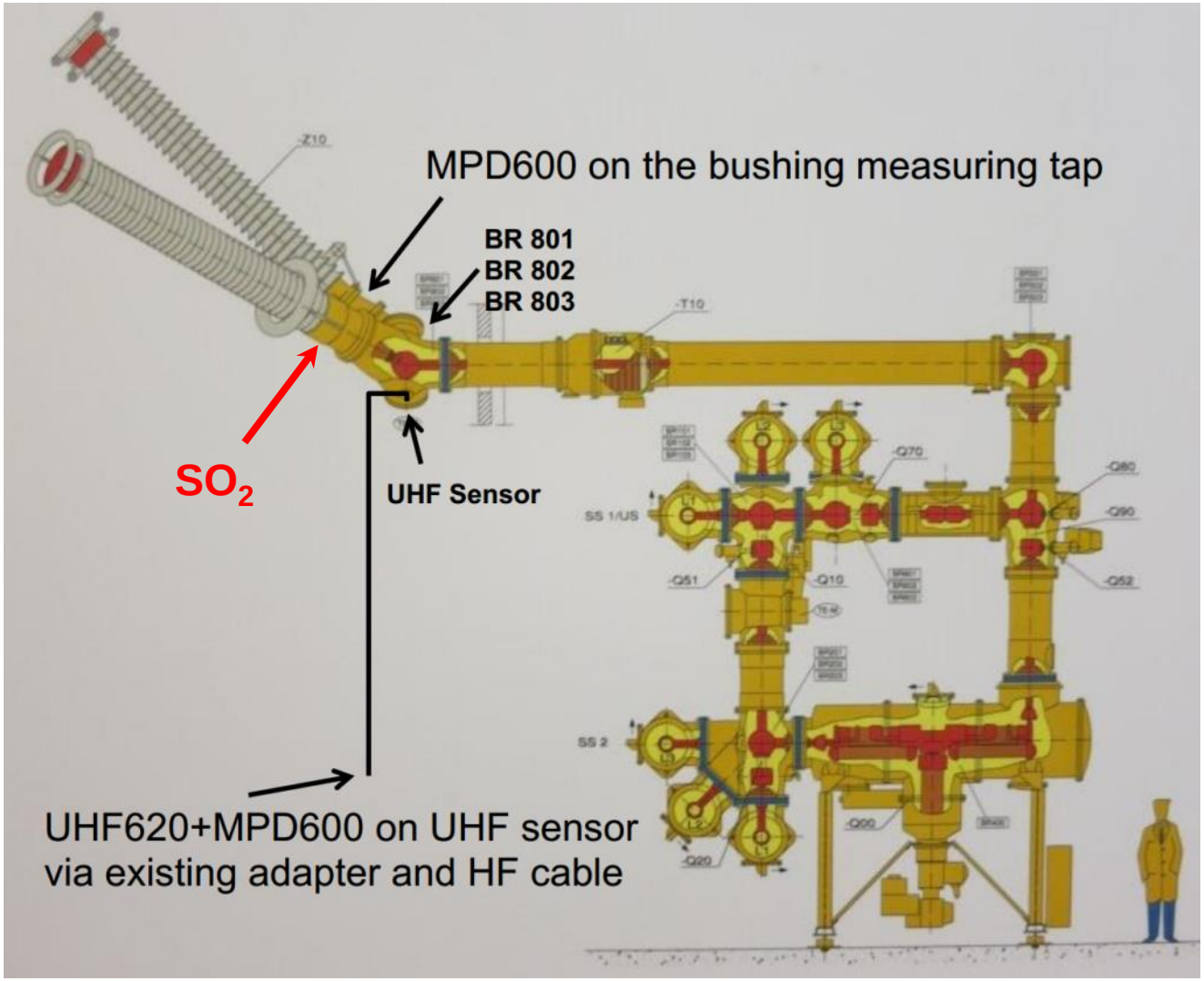
# Diagnostic Measurements on GIS Components

PD Measurement on GIS Voltage Transformers

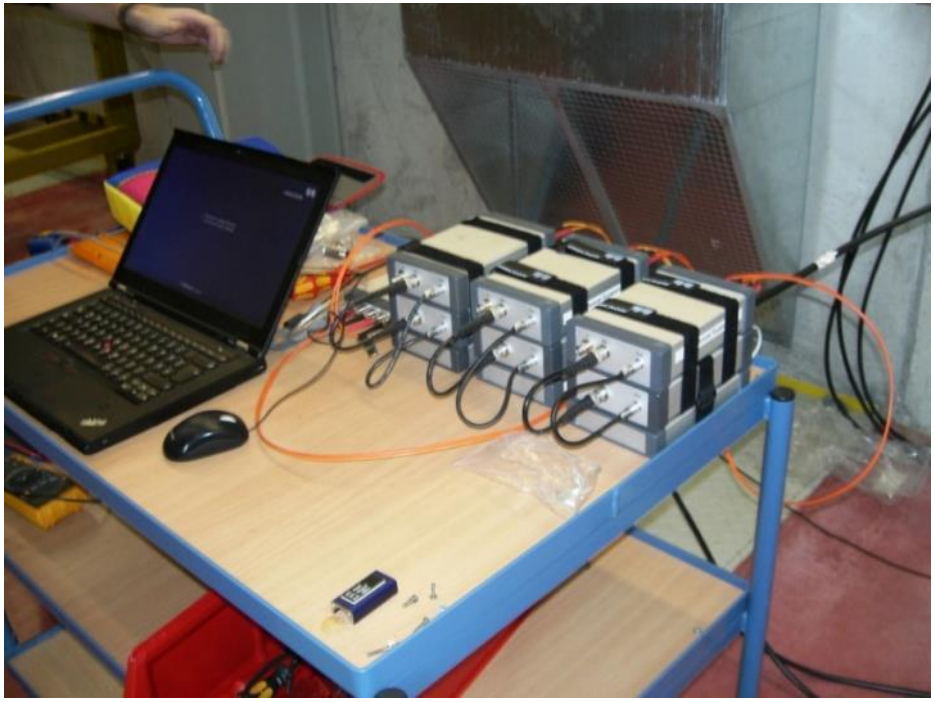
**Diagnostic Measurement on GIS HV Bushings**

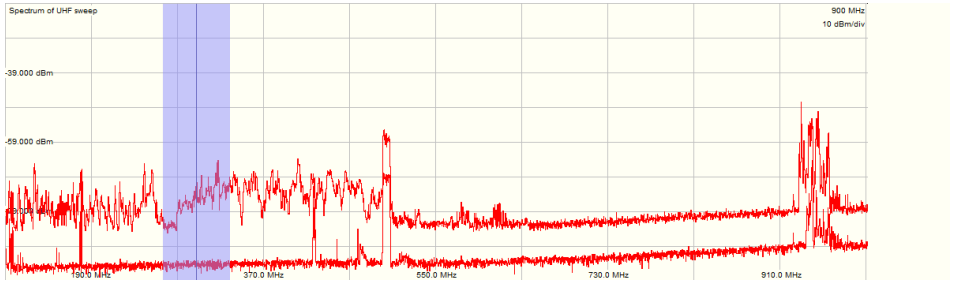
# Measurements on a 420kV GIS

# Online PD Measurement



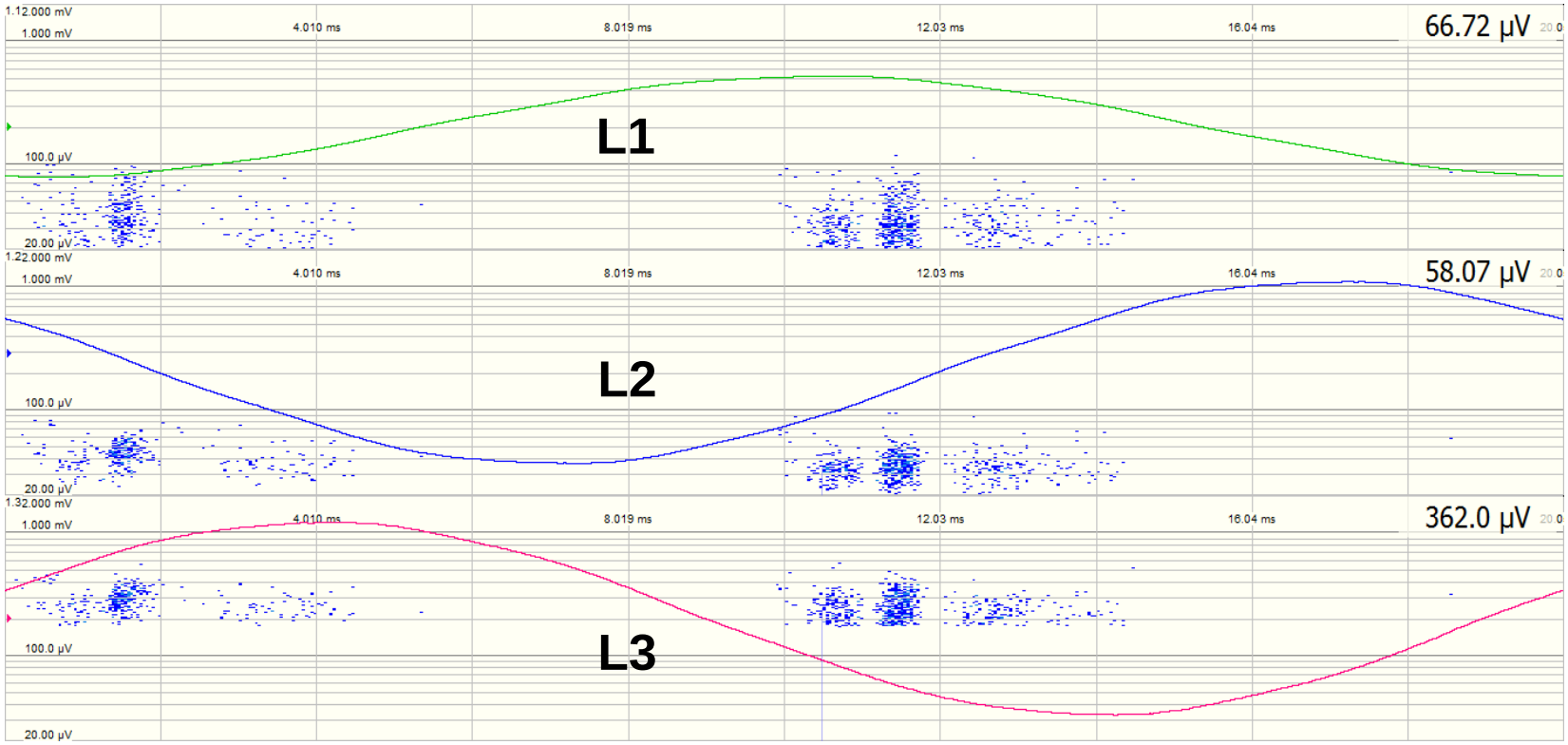
# PD Measurement at the UHF-Sensors



# PD Measurement at the Bushing Taps

# Online PD UHF Measurements



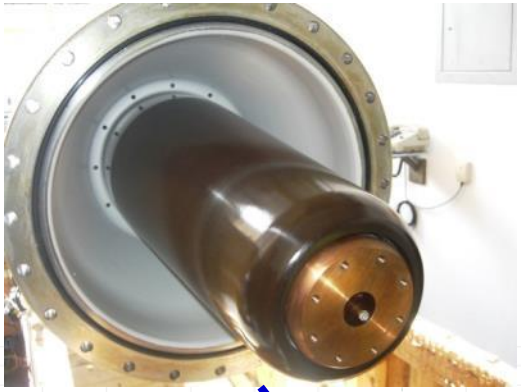
# Opened Gas Compartment at the Bushing

# Dielectric Response Measurement

## with FDS on a Spare Bushing

# Dielectric Response Measurement

## with FDS on a Spare Bushing

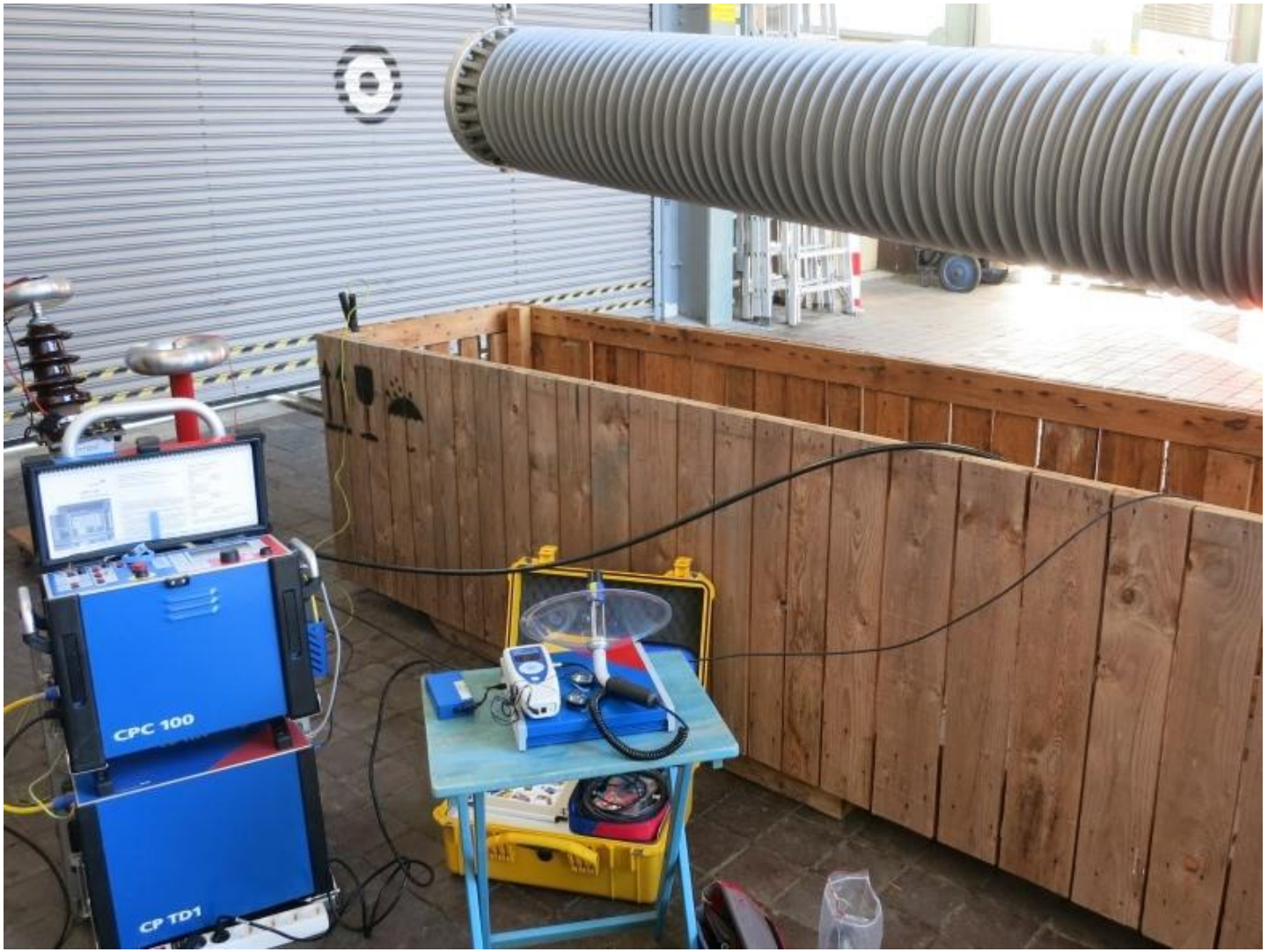


without protection hood


with protection hood

# Measurements on the Defective Bushing

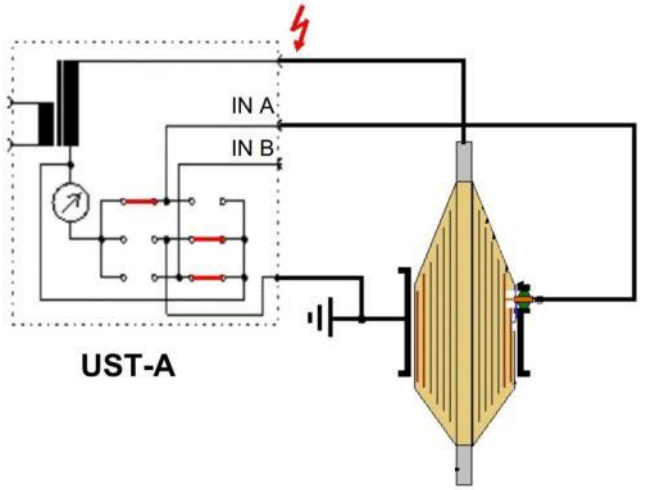
# Capacitance and Tan Delta Measurement of C1



# Capacitance and Tan Delta Measurement of C1

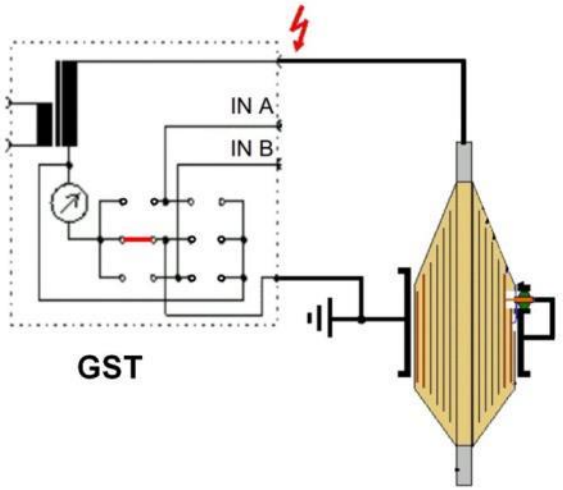
**Capacitance and Tan Delta at U=10kV und f=50Hz**
**UST Measurement to the measurement tap with earthed flange (Guard)**

| U test* [V] | I test [A] | C [F] | Tan Delta [%] measured |
|---|---|---|---|
| 10001,00 | 1,21E-03 | 3,852E-10 | 4,0732 |

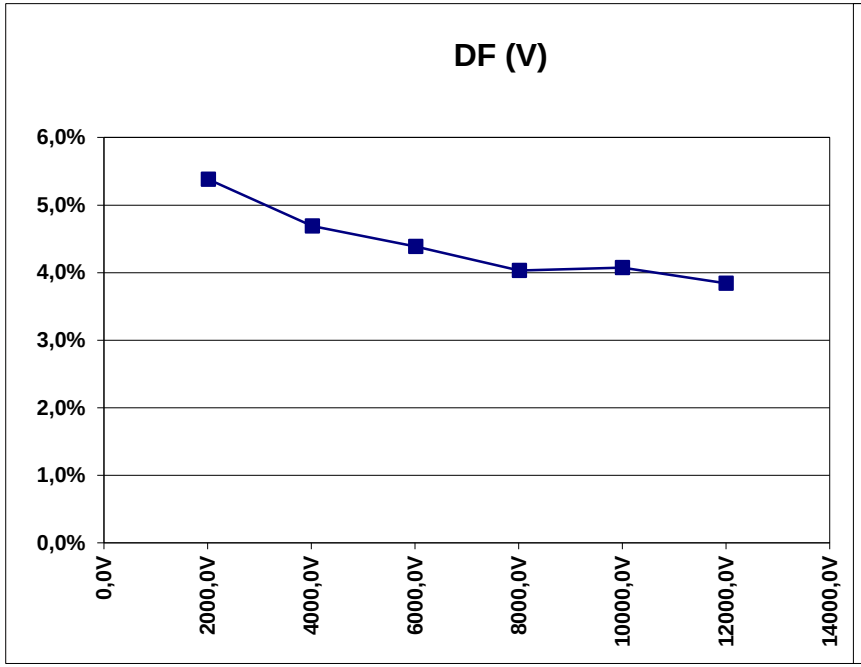


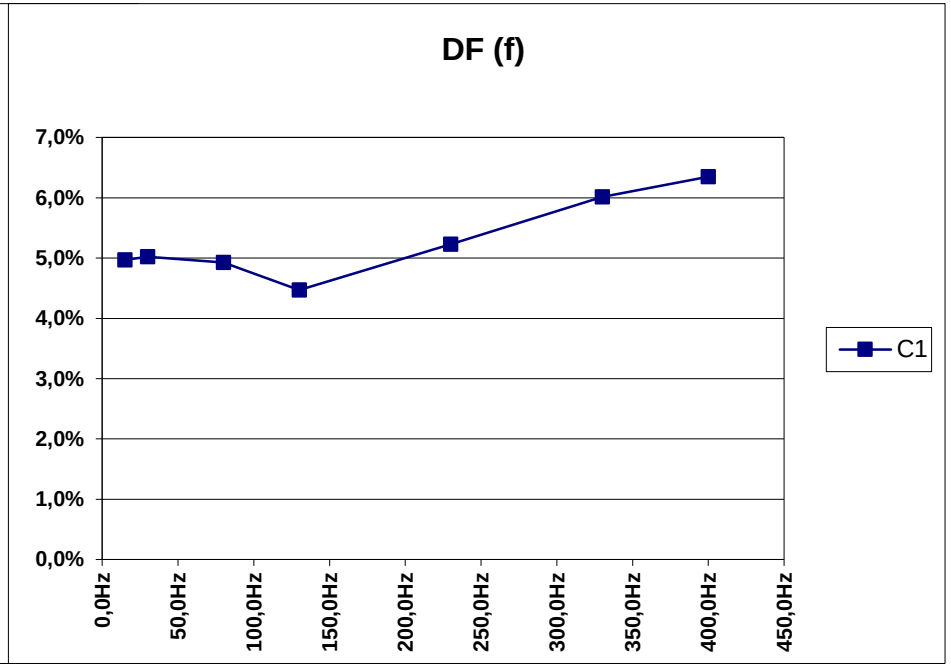

**Capacitance and Tan Delta at U=10kV und f=50Hz**
**GST Measurement to flange with mounted measurement cap, measurement tap shorted**

| U test* [V] | I test [A] | C [F] | Tan Delta [%] measured |
|---|---|---|---|
| 10000,00 | 2,13E-03 | 6,784E-10 | 4,0387 |



# Capacitance and Tan Delta Measurement of C1



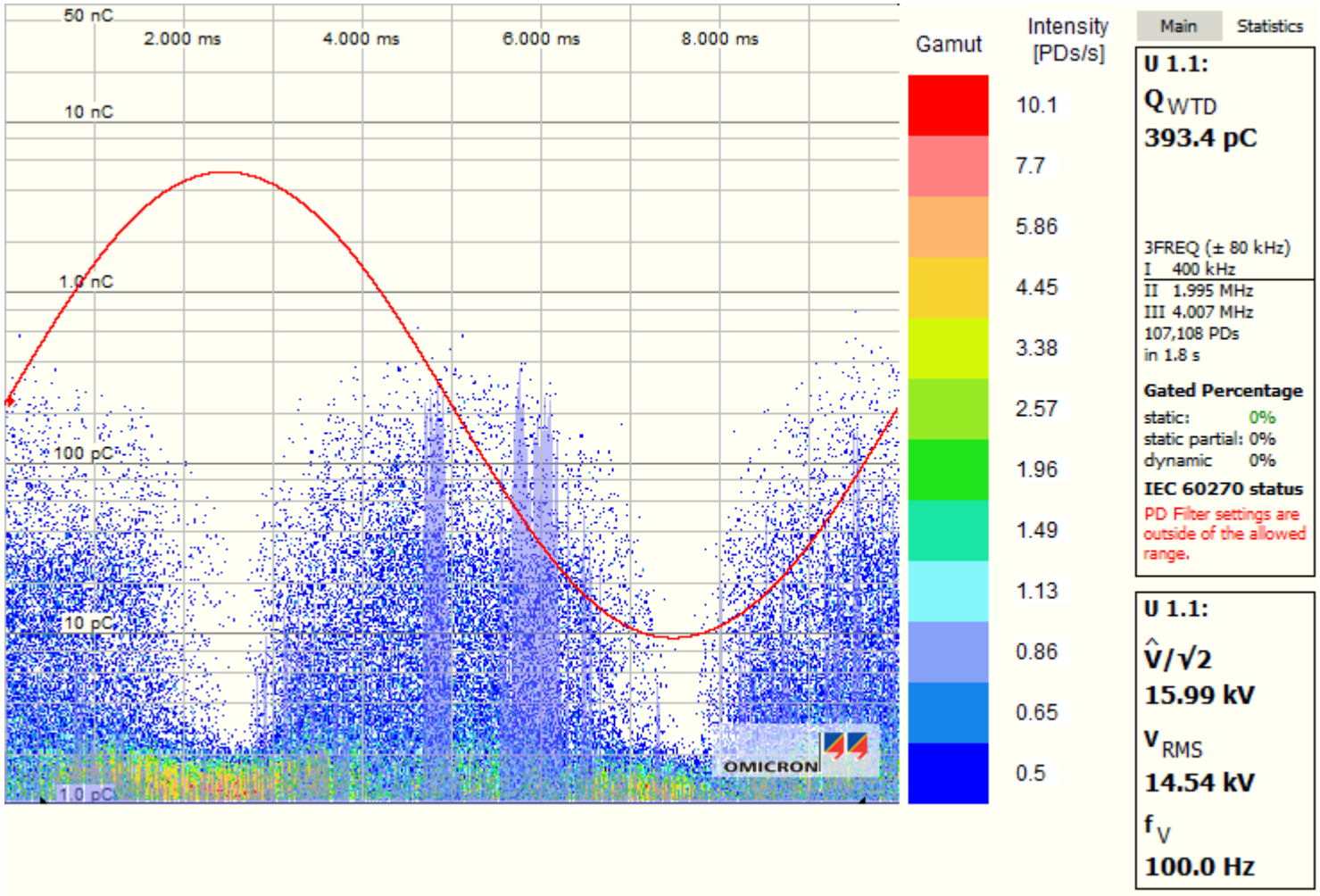



# Insulation Resistance

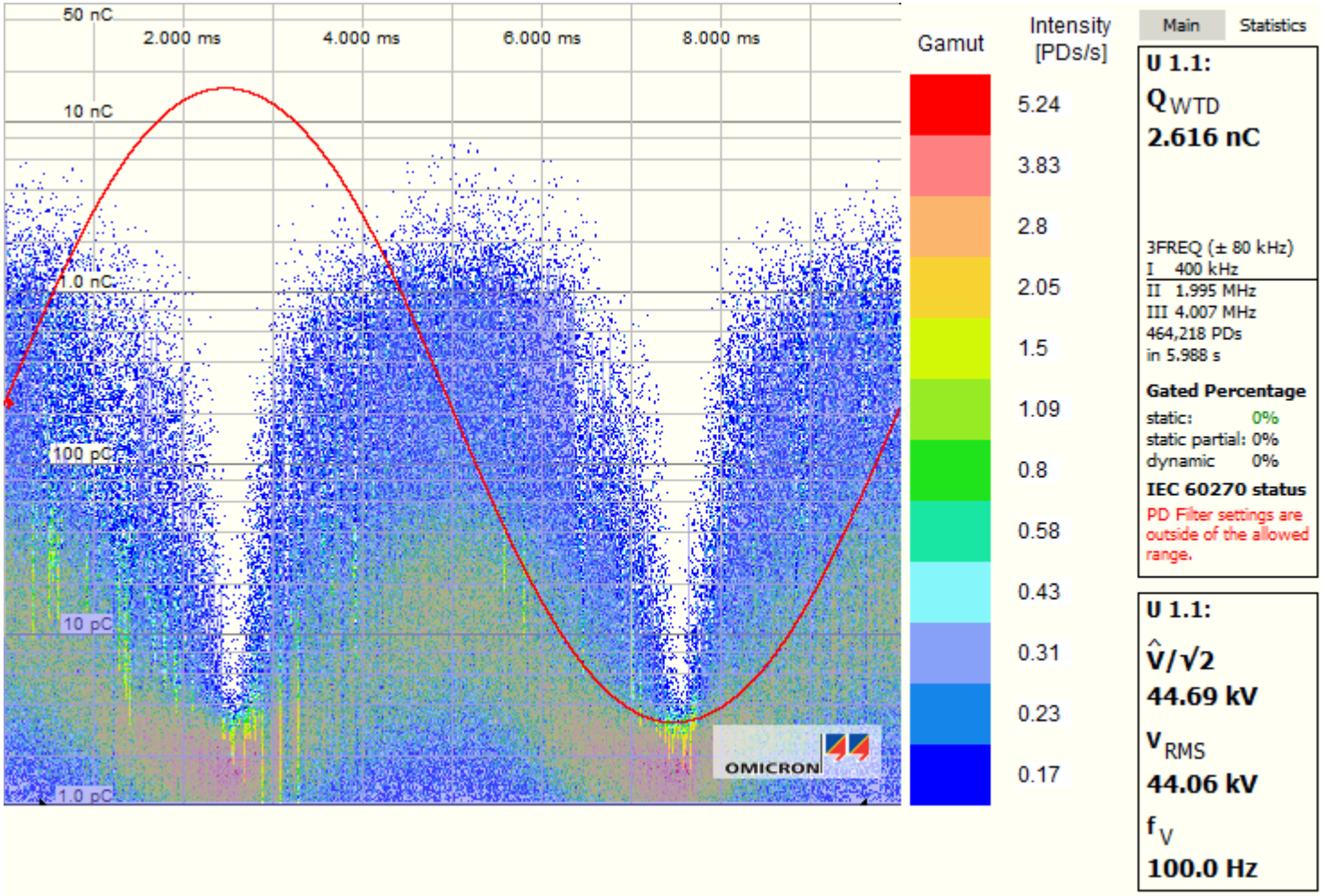
## of the Measuring Tap to Flange

# PD Measurement

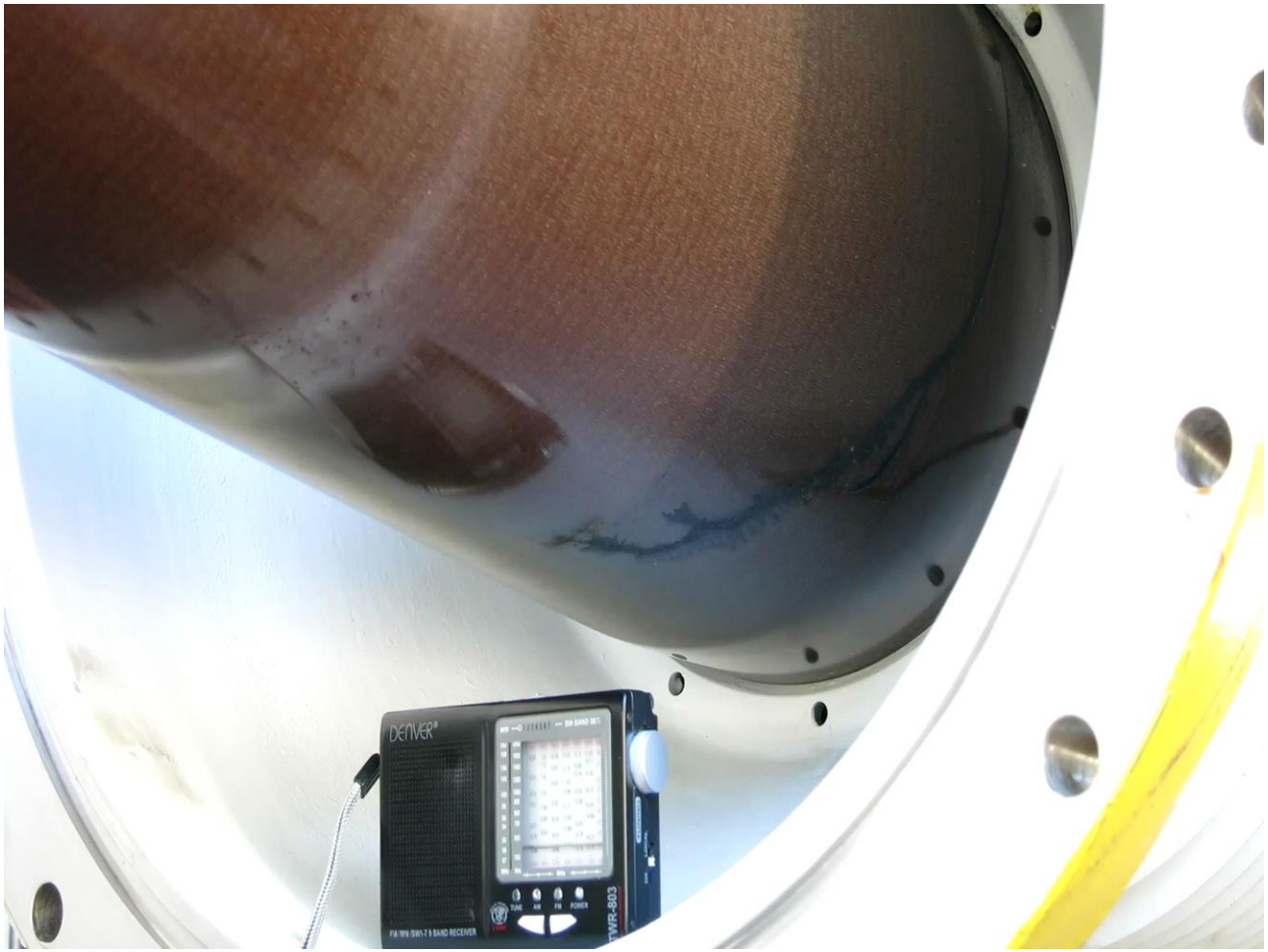
# PD Inception Voltage below 20kV



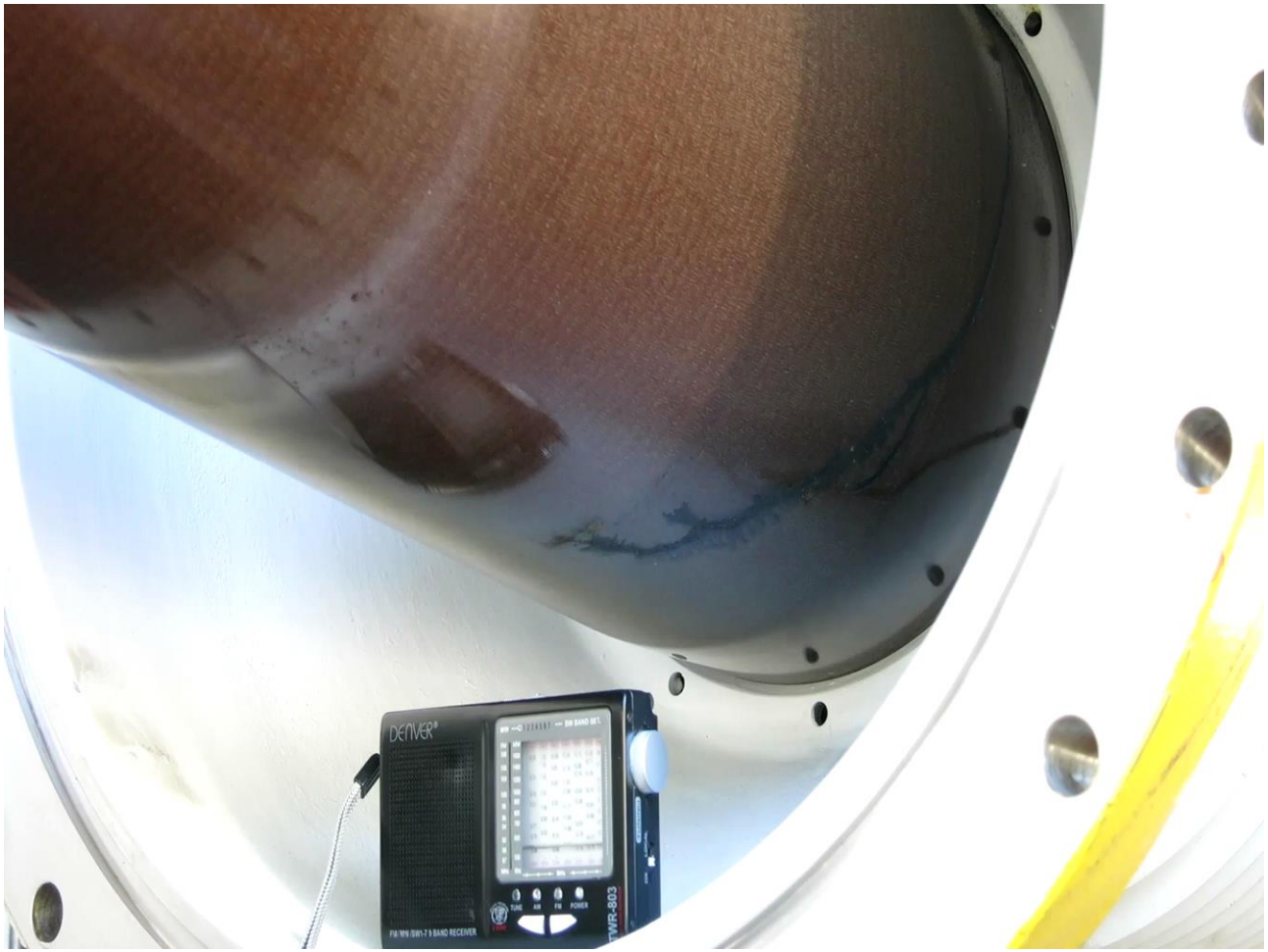
# PD > 2nC at 45 kV



# PD Location



# PD Location



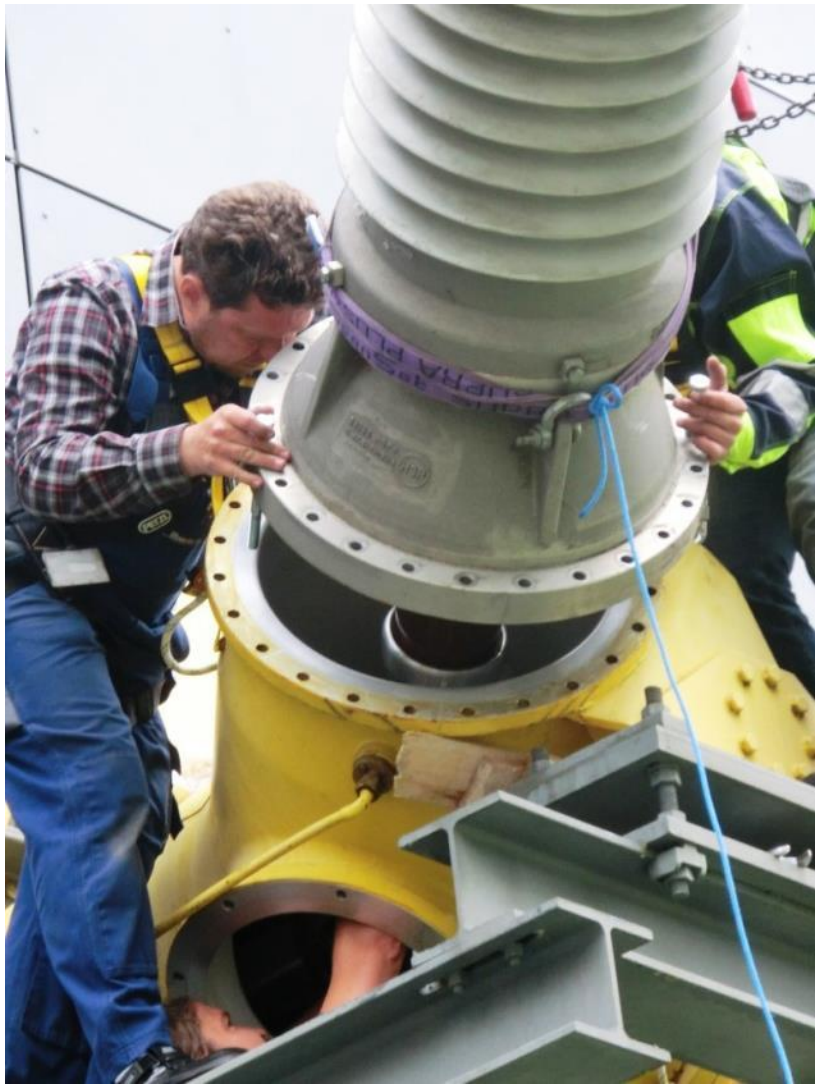
# Measurement Tap

# Measurement Tap

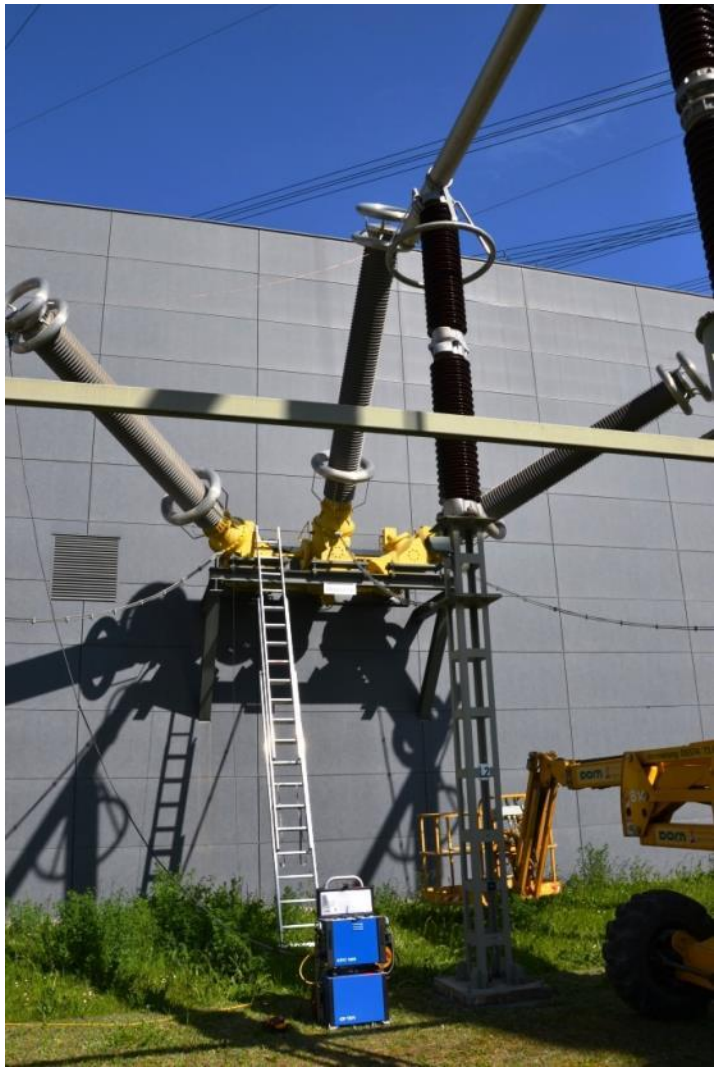
# Cut of the Bushing

# Burned Contact Spring

# Mounting of the Spare Bushing

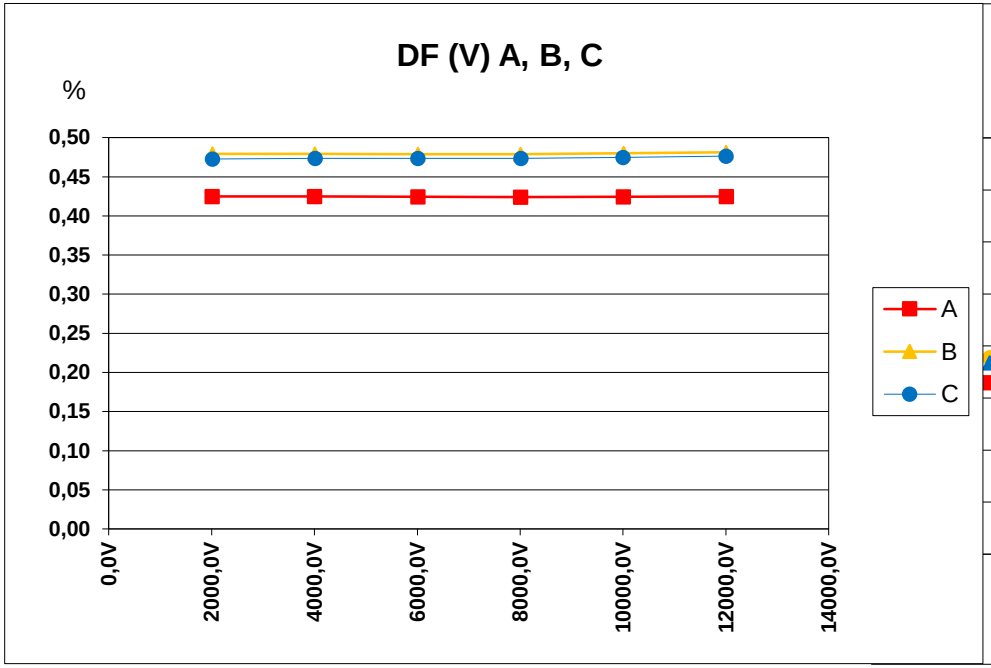


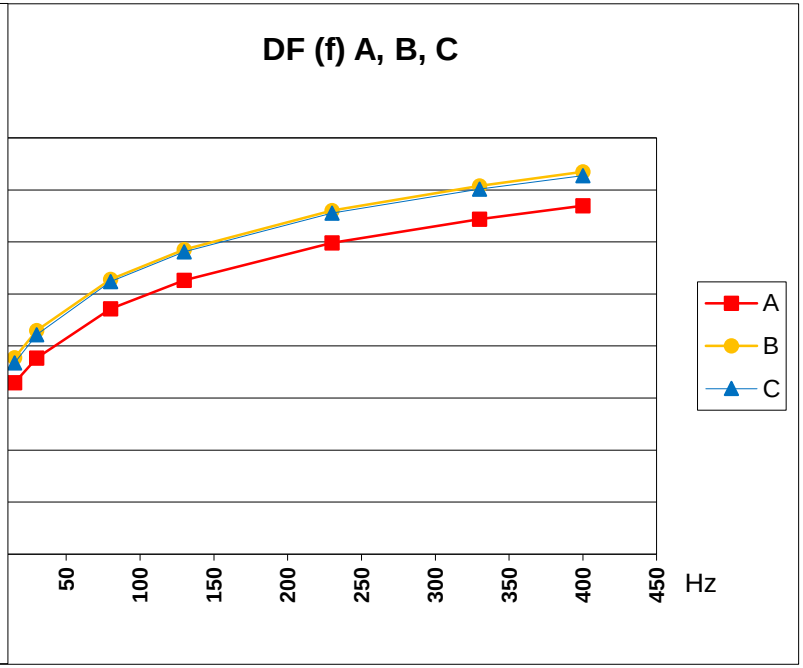
# Capacitance and Tan Delta Measurement
## of all Bushings



# Results of Capacitance and Tan Delta Measurements

| C [F] | DF [%] |
|---|---|
| 5,001E-10 | 0,4244 |
| 5,043E-10 | 0,4801 |
| 5,032E-10 | 0,4746 |



michael.krueger@omicron.at

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